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PROGRESS AT ISIS

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ABSTRACT

Recent progress at the ISIS pulsed neutron source is reviewed. Specific developments in instrumentation and source performance are described together with plans for the future development of the facility.

1 Introduction

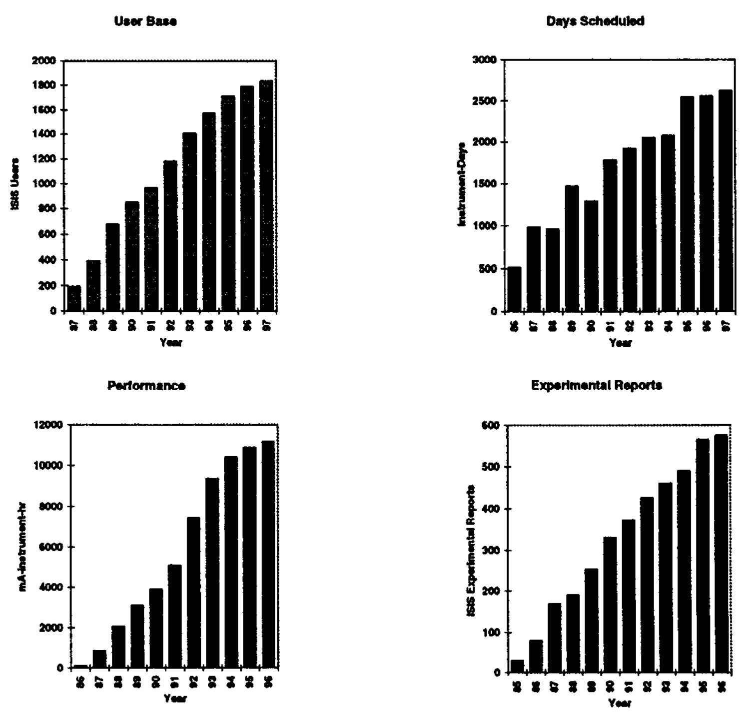

Figure 1. Measures of ISIS performance.

The last few years have seen ISIS continue to grow and develop as the world's most powerful pulsed neutron source. Instrument and source developments enable the facility to be increasingly productive, as indicated by some of the measures shown in figure 1. Investment for new instruments has come from UK research councils and international partners over and above our normal budget. The main activities at ISIS are directed towards the users' scientific programmes, and the UK user community is rising to the challenge of the new access mechanism, known as the 'tickets' system, introduced by the funding U.K. Research Councils in 1996. Examples of instrument and source upgrades, and prospects for the future expansion of the facility, are described below.

2 Source

The performance of the ISIS accelerator in terms of the average daily current delivered is shown in figure 2. Despite running at low currents at the beginning of 1996 due to accumulated damage to RF screens in the main synchrotron dipoles, the accelerator recovered to produce average daily currents in excess of 200 μA, and the past year has seen the source running with greater than 90% reliability. Replacement of obsolete equipment and development of machine components continue with the aim of improving reliability and performance. Upgrade of the synchrotron diagnostics systems and the use of infrared thermography to locate potential trouble spots are improving source operations, and development continues to replace the Cockcroft-Walton pre-injector with a Radio Frequency Quadrupole to increase the Linac beam current. The tantalum neutron production target continues to give reliable performance after receiving over 4000 Coulombs of proton beam.

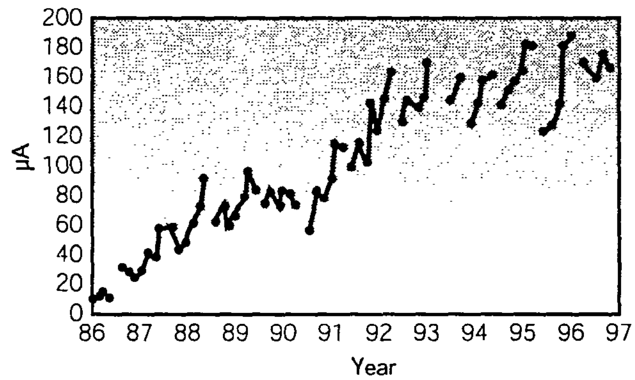

Figure 2. Average daily ISIS current since 1986.

3 Instrumentation Developments

Upgrades and development of ISIS instruments continue apace; the full instrument suite is shown in figure 3. Over the past year, two new spectrometers, OSIRIS and TOSCA, have been commissioned. OSIRIS is optimised for the use of cold neutrons, enabling high-resolution, long wavelength diffraction, high-resolution spectroscopy and polarisation analysis. The significant increase in flux compared with IRIS, produced by novel guide and supermirror designs, will open up the possibility of real-time phase transition studies. TOSCA is a development of the TFXA vibrational spectroscopy instrument. Phase I of this programme, a five-fold increase in the number of detectors, was completed this year with commissioning runs demonstrating the improved detected flux. Resolution improvements will be forthcoming when TOSCA is moved further from the ISIS target in 2000; a background chopper and second analyser array will be installed at the same time.

The ISIS Pressure and Engineering Advanced Research Line (PEARL) has been significantly developed over the past year. Two dedicated stations are now available to the ISIS user community: HiPr, the High Pressure facility, and ENGIN, the Engineering science facility. Both facilities have seen improvements in terms of sample environment equipment (the ordering of a new Paris-Edinburgh pressure cell for HiPr, and a dedicated stress rig built for ENGIN), as well as improvements to the HiPr detector array. Other instruments have also received significant development: a new location and improved detector complement for POLARIS; a new high-angle detector bank for LOQ; the installation of state-of-the-art supermirrors and spin flippers for reflectometry studies using polarised neutrons on CRISP; and development of a source of slow muons for thin film and surface studies using the muon spin rotation/relaxation technique.

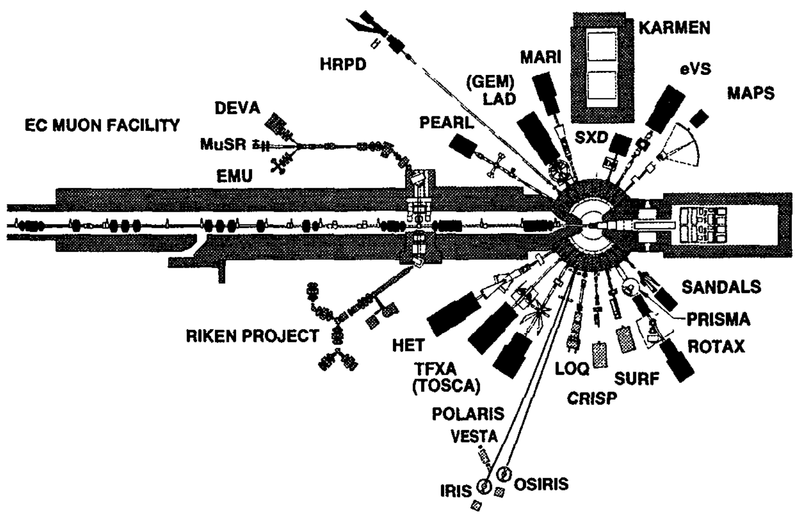

Figure 3. The ISIS instrument suite.

The MAPS spectrometer, optimised for measuring high energy coherent magnetic excitations in single crystals, will be the first ISIS instrument with detectors consisting entirely of position sensitive ^{3}He gas tubes (PSDs), arranged in an array covering an area of over 16m^2. The two huge detector tanks were delivered to ISIS in November 1997, and two PSD modules, based on the MAPS technology, were installed in summer 1997 on HET and are performing extremely well in terms of resolution, efficiency and stability. MAPs is expected to be ready for first neutrons before the end of 1998.

Design and construction of the new General Materials Diffractometer (GEM) continues. GEM will combine a high resolution over a wide Q range with the high count rate required to study samples under varying conditions such as temperature, pressure and chemical reaction. Its special features will include a large detector area, with high detector stability over a large solid angle; prototype detector modules constructed over the past year have achieved both the resolution and stability required. Installation of GEM is expected to be completed by August 1999.

And instrument developments continue into the foreseeable future. Funding was achieved this year for an upgrade to the eVS spectrometer for Neutron Compton Scattering, with realisation of this new instrument, VESUVIO, anticipated for the end of 2001.

4 Science

The range of science at ISIS continues to span Physics, Chemistry, Biology, Engineering, Materials and Earth Science. In-situ and real-time studies of complex systems are developing, whilst fundamental studies of materials with technological potential, for example giant magnetoresistance materials, spin valves, superconductors, polymers and surfactants, molecular materials and ionic conductors, continue. Full descriptions of science at ISIS can be found in the facilities annual reports (ISIS96-98).

5 Future Facility Developments

In addition to the upgrading of individual instruments, plans continue to progress for upgrades to the facility as a whole. The potential exists for an upgrade to the ISIS synchrotron to enable production of 300 μA beam currents, an increase of 50%, by addition of four RF cavities operating at twice the frequency of the existing cavities. The existing target station would require only minimal changes to its shielding and cooling to be made capable of handling the increased current, and the enhanced beam could be available by 2001.

The enhanced 300 μA current would enable pulse sharing of the proton beam to supply a second ISIS target station (figure 4). The addition of new instruments to the ISIS suite now requires the removal of existing instruments as all available ports from the ISIS target are occupied. But new instruments can be envisaged which would significantly improve upon existing instruments, or which would open up entirely new areas of science. The solution to this problem is the development of a second target station, which would be optimised for the production of cold neutron beams for high intensity, high resolution applications. The ISIS proton current would be pulse-shared between the two target stations, with the new station taking, for example, one pulse in five. This lower rate would open up the possibility of using uranium as the target material for the second station, and would enable the use of solid methane at 25K as a moderator. Such an assembly offers the prospect of pulse intensities an order of magnitude greater than that of the existing target station, and would open up opportunities in the fields of biological sciences (pharmaceuticals, membranes, proteins and food science), complex inorganic and organic assemblies such as clathrates, intercalates and zeolites, magnetic materials (systems with small moments, low magnetic exchange or long range structures), and surfaces, interfaces and soft condensed matter including magnetic thin films, polymers, colloids and surfactants. Such developments will provide exciting scientific opportunities in the short term, and will pave the way for the planned third generation European Spallation Source.

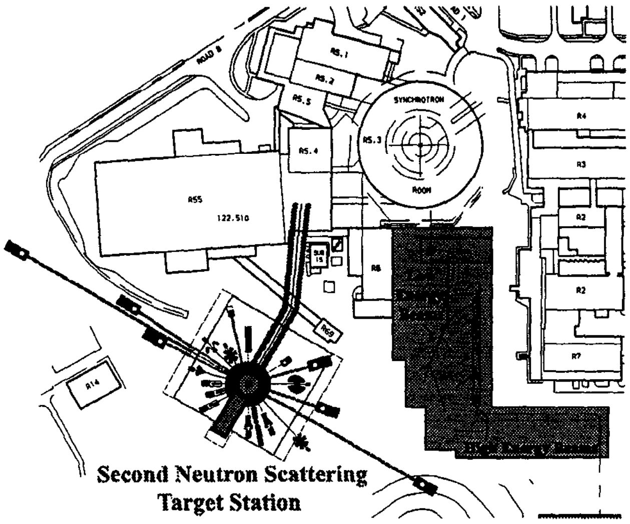

Figure 4. Layout of a second target station and a proposed radioactive beams facility, SIRIUS, at ISIS.

6 ISIS Review

1998 has seen an independent Review of the ISIS facility, chaired by Sir Michael Thompson, former Vice-Chancellor of Birmingham University. The Review was to consider the scientific output, the technical performance of the facility, and the scope for future improvements, and its report was presented to the Council of the CLRC, the U.K. Research Council with responsibility for ISIS, in September 1998. The Review concluded that neutron scattering is an important tool for basic, strategic and applied research; that ISIS has demonstrated the advantages of accelerator-based sources and that future sources are likely to build on the ISIS design; that the construction of a second target station at ISIS is essential and justified, and would ensure ISIS' place as *the* world centre for neutron scattering science; and that the second target station would pave the way for a Third Generation Neutron Source.