ESRF	**Experiment title:** Element selective magnetometry in the ferrimagnetic iron garnet Er3Fe5O12	**Experiment number**: HE3347
Beamline:	**Date of experiment**: from: 30/06/2010 to: 06/07/2010	**Date of report**: 01/03/11
Shifts:	**Local contact(s)**: Cornelius Strohm	*Received at ESRF:*

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Report:

The goal of the present experiment was to perform element selective magnetometry in ErIG at the Fe K, as well as at the Er $L_{2,3}$ edges.
In order to be able to efficiently detect and to quantitatively exploit the small Fe K-edge signal, we have developed a multiframe detection scheme published in:

C. Strohm, F. Perrin, M. C. Dominguez, J. Headspith, P. van der Linden and O. Mathon. *J. Synchrotron Rad.* (2011). **18**, 224-228
Multi-frame acquisition scheme for efficient energy-dispersive X-ray magnetic circular dichroism in pulsed high magnetic fields at the Fe *K*-edge.

Abstract:
Using a fast silicon strip detector, a multi-frame acquisition scheme was implemented to perform energy-dispersive X-ray magnetic circular dichroism at the iron *K*-edge in pulsed high magnetic fields. The acquisition scheme makes use of the entire field pulse. The quality of the signal obtained from samples of ferrimagnetic erbium iron garnet allows for quantitative evaluation of the signal amplitude. Below the compensation point, two successive field-induced phase transitions and the reversal of the net magnetization of the iron sublattices in the intermediate phase were observed.

The measurements along different cuts through the magnetic phase diagram of ErIG allow to directly observe the Fe sublattice magnetization, its reversal at the compensation point and the Fe spin reorientation in canted phase (fig 1). No induced signal from the rare earth was observed in the Fe K-edge XMCD with the available resolution, even though the inverse appears to be the case.

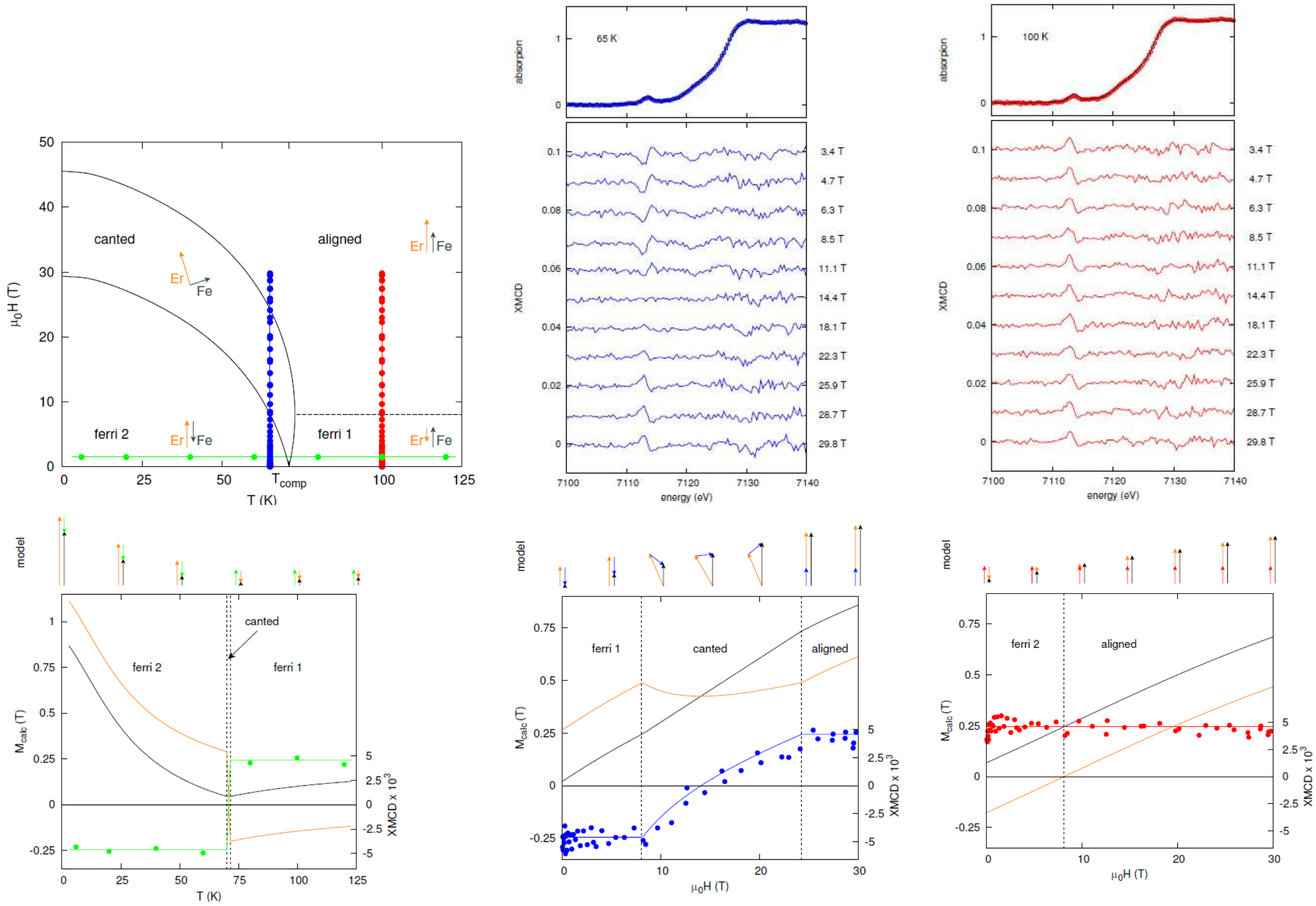

Fig. 1: Magnetic phase diagram of ErIG in a simplified two sublattice model. Selected XMCD spectra at 65 K and at 100 K. XMCD amplitude and sublattice magnetizations. Bulk magnetization measurements performed recently show, that the phase diagram and sublattice magnetizations need to be re-calculated with a corrected value of the compensation temperature.

Previous data obtained in preparation of HE3347 showed that the R L-edge spectra change shape as a function of temperature and field. Similar beahviour was also reported in the literature for a temperature dependence. This reminds the well studied case of the rare earth transition metal intermetallics (RTI), even though the interactio pathway in ErIG is very different. In order to disentangle different spectral contributions to the XMCD signal we have tentatively applied principal component analysis to the XMCD signal. Despite the limited data quality, two dominating components could be extracted. One ‘Fe-like’ component very closely follows the calculated and measured curves for the Fe sublattice magnetization, whereas the the behviour of the ‘Er-like’ component is much less clear (fig. 2).
We thererfore strongly encourage the attribution of further beamtime to study the R-T interaction in the XMCD signal. Even though very similar effects were well studied in the RTIs, the case of the rare earth iron garnets merits further investigation because:
1) We observe a strong induced signal in the Ledges, but surprisingly none at the Fe Kedge. 2) The use of PCA, tested here, instead of reference samples with only one magnetic constituents is very promising. 3) The data is unfortunately compromised by strong beam heating effects that were however understood, solved and can be handled in future experiments.

We therefore strongly encourage the attribution the attribution of further beamtime for the study of the R-T interaction in the RIGs.

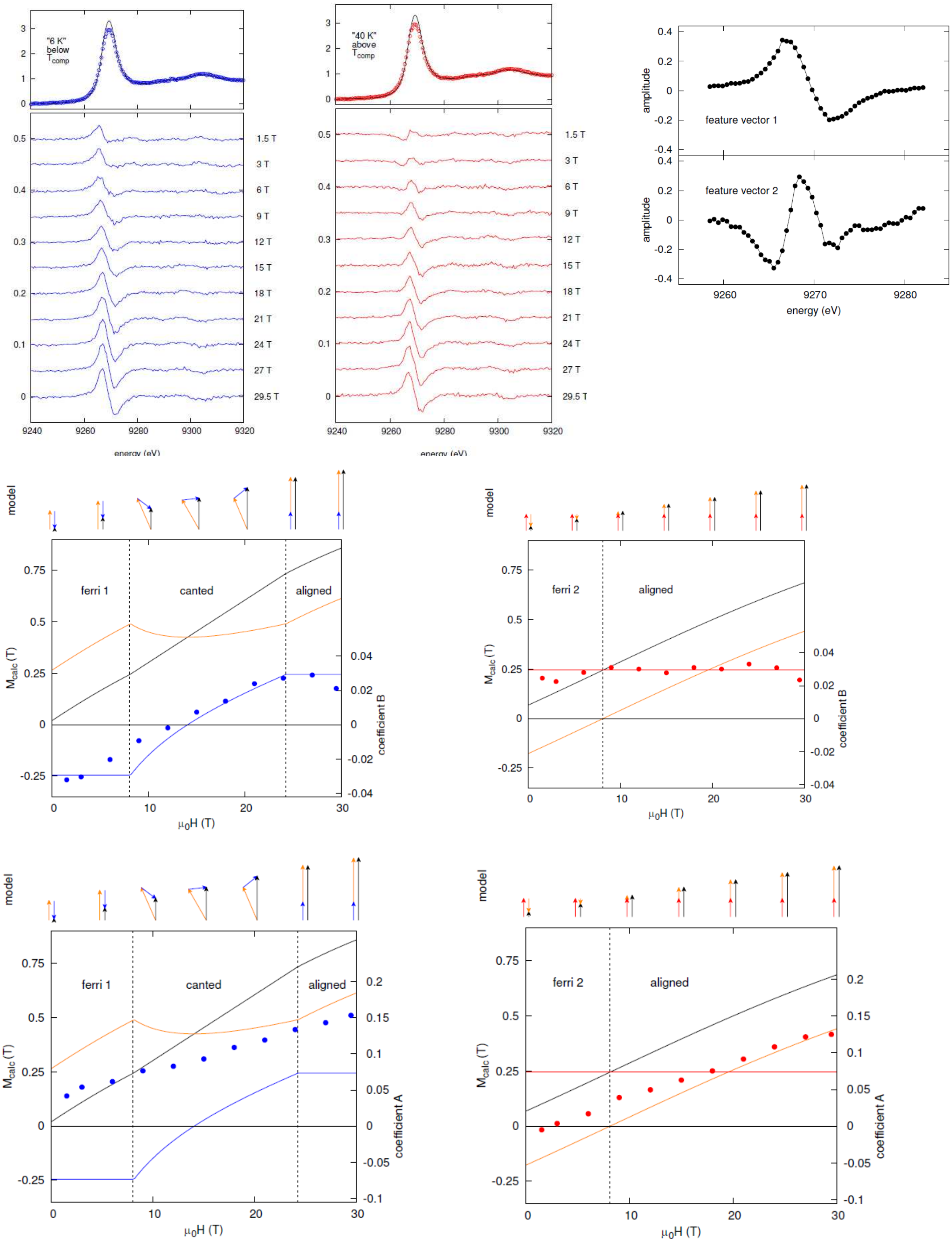

Fig. 2: Spectra, feature vectors obtained by application of PCA, evolution of the coefficient of the 'Fe-like' (top) and 'Er-like' (bottom) feature vectors as a function of field compared with model calculations of the sublattice magnetization.