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MEMORANDUM

ATTENTION	Senate	**DATE**	October 8, 2021
FROM	Catherine Dauvergne, Vice-President, Academic and Provost and Chair, SCUP	**PAGES**	1 of 1
RE:	External Review of the Department of Physics (SCUP 21-28)		

At its October 6th, 2021 meeting, SCUP reviewed and approved the Action Plan for the Department of Physics that resulted from its External Review.

The Educational Goals Assessment Plan was reviewed and is attached for the information of Senate.

Motion:
That Senate approve the Action Plan for the Department of Physics that resulted from its external review.

C: B. Frisken, P. Kench and G. Nicholls

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MEMORANDUM

Attention: Catherine Dauvergne, Vice-President, Academic and Provost and Chair, SCUP

From: Wade Parkhouse, Vice-Provost and Associate Vice-President, Academic

Re: Faculty of Science: External Review of the Department of Physics

Date: August 16, 2021

Attached are the External Review Report and the Action Plan for the Department of Physics. The Educational Goals Assessment Plan is included, for information only, with the Action Plan.

Excerpt from the External Review Report:
"The review committee formed a very positive impression of the Department, its activities, and its members. The data presented to us paint a picture of a highly-performing department: 33% of all of the Science Faculty's honours students are in physics programs; the physics department is engaged with projects receiving 20% of the entire University's CFI funding, across all fields; the department ranks fourth in citations across all of SFU (and the higher-ranked units are, in some cases, very much broader than a single department). This strength is recognized within the University, with both the Dean and the AVP-Research commenting to the committee that Physics is one of the strongest units within SFU."

Following the virtual site visit, the Report of the External Review Committee* for the Department of Physics was submitted in April 2021. The Reviewers made a number of recommendations based on the Terms of Reference that were provided to them. Subsequently, a meeting was held with the Dean of the Faculty of Science, the Chair of the Department of Physics, and the Director of Academic Planning and Quality Assurance (VPA) to consider the recommendations. An Action Plan was prepared taking into consideration the discussion at the meeting and the External Review Report. The Action Plan has been endorsed by the Department and the Dean.

Motion:

That SCUP approve and recommend to Senate the Action Plan for the Department of Physics that resulted from its external review.

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*External Review Committee:
Kenneth Ragan, McGill University (Chair of External Review Committee)
Kris Poduska, Memorial University
Gary Slater, University of Ottawa
Dipankar Sen (internal), Simon Fraser University

Attachments:
1. External Review Report (April 2021)
2. Department of Physics Action Plan
3. Department of Physics Educational Goals Assessment Plan

cc Paul Kench, Dean, Faculty of Science
Barbara Frisken, Chair, Department of Physics

Simon Fraser University

Department of Physics

External Review Report

16 April 2021

Kris Poduska[1], Kenneth Ragan[2], and Gary Slater[3]

[1] Professor and Department Head, Department of Physics and Physical Oceanography, Memorial University

[2] Professor, Department of Physics, McGill University; chair of the review committee

[3] Professor, Department of Physics, University of Ottawa

Introductory Remarks

This report presents the findings of a committee charged to review the Department of Physics at Simon Fraser University. The review was commissioned by Dr. Glynn Nicholls, Director, Academic Planning and Quality Assurance (a unit of the Vice-President Academic's office). The review was originally planned to be in-person in March 2020, but in view of the covid pandemic it was postponed until March 2-5, 2021, and then held in a remote (online) format over four days. The Terms of Reference of the committee are attached in Appendix A. The committee membership includes the three authors of this report and the internal (SFU) member, Prof. Dipankar Sen, Department of Molecular Biology and Biochemistry.

In advance of the review, the committee members were provided with extensive documentation, including the Department's self-study report from January 2021, the Department's five-year academic plan for 2018-2023, CVs of the Department's faculty members, the 2013 External Review Report Action Plan (established after the previous review in 2013), the Faculty of Science's Academic Plan, and various SFU university-level strategic planning documents.

The online review itself was comprehensive; the review committee had sessions with all interested parties – staff, students, and faculty, as well as several of the Department's standing committees, in addition to meeting with members of the University administration, the Dean of Science, and several of the other Chairs in the Faculty of Science. The agenda of the review is attached in Appendix B. The online format did not allow us to visit the Department's offices, labs, or facilities, although the Chair of the Department did present a rapid video tour in the opening session. The atmosphere of the online sessions was constructive and congenial, hallmarked by open discussion, frank

appraisals, and clear expressions of commitment to the process and the importance of the external review.

Structure of This Report

During the course of the four-day review, the committee members developed a broad understanding of the activities of the Department of Physics, including the undergraduate and graduate programs, the research areas, and the outreach/public engagement.

We structure this report and our comments in parallel with the six broad subjects suggested in the Terms of Reference, namely: quality of programs, quality of research, administration, environment, future plans, and items of specific interest to the Department. For each of the six sections, we record our major observations/conclusions, and call out specific recommendations for action (numbering 19 in total). We prepend the main body of the report with an Executive Summary, including comments on some of the overarching issues.

Acknowledgements

The committee would like to thank all those responsible for making the arrangements required for the review, and for the attention that went into the construction of a necessarily full schedule. We particularly thank Prof. Dipankar Sen, the internal (SFU) member of the committee (who did not participate in the report writing) for insightful comments about the Faculty and the University.

Executive Summary

The review committee formed a very positive impression of the Department, its activities, and its members. The data presented to us paint a picture of a highly-performing department: 33% of all of the Science Faculty's honours students are in physics programs; the physics department is engaged with projects receiving 20% of the entire University's CFI funding, across all fields; the department ranks fourth in citations across all of SFU (and the higher-ranked units are, in some cases, very much broader than a single department). This strength is recognized within the University, with both the Dean and the AVP-Research commenting to the committee that Physics is one of the strongest units within SFU.

In addition, the department appears to be a **collegial** unit, with a generally positive environment across the board - research groups, instructors, and administrators. All university departments embody some amount of personal and professional tension, which sometimes rises to the level of drama; the SFU Physics Department is to be congratulated for being on the low end of that spectrum.

The **educational mission** of the Department is well served by a diversity of degree programs, including co-op programs. Its success can be measured in part by the success of physics students in co-op work placements. The department has been very successful in **outreach** activities and this should be recognized, supported, and celebrated. While **time-to-completion** for both undergraduate and graduate degrees appears to be long, this appears to be an SFU-wide phenomenon, not specific to physics.

Research in the department is of a high calibre and is concentrated in an appropriate number of sub-fields. Each sub-field has its own demographics and strengths and weaknesses; some of these groups are unique and high-profile on the national scene. It appears that the Department has a reputation for being overly conservative; it should develop an ambitious **strategic plan** for research that builds on its strengths, with the recognition that not all research groups can be prioritized - a strong Department growing in *some* areas is a better environment for *all* research groups than a Department in which no growth is occurring (or worse, a Department beset by attrition) because priorities are not set or cannot be agreed upon.

The **space situation** of the Department is dire, and appears to be worsening. Here we refer not just to the quantity of space, but primarily to its quality. While we are aware that upgrading or replacement of the Shrum Science Centre is an institutional priority, and that space problems affect many SFU departments, the ramifications of these problems may not be entirely appreciated. Poor or difficult-to-modify lab space affects research progress, but also the ability to attract new hires, the cost of lab refits (with repercussions for start-up funds) and the satisfaction level and productivity of technical staff; uncomfortable and decrepit office space leads to staff dissatisfaction and possible health problems; poor teaching space leads to unhappy students and hinders recruitment. We note that the previous departmental review, in 2013, already had negative comments concerning space, and we hope that the 2028 review will not have to make the same observations!

One major new element that affects the Physics Department is the advent of the **Quantum Algorithms Institute** (QAI). At the time of this review, the basic structure of the QAI was not yet fully formed, making it difficult to determine how the Department could best contribute to, and benefit from, this initiative. Nonetheless, the committee notes that the institute will be a well-funded, multi-university, provincially-supported research centre, and that quantum initiatives may well emerge as a national priority in the near future. Furthermore, the QAI will cut across many disciplinary lines - physics, computing science, engineering, and perhaps others. SFU's participation and strategy need to be coordinated (and prioritized!) at the **highest University levels**. A particular concern for the Department is that while physicists assume ownership of quantum initiatives because of the underlying physics, the QAI will not be a basic physics institute - it appears much more focussed on the engineering, commercialization, and applications of quantum computing. Thus, physics should advocate strongly for new positions - possibly CRCs - that are inter-disciplinary, and at the same time work to develop curriculum offers that build on the interest for the quantum "brand".

Our highest-priority recommendations from the complete list in the sections below are:

- The space situation is dire, in both quantity and quality, and needs to be addressed promptly.
- Develop a coherent, focussed and ambitious strategic plan and advocate for strong institutional support (through CRCs, for example) in a small number of targeted areas that present unique opportunities.
- As an institution, develop a coherent plan to leverage QAI's siting at the Surrey Campus where SFU is the highest-profile occupant.

In what follows, we address the six areas named in the Terms of Reference, with observations and recommendations for action.

1. Graduate and Undergraduate Programs

It is widely recognized in the Canadian physics community that the quality of the (graduate and undergraduate) programs offered by the SFU Department of Physics is high. Our analysis fully supports this perception.

We have also determined that there are measures in place to ensure the evaluation and the revision of the teaching programs. The teaching staff is overall very dedicated to the quality of the student experience.

We would like to highlight the following points:

- **Reputation**: Outside of the lower mainland, the public perception of the quality of the SFU programs is often lower than it should be (after all, SFU was among the top under-50 Universities in the world until it turned 50!). This is likely affecting Physics recruitment. It makes it all the more important for Physics to make sure that its programs (and research) be seen as of high quality but also unique and different.
- **Service teaching**: Physics (like Mathematics) does a lot of service teaching. This is a situation we encounter at all other Universities. Unfortunately, there is often a tendency for other Faculties/Departments/Programs to try to reduce their dependence on Physics or Math courses. This threat is very real and must be dealt with by the Deans and Central Administration since it is generally an unfortunate and unwelcome consequence of the internal funding scheme. We understand that this threat is currently present at SFU. Given the remarkable strength of the Department of Physics, this would be very counter-productive. We invite the Administration to remain very vigilant in this matter.
- **Analyzing demographics data**: The Department would greatly benefit from building a better system to track the students' progress through the program. Although flexible course loads and the co-op program lead to a weak sense of "cohort", it would be useful to investigate student success (and retention) and completion times in terms of when students started, correcting for Co-op terms and other well-defined delays. Similarly, a detailed study of the impact of gender, indigenous status, origin (Canadian vs International, BC vs other provinces) and other key factors should be considered. In some cases, our reading of the data led to conflicting conclusions about the graduation and retention rates. Graduate numbers did not always distinguish between Masters' and PhD students, and no clear funding data was available. The number of female students has been decreasing for several

years; recruitment efforts would greatly benefit from a better understanding of the possible reasons behind this.

- **TA hours**: At the graduate level, the committee was surprised by the number of TA hours (210 hrs/semester). To be blunt, this is about twice what we observe in other Canadian Universities. It is generally accepted that numbers above 100-120 hrs/semester have a negative impact on student success and completion times. This urgently needs to be examined. However, it is also important to keep in mind that the funding package offered to the graduate students is currently modest by Canadian standards; cutting the number of hours must be compensated in some other ways (indeed, the graduate students stressed the fact that the local cost of living was very high).
- **First year quantum leap**: The undergraduate students we met were of the opinion that the first year is tough – the pace is fast compared to high school. In our experience, this is not uncommon. We did not find out if there was a specific element of the program that led to this perception. Although the students said that this improves in later years, partly because the physics content becomes more interesting, it might be worth investigating the issue (perhaps using a student survey, in house or CUSC, and/or focus groups) and the attractiveness of the first year curriculum. The recent push by the University to have students declare science majors earlier is probably helpful here since the absence of real cohorts generally weakens the sense of belonging.
- **Number of programs**: The committee was somewhat surprised by the rather large number of undergraduate programs. Some of these programs have low enrollment. We were told that these programs exist in part because of a belief that a wider variety of programs may help recruitment. In absence of strong evidence in favour of this belief, it might be a good idea to review some of these lower-enrollment programs to reduce the very real administrative hassles when courses change. On the other hand, some data suggest that an enriched program has a higher retention rate, a promising alternative to managing a multiplicity of small programs.
- **Educational goals**: The development of Educational Goals and Learning Outcomes seems to be taken seriously by the Faculty Members, but they were not central to our discussions. Section 6.4 in the Departmental self-study document (SSD) is convincing. Often the weakest part of Physics programs are the professional and workplace skills (Program-Level Educational Goal 6, in Table 2 of the SSD) but the existence of the PHYS 201 (Physics Undergraduate Seminar) course plays an important role in this regard at SFU. Table 3 of the SSD presents a mapping of the courses, but it is rather hard to follow. This part of the SSD needs to be improved for the next cycle. At the Graduate level, PHYS 802 (Introduction to Graduate Studies: Research and Teaching in Physics) plays an equally important role.

- **Coding/Programming**: Our discussions with several key actors strongly suggest that the undergraduate students would greatly benefit from having better training in programming and computational physics, from the first year. This would help them with upper level courses, but also when applying for Co-op jobs, post-graduation employment or graduate school.
- **The Co-op option**: SFU has a well-known Co-op system. However, we have the impression that the Physics Department is not exploiting its advantages to the fullest (only about 25% of the students are registered in this option). Co-op is a major recruitment tool at many Canadian universities, and the Department might gain from examining how other institutions use it. The Vancouver area is very expensive but also quite active in the high-tech sector, two factors that should make the Co-op option attractive. This may require some adjustment to the course sequences in order to make sure that Co-op students are not penalized while also minimizing the number of courses that must be taught more than once per year. It was unclear to us whether it was possible to do several consecutive work terms; if not, this should be considered (employers tend to prefer this). We noted that some Physics students appear to have made good use of Co-op program, obtaining jobs nominally posted for engineers. Remarkably, 90% of the Co-op placements appear to be outside of academic research labs, which is what one needs to expand a Co-op program. International students are well represented, which is not surprising since enjoying a Canadian work experience is extremely important for many of them; Co-op should be used as a recruitment tool with International students (if it is not already the case).
- **PHYS 201 (Physics Undergraduate Seminar)**: This is a very interesting course, one that should perhaps be part of all undergraduate programs in the country. We were impressed by the impact on the students. Perhaps this is where the Department could introduce the benefits of the Co-op option to the students. The title of this course is rather low-key and does not really attract attention: we recommend that it be improved to reflect the content.
- **The "Adopt a physicist" program**: This is another great idea that should be seen as a Best Practice. The students we met were generally aware of its existence and all wished they would have tried it (although none were enrolled it). It is clearly underused. We strongly recommend that it be promoted more aggressively.
- **Joint programs**: We encourage the Departement to explore the creation of joint programs with other units, especially given the importance of the Big Data initiative and of the QAI. In both cases, no department can alone claim the whole field.
- **Completion times**: Overall, students appreciate the flexibility of taking reduced course loads. This allows some to more easily make the jump between High School life and the University-level courses and requirements. Others make use of the flexibility to combine their studies with part-time jobs (a plus in a high-cost region). However, this flexibility contributes to long completion times (compared to other Canadian Physics programs). To our surprise, these long completion times did not

seem to be a concern for the students we met; moreover, physics completion times do not seem to be outliers at SFU. Nevertheless, we are a bit concerned about these long completion times, and their potential impact on the likelihood that the graduates will want to join Graduate School after a long 5-6 year Bachelor degree. A deeper study of the students' opinions and motivations is highly recommended. In parallel, the Department should examine if part of these long completion times is due to course availability (some students mentioned the few courses offered during the summer as a possible cause) and/or unclear course sequences. In fact, there does not seem to be any incentive to finish early (from the student side) or to control the completion times (from the University side). We did not have access to data that would have given us an idea of the distribution of completion times.

- **Graduate course load**: The course requirements for the two graduate programs seem to be a bit high. In fact, we found the information on the web site confusing regarding this matter. It might be a good idea to carry out a benchmark comparison with other Canadian universities to see if the programs are outliers or not. In particular, given the long times to completion, it is important to understand whether the course load is (or is not) a contributing factor.
- **Programs in Quantum**: The recent creation of the QAI, and the growing realization that Quantum Technologies will transform our world over the next couple of decades, opens up new opportunities for physics teaching (beyond the currently existing graduate research-based degrees). One possibility would be to create programs related to the field, either as Physics programs or as joint programs with other disciplines such as Computer Science and Electrical Engineering, or even joint with other institutions. It is not up to this committee to recommend specific options. However, it might be interesting to consider a Professional Master's program in Quantum Technologies with entrepreneurship components. It is clear that several Canadian universities are currently considering such options. The emergence of the QAI puts SFU in an enviable situation and timely action will be required.
- **Data provided to the committee**: Overall, the granularity of the data related to students (both undergraduate and graduate) that was provided to us (and would thus be available to the Department) was not sufficient to address some of the points above . Some of this could be collected by the Department, but some would be appropriate for the University to collect and provide. The committee had to ask for additional data during the week in order to (partly) clarify some points. We recommend that SFU work on a standard set of data to be produced on a regular basis (more frequently than once every seven years) to help programs understand the issues they face. Future external evaluators will certainly appreciate it. Although we were told that an exit survey does exist, the results were not available.
- **Students feedback**: Unfortunately, we only met with four undergraduate and four graduate students (in two separate meetings). It is unclear how representative these students were of the general student population. We recommend that future SFU evaluations include much larger student groups, and/or that a survey be used to

gather useful information about their perception of some key issues (e.g., those issues raised in recent evaluation reports). The students agreed that the teaching staff genuinely wanted to help them and were dedicated.

- **The Fraser International College** (FIC): This is a somewhat unique feature of the SFU environment. It attracts a large number of international students. However, it seems that very few of them join the physics program at the end of their training. It was not clear to us why it was so. Given that a large fraction (probably most) of these international students come to Canada to study in the STEM disciplines, this is a bit puzzling. We recommend that the Physics Department investigate this matter.
- **Surrey Campus**: This second campus should probably be treated as an opportunity (this goes beyond Physics) because it is unique to SFU and located in a region rich in High Schools. The absence of a shuttle service seems to be a bit problematic since some students may have to take classes at both campuses on the same day. The idea of creating a "first-year Surrey cohort" should be seriously examined.

Given the above, we feel the Department (#1-3) and the University (#4-6) should explore the following actions:

1. Rethink the need for so many undergraduate programs and optimize the offering.
2. Make the Co-op program a key recruitment tool and optimize its attractiveness.
3. Identify the roadblocks to timely completion and build the necessary incentives.
4. Improve data collection (including the exit survey) and analysis, and use these tools to understand key issues such as completion times and student demographics.
5. Reduce the TA hours and benchmark the course load of graduate students.
6. Develop plans to fully benefit from the FIC, the Surrey Campus and the QAI.

2. Research

We find that the **quality of faculty research** is very high, and that faculty collaboration and interaction provide a stimulating academic environment. Research is a clear strength of this Department, and the University can be very proud of their contributions to the local, national, and global research communities.

- **Evidence of success:** The Department's self-study document provided ample evidence of success in a range of different quantitative and qualitative metrics. It is clear that this Department punches above their weight in terms of research quality, productivity, and international visibility.

- **Research Themes:** We met with four thematic groups: quantum information + atomic-molecular-optical (QI+AMO), Biophysics, Condensed Matter, and Subatomic + Cosmology (SA+C). Historically, all of these groups have played important roles in SFU physics. Each group showed distinct interaction dynamics with different seniority demographics. We see extensive evidence of collaborations and interactions, and an environment and dynamics that are collegial and productive.
- **Unique Focus Areas:** SFU stands out nationally because Biophysics and QI are particularly unique focus areas among Canadian physics departments. Biophysics is an historical strength at SFU, and they were early national leaders in this area. The Department's new QI efforts make them an early leader in Canada, and they should act now to be on the forefront as this field expands. This includes the emerging QAI initiative. Capitalizing on these unique focus areas will help attract and retain research-active students and new faculty members.
- **Leveraging opportunities:** Big data initiatives hosted by the University appear to be underutilized by all research groups. We suggest that participation in such initiatives could be leveraged to great advantage.

To continue on this path of research excellence, we suggest that the Department could explore the following:

7. Emphasize faculty growth in research areas with unique strengths that are likely to attract undergraduate and graduate students. We see QI and Biophysics as potential areas of focus.
8. Leverage University-wide big data and QAI initiatives to improve collaborations and interactions within the SFU research ecosystem.

3. Administration of the Department

From the Terms of Reference: "Unit **members participate in the administration** of the Unit. Some issues to consider include Unit size, adequacy and effectiveness of the administrative complement and facilities."

Our observations about the department's administration are as follows:

- **Committee work:** Departmental committees and their administration appear to be effective. While we did not get information about how committee work is distributed across the department, we did see broad participation and efficient delegation.
- **EDI Committee:** We strongly support and encourage the new EDI committee ("IDEA", for Inclusion, Diversity, and Equity Alliance) which is particularly forward looking and is necessary to continue to address the unbalanced demographics in the field. IDEA plans to continue to concentrate on early high-school students to make

physics an attractive option for all students, and we support this initiative. Statistical information on differences in applications, acceptances, times to completion, dropout rates, etc… for different demographic groups may help them in this effort, and this is an area where additional admin support (see below) would be welcome. It is especially encouraging to see the broad make-up of the IDEA committee, comprising faculty, students (both undergrads and graduate students), and staff.

- **Admin team cohesiveness:** The administrative staff appear to form a well-managed and enthusiastic team, with good communications and regular meetings with the Department Manager, both one-on-one and as a team. The encouragement of cross-training, so that every task can be handled by at least two people, is to be commended.
- **Professional development:** The Department Manager encourages the staff in their professional development activities; we strongly support this policy of skills upgrading, including for the Department Manager herself (and note that she has recently completed an in-house leadership course, which we laud).
- **Documentation:** The advent and maintenance of more extensive documentation about administrative tasks (such as Standard Operating Procedure documents, an internal wiki page, etc) is a laudable initiative and the staff agree that this represents a big improvement in continuity and consistency. The wiki, in particular, is an idea that we feel should be shared (and encouraged) with other departments and units.
- **Workload:** We have some concerns about the overall workload of the administrative staff (ie, we believe it is high), and about the policy of possible secondment to other departments (which we understand is a relatively new policy). Our experience in other, similar departments leads us to conclude that the overall level of administrative support is probably sub-optimal, and the recent loss of a half-position has exacerbated this situation. This naturally pushes some administrative tasks into the hands of faculty - to the detriment of time spent on the core university missions of research and teaching. While no university administrator that we are aware of wants to hear this message, we feel it's necessary to state strongly that adequate administrative support is essential for the efficient and equitable functioning of a university unit like this one.
- **Undergraduate assistant:** Specifically, the staff pointed to the lack of an undergraduate assistant as a missing element; such a person could help to maintain more complete statistics such as time to completion per cohort, per demographic category, etc. As noted above, having more granular data might allow progress to be made in removing impediments to graduation and thus in reducing time-to-graduation (but see other comments on this subject in this document), as well as in improving the attractiveness of physics to a broader demographic.
- **Space and facilities:** As an online review, we were unable to evaluate in person the administrative facilities (suitability of offices and the office environment, layout of the department and its location relative to other units in the University, etc.).

However, a recurring element of concern in several of the review's meetings was the quality of the Departmental space and the need for major renewal, renovation, or reconstruction, and we will return to this subject in the next section. This problem extends to administrative office space as well as lab and teaching spaces.

In view of the above, we make the following recommendations:

9. (Department) Continue to expand and systematize the documentation of administrative tasks.
10. (Department and/or Faculty): Move to re-hire the lost ½ administrative position, possibly associated to a specific task (such as better undergraduate enrollment data) that will further the Department's missions.
11. (Faculty) Explore the use of wiki-based SOPs and documentation throughout other departments and units.

4. Workplace Environment

From the Terms of Reference: "The **Unit's workplace environment is conducive to the attainment of their objectives**, including working relationships within the Unit, with other University units, the community and the Unit's alumni."

While the terms specifically mention working (ie, interpersonal) relationships, we expand "workplace environment" to include technical and IT support, physical space, and other factors that do not obviously fit into Sections 1 through 3 above.

Our observations are:

- **General workplace atmosphere:** The general atmosphere of the department appears to be positive and congenial. While *every* academic environment in which we have worked has strong personalities that sometimes have differences, the administrative, teaching and research interviews that we conducted were collegial and characterized by frank and open discussions.
- **Alumni and outreach:** The Department has excellent outreach activities, centered on (but broader than) the Trottier Observatory and astronomical activities. These activities have brought tremendous visibility in the local community; during the covid pandemic, the observatory's activities have moved online through live-streaming, bringing national and international visibility. These outreach activities may also be a natural way to connect with the alumni community. The Department's self-study document indicates that LinkedIn is used to connect with alumni, although no details were given about the percentage of alumni that are

reached. Our own experience at our institutions is that reaching alumni is a difficult problem once they have left the university. An exit survey of graduating students by the Department could help here, with an explicit question about whether they would agree to be contacted periodically by the Department.

- **IT support, workload, and hiring:** The centralization of IT support across campus appears not to be a positive for the physics department. The IT support personnel must answer to multiple masters, and centrally-imposed solutions rarely work in an environment marked by an extreme heterogeneity of systems, specialized software, and the use of many legacy systems on key pieces of research or teaching lab equipment. The current IT support is "minimalist" and the person assigned to the Department appears heavily overworked. Efforts to hire a new IT staff member appear to be focussed on an internal (SFU) person, which will create a domino effect shortchanging some *other* university department. The clear solution is to offer conditions that attract competent IT professionals from outside SFU - but we recognize that this may require an effort at the Faculty or University level.
- **Teaching faculty workload and vacations:** Lecturer-stream faculty indicated to us that they were often not able to schedule regular vacation time because of the three-term academic year. Clearly this leads to workload and possibly burnout issues. Suggested alternatives are (a) team-teaching of summer courses, or (b) allowing faculty who are teaching in all three terms first choice of summer teaching assignments, allowing them to pick courses which may finish earlier in the term.
- **Surrey Campus:** The Surrey campus presents both challenges and opportunities to the Department. Challenges may include isolation of personnel, time lost to travel, and difficulties related to equipment (duplication of teaching demos, necessity to transport liquid nitrogen between campuses). At the same time, it opens up opportunities such as the availability of a large near-campus high-school population who may see the Surrey campus as their "local" university, and the possible development of a Surrey "cohort" which would enrich the undergraduate experience.
- **Space (quality and quantity)**: The space situation is critical, and getting worse. We heard from technical staff that the building quality severely and adversely affects research progress: minor lab alterations become major issues, driven by safety/building code issues; lead times are long; work is expensive and sometimes slow. At a more technical level, the quality of the power supply (stability and availability) is a concern for some labs. One person remarked that "Facilities seems overly cautious" and while we understand that safety and legal requirements are important, we also know that university administrations can become overly bureaucratic. In one case, it was claimed that installation of whiteboards took several **months**. The internal committee member noted that other university departments see similar institutional issues. While the long-term solution is a major renovation or replacement of the Shrum Centre, the Faculty and University need to work to facilitate smaller renovations and improvements; they should be perceived

by researchers and technical staff as part of the solution, and not part of the problem.

- **Technical staff:** The Department has both departmental technical staff, and grant-supported technical staff; in aggregate, the latter is larger than the former, and there appears to be good communication and some coordination between them. The departmental staff complement has recently been reduced, but needs bolstering to improve support for access to Department-owned equipment, including training and user support, and improvement of the spaces where this equipment is located. The Department also has teaching technical staff; the level of coordination and communication between the research technical staff and the teaching technical staff was not obvious to the committee. We recommend that the Department think about whether coordination would be useful here (we don't know the answer!).
- **Administrative difficulties for RAs and post-docs:** The RAs and post-docs that we interviewed indicated that they often had problems of an administrative/work-life nature. Specifically, they mentioned difficulties due to the high cost of housing in the lower Mainland; lack of support for spousal employment, and the administrative overhead of one-year work visas and contracts. The University and Department should be aware of these issues and recognize that failure to address them may carry reputational risk (difficulty in attracting post-docs in the future), for the Physics department and for the University.
- **Relationships with other units:** The research groups appear to have some modest connections with other SFU units, and these connections seem to be primarily informal and generally harmonious. One issue that we were alerted to was the **difficulty of access to equipment outside the department** (for example, 4D Labs and LASIR, led by the Materials Science group of the Department of Chemistry) which, in some cases, require internal user fees. We were not given enough information to determine if these user fees are justified in terms of maintenance costs, etc. but are concerned about any situation in which researchers feel that their progress suffers through lack of access to instrumentation, and we feel that the Faculty should be aware of this issue.

From the above, we make the following recommendations:

12. (Faculty/University) Recognize the criticality of the Department's space issues, both in quality and in quantity, and move to resolve them in a timely way. Facilities management needs to be more responsive to researchers' and technical staff needs concerning improvements to research spaces.
13. (Department) Resolve the issue of vacation time for teaching faculty, for example by making summer courses team-taught, or allowing teaching faculty first dibs on choice of summer teaching.

14. (Department/Faculty) Complete the hiring of additional IT support personnel (Department) and recognize that units marked by the characteristics above require additional IT support compared to institutional averages (Faculty).
15. (Faculty/University) Improve conditions for IT personnel with the goal of attracting candidates from outside SFU.
16. (Department) Investigate whether more coordination between research technical staff and teaching technical staff would be advantageous.

5. Future Plans

We find that the **future plans** of the Unit can be refined and focused in order to be appropriate and manageable.

With regard to overall considerations:

- **Strategic Planning:** The Department needs a coherent strategic plan as soon as possible, and the plan must be developed in a collegial way. It should address explicitly both a student recruitment/retention plan and a faculty hiring plan. The Faculty's perception is that the Department has been conservative in the past; now is the time for aspirational planning that propels the Department to be leaders.
- **Strategic Growth:** For the plan to be strategic, it must not seek growth in every thematic research area that currently exists. The Department Chair should develop a strategic planning committee in which membership is not intended to be a proxy for lobbying for specific interests of a single research theme. Growth for the Department as a whole is necessary, and this cannot happen in all areas at once.
- **Space needs MUST be met:** For the Department's plan to be successful, the University must ensure that space (and space quality) issues are addressed immediately.

With regard to student recruitment:

- **Draw students to dynamic areas:** We note that some research themes appear more dynamic (QI+AMO, for example) than others, and they are able to draw scholarship students to the Department -- at both the undergraduate and graduate levels - to the benefit of all within the Department.

With regard to faculty hiring:

- **Sustainability:** Maintaining a large number of research themes could place the Department at a disadvantage with respect to future faculty hiring. The perception is that the Department has been conservative in its planning in the past. However, they

can capitalize on opportunities right now -- with a focused strategic plan -- that would be of great benefit to the Department.

- **Emphasize strengths:** We see particular strong points in the emergence of QI, the historical strength of Biophysics, and the geographical proximity to TRIUMF.
- **Demographics:** In the context of Department demographics, we note that Biophysics faces many imminent retirements. We also note that particle physics/cosmology had sought a phenomenologist hire that didn't occur; the case for this hire could be even stronger now.
- **Joint appointments:** A strategic plan could envisage joint positions with other departments: Biophysics with biology or MBB, QI with Engineering or Comp Sci, Subatomic physics with Comp Sci.
- **Start-up funds**: It is critical that the University provide competitive start-up funds to new hires. The Department was worried that recent SFU start-up amounts were so low that they would not be competitive enough to attract the best new hires.

In light of the comments above, we recommend the following actions:

17. (Department) Develop a Departmental Strategic Plan immediately that addresses priorities for new faculty hires and student recruitment/retention goals. Concentration on a few unique and compelling research themes as core areas would be an advantage. We emphasize that this does not imply eliminating any existing research programs; in contrast, the Department could use different wording to define core areas that is more inclusive and comprehensive.
18. (Faculty/University) Improve the quantity and quality of Departmental space immediately. This includes research, teaching, and office spaces.
19. (Faculty/University) Ensure that start-up budgets are competitive in order to attract and retain new faculty.

6. Issues of Specific Interest to the University and/or the Department

The Terms of Reference asked us to address the following specific questions. Many of our observations and suggestions here (added in bullet point form after each question) are referred to in our discussion above.

6.1. How can Physics attract and retain sufficient numbers of undergraduate students to meet enrollment targets?

- The Co-op program could be expanded and used as a recruitment tool (including with international students).

- The Outreach-Recruitment-Retention committee appears to be quite effective, but efforts should be made to recruit beyond the lower mainland area, including across the whole country.
- The unique flexibility offered by SFU with its year-around course options should be used as a recruitment tool.
- Work with the Fraser International College to get more international students in the Physics programs.
- The Adopt-a-physicist program should be expanded.
- Investigate the possibility of having a Surrey Campus first-year cohort.

6.2. How should Physics develop/adapt the curriculum to ensure a contemporary program that is appealing to students, and market the program to best capture the career opportunities available to physics graduates?

- Joint interdisciplinary (or dual) programs are becoming popular at many institutions. Given the nature of the Physics Department and the new opportunities (QAI and Big Data, for example), one could easily imagine creating such programs.
- Offer a course such as "Introduction to Quantum without math" to the broader community in order to capitalize on the presence of the QAI.
- Keep PHYS 201 (Physics Undergraduate Seminar) and make it even more relevant, with a better title, and more connected to the job market. Change its title to better capture what it covers.
- Include more computational/coding coursework from the first year.
- Enhance the attractiveness of Quantum to a broader tech-savvy audience by adding a QI certificate option or a course-based Masters in QI.

6.3. Given a desire to further reduce undergraduate degree completion times for physics students, is there an appropriate balance between flexibility (*e.g.*, prerequisites, modes of delivery, course requirements etc.) and rigor in our undergraduate degree requirements?

- We didn't see that students found this to be a problem (we only met with 4 students and no exit survey data was made available, so this conclusion may not be as strong as it could be).
- Without incentives (or disincentives) for students, faculty, and the University to improve completion times, it will not be easy to improve.
- Nevertheless, clear course (cohort-like) sequences that allow students to finish in 4 and 5 years (without Co-op) or in 5 or 6 years (with Co-op), might help.
- A key approach might be to investigate this from the students' perspective. A cohort approach could be effective. In the absence of data on students' motivations, it is difficult to offer evidence-based solutions.

6.4. What could be done to further enhance Physics' research success, both in the short term and the long term?

The key to enhancing research success in Physics is to ensure that there are sufficient, well-supported personnel (faculty, students, post-docs, technical staff) for continuity, as well as appropriate infrastructure to support their research needs. Our recommendations echo comments that appear earlier in this document:

- (Department/University) **Ensure support for students and post-docs is adequate**: review financial support for graduate students, and explore support for post-docs in the areas of housing and spousal jobs.
- (Department) **Develop a strategic plan**: for new faculty hiring and student attraction/retention.
- (Faculty/University) **Improve Space:** Without any hesitation, more and better space. This problem has been mentioned in the previous report, and it is getting worse.
- (Faculty/University) **Increase technical support:** Improved technical support capacity, replacing retirements.
- (Faculty/University) **Reduce internal paywalls:** Faculty perceive difficulty in accessing equipment outside the department (for example, 4D Labs and LASIR, led by the Materials Science group of the Department of Chemistry). Their concern is that internal user fees are unreasonably high. Researchers feel that their progress suffers because high fees limit their access to such instrumentation.

6.5. How should Physics position themselves to take full advantage of the opportunities provided by the Quantum Algorithms Institute, and address the potential structural challenges that the institute may present?

- There must be an institutional-level decision for SFU to support QAI as a unique opportunity and a priority area. This requires coordinated effort across Faculties.
- Although Physics is the central science underpinning QAI, physics is necessary but not sufficient for QAI to succeed. This means that continued growth and support will need to come from partnering with other Departments and Faculties such as Engineering and Computer Science, and even with other institutions.
- As mentioned previously, Physics should seriously consider adding Quantum options to its programs. A QI certificate/concentration option at the undergrad level could also help with recruitment. A course-based professional Masters' in QI should also be considered.
- It's too early to know about structural challenges because the structure is not yet defined.

Appendix A: Terms of reference of the Committee

Department of Physics
Simon Fraser University
External Review Committee 2019/20 - Terms of Reference

The Review Committee will assess the Unit and comment on its strengths and weaknesses, and on opportunities for improvement. The Review Committee should make recommendations that address major challenges and opportunities.

The review process is intended to ensure that:

1. The **quality of the Unit's programs** (graduate and undergraduate) is high and there are measures in place to ensure the evaluation and revision of the teaching programs. Some issues to consider include:
   - degree requirements, structure, breadth, orientation and integration of the programs including the cooperative education program and the course offering schedule of the graduate programs;
   - enrolment management issues, student progress and completion, and support for graduate students;
   - educational goals that are clearly aligned with the curriculum and are assessable.

2. The **quality of faculty research** is high, and faculty collaboration and interaction provide a stimulating academic environment.

3. Unit **members participate in the administration** of the Unit. Some issues to consider include Unit size, adequacy and effectiveness of the administrative complement and facilities.

4. The **Unit's workplace environment is conducive to the attainment of their objectives**, including working relationships within the Unit, with other University units, the community and the Unit's alumni.

5. **Future plans** of the Unit are appropriate and manageable.

6. **Issues of specific interest** to the University and/or the Unit that the Review Committee should consider during the review are:

6.1. How can Physics attract and retain sufficient numbers of undergraduate students to meet enrollment targets?

6.2. How should Physics develop/adapt the curriculum to ensure a contemporary program that is appealing to students, and market the program to best capture the career opportunities available to physics graduates?

6.3. Given a desire to further reduce undergraduate degree completion times for physics students, is there an appropriate balance between flexibility (*e.g.*, prerequisites, modes of delivery, course requirements etc.) and rigor in our undergraduate degree requirements?

6.4. What could be done to further enhance Physics' research success, both in the short term and the long term?

6.5. How should Physics position themselves to take full advantage of the opportunities provided by the Quantum Algorithms Institute, and address the potential structural challenges that the institute may present?

Appendix B (following pages): Agenda of the Online Review

SFU FACULTY OF SCIENCE | DEPARTMENT OF PHYSICS

External Review Itinerary
March 2 - 5, 2021

All meetings are listed in Pacific Time

External Review Committee Members:

Dr. Kenneth Ragan, McGill University (Chair of External Review Committee)
Dr. Kristin Poduska, Memorial University
Dr. Gary Slater, University of Ottawa
Dr. Dipankar Sen, Simon Fraser University

Tuesday, March 2, 2021

Meeting Time	Meeting Items and Attendees	Zoom Link
8:00am – 9:00am	**Opening meeting with Senior Administrators:** Wade Parkhouse, Associate VP Academic (Chair) Glynn Nicholls, Director, Academic Planning Angela Brooks-Wilson, Associate VP, Research Jeff Derksen, Dean, GPS Paul Kench, Dean, Faculty of Science Bal Basi, Coordinator, Quality Assurance	Join Zoom Meeting https://sfu.zoom.us/j/8307806943
9:00am – 10:00am	**Meeting with Department Chair** Barbara Frisken	March 2, 2021 Meeting Link: https://sfu.zoom.us/j/62586049691?pwd=VlVxYjVxdWRmTit2VEgrQzJ3dDYvUT09
11:00am – 11:30am	**External Review Committee Discussion Time** External Review Committee Only	

All meetings are listed in Pacific Time

Wednesday, March 3, 2021

Meeting Time	Meeting Item and Participants	Zoom Link
8:00am – 8:30am	**Administrative Staff** Maegan Kelleway, Ben Lin, Ayako Nagasawa	March 3, 2021 Meeting Link: https://sfu.zoom.us/j/68835568945?pwd=c0E2MWN5NWw4R0NXSHdBMWwzVDlSZz09
8:30am – 9:00am	**Technical Staff – Teaching Support** David Lee, Ricky Chu, Laura Haidl, Rasoul Narimani	
9:00am – 9:30am	**Technical Staff – Research Support** Ken Myrtle, Bryan Gormann, Chang Min Kim	
9:30am – 10:00am	**Department Manager** Rose Evans	
10:00am – 10:30am	Break	
10:30am – 11:00am	**Outreach, Recruitment and Student Engagement Committee** Sarah Johnson, Levon Pogosian, and Cameron Forde	
11:00am – 11:30am	**Undergraduate Curriculum Committee Chair + Undergraduate Advisor** Eldon Emberly, Cameron Forde	
11:30am – 12:00pm	**Physics Undergraduate Students** Shariq Ahsan, Adrian Yeung, Manuel Rojas, Rob Quirey	
12:00pm – 12:30pm	**Faculty of Science, Department Chairs** TBD	
12:30pm – 1:00pm	**External Review Committee Discussion Time** External Review Committee Only	
1:00pm – 2:00pm	**Faculty of Science, Dean** Paul Kench	
2:00pm – 2:30pm	**Faculty of Science, Co-operative Education** Gwen Litchfield, Natalie Erickson	
2:30pm – 3:30pm	**External Review Committee Discussion Time** External Review Committee Only	

All meetings are listed in Pacific Time

Thursday, March 4, 2021

Meeting Time	Meeting Item and Participants	Zoom Link
8:00am-8:45am	**Office of the Vice-President, Research** Angela Brooks-Wilson (Associate VP, Research)	March 4, 2021 Meeting Link: https://sfu.zoom.us/j/65845742131?pwd=UlVqaEFwaHhzT3dFLzlObTdvZEdqUT09
9:00am-9:30am	**Teaching Faculty** Sarah Johnson, Andrew DeBenedictis, Joanna Woo, Neil Alberding	
9:30am – 10:00am	**SFU Surrey Campus** Neil Alberding, Rasoul Narimani, Sarah Johnson, Eldon Emberly, Barbara Frisken	
10:00am – 10:30am	Break	
10:30am – 11:00am	**Quantum Information + Atomic, Molecular, Optical** Michael Hayden, Jeff McGuirk, Paul Haljan, Stephanie Simmons, Hoi-Kwan (Kero) Lau)	
11:00am-11:30am	**Particle Physics + Cosmology** Bernd Stelzer, Michel Vetterli, Matthias Danninger, Andrei Frolov, Levon Pogosian	
11:30am– 12:00pm	**Biophysics + Soft Matter** Eldon Emberly, David Sivak, Nancy Forde, John Bechhoefer, Barbara Frisken, Jenifer Thewalt	
12:00pm-12:30pm	Break	
12:30pm-1:00pm	**Condensed Matter** David Broun, Steve Dodge, Erol Girt, Karen Kavanagh, Igor Herbut, Malcolm Kennett, Eundeok Mun, Jeff Sonier, Simon Watkins)	
1:00pm-1:45pm	**Dean of Graduate & Postdoctoral Studies** Jeff Derksen	
2:00pm-2:30pm	**Physics Graduate Program Chair** Malcolm Kennett	
2:30pm-3:30pm	**Discussion** External Review Committee Only	

All meetings are listed in Pacific Time

Friday, March 5, 2021

Start Time	Meeting Item and Participants	Notes
9:00am – 9:30am *New*	**Physics + Science IT Support** James Lang	March 5, 2021 Meeting Link: https://sfu.zoom.us/j/64931379781?pwd=NEY0Q2tMYklKcWcrRXVoeStwZ3hBdz09
9:30am – 10:00am	**Physics Graduate Students** Matthew Martin, Brendin Chow, Emma Lathouwers, Mayur Patel	
10:00am-10:30am	**Post Doctoral Fellows + Research Associates** Julia Link, Jannik Ehrich, Kevin Morse, Scott Beaupre	
10:30am-11:00am	**Quantum Algorithms Institute** Daria Ahrensmeier, Stephanie Simmons, Hoi-Kwan (Kero) Lau	
11:00am-11:30am	**Trottier Observatory** Joanna Woo, David Lee	
11:30am-12:00pm *New*	**Inclusion, Diversity and Equity Alliance (IDEA) Team** Sarah Johnson, Nancy Forde,	
12:00pm-12:30pm *Rescheduled*	**Closing Meeting with Department Chair** Barbara Frisken	
12:30pm-1:00pm *Reduced by 30min*	**Discussion** External Review Committee Only	
1:00pm-2:00pm	**Closing meeting with Senior Administrators:** Wade Parkhouse, Associate VP Academic (Chair) Catherine Dauvergne, VP Academic and Provost Glynn Nicholls, Director, Academic Planning Angela Brooks-Wilson, Associate VP, Research Jeff Derksen, Dean, Graduate & Postdoctoral Studies Paul Kench, Dean, Faculty of Science Bal Basi, Coordinator, Quality Assurance	Join Zoom Meeting https://sfu.zoom.us/j/8307806943

EXTERNAL REVIEW – ACTION PLAN

Section 1 – To be completed by the Responsible Unit Person e.g. Chair or Director

Unit under review	Date of Review Site visit	Responsible Unit person	Faculty Dean
Physics	Mar 2-5 2021	Barbara Frisken	Paul Kench
……	……	……	……

Notes

1. *It is **not** expected that every recommendation made by the External Review Committee be covered by this Action Plan. The major thrusts of the Report should be identified and some consolidation of the recommendations may be possible while other recommendations of lesser importance may be excluded.*
2. *Attach the required plan to assess the success of the **Educational Goals** as a separate document (Senate 2013).*
3. *Should any additional response be warranted, it should be attached as a separate document.*

1. PROGRAMMING

Recommendations

1. Rethink the need for so many undergraduate programs and optimize the offering.
2. Make the Co-op program a key recruitment tool and optimize its attractiveness.
3. Identify the roadblocks to timely completion and build the necessary incentives.
4. Improve data collection (including the exit survey) and analysis, and use these tools to understand key issues such as completion times and student demographics.
5. Reduce the TA hours and benchmark the course load of graduate students.
6. Develop plans to fully benefit from the FIC, the Surrey Campus and the QAI.

1.1 Action/s (description what is going to be done):

1.1.1 Undergraduate:

1. Recruitment: We will emphasize what makes SFU Physics unique in our recruitment efforts including: Co-op, research opportunities for undergraduates, involvement in the Quantum Algorithms Institute, and our welcoming department culture. We will expand recruitment efforts to attract students from across BC and Canada. We will hold recruiting events for students in the new FIC Science stream.
2. Program Review: We currently review programs on a regular basis, with the last review conducted in 2018-2019. We will continue our practice of regular reviews, aiming to achieve a major review once every external review cycle.
    a. During the next review, we will focus our review on assessing whether the objectives of our programs may be accomplished using options currently offered within the SFU system that have less administrative overhead.
    b. To accomplish this, we will first review the options currently offered within the SFU system.
    c. We will review and update learning path/program information on our website for students.

d. We will complete work currently underway on a joint program in Physics and Computing Science.
e. We will conduct a survey of students and graduands to identify strengths and weaknesses of the way our programs are set up.

3. Co-op: Co-op is currently promoted in PHYS 201, and participation has increased since the introduction of this course in 2015.
    a. We will ensure that students understand that working in an academic research lab can be counted as co-op and that, by doing 2- or 3-semester long appointments, it is possible to complete co-op credentials in one year.
    b. We will conduct a survey of co-op students and graduands to help us identify areas for improvement. In particular, is SFU co-op actively helping our students to get jobs?
    c. We will also discuss with SFU Co-op the possibility of a tiered fee scheme that may be more attractive to academic/research minded students. There are payment equity issues around co-op positions in academic labs vs industrial ones that are not being accounted for.
4. Degree completion: We will investigate whether course availability is hindering completion times. We will also assess the effect of enrollment in the co-op program on completion times.
5. Data collection:
    a. The IDEA team is collecting data to assess success, as measured by completion times, cGPA, co-op participation, etc., and compare this to a range of demographic information.
    b. ORSEC will develop an exit survey to collect program feedback and contact info from graduands and early leavers.
6. Surrey campus: We will work with the Faculty of Science to create (or promote if it already exists) a first-year Surrey cohort.

1.1.2 Graduate:

7. TA loads: This issue was also raised in our last External Review.
    a. Most students do not actually do two full TAs (5.17 BU each) per year, but we plan to obtain data on the distribution of TA loads amongst graduate students in the department. We will also try to cross-reference these TA loads with completion times. We will try to compare our TA loads with other schools in Canada.
    b. One resource implication of cutting TA loads is that without additional sources of funding it would require the size of our graduate program to decrease. We will raise this issue with the Faculty of Science GPC and the Dean of Graduate Studies; one thing that emerges in these external reviews is that students in other provinces receive better support. The Province has recently been offering a special BC Graduate Scholarship, worth $15,000 to entering students, which we have been using to attract top students to SFU that might otherwise have chosen to attend other universities in Canada. We are worried that this program may not continue.
8. Graduate Course Loads: The GPC felt that our graduate course load is reasonable, but we will survey comparable Canadian universities and compare our graduate course loads with their programs. It is not clear that there is much in the way of resource implications, since we will probably still want to offer the same number of graduate courses as previously.
9. Professional Masters: We will look into the possibility of setting up a professional masters program with entrepreneurship components, or other graduate programs relating to quantum technology. If we are to set up a new program, this would likely

require additional graduate courses, which would have resource implications for their development. A professional masters program would also bring in revenue that may or may not be directed to the department.

1.2 Resource implications (if any):

1-9 None

1.3 Expected completion date/s:

1. Implementation with next recruitment cycle, Fall 2021
2. Fall 2022
3. Fall 2022
4. Fall 2023
5. Fall 2023
6. Fall 2022
7. Fall 2022
8. Fall 2022
9. Fall 2022

2. RESEARCH

Recommendations:

7. Emphasize faculty growth in research areas with unique strengths that are likely to attract undergraduate and graduate students. We see QI and Biophysics as potential areas of focus.
8. Leverage University-wide big data and QAI initiatives to improve collaborations and interactions within the SFU research ecosystem.

2.1 Action/s (what is going to be done):

1. The department will embark on a strategic planning exercise to determine a 10-yr plan that will provide long-term vision for the department's research and teaching programs. One of the goals of this plan will be to improve coordination and collaboration with Faculty and University research initiatives.
2. The Chair will work with Senior Administration to encourage a coherent plan to leverage the establishment of the QAI at SFU's Surrey campus.

2.2 Resource implications (if any):

1. Occasional lunch, possible booking charges during retreat exercises

2. None

2.3 Expected completion date/s:

1. Spring 2023
2. Spring 2022

3. ADMINISTRATION

Recommendations

9. (Department) Continue to expand and systematize the documentation of administrative tasks.
10. (Department and/or Faculty): Move to re-hire the lost ½ administrative position, possibly associated to a specific task (such as better undergraduate enrollment data) that will further the Department's missions.

3.1 Action/s (what is going to be done):

1. We plan to continue to expand documentation of administrative tasks, first focusing on the department manager role, standing committees, and service roles. In a second stage, we will focus on documentation of technician roles and the recruiting/advising role.
2. We have used funds released by this cancellation to increase the Advisor/Recruiter position from 50 to 60% and will use it to offset costs for the new Operations Manager position (see Section 4.1). We are also considering part-time hires for temporary work.

3.2 Resource implications (if any):

1. None
2. There is a potential for additional expense when hiring of part-time staff for specialized tasks is required.

3.3 Expected completion date/s:

1. We expect to complete content for the department manager role, standing committees, and service roles by May 2022. We will then continue to the technician and recruiting/advisor roles, completing by September 2022. Following this, we will review and update on a regular basis.
2. Ongoing

4. WORKING ENVIRONMENT

Recommendations

11. (Faculty) Explore the use of wiki-based SOPs and documentation throughout other departments and units.
12. (Faculty/University) Recognize the criticality of the Department's space issues, both in quality and in quantity, and move to resolve them in a timely way. Facilities management needs to be more responsive to researchers' and technical staff needs.
concerning improvements to research spaces.
13. (Department) Resolve the issue of vacation time for teaching faculty, for example by making summer courses team-taught, or allowing teaching faculty first dibs on choice of summer teaching.
14. (~~Department~~/Faculty) Complete the hiring of additional IT support personnel ~~(Department)~~ and recognize that units marked by the characteristics above require additional IT support compared to institutional averages (Faculty). (now completed with a new person in place)
15. (Faculty/University) Improve conditions for IT personnel with the goal of attracting candidates from outside SFU.
16. (Department) Investigate whether more coordination between research technical staff and teaching technical staff would be advantageous.

4.1 Action/s (what is going to be done):

1. SOPs: The department will continue to share its experience in developing wiki-based SOPs and documentation with other departments and units.
2. Space: The department will work with the faculty facilities team to map out current space and develop a plan for renewal that will support our strategic goals.
3. Vacation time for teaching faculty: Generally all summer teaching is reserved for teaching faculty, as they are required to teach 6 courses a year. We will explore running summer courses on shorter timetables. This will require coordination with Scheduling to develop the appropriate structure. We will also encourage teaching faculty to consider a 3/3/0 workload or plan non-teaching semesters or course reductions due to course-equivalency credit during the summer.
4. IT Support: The hire of the replacement IT support person is now complete. The Department Chair will raise the issue of IT resource deployment with the Dean.
5. Technician coordination: The Department is planning to hire an Operations Manager to provide a single point-of-contact for matters related to teaching and research laboratory operations. This will improve operations of the department, support staff engagement, and address Chair and MAAS workload issues.

4.2 Resource implications (if any):

1. None
2. Consultant fees, if required
3. None
4. None
5. We are not planning to fill a technician position vacated by a retirement.

4.3 Expected completion date/s:

1. Ongoing

2. Spring 2023
3. Implementation Fall 2021
4. Summer 2021
5. Fall 2021

5. Strategic Planning

Recommendations

17. (Department) Develop a Departmental Strategic Plan immediately that addresses priorities for new faculty hires and student recruitment/retention goals. Concentration on a few unique and compelling research themes as core areas would be an advantage. We emphasize that this does not imply eliminating any existing research programs; in contrast, the Department could use different wording to define core areas that is more inclusive and comprehensive.
18. (Faculty/University) Improve the quantity and quality of Departmental space immediately. This includes research, teaching, and office spaces.
19. (Faculty/University) Ensure that start-up budgets are competitive in order to attract and retain new faculty.

5.1 Action/s:

1. Strategic Planning:
    a. Develop a team to support ongoing strategic planning in the department to consist of a small advisory group, led by the Chair, that will guide the department in a series of discussions or retreats and translate outcomes and insights from those discussions into action plans.
    b. Develop a series of steps leading to a 10-year plan that would provide long-term vision for the department
    c. Implement these steps and draft a 10-year plan to provide long-term vision for the department
    d. Institute an annual process to
        - review of progress towards this plan and
        - set near-term targets for making progress towards longer term goals
    e. Review and revise the 10-year plan as part of the preparation for the next external review
2. Space: The critical nature of the Department's space issues was raised in our last External Review. The department hopes that we will see some firm commitment to renewal before the next External Review.
3. Start-up Budgets: The department will conduct a review of start-up budgets typical in the field.

5.2 Resource implications (if any):

1. Costs associated with (short half-day) retreats
2. Unknown
3. None

5.3 Expected completion date/s:

1. Strategic Planning:
    a. Summer 2021
    b. Fall 2021
    c. Spring 2022
    d. Spring 2023
    e. Spring 2027
2. Unknown
3. January 1, 2022

The above action plan has been considered by the Unit under review and has been discussed and agreed to by the Dean.

Unit Leader (signed)		
Name: Barbara Frisken	**Title:** Chair	**Date:** June 15, 2021

Section 2 - Dean's comments and endorsement of the Action Plan:

I would like to thank the review committee for their considered and robust review of the Department of Physics. The committee highlighted the quality of the department in terms of teaching and research strengths and set out a number of clear recommendations for the department to consider. The department has responded to the majority of recommendations and some are subsumed in a proposed strategic planning process that will enable to department to clarify its goals over the next 5-10 years.

Academic programs. The review makes multiple recommendations related to undergraduate and graduate programming, including review and optimization of undergraduate programs and consideration of orienting programs to their strengths and new opportunities. The department intends to respond to these recommendations through a review and strategic planning process. The review report provided some helpful suggestions on new program opportunities including leveraging the recent university initiatives related to Quantum. The Faculty is also interested in supporting the department to explore the structure and viability of a graduate professional degree offering.

The department is interested in exploring a first-year science cohort at Surrey. The Faculty is also interested in re-evaluating this possibility in light of recent expansion of science-related programs at Surrey, and the Faculty of Science strategy to develop a standalone science program at Surrey.

The review committee also suggested the University/Faculty explore how FIC could be leveraged to improve student enrolments in physics. The Faculty of Science established a science stream at FIC in 2018/2019, with the intent to grow international student enrolments in science. This recent initiative should afford opportunities for the Department of Physics.

Space. The report identifies space as an increasingly critical issue for the existing operations of Physics and any future strategic developments. Space is an issue that has been cited in external reviews of each department in the Faculty of Science in recent years, underscoring the pressures of space across the Faculty of Science. While there are departments in the Faculty of Science with more critical space issues it is important that the specific nature of space limitations in Physics, and future space needs are clearly identified and a plan established to work towards improved space conditions. The Faculty will support a robust space assessment and, pending outcomes of the department strategic planning process, will assist in determining clear space priorities that are consistent with space management plans.

Research. It is pleasing to see the recommendation that the department consider building its research strengths in Bio-physics and Quantum as areas where the department could increase its reputation and attract students. Such an approach should occur in tandem with a strategy to strengthen all its core research areas to remain competitive in attracting graduate research students. Pending the outcome of the departmental strategic planning process such a commitment to these research areas would inevitably influence the medium-term faculty renewal planning process.

Working Environment:

- **Staff.** The Faculty commits to reviewing the staffing support to the department that is consistent with similar functions and levels in departments across the Faculty of Science.
- **Teaching faculty.** The Faculty supports consideration of alternate teaching program delivery in the Summer to enable all teaching faculty vacation time.

Faculty Dean  ……	**Date** **15 June 2021** ……

Assessment Plan/Report Card

This form is intended to facilitate documentation of program-level Education Goals assessment for unit self-study, internal, and external reporting.
Units can customize and adapt this form to their unique needs. This means adding columns, removing columns or creating an entirely new form.

Unit/Program:____PHYSICS_____ **Date:_____May 20, 2021_____**

Unit EG Coordinator: _____Eldon Emberly_____ **Unit Chair/Director: _____Barbara Frisken_____**

PROGRAM EGs	COMPONENTS/ DEFINITIONS OF EGs	DATA SOURCE	DIRECT ASSESSMENT	INDIRECT ASSESSMENT	YEARS/ SEMSTERS OF DATA COLLECTION	MAJOR FINDINGS	ACTIONS RESULTED FROM FINDINGS
PLEG 1: Model complex and diverse real-world phenomena	o Define and formulate the question or problem o Identify and apply the relevant physical principles from classical mechanics, electromagnetics, quantum mechanics and statistical physics, and other core areas of physics o Apply fundamental laws of physics such as Newton's Laws and conservation laws, and fundamental concepts such as symmetry and the appropriate choice of a physical system o Model in multiple ways including mathematically, conceptually, verbally,	PHYS413*, PHYS415*, PHYS421*, PHYS445*, PHYS385, PHYS321	TBD	TBD	2021-22, 2022-23	TBD	TBD

	pictorially, computationally, and by simulation						
PLEG 2: Solve problems and assess solutions quantitatively using mathematical and computational tools	o Solve problems using estimation, analytical or numerical methods o Evaluate the quality and limitations of the solution (order of magnitude, dimensional analysis, limitations of an analytical solution, implications of the model chosen, evaluation of the modelling uncertainty) o Perform refinements, if appropriate	PHYS395, PHYS413*, PHYS415*, PHYS421*, PHYS445*, PHYS432*, PHYS332, PHYS321, PHYS385	TBD	TBD	2021-22, 2022-23	TBD	TBD
PLEG 3: Design and perform experiments to test physical hypotheses and characterize physical phenomena	o Plan an experimental/observational investigation taking into account the choice of instrumentation and the types, amount, and accuracy of data needed to give reproducible and accurate results o Demonstrate competency in basic experimental technologies (e.g. electronics, optics) o Apply systematic strategies and persistence in troubleshooting, using feedback from modeling and data analysis o Analyze data, including statistical and	PHYS332, PHYS432*	TBD	TBD	2021-22, 2022-23	TBD	TBD

	uncertainty analysis; distinguish between models; and present those results with appropriate tables and charts o Evaluate the quality and limitations of the results, and suggest and perform refinements, if appropriate						
PLEG 4: Critically assess the quality and reliability of resources and scientific statements	o Assess the quality and reliability of both technical and non-technical scientific statements o Find the resources relevant to addressing any gaps in knowledge	PHYS332, PHYS321, PHYS385, PHYS413*, PHYS415*, PHYS421*, PHYS445*, PHYS432*	TBD	TBD	2021-22, 2022-23	TBD	TBD
PLEG 5: Communicate and explain physical phenomena and theories	o Communicate at different levels suitable and relevant for a wide variety of audiences (physicists, scientists, engineers, general public) o Communicate in a wide variety of formats (oral, visual, written) o Include context as needed, including related historical and philosophical background	PHYS332, PHYS432*, Other?	TBD	TBD	2021-22, 2022-23	TBD	TBD
PLEG 6: Professional/workplace skills	o Work collaboratively in diverse, interdisciplinary teams	PHYS332, PHYS432*, PHYS201, Other?	TBD	TBD	2021-22, 2022-23	TBD	TBD

	o Independently identify gaps in their knowledge and skills and address them o Demonstrate critical professional skill, including time management, responsibility, independence, resourcefulness, integrity, and ethical behaviour o Display awareness of career opportunities and pathways for physics graduates o Demonstrate awareness of standard practices for effective résumés and job interviews, as well as professional appearance and behaviour						

* These courses are required in our Honours program, and are optional for our Majors program.

Overall Results & Actions:

- We will continue to do yearly review of our program level educational goals (PLEGS) and look for gaps in our curriculum map. Further attention will be given to PLEGs 5 and 6 and how well courses map to them.
- We have identified courses as data sources for evaluating each PLEG at the terminal part of our majors/honours program but now need to select direct and indirect course level assessments to collect such data. Additional data sources may be needed for PLEGs 5 and 6.
- We will review and adopt available rubrics for assessing program level goals using course level assessments.
- We will continue to develop course level learning goals.
- We plan to collect data to assess our PLEGS from 2021-23.

Assessment Chart Legend

Program Level Educational Goal: Identify the knowledge, skills, abilities, etc., that students should be able to demonstrate upon completion of the program. The goals need to be specific and measurable.

Breakdown of EGs: Sometimes it might be helpful to break down a program level EG to smaller operationalizable units. This will help you to find the data you need in your curriculum in order to assess your program level EGs.

Data Source: Programs should identify where in their curriculum (course number) data is being gathered to assess the specific EG. Remember: not all courses need to be assessed.

Direct Assessment: Direct Assessment requires students to demonstrate their knowledge, etc., for faculty to then assess whether/how well students are achieving/have achieved a program level EG. Examples of direct assessment include artistic work, case studies, exams, juried performances, oral presentations, papers, and portfolios.

Indirect Assessment: Indirect Assessment gathers perceptions of whether/how well students are achieving/have achieved a program level EG. Examples of indirect assessment include alumni, employer, and student surveys, exit and focus group interviews, enrolment and retention data, and job placement data. Indirect assessment complement the data collected from direct measures and cannot stand alone as sole measures of student performance.

Years/Semester of Data Collection: Programs should identify when (in which year or semester) the data is being gathered

Major Findings: Programs should identify the major findings after analyzing the data collected.

Actions Resulted from Findings: Programs should provide evidence that the findings have been used to further develop and improve student achievement of program level EGs (i.e., actions that were taken as a result of data collection and analysis). It is also important to state when findings provide evidence that students are successfully achieving a program level EG.

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MEMORANDUM

ATTENTION:	Dr. Barbara Frisken, Chair, Department of Physics
FROM:	Elizabeth Elle, Vice-Provost, Learning & Teaching
RE:	Educational Goals Assessment Plan
DATE:	15 August 2021

I have reviewed your assessment plan as well as the report from your external reviewers. The latter refers to the strength of undergraduate programs in Physics, and notes the thoughtful attention you are paying to Educational Goals. There are also comments that your mapping of EGs to courses could be presented more clearly, and that you could improve data collection and analysis in ways to better understand key issues in Physics. I hope that through further development of your assessment plan you can address these comments.

I met with Eldon Emberly in May to provide guidance, and see that you have identified key courses in your undergraduate program in which to perform assessments. This is a great first step. I recognize that further development of the next steps has been hampered by limited resources for EG assessment, something that we are actively working on. Expect a new webpage to be launched in September, and we recently hired an EG assessment specialist (Alice Campbell) in LEAP, the Learning Experiences Assessment and Planning group, who you can contact for further guidance at leap@sfu.ca.

I recommend the following to build out your assessment plan.

1) Consider what you would like to learn through EG assessment so you can build a plan that will benefit your program directly, rather then just be something you "have to do". Once you've identified your aims, I recommend choosing a subset of your 6 EGS to evaluate (one or two) that are linked to those aims for initial assessment.
2) You have indicated courses where you may be able to use course-based, direct assessments, but suggest you haven't determined which assignments to use yet. If you could use help in determining how to use existing assignments in those courses for assessment please contact me or LEAP.
3) Indirect assessments such as surveys may be useful to you in ways beyond your EGs, as suggested by your external reviewers. Again, LEAP can help to design and analyze a survey for you.

I hope that my staff can help you design more particulars into your assessment plan, as it will result in greater insight into your program. Your external reviewers are correct that the faculty in Physics are dedicated to the student experience and take the EG process seriously. We'll support you in that work.