ESRF	**Experiment title:** **High resolution strain scanning**	**Experiment number:** **HS - 169**
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Shifts: 11	**Local contact(s):** **G Vaughan**	*Received at ESRF :*

Names and affiliations of applicants (*indicates experimentalists):

P J Webster*

G Mills*

W P Kang*

#G B M Vaughan*

The Telford Research Institute for Structures and Materials Engineering
University of Salford
Salford, MS 4WT, UK

#ESRF

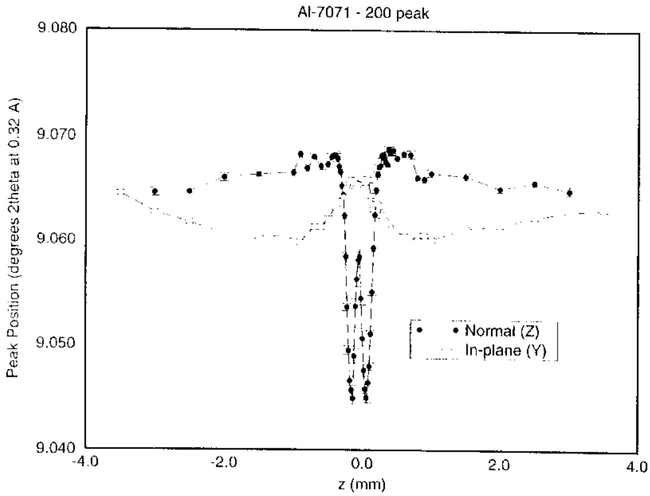
Report:

This proposal was for an allocation of beamtime to develop techniques and dedicated hardware and software to adapt BMI6, a high resolution powder diffractometer, for strain scanning applications, to assess the instrumental spatial resolution and to calibrate the scanner with standard samples using different configurations and wavelengths. This development is to support a series **of specific** investigations into treated, high performance, light alloy materials used widely in aerospace industries and to facilitate the use of the instrument by other research engineers.

In previous investigations, HC-326 and HS-35, measurements were made internally and through the surfaces of three 1.6 mm thick Ti-6AI-4V alloy samples peened to different intensities and a heavily peened 7071 aluminium alloy plate 10.6 mm thick, using energies of 35 keV and then 39 keV to reduce attenuation. One consequence of the short wavelengths used is that useful Bragg reflections are all at relatively low angles and the ‘gauge’ cross-section, defined by 100 µm wide slits in the incident and diffracted beams, is an elongated diamond shape, with aspect ratio typically between 5 and 15, so that although the gauge cross-section is only 100 µm wide it is between 0.5 and 1.5 mm long, Consequently the resolution function, and its sharpness, is very different in the two directions and different volumes are sampled as the sample is rotated from the in-plane to the normal orientation, as is required for strain scanning. This poses particular problems at and near surfaces, and at interfaces, where steep stress gradients can occur and the gauge is only partly immersed in the sample,

A series of measurements was made, using a macroscopically strain-free plate-shaped aluminium powder cell, with 100 µm slits, to determine the magnitude of the instrumental surface effect. The instrumental effect was found to be significant but not excessive and could be reduced by decreasing the gauge size near surfaces or be allowed for by calculation,

Measurements made in transmission, through parallel-sided samples, are not distorted by attenuation effects but those in reflection are. The effective gauge position can seriously shift and asymmetrically distort through-surface data. This effect was eliminated by making measurements through a cube-shaped sample of side approximately 10 mm, with a thin sharply defined strained layer across its centre made by slicing the peened aluminium plate used in HS-35 down its central plane, cutting the two halves to size and putting the two peened sides together in the middle. The adjacent peened layers formed a well defined symmetrical strained layer that was scanned through constant material thickness in orthogonal symmetry directions enabling undistorted data to be obtained in-plane and normally for both long and short axes of the gauge. Typical results, for the (200) reflection, are shown in the figure.



Normal and in-plane (ZOO) peak shifts versus position .z through two adjacent heavily peened layers at the centre of an aluminium 707I *alloy cube showing strain and instrument resolution related effects.*

In the normal direction the expected W-shaped strain field is resolved but the corresponding in-plane field, which should be similar but inverted and M-shaped, is not. This is because, at the wavelength used, 0.32 A, for this reflection the gauge cross-sectional dimensions are 100 pm and 1270 µm respectively. Additional measurements made using higher order reflections (such as (3 11) and (422)) and narrower slits (50 µm) indicated that resolution could be significantly improved but counting times had to be increased proportionately and some grain size effects were observed. Work is continuing to determine optimum instrumental parameters for these types of measurement.