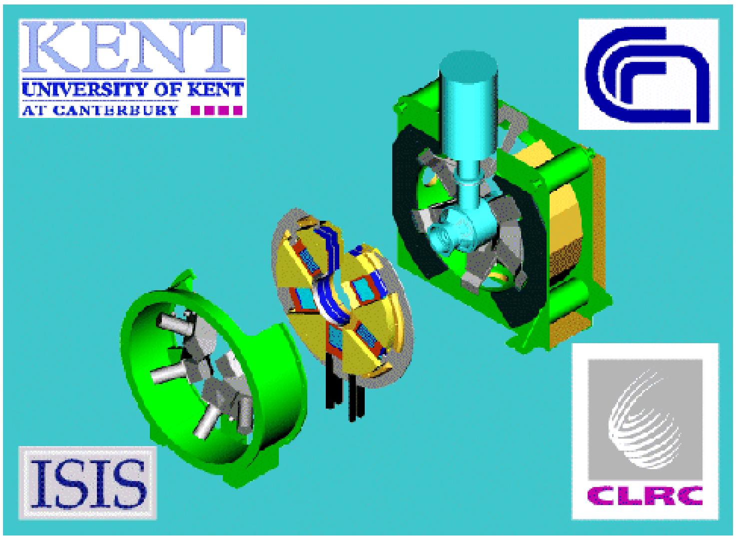
TOSCA



TOSCA: A World Class Inelastic Neutron Spectrometer

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Since its first operation in 1985, almost 500 experiments were carried out on the inelastic neutron scattering (INS) spectrometer, TFXA, at ISIS. Its wide energy range (16 to 4000 cm^{-1}), good resolution and ease of operation attracted users from many disciplines. TFXA was designed to study hydrogenous samples, however, there have also been notable successes with non-hydrogenous systems such as fullerenes and minerals. The principle limitation of TFXA was *insensitivity*. A good quality spectrum could be obtained from 2 - 3 gm of a hydrogenous material in 8 - 12 hours, thus applications where a few samples were sufficient were well-suited to TFXA. In contrast, where there are many variables, a large number of samples is vital. Examples of such systems are the preparation of amorphous hydrogenated carbon and ceramics based on the sol-gel process. Another area of great technological interest is applied catalysis. This requires the study of supported metal catalysts with low metal loadings, 1 - 10 wt%, thus per gram of sample there are only a small number of active sites. A third example is new developments; novel materials are only available in small quantities, thus to be at the leading edge necessitates the ability to study small samples. All these applications demanded an instrument of greatly increased sensitivity.

To address the problems of sensitivity encountered with TFXA it has been replaced with the new instrument TOSCA. The instrument is a collaboration between the CNR of Italy, the University of Kent at Canterbury and ISIS. Fig. 1 shows the overall layout of the spectrometer.

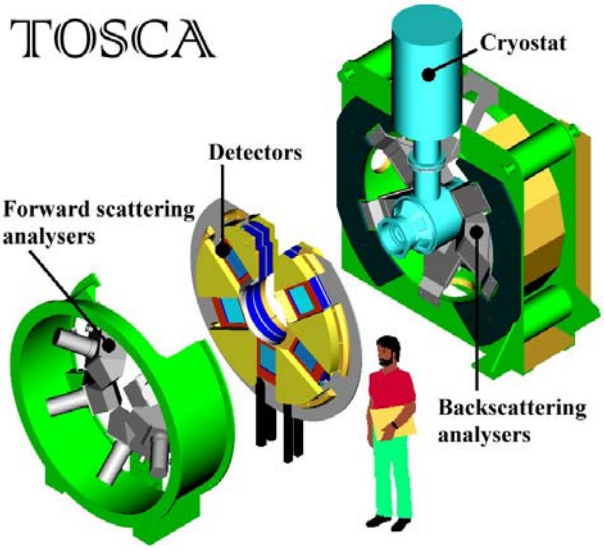

Figure 1: View of TOSCA showing detector banks for forward and backward scattering.

The instrument builds on the strengths of TFXA, but has detector banks in forward and backward scattering to give a much larger detector area and hence improved sensitivity. The instrument was built in two stages: the backscattering spectrometer was installed at the same position as TFXA (12 m), 12 months later the second phase was installed. This consisted of the forward scattering detector bank. However, to accommodate the increased size of the instrument, it was necessary to move it downstream, such that the primary flight path is now 17 m.

At 17 m frame overlap occurs and to prevent this a Nimonic chopper was installed. This also removes the short-time high energy neutrons that accounted for a large part of the background on the first phase of TOSCA. To alleviate the loss of flux caused by the decreased solid angle seen by the sample, the beamsize has been increased from 5 x 2 cm (h x w) to 4 x 4 cm. The sum of these changes was that the beamline was completely rebuilt from the shutter insert to the (re-located) beamstop.

The move to 17 m has the added advantage of a significant improvement in resolution, Fig. 2. Historically, it is improved resolution that has lead to new science and we anticipate that areas such as lineshape studies to gain information on intermolecular interactions as well as the improved understanding of molecular systems that comes with better resolution will be important. Additionally, by enabling a better separation of a peak from its phonon wing, high energy transfer (> 2000 cm^{-1}) vibrations will be easier to study. The result is an instrument that retains the advantages of TFXA but with a significant improvement in detected flux and resolution over TFXA. Further details and pictures are available at the CNR TOSCA website.

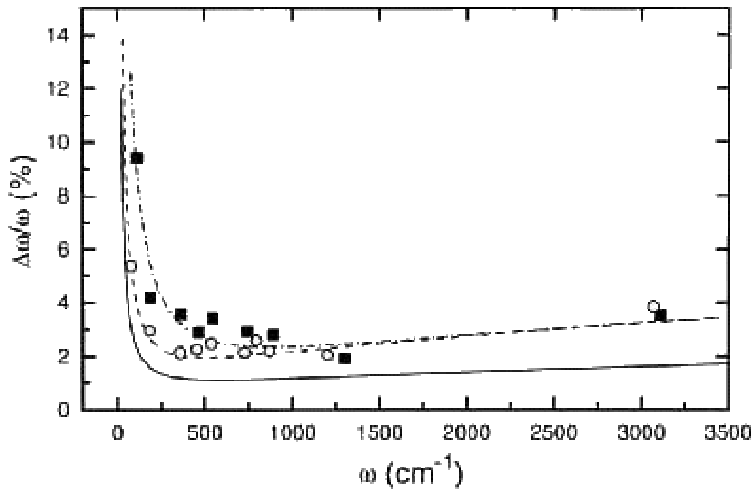

Figure 2: Comparison of calculated resolution functions for TFXA (top trace) and TOSCA (phase 1 middle trace, final installation, lower trace). Experimental measurements are shown as points (TFXA: filled squares, TOSCA phase 1: open circles).

TOSCA will also have a diffraction capability with detectors at a range of angles to provide a good coverage of *Q*-space (0.5 - 35 Å^{-1}) and *d*-plane spacing as shown in Fig. 3. (Initially only those in backscattering are available.) Thus TOSCA will link together both vibrational and structural capabilities. These techniques are clearly complementary: information on local and long range order is provided by diffraction while information on the dynamics is provided by the vibrational data.

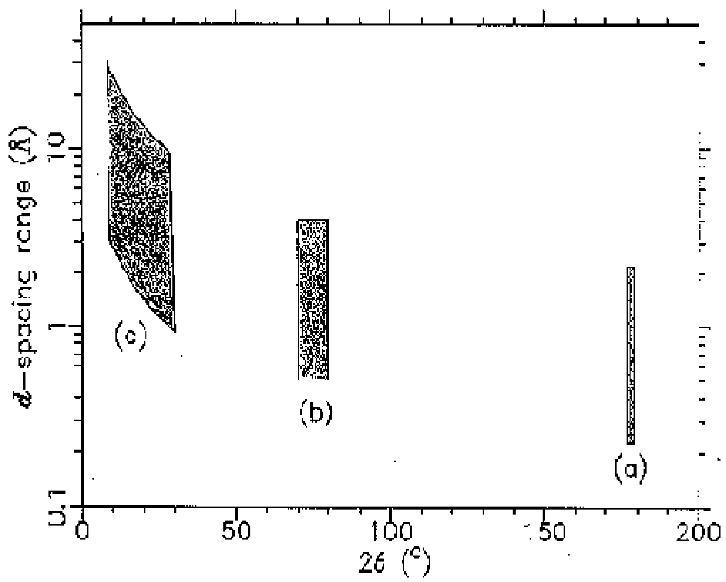

Figure 3: The range of d-plane spacings that will eventually be accessible on TOSCA, for diffraction detectors at: (a) backscattering, Δ d/d = 2x10^{-3}, (b) 75°, Δ d/d = 1x10^{-2}, and (c) 10° to 30°, Δ d/d = 3x10^{-2}.