National Aeronautics and Space Administration

Trailblazer

Flight Projects Directorate Quarterly Highlights

Langley takes flight blazing new trails for science.

3rd Quarter

May - July 2016

SAGE III and CLARREO Pathfinder headed for ISS integration / ARRM prototype legs redesign and fabrication / FPD's CMC pre-review process gets a fresh new step

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FPD Trailblazer Quarterly Highlights

2016 Third Quarter Image Contest Winners

The competition was fierce this quarter with nine great submissions and more than 50 votes! The contest was close with only a couple of votes separating the winners. Thank you to everyone who submitted a photo and voted, making this contest even better than the last.

This quarter's winning entry is a series of photos from the CLARREO Pathfinder on ISS team telling the story of a recent adventure they had that turned into an opportunity for some lessons learned.

Part of the job of a project manager is to report to stakeholders at headquarters. On the way back to NASA's Langley Research Center from a trip to do just that on July 8, 2016, the van carrying Gary Fleming, Michael Koch, Mary DiJoseph, and Bruce Wielicki, encountered a flat tire. The team documented the experience, using the photos to illustrate some safety tips during July 's Flight Projects Directorate All Hands meeting.

This will be a regular quarterly contest so brush up on your photography skills and get creative with some images for the next round.

Go to page 12 to see the second and third place runners up.

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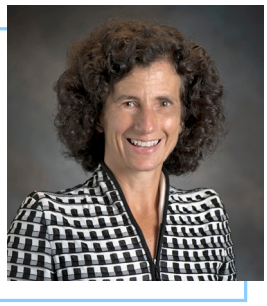

Mary DiJoseph, Director
NASA Langley Flight Projects Directorate

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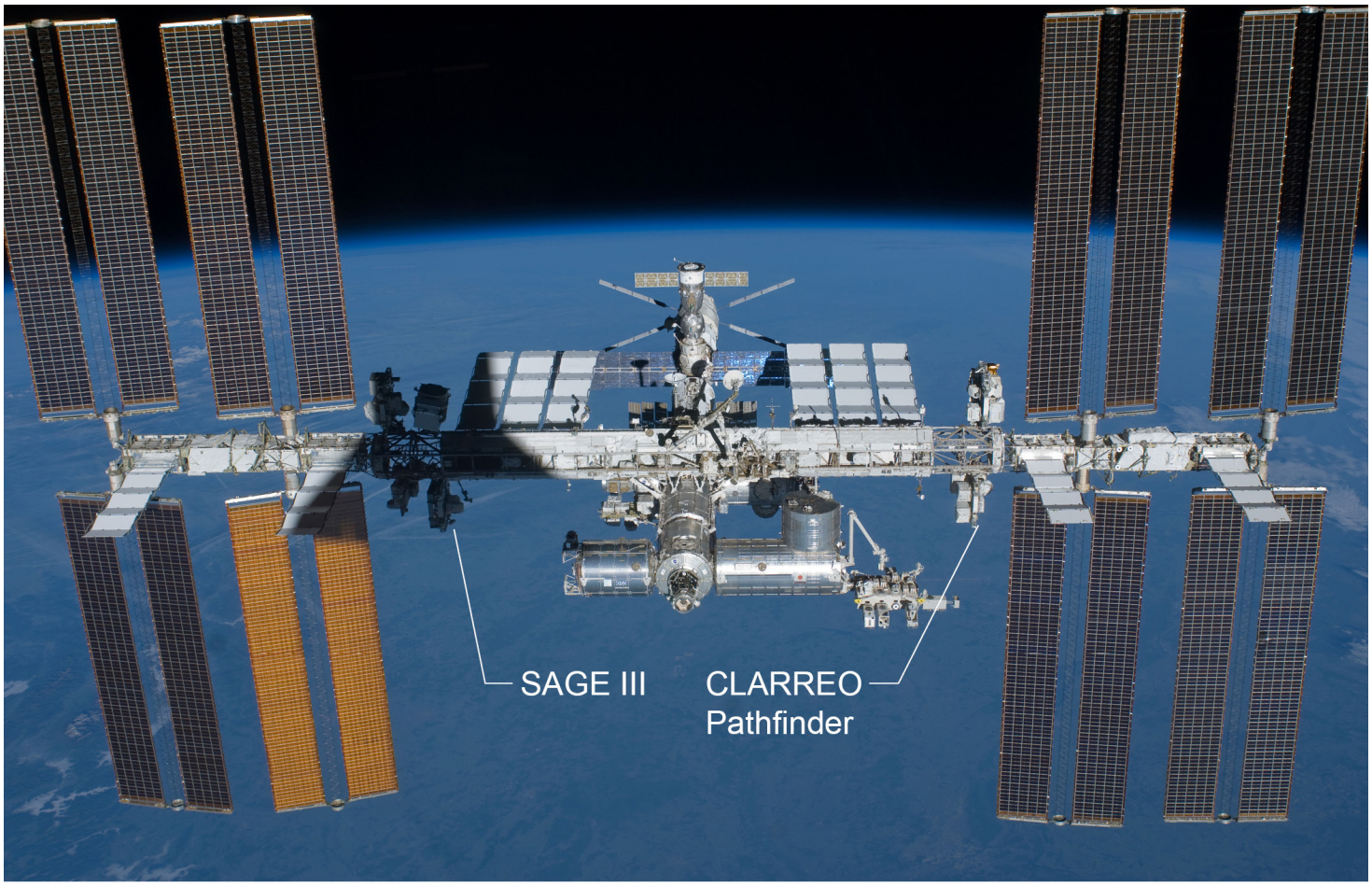
SAGE III and CLARREO Pathfinder on ISS: A Chapter in History



In this photo, the instrument integration locations on ISS for both SAGE III and CLARREO Pathfinder are labeled.

No matter one's life journey or contribution to history, time has the privilege of telling its own tales, a myriad over the centuries far greater than any could possibly know.

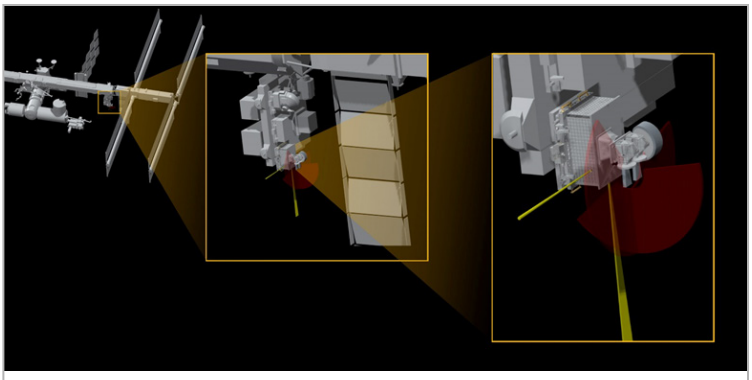
With sheer marvel we all watched as our post–Industrial Revolution stories of exploration played out. The taking of flight at Kitty Hawk, a human footprint impressed upon Earth's moon, Everest's tower is peaked and Challenger Deep uncloaked in the Mariana Trench, and for nearly 40 years Voyager continues reporting from its interstellar trek.

Some, like the Wright brothers or Edmund Hillary, journeyed those paths writing a page in history, imprinting us with their accomplishments. Still others sojourn today, setting the words and sentences that will one day contribute to yet another chapter in the book of time.

That's where the International Space Station comes into the story.

Through a NASA-led, broad payload community activity organized in 2014 and referred to as "RISE", meaning Revolutionize ISS for Science and Exploration, a shift is underway in how we think about and what we want from the ISS Program. In the past, processes and ISS activity focused on assembly, perfect for building an orbiting space laboratory, and we did. That chapter is set. Moving forward, the focus is on curating science and technology discoveries. A new chapter begins.

Two of NASA Langley Research Center's Flight Projects Directorate programs, SAGE III and CLARREO Pathfinder, are paving the way for the philosophical shift. SAGE III will launch later this year to be installed on the ISS and CLARREO Pathfinder will follow in 2020, providing



The Climate Absolute Radiance and Refractivity Observatory (CLARREO) mission monitors the pulse of the Earth to better understand climate change. CLARREO is a climate-focused mission that will become a key element of the climate observing system.

The foundation for CLARREO is the ability to produce highly accurate and trusted climate records. Measurements derived from CLARREO will be used to detect climate trends and to test, validate, and improve climate prediction models.

In 2016, the CLARREO project received funding for a pathfinder mission to demonstrate essential measurement technologies required for the full mission. The allocated funds support the flight of a Reflected Solar (RS) spectrometer, hosted on the International Space Station (ISS) in the 2020 time frame. The key feature of CLARREO Pathfinder (CPF) is the Reflected Solar Instrument, which is integrated on the ExPA and installed on the ExPRESS Logistics Carrier number 1 (ELC-1). The CPF is a Class D mission with 1 year of operations on orbit and 1 year for analysis of acquired data.

The CPF provides high accuracy spectral reflectance and radiance measurements enabled by an RS spectrometer operating between 350 - 2300 nm contiguous spectral coverage (> 95% of reflected energy) with uncertainty < 0.5% broadband and < 1% spectral (κ = 2)3. The RS spectrometer will be capable of pointing to the moon and sun for calibration, as well as tracking time and angle matched observations when used for reference inter-calibration of other radiometers as shown in the figure above. The CPF RS spectrometer will provide Earth nadir observations between 52° N and 52° S latitude with full diurnal cycle sampling in approximately 1 month.

valuable data to scientists here on Earth.

Jonathan Chrone, ISS systems engineer for both SAGE III and CLARREO Pathfinder, says, "The build-up and construction phase for ISS lasted up until 2011. Now, with RISE, the ISS Program is looking at streamlining processes and making it easier for payloads to integrate with the station. The intent of RISE is to transform the ISS culture by bringing research to the forefront and to utilize the ISS as a platform for science and technology. The SAGE III project was well underway at the beginning of RISE and has contributed to its progress. CLARREO Pathfinder will be able to reap the benefits of that interaction."

The transition efforts span agency projects and programs, industry, and countries. This dynamic, Chrone says, presents some challenges.

"There are many facets to understand," he explains. "The ISS Program is large with a lot of pieces, each with a different role: the Vehicle Office manages maintenance and technical requirements, the Research Integration Office works with the payload community, and the Transportation Integration Office coordinates with launch providers, just to name a few. Each organization, and its people, is a stakeholder with its own priorities and processes. There are many layers to navigate, and all in an effort to understand the 'language' of ISS. For some payloads there are industry and international partners involved as well."

Chrone says understanding the crossover is important because everyone has a unique goal in mind and at the same time everyone has something to add. The benefits realized through the various interactions far surpass the challenge of immersing oneself in ISS Program culture.

Working closely with Chrone in streamlining efforts, Brian Boland, lead systems engineer for both SAGE III and CLARREO Pathfinder and one who participated early on in the ISS Program, says SAGE provides a good example of the collaboration between projects and the ISS Program to achieve the desired state of a true science return laboratory.

"SAGE was one of the first payloads specifically targeted for ISS. It was waiting for the ISS to be built," says Boland. "As changes were made to the space station, SAGE's interface changed, so we had to engineer the instrument's interface to meet with the station's mount

specifications. We are writing the processes to make it easier for payloads to interact with ISS, simplifying things to ease the burden on payloads to get to the ISS."

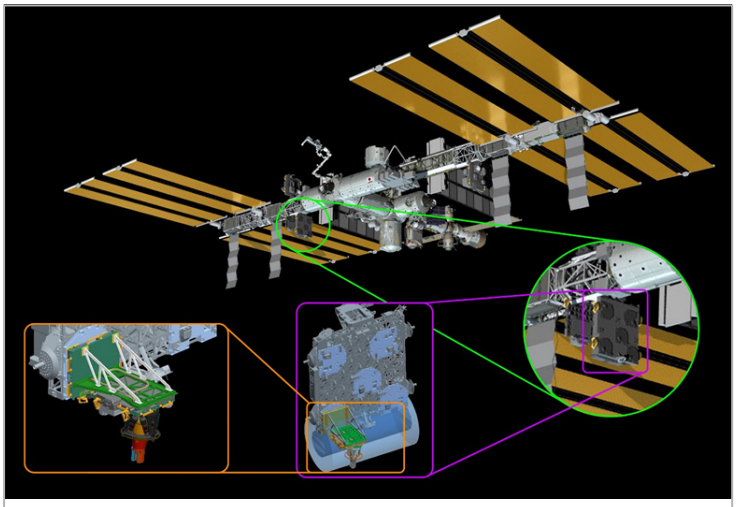
Boland is referencing the documentation coming out of preparing SAGE III and CLARREO Pathfinder for their journeys, and any further observations recorded when the instruments are physically mounted to the station. The information is important because what works in one instance, or even what doesn't, informs what can or needs to work for other science payloads to one day interface with the station.

"SAGE is already a proven 'pathfinder' and not just because it is a scientist's best record, a true record, with 30-plus years of data continuity measuring stratospheric gases," says Boland. "One example is when preparing an instrument for flight; contamination control is a challenge. SAGE is super sensitive where others are not. We laid the groundwork for contamination control processes and programmatic discussions to upgrade the clean room facilities at Kennedy. There was an immediate value added there from SAGE for the launch service provider and other programs in that preparing instruments for launch is done in a much cleaner environment, and the processes are refined, more efficient."

Other benefits already in place are the existing mechanical infrastructure with which instruments interface and the software built to execute communications, sending data from in-flight to the ground. With these features established, there is no additional cost to programs to design or build hardware and software. Instruments are engineered to meet with those existing specifications, and interface functionality can be validated prior to flight, yet another benefit to the payload community.

Boland is pleased that the time investment and technological progress are now coming to fruition. His work with the ISS Program at NASA's Johnson Space Center included developing ground systems in the Mission Control Center earlier on, and then the crew laptop currently used onboard to command the ISS. "It is truly satisfying to see the work that we did back then paying off now as we see the ISS fulfill its potential," he says. "Now it's a true science platform and a test bed for future exploration technologies."

Once SAGE III and CLARREO Pathfinder are operating and taking science from the ISS, this next chapter in history promises to be an interesting read.



The Stratospheric Aerosol and Gas Experiment (SAGE) III instrument is used to study ozone, a gas found in the upper atmosphere that acts as Earth's sunscreen, and aerosols, or tiny particles in the atmosphere. These measurements are vital inputs to the global scientific community for improved understanding of climate, climate change and human-induced ozone trends.

NASA scientists are preparing to send a SAGE III instrument to the International Space Station (ISS). Instead of flying on an un-manned satellite, SAGE III will be mounted to the ISS where it will operate alongside experiments from all over the world in the space-based laboratory. The orbital path of ISS will help maximize the scientific value of SAGE III observations as it provides global, long-term measurements of key components of Earth's atmosphere.

The SAGE III sensor assembly consists of pointing and imaging subsystems and a UV/visible spectrometer. The pointing and imaging systems are employed to acquire light from either the sun or moon by vertically scanning across them.

The spectrometer uses an 800-element CCD linear array to provide continuous spectral coverage between 290 and 1030 nm. Additional aerosol information is provided by a discrete photodiode at 1550 nm. This configuration enables SAGE III to make multiple measurements of absorption features of target gaseous species and multi-wavelength measurements of broadband extinction by aerosols.

Orion Drop Test

On June 24, 2016, at NASA Langley Research Center's Hydro Impact Basin, NASA mimicked some of the most stressful water landing conditions Orion could experience when it returns from deep space and splashes down in the Pacific Ocean. The Orion capsule is the spacecraft that will bring astronauts back from orbit around the moon and Mars. Langley engineers outfitted a test version of the crew module with Orion's heat shield that flew in space and strapped two test dummies inside to evaluate loads the crew may experience during real missions and ensure that splashing down in the ocean during high winds would not injure the crew.

NASA's Orion spacecraft is built to take humans farther than they've ever gone before. Orion will serve as the exploration vehicle that will carry the crew to space, provide emergency abort capability, sustain the crew during space travel, and provide safe reentry from deep space return velocities. Orion will launch on NASA's new heavy-lift rocket, the Space Launch System. The integrated mission of Orion and SLS, known as Exploration Mission-1 (EM-1), is planned for launch in 2018.

NASA Langley's Flight Projects Directorate manages the Orion Launch Abort System and the Ascent Abort-2 test, the final launch abort system test, scheduled for 2018. The June 2016 milestone is one in a series of drop tests NASA is conducting to look into different aspects of splash down Orion will encounter after having completed its missions into space. Test points include wind conditions, landings via parachute, speed, and conditions of the water.

Artist's rendering of NASA's Orion spacecraft, currently being tested on the ground, which will one day take astronauts deeper into space than ever before and then safely return them to Earth.

ARRM Prototype Legs Undergo Redesign and Fabrication

During a tour of Langley's fabrication shop, John Teter overviewed the redesign efforts currently underway. Here he demonstrates how and where the actuator nut mount will be attached to the leg sections.

The latest design iteration is complete and fabrication underway at NASA's Langley Research Center of a soon to be operational set of the Contact and Restraint Subsystem (CRS) Project's prototype "legs", which are being designed and developed for attachment to the Asteroid Redirect Robotic Mission's (ARRM) capture module.

When looking at conceptual drawings of the ARRM capture module fitted with its CRS, one is immediately reminded of Erector Set structures and how those models could be changed, individualized, reformulated, and eventually become anything the imagination might draw forth.

Far from being a toy, ARRM's capture module will be part of a human exploration mission involving in-space interaction with an asteroid boulder in the mid-2020s. The mission will provide systems and operational experience required for several key science areas: human exploration of Mars; demonstrating an advanced solar electric propulsion system; enhancing detection, tracking and characterization of near-Earth asteroids, enabling strategies to defend our home planet; and expanding our knowledge of small celestial bodies to possibly mine asteroids for resources enabling commercial and exploration needs.

Scott Belbin, a senior mechanical engineer with Langley's Engineering Directorate, is technical lead for design and development of the CRS. Belbin worked analyzing alternatives to the so-called "capture bag" concept wherein a small (about 10 meters) free-floating asteroid would be captured in a deployable bag for redirection to lunar orbit, intended for astronaut extra-vehicular activity. He was subsequently asked to lead the boulder capture-module design effort during the comparison study between the original capture bag concept and what was eventually chosen, the mission that will land a robotic spacecraft on the surface of a larger near-Earth asteroid and collect a boulder of scientific interest.

"After a series of initial ideas and methods of landing and capturing the boulder were explored, the CRS was eventually settled upon as being able to meet the required

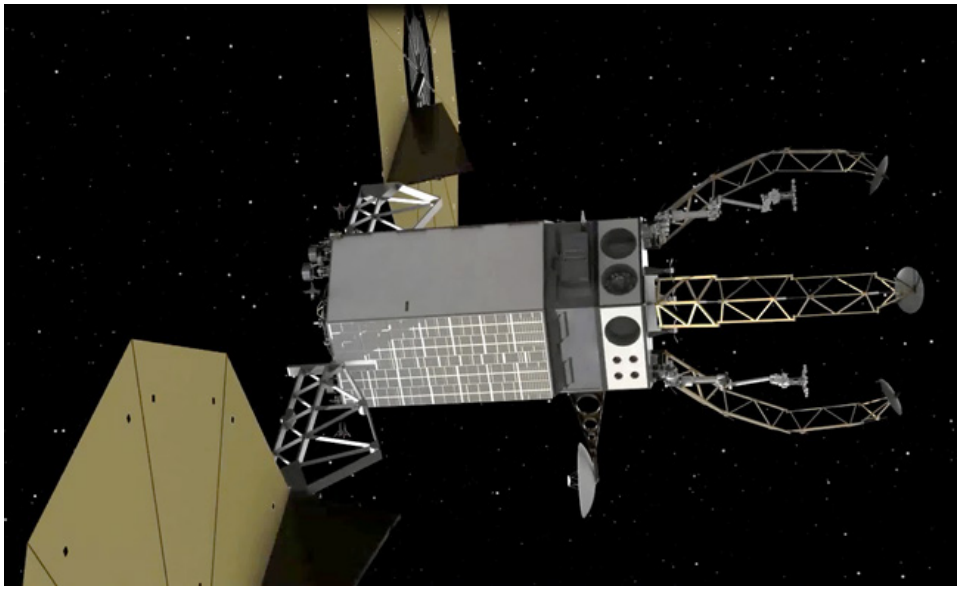
criteria," says Belbin. "As part of the capture module, we'll be designing, fabricating and delivering engineering development units, and flight versions of the CRS, to Goddard for integration into the capture module, an effort being managed by the Flight Projects Directorate."

Belbin says the CRS constitutes the legs of the spacecraft because they first act as landing gear, attenuating the vehicle's momentum and bringing it to rest on a surface without using thrusters. The legs then push the vehicle and boulder off of the surface, again without thrusters, to an altitude where it is safe to thrust again.

"The asteroid's surface is expected to be covered with regolith—fine, sharp particles created in the collisional processes asteroids experience—that can coat solar arrays and degrade performance or get into mechanical joints causing premature failure," explains Belbin. "Once spaceborne, the CRS restrains the boulder, like your legs around a beach ball, which frees up the robotic arms to conduct science and sample preparation on the trip to lunar orbit."

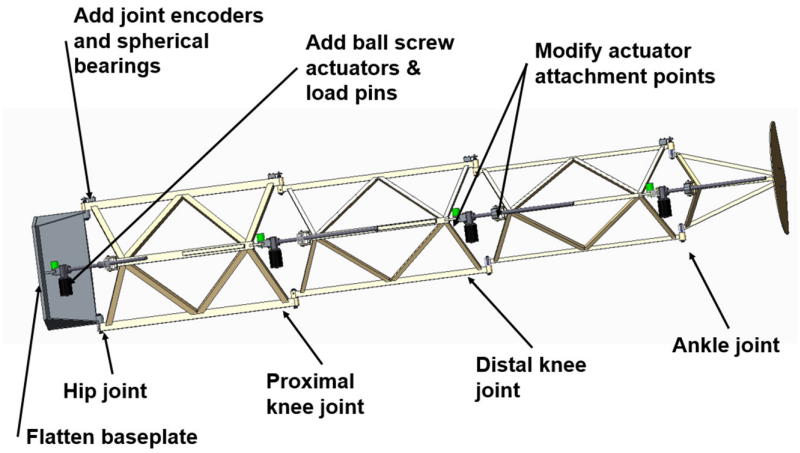
One improvement over the CRS demonstrator—made of sheet metal not matching the stiffness of the flight design—is that the prototype legs are welded tube frames, a better parallel to the flight design. Coupled with actuators of similar layout as the flight actuators, the modified prototype legs will allow the team to verify system modeling.

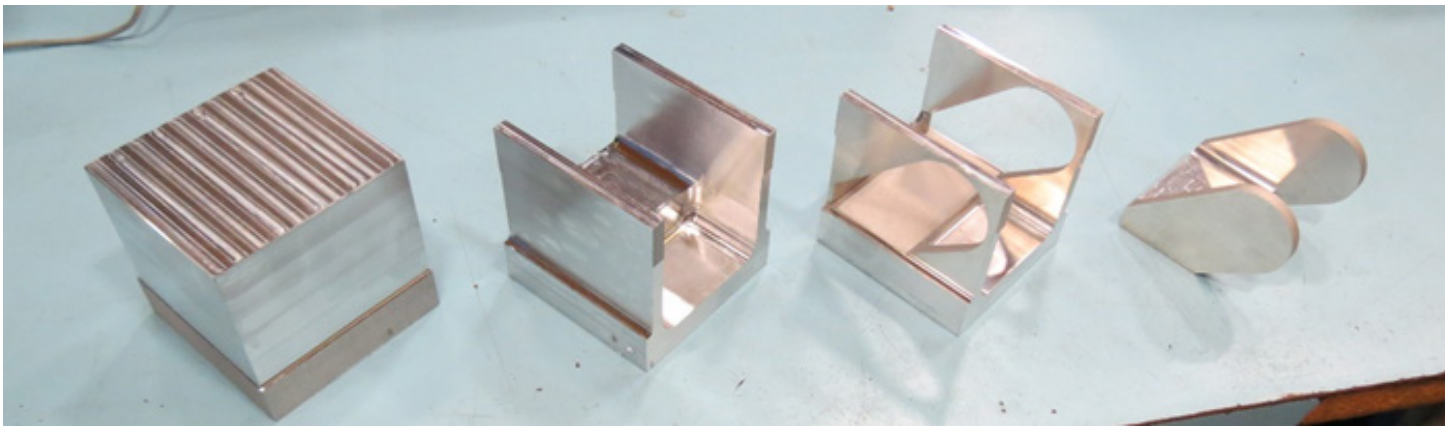
"Once verified, we'll be able to run many more boulder shape and size cases than is possible with our physical representation," says Belbin. "We're also adding dampers and load cells to explore the various options we have for descent and contact, ranging from a failsafe unactuated landing (stiff-legged with and without dampers), open-loop control (so-called pre-



Concept ARRM Capture and Restraint Subsystem as envisioned attached to a capture module and spacecraft with solar electric propulsion system.

Detail of CRS concept demonstrator leg segments, joints, actuators, and sensors in Langley's Technology Demonstrator Lab. The diagram below summarizes the areas under upgrade for producing electromechanical actuation of prototype legs.





The actuator nut mount goes through numerous machining steps to get the strong, solid part needed to position this key piece of equipment.

canned motion programming) and force-feedback closed-loop control."

Based on operational assessments with the earlier concept demonstrator legs, changes underway have a lot to do with the nuts and bolts of things, but also include going from a functioning two-dimensional approach, i.e., from a two-leg flat-floor concept demonstrator, to an operational three-dimensional three-leg flight system concept approach. Getting there calls for modification of a set of welded metal legs that were previously constructed as part of a pathfinder fabrication activity. For this design iteration, the project is taking an existing set of legs constructed for static display and manual manipulation and is transforming these legs into an operational system outfitted with electromechanical actuators, leg segment position sensors, and segment force sensors.

"The model's construction is more complicated each time, and even gets changed during an iteration's development," says John Teter, a mechanical engineer instrumental in the design upgrades and also with Langley's Engineering Directorate. "We take a model, evaluate test capabilities, equipment and overall functionality, and then identify refinements. Eventually you come to what you need to actually go to the asteroid."

The base attaching the legs to the capture module is being constructed of a greater thickness material than originally planned for this iteration after some warping occurred when welding the sections together. The base itself curved, causing the pivot-tube holes to move out of alignment with one another. Base fabrication designs were adjusted from a half-inch thickness to a full inch. Machining the flat side of the base to precision measurements ensures the most accurate fit.

Great detail went into redesigning the joints because a different geometry exists for each link, and the joints are the location for encoders, the electrical sensors reading joint angle during motion, which provide feedback for actuators. These data are used to control the capture module's positioning during a capture procedure.

Teter says it is particularly important that the force readings are correct. "Given that there is a range of possible compressive strength expectations for boulders that may be collected from an asteroid, with the low end of hardness being closer to chalk, we don't want to use too much force restraining a boulder after collection or it may simply crumble."

Other specific changes being addressed include actuator adaptors and associated mounts, the base bracket pad eye, and incorporating spherical bearings for all joints.

Once completed, the three operational prototype legs will be attached to an adapter structure currently under design that will simulate the capture module deck interface. Going forward, this will then become a test bed to support system-level operational command and control scheme development. Another potential use is as a pathfinder to provide early-on assessment of landing and ascent capability at Langley's Landing and Dynamics Impact Range (LanDIR) gantry facility.

STC Machinist Chase Whaley gives a status on machining the base that attaches to the module.

FPD Refines Process to CMC Review Preparation

NASA Langley Research Center's Flight Projects Directorate (FPD) is home to many challenging and innovative projects, all subject to a rigorous review process. To prepare, FPD performs dry runs reviewing and evaluating project performance before presenting to Center management. To help make the process more effective and efficient, FPD has implemented a well-received pre-review step to its part in the Center Management Council (CMC) reporting requirement.

"We changed the focus from a dry run to a pre-review, or monthly Directorate review, perspective," says FPD's Acting Deputy Director Steve Gaddis. "This is more in line with Mary's [FPD Director Mary DiJoseph] expectations, making sure the project performance is being 'scrubbed' and evaluated in detail before going to the CMC."

Key refinements include changing the focus from being on status to performance; increasing review time to allow a complete evaluation of all project performance; following up on Headquarters, CMC, Center Leadership Council (CLC), and pre-CMC actions and requests; and adding data that allows more in-depth review of requirements such as milestone trends, variance reporting, and risk management.

"Conveying clear and concise messaging is everyone's goal," says Gaddis. "We want to improve strategic communications with all of our stakeholders beginning with FPD and the Center. We want to clearly and crisply present the project issues, impacts, recovery plans, and risks to the CMC so leaders can have informed discussions when required."

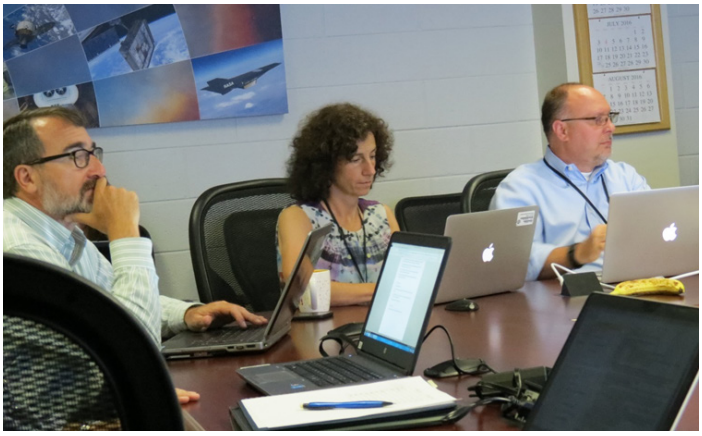
To aid in sharing project experiences and insights that are more in line with CLC expectations, a new reporting template was created by Sarah Waechter, FPD schedule analysis and risk management lead who works in program/project planning and control. Waechter finds the new template an improvement in best practices benefitting both the organization and the projects.

"The template updates are helping reviewers to better understand the project's current performance due to consistency in data formats, data comparisons between months, and more in-depth analysis," says Waechter. "As a reviewer, I have also greatly appreciated the more in-depth discussions in the reviews, which helps me better understand the context of monthly changes in project reporting."

Mike Cisewski, SAGE III/ISS project manager, says, "The improved pre-CMC format permits more time to discuss issues or concerns with key internal stakeholders. I think the updated, more consistent format, with emphasis on problem areas, helps Center leadership better assess and support project execution."

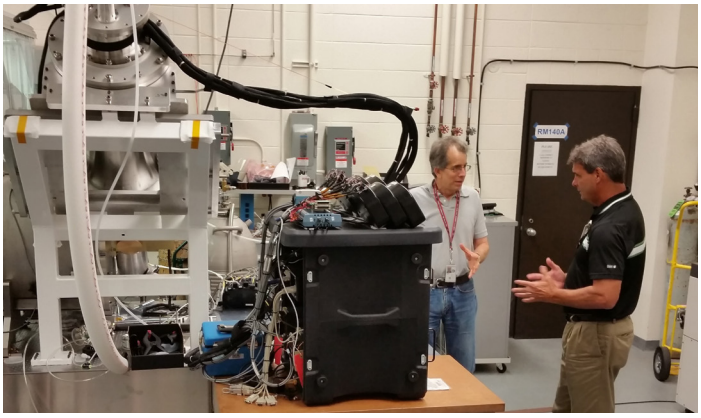
Gaddis shared that the CLC has seen improvement in CMC presentation content, quality, and weekly reporting. "Feedback from CMC leadership has been extremely positive," he says, "so we will continue our improvement efforts."

During the gatherings, project team members, such as Kory Priestly, project scientist with CERES FM6 (farthest left), engage in discussion to help clarify data during the CERES presentation. As necessary, the group breaks off to get into the weeds a bit, asking detailed questions and trying to pinpoint areas of need and how to address them.



FPD Director Mary DiJoseph (center), with Drew Hope, associate director for science in the Engineering Directorate (left), and FPD Acting Deputy Director Steve Gaddis (right) listen to presentations during the July 14, 2016 session.

Team Profile: Michael Koch



Dave Johnson gives Michael Koch an overview of the CLARREO Infrared (IR) Calibration Demonstration System at NASA's Langley Research Center. The project Koch is working on, CLARREO Pathfinder on ISS, is aimed at demonstrating measurement technologies required for the full CLARREO mission.

The generation that grew up in the 1960s and 1970s watched as NASA made history with the Mercury and Gemini launches, the Apollo program and the first men stepping foot on the Moon, and the beginnings of international human space flight, Mars and deep space exploration.

Many of those children were inspired to pursue math and science and grew up to become engineers and scientists. Mike Koch, deputy project manager for the CLARREO Pathfinder on ISS Project, was one of those children and is now helping to lead the next generation of NASA Earth science flight projects.

"I was fascinated with space exploration," Koch said. "Tinkering with crystal radio sets and flying model rockets and airplanes were a passion well into my teen years."

As Koch prepared to graduate high school and plan for his future, he knew exactly where he was headed. For Koch, NASA represented the embodiment of state-of-the-art technology development and that is where he wanted to work.

"Coming out of high school, I wanted to become an engineer, but I also wanted to continue playing football," he said. "Gifted with limited athleticism, large schools with engineering programs were not an option, so I attended Randolph Macon College where I played football and studied physics. Football lasted only a year, but I did manage to log a whopping eight seconds of playing time in the NCAA books. We were up 27-0 and the coach figured I couldn't do much harm, so he put me in at the end of the game. Physics lasted longer."

Of all the topics studied in physics, electronics was Koch's favorite and he went on to study electrical engineering at The George Washington University. After school, Koch got his first job at NASA, just as he had planned. He worked as part of the team that developed the LIDAR In-Space Technology Experiment (LITE) instrument. LITE was billed as the first LIDAR in space and served as a steppingstone to CALIPSO.

"To this day, that experience remains the highlight of my career," Koch said.

A couple years after LITE, Koch left NASA for the private sector to focus solely on embedded design engineering. After 14 years of working at GE and a couple of small consulting firms in Charlottesville, Va. he got the itch to return to NASA and was given the opportunity to lead a couple aeronautic research activities in the Research Directorate.

"When the DPM position for CLARREO Pathfinder was announced, I jumped at the opportunity to support the development of another climate science instrument," he said.

Like any job, this one is not without challenges.

"CLARREO Pathfinder is a cost-capped, Class-D technology proof-of-concept mission, which should afford the project relief from many of the process requirements defined in NPR 7120.5 and NPR 7123.1," Koch said. "However, striking a balance between cost, scope, and risk has proven to be a challenge as we develop a mission concept that will lead to success."

Outside of work Koch, enjoys spending time with his family to decompress. Now that his children are grown and out of the house, family gatherings are rare but cherished.

"Spending time with the family is often coupled with things I enjoy such as golf, boating, sporting events, wineries, and breweries," Koch said.

But his work at NASA is also still a passion of his, as it was when he was a boy.

"I'm thrilled to be part of FPD and the CLARREO Pathfinder team," Koch said. "I find it rewarding to work on a project that, if successful, can lead to a full CLARREO mission, which has the potential to influence public policies for better stewardship of the environment."

Intern Profile: Scott Forsythe

In this image, Scott Forsythe proudly stands in front of the Center's sign at the main gate. Right now, he says, because of the internship and opportunity, it is his favorite picture.

Concentration

Computer Engineering Technology

Attending

Purdue University, Fort Wayne, Indiana

Awards (partial)

Purdue's Chapman Scholarship

Coca-Cola Scholars Foundation

Nordstrom Scholarship

Hobbies / interests

I enjoy programming and software development as a hobby as well as a career focus, and I have participated in two hack-a-thons and a year-long Java programming competition—of which I am happy to announce I was the winner! I also enjoy video games like Portal and Skyrim, but I especially enjoy "modding" those games—that is, expanding on the games by using my programming skills to create new levels, items, functionalities, and people. I have even developed a completely stand-alone puzzle game from scratch with my team for the Global Game Jam. That was an intense weekend!

Community service (partial)

Founder: Dyslexic Kids, an organization providing information, support, mentoring and resources for children and teens with dyslexia

Creator: an official Indiana State Legacy app for the Limberlost State Historic Site, "Birding with Gene Stratton-Porter at Limberlost"

Summers at NASA's Langley Research Center are filled with excitement and chatter as over 200 college and high school students from around the country are dotted across Langley's campus, working side-by-side with scientists and engineers on research paving the way for future exploration, whether that be in how we solve problems on our planet or how we touch down on another.

For 19-year-old Scott Forsythe, that means working to address challenges on our planet by developing a software analysis model for CERES, the Clouds and the Earth's Radiant Energy System experiment, which focuses on the role of clouds and the energy cycle in global climate change. Upon completion, this subsystem will be integrated with a system end-to-end model of the CERES instrument.

Forsythe's specific focus is in developing a program that uses several MATLAB techniques he has learned during his internship to calculate how photons will move around within a calibration target on the CERES instrument. The math techniques include preallocation, vectorization, file input/output, constrained random value generation, and graphical plotting of values, all of which he uses in a function he wrote to discretize a non-square shape into uniform and seamless triangle units and to evenly distribute points within each triangle.

"As an analogy," Forsythe explains, "you could think of the target as being a built-in optometry tool that is brought into space with the rest of the instrument. Occasionally, the sensors that are capturing the data will stop scanning and point at the target, which is analogous to you or me looking at a Snellen chart to test our eyesight. However, in order to know what the correct result of that would be and where errors might occur, we need to have a model of how light will exit the target. To extend the analogy, we need to set a baseline for what letters can be seen with different levels of visual acuity. A MATLAB Monte-Carlo Ray Trace (MCRT)model allows us to see exactly how the situation might play out under different circumstances, and from there, track down and compensate for issues with the sensors or 'eyes'."

Forsythe's work is to be implemented in an end-to-end model that will allow NASA scientists on the ground to simulate issues, understand unexpected inputs, and improve the design of the CERES instrument.

"The model is one of the best tools available for understanding how the instrument will react in situations that

simply cannot be tested," says Forsythe. "I am very excited to be working directly on developing the MCRT model for a component called the Infrared Calibration Target (ICT), which will be integrated directly into the end-to-end model. I have also contributed several smaller functions and code snippets that may improve other components of the end-to-end model."

For someone who deeply enjoys physics, astrophysics, astronomy, and learning about the amazing universe in which we live, interning at NASA is a dream come true for Forsythe.

"I am fascinated both by the incredible vastness of space and by the minute building blocks that make it all work" he says. "An internship is a fantastic way to learn about a given field and potential employer, especially for engineering students. I have been a fan of NASA for as long as I can remember, and I was tremendously excited when I was given this position. NASA is an organization that has very literally taken humanity farther than any other, and I immediately knew that through this internship, I could learn a great deal while working on projects that I enjoy for an organization I deeply respect."

When asked where he hopes to be in 10 years, Forsythe says he is still giving that question a lot of thought. Having a deep love for working with computer logic to solve problems and create new tools, he is especially passionate about making tools that help others. Community service has always been important to Forsythe—who at the modest age of 13 created a global organization that assists learning-disabled children (Dyslexic Kids @ dyslexickids.net) and now has over 10,000 members worldwide—so he wants to have a job that makes a difference.

"This internship has been both interesting and meaningful," he says. "I have had the incredible opportunity to work directly with my mentor on a MATLAB MCRT model that will help give humanity a much deeper understanding of Earth's energy cycle. In 10 years, and for the duration of my career, I hope to be working on equally meaningful projects that use the power of technology to help make the world a better place."

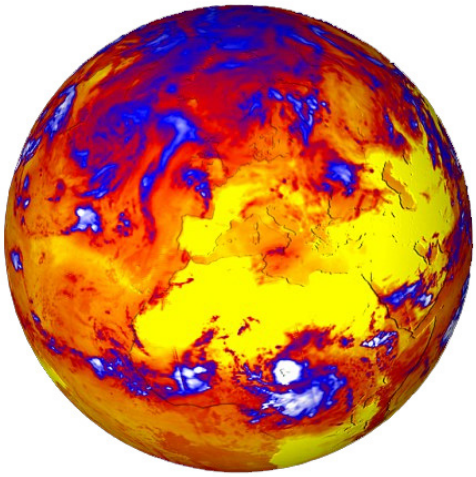
Forsythe is being mentored by the Engineering Directorate's Anum Barki, who works with electro-optical sensor systems. "It has been a pleasure having Scott on board the Earth Radiation Budget team. He has brought with him so much enthusiasm and has shown extreme diligence in his work here at Langley."

Barki says she is most impressed by Scott's determination, persistence, and the ability to keep moving forward even when an obstacle is encountered. "On his very first day at work," she says, "Scott was able to complete a graduate-level programming problem in less than 2 hours. Furthermore, he gave a brief but very impressive talk the same day, summarizing his solutions to two visiting professors from Virginia Tech."

Scott's internship with CERES has entailed developing an MCRT model of one of the on-board calibration sources of the instrument.

Barki feels the greatest advantage of having interns is the new perspective they bring to an organization and its work. "Interns are eager to learn and they often bring new ideas for doing things that we might not see," she says.

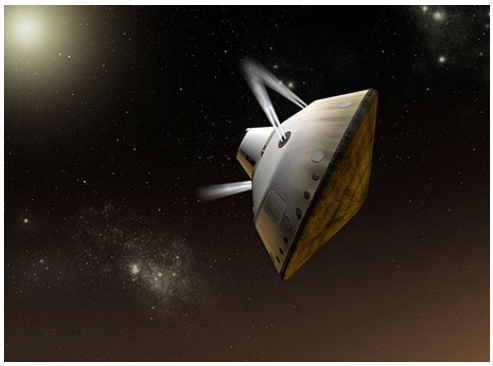
Although during this discussion he wasn't quite finished with his internship, Forsythe says he'd already gained a lot. "I have learned more about MATLAB and software development in five weeks than I thought I would learn over the entire course of the internship, and I have been able to learn more about other topics from public speaking to aerodynamics to photonics. Most of all, I will be coming away from this internship having met and worked with incredible people with whom I hope to work again."



The Clouds and the Earth's Radiant Energy System instrument measures reflected sunlight and thermal radiation emitted by the Earth. Earth's climate system tries to balance radiant energy from the sun that reaches the Earth with the energy that is emitted from Earth back to space. Measurements from CERES help scientists understand the links between the Earth's incoming and outgoing energy and the properties of the atmosphere that affect that energy. In this data image, the yellow areas are those emitting the most heat, such as deserts. Blue and white areas are the coldest regions or cloud cover.

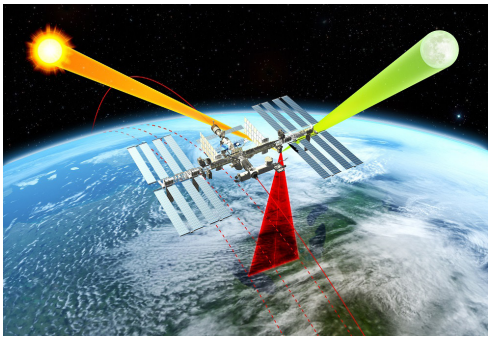
Along the Way to Flight: Future Milestones for FPD

SEPTEMBER



MEDLI2
Do No Harm Arc Jet Testing: September 2016

MEDLI2 is an instrument suite to be installed in the heatshield and backshell of the Mars 2020 aeroshell. MEDLI2 will gather data on the aerothermal, thermal protection system, and aerodynamic performance characteristics of the Mars 2020 Entry Vehicle during its entry and descent to the Mars surface providing engineering data to improve future Mars missions. Langley Research Center leads the overall project providing project management and systems engineering, and development of the Mars Entry Atmospheric Data System and the Sensor Support Electronics.

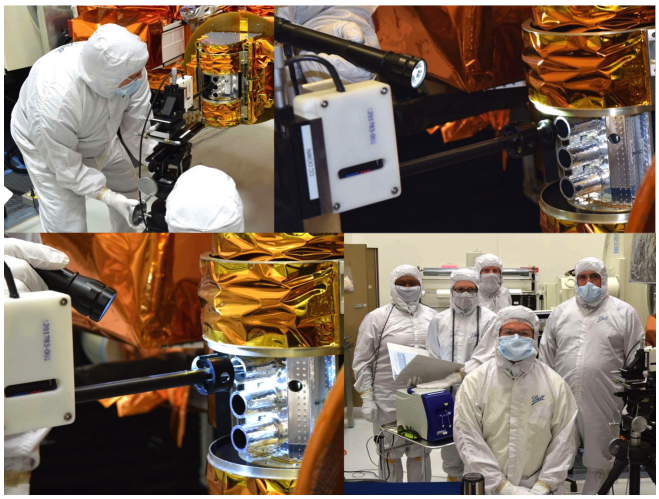


CLARREO Pathfinder on ISS
KDP-A: September 2016

The Climate Absolute Radiance and Refractivity Observatory (CLARREO) Pathfinder on ISS mission will demonstrate essential measurement technologies required for a full CLARREO mission. The Reflected Solar (RS) will be hosted on the International Space Station (ISS) in the 2020 time frame. The foundation of CLARREO is the ability to produce highly accurate climate records to test climate projections in order to improve models and enable sound policy decisions.

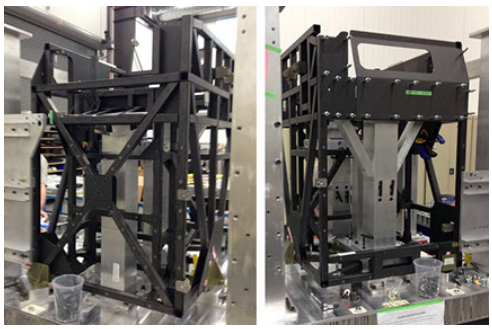
Image Contest Winners, cont.

Second place: TEMPO team-building hike at Boulder Flat Irons at the Chautauqua National Park in Colorado right before their successful Critical Design Review in June 2015. Left to right: Robert Neece, Tony Tyler, Don Shick, Craig Jones, Mark Andraschko, Brian Luoto, and Wendy Pennington.



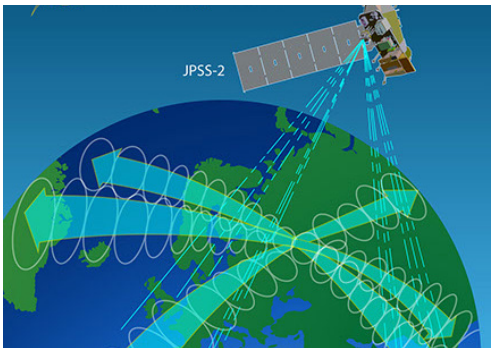
Third place: An example of the great technical work that is done by project teams at NASA's Langley Research Center. The photo collage features CERES FM6 team members performing a routine visual inspection of the instrument when potential contamination was identified on the surface of the shortwave filter. Left to right at bottom right: Gugu Rutherford, Elaine Seasly, Kevin Daugherty, Ed Nemie, and Joe O'Connell.

OCTOBER



TEMPO Instrument
Hosted Payload Summit: October 20, 2016

NASA's first Earth Venture Instrument will measure pollution of North America\. The TEMPO (Tropospheric Emissions: Monitoring of Pollution) instrument is a UV-visible spectrometer, and will be the first ever space-based instrument to monitor air pollutants hourly across the North American continent during daytime. It will collect high-resolution measurements of ozone, nitrogen dioxide and other pollutants, data that will revolutionize air quality forecasts. TEMPO is expected to fly on a host spacecraft in 2019.



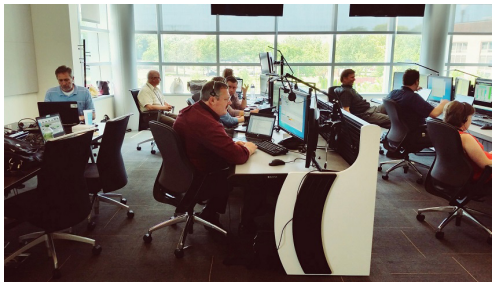
RBI
AzCal CCA CDR/CSM Control Electronics CDR: September 7, 2016

The Radiation Budget Instrument (RBI) is a scanning radiometer capable of measuring Earth's reflected sunlight and emitted thermal radiation. RBI will fly on the Joint Polar Satellite System 2 (JPSS-2) mission planned for launch in November 2021, and will extend the unique global climate measurements of the Earth's radiation budget provided by the Clouds and the Earth's Radiant Energy Systems (CERES) instruments since 1998.

NOVEMBER

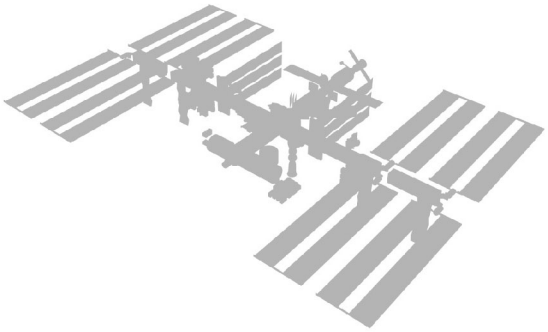
Orion LAS
LAS hatch Critical Design Review (CDR): November 2016

NASA will use the Orion spacecraft, launched atop the Space Launch System rocket, to send a new generation of astronauts beyond low-Earth orbit to places like an asteroid and eventually Mars. In order to keep astronauts safe in such difficult, yet exciting missions, NASA and Lockheed Martin collaborated to design and build the Launch Abort System, or LAS. The LAS is positioned atop the Orion crew module. It is designed to protect astronauts if a problem arises during launch by pulling the spacecraft away from a failing rocket.



SAGE III/ISS
Launch: November 2016

The SAGE (Stratospheric Aerosol and Gas Experiment) III instrument will launch later this year on SpaceX-10 to the International Space Station where it will monitor ozone and aerosol in the upper atmosphere. SAGE III makes its measurements by scanning across the limb, or thin profile, of the atmosphere, using the sun and moon as light sources. These measurements are vital inputs to the global scientific community for improved understanding of climate, climate change and human-induced ozone trends.



do not go
where
the path may lead,
go instead
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there is no path
and leave a trail.

—Ralph Waldo Emerson

Unless specified, all images are courtesy of NASA.

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NP-2016-08-832-LaRC