ESRF	**Experiment title: Measurement of the spin-magnetisation for ErNi2B2C in the co-existing ferromagnetic and superconducting state**	**Experiment number**: HE-1255
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Shifts: 18	**Local contact(s)**: Veijo Honkimaki	*Received at ESRF:*

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Report:

The rare-earth nickel borocarbide, ErNi$_2$B$_2$C displays both type-II superconductivity and magnetic order. It has a superconducting critical temperature of 10.5K, and becomes antiferromagnetic at TN = 6.5. The onset of the AF state appears to have no effect on the superconductivity. On cooling, a weak ferromagnetic state emerges below TC = 2.5K, and this again coexists with the superconductivity for H < 1.2T [1-4]. It is thought that the superconductivity is associated with the Ni *3d* electrons and the ferromagnetism with the Er *4f* electrons. In this experiment, the ferromagnetic moment induced by an applied magnetic field was studied using spin-polarised Compton scattering in both the normal and superconducting states. This method permits the study of the ferromagnetic moment with complications arising from the diamagnetism. An increase of the susceptibility was measured in the proposed weak ferromagnetic state below 2.3K. The induced moment has a Eu 4f character with an extra contribution from the conduction electrons.

Magnetic Compton scattering (MCS) samples the spin-dependent electron momentum density through the use of circularly polarised synchrotron radiation. MCS is sensitive to only the spin moment of the sample. The technique involves high-energy inelastic scattering of a monochromatic beam of circularly polarised photons E_I = 200-250keV. The energy dispersion of the scattered beam is directly related to the electron momentum distribution. In this case, an energy of ~205keV was used, with a scattering angle of ~172 degrees, which gives the optimal resolution and countrate. The 13 element Ge detector was used, giving a total countrate of ~25kcps (note that since this experiment, this has been improved to 120kcps, and will improve further with the introduction of digital signal processing). In order to extract the spin polarised signal two measurements are made with parallel and antiparallel applied field directions with respect to the scattering vector. The magnetic field was applied using the 1.0T electromagnet installed on ID15a, and an "orange" cryostat was used with kapton windows to minimise background scattering.

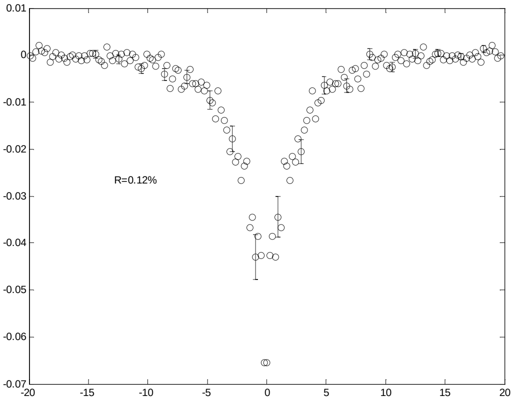

Figure 1. Spin-polarised Compton profile of $ErNi_2B_2C$ at 2K, in an applied field of 1T.

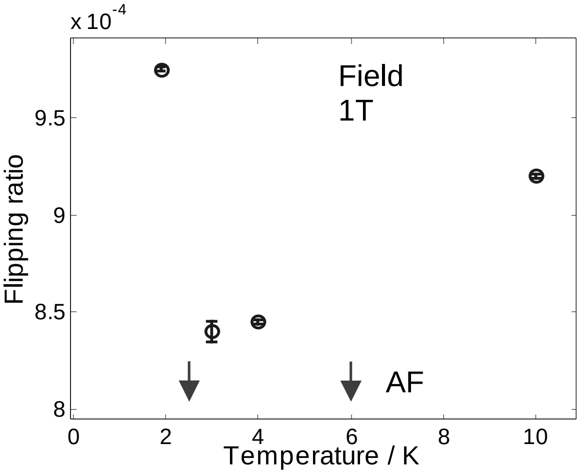

Figure 2. Spin susceptibility of $ErNi_2B_2C$ as measured using magnetic Compton scattering

An example spin-polarised Compton profile is shown in figure 1. The negative signal indicates that the spin moment is align antiparallel to the net moment; i.e. the orbital moment is larger than the spin. The signal is characteristic of a Er 4f contribution, together with a small conduction electron moment. Figure 2 depicts the spin-susceptibility of the sample, as determined from MCS measurements at different temperatures. Unfortunately, only four meaurements were possible. We note that with the new electronics, this could easily have been more than 10-15. From these data, a drop in susceptibility is observed between 10K and 4K, which is likely to arise from the onset of AF order at 6K. Note that the applied field still induces a net moment. The susceptibility then rises below 3K, consistent with the emergence of the weak ferromagnetic state.