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GLAST Begins Its Extreme Adventure

On June 11, just after noon Eastern time, a Delta II rocket bearing NASA' s newest sky eye — GLAST, or the Gamma Ray Large Area Space Telescope — rose from a Florida launch pad. "Both the spacecraft and its revolutionary instruments are functioning perfectly," says Project Scientist Steve Ritz at Goddard. Astronomers expect the observatory's long-awaited trip to space will help them solve the riddles of gamma-ray bursts, unravel the mysteries of active galaxies powered by supermassive black holes, and discover objects none of them can quite imagine right now.

To loft the 4,303-kilogram observatory, the Delta II's first stage

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Message from the Director Of

Greetings:

It's amazing how fast time passes. Since the last issue of The Critical Path, GLAST was successfully launched. On-orbit commissioning is almost complete and has been smoother than almost any observatory I can remember. Both the Gamma Ray Burst Monitor and the Large Area Telescope are operating extremely well. Congratulations to Kevin Grady and the entire GLAST team. The IBEX mission was delayed from its original June launch date due to late breaking launch vehicle loads issues. The team quickly regrouped and designed a "shock ring" assembly to attenuate the loads. The IBEX launch readiness date is now October 5, 2008.

Due to delays in Space Shuttle external tank processing, HST Servicing Mission 4 was delayed from its August launch date and is now manifested on October 8, 2008. With the installation of the Cosmic Origins Spectrograph and the Wide Field Camera 3 and the repair of the Space Telescope Imaging Sepctrograph and the Advanced Camera for Surveys, this last servicing mission for HST will be the most challenging and will leave the observatory with the greatest discovery capability ever. Replacement of life limited components like gyros and batteries on this mission will also ensure continued HST operations for at least another 5 years. The HST servicing mission will be the last GSFC launch of the year. GOES-O, SDO, and LRO while all on schedule from an I&T perspective have been delayed into 2009 due to the very crowded Delta IV and Atlas 5 launch vehicle manifest. That means that in 2009 GOES-O, NOAA N', LRO, Glory, and SDO will all launch - a very busy schedule.

In celebration of the numerous GSFC launches during the next year, a LaunchFest event is being planned for September 13, 2008. This community open house will showcase the upcoming launches as well as the GSFC mission in general. I hope you can participate.

On July 31, we had a very successful Goddard Day event. This event is designed to celebrate the Diversity of GSFC as well showcase the mission. Thanks to all who contributed their time to the success of the event and mission unique materials for the Flight Projects booth. I've heard several times that our booth was by far the most popular.

I hope everyone has taken some time this summer for rest and relaxation. With the HST and IBEX launches coming up, the next quarter will prove to be a busy and exciting one indeed.

George

PERSONALITY TINTYPE

Gerry Daelemans

Gerry presently serves as the Venus Reconnaissance Orbiter (VRO) Dante Project Formulation and Capture Manager for the Advanced Concepts and Formulation Office, Code 401.

Born: Mineola, New York

Education: Gerry earned a BSEE from the University of Maryland before the Internet was born and there were computers on everyone's desk, and recently completed a Masters of Science in Technical Management from University of Maryland University College.

Life before GSFC: Gerry worked for a number of Beltway Bandits upon graduation from college before beginning his GSFC career in 1988.

Life at GSFC: Gerry began his career in the Engineering Directorate I&T branch completing the integration and qualification test program for the 4 Hitchhiker Avionics units that would be the backbone of the Shuttle Hitchhiker Program for nearly 20 years. He served in increasingly more responsible positions within the Shuttle Small Payloads Project Office eventually serving as Chief of that Office till the program was shut down following the Columbia accident. He was the mission manager for the very successful, still going strong after 10 years, in-house developed TRACE SMEX mission, has served as Deputy Project Manager for the in-house MMS mission, and provided project formulation management for a number of proposed SMEX and other small competed missions.

Gerry takes an interest in and has supported many Center wide activities, having recently supported the Center Safety Cultural Survey process and the GSFC Future Planning development work. One of the most challenging times in his career came in leading his Office through the aftermath of the Columbia accident (his Office had a very large payload on that

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Angela L. Conley

Angela is a Service Source Administrative Assistant, working in the Heliophysics Projects Division, Code 410/460.

Born: Washington, D.C.

Education: A graduate of Ballou High School and a student with the former Washington Technical Institute, also located in Washington, D.C.

Family: Angela has been married to Leonard W. Conley, Sr. for 27 years. They have three children – Alicia, who is the mother of their granddaughter, Autumn Lynne; Ella, who is the mother of their grandson, Ernest; and Leonard, Jr.

Life at Goddard: Angela was among the first to be hired in 1998 with Fairfax Opportunities, Unlimited, which is now Service Source, Inc. She started in Code 200, working with Sharon Foster, then, in 1999, she joined the Explorers Project, which is now a part of the Heliophysics Projects Division. Angela has enjoyed working on different Explorer missions, such as CHIPS, Swift, THEMIS, and AIM, just to name a few. Angela says the most rewarding part of working on a mission was being able to witness a launch.

Passions: Angela enjoys singing. She is a member of her church choir and praise team; the P.G. Chapter of the Gospel Music Workshop of America; and most recently auditioned and was chosen for the 100 Voice National Harbor Choir. You may have seen Angela sing the National Anthem at various GSFC events, such as the Robotic Competition (2005), the Black History Program (2007), the Martin Luther King celebration (2008), or Celebrate Goddard (2004 & 2008). She also cooks a pretty good Cream Cheese Pound Cake!!!!!

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needed added thrust from nine strap-on solid rocket boosters. The second-stage engine fired for 5 minutes 35 seconds over the Atlantic Ocean, and burned again for a little over a minute above the South Pacific. An hour and 15 minutes after launch, GLAST separated from its booster and entered a circular orbit 565 kilometers high, the first step in obtaining an unprecedented look at the extreme cosmos.

For Goddard's Dave Thompson and Neil Gehrels, both deputy project scientists for the mission, launch delays meant they couldn't witness the pyrotechnics firsthand — both had to leave Florida to attend a scientific meeting in Japan. "We were only able to watch the launch from my laptop in a hotel lobby in a Tokyo suburb in the middle of the night," Thompson recalls. "It was still exciting."

What really sets GLAST apart from other telescopes is its huge field of view. "Both instruments scan the entire sky every three hours in normal operations," Thompson says. "We are using the entire sky for checkout, and the 'first light' image will be a full-sky gamma-ray map."

Riding a Delta II booster, GLAST lifted off from Pad 17-B at the Cape Canaveral Air Force Station, Florida, June 11 at 12:05 p.m. EDT. Credit: United Launch Alliance/Carleton

GLAST is also about 30 times more sensitive to these ultra-high-energy photons than its predecessors. NASA's Compton Gamma-ray Observatory, which was de-orbited in 2000, took years to produce its first all-sky view of the gamma-ray universe. GLAST will accomplish this feat in its first few days of observations — and then continue mapping the whole sky every three hours for most of its first year in space.

Wake-up call

But before the science could begin, GLAST and its instruments had to be turned on, tuned up, and checked out. This validation and calibration process continued into July.

In the days following launch, controllers established routine communications with GLAST, powered up all of its navigational systems, and successfully extended the spacecraft's lifeline — its power-generating solar panels. Averaged over an orbit, GLAST uses about 1.5 kilowatts of power, or a little less than half of what the solar arrays can produce in full sunlight. Batteries store any excess charge for

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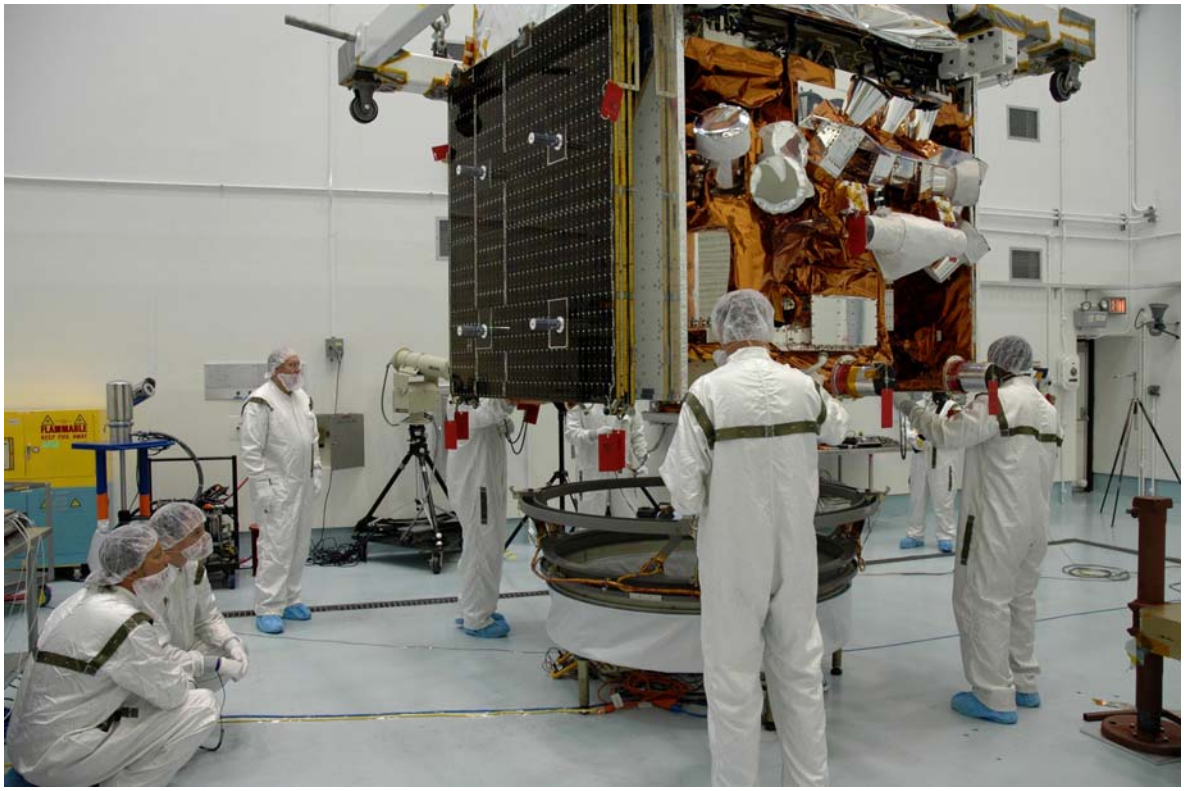

Technicians lower GLAST onto the payload attach fitting. Credit: NASA/Jim Grossmann

periods when GLAST slips into Earth's shadow and sunlight isn't available.

GLAST needs to keep track of how its solar panels angle toward the Sun, but it also needs to know where its instruments are pointing in the sky — even as the spacecraft is changing its orientation to observe new targets. GLAST uses gyroscopes, spinning masses called reaction wheels, Global Positioning Satellites, and small telescopes known as star trackers (which automatically recognize the positions of bright stars) to keep track of where it's looking.

Steve Ritz describes the spacecraft's transition from pointed observations — staring at a single object — to survey operations — where instruments sweep across the sky — as a "beautiful ballet." By the end of GLAST's first week in space, controllers had calibrated its navigational systems and started putting the spacecraft through maneuvering exercises. GLAST danced perfectly. "To accomplish this, many things must work together in a coordinated way, and this is a great milestone in the early operations checkout," Ritz noted on June 16.

With the spacecraft put through its paces, attention turned to its two instruments: the Large Area Telescope (LAT) and the GLAST Burst Monitor (GBM). These detectors observe gamma rays ranging in energy from a few thousand electron volts to many hundreds of billions of electron volts or higher, the widest range of coverage ever available on a single spacecraft. The high end of this range, which corresponds to energies more than 5 million times greater than dental X-rays, is little explored.

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Cross-country operations

GLAST is an astrophysics and particle physics partnership, developed in collaboration with the U.S. Department of Energy, along with important contributions from academic institutions and partners in France, Germany, Italy, Japan, Sweden, and the U.S. As a result, the mission has five different bases of operations.

NASA Goddard is responsible for several aspects of the mission as GLAST begins transmitting its data. The Center provided and hosts both the Mission Operations Center (MOC) and the GLAST Science Support Center (GSSC). The MOC, which commands the observatory from Building 14, was staffed by a diverse team from across the project during the on-orbit commissioning phase.

The GLAST Science Support Center in Building 2 is the primary interface between the mission and the scientific community. “My most important responsibility is to facilitate broad community involvement in the science,” says Chris Schrader from the University of Maryland, Baltimore County, who manages the center. "The GSSC will provide access to the GLAST data, the software to analyze those data, and assist scientists from the U.S. and abroad who wish to become involved." This guest investigator program, administered by the GSSC for NASA Headquarters, provides proposal preparation tools, documentation, and technical and scientific support.

Across the country, at the Stanford Linear Accelerator Center in Menlo Park, Calif., lies a third important facility: the Instrument Science Operations Center (ISOC) for the Large Area Space Telescope. The ISOC’s core functions include planning LAT command sequences, monitoring the instruments health and safety, maintaining flight software, and distributing science data products and instrument analysis tools to team members and the GSSC.

Rounding out the observatory’s far-flung science facilities is the GLAST Burst Monitor Instrument Operations Center. Hosted by NASA’s Marshall Space Flight Center (MSFC) in Huntsville, Ala., the center is located at the National Science and Technology Center, a partnership between NASA, the state of Alabama, and several universities. A complementary operations center is located at the Max Planck Institute for Extraterrestrial Physics in Garching, Germany. The Huntsville-based team hosts regular teleconferences with their German colleagues to discuss operations, instrument performance, and data analysis.

Power up

Controllers turned on the power to both the LAT and the GBM on June 25. For the LAT, the ISOC team fed power to each of the 16 towers of silicon detector strips that comprise the 3-ton detector. "What impressed me the most is that everything went by the book," says Peter Michelson, LAT principal investigator at Stanford University, Calif. "We’re elated."

Because gamma-rays have wavelengths around a trillionth of a meter — no larger than an atomic

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nucleus — and extremely high energies, the LAT is a very different kind of telescope. It relies on a process called pair production. An incoming gamma ray collides with a layer of tungsten and creates a pair of particles — an electron and its antimatter counterpart, a positron. Silicon detector strips track these particles as they course through the instrument. By sensing the paths of these particles, the instrument backtracks to determine the direction of the original gamma ray. A separate detector absorbs and measures the particle energies.

Unfortunately, there is another form of high-energy radiation that can penetrate the LAT: cosmic rays. Unlike gamma rays, which are a form of electromagnetic radiation, cosmic rays are fast-moving subatomic particles (mostly protons). Because these particles outnumber gamma-ray photons by 100,000 or more, the LAT uses another component — called an anti-coincidence detector — to weed them out. By sensing when subatomic particles pass through it, this device becomes the equivalent of “the dog that did not bark” from a famous Sherlock Holmes story. If the LAT senses an electron-positron pair when the anti-coincidence detector detects nothing, then the signal is probably a gamma ray.

The LAT’s silicon-strip technology is a direct legacy from the field of particle physics. Michelson says developing the LAT took 16 years from concept to orbit. “Back in 1991, the results from the EGRET instrument aboard the Compton Gamma-ray Observatory were pretty spectacular, but it was clear we needed something better to take the next big step,” he says. Bill Atwood at the

In April, Technicians checked the newly installed sun shades on GLAST’s star trackers (near KSC)
Credit: NASA/Kim Shiflett

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Stanford Linear Accelerator Center approached him with the concept that ultimately materialized as the LAT. “There were a few bumps along the road,” Michelson recalls, “but the instrument was never scaled back. We’re pretty proud of that.”

The LAT is not only much more sensitive than EGRET, but each photon is much better characterized. “The LAT gains for three reasons: a much wider field of view, a larger effective area, and better angular resolution,” Michelson explains. The instrument sees gamma rays with energies ranging from 20 million electron volts to over 300 billion electron volts (GeV). For energies lower than 10 GeV, the LAT has about 30 times EGRET’s sensitivity. For energies greater than 100 GeV, there is no effective comparison — it’s *terra incognita*. “This is a huge discovery space that we’re just beginning to probe,” he says.

There are a few topics where LAT’s capabilities guarantee new science results. One is pulsars, fast-spinning neutron stars that emit beams of radiation lighthouse style. Astronomers have cataloged some 1,500 pulsars. Most were found thanks to a fortuitous alignment of the pulsar beam, which regularly sweeps across our line of sight and can be detected at radio wavelengths. One pulsar, though, produces no radio emission and was discovered as a gamma-ray source: Geminga, which in Italian means “it’s not there”. The LAT provides a new way to search for other such radio-quiet pulsars. “We expect to find dozens of new pulsars at different geometries. This will give us a clearer census and help us better understand the physics of the beam and the magnetic environment near the star,” Michelson says.

Active galaxies represent another topic LAT is expected to revolutionize. It came as something of a surprise that some of the brightest gamma-ray sources found by Compton’s EGRET instrument were active galaxies like quasars and blazars. Astronomers believe that these galaxies emit torrents of radiation as a central supermassive black hole somehow converts infalling matter into tightly aligned beams that can span thousands of light-years. Blazars are galaxies whose beams happen to be directed along our line of sight, which makes their emission especially bright.

About 1,200 blazars are now known; scientists expect the LAT will discover thousands more. And because emission from active galaxies can change in as little as 15 minutes, the instrument’s quick all-sky snapshots will provide an unprecedented look at their temporal evolution. Just days after the LAT powered up, says Dave Thompson, the instrument confirmed observations made in other wavelengths that the blazar 3C 454.3 in Pegasus was especially bright. LAT measurements in mid-July showed that this galaxy, some 7.1 billion light-years away, is blasting high-energy radiation at record rates.

Burst watcher

Controllers at the GBM Instrument Operations Center in Huntsville powered up their instrument the same day the LAT came to life. At precisely 7:45 p.m. CDT on June 25, high-voltage for the GBM’s 14 sensors — a dozen sodium-iodide detectors for low-energy X- and gamma rays and bismuth germinate devices for higher-energy radiation — was switched on successfully. The instrument is

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designed to locate gamma-ray bursts, sudden high-energy blasts that occur when massive stars die or when orbiting neutron stars spiral together and merge.

"Our job is to see the whole sky and identify burst locations well enough to tell the LAT where to look," says Charles Meegan, GBM's principal investigator at MSFC. "We're operational now, and as time goes on we'll get even better by reducing errors in the location measurement."

The GBM is sensitive to less energetic gamma rays (8,000 to 30 million electron volts) than LAT. Although the LAT's primary job is the all-sky survey, it will automatically point to study bursts meeting certain criteria. Bursts seen by both instruments will provide a never-before-seen look across a broad gamma-ray spectrum, enabling scientists to peer into the processes that make these events so powerful. Within its first 16 days of operation, the GBM pinpointed 14 gamma-ray bursts.

"The most exciting part of the mission is still ahead when we, hopefully, begin to answer long-standing questions about how these fantastically powerful gamma-ray bursts are created," Meegan says.

Scientists expect to operate the $690 million spacecraft for at least 5 years, and they're hoping for a full decade. It's successes may reach far beyond pulsars, active galaxies, and gamma-ray bursts. After several years of observations, GLAST may provide insight into some deeply unknown aspects of the cosmos. The LAT may detect radiation emitted by collisions between as-yet-undiscovered particles that make up the bulk of the universe's mass, known to astronomers as dark matter. Candidates for those particles may be identified by the Large Hadron Collider (LHC), a powerful new particle accelerator in Switzerland that will begin smashing nuclei in September.

"This is a very exciting time, with new major facilities such as LHC and GLAST providing great opportunities for discovery," notes Steve Ritz. "Experiments at the boundary between particle physics and astrophysics make important and unique contributions to both fields."

Francis Reddy
Senior Science Writer
Code 660.1/Office of General Investigative Programs
Astrophysics Science Division

IBEX Set for October Launch

The Interstellar Boundary Explorer (IBEX) is a Small Explorer (SMEX) class mission managed by the Explorers Program Office. It was selected in January 2005 in response to a Science Mission Directorate Announcement of Opportunity. The Principal Investigator, Dr. David McComas and project office are at Southwest Research Institute (SwRI) in San Antonio, Texas. SwRI leads a contractor team that designs, builds, integrates and tests all mission elements. A small team of engineers and quality assurance personnel provide insight and oversight on the development of the mission elements for the Explorers Mission Manager, Greg Frazier.

IBEX's sole, focused science objective is to discover the global interaction between the solar wind and the interstellar medium. IBEX achieves this objective by taking a set of global energetic neutral atom (ENA) images that answer four fundamental science questions:

1. What is the global strength and structure of the termination shock?
2. How are energetic protons accelerated at the termination shock?
3. What are the global properties of the solar wind flow beyond the termination shock and in the heliotail?
4. How does the interstellar flow interact with the heliosphere beyond the heliopause?

It will conduct the mission from a highly elliptical Earth orbit of 7000 km x 50 Re (that's almost 2/3 the distance to the moon!) at an 11 degree inclination. A Pegasus XL vehicle will launch IBEX from the Kwajalein Atoll in the Marshall Islands in October of this year.

Figure 1 shows the IBEX flight hardware. The spacecraft bus, adapter cone and motorized light bands are provided by Orbital, the Star 27 solid rocket motor is supplied by ATK and the instrument was designed and built by a team led by SwRI, Lockheed Martin Advanced Technical Center (LMATC) and the Los Alamos National Laboratory (LANL). Total mass and power of the flight system is 1016 pounds and 82 W respectively. The observatory is about 3 feet across (octagon-shaped) and 2 feet tall. Two hemispherical antennas provide a nominal 320 kbps downlink communication rate.

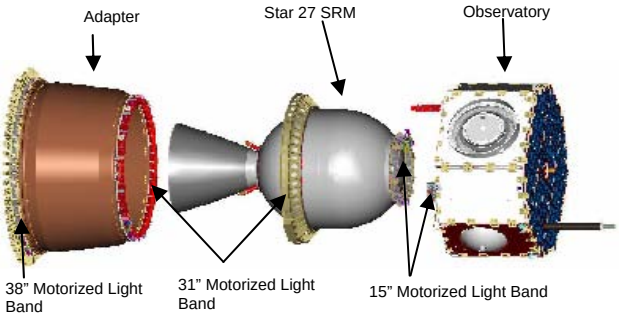

Figure 1: IBEX flight hardware components

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Two sensors and an electronics unit comprise the instrument. The Combined Electronics Unit (CEU) is designed and manufactured by SwRI. One of the sensors, the IBEX-Lo (see figure 2), is provided by a team led by LMATC. The team includes the University of New Hampshire (UNH), Goddard Space Flight Center (GSFC), Johns Hopkins University Applied Physics Lab and the University of Bern (UoB), Switzerland. The sensor covers the energy range of 0.01-2 keV. Sensor integration and test was performed in Europe with assembly, vibration, thermal-vacuum testing and calibration performed at the UoB. Acoustic testing was performed at IABG in Munich, Germany. A huge effort was required to get the hardware and personnel needed at the UoB to support the activities there. Many thanks go to the GSFC Logistics and Transportation Management Branch along with the Export Control Office for their invaluable assistance.

The other sensor, IBEX-Hi (see figure 2), is provided by a team led by LANL. Their team includes the UNH and SwRI. IBEX-Hi covers the 0.3-6 keV energy range. Sensor integration was performed at LANL and environmental testing conducted at the Air Force Research Laboratory at Kirkland AFB.

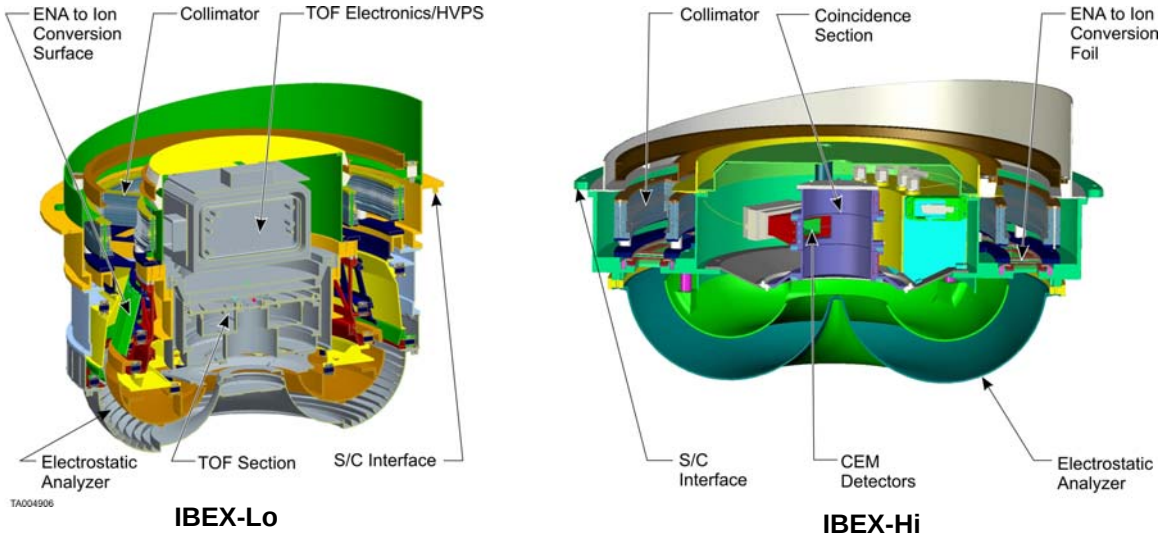

Figure 2: Instrument Sensors

The spacecraft bus is provided by Orbital with the electronics derived from its Microstar product line. However, since the mission required a Star 27 Solid Rocket Motor (SRM) to help achieve its highly elliptical operational orbit, a more robust structure than that normally used on the Mircrostar bus was required. A larger composite structure was designed by Orbital and built by Alliance Spacesystems. Orbital designed and built the avionics boxes for the spacecraft. Procured spacecraft bus components included a solar array from Emcore in Albuquerque, a star camera from Technical University of Denmark, a transponder from Alcatel, in Spain,

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a lithium-ion battery from Yardney in Connecticut and Hydrazine Propulsion System (HPS) components from Arde in New Jersey.

With so many vendors and activities being performed in parallel, it was a challenge to develop and implement SwRI and GSFC engineering and quality assurance surveillance plans. In the end, both teams of engineers and quality assurance personnel provided outstanding support and went beyond the call of duty to travel far and wide, across the US and Europe to complete their assignments.

Instrument to spacecraft bus integration and test occurred at Orbital last winter. Figure 3 shows the integrated observatory. The I&T program was a success and we recently shipped the hardware to VAFB for launch site processing.

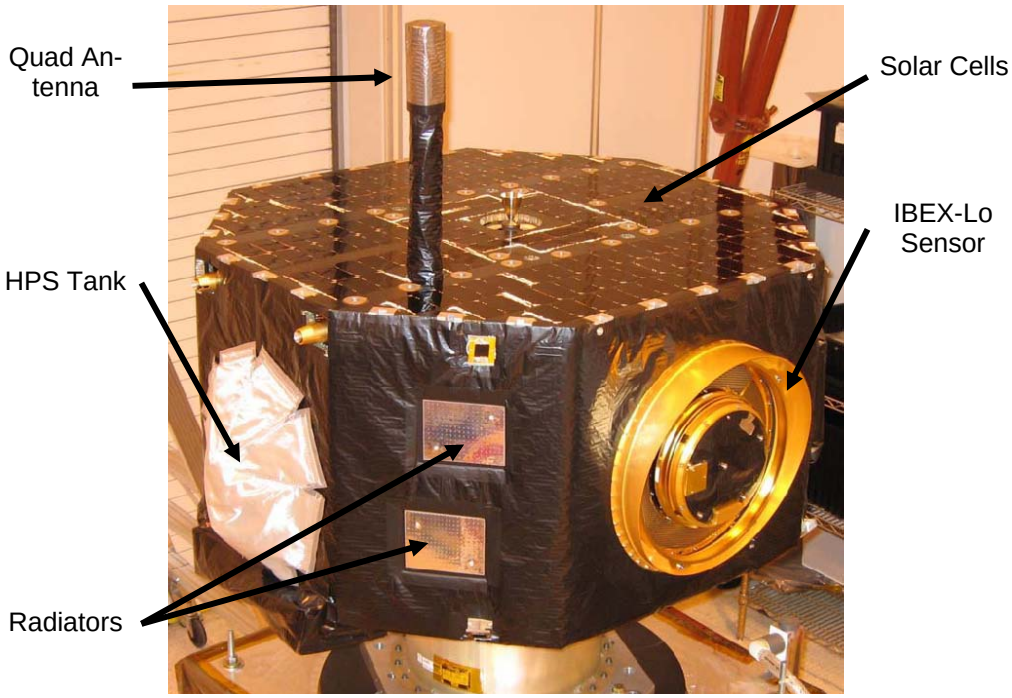

Figure 3: Integrated IBEX Observatory

IBEX processing is continuing through August and the flight system will be mated to the Pegasus in early September. IBEX and Pegasus will then get attached to the L1011 Stargazer aircraft which will ferry them to Kwajalein in late September. After about a week of final Pegasus activities, IBEX will launch in early October.

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The Pegasus will drop IBEX off at a 200 km orbit. The SRM will then deliver IBEX to an altitude of 16-22 Re. After a series of burns by the HPS, IBEX will reach its operational orbit in about 3 weeks. The mission operations control center is at Orbital and they will conduct the 2 year mission while coordinating with the science team at science operations control centers at SwRI and Boston University.

“The solar system’s frontier is billions of miles away, so it’s difficult for us to go there, but interesting things happen at boundaries, and with IBEX, we will see them for the first time,” said Dr. Robert MacDowall (Code 695), IBEX Mission Scientist.

“IBEX will let us make the first global observations of the region beyond the termination shock at the very edges of our solar system. This region is critical because it shields out the vast majority of the deadly cosmic rays that would otherwise permeate the space around the Earth and other planets,” said Dr. McComas (PI/SwRI).

Greg Frazier/Code 410
IBEX Mission Manager

Cultural Tidbit

Did you know…… that in Central America and South America some people get offended when they ask a person from the United States where they are from and they respond "I'm American". The term "American" is defined in some dictionaries as "of or relating to North or South America, the West Indies, or the Western Hemisphere". To people born in North, Central or South America, everyone born in North, Central or South America is an "American", not just the people born in the United States.

Sandra Cauffman
Code 400

Do you have a cultural tidbit to share? Send it to the Code 400 Diversity Council c/o Andrea Razzaghi @ andrea.i.razzaghi@nasa.gov and we'll publish it in a future issue.

GLORY: Explaining the Earth's Energy Budget

WHY GLORY?

The Sun provides heat to our planet. However, only about half of the sunlight heats the surface of the Earth. A third of the sunlight is reflected back into space by the surface and atmosphere, while one sixth is absorbed in the atmosphere and then re-emitted. This energy budget of "heat in" versus "heat out" directly influences the Earth's short-term and long-term climate trends.

An accurate description of Earth's energy budget is important for scientists in order to anticipate future changes to our climate. Shifts in the global climate and the associated weather patterns impact human life by altering landscapes and changing the availability of natural resources. Scientists are actively working to better understand exactly how and why this energy budget changes. The NASA Goddard Space Flight Center (GSFC) Glory mission will provide significant contributions toward this critical endeavor.

GLORY SCIENCE

Scientists who study the Earth's energy balance consider the difference between energy entering and energy leaving the lowest layer of Earth's atmosphere (generally, energy entering has a warming effect while energy leaving has a cooling effect).

Specifically, the Glory mission is intended to meet the following two scientific objectives:

1. Measure solar energy entering the Earth's atmosphere to determine its long-term effects on the Earth's climate record.
2. Collect data on the properties of natural and human-caused aerosols in the Earth's atmosphere.

The Sun Factor

The primary input to the Earth's energy balance comes from a natural source – our Sun. To find out the contribution of this giant space heater to the Earth's energy budget, scientists will measure the amount of energy that reaches the Earth's atmosphere over a given period of time. The current estimate is approximately 1,361 watts per square meter. That's enough energy incident on the Earth to continuously power nearly half a million 60-watt light bulbs *per person*. Previous sensors have provided a data record spanning the past 30 years, but these measurements of solar intensity contain slight offsets. That's one reason why scientists must maintain a continuous solar measurement record; Glory will provide continuity of this measurement.

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Energy from the Sun fluctuates depending on solar changes, such as sunspots, which peak in number with an 11-year average period. While it is easy to recognize that the Sun contributes to the "heat in" portion of the Earth's energy budget, it is not so simple to account for the subtle changes in the Sun's intensity in this budget analysis. The data from the instruments on Glory will help to answer some of these questions.

Particle Puzzles

A second factor affecting the Earth's energy balance is the influence of aerosols, which are tiny particles suspended in the atmosphere. Aerosols come from both natural sources such as volcanoes, fires and desert dust, and from human sources, such as the burning of fossil fuels. Aerosols impact the Earth's energy balance by either absorbing or reflecting solar energy. Black carbon aerosols, for example, absorb the heat and then re-radiate some of that energy, contributing to more "heat in." Non-absorbing aerosols, such as sulfates, reflect the Sun's energy back into space causing cooling, or "heat out." In addition, aerosols also indirectly impact atmospheric cooling by changing the properties of clouds and altering precipitation patterns.

Both natural and human-caused aerosols have an impact on global temperatures. Over the past century, the average temperature of the Earth has increased by approximately 1.3 degrees F (0.7 degrees C). Accurately attributing this increase and the accompanying climate change to natural events, human sources, or a combination of both is of primary importance to scientists and policy makers. The aerosol sensor on Glory will provide scientists with accurate measurements of aerosols in our atmosphere and will help scientists better understand how they influence the climate.

The impact of solar variability and aerosols on the Earth's climate is believed to be comparable to the impact posed by greenhouse gases. Still, aerosols remain poorly measured and may represent the largest uncertainty in our understanding of climate changes. The root of the problem is

GLORY Team

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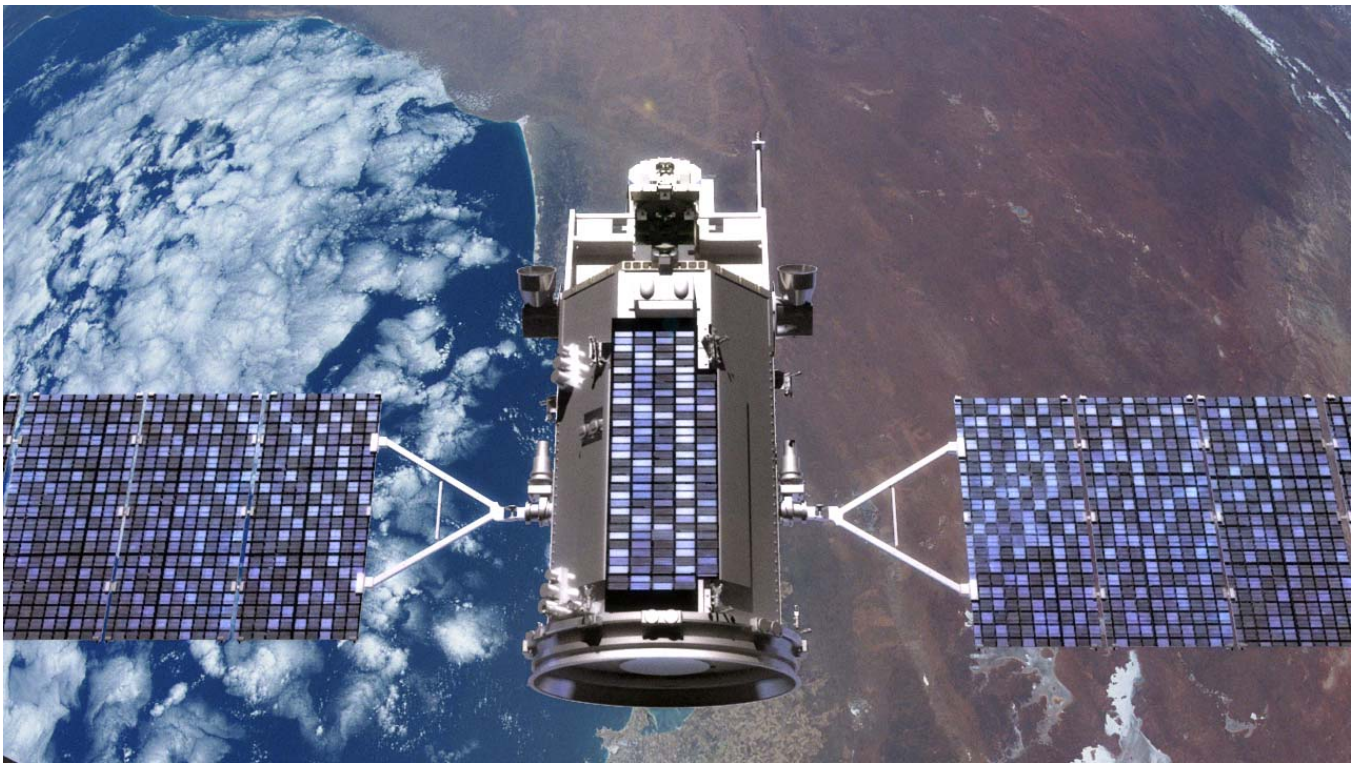
that the Earth's atmosphere and its surface have a complex relationship, which leads to large uncertainties in simulations that scientists use to describe and understand this system. The objective of the Glory mission is to reduce these uncertainties.

GLORY'S INSTRUMENTS

The Glory spacecraft is equipped with the following scientific instrumentation: The Total Irradiance Monitor (TIM); and the Aerosol Polarimetry Sensor (APS), along with its two supporting Cloud Cameras.



Total Irradiance Monitor

The TIM instrument was built by the University of Colorado's Laboratory for Atmospheric and Space Physics in Boulder, Colorado. The instrument measures the amount of solar energy that enters the Earth's atmosphere. This information will help researchers understand any long-term changes in the amount of energy coming from the Sun and how those changes affect Earth's climate. The accuracy of Glory's TIM instrument is expected to be better than that of any other solar irradiance instruments currently in space. It will follow a record of observations made by an earlier TIM instrument flown on the SOlar Radiation and Climate Experiment (SORCE) mission, and continue an uninterrupted series of solar observations that span the past 30 years.

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The TIM instrument will monitor the Sun during the daylight portion of each Glory orbit. Data acquired in 50-second intervals will track changes in the total solar energy, which will then be averaged to provide both 6-hourly and daily values. This virtual continual monitoring will help diagnose short-term solar mechanisms causing energy budget changes and will contribute to the vital long-term solar record.

Aerosol Polarimetry Sensor

The Aerosol Polarimetry Sensor (APS) instrument was built by Raytheon Inc. in El Segundo, California. This instrument will measure the size, quantity, refractive index, and shape of aerosols. This is the first space-based instrument to be able to identify different aerosol types, which will help researchers distinguish the relative influence of natural and human-caused aerosols on our global climate. The aerosol characterization capabilities of APS, coupled with the cloud identification function performed by the two on-board Cloud Cameras will allow scientists to determine, with very high accuracy, the global distribution of aerosols and cloud properties. The Glory Cloud Cameras were built by Ball Aerospace and Technologies Corporation (BATC) in Boulder, Colorado.

Glory will complete a series of 233 orbits of the Earth along differing ground tracks to create a net of observations. This pattern is repeated every 16 days. Such complete coverage of the Earth will help scientists learn about aerosols and their impacts across the globe.

GLORY SPACECRAFT

The Glory Spacecraft was built by Orbital Sciences Corporation, in Dulles, Virginia. The spacecraft has two deployable solar array wings, is 3-axis stabilized, and has X-band/S-band RF communications capabilities. The structure is an octagonal aluminum space frame and there is a blowdown hydrazine propulsion module which contains enough fuel for much more than the 36 month baseline mission. The spacecraft bus provides payload power; command, telemetry, and science data interfaces, including onboard storage of data. The attitude control subsystem supports instrument pointing requirements in the 10's of arc-seconds.

GLORY LAUNCH AND ORBIT

The Glory satellite is scheduled for launch in 2009 on a Taurus XL launch vehicle from the Vandenberg Air Force Base, located on the central coast of California, and will orbit as part of the Afternoon Constellation, also known as the A-Train, which is a series of Earth-observing satellites flying in close formation. The A-Train orbits the Earth once every 100 minutes.

(GLORY Continued on page 18)

(GLORY Continued from page 17)

WHY FLY IN THE A-TRAIN

From its A-Train orbit, Glory will enhance existing satellite science data through a comparison of Glory science data with data from other instruments located on satellites orbiting in the A-Train through a process known as co-observation.

WORKING TOGETHER TO MAKE GLORY WORK

Getting Glory into space, and maintaining it once it is in orbit, will require the collaboration of numerous organizations across the United States.

Orbital Sciences Corporation is responsible for operating the spacecraft from the Mission Operations Center in Dulles, Virginia.

The Laboratory for Atmospheric and Space Physics in Boulder, Colorado will provide the capability to command the TIM instrument, monitor its performance, and generate science data products.

The Goddard Institute for Space Studies in New York City will schedule APS instrument activities, monitor instrument (APS and Cloud Cameras) performance, and generate aerosol and cloud data products.

The TIM, APS and Cloud Camera data products will be archived and distributed by the Goddard Earth Sciences Data and Information Services Center (GES DISC) at NASA Goddard Space Flight Center (GSFC) in Greenbelt, Maryland.

GLORY Team/Code 426

Congratulations, Vince!

It seems like just yesterday that we published an item congratulating Code 403's Vince Gigliotti on his 50th Anniversary as a Federal employee. Well time really does fly.

Vince, congratulations on attaining your 55th Anniversary of Federal service on May 23. Perhaps when you reach 60 years you'll hold the all time NASA record. We're doing some research on that subject.

The Editor

Quotes To Think About

"The greater the difficulty, the more the glory in surmounting it."
- Epicurus (341 – 270 BC)

"I can resist anything but temptation."
- Oscar Wilde (1854 – 1900)

"I bought some batteries, but they weren't included."
- Steven Wright (1955 ---)

"The scientific theory I like best is that the rings of Saturn are comprised entirely of lost airline luggage."
- Mark Russell (1932 ---?)

"The world is full of willing people, some willing to work, others willing to let them."
- Robert Frost (1874 – 1963)

NASA Participates in Smithsonian Folklore Festival

In late July and early August, NASA was one of three featured programs in the 42nd Annual Smithsonian Folklife Festival on the National Mall. "NASA: Fifty Years and Beyond" showcased the role that NASA's men and women have played in broadening the horizons of American science and culture and will continue to play in helping to shape the future.

NASA's program included living presentations, hands-on educational activities, demonstration of skills, techniques, and knowledge, narrative 'oral history' sessions, and exhibits that explored the spirit of innovation, discovery, and service embodied by the Agency. Visitors were encouraged to ask questions of astronomers, astronauts, astrophysicists, educators, engineers, and other experts: a cross-section of NASA's 18,000 civil servants and 40,000 contractors and grantees.

NASA turns 50 on October 1, 2008. NASA's 50th anniversary logo, appearing on this page, was unveiled last September by NASA Deputy Administrator Shana Dale.

(Daelemans Tintype Continued from page 3)

flight). Since then, in response to the findings of the Columbia Accident Investigation Board (CAIB) accident report, he has committed himself to bringing the 'technology of transformation' to the GSFC community as a means of creating a powerful, effective, and inspiring GSFC workforce.

Life outside GSFC: Gerry is passionate about his family and has been married for 18 years to Rosalie. They have 3 children, Natalie age 13, Adam 10, and Vanessa 5 all of whom have appeared with Gerry and his wife at one time or another on the GSFC Music and Drama Club (MAD) stage. Gerry enjoys cartooning (see cartoon this issue of The Critical Path on page 26), reading, and has recently been seduced by the best game in the world – Golf!

Comings & Goings

Comings:

Donald Shinners to 452/Space Network Project, White Sands Station Director

Ken Mobeck to 417/GOES-R LMATC, Palo Alto, CA, Resident Manager

Pam Henderson to 453/Ground Network Project, Resource Analyst

Melissa Rice to 452/Space Network Project, Resource Analyst

Bruce Milam to 455/Exploration Systems Project, Cx Unpressurized Cargo Study Manager

Mark Voyton to 443/JWST Project, Instrument Systems Manager

Elaine Shell to 452/Space Network Project, Ground Segment Manager for TDRS K/L

Chris Doria-Warner to 443/JWST Project, ISIM Financial Manager

Linda Baumann to 422/GPM Project, Resource Analyst

Lorrie Eakin detailed to 480/POES Project, Mission Business Manager

Ben Hall to 454/TDRS Project, Resource Analyst

Sherri Wood to 450/Exploration & Space Communication Projects Division, Senior Resource Analyst

Goings:

Thomas Miller resigned from 464/SDO Project, Deputy Project Manager-Resources

Ken Mobeck Resigned from 480/POES Project, Resident Manager

David Slusher transferred to The Comptroller of Navy Region N.W.

Dennis VanderTuig to 700/Deputy Director for Operations

Mark Flanegan to Code 599

Bryan Gioannini resigns from 456/Senior Systems Engineering Manager

Ed Macie detailed to Code 227

Bernie Klein retires from 460/Heliophysics Projects Division, Instrument Systems Manager

Jahi Wartts to 153.1

Bernie Cullinan retires from 423/ESDIS Project, Financial Manager

William H. Brown retires from 446/GLAST Project, Instrument Manager

Dr. Shaida Johnston resigns from 420.1/NPOES IPO Support Office, Technology Systems Manager

Bonnie Matters to Code 153

News of Center Interest

NASA Names Rob Strain New Director of Goddard Space Flight Center

NASA Administrator Michael Griffin announced that Robert Strain, current head of the Space Department at the Johns Hopkins University Applied Physics Lab in Laurel, MD would become Director of GSFC effective August 4, 2008.

On August 6 Mr. Strain was introduced to Goddard employees by former Center Director Dr. Ed Weiler and by former Deputy Center Director Chris Scolese, both now at Headquarters. Mr. Strain then addressed the "full house" audience and fielded a number of employee questions.

Prior to coming to APL in the fall of 2004, Mr. Strain held various executive positions with Axiom Corporation, Orbital Sciences Corporation, and Fairchild Space and Defense Company.

Orbital Sciences Corporation Selects "MARS"

Orbital Sciences Corporation and Virginia Governor Timothy Kaine recently announced that Orbital has selected the Mid-Atlantic Regional Spaceport (MARS), located at Wallops Island, as its base of operations for the company's new Taurus II rocket. Orbital will assemble, test and launch the Taurus II space launch vehicle at MARS. Its first mission, scheduled for 2010, will launch a joint NASA and Orbital cargo delivery demonstration to the International Space Station. Science missions using the Taurus II will also originate from Wallops.

Social Security's Most Popular Baby Names List

Quite a few years ago, The Critical Path published the most popular boys' and girls' names as announced by the Social Security Administration on Mother's Day of that year. Well nothing has changed for the most popular girls' name since 1996 and the most popular boys' name since 1999. Without looking at the answers, and the remaining top nine names noted in the latest announcement for babies born in 2007, see if you can come up with the two winning names. You can take five guesses in each category. Chances are you will not be a winner yourself. Start writing them down now, and then turn to page 26 to see how well you've done.

Hubble As A Public Observatory

Hubble completed 100,000 orbits on August 11, 2008

4385 different PI's and Co-I's have been awarded observing time or funding for archival research over the first 17 cycles of the HST General Observer program

Oversubscription of available observing time averages 5.6:1

860,000 exposures on 27,000 targets have yielded 33 Tbytes of science data

8821 scientists worldwide are registered users of the Hubble data archive

7724 different authors have written refereed papers using HST data

On average, 14 scientific papers per week based on Hubble data currently appear in refereed scholarly journals

The collective brainpower of thousands of astronomers around the world uses Hubble's cutting-edge tools to revolutionize our understanding of the universe

David Leckrone
HST Sr. Project Scientist

Senator Barbara Mikulski, D-Maryland Comments on HST's 100,000th Orbit

"This morning (Aug. 11), the greatest scientific instrument since Galileo's telescope has reached another great milestone - its 100,000th orbit around the Earth. Hubble has given us amazing insight into the origins of our universe, and I'm so proud of the men and women at Goddard and the Space Telescope Science Institute for their contributions and dedication to these great discoveries. The entire world is looking forward to the Hubble servicing mission in October 2008, when Hubble will get new scientific instruments, new batteries and new gyroscopes. The servicing mission will extend Hubble's life and give it a more powerful view of our universe. Hubble is the telescope that could, and its best years are ahead of it!"

Letter Excerpts

"I just finished reading through the latest edition of The Critical Path (Spring 2008). Even though I could count the names I know on the fingers of my (two) hands, I found it interesting. Ceppi keeps Goddard busy, and Johnson (Space Center) aware that there is a purpose to space flight beyond giving humans a joy ride.

Keep 'em coming."

John (Boeckel)
Former Director of Code 300 and Engineering (and several other senior management positions at GSFC)

"I appreciate your keeping me on your mailing list so I can try to keep up with Code 400. You are doing a really great job with the publication. My, how things have changed! I only recognized one name besides yours in the whole issue. It was also very interesting to note how many women have reached senior management positions in Code 400.

I hope The Critical Path keeps going. It's an important publication."

Margie Townsend

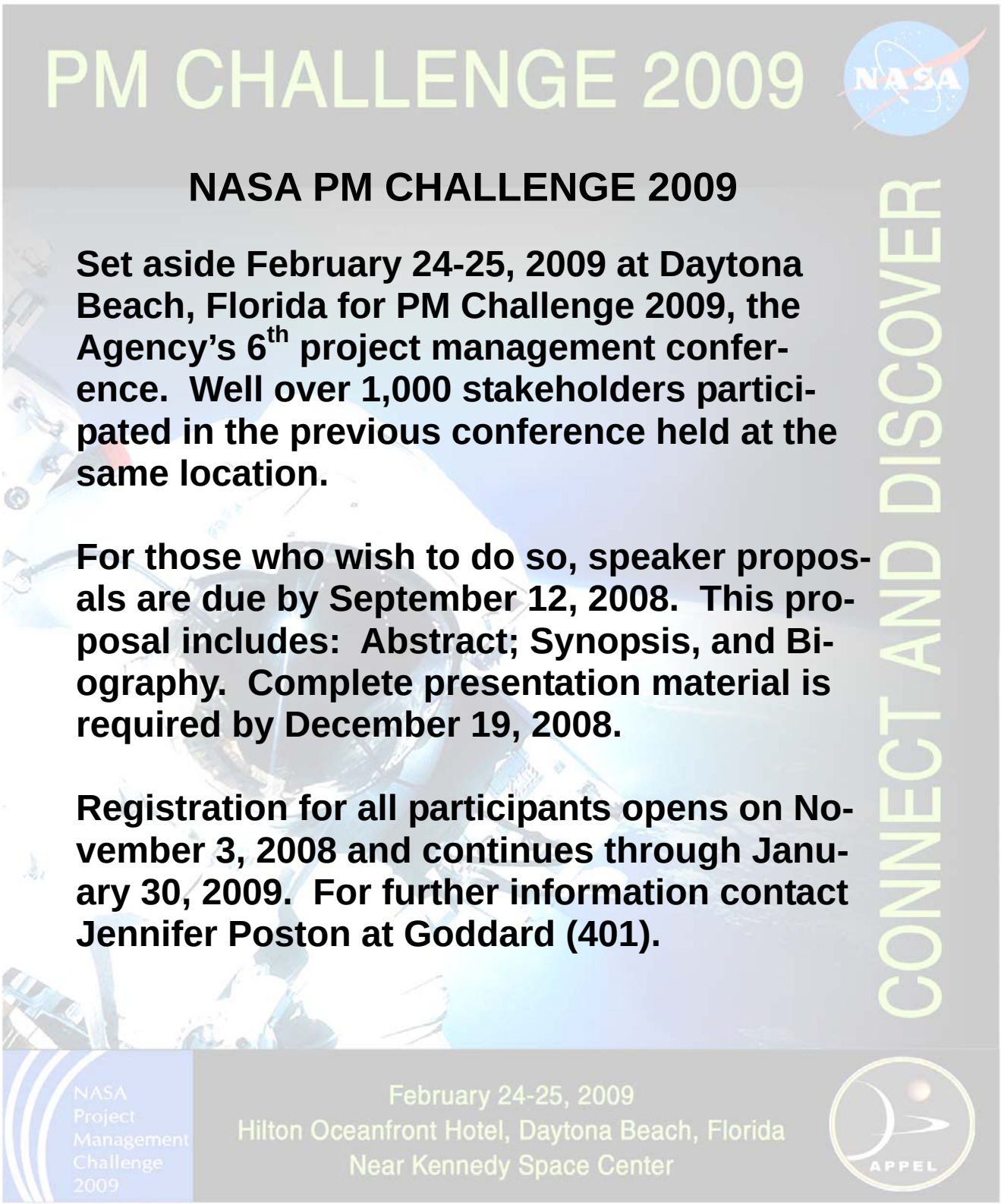
Margie was the first woman Flight Project Manager at Goddard and was a pioneer in opening up senior management positions for women throughout the Center.

The Critical Path Makes The New York Times!

As part of an item run by the Times on its "Wedding Announcements" page concerning the Ottenstein/Bonheim wedding, the last sentence stated: "His father coordinates a management training program at the NASA Goddard Space Flight Center in Greenbelt, Md., where he is also the editor of The Critical Path, an in-house newsletter."

I just couldn't resist putting this in the TCP. Incidentally, the referenced management training program is PMDE.

The Editor



NASA PM CHALLENGE 2009

Set aside February 24-25, 2009 at Daytona Beach, Florida for PM Challenge 2009, the Agency's 6th project management conference. Well over 1,000 stakeholders participated in the previous conference held at the same location.

For those who wish to do so, speaker proposals are due by September 12, 2008. This proposal includes: Abstract; Synopsis, and Biography. Complete presentation material is required by December 19, 2008.

Registration for all participants opens on November 3, 2008 and continues through January 30, 2009. For further information contact Jennifer Poston at Goddard (401).

Here are the winners and the remaining names for the top ten in each category

Boys' Winner:	**JACOB**	Girls' Winner:	**EMILY**
Followed by:	Michael		Isabella
	Ethan		Emma
	Joshua		Ava
	Daniel		Madison
	Christopher		Sophia
	Anthony		Olivia
	William		Abigail
	Matthew		Hannah
	Andrew		Elizabeth

Social News

Congratulations:

Karen Kaczorowski, daughter of Gail Regan (403), married Matt Hudson in West Lafayette, IN, on August 8, 2008. Both Karen and Matt are PhDs in plant biology. Matt is at the University of Illinois and Karen is with the USDA located at Purdue University in Indiana. Their goal is to find jobs closer together!!!

Congratulations go out to Nancy White(403)and Loretta Cale(443) for their new role as Great Aunts. On August 6th their niece Lyndsey Crowder gave birth to a 7 pound baby girl named Kaelynn. Both mom and baby are doing great.

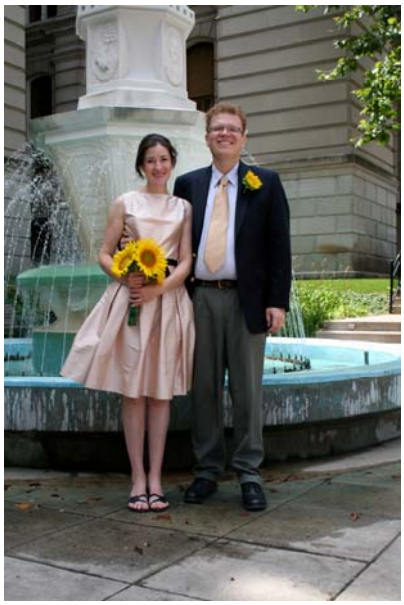
Steven Ottenstein, son of The Critical Path editor Howard Ottenstein (403) and Karen Bonheim were married in New York City on June 28. After a honeymoon in Bora Bora, Steven is back at work at The New York Times, and Karen at the magazine Cosmo Girl.

Congratulations to Tom Venator (426) who married Kathryn DeLima on July 19 in Annapolis. They met while Tom was on travel to Los Angeles for the Glory project. The new family, which includes Duncan Turner, (age 11), resides in Riva.

Gerald Conwell, son of Evette Brown-Conwell (450.1) graduated from DeMatha Catholic High School with honors. Gerald will be attending the University of Maryland Baltimore County (UMBC) in the fall, majoring in Chemistry. Evette's daughter Jasmine recently received the Girl Scout 2nd highest award, the Silver Award for community service. She is a sophomore at Elizabeth Seton High School.

Pamela Wood, daughter of Paula Wood (460), recently graduated from Bowie High School, class of 2008. She will be attending Lock Haven University of Pennsylvania in the fall, majoring in Communications Media.

Congratulations to Elizabeth Whorton (403) and Daniel Choi! They were married on June 27, 2008, at the Elkridge Furnace Inn. They started married life with a honeymoon to Europe. Welcome back Mrs. Choi!



Karen Kaczorowski and Matt Hudson

Kaelynn Crowder

Elizabeth Whorton (403) and Daniel Choi

Tom Venator (426) and Kathryn DeLima

www.nasa.gov

FUTURE LAUNCHES CALENDAR YEAR 2008/2009	
IBEX (SMEX-10)	OCT
HST SM4	OCT
GOES-O	JAN
LRO	FEB
NOAA-N'	FEB
SDO (LWS)	APR
GLORY	JUN
MSL/SAM	SEP
WISE (MIDEX-6)	NOV

ATTENTION INTERNET BROWSERS:

We're on the WEB
http://fpd.gsfc.nasa.gov/news.html
Or via the New "Code 400" Homepage
http://fpd.gsfc.nasa.gov

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— In April, August, and December —

Howard K. Ottenstein,
Editor

Nancy L. White,
Production Assistant/Photographer

Paula L. Wood,
Editorial Assistant

If you have a story idea, news item, or letter for The Critical Path, please let us know about it. Send your note to Howard Ottenstein via Email: Howard.K.Ottenstein@nasa.gov, Mail: Code 403, or Phone: 6-8583. Don't forget to include your name and telephone number. Deadline for the next issue is November 15, 2008.