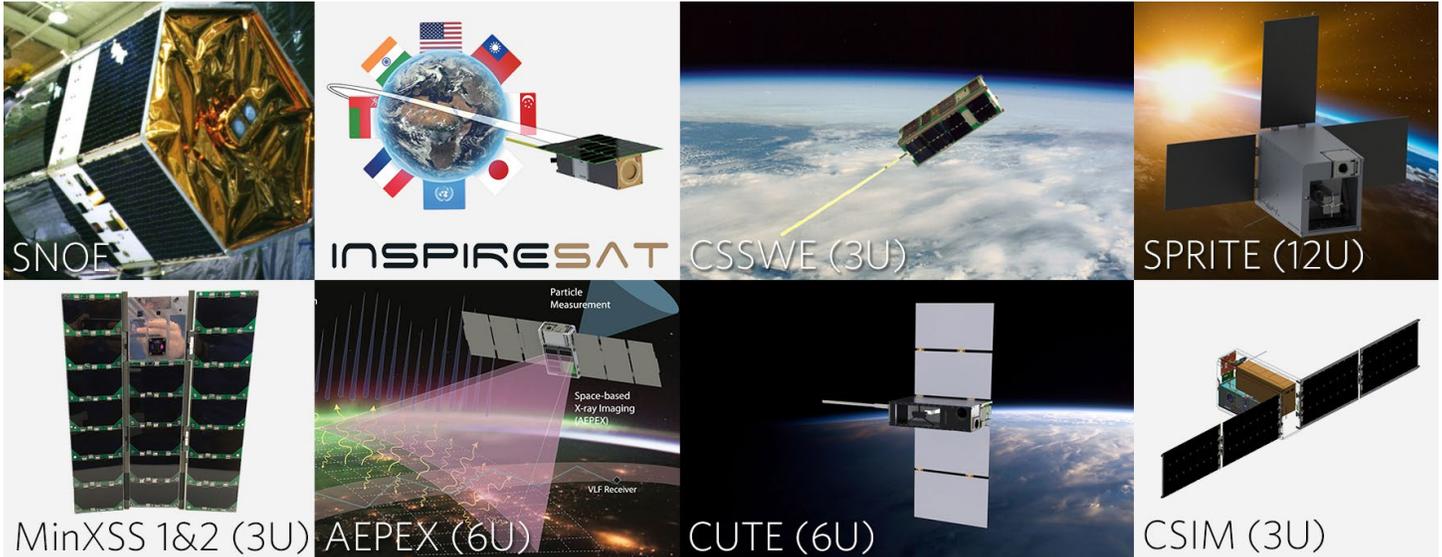


LASP SmallSat Capabilities

SmallSats designed, built, and operated by LASP



LASP's full mission capabilities allow for the design, build, test, and operations of small satellite science missions all at one facility. Ask us how LASP can support your mission and operations. (Images courtesy LASP and CU/AES)

LASP's Small Satellite (SmallSat) Expertise

LASP's heritage and expertise encompass all aspects of design, analysis, fabrication, testing, and operation of small satellites (ranging in size from 3U, 6U, 12U, small explorer) for space science missions.

- **Science instruments**

With decades of specialization in X-ray, UV, VIS, and NIR measurements, instrument expertise includes photometers, spectrometers, imagers, particle detectors, astronomical telescopes, magnetometers, ion probes, and GPS occultation.

- **Spacecraft structures**

In-house design and build of structures, mechanisms, and deployment systems include aluminum and composite structures, one shot covers, bi-stable mechanisms, multi-axis pointing platforms, and solar array deployment and antenna deployment mechanisms.

- **Electrical power system (EPS)**

LASP offers system design for power regulation, batteries, solar arrays, and high voltage power supplies with customizable payload interfaces.

- **Command and data handling (C&DH)**

Radiation tolerant C&DH systems include embedded processors in a reprogrammable FPGA with a real-

time clock, memory devices (EEPROM, RAM, NAND Flash), and serial interfaces (RS232/422, SPI, I²C).

- **Flight software**

Flight software options include a deterministic event scheduler operating system, power control and monitoring, time-tagged and real-time command and telemetry handling, instrument operations, fault protection and response code, and mechanism control software.

- **Attitude determination and control system (ADCS)**

LASP expertise includes the integration, test and flight operations of commercial ADCS for SmallSats.

- **Communication (COMM)**

Skilled in the integration, test, and flight operations of commercial communication systems for SmallSats, including AstroDev, SpaceQuest, and Clyde Space.

- **Thermal control systems**

Passive and active thermal control systems are designed with on-site mission thermal system analysis and test capabilities.

SmallSat Flight Operations

Operation Capabilities

LASP provides full mission operations for the emerging field of SmallSats. The SmallSat Operations Center builds on a legacy of providing superior on-orbit mission operations and scientific instrumentation for NASA space missions. The ground stations (UHF and S-Band) are controlled through the SmallSat Operations Center at the lab's main building in Boulder, Colorado.

Mission Operations & Data Systems (MO&DS)

The MO&DS staff manage the day-to-day mission and scientific operations for numerous NASA spacecraft and instruments including SmallSats. LASP is one of only a few university-based mission operations centers in the world. The laboratory trains and certifies undergraduate and graduate students to perform flight mission and instrument operations. Our unique mix of professional and certified student staff increases access to space for university researchers and private sector partners.

Future expansion

In addition to the aforementioned UHF and S-band capabilities at the Boulder facility, LASP plans to connect the SmallSat Operations Center to external ground assets in Singapore and Taiwan as part of the INSPIRE program. Continued expansion of operation capabilities support a broad range of scientific investigations as well as offer increased performance for CubeSat and SmallSat programs for LASP and our partners.

LASP has a proven record of successful SmallSat operations

Beginning with SNOE in 1998, LASP has continued to provide operations for SmallSats including: Colorado Student Space Weather Experiment (CSSWE), 2012–2014; the Miniature X-ray Solar Spectrometer -1 and -2 (MinXSS-1), 2015–2017; (MinXSS-2), 2018–2019; and the Compact Solar Spectral Irradiance Monitor (CSIM), 2018–present.

LASP is looking for opportunities to collaborate and partner with other university-based space programs, as well as private, commercial CubeSat and SmallSat enterprises.



LASP maintains UHF uplink and downlink (@9.7 Kbps) capabilities with antennas in Boulder, Colorado and Fairbanks, Alaska, as well as an S-band downlink capability (@1.0 Mbps) at the Boulder facility.

Future mission operations

The LASP SmallSat operation team is currently preparing for the upcoming CubeSat launches supported through NASA's CubeSat Launch Initiative (CSLI) and India's Polar Satellite Launch Vehicle (PSLV):

- **Atmospheric Effects of Precipitation through Energetic X-rays (AEPEX)**, planned launch 2022, CSLI
- **Compact Total Irradiance Monitor (CTIM)**, planned launch Q4 2021, CSLI
- **Colorado Ultraviolet Transiting Experiment (CUTE)**, Secondary on Landsat-9 NET 3/2021, CSLI
- **CubeSat: Inner Radiation Belt Experiment (CIRBE)**, planned launch Q3 2021, CSLI
- **INSPIRESat-1**, planned launch Q1 2021, PSLV
- **MinXSS-3**, MinXSS 1&2 hosted instrument on INSPIRESat-1
- **Supernova Remnants and Proxies for ReIonization Testbed Experiment (SPRITE)**, planned launch 2022, CSLI

LASP's SmallSat Missions

LASP built and provided operations for all listed missions except where noted.

Mission	Size	Launch date	Science focus
Past missions			
SNOE	SmallSat	Feb. 26, 1998	Global mapping of nitric oxide in the Earth's thermosphere
CSSWE	3U	Sept. 13, 2012	Relativistic electrons and protons over the Earth's poles
MinXSS-1*	3U	Dec. 6, 2015	Solar soft X-ray spectrum during solar flares
MinXSS-2	3U	Dec. 3, 2018	Solar soft X-ray spectrum during solar flares
Currently active missions			
CSIM	6U	Dec. 3, 2018	Solar spectral irradiance from 200–2600 nm using novel vertically aligned carbon nanotubes
Missions in development			
CUTE	6U	NET Q2 2020	Characterization of the composition and mass-loss rates of exoplanet atmospheres
INSPIRESat-1	~27U	NET Q1 2021	Ionosphere dynamics and plasma transport and soft X-ray solar cycle studies
CIRBE	6U	NET Q3 2021	High energy resolution of Van Allen Belt relativistic electron and proton
CTIM	6U	NET Q4 2021	Precision measurements of total solar irradiance
AEPEX	6U	NET 2022	X-Ray imaging to determine electron precipitation in the Earth's upper atmosphere
SPRITE	12U	NET 2022	Galactic contributions of ionizing radiation to the intergalactic medium
INSPIRESat-4 [†]	9U	NET Q4 2022	Mesospheric and thermospheric temperatures, very low orbit maintenance
INSPIRESat-3 [†]	9U	NET 2024	FUV solar occultation and mesospheric and thermospheric temperatures

*MinXSS-1 was awarded "Mission of the Year" at the 2016 AIAA SmallSat Conference.

[†]LASP contributed instruments and engineering support, but not operations.

For more information regarding collaboration or support for your SmallSat program, please contact Tom Sparn (303-492-2475, tom.sparn@lasp.colorado.edu) or Rick Kohnert (303-492-6804, rick.kohnert@lasp.colorado.edu).

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>.