



NUI MAYNOOTH
Dlíocht na hÉireann Mhí Nuad

**Quality Review of the
Department of Experimental Physics
24 – 26 March 2009
Peer Review Report**

Peer Review Group:

External Reviewers: Professor Sarah Church, Stanford University, USA;
Professor George King, University of Manchester, UK.

External Stakeholder: Mr Seán Ashe, CEO, Kildare VEC.

Internal Reviewers: Professor Margaret Kelleher,
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1 Introduction

The Peer Review Committee was charged with reviewing the Experimental Physics Department, which is part of the Faculty of Science and Engineering. To provide context for our report we begin by briefly summarizing the activities of the Department, based on a combination of the description that was provided in the departmental self-assessment report and our own observations.

The Experimental Physics Department carries out teaching and research in the broad area of experimental physics and astrophysics. Its research programme includes several world-class research groups and attracts excellent and enthusiastic graduate students. A diverse teaching programme caters to both undergraduate and graduate students. The Department is situated in a well-equipped building of recent construction with state-of-the-art facilities that include teaching and research laboratories, computer equipment, including both hardware and software resources, and mechanical and electronic workshops. These workshops provide services to other departments in addition to Experimental Physics.

The following full undergraduate degree programmes are provided by the Department:

- BSc Single Honours in Experimental Physics, MH201 (Common Science Entry)
- BSc Double Honours in Experimental Physics with a Second Subject, MH201 (Common Science entry)
- BSc Double Honours in Experimental Physics and Computer Science (with industrial placement, managed with the computer science department), MH201 (Common Science entry)
- BSc Physics with Astrophysics MH204 (Denominated Degree entry)
- BSc in Science Education MH212 (with Experimental Physics to Degree level)

In addition the Department also provides service teaching for degree programs in the Electronic Engineering department, and provides core subject teaching for science students who are progressing towards degrees other than those mentioned above. Indeed, the majority of students in the first year of Experimental Physics will specialize in another science for which a solid foundation in experimental physics is advantageous.

The Department also provides the following post-graduate degree programmes:

- Higher Diploma in Applied Physics. A full-time one-year course for graduates in physics or related disciplines that emphasizes project work and practical applications.
- MSc by research
- PhD

Departmental operations are funded mostly by a core grant from the University. This is supplemented by some additional funds for service teaching, a schools program, in which high school students visit the Department to carry out some of their experiments, and some funds for books and other scholarly materials. Research is funded by external grants from a mixture of agencies in Ireland and Europe.

1.1 The Site Visit

The Committee was provided with a range of materials prior to the site visit, including a very comprehensive self-assessment document assembled by the Experimental Physics Department. The committee met with both university and departmental staff, and with students

and external stakeholders, during their visit. We also met with university staff who are end-users of teaching and other resources provided by the Department.

The detailed findings and recommendations of the committee are presented in the appropriate sections below, but overall the committee was very impressed with the quality of the departmental research and teaching. The Department also has an ambitious plan for building and improving the quality of its activities moving forward. It is clear, however, that there are a number of challenges that the Department faces.

1. Available resources are stretched to the limit, particularly in light of the tight economic times that have caused cutbacks in expenditure by the Irish Government. This is likely to have a future impact on the ability of the Department to maintain its high quality facilities including, for example, up-to-date computer equipment.
2. There are increased demands on the time of the academic staff, in particular in the wake of the tragic loss of one lecturer in a car accident. Furthermore, a second member of the academic staff is currently VP for research, further reducing the resources available to the Department. This point was highlighted by the Department itself in section 1.3.2 of the self-assessment report.
3. It is clear that the degree to which current high-school courses prepare incoming students for the degree programs of the Department is changing. In particular the preparation in mathematics and basic science is not as strong as it used to be. The committee notes that this is a larger (possibly worldwide) trend.

Despite these challenges, the Department has laid out in the self-assessment document a commendably ambitious vision for its future. In formulating its recommendations, the committee has attempted to balance suggestions that are intended to help the Department meet these goals with the reality of what can be achieved in the straightened environment that is likely to exist for the next few years.

2 Response to the Self Assessment Document

The committee commends the Department of Experimental Physics on a self-assessment document that was extensive, comprehensive and well-laid out. The report highlighted achievements, self-identified some areas in need of improvement and laid out future plans and goals in a logical, easy to follow format. The committee feels that this reflects the overall high quality of the Department and this document can be used as a model for other departments (see “best practices” in Section 4.2). We now review the various departmental activities in the context of these goals.

2.1 Teaching, Learning and Assessment

The Department provides a variety of undergraduate degrees that are intended to produce a workforce trained for careers in universities, industry, teaching and other careers typical for physics and engineering graduates. Some of the degrees emphasize particular post-graduate paths through work placement programmes; see for example the double honors degree in Experimental Physics and Computer Science. The Department also provides service teaching to the Electronic Engineering department, emphasizing the areas of physics that are most relevant to that discipline.

Since 2000, the Department has steadily introduced new programs at a rate of one per year including courses that target areas such as Physics with Astrophysics and Experimental Physics/Computer Science including industrial placement opportunities. These programs have been successful but have increased the teaching load for both the academic and support staff.

The teaching methods that are used by the Department include not only the traditional methods of lectures, tutorials and practical classes, but also newer e-learning techniques, based around the NUI “Moodle” system. As is appropriate for an experimental physics programme, practical laboratory courses and applications are emphasized in all of the degree programmes, and field trips are used to provide exposure to more specialized research methods, particularly in the area of astronomy.

The mechanisms for course evaluation and appraisal are well-documented in the self-assessment report. They include regular meetings of the teaching staff, Moodle-based feedback, end of module questionnaires and an internal examination board. Examinations are overseen by an external examiner who provides a written report to the University. These degrees are accredited by the Institute of Physics (IOP) on a regular basis. Most recently the accreditation was extended to 2011 with a very positive report that was included as an appendix in the self-assessment document. The IOP report concluded that the Department of Experimental Physics is “providing an excellent physics curriculum with a good coverage of graduate skills” and made several recommendations which are echoed by this report.

Graduate degrees include the Higher Diploma in Applied Physics. This was originally designed as a stepping stone from a 3-year General Science degree, now discontinued, to postgraduate research degrees. It is now taken typically by 4-year honours degree students who have not obtained a sufficiently high grade to undertake a postgraduate research degree or who want a post graduate qualification in a more applied programme suitable for industry.

Students pursuing MSc and PhD degrees have the opportunity to spend extended periods at overseas laboratories through the strong collaborative links of these labs with many of the Department's research groups. This provides excellent training for future careers in both the academic and private sector.

2.2 Research and Scholarship

The Department is to be commended for maintaining an international leadership position in several fields of experimental physics and astrophysics, as summarized in Section 3.1 of the self-assessment report. The strength of the research programme is evident from:

- Significant contributions to the various fields of research via a list of publications in international journals and conference proceedings.
- Multiple collaborations and key roles in international projects for most of the research groups. Individual research staff are also involved in the organization of international conferences.
- Successful applications for research funding, particularly in the area of submillimetre astronomy and terahertz technology.
- A vibrant community of graduate students who successfully compete for postgraduate scholarships and who go on to successful careers in both the academic and private sectors.
- Tours for the committee of several well-equipped research labs with state-of-the-art equipment and enthusiastic students and researchers.

The Department continues to regard research as one of its core activities but acknowledges the pressures due to the tight budgetary environment and increasing demands on the time of the staff.

2.3 Service to Academic and Other Key Communities

The service activities documented in the self-assessment report include participation in university governance and committee service. Departmental staff also participate in the wider physics community via service to scholarly societies and professional bodies, and by acting as external examiners for a variety of national and international universities.

The peer review panel found that the Departmental service to the University was recognized outside the Department as valuable. Furthermore the service activities include some that were not explicitly mentioned in Section 4 the self-assessment report, such as:

- Access to an excellent machine shop for departments beyond Experimental Physics.
- Service teaching for other departments such as Electrical Engineering. Although the structure of the self-assessment report places this activity under teaching rather than service, it is worth noting here as the committee received positive feedback from other members of the University.

The Department also places emphasis on other activities such as community outreach, communicating science to a broader public, teaching outreach via training for teachers and the *Discover Primary Science* programme, the *Schools Programme* that provides local schools with access to laboratories, and participating in student recruitment to Physics programmes. This is a commendable degree of engagement with the wider community.

2.4 Management and Leadership; Training and Development

The Department seems to be flourishing under the current management structure which emphasizes a collegial working environment in which all departmental members are encouraged to play a role in the smooth running of the Department. The open-door policy, of which the Department is rightfully proud, seems to be working well, ensuring a smooth flow of information through all layers of the management structure. The students are also aware of and appreciate this policy.

The training opportunities for the staff are documented in the self-assessment report and the committee found the staff to be aware of these opportunities.

The academic administration structure was also clearly laid out, including descriptions of the various committees (Departmental Committee, Teaching Sub-Committee, Staff-Student Committee) and their roles. The management structure is well suited to allowing staff to take advantage of leadership and other advancement opportunities. In particular junior academic staff are very engaged in every aspect of the operation of the Department. The only concern that might be raised is that of overburden and burnout.

2.5 University Policies and Processes; Integrating Support Services

The self-assessment document indicates that the Department is aware of and complying with all university policies and processes. The number of support staff is small and consequently overburdened but the peer review committee did not find any major problems during their visit. There are some issues with the department-university interface for certain programmes. For instance, the career development programmes for undergraduate students doesn't seem as effective as it could be, leading to some student frustration. The root of this issue appears to be in the University Career Development Centre rather than the Department but the Department should make sure that the interface is working. It is possible that the students have not been aware or taken advantage of the opportunities available to them. If this is the case, the department should re-examine its communication with both students and the career centre to ensure effectiveness.

3 Review of the Departmental Quality improvement Plan

The self-assessment document includes a detailed quality improvement plan, which we now comment upon. Recommendations by the committee that relate to the Quality Improvement Plan are discussed in more detail in Sections 4 and 5 of this report.

3.1 Teaching and Learning

The teaching and learning targets are laid out in section 7.2.1 of the Quality Improvement Plan in the self-assessment report. Specific comments on these targets are as follows:

Target 1: The goal of increasing student enrollment in the Experimental Physics and the Physics with Astrophysics Programs is laudable but should include an assessment of the impact of increased student numbers on existing resources, particularly staff availability, and funding availability in tight budgetary times. Realistically, increased student enrollment is likely to require increased funding.

Target 5: The goal of identifying modules from other departments is a good way to increase student opportunities without increasing the teaching workload and is to be encouraged. This is discussed further in Section 4 of this report.

Target 6: The goal of increasing the provision of tutorials, presumably with a goal of increasing teacher-student ratios is laudable and would address some issues identified by this committee in Section 4. However, this will be hard to achieve without an increase in funding.

Targets 12 and 13 which increase the participation of the Department in national activities such as the Dublin Region Higher Education Alliance Programme for physics and the national Physics Graduate Research Education Programme are to be encouraged provided that new funds are available.

3.2 Research and Scholarship

The committee endorses the departmental strategy for strengthening research. Some of the targets are emphasized and expanded upon in the recommendations of this committee. In particular the strong international standing of the Experimental Physics Department must be maintained by providing adequate time to the academic staff to develop their research programmes.

3.3 Service to Academic and Other Communities

The committee endorses the departmental strategy for the services delivered to university and external communities.

3.4 Long Term Vision and Strategy for the Future

The self-assessment report outlines a bold vision for the future of both teaching and research in the Department. These include:

- The development of new course options for undergraduates in emerging areas of interdisciplinary research with a strong experimental physics component such as atmospheric and climate change physics. The committee agrees that this is a very good plan that will not only be likely to increase student enrollment but that will also prepare students for a changing world and work environment.

- Participation in the development of a national graduate research education programme. This will clearly benefit not only the Department but also the national program by exposing a larger cadre of students to some of the world-leading research programs of the Department.
- Increase the scope of the research program by taking advantage of national and international programmes that permit recruitment of extra lecturers and professors.

All of these programs require extra resources, as recognized in the self-assessment document. The committee commends the ambitious nature of this vision, but cautions the Department to be aware of the possibility of spreading existing resources too thinly even if new resources become available.

4 Committee Findings, Conclusions and Recommendations

4.1 Strengths of the Department

Management, Leadership and Team Work

The members of the Department of Experimental Physics form a coherent and effective team that is enthusiastic and dedicated to the success of all departmental activities. This is due in large part to the fact that the departmental management style fosters a strong collegiate spirit with no inappropriate hierarchy, allowing all department members to feel involved in the successful operation of the Department. The result is an atmosphere that is congenial and cooperative and that fosters a strong sense of mutual respect between all members of the Department, including academic, administrative and technical.

The age profile of the Department is well-balanced and includes younger staff members. This, coupled with the fact that the Department has a clear set of goals for the future and a clear plan of how to get there, augers well for its future.

The Department has highly motivated technical and administrative staff and the morale of these staff members is high. These staff provide a quality of service to the other members of the Department that is highly valued. Staff are strongly engaged in the research and teaching and the departmental operation. In particular, they are very flexible in the roles they play in the Department, which considerably adds to their effectiveness.

Facilities

The building that houses the Department provides excellent working conditions and the available space is well utilized. The Department has excellent workshop facilities and IT facilities.

Teaching

The Department provides strong teaching programmes at both undergraduate and postgraduate levels that have been endorsed by the Accreditation Report of the Institute of Physics. All students (both undergraduate and postgraduate) commented on the approachability of the staff; students feel that there is always someone they can talk to. There are plenty of points of staff-student contact and the Department operates an open-door policy so that staff members are widely available to the students. Clearly, there exists a general attitude of concern for the well being of the students.

Innovations in teaching methods are underway in the Department and look promising, for example, the use of “clickers” in lecture courses and other types of e-learning. The committee found considerable enthusiasm, particularly among the younger staff members, for these innovations.

The teaching laboratories are impressively well equipped and well-organized. Importantly, a substantial amount of student project work is conducted in the research laboratories. Moreover, 4th year students are provided with dedicated computers, which is clearly beneficial to their studies.

Research

All academic members of the Department are research active. The research activities include world-class programmes, significant collaboration with other university departments and collaborations with international research centres. The research activities of the Department have attracted substantial research funds and resulted in published papers in leading international journals.

The staff appear to be mindful of the prevailing financial difficulties and tailor their research activities to make the most of available financial resources and experimental apparatus.

There are a significant number of PhD research students in the Department. These students have frequent meetings with their research supervisors and are well advised by these supervisors. The committee enjoyed its interactions with these enthusiastic Department members.

University Service

Members of the Department play a very active role in the development of the University through their participation in University boards and as officers of the University. They are also involved in external service to national and international professional bodies.

The technical services provided by the Department are utilized by a wider university community and provide a valuable university resource.

Staff Training and Development

Staff are encouraged to undertake training courses and research degrees and they have done so with much success.

Broader Community

The outreach programmes of the Department to high schools and the wider community are outstanding as demonstrated by numerous examples in the self-assessment document.

4.2 Best Practices

The Committee identified the following best practices.

The self-assessment document of the Department that was supplied to the committee is comprehensive, well laid out and easy to follow. The achievements, future plans and goals are well conveyed and, in general, the self-assessment document reflects the high quality of the Department. It would serve as a good model for similar reports by other departments.

The Department has a clear set of goals for the future and a clear plan of how to get there.

The open-door policy of the Department and the emphasis on the accessibility of the staff to students is valued by students and staff alike. Every group that we interviewed commented favourably on this policy.

From our meetings with other members of the university community, the committee concluded that the technical services of the Department that are made available to other departments constitute an excellent university-wide resource. The Department is perceived by other members of the University as a good citizen.

The outreach programmes of the Department are outstanding and are a model for other departments. In particular, the *Schools Programme*, in which schools can use the

undergraduate laboratories to provide equipment and space for the requirements of the Leaving Certificate physics syllabus is an extremely successful program. The fact that a relatively small department can impact 20% of the total number of students in Ireland that are taking Physics in their final year is quite an achievement that must benefit student recruiting as well as national standards.

4.3 Areas for Improvement

Teaching

In the committee's opinion, the teaching programme is approaching the limit of what is realistically achievable with existing resources, particularly academic staff teaching load. It is critical that the Department carefully assesses any new activities to ensure that an already overstretched system does not break.

The IOP report recommended that the Experimental Physics Department should foster stronger communication with the Mathematical Physics Department to ensure that students taking different modules offered by the two departments are not seeing the same material twice. We concur with that recommendation. The departmental heads are in discussion and this should be continued to conserve the stretched teaching resources of the Department.

Postgraduates are giving lecture courses. There is nothing inherently wrong with this practice, and it serves a useful purpose in providing teaching experience for future academics and helps to ease some of the strain on the permanent teaching staff. However, the feedback from the undergraduates about the effectiveness of postgraduate lecturers was uneven. The Department needs to continue to carefully monitor the performance of postgraduate teachers and, where possible, assign them to the smaller classes of more experienced students.

There is clearly no slack in the system to be able to cope with extended teaching staff absences, both unexpected (for example, ill-health) or expected and desirable, for example during sabbatical leave. In the long term this could have a negative effect on staff morale and a potential impact on departmental performance.

Our discussions with the teaching staff, and also with the students themselves, lead us to conclude that the Department needs a plan to address the trend in weaker mathematics and science preparation among its incoming students (this trend seems to be international and does not reflect on the Department or the University). In particular we note that:

- The weaker students in the first year struggle with much of the material, while stronger students can potentially become complacent when the first year courses are not challenging. The challenge of catering to a large range in ability and preparation is likely the explanation for the comments that the committee heard from the undergraduate students about the increase in the difficulty of courses that occurs between years 3 and 4.
- A related issue is the need to respond to the changing work ethic and priorities of incoming students. Students acknowledge that they need to be pushed to avoid falling behind. This could be accomplished by judicious use of more continuous assessment, taking care, however, not to increase the work load of an already stretched staff.

In the self-assessment report, the Department set a goal of implementing smaller group tutorials (for second year students for example). This is a very commendable goal that would definitely improve teaching and would certainly address some concerns of undergraduate students. However, additional resources, primarily manpower, would be needed.

Many of the undergraduate students seemed anxious about future career prospects. This is likely due to the world-wide economic situation, which has hit Ireland quite hard. However, the committee found that career advising, which is jointly organized between the Department and the University Career Development Center, could be improved.

Research: The committee recognizes the quality of the departmental research, including the strength of the postdocs and students. However:

- The number of postdocs is small, most likely due to funding issues, which is likely to affect research productivity.
- The publication list included a higher ratio of conference to refereed publications than is ideal. Work is presented at international conferences, which speaks well of its quality, but the absence of follow-up papers in refereed journals suggests that the work cannot always be written up in a timely manner.
- The pressure on the time of the academic staff is preventing young faculty members from taking sabbatical time, a necessary requirement both for the development of their research programmes, and for avoiding burnout.

Management and Future Plans: A detailed plan to deal with the expected reduction in core funding was not presented in the self-assessment document.

4.4 Recommendations

The committee makes a number of recommendations that are detailed below. However we *strongly caution* that the benefits of any changes or increase in the scope of departmental activities *must* be carefully weighed against the negative impact of increases in demand on resources that already thinly stretched to the limit. In particular the teaching load of the permanent staff cannot be increased further without impacting research productivity and morale and so there must be careful analysis of the impact and consequences of new activities in any area.

Teaching, Learning and Assessment

We recommend that the Department take steps to address the gap between students with weak and strong preparation in mathematics and physics. It may be possible to address this issue without further straining resources. For example:

- Make use of the remedial mathematics programme offered by the Mathematics Department to address weaknesses in the mathematics preparation of incoming students.
- Consider using some material from the existing Foundation Year NUI Certificate in Science to address the problem of inadequate physics background in incoming students. This could be implemented through some kind of placement of students into parallel but separate streams in the first semester that could be combined at a later stage. This could allow students with weaker preparation to catch up, while keeping the stronger students engaged.
- Work with the Department of Mathematical Physics to streamline existing modules that currently have significant overlap. Solid state physics was presented to the committee as an example of a subject that is separately taught by each Department, with important differences in emphasis, but nevertheless with a large degree of overlap.
- If possible increase the use of continuous assessment to train students in time management and to ensure consistent effort.

- Consider how to evaluate the effectiveness of innovative e-learning teaching methods to maximize use of resources.
- To maintain consistency for students in the crucial early stages of a degree, consider restricting the teaching activities of postgraduate students to lecture courses in later years.

There is a system in place to collect student feedback on lecture courses, but it is unclear to students what is accomplished by their feedback. We recommend:

- The Department should consider how best to publish student questionnaires on lecture courses. For example, some minor comments that the committee heard could be addressed by “closing the loop” to show how student comments have been acted upon. This includes a comment that the weighting of lab component as a fraction of final grade should reflect expended student effort.
- The Department may wish to solicit student feedback at regular intervals during the course as well as at the end of the course.

The Department should improve career advising for both undergraduate and postgraduate students in the context of a changing economic environment. A physics degree remains excellent preparation for a range of careers including emerging areas such as biophysics and the so-called “green sector”, but enabling students to take full advantage of opportunities may require a different approach to advising. It may be appropriate to investigate whether new internship programmes would improve student job prospects in a difficult economic climate.

Assuming that sufficient resources are available we suggest:

- Increase the offering of optional course modules to cover subjects at the interface between physics and other fields e.g. medical physics, climate change. To maximize available resources, it is recommended that such offerings are developed in close collaboration with other departments.
- Consider developing an MSc in Physics & Education to provide a trained workforce that can fill future anticipated gaps in the teaching profession. Again, this should be implemented using *existing* course offerings as far as possible.

The proposed links with other universities to develop a taught graduate programme are commendable but should be examined in the context of shrinking resources.

Research

- The committee strongly endorses the departmental goal of protecting research time, especially for younger staff members. The University should help the Department to ensure that teaching staff are given adequate time for research, including sabbatical leave.
- The committee also endorses the departmental goal of encouraging staff to develop common research programmes in order to maximize use of resources. This has worked extremely well for the Space Terahertz group for example. Similarly, efforts to develop research ties with other departments are commendable and should be encouraged to spark new research directions. The ICARUS collaboration is a good example.

Management

- It is recommended that the departmental leadership develop a clear plan for how the Department will deal with the expected reduction in core funding.

University Procedures and Services

Although these are not departmental services, they were raised as concerns by students and so we mention them here as issues that the Department should be aware of.

- The career office accessibility was a concern among 4th year undergraduates
- The post-graduate office accessibility was a concern among postgraduates especially in light of the very bureaucratic national admissions procedure for PhD students.

5 Comments on the Review Process

The peer review group would like to thank the Quality Control Team for an excellent briefing in which the charge was clearly conveyed. The peer review visit was well-managed with a range of meetings with departmental and university personnel that enabled us to perform the task.

In future we would suggest that the schedule perhaps allow some extra reviewer interaction time, for example 5-10 minutes, between departmental meetings to allow the committee to process what it has heard and to formulate follow-up questions. We acknowledge however that this may be difficult to accomplish in what is quite a busy two days.

Finally the committee would like to thank the Experimental Physics Department for its openness and cooperation in the peer review process. We would also like to thank both the University and the Department for its hospitality and assistance that made the review ultimately an enjoyable experience.

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