Review Process

The review process was led by the Guelph-Waterloo Physics Institute (GWPI) Director, Professor Brian McNamara. The process was undertaken under the University of Waterloo IQAP and its provisions for joint reviews, as Professor Brian McNamara is from University of Waterloo. Since there is also a coursework-only Master’s program offered by University of Waterloo and taught at the Perimeter Institute (the PSI program – Perimeter Scholars International), the Perimeter Institute was also involved in the review visit.

An assistant was hired on a short-term contract to collect the data from both universities (not all data are available in the same format). The Director held meetings at both the Waterloo and Guelph campuses in winter 2012, and question-and-answer sessions at Guelph and with PSI students in winter 2012. In addition an on-line questionnaire was administered to students, faculty, postdoctoral fellows and staff, with questions tailored to each group. Responses were received from 13 faculty, 20 graduate students, and a small number of postdoctoral fellows and staff.

The review was undertaken by Dr. Richard Keeler, Professor of Physics, University of Victoria, and Dr. Norm Murray, Professor and Director, Canadian Institute for Theoretical Astrophysics, University of Toronto. The site visit occurred on April 30 and May 1, 2013, and the internal reviewer was Dr. Scott Leatherdale, School of Public Health and Health Systems at University of Waterloo.

The previous OCGS Program Review (2005) at the Graduate level raised several concerns:

- The need for the continuing existence of the Guelph-Waterloo Physics Institute (GWPI)
- The shortage of TA funding at both universities
- The quality of teaching over the video link facilities
- Asymmetry of faculty graduate teaching loads between the two universities
- The “cooling” of relations between the universities and the Perimeter Institute
- Failure to take full advantage of GWPI’s resources and to “brand” itself as a premier physics institute
Some similar issues were raised in the current review (with however positive changes in the relationship with the Perimeter Institute), and clearly the responses to the previous review did not ameliorate all the issues.

The undergraduate program at University of Waterloo is currently under review under a separate process.

**Characteristics of the Program**

The joint program began in 1981, and the joint graduate degrees were first offered in 1985. The Institute now has 300 members and attracts $25.6m a year in research funding. It is the largest physics and astronomy graduate program in Canada and among the largest in the world. The founding of the Perimeter Institute in Waterloo in 1999 has played a significant role in the growth of the program, as have the synergies with the Institute for Quantum Computing (IQC) at the University of Waterloo, one of the top three research priorities of the University. The graduate program along with the faculty numbers grew significantly since 2005, when there were 84 faculty and 65 graduate students; in 2012 these numbers had grown to 136 and 230 respectively. This includes the coursework, one-year Master’s degree offered by University of Waterloo and based at the Perimeter Institute, Perimeter Scholars International (PSI), which brings in a highly international class of 30 very promising students each August. Graduates from this program have gone on to doctoral students at prestigious institutions, and 33 of them have continued on to the doctorate at the Guelph-Waterloo Physics Institute.

**Academic Programs Offered**

The programs offered include a research Master’s and PhD (joint between the two universities). Teaching is one jointly using a video link. University of Waterloo also offers a course-based Master’s, of which one cohort is offered at the Perimeter Institute (entitled Perimeter Scholars International or PSI). The graduate programs (with the exception of the PSI program) are also available in co-op form, however since no recent students have taken this option, the self-study document recommends that it should be closed.

**Program Objectives**

1. to perform groundbreaking research in physics and astrophysics,
2. to offer a broad physics education at the graduate level,
3. to train our students to perform fundamental and applied research of the first rank,
4. to supply technically skilled and creative personnel to the Canadian workforce and those of her partners, and to promote economic, intellectual, and social well being in Canada and across the globe.

The objectives of the thesis MSc program are to train graduate students with the knowledge and skills needed to carry out high-quality scientific research, to instill a sense of curiosity about the natural world, and to become productive and creative members of the workforce.
The PSI (course-based Master’s) program “is designed to prepare outstanding students from around the world for cutting-edge research. The syllabus exposes students to the full spectrum of theoretical physics through a stellar array of international lecturers as well as dedicated professional tutors.”

The PhD program is designed to train the next generation of independent and innovative research scientists.

**Specific Learning Outcomes**
Specific learning outcomes and mapping to Degree Level Expectations remain to be done prior to the next review.

**Significant strengths of program**

The program offers eight fields (astrophysics and gravitation; atomic, molecular and optic physics; biophysics; condensed matter and materials physics; chemical physics; industrial and applied physics; quantum computing; subatomic physics). Astrophysics and gravitation has benefited in particular from the additional resources available at the Perimeter Institute, and the quantum computing field in particular has benefited from the additional resources available at the Institute for Quantum Computing (IQC). The reviewers commented “the new facilities we saw were world class and many of the faculty members are internationally renowned. Clearly the program is on an upward trajectory and in some cases already the best in Canada. In particular, we were impressed by our visit to the Quantum Information Institute. The quality of the new space is world class.” (Note, the correct title is Institute for Quantum Computing).

At the time the self-study was written, IQC had 17 faculty, 5 research assistant professors, 38 postdoctoral fellows and 80 students predominantly in areas of mathematics and physics, and is continuing to grow. The Perimeter Institute has around 19 faculty, many Associated faculty and visiting researchers, and between 35-40 postdoctoral fellows. Guelph houses the Advanced Analysis Centre, which has approximately $30m worth of state-of-the-art equipment particularly useful for characterization of the structure of materials. The program also benefits from national facilities such as Canadian Light Source, the Canadian Space Agency and TRIUMF (Canada’s particle facility, in which two Guelph faculty play a key role).

The reviewers also commented on the cultural diversity of the faculty and students at Waterloo and the Perimeter Institute. On the one hand the program has the resources to bring in international faculty and students (the PSI program in particular conducts enormous amounts of outreach to bring gifted students from all over the globe, with generous scholarships). On the other hand, the reputation of the program, combined with that of the Perimeter Institute and IQC, helps to attract world-calibre faculty and students.

**Faculty**
The Institute has 58 faculty members in category 1 (full-time, tenure stream or tenured appointments in one of the two Departments). Of these, 15 are appointed at Guelph, 3 are appointed both at Waterloo Physics and Perimeter, 8 are appointed both at Waterloo Physics and IQC, and the balance (32) at Waterloo Physics. Another 28 are cross-appointed from other Departments/Institutes at the two universities as well as Wilfrid Laurier University, and there are 42 who are adjunct/emeritus etc. There are a small number of lecturers who participate mainly in the undergraduate programs. The faculty at Waterloo has grown substantially, particular in the Quantum and Astrophysics and Gravitation fields; by contrast faculty numbers at Guelph declined from 20 at the last review to 15 currently.

The faculty quality is evidenced by the number of research chairs, awards and publications. The group includes seven Tier 1 and four Tier 2 Canada Research Chairs, two NSERC Industrial Chairs, and four University Research Chairs (three at Waterloo, one at Guelph). The faculty hold numerous awards: four are fellows of the Royal Society of Canada, five are fellows of the American Physical Science Society, six are winners of the Herzberg medal, three have held Sloan fellowships, two have held Killam fellowships, one has held a Steacie Memorial Scholarship, and numerous other prestigious awards. Nobel Laureate Sir Anthony Leggett is jointly appointed to Waterloo Physics and IQC. The faculty have authored 3450 journal articles over the past seven years, and have collectively attracted 240,000 citations (2000 per researcher). Three faculty have more than 10,000 citations each, and 12 more than 5,000 each.

**Staff/Administration**

GWPI is administered academically by a Director (from Waterloo) and an Associate Director (from Guelph) who liaise with the Graduate Associate Chairs at each individual university. There is one staff assistant dedicated to the GWPI who focuses on liaison between the two universities and various Institutes concerned (Perimeter, IQC, Waterloo Institute for Nanotechnology), as well as recruitment. Both university Physics Departments also have their own graduate directors (faculty members) and graduate coordinators (staff) who fulfill the usual tasks of advising students and dealing with the usual university requirements. At Waterloo the graduate coordinator is assisted by a graduate secretary, whereas at Guelph the coordinator calls on other Departmental staff as there is not dedicated graduate secretary.

**Students**

The thesis Master’s program has admitted close to 30 students per year on average over the past seven years, with about two-thirds of these admitted via University of Waterloo. The PSI Master’s just admitted its fourth class, and takes in 30 students per year. The doctoral program has admitted on average 21-22 students per year over the last seven years, of whom 18 were via University of Waterloo and 3-4 via Guelph. The research Master’s and PhD numbers have grown over the period at Waterloo.

Virtually all graduate students on both campuses receive funding support, with the exception of some students going over time limits for completion, and a very few “self-funded” students at
Guelph. Reported average funding is higher for University of Waterloo due to the higher proportion of international students, who receive scholarships to cover the international student fee differential. The Guelph Department is concerned over its limited ability to fund international students; the Waterloo Department is particularly concerned over the slow growth in funding for teaching assistantships (over the period of rapid student growth) and its ability to remain competitive nationally. The funding tables only cover the thesis programs; the PSI students are generously funded and highly international.

Student caliber is reflected in the external fellowships won by students. Those from Waterloo have held 127 NSERC scholarships, 110 OGS and OGSST scholarships, and 12 prestigious Vanier scholarships over the past seven years. Guelph students have held 131 NSERC scholarships and 41 OGS and OGSST over the seven years 2005-2011. Over the seven year period, 57% of applicants were international, and 23% female. Completion times for the Master’s are a little over two years (Waterloo), and a little less (Guelph – with much smaller numbers), and one year (PSI program). Completion times for the doctorate are 4.5 years (Waterloo) and 5.5-6 (Guelph).

About half of the graduates of the thesis Masters programs who could be tracked go on to doctoral studies and half to employment. Two-thirds of doctoral students go on to post-doctoral positions (it is rare to proceed directly to a faculty position: only three did this); and the balance took employment in the public and private sector. Of the 97 graduates from the coursework program (the first graduates were in 2010), 80 went on to doctoral studies, many at top institutions internationally.

**Reviewers’ Recommendations/Departmental response regarding program enhancements**

The review visit occurred on April 30 and May 1, and the external reviewers were Dr. Richard Keeler, Professor of Physics, University of Victoria, and Dr. Norm Murray, Professor and Director, Canadian Institute for Theoretical Astrophysics, University of Toronto.

They commented very favourably on the program, summarizing as follows:

“The new facilities we saw during our review of GWPI are world class, and many of the faculty members are internationally renowned. Clearly the program is on an upward trajectory; in some areas it is already the best in Canada. GWPI is doing an excellent job of utilizing the impressive resources the program and the associated departments have attracted.”

They also noted areas for improvement, including the video link technology, stress on staff time as the program has grown, and student support, and they provided five recommendations, and three other suggestions.
1. **Suggestion:** the reviewers expressed concern about dependence on a single staff person

2. **Recommendation:** GWPI should produce a budget for funds expended each year and a request for funds for the following year. There should be a process to review the budget and the request.

3. **Recommendation:** Evaluate whether the admission process was adequately resourced and whether the procedures could be streamlined.

4. **Suggestion:** The Self Study explicitly asked if a strategic plan for the GWPI should be considered, and the reviewers agreed that such a plan was needed, in view of the rapidly changing nature of the program.

5. **Recommendation:** Improve levels of graduate financial support through scholarships or other means to provide a level that is roughly commensurate with competing institutions.

6. **Recommendation:** The University of Guelph should facilitate international graduate students through extra funding. Even a small number of students would be an important improvement in the diversity of the graduate student population.

7. **Recommendation:** The Guelph video link room urgently needs a technology refresh. Given the rapid advance of this type of technology, a technology refresh should be budgeted for every four to five years at both sites.

8. **Suggestion:** Research space: “new buildings were of world class, while legacy space is of considerably lower standard. Some effort to redress inequalities should be attempted.”

**Response to recommendations**

There were three sets of responses, from GWPI and from the two Deans concerned. These responses did not necessarily agree, and as such, it is not easy to define a two year plan. Broadly speaking, the Department agreed with the recommendations and suggestions for developing a strategic plan and a budget for the unit, the need for additional resources for staff, for renovation of older space and the video link, for increased student support, and for increased timeliness in admissions.

The Guelph Dean referred to the ongoing program prioritization process at Guelph (the University is in the throes of budget cuts), but endorsed the Physics graduate program as a successful and priority one which should request additional resources. He offered to work with the Director and Associate Director on funding to upgrade the video link, and (through the new
budget model) to allow Physics to utilize some of the foreign student tuition receipts to provide fee-differential scholarships to international students.

The University of Waterloo Dean agreed with the recommendations, but felt that almost all of them were being accomplished with no further action needed: GWPI does not need its own strategic plan or budget since Waterloo Physics has a plan and its own budget; additional staff support can come from specialized staff at the Faculty of Science level; the Provost has already provided $0.5m in additional scholarship funding following the review; a second graduate assistant has recently been hired at the Faculty level which should expedite admissions; lastly Physics is doing world class research in old buildings, but will get additional research space in a new building which would commence construction sometime after spring 2015.

These three responses reveal underlying differences in the vision for GWPI, likely not easy to resolve in view of the inherent issues involved in bridging between two universities, two Departments, and at least two other Institutes (Perimeter and IQC). All agree that GWPI is a resounding success; but in one view, its success will continue as a part of the growth and success of the whole faculty; and in the other view it should be prioritized.

**Two-Year Plan**

The following summary was developed by the Associate Provost, Graduate Studies at University of Waterloo, and reviewed by the Department and both Deans. A two-year report is required to be submitted August 31, 2015, on progress.

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<tr>
<th>Recommendation and Proposed Steps</th>
<th>Who is responsible?</th>
<th>Timeline</th>
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<tr>
<td><strong>1, 2. Budget and staff:</strong> Guelph Dean will work with Department to submit a prioritization request. Waterloo Dean does not support need for further action.</td>
<td>Guelph Dean with Director and Associate Director</td>
<td>Report in 2015</td>
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<td><strong>3. Resources for/streamlining of admissions</strong> (directed at Waterloo): Waterloo Dean: a second graduate assistant has been hired in the graduate office</td>
<td>GWPI will monitor processing times at Faculty level at Waterloo</td>
<td>Report in 2015</td>
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<td><strong>4. Strategic planning:</strong> Waterloo Dean did not support strategic planning by GWPI separately from Waterloo Physics; Guelph Dean did not address</td>
<td>No action contemplated</td>
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<td><strong>5, 6. Student financial support levels</strong> (both universities): Response, Waterloo Dean: further support has been provided; Guelph Dean: will work with Department; and new budget model may permit Department to offer international fee waivers</td>
<td>GWPI will monitor financial support packages</td>
<td>Report in 2015</td>
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<td><strong>7. Technology update – video link</strong> (directed at)</td>
<td>Guelph Dean with</td>
<td>Not specified:</td>
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Guelph): The **Guelph Dean** will work with the Director and Associate Director to ensure facility meets standards

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<th>Director and Associate Director</th>
<th>report on progress in 2015</th>
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8. **Research space**: **Waterloo Dean** did not believe anything further was needed given future building plans; **Guelph Dean** did not respond specifically (conceivably this is a Waterloo issue)  

| No action contemplated | No further action planned; new space will not come until 2017 |

This report will go to Waterloo Senate Graduate and Research Council on December 9 2013, and to Senate on January 20 2014.