ESRF	**Experiment title:** Very high resolution mapping of stress fields around crack tips.	**Experiment number:** HS-21
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Shifts:	**Local contact(s):** **Ake** Kvick	*Received at ESRF:*

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Report:

In this experiment we examined a well-characterised single edge notch bending specimen of 14 x 14 x 100 mm dimensions, made of fine grain sized (< 5 pm) 2124 Al alloy reinforced with 20 vol.% SIC particles. The specimen contained a fatigue crack grown to approx. 0.5-0.6 of its width, and had high levels of both micro- and macroscopic residual stresses, thus ensuring that the crack was held open. In this situation, stress intensification is known to occur around the crack tip. This experiment was aimed at trying to resolve for the first time the stress field in the immediate vicinity of the crack tip. A specially designed four-point bend rig was used to load the previously fatigued specimen in situ on the beam line to the maximum opening load experienced during fatigue cycling. The applied load level was monitored using a strain gauge mounted on the back face of the specimen. A lateral spatial resolution of 100μm was used and the specimen was scanned across the beam in order to map the strains in the near crack region. The experiment data were collected in the form complete diffraction rings recorded by CCD camera. This was done with the aim of extracting maximum information from the measurements by accurately fitting ellipses to the ring pattern. Such an analysis has the prospect of furnishing information about the in-plane strain magnitudes as well as the orientation of the principal axes as a function of position near the crack-tip. Good peak intensity was obtained with fairly fast data acquisition times (<20secs). Automated data acquisition and specimen translation were achieved.

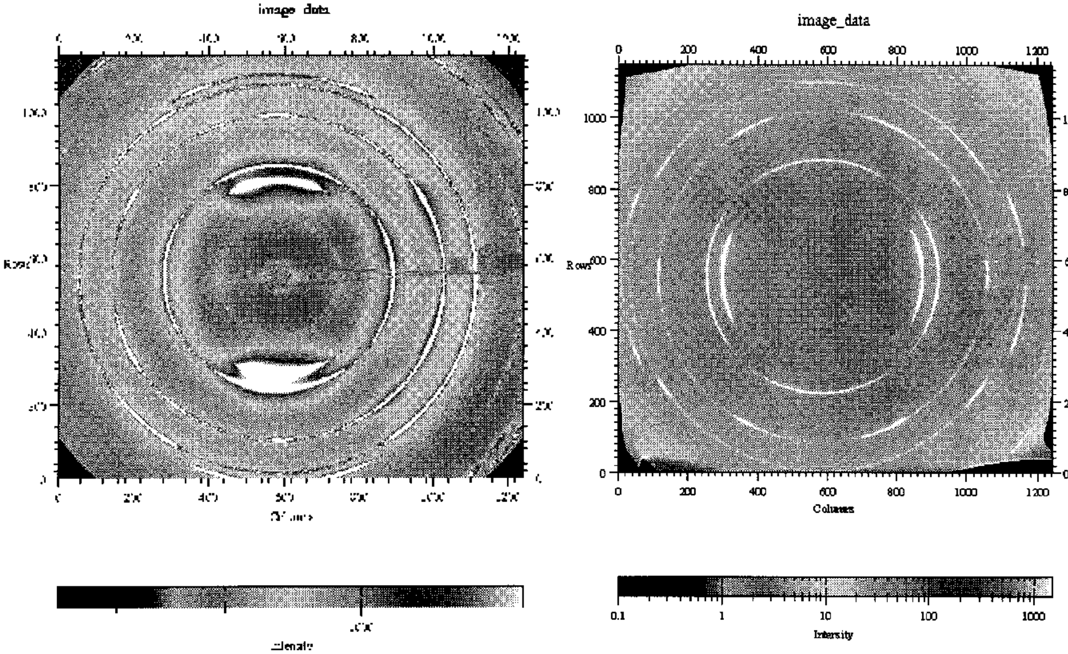

Fig.1. Examples ***of*** *(a) raw diffraction pattern and (b) corrected* ***for*** *spatial distortion.*

For the analysis of data we have used the ESRF in-house diffraction pattern fitting program, FIT2D, written by Andy Hammersley. An example of the CCD camera image record visualised using this program is shown above. An important step in the analysis involves the correction both for the distortions occurring in the CCD, and for spatial distortions. This is achieved by using an image of a known grid of holes on a calibration mask. Their positions were fitted using the corresponding option in FIT2D (the help of Andy Hammersley with performing this fitting procedure is gratefully acknowledged), and the spatial correction function applied to the raw diffraction images. It was our intention to proceed by fitting the corrected rings using the TILT option in FIT2D, which allows the orientation of the principal axes of the ellipse, as well as their magnitudes and excentricity to be calculated.

At the present time, the analysis of the data is not complete. Problems have been encountered, in particular in obtaining consistent values of strain and principal axes orientation. In our opinion, these difficulties are associated with the insufficient quality of the original calibration data, which can be improved by choosing longer data acqusition times at the calibration step. Also, it is clear that while the existing analysis codes are very powerful, they need further modification to be customised for the proposed task of strain measurement and analysis (for which they were not originally intended). It is hoped that this customisation procedure can be undertaken in collaboration with the ESRF data analysis support team in the near future, as work on the corresponding proposals is already under way.