Custom Detector Technology

Laboratory for Atmospheric and Space Physics
University of Colorado **Boulder**

(Courtesy LASP)

LASP specializes in the design and development of space instruments, with a focus on game-changing technologies.

LASP satellite instruments include a wide range of technology, including detectors, mechanisms, and rad-hard electronics. These devices make state-of-the-art measurements for remote sensing of the sun, planetary atmospheres including Earth's, and for in-situ sampling of energetic particles, electric fields, and dust particles in space.

Low-noise detectors are critical technology for our instrumentation. LASP has developed and flown an extensive variety of detectors.

CCD Imagers

Extremely low-noise CCDs and intensified CCDs have flown on SDO for observing solar EUV and on AIM for observing mesospheric clouds. CCDs will soon fly on MAVEN for Mars airglow observations.

Dust Detectors (PVDF, MCP-based)

LASP is one of the few institutions in the world that has flown dust detectors on sounding rockets, as well as space missions (AIM, New Horizons) to observe terrestrial, interplanetary, cosmic, and lunar dust.

Space Plasma & Electric Fields

LASP has developed electric and magnetic field digital signal processing electronics for Earth-orbiting (THEMIS, Van Allen Probes, MMS), as well as planetary and solar missions (MAVEN, SPP). Instruments include sensors, deployable booms, and state-of-the-art digital signal processing electronics.

Quick Facts

LASP has 14 instruments on 10 NASA satellites: AIM, Cassini, MESSENGER, New Horizons, SDO, SORCE, THEMIS, TIMED, Van Allen Probes, Voyager

LASP operates 4 NASA satellites: AIM, Kepler, QuikSCAT, SORCE

LASP is developing 15 instruments for 8 missions: NASA—HySICS, LDEX, MMS, MAVEN, SPP, TCTE; NOAA—GOES-R, TSIS

Photodiodes

Si photodiodes are providing extremely stable solar EUV irradiance results for NASA SDO, SORCE, and TIMED; the upcoming MAVEN mission to Mars; and NOAA GOES-R EXIS.

Electrometer ASIC

A custom low-noise, 6-channel electrometer ASIC has been developed with several industry partners to use with Si Photodiode arrays for NOAA GOES-R EXIS.

Particle Detectors

LASP incorporates Si-based detectors into instruments that measure energetic electrons and protons (NASA Van Allen Probes mission, miniature version in an NSF CubeSat).

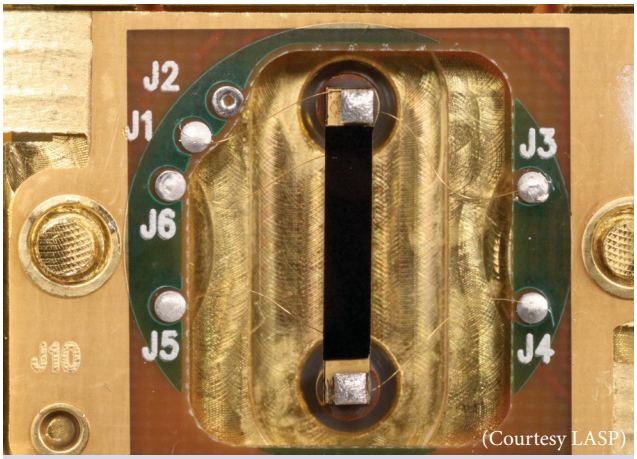
Radiometers

LASP's Electrical Substitution Radiometers (ESRs) are providing precise (10 ppm) and accurate (300 ppm) solar irradiance on NASA SORCE; ESRs will also fly on NOAA TSIS.

High-Accuracy Radiometry

At the heart of LASP's TIM and SIM solar instruments are high-accuracy and very low-noise electrical substitution radiometers (ESRs), which provide an absolute reference on orbit. ESRs:

- provide a measurement scale with the high accuracy and stability on orbit necessary for long-term climate data records.
- are validated/calibrated directly against ground-based primary standard detectors, (cryogenic radiometers); LASP is the first to do this.

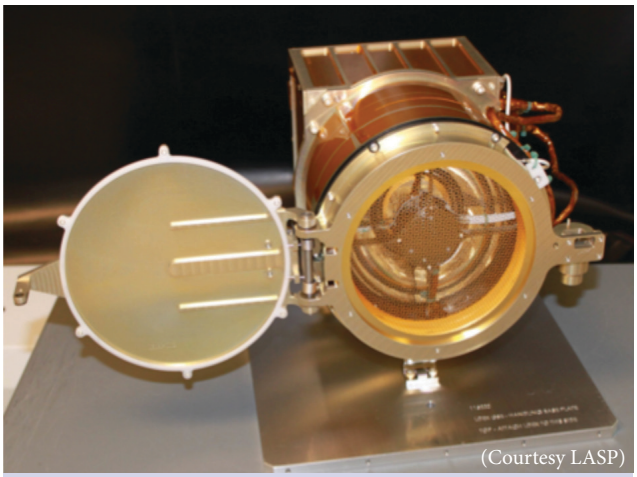


LASP ESRs benefit from first-of-its-kind validation/calibration in special on-site facilities.

Lunar Dust EXperiment (LDEX)

The LDEX instrument was developed for the NASA LADEE mission. It is designed to map the spatial and temporal variability of dust in the lunar environment. LDEX provides:

- a low-mass (3.5 kg), low-power (4W), small-footprint planetary dust detector that can fly anywhere in the solar system.
- fast-track development: 2.5 years from contract to flight readiness.
- the ability to measure in-situ lofted dust grains and distinguish between grains lofted from meteor impacts versus solar charging effects.
- impact ionization dust detection measurement: dust impacts create ion-electron cloud; ions are focused onto a microchannel plate for detection, electrons onto a rhodium target; two simultaneous measurement modes yield single-impact detection of grains with radius rg > 0.3 μm and collective current from dust grains below this threshold.

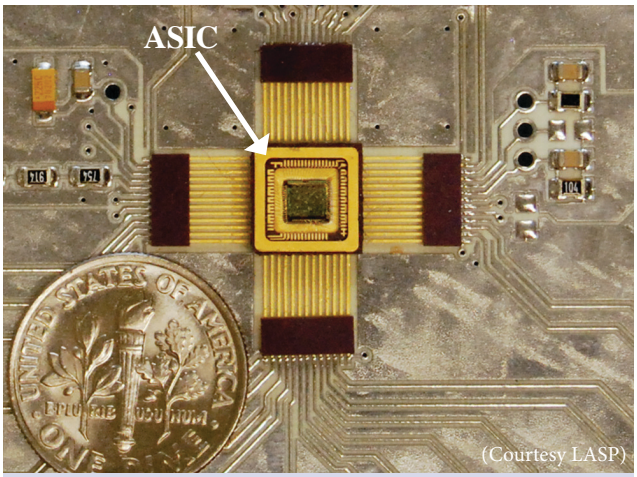


The quick-to-develop, go-anywhere LDEX instrument adds lunar dust to LASP's ongoing expertise in terrestrial, interplanetary, and cosmic dust observation.

Six-Channel ASIC Electrometer

An innovative low-noise, low-power electrometer was developed as an ASIC for the Si photodetectors in the GOES-R EUV EXIS instrument. LASP's industry partners include Space Instruments (ASIC design), MOSIS (wafer fabrication), and Kyocera America, Inc. (packaging ASIC into a 52-pin QFP ceramic package, 14 mm x 14 mm). The ASIC electrometer offers:

- six channels of charge-sensitive electrometers in one ASIC.
- rad-hard to better than 500 kRad.
- low noise at room temperature of ~10 fC (1 fC = 10^{-15} C).
- low power: 5 mW for ASIC; 0.1 W external bias circuitry.
- digital output so no read-out noise.
- highly linear over full dynamic range of 10^{-14} to 10^{-8} C.
- flexible integration time from 0.1 to 100 seconds.



The six-channel ASIC electrometer, shown here mounted on a circuit board, is both low-noise and low-power.

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.

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