TS2 news

news from the ISIS second target station project

Issue 4 March 2005

Instrument funding assured

Minister for Science and Innovation, Lord Sainsbury, has announced a further £27.5 million funding to the ISIS Second Target Station project to construct the first seven neutron scattering instruments. His announcement during a visit to the CCLRC Rutherford Appleton Laboratory in October 2004 comes on top of the £100.4 million core funding allocated to the project in April 2003.

"World class scientific research is of key importance for UK prosperity and creates technologies that benefit us all," Lord Sainsbury said. "The ability to look deep into matter is fundamental to achieving new breakthroughs in many areas from medical treatment and drugs to understanding the origins of our planet."

The European Union has separately awarded €11 million towards the construction of the instrument suite through the Construction of New Infrastructures activity of the Structuring the European Research Area programme in Framework Programme 6. This is the first time that the EU has granted a major award to a facility construction project.

"This funding will enable us to develop the first suite of instruments which scientists will use to discover how the molecular construction of materials defines and controls their behaviour," said ISIS Director, Andrew Taylor. "The science benefiting from ISIS is already very broad. The new capabilities of the ISIS Second Target Station will further increase the range of phenomena in materials that we can investigate."

The EU project will be co-ordinated by Universita Roma Tre in Italy, working with partners in The Netherlands, Germany, Hungary, Greece, Italy, Spain, Sweden and Denmark.

Costain and Corus win major contracts

Two of the biggest contracts within the scope of the ISIS Second Target Station project totalling nearly £36 million have been awarded.

International engineering and construction group Costain has already begun work on the £25.6 million experimental hall building that will house the neutron target and seven new instruments. The company is already familiar with the CCLRC Rutherford Appleton Laboratory site as it is the main contractor for the Diamond Light Source project. Costain will complete the building in late 2006.

Corus Northern Engineering Services, a subsidiary of Anglo-Dutch metals group Corus, has been awarded the £10.7 million contract to design and build the target station shielding monolith.

The massive steel and concrete bulk of the monolith will contain the neutron target inside the experimental hall. CNES will design and manufacture the monolith in Scunthorpe before installation at ISIS during 2006.

Technical support building open for business

Professor Sir David King, the UK's Chief Scientific Adviser inaugurated the Technical Support Building on 16 December 2004 during the ISIS 20th anniversary celebrations. The building provides workshops and offices for support staff.

Twenty years of excellence

ISIS celebrated 20 years of neutrons on 16 December 2004 with a day of events for around 200 invited guests, including many of the key figures who have helped to ensure the continued success of the facility over the years.

Giving the keynote lecture, the Chief Scientific Adviser to the government, Professor Sir David King, said, "The twentieth anniversary of ISIS – one of the UK's major scientific achievements – is a real cause for celebration. This gigantic and complex particle accelerator allows scientists to probe deep into the internal structure of different materials and it is the world's leading pulsed neutron and muon source."

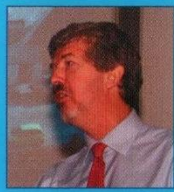
> "Although those of us involved in the early days were supremely confident that pulsed spallation was the way for us to go, I doubt that any of us would have predicted the degree of success which has been realised consistently by the ISIS team and the user community."
>
> Leo Hobbis, December 2004, founding head of the Neutron Beam Research Unit at RAL

Sir David's comments were echoed by ISIS Director Andrew Taylor. "ISIS has been a remarkable success," he said. "Scientifically, it has enabled researchers world-wide to make advances over a wide range of science. Technologically, it has defined the direction for neutron sources of the future. The power of ISIS lies in using a large machine to enable a host of small experiments and discoveries to be made across a wide spectrum of science."

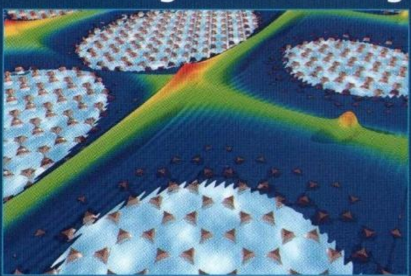
Invited speakers gave their own personal accounts of the past successes of ISIS and perspectives on future scientific opportunities.

Professor Andrew Harrison (University of Edinburgh) discussed the impact of ISIS neutrons on crystallography and magnetism whilst Dr Olwyn Byron (University of Glasgow) considered the great potential for bioscience research using instruments at the Second Target Station. Professor Stephen Blundell (University of Oxford) examined the opportunities for ISIS muons as a complementary technique to neutron scattering. Professor Gabriel Aeppli (University College London) highlighted the definitive role that neutron scattering can play in the emerging field of nanoscale science.

Over 20 years, ISIS has enabled the international research community to make advances over a very wide range of science. Unique partnerships will continue to be forged with this world-wide user community during the next 20 years.



Magnetic listening



Listeners to BBC Radio 4's weekly science feature 'The Material World' were able to tune in on 16 December and hear about 20 years of neutron scattering from ISIS senior scientists Bill David and Sean Langridge.

Bill explained to presenter Quentin Cooper why ISIS is such an important tool for research across physics, chemistry, materials science, engineering, biology and geology, and how it helps scientists to understand the fundamental atomic structure of materials. Quentin and Sean discussed how using ISIS to study the minutiae of magnetism might lead to portable music players storing even more music than they do now.

You can hear the programme again by visiting the BBC Radio 4 website at

http://www.bbc.co.uk/radio4/science/thematerialworld_20041216.shtml

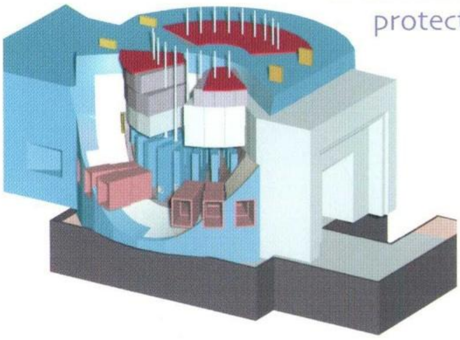
Target station design

Lying at the heart of the new project, the target station relies on the expertise of many engineers.

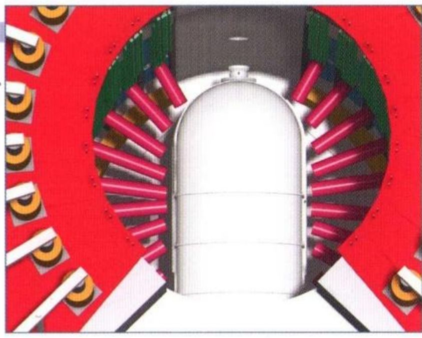
David Jenkins heads up the team responsible for the design of the shielding monolith, target and moderators, cooling systems, beryllium reflectors, stainless steel containment vessels and target services area. Construction of the target station inside the new experimental hall will begin later this year and will be completed by the end of 2006. Team members from left to right are Mike Colley, Dave Bellenger, Marc Simon, Chris Aldis, Andy Caulfield, David Jenkins, Dan Coates, Sean Higgins and Robbie Scott.

Solid engineering

The shielding monolith is a major civil engineering exercise within the experimental hall building. Its massive bulk is required to contain the neutron producing target and protect workers in the experimental hall.



The 12m diameter, 7m high steel and concrete structure closely follows the existing target station design. The interior contains the target and moderator assembly surrounded by a stainless steel containment vessel filled with helium. For maintenance, the target assembly can be withdrawn into a service area with remote handling equipment.



Eighteen radial beam ports allow neutrons to travel out to the instruments. Hydraulically operated steel shutters can be closed across the beam to allow safe access.

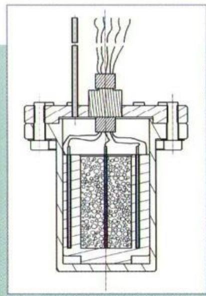
Vital in-foam-ation

Both of the moderators in the Second Target Station will use solid methane to slow down neutrons from the target to useful energies for experiments

Solid methane is the best material for producing large numbers of low-energy, long-wavelength neutrons. But the low thermal conductivity of solid methane (0.3 W/mK at 22K) and deterioration due to radiation damage present tough challenges to efficient operation.

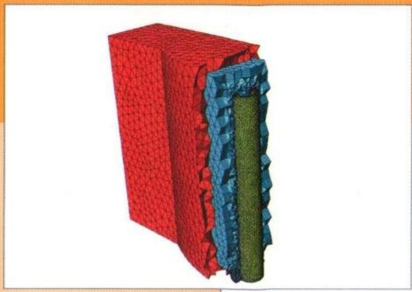
Placing aluminium foam into the moderator is one solution that improves solid methane's thermal conductivity, helping to keep the moderator at an optimal temperature of 22K. The density of the aluminium foam must be kept as low as possible to maximise neutron production performance. However, periodically replacing the moderator is the only option to avoid the moderator blocking up as methane turns into tarry, carbon strands.

Thermal conductivity of aluminium at low temperatures improves dramatically with purity, and computer simulations have shown that 99.99% purity aluminium is needed to be able to extract enough heat from the methane to enable the moderators to work efficiently.

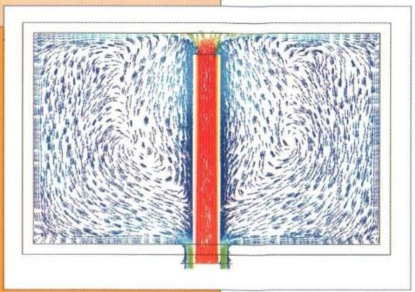


Sean Higgins and moderator scientist, Stuart Ansell, have developed equipment to determine the thermal conductivity of solid methane within aluminium foams. Their results closely match values calculated from published numerical methods, and confirm that only 99.99% purity aluminium foam can be used within the moderator.

Cool engineering



Cryogenics engineer Marc Simon needs to keep cool as he designs the hydrogen and methane cryogenic systems for the two moderators in the new target station.

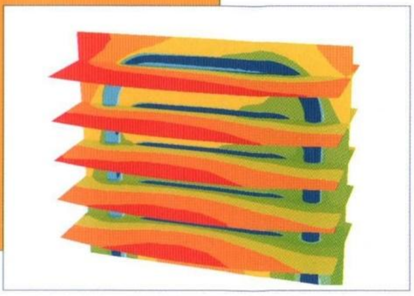


The coupled grooved moderator consists of two chambers, one of which will contain flowing liquid hydrogen. This will serve not only as a moderator but also as the primary cooling for the condensing and freezing of methane in the neighbouring chamber.

The decoupled moderator will have a primary helium cooling circuit connected via a heat exchanger so that methane can be condensed and frozen directly into the moderator.

The moderators must remain mechanically stable during their lifetime, permit routine maintenance to be carried out easily and conform to industry standard regulations for the design of pressure vessels.

One problem in operating solid methane moderators is the spontaneous release of radiation damage energy within the solid methane that has the potential to cause catastrophic failure of the moderator vessel. To prevent 'burping' as it is known, the solid methane will be warmed periodically to around 65 K to release the stored energy and allow hydrogen gas to be drawn off.



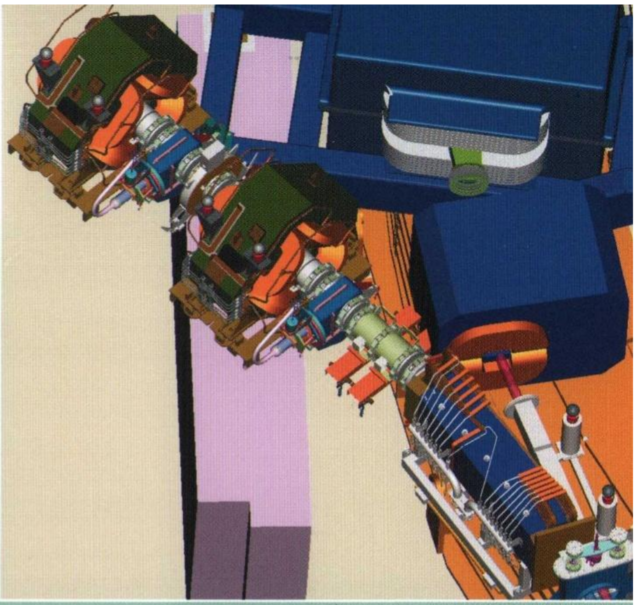
Target cooling

Neutrons will be produced at the Second Target Station when the proton beam collides with a solid cylinder of tungsten clad with tantalum. The 58 mm diameter, 300 mm long cylinder has its long axis aligned along the proton beam and has a design lifetime of six years.

The 36 mm diameter proton beam delivers around 48 kW of energy to the target of which 29 kW remains within the target as heat. The remainder is accounted for by escaping neutrons and photons and other processes.

Heat will be removed from the target by flowing pumped D_2O over the surface. This primary circuit will deposit the heat into a dedicated secondary demineralised water circuit via a heat exchanger, and this in turn will deposit the heat into a common process water circuit via an additional heat exchanger.

Proton diversions



Designing the proton extraction area for the second target station.

This is the latest image showing the complexity of the Second Target Station proton beam extraction area just above the main ISIS synchrotron accelerator. The image is taken from a three-dimensional computer model generated by engineers Steve Jago and Simon Spurdle.

The proton beam inside the synchrotron is lifted up and over the horizontal orbit plane of the synchrotron and sent to the target station. One pulse in five from the main proton beam will then be diverted to the second target station along the leftwards path. The main circulating beam in the synchrotron is on the right-hand side of the picture bending to the right.

Steve Jago explained further. "Starting from the bottom, the main elements you can see are the extraction septum magnet designed by me and Dan Faircloth, and an asymmetric dipole bending magnet above it, both in blue. The new dipole is needed to replace an existing magnet because space is very tight. In green are two focussing quadrupole magnets. Then between the main components are several types of beam monitors, designed by Eamonn Quinn, that will be used to characterise and control the extracted beam properties."

Task Leader John Hirst is impressed with the power of current 3-D computer modelling. "It's impressive for me to see everything laid out in three dimensions so that it can be easily explained to other staff," he said. "I'm more used to assembling the whole thing in my head from two-dimensional drawings."

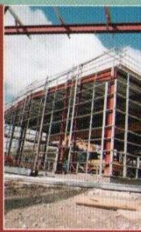
Project data: major orders

Major orders for the Second Target Station Project must be advertised across Europe in the Official Journal of the European Union to ensure fair access to opportunities.

Major orders placed	£ million
Second Target Station site preparation and earthmoving (VHE Group)	1.4
Construction of access roads (Hanson Plc)	1.2
Construction of technical support building R78 (ASHE Construction)	3.7
Construction of experimental hall building R80 (Costain)	25.6
Manipulator arms for target station service area	0.3
4,550 tonnes steel for extracted proton beam east wall shielding (Corus)	1.4
Design and construction of steel and concrete target station shielding monolith (Corus Northern Engineering Services)	10.7
Type Q11 quadrupole focussing magnets for extracted proton beam line	0.4
Cryogenic systems for moderator cooling	2.3

Major orders for the next six months
Type Q12 quadrupole focussing magnets for extracted proton beam line
Extracted proton beam profile monitors
10,500 tonnes steel for extracted proton beam west wall and roof
Manufacture of beryllium reflector for target station
Target station stainless steel void vessel

Price rises steel the limelight



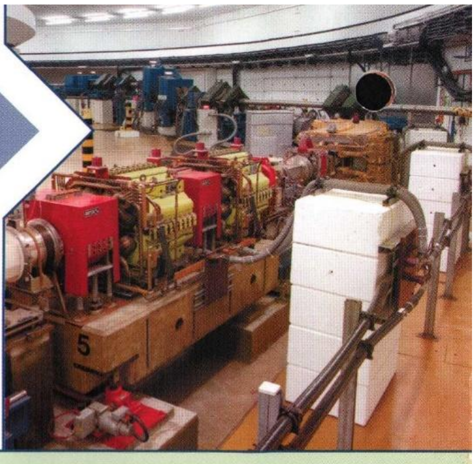
Surging steel demand around the world over the past year has outstripped supply and forced a sharp rise in prices for all steel products. There is currently no consensus on future price changes. Some sources suggesting a period of stability followed by a slow drop, whilst others suggest prices may continue to rise.

Supply price is a serious issue for the project. 10,500 tonnes of steel are still required for the core project and many instrument components require steel products. Some savings have been made by bringing forward purchases of steel for shielding walls and the frame of the experimental hall building.

The project team is keeping a careful eye on the market. "We are in regular contact with major suppliers to ensure that we can get the best deal for the project," said Project Sponsor Tim Broome.

Safe and PROMT delivery

Sending proton beams to multiple targets.



Integrating the Second Target Station into current ISIS systems is a significant area of work. Teams covering machine controls and timing (led by Bob Mannix), proton beam diagnostics (Dean Adams), personnel protection systems (Peter Gear), and operational safety (Paul Wright), have been set up under the umbrella of PROMT Co-ordinator, Peter Gear. Together they are upgrading accelerator control systems to successfully deliver proton beams to multiple targets.

Ensuring a safe working environment

The safety of ISIS staff and visitors whilst at work is our highest priority and many precautions are taken to eliminate access to hazardous areas when ISIS is operating.

At ISIS, radiation areas are shielded by concrete, wax and steel walls and ceilings as required by the Ionising Radiation Regulations 1999. High visibility signs and sound warnings and controlled interlock access to each area are other ways that safe operation is ensured. Chains of electrical switches, access locks and keys, and search patterns must all be completed before proton beams can be accelerated.

ISIS personnel interlock systems will be upgraded to a new system conforming to IEC Standard 61508 Functional Safety requirements to allow safety systems for the Second Target Station to be integrated.

A personnel interlock system first developed at the CCLRC Daresbury Laboratory for the SRS will be installed at ISIS. The ESRF Grenoble and Diamond Light Source have both adopted the system. The ISIS choice ensures that a standard personnel protection system will be installed across all CCLRC accelerators.

Accelerator operations

With two targets to be supplied with protons from ISIS accelerators, modifications to the accelerator timing and control systems will be made to allow each target to be run independently as well as together. Safety schemes will be implemented to allow access to each target for maintenance whilst continuing to supply beam to the other.

Target access will be controlled by interlock systems that will switch off steering magnets in the accelerator and prevent the proton beam reaching a target. Timing signals for beam switching magnets will also be interlocked and beam detection systems will add a further level of security.

A separate requirement is to ensure that the correct beams are transported to each target. The Second Target Station is designed to receive 10 proton pulses per second (10 Hz), the existing target station will receive protons at 40 Hz and the ISIS accelerators will continue to operate at 50 Hz.

Presently, a fundamental 50 Hz signal derived from the synchrotron magnetic field is used to distribute a phase-locked 200kHz timing signal throughout the control system. A new central timing distributor will generate two additional timing signals at 10 Hz and 40Hz.

Beam control and machine protection

The design of the new target station calls for the proton beam to be delivered to the centre of the target with a positional accuracy of around 1mm.

Drawing on over 20 years of experience, the design teams for the extracted proton beam line have built in a wide range of correction strategies to allow good proton beam transmission efficiency and position control.

Controlling the proton beam to maintain low loss transmission to the target is very important. Poor beam transmission efficiencies will lead to component failures and unnecessarily long maintenance periods.

The proton beam line to the second target station will be equipped with a suite of diagnostic and beam correction systems to protect the machine. Beam monitors will measure a variety of parameters for each proton pulse delivered to the target and will turn the ISIS accelerators off should pre-set tolerance levels be exceeded.

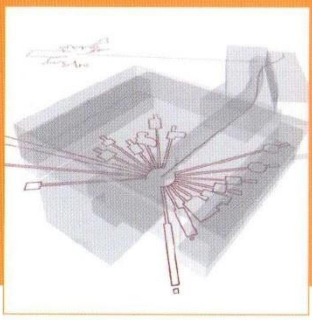
Safety Working Group

The Safety Working Group provides expert advice to Task Leaders on all safety matters associated with the project (except construction). The group ensures that safety documentation is compiled correctly and comprehensive risk assessments are made.

The group is chaired by Paul Wright with core members Tim Broome (Project Sponsor), Harry Jones (Project Manager), Steve Stoneham (Electrical Task Leader), Peter Gear (PROMT Co-ordinator), Jim Wells and Brian Wyborn. Task leaders and other specialists join as required.

The group has met six times over the past year to consider issues ranging from personnel protection, safe operation of the accelerator with two targets through to the design of target cooling systems.

Call for new instrument proposals



In July 2005 the Scientific Advisory Committee (SAC) will consider proposals from the user community for the next phase of instruments to be built at the second target station from 2008 onwards.

The SAC will use a selection process based on the following guidelines:

(i) The science case should be well matched to the scientific objectives of the Second Target Station and should enable new science.

(ii) The instrument should benefit from the design performance features of the Second Target Station.

(iii) User support and demand should be demonstrated.

(iv) The outline instrument design and technical details should be sufficiently developed, and innovative concepts should be incorporated.

The SAC will also identify areas where the combined instrument suite including the seven Phase 1 instruments is unbalanced, and may request that proposals be developed in areas where opportunities are being missed. Funding will be sought for this further phase of instrumentation from the Office of Science and Technology Large Facilities funding line.

Four instruments that were not included in the initial instrument suite (HRPD-2, LMX, HERBI, SANS2a) will automatically be reconsidered, although their proposals can be updated or withdrawn.

User groups are encouraged to submit proposals for new instruments by 31 May 2005. Further information can be found on the Second Target Station website.

http://ts-2.isis.rl.ac.uk

Instrument technical review

A technical review of the first seven instruments to be built at the Second Target Station was held on 8 November 2004. Public presentations of the instrument designs were followed by a closed meeting of the review panel.

Each instrument was assessed against the scientific specification originally presented to the SAC. Cost effectiveness and practicality of the design, delivery of anticipated performance and high risk items were also considered. The review panel was pleased with the good approach to instrument design and the thorough use of computer simulations. Instrument design teams are now working through the recommendations of the panel.

The review panel was led by SAC Chairman Bob Thomas (University of Oxford), and included Masatoshi Arai (J-PARC, Japan), Jack Carpenter (IPNS, USA), Werner Press (ILL, France), Roger Eccleston (Sheffield Hallam University) and Project Scientist Jeff Penfold, Uschi Steigenberger and Adrian Hillier from ISIS.

Welcome to:

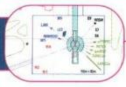
- Steve Stoneham, Electrical Task Leader
- Uschi Steigenberger, TRIM Co-ordinator
- Sean Langridge, Chair of the Instrument Working Group

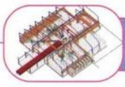
Time line

First Science and Technical Advisory Committee **July 2002**

Detailed planning approval **March 2003**

Approve initial instrument suite **June 2003**





Approve target station design concept **July 2003**

First Project Board **October 2003**

Complete earth moving and landscaping **November 2003**

Complete access Road 10 **October 2004**

Complete R78 technical support building **November 2004**

Begin R80 experimental hall construction **January 2005**

Compete R80 structural frame **May 2005**

R80 weather-tight **November 2005**

Complete target monolith foundation **December 2005**

Complete R80 construction **March 2006**

Complete target services area structure **May 2006**

Begin Extracted Proton Beam installation in synchrotron **July 2006**

Complete target services area equipment **March 2007**

Complete EPB **March 2007**

Complete instrument neutron guides **May 2007**

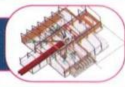
Complete target station **May 2007**

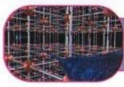
Complete first phase instrument detectors **June 2007**

First Proton Beam to Target **June 2007**

First Operation of Instruments **November 2007**

Complete instrument installation **December 2007**





Start of experimental programme **October 2008**

About the ISIS Second Target Station Project

ISIS is the world's leading spallation neutron source, providing UK and international researchers access to the best scientific facilities of their kind. ISIS has contributed significantly to many of the major breakthroughs in materials science, physics and chemistry since it was commissioned in 1985.

Expansion of ISIS through the building of a Second Target Station was announced in April 2003 by the Science Minister, Lord Sainsbury, as a key part of the UK investment strategy in major facilities.

Neutron scattering is a unique and powerful way of studying the properties of materials at the atomic level. Neutron scattering experiments reveal where atoms are and what they are doing, enabling the spacing of atoms and the forces between them to be measured.

The ISIS Second Target Station will open up new opportunities in technologically significant areas, particularly in the fields of soft condensed matter, bio-molecular science, advanced materials and nanoscale science. The experimental programme will begin in 2008.

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TS2 ISIS second target station project

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