2015 Summer Intern Poster Session and Abstracts

NASA Goddard Space Flight Center

Greenbelt, MD, USA
July 30, 2015

Director, Office of Education, Goddard Space Flight Center
Dr. Robert Gabrys

Deputy Director, Office of Education, Goddard Space Flight Center
Dean A. Kern

Acting Lead, Internships, Fellowships, and Scholarships, Goddard Space Flight Center
Mablelene Burrell

Prepared by
USRA

Republication of an article or portions thereof (e.g., extensive excerpts, figures, tables, etc.) in original form or in translation, as well as other types of reuse (e.g., in course packs) require formal permission from the Office of Education at NASA Goddard Space Flight Center.
Preface

NASA Education internships provide unique NASA-related research and operational experiences for high school, undergraduate, and graduate students. These internships immerse participants with career professionals emphasizing mentor-directed, degree-related, and real NASA-mission work tasks. During the internship experience, participants engage in scientific or engineering research, technology development, and operations activities.

As part of the internship enrichment activities offered by Goddard’s Office of Education, the Greenbelt Campus hosts its annual all-intern Summer Poster Session. Here, interns from Business, Science, Computer Science, Information Technology, and Engineering and Functional Services domains showcase their completed work and research to the entire internal Goddard community and visiting guests. On July 30, 2015, more than 375 interns presented their work at Greenbelt while having the opportunity to receive feedback from scientists and engineers alike. It is this interaction with Center-wide technical experts that contributes significantly to the interns’ professional development and represents a culminating highlight of their quality experience at NASA.

NASA’s internships reach out to students not just from the Maryland area but also worldwide. This year, approximately 64 percent of the interns participating in the poster session were from out-of-state, while approximately 36 percent live permanently in Maryland. While NASA internships are available to students with a wide variety of majors, predominately NASA-related STEM fields, individual internship opportunities target specific disciplines. Engineering and Science were the two domains with most participants in the poster session, with 43 percent for Engineering and 41 percent for Science.

Goddard Space Flight Center’s Office of Education acknowledges the outstanding potential assembled at the poster session each year, where great ideas are presented to the NASA public. It is our goal to make all this information accessible. Hence, we are releasing a compilation of the contributions submitted and presented by the interns during the poster session and in individual presentations. A total of 260 abstracts from the summer 2015 Goddard Internship Program are now accessible, on a limited basis, for research and educational purposes.

Producing the 2015 Summer Intern Poster Session Proceedings required the dedicated effort of many individuals. In particular, the quality of this publication depends on the commitment of the many mentors who took time from their busy schedules to review and edit papers. We thank you all for your support! It is very much appreciated.

Last but not least, this compilation of abstracts directly reflects the work of our interns. Without your hard work and dedication, neither the Poster Session nor this publication would be possible. We thank you for preparing your presentations and papers, and for showing the professionalism and enthusiasm that makes the Summer Poster Session such a great intellectually stimulating event time after time!
# Table of Contents

**Business**

- Reimbursable Agreements .................................................................................................................. 2

**Computer Science/IT**

- Web Services for Property and Software Tracking (PaST) ................................................................. 4
- RSA Token Reconciliation Project ....................................................................................................... 5
- Development for GMSEC Services Suite (GSS) .................................................................................... 6
- Development for GMSEC Services Suite (GSS) and Messaging Interface Standardization Toolkit (MIST) ................................................................................................................................. 7
- Data Extraction Utility for JPSS ........................................................................................................... 8
- IMAGESEER – Lunar Data Pre-Processing ............................................................................................ 9
- Open Source Data Management ......................................................................................................... 10
- Common Mission Security Services ................................................................................................ 11
- Hardware Components Database ...................................................................................................... 12
- Global Climate Simulation ...................................................................................................................... 13
- Enterprise Monitoring Solutions ......................................................................................................... 14
- An iOS Application for iSWA ............................................................................................................. 15
- Data Access Toolkit (DAT) Gridx and Mnemonic Archive Data (MAD) Files ........................................ 16
- Flight Software for Distributed Spacecraft Mission Communication .................................................. 17
- Visualizing Satellite Data – Worldview User Interface Improvements ................................................ 18
- Implementing Automated Security Monitoring Using OpenSCAP .................................................... 19
- Flood Dashboard Capabilities Enhancement .......................................................................................... 20
- GEOS-5 Interactive Mobile Application ................................................................................................. 21
- Designing a Virtual Assistant for Systems Engineers .......................................................................... 22
- Web-Based Monitor for the Simple, Scalable, Script-Based Science Processing System ........................ 23
- NICER X-Ray Mission Development: Enhancing the Precision of the NICER Clock ............................ 24
- Developing an Application for CFS-CFE and Rhapsody UML2.0 ....................................................... 25
- Geo-Electric Field Calculator Tool .................................................................................................... 26
- NEN Live ............................................................................................................................................... 27
- Evolving Middleware Support for Goddard Mission Services Evolution Center (GMSEC) Application Programming Interface (API) .................................................................................................................. 28
- EOS Zenoss Problem Resolution ........................................................................................................ 29
- Development of Heater Control Application for the Core Flight System ............................................. 30
- Software Architecture Based on UML Diagrams .................................................................................. 31
- Content and Log Analysis Using MySQL and Graylog .......................................................................... 32
- Shearlet Features for Remotely Sensed Image Registration .................................................................. 33
Microfabrication of MEMS Devices .............................................................................................................. 70
3D Printed Model of the WFIRST Observatory using Additive Manufacturing Techniques .......... 71
Installation and Removal Techniques of Surface Mount Electronic Components Using Infrared Heating Equipment ................................................................................................................................. 72
Design of Edge-Trimming Machine for Light-Weighted Monocrystalline Silicon Optical Structures .. 73
JPSS Flight Project Training Database ............................................................................................................. 74
Mechanical Support and Testing Structures for Optical Systems on BETTI1I ............................................ 75
Metal Whiskers ............................................................................................................................................. 76
Development of Image Analysis Routines for WFIRST Detector Characterization ..................... 77
Thermal Coating Processing Improvements with the Use of O2 Plasma ......................................................... 78
GPS III Space Service Volume Specifications Study .................................................................................. 79
Alignment and System Testing for OTS for LCRD ....................................................................................... 80
Alternative Wick Structure Testing for Loop Heat Pipes ................................................................................ 81
Underwater Wireless Optical Communications .......................................................................................... 82
Absolute Position Sensor Development ...................................................................................................... 83
Long-Duration, Low-Gravity Sloshing Experiment ..................................................................................... 84
Integration of Flight Software with 42 to Enable CubeSat Hardware-in-the-Loop Testing ................. 85
Space Communications and Navigation Network Integration Project Cesium Access Planning Environment ................................................................................................................................................................. 86
Tracking and Data Relay Satellite Systems Waveform and Noise Generator Design ..................... 87
Advanced Energetic Pair Telescope Instrument Structure Design .................................................................. 88
The Effects of the Biophysical Microenvironment on Human Mesenchymal Stem Cell Behavior during Simulated Microgravity ........................................................................................................ 89
Development of Circuit Simulations and Control Algorithms for Critical Flight Test Hardware .... 90
Silicon Mirror Grinding Equipment ............................................................................................................... 91
Balloon Experimental Twin Telescope for Infrared Interferometry (BETTI1I) .............................................. 92
Temperature and Flow Rate Sensor Fabrication ......................................................................................... 93
Precision Eddy Current Displacement Sensor .............................................................................................. 94
Visual Inspection and Use of Satellite NO2 Observations ........................................................................ 95
Portal-Based Interplanetary Communications Modeling ............................................................................ 96
Building Energy Efficiency .......................................................................................................................... 97
Two-Phase Microgap Cooling for Next Generation Electronic Systems ............................................... 98
PiSat 2.0, Flight Software Systems Testbed ................................................................................................. 99
Graphene Based Chemical Sensors for Space Applications ..................................................................... 100
Optical Navigation Methods for OSIRIS-REx Mission .......................................................................... 101
Low-Cost Reaction Wheel System for Use in CubeSats .......................................................................... 102
Reflow Soldering and Silver Leaching on ICESat-2 Silver-Palladium Electrical Terminations .......... 103
Actuator Sizing for Reconfigurable Operational Spacecraft for Science and Exploration (ROSE) ............. 138
Systems Engineering .......................................................................................................................... 139
Next Generation Tracking and Data Relay Satellite Concept Study ............................................. 140
Next Generation Attitude Control Technology ............................................................................... 141
Creating a Cubesat Design Tool and Developing Cubesat Thermal Louvers ................................. 142
Comparison of Dynamics Models for Spacecraft Attitude Filters via Monte Carlo Analysis ............. 143
Designing and Modeling for the NICER Project .......................................................................... 144
FPGA Co-Processing to Accelerate Processing of Hyperspectral Images ..................................... 145
Modifying the Automated Safe-To-Mate (ASTM) Tester ................................................................. 146
JPSS Simulation Control Development Project .............................................................................. 147
CubeSat Design Approach at Goddard Space Flight Center ............................................................. 148
Development of a System for Extended Depth of Field Imaging ................................................... 149
Comet Sample and Return Projectile Launcher Calibration and Design ........................................... 150
Test Setup for the WFIRST GRISM Spectrograph ....................................................................... 151
Transmission Performance of WFIRST’s Optical Filters from the Visible to Infrared ..................... 152
Design of a Tunable ND:YVO4 Self-Raman Laser for Sodium Lidar ............................................... 153

GSFC Functional Services ............................................................................................................ 154
Going Native: The Reform of Landscaping at Goddard ................................................................. 155
Cost Tickets and Analysis (FY2014 & FY2015) ............................................................................ 156
Career Path for GSFC ..................................................................................................................... 157
Hubble Exhibit Video Editing Project ............................................................................................. 158
The Backfill Project ......................................................................................................................... 159
Hazardous Waste at NASA Goddard Space Flight Center ............................................................. 160

Science ........................................................................................................................................... 161
Radio Frequency Interference: A Comparison of SMAP and Aquarius Methods and Techniques ... 162
An Analysis of Eta Carinae’s Background X-ray Emission ............................................................... 163
Mapping the Latitude Dependence of the Primary Stellar Wind of eta Carinae Using the Spectrum Reflected on the Homunculus Nebula ................................................................. 164
Simulating Infrared Transmission through Porous Dielectric Foam ............................................... 165
Supercomputing Sub-Meter Satellite Stereo Data for the Forest-Tundra Ecotone ......................... 166
Deep Blue Website Project .............................................................................................................. 167
Space Weather Forecasting and Research ....................................................................................... 168
Clumpy Regions in the UV HUDF at 0.5 ≤ z ≤ 1.5 ..................................................................... 169
Variability of the Terrestrial Ionosphere ....................................................................................... 170
Science Writing for Earthzine ......................................................................................................... 171
Extended Gamma Ray Emission from SNR G150.3+4.5 ................................................................ 172
Martian Crustal Magnetic Field with MAVEN ................................................................. 204
Neutral Atom Flux Simulation of the Earth's Ring Current ........................................... 205
Tracing the Galactic Center using Bremsstrahlung, Synchrotron, and Thermal Emissions ........... 206
Integrating FLUXNET and EO-1 Hyperion Reflectance Data for Use in Remote Sensing of Vegetation
Carbon Flux Dynamics ..................................................................................................... 207
Comparisons of Multi-Scale Remote Sensed Data .......................................................... 208
JPSS Data Product Quality .............................................................................................. 209
Alignment of a Prototype Telescope for Scattered Light Measurements and Analysis ................ 210
Space Weather Forecasting: Impacts at Mars ................................................................. 211
Preliminary Results of Ar Diffusion through Silicate Glasses .......................................... 212
DREAM2: Using Apollo Data to Characterize the Lunar Environment .............................. 213
The Formation of Fluvial Channels on Alba Mons, Mars ............................................... 214
The Environmental Effects on Star Formation in Galaxies ................................................. 215
Developing an Effective Geospatial Data System in Support of the ABoVE Project ........................ 216
Characterizing Alien Worlds: Ground-based Transit Spectroscopy of GJ1214b with VLT-KMOS .... 217
Modularized Software Control for the RIMAS Instrument ................................................ 218
Levels of Lead Fume Exposure in Soldering Labs ............................................................ 219
Auroral Occurrence In and Out of Solar Maximum .......................................................... 220
Development of a Telescope System for VHE Astronomy ............................................... 221
Exploring the Negative Feedback of Vegetation to Greenhouse Gas Warming ...................... 222
Data Restoration and Analysis of Daytime Lunar Mass Spectra of the Lunar Atmosphere Composition
Experiment (LACE) ........................................................................................................... 223
Analysis of Volcanic Deposits on Venus Using Radar Polarimetry ..................................... 224
Water Abundance in the Stratospheres of Saturn and Titan based on CIRS ........................ 225
Mariner 2 Magnetometer Data .......................................................................................... 226
Space Weather Forecasting and High Speed Streams ....................................................... 227
Tropical Cyclone Evolution and Water and Energy Fluxes: A Hurricane Katrina Case Study .... 228
Cryogenic Thermometry for RIMAS ................................................................................. 229
Synthetic Multiband Photometry in the Early Detection of Type 1a Supernovae for the WFIRST .... 230
Association of Short Gamma-Ray Bursts with Galaxy Clusters ........................................... 231
Refining the Wheel: Analysis of Solar Cycle Prediction Precursor Technique .................... 232
Testing a New Model of Gamma-Ray Burst Prompt Emission ............................................ 233
Comparison of Satellite-derived Fire Emissions Results with Airborne Measurements of Smoke
Constituents ...................................................................................................................... 234
Developing a Test Stand for Lifetime Measurements Using a Narrow Gap Detector ............. 235
Possible Magnetic Reconnection Events Observed Near Earth by Multiple Satellites ............ 236
Analyzing Emissions from Blazar B2013+370 and Pulsar Wind Nebula VER J2016+371 .......... 237
Characterization of the Performance/Lifetime of Next Generation X-Ray Polarimeter Prototype... 238
Laser Heterodyne Radiometer-CubeSat........................................................................................................ 239
A Solar Hiccup: Analysis of an “Almost” Coronal Hole ........................................................................... 240
Lifetime Measurements of Narrow Gap X-ray Polarimeter ........................................................................ 241
Improving STEM Education in the Classroom: NASA Goddard’s Summer Watershed Institute....... 242
Thermal Coatings Qualification and Development .................................................................................... 243
Calibrating Mercury Laser Altimeter Data Using Stereo Image-Based Digital Elevation Models ...... 244
BETTII – Internship........................................................................................................................................ 245
A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters ................................................... 246
Sodium in the Lunar Exosphere .................................................................................................................. 247
Hot Flow Anomalies at Earth's Bow Shock and Their Ground Signatures ............................................. 248
Correcting Inaccurate WISE1 Magnitudes for Disk Detective ................................................................. 249
Investigation of the Use of the Aquarius Scatterometer Data in Polar Regions .................................. 250
Optimization and Testing of Coastline ID for GOES-R GLM................................................................. 251
A Survey of Cryovolcanically Emplaced Domes on Europa .................................................................... 252
Engaging the Aurorasaurus Citizen Science Project: Multi-tasking Across Multiple Disciplines...... 253
Detection Levels of the Exoplanet HAT-P-11b Secondary Transit........................................................... 254
Design and Optimization of an Electric Field Cage for AdEPT .............................................................. 255
The Infrared Spectra and Stability of Icy Extraterrestrial Molecules ......................................................... 256
Characterization of MLA, GLAS, Rubidium and Cesium Clocks ............................................................. 257
Development for WFIRST and CLASS...................................................................................................... 258
Solar Wind Hydrogen Implantation and Diffusion from Regolith of the Mood and Asteroids.......... 259
States of Black Hole and Neutron Star Binaries with MAXI................................................................. 260
Determining Landslide-related Relationships Using the Global Landslide Catalog .......................... 261
LDI-MS Analysis of Martian Soil Analogues .............................................................................................. 262
Satellite Observations of the Antarctic Ice Shelves ................................................................................ 263
MEMS Sensor Fabrication and Testing ...................................................................................................... 265
Life on Mars: Extremophilic Bacteria in a Simulated Martian Environment ....................................... 266
WFIRST Mockup Design ......................................................................................................................... 267
Tribal Colleges and University Archiving Project .................................................................................... 268

Appendix A: Interns ........................................................................................................................................ 269
Appendix B: Mentors ................................................................................................................................... 298
Business
This summer I was an intern for financial services. Every year Goddard Space Flight Center is audited. The auditors examine the Reimbursable Department’s files and processes. We have a full step-by-step process that is completed to create and close out an agreement. This step-by-step list of tasks gives us a constant method to follow and an audit trail for auditors to follow along with. I supported the reimbursable closeout activities. I was responsible for closing out a list of reimbursable agreements. From beginning to end, I checked off the tasks on the list as each was completed. My job was to complete the close out process checklist in order to reconcile and validate all of the agreements were eligible for close out. I had to go through each agreement I was assigned and verify that what was stored on the computer matched the documents in the physical folders. If anything didn’t balance I had to then contact my mentor and make adjustments. I used different applications such as SAP (Services Application and Products), BOB-J (Business Objects), and MdM (Metadata Manager) to assist me in completing the checklists. As I went through each agreement, I made notes of each agreement when the computer folder and physical folder did not balance or equal out. I found that most of the agreements were equal in the physical and electronic folders. This meant that I could then close each of them out.
Computer Science/IT
Web Services for Property and Software Tracking (PaST)

Denzel Ketter¹, Malinda Hammond²
¹University of Maryland, Baltimore, MD, USA
²The Computing Environments and Collaborative Technologies Branch, NASA Goddard Space Flight Center, Mail Code 585, Greenbelt, MD, USA

The goal of this project aims at utilizing libraries of tools, which will implement a web service that can perform user lookups to help determine the roles and organizations of the user logged in to the PaST application, as well as other applications developed in Code 585. This project will also improve of the PaST application by implementing an import feature for N-PROP data. N-PROP is a property management system for NASA employees that feature online transaction initiations from property holders within a user-controlled database. The new web service, and PaST, will enable System Administrators to perform easier, more accurate searches of all of hardware and software equipment that is associated with NASA employees of various roles within their division. It is an efficient upgrade of the existing PaST application, N-PROP, and could significantly improve over time.

In order to optimize the use of these languages and its respective libraries, we are using integrated development environments (IDES) and text editors, such as the Continuum Analytics Anaconda distribution, Sublime Text 2, WinSCP, and Notepad++. The Anaconda distribution assists with handling all errors in the code before deployment. Sublime Text 2 enables the ability to review and make consistent changes to all files containing code for the project. WinSCP is used as a client that synchronizes all changes to project files, which are transported from the locally to the server. Notepad++ is a tool that handles logistics, using markup language, in the interest of evaluating steady progress throughout the project.
RSA Token Reconciliation Project

Virginia Schwartz\(^1\), Katie Poole\(^2\)

\(^1\)University of Baltimore, Baltimore, MD, USA
\(^2\)Communications and Security Services Division (CSSD), NASA Goddard Space Flight Center, Mail Code 760, Greenbelt, MD, USA

There are wide variations in the way government facilities secure and control user’s access levels based on different criteria necessary to perform their job responsibilities. At NASA/Goddard Space Flight Center (GSFC) and Wallops Flight Facility (WFF), there is a two-factor identification process in place that provides the necessary security to obtain certain access levels by using a remote service application (RSA) token. The RSA token reconciliation project has generated an appendix of applications that require tokens. The spreadsheets and reports on applications or projects that require RSA tokens have been reconciled and are deemed accurate. As the token collection process is implemented in late FY2015, it is necessary for anyone that does not need a token to return it. Token collection points and times available for returns have been issued and communicated throughout GSFC in a center-wide bulletin. Over the years, the token usage has grown and is currently over 8,100 for the GSFC facility. In 2004, Homeland Security Presidential Directive 12 (HSPD-12) was issued to reduce token usage and implement a standard practice for security access. This was accomplished through the issuance of Personal Identity Verification (PIV) smartcards to all civil servants and contractors. In an effort to reduce GSFC’s RSA token footprint and to support this directive, all employees that no longer require the RSA token should return it to the Communications and Security Services Division (CSSD). Collection points and times have been established for both Greenbelt and Wallops. It is the goal of this project to reduce token usage by 40% by the beginning of FY2016. There are, however, some applications or projects that will still require the use of the tokens and are exempt from complying with this directive. All RSA tokens expire in FY2017 and it is the intent of this initiative to ensure GSFC is more secure, efficient, effective and in compliance with the Presidential Directive (HSPD-12). In January 2016, beta testing of a soft token, which is an application on a smart phone will start at Goddard. Once GSFC has completed successful testing, users will be able to begin using the soft token which will further help reduce the footprint. This is not only a fiscally responsible agenda but one that affects the security of the Agency. With the recent breaches and the threats to proprietary intelligence, it is necessary to standardize the access to security levels with the PIV card and reduce the amount of overall tokens. The RSA project addresses and provides solutions for reduction of the RSA token footprint at GSFC.
Development for GMSEC Services Suite (GSS)

Alan Birchler De Allende¹, Barbara Milner²

¹Virginia Polytechnic Institute and State University, Blacksburg, VA, USA
²Ground Software Systems Branch, NASA Goddard Space Flight Center, Mail Code 583, Greenbelt, MD, USA

The GMSEC Services Suite (GSS) is a new GMSEC development concept that will enable the user to configure and access GMSEC via the web. In order to help develop this new aspect, my task is first to convert all of GMSEC’s documentation files into Tiddly Wiki pages in order for them to be accessible via GSS. My second task is to design and implement a GMSEC application (Simple Mail Transfer Protocol - SMTP service) that can receive request messages from the GMSEC middleware bus and then send an alert email to the administrator. In order to complete the GSS SMTP service task, I will design, implement, test (both unit and integration), document, and ultimately package and release the final product.
Development for GMSEC Services Suite (GSS) and Messaging Interface Standardization Toolkit (MIST)

Ashley Cheng¹, Barbara Milner²

¹University of Maryland, College Park, College of Computer, Mathematical, and Natural Sciences, College Park, MD, USA
²Ground Software Systems Branch, NASA Goddard Space Flight Center, Mail Code 583, Greenbelt, MD, USA

The Goddard Mission Services Evolution Center (GMSEC) aims to simplify development, integration, and testing. One task was to integrate GMSEC documents into GSS WebAdmin using TiddlyWiki. This new feature allows users to more easily view GMSEC documents via the web. Another task was to create a GMSEC component that provides a set of functions which allow users to more quickly generate standardized and GMSEC Interface Specification Document compliant messages than is possible with the base API Connection. This new program created and initialized a new MIST Connection Manager, started the Connection Manager’s heartbeat service, and produced a set of valid and invalid messages. These new components contribute to the GMSEC mission by improving usability and simplifying development.
Data Extraction Utility for JPSS

Andrew Huber\textsuperscript{1}, William Thomas\textsuperscript{2}

\textsuperscript{1}University of Maryland Baltimore County, Computer Science and Electrical Engineering, Baltimore, MD, USA
\textsuperscript{2}JPSS Ground Project, NASA Goddard Space Flight Center, Mail Code 474, Greenbelt, MD, USA

Data from the (Suomi NPP) S-NPP and JPSS (Joint Polar Satellite System) satellites flow through a system called GRAVITE. When JPSS-1 launches, twice the amount of data will flow through the system. In order to analyze this data quickly—whether it be for weather prediction, research, or better optimization of the instruments on-board S-NPP and JPSS—we need to improve preexisting software in order to accommodate this increase in data flow and have the data processed and analyzed in a timely fashion. One of the areas of greatest concern is the ability to count and categorize the pixels that make up S-NPP/JPSS images. With the script that is currently in place, it takes 10 seconds to analyze a single file; with the new script, it takes less than two. With this added performance, we will be able to analyze greater volumes of data in a shorter time frame (e.g., instead of taking 20 hours, it now takes four). With this improved performance, we can detect deviations from trends, determine whether the satellite and ground systems are working as intended, and perform additional analyses.
IMAGESEER – Lunar Data Pre-Processing

Arthur He¹, Justin Ku², Michael Walker³, Jacqueline Le Moigne⁴
¹Thomas Jefferson High School for Science and Technology, Alexandria, VA, USA
²University of Southern California, University Park Campus, Los Angeles, CA, USA
³Marriotts Ridge High School, Marriottsville, MD, USA
⁴Software Engineering Division, NASA Goddard Space Flight Center, Mail Code 580, Greenbelt, MD, USA

IMAGESEER (IMAGEs for Education, Experimentation, and Research) is a growing website that offers users downloadable image data for the practice of image processing (IP) techniques. The current website only includes earth science data from the EO-1, Landsat 4-5, and Landsat 7 missions. The intern team this summer was tasked with expanding the website to include lunar data around Apollo landing sites from the LRO, Chandrayaan 1, and Clementine missions. Data from these missions were converted into commonly accepted IP formats (tiff and raw) and used for comparison with ground truth from the Apollo missions. In addition to the dataset expansion, the intern team added to the Imagepedia section of the IMAGESEER website. Imagepedia is an educational resource that includes brief tutorials and explanations of IP-related techniques. This function of the IMAGESEER website became a way for the intern team to document their progress.
The GRAVITE system currently stores and distributes nearly 5TB of data per day from the Suomi National Polar-orbiting Partnership (NPP) spacecraft. The follow up to this mission is the Joint Polar Satellite System (JPSS), and with the launch of the JPSS-1 spacecraft, data ingestion into the GRAVITE system will double to 10TB of data per day. With the increase in data comes more demand on the storage and distribution servers; by leveraging open source big data technologies such as Apache Hadoop and GlusterFS, the extra demand on the GRAVITE system may be reduced. A test server running Red Hat Enterprise Linux was set up to benchmark and demonstrate if the abilities of Hadoop and Gluster could help alleviate some of the demand for this data. This experimentation will produce further insight into more efficiently processing the increasing environmental data collected, allowing more accurate predictions of severe weather and study of our climate.
Common Mission Security Services

Ciara Lynton¹, Brennan Hay²

¹Morgan State University, Clarence M. Mitchell, Jr. School of Engineering, Baltimore, MD, USA
²Information Technology and Communications Directorate, NASA Goddard Space Flight Center, Mail Code 700, Greenbelt, MD, USA

NASA executes the vision, “To reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind” through missions that are typically independently organized. This independence creates sub-optimization whereby missions meet their own needs at the cost of overall optimization. In an evolving environment, increasingly vulnerable to security breaches, it is important to have a solid security infrastructure. While this infrastructure may exist in individual missions, it does not exist for consumption by new missions. NASA is spending significant funds on mission-specific security due to the absence of a standard mission security system. We will change that. The purpose of my summer internship here at Goddard Space Flight Center is to do research supporting the development of the Common Mission Security Services concept. Reinventing new security capabilities for each mission is not cost-effective and NASA would greatly benefit from automating and standardizing security capabilities across each mission. My goal is to perform research into automated tools for security configuration management for the Common Mission Security Services concept. The configuration management tools I will be researching include Puppet, Chef, Ansible, SaltStack, CF Engine and Fabric. Upon completion of this research, I will provide NASA Goddard with a more informed view into which configuration management tools best fit the Common Mission Security Services concept.
Hardware Components Database

Callan Cramer¹, Elizabeth Timmons²

¹Langley High School, McLean, VA, USA
²Science Data Processing Branch, NASA Goddard Space Flight Center, Mail Code 587, Greenbelt, MD, USA

The Science Data Processing Branch uses hundreds of hardware components but there is no single location that contains information about all of these parts. The purpose of this internship was to create a database containing that information in one location with a web interface. The web interface was designed to allow people with no knowledge of MySQL to be able to use the database. The database also contained additional features such as alerts when stock decreased below the desired level as well as specification of the devices in which each component was used and which components would work interchangeably. The database was created using MySQL and the web interface functionality was primarily created in PHP with some elements of JavaScript and CSS. This database is now functional and will aid the Science Data Processing Branch in keeping track of stock.
The Global Modeling and Assimilation Office at Goddard created a two-year simulation of the world climate at a very high global resolution. This generates an extremely large amount of data, on the order of 4 Petabytes of data from a resolution of 7k globally. The specific task is to create novel visualizations of large scale climate models using this data, as without an engaging and approachable presentation format, raw data remains useless to general public. The global climate simulation is created in a web-based, 3D interactive format and designed to make this data easy to understand and follow. The base of the visualization is built on the WebGL Globe, an open platform for geographic data visualization; WebGL is a web technology based on OpenGL that brings hardware-accelerated 3D graphics to the browser. The project uses a blend of HTML/CSS, Javascript (THREE.js API), and IDL ultimately to create the final product. By generating many images of the climate data and compressing them into a WEBM video format, it is possible to create a continually progressing view and timeline of weather data on the interactive globe. Transforming the climate data from its native format into a powerful visualization and aesthetically appealing interface allows the information to be more accessible and meaningful to the world.
Enterprise Monitoring Solutions

Dakota Peck\textsuperscript{1}, William Truxon\textsuperscript{2}

\textsuperscript{1}Linn-Benton Community College, Albany, OR, USA
\textsuperscript{2}Information Technology and Communications, NASA Goddard Space Flight Center, Mail Code 700, Greenbelt, MD, USA

Consolidated enterprise monitoring allows one-stop insight to network infrastructure, network traffic, application availability, database utilization, and other service performance. This allows for greater knowledge of the inner workings by way of metrics gathering, identification of performance bottlenecks, routine reporting for management, and in-time alerts to service providers when services are interrupted. This also assists in identifying necessary avenues of improvement as well as planning for future growth. Allowing the data center to be proactive to stakeholder needs and allow greater Quality of Service.
An iOS Application for iSWA

David Li Cao¹, Richard Mullinix², Masha Kuznetsova²
¹University of Pennsylvania, College of Engineering, Philadelphia, PA, USA
²Community Coordinated Modeling Center, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

The Integrated Space Weather Analysis (iSWA) system allows forecasters to analyze observational data gathered from various satellites and modeled data in order to monitor and predict space weather and notify robotics missions of possible impacts. Currently, there is a web interface, an Android application, and an iOS application. However, while the iOS application has over 100,000 installs, it has yet to be updated in over five years. Thus, they need to redevelop a new application. The app was developed in Xcode, and used various open source materials through the package manager CocoaPods. New features, such as “History Mode” and graphs were added, as well as a complete redesign. Once the app is released in the Apple Store, forecasters will be able to view and analyze data from their iPhone and/or iPad. Moreover, the app will expose the public to the importance of space weather forecasting.
Data Access Toolkit (DAT) Gridx and Mnemonic Archive Data (MAD) Files

Dexter S. Ballerda¹, LaMont Ruley²
¹Bowie State University, Bowie, MD, USA
²Ground Software Systems Branch, NASA Goddard Space Flight Center, Mail Code 583, Greenbelt, MD, USA

DAT is a multi-satellite data archive, access, trending, and analysis system that supports a variety of NASA missions. It consists of grids that display data such as mnemonic, archive, raw and converted data, etc. The first problem is that these grids do not share the same pattern in terms coding and their characteristics. The solution to this problem is to find a good and efficient pattern so that these grids are easier to maintain. A consistent pattern will make the maintenance of the software less expensive and the grids will be more efficient. In addition, it will also enhance the readability of the code. Moreover, MAD files contain data that are arranged from the telemetry archive. There are numerous problems that are associated with these MAD files, such as: MAD files can be too large, set of MAD files for a mnemonic might contain many tiny MAD files, MAD files can contain duplicate data, MAD files can contain many tiny segments, and MAD files might contain data with bogus timestamps. The solution to these problems are to split large MAD files into two or more smaller MAD files, combine a set of MAD files into a set with fewer but larger MAD files, remove duplicate data, rearrange and merge segments within a MAD file, and remove data with too far into the future timestamps. As a result of these solutions and implementations to the DAT, the software will be more efficient. In addition, the collection of MAD files will also be more optimized and effective in terms of representation and data retrieval.
Flight Software for Distributed Spacecraft Mission Communication

David Kessler¹, Elizabeth Timmons²

¹The University of Texas at Austin, The University of Texas at Austin, Austin, TX, USA
²Science Data Processing Branch, NASA Goddard Space Flight Center, Mail Code 587, Greenbelt, MD, USA

The Software Bus is a key component of the Core Flight Executive (cFE) and is used for inter-application messaging. The Software Bus Network application is an extension of the cFE’s Software Bus that provides messaging services across multiple processors running on a single spacecraft. The SBN supports multiple hardware interface implementations such as Ethernet, Serial Port, SpaceWire, and shared memory on multi-core processors, thus providing a highly flexible system for intra-spacecraft communication. This project is part of an effort to extend the Software Bus Network to support inter-spacecraft communication; allowing flight software communication among multiple spacecraft in a Distributed Spacecraft Mission.
Visualizing Satellite Data – Worldview User Interface Improvements

Edmond Lee¹, Mike McGann², Ryan Boller³
¹University of California – Santa Cruz, Santa Cruz, CA, USA
²Columbus Technologies and Services, Greenbelt, MD, USA
³Science Data Systems Branch, NASA Goddard Space Flight Center, Mail Code 586, Greenbelt, MD, USA

Worldview, a web application developed in JavaScript, interactively visualizes satellite imagery and data from the Terra, Aqua, Aura, GPM, and GCOM-W1 satellites through the Global Imagery Browse Services (GIBS). Since data from these satellites is continuously acquired daily, Worldview allows users to observe, save, and share the satellite data. A wide variety of map layers and overlays are available that may be combined to visualize interesting imagery and observe natural phenomena over time. My tasks are to develop useful features to improve the application and to create new ways to visualize satellite data. The features include the ability to animate and rotate the satellite views, which involve both backend functionality and a frontend user interface. These are important features for end users because animations can more clearly visualize patterns of change among the data, while rotatable polar map views allow more flexibility for scientific applications. I collaborated with my mentors to discuss requirements for the functionality and how the interface should meet user needs. We used the agile development methodology to frequently report our progress and establish what we will work on for two week periods.
Implementing Automated Security Monitoring Using OpenSCAP

Graham Mosley¹, George Rumney², John Jasen²

¹University of Pennsylvania, School of Engineering and Applied Science, Philadelphia, PA, USA
²High Performance Computing, NASA Goddard Space Flight Center, Mail Code 606.2, Greenbelt, MD, USA

In order for NASA High Performance Computing systems to be operational, they must be secure. That security is greatly enhanced using continuous monitoring of Configuration and Control compliance with standardized tools. This internship focused on research of automated security monitoring for use with the NASA Center for Climate Simulation (NCCS). The National Institute of Standards and Technology provides a protocol for automated security testing called SCAP (Security Content Automation Protocol). Since SCAP is just a protocol, a program is needed that implements it. For this project, OpenSCAP, a free open-source implementation maintained by Red Hat was chosen. The OpenSCAP tool was used to evaluate vulnerabilities and configurations of CentOS, SUSE Linux Enterprise Server, and Debian Linux distributions. In addition to testing the OpenSCAP tool, Perl scripts were written to improve automation and tailor it to the needs of the NCCS by integrating it with NAGIOS monitoring using passive service checks. Currently, this project is still in the testing phase. However, early results for RedHat, CentOS and SUSE Linux Enterprise Sever are promising and may be implemented into the NCCS operational environment.
Flood Dashboard Capabilities Enhancement

Jenny Mandl¹, Matt Handy²

¹University of Maryland College Park, James A. Clark School of Engineering, College Park, MD, USA
²Software Engineering Division, NASA Goddard Space Flight Center, Mail Code 619, Greenbelt, MD, USA

In order to improve the capabilities of the Namibia Flood Dashboard, modifications were made to the software that added features, and optimized execution of existing features. The goal of the dashboard is to provide a display that combines both remote sensing data and local sensor data in order to support decision making regarding flood response. The changes made centered around increased usability of the bulletin mailer system, streamlining and efficiency improvements in the river system and general future capability for uploading sensor data.
GEOS-5 Interactive Mobile Application

Joseph Clamp¹, Daniel Duffy²

¹Pennsylvania State University, College of Earth and Mineral Sciences, University Park, PA, USA
²NASA Center for Climate Simulation, NASA Goddard Space Flight Center, Mail Code 606, Greenbelt, MD, USA

The Goddard Earth Observing System Model, Version 5 (GEOS-5) is a system of global models developed by the Global Modeling and Assimilation Office (GMAO) that produces forecasts for weather, climate, and environmental data. This project utilizes the data produced by GEOS-5 to develop an interactive mobile application for visualizing its data output. Currently, there is no mobile application that delivers GEOS-5 data to the public for viewing. With mobile phones continuing to become an integral part of everyday life, it is important to give users the ability to view GEOS-5 data on their phone. The application was built with a back-end Web Mapping Service (WMS) to render the data for each included GEOS-5 output variable. The WMS allows the data to be split up into tiles and sent to the mobile application only when the users' current view includes the bounding box of a given tile. Furthermore, this also allows for the use of OpenLayers, which is a mapping framework like Google Maps, for overlaying the data onto a global map. The front-end of the application was built using the Ionic mobile app framework for easy deployment to iOS and Android devices. Using Ionic, the app was written in JavaScript and HTML. Above all, the mobile application will allow scientists and the public to visualize GEOS-5 forecasts for aerosols, precipitation, atmospheric ozone, temperature, and many others in the palm of their hands.
Designing a Virtual Assistant for Systems Engineers

Jitin Krishnan¹, Trevor Reed², Patrick Coronado³

¹George Mason University, Fairfax, VA, USA
²University of Southern California, Los Angeles, CA, USA
³Direct Readout Laboratory, NASA Goddard Space Flight Center, Mail Code 606.3, Greenbelt MD, USA

Systems Engineer’s Virtual Assistant (SEVA) is designed to assist a Systems Engineer in their daily work environment through intelligent bookkeeping, which will augment their problem-solving abilities. SEVA is a real time and interactive system that collects information by ingesting various types of discipline-specific documents including text, tables, graphs, and keyboard input. It uses natural language processing tools to convert the information into a knowledge base, which is represented as an Ontology. It has the ability to handle information relating to schedule and resources. It is capable of modifying information as well as keeping track of old and new information by time tagging them. Its primary function is to answer questions asked by the user by making logical inferences from the knowledge base, deriving new information in the process if required. SEVA also has an important capability to remember scenarios as experiences, thus making the knowledge representation a function of questions, answers, and commands which in turn keeps it free of Case-based traditional structures. The paper proposes an efficient combination of tools to be implemented in SEVA’s information extraction, ontology building, and reasoning processes in addition to testing the soundness and feasibility of the designed system. The end result of this research will be a conceptual architecture for SEVA.
Web-Based Monitor for the Simple, Scalable, Script-Based Science Processing System

Joshua Veltri¹, Christopher Lynnes²

¹Case Western Reserve University, Case School of Engineering, Cleveland, OH, USA
²Science Data Management Branch, NASA Goddard Space Flight Center, Mail Code 423, Greenbelt, MD, USA

The Simple, Scalable, Script-Based Science Processing (S4P) system is a tool used by scientists at NASA to process science data received from various earth-observing satellites. Due to the amount of data, handled by the system, it became necessary to develop a simple user interface to assist with monitoring and controlling the data processing. Initially, this interface was implemented using a server-side Perl/Tk program with X11 window forwarding to the client. As supporting this application architecture on modern workstations became increasingly difficult, it became necessary to re-implement the monitor and control application using widely supported, modern technologies. The introduction of the ability to make asynchronous server requests via the XMLHttpRequest (Ajax) standard makes web technologies the ideal choice for implementing such an application because it enables seamless communication between the client’s own computer and the S4P server. Consequently, it is possible to largely achieve both the user-interface benefits of running a local application and the performance benefits of running an application remotely. Using the AngularJS Javascript framework, we built a front-end user interface that seamlessly retrieves status information from and sends control commands to the Perl-based S4P back-end. The result is a web-based monitor and control application that should both provide a better user experience and be far easier to support from an IT perspective than the Perl/Tk-based application that it replaces.
NICER X-Ray Mission Development: Enhancing the Precision of the NICER Clock

Jessica Hatfield¹, Keith Gendreau², Craig Markwardt²
¹University of Maryland, College of Computer, Mathematical, and Natural Sciences, College Park, MD, USA
²X-Ray Astrophysics Division, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA

My work with the NICER X-Ray Telescope project aims to enhance the precision of the NICER clock, which will, in turn, contribute to the project’s overall goal of studying the interior composition of neutron stars. The accuracy of the NICER clock is determined by the MPU oscillator. The oscillations are counted and divided by the frequency of the oscillator (about 25MHz) to determine how many seconds have passed. However, the frequency of the oscillator is not always constant; rather, it is dependent on changes in temperature and power. Because of this, it is my job to study the relationship between frequency, temperature, and power in order to create an accurate model of the MPU oscillator’s frequency. To do this, I began by observing the behavior of the MPU oscillator. I found that, in all cases, as the temperature of the MPU’s digital board increased, the frequency of the oscillator decreased. Also, boards operating at higher powers had different oscillator frequencies than boards operating at lower powers. In order to apply this knowledge to a wide range of MPU board data, I wrote a piece of software that returned a function modeling this behavior. After my time here at Goddard, my software will continue to be used to improve the understanding and precision of the clock as NICER studies neutron stars in our universe.
Developing an Application for CFS-CFE and Rhapsody UML2.0

Justin Yum\textsuperscript{1}, Gary Smith\textsuperscript{2}

\textsuperscript{1}Yale School of Forestry and Environmental Studies, Yale University, New Haven, CT, USA
\textsuperscript{2}Software Systems Engineering, NASA Goddard Space Flight Center, Mail Code 581, Greenbelt, MD, USA

This project will investigate developing flight software used onboard satellites as well as ground control software, as well as the overall flight software development process. Specifically, it will answer the issue of reducing the life cycle costs of developing embedded software systems used onboard satellites, as well as porting heritage code into modern software development paradigms. This project will entail developing an app for the Core Flight System Core Flight Executive (CFS-CFe), a text-based open-source development framework, which can receive commands and send telemetry with a ground system. This code will interface with a Zedboard off-the-shelf hardware. Additionally, this code will be reverse-engineered into a UML2.0 framework using Rhapsody. Thus far, this project has successfully created an app meeting the stated requirements. Development is ongoing on the open-source COSMOS ground system, which will enable communication with the CFE. This study will be significant by saving money for NASA and allowing it to reuse decades of legacy code in future projects.
Geo-Electric Field Calculator Tool

Katie Krohmaly¹, Antti Pulkkinen², Masha Kuznetsova²

¹Christopher Newport University, Newport News, VA, USA
²Community Coordinated Modeling Center, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

During a severe geomagnetic storm caused by extreme space weather, geomagnetically-induced currents (GIC) can occur on the ground around man-made conductors such as high-voltage power transmissions systems. A geo-electric field induced on the ground drives the GIC’s in these conductors and this can interfere with and disrupt high-voltage power transformers. There can be direct and negative societal effects of extreme space weather storms as they can cause damage to both power and pipeline equipment. Very severe storms also have the potential to cause widespread electric blackouts. This tool will calculate the geo-electric field given the x- and y-components of the incoming magnetic field, as well as the depths and conductivities of specific conductors in the ground. A version of the core calculator engine existed previously and was originally written as a program in MATLAB. This project required it to be rewritten in the JAVA programming language so it could be adapted/re-engineered as a web application for power engineers to use. The ultimate goal of this project is to develop an infrastructure that provides remote users with (1) the ability to access the core calculator engine through the web, (2) interactive input data upload and data selection capabilities, (3) and interactive graphical analysis. This new tool will enable power engineers to quickly calculate geo-electric fields via a web browser interface allowing them to better anticipate and prepare for approaching geomagnetic storms.
The initial concept development will result in middleware-based, publish/subscribe infrastructure providing near real-time status data to a web site offering secure public view of communications amongst NEN ground stations and NEN customers’ spacecraft. The development of this concept requires interaction with several organizations such as Space Communications Network Services (SCNS) Software Engineers supporting the NEN, Exploration and Space Communications (ESC) management, and the ESC Education and Public Outreach (EPO) team. The team will explore opportunities in the integration of Goddard Mission Services Evolution Center (GMSEC) technology for the NEN. This infusion will enable situational awareness, potentially simplify development, integration, and test of imminent technologies/capabilities, and support evolving NEN development and operation concepts. This prototype system will demonstrate the potential relevancy of GMSEC integration with NEN ground stations.
Evolving Middleware Support for Goddard Mission Services Evolution Center (GMSEC) Application Programming Interface (API)

Logan Abel¹, Matthew Handy²
¹Massachusetts Institute of Technology, Cambridge, MA, USA
²Ground Software Systems Branch, NASA Goddard Space Flight Center, Mail Code 583, Greenbelt, MD, USA

Middleware and protocol technologies are constantly evolving and changing as new algorithms are developed and standards are created. GMSEC software must evolve to incorporate these new technologies to stay current with modern practices and security, thus allowing the software to continue running quickly, efficiently, and stably. Two new technologies, the Advanced Message Queuing Protocol (AMQP) and the Apache Apollo message broker, have been released within the last three years. AMQP provides a system-agnostic international messaging protocol standard. It supports many different messaging topologies, is open source, and is efficient. Apache Apollo is a message broker that aims to offer more reliable and quicker messaging than its predecessor (ActiveMQ), and provides support for new standards such as AMQP and older messaging such as with CMS (C++ Messaging Service). This GMSEC project aims to add support of AMQP and Apache Apollo to the GMSEC API with full security functionality. These components will be coded in C++ and integrated into the GMSEC API, and then rigorously tested on all supported operating systems with the full suite of standard and security tests. These changes will provide customers using the current GMSEC API middlewares with an easy transition to new technology and future customers with more options to choose from when setting up GMSEC systems.
**EOS Zenoss Problem Resolution**

Chaddon Law\(^1\), Donald Anderson\(^2\)

\(^1\)Capitol Technology University, Laurel, MD, USA

\(^2\)Flight Projects Directory, NASA Goddard Space Flight Center, Mail Code 428, Greenbelt, MD, USA

Zenoss is a networking management tool utilized at NASA Goddard in support of the Earth Observing Systems (EOS) project. It provides a device-centric unified monitoring system for many of the switches, firewalls, routers and other systems in use. It offers a tracking database that stores past system generated events by daemon processes configured for the network that give information such as device IP, severity level, and event summary. These class fields are a key part of Zenoss events as they give context as to what the event is reporting and to which daemon it belongs to once arriving in Zenoss. This tool acts like a careful watcher over thousands of machines and aids in resolving prioritized problems by giving insight for affected services before mission impact. Over the course of my internship, I have investigated and addressed several issues that helped the network operations team including resolving one event issue that hindered Zenoss monitoring. All of my efforts towards NetOps have given me a greater understanding of the IT infrastructure in a professional working environment.
Development of Heater Control Application for the Core Flight System

Lindsay Walton¹, Susanne Strege²

¹University of Colorado at Boulder, Boulder, CO, USA
²Flight Software, NASA Goddard Space Flight Center, Mail Code 582, Greenbelt, MD, USA

The core Flight System (cFS) is an embedded system framework that provides a development and runtime environment for building and hosting applications and libraries. The cFS was designed for reuse on any spacecraft or satellite flight software system. The platform and project independent nature of the cFS allows use on any embedded system. The goal of this project is to develop a heater control application for the cFS application reuse library. The primary objective of the heater control application is to perform heater control services and functions to ensure mission/project defined temperature regions are within range. The heater control software requirements have been provided. This project involves detailed requirements analysis, software design, development, and testing for the cFS heater control application. The design includes the flow control and software context. The heater control application is developed in accordance to the design. A simulator is also developed for testing and proof of concept.
Software Architecture Based on UML Diagrams

Luke Cannon\textsuperscript{1}, Art Ferrer\textsuperscript{2}

\textsuperscript{1}Thomas Jefferson High School for Science and Technology, Alexandria, VA, USA
\textsuperscript{2}JPSS, NASA Goddard Space Flight Center, Mail Code 500, Greenbelt, MD, USA

The Government Resources for Algorithm Verification, Independent Testing and Evaluation (GRAVITE) is a hardware/software environment used by the Joint Polar Satellite System Ground Project to develop, refine, and verify science data processing algorithms before transitioning them to operational use. This project has two goals. The first is a limited analysis of the GRAVITE software architecture to assess Object-Oriented Design and Programming techniques used in GRAVITE development. We analyze the software architecture by reverse engineering the code to create Unified Modeling Language (UML) diagrams. Once the diagrams are generated, we compare them to the original source code and ensure that the structure of the software makes sense. Important parts of the analysis include making sure the classes and methods flow in a logical hierarchy and checking to see that all of the methods are useful and have logical parameters and returned values. The second goal is to investigate static code analysis findings, which identify non-recommended practices or potential problems in the software code. The investigation will be conducted using static analysis outputs from the tools, Understand and Klocwork, and will involve manual examination and assessment of the source code related to each finding. The objective is to determine if the finding actually identifies a potential problem or if the finding is a “false positive.” This could be an indication of a potential error, or that the code was developed in a manner where there is no impact to software performance for function. Results from this project will be communicated to the GRAVITE development team for product feedback and improvement.
Content and Log Analysis Using MySQL and Graylog

Magdalene McArthur¹, Barbara Grofic²

¹Howard University, College of Engineering, Architecture and Computer Science, Washington, DC, USA
²Science and Exploration Directorate, NASA Goddard Space Flight Center, Mail Code 600, Greenbelt, MD, USA

Ensuring the security and reliability of NASA’s reporting websites and internal networks play a key role in reaching one of NASA’s strategic goals: to serve the American public by effectively managing its people, technical capabilities and infrastructure. In this study, the Relational Database Management System MySQL is used to create scripts that audit the Science and Exploration Directorate (SED) website for out-of-date and/or incorrect information. The log analysis tool, Graylog, is also used to help facilitate a central logging server (CLS) for SED, which will analyze log data from users on the internal network at Goddard. The goal of this study is to create a CLS that can analyze large data volumes of 10 GB/day and can separate data streams based on computer name or header. This study will play an important role of ensuring the validity of purported data from SED and the security of the networks the center’s scientists use to communicate and share valuable data.
Shearlet Features for Remotely Sensed Image Registration

Omar S. Navarro Leija\textsuperscript{1}, Jacqueline Le Moigne\textsuperscript{2}

\textsuperscript{1}University of Nevada Las Vegas, Las Vegas, NV, USA
\textsuperscript{2}Software Engineering Division, NASA Goddard Space Flight Center, Mail Code 580, Greenbelt, MD, USA

Image registration is the task of aligning two or more images representing the same scene or object. As remote sensing data grows, it is necessary to have robust, fast, and widely applicable algorithms for registration. Shearlets provide a mathematical framework for feature extraction with increased directional sensitivity and superior performance. Ureg is an image registration program developed by GSFC, the goal for this project was to integrate shearlets into Ureg and develop new algorithms for image registration. We implemented a standalone Shearlet library based on computationally efficient algorithms with support for parallelism. We integrated shearlets into Ureg and extended its functionality by adding new registration methods based on computing shearlets at different levels of decomposition. These methods are slightly less accurate than shearlets alone but are far faster and efficient. The Shearlet library will be released to the world as standalone open source software where it can be applied to other general problems.
Ground Software for Balloon Infrared Interferometer

Naomi Rubin¹, Stephen Rinehart²

¹Carnegie Mellon University, School of Computer Science, Pittsburgh, PA, USA
²Observational Cosmology Laboratory, NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA

BETTII (Balloon Experimental Twin Telescope Infrared Interferometer) is an interferometer that will use the far-infrared to study clustered star formation and active galactic nuclei. BETTII will fly on a balloon at a height of about 130,000 feet to minimize blurring and absorption by the atmosphere. During its flights, BETTII will be in continuous communication with the ground, both receiving commands from the ground and sending down the data it measures. This project consisted of making additions and improvements to the code that will run on the ground. Several aspects of the user interface were improved, including a panel that displays information about errors triggered throughout the code and one that keeps track of commands sent to the balloon. These will allow users on the ground to more effectively monitor the state of the balloon and make sure the balloon is successfully executing commands. A panel was also added to send commands to the balloon, and error checking was added when sending these commands. These changes will be used when the balloon is flown next year.
Implementing Responsive Web Design

Robert Southall¹, Matthew Showalter²

¹Bay Mills Community College, Brimley, MI, USA
²Advanced Manufacturing Branch, NASA Goddard Space Flight Center, Mail Code 547, Greenbelt, MD, USA

Successful businesses, institutions, and individuals have websites to extend their influence to a broader audience or customer base. In today’s market, though it’s not sufficient just to have a traditional website and be recognized by various search engines, users are increasingly using mobile platforms (i.e., smartphones and tablets) for accessing the Internet, not just stationed platforms (desktops and notebooks). Therefore, websites need to be optimized for all of these devices in order to provide the best user experience. The Advanced Manufacturing Branch’s website is suffering from this problem. The solution is to develop a website with responsive web design, allowing the website to adapt to any of these platforms, i.e. their resolution. This is accomplished by coding in updated web languages like HTML 5 and CSS3 along-side with a consistent grid system framework to allow content to flow effortlessly to different platforms. Also, the new layout has been progressively changed to include a single page flat design and white space (content spaced out) in order to provide the users with a less cluttered and easy to navigate website. With this new implementation of the Advanced Manufacturing Branch’s Website, the user will ultimately stay for longer periods of time and be able to conveniently access the website from any cross-platform device.
New Validation Suite for the CCMC

Sean Malone¹, Marlo Maddox²
¹River Hill High School, Clarksville, MD, USA
²Community Coordinated Modeling Center, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

In a study done of the factors that affect the success of video games, it was found that 87% of the users agree the display of the game demo will affect their decision to continue playing the game. Thus, the display of software is a significant factor in software effectively providing a service to its users. The Community Coordinated Modeling Center provides validation of models for Space Weather Forecasters, but the current validation suite and existing toolset was identified as an ideal candidate for a comprehensive overhaul to improve the usability of the tools while also improving the user experience. Thus the suite no longer effectively provides a service for its user, Space Weather Forecasters. To solve this problem, a new web application that upgrades the layout and has enhanced navigation will replace the current suite. The new validation suite will replace a text heavy page with a geometric layout and a graph of observed and modeled data over time. It will also calculate the accuracy of the chosen model into a set of scores. Finally the new tool will be easily modifiable for future upgrades and versions. Through continuous use of the new validation suite, models and forecasters will increase in accuracy of their predictions.
Detector Characterization Data Interpretation Using Python

Victor Baules\textsuperscript{1}, Michael Hickey\textsuperscript{2}
\textsuperscript{1}California Institute of Technology, Pasadena, CA, USA
\textsuperscript{2}Detector Characterization Laboratory, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

Detector Characterization involves a multitude of tests and huge amounts of data to ensure proper detector function. Given time and human constraints, running data on a single computer system may be time inefficient. One solution is to develop programs for certain tests or data that could run on a computer with less RAM. Programs were written in Python to determine whether Python would be beneficial for running through test data. A general understanding of each test, as well as the math behind obtaining the results, was used to develop the programs. Attempts were made to keep memory usage as efficient as possible. It is expected that only full detector gain will prove to be useful if performed in python. However, if tests can be performed while using less memory, it may be possible that running the tests in a much faster programming language would make them relevant. Displaying data and detector properties using a language other than IDL could be useful in a setting with team members who do not know IDL or who have computers capable of handling certain amounts of data. This would make it possible for longer tests to be done on NASA servers while one or several others can be carried out simultaneously on a personal computer, thus increasing the speed of data analysis.
Engineering
Freeform Optical Design of 2 and 3 Mirror Telescopes

Alexander Q. Anderson¹, Isaac L. Trumper¹, Garrett J. West², Joseph M. Howard²

¹University of Rochester, Institute of Optics, Rochester, NY, USA
²Optics Branch, NASA Goddard Space Flight Center, Mail Code 551, Greenbelt, MD, USA

Freeform optical design enables more compact and lighter telescopes, while improving the image quality and allowing wider fields of view. For the purposes of this project, a freeform optic is a non-rotationally symmetric mirror or lens, typically with large departures from a best-fit spherical surface (μm or mm). New manufacturing and testing methods have enabled the production of these types of surfaces, but understanding about the capabilities of freeform optical systems is still limited. Also requiring development are tools to evaluate the optical performance of such systems. To address these problems, a suite of software tools for analysis and design of such systems were developed and applied to conduct a design survey of 2 and 3 mirror freeform telescopes to provide optical designers a general overview of the capabilities and limitations of such telescopes. This survey offers starting points for optical designers and allows them to gain a quick understanding of which design form is capable of achieving their performance requirements. As an application of this survey, these techniques were applied in the development of a freeform optical concept for the Coastal Ocean Ecosystem Dynamics Imager (COEDI) spectrometer, reducing the number of mirrors in the system from 9 to 6 using freeform optics. The tools and resources developed in this project will facilitate the incorporation of freeform optical design in future Goddard instrument proposals.
Engineering

Space Flight Instrument Catalog

Michael D. Leveille¹, Michael L. Adams²

¹Colorado College, Department of Physics, Colorado Springs, CO, USA
²Advanced Concepts and Formulations Office, NASA Goddard Space Flight Center, Mail Code 401, Greenbelt, MD, USA

NASA’s Goddard Space Flight Center has a rich history of missions and science instruments, yet information about these instruments is scattered and incomplete. The goal of this project is to create a comprehensive spaceflight instrument catalog that is a resource for technical instrument data, mission heritage, and rapid cost estimating. This knowledge was collected from technical papers, NASA mission webpages, instrument managers and scientists, principle investigators, and existing NASA databases. The catalog will be in electronic form and be easily searchable for use by GSFC personnel. This catalog can be updated continually and added to as new information becomes available or as new missions and instruments are built and launched.
BPSK Receiver Design for the MTRS to Improve Reliability of Data Transmission

Minh Trang Nguyen¹, Philip Baldwin²

¹Columbia University, Fu Foundation of Engineering and Applied Science, New York, NY, USA
²Telecommunication Networks and Technology Branch, NASA Goddard Space Flight Center, Mail Code 566, Greenbelt, MD, USA

The McMurdo TDRSS Relay System (MTRS) is one of the first systems to integrate NASA's Space Network and the Near Earth Network. Design of the BPSK receiver will continue to integrate the two networks and advance NASA communications technologies with state of art communication design. The receiver will be implemented on MTRS to support NASA's earth exploration and observation goals. The design simulation will filter frequency carrier phase shift, handle high level of noise, and retrieve the data with the accuracy of 99.95%. The MTRS system will implement the receiver design further ensure the reliability of its data transfer from McMurdo Antarctica.
Characterization of MOSFET Devices at Cryogenic Temperatures

Lakirah Walker ¹, Laddawan Miko², Dan Kelly²
¹Spelman College, Atlanta, GA, USA
²Detectors Systems Branch, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

One of the benefits of metal-oxide-semiconductor-field-effect-transistor (MOSFET) devices at cryogenic temperatures is the reduction of noise in detectors used in space-based telescopes. Measured data was analyzed from MOSFET devices at room temperature (295K) as well as 80K. The various characterization parameters were extracted from the data and calculations were performed to determine the characteristics of the transistors' performance. The characterization parameters that were found for each transistor data set were the threshold voltage, channel length modulation factor, and transconductance parameters. The parameters matched well with expected values of the transistors and will be used in further development of cryogenic electronics for space-based telescopes.
Search and Rescue On-A-Chip (SARC) Thermal and Structural Analyses and Waterproofing

Jocelyn Wilkins¹, Matthew Colvin², Milton Davis²

¹University of Maryland, Baltimore County, Baltimore, MD, USA
²Components and Hardware Systems, NASA Goddard Space Flight Center, Mail Code 596, Greenbelt, MD, USA

The goal of this project is to aid in the miniaturization of a Second Generation Beacon (SGB) Personal Locator Beacon (PLB) for use by the crew of NASA’s Orion Crew. This PLB will begin operation only after splashdown and emergence from capsule by the crew. This device will serve as a significant advance of Search and Rescue (SAR) and GSFC technology. In order to be fully functional for Orion’s crew, this PLB must be waterproof. It must also be able to withstand drastic temperature and pressure changes. To ensure that the PLB is waterproof, research must be done on current electronics waterproofing techniques. This research must then be applied to the design of the PLB. In addition to researching electronics waterproofing techniques, thermal and structural analysis must be performed on the printed circuit board (PCB) of the PLB and its enclosure. Structural analysis of the PLB must be done to ensure the electrical parts will not fatigue due to PCB flexing. Also, mechanical components must be below their materials’ strength limits. Each of these tasks can be simulated in Autodesk Simulation Multi-physics software. Analysis is verified using hand calculations and empirical data. A thermal analysis must also be performed to ensure the system is capable of keeping the electrical parts within their thermal junction temperature limits.

While there is no single method through which a project begins, typically a person or group has an idea and petitions NASA to implement the idea and achieve the desired end goal. NASA then studies the idea for feasibility and scientific merit and determines how this goal might be accomplished. During this process, a team including science and engineering experts studies the potential project’s scientific merit and brainstorms different ways to get the desired scientific advance. This is known as the Pre-Phase A in the “Systems Engineering View of the NASA Project Life Cycle Process Flow for Flight and Ground Systems”. In Phase A, NASA establishes the project, defines the mission concept and scientific opportunities, goals, requirements, and system concepts. Next the project is further defined in Phase B at which time the preliminary plan is turned into a baseline technical solution. Requirements are defined, schedules are determined, and specifications are prepared to initiate system design and development. In Phase C a detailed design of the system is created, which includes requirements for how the system needs to work. During Phase D, the different subsystems are tested and integrated with one another. In this phase, the system is verified to ensure that it meets the requirements, and validated to ensure that the requirements satisfy the mission goals. Next is Phase E, which is the operational phase of the project wherein the science data is collected. Finally, Phase F covers decommissioning of the project and the final data is analyzed.
My project pertains to the verification of requirements for the James Webb Space Telescope (JWST) ground segment subsystems. I reviewed reports that documented tests performed by analysis to verify that the analyses are correct, that the requirements are being met and to show that the analyses can be reproduced. Through my analysis of various reports, I found errors in the data, directions and citations, which made some analyses irreproducible. This means the reports need to be corrected. In addition, I reviewed requirements verification data spanning several months to show the trend for verified requirements over time as compared to the plan leading up to full system verification.
MMS AMS SPIKES

Ameer Insaf Mohammed¹, Lia Sacks²
¹University of Maryland – College Park, College Park, MD, USA
²Attitude Control Systems Engineering Branch, NASA Goddard Space Flight Center, Mail Code 591, Greenbelt, MD, USA

MMS is a Goddard Mission that utilizes four spacecrafts to investigate the process of magnetic reconnection between the Sun and the Earth. These four spacecrafts were launched on March 12, 2015, and have since undergone numerous maneuvers in order to be positioned in an ideal location for data collection. The purpose of this project was to utilize telemetry data to determine if these spacecrafts at any point are being hit by orbital debris, or micrometeorites. This was done through utilization of free space, a simulation tool developed by code 591 at Goddard. A script was created that, when read in free space, would find data above a certain threshold, and single out the spikes that did not coincide with a known deployment time or particular spacecraft mode. These spikes were then outputted to a text file in order for the data to be analyzed and preserved. Across the board, the results showed that all four spacecrafts generally had around 2-4 spikes per orbit, with the average x y and z acceleration standard deviation values within the 100-115 micro g ranges. Once paired with information provided by the orbital debris department, these spikes will help show how many of the recorded hits were expected per orbit, and more importantly, how were not anticipated, allowing for future action to prevent any more unexpected hits.
OPSPARC: OPTIMUS PRIME Spinoff, Promotion, and Research Challenge

Zubair Khan¹, Rachel Lin², Alexander Sharp³, Darryl Mitchell⁴
¹University of Maryland, College Park, MD, USA
²Howard High School, Elicott City, MD, USA
³Winters Mill High School, Westminster, MD, USA
⁴Innovative Technology Partnerships Office, NASA Goddard Space Flight Center, Mail Code 504, Greenbelt, MD, USA

The purpose of our internship is to create promotional materials such as videos and printed materials to promote the Optimus Prime Spinoff and Research Challenge (OPSPARC) contest that the Innovative Technology Partnerships Office (ITPO) manages. OPSPARC is a nation-wide contest that encourages students from grades 3 through 12 to create short videos that either promotes the discovery of spinoffs or that discuss the impact that a certain spinoff may have on our everyday lives. Some problems that occur during our internship include trying to find creative, new, effective ways to engage our target audience, trying to create material that will encourage students of various ages to participate in the contest, and learning the software needed to engage our audience. We use a variety of media software while working with ITPO. We use software such as Adobe Premiere Pro and Adobe After-Effects to create and edit the promotional videos for the contest. We use software such as Adobe Illustrator and Adobe Photoshop for certain visual elements used for the videos and outreach for ITPO. There are many steps involved in creating the promotional videos for OPSPARC. First, we brainstorm ideas and try to find new ways to reach our target audience. Typically, we make three videos, each targeted for the different age groups (one for Elementary students, one for middle school students, and one for high school students). Then we write scripts to present to our mentor for revision. Afterwards, we gather the people and materials needed for our videos. Then, we film our videos and edit them on the computer. Finally, the videos are posted on the contest website.
Simultaneous Localization and Mapping of Small Planetary Bodies

Andrew Liounis¹, Kenneth Getzandanner²

¹West Virginia University, Benjamin M. Statler College of Engineering and Mineral Resources, Department of Mechanical and Aerospace Engineering, Morgantown, WV, USA
²Navigation and Mission Design Branch, NASA Goddard Space Flight Center, Mail Code 595, Greenbelt MD, USA

Simultaneous Localization and Mapping (SLAM) processes attempt to both model the scene being observed (mapping) and estimate the location of the observer in the scene (localization). For space-based applications, the current state of the art SLAM technique is the process of Stereophotoclinometry (SPC) developed by Dr. Robert Gaskell of the Planetary Science Institute. SPC works by using motion induced stereovision to generate a topographical map of the surface, and then uses the developed map to refine the state vector (position and attitude) of the spacecraft. The SPC processes were originally developed using the Fortran programming language, which has a shrinking user-base, and rely solely on a command line interface with limited visualization capabilities. The goal of this work was to recreate the current SPC processes in the MATLAB programing language to make them more accessible to a wider audience as well as simplifying the user-experience with a graphical user interface (GUI). The translation from MATLAB to FORTRAN was straightforward and the developed MATLAB program was tested and compared against the original routines for different cases to ensure no errors were introduced. In addition, during the translation the code was refactored and better documented to assist with future development efforts. The GUI was used to make the routines more robust to user input and introduced better visualization tools for analyzing the steps in the SPC processes. The developed MATLAB utilities will serve as a confirmation step for the Origins Spectral Interpretation Resource identification Security –Regolith Explorer (OSIRIS – REx) mission (in checking the output from the original Fortran routines) and will also allow future development of the SPC methods for use on upcoming missions.
Optimizing GEO-LEO CubeSat Constellation for Global Earth Surface Sensing - Potential Demonstration of Space Mobile Network (SMN) Communication Architecture

Alton Micah Vaughan¹, Dr. Obadiah Kegege²

¹Air Force Institute of Technology, Wright-Patterson AFB, OH, USA
²Telecommunications Network and Technology, NASA Goddard Space Flight Center

Mail Code 566, Greenbelt, MD, USA

This project analyzed end-to-end communications concepts for a mission that utilizes constellations of CubeSats in LEO orbit and signals of opportunity in GEO orbit to provide global Earth surface sensing. The methodology uses sensitive receivers (in LEO CubeSat) to measure the ground reflection of VHF-band signals transmitted from GEO communications satellites. This is done using two antennas on the CubeSat terminals to receive the direct signal from the transmitter and the reflected signal from the ground. The reflection coefficient (in the form of a delay-Doppler map or DDM) of the Earth surface is determined by cross-correlating the two signals. The feasibility of this concept was explored by designing the orbital configuration and communication parameters for LEO CubeSat constellation. The analysis focused on minimizing the number of satellites in the constellation while still accomplishing global land coverage at required resolution. Various Walker constellations of CubeSats were simulated and their communications and coverage capabilities were analyzed. In an effort to provide enhanced communication capabilities for the LEO CubeSat constellation, the concept of Space Mobile Network (SMN) was explored. Space Mobile Network will establish the framework that will allow space communications assets to dynamically and instantaneously meet the user’s needs.
Satellite Ground Systems Basic Concepts

Ciara Davis¹, Alexandra Mangold², Carl Wales³

¹Temple University, College of Engineering, Philadelphia, PA, USA
²University of Maryland Baltimore County (UMBC), College of Engineering and Information Technology, Baltimore, MD, USA
³Software Systems Engineering, NASA Goddard Space Flight Center, Mail Code 581, Greenbelt, MD, USA

This project consisted of researching and compiling information for the beginnings of a “Rule of Thumb” handbook regarding satellite communications and design. The goal of this handbook is to provide an easily accessible guide containing all essential information pertaining to satellite design, communication, and performance for all those who need a quick refresher or a detailed explanation of how satellite communications are accomplished. This handbook provides all of the logic associated with implementing satellite communications from every perspective, what parameters are necessary in order to achieve communications, and in turn addresses any design flaws or complications that are impractical or negatively affect communication. The overall goal of this project is to identify which parameters and variables in satellite system design can be manipulated in the design of a satellite system and understand the effects of each variable on the system. This project required using systems thinking, which involved taking a step back and looking at the “big picture” of satellite communications and all its components, rather than focusing in on each equation making up a part of the system. Overall, the handbook covers all topics pertaining to satellites as orbital mechanics, communications configuration, communications parameters, satellite maps, and finally the link budget equation.
Fabrication and Characterization of Novel Nanoporous Bolometer

Jaclyn Andrews¹, Larry Hess²

¹Lafayette College, Easton, PA, USA
²Detector Systems Branch, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

Porous silicon has many unique properties that would make it useful in detector development. The porosity is tunable, which impacts heat transfer and optical properties of the material. Specifically, using porous silicon to support YBCO/Sapphire pixels in a bolometer would allow the detector’s specific detectivity and time constant to be tuned based on the thermal isolation of the pixel. This would create more sensitive detectors for use in a number of missions. To determine feasibility of this design, two bolometers were fabricated without porous silicon, to be used as a baseline in testing. From there, three detectors were fabricated with the addition of the pores in the support beams. To do this, the support beams were isolated by use of a nitride layer masking the non-porous sections of the wafer. Aluminum was deposited in a ring around the edge to create better electrical contact with the electrode. The wafer was placed in the porous silicon etching system and current was applied until the support beams etched pores. The rest of the processing was the same as the non-porous wafers: a metal deposition and etch, oxide etch, deep etch to release the “diving boards”, and a deep etch on the backside. This work is significant because the precision of detectors, as well as the time constant, is of great importance to cutting-edge missions such as the Europa Clipper and the Saturn Probe.
Magnetic Shape Memory Alloy Actuator for Nano-Positioning

Anjali Mittu¹, Umesh Patel²
¹University of Maryland, College Park, MD, USA
²Electro-Mechanical Systems Branch, NASA Goddard Space Flight Center, Mail Code 544, Greenbelt, MD, USA

The goal of this project is to design, manufacture, and test a precision actuator based on new Magnetic Shape Memory Alloy (MSMA) material for space applications. MSMAs have been gaining attention since they perform better than current crystal materials used for precision actuators. MSMA have larger strains, higher stiffness, higher bandwidth, and lower amplifier volt-amp requirements compared to other materials. They require no lubrication and can run at cryogenic temperatures, thus allowing them to function for millions of cycles.

In the martensitic phase, MSMA is composed of different areas with alternating orientations of the easy axis of magnetization, called the twin variants. When a magnetic field is applied to the material, there is growth in the variants aligned with the field. This causes an overall lengthening of the sample. When the field is removed, the elongation is self-supported until an external force or a magnetic field at 90⁰ to the original field is applied to restore the original shape.

Tests are being set up to study the force and magnetic field of the actuator in relation to current and to record the displacement of the actuator. The results of this project will help engineers design future MSMA based components.
The launch vehicle database is the Earth Systematic Missions Project Office’s main source of up to date launch vehicle information and is used to access new and existing launch vehicles and their capabilities against the needs of earth science payloads. The goal of this study was to update the old database’s information, including the addition of newly announced launch vehicles and changes made to already active vehicles, and to create a new Word document version from the old Excel spreadsheet version. Updating the database required much Internet research and the reading of each launch vehicle’s user’s guide to check the existing information from a reliable source. The resulting database now contains completely updated information, including all vehicles’ most recent flight histories, carrying capacities to different orbits, engine types, and available launch sites, and several new launch vehicles that have been recently announced. This project was a great success in the amount of information that was gathered in such a short period of time and it will be a great resource once it has been completed.
NASA’s Space Technology 5 (ST-5) satellite launched on March 22, 2006 and has since been downlinking data to the servers at Goddard Space Flight Center. ST-5 was equipped with a Slit Sun Sensor and a magnetometer for its attitude determination. This project consisted of designing an open-loop attitude simulator in MATLAB that gets as close to truth as possible using. External torque, such as residual magnetic dipole moments, Eddy Currents, and gravity gradients, were implemented once the open loop simulator was complete. With external torques successfully executed, thrusters were added in order to make this a close-loop simulator. The final step of this project was to attempt an attitude maneuver using the thruster model. With this close-loop simulator, errors between the truth model and simulator model were as small as 10e-5.
Analyzing Hyperspectral Data with Neural Networks

David T. Wang¹, Phoebe Whitmore², Benjamin Kobler³

¹University of California, Berkeley, College of Engineering, Berkeley, CA, USA
²Thomas Jefferson High School for Science and Technology, Alexandria, VA, USA
³Software Engineering Division (Emeritus), NASA Goddard Space Flight Center, Mail Code 580, Greenbelt, MD, USA

Artificial neural networks (ANNs), a type of machine learning algorithm designed to mimic the brain, are used for everything from stock market predictions to optical character recognition. The goal of this study was to evaluate their ability to classify hyperspectral images of Earth and Mars, a conceptually similar task to other applications where ANNs have been successful. This study attempted to find a relationship between network configuration, including width, depth, and learning rate, and the accuracy with which the algorithm classified spectra. Spectral data obtained from both the AVIRIS (Earth-based) and CRISM (Mars-based) instruments consisted of reflectance values and a key describing which mineral or plant was present. The ANN was repeatedly reconfigured, trained to categorize part of the data and tested on its accuracy at classifying the rest. Preliminary analysis indicates that the largest gains in accuracy are obtained by ANNs with few layers of many nodes each, as opposed to narrower, deeper configurations. Better accuracies were obtained for datasets with spectra evenly distributed across categories (e.g., equal numbers of spectra for each mineral) than for unevenly-distributed sets. In addition, performance gains were obtained by moving matrix computations to a GPU chip. Because shallower neural networks usually take less time to run than deeper ones, shallow ANNs may be a better option than the current standard of least-squares regression for classifying hyperspectra en masse with comparable accuracy. Greater efficiency may be helpful in identifying patterns, such as carbonate distribution on Mars or drought on Earth.
NASA’s Suomi National Polar-orbiting Partnership (SNPP) Science Data Processing Support

Avian L. Richardson¹, Alfreda Hall², Evelyn Ho², James Williams²
¹Morgan State University, Clarence M. Mitchell, Jr. School of Engineering, Baltimore, MD, USA
²Science Data System Branch, NASA Goddard Space Flight Center, Mail Code 423, Greenbelt, MD, USA

The Earth Science Data and Information System (ESDIS) Science Data Segment (SDS) acquires Suomi National Polar-orbiting Partnership (SNPP) raw mission data and makes it available to the Science Investigator-led Processing System (SIPS) for NASA’s generation of standard data products. The SIPS makes the products available to NASA’s Distributed Active Archive Center (DAAC) who distributes the data products to the user community. An Interface Control Document (ICD) Appendix and a SIPS requirements test plan are needed to define the data flows, protocols, security controls, etc., needed between the SIPS and the DAAC interfaces. Additionally, a feature page providing an overview of SNPP SIPS as well as the standard products were developed for the NASA’s Earth data Wiki web page. As the SNPP SDS Systems Engineering Intern, this project provided insight into the roles and responsibilities of a systems engineer as well as experience identifying and documenting specific parts of the system life cycle development such as interface definition and requirement verification and validation. This poster will display the systems engineering support provided.
Spacecraft Dynamics Simulation

Axel Rigoberto Garcia De la Garza¹, Rick Harman²

¹Quince Orchard High School, Gaithersburg, MD, USA
²Space Science Mission Operations, NASA Goddard Space Flight Center, Mail Code 400, Greenbelt, MD, USA

This internship has the main purpose of creating a simulator that models the behavior of the Space Technology 5 (ST5) decommissioned satellite. The ST5 mission consisted of 3 micro satellites that orbited the Earth and relayed the data it collected back to Earth. The simulator, which is to be created by the interns, has the purpose of receiving this data and creating coordinates relative to the Earth’s 3D Cartesian coordinate system. Through the creation of this simulator, the interns will be able to compare the results from the simulator to the real-life results. The interns learn how to create the simulator through documents issued to them by their mentor. Working as a team, the interns will learn about MATLAB and learn more about the tracking of satellites. The resulting data output closely matched the real-life data that the ST5 relayed back to Earth. The results prove that simulators are extremely efficient when tracking the position of a satellite relative to the Earth. This internship teaches interns about how the benefits of the satellite dynamics simulator and teaches the interns about the importance of having advanced sensor technology when locating the position of a satellite.
The Effects of Thermal Cycling and Physical Shock on Particle Fallout in Coatings

Beqir Krasniqi¹, Mark Hasegawa²

¹University of Maryland, James Clark School of Engineering, College Park, MD, USA
²Contamination and Coatings Engineering Branch, Mail Code 546, Greenbelt, MD, USA

In contamination control engineering, particle fallout refers to the small particles of coating that are dislodged from a coated surface. Particle fallout can be an issue because small particles can land on sensitive measurement devices and obscure results. Using image analysis, the number and size of the fallout particles can be measured and recorded. Two experiments were developed and performed to evaluate the particle fallout from a commonly used white thermal control coating. The first experiment characterized the amount of particle fallout generated from thermal cycling. The second measured the effectiveness of KASIL 2130 binder on reducing particle fallout due to physical shock.

In the first experiment, a setup was designed with several coated aluminum samples attached to a thermal cycler. Wafers were placed underneath the samples, and the cycler was activated. The goal of this experiment was to develop a mathematical model relating the amount of fallout to the number of cycles that the sample undergoes. This was repeated for various substrate shapes and different coating patterns.

In the second experiment, a setup was created to allow for a consistent force to be applied to coated aluminum surfaces. Half of each surface was covered with KASIL 2130, a potassium silicate binder. Underneath the substrate a wafer was placed to capture fallout. The two sides of each wafer were compared to each other. The goal of this experiment was to determine what effect the binder had on the amount of fallout generated. This procedure was repeated for different concentrations of the binder. Preliminary results indicate a reduction in the number of particles generated from the “protected” side; however, the total area covered does not appear to be significantly changed.
Rapid ATP Bioburden Test

David Berlin¹, Erin Lalime², Nancy Carosso²
¹College of the Sequoias, Visalia, CA, USA
²Contamination and Coatings Engineering, NASA Goddard Space Flight Center, Mail Code 546, Greenbelt, MD, USA

The purpose of this project is to develop a sterile water based rapid bioburden test. Contamination engineers use two tests to assess the level of biological contamination on hardware: the rapid five minute bioburden test, which is a molecular screening of the amount of Adenosine triphosphate (ATP), a molecule found in all cells on the hardware, and a slower colony growth test, which is used to give a more accurate representation of the amount of microbes on the hardware. However, the rapid bioburden test has limited application because it leaves a chemical residue that can be detrimental to sensitive hardware. This can cause project delays while waiting for the results from the three day colony growth test. We address this problem by changing the germicide based ATP system to a sterile water based system. The test works by reacting ATP with D-Luciferin and the Luciferase protein to yield light. The light is then detected by a luminometer that outputs a Relative Light Unit (RLU) amount depending on how much ATP is present. To analyze the effectiveness of the new test, we developed a correlation between amounts of ATP and the RLU they produce using the germicide based system. From these experiments, we've generated a consistent relationship between the two in the form of a power curve. From there, we developed a correlation curve between the amount of colonies and the RLU they produced. With these two curves, we can test the accuracy and effectiveness of the sterile water based system.
External Payload Proposer’s Guide to the International Space Station

Benjamin Serano¹, Stephen Leete²
¹Capitol Technology University, Laurel, MD, USA
²Mission Systems Engineering, NASA Goddard Space Flight Center, Mail Code 420, Greenbelt, MD, USA

Individuals wishing to fly payloads on the International Space Station (ISS) have many documents to search through in order to write their proposals. The External Payload Proposer’s Guide to the International Space Station or “The Guide” was created to assist in the proposal writing process by serving as a “one-stop-shop” for information. The Guide has successfully been released and is now in need of an update. In order to perform this update, veteran proposers and engineers are being interviewed to assess the document. Their recommendations are used in conjunction with editorial changes to produce a more complete and useful guide. Some of the changes in the update include: a complete list of provided hardware, a streamlined launch vehicle section, and an improvement of graphics. The Guide provides proposer’s the information necessary for successful selection, and with periodic update, this document will continue to assist and encourage future proposers to fly on the ISS.
NICER Pointing System

Robert Campion¹, Tyson Mulder², Michael Wolfe³, Keith Gendreau⁴, Alice Liu⁵, Ben Kaplan⁶, Jerrin Johnson⁷

¹University of Illinois at Urbana-Champaign, Department of Aerospace Engineering, Urbana, IL, USA
²University of Washington, College of Engineering, Seattle, WA, USA
³University of Maryland, Baltimore County, Department of Physics, Baltimore, MD, USA
⁴X-Ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA
⁵Attitude Control Systems Engineering Branch, NASA Goddard Space Flight Center, Mail Code 591, Greenbelt, MD, USA
⁶U-32 High School, Montpelier, VT, USA
⁷C.D. Hylton High School, Woodbridge, VA, USA

The Neutron Star Interior Composition Explorer (NICER) is an X-ray timing and spectroscopy instrument that will be installed as an external payload to the International Space Station (ISS) in 2016. NICER will resolve the nature of ultra-dense matter as well as demonstrate pulsar navigation by studying the dynamic processes and radiative mechanisms active within neutron stars. Pointing the instrument presents a unique challenge due to the accuracy required and the dynamics of both the ISS and the stepper motor actuators. As the mission prepares to receive flight hardware, several tests were implemented on the NICER engineering test units (ETU’s) to validate pointing performance. Two types of tests were performed. Functional testing integrated the flight software with the electronic ground support equipment. This test required closed loop software interfacing. To achieve this, a star field was projected onto screen such the star stacker ETU (mounted on top of a NICER shaped mass simulator) would calculate pointing positions and orbit rate. This telemetry was sent to the main electronics box (MEB) ETU, compiled into gimbal commands, and sent off as current motor windings to the actuators. This moved the mass simulator such that it could track a star on the moving star field. The second type of test was the performance test, which validated the mechanical ground support equipment pointing requirements. To do this, the actuators had to move a NICER system that simulated both its inertia and the friction free environment of space. Air bearings were attached to the large mass sim with a modified rotational inertia such that it could move frictionless in two dimensions therefore simulating its vibrational properties in the lab. These tests analyzed the jitter NICER would experience on orbit. This analysis would be used to correct for the instrument’s pointing in the flight software.
Ion Focusing via Electrostatic Lenses for Interfacing Liquid Chromatograph

Brandon J. Colón Curiel¹, Stephanie Getty², Adrian Southard³

¹ University of Puerto Rico, Mayagüez Campus, Mayagüez, PR, USA
² Solar System Exploration, NASA Goddard Space Flight Center, Mail Code 699, Greenbelt, MD, USA
³ USRA University Space Research Association, NASA Goddard Space Flight Center, Mail Code 699, Greenbelt, MD, USA

The OASIS (Organics Analyzer for Sampling Icy Surfaces) project aims to interface a liquid chromatograph (LC) with a mass spectrometer for future space exploration missions. This will allow for in situ detection of amino acids and other organic materials during future missions to Europa, Enceladus and other icy bodies that will help understand the origins of organic material on Earth. Prior to entering the mass spectrometer, transmitted ions from the liquid phase to the gas phase require a focusing interface. This project centers on the design, assembly and testing of an electrostatic lens stack capable of achieving the desired ion trajectories using differential pressures and electric fields. A five-element zoom lens was designed based on charged particle optics theory using 3D modeling CAD software. Based on physical constraints and design parameters, the electronics interface was arranged using standardized off the shelf components. Current spacing and existing features on the mass spectrometer played a key role in the design of a viable lens stack. The assembly was simulated using ion optics software, SIMION, through which ion trajectories were studied in order to determine the required voltages. Simulations showed that optimum voltages for the individual lenses are relatively low and can be achieved with commercially available parts. The lens stack is now ready for assembly and component level testing to ensure efficient ion transmission and successful integration to the current liquid chromatograph and mass spectrometer components.
Manufacturing Robotic Arm Concept

Cole Daitch¹, Brendan Jordan², Kyle Pletan³, Rohan Punnoose⁴, Tarun Punnoose⁵, Colin Yancey⁶, Matthew Showalter⁷

¹Archbishop Spalding High School, Edgewater, MD, USA
²Hammond High School, Columbia, MD, USA
³University of North Dakota School of Engineering and Mines, Grand Forks, ND, USA
⁴University of Michigan, Ann Arbor, MI, USA
⁵Thomas Jefferson High School, Alexandria, VA, USA
⁶Howard High School, Ellicott City, MD, USA
⁷Advanced Manufacturing Branch, NASA Goddard Space Flight Center, Mail Code 547, Greenbelt, MD, USA

The Advanced Manufacturing Branch is investigating the use of an industrial robotic arm to automate the process of manufacturing parts. The Innovation Lab team has been tasked with making a small scale system that will function like the proposed industrial robotic arm. Colored targets will be randomly placed in a sorting area that the arm can easily reach. The Xbox 360 Kinect will be used as a vision system, and will identify both the coordinates of the targets in 3D space and the color of the targets, sending the information to our robotic arm’s software. The arm will process the coordinates and grab the target to place it in a defined orientation and area. The smaller scale robotic arm will demonstrate some of the tasks that the larger model will accomplish. An interchangeable head design will be constructed for additional functionality of the robotic arm, so the Innovation Lab team can demonstrate that the arm can be used for an assortment of tasks, mimicking the potential ease of assembling and disassembling heads on the industrial arm. The small scale robotic arm and track will show the Advanced Manufacturing branch what a large scale robotic arm will be capable of as well as the limitations of the system. The Innovation Lab team’s work will lay the foundation for the planned industrial scale robotic arm.
This project involves the flight build, testing and delivery of the INMS (Ion Neutral Mass Spectrometer) instrument that will be integrated on the Dellingr 6U CubeSat. The goal is to use the INMS to map the composition and density of particles in the Earth’s atmosphere. Once integrated, the instrument was tested in a vacuum chamber, where mechanical parts were designed (using Solidworks) for a 5-axis motion platform system to assist in the alignment and spacing of the instrument for calibration and testing. The system is aligned with a low energy ion gun within the chamber. A thermal chamber box was designed for future integration into the vacuum chamber to thermally test the instrument, a new capability the current facility does not have. These efforts, along with other tasks have contributed to the development and delivery of the INMS and the Particle Spectrometry Lab Facility. The spaceflight data collected once Dellingr is launched will provide valuable information that can be used to assess global structure and climatology as well as characterization of storm-time behavior and response.
Engineering

Engineering Technician Assistance

Caleb B. Decker\textsuperscript{1}, Matt Showalter Sr.\textsuperscript{2}
\textsuperscript{1}Liberty University, Lynchburg, VA, USA
\textsuperscript{2}Advanced Manufacturing Branch, NASA Goddard Space Flight Center, Mail Code 547, Greenbelt, MD, USA

The science and engineering of today’s NASA programs requires increasingly higher quality components to be manufactured. These demands result in longer manufacturing times due to the complexity and accuracy required of the components. This position provided assistance to the technicians for the normal workload, which supports NASA projects. It also involved support for the intern teams under Branch Code 547 by providing them concept and design ideas, as well as the manufacturing of completed designs. The work for both groups was completed on Computer Numerical Control (CNC) machines, as well as manual machines, and 3D printers. The complexity and design of the component determines what machines were acceptable to make the component as well as if any work was to be done in a Computer Aided Manufacturing (CAM) system, such as FeatureCam, which generated the program for the manufacturing of the component. Components that were made for the technicians included parts that were supporting NASA programs such as the WFIRST project and other smaller projects. For the intern groups, assistance was given in the design and manufacturing of an interchangeable gripper design and mounting plate, as well as different type of grippers for the robotic arm. The manufacturing assistance to the interns resulted in modifications to strengthen the safety barrier of the robotic arm project, as well as manufacturing of plates connecting the robotic arm to the guide rail that provides the robot’s maneuverability. The opportunity allowed for personal advancement in FeatureCam usage and proper manufacturing practices while providing the needed experience of manufacturing to the intern groups for design requirements. The work completed helped all of the parties involved to better meet their deadlines by providing a multifaceted skill set that could support the work among the different groups according to their needs.
Finite Element Modeling and Structural Analysis of Composite Structures

Cameron Kauffman¹, Babak Farrokhi², Ken Segal³

¹Montana Tech of the University of Montana, Butte, MT, USA
²Mechanical Systems Analysis and Simulation Branch, NASA Goddard Space Flight Center, Mail Code 542, Greenbelt, MD, USA
³Mechanical Engineering Branch, NASA Goddard Space Flight Center, Mail Code 543, Greenbelt, MD, USA

Composite structures are important for space applications because in many cases they have superior strength and are lighter weight than other materials. They also have low thermal expansion coefficients, and experience very little thermal deformation - an important property in the high thermal gradient environment of space. The purpose of this project was to first understand the process of analyzing composites and then apply that knowledge to the design of a structure. Experimental data on the ultimate failure of composite test specimens was found and compared to existing failure theories. This knowledge was applied to strength and buckling analysis of a composite pressure vessel for the proposed satellite gamma ray detector called AdEPT, the Advanced Energetic Pair Telescope. The new composite design is expected to reduce the weight of the project enough to enable feasibility of a future mission.
Mechanical Structure Developments for PIPER within Vacuum and Cryogenic Environments

Callie Branyan\textsuperscript{1}, Alan Kogut\textsuperscript{2}, Paul Mirel\textsuperscript{2}

\textsuperscript{1}University of Arizona, Department of Aerospace and Mechanical Engineering, Tucson, AZ, USA
\textsuperscript{2}Astrophysical Sciences Division Observational Cosmology Laboratory, NASA Goddard Space Flight Center, Mail Code 665, Greenbelt MD, USA

The Primordial Inflation Polarization Explorer (PIPER) is a balloon-borne, sub-orbital payload that will be used to measure the polarization of the cosmic microwave background (CMB) and search for the imprint of gravity waves produced during an inflationary epoch in the early universe. Detection of these gravity wave signatures would establish inflation as a physical reality and would provide a direct, model-independent determination of the relevant energy scale. The payload consists of proven technology which includes two cryogenic, off-axis telescopes cooled to 1.5K and a detector suite all situated in a 5000 liter Dewar and submerged in liquid helium. The liquid helium is used to bring the sensor suite and telescopes down to 1.7K in order to operate at background limited sensitivity. PIPER consists of a detector suite that provides an extremely accurate measurement of the CMB that will distinguish the unique signature of inflationary physics in the early universe. The results from the flight will have profound consequences for cosmology and high-energy physics showing that the universe did enter an inflation epoch. The 5120 detectors located within the Dewar must be sealed in a vacuumed vessel and submerged within the liquid helium. It is crucial that the vacuum is maintained so that the detectors can function properly. A window is needed to allow light waves to enter the vessel and interact with the detectors. A glass-to-metal seal between a fused silica window and the stainless steel vessel was developed and tested in order to withstand the vacuum under cryogenic conditions. A lid for the Dewar was also designed to keep the sensor suite cold while it awaits its launch. It is also used to channel the exhaust helium gas out through the aperture to keep the ambient air from condensing on the optics when the instrument is at float altitude with the door open. The lid has an articulated door that will close when the sight of the telescopes is pointed towards the sun in order to prevent the liquid helium from boiling off. These mechanisms will be used to allow all instruments to maintain their sensitivity and to function properly.
Development of Zero Stress Tungsten Thin Film Characterization for in Situ Mission to Solar System Primitive Bodies

Cody A. Gonzalez¹, Manuel A. Balvin²

¹University of California, Bourns College of Engineering, Riverside, CA, USA
²Detector Development Laboratory, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

This study will develop a method for achieving zero intrinsic stress in Tungsten thin films deposited by magnetron sputter deposition. Tungsten was selected for its relatively low thermal expansion coefficient of 4.3 \(10^{-6}\) m/m K compared with 22.2 for Aluminum.

The examination of the stress in these materials is driven by efforts to advance the development of a detector that utilizes a micro-lid to capture prebiotic compounds such as amino acids. The microlid will be actuated by the application of electricity to heat a bilayer film cantilever beam, which will open due to the difference in thermal expansion coefficients. A characteristic feature of the intrinsic stress behavior in tungsten is its sensitivity to the magnitude and sign of the intrinsic stress with argon gas pressure, including the existence of a critical pressure that results in zero film stress. The film will be characterized by a Film Stress Measurement (FSM) machine prior to and after the deposition at various pressures above and below the critical pressure as well as after any annealing of the thin film. Low stress films are important in the development of cantilevers because that will allow them to maintain a neutral bend. Current work performed includes the characterization of the deposition parameters of Tungsten so that the appropriate thickness can be deposited with low intrinsic film stress.
Thermal Analysis of a Printed Circuit Board

Christopher Cody Howes¹, Charles E Clagett²

¹University of Maryland, A. James Clark School of Engineering, College Park, MD, USA
²Components and Systems Branch, NASA Goddard Space Flight Center, Mail Code 596, Greenbelt, MD, USA

A major concern when designing a spaceflight hardware system is determining whether the components will perform sufficiently in the mission environment. In particular for printed circuit boards (PCBs), the component temperatures should be evaluated to determine if they will overheat. My task this summer was to determine the temperature contours of the GEDI MCE board in the flight chassis. To conduct such a study, one must have the power dissipation of each component, maximum temperature these components can perform at, boundary conditions, and a program that can analyze all of this information. To analyze such a configuration, one must import the PCB assembly from a computer-aided design program into a thermal analysis program, and input all the power dissipations and boundary conditions. The program will then analyze the system and compute the final temperature of each component. Then one can calculate the margin between the maximum allowable junction temperature and the junction temperature measured. Once the computation was complete, the average temperature margin out of all the components was about 36°C, with the greatest and smallest margins being 125°C and 3°C. The results indicate the current configuration is not expected to malfunction during flight due to overheating. This analysis technique is very useful and adaptable to many configurations of equipment and is a vital tool when analyzing a system.
Physics-based NEO Deflection Tool Validating Kinetic Impactor Mission Opportunities

Christopher Kenny¹, Yadvender Singh Dhillon¹ Brent Barbee²
¹International Space University, Rue Jean-Dominique Cassini, France
²Navigation and Mission Design Branch, NASA Goddard Space Flight Center, Mail Code 595, Greenbelt, MD, USA

The project investigates the domain of flight dynamics in planetary defense using kinetic impactor technology to deflect Near Earth Objects (NEO), which pose a significant threat to planet Earth. A detailed literature review has revealed analysis of the NEO population and evidence of wide ranging impact-events in the past. The project ultimately addresses the maximum potential deflection imparted on a NEO for a range of launch windows and time of flight (TOF) to the NEO. The project addresses the physics-based decision making algorithms with several constraints in place. Specifically the model incorporates ephemeris data in to a restricted 4-body problem, and solves for potential TOF and velocity vectors for the spacecraft using a Lambert solver. In addition, NEO physical characteristics have been considered and the collective results are utilized to compute deflection imparted on a target NEO. Results obtained were then used to plot the spacecraft TOF versus launch date indicating the potential NEO deflection due to kinetic impact. Further post-processing and mission simulation were conducted to form detailed analysis. The results can be used to demonstrate the performance of the kinetic impactor NEO threat mitigation strategy. In addition, the tool generated can be incorporated in to complex models for enhanced decision-making.
Lab on chip devices can provide accurate results while having the advantage of being compact and lightweight. A Tungsten-Aluminum (W-Al) Bi-metal cantilever, for implementation in a MEMS device, is fabricated to act as a “box lid” that will open to collect samples. Much like how a thermostat coil works, the cantilever will be actuated by a coefficient of thermal expansion (CTE) mismatch between the W and Al. Silicon Dioxide was grown and then patterned onto a silicon wafer; a sacrificial layer of Parylene was deposited at the same thickness as the silicon oxide. Aluminum was deposited and patterned on the wafer. The low CTE Tungsten was then deposited and removed via lift-off. A final Al layer was then deposited, patterned, and the excess was removed using lift-off. It is crucial to the proper functioning of the cantilever, that the metals are deposited with low/zero stress characteristics. Without this criteria, the cantilevers will warp and potentially break due to intrinsic filmstress. Finally, the wafer is dry etched to remove the sacrificial Parylene layer, thus allowing for a free hanging cantilever. In conclusion, Bimetal cantilevers, actuated by CTE mismatch, are a necessary part to the overall success of the device, and both reliable and reproducible once the proper recipe has been determined.
3D Printed Model of the WFIRST Observatory using Additive Manufacturing Techniques

William Alberding¹, Rosemary Davidson², Christen McWithey³, Jonathan Ruffa³, Jeff Stewart⁴, Giulio Rosanova⁴

¹St. Mary's College of Maryland, St. Mary's City, MD, USA
²University of Maryland, College Park, MD, USA
³University of Maryland, Baltimore, MD, USA
⁴Mechanical Engineering Branch, NASA Goddard Space Flight Center, Mail Code 543, Greenbelt, MD, USA

The Wide-Field Infrared Survey Telescope (WFIRST) is currently a Pre-Phase A observatory project, preparing for conceptual design reviews. In order to effectively visualize the current design concept of WFIRST, an interactive model of the entire observatory was created for the benefit of all personnel involved in the project. Given the amount of time and resources available, a MakerBot Replicator 2X 3D printer was identified as the most efficient tool for production. There are five main components of the observatory that were produced as removable sections: the spacecraft, the instrument carrier, the telescope (including the Outer Barrel Assembly (OBA)), and the main instruments (Wide Field Instrument (WFI), Coronagraph (CGI)). A stand was also designed to safely secure the model while on display. It was necessary that the model be accurately downscaled, yet robust enough to withstand frequent handling loads. To achieve the required size, the observatory was scaled down to 4% of actual size. Many properties of the design were structurally weak and/or inadequate when scaled down. Therefore, several parts were adjusted or redesigned to be thicker, stiffer, and more realistic for Additive Manufacturing production techniques. Additionally, designated interior features of the observatory were required to be accessible and visible. New parts were engineered to accommodate the need for user interaction and the 3 deployable systems were designed as moving components. These are the Solar Arrays, High Gain Antenna, and Telescope Door. Due to the small size of the model, extremely fragile pieces were redesigned [by the interns], and manufactured out of metal to prevent structural failure. The observatory can be displayed in two configurations: stowed, the initial position during launch; and deployed, when the Observatory is operational in space. Different types of adhesives were used to assemble the model that demonstrates both configurations. The completed mockup provides viewers with a more in-depth, hands-on understanding of the design of the WFIRST observatory.
Installation and Removal Techniques of Surface Mount Electronic Components Using Infrared Heating Equipment

Colin Tardrew¹, Ken Simms²
¹Georgia Institute of Technology, Atlanta, GA, USA
²Astrophysics Science Division, Instrument Development Branch, NASA Goddard Space Flight Center, Mail Code 619, Greenbelt, MD, USA

In modern electronics, components that are shipped with solder, such as a chip with a ball-grid array mounting pattern, are typically shipped with lead-free solder for environmental reasons. This type of solder is prohibited by NASA’s standards for space flight devices because lead-free solder is typically made up of high percentages of tin, which leads to a phenomenon called tin whiskering, which can cause electrical shorts. The purpose of this project is to explore methods for installing and removing these components on an electronic circuit board. Because we are unable to use lead-free solder for flight purposes, it is necessary to develop a procedure for removing the lead-free solder balls shipped on ball-grid-array chips, and subsequently re-ball them with flight suitable tin-lead alloy solder. I have developed a method to prepare these components using an infrared heating apparatus and install them on a board using the same IR heater. By trial and error, I have developed various heating profiles in the machine’s control software, which optimally heat electrical components and circuit boards for installation and removal without damaging other components or the board. This makes it easier to use widely available commercial electronic components for flight quality devices.
Design of Edge-Trimming Machine for Light-Weighted Monocrystalline Silicon Optical Structures

Connor Zipfel¹, Ryan McClelland²

¹University of Maryland, A. James Clark School of Engineering, College Park, MD, USA
²Next Generation X-Ray Optics, NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

This project is a continuation of previous Next Generation X-Ray Optics (NGXO) monocrystalline silicon manufacturing technology development efforts. It focuses on designing machines capable of producing accurate edge trimming of mono-silicon optical structures. Methodology centers on dimensional tolerances and cost analysis. Prior research and experimentation demonstrated feasibility of high quality, low cost silicon manufacturing using fixed diamond abrasive sawing. Edge-trimming procedures will be optimized to produce these results. The new technology will allow another step of the mono-silicon manufacturing process to be done in-house, thus adding a degree of control to, and decreasing the cost of, the NGXO mission.
JPSS Flight Project Training Database

Daniel Comberiate\textsuperscript{1}, Casey Hoercher\textsuperscript{2}

\textsuperscript{1}University of Maryland, A. James Clark School of Engineering, College Park, MD, USA
\textsuperscript{2}Joint Polar Satellite System Flight Projects Directorate, NASA Goddard Space Flight Center, NASA JPSS Facility, Mail Code 474, Lanham, MD, USA

The purpose of this project is to create a database for the Joint Polar Satellite System (JPSS) Flight Project that can be used by the training lead to create knowledge tests for the Mission Operations Support Team (MOST). This training database will contain information on the spacecraft and each of the instruments as well as general flight operations. It will transform the current training method of pulling training questions from the vendor-provided PowerPoint presentations into a quantitative testing system using Microsoft Access queries that will generate a random set of questions from the database. These questions form knowledge quizzes used during training activities that test the operations engineers’ understanding on the various aspects of operations. As part of creating the database, I have to first become familiar with the information myself in order to create questions and find answers. This entails reading through instrument source material including user manuals, recommended operating procedures, and training presentations and contacting engineers who are working on the instruments. Using this training database, MOST will be able to generate quizzes effectively and quickly to train team members and ensure that the team has the required understanding.
Mechanical Support and Testing Structures for Optical Systems on BETTII

David Levine\textsuperscript{1}, Stephen Rinehart\textsuperscript{2}, Arnab Dhabal\textsuperscript{2}

\textsuperscript{1}Cornell University, Sibley School of Mechanical and Aerospace Engineering, Ithaca, NY, USA
\textsuperscript{2}Observational Cosmology Laboratory, NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

The purpose of this research was to design and manufacture ground support equipment and support mechanisms for the internal optical systems on BETTII (Balloon Twin Telescope for Infrared Interferometry). BETTII is a balloon-based interferometer that will provide newfound insights into clustered star formation and active galactic nuclei when it is launched in Fall 2016. Specifically, this research addressed the method used to support and hang the bench holding BETTII’s internal optics so they could be properly aligned and tested before launch. This project also included the design and manufacture of enclosures/supports for electronics controlling BETTII’s warm and cold delay lines. These structures were designed after the analysis of the optical bench/delay line electronics and consultation with senior engineers on the BETTII team in order to identify specific design constraints. Designs were then created using SolidWorks, and promptly fabricated using manual machining techniques. The ground support equipment will effectively support the optical bench in the same manner that it will be supported in flight, where it will be vertically lowered in a cryostat. The enclosures for the delay line electronics will provide physical protection for the important optical control systems (whose LabView code was also improved) and will be mounted to BETTII’s exterior. Overall, these mechanical support/testing structures should help BETTII reach its goal of proving the functionality of a space-based interferometer and revolutionizing astrophysics through its exploration of the far-infrared.
Metal Whiskers

Duncan Turner¹, Dr. Henning Leidecker²

¹Mount Vernon High School, Alexandria, VA, USA
²Electronic Parts and Packaging, NASA Goddard Space Flight Center, Mail Code 562, Greenbelt, MD, USA

My summer project is an experiment that is a continuation of Karim Courey’s doctoral dissertation. He determined the voltage needed to break down the insulating films on metal whiskers. Breaking down the insulating layer on the whiskers means they become conductive and can cause electrical shorts. My experiment uses a similar method, but instead of measuring the breakdown potential of the insulating layers, I am measuring the breakdown potential of the contact resistance of the whiskers. This is important because when the contact resistance of the whisker breaks down it can cause electrical shorts as well. I will be running a voltage through the whiskers, and at the point where the contact resistance breaks I will measure the voltage. Through collecting all this data I will be able to create a probability curve that can determine the probability that a whisker becomes conductive.
Development of Image Analysis Routines for WFIRST Detector Characterization

Davis Gustav Unruh¹, Jonathan Mah²
¹Bowdoin College, Brunswick, ME, USA
²Detector Characterization Lab, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

In order to compare the performance of IR imaging detectors for astronomy applications, the image data needs to be analyzed to produce certain figures of merit. Most notable are dark current, noise, gain, and quantum efficiency. Depending on the operating conditions such as temperature and voltage bias, these can vary for a particular detector. It is important to be able to accurately represent these statistics in order to properly compare detectors. This project examines the design and development of image analysis routines to characterize different properties of IR detectors. Over the course of the project, these routines were developed in the form of a graphical interface to measure these different properties for data read out of a generic square IR detector. The figures of merit generated using this interface will be compared across detectors and varying operating conditions, and used in the process of developing and improving the detectors for eventual use in the WFIRST telescope.
Thermal Coating Processing Improvements with the Use of O₂ Plasma

Dylan Kline¹, Mark Hasegawa²

¹University of Arizona, College of Engineering, Tucson, AZ, USA
²Thermal Coatings Laboratory, NASA Goddard Space Flight Center, Mail Code 546, Greenbelt, MD, USA

It has been estimated that 90 percent of all coating failures are directly related to poor surface preparation. However, this liability could be alleviated with the use of a well-defined process for surface preparation that can be used for a variety of coatings currently used in space flight hardware. After exposure to oxygen plasma, the MLP 300 primer demonstrated an improvement of the adhesion to the Z93 CS5 thermal coating. In the interest of a larger scale thermal coating production with this method, it is important to determine how the plasma is distributed within the vacuum chamber in order to guarantee qualities of the product, as well as to determine the time and cost to prepare the surface in this manner. Using an array of carbon-coated mirrors, oxygen plasma concentration was determined based on how much carbon was eroded from the surface of the mirror through the use of optical measurements. After determining that the plasma concentration was symmetrical about a center line in the vacuum chamber, a higher resolution image of the plasma distribution could be determined through closely placed mirrors. It was shown that plasma concentration is inversely related to the distance from the oxygen inlet and inversely related to the distance from the electrode in the chamber. This characterization of the plasma distribution and its effects allows for better overall thermal coating production for future space flight hardware.
GPS III Space Service Volume Specifications Study

Elizabeth Blair Carter¹, Joel Parker², Jennifer Valdez³

¹University of Tennessee, College of Engineering, Knoxville, TN, USA
²Navigation and Mission Design, NASA Goddard Space Flight Center, Mail Code 595, Greenbelt, MD, USA
³Components & Hardware Systems, NASA Goddard Space Flight Center, Mail Code 596, Greenbelt, MD, USA

While the Global Positioning System (GPS) is commonly used to provide positioning, navigation, and timing (PNT) services to land, marine, and air applications on Earth, spacecraft are also increasingly reliant on GPS for PNT services. All spacecraft in the Space Service Volume (SSV), the region that includes Medium Earth Orbit (MEO), Geosynchronous Orbit (GEO) and High Earth Orbit (HEO), receive GPS signals, enabling spacecraft to have high precision orbit determination and less expensive attitude and timing solutions compared to attitude sensors and atomic clocks. At orbits above the GPS constellation, the Earth blocks most of the GPS signals, so spacecraft rely on GPS signals broadcast over the limb of the Earth. Most of these signals are from sidelobes, rather than the main lobe of GPS signals, making the sidelobes vital to spacecraft above the GPS constellation. Currently, there are no specific requirements for GPS sidelobe performance, so SSV users are subject to a wide range of signal strength and satellite availability. Certain requirements are necessary to ensure a guaranteed level of GPS performance, particularly for spacecraft relying on the sidelobe signals. This study focuses on determining an adequate level of signal availability and received power for SSV users, so that requirements can be set. The study uses GPS antenna patterns to determine the minimum mean received power at GEO from sidelobes, the total received power at GEO from sidelobes, availability of GPS satellites at MEO and HEO/GEO, and dilution of precision at GEO. The results provide a framework for future GPS III satellite requirements, an important step in maintaining GPS services for SSV users.
Alignment and System Testing for OTS for LCRD

Ethan F. Julius¹, Peter N. Blake²

¹Cornell University, Cornell School of Arts and Sciences, Ithaca, New York, USA
²Optics Branch, NASA Goddard Space Flight Center, Mail Code 551, Greenbelt, MD, USA

The Laser Communications Relay Demonstration (LCRD) is the next step in optical communications and aims to eventually have satellites communicate via laser rather than the traditional radio frequency (RF) waves. This will both increase the bandwidth available for sending and receiving data as well as greatly reduce the amount of energy required to do so. LCRD uses an Optical Test Set (OTS) to test the Optical Assembly (OA), and then the Optical Module (OM). The OTS is being assembled and tested in a clean room facility in preparation for the arrival of the flight hardware. The goals have been to continue moving forward with the alignment and eventual system testing of the OTS. We are aiming to complete all alignment procedures for the Calibration, Telescope, Wide Field of View and Small Optics bread boards. Interferograms of the Calibration and Telescope bread boards were taken and analyzed to ensure a wavefront error of less than 0.04 waves. A Laser Unequal Path Interferometer (LUPI) at 633nm was used to check the wavefront double passing through the Calibration optics and Telescope. The LUPI was eventually replaced with the infrared laser used for the Calibration beam which was then passed through all breadboards to the wavefront sensor. The wavefront error was still below the tolerance of 0.04 waves. Additional procedures are now being followed to boresight and co-align all the breadboards as well as characterize the angular magnification, stability, uplink polarization, and uplink and downlink powers. Additional work includes installation of all computer hardware, motorized stages and the corresponding scripts and pieces of software. When the OTS is finally completed and fully tested, it will be used to help verify that the OA and OM are ready to be added to the LCRD payload and launched into orbit.
Alternative Wick Structure Testing for Loop Heat Pipes

Efrain Alejandro Torres¹, Eric Silk², Henry Fitzpatrick³

¹University of Puerto Rico at Mayaguez, College of Mechanical Engineering, Mayagüez, PR, USA
²Cryogenics and Fluids Branch Head, NASA Goddard Space Flight Center, Mail Code 552, Greenbelt, MD, USA
³Cryogenics and Fluids Associate Branch Head, NASA Goddard Space Flight Center, Mail Code 552, Greenbelt, MD, USA

Loop Heat Pipes (LHP) technology has contributed successfully to numerous space applications, for purpose of thermal control on satellites and spacecraft. The LHP is a two-phase thermal management device that operates by acquiring heat from a source and rejecting it to a temperature sink. Also, this technology does not have moving parts, thus making it more effective and reliable. During this study, we used a Loop Heat Pipe designed and manufactured by Mikros Manufacturing Inc., and validated by Goddard Space Flight Center’s Thermal Engineering Branch Laboratory to investigate heat flux performance capability of a low surface tension fluid when using a porous foam. The LHP’s primary and secondary wick structures are made of compressed carbon foam. The working fluid used during the experiments was PF-5060. In order to add heat to the LHP, a heater block containing two 500 Watts cartridge heaters, immediately in contact with the evaporator that has a cross-sectional area of 0.877 cm². To better characterize the thermal performance, the sub-cooler/condenser works in three different temperatures combinations (15°C, 10°C and 5°C).
Underwater Wireless Optical Communications

Emily Lunde\textsuperscript{1}, Patrick Coronado\textsuperscript{2}, Ron Shiri\textsuperscript{2}

\textsuperscript{1}University of Minnesota – Twin Cities, Department of Mechanical Engineering, Minneapolis, MN, USA
\textsuperscript{2}Optics Branch, NASA Goddard Space Flight Center, Mail Code 551, Greenbelt, MD, USA

The purpose of this project is to develop a testbed for an underwater wireless optical communication system. Acoustic systems are primarily used for underwater applications; however, the bandwidth of such systems is low because sound propagates slowly through water. In the visible light spectrum, blue and green wavelengths have lower absorption and scattering levels in water than other wavelengths of light. Since light travels at a faster speed than sound, a higher bandwidth can be obtained. Initially we transmit and receive data using LED sources in free space. For this purpose, we employ Arduino test boards. On the transmitter side, a file is converted into binary strings. This is sent from the computer to an Arduino which modulates a blue LED by turning it on and off depending on what bit the Arduino is reading. The light then travels through the air and through a lens that directs the light to a photodiode. A second Arduino reads the photodiode output and sends the data to a computer where it is converted back into a readable file. To apply this to underwater applications, we are employing a fiber-coupled green laser placed outside a small water tank and a photodiode receiver placed on the opposite side of the tank. The goal is to achieve a data transfer rate of about 1 Mb/s.
Absolute Position Sensor Development

Katherine Everett¹, Umesh Patel²

¹Rowan University, College of Engineering, Glassboro, NJ, USA
²Electromechanical Systems Branch, NASA Goddard Space Flight Center, Mail Code 544, Greenbelt, MD, USA

The goal of this project was to develop a design concept for a new optical absolute position encoder. The need for position encoders spans a wide variety of NASA missions, including any application where it is necessary to track the location of a moving part (such as when aiming an instrument). This project involved researching existing position sensor technologies and identifying the key features that make an encoder accurate, reliable, and capable of being produced in-house at a low cost. The final product included the design of a scale to be used in a pattern recognition encoder, as well as the algorithm that the encoder uses to process information and translate it to position data. Based on research of existing technologies, it was determined that Leviton’s barcode-style pattern recognition encoder would be the best suited for this application; the pattern of this encoder can be designed to be one-dimensional and redundant in nature, allowing for both faster and more reliable computations. The patterned scale of this encoder was paired with a newer charge-coupled device (CCD) in order to test this encoder and identify any weaknesses in the design that could be improved upon.
Long-Duration, Low-Gravity Sloshing Experiment

John C. Froehlich¹, Steven Kosco², David J. Benson³
¹Portland State University, Portland, OR, USA
²West Virginia University, Morgantown, WV, USA
³Propulsion Branch, Goddard Space Flight Center, Mail Code 597, Greenbelt, MD, USA

The sloshing dynamics of liquid propellant tanks in micro-gravity environments present many current problems that affect the performance of spacecraft attitude control. Energy lost from the movement of the propellant in fuel tanks affects the gyroscopic stability of spacecraft, this instability can lead to catastrophic control issues caused by nutation (rocking, swaying, or nodding motion). Currently, there is a major lack of experimental benchmarks to validate computational fluid dynamics (CFD) sloshing predictions and because of this, predicting slosh motion continues to be of great difficulty to the aerospace industry. The goal of this project is to begin designing an experiment that will map the force distribution along the inside wall and propellant management device (PMD) of a propellant tank, while collecting low-gravity, long-duration sloshing data for the purpose of validating common CFD slosh motion models.
Integration of Flight Software with 42 to Enable CubeSat Hardware-in-the-Loop Testing

Gabriel Gonzalez ¹, Cinnamon A. Wright²

¹ Boston University, Department of Astronomy, Boston, MA, USA
² Navigation and Mission Design Branch, NASA Goddard Space Flight Center, Mail Code 595, Greenbelt, MD, USA

One way that CubeSat programs lower cost and save time is by bypassing much of the analysis and documentation that larger missions undertake, and focusing on testing throughout all phases of the project. Streamlining a mission's hardware testing can drastically reduce the amount of person hours spent on developing a test from scratch, which not only reduces the cost of the mission, but speeds up the test/build phase as well. This all amounts to a mission that is able to get launched much sooner, for less money. Consequently, the goal of this study was to create an interface between a CubeSat and flight software, as well as between flight software and 42. Once the interface was created, it would be generalized to allow future CubeSat missions to easily connect to the software package and test one or more of its satellites and sensors, in parallel. To accomplish this, key areas of the software and its design were targeted; namely, critical actions that needed to be done (e.g. Initialize, Receive, Analyze, Collect, Send, Receive, ...), the method of communication, the format of data being sent, and necessary sensor attributes. By focusing on these points, the team was able to integrate a simulation environment with two mock-up satellite platforms enabling testing of both their flight software and hardware. The hardware testing included a Raspberry Pi with a Coarse Sun Sensor, created using four solar cells, and a DC motor as the sensor/actuator combination.
Space Communications and Navigation Network Integration Project Cesium Access Planning Environment

Matthew Hansen¹, George Bussey²

¹Parks College of Engineering, Aviation, and Technology at Saint Louis University, St. Louis, MO, USA
²Telecommunication Network Technology, Mail Code 566, Greenbelt, MD, USA

With the independent maturation of the various space communication networks, there currently exists a need for a single customer interface that both simplifies and streamlines the communication planning process. The SNIP project satisfies both of these requirements, while optimizing communication intervals to allow for maximum customer access to the various networks. SCAPE will create a user friendly environment for customer interface interaction. SCAPE utilizes Cesium, a program produced by Analytic Graphics Inc., to allow for the visualization of these intervals in a free web-based environment. With the ability to upload CCSDS compliant ephemeris data into the web-based portal, SCAPE provides the customer with the capability to quickly determine the access plan that best suits their needs for mission success. SCAPE also allows for future mission planning by providing a means to upload and compare various orbits simultaneously. When the development phase completes, SCAPE will remove current program dependencies, which require costly licenses to maintain. SCAPE’s functionalities will save both time and cost over the current system resulting in an overall increase in satisfaction for both client and provider.
Tracking and Data Relay Satellite Systems Waveform and Noise Generator Design

Ian Madray¹, Haleh Safavi²

¹University of Louisiana at Lafayette, Lafayette, LA, USA
²Telecommunications and Networking Technology Branch, Mail Code 566, Greenbelt, MD, USA

The Tracking and Data Relay Satellite Waveform and Noise Generator (TWANG) acts as a Space Network User Guide-compatible transmitter waveforms as well as a source of signal distortions. The project enables NASA to verify compliance with functional, performance, and interface requirements. In 2010, the original TWANG software was written and tested. However, the project terminated in the same year of its genesis. As a result, little documentation existed of the code. Thus, the current project, in regards to the TWANG software, is to debug, verify, and simulate the created software. Overall, the project consists of three steps: first, the debugging and verification of testing files, second, the debugging and verification of the main Graphical User Interface files, and third, the integration of the main software with a software-defined radio. For the duration of the project, the focus was completing the first step. The completion of the first step will produce a convolutional code, a Low Density Parity Check (LDPC) code, a Reed-Solomon code, a Turbo Product code, a pseudo-noise generator, an additive white Gaussian noise wave, and a Gold code. In the future, the TWANG project will be used for another project: the Tracking and Data Satellite Radiometrics and Channel Simulator (TRaCeS). TRaCeS’s primary purpose is to simulate valid customer return service signals as well as provide digital samples of Space Network waveforms.
Advanced Energetic Pair Telescope Instrument Structure Design

Jaime Berez\textsuperscript{1}, Kenneth Segal\textsuperscript{2}

\textsuperscript{1}University of Maryland, College Park, University of Maryland, College Park, MD, USA
\textsuperscript{2}Mechanical Engineering Branch, NASA Goddard Space Flight Center, Mail Code 543, Greenbelt, MD, USA

The Advanced Energetic Pair Telescope, or AdEPT, is a gamma-ray imaging instrument being researched and developed by scientists at NASA’s Goddard Space Flight Center. The detection method that AdEPT uses requires the instrument hardware to operate in a pressurized environment with a specific gaseous mix present. Thus, a structure that supports the instrument hardware and accommodates the pressurized environment is required. This structure presents a mechanical design challenge, and the AdEPT science team has approached designers and analysts of the Mechanical Engineering Branch to help them find a solution. The design of the AdEPT instrument structure aims to find a solution that is low-cost, light-weight, and meets the requirements of the AdEPT instruments and science team. These two attributes of cost and mass are specifically important as the AdEPT science team would like to use these designs to help build a scaled proof-of-concept model and eventually prove the viability of a full-scale flight mission. Thus a design that utilized composite materials and structures is was pursued. The deliverables of this design include and overall concept design of the AdEPT instrument structure, description of the trade space considered, detailed CAD models of the designs, and defining documents for the structure/instrument interface. The design address creating a pressure vessel that can sustain the loading applied and provide instrument interfaces that create meet the scientific needs.
The Effects of the Biophysical Microenvironment on Human Mesenchymal Stem Cell Behavior during Simulated Microgravity

James L. Wang¹, Carlos Luna², Adam H. Hsieh², Alvin G. Yew³

¹University of California: Los Angeles, Henry Samueli School of Engineering and Applied Sciences, Los Angeles, CA, USA
²University of Maryland: College Park, A. James Clark School of Engineering, College Park, MD, USA
³Applied Engineering & Technology Directorate, NASA Goddard Space Flight Center, Mail Code 500, Greenbelt, MD, USA

Studies have previously shown that human mesenchymal stem cells adapt to simulated microgravity by changing their morphology and decreasing their cell area. In addition to external forces (such as gravity), the cellular microenvironment plays a vital role in cell morphology, behavior and stem cell lineage. This study explores the potential effects of controlling the cellular microenvironment during simulated microgravity and hypothesizes that biophysical alterations to the cell substrate (stiffness, topography and micro-patterns) will modulate cell behavior in simulated microgravity. To test the individual and combined effects of these variables, a previously developed clinochip system was used to create a lab-on-chip device that included substrates of different properties. First used was a substrate made of polydimethylsiloxane (PDMS) micro-posts suitable for traction-force microscopy and clinorotation. The posts were organized 2.5 or 5 µm apart with a height between 5-10 µm and a diameter of 2.5 µm. The density and stiffness (0.1 or 1 MPa) of the micro-posts allowed for the modulation of cell adhesion as well as the measurement the traction forces during simulated microgravity. Second, fibronectin surfaces were micro-patterned onto glass slides to constrain cell adhesion using lines (5,10, and 15 µm thick) and circles with the same array as the previously described micro-posts. These surfaces facilitated the control of cell geometrical shape. The cells were then exposed to clinorotation prior to the measurement of cell morphology, actin cytoskeleton, and cell adhesion. This study allows us to understand the relationship between cell microenvironment, microgravity, and cell adhesion. Future studies will explore the potential effects of modulating cell adhesion and osteogenesis in microgravity.
Development of Circuit Simulations and Control Algorithms for Critical Flight Test Hardware

Jacob Drewniak¹, Umesh Patel²

¹University of Illinois at Urbana-Champaign, UIUC School of Engineering, Urbana, IL, USA
²Electromechanical Systems Branch, NASA Goddard Space Flight Center, Mail Code 544, Greenbelt, MD, USA

Safe-to-Mate hardware testing is an important part of the design process because it ensures that hardware is designed correctly and effectively in a low risk scenario before being connected to critical flight electronics systems. It is also useful for ensuring proper workmanship and assembly during manufacturing. Automating this process can reduce testing time as well as prevent possible human measurement error. The project to produce an ASTM (Automated-Safe-To-Mate) is in the design review stage, and the current design is being refined and validated by writing programs to simulate the performance of the ASTM and control its pin connections to provide the most accurate impedance readings. According to the findings of the simulation programs, the current design works effectively for measuring pure resistance, but some alterations to the design and control algorithm are necessary to measure impedance across more complex connections involving RC and RL circuitry. These alterations show promising results but are as of yet unfinished. The significance of this study cannot be undersold because it is necessary for validating proper connection and functionality of critical flight hardware.
Silicon Mirror Grinding Equipment

Jaime McCarrell¹, Raul Riveros², Michael Biskach²
¹Trine University, Angola, IN, USA
²Next Generation X-Ray Optics, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA

In order to achieve the next great X-ray images, mirror creation is a vital step that must be improved. The Next Generation X-Ray Optics team has found that very high angular resolutions can be achieved when the mirrors used to redirect and concentrate the x-rays are fabricated from silicon blocks. The results found using the silicon mirrors outshone even the best results found using the previous method of glass slumping. Using this new method, the mirrors are ground and polished from single crystal silicon blocks. The first step of mirror creation is to rough grind the approximate radius of the mirror into each silicon block. Later the block will be precision ground on the micron level, then polished to make the surface reflective. A functioning grinding machine exists and is currently in use for the smaller radius mirrors, but a need arose for machinery with which to grind the larger radius mirrors. To resolve this issue, an additional grinding machine was built that is able to accommodate the grinding tool for these large radius mirrors. In addition to the grinding machine, a turntable-type grinding machine was built to be used for grinding the corners and rough edges of the silicon blocks. This helps maintain part quality in subsequent manufacturing steps. Both of these machines will contribute to the further development of the silicon mirror fabrication process. Once the grinding and polishing processes are perfected, mirrors will be able to be mass-produced with a greater resolution than ever before.
Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII)

Caleb Jo¹, Dr. Stephen Rinehart², Maxime Rizzo²
¹University of Idaho, Moscow, ID, USA
²NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII) is high altitude balloon. The balloon consists of a payload to provide data from an 8 meter-long system with two telescopes to provide high angular resolution in the far-infrared. Star cameras are required to find the orientation of the payload based on the balloon position relative to stars. An auto focus mechanism was developed to insure that accurate data can be acquired. The camera and the auto focus mechanism were tested in thermal-vacuum chamber and an auto-tensioner was added to keep constant tension on the belt. The onboard flight computer will not be in a pressure vessel therefore testing was needed to insure this computer would function in the operating environment. The computer system was tested in the thermal-vacuum chamber using a custom copper strap attached to the heat sink. Adjustments were made to the power supply so it would turn on at lower temperatures. The payload has multiple power sources and an Arduino based system was designed to read and record the current used by the entire balloon in Amp-hrs. This will give an accurate measurement of the life left in the batteries during flight.
Temperature and Flow Rate Sensor Fabrication

Jonathan Itschner¹, George Manos²
¹West Virginia University, Benjamin M. Statler College of Engineering and Mineral Resources, Morgantown, WV, USA
²NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

Microfabrication processes allow for the development of compact electrical sensors and mechanisms nearly invisible to the naked eye. A fluid flow and temperature sensor is one such device that can be used to measure the temperature and flow rate of a fluid through a specially designed channel. This project is unique in that it incorporates the fluid flow into the sensor chip, creating a "Lab on a Chip" type of system. It eliminates the need to route fluids outside of the sensor area, resulting in a more streamlined and efficient process for sensor measurements. Various microfabrication procedures such as photolithography, reactive ion etching, and metal deposition are used to construct such a sensor. The careful planning and ordering of each step of the manufacturing process ensures the end product will closely match the original design. Once the sensors are assembled, they are packaged in such a way so that data can be read from them and their functionality tested. A properly functioning sensor with expected data outputs indicates a successful fabrication run and verifies the sensor design.
Precision Eddy Current Displacement Sensor

Justin Dao¹, Umesh Patel²

¹University of Vermont, Electrical Engineering Department, Burlington, VT, USA
²Electromechanical Systems Branch, NASA Goddard Space Flight Center, Mail Code 544, Greenbelt, MD, USA

The purpose of this project is to develop an in-house, inductive eddy current displacement sensor capable of micrometer-scale resolution. Inductive displacement sensors are used currently in a wide variety of applications such as telescope mirror positioning, pointing and tracking in laser systems, and various vibrational control systems. Many commercially available products today are expensive, considered proprietary, and depend on analog demodulation techniques that are highly susceptible to noise and variations in operational temperature. In this research, alternative frequency and phase modulation techniques were explored in LR and LC tank circuits respectively, and capabilities of each method are presented in an initial review. This preliminary discussion of various techniques will further NASA’s development of eddy current sensors in hopes of eventual integration into field-programmable gate arrays (FPGA).
Engineering

Visual Inspection and Use of Satellite NO$_2$ Observations

Jazmin C. Urioste$^1$, John F. Moses$^2$

$^1$Arkansas Tech University, Russellville, AR, USA  
$^2$Science Data Systems Branch, NASA Goddard Space Flight Center, Mail Code 586, Greenbelt, MD, USA

One of NASA’s goals is to study Earth from space to advance scientific understanding and meet societal needs. Nitrogen Dioxide (NO$_2$) is a widespread noxious air pollutant. NO$_2$ forms when coal, oil, gas or diesel fuels are burned at high temperatures. The most prominent sources are cars, truck and bus engines and power plants. The highest concentrations occur in large urban regions and are highest near heavily travelled roadways. The US Environmental Protection Agency has found adverse effects on the environment and human health when average concentrations were over 53 ppb annually. Since the launch of the Aura spacecraft in 2004, NASA has provided satellite measurements of NO$_2$ from the Ozone Monitoring Instrument (OMI). The purpose of this project is to explore instrument data processing methods for utilizing OMI observations of Nitrogen dioxide. We add functionality to test science data algorithms for use in building multi-day composites. We have modified and added descriptions of components within the algorithm to gain better understanding of the purpose of each class and what it is contributing to the composite algorithm. In order to create a more precise display of NO$_2$ concentrations, we included additional functions within the composite algorithm that will display a geopolitical boundary to enable a more accurate visual inspection of the OMI product. Along with the geo-political boundaries, we added additional evaluation steps for analysis-ready NO$_2$ grids. In some instances, NO$_2$ concentration is not observed in areas due to cloud coverage in the atmosphere, which causes our display to shows holes, or gaps. To avoid this distraction of visual inspection, we have added an algorithm that fills the gaps. We have developed a simple atmospheric model, which allowed us to consider methods that compare ground-based observations with satellite observations. Results show that the atmosphere model played a significant role in the ability to use satellite observations of NO$_2$ concentrations.
Engineering

Portal-Based Interplanetary Communications Modeling

Kaley Pinover¹, George Bussey²

¹University of Colorado Boulder, College of Engineering and Applied Sciences, Boulder, CO, USA
²Telecommunication Networks & Technology Branch, NASA Goddard Space Flight Center, Mail Code 566, Greenbelt, MD, USA

Reliable communications planning is essential to the successful exchange of data and spacecraft commands in spaceflight missions. Both commercial and government missions rely on NASA’s Space Communication and Navigation (SCaN) networks for telecommunications during flight; currently, potential SCaN network customers are forced to contact each of NASA’s three networks independently for preliminary mission design. In order to provide an integrated customer interface for the Near Earth (NEN), Space (SN), and Deep Space (DSN) networks, NASA is establishing the SCaN Network Integration Portal (SNIP), which will allow customers to access telecommunication planning and analysis tools for all three networks in a web-based portal. This project focused on the development of one SNIP tool, LATTE (Loading Analysis Tool for Telecommunications Engineers), which provides spacecraft communication schedules. Since LATTE is limited to near-Earth missions and is reliant on specific spacecraft position information for schedule generation, this study sought to create software to extend LATTE’s planning capabilities to interplanetary missions and a variety of spacecraft position data inputs. Interplanetary mission compatibility required inclusion of hyperbolic trajectory calculations, planetary position modeling and interference determinations, and time compensations to account for relativistic warping and speed of light signal limitations. LATTE was also altered to allow three distinct inputs: orbital elements, position and velocity at a single point during flight, and position over a specified interval. These inputs are industry standards defined by the Consultative Committee for Space Data Systems (CCSDS), and enable LATTE to accept information from a variety of customers. Upon implementation of these updates and validation using existing high-fidelity models, LATTE produced interplanetary communication schedules with accuracies of ±0.75 minutes, and is CCSDS compliant. These contributions enhance SNIP’s interplanetary planning capabilities and further SCaN’s goals of CCSDS compliance, which enables dissemination of space mission planning information to customers and the general public.
All Federal agencies have a directive from the Energy Policy Act of 2005 (EPAct 2005) to reduce energy use in new and existing federal buildings. Subsequently, the Energy Independence and Security Act (EISA) of 2007 extended the energy reduction goal to 30% by fiscal year 2015. March 2015’s Executive Order 13693 extends energy and water reduction goals to FY2025 with FY15’s usage data serving as the baseline year. The aforementioned Federal policies provide the basis for NASA’s goals for energy and water reduction and efficiency. Energy and water efficiency and reduction at NASA Goddard Space Flight Center (GSFC) focused on: (1) obtaining baseline energy usage data for building operations; (2) ensuring that each building at GSFC is operating at optimal efficiency considering building utilization, occupancy, and other factors that are critical to the building purpose; and (3) reducing the baseline usage data through implementing energy maintenance and reduction initiatives and projects. During this summer, I started formalizing the Emergency Energy Security and Conservation Plan, which is a document required under the Federal policies mandating energy reduction. In addition, I worked on creating a visual basic application (VBA) algorithm that allowed for a more streamlined analysis of building electric and water meter data. The data is uploaded into the Energy Star Portfolio Manager online software for energy and water use analysis.
Two-Phase Microgap Cooling for Next Generation Electronic Systems

Keith Coulson¹, Frank Robinson²
¹Missouri University of Science and Technology, Rolla, MO, USA
²Thermal Engineering, NASA Goddard Space Flight Center, Mail Code 545, Greenbelt, MD, USA

Electronics are getting both smaller and more capable. However, in order to continue making improvements in small-scale electronics, current thermal management limitations must be overcome. Remote cooling has long been the preferred method of cooling computer chips, but it cannot maintain its effectiveness at higher heat fluxes and heat densities. To conquer the thermal limitations, embedded cooling is required. Forced convection using fluids like water provide enough heat transfer, however two-phase flow, specifically annular flow as opposed to other regimes, is preferable. The microgap causes the fluid to transition to annular flow earlier than it would in a larger channel, and it reduces the flow's sensitivity to gravity. For these reasons, it is preferable to cool the chips using two-phase microgap cooling. By testing the cooling capabilities of two-phase flow in a high aspect ratio microgap with various orientations, gravity independence and cooling capabilities can be verified.
PiSat 2.0, Flight Software Systems Testbed

Keegan Moore\textsuperscript{1}, Alan Cudmore\textsuperscript{2}

\textsuperscript{1}Capitol Technology University, Laurel, MD, USA
\textsuperscript{2}Flight Software Systems Branch, NASA Goddard Space Flight Center, Mail Code 582, Greenbelt, MD, USA

PiSat is an Internal Research and Development (IRAD) project to create a low-cost mission testbed for flight software systems and a potential CubeSat prototype. The Raspberry Pi, an embedded Linux system, which is about the size of a credit card, was the platform used due to its speed and size, general purpose input/output (GPIO) pins and USB ports, not to mention its extremely low cost. The Raspberry Pi and its peripherals including modules such as a GPS receiver, compass, accelerometer, RF transceiver, and camera allow us to test the flight software being developed while collecting actual data from the testbed instead of using simulated hardware. PiSat uses the core Flight Software System (cFS), a system developed and deployed for multiple satellites including LADEE, LRO, GPM, and MMS, as the software framework for developing software on the Raspberry Pi. Using the cFS required little time to be spent working on the basic flight software functionality and allowed for more attention to be paid to the actual mission testbed and mission applications which can easily be added to the cFS. The key flight software application created includes interfacing with a visible light spectrometer and updates to the navigation module. Development of all flight software applications included creating ground system components to communicate with. The IRAD developed a small, low cost system with key features like navigation, file transfer, and science data collection, and PiSat 2.0 demonstrated its growth as a flight software system testbed.
Graphene Based Chemical Sensors for Space Applications

Peter M. Knapp¹, Stephen W. Lebair², Mahmooda Sultana³

¹University of Illinois at Urbana Champaign, Department of Mechanical Science and Engineering, Mechanical Engineering Building, Urbana, IL, USA
²University of Maryland at College Park, Department of Materials Science and Engineering, College Park, MD, USA
³Detector Systems, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

Sensors to detect gasses will be instrumental in future space exploration allowing for the detection of chemical hazardous or even life. Graphene, a 2D form of carbon, has shown promise as a material for chemical sensors because of its measurable change in electrical properties upon exposure to gases. In order to utilize these sensors it is necessary to produce them reliably and insure they will respond to compounds of interest. To that end the aims of this project were to refine transfer methods, to build graphene devices, and to determine how to functionalize graphene surfaces such that they respond to specific gases. The quality of graphene grown in-house and by collaborators via Chemical Vapor Deposition (CVD) is determined by Raman Spectroscopy. The primary problem addressed in refining device production was the need to reduce polymer residues that remain after graphene is placed on a substrate. Various solvents including acetone, N-Methyl-2-pyrrolidone (NMP), and chloroform, were used to dissolve the residues; success of cleaning was gauged using Atomic Force Microscopy (AFM). In order to functionalize graphene sensors nanoparticles, of varying composition and density were deposited on graphene using Atomic layer Deposition (ALD) and Electron Beam Evaporation techniques, and was subsequently tested for selectivity and sensitivity. Results of these experiments indicated that strong solvents (NMP and Chloroform) were needed to reduce polymer residues to levels low enough to be fully removed by a final anneal in argon and hydrogen. Literature review and preliminary tests indicate that metal nanoparticles sensitize graphene to simple gases while oxide nanoparticles sensitize graphene to more complex and even organic compounds. The fully integrated device was tested by measuring the electrical response of the graphene to the exposure of ambient gases under vacuum. In conclusion, graphene can be utilized, using proper processing techniques, to make highly selective gas sensors.
Optical Navigation Methods for OSIRIS-REx Mission

Kirsten Strandjord¹, Kenneth Getzandanner²

¹Purdue University, School of Aerospace Engineering, West Lafayette, IN, USA
²Navigation & Mission Design Branch, NASA Goddard Space Flight Center, Mail Code 595, Greenbelt, MD, USA

The OSIRIS-REx spacecraft will begin its approach to the asteroid Bennu in August of 2018. At the time of approach, the spacecraft will be millions of kilometers away from the asteroid and orbit determination will rely on optical navigation to calculate accurately the spacecraft ephemeris. Pictures from onboard cameras will provide astronomical images that will be used to reference photometric models. The method to generate the models uses the star Vega as a standard candle and point spread functions to simulate stars queried from a catalogue based on the field of view from an a priori estimate of the camera orientation. The process for matching the photometric model to the astronomical image employs a geometric hashing algorithm and a higher fidelity least squares estimator. Utilizing several techniques of optical navigation and image processing, the approach is proficient in star detecting, center finding, and matching the image orientation. The procedure is an important first step in determining the spacecraft and camera pointing while the target body, Bennu, is still resolved only as a point source of light.
Low-Cost Reaction Wheel System for Use in CubeSats

Kurtis Boulter\textsuperscript{1}, Charles Clagett\textsuperscript{2}

\textsuperscript{1}University of Maryland Baltimore County, Baltimore, MD, USA
\textsuperscript{2}Mission Engineering and Systems Analysis Division, Mail Code 596, Greenbelt, MD, USA

The purpose of this project is to design a low-cost reaction wheel system to position a small-scale satellite while it is in orbit. The systems that are currently used are expensive and cannot be optimized to work with small satellites varying in size and configuration. During this project a reliable, universal, and versatile reaction wheel system will be designed, built, and tested. In order to keep costs down, off-the-shelf parts will be utilized. Research is being conducted to select an appropriate brushless DC motor, and to determine what modifications would need to be made to an off-the-shelf motor in order to prepare it for use in a space environment. Also, specific dimensions for a set of different reaction wheel masses will be determined so that one basic motor system can produce different amounts of torque and thus be used on a wide range of small satellites. Motor choices are being made and the modifications to allow the motor to operate in a vacuum are being carried out. This summer, the mechanical portion of this project will be completed so that in the future work can be continued on the electrical portion and a usable system can be built. This project has that potential to be significant because it will not only save money on an important subsystem of CubeSats but also will be universal by having interchangeable masses so that it can be used on a wide range of satellites.
Reflow Soldering and Silver Leaching on ICESat-2 Silver-Palladium Electrical Terminations

Kyle S. Johnson¹, Lyudmyla Panashchenko²
¹ The George Washington University, George Washington University School of Engineering and Applied Science, Washington, DC, USA
² Electronic Parts, Packaging, and Assembly Technologies, NASA Goddard Space Flight Center, Mail Code 562, Greenbelt, MD, USA

This project presents the results of investigation that was performed to augment failure analysis on ICESat-2 project. The electronic part in question was a MiniCircuits’ TCCH-80+ RF chokes with silver-palladium (Ag/Pd) 80/20% by weight pads used in the ATLAS instrument on ICESat-2. The part experienced an electrical open during box-level temperature cycling testing, which was traced to a damaged Ag/Pd pad on the part. In this experiment, the RF chokes were exposed to two types of molten solder for a varying number of dips and varying dip durations. Eutectic tin-lead (Sn/Pb) solder was tested to match the solder used on ICESat-2, and tin-lead-silver (Sn/Pb/Ag) 62/36/2% by weight was tested to determine the impact of silver leaching on bond integrity. After the refloows, the parts were tested for electrical continuity and compared to virgin parts. Finally, the parts were cross-sectioned and metallurgical analysis was performed to detect the presence of intermetallics that may have formed during exposure to molten solder as well as to determine the amount of degradation in the bonding/Pd pad. The data suggest that cumulative duration above solder melting temperature determines the amount of bond degradation present, with prolonged durations resulting in open circuit. Furthermore, these methods show that bonds fabricated using eutectic Sn/Pb solder degrade after significantly less time above melting temperature than do the bonds created using Sn/Pb/Ag solder due to silver leaching into the Sn/Pb solder. Sn/Pb/Ag solder was demonstrated to not have a noticeable effect on leaching of Ag from the pad. The failure observed on ICESat-2 can, therefore, be explained by excessive rework of the part with SnPb solder that lead to degradation of the Ag/Pd pad termination. It is recommended that parts with Ag and Ag/Pd terminations are not reworked. However, if rework is inevitable, use of Sn/Pb/Ag solder should be used to avoid degradation of the termination that may result in an electrical open.
Embedded Systems containing a field-programmable gate array (FPGA) are susceptible to radiation in space and mitigation techniques have been developed to improve the reliability of such devices. Radiation is difficult to simulate at a realistic rate. This study is to develop a tool that can simulate radiation upsets (SEUs) so mitigation techniques can be tested and improved upon. This tool would allow a user to test every possibility and control the rate of radiation upsets. The target device in this study is SpaceCube, a hybrid computing system based on Xilinx Virtex-5 FPGAs. The device that simulates radiation upsets by injecting faults through the JTAG interface is a BYU, Brigham Young University, ConfigMon. In this study, three different configurations for the FPGA were tested by injecting a single fault at a time while the effect and recoverability of the error was observed. The results showed that less than 1.5% of the possibilities resulted in an error in the output and required a reset. Less than 0.01% of the possibilities required a full reconfiguration of the FPGA. The tool was successfully able to test the possibilities that could happen in reasonable time. The configurations in the study contained no mitigation techniques and with this tool, configurations that contain mitigation techniques can be tested and compared to the ones that were tested to prove their reliability in space.
Next Generation X-Ray Optics: Mirror to Module Bonding

Lindsey Barner¹, Michael Biskach²

¹Messiah College School of Engineering, One College Avenue, Mechanicsburg, PA, USA
²Next Generation X-Ray Optics, NASA Goddard Space Flight Center, Mail Code 660, Greenbelt MD, USA

In light of ongoing efforts at NGXO to develop unprecedented X-ray telescopic capabilities, the advancement of X-ray optics is essential. In part, this mission necessitates improving methods to bond mirrors to modules. Currently, NGXO manually applies adhesive material to bonding locations. Since it is a tedious process, this study sought to establish application methods and solutions that are efficient, consistent, and repeatable. Specifically, this study determined the underlying cause of Loctite migration, a phenomenon that causes premature lockdown on untouched pins. A working solution to impede this undesired effect was implemented. In addition, this study sought to optimize the repeatability of adhesive application by exploring the use of syringe dispensers. While syringes have not yet been integrated into current processes, they serve as a basis for further consideration. They may eliminate application variability and improve bonding consistency. In essence, this study made considerable progress in regards to bonding mirrors to modules. Application problems were addressed, solutions investigated, and new possibilities explored. Nevertheless, this study does not conclude the development of methods, but rather justifies the need for continued research.
Noisy Neighbors: Understanding Noise Generating Components in Your System

Luke Conover¹, John McCloskey²

¹University of the Sciences in Philadelphia, Philadelphia, PA, USA
²Electrical Systems Branch, NASA Goddard Space Flight Center, Mail Code 560, Greenbelt, MD, USA

To ensure that signals are relayed to a system operating on Earth or in Space, it is crucial to test the system for electromagnetic compatibility (EMC). If it is not compatible, the system could become uncontrollable during flight or experimentation. Among the primary sources of Electromagnetic interference (EMI) on spacecraft are power converters. Power converters are used to transform lower DC voltage into a new AC voltage that can be used elsewhere. A byproduct of the design is that it also generates a noisy signal due to the switching frequency that converts the DC level to an AC voltage across the transformer. A simple design using an input voltage, resistive load, and a power converter was constructed to observe and analyze the noise that can be generated. To collect the data, both antennas and current probes were utilized; allowing for the measurement of both radiated and conducted emissions. The data recorded from the tests did indeed show that the power converter generates noise at its fundamental switching frequency and its harmonics. To counter this issue, a series of filtering systems and dampening networks were integrated into the design to help attenuate the noise from the power converter. The filtering systems and dampening networks consisted of a combination of capacitors, inductors, and resistors which helped attenuate the noise of the power converter by at least 15-25 dB; proving that it is an effective method. The tests conducted were performed to electronically show that if a system is not treated for EMI, it will not be electromagnetically compatible with a spacecraft or system, and could result in lost time, skewed measurements, and financial repercussions.
Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities

Nyki L. Anderson¹, Anshula Gandhi², Taylor K. Handleton³, Mackenzie K. Kynoch⁴, Sean K. Terry⁷, Rahul Tiwari⁶, Kathryn M. Waychoff⁴, Yongsong A. Cho⁷, Emily A. Gilbert⁸, Ciera A. McCrary⁷, Ryan W. Pfeifle⁹, Joseph Roth¹⁰, Spencer C. Shabshab⁷, Dr. Richard K. Barry¹¹

¹University of Maryland, College of Computer, Mathematical, and Natural Sciences, College Park, MD, USA
²Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA, USA
³University of Maryland, Department of Electrical & Computer Engineering, College Park, MD, USA
⁴Dartmouth College, Department of Physics and Astronomy, NH, USA
⁵Catholic University of America, Department of Physics – Graduate Program, Washington, DC, USA
⁶Purdue University, School of Mechanical Engineering, West Lafayette, IN, USA
⁷United States Naval Academy, Aerospace Engineering Department, Annapolis, MD, USA
⁸Brown University, Department of Physics, Providence, RI, USA
⁹George Mason University, School of Physics, Astronomy, and Computational Sciences, Fairfax, VA, USA
¹⁰North Dakota State University, Department of Physics and Astrophysics, Fargo, ND, USA
¹¹Laboratory for Exoplanets and Stellar Astrophysics, NASA Goddard Space Flight Center, Mail Code 667, Greenbelt, MD, USA

The goal of the Precision High Altitude Star Tracker (PHAST) is to conduct a baseline investigation of low-cost, open source fine pointing instruments for use on ballooncraft. Scientific ballooning provides a unique platform for subjecting experimental hardware to space-like conditions without expending a significant amount of budget. Advancing technologies are enabling powerful new payloads and these experiments will open new discovery spaces for science at a fraction of the cost of a space mission. PHAST’s scalable and open-source design will be made available to all researchers to unlock this new discovery space for scientific ballooning. The current focus is on fabrication and optimization of a star tracker composed of commercial computers, cameras, and lenses, as well as open source astrometric software. Ruggedized computers and compact cameras have been shown to perform exceptionally well in float conditions without the need for a pressurized vessel. Small CCD and CMOS sensors are an excellent candidate for the camera system on PHAST. Now, that off-the-shelf components are a viable option for suborbital missions, PHAST software prototypes are on the verge of mission launch. Eventual total system integration testing procedures are in the works. Preliminary results suggest that fine pointing instrumentation can be built on a budget about 10% that of commercial star trackers and requires little to no specialized skill. PHAST, though still early in its development, has indicated great potential for similar low-tech, high-performance instruments. There are many areas that would benefit from such technology and with them, discovery spaces we have yet to imagine.
Quality Management System in the Applied Engineering and Technology Directorate

Miles Harriston¹, Melonie Scofield²

¹University of Maryland, A. James Clark School of Engineering, College Park, MD, USA
²Applied Engineering and Technology Directorate, NASA Goddard Space Flight Center, Mail Code 500, Greenbelt, MD, USA

Quality engineering is central to the NASA mission: without proper quality assurance in place, there would be no way to verify whether or not a product meets its needs and expectations. Quality is necessary in all departments of NASA, especially the Applied Engineering and Technology Directorate (AETD). If even the smallest piece of hardware is flawed in some way, whether shorted out from electrostatic discharge, or chipped from improper handling, there is an increased risk of mission failure. It is crucial that there are procedures in place for AETD to have proper quality assurance. This project established a training program for AETD’s supervisors to ensure that the levels of quality assurance will be sufficient in all branches of the directorate. The finished product of the program was in the form of a presentation. It covered the various responsibilities supervisors must undertake, identifies AETD’s mission of continuous improvement and ways in which it strives for it, how to deal with nonconformance reports through root cause analysis and use of the Meta system, how to maintain documents and forms within the directorate, and maintain training in their branches. Once this training program is implemented, it is expected that it will further supervisors’ understanding of the necessity of quality in their fields and how they can contribute to improving it throughout AETD.
Polarization Modulator Drive System Design and Testing

Andrew Mahon¹, Al Kogut², Paul Mirel³

¹University of Minnesota – Twin Cities, College of Science and Engineering, Department of Aerospace Engineering and Mechanics, Minneapolis, MN, USA
²Observational Cosmology Laboratory, Astrophysical Sciences Division, NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA
³Principal Systems Engineer, PIPER Project, Observational Cosmology Laboratory, Astrophysical Sciences Division, Wyle Information Systems, NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA

The Primordial Inflation Polarization Explorer (PIPER) is a balloon-borne experiment from the Observational Cosmology Laboratory of the Astrophysics Science Division at NASA Goddard Space Flight Center. The experiment seeks to observe B-mode polarization in the Cosmic Microwave Background (CMB) Observation and characterization of this polarization, if it exists, is a direct test of inflationary physics. ”

To measure this polarization the PIPER mission will utilize a pair of twin, off-axis telescopes; each paired with a Variable-Delay Polarization Modulator (VPM). The VPM consists “of a polarizing grid in front of and parallel to a planar mirror. The polarization parallel to the grid is reflected by the grid. The orthogonal linear polarization passes through the grid and is reflected off the mirror. The two components are recombined at the output … with a relative phase delay that is dependent upon the grid-mirror separation…” This phase delay between the two signal paths modulates the polarization angle of the output, allowing rotation from linear to circular polarization.

Additionally, the VPM provides the primary signal modulation for the PIPER mission’s instruments. It is the first optical element in each telescope chain, and as such instrumental systematic errors from other elements can be removed through signal demodulation. To ensure a high signal to noise ratio the VPM, and all other optical elements, are kept at 1.7K in a liquid Helium bath.

A linear drive system is used to oscillate the VPM’s planar mirror through 1 millimeter of travel at a frequency of 3 Hz, modulating the distance between mirror and wire grid. It has been proposed to drive this oscillatory motion with an electromagnetic Voice Coil (VC) Motor. Driving modulation with a VC Motor would provide a system that was compact, has a low thermal impact on the overall telescope system, and adds no mechanical noise. Since these motors provide a force response, rather than a position response it is also necessary to design a controls system to position the mirrors precisely.

The first work I undertook was to quantify the system’s motion and the necessary driving forces. Once this was completed I researched and ordered the appropriate VC Motor. I completed CAD modeling to modify the experimental models to facilitate installation of the new motor. Sensors and sensor mounts were added to quantify the mirror’s position and velocity for the input into the controls system. Parts were manufactured by the M&P Machine Shop in Code 665, after which I assembled the VPM system to
begin control system development and testing. Currently I am extracting the system PID parameters, after which we hope to proceed to a cryogenic temperature systems test.
Satellite Service Valve O-ring Radiation and Leak Test

Marcos Robert Vaughn Espinosa¹, Gregory Thomas Coll²

¹California State University Long Beach, Long Beach, CA, USA
²Satellite Servicing Capabilities Office, NASA Goddard Space Flight Center, Mail Code 408, Greenbelt, MD, USA

The Satellite Servicing Capabilities Office of NASA’s Goddard Space Flight Center is developing technology to robotically refuel a satellite in orbit, via its service valves. The service valves include a dynamic o-ring secondary seal, which is necessary to prevent propellant leakage once the primary seal is opened. Since high energy radiation in the space environment causes physical degradation of soft materials, it was necessary to confirm the viability of service valve o-rings already installed in satellites which have been in geosynchronous or low earth orbits for years. This study exposed service valve o-rings to high energy radiation with two material types, identical to those typically found on spacecraft currently in orbit. The leak rates were then measured after each dose, and the safety factors of radiation exposure were also determined for each o-ring material.
Intensity Measurement of Petal-Shaped Grayscale Lithography Mask for Gravity Wave Mission

Michael Christopher Maring¹, Ron Shiri²

¹University of Minnesota-Twin Cities Department of Biomedical Engineering, Minneapolis, MN, USA
²Optics Branch, Wavefront Sensing and Controls Group, NASA Goddard Space Flight Center, Mail Code 551, Greenbelt, MD, USA

Binary petal masks have been used in optical systems to block the light source in order to be able to take measurements from faint objects within the field of view. In particular, this geometry of mask has shown an advantage over traditional circular occulters (masks) by reducing the intensity of the hotspot in the shadow of the mask, known as the Poisson spot. However, for use on the gravity-wave missions, the suppression of the light is required to be ten orders of magnitude lower than the source, which is not currently possible due to geometric limitations of the binary mask on the secondary mirror of optical telescope. Grayscale lithography masks function by altering the phase of the incoming light, which achieves the same level of suppression as the binary petal masks. Both the binary and grayscale masks have been modeled using Fresnel impulse response propagation. Intensity measurements of the masks have been taken using an electron multiplier charge-coupled device (emCCD) camera, and have been compared to the models to validate the results.
Radiation Effects Testing and Analysis for MAX9180 LVDS Repeater

Yuechen Yang¹, Michael J. Campola²

¹Massachusetts Institute of Technology, Cambridge, MA, USA
²Radiation Effects and Analysis Group, NASA Goddard Space Flight Center, Mail Code 561, Greenbelt, MD, USA

Flight missions possess inherent risk of exposing mission crucial electronics to radiation. Protons, electrons, and heavy ions from sources such as Van Allen belts, the magnetosphere, Galactic Cosmic ray, and Solar flares – can all have adverse effects on flight hardware. The primary objective of this project is to conduct and analyze a total ionizing dose test on the Maxim MAX9180 Low-Voltage Differential Signaling (LVDS) Repeater. The parameters of interest are the supply current, rise time, and fall time of the device. Radiation testing is done by exposing test circuit boards mounted with the chips to gamma radiation at high and low dose rates. Twelve parts are tested – 10 exposed to radiation (5 are biased with 3.3 V at Vcc, and 5 are unbiased), and 2 as controls. The dose steps are 0.5 kRad(Si) from total dose level 0 kRad(Si) to 2 Krad(Si). Since the device still performed with specifications after 2 kRad(Si) total dose, the dose step is increased to 1, 2.5, and 10 kRad(Si) respectively. Then After each dose step, the parts are tested again and returned for irradiation within the time limits defined by MIL-STD-883, Method 1019. The data is analyzed with R and the device is shown to be performing within specifications at approximately 30 kRad(Si) total dose.
Analysis of the Effectiveness of 3D Printing with HIPS Support Material

Maxwell Hakun¹, Steven Kenyon²

¹University of Maryland-College Park, College Park, MD, USA
²NASA Goddard Space Flight Center, Mail Code 543, Greenbelt, MD, USA

In order to create complex machinery such as the instruments at NASA, one cannot simply build the space-bound instrument immediately. For the process of designing building an instrument from first pitching the idea to testing the instrument for the eventual launch, models are an integral part of turning the ideas of scientists into realities. For my internship I have been given the goal of improving the NICER mechanical team’s ability to generate models vital to the NICER. The focus of my study was on analyzing the practical applications of an alternative support material called HIPS for its properties of dissolution in Limonene and the generation of standard values and protocols on how to best use and handle the substance to ensure maximum results. I also worked on general improvement, maintenance, repair, and building of the 3D printers and a computer in the office for my use. For the testing of the HIPS support material in conjunction with standard ABS plastic I was given a part to print repeated times to experiment and list the effectiveness of certain input values such as temperature and speed for the printing, while also factoring a comparison to using only ABS plastic. Along with analyzing and recording these findings, the cleaning of the multiple repeated parts of the HIPS residue allowed me to experiment and determine a basis upon which to maximize the effectiveness and ease of cleaning away the Limonene and HIPS to leave only the intended ABS part. My findings through this testing allowed me to develop the opinion of circumstance to the effectiveness and whether to use HIPS support material. Some parts which are open or thin or parts through which no other type of support will work should be recommended to use HIPS support material as it works quite well in printing in conjunction with ABS and if the part is so designed to be open can be relatively effectively cleaned. However, my test part and those, which contain hard to reach crevices will be found impossible to effectively clean. When effective I would still recommend standard ABS based support due to the hassle of cleaning and operating, though I commend it for offering an alternative and overall acceptable solution to the problem of printing some parts.
The project's general description was to design a room that would hold a robotic cell, including a robotic freeform area. Within the robotic cell there could be a minimum of 4 specific machines including a turning center, a milling machine, a multi-tasking machine, and a coordinate-measuring machine (CMM). However, any variety and number of these manufacturing activities can be accommodated as long as it fits in the space. The freeform area, also known as the sandbox, would include a robotic arm that would be able to perform freeform manufacturing, whether it be welding, additive manufacturing, grinding, laser cutting, assembly, etc. In designing the room a proposal was made for the minimum floor space required, and also the air, power, lighting, maintenance and safety requirements, while staying in proper code and regulations. After the research was completed and different cell options were drawn and proposed, the linear floor track cell was chosen. With the flexible floor plan of the linear floor track, the next step was to find a location within the facility that would be able to hold and maintain the robotic cell. Once the location was chosen, using the specs of the utilities in that area and the minimum utilities needed for the robotic cell, an outline for the remaining utilities that would have to be installed in the area in order for the robotic cell to function will be written. Any changes that need to be made, whether it is to the infrastructure or to the utilities in the area, will be presented. In the end, an area was chosen and the minimum requirements for the robot cell were listed. The next intern on this project will now be able to continue building the cell and ensure that the cell meets its full potential.
Gamma 300 Case Design and Air Track Rail Construction

Matthew Campbell¹, Kyle Reed², Joseph Scolaro³, Connor Tagg⁴, Brian Roberts⁵

¹River Hill High School, Clarksville, MD, USA
²Severna Park High School, Severna Park, MD, USA
³University of Maryland-College Park, College Park, MD, USA
⁴Case Western Reserve University, Cleveland, OH, USA
⁵Satellite Servicing Capabilities Office, Goddard Space Flight Center, Mail Code 408, Greenbelt, MD, USA

The goal of the gamma 300 case project was to design a case and clamp for the gamma 300, a multi-jointed robotic arm to enhance high school level engineering and programming courses. The air track rail is designed to simulate the collisions in space for testing purposes for the re-fueling robotic arms. The air track is designed to test how reaction forces will move the robotic arms when they collide with the satellites they are intended to re-fuel so that the collisions can be tested before the multi-million dollar equipment is launched into space. To build the air track system a basic air track glider, like the ones in every physics class, was used but then equipped with electronic equipment to measure the position along an encoder strip.
Simulation Using a Zedboard

Miranda Nettey\textsuperscript{1}, Charles Rogers\textsuperscript{2}

\textsuperscript{1}University of Maryland Eastern Shore, Princess Anne, MD, USA
\textsuperscript{2}NASA Goddard Space Flight Center, Mail Code 428, Greenbelt, MD, USA

Spacecraft simulators are critical to the development of in-house spacecraft and instruments. These simulators are critical to every phase of the spacecraft development from developing a feasible design and developing a cost model (Instrument development lab (IDL), Mission Design Lab), to developing and collaborating during the development phases (spacecraft sims, instrument sims) to I&T for spacecraft testing (Goddard Dynamic Simulator (GDS), spacecraft software sims to allow for procedure development to post launch activities (ground base anomalous and training simulation). The objective is to create a simulation environment using a Zedboard (dual ARM) system on a chip. Real time Xenomai/Win drivers VxWorks RTOS and Goddard Core Flight Executive/Core Flight System (CFe/CFS) will be ported to the platform. Additionally, ground systems will be ported to control the sim. Custom interfaces will be ported (MIL-STD1553/Space wire). This is the basis for the new Sims.
Developing the Multi-channel Frequency Conversion Module (MFCM) for the Wide-swath Shared-aperture Cloud Radar (WiSCR)

Daniel Hirsh1, Martin L. Perrine2
1The City College of New York, New York, NY, USA
2Microwave Communications Branch, NASA Goddard Space Flight Center, Mail Code 567, Greenbelt, MD, USA

In order to understand the effect of climate change on Earth’s hydrological cycle and energy balance, it's critical to obtain accurate global-scale cloud and precipitation measurements. Prior and present missions, such as CloudSat, the Tropical Rain Measurement Mission (TRMM) and the Global Precipitation Measurements (GPM), only focus on either cloud or precipitation measurements, but not both simultaneously. The Wide-swath Shared-aperture Cloud Radar (WiSCR) is a multi-frequency radar with high sensitivity and imaging capability, which can measure clouds and precipitation simultaneously. This project aids in the design of the Multi-channel Frequency Conversion Module (MFCM), which is part of WiSCR that handles bidirectional frequency conversion in order to support the various transmit and receive channels. Multiple radio frequency (RF) simulations were run, on both a component and circuit level. In addition, a test board was designed in order to allow for function testing and RF characterization of numerous subcircuits, such as amplifier circuits, bandpass and lowpass filters, power dividers, and frequency mixers, as well as to test and characterize transmission line effects. Time permitting, programming will be done to perform data analysis on existing radar data sets. The MFCM module, along with a Multi-channel Arbitrary Waveform Generator (MAWG), will be evaluated on the High-altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) through science flights in order to reduce the risk for usage on the space-borne radar platform.
X-ray Detector Development and Testing

Nicole Farrall¹, Jay Chervenak²

¹University of Maryland, James A. Clark School of Engineering, University of Maryland, College Park, MD, USA
²Detector Development Laboratory, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

NASA requires x-ray focal planes for future astrophysics missions. Each pixel in the focal plane has a distinct absorber structure that stops x-rays in order to measure their energy and location of impact on the array. The goal is to determine how closely packed we can make the x-ray absorbers, because the closer the absorbers are the higher the quantum efficiency of the focal plane will be. In this process it is also important to keep the time constant of the absorbers in the appropriate range (50 counts-per-second to 1000 counts-per-second), which is ultimately dependent on the absorber thickness. By fabricating devices that have different gold thicknesses, and various gap sizes we were able to determine the minimum gap size that could be cleared for each of the thicknesses. It was determined that gold with a 2 micron thickness can have absorbers that are separated by only 1.5 microns, while gold that is 4 microns thick can only support absorbers separated by 2 microns or more. This is significant because it was originally thought that the minimum separation attainable between absorbers was 1.8 microns. This process allows for the development of absorbers that are only 1.5 microns apart. Being able to fabricate absorbers that are this close together would lead to higher quantum efficiencies for the focal plane.
During my summer internship at NASA Goddard Spaceflight Center, I have worked in the Energy Management Program under code 200 and will be finishing the internship with working in the Satellite Servicing Capabilities Office (SSCO) under code 408. In the Energy Management Program, I worked on determining the financial impact of complying with the Imminent phasing out the Ozone harmful refrigerant HCFC-22 that is currently being used in several central power plant chillers at the Greenbelt Campus. In the Satellite Servicing Capabilities Office, I’m working with technicians and engineers to prepare room 150 in building 29 for robotic demonstration purposes. I have worked in Cell A, which contains an adjustable structure that supports the mockup of the Satellite Landsat 7 for the purpose of demonstrating refueling capabilities through robots. Also, in Cell B which holds the Engineering Design Unit (EDU) Robotic Servicing Arm which can be used to service satellites, assemble and service telescopes, and assist in asteroid capture. Through this experience I have been able to assist in assembly and tests in order to contribute to the mission of SSCO.
The primary goal of this internship was to use software to develop and utilize tools, mainly in the form of graphical user interfaces, for data processing and analysis. This was done for data coming from the Advanced Technology Microwave Sounder (ATMS) instrument onboard the Suomi-NPP satellite currently in orbit, and in preparation of ATMS instruments onboard future Joint Polar Satellite System (JPSS) satellites. Tools were built for science data, motor dwell data, and telemetry data, among other things, in order to determine characteristics of the ATMS motor, and the different data it sends back. This will benefit the scientists and engineers of the JPSS team who rely on this data to diagnose issues with ATMS. These tools allow for quick and easy display of different characteristics of the datasets, in order to uncover root causes of those issues that weren’t able to be seen previously, so that they might attempt to correct them.
International Space Station Instrument Pointing Platform Control System Design

Timothy Davison¹, Nicolas Augustus Rongione², Stephen J. Leete³

¹Trinity University, Department of Engineering Science, San Antonio, TX, USA
²University of Miami, Department of Mechanical and Aerospace Engineering, Coral Gables, FL, USA
³Mission Systems Engineering Branch, NASA Goddard Space Flight Center, Mail Code 599, Greenbelt, MD, USA

The International Space Station (ISS) provides a versatile and cost-effective platform on which to mount Earth science instruments. However, compared to traditional Earth science spacecraft, the ISS is an unsteady instrument platform with orbital variations in roll, pitch, and yaw of up to 15° in amplitude. These orbital variations result in errors for nadir or target of opportunity pointing of up to 90 km. In addition, the ISS provides knowledge of its state within 1 degree attitude, 1 second time, and 50 meters position error margins. Often, the high-fidelity science sought today for remote sensing applications requires on the order of arcseconds attitude using star trackers, and smaller time and position errors using onboard GPS. A pointing platform is being designed to incorporate these sensors and provide a two degrees-of-freedom solution to compensate for the ISS orbital movements for a variety of payload instruments on the ISS. The platform provides plug-and-play pointing control capabilities for a broad suite of Earth science instruments, facilitating more economical Earth science over multiple instrument life-cycles. Various aspects and functions of the pointing platform were simulated using MATLAB and Simulink. A control system was designed for the gimbal platform to meet the pointing requirements of Earth science instruments and accommodate the attitude variations of the ISS. This investigation included the characterization of the jitter induced by the ISS and a preliminary solution to the pointing and navigation problems. Overall, the solutions presented for the control system, ISS jitter, and vector pointing problems proved the technical feasibility of an ISS mounted pointing platform for future Earth science instruments.
Purge Flow Analysis

Nicole Demetrides¹, Jillian Pulia²

¹University of Maryland Baltimore County, Baltimore, MD, USA
²Contamination and Coatings Branch, NASA Goddard Space Flight, Mail Code S46, Greenbelt, MD, USA

This study seeks to improve understanding of the process of purging to increase its effectiveness in contamination and humidity control. The effects of a number of variables previously excluded from the governing purge equations including volume, diffusivity, and wall thickness on the time elapsed for the system gas to reach ambient conditions are to be tested and analyzed. At the current stage of the study, the test set up has been finalized and manufactured to include varying control volumes with a constant vent-to-volume ratio, a purge line into the volume, and temperature, pressure, and humidity sensors. In the upcoming weeks, the tests will be conducted and a new governing equation will be derived from the data.
Analysis of the Use of Composite Materials as Structural Radiation Shielding in the Exploration Augmentation Module

Olivia Landgrover¹, Kenneth Segal²

¹University of Pennsylvania, School of Engineering and Applied Sciences, Philadelphia, PA, USA
²Mechanical Engineering Branch, NASA Goddard Space Flight Center, Mail Code 540, Greenbelt, MD, USA

The aim of this work was to provide support to engineers at Goddard in collaboration with Langley Research Center and Marshall Space Flight Center working to develop habitats and radiation shielding onboard the Exploration Augmentation Module (EAM) to facilitate longer missions. Specifically, the potential role of composites in replacing aluminum components of habitat structures designed at Marshall Space Flight Center was evaluated. To do this, a rough model of the radiation environment en route to Mars using data from Curiosity's Radiation Assessment Detector (RAD) was developed to determine the long-term (>5 years) effects of radiation exposure on the materials, and in turn their ability to protect the crew over long periods of time. Mass reduction calculations, durability in harsh radiation environments, and mechanical properties of potential materials are evaluated to determine their suitability for deep space habitation and potential benefits over their aluminum counterparts, as well as the ease of design adaptability. Future implications include reduction of mass to an acceptably low level for launch as well as mitigation of secondary (scattered) radiation caused by the interaction of galactic cosmic radiation (GCR) and solar flares with metallic spacecraft components. Thus, two significant barriers to long-term missions beyond the Earth's protective magnetospheres can be reduced.
Package Design of a Waveguide to Microstrip Transition at W-band Frequency

Olga Rivera¹, Kongpop U-Yen²

¹Universidad del Turabo, School of Engineering, Gurabo, PR, USA
²Microwave Instrument & Technology, NASA Goddard Space Flight Center, Mail Code 555, Greenbelt, MD, USA

The goal of this work is to design a mechanical package for a waveguide to microstrip line transformer to thin-film superconductor. In addition, superconducting microstrip transmission lines and resonator resonators were studied for thin-film superconductor parameters extraction at the frequency band between 85 and 105 GHz. The package and microwave model of the structure were designed using SolidWorks and ANSYS High Frequency Software Simulator (HFSS), respectively.
Evaluation of Aerosol Jet Additive Manufacturing of High Density Printed Circuits

Omari Carter¹, Beth Paquette²

¹The University of Maryland Eastern Shore, Princess Anne, MD, USA
²Parts, Packaging and Assembly, NASA Goddard Space Flight Center, Mail Code 562, Greenbelt, MD, USA

NASA is sending an apparatus into space with the ability to monitor discharge of X-rays. However, the sensors being used are restricted by the size and type of metal traces, due to the etching process to create the traces. Aerosol Jet printing could be a solution to improve sensitivity and reduce detector size for astrophysics applications. This project determines if Aerosol Jet printing is a practical method for printing metals on a minute scale. 20 strips of Liquid Crystal Polymer (LCP)-half-printed with silver ink and the other with gold ink- were cut, cleaned, and then tested. They were tested for the metal’s adhesion to the polymer, the coupon’s ability to withstand intense heat and cold, and the coupon’s ability to function while bent at a maximum of a 90-degree angle. The testing proved that the traces could not be printed on the gloss side of the LCP in order to achieve the required adhesion. The LCP that was printed on also needed to be cleaned by Plasma Etching and could not withstand more than a few pounds of direct force to the traces. With the proper equipment and necessary precautions taken, Aerosol Jet printing can sufficiently reduce the sensor’s size and increase its accuracy.
NEXT Thruster Performance Curve Analysis

Pratik Saripalli\(^1\), Eric Cardiff\(^2\)

\(^1\)University of Maryland, College Park, University of Maryland, College Park, MD, USA
\(^2\)Propulsion, NASA Goddard Space Flight Center, Mail Code 597, Greenbelt, MD, USA

NASA’s Evolutionary Xenon Thruster (NEXT) is a flight-qualified EP system that is capable of offering 2 and a half times the thrust of the NSTAR ion engines. In order for it to be in future missions, its capabilities as a thruster must be quantified for mission planning. Therefore, performance curves of the NEXT thruster are highly important in determining the thruster’s ability towards mission-specific goals. However, existing performance curves don’t fully describe the thruster performance nor do they account for thruster degradation, resulting in possible inaccuracies in mission design. This research aims to generate new performance curves and compare them to the existing ones. Performance curves were generated for BOL, EOL, and high thrust modes for NEXT using tabulated data. These curves plot the thrust and mass flow rate as a function of input power at constant beam power supply voltage. They were then tested using the Evolutionary Mission Trajectory Generator (EMTG). EMTG is an in-house NASA GSFC flight dynamics low thrust global optimizer that provides solutions for various mission criteria. Starting with user-inputs of thrust and m-dot curves along with other constraints, EMTG produces a full mission solution. EMTG is also capable of optimizing solutions for a certain parameter. Three missions have been optimized for in this analysis: propellant, delta-V, and trip time. Three test missions were used to compare the throttle curves. They are an Earth to Mars, Earth to Vesta via Mars Flyby, Vesta to Ceres (DAWN) and Earth to Nereus, Earth to 1996 FG3 (NEARER). Launch and arrival dates along with propellant used were tracked and compared. The research shows variations in mission solutions based on which throttle curve is used. Furthermore, variations between BOL and EOL mission solutions exist, proving that thruster degradation has a possible effect on mission solution.
Development of a PC-based MPU Simulator for NICER

Rai Munoz1, Rohan Banerjee2, Dr. Keith Gendreau3, Dr. Jason Mitchell4
1Electrical Engineering, City University of New York, New York, NY, USA
2Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, MA, USA
3X-ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA
4Navigation & Mission Design Branch, NASA Goddard Space Flight Center, Mail Code 595, Greenbelt, MD, USA

The Station Explorer for X-ray Timing and Navigation Technology (SEXTANT) component of the Neutron-star Interior Composition Explorer (NICER) mission concentrates on demonstrating the effectiveness of real-time X-ray pulsar navigation (XNAV) to enable a GPS-like navigation capability. By observing Millisecond Pulsars (MSPs), which are neutron stars rotate hundreds of time per second, and using a series of filters and algorithms, SEXTANT will attempt maintain orbital state knowledge to within a 10 km error. To enable ground testing capability, Ground Support Equipment (GSE) is required to emulate the NICER detector hardware, and provide realistic science data measurements to the SEXTANT flight software. The current 7-channel Raspberry Pi based NICER detector GSE provides only functional testing capabilities, i.e., representing appropriate data rates, rather the performance testing capabilities, i.e., producing representative science data at appropriate data rates. For SEXTANT, a similar, single-channel emulator has been created, providing only functional test capabilities. To enable performance testing of the SEXTANT flight software in real-time and with hardware-in-the-loop, a full 7-channel detector emulator providing realistic science data at appropriate rates is required.

To address this issue, we propose to construct a simplified science data playback emulator using current SEXTANT ground software, a standard PC, a multi-port USB 2.0 PCI Express card, 7 USB to RS-422 cables, a modern Linux Operating System (OS), and a 1 Pulse Per Second (1PPS) hardware synchronization capability implemented as a custom, low-latency Linux kernel module. The kernel module is an interrupt handler that registers the external analog 1PPS signal via PCI Express parallel port card. The emulator will run on CentOS 7.1 with a real-time kernel in order to minimize and provide deterministic latency. The goal of this emulator will be to deliver Consultative Committee for Space Data Systems (CCSDS) formatted versions of the science data via RS-422, while maintaining an average latency <100µs for a 1PPS pulse of at least 25µs width. Completion of this simulator will enable real-time and faster than real-time performance tests of the XNAV algorithm in support of flight software acceptance testing, which will significantly reduce risk for NICER/SEXTANT.

Keywords: NASA, NICER, SEXTANT, X-Ray Pulsar Navigation, XNAV, MPU
Software Defined Radio for Doppler Weather Radar

Raphael Elspas\(^1\), Manuel Vega\(^2\)

\(^1\)Educational University of Maryland, School of Computer and Electrical Engineering, College Park, MD, USA
\(^2\)Microwave Instrument Technology Branch, NASA Goddard Space Flight Center, Mail Code 555, Greenbelt, MD, USA

The dual-frequency, dual-polarized, Doppler radar (D3R) is a ground-based system developed in support of the ground validation (GV) activities within the Global Precipitation Measurement (GPM) mission. The D3R provides a reference with which to verify the data measured and transmitted by the GPM core satellite. Signal processing is a vital element of both of these systems and radars in general. In these systems, as well as in many others, signals are processed directly with hardware that can mix, filter, modulate, etc. a provided input. In order to provide flexibility in signal processing, Software Defined Radio (SDR) can be used as a replacement for some of these hardware components. SDR is a system that allows hardware in radio communication systems to be replaced with software-based substitutes. The SDR chosen for this work is the USRP E310, which features 4 programmable channels (2 receive and 2 transmit) and an embedded dual core processor. Focus will be placed on the initial configuration and characterization of the SDR, among other tasks in support of the D3R. This technology will hopefully enable future lower-cost radar designs to further our understanding of Earth's weather systems, a collective goal shared by each member of NASA's Earth Science Division.
Inertial Navigation Attitude Filter Computational Complexity Optimization

Rebecca Foust¹, Joseph Galante²
¹University of Illinois at Urbana-Champaign, College of Engineering, Urbana, IL, USA
²Attitude Control Systems Engineering, NASA Goddard Space Flight Center, Mail Code 591, Greenbelt, MD, USA

Rebecca is investigating computational performance enhancements via algorithm manipulation on the Multiplicative Extended Kalman Filter (MEKF) used in the Raven inertial navigation filter (INF). The Raven mission is an autonomous pan/tilt actuated sensor suite to be launched early next year. Raven will be deployed on the International Space Station to track incoming vehicles using visual, IR, and LiDAR cameras. Much of the technology developed on the Raven experiment is directly related to the much larger Restore mission, which will dock with aging satellites to replenish their fuel and perform repairs to lengthen their mission duration. The filters developed for Raven will serve as prototypes for Restore since Raven and Restore share similar sensor types and navigation objectives.

In particular, Rebecca’s project is working to improve attitude estimation algorithms, especially for missions with a wide disparity in sensor accuracies in computational-resource limited platforms. This allows her to wring more performance out of cheap, low quality sensors with a minimal computational footprint by using advanced math. To accomplish this, she is investigating the impact of square root implementations of the MEKF, measurement decorrelation, and other filter enhancements given the limited computational resources available to the Raven INF. This project will result in an analysis tool suite useful for future sensor selection and proposal feasibility studies. The analysis suite will help inexpensive missions like CubeSats achieve better performance with limited sensor capability and limited personnel time and enable sensor suite cost/benefit analysis for Explorer and Discovery class missions.
Cryogenic Stability

Ryan Frankle\textsuperscript{1}, Miko Laddawan\textsuperscript{2}

\textsuperscript{1}University of Maryland, College Park, Clark School of Engineering, University of Maryland, College Park, MD, USA
\textsuperscript{2}Detector Systems Branch, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

Cryogenic detector and electronics testing requires both a highly robust, and very stable, thermal and mechanical interface to reduce the noise associated with the physical set-up of the vessel. Cryogenic vessels, called ‘Dewars,’ are often used to test electronic, materials, optics, and other experimental and flight components in a stable, controlled, and cold space-like environment. While most vessels are needed to keep everything within the Dewar at the set cryogenic temperature, this test set-up represents a unique challenge, as there is both a cooled section of test electronics, at 80 Kelvin, and a warm section of electronics at 200–250 Kelvin, both at very close proximity to each other. This unique scenario gives rise to the problem of designing and building a thermally and electronically optimized testing environment to isolate these close-proximity electronics at large temperature differences. This problem is being solved by measuring and studying thermal parameters of the WFIRST cryogenic test design and using numerical methods to optimize the PID temperature controller tuning (PID: proportional, integral, derivative equation for removing difference between a desired set point and an actual input value.), infrared shields to minimize direct thermal radiation, and heat sinks in the form of copper straps to remove a set amount of power from the electronics. After producing the copper straps and heat shield, and tuning the PID control for the temperature of the warm electronics, the thermal characteristics of the test set-up will be re-evaluated and improved with more iterations of cooling and warming of the Dewar, thus further improving (reducing) the base noise produced by the physical test set-up.
Ideal Integrating Bolometer for Far-infrared Spectroscopy

Roberto De Alba¹, Edgar Canavan², Thomas Stevenson³, Peter Nagler³
¹Cornell University, Department of Physics, Cornell University, Ithaca, NY, USA
²Cryogenics and Fluids Branch, NASA Goddard Space Flight Center, Mail Code 552, Greenbelt, MD, USA
³Detector Systems Branch, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

Bolometers are among the most sensitive detectors currently available for submillimeter radiation. They constitute one of the major tools that have turned cosmology into a precision science, enabling direct measurement of the Cosmic Microwave Background during the Planck and COBE missions. The operating principle behind bolometry is to measure the temperature rise of an optical absorber due to impinging light. Ultimately, the sensitivity of these devices is limited by the quality of thermal isolation between the absorber and the rest of the instrument. However, some thermal conduction is needed to “reset” detectors, as they are easily saturated by cosmic rays. The focus of this study is to test micro-fabricated heat switches that will enable electrical control over the thermal isolation of bolometer absorbers; such switches will allow detectors to operate at highest sensitivity, unhindered by cosmic rays. The heat switches used were designed and fabricated at Goddard Space Flight Center, and utilize the superconducting transition of aluminum as a means to control thermal conduction. They were designed to be fabricated on-chip with detectors, minimizing added size and weight. For testing, samples were mounted in a cryostat and studied at temperatures ranging from 100mK to 1K. Initial tests have shown that the electrical conductivity can be switched with a high on/off ratio, and further tests of the thermal conductivity are currently underway. Once completed, this work will demonstrate the utility of heat switches in bolometer assemblies, and enable detector operation with greater sensitivity than ever before.
Modern Applications of Initial Orbit Determination

Ryan F. Willmot¹, J. Russell Carpenter²

¹Purdue University School of Aeronautics and Astronautics, West Lafayette, IN, USA
²Navigation and Mission Design Branch, NASA Goddard Space Flight Center, Mail Code 595, Greenbelt, MD, USA

An increasing population of space debris presents a growing threat to space vehicles, and the ongoing discovery of asteroids that might impact the Earth is currently peaking interest in planetary defense measures. A key aspect of minimizing the risks associated with both space debris and potentially hazardous asteroids is determining the orbits of the dangerous objects so that future encounters may be predicted. These issues have re-ignited interest in the initial orbit determination (IOD) problem, and stimulated the development of modernized IOD tools. Using classical IOD methods developed by Laplace and Gauss, as well as more modern techniques developed by Pedro Escobal and Stefano Casotto, a comprehensive MATLAB package has been created to meet these challenges. The MATLAB package makes use of a sigma-point transformation to approximate the covariance of the IOD solution. Coupled with classical differential correction methods, the MATLAB package allows for the calculation of precision initial state vectors from limited observations. Due to the unreliability of certain IOD methods for certain orbits and observational data, it can often be difficult to select the most efficient IOD technique. This package provides an easy and fast way to compare different IOD techniques, allowing for an investigation into the strengths of each technique as well as providing the most accurate orbit information possible. Results will be used to develop strategies to protect space vehicles and the Earth, as space-based threats become better understood.
Evaluating the Effect of Oxygen Plasma on Thermal Coatings

Sarah Scroggs¹, Mark Hasegawa²
¹T.C. Williams High School, Alexandria, VA, USA
²Thermal Coatings Laboratory, NASA Goddard Space Flight Center, Mail Code 546, Greenbelt, MD, USA

Thermal coatings are an integral part of space flight hardware. Use of poor coatings and improper application to hardware can be detrimental, causing reduced mission time and failure. Oxygen plasma has been found to improve the adhesion of thermal coatings to their substrates, as well as the cohesion in the coating itself. Increased adhesion and cohesion result in stronger coatings that are better suited for the harsh conditions of space. The purpose of the experiment was to determine the most precise and effective methods to evaluate thermal coatings, as well as to determine the effects of oxygen plasma exposure on coatings. In the main experiment, two different lots were prepared—one with oxygen plasma, one not receiving the exposure. The two groups were spray-coated and cured for differing time periods. Afterwards, tensile strength was measured using a Positest ATA machine, which conducted a coating pull test. These tests were used to determine strength of adhesion between the coating and substrate, as well as the level of cohesion within the thermal coating. Concurrent tests were run to determine the most precise method of evaluating coatings. A series of tensile strength tests were conducted to identify the most precise procedure for testing coatings. Expected results of the main experiment include a stronger adhesion between the coatings and the substrate after an exposure to oxygen plasma, as well as an increase in tensile strength. It is expected that the concurrent tensile strength tests will establish a method for evaluation that produces precise data. The experiment and its data will help create a useful method for the assessment of thermal coatings, as well as determine the effects of plasma on the coatings.
Building Energy Efficiency

Samuel Leon Cole Jr.¹, Evelyn Baskin²

¹South Carolina State University, School of Nuclear Engineering, Orangeburg, SC, USA
²Energy Management, NASA Goddard Space Flight Center, Mail Code 200, Greenbelt, MD, USA

The focus of energy management is to improve energy efficiency for buildings located on Goddard Space Center. Goddard and other NASA centers mission is to accomplish the goal of improving their buildings efficiency by 30% at the end of the 2015 year. This improvement should allow NASA centers to cut costs for utility and all associated energy cost. How is energy efficiency used efficiently? Proposals include new ideas for power plant design, such as upgrading boilers, upgrading meters, replacing rusted pipes, etc. Energy management includes data inputted into software known as “Energy Portfolio Manager” for editing purposes. The software will inform energy managers what needs to be done to improve a building’s energy consumption.
Deep Dive Analysis of PR/PFR Records, Importation of Legacy Watchlist Data into Meta, Beta Testing of Watchlist Application in Meta

Steven Hearne¹, Sital Khatiwada², Jonathan Root³

¹University of Maryland, Robert H. Smith School of Business & A. James Clark School of Engineering, College Park, MD, USA

²University of New Hampshire, College of Engineering and Physical Sciences, Durham, NH, USA

³Jonathan Root, Safety and Mission Assurance Directorate, NASA Goddard Space Flight Center, Mail Code 382, Greenbelt, MD, USA

The Safety and Mission Assurance Directorate is attempting to improve Goddard’s mission performance via deployment of the Meta management system. Numerous legacy systems exist and are utilized at Goddard, many of which contain data that must be transferred to Meta. Watchlist and Product Finding are such systems currently being developed as an application within Meta. Watchlist required heavy beta testing prior to its release into the Meta environment. Legacy Watchlist data also needed to be imported into the Meta environment to ensure information housed in the legacy Watchlist system is successfully integrated into Meta. Product Finding allowed access to Problem Reporting (PR) and Problem Failure Reporting (PFR) data, which was used to perform a deep dive analysis in search of a meaningful trend. Beta testing of Watchlist was performed through collaboration between various users with different levels of access within the system to assess the workflow of Meta. Importation of legacy Watchlist data was performed through sorting user and project based data, then matching them successfully before import. PR/PFR data was analyzed through data manipulation in Microsoft Excel. The results yielded improved functionality of Meta, completion of data import, and relations found between PR/PFR “Open” and “Closed” statuses, showing a trend of how some projects are significantly more efficient in reporting and resolving problems than others. The overall operations improved Goddard’s mission performance and provided insight on project operations throughout Goddard.
Simulating the Space Technology 5 Mission

Savyasachi Konkalmatt¹, Richard R. Harman²

¹Centennial High School, Ellicott City, MD, USA
²Space Science Mission Operations, NASA Goddard Space Flight Center, Mail Code 400, Greenbelt, MD, USA

The project simulates and observes the results of the decommissioned ST-5 (Space Technology 5) satellite for better understanding of actual results during the mission. The ST-5 satellite is made up of 3 micro satellites that are a part of NASA's New Millennium Program, which was created to identify, develop, build, and test innovative technologies and concepts for use in future missions. When the occasional anomaly arises between the actual and simulated data, the two are compared to help explain why and what may have been the cause of the difference. In the process, data and variables simulated and/or observed are such as: Quantized sun angles, Orbital Dynamics, Reference Magnetic Field. The project will ultimately put together various data to simulate the attitude of the satellites. Several models are made in the process including a Sun Sensor Model, Magnetometer Model. Each piece of data is used to map and understand the findings of the ST-5 program. In simulation, there were significant constancies as well as discrepancies present. From comparison of actual results and simulated results, discrepancies and measured values can help understand what developments are needed for the new technology.
The Reconfigurable Operational spacecraft for Science and Exploration (ROSE) is a spacecraft bus designed to be easily serviceable and refuelable while in orbit by modularizing all of the flight hardware. The preliminary design for the actuators, including the magnetic torque bars and momentum wheels, was completed. This included sizing and orienting each component so they would fit within the replaceable modules positioned around the exterior of the spacecraft bus. The analysis utilized the simulation program 42 to determine the environmental torques on the spacecraft over a one day period. Additionally, the moment of inertia and center of mass calculations were completed in order to determine the momentum and torque requirements for varying slew maneuvers. Various ZARM Technick Magnetic Torquer bars were analyzed as sources to dump the secular momentum build up due to the environmental torques. Lastly, scaled down Global Precipitation Measurement (GPM) momentum wheels were analyzed in comparison to Honeywell and Moog Bradford momentum wheels to find the most efficient setup in terms of the mass, volume, and orientation.
This project focused on developing a better understanding of how Systems Engineering processes may be modeled, versus a document-centric approach, to help improve efficiencies and/or reducing risks. One specific relationship included a parametric model and linked a discipline tool such as CAD or STK for doing a parametric trade within the modeling structure. Skills developed for this work included modeling tool capabilities such as Magic Draw, Innoslate, Enterprise Architect, and Vitech CORE.

The systems engineers here at the NASA Goddard Space Flight Center follow a document-centric approach rather than a model-based approach. A series of surveys were completed in order to compare the four models (Magic Draw, Innoslate, Enterprise Architect, and Vitech CORE). The study compared the pros and cons of switching to a model-based systems approach and concluded which system was best suited for the NASA Goddard Space Flight Center.
Next Generation Tracking and Data Relay Satellite Concept Study

Samuel Pasco¹, Gregory Heckler²
¹University of Wyoming, Laramie, WY, USA
²Telecommunications and Networking Technology Branch, Goddard Space Flight Center, Mail Code 566, Greenbelt, MD, USA

The Tracking and Data Relay Satellites (TDRS) system is a vital component of NASA’s communications networks that provides support for mission operations and science data delivery. NASA is studying the next generation of TDRS spacecraft, and a driving need is an Enhanced Multiple Access (EMA) system. Towards this end, many methods have been investigated to improve the Multiple Access (MA) system of TDRS. First, design requirements on the directivity and field of view of an EMA system have been proposed. Next, a model that simulates the radiation pattern of an arbitrary phased array is developed in Matlab. The model is applied to the TDRS MA phased array and verified with measured data from the initial design documents. With a verified model, modifications to the array geometry and number of elements are simulated to determine the effect on directivity and field of view. Many proposed geometries have been evaluated based on the design requirements and systems engineering trade-offs. Initial results show that the proposed requirements on directivity can be met by significantly increasing the number of elements, but with a reduced field of view in one direction. Research into alternative methods has been done, including spacecraft based D/A conversion and the potential use of reflectarrays. Finally, recommendations on the EMA system have been given based on the results of the study.
Next Generation Attitude Control Technology

Sahadeo Ramjatan\textsuperscript{1}, Alvin Yew\textsuperscript{2}

\textsuperscript{1}University of Florida, Gainesville, FL, USA
\textsuperscript{2}Mission Engineering and Systems Analysis Division, NASA Goddard Space Flight Center, Mail Code 596, Greenbelt, MD, USA

Conventional reaction wheels composed of three separate flywheels with motors in an orthogonal arrangement can result in highly unwanted cross coupling effects that result from the three gyroscopic forces. In addition, during the mission duration of a spacecraft, failure of the operating reaction wheels can occur due to instability of the bearing unit. Thus, the bearing unit remains the principal life-limiting problem on momentum and reaction wheels and therefore this study investigates the novel approach of a bearingless rotor design from launch to successful operation in space. Preliminary work involved designing a passive release mechanism to protect the structural integrity of the bearingless rotor from excessive launch vibrations while allowing easy operation in space. A new application involves investigating a spinning cylindrical rotor with no confinement in Low Earth Orbit with the goal of preventing rapid orbital decay and altitude loss. The lift coefficient was examined at different radii, altitudes, spin ratio, and freestream velocities. In addition, a comparison of the lift and drag coefficient is made for a ‘dimpled’ rotor for a simple reentry trajectory.
Creating a Cubesat Design Tool and Developing Cubesat Thermal Louvers

Eric Stoker-Spirt\textsuperscript{1}, Allison Evans\textsuperscript{2}

\textsuperscript{1}Georgia Institute of Technology, Guggenheim School of Aerospace Engineering, Atlanta, GA, USA
\textsuperscript{2}Components and Hardware Systems, NASA Goddard Space Flight Center, Mail Code 596, Greenbelt, MD, USA

To write a proposal for a CubeSat, scientists who design the payload have to consult with an engineer to choose, position, and install the supporting hardware on the spacecraft. This is a time-consuming process. A 2016 IRAD has been proposed that would allow scientists to design a CubeSat sufficiently well to submit a proposal on their own. The IRAD features a drag-and-drop software that contains a database of parameterized hardware components that can be placed on the virtual CubeSat. Necessary features of the components, such as mass, power consumption, and performance characteristics will be included. This way, each component can be optimized for whatever limiting factor the spacecraft designer is facing. The software will guide the user to placing compatible components on a spacecraft in such a way that the power budget, maximum mass, and other constraints are not violated.

The student has created a database containing over 100 commercial-off-the-shelf components viable for CubeSats. Each of these parts has an associated CAD model, and all necessary characteristics recorded.

As a separate project, the student has helped in the testing of miniaturized thermal louvers. Thermal louvers have traditionally been used on larger spacecraft, but with newer manufacturing technology, it is now possible to design louvers small enough to use on a CubeSat. These louvers have a spring that expands with a flap assembly attached, causing them to open in a hot environment and close in a cold environment. This allows for active thermal control with no power consumption.

These louvers will have gone from TRL 3 to TRL 5 by August 2015, having gone through thermal vacuum testing and vibration testing.
Engineering

Comparison of Dynamics Models for Spacecraft Attitude Filters via Monte Carlo Analysis

Tyler Simonson Del Sesto¹, Joseph Galante²

¹Carnegie Mellon University, College of Engineering, Pittsburgh, PA, USA
²Attitude Control Systems Engineering, NASA Goddard Space Flight Center, Mail Code 591, Greenbelt, MD, USA

The project detailed herein is two-fold. The first aspect of the completed work consists of comparing a dynamics replacement model filter to an intuitive model filter through modeling and simulation of a single axis spacecraft. To support the Raven mission, this study included the development of an analysis suite to enable rapid execution of multi-dimensional parameter sweeps and Monte Carlo Simulations within Goddard’s Freespace-Casino simulation environment. The results of the single axis analysis provided insight into the relative accuracy between the filter models over real-world parameter ranges, including the benefits of a dynamics replacement model when the spacecraft inertia and disturbance torques are not accurately known. Additionally, these simulations assist in the tuning and debugging process for filters.

The second study is an application of these analysis techniques to the Raven Relative Navigation Filter (RNF). The Raven mission is a flight-test mission for autonomous observation of vehicles on approach to rendezvous with the International Space Station. The RNF filter on Raven is a prototype algorithm for the Restore mission, where a refueling/repairing satellite will autonomously dock with satellites needing assistance. The analysis of the RNF includes studies of filter robustness to process noise and sensor outages, sensitivity sweeps over wide ranges of sensor accuracies to guide filter tuning, as well as a determination (via Monte Carlo simulation) of the expected mission performance.
Designing and Modeling for the NICER Project

Tate DeWeese¹, Steven Kenyon²
¹Massachusetts Institute of Technology, School of Engineering, Cambridge, MA, USA
²NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

The NICER Project is sending an x-ray telescope to the International Space Station to study neutron stars’ properties more accurately. For this project, I assist the mechanical engineering team in designing parts in order to speed the building process. I first draw and dimension the parts, then use PTC Creo to model parts on my computer, and, lastly, 3D print them using a Makerbot 3D printer. I have found that 3D printing saves time and money in building parts. 3D printing is quick and inexpensive, allowing many iterations of a design to be tested quickly, and to be sent out for manufacturing once complete and accurate. Additionally, printing scale models of the telescope increase effective communication amongst the team. This internship has shown me that 3D printing is an integral part for any mechanical engineering team that can prevent costly mistakes.
FPGA Co-Processing to Accelerate Processing of Hyperspectral Images

Trokon Johnson¹, Daniel Mandl², Vuong Ly²
¹The University of Florida, Gainesville, FL, USA
²Software Systems Engineering Branch, NASA Goddard Space Flight Center, Mail Code 581, Greenbelt, MD, USA

The advent of Cubesats has made space processing applications more feasible for many projects, but also introduce many to the constraints due to working in such a remote environment. Two major constraints involve working with a limited power supply, and the lack of room for high performance processors. We have a hyperspectral camera that is currently being used for collecting images of the Chesapeake Bay by way of helicopter flights, in order to simulate its eventual role in communicating with a ground station, and sending down preprocessed data. The MicroZed development board makes use of a Zynq 7020 System on a Chip (SoC), including an Dual Core ARM Processing System (PS) and the Programmable Logic (PL) of a Field Programmable Gate Array (FPGA). We were able to use the Xillybus IP core in order to establish simple communication between the two parts of the SOC. Currently, a traditional multi-core processor runs a radiometric correction program written in C on the incoming data. This program accounts for variances in the camera hardware to clean up the data. We used Xilinx's Vivado High Level Synthesis Toolchain to synthesize the C code into Verilog, a Hardware Description Language (HDL) used to configure the FPGA’s hardware logic. By using specialized hardware to process the data, the design can be implemented much more quickly in parallel. In addition, the MicroZed board uses significantly less power than the current processor used in the design. In the near future, we will verify the output of the hardware logic, and compare to our current implementation on additional flights.
Modifying the Automated Safe-To-Mate (ASTM) Tester

Tony Zhang¹, Umeshkumar Patel²

¹University of Maryland, College Park, College Park, MD, USA
²Electromechanical Systems Branch, NASA Goddard Space Flight Center, Mail Code 540, Greenbelt, MD, USA

The Automated Safe-To-Mate (ASTM) Tester is essential to make sure flight equipment is secure and functioning properly. What it does is measure impedance between any two pins in order to verify connectivity and isolation. This is done in a fast and reliable manner and is very useful when dealing with electronics with as many as 632 pins.

Based on the most up-to-date schematic design, the ASTM system begins at the PC, which communicates with the PIC microcontroller. Next the PIC microcontroller selects one pair of the 632 input channels to measure its impedance. Then it communicates with the mbed processor, which selects the resistance range, picks the best circuit to measure the impedance, and retrieves measurements from the analog-to-digital converter (ADC). Finally, after the impedance gets calculated, it sends it back to the PIC microcontroller, which sends it back to the PC to be recorded. After the entire ASTM schematic gets completed, the ASTM Tester can operate more efficiently and spacecraft electronics can be more thoroughly tested.

Currently, the ASTM is being modified so that it can operate faster and more efficiently. As a result, the ARM-based mbed microcontroller is being incorporated to the ASTM, so the mbed requires firmware to execute operations in a timely manner. In addition, the PIC microcontroller needs additional commands in order to communicate with the mbed effectively. Finally, a new printed circuit board is required to incorporate all of the new components, in particular the mbed microcontroller.
The Joint Polar Satellite System is a project currently in development through the joint effort of NASA and NOAA and will be used for monitoring climate and tracking severe weather. A critical part of this mission is preparing the operators for mission operations and to test the operations procedures prior to use on the satellite both prior to and after launch. The Flight Vehicle Test Suite is a system of simulators that allows operators to run through any procedure for the spacecraft and instruments before using them on the flight system. Simulation Control is a key component currently in development by NASA that enables the connection and synchronization of all simulators in FVTS. The current goal of the Simulation Control test team is to verify the software meets the requirements and to validate that it is useful to the end user. Our work over the summer is to support the ongoing testing efforts by supporting test preparation, the as run tests, requirements verification, discrepancy closure, and post-test analysis.

The current goal of the team building Simulation Control is to implement all of the necessary scripts each simulator must follow into the software, while also ensuring that the system functions properly and meets the requirements of the mission.

The team routinely conducts As-Run Tests to check that procedures run by the software work as expected. Additionally, Test Readiness Reviews are conducted to verify that FVTS as a whole continues to meet requirements as the system becomes more developed. At this point in time, Simulation Control is not fully complete, but is expected to be ready by August 31, 2015. All components of FVTS are critical to ensuring that the mission goes as planned when JPSS1 launches in 2017.

Being software as part of the FVTS System, Simulation Control has an incremental deployment cycle. Over the course of the summer multiple release of Simulation Control were deployed. The final planned major release is at the end of August, 2015.
CubeSat Design Approach at Goddard Space Flight Center

Trang Luu¹, Juan Rodriguez-Ruiz²

¹Massachusetts Institute of Technology, Cambridge, MA, USA
²Thermal Branch, NASA Goddard Space Flight Center, Mail Code 545, Greenbelt, MD, USA

When the idea of flying smaller, lower-risk satellites such as CubeSats, came into the playbook, engineers and scientists saw it as a likely alternative solution for science experiments that don't need large, expensive, time-consuming, spacecraft to carry its instruments. But right now at Goddard, CubeSats could be at risk of losing their attractiveness because engineers who are working on designing, building, and testing CubeSats are spending more time and resources than necessary. These challenges are occurring due to a lack of guidelines, systems, and processes to streamline their development, which could result in an expensive price tag on the Goddard CubeSats. A living guideline that compiles and organizes information about CubeSats can help engineers from the first designing stage to the final launching processes. The first steps was to organize questions that new engineers working on CubeSat would encounter. Some questions include how much testing will be required for CubeSats? What are some allowable risks that CubeSats can accept? And how can we work with the power, mass, and volume limitations of CubeSats? To answer these questions, efforts were made to reach out to senior engineers, branch heads, and even college professors. Publications and presentations were also studied. This living document will continue to evolve because it is a place to capture and share what different engineers have learned building a CubeSat. The outcome of this project will benefit NASA for years to come by helping future teams that work on CubeSats save time and resources. CubeSats are a great alternative to large spacecrafts, but to make CubeSats a working solution, engineers have to commit to this effort. It will take all of their compiled knowledge and all of their joined effort to once again achieve another “small step for man, a giant leap for mankind.”
Development of a System for Extended Depth of Field Imaging

Taylor Gosnell¹, Justin S. Jones², Devin Burns²

¹West Virginia University, Benjamin M. Statler College of Engineering and Mineral Resources, Morgantown, WV, USA
²Materials Engineering, Microscale Mechanical Testing Laboratory, NASA Goddard Space Flight Center, Mail Code 541, Greenbelt, MD, USA

For materials characterization and analysis, it is common for objects to have a varying degree of contour and topology, leading to problems with conventional microscopes when trying to capture an image which shows the full depth of the object’s features. This limitation relates to the depth of field of the imaging system, which becomes shallower with increasing magnification. To combat this problem, a stack of images, taken at different elevations, can be processed into one composite image. Advanced digital microscopes exist with this capability, but are very costly. A mechanical system was developed using existing hardware for the Microscale Mechanical Testing Laboratory at GSFC. The system allows the lab to view different components and samples with an extended depth of field. The system is driven using a LabVIEW interface and uses a linear actuator to move the sample on a z-stage through a distance which encompasses the topology of the object. The system is automated so the actuator stops at desired positions to gather an image before moving on to the next position. This process is repeated until the desired depth of field is captured. The stack of images are then saved and analyzed using ImagePro software for EDF processing. The device was successfully able to capture an extended depth of field image on a variety of samples.
Comet Sample and Return Projectile Launcher Calibration and Design

Wanyi Ng¹, Daniel Ramspacher²

¹Duke University, Pratt School of Engineering, Durham, NC, USA
²Propulsion Engineering Branch, NASA Goddard Space Flight Center, Mail Code 597, Greenbelt, MD, USA

Comet core sample and return missions can reveal insight into the likelihood of comets as the original source of organic molecules on Earth, as well as the best means of deflecting a comet should one enter a hazardous path towards Earth. The launcher calibration and design was a proof of concept project seeking to develop a projectile launcher capable of fulfilling a variety of missions related to sample retrieval. Following the assembly of an initial prototype, leak and proof tests were performed at the maximum expected operating pressure of the system. Test fires were conducted to determine the relationship between the projectile velocity and feed pressure. The velocities were determined using high speed photography to conduct a time of flight measurement. Iterative design modifications were made to enhance the performance and versatility of the launcher. The assembled prototype passed both leak and proof tests. Test fire data from the first prototype indicated velocities faster than predicted via computational fluid dynamics calculations for respective feed pressures. During firing, the piston rod failed by separating from the upper piston head, likely due to inertial forces causing the shearing of epoxy at the connection. Design modifications were successfully implemented to strengthen physical connections that caused the abovementioned failure, consolidate the initial dual tether system into a single central tether, and retrofit the launcher to perform experiments on a rotating tetherless projectile. With further experimentation, design refinement, and effective integration to spacecraft, the launcher has the ability to collect and retrieve a core sample for analysis on Earth.
Test Setup for the WFIRST GRISM Spectrograph

William Green¹, Qian Gong², Margaret Dominguez²
¹University of Rochester Mechanical Engineering, Rochester, NY, USA
²Optics, NASA Goddard Space Flight Center, Mail Code 551, Greenbelt, MD, USA

The GRISM, in its current design, is a three element spectrograph consisting of two diffractive surfaces, capable of diffraction limited performance from 1.35 to 1.95 um. This prototype is extremely sensitive to manufacturing errors, and care must be given to the setup that tests its optical performance. These tests will provide data both on diffraction efficiency and surface figure of the manufactured parts. Deliverables include the design and modeling of test configurations for the optical elements, along with the integration of a program to produce computer-generated holograms (CGH), as well as diffraction efficiency measurements on grating samples.
Transmission Performance of WFIRST’s Optical Filters from the Visible to Infrared

Winson Huang¹, Kevin H.Miller²

¹Stanford University, Materials Science and Engineering, Stanford, CA, USA
²Optics Branch, NASA Goddard Space Flight Center, Mail Code 551, Greenbelt, MD, USA

The optical bandpass filters are crucial to the functionality of the Wide-Field Infrared Survey Telescope (WFIRST), the next generation of space telescope with the goals to detect the effects of dark energy on the expansion of the universe. For the purpose of risk reduction, it is important to select and cooperate with the manufacturer(s) capable of producing high quality filters meeting the challenging optical specifications. In this project, 3 bandpass filters (Grism, W149, and Z087) prepared by 3 vendors (Alluxa, JDSU, and Materion) were studied to provide quantitative analysis of spatial uniformity and temperature dependency of transmission rate at the range of visible and near-infrared. The spatial uniformity of the filters was examined by measuring and comparing the transmission response to electromagnetic waves at a variety of wavelengths at 5 locations, the center, the top, the bottom, the right, and the left of the filters. To understand the performance of the optical filters in the on-orbit operating temperature, the temperature dependency of transmission was evaluated at the temperatures of 295K, 200K, 170K, and 100K with the implementation of cryogenic techniques. The overall characterization report will be reviewed by the WFIRST research team to determine the potential manufacturer(s) for supplying the 3 types of bandpass filters used in the actual space flight mission.
Design of a Tunable ND:YVO4 Self-Raman Laser for Sodium Lidar

Wolfgang Zober¹, Anthony Yu², Michael Krainak³

¹Wheeling Jesuit University, Wheeling, WV, USA
²Instrument Systems and Technology Division, NASA Goddard Space Flight Center, Mail Code 550, Greenbelt, MD, USA
³Laser and Electro-Optic Branch, NASA Goddard Space Flight Center, Mail Code 554, Greenbelt, MD, USA

Within the upper atmosphere, specifically the mesosphere, there is a layer of non-ionized sodium atoms between 80 km and 105 km above the surface. This layer, created though the ablation of meteors, weakly emits a doublet, two spectral lines D2 and D1, which are respectively 589 nm and 589.6 nm. Through a process known as sodium fluorescence lidar, researchers can specifically target these wavelengths to measure the concentration of sodium in the mesosphere. This provides temperature measurements in this region and allows scientists to explain and separate solar and Earth induced heat changes in the atmosphere. This will also enable scientists to further understand middle and upper atmospheric chemistry, structure, dynamics, and gravity waves, all of which play a fundamental role in atmospheric modeling. This is an investigation into creating a tunable Nd:YVO4 self-Raman laser as a tool for sodium lidar. A C-cut Nd:YVO4 crystal is pumped with 808 nm light from a laser diode to produce 1066 nm light within the crystal. The crystal then undergoes Stokes emission at 1178 nm. This newly emitted light is then taken through a process known as frequency doubling which halves the wavelength into the desired 589 nm. This is further improved on by making the laser tunable. Such that the final output wavelength of the laser can be changed. This allows the full mapping of the Sodium doublet spectrum.
GSFC Functional Services
Native plants are classified as plants that naturally evolved to live in a particular region; consequently, they generally have longer lifespans and require less maintenance than nonnative species. When introduced, nonnative species may threaten the balance of the ecosystem by aggressively competing against native species; because they are foreign they usually have no local predators and can reproduce at a rate that diminishes the population of native plant species. In the wild, this shift in botanical composition has dramatic effects on the populations of wildlife that rely on the indigenous species for food and habitat. Given the unfavorable aftereffects of a nonnative overtaking, it is crucial to ensure that only native plant species are established.

The SRD (Standard Reference Document) List for NASA Goddard Space Flight Center enumerates the shrubs, trees, and groundcover plants that are permitted for planting at Goddard. However, this list of plants, last edited approximately twenty years ago, contains a host of invasive plant species that would be extremely undesirable for use in landscaping at Goddard. Of the 137 plants or plant species listed, at least fourteen were currently identified as invasive by the Maryland Department of Agriculture and/or the University of Maryland Extension Home and Garden Information Center (UME HGIC), which compiled a comprehensive list of regionally invasive species from various authoritative sources. This project focuses on the revision of the original SRD list, eliminating the invasive plants and identifying species that are preferred for planting on Goddard grounds. The product will be a plant guidebook for future landscaping projects, outlining the planting policies for NASA Goddard and describing the plant species that are on the Goddard “Preferred List” of plants. With the creation of this guide, clear guidelines will be set for landscapers in future project contracts, as an explicit list of plants unacceptable for establishing will be included. As a distinguished agency, NASA Goddard Space Flight Centre must also demonstrate its environmental initiative and reform its policies to protect the environment on Earth, the home of humanity, exploration, and discovery.
Cost Tickets and Analysis (FY2014 & FY2015)

Daniel Adenaw¹, Gaynell Johnson²
¹St. Andrew’s Episcopal School, Potomac, MD, USA
²Regional Finance Office, Cost Department, NASA Goddard Space Flight Center, Mail Code 100, Greenbelt, MD, USA

Cost ticket processing is a procedure that is used to eliminate downward adjustments on purchase orders and contracts. Analyze cost tickets from the past two fiscal years in order to discover trends and calculate how much cost tickets cost the department. Review of Excel spreadsheets detailing each cost ticket followed by independent calculation and analysis for any trends or anomalies. Most frequent reasons for cost tickets, average time to process cost tickets, # that are 533 contracts, # that require NSSC, cost to department, total adjustments, and # of invoices. Many are due to human error so more diligence when filing cost tickets can result in less cost to the department.
NASA Goddard Space Flight Center (GSFC) is widely known for its many complex, innovative, cutting edge projects as well as the brilliant minds behind them. With multiple directorates, divisions and branches it becomes challenging to plan one’s future with Goddard. A center wide Career Path tool (CPT) would provide a thoroughly transparent, single resource to easily traverse through potential opportunities and establish a career plan within Goddard in order to help employees grow and advance. Nebula, the CPT, is a public website that serves as a map for employees and prospective employees, providing crucial information like educational requirements and core competencies, as well as mandatory and suggested training, skills, and a general overview of all civil servant managerial, technical, professional, and administrative positions. By reviewing these positions, it was possible to create an online layout for Code 400 to show the wide range of possible lateral, vertical, and cross functional moves within an organization while setting clear requirements with no guarantee of promotion or employment. Having the tool enables one to create a career path that boosts morale and fulfillment in the workplace while giving clear direction for the future. Nebula serves GSFC employees by helping manage one’s career by illustrating training, development planning, and growth opportunities, while aiding GSFC in maintaining positive morale and retention, easing the recruiting process, creating cross-organizational success and succession planning, as well as preserving the title of “Employer of Choice and one of the Best Places to Work in the Federal Government”. Nebula pacifies the process of choosing a career for any GSFC civil servant anticipating a career change or any prospective GSFC employees.
Hubble Exhibit Video Editing Project

Cathleen Kong¹, Maurice Henderson²
¹Richard Montgomery High School, Rockville, MD, USA
²Hubble Space Telescope Project, NASA Goddard Space Flight Center, Mail Code 441 Greenbelt, MD, USA

The goal of this project was to make the traveling Hubble Exhibit more interactive and consistent. The exhibit is split up into different sections that give an overview of the Hubble and what it has discovered; the sections are: Servicing Missions, Planets, Pluto and the Kuiper Belt, Stars, Nebulae, Galaxies, Galaxy Collisions, the Universe, Dark Matter, JWST Technology, the Electromagnetic Spectrum, JWST Science, the Evolution of the Universe, as well as a theater celebrating the 25th anniversary of the Hubble. In each section there is a kiosk from which viewers can select videos to play. The kiosks needed to be updated so that each video within each section had the same title page and credits page, by using Final Cut Pro. There also needed to be more screensaver images that would make passersby more interested in viewing the videos at each station; this was done using iMovie. Lastly, the kiosk functions themselves needed to be user-friendly, so the HTML and JavaScript files were changed to include items such as information pages or pause buttons. As a result, the consistent kiosks created coherency and user-friendliness for the exhibit. This project is significant because the exhibit helps the general public better understand the Hubble and what it discovers. When people are interested in the exhibit, they will want to learn more about the Hubble.
The Backfill Project

John Ajamian¹, Caroline Parsons², Michael Strittmatter³, Laura Wunderlick⁴, Amy Fedorchak⁵

¹Montgomery College, Germantown, MD, USA
²Broadneck High School, Annapolis, MD, USA
³Capitol Technology University, Laurel, MD, USA
⁴University of Maryland College Park, College Park, MD, USA
⁵Facilities Engineering Manager, NASA Goddard Space Flight Center, Mail Code 200, Greenbelt, MD, USA

As the backbone of Goddard Space flight Centers functionality, our job is to provide used workstations and necessary furniture to employees in order to both save money and promote productivity. If there is new inventory in old buildings, can it be used after the building is brought down? Yes, and it saves NASA money. Detailed dimensioning and cataloging of furniture was required by our team in order to complete our goal of inventorying the soon to be torn down buildings. By creating a database in which a user can both import and export information on Goddard resources, we have created a sleek stream line process in which information will become organized and allow access to furniture needed at Goddard. This database offers users high availability, powerful search tools, and easy to use interfaces that will be used for many years to come. In essence our job is the most important and necessary job that all other branches at Goddard depend on.
Hazardous Waste at NASA Goddard Space Flight Center

Vaibhav Dronamraju¹, Lixa Rodriguez-Ramon²
¹Centennial High School, Ellicott City, MD, USA
²Medical and Environmental Division, NASA Goddard Space Flight Center, Mail Code 250, Greenbelt, MD, USA

NASA Goddard Space Flight Center produces various types of waste as a result of activities that occur onsite. Hazardous waste can pose a threat to human and environmental health. Thus, it is crucial to manage the waste effectively, and strive to minimize the amount that is produced. Visitations will be conducted to sites of hazardous waste generation, sites of storage, and regulations set forth in the Resource and Conservation Recovery Act (RCRA) as well as Uniform Hazardous Waste Manifests will be used to better understand hazardous waste, the risk involved in transporting and managing the waste, and learn how to minimize the waste. Based on previous studies and additional research, most hazardous waste use cannot be limited or minimized. However, it can be managed more effectively and in a way that will limit environmental impact. If this is done, then the safety and health of humans and the environment can be improved.
Science
Radio Frequency Interference: A Comparison of SMAP and Aquarius Methods and Techniques

Jessie D Jamieson¹, Yan Soldo²

¹University of Nebraska-Lincoln, Department of Mathematics, Lincoln, NE, USA
²Cryospheric Sciences Laboratory, NASA Goddard Space Flight Center, Mail Code 615, Greenbelt, MD, USA

The intents of the Soil Moisture Active Passive (SMAP) telescope and Aquarius instrument are to provide radiometric data from which soil moisture and ground freeze/thaw information and sea surface salinity measurements can be interpreted, respectively. However, radio frequency interference (RFI) is present in the measurements taken by each of these instruments. The purpose of this investigation is to compare RFI effects, detection, and mitigation between the two instrumentation packages.

The number of underrepresented minorities entering college to pursue STEM fields is small and dwindling. While minorities comprise approximately 30% of the US population they only receive 12.5% of STEM bachelor degrees awarded (NACME, 2013). As our nation’s workforce is becoming increasingly diverse (CAP, 2012), the success of our nation’s economy is dependent on having a racially and ethnically diverse workforce trained in quantitative and technical fields. It is imperative that we identify and evaluate the achievement factors connected to math and science success so that minority students in high school can be directed towards STEM subjects in the classroom. The following paper discusses the Four Factor Hybrid Model that consists of four achievement factors, engagement, capacity, continuity, and guiding functions (Boykin & Noguera, 2011). Each factor embodies certain achievement functions such as determining the interest level of math and science, rigor of the subject, and various institutional opportunities afforded to the students (ECC Trilogy Model & Boykin/Noguera model). Empirical research project designed to evaluate the effectiveness of the Four-Factor Hybrid Model will be reviewed and discussed. By evaluating the success of these four factors through the literature and an empirical study, a better understanding of how to incorporate these four factors in outreach programs, trainings and developmental programs will become essential for the National Aeronautics and Space Administration to promote a more diverse STEM workforce population and to manage GSFC training and developmental programs around these four factors. The predicted hypothesis is to evaluate the interaction of factors proposed in the Four Factor Hybrid Model and determine what combination of factors best work together (Appleton, et.al, 2006) to predict STEM degrees and achievement levels. NASA professionals can utilize these results as a support tool to evaluate how to increase these four factors in outreach programs, training and developmental program.
An Analysis of Eta Carinae’s Background X-ray Emission

Jamar K. Liburd¹, Michael F. Corcoran²,³, David C. Morris¹

¹University of the Virgin Islands, UVI College of Science and Mathematics, John Brewers Bay, VI, USA
²CRESST and X-ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA
³Universities Space Research Association, Columbia, MD, USA

Eta Carinae is an extremely massive binary star system that serves as one of the biggest and brightest stars in the Milky-Way galaxy. Eta Carinae’s complex X-ray variations are caused by the colliding winds of the larger primary star and the smaller companion star as the two stars orbit each other. We examine observations from 97 pointings of eta Carinae using the X-ray Telescope (XRT) on the Swift Space Observatory in Windowed Timing (WT) mode. In WT mode, the number of X-ray photons that interact with the detector are read out in a one-dimensional array which may include contaminating X-ray photons from other sources near eta Carinae depending on space craft roll angle. We present estimates of this contamination using the X-ray Multi Mirror Mission (XMM-Newton) for each Swift observation. The background X-ray variability is extremely important during the deep X-ray minimum phase while analyzing the emission from the colliding winds. We also present analysis of the 2014 July 12 X-ray maximum where the eta Carinae source was observed near the bad column on the Swift XRT detector. We measure the range of the energy flux to be $2.76 - 3.87 \times 10^{-10}$ ergs cm$^{-2}$ s$^{-1}$ which is dependent on the location of the extraction region. The authors gratefully acknowledge support from the South Carolina Space Grant Consortium.
Mapping the Latitude Dependence of the Primary Stellar Wind of eta Carinae Using the Spectrum Reflected on the Homunculus Nebula

Rachel Odessey¹, Theodore Gull²

¹Scripps College, Claremont, CA, USA
²Astrophysics, NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

The binary star Eta Carinae underwent a massive eruption in the 1840s, resulting in a huge nebula of ejected material, called the Homunculus. Despite preventing us from the direct view from the central source, the Homunculus acts like a mirror, allowing us to see the spectrum of the central binary system from different stellar latitudes. Therefore, by mapping the spectrum along the nebula we are actually probing the dependence of the spectrum with stellar latitude. Our project focuses on the P Cyg absorption component of H lines mostly in the optical and near-infrared wavelengths. In order to investigate the structure of the primary stellar wind, a full spectral mapping of the entire nebula was constructed by combining multiple dithered long slit observations using the ESO/X-Shooter high-resolution spectrograph. Such mapping allowed us to assemble a data cube containing the spectrum of each position along the nebula. Preliminary analysis confirms that the primary wind indeed has a deeper absorption component at high stellar latitudes (polar region). Also, contrary to our expectations, our analysis indicates that the polar region does not seem entirely radially symmetric in terms of density, which invites further investigation into the source of these discrepancies.
Simulating Infrared Transmission through Porous Dielectric Foam

Maxfield T. Torke¹, Edward J. Wollack²
¹Sonoma State University, Rohnert Park, CA, USA
²NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA

Infrared radiation can interfere with satellite measurements by changing the temperature and thus the responsivity of sensitive components. For millimeter wavelength sensors, a simple solution to this challenge is to reject thermal infrared radiation with a thin layer of dielectric foam. The transmission of infrared radiation through a dielectric window made from porous Teflon foam was simulated and compared to experimentally measured data. This simulator serves as a tool for determination of the appropriate dielectric window thickness to filter by diffusely reflecting or scattering incident infrared radiation. The simulator was implemented in MATLAB using a transmission matrix method. A series of rotational lines were used in the dielectric function to account for the observed absorption peaks in the transmission spectrum. Decoherence of the light due to scattering in the material can be accounted for in the simulation. After extraction of the material parameters by a least squares fit, theoretical plots for any reasonable dielectric thickness can be generated. This program can accurately predict transmission spectra given easily measurable inputs. Once the material parameters are in hand optimization of the window geometry by simulation provides an efficient means of optimizing the desired instrument response.
Supercomputing Sub-Meter Satellite Stereo Data for the Forest-Tundra Ecotone

Stephanie S. Miller¹, Christopher S. Neigh²

¹University of Michigan, School of Natural Resources and Environment, Ann Arbor, MI, USA
²Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Mail Code 618, Greenbelt, MD, USA

Climate change has already affected vegetation productivity and other processes in the Higher Northern Latitudes. Previous studies to establish the current boundary between the Forest and Tundra biomes used MODIS satellite imagery at moderate to coarse resolution. These studies found that due to the wide variety of vegetation structure forms (many of which are not resolvable by earth observing satellites), the spatial precision was insufficient to monitor warming impacts. However, high resolution imagery requires much more time and computing power to process. This project explored the use of NASA’s Ames Stereo Pipeline (ASP) and supercomputing resources to enable processing of sub-meter resolution space-borne imagery across several test sites. Results will be compared to LiDAR data in the study region. These refined digital elevation models will be used to improve estimates of the circumpolar arctic tree line, train Landsat vegetation continuous field (VCF) products, and establish a baseline that can be used to monitor climate impacts on vegetation cover.
Deep Blue Website Project

Amy Chen\textsuperscript{1}, Bryan Howl\textsuperscript{2}, Alon Sidel\textsuperscript{3}, Andrew Sayer\textsuperscript{4a, 4b}
\textsuperscript{1}Richard Montgomery High School, Rockville, MD, USA
\textsuperscript{2}Southern High School, Harwood, MD, USA
\textsuperscript{3}Montgomery Blair High School, Silver Spring, MD, USA
\textsuperscript{4a}Climate and Radiation Laboratory, NASA Goddard Space Flight Center, Mail Code 613, Greenbelt, MD, USA
\textsuperscript{4b}GESTAR/USRA, Columbia, MD, USA

For this project, the goal was to create a website about the Deep Blue algorithm that would be informative to the public. The Deep Blue algorithm is used on satellites to calculate Aerosol Optical Depth (AOD) over land. The challenge was to create a website that could effectively explain the Deep Blue algorithm to those who are unfamiliar with aerosols, why they are important, and how they are measured. This was accomplished through tabs created to introduce aerosols and the satellites used in the Deep Blue project. To create the website, HTML script inside the program Drupal was used. Research on aerosols and satellites had to be conducted to make the website as effective as possible. After the text was written and graphics created, they were added to the website. The website then went through a series of revisions to make the site visually appealing as well as concise. Overall, the project was a great learning experience with much significance. With this website complete, the public can learn more about aerosols and what Deep Blue does, while professionals can gain a greater understanding of the Deep Blue algorithm.
Space Weather Forecasting and Research

Mary Aronne¹, Tamar Novetsky², Ethan Robinett³, Zachary Waldron⁴, Alexandra Wold⁴, Yihua Zheng⁵

¹University of Maryland, Baltimore County, Department of Physics and Department of Mathematics, Baltimore, MD, USA
²Princeton University, Department of Astrophysical Sciences, Princeton, NJ, USA
³Catholic University, Department of Mechanical Engineering and Department of Mathematics, Washington, DC, USA
⁴American University, Department of Physics, Washington, DC, USA
⁵Space Weather Laboratory, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

The Space Weather Research Center (SWRC) provides experimental research forecasts and analysis for NASA robotics missions operators. Using tools and models developed at the Community Coordinated Modeling Center (CCMC), space weather forecasters monitor space weather conditions to provide advance warning and forecasts based on observations and modeling, as well as contribute to DONKI, a database logging space weather events and impacts. Space weather events include solar flares, coronal mass ejections (CMEs), radiation belt enhancements, and solar energetic particle events (SEPs). These can impact robotics missions by causing surface charging, internal charging, thermal drag, orbit decay, and communications disruptions, as well as impacts on Earth such as geomagnetically induced currents and aurora. Ongoing multidisciplinary research is being done to understand space weather drivers, introduce new methods and models, and produce more accurate forecasts.
Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$

Emmaris Soto$^{1,2}$, Duilia F. De Mello$^{1,2}$, Jonathan P. Gardner$^3$, Harry I. Teplitz$^3$, Nicholas A. Bond$^2$, Marc Rafelski$^2$, Swara Ravindranath$^5$, Claudia Scarlata$^6$, Alex Codoreanu$^{6,7}$, Anton M. Koekemoer$^5$, Peter Kurczynski$^8$, Norman Grogin$^5$

$^1$The Catholic University of America, Washington, DC, USA
$^2$NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA
$^3$Infrared Science Archive (IRSA), Pasadena, CA, USA
$^4$IPAC/Caltech, Pasadena, CA, USA
$^5$STScI, Baltimore, MD, USA
$^6$University of Minnesota, Minneapolis, MN, USA
$^7$Swinburne University of Technology, Hawthorn, Victoria, Australia
$^8$Rutgers University, New Brunswick, NJ, USA

Presented is an investigation of clumpy galaxies using the deepest ultraviolet data in the Hubble Ultra Deep Field (HUDF) taken with Wide Field Camera 3 UVIS detector. For an in-depth UV analysis of the data, 3 new post-flashed UV images taken with the F225W, F275W, and F336W filters are used. Here we present an analysis of all galaxies in the $0.5 \leq z \leq 1.5$ redshift range. These galaxies show a variety of properties, with objects having just a single clump to galaxies littered with clumps. The flux and magnitude in each of the observed bands is found and the mass, age, and star formation rates of the clumps are determined utilizing FAST (Fitting and Assessment of Synthetic Templates). Clump properties are compared to the overall properties of their host galaxies, such as rest-frame UV flux ratios, to understand the role of these clumps in the evolution of their host galaxies.
Variability of the Terrestrial Ionosphere

Andrea C.G. Hughes\textsuperscript{1}, Jeffrey Klenzing\textsuperscript{2}

\textsuperscript{1}Embry-Riddle Aeronautical University, Department of Physical Sciences, Daytona Beach, FL, USA
\textsuperscript{2}Space Weather Laboratory, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

This study focuses on the Sun’s interactions with the Earth and the Solar System and the fundamental physical processes of the space environment from the Sun to Earth. The primary goal of this project is to better understand the sources and sinks of the variability in Earth’s Ionosphere (e.g., seasonal variations, the solar cycle, magnetic latitude/longitude, etc.). In order to accomplish this goal, we analyzed multiple seasons of radio occultation data from the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) satellite. Using the COSMIC dataset, we created global maps of the shape of the Ionosphere. These maps were used to identify long-term changes due to solar and terrestrial influences. We also generated seasonal maps of the mid- and low-latitude F-region Ionosphere, specifically focusing on the median and quartile values of maximum ionospheric densities (NmF2) and the corresponding ionospheric altitudes (hmF2). All analyses were completed in the computer software program Python, and an extension toolkit called the Python Science Analysis Toolkit (pysat). The resulting ionospheric maps are compared to models during the deepest part of the recent solar minimum to quantify the variability of the ionosphere during extremely low solar activity.
Science Writing for Earthzine

Alec Drobac\textsuperscript{1}, Kyle Turner\textsuperscript{2}; Paul Racette\textsuperscript{3}
\textsuperscript{1}Middlebury College, Middlebury, VT, USA
\textsuperscript{2}George Mason University, Fairfax, VA, USA
\textsuperscript{3}Microwave Instrument and Technology Branch, NASA Goddard Space Flight Center, Mail Code 555, Greenbelt, MD, USA

Earthzine is an online IEEE publication funded by NASA that focuses on “fostering Earth sciences and global awareness.” Its mission is to enable the transfer of up-to-date information from Earth science professionals to the global community of Earth observers and readers of general interest. The goal of this internship was to produce several pieces on subjects in Earth science for publication on the Earthzine website. These pieces ranged from short “quick looks” to longer, more developed articles, and sought to provide content relevant to the current theme(s). The internship program promoted the development of science writing skills, which include but are not limited to: conveying scientific material to an unprofessional audience; interviewing professionals for reliable, firsthand perspectives; writing objectively and substantively on subject material; and removing personal bias or opinion. There were also lessons in publication and content management through team meetings and discussions. Research was conducted both with online searches and with interviews with professionals at NASA and beyond. Articles were drafted and then revised and edited by multiple Earthzine employees, the last being the managing editor. Topics researched over the course of this program include implementation of smart water metering; remote sensing of ocean color; benefits for Earth studies in exploring exoplanets; and the integration of arts into the Earth sciences.
Extended Gamma Ray Emission from SNR G150.3+4.5

Ajay R Mysore\(^1\), John W Hewitt\(^2\)

\(^1\)University of Maryland: College Park, Department of Physics and Department of Astronomy, College Park, MD, USA

\(^2\)High Energy Astrophysics Branch, NASA Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA

Subatomic particles moving at relativistic speeds penetrate our atmosphere from all directions. These cosmic “rays” are thought to be accelerated to relativistic energies in Supernova Remnants (SNRs). The Fermi Gamma-Ray Space Telescope detects gamma rays produced by cosmic ray interactions with galactic gas and dust. Observing these gamma rays tests the idea of SNR cosmic ray acceleration and reveals the normally invisible systems where they might occur. In 2015, the Second Catalog of Hard Fermi-LAT sources conducted a full sky survey with the Large Area Telescope (LAT) instrument on Fermi looking for spatially extended gamma ray sources above 50 GeV and found an unidentified source in the Galactic region G150.3+4.5. Despite previous conjectures on the region, earlier tests had been inconclusive. The LAT is a photon counting detector, and its sensitivity to high-energy photons is increasing roughly linearly with time. As such, with 7 years of the newly released Pass 8 data, this source can be studied in detail in the energy range of 10-500 GeV. We identify extended emission from a uniform disk with a radius of about 1.5°. Based on the source’s extended nature, it is likely associated with the recently discovered radio SNR in the same region. The large angular size of the source suggests that it is either a very old SNR or extremely close-by. The photon spectrum of G150 follows a “hard” power-law index of -1.6, typically seen in young SNRs with ages of ~1-3,000 years. However, these SNRs emit prominent X-rays, while G150 does not. If G150 is an older gamma-ray SNR (~5-50,000 years) then it is expected to have a much “softer” power-law index of -2 to -3. This is the first gamma-ray SNR discovered having such a large extension yet also such a “hard” spectrum and breaches current ideas of particle acceleration during the course of SNR evolution. Despite previous conjectures on the region, earlier tests had been inconclusive. The LAT is a photon count detector however, so its data only gets better with time, and as such with the newly released Pass 8 data synthesis, this source can finally be observed scientifically. Early tests show a significant detection in the range of 10-500 GeV of an extended emission with a radius of about 1.5°. Based on the source’s extended nature, it is likely associated with the recently discovered radio SNR in the same region. The source features a fairly bright gamma extension with a power law index of -1.62, but is not visible in any other wavelengths, bar radio. The large angular size of the source and faint detection, suggests that it could be a rather old SNR or just very close-by. However G150’s spectrum energy distribution follows closely with that of young SNR RX J1713.7-3946 at 1,700 years old and power law index -1.53. Another paradox of this source is the lack of TeV detections as well as any X-ray detections, both of which are expected in young SNRs like RX J1713. This kind of system has never been discovered nor anticipated and breaches current ideas of SNR evolution.
Early Bombardment History of the Moon

Aisha Khatib¹, Aditi Shetty², Dr. Herbert Frey³

¹Georgetown University, Washington, DC, USA
²Montgomery Blair High School, Silver Spring, MD, USA
³Planetary Geodynamics Laboratory, NASA Goddard Space Flight Center, Mail Code 698, Greenbelt, MD, USA

Large impact basins on the moon date back billions of years and can be used to assess the early bombardment history of the Earth and the rest of the inner solar system. Previous work has identified visible lunar craters through photogeology and hidden impact basins through topography and crustal thickness data. This project analyzes 69 total basins identified using both methods. The purpose of this project is to measure Bouguer gravity contrasts (background to center of basin) and topographical contrasts (rim to floor) of various large lunar impact basins (>300 km diameter) to see how they correlate with basin age. The project uses the most high-resolution Bouguer gravity (from the GRAIL mission) and topography data (from the lunar orbiter LOLA) to date, accessed using IDL software, GRIDVIEW. Absolute ages for most lunar basins are not available. A system of relative ages, called Crater Retention Ages (CRAs), was developed using the density of superimposed smaller craters. Preliminary results have shown a general correlation of contrast increasing as age decreases, likely because older basins formed when the Moon was warmer and impact basin structure would have more rapidly relaxed.
Apollo ALSEP/SIDE Ion Observations during Periods of Intense Ion Cyclotron Wave Activity Observed by the Apollo LSM

Anastasia Newheart\textsuperscript{1}, Michael Collier\textsuperscript{2}

\textsuperscript{1}St. Mary’s College of Maryland, St. Mary’s City, MD, USA
\textsuperscript{2}Planetary Magnetospheric Laboratory, NASA Goddard Space Flight Center, Mail Code 695, Greenbelt, MD, USA

We present ion observations from the Apollo 14 Suprathermal Ion Detector Experiment (SIDE) from periods on four days during 1972 (117, 118, 119, 149, and 177) when the Apollo 15 and 16 Lunar Surface Magnetometers (LSM) observed narrowband ion cyclotron waves on the surface of the Moon in the terrestrial magnetotail [Chi et al. (2013), Planet. Space Sci., 89, 21-28, doi:10.1016/j.pss.2013.08.020]. SIDE measures ions over an energy range from 7 eV through 3 keV in eleven logarithmically spaced passbands each having an energy width (dE/E) of 10\%. For this study, we chose what we believe are lobe time periods occurring far from the current sheet and identified based on the magnetic field data. Our results show that during periods of high ion cyclotron wave activity (>20 nT\(^2\)), the energy density of the particles observed by SIDE was higher than during periods of low ion cyclotron wave activity (<5 nT\(^2\)) by a factor of two, with average energy densities of 0.1741 and 0.0878 eV/cm\(^3\) respectively. Furthermore, a comparison between ion spectra summed over low wave intensity periods and ion spectra summed over high wave intensity periods shows that on all days examined so far, the ion fluxes at the high energies (>500 eV) are greater by a factor of two during the high wave intensity periods than during the low wave intensity periods. These results strongly suggest that the ion populations observed by SIDE play a role, either associative or causative, in the ion cyclotron wave activity observed by Chi et al.
The Search for ExoPlanets in the Beta Pictoris Debris Disk

Ameer R. Blake¹, Dr. Aki Roberge²

¹Howard University, Washington, DC, USA
²NASA Goddard Space Flight Center, Mail Code 667, Greenbelt, MD, USA

The objective of this project is to further the growing knowledge about our celestial surroundings. This project aims to study the massive and second brightest star of the Pictor constellation, Beta Pictoris. This star, which is nearly twice the mass of our sun and more than 8 times as luminous, happens to be encircled by a massive disk of dust and space debris reaching out 500-800 AU from the star. We call this a Debris-Disk. With all that space it was assumed there might be planets in the disk. This was confirmed a few years ago in 2009 when a ground based telescope was able to direct image a huge super Jupiter in orbit around the star. With this interesting target as the focus of the project, it is worth noting that this specific system has the optimal property of being edge on our observations. With this fact we are perfectly set up to use Transit photometry to look for the existence of other planets in the debris disk. We hope to do so by surveying the star over a given period, using a small satellite called a CubeSat. By reading and analyzing the light curves obtained by the CubeSat we can identify orbits of planetary bodies, mostly of the Jupiter size, maybe as small as Neptune.
Post-mission Characterization of the Mercury Laser Altimeter

Alvin Cao¹, Xiaoli Sun²

¹Cornell University, College of Engineering, Ithaca, NY, USA
²Laser Remote Sensing Branch, NASA Goddard Space Flight Center, Mail Code 694, Greenbelt, MD, USA

The use of lidar (Light Detection and Ranging) in space has resulted in significant advancements to our understanding of the solar system. Specifically, its use in laser altimetry has enabled detailed, accurate topographic mapping of celestial bodies such as the Earth, Moon, Mars, and Mercury. One such laser altimeter, the Mercury Laser Altimeter (MLA), launched aboard the MESSENGER (Mercury Surface, Space Environment, Geochemistry, and Ranging) spacecraft in August 2004 and was used to examine the topography of Mercury until the mission ended in April 2015. In order to maximize the science returns from MLA in orbit, it is important to ensure that factors such as instrumentation and systematic error are minimized. In order to do this, an engineering model of MLA is set up and will be tested using simulated return laser pulses and its results compared to the in-orbit data. Additionally, the MLA timebase (clock) will be characterized to determine its long-term stability, which is vital for accurate laser altimetry during long missions such as MESSENGER. This study will involve detailed analysis of the instrumentation performance of MLA, including the accuracy of its data from Mercury, as well as provide insights into possible improvements for laser altimeters and timebases in future NASA missions.
Fragmentation of natural and agricultural landscapes impact biodiversity, disaster resilience, and productivity assessments. Remote Sensing tools are used to monitor and analyze these patterns around the world. MODIS provides high temporal data capable of documenting regional pattern changes, but does not have the spatial resolution to identify small changes. Landsat and commercial high resolution platforms can document smaller patterns, like small agriculture parcels, but have limitations to their ability to collect data during specific periods of interest. A literature review was conducted to identify the platforms and pattern metrics most frequently used in Landscape Pattern studies. Results demonstrate many cross resolution studies use artificially derived landscapes rather than a direct comparison between remote sensing platforms. A study was conducted to assess cross resolution impact on pattern recognition through the use of very high spatial (commercial products), high (Landsat), and moderate (MODIS) resolution platforms. Natural and agricultural sites were selected where all three resolution images were available and could be compared through their identification of Landscape pattern metrics.
Space weather forecasting addresses NASA’s interests by assisting scientific research with the production of data, measurements, and models of the solar activity that drives space weather. Forecasting is also necessary to protect NASA’s assets, as space weather can damage technological infrastructure, including the power grid, satellites, and other spacecraft. Some space weather events include solar flares, coronal mass ejections (CMEs), and high speed streams (HSS). This project analyzes the solar activity of active region (AR) 2371, which rotated onto the Earth-facing solar disk on June 16, 2015 and produced many space weather events that forecasters measured, modeled, and reported.

The Integrated Space Weather Analysis system (iSWA), which is comprised of various cygnets that access real-time data and innovative models, was utilized to forecast the activities of AR 2371. In the case of CMEs, measurements were made utilizing programs including SWPC_CAT and STEREO_CAT. Forecasters sent notifications from the Space Weather Database of Notifications, Knowledge, Information (DONKI), where the events are stored for later use by forecasters and researchers. The project goes into detail about the 2015-06-21T01:02Z and 2015-06-21T02:06Z solar flares and the corresponding 2015-06-21T02:48Z CME, outlining the sequential events, which included an SEP event, a geomagnetic storm, magnetopause crossing, and radiation belt enhancement, as well as aurora sightings at low latitudes.
Comprehensive Study of GRB Host Star Formation Rates

Alexandra Yep¹, Antonino Cucchiara²

¹California State University, Northridge, School of Physics and Astronomy, Northridge, CA, USA
²NASA Postdoctoral Program Fellow, NASA Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA

We collected the largest emission line based dataset of gamma-ray burst (GRB) host galaxies from recent VLT/X-Shooter compilation of Krhuler et al. (2015) as well as from the literature. Our main goal is to build the most comprehensive view of GRB host galaxies’ properties, in order to compare them with other star-forming galaxies at low and high redshifts. All emission line fluxes were uniformly reprocessed using Cardelli et al. (1989) to correct for our Galactic extinction and Pei et al. (1992) to correct for host galactic extinction, assuming a Milky Way extinction curve and Salpeter initial mass function (IMF). We then compared star formation rates (SFRs) from emission line measurements with SFRs from multiband spectral energy distributions (SEDs) from rest-frame UV to understand the role of recent star-formation episodes (from the former) with longstanding star formation rates (from the latter): If GRBs are thought to be associated with recent episodes of star formation, we would expect emission SFRs to differ from UV SFRs. We also study our sample in the context of biases of GRB production, in particular at z<1, where previous studies have shown that GRBs avoid massive galaxies.
Investigating the Long-term Variability of 4U1705-44; Evidence for an Underlying Nonlinear Double-Welled Oscillator

Rebecca Phillipson¹, Patricia Boyd², Alan Smale²,
¹Colorado State University, Fort Collins, CO, USA
²NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

The bright low-mass X-ray binary 4U1705-44, a bursting atoll source, exhibits long-term semi-periodic variability with a timescale of several hundred days. The All-Sky Monitor (ASM) aboard the Rossi X-ray Timing Explorer (RXTE) observed 4U1705-44 continuously from December 1995 through January 2012. MAXI, the Japanese X-ray All-Sky Monitor aboard the International Space Station has observed the source from August 2009 through the present. By combining the ASM and MAXI data sets, we can from a continuous time series over fifty times the length of the timescale of interest. Using traditional time series analysis techniques, such as investigating the power spectra of the time series, combined with novel time series analysis techniques, such as close returns analysis, we can investigate the nature of the long term variability. The phase space embedding of the flux versus its first derivative shows a strong resemblance to a double-welled nonlinear oscillator. When comparing our time series analyses against well-known nonlinear oscillators, we find that 4U1705-44 exhibits behavior akin to the Duffing oscillator in particular. We have found a range of parameters and initial conditions for which the Duffing oscillator closely follows the time evolution of 4U1705-44. We argue that the associated period-1 orbit in 4U1705-44 has a period of approximately 180 days in correlation with the driving frequency given by the range of parameters of the Duffing equation. We can extract these orbits from both the 4U1705-44 and Duffing oscillator time series and compare their topological information in phase space, such as their relative rotation rates. There appears to be a strong correlation between the resulting relative rotation rates and thus the Duffing oscillator is a strong candidate for describing the long-term variability of 4U1705-44. We will continue to verify these results with further relative rotation rates calculations and begin to explore the implications of this discovery on the allowable models to describe the long term variability of 4U1705-44 and by extension to the allowable models describing the class of X-ray binaries which show high amplitude, long term variability at timescales many times the orbital periods of the systems.
Science

Observation and Analysis of Global Storm Tracks and their Variations

Rebekah Esmaili¹, Yudong Tian²
¹University of Maryland, College Park, MD, USA
²NASA Goddard Space Flight Center, Mail Code 610, Greenbelt, MD, USA

The movement and evolution of storms signifies the complex water and energy transport in the atmosphere-ocean-land system. Storms are a global phenomenon and span a wide range of spatial and temporal scales. A cloud area-overlap tracking algorithm is used to track the two-dimensional geometric and thermodynamic variations of each storm, from high-resolution infrared satellite observations at 30-minute, 4-km resolution, for a period of 10 years. We found that the majority of events were both small and short-lived, which endorses the usefulness of the high-resolution satellite data. The 10-year climatology revealed that the most active regions were along the equator and monsoon regions, but also showed greater activity linked to the wintertime midlatitude storm tracks. This large sample of individually tracked storms across their entire lifespan produced reliable dynamic and stochastic characterization of their Lagrangian evolution, especially the nonlinear evolution in their geometric and thermodynamic behavior. This project provides a comprehensive global survey of high-resolution storm characteristics, and is useful for validating high-resolution global models or for improving multi-sensor cloud and precipitation estimation algorithms.
Simulation of Hyper-Velocity Impacts: Implications for Impact-Induced Organic Molecule Synthesis on the Early Earth

Benjamin Farcy1,2, Anderj Grubisic2, William Brinkerhoff2

1Geology Department, Southern Illinois University, Carbondale, Carbondale, IL, USA
2NASA Goddard Space Flight Center, Mail Code 699, Greenbelt, MD, USA

Extraterrestrial hyper-velocity impacts (HVI’s) could have potentially been a driving force in the production of relevant pre-biotic chemistry, such as amino acids or nucleobases, in the early Earth and other planetary bodies in the solar system. Using C, N, H, and O-bearing compounds, we have simulated these HVI’s using a Nd:YAG laser in order to investigate the organic compounds produced in the presence of impact-induced plasma fields. We have found that simulated planetary compositions using SiO₂, amorphous C, and H₂O do not produce any discernable organic yield when exposed to plasma fields. However, High Pressure Liquid Chromatography (HPLC) analyses on similar simulated environments using N-bearing compounds are forthcoming. The possible production of relevant amino acids and nucleobases from HVI’s shows that meteorite and cometary bombardment of the early Earth could have been a necessary step in the development of life in the solar system. Similar experiments performed in vacuo using these same compounds are scheduled to be performed, in order to demonstrate how these pre-biotic molecules could be produced on airless rocky bodies in the solar system or in interstellar dust clouds.
Calibration of Adaptive Langmuir Probe

Brandt Monson\textsuperscript{1}, Jeff Klenzing\textsuperscript{2}

\textsuperscript{1}University of Washington, Aeronautical and Astronautical Engineering, Seattle, WA, USA
\textsuperscript{2}Heliophysics Science Division, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

Langmuir Probes provide measurements of the electron temperature and density in a plasma by sweeping over a range of voltages and recording the collected current. They are ideal for missions where space is limited because of their simplicity and compact design. To account for the wide range of plasmas encountered on a typical mission, most probe designs will sweep over a large range of bias voltages. Voltages well above the floating potential can cause a large current (known as the electron saturation current) to return to the spacecraft, possibly leading to spacecraft charging or the damage of other instruments onboard. For large spacecraft, charging is minimal, but this problem is of particular interest to small spacecraft like CubeSats. To help reduce any large bias voltages, we have programmed the Langmuir Probe’s integrated circuit to identify the different floating potential levels and adjust the corresponding bias voltage sweep pattern. Testing the Langmuir probe in a vacuum chamber where the level of plasma can be controlled allows for the calibration of the circuit. This will remove the need for large bias voltages in plasma where the current is small, reducing any large current problems with the spacecraft as well.
Channel Electron Multiplier Performance Testing

Claudelle Calfat¹, Dr. Ricardo Arevalo²,
¹Embry Riddle Aeronautical University, College of Engineering, Prescott, AZ, USA
²Planetary Environments Lab, NASA Goddard Space Flight Center, Mail Code 699, Greenbelt, MD, USA

The topic of investigation was mass spectrometry, with a specific purpose of testing a channel electron multiplier across different pressures, temperatures, and emission currents. Results will help monitor detector performance, including electron gain and counts per second, and help evaluate end of life criteria for the detector. More specifically, important tests included emission current versus counts per second and electron gain; temperature versus dark counts; and emission current versus average counts per second and versus electron gain. These tests were conducted using a detector test stand, which maintains Mars conditions and allows for the control of voltages into the system, pressure, temperature, and emission voltage. Results are collected through specialized MOMA software which collects counts per second, pressure, pulse height distributions, electron multiplier voltage and current, and dynode current and voltage, as well as with a multimeter, picoameter, and digital thermometer connected into the system. Results are expected to have counts scale with pressure, and to have clear and predictable relationships between emission current versus counts and electron gain, as well as a relationship between electron multiplier voltage versus counts and electron gain.
Micrometeorite Data Analysis for LISA Pathfinder

Cameron Hashem-Reza Parvini¹, James Ira Thorpe²
¹The George Washington University School of Engineering and Applied Sciences, Washington, DC, USA
²Gravitational Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 663, Greenbelt, MD, USA

Due to the time and complexity involved in the mission design process, endeavors such as LISA Pathfinder must have a well-defined expectation for data being collected during their lifetime. In 2014, the GAIA star surveyor satellite experienced a number of small scale disturbances taking the form of sharp spikes above the baseline noise level. It was originally theorized that these spikes could be caused by micrometeorites striking GAIA’s body: an obvious concern for the LISA Pathfinder mission slated to launch with even more sensitive technology aboard. The purpose of this study was to investigate the physics behind micrometeorite impacts on a spacecraft within the context of the LISA Pathfinder mission, develop a pipeline for detection, and subsequently glean useful information about the magnitude and frequency of such events by utilizing technology already aboard the satellite. An analytical model was developed that described the momentum transfer from a single direction, then generalized into 3D space and tested using simulation tools available in the LTPDA (Lisa Technology Package Data Analysis) toolbox in Matlab. Once the model was confirmed to represent the physics accurately, sensor noise was included to provide a more realistic representation of the impact sensitivity available by using the test mass data from the spacecraft. Preliminary results indicate impacts on the order of 1 microNewton-second could be seen in the test mass accelerometer data, and detection via matched filtering and maximum likelihood appeared promising. The results of this study appear beneficial to both characterizing the effect of micrometeorites as a disturbance input to the LISA Technology Package, and characterizing micrometeorites in a manner previously unexplored. While a pipeline that implements the physics would be a useful tool, creating such a document is beyond the scope of a ten-internship period.
Measuring Snow Depth on top of Arctic Sea Ice

Camilo Joya Diaz¹, Ludovic Brucker²

¹Morgan State University, School of Computer, Mathematical, and Natural Sciences, Baltimore, MD, USA
²Cryospheric Sciences Lab, USRA GESTAR, NASA Goddard Space Flight Center, Mail Code 615, Greenbelt, MD, USA

At the core of our research is sea ice and its importance to planet Earth’s climate system. The white surface of the ice reflects sunlight well, a temperature cooling effect. As sea ice melts its mass and surface area both shrink. So its ability to cool declines and it reflects less sunlight. Sea Ice has proven to be sensitive to changes in global temperature, in other words sea ice serves as a great indicator of Earth’s climate state.

Specifically we will be measuring the depth of the snow on top of the sea ice. For these measurements we will be referring to two sets of data. One comes from the Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) and the other comes from Operation IceBridge (OIB). The AMSR-E provides brightness temperatures, which can then be used to compute the snow depth via a retrieval algorithm developed in the 1990’s. This algorithm was developed using in situ measurements over Antarctic sea ice. Considering that AMSR-E uses a microwave radiometer (a passive sensor) and OIB uses a radar (an active sensor), we come across the problem of using two different instruments to quantify snow depth. To quantify snow depth from AMSR-E, the equation of significance is:

\[
\text{Snow Depth} = \alpha + \beta \cdot \text{Gradient Ratio},
\]

where the Gradient Ratio is computed using the brightness temperatures at two frequencies (18.7 and 36.5 GHz). Our ultimate goal is to see if there is any potential for improving snow depth retrievals through the use of different \( \alpha \) and \( \beta \) coefficients. The Root Mean Square Error (RMSE) calculation is used to assess the quality of the new and coefficients. We will compute the RMSE twice:

between the OIB Snow Depth and the AMSR-E operational Snow Depth distributed by the US National Snow and Ice Data Center; and

between the same OIB Snow Depth mentioned above and the AMSR-E Snow Depth computed as a function of given brightness temperatures.

These two RMSE values will be compared.
Modeling of LISA Pathfinder with Inverted Pendulum on Cart Control

Christopher J. Bambic¹, James Ira Thorpe²

¹Department of Physics, University of Maryland, College Park, MD, USA
²Gravitational Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 663, Greenbelt, MD, USA

LISA Pathfinder is a joint NASA-ESA mission designed to test the technologies necessary to the launch of the Laser Interferometer Space Antenna (LISA), a space-based gravitational wave observatory. Pathfinder will demonstrate a drag-free control system, which can reduce environmental disturbances such as micrometeorites, radiation pressure, and solar winds in order to create the inertial rest frame necessary to the detection of gravitational waves in space. In order to explain the control systems at work on Pathfinder to a wider range of audiences, we analyze a classic problem in control theory: an inverted pendulum on a cart. By designing a cart, which is able to reject disturbances to a mechanically-unstable inverted pendulum, we are able to demonstrate the feedback processes in one degree of freedom which allow Pathfinder to function in six degrees of freedom. We will present both the methods for designing and simulating the control as well as the working cart-pendulum system and data generated by the control’s response.
Energetic Particles in Star-forming Galaxies

Carolina “Cee” Gould\textsuperscript{1}, Tonia Venters\textsuperscript{2}
\textsuperscript{1}UC Berkeley, Berkeley, CA, USA
\textsuperscript{2}Astroparticle Branch, NASA Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA

An exciting result from the Fermi Gamma-ray Space Telescope is the detection of star-forming galaxies at gamma-ray energies. In star-forming galaxies, gamma rays are produced through the interactions of highly energetic cosmic rays (including electrons, protons, and nuclei) with interstellar gas and radiation. As such, star-forming galaxies are an extragalactic gamma-ray source class, which can be studied to better understand the physics of cosmic rays in a variety of interstellar environments. The gamma rays arising from the cosmic ray interactions are part of a spectrum of emission that extends other wavelengths such as X-rays and radio. Thus, nearby star-forming galaxies, such as NGC 253, have been the subject of multi-wavelength observations by telescopes such as Fermi (at GeV energies), NuSTAR (in X-rays), VLBA (radio), and HESS and VERITAS (at TeV energies). Even so, the details surrounding the mechanism for producing the gamma rays remain elusive for many star-forming galaxies. Do the gamma rays originate from interactions of cosmic ray electrons with interstellar gas and radiation from stars and dust? Or are they the result of interactions of cosmic ray protons and nuclei with interstellar gas? The gamma-ray production mechanisms are even more uncertain for galaxies that are farther away and would be observed at earlier epochs in the history of the universe. As the universe evolves, the star-formation properties and interstellar environments of star-forming galaxies also evolve, impacting the cosmic ray physics responsible for producing gamma rays. For this opportunity, we conducted a theoretical study of cosmic ray physics in star-forming galaxies, including studying how evolution in interstellar environments with cosmic epoch impacts cosmic ray physics in star-forming galaxies and their resulting emission. Our goal is to make predictions for observations from Fermi and NuSTAR, as well as for telescopes operating in other wavebands. At this point, our predictions are still in progress, but will be updated as soon as possible. We are hoping that our predictions will align with studies from others in the field, while shining new light on the FERMI NGC 253 observations.
Investigations of Venus Ionosphere Holes as Observed by Pioneer Venus Orbiter

Caleb J. Gimar¹, Joseph M. Grebowsky²

¹Wichita State University, Fairmount College of Liberal Arts and Sciences, Department of Mathematics, Statistics, and Physics, Wichita, KS, USA
²Planetary Magnetospheres Laboratory, NASA Goddard Space Flight Center, Mail Code 695, Greenbelt, MD, USA

This study investigated the nature of the ionospheric holes in the Venusian atmosphere observed by the Pioneer Venus Orbiter (PVO), with the intent of refining current theories concerning the holes’ origin and structure. One of the leading explanations for the phenomenon (magnetic fields produced as a result of ionospheric plasma flow dynamics) has been addressed here. Attention was given to the measurement of electric currents, which may contribute to the magnetic fields responsible for the holes, and to the comparison of magnetic and plasma pressures at the hole boundaries. Data obtained from the PVO magnetometer were analyzed with the application of Ampere’s Law to find the electric currents in question, while data from both the magnetometer and the Orbiter Electron Temperature Probe were analyzed to find the plasma and magnetic pressures. Results from the electric current calculations indicated a radial electric current structure at the hole boundaries, while the pressure measurements indicated a balance between ion and magnetic pressures at the hole boundaries which have been found in previous, more limited studies. However, these pressure balances may be more complicated in nature than formerly determined. As a whole, the results given here support the hypothesis of the ionospheric plasma flow contributing to the production of ionospheric holes.
Investigating the Short Gamma-Ray Burst Detection Rate of the Swift Burst Alert Telescope via Trigger Simulations

Charles Law¹, Amy Lien²,³

¹Harvard University, Department of Physics, Cambridge, MA, USA
²Center for Research and Exploration in Space Science and Technology (CRESST), NASA Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA
³Department of Physics, University of Maryland, Baltimore County, Baltimore, MD, USA

The burst alert telescope (BAT) aboard the Swift spacecraft uses a complex two-stage trigger algorithm in which successful gamma-ray burst (GRB) detections must pass at least one “rate trigger” criterion as well as an “image threshold.” However, BAT detects short GRBs with a significantly lower frequency than other comparable instruments, such as Fermi’s Gamma-ray Burst Monitor (GBM). Due to their short pulse durations, short GRBs may not be able to accumulate sufficient photon fluence to exceed the image threshold. As a result, it is believed that short GRBs are more likely to trigger only the rate criteria (but fail to reach the image threshold) than long GRBs and thus many short GRBs may have valuable information stored in BAT’s failed event data. By determining the reasons for these missed detections, one can further characterize BAT’s instrumental bias. Additionally, for GBM-detected bursts that lie within BAT’s field of view, it is possible to recover these short bursts in the BAT failed event data to provide better burst localization for ground-based follow-up and redshift measurements. Using a BAT trigger simulator code, which incorporates rate and image criteria, a sample of actual short GRBs lying in both the BAT and GBM’s field of view was tested to confirm that the code correctly reproduced the BAT’s observations. Then, a set of bursts was simulated with varying parameters (e.g. spectral shape, incident angle, redshift) and relevant correlations between burst characteristics and BAT’s response (triggered, missed as failed event, or undetectable) were identified. The trigger code generally reproduced the BAT’s response for short GRBs, showing only minor deviations. However, for very off-axis short GRBs, the trigger code showed more significant discrepancies from the actual BAT response. In particular, the code’s method of assigning an image threshold led to some incorrect predictions of BAT’s behavior. This work provides a confirmation of the trigger code’s efficacy for short GRBs and is a systematic study of the causes of BAT non-detection of short GRBs. The eventual goal of this investigation is to increase BAT detections of short bursts and to develop an automated pipeline for recovering short GRB data (of GBM-detected short bursts) from the failed event data. This ultimately will lead to better short GRB localizations and correspondingly improved follow-up observations as well as a higher frequency of redshift determinations.
The sun erupts more or less frequently according to an 11 year cycle, discharging bursts of plasma and magnetic structures known as coronal mass ejections (CMEs); however, beyond the cycle, exactly when and where CMEs will occur is not well understood. These CMEs can cause damage to satellites, interfere with electrical grids, and disrupt telecommunications. It is important to classify and categorize the data that has been collected in order to better analyze the past events and ultimately to predict future CMEs. In order to classify the past CMEs, images from STEREO A and B were compared with known events to classify types and origins of eruptions. In the past, only the CMEs able to be seen from Earth could be recorded, however STEREO allow for viewing and measurements around the entire sun and provides a more 3D image. These images were also checked against the images from LASCO. Through this method, several months of solar images were able to be analyzed and the events from these months classified and recorded in data tables. Although the nature of solar data is dynamic in that new events are still occurring, these categorized events help provide a clearer picture of how our sun operates.
Testing the Universality of the Stellar IMF with Chandra

David Coulter\textsuperscript{1}, Bret Lehmer\textsuperscript{2}

\textsuperscript{1}Portland State University, Department of Physics, Portland, OR, USA
\textsuperscript{2}X-ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA

Observations of the mass to light ratios (M/L) of early-type, elliptical galaxies show a systematic increase of M/L with increasing galaxy mass. This trend deviates from predictions made by canonical models, with several leading theories seeking to explain this discrepancy by introducing a stellar initial mass function (IMF) that varies as a function of galaxy mass. Bottom-heavy IMFs, with steep, Salpeter-like power-laws ($x = -2.8$) are consistent with both the observed M/L ratios, as well as an increase of gravity-sensitive absorption features in stellar spectra that trace dwarf star populations. However, low mass ellipticals are well-characterized by shallower, Kroupa-like IMFs at the low mass end, and suggest that the relative number of stellar remnants for each type of galaxy should therefore differ. This difference in the stellar remnant population, and therefore in the number of low-mass, X-ray binaries (LMXBs) formed in each galaxy, should exhibit an observable difference in the number of LMXBs per unit k-band luminosity as a function of galaxy mass. Previous work in exploring this difference has found that there are a relatively constant number of LMXBs per unit k-band light, although the sample of galaxies studied were clustered around high mass ($\sigma \geq 200$ km s$^{-1}$). Our study seeks to extend this work and characterize the LMXB population of an ensemble of lower mass ellipticals ($\sigma \leq 100$ km s$^{-1}$; $L_K \approx 10^{10} L_K,\odot$), and thus constrain the relative shape of the high-mass end of the early-type elliptical IMF. Initial results suggest that the LMXB frequency for low mass ellipticals is similar to their high mass counterparts, and we further seek to develop a variable IMF form which uses this constraint to model the transition from a Kroupa-like IMF to a steep power-law IMF as a function of galaxy mass.
Superthermal Electron Magnetosphere-Ionosphere Coupling in the Diffuse Aurora in the Presence of ECH and Whistler Waves

Louis Gregory Detweiler¹, George Valdimir Khazanov²

¹Southern Oregon University, College of Arts and Sciences, Ashland, OR, USA
²Heliophysics Division, Geospace Laboratory, NASA Goddard Space Flight Center, Mail Code 673 Greenbelt, MD, USA

Precipitating electrons with the energies of 600 eV to 10 KeV that are initially injected from the plasmasheet to the loss-cone via wave-particle interaction processes degrade in the atmosphere toward lower energies and produce a cascade of secondary electrons via impact ionization of the neutral atmosphere. These secondary electrons can escape back to the magnetosphere, and can become trapped on closed magnetic field lines, and thus can deposit their energy back to the inner magnetosphere. Such a situation exists in the simulation scenario of Superthermal Electron (SE) energy interplay in the region of the diffuse aurora, modeled by the solution to the Boltzmann-Landau kinetic equation presented and discussed by Khazanov et al. [2014] and will be quantified in this presentation by taking into account the interaction of secondary electrons with ECH and whistler waves. This information will be presented in the forms of graphs of the electron fluxes with respect to electron energy (eV) and electron pitch angle at various altitudes and L-shell values of 4.6 and 6.8 earth radii. The total energy flux and total particle flux of these electrons was calculated by solving the equations \( \int_{1}^{10,000} E * \Phi dE \), and \( \int_{1}^{10,000} \Phi dE \) respectively for various energy ranges (1 - 600 eV, 600 – 10,000 eV, and 1 – 10,000 eV) and altitudes for L-shell values of 4.6 and 6.8 and will be presented in forms of tables. The total energy density and total particle density along closed field lines for the same energy ranges, altitudes, and L-shell values will also be presented in tables and were calculated by solving the equations \( 4\pi \int_{1}^{10,000} E * \frac{\Phi}{v} dE \), and \( 4\pi \int_{1}^{10,000} \frac{\Phi}{v} dE \) respectively.
Effect of Urbanization on Surface Temperatures in 24 U.S. Cities

Edward Lo¹, Lahouari Bounoua²

¹University of Maryland College Park, College Park, MD, USA
²Biospheric Sciences, NASA Goddard Space Flight Center, Mail Code 618, Greenbelt, MD, USA

This project aims to gain a better understanding of urban heat islands and the effects of increased temperatures on energy use in major U.S. cities. Previous research has shown that major east coast cities (New York, DC, Atlanta, Philadelphia) have higher temperatures in urban areas than vegetated in the summer, but have lower temperatures compared to vegetated areas in the winter. This project expands study cities to all over the U.S. An overall relationship and trend between temperature and urbanization will be looked for. The project uses satellite data and the Simple Biosphere Model to simulate multiple land surface state variables, such as surface temperature, soil moisture, and carbon fluxes. For this project, surface temperature data obtained from Landsat and Modis satellites using a Climate Modeling Grid of approximate 5 km x 5 km areas are used. Satellite readings were taken for 24 cities in 30 minute intervals for a year and 12 land types were utilized. A Python program is used to organize the data and Excel is used to graph the results. The results are similar to the previous research, as most cities had higher temperatures than vegetated areas in the summer and lower temperatures in the winter, but it was found that the relationship is not as strong when the amount of cities increased to 24. However, the findings are still significant because this means that air conditioning use will be high in the summer and heater use will be high in the winter throughout the U.S. Energy companies will use this information for budget and energy use strategies. This information will also be useful for urban planning and the development of future land cover maps.
Temperature Inversions in Hot Jupiters

Emily Garhart 1, Avi Mandell 2

1University of Maryland, College Park, MD, USA
2Planetary Systems Laboratory, NASA Goddard Space Flight Center, Mail Code 693, Greenbelt, MD, USA

We present a systematic study of 33 hot Jupiter secondary eclipses, including 16 never before characterized hot Jupiters, observed at the 3.6 μm and 4.5 μm bandpasses of Warm Spitzer in order to classify their atmospheric structure, namely the existence and cause of temperature inversions. This is a robust study in that these planets orbit stars of varying composition, temperature, and activity levels. Having this wide range of conditions allows us to investigate the source of temperature inversions, specifically, its correlation with stellar irradiance and magnetic activity. We correct for systematic and intra-pixel sensitivity effects with a pixel level decorrelation (PLD) method seen in Deming et al. (2015). The relationship between eclipse depths and a best-fit blackbody function versus stellar activity, a method seen in Knutson et al. (2010), will enable us to appraise the current hypotheses of temperature inversions.
Analysis of Colored Dissolved Organic Matter and Particulate Organic Carbon

Eric Hasegawa¹, Michael Novak²
¹River Hill High School, Clarksville, MD, USA
²Ocean Ecology Laboratory, NASA Goddard Space Flight Center, Mail Code 616, Greenbelt, MD, USA

Satellite imagery of the oceans allows visualizations of a variety of data such as currents, water temperature, and carbon concentrations. However, errors from atmospheric correction and water-leaving radiance measurements often lead to uncertainties in the accuracy of the data products. Therefore, the analysis of data from the field alongside satellite imagery can validate current satellite algorithms while also developing new ones. The Ocean Ecology Laboratory at the NASA Goddard Space Flight Center studied and verified the accuracy of satellite imagery showing “colored dissolved organic matter” (CDOM) absorptions and “particulate organic carbon” (POC) concentrations by collecting water samples from locations monitored by satellites and comparing them to the satellites’ data on these specific locations. To study the accuracy of satellites’ detection of CDOM absorptions, a spectrophotometer was used to analyze the attenuation of light through CDOM samples, and these data were compared to existing satellite records on the absorption of light in ocean water. POC concentration was analyzed by combusting samples in an elemental analyzer to produce carbon dioxide, which in turn was used as a direct correlation to the total organic carbon content of the samples. The data measured from the field showed the actual absorption of CDOM and POC concentration in ocean waters, and were used to validate the satellite data from the collection region. These data support the progress of algorithm refinement and can be used to more effectively monitor ocean CDOM absorptions and POC concentrations.
Lunar Exospheres and Instrument Control

Margaret A. Gallant¹, Ronald J. Oliversen², Edwin J. Mierkiewicz¹, Jeffrey W. Percival³, Kurt P. Jaehnig³

¹Embry-Riddle Aeronautical University, Physical Sciences Department, Daytona Beach, FL, USA
²Planetary Magnetospheres Laboratory, NASA Goddard Space Flight Center, Mail Code 695, Greenbelt, MD, USA
³University of Wisconsin-Madison, Space Astronomy Laboratory, Madison, WI, USA

Researchers at NASA Goddard Space Flight Center, Embry-Riddle Aeronautical University, and the University of Wisconsin-Madison are currently developing a remote observatory for investigating the exospheres of the Earth and other planetary objects. Both universities have demonstrated that the optical and instrument control systems can be controlled using LabVIEW graphical programming. The Instrument Control project at GSFC contributes to the collaboration by demonstrating that a third-party CCD and filter wheel from SBIG can be controlled using LabVIEW. The camera system allows remote observers to identify targets on the sky, as well as for use as a data collection instrument. The project objective is to develop a Graphical User Interface (GUI) that allows an observer to remotely control the camera system for field identification and/or data collection, and to investigate the capability for auto-guiding. We have successfully demonstrated basic control of the camera and continue to develop full capability and integration into the remote observatory.
Enhancing Data Collection and Analysis Methods for Wide-Field Imaging Interferometry

Gloria Diederich¹, Dr. Dave Leisawitz²

¹University of Maryland Baltimore County, Department of Mathematics and Statistics, Baltimore, MD, USA
²Sciences and Exploration Directorate, NASA GSFC, Mail Code 600, Greenbelt, MD, USA

In this project, we introduce a simpler and less user-intensive method of data selection and develop an astronomically realistic hyperspectral test scene for projection into the Wide-Field imaging Interferometry Testbed (WIIT). Our program is designed to advance spatio-spectral interferometry for future application on a space based far-IR interferometer, as envisaged in the NASA Astrophysics Roadmap. Such an interferometer will probe protoplanetary and debris disks and help us understand how the conditions for habitability arise during the planet formation process.

The goal is to demonstrate that an interferometer can capture complex hyper-spectral images of such disks with the desired spatial and spectral resolution. This requires preparation of realistic test scenes with varied spatial and spectral information. The Calibrated Hyperspectral Image Projector (CHIP) in WIIT is capable of projecting these scenes into the interferometer. The test scene we developed is that of a debris disk with realistic structure and spatially varying spectra. Unlike previous tests used to test basic performance, this will challenge the interferometer’s ability to accurately observe an astronomical object and advance our knowledge of how well the space-based interferometer will work.

An automated program that sorts data for each FITS data file generated by WIIT and creates a map of interferometric fringe visibility will enable quick calibration and inspection of the tens of gigabytes of data generated by each WIIT experiment. The user can compare the visibility map with the low-resolution image captured with the WIIT camera, and click on parts of the visibility map to inspect the interferograms in individual pixels to determine if the data are usable for hyper-spectral image construction. Previously this task was monotonous and time consuming, using multiple commands in the command line of IDL. Our developed program in Python is much quicker and easier for the user, and yields more valuable information.
Development of Superhydrophobic Surface Coatings

Nathaniel Hawthorne¹, Mark Hasegawa²

¹Union College, Schenectady NY, USA
²Thermal Coatings and Contamination, NASA Goddard Space Flight Center, Mail Code 546, Greenbelt MD, USA

The need for a self-cleansing, dust mitigating surface has arisen due to the problems that dust has caused for both manned and unmanned space missions in the past. This challenge has given need to the creation of a superhydrophobic surface coating, which would be easy to clean and solve the issue of dust build up on important sensors or instruments. This study tested the practicality of a one-step fluorinated silica layer as a superhydrophobic surface coating. This study also tested the effect that adding a primer layer has on the durability of a superhydrophobic surface coating. A one-step fluorinated silica layer has given contact angles with water droplets upwards of 165°. The surface coating erodes quickly under mechanical stress however. Sol-gel chemistry can be a useful method for creating superhydrophobic surface coatings in the future, if the durability of the coating itself could be increased.
Effects of Volcanic Eruptions on Climate and the Environment using Satellite Observations of SO2 and Ash and a Global Model

Heather Chen¹, Dr. Mian Chin², Tom Kucsera³

¹University of California, Berkeley, College of Letters and Science, Berkeley, CA, USA
²Sciences and Exploration Directorate, Earth Sciences Division, Atmospheric Chemistry and Dynamics, NASA Goddard Space Flight Center, Mail Code 614, Greenbelt, MD, USA

The purpose of this project is to identify volcanic emission heights as a constraint for global models such as GEOS-5/GOCART that simulate climate and the environmental effects of volcanic eruptions. Volcanic eruptions cause substantial climate and air quality hazards by injecting ash and gaseous material such as sulfur dioxide (SO2) into the atmosphere. By collecting and analyzing injection heights and their relationships with other factors, we aim to understand how much of an effect the eruptions have on climate, wind systems, energy budget and the water cycle. The study collected emission height of SO2 from major volcanic eruptions from 2002-2012 estimated with several different techniques, including the empirical relationships between the volcanic eruption magnitude and injection height, the retrieval of plume height from MISR stereo imaging, the spectral linear fitting using SO2 column amount from OMI, and the back trajectory analysis. From these comparisons and observation of volcanic plume transport patterns, we construct a database of "volcanic source function" that contains our optimal estimation of volcanic injection heights for major volcanoes together with the total SO2 amount from OMI. Such database will be implemented into the GEOS-5 model to study the environmental effects of volcanic eruptions.
The Use of Shack-Hartman Sensors to Characterize Photoreceivers for the eLISA Mission

Hudson Loughlin¹, Dr. Jeffrey Livas²

¹Princeton University, Princeton, NJ, USA
²Gravitational Astrophysics Lab, NASA Goddard Spaceflight Center, Mail Code 663, Greenbelt, MD, USA

The eLISA mission will use long-baseline interferometry in space to detect gravitational waves by measuring small variations in distance between spacecraft. The alignment of these satellites requires the use of low noise quadrant photoreceivers to detect fringes from the spacecraft’s interferometer. Previous studies have investigated the performance of these photoreceivers on a component level including their noise, bandwidth and transfer function but have not investigated their performance on a system level. This study investigated the possibility of using a Shack-Hartman wavefront sensor to evaluate the interaction between these photoreceivers and the interferometer as a system. The study used known wavefronts to test the accuracy of a Shack-Hartman sensor to ensure its ability to make the necessary measurements on the interferometric system. The sensor successfully reconstructed simple test wavefronts and successfully calculated parameters about the test beam such as its waist location. The sensor appears to be properly functioning but further testing may be required to examine its accuracy with more complicated wavefronts such as the ones produced by eLISA’s interferometer.
SPACE Interactive Tool

Zoe Himwich¹, Robin Leiter², Aparna Natarajan³, Jacob Rosenthal⁴, Huong Vo⁵, Pamela E. Clark⁶

¹Stanford University, Stanford, CA, USA
²University of Virginia, Charlottesville, VA, USA
³University of Maryland-College Park, College Park, MD, USA
⁴Virginia Tech, Blacksburg, VA, USA
⁵University of Washington, Seattle, WA, USA
⁶Planetary Magnetospheres Laboratory, NASA Goddard Space Flight Center, Catholic University of America, Mail Code 695, Greenbelt MD, USA

As interest in the development of micro- and nano-satellites for scientific mission applications grows, more commercial off-the-shelf components for CubeSats, nanosatellites of a standard volume, are becoming available. Our project at NASA Goddard was to create a program and user interface that facilitates the design of theoretical payloads for CubeSat missions in the early stages of mission design. The SPACE tool separates the design process of a CubeSat mission into selection of an instrument or payload and selection of various subsystems. In addition to the SPACE program, we created a database of commercially available satellite components designed for CubeSats, which the SPACE tool is able to search and select from. After subsystems are selected, the tool allows the user to tweak their mission concept or subsystem selections and then access 3D models of the CubeSat parts and bus. These parts can be printed individually or as a complete CubeSat layout assembled in a CAD program. This program allows scientists and engineers in early phases of mission design to determine the state-of-the-art technological capability of CubeSats and find initial estimates mass, power, volume, and bandwidth of a specific nanosatellites mission. Our hope for the future of this tool is that it will be made available online for public use, and as more scientists, engineers, and manufacturers use the tool, they will contribute to the CubeSat database, increasing the functionality of our tool.
MMS Data Calibration using IDL

Isaac Huang, Kenneth Bromund, Guan Le

1Severn School, Severna Park, MD, USA
2Heliophysics Science Division, Space Weather Laboratory, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

The Magnetospheric Multiscale (MMS) Mission aims to study the phenomenon of magnetic reconnection at the point where the Earth’s and Sun’s magnetic fields meet. Magnetic reconnection is pertinent to understanding the effects of solar wind on the Earth’s magnetosphere. Strong bursts of energy may shut down Earth’s communication, satellite, and electrical systems. Studying the phenomenon of magnetic reconnection may help prevent and prepare for these natural disasters. The MMS mission consists of 4 identical spacecraft to measure the three dimensional structures of the reconnection region. Each spacecraft carries two magnetometer sensors to make in-situ measurements of the magnetic field, a key component of the MMS science data. The MMS spacecraft were launched in an elliptical orbit around the Earth on March 12, 2015, and are spin stabilized in orbit. Raw magnetometer data telemetry from the spinning spacecraft coordinate system must be calibrated and processed by a set of software tools in order to generate high level science data products in geophysical coordinate systems for the use of scientific researches. The data collected from the MMS magnetometer carry a lot of inherent noises from both the instrument itself and the spacecraft interferences and require corrections and calibrations to be correctly interpreted. The goal of the project is to determine a set of calibration parameters and correct these data using the calibration parameters so the data can be passed on for further evaluations and studying by scientists. Software tools in IDL code are used to transform the data into legible information. There are a variety of parameters that must be adjusted. Editing and running the calibration scripts allowed for the background noise to be removed and slight offsets to be accounted for and corrected. The resulting product is a graph of approximately a month’s worth of data with minimal background noise.
Martian Crustal Magnetic Field with MAVEN

John A. Clarke¹, John E.P. Connerney²

¹Massachusetts Institute of Technology, Cambridge, MA, USA
²Planetary Magnetospheres Laboratory, NASA Goddard Space Flight Center, Mail Code 695, Greenbelt, MD, USA

Though Mars lacks a global magnetic field, its crust is home to a wide array of local magnetic anomalies. Theory suggests that, like the plates on Earth, these crustal fields were formed by magma outflows that cooled and preserved the global field’s direction and polarity. Thus, the crustal fields serve as excellent probes into nature of the global field and understanding them is crucial to developing a theory for the evolution of Mars’ magnetic field. Furthering the efforts of Connerney et al. (1998), we used the newly acquired magnetic field data from MAVEN to create a mapping of the local magnetic fields onto the crust. This map provides a higher resolution snapshot of Mars’ ancient magnetic field will help answer fundamental questions about its evolution.
Neutral Atom Flux Simulation of the Earth's Ring Current

Jeffery D. Craven II1, Mei-Ching Fok2, Natalia Buzulukova2
1Auburn University, College of Science and Mathematics, Auburn, AL, USA
2Geospace Physics Laboratory, NASA Goddard Space Flight Center, Mail Code 673, Greenbelt, MD, USA

Earth’s ring current is an electric current carried by charged particles trapped in the magnetosphere. The enhancement of the ring current particles produces magnetic depressions and disturbances to the Earth’s magnetic field called a geomagnetic storm. The simulation with the comprehensive inner-magnetosphere ionosphere (CIMI) model of magnetic storm since the year 2009 is instrumental for understanding the basic formation and behavior of the ring current. The purpose of this model is to compare and contrast simulation data and empirical data obtained from satellites to discover new processes and procedures related to the interaction between the magnetosphere and solar storms. The basic procedure was to use the CIMI model for all of the storms tested. Each of the storms had varying parameters in terms of particle flux values as well as magnetic field disturbances, in addition to other values of data collected, which varied with the actual storm. The simulated storms were also initially run under the same simulation parameters so as to maintain consistency, such as initial species populations of ions and electrons and varying magnetic fields. Expected results revealed the simulation parameters for various storms needed to be adjusted so as to create a more accurate description of the storm, such as using static magnetic fields or initial populations set to zero, and that not all storms needed the same parameters to be adjusted to create more accurate representations of the storms when compared with empirical storm data. The model is incapable of creating exact representations of the storms and it is these discrepancies that exist between existing data and simulation data that drive the desire to understand the mechanics of the storms in more detail or to discover mechanics of the storms that were previously unknown. The use of this model assists with the understanding of this interaction and furthers knowledge within the field of space weather.
The center of our Milky Way Galaxy, better known as the Galactic Center, is host to many important and influential landmarks, including the supermassive black hole Sgr A*, stellar complexes like Sgr B, and many young ultraviolet light producing stars. The stellar radiated output produced by these stars is absorbed by the dust and gas present in the ambient medium around these stars. This radiation produced by stars gives rise to ionized H II regions, which then emit through bremsstrahlung emission (free-free emission). Bremsstrahlung emission occurs when electrons scatter off ions without being captured, so they are free before and after interaction. Another emission component seen in the Galactic Center is synchrotron emission, which is produced by energetic electrons generated from the jet of the supermassive black hole and supernova remnants, spiraling around magnetic field lines. Any object that is hot gives off light, or thermal emission. When the ultraviolet radiation from stars is absorbed by the dust, the dust is heated, and then re-radiates as thermal emission at far-infrared wavelengths. Using the three previous emission components, this environment was analyzed in order to identify three main features in the Galactic Center: ionized gas, magnetic fields and dust. Bremsstrahlung emission was used to trace H II regions (ionized gas), synchrotron emission was used to trace magnetic field lines, and thermal emission was used to trace the dust. After tracing these spectral features, they were displayed, resulting in a map of the Galactic Center showing all three of these features that can be used for further analysis in the near future.
Integrating FLUXNET and EO-1 Hyperion Reflectance Data for Use in Remote Sensing of Vegetation Carbon Flux Dynamics

James Saulsbury¹, Sarah Voorhies², Petya K. Entcheva Campbell³,⁴
¹University of California, Berkeley, Department of Integrative Biology, Berkeley, CA, USA
²Bowie State University, Department of Mathematics, Bowie, MD, USA
³University of Maryland, Baltimore County, Joint Center for Earth Systems Technology, Baltimore, MD, USA
⁴Biospheric Sciences Laboratory, NASA Goddard Space Flight Center, Mail Code 618, Greenbelt, MD, USA

Efforts to understand the role of vegetation in controlling regional and global atmospheric CO₂ dynamics are hampered by two problems of resolution. The EO-1 satellite’s Hyperion instrument images at a spatial resolution of 30m and a spectral resolution of ~10nm (400-2500nm), but can only image particular sites a maximum of 5 times every 16 days. This limits our understanding of short-term phenological dynamics like the day-night cycle, which are more easily studied with on-the-ground measurement techniques like eddy covariance. Eddy covariance and other measurements provided by FLUXNET’s micrometeorological towers are in turn limited in their spatial resolution to a small (approx. 0.25km²) footprint. It is therefore worthwhile to integrate remote sensing and tower-based measurements, especially in using parameters measurable by one technique to estimate those of another. In that interest, efforts are underway to understand the relationship between CO₂ flux and spectral data for sites imaged by EO-1 and accessed by FLUXNET. Building on existing methodology used for a site in Mongu, Zambia (FLUXNET site code ZM-Mkt), we here present reflectance time series from the Hyperion instrument for sites at Hyytiälä, Finland (FI-Hyy), Harvard Forest, Massachusetts (US-Ha1, US-Ha2), and Park Falls, Wisconsin (US-Pfa). These time series are obtained by applying atmospheric correction to radiance data, and are used to obtain a number of spectral bio-indicators (SBIs). We assessed the relationship between these SBIs and CO₂ FLUX parameters (net ecosystem production, gross ecosystem carbon exchange, etc.) derived from FLUX tower measurements taken at all sites. Our results encompass several vegetation types and support the use of hyperspectral imagery in estimating environmental parameters.
Comparisons of Multi-Scale Remote Sensed Data

Jeff Long¹, John David²

¹University of Arkansas at Little Rock, Little Rock, AR, USA
²SSAI/NASA-GSFC, NASA Goddard Space Flight Center, Mail Code 610, Greenbelt, MD, USA

Remote-sensed data can be acquired on multiple scales, which raises the question of how to coherently compare these multi-scale data. This study aims to determine how well structures present in high-resolution Unmanned Aerial Vehicle (UAV) Normalized Difference Vegetation Index (NDVI) imagery correlate and scale to much coarser-resolution Landsat and other satellite NDVI imagery structures. UAV imagery was acquired from a public domain source (publiclab.org) and satellite imagery was obtained from Landsat 7 and ASTER data sources. Analyses were done using free and open source software such as QGIS, Python, and the scikit-image Python library. The study demonstrated that landscape structures in high-resolution NDVI imagery do scale relatively well to coarser resolutions in most circumstances. We show that these same principles work across several different satellite derived vegetation indices as well. In addition, the effects of applying spatial enhancement techniques such as pan-sharpening were shown not to have a dramatic effect on the structures. Knowing that this high-resolution data can be scaled to coarse resolutions is valuable for using large-scale satellite imagery to target the collection of high-resolution, fine-scale UAV imagery.
This project supports the Calibration and Validation (Cal/Val) of data products for the Joint Polar Satellite System (JPSS), specifically of the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument. The trends in the cloud top properties and cloud mask data products were analyzed. They were analyzed using Python to plot the day to day global cloud cover and cloud top temperatures. Averages and standard deviations of each plot were also calculated. These plots are used to assess the data products quality. By finding the trends and metrics of the products, anomalies in the Cal/Val and algorithm system can be indicated, so that changes to the algorithms can be implemented, and quality can improve.
Alignment of a Prototype Telescope for Scattered Light Measurements and Analysis

Julie Rose¹, Shannon Sankar², Jeffrey Livas²

¹University of Maryland, College of Computer, Math, and Natural Sciences, College Park, MD, USA
²Astrophysics Science Division, NASA Goddard Space Flight Center, Mail Code 663, Greenbelt, MD, USA

The evolved Laser Interferometer Space Antenna (eLISA) project is a space-based gravitational wave observatory designed to directly detect gravitational waves by measuring changes in distance between free-falling proof masses using laser interferometry. The project consists of three spacecraft, each carrying two telescopes that transmit laser beams to the other spacecraft, essentially forming three interferometric arms in the shape of an equilateral triangle. Because each telescope is transmitting a high power beam (1 W) while simultaneously receiving a low power signal (100 pW), stray light in the telescope can present difficulties for accurate signal detection; thus, eLISA requires that the scattered light be $< 10^{-10}$ of the transmitted power. A prototype telescope was assembled and aligned using a Point Source Microscope (PSM) and a Laser Unequal Path-length Interferometer (LUPI). This prototype can be used to take scattered light measurements in an attempt to determine the most significant sources of scatter and the best methods of reducing scattered light from those sources. Tools were developed in Matlab to display and analyze these data to facilitate validation of models that suggest that the tertiary and quaternary mirrors are the primary sources of scatter. Additionally, modeling software can help interpret whether cleanliness, surface roughness, or another parameter plays the largest role in producing scatter. These results will provide important information for future upgrades to the design of the telescope, and will play an important role in the success of the eLISA mission.
Space Weather Forecasting: Impacts at Mars

Jenna Lynn Zink\textsuperscript{1}, Yihua Zheng\textsuperscript{2}

\textsuperscript{1}George Mason University, Fairfax, VA, USA
\textsuperscript{2}Space Weather Research Center, Mail Code 674, Greenbelt, MD, USA

The Space Weather Research Center at the Community Coordinated Modeling Center is constantly monitoring the space weather environment at Earth. Solar eruptions can cause severe damage to satellites due to excessive electrons, protons, and heavy ions that can then cause surface charging, internal charging or single event effects and degradation of satellite components. Currently there are several missions orbiting around Mars that feel the effects of solar events, such as solar flares and coronal mass ejections. The project has been dedicated to building a database of coronal mass ejections from 2010 to the present day that have been modeled and predicted to impact Mars. Using the Database of Notifications, Knowledge, and Information, a total of 173 coronal mass ejections were found to have impacted Mars. Having a database of the coronal mass ejections at Mars will help the satellites carry out their scientific goals while being protected from these solar eruptions. For some broad and fast coronal mass ejections, the impacts can be measured at multiple locations in interplanetary space. The database that was created from this project will improve the studies of such large ejections.
Preliminary Results of Ar Diffusion through Silicate Glasses

Katrina Bermudez¹, Pamela Conrad²

¹Rensselaer Polytechnic Institute, Troy, NY, USA
²Planetary Environments, NASA Goddard Space Flight Center, Mail Code 699, Greenbelt, MD, USA

Radiometric argon dating methods have been crucial to the understanding the impact history of the earth-moon system. A key assumption is that argon is diffusively immobile in the glass made by impact, implying that argon will not degas out of the glass over time. The only time argon will be released is during analysis for radiometric dating. To test this assumption, a variety of samples with differing silica content (from basaltic in composition to pure SiO₂) were heat treated and/or made under an argon atmosphere, at a high temperature at Rensselaer Polytechnic Institute. The glasses were brought to Goddard Space Flight Center to be pyrolyzed. The thermally evolved gas was measured as a function of temperature using mass spectrometry to determine the amount and rate of argon diffusion out of the glass. The data shows that there are elevated levels of argon in the samples compared to atmospheric argon, suggesting that argon can degas out of the glass. These results are also compared to pyrolyzed experiments completed at GSFC last summer, where samples were implanted with argon instead of made in an argon environment.
DREAM2: Using Apollo Data to Characterize the Lunar Environment

Keenan Hunt-Stone\textsuperscript{1}, Timothy Stubbs\textsuperscript{2}

\textsuperscript{1}Howard University, Howard University Department of Physics and Astronomy, Washington, DC, USA
\textsuperscript{2}Solar System Exploration, NASA Goddard Space Flight Center, Mail Code 695, Greenbelt, MD, USA

From 1969 to 1972 astronauts deployed the Apollo Lunar Surface Experiments Package (ALSEP) to better understand the lunar environment. During Apollo 14, this included the Charged Particle Lunar Environment Experiment (CPLEE), which was used to measure the differential number fluxes of electrons and ions incident at the lunar surface. CPLEE had the advantage of being able to detect both electron and ions when the Moon was traversing the Earth’s magnetotail; while the Superthermal Ion Detector Experiments (SIDE) deployed during Apollo 12, 14, and 15 only detected ions, and the Solar Wind Spectrometers (SWS) deployed by Apollo 12 and 15 were only able to measure electrons and ions when the Moon was in the denser solar wind plasma. The main focus of this project was to investigate the interaction between the lunar surface and the tail lobe and plasma sheet environments in the Earth’s magnetotail. In particular, our objective was to constrain values for the electric potential between the lunar surface and the surrounding plasma environment. Previous studies of CPLEE measurements reported a dayside lunar surface potential of \( \sim 200 \) V positive, which is about an order of magnitude greater than expected. CPLEE data is used to further analyze this data and determine the cause of this discrepancy. CPLEE data is imported and plotted using the MATLAB programming language, whereupon models of electron differential number flux are fit to the CPLEE data to determine temperature, and concentration as a function of lunar surface potential. The CPLEE instrument’s lowest energy level for detection is 40 eV, which means we have to infer the properties of the cooler electron populations by extrapolating to lower energies. Anticipated results for this project include developing a program to iterate through CPLEE data and fit models to constrain lunar surface potentials and determine the source of the electron populations detected by CPLEE.
The Formation of Fluvial Channels on Alba Mons, Mars

Karin Lehnigk¹, Dr. Brent Garry²

¹The College of William and Mary, Williamsburg, VA, USA
²Planetary Geodynamics Laboratory, NASA Goddard Space Flight Center, Mail Code 698, Greenbelt, MD, USA

Alba Mons is one of the oldest and largest volcanoes in the Tharsis region on Mars. Previous research shows that channel features exist on the central edifice and flanks of Alba Mons (Ivanov and Head, 2006). Many of these fluvial channels are embayed by younger lava flows and disrupted by graben, indicating they formed while the volcano was still active. The purpose of this study is to determine what the distribution and morphology of meltwater channels on Alba Mons indicate about volcano-ice interactions when the volcano was active. This study involves mapping surface features around Alba Mons on Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) images (6 meters/pixel) to show their distribution on the volcano. We will then conduct detailed investigations of individual well-defined channels using both CTX and Hi-RISE (0.25 meters/pixel) images to quantitatively relate channel morphology to formation processes and environmental conditions during volcanic activity. Currently we are focusing on the northern side of the volcano where there are numerous, well-defined channel networks and drainage basins allowing for high-resolution 2D analysis. We are also in the process of developing Digital Terrain Models derived from CTX stereo-pairs using Ames Stereo Pipeline for 3D analysis. Meltwater streams are useful indicators of a volcano’s microclimate (Marchant and Head, 2007), and would have been the most recently habitable places on Mars, making them important spots to understand in the search for traces of life (Scanlon et al., 2014).
The Environmental Effects on Star Formation in Galaxies

Kaitlyn Shin¹, Chun Ly²

¹Stanford University, Stanford School of Humanities and Sciences, Stanford, CA, USA
²Astrophysics Science Division, NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

The effects of local environment on the formation and evolution of galaxies have yet to be fully understood. Hoping to illuminate a clearer relationship between environmental factors and the properties of galaxies, this study examined over 9,000 star-forming galaxies at redshifts of 0.1 to 1.6 (over 8 billion years) using observations from the 8.4-meter Subaru telescope, the 10-meter Keck telescope, and the 6.5-meter Multiple Mirror Telescope. This study aggregated information such as projected physical distances and stellar masses in order to determine the gravitational force from each nearby satellite. The distances were computed from transforming the angular separation between galaxies to a physical distance in a CDM universe, and the stellar masses were estimated from modeling the spectral energy distributions with stellar synthesis models for galaxies. By comparing against emission-line luminosities and rest-frame equivalent widths (i.e., the relative strength of star formation), this study is expected to show some dependence such that galaxies with a massive and/or significantly close companion are undergoing intense or episodic star formation. This analysis was conducted primarily with Python and IDL.
Developing an Effective Geospatial Data System in Support of the ABoVE Project

Kyle T. Peterson¹, Elizabeth Hoy²

¹University of Missouri, Columbia, MO, USA
²Carbon Cycle and Ecosystems Office, NASA Goddard Space Flight Center, Mail Code 618, Greenbelt, MD, USA

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a large-scale field campaign designed to enhance our understanding of a changing Arctic-Boreal region, and the underlying causes and impacts of this ecological change. The ABoVE project will integrate field-based studies, modeling, and data from airborne and satellite remote sensing platforms. Utilizing a high-performance cloud based computing system, along with the latest data management and Geographic Information System (GIS) techniques; the NASA ABoVE Science Cloud (ASC) aims to create a fully integrated system that enhances the development and deployment of data to support field scientists and end users. In order to accomplish this, the ABoVE Science Cloud Computing System incorporates and utilizes the flow of data throughout the entirety of the project (i.e. from planning, collection and analysis, to archival and publication of final results), while also providing access to data previously collected in other NASA and related studies. Integrating the goals of the ABoVE project and the Science Cloud, tests were conducted on system architecture to ensure an enhanced user interface, along with ease of usage by creating online, easily accessible, cloud-hosted, datasets for ABoVE. Using these datasets GIS-based educational tools and materials were derived (as proof of concept) in support of the project. While creating and testing the data system for the Science Cloud, system documentation and a troubleshooting manual will be maintained and developed in order to allow ABoVE Scientists to enhance their development and output of impactful data products with ease. The ultimate goal of this summer project is to develop an effective geospatial data management system, utilizing the sophisticated computing environment provided within the NASA ABoVE Science Cloud in order to increase the capabilities of the ABoVE scientists and the quality of the data products created.
Characterizing Alien Worlds: Ground-based Transit Spectroscopy of GJ1214b with VLT-KMOS

Brianna Lacy¹, Daniel Angerhausen²

¹University of Washington Astronomy Department, University of Washington, Seattle, WA, USA
²NASA Astrophysics Science Division, NASA Goddard Space Flight Center, Mail Code 667, Greenbelt, MD, USA

Transit spectroscopy has successfully characterized atmospheres of many hot Jupiter atmospheres, but is still developing for the atmospheres of smaller planets. GJ 1214b presents a unique opportunity for ground-based study of a super-earth sized exoplanet atmosphere due to its position around a nearby M dwarf star. The possible water-world GJ 1214b was the first planet in the super-Earth/mini-Neptune range to be characterized, but ambiguity still remains as to whether it is a water-world or a cloudy mini-Neptune. To investigate this further, data was collected with the Very Large Telescope’s (VLT) multi-object integral field spectrograph—KMOS— during three transits of GJ 1214b in the H and K bands on May 25, 2014, June 26, 2015 and July 14, 2015. This data was reconstructed into a time series of data cubes for the target star GJ1214 and three comparison stars using the KMOS data reduction pipeline. Then these data cubes were binned along the spectral axis to attain an adequate SNR for differential aperture photometry. These light curves, one for each spectral bin, can now be used to fit an analytic model of a transit light curve. The variation in transit depth across the wavelength bins will correspond to the radius of the planet that in turn corresponds to the level of absorption in the planet’s atmosphere. Ultimately, this observed spectrum can constrain the overall structure and the chemical composition of the atmosphere. Success with GJ1214b will pave the way for future observations of a wide range of exoplanet atmospheres with VLT-KMOS.
Modularized Software Control for the RIMAS Instrument

Lauren Chambers¹, Alexander Kutyrev², Neil Gehrels³

¹Yale University, College of Arts and Sciences, Astronomy Department, New Haven, CT, USA
²Observational Cosmology Laboratory, NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA
³Astroparticle Physics Laboratory, NASA Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA

Gamma ray bursts (GRBs) are the highest-energy events in the universe, produced only in the most violent conditions such as supernovae or compact object mergers. Due to their extreme energies, GRBs are powerful probes that can reveal the properties of our universe as it existed up to 13 billion years ago. The Rapid Near-Infrared Imager/Spectrometer (RIMAS) Instrument, expected to be installed in the Discovery Channel Telescope at Lowell Observatory in December 2015, will be used for rapid-response near-infrared (YJ- and HK-band) observations of GRBs. The development of a hierarchy of control software, ranging from primitive serial communication to advanced user-controlled interfaces, is necessary for successful operation of the RIMAS instrument. This software must be modularized to simultaneously control many instrumental components, including motor control of filter and spectroscopic slit wheels, motor control of linear stages for focusing purposes, control of the thermometric system for measuring and maintaining temperatures in the instrument, and control of the Mercury Cadmium Telluride (HgCdTe) detectors for data acquisition. Additionally, the software must incorporate communication with the Discovery Channel Telescope, for pointing and general telescope status, and the Swift satellite, for GRB triggers and locations. Using LabVIEW, comprehensive software control for the filter wheel and detector systems have been developed. When completed, these controls will be used by observers at Lowell Observatory to communicate with and control the RIMAS instrument.
Levels of Lead Fume Exposure in Soldering Labs

Laura Deza¹, Jeffrey Dalhoff CIH², Kelly Ngo³

¹The University of Toledo, Toledo, OH, USA
²Industrial Hygiene, NASA Goddard Space Flight Center, Mail Code 360, Greenbelt, MD, USA
³Eleanor Roosevelt High School, Greenbelt, MD, USA

Industrial Hygienists work to prevent safety hazards and promote a better working environment for employees. Data on potentially hazardous levels of lead fumes have yet to be compiled in the workplace as there are no mandatory precautionary measures for prevention. This study aims to discover if the exposure levels of lead fumes to employees are potentially hazardous. It also looked for what precautionary measures can be done to protect employees from further exposure. Air sampling pumps were attached to employees to determine the effectiveness of ventilation systems and to collect the potential level of lead fume exposed. Three wipe samples were taken before and after cleaning of each workstation and observations and data were recorded. Data is still in the process of analysis in professional labs. Results are expected to be returned in about a week. Because data is still being processed, conclusions cannot be extrapolated yet.
Auroral Occurrence In and Out of Solar Maximum

Cooper Lehr¹, Marilia Samara²

¹Missouri University of Science and Technology, Rolla, MO, USA
²Heliophysics Science Division, NASA Goddard Space Flight Center, Mail Code 673, Greenbelt, MD, USA

The Aurora Borealis is a magnificent light show displayed at the earth’s magnetic poles. The aurora is caused by charged particles entering the atmosphere, and reacting with atoms and molecules at an altitude of around 100 kilometers. These reactions create the beautiful lights seen in the night sky. The intensity of the charged particles determines how deep into the atmosphere the aurora is shown, and what color it is seen as. The charged particles that cause the aurora come from the solar wind that is constantly emitted from the sun, and is often referred to as space weather. This project advances our understanding of auroral processes which is an integral part of ionospheric science and the ionosphere-magnetosphere coupling that is a critical aspect of our sun-earth environment interaction. This project will take data observing the aurora with an all sky imager placed on the ground in Alaska. Knowledge of auroral processes has far reaching implications involving space weather. This data stretches back to the fall of 2011, and ends in May of 2015. With these records, the intensity of the auroral activity will be plotted on a graph with the hours in a day on the Y-axis, and the months from the fall of 2011 through the spring of 2015 on the X-axis. Putting these data points together will show auroral effects in and out of solar maximum, and it will give brief insight on trends in solar wind.
Development of a Telescope System for VHE Astronomy

Laiya Ackman\textsuperscript{1}, Jeremy Perkins\textsuperscript{2}

\textsuperscript{1}Columbia University, School of Engineering and Applied Science, New York, NY, USA
\textsuperscript{2}Astroparticle Physics Laboratory, NASA Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA

Over the past ten years, the field of very high energy (VHE) astrophysics has developed dramatically, with the number of known sources jumping from 30 in 2005 to over 160 today, as reported by TeVCat. The Cherenkov Telescope Array (CTA) is the next major international project in the field, scheduled for first observations in 2018. However, as with any telescope, CTA will have a finite field of view and limited number of observing hours per year. The ultimate goal of this project is to demonstrate that it is possible to build a relatively low cost (~$50,000) telescope, complimentary to the capabilities of CTA, capable of studying VHE (>1TeV) gamma rays. Over the course of the summer the mounting and pointing systems for a prototype imaging atmospheric Cherenkov telescope will be completed. This will involve both hardware additions to the system and the development of a software program to control pointing and tracking. Ultimately, the prototype telescope will be installed at the Goddard Geophysical and Astronomical Observatory, and will be integrated with the components developed by external collaborators.
Exploring the Negative Feedback of Vegetation to Greenhouse Gas Warming

Lisa Marie Redsteer¹, Lahouari Bounoua²,³
¹Olympic College, Bremerton, WA, USA
²Northwest Indian College, Bellingham, WA, USA
³Earth Science Remote Sensing, NASA Goddard Space Flight Center, Mail Code 618, Greenbelt, MD, USA

Over the past century, observations show that greenhouse gas emissions are increasing at global scale driving a temperature increase. The increase in temperature is also causing an increase in precipitation. These increases may have initiated a vegetation growth, which may have led to an increase of evapotranspiration and a cooling of the air. This evaporation cooling may slow the greenhouse warming. We test this hypothesis using data from the The National Oceanic and Atmospheric Administration’s Climate record. Results indicate a slower warming rate in vegetated areas as compared to less vegetated regions.
Data Restoration and Analysis of Daytime Lunar Mass Spectra of the Lunar Atmosphere Composition Experiment (LACE)

Lydia Brothers¹, Dave Williams²
¹University of Kentucky, Lexington, KY, USA
²Solar System Exploration Data Services Office, NASA Goddard Space Flight Center, Mail Code 690.1, Greenbelt, MD, USA

The Apollo 17 Lunar Atmosphere Composition Experiment (LACE) instrument was a magnetic deflection mass spectrometer designed to measure the composition and variation of gasses in the lunar atmosphere. In this study, a critical re-examination of the LACE dataset is being performed to verify and expand upon the previous results. This project builds upon the Apollo legacy by integrating the dataset into the Planetary Data System so that it is more easily accessible by the scientific community, as well as by looking specifically at the lunar pre-dawn and daytime measurements to see if any low intensity mass peaks were overlooked. An increase of mass peaks were observed as lunar sunrise approached with a sharp increase in mass peaks at sunrise. Presumably, volatile species freeze out (condense) of the atmosphere during the lunar night and only when the sunlit terminator approaches do they sublimate and become measurable. By detecting and classifying peaks based on routines in python, the initial findings of the experiment can be confirmed with additional information about other various molecular gas species (CH₄, NH₃, CO₂, OH, et cetera).
Analysis of Volcanic Deposits on Venus Using Radar Polarimetry

Madison M. Douglas¹, Lynn Carter²

¹Massachusetts Institute of Technology, Department of Earth, Atmospheric and Planetary Science, Cambridge, MA, USA
²NASA Goddard Space Flight Center, Mail Code 698, Greenbelt, MD, USA

Remote observations of the volcanic surface of Venus are hindered by the planet’s thick atmosphere, but an atmospheric window provides an opportunity to examine the surface using radar. The highest resolution radar images come from the Magellan mission, which mapped 98% of Venus’s surface by transmitting and receiving unidirectionally polarized radiation. Upgrades to the ground-based Arecibo telescope in 1999 allowed further imaging of the surface of Venus at conjunction in 1999, 2001, and 2004 by the transmission of a circularly polarized beam at 12.6 cm wavelength and then receiving two orthogonal circular polarization measurements [Carter et al., 2006]. We applied the Stokes vector method to the Arecibo measurements to calculate the circular polarization ratio (CPR), a measurement of surface roughness, and the degree of linear polarization (DLP), a measure of whether there is subsurface scattering of the radar wave. While previous studies have used either CPR or DLP to characterize the surface features on Venus’s northern hemisphere, we examine the major southern volcanoes visible at conjunction using both CPR and DLP, and include multiple viewing geometries from different years of observations. This approach permits more precise characterization of volcanic edifices and lava flows on Venus, allowing us to discern differences between types of lava flows and compare them to terrestrial examples.
Water Abundance in the Stratospheres of Saturn and Titan based on CIRS

Malena Rice¹, Conor Nixon², Brigette Hesman³

¹University of California–Berkeley, Berkeley, CA, USA
²Planetary Systems Laboratory, NASA Goddard Space Flight Center, Mail Code 690, Greenbelt, MD, USA
³Department of Astronomy, University of Maryland at College Park, College Park, MD, USA

The Cassini spacecraft has been in orbit around Saturn since 2004, carrying twelve instruments on board to gather information about the Saturn system. One of these instruments, the Cassini Infrared Spectrometer (CIRS), retrieves data in the infrared spectrum in order to determine the composition and thermal properties of Saturn and surrounding objects. In this investigation, data from the CIRS instrument was utilized to create spectral bins organized by latitude and time to investigate Saturn and Titan for meridional and seasonal differences in stratospheric water vapor. Water vapor lines were measured by observing the average spectra taken and removing the large baseline from each to reveal the details of these smaller signal-to-noise features. The intensities of these peaks were recorded to deduce the strength of the water signal detected. Observations were then separated into time frames, each representing a single season on the respective celestial body. Within these time frames, spectra from observations were placed into bins and averaged based upon latitude to determine variations in water abundance in different regions of Titan and Saturn. Both on- and off-disk measurements (nadir and limb, respectively), including riders (observations where CIRS does not control the pointing), were utilized in this analysis. Radiative transfer models were used to deduce the water vapor abundances of both Titan and Saturn. This study will further improve knowledge of the abundance of water in both atmospheres with the eventual goal of deducing the source of water in the Saturn system.
Mariner 2 Magnetometer Data

Joseph L Dowling1, David R Williams2
1Mount Saint Joseph High School, Baltimore, MD, USA
2NASA Space Science Data Coordinated Archive, NASA Goddard Space Flight Center, Mail Code 690.1, Greenbelt, MD, USA

A set of data from the Mariner 2 magnetometer was found by JPL and sent to Goddard for assessment and preservation. Previously, the only data from Mariner 2’s magnetometer were in the form of plots and graphs, but these rolls of microfilm had the raw numbers from which those plots were derived. The data needed to be recorded so as to provide a more thorough and more exact analysis of the magnetic fields in the vicinity of Venus and during the cruise from Earth. The data was stored on rolls of microfilm inside over 100 metal canisters marked with an “A” or “D” as well as the time and date. The films were scanned into digital images, and put on reels. The data on select films were converted from image to digital form. The “D”-labeled canisters contained the decommutated data, the raw numbers, from the magnetometer. The “A”-labeled canisters contained the analyzed data, including the magnetic fields in terms of gamma, graphs, and the data from the ion chamber experiment, plasma current and voltage, and particle counter. These canisters of film contained data that were thought to have been lost and provide a relatively contiguous span of time for which data were collected. Data from significant events during the mission, including the Venus encounter, the passage through a solar shock event, and a possible large particle collision with the spacecraft, are also being analyzed.
Space Weather Forecasting and High Speed Streams

Mary Aronne¹, Yihua Zheng²

¹University of Maryland, Baltimore County, Department of Physics and Department of Mathematics, Baltimore, MD, USA
²Space Weather Laboratory, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

The Space Weather Research Center provides experimental research forecasts and analysis for NASA robotics missions operators. Space weather forecasters monitor space weather conditions to provide advance warning and forecasts based on observations and modeling. High-speed streams (HSS) are a type of space weather driver involving the high-speed component of the solar wind that originates from coronal holes, which can last for many solar rotations. High-speed streams produce geomagnetic storms with different source signatures than those of geomagnetic storms caused by coronal mass ejections (CMEs). Coronal mass ejections are studied extensively and are well known for producing strong geomagnetic storms and impacting Earth’s radiation belts. High speed streams pump energy into the Earth’s magnetosphere for a longer period of time than that of a flux rope, producing energetic electron flux enhancement in Earth’s outer radiation belt (near geosynchronous orbit) and prolonged substorm activity. It is important to understand high-speed streams as a driver of space weather activity due to the energetic electron enhancement that can impact spacecraft in the near-Earth environment. This project will focus on the high-speed stream events on June 8, 2015, July 4, 2015, and July 10, 2015, in order to understand the different arrival signatures, impacts on electron flux enhancement, and development of geomagnetic storms from high-speed streams.
Tropical Cyclone Evolution and Water and Energy Fluxes: A Hurricane Katrina Case Study

Marielle Pinheiro¹, Yaping Zhou²

¹University of California, Davis, Davis, CA, USA
²Earth Science Division, NASA Goddard Space Flight Center, Mail Code 613, Greenbelt, MD, USA

Tropical cyclones are a highly destructive force of nature, characterized by extreme precipitation levels and wind speeds and heavy flooding. The occurrence of such an event has devastating effects on the regions that lie in the path of a tropical cyclone, from billions of dollars in infrastructure damage to death and displacement of inhabitants. There are concerns that climate change will cause changes in the intensity and frequency of tropical cyclones. Therefore, the quantification of the water and energy fluxes that occur during a tropical cyclone’s life cycle are important for anticipating the magnitude of damages that are likely to occur. This study used HURDAT2 storm track information and data from the satellite-derived SeaFlux and TRMM products to look at changes in precipitation, sea surface temperature, and latent and sensible heat throughout the life cycle of Hurricane Katrina. Preliminary results show that there is a drop in sea surface temperatures in the wake of the hurricane, with the strongest latent heat flux occurring at the front of the hurricane. Accumulated precipitation did not show a discernable pattern along the storm track as expected.
Cryogenic Thermometry for RIMAS

Marc Finzi
Alexander Kutyrev

1Harvey Mudd College, Claremont, CA, USA
2Astrophysics, NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA

The Rapid infrared IMAger Spectrometer (RIMAS) is being developed to study GRB afterglows on the Discovery Channel Telescope, Lowell observatory in Flagstaff, AZ. This instrument will have two near infrared H2RG detectors, operating at 60K. The objective of this project was to develop an inexpensive, lightweight and scalable temperature controller capable of both monitoring and regulating the temperature of multiple independent channels with a high precision. The final product will consist of several boards that can stack onto an Arduino forming an easy to use standalone controller with capability of taking commands and outputting data via USB. To measure temperature, we supply 10µA to a diode inside a commercially available transistor and measure the temperature dependent voltage drop across the diode. We have characterized this voltage-temperature curve and have fit it with Chebychev polynomials. The PID control loop coefficients will be calculated analytically from a thermal model of the detector, heater and cold-strap system. We intend to release the fitting software, driver software and pcb designs to the public, as part of an open source initiative to reduce the costs of cryogenic research.
Synthetic Multiband Photometry in the Early Detection of Type 1a Supernovae for the WFIRST

Molly L. Grabill¹, Jeffrey Kruk, Ph.D.², Catherine Peddie³
¹University of Maryland, College Park, College Park, MD, USA
²Observational Cosmology Laboratory, NASA Goddard Space Flight Center, Mail Code 665, Greenbelt, MD, USA
³AFTA Study Office, NASA Goddard Space Flight Center, Mail Code 448, Greenbelt, MD, USA

The Wide Field Infrared Survey Telescope (WFIRST) is an astrophysics mission presently conducting pre-phase A studies. One of the primary scientific mission goals for WFIRST is to study the effect of dark energy on the evolution of the universe. The WFIRST’s Type Ia Supernovae (SNe) Survey will answer that question by using the Wide-Field Instrument to measure the distance and redshift of the SNe, as type 1a SNe have a unique property as “standard candles”: they consistently explode at a similar absolute magnitude (-19.3<M<-18.3). This variation in intrinsic brightness is correlated with the shape of the light curve, so measurements of the evolution of each SN can be used to measure its distance with an uncertainty of only a few percent. Current classification methods rely primarily on analysis of the SN spectra, looking for characteristic hydrogen or silicon absorption lines. But when the SNe are especially faint, spectroscopy is not always practical early on. Poznanski et al. (2002) developed a new classification method, finding that SNe of different types occupied different locations in color-color diagrams. The study utilized the Johnson-Cousins UBVRI filters (e.g. a plot of B-V colors vs. R-I colors) to observe how the color signature of a SN varies depending on type.

In this project, the spectral templates from different types of SNe were used to generate color-color diagrams using the near-IR filters that will be in the WFIRST observatory, to find the unique signatures of each type of SNe. This project will report on the filter comparisons, and how these differences can for allow for the development of a set of criteria that weed out the majority of non-Ia SNe early in their evolution. This technique enables early selection of a fairly pure SN-Ia sample so that follow-up observations of Ia spectra can be obtained efficiently by the WFIRST.
Association of Short Gamma-Ray Bursts with Galaxy Clusters

Natalie Bremer\textsuperscript{1}, Eleonora Troja\textsuperscript{2}

\textsuperscript{1}University of Colorado Boulder, Department of Astrophysical and Planetary Science, 2000 Colorade Ave, Boulder, CO, USA

\textsuperscript{2}NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA

Short Gamma-ray bursts (GRBs) are very brief, highly energetic electromagnetic flashes that are not well understood. It is thought that short GRBs originate from the merger of two neutron stars or a neutron star and black hole. Finding a correlation between short GRBs and galaxy clusters will support this merger model for short GRB progenitors. The ratio of short GRBs in clusters to those found in the field will allow for a progenitor age distribution to be found. The X-ray afterglow of 78 short GRBs observed by Swift-XRT was analyzed. For each GRB, the observations were summed and the software EXSdetect was used to identify extended X-ray sources, which would indicate a galaxy cluster. Detected extended sources were then compared to the results obtained when wavdetect was run on the data, to confirm the detection. Through this process, few extended X-ray sources were found, implying that there is not a strong correlation between short GRBs and galaxy clusters. This result suggests that the progenitors of short GRBs span a broad range of ages.
Refining the Wheel: Analysis of Solar Cycle Prediction Precursor Technique

Emily I. Sobel\textsuperscript{1}, Douglas Rabin\textsuperscript{2}

\textsuperscript{1}SUNY New Paltz, New Paltz, NY, USA
\textsuperscript{2}Heliophysics Science Division, NASA Goddard Space Flight Center, Mail Code 670, Greenbelt, MD, USA

The Western hemisphere has been recording sunspot numbers since Galileo discovered sunspots in the early 17\textsuperscript{th} century, and the roughly 11-year solar cycle has been recognized since the 19\textsuperscript{th} century. However, predicting the strength of any particular cycle remains a relatively imprecise task. This project’s aim was to update and improve a forecasting technique based on geomagnetic precursors of future solar activity. The model is a refinement of R. J. Thompson’s 1993 paper that relates the number of geomagnetically disturbed days, as defined by the aa and Ap indices, to the sum of the sunspot number in the current and the next cycle, $R_n + R_{n+1}$. The method exploits the fact that two cycles coexist for some period on the Sun near solar minimum and therefore that the number of sunspots and disturbed days during the declining phase of one cycle gives an indication of the following cycle’s strength. We wrote and updated IDL software procedures to define disturbed days with varying threshold values and graphed $R_n + R_{n+1}$ against them. The aa threshold was derived from the Ap threshold. After comparing the graphs for Ap values from 25 to 45, an Ap threshold of 30 and the corresponding aa threshold of 44 were chosen as yielding the best correlation. Confidence regions were computed to provide a quantitative uncertainty on future predictions. The 80\% confidence region gives a range of ±40 in sunspot number.
Testing a New Model of Gamma-Ray Burst Prompt Emission

Nicholas Gorgone¹, Sylvain Guiriec²

¹ The George Washington University, Washington, DC, USA
² Astroparticle Division, NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

A Gamma-Ray Burst (GRB) is the brightest high-energy explosion in space (keV - MeV), signaling the creation of a black-hole at some cosmological distance. Following the explosion, it is thought that thermal energy from an expanding fireball is converted into kinetic energy, which is then dissipated by thermal and non-thermal processes. A new spectro-temporal model linearly combines a broken power-law (non-thermal) that is interpreted as synchrotron emission, a black-body component (thermal) considered photospheric emission, and sometimes a power law with exponential cutoff (non-thermal) most likely of inverse-Compton origin. The goal of this project is to test this model on a moderate sample of bursts using recent and archival data.
Comparison of Satellite-derived Fire Emissions Results with Airborne Measurements of Smoke Constituents

Olivia Dickens\(^1\), Charles Ichoku\(^2\)

\(^1\)Department of Physics and Astronomy, Howard University, NW, DC, USA
\(^2\)Climate and Radiation Laboratory, NASA Goddard Space Flight Center, Mail Code 613, Greenbelt, MD, USA

Wildfires and other types of vegetation burning emit large amounts of smoke containing particles and gases, including greenhouse gases, such as carbon dioxide and methane, which contribute to the warming of the earth by absorbing radiation from the Sun. With the greenhouse gas emissions and average global temperature both increasing in the past century, scientists are seeking to improve the quantification of contributions from different sources by using top-down (satellite observations), computational models, and bottom-up (aircraft experiments) approaches to determine how the greenhouse gas emissions from biomass burning contributes to global climate change. The objectives of my project are to: (1) compare the monthly retrievals from the Aqua AIRS satellite sensor to corresponding model output obtained from a NASA Global Modeling Initiative (GMI) Chemical Transport Model using the NASA Fire Energetics and Emissions Research (FEER) satellite-derived emissions products and (2) compare the daily gas measurements from the SEAC4RS aircraft mission to the corresponding daily satellite retrievals from the Aqua AIRS sensor. The smoke constituent gas emissions that this project focuses on are CH\(_4\) (methane) and CO (carbon monoxide) data from various dates within August and September of 2013. The results from this project will be used to verify the agreement between the direct satellite retrievals of these fire-emitted constituents and the Chemical Transport Model output based on the FEER emissions, as well as to determine the statistical variations between the observed emissions from the SEAC4Rs aircraft mission and Aqua AIRS satellite retrieval.
 Developing a Test Stand for Lifetime Measurements Using a Narrow Gap Detector

Omani Tuitt¹, Rafael Almonte¹, Dr. Joe Hill-Kittle², Dr. Keith Jahoda², Dr. David Morris¹

¹University of the Virgin Islands, John Brewers Bay, VI, USA
²NASA Goddard Space Flight Center, Mail Code 660, Greenbelt, MD, USA

The University of the Virgin Islands (UVI) recently won a proposal “The First Four-Year Physics and Astronomy Degree at the University of the Virgin Islands; A new Era in Caribbean Participation in NASA Science” in collaboration with NASA Goddard Space Flight Center (GSFC). The proposal included building a detector life-test chamber at UVI to support the degree program as well as assist NASA by running tests on detector components and reporting the results.

The team at GSFC is developing X-ray polarimeters that can be used in detecting and imaging astrophysical sources such as black holes and neutron stars. The purpose of our research is to understand the effects that the degradation of gas has on the performance of the detectors. The current generation of time projection polarimeter incorporates a narrow gap detector assembled with epoxy. The addition of the epoxy allows a smaller gap with the minimal amount of changes from the original design, enhancing the performance of the detectors.

With the use of epoxy, lifetime measurements have to be made to see how the epoxy detectors compared to previous iterations. We have been studying the effects on the narrow gap detector in the Mahaffey chamber in order to determine whether the epoxy affects the cleanliness of the gas. Tests have been conducted with a residual gas analyzer (RGA) in order to monitor the cleanliness of the gas inside of the Mahaffey chamber while being baked out. Results show that the detector is in fact getting cleaner as time progresses. The plan is to recreate a chamber like that of RXTE where the gas stayed in the chamber for 13 years and had minimal degradation.
Possible Magnetic Reconnection Events Observed Near Earth by Multiple Satellites

Patrick Fox¹, Dr. Leonard N. Garcia², Dr. Shing Fung²

¹Montgomery Blair High School, Silver Spring, MD, USA
²Heliophysics, NASA Goddard Space Flight Center, Mail Code 673, Greenbelt, MD, USA

On August 19, 2001, two satellites almost 50,000 miles apart picked up the same strange radio burst, emanating from a spot far above the earth that moved across the sky. Further analysis revealed that it was very likely that the radio burst was triggered by the merging of sun’s magnetic field lines with earth’s magnetic field in a physical phenomenon known as magnetic reconnection. The object of this study is to find additional examples of this type of radio burst and scour the solar wind data for parameters that could have led to them to determine if magnetic reconnection really does occur near earth, and if it does, its effects. Four different satellites provided years of radio wave data, which was used to search for additional examples. Once these examples were found, they could be compared across satellites and then checked for the solar wind and magnetic field conditions during the events to see if they could have influenced them. The data revealed interesting patterns. While no obvious mirrors of the original burst turned up, there were many similar unidentifiable bursts that were confirmed by multiple satellites. The correlation with solar wind and magnetic values is yet to be determined and does not yield any immediate conclusions. It may be true that these bursts are in fact caused by magnetic reconnection. In this case, it would be a great boon to physicists to be able to observe the event so near earth and to analyze the radio waves produced by it. Additionally, it could provide a tool to observe magnetic reconnection remotely. A unique radio signature for magnetic reconnection could prove extremely valuable for missions such as MMS, which currently rely on in situ measurements.
Analyzing Emissions from Blazar B2013+370 and Pulsar Wind Nebula VER J2016+371

Qiana Hunt¹, Dr. John Hewitt²

¹University of Alabama in Huntsville, Huntsville, AL, USA
²Astroparticle Physics Lab, Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA

The Large Area Telescope (LAT) is the main instrument onboard the Fermi Gamma-Ray Space Telescope, which surveys the entire sky for gamma-ray sources eight times each day. More than 3000 sources have been detected by the LAT since its launch in 2008, of which about 30% are not associated with known phenomena. Until recently, the gamma-ray source 3FGL J2015+3709 was thought to be associated with the blazar B2013+370. Blazars are a sub-class of active galactic nuclei that feature relativistic jets pointed along the line of sight of the observer. Because blazars are variable, the association with 3FGL J2015+3709, which showed similar variability, was thought to be strong. However, another potential gamma-ray source, the pulsar wind nebula (PWN) VER J2016+371, is within 6 arcminutes of 3FGL J2015+3709. PWNe are clouds of charged particles that have escaped along the magnetic field of a rapidly rotating pulsar and encounter a shock as they enter the surrounding interstellar medium. The apparent position of 3FGL J2015+3709 shifts with changing energy, becoming more consistent with the position of PWN near TeV energies. The emissions from VER J2016+271, however, are imbedded within the emissions from B2013+370. To disentangle the signals of these two sources, we create a light curve of 3FGL J2015+3709 by analyzing monthly time intervals over the past 7 years. Since the PWN is not variable over short timescales, the light curve tracks the fluctuation of emissions from B2013+370 only. From the light curve, the flaring periods - moments at which the blazar is emitting strongly - are identified and removed. The underlying gamma-ray spectrum allows us to study electrons accelerated in VER J2016+371, one of the few young PWN in our galaxy, from GeV to TeV energies.
Characterization of the Performance/Lifetime of Next Generation X-Ray Polarimeter Prototype

Rafael G. Almonte Jr. 1, Omani R. Tuitt1, Joanne E. Hill-Kittle2, Keith M. Jahoda2

1University of the Virgin Islands, John Brewers Bay, VI, USA
2X-ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA

Time projection polarimeters are gas detectors where incident X-rays interact with a gas atom to produce a photoelectron whose direction is correlated with the polarization of the incident X-ray. By imaging the path of many photoelectrons the polarization of the incident X-ray can be determined.

The next generation of x-ray polarimeters will come with two GEMs (Gas Electron Multipliers) and will be housed in nitro-methane gas. The use of the nitro-methane gas within the polarimeter is to minimize the diffusion of the electron path in the drift field by using charge carrying ions. However using the nitro-methane gas reduces gain in the detectors, as a result two GEMs are needed to obtain the necessary gain.

The beginning of the summer was used to characterize the performance of double GEM that had been soaking in nitro-methane for 9-10 months. Upon completion of the measurements in CO2, the double GEM was removed and showed no signs of visible degradation. To improve the performance and results, all excess copper was removed from the chamber system. The goal for the end of the summer is take measurements using a flight like detector in nitro-methane gas and compare to previous results.
Laser Heterodyne Radiometer-CubeSat

Renee Yang¹, AJ DiGregorio², Emily Wilson³
¹River Hill High School, Clarksville, MD, USA
²American University, Washington, DC, USA
³Laser Remote Sensing Lab, NASA Goddard Space Flight Center, Mail Code 694, Greenbelt, MD, USA

LHR-CUBE (Laser Heterodyne Radiometer-CubeSat) will measure atmospheric methane (CH₄) at 1653.7 nm from within a 6U (1U = 10 cm³) CubeSat spacecraft in an occultation (sun) viewing orbit. A ground-based LHR has been under development at NASA Goddard Space Flight Center since 2012 that measures both methane and carbon dioxide in the atmospheric column. In both ground and flight versions of the instrument, sunlight passes through a portion of the atmosphere, undergoes absorption by the trace gas, and is then collected with collimation optics in the instrument. Collected sunlight is then superimposed with light from the Distributed Feedback (DFB) laser (local oscillator) in a single mode fiber coupler. Superimposed light is mixed in an InGaAs detector (fast photoreceiver) to produce the RF beat signal. The RF receiver amplifies, and detects the beat signal, that is proportional to the concentration of the gas in the atmosphere. During the course of this internship, each component was drawn in FreeCAD and 3D printed on a Cubify Pro. Printed components were then assembled into the 4U space allotted for the LHR to confirm fit and orientation prior to assembly of the flight instrument that is scheduled to launch in early 2016.
A Solar Hiccup: Analysis of an “Almost” Coronal Hole

Rachel O’Connor¹, W. Dean Pesnell²
¹Smith College, Northampton, MA, USA
²Heliophysics Science Division, NASA Goddard Space Flight Center, Mail Code 671, Greenbelt, MD, USA

Coronal Holes--the dark regions on the Sun’s corona that develop within “open” magnetic field lines--come in many different shapes, sizes, and forms. Ephemeral holes are the short-lived form of the phenomena, sometimes lasting only a few days at a time. On October 26, 2010, NASA’s Solar Dynamics Observatory (SDO) observed what was first thought to be an unusual ephemeral coronal hole, appearing for a short time (under 48 hours) and surrounded by a filament. In an effort to understand the formation and characteristics of ephemeral coronal holes, an analysis of the area and magnetic signature of both the filament and suspected hole, as well as solar wind data, was conducted. Results from such analysis have shown that this event was not in fact an ephemeral coronal hole, but rather a solar ‘hiccup’--an attempted, and failed, formation of a small coronal hole. While the reasons behind the failure of the hole to form are still speculative, these findings show that a lot of potential lies in future research of this event--in observing the interactions between the hole and the filament, and our continued understanding of the formation and characteristics of coronal holes.
Lifetime Measurements of Narrow Gap X-ray Polarimeter

Ross McCurdy1, Joanne Hill-Kittle2, Keith Jahoda2

1University of Iowa, Department of Physics and Astronomy, Iowa City, IA, USA
2X-ray Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 662, Greenbelt, MD, USA

The Polarimeter for Relativistic Astrophysical X-ray Sources (PRAXyS) is a small explorer mission based on technology developed for the Gravity and Extreme Magnetism Small Explorer (GEMS). The detectors use a Time Projection Chamber (TPC) filled with Dimethyl Ether to measure the polarization of X-ray sources. TPCs are very sensitive to systematic errors as a result of using orthogonal time and space coordinates. In order to reduce the systematic errors of the PRAXyS detector the separation between the gas electron multiplier and the readout strips was reduced from 800 microns to 250 microns. The minimum design change necessary for the narrow gap detector was to use epoxy to mount the readout strips to the detector frame instead of a knife-edge clamp. The GEMS detector was tested to TRL-6 and its lifetime satisfied mission requirements, however it did not contain epoxy. Measurements were taken this summer to determine if the inclusion of epoxy significantly decreases the polarimeter's lifetime and if it still fulfills the extended mission requirement of twenty-five months for the PRAXyS SMEX mission proposed in 2014.
Improving STEM Education in the Classroom: NASA Goddard’s Summer Watershed Institute

Rachel Paleg1, Dalia Kirschbaum2

1University of Georgia, Franklin College of Arts and Sciences, Athens, GA, USA
2Hydrological Sciences Laboratory, NASA Goddard Space Flight Center, Mail Code 617, Greenbelt, MD, USA

The Global Precipitation Measurement mission is an international satellite constellation that provides near real-time observations of precipitation from around the globe. GPM’s education and outreach department focuses on educating the public about the mission’s work, increasing accessibility of data access, and engaging the community to utilize GPM’s data in various and meaningful ways. The team accomplishes these goals in multiple ways, including the creation of the Summer Watershed Institute (SWI). This week-long course brought together 30 elementary school teachers from nine different counties across Maryland to teach them about the Chesapeake Bay and Earth sciences through NASA resources. The institute focused on teaching data collection protocols from the Global Learning and Observations to Benefit the Environment (GLOBE) program, as well as how to integrate lessons into the curriculum the fulfill Maryland's new scientific teaching requirements, including the Next Generation Science Standards (NGSS) and Meaningful Watershed Educational Experience (MWEE). The teachers were also given the opportunity to have breakout sessions with various Goddard scientists and engineers, which sparked conversation about ways to implement Goddard research and mission science into their own curriculums. Before the institute began, the teachers were given approximately 14 hours of online assignments to complete to make sure they came in with the background information necessary to understand the content. To measure the effectiveness of the SWI, a pre-assessment was administered before the institute, which will be followed by a post-assessment after the program. Evaluations were conducted after every day of the week-long institute to determine the best way to steer the course, as well as how to adapt the activities to be most successful for future years. With the changing standards and increased expectations of STEM education around the world, there needs to be engaging, interactive, and sustainable programs, such as Goddard’s SWI, to help teachers be as successful as possible in their classrooms.
Thermal Coatings Qualification and Development

Rebecca Pontius¹, Mark Hasegawa²

¹Clemson University, Clemson College of Engineering and Science, Clemson, SC, USA
²Thermal Coatings Laboratory, NASA Goddard Space Flight Center, Mail Code 546, Greenbelt, MD, USA

Thermal coatings are an integral part of the protection of spacecraft. They can reflect or absorb light, conduct or resist electricity, adsorb molecular contamination, and physically protect spacecraft. Thermal engineers choose specific coatings based on the needs of a particular piece of hardware. A highly desirable coating is one that is both white and conductive. The purpose of this research was to develop a coating that has the extreme white color (reflectivity) of boron nitride nanomesh, and the electrical conductivity of indium hydroxide. To encourage the thorough mixture of boron nitride nanomesh (BNNM) and indium hydroxide, water was used as a vehicle to combine solid sodium hydroxide and solid BNNM. After all water was evaporated off, the resulting solid was ground to form a fine white powder. Finally, the solid sodium hydroxide/ BNNM mixture was dissolved into aqueous indium nitrate. Immediately, an indium hydroxide/BNNM precipitate formed, leaving an aqueous sodium nitrate solution that can be rinsed off easily with water, allowing the solid to be filtered out. The solid indium hydroxide/ BNNM powder was pressed into a pellet and tested for reflectance and conductivity values. The best findings of several trials were an alpha value of 0.0917 and a resistivity value of $1.54 \times 10^6 \ \Omega \cdot \text{cm}$. These findings suggest this new coating has the high reflectiveness of an ideal dissipative coating and the low resistivity of a good conductive coating.
Calibrating Mercury Laser Altimeter Data Using Stereo Image-Based Digital Elevation Models

Rebecca Bauer¹, Michael Barker², Erwan Mazarico³, Gregory A. Neumann³

¹Stanford University, Stanford, CA, USA
²Sigma Space Corporation, Lanham, MD, USA
³Solar System Exploration Division, NASA Goddard Space Flight Center, Mail Code 698, Greenbelt, MD, USA

The Mercury Laser Altimeter (MLA), an instrument onboard the MESSENGER space probe, made high-resolution measurements of Mercury’s topography. Laser altimetry requires extremely accurate knowledge of the position of the laser transmitter and receiver. To ensure this information is exact, it is helpful to compare MLA data with information from other instruments on MESSENGER. One such instrument is the Mercury Dual Imaging System (MDIS), consisting of a narrow angle and a wide angle camera with typical surface resolutions of ~50 m and ~250 m per pixel, respectively. In order to calibrate MLA data from MESSENGER’s 2008 flybys of Mercury, stereo pairs of MDIS images were selected based on their resolution and illumination conditions. We then used the NASA Ames Stereo Pipeline to construct digital elevation models (DEMs) from the image pairs that contained MLA flyby data points. Comparison between MLA data and the elevation data in these DEMs enables more reliable determination of Mercury’s surface elevation and MESSENGER’s trajectory during the 2008 flybys. Obtaining accurate elevation measurements from the flybys is especially important because they passed over the southern hemisphere, where MLA coverage from the orbital mission is sparse. In general, calibrating MLA data improves our knowledge of Mercury’s topography, knowledge which is crucial to understanding Mercury’s complex geology and history as well as its current rotation state.
BETTII (Balloon Experimental Twin Telescope for Infrared Interferometer) aims to view the cosmos using a special method of observation called interferometry. Interferometry is a technique where electromagnetic (in BETTII’s case, infrared) waves are superimposed in order to extract information about the waves. My main tasks on the project were to program the system that oversees all the measured temperatures on the structure supporting the optical equipment, along with designing, constructing, and programming the wires and software connecting to all the motion sensors to BETTII’s main flight computer. The temperature monitoring system was coded using labview and it plots the particular data points from thermometers for analysis. The wires were designed by interpreting circuit board and sensor blueprints to connect the correct pins to each other. The programming of the sensors has so far been successful and the program displays the data acquired from these sensors. The custom wires have been tested and all the corresponding pins are connected correctly. The sensors were then tested using the custom made wires and gave the compute the proper data to compile and display. These wires and sensors will be mounted and wired onto the BETTII structure and will help observe, measure, and stabilize the device.
A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters

Sarah Blumenthal¹, Avi Mandell², Joseph Harrington¹, Eric Hebrard², Patricio Cubillos¹, Olivia Venot³, Jasmina Blecic¹

¹University of Central Florida, Orlando, FL, USA
²Goddard Center for Astrobiology, NASA Goddard Space Flight, Mail Code 693, Greenbelt, MD, USA
³Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, Belgium

Signatures of disequilibrium chemistry can provide new insights into the complex dynamical and radiative environments in hot exoplanets (Cooper & Showman 2006, Showman et al. 2008, Moses 2011), and may eventually provide a strategy for determining whether Earth-like exoplanets are inhabited. To begin to study departures from chemical equilibrium (CE), we first compare results for CE calculations from some existing models: CEA (Gordon & McBride 1994), and Venot (Venot et al. 2012). We then compare the CE results to Venot models including disequilibrium processes such as photochemistry. We also present preliminary results on distinguishing spectral features between equilibrium and non-equilibrium chemistry in HD209485b and HD189733b using the open-source spectral modeling code, transit, (www.github.com/pcubillos/transit/), and discuss future work on probing spectral variation across new regimes of planetary parameter space. As we near the advent of higher spectral resolution provided by missions such as JWST and E-ELT, we hope this preliminary study will provide another stepping stone in understanding a broader range of planetary environments.
Sodium in the Lunar Exosphere

Sara A Rosborough$^1$, Ronald J Oliversen$^2$, Edwin J Mierkiewicz$^1$, Dona Chathuni Kuruppuaratci$^1$, Nicholas J Derr$^3$, Margaret A Gallant$^1$, Robert A Kallio$^1$

$^1$Embry-Riddle Aeronautical University, Department of Physical Sciences, Daytona Beach, FL, USA
$^2$Planetary Magnetosphere Laboratory, NASA Goddard Space Flight Center, Mail Code 695, Greenbelt, MD, USA
$^3$Wisconsin-Madison University, Department of Physics, Madison, WI, USA

Contrary to popular belief, the moon has a thin atmosphere, technically referred to as an exosphere, which contains sodium and potassium. This experiment focuses on sodium observations and how solar interactions, such as wind, ultraviolet light, and radiation pressure, affects the exosphere of the moon. From late May to early June 2015, observers took high-spectral resolution (R = 200,000 or 1.5 km/s) data of the sunlit limb of the moon through 2 min or 3 min entrance aperture using a Fabry-Perot Spectrometer. Images of thorium and sodium spectral lines provide the instrumental profile and wavelength calibration. All of the images were reduced in IDL and the resultant one-dimensional spectra fit with a method called VoigtFit. The line profile measurements determine the temperature, velocity, and intensity of the sodium in the moon’s exosphere and are compared as a function of lunar phase.
Hot Flow Anomalies at Earth’s Bow Shock and Their Ground Signatures

Christina Seiman Chu1, David G. Sibeck2

1University of Alaska Fairbanks Geophysical Institute, Fairbanks, AK, USA
2Space Weather Laboratory, NASA Goddard Space Flight Center, Mail Code 674, Greenbelt, MD, USA

Hot flow anomalies (HFAs) at Earth’s bow shock were identified in THEMIS C satellite data for August 2007 to December 2009. The 142 events were classified as “young” or “mature” and then “spontaneous” or “regular”. Spontaneous HFAs are also called SHFAs. HFAs occur over a wide range of magnetic local times (MLT). In this study, HFA parameters were analyzed relative to their locations with respect to a model bow shock and the MLT. HFAs and SHFAs occurred more often for more radial interplanetary magnetic field orientations. In this study, SHFAs and HFAs do not show major differences in their plasma parameters and occurrence locations. Initial results indicate that there are signatures at geosynchronous orbit and on the ground corresponding to HFAs.
Correcting Inaccurate WISE1 Magnitudes for Disk Detective

Shambo Bhattacharjee¹, Dr. Marc Kuchner²
¹International Space University, Rue Jean-Dominique Cassini, France
²Exoplanets and Stellar Astrophysics Laboratory, NASA Goddard Space Flight Center, Mail Code 619, Greenbelt, MD, USA

Some of the best, brightest sources on Disk Detective suffer from "WISE 1 dropouts", that is, the photometry is saturated in the WISE 1 bands. The goal of this project is to figure out--for all of the 273,000 sources in the project—which ones are WISE 1 dropouts, and correct the problem, ideally by calculating corrected flux and making new SED plots. In order to do that, for all subjects initially (Ks-WISE1) magnitude values are calculated and further analysis is performed. Additionally, I compare the existing data from the All-WISE catalog to those from the WISE All-Sky Catalog. This correction for WISE1 dropout will make image classification by our citizen scientists easier, as well as eliminate some false-positive objects.
Investigation of the Use of the Aquarius Scatterometer Data in Polar Regions

Shanah K. Sharpe\textsuperscript{1}, Paolo de Matthaeis\textsuperscript{2}

\textsuperscript{1}Jackson State University, Department of Mathematics and Statistical Sciences, Jackson, MS, USA
\textsuperscript{2}Cryospheric Science Laboratory, NASA Goddard Space Flight Center, Mail Code 615 Greenbelt, MD, USA

This project falls within the National Aeronautics and Space Administration (NASA) Cryospheric Science Laboratory’s mission to investigate Earth’s ice cover and its connection to the rest of the climate system. NASA developed the Aquarius mission to map changes in global sea surface salinity, however its measurements have the potential of being used for Cryospheric Science applications.

The main purpose of this study is to explore the relationship between the radar response of sea ice observed by the Aquarius radar scatterometer and physical parameters of the sea ice, particularly its thickness. Previous studies have shown that the Aquarius passive measurements from its radiometer instrument are related to sea ice thickness, and the goal would be to combine together information provided by both the Aquarius scatterometer and radiometer to develop a retrieval model for sea ice thickness.

Comparisons and correlations are made between Aquarius radar scatterometer measurements and data acquired by the CryoSat instrument, a radar altimeter built by the European Space Agency (ESA) to determine variations in the thickness of the Earth’s continental ice cover and sea ice. Analyses are also performed using a theoretical model for the sea ice to compare with the Aquarius scatterometer observations. The work is carried out using Matlab. The observations and results will be discussed.
Optimization and Testing of Coastline ID for GOES-R GLM

Jeffrey Small¹, Donald Chu²
¹James Madison University School of Science and Mathematics, Physics, Harrisonburg, VA, USA
²GOES-R Flight Project, Goddard Space Flight Center, Mail Code 417, Greenbelt, MD, USA

Due to temperature deformations, the GOES-R Geostationary Lightning Mapper (GLM) can be misaligned, leading to greater uncertainty in predicting where lightning events are. In order to correct for this, an algorithm (Coastline ID) was developed to calibrate the unknown GLM camera alignment error. The purpose of this project was to optimize Coastline ID by testing various algorithms and input parameters. Additionally, algorithms for image navigation (IN) were also created to work with Coastline ID in determining the location of events relative to the fixed grid (fg) plane. It was found that a combination of input parameter values and algorithm adjustments produced Coastline ID errors within the assigned budget. Additionally, an alternate algorithm was developed that may be useful for future implementation. The results of this project are very promising. It was found that the Coastline ID error met the assigned requirements, and algorithms for image navigation were created. This calibration for the GLM camera alignment means that lightning events can be pinpointed to smaller areas, meaning more accurate weather reports, and a safer public.
A Survey of Cryovolcanically Emplaced Domes on Europa

Sierra N. Ferguson¹, Lynnae C. Quick², Lori S. Glaze³
¹Northern Arizona University, Department of Physics and Astronomy, Flagstaff, AZ, USA
²Planetary Geodynamics Lab, NASA Goddard Space Flight Center, Mail Code 698, Greenbelt, MD, USA
³Solar System Exploration Division, NASA Goddard Space Flight Center, Mail Code 690, Greenbelt, MD, USA

Certain domes on the surface of Jupiter’s moon Europa may have formed as a product of extrusive cryovolcanism. If these domes were cryovolcanically emplaced, determining their formation mechanisms would help to constrain the role cryovolcanism has played in resurfacing the icy satellite. This study determines the prevalence of putative cryovolcanic domes on Europa by surveying data returned from the Galileo spacecraft’s Solid State Imager (SSI). In the search for cryovolcanic domes, regional image data at approximate resolutions of 200 m/pixel from Galileo orbits E15 and E17, were surveyed. Domes that may have been formed by the eruption and extrusion of viscous cryolavas were classified as circular to elliptical, positive-relief features greater than 15 pixels in diameter. These putative cryolava domes have low albedos relative to the surrounding terrain. This is perhaps indicative of the upwelling of brines from the subsurface. Additionally, these domes do not mimic the surrounding terrain, being smoother than nearby features. For this study a database of all domes on the surface greater than 15 km in diameter was compiled. This database is inclusive of dome coordinates, diameters, areas, and descriptions of the terrain surrounding them. In an effort to make the dataset more accessible, a modified version of the database with images of each dome was also produced. Based on mapping, we find that there is a large population of domes that are concentrated around the low latitude regions between -21°N and 45°N. Out of the 54 domes that have been surveyed, 26 of them may be products of extrusive cryovolcanic activity. Quantitative data pertaining to these domes will be utilized further in dome formation models in order to understand the emplacement of putative cryovolcanic domes on Europa. Further analysis is ongoing, the results of which I will present.
Engaging the Aurorasaurus Citizen Science Project: Multi-tasking Across Multiple Disciplines

Sean P. McCloat¹, Elizabeth A. MacDonald²,³, Nathan A. Case²,³

¹University of North Dakota, John D. Odegard School of Aerospace Sciences-Department of Space Studies, Grand Forks, ND, USA
²Geospace Physics Laboratory, NASA Goddard Space Flight Center, Mail Code 673, Greenbelt, MD, USA
³New Mexico Consortium, Los Alamos, NM, USA

The Aurorasaurus Citizen Science project uses reported observations of the Northern and Southern Lights on its website and apps as well as social media outlets (e.g. Twitter) in order to characterize the global visibility of the aurora. The reports serve the short term goal of sending alerts to registered users that the aurora may be visible in their area (now-casting), and the long term goal of using the reports to improve space weather models. To that end, users are invited to verify tweets received on the site as actual sightings of the aurora. Aurorasaurus team members represent expertise across many disciplines, including space weather physics, citizen science, science education, and sociotechnical interactions. The work is thus equally varied, including data validation and analysis, creating educational content, and optimizing the user interface. Data analysis consisted in identifying the “trustworthy tweet”, including validating the verified tweets, tracking how many tweets are received and subsequently verified on a daily and monthly basis, and categorizing the common errors in verification. Data visualization was achieved using Interactive Data Language (IDL) computer programming software. Educational content contributed to the Aurorasaurus project includes regular blog posts, including “heads-up” aurora activity potential, explaining technical aspects of space weather monitoring, and folktales about the aurora. The project design is an iterative one, and as the direction and goals of Aurorasaurus expand, the website and app layouts need to expand accordingly with them.
Detection Levels of the Exoplanet HAT-P-11b Secondary Transit

Sean K. Terry 1 Kathryn M. Waychoff 2 Emily Kilen 3, Nyki Anderson 4 Rahul Tiwari 5 Anshula Gandhi 6 Mackenzie Kynoch 2, Dr. Richard K. Barry 7

1Catholic University of America, Department of Physics, Washington, DC, USA
2Dartmouth College, Department of Physics and Astronomy, Hanover, NH, USA
3United States Naval Academy, Aerospace Engineering Department, Annapolis, MD, USA
4University of Maryland, College of Computer, Mathematical, and Natural Sciences, College Park, MD, USA
5Purdue University, School of Mechanical Engineering, West Lafayette, IN, USA
6Massachusetts Institute of Technology, Department of Electrical Engineering and Computer Science, Cambridge, MA, USA
7Laboratory for Exoplanets and Stellar Astrophysics, NASA Goddard Space Flight Center, Mail Code 667, Greenbelt, MD, USA

The exoplanet HAT-P-11b, discovered by G. Bakos and colleagues using the Hungarian Automated Telescope Network, is a warm Neptune with many features still shrouded in mystery. We conducted observations of the planet’s occultation by its host star using the Spitzer Space Telescope in 2009. We observed the system at 3.6 microns for a period of 22 hours centered on the anticipated occultation time, to detect the secondary eclipse and determine its phase. After processing these data to remove the strong, pointing-correlated, intra-pixel noise and ramp signals, we made what we considered to be a marginal detection. We conducted a more focused series of observations in both the 3.6 and 4.5 micron bands centered on this phase and, using the new and previous 3.6 micron data, phase wrapped, found no robust evidence of occultation. Colleagues have now conducted new Spitzer observations of the putative secondary transit and will use Pixel Level Decorrelation on these new data in combination with our 2009 data. Anticipating a likely non-detection or marginal detection, our team has conducted calculations to assess the implications. We describe our efforts to model atmospheric temperature profiles, changes in planetary brightness temperature with orbital phase, orbital eccentricity, Spitzer observation noise-floor contributors, and atmospheric heat redistribution efficiencies.
Design and Optimization of an Electric Field Cage for AdEPT

Timothy Dubill¹, Andrei R. Hanu², Stanley D. Hunter²

¹University at Buffalo, Amherst, NY, USA
²Sciences and Exploration, NASA Goddard Space Flight Center, Mail Code 661, Greenbelt, MD, USA

The Advanced Energetic Pair Telescope (AdEPT) is a medium-energy gamma-ray polarimeter that relies on the gas filled 3-DTI Time Projection Chamber (TPC) to achieve kinematically limited gamma-ray angular resolution and high polarization sensitivity. A key component to this technology is a constant electric field in the gas detection chamber, which results in ionized electrons drifting towards a position sensitive charged particlesensor. This study looks at the design of the electrostatic field cage around the gas chamber that provides a uniform and constant electric field. The electrostatic field cage consists of a wire ring array of voltages varying from the drift electrode to the detector surface potentials. To carry out this optimization study, computer programs used the finite element analysis method to simulate the electrostatic field cage and optimize parameters such as wire width, thickness, and pitch. This study found the electric field is optimized when the wire width to pitch ratio is between 0.6 and 1.0. Furthermore, wire diameter and insulator thickness were found to have negligible effects on the field quality when the quantities were kept below 50 microns. Mirror wires behind the field wires are effective in blocking out potentials from outside sources such as the ground or high voltage cable. In summary, a field cage with a .6 to 1 wire width to thickness ratio and mirror wires is the best option for creating a uniform electric drift field in the AdEPT instrument.
The Infrared Spectra and Stability of Icy Extraterrestrial Molecules

Tatiana Tway¹, Reggie Hudson², Perry Gerakines²

¹Delaware Valley University, School of Life and Physical Sciences, Doylestown, PA, USA
²Astrochemistry Laboratory, NASA Goddard Space Flight Center, Mail Code 691, Greenbelt, MD, USA

Due to potential biological implications, the presence of organic matter in outer space has long been of interest to scientists from a variety of disciplines. Within the solar system, as well as interstellar space, organic molecules exist on or within various astronomical objects. Two particular areas of interest are the cold permanently shaded polar regions of the Moon and Mercury, where organic molecules are thought to have been transferred by collisions from comets, meteors, and asteroids. Using infrared spectrophotometry, the presence of these molecules can be detected and quantified. While spectral data exists for many known organic molecules on Earth, using terrestrial data to predict the spectra of extraterrestrial objects presents unique challenges. Molecules present in outer space are subject to bombardment from ultraviolet light from the sun and high-energy ionizing radiation, such as cosmic rays. Furthermore, these molecules exist at different temperatures and in different molecular phases than they would on Earth. Having reliable spectra for organic molecules under these conditions is essential for accurate detection and quantification of these molecules, yet at present little laboratory data exists. To remedy this, two problems have been examined, one with an aliphatic compound and one with an aromatic. First, the near- and mid-infrared spectra of methanol (CH₃OH) have been recorded at 10-140 K to aid in the remote detection and quantification of this molecule. Second, samples of naphthalene (C₁₀H₈) have been exposed to a beam of ~1 MeV protons under vacuum at cryogenic temperatures to simulate the irradiation of this molecule in space.
Characterization of MLA, GLAS, Rubidium and Cesium Clocks

Timothy Tianming Zhou¹, Xiaoli Sun²

¹Montgomery Blair High School, Silver Spring, MD, USA
²Laser Remote Sensing Branch, NASA Goddard Space Flight Center, Mail Code 694, Greenbelt, MD, USA

Laser altimeters utilize laser pulses emitted from a spacecraft, to measure the time of the laser pulses and hence the altitude of the spacecraft. The clock oscillator in the laser altimeter serves as the time base for the laser pulse time of flight measurement. Therefore, the accuracy and stability of the clock are crucial when analyzing the measurement results - especially when on long missions. This project’s task is to characterize various clock oscillators against atomic frequency standards (Rubidium and Cesium) as well as clock oscillators used in various projects at Goddard including Mercury Laser Altimeter (MLA), Lunar Reconnaissance Orbiter (LRO) and Geoscience Laser Altimeter System (GLAS). First the noise floor of the measurement setup will be determined. Then the oscillator frequency, fluctuation and Allan deviation will be measured. Finally, the results from these clock oscillators and frequency standards will be compared to determine the exact offset necessary to analyze results from missions such as MLA, GLAS, and LRO.
Development for WFIRST and CLASS

Jacqueline Andrews¹, Noah Vaughnn², Kevin Denis³

¹University of Maryland, College Park, College of Mathematics and Natural Sciences (CMNS)
²University of Maryland, College Park, MD, USA
³Detector Systems Branch, NASA Goddard Space Flight Center, Mail Code 553, Greenbelt, MD, USA

WFIRST stands for Wide-Field Infrared Survey Telescope and in development with a projected launch date of a time in the mid 2020’s. This project’s aim is to be able to see as much of the sky as possible at one time at a reasonable infrared or visible light spectrum. This telescope could be compared to Hubble in terms of its possible resolution, but offers a much wider field of view, hence the name.

CLASS stands for Cosmology Large Angular Scale Surveyor, and is going to be a frequency-based land built telescope. The aim of this project is to detect the polarized signals that come from the cosmic microwave background, and compare them to a higher degree of certainty and accuracy against existing telescopes.

For CLASS, I have been trying to solve the problem of figuring out a viable solution to having crossovers on a detector without introducing noise in the signal. The problem is that when you have such small parts on a detector, creating a crossover of metals is an extremely delicate and difficult process. I have been trying a process where metal is deposited on top of a layer of photoresist, and then photoresist is removed, but the photoresist seems to always leave behind residue no matter what cleaning methods we use. We have found out that the only logical solution is to try different methods of depositing metal and or using a different type of photoresist in the bottom layer. This seems like a logical step, and I’m certain there will be a solution based on how close these crossovers have come to being perfect.

For WFIRST, I have been working on attesting the fan-out boards that will be used for the instruments on board. The fan-out keeps all the electronics sorted out and is the pathway for each electronic system to communicate with other parts of the telescope. Because all the electronics in the instrument need to pass through this connector, it needs to be tested in order to make sure that each connection is working fully, and properly. I created test points in a designing software in order to designate each point of testing and am waiting on a time to take these test points in the correct format into a characterization lab to use a flying probe tester and test each of the connections for functionality.
Solar Wind Hydrogen Implantation and Diffusion from Regolith of the Mood and Asteroids

Vincent J Esposito\textsuperscript{1}, William M Farrell\textsuperscript{2,3}  
\textsuperscript{1}University of South Carolina, Department of Chemistry and Biochemistry, Columbia, SC, USA  
\textsuperscript{2}NASA Goddard Space Flight Center, Mail Code 690, Greenbelt, MD, USA  
\textsuperscript{3}NASA’s Solar System Exploration Research Virtual Institute, NASA Ames Research Center, Moffett Field, CA, USA

Solar wind protons are directly incident on the lunar surface displacing atoms from the crystal lattice and creating a vacancy layer. These displaced atoms can be sputtered from the surface if they have enough recoil energy or moved to another location as a non-crystal atom. We used three different codes to investigate this process. We began with the idea of integrating two previously unrelated codes, but found the need for a middle, bulk damage code. From the Transport of Ions in Matter (TRIM) software, we discovered that the vacancy layer and final ion depth were two separate layers, both of which are at a much shallower depth than previously believed. This gave rise to the thought that as the implanted hydrogen diffuse toward the surface they interact with the vacancy layer. We looked at several different cases of solar wind, as well as magnetic anomaly regions on the lunar surface. We discovered that as the ion energy increases, the amorphousization time decreases in a logarithmic manner, however, the number of non-crystal atoms, vacancies, and lattice atoms only display a slight variation despite the changes in energy. As time moves to infinity, the vacancies and lattice atoms reach an equilibrium that is a function of ion energy. Because the vacancies and non-crystal atoms have high activation energies, they have a greater ability to trap diffusing hydrogen atoms. This increased trapping ability leads to longer diffusion times, and therefore an increased chance of production of hydroxyl and water.
The goal of this project is to classify the states of a wide variety of galactic accreting black hole and neutron star binary systems. These objects emit x-rays and are called x-ray binaries (XRBs). I used data from the Monitor of All-sky X-ray Image (MAXI). This is a Japanese telescope that is currently mounted on the International Space Station (ISS). The different states are defined by the spectra of XRBs. For black hole binaries there are three main states: soft state, intermediate state, and hard state. If the accretion disk dominates the spectra, then the black hole is in the soft state. If the corona dominates the spectra, then the black hole is considered to be in the hard state. If both the corona and the accretion disk are comparable, then the black hole is considered to be in the intermediate state. Ideally one would always do spectral analysis, but sometimes we only have enough photons to determine the count rate for different energy bands. I used the models developed in Zezas et al. 2015 based on Milky Way XRBs to define regions of color that correlate to different states and to find the state frequency. Additionally I took models of the spectra neutron stars given in various literature and placed them onto diagrams similar to those seen in Zezas et al. 2015 using XSPEC.
Determining Landslide-related Relationships Using the Global Landslide Catalog

Winne Luo¹, Dr. Dalia B. Kirschbaum ²

¹Montgomery Blair High School, Silver Spring, Maryland, USA
²Hydrological Systems Laboratory, NASA Goddard Space Flight Center, Mail Code 617, Greenbelt, Maryland, USA

With the potential to occur rapidly and without warning, landslides can be destructive and have devastating effects on infrastructure and human life. The Global Landslide Catalog (GLC) is one of the only databases documenting rain-triggered landslides and their impacts all over the earth, and is updated manually using news reports from the web. This project aimed to use data from the GLC to isolate select regions all over the earth and determine how monthly totals of landslide reports entered into the database correlated with average monthly rainfall in those regions. This was done by graphing Tropical Rainfall Measuring Mission (TRMM) data from January 2007 (the start of the GLC) to April 2015 (the latest available TRMM data at the time of this study) with manually calculated monthly totals exported from the GLC. In addition, this project conducted in-depth searching for landslides occurring in these regions, taking into account local languages and reporting. Because the GLC uses mostly results produced from certain keywords in Google Alerts, it is likely that many landslides that did not make it to English news websites were left out. This study aimed to investigate the reporting bias in terms of accuracy and quantity for these regions so that further analyses using the GLC will be conducted with this bias in mind. Finally, the study aims to analyze the relationship between socioeconomic condition and human injury/fatality using ArcGIS.
LDI-MS Analysis of Martian Soil Analogues

William Dean¹, Xiang Li²

¹University of Maryland, Baltimore County, Department of Chemistry and Biochemistry, Baltimore, MD, USA
²Planetary Environments Laboratory, NASA Goddard Space Flight Center, Mail Code 699, Greenbelt, MD, USA

One of the top priorities of Mars exploration is to identify signatures of life that may be preserved on the Martian surface. Previous Mars missions have employed techniques such as pyrolysis and gas chromatography mass spectrometry (GC-MS) towards this end, but the unambiguous detection of organic molecules on Mars has yet to be achieved. Laser desorption ionization mass spectrometry (LDI-MS) is a powerful technique that allows organic molecules and biomarkers on the Martian surface to be detected with good sensitivity. The Mars Organic Molecule Analyzer (MOMA) is a key instrument on the 2018 ExoMars mission and is capable of both pyr/GC-MS and LDI-MS. In order to test the performance of the LDI-MS function, a library of spectra from organic chemical standards and Mars soil analogues is being created using two commercial instruments. The first is a Thermo LTQ MALDI-MS (Linear Trap Quadrupole Matrix-Assisted Laser Desorption Ionization Mass Spectrometer), and the other is a Bruker Autospeed MALDI-TOF (MALDI Time-of-Flight) MS. The organic standards being tested include oxalate compounds, aromatic carboxylic acids, and fatty acids. The Martian analogues include soils from Antarctica, the Sverrefjelle red beds, and the Atacama Desert, as well as standards used in testing the Mars Science Laboratory. These data will provide essential knowledge for the analysis of mass spectra from the MOMA instrument, and will significantly increase confidence in the assignment of mass peaks. In addition, the library will benefit future Mars missions that use LDI mass spectrometry.
Satellite Observations of the Antarctic Ice Shelves

William Sprecher$^{1, 2}$, Ludovic Brucker$^{2, 3}$, Emmanuel Dinnat$^{2, 4}$

$^1$City College San Francisco, San Francisco, CA, USA
$^2$Cryospheric Sciences Laboratory, NASA Goddard Space Flight Center, Mail Code 615, Greenbelt, MD, USA
$^3$Universities Space Research Association, GESTAR, Columbia, MD, USA
$^4$Chapman University, School of Earth and Environmental Sciences, Orange, CA, USA

Satellite observation of Earth’s cryosphere is vitally important for the further understanding of Earth’s polar regions and their impact on Earth’s climate system. Stability of Arctic and Antarctic Ice Sheets is crucial to ensure prolonged societal health and stability on Earth. As the planet undergoes changes due to a warming climate, it is important to study what effects these changes have on the polar regions to gain a better understanding of their impacts on global populations. One such area of interest is the thickness of Antarctic ice shelves. Current methods of studying ice thickness, such as airborne measurements acquired with NASA Operation Ice Bridge, are extremely precise but limited in scope. By harnessing the power of orbiting satellites, it is our goal to investigate the potential of monitoring ice shelf thickness using existing data obtained from NASA satellites Aquarius and SMAP.

Aquarius, launched in June 2011, collects L-band observations and provides detailed information on how salinity varies throughout the ocean and how this changes as a result of season. Additionally, mapping the spread of ocean salinity allowing a better understanding how changes in the Earth’s climate affect ocean currents and water cycles.

SMAP, launched in January 2015, also collects L-band observations to monitor global soil moisture and freeze/thaw cycles with the purpose of gathering data on links between water, energy and carbon cycles.

Both Aquarius and SMAP use passive radiometers to measure emitted microwaves in L-Band at 1.4 GHz. This is used to determine Brightness Temperature (TB) of the Antarctic. While this measurement is good for studying many different aspects of Earth’s climate system, it is our goal to be able to use it to determine ice shelf thickness. An analysis of this sort has never been done with L-band TB. Aquarius (and forth coming SMAP) TB data is analyzed over Antarctic ice shelves for a correlation with the ice shelves thickness.

This poster will present the findings of this analysis. Additionally, it will provide a detailed explanation of the cryosphere, Antarctic Ice Shelves, along with methods used for interpreting the data collected and it’s connection to ice shelf thickness retrieval.

If a correlation can be established, models can be developed to provide retrieval of ice thickness with a much greater scope than is currently used by the Operation Ice Bridge airborne mission. This will ensure
that ice shelf monitoring can be done much more efficiently and effectively, over longer periods of time further expanding the scope of scientific research in Earth’s polar regions.
Changes in pressure need to be monitored during the re-entry of space crafts. For this reason, MEMS (microelectromechanical systems) pressure sensors that are able to withstand high temperature and corrosive environments were developed and fabricated. The pressure sensors are diaphragm based. Piezo resistors deposited on the diaphragm allow the pressure change to be converted to a measurable voltage output. The piezo resistors are made of materials that can operate in high temperature conditions. Additionally, the sensors are chemically inert and will be able to survive harsh environments, such as Venus’s atmosphere. After fabrication, the sensors are electrically tested to characterize the response of the different sensor designs.
Life on Mars: Extremophilic Bacteria in a Simulated Martian Environment

Zachary K. Garvin¹, Melissa Floyd²
¹Brown University, Providence, RI, USA
²Planetary Environments Laboratory, NASA Goddard Space Flight Center, Mail Code 699, Greenbelt, MD, USA

Extremophilic microbes are capable of living in Earth’s most extreme environments and conditions, holding the potential to thrive in harsh settings that appear unsuitable to sustain life. Soil samples were obtained from the Yungay region of the hyper-arid Atacama Desert in Chile to analyze the xerophilic bacterial diversity present in the area and test their abilities to adapt to Mars-like conditions. Using direct dry-plating methods, three distinct species were observed and collected—Streptomyces albidochromogenes, Bacillus muralis, and Kocuria rhizophila. The bacteria were inoculated as a community into samples of JSC Mars-1A, a spectral analog to Martian soil, along with small amounts of water and nutrients (< 2.5% v/w LB medium). Inoculated samples were placed into a Mars Chamber in order to simulate Martian pressure, temperature, and atmospheric composition. After two weeks, the samples were retrieved from the chamber, and cells were counted to determine the bacterial recovery rates. Additional “shock” experiments were performed by exposing the communities to the extreme conditions of the Mars Chamber for one hour to ascertain whether an immediate die-off occurs upon initial exposure. While recovery rates from the Mars Chamber after two weeks indicate low survivability, reduced recovery from the shock tests could suggest partial regrowth of the community following early death.
The project I am working for is the mock up design for the Wide Field Infrared Survey Telescope or WFIRST. WFIRST is going to be the next large scale satellite for NASA after the James Webb Space Telescope. My part in this project, is to take the current radiator design and redesign the assembly for the full scale mock up version that is scheduled to be completed next year. The current radiator was too complicated for the purpose of a low-fidelity mock up, therefore, I analyzed the various components of the radiator and found what could be replaced or moved into a more manageable position in the assembly. The end result was a frame for the radiator that was immensely simpler but still retained the same practicality, functionality, and general footprint as the original design. This was achieved through moving members and connecting points, as well as using square hollowed tubing instead of solid pieces of metal thereby shedding mass. Through this process I learned what it was like to work with a team of designers and the various stages of revisions that come with a project of this scale. I gained information on how the actual design process works as well as figuring out what the best and most economically sound method of manufacturing was for my assembly.
Tribal Colleges and University Archiving Project

Rustie J. Anglin¹, Torry A. Johnson²

¹Haskell Indian Nations University, Lawrence, KS, USA
²NASA Goddard Space Flight Center, Mail Code 160, Greenbelt, MD, USA

This project will examine the relationship between the National Aeronautics and Space Administration (NASA) and the Tribal Colleges and Universities (TCU’s) around the United States. By examining this relationship we are able to get a better understanding of how NASA engaged with American Indian and Alaskan Native students in Science, Technology, Engineering and Mathematics (STEM) fields through NASA centers or projects. Several research strategies will be used for this project including: interviews, published White House Initiative on Tribal Colleges and Universities (WHITCU) reports, published Annual Performance Reports, activity reports, conference proceedings, records, and online research. In developing an archival project related to the TCU efforts we are able to build a historical tool regarding the work that NASA has done in the Native American community. By creating a catalogue of events and partnerships we can look at the best practices for the program, and new opportunities to grow the American Indian and Alaskan Native engagement. Additionally we are able to foster collaboration with advocacy groups and share our data with a wider audience. The beneficial products of this project include a poster, a detailed PowerPoint, a historical timeline, an organized platform for project data, and in the future a website.
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abel</td>
<td>Logan Handy</td>
<td>583</td>
<td>Evolving Middleware Support for Goddard Mission Services Evolution Center (GMSEC)</td>
<td>28</td>
</tr>
<tr>
<td>Ackman</td>
<td>Laiya Perkins Jeremy</td>
<td>661</td>
<td>Development of a Telescope System for VHE Astronomy</td>
<td>221</td>
</tr>
<tr>
<td>Adenaw</td>
<td>Daniel Johnson Gaynell</td>
<td>100</td>
<td>Cost Tickets and Analysis (FY2014 &amp; FY2015)</td>
<td>156</td>
</tr>
<tr>
<td>Ajamian</td>
<td>John Fedorchak Amy</td>
<td>200</td>
<td>The Backfill Project</td>
<td>159</td>
</tr>
<tr>
<td>Alberding Jr.</td>
<td>William Rosanova Giulio</td>
<td>543</td>
<td>3D Printed Model of the WFIRST Observatory using Additive Manufacturing Techniques</td>
<td>71</td>
</tr>
<tr>
<td>Alejandro</td>
<td>Efrain Silk Eric</td>
<td>552</td>
<td>Alternative Wick Structure Testing for Loop Heat Pipes</td>
<td>81</td>
</tr>
<tr>
<td>Almonte</td>
<td>Rafael Hill-Kittle Joe</td>
<td>660</td>
<td>Developing a Test Stand for Lifetime Measurements Using a Narrow Gap Detector</td>
<td>235</td>
</tr>
<tr>
<td>Almonte</td>
<td>Rafael Hill-Kittle Joanne</td>
<td>662</td>
<td>Characterization of the Performance/Lifetime of Next Generation X-Ray Polarimeter Prototype</td>
<td>238</td>
</tr>
<tr>
<td>Ameer</td>
<td>Mohammed Sacks Lia</td>
<td>591</td>
<td>MMS AMS SPIKES</td>
<td>45</td>
</tr>
<tr>
<td>Anderson</td>
<td>Alexander Howard Joseph</td>
<td>551</td>
<td>Freeform Optical Design of 2 and 3 Mirror Telescopes</td>
<td>39</td>
</tr>
</tbody>
</table>

269
<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor1</th>
<th>Mentor2</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson</td>
<td>Nyki</td>
<td>Barry</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td>Anderson</td>
<td>Nyki</td>
<td>Barry</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td>254</td>
</tr>
<tr>
<td>Andrews</td>
<td>Jaclyn</td>
<td>Hess</td>
<td>553</td>
<td>Fabrication and Characterization of Novel Nanoporous Bolometer</td>
<td>50</td>
</tr>
<tr>
<td>Andrews</td>
<td>Jacqueline</td>
<td>Denis</td>
<td>553</td>
<td>Development for WFIRST and CLASS</td>
<td>258</td>
</tr>
<tr>
<td>Anglin</td>
<td>Rustie</td>
<td>Johnson</td>
<td>160</td>
<td>Tribal Colleges and University Archiving Project</td>
<td>268</td>
</tr>
<tr>
<td>Aronne</td>
<td>Mary</td>
<td>Zheng</td>
<td>674</td>
<td>Space Weather Forecasting and Research</td>
<td>168</td>
</tr>
<tr>
<td>Aronne</td>
<td>Mary</td>
<td>Zheng</td>
<td>674</td>
<td>Space Weather Forecasting and High Speed Streams</td>
<td>227</td>
</tr>
<tr>
<td>Austin</td>
<td>Tyler</td>
<td>Fulwood</td>
<td>157.1</td>
<td>Reimbursable Agreements</td>
<td>2</td>
</tr>
<tr>
<td>Azzopardi</td>
<td>Nicholas</td>
<td>Cymerman</td>
<td>474</td>
<td>JPSS Instrument Development</td>
<td>121</td>
</tr>
<tr>
<td>Ballerda</td>
<td>Dexter</td>
<td>Ruley</td>
<td>583</td>
<td>Data Access Toolkit (DAT) Gridx and Mnemonic Archive Data (MAD) Files</td>
<td>16</td>
</tr>
<tr>
<td>Bambic</td>
<td>Christopher</td>
<td>Thorpe</td>
<td>663</td>
<td>Modeling of LISA Pathfinder with Inverted Pendulum on Cart Control</td>
<td>187</td>
</tr>
<tr>
<td>Banerjee</td>
<td>Rohan</td>
<td>Mitchell</td>
<td>595</td>
<td>Development of a PC-based MPU Simulator for NICER</td>
<td>128</td>
</tr>
<tr>
<td>Barker</td>
<td>Michael</td>
<td>Mazarico</td>
<td>698</td>
<td>Calibrating Mercury Laser Altimeter Data Using Stereo Image-Based Digital Elevation Models</td>
<td>244</td>
</tr>
<tr>
<td>Barner</td>
<td>Lindsey</td>
<td>Biskach</td>
<td>660</td>
<td>Next Generation X-Ray Optics:</td>
<td>105</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor 1</th>
<th>Mentor 2</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauer</td>
<td>Rebecca Neumann</td>
<td>Gregory</td>
<td>698</td>
<td>Mirror to Module Bonding</td>
<td>244</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Calibrating Mercury Laser Altimeter Data Using Stereo Image-Based Digital Elevation Models</td>
<td></td>
</tr>
<tr>
<td>Baules</td>
<td>Victor Hickey</td>
<td>Michael</td>
<td>553</td>
<td>Detector Characterization Data Interpretation Using Python</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berez</td>
<td>Jaime Segal</td>
<td>Kenneth</td>
<td>543</td>
<td>Advanced Energetic Pair Telescope Instrument Structure Design</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berlin</td>
<td>David Carosso</td>
<td>Nancy</td>
<td>546</td>
<td>Rapid ATP Bioburden Test</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bermudez</td>
<td>Katrina Conrad</td>
<td>Pamela</td>
<td>699</td>
<td>Preliminary Results of Ar Diffusion through Silicate Glasses</td>
<td>212</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bhattacharjee</td>
<td>Shambo Kuchner</td>
<td>Marc</td>
<td>619</td>
<td>Correcting Inaccurate WISE1 Magnitudes for Disk Detective</td>
<td>249</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bian</td>
<td>Brent Rodriguez</td>
<td>Marcello</td>
<td>540</td>
<td>Particle Spectrometry Lab: Mini Ion Neutral Mass Spectrometer</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birchler</td>
<td>Alan Milner</td>
<td>Barbara</td>
<td>500</td>
<td>Development for GMSEC Services Suite (GSS)</td>
<td>6</td>
</tr>
<tr>
<td>De Allende</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blake</td>
<td>Ameer Roberge</td>
<td>Aki</td>
<td>667</td>
<td>The Search for ExoPlanets in the Beta Pictoris Debris Disk</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blecic</td>
<td>Jasmina Hebrard</td>
<td>Eric</td>
<td>693</td>
<td>A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters</td>
<td>246</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mandell Avi</td>
<td></td>
<td>693</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blumenthal</td>
<td>Sarah Mandell</td>
<td>Avi</td>
<td>693</td>
<td>A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters</td>
<td>246</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hebrard Eric</td>
<td>693</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boulter</td>
<td>Kurtis Clagett</td>
<td>Charles</td>
<td>596</td>
<td>Low-Cost Reaction Wheel System for Use in CubeSats</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branyan</td>
<td>Callie Kogut</td>
<td>Alan</td>
<td>665</td>
<td>Mechanical Structure Developments for PIPER within Vacuum and Cryogenic Environments</td>
<td>66</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bremer</td>
<td>Natalie</td>
<td>662</td>
<td>Association of Short Gamma-Ray Bursts with Galaxy Clusters</td>
<td>231</td>
</tr>
<tr>
<td>Brothers</td>
<td>Lydia</td>
<td>690.1</td>
<td>Data Restoration and Analysis of Daytime Lunar Mass Spectra of the Lunar Atmosphere Composition Experiment (LACE)</td>
<td>223</td>
</tr>
<tr>
<td>Brown</td>
<td>Megan</td>
<td>547</td>
<td>The Robotic Cell Design</td>
<td>115</td>
</tr>
<tr>
<td>Byrne</td>
<td>Brandon</td>
<td>400</td>
<td>Open Source Data Management</td>
<td>10</td>
</tr>
<tr>
<td>Cage</td>
<td>Kailyn</td>
<td>220</td>
<td>Building Energy Efficiency</td>
<td>97</td>
</tr>
<tr>
<td>Calfat</td>
<td>Claudelle</td>
<td>699</td>
<td>Channel Electron Multiplier Performance Testing</td>
<td>184</td>
</tr>
<tr>
<td>Campbell</td>
<td>Matthew</td>
<td>408</td>
<td>Gamma 300 Case Design and Air Track Rail Construction</td>
<td>116</td>
</tr>
<tr>
<td>Campion</td>
<td>Robert</td>
<td>662</td>
<td>NICER Pointing System</td>
<td>60</td>
</tr>
<tr>
<td>Cannon</td>
<td>Luke</td>
<td>500</td>
<td>Software Architecture Based on UML Diagrams</td>
<td>31</td>
</tr>
<tr>
<td>Cao</td>
<td>David</td>
<td>674</td>
<td>An iOS Application for iSWA</td>
<td>15</td>
</tr>
<tr>
<td>Cao</td>
<td>Alvin</td>
<td>694</td>
<td>Post-mission Characterization of the Mercury Laser Altimeter</td>
<td>176</td>
</tr>
<tr>
<td>Carter</td>
<td>Elizabeth</td>
<td>595</td>
<td>GPS III Space Service Volume Specifications Study</td>
<td>79</td>
</tr>
<tr>
<td>Carter</td>
<td>Omari</td>
<td>562</td>
<td>Evaluation of Aerosol Jet Additive Manufacturing of High Density Printed Circuits</td>
<td>126</td>
</tr>
<tr>
<td>Chambers</td>
<td>Lauren</td>
<td>665</td>
<td>Modularized Software Control for the RIMAS Instrument</td>
<td>218</td>
</tr>
<tr>
<td>Chen</td>
<td>Amy</td>
<td>613</td>
<td>Deep Blue Website Project</td>
<td>167</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td>------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>Chen</td>
<td>Heather</td>
<td>610</td>
<td>Effects of Volcanic Eruptions on Climate and the Environment using Satellite Observations of SO2 and Ash and a Global Model</td>
<td>200</td>
</tr>
<tr>
<td>Cheng</td>
<td>Ashley</td>
<td>583</td>
<td>Development for GMSEC Services Suite (GSS) and Messaging Interface Standardization Toolkit (MIST)</td>
<td>7</td>
</tr>
<tr>
<td>Cho</td>
<td>Yongsong</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td>Chu</td>
<td>Christina</td>
<td>674</td>
<td>Hot Flow Anomalies at Earth’s Bow Shock and Their Ground Signatures</td>
<td>248</td>
</tr>
<tr>
<td>Clamp</td>
<td>Joseph</td>
<td>606</td>
<td>GEOS-5 Interactive Mobile Application</td>
<td>21</td>
</tr>
<tr>
<td>Clarke</td>
<td>John</td>
<td>695</td>
<td>Martian Crustal Magnetic Field with MAVEN</td>
<td>204</td>
</tr>
<tr>
<td>Codoreanu</td>
<td>Alex</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at 0.5 ≤ z ≤ 1.5</td>
<td>169</td>
</tr>
<tr>
<td>Cole</td>
<td>Samuel</td>
<td>200</td>
<td>Building Energy Efficiency</td>
<td>135</td>
</tr>
<tr>
<td>Colon</td>
<td>Brandon</td>
<td>699</td>
<td>Ion Focusing via Electrostatic Lenses for Interfacing Liquid Chromatograph</td>
<td>61</td>
</tr>
<tr>
<td>Comberiate</td>
<td>Daniel</td>
<td>474</td>
<td>JPSS Flight Project Training Database</td>
<td>74</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Coulson</td>
<td>Keith</td>
<td>545</td>
<td>Two-Phase Microgap Cooling for Next Generation Electronic Systems</td>
<td>98</td>
</tr>
<tr>
<td>Coulter</td>
<td>David</td>
<td>662</td>
<td>Testing the Universality of the Stellar IMF with Chandra</td>
<td>192</td>
</tr>
<tr>
<td>Cramer</td>
<td>Callan</td>
<td>587</td>
<td>Hardware Components Database</td>
<td>12</td>
</tr>
<tr>
<td>Craven</td>
<td>Jeffery</td>
<td>673</td>
<td>Neutral Atom Flux Simulation of the Earth’s Ring Current</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters</td>
<td>246</td>
</tr>
<tr>
<td>Cubillos</td>
<td>Patricio</td>
<td>693</td>
<td>Manufacturing Robotic Arm Concept</td>
<td>62</td>
</tr>
<tr>
<td>Daitch</td>
<td>Cole</td>
<td>547</td>
<td>Precision Eddy Current Displacement Sensor</td>
<td>94</td>
</tr>
<tr>
<td>Dao</td>
<td>Justin</td>
<td>665</td>
<td>3D Printed Model of the WFIRST Observatory using Additive Manufacturing Techniques</td>
<td>71</td>
</tr>
<tr>
<td>Davidson</td>
<td>Rosemary</td>
<td>543</td>
<td>Satellite Ground Systems Basic Concepts</td>
<td>49</td>
</tr>
<tr>
<td>Davison</td>
<td>Timothy</td>
<td>599</td>
<td>International Space Station Instrument Pointing Platform Control System Design</td>
<td>122</td>
</tr>
<tr>
<td>De Alba</td>
<td>Roberto</td>
<td>552</td>
<td>Ideal Integrating Bolometer for Far-infrared Spectroscopy</td>
<td>132</td>
</tr>
<tr>
<td>De Mello</td>
<td>Duilia</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at 0.5 ≤ z ≤ 1.5</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dean</td>
<td>William</td>
<td>699</td>
<td>LDI-MS Analysis of Martian Soil</td>
<td>262</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Decker</td>
<td>Caleb</td>
<td>Showalter Matt</td>
<td>Analogues 547 Engineering Technician Assistance</td>
<td>64</td>
</tr>
<tr>
<td>Demetrides</td>
<td>Nicole Pulia Jillian</td>
<td>546</td>
<td>Purge Flow Analysis</td>
<td>123</td>
</tr>
<tr>
<td>Derr</td>
<td>Nicholas</td>
<td>Oiversen Ron</td>
<td>Sodium in the Lunar Exosphere 695</td>
<td>247</td>
</tr>
<tr>
<td>Detweiler</td>
<td>Louis Khazanov George</td>
<td>673</td>
<td>Superthermal Electron Magnetosphere-Ionosphere Coupling in the Diffuse Aurora in the Presence of ECH and Whistler Waves</td>
<td>193</td>
</tr>
<tr>
<td>DeWeese</td>
<td>Tate</td>
<td>Kenyon Steven</td>
<td>Designing and Modeling for the NICER Project 660</td>
<td>144</td>
</tr>
<tr>
<td>Deza</td>
<td>Laura</td>
<td>Dalhoff Jeffrey</td>
<td>Levels of Lead Fume Exposure in Soldering Labs 360</td>
<td>219</td>
</tr>
<tr>
<td>Dhillon</td>
<td>Yadvender</td>
<td>Barbee Brent</td>
<td>Physics-based NEO Deflection Tool Validating Kinetic Impactor Mission Opportunities 595</td>
<td>69</td>
</tr>
<tr>
<td>Diaz</td>
<td>Walter</td>
<td>Amatucci Edward Coleman Frank 592</td>
<td>Systems Engineering 500</td>
<td>139</td>
</tr>
<tr>
<td>Diaz</td>
<td>Camilo</td>
<td>Brucker Ludovic</td>
<td>Measuring Snow Depth on top of Arctic Sea Ice 615</td>
<td>186</td>
</tr>
<tr>
<td>Dickens</td>
<td>Olivia</td>
<td>Ichoku Charles 613</td>
<td>Comparison of Satellite-derived Fire Emissions Results with Airborne Measurements of Smoke Constituents</td>
<td>234</td>
</tr>
<tr>
<td>Diederich</td>
<td>Gloria Leisawitz Dave</td>
<td>600</td>
<td>Enhancing Data Collection and Analysis Methods for Wide-Field Imaging Interferometry</td>
<td>198</td>
</tr>
<tr>
<td>DiGregorio</td>
<td>AJ Wilson Emily</td>
<td>694</td>
<td>Laser Heterodyne Radiometer-CubeSat</td>
<td>239</td>
</tr>
<tr>
<td>Douglas</td>
<td>Madison Carter Lynn</td>
<td>698</td>
<td>Analysis of Volcanic Deposits on Venus Using Radar Polarimetry</td>
<td>224</td>
</tr>
<tr>
<td>Dowling</td>
<td>Joseph Williams David</td>
<td>690.1</td>
<td>Mariner 2 Magnetometer Data</td>
<td>226</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Drewniak</td>
<td>Jacob</td>
<td>Patel Umesh</td>
<td>Development of Circuit Simulations and Control Algorithms for Critical Flight Test Hardware</td>
<td>90</td>
</tr>
<tr>
<td>Drobac</td>
<td>Alec</td>
<td>Racette Paul</td>
<td>Science Writing for Earthzine</td>
<td>171</td>
</tr>
<tr>
<td>Dronamraju</td>
<td>Vaibhav Rodriguez-Ramon Lixa</td>
<td>250</td>
<td>Hazardous Waste at NASA Goddard Space Flight Center</td>
<td>160</td>
</tr>
<tr>
<td>Dubill</td>
<td>Timothy Hanu Andrei Hunter Stanley</td>
<td>661</td>
<td>Design and Optimization of an Electric Field Cage for AdEPT</td>
<td>255</td>
</tr>
<tr>
<td>Duncan</td>
<td>Daniel St. Cyr Chris Xie Hong</td>
<td>670</td>
<td>Classifying Solar Events with STEREO</td>
<td>191</td>
</tr>
<tr>
<td>Eissner</td>
<td>Jordan Thomas William</td>
<td>474</td>
<td>JPSS Data Product Quality</td>
<td>209</td>
</tr>
<tr>
<td>Esmaili</td>
<td>Rebekah Tian Yudong</td>
<td>610</td>
<td>Observation and Analysis of Global Storm Tracks and their Variations</td>
<td>181</td>
</tr>
<tr>
<td>Espinosa</td>
<td>Marcos Coll Gregory</td>
<td>408</td>
<td>Satellite Service Valve O-ring Radiation and Leak Test</td>
<td>111</td>
</tr>
<tr>
<td>Esposito</td>
<td>Vincent Farrell William</td>
<td>690</td>
<td>Solar Wind Hydrogen Implantation and Diffusion from Regolith of the Mood and Asteroids</td>
<td>259</td>
</tr>
<tr>
<td>Everett</td>
<td>Katherine Patel Umesh</td>
<td>544</td>
<td>Absolute Position Sensor Development</td>
<td>83</td>
</tr>
<tr>
<td>Farcy</td>
<td>Benjamin Grubisic Anderj Brinkerhoff William</td>
<td>699</td>
<td>Simulation of Hyper-Velocity Impacts: Implications for Impact-Induced Organic Molecule Synthesis on the Early Earth</td>
<td>182</td>
</tr>
<tr>
<td>Farrall</td>
<td>Nicole Chervenak James</td>
<td>553</td>
<td>X-ray Detector Development and Testing</td>
<td>119</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferguson</td>
<td>Sierra</td>
<td>690</td>
<td>A Survey of Cryovolcanically Emplaced Domes on Europa</td>
<td>252</td>
</tr>
<tr>
<td></td>
<td>Glaze</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lori</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fields</td>
<td>Naje</td>
<td>580</td>
<td>NEN Live</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Turner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ryan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finzi</td>
<td>Marc</td>
<td>665</td>
<td>Cryogenic Thermometry for RIMAS</td>
<td>229</td>
</tr>
<tr>
<td></td>
<td>Kutyrev</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alexander</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foust</td>
<td>Rebecca</td>
<td>591</td>
<td>Inertial Navigation Attitude Filter Computational Complexity Optimization</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Galante</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Joseph</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fox</td>
<td>Patrick</td>
<td>673</td>
<td>Possible Magnetic Reconnection Events Observed Near Earth by Multiple Satellites</td>
<td>236</td>
</tr>
<tr>
<td></td>
<td>Garcia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leonard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frankle</td>
<td>Ryan</td>
<td>553</td>
<td>Cryogenic Stability</td>
<td>131</td>
</tr>
<tr>
<td></td>
<td>Laddawan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Miko</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Froehlich</td>
<td>John</td>
<td>597</td>
<td>Long-Duration, Low-Gravity Sloshing Experiment</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Benson</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>David</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gallant</td>
<td>Margaret</td>
<td>695</td>
<td>Lunar Exospheres and Instrument Control</td>
<td>197</td>
</tr>
<tr>
<td></td>
<td>Oliversen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ronald</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gallant</td>
<td>Margaret</td>
<td>695</td>
<td>Sodium in the Lunar Exosphere</td>
<td>247</td>
</tr>
<tr>
<td></td>
<td>Oliversen</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ronald</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gandhi</td>
<td>Anshula</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Barry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Richard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gandhi</td>
<td>Anshula</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td>254</td>
</tr>
<tr>
<td>De la Garza</td>
<td>Axel</td>
<td>400</td>
<td>Spacecraft Dynamics Simulation</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Harman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garhart</td>
<td>Emily</td>
<td>693</td>
<td>Temperature Inversions in Hot Jupiters</td>
<td>195</td>
</tr>
<tr>
<td></td>
<td>Mandell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Avi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garvin</td>
<td>Zachary</td>
<td>699</td>
<td>Life on Mars: Extremophilic Bacteria in a Simulated Martian Environment</td>
<td>266</td>
</tr>
<tr>
<td></td>
<td>Floyd</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Melissa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gilbert</td>
<td>Emily</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Barry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Richard</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gimar</td>
<td>Caleb</td>
<td>Grebowsky Joseph</td>
<td>Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>189</td>
</tr>
<tr>
<td>Gonzalez</td>
<td>Cody</td>
<td>Balvin Manuel</td>
<td>Investigations of Venus Ionosphere Holes as Observed by Pioneer Venus Orbiter</td>
<td>67</td>
</tr>
<tr>
<td>Gonzalez</td>
<td>Gabriel</td>
<td>Wright Cinnamon</td>
<td>Development of Zero Stress Tungsten Thin Film Characterization for in Situ Mission to Solar System Primitive Bodies</td>
<td>85</td>
</tr>
<tr>
<td>Gonzalez Quiles</td>
<td>Junellie</td>
<td>Dwek Eli</td>
<td>Integration of Flight Software with 42 to Enable CubeSat Hardware-in-the-Loop Testing</td>
<td>206</td>
</tr>
<tr>
<td>Gorgone</td>
<td>Nicholas</td>
<td>Guiriec Sylvain</td>
<td>Tracing the Galactic Center using Bremsstrahlung, Synchrotron, and Thermal Emissions</td>
<td>233</td>
</tr>
<tr>
<td>Gosnell</td>
<td>Taylor</td>
<td>Jones Justin</td>
<td>Testing a New Model of Gamma-Ray Burst Prompt Emission</td>
<td>149</td>
</tr>
<tr>
<td>Gould</td>
<td>Carolina</td>
<td>Venters Tonia</td>
<td>Development of a System for Extended Depth of Field Imaging</td>
<td>188</td>
</tr>
<tr>
<td>Gower</td>
<td>Zachary</td>
<td>Showalter Matthew</td>
<td>Energetic Particles in Star-forming Galaxies</td>
<td>267</td>
</tr>
<tr>
<td>Grabill</td>
<td>Molly</td>
<td>Peddie Catherine</td>
<td>Synthetic Multiband Photometry in the Early Detection of Type 1a Supernovae for the WFIRST</td>
<td>230</td>
</tr>
<tr>
<td>Green</td>
<td>William</td>
<td>Gong Qian</td>
<td>Test Setup for the WFIRST GRISM Spectrograph</td>
<td>151</td>
</tr>
</tbody>
</table>
# Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grogin</td>
<td>Bond</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$</td>
<td>169</td>
</tr>
<tr>
<td>Haase</td>
<td>Hanyok</td>
<td>408</td>
<td>Energy Management &amp; Satellite Servicing Capabilities</td>
<td>120</td>
</tr>
<tr>
<td>Hakun</td>
<td>Kenyon</td>
<td>543</td>
<td>Analysis of the Effectiveness of 3D Printing with HIPS Support Material</td>
<td>114</td>
</tr>
<tr>
<td>Handleton</td>
<td>Barry</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td>Hansen</td>
<td>Bussey</td>
<td>566</td>
<td>Space Communications and Navigation Network Integration Project Cesium Access Planning Environment</td>
<td>86</td>
</tr>
<tr>
<td>Harrington</td>
<td>Hebrard</td>
<td>693</td>
<td>A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters</td>
<td>246</td>
</tr>
<tr>
<td>Harrison</td>
<td>Turner</td>
<td>580</td>
<td>NEN Live</td>
<td>27</td>
</tr>
<tr>
<td>Harriston</td>
<td>Scofield</td>
<td>500</td>
<td>Quality Management System in the Applied Engineering and Technology Directorate</td>
<td>108</td>
</tr>
<tr>
<td>Hasegawa</td>
<td>Novak</td>
<td>616</td>
<td>Analysis of Colored Dissolved Organic Matter and Particulate Organic Carbon</td>
<td>196</td>
</tr>
<tr>
<td>Hatfield</td>
<td>Gendreau</td>
<td>662</td>
<td>NICER X-Ray Mission Development: Enhancing the Precision of the NICER Clock</td>
<td>24</td>
</tr>
<tr>
<td>Hawthorne</td>
<td>Hasegawa</td>
<td>546</td>
<td>Development of Superhydrophobic Surface Coatings</td>
<td>199</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor 1</th>
<th>Mentor 2</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>He</td>
<td>Arthur</td>
<td>Le Moigne</td>
<td>Jacqueline</td>
<td>IMAGESEER – Lunar Data Pre-Processing</td>
<td>9</td>
</tr>
<tr>
<td>Hearne</td>
<td>Steven</td>
<td>Root</td>
<td>Jonathan</td>
<td>Deep Dive Analysis of PR/PFR Records, Importation of Legacy Watchlist Data into Meta, Beta Testing of Watchlist Application in Meta</td>
<td>136</td>
</tr>
<tr>
<td>Hemphill</td>
<td>Carlton</td>
<td>Balvin</td>
<td>Manuel</td>
<td>Microfabrication of MEMS Devices</td>
<td>70</td>
</tr>
<tr>
<td>Hesman</td>
<td>Brigette</td>
<td>Nixon</td>
<td>Conor</td>
<td>Water Abundance in the Stratospheres of Saturn and Titan based on CIRS</td>
<td>225</td>
</tr>
<tr>
<td>Himwich</td>
<td>Zoe</td>
<td>Clark</td>
<td>Pamela</td>
<td>SPACE Interactive Tool</td>
<td>202</td>
</tr>
<tr>
<td>Hirsh</td>
<td>Daniel</td>
<td>Perrine</td>
<td>Martin</td>
<td>Developing the Multi-channel Frequency Conversion Module (MFCM) for the Wide-swath Shared-aperture Cloud Radar (WISCR)</td>
<td>118</td>
</tr>
<tr>
<td>Howes</td>
<td>Christopher</td>
<td>Clagett</td>
<td>Charles</td>
<td>Thermal Analysis of a Printed Circuit Board</td>
<td>68</td>
</tr>
<tr>
<td>Howl</td>
<td>Bryan</td>
<td>Sayer</td>
<td>Andrew</td>
<td>Deep Blue Website Project</td>
<td>167</td>
</tr>
<tr>
<td>Hsieh</td>
<td>Adam</td>
<td>Yew</td>
<td>Alvin</td>
<td>The Effects of the Biophysical Microenvironment on Human Mesenchymal Stem Cell Behavior during Simulated Microgravity</td>
<td>89</td>
</tr>
<tr>
<td>Huang</td>
<td>Winson</td>
<td>Miller</td>
<td>Kevin</td>
<td>Transmission Performance of WFIRST’s Optical Filters from the Visible to Infrared</td>
<td>152</td>
</tr>
<tr>
<td>Huang</td>
<td>Isaac</td>
<td>Le</td>
<td>Guan</td>
<td>MMS Data Calibration using IDL</td>
<td>203</td>
</tr>
<tr>
<td>Huber</td>
<td>Andrew</td>
<td>Thomas</td>
<td>William</td>
<td>Data Extraction Utility for JPSS</td>
<td>8</td>
</tr>
<tr>
<td>Hughes</td>
<td>Andrea</td>
<td>Klenzing</td>
<td>Jeffrey</td>
<td>Variability of the Terrestrial Ionosphere</td>
<td>170</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>------</td>
<td>-------------------------------------------------------------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Hunt</td>
<td>Qiana</td>
<td>661</td>
<td>Analyzing Emissions from Blazar B2013+370 and Pulsar Wind Nebula VER J2016+371</td>
<td>237</td>
<td></td>
</tr>
<tr>
<td>Hunt-Stone</td>
<td>Keenan</td>
<td>695</td>
<td>DREAM2: Using Apollo Data to Characterize the Lunar Environment</td>
<td>213</td>
<td></td>
</tr>
<tr>
<td>Inzinga</td>
<td>Sarah</td>
<td>474</td>
<td>JPSS Simulation Control Development Project</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td>Itschner</td>
<td>Jonathan</td>
<td>553</td>
<td>Temperature and Flow Rate Sensor Fabrication</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Jaehnig</td>
<td>Kurt</td>
<td>695</td>
<td>Lunar Exospheres and Instrument Control</td>
<td>197</td>
<td></td>
</tr>
<tr>
<td>Jamieson</td>
<td>Jessie</td>
<td>615</td>
<td>Radio Frequency Interference: A Comparison of SMAP and Aquarius Methods and Techniques</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>Jo</td>
<td>Caleb</td>
<td>660</td>
<td>Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII)</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rizzo</td>
<td>660</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maxime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnson</td>
<td>Jerrin</td>
<td>591</td>
<td>NICER Pointing System</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gendreau</td>
<td>662</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnson</td>
<td>Kyle</td>
<td>562</td>
<td>Reflow Soldering and Silver Leaching on ICESat-2 Silver-Palladium Electrical Terminations</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>Johnson</td>
<td>Trokon</td>
<td>581</td>
<td>FPGA Co-Processing to Accelerate Processing of Hyperspectral Images</td>
<td>145</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Young</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jordan</td>
<td>Brendan</td>
<td>547</td>
<td>Manufacturing Robotic Arm Concept</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Juliano</td>
<td>Matthew</td>
<td>444</td>
<td>Spacecraft Dynamic Simulation</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Julius</td>
<td>Ethan</td>
<td>551</td>
<td>Alignment and System Testing for OTS for LCRD</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Blake</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kallio</td>
<td>Oliversen</td>
<td></td>
<td>Sodium in the Lunar Exosphere</td>
<td>247</td>
</tr>
<tr>
<td>Kaplan</td>
<td>Liu</td>
<td>591</td>
<td>NICER Pointing System</td>
<td>60</td>
</tr>
<tr>
<td>Kauffman</td>
<td>Farrokh</td>
<td>542</td>
<td>Finite Element Modeling and Structural Analysis of Composite Structures</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Segal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kenny</td>
<td>Barbee</td>
<td>595</td>
<td>Physics-based NEO Deflection Tool Validating Kinetic Impactor Mission Opportunities</td>
<td>69</td>
</tr>
<tr>
<td>Kessler</td>
<td>Timmons</td>
<td>587</td>
<td>Flight Software for Distributed Spacecraft Mission Communication</td>
<td>17</td>
</tr>
<tr>
<td>Ketter</td>
<td>Hammond</td>
<td>580</td>
<td>Web Services for Property and Software Tracking (PaST)</td>
<td>4</td>
</tr>
<tr>
<td>Khan</td>
<td>Mitchell</td>
<td>504</td>
<td>OPSPARC: OPTIMUS PRIME Spinoff, Promotion, and Research Challenge</td>
<td>46</td>
</tr>
<tr>
<td>Khatib</td>
<td>Frey</td>
<td>698</td>
<td>Early Bombardment History of the Moon</td>
<td>173</td>
</tr>
<tr>
<td>Khatiwada</td>
<td>Root</td>
<td>382</td>
<td>Deep Dive Analysis of PR/PFR Records, Importation of Legacy Watchlist Data into Meta, Beta Testing of Watchlist Application in Meta</td>
<td>136</td>
</tr>
<tr>
<td>Kilen</td>
<td>Barry</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td>254</td>
</tr>
<tr>
<td>Kline</td>
<td>Hasegawa</td>
<td>546</td>
<td>Thermal Coating Processing Improvements with the Use of O2 Plasma</td>
<td>78</td>
</tr>
<tr>
<td>Knapp</td>
<td>Sultana</td>
<td>553</td>
<td>Graphene Based Chemical Sensors for Space Applications</td>
<td>100</td>
</tr>
<tr>
<td>Koekemoer</td>
<td>Bond</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at 0.5 ≤ z ≤ 1.5</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td>Gardner</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Kong</td>
<td>Cathleen</td>
<td>441</td>
<td>Hubble Exhibit Video Editing Project</td>
<td>158</td>
</tr>
<tr>
<td>Konkalmatt</td>
<td>Savyasachi</td>
<td>400</td>
<td>Simulating the Space Technology 5 Mission</td>
<td>137</td>
</tr>
<tr>
<td>Kosko</td>
<td>Steven</td>
<td>597</td>
<td>Long-Duration, Low-Gravity Sloshing Experiment</td>
<td>84</td>
</tr>
<tr>
<td>Krasniqi</td>
<td>Beqir</td>
<td>546</td>
<td>The Effects of Thermal Cycling and Physical Shock on Particle Fallout in Coatings</td>
<td>57</td>
</tr>
<tr>
<td>Krishnan</td>
<td>Jitin</td>
<td>606.3</td>
<td>Designing a Virtual Assistant for Systems Engineers</td>
<td>22</td>
</tr>
<tr>
<td>Krohmaly</td>
<td>Katie</td>
<td>674</td>
<td>Geo-Electric Field Calculator Tool</td>
<td>26</td>
</tr>
<tr>
<td>Ku</td>
<td>Justin</td>
<td>580</td>
<td>IMAGESEER – Lunar Data Pre-Processing</td>
<td>9</td>
</tr>
<tr>
<td>Kurczynski</td>
<td>Peter</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$</td>
<td>169</td>
</tr>
<tr>
<td>Kuruppuaratchi</td>
<td>Dona</td>
<td>695</td>
<td>Sodium in the Lunar Exosphere</td>
<td>247</td>
</tr>
<tr>
<td>Kynoch</td>
<td>Mackenzie</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td>Kynoch</td>
<td>Mackenzie</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td>254</td>
</tr>
<tr>
<td>Lacy</td>
<td>Brianna</td>
<td>667</td>
<td>Characterizing Alien Worlds: Ground-based Transit Spectroscopy of GJ1214b with VLT-KMOS</td>
<td>217</td>
</tr>
<tr>
<td>Lalime</td>
<td>Erin</td>
<td>546</td>
<td>Rapid ATP Bioburden Test</td>
<td>58</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>------</td>
<td>-----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Landgrover</td>
<td>Segal</td>
<td>540</td>
<td>Analysis of the Use of Composite Materials as Structural Radiation Shielding in the Exploration Augmentation Module</td>
<td>124</td>
</tr>
<tr>
<td>Law</td>
<td>Lien</td>
<td>661</td>
<td>Investigating the Short Gamma-Ray Burst Detection Rate of the Swift Burst Alert Telescope via Trigger Simulations</td>
<td>190</td>
</tr>
<tr>
<td>Law</td>
<td>Anderson</td>
<td>428</td>
<td>EOS Zenos Problem Resolution</td>
<td>29</td>
</tr>
<tr>
<td>Lebair</td>
<td>Sultana</td>
<td>553</td>
<td>Graphene Based Chemical Sensors for Space Applications</td>
<td>100</td>
</tr>
<tr>
<td>Lee</td>
<td>Boller</td>
<td>586</td>
<td>Visualizing Satellite Data – Worldview User Interface Improvements</td>
<td>18</td>
</tr>
<tr>
<td>Lehnigk</td>
<td>Garry</td>
<td>698</td>
<td>The Formation of Fluvial Channels on Alba Mons, Mars</td>
<td>214</td>
</tr>
<tr>
<td>Lehr</td>
<td>Samara</td>
<td>673</td>
<td>Auroral Occurrence In and Out of Solar Maximum</td>
<td>220</td>
</tr>
<tr>
<td>Leiter</td>
<td>Clark</td>
<td>695</td>
<td>SPACE Interactive Tool</td>
<td>202</td>
</tr>
<tr>
<td>Leveille</td>
<td>Adams</td>
<td>401</td>
<td>Space Flight Instrument Catalog</td>
<td>40</td>
</tr>
<tr>
<td>Levine</td>
<td>Rinehart</td>
<td>660</td>
<td>Mechanical Support and Testing Structures for Optical Systems on BETTII</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Dhabal</td>
<td>660</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lewis</td>
<td>Swann</td>
<td>400</td>
<td>Career Path for GSFC</td>
<td>157</td>
</tr>
<tr>
<td>Liburd</td>
<td>Corcoran</td>
<td>662</td>
<td>An Analysis of Eta Carinae’s Background X-ray Emission</td>
<td>163</td>
</tr>
<tr>
<td>Lin</td>
<td>Mitchell</td>
<td>504</td>
<td>OPSPARC: OPTIMUS PRIME Spinoff, Promotion, and Research Challenge</td>
<td>46</td>
</tr>
<tr>
<td>Liounis</td>
<td>Getzandanner</td>
<td>595</td>
<td>Simultaneous Localization and Mapping of Small Planetary Bodies</td>
<td>47</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor 1</th>
<th>Mentor 2</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lo</td>
<td>Edward</td>
<td>Bounoua</td>
<td>Lahouari</td>
<td>Effect of Urbanization on Surface Temperatures in 24 U.S. Cities</td>
<td>194</td>
</tr>
<tr>
<td>Long</td>
<td>Jeff</td>
<td>David</td>
<td>John</td>
<td>Comparisons of Multi-Scale Remote Sensed Data</td>
<td>208</td>
</tr>
<tr>
<td>Loughlin</td>
<td>Hudson</td>
<td>Livas</td>
<td>Jeffrey</td>
<td>The Use of Shack-Hartman Sensors to Characterize Photoreceivers for the eLISA Mission</td>
<td>201</td>
</tr>
<tr>
<td>Luna</td>
<td>Carlos</td>
<td>Yew</td>
<td>Alvin</td>
<td>The Effects of the Biophysical Microenvironment on Human Mesenchymal Stem Cell Behavior during Simulated Microgravity</td>
<td>89</td>
</tr>
<tr>
<td>Lunde</td>
<td>Emily</td>
<td>Shiri</td>
<td>Ron</td>
<td>Underwater Wireless Optical Communications</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Coronado</td>
<td>Patrick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Luo</td>
<td>Winne</td>
<td>Kirschbaum</td>
<td>Dalia</td>
<td>Determining Landslide-related Relationships Using the Global Landslide Catalog</td>
<td>261</td>
</tr>
<tr>
<td>Luu</td>
<td>Trang</td>
<td>Rodriguez-Ruiz</td>
<td>Juan</td>
<td>CubeSat Design Approach at Goddard Space Flight Center</td>
<td>148</td>
</tr>
<tr>
<td>Ly</td>
<td>Cathy</td>
<td>Ramsey</td>
<td>Mary Ellen</td>
<td>Going Native: The Reform of Landscaping at Goddard</td>
<td>155</td>
</tr>
<tr>
<td>Lynton</td>
<td>Ciara</td>
<td>Hay</td>
<td>Brennan</td>
<td>Common Mission Security Services</td>
<td>11</td>
</tr>
<tr>
<td>Madray</td>
<td>Ian</td>
<td>Safavi</td>
<td>Haleh</td>
<td>Tracking and Data Relay Satellite Systems Waveform and Noise Generator Design</td>
<td>87</td>
</tr>
<tr>
<td>Maher</td>
<td>Ryan</td>
<td>Rinehart</td>
<td>Stephen</td>
<td>BETTII – Internship</td>
<td>245</td>
</tr>
<tr>
<td>Mahon</td>
<td>Andrew</td>
<td>Kogut</td>
<td>Al</td>
<td>Polarization Modulator Drive System Design and Testing</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mirel</td>
<td>Paul</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malone</td>
<td>Sean</td>
<td>Maddox</td>
<td>Marlo</td>
<td>New Validation Suite for the CCMC</td>
<td>36</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>--------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Mandl</td>
<td>Handy Matt</td>
<td>619</td>
<td>Flood Dashboard Capabilities Enhancement</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Mangold</td>
<td>Wales Carl</td>
<td>581</td>
<td>Satellite Ground Systems Basic Concepts</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Maring</td>
<td>Shiri Ron</td>
<td>551</td>
<td>Intensity Measurement of Petal-Shaped Grayscale Lithography Mask for Gravity Wave Mission</td>
<td>112</td>
<td></td>
</tr>
<tr>
<td>McArthur</td>
<td>Grofic Barbara</td>
<td>600</td>
<td>Content and Log Analysis Using MySQL and Graylog</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>McCarrell</td>
<td>Biskach Michael</td>
<td>662</td>
<td>Silicon Mirror Grinding Equipment</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>McCloat</td>
<td>MacDonald Elizabeth</td>
<td>673</td>
<td>Engaging the Aurorasaurus Citizen Science Project: Multi-tasking Across Multiple Disciplines</td>
<td>253</td>
<td></td>
</tr>
<tr>
<td>McCrary</td>
<td>Case Nathan Barry Richard</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>McCurdy</td>
<td>Hill-Kittle Joanne Jahoda Keith</td>
<td>662</td>
<td>Lifetime Measurements of Narrow Gap X-ray Polarimeter</td>
<td>241</td>
<td></td>
</tr>
<tr>
<td>McGann</td>
<td>Boller Ryan Stewart Jeff</td>
<td>586</td>
<td>Visualizing Satellite Data – Worldview User Interface Improvements</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>McWithey</td>
<td>Rosanova Giulio</td>
<td>543</td>
<td>3D Printed Model of the WFIRST Observatory using Additive Manufacturing Techniques</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Mierkiewicz</td>
<td>Oliversen Ronald</td>
<td>695</td>
<td>Lunar Exospheres and Instrument Control</td>
<td>197</td>
<td></td>
</tr>
<tr>
<td>Mierkiewicz</td>
<td>Oliversen Ron</td>
<td>695</td>
<td>Sodium in the Lunar Exosphere</td>
<td>247</td>
<td></td>
</tr>
<tr>
<td>Miller</td>
<td>Neigh Christopher</td>
<td>618</td>
<td>Supercomputing Sub-Meter</td>
<td>166</td>
<td></td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Mittu</td>
<td>Anjali</td>
<td>544</td>
<td>Satellite Stereo Data for the Forest-Tundra Ecotone</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Monson</td>
<td>Brandt</td>
<td>674</td>
<td>Calibration of Adaptive Langmuir Probe</td>
<td>183</td>
<td></td>
</tr>
<tr>
<td>Moore</td>
<td>Keegan</td>
<td>582</td>
<td>PiSat 2.0, Flight Software Systems Testbed</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Morris</td>
<td>David</td>
<td>662</td>
<td>An Analysis of Eta Carinae’s Background X-ray Emission</td>
<td>163</td>
<td></td>
</tr>
<tr>
<td>Mosley</td>
<td>Graham</td>
<td>606.2</td>
<td>Implementing Automated Security Monitoring Using OpenSCAP</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jasen</td>
<td>606.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mulder</td>
<td>Tysen</td>
<td>591</td>
<td>NICER Pointing System</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Munoz</td>
<td>Rai</td>
<td>595</td>
<td>Development of a PC-based MPU Simulator for NICER</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gendreau</td>
<td>662</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mysore</td>
<td>Ajay</td>
<td>660</td>
<td>Extended Gamma Ray Emission from SNR G150.3+4.5</td>
<td>172</td>
<td></td>
</tr>
<tr>
<td>Nagler</td>
<td>Peter</td>
<td>552</td>
<td>Ideal Integrating Bolometer for Far-infrared Spectroscopy</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Natarajan</td>
<td>Aparna</td>
<td>695</td>
<td>SPACE Interactive Tool</td>
<td>202</td>
<td></td>
</tr>
<tr>
<td>Navarro Leija</td>
<td>Omar</td>
<td>580</td>
<td>Shearlet Features for Remotely Sensed Image Registration</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Nettey</td>
<td>Miranda</td>
<td>428</td>
<td>Simulation Using a Zedboard</td>
<td>117</td>
<td></td>
</tr>
<tr>
<td>Newheart</td>
<td>Anastasia</td>
<td>695</td>
<td>Apollo ALSEP/SIDE Ion Observations during Periods of Intense Ion Cyclotron Wave Activity Observed by the Apollo LSM</td>
<td>174</td>
<td></td>
</tr>
<tr>
<td>Ng</td>
<td>Wanyi</td>
<td>597</td>
<td>Comet Sample and Return Projectile Launcher Calibration and Design</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ramspacher</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>--------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Ngo</td>
<td>Kelly Dalhoff</td>
<td>360</td>
<td>Levels of Lead Fume Exposure in Soldering Labs</td>
<td>219</td>
<td></td>
</tr>
<tr>
<td>Nguyen</td>
<td>Minh Trang Baldwin Philip</td>
<td>566</td>
<td>BPSK Receiver Design for the MTRS to Improve Reliability of Data Transmission</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Nguyen</td>
<td>Sophia Coleman Frank Amatucci Edward</td>
<td>500</td>
<td>Systems Engineering</td>
<td>139</td>
<td></td>
</tr>
<tr>
<td>Noteboom</td>
<td>Anna Leete Stephen</td>
<td>420</td>
<td>Launch Vehicle Database</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Novetsky</td>
<td>Tamar Zheng Yihua</td>
<td>674</td>
<td>Space Weather Forecasting and Research</td>
<td>168</td>
<td></td>
</tr>
<tr>
<td>O'Connor</td>
<td>Rachel Pesnell W. Dean</td>
<td>671</td>
<td>A Solar Hiccup: Analysis of an “Almost” Coronal Hole</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td>Odessey</td>
<td>Rachel Gull Theodore</td>
<td>660</td>
<td>Mapping the Latitude Dependence of the Primary Stellar Wind of eta Carinae Using the Spectrum Reflected on the Homunculus Nebula</td>
<td>164</td>
<td></td>
</tr>
<tr>
<td>Paleg</td>
<td>Rachel Kirschbaum Dalia</td>
<td>617</td>
<td>Improving STEM Education in the Classroom: NASA Goddard’s Summer Watershed Institute</td>
<td>242</td>
<td></td>
</tr>
<tr>
<td>Parsons</td>
<td>Caroline Fedorchak Amy</td>
<td>200</td>
<td>The Backfill Project</td>
<td>159</td>
<td></td>
</tr>
<tr>
<td>Parvini</td>
<td>Cameron Thorpe James</td>
<td>663</td>
<td>Micrometeorite Data Analysis for LISA Pathfinder</td>
<td>185</td>
<td></td>
</tr>
<tr>
<td>Pasco</td>
<td>Samuel Heckler Gregory</td>
<td>566</td>
<td>Next Generation Tracking and Data Relay Satellite Concept Study</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Peck</td>
<td>Dakota Truxon William</td>
<td>700</td>
<td>Enterprise Monitoring Solutions</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Percival</td>
<td>Jeffrey Oliversen Ronald</td>
<td>695</td>
<td>Lunar Exospheres and Instrument Control</td>
<td>197</td>
<td></td>
</tr>
<tr>
<td>Peterson</td>
<td>Kyle Hoy Elizabeth</td>
<td>618</td>
<td>Developing an Effective Geospatial Data System in Support of the ABoVE Project</td>
<td>216</td>
<td></td>
</tr>
<tr>
<td>Pfeifle</td>
<td>Ryan Barry Richard</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST)</td>
<td>107</td>
<td></td>
</tr>
</tbody>
</table>
# Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phillips III</td>
<td>Lafayette</td>
<td>Turner Ryan</td>
<td>NEN Live with Fine Pointing Capabilities</td>
<td>27</td>
</tr>
<tr>
<td>Phillipson</td>
<td>Rebecca</td>
<td>Boyd Patricia</td>
<td>Investigating the Long-term Variability of 4U1705-44; Evidence for an Underlying Nonlinear Double-Welled Oscillator</td>
<td>180</td>
</tr>
<tr>
<td>Pinheiro</td>
<td>Marielle</td>
<td>Zhou Yaping</td>
<td>Tropical Cyclone Evolution and Water and Energy Fluxes: A Hurricane Katrina Case Study</td>
<td>228</td>
</tr>
<tr>
<td>Pinover</td>
<td>Kaley</td>
<td>Bussey George</td>
<td>Portal-Based Interplanetary Communications Modeling</td>
<td>96</td>
</tr>
<tr>
<td>Pletan</td>
<td>Kyle</td>
<td>Showalter Matthew</td>
<td>Manufacturing Robotic Arm Concept</td>
<td>62</td>
</tr>
<tr>
<td>Pontius</td>
<td>Rebecca</td>
<td>Hasegawa Mark</td>
<td>Thermal Coatings Qualification and Development</td>
<td>243</td>
</tr>
<tr>
<td>Potter</td>
<td>Alyssa</td>
<td>Harman Richard</td>
<td>Spacecraft Dynamic Simulation</td>
<td>53</td>
</tr>
<tr>
<td>Punnoose</td>
<td>Tarun</td>
<td>Showalter Matthew</td>
<td>Manufacturing Robotic Arm Concept</td>
<td>62</td>
</tr>
<tr>
<td>Punnoose</td>
<td>Rohan</td>
<td>Showalter Matthew</td>
<td>Manufacturing Robotic Arm Concept</td>
<td>62</td>
</tr>
<tr>
<td>Ramjatan</td>
<td>Sahadeo</td>
<td>Yew Alvin</td>
<td>Next Generation Attitude Control Technology</td>
<td>141</td>
</tr>
<tr>
<td>Ravindranath</td>
<td>Swara</td>
<td>Bond Nicholas</td>
<td>Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gardner Jonathan</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rafelski Marc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redsteer</td>
<td>Lisa</td>
<td>Bounoua Lahouari</td>
<td>Exploring the Negative Feedback of Vegetation to Greenhouse Gas Warming</td>
<td>222</td>
</tr>
<tr>
<td>Reed</td>
<td>Trevor</td>
<td>Coronado Patrick</td>
<td>Designing a Virtual Assistant for Systems Engineers</td>
<td>22</td>
</tr>
<tr>
<td>Reed</td>
<td>Kyle</td>
<td>Roberts Brian</td>
<td>Gamma 300 Case Design and Air Track Rail Construction</td>
<td>116</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
<td>------</td>
<td>--------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Replicon</td>
<td>Violet</td>
<td>662</td>
<td>States of Black Hole and Neutron Star Binaries with MAXI</td>
<td>260</td>
</tr>
<tr>
<td>Rice</td>
<td>Malena</td>
<td>690</td>
<td>Water Abundance in the Stratospheres of Saturn and Titan based on CIRS</td>
<td>225</td>
</tr>
<tr>
<td>Richardson</td>
<td>Avian</td>
<td>423</td>
<td>NASA’s Suomi National Polar-orbiting Partnership (SNPP) Science Data Processing Support</td>
<td>55</td>
</tr>
<tr>
<td>Rivera</td>
<td>Olga</td>
<td>555</td>
<td>Package Design of a Waveguide to Microstrip Transition at W-band Frequency</td>
<td>125</td>
</tr>
<tr>
<td>Riveros</td>
<td>Raul</td>
<td>662</td>
<td>Silicon Mirror Grinding Equipment</td>
<td>91</td>
</tr>
<tr>
<td>Robinett</td>
<td>Ethan</td>
<td>674</td>
<td>Space Weather Forecasting and Research</td>
<td>168</td>
</tr>
<tr>
<td>Rongione</td>
<td>Nicolas</td>
<td>599</td>
<td>International Space Station Instrument Pointing Platform Control System Design</td>
<td>122</td>
</tr>
<tr>
<td>Rosborough</td>
<td>Sara</td>
<td>695</td>
<td>Sodium in the Lunar Exosphere</td>
<td>247</td>
</tr>
<tr>
<td>Rose</td>
<td>Julie</td>
<td>663</td>
<td>Alignment of a Prototype Telescope for Scattered Light Measurements and Analysis</td>
<td>210</td>
</tr>
<tr>
<td>Rosenthal</td>
<td>Jacob</td>
<td>695</td>
<td>SPACE Interactive Tool</td>
<td>202</td>
</tr>
<tr>
<td>Roth</td>
<td>Joseph</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td>Rubin</td>
<td>Naomi</td>
<td>665</td>
<td>Ground Software for Balloon Infrared Interferometer</td>
<td>34</td>
</tr>
<tr>
<td>Ruffa</td>
<td>Jonathan</td>
<td>543</td>
<td>3D Printed Model of the WFIRST Observatory using</td>
<td>71</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor 1</th>
<th>Mentor 2</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saripalli</td>
<td>Pratik</td>
<td>Cardiff</td>
<td>543</td>
<td>Additive Manufacturing Techniques</td>
<td></td>
</tr>
<tr>
<td>Saulsbury</td>
<td>James</td>
<td>Campbell</td>
<td>597</td>
<td>NEXT Thruster Performance Curve Analysis</td>
<td>127</td>
</tr>
<tr>
<td>Scarlata</td>
<td>Claudia</td>
<td>Bond</td>
<td>665</td>
<td>Integrating FLUXNET and EO-1 Hyperion Reflectance Data for Use in Remote Sensing of Vegetation Carbon Flux Dynamics</td>
<td>207</td>
</tr>
<tr>
<td>Schwartz</td>
<td>Virginia</td>
<td>Poole</td>
<td>760</td>
<td>RSA Token Reconciliation Project</td>
<td>5</td>
</tr>
<tr>
<td>Scolaro</td>
<td>Joseph</td>
<td>Roberts</td>
<td>408</td>
<td>Gamma 300 Case Design and Air Track Rail Construction</td>
<td>116</td>
</tr>
<tr>
<td>Scroggs</td>
<td>Sarah</td>
<td>Hasegawa</td>
<td>546</td>
<td>Evaluating the Effect of Oxygen Plasma on Thermal Coatings</td>
<td>134</td>
</tr>
<tr>
<td>Serano</td>
<td>Benjamin</td>
<td>Leete</td>
<td>420</td>
<td>External Payload Proposer's Guide to the International Space Station</td>
<td>59</td>
</tr>
<tr>
<td>Shabshab</td>
<td>Spencer</td>
<td>Barry</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td>Sharp</td>
<td>Alexander</td>
<td>Mitchel</td>
<td>504</td>
<td>OPSPARC: OPTIMUS PRIME Spinoff, Promotion, and Research Challenge</td>
<td>46</td>
</tr>
<tr>
<td>Sharpe</td>
<td>Shanah</td>
<td>de Matthaeis</td>
<td>615</td>
<td>Investigation of the Use of the Aquarius Scatterometer Data in Polar Regions</td>
<td>250</td>
</tr>
<tr>
<td>Shetty</td>
<td>Aditi</td>
<td>Frey</td>
<td>698</td>
<td>Early Bombardment History of the Moon</td>
<td>173</td>
</tr>
<tr>
<td>Shin</td>
<td>Kaitlyn</td>
<td>Ly</td>
<td>660</td>
<td>The Environmental Effects on</td>
<td>215</td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Simonson</td>
<td>Tyler</td>
<td>591</td>
<td>Comparison of Dynamics Models for Spacecraft Attitude Filters via Monte Carlo Analysis</td>
<td>143</td>
<td></td>
</tr>
<tr>
<td>Del Sesto</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>Jeffrey</td>
<td>417</td>
<td>Optimization and Testing of Coastline ID for GOES-R GLM</td>
<td>251</td>
<td></td>
</tr>
<tr>
<td>Smith</td>
<td>Casey</td>
<td>444</td>
<td>Spacecraft Dynamic Simulation</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Smith</td>
<td>Asher</td>
<td>591</td>
<td>Actuator Sizing for Reconfigurable Operational Spacecraft for Science and Exploration (ROSE)</td>
<td>138</td>
<td></td>
</tr>
<tr>
<td>Sobel</td>
<td>Emily</td>
<td>670</td>
<td>Refining the Wheel: Analysis of Solar Cycle Prediction Precursor Technique</td>
<td>232</td>
<td></td>
</tr>
<tr>
<td>Soto</td>
<td>Emmaris</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at 0.5 ( \leq z \leq 1.5 )</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southall</td>
<td>Robert</td>
<td>547</td>
<td>Implementing Responsive Web Design</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Sprecher</td>
<td>William</td>
<td>615</td>
<td>Satellite Observations of the Antarctic Ice Shelves</td>
<td>263</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stanforth</td>
<td>Austin</td>
<td>618</td>
<td>Comparison of Landscape Pattern across Multiple Scales, Sensors, and Features</td>
<td>177</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stevenson</td>
<td>Thomas</td>
<td>552</td>
<td>Ideal Integrating Bolometer for Far-infrared Spectroscopy</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stoker-Spirit</td>
<td>Eric</td>
<td>596</td>
<td>Creating a Cubesat Design Tool and Developing Cubesat Thermal Louvers</td>
<td>142</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strandjord</td>
<td>Kirsten</td>
<td>595</td>
<td>Optical Navigation Methods for OSIRIS-REx Mission</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strittmatter</td>
<td>Michael</td>
<td>200</td>
<td>The Backfill Project</td>
<td>159</td>
<td></td>
</tr>
<tr>
<td>Intern</td>
<td>Mentor</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>----------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>Tagg</td>
<td>Connor</td>
<td>408</td>
<td>Gamma 300 Case Design and Air Track Rail Construction</td>
<td>116</td>
<td></td>
</tr>
<tr>
<td>Tardrew</td>
<td>Colin</td>
<td>619</td>
<td>Installation and Removal Techniques of Surface Mount Electronic Components Using Infrared Heating Equipment</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Teplitz</td>
<td>Harry</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$</td>
<td>169</td>
<td></td>
</tr>
<tr>
<td>Terry</td>
<td>Sean</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Terry</td>
<td>Sean</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td>254</td>
<td></td>
</tr>
<tr>
<td>Tiwari</td>
<td>Rahul</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Tiwari</td>
<td>Rahul</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td>254</td>
<td></td>
</tr>
<tr>
<td>Torke</td>
<td>Maxfield</td>
<td>665</td>
<td>Simulating Infrared Transmission through Porous Dielectric Foam</td>
<td>165</td>
<td></td>
</tr>
<tr>
<td>Tran</td>
<td>Andrew</td>
<td>474</td>
<td>JPSS Simulation Control Development Project</td>
<td>147</td>
<td></td>
</tr>
<tr>
<td>Trumper</td>
<td>Isaac</td>
<td>551</td>
<td>Freeform Optical Design of 2 and 3 Mirror Telescopes</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Tuitt</td>
<td>Omani</td>
<td>660</td>
<td>Developing a Test Stand for Lifetime Measurements Using a Narrow Gap Detector</td>
<td>235</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hill-Kittle</td>
<td>660</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jahoda</td>
<td>660</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morris</td>
<td>David</td>
<td>660</td>
<td>Characterization of the Performance/Lifetime of Next Generation X-Ray Polarimeter Prototype</td>
<td>238</td>
</tr>
<tr>
<td>Tuit</td>
<td>Omani</td>
<td>662</td>
<td>Metal Whiskers</td>
<td>76</td>
</tr>
<tr>
<td>Turner</td>
<td>Duncan</td>
<td>562</td>
<td>Science Writing for Earthzine</td>
<td>171</td>
</tr>
<tr>
<td>Tway</td>
<td>Tatiana</td>
<td>691</td>
<td>The Infrared Spectra and Stability of Icy Extraterrestrial Molecules</td>
<td>256</td>
</tr>
<tr>
<td>Unruh</td>
<td>Davis</td>
<td>553</td>
<td>Development of Image Analysis Routines for WFIRST Detector Characterization</td>
<td>77</td>
</tr>
<tr>
<td>Urioste</td>
<td>Jazmin</td>
<td>586</td>
<td>Visual Inspection and Use of Satellite NO2 Observations</td>
<td>95</td>
</tr>
<tr>
<td>Vaughan</td>
<td>Alton</td>
<td>566</td>
<td>Optimizing GEO-LEO CubeSat Constellation for Global Earth Surface Sensing - Potential Demonstration of Space Mobile Network (SMN) Communication Architecture</td>
<td>48</td>
</tr>
<tr>
<td>Vaughnn</td>
<td>Noah</td>
<td>553</td>
<td>Development for WFIRST and CLASS</td>
<td>258</td>
</tr>
<tr>
<td>Veltri</td>
<td>Joshua</td>
<td>423</td>
<td>Web-Based Monitor for the Simple, Scalable, Script-Based Science Processing System</td>
<td>23</td>
</tr>
<tr>
<td>Venot</td>
<td>Olivia</td>
<td>693</td>
<td>A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters</td>
<td>246</td>
</tr>
<tr>
<td>Vo</td>
<td>Huong</td>
<td>695</td>
<td>SPACE Interactive Tool</td>
<td>202</td>
</tr>
<tr>
<td>Voorhies</td>
<td>Sarah</td>
<td>618</td>
<td>Integrating FLUXNET and EO-1 Hyperion Reflectance Data for</td>
<td>207</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waldron</td>
<td>Zachary Zheng Yihua</td>
<td>674</td>
<td>Use in Remote Sensing of Vegetation Carbon Flux Dynamics</td>
<td></td>
</tr>
<tr>
<td>Waldron</td>
<td>Zachary Zheng Yihua</td>
<td>674</td>
<td>Space Weather Forecasting and Research</td>
<td></td>
</tr>
<tr>
<td>Walker</td>
<td>Michael LeMoigne Jacqueline</td>
<td>580</td>
<td>Space Weather Forecasting: An Analysis of Active Region 2371</td>
<td></td>
</tr>
<tr>
<td>Walker</td>
<td>Lakirah Miko Laddawan Kelly Dan</td>
<td>553</td>
<td>IMAGESEER – Lunar Data Pre-Processing</td>
<td></td>
</tr>
<tr>
<td>Walton</td>
<td>Lindsay Streege Susanne</td>
<td>582</td>
<td>Characterization of MOSFET Devices at Cryogenic Temperatures</td>
<td></td>
</tr>
<tr>
<td>Wang</td>
<td>Cherrie Duffy Daniel</td>
<td>606</td>
<td>Development of Heater Control Application for the Core Flight System</td>
<td></td>
</tr>
<tr>
<td>Wang</td>
<td>David Kobler Benjamin</td>
<td>580</td>
<td>Analyzing Hyperspectral Data with Neural Networks</td>
<td></td>
</tr>
<tr>
<td>Wang</td>
<td>James Yew Alvin</td>
<td>500</td>
<td>The Effects of the Biophysical Microenvironment on Human Mesenchymal Stem Cell Behavior during Simulated Microgravity</td>
<td></td>
</tr>
<tr>
<td>Waychoff</td>
<td>Kathryn Barry Richard</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td></td>
</tr>
<tr>
<td>Waychoff</td>
<td>Kathryn Barry Richard</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td></td>
</tr>
<tr>
<td>Whitmore</td>
<td>Phoebe Kobler Benjamin</td>
<td>580</td>
<td>Analyzing Hyperspectral Data with Neural Networks</td>
<td></td>
</tr>
<tr>
<td>Wilkins</td>
<td>Jocelyn Colvin Matthew</td>
<td>596</td>
<td>Search and Rescue On-A-Chip (SARC) Thermal and Structural Analyses and Waterproofing</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willmot</td>
<td>Ryan</td>
<td>595</td>
<td>Modern Applications of Initial Orbit Determination</td>
<td>133</td>
</tr>
<tr>
<td>Wilson</td>
<td>Andrew</td>
<td>587</td>
<td>Embedded Systems Fault Injection and Recovery</td>
<td>104</td>
</tr>
<tr>
<td>Wold</td>
<td>Alexandra</td>
<td>674</td>
<td>Space Weather Forecasting and Research</td>
<td>168</td>
</tr>
<tr>
<td>Wold</td>
<td>Alexandra</td>
<td>674</td>
<td>Space Weather Forecasting: An Analysis of Active Region</td>
<td>178</td>
</tr>
<tr>
<td>Wolfe</td>
<td>Michael</td>
<td>591</td>
<td>NICER Pointing System</td>
<td>60</td>
</tr>
<tr>
<td>Wunderlick</td>
<td>Laura</td>
<td>200</td>
<td>The Backfill Project</td>
<td>159</td>
</tr>
<tr>
<td>Yancey</td>
<td>Colin</td>
<td>547</td>
<td>Manufacturing Robotic Arm Concept</td>
<td>62</td>
</tr>
<tr>
<td>Yang</td>
<td>Yuechen</td>
<td>561</td>
<td>Radiation Effects Testing and Analysis for MAX9180 LVDS Repeater</td>
<td>113</td>
</tr>
<tr>
<td>Yang</td>
<td>Renee</td>
<td>694</td>
<td>Laser Heterodyne Radiometer-CubeSat</td>
<td>239</td>
</tr>
<tr>
<td>Yep</td>
<td>Alexandra</td>
<td>661</td>
<td>Comprehensive Study of GRB Host Star Formation Rates</td>
<td>179</td>
</tr>
<tr>
<td>Yu</td>
<td>Caroline</td>
<td>553</td>
<td>MEMS Sensor Fabrication and Testing</td>
<td>265</td>
</tr>
<tr>
<td>Yum</td>
<td>Justin</td>
<td>581</td>
<td>Developing an Application for CFS-CFE and Rhapsody UML2.0</td>
<td>25</td>
</tr>
<tr>
<td>Zhang</td>
<td>Tony</td>
<td>540</td>
<td>Modifying the Automated Safe-To-Mate (ASTM) Tester</td>
<td>146</td>
</tr>
<tr>
<td>Zhou</td>
<td>Timothy</td>
<td>694</td>
<td>Characterization of MLA, GLAS, Rubidium and Cesium Clocks</td>
<td>257</td>
</tr>
<tr>
<td>Zink</td>
<td>Jenna</td>
<td>674</td>
<td>Space Weather Forecasting: Impacts at Mars</td>
<td>211</td>
</tr>
<tr>
<td>Zipfel</td>
<td>Connor</td>
<td>660</td>
<td>Design of Edge-Trimming Machine for Light-Weighted Monocrystalline Silicon Optical Structures</td>
<td>73</td>
</tr>
</tbody>
</table>
## Appendix A: Interns

<table>
<thead>
<tr>
<th>Intern</th>
<th>Mentor</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zober</td>
<td>Wolfgang</td>
<td>554</td>
<td>Design of a Tunable ND:YVO4 Self-Raman Laser for Sodium Lidar</td>
<td>153</td>
</tr>
<tr>
<td></td>
<td>Knainak</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Michael</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yu</td>
<td>Anthony</td>
<td>550</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adams</td>
<td>Michael</td>
<td>401</td>
<td>Space Flight Instrument Catalog</td>
<td>40</td>
</tr>
<tr>
<td>Amatucci</td>
<td>Edward</td>
<td>592</td>
<td>Systems Engineering</td>
<td>139</td>
</tr>
<tr>
<td>Anderson</td>
<td>Donald</td>
<td>428</td>
<td>EOS Zenoss Problem Resolution</td>
<td>29</td>
</tr>
<tr>
<td>Angerhausen</td>
<td>Daniel</td>
<td>667</td>
<td>Characterizing Alien Worlds: Ground-based Transit Spectroscopy of GJ1214b with VLT-KMOS</td>
<td>217</td>
</tr>
<tr>
<td>Arendt</td>
<td>Rick</td>
<td>665</td>
<td>Tracing the Galactic Center using Bremsstrahlung, Synchrotron, and Thermal Emissions</td>
<td>206</td>
</tr>
<tr>
<td>Arevalo</td>
<td>Ricardo</td>
<td>699</td>
<td>Channel Electron Multiplier Performance Testing</td>
<td>184</td>
</tr>
<tr>
<td>Baldwin</td>
<td>Philip</td>
<td>566</td>
<td>BPSK Receiver Design for the MTRS to Improve Reliability of Data Transmission</td>
<td>41</td>
</tr>
<tr>
<td>Balvin</td>
<td>Manuel</td>
<td>553</td>
<td>Development of Zero Stress Tungsten Thin Film Characterization for in Situ Mission to Solar System Primitive Bodies</td>
<td>67</td>
</tr>
<tr>
<td>Balvin</td>
<td>Manuel</td>
<td>500</td>
<td>Microfabrication of MEMS Devices</td>
<td>70</td>
</tr>
<tr>
<td>Barbee</td>
<td>Brent</td>
<td>595</td>
<td>Physics-based NEO Deflection Tool Validating Kinetic Impactor Mission Opportunities</td>
<td>69</td>
</tr>
<tr>
<td>Barry</td>
<td>Richard</td>
<td>667</td>
<td>Integrating an Economic and Open Source Precision High-Altitude Star Tracker (PHAST) with Fine Pointing Capabilities</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kynoch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mackenzie</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gandhi</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cho</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gilbert</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Handleton</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>McCrory</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pfeifle</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Roth</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shabshab</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Terry</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tiwari</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waychoff</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barry</td>
<td>Richard</td>
<td>667</td>
<td>Detection Levels of the Exoplanet HAT-P-11b Secondary Transit</td>
<td>254</td>
</tr>
<tr>
<td></td>
<td>Anderson</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gandhi</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kilen</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kynoch</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tiwari</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waychoff</td>
<td>667</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baskin</td>
<td>Evelyn</td>
<td>220</td>
<td>Building Energy Efficiency</td>
<td>97</td>
</tr>
<tr>
<td>Baskin</td>
<td>Evelyn</td>
<td>200</td>
<td>Building Energy Efficiency</td>
<td>135</td>
</tr>
<tr>
<td>Benson</td>
<td>David</td>
<td>597</td>
<td>Long-Duration, Low-Gravity Sloshing Experiment</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Froehlich</td>
<td>597</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biskach</td>
<td>Michael</td>
<td>662</td>
<td>Silicon Mirror Grinding Equipment</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Riveros</td>
<td>662</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biskach</td>
<td>Michael</td>
<td>660</td>
<td>Next Generation X-Ray Optics: Mirror to Module Bonding</td>
<td>105</td>
</tr>
<tr>
<td>Blake</td>
<td>Peter</td>
<td>551</td>
<td>Alignment and System Testing for OTS for LCRD</td>
<td>80</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boller</td>
<td>Ryan</td>
<td>Lee</td>
<td>Edmond</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Visualizing Satellite Data – Worldview User Interface Improvements</td>
<td></td>
</tr>
<tr>
<td>McGann</td>
<td>Mike</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bond</td>
<td>Nicholas</td>
<td>Codoreanu</td>
<td>Alex</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$</td>
<td></td>
</tr>
<tr>
<td>De Mello</td>
<td>Duilia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grogin</td>
<td>Norman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koekemoer</td>
<td>Anton</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kurczynski</td>
<td>Peter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ravindranath</td>
<td>Swara</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scarlata</td>
<td>Claudia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soto</td>
<td>Emmaris</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teplitz</td>
<td>Harry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bounoua</td>
<td>Lahouari</td>
<td>Lo</td>
<td>Edward</td>
<td>194</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Effect of Urbanization on Surface Temperatures in 24 U.S. Cities</td>
<td></td>
</tr>
<tr>
<td>Bounoua</td>
<td>Lahouari</td>
<td>Redsteer</td>
<td>Lisa</td>
<td>222</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Exploring the Negative Feedback of Vegetation to Greenhouse Gas Warming</td>
<td></td>
</tr>
<tr>
<td>Boyd</td>
<td>Patricia</td>
<td>Phillipson</td>
<td>Rebecca</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Investigating the Long-term Variability of 4U1705-44; Evidence for an Underlying Nonlinear Double-Welled Oscillator</td>
<td></td>
</tr>
<tr>
<td>Brinkerhoff</td>
<td>William</td>
<td>Farcy</td>
<td>Benjamin</td>
<td>182</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Simulation of Hyper-Velocity Impacts: Implications for Impact-Induced Organic Molecule Synthesis on the Early Earth</td>
<td></td>
</tr>
<tr>
<td>Bromund</td>
<td>Kenneth</td>
<td>Huang</td>
<td>Isaac</td>
<td>203</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MMS Data Calibration using IDL</td>
<td></td>
</tr>
<tr>
<td>Brucker</td>
<td>Ludovic</td>
<td>Diaz</td>
<td>Camilo</td>
<td>186</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Measuring Snow Depth on top of Arctic Sea Ice</td>
<td></td>
</tr>
<tr>
<td>Brucker</td>
<td>Ludovic</td>
<td>Sprecher</td>
<td>William</td>
<td>263</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Satellite Observations of the Antarctic Ice Shelves</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burns</td>
<td>Laura</td>
<td>Inzinga Sarah</td>
<td>JPSS Simulation Control Development Project</td>
<td>147</td>
</tr>
<tr>
<td></td>
<td>Tran</td>
<td>Andrew</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burns</td>
<td>Devin</td>
<td>Gosnell Taylor</td>
<td>Development of a System for Extended Depth of Field Imaging</td>
<td>149</td>
</tr>
<tr>
<td>Bussey</td>
<td>George</td>
<td>Hansen Matthew</td>
<td>Space Communications and Navigation Network Integration Project Cesium Access Planning Environment</td>
<td>86</td>
</tr>
<tr>
<td>Bussey</td>
<td>George</td>
<td>Pinover Kaley</td>
<td>Portal-Based Interplanetary Communications Modeling</td>
<td>96</td>
</tr>
<tr>
<td>Buzulukova</td>
<td>Natalia</td>
<td>Craven Jeffery</td>
<td>Neutral Atom Flux Simulation of the Earth’s Ring Current</td>
<td>205</td>
</tr>
<tr>
<td>Campbell</td>
<td>Petya</td>
<td>Saulsbury James</td>
<td>Integrating FLUXNET and EO-1 Hyperion Reflectance Data for Use in Remote Sensing of Vegetation Carbon Flux Dynamics</td>
<td>207</td>
</tr>
<tr>
<td></td>
<td>Voorhies Sarah</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campola</td>
<td>Michael</td>
<td>Yang Yuechen</td>
<td>Radiation Effects Testing and Analysis for MAX9180 LVDS Repeater</td>
<td>113</td>
</tr>
<tr>
<td>Canavan</td>
<td>Edgar</td>
<td>De Alba Roberto</td>
<td>Ideal Integrating Bolometer for Far-infrared Spectroscopy</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Nagler</td>
<td>Peter Thomas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiff</td>
<td>Eric</td>
<td>Saripalli Pratik</td>
<td>NEXT Thruster Performance Curve Analysis</td>
<td>127</td>
</tr>
<tr>
<td>Carosso</td>
<td>Nancy</td>
<td>Berlin David</td>
<td>Rapid ATP Bioburden Test</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Lalime</td>
<td>Erin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpenter</td>
<td>Russell</td>
<td>William Ryan</td>
<td>Modern Applications of Initial Orbit Determination</td>
<td>133</td>
</tr>
<tr>
<td>Carter</td>
<td>Lynn</td>
<td>Douglas Madison</td>
<td>Analysis of Volcanic Deposits on Venus Using Radar Polarimetry</td>
<td>224</td>
</tr>
<tr>
<td>Mentor</td>
<td>Intern</td>
<td>Code</td>
<td>Title</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td>------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Case</td>
<td>Nathan</td>
<td>McCloat</td>
<td>673</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chervenak</td>
<td>James</td>
<td>Farrall</td>
<td>553</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nicole</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chin</td>
<td>Mian</td>
<td>Chen</td>
<td>610</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Heather</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chu</td>
<td>Donald</td>
<td>Small</td>
<td>417</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jeffrey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clagett</td>
<td>Charles</td>
<td>Howes</td>
<td>596</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Christopher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clagett</td>
<td>Charles</td>
<td>Boulter</td>
<td>596</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kurtis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clark</td>
<td>Pamela</td>
<td>Himwich</td>
<td>695</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Natarajan</td>
<td>Zoe</td>
<td>695</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vo</td>
<td>Aparna</td>
<td>695</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leiter</td>
<td>Huong</td>
<td>695</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rosenthal</td>
<td>Robin</td>
<td>695</td>
<td></td>
</tr>
<tr>
<td>Coleman</td>
<td>Frank</td>
<td>Nguyen</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diaz</td>
<td>Sophia</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Walter</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Coll</td>
<td>Gregory</td>
<td>Espinosa</td>
<td>408</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marcos</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collier</td>
<td>Michael</td>
<td>Newheart</td>
<td>695</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anastasia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colvin</td>
<td>Matthew</td>
<td>Wilkins</td>
<td>596</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jocelyn</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connerney</td>
<td>John</td>
<td>Clarke</td>
<td>John</td>
<td>Martian Crustal Magnetic Field with MAVEN</td>
</tr>
<tr>
<td>Conrad</td>
<td>Pamela</td>
<td>Bermudez</td>
<td>Katrina</td>
<td>Preliminary Results of Ar Diffusion through Silicate Glasses</td>
</tr>
<tr>
<td>Corcoran</td>
<td>Michael</td>
<td>Liburd</td>
<td>Jamar</td>
<td>An Analysis of Eta Carinae’s Background X-ray Emission</td>
</tr>
<tr>
<td>Coronado</td>
<td>Patrick</td>
<td>Reed</td>
<td>Trevor</td>
<td>Designing a Virtual Assistant for Systems Engineers</td>
</tr>
<tr>
<td>Coronado</td>
<td>Patrick</td>
<td>Lunde</td>
<td>Emily</td>
<td>Underwater Wireless Optical Communications</td>
</tr>
<tr>
<td>Cucchiara</td>
<td>Antonino</td>
<td>Yep</td>
<td>Alexandra</td>
<td>Comprehensive Study of GRB Host Star Formation Rates</td>
</tr>
<tr>
<td>Cudmore</td>
<td>Alan</td>
<td>Moore</td>
<td>Keegan</td>
<td>PiSat 2.0, Flight Software Systems Testbed</td>
</tr>
<tr>
<td>Cymerman</td>
<td>John</td>
<td>Azzopardi</td>
<td>Nicholas</td>
<td>JPSS Instrument Development</td>
</tr>
<tr>
<td>Dalhoff</td>
<td>Jeffrey</td>
<td>Ngo</td>
<td>Kelly</td>
<td>Levels of Lead Fume Exposure in Soldering Labs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deza</td>
<td>Laura</td>
<td>Comparisons of Multi-Scale Remote Sensed Data</td>
</tr>
<tr>
<td>David</td>
<td>John</td>
<td>Long</td>
<td>Jeff</td>
<td>Search and Rescue On-A-Chip (SARC) Thermal and Structural Analyses and Waterproofing</td>
</tr>
<tr>
<td>Davis</td>
<td>Milton</td>
<td>Wilkins</td>
<td>Jocelyn</td>
<td>Investigation of the Use of the Aquarius Scatterometer Data in Polar Regions</td>
</tr>
<tr>
<td>de Matthaeis</td>
<td>Paolo</td>
<td>Sharpe</td>
<td>Shanah</td>
<td>Development for WFIRST and CLASS</td>
</tr>
</tbody>
</table>

**Note:** The table above lists the mentors and their interns along with the codes, titles of their projects, and the corresponding pages.
# Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deweese</td>
<td>Keith</td>
<td>591</td>
<td>Actuator Sizing for Reconfigurable Operational Spacecraft for Science and Exploration (ROSE)</td>
<td>138</td>
</tr>
<tr>
<td>Dhabal</td>
<td>Arnab</td>
<td>660</td>
<td>Mechanical Support and Testing Structures for Optical Systems on BETTII</td>
<td>75</td>
</tr>
<tr>
<td>Dinnat</td>
<td>Emmanuel</td>
<td>615</td>
<td>Satellite Observations of the Antarctic Ice Shelves</td>
<td>263</td>
</tr>
<tr>
<td>Dominguez</td>
<td>Margaret</td>
<td>551</td>
<td>Test Setup for the WFIRST GRISM Spectrograph</td>
<td>151</td>
</tr>
<tr>
<td>Duffy</td>
<td>Daniel</td>
<td>606</td>
<td>Global Climate Simulation</td>
<td>13</td>
</tr>
<tr>
<td>Duffy</td>
<td>Daniel</td>
<td>606</td>
<td>GEOS-5 Interactive Mobile Application</td>
<td>21</td>
</tr>
<tr>
<td>Dwek</td>
<td>Eli</td>
<td>665</td>
<td>Tracing the Galactic Center using Bremsstrahlung, Synchrotron, and Thermal Emissions</td>
<td>206</td>
</tr>
<tr>
<td>Evans</td>
<td>Allison</td>
<td>596</td>
<td>Creating a Cubesat Design Tool and Developing Cubesat Thermal Louvers</td>
<td>142</td>
</tr>
<tr>
<td>Farrell</td>
<td>William</td>
<td>690</td>
<td>Solar Wind Hydrogen Implantation and Diffusion from Regolith of the Mood and Asteroids</td>
<td>259</td>
</tr>
<tr>
<td>Farrokh</td>
<td>Babak</td>
<td>542</td>
<td>Finite Element Modeling and Structural Analysis of Composite Structures</td>
<td>65</td>
</tr>
<tr>
<td>Fedorchak</td>
<td>Amy</td>
<td>200</td>
<td>The Backfill Project</td>
<td>159</td>
</tr>
<tr>
<td></td>
<td>Ajamian</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Strittmatter</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wunderlick</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferrer</td>
<td>Arturo</td>
<td>500</td>
<td>Software Architecture Based on UML Diagrams</td>
<td>31</td>
</tr>
</tbody>
</table>
### Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitzpatrick</td>
<td>Henry</td>
<td>552</td>
<td>Alternative Wick Structure Testing for Loop Heat Pipes</td>
<td>81</td>
</tr>
<tr>
<td>Floyd</td>
<td>Melissa</td>
<td>699</td>
<td>Life on Mars: Extremophilic Bacteria in a Simulated Martian Environment</td>
<td>266</td>
</tr>
<tr>
<td>Fok</td>
<td>Mei-Ching</td>
<td>673</td>
<td>Neutral Atom Flux Simulation of the Earth’s Ring Current</td>
<td>205</td>
</tr>
<tr>
<td>Frey</td>
<td>Herbert</td>
<td>698</td>
<td>Early Bombardment History of the Moon</td>
<td>173</td>
</tr>
<tr>
<td></td>
<td>Shetty</td>
<td>698</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fulwood</td>
<td>Sandra</td>
<td>157.1</td>
<td>Reimbursable Agreements</td>
<td>2</td>
</tr>
<tr>
<td>Fung</td>
<td>Shing</td>
<td>673</td>
<td>Possible Magnetic Reconnection Events Observed Near Earth by Multiple Satellites</td>
<td>236</td>
</tr>
<tr>
<td>Galante</td>
<td>Joseph</td>
<td>591</td>
<td>Inertial Navigation Attitude Filter Computational Complexity Optimization</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Foust</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galante</td>
<td>Joseph</td>
<td>591</td>
<td>Comparison of Dynamics Models for Spacecraft Attitude Filters via Monte Carlo Analysis</td>
<td>143</td>
</tr>
<tr>
<td></td>
<td>Simonson</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Del Sesto</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garcia</td>
<td>Leonard</td>
<td>673</td>
<td>Possible Magnetic Reconnection Events Observed Near Earth by Multiple Satellites</td>
<td>236</td>
</tr>
<tr>
<td>Gardner</td>
<td>Jonathan</td>
<td>665</td>
<td>Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td>Soto</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emmaris</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Codoreanu</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alex</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>De Mello</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duilia</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grogin</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Norman</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Koekemoer</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anton</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kurczynski</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Peter</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ravindranath</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Swara</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scarlata</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Claudia</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teplitz</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Harry</td>
<td>665</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garry</td>
<td>Brent</td>
<td>698</td>
<td>The Formation of Fluvial Channels on Alba Mons, Mars</td>
<td>214</td>
</tr>
<tr>
<td></td>
<td>Lehnigk</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Karin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mentor</td>
<td>Intern</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Gehrels</td>
<td>Neil Chambers</td>
<td>661</td>
<td>Modularized Software Control for the RIMAS Instrument</td>
<td>218</td>
</tr>
<tr>
<td>Gendreau</td>
<td>Keith Hatfield</td>
<td>662</td>
<td>NICER X-Ray Mission Development: Enhancing the Precision of the NICER Clock</td>
<td>24</td>
</tr>
<tr>
<td>Gendreau</td>
<td>Keith Campion</td>
<td></td>
<td>NICER Pointing System</td>
<td>60</td>
</tr>
<tr>
<td>Gendreau</td>
<td>Keith Johnson</td>
<td></td>
<td>Development of a PC-based MPU Simulator for NICER</td>
<td>128</td>
</tr>
<tr>
<td>Gendreau</td>
<td>Keith Banerjee</td>
<td>662</td>
<td>The Infrared Spectra and Stability of Icy Extraterrestrial Molecules</td>
<td>256</td>
</tr>
<tr>
<td>Gerakines</td>
<td>Perry Tway</td>
<td>691</td>
<td>Ion Focusing via Electrostatic Lenses for Interfacing Liquid Chromatograph</td>
<td>61</td>
</tr>
<tr>
<td>Getty</td>
<td>Stephanie Colon</td>
<td>699</td>
<td>Simultaneous Localization and Mapping of Small Planetary Bodies</td>
<td>47</td>
</tr>
<tr>
<td>Getzandanner</td>
<td>Kenneth Liounis</td>
<td>595</td>
<td>Optical Navigation Methods for OSIRIS-REx Mission</td>
<td>101</td>
</tr>
<tr>
<td>Getzandanner</td>
<td>Kenneth Strandjord</td>
<td>595</td>
<td>A Survey of Cryovolcanically Emplaced Domes on Europa</td>
<td>252</td>
</tr>
<tr>
<td>Glaze</td>
<td>Lori Ferguson</td>
<td></td>
<td>Test Setup for the WFIRST GRISM Spectrograph</td>
<td>151</td>
</tr>
<tr>
<td>Gong</td>
<td>Qian Green</td>
<td>551</td>
<td>Investigations of Venus Ionosphere Holes as Observed by Pioneer Venus Orbiter</td>
<td>189</td>
</tr>
<tr>
<td>Grofic</td>
<td>Barbara McArthur</td>
<td>600</td>
<td>Content and Log Analysis Using MySQL and Graylog</td>
<td>32</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grubisic</td>
<td>Anderj</td>
<td>699</td>
<td>Simulation of Hyper-Velocity Impacts: Implications for Impact-Induced Organic Molecule Synthesis on the Early Earth</td>
<td>182</td>
</tr>
<tr>
<td>Guiriec</td>
<td>Sylvain</td>
<td>660</td>
<td>Testing a New Model of Gamma-Ray Burst Prompt Emission</td>
<td>233</td>
</tr>
<tr>
<td>Gull</td>
<td>Theodore</td>
<td>660</td>
<td>Mapping the Latitude Dependence of the Primary Stellar Wind of eta Carinae Using the Spectrum Reflected on the Homunculus Nebula</td>
<td>164</td>
</tr>
<tr>
<td>Hall</td>
<td>Alfreda</td>
<td>423</td>
<td>NASA's Suomi National Polar-orbiting Partnership (SNPP) Science Data Processing Support</td>
<td>55</td>
</tr>
<tr>
<td>Hammond</td>
<td>Malinda</td>
<td>580</td>
<td>Web Services for Property and Software Tracking (PaST)</td>
<td>4</td>
</tr>
<tr>
<td>Handy</td>
<td>Matt</td>
<td>619</td>
<td>Flood Dashboard Capabilities Enhancement</td>
<td>20</td>
</tr>
<tr>
<td>Handy</td>
<td>Matthew</td>
<td>583</td>
<td>Evolving Middleware Support for Goddard Mission Services Evolution Center (GMSEC) Application Programming Interface (API)</td>
<td>28</td>
</tr>
<tr>
<td>Hanu</td>
<td>Andrei</td>
<td>661</td>
<td>Design and Optimization of an Electric Field Cage for AdEPT</td>
<td>255</td>
</tr>
<tr>
<td>Hanyok</td>
<td>Thomas</td>
<td>408</td>
<td>Energy Management &amp; Satellite Servicing Capabilities</td>
<td>120</td>
</tr>
<tr>
<td>Harman</td>
<td>Richard</td>
<td>444</td>
<td>Spacecraft Dynamic Simulation</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Potter</td>
<td>444</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Smith</td>
<td>444</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Juliano</td>
<td>444</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harman</td>
<td>Rick</td>
<td>400</td>
<td>Spacecraft Dynamics Simulation</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Garcia De</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>la Garza</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Axel</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern 1</th>
<th>Intern 2</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harman</td>
<td>Richard</td>
<td>Konkalmatt</td>
<td>Savyasachi</td>
<td>Simulating the Space Technology 5 Mission</td>
<td>137</td>
</tr>
<tr>
<td>Hasegawa</td>
<td>Mark</td>
<td>Krasniqi</td>
<td>Beqir</td>
<td>The Effects of Thermal Cycling and Physical Shock on Particle Fallout in Coatings</td>
<td>57</td>
</tr>
<tr>
<td>Hasegawa</td>
<td>Mark</td>
<td>Kline</td>
<td>Dylan</td>
<td>Thermal Coating Processing Improvements with the Use of O2 Plasma</td>
<td>78</td>
</tr>
<tr>
<td>Hasegawa</td>
<td>Mark</td>
<td>Scroggs</td>
<td>Sarah</td>
<td>Evaluating the Effect of Oxygen Plasma on Thermal Coatings</td>
<td>134</td>
</tr>
<tr>
<td>Hasegawa</td>
<td>Mark</td>
<td>Hawthorne</td>
<td>Nathaniel</td>
<td>Development of Superhydrophobic Surface Coatings</td>
<td>199</td>
</tr>
<tr>
<td>Hasegawa</td>
<td>Mark</td>
<td>Pontius</td>
<td>Rebecca</td>
<td>Thermal Coatings Qualification and Development</td>
<td>243</td>
</tr>
<tr>
<td>Hay</td>
<td>Brennan</td>
<td>Lynton</td>
<td>Ciara</td>
<td>Common Mission Security Services</td>
<td>11</td>
</tr>
<tr>
<td>Hebrard</td>
<td>Eric</td>
<td>Blecic</td>
<td>Jasmina</td>
<td>A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters</td>
<td>246</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blumenthal Sarah Patricio Harrington Joseph Venot Olivia</td>
<td>693</td>
</tr>
<tr>
<td>Heckler</td>
<td>Gregory</td>
<td>Pasco</td>
<td>Samuel</td>
<td>Next Generation Tracking and Data Relay Satellite Concept Study</td>
<td>140</td>
</tr>
<tr>
<td>Henderson</td>
<td>Maurice</td>
<td>Kong</td>
<td>Cathleen</td>
<td>Hubble Exhibit Video Editing Project</td>
<td>158</td>
</tr>
<tr>
<td>Hess</td>
<td>Larry</td>
<td>Andrews</td>
<td>Jaclyn</td>
<td>Fabrication and Characterization of Novel Nanoporous Bolometer</td>
<td>50</td>
</tr>
<tr>
<td>Hewitt</td>
<td>John</td>
<td>Mysore</td>
<td>Ajay</td>
<td>Extended Gamma Ray Emission from SNR G150.3+4.5</td>
<td>172</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hewitt</td>
<td>John</td>
<td>661</td>
<td>Analyzing Emissions from Blazar B2013+370 and Pulsar Wind Nebula VER J2016+371</td>
<td>237</td>
</tr>
<tr>
<td>Hickey</td>
<td>Michael</td>
<td>553</td>
<td>Detector Characterization Data Interpretation Using Python</td>
<td>37</td>
</tr>
<tr>
<td>Hill-Kittle</td>
<td>Joe</td>
<td>660</td>
<td>Developing a Test Stand for Lifetime Measurements Using a Narrow Gap Detector</td>
<td>235</td>
</tr>
<tr>
<td></td>
<td>Almonte</td>
<td>660</td>
<td>Characterization of the Performance/Lifetime of Next Generation X-Ray Polarimeter Prototype</td>
<td>238</td>
</tr>
<tr>
<td></td>
<td>Almonte</td>
<td>662</td>
<td>Lifetime Measurements of Narrow Gap X-ray Polarimeter</td>
<td>241</td>
</tr>
<tr>
<td>Ho</td>
<td>Evelyn</td>
<td>423</td>
<td>NASA’s Suomi National Polar-orbiting Partnership (SNPP) Science Data Processing Support</td>
<td>55</td>
</tr>
<tr>
<td>Hoercher</td>
<td>Casey</td>
<td>474</td>
<td>JPSS Flight Project Training Database</td>
<td>74</td>
</tr>
<tr>
<td>Hornschemeier Cardiff</td>
<td>Ann</td>
<td>662</td>
<td>States of Black Hole and Neutron Star Binaries with MAXI</td>
<td>260</td>
</tr>
<tr>
<td>Howard</td>
<td>Joseph</td>
<td>551</td>
<td>Freeform Optical Design of 2 and 3 Mirror Telescopes</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>Anderson</td>
<td>551</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoy</td>
<td>Elizabeth</td>
<td>618</td>
<td>Developing an Effective Geospatial Data System in Support of the ABoVE Project</td>
<td>216</td>
</tr>
<tr>
<td>Hudson</td>
<td>Reggie</td>
<td>691</td>
<td>The Infrared Spectra and Stability of Icy Extraterrestrial Molecules</td>
<td>256</td>
</tr>
<tr>
<td>Hunter</td>
<td>Stanley</td>
<td>661</td>
<td>Design and Optimization of an Electric Field Cage for AdEPT</td>
<td>255</td>
</tr>
</tbody>
</table>
# Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern 1</th>
<th>Intern 2</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ichoku</td>
<td>Charles</td>
<td>Dickens</td>
<td>613</td>
<td>Comparison of Satellite-derived Fire Emissions Results with Airborne Measurements of Smoke Constituents</td>
<td>234</td>
</tr>
<tr>
<td>Jahoda</td>
<td>Keith</td>
<td>Almonte</td>
<td>660</td>
<td>Developing a Test Stand for Lifetime Measurements Using a Narrow Gap Detector</td>
<td>235</td>
</tr>
<tr>
<td>Jahoda</td>
<td>Keith</td>
<td>Almonte</td>
<td>662</td>
<td>Characterization of the Performance/Lifetime of Next Generation X-Ray Polarimeter Prototype</td>
<td>238</td>
</tr>
<tr>
<td>Jahoda</td>
<td>McCurdy</td>
<td>Ross</td>
<td>662</td>
<td>Lifetime Measurements of Narrow Gap X-ray Polarimeter</td>
<td>241</td>
</tr>
<tr>
<td>Jasen</td>
<td>John</td>
<td>Mosley</td>
<td>606.2</td>
<td>Implementing Automated Security Monitoring Using OpenSCAP</td>
<td>19</td>
</tr>
<tr>
<td>Johnson</td>
<td>Gaynell</td>
<td>Adenaw</td>
<td>100</td>
<td>Cost Tickets and Analysis (FY2014 &amp; FY2015)</td>
<td>156</td>
</tr>
<tr>
<td>Johnson</td>
<td>Torry</td>
<td>Anglin</td>
<td>160</td>
<td>Tribal Colleges and University Archiving Project</td>
<td>268</td>
</tr>
<tr>
<td>Jones</td>
<td>Justin</td>
<td>Gosnell</td>
<td>541</td>
<td>Development of a System for Extended Depth of Field Imaging</td>
<td>149</td>
</tr>
<tr>
<td>Kelly</td>
<td>Dan</td>
<td>Walker</td>
<td>553</td>
<td>Characterization of MOSFET Devices at Cryogenic Temperatures</td>
<td>42</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenyon</td>
<td>Steven</td>
<td>543</td>
<td>Analysis of the Effectiveness of 3D Printing with HIPS Support Material</td>
<td>114</td>
</tr>
<tr>
<td>Kenyon</td>
<td>Steven</td>
<td>660</td>
<td>Designing and Modeling for the NICER Project</td>
<td>144</td>
</tr>
<tr>
<td>Khazanov</td>
<td>George</td>
<td>673</td>
<td>Superthermal Electron Magnetosphere-Ionosphere Coupling in the Diffuse Aurora in the Presence of ECH and Whistler Waves</td>
<td>193</td>
</tr>
<tr>
<td>Kirschbaum</td>
<td>Dalia</td>
<td>617</td>
<td>Improving STEM Education in the Classroom: NASA Goddard’s Summer Watershed Institute</td>
<td>242</td>
</tr>
<tr>
<td>Kirschbaum</td>
<td>Dalia</td>
<td>617</td>
<td>Determining Landslide-related Relationships Using the Global Landslide Catalog</td>
<td>261</td>
</tr>
<tr>
<td>Klenzing</td>
<td>Jeffrey</td>
<td>674</td>
<td>Variability of the Terrestrial Ionosphere</td>
<td>170</td>
</tr>
<tr>
<td>Klenzing</td>
<td>Jeff</td>
<td>674</td>
<td>Calibration of Adaptive Langmuir Probe</td>
<td>183</td>
</tr>
<tr>
<td>Kobler</td>
<td>Benjamin</td>
<td>580</td>
<td>Analyzing Hyperspectral Data with Neural Networks</td>
<td>54</td>
</tr>
<tr>
<td>Kogut</td>
<td>Alan</td>
<td>665</td>
<td>Mechanical Structure Developments for PIPER within Vacuum and Cryogenic Environments</td>
<td>66</td>
</tr>
<tr>
<td>Kogut</td>
<td>Al</td>
<td>665</td>
<td>Polarization Modulator Drive System Design and Testing</td>
<td>109</td>
</tr>
<tr>
<td>Krainak</td>
<td>Michael</td>
<td>554</td>
<td>Design of a Tunable ND:YVO4 Self-Raman Laser for Sodium Lidar</td>
<td>153</td>
</tr>
<tr>
<td>Kruk</td>
<td>Jeffrey</td>
<td>665</td>
<td>Synthetic Multiband Photometry in the Early Detection of Type 1a Supernovae for the WFIRST</td>
<td>230</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuchner</td>
<td>Marc</td>
<td>619</td>
<td>Correcting Inaccurate WISE1 Magnitudes for Disk Detective</td>
<td>249</td>
</tr>
<tr>
<td>Kucsera</td>
<td>Tom</td>
<td>614</td>
<td>Effects of Volcanic Eruptions on Climate and the Environment using Satellite Observations of SO2 and Ash and a Global Model</td>
<td>200</td>
</tr>
<tr>
<td>Kutyrev</td>
<td>Alexander</td>
<td>665</td>
<td>Modularized Software Control for the RIMAS Instrument</td>
<td>218</td>
</tr>
<tr>
<td>Kutyrev</td>
<td>Alexander</td>
<td>665</td>
<td>Cryogenic Thermometry for RIMAS</td>
<td>229</td>
</tr>
<tr>
<td>Kuznetsova</td>
<td>Masha</td>
<td>674</td>
<td>An iOS Application for iSWA</td>
<td>15</td>
</tr>
<tr>
<td>Kuznetsova</td>
<td>Masha</td>
<td>674</td>
<td>Geo-Electric Field Calculator Tool</td>
<td>26</td>
</tr>
<tr>
<td>Laddawan</td>
<td>Miko</td>
<td>553</td>
<td>Cryogenic Stability</td>
<td>131</td>
</tr>
<tr>
<td>Le</td>
<td>Guan</td>
<td>674</td>
<td>MMS Data Calibration using IDL</td>
<td>203</td>
</tr>
<tr>
<td>Le Moigne</td>
<td>Jacqueline</td>
<td>580</td>
<td>IMAGESEER – Lunar Data Pre-Processing</td>
<td>9</td>
</tr>
<tr>
<td>Le Moigne</td>
<td>Jacqueline</td>
<td>580</td>
<td>Shearlet Features for Remotely Sensed Image Registration</td>
<td>33</td>
</tr>
<tr>
<td>Leete</td>
<td>Stephen</td>
<td>420</td>
<td>Launch Vehicle Database</td>
<td>52</td>
</tr>
<tr>
<td>Leete</td>
<td>Stephen</td>
<td>420</td>
<td>External Payload Proposer’s Guide to the International Space Station</td>
<td>59</td>
</tr>
<tr>
<td>Leete</td>
<td>Stephen</td>
<td>599</td>
<td>International Space Station Instrument Pointing Platform Control System Design</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Davison Timothy</td>
<td></td>
</tr>
<tr>
<td>Lehmer</td>
<td>Bret</td>
<td>662</td>
<td>Testing the Universality of the Stellar IMF with Chandra</td>
<td>192</td>
</tr>
<tr>
<td>Leidecker</td>
<td>Henning</td>
<td>562</td>
<td>Metal Whiskers</td>
<td>76</td>
</tr>
<tr>
<td>Leisawitz</td>
<td>Dave</td>
<td>600</td>
<td>Enhancing Data Collection and Analysis Methods for Wide-Field Imaging Interferometry</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LeMoigne</td>
<td>Jacqueline</td>
<td>Walker</td>
<td>Michael</td>
<td>IMAGESEER – Lunar Data Pre-Processing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ku</td>
<td>Justin</td>
<td></td>
</tr>
<tr>
<td>Li</td>
<td>Xiang</td>
<td>Dean</td>
<td>William</td>
<td>LDI-MS Analysis of Martian Soil Analogues</td>
</tr>
<tr>
<td>Lien</td>
<td>Amy</td>
<td>Law</td>
<td>Charles</td>
<td>Investigating the Short Gamma-Ray Burst Detection Rate of the Swift Burst Alert Telescope via Trigger Simulations</td>
</tr>
<tr>
<td>Liu</td>
<td>Alice</td>
<td>Wolfe</td>
<td>Michael</td>
<td>NICER Pointing System</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kaplan</td>
<td>Ben</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Johnson</td>
<td>Jerrin</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mulder</td>
<td>Tysen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Campion</td>
<td>Robert</td>
<td></td>
</tr>
<tr>
<td>Livas</td>
<td>Jeffrey</td>
<td>Loughlin</td>
<td>Hudson</td>
<td>The Use of Shack-Hartman Sensors to Characterize Photoreceivers for the eLISA Mission</td>
</tr>
<tr>
<td>Livas</td>
<td>Jeffrey</td>
<td>Rose</td>
<td>Julie</td>
<td>Alignment of a Prototype Telescope for Scattered Light Measurements and Analysis</td>
</tr>
<tr>
<td>Ly</td>
<td>Young</td>
<td>Johnson</td>
<td>Trokon</td>
<td>FPGA Co-Processing to Accelerate Processing of Hyperspectral Images</td>
</tr>
<tr>
<td>Ly</td>
<td>Chun</td>
<td>Shin</td>
<td>Kaitlyn</td>
<td>The Environmental Effects on Star Formation in Galaxies</td>
</tr>
<tr>
<td>Lynnes</td>
<td>Christopher</td>
<td>Veltri</td>
<td>Joshua</td>
<td>Web-Based Monitor for the Simple, Scalable, Script-Based Science Processing System</td>
</tr>
<tr>
<td>MacDonald</td>
<td>Elizabeth</td>
<td>McCloat</td>
<td>Sean</td>
<td>Engaging the Aurorasaurus Citizen Science Project: Multi-tasking Across Multiple Disciplines</td>
</tr>
<tr>
<td>Maddox</td>
<td>Marlo</td>
<td>Malone</td>
<td>Sean</td>
<td>New Validation Suite for the CCMC</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mah</td>
<td>Jonathan</td>
<td>553</td>
<td>Development of Image Analysis Routines for WFIRST Detector Characterization</td>
<td>77</td>
</tr>
<tr>
<td>Mandell</td>
<td>Avi</td>
<td>693</td>
<td>Temperature Inversions in Hot Jupiters</td>
<td>195</td>
</tr>
<tr>
<td>Mandell</td>
<td>Avi</td>
<td>693</td>
<td>A Study of Equilibrium and Disequilibrium Chemistry in Hot Jupiters</td>
<td>246</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blecic, Jasmina</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cubillos, Patricio</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Harrington, Joseph</td>
<td>693</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Venot, Olivia</td>
<td>693</td>
</tr>
<tr>
<td>Mandl</td>
<td>Daniel</td>
<td>581</td>
<td>FPGA Co-Processing to Accelerate Processing of Hyperspectral Images</td>
<td>145</td>
</tr>
<tr>
<td>Manos</td>
<td>George</td>
<td>553</td>
<td>Temperature and Flow Rate Sensor Fabrication</td>
<td>93</td>
</tr>
<tr>
<td>Manos</td>
<td>George</td>
<td>553</td>
<td>MEMS Sensor Fabrication and Testing</td>
<td>265</td>
</tr>
<tr>
<td>Markwardt</td>
<td>Craig</td>
<td>662</td>
<td>NICER X-Ray Mission Development: Enhancing the Precision of the NICER Clock</td>
<td>24</td>
</tr>
<tr>
<td>Mazarico</td>
<td>Erwan</td>
<td>698</td>
<td>Calibrating Mercury Laser Altimeter Data Using Stereo Image-Based Digital Elevation Models</td>
<td>244</td>
</tr>
<tr>
<td>McClelland</td>
<td>Ryan</td>
<td>660</td>
<td>Design of Edge-Trimming Machine for Light-Weighted Monocrystalline Silicon Optical Structures</td>
<td>73</td>
</tr>
<tr>
<td>McCloskey</td>
<td>John</td>
<td>560</td>
<td>Noisy Neighbors: Understanding Noise Generating Components in Your System</td>
<td>106</td>
</tr>
<tr>
<td>Miko</td>
<td>Laddawan</td>
<td>553</td>
<td>Characterization of MOSFET Devices at Cryogenic Temperatures</td>
<td>42</td>
</tr>
<tr>
<td>Mentor</td>
<td>Intern</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------</td>
<td>------</td>
<td>-------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Miller</td>
<td>Kevin Huang</td>
<td>551</td>
<td>Transmission Performance of WFIRST’s Optical Filters from the Visible to Infrared</td>
<td>152</td>
</tr>
<tr>
<td>Milner</td>
<td>Barbara Birchler</td>
<td>500</td>
<td>Development for GMSEC Services Suite (GSS)</td>
<td>6</td>
</tr>
<tr>
<td>Milner</td>
<td>Barbara Cheng</td>
<td>583</td>
<td>Development for GMSEC Services Suite (GSS) and Messaging Interface Standardization Toolkit (MIST)</td>
<td>7</td>
</tr>
<tr>
<td>Mirel</td>
<td>Paul Branyan</td>
<td>665</td>
<td>Mechanical Structure Developments for PIPER within Vacuum and Cryogenic Environments</td>
<td>66</td>
</tr>
<tr>
<td>Mirel</td>
<td>Paul Mahon</td>
<td>665</td>
<td>Polarization Modulator Drive System Design and Testing</td>
<td>109</td>
</tr>
<tr>
<td>Mitchell</td>
<td>Darryl Sharp</td>
<td>504</td>
<td>OPSPARC: OPTIMUS PRIME Spinoff, Promotion, and Research Challenge</td>
<td>46</td>
</tr>
<tr>
<td>Mitchell</td>
<td>Darryl Khan</td>
<td>504</td>
<td>OPSPARC: OPTIMUS PRIME Spinoff, Promotion, and Research Challenge</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>Rachel Lin</td>
<td>504</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitchell</td>
<td>Jason Munoz</td>
<td>595</td>
<td>Development of a PC-based MPU Simulator for NICER</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>Rohan Banerjee</td>
<td>595</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morris</td>
<td>David Almonte</td>
<td>660</td>
<td>Developing a Test Stand for Lifetime Measurements Using a Narrow Gap Detector</td>
<td>235</td>
</tr>
<tr>
<td></td>
<td>Rafael Tuitt</td>
<td>660</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moses</td>
<td>John Urioste</td>
<td>586</td>
<td>Visual Inspection and Use of Satellite NO2 Observations</td>
<td>95</td>
</tr>
<tr>
<td>Mullinix</td>
<td>Richard Cao</td>
<td>674</td>
<td>An iOS Application for iSWA</td>
<td>15</td>
</tr>
<tr>
<td>Neigh</td>
<td>Christopher Miller</td>
<td>618</td>
<td>Supercomputing Sub-Meter Satellite Stereo Data for the Forest-Tundra Ecotone</td>
<td>166</td>
</tr>
<tr>
<td>Mentor</td>
<td>Intern</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------------</td>
<td>----------</td>
<td>------</td>
<td>-----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Neumann</td>
<td>Gregory</td>
<td>698</td>
<td>Calibrating Mercury Laser Altimeter Data Using Stereo Image-Based Digital Elevation Models</td>
<td>244</td>
</tr>
<tr>
<td></td>
<td>Bauer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rebecca</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nixon</td>
<td>Conor</td>
<td>690</td>
<td>Water Abundance in the Stratospheres of Saturn and Titan based on CIRS</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malena</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hesman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brigette</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novak</td>
<td>Michael</td>
<td>616</td>
<td>Analysis of Colored Dissolved Organic Matter and Particulate Organic Carbon</td>
<td>196</td>
</tr>
<tr>
<td></td>
<td>Hasegawa</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eric</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oliversen</td>
<td>Ronald</td>
<td>695</td>
<td>Lunar Exospheres and Instrument Control</td>
<td>197</td>
</tr>
<tr>
<td></td>
<td>Gallant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Margaret</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jaehnig</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kurt</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mierkiewicz</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edwin</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Percival</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jeffrey</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oliversen</td>
<td>Ron</td>
<td>695</td>
<td>Sodium in the Lunar Exosphere</td>
<td>247</td>
</tr>
<tr>
<td></td>
<td>Rosborough</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sara</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Derr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nicholas</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gallant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Margaret</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kallio</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Robert</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kuruppuaratchi</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dona</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mierkiewicz</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Edwin</td>
<td>695</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panashchenko</td>
<td>Lyudmyla</td>
<td>562</td>
<td>Reflow Soldering and Silver Leaching on ICESat-2 Silver-Palladium Electrical Terminations</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>Johnson</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kyle</td>
<td>562</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paquette</td>
<td>Beth</td>
<td>562</td>
<td>Evaluation of Aerosol Jet Additive Manufacturing of High Density Printed Circuits</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td>Carter</td>
<td>562</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Omari</td>
<td>562</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parker</td>
<td>Joel</td>
<td>595</td>
<td>GPS III Space Service Volume Specifications Study</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Carter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Elizabeth</td>
<td>595</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patel</td>
<td>Umesh</td>
<td>544</td>
<td>Magnetic Shape Memory Alloy Actuator for Nano-Positioning</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Mittu</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anjali</td>
<td>544</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patel</td>
<td>Umesh</td>
<td>544</td>
<td>Absolute Position Sensor Development</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Everett</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Katherine</td>
<td>544</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patel</td>
<td>Umesh</td>
<td>544</td>
<td>Development of Circuit Simulations and Control Algorithms for Critical Flight Test Hardware</td>
<td>90</td>
</tr>
<tr>
<td>Patel</td>
<td>Umesh</td>
<td>544</td>
<td>Precision Eddy Current Displacement Sensor</td>
<td>94</td>
</tr>
<tr>
<td>Patel</td>
<td>Umeshkumar</td>
<td>540</td>
<td>Modifying the Automated Safe-To-Mate (ASTM) Tester</td>
<td>146</td>
</tr>
<tr>
<td>Peddie</td>
<td>Catherine</td>
<td>448</td>
<td>Synthetic Multiband Photometry in the Early Detection of Type 1a Supernovae for the WFIRST</td>
<td>230</td>
</tr>
<tr>
<td>Perkins</td>
<td>Jeremy</td>
<td>661</td>
<td>Development of a Telescope System for VHE Astronomy</td>
<td>221</td>
</tr>
<tr>
<td>Perrine</td>
<td>Martin</td>
<td>567</td>
<td>Developing the Multi-channel Frequency Conversion Module (MFCM) for the Wide-swath Shared-aperture Cloud Radar (WiSCR)</td>
<td>118</td>
</tr>
<tr>
<td>Pesnell</td>
<td>W. Dean</td>
<td>671</td>
<td>A Solar Hiccup: Analysis of an “Almost” Coronal Hole</td>
<td>240</td>
</tr>
<tr>
<td>Petrick</td>
<td>David</td>
<td>587</td>
<td>Embedded Systems Fault Injection and Recovery</td>
<td>104</td>
</tr>
<tr>
<td>Poole</td>
<td>Katie</td>
<td>760</td>
<td>RSA Token Reconciliation Project</td>
<td>5</td>
</tr>
<tr>
<td>Pulia</td>
<td>Jillian</td>
<td>546</td>
<td>Purge Flow Analysis</td>
<td>123</td>
</tr>
<tr>
<td>Pulkkinen</td>
<td>Antti</td>
<td>674</td>
<td>Geo-Electric Field Calculator Tool</td>
<td>26</td>
</tr>
<tr>
<td>Quick</td>
<td>Lyannae</td>
<td>698</td>
<td>A Survey of Cryovolcanically Emplaced Domes on Europa</td>
<td>252</td>
</tr>
<tr>
<td>Rabin</td>
<td>Douglas</td>
<td>670</td>
<td>Refining the Wheel: Analysis of Solar Cycle Prediction Precursor Technique</td>
<td>232</td>
</tr>
<tr>
<td>Racette</td>
<td>Paul</td>
<td>555</td>
<td>Science Writing for Earthzine</td>
<td>171</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rafelski</td>
<td>Marc</td>
<td>Codoreanu Alex</td>
<td>Clumpy Regions in the UV HUDF at $0.5 \leq z \leq 1.5$</td>
<td>169</td>
</tr>
<tr>
<td>De Mello</td>
<td>Duilia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grogin</td>
<td>Norman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koekemoer</td>
<td>Anton</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kurczynski</td>
<td>Peter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ravindranath</td>
<td>Swara</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scarlata</td>
<td>Claudia</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soto</td>
<td>Emmaris</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teplitz</td>
<td>Harry</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramsey</td>
<td>Mary Ellen</td>
<td>Ly Cathy</td>
<td>Going Native: The Reform of Landscaping at Goddard</td>
<td>155</td>
</tr>
<tr>
<td>Ramspacher</td>
<td>Daniel</td>
<td>Ng Wanyi</td>
<td>Comet Sample and Return Projectile Launcher Calibration and Design</td>
<td>150</td>
</tr>
<tr>
<td>Rinehart</td>
<td>Stephen</td>
<td>Rubin Naomi</td>
<td>Ground Software for Balloon Infrared Interferometer</td>
<td>34</td>
</tr>
<tr>
<td>Rinehart</td>
<td>Stephen</td>
<td>Levine David</td>
<td>Mechanical Support and Testing Structures for Optical Systems on BETTII</td>
<td>75</td>
</tr>
<tr>
<td>Rinehart</td>
<td>Stephen</td>
<td>Jo Caleb</td>
<td>Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII)</td>
<td>92</td>
</tr>
<tr>
<td>Rinehart</td>
<td>Stephen</td>
<td>Maher Ryan</td>
<td>BETTII – Internship</td>
<td>245</td>
</tr>
<tr>
<td>Rizzo</td>
<td>Maxime</td>
<td>Jo Caleb</td>
<td>Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII)</td>
<td>92</td>
</tr>
<tr>
<td>Roberge</td>
<td>Aki</td>
<td>Blake Ameer</td>
<td>The Search for ExoPlanets in the Beta Pictoris Debris Disk</td>
<td>175</td>
</tr>
<tr>
<td>Roberts</td>
<td>Brian</td>
<td>Campbell Matthew</td>
<td>Gamma 300 Case Design and Air Track Rail Construction</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tagg Connor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reed Kyle</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scolaro Joseph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mentor</td>
<td>Intern</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Robinson</td>
<td>Franklin</td>
<td>545</td>
<td>Two-Phase Microgap Cooling for Next Generation Electronic Systems</td>
<td>98</td>
</tr>
<tr>
<td>Rodriguez</td>
<td>Marcello</td>
<td>540</td>
<td>Particle Spectrometry Lab: Mini Ion Neutral Mass Spectrometer</td>
<td>63</td>
</tr>
<tr>
<td>Rodriguez-Ramon</td>
<td>Lixa</td>
<td>250</td>
<td>Hazardous Waste at NASA Goddard Space Flight Center</td>
<td>160</td>
</tr>
<tr>
<td>Rodriguez-Ruin</td>
<td>Juan</td>
<td>545</td>
<td>CubeSat Design Approach at Goddard Space Flight Center</td>
<td>148</td>
</tr>
<tr>
<td>Rogers</td>
<td>Charles</td>
<td>428</td>
<td>Simulation Using a Zedboard</td>
<td>117</td>
</tr>
<tr>
<td>Root</td>
<td>Jonathan</td>
<td>382</td>
<td>Deep Dive Analysis of PR/PFR Records, Importation of Legacy Watchlist Data into Meta, Beta Testing of Watchlist Application in Meta</td>
<td>136</td>
</tr>
<tr>
<td>Rosanova</td>
<td>Giulio</td>
<td>543</td>
<td>3D Printed Model of the WFIRST Observatory using Additive Manufacturing Techniques</td>
<td>71</td>
</tr>
<tr>
<td>McWithey</td>
<td>Christen</td>
<td>543</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ruffa</td>
<td>Jonathan</td>
<td>543</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Davidson</td>
<td>Rosemary</td>
<td>543</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ruley</td>
<td>LaMont</td>
<td>583</td>
<td>Data Access Toolkit (DAT) Gridx and Mnemonic Archive Data (MAD) Files</td>
<td>16</td>
</tr>
<tr>
<td>Rumney</td>
<td>George</td>
<td>606</td>
<td>Implementing Automated Security Monitoring Using OpenSCAP</td>
<td>19</td>
</tr>
<tr>
<td>Sacks</td>
<td>Lia</td>
<td>591</td>
<td>MMS AMS SPIKES</td>
<td>45</td>
</tr>
<tr>
<td>Safavi</td>
<td>Haleh</td>
<td>566</td>
<td>Tracking and Data Relay Satellite Systems Waveform and Noise Generator Design</td>
<td>87</td>
</tr>
<tr>
<td>Samara</td>
<td>Marilia</td>
<td>673</td>
<td>Auroral Occurrence In and Out of Solar Maximum</td>
<td>220</td>
</tr>
</tbody>
</table>

Khatiwada Sital
# Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sankar</td>
<td>Shannon</td>
<td>Rose</td>
<td>Julie</td>
<td>663</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Alignment of a Prototype Telescope for Scattered Light Measurements and Analysis</td>
<td>210</td>
</tr>
<tr>
<td>Sayer</td>
<td>Anldrew</td>
<td>Howl</td>
<td>Bryan</td>
<td>613</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sidel</td>
<td>Alon</td>
<td>613</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chen</td>
<td>Amy</td>
<td>613</td>
</tr>
<tr>
<td>Scofield</td>
<td>Melonie</td>
<td>Harriston</td>
<td>Miles</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quality Management System in the Applied Engineering and Technology Directorate</td>
<td>108</td>
</tr>
<tr>
<td>Segal</td>
<td>Ken</td>
<td>Kauffman</td>
<td>Cameron</td>
<td>543</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Finite Element Modeling and Structural Analysis of Composite Structures</td>
<td>65</td>
</tr>
<tr>
<td>Segal</td>
<td>Kenneth</td>
<td>Berez</td>
<td>Jaime</td>
<td>543</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Advanced Energetic Pair Telescope Instrument Structure Design</td>
<td>88</td>
</tr>
<tr>
<td>Segal</td>
<td>Kenneth</td>
<td>Landgrover</td>
<td>Olivia</td>
<td>540</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analysis of the Use of Composite Materials as Structural Radiation Shielding in the Exploration Augmentation Module</td>
<td>124</td>
</tr>
<tr>
<td>Shiri</td>
<td>Ron</td>
<td>Lunde</td>
<td>Emily</td>
<td>551</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Underwater Wireless Optical Communications</td>
<td>82</td>
</tr>
<tr>
<td>Shiri</td>
<td>Ron</td>
<td>Maring</td>
<td>Michael</td>
<td>551</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intensity Measurement of Petal-Shaped Grayscale Lithography Mask for Gravity Wave Mission</td>
<td>112</td>
</tr>
<tr>
<td>Showalter</td>
<td>Matthew</td>
<td>Southall</td>
<td>Robert</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Implementing Responsive Web Design</td>
<td>35</td>
</tr>
<tr>
<td>Showalter</td>
<td>Matthew</td>
<td>Daitch</td>
<td>Cole</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Manufacturing Robotic Arm Concept</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Jordan</td>
<td>Brendan</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Yancey</td>
<td>Colin</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pletan</td>
<td>Kyle</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Punnoose</td>
<td>Tarun</td>
<td>547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Punnoose</td>
<td>Rohan</td>
<td>547</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Showalter</td>
<td>Matt</td>
<td>547</td>
<td>Engineering Technician Assistance</td>
<td>64</td>
</tr>
<tr>
<td>Showalter</td>
<td>Matthew</td>
<td>547</td>
<td>The Robotic Cell Design</td>
<td>115</td>
</tr>
<tr>
<td>Showalter</td>
<td>Matthew</td>
<td>547</td>
<td>WFIRST Mockup Design</td>
<td>267</td>
</tr>
<tr>
<td>Sibeck</td>
<td>David</td>
<td>674</td>
<td>Hot Flow Anomalies at Earth’s Bow Shock and Their Ground Signatures</td>
<td>248</td>
</tr>
<tr>
<td>Silk</td>
<td>Eric</td>
<td>552</td>
<td>Alternative Wick Structure Testing for Loop Heat Pipes</td>
<td>81</td>
</tr>
<tr>
<td>Simms</td>
<td>Ken</td>
<td>619</td>
<td>Installation and Removal Techniques of Surface Mount Electronic Components Using Infrared Heating Equipment</td>
<td>72</td>
</tr>
<tr>
<td>Smale</td>
<td>Alan</td>
<td>660</td>
<td>Investigating the Long-term Variability of 4U1705-44; Evidence for an Underlying Nonlinear Double-Welled Oscillator</td>
<td>180</td>
</tr>
<tr>
<td>Smith</td>
<td>Gary</td>
<td>581</td>
<td>Developing an Application for CFS-CFE and Rhapsody UML2.0</td>
<td>25</td>
</tr>
<tr>
<td>Soldo</td>
<td>Yan</td>
<td>615</td>
<td>Radio Frequency Interference: A Comparison of SMAP and Aquarius Methods and Techniques</td>
<td>162</td>
</tr>
<tr>
<td>Southard</td>
<td>Adrian</td>
<td>699</td>
<td>Ion Focusing via Electrostatic Lenses for Interfacing Liquid Chromatograph</td>
<td>61</td>
</tr>
<tr>
<td>St. Cyr</td>
<td>Chris</td>
<td>670</td>
<td>Classifying Solar Events with STEREO</td>
<td>191</td>
</tr>
<tr>
<td>Staguhn</td>
<td>Johannes</td>
<td>665</td>
<td>Tracing the Galactic Center using Bremsstrahlung, Synchrotron, and Thermal Emissions</td>
<td>206</td>
</tr>
<tr>
<td>Stewart</td>
<td>Jeff</td>
<td>543</td>
<td>3D Printed Model of the WFIRST Observatory using Additive Manufacturing Techniques</td>
<td>71</td>
</tr>
</tbody>
</table>
# Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davidson</td>
<td>Rosemary</td>
<td>543</td>
<td>Development of Heater Control Application for the Core Flight System</td>
<td>30</td>
</tr>
<tr>
<td>McWithey</td>
<td>Christen</td>
<td>543</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ruffa</td>
<td>Jonathan</td>
<td>543</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strege</td>
<td>Susanne</td>
<td>582</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stubbs</td>
<td>Timothy</td>
<td>695</td>
<td>DREAM2: Using Apollo Data to Characterize the Lunar Environment</td>
<td>213</td>
</tr>
<tr>
<td>Sultana</td>
<td>Mahmooda</td>
<td>553</td>
<td>Graphene Based Chemical Sensors for Space Applications</td>
<td>100</td>
</tr>
<tr>
<td>Sun</td>
<td>Xiaoli</td>
<td>694</td>
<td>Post-mission Characterization of the Mercury Laser Altimeter</td>
<td>176</td>
</tr>
<tr>
<td>Sultana</td>
<td>Lebair</td>
<td>553</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sun</td>
<td>Xiaoli</td>
<td>694</td>
<td>Characterization of MLA, GLAS, Rubidium and Cesium Clocks</td>
<td>257</td>
</tr>
<tr>
<td>Swann</td>
<td>Donna</td>
<td>400</td>
<td>Career Path for GSFC</td>
<td>157</td>
</tr>
<tr>
<td>Thomas</td>
<td>William</td>
<td>474</td>
<td>Data Extraction Utility for JPSS</td>
<td>8</td>
</tr>
<tr>
<td>Thomas</td>
<td>Byrne</td>
<td>400</td>
<td>Open Source Data Management</td>
<td>10</td>
</tr>
<tr>
<td>Thomas</td>
<td>Eissner</td>
<td>474</td>
<td>JPSS Data Product Quality</td>
<td>209</td>
</tr>
<tr>
<td>Thorpe</td>
<td>James</td>
<td>663</td>
<td>Micrometeorite Data Analysis for LISA Pathfinder</td>
<td>185</td>
</tr>
<tr>
<td>Thorpe</td>
<td>Ira</td>
<td>663</td>
<td>Modeling of LISA Pathfinder with Inverted Pendulum on Cart Control</td>
<td>187</td>
</tr>
<tr>
<td>Tian</td>
<td>Yudong</td>
<td>610</td>
<td>Observation and Analysis of Global Storm Tracks and their Variations</td>
<td>181</td>
</tr>
<tr>
<td>Timmons</td>
<td>Elizabeth</td>
<td>587</td>
<td>Hardware Components Database</td>
<td>12</td>
</tr>
<tr>
<td>Timmons</td>
<td>Kessler</td>
<td>587</td>
<td>Flight Software for Distributed Spacecraft Mission Communication</td>
<td>17</td>
</tr>
<tr>
<td>Troja</td>
<td>Eleonora</td>
<td>662</td>
<td>Association of Short Gamma-Ray Bursts with Galaxy Clusters</td>
<td>231</td>
</tr>
<tr>
<td>Mentor</td>
<td>Intern</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Truxon</td>
<td>William</td>
<td>Peck</td>
<td>Dakota</td>
<td>14</td>
</tr>
<tr>
<td>Turner</td>
<td>Ryan</td>
<td>Fields</td>
<td>Naje</td>
<td>Enterprise Monitoring Solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harrison</td>
<td>Kierra</td>
<td>NEN Live</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phillips III</td>
<td>Lafayette</td>
<td>Package Design of a Waveguide to Microstrip Transition at W-band Frequency</td>
</tr>
<tr>
<td>U-Yen</td>
<td>Kongpop</td>
<td>Rivera</td>
<td>Olga</td>
<td>GPS III Space Service Volume Specifications Study</td>
</tr>
<tr>
<td>Valdez</td>
<td>Jennifer</td>
<td>Carter</td>
<td>Elizabeth</td>
<td>Comparison of Landscape Pattern across Multiple Scales, Sensors, and Features</td>
</tr>
<tr>
<td>Van Den Hoek</td>
<td>Jamon</td>
<td>Stanforth</td>
<td>Austin</td>
<td>Satellite Ground Systems Basic Concepts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Energetic Particles in Star-forming Galaxies</td>
</tr>
<tr>
<td>Wales</td>
<td>Carl</td>
<td>Davis</td>
<td>Ciara</td>
<td>661</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Mars Campaign for Energetic Particles in Star-forming Galaxies</td>
</tr>
<tr>
<td>West</td>
<td>Garrett</td>
<td>Anderson</td>
<td>Alexander</td>
<td>Freeform Optical Design of 2 and 3 Mirror Telescopes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NASA’s Suomi National Polar-orbiting Partnership (SNPP) Science Data Processing Support</td>
</tr>
<tr>
<td>Williams</td>
<td>James</td>
<td>Richardson</td>
<td>Avian</td>
<td>Data Restoration and Analysis of Daytime Lunar Mass Spectra of the Lunar Atmosphere Composition Experiment (LACE)</td>
</tr>
<tr>
<td>Williams</td>
<td>Dave</td>
<td>Brothers</td>
<td>Lydia</td>
<td>Mariner 2 Magnetometer Data</td>
</tr>
<tr>
<td>Wilson</td>
<td>Emily</td>
<td>Yang</td>
<td>Renee</td>
<td>239</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DiGregorio</td>
<td>AJ</td>
<td>Laser Heterodyne Radiometer-CubeSat</td>
</tr>
<tr>
<td>Mentor</td>
<td>Intern 1</td>
<td>Code</td>
<td>Title</td>
<td>Page</td>
</tr>
<tr>
<td>--------</td>
<td>----------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Wollack</td>
<td>Edward</td>
<td>Torke</td>
<td>Maxfield</td>
<td>665</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Simulating Infrared Transmission through Porous Dielectric Foam</td>
<td>165</td>
</tr>
<tr>
<td>Wright</td>
<td>Cinnamon</td>
<td>Gonzalez</td>
<td>Gabriel</td>
<td>595</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Integration of Flight Software with 42 to Enable CubeSat Hardware-in-the-Loop Testing</td>
<td>85</td>
</tr>
<tr>
<td>Xie</td>
<td>Hong</td>
<td>Duncan</td>
<td>Daniel</td>
<td>670</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Classifying Solar Events with STEREO</td>
<td>191</td>
</tr>
<tr>
<td>Yew</td>
<td>Alvin</td>
<td>Wang</td>
<td>James</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The Effects of the Biophysical Microenvironment on Human Mesenchymal Stem Cell Behavior during Simulated Microgravity</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hsieh</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Luna</td>
<td>500</td>
</tr>
<tr>
<td>Yew</td>
<td>Alvin</td>
<td>Ramjatan</td>
<td>Sahadeo</td>
<td>596</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Next Generation Attitude Control Technology</td>
<td>141</td>
</tr>
<tr>
<td>Yu</td>
<td>Anthony</td>
<td>Zober</td>
<td>Wolfgang</td>
<td>550</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Design of a Tunable ND:YVO4 Self-Raman Laser for Sodium Lidar</td>
<td>153</td>
</tr>
<tr>
<td>Zheng</td>
<td>Yihua</td>
<td>Wold</td>
<td>Alexandra</td>
<td>674</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Space Weather Forecasting and Research</td>
<td>168</td>
</tr>
<tr>
<td></td>
<td>Aronne</td>
<td>Mary</td>
<td>674</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Novetsky</td>
<td>Tamar</td>
<td>674</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Robinett</td>
<td>Ethan</td>
<td>674</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waldron</td>
<td>Zachary</td>
<td>674</td>
<td></td>
</tr>
<tr>
<td>Zheng</td>
<td>Yihua</td>
<td>Waldron</td>
<td>Zachary</td>
<td>674</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Space Weather Forecasting: An Analysis of Active Region 2371</td>
<td>178</td>
</tr>
<tr>
<td>Zheng</td>
<td>Yihua</td>
<td>Zink</td>
<td>Jenna</td>
<td>674</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Space Weather Forecasting: Impacts at Mars</td>
<td>211</td>
</tr>
<tr>
<td>Zheng</td>
<td>Yihua</td>
<td>Aronne</td>
<td>Mary</td>
<td>674</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Space Weather Forecasting and High Speed Streams</td>
<td>227</td>
</tr>
</tbody>
</table>
## Appendix B: Mentors

<table>
<thead>
<tr>
<th>Mentor</th>
<th>Intern</th>
<th>Code</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zhou</td>
<td>Yaping</td>
<td>613</td>
<td>Tropical Cyclone Evolution and Water and Energy Fluxes: A Hurricane Katrina Case Study</td>
<td>228</td>
</tr>
<tr>
<td>Zhou</td>
<td>Pinheiro</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zhou</td>
<td>Marielle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>