

Chairperson Dr. Vincent Casey

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Prof. Patrick Cunningham
Government Chief Science Adviser
Wilton Park House
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Irish Membership of CERN and European Southern Observatory

Dear Prof. Cunningham,

The Institute of Physics in Ireland is very pleased to welcome your recent appointment as Government Chief Science Adviser and wishes you every success in your position.

The Institute of Physics in Ireland (IOPi)* is the professional organisation for physics in Ireland, both Northern Ireland and the Republic. It is a key educational and research stakeholder and regularly produces reports and recommendations on many aspects of physics. In particular, the Institute has called for Irish membership of European Laboratory for Particle Physics (CERN) and the European Southern Observatory (ESO). Benefits of membership include:

- Access to world class research facilities providing a considerable boost to Ireland's science community in areas including micro and opto-electronics, ICT, detectors, fundamental physics
- Significant economic returns by way of R&D contracts and technology transfer
- Stimulating interest in science in schools and the wider community

In the drive to ensure Ireland's position in the global knowledge economy, the Institute considers membership of these facilities to be critical. We note that in the recent HEA/Forfas Report 'Research Infrastructure in Ireland, Building for Tomorrow' there is a call for active consideration at government level to be given to membership of a number of international instruments. Indeed the report advises " that future investment should concentrate on building on those research teams and facilities which are now in place, addressing the infrastructural issues identified, to move Ireland up to the next level in research" [p44]. We would like to encourage you to give this matter urgent consideration

Please find attached some brief background information on the case for Irish membership of these facilities. If you require any further details, please do not hesitate to contact me.

Yours sincerely,

Dr. Sheila Gilheany
Policy Officer

The Case for Irish Membership of CERN and ESO

Many areas of modern science require resources of such a scale that they are only possible in the context of international collaborations. Traditionally this so-called 'big science' has been underrepresented in Ireland hence there is a structural deficit in mechanisms to support work of this nature. While many Irish scientists participate in international collaborations there are some world-class instruments, which require membership in order to have full access to their facilities. Chief amongst these, are the European Laboratory for Particle Physics (CERN) and the European Southern Observatory (ESO).

Both of these facilities share a number of common features. They are universally acknowledged as being world leaders in their fields bringing together the very highest calibre of scientists and drawing together knowledge across many areas of science and technology. They require the most cutting edge technology in such areas as detectors, high-speed micro and opto-electronics, high-performance computing, high-speed networking, large volume data storage, mechanical and electrical engineering – all areas with tremendous potential for technology transfer and industrial spin-offs. In addition, they explore fundamental areas of physics, which have exceptional appeal to young people and to the broader public and as such act as outstanding tools to attract much needed students into science.

In the drive to ensure Ireland's position in the global knowledge economy, the Institute* considers membership of both these facilities to be critical.

CERN

Based near Geneva, CERN is the world's premier research laboratory in particle physics. Most European nations are CERN member states, including all 15 of the old EU countries except Ireland and Luxembourg. Many eastern European countries are in the process of applying for, or are already, CERN members. ¹ In addition India, Israel, Japan, Turkey, Russia and the USA are observer states.

Because Ireland is not a member of CERN, Irish R&D is not involved in the CERN programme which includes detector development, high performance computing and networks, material developments and large scale civil and mechanical engineering.

Research Opportunities

Currently, by far the largest and most powerful particle accelerator in the world, the 27km ring-shaped Large Hadron Collider (LHC) is under construction at CERN. Together with four large detectors for measuring particle collisions it is due to come on line in 2007. The facilities at CERN seek to answer fundamental questions about the nature of matter and energy and the past and future evolution of our universe. Although the core physics being investigated may seem esoteric, the science and technology required for the accelerator and detectors has many applications in solid-state physics and in the life sciences, while the ICT requirements are at the cutting edge of developments in this area.

Irish research groups in theoretical physics are highly active in a number of institutions, including, DIAS, TCD, UCD, NUI Galway and NUI Maynooth, while there are a number of scientists in Ireland already using CERN through special arrangements including staff at DCU, NUI Maynooth, TCD and UCD. CERN membership is essential for these research groups to realise their full potential and removing the significant disadvantage in relation to other European groups.

It may seem surprising, but the overwhelming majority of existing particle accelerators are used in medical science – e.g. radiation oncology. This leads to a requirement for highly-trained scientists and engineers for design, commission and operation in hospitals. Developments in the experimental techniques such as image reconstruction and instrumentation have greatly stimulated

parallel developments in medical procedures, particularly in the areas of non-invasive imaging and cancer therapy. Of particular interest in Ireland are the applications in solid-state detector elements, used for example in bulk checking of shipping containers for drugs, bombs or simply content verification - corresponding research is performed in nearly all engineering departments at Irish universities and at several Institutes of Technology.

Information and Communication Technology (ICT)

As is well known, the world-wide web was invented at CERN as a means for world-wide particle physicists to communicate. Today, CERN is leading the effort in research, development and deployment of the so-called Grid data and computing infrastructure. The goal of the Grid is to offer large-scale data and computing capacity much like the electric power grid provides electricity. The Grid initiative is driven by the extraordinary ICT needs of the new LHC particle physics experiments at CERN. Each experiment produces vast amounts of data annually and will require the computing power of several 10,000 PCs for data handling and analysis as well as high-speed networking for linking Grid sites to thousands of scientists at hundreds of institutions world-wide.

Involvement in particle physics Grid activities would be a significant boost to Grid research in Ireland, which is currently funded through PRTL and SFI. All universities in Ireland, and a number of Institutes of Technology are involved at one level or other in Grid activities with around 30 academic staff involved in core Grid activities and more than 100 Grid users.

Education and Training

CERN offers a wide range of education and training programmes at all levels, second-level school programmes for students and teachers, doctoral student programmes placing students at CERN for extended periods and programmes for visiting research scientists. However, only membership provides full access for Irish nationals to these programmes, which are highly sought after.

CERN membership would undoubtedly raise awareness in Ireland of the physical sciences. Along with astrophysics, particle physics asks the most fundamental questions and this is one of its great attractions to young people. Access to the multitude of outstanding training programmes at CERN could be harnessed for the ongoing drive in Ireland to increase the numbers of students taking physics.

CERN Membership Fee and Benefits

The membership fee is calculated on the basis of the nation's net national income. In 2005, for Ireland, this would have been 9.0M€, which is comparable to some of the larger SFI grants. Some of this investment is returned to the country as CERN contracts are awarded preferentially to companies residing in member states. For example, as a CERN member state, Finland, of similar size and structure to Ireland had supply contracts worth 5.8 M€ in 2003 compared with its annual fee that year of 8.5 M€.

There is a highly compelling case on scientific, economic, social and cultural grounds for Ireland to join CERN. Given that the LHC is due to come on line in 2007, with all its attendant opportunities for research and technology transfer, coupled with recent strategy announcements regarding doubling of PhD numbers,² the timing has never been more opportune for Ireland to join CERN.

European Southern Observatory (ESO)

The European Southern Observatory (ESO) is an intergovernmental European organisation for astronomical research and is widely regarded as the best astronomical observing facility in the world. It consists of a suite of telescopes located in the high Andes of Chile giving access to research in Infrared, optical and radio wavelengths. It currently has 13 member states³ and has its headquarters near Munich in Germany. It is also a significant driver and consumer of advanced technology generating large industrial R&D contracts and spin-offs for its members.

Its current flagship project in operation is the Extremely Large Telescope, which uses the most advanced technology available to achieve a higher resolution in the infra-red than the Hubble Space Telescope – a remarkable achievement given that the instrument corrects for atmospheric effects in real time. Its next major project, the Atacama Large Millimetre Array (ALMA), will push the boundaries between radio and optical astronomy and will require significant technological developments in antenna design, high frequency radio detection and robotic operation at high altitude. In addition approval has recently been granted by the ESO's governing body to proceed with detailed studies for the European Extremely Large Telescope. This study, with a budget of €57 million will make it possible to start, in three years time, the construction of an optical/infrared telescope with a diameter around 40m that will revolutionise ground-based astronomy. Indeed Irish researchers are already working on instrumentation options for this telescope.

In common with CERN, ESO is constantly developing new instruments and technologies, while simultaneously taking the lead in ICT developments particularly in sophisticated analysis software and also supporting the wider astronomical community through outreach activities and education.

Research Opportunities

Astronomy is a particular strength in Irish research with nearly 150 researchers working in this area. However, since the recent termination of the international agreement whereby Irish astronomers had access to telescopes on La Palma in the Canary Islands, Ireland now has no formal access to any astronomical facilities, a situation which is unique within the pre-enlargement EU and is a severe blow to the Irish astronomical research community. ESO membership would significantly redress this and enhance opportunities for astronomical research in Ireland. It is also of note that in 2000, the UK International Review Panel for Physical Sciences recommended that the UK should join ESO. This recommendation led to the UK joining ESO in 2002 and the 2005 report of the International Panel highlights the highly significant benefits to UK astrophysics of having joined ESO.⁴

ICT and Technology Development

ESO is heavily involved in many aspects of cutting edge technology development in fields such as active optics, fibre lasers, Virtual Observatories, dynamic scheduling software, instrument interfaces, data archiving/mining, and automated data reduction pipelines. ESO actively promotes technology transfer into the broader economy and there are many examples of ESO developments that have been taken over by a manufacturer or produced commercially for a wider market including liquid nitrogen cryostats for charge-coupled devices (CCDs), flexible mirrors and infrared detectors.

Education and Training

Astronomy is one of the main drivers of interest in third level physical sciences courses with six Irish universities and one Institute of Technology offering full degrees and/or options in astrophysics. However, success at 3rd level teaching depends upon maintaining and recruiting internationally rated researchers who require access to the highest standard of facilities. In addition, it is no accident that astronomy is the theme of Ireland's first interactive science centre which will be opened in Cork in May 2007 at a cost of some 6M€, because astronomy excites young minds to explore science and engineering perhaps like no other discipline.

This is also a highly significant area for attracting Ph.D. students. Membership of ESO would provide opportunities for world-class postgraduate training and hence a major boost to government

plans to double Ph.D. numbers. Through its Student, Fellowship and Associate Programmes, ESO has contributed to the training of hundreds of young scientists and engineers over the years who have since returned to their own countries bringing significant value to their national research programmes.

In addition, like CERN, access to its excellent outreach programmes could be used as a corner stone in current Irish science outreach activities. Such ESO activities are particularly geared towards secondary schools and include teaching materials, courses for teachers, summer schools and specific educational projects, often in collaboration with partners such as the [European Association for Astronomy Education \(EAAE\)](#), the [EIROforum](#), the European Commission and others.

ESO Membership Fee and Benefits

Membership of ESO would allow Irish firms to bid for significant R&D contracts. In addition, there is a very substantial multiplier effect in that by working at and beyond the limits of standard technology, firms gain a competitive edge in the global market place and benefit from inward technology transfer. This would be particularly true for firms in the ICT sector but also radio communication and advanced optics, all areas where Ireland has growing strengths. Such factors weigh considerably against the initial entry fee of some 10M€ and annual fee of approximately 1.5M€.

ESO is currently in membership negotiations with Austria and a number of Eastern European states, some with considerably lesser economic resources than Ireland. The time is surely long overdue for Ireland to take its place in Europe's foremost astronomical research facility.

Notes:

1. The 20 CERN member states are: Germany, United Kingdom, France, Italy, Spain, Netherlands, Switzerland, Belgium, Norway, Sweden, Austria, Poland, Denmark, Finland, Greece, Portugal, Czech Republic, Hungary, Slovak Republic, Bulgaria. Only European nations are eligible for membership.
2. Strategy for Science, Technology and Innovation, 2006-2013, June 2006. Dept. of Enterprise, Trade and Employment
<http://www.entemp.ie/publications/science/2006/sciencestrategy.pdf>
3. ESO member states: Belgium, Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom
4. The Second International Review - International Perceptions of UK Research in Physics and Astronomy 2005
http://www.iop.org/Our_Activities/Science_Policy/Projects/International_Review/file_6363.pdf

***The Institute of Physics in Ireland**

The Institute of Physics in Ireland (IOPi) is the professional and scholarly organisation for physics in Ireland, both Northern Ireland and the Republic. It represents over 1700 physicists active in education, research, industry, the public service and commerce in Ireland. It is a branch of the London-based Institute of Physics, a leading international body and learned society with over 37,000 members in Ireland, the United Kingdom and elsewhere, which promotes the advancement and dissemination of a knowledge and education in the science of physics, pure and applied.