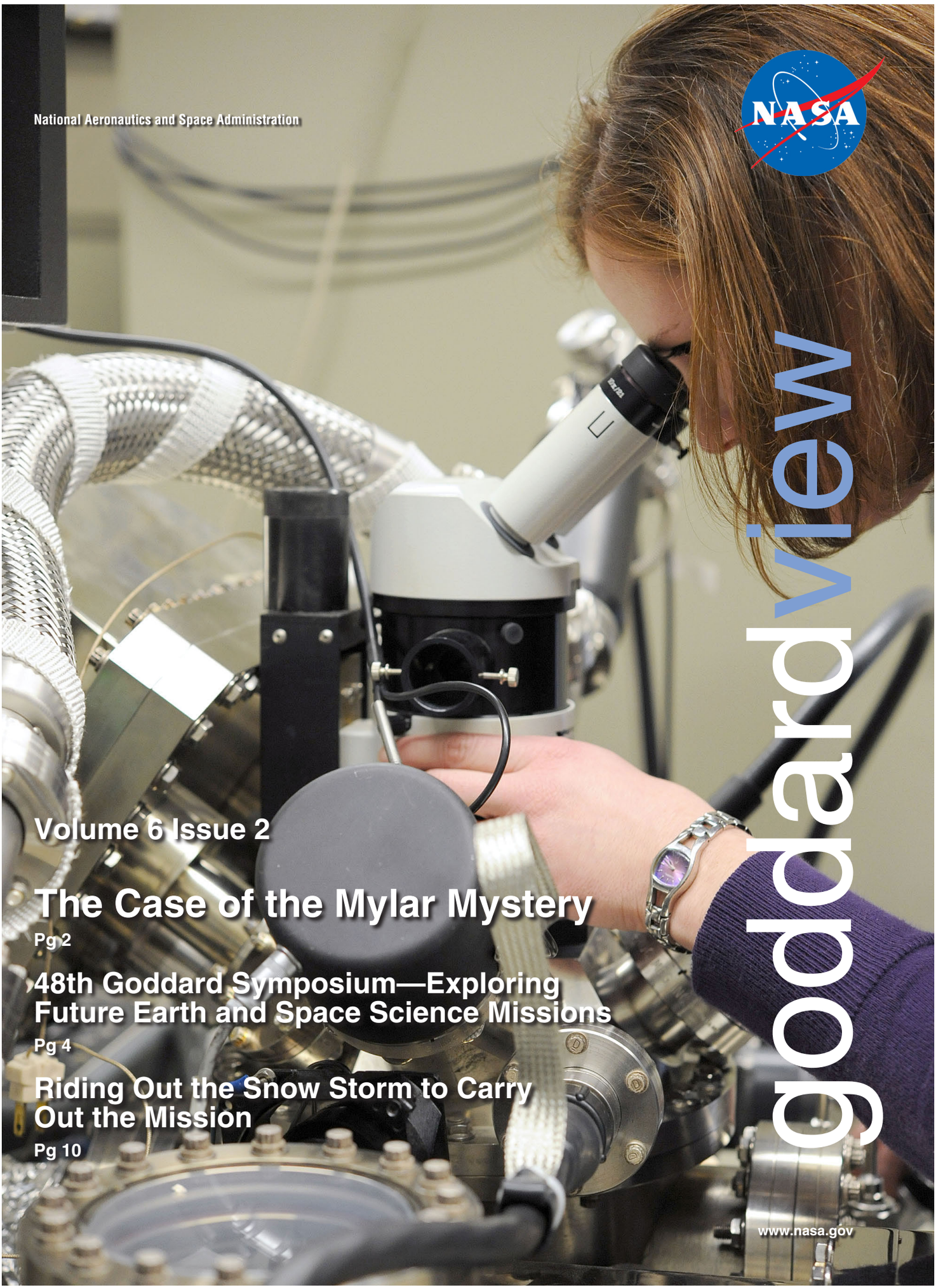

National Aeronautics and Space Administration

goddardview

Volume 6 Issue 2

www.nasa.gov

The Case of the Mylar Mystery

By Elizabeth M. Jarrell and Dee Kekesi

There is a mystery afoot at Goddard—the case of the Mylar mystery to be exact. On January 11, 2010, "History Detective" Tukufu Zuberi, from the PBS show "The History Detectives," came to Goddard to investigate a mystery. "The History Detectives" show asks viewers to submit unusual objects or clues with a possible historical interest and then selects one as the basis of investigating an historical mystery.

In our case, Zuberi had one clue: a small, unassuming, silver sample of Mylar with pink residue on one side. The mystery to be solved was whether or not this bit of Mylar was from Goddard's *Echo II* satelloon project. Satelloons are a combination of satellites and balloons, which were constructed out of bright, metallic Mylar for increased visibility.

During the early 1960s, Goddard launched the *Echo I* and *Echo II* satelloon projects. The *Echo* projects were instrumental in letting the world see that the U.S. was a major force in the space race and not very far behind the Soviet Union. Among the many contributions of the *Echo* programs are the first voice communication via satellite, which was made by none other than president Dwight Eisenhower, and the first coast-to-coast telephone call using a satellite. In addition, the *Echo* programs resulted in advances in atmospheric density, solar pressure, gossamer structures, solar sailing, and transmitting video via satellites.

History Detective Zuberi turned to retired NASA engineer and self-professed *Echo* satelloon historian Ron Muller for help in solving the Mylar mystery. He received additional assistance in the form of testing from four members of Goddard's Materials Engineering Branch including Michael Viens, Alejandro Montoya, Debbie Thomas, and Marjorie Sovinski.

Photo credit: NASA/Debora McCallum

Caption: Debbie Thomas cutting the Mylar sample to be tested during a visit from the PBS series "The History Detectives," while host Tukufu Zuberi looks on.

So, what did History Detective Zuberi and his Goddard colleagues determine? Was the silver bit of Mylar from our Echo II satelloon project? For the answers to these and other questions regarding the case of the Mylar mystery, stay tuned to watch a future episode of "The History Detectives" airing on PBS in the summer of 2010. ■

GoddardView

Volume 6 Issue 2

Table of Contents

Cover caption: Marjorie Sovinski, from Goddard's Materials Engineering Branch (Code 541), peers into the X-Ray Photoelectron Spectrometer for the presence of chromium.

Photo credit: NASA/Debora McCallum

GoddardView Info

Goddard View is an official publication of the Goddard Space Flight Center. It is published bi-weekly by the Office of Public Affairs in the interest of Goddard employees, contractors, and retirees. A PDF version is available online at:
http://www.nasa.gov/centers/goddard/news/index.html

Managing Editor: Trusilla Steele
Editor: John Putman

Deadlines: News items for publication in the Goddard View must be received by noon of the 2nd and 4th Friday of the month. You may submit contributions to the editor via e-mail at john.m.putman@nasa.gov. Ideas for new stories are welcome but will be published as space allows. All submissions are subject to editing.

NASA Day at Maryland Capitol Celebrates *Hubble*'s 20th Anniversary

By John Putman

On February 23, Goddard employees presented interactive exhibits and engaging presentations in the Presidential Conference Center at the Miller Senate Office Building at the State Capitol in Annapolis, Maryland. House and Senate members, their staffs, and visitors experienced Goddard's scientific achievement with a breakfast presentation by astronaut Dr. John Grunsfeld. Last summer, Grunsfeld touched the *Hubble Space Telescope* for a final time during the Fifth servicing mission onboard the STS-125 Shuttle mission.

Representatives from Goddard spend the day visiting Maryland lawmakers to remind them about Goddard's mission and its continuing contribution to education and the state's economy. Goddard is one of Maryland's most remarkable institutions employing over 9,600 people and obligating over $1 billion within the state.

Photo credit: NASA/Pat Izzo

Caption: Goddard Deputy Director for Science and Technology, James Garvin (left), and Astronaut Dr. John Grunsfeld (center) visit with Maryland House Speaker Michael Busch.

Part of the day's activities included the presentation of two Resolutions, one from the Maryland House of Delegates and one from the Maryland State Senate, congratulating Goddard in recognition of the 20th anniversary of the *Hubble Space Telescope* and its continuing contribution to mankind. Associate Director and Program Manager for *Hubble*, Preston Burch, and Deputy Associate Director of NASA's *Hubble Space Telescope* Development Project, Frank Cepollina, accepted the documents on behalf of Goddard.

Photo credit: NASA/Pat Izzo

Caption: Preston Burch and Frank Cepollina, stand with the Resolutions presented to Goddard by both houses of the Maryland legislature.

The highlight of the morning was astronaut Grunsfeld's inspiring presentation entitled, "Maryland—*Hubble* Central." The talk included stunning images and stirring video of the historic journey to *Hubble*. Audible gasps filled the room more than once during Dr. Grunsfeld's presentation.

Photo credit: NASA/Debora McCallum

Caption: Astronaut Dr. John Grunsfeld wows the audience with images and video of his journey to Hubble.

Visitors to NASA Day were also treated to exhibits from *Hubble* and the *James Webb Space Telescope*, *Hubble*'s scientific successor. The exhibits featured video presentations, scale models of spacecraft, and plenty of giveaways. Many of the tools used to repair and improve *Hubble* were displayed on several tables. *Hubble* team members from Goddard were there to talk about the tools and explain their uses.

Photo credit: NASA/Debora McCallum

Caption: Hubble *Materials Engineer Ben Reed describes a sample of multi-layer thermal insulation from* Hubble. *The insulation was replaced by a New Outer Blanket Layer during Servicing Mission 4.*

This annual event provides an excellent opportunity for Maryland lawmakers to gain a better understanding of Goddard's impact within the state, the Nation, and our global community. ■

48th Goddard Symposium—Exploring Future Earth and Space Science Missions

By Dewayne Washington

"Earth and Beyond: The Next Decades" is the theme for the 48th Robert H. Goddard Memorial Symposium to be held March 10–11, 2010 at the Greenbelt, Marriott Hotel. The American Astronautical Society (AAS), with support from the Goddard Space Flight Center, sponsors the annual event in honor of the "Father of Modern Rocketry."

For almost 50 years, senior leaders from around the world have met to discuss the latest research in space exploration. "The Goddard symposium is extremely well-timed, just weeks after the announcement of NASA's budget for the coming year," says Dr. Harley Thronson, second-year Chairperson of the Symposium Committee. "This year, with the apparent direction change for human spaceflight, we offer leaders in space exploration inside and outside Government the opportunity to present and discuss this from different perspectives."

Thronson is the Assistant Director for Advanced Concepts in Astrophysics at Goddard. The four-year Goddard employee's career is as diverse as the symposium. Before working 10 years at NASA Headquarters, the former University of Wyoming professor was also on the senior staff of the Royal Observatory in Edinburgh, Scotland. "To consistently produce engaging, thought-provoking sessions, I believe you must begin with an intelligent, diverse planning team," says Thronson. "For many team members, this is the fourth or fifth year, which speaks well of their dedication."

Photo credit: NASA/Bill Hrybyk

Caption: Dr. Harley Thronson, Chairperson for the Symposium Planning Committee.

The invited list of presenters includes Dr. John Holdren, Science Advisor to President Obama; Lori Garver, NASA Deputy Administrator; Rob Strain, Director, Goddard Space Flight Center (GSFC); and Dr. John Grunsfeld, Deputy Director, Space Telescope Science Institute.

"The Goddard Symposium is also an excellent opportunity to gain a better understanding about what is evolving within the aerospace industry," said James Kirkpatrick, Executive Director, AAS.

The complete 2010 program can be viewed at http://astronautical.org.

Committee members for the 2010 session include Marty Frederick, Corporate Director, Civil Space Programs, Northrop Grumman Space Technology; Jon Malay, Director, Civil Space Programs, Lockheed Martin Washington Operations; Kathy Nado, NASA Headquarters; Jan Kalshoven, NASA GSFC Emeritus; Mike Calabrese, SGT, Inc.; Joe Gillin, Lockheed Martin Missions Services; Pat Rainey, Business Development, The Boeing Company; and Sarah James, Executive Director, SOLE: The International Society of Logistics.

The first Goddard symposium was held 1961 in conjunction with the National Space Club's Annual Goddard Dinner. "Interaction of Space Vehicles with an Ionized Atmosphere" was the theme for the first meeting enthusiastically supported by Mrs. Robert Goddard.

That successful meeting became an annual event with evolving themes from strictly technical to more general topics of interest to the civil space community. The Goddard community officially began supporting the symposium in 1997 with prepaid registration for Center personnel to attend.

"My favorite memory of the symposium was when Dr. John H. Marburger III, Science Advisor for President Bush, presented his two symposium speeches to the Augustine Committee," says Thronson. "It was the best statement of the then White House space policy and revealed the respect given to this meeting."

The Robert H. Goddard Memorial Symposium is dedicated to encouraging the expansion of our knowledge of the Earth, our solar system, and the universe through observations from space. To ensure our Nation maintains leadership in this endeavor, Goddard is committed to excellence in scientific research and investigation, the development of space systems, and the advancement of essential technologies. The Goddard Symposium provides an environment to dream of yesterday, realizing it is the hope today, and the reality of tomorrow, an environment Dr. Robert Goddard could truly treasure. ■

NASA and NOAA's GOES-P Launched Successfully

By Steve Cole, John Leslie, and George H. Diller

The latest *Geostationary Operational Environmental Satellite*, GOES-P, lifted off March 4, 2010 aboard a Delta IV rocket from Space Launch Complex 37 at the Cape Canaveral Air Force Station, Fla. The new National Oceanic and Atmospheric Administration (NOAA) satellite joins four similar spacecraft to improve weather forecasting and monitoring of environmental events.

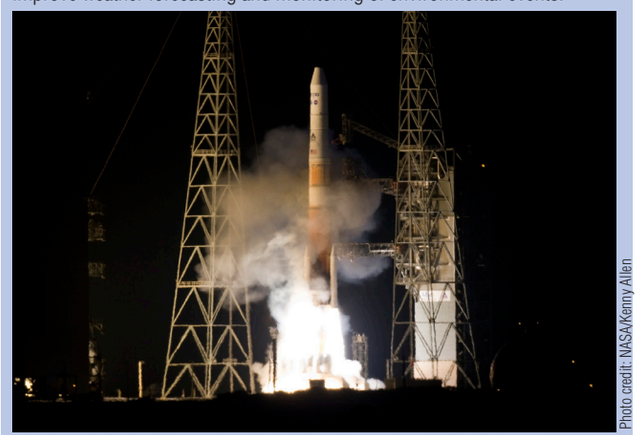

Photo credit: NASA/Kenny Allen

Caption: A Delta IV launch vehicle lifts off carrying GOES-P into orbit.

"It's a great day for NASA and NOAA, as this last launch completes the spacecraft in the GOES N-P series," said Andre Dress, the NASA GOES Deputy Project Manager. "It means the hard work and dedication from this team during the past 12-plus years all has been worth it. Our review of the spacecraft and launch vehicle data shows that GOES-P is in a nominal transfer orbit with all spacecraft systems functioning properly."

GOES-P is the third and final spacecraft in the GOES-N series of geostationary environmental weather satellites. On March 13, GOES-P is scheduled to be placed in its final orbit and renamed GOES-15.

NOAA has two operational GOES satellites hovering 22,300 miles above the equator—GOES-12 in the east and GOES-11 in the west. Each provides continuous observations of environmental conditions in North, Central, and South America and the surrounding oceans. GOES-13 is being moved to replace GOES-12, which will be positioned to provide coverage for South America as part of the Global Earth Observing System of Systems (GEOSS).

NASA contracted with Boeing Space and Intelligence Systems of Seal Beach, Calif., to build and launch GOES-P. Approximately 20 days after launch, Boeing Space and Intelligence Systems will turn engineering control over to NASA. About five months later, NASA will transfer operational control of GOES-15 to NOAA.

NOAA manages the GOES program, establishes requirements, provides all funding and distributes environmental satellite data for the United States. Goddard procures and manages the design, development, and launch of the satellites for NOAA.

For more information about GOES-P, visit: http://www.nasa.gov/goes-p.
For more information about NOAA, visit: http://www.noaa.gov. ■

Solar Dynamics Observatory Launches

By Don Savage

On February 11, NASA's *Solar Dynamics Observatory* (SDO) lifted off from Cape Canaveral Air Force Station's Launch Complex 41 on a first-of-a-kind mission to reveal the Sun's inner workings in spectacular detail. The launch aboard an Atlas V rocket occurred at 10:23 a.m. EST.

Photo credit: NASA

Caption: An Atlas V rocket carries SDO into orbit.

The most technologically advanced of NASA's heliophysics spacecraft, SDO will take images of the Sun every 0.75 seconds and daily send back over 1.5 terabytes of data—the equivalent of streaming 380 full-length movies.

SDO will reveal the Sun's inner workings by constantly taking high resolution images of the Sun, collecting readings from inside the Sun, and measuring its magnetic field activity. This data is will give insight to predict solar storms and other activity on the Sun that can affect spacecraft in orbit, astronauts on the International Space Station, and electronic and other systems on Earth. SDO also will provide a better understanding of the role the Sun plays in Earth's atmospheric chemistry and climate.

"This is going to be sensational," said Richard Fisher, Director of the Heliophysics Division at NASA Headquarters in Washington. "SDO is going to make a huge step forward in our understanding of the sun and its effects on life and society."

SDO is the crown jewel in a fleet of NASA missions to study our Sun. The mission is the cornerstone of a NASA science program called Living With A Star. This program will provide new understanding and information concerning the Sun and the solar system that directly affect Earth, its inhabitants, and technology.

The SDO project is managed at NASA's Goddard Space Flight Center. NASA's Launch Services Program at Kennedy Space Center managed the payload integration and launch.

For more information on the *Solar Dynamics Observatory*, visit:
http://sdo.gsfc.nasa.gov ■

New Fourier Transform Spectrometer to Change Component Measuring For the Better

By Christina Coleman

Optical engineers at Goddard are nothing less than ecstatic about the new Fourier Transform Spectrometer (FTS) in the Optics Branch. Not just because of its groundbreaking and revolutionary measuring capabilities, but because the previous archaic and bulky bench top unit reminiscent of early 80s technology won't clutter their lab space anymore.

Well, not exactly. But Ross Henry, one of the Associate Branch Heads of the Optics Branch, is impressed with the stability of the machine, which is the first of its kind at Goddard, compared to the old unit.

"There have been such huge developments with electronics," Henry said. The instrument has been deemed an institutional piece of equipment and was heavily funded by Goddard Chief Technologist Peter Hughes and the Internal Research And Development (IRAD) program. "The old unit used these big circuit boards and had bad stability problems. We might have to test a sample a bunch of times to get a level measurement."

The new FTS instrument, which was built in six months by Bruker Optics, can produce "lots of data really fast and is highly configurable," so much so that a measurement that would have taken three to four days on the old instrument can take just about a day on this new instrument.

Photo credit: NASA/Debora McCallum

Caption: Ross Henry (left) and Manuel Quijada calibrate the new Fourier Transform Spectrometer.

"Spectrometers measure the response of light over a wavelength range. What we use this instrument for in the components group of the Optics Branch is to test individual optical components," Henry said. "Goddard has this mind set of 'test, test, and test again.' We're at the beginning stage of testing. You test at the component level, test at the instrument level and then test at the spacecraft level."

Samples that range from mirrors, filters, beamsplitters, and thin film coating are subject to testing on the FTS. The idea is to ensure that once these optical components are assembled into larger optical systems, such as spaceflight cameras, they will work properly. At the heart of the 11 chamber spectrometer is a typical Michelson interferometer that is responsible for modulating the light. With three different sources, six different detectors and five beamsplitters, the spectrometer's versatility allows for greater measurement possibilities that weren't available before.

Photo credit: NASA/Debora McCallum

Caption: Manuel Quijada installs a 75 micron thick Mylar® beamsplitter into the interferometer chamber of the new Bruker FTS.

"This whole big unit is its own entity and it has all these accessories that will do various specific types of measurements," Henry said. Out of a handful of accessories that come with the FTS, the Optics Branch has about three. This includes the Variable Angle Reflectance accessory, which the branch is now using to test the pick-off mirror from *Hubble*'s Wide Field Camera 2 to see how well it performed over the 16 years spent in space.

Although the previous instrument heavily supported the Space Science group at Goddard, the Optics Branch is hoping to make a push to support the Earth Science crowd as well. In fact, one of the bigger projects they will support is the Thermal Infrared Sensor (TIRS), which monitors rainfall and vegetation. The Optics Branch will use the FTS to test flight parts and engineering units of flight parts.

Explains Henry, "Goddard gets these directive missions and if we are going to build an instrument we want to make sure it lives a long time. We're at the very beginning of the instrument assembly line. We're at the front of the fight here."

Already back logged with samples to test, Ross Henry and Manuel Quijada, who did "all the leg work to get this instrument here and is the go-to guy," are eager to get to testing.

"People are paying tons of money to send their samples to other companies. We want to let Goddard know that we've invested in it and it is here." ■

Reviews Clear Way for New Tracking and Data Relay Satellites

By Susan Hendrix

NASA does an incredible job tracking more than 50 Earth-orbiting spacecraft at any given time. This remarkable feat is accomplished using a high-tech constellation of *Tracking and Data Relay Satellites* (TDRS) and a series of dedicated ground stations, which together form the TDRS System (TDRSS).

The very first TDRS was launched aboard the Space Shuttle in the early 1980s, followed by six additional first-generation spacecraft, the last being deployed in 1995. NASA then launched newer, more sophisticated models on expendable rockets between 2000 and 2003, replenishing the fleet.

Soon, the current TDRSS constellation will be joined by two new satellites, designated TDRS K and TDRS L. Steady progress is being made with the new duo passing recent in-depth pre-assembly reviews at the contractor's facility in El Segundo, Calif.

Image credit: NASA

Caption: Artist's conception of the latest TDRS spacecraft.

The reviews were conducted by NASA project and program officials, along with NASA Headquarters officials and independent review team members. Each member carefully evaluated the TDRS K/L spacecraft and mission design, including spacecraft assembly and systems integration, testing and safety requirements.

According to Jeff Gramling, TDRS Project Manager at Goddard, the two reviews, called the Critical Design Review and the Performance Readiness Review, bridge the design and manufacturing stages of the TDRS program. With the successful completion of these reviews, Boeing Space and Intelligence Systems will proceed with assembly of TDRS K and L.

The new Boeing-built TDRS K and L series will augment existing TDRSS spacecraft that serve as NASA's means for continuous, high-data rate communications with users, be it human missions or robotic spacecraft, or expendable launch vehicles. Some of TDRSS's more famous customers include the Space Shuttle, *Hubble Space Telescope*, and the *International Space Station*. Future projects TDRSS will support include the *James Webb Space Telescope*, *Glory*, the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project, the Global Precipitation Measuring mission, and other low-Earth orbiting spacecraft.

"Successfully completing these reviews is an important milestone," said Pete Vrotsos, Space Communication and Navigation (SCaN) Network Services Director at NASA Headquarters in Washington. "These new spacecraft will enable NASA to replenish aging TDRS spacecraft and maintain the outstanding level of communications services to NASA and the Nation."

The new TDRS K and L will use Boeing's proven spring-back antenna design that was first used on the TDRS H, I, and J spacecraft. The patented design consists of two 15-foot diameter antennas with innovative flexible membrane reflectors that fold up to fit inside the launch vehicle's fairing and spring back into their original cupped shape once on orbit.

TDRS K is scheduled to launch in 2012 aboard an Atlas V rocket from Cape Canaveral Air Station in Florida. TDRS L is planned for a 2013 launch.

They will join an existing TDRSS constellation of eight satellites in geosynchronous orbit—seven in use with one in reserve. Together with their ground stations, the TDRS System has provided unparalleled service to NASA and other system users since TDRS-1 launched in 1983. TDRS-1 was retired from service in the fall of 2009, after more than 25 years of outstanding service.

For more detailed information about TDRS K and L spacecraft and the existing TDRSS fleet, visit: http://tdrs.gsfc.nasa.gov. ■

Into a Volcano to Test Suitcase-Sized Science Lab

By Bill Steigerwald and Inge Ten Kate

Some scientists will go anywhere for a proper test, including the mouth of a (sleeping) Hawaiian volcano. Dr. Inge Ten Kate, a University of Maryland Baltimore County research assistant, led an expedition into a cinder cone atop Mauna Kea, Hawaii, to test the prototype for an instrument that will be a miniature laboratory to discover the composition of rocks and atmospheres on moons, asteroids, and planets across the solar system.

The instrument is being built at Goddard, and Goddard scientist Dr. Daniel Glavin joined the expedition, which began January 29 and wrapped up February 5. Although the prototype weighs about 80 pounds and is about the size of a small dorm-room refrigerator, the team plans to shrink it to about the size of a suitcase, and give it a more manageable weight of around 20 pounds.

"The idea is that it could be carried and deployed by astronauts or small robotic rovers," says Ten Kate. The final version will be called VAPoR, for Volatile Analysis by Pyrolysis of Regolith, NASA-speak for heating up soil and analyzing the gases. The prototype contains tiny ovens that gradually heat samples to more than 2,500 degrees Fahrenheit (about 1,400 degrees Celsius). As the temperature rises, different compounds vaporize and are directed into a mass spectrometer, which separates and identifies atoms and molecules based on their weight and electric charge.

Why a volcano? "The terrain and composition are similar to what we expect to find on the Moon, asteroids, and Mars," says Ten Kate. "Also, there will be outgassing from the volcano, so we can test our ability to measure trace gases in atmospheres. Finally, the differences among various areas on the volcano's cinder cone will be subtle, so it's a good test of our sensitivity and our ability to distinguish different regions."

The purpose of a field test is to uncover surprises, and the team certainly found some: "Lesson 1 - errors that NEVER happen in the lab WILL happen to you in the field," wrote Ten Kate in her day-by-day account of the expedition at: http://vapor-fieldtesting.blogspot.com.

"After exchanging the blank for a real (1-meter deep wet) sample and leaving that at 50°C for a while to get rid of the water, it was time to start measuring our second real sample! And then the Residual Gas Analyzer (RGA) gave up... A lot of trouble shooting [sic] later, it seemed that there's something wrong with the voltage going to the quadrupole [sic] rods of the RGA, so we decided to leave it baking at 200°C for a few hours to get rid of potential contamination and call the company tomorrow.

"Before leaving for the field site I had spoken to the company, who sent me a troubleshooting guide (why are those things not standard in the manual?). As soon as we had verified everything else was fine, we worked our way through the troubleshooting. After about 30 seconds we had identified the problem - 3 fried transistors.

"Chris Johnson, our irreplaceable VAPoR hero, had already confirmed that a new unit would be shipped out to get here by tomorrow 17.00. But to be on the safe side we decided to order replacement transistors for overnight shipping as well. Then we shut off VAPoR and covered it for a two-day hibernate. This gives me a good opportunity to emphasize that the reason that VAPoR is not working has nothing to do with the actual part we were testing, the oven, but with some commercial mass spectrometer.

"Lesson 2 - do NOT be stupid and go back to the field site around 23.00 to fill up the generator to keep everything warm. Around 15.30 we left the system up and running and hiked back to HP-lodge, where just after taking a shower I got a phone call that the generator had died (not out of gas, just dead). Sigh… But, the generator was replaced and by guiding the guy who replaced it, through the different panels on the front, everything seemed to be fine (apart from the bake out temperature that had dropped ~100°C), so back up and running."

But the team overcame these difficulties. "We met all of our goals during the VAPoR field test on Mauna Kea, which included the analysis of a volcanic gas vent sample as well as regolith collected from the crater surface down to 4 meters," said Glavin. "The cold and dusty environment on the volcano was particularly challenging for VAPoR, and future modifications to the field unit including dust protection will be made prior to the next field campaign. Overall, we were extremely pleased with the performance of VAPoR and look forward to participating in other lunar and Mars analog field campaigns in the future."

Photo credit: Jack Farmer, Arizona State University

Caption: Inge Ten Kate and Daniel Glavin celebrate a successful test of the VAPoR prototype.

And it was not all work. "Around 8 PM Honeybees Kris and Jack and I went back to the site to refill my generator. After we were done, we turned off the car lights and had the most beautiful view of the night sky and the Milky Way I've ever had. Everything was dark except for the stars. Very, very, very beautiful," said Ten Kate.

For more photos and the full account of the expedition, refer to: http://vapor-fieldtesting.blogspot.com. ■

Lunar Reconnaissance Orbiter and *Hubble Space Telescope* Teams Receive NASA Award

By Susan Hendrix

It's no secret that NASA Goddard Space Flight Center specializes in complex scientific missions. Our engineers are some of the best in the world, accustomed to dealing with last minute setbacks and changes that require a unique perspective. It comes as no surprise, then, that two such teams recently won NASA's coveted Systems Engineering Activity of the Year Award for 2010.

And the award goes to…the *Hubble Space Telescope* (HST) and the *Lunar Reconnaissance Orbiter* (LRO) engineering teams for their consistent and disciplined excellence in the application of systems engineering practices. Despite numerous challenges, including the November 2005 change to the launch vehicle that required a complete redesign of the spacecraft structure, the robust and modular approach implemented by the LRO team kept the mission on track.

"The LRO team took the system from the preliminary design review to the pre-ship review in three years," said Dave Everett, LRO Mission Systems Engineer at Goddard. "Ensuring success on a mission with this schedule and LRO's complexity was a big challenge. It is a great honor for our team to receive this award."

Photo credit: NASA/Pat Izzo

Caption: Engineers, scientists and other Lunar Reconnaissance Orbiter *team members toast the successful arrival of LRO at the Moon in this photograph taken inside a control room at Goddard.*

Last year also saw the nail-biting final shuttle servicing mission to the *Hubble Space Telescope*. Once completed, the mission successfully brought the famed telescope to the "apex of its capabilities."

To achieve a high level of mission success, the HST Servicing Mission 4 (SM4) systems engineers overcame very complex and constantly evolving challenges well beyond the traditional system complexities of design, integration, and performance. They not only developed repair procedures for the Advanced Camera for Surveys, which failed in January 2007, but also provided a replacement unit for the Science Instrument Command and Data Handling unit, which failed just two weeks out from the scheduled October 2008 Shuttle launch.

Photo credit: NASA

Caption: The SM4 Flight Crew with the team of Goddard engineers and technicians who have worked with them during the six crew familiarization sessions at the Goddard Space Flight Center. The team is posing in Goddard's large, class 10,000 clean room where the flight crew practiced EVA procedures and tool operations for the last servicing call to the Hubble Space Telescope.

"The HST team achieved success despite multiple changes to the core mission objectives, continuing concern for crew safety and the constraints of manned space flight, and unanticipated failures on the aging *Hubble Telescope*; the last of which threatened the integrity of the entire mission just two weeks before the originally scheduled launch date," said Preston Burch, Associate Director of Flight Projects for HST at Goddard.

Congratulations to the HST and LRO teams on their outstanding accomplishment.

Award recipients were honored on February 10 at the 2010 NASA Project Management Challenge in Galveston, Texas. For a complete list of awardees, visit:
http://www.nasa.gov/centers/ames/news/features/2010/OCE_award.html.

Riding Out the Snow Storm to Carry Out the Mission

By Rani Gran

While most of us were digging out from "Snowmageddon," hundreds of ground crew workers at Goddard worked for days to keep buildings safe and ensure essential employees were there to support the Space Shuttle *Endeavour* (STS-130) mission and the launch and operation of the *Solar Dynamics Observatory* (SDO).

Civil servants, contractors, and subcontractors worked together using hundreds of front loaders, Bobcats®, snow plows, dump trucks, and shovels to clear roads and sidewalks on Center.

Photo credit: NASA

Caption: Heavy equipment and their crews work to clear snow from the Building 28 parking lot.

The biggest challenge to handling this storm was finding a place to put all the snow, according to Eric Holmes, Goddard Facility Manager. "We hauled over 2,000 truckloads of snow and dumped it behind Building 28," said Holmes. "We've built 'Mount Goddard'."

Emergency planning began when Holmes received a weather report from AccuWeather about the storm. "We made sure we had enough fuel, rock salt, and magnesium chloride," said Holmes. "About 250 tons of rock salt was delivered to the Center on Thursday. We also made sure contractors and Government personnel were prepared."

Crews lived inside Building 4 for the duration of the storm. There is a full kitchen and hundreds of cots and air mattresses were set up.

We were prepared to open the Center," said Holmes. "However, because of the surrounding county roads, Center management thought it would be safer for employees to stay home."

"Employees staffed the Network Integration Center (NIC) 24 hours a day," said Jim Bangerter, Network Director for Human Space Flight at Goddard.

Goddard provides critical communications for human spaceflight missions. The Goddard team provides data to Johnson Space Center's Mission Control Center that allows them to monitor the performance of thousands of systems on the Shuttle, send flight commands and navigational instructions, relay science data, support voice communications between the astronauts and mission control, along with video and live television feeds.

In addition to the Shuttle, Goddard also provides critical mission support to the *Solar Dynamics Observatory* through its entire mission from Building 14's Mission Operation Center. The Center is fully staffed and ready to monitor and control the spacecraft through its initial orbits, using the orbital data provided to them by the Flight Dynamics Facility (FDF).

Pre-storm planning for Shuttle and SDO mission support included contractors securing rooms at the Greenbelt Holiday Inn and Greenbelt Marriott hotels. They also made sure they had 4-wheel-drive vehicles. Employees packed extra food, water, and shovels. "Several people who did not have to work over the weekend volunteered to drive people between the hotels and Goddard during the storm," said Melissa Blizzard, Human Space Flight Operations Center Manager. Blizzard works in the NIC. "I was amazed by how people pulled together to help one another during this storm."

"We could not say enough about the work the ground crew is doing at Goddard," said Joan Dunham, Flight Dynamics Support Services Operations Domain Lead with a.i. solutions, a contractor at the FDF. "Crews spent a lot of time clearing snow from parking lots and sidewalks from behind Building 28. It was like plowing an ocean," said Dunham, "They cleared one area and more snow fills in."

Dunham added that about a dozen dump trucks, bulldozers, and Bobcats® worked to clear the Building's parking lot. They also kept a backup generator clear of snow. Building 28 houses the Flight Dynamics Facility and NASA Television operations. Both facilities are critical to mission operations.

Photo credit: NASA

Caption: Flight Dynamics Facility staff inside Building 28.

Continued on Page 11

Riding Out the Snow Storm to Carry Out the Mission

Continued from Page 10

Photo credit: NASA/Bill Hrybyk

Caption: "Mount Goddard" rises high above COBE Road behind Building 28.

Bangerter stayed in the NIC from Friday afternoon to Monday morning. Bangerter lives in Annapolis, Md. and didn't want to take a chance on the roads. He slept on a couch in the Mission Management Area. "It was kind of like the old days, before some our operations were moved to White Sands, NM a few years ago," said Bangerter. "We used to camp out at Goddard during storms like this."

NASA Goddard contractors did a great job planning for this storm. "Nobody missed a shift," Bangerter said. "Everyone was able to focus on the Space Shuttle launch. I am deeply grateful for those who put themselves in harm's way to make sure our crews were able to get to work safely."

Many mission support personal were able to take a break after the Space Shuttle launch. Several dozen, however, were right back at Goddard for the *Solar Dynamics Observatory* launch.

Ground crews worked through the storm until Goddard was able to open again. "We are a very big team here," said Holmes. "Everyone is goal-oriented here. We recognize we are part of history." ■

Goddard Employees Earn SFA Award

By Amy Pruett

The Space Flight Awareness (SFA) Honoree Award under the Space Flight Awareness program is presented to civil servant and contract employees for their dedication to quality work and flight safety.

To qualify, the individuals must have contributed beyond their normal work requirements to achieve significant impact on attaining a particular human spaceflight program goal; contributed to a major cost savings; been instrumental in developing modification to hardware, software, or materials that increase reliability, efficiency, or performance; assisted in operational improvements; or been a key player in developing a beneficial process improvement.

Recipients of the Honoree Award have the opportunity to travel to Florida to celebrate their achievements during a tour of Kennedy Space Center and viewing of a Space Shuttle launch.

Thirteen exemplary Goddard team members earned the prestigious Space Flight Awareness Honoree Award, participating in the STS-130 Honoree Event.

On Monday, February 22, 2010, Goddard Honoree Award recipients were recognized by Center Director Rob Strain at NASA Goddard's Greenbelt campus:

Gary A. Burkholder (Code 441), Earl H. Daniel (452), Gregory J. Goulet (Code 441), John D. Kazeva (Code 459), Kenneth McCaughey (Code 596), Eric S. Mount (Code 452), Yi-Pheng Ngan (Code 567), Chitra Patel (Code 450), Sue E. Pollard (Code 321), Claude A. Sanders (Code 442), Edward L. Shade (Code 443), L. Colleen Townsley (Code 441), and Janelle L. Vreeland (Code 441).

The remaining honoree, Deborah Dukes (Code 452), will be honored during a future awards ceremony at the Wallops Flight Facility.

Full citations for each recipient can be viewed on InsideGoddard at: https://internal.gsfc.nasa.gov/web/news/sts130ha. ■

Flipping the Bone: A Father-Daughter Dinosaur Dig

By Elizabeth M. Jarrell

Fifteen-year-old Rachel Livengood, the daughter of Goddard astrophysicist and planetary spectroscopist, Dr. Timothy A. Livengood, has always been fascinated by paleontology. She grew up listening to her father, a storyteller associated with several local storytelling groups, relate dinosaur bedtime stories. Rachel has Asperger's Syndrome, an autistic spectrum disorder, which has made school at times challenging. At the same time, Asperger's Syndrome has allowed her to become intensely focused on and knowledgeable about her main interest; namely, dinosaurs.

As a result, last June, Tim and Rachel went on a week-long dinosaur dig in Wyoming. Tim wanted Rachel to experience success doing something in which she excelled and that she loved and knew that a dinosaur dig was the perfect opportunity. Tim, who honeymooned at Stonehenge, was also excited. "I have always had a weird fascination about things that have been on Earth longer than me. I have always been interested in history and the world I have been born into. I like dinosaur bones and ancient history."

The dinosaur dig was led by Dr. Alton Dooley of the Virginia Museum of Natural History in Martinsville, Va. The dig team consisted of Dr. Alton Dooley and his son, Tim, Rachel, and two others. The expedition was funded by the Virginia Museum of Natural History together with grants, gifts, and contributions from dig participants.

The site is on land administered by the U.S. Department of the Interior's Bureau of Land Management. Surface prospecting is legal, but a permit is required to excavate. This particular site is a mature dig, which has been worked for several years and has 130 million-year-old dinosaur bones. According to Tim, "The amazing thing is that once you know what broken fragments of dinosaur bones look like, they are everywhere."

The dig team stayed in a cabin at a local campground. They had breakfast and dinner in town, and packed a lunch to eat at the excavation. The group drove to the site in a four-wheel drive and then hiked the last part to avoid leading anyone unwanted to the site. The exact location of the site is kept quiet to avoid notice by unscrupulous traders.

All work during the excavation is done with one goal in mind—to preserve the bones. According to Tim, "Dinosaur bones are extremely fragile. A big expense of dinosaur excavation is all the glue you need. You are constantly gluing fragments of bone together. The fossilized dinosaur bones are in many pieces that are held in place by the sediment they're buried in. It's like a glass buried in sand and then the box of sand is crushed and the glass is broken. You have to glue the pieces together as you remove the sand so they won't get jumbled up."

There is a prescribed method to digging because of the extreme fragility of the ancient bones. Explains Tim, "You begin with shovels. Once you find something, you start being more careful. When you get down to bone, you dig around it with trowels, dental picks, or whatever. Very big screwdrivers were used to pry up bits of packed sediment. Once you have gotten down to the bone, you use a brush to remove the sediment very carefully."

Photo credit: Rachel Livengood

Caption: Tim Livengood (left) stabilizes a plaster-jacketed vertebra while Dr. Alton Dooley trims the excess plaster and burlap from the jacket, in preparation for completing the jacket with more plaster and burlap.

Rachel spent a lot of time digging out a femur, possibly from a young Camarasaurus. The femur was about 3 feet long, 5 inches high, and 8 inches wide. Rachel dug out the middle of the femur, leaving both ends still supported on sediment. Rachel then had a "deeply emotional moment" when one end of the femur broke off while she was brushing it clean. "We glued it back on essentially using superglue. This is not the permanent fix; this is just so all the parts get to the lab in the right position."

The exposed bone was next encased in plaster for protection before transporting it to the lab. After the bone is exposed, the upper surface is covered in damp toilet paper. Next, the bone is wrapped in big strips of burlap soaked in plaster of Paris. Larger bones such as the femur Rachel worked on are also braced with wood. Once dry, the remaining sediment posts are chipped away.

The next crucial step involves very carefully turning over the bone, which is called "flipping the bone," so as to plaster the other side. The fully plastered bone is carried out of the dig on a stretcher. As Tim explained, "You cannot reliably carry the bone by its plaster jacket because the bone is so fragile."

While working the dig, Tim and Rachel saw much wildlife including pronghorn antelope, moose, scorpions, and lizards. They even found mice nesting in the shredded toilet paper in a plaster jacket. In addition to wildlife, they also had to be aware of lightning storms. Tim was philosophical, "The dinosaur bones waited 130 million years; they can wait another day."

The dinosaur dig reinforced Rachel's interest in a career in paleontology and opened the door for her to possibly work for Dr. Dooley next summer. As for Tim, he was very happy that his daughter had been so successful. Indeed, Tim said that, "The best part was that I got to see my daughter doing something that she really shines at. I knew she could be good at it. It was good to see her discover that she could be good at it." ■