ESRF	**Experiment title:** Suppression of Magnetism to a Quantum Critical Point with Corresponding Crystal Structure Determination in the Itinerant Ferromagnet $SrRuO_3$	**Experiment number**: HE3345
Beamline: ID24	**Date of experiment**: from: 10/03/2010 to: 17/03/2010	**Date of report**: 01/03/2011
Shifts: 15	**Local contact(s)**: Dr. Cornelius Strohm	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

Proposer: Dr Emma Pugh*, Cavendish Laboratory, University of Cambridge, Cambridge, UK

In addition to the proposer the following attended and helped during the experiment: Ms Johanne Wensley* (PhD Student), Cavendish Laboratory, University of Cambridge, Cambridge, UK

Report:

$SrRuO_3$ is a member of a class (Ruddlesden-Popper series) of layered perovskite materials which have widely varying properties. These materials therefore give an ideal opportunity to investigate the relationship between structure and magnetic and electronic properties. $SrRuO_3$ is a weak itinerant ferromagnet with a Curie temperature, T_c, around 165K. The aim of this experiment was to use X-ray magnetic circular dichroism (XMCD) at the Ru K-edge (from which the magnetic moment can be obtained indirectly) to measure the evolution of ferromagnetic order in $SrRuO_3$ with pressure. In this way it was hoped to be use pressure as a quantum tuning parameter to gradually suppress the ferromagnetic ordering in $SrRuO_3$ to measure the evolution of the magnetic ordering as the material was pushed from the ferromagnetic to paramagnetic state. The critical pressure at which the ferromagnetism is expected to be suppressed in $SrRuO_3$ is ~25GPa at a quantum critical point.

Unfortunately during the experiment a number of issues arose, which resulted in us not being able to detect a suitable XMCD signal at the Ru K-edge in $SrRuO_3$. Having spoken with the local contact, Dr. Cornelius Strohm, it is thought that the possible reasons for this are as follows and relate primarily to the optics on ID24 (prior to upgrade).

1. K-edge XMCD at high energies:
   The ferromagnetism in $SrRuO_3$ arises from the $Ru^{4+}{}_{t2g}$ electrons so we were measuring the Ru K-edge which is around 22 keV. For the pre-upgrade optics on ID24, the XMCD signal is normally extremely weak at these energies. The obtained signal was also spectrally very

narrow and limited energy resolution of the beamline optics and detection may have led to a further reduction in signal.

2. Polarization rate:
   The reflection of the Si quarter wave plate is quite narrow, so it is difficult to properly align it and keep the alignment. Therefore, during the experiment we were probably averaging over the diffraction profile of the quarter-wave-plate (QWP) and in so doing loosing a lot in polarisation rate. This had the consequence of reducing the observed signal.

3. Apparent sample thickness:
   Focusing of the beam was 'poor' - an intrinsic problem of the optics on ID24 at such high energies. This means, a significant part of the beam (tails of the focal spot) passes at the side of the sample and reduces the absorption jump. The XAS near edge jump in the pressure cell was ~10% of what one would like for XMCD. This reduces the measured signal amplitude.

We were not able to resolve any XMCD signal under pressure so tried to measure an ambient pressure sample using a much thicker sample (~x10 larger) than that in the pressure cell. We were then able to produce a signal at the correct energy but it was extremely weak (of order 10^{-4}) and very narrow. ID24 is currently being upgraded and it may be that after that, with improved optics, the experiment will be possible.