Physics and Astronomy

Responses to Budget Committee Suggestions

Department of Physics and Astronomy

October 7, 2020

Executive Summary

The UH Department of Physics & Astronomy (P&A) serves a vital role in shaping Hawaii's future. P&A trains a growing number of undergraduate majors, both in the classroom and the research lab. The Department of Physics & Astronomy provides valuable classroom and hands-on technical training to students at all levels. The service courses of P&A, for example PHYS 151/152 and 170/272/274, are cumulatively taken by over one thousand students per year across CNS, Engineering, and other units. These courses provide fundamental frameworks for further work in science and engineering, and are an essential offering to grow the high-tech industry of the state. Many graduates and researchers from P&A go on to employment in Hawaii's tech industry, or have even started their own local tech companies. This pipeline of local researchers and engineers ultimately brings further significant external funding both to the state and the university. Further development of this pipeline is essential to preparing the state for the future, scientifically and economically.

The deep connections between physics, astrophysics, and astronomy are demonstrated, not only in the strong overlap in courses required for the BS Physics, BS Astrophysics, and BA Astronomy majors, but also in the specializations of the P&A faculty. Thirteen of the twenty P&A faculty specialize in astrophysics, and this not only informs the teaching focus of these faculty, but provides undergraduate research opportunities in the field of astrophysics. To separate the Astrophysics and/or Astronomy degree programs from P&A would sever these connections, to the detriment of the students.

The following points summarize our responses to the specific proposals and suggestions that have been made. More detailed responses can be found in the second section of this document.

1. *Suggestion*: Reorganize the Astronomy degree program into the Institute for Astronomy OR (based on discussion with unit) explore a collaborative administration of the program between IfA and Physics.

   Response: The Astronomy graduate program (MS Astronomy and PhD Astronomy) is already fully managed by the IfA, whose faculty handle admissions, graduate courses, research supervision, and awarding of degrees. However, due to the deep connection that Astrophysics & Astronomy undergraduate majors have with Physics courses, classmates, and the P&A Department, we strongly oppose relocating any of the undergraduate programs (BS Astrophysics or BA Astronomy) out of P&A. Currently, an IfA faculty committee and Astronomy Undergraduate Program Chair supervise the curriculum and administration of all undergraduate ASTR courses and degrees; P&A accepts and helps to enforce their decisions. Together, IfA and P&A collaboratively manage their common undergraduate courses and overlapping program components, including laboratory classes, research projects, and academic advising.

2. *Suggestion*: Reduce inequities in the level of graduate student support.

   Response: The graduate student pay inequity between P&A and IfA is a serious problem which must be addressed. The P&A TAs perform work which is functionally identical to the IfA TAs, and they deserve the same pay. However, transferring the Astronomy program from P&A to IfA will not address this problem; the two issues are unrelated. P&A graduate students primarily TA for physics services courses, and would be unaffected by such a move. It is critical that CNS funding levels for TAs increase, so that P&A graduate students can be paid equitably. The current P&A TA pay level is inadequate and adversely affects graduate recruitment and retention.

3. *Suggestion*: Review the BA/BS to address declining majors.

   Response: Although the number of BS Physics majors has declined since 2012, this is due to a large number of potential physics majors choosing the BS Astrophysics major (which did not exist in 2012) instead. A more appropriate comparison is to the combined number of BS Physics and Astrophysics majors, which is now 110 and shows steady growth. The department is taking steps to handle the demands of the new major and to continue this trend of increasing enrollment. This includes the hire of a tenure-track specialist who is developing the BA Astronomy and BS Astrophysics programs.

4. *Suggestion*: Consider developing a capstone experience or partnering with UROP to develop and expand faculty-mentored research experiences.

   Response: Beyond coursework, the department actively trains students for technology careers through participation in research projects. This includes valuable training in detector instrumentation & electronics, data acquisition, numerical computation, and “big data” analysis. The BS Astrophysics & BA Astronomy programs already have a successful capstone experience, and a proposal for creating a capstone experience for the BS Physics program was brought up for consideration in Feb. 2020. Due to the focus on transitioning to online teaching, consideration of this proposal was delayed. But with the transition now complete, we expect this proposal for a capstone experience to be acted on shortly.

In summary, while we agree on the importance of P&A contributing to Hawaii’s short-term and long-term future, we believe that some of the specific proposals made are based on misconceptions regarding P&A. In fact, P&A extramural funding has not been declining, the number of P&A majors has been growing, and research opportunities for undergraduates as well as opportunities for technical training are also growing, as is the impact of these students on Hawaii’s economic and technological future. P&A is taking concrete steps to improve student outcomes even further.

Detailed Responses

1) Reorganize the Astronomy degree program into the Institute for Astronomy OR (based on discussion with unit) explore a collaborative administration of the program between IfA and Physics.

The Astronomy graduate program (MS Astronomy & PhD Astronomy) is already fully managed by the IfA, whose faculty handle all admissions, graduate courses, research supervision, and awarding of degrees. While Astronomy graduate students are technically academically part of P&A, IfA runs the entire Astronomy graduate program in a manner similar to an independent department. If UH wishes to rescope ORUs to allow them to fully house their own academic programs, then officially "moving" the Astronomy graduate degree programs to IfA will constitute virtually no change from the status quo.

However, due to the deep connection that Astrophysics & Astronomy undergraduate majors have with Physics courses, classmates, and the P&A Department, we strongly oppose relocating any of the undergraduate programs (BS Astrophysics or BA Astronomy) out of P&A. Currently, an IfA faculty committee and Astronomy Undergraduate Program Chair supervise the curriculum and administration of all undergraduate ASTR courses and degrees; P&A accepts and helps to enforce their decisions. Together, IfA and P&A collaboratively manage their common undergraduate courses and overlapping program components, including laboratory classes, research projects, and academic advising.

Physics is the central science that underlies all astronomical research, and all professionals in astronomical fields are expected to have strong backgrounds in physics. Therefore, to provide the necessary preparation to enter graduate study and careers in astronomical sciences or related fields, we designed the BS Astrophysics degree to contain most of the core BS/BA Physics courses. Indeed, counting laboratory courses, the importance of physics within the BS Astrophysics degree is demonstrated by its plurality of the required courses:

BS ASTP:	**PHYS: 12**	**ASTR: 9**	**MATH: 5**	**CHEM: 4 courses**
BS PHYS:	PHYS: 18		MATH: 5	CHEM: 4 courses
BA PHYS:	PHYS: 11		MATH: 5	CHEM: 2 courses
BA ASTR:	PHYS: 5	ASTR: 10	MATH: 2	CHEM: 4 courses

(Note: BA students can increase these numbers via their choice of elective courses.)

Given the emphasis of physics within the BS Astrophysics curriculum, we do not see the value of further relocating the "home" of the BS Astrophysics degree (including student advising & support) from the Dept. of Physics & Astronomy (P&A) to the Institute for Astronomy (IfA). Furthermore, we see even less value in relocating only the smaller BA Astronomy degree to IfA, instead of the administrative and social advantages of keeping it alongside our other degree programs.

Both of the undergraduate curriculum committees that manage our degrees (Astronomy Undergraduate Program Committee and Physics Undergraduate Program Advisory Committee) do so in a collaborative fashion. The Astronomy UGPC oversees the curricula of all undergraduate ASTR courses and Astrophysics & Astronomy degrees, while the Physics UGPAC oversees the curricula of all undergraduate PHYS courses and Physics degrees. However, the two committees share two members in common, and they maintain frequent communication on issues of common concern: courses, program requirements, learning objectives, and collaborations with other departments.

Additional reasons for the BS Astrophysics and BA Astronomy programs to remain at P&A:

• Geographically, BS Astrophysics and BA Astronomy majors take all of their degree-related courses on the Manoa campus, mostly within Watanabe Hall (the home of P&A), and *not* at the IfA facility, which is located approx. one mile away.

• Academic advising for both Astro and Physics majors is performed collaboratively by faculty Major Advisors on campus within Watanabe Hall (where undergraduates spend the majority of their time), not at IfA. Also, academic advising for Astrophysics & Astronomy majors is currently strongly supported by the College of Natural Sciences (CNS); removing those degree programs from P&A (and hence, CNS) would sever that beneficial relationship.

• Both Astro and Physics majors are involved in participation and leadership of the UH Manoa Chapter of the Society of Physics Students (SPS), a national pre-professional organization that caters to students studying both Physics and Astronomy. The collective growth of our P&A degree enrollments over the past decade has turned our previously dormant SPS Chapter into a lively and active student-led organization. SPS typically plans and executes 2–3 events per month, including professional development, career exploration, and social activities that cover a mix of both Physics and Astronomy.

• Socially, all of our Astro & Physics majors share the P&A Library located in Watanabe Hall as a common study center. Likewise, all of our Physics & Astro majors are equally encouraged to participate in P&A Department events, which they do: colloquia & guest speakers, open houses & public outreach, and social gatherings. This creates great cohesiveness among *all* of our majors, and it provides them a network of peers for studying together and sharing advice. Furthermore, it promotes the development of STEM identities for all of our majors and a sense of belonging to a community of scientists. Relocating any of our undergraduate degree programs to IfA would remove those students from this valuable social network, isolating them and depriving them of those benefits.

2) Reduce inequities in the level of graduate student support.

It is critical that CNS funding levels for TAs increase. A short, informal search of TA pay in eight other physics departments in the US reveals average pay of $22.8K per year, with a standard deviation of $3.2K per year. This can be compared to starting TA pay in our department of around $19K per year. While a formal study would reveal more precise figures, this already indicates that TA pay in our department is at the lower end of pay for physics departments in the country, even without making adjustments for the very high cost of living in Hawai'i.

In addition to addressing the inequities in TA pay with other units, benefits of increased TA support would be:

- increased graduate student recruitment success, which is also needed for the health of the externally funded research program,
- better graduate student retainment rates,
- allowing the graduate students to live above the "extra low-income" level as defined by the U.S. Department of Housing and Urban Development.

3) Review the BA/BS to address declining majors.

Again, physics is the central science that underlies all astronomical research. Virtually all Astronomy-related graduate programs require applicants to have strong backgrounds and extensive undergraduate coursework in Physics, and it is very common for Astronomy graduate students to have earned their undergraduate degrees in Physics. Thus, prior to the creation of our BS Astrophysics & BA Astronomy degrees in Fall 2014, our undergraduate students who were interested in serious study and research careers in astronomical sciences usually declared Physics as a major, as is typical at other major U.S. universities that lack undergraduate Astronomy/Astrophysics degree programs.

Therefore, both prior to and following the establishment of our Astrophysics & Astronomy degrees in 2014, it is the *total* students enrolled in all P&A majors that should be viewed as a measure of the appeal of our degree programs. That total has shown steady growth from roughly 40 students for many years prior to 2010 to well over 100 students in 2020. The apparent decrease in officially declared Physics majors during 2015-2017 is exactly correlated with a corresponding (and even larger) growth of declared students in the newly created Astrophysics major, and our department's Major Advisors anecdotally confirm that a large migration occurred from Physics into the new Astrophysics program. For 2018 onward, the number of declared Physics majors has stabilized near its historical value of approx. 40 students, while the total declared Astronomy + Astrophysics majors has grown to around 70 students:

<u>Fall 2020 Declared P&A Majors (late Sept. 2020)</u>:

BA Astronomy = 17 BA Physics = 6

BS Astrophysics = 55 BS Physics = 39
Total Astro = 72 Total Physics = 45
Total P&A = 117 students

Although 55 declared majors in BS Astrophysics is lower than the original projection of 80 in our degree proposal document, it is not significantly so. BS Astrophysics enrollment grew very quickly during its probationary period, and by many measures, 55 declared majors would be considered a success by other degree programs at UH Manoa. We anticipate continued (albeit more limited) growth over the coming half-decade, and we continue to receive a steady stream of inquiries from prospective students from around the world.

While 17 BA Astronomy majors is likewise below our original projection of 40 in our degree proposal, we add the following:

a. Given the existence of the BS Astrophysics degree, we emphasize that the BA Astronomy degree *costs almost nothing extra to offer*. Only a single course (ASTR 210) is unique to the BA Astronomy program; all other required ASTR, PHYS, CHEM & MATH courses, and all other Astronomy-related STEM electives, are already regularly offered by their respective departments. Therefore, lower-than-expected enrollment is not a major concern, and cancellation of the BA Astronomy degree program would not result in any significant savings of resources. Indeed, the elimination of those 17 students would have the opposite effect, reducing our income as they move to other majors or leave UH Manoa.
b. Based on student assessment and feedback by our core-course instructors over the past two years, the Astronomy Undergraduate Program Committee has been vigorously discussing possible modifications to the curriculum of the BA Astronomy program. These types of adjustments are to be expected in a new program which is still in its probationary period. In particular, the committee is designing changes that will make the BA Astronomy content more cohesive and career-focused, as well as increasing overall rigor and computer programming content. The committee is currently designing recommended “Tracks” to emphasize career-specific preparation — likely options include Data Science, Instrument Design, Planetary Exploration, Education, and Science Writing. All of these will increase collaboration with other departments on campus and will rely on existing courses. These program modifications are likely to be submitted within this academic year.

Prior to 2015, BA Physics enrollment was vanishingly small, because the course requirements for BA Physics were nearly identical to those for BS Physics. Therefore, in 2015, we overhauled our BA Physics degree, inspired by the successful Univ. of Wisconsin model: we eliminated a half-dozen of the most advanced BS Physics courses, and we instead required students to add their own set of non-introductory courses with a Physics-related theme (the Interdisciplinary Concentration). While still providing all of the essential, rigorous preparation of

the BS Physics core, our revised BA Physics degree now serves a distinct and valuable purpose, and every year since 2015, a handful of students have actively chosen to declare and pursue it. Although BA Physics is still the smallest of our four degree programs (currently at 6 declared majors), we emphasize that it *costs nothing extra to offer*. Every required PHYS, CHEM & MATH course, and all elective Interdisciplinary Concentration courses, are already regularly offered by their respective departments. Therefore, small enrollment should not be a concern, and cancellation of the degree program would not result in any savings. Indeed, the elimination of those 6 students would have the opposite effect, reducing our income as they move to other majors or leave UH Manoa.

4) Consider developing a capstone experience or partnering with UROP to develop and expand faculty-mentored research experiences.

The BS Astrophysics & BA Astronomy programs already have a successful capstone experience. Students in both degrees are required to complete individualized senior research projects under direct faculty supervision (2 semesters of ASTR 399 Directed Research for BS Astrophysics, 1 semester for BA Astronomy), and to enroll concurrently in our Senior Project Writing Seminar (ASTR 494). This capstone experience has already been completed by 21 graduates, and is currently underway by 11 more seniors. While the large majority of project advisors are IfA Astronomers, they have also included faculty from P&A, SOEST, Chemistry, and Engineering whose research involves space-related topics. To prepare our majors during the junior-year ASTR 300-301 course sequence, we intentionally teach common software tools and methods of astronomical research, and we introduce students to potential senior-project advisors via guest speakers and interview assignments.

Prior to their senior capstone experience, we encourage all of our majors to pursue undergraduate research opportunities and summer programs throughout their undergraduate careers. Since 2017, P&A has hosted semi-annual advising sessions with presentations and guest speakers to emphasize the importance of undergraduate research experience, and to introduce our majors to relevant opportunities: UH Manoa UROP funding, UH Space Grant fellowships, the Akamai Internship Program, NSF's summer REU Programs, and other local and national programs and fellowships. P&A students who complete research projects can apply to our department for up to $500 annually to fund presentation of their results (poster printing, conference registration, or travel).

For the BS Physics program, in Feb. 2020, the P&A Assessment Committee forwarded to the Physics Undergraduate Program Advisory Committee (UGPAC) a proposal for the creation of a capstone experience. Needless to say, the department (and particularly the UGPAC) was almost immediately swamped with responsibilities associated with the transition to online teaching, as a result of Covid-19. With that transition nearly complete, the Physics UGPAC has again taken up this proposal, and action is expected very soon. The proposal is appended to the end of this response as an attachment.

In the meantime, steps have already been taken to create greater opportunities for undergraduate research for BS Physics majors. Our 20 Physics faculty are currently training 20 undergraduates in physics research projects, where they are learning valuable skills in detector instrumentation, electronics, data analysis, numerical computation, and advanced theory. The department has recently initiated a “1-Minute Colloquium” series, which introduces undergraduates to physics research opportunities.

The Instrumentation and Development Lab is an excellent example of a cross-cutting research facility, with engineering and physics students working cooperatively on designing cutting edge experimental instrumentation. Students from this and other labs have an excellent record of going on to successful careers in Hawai’i and across the country in high tech industries like semiconductors, aerospace, and as researchers and engineers at national labs. More recently, many former students have gone on to work in the local technology industry, at companies like Oceanit and Nalu Scientific.

Nalu Scientific, in particular, was founded in 2016 by a former P&A postdoc from the high energy physics group and has employed 15 recent UH graduates, most from P&A and Engineering. Nalu Scientific has brought to Hawaii over $9.2M in federal funding and subcontracts, and is continuing to grow rapidly. They also continue to engage in collaborative research with the department, and have issued to UH subawards of around $700k since their founding.

We look forward to completing a hire of an accelerator physics R&D faculty member, which was postponed in the spring, to further expand the technical training program of the department and to allow the use of the existing electron linear accelerator on campus for student training, tests of detectors, and cooperation with local Hawai’i high-tech companies. Accelerators, especially the U.S. Dept. of Energy’s accelerator light sources, play a critical role in the battle against the pandemic and future viruses. The multi-billion-dollar x-ray light source facilities at Argonne National Laboratory, SLAC National Laboratory, Brookhaven National Laboratory, etc., use their beams to provide detailed structures of the COVID-19 virus and its proteins, as well as test potential treatments. These light sources could also provide substantial opportunities for UH P&A graduates in the future. We note that this hiring proposal, as well as on-going research on the instrumentation frontier of high energy physics, is extremely well-aligned with the Hawai’i Innovation Initiative.

Finally, we note here that the picture painted of P&A’s extramural funding profile on the Provost’s webpage is misleading. It appears to show a significant drop in funding in 2019. But this drop in funding is just a bookkeeping artifact, which largely results from the fact that a major grant from the Department of Energy was delayed, and not processed until FY2020. In fact, P&A extramural funding has been steady, and the external funding level for FY2020 ($5.8M) is higher than in previous years. This is documented in the second attachment.

Attachments

1) Proposal for Implementation of a Capstone Experience
2) Documentation of Extramural Funding for FY15-FY20

UNIVERSITY OF HAWAI'I AT MĀNOA

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Feb. 5, 2020

Dear Prof. Gorham and Prof. Szarmes,

The Assessment Committee has reviewed our recent departmental assessment reports, and has considered proposals for learning improvement projects. The Assessment Committee has decided, by unanimous vote, to forward the following proposal to the Undergraduate Program Advisory Committee.

The Department of Physics and Astronomy of UHM proposes to institute an elective senior physics-major project as a capstone course. Previously we have polled P&A graduates after a few years out, as to the relevance of their UH P&A experience, as well as a random assortment of faculty at other universities, and we found that many, perhaps most other Physics programs have capstone senior thesis projects. Most tellingly we have heard back from our graduates that the two items they wished most to have experienced in our program were more social interactions amongst the peer group and faculty, and for a senior project capstone course.

We propose that this course be offered on an individual basis as a Physics 399 course (Individual Work in Advanced Physics) with individual faculty mentoring (with this counting for faculty teaching quota). In the Spring Semester of each year, there would be a further one credit Physics 399 joint registration under the guidance of a single faculty member where individuals would give reports on their efforts. Not only would they receive credit (for both the work done under 399 mentorship and for the single credit of the seminar report), but the Department will establish a computer area to display the reports. Those reports that rise to an adequate level should be encouraged to be submitted for publication. The success in the thesis activity should be sufficiently made public as to enable citation by the student authors (and possibly with their mentors).

This program to be instituted in the next academic year, since it can be accomplished by P&A alone without new course approval, and without affecting the P&A requirements since it will be voluntary.

Sincerely,
Jason Kumar
Chair, Assessment Committee

P&A Extramural FY15-FY19

PI NAME	SPONSOR	ACCOUNT	PROJECT NAME	PROJECT PERIOD	FY#15$ 7/1/14-6/30/15	FY#16$ 7/1/15-6/30/16	FY#17$ 7/1/16-6/30/17	FY#18$ 7/1/17-6/30/18	FY#19$ 7/1/18-6/30/19	FY20$ 7/1/19-6/30/20	NOTE
Kumar, Jason	NSF		Novel Dark Matter Models and Detection Strategies	6/15/2013-5/31/2018	80,000						First FY didn't count--FY14
Kumar, Jason	NSF		Novel Dark Matter Models and Detection Strategies	6/15/2013-5/31/2018		80,000					
Kumar, Jason	NSF		Novel Dark Matter Models and Detection Strategies	6/15/2013-5/31/2018			80,000				
Maricic, Jelena	BNL		Photosensor Characterization for LBNE	04/26/2013 -9/30/2015	45,647						Amendment 5. Amdt1-4 were before FY15 and Amdt 6-7 NCE only.
Maricic, Jelena	DOE		Resolving Reactor Antineutrino Anomaly with a Strong Antineutrino Source	07/15/2013 - 7/14/2019		150,000					Amdt 2
Maricic, Jelena	DOE		Resolving Reactor Antineutrino Anomaly with a Strong Antineutrino Source	07/15/2013 - 7/14/2019			150,000				Amdt 3
Maricic, Jelena	DOE		Resolving Reactor Antineutrino Anomaly with a Strong Antineutrino Source	07/15/2013 - 7/14/2019				150,000			Amdt 4. Amdt 5 & 6 NCE only
Maricic, Jelena	FNAL		Proposal for Institutional Responsibilities to ProtoDUN	09/26/2017 - 6/30/2018				28,000			
Maricic, Jelena	FNAL		Deep Underground Neutrino Experiment (DUNE)	01/01/2020-11/30/2020						21,800	
Learned, John	LLNL		University of Hawaii Participation in WATCHMAN Dev	05/04/2018-9/30/2018				57,307			Sub#B628262, eff 5/3/2018
Learned, John	LLNL		Development and Testing of a New 64-Rod Antineutri	11/16/2017-12/31/2017				5,997			Subcontract#B626541, eff 11/14/2017. ORS reported this figure twice
Learned, John	LLNL		Watchman Related Studies	05/20/2015-9/30/2015	47,000						Subcontract#B613531, eff 05/20/2015
Learned, John	LLNL		Watchman Related Studies	07/13/2016-11/30/216			18,000				Subcontract#B618950, eff 07/11/2016
Learned, John	LLNL		University of Hawaii WATCHMAN Contributions for 2020	12/16/2019-09/30/2020						81,343	
Learned, John	NGA via ARL (**)		Antineutrino/Neutron Geolocation Program V	06/25/2015-01/25/2017	1,400,000						This was reported under ARL
Learned, John	NGA via ARL (**)		Neutron TimeCube CONOP Suitability Investigation	08/24/2015-07/26/2016	494,927						This was reported under ARL
Learned, John	NGA via ARL (**)		Antineutrino/Neutron Geolocation Program VI	09/22/2016-02/28/2018			500,000				This was reported under ARL
Learned, John	U. Michigan via HIGP		Consortium for Monitoring, Technology, and Verification	09/20/2019-09/19/2020						145,771	The amount need to be confirmed with Gavin at HIGP.
Nishimura, Kurtis	U. Texas Arlington	6108712	QPix Technology: Research and Development Towards kiloTon Scale LArTPC	05/01/2019-03/31/2020						65,108	
Nishimura, Kurtis	U. Texas Arlington	6109339	QPix: Achieving Kiloton Scale Pixelated Readout for Liquid Argon Time Projection Chambers	06/01/2020-03/31/2021						36,500	This grant award is making its process through the system.
Nishimura, Kurtis	Praxis Inc.		Engineering Support for NRL COMPTON Project	07/12/2018 - 12/31/2018					25,522		All Change order 1-5 didn't increase fund
Nishimura, Kurtis	Sandia National Laboratories		Single Volume Scatter Camera (SVSC)	02/05/2018-12/31/2020				375,000			Initial award performance period 01/23/2018-09/30/2018
Nishimura, Kurtis	Sandia National Laboratories		Single Volume Scatter Camera (SVSC)	02/05/2018-12/31/2020					200,000		REV4 ending period 09/30/2019. Any REV thereafter >FY19
Nishimura, Kurtis	Sandia National Laboratories		Single Volume Scatter Camera (SVSC)	02/05/2018-12/31/2020						550,000	$400K was received in cal year 2019 and $150K was received in cal year 2020.
Nishimura, Kurtis	FNAL		DUNE Cold Electronics Support	09/23/2019 -09/01/2020, NCE 03/01/2021						79,605	
Vahsen, Sven	DOE		Negative Ion Drift Time Projection Chamber Developr	07/01/2017-06/30/2018				9,000			
Browder, Thomas	DOE		Research in High Energy Physics	06/01/2013-03/31/2016	1,530,000						MOD3
Browder, Thomas	DOE		Research in High Energy Physics	06/01/2013-03/31/2016	60,000.00						MOD2 supplement
Browder, Thomas	DOE		Research in High Energy Physics	06/01/2013-03/31/2017		1,410,000					MOD4
Browder, Thomas	DOE		Research in High Energy Physics	06/01/2013-03/31/2017			10,000				MOD5 (ORS/system reported in FY17)
Browder, Thomas	DOE		Research in High Energy Physics	06/01/2013-03/31/2018			1,355,000				MOD6
Browder, Thomas	DOE		Research in High Energy Physics	06/01/2013-03/31/2019				1,525,000			MOD7
Browder, Thomas	DOE (*)		Research in High Energy Physics	06/01/2013-03/31/2020						1,283,000	MOD9
Browder, Thomas	DOE		Research in High Energy Physics	06/01/2013-03/31/2021						1,446,000	MOD10
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017	106,591						First year, eff 12/01/2014
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017	326,365						Supp1, eff 3/5/2015
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017		52,598					Supp2, eff 8/4/2015
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017		147,402					Supp3, eff 8/31/2015
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017		164,857					Supp4, eff 11/28/2015
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017		118,241					Supp5, eff 01/07/2016
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017		181,759					Supp6, eff 03/09/2016
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017			100,000				Supp7, eff 08/05/2016
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-4	12/01/2014-11/30/2017			243,377				Supp8, eff 10/31/2016. Supp9 is NCE
Gorham, Peter	NASA		Search for cosmic ultra-high energy neutrinos with AN	09/001/2016-12/31/2020			30,000				First year, eff 09/01/2016

P&A Extramural FY15-FY19

PI NAME	SPONSOR	ACCOUNT	PROJECT NAME	PROJECT PERIOD	FY#15$ 7/1/14-6/30/15	FY#16$ 7/1/15-6/30/16	FY#17$ 7/1/16-6/30/17	FY#18$ 7/1/17-6/30/18	FY#19$ 7/1/18-6/30/19	FY20$ 7/1/19-6/30/20	NOTE
Gorham, Peter	NASA		Search for cosmic ultra-high energy neutrinos with AN	09/001/2016-12/31/2020				45,000			Supp1, eff 9/01/2017
Gorham, Peter	NASA		Search for cosmic ultra-high energy neutrinos with AN	09/001/2016-12/31/2020					45,000		Supp2, eff 9/01/2018. Supp3 & 4, NCE only
Gorham, Peter	DOE		Research in New High Energy Physics Detectors With Picosecond Timing Capabilities	05/01/2017-03/31/2018				112,000			First year, eff 05/01/2017 (ORS/system reported in FY18)
Gorham, Peter	DOE		Research in New High Energy Physics Detectors With Picosecond Timing Capabilities	05/01/2017-03/31/2019				114,000			MOD1, eff 05/01/2018
Gorham, Peter	DOE		Research in New High Energy Physics Detectors With Picosecond Timing Capabilities	05/01/2017-03/31/2020					114,000		MOD2, eff 05/01/2019
Gorham, Peter	NASA		Extreme Energy Particle Astrophysics with ANITA-V	01/25/2018-01/24/2020				355,000			
Gorham, Peter	NASA		Ultra-high Energy Particle Astrophysics with ANITA-V	07/01/2019-06/30/2020						55,000	
Gorham, Peter	NASA	6108976	Particle Astrophysics with the Payload for Ultrahigh Energy Observations (PUEO): A Next Generation Long-duration Balloon-borne Instrument for the Cosmic High Energy Frontier -- Univ. of Hawaii Co-I	03/02/2020-03/01/2022						192,795	
Gorham, Peter	DOE	6109284	High Energy Physics Detector Development: Ultra-high Precision Timing Layers for Future Collider Detectors	04/01/2020-03/31/2021						140,000	This grant award is making its process through the system.
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	06/01/2014-09/30/2015	219,127						MOD3, eff 06/30/2014 (ORS/sys reported in FY14)
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	09/01/2014-09/30/2015	1,340,319						Sub#207867, MOD4, eff 09/01/201. MOD5 for tasks
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	09/01/2014-03/31/2016		117,615					MOD7, eff 10/16/2015 (this MOD is to add funds to MOD4)
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	09/01/2014-04/30/2016		108,702					MOD8, eff 2/29/2016 (MOD to add funds to previous MOD). MOD9&10, NCE
Varner, Gary	U. Californail Berkeley		High Performance Cross-Strip Micro-Channel Plate Detector Systems for Spaceflight Experiments	02/08/2012-05/31/2016							Funds were awarded before FY15
Varner, Gary	KEK		JFY 2014 US/Japan Program for Cooperation in High Energy Physics for High Luminosity R&D	06/11/2014-02/28/2015	31,924						Contract awarded 7/10/2014
Varner, Gary	InnoSys		Design and Implementation of Digital Electronics for Fast Readout and Processing of Multi-Channel Experimental Data	03/01/2015-09/30/2015	49,500						
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		Carbon Sequestration Muon Detector (CSMD Readout)	04/15/2015-09/30/2016	24,975						Initial contract256287, eff 048/15/2015
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		Carbon Sequestration Muon Detector (CSMD Readout)	04/15/2015-09/30/2016		20,000					MOD1, eff 10/16/15
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		Carbon Sequestration Muon Detector (CSMD Readout)	04/15/2015-09/30/2016		31,944					MOD2, eff 02/08/2016
Varner, Gary	KEK		JFY 2015 US/Japan Program for Cooperation in High Energy Physics for High Luminosity R&D	06/04//2015-02/29/2016		43,947					Contract awarded 7/14/2015
Varner, Gary	InnoSys		Design and Implementation of a Deep Buffer 15 Gigasample/sec ASIC	06/05/2015-03/07/2016		29,000					Contract, eff 2/17/2016
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	04/15/2016-09/30/2018		118,000					Contract#292035, eff 5/04/2016
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	04/15/2016-09/30/2018			10,000				MOD2, eff 02/27/2017
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	04/15/2016-09/30/2018				62,452			MOD3, eff 07/11/2017
Varner, Gary	BATTELLE MEMORIAL INSTITUTE		US Belle II Project Subcontract	04/15/2016-09/30/2018				46,464			MOD4, eff 09/19/2017
Varner, Gary	InnoSys		Design and Implementation of Digital Electronics for Fast Readout and Processing of Multi-Channel Experimental Data	04/11/2016-04/10/2018			449,968				Contract eff 07/11/2016

P&A Extramural FY15-FY19

PI NAME	SPONSOR	ACCOUNT	PROJECT NAME	PROJECT PERIOD	FY#15$ 7/1/14-6/30/15	FY#16$ 7/1/15-6/30/16	FY#17$ 7/1/16-6/30/17	FY#18$ 7/1/17-6/30/18	FY#19$ 7/1/18-6/30/19	FY20$ 7/1/19-6/30/20	NOTE
Varner, Gary	U. Californail Berkeley		Development of Large Area (10x10cm) photon counting UV detectors	02/09/2016-02/08/2020		163,907					Subcontract#00009142, eff 02/09/2016
Varner, Gary	U. Californail Berkeley		Development of Large Area (10x10cm) photon counting UV detectors	02/09/2016-02/08/2020			110,511				Amdt01, eff 02/09/2017. Amdt2 is NCE
Varner, Gary	Nalu		Design and Fabrication of the ASoC: a System-on-Chip Data Acquisition System	02/22/2016-11/21/2016		45,000					Sub, eff 6/6/16
Varner, Gary	KEK		JFY 2016 US-Japan Program for Cooperation in High Energy Physics 1st Installment of Funds for High Luminosity R&D	05/31/2016-02/28/2017			53,933				Contract, eff 07/05/2016
Varner, Gary	KEK		JFY 2016 US-Japan Program for Cooperation in High Energy Physics 1st Installment of Funds for High Luminosity R&D	05/31/2016-02/28/2017			3,955				Amd, eff 01/13/2017
Varner, Gary	KEK		FY JFY 2017 US-Japan Cooperative Program in High Energy Physics 1st Installment of Fund for High Luminosity R&D	06/02/2017-02/28/2018			16,115				eff 6/19/2017
Varner, Gary	DOE		High-Speed, Bunch-By-Bunch X-Ray Beam Diagnostic	07/01/2017-06/30/2019				70,000			eff 07/01/2017
Varner, Gary	Nalu		Design & Fabrication of the "SiREAD"- Silicon Photomultiplier Readout, Automated Calibration & Detection: A Low Power, Low Noise & High Performance Waveform Sampling Chip for High Channel Count SiPM.	02/21/2017-11/20/2017			31,000				eff 06/28/2017
Varner, Gary	Nalu		Design and Fabrication of the "AARDVARC" - ASoC Rapid Digitizer, Variable Adaptive Readout Chip	06/12/2017-04/26/2018				28,000			eff 01/19/2018
Varner, Gary	Nalu	6108716	Design and Fabrication of the AARDVARC- Advanced ASoC Rapid Digitizer Variable Adaptive Readout Chip (Phase II)	08/252/2019-08/26/2020						100,000	
Varner, Gary	BNL		eRD14: An Integrated Program for Particle Identification (PID) at a Future Electron Ion Collider (EIC)	01/09/2018-09/30/2021				25,000			Subcontract#340640, eff 01/09/2018. Amdt 4 received in FY20
Varner, Gary	BNL		eRD14: An Integrated Program for Particle Identification (PID) at a Future Electron Ion Collider (EIC)	01/09/2018-09/30/2021					35,000		Amdt1-3?
Varner, Gary	BNL		eRD14: An Integrated Program for Particle Identification (PID) at a Future Electron Ion Collider (EIC)	01/09/2018-09/30/2021, NCE 09/30/2021						41,400	MOD4, eff 09/19/2017
Varner, Gary	Nalu		Design and Fabrication of the ASoC: a System-on-Chip Data Acquisition System	04/10/2017-11/16/20109				181,034			Sub, eff 04/20/2018
Varner, Gary	BNL		University of Hawaii Belle II Operations Subcontract	11/28/2018-09/30/2021					141,360		Subcontract#353181, eff 11/28/2018
Varner, Gary	BNL		University of Hawaii Belle II Operations Subcontract	11/28/2018-09/30/2021						141,360	MOD1
Varner, Gary	BNL		University of Hawaii Belle II Operations Subcontract	11/28/2018-09/30/2021						9,840	MOD2
Varner, Gary	Ursus Medical Design		Analog Sampling (ARAM) Test Chip Design and Verification	09/15/2018-08/31/2019					60,000		
Varner, Gary	Standford University		R&D for SuperKEKB and the Next Generation High Luminosity Colliders	2/1/2019-05/31/2019					58,536		Can't find on the award mygrant
Varner, Gary	Standford University	6108708	R&D for SuperKEKB and the Next Generation High Luminosity Colliders	10/2019-09/30/2020, NCE 06/30/2021						25,000	MOD2
Varner, Gary	Nalu		Design and Fabrication of the AODS: All in One Digitizer System on a Chip	02/12/2019-11/18/2019						20,000	
Varner, Gary	Nalu	6109055	Design and Fabrication of the AODS - All in One Digitizer System on a Chip	04/06/2019-04/05/2021						50,000	
Varner, Gary	Nalu		Development and Implementation of the SWELL, a Single-Photon-Sensitive Waveform Enhanced and Lightweight Lidar: Electronics for Ultra-High Resolution, Single-Photon Sensitive, Fully Integrated	08/19/2019-02/18/2020						10,000	
Varner, Gary	Nalu		Design and Development of High Density Digitizer System on a Chip (HDSoC)	02/18/2020-02/17/2021						18,000	
Varner, Gary	U. Washington		Development of a Novel Imaging Calorimeter for Gamma-Ray and Cosmic Ray Studies	02/25/2019-02/24/2020						47,289	
Dye, Steve	LLNL		Remote Discovery and Monitoring of Small Reactors	03/25/2015-09/30/2016	20,000						
Dye, Steve	LLNL		Remote Discovery and Monitoring of Small Reactors	05/09/2016-09/30/2016		38,500					
Dye, Steve	LLNL		Remote Discovery and Monitoring of Small Reactors	02/13/2017-11/30/2017			60,000				Subcontract#B621682, eff 02/02/2017
Dye, Steve	LLNL		Remote Discovery and Monitoring of Small Reactors	02/13/2017-06/30/2019				81,863.00			

P&A Extramural FY15-FY19

PI NAME	SPONSOR	ACCOUNT	PROJECT NAME	PROJECT PERIOD	FY#15$ 7/1/14-6/30/15	FY#16$ 7/1/15-6/30/16	FY#17$ 7/1/16-6/30/17	FY#18$ 7/1/17-6/30/18	FY#19$ 7/1/18-6/30/19	FY20$ 7/1/19-6/30/20	NOTE
Dye, Steve	LLNL		Remote Discovery and Monitoring of Small Reactors	05/04/2018-06/30/2019					52,265		MOD4, eff 05/21/2019
Dye, Steve	LLNL		Cleanliness/Antineutrino Signals	02/26/2020-09/30/202						146,058.00	
Dye, Steve	LLNL		Remote Discovery and Monitoring of Small Reactors	08/23/2019-06/30/2020						77,953.00	
Szarmes, Eric	U. Chicago		Does a Free Electron Laser Exhibit Non-Classical Statistics?	01/01/2018-12/31/2018				57,030			
Szarmes, Eric	UCHICAGO ARGONNE, LLC		Does a Free-Electron Laser Exhibit Non-Standard Statistics? Part II: Theory	07/01/2019-12/31/2019						22,394.00	
Yepez, Jeffrey	DEFENSE, DEPT-AIR FORCE OFC OF SCI RSCH		Quantum Computational Mathematics for Efficient Computational Physics	11/15/2016-11/14/2019			100,000				
Yepez, Jeffrey	DEFENSE, DEPT-AIR FORCE OFC OF SCI RSCH		Quantum Computational Mathematics for Efficient Computational Physics	11/15/2016-11/14/2019				100,000			
Yepez, Jeffrey	DEFENSE, DEPT-AIR FORCE OFC OF SCI RSCH		Quantum Computational Mathematics for Efficient Computational Physics	11/15/2016-11/14/2019					100,000		
Farrah, Ducan	SPACE TELESCOPE SCIENCE INSTITUTE		A Case Study of an Extremely Luminous, Highly Spatially Extended Starburst Only 1.7Gyr After the Big Bang	1/1/2019-12/31/2020					19,816		
Farrah, Ducan	NSF		A Deep and Wide-Area Census of Infrared-Luminous Galaxies in the High-Redshift Universe	01/01/2019-04/30/2020						200,429.00	
Ditto, William	FirstPass Engineering		Computing With Chaos	7/1/2014-12/31/2014	60,000						
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-09/30/2014	47,613						07/18/2014 - T72497
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-04/30/2015	51,760						10/16/2014 - T72497 CO 1
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-09/30/2015	158,240						04/30/2015 - T72497 CO 2
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-10/31/2015		13,436					09/21/2015 - T72497 CO 3
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-09/30/2016		196,564					11/13/2015 - T73013
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-09/30/2017			380,000				09/29/2016 - T73013 CO2
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-09/30/2018				346,000			09/28/2017 - T73013 CO5
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-09/30/2019					390,000		11/19/2018 - T73013 CO9
Bindi, Veronica	Wyle Lab		Study of Proton Fluxes and Plan for GCR Flux Data from Alpha Magnetic Spectrometer (AMS) Data	07/18/2014-09/30/2020						450,000	01/24/2020- T73013 CO10
Bindi, Veronica	Notre Dame Univ		QuarkNet	09/01/2014-08/31/2015	2,000						08/24/2014
Bindi, Veronica	Notre Dame Univ		QuarkNet	09/01/2014-08/31/2017		2,000					10/14/2015 - MOU 2015-16
Bindi, Veronica	Notre Dame Univ		QuarkNet	09/01/2014-08/31/2017		17,440					04/15/2016 - Supplement
Bindi, Veronica	Notre Dame Univ		QuarkNet	09/01/2014-08/31/2017			2,000				08/24/2016 - Supplement
Bindi, Veronica	Notre Dame Univ		QuarkNet Summer Projects	09/01/2014-08/31/2017				19,540			03/31/2017 - Supplement ORS reported in FY18 (vp)
Bindi, Veronica	Notre Dame Univ		QuarkNet	09/01/2014-08/31/2018					3,000		06/28/2018 - MOD3
Bindi, Veronica	Notre Dame Univ		QuarkNet	09/01/2014-08/31/2020						3,000	10/23/2019 - Supplement
Bindi, Veronica	NSF		Study of the Most Energetic SEPs from Space with the State-of-the-Art Experiment, AMS-02	06/15/2015-05/31/2020		4,000					06/08/2015 - AGS-1455202 AMDT 001 Double counted in ORS report because it reporte
Bindi, Veronica	NSF		Study of the Most Energetic SEPs from Space with the State-of-the-Art Experiment, AMS-02	06/15/2015-05/31/2020			71,072.00				06/26/2017 - 1455202 AMDT002
Bindi, Veronica	NSF		Study of the Most Energetic SEPs from Space with the State-of-the-Art Experiment, AMS-02	06/15/2015-05/31/2020				90,211.00			06/13/2018 - 1455202 AMDT003
Bindi, Veronica	NSF		Study of the Most Energetic SEPs from Space with the State-of-the-Art Experiment, AMS-02	06/15/2015-05/31/2020					123,222		6/20/2019 - 1455202 AMDT004
Bindi, Veronica	NASA		Multi-Spacecraft Studies of the Highest Energy SEPs with AMS-02	09/01/2015-08/31/2016		30,000.00					08/18/2015 - NNX15AT09H
Bindi, Veronica	NASA		Multi-Spacecraft Studies of the Highest Energy SEPs with AMS-02	09/1/2015-08/31/2017			30,000.00				08/18/2016 - NNX15AT09H SUP 000001
Bindi, Veronica	Michigan, Univ of		Effect of Solar Variability on the Geospace Radiation Environment	09/12/2017-09/11/2021				15,509.00			10/31/2017 - 3004685380

P&A Extramural FY15-FY19

PI NAME	SPONSOR	ACCOUNT	PROJECT NAME	PROJECT PERIOD	FY#15$ 7/1/14-6/30/15	FY#16$ 7/1/15-6/30/16	FY#17$ 7/1/16-6/30/17	FY#18$ 7/1/17-6/30/18	FY#19$ 7/1/18-6/30/19	FY20$ 7/1/19-6/30/20	NOTE
Bindi, Veronica	Michigan, Univ of		Effect of Solar Variability on the Geospace Radiation Environment	09/12/2017-09/11/2021						29,611	03/12/20 - AMDT2
Bindi, Veronica	NASA		Including AMS Time Variation Data in the NASA Database	02/12/2018-02/11/2019				55,730			02/23/2018 - 80NSSC18K0506
Bindi, Veronica	NSF		Third Workshop on New Opportunities in the AMS Era: Solar Energetic Particles, Solar Modulation, and Space Radiation; Washington, District of Columbia; June 25-28, 2018	01/01/2018-12/31/2018				13,416			12/5/2017 - 1808722
Bindi, Veronica	NASA		IPA NASA Headquarter	01/07/2019-01/06/2021					505,703		Need to check with Peter/Veronica if this should b
Maricic, Jelena	NSF		Collaborative Research: Commissioning and Operation of DarkSide-50 at LNGS	06/15/2014-05/31/2017	55,000.00						6/13/2014 - PHY-1314268
Maricic, Jelena	NSF		Calibration for DarkSide50 experiment	06/15/2014-05/31/2017		55,000.00					6/29/2015- PHY-1314268 AMDT 001
Maricic, Jelena	NSF		Collaborative Research: Commissioning and Operation of DarkSide-50 at LNGS	06/15/2014-05/31/2017		32,000					07/9/2015 - PHY-1314268 AMDT 002
Maricic, Jelena	NSF		Collaborative Research: Direct Search for Dark Matter with Underground Argon at LNGS	06/15/2014-05/31/2017			87,000.00				6/14/2016- PHY-1314268 AMDT 003 (ORS repor
Maricic, Jelena	NSF		Collaborative Research: Direct Search for Dark Matter with Underground Argon at LNGS	06/15/2014-05/31/2018			32,000.00				7/6/2016 - PHY-1314268 AMDT 004
Maricic, Jelena	NSF		Collaborative Research: Direct Search for Dark Matter with Underground Argon at LNGS	06/15/2014-05/31/2019				87,000.00			06/30/2017 - 1314268 AMDT005 ORS didn't include in the report (vp)
Maricic, Jelena	NSF		Collaborative Research: DarkSide-20k: A Global Program for the Direct Detection of Dark Matter Using Low-Radioactivity Argon [1]	09/01/2018-08/31/2022					100,000		08/31/2018 - 1812482
Maricic, Jelena	NSF		Collaborative Research: DarkSide-20k: A Global Program for the Direct Detection of Dark Matter Using Low-Radioactivity Argon	09/01/2018-08/31/2022						100,000	07/06/2019 - 1812482 AMDT001
von Doetinchem, P	NSF		CAREER: Dark matter identification with cosmic-ray antideuterons	03/01/2016-02/28/2021		387,238					Initial award
von Doetinchem, P	NSF		CAREER: Dark matter identification with cosmic-ray antideuterons	03/01/2016-02/28/2021					160,092		
von Doetinchem, P	NSF		CAREER: Dark matter identification with cosmic-ray antideuterons	03/01/2016-02/28/2021						161,060	
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021			58,970				ORS reported in FY17, not in FY18. Thus, removed FY18 amount. Pls note the total FY17-20 are correct as the contract total $$408,411 in Supp#7 (vp)
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021			58,971				
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021				~~39,410~~			12/06/2017 - NNX17AB47G SUPP000002 With Supp#2 total award in the contract said $157
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021				~~39,410~~			06/15/2018 - NNX17AB47G SUPP000004
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021					78,820		
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021					78,820		
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021						35,000	12/18/2019 - NNX17AB47G SUPP000006
von Doetinchem, P	NASA		The GAPS Experiment: A Search for Dark Matter Using Low Energy Antiprotons and Antideuterons	01/01/2017-12/31/2021						97,830	01/17/2020 - NNX17AB47G SUPP000007
von Doetinchem, P	NASA		Dark Matter Search with the GAPS Experiment	09/01/2019-08/31/2022						45,000	08/25/19 - 80NSSC19K1425
				Total, Actual P&A Received (*):	**4,256,061**	**3,759,150**	**3,541,872**	**4,055,553**	**2,291,156**	**5,782,375**	
				Total, Actual Received outside P&A(**):	**1,894,927.00**	**0.00**	**500,000.00**	**0.00**	**0.00**	**145,771.00**	
				Grand Total P&A:	**6,150,987.63**	**3,759,149.96**	**4,041,872.00**	**4,055,553.00**	**2,291,156.00**	**5,928,146.00**	
				Total in ORS/Provost Reports FY15-FY19:	**4,384,169.00**	**3,659,143.00**	**3,519,262.00**	**3,968,550.00**	**2,291,084.00**		

(*) Due to the delay of DOE umbrella grant, FY19 funding of $1.283M was received and recorded in FY20.

(**) FY15 and FY17, John received funding from NGA via ARL total amount of $2,394,927. He also received ~$145K via HIGP. But these didn't include in the P&A funds in the

----------THIS IS THE END OF REPORT----------

[1] NSF grant June 1st 2018 - May 31st 2022 ($400,000 total, or $100,000/year)

Life Sciences

Life Sciences Response to Recommendations by Provost Bruno and Committee

Upon the creation of the School of Life Sciences (LS) in January 2020, we immediately began critically reviewing all aspects of our programs and revising our procedures. The COVID pandemic has complicated these efforts, but LS has continued to move forward with simplifying, streamlining, and modernizing our 14 degree programs, which serve 1,300 undergraduate majors and 100 graduate student. This work encompasses and expands upon many of the points raised in the Recommendations provided to LS.

To meet the needs of our students and the State of Hawaiʻi, Life Sciences is leveraging its multidisciplinary and gender-balanced faculty to offer new programs and tracks within existing programs. These programs provide excellent opportunities for collaboration with JABSOM, CTAHR, SOEST (including PBRC) and programs at UH Hilo. The current programs being explored for implementation include:

- **Marine Biology Bachelors and Master's (BAM) program** to recruit and retain undergraduate Marine Biology majors to complete a Master's degree at UH Mānoa, ensuring they are competitive for well-paying Marine Biology-oriented careers across the Pacific.
- **Microbiology Bachelors and Master's (BAM) program** will provide a direct route for students wishing to accelerate training for jobs in clinical and research laboratories, a desirable career path for many local students. The State of Hawaiʻi has a recognized need for more highly trained clinical lab and biomedical research scientists, an ongoing need that is intensified as a result of the COVID19 pandemic.
- **Clinical Microbiology track within the undergraduate Microbiology degree** that will prepare undergraduate students for licensure to work in clinical microbiology labs within the State of Hawaiʻi. Now, more than ever, graduates with these skills are essential to the State. We are currently creating a certificate in Clinical Microbiology. JABSOM would be seen as a key partner in these endeavors.
- **Computational Biology/Bioinformatics track in the undergraduate Biology degree.** Recent hires within the school have strengths in this discipline and there is a need within the community for graduates who have strengths in computational modeling of biological processes and understand how to use and manipulate biologically-oriented "big data." This would be an interdisciplinary program that will include faculty from Information & Computer Sciences (ICS) and Mathematics. In addition, there are opportunities to include JABSOM and CTAHR, where strengths in these disciplines also exist.
- **Professional Master's Degree in Conservation Biology** to train students for wide-ranging jobs that are in demand throughout the State of Hawaiʻi. This program would benefit from collaboration with PCSU, CTAHR and UH Hilo, and provide internship opportunities with agencies throughout the State, thus enhancing students' employment opportunities upon graduation.

- **Professional Master's Degree in Genetic Counseling** to train students to obtain jobs in hospitals, health clinics, and State public health. Collaborations with JABSOM and CTAHR would be essential to creating a strong program to benefit local students who plan to train and later work in Hawaiʻi.
- **Merging the Botany and Zoology graduate programs** is under discussion. A combined program will facilitate effective use of the broad expertise of our faculty in Ecology, Evolution, Conservation Biology, Organismal Biology and Biodiversity. Programs at peer institutions are being reviewed as models.
- **Microbiology graduate program** is under self-review including: updating the graduate manual, reviewing State needs with our partners at DOH and other outside entities, and exploring new opportunities in consultation with its graduate faculty from CNS, JABSOM, SOEST, and CTAHR.

Response to Life Sciences Recommendations

Administration Suggestion: Strongly encourage collaboration with life sciences units across campus. Pursue joint hires to facilitate collaboration on research and instruction.
As indicated above, our plans for the LS demonstrate our desire to work collaboratively to meet the needs of the University and the State, through initiatives which will be planned carefully to ensure no increase in administrative costs. We have a history of such collaborations, including:

- Our affiliation with the Ecology, Evolution and Conservation Biology (EECB) Graduate Specialization (a collaboration of 10 different graduate programs) will expand the impact of our new graduate program (see below) by integrating with programs across campus. LS faculty have chaired this program for 17 of the past 24 years.
- Life Sciences will continue to leverage our multidisciplinary faculty as we have with the new CNS/SOEST hybrid Marine Biology Graduate Program where curriculum is cross-listed between graduate programs and LS faculty share instructional responsibilities. Similarly, the OPIHI undergraduate program bridges instruction between LS and the College of Education.
- Lyon Arboretum director is a Cooperating faculty member in LS, and LS was intimately involved in his selection. Lyon Arboretum and LS recently joint-hired a new faculty member.
- Life Sciences is currently developing guidelines for selection and oversight of faculty from other units wishing to participate in instruction of undergraduate courses within LS programs. These guidelines will provide avenues for collaboration with JABSOM, CTAHR, SOEST or other units wishing to contribute to undergraduate instruction while maintaining the high quality of our curricula. Toward this, a MOA is being discussed for JABSOM to contribute to instruction in the Life Sciences.

Administration Suggestion: Consider stopping out the MS and PhD programs in Botany.
The new School of Life Sciences has many strengths within ecology, evolutionary biology, and conservation biology. There is no better place to study these disciplines than in Hawaiʻi, which is known

world-wide for its spectacular ecological and evolutionary diversity. Sadly, anthropogenic disturbance has also led Hawaii to become known as the endangered species--and extinction-- capital of the world due to habitat loss, depleted environmental resources, invasive animal species, and impacts of urbanization and agriculture. Therefore, developing a high-quality conservation workforce with a strong scientific background is a critical State need that this program has long contributed to fulfilling.

A statement by Pres. Lassner prioritized conservation, sustainability, natural resource management, and biosecurity: areas in which LS has great expertise and which could be supported by the implementation of an Ecology, Evolution, and Organismal Biology Graduate Program. Therefore, combining the Botany and Zoology Graduate Programs will improve efficiency in preparing our students to continue to meet the employment needs of the State. This more clearly defined focus will allow LS to enhance already established collaborations with units across campus including EECB, PBRC, CTAHR, SOEST, and UH-Hilo.

Administration Suggestion: Support ways to accelerate the curricular changes needed to eliminate the duplication of courses, and possibly, to consolidate degrees. Consider hiring a consultant to facilitate this work.

One motivation for the creation of LS was the opportunity to streamline curricula across our degree programs (> 300 courses in 14 degree programs). We have already begun to:

- Retire courses that are no longer needed.
- Consolidate courses that have overlapping content to eliminate redundancy and increase the frequency of course offerings, thus decreasing time to degree for students across LS.
- Collaborate with faculty and administrators across the UH system to determine the most efficient path to simplifying course offerings without negatively impacting degree programs and course offerings outside the LS.
- Take advantage of our new structure to combine sets of existing courses in innovative ways to create tracks/certificates/minors in areas of specialization for which there is high demand, without the allocation of new resources.

We are also discussing innovative new ways to develop place-based learning opportunities to provide extensive experiences in our marine and terrestrial environments within the curriculum for our undergraduate students. This will promote retention and prepare them for future careers in academics or with Federal, State or non-government agencies.

Administration Suggestion: Stop-out the MS and PhD programs in Microbiology.

Microbiology is recognized as a needed graduate program at UH Mānoa. As the only microbiology program in the State of Hawaiʻi, it is a required discipline for Hawaiʻi-based students to get jobs in this industry in our State, and importantly has trained many scientists who are now faculty at JABSOM, UH Manoa and other colleges within the State. Research carried out by the microbiology graduate faculty spans all areas of microbiology as it relates to our geographically isolated location. Of immediate

concern is meeting the demand for microbiologists within the State as we move toward a post-pandemic Hawai‘i.

The Microbiology Graduate Program is currently undergoing a self-review and modernization. Working with the Microbiology Graduate Faculty from other units (including SOEST, JABSOM and CTAHR), the goal is to expand the graduate faculty, increase course offerings, and improve graduate research opportunities. Potential additional cooperating graduate faculty have been identified in multiple programs throughout the UH System, and in some cases are faculty without any other primary graduate program with which to affiliate. The Microbiology Graduate Program is critical for these research programs that come from multiple colleges. These modernization efforts will strengthen the Microbiology Graduate Program, provide microbiologists across the campus with a programmatic home for their graduate students, improve the breadth of the offered curriculum, improve graduate and undergraduate education, and provide well-trained Teaching Assistants for LS undergraduate lab courses.

Administration Suggestion: Consider joint JABSOM/Life Sciences (and perhaps CTAHR and SOEST/HIMB/PBRC) administration of the life sciences graduate programs.
As indicated above, changes to the Botany, Zoology and Microbiology graduate programs within the School of Life Sciences are being considered.

Information and Computer Science

Information and Computer Sciences
Response to Reorganization Proposal

Background and Vision

The Information and Computer Sciences (ICS) Department has a 52-year history in the College of Natural Sciences. The ICS department offers a BA in ICS, BS in Computer Science, MS in Computer Science, and Ph.D. in Computer Science, and participates in an interdisciplinary Ph.D. in Communication and Information Sciences.

The administration's current reorganization plan calls for moving the ICS Department out of the College of Natural Sciences and into the College of Engineering. In this plan, ICS would be combined with Computer Engineering (CE) and reorganized into a program within the Department of Electrical Engineering. All of the degrees and, presumably, all faculty who wish to move would transfer to the College of Engineering. In this document, we argue that the ICS program should maintain its autonomy and remain in the College of Natural Sciences.

Computer science is a broad discipline with application areas, skill sets, perspectives, and objectives spanning the sciences, humanities, and arts. In less than 80 years, computer science has moved from the field invented by electrical engineers and mathematicians into an everyday necessity for most people. For example, over five billion people around the world (>66% of the global population) now carry with them a mobile computing device which is connected to a global communication and information network. The device enables point-to-point communication with anyone almost anywhere in the developed world; it is capable of monitoring location and biometric information useful for mobility, recreational, and medical applications; it enables secure financial transactions; it holds music, videos, and texts useful for entertainment and education; it connects friends in social networks that include literally half of the world's population; and more. During the COVID crisis, most students from kindergarten through graduate school are learning via laptops and desktops utilizing collaboration software developed over the last decade in corporate and academic computer science research labs. Similarly, a vast number of workers are using the same tools to do their jobs from home, and many businesses are planning to keep it that way. The urban informatics infrastructure developing in many cities globally provides traffic managers, police, emergency responders, commuters and others with vital information presented in novel visualizations operating in real time. It is easy to add to this list.

The ubiquitous use and range of applications of computing systems also raise opportunities for misuse. Each system mentioned in the previous paragraph can be viewed in the context of security and ethics frames that students must also learn about and be capable of considering in their careers. These concerns are also now central to any research endeavor in computer science.

The point of these examples is that people trained in computer science must be ready to deploy knowledge and skills in an ever-expanding array of novel application areas with an awareness of the contexts of use and the consequences of misuse. It is the responsibility of computer science educators to provide students with the ability to do so. It is the responsibility of computer scientists to expand their horizons and truly live up to the National Science Foundation's mandate for researchers to identify not only the *intellectual merit* of their endeavors, but also explain *broader impacts*.

The ICS department strives to provide our students with an education not only in core computer science, but also with exposure to a range of application areas and the broader impacts of the discipline. As such, our faculty is diverse and includes individuals whose primary training has been in other disciplines such as biology, social sciences, or physics. The recently-hired data scientists in the ICS department practice their skills across disciplines as diverse as astronomy and medicine. The visualization lab in the ICS department explores a range of application areas from gaming to earth science to situation awareness. Our vision is to continue to expand the horizons of our students and researchers while, at the same time, providing a core education that prepares our students for the workforce.

Computer Science Is a Science

Many computer science departments, including ICS at UHM, moved away from Electrical Engineering because computer science was developing scientific problems distinct from those in EE. With the exception of computer engineering, which interfaces with computing machinery and sensing devices, and software engineering, which interfaces with complex project processes and systems management, there is little overlap in the scientific problems being addressed by computer scientists and those being addressed by engineers. At a practical level, software systems are now critical to many engineering systems (autonomous vehicles and robots, for example), but the scientific problems that need to be solved in these application areas (e.g. path planning, scene analysis, natural language processing) are pure computer-science problems. Indeed, the software solutions that are central to many current applications that drive the economy were once far-out research problems in computer science, invented while industry's expressed need for vocational training focused elsewhere. To prepare students for the economy of the future, a healthy computer science program at a Research I university needs to keep the "science" in computer science.

An education in ICS located in a science-oriented college can and should be practical. However, there is an argument to be made that an engineering-oriented CS education could de-emphasize the very fundamentals that make an education within *Arts and Sciences* at a research university different from a more vocationally-focused education aimed at creating what some have called a "workforce product."

We consider our location in the College of Natural Sciences to be an advantage that enables us to work easily across disciplines and stay closely aligned with mathematics. In the last few years, the College of Natural Sciences has hired at least eight computational scientists in

multiple areas such as biology, chemistry, mathematics, and physics. Together, this focus on computational sciences provides an opportunity to develop a radically multidisciplinary educational environment that fits with the future of computer science.

Computational Science, Information Science, and Breadth of Application Areas

The application of computational thinking and computational methods in other disciplines has become an important area which is distinct, though obviously related, to computer science. Often these applications are subsumed under categories such as “data science” and “information science.”

It is difficult for undergraduates who are not planning to become computer scientists or software engineers to find the appropriate courses and training to become computationally literate in their chosen discipline. One solution to this problem is to have a computer science minor for students majoring in other disciplines, however this does not really meet the need since the computer sciences courses taken are not tailored to the discipline. A bioinformatics specialist, or a computational chemist, or a computational economist, or a security analyst using computational and data-science tools, need specialized coursework that is not really available in either the main discipline or in a narrowly-focused computer science degree program designed to produce coders. Instead, such new fields require foundational education in computational thinking and computational methods in order to foster novel applications of ideas.

A robust computational science effort within the ICS department, parallel to the machine learning and data science initiative that ICS has already invested heavily in, is an important contribution to the education of a broader range of students. It would also contribute to the state of Hawaiʻi in a manner that is consistent with President Lassner’s vision of a post-COVID economy.

Current Activities

Over the last three years, the department has taken many steps to change direction in ways consistent with many of the goals that were subsequently outlined by external reviewers and by the UH administration:

1. **Capstone Requirement:** The ICS Department has created a capstone course and has gained approval for a curriculum change requiring that the course be completed in the senior year before graduation. The goal of the new capstone requirement is to engage students in a team-based software development project in order to hone their coding skills, reinforce software engineering and project-planning expertise, and develop collaboration and presentation skills. The course will culminate in a poster presentation day to which all ICS stakeholders, including external stakeholders and especially local employers, will be invited. This is an initial step toward a multi-year, multi-stage project requirement modeled after the College of Engineering’s Vertically Integrated Project program. Capstones and internships are a good fit to the College of Natural Sciences

because computer science is multidisciplinary (including data science and computational science), often working with other Natural Science disciplines.

2. **Internship Program:** The ICS Chair, ICS Associate Chair, and STEM Coordinator in Natural Sciences have been meeting with Career Services to develop an ongoing internship program. The internship program will provide a pathway to practical experience with local companies, local military, and, given the new emphasis on remote work, will explore online internships with mainland and international organizations.
3. **New Introductory Courses:** The ICS Department has added two new introductory courses designed to introduce freshmen and other non-majors to exciting aspects of data science and computer science without any prerequisites or major restrictions.
    a. ICS 102: Introduction to Data Science (approved and offered once already) "provides students with an overview of the field of data science by introducing subjects such as data format, processing, visualization and storage. Special emphasis is put on historical context and simple practical examples" (from the catalog description).
    b. ICS 103: Introduction to Computer Science Principles (approved) "provides a broad overview of computer science. Will address abstraction, data and information, algorithms, programming, the Internet and the global impact of computers" (from the catalog description), and is designed to align with high school AP courses.

    These courses are "attractor" courses designed to interest broad audiences and increase interest in computer science and data science.
4. **Data Science Track within ICS and Math:** The ICS and Mathematics departments have developed, to our knowledge, the first Data Science tracks at UHM within their respective B.S. degree programs. In conjunction with this approval, new upper-division ICS courses were created in data science:
    a. ICS 434: Data Science Fundamentals
    b. ICS 438: Big Data Analytics
    c. ICS 422: Network Science Methodology (had already been approved in 2017)

    The track is highly collaborative with the Mathematics Department, and the departments are currently working on establishing a Data Science track for double majors.
5. **Certificate in Creative Computational Media:** The College of Natural Sciences is the home of the new proposed undergraduate certificate in Creative Computational Media which is a collaboration between 3 colleges and 4 departments: (ICS in Natural Sciences), ACM and Theatre & Dance (Art and Humanities) and EE (College of Engineering). Prerequisites were actively updated to accommodate unclassified students and professionals.
6. **Certificate in Data Science:** ICS is the home of the new proposed undergraduate Certificate in Data Science that is a collaboration between the ICS department and the Hawaii Data Science Institute. This proposed certificate relies heavily on the current ICS courses and faculty, will surely attract many Natural Sciences students, and could involve courses from many Natural Sciences departments as electives. Data Science

and Computational Science for Natural Science disciplines are important trends, and easy access to the certificate by the students in CNS is critical to success.

7. **BAM Pathway in Computer Science:** ICS was one of the first departments to successfully gain approval for a 5-year BS/MS pathway plan under the university's BAM (Bachelor and Masters) program.
8. **Workload:** The ICS Chair has modified the annual faculty workload evaluation to stress outcomes as opposed to hours and has circulated and applied a quality (in addition to quantity) metric for success in teaching, research, and service. The annual evaluation now includes higher standards for publication, proposal writing, external funding, and graduate student involvement in research.
9. **Curriculum Update Committee:** The ICS Department has committed to examining every course offered for its correspondence to professional guidelines (ACM, IEEE, ABET), alignment/duplication with similar courses in other departments, and inclusion of practical, project-based software assignments.
10. **Hiring**: In the last two hiring cycles, the ICS Department has proposed to hire in applied areas including Applied AI and Machine Learning, Applied AI for Cybersecurity, Software Engineering, Applied Data Security, Cyber Forensics, and Information Assurance and "Professors of Practice," who are also grounded in the local industry sector. When it becomes possible to hire again, these priorities will help the department meet the need for current and future workplaces.

Additional Changes

In addition to what we already have underway, we are now discussing several additional changes.

1. **Programming language replacing foreign language requirement:** Three observations lead to an additional major program change that we would like to pursue:
    a. Industry representatives want our students to have stronger programming skills
    b. The Arts & Sciences general education requirements do not leave enough available credits for us to impose additional requirements
    c. Students often complain about the foreign language requirement. Therefore we propose that the foreign language requirement credit requirement be replaced with an additional programming language requirement in ICS. Competence in multiple diverse programming languages is important for CS graduates in the marketplace, and we can easily develop courses that introduce programming languages while also addressing other application areas (e.g., some Data Science courses introduce Python, and Network Science introduces the R statistical programming language).
2. **Certificates for unclassified students and professionals:** Some modifications to our curriculum can support certificates for non-majors with existing courses. For example, the CCM Certificate (Creative Computational Media) proposal is at the faculty senate level of review. This proposal updates prerequisites of required courses so there is no

extensive series of prerequisites that makes a 1-year certificate difficult to achieve if you are not in the major.

3. **Change the BA ICS to a BA in Computational Sciences**: At this time, the ICS program offers a BA in “Information and Computer Science” which has a current enrollment of over 113 students. This degree can be confused with the BS in Computer Science and has very similar requirements. To meet the increasing need for interdisciplinary scholars at the undergraduate level, the ICS Department proposes to change the name of the degree to “BA in Information and Computational Sciences” and refocus it as a radically interdisciplinary degree analogous to the Ph.D. in Communication and Information Sciences. Such a program would partner with other departments across the university system to meet the needs of students who need the ICS skills, but not the CS degree. It could include the option for a focus on Data Science.
4. **Collaborate with CENG to propose a joint program in Software Engineering**. Rather than reorganizing ICS into EE, we propose to create a Software Engineering B.S. degree with a home in EE. The applied program could include many courses taught by ICS and cross-listed in EE.

The changes discussed in this and the prior section can be undertaken without a reorganization. Deciding to remove the ICS program from the College of Natural Sciences less than one year after the external review, and fewer than two months after the Provost’s office issued an enthusiastic go-ahead on proposed changes, adds the additional burden of integrating multiple departments (EE, CE, and ICS) to the task of changing our direction.

Enrollment and Faculty Size

Moving the ICS department is not a small undertaking.

- In AY 2019-2020, 467 undergraduates were enrolled in the ICS BS program and 113 undergraduates were enrolled in the ICS BA program. In contrast to many other majors and to the general enrollment trend at UH Mānoa, enrollment in the BS program has increased every year since 2013. Enrollment is up 2% from AY 2018-2019, up 15.6% from AY 2017-2018, and up 26.6% from 2016-2017. ICS alumni are employed in every tech-related industry in Hawaii as well as many significant companies on the mainland.
- In AY 2019-2020, 118 undergraduates were enrolled in the BS program in CE, and enrollment has fallen every year over the last three years. Enrollment is down 3.3% from AY 2018-2019, down 13.2% from AY 2017-2018, and down 12.6% from 2016-2017 (Electrical Engineering has seen similar enrollment drops).
- In AY 2019-2020, the enrollment in ICS was greater than enrollment in both Electrical Engineering and Computer Engineering combined. Enrollment in ICS has grown while enrollment in both Electrical Engineering and Computer Engineering has dropped.
- The ICS Department currently (Fall 2020) has 16 tenured faculty members, 2 tenure-track Assistant Professors, 3 professors on rolling-three temporary contracts, 2 faculty specialists, and 4 APT/secretarial staff. (This does not count the Library and

Information Sciences faculty who are slated to move to the School of Communications). The CE program in Electrical Engineering has four faculty members.

One stated goal of the Engineering Dean is to increase the size of the EE department in order to bring it into alignment with peer institutions. He seeks to achieve this by combining CE and ICS as a program within EE. This demotion from department status to program status will diminish the autonomy of the ICS faculty and program and bring together two faculties of more-or-less equal size who have very little in common. It is counterproductive to merge the larger, growing, successful ICS academic programs and use them to “prop up” the EE program. Before such a move is made, the university should at least undertake a careful study of why – from programmatic, academic, and research perspectives – this merger makes sense.

ICS Faculty Sentiment

A poll of ICS faculty members asked whether they wished to 1) remain in Natural Sciences and implement needed changes, 2) move as a whole to Engineering and implement needed changes, 3) move selected faculty to Engineering, or 4) something else. Nineteen faculty members responded and 63% (12 individuals) preferred remaining in Natural Sciences. One faculty member voted to move the entire department and one voted to move selected individuals. For people who responded with other ideas, one said that they prefer to remain in Natural Sciences but if forced to move only selected faculty members who wish to move should move, one indicated that the move to Engineering would be good administratively, and two faculty members were noncommittal.

The comments provided by faculty, while varied, showed a strong agreement that the ICS department can and will change to meet the suggestions in the external review and the needs of the state. They also make several other points explored elsewhere in this document, including that computer science at Mānoa should remain science-oriented and not engineering-oriented, and that details of how the reorganization would proceed are necessary to render a judgement. There is also a sense of inevitability expressed in some comments and a sense that this is a non-negotiable, top-down decision. A minority of faculty members do agree that a move to Engineering would, or could, be productive.

Despite some variation, the majority opinion was to remain in Natural Sciences. Hence, moving ICS does not have majority faculty support at this time and would be counter to principles of faculty governance.

Cost Savings and Timing

Provost Bruno informed the ICS Department on October 6, 2020 that the changes to ICS proposed by the administration will not save costs, and that they were not proposed for that reason. Since the changes are not cost-saving, there is no logical reason why the changes should adhere to the same timeline as the cost-saving changes.

In the current COVID crisis, faculty members are tired and overwhelmed with new demands for online course content. Many also have new responsibilities at home such as childcare and home-based schooling. Some are dealing with lost jobs and reduced income within their family units. Imposing the reorganization plan at this time has impacted morale and worried many faculty members who felt that they had won time for planning and implementing changes consistent with the external review.

The planned re-organization of ICS can be discussed with faculty, students and other stakeholders in due time. There is no time pressure imposed by the budget deficit.

Conclusion

A significant factor in moving ICS into the College of Engineering is to make the undergraduate experience more “practical” and less “theoretical.” This distinction has been made several times, in various other guises (e.g. “separating the “I” from the “CS,” selecting “right-minded” faculty) during discussions and in evaluations of the ICS and CE programs. In point of fact, ICS has always concentrated on both application areas and practical aspects of computing as well as fundamentals of computer science. In fact, this combination is at the core of our identity.

While it is an overgeneralization to say that Engineering is only practical while the brand of computer science in ICS is only theoretical, it is reasonable to argue that the engineering-oriented disciplines have more of a “maker” focus while the science disciplines have more of a “fundamentals” focus. Employers have indicated that they need both, but that they value graduates who can apply the fundamentals of the science when necessary instead of being limited by well established methods and solutions which become outdated quickly.

What is needed from the University of Hawaii at Mānoa is a balanced approach. It is reasonable for the College of Engineering to develop a degree focusing primarily on the process of creating software artifacts and managing software development projects (e.g. an ABET-accredited Software Engineering degree), and we support and would collaborate with such an effort. But it is imperative that UHM also provide an education in the fundamentals of computer **science**, including its theoretical and mathematical foundations, programming and software engineering skill set, and additional educational opportunities in information science, or the broad range of application areas for computer scientists. It is imperative that a Research I university maintain a faculty that is engaged with developing new frontiers in computing, including novel computing applications in diverse areas, and that this research expertise is reflected in the coursework of undergraduates as well as the experiences of Ph.D. students and undergraduates engaged in research.

We believe that the best place for a science-oriented program in computer science is in a *science-based* college. The College of Natural Sciences has been the home of ICS for 52 years, and this positioning has facilitated many fruitful collaborations and research activities.

In his vision for a post-COVID recovery, President Lassner emphasized the importance of computer science and engineering in opening new opportunities for economic development. Deemphasizing the *science* aspect of *computer science* at Hawai‘i’s premier research campus moves in the wrong direction for realizing this vision. Yes, we need software engineers, programmers, and other practically-oriented computing professionals to make software products. But we also need computer scientists, computing researchers, and theorists to think things up and take us into new computing frontiers. We need “computational scientists” who specialize in applying computing techniques and tools in other disciplines in the natural sciences, the social sciences, and the business world. The advanced tools and techniques currently being used in computer science, and in many cases driving our society’s economy, were once novel ideas, often in fringe areas or areas not considered to be “true” computer science. A Research I university should nurture such ideas.

Chemistry

Oct 8, 2020

COMMENTS ON THE BUDGET TEAMS RECOMMENDATIONS FOR THE CHEMISTRY DEPARTMENT

The recommendations made to the Chemistry Department are as follows:

- Continue addressing low success rates in gateway courses and Organic Chemistry.
- Review the BA/BS in Chemistry to address declining majors and retention issues.
- Ensure graduate students have access to the courses needed in identified sub-disciplines.
- Collaborate with faculty outside of Chemistry on research and a faculty-hiring plan.
- Encourage faculty with grant funding to provide research rather than teaching assistantships to support students.

Context: Most of the recommendations are from a 2014 program review, which the college will undergo again this year. As such, many are issues that Chemistry has made significant progress on over the last six years. We have discussed these recommendations and formulated the initial responses below. Ultimately, the path forward on each issue will depend on a more comprehensive analysis of the benefits and costs associated with the proposed action in collaboration with the appropriate stakeholders.

Response:

Continue addressing low success rates in gateway courses and Organic Chemistry.

Comments: We have invested considerable effort into improving success rates in our gateway courses and organic chemistry. We have expanded the emporium hours for general chemistry and organic chemistry. Even before COVID, these changes included offering assistance in the evenings over zoom. These resources tend to be utilized by a small fraction of students, though, and ignored by those that genuinely need assistance. We have offered “fourth hours” for years and have been experimenting with various structures, e.g., faculty-, TA- or learning assistants-led Q&A, mandatory and optional sessions. We are currently experimenting with sessions led by a TA supported by learning assistants that are mandatory. One crucial effort that was ultimately unsuccessful was an attempt last academic year to hire another tenure-track assistant professor who could help teach organic chemistry. While a great candidate was identified, this effort was ultimately ended after the hiring freeze.

Actions: We will continue to explore the best way to assist students in our gateway and organic chemistry courses. Finding a better way to get students to use the available resources will be crucial. Low success rates are only part of the equation though, and student performance in subsequent classes must be considered. According to our data, students who take courses with tenure-track faculty perform better in their next class. New faculty are needed to replace recent retirements, or the problem will be compounded in subsequent classes.

Studies have shown student success in General Chemistry correlates strongly with math skills. Our limited data suggests our success rates for students with a given Math ACT or SAT score is similar to our peers. Based on this data, there has been a suggestion to add a math prerequisite to GenChem or to work closer with the Math department to find ways to better address any math deficiencies with first-year students. Assessment data for our CHEM placement exam will also be reviewed again, and the questions updated to enable better matching of a student's current abilities with the correct gateway class. Studies have also shown the refresher "boot camps" just before the start of a course can improve student success in organic chemistry, and this is an approach we will explore in the future semesters for OChem II. We will also take a more holistic approach and examine the lab experiments in the gateway courses to ensure those emphasize the critical points from the corresponding lecture.

Review the BA/BS in Chemistry to address declining majors and retention issues.

Comments: Enrollment in the BA and BS Chemistry degrees has decreased from 128 majors in 2012 to 70 in spring 2015, and been around this level in the spring since. The majority of that decline can be directly attributed to the introduction of BS and BA BIOC degrees within the Department of Chemistry, which has significantly increased overall enrollment in our undergraduate degrees, e.g., we had 247 BIOC and CHEM students in Fall 2019; 143 BIOC & 104 CHEM vs 128 CHEM majors in spring 2012). A portion of those BIOC majors are students who would otherwise have been enrolled in the BS and BA CHEM degrees and, in particular, the latter, which was very popular with pre-professional students prior to the introduction of the BIOC degree. Much of our efforts in the last six years have been focused on growing the BIOC program, and we recognize it is now time to focus more efforts on revitalizing the CHEM degrees.

Action: One option the department is exploring currently is adding degree tracks (concentrations) to our BS or BA degrees, which would be consistent with general recommendations from the American Chemical Society. Adding these tracks would require the approval of UH, but not the ACS, so their design is flexible. The nature of these tracks remains to be decided and will be driven in part by student assessment and examination of peer and benchmark universities' offering. One possible concentration would be in material science. An upper-division material science lab was recently approved, which is co-taught with faculty from Engineering. Another viable option would be a concentration in computational science, which would involve students taking a recently approved course in this area and connect with offerings in other units. Similar to our current BS CHEM degree, graduate courses would be used to provide students more in-depth material related to their concentration, which will require specific core graduate courses to be offered on a more regular schedule. The breadth of these tracks could be easily expanded in the future with hires planned in collaboration with other units.

Ensure graduate students have access to the courses needed in identified sub-disciplines

Since this recommendation, we have endeavored to offer graduate courses on a more regular schedule. The frequency of our offerings in each sub-discipline depends heavily on the needs of our incoming graduate class though, and is determined by its size and the students' interests. We typically recruit eight new graduate students each fall. This can lead to low enrolment in some

critical graduate classes when the incoming class is split over the sub-disciplines of biochemistry, organic chemistry, inorganic chemistry, and physical chemistry. We anticipate adding undergraduate degree tracks requiring graduate courses will increase the demand for these classes and result in a more consistent schedule.

Collaborate with faculty outside of Chemistry on research and a faculty-hiring plan.

Comment: The majority of research-active faculty within the Department of Chemistry have strong research ties with other units. The collaborations listed below include those with current funding, those that have resulted in publications, and those that are actively working to secure external funding or produce peer-reviewed manuscripts.

1. With the UH Cancer Center (Tius, Williams, Haglund). Hires within the Organic Chemistry and Biochemistry sub-divisions are routinely coordinated with UH Cancer Center, and one of their faculty members is usually on our search committees to help identify candidates that would work well with UH Cancer Center.

2. With HNEI and Engineering (Jensen and Hyvl). Professor Jensen's efforts in material sciences are well-funded by external grants with these units, and Professor Hyvl is actively applying for funding with his collaborator.

3. With PBRC (Williams). Professor Williams is a core leader, and mentor for the COBRE grant in PBRC focused on the microbiome. In this role, he recently organized faculty in PBRC, CTAHR, and the School of Life Sciences to submit a coordinated MRI preproposal for a new LC-MS instrument.

4. With HIGP, IfA and Physics (Kaiser). Professor Kaiser's well-funded research program in astrochemistry has strong ties to faculty in the HIGP, and has been awarded funding based on these collaborations. He currently has one collaboration with Dr. Li in HIGP with the overarching goal to investigate the in situ formation of water along with its destruction mechanisms on the lunar surface. He also has collaborative funding for the *Shanghai-Hawaii-Hefei Advanced Research Center for Astro-chemistry* to explore experimentally the formation of key classes of complex organic molecules (COMs). (Chemistry – Physics –IfA – HIGP; Kaiser, Sun – Sattler – Meech – Sharma)

5. With JABSOM (Sun). Professor Sun is Co-PI on a NIH-funded grant searching for compounds active against SARS-CoV-2.

6. Mechanical (Sun). In collaboration with Dr. Yi Zuo from the Mechanical Engineering Department, Professor Sun is examining the nature of the interactions between membranes (i.e. tear film and lung) and organic molecules.

Action: We will continue to try to develop stronger ties to other units on campus. As importantly we will work to leverage these interactions with other units to improve our research and teaching outcomes, and to find common areas for future faculty hires.

Encourage faculty with grant funding to provide research rather than teaching assistantships to support students.

Comments: Ultimately, this recommendation concerns growing the graduate program and is based on a conclusion that the limiting factor for the growth of the graduate program is the number of available TA positions for incoming students. For the better part of 20 years, though, we have needed more teaching assistants than available from our pool of graduate students. For perspective, only 27 out of 42 teaching assistants currently employed are CHEM graduate students. Another 11 students, or 26% of CHEM GAs, are currently supported as RAs. It is also worth noting that most of our GAs receive summer overload as RAs. This approach is a more effective way of dealing with the low TA stipend in CNS than a year-long RA position, e.g., 24K split three ways as summer overload helps three students compared to one student on an RA appointment.

Action: We recognize the need to grow our graduate program, but focusing our efforts on increasing the number of high-quality applicants would have a more immediate benefit. In this regard, we plan on attempting to be more proactive at recruiting and reach out to undergraduate chemistry clubs at other schools, update aspects of our webpage and create more promotional content.

Mathematics

RESPONSE FROM THE DEPARTMENT OF MATHEMATICS

Instructional innovations. There are a number of department initiatives in progress that are in line with the University recommendation to improve innovations in instruction. These include

1) Pre-calculus instruction. The department hired its first pre-calculus coordinator in 2019. The job description includes revamping and updating the pre-calculus curriculum and pedagogy, as well as running training sessions for starting TAs. With the support of the department, the coordinator has been attending national trainings on best practices and is in the process of instituting changes at UH Mānoa.

2) Undergraduate learning assistants (now called LAs). Versions of learning assistants have been used in the department for at least ten years. The program is currently at a high point, with LAs used in the majority of lower-division courses. LAs get extensive training in modern pedagogy from Tara O'Neill (CoE) and through regular meetings with several math faculty. The LAs benefit as they get training in pedagogy and reinforcement of foundational math skills; the students benefit as they get hands-on assistance from their peers; the state benefits as we expect that some trained LAs will become much-needed K-12 STEM educators.

3) Early Action Program. While our retention of students in Calculus I and II already compares favorably to the national average, finding innovative ways to improve student success in those courses is an ongoing priority. The Early Action Program targets students who are found to be at risk of receiving a DFW. It provides (mandatory) extra training and a retake opportunity for students who perform poorly on an early exam. Faculty are currently engaged in analyzing data from the first two years of the program to judge its success.

4) Tracks and certificates. The department has recently added a Data Science track to our major, developed in collaboration with ICS, and we also have a Mathematical Biology certificate. As we assess the success of these programs, the department will be considering the addition of more interdisciplinary tracks or certificates.

5) Outside instruction. In response to severe faculty shortages this year, Math courses are being taught by School of Life Sciences faculty (applied calculus courses) and College of Education faculty (elementary education courses); these faculty have graciously volunteered their time and efforts. Information collected from these educators will be used to adapt our courses to better serve the target audiences as needed. Long-term, we continue to believe a mathematician brings a deeper understanding of the core material, and unique perspective and insights on the subject which cannot be duplicated by non-mathematician instructors.

6) NSF-IGE grant. A team of mathematicians is in the process of applying for an NSF-Innovations in Graduate Education grant. HiTime (Hawaiʻi innovative Team-based industrial mathematics education) focusses on interdisciplinary and industrial training for mathematics

MA and PhD students to prepare them for nonacademic careers. The grant includes senior personnel from other UH departments, as well as business, industry and government lab partners. The proposal was selected last August in the internal UH Mānoa competition as one of two proposals from UH.

Strategic hiring. As recommended in the 2014 Program Review, the department has and will continue to think strategically about hiring in the broad range of pure, applied and computational mathematical sciences. Half of our not-yet-fully-promoted tenure-track faculty engage in applied mathematics and interdisciplinary research. Mathematics Department faculty, graduate, and undergraduate students are involved in foundational work in applied mathematics and have also provided assistance with statistics, computational methods, and modeling to faculty and research groups from across campus. We envision building on this, while continuing to support our strength in pure mathematics.

1) Collaborations with other units. As job candidates with interdisciplinary interests are considered, we have and will continue to solicit input from outside departments. Math faculty are involved in more than a dozen interdisciplinary collaborations with faculty in other units, including ICS, Life Sciences, Physics, IfA, CTAHR, Engineering, Geography, Shidler School of Business, and the Hawai‘i Data Science Institute.

2) TAP program. Postdoctoral programs are as fundamental in mathematics departments as graduate programs, and a university funded program is an absolutely necessary component of a ranked mathematics department. The 2014 Program Review recommended that the department's fledgling TAP (Temporary Assistant Professor), or postdoctoral, program be expanded. This was supported by the university and we now rely on TAPs for much of our 200 – 300 level instruction. Our TAP program has benefitted the department and the university in a number of ways: it has invigorated research in the department; its success has been cited by funding bodies when awarding grants; it has been key in attracting high quality tenure-track candidates, most of whom ask about the program during their interviews; TAPs have brought fresh curricular ideas and innovations to the department; graduate classes and seminars offered by TAPs have provided students and faculty with access to the latest research ideas and methods; the program has helped to establish strong, permanent research networks with other math departments.

We intend to look for ways to improve and expand our TAP program. One possibility we are considering is to apply for funding through the NSF Research Training Groups in the Mathematical Sciences (RTG) program. From the program's synopsis, "Research groups supported by RTG must include vertically-integrated activities that span the entire spectrum of educational levels from undergraduates through postdoctoral associates", so any cut to our TAP program would jeopardize or possibly eliminate our access to this funding.