ESRF	**Experiment title:** Nanosecond Resolved X-ray Magnetic Circular Dicrhoism	**Experiment number:** HE-369
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Report:

Time resolved XMCD experiments have been currently carried out at ID24, using a pump-probe approach, thanks to the ESRF single bunch time structure associated with a pulsed magnetic field generated by a 50μm micro-coil. The single bunch repetition rate (360kHz) leads to some limitations in pulse height and length, due to the thermal power generated in the coil itself and in the electronics for pulse generation. In practice, we are able to produce a 20ns long 0.7T magnetic pulses, that sometimes are not enough to saturate the magnetization of rare-earth based magnetic materials. To overcome this restriction a real time approach was implemented with a fast x-ray detector in the 2/3 ESRF filling mode.

The use of a fast x-ray detector (an avalanche photodiode - Hamamatsu C5658) instead of the CCD camera used at ID24, associated with a fast acquisition system (a digital oscilloscope - LeCroy LC394) has made it possible to measure the whole time dependence in a single phase condition. A 300μm horizontal slit was used in front of the photodiode in order to select an energy bandwidth of 5eV in the Gd L_3 absorption edge (7243eV). In this case we used the 2/3 filling mode and consider the beam like a continuous source. Figure 1 shows the actual ESRF time structure measured with a 100MHz PIN photodiode.

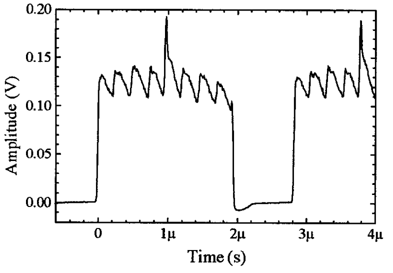

Figure 1: Time structure of the ESRF beam in the 2/3 filling mode (ID24 MAR/98)

The magnetic system used for this experiment was an amorphous film of GdCo, with an easy axis of magnetization in the plane and a coercive field of about lmT, mounted in the micro-coil in a quasi-planar geometry (30°). These measurements were carried out with a bias field applied contrary to the pulsed field, to probe the magnetization reversal dynamics of the Gd in the film. Thus, we start in one saturated magnetic state and, with the field pulse, the magnetization is reversed.

For statistical reasons, an average of 7.10^5 measurements was made, allowing a signal to noise ratio better than 0.5% in 18 minutes, with a time resolution of Ins in a 500ns window. Figure 2 shows the pulsed magnetic field and the Gd L_3 XMCD signal as function of time, at room temperature. After the pulse of field (100ns), the Gd magnetization still remains some ns, characteristic of a domain nucleation phase. After this, the magnetization goes back to its initial state in a decay time of approximately 30ns, showing the domain wall propagation phase. Other measurements were performed with various conditions of bias and pulsed field, and are coherent with the thermally activated nature of the magnetization reversal process.

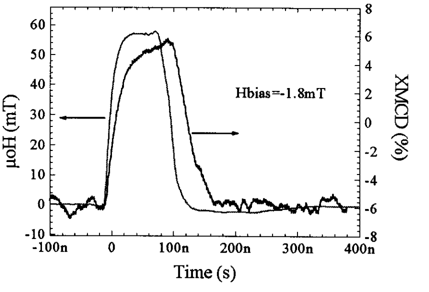

Figure 2: Magnetization reversal dynamics of Gd L_3 in a GdCo amorphous film, with a reversed bias of 1.8mT

In this first experiment, we lost time between acquisitions because of the non automated interaction between the oscilloscope and the computer running SPEC. This interaction is necessary to synchronize the acquisitions with the photon helicity change (right and left circular polarization) performed by a QWP mounted in a goniometer. An automatization software will be soon implemented using the GPIB interface of the oscilloscope. It will allow us to reduce by a factor of 3 the total measurement time.

The repetition rate used for the pulse of field was lkHz, i.e., 360 times smaller than that of the single-bunch condition. Considering the thermal constraints, this allows an increase of 19 times in the peak of the possible magnetic field in the micro-coil. This corresponds to fields up to 10T in perpendicular and 5T in parallel micro-coil geometries, with a pulse width of about 50ns. A new micro-coil current driver capable of delivery this current is now under construction.