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Reactor Operations Facilities – General

The key objectives of ANSTO Reactor Operations are to:

- provide a major neutron source as a national irradiation and beam facility using the Australian research reactor OPAL
- provide a waste management service to LHSTC
- provide support for research and development in nuclear science and associated technologies by other programs
- provide neutron irradiation facilities for the production of radioisotopes for medical and industrial applications
- provide neutron irradiation facilities for revenue producing projects

8100 OPAL – Irradiation Rigs & Facilities, Including High Activity Target Handling

Description

Irradiation facilities and neutron fluxes are as follows:

The Bulk production Irradiation Facilities (BIF) allow the irradiation of targets contained in sealed irradiation cans on removable rigs that are located inside irradiation tubes provided within the reflector vessel. The arrangement of the 17 irradiation tubes gives a thermal neutron flux in these facilities ranging from approximately $6x10^{13}$ $n.cm^{-2}s^{-1}$ to more than $2x10^{14}$ $n.cm^{-2}s^{-1}$, averaged within a target position.

The Long Residence Time general purpose irradiation facilities (LRT) allow the irradiation of targets contained in sealed irradiation cans. The cans are transferred for irradiation to positions within the reflector vessel by means of a pneumatic transport system. The arrangement of the 55 irradiation positions gives a thermal neutron flux in these facilities that ranges from approximately $2x10^{12}$ $n.cm^{-2}s^{-1}$ to more than $1x10^{14}$ $n.cm^{-2}s^{-1}$, while in the fast flux positions the fast flux exceeds $7x10^{12}$ $n.cm^{-2}s^{-1}$.

The Short Residence Time irradiation facilities (SRT) allow neutron activation analysis (NAA) and delayed neutron activation analysis (DNAA) to be undertaken. The target material is enclosed in a sealed irradiation can that is sent for irradiation to positions in the reflector vessel by means of a pneumatic transport system operated by nitrogen. The transit time between the irradiation facility and the load/unload station is a few seconds, allowing short-lived radionuclides to be analysed. The arrangement of the irradiation positions gives a thermal neutron flux in the NAA facility ranging from approximately $2x10^{13}$ $n.cm^{-2}s^{-1}$ to $5x10^{13}$ $n.cm^{-2}s^{-1}$ and in the DNAA facility from $2x10^{12}$ $n.cm^{-2}s^{-1}$ to $5x10^{12}$ $n.cm^{-2}s^{-1}$.

Further information on the NAA and DNAA facilities can be found in the environmental research section of the AINSE User Guide.

Large Volume irradiation facilities (LVF) are dedicated to the neutron transmutation doping (NTD) of single-crystal silicon ingots. The silicon ingots in unsealed cans are placed inside rotating rigs installed in six irradiation tubes provided in the reflector vessel. During irradiation, the cans containing silicon ingots or samples are rotated by automatic means to ensure adequate homogeneity of the doping. The arrangement of the 6 irradiation tubes gives a thermal neutron flux within the silicon ingots and other samples ranging from approximately $3x10^{12}$ $n.cm^{-2}s^{-1}$ to $2x10^{13}$ $n.cm^{-2}s^{-1}$.

High Activity handling Hot Cells are available, complete with master-slave manipulators for handling irradiated targets. The hot cells have appropriate shielding and an active ventilation system for radiation protection purposes.

Support Services and Facilities:

- Operation of facilities and maintenance of rigs
- High level radioactive handling facilities
- Breakdown, mechanical and physical testing

Applications

Applications include neutron activation analysis, transmutation doping of silicon semiconductors, neutron radiography and determination of atomic and molecular structures in inorganic and biological substances.

Costs to Members of AINSE

The contribution to cost-recovery is determined on a case-by-case basis. There is, in addition, a charge for the facility in OPAL which is used and the charge varies from utility to utility. The charges can be provided on request.

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Mr Kith Mendis – Reactor Operations
Phone: (02) 9717 7089
Fax: (02) 9717 7139
Email: klm@ansto.gov.au

8200 Computer Evaluation of Reactor Operation and Safety, Neutronics and Shielding Calculations

Description

Reactor Operations develops and maintains computer software and associated data libraries with which neutron and/or gamma ray fluxes can be calculated for proposed experimental assemblies. These assemblies may be free standing or form part of rigs for insertion in OPAL. In the latter case the effect on OPAL can be calculated, if necessary, to determine the implications of the rig insertion on the safety of the reactor.

For assemblies containing fissile materials criticality certificates would need to be issued before the experiments begin. The results of the appropriate calculations can be provided to users.

Where the assemblies produce radiation fields of consequence to users and others, assessment of the necessary shielding can be provided.

Support Services and Facilities

For projects that involve computer simulation of neutron and/or gamma ray populations in target materials or assemblies, advice and assistance are available in using the bank of software and data maintained on ANSTO computers. These include multigroup SN and neutron diffusion codes, codes to prepare multigroup data from a master library of 200 neutron and 37 photon groups, the ENDF/B-VI cross section file.

ANSTO Contact Scientist:

Dr George Braoudakis - Reactor Operations
Phone: (02) 9717 3473
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8300 Water Tunnel Flow Facility

Description

The Reactor Operations Water Tunnel is a closed loop flow rig of 3000L capacity, used for velocity measurements, pressure loss measurements and flow visualisation in flow fields surrounding immersed bodies, or within hydraulic components. Water is circulated by a double suction pump driven by a 75 kW AC motor and variable speed controller, to achieve flow control up to 230 Ls^{-1}. The pipes range from 230mm to 690mm in diameter.

Models of the flow components, usually manufactured from highly polished acrylic, are positioned in the test section of the loop. Reflective particulate additives are used as flow tracers which are illuminated by a double pulsed Nd-YAG laser or a continuous wave Argon laser system. The resulting images of the flow patterns are captured digitally and processed to provide flow velocity and direction information.

The WTFF has also undertaken performance tests on hydraulic fittings, eg. valves, to Australian Standards. These tests include flow/pressure characteristic tests and endurance testing.

Support Services and Facilities

- Laser PIV and LDV systems
- Workshop machinery available for model manufacture and development
- Computing facilities

Applications

Flow analysis in hydraulic systems using PIV and LDV measurement techniques and flow visualisation. Hydraulic testing of fittings to Australian Standards, determining flow loss and endurance characteristics.

Availability

The Water Tunnel is available on an advance booking basis and subject to ANSTO needs.

ANSTO Contact Scientist:

Mr David Wassink - Reactor Operations
Phone: (02) 9717 3818
Fax: (02) 9717 3710
Email: dfw@ansto.gov.au

1900 Neutron Activation Analysis

Description

Instrumental neutron activation analysis (INAA) is a very sensitive method of quantitative elemental analysis based on the nuclear activation of the chemical elements present in a sample. Activation is achieved by placing the sample in the neutron flux of the OPAL reactor, using the facilities described in the OPAL section of the AINSE User Guide. The specific activity of each radionuclide may be determined by measuring the characteristic gamma radiation emitted from the sample after it has been removed from the reactor. Two methods of standardisation are available, the relative (comparator) method and the k_0-method. Around 65 elements can be measured by INAA. The irradiation time can be selected to optimise the detection limit for particular elements, making use of the short residence time (SRT) and long residence time (LRT) facilities, as indicated below.

Delayed neutron activation analysis (DNAA) can measure the uranium content of a sample at concentrations from 0.5 to 100,000 ppm. The technique determines the concentration of the isotope ^{235}U by measuring the rate of emission of delayed neutrons from the sample after it has been irradiated in the OPAL neutron flux.

Sample preparation

There are strict requirements on the handling and nature of samples that are to be irradiated in OPAL facilities. In some cases samples will need to be analysed by XRF prior to irradiation, for an additional fee. Samples can only be loaded into approved polythene irradiation containers at the Lucas Heights site by accredited ANSTO staff. Please contact ANSTO early in the process of project development to discuss target and canning aspects.

Samples should be dry, powdered and homogeneous. Samples for DNAA should be ground to less than 200 µm. Between 100 mg and 10 g of sample will be weighed into the irradiation containers that will be supplied by ANSTO. The actual amount of sample used will depend on the expected dose-rate from the sample at the end of the planned irradiation.

Sample storage and return

Unused samples will be stored for 6 months prior to disposal. If requested, this unused material can be returned at the client's cost.
In certain circumstances, it may be possible to return irradiated samples to the client, subject to ARPANSA regulations.

ANSTO Contact Scientist:

Dr John Bennett
Phone: 02 9717 3743
Fax: 02 9717 9669
Email: john.bennett@ansto.gov.au

1910 NAA – short residence time facility

A selection of elements that are best measured in the short residence time facility are shown in the following table. Detection limits (ppm) are also provided for guidance but they may depend on the bulk matrix of a sample, the elemental composition and the method of standardisation used.

Indicative detection limits (ppm) of selected elements:

Al	1000	Na	50
Ca	200	K	200
Ti	200	Br	1
V	10	In	1
Mn	0.1	I	5
Mg	1000	Ga	20
Ba	2		

ANSTO Contact Scientist:

Dr John Bennett
Phone: 02 9717 3743
Fax: 02 9717 9669
Email: john.bennett@ansto.gov.au

1920 NAA – long residence time facility

A selection of elements that are best measured in the long residence time facility are shown in the following table. Detection limits (ppm) are also provided as guidance but they may depend on the bulk matrix of a sample, the elemental composition and the method of standardisation used.

Indicative detection limits (ppm) of selected elements:

As	1	La	0.5
Sb	0.2	Ce	2
Cr	5	Sm	0.2
Fe	200	Eu	0.5
Sc	0.1	Yb	0.5
Th	0.5	Lu	0.2
U	2	Se	5
Zn	100	Au	1

ANSTO Contact Scientist:

Dr John Bennett
Phone: 02 9717 3743
Fax: 02 9717 9669
Email: john.bennett@ansto.gov.au

1930 DNAA - uranium analysis

Subject to initial review by ANSTO, the uranium concentration of any dry, stable, non-corrosive powder may be determined using this method.

The precision of the analysis is 3% (one sigma) of the stated uranium concentration above 5 ppm and about 10% below 5 ppm.

ANSTO Contact Scientist:

Dr John Bennett
Phone: 02 9717 3743
Fax: 02 9717 9669
Email: john.bennett@ansto.gov.au

9010 Cemented Waste Facilities

Description

Cement Waste Forms Laboratory is for

- the characterisation of cement and cemented waste forms eg. shrinkage at different relative humidities
- sample preparation for SEM, XRD
- preparing hydrated cement compounds eg milling, shear mixing and glove boxes
- examining conditioned cemented wastes (eg leach testing)

Applications

For characterisation of cement and cemented waste forms.

ANSTO Contact Scientist:

Dr Kapila Fernando
Phone: (02) 9717 9488
Fax: (02) 9717 9277
Email: kfe@ansto.gov.au

9020 Health and Safety – Gamma Irradiation Suite (GIS) – irradiation only

9021 Health and Safety – Gamma Irradiation Suite (GIS) – irradiation and biology rooms

The gamma irradiation suite (GIS) is utilised in radiobiology research. It consists of two main sections: the irradiation room and the animal/biology rooms.

The irradiation room is equipped with a Cobalt-60 collimated beam (Theratron). Different gamma dose rates can be obtain by changing the Source to Sample Distance, however, the field size is function of the SSD. A number of beam attenuators are also available. They can be used to reduce the dose rates with little change to the field size however, the scattered radiation is proportional to the attenuator thickness. The Irradiation period can run from seconds to days.

The suite has a dedicated room to hold small animals e.g. mice over days to a few weeks. It has also an adjacent room to perform animal dissection and CO2 euthanasia if required. The biology lab is classified as PC1. Biological supporting staff may available to limited tasks.

The temperature, humidity and light of the suite are controlled.

Availability and cost

The GIS service is normally available from Monday to Friday (9am to 5pm) throughout the working year. However, continues operation can be arranged. Appointment is essential.
Irradiation = $600 per day
Utilisation of Biology/animal rooms = $300 per day
Biology supporting staff = extra $, depend on availability and tasks

ANSTO Contact Scientist:

Haider Meriaty (Harry)
Phone: (02) 9717 9257
Fax: (02) 9717 3899
Email: ham@ansto.gov.au

9030 Health and Safety – in vivo gamma spectrometry (IVGS)

Generally not applicable to AINSE users but grants have been awarded for whole body monitoring.

Description

The Internal Radiation Dosimetry (IRD) provides a qualitative and quantitative measurement of radioactivity in living samples eg. the human body. The investigated radionuclide must be a photon emitter of energy greater than 14KeV ie. gamma radiation or x-ray. The measurements are usually performed in a graded shielded room to provide a low radiation background environment. The detection system utilises NaI, HPGe or Phoswitch large crystals as a detector.

Applications

- whole body gamma spectrometry
- thyroid gamma spectrometry
- lungs gamma spectrometry
- K-40 body content
- gamma spectroscopy on bulk samples in a low radiation background environment

Availability and cost

The IRD service is available from Monday to Friday (9am to 5pm) throughout the working year. Appointment is essential.
$300 per normal sample i.e. 30 minutes

ANSTO Contact Scientist:

Haider Meriaty (Harry)
Phone: (02) 9717 9257
Fax: (02) 9717 3899
Email: ham@ansto.gov.au

9200 Heavy Water

Description

Specifications of the heavy water available is normally as follows

- isotopic purity - nominally 99.92% by mass
- conductivity - less than 1 mS/m
- turbidity - less than 2 NTU
- $KMnO_4$ demand - Less than 10 mg/kg
- tritium content - less than 5 µCi/kg
- oxygen-18 content - approximately 0.22 atom per cent

Support services and facilities

The heavy water is normally supplied in 500g or 1000g quantities in stainless steel transport containers dispensed under dry nitrogen. On receipt the heavy water should be transferred to the consignee's own container and the transport container returned to ANSTO at the expense of the consignee. On occasions larger quantities may be supplied in similar, larger, returnable transport containers, when available.

9210 Heavy Water Dispensing Fee

Please note that a prerequisite of supply of heavy water is the receipt by ANSTO of information on proposed end use and regulatory approval.

Availability

Limited quantities of heavy water may be made available to academic organisations. Although the heavy water is subject to the Nuclear Non-Proliferation (Safeguards) Act 1987, no Permits are required for small quantities used for research purposes, however, supply is contingent upon regulatory (ASNO) approval for the transfer.

ANSTO Contact:

Nuclear Safeguards Officer and deputy – Campus Services
Phone: (02) 9717 3872 & 9717 3658
Fax: (02) 9717 9288
Email: safeguards@ansto.gov.au

9300 ANSTO Library

ANSTO Library is Australia's most comprehensive scientific centre for nuclear information. It is a much-valued national resource which supports the scientific, research, commercial and educational activities of the Australian Nuclear Science and Technology Organisation (ANSTO). The library principally serves the staff of the two scientific organisations on site: the Australian Nuclear Science and Technology Organisation (ANSTO), the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Library services are also available to approved visiting researchers.

The Library began as a collection in the early 1950s at the Coogee headquarters of the Australia Atomic Energy Commission (AAEC – ANSTO's predecessor). In August 1957, the Library collection was transferred to the Lucas Heights site.

Today, the Library has eight full-time staff and its collection contains 50,000 monograph titles, over 6,000 electronic journals, more than 1700 print journal titles and over 200 databases. It also encompasses an extensive classic collection of technical reports dating from the 1950s, as well as a vast range of patents, standards, theses and nuclear literature, available in electronic, hardcopy or microfiche formats.

In addition to physics, chemistry and engineering, the subject areas covered by the collection include: environmental sciences, radiopharmacology, materials sciences, management, counter terrorism, climate change, minerals, nuclear medicine, food sciences and safeguards.

INIS – the International Nuclear Information System

ANSTO Library also hosts the Australian INIS Centre where Australian nuclear science and technology literature is indexed, scanned and recorded into the global INIS Database. INIS is the world's leading information system on the peaceful uses of nuclear energy. It is produced and maintained by the International Atomic Energy Agency (IAEA). ANSTO's submissions to the INIS database are also available as the Australian Science & Technology Information (ANSTI) database available from INFORMIT.

Institutional Repository

The Library co-ordinates input of ANSTO authored publications into ANSTO Publications Online, ANSTO's institutional repository which showcases ANSTO research. For more details see http://apo.ansto.gov.au/dspace/.

Library Access

Physical access to the library is restricted to site staff only. However, most items on our Library Catalogue are available for Inter Library Loan through Libraries Australia. Contact your library to request an Inter Library Loan. Persons with site access are entitled to physical access to the Library and may browse the collection and the new serials display Photocopying facilities are available.

Access to other services such as borrowing, electronic databases and full-text journals is dependent on appointment type and requires ANSTO network access.

ANSTO Contact:

Library Information Desk
Ph: (02) 9717 7755
Email: nlhr@ansto.gov.au

9400 Design and Project Engineering, Manufacture, Assembly and Commissioning

ANSTO Engineering & Technical Services (E&TS) has expertise in:

- Project management for research and development applications, such as specialised equipment installations and pilot plants.
- Computer aided engineering design
- Concept development
- Finite Element Analysis
- Project management for research and development applications, such as laboratory fit-outs, specialised equipment installations and pilot plants, of jobs involving conditioning, transport and storage of radioactive materials.
- Design and manufacture of
    - gamma and neutron shields for radiation source handling
    - nuclear medical facilities and equipment
    - stainless steel and aluminium pressure and vacuum vessels
    - transport packages for radioactive material;
    - in pile irradiation rigs
- Component development and prototype manufacture
- Development of manufacturing techniques and prototype testing
- Electrical distribution equipment upgrade and expansion
- Electrical distribution equipment upgrade and expansion
- Power quality analysis and electrical interference investigations
- Control and monitoring systems design and implementation
- Programming and support for PLCs (programmable logic controllers) and SCADA (supervisory control and data acquisition) systems

ANSTO Engineering & Technical Services (E&TS) is able to provide:

- hazardous materials machining facilities
- lead casting and machining services
- high volume precision machining
- high volume precision sheet metalwork
- testing of radioactive transport containers
- manufacturing, fabrication and installation support

ANSTO E&TS is a QA accredited organisation to ISO/AS/NZS9001- 2000

ANSTO Contact Scientist

Mr Stephen Morris
Phone: (02) 9717- 33653
Email: stephen.morris@ansto.gov.au

9450 Engineering Quality Control, Inspection, Testing and Calibration

ANSTO Engineering's Quality Control Laboratories are NATA registered for:

- Mechanical testing and
- Fabrication inspection

The Quality Control Laboratories also provide the Lucas Heights site with additional calibration services such as:

Metrology

- Length measurement 1 m to 20m
- Angular measurement
- Mass measurement
- Dimensional inspection of components
- Pressure measurement
- Torque measurement
- Temperature & humidity measurement
- Paint thickness measurement
- Hardness testing
- Luminance measurement
- Surface roughness measurement

Non-Destructive Testing including:

Magnetic Particle Testing	Electromagnetic Yoke Prods Coil Fluorescent or visible magnetic inks and dry powders
Penetrant Testing	
X-Ray Radiography	Up to 5 mA x 260 kV
Ultrasonic Testing	Thickness testing Flaw detection
Surface Coating Thickness Testing	0 - 1250mm (ferrous and non-ferrous substrates)

Pressure Equipment & Radioactive Package Inspection & Testing

- Site in-service inspection of pressure equipment its registration
- Pressure equipment testing and inspection
- Radioactive Package testing

General Inspection and Testing

- Visual inspection
- Weld inspection
- Inspection of components (machined parts, fabrication, assembles)
- Functional testing of assemblies
- Radioactive Package Certification
- Site registration and inspection of lifting equipment
- Site registration of crane and hoists

Nuclear Inspection and Testing

- Testing and inspection in a nuclear environment
- Testing and inspection meeting ISO, IAEA and ARPANSA requirements

ANSTO Contact Scientist

Mr Stephen Morris
Phone: (02) 9717- 33653
Email: stephen.morris@ansto.gov.au

9800 AINSE Facilities

Description

Lecture Theatre

- 150 seat capacity
- Equipped with audio-visual equipment.

Conference / Seminar Room complete with audio-visual equipment; to seat up to 40 people.

In general, there is no charge to AINSE member universities or ANSTO. A hiring fee may be applicable in all other cases.

Costs

Theatre	$400 per day
Council Room	$300 per day
Foyer Area	$200 per day

The rooms are only hired out to corporate groups.

AINSE Conferences - Contribution to Travel and Accommodation

Depending upon circumstances, AINSE may provide a contribution towards travel costs for nominated participants from member universities. The extent of any such travel contribution will be determined by AINSE when all nominations have been received and the circumstances are known. Preference is given to students presenting papers and posters. Where appropriate, group leaders will be advised of the amount which can be made available for travel costs for the group, and the basis for payment. AINSE may meet bed and breakfast charges for participants from member organisations during the conference.

AINSE Awards - Travel and Accommodation

Researchers planning to use the Lucas Heights facilities are expected to take advantage of the discounted airfares. The airfares are normally calculated on the basis of advance purchase airfares plus $160 to cover the cost of taxis to and from Sydney airport.

Bus Sutherland train station - Lucas Heights

Schedule passenger run:

Depart Sutherland train station bus bay 6 for Lucas Heights	7.55am
Depart Lucas Heights for Sutherland train station	4.55pm

Car travel

AINSE interstate award holders who wish to use cars for travelling to Lucas Heights may be eligible to receive reimbursement. A tax invoice must be received from the University claiming an agreed amount and not exceeding the AINSE award.

Bookings and further information

Rhiannon Still – AINSE Secretariat
Phone: (02) 9717 3376
Fax: (02) 9717 9268
Email: ainse@ansto.gov.au

9910 Linear Accelerator / Pulse Radiolysis Facility – the University of Auckland

Description

A Dynaray 4 linear accelerator converted to deliver electrons in single pulses of up to 180 mA current. Pulse lengths available are 200 ns, 750 ns, 1.5 µs and 3 µs. Beam energy can be varied between 0.5 and 5 MeV but normal operation is at 4 MeV. Radiation dose per pulse can be set between 1 and 100 Gy. A range of optical cell pathlengths between 0.5 cm and 3.0 cm as well as combined optical and AC conductivity detection cells of 1.0 cm and 2.0 cm are available for pulse radiolysis studies. Transient spectrophotometric detection is over 210 nm – 2000 nm using photomultipliers and photodiode detectors. Conductivity measurements are made using a 250 kHz AC system capable of handling up to 0.01 Ω^{-1}. Optical and conductivity detection cells, combined with temperature control (4-90 ^{o}C), are also available, as well as a pre-pulse rapid-mix facility (under development). Both xenon (for uv-vis detection) and tungsten lamps (for long observation times, seconds) are available.

Support Services and Facilities

The modern, PC-driven, optical and conductivity radical detection system is operated in a LabWindows environment. Data is harvested/displayed by a 300 MHz digitizer/scope and full kinetic, spectral and conductance analysis is carried out using dedicated modern software. Data analysis can also be carried out off-line using stand-alone software as well as data sent to home institutions via the internet. Gas mixing lines are installed for saturating samples prior to pulse radiolysis and samples changed remotely between electron pulses.

The dedicated facility is located in the Department of Chemistry, the University of Auckland. The full range of research facilities on site includes a ^{60}Co gamma source providing a dose rate of up to 7 Gy min^{-1} for complementary steady-state radiolysis studies. A fully equipped laboratory is available for sample preparation and analysis. Experienced radiation chemists are on the staff and can assist with experimental design and supervision of student research projects.

Applications

Pulse radiolysis experiments are used to identify radical intermediates and to study reaction mechanisms in solution by measuring time-resolved spectra and conductance changes. Electron transfer reactions between donors and acceptors are studied in real time. Conductivity measurements can be used to identify and study charged species that do not have accessible absorption spectra and to confirm the protonation state of species. Studies on complex organic and inorganic molecules as well as biological systems can be carried out. Temperature-dependent kinetic studies are used to obtain thermodynamic parameters for the studied reactions. Thermodynamic redox potentials of compounds and their radical intermediates are determined from radical equilibrium measurements with reference compounds.

Cumulative electron pulses for material science and sterilization studies are also available.

Availability

This facility is currently available to AINSE members under the AINSE grant scheme. Bookings are essential.

The University of Auckland Contact

Associate Professor Bob Anderson - Department of Chemistry
Phone: 64 9373 7599 ext 88315
Fax: 64 9373 7422
Email: r.anderson@auckland.ac.nz

9920 21 MeV Linear Accelerator/Pulse Radiolysis Facility - ARPANSA

9920a 21 MeV Linear Accelerator/Pulse Radiolysis - high dose irradiations - ARPANSA

Description

A Vickers (Radiation Dynamics) electron linear accelerator, previously used at the University of Toronto for nuclear physics research and picosecond pulse radiolysis, is operated for the maintenance of national dosimetry standards and as an irradiation resource for approved users. The electron beam energy can be varied continuously between 7 and 21 MeV. Pulse repetition frequencies are available from 3 to 200 pulses per second as well as having a single shot mode. The single shot pulse is initiated at the user data acquisition station and can be delayed at will with respect to the data acquisition start pulse.

A peak pulse current up to 330 mA, depending on the energy, can be reached corresponding to a dose/pulse at the radiolysis cell of roughly 90 Gy at 12 MeV. Lower currents and dose rates can be selected by adjustment of the gun emission and pulse width. The pulse width can be varied from below 100 ns to 4 μs and, up to at least 600 ns there is a useful linear relationship to the dose/pulse. A quadrupole focussing system on the electron beam line allows optimum response to be achieved for a wide range of optical cell pathlengths.

Support services and facilities

A fast response (50 ns) spectro-photometric detection system exists for absorption and emission kinetic spectroscopy. It is supported by a fully computerised data acquisition and analysis facility. There are *in situ* gas mixing lines for pre-irradiation sample saturation and an automatic sample changing system for liquids. Wet lab facilities are provided for preparation and analysis of solution samples. Local ethernet access exists for ftp transfer of data to remote sites.

A general purpose, high dose irradiation facility is available on a 90^{o} arm of the electron beam line. A fan beam giving up to 5 Gy/pulse is directed onto a horizontal motorised table for repetitive transits of the beam. Sample sizes up to 5 cm in the fan plane can be accommodated.

Applications

The pulse radiolysis system can be used to study transient species in irradiated liquids and solids. Measurement of spectra of transient free radicals and ions and determination of absolute rate constants for chemical reactions in solution and solid state can be made.

Contact:

Australian Radiation Protection & Nuclear Safety Agency (ARPANSA)
619 Lower Plenty Road, Yallambie, Victoria 3085

Dr David Webb
Phone: (03) 9433 2227
Fax: (03) 9432 1835
Email: david.webb@arpansa.gov.au

9930 National Plasma Fusion Research Facility (H-1NF) - Australian National University.

The H-1 National Plasma Fusion Research Facility (H-1NF) is designed to perform research into the basic properties of magnetically confined, high-temperature plasma as part of an international program, whose ultimate aim is environmentally sustainable power generation by the controlled fusion of hydrogen isotopes. This facility is built around the existing H-1 Heliac experimental confinement device at the Australian National University, established under the Commonwealth Major National Research Facilities program. The research aims to build upon Australia's internationally recognised position of excellence in basic plasma physics and applications such as plasma diagnostics and plasma processing, and to enable Australian scientists, engineers and industry to tackle the "grand challenge" problems presented by fusion research; this provides excellent postgraduate training and generates spin-offs with commercial potential.

The H-1 Facility is integral to the strategy for Australian fusion science and engineering, developed by the Australian ITER Forum, an association of over 100 scientists, engineers, students and others interested in the development of plasma fusion energy. A significant allocation for facility upgrades in the 2009 Budget will enable the facility to support the key elements of this strategy such as building Australia's capability, and developing advanced instrumentation for fusion reactor prototypes, and ultimately ITER.

Research Fields

Physics and technology of magnetically confined plasma, including its generation, heating, confinement, stability, remote measurement systems and numerical modelling.

Research Outcomes

- A detailed understanding of the behaviour of hot plasma which is magnetically confined in the helical axis stellarator configuration. (This forms part of an international program under the IEA Implementing Agreement on Stellarators, to which Australia is a party).
- The development of advanced measurement systems ("diagnostics"), integrating optical and microwave detectors, real-time processing and multi-dimensional visualisation of data on large scale computer networks, and theoretical modelling.
- Fundamental studies of turbulence and transport of particles and energy in confined plasmas.
- Significant contributions to the global fusion research effort and an increased Australian presence in the field of plasma fusion power.
- Improvements in knowledge of basic plasma physics and related technologies for applications such as plasma processing of semiconductors.
- Improvements in skills of Australian industry in the areas of materials, modern power engineering, and communications and control.

Description

H-1NF is a three-field period flexible heliac, a type of stellarator in which the minor axis of the plasma twists three times as it goes around the torus the long way. Figure 1 illustrates the magnetic configuration of H-1. The external toroidal field coils are displaced helically around a central coil assembly comprising a circular ring coil and helical coil. By adjusting the relative currents in the circular, helical, and other coils, the H-1NF configuration can be made to vary its shape and confinement properties; hence it is called a flexible heliac.

The plasma in H-1NF is heated by 50-250 kW of rf power at 4-26 MHz and a 200 kW, 28 GHz gyrotron microwave source from Kyoto University and the National Institute of Fusion Science in Japan. A large number (>100) of ports provide access for diagnostics, and several gate valves of various sizes allow convenient connection of user's instruments.

A number of internationally unique diagnostic systems are being developed as part of the MNRF development project. These include:

- mm-wave tomographic interferometry for electron density imaging;
- Individual and arrays of electrical probes to measure particle energies and fluxes, and a dual 20 coil magnetic probe array for investigation of MHD/Alfvén instabilities;
- 8-mm microwave scattering for turbulence studies;
- Coherence spectroscopy systems for imaging plasma temperatures, flows, and fluctuations;
- Supersonic helium beams for local spectroscopic measurement of electron temperature and density.

Applications

The H-1NF Facility upgrade builds on a major investment by the ANU, allowing Australia to capitalise on the current resurgence of interest in magnetic fusion configurations of the stellarator type. The flexibility of H-1NF provides access to a wide range of configurations, including some with the promising “reversed shear” characteristic of advanced tokamaks, but without the drawback of multi-megampere plasma currents and associated instabilities. This allows H-1 to be used for basic studies or as a test-bed for divertor and edge diagnostics for ultimate application to the international fusion experiment, ITER.

H-1NF is Australia’s main experimental contact with the international fusion community and is the largest plasma facility in the Southern Hemisphere, and the only alternative concept device in the South East Asian region. The H-1NF Facility offers many diplomatically important opportunities for academic and technological exchange. Significant collaborative activities with Japan, Korea, Europe and the US are already under way, with exchanges of personnel and scientific equipment.

Availability

The Facility is available to all Australian physicists and engineers and is affiliated with AINSE. Scientists outside of the ANU are involved in all aspects of experimental program of the H-1NF, and to this end, much of the data acquisition and analysis is readily conducted over the AARNET computer network, enabling data mining, remote access via metadata portals and grid computing.

Time allocation is overseen by the appropriate AINSE Specialist Committee. Proposals may be made at any time by contacting the Director, and scheduling of experimental time will be arranged between the applicant and the Management Committee of the H-1NF. Typical projects include development of new diagnostics, or use of the many existing diagnostics for studying wave, turbulence or confinement physics, or materials interaction, possibly leading to further experimentation on international devices.

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9940 The Australian Positron Beamline Facility at the Research School of Physical Sciences and Engineering, ANU

Description

The Australian Positron Beamline Facility (*APBF*) provides a unique national facility for scientists to study fundamental interactions of positrons with matter and to use positrons as a diagnostic tool for materials and bioscience activities. It was initially supported by the ARC through LIEF and Centre of Excellence grants. Participants include the ANU, Flinders, Griffith, Murdoch, Curtin, Adelaide, UWA, James Cook and Charles Darwin Universities, ANSTO, and the CSIRO. The *APBF* provides the only variable energy, positron beam lines in Australia. Positrons emitted from a 50 mCi ^{22}Na source are moderated using solid neon and then loaded into a Penning-Malmberg trap, where they are accumulated and cooled, using gas-collision techniques, to form a positron cloud at room temperature (~30 meV). By modulating the well depth of the trap, pulses of positrons several usec wide are produced, with a 100-4000 Hz repetition rate, and these are then used in two experimental beamlines.

Applications

The two positron beamlines are available for both high and low energy studies:

(i) The low energy (0.1-200 eV), high-energy-resolution (~30 meV) beamline is being used to investigate positron interactions with atoms and molecules, including measurements of ionization, annihilation and positronium formation. Important bio-molecules, and the fundamental interactions with them that underpin medical imaging processes such as Positron Emission Tomography (PET), will be studied.

(ii) The second, high energy (0.1-20 keV) beamline is dedicated to materials science and bioscience studies. The pulsed beam will be further bunched to form a sub-nanosecond, positron pulse that can be injected at high energies into the surface of the material under study. The positrons quickly thermalise and many of them combine with an electron in the material to form positronium – a mutually orbiting electron-positron pair. When this exotic 'atom' decays, it produces gamma rays that are detected in time coincidence, allowing the lifetime of the positronium to be determined. The lifetime depends critically on the free space in the material, and it is thus an excellent probe of voids and defects in materials, on the nano-scale, and at depths up to several microns. The *APBF* will enable, for the first time in Australia, the study using a variable energy positron beam, of new and exotic materials that are designed to have certain characteristics such as porosity or conductivity, or the controlled release of embedded agents such as drugs.

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1700 SIMS - Secondary Ion Mass Spectrometry - Cameca IMS 5f, located at the University of Western Sydney's Hawkesbury Campus, Richmond NSW.

The Cameca IMS 5f magnetic sector SIMS instrument is used for elemental surface analysis and depth profiling of a wide variety of materials. It can be operated in either microprobe or microscope mode enabling a unique combination of in-situ analysis, depth profiling and imaging. Analyses and images of masses between 1 – 500amu can be made in areas up to the size of 500μm x 500μm. Concentrations in the ppm/ppb range can be detected under favourable conditions. Depth profiling can be performed to depths of around 10μm.

The instrument is routinely used for isotopic analysis, studies of surface contaminants, imaging of materials and the analysis of trace and rare earth elements in samples. Samples are to be supplied suitable for mounting. Specimens should be less than 2.5cm in diameter and less than 1cm deep. Where possible the upper surface should be as flat as possible.

Support services and facilities

Sample preparation is a critical step in SIMS analysis and all samples must be fully prepared prior to arriving at UWS. It is strongly recommended that the SIMS Instrument Scientist is consulted for advice in this matter. The SIMS Instrument Scientist is available for consultation on matters relating to data interpretation following SIMS analysis.

Availability

The SIMS instrument has periods of down time while routine maintenance is performed. To maximise operational efficiency the instrument is operated in a single mode for scheduled periods. Accordingly, successful grant applicants will be allocated scheduled instrument time by the SIMS Instrument Scientist The projects and instrument time required must be agreed with the SIMS Instrument Scientist prior to the submission of an application.

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