7 The Fifth Decade 1998-2008 – quality and renewal

The new century was to bring with it new challenges and a change in the manner that many perceived the world. On the eve of the new century, Australia hosted the 2000 Olympic Games and this brought a new sense of achievement and optimism. Within a year this would change with the dramatic events that occurred in the USA on 11 September 2001 and terrorism now became a major concern.

Education became a major focus of both the Government and the Labor Opposition. In 2002 the Government implemented a high-level review of higher education. The review was extensive and was characterised by the publication of a series of discussion papers, consultations and reports. All areas of higher education were addressed including the policy framework, learning experiences and regional engagement, efficiency and effectiveness, governance and management, workplace relations, financing, specialisation and unnecessary bureaucratic restrictions. Quality of outcomes and the process to make it easier for universities to commercialise the results of research were addressed - each of these becoming more important as the decade progressed. The Replacement Research Reactor Project at ANSTO was fully funded by the Australian Government and proceeded without dela.

ANSTO finally bade farewell to HIFAR, which was shut down on 30 January 2007, just a year short of its 50th birthday. HIFAR was replaced by OPAL (Open Pool Australian Light Water Reactor), which went critical on 13 August 2006, reached full power on 3 November 2006, and was officially opened on 20 April 2007 by the Prime Minister, John Howard. It was then shut down on 27 July to deal with a fuel assembly problem. It returned to full operational power on 23 May 2008 after a ten month shutdown following approval by the nuclear regulator, ARPANSA to use a modified fuel design. OPAL promises to provide a new and exciting tool for neutron-scattering studies well into the future.

The initial suite of eight instruments includes at least two which are among the best in the world. The instruments now under commissioning are:

- Echidna - a high-resolution powder diffractometer
- Platypus -a reflectometer
- Taipan - a thermal 3-axis spectrometer
- Koala - a quasi-Laue diffractometer
- Quokka - a small-angle neutron-scattering spectrometer
- Wombat - a high-intensity powder diffractometer
- Kowari - a residual-stress diffractometer
- Pelican - a polarisation analysis spectrometer

The quality of the science expected to come from these neutron instruments required early preparation and education of the scientific and engineering community. This was done by means of a number of initiatives. ANSTO coordinated user meetings for each of the instruments in 2004 and AINSE provided the necessary travel and accommodation support. AINSE ensured an increasing number postgraduate scholars had access to neutron-scattering facilities. Conferences focusing on the various neutron-scattering techniques were held at a higher rate than those in earlier decades. An annual neutron school commenced in December 2007, and is to be run each year. It will ensure that experimental techniques are within the grasp of research students and young career researchers.

Meanwhile, the AINSE Executive Committee, the Council and Executive Secretary focused on new initiatives and administrative flexibility to enhance members' interests and benefits as well as the quality issue.

The 2003 AINSE Strategic Plan and the associated review of the Institute's mission and goals in the context of changing national and academic polices, was developed to guarantee robustness in AINSE's performance. In addition to AINSE's continued support for traditional functions in other areas more attention was given to broadening the membership and generating income from international conferences.

There was a strong influence from the Research Assessment Exercise (RAE) in the UK which provided a framework for the comparison of research outcomes, and the Australian Government established plans to establish a research quality framework (RQF) in Australia. The Labor Government, when elected in 2007, rejected the RQF and announced another plan in early 2008.

Restructuring at ANSTO

One of Ian Smith's reforms at ANSTO was to restructure the ANSTO Research Divisions.

New groups were to be called Institutes. The Physics Division was split up and the neutron-scattering group was the first Instiute to be named. It is now known as the Bragg Institute, and it was named in honour of Australians William and Lawrence Bragg, who jointly won the 1915 Nobel Prize for Physics for pioneering the analysis of crystal structures by means of x-rays.

The accelerators from the Physics Division with their research and technical staff were put with the Environment Division resources. This was then called the Institute for Environmental Research.

Materials Division became the Institute of Materials Engineering.

Radiopharmaceuticals Division became the Radiopharmaceuticals Research Institute.

With broadened outreach in science and technology and excellent new facilities it was essential for AINSE to impose goals for the highest quality work in the new millennium. Benchmaking in this respect would assist in providing objective as well as subjective means of measuring AINSE's performance on a cumulative basis.

Under the leadership of John White, President 2005 and 2006, the records of research output reached a new level.

7.1 Benchmarking 2004

The 2003 AINSE Strategic plan reinforced the statement that*:*

> *AINSE's mission is to advance research, education and training*

and so a goal of any strategic plan must be to improve how the Institute performs in this core area.

At the AINSE Executive Committee meeting of 6 February 2004, Dennis Mather distributed a paper entitled 'AINSE's Mission'. At that meeting it was decided that John White and Rob Robinson, Head of ANSTO's Bragg Institute, would prepare a paper to be considered by the Executive Committee well before the May meeting in connection with Goal 2 of the AINSE Strategic Plan agreed by Council in December 2003:

> *By the end of 2008 the research performance of our scientific outcomes will have increased substantially*.

Two strategies were employed.

1. *AINSE will undertake a benchmarking exercise in 2004 to evaluate our current performance and will continue thereafter to monitor our progress towards this goal and will establish a set of performance targets.*
2. *AINSE will continue to develop its peer review processes with an emphasis on the quality of proposals and their outcomes.*

A detailed comparison of the performance of AINSE-supported university-based neutron-scattering research with that undertaken solely by the research scientists at ANSTO's Bragg Institute - both with access to HIFAR and overseas neutron facilities - was made. To this end a paper, distributed initially to the Specialist Committees for comment in October 2004, was presented to the AINSE Council in December 2004 with an introductory rubric stating

> *The objective therefore of the present paper is to apply a broad set of indicators and promote discussion of any differences between the outcomes measured by these indicators for the different subject groups.*
>
> *In this survey of AINSE's activities we look at the **inputs** and the **outputs** and make some preliminary assessment of the **outcomes** from the time and money spent as inputs. We attempt to measure also the recognition obtained from papers and other outputs that the program has produced over the last five years in the area covered by the Structure and Dynamics (Neutron) Specialist Committee where Rob Robinson has kindly facilitated a comparison with ANSTO's own performance.*
>
> *The comparison showed that the science from the two groups was high quality and also indicated positive outcomes both from the technique and the AINSE/Bragg Institute collaboration. The authors believe it would be of value to extend this benchmarking exercise to the other AINSE specialist areas and to add additional performance indicators to the outcomes such as those mentioned in the early parts of this paper.*
>
> *The authors request the AINSE Council and the specialist subcommittees to give consideration for ways to improve our understanding of the demonstrable value of the AINSE/ANSTO collaborative process.*

A total of over 466 publications were included in the analysis. In order to illustrate the collaboration between AINSE members and ANSTO's Bragg Institute the papers were sub-divided into those with only Bragg Institute authors (160 papers), and those with only AINSE authors or those with authors from both AINSE and the Bragg Institute (134). In order to get some idea of the citation rate from these two categories the number of citations per year from the two categories has been normalised by 1.6 and 1.34 respectively. These normalised citation data for 2002, 2003 and 2004 are shown in Figure 4.

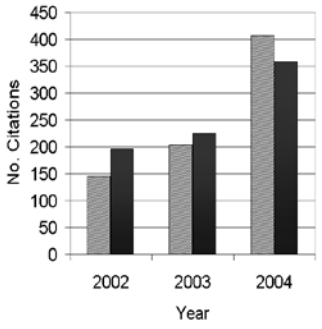


Figure 4 Normalised Citations/Numbers of Papers Considered/ Per Annum

Shaded = AINSE. Black = Bragg Institute

7.2 Membership

In May 1996 Professor Andrew Glenn, Pro Vice-Chancellor, Research at Murdoch University notified AINSE of his intention to withdraw the university from membership effective at the end of 1997. In 1996 Murdoch University had paid $7,700 (the second lowest level) for membership subscription and Andrew Glenn felt the university was not getting good value for this contribution. The number of staff applying for AINSE/ANSTO facilities had reduced to the point where applications were intermittent and, together with the overall scarcity of funding for the university, were probably the drivers for the Pro Vice-Chancellor's decision.

At the time, Bruce Mainsbridge, who had been AINSE Councillor from 1985 to 1991 had become involved in a (non AINSE related) protracted and high-profile legal action against Murdoch University. This action may have reflected on AINSE within the university and may also have been a factor in the Pro Vice-Chancellor's decision to withdraw from membership.

Murdoch University was absent from the fold for a very short period. By the beginning of 1998 Murdoch had an interim PVC(R), Kateryna Longley, and AINSE had a new Scientific Secretary. They met in August 1998 with Stephen Thurgate, AINSE Councillor at Murdoch University to discuss issues, opportunities and strategies and shortly after this meeting Murdoch University decided to rejoin AINSE from the beginning of 1999.

In December 1998 the University of Ballarat advised that it was considering leaving AINSE, for much the same reasons as Murdoch. The University of Ballarat's membership was on level 1 (the lowest level) of the membership scale. The Scientific Secretary met with the Deputy Vice-Chancellor, Research, Kerry Cox, and also provided briefings to staff on the opportunities for research at ANSTO. This visit, together with a subsequent visit in early 1999 with the AINSE Vice President Ron Cooper, stabilised the situation and the University of Ballarat remains a member of AINSE.

Both of these instances of membership restlessness signalled the growing stress being felt in some universities, which was a reflection of reforms in the tertiary sector. This was identified by the Executive Committee as a threat to AINSE and to ensure the integrity and comprehensiveness of its membership, AINSE moved to design a membership category to cater for those universities which were not regularly winning research awards but could still see the value of retaining membership with a low membership fee.

The notion of an Associate Membership had been discussed in the early 90s but at the Executive Committee meeting in February 1993 it was agreed *that introduction of an Associate level of AINSE membership should not be reconsidered at this time*. The option to discuss the idea of associate membership at some future date was, however, left open.

Two issues that faced many of the newer universities were:

1. for universities which had previously been TAFEs or CAEs, the bulk of their staff were teachers more than researchers;
2. regional universities focussed on local issues, research into which commonly did not require access to the large instrumentation at ANSTO.

As a result, these universities have generally had a lower requirement for the facilities on offer through AINSE. Typically these universities have had only one or two members of staff, and their postgraduate students, active in AINSE programs. Frequently these staff members did not seek AINSE support every year. When these staff moved on to other appointments their replacements would have their own research interests which may not have required access to ANSTO facilities. In these cases the university paid a membership subscription with very little in return and when funding became critical for the university, AINSE membership would be under review and possibly under threat.

In December 2000, Council agreed to introduce a new membership level to cater for those universities on level 1 who had not received a 3:1 benefit for a number of years.

Universities on the new level 0 were able to continue sending students to the Winter School, receive conference support, receive copies of minutes of Council meetings and, should a need emerge, access to research facilities at ANSTO could be rapidly facilitated. A university would become eligible for level 0 if it had not had a research award in the previous two years. When one of these members received a research award, the membership level would be reviewed in the following year. The membership fee for level 0 was set at $2,000 per annum. A Councillor from such a university would be invited to attend council meetings at their own expense as a non-voting member. In this way the AINSE Council has been able to continue to include most

Associate/Professor Ron Cooper, when AINSE President 2001 and 2002

Associate Professor Ron Cooper

was the University of Melbourne Councillor from 1989, AINSE President 2000 - 2001, chair of the Radiation Science Specialist Committee 1988 - 2001, and a founding member of the AINSE Winter School Committee, designing the radiation science program. Ron was instrumental in organising Australia's membership of the International Association for Radiation Research (IARR) with AINSE as the umbrella organisation. In 2003, the IARR held its World Congress of Radiation Research in Brisbane under AINSE's auspices and Ron together with other AINSE members organised a highly successful and profitable congress.

Ron completed a PhD in radiochemistry under the supervision of Don Stranks. Ron moved to the University of Melbourne in 1961, becoming a Senior Lecturer in 1968 and Reader in 1979. He retired in 1996 as Associate Professor and Reader. During this time Ron was awarded the David Syme Research Prize (1984), elected as a Fellow of the Royal Australian Chemical Institute and elected as an AINSE Honorary Fellow (2003). He held visiting positions at Argonne National Laboratory (1970-1996), ETH, Zurich, Switzerland (1975), and the Technical University of Delft, The Netherlands (1986).

His research focused on the chemical and physical changes produced by ionising radiation. Initially the stability of fluorocarbon gases was examined since these gases were being considered as coolants in gas cooled reactors. Towards the end of his career he looked at the impact of irradiation on ceramic oxides, for fission product immobilisation, in collaboration with the solid state division at ANSTO.

As President of AINSE Ron dealt with two major issues. First, the financial impact of the dramatic slump in the Australian dollar against the euro in 2001 while purchasing the STAR accelerator, and secondly, the issue of not being able to find an insurance underwriter for STAR (Section 7.5.3).

of the Australian universities as members of the organisation.

New members in this decade included: The Australian Catholic University, which joined AINSE in 2001, and a number of New Zealand members. GNS Science, which had been supporting and participating in the University of Auckland's membership, joined as a full member in 2004. The University of Canterbury joined in 2005, followed by the University of Otago in 2006. At this point AINSE Council agreed that membership for New Zealand universities should be based on a 2:1 benefit ratio.

In 2006 AINSE now had 36 Australian university members and four New Zealand members, plus ANSTO. AINSE today counts amongst its members essentially all Australian universities which have active research programs in the sciences.

7.3 Finances

During this decade, member universities have enjoyed an average benefit of more than the target of 3:1 (Table 15). These maximised benefits have been made possible by three major factors: the success of AINSE in gaining ARC LIEF support for infrastructure projects; the successful management of two international conferences, each of which returned a healthy surplus to AINSE; and a reorganisation of the staffing at AINSE which helped contain salaries and on-costs.

Table 15. Membership benefit ratios 2000 - 2006

Benefit ratio	2000	2001	2002	2003	2004	2005	2006
One year	3.23	3.39	3.61	2.99	3.13	3.06	3.24
5-year average	3.41	3.31	3.36	3.25	3.27	3.24	3.21

In 1998 and later in 2001 another subscription level was added at the top; 20% higher than the previous top level. This is indicative of AINSE's continued growth and in the use made of AINSE programs by some universities. At the other end, in 2001 AINSE had introduced level 0, to allow the universities to remain members even if they had no current AINSE research awards or studentships. The subscription rate for membership at this level was initially set at $2,000 and has been indexed since 2002 along with the other levels of membership.

The annual review of subscriptions for 2007 averaged benefits over three years rather than five. This allowed the membership subscriptions to follow more closely variations in demand at the universities.

Today there are 15 levels of AINSE membership starting at about $3,000 for level 0 and increasing by 20% increments to about $100,000 for level 14. Universities with greater demands on AINSE services pay more. This ensures that university members pay a membership fee based on their actual use of AINSE programs.

In 2000 the Commonwealth Department of Finance and Administration undertook a review of ANSTO's facility charges. The Department did not accept ANSTO's pricing policy for facilities and they provided ANSTO with a formula to calculate facility charges. This formula was applied to the AINSE facility prices from 2001 and resulted in an average increase in facility prices of 10%. However, the charges for neutron-scattering facilities increased by over 300%, reflecting the fact that AINSE had not been paying anything like true cost for many years. While this caused considerable stress in the AINSE budgets for the next three years, the Executive Committee took the decision to cover the shortfall out of accumulated funds so that the quantity of research should not be compromised.

Just as the benefit ratios were starting to return to the benchmark of 3:1, the Commonwealth provided ANSTO with funds to operate a full-service user program at OPAL based on open internationally competitive peer review as occurs at other leading centres around the world, and ANSTO decided not to charge for neutron-scattering instrument time for nonproprietary proposals from 2007. This

Dr Ian Smith, CEO of ANSTO 2004 - 2008

Dr Ian Smith

Ian Smith first was introduced to Lucas Heights as an undergraduate when he came as a vacation student at the AAEC between years three and four in his engineering degree at the University of Queensland. During this period he learned about AINSE and he decided to submit an application for an AINSE studentship which was successful. He completed his doctoral studies in 1969.

Ian Smith said *My time at Lucas Heights was made exciting by the inspirational people who I worked with. These included Brian Hickman, who was head of the Materials Division, and Terry Walker, who went on to become Executive Director of the AAEC and first CEO of ANSTO.* His sense of excitement was enhanced by the political environment at that time, when the government had plans to develop a nuclear industry in Australia.

Ian Smith then took up a post-doctoral post at the University of Queensland and wasted no time in applying for AINSE funds to support continued research at Lucas Heights. Three consecutive AINSE research awards in 1971, 72 and 73 provided a kick-start to his career. He became a lecturer in 1972. He then rapidly established a substantial research group which included five postgraduate students and one postdoc. He became head of department in 1985.

Between 1989 and 1995 he worked in Western Australia first as General Manager, CRA's Advanced Technical Development Perth Facility and then as General Manager, Comalco Research Centre, in Melbourne. He then returned to academia as Deputy Vice-Chancellor (Research, Enterprise and International) at Otago University.

Ian Smith became CEO of ANSTO in May 2004 with a clear view that Australia would come to realise that it needed a nuclear industry particularly if it was to meet its greenhouse obligations. On his time at ANSTO, Ian Smith said that he hoped that the scientific standards had been raised, and that the research directions had been refocused on nuclear research, not only for power but also in medical applications and in the environmental arena. He concluded his term at ANSTO in May 2008.

Ian Smith believes that AINSE has a very good track record in training young scientists and technicians and he believes that this is where the organisation's future focus should be.

decision caused AINSE to reconsider the way member benefits are measured, and this chapter is yet to be closed.

Since 1990, university subscriptions have been based on tangible benefits received by researchers and their students. These benefits are measured in dollars and by not charging for neutrons the provision of access to these unique facilities in Australia would not be reflected in AINSE membership subscriptions. Finally AINSE agreed to provide $200,000 pa in support of 'training proposals' for access to OPAL. These proposals would be submitted by Australian academic researchers with little or no experience in neutron-scattering techniques. AINSE continues to provide travel and accommodation support to all successful neutron-scattering applicants from member universities. While this meant that AINSE was paying for access to the OPAL neutron-scattering facilities, it is a measure of AINSE's commitment to education and training in neutron-scattering in that it is prepared to underwrite this cost.

7.4 Governance and process

7.4.1 Governance

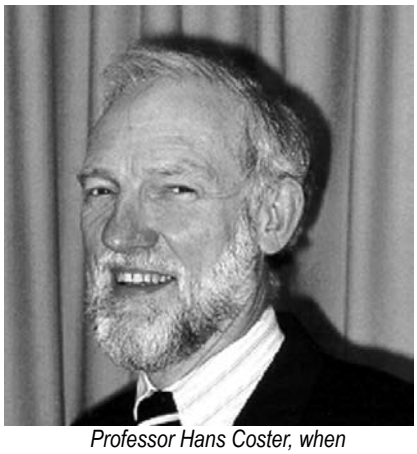
The Memorandum of Agreement between AINSE and ANSTO was reviewed and renewed at the end of 2002. Negotiations leading to this third Memorandum of Agreement had fewer problems than the first. The basic structure of the agreement remained the same as that in the first and second Memoranda although in this new agreement the words … *measures to generate more AINSE resources via external funding, to provide increased facility access should be devised and implemented* were included. The Agreement was signed on 6 December 2002 by the President, Associate Professor Ron Cooper and ANSTO Executive Director, Professor Helen Garnett at the second Council meeting of the year. This agreement was to conclude on 31 December 2005. By this time ANSTO had a new Chief Executive Officer, Ian Smith, who had joined ANSTO in May 2004.

The fourth Memorandum of Agreement was signed by Ian Smith for ANSTO and John White for AINSE on 21 December 2005 for a period of five years and it was a much longer document than the previous one because it needed to take into account the special arrangements relating to access to the STAR and OPAL facilities. STAR is an accelerator acquired by AINSE under a LIEF Grant in 2000 with the assistance of 26 universities plus ANSTO. Ownership was transferred from AINSE to ANSTO at the beginning of 2007.

7.4.2 Strategic plan

In 2003 the Executive Committee, with the strong encouragement of the President, Professor Hans Coster, decided to develop a new strategic plan for the Institute. The Committee was particularly keen to broaden the membership of AINSE to include museums, hospitals and other research establishments. This was considered by some to be a delicate issue and the President was engaged in extensive lobbying on this issue. He approached the Councillor for Murdoch University, Professor Stephen Thurgate, who had considerable recent experience in developing strategic plans to assist and provide guidance to the Executive Committee on this matter. This new plan was put together during Helen Garnett's final years on the AINSE Executive Committee and was presented to and endorsed by the Council at its meeting in 2003. The plan included the possibility of facilities, additional to those at ANSTO, becoming available through AINSE. In particular, the facilities at GNS Science in New Zealand were considered as an example. The possibility that AINSE might provide university access to the new Australian Synchrotron was also considered by the Executive Committee and the President explored the possibility that the Federal Government provide a dollar-for-dollar contribution similar to that which it originally agreed to provide for AINSE access to the ANSTO facilities. The Minister for Science, Peter McGaurin, gave a sympathetic hearing to this proposition in a meeting with Professor Coster and later at a meeting at the University of New South Wales in 2003.

As part of the new plan, the Scientific Secretary and the President made several trips to New Zealand to recruit New Zealand members and to lobby for New Zealand government support to provide the dollar-for-dollar contribution to allow the New Zealand members to receive full benefits on par with the Australian University members. It proved difficult to get the New Zealand Government to commit to making any contibution, although they had



Professor Hans Coster, when AINSE President in 2003 and 2004

Professor Hans Coster

Hans Coster has had a very long association with AINSE, initially through consultations with the Scientific Secretary Bill Palmer, later as the University of New South Wales (UNSW) Councillor, adjunct (invited) member of the Executive Committee on some occasions, and later as a member of the Executive Committee, Vice President and then President. He was a Member of the AINSE Council in 1981, 1985, 1989, and 1990 and from 1992 to 2000, Vice President in 2001 and 2002, and President in 2003 and 2004.

Hans Coster was particularly keen to broaden the scope of AINSE and extend its membership to other research institutes both in Australia and New Zealand. He was pivotal in discussions leading to Council's adoption of a broader strategy on this matter, although in the end only some New Zealand Universities became members of the Institute.

His primary interests were in the general field of Biophysics and in 1986 he established the Department of Biophysics in the School of Physics at UNSW. (The Biophysics activities at the University were initially started by Professor Paul George in the late 60s. Paul George served on the AINSE Council in 1964 and 1965, 1967 and 1968 and from 1973 to 1979). Hans Coster's primary research interests were in the structure and properties of cellular membranes and biomimetic lipid membrane constructs. He applied many different research tools to the endeavours, including low angle x-ray and neutron-scattering techniques as well as developing a very high-resolution impedance spectroscopy method to obtain the dielectric structure of these systems.

Hans Coster is currently Director, Biophysics and Bioengineering, School of Chemical and Biomolecular Engineering, University of Sydney.

expressed support for such a scheme in meetings with AINSE.

The strategic plan operated from 2003 to 2007. In the end no non-university members were recruited into AINSE, partly because of the complications arising from the fact that government support for AINSE paid through ANSTO would not be available for non-university AINSE members.

Stephen Thurgate led the discussion on strategic planning at the December Council meeting in 2007. In early 2008 a new strategic plan was considered by the Executive Committee and the changes were encouraged at the May 2008 Council meeting. In this strategic plan the main feature is a return to core business. AINSE was no longer looking at introducing facilities beyond ANSTO, nor was it canvassing for membership outside the tertiary sector although it left open the possibility of accepting new overseas university members.

In late 2007 AINSE received a letter from the regulator of incorporated associations in New South Wales, the Department of Fair Trading pointing out that AINSE was trading well beyond their guidelines for an association incorporated in NSW, with recurrent income in excess of $3 million pa, and operations covering all states and territories in Australia and New Zealand. AINSE then set about registering with the Australian Securities and Investments Commission as a company limited by guarantee. This process is continuing at the time of writing.

At the same time AINSE set about establishing a charitable trust with deductible gift recipient status, to receive donations and to finance student scholarships and research fellowships. It hoped to have a better response this time around, in comparison with that in 1961 when companies were requested to give donations and a £1,150 was raised. See Section 3.3.

7.4.3 Council

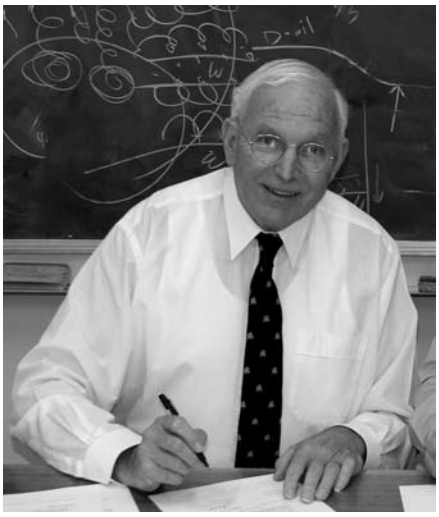
Much has been made of the length of service of Councillors and certainly in the first few decades a tradition was established whereby Councillors would serve AINSE for long periods. This longevity of service would deliver positive results. In 1977 the average length of service of a Councillor was 9.6 years; however, by 2007 the average length of service of a Councillor had reduced to 5.65 years (Table 16). This was probably a reflection of the changed work environment in the tertiary sector and in the community at large over that period. The higher turnover facilitates the continuing input of new ideas and approaches in Council.

Table 16. Average years of service for Councillors 1977 - 2007

Year	1977	1987	1997	2007
Average service (yrs)	9.65	8.5	6.24	5.65

The length of service of Executive Committee members has been raised in discussions. In the normal course of events, people elected to the Executive Committee will have already spent an average of eleven years on Council. Then when each member on the Executive Committee participates in each position for the usual two-year period, the President would retire after six years on the Executive Committee and in many cases be invited back for a seventh year as immediate Past President on the Executive Committee making a total average commitment to AINSE of 18 years. While this arrangement might have been comfortable in the 60s and 70s when people stayed in jobs for longer, this may no longer be a reasonable expectation.

The selection of the Councillor is at the discretion of the Deputy Vice-Chancellor, Research, at each university. AINSE has not achieved gender equity in terms of representation on Council, and once again this probably reflects trends within universities and the predominantly male balance of students and staff in the physical sciences and engineering. Robyn Crumbie, Councillor for the University of Western Sydney from 1993 to 2006, was the first Councillor for this university. Her fourteen years service on AINSE Council makes her the longest serving woman. Helen Garnett, Executive Director of ANSTO, sat on AINSE Council from 1992 until 2003 and while this is a shorter time, it must also be kept in mind that she was also a member of the Executive Committee for the entire period. Her considerable contribution to the organisation through her vigorous participation in Council and Executive Committee meetings and her active lobbying for AINSE in external fora are acknowledged. In 2008 three of the 45 AINSE Councillors were female.



Professor John White, when AINSE President 2005 and 2006

Professor John White CMG FRS FAA

John White was AINSE president in 2005 and 2006. He has been AINSE Councillor for the Australian National University from 1988 to 1991 and 2001 to 2008. He has chaired the neutron-scattering specialist committee. During this time John has been a tireless advocate for AINSE as a vehicle for facilitating excellence in research and for the promulgation of this message throughout the wider academic and political community.

His research interests are in the use of neutron scattering and x-ray scattering to understand the structure of matter, particularly for novel compounds which may be of commercial interest.

Before taking up his position at ANU he was director at ILL.

He has maintained an interest in using the most powerful neutron sources – particularly ILL and ISIS. In this respect he has been the most active of the Australian researchers using ISIS over the past ten years. He has conducted 56 experiments since 1998 utilising 133 days on the SURF and LOQ instruments. This work alone has resulted in 31 publications.

He has held seven AINSE research awards between 1996 and 2007, and supervised one AINSE PGRA scholar, Adam Perriman.

7.5 Research achievements

7.5.1 Neutron scattering

AINSE support for neutron-scattering continued into the 00s. This involvement included the development of instruments on HIFAR, the provision of research awards, postgraduate scholarships and research fellowships as well as access to ISIS.

Grants and Funding. Following the success in the ARC infrastructure grant schemes through the fourth decade, one last grant relating to instruments attached to HIFAR was gained in 1999. This grant was for a cryomagnet for powder diffraction and a reflectometer. At this time it was clear that a replacement reactor would be commissioned in about five years and that the neutron beam instruments at HIFAR instruments would largely become redundant, so no further ARC funding was sought for HIFAR instrumentation.

As a result of the Carver Report (1985), ASTEC established a Working Party under the Chairmanship of Professor D J Nicklin and including two people known to AINSE, John White and Hans Freeman. Fifteen submissions were received from interested parties, including. 'A Strategy to Introduce High Technology into Australia' from John Boldeman from ANSTO. The report entitled 'Small Country – Big Science' (1990) produced a set of recommendations on Australian participation in major international scientific research facilities. ANSTO endeavoured to obtain department funding for the main recommendations, however, this was not successful. Consequently, it was decided to fund these internally with outside support and in 1992 ANSTO decided to contribute $400 K per annum to ISIS, Oxfordshire, UK (the most powerful spallation neutron source in the world). ANSTO also obtained a grant from the Department to station a representative at ISIS who participated in the construction of a new instrument called SURF.

Up until 1997 ANSTO had paid the Australian membership fee to ISIS - which allowed Australian researchers to compete for beam time in two rounds each year. In that year Helen Garnett proposed that AINSE take over the payment of the ISIS membership fee and Council agreed. The decision meant that AINSE would be responsible for sourcing an annual payment of AU$400,000. AINSE then applied to the ARC RIEF scheme for financial assistance. The first application succeeded and $350,000 was granted for 1998. The remaining $50,000 was provided by AINSE and ANSTO.

The ARC RIEF proposal for access to ISIS in 1999 was unsuccessful. AINSE's Scientific Secretary then negotiated with DEST throughout 1999 and finally managed to secure the funds needed for the membership fee. By the time of the 2000 round, the ARC had renamed the RIEF scheme and the new LIEF scheme required all participating organisations to make a financial contribution to their proposals. In this round $255,000 was obtained from the ARC with the balance being made up with contributions from seven universities: the University of Sydney, the Australian National University, the University of Queensland, Curtin University of Technology, the University of Newcastle, Griffith University, the University of New South Wales as well as ANSTO and AINSE. With the exception of 2007, when the application was again unsuccessful, the ARC has contributed a steadily reducing amount to this membership fee which has remained at $400,000 pa.

In 2008 a five-year LIEF grant was won which contributes $200,000 pa to this membership fee. The remainder of the $400,000 pa fee will be shared by the participating organisations, which in addition to those mentioned above now includes the University of Adelaide, Monash University, and the University of Melbourne. The number of universities contributing has steadily increased to ten. This considerable investment has provided an average of 19 refereed publications per year since 2000.

Access to ISIS has allowed the quality of Australian research at this facility to be judged against international standards. AINSE has monitored the success of Australian proposals in the ISIS peer review process and found that Australian researchers win between three to five times that which the Australian subscription could buy at the standard daily rate. This success is a testament to the high regard in which these Australian scientists are held within the international community.

ISIS has also provided for access to instruments which were not available in Australia. Australian researchers have been highly regarded at ISIS and several have served on the ISIS committees which assess proposals including Ian Gentle (the University of Queensland), Evan Gray (Griffith University), Philip Reynolds and John White (the

Emeritus Professor Brian O'Connor, when AINSE President in 2007

Emeritus Professor Brian O'Connor

Brian O'Connor's association with AINSE commenced in 1964 as a PhD student at the University of Western Australia (UWA) where his mentor was Ted Maslen. His exciting introduction then to neutron diffraction via AINSE profoundly influenced his career choices. He then moved to AERE Harwell as a Research Fellow where he worked, together with DPhil student Frank Moore (later to join AINSE), B T M Willis and Nobel laureate Dorothy Hodgkin of Oxford University, on an epic neutron diffraction study of vitamin B12.

Brian returned to UWA in 1968 as a QEII Fellow during which he made extensive use of HIFAR for electron-density studies. He then joined the WA Institute of Technology (later Curtin University of Technology) where he established a materials research group (now the Curtin Centre for Materials Research) which makes extensive use of laboratory x-ray diffraction, neutron scattering and synchrotron radiation diffraction. During 35 years at Curtin, where he gained a Personal Chair as Professor of Applied Physics, he worked on the synthesis of advanced ceramics from Australian minerals, notably alumina-based ceramics. His use of neutron scattering over more than 45 years was recognised by peers in 2007 through the award of a Career Achievement ANBUG Medal for Contributions to Australian Neutron Science.

Brian served on the AINSE Council from 1990-2007, including five years with the` Executive which culminated in his service as AINSE President in 2007. During 1991 – 2006 he was a member of the AINSE Neutron Scattering Specialist Committee which included six years as chair.

Australian National University). Another measure of the esteem in which the regular Australian users of ISIS are held became evident in 2007 when the ARC application failed and AINSE was unable to pay the membership fee. The Director of ISIS, Dr Andrew Taylor, waived the membership fee for that year and encouraged Australian applications. The outcome for 2007 was a total of 32 days on various instruments at ISIS. This is nearly as many days as might have been expected had the membership fee been paid and was an outstanding outcome, especially given the long shut-down at ISIS in 2007 while a second target station was installed.

The unscheduled extended shutdown of OPAL from July 2007 to May 2008 was caused by the need to address the problem of dislodged plates in fuel assemblies. Before the reactor could return to service, approval by the independent safety regulator Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) was required. This meant that, as HIFAR had been shut down early in 2007, there were no neutrons available for experimentation until May 2008 when the reactor was restarted.

To help bridge the gap, AINSE provided travel funds to researchers who were able to demonstrate that they had successfully competed for peer-reviewed access to overseas neutron sources, but who were unsuccessful in gaining travel support from the Commonwealth Government's Access to Major Research Facilities Program. This action was essential for several groups with students who were relient on continuing access to quality neutron diffraction instrumentation.

Research Activities. An inspection of AINSE research awards for neutron-scattering reveals that a total of 1189 projects have benefited from AINSE funding over the past 47 years (Figure 5). The steady growth over time is reflected by the fact that 303 awards were made during seven years of the current decade (2000-2006, the last full year of AINSE Research Awards for neutron-scattering) compared with the total of 331 awards over the decade of the 90s. Clearly Australia's neutron-scattering research community remains buoyant.

The thrust of recent activities was again carried out by several major groups centred on the following lead investigators. It is also evident that the distribution of centres and their range of research topics has broadened, leading to an overall healthy distribution of expertise and interests across Australian science.

- Monash University leads the way with both Trevor Finlayson (16 AINSE research awards) and Trevor Hicks (15 AINSE research awards) maintaining their established research directions while also embracing new areas. As examples, Trevor Finlayson and his group besides investigating neutron residual stress measurements for welds in steel structures and pressure vessels, has explored phase transformations in shape-memory alloy single crystals and relaxation effects in triglycine sulfate ferroelectrics. Trevor Hicks and his group has revealed increasing diversity with neutron spectroscopy studies of heavy fermion systems near quantum critical points in addition to his more traditional interests in disordered and low dimensional magnetic systems.
- Brendan Kennedy of the University of Sydney and his group consolidated their investigation of the structures of perovskites and related materials with the aid of 15 AINSE research awards. Also from the University of Sydney, Chris Ling with his three AINSE research awards is investigating such topics as oxygen nonstoichiometry in misfit-layered cobaltites and the structural and magnetic ordering in transition metal doped Aurivillius phases, and is poised to make an increasingly significant contribution to the Australian neutron-scattering field. Siegbert Schmid is analysing defect perovskites suitable for Li ion intercalation.
- The increasing impact and contribution of the groups from Curtin University of Technology is also evident in this period with the award of a total of 27 AINSE research awards over the seven year period. Jim Low's work (10 AINSE research awards) has focused on determining structures in alumina and zirconia derivatives and ternary carbides. This research was conducted alongside surface analysis using SIMS and electron microscopy for materials which are intended for specific applications. Craig Buckley meanwhile mainly applied his ten AINSE research awards on the use of SANS on alumina and silica-derived materials, with particular interest in pore sizes while Roland de Marco (seven AINSE research awards) has focused on the design of a glass chalcogenide electrochemical sensor. In

Emeritus Professor Stewart Campbell

Stewart Campbell's love affair with neutron scattering began in the mid 60s when, as a vacation scholar at the UKAEA during his BSc (Hons) degree in Natural Philosophy at Aberdeen University, he carried out his first neutron diffraction experiment using the Harwell linear accelerator. Experience on the DIDO reactor during his MSc studies at Salford University with Professors Peter Webster and Graham Booth, proved an ideal background for his later PhD studies at Monash University when he was heavily involved in building LONGPOL in the early 70s with Trevor Hicks and colleagues.

The majority of Stewart Campbell's academic and research career in condensed matter and materials physics (magnetic materials in particular, using Mössbauer spectroscopy and neutron scattering) has been spent at the University of New South Wales, initially at the Faculty of Military Studies Campus, RMC Duntroon (1976-1979; 1983-1985), and then primarily at UNSW@ ADFA where he was promoted to professor. Stewart Campbell also enjoyed periods with Oxford Instruments (1974-1976) and the Australian National University (1979-1983).

Stewart Campbell's research students and postdoctoral fellows have followed a wide range of interesting careers; these include positions in the public service and universities in Australia (UNSW@ADFA, ANU and Edith Cowan) as well as academic and research appointments at universities in the USA and China.

He was appointed Emeritus Professor by UNSW in 2005 and remains fully engaged in research, while contributing to the continuing development of the Australian neutron-scattering community. Recent activities include terms on the AINSE Specialist Committee (2004-2007), ANBUG President (2005-2006), Program Advisory Committee for the Bragg Institute (2007-present) and currently chair/member of the Instrument Advisory Teams for three of OPAL's new instruments. Stewart Campbell was awarded the AINSE Gold Medal in 2007.

conjunction with SIMS he has used SANS and neutron reflectometry to understand the structures of the detectors.

- Stewart Campbell's group at UNSW@ADFA (nine AINSE research awards) continued its emphasis towards understanding the interplay between the structural and magnetic properties of rare earth intermetallic compounds. This has led to the discovery of a new family of quaternary intermetallic compounds. Other interests surrounded clarifying structural issues of strontium ferrite $SrFeO_{3-d}$ and related compounds and tracking structural and magnetic changes resulting from mechanochemical treatments of iron oxides.
- the University of Newcastle also remained at the forefront of neutron-scattering research via the activities of Robert Burns (8 AINSE research awards) and Erich Kisi (5 awards). Robert Burns' interests focused on the determination of the structures of various oxidation-reduction catalysts of the type $M'_3[PM''_{12}O_{40}]$ where M'=group I metals and M''= Mo or W, while Erich Kisi and his group continued to explore *in-situ* neutron diffraction studies of materials in extreme service environments.
- Evan Gray and his group at Griffith University continued their interests in hydrogen storage materials, employing their 6 AINSE research awards, together with their three AINSE PGRAs, to study the structures of a disparate set of compounds. The materials of interest range from issues of the site occupancy of H and D in simple metals such as palladium, to graphite intercalation compounds and lithium-magnesium-based hydrogen absorbers.
- Also of significance and encouraging for the continued development of neutron-scattering in Australia are the AINSE-related research activities of several new investigators and their group members. Apart from Chris Ling who is mentioned above, this category includes Darren Goossens, at the Australian National University (5 AINSE research awards), who has applied his expertise gained initially at HIFAR while at Monash to the investigation of an interesting variety of materials using powder and diffuse scattering techniques, and Wayne Hutchison, UNSW@ADFA (4 AINSE research awards), for his investigations of rare earth magnetism to complement his studies using nuclear hyperfine probe techniques.

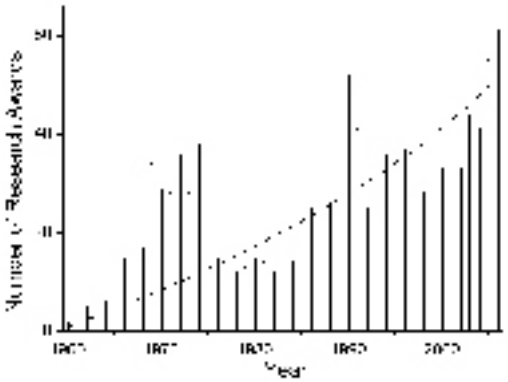


Figure 5. Neutron scattering research awards 1960 to 2007

Serving the future. The neutron-scattering community in Australia has been extremely well served by AINSE over the years. As the graph shows, the number of AINSE research awards in the field of neutron-scattering has increased steadily since commissioning of HIFAR in 1959, reaching a peak of 61 awards in 2006. This was the last full year for operation of such AINSE research awards before the transfer of this research to OPAL and the Bragg Institute, ANSTO.

The research productivity and output is also demonstrated by the graph of research publications over this period (Figure 6). Altogether over 1000 refereed publications have resulted from AINSE-supported research in neutron-scattering. In addition to the numerous research students (PhD and MSc) for whom access to the neutron facilities at HIFAR over the years has been an integral component of their research, a significant number of honours students has also benefited from their access to the neutron facilities via the AINSE research awards to their supervisors.

The import of the contribution which AINSE has made to the Australian neutron-scattering community extends beyond the capabilities of the HIFAR and OPAL reactors. As outlined above in this Section, building on the ties which ANSTO had established from the early 90s to 1997 with ISIS (Rutherford Appleton Laboratory, UK), AINSE together with a consortium of investigators from several universities, has since been responsible for the community's annual application to the ARC for LIEF support for application to access ISIS. Given that ISIS is the world's most powerful spallation source of neutrons and muons, Australian scientists enthusiastically responded to the challenge and have been highly successful in exploiting this scope for access to this World-class facility. In brief, besides producing excellent scientific outcomes, the AINSE-ISIS agreement has contributed to growth in the Australian neutron community that has been further sharpened by exposure to the highest standards of international competition.

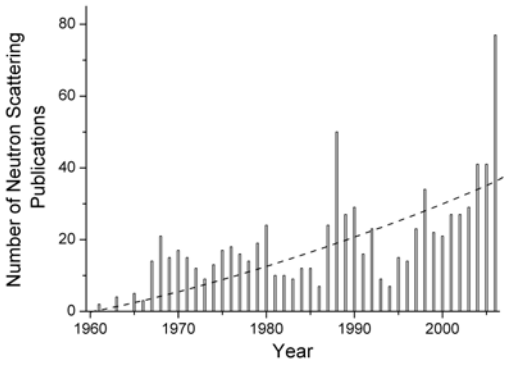


Figure 6. Neutron scattering publications 1960 to 2007

AINSE contributed to the development of the neutron-scattering community via its

support of a regular series of AANSS symposia (AINSE-ANBUG Neutron Scattering Symposium). Following the success of ICNS2005 (International Conference on Neutron Scattering, Sydney, December 2005) with over 700 delegates, AINSE has supported annual AANSS meetings (typically about 80 delegates) at which all members of the community have the opportunity to present their latest findings.

Another benefit which AINSE has bestowed on the Australian research community over the years is the encouragement provided by recognition of investigators and their groups via award of the AINSE Gold Medal for research excellence based on publications which acknowledge AINSE support. The Gold Medal is also awarded to postgraduate students. It is relevant to note that of the 11 Gold Medals awarded to AINSE investigators since the initial award in 1992, four of the recipients have been to researchers in the field of neutron-scattering. All four of these recipients – Trevor Hicks, Monash University (1997), Brendan Kennedy, the University of Sydney (2003), Shane Kennedy, Bragg Institute, ANSTO (2005) and Stewart Campbell, UNSW@ADFA (2007) - are still actively involved in research. This augurs well for the continued development of the Australian neutron-scattering community. Similarly, the community will be well served in the future by the first recipients - Brian O'Connor, Curtin University (2007), and Erich Kisi, the University of Newcastle (2007) - of the recently introduced ANBUG awards in neutron science.

Now, with OPAL and its initial suite of nine instruments an operational reality and already proving itself to be among the World's finest centres for neutron-scattering research, the Australian community is extremely well placed to continue its very fine traditions in neutron-scattering research. Indeed, as the achievements and successes attained by Australian neutron scientists, with the help of AINSE over the years attest, AINSE has created a legacy of which it can be rightly proud. This legacy will serve the nation well as the Bragg Institute, ANSTO together with OPAL and the Australian neutron-scattering community, continue their march on the road of research excellence championed by AINSE for the past 50 years.

7.5.2 Plasma/fusion

In 1996 an international collaborative project, called ITER (International Thermonuclear Energy Reactor), was established to demonstrate the scientific and technological feasibility of harnessing fusion energy for peaceful purposes. ITER is funded by the ITER partners: the European Union (represented by Euratom, including Switzerland), Japan, the Russian Federation, the United States of America, the People's Republic of China, the Republic of Korea and India. Each country has guaranteed a contribution of US$10 million pa for ten years.

In June 2005 the ITER partners decided that the ITER site would be in Cadarache, near Aix-en-Provence, France. Two associated sites Garching (near Munich, Germany) and Naka (near Tokyo, Japan) will supplement this main site.

AINSE, as part of its continuing support for the AFRG and H1, and in line with its practice to champion emerging areas of nuclear research, became a participant in the Australian ITER Forum. The Forum is a collection of scientists and engineers supporting a mission-oriented goal of controlled fusion as an energy source. Its members are the University of Sydney, Australian National University, University of Newcastle, Murdoch University, Flinders University, University of Canberra, University of Wollongong, ANSTO and AINSE. The main purpose is to encourage the Australian Government to contribute funds which would enable Australian researchers to engage in the ITER research program and allow Australia to share in the intellectual property arising from the project.

AINSE underwrote and helped organise a successful workshop held from 11 - 13 October 2006 entitled 'Towards an Australian involvement in ITER'. It was attended by representatives of most of the ITER partners as well as the Australian Government. The Chief Scientist of Australia, Jim Peacock, opened the workshop. AINSE has also played an active part in the development of an Australian strategy for engagement in ITER.

AINSE President John White with the Minister for Science Dr Brendan Nelson at the opening of STAR (January 2005). This accelerator was purchased with the assistance of an ARC LIEF Grant

7.5.3 Accelerator science

The largest ARC LIEF grant to be won to date by AINSE was for a new accelerator, called STAR to replace the very old 3 MeV van de Graaff accelerator which had served AINSE and ANSTO for 40 years. An ARC LIEF grant contributed $1 million, 26 universities contributed $512,000, ANSTO contributed $600,000 and AINSE provided the rest for the $3 million facility. ANSTO also paid for refurbishment of the building and operates the facility.

The STAR accelerator was commissioned and opened in January 2005 by the Minister for Industry Science and Technology, Dr Brendan Nelson. STAR is used for ^{14}C AMS analyses and for PIXE/PIGE analyses.

An issue arose shortly after commissioning when it became clear that AINSE would not be able to insure the facility as no underwriter could be found who accept its insurance. This put AINSE in breach of the LIEF contract.

Helen Garnett was adamant that ANSTO could not insure a facility which it did not own, and so STAR commenced operations uninsured. Following extended negotiations with the ARC, the transfer of ownership of STAR to ANSTO was agreed in 2007 thus allowing the facility to be covered by ANSTO insurance arrangements. The continuing use of the facility is now overseen by a joint AINSE/ANSTO committee.

To support the demand for radiocarbon dating, AINSE in 2004 purchased an Elemental Analyser/Isotope Ratio Mass Spectrometer. This instrument measures delta-^{13}C, which is used to calibrate the ^{14}C dates. After installation, ownership was transferred to ANSTO.

From the very first PIXE measurements done in Sweden in the mid 70s it was appreciated that fine atmospheric particles collected on filter papers were ideal targets for characterisation by nuclear methods. However, it was not until the late 80s and early 90s that fine particulate atmospheric pollution became a significant public issue worldwide, and with it a window of opportunity for nuclear techniques came to the fore. In 1990 ANSTO developed an Aerosol Sampling Program (ASP) with $400k of external funding over three years from the Energy Research and Development Corporation (ERDC). The original ERDC proposal included ANSTO, The New South Wales Environment Protection Authority, Pacific Power, University of New South Wales and Macquarie University. This was the first large-scale fine particle monitoring and characterisation network established in Australia. Furthermore, this research, through the ASP Program at ANSTO, has been picked up by several other departments in Australian universities resulting in several PhD and MSc theses and numerous publications over the past 15 years.

A particularly large study, using the ANSTO ASP facilities, was carried out by Professor Rod Simpson from Griffith University during 1993 - 97 in the Brisbane area. This work was done in collaboration with the Queensland Department of Environment. The ASP program continues today with AINSE projects from Monash University, Griffith University and the University of New South Wales.

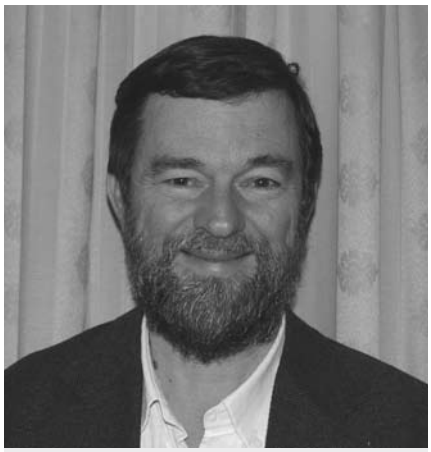
7.5.4 Radiation chemistry

The radiation chemistry of polymers has been a major research focus at the University of Queensland for almost 45 years, and today the Polymer Group is recognised internationally as a major centre of excellence in this area. Over this time the Group has graduated well over fifty students who have worked on radiation-based projects. AINSE has been intimately involved in the research of the Group and it has contributed significantly to the training and development of all those students who have graduated from the Group. See Section 8.2.

7.5.5 Geosciences

The most high profile geoscience groups throughout the 00s are those of Professor Andrew Gleadow, Professor Ian McDougall and Professor Allan Chivas. The work of the Gleadow team in fission track analysis continued to develop from the program that was already well established in the 90s, see Section 6.13. The work of the McDougall group in argon-argon dating is reported in Section 6.6.7. Andrew Gleadow and Allan Chivas received eight and thirteen awards respectively in the 00s.

A brief description of one aspect of the work of the Chivas team relates to the Gulf of Carpentaria in northern Australia which is today a large embayment connecting the Indian



Professor Allan Chivas

Professor Allan Chivas is an isotope geochemist and geologist. After his PhD at the University of Sydney and post-doctoral positions at the US Geological Survey, California, and CNRS, France, he joined the Research School of Earth Sciences, ANU, from 1979 to become leader of the Environmental Geochemistry Group. In 1995, he became Foundation Professor of Geosciences at the University of Wollongong, charged with combining its separate departments of Geology and of Geography into a single School of Earth Sciences. His research has used stable isotopes (oxygen, hydrogen, carbon, sulfur, nitrogen, boron, chlorine), ^{14}C and ^{36}Cl in tracing and dating Earth-surface processes and palaeoclimate.

As well as developing his own laboratories (ICP-MS, conventional light-element stable-isotopes, compound-specific ^{14}C dating and ^{13}C, and clumped-isotope palaeothermometry), he has worked closely with the ANSTO AMS group over many years. He served on AINSE's AMS Committee from 1995 to 2002, and with the Archaeology and Geosciences Committee (2002-2005), and chaired both from 1998 to 2005. He joined the AINSE Executive in 2005. Together with Claudio Tuniz (ANSTO), he was a principal driver of the ARC application to acquire the STAR accelerator, and has contributed to several AINSE-sponsored Quaternary Dating Conferences. Allan served on the ARC College of Experts (physics, chemistry and geosceinces panel) from 2006 to 2008. He is the current President of the International Union for Quaternary Research (INQUA) and President of AINSE.

and Pacific Oceans.

Throughout much of the past two million years, when sea-levels were commonly lower than that of today, the Gulf was a lake, bordered by land bridges between Australia and New Guinea at Torres Strait in the east, and the Arafura Sill in the west. At times, the lake was very large, encompassing an area substantially larger than Tasmania (Figure 7).

A study of the sediment cores recovered from the floor of the present Gulf has been used to identify the timing of the lake's most recent filling and helping to pinpoint past variations in monsoonal rains which maintained water in the lake. The land bridges around the lake are the likely sites of human migrations into Australia.

The group at the University of Wollongong including Allan Chivas, Adriana García and Dioni Cendón, together with PhD students Jessica Reeves, Sabine Holt and Martine Couapel, has provided a record of the lake's history for the past 130,000 years using a variety of chemical and dating techniques and a detailed examination of the organisms preserved in the sediments.

Dioni Cendón, an ARC-supported Research Fellow at the University of Wollongong accepted a position with ANSTO's Institute for Environmental Research in 2006.

Collaborative research with Dr David Fink, at ANSTO, using AMS ^{14}C dating, provided details of the lake's more recent history by dating small shells including molluscs and ostracods. Twenty thousand years ago, at the last glacial maximum, Carpentaria was a nearly-dry lake basin with negligible monsoonal rain. By about 15,000 years ago, the monsoon became more intense and the lake began to fill fairly rapidly. By 12,000 years ago, freshwater from the lake was overflowing into the Arafura Sea to the west.

At about this time the sea-level had risen sufficiently to flood back into the lake, also from the west, and converted the area into a large embayment of the sea. About 7,500 years ago, with sea-level rising further, the land bridge at Torres Strait was breached to form a seaway between Australia and New Guinea, a position maintained until today.

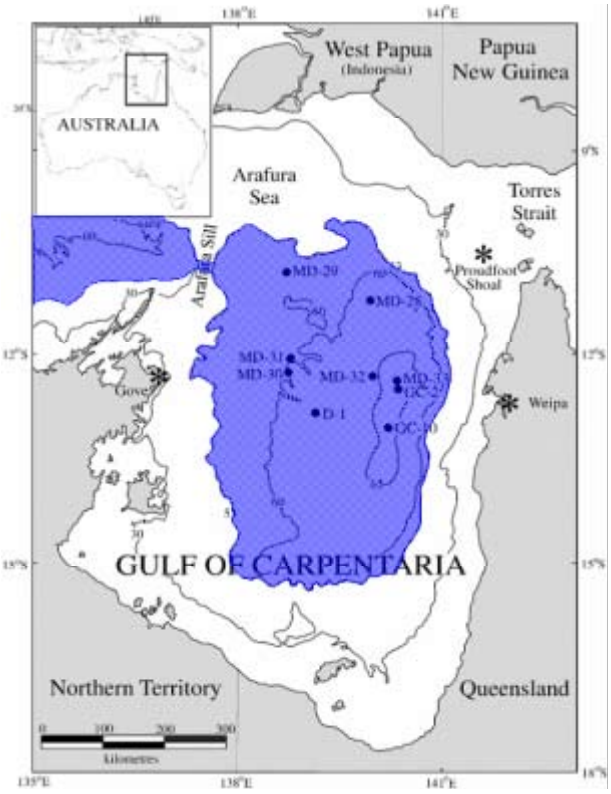


Figure 7. Map of the shorelines of Lake Carpentaria (dark area) and its connection to the ocean at about 12, 000 years ago. The light pattern indicates the current shorelines and the contours are the present water depths. The sample points in the central area of the Gulf mark the sites of drill cores.

7.5.6 Biomedical science

In the 00s the primary focus of biological research continued in oncology. Associate Professor Chris Rowe at Melbourne University continued research with ^{123}I iododexetimide (IDEX) as well as ^{123}I-beta-CIT SPECT for use in the diagnosis of diffuse Lewy body dementia as well as the development of other sub-type selective radiotracers for the study of muscarinic(m2) receptors; ^{123}I labelled radiopharmaceuticals for the study of the NMDA receptor system; and carrier-free synthesis of ^{123}I-alpha-methyl-L-tyrosine ([^{123}I]-IMT). He has held nine AINSE research awards between 2000 - 2003.

Dr Michael Hay, in conjunction with Associate Professor Bob Anderson, at the University of Auckland measured reduction potentials and examined the reduction chemistry of novel benzotriazine dioxide hypoxia-selective anti-tumour agents. He has held seven AINSE research awards since 2002.

Associate Professor Michael Kassiou at the University of Sydney worked on the development and evaluation of a SPECT radioligand for the peripheral benzodiazepine receptor as well as the effect of chronic nicotine treatment on sigma receptors in the rat brain. He has held seven AINSE research awards between 2003 - 2006.

Dr Paul Keller at the University of Wollongong worked on the development of radiolabelled EGF and VEGF receptor tyrosine kinase inhibitors as antitumour agents. He has held eight AINSE research awards between 2002 and 2007.

Associate Professor Roger Martin at the University of Melbourne investigated DNA damage by ^{123}I labelled DNA ligands, and also mechanistic studies on new DNA binding radioprotectors, in collaboration with Associate Professor Bob Anderson on his pulse radiolysis facility at the University of Auckland. He has held 13 AINSE research awards, 2000 - 2007.

In 1996 Dr Suzanne Smith of the Radiopharmaceutical Program at ANSTO was approached by Alan Sargeson from the Australian National University and Jim Camakaris from Melbourne University regarding copper radionuclides. In 1998 she commercialised the production of ^{64}Cu and ^{67}Cu as by-products from the routine commercial production of ^{67}Ga at the National Medical Cyclotron, at Camperdown. Jim Camakaris' interest lay in the use of ^{67}Cu and ^{64}Cu for the study of relationship between copper metabolism and diseases such as Alzheimer's and Menkes disease, see Section 6.6.8. Alan Sargeson had an international reputation in the design and synthesis of unusually stable metal templated hexa-aza cages and he was interested in the use of the ^{64}Cu for the design of the next generation PET agents. Both research programs required high purity and high specific product which could not be generated in HIFAR. These scientists contributed to setting the performance criteria for the separation of high purity ^{64}Cu and it has since been used to support a wide array of research project in biomedicine and in material science that have been AINSE funded.

The AINSE-sponsored work of Professor Sargeson[80] was so successful that the project expanded to become a major research project at ANSTO and the development of the SarAr Technology and a number of patents were secured in the USA, Europe and Australia.[81,82]. In collaboration with Harvard Medical School Boston, USA, the SarAr technology was used to develop new PET agents for melanoma and neuroblastoma leading to a publication in the prestigious *Proceedings of the National Academy of Science of the United States of America* [83] and is now part of the materials research program in the ARC Centre of Excellence in Antimatter-Matter Studies[84] and in an International Science Linkage collaboration with Cambridge University, UK. The SarAr technology is now being commercialised by Access ANSTO and interest in its application in medicine continues to grow. Alan Sargeson's outstanding contribution to inorganic chemistry is well recognised internationally. However, his impact is now being felt throughout the nuclear medicine community, as this SarAr platform technology is being sought for the development of an array of ^{64}Cu PET agents around the world. In the material science field it is being developed for the use in the engineering of materials and the radiolabelling and tracking of nanoparticles to assess their nanotoxicology. Alan Sargeson has held 26 AINSE research awards.

Another cyclotron product, ^{18}F, has been used to develop F-18 fluorodeoxyglucoase (F-18FDG) for use in advanced imaging of cancers. Dr Monica Rossleigh and Dr Walter Haindl from the University of New South Wales have held four AINSE research awards in this area.

Associate Professor Pamela Sykes and Dr Antony Hooker from the Flinders Medical Centre have developed a sensitive mouse assay which enables observation of chromosomal inversion (a common type of chromosomal change observed in many cancers) in mouse tissues at doses of radiation that are 1000 times lower than previously reported. Ionising radiation can cause chromosomal changes which are part of the process of the development of cancer, and it is important to have radiation standards which define the levels of exposure which are considered to be safe. These standards are presently determined based on the linear no threshold (LNT) dose response model.

This model predicts that the relationship between biological effects such as chromosomal changes and radiation dose is linear, and that even the tiniest dose will have a damaging effect. Almost all of the data on biological effects of ionising radiation come from the study of high doses. The human population is, however, unlikely to be exposed to such doses.

Their results suggest that ultra-low doses of radiation (5 - 10μGy) cause more inversions than low doses (1 – 10mGy). In fact, at low doses the number of inversions is less than in unirradiated animals suggesting a possible protective effect. These results do not fit a

80 Di Bartolo N M; Sargeson, A M; Donlevy, Therese M; Smith S V J. Synthesis of a new cage ligand, SarAr, and its complexation with selected transition metal ions for potential use in radioimaging. *J Chem Soc Dalton Transactions* **15** 2303-2309 2001

81 Smith S V, Harrowfield J, Di Bartolo N, Sargeson A. Cryptate compounds and methods for diagnosis and therapy. PCT Int Appl (2000), WO 0040585. Europe 1147111. Granted USA patent 6869589 22 Mar 2005. Aust 780635 21 Jul 2005

82 Di N Bartolo, Sargeson A M, Smith S V. New ^{64}Cu imaging agents for personalised medicine and drug development using the Hexa-Aza Cage, SarAr. *Org Biomol Chem* **4** 3350-3357 2006

83 Voss S D; Smith S V; Di Bartolo, N; McIntosh L J; Cyr E M.; Bonab, A A; Dearling J L J; Carter E A; Fischman A J; Treves S T; Gillies S D; Sargeson A M; Huston J S; Packard A B. Positron emission tomography (PET) imaging of neuroblastoma and melanoma with ^{64}Cu-SarAr immunoconjugates. *Proc Nat Acad Sci USA*. **104** 17489-17493 2007

84 Smith S V. SarAr technology for the application of copper-64 in biology and materials science. *Quarterly J Nucl Med Mol Imaging* **52** 193-201 2008

standard LNT model, and may have implications for the way in which regulatory standards are presently set and for understanding radiation effects. These data have been determined using single, high dose-rate exposure which is relevant to routine diagnostic medical procedures. The studies have continued on the effect of lower dose rates on mutations in the mice using ^{60}Co irradiation facilities at ANSTO in collaboration with ANSTO radiation dosimetry experts Dr Henk van der Gaast, Justin Davies, Allan Murray and radiation biologists Dr Renate Domel and Dr Bill Burch. Pamela Sykes received four AINSE research awards since 2003.

7.5.7 Environmental science

AINSE's strong support for environmental based research has continued into the 00s. One enduring area of support has been that of climate studies.

Some of the more active research teams in environmental science include Professor Peter Gell and his team from the University of Adelaide until 2007 and now at the University of Ballarat investigating wetlands in South Australia and elsewhere. They have produced high-resolution reconstructions of climatic variations, and wetland condition changes, over the past 2000 years. Professor Colin Woodroffe at the University of Wollongong have collected extensive data on sedimentation rates in coastal lagoons and estuaries, and coral reef environments. Other AINSE-supported research in the 00s include

- Dr Kathryn Taffs and her students at Southern Cross University have studied the environmental history of a number of coastal lakes in northern NSW and examined the acidification and eutrophication trends pre and post European settlement. She has held six AINSE research awards since 2000.
- Dr Brian Jones from the University of Wollongong has used ^{210}Pb dating to investigate sedimentation rates in lagoons and estuaries in various regions around Australia. He has held five AINSE research awards since 2000.
- Dr John Prescott from the University of Adelaide has done extensive work in low-level uranium and thorium determinations for luminescence dating. He has held eight AINSE research awards since 2000.
- Dr Russell Drysdale and his team at the University of Newcastle, which includes three PGRA students, has focussed on the analysis of speleothems to develop high-resolution climate records using U-Th dating techniques. He has held four AINSE research awards since 2001.
- Dr John Webb at La Trobe University, along with his students, including three PGRAs, have done extensive research on groundwater, in particular understanding the salinisation process and recharge rates. This research has used both tritium dating of the groundwater, as well as AMS ^{14}C. He has held seven AINSE research awards since 2000.
- Professor Peter Kershaw and his team at Monash University have used ^{210}Pb, U-Th and especially AMS ^{14}C to help in understanding the history of vegetation-fire-soil-climate relationships as well as water quality and human impact at centennial to millennial scales from sediment sequences in the humid eastern fringe of Australia extending into South-east Asia. He has held eleven AINSE research awards since 2000.
- Professor Andrew McMinn, at the University of Tasmania, continued his work on heavy metal accumulation in aquatic micro-organisms in Australian, New Zealand and Antarctic waters. He has held nine AINSE research awards between 2000 and 2007.
- Professor Michael Barbetti, at the University of Sydney until 2003, had done extensive work on the use of tree rings from South East Asia as a record of climate variability. The individual rings have been dated using AMS ^{14}C method. He has held eleven AINSE research awards between 2000 and 2007.

With a view to phytoremediation of polluted soils, a number of other groups investigated the hyperaccumulation of heavy metals in plants. Researchers used SIMS to better understand how and where the metals were located in plant cells. Bulwant Singh at the University of Sydney focused on arsenic; Nanjappa Ashwath from Central Queensland University focused on nickel; Damian Gore from Macquarie University on chromium; and Bear McPhail, while he was at Monash University, and his AINSE postgraduate scholar Desmond

Dr Ziggy Switkowski

Ziggy Switkowski, Chairman of the ANSTO Board, first visited Lucas Heights in the early 70s as a doctoral student under the supervision of Dr Graham Sargood in the School of Physics at the University of Melbourne. He used the 3 MeV Van de Graaff accelerator to study ^{23}Na(p,γ)^{24}Mg and other reactions of astrophysical significance. He was assisted in this work by Roger Bird who was then in charge of the accelerator facilities at ANSTO. He recalls that the accelerator was in high demand and he, on more than one occasion, spent Christmas at Stevens Hall while conducting experiments on the accelerator. In those days data were acquired on punched tape, and then batch processed on early computers overnight. At this time hand held calculators were the latest thing. The facilities at ANSTO were much more advanced than those at the University of Melbourne where he conducted research on a small 700 keV accelerator called a Statitron. He recalls obtaining some data from this infamously temperamental instrument, but only with the assistance of long-suffering technicians who had to deal with the enthusiastic but less competent graduate students.

After completing postdoctoral research at Caltech and the Niels Bohr Institute he moved to the business world, which culminated in his leadership of Telstra from 1999 to 2005.

In his post-executive life he has returned to ANSTO via the task force which produced the 'Uranium Mining, Processing and Nuclear Energy – Opportunities for Australia?' Report in 2006. He was appointed Chairman of the ANSTO Board on 1 March 2007.

He is optimistic for the future of AINSE and ANSTO and sees many opportunities for the organisations to contribute to the big issues facing society today including nuclear medicine, climate change, energy and industrial applications of nuclear techniques.

Dev Menon, investigated the hyperaccumulation of a number of heavy-metals.

The environmental radiochemistry laboratory at ANSTO intensified its collaboration with universities in the early 90s after Dr Henk Heijnis joined the unit. This collaboration is typified by the many student research projects which were developed by Heijnis and university researchers. In addition, the number of AINSE postgraduate scholars grew and many occupy senior research positions in Australia and elsewhere.

One such scholar is Dr Brendan Brooke, now at Geoscience Australia, who worked on elucidating the most recent geological history of Lord Howe Island for his 1999 PhD thesis at the University of Wollongong.

The carbonate platform surrounding Lord Howe Island harbours the world's most southerly coral reef. This is possible because the warm East Australian Current turns eastwards from the NSW Coast and feeds warm tropical waters to the region of Lord Howe Island. During the past 200,000 years, as part of the Ice Age cycles, the East Australian Current was disturbed several times. Also, a fall in sea-level by as much as 120 metres left much of the carbonate platform surrounding Lord Howe Island exposed. The current dune systems on the Island are, as the hypothesis predicts, formed during times of low sea-level and relatively colder conditions. The timing of formation of those dunes would reveal under what conditions and at what rates these dunes had formed.

In the Galápagos Islands, Dr Simon Haberle from the Australian National University (right) and AINSE PGRA scholars Iona Flett from the Australian National University and Ashley Natt from the University of Adelaide take a core from a lake bed for ^{210}Pb dating

As part of his AINSE PGRA, Brendan Brooke worked at ANSTO dating fossil corals and cave sediments associated with the beach and dune formations of the Island. The uranium/thorium dating, performed at ANSTO, of the beach units and the dune systems confirmed that the during the early stages of glacial (between 90,000 - 60,000 years ago), low sea-level combined with the absence of coral reefs provided the right conditions for dune formation on the island. The other important clue was the timing of coral growth during warm conditions, with an active East Australia Current. These different conditions in the forming of the current landscapes on Lord Howe Island are important for understanding the impact of future climate change on this world heritage listed Island. He is now a senior researcher at the Coastal Unit, Geoscience Australia.

7.5.8 Archaeology

In 1998 archaeological research activities were grouped under the AMS facility-based banner in the AINSE Annual Report. By 2002 archaeology and geosciences had achieved its own headline.

Dr Peter White, Dr Robin Torrence and their co-workers at the University of Sydney worked on a number of projects centred around trade based on prehistoric obsidian in the south Pacific using PIXE to characterise the obsidian and AMS ^{14}C dating. Peter White received eight awards between 2002 and 2007, and Robin Torrence received five awards between 2002 and 2006.

Professor Colin Woodroffe's research at the University of Wollongong into the chronology of reef islands off the Australian coast has increased our understanding of climate variability. He has held 13 AINSE research awards since 2000.

Dr Susan O'Connor from the Australian National University has used AMS ^{14}C dating of pollen and shell artefacts in South East Asia to underpin her archaeological studies into cave dwelling societies. She held seven AINSE research awards between 2000 and 2007.

Dr Peter Grave at the University of New England has used nuclear activation analysis and PIXE to characterise Iron Age ceramics from Anatolia and the Russian far east, agate and carnelian ornaments and artefacts from South-east Asia, Turkey, Philippines, and northern Thailand, as well as AMS ^{14}C dating to date ancient mortars and plasters from Pompeii. He held eleven AINSE research awards between 2000 and 2007.

Dr Denise Donlon at the University of Sydney has used AMS ^{14}C dating of Aboriginal burials in the Sydney Basin and her PGRA scholar Anne-Marie Williams in collaboration with Rainer

Siegele from ANSTO used PIXE analysis of trace elements in skeletal remains in 19th century juvenile skeletal remains in relation to diet, health and environment. She held six AINSE research awards between 2000 and 2003.

Dr Stephen Bourke at the University of Sydney has used both AMS ^{14}C and PIXE techniques to help understand urbanisation and the origins of the state in the Southern Levant (ca 5000-2500 BC); he has dated the earliest domestic olives in the World. He held six AINSE research awards between 2001 and 2005.

Professor Bill Boyd at Southern Cross University has used AMS ^{14}C in studies of the archaeology and geoarchaeology of ancient human settlement in Papua New Guinea, Thailand and Australia, and post-glacial sea-level change in Vietnam, as well as ^{210}Pb dating of aboriginal camp-grounds in northern NSW.

Dr Bruno David from Monash University has dated early cultural sites on islands in the Torres Strait. He has held eleven AINSE research awards since 2000.

7.6 AINSE support for the replacement research reactor (OPAL) at ANSTO

In the new millennium, AINSE continued its involvement in consultations which had commenced in 1997 on the planned replacement reactor at ANSTO. The new reactor became a standing item on the Executive Committee and Council meeting agendas and regular updates on progress were received by the Executive Committee and Council as the approval process progressed.

AINSE also publicly supported the move by ANSTO to replace HIFAR with a new research reactor. In August 2000, the Senate established a Select Committee for an Inquiry into the Contract for a New Reactor at Lucas Heights. On 25 October 2000, presentations were made to the Select Committee by Evan Gray and Erich Kisi representing AINSE and by John White representing the National Committee for Crystallography, and the Australian Academy of Science.

The AINSE presentation listed five benefits for Australian science that would arise from a new reactor.

[Australian Science] would get

- *parity with what is available in developed countries overseas*
- *an instrument suite specified by Australians for Australia's needs*
- *quick turnaround for industry*
- *no five-day overhead for overseas visits*
- *instruments that are first class—not second class or third class—with some being world leaders*[85].

In December 2001, the head of the licensing authority, ARPANSA, held a public forum on the research reactor and AINSE participated through a subcommittee consisting of Gerald Laurence, Ron Cooper and Riaz Akber who worked through questions that could be put to the regulator.

By the end of 2002, AINSE had supported ten workshops which had been held to discuss with the user community the neutron-beam instruments at the new reactor. The workshops were well attended and included research scientists from overseas facilities. The workshops facilitated user input into the development of the new instrumentation on the replacement reactor. AINSE provided support for travel and accommodation for member representatives and AINSE was identified as an active sponsor of the workshops. The workshops held were:

- Data Visualisation, Reduction and Analysis, 30-21 March 2004
- Polarisation Analysis and Inelastic Cold-Neutron Scattering, 27-28 January 2004
- Neutrons for the Geosciences, 12-13 December 2002
- Neutrons for Engineering, 16-17 September 2002
- Small-Angle Neutron Scattering, 13-14 December 2001

At the opening of OPAL on 3 November 2006*:*
Dr Ian Smith, CEO of ANSTO; The Hon Julie Bishop, Minister of Science; The Right Hon John Howard, Prime Minister and Dr Ziggy Switkowski, Chairman of ANSTO

85 Select Committee for an Inquiry Into the Contract for a New Reactor at Lucas Heights: Discussion, p88

- Single-Crystal Diffraction, 11-12 December 2001
- Dynamics, Excitations and Magnetism, 27-28 August 2001
- Neutron Reflectometry, 8-9 May 2001
- Neutron Radiography, 30 November and 1 December 2000
- Powder Diffraction, 17-18 October 2000.

At all stages of the approval and construction phases of the new OPAL research reactor, AINSE was identified as a vigorous supporter. This support is consistent with AINSE's determination over the decades to be an active player in relevant infrastructure deliberations and development.

7.7 Specialist Committees

Specialist committees comprise representatives from universities and from ANSTO. When the committees were structured so that they reflected the instruments required, it became apparent that it was not possible to have the necessary spread of expertise on these committees of six people to cover the spread of disciplines of the applicants, and therefore, judging the science in the applications was difficult. Additional reveiwers were co-opted but this solution was not optimal.

At the December 2002 Council meeting the pendulum swung back to discipline-based specialist committees

> *the restructuring of the Specialist Committees has resulted in an effective shift of emphasis from the use of facilities to quality of science being presented in applications.*

In 2003, five major research areas were identified and corresponding committees established as follows:

- Archaeology and Geosciences
- Biomedical Science and Biotechnology
- Environmental Sciences
- Materials – Properties and Engineering
- Materials – Structures and Dynamics.

The Council also decided that it would be in the best interests of AINSE if membership of specialist committees were regularly refreshed. It was decided that one of the university positions on each committee would be open for a new nomination every year. In making this decision the Council was hopeful that the constant invigoration of membership of the committees would lead to the introduction of fresh ideas and new approaches.

With the commissioning of OPAL in 2007, consideration of applications for neutron beam time was transferred from the AINSE Materials – Structures and Dynamics Specialist Committee to ANSTO's Bragg Institute Program Advisory Committee, which includes two AINSE nominees.

In 2007 AINSE President Brian O'Connor proposed the formation of a Nuclear Technology Specialist Committee to manage the anticipated resurgence in interest in nuclear power technology. The Howard government had placed $12.5 million into the forward estimates for ANSTO to engage in nuclear power technology research. $7.5 million of this was earmarked for distribution to university researchers via AINSE, for research which would feed into the Generation IV Nuclear Energy Systems (Gen-IV) research program which is an initiative of the Global Nuclear Energy Partnership (GNEP), to develop new generation power reactors.

The committee coordinated a workshop in late 2007 to develop collaborative research proposals. The successful proposals were to have been focused on gaps in the existing GNEP program. Then the general election was announced in late November 2007. At the same time, a number of universities started planning courses to underpin a nuclear industry. AINSE set up the Australian Nuclear Education Council with the aim of providing a forum for interested universities to exchange ideas.

Following the election of the Rudd Labor Government these funds were withdrawn and nuclear power technology research was relegated to the back burner again, and the operation of these committees was suspended.

7.8 Research awards

Initially universities had regarded nuclear physics and engineering as being the major areas of operation for AINSE. As nuclear-based scientific techniques and technologies developed, an expanding range of academic disciplines could take advantage of the access to facilities at Lucas Heights that AINSE provided. Indeed over the last fifty years there has been a growth in the variety of disciplines that have taken advantage of this access from the core disciplines of physics and chemistry to biology, engineering, materials science, pharmacology, environmental sciences, geology and finally archaeology and anthropology (Figure 8).

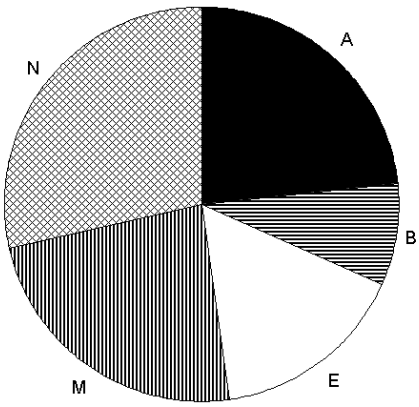


Figure 8. Distribution of funds for AINSE Research Awards in 2006

A - Archaeology and Geosciences
B - Biomedical Science and Biotechnology
E - Environmental Science
M - Materials Properties and Engineering
N - Materials – Structures and Dynamics

7.9 Research fellowships

In 2006, after a hiatus of 14 years, AINSE President, John White, proposed that AINSE research fellowships be reintroduced to seed new neutron-scattering groups in universities and enhance long-term, excellent, research output from the new instruments at OPAL. Council adopted the proposal and a committee was set up to review applications, chaired by Emeritus Professor Don Napper. It recommended the appointment of two fellows in 2006 and another two in each of 2007 and 2008 with the intention to appoint two additional fellows each year.

The Fellowships were set up with the clear intention that, at the end of their Fellowship, Fellows would be in a strong position to be employed at their university. AINSE ensured that DVCs, Deans and Heads of Schools understood this.

There was a clear intention to seed new neutron-scattering groups in universities. With this in mind the fellowships were targeted at people with three to eight years postdoctoral experience. Starting salaries in the lecturer level B range were offered.

While one of the first four research fellows went to a university with an established neutron-scattering group, the other three research fellows went to universities which did not. The third round included high-resolution climate records along with neutron-scattering as a priority area and the appointments included one neutron scatterer and one environmental scientist (Table 17).

Both first-round research fellows had previously benefited from AINSE: Daniel Riley had conducted research under the AINSE Research Awards program in the name of his doctoral supervisor Erich Kisi at University of Newcastle; and Darren Goossens had been an AINSE PGRA scholar and received the AINSE Gold Medal for excellence in research in 1999.

Table 17. AINSE Research Fellowships 2006 - 2008

Year	Fellow	UNI	Project Area
2006	Dr Darren Goosens	ANU	Study of the nature and role of nanoscale order in complex materials
2006	Dr Daniel Riley	MEL	Use of ultra-fast *in situ* neutron diffraction in the development of advanced materials
2007	Dr Moeava Tehei	WOL	Study of relationships between functions, structure and dynamics of biological molecules by neutron-scattering
2007	Dr Duncan McGillivray	AUK	Probing the mechanism of biomembrane interactions
2008	Dr Helen McGregor	WOL	El Niño in context: reading the coral record of past climate extremes
2008	Dr Lizhong He	QLD	The physical states of pharmaceutical proteins and self-assembled proteins

7.10 AINSE postgraduate scholarships

The number of AINSE postgraduate scholarships awarded each year has continued to grow. In 1998 22 were supported and by 2007 there were 60. However, unlike the expansion in the 90s, which was primarily a result of the change from the fully funded studentships to the much cheaper supplementary scholarships, the expansion in the fifth decade reflects increased budgets for this program.

The selection of postgraduate scholars is based on their undergraduate record and the talent pool is deep. Invariably scholars will have not only a First Class Honours degree but will have other recognition for academic excellence and achievements.

Outstanding PGRAs scholars have been awarded the AINSE Gold Medal for excellence in research, see Appendix 4. The only student to be awarded the Gold Medal who was not a PGRA was Ismunander in 1998. He was a student of Brendan Kennedy at the University of Sydney, who in turn was himself awarded the Gold Medal in 2003. Ismunander returned to his native Indonesia following the completion of his PhD and is now Professor and Head of the Department of Chemistry, Institute of Technology, Bandung.

Another feature of the PGRAs in the fifth decade has been an emphasis on students undertaking neutron-scattering experiments (Figure 9).

To date AINSE has funded 221 PGRAs and studentships covering every area of AINSE and ANSTO's research interests. A considerable part of AINSE's continuing success relates to the research output of these students. Many of these scholars have been subsequently employed as academics and who then send their students to do experiments at Lucas Heights.

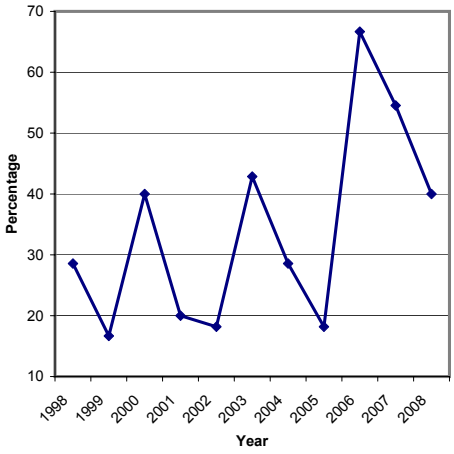


Figure 9. Percentage of PGRA students, undertaking neutron-scattering research 1998-2008

7.11 AINSE looks at the policy development environment

At times in its history AINSE has not shied away from being involved in high-level consideration of issues that could impact on its members' research aspirations. In this decade AINSE determined that its experience and membership base equipped it to provide input into Governmental and Departmental-level considerations relating to its area of operations. Consequently in the fifth decade, AINSE has made a number of submissions to Government enquiries and reviews. These include:

- 2000 Select Committee *Inquiry into the Contract for a New Reactor at Lucas Heights;*
- 2006 Review *Uranium Mining Processing and Nuclear Energy in Australia* (the Switkowski Report);
- 2006 House of Representatives Standing Committee on Industry and Resources Report *Australia's uranium – Greenhouse friendly fuel for an energy hungry world;*
- 2008 House of Representatives Standing Committee on Industry, Science and Innovation *Inquiry into research training and research workforce issues in Australian universities.*

7.12 Conferences

As a general rule, AINSE has supported, sponsored and organised at least three major research conferences every year and this has been the case since the 60s. These conferences are mostly in the same areas as those supported by AINSE scholarships, fellowships and research awards.

Conferences provide a mechanism for show-casing AINSE-sponsored research. Furthermore, the conferences have acted as a conduit through which researchers working in similar areas could develop collaborations with each other.

In the fifty years of its existence, AINSE has organised over 120 conferences on virtually every aspect of nuclear science, or any discipline that required the specialist facilities available at Lucas Heights. These conferences have generated over a thousand academic papers most of which were assisted in some way by an AINSE research award.

Some of the more recent of the conferences held regularly on a given topic, usually every alternate year, by AINSE, include:

- 15th AINSE Conference on Nuclear and Complementary Techniques of Analysis, in November 2007
- Radiation Conference 2006, incorporating the 21st AINSE Radiation Chemistry and the 18th Radiation Biology Conference, in April 2006
- 22nd Nuclear and Particle Physics Conference, in December 2008 and
- 27th Plasma Science Conference, in December 2008.

The first AINSE Nuclear Physics Conference was held at the University of Melbourne in August 1965. Approximately 100 academics and research students from the Institute's member organisations took part and about 40 papers were presented. By 1992, the 14th conference had been renamed as the Nuclear and Particle Physics Conference.

In the sixties and seventies this conference was supported by the Nuclear Science Specialist Committee but when this committee was disbanded in 1991, AINSE made the decision to continue planning and providing financial support for this meeting. Since 1996, this conference has been held in conjunction with the Australian Institute of Physics Congress.

In addition to the regular conferences organised by AINSE, two international conferences organised and underwritten by AINSE during this decade are worthy of mention.

- The 12th International Congress of Radiation Research (ICRR) held at the Brisbane Convention Centre, 17-22 August 2003. There were 1087 participants including 251 from Australia, the remainder came from thirty eight other countries. The program covered all of the major disciplines of radiation science, namely from physics, chemistry, biology and medicine. It included nine congress and eight plenary lectures, 267 papers and 650 posters.
- The International Conference on Neutron Scattering (ICNS2005) held at Darling Harbour in Sydney, 27 November – 2 December 2005. There were 737 registered delegates from 38 countries. The oral program ran four parallel sessions involving 177 papers including five plenary and six keynote presentations. Some 600 posters were displayed at the two poster sessions. There were 142 Australian delegates.

In 2004 AINSE introduced an International Travel Scholarship for postgraduate students. This fund of $40,000 was established with the surplus generated from ICRR2003. These travel scholarships now enable postgraduate students to travel overseas and present their AINSE-supported research at international conferences.

Ismunander receiving his AINSE Gold Medal from President Ron MacDonald in 1999

7.13 AINSE Winter School

The AINSE Winter School at ANSTO is a five-day program of lectures and experiments designed to introduce prospective research students to some of the instruments at ANSTO. Each Councillor selects a student, and while this process is usually merit-based the evaluation methods of the Councillors vary widely.

The Winter School experiments cover a wide field. In 2008, the five experiments were as follows

(1) **Rutherford backscattering (RBS) and proton-induced gama-ray emission (PIGE)**. Selected samples are analysed to illustrate the types of information that can be obtained from these characterisation techniques.

(2) **Radiation dosimetry measurements**. Organo-chlorine degradation. Examination of the radiation modification of polymer properties.

(3) **Measurement of peak position as a function of the charge state of a Li-ion battery**. Neutron diffraction is a technique that is used to study interatomic lattice spacings. Demonstration of the measurement of diffraction lines while a battery is being charged/discharged are made on Wombat (high intensity powder diffractometer). The line positions are analysed for lattice spacing changes as the Li enters/leaves the graphite.

(4) **Use of natural radioactivity in environmental studies.** Experiments to work out pathways of uranium-series nuclides in river and estuarine environments, extracting lead and radium from the sediment, using alpha-spectrometry and high-resolution gamma-spectroscopy.

(5) **Radiation safety surveys and decontamination.** Students are introduced to methods for identifying the site of radiation and how to determine the risk posed by these sources. The effectiveness of different materials in shielding and approaches to decontamination are presented.

The Winter School is considered today as AINSE's most successful promotional tool, particularly within member universities. It also assists in developing interrelationships important for the scientific process.

At the May 2000 Council meeting, Helen Garnett gave the Winter School a seal of approval when she stated that

the Winter School had already produced students who return to ANSTO to do research.

Each year, there are several new PGRA scholars who have previously attended the Winter School. Successful PGRA applicants who were Winter School participants are listed in Table 18.

Table 18. Winter School (WS) students who have become AINSE PGRA scholars

WS	Name	Uni	PGRA
2005	Edmund Burt	GRI	2007
2005	Sarah Hagerty	LAT	2007
2005	Shane Lawrence	CUR	2007
2005	Anthony Musumeci	QUT	2007
2004	Fionnuala Buckley	GRI	2006
2004	Betime Nuhiji	DEA	2006
1999	Mark Peterson	WOL	2004
2002	Krystyna Saunders	TAS	2004
2002	Andrew Wroe	WOL	2004
2000	Yasmin Antwertinger	CDU	2003
2000	Tim Ralph	MAC	2002
1998	Matthew Rowles	CUR	2002
2000	Andrew Whitten	UNE	2002
1998	Tristan Burg	NSW	2001
1998	Iwan Cornelius	WOL	2000

In addition to these PGRAs, other Winter School students return to do postgraduate research on their supervisor's research awards.

The structure of the Winter School has remained, more or less, unchanged since 1996. New experiments and lectures have been introduced but rarely more than one per year.

The Winter School is a true partnership between universities and ANSTO. Lectures and experiments have been delivered by people from each organisation and without the cooperation of people from both ANSTO and the universities the Winter School would not continue. Peter Evans, Henk Heijnis and Margaret Elcombe from ANSTO have been involved with the Winter School from the beginning, as have Ron Cooper and the late Ken Doolan from the universities. But behind these leaders there are other volunteers from ANSTO who have regularly contributed their time to the Winter School by helping out with tours and assisting in the experiments.

In 2004 five postgraduate students joined the organising team to act as guides and mentors for the students. In 2007 Gerald Laurence ran his last Winter School and the 2008 Winter School was convened by Danielle Meyrick from the University of Western Australia.

AINSE Winter School 2008