

2022 Program Performance Review
Department of Physics
External Reviewers Report
May 20, 2022

To: Dr. Marie Johnson, Dean, California State University-Fullerton, College of Natural Sciences and Mathematics
From: Dr. Andreas Bill, California State University-Long Beach
Dr. Jennifer Shaw, Syracuse University
Dr. Jeffrey R. Knott, California State University-Fullerton
Subject: Department of Physics, Program Performance Review, External reviewer report

Dr. Johnson,

As the Department of Physics Program Performance Review team (Team), we completed the following tasks:

- Reviewed the Department of Physics 2021-2022 Program Performance Self-Study
- On April 29, 2022, we
 - Met with yourself and Associate Dean Sean Walker
 - Toured the Department of Physics facilities
 - Met with a group of graduate students, some of whom were teaching associates in the Department
 - Met with a group of undergraduate students
 - Met with a member of Department staff
 - Met with tenure and tenure-track faculty
 - Met with yourself and Associate Dean Sean Walker

Your suggestions for the focus of our assessment were in the following areas:

- a) Improving student success (i.e., course availability)
- b) Is the Department work environment welcoming and inclusive?
- c) What is the status of undergraduate/graduate/faculty research?
- d) What is the Department's balance between teaching and research?
- e) What is the role of online teaching?

We should point out that we did not meet with part-time faculty members or tenure/tenure-track faculty with research interests in physics education.

Student Success

We gleaned the most productive information on student success from our meetings with the students. An equal number of about 20 graduate and undergraduate students met with the Team. The students clearly identified themselves as physicists. With the exception of one community college transfer, the undergraduate students entered CSUF as physics majors. Undergraduate students stated that the schedule of classes was clearly laid-out and that academic advising was consistent and of high quality.

Both undergraduate and graduate students commented positively on the opportunities for research, the mentoring provided by the faculty and opportunities to attend scientific conferences and present research. The communal “grad room” lounge to gather and work together, is used by both grad and undergraduate students. Graduate students used Slack/Discord to communicate, but undergraduates did not have a similar communication network. When asked, graduate students stated that their training for teaching physics labs was limited to operational aspects of the labs provided by the Physics technical staff, and they did not receive any instruction on effective teaching methods from the faculty.

The students made several useful suggestions:

- With the lessening of pandemic restrictions, students would enjoy a reintroduction of social events to gather faculty, graduate students, and undergraduates together.
- Undergraduates would benefit from reinstating the Society of Physics Students chapter (SPS). It is recommended to have a faculty advisor for the SPS.
- Both undergraduate and graduate students stated that they would benefit from more information about possible employment opportunities. This could be as simple as a career panel where alumni share their career path.
- Students have expressed interest in additional research opportunities being posted (for example Research Experience for Undergraduates -REU- from NSF).
- In the course of discussion, students said that they found MATH 250B facilitated understanding in PHYS 300; however, MATH 250B is not a pre-requisite for PHYS 300 at this time.
- Students agreed that there was a noticeably positive improvement in instruction by professors who had consulted with and utilized teaching methods promoted by the physics education professors.
- Both undergraduate and graduate students expressed the need to have a better and more visible flow chart for their respective degrees.

Inclusive Environment

We will address inclusivity from three perspectives: staff, student, and faculty.

Staff

The Team met the available staff member who expressed that the work environment was positive and inclusive. The staff member also described positive relations with the CNSM and staff in other departments via regular meetings and a sense of teamwork developed through mutual efforts at special events. Essentially, Physics staff are part of the larger CNSM team.

The one area of concern related to inclusivity and teamwork expressed by Physics staff relates to attempts to the ongoing efforts to fill vacant staff positions. CSUF human resources is difficult and impersonal acting as more of a barrier to success rather than including Physics staff as teammates working toward a shared goal.

Students

As stated above, the students expressed that they identified as physicists and felt that they belonged in the department. They felt that the faculty and department were accepting of them both as a fellow researcher and as individuals. With one exception who was looking for a research mentor, all of the undergraduate students we met with were involved in research. The undergraduate students we

met with were a strong cohort; however, they expressed that while gender diversity was adequate in their minds, racial diversity was lagging.

Graduate students said they are encouraged and supported by the faculty in terms of their research, classes, and teaching duties. Both undergraduate and graduate students appreciated that the “grad room” acted as a hub for both social and scientific activities. Graduate students have a close-knit group with open communication via a messaging/chat app. The undergraduate students did not have a similar network and were not frequent visitors to the Physics web page.

Based on the student comments, we recommend:

- Continuing the department activities, such as mentoring and research, that produces the current environment.
- Development of a recruitment plan aimed at both community college and high school students that emphasizes engagement of underrepresented groups. This plan should have clearly defined, measurable benchmarks and goals.
- Development of a faculty-mediated communication platform with undergraduate and graduate students. The undergraduate students recommended the Slack app. Slack is good because students can make separate channels to talk among themselves in addition to having a general channel.

Faculty

The Team initially met with five faculty (Ahmed, Childers, Hargreaves, Read and Shen) and were subsequently joined by the remaining available faculty (Khakoo, Lovelace, Smith and Tifrea). The Team did not meet with Drs. Cheng, Fearn, Passante, Loverude or Wanser. We appreciated that the faculty were forthcoming with answers to our various questions and provided valuable input.

The faculty described a collegial atmosphere where they frequently met informally for social lunches. Faculty volunteered that there never was a case where a faculty member did not earn tenure in Physics. This was attributed to a relatively clear tenure process and mentoring. When asked, it was revealed that tenure-track faculty have an assigned, tenured-faculty member as their mentor, but do not have annual or regularly scheduled meetings with the Physics department chair. Some faculty provide informal support to young faculty to write grants.

Also, tenure-track faculty with expertise in physics education provide informal mentoring on teaching technique and strategies. It was acknowledged that the Department Personnel Document must be updated during the 2022-23 academic year. The current document apparently has rigid requirements for tenure regarding teaching and research standards.

The Team was particularly concerned about the mentoring of the women faculty. Because most of the mentoring came through casual interactions, and minoritized individuals, by definition, are not “one of the guys” they are less likely to receive the same level of informal mentoring as majority persons.

Discussion of the tenure and promotion process was not extensive. It was made clear that there were rigid requirements for publication that did not accommodate the fact that different subdisciplines of physics would have different rates of publication. Further, the teaching assessment appears to emphasize the Student Opinion Questionnaire (SOQs). being within one standard deviation of the mean for all the classes - even though different classes likely have different historic averages.

Based on our conversations with available faculty, the Team recommends:

- Formalization of the department mentoring process. This should include documented meetings between the tenure-track faculty and the chair as well as the tenured faculty mentor.

- It is recommended the revised and updated tenure and promotion criteria review the role of the SOQ data and how to interpret these data. The SOQ should be only one of several criteria to assess faculty teaching. New criteria should reflect recent research on student biases, etc., related to SOQs.
- It is recommended to have a more formal in-class review process for each faculty under review by at least two faculty members for two lectures and to use these peer evaluations as part of the tenure case.
- The publication requirements for tenure seemed to not consider the standards of various sub-disciplines in determining the actual productivity of faculty.

Undergraduate/Graduate/Faculty Research

Twelve faculty curriculum vitae were included in the self-study. The Team recognizes that the curriculum vitae may be incomplete, and that formatting is not consistent. For example, many do not have a chronological list of mentored undergraduate and graduate students.

Eight faculty (67%) have active external research grants and five (41%) listed mentored students. Eight faculty (67%) published in peer-reviewed journals since 2019. Many faculty list publications and conference presentations with student co-authors, which is excellent. In summary, considering the teaching requirements of each faculty member, the research production within Physics is deemed to be high and admirable.

Research is an important part of the training and education of a physicist. The department is commended for providing high quality research opportunities for a large portion of its undergraduate and graduate students. It is also commended for including students as co-authors on peer-reviewed publications and conference presentations. There is a healthy number of undergraduate students doing research mostly in experimental physics groups as it is more difficult to involve them in theory research projects. It is noted that there is no formal process for students to find a group to do research with. Students would benefit from a communication channel (*e.g.* Slack) that points them to research opportunities in the and out of the department.

Student research is supported financially through two main channels. One is from external research grants of individual faculty members. The other is philanthropic (*e.g.* Black Family Trust, N. and L. Begovich). Only 14% (19%) of undergraduate (graduate) students are not financed. A rather large fraction of students is supported to do research.

For the most part, the department should continue what is currently being done, with some minor recommendations:

- It is recommended to have meetings each year or semester where faculty or students in their groups inform new graduate and undergraduate students about research activities and opportunities. This could involve the Society of Physics Students for undergrads.
- Leadership should look for ways to re-engage faculty who are slowing down in publishing (for example mid-career faculty).

Teaching and Research Balance

Many faculty have active, funded, research projects and laboratories, which we saw in our tour of Physics facilities. The level of research is outstanding with an impressive number of external grants and philanthropic support. The desire for a research/teaching balance seemed genuine among the faculty with newly hired faculty receiving release time during the first two years at CSUF. There was general agreement that an equitable class load consists of a large undergraduate class (6 weighted teaching units [WTUs]), a smaller upper division or graduate class (3 WTUs) and additional three WTUs for mentoring graduate and undergraduate student research. It was clear that the faculty enjoyed and did not shirk teaching general education, undergraduate, and graduate courses.

One faculty member felt that the teaching load was unfair with the perception that female faculty members received a higher teaching load. One faculty member mentioned, as did the self-study, that, at times, faculty with externally funded release time were unable to utilize that time due to teaching requirements. Although this was in the study, it appears that the use of these release times was not always based on merit or equitably given out. Junior faculty also mentioned that they were unaware of the teaching loads of their colleagues. The perception being that those faculty who were active mentoring students were penalized because their less-active colleagues who did not accumulate three WTUs of mentoring had less work.

The Team did not have sufficient information to examine the faculty teaching loads. Some of the curriculum vitae listed courses taught, but not all provided this information. We this limitation, we recommend improving communication:

- Transparency regarding teaching assignments and;
- allow the department and faculty to anticipate potential release time conflicts.
- Teaching loads and release time should be shared among the faculty to demonstrate the equity or inequity of workload.
- Special care should be given to make sure that minoritized faculty are allowed to take the release time that they have been awarded through federally funded buy-outs. These buy-outs should give the dean/department the funds needed to recruit a teaching staff member.

Role of Online Instruction

The role of online instruction in the physics degree programs did not come up during our day of meetings. One course was listed as online in the self-study, ASTR 101. A second course is also offered online: PHYS 301, Energy & Sustainability, a GE course offered in Area B.5 that may be used as an upper-division elective for Physics B.S. students.

After reviewing the self-study and as a result of our meetings, below are items that we believe are worthy of comment and consideration by Physics, CNSM, and CSUF.

Curriculum

The overall offering of classes is adequate for the undergraduate and graduate physics programs, but a few aspects can be improved. It is commendable that the department has laid out multiple tracks for the undergraduate B.S. to allow students with different preparations to see their way through the major in a timely manner. At both the undergraduate and graduate level, it is unorthodox to not require statistical mechanics as part of the core curriculum, especially given the condensed matter research activities for which it really is a fundamental topic. Further, statistical mechanics overlaps and reinforces

classical and quantum mechanics, as it can be applied to both types of systems, giving more integration to the curriculum.

It is clear that Physics is actively updating the curriculum as evidenced by four new courses that were added to the undergraduate curriculum. A general education course, Quantum computing for everyone, is proposed (category B.1). At the graduate level, Physics of Sports, and an advanced experimental physics class were added; two courses were retired because of low student interest.

The CSUF B.S. in Physics requires 8 units of Chemistry (CHEM 120A and CHEM 125). The department had no clear explanation for such a high unit load of Chemistry. The Chemistry (or biology in some instances) requirements for the B.S. in Physics at nearby CSU campuses is at most 5 units; CSUF requires more Chemistry by units than most other local CSUs. Reducing the Chemistry requirement may be an opportunity for CSUF to examine the major requirements and provide flexibility to add MATH and PHYS courses to the curriculum.

The self-study provided the curriculum for the B.S. in Physics degree. The number of units required is at the maximum of 120; however, below are some items that came out during discussion a few suggestions are made below.

- PHYS 300 (Survey of Mathematical Physics) appears to be a bottleneck of the program because all upper division courses require it. Due to the decline in upper division class enrollment the course cannot be offered each semester anymore; it is now offered in the spring. In addition, PHYS 300 cannot cover the mathematics needed in all the classes.
- Consider requiring MATH 250B for differential equations and linear algebra. The undergraduate students commented that this course improved comprehension in PHYS 300. Requirements for the latter should hence be reconsidered. Undergraduate advisors should recommend the MATH 250B class for physics students wanting to go to graduate school.
- While core classes are offered regularly an elective in soft condensed matter is missing. This seems particularly important given that faculty have expertise in this field and enroll many students in research experience.
- We understand that new course proposals are often the result of enthusiasm for a particular subject by a faculty member. With that said, we recommend that Physics reconsider the name of the proposed GE class “Quantum Computing for Everyone.” This consideration should be made in the light of the fact that Academic Affairs asked Geological Sciences to change “Physical Geology” to “introduction to Geology” because the word “Physical” was too intimidating for non-science majors. If the intent of this course is to develop a large-format class (i.e., >80 students), then it is hard to imagine that non-science majors will warm to a class with “Quantum Computing” in the title.
- Statistical Mechanics (PHYS 416/516) is only offered sporadically and is not a core class of the graduate program. We suggest that this class be offered more frequently or be required in the core curriculum because it is commonly a requirement for graduate schools.
- The department should consider the possibility of removing at least one semester of chemistry courses from the requirements for majors and replace it with additional courses in mathematics, statistical mechanics, or other course more relevant to the physics major.

Bachelor of Science – Business Emphasis

This B.S. degree program was not discussed on April 29th. The self-study states that this degree program has 1 student every 2-4 years. The following questions should be addressed by the department to assess this Business emphasis:

- Who among the faculty in Physics and Business champion this degree program?

- Why continue a degree program with such low enrollment?
- Is there a plan to increase enrollment in this degree program (i.e., new faculty hire)?

Note that CSUF University Policy Statement UPS 410.200 states that each participating unit (e.g., College of Business) shall participate in the review.

Part-Time Faculty Needs and Graduate Teaching Associates

The self-study noted that Physics has difficulty finding qualified part-time faculty, which is a common problem in southern California. Our understanding is that most of the current lecturers are alumni of the CSUF Physics master's program. In our discussions with the graduate teaching associates (TAs), the TAs stated that the only pre-instruction training they received was a briefing on the technical aspects of each lab from the department technician. The TAs received no training or assistance regarding effective teaching pedagogy.

This leads to the following observations:

- There may be an opportunity for Physics. Many of the TAs may continue to reside locally after completing their M.S. degrees. Providing these TAs with training that improves their teaching skills and, possibly, their enjoyment and satisfaction with teaching may develop more part-time instructors for the department.
- In any event, a training program on effective teaching strategies, even a series of informal readings, should be implemented to improve the learning experience of CSUF students in general. Additionally, the TAs would very likely benefit from regular meeting during the semester with a faculty member to discuss common issues (e.g., making exams, grading, etc.). Such programs exist in CSUF Biological Sciences and Geological Sciences.

Time to Graduation and Recruitment

During the review period, the time to graduation has significantly improved from 25% for the 2013 cohort to 57.9% for the 2015 cohort. This is observed for both first-time freshmen and transfer students. This is commendable. Time to graduation is reasonable: 3 years once students declare the physics major. Similarly, the graduation rate in the graduate program improved, and enrollment grew. Because the graduate program is mostly composed of undergraduate students of the department who decide to pursue a master's degree, the reduction in undergraduate enrollment affects the graduate program cohort.

The Team supports the department's continuing effort to increase graduation rates and notes that the department is apparently effective in recruiting undergraduate students into the graduate program. Goals outlined in the self-study included strengthening the graduate program by increasing financial support and encouragement of plan BC.

We recommend:

- With the establishment of the Begovich Center for Gravitational Wave Physics and Astronomy, Physics could pursue graduate students recruited from other local institutions (e.g, UC Irvine). Local students may not be as impacted by the high cost of housing in Fullerton.
- Considering that the majority of physics majors entered CSUF as freshman with a physics major declared, Physics should develop a recruitment plan that targets local high school students, especially from underrepresented groups.

- Since incoming students know they want to do physics, work on creating cohorts of students and other peer and near-peer support networks will be beneficial to keeping students in the program.
- Another avenue for recruitment is community colleges. Providing information to surrounding community colleges regarding CSUF opportunities and pre-requisite information may increase undergraduate transfers and reduce the time to graduation.

Graduate Advising

While undergraduate students have more formal, regular advising meetings with the advisor, the graduate program relies on the advising of the entire faculty and, in particular, research mentors. Students in the graduate program expressed the need to have some more established regular meetings. For example, graduate students have an orientation at the beginning of the academic year but it is centered on the work of TAs. Graduate students created Slack/Discord groups to which all students are invited.

The following suggestions should be considered:

- It is encouraged to have an orientation that facilitates the induction of all graduate students into the program.
- Cohort building can also include a hike or other off campus event as part of getting to know each other.
- In addition, meetings between the graduate advisor and graduate students should be offered at least once a semester to provide equitable advising for all students.
- It is recommended to formalize the Discord/Slack communication to make sure all students have access so that important information is conveyed to all students.
- Students also expressed insufficient guidance for after graduation. The graduate advisor provides such information, but more can be done especially regarding non-academic positions.
- TA training is also important and can focus on pedagogy and best practices for equity and inclusion in the classroom.

Resources

The department has an allotted Operating Expense fund (OEE) that has remained flat during the review period. It has not been adjusted to the increased FTES or other measures. The department appears to be doing its part by acquiring some impressive philanthropic contributions. The Nicholas and Lee Begovich Center for Gravitational-Wave Physics and Astronomy includes an endowed center director line and graduate student fellowships.

Physics is an experimental science, sufficient operating funds to run teaching laboratories and replace equipment is important. With the growing role of computational physics, it is also important to provide updated computers on a regular basis (every 3 years). Student lab fees are very low, which is good for students, but may not be enough when larger equipment or computing purchases are needed.

To hire quality, diverse faculty requires adequate startup packages to be competitive. The package comprises sufficient funding to start their laboratory and adequate space. The figure mentioned in the PPR of \$250- 500k for new experimental hires is indeed the current norm for faculty at physics departments of similar size and scope.

Although the following recommendations are more accurately directed toward the Provost and Dean and not Physics, we think it is important to express that Physics has been meeting goals and acquiring external funds without a commensurate effort by CSUF or CNSM.

The PPR expresses concern about access to a list of journals. The mechanisms for obtaining articles from these journals may need to be reviewed with the faculty.

We recommend:

- Physics OEE should be increased to reflect the FTES of the department and to the needs of a modern curriculum.
- The Provost should barter an agreement between Physics and Information Technology that provides the required computer hardware for laboratory instruction. These computers benefit multiple departments in CNSM and the College of Computer Science and Engineering and, therefore, are a CSUF resource that should be funded by CSUF.
- Start-up funding for experimental physics hires is woefully inadequate. This hampers Physics when recruiting productive, diverse faculty.

Facilities

Laboratories are distributed over several buildings. In addition, some of these research laboratories are too small for the equipment and number of students who work in these labs. It is recommended to relocate, increase the size and improve the infrastructure of some of the laboratories, depending on faculty activity levels and field of research; special attention should be given to younger experimental faculty members. This is especially important given the two new experimental hires to replace retiring faculty. It is important the university provides adequate laboratory space for the department to continue thrive.

It is also important for research laboratories to have sufficient technical support. Next to the focus on instructional laboratories the technical staff should have the skills and time to support the research of its faculty. This should be accompanied with a continued, existing access to the campus machine shop.

Classrooms are a concern for the department. There is an imperative necessity of large classrooms to teach lower division classes with increased FTES. It is recommended to review the policies to assign large classrooms to provide the department with adequate space for the service classes.

Faculty Retreat

The self-study mentions that a faculty retreat was held a “couple of years ago”. We suggest that the faculty consider another retreat soon. Two faculty are retiring; two faculty are arriving. One faculty member arrived during the pandemic. A retreat is a good opportunity to reinforce existing relationships and establish new ones.

At a retreat, the Physics faculty may discuss and outline revisions for the revised Department Personnel Document that must be completed during the next academic year. The self-study states that a five-year hiring plan is in development. A retreat is a good venue to discuss the hiring plan prior to the discussions with the Provost in the fall. The suggestions/recommendations in this report may provide some topics for additional discussion as well.

We suggest that Physics employ a 3rd party moderator. Someone unattached to CSUF who can facilitate all voices being heard equitably.