ESRF	**Experiment title:** *Measurement of elastic strain/stress field around the plastic zone determined by short cracks*	**Experiment number**: ME-450
Beamline:	**Date of experiment**: from: 6/11/2002 to: 10/11/2002	**Date of report**: August 2003
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Report:

The main aim of this experiment is the validation of numerical calculations, based on innovative models of crack growth mechanisms including first stages (short cracks) [1], by measuring elastic strain/stress fields in the vicinity of the plastic zone around the short crack.
The investigated samples are 2024 Al alloy notched bars, the geometry of which is shown in fig.1.

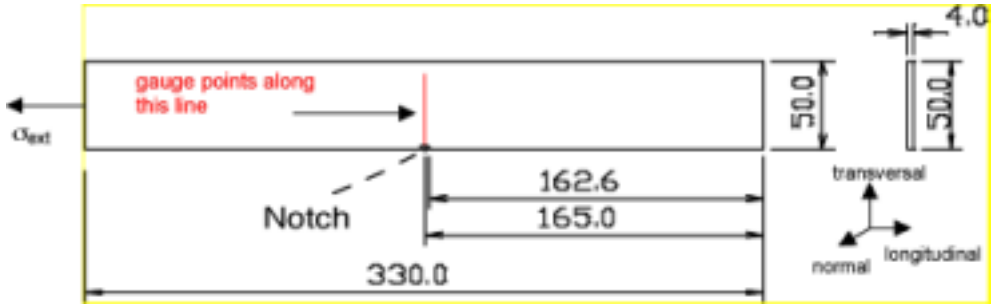

Fig.1 - Geometry of the investigated samples; the definition of principal axes and the location of gauge points in the neutron diffraction experiments are also shown.

The samples were submitted to fatigue cycling (R = 0.06, σ_{max} = 90 N/mm^2), through which a shot crack (few hundreds μm) was induced at the notch.
synchrotron radiation experiments were carried out with the specimens submitted to external static loading. To this end, a tensile machine was designed and built by University of Naples.
The load is applied manually, and it is controlled by the application of four strain gages on the surfaces of the specimen (two on each surface).
Synchrotron radiation diffraction measurements were carried out at the ID15A diffractometer. The scattering angle 2θ was fixed at 7.5¡. The external load (about 90 MPa) was applied to a specimen with a short crack (few hundreds μm). Measurements were carried out in this specimen also without external load (residual stresses) and in an uncracked specimen. The latter was performed with the aim of evaluating the residual stress field due to manufacturing processes.
Three different planes were investigated in the cracked specimen, both for the unloaded and the loaded case: 1 mm under each each surface and in the middle plane. In the loaded case, only the transversal strain was investigated in the two planes under the surfaces. The longitudinal and transversal strain directions were

investigated in several points inside an angular sector ϕ = –30¡ around the short crack position, up to a distance of ¯1 mm from the notch. For the loaded case, in the transversal direction, also points at 1.5 mm and 2 mm from the notch were considered.
Some points far from the crack (at an angle ϕ ¯ 88¡ from i), in the loaded case, were used for the evaluation of the unstrained interplanar distance.
An example of the spectra obtained in the synchrotron radiation experiment is shown in fig2. The presence of texture is revealed by the depression of some Bragg peaks. . Moreover, this texture state seems to be more relevant when the external load is applied.

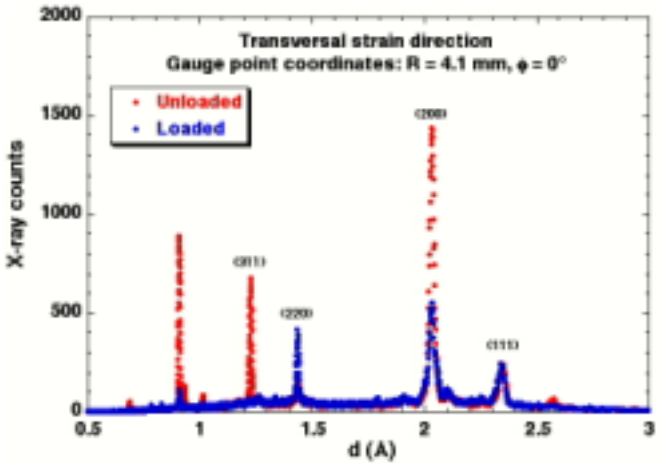

Fig.2 — Example of spectra obtained at ESRF.

In fig.3 an example of the measured strain field (longitudinal) in the cracked specimen, under external loading, is shown The presence of the short crack is revealed by the presence of strain gradients in the region where the crack is supposed to be (at about X = Y = 4 mm). According to this, the crack seems to be located on the side corresponding to surface n.1.

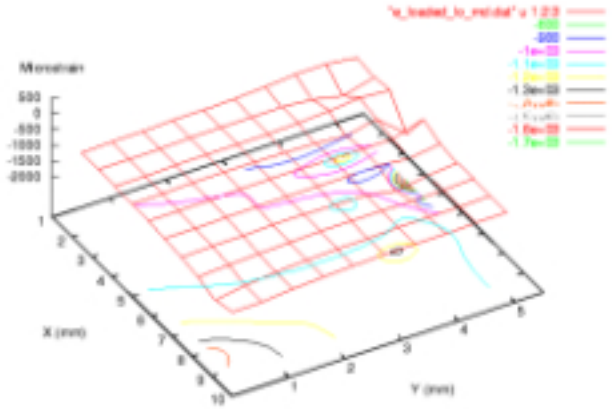

Fig.3 — Longitudinal strain map in the cracked specimen, with external loading (mid-thickness plane).

[1] Sadananda, K.and A.K. Vasudevant, A.K., Short crack growth and internal stresses, Int. J. Fatigue, Vol. 19, 599 (1998) S108.