ESRF	**Experiment title:** UFe multilayers	**Experiment number**: HE 1516
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Report:

This experiment is part of a continuous research programme to study the magnetism of 5f systems in multilayers. In this sense a set of uranium/iron multilayer samples are currently being investigated by a number of techniques. In our previous experiment at XMaS (04/2002) [1], a magnetic moment from the U site was clearly seen and early measurements indicated that the spatial distribution of these moments were not uniform through the U layer. A further experiment using XMCD at ID12 was carried out succesfully to measure the mean U magnetic moment. In order to have a more detailed picture of the magnetic moment distribution in our multilayers it is necessary to study the role of the Fe as a magnetic site. This involves the study of the distribution of the Fe magnetic moments through the Fe layer. The sample under investigation was the same sample used in the previous experiments, being a nominal [U(30Å)/Fe(40Å)]30 multilayer deposited onto a glass substrate.

The x-ray resonant reflectivity experiment was performed using circularly polarized radiation. A circular polarisation of 98.2% was obtained by offsetting a 0.3 mm diamond (111) phase plate, 300 arcseconds from the Bragg condition. The sample and cryostat were mounted on a six circle Huber diffractometer between the pole pieces of an electromagnet. The system was evacuated and aligned for specular reflectivity in the vertical scattering plane. Measurements were taken at 5K, with magnetic field aligned along/opposite to the forward beam direction while the energy was scanned through the Fe K edge (7.11 keV). Windows were fitted onto the pole pieces of the Xmas electromagnet to allow evacuation, and all the other air paths were were minimized. Harmonic rejector mirrors were employed to avoid detector saturation from the higher-order contamination of the incident beam.

The measurements were carried out by reversing the photon helicity and the applied field. For each helicity the applied field was reversed in a four step sequence (+0.13T -0.13T -0.13T +0.13T) allowing two sets of measurements per helicity per point. Figure 1 shows the asymmtery ratio R= $I^{+}-I^{-}/I^{+}+I^{-}$, as a function of energy at different wavevectors perpendicular to the (0 0 L) planes. The signal corresponding to the asymmetry ratio at the Fe K edge is small, but observable.

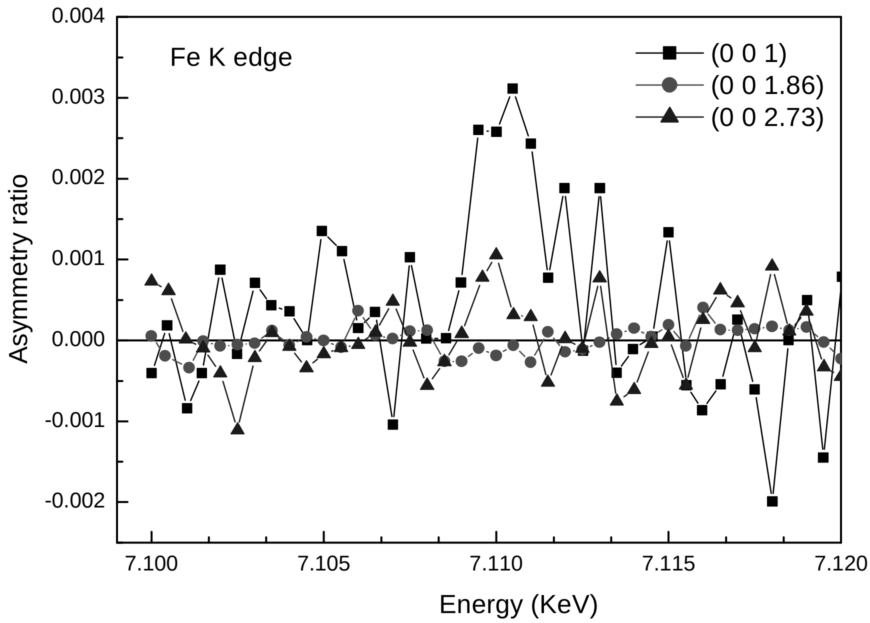

Figure 1 . Assymetry ratio around the Fe K resonant energy taken at different crystallographic planes (0 0 L).

In order to investigate the distribution of the magnetic signal from the Fe site through the Fe layer, a specular Q scan was performed around the first, second and third multilayer Bragg reflexions, at the fixed Fe K resonant energy. Figure 2 shows the difference in signal between the two polarities ($I^{+}-I^{-}$) through the Fe layer. This figure shows a polarity reversal for the third multilayer peak. This has been observed in other systems [2] and is associated to a nonuniform moment distribution through the Fe layers.

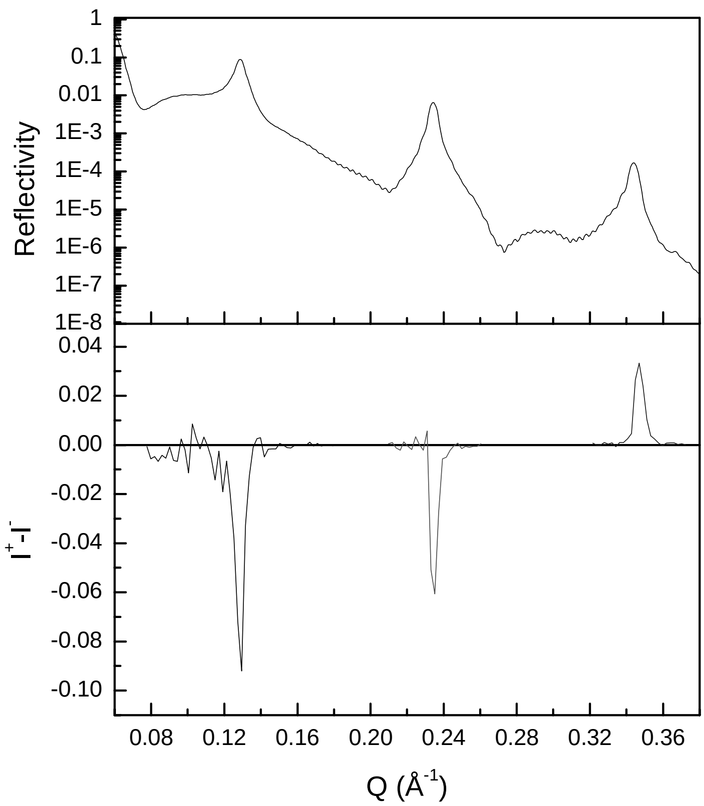

Figure 2. Difference between the intensities corresponding to different polairities taken at Fe K edge resonant energy. For comparison purposes, the upper panel shows the first three specular reflectivity Bragg peaks taken at 7 keV.

Further experiments will be carried on to measure in detail the spatial distribution of the magnetic moment on U site through several Bragg reflections. Using these results, modelling of the magnetic distribution in the system will be performed.

[1] S. D. Brown et al. Journal of Applied Physics, Vol. 93, No. 10, 6519-6521 (2003).

[2] N. Ishimatsu et. al., Phys. Rev. B 60,9596 (1999).