

# Mission Operations & Data Systems



(Courtesy LASP)

*Mission operators, operational and planning-and-scheduling software engineers, and data systems experts work together to support the years-long operation of multiple spacecraft simultaneously.*

The LASP Mission Operations & Data Systems (MO&DS) group staffs several Mission Operations Centers and Science Operations Centers for the day-to-day operations of NASA spacecraft and instrument missions. LASP is one of only a few university-based mission operations centers. We train and certify undergraduates to perform mission operations for NASA satellites totaling more than \$1.5 billion in value.

Our skilled mission operators monitor and control the spacecraft and their on-board scientific instruments. Our software engineers and scientists process, analyze, distribute, and archive the mission data, and create the software to support MO&DS activities.

Each day, more than 100 GB of data come through LASP servers to support ongoing space missions and the scientific data that scientists from all over the world rely on. LASP experts ensure fast and accurate data transfer, management, archiving, and the development of software tools that support scientific data users.

## Flight Operations

Mission operators at our in-house facilities use ground stations around the world to guide spacecraft and instruments after launch. LASP has two such facilities for spacecraft operations, called Mission Operations Centers. LASP currently operates four satellites and fourteen instruments from these Mission Operations Centers.

Examples of commands that mission operators might give a satellite are powering on or off specific instruments, changing the tilt of solar panels, or pointing an instrument in a particular direction to take specified data. LASP uses a worldwide network of sophisticated ground antennas and satellites to relay signals between the Mission Operations Centers and the spacecraft we control.

One of the most exciting and unusual aspects of mission operations at LASP is the opportunity for CU undergraduate students to become certified mission operators. Our student operators, who must pass a summer-long course held at LASP, work under the supervision of professional staff to operate billions of dollars worth of spacecraft.

## Operational Software

Spacecraft and instruments run using specialized operational software, tailored to specific missions and instruments. Operational software acts like the health systems in a body, ensuring that temperature, energy levels, and other parameters on the spacecraft or instrument are running in an acceptable range. The software monitors the health of on-board systems; anything unusual is flagged and sent to mission operators who can look into potential causes and solutions.

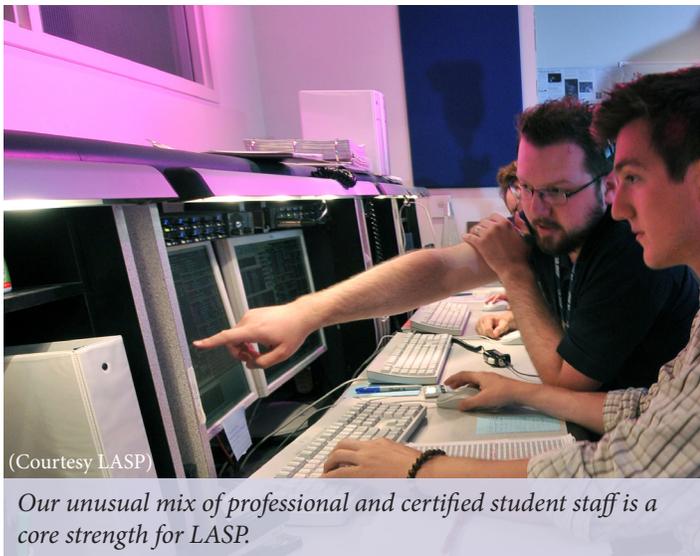
The operational software that we use, almost all of which was created in-house, is available to other operations groups for their use. Our operational software falls in four categories: Command and Control, Telemetry Data Processing, Engineering Analysis, and Quality and Status Monitoring.

## Planning & Scheduling

---

An important part of mission operations is ensuring that the instruments take the right scientific data at the right time. The Planning & Scheduling team functions as each instrument's time-management assistant, determining where the instrument should point, when it should take data, and what types of data it should take.

To keep track of each spacecraft's schedule, the team uses specialized planning and scheduling software. The software we use the most, which we developed here at LASP, is called the Operations and Science Instrument Support Planning and Scheduling system (OASIS-PS). OASIS-PS is capable of automatically generating operations plans based on rules and constraints programmed into the software or stored in the supporting database. Operations activities can be displayed on a timeline and operators can add, modify, or delete activities from the timeline.



Central to the Planning & Scheduling team's success are our trained undergraduate and graduate students, who often lead the daily science collection requirements and spacecraft events under supervision of staff.

## Data Systems

---

In the end, the primary focus of space missions is not the excitement, adventure, or challenge of designing and launching spacecraft, but the scientific data they return to us and the information scientists draw from this data.

Software engineers and data analysts on the LASP Data Systems team serve at the interface between software and science, focusing on the development of data systems that generate, display, and perform quality control corrections on scientific data. Scientists around the world then use these high-quality data products to further scientific understanding of atmospheric and space science.

*The Laboratory for Atmospheric and Space Physics (LASP) combines all aspects of space exploration through our expertise in science, engineering, mission operations, and data management. As an institute at the University of Colorado Boulder, LASP includes students throughout our activities. Learn more at <http://lasp.colorado.edu>.*

LASP's Data Systems group maintains expertise in all facets of data systems development: numerical analysis, algorithms, programming techniques and methodologies, data management and analysis, data system design, and software project management. Our emphasis is on developing and maintaining large-scale, robust data systems.

## Data Products

---

LASP generates, maintains, and disseminates a range of space and atmospheric science data, including both individual data sets and broad data collections. Available data sets span many scientific disciplines and more than four decades of space-based research at LASP.

## Facilities

---

The cornerstone facilities of the Mission Operations & Data Systems division are our on-site Mission Operations and Science Operations Centers. These facilities enable our mission operators to communicate with the spacecraft through specialized satellite tracking facilities located around the world.

Our two Mission Operations Centers have large banks of computers and displays for monitoring spacecraft and sending commands to them. Our Science Operations Centers provide a similar function for science instruments. The instruments are monitored through these centers and commanded by our professional and student teams.

Our facilities house our team of professional staff and trained undergraduate and graduate students as they perform flight operations, such as converting the activity sequences provided by the Planning & Scheduling team into commands to the instrument to take data and perform other activities, or checking on the health and status of the spacecraft using operations software. Our facilities also serve to ingest data arriving from the spacecraft we operate so that we can begin processing, distributing, and archiving the data on behalf of the scientific community.

## Personnel

---

Our mission operators, planning and scheduling experts, operation software engineers, and data systems experts form the backbone of the MO&DS division. With our unusual mix of professional staff and certified undergraduate students, we offer NASA and other agencies low-cost space system operations; on-the-job training for the space industry experts of the future; robust in-house software tools; and world-class data products driven by close collaboration with scientists.

To read more about MO&DS at LASP, visit:  
<http://lasp.colorado.edu/home/mission-ops-data>.