2015 NASA Space Grant Undergraduate Student Instrument Project (USIP) Proposal Abstracts

Announcement Number: NNH15ZDA010C

Utah State University – Proposal #2

Dr. Stephen Whitmore

Arc-Ignition "Green" Thruster for SmallSats

Project Description: This project will design; build, and flight-test a novel arc-ignition green-propellant Cubesat thruster system. The proposed flight test will assess the restart-capability and vacuum performance of a space thruster prototype currently under development at Utah State University (USU). The tests will also perform plume contamination measurements to characterize potential deleterious effects on spacecraft optical sensors, external electronics, and solar panels.

Current Prototype Technology Readiness Level (TRL): Based on established TRL assessment tools, the estimated TRL of the prototype thruster lies between 3.5 and 4. This system maturity level is not competitive for orbital flight demonstrations, as these opportunities that require an entry-level of at least TRL 5.0. Thus, the SFRO Flight Opportunity Program offers a unique chance for the proposed project to gain a significant TRL enhancement in a true space environment without the associated mass and packaging risks coincident with a small spacecraft rideshare opportunity. Multiple critical design features will be assessed with the single proposed experiment.

Compliance with NASA's Road Map: Although the proposed research activity mainly targets small spacecraft propulsion applications, the developed technology has many potential applications that are directly aligned with NASA's objectives, including launch systems and power generation cycles. The proposed research activity aligns with several key elements of NASA's In-Space Propulsion Road Map, including:

- NASA TA02.2.1.1, In-Space Propulsion Technologies, Storable Propellants, “Evaluate alternate green propellants that allow thrusters to operate in pulse and continuous modes with these new propellants. Qualify propellants and components for spaceflight.” This project also supports a primary objective of the NASA Office of education, NASA Strategic Plan Goal 3, “Create the innovative new space technologies for our exploration, science, and economic future.”

Proposed Flight Test Platform: This proposed system will be developed for flight test under the guidance of the NASA Sounding Rocket Program Office (SRPO) operated by the Suborbital and Special Orbital Projects Directorate (SSOPD) at the NASA Goddard Space Flight Center (GSFC)/Wallops Flight Facility (WFF). The improved Orion sounding rocket with a standard 14" Ignition Recovery Module Assembly (IRMA) recovery system is proposed as the launch vehicle. Although real time telemetry is proposed to relayed sensitive data from the flight vehicle to the WFF for archival and post-flight analysis, post flight recovery of the experiment module will allow redundant onboard data archival and post flight inspection of system components including total propellant mass consumption. The proposed systems will meet all WFF SRPO safety and reliability requirements.

Student Team Makeup: This proposal teams the Mechanical and Aerospace Engineering (MAE) and Electrical and Computer Engineering (ECE) at Utah State University (USU) with the Mechanical and Civil Engineering Department (MCE) at Alabama A&M University (A&M) -- an open enrollment, historically black, land-grant university. USU will matriculate the project as a single crosslisted capstone senior design course, and USU faculty instructors will actively recruit students from all demographic backgrounds including women and under-represented minorities to participate in the project. Alabama A&M undergraduate students will be asked to develop a "strap-on" suite of plume contamination sensors to be integrated into the overall thruster systems experimental pod. At least two graduate students -- one from each university will be funded to mentor the senior design teams.

West Virginia University – Proposal 15-USIP15-0003

Dr. Majid Jaridi

Magnetic Solder to Improve Solder Joints Formed in Microgravity

The proposed research will demonstrate capability of a magnetically-enhanced solder to eliminate voids in solder joints that are formed in microgravity. This is expected to lead to stronger, more conductive, and more reliable solder joints. This experimental concept has been developed by undergraduate students at West Virginia University (WVU); they have conceived of using a magnetic field localized at the soldering location to impose a body force on the solder that will replace Earth gravity to drive flux vapors from the molten solder before solidification when the solder joint is formed in a microgravity environment.

The assembled research team is comprised of 12 current full-time undergraduate students: eight engineering majors at West Virginia University, two chemistry majors at Fairmont State University, and an engineering student and a dual-major math/engineering student at Shepherd University. The team has been organized into three sub-teams to work to: 1. develop an optimized magnetic solder, 2. design, fabricate, and test the microgravity magnetic solder experimental payload, and 3. prepare and analyze all solder samples using a Scanning Electron Microscope (SEM) and materials testing equipment.

The team will develop microgravity soldering experiments that will be flown on two separate parabolic-trajectory aircraft flights: an initial experiment flight during fall of 2016, and a second flight of a more sophisticated experiment during fall of 2017. Both the Zero-G Corporation and Integrated Spaceflight Services are being considered to provide the parabolic aircraft flights. The team will develop the Research Proposal Package engineering and safety documents that are required for the parabolic aircraft Test Readiness Reviews, to be conducted by the company that is selected to provide the parabolic-trajectory aircraft flights.

The WVU team members will be managed and mentored through their enrollment in the WVU courses, MAE 430 and MAE 431, Microgravity Research Team 1 and 2, developed and taught by project Co-I, Dr. John Kuhlman, who has taught and mentored 12 similar previous WVU student microgravity projects through the former NASA RGSFOP and RGEFP programs. Team members from partnering universities are also being mentored via a combination of weekly or twice-weekly Skype sessions and on-site participation. All team members will be trained to solder by a WVU electronics technician. All team members will attend a half-day workshop that will be delivered by NASA personnel from the NASA IV&V Facility in Fairmont, WV, on the NASA project Management principles documented in NASA NPR 7120.8. Outreach will be conducted by the team; funding is requested for NASA fellowships or internships for several team members, and to support a graduate student team mentor. Additional training will be provided in technical writing, laboratory safety, SEM sample preparation, and use of the SEM, and data analysis.

University of North Dakota, Grand Forks – Proposal 15-USIP15-0004

Dr. James Casler

Development of Digital Thermosonde Instrument for Quantification of Relative Cn2 Estimation Error between NWP Analysis and Thermosonde Measurements

Key Central Objectives:

The University of North Dakota (UND) and the University of Montana (UM) propose a study characterizing optical turbulence in Earth's atmosphere. This will be done through measurements of the vertical profile of the refractive index structure parameter, using student-built thermosondes launched aboard high altitude balloons (HAB), defined in the NASA USIP-2015 SFRO as Hand-Launched Balloon (Small). The multidisciplinary team will complete the design and build of the instruments, data analysis, and market applications for future commercialization of the system.

Methods:

In the spring of 2016, thermosonde design and construction will occur at UND, while radiosonde integration will occur at both UM and UND. UM will conduct the code development and model runs used to analyze the refractive index structure parameter. The National Center for Atmospheric Research (NCAR) Weather Research Forecasting (WRF) model will be compared to the radiosonde data. In the fall of 2016, there will be three HAB flights: one each from the UND campus, UM campus, and a centralized location of Dickinson, ND. The geographically diverse launch locations are expected to enable more general conclusions on atmospheric profiling. The evaluation of the thermosonde market potential will occur at UM. In the 2016-2017 academic year, team members at both universities will complete the final analysis of instrumentation and data, preparation of presentations, and delivery of final results across institutions.

Perceived Significance:

The digital thermosonde instrument development, testing, and market analysis will serve as "research on key innovative technologies." Making direct measurements with the thermosonde will reduce the uncertainties present with numerical weather models and predictions. Its commercialization will help strengthen our economy as we collaborate with private industry radiosonde manufacturers and focus on workforce development. The anticipated science results are of significance to NASA's Strategic Goal 2, "in advancing our understanding of Earth and developing technologies to improve the quality of life on our home planet."

This multi-institutional project will provide peer mentorship opportunities for graduate and undergraduate students, strengthening their communication and leadership skills.

They will received leadership, technical, and project management training throughout the project, while experiencing the complete project lifecycle model used by NASA. Additionally, this real-world application will offer substantive high level scientific and engineering research experience for the student team members.

University Of Alaska, Fairbanks – Proposal 15-USIP15-0005

Dr. Denise Thorsen

UAF Space Systems Engineering Program

On October 8, the first CubeSat (ARC1) designed and built by an interdisciplinary group of engineering and science students from Alaska was launched. Through this satellite we were able to develop a complete satellite bus, purchasing only the EPS subsystem. Additionally, we developed processes and training material for use with future missions. The Electrical and Mechanical leads now provide this training to new students. Our Graduate Student Mentor, Morgan Johnson, is currently working with a new group of undergraduate students, with a one year plan to lead them through concept studies to engineering model development and testing.

Our primary mission for this current solicitation is to refine our ARC bus architecture, fly an improved Launch Environment Data Logger, and modify our COMM subsystem by creating a flexible communication infrastructure (satellite and ground) that would allow testing of variable coded modulation techniques and retro-directive antenna arrays for small satellites. Additionally, we have solicited science payloads which may take longer than the 18 months delivery cycle of this solicitation. We intend to develop several student payloads, fly the one that completes in the time frame allowed, while progressing others for future missions. Some of these payloads (currently in concept phase) include developing (i) a Solar Sail deployment and drag experiment; (ii) an imager system to observe sprites in the upper atmosphere; (iii) an imager system to observe Arctic methane and black carbon.

Lastly, UAF students will support the development of a CubeSat in the Oregon Space Grant Consortium by providing mentorship; on-site summer training; and environmental testing support.

Carthage College – Proposal 15-USIP15-0008

Kevin Crosby

CaNOP CubeSat Consortium: Canopy Near-IR Observing Program

Forests currently absorb as much as 30% of annual global anthropogenic carbon dioxide emissions. This natural carbon sequestration is a critical yet poorly understood component of climate change mitigation. Many of the scientific questions around global forest carbon-uptake are large-scale questions of landscape ecology and therefore are appropriately addressed through space-based remote sensing. The Wisconsin Space Grant Consortium proposes to develop a CubeSat-based remote sensing platform for performing multispectral imaging of global forests in support of efforts to understand large-scale biomass production and carbon uptake in both mature and harvested forests. CaNOP will be a CubeSat platform for performing basic multispectral imaging of forest canopies in the Landsat Thematic Mapper bands TM2, TM3, and TM4.

The specific goals of CaNOP include imaging global forest regions of comparable biomass but varying histories of harvesting to obtain reflectance data in the visible and near infrared. These data will be used to compute the Normalized Difference Vegetation Index and related indices, which in turn can be used to estimate primary production metrics for biomass and carbon sequestration potential. The comparison between harvested and un-harvested forests may help address a recent and paradoxical observation that suggests that un-harvested forests are absorbing more carbon than they release.

The pedagogical goals of the proposed mission are to provide (1) an introduction to the space environment and associated design considerations, (2) an introduction to space systems engineering, (3) skill development in data modeling and validation, (4) specific competencies related to CubeSat design, deployment and mission operations, and (5) develop awareness around internship/career opportunities for students with CubeSat design-build-fly experience.

In support of the pedagogical goals associated with the CaNOP project, the Wisconsin Space Grant Consortium will host a design-build-fly workshop series that leverages our emerging partnership with historic Yerkes Observatory s Education Outreach Center to lead a team of 12 undergraduates through the process of designing and flying the first multi-institution CubeSat project in the state. The WSGC will then build on the skills and relationships established through CaNOP to provide ongoing summer workshop series for Affiliates from across the state to introduce the design-build-fly process in a low-barrier curriculum for small teams of students and faculty.

Despite the recent increase in interest and visibility of CubeSat projects, educational CubeSats are still largely confined to campuses with specialized faculty expertise. Further, most educational CubeSats have limited potential for scientific return. This USIP proposal seeks to demonstrate the potential for undergraduate-led scientifically rigorous research on the CubeSat platform. The proposal further seeks to build the infrastructure for a sustainable series of summer payload and space environment workshops to provide teams of faculty and students with the basic competencies to participate in CubeSat solicitations, sounding rocket payload programs, and other emerging educationally focused space hardware programs.

University of Washington – Proposal 15-USIP15-0018

Dr. Robert Winglee

HuskySat I – A Precusor for a Lunar Magnetic Field Mapper CubeSat

The proposed effort seeks to have undergraduates build a 3U CubeSat with onboard plasma propulsion and high gain telemetry for Low Earth Orbit that would be a precursor for an attempt at a larger 6U CubeSat designed for orbital insertion at the Moon as part of NASA's Centennial Challenge: CubeQuest. The ultimate goal is to develop a CubeSat system that would enable more extensive mapping of solar system objects including the Lunar magnetic anomalies. The proposed plasma propulsion system will use a pulsed plasma thruster using sulfur as its propellant. This system offers higher specific thrust than Teflon equivalents and as such would provide an important resource for CubeSats for orbital maneuvers. The communication system will utilize a deployable reflectarray that has the potential for greatly increasing the telemetry rate and range for communications for CubeSats and there greatly increase their scientific return.

The development of this project is a single institution effort at the University of Washington, but involves an interdisciplinary team with students from the College of Arts and Sciences, College of Engineering and College of the Environment. The team is diverse not only in majors but includes several women, Asians, an African American and a Hispanic. It will have a significant outreach component through collaborations with Radio Amateur in Space (AMSAT) and with Aviation High School. Their participation comes at no cost to the proposal but adds significantly to the full impact that the proposed efforts would have on STEM education.

The proposed work addresses NASA Strategic address NASA's Strategic Objectives: 1.4: Understand the Sun and its interactions with Earth and the solar system, including space weather, Objective 1.7: "Transform NASA missions and advance the Nation's capabilities by maturing crosscutting and innovative space technologies" and Objective 3.1: "Attract and advance a highly skilled, competent, and diverse workforce, cultivate an innovative work environment …"

South Dakota School Of Mines & Technology – Proposal 15-USIP15-0019
Prof. Charles Tolle
Development of a Multi-Spectral Imaging Device for Aerial Crop Monitoring

This is a joint proposal from two institutions within the South Dakota NASA Space Grant. It is led by South Dakota School of Mines and Technology (SDSM&T) and its partner South Dakota State University (SDSU). The project is focused on the development of a multi-spectral imaging device for crop observation. This device is intended for use on a tethered aerostat platform provided by industrial partner Raven Industries/Aerostar Inc. This project is designed to improve upon, calibrate, and harden a prototypical design of a multi-spectral camera created during a previous student NSF REU program in the summer of 2015 at SDSM&T. Furthermore, this project intends to foster an understanding of concepts vital to engineering including: interacting with multiple disciplines, designing for safety and reliability, and implementing detailed documentation among other realistic constraints.

This project has a heavy focus on mentoring. To that end, it is important to note that this proposal was written by students under the mentoring of the PI and Co-Is. Also, this project will be executed as a series of coordinated senior design/capstone projects at SDSMT as well as a series of closely coordinated student lead projects within the agricultural education and research programs at SDSU. This team will be student-led with students receiving mentoring and guidance from the project PI and Co-Is. Having students lead the team and holding the team to real industry standards intends to promote an understanding of real world engineering processes and promote leadership abilities in those students as they manage their team.

Michigan Technological University – Proposal 15-USIP15-0020

Prof. Lyon King

Stratus: cloud mapping cubesat

Cloud properties are important for the energy budget of the Earth, as both incoming sunlight and outgoing thermal radiation are very sensitive to cloud variables. Global models need to represent the role of clouds in Earth s coupled climate systems in order to produce reliable projection of climate change. Cloud fraction (CF), cloud top height (CTH), and cloud top wind (CTW) are important cloud properties that can be measured from orbital platforms. We propose here a cloud research mission named Stratus. The goal of the Stratus mission is to build, deploy, and demonstrate a low-cost CubeSat platform capable of measuring CF, CTH, and CTW with performance comparable to the best data obtained from NASA s flagship earth observing spacecraft. Our vision is that Stratus would serve as a pathfinder and, if successful, a number of inexpensive Stratus spacecraft could be deployed to gather extensive data relevant to cloud-driven climate forecast models.

The raw data returned by Stratus will be thermal infrared (TIR) images of cloudy scenes in Earth s atmosphere. During Phase I of the mission Stratus will operate in a three-axis-stabilized configuration with TIR imager boresight in the nadir direction. In this configuration Stratus will operate as a cloud surveyor, providing images that directly yield CF. During Phase II Stratus will collect data that will reveal CTH and CTW. This will be accomplished using asynchronous stereo imaging. In this technique two or more images of the same scene are recorded from different viewpoints. Features in the scene will be shifted laterally from image to image based on the parallax of the viewpoint. This displacement, combined with knowledge of the viewing direction, can be used to extract CTH and CTW. The Stratus vehicle will be integrated from commercially available components with very little custom hardware development. This approach minimizes the schedule risk associated with the 18-month timeline.

The Stratus investigating team is led by Prof. Lyon B. King, the Ron and Elaine Starr Professor of Space Systems Engineering at Michigan Tech. Co-I Mike Roggeman is an expert in image processing and Co-I Ossama Abdelkhalik is an expert in spacecraft dynamics and control. Dr. Dong Wu, a cloud and climate expert from the NASA Goddard Spaceflight Center, is the science customer and NASA collaborator. The faculty and science advisors will be assisted by a PhD graduate student teaching assistant who is provided as cost share by the university. The Stratus design and development will be conducted by an interdisciplinary team of undergraduates organized under the

Engineering Enterprise program at Michigan Tech. This team, which is already in place, consists of over 60 students from multiple academic disciplines. Students join the team in their freshman or sophomore years and remain with the team through graduation. The undergraduate team has significant prior nanosatellite development experience, having recently delivered the 70-kg Oculus-ASR spacecraft to the Air Force Research Laboratory for launch in 2016. A rigorous curriculum exists that will train/mentor the students throughout the program.

Rochester Institute Of Technology – Proposal 15-USIP15-0021

Dr. Michael Zemcov

The Cryogenic Star Tracking Attitude Regulation System (CSTARS)

Charge coupled devices (CCDs) have been the dominant optical-wavelength detector architecture for high-end optical imaging applications for decades. However, CCDs are inoperable below 120K due to electron freeze-out effects, prohibiting their use in space exploration applications requiring cryogenic temperatures. Mega-pixel complementary metal-oxide-semiconductor (CMOS) devices are known to work at temperatures as low as 10 K, suggesting that imaging devices based on this technology would operate in cryogenic environments without requiring active heating. In this program, we will take the first step to maturing this technology for flight applications in the cryogenic regime by developing and flying an attitude-sensing camera employing a low noise, high quantum efficiency cryogenic CMOS detector. By implementing an alternative imaging technology, we address NASA's major objective to ``transform NASA missions and advance the Nation s capabilities by maturing crosscutting and innovative space technologies.'' This technology will enable instruments ranging from actively-cooled star trackers for sounding rockets to low-temperature deep space cameras. As proof of this potential, we propose to use this instrument to enable a scientific study in which we will search for diffuse light around galaxies.

This investigation is a hands-on experiential learning experience that will develop the technical and leadership skills of a diverse and multi-disciplinary undergraduate student-led team. The team will consist of at least six undergraduates, one graduate student mentor, a faculty principal investigator, and two faculty mentors. The undergraduates will execute the project, with responsibility for the mechanical, optical and electrical engineering systems; firmware/algorithm development; flight planning and operations; and documentation and administration. The graduate student and faculty mentors will help train and advise the team. The principal investigator, who has significant experience working on a variety of space-flight projects, will guide and provide oversight for the project, which will span an 18 month period beginning in January 2016.

In this investigation, we will develop and fly an instrument for attitude regulation of cryogenic payloads. Images from the 5.5 mega-pixel CMOS sensor operating at 77K will be processed by on-board software, and pointing information will be used to determine control inputs to a celestial attitude control system. The instrument will first fly on a Black Brant IX technology demonstration flight, followed by a second deployment on a Black Brant IX science mission. Successful implementation of this instrument requires the development of various sub-systems. The mechanical/optical sub-system comprises a cryostat, optical camera, and interfaces to the sounding rocket. The electrical sub-system requires interface, control, and readout/processing components. Finally, the attitude sensing and control sub-system comprises the on-board firmware and software designed to detect stars, track the payload drift, and compute control inputs to the on-board attitude control systems. After each sub-system is built and tested at the component level, it will be integrated into the full instrument. When the instrument is operational and has been fully characterized, the student team will travel to Wallops Flight Facility in Virginia to integrate it with the rocket systems. Launch readiness will be achieved by the end of September 2016. The technology demonstration flight is currently scheduled for November 2016, giving 6 weeks of schedule reserve. Following a successful initial flight, we will modify the attitude correction algorithms in response to the achieved system performance, and a revised version of the camera will be flown as part of the science payload by late February 2017.

Montana State University, Bozeman – Proposal 15-USIP15-0022

Dr. Brock LaMeres

Student-Built CubeSat to Demonstrate a Radiation Tolerant Computer Technology

In this project, an interdisciplinary undergraduate student team will design and build a 3U CubeSat to demonstrate a novel radiation tolerant computer technology. The computer technology represents an advance to the state-of-the-art in performance, cost, and reliability and directly contributes to Objective 1.7 of the NASA Strategic Plan to "mature crosscutting and innovative space technologies". The technical readiness level of this novel computer system has been matured to TRL-6 over the past 8 years at Montana State University through a series of NASA-funded projects. These projects have allowed this technology to be demonstrated in cyclotrons, on high altitude balloons, on sounding rockets, and on an upcoming mission to the International Space Station. In this project, the technology will achieve its highest level of readiness yet (TRL-9) through a stand-alone satellite mission that will be fully planned, designed, and executed by an interdisciplinary team of undergraduate students at MSU. This mission will allow the undergraduate team to learn the formal systems engineering process used in aerospace missions through a comprehensive training and mentoring plan. The student training plan includes both formal classroom work through the 3-semester, engineering design course sequence at MSU in addition to rigorous mentoring from the MSU Space Science & Engineering Laboratory staff, which has successfully deployed 5 prior CubeSats.

In this project, an interdisciplinary team has been assembled consisting of students from physics, architecture, mechanical engineering, computer engineering, electrical engineering, and education. Over the 24-month project duration, this student team will fully plan and execute a mission to deploy a 3U CubeSat from the ISS using the NanoRacks CubeSat Deployer. This project is designed to provide rigorous training to the undergraduate design team on the NASA systems engineering process while also providing a low-risk path for mission success. The 3U CubeSat will use existing avionics that have been developed for prior MSU satellites. The avionics include control & data handling, communication to the existing MSU UHF/VHF ground station, and a power management system. The radiation tolerant computer system has been matured to flight-ready status through an existing grant from the NASA SmallSat Technology Partnership program. This eliminates a significant amount of risk in designing the final satellite by using existing, flight-proven or flight-ready sub-systems. Furthermore, using the NanoRacks CubeSat deployer will provide a low risk and achievable path to deployment by using a soft-stow launch environment. This reduces the required level of flight qualification to one that can be accomplished within the 24-month project duration and budget cap. Using the NanoRacks system also reduces the amount of logistical work required by the team to pass the NASA safety review phases for ISS deployment while still providing meaningful training in the mission review process.

This project also contains two unique outreach activities enabled by the interdisciplinary make-up of our team. First, the undergraduate student from the department of education will develop a set of learning modules for elementary school students based on this project. The modules will cover the characteristics of the space environment (gravity, pressure, radiation) and be deployed through the Montana Space Grant Consortium's Space Public Outreach Team to the rest of the state. Secondly, the undergraduate student from the school of architecture will create and manage a "mission patch design" activity in which 2nd graders from Morning Star Elementary School will create the artwork for the mission logo patch. The architecture student will then render the mission patch using a professional drafting tool and have actual patches created that will be given to the 2nd graders in addition to being used as advertising for the mission.

University Of Nebraska, Omaha – Proposal 15-USIP15-0024

Scott Tarry

Retractable Boom for Microgravity Payload

The NASA Sounding Rocket Program Office (SRPO) has identified limitations in present boom designs and desires a long-reach boom design that allows for re-stowing of the boom or attached hardware during flight. There is value in being able to recover hardware based on financial and scientific value. Additionally, in previous work, NASA Langley Research Center s Structural Dynamics Branch (Langley-SDB) initiated prototyping a solar panel designed to deploy through an unfolding process, a project that currently is unfunded. Langley-SDB would like a team to revisit the design, building and testing of a solar panel capable of being deployed and re-stowed from a sounding rocket. The objective of University of Nebraska-Lincoln (UNL) team s proposed project will be to advance the design and development of deployable/re-stowable booms and hardware in collaboration with NASA and Langley-SDB. This will involve creation of a long-reach retractable boom targeting increased reach combined with improved compactness in the stowed configuration, which will be the base unit for a new actuation system for stowing and deploying the panel. The retractable mechanical system could be integrated across other suborbital platforms containing deployable mechanisms for the safety and ease of recovery of the hardware.

A sounding rocket with deployable skin on the payload section and de-spin will be used as a launch vehicle for engineering validation of the boom and solar panel. This project will be led and performed by a multi-discipline student team who will apply technical and project management skills to achieve project success. The student team s technical and project skills will be enhanced through mentoring, training, and active participation in project development and monitoring, planning, building, testing, analysis, and, as needed, development of recovery plans. In addition to applying technical and programmatic skills for design and prototyping, students will participate in summer fellowships to grow their knowledge and enhance project development. A senior level three-credit-hour course will divide time between technical project development and application and training on project management and assessment tools to fully understand the multiple facets that affect successful project and program performance. The students will be supported in their efforts by faculty and graduate students with a variety of backgrounds (engineering, project management, law, etc.) to provide the students broad exposure to project considerations. Langley-SDB personnel will also continue their mentorship of this project.

Harvard College – Proposal 15-USIP15-0025

Prof. James Anderson

Harvard USIP 2015

Among the most urgent problems facing today s society is the impact of increasing global demand for resources on climate and the environment. To find innovative solutions to this and other challenges, it is imperative that tomorrow s scientists and engineers learn to integrate skills and ideas from science and engineering, as well as economics and the social sciences into their thinking. We will address these societal and educational imperatives through an innovative design project that builds students scientific understanding and engineering skills in the context of the design and fabrication of a cutting-edge instrument for measurement of atmospheric trace gases. Specifically, students will build an integrated cavity output spectrometer (ICOS) to provide measurements that characterize the effect of changing climate on halogen catalytic chemistry and ozone in the upper troposphere and lower stratosphere. Students will execute the entire design process, from scientific requirements through post-flight analysis, addressing optical, mechanical, electronic, and software challenges as well as design methodologies and project management. This endeavor will expand on the project-based design course (ES96) that we have offered in past years, in which students produced a working prototype by the end of the semester. Through summer and semester internships, senior theses and independent research projects, the USIP program will allow this year s ES96 students to carry their design beyond a prototype to a fully-functional flight. We propose a series of test and science flights of the USIP instrument on zero-pressure balloons, although the instrument would also be suited to aircraft and long-duration balloons.

University Of Massachusetts, Lowell – Proposal 15-USIP15-0026

Prof. Supriya Chakrabarti

SPACE HAUC: Science Program Around Communication Engineering with High Achieving Undergraduate Cadres

At the University of Massachusetts, Lowell (UMass Lowell) we have strong research programs in Printed Electronics and Space Science and Technology. This proposed mission will leverage these on-going efforts to provide an opportunity for undergraduate students to develop and flight demonstrate aboard a CubeSat platform a state-of-the-art, low-cost phased array antenna and phase shifter electronics manufactured by 2-D Printing.

Experiential Learning and Entrepreneurship are two key tenets on which a UMass Lowell undergraduate student s education is based. Our DifferenceMaker program systematically marries classroom education across various disciplines (science, engineering, humanities, education, and management) with project-based learning that produces work-ready and entrepreneurial students. The proposed Science Program Around Communication Engineering with High Achieving Undergraduate Cadres (SPACE HAUC) project will leverage these resources and those of the Massachusetts Space Grant Consortium (MASGC).

We plan to develop a spacecraft design curriculum in our Honors College and use the proposed mission aboard a CUBESat platform as its laboratory component . During the two years of this project, undergraduate students will gain hands-on experience in a broad range of spaceflight technology topics, such as, spacecraft and instrument design, hardware development, control theory, integration and tests, and remote spacecraft operations, as well as data analysis. The undergraduate students with different backgrounds (e.g., science and engineering) will team up and participate in this research and development effort for the equivalent of two courses. Graduate students involved in on-going spaceflight missions for their Ph.D. dissertation work will serve as mentors to the student teams.

SPACE HAUC s faculty team includes members who led a Student Launch Program sounding rocket experiment (SPECTRE), numerous sounding rocket and balloon experiments, and held leadership roles in a university-class explorer mission (TERRIERS).

In addition to the UMass Lowell administration, we are fortunate to receive strong support from two world-renowned aerospace organizations. BAE Systems has pledged to allow us use their environmental facilities at no cost. In addition, a systems engineer from Charles Stark Draper Laboratory and three veteran engineers from BAE Systems will mentor the students and participate side-by-side with the UMass Lowell team to make SPACE HAUC an unqualified success.

Old Dominion University Research Foundation – Proposal 15-USIP15-0027

Ms. Mary Sandy

Virginia Cubesat Constellation

The Virginia Cubesat Constellation mission is a collaborative project administered by the Virginia Space Grant Consortium (VSGC) that involves four Virginia Space Grant universities: Old Dominion University, Virginia Tech, University of Virginia and Hampton University. The project will be executed by an undergraduate student team that will be led by a Student Team Leader, Student Science Principal Investigator and Student Chief Technologist. The latter two students will each lead a science investigation and technology investigation, respectively. There will be a total of 17 named science and engineering positions in the student management structure. Student leaders and team members will consist of undergraduate students studying in the disciplines of Physics, Aerospace Engineering, Mechanical Engineering and Chemical Engineering. Across the four partner academic institutions, we expect at least 48 under- graduate students to be involved in nine university courses and two extracurricular independent study topics.(

The work will be integrated into the undergraduate engineering curricula at Old Dominion, Virginia Tech and University of Virginia through senior capstone design courses. These students will collaborate with students at Hampton University who have expertise in atmospheric science. The undergraduate students will be mentored by faculty, staff and graduate students. The mission will include both science and technology investigations. The science objective will be to obtain measurements of the orbital decay of multiple satellites to obtain in situ quantification of atmospheric drag and the variability of atmospheric properties. This objective will be achieved by designing and constructing three 1U CubeSats that will be launched and deployed simultaneously. By measuring the acceleration histories of a swarm of satellites -- with and without the deployment of devices to alter the spacecraft drag coefficient -- it will be possible to provide important spatial and temporal information on atmospheric properties. The technology objective will be to evaluate and demonstrate a system to determine and communicate relative and absolute spacecraft position across an orbiting constellation. This objective will support the science investigation but will also demonstrate that small, low-power radios (both traditional and software defined radios, or SDRs) can be used for assessing relative satellite separation distances in constellation missions and will also provide experience in ingesting and interpreting simultaneous datasets from multiple satellites. Multiple orbital insertion altitudes and inclinations are acceptable. Therefore, the mission is flexible in terms of desired orbital parameters, launch vehicles and launch locations. Simultaneous (or near-simultaneous) deployment of the three spacecraft is required. The launch will be manifested through the NASA HEOMD CubeSat Launch Initiative (CSLI).

Improving our ability to model and forecast the dynamic behavior of the thermosphere aligns with NASA s first strategic goal to Expand the frontiers of knowledge, capability, and opportunity in space.   The Virginia CubeSat Constellation also addresses NASA Objective 1.7, Transform NASA missions and advance the Nation s capabilities by maturing crosscutting and innovative space technologies. Accurate aerodynamic drag data will be invaluable to future CubeSat planners and will also provide additional temporal and spatial density data that can be correlated with solar activity to enable users to predict orbital lifetimes with greater confidence. The ability to gather spatially and temporally well-resolved datasets is relevant to a wide range of technological problems in space and Earth science.

University Of Illinois, Urbana-Champaign – Proposal 15-USIP15-0028

Prof. Victoria Coverstone

CAPSat

The Cooling, Pointing and Annealing Satellite (CAPSat) is a 3U CubeSat bus developed at Illinois. This satellite will be a technology demonstrator for three key experiments. First, it will demonstrate an active liquid cooling system for CubeSats. Second, it will demonstrate jitter control using piezoelectric actuators embedded in solar panels. Finally it will develop a single-photon annealing technique to extend the lifetime of sensors important to quantum entanglement experiments in space. The project is a multidisciplinary, multi-institutional effort involving engineers, physicists, business majors, journalists and interactive media students.

University Of Minnesota – Proposal 15-USIP15-0031

Prof. Demoz Gebre-Egziabher

Signal of Opportunity CubeSat Ranging and Timing Experiments (SOCRATES)

The objective of the Signal of Opportunity Cubesat Ranging and Timing Experiments (SOCRATES) mission is to validate the performance of a prototype positioning and timing (PNT) sensor for small satellites. The sensor makes opportunistic use of signals emitted by celestial gamma-ray and x-ray sources for relative ranging and clock synchronization between a pair of cooperating space vehicles. It is passive and is suitable for autonomous operations in deep-space. The sensor was developed by students under a Minnesota Space Grant Consortium sponsored project and is currently at a TRL of 5. SOCRATES will transition it to TRL 7.

Once in space on any orbit, SOCRATES will record and accurately time-tag high-energy photon events. Correlating this data with observations made of the same events by other observatories (e.g. SWIFT gamma-ray observatory) allows assessing PNT performance of the sensor only using one cubesat.

The High Altitude X-ray Detector Testbed (HAXDT) project will manage SOCRATES. HAXDT is an undergraduate-run, independent research project (sponsored by the Minnesota Space Grant since 2010) which designs and flight-tests high-energy photon detectors. System design will be integrated into the two-semester, capstone design course in aerospace engineering. Century (Community) College will help design and fabricate the cubesat structure. Sensor characterization and calibration will be integrated into an undergraduate physics laboratory experiments course. Technical documentation, reporting and press releases will be integrated into the technical writing and communication program.

Northwest Nazarene University, Inc. – Proposal 15-USIP15-0039

Dr. Miles Lawrence

Backscatter Radio Communication Between CubeSat and Remote Wireless Sensors

The goal of the NNU-CubeSat 2 mission is to test a system for deploying small, wireless sensor tags from the spacecraft that harvest RF energy and communicate with the spacecraft using backscatter radio. The sensor tags could be used to sense many phenomena including, but not limited to, acceleration, electric field strength, magnetic field strength. The wireless sensor tags will provide flexible sensor communication mechanism and reduced mission risk by reducing the complexity of the deployable boom design. Benefits of the wireless RF sensor tags include:

1)Use of wireless sensor tags reduces the complexity of the deployable boom design.

2)Elimination of the wired connection between the deployed sensor and the spacecraft may allow for sensitive electric and/or magnetic field measurements without interference from stray currents that often present on wired connections.

3)Use of energy harvesting sensor tags allows the sensor mass to remain small by eliminating the need for large solar array or large battery.

4)Backscatter communication allows the deployed sensor s data to be sent to the spacecraft with nearly zero additional power required from the sensor.

We intend to use the HEOMD CubeSat Launch Initiative (CSLI) for the deployment of the CubeSat.

University Of Michigan, Ann Arbor – Proposal 15-USIP15-0041

Prof. Brian Gilchrist

Langmuir Probe on the Miniature Electrodynamics Tether System (MiTEE) 3U CubeSat Mission

We intend to implement a CubeSat-based Langmuir Probe (LP) for ionospheric plasma density and temperature measurements that is based on a high TRL heritage design. The project will include a novel ground plasma chamber calibration to improve on-orbit temperature measurements. The Michigan USIP-LP will be integrated into the MiTEE 3U CubeSat electrodynamic tether mission. MiTEE is investigating the use of very short (~10 m) tethers to provide propellantless propulsion for drag make-up and orbital maneuvering of small, "smartphone"-sized spacecraft (picosats) and the 3U CubeSat is providing the test platform. The student project will include miniaturization and updating of electronics, modification of an existing LP probe design, adding a new deployment mechanism, and special design fabrication of the solar array covered side panels of the CubeSat to maximize plasma return current to the LP.

MiTEE was selected for flight through the NASA CubeSat Launch Initiative (CSLI) in February 2015. It has tentatively been assigned to ELaNa XX with a December 2017 launch date that is inline with USIP requirements. The USIP-LP students will work closely with the overall MiTEE team for instrument development, ground testing, spacecraft integration, and mission operations.

An important USIP-LP (and now USIP) mission goal is to provide a hands-on multidisciplinary spaceflight development educational experience rooted in faculty driven research and understand its impact on STEM education. Curricular and co-curricular mentoring and training is happening at several levels: experienced students on the team, industry supporters, faculty instruction, and professional engineers from Michigan s Space Physics Research Laboratory/XTRM Labs.

South Dakota School Of Mines & Technology – Proposal 15-USIP15-0045

Dr. Jason Ash

Acoustic Temperature Measurement of Lift Gas in High-Altitude Balloons

Through collaboration with Raven Industries / Aerostar International, an industry need has been identified to accurately measure the lift gas temperature within high-altitude balloons along with the temperature of the ambient air outside the balloon. Accurate temperature measurements of this nature would assist in validating the performance characteristics of future balloons. The multidisciplinary SDSMT student team will work on developing the technology necessary to do this.

The primary objective of the investigation, to be explored by a series of senior capstone design teams, will be on designing and developing an acoustic temperature measurement system. Results will be compared with more traditional measurement systems using radiant insulation.

The anticipated mission will include flying the technology on a balloon launched and recovered by Raven/Aerostar, either out of their facilities in Sioux Falls, SD, or Sulphur Springs, TX. The project will be an experience like no other for the students and faculty involved. The technology will be very innovative which will cause the team to conduct ample amounts of research and learn new techniques in systems engineering, design, and manufacturing. Fixtures that hold electrical sensors or relays will have to be designed and integrated into the balloon design. Different students will have the opportunity to lead sections of the project giving them firsthand leadership experience. Faculty advisors will constantly monitor the students and their progress. Underclass students will be trained and mentored by senior students. This project will be crucial for students wanting to learn more about the aerospace industry.

Purdue University – Proposal 15-USIP15-0046

Prof. Barrett Caldwell

Undergraduate Nano Ionospheric Temperature Explorer (UNITE),

The Indiana Space Grant Consortium (INSGC) is proposing that consortium academic affiliate, the University of Southern Indiana (USI), form a multidisciplinary student project team to develop, build and fly a 2U CubeSat to make a series of global measurements in the largely unexplored lower ionosphere. Critical build and test experience will be performed at INSGC industry affiliate, Near Space Launch LLC (NSL). The project name would be: Undergraduate Nano Ionospheric Temperature Explorer (UNITE). In addition, INSGC industrial affiliate Near Space Launch (NSL) will assist the project team in prototyping and testing the CubeSat components during 10 week internships at NSL in summer 2016. The objective of the science/technology component would be to explore the Extremely Low Earth Orbit environment and would feature (1) space weather measurements using a Langmuir plasma probe, (2) assessment of CubeSat drag in this lower region of the ionosphere and (3) CubeSat temperature measurements to compare against a thermal model. These UNITE objectives would be supported by the purchase of these Technical Readiness Level 9 subsystems: 2U structure, an electric power system, the Globalstar communications systems and Langmuir plasma probe. The Globalstar communications systems allows 24/7 data reception on a university server while the CubeSat orbits the earth. These key subsystems, with flight heritage from the successful TSAT (Taylor Satellite) CubeSat, will help ensure a high probability of UNITE mission success. The UNITE CubeSat flight would last between 30 and 60 days if inserted into an approximately 325 km, 50° inclination orbit.

USI and other INSGC affiliates are committed to having team members enrolled in a capstone design course, or equivalent course (for those students not yet seniors) to provide mentoring and training, including the use of NASA systems engineering training materials, with the goal of enhancing the students' technical, leadership and project skills. In addition, NSL will be the site of internships for students in order to prototype the CubeSat, complete the Preliminary Design Review, and provide further mentoring and training.

Louisiana State University and A&M College – Proposal 15-USIP15-0048

Prof. T. Gregory Guzik

COTEL

High energy gamma ray flashes from terrestrial sources have been observed by NASA satellites for decades, but the actual mechanism, assumed to be thunderstorm lightning, has yet to be fully characterized. Recently, a scientific group at LSU (TETRA) produced the first catalog of Terrestrial Gamma ray Flashes (TGF) observed from the ground and is now supported by NASA EPSCoR to greatly expand the ground observations. The goal of this project is to complement the TETRA ground measurements by characterizing conditions within thunderstorms that might lead to TGF emission. This will be accomplished using a small network of balloon-borne payloads suspended in and around thunderstorms to detect, timestamp and measure the intensity of localized electric fields, gamma radiation bursts and lightning strikes. Ground-based radar and lightning detection arrays will be used in conjunction with the balloon data to temporally and spatially chart recorded events to create a time-elapsed map correlating storm conditions with observed TGFs. Launching balloons safely in close proximity to thunderstorms presents a variety of challenges and risks. Therefore, mission design will be a high priority project objective and lessons learned from previous similar successful experiments will be incorporated into all aspects of the project to design / develop procedures and hardware to mitigate these risks. This project will be led by a multidisciplinary, undergraduate team from Louisiana State University. Students from Baton Rouge Community College, River Parishes Community College, and Southern University shall be trained and incorporated into the team through internships following the start of the project.

Participating Institutions include Louisiana State University (lead), Southern University Baton Rouge, Baton Rouge Community College, and River Parish Community College. The student team leader is Victor Fernandez-Kim and team members include David Bordelon, Jordan Causey, Joshua Collins, Robert Cottingham, Allen Davis, Stephen Harb, Brad Landry, Adam Majoria, Deanna Petty, and David Williams.

University Of Kentucky, Lexington – Proposal 15-USIP15-0049

Suzanne Smith

Metal-based 3D Printing in Microgravity

The objective is to characterize advanced 3D printing processes under microgravity conditions by building a compact 3D metal printer based on electron beam or laser in the Rapid Prototype Center at the University of Louisville. Melting pool characterization, material characterization and mechanical property testing will be performed. Melting pool morphology evaluation will be accomplished via single-track material deposition with various process parameters corresponding to different thermal input conditions. Morphologies of solidified cross sections such as width, height and depth of penetration will be measured under optical microscope and compared against computer simulations. A high-speed IR camera will capture real-time evolution of melting pool morphology and temperatures. Comparison between single-track experimental results and simulation results will calibrate models and guide microgravity investigations.

Experiments in microgravity will be conducted on a suborbital reusable launch vehicle to determine the effects of microgravity on the 3D printing process. Comparisons will be made between the 1-g and microgravity conditions. Measured results under microgravity will also be compared with the simulation results.

Undergraduate student participants will benefit from the hands-on experience of developing and launching a successful flight experiment, working with NASA for integration and pre-flight testing. They will learn from expert faculty and staff who are leading researchers in computational modeling and 3D printing. Two sub-teams will focus on the experiment (with UL Rapid Prototype Center) and on simulation (with the UL Computational Fluid Dynamics Laboratory), respectively. We also plan to send student interns to NASA centers and companies such as Blue Origin.

Brigham Young University – Proposal 15-USIP15-0050

Prof. David Long

Passive Inspection CubeSat

Spacecraft or satellite exterior inspection is critical to understanding mechanical and structural integrity and revealing unforeseen deficiencies, but existing techniques are expensive and require complex hardware. We propose to demonstrate a CubeSat-based method that will dramatically reduce the cost and complexity of partial inspection of the exterior of a spacecraft.

The proposed technology involves a CubeSat capable of capturing image data while near its parent vehicle. For testing purposes, the prototype Passive Inspection CubeSat (PIC) system will require rapid camera initialization after launch. With cameras powered immediately after separation, the CubeSat records video data of the exterior of the parent vehicle. This data is later downlinked to ground, reconstructed, and processed using student-developed software. A
s a secondary objective, we propose to conduct flight testing of the CHREC Space Processor (CSP), being developed by the University of Florida, BYU, and NASA Goddard as part of the NSF Center for High-Performance Reconfigurable and Embedded Computing (CHREC).

The principal investigator has extensive practical experience in mission development. He and faculty co-investigators will mentor student team members in senior project and senior capstone courses, individual mentoring, leadership development exercises, and hardware fabrication and testing. Associates in industry, including those at NASA Goddard, will provide additional technical mentoring. Experienced graduate students at BYU will help train undergraduate students who will be subsystem managers, technicians, and outreach coordinators.

University Of Kentucky, Lexington – Proposal 15-USIP15-0052

Suzanne Smith

KRUPS - Microgravity Testbed

The Kentucky Re-entry Universal Payload System (KRUPS) is a small re-entry capsule designed as a technology testbed. For its first incarnation, KRUPS has been designed to test Thermal Protection System (TPS) material and instrumentation. TPS are used to protect spacecraft, and its payload, from the extreme conditions of planetary entry. KRUPS has been developed at the University of Kentucky over the past 3 years, partially supported by funding by the Kentucky Space Grant. Currently, progress is being made in system verification, software implementation, and launch qualifications.

The objective at the end of the funded period is to launch KRUPS off a sounding rocket. As an interim step, KRUPS will be first put on a balloon flight, using local expertise and readily available material at the University of Kentucky. Following this initial test-flight, selected members of the KRUPS team will participate in the Rock-on! 2016 workshop at the end of June. This training will enable the students to prepare for the sounding rocket launch one year later.

For both launches, the KRUPS capsule will not undergo free-flight, but will serve as the data acquisition system for a hosted experiment. The launches will serve two purposes: qualify the systems for the KRUPS capsule, and provide experimental data for a group of undergraduate biology students studying the development of zebrafish cells.

It is expected that all the students participating in the project, including the non-engineering students, will undergo training for the NASA Project Management Requirements. Engineering students will also participate in the Rock-on! workshop program. In addition to the PI, the students will be mentored by three faculty members (two from the Department of Mechanical Engineering, and one from the Department of Biology), each providing unique skills and expertise. An engineering graduate student will provide expert support to the undergraduate students responsible for developing the KRUPS spacecraft, and two biology graduate students will do the same for the undergraduate biology team. Additionally, a team lead by an undergraduate student from the Department of Management will develop a commercialization plan for the KRUPS capsule.

Ohio State University – Proposal 15-USIP15-0053

Dr. Peter Lee

Microgavity sensing in tissue-engineered muscle

It is well know that extended spaceflight causes significant skeletal muscle atrophy in astronauts. However, the mechanisms that drive this process are not well understood. Previous experiments have shown that spaceflight leads to atrophy in isolated tissue-engineered skeletal muscle. We do not know how muscle tissues sense the microgravity environment leading to the muscle atrophy. We propose flying miniaturized tissue-engineered skeletal muscle constructs on a suborbital reusable launch vehicle and measuring real-time passive and active force production. Additionally, these tissues will be fixed with RNAlater at the end of the microgravity period to determine the differential expression of key genes when compared to ground controls. The team will design, build, and test the necessary hardware for the experiment. We will also optimize the tissue-engineering process. After the flight, the tissues will be processed in our laboratories for functional and gene expression analysis. The team is composed of an enthusiastic group of undergraduate students from multiple disciplines at The Ohio State University and Emory University. There will be regular meetings with a formal mentorship program in place. Faculty members from various disciplines will also serve as advisors and mentors for the group. Students will have the opportunity to serve as project or section leaders and it is anticipated that some of the students will commit to summer internships and/or get course credit as part of an independent study or capstone project. We also propose a formal educational outreach program, targeting K-12 students. Finally, we will also actively engage our public relations office to maximize the exposure of the team s activities and research.

University Of Georgia, Athens – Proposal 15-USIP15-0054

Dr. Deepak Mishra

CubeSat for GA Water Resources

The primary scientific goal of this mission is to develop and operate the first moderate resolution coastal ecosystem and ocean color CubeSat with a focus on Earth science applications. The mission will generate multispectral moderate resolution imaging products to monitor coastal wetlands status, estuarine water quality, and near-coastal ocean productivity in compliance with National Aeronautics and Space Administration (NASA)'s strategic objective of advance knowledge of Earth as a system to meet the challenges of environmental change and to improve life on our planet (Objective 2.2, Strategic Goal 2). The data will be used to monitor wetland biophysical characteristics and phytoplankton dynamics in estuarine and near-shore waters. We will utilize a spectral imager - the Argus UV Spectrometer (AUVS) - to acquire image data between 400 and 800 nm. We will also use the NanoCam C1U (NC1U), a moderate resolution Red, Green, and Blue light (RGB) camera, to provide visual images as well as perform proof-of-concept structure from motion (SfM) photogrammetry measurements from Low-Earth Orbit (LEO). The 3U CubeSat will contain all relevant ight systems, including Attitude Determination and Control System (ADCS), 2.4 GHz radio band used for data transmission (S-band) and Radio bands used for commands/telemetry (VHF/UHF) communications, a Microcontroller Unit (MCU)(the Texas Instruments Multi-Signal Processor Unit 432 (MSP432)), and power and thermal dispersion. We have partnered with NASA Ames for testing of the payload and communications. The CubeSat will be delivered and subsequently deployed from the International Space Station (ISS) via a Japanese H-II Transfer Vehicle (HTV), Russian Soyuz, or Commercial Cargo vessel under NASA CubeSat Launch Initiative (CSLI).

The student team will actively lead and participate in all aspects of the project; they have already formed groups to study communications issues, power specifications, temperature regulation, attitude control, project management and budgeting. This project provides a unique opportunity to further the growth of our educational programs, expose undergraduates to the challenges of space exploration, strengthen knowledge of coastal ecosystems process, and attract students into the NASA-related workforce.

Hartford College for Women – Proposal 15-USIP15-0059

Dr. Hisham Alnajjar

Development of the next phase of a high altitude robotic puppet that will be used to engage younger students (K-6) in real time on Near Space balloon missions.

Our proposal focuses on the development of the next phase of a high altitude robotic puppet that will be used to engage younger students (K-6) in real time on Near Space balloon missions. The prototype robotic puppet has been under the development at the University of Bridgeport supported by a Connecticut Space Grant Consortium (CSGC)Faculty Seed Money Grant awarded to Dr. Neal Lewis (PI) and Dr. Jani Pallis (Co-PI). The University of Bridgeport students already have experience with the prototype.

Additionally, during the summer 2015 semester, an undergraduate mechanical engineering student at Vanderbilt University (and CT resident) worked on this project with the University of Bridgeport student team and Drs. Pallis and Lewis. The student was responsible for the capsule design and initial capsule prototype (which looks like a Mercury capsule) and the three cameras that reside on/in the balloon capsule. The robotic monkey resides as the payload in the capsule. University of Bridgeport Industrial Design students designed and sketched the robot s animated motions as well as the interior of the Mercury capsule (boards that look like spacecraft control panels), while UB Electrical Engineering graduate students have designed and built the robot s circuitry and worked with command, control, telecommunications and data.

There has been significant discussion at the CSGC meetings regarding collaboration and capacity building within the consortium partners. The state of Connecticut is home to UTC (United Technologies Corporation) and its divisions Pratt and Whitney, UTRC (United Technologies Research Center), United Technologies Aerospace Systems (UTAS). Additionally, Connecticut has an additional 140 companies state-wide focused on aerospace. Prior to the sale of Sikorsky from UTC to Lockheed, UTC was the single highest employer of Connecticut residents. Thus, the CSGC feels the importance of serving as a catalysis and to contribute to the development of a pipeline of qualified, highly skilled and well-educated individuals for these Connecticut aerospace employers.

When the CSGC became aware of the NASA USIP announcement, the group believed that this would be an opportunity to build a multi-university interdisciplinary team for Near Space missions. UB is the only CSGC affiliate conducting ballooning and small satellite development.

UB works with a local children's museum (the Discovery Museum and Planetarium in Bridgeport, CT) which has a Challenger Center and the two groups are working on small satellite and ballooning projects together. University students developed software that runs on the museum's Challenger Center computers that serve as a real "mission control" for balloon flights (with a mission director, and different science stations). However from working with children we know the view from a HAB may not unfortunately enthrall a younger student for very long. And the thought was (as unusual as it may sound), "What if the children had a little friend onboard the HAB that they could interact with?"

The "friend" has become a robotic monkey (reminiscent of the early space flight days), and the robot is named after the actual chimpanzee that travelled into space, "HAM". However, this "HAM" stands for "High Altitude Monkey". The project has been student designed and the prototype is almost completed. We have a HAB test flight for some of the robot's motors scheduled for December 6, 2015. We see a rich educational curriculum in mission control, life sciences, Earth observation, remote sensing and history of space flight around HAM and the HAM HAB flights. The actually HAM HAB flights will be conducted several times per year as an outreach activity through the museum.

The team is interested in a HASP flight because we want to ensure that the robot will function at high altitude and temperature for periods of time (in particular the longevity and continued functionality of the servo motors used in the robot).

University Of Oklahoma, Norman – Proposal 15-USIP15-0060

Prof. John Dyer

Intelligent Airborne Radar Sensor Instrumentation for Multiple Flight Missions

The Intelligent Airborne Radar Sensor Instrumentation for Multiple Flight Missions will provide an excellent undergraduate experience for the students and contribute to the scientific knowledge base. Experiential learning in Science, Technology, Engineering, and Mathematics (STEM) is becoming a primary focus of the modern education system. In addition, creating mentored, student-driven opportunities gives undergraduates the chance to acquire critical real-world experience and skills needed by science and industry leaders. In this project, student teams will design and implement a small Ka-band radar capable of being mounted and deployed on a high-altitude airborne platform. The radar will be capable of a scanning range of three to five kilometers with multiple mission configurations. The system will employ a novel frequency-modulated continuous wave (FMCW) waveform and baseband radar scheme. In collaboration with the Goddard Space Flight Center and Jet Propulsion Laboratory, the developed instrument will be deployed to gain a better understanding of cloud microphysics, dynamics, and mixing. Data collection will also enable using the instrument for situational awareness in unmanned aerial systems (UAS). This project provides a pivotal foundation to enhance undergraduate STEM education through collaborative hands-on experiences in instrument design, development, implementation, and research.

Gadsden State Community College – Proposal 15-USIP15-0061

Ms. Audrey Webb

Microgravity Flight testing for Veggie Watering System

One of the major challenges in long-duration space missions aboard the International Space Station (ISS) and future missions to Mars is the need for a sustainable supply of fresh food for the crew. Plants grown aboard ISS were previously shown to provide the crew with nutritional substance and psychological benefits when grown in space. The VEGGIE unit currently aboard the ISS, experienced water flow problems during growth of lettuce samples. The suspected issue with the water delivery system was caused by dissolved salts precipitation and clogging the water membrane, preventing water from getting to plants. Our objective is to create, design, build, and flight test a passive plant watering reservoir for the VEGGIE system aboard ISS. The team will pay particular interest to what type of material is best used to store water for the plants, membranes to transport water across soil containment systems, and design constraints with the VEGGIE hardware. The team will operate the flight unit aboard the ZeroG aircraft to test the fluid dynamics in a reduced gravity environment. This work will focus on growing plants in space.

University Of Florida, Gainsville – Proposal 15-USIP15-0065

Dr. Norman FitzCoy

SwampSat II

SwampSat II is an innovative student led CubeSat project designed to study atmospheric weather phenomena in LEO, including very low frequency (VLF) wave propagation and energetic events caused by lightning. As a 3U CubeSat, SwampSat II will deploy a 5 m square loop antenna to receive VLF signals. The project s technical innovation will be the deployment of the loop antenna. The deployment mechanism is similar in concept to those found on solar sails; however, unlike sails which involve membranes which cannot tangle, the filament which forms the antenna loop can become entangled and thus requires an innovative spooling concept. The student team has begun the design/prototyping of this innovative deployment mechanism and to date has demonstrated the deployment of four 3.6 m booms that will deploy and support the loop antenna.

The proposed project is entirely student-run by the members of the Small Satellite Design Club (SSDC) and promotes the development of independent, scientific discovery outside of the classrooms. The membership of SSDC is composed of a culturally and ethnically diverse group of students from a broad spectrum of undergraduate classes and disciplines. The structure of SSDC is such that underclass students are mentored by upper-class students who themselves are mentored by graduate students. Additionally, since several team members from SwampSat (launched in 2014) are currently seniors and graduate students, they are ideal mentors for the SwampSat II team. Similar to SwampSat, SwampSat II plans to seek a flight opportunity via NASA s CubeSat Launch Initiative program.

University Of Wyoming – Proposal 15-USIP15-0067

Kevin Kilty

Inexpensive Microgravity Environment

The proposal is to perform design and development of a system to achieve microgravity for a duration of up to 20 seconds by means of dropping a low drag vehicle from a high altitude balloon with boundary layer control or small rocket motor assist.

Missouri University of Science and Technology – Proposal 15-USIP15-0072

Dr. Henry Pernicka

Use of Multi-Mode Propulsion to Expand CubeSat Mission Capabilities

The investigation to be proposed will involve the technology demonstration of a multi-mode propulsion thruster integrated into a 3U CubeSat. The multi-mode propulsion system can provide both large and small thrust profiles, enabling expanded mission capabilities. Historically, the use of CubeSat propulsion systems on orbit has been limited. The strengths of Missouri S&T faculty in spacecraft propulsion, microsatellite design, power, and GN&C will be used to mentor a multidisciplinary team of undergraduates to design, fabricate, test, and conduct operations on-orbit to enable project success.

Mission operations will use a launch to low Earth orbit secured through a NASA CSLI application. Once on-orbit, the multi-mode thruster will be used in its high-thrust mode to execute a relatively large maneuver to lower the orbit perigee by a significant amount. The multi-mode thruster will then be operated in its low-thrust mode to decay the orbit until reentry occurs. The functionality of the thruster will be validated by post-processing of telemetry data by the undergraduate team to determine both the low and high thrust values achieved.

The technical, leadership, and project skills for the student project team will be developed through careful mentoring by the PI and the three co-investigator faculty members. A doctoral graduate student (with experience from a summer internship at JPL, as well as leading a Missouri S&T team developing and preparing to fly a microsatellite in the near future after placing first in AFRL s Nanosat 8 competition) will guide the student team on a daily basis. Guidance from colleagues at NASA Ames and Marshall will be sought as well.

A preliminary student team has been formed, composed mostly of junior-level students committed to the full duration of the 18-month project (from the commencing of the project in January 2016 through July 2017). A student team leader has been named (Damon Wendt), and eighteen students currently on the multidisciplinary team include Jon Rasche, Grant Watkins, Sarah Dawson, Jerrica Givens, Kyle Segobiano, Ian Murphy, Connor O Leary, Ajeenah McShan, Anton Kuzubov, Elizabeth Gaa, Zak Kessel, Jon Rodhouse, Peter Dolan, Jill Davis, Bruce Morrison, Darci Graefser and Jacob Listhartke. Others will be added as needed as the project progresses.

University Of Idaho, Moscow – Proposal 15-USIP15-0073

Dr. Joseph Law

Training in Advanced Technology and Exploration Research To Optimize Teamwork in Space (TATER TOTS)

Objectives of the proposed science/technology demonstration:

The primary objective of the science/technology demonstration is to develop and test a low-cost imaging payload to be launched on a high-altitude balloon platform. The secondary objective is to develop and test the feasibility of a local positioning system that could be used in a Martian environment to track astronauts in the absence of a global positioning satellite system. The tertiary objective is to fly a microbial payload to understand the effects of the high-altitude environment on microbial growth rate. All of the payloads will be designed, developed, tested, and flown by the student team with guidance from the graduate student mentor and the principal investigator.

Anticipated mission operations:

The payloads will be launched during the NASA (Field Investigations to Enable Solar System Exploration (FINESSE) field research expedition at Craters of the Moon National Monument and Preserve in southern Idaho in August 2016. The high altitude imaging data collected will be compared to data collected on the ground by the field research team and by unmanned aerial vehicles also in use at the site. The local positioning system will use three tethered balloons and will also feature a thermal camera to gather thermal profile data for the FINESSE research team. The microbial payload will fly as an additional add-on payload on the high-altitude balloon.

Plans to enhance the technical, leadership, and project skills for the student project team, including mentoring and training:

As part of this project, the student team will receive the following training:

Technical

- Building and programming multiple payloads
- Collecting and analyzing high-altitude imagery data
- Launching and retrieving a high-altitude balloon payload
- Launching and retrieving tethered balloon payloads
- Designing and building a prototype local positioning system

Leadership

- Networking and collaborating with peers and mentors
- Presenting at scientific conferences
- Observing and working with researchers during internship/summer research opportunities

Project skills

- Planning and managing projects
- Managing budgets and schedules
- Reporting on executed projects

Montana State University, Bozeman – Proposal 15-USIP15-0075

Dr. John Sample

LAFTR:Light And Fast TGF Recorder

Terrestrial Gamma-ray Flashes (TGFs) are submillisecond bursts of radiation from lightning flashes. The accelerated electrons (up to tens of MeV) and the gamma-rays they produce in the atmosphere are intense enough to be hazardous to aircraft passengers and crew. TGFs have been extensively studied by NASA spacecraft (CGRO, RHESSI, Fermi). However, reconciling competing models of TGF formation requires more photon counts per event. A small but high-throughput detector at balloon altitudes, about 10-20 km above the TGF, can accomplish as much in this direction as an enormous new spacecraft instrument in low-Earth orbit. This detector could later be mass produced for ground-based thunderstorm observations (e.g. wind turbines television towers, or a network of high schools), for observations from UAVs and dropsondes, and as an inexpensive but capable all-sky monitor on a spacecraft for rare ultrabright cosmic x-ray transients (Soft Gamma Repeater outbursts, Galactic supernova, etc.) The proposed effort is to develop a complete detector package that is small enough (mass, volume) that it can be flown on 3000 gram balloons for wide distribution and simple flight operations around thunderstorms. The prototype detector will also be flown as part of a typical piggyback balloon launch provided by NASA. As this is a complete science mission, from detector development through data collection and analysis, it is well suited to the multidisciplinary goals of this opportunity. The multi institution student led project is a realistic training experience with engineering and science tasks being shared between the two institutions, with appropriate mentors at both.

Arizona State University – Proposal 15-USIP15-0076

Prof. Judd Bowman

Phoenix 3U CubeSat To Study Urban Heat Islands

Urban environments have become an important component of the global climate system, yet regional (km-scale) environmental monitoring of cities and their surroundings remains lacking. Routine orbital imaging of cities can address the effects of urbanization on local and regional land-atmosphere interactions, air quality, health, hazard assessment, water and energy transportation, and other climate factors. We propose a 3U CubeSat to demonstrate the effectiveness of nanosat platforms to conduct scientific investigations of urban environments. The Phoenix CubeSat will carry a thermal-IR imaging payload to study spatial and temporal changes in the heat properties of Phoenix, Arizona. The imager is based on the THESIS instrument developed by an ASU student using commercial micro-bolometer arrays.   The system will yield secondary science from thermal imaging of ocean currents, volcanic plumes, and other surface processes.

Minimum orbital requirements are satisfied by 40-degree inclinations and 400 km or higher altitudes. Launch will be coordinated through CSLI and operations will be conducted from ASU s Tempe campus using its ground data station.

Phoenix will be designed and fabricated by ASU s Sun Devil Satellite Lab undergraduate organization with mentoring from an ASU graduate student and faculty, including the PI and Prof. Phil Christensen. Senior capstone teams from ASU s Schools of Engineering will work with interdisciplinary teams of geoscience and sustainability undergraduates to conduct the mission. ASU will create new internships for journalism undergraduates to be embedded in the project for documentation. Graphic design undergraduates will provide dedicated artwork for the spacecraft, mission materials, and data analytics.

Northwestern University, Evanston – Proposal 15-USIP15-0081

Dr. David Dunand

SpaceICE - Interface Convective Effects

Directional freeze-casting is an ice-templating technique that can be utilized to fabricate a wide variety of materials. In this process, aqueous suspensions are subjected to a thermal gradient, causing ice dendrites to grow unidirectionally. As the solidification front advances, suspended particles are rejected, subsequently self-assembling within interdendritic space. Ice dendrites are later removed, leaving elongated, aligned pores. This technique has the potential to offer a high degree of microstructural control, provided solidification conditions are well-controlled. However, the underlying principles that govern solidification behavior in this complex system are not well understood. Indeed, the limited accuracy of computational models, containing inevitable simplifications, makes a priori predictions impossible. This work serves to utilize a CubeSat platform to obtain the experimental data necessary to improve computational modeling.The proposed training and mentoring plan expands upon traditional mentoring programs by incorporating mentors at varying levels of career and academic advancement. Inherently, this approach empowers students to take on leadership roles at varying levels of responsibility. Students will receive extensive technical, scientific, and leadership training throughout the program.

Sonoma State University – Proposal 15-USIP15-0085

Prof. Lynn Cominsky

EdgeCube: A 1U Global Monitor for Earth's Ecosystems

The EdgeCube project is a partnership between Sonoma State University (SSU), Santa Clara University (SCU) in California and Morehead State University (MSU) in Kentucky, with additional support from the California Space Grant Consortium (CaSGC).

EdgeCube is a 1U CubeSat that has been specifically designed to monitor the red edge characteristics of 300 km areas of the earth using five narrow spectral bands in the wavelength range 630-800 nm. Although EdgeCube s ground spatial resolution is substantially less than conventional multispectral satellites, its design will test the red-edge monitoring concept within the limitations of a CubeSat project. Data from EdgeCube will enable tests of different red-edge analysis techniques that are particularly suited for detecting long term change in large, relatively homogeneous ecosystems.

The EdgeCube project will build on the successful construction and operations of the 3P PocketQube T-LogoQube that telemetered magnetometer data from orbit for 2 months in 2013 (see http://universe.sonoma.edu/T-LogoQube for details). The proposed EdgeCube project will enhance the technical, leadership, and project skills for the diverse eight-member multi-disciplinary undergraduate student team. These students will design, construct, test and operate EdgeCube. Ground operations will be conducted using existing facilities at SCU, SSU and MSU.

Students will be mentored by Lynn Cominsky (PI, SSU), Co-I Matthew Clark (SSU), Co-I Garrett Jernigan (retired from UC Berkeley's Space Sciences Laboratory), Co-I Christopher Kitts (SCU), Co-I Bob Twiggs (MSU), Warren Wiscombe (retired from NASA's Goddard Space Flight Center) as well as by a graduate student from Santa Clara University and additional volunteers from SSU and SCU. Work done by undergraduate students will fulfill degree requirements for senior capstone projects in geography, physics, electrical engineering, mechanical engineering, computer engineering, and computer science majors.

Georgia Tech Research Corporation – Proposal 15-USIP15-0086
Dr. Brian Gunter
Development of a lidar cubesat mission

The objective of this project is to provide a group of select and talented undergraduates hands-on experience on all aspects of the development of a satellite mission. Under the guidance of faculty, staff, and graduate students, the undergraduate student team will assemble, test, and integrate a miniaturized LiDAR imaging camera into a 3U cubesat. A parallel development will also design and test a deployable inflatable that will serve as the lidar camera s primary imaging target. The goal of the cubesat mission is to demonstrate cm-level altimetry precision over tens of kilometers. The applications for a compact laser altimetry system are numerous, and are particularly valuable for planetary missions involving the topographic mapping of planetary bodies such as moons and near-Earth asteroids. Furthermore, the mission will be able to accomplish its mission objectives in any low-Earth orbit altitude, making it an ideal candidate for future rideshare opportunities. The project team would consist of a mixture of science and engineering undergraduate students that would be guided and trained throughout the project lifecycle by faculty and graduate students with prior cubesat and lidar experience. Select students would develop leadership skills by serving in subsystem lead roles, and by presenting project results at national conferences. Participating undergraduate students would also receive course credit for their efforts.

University Of California, San Diego – Proposal 15-USIP15-0090

Prof. John Kosmatka

Solar-Powered Unmanned Aircraft System for Long-Endurance Enviromental Monitoring

Undergraduate engineering and science students from the University of California, San Diego will develop a new Unmanned Aircraft System (UAS) for long endurance (20+hours) arctic summer science missions. These missions include atmospheric monitoring, animal migration patterns, and ground surveillance. The proposed UAS will be developed based upon the flying wing "Prandlt" glider currently being developed at the NASA Armstrong Flight Research Center (PI: Al Bowers) with students from the University of California, San Diego. Preliminary wind tunnel tests (NASA-Langley) and glider flight tests (NASA Armstrong) have shown that this radical configuration has more than 30% less drag than conventional aircraft. The proposed USIP project involves transforming this low-drag glider design to a very efficient solar power autonomous UAS by incorporating solar cells, electric motors, and batteries. This radically new aircraft platform along with flight performance instruments will be flight tested at NASA Armstrong during this USIP program time period. Once proven, this aircraft will be used for a long-range atmospheric science mission in northern Alaska (summer, 2018). There are no existing UASs that can perform these long-range zero-pollution missions. This new 'green' UAS platform will expand NASA's fleet of long-range science aircraft.

Undergraduate students will (1) perform the engineering design and analysis to develop the solar electric powered UAS, (2) fabricate the composite aircraft using NASA Armstrong provided tooling, (3) install the aircraft autopilot and performance sensors, (4) perform flight testing at NASA Armstrong Flight Research Center, and (5) evaluate the UAS performance for the upcoming arctic science mission. Students will be mentored by Professor John Kosmatka (UCSD, PI), university graduate students, and unfunded NASA mentors (Al Bowers, Oscar Murillo, Dave Berger).