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ILL in the changing international context

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Abstract

The Institut Laue Langevin, now operating in its fourth decade, has embarked upon a series of investment programmes designed to ensure a lifetime extending beyond 2020. Instrument and Infrastructure renewals as well as a Key Reactor Components programme are proceeding in parallel with the user programme. A plan to upgrade the user facilities on site is being embarked upon in collaboration with the ESRF (European Synchrotron Radiation Facility) and the EMBL (European Molecular Biology Laboratory).

Keywords: Neutron sources; Neutron instrumentation

1. Introduction

The ILL reactor first went critical in August 1971 and the institute opened its doors to the user community 18 months later. It had invested heavily in innovative techniques—a hot source, a 25 litres cold source and the installation of a large number of neutron guides leading to a spacious experimental hall. Its reactor—a single-element core rated at 58 MW—was also innovative, as was the design criterion that all sections of the reactor should be replaceable, for instance the beam tubes were not welded in place but removable. It was the first neutron source to be conceived, not for an on-site team of scientists, but as a purpose-built user-centre oriented towards the needs of as wide a community of external researchers as possible. The instruments were similarly innovative: backscattering, tanzbodens, small-angle cameras; and there was development money available for monochromators, cryostats and other novel devices. Not everything worked of course, but those who had elaborated and implemented the overall concept of the institute were clearly willing—and eager—to take technical and political risks, and these pioneers were of sufficient stature to be supported by their funding bodies. Of course, in retrospect, we know it to have been a great success as evidenced by the number of publications in high-impact journals, the still rising number of proposals which now exceeds 1000 per year, and the continuing use of ILL as a yardstick when new sources are being planned or old instruments are being upgraded.

However, ILL finds itself now in uncharted territory. It is still the reference against which all other neutron sources are judged; its output in the highest impact journals remains impressively high at more than 70 publications per year in Nature, Science, Physical Review, Physical Review Letters and the Journal of Molecular Biology but, as was said at the ILL's Scientific Council last month, for the first time in its history ILL has serious competition for its pre-eminent position. Principally, but not exclusively, this is symbolised by the Spallation Neutron Source being built in Oak Ridge, and scheduled to produce its first neutrons in a few months' time.

What has ILL been doing to respond to this changing scenario? A number of initiatives have been pursued with two major goals—to widen the user community, both scientifically and geographically, and to provide a vastly improved and cost-effective scientific service to all researchers. These initiatives are primarily:

- An instrument and infrastructure renewal programme, the Millennium Programme, launched in 2000.
- A Reactor Key Components programme, which started in 2002 with a 30 M€ Seismic Refit Programme.
- A Site Development Plan, in collaboration with our two neighbouring European Institutes, the ESRF and the EMBL.

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These three programmes, summarised below, are being implemented whilst, at the same time, continuing and enhancing the scientific user programme.

2. ILL's Millennium Programme

Investment in ILL's instrument suite was overshadowed in the early 1990s by the rebuilding of ILL's reactor core and the need to concentrate finance single-mindedly on this task. Interestingly, the budget for the institute remained remarkably flat in real terms for the first 3 decades of ILL's existence and no additional income was forthcoming for this crucial rebuild. In the mid 1990s, it was possible to gather sufficient finance to begin a limited instrument renewal programme, and this can now be seen as the first stirrings of the Millennium Programme, which was formally launched in January 2000. Importantly, infrastructure was included as an integral part of the new programme since the neutron guides, which were one of the reasons for ILL's reputation, were beginning to show signs of degradation. New instruments, as well as upgrades to still scientifically powerful existing instruments, were included in the programme, and scheduled for construction and implementation as and when funds became available, according to a priority set at the Scientific Council.

In particular, ILL is focussing upon its demonstrated strengths:

- Intense beams of cold and thermal neutrons, and UCN.
- Large moderators, well-coupled guides.
- Focussing monochromators and big detectors.
- White and whitish beams.
- Polarised neutrons and techniques development.
- Reliability, predictability and stability of our beams.
- Relatively low operating costs (low electricity and steel consumption).

Instruments that have already been rebuilt (see www.ill.fr/YellowBook) include the powder diffractometers D20 and D2b, each with large position-sensitive detectors. The liquids diffractometer D4 has also been reconstructed with a large solid angle and a very stable micro-strip detector, combining well with the stable and reliable neutron source. Kinetic experiments—fast chemical reactions for instance—are well-suited to such instruments, with frame times of less than 1 s The fibre-diffractometer D19 has been transformed by a large 2-D position-sensitive detector, built in-house like most of our new detectors. Image-plate instruments, both compact and efficient, have been installed on cold (Ladi) and thermal (Vivaldi) beams, and the concept of the Cryopad neutron polarimeter has been perfected on the D3 diffractometer. A novel strain scanning instrument, Salsa, is newly commissioned, with its hexapod sample table capable of locating 500 kg specimens to an accuracy of 50 μm.

The triple-axis spectrometer IN8 has been furnished with a "virtual source" and a large 3-faced monochromator, rendering it the highest intensity machine in existence with a monochromatic flux on the sample at 35 meV of 6.5×10^8 n/cm^2/s. Equally well the IN20 polarisation analysis TAS now benefits from a larger diameter beam-tube, a 2-D Heusler monochromator and a flat-cone multi-analyser–detector array. The new vertical sample reflectometer D17 is soon to be accompanied by a horizontal surface machine, Figaro. The D22 small-angle scattering instrument now has a high count rate detector, lifting the instrument well beyond its previous deadtime limit of 50 kHz to a maximum count-rate which exceeds 2 MHz. The D7 polarisation analysis TOF machine, which was the test bed for a number of demonstration experiments, has had its data rate increased by more than a factor of 20, by the installation of a new monochromator and a very efficient set of 42 large solid-angle polarising supermirror analysers, turning it at last into an instrument for a wide circle of users with ongoing scientific programmes. The flagship IN5 multichopper spectrometer is well on the way to being a factor of 100 times more intense than its predecessor of 1999 by the installation of new choppers and a focussing supermirror guide, now operational, and an evacuated 4 m diameter flight chamber, with an extensive position-sensitive detector to rival the most ambitious detectors being planned for spallation source instruments. The Millennium Programme is therefore a continuous process of instrument renewal.

A public Instrument Review launched in September 2004 underwent a consultation process with ILL's user community which continued for over 12 months. This was intended to take advantage of the momentum and new ideas created by the Millennium Programme and has led to the definition of a consolidated investment programme of neutron delivery, instrumentation and improved user support facilities, to be implemented over two consecutive 5-year periods. Central to these plans are a set of new thermal guides to feed high-intensity beams to instruments such as the novel polarisation analysis time-of-flight spectrometer Pastis, whose concept has recently been proven, and Dracula, a medium-resolution very high-intensity powder diffractometer to rival the best possible machines proposed for pulsed sources. In addition, the installation of a variable spectrum third cold-source would illuminate new instruments in the main guide-hall. The overall plans are shown in Fig. 1.

In collaboration with ESRF, a power supply will be installed to feed high field-magnets (up to 35 T) to sit on dedicated, purpose-built instruments on these new guides. Other new instruments are included in these plans:

- a high-intensity spin-echo spectrometer WASP,
- a state-of-the-art backscattering machine to take the place of IN10 and IN16 on a full-intensity cold neutron guide with a phase-space transformer building upon the experience at NIST and Jülich,
- a polarised beam, polarised sample image plate single-crystal diffractometer modelled on Vivaldi and Ladi.