



University of Colorado **Boulder**

2017 Program Review

Laboratory for Atmospheric and Space
Physics

Academic Review and Planning
Advisory Committee Report

Approved

A handwritten signature in black ink, appearing to read "Paul M. ...".

03/20/2018

Provost and Executive Vice Chancellor for Academic Affairs: Date

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Process Overview

This review of the Laboratory for Atmospheric and Space Physics (LASP) was completed in accordance with the 2017 review guidelines. The Academic Review and Planning Advisory Committee (ARPAC) conducts and writes the final reviews of all Boulder campus academic units. The unit prepared a self-study during 2016, which was checked in January 2017 by an internal review committee, composed of two CU Boulder faculty members from outside of LASP, who conducted a survey of undergraduate and graduate students and met with LASP administrators, faculty, staff, employees, and students. A four person external review committee of experts within the field from outside of the University of Colorado, visited the unit over April 13-14, 2017. The external reviewers reviewed relevant documents, toured LASP facilities, and met with CU Boulder campus-level and LASP administrators, employees, and students. The internal and external reviewers' assessments and recommendations are cited at appropriate points in this report. This public document reflects the assessment of and recommendations for LASP as approved by ARPAC.

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and Planning
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Unit Overview

The campus's standardized description of the unit may be found on the website of the Office of Data Analytics (ODA) at <https://www.colorado.edu/oda/institutional-research/institutional-level-data/information-department/academic-review-and-planning>.

ODA updates the profile annually in the fall semester. This report cites the ODA data for LASP posted in October 2016, reflecting the state of LASP as of academic year (AY) 2015-16.

LASP, a research laboratory that reports to the vice chancellor for research and innovation, stands as one of CU Boulder's most distinguished units. Arguably the preeminent university-based space research lab in the United States, if not the world, LASP is notable for its end-to-end capacity to design, build, and operate spacecraft and instruments, as well as to analyze and model the data they provide; its prominent role in promoting international space science collaborations; and its participation in inter-institutional cooperative teaching of space science. LASP vertically integrates design and engineering, mission operations, and scientific analysis. Some of its current high-profile projects include three that examine upper atmospheric interactions with solar winds and emissions (the Mars Atmosphere and Volatile Evolution [MAVEN] mission, the Van Allen Probes and the Magnetospheric Multi-Scale [MMS] mission, and the Solar Dynamics Observatory [SDO] and Geostationary Operational Environmental Satellite [GOES-R]); two that demonstrate the scientific efficacy of small "cubesat" satellites (the Colorado Student Space Weather Experiment [CSSWE] and the Miniature Solar X-Ray Spectrometer [MinXSS]); the Kepler mission to search for planets outside of our solar system; and the Emirates Mission to Mars, a pioneering international collaboration in space exploration. LASP generates approximately \$50-100 million in extramural funding annually, with \$68.6 million in fiscal year (FY) 2016. This

funding is sponsored largely by the National Aeronautics and Space Administration (NASA), but also by agencies including the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation, and the Department of Defense.

Personnel
and
Governance

LASP encompasses four divisions: science; engineering; missions operations and data systems (MODS); and administration. Its 540 employees include 369 employees categorized as tenured and tenure-track faculty, non-tenure track scientists, and staff, along with 21 employees in other categories and 150 students. The science division employs all of the laboratory's 24 tenured and tenure-track faculty, who hold appointments in the departments of Astrophysical and Planetary Sciences (APS), Atmospheric and Oceanic Sciences (ATOC), Geological Sciences (GEOL), Physics (PHYS), and Aerospace Engineering Sciences (ASEN). (Note: a table in the self-study specifies 21 tenured and tenure-track faculty and 63 research scientists, while the text discrepantly claims 24.) The university supports the tenured and tenure-track faculty, who typically hold nine-month appointments with teaching responsibilities in their respective departments. Extramural funding supports the remainder of LASP employees.

LASP operates under a governance structure that includes a director (normally a tenured professor), an executive associate director, two associate directors, and two division directors, along with standing committees such as the Executive Committee, Business Committee, and Project Development Committee. The laboratory's bylaws define faculty as encompassing faculty research associates (who hold tenure-track appointments in academic units), research scientists or research associates (who are non-tenure track, PhD holders), and research professors. All faculty with at least 50%

appointments in LASP enjoy voting rights on faculty matters except for those holding the rank of Research Scientist I, which is equivalent to a postdoctoral fellowship. The bylaws concentrate decision-making powers in the administration, faculty, and senior staff. Eligible voters for general lab matters include faculty with at least 50% LASP appointments, senior research assistants with at least 50% appointments, and division directors. Including senior research assistants as eligible voters is seen as analogous to including instructors as voting members of departments throughout CU Boulder. The laboratory's grievance policy specifies that the appropriate division director, associate director, or executive associate director handles grievances and may refer matters to an ad hoc grievance committee. The director holds final authority to adjudicate internal LASP grievances, while grievances pertaining to harassment or external to LASP may be referred to the vice chancellor for research and innovation.

Research and Scholarship

LASP engages in a broad range of space science research. It strives to identify new research questions that broadly impact humanity in the long run; to explore innovative methodologies; to design, build, and operate sensors and spacecraft; and to model and analyze data. While much of its research can be quantified in terms of publications and extramural funding, LASP devotes significant resources to designing and building instruments and spacecraft, operating missions, and managing the large data sets gathered. All of these activities are integral to its research mission but are not captured in publication metrics alone. The engineering and MODS divisions comprise over half of the laboratory's employees. The internal reviewers note that junior scientists are writing fewer hardware proposals than senior colleagues and calls upon LASP to find ways to strengthen its engineering capabilities, especially as more senior scientists near retirement. The external reviewers note

that NASA’s increasingly risk-averse approach to funding space mission development presents a challenge to LASP, and the external reviewers thus applaud the laboratory’s move toward greater collaboration, particularly its participation in international cooperative ventures. LASP plays a principal role in the International Space Program in Research and Education (INSPIRE)—a consortium including institutes, universities, and national agencies in the United States, Taiwan, and India—which aims to develop small satellites and ground stations around the world. The Emirates Mission to Mars represents an international collaboration in which LASP partners with the United Arab Emirates, the Space Sciences Laboratory at the University of California, Berkeley, and Arizona State University to develop a spacecraft and instruments for Mars exploration. The external reviewers also praise the laboratory’s willingness to “pivot towards a greater role in space weather research,” an interdisciplinary field that draws support from multiple government agencies.

The self-study observes that scientists must invest “a large fraction of their time over months or even years to develop mission/instrument proposals” before these proposals yield funding, and that LASP should support scientists as they develop these complex proposals. The self-study also suggests that LASP should create a “realistically sized Internal Research and Development (IRD) fund” to support investments in “game-changing technologies or capabilities.” The internal reviewers urge LASP to “consider more venture capital” to enhance its engineering capacity.

Office of Data Analytics statistics rank LASP as first among eight relevant units in the current review cycle in refereed articles and chapters, third of eight in conference papers and presentations, third of three in textbooks, third of seven in

edited books, and seventh of seven in books and monographs. This alone represents a strong research profile, but as discussed above, the laboratory's research productivity cannot be adequately captured through publication and presentation data alone.

Undergraduate Education

Although LASP offers no undergraduate majors or minors, it contributes significantly to undergraduate education. LASP employs 98 undergraduates across all four divisions, with the number of undergraduate employees rising in the summer. They work on data analysis, computer simulations, mission operations, software development and support, and instrument design, development, and testing. Undergraduate mission controllers receive training equivalent to NASA professionals, and some have gone on to be hired at places like the Jet Propulsion Laboratory. These opportunities provide students with first-hand experience that enhances their ability to gain admission to graduate school and to find employment. Both tenured and tenure-track faculty and research associates work closely with undergraduates.

LASP also coordinates and hosts a National Science Foundation Research Experience for Undergraduates (REU) program in Solar and Space Physics serving 16-20 students annually. Of the 85 undergraduates enrolled in this program over the past five years, 82% went on to graduate school within three years of graduating.

Undergraduate students report extraordinarily high levels of satisfaction with their LASP experiences. The internal reviewers' undergraduate survey garnered 41 responses, approximately three-fifths from seniors, roughly one-fifth each from juniors and sophomores, and none from first-year students. Among the respondents, 95% reported being "satisfied" or "very satisfied"

with the mentoring received, the flexibility LASP shows in creating work schedules, their LASP supervisor, the career advice received, opportunities to present their work, and the culture of supporting students, and 83% responded that they were “satisfied” or “very satisfied” with the financial support they receive. Overall, a total of 93% of undergraduates reported their level of satisfaction with the unit as “satisfied” (22%) or “very satisfied” (71%), whereas 7% reported their satisfaction level as “neutral” and none as “dissatisfied” or “very dissatisfied.”

Graduate Education

LASP does not offer any graduate degrees, but its tenured and tenure-track faculty teach courses, as well as advise and supervise graduate students in their respective departments. The laboratory’s research associates provide research opportunities and supervision to graduate students in an array of departments and occasionally teach classes. Some departments allow research associates to serve as primary advisors for graduate students, while others do not. LASP employs 59 graduate students, mostly in the science division. Tenured and tenure-track or research faculty supervise graduate students employed in the science division and encourage them to present and publish their research findings. Graduate students employed in the engineering or MODS division tend to perform design and operational work.

LASP is also involved in important international and online graduate teaching. By participating in the INSPIRE consortium, LASP joins colleagues in Taiwan and India in educating students in spacecraft design, building, and operation, as well as in data gathering and analysis. INSPIRE aims to take both undergraduate and graduate students through a three-year curriculum that proceeds from concept through flight. This novel program may provide a model of interdisciplinary and

international teaching and learning. LASP is also a member of the COLLABorate Graduate Education (COLLAGE) program in Solar and Space Physics, which includes CU and four other universities along with two national laboratories. COLLAGE courses provide instruction in a distributed, online environment and are taught by CU instructors and/or instructors from other institutions.

Graduate students report generally high satisfaction levels with their LASP experiences. The internal reviewers' graduate student survey obtained 28 responses, 19 from doctoral students and nine from master's students. These respondents reported being "satisfied" or "very satisfied" at the following rates: 79% with mentoring, 96% with flexibility in constructing work schedules, 86% with their LASP supervisors, 82% with opportunities to present work, 75% with the laboratory's culture of supporting students, and 82% with financial support. Only the question regarding "help making career decisions" lagged significantly, with just 46% responding that they were "satisfied" or "very satisfied." The survey showed high levels of satisfaction with the LASP graduate program in general, with 36% responding that they were "very satisfied," 54% "satisfied," 7% "neutral," 4% (n=1) "dissatisfied," and none "very dissatisfied."

Although the internal reviewers conducted a survey of graduate students, neither the unit nor ARPAC surveyed postdoctoral fellows to ascertain their general satisfaction with and opinion of the laboratory's climate. There also is no information offered in the self-study about the job placement of graduate students and postdoctoral fellows who have worked at LASP. This is not surprising; although LASP members are extensively engaged in various forms of graduate training, the unit currently relies upon member CU Boulder departments to provide mentorship,

general academic oversight, and presumably monitoring matters such as job placement. Nevertheless, it may be useful for LASP to collect more information about postdoctoral fellows' opinions of the unit and their subsequent job market experience.

Space
and
Infrastructure

LASP sprawls across five facilities located on both the Main East campuses. On East Campus, the Space Sciences (SPSC) building houses scientists and some MODS staff; the LASP Space Technology Building and Annex (LSTB) houses engineering, MODS, and administrative staff; and the Astrophysics Research Laboratory (ARL) houses engineering staff working on the Emirates Mission to Mars. Although the Nuclear Physics Laboratory near Marine Street, which houses scientists and engineers, is technically located on East Campus, LASP reports that it is too distant from the other buildings to be easily reached on foot. Teaching faculty occupy offices on the main campus in the Duane Physics building. The self-study argues that the physical separation of scientists from engineers, in particular, hinders the collegiality and close collaboration that has driven the laboratory's success. Furthermore, LASP indicates that it needs new space to accommodate its staff, whose number grew approximately 10% in 2013-2016 and is anticipated to continue to grow at a similar rate. The unit reports that a surge of visiting scientists in the summer exacerbates the space shortage on a seasonal basis.

The self-study argues that "LASP functions as a business subsidiary of CU Boulder" and that constraints on its financial model, budget, purchasing, and ability to set salaries pose challenges to its ongoing success. The vast majority (80%) of its operational funds derive from facilities and administrative (F&A) fees rather than direct campus support. The LASP F&A

rate of 40% is significantly lower than CU Boulder's general F&A rate. LASP proposes that its share of F&A from the campus be increased to 60% from 40% to fund investments in new initiatives and infrastructure. The external reviewers propose an F&A rate of 50-55% to cover actual costs, which it reports to be in line with the laboratory's competitors.

LASP participates in a competitive market to hire and retain both faculty and research staff, and it believes that it must have more flexibility to adjust salaries and bonuses to remain competitive. For tenured and tenure-track faculty, LASP asserts that annual merit increases do not allow the lab to offer fair compensation and laments a problem with salary compression. In contrast, for engineers and research associates funded through extramural support, annual salary increases are usually limited to the percentage increase for tenured and tenure-track faculty (though this was not the case in the year in which the self-study was written), making it difficult for the lab to respond to market conditions. Since the self-study was written, LASP has received a raise pool in the most recent non-merit salary exercise. LASP requests that increases in salary for staff supported by soft money be separated from tenured and tenure-track faculty raises. The internal reviewers recommend that LASP be granted the ability to set competitive salaries for soft-money positions, and the external reviewers agree, contending that the laboratory's average engineering salary lags 25% below the aerospace standard.

Parking and transportation present challenges to LASP. The self-study reports that LASP spends over \$20,000 per year for parking for the many visitors it receives due to international visibility and numerous partnerships with off-campus corporations and agencies. In addition, faculty, staff, and students who commute to the main campus find the bus

service to be too sporadic and slow. The internal reviewers agree that solutions to visitor parking should be explored, and that transportation to and from main campus should be addressed.

Inclusive Excellence

The demographic composition of LASP remains “monolithic,” according to the self-study. Office of Data Analytics statistics on LASP tenured and tenure-track appointees show zero women, one underrepresented minority person, and one international person. LASP reports that nearly 90% of its professional staff and 80% of its students are “Caucasian” (an outdated term that should be corrected to “white”) and that 9% of its employees were born outside the United States.

LASP recognizes the importance of nurturing employee and student diversity as “an important issue” and outlines steps that “LASP could consider.” However, the self-study does not articulate a concrete strategic plan, document what measures have already been taken, or suggest how to track progress. Additionally, LASP has not submitted an inclusive excellence narrative to campus administration.

Climate and Outreach

In the self-study, LASP acknowledges that “we do not know what LASP employees think about the climate in the lab.” LASP believes that a university-conducted survey on lab climate was “implemented in a haphazard way” that yielded unreliable results, and that the survey’s categorization of people into “faculty” and “staff” was too broad and inappropriate for the laboratory’s employee classifications. However, the self-study voices a strong recognition that LASP must be proactive in building a supportive, professional, and inclusive work environment. It requests that the university collaborate with LASP to create an appropriate instrument and administer an appropriate survey.

The internal reviewers' graduate student survey showed that 93% of graduate students "agree" or "strongly agree" that "LASP encourages a climate that is tolerant and respectful of diversity," while 7% are neutral and none disagree or strongly disagree. Undergraduate students responded similarly, with 95% agreeing or strongly agreeing, 2% neutral, and 2% (n=1) strongly disagreeing. The small number of respondents who express neutrality or dissatisfaction with the climate is encouraging, but the lack of diversity within the laboratory's community overall makes it difficult to draw any definite conclusions about the climate for women and underrepresented minorities.

The LASP Office of Communications and Outreach (OCO) supports a robust array of programs and events that promote and publicize the laboratory's research and contributions to the state economy. The OCO also serves an important role in connecting LASP to K-12 science educators and providing teachers professional development. Recent cutbacks in NASA's education budget have forced the OCO to operate with reduced staff and funding. Nevertheless, the OCO continues to coordinate LASP messaging and operate outreach programs such as facility tours, public lectures, school visits, and job fair attendance.

Past Reviews

The last LASP review occurred in 2010. At that time, ARPAC recommended that LASP work to preserve its prominence as a research and educational laboratory, enhance its diversity efforts, identify ways to strengthen its relationship with academic units, and prepare to move additional personnel to East Campus. It recommended that LASP, in concert with campus administration, improve coherence between LASP and departmental graduate programs, explore ways for LASP to be involved in departmental graduate admissions, build its fundraising capacity, and address support for proposal writing. Furthermore, it recommended that campus administration obtain adequate contiguous space for LASP and help the laboratory to address market demands on salaries.

LASP has indeed remained a prominent player in space science research and education. Coherence between LASP and academic departments in tenured and tenure-track faculty hiring and graduate education in the area of solar and space physics has improved, in part as a result of the move of the National Solar Observatory to Boulder. In contrast, the self-study notes that such improvements have not been noted in planetary sciences. Not much progress has been made on the diversity front, parking remains problematic, and fundraising has not advanced significantly, quite possibly due to continued instability in the campus's fundraising office.

Campus Context

LASP serves as a hub that connects many academic units, mostly in the natural sciences (APS and ATOC, primarily) and engineering (ASEN, in particular). Some 24 tenured and tenure-track faculty hold LASP appointments and while also supporting the missions of their home departments. The laboratory's non-tenure track scientists teach and supervise undergraduate and graduate students (although unevenly across academic units). Additionally, LASP employs graduate students and undergraduates in its science, engineering, and MODS divisions.

Disciplinary Context

While it is easy to laud the laboratory's national profile, in truth, its profile is global. As the most extensive and capable university-based space research lab in the United States and arguably worldwide, LASP does what no other lab can do: conceptualize, propose, design, build, and operate instruments and spacecraft from the ground up, and conduct scientific analysis on the data collected. The external reviewers note that the laboratory's presence has drawn the National Solar Observatory to Boulder and benefitted the NOAA Space Weather Prediction Center, the University Corporation for Atmospheric Research (UCAR) High Altitude Observatory, and the growing aerospace industry in the Boulder area. LASP plays a leading role in the internationalization of space science with the Emirates Mission to Mars and in space science education with INSPIRE.

Analysis

While it is a highly successful laboratory, LASP faces challenges to sustaining its preeminent position. These include its funding model, administrative flexibility and responsiveness, need for contiguous space, and inclusive excellence engagement.

Research and Scholarship

ARPAC commends LASP for its proactive approach to conducting research in a changing funding environment in which NASA proposals are becoming both more expensive to produce and less likely to be funded. Embracing international partnerships and exploring new areas that promise to draw multiple sources of funding, such as space weather, show the laboratory's forward-looking approach and should position it well as conditions continue to shift. The internal reviewers approvingly observe that the laboratory's collaborations on cubesats are enhancing its relationship with Aerospace Engineering and recommends that this relationship continue to be cultivated and grown—a recommendation with which the external reviewers concur.

The laboratory's desire to increase its internal funding will require careful strategizing and collaboration with the provost and with the chief financial officer. Since writing the self-study, LASP has reviewed how research space is accounted for in order to ensure that its facilities and administrative (F&A) properly reflects all of its research facilities. This may enable LASP to accommodate its funding needs. However, if this review does not produce satisfactory funding, ARPAC suggests three potential avenues that could be explored. First, LASP could be incorporated into the general CU Boulder F&A rate, a move that would raise the laboratory's F&A rate substantially but could also adversely affect the rest of campus by lowering the overall rate. Second, LASP could explore how to raise its F&A rate through strategic investments by the campus. Third,

LASP, the provost, and the chief financial officer could negotiate for a higher percentage of the F&A to be returned from the campus to LASP.

Both the internal and external reviewers agree with the laboratory's contention that additional tenured and tenure-track faculty would benefit not only LASP, but also the campus as a whole, especially since space science is a growing field that attracts commercial investments. ARPAC suggests that LASP develop—in conjunction with its academic partners—a strategic plan that lays out the rationale for potential hires; articulates how they would benefit LASP, the academic units in which they would be rostered, and the campus as a whole; and explains how they fit into the laboratory's plan for inclusive excellence.

Undergraduate Education

ARPAC commends LASP for incorporating undergraduates into all aspects of its mission. ARPAC is particularly impressed by how LASP trains undergraduates as mission controllers, which helps them with graduate admissions or employment opportunities. The self-study reveals a careful consideration of the laboratory's recruitment and cultivation of undergraduates. It notes that finding accommodations for the rapidly fluctuating number of undergraduates can be challenging, although no lasting issues have arisen. It also suggests that LASP could do a better job of providing undergraduates with ways to connect to each other and voice their concerns to the administration. The external reviewers make a reasonable proposal for the creation of a "forum or electronic billboard" to communicate with undergraduate students. ARPAC recommends that in addition, LASP should follow its own proposal to sponsor undergraduate student events, which could provide opportunities for undergraduates to socialize and to present their research. Furthermore, ARPAC suggests that LASP form a full-fledged undergraduate student organization (rather than the

“undergraduate concerns committee” that the self-study mentions), which could sponsor events, foster a sense of community, and provide ways to convey student desires and concerns to LASP administrators.

Because LASP is not an academic department and does not offer undergraduate courses, its non-tenured and tenure-track research associates have difficulty recruiting undergraduate students to their projects. In addition, research associates have scant opportunity to teach undergraduate courses in departments. Both of these problems could be addressed by encouraging departments to invite research associates to teach undergraduate courses more regularly, and ARPAC recommends that LASP engage departments on this matter. Furthermore, ARPAC recommends that LASP improve communications with undergraduates by establishing an undergraduate page on the LASP website, sponsoring events in departments at which research associates discuss their research and posting LASP opportunities on the student listservs of cognate departments.

Graduate Education

LASP operates in an exciting interdisciplinary arena of graduate teaching and advising. In addition to its tenured and tenure-track faculty, who teach in their departments regularly, its research faculty teach courses in departments “on a part-time to quasi-regular basis,” according to the self-study. LASP has proactively taken the commendable step of topping off the meager stipends offered to honorarium instructors so that research associates receive 30% of their salary for teaching a full course. These research faculty fill a vital role by providing research opportunities and instruction in areas that tenured and tenure-track faculty alone could not cover. However, whereas some departments allow non-tenured and tenure-track PhD holders to serve as primary advisor to graduate students,

others do not. ARPAC recommends that LASP engage in conversations with the departments about the advantages of allowing research faculty to sit on admissions committees and advise graduate students.

ARPAC suggests that it would be helpful for LASP to conduct a survey of postdoctoral fellows' attitudes about program satisfaction and climate, as well as to collect data about both graduate students' and postdoctoral fellows' job placement.

Space
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Infrastructure

The biggest challenges to the laboratory's ongoing success lie in the areas of administrative nimbleness, budget, and campus space. As an entity that designs, builds, and operates complex instruments and spacecraft, LASP operates on a scale and at a pace that stretches the capacity of campus administrative units in the areas of procurement, hiring, and accounting. In addition, LASP contends with complexities such as the International Traffic in Arms Regulation (ITAR). The external reviewers recommend that CU Boulder delegate to LASP as much authority as policy allows to "conduct the administrative functions that are essential for its success," suggesting that "full purchasing authority should be delegated to LASP" and that human resources functions like hiring "be made as efficient as possible." The internal reviewers endorse the local control that LASP has already been granted over procurement and submission of contracts and grants but cautions that the laboratory has taken on these functions without consideration for its administrative overhead. ARPAC submits that rather than conceiving of the laboratory as a "business subsidiary of CU Boulder," LASP might consider itself to be a leader in efforts to guide the campus toward flexibility and efficiency in its procurement and hiring operations. Since the self-study was written, the campus's Department of Human Resources has undergone changes driven in part by dialogue with LASP and

other units about their needs, and ARPAC trusts that these changes have benefitted LASP, as well as the campus as a whole.

LASP operates in a funding environment that straddles the commercial and academic spheres. It believes that university policies and procedures impede its ability to enter into contracts that follow industry, rather than research, norms, and desires increased autonomy to do so. ARPAC encourages the laboratory's efforts to find new funding sources and recognizes that doing so will require revisions to university policies and procedures. We suggest that LASP commence detailed discussions with the provost, and with the chief financial officer, and Office of Contracts and Grants to find solutions that benefit LASP and CU Boulder.

The LASP facilities and administrative (F&A) rate of 40% is anomalously low by both CU Boulder and national standards. ARPAC recommends that LASP, the provost, and the chief financial officer negotiate an appropriate F&A return rate that would allow LASP to recoup actual costs and administrative overhead. A renegotiated rate should also enable LASP to support proposal writing, make investments in new technologies, enhance communication and computing infrastructure, and fund a dedicated outreach program that is not dependent on individual projects. In addition, ARPAC echoes the internal reviewers' call for LASP to explore how using venture capital may enhance its engineering capacity.

The internal and external reviewers concur that LASP must have the flexibility to set salaries that attract and retain faculty and research staff in a competitive aerospace market. In the prior review, ARPAC recommended that LASP be granted the ability to define salary ranges and annual raises for faculty and

staff supported by extramural funding. ARPAC continues to recommend this course of action. As for tenured and tenure-track, university-funded faculty, ARPAC notes that salary compression remains a campus-wide challenge and commends LASP for successfully participating in the recent non-merit salary exercise.

LASP requests both additional space for its growing staff and contiguous space, noting that the Nuclear Physics Lab lies far enough away from the Space Sciences (SPSC) facility and the LASP Space Technology Building and Annex (LSTB) to require a short drive. As mentioned above, the self-study reports that the physical separation of its science and engineering divisions impedes the types of close collaborations that have driven the laboratory's success. LASP requests that the university consider building a facility nearer to or adjacent to the LSTB, which could obviate the laboratory's need for space in the SPSC. The external reviewers support a contiguous space request, while the internal reviewers recommend additional East Campus space for LASP. ARPAC recommends that LASP work with the Office of Space Optimization to explore strategies for space usage that facilitate collaboration to the greatest extent possible.

ARPAC recognizes that transportation to and from East Campus affects LASP and other units. We recommend that LASP define its transportation needs and work with the provost and with the chief financial officer to find solutions.

Inclusive Excellence

The need and desire to diversify its tenured and tenure-track faculty weighs heavily on LASP. The external reviewers assert that "a more proactive approach to increasing diversity is appropriate" and notes a lack of diversity in LASP senior management. The external reviewers suggest that the campus

assist LASP in creating faculty lines to improve diversity. CU Boulder's Strategic, Targeted, and Accelerated Recruitment (STAR) program aims to enhance diversity and inclusion through targeting and recruiting members of underrepresented groups, and ARPAC recommends that LASP and its departmental hiring partners explore this program. In addition, ARPAC recommends that LASP consult with the Office of Diversity, Equity, and Community Engagement (ODECE) and with science, technology, engineering and mathematics units such as those in the College of Engineering and Applied Sciences about creating an inclusive excellence narrative that uses best practices in hiring, mentoring, promotion, as well as developing and maintaining a positive climate.

LASP also strongly wishes to recruit a student community that includes women and other underrepresented groups. The external reviewers note that "LASP and the University face a challenge recruiting minority students because of a lack of diversity in local communities." Yet approximately a third of Colorado high school graduates come from underrepresented groups, and over half are female. ARPAC commends LASP for its desire to recruit more widely and suspects that Colorado may provide fertile grounds for finding suitable undergraduates. In addition, ARPAC notes that as a nationally and internationally renowned laboratory, LASP should consider widening its recruitment pool beyond the local, especially through its programs like the National Science Foundation Research Experience for Undergraduates (REU).

One passage of the self-study requires comment. It asserts that "attempts to recruit [faculty and research staff] from underrepresented groups may just move individuals between institutions (which has little overall societal benefit) without increasing the size of the population." However, building a

critical mass of women and people from underrepresented groups within an institution can lead to greater visibility and sense of community, both of which contribute to enhanced recruitment and retention. Such efforts are hardly a zero-sum game, since they ultimately contribute to increasing the number of women and people from underrepresented groups in the field overall.

Climate In its self-study, LASP laments that the university-conducted climate survey did not divide respondents into categories appropriate to the laboratory (scientists, MODS staff, engineering staff, administration staff, and IT staff) and points to anomalies that led LASP to reject its findings. Despite its problems, however, LASP reports that the survey identified the laboratory's climate as generally congenial. LASP desires to work with the campus to develop an appropriate instrument and proposes that a campus office administer the survey. ARPAC endorses this proposal.

LASP expresses unambiguous support for building a genuinely welcoming and inclusive climate, which ARPAC applauds. LASP recognizes that, nationwide, women in space sciences (and sciences in general) suffer from unacceptable levels of harassment, which frequently goes unreported. As they state, "We cannot simply assume or hope that LASP is immune from this or other types of problematic behavior. . . . LASP needs to ensure that appropriate steps are taken to ensure that this does not happen." LASP also charges itself with creating a written policy on "harassment, assault, and discrimination" defining unacceptable behaviors and pointing to resources for people who have suffered from them, and tasks administrators with establishing a tone of non-tolerance for such behaviors. ARPAC agrees that a written protocol consistent with campus policies must be established, and that LASP administrators must set a

tone of supporting diversity and inclusion, and of non-tolerance of discriminatory behaviors. The website of the Department of Astrophysics and Planetary Sciences (APS) provides an excellent example, with a statement on inclusivity posted prominently on its home page and a detailed “Diversity and Collegiality” page that includes protocols, policies, and reporting options. Furthermore, ARPAC recommends that LASP revise its grievance policy to emphasize that incidents of harassment, assault, and discrimination are not internal LASP issues, but instead must be handled through institutional policies and procedures, which specify reporting to the Office of Institutional Equity and Compliance.

Recommendations

The members of the Academic Review and Planning Advisory Committee (ARPAC) address the following recommendations to the Laboratory for Atmospheric and Space Physics and to the offices of responsible administrators:

To the Unit:

1. Develop an inclusive excellence narrative. Consult with the Office of Diversity, Equity, and Community Engagement and with science, technology, engineering and mathematics units, such as those in the College of Engineering and Applied Sciences, to create an inclusive excellence plan that uses best practices in hiring, mentoring, promotion, and developing and maintaining a positive climate.
2. Develop a strategic hiring plan that explains the rationale for new tenured and tenure-track faculty hires and articulates how they would benefit LASP, academic hiring units, and the campus as a whole.
3. Develop a concrete recruitment plan for increasing the representation of women and members of underrepresented minorities in faculty and staff ranks, using tools such as the Strategic, Targeted, and Accelerated Recruitment Program and the Chancellor's Postdoctoral Fellowship Program.
4. Work with the Office of the Vice Chancellor for Research and Innovation to define job descriptions, salary ranges, and annual raises appropriate for grant-funded research staff.
5. Write a strong protocol consistent with campus policy on harassment, assault, and discrimination that defines inappropriate conduct and provides resources to people who have witnessed or experienced it and to mandatory reporters.

6. Revise the laboratory's grievance policy to conform to university policies regarding harassment and discrimination.
7. Sponsor an undergraduate student organization that enhances undergraduate engagement and can convey concerns to LASP administration.
8. Conduct a survey of postdoctoral fellows to ascertain their satisfaction with LASP and their views about climate and inclusivity.
9. Work with member departments, the Office of Data Analytics, and internal records to collect information about job placement for graduate students and postdoctoral fellows who have done significant amounts of work at LASP.
10. Engage in conversations with departments and the Graduate School on enhancing the role of LASP research faculty (research associates) in areas such as teaching undergraduate and graduate courses, sitting on graduate admissions committees, and advising graduate students.
11. Work with the Office of the Vice Chancellor for Research and Innovation to explore ways to increase internal funding.
12. Work with the Office of Space Optimization to explore how to better allocate existing space to enhance research collaboration and teaching.
13. Continue to investigate enhancing engineering capacity by drawing on funding sources other than US federal agencies.

To the Office of the
Vice Chancellor for
Research and
Innovation:

14. Work with LASP to define job descriptions, salary ranges, and annual raises appropriate for grant-funded research staff.

To the Provost:

15. Work with LASP and the Office of Contracts and Grants to explore ways for LASP to increase its ability to enter into contracts that follow aerospace industry norms.

16. Work with LASP to explore ways to increase its internal funding.

17. Work with LASP and Parking and Transportation Services to address visitor parking and optimize transportation to and from East Campus.

18. Work with the Office of Advancement, CIRES, the vice chancellor for research and other institutes to develop a pan-institute model for advancement

Required Follow-Up

The director of the Laboratory for Atmospheric and Space Physics shall report annually on the first of April for a period of three years following the year of the receipt of this report (i.e., April 1st of 2019, 2020, and 2021) to the vice chancellor for research and innovation and to the provost on the implementation of these recommendations. The provost, as part of the review reforms, has agreed to respond annually to all outstanding matters under their purview arising from this review year. All official responses will be posted online.