ESRF	**Experiment title:** Atomic scale investigation on the magnetoelectric coupling of multiferroic CaBaCo4O7 under applied magnetic fields.	**Experiment number**: HC2415
Beamline: BM23	**Date of experiment**: from: 30/03/2016 to: 03/04/2016	**Date of report**: 17/07/2017
Shifts:	**Local contact(s)**: Vera Cuartero	*Received at ESRF:*

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Report:

$CaBaCo_4O_7$ is an orthorhombic compound, showing long range ferrimagnetic ordering below T_c~65 K, being **b** the easy magnetic axis. At this temperature, when applying a magnetic field along **b** axis a very sharp peak is observed at the dielectric constant for H=1T (**E**//**c**, being **c** the polar axis) [2]. The origin of this anomaly is not fully understood yet and different origins can be discussed: (i) spin supercurrents [5] or (ii) asymmetric exchange striction. In the first case, the origin of FE is purely electronic, with no atomic displacements, while in the second case magnetostriction is playing the main role on the achievement of the FE ground state, causing atomic displacements.

In this experiment on BM23 beamline, we will change the direction of the magnetic field **H** of 2 T, with respect to the x-rays polarization vector **ε** using the magnetic wheel set up described in [1] at a fixed temperatures below 65 K. The DiffEXAFS spectra taken under these conditions are plotted on figure 1, and result from averaging a sufficient number of differences between the two conventional EXAFS spectra obtained with the sample magnetization parallel (**H**//**ε**, up) and perpendicular (**H**$^{\perp}$ **ε**, down) to the x-rays polarization vector.

There are noticeable changes on the oscillation that appears around 2 A-1, which are enhanced around 62 K for the **H**//**ε** configuration. The interpretation of these changes can be better determined by the data analysis, that was performed using Artemis within Feff 8 calculations. The pure spectra were analysed considering a local distortion for CoO4 tetrahedra using 2 different average distances with N=2 (one long and one short), and only one Debye Waller factor for both types of paths. An example of such a fit for shells up to R = 4 A is shown on figure 2, being S02 fixed to 0.7 (reference of Co3+ on a tetrahedral environment).

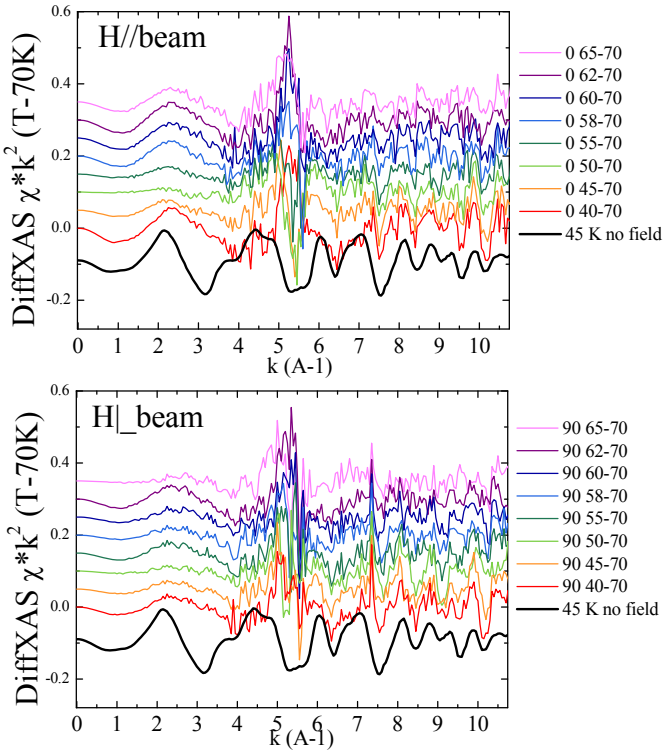

Fig. 1. Differential chi*k^2 exafs signal between exafs at different temperatures with respect to the 70 K signal, with an external magnetic field of 2 T applied parallel (up) and perpendicular (down) to the x-ray beam polarization vector.

The evolution of the DW factors for Co-O paths is shown on figure 3. As can be observed, there is a clear anomaly that appears only for **H**//**ε** configuration, which is a clear sign of the increase of the distortion of the CoO4 tetrahedra due to the applied magnetic field, and so it is related to the enhancement of the electric polarization due to magnetoelastic coupling.

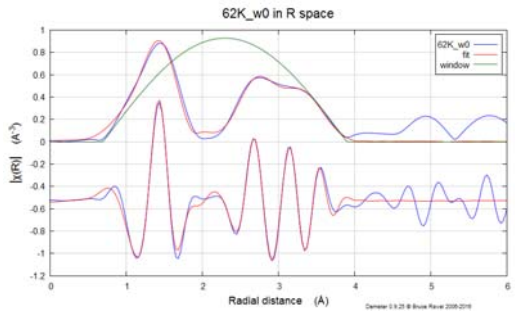

Fig. 2. Signal and fit from chi*k2 EXAFS signal for the spectrum taken at 62 K with the beam//H.

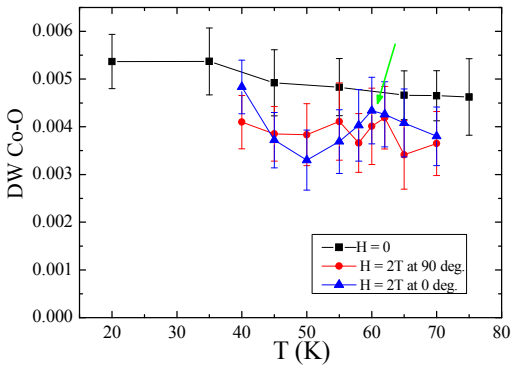

Fig. 3. DW T-evolution for Co-O paths with 2 T applied along (blue) and perpendicular (red) to the beam polarization direction, compared with the evolution without applied magnetic field (black).

[1] R. Pettifer et al., Nature **435**, 78 (2005)