ESRF	**Experiment title:** K-edge XMCD measurements at high-pressure and low temperature: a study of magnetic transitions in Mn_3GaC	**Experiment number**: HE-2186
Beamline: ID24	**Date of experiment**: from: 19/04/2006 to: 25/04/2006	**Date of report**: 15/09/2006
Shifts: 24	**Local contact(s)**: A. Trapananti	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

***A. Trapananti, ESRF**

***O. Mathon, ESRF**

S. Pascarelli, ESRF

***F. Baudelet, Synchrotron SOLEIL - BP 48, F-91192 GIF-sur-YVETTE CEDEX**

D. Fruchart, Laboratoire de Cristallographie-C.N.R.S, B.P.166, F-38042 Grenoble

Report:

The aim of the proposed experiment was two-fold: first, we wanted to install a setup for extending the feasibility of high-pressure XMCD measurements on ID24 to the low temperature regime. Second, we aimed at studying Mn_3GaC to verify experimentally the occurrence of the pressure induced magnetic moment collapse which has been recently predicted by ab-initio theoretical calculations.

This report will focus mainly on a description of the experimental setup and the first preliminary results on Mn_3GaC.

In Fig. 1, we report a picture of the set-up installed on ID24. We used a cryostat especially designed (J. C. Chervin, IMPMC-Paris VI) for high-P/low-T experiments with diamond anvil cells (DAC). A membrane type CuBe DAC fits in a copper sleeve in thermal contact with an exchanger where liquid He vaporizes. Temperature is controlled by an electric temperature controller which regulates the current flow through a resistance wire wound around the sleeve. For thermal isolation, the system is within a vacuum chamber equipped with two windows (made of kapton and milar) for the x-ray and laser beam (used for pressure measurements by ruby fluorescence). Temperature was monitored by a temperature sensor placed on the sleeve. The ruby luminescence was also used as an in-situ thermometer in the 10-100 K temperature range.

Owing to the thickness of the cryostat chamber (40 mm) the magnetic field produced by the electromagnet normally available on ID24 was limited to 0.2 T. In order to maximize the magnetic field, we had to install a new electromagnet producing a field of 0.7 T on the sample. We then spent several shifts to set-up and align the new device on the ID24 bench. Since data acquisition macros had to be modified to integrate the new electromagnet into SPEC, the operation of the new set-up was ckecked by measuring Fe foil: data are comparable with Fe K-edge XMCD signals previously measured on ID24 under the same conditions.

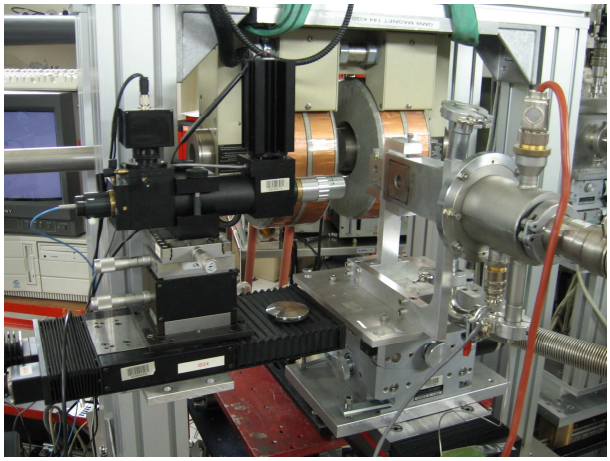

Figure 1: Experimental set-up installed on ID24

The sample used for this first experiment was micrometric Mn_3GaC powder preliminary characterized by magnetization and diffraction measurements (provided by D. Fruchart, CNRS Grenoble).
We used a pair of 400 µm culet and 1.2 mm thick diamond anvils. Silicone oil was used as pressure transmitting medium. The Mn K-edge dichroic signal of Mn_3GaC, in the anvil cell at T=165 K (ferromagnetic phase) and nearly atmospheric pressure, is shown in Fig. 2. In order to normalize the XMCD signal, XANES spectra were also recorded.

The amplitude of the Mn K-edge XMCD signal is 4×10^{-4} of the absorption jump. In order to improve the signal-to-noise ratio a large number of spectra were taken by flipping the magnetic field and the signal was averaged over several μ^+/μ^- pairs (the signal reported in Fig. 2 has been obtained in 4 hours, corresponding to 200 pairs).
However, the noise is still high due the high absorption by the quarter wave plate and the diamonds. We are considering the use of perforated diamond anvils for future experiments at these low energies.
In order to verify the magnetic origin of the signal, we also verified that the signal was reversed when flipping the beam polarization. We then increased the pressure up to 4.5 GPa, without observing any significant change of the XMCD signal amplitude.

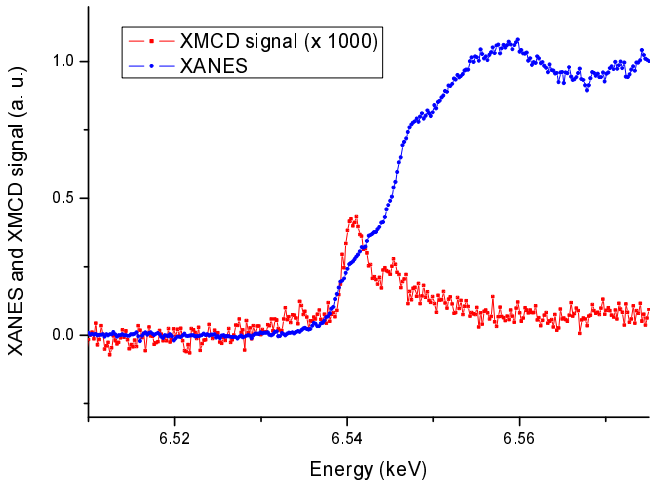

Figure 2: normalized XANES and XMCD signal recorded at 165 K on Mn_3GaC at Mn K-edge.

The residual beamtime did not allow us to perform a complete investigation as a function of pressure and conclude about the collapse of the magnetic moment predicted by theoretical calculations.
In summary, we can conclude that the first experiment has successfully achieved its primary aim: the feasibility of K-edge XMCD measurements at low-temperature and high-pressure on ID24 has been demonstrated. The allocated beamtime was not sufficient to perform a complete investigation of Mn_3GaC. We hope to obtain additional beamtime in order to complete the experiment and collect XMCD signals also at Ga K-edge. We also plan also to use a different pressure trasmitting medium (alcohol mixtures or Ar) to obtain better conditions of hydrostaticity.

We would like to acknowledge the assistance of the technical and engineering staff of ID24: M-C. Dominguez, T. Mairs, S. Pasternak and F. Perrin.