ESRF	**Experiment title:** **Test of Diamond Quarter Wave Plates for performing XMCD measurements at SpLine**	**Experiment number**: **25-01-643**
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Report:

This proposal belongs to a general study aimed to explore the feasibility of developing an XMCD end-station at the Spanish XAS beamline, SPLINE, at the ESRF (European Synchrotron Radiation Facility, Grenoble, France). This is one of the main scientific objectives of the coordinated project "**FUNCTIONAL AND NANOSTRUCTURED MAGNETIC MATERIALS: SYNTHESIS, CHARACTERIZATION AND MODELLING" f**unded by the spanish Ministerio de Educación y Ciencia: Ref. CICYT MAT2005-06806-C04. This coordinated project intends to join the effort of several research groups from the Universities of Oviedo, Cantabria, País Vasco and ICMA.

As above indicated one of the main objectives of this project was the design of an X-ray circular magnetic dichroism experimental set-up at the Spanish beam line (SpLine) at the ESRF. It should be noted the peculiarity of the design of this line is relatively complex. In fact, the radiation is provided by a bending magnet through a port that has been split to provide photons to two hutches, A and B. Moreover, the available beamtime in hutch A has to be shared between XAS and X-ray powder diffraction. The part of hutch A devoted to XAS in SPLINE has been designed to fulfil the basic requirements of standard, not highly demanding XAS experiments. In particular, it is well designed for analysis at high energy (range between 5 and 35 keV). Moreover, the initial design did not consider any special detection systems and, as a consequence, other devices to control sample environment will not have much space available for installation.

The proposed XMCD Station combines the linear polarized x-rays coming from the BM with a phase retarder. The phase retarder can function as both a quarter-wave plate, which converts from linear to circular polarization, and a half-wave plate, which generates vertical linear polarization. This setup allows using two standards methods for recording the XMCD spectrum: magnetic field-reversal and helicity-reversal. Because reversing of the magnetic field can affects the sample by inducing noise due to sample vibration, grain movement, etc., helicity-reversal mode (HM) should be preferred. Therefore, XMCD experiments will be performed in the helicity-modulation mode, by combining an XPR with a phase-sensitive (lock-in) detection system. This technique provides extremely high quality XMCD spectra in short measurement times. Typically, a dichroism signal in the order of 10^{-4} is obtainable with a good signal-to-noise ratio for 10 seconds integration times at each energy point with a properly prepared sample. The advantage of the proposed XMCD setup is that it is completely compatible with that used for standard XAS measurements. The only difference resides in the polarization conversion stage that is performed before the beam enters the experimental hutch. Therefore, the same flexibility for detection mode as for XAS is obtained. The preferred detection modes will be transmission, by using ionization chambers, and fluorescence, by using solid state or fluorescence ionization chamber (Lytle) detectors.

The fist step in the feasibility study is to test is to test the transmission of the quarter plate. To this end we have adquired a diamond plate 7 x 3.5 x 0.5mm (with 111 orientation). We propose to mount the phase retarder on the standard arrangement for XAS measurements to test the transmittance of the plate. In this way we test the possibilities of using such a setup within the energy range corresponding to the following absorption edges: the K-edge of both the 3d and 4d transition metals and the $L_{2,3}$-edges of the lanthanides and 5d transition metals. The setup needs for a XMCD experiment does not affect the optics of the XAS station and therefore, the available energy range would be the same as for XAS experiments. However, it should be noted that the energy range for XMCD measurements is restricted by the absorption of the phase plate. Therefore, by using diamond crystals of different thickness it is possible to cover the energy range from 5 to 16 keV. For the present test we planned to perform XANES measurements at the $L_{2,3}$-edges of the lanthanides, the K-edge of 3d elements and the $L_{2,3}$-edges of the 5d elements up to Pt in the transmission mode by using the ionization chambers already available at SPline.

The results obtained during the experiment demonstrate that the decrease of flux due to the absorption by the plate does not affects the signal to noise ratio within the range of interest. Therefore, we think it is possible to complete the installation of the whole XMCD setup as proposed. Finally, a preliminary test of the XMCD measurement was made by fixing the helicity and reversing the applied magnetic field. The results are shown below.