

Engineering Facilities



Having the facilities to develop and test spacecraft on-site is a key factor in LASP's success. Our extensive test and calibration facilities allow our in-house engineers to work closely with scientists and mission operations staff in "test-like-you-fly" scenarios. Our ongoing legacy of in-house knowledge and focus on extensive testing before flight has contributed greatly to LASP's superior on-orbit performance record.

Our in-house facilities include:

- A fully equipped machine shop and metrology laboratory for mechanical fabrication
- A NASA-qualified electrical assembly and polymeric lab for electronics and cable fabrication
- Multiple calibration labs for instrument characterization from the ultraviolet to the infrared
- Several vacuum tanks for bake-out, thermal vacuum tests, and detector/instrument calibration
- Various quality assurance inspection and cleaning labs, including four class-10,000 clean rooms for final instrument assembly

Machine Shop

The LASP Machine Shop creates instrument components using a variety of materials, such as aluminum, magnesium, stainless steel, ceramic, plastic, and titanium. Our shop achieves close tolerances of 0.0005 of an inch. Experts work from prints, sketches, and Computer Aided Design (CAD) solid models, then import that information using Master Computer Aided

LASP engineering facilities are co-located with our scientific and technical resources. This collaborative environment enables dynamic interaction, problem-solving, and the exchange of ideas.

Machining (MasterCAM) software to program our machining centers. We have four-axis capability and numerous manual lathes and milling machines for secondary operations.

Equipment and capabilities include:

- Computer numerically controlled high-speed machining centers
- Manual milling machines
- Manual lathes
- Deltronic video comparator
- Brown and Sharpe micro height and Ziess Coordinate Measuring Machine for instrument metrology

Clean Rooms

Environmental pollutants, such as dust, particles, and vapors, are an important consideration during the development of space instruments and components; a stray dust particle or fingerprint could disrupt or disable scientific instruments. NASA and other agencies have strict guidelines concerning the level of allowable contamination for space-bound products. LASP's four on-site cleanrooms—special rooms with controlled and restricted levels of pollutants—allow us to meet those specifications.

Cleanroom standards are federally and internationally regulated and designated by class, which is an indication of the size and number of particles allowed per volume. For example, an International Organization for Standardization (ISO) Class-5 cleanroom has at most 100,000 particles bigger than a half micron per cubic meter. Or, a Federal Standard Class-100 cleanroom has

at most 100 particles bigger than half a micron per cubic foot.

Depending on their class designation, LASP clean rooms have special systems and features to control contamination. These may include isolated air filtration, humidity, and temperature systems; anterooms for staff entering and exiting the cleanroom; and special protective clothing for workers, including coveralls, shoe covers, face masks, gloves, hairnets, and goggles. Equipment inside the cleanrooms is also controlled so that it does not generate air or particulate contamination.

One of the challenges in developing spacecraft is the space needed to manipulate the components during assembly. LASP's on-site high-bay cleanroom allows our engineers the flexibility to engineer large spacecraft. This Class-10,000 cleanroom also has a large control room, a vacuum chamber room for environmental testing, an ante-room for staff to don cleanroom suits, and a cleaning room.



(Courtesy LASP)

Our laboratories allow LASP engineers to develop, test, and calibrate components and instruments on-site.

Vacuum Test Chambers

Engineering products that will endure the extremes of the space environment is a challenge. Engineers need to test and condition their instruments and components to ensure that they will function properly when exposed to designated temperatures, humidity levels, radiation levels, acoustic levels, acceleration and other conditions. To perform this pre-flight testing, LASP uses vacuum test chambers.

LASP has nine vacuum systems for environmental testing and conditioning of space instruments. Oil-free roughing pumps and the cleanliness of the systems are monitored with Residual Gas Analyzers and Thermo-Electric Quartz Crystal Micro Balances.

Laboratories

LASP has extensive laboratory facilities that allow our engineering staff to develop, assemble, build, test, clean, and calibrate

the components and instruments that we build on-site. Each laboratory has distinct uses. For example, visitors to LASP often note that we have nicknamed two of our laboratories the Black Lab and the Yellow Lab; these facilities are designed—and “decorated”—to allow testing under specific light conditions.

We have five electronic assembly workstations set up for hand and surface mount soldering and assembly of flight-printed circuit boards, cabling, and subassemblies. Our electronics test area is fully equipped with ESD Floors, ionizers, and other ESD control surfaces. Our polymeric laboratory is an environmentally controlled area where certified personnel mix and apply bonding materials, conformal coatings, encapsulants, and other polymeric materials. Our cleaning lab is equipped with ultrasonic tanks and a de-ionized water rinsing station. A 360 °F drying oven is available for special applications. Our metrology lab is environmentally controlled in temperature, humidity, lighting, filtered air supply, minimal room vibration levels, and environmental cleanliness. We also have facilities for photometric calibration of instruments, optical components, and detectors, and a variety of NIST secondary standard detectors to allow cross calibrations of detectors over a variety of wavelengths.

Computing

LASP Engineering incorporates many different software applications and simulation technology tools to assist in the design and production of instruments and components.

Software and computer-aided design tools include:

- PDMWorks and Agile for managing drawings and product specifications
- Microsoft Project to generate schedules and maintain status
- Telelogic's DOORS software to track requirements
- ZEMAX, FRED and IRT as optical design tools
- LabView and Matlab to automate tests
- SolidWorks, for design

A wide variety of computer-aided engineering tools are used for modeling and analyzing mechanical, electrical, and thermal performance.

Even the tools used to create our science instruments are now computerized: LASP has two large numerical control machine tools for producing instrument casings and other components with extreme accuracy. Much of the test equipment used by our engineers is computerized, monitored, and controlled online. The scientific instruments that we create are all controlled by software and firmware developed by LASP engineers and programmers, and their code is carefully designed and thoroughly tested to assure ultra-high reliability in a demanding real-time operating environment.

To read more about Engineering Facilities at LASP, visit:
<http://lasp.colorado.edu/home/engineering/facilities>.

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>.