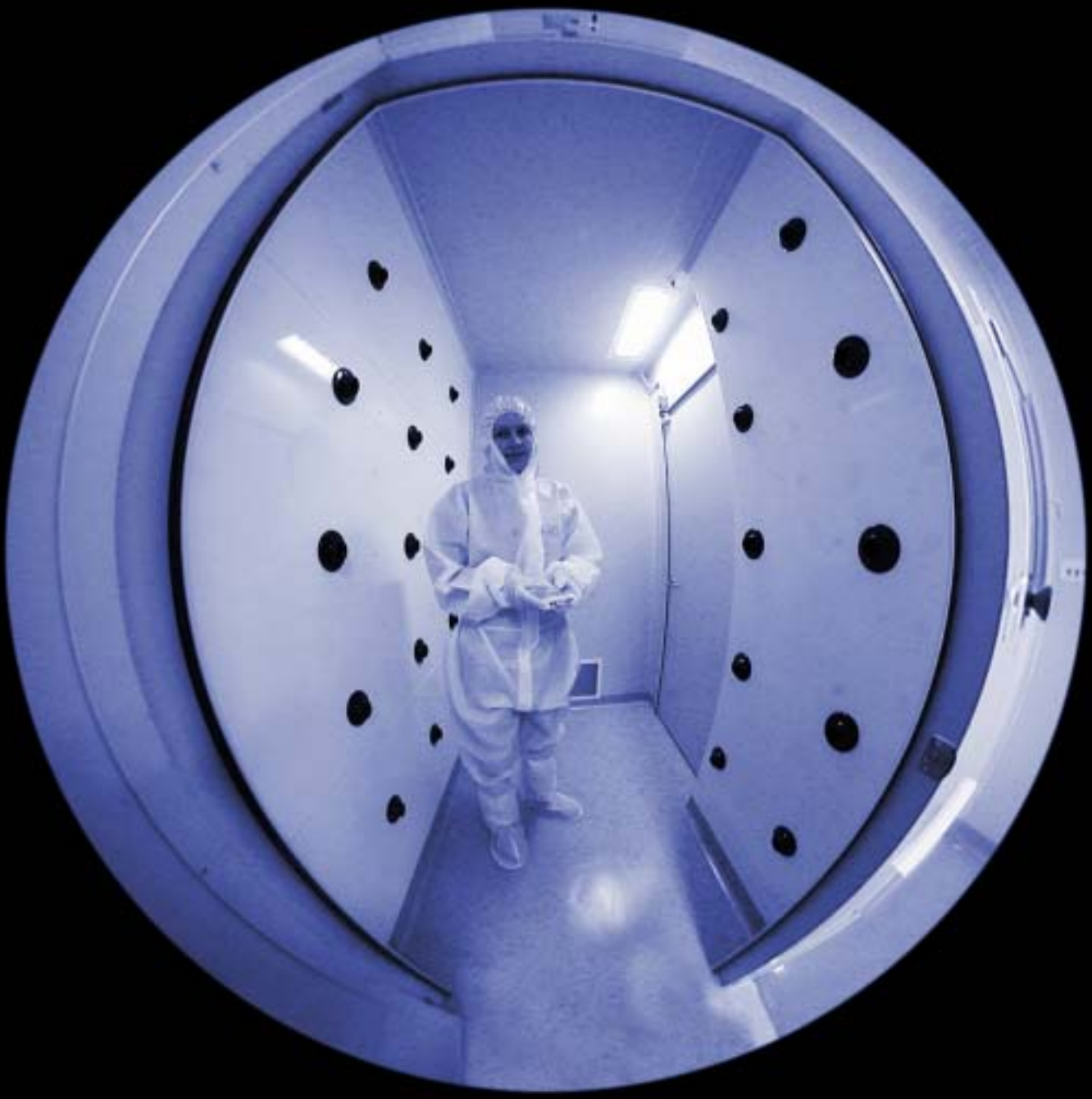
RESEARCH SCHOOL OF PHYSICAL SCIENCES & ENGINEERING

THE AUSTRALIAN NATIONAL UNIVERSITY

2003 ANNUAL REPORT TO COUNCIL



1 Overview

Professor Jim Williams, Director

The School continued to make substantial contributions to Australia's research and research training activities across many areas of the physical sciences and engineering, with specific programs providing a balance between fundamental, strategic and applied research. In addition to the strong emphasis on front line fundamental research and the advancement of knowledge, the School also very actively focuses on the commercialisation of its research results where applicable.

The School's success with external funding in 2003 substantially exceeded expectations. This outcome will result in around 55% of the School's budget for 2004 coming from external sources. A major success has been from the range of ARC funding schemes, with more than $9 million derived from such sources for 2004 alone. For example, in the 2003 Discovery Project round, for funding from 2004 onwards, RSPhysSE was again extremely successful, winning nearly $6.5M in funding, some involving other parts of the ANU. The School now holds 67 active ARC Discovery Projects and more than 80 grants from the ARC in total. Included in the above total were the award of 4 Linkage Projects, 3 major Linkage Infrastructure (LIEF) grants totalling $1.5 million, partnership in a third Centre of Excellence in Functional Nanomaterials (Ying Chen) and several Linkage Fellowship awards. The major non-ARC competitive grant success in 2003 was the award of $2.7 million from AusIndustry for the establishment of the Australian Materials Technology Network (AMTN), in which ANU was the lead institution. AMTN has research and industry association partners in almost all states and territories and its mission is to substantially enhance the connection between Australian industry and the country's world-leading materials research. Despite the success with external funding, the School's recurrent budget has been under increasing pressure, with the substantial salary increases under the 2003 EBA and limited opportunity to offset recurrent salary commitments with external grant funding. Around 94% of the School's recurrent budget in 2004 will be expended on salaries, a fraction that is far too high. The School is developing strategies to progressively improve this situation over the next several years.

Several staff of the RSPhysSE were recognised for the excellence of their research and/or research support in 2003. Professor Barry Luther-Davies was awarded one of the few Federation Fellowships by the ARC and Professor Jim Williams was elected as a Fellow of the Australian Academy of Science. Some other noteworthy honours include the award of the Lyle Medal in 2003 to Professor George Dracoulis, Centenary Medals awarded to 14 School staff, two Fellowships of the American Physical Society and Michael Aggett was awarded the 2003 Council Medal for General Staff Excellence. In addition, the previous Director of the School, Professor Erich Weigold, has been appointed as Executive Director of the ARC's Physics, Chemistry and Geoscience Panel.

The School has continued to play a leading role in the National Institute of Physical Sciences and is heavily involved with 3 other National Institutes. Indeed, Science ANU, that brings together the 5 science-health-engineering National Institutes, was largely an initiative of this School. Science ANU already plays a prominent role in promoting ANU science and engineering both within and external to the university and continues to support a range of flagship outreach programs such as the National Youth Science Forum, the Science Olympiads, The Science Circus, the Australian Science Festival and Adopt a Physicist programs.

During 2003, the School continued to put in place mechanisms and procedures to assist in exploiting our intellectual property through commercialisºation. The co-location of Mr Tony Cooke from Anutech in the School has greatly assisted in identifying opportunities for industry interaction and commercialisation. The School in currently involved with 3 'spin off' companies and a further company is very likely to be set up in 2004 to further the commercialisation of an innovative silicon-based high density memory device. In addition, the School has taken great strides in building interactions with industry by attracting them to partner with us in grant applications, for example, ARC Linkage, ACT Government Knowledge Fund and DITR/Innovation Access and AusIndustry Schemes. It is hoped that such interactions will build to much larger and better funded joint ventures in the future, as well as leading to new commercialisation opportunities.

The major program to refurbish the School's fifty-year old buildings continued apace during 2003. A new building, to be called the Erich Weigold Building, to replace the Roundhouse and other temporary buildings is complete and will be opened around mid-2004. This will enable the Atomic and Molecular Physics Laboratories and part of the Plasma Research Laboratory to be rehoused in modern facilities meeting current safety standards. Redevelopment of the eastern half of the Cockcroft Building is now nearing completion and the refurbishment of the western half will begin early in 2004. Despite this major capitals works program, there is much still to be done to ensure all our buildings have appropriate safety and other facilities for our staff. Indeed, our external funding success has resulted in an accommodation crisis that we are currently addressing with the university.

In terms of research highlights, there have been many that have gained international acclaim during 2003. Three achievements worthy of mention here are: the first demonstration of a working two-qubit quantum logic gate using an optical technology with solid state impurity sites that is the forerunner of a quantum computer; the development of a plasma thruster that is attracting much interest from the European Space Agency; and synthesis of novel materials that casts doubts on the validity of nanofossils and Martian life. A paper on the last topic has recently appeared in the journal *Science*. Overall, the research profile of the School has never been stronger and we look forward to the future with much expectation and excitement.

2 Local Strategic Goals

1 Enhance our International Reputation and Develop our International Roles

The School continues to enhance its many strong collaborative research programs with overseas universities, research laboratories and industry. For example, in 2003 there were around 264 such collaborations that resulted in either a joint publication or secured external funding. A further indication of the strength of our international collaborations is the number of our International Visiting Fellows, 75 in 2003. Recognition of the School's high international reputation comes in many ways. For example, during 2003, School staff received more than 85 invitations to give keynote presentations at international conferences and our staff hold membership of more than 19 editorial advisory boards of international journals or conference series.

2 Identify our National Roles

During 2003, RSPhysSE has continued to foster its national research role in many ways. For example we are:

i) the lead institution in the AusIndustry funded, Australian Materials Technology Network (AMTN).

ii) the lead institution in four ARC Network proposals (complex systems, advanced materials, nanotechnology, synchrotron science)

iii) continuing to develop major national facilities such as the H1-NF plasma fusion facility and the Heavy Ion Accelerator facility;

iv) playing a leading role in two CRCs (Functional Communication Surfaces and in the Australian Photonics CRC)

v) a partner in three Centres of Excellence: Australian Centre for Quantum Atom Optics, Centre for Ultrafast Bandwidth Devices for Optical Systems and Centre for Functional Nanomaterials.

3 Improve the Educational Experience of our Students

The School has initiated and continues to host a number of student prizes, awarded for excellence in research. The Carver Prize for the best student presentation during the Graduate Program in Physical Sciences Seminar Series in 2003 was awarded to Milica Jelisavchich and the Director's Prize for the best student research paper published in 2003 was awarded to Elliot Fraval.

The School was also pleased to introduce the Robert and Helen Crompton Scholarship for travel this year, made possible by a generous donation by Professor Crompton and his wife. The School hopes to encourage academic excellence amongst its students by rewarding high achievers with this scholarship which enables them to travel overseas for study or to attend conferences.

We have a strong Honours year Program run jointly with the Department of Physics of the Faculty of Science, and have final year engineering students carrying out their projects in the School. The School also hosted several students from Flinders University, undertaking projects in nanotechnology.

4 Enhance our Research Performance

During 2003 the School was a major player in three ARC Centres of Excellence and two CRCs. In terms of overall research performance, RSPhysSE continues to be the benchmark nationally, clearly leading in terms of the quality and impact of research publications, international recognition of academic staff by way of awards, invitations for keynote talks, reviews, editorial boards and election to office bearer positions in professional societies. These research indicators will form the basis for allocation of the School's recurrent budget in future years.

5 Enhance our Role in Research Training

During 2003, the School continued its student recruitment efforts, the most significant single event being the Inaugural National Physics Competition organised by Dr David Williams. See next section - Student Numbers - for details.

6 Continue to Develop our Staff

The School has recently appointed around 63 externally funded level A and B academic staff, and is widely considered an early career launching pad. At the other end of the academic spectrum, we have had three promotions to professor (Aidan Byrne, David Hinde and Wieslaw Królikowski). Several general staff from the School (Rana Ganguly, Anita Smith, Martina Landsmann) have participated in the ANU Career Development Scheme in 2003.

7 Develop a Comprehensive Information Plan for the University

During 2003, the School has upgraded its virus scanning of incoming mail and improved the accessibility of web email - especially important to those working from home such as staff on maternity leave.

The School's Departmental Administrators have all attended centrally run courses to help train them in the use of the new ESP system and School staff continue to contribute to the evolution and improvement of this system.

8 Seek Appropriate Partnerships and Alliances, both Academic and Business

Much of the School's research into advanced materials has commercially attractive technological spin offs and as always, RSPhysSE has capitalised on this wherever possible. For example, in 2003 a partnership was developed with Intel, based on phase change memory technology developed in the School.

The School has academic partnerships with a range of other research organizations (more than 150 in total).

The School is also continuing to pursue commercialisation of its BushLAN technology, infrared imaging, nanotubes, plasma ion sources, etc.

9 Improve our Professional (Consulting) Activities

Staff of the School have been involved in local, national and international scientific committees, boards and business ventures. For example 55 of the School's staff provided services to outside organisations in 2003.

10 Develop Asset Maintenance Plan

During 2003, the School assisted the University in a major asset evaluation exercise for insurance purposes. This was quite a major undertaking since the School has the largest value of material assets on campus totalling roughly $150m

11 Diversify Funding Base

The School has always actively sought external funding and 2003 has been an extremely successful year in this regard. Our successes in ARC funding and other competitive schemes means that by 2004 we expect 55% of our academic staff to be externally funded.

12 Budget Performance

The School has effectively ended 2003 with a balanced budget after accounting for carryovers to cover commitments for equipment, student support, residual planning and performance funds and ongoing staff salary commitments. The School also carries a $1.1 million University Restructuring and Retirement Scheme (URRS) deficit which has been held since June 1999. A strategy has been developed to pay this debt back to the University over the next several years through regular installments beginning in 2005. The School also borrowed $1.15 million in 2003 from the Development Bank for the purpose of funding a three-year lease and buy back arrangement for research equipment with RPO Pty Ltd, a School spin off company.

The School has again been very successful in attracting external funds during 2003. Over half (about 55%) of its annual budget for 2004 (estimated to exceed $31 million) will be derived from external funds and over half of its active research staff (most of them early career researchers) will be externally funded in 2004. Most of this increased income has been obtained through success with ARC grants, a major share of which is committed to meeting salaries of early career researchers appointed at levels A and B, to work on these grants. However, despite this success, there is continuing to be a substantial pressure on the School's recurrent budget as a result of:

i) the impact of the recent round of enterprise bargaining on salary costs;

ii) the two-year phase lag between the arrival of increased RIBG, IGS and RTS returns that result from our research success and the research performance on which such returns are based;

iii) the need to use recurrent funds to leverage external funds such as Federation Fellowships, ARC LIEF grants, Centres of Excellence, etc.;

iv) an inability to charge overheads on all ARC and Government grants;

v) a shortfall between allowable salary overheads in some grants and those imposed by ANU; and

vi) the more than 200 active grants that have resulted in the necessity to recruit additional administrative staff (Finance and Human Resources) to cope with increased workloads.

At present the Recurrent funds are almost entirely (about 94% of it) consumed in funding School salaries or students' expenses, leaving external grants to fund almost all other research-related expenditure in the School. Strategies are being developed to free up more recurrent funds for existing and new research initiatives, thus giving the School more financial flexibility.

3 Summary Reports

Significant Achievements in Research and Training

In order to try to increase the ease with which information flows from the School's research to Marketing and Communications Division, we have decided to highlight a dozen or so topics of particularly important achievements and prepare a "new scientist" style article about each. These will be passed on to MAC and also published in lieu of the traditional "Research" section of the School's full Annual Report. Our topics for 2003 include:

- Nonlinear optics in optically-induced lattices - recent demonstrations of novel nonlinear optical effects with possible spin offs into new technologies
- Bend loss in optical fibres - new theoretical model to help improve optical fibre communications
- First demonstration of a two-qubit qantum logic operations in solid state impurity sites - the first tangible step on the road to a quantum computer
- Femtosecond laser writing and reading of 3D optical memory - high speed laser technology applied to all optical computing
- The missing link - solutions to a long-standing problem in nuclear physics
- The last ice age in Australia - data from glaciers coupled with novel superhigh sensitivity spectroscopy techniques developed at the ANU, leads to surprising conclusions about global warming
- Development of a new computed tomography system - providing high resolution 3D X-ray images of a variety of materials from rock to insects
- The role of the NO molecule in infrared auroral emissions - a radical new theoretical model of an important atmospheric molecule with implications to global warming
- Velocity-map imaging of photoelectrons
- The so-called fossils - ANU laboratory results casting doubts on nanofossils and martian life
- Plasma turbulence in the heliac - application of novel sensors and theoretical modeling to the study of plasma turbulence with a view to realising clean and economical fusion power
- Plasma thrusters - a novel ANU deep space engine attracting interest from the European Space Agency and NASA.

Gender Equity Performance

The School continues to pro-actively seek female academic staff members and encourage the career development of our current female academics. We are encouraged by our very well balanced student gender ratio (around 50:50 in 2003) and believe that this will ultimately lead to gender equity at the most senior levels whilst retaining a merit-based and equitable academic environment.

Student Numbers

The School pursued a number of recruitment strategies in 2003. One highly successful new event was the Australian National Physics Competition organised by Dr David Williams. Forty Five of the Country's top university physics students were brought to Canberra to participate in the competition and were given tours of the School and campus - naturally in the hope that they would choose to undertake their Honours and/or postgraduate study here.

Recent research performed by the Marketing and Communications Division, shows the University's newspaper advertising campaign to be working effectively in raising the profile of the ANU. What is particularly interesting is that students surveyed said that their first preference for obtaining further information was initially the internet, then to be followed up by printed material. This was seen as good news in RSPhysSE, since our student information focus has for several years been the web site. In 2003 the site was redesigned to become ANU style compliant and also to enhance the conceptual ease of navigation and remove any oddities that have resulted from its evolution. We

Left: PhD Student, Fenton Glass with the H1-NF

Right: The prototype ANU plasma thruster with some members of the development team

Above: Dr Hoe Tan with the new wet etch system

have for several years now been operating a forms-based system for visitors to request a student information pack to be mailed to them and, in 2003, 203 packs were sent in response to enquiries.

As part of our wider outreach to potential future students, the School again participated in the hosting of the National Youth Science Forum, taking 130 year 11 and 12 students over two weeks. Activities included tours of the major facilities and lab days where students were able to participate in experiments. The School also hosted the Siemens Science and Engineering Experience.

Major Prizes, Honours and Awards

School students and staff received many awards during 2003, including:

- Professor Barry Luther-Davies became the School's second Federation Fellow (the same award being made to Professor Yuri Kivshar in 2002).
- Professor Jim Williams was elected to the Australian Academy of Science
- **14** Centenary Medals awarded to School staff by the Australian Government in 2003. (Professors Barry Ninham, John Carver, Bob Crompton, Erich Weigold, Allan Snyder, Neville Fletcher, Jim Williams, Yuri Kivshar, Rod Boswell, Rodney Baxter, Bob Dewar, Kenneth Le Couteur, John Newton, and George Dracoulis.)
- **2** Fellowships of the American Physical Society were received by School staff (Professor C. Jagadish and Dr Mukunda Das).
- Professor George Dracoulis was awarded the 2003 Lyle Medal.
- The School's Electronic & Computer Units were awarded the Clare Burton Award for their support of Mr Dean Larkman.
- Michael Aggett was awarded the 2003 Council Medal for General Staff Excellence.
- Dr Mark Ridgway was awarded the Vice-Chancellor's Award for Excellence in Supervision.

New Grants

The School was delighted to note the award of its second federation fellowship to Professor Barry Luther-Davies in 2003. In addition to this the School has received very substantial external funds listed in detail in the *Contestable Funding* section on the next page.

Future Directions

Our research priorities for the future include initiatives in the following new and advancing areas:

- Research at the boundaries of physical science and biology.
- The physics of complex systems.
- Physics and the environment.
- Photonics, advanced communications and information processing.
- Materials science and nanotechnology.
- Full exploitation of our major national facilities.

In addition, it is part of the School's mission to commercialise and develop its intellectual property (IP) whenever possible. The School's commercialisation committee, along with Anutech, will continue to exploit the School's IP by seeking avenues for commercialisation from licensing, through industry contracts to establishment of start-up companies. To help facilitate this, Tony Cooke from Anutech is based within RSPhysSE.

Above: A new computer controlled mill arrives in the workshop

4 National Institutes

RSPhysSE has a heavy involvement in several of the National Institutes, though naturally the majority of our National Institute activities centre on The National Institute for Physical Sciences (NIPS).

Raising the public profile of the ANU, both academically and nationally, is a high priority for NIPS. We are achieving this by implementing the National Institute's Marketing and Communications Strategy, using a range of tailored events that are designed to raise awareness while strengthening and promoting our prestigious physical science research and teaching activities.

NIPS Coordinated Outreach Activities

The National Institute of Physical Sciences has a strong involvement with flagship national outreach programs such as the National Youth Science Forum, the Mathematics and Science Olympiads and the Science Circus. It is also involved in the Centre for Public Awareness of Science and the ANU Summer Scholarship Program; it facilitates the Adopt-A-Physicist Outreach Program; has strong involvement in National Science Week and the Australian Science Festival, and a leadership role in professional societies. NIPS also host lectures as part of the ANU Public Lecture Series and hold public fora, colloquia and seminars.

NIPS Priority Areas

The Physics and Chemistry of Matter, Interactions and Systems: research into the understanding and exploitation of fundamental phenomena involving atoms and molecules, their structure and interactions, electromagnetic radiation, materials science and complex systems.

Mathematical Theory and Tools: research to develop mathematics and exploit mathematical tools, including computation, that often underpin investigations not only across the spectrum of physical sciences and engineering but also across the biological and social sciences and through to diverse applications for industry, medicine and government.

Earth and Astronomical Sciences: studies of complex phenomena that control the make up and behavior of the Earth and Space, from geophysical and geochemical processes relevant to mineral resources to the astrophysical ones underlying the origin of planets, stars, galaxies and the Universe.

5 Contestable Funding

Of the 57 Discovery applications that the School submitted as lead, we have been successful in 21 (roughly 37%) with total funding over the next five years of:

2004 $2.158m

2005 $2.153m

2006 $2.073m

2007 $0.2m

2008 $0.1m

Our 17 proposals represent about 18% of the 95 ANU (IAS and Faculties) total and the ANU (based on our initial information) has the best success rate of the major research universities.

In addition to this the School has the leading role in three major Linkage Infrastructure awards, each of over $500,000 in Nuclear Physics, Electronic Materials Engineering, and Atomic and Molecular Physics Laboratories (these will draw additional support from the Major Equipment Committee also). The School picked up 3 of 4 such awards granted to the ANU, a great success rate. We also have a significant share in a number of other externally-led Linkage Infrastructure awards.

In other Linkage categories (Projects, Fellowships and Awards) staff in Theoretical, Laser, Nuclear Physics and Applied Maths have been successful with grants totaling $440, 000 for 2004-2006.

While our Discovery success rate (37%) is lower than in 2002 this is perhaps to be expected, and we still remain well above national average which has dipped to ~25%, largely, it would appear, as a result of more money being awarded per grant.