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The new station 3.1 at the Daresbury SRS

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THE NEW STATION 3.1

Since the SRS started, Station 3.1 has been based on a Seya monochromator. This is named after the Japanese physicist who discovered a particularly simple method of scanning a near-normal incidence spectrometer in the vacuum ultra violet (VUV) region, while maintaining reasonable focus and thereby preserving wavelength resolution over a wide range of wavelengths. However, such an instrument was never really designed for use on a synchrotron radiation source and the use of the Seya was a stop-gap measure until a more suitable instrument could be purchased. Like so many stop-gap measures it became semi-permanent until finally, after 18 years of use an EPSRC grant has allowed it to be replaced with a more suitable instrument.

Even so the Seya had given sterling service for all that time, having been first put to use at the Bonn synchrotron in 1978 during the period between closure of the NINA Synchrotron Radiation Facility and the start-up of the SRS. It served two communities, the gas phase community carrying out ion spectrometry and fluorescence measurements and the circular dichroism (CD) community who were extending the range of CD measurements on molecules of biological interest into the VUV. It was also much used by several groups from Moscow University interested in the optical properties of alkali halide crystals. The scientific programme was nevertheless becoming ever more demanding in its requirements for high photon flux and it became clear that a new instrument, purpose built for use on an SRS beamline, was essential. As the culmination of several attempts to raise funding, in April 2000, under the EPSRC intitiative for multi-project research equipment, a grant of £0.5M was made to Richard Tuckett of Birmingham University and John West and Elizabeth Towns-Andrews of Daresbury Laboratory to build a high flux instrument to replace the Seya. The scientific programme was based on the fact that higher photon flux, estimated to be at least two orders of magnitude greater than that of the Seya, would permit wavelength-dispersed fluorescence measurements on small polyatomic molecules to be made, as well as enhance the capability of making VUV CD measurements on biological molecules.

The design chosen was the so-called Wadsworth [1], a tried and tested design first used on a synchrotron radiation source by Skibowski and Steinmann [2] at DESY in the late 1960s, and also at the NINA SRF in the 1970s. It derives its high efficiency from the fact that it accepts a large aperture from the synchrotron and focuses the source onto an exit slit using just one optical component, a concave diffraction grating. It is therefore very simple in principle and highly efficient, providing adequate resolution for experiments of the type outlined above. There are several refinements in the present design to extend its capabilities, mainly by providing a choice of gratings interchangeable under vacuum and a flexible scanning system which permits those gratings to be used optimally, but the basic principle remains the same as the earlier instruments. Also, the design is much more compact then the Seya, allowing more space in the experimental area for wider range of experiments.

The new instrument is shown on the left; the beam from the SRS enters from the left, through the chamber at the back to the grating chamber on the right. It leaves from right to left, after being dispersed by the grating, passing through the valve, to the exit slit assembly in the foreground on the left. Some modifications to the existing beamline were required mainly to the pre-mirror system which required a flat water cooled mirror in place of the cylindrical uncooled mirror used by the Seya. Water cooling was essential to prevent thermal drift of the pre-mirror due to warming by the synchrotron radiation, since this monochromator design is very sensitive to movements of the source or pre-mirror. Mechanical construction of both the monochromator and beamline mechanisms was complete by August 2002 and commissioning work with the new instrument is scheduled to begin in April/May 2003 when the SRS starts up again. The first experiments on molecular fluorescence will begin in July, with the new station being made available for users by September 2003.

It remains to be seen whether this new instrument will have as long a life on the SRS as the Seya did, but the design is highly adaptable and would certainly benefit, in terms of resolution, from the greater brightness available from a Diamond bending magnet. We therefore expect a long and productive life for this new monochromator, whose optical principle was defined by one of the earliest pioneers of VUV spectroscopy at the end of the nineteenth century, a principle just as relevant today on the most modern of light sources.

GENERAL REFERENCES:

[1] Wadsworth FLO, *Astrophys. J* **3**, 54 (1896)

[2] Skibowski M and Steinmann W, *J. Opt. Soc. Am.* **57**, 112 (1967)

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