



## Department of Physics and Astronomy Final Assessment Report & Implementation Plan

<b>Faculty / Affiliated University College</b>	Faculty of Science
<b>Degrees Offered</b>	Bachelor of Science (BSc)
<b>Modules Reviewed</b>	Honors Specialization, Specialization and Major in Physics; Honors Specialization, Specialization and Major in Astrophysics; Honors Specialization, Specialization and Major in Medical Physics; Honors Specialization in Integrated Science with Physics
<b>External Consultants</b>	Dr. Sharon Morsink, Associate Professor, Department of Physics, University of Alberta Dr. Joanne O'Meara, Professor, Associate Chair (undergraduate), Department of Physics, University of Guelph
<b>Internal Reviewer</b>	Dr. Joseph Michalski, Associate Academic Dean, King's University College at Western
<b>Date of Site Visit</b>	March 25-26, 2019
<b>Evaluation</b>	<b>Good Quality</b>
<b>Approval Dates</b>	SUPR-U: June 10, 2019 SCAPA: September 11, 2019 Senate:
<b>Year of Next Review</b>	2026-27

### Executive Summary

The external reviewers, Dr. Sharon Morsink and Dr. Joanne O'Meara, conducted a two-day site visit on March 25-26, 2019 to examine the undergraduate programs in the Department of Physics and Astronomy. The team met individually the first morning with the Vice-Provost (Academic Programs), the Department Chair, the current and former Undergraduate Chair, and two faculty representatives from the Western Integrated Science Program. The team then had lunch with several undergraduate students before a series of 30-minute, afternoon meetings with the following groups: 1) second-year instructors; 2) upper-year instructors; 3) first-year instructors; 4) the administrative staff; 5) Associate Librarian and Associate Chief Librarian; and 6) the Associate Academic Dean, Faculty of Science. The second day, March 26, involved a meeting with the Vice-Provost (Academic Planning, Policy & Faculty), coffee with several Teaching Assistants, and a joint meeting with the Undergraduate Chair of Medical Biophysics and faculty members. The reviewers then met with technical staff members before adjourning for a private lunch. The site visit concluded after a guided tour of the building, teaching facilities, and labs, followed by one more meeting with the current and former Undergraduate Chair.

The Department offers three main programs—Physics, Astrophysics, and Medical Physics—and a fourth HSP involving Integrated Science with Physics. The reviewers and the Department’s self-study both emphasize that the Department of Physics and Astronomy at Western is a close-knit community with a clear commitment to providing a quality experience for undergraduates. The faculty supervisors and general engagement with students continue to be core features that ensure analytic success and the necessary background preparation for graduate studies or scientific-industrial-medical positions in physics-related disciplines. As the external reviewers have commented in general, “The programs are well-resourced, addressing the current state of the discipline and meeting the identified learning outcomes... The physical resources supporting the undergraduate programs are enviable, (including) the newly renovated building (offering) a lovely and energetic space.”

The Honors Specialization in Integrated Science with Physics has been described as “an excellent program that appears to be introducing many highly motivated students into the physics department (and) should certainly continue to be supported.” In addition, in view of the many seminar courses available at the 2000- and 3000-levels with fewer requirements than the specialization module, the Department and the Faculty of Science in general should aim to expand the double-major combinations to the mutual benefit of the undergraduate students and the science programs in general.

The quality of the teaching has been rated quite high overall, including for the first-year physics courses that involve a much more diverse group who must take a required physics course. The students report an extremely high level of satisfaction as a whole, with the vast majority of alumni in particular suggesting that they would recommend the Western program to future students. The high faculty-student ratio helps to explain the positive impacts via personalized attention, but at the same time presents some “risks” in terms of continuing to mount such a broad range of upper-year courses with relatively low enrollments.

The more acute concerns identified include the available funding to hire Graduate Teaching Assistants, which can compromise to a degree the undergraduate experience. The reviewers have noted too that some additional clarification and streamlining of second-year courses would help address lingering concerns and confusion that some of the undergraduate students expressed. Yet from a more holistic perspective, the reviewers have concluded that “the curriculum addresses the current state of the discipline, with several unique features that speak to the department’s commitment to offering an innovative, quality undergraduate experience... The program’s learning outcomes are met through appropriate and effective modes of delivery, with a significant reliance on the lab courses, the undergraduate seminar courses, and the thesis project course in meeting these 10 program-specific outcomes. Continued support, investment, and development in these courses is critical to the continued success of the program in meeting these outcomes.”

### **Significant Strengths of the Program**

The following program strengths have been identified in both the self-study and the External Consultants’ Report:

First, a consensus emerged with respect to the program's innovative instruction, as well as direct experience in working with faculty supervisors. These include a range of high-impact learning opportunities, such as MakerSpace, support for PhUnC, study abroad opportunities, group projects in senior-level courses, and the student-organized Physics Undergraduate Conference. As the reviewers noted, "Students and faculty spoke positively about these opportunities and experiences (that are) enabled by the high faculty-student ratios in this academic unit." Indeed, the recent graduates overwhelmingly (95%) "would recommend Western to a friend," confirming an extremely high level of course and program satisfaction.

A second related strength involves the program's focus on analytic and experimental background preparation for graduate school or research-industry-field work opportunities. Each student in the program has an opportunity during their undergraduate studies to work on one or more major research programs, including the approximately 30 students from Western (and other universities) working with faculty over the summer months. In addition, the weekly Fusion Pizza journal club with graduate students and faculty affords opportunities to learn more about research presentations, while faculty members provide mentoring in scientific literacy and presentation skills. The Department has two strategic projects designated to increase undergraduate enrollment in upper-year courses to a minimum of 22 students each (Freedom22) and to increase the matriculation of Canadian Graduate students (CanGRAD).

A third strength clearly involves an intentional sense of developing a community and inclusion, especially among the growing proportion of female students. The fact that many of the faculty are women contributes to the overall gender balance. The reviewers and faculty alike have lauded the enhanced physical space and building renovations that allow for much greater daily, meaningful interaction. The department further maintains an active social media presence via Facebook, Twitter, and LinkedIn, as well as inviting alumni to speak in seminars and at March Break Open House. The Department offers additional participatory incentives through the First Year Physics Summer Prize Internship and the Elizabeth Lair Prize Lecture, while introducing faculty mentoring of the PASA executive to enhance the quality and consistency of their events.

Yet another strength consists of the fact that the scholarship and research activities of the undergraduate students continue to be well-supported, through the faculty, the infrastructure and lab spaces, and library services. The framework for support and the more general efforts to socialize students into the professional ranks commences through what the reviewers describe as a "fantastic feature": the set of required non-credit undergraduate seminar courses (PHYSICS 2950Y, 3950Y, and 4950Y). Additionally, the small class sizes and experiential learning opportunities offer tremendous hands-on opportunities for the students and provide a robust and healthy learning environment for the students in the program.

### **Summary of the Reviewers' Key Recommendations and Department/Faculty Responses**

The reviewers summarized and prioritized five main recommendations, which prompted further responses from the Department. Their comments and the departmental responses follow accordingly.

### *External Consultants' Five Main Recommendations*

1. A holistic approach to integrating computing/programming/software skills throughout the program;
2. A clear examination of the second-year curriculum and the role it plays in learning outcomes, recruitment, and retention;
3. An intentional effort to provide guidance, networking, and internship opportunities for students interested in the private sector upon graduation;
4. A continued commitment to exploring innovative methods such as MakerSpace, undergraduate seminars, PhUnC support, and peer helping programs to provide experiential and community-service based learning opportunities; and
5. A careful examination of enrolment data to determine if there are underlying issues that need to be addressed.

### *Departmental Responses to Five Main Recommendations*

1. The Department agrees strongly with the recommendation, noting those courses where such computing skills exist and acknowledging areas where more could be added. In addition to selected courses, the Department has been developing an Active Learning Space to support technology-based, collaborative learning *and* will be introducing Math Methods courses in the program's second year that will have a computing component.
2. The Department has suggested that the recommendation originates from concerns expressed by students that some of the 2000-level courses "appeared to lack focus" and there seemed to be "some redundancy." The student frustrations (not necessarily the evaluators' main concerns) almost certainly reflect the fact that so much core material must be covered in preparation for advanced study in upper-year courses. The Department plans to review current practices in an effort to identify efficiencies and streamline some of their offerings.
3. While the evaluators have noted that the seminar courses help "provide professional development, communication skills, and many skills that are transferable to both academia and jobs outside of academia," the Department acknowledges too that the seminars could provide even more preparation for private-sector careers by inviting more non-academic alumni to speak about their experiences and by increasing the networking and internship opportunities.
4. The Department remains fully "committed to increasing the experiential learning component of our modules." For example, the PhUNC had a Job Fair with representatives from local industry in attendance to provide networking opportunities, while the Science Internship Program aims to increase the spaces available for experiential learning and internship placements.
5. The Department has studied the data more systematically since 2015, with a special eye toward female enrollment and the impact of Western's Integrated Science (WISc) program, where elite students study Integrated Science with a particular subdiscipline. Yet enrollment statistics do not count WISc students as enrolled in the Physics-Astronomy Honors Specialization module, which has resulted in a degree of underreporting of students enrolled. In fact, the evidence points to recent enrollment increases if one uses a more comprehensive measure, from 45 in 2015 to 64 in 2018. The

gender balance has increased too, with roughly one-third female students across the seminars. Finally, the Department services upwards of 2,000 students in undergraduate programs in Engineering, Medical Sciences, and the Faculty of Science in general.

### **Other Opportunities for Program Improvement and Enhancement**

In considering the range of program offerings and resources, the reviewers have recommended an amended model with four main streams to help “level the playing field” for students entering the program with different preparatory backgrounds (e.g., high school physics or calculus, or the lack thereof):

1. Physics 1028/1029 - either Life Sciences or Biological Sciences - anyone who does not have Grade 12 physics.
2. Physics 1301/1302 - either Life Sciences or Biological Sciences - anyone who does have Grade 12 physics.
3. Physics 1401/1402 - Engineering - prerequisites of both Grade 12 Calculus and Grade 12 Physics
4. Physics 1501/1502 - enriched - prerequisites of both Grade 12 Calculus and Grade 12 Physics

The approach allows for greater divergence in content and delivery to match the interests and motivations of the various target audiences, which should enhance further the retention of students and their long-term success. Indeed, the enrollment figures appear to indicate a five-year decline in students, although the exact numbers can be disputed if one were to examine different methods of counting students enrolled in the program and cognate programs. Yet the reviewers highlight certain structure- and curriculum-specific recommendation as well, including:

- Capitalize on the growing interest in double majors
- A new course in the 2nd year for the Medical Physics streams
- Explore possibilities for rejuvenating the Materials Science streams in collaboration with Engineering
- Consider alternate models for service courses offered to other disciplines in first year to better serve the different levels of background preparation and interests
- Reexamine the role of the second-year core with respect to learning outcomes, recruitment, and retention
- Offer more senior-level courses to broaden students’ physics knowledge, likely on an every-other-year basis to ensure sufficient enrolment
- A careful examination of enrolment data to determine if there are underlying issues that need to be addressed

Finally, the reviewers noted several objective-specific recommendations, including:

- Direct connections between MakerSpace and the curriculum at the 3rd and 4th years
- Require all Honours Specializations to complete PHYSICS 4999E
- Continued promotion of the internships program
- Investigation into the effect of student feedback in decision-making processes

- Enhanced connections between in-course students and alumni
- Continued support for students in pursuing research opportunities abroad
- Consideration of the J-TUPP recommendations for concrete steps to address career preparedness

### Implementation Plan

The Implementation Plan provides a summary of the recommendations that require action and/or follow-up. The Department Chair, in consultation with the Dean of the Faculty will be responsible for monitoring the Implementation Plan. The details of progress made will be presented in the Deans' Annual Report and filed in the Office of the Vice-Provost (Academic).

Recommendation	Proposed Action and Follow-up	Responsibility	Timeline
Enhance high-impact learning opportunities	<ul style="list-style-type: none"> <li>• Establish connections between MakerSpace and the curriculum at the 3rd and 4th years</li> <li>• Explore other experiential learning opportunities such as 4000-level thesis courses and internship</li> </ul>		
Restructure selected curriculum features	<ul style="list-style-type: none"> <li>• Encourage growth of double majors</li> <li>• Rejuvenate materials science stream in collaboration with engineering</li> </ul>		
Review first year course offerings	<ul style="list-style-type: none"> <li>• Reevaluate alternate models for first-year students with varied backgrounds</li> </ul>		
Review senior-level course offerings	<ul style="list-style-type: none"> <li>• Reexamine role of second-year core with respect to learning outcomes, recruitment and retention</li> </ul>		
Enhance career preparedness and	<ul style="list-style-type: none"> <li>• Ensure more chances for alumni to meet</li> </ul>		

enhance connections with alumni	and interact with students in programs <ul style="list-style-type: none"><li>• Continue to develop “soft skills”</li><li>• Offer more internship and/or study abroad options</li></ul>		
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