DUBBLE (DUTCH-BELGIAN BEAMLINE) ON BM26

M. OVERSLUIZEN, P. GOEDTKINDT, W. BRAS, D. DETOLLENAERE, R. VAN TOL AND W. DE JEU
WITH SUPPORT FROM
I. CERJAK, D. GLASTRA VAN LOON, P. LASSING, B. MUNNEKE, J. DERKS, M. KONIJNENBURG, M. BORSBOOM, H. ALBERDA, R. BAKKER, F. UDO
AND SEVERAL OTHER TECHNICIANS, ENGINEERS AND SCIENTISTS

Although neither Belgium nor the Netherlands have a national facility for the use of synchrotron radiation, researchers from these countries have been using synchrotron radiation as a tool for a long time. Lure, Desy and Daresbury in particular have regularly been hosts for scientists from these countries. The Netherlands Research Council (NWO) has been an active promoter of the use of synchrotron radiation notably through its formal involvement in Daresbury where two beamlines were constructed and several other Dutch/English projects received financial support. For over ten years NWO-funded scientists were part of the staff in Daresbury. When the CRG program at the ESRF was approved attention shifted towards Grenoble. After extensive consultations with possible users a consortium was formed consisting of NWO, the universities of Utrecht and Amsterdam and AMOLF from the Netherlands, and NFWO and the universities of Leuven, Antwerp, Gent and Brussels in Belgium. The decision was made to build two beamlines, which after the decision from the ESRF to support the development of the wide 9 mrad front-ends, will be equipped with full focusing optics on both beamlines. The experimental techniques that will be implemented are interface diffraction, powder diffraction EXAFS and time-resolved simultaneous SAXS/WAXS. This reflects the need of a large part of the Dutch and Belgian user community. The DUBBLE project will considerably enhance the number of shifts available to Dutch and Belgian users at the ESRF.

The design and construction is done mainly at the Amsterdam-based institutes AMOLF and NIKHEF. NIKHEF is the Dutch high-energy physics institute which had already been involved in the construction of synchrotron radiation beamlines. A team of four scientists and two technicians is responsible for the building and commissioning of the beamlines but there is generous support from AMOLF and NIKHEF so that the expertise and effort from several engineering disciplines is available. The collaboration between the high-energy physics and synchrotron radiation experts is quite unique, especially in the collaboration on position-sensitive detectors. Much is expected of this.

Besides the optics hutch there are two experimental hutches. The first will house the EXAFS and powder diffraction equipment, and the second the interface diffraction and SAXS/WAXS. The latter hutch is rather large in order to house the long optical bench for SAXS and to be able to mount large sample environments used for instance in polymer processing but also to house the large six-circle interface diffractometer.

The project is, after some slight delay, in an advanced state and it is expected that the first technique, time-resolved SAXS/WAXS, will become operational in the first half of 1998, followed by interface diffraction shortly afterwards. Later in 1998 the construction of the EXAFS and powder diffraction stations will start. This will be completely finished in 1999. At the moment two staff members are permanently based in Grenoble. This number will increase to five in 1998 when more equipment, assembled in Amsterdam, is ready to be mounted on the beamlines. It is also foreseen that more universities will join the consortium in the coming years. ■

XMAS (UK BEAMLINE) ON BM28: X-RAY MAGNETIC AND HIGH-RESOLUTION SCATTERING

This project was conceived back in 1990 when M. Cooper, B. Stirling and G. Stirling (no relation) were emptying a bottle of wine at a Daresbury Users' Meeting. Three years were spent in refining and revising an application to the UK Science Research Council (EPSRC); the budget grew by a factor of five from our first naive estimate. The proposal was eventually accepted by EPSRC and funds allocated for construction of the beamline in 1994. It was not until January 1996 that the first hutch was erected on the floor in front of dipole D28 and the construction began in earnest. A grant to run it was thankfully forthcoming from the EPSRC earlier this year and on 19 September the transition to the new funding was marked by further emptying of wine bottles. As is usual in these circumstances, the «opened» beamline is still being commissioned and we expect to take our first really independent users in Spring 1998.

The acronym XMaS (**X**-ray **Ma**gnetic **S**cattering) was invented by B. Forsyth, but if you think it is corny take a moment to savour those of some of our continental European colleagues (have Dubble never heard of *double Dutch?*). Our objective is to focus a few areas of physics that can peacefully co-exist on a single beamline. It is designed primarily for single-crystal diffraction studies, especially magnetic diffraction studies, but also other forms of high-resolution single crystal diffraction, white beam studies and powder diffraction will be possible. The UK scientific community waiting to use it is big enough to justify the expense but small enough to ensure that users can expect to win sufficient time to sustain their research programs. The beamline has some features that are different from other dipole lines at the ESRF. First, it is aligned on the soft end of the dipole in order to maximize the flux that we get at 3-4 keV. This is specifically in response to our interest in the magnetic structure of the actinides and transuranic materials whose compounds have fascinating magnetic properties: their M-edges are at these low energies.

The beamline is also a white beam station because the only viable method developed to date for measuring the magnetic form factors of ferromagnets is based on the use of white beam. In fact as part of the commissioning exercise we have characterized the polarization of the source in a white beam diffraction study of the magnetic form factor of nickel. It is the angular distribution of the electron trajectories at the source point that governs the beam polarization. Our study showed that the linear polarization, P_L, of the beam from the dipole source D28 is 99.85 ± 0.01% at 10 keV; the corresponding figures at 5 and 15 keV are 99.88 and 99.83, respectively. The 10 keV result, as a function of the angle out of the orbital plane at which the source is viewed, is shown in Figure 1 together with the circular polarization, P_C, and the factor $f_P = P_C/(1-P_L)$, which «magnifies» the ratio of magnetic to charge scattering in the white beam method (see for example, Collins *et al*, Phil. Mag. **B65**, 37 1992). The high degree of polarization helped us to measure magnetic form factors out to the (18,0,0) reflection (Laundy et al: in print Journal of Synchrotron Radiation).

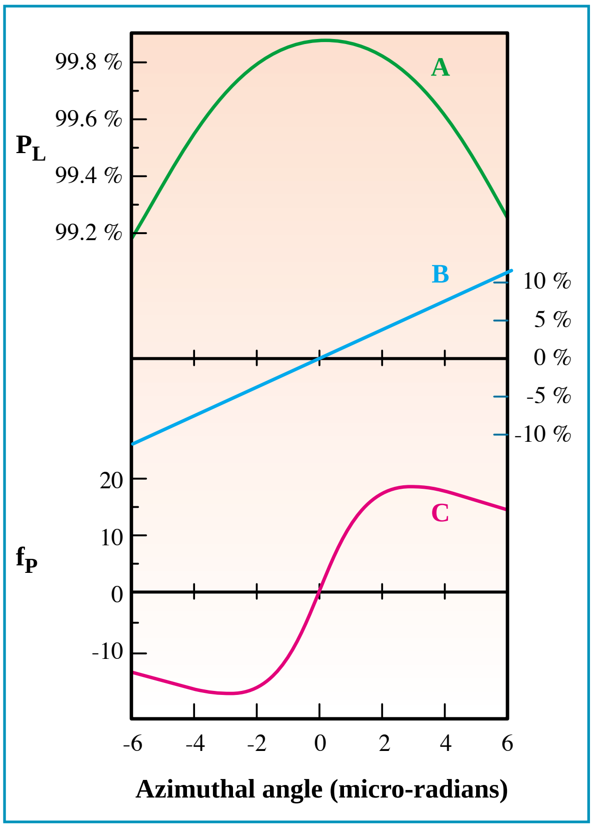

Fig. 1: Curve A is the linear polarisation P_L calculated from measurements of Bragg peaks observed at a scattering angle of 90° in the horizontal plane at the XMaS beamline as a function of the azimuthal angle. The degree of circular polarisation, P_C, is shown in curve B and f_P (= $P_C/(1-P_L)$) is the factor that enhances the ratio of magnetic to charge scattering. The benefit of a highly polarised source is self evident and the curve shows that an angle of 2-3 microradians is optimum for the white beam experiment.

The subjects identified for study by the CRG's user group (there are over a dozen groups in the UK who plan to use the XMaS facility) fall into two broad categories. First, magnetic materials: the magnetic structure of lanthanide and actinide metals, compounds and multi-layers using resonant exchange scattering, and their magnetic and structural phase transitions will be investigated. Second, non-magnetic materials: lattice distortions in bulk material and real (i.e. non-UHV) surfaces and interfaces.

Examples from commissioning experiments are shown below. Figure 2 presents the intensity of the (0,0,2+q) magnetic satellite of holmium as a function of energy at the L_{III} resonance. The resonant enhancement at the M_{IV} edge of uranium is exemplified by Figure 3 for a mixed UAs/USe single crystal, just below its Neel temperature. The beamline appears to be working according to specification.

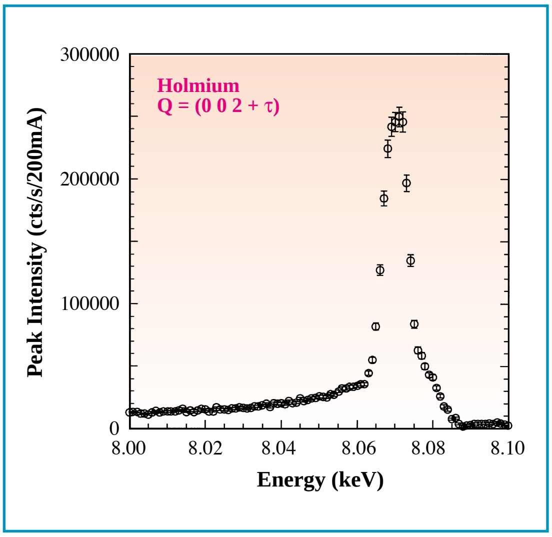

Fig. 2: Resonant enhancement at the L_{III} absorption edge of holmium.

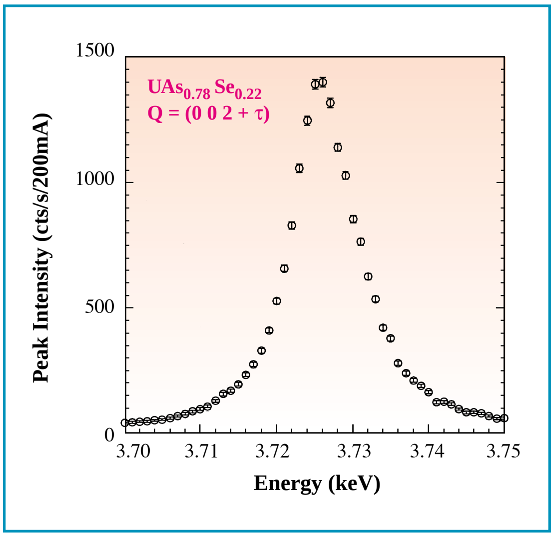

Fig. 3: The uranium M_{IV} resonance for a UAs/USe sample, just below T_N.