LASP SPACE
Laboratory for Atmospheric and Space Physics
University of Colorado **Boulder**
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Features: **Extended IMPACT funding • 30+ years of rocket success • Undergraduate research thrives • Balloon observes volcanic plume**

Letter from the director

Dan Baker

Along with everything else, space research has been totally upended by COVID-19. Despite the immense difficulties presented by the global pandemic, LASP teams are rising to the challenge and forging ahead with continued work on mission development, spacecraft operation, and science investigations.

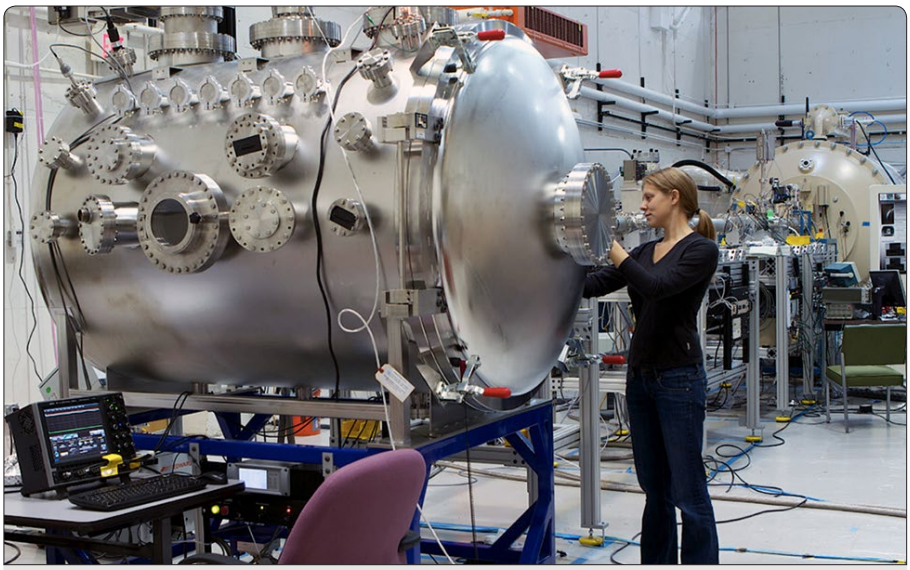
In the realm of space exploration, attention is often given to the largest, most complex and expensive space missions. Policy makers and the public are fascinated with costly, major flight programs. However, big projects grow from small seeds.

LASP has long played key roles in major NASA solar, planetary, and space physics research missions and in large NOAA operational missions. But what makes these major contributions possible is the early foundational work LASP did on the small end. Since its inception, LASP has used sounding rockets and balloon payloads to test ideas and train the next generation. Today, SmallSat programs have burgeoned at LASP and great science is being accomplished with remarkably compact packages. From the smallest to the largest space missions, LASP moves ahead with a full spectrum of indispensable tools.

Stay well.

IN FOCUS

Extended IMPACT funding sustains lab advancement



A graduate student works with the large experimental chamber (LEIL), one of a variety of target chambers that can be mounted at the end of the beam line of the Dust Accelerator. *(Courtesy LASP)*

The LASP Institute for Modeling Plasmas, Atmospheres, and Cosmic Dust (IMPACT) was selected last July as one of eight teams to collaborate in NASA's Solar System Exploration Research Virtual Institute (SSERVI). The $3.75 million award—IMPACT's third round of funding—advances the center's capabilities to study dusty plasma environments around the Moon and other airless bodies in the solar system.

Since inception in 2009, IMPACT has advanced the study of impact-related phenomena, long-term usability of devices in space, and the development of interplanetary dust-detecting instruments. The centerpiece Dust Accelerator

Continued on next page

Laboratory (DAL) facilitates the study of hypervelocity dust impacts on simulated planetary regoliths and icy moons. By studying the particle composition released after meteoric impact, scientists gain an understanding of embedded organic and inorganic material in airless bodies.

DAL also supports the development and calibration of dust instruments for space missions, such as the LASP-built Lunar Dust Experiment onboard the Lunar Atmosphere and Dust Environment Explorer (LADEE) mission. Other missions, including New Horizons, use DAL for post-launch model testing, and dust impact hazard assessment. And the SUrface Dust Analyzer instrument for the 2025 Europa Clipper launch is currently in testing in DAL.

New objectives include research on the composition of neutral and ionized gas puffs generated by dust impacts and the characterization of secondary ejecta particles, as well as the development of new capabilities to accelerate icy dust particles to velocities of up to 5 km/s.

IMPACT facilities are available to industry and research groups. The team is ready to assist in the design, development, and completion of new experimental ideas.

For more information on IMPACT, or to inquire about using the DAL, visit https://impact.colorado.edu.

By Mihály Horányi, principal investigator of IMPACT and professor of physics at CU Boulder; and Zoltan Sternovsky, co-investigator of IMPACT and associate professor of aerospace engineering sciences at CU Boulder.

Undergraduate research thrives at LASP

Training the next generation of scientists is a LASP primary goal. In addition to employing many CU students, LASP also introduces students from around the nation to solar and space physics through an NSF-funded Research Experience for Undergraduates (REU) program. This multi-institute program has grown from a humble 30 applicants in 2007 to more than 400 applicants in 2019.

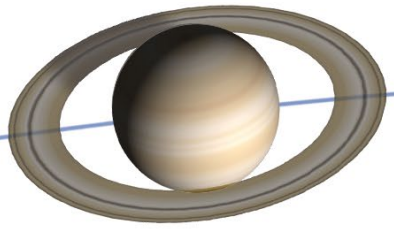
Each summer, about 20 students come to Boulder to be mentored in an authentic research project by a scientist from LASP or one of its eight Boulder Solar Alliance partner institutes, including the NOAA Space Weather Prediction Center, the High Altitude Observatory at NCAR, and the National Solar Observatory. Due to COVID-19, this summer's 24 REU students will pivot to a virtual research experience, to which guest speakers will be invited to participate. As students remain remote, Zoom will be used for group activities, lectures, and one-on-one mentoring, as well as final talks and poster sessions.

The LASP REU program recruits students primarily from small colleges where they do not have the opportunity to participate in research. Undergraduate students gain valuable experience in the scientific method, programming, data analysis and presentation skills over the 10 weeks spent in Boulder. Young future scientists are encouraged to submit an application through the LASP website.

2019 REU students Joel Tibbets (Grinnell College) and Emma Lieb (CU Boulder) build a computer-controlled platform to track the Sun. *(Courtesy Glenn Akasawa/CU)*

For more information on REU, or to submit an application, visit http://lasp.colorado.edu/home/education/reu/.

By Martin Snow, research scientist at LASP and REU lead since 2010.



Funded mission status

Phase A (concept development)
- DALI/EDA
- ESCAPE SMEX
- Libera EVC-1

Phase B (preliminary designs)
- AEPEX CubeSat
- CANVAS CubeSat
- IMAP IDEX
- LSITP/L-CIRiS and LuSEE
- SPRITE CubeSat
- VISORS NSF CubeSat

Phase C (design and fabrication)
- CIRBE CubeSat
- CLARREO Pathfinder
- Europa Clipper/SUDA
- INSPIRESat-4/OWLS
- IXPE SMEX
- TSIS-2

Phase D (assembly and test)
- Compact TIM CubeSat
- CUTE CubeSat
- GOES-T/EXIS, GOES-U/EXIS
- INSPIRESat-1/DAXSS

Launch/Commissioning [launch date]
- Emirates Mars Mission (EMM) [Jul. 2020]
- GOES-17/EXIS [Mar. 2018]

Prime Mission [end date]
- GOLD [2020]
- Compact SIM CubeSat [Nov. 2020]
- TSIS-1 [2023]
- Parker Solar Probe [Aug. 2025]
- GOES-16/EXIS [2026]

Extended Mission [end date]
- AIM [2020]
- MMS, four spacecraft [2020]
- SDO/EVE [2020]
- THEMIS and ARTEMIS [2020]
- TIMED/SEE [2020]
- New Horizons/SDC [2021]
- MAVEN [2022]

For more information on current missions, as well as full instrument and mission names, visit http://lasp.colorado.edu.

30+ years of calibration rocket success

Left: Original LASP Rocket Team members Ucker, Kohnert, and Woods pose under a calibration rocket in 1988, and again in 2018. Right: A LASP sounding rocket used to calibrate the SDO EVE instrument launches from White Sands Missile Range. *(Courtesy LASP)*

LASP celebrated the 30th anniversary of calibration rocket flights in 2018 and continues to build on this success. The next LASP rocket launch, NASA rocket 36.353, is scheduled to launch in October from White Sands Missile Range in New Mexico.

Calibration rockets are flown to refresh the calibration of research instruments on orbiting spacecraft that become degraded from exposure to harsh radiation and the vacuum environment of space. The fresh calibration provided by the sounding rocket instrument is transferred to the aging spacecraft instrument through comparison of simultaneous solar measurements made by both.

LASP flew its first rocket in 1988 to calibrate the San Marco solar satellite. Since then, 14 successful rockets have flown to update the calibrations of solar instruments on the TIMED, SORCE, SDO, Hinode, and GOES satellites.

Three original team members, Tom

Mission & technical stats

- LASP operates 1 spacecraft and 1 SmallSat.
- LASP operates 140 instruments on 14 spacecraft and 1 SmallSat.
- LASP is currently developing 1 spacecraft, 6 SmallSats, and 25 instruments for 22 missions.

Staff stats

(January 3, 2020)

Scientific researchers	85
Tenure-track faculty	25
Visiting faculty	4
Professionals	342
Graduate students	46
Undergraduate students	90
Total	**592**
Affiliates	226
Open positions	17

For employment information, visit http://lasp.colorado.edu/home/about/jobs.

Distinguished visitors

LASP hosted more than 1800 total visitors in the fall of 2019 including distinguished visitors such as Clinton Wallace, director of the Space Weather Prediction Center and Eugene Tu, director of NASA Ames. In addition, LASP hosted the 19th Expedition of the Space Angels—a global network of angel investors—during their first visit to the front range, and a group of aspiring aerospace cadets from the United States Air Force Academy.

Woods, Rick Kohnert, and Greg Ucker, are still working on the rocket program; and Michael Klapetzky joined the team in 2010. Rocket calibration remains a critical factor in the success of solar science missions—then, now, and into the future.

For more information on the LASP rocket program, visit http://lasp.colorado.edu/home/missions-projects/lasp-rockets/.

By Rick Kohnert, SmallSat program manager at LASP.

FIELD NOTES

High-altitude balloon observes Russian volcanic plume over USA

Major volcanic eruptions can have a dramatic effect on the Earth's global and regional climate by injecting large amounts of ash and sulfur into the upper atmosphere, which can cause a direct cooling effect on our planet. The Raikoke Volcano in Russia's Kuril Islands erupted in June 2019, producing a detectable impact across the northern hemisphere. Although this eruption was only of moderate size relative to historical eruptions, its impact was noticed as far away as Boulder, Colorado as increasingly purple sunrises and sunsets filled the skies through the late summer and fall. LASP atmospheric scientists keenly watched the plume move away from Raikoke. And when it arrived over the United States, they launched a high-altitude balloon with LASP-developed instruments to sample the volcanic aerosols in the stratosphere (between 60,000 and 80,000 feet). Not only did these measurements confirm the cause of the unusual sunsets, but the experiment

LASP scientists Lars Kalnajs, Terry Deshler, Bruce Kindle and NOAA scientist Sean Davis inflate a 141,000 cubic foot research balloon against a purple sunrise at Laramie Airport in Wyoming on August 28, 2019. *(Courtesy Doug Goetz/LASP)*

provided a useful practice run to help scientists prepare for the next truly major volcanic eruption.

For more information on this story, visit http://lasp.colorado.edu/home/2019/09/12/volcanic-eruption-may-explain-recent-purple-sunrises/.

By Lars Kalnajs, research scientist at LASP, principal investigator for FLOATS, and co-principal investigator and instrument scientist for RACHuTS, both high-altitude balloon instruments.

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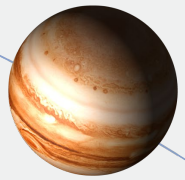

INNER SPACE

News

LASP had a large showing at NASA's first PI Launchpad workshop in Tucson, AZ on November 18–20. The PI Launchpad trains researchers in any NASA Science Mission Directorate discipline who want to be a principal investigator on future NASA space missions but have not yet held a leadership position on mission proposals or large science teams. Out of the 40 attendees, six LASP staff were chosen from the competitive application process. Arika Egan, Katie Greer, Margaret Landis, Sebastian Pineda, Connie Spittler, Allison Youngblood, and Hong Zhao attended the three-day workshop to learn the skills they need to be future leaders of NASA missions.

Administrative update

LASP continues to contribute a large share of funding to the bottom line for the University of Colorado (CU). In fiscal year 2019, CU realized $613M in research funding. Of the total, $574M represents research awards from sponsors, with the remainder being gifts and donations. The LASP contribution to total CU research funding was a generous 22.6%, with the contribution to CU Boulder specifically, at 13%. LASP put the funding to work with research expenditures during this period exceeding $108M. NASA remains the major research sponsor for LASP and CU Boulder.

Achievement awards

In Baltimore, MD on October 7, the Terra satellite team was presented with the William T. Pecora Award from the U.S. Department of the Interior and NASA. LASP scientist Michael King is the team leader of the MODIS instrument, which has had in excess of 19,000 publications using Terra products to date.

The Terra mission was lauded for "invaluable contributions in all areas of Earth science, with scientific impacts and a legacy that make it one of the most successful missions in the long line of Earth Observing System satellites."