ESRF	**Experiment title:** **Origin of disorder induced orbital magnetism in $Fe_{60}Al_{40}$ thin films**	**Experiment number**: HC-1811
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Report (preliminary):

We were focused on particular qualities of a disorder-induced magnetism in $Fe_{60}Al_{40}$ thin films when chemical disorder is created locally via Ne+ ion-irradiation with fluences up to 6E14 ions*cm-2. Such a system exhibits an order to chemical disorder transition (B2 -> A2) at RT leading to strong changes in the magnetic properties. Studied thin films of $Fe_{60}Al_{40}$ have been prepared by magnetron sputtering with further annealing and ion irradiation as it was claimed in [1]. The 'disorder-gradient' sample has been prepared by a continuous increase of Ne^+ irradiation dose along the film surface with the step of ~100 μm. By prior magneto-optical Kerr effect measurements it was found that magnetization is a smooth “S”-shape function of an ion dosage that is correlated to slight changes in the number of Fe-Fe nearest neighbors [1].

During the beamtime XMCD and EXAFS spectra at the Fe K edge were recorded at RT and LT (100K) on a 'disorder-gradient' $Fe_{60}Al_{40}$ sample of 40nm thickness and two reference samples of the same thickness – ordered and maximally disordered one – under external magnetic field of +/- 0.9T (and at zero field for EXAFS) with circular polarized X-rays (spectra of reference samples at RT are shown at Fig.1 and Fig.2). XMCD and EXAFS spectra have been taken from strictly the same point of the sample that provides the most precise correlation between a chemical disorder and magnetism on the local scale. In such a way it would be possible to determine locally Fe-Fe nearest neighbors distances, coordination numbers and the orbital magnetic moment of Fe atoms depending on a degree of disorder.

Spectra were recorded in the backscattering geometry by TFY to probe the whole volume of the film; to reduce possible nonmagnetic experimental artefacts XMCD spectra were measured for two opposite

directions of applied magnetic field for both +/- circular polarizations.

The visible changes in EXAFS oscillations for ordered and maximally disordered samples as well as differences in spectra with temperature have been obtained (see Fig.2). This will allow to distinguish contributions from static and dynamic disorders to magnetic moment of iron atoms.

In addition to the visible XMCD signal the strong multi-electronic excitation (MEE) peak was obtained for all samples with a disorder. The element-specific hysteresis curves have proved the in-plane preferential orientation of Fe orbital magnetic moment; the magnetic field of 0.9T was enough to saturate the film in the grazing incidence geometry.

The precise data analysis and first-principal DFT calculations on the basis of SPR-KKR code are upcoming.

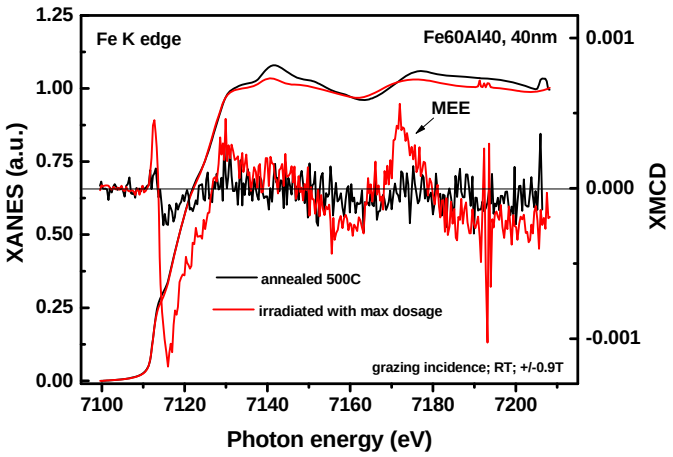

Fig.1 XANES (left scale) and XMCD (right scale) spectra measured at Fe K edge for annealed (ordered, B2) and irradiated with max fluence (disordered, A2) $Fe_{60}Al_{40}$ samples of 40nm thickness

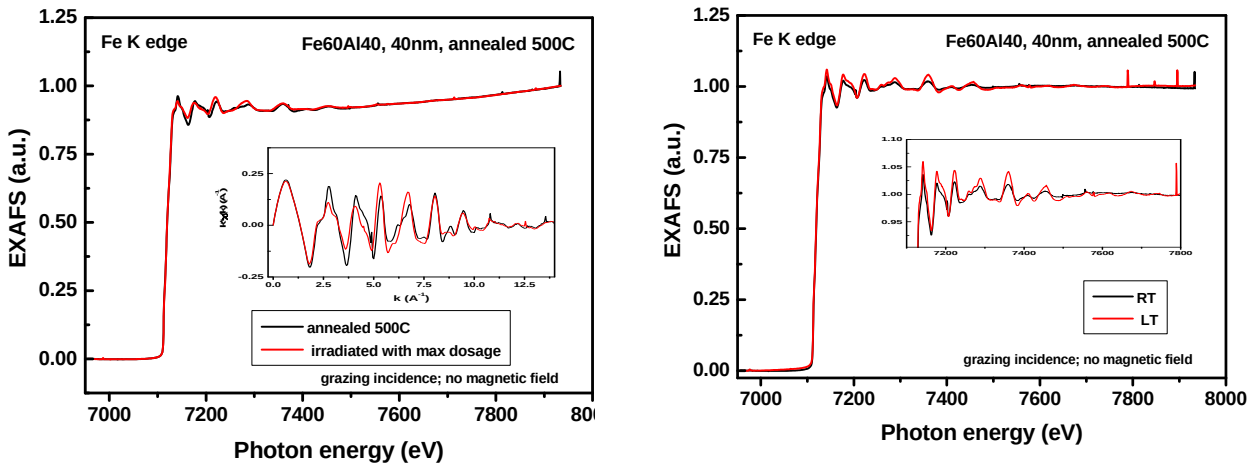

Fig.2 EXAFS spectra at Fe K edge measured for annealed (B2) and irradiated (A2) samples at RT (left); for annealed (B2) sample at RT and LT (100K) (right)

[1] R.Bali et al, **Nano Lett.** 14, pp 435-441 (**2014**)