ESRF	**Experiment title:** Atomic scale investigation on the magnetoelectric coupling of multiferroic $CaBaCo_4O_7$ under applied magnetic fields.	**Experiment number**: HC1988
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Report:

$CaBaCo_4O_7$ (CBCO) is an orthorhombic cobaltite (space group $Pbn2_1$), ferrimagnetic below T_c=70K [1] and is suggested to be FE below this temperature as well [2]. The mechanism promoting FE has not been fully clarified yet, although a magnetic driven FE is proposed because no structural phase transition is observed across T_c by neutron diffraction experiments [1]. The crystallographic structure of $CaBaCo_4O_7$ consists of triangular (T) and kagomé (K) layers of CoO_4 tetrahedra along **c** axis [1].

Magnetoelectric coupling has been recently claimed on this compound, coming from the observation on an increase on the electric polarization under applied magnetic fields above 1 T and below 65 K [2]. The aim of this experiment is to shed light on the origin of the magnetoelectric coupling on $CaBaCo_4O_7$ by means of Differential EXAFS. To do so, we have adapted a permanent magnet of 2 T inside a support which can make it rotate, in such a way that the applied magnetic field can be both parallel or perpendicular to the polarization of the incoming beam, and therefore the magnetization of the samples changes accordingly. The difference EXAFS signal between both configurations stands for the so-called Magnetic-EXAFS signals, which gives direct account of the modulation on the photelectron scattering path coming from magnetostriction effects.[3]

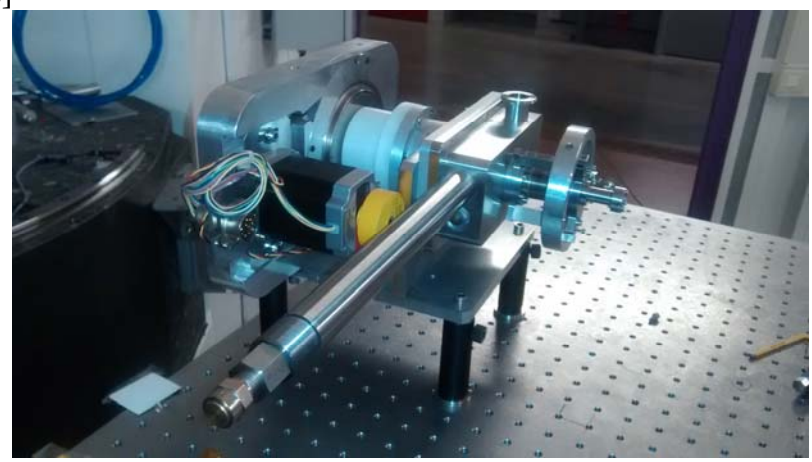

Fig. 1. Cryostat adapted inside the hole of the magnetic wheel on ID24.

In adittion to that, the cryostat in figure 1 was adapted so that the sample was placed in the middle of the magnet, ensuring the optimal field conditions.

In order to ensure the right performance of the set up, we used a Co foil to get the standard DiffEXAFS signal. The results are shown in figure 2, where we got a signal aproximately doubled as the obtained previously at 0.7 T.[4] The statistical noise is approximately 7% of the differential signal on the foil (0//0 signal). However, when considering the zero signal by moving the magnet (0//180 signal), the statistical noise becomes 30% of the differential signal. This might be ascribed to small movements of the sample related to the magnet flipping.

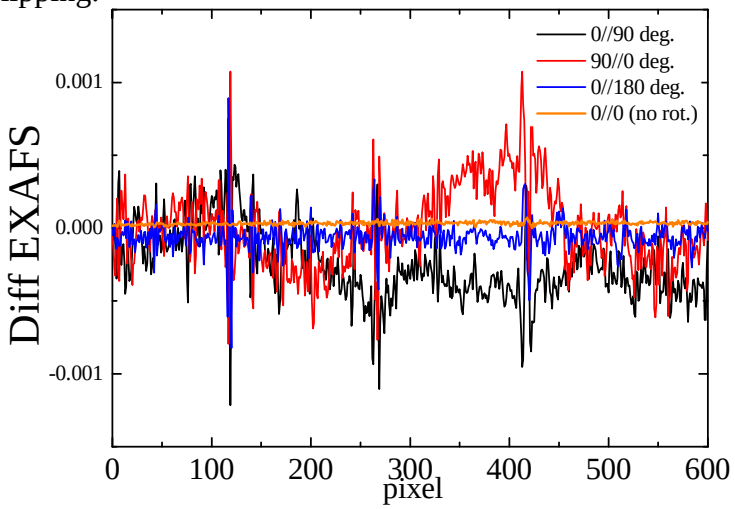

Fig. 2. DiffEXAFS signal from a Co foil.

Powdered samples of $CaBaCo_4O_7$ were mixed with cellulose and the resulting powder was left for 2 hours on the ball miling morter available on the Chemisitry Lab of ID24, in order to get the highest sample homogeneity. Nevertheless, the noise observed at the XAS signal is too high (the signal to noise ratio is 1/0.1), so it didn't allow us to get a reasonable DiffXAS signal, as shown in the left pannel of fig. 3. Several samples were tested mixing the powders differently and glueing them differently into the sample holder, but similar results were obtained. Besides the inhomogeneity of the sample, every tiny movement of the sample into the magnet is detrimental for the spectra, due to the small horizontal size of the beam on id24 dispersive beamline. Therefore, based on the much improved signal to noise ratio obtained in BM23 for the same sample (fig. 3 right), we propose that beamline to perform DiffXAS at low temperatures with the set up described on figure 1, profiting from the quick scanning mode on the monochromator.

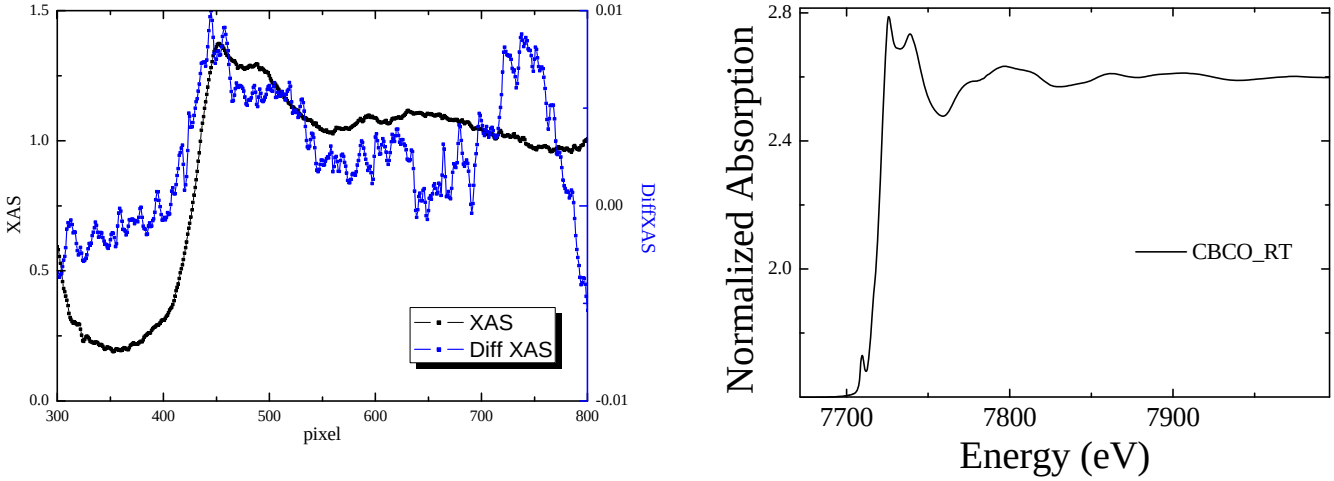

Fig. 3. Left: In black, XAS signal from CaBaCo4O7 at RT measured in ID24, in blue differential signal at 2T. Right: XAS of CaBaCo4O7 measured on BM23.

References.

[1] V. Caignaert et al., Phys. Rev. B **81**, 094417 (2010).
[2] V. Caignaert et al., Phys. Rev. B **88**, 174403 (2013).
[3] R. Pettifer et al., Nature **435**, 78 (2005)
[4] M. Ruffoni, private communication.