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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title: Magnetization dynamics in spin valves induced by spin-polarized currents: a micro-scopic and layer-selective study using PhotoEmission Electron Microscopy**	**Experiment number**: HE-2107
Beamline:	**Date of experiment**: from: 22/05/2006 to: 31/05/2006	**Date of report**: 31/08/2006
Shifts:	**Local contact(s)**: Dr. Julio Criginski CEZAR	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

During this beamtime we made a first attempt to directly observe current-induced domain wall movement in nanoscopic spin-valve lines using photoelectron emission microscopy combined with x-ray magnetic circular dichroism (XMCD-PEEM). Current-induced magnetization dynamics is a subject of strong fundamental and technological interest, since it will allow a simplification of architecture for high-density magnetic storage and magnetic random access memory (MRAM). Until now, all observations of domain wall displacement using currents have been done using static measurements, looking at the shape and position of the domain wall after the application of a current pulse. For a better theoretical and experimental understanding of the interaction between spin polarized currents and domain walls it is crucial to observe directly, during the displacement, the domain wall position and shape. Time-resolved XMCD-PEEM is a tool of choice for this direct observation, combining element-selectivity and a good temporal resolution with an excellent spatial resolution.

The experiment we wanted to perform was very challenging for several reasons. The intensity of one x-ray pulse is not sufficient to obtain good quality images of our sample and the measurements have therefore to be performed in pump-probe mode [1]. In this case, the imaged domain wall movement has to be reversible and reproducible in order to obtain accurate images. For that, we used zigzag-shaped samples (see Fig. 1a) in which after each current- and photon pulse the domain walls are repositioned in the curved part of the sample by applying a magnetic field pulse (see timing scheme in Fig. 2). Moreover, since the magnetic pulses are power consuming, they can not be applied at the full repetition rate of the four-bunch mode, but only at half this repetition rate (714 kHz). The current pulses are at the same repetition rate as the magnetic field pulses. The photo-electrons generated by absorption of the photon pulses that are not associated to a current pulse are suppressed by applying a

negative pulse (-20V) on a grid in front of the imaging optics, in order to avoid a high background contribution to the images.

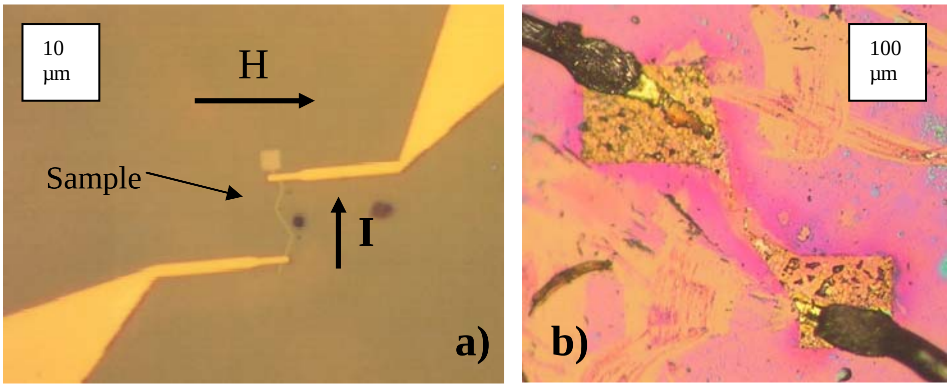

Fig.1 : a) Geometry of field and current pulses applied to the FeNi/Cu/Co sample. b) sample and contacts after discharges between PEEM objective lens and sample contacts.

We have successfully tested this complicated timing scheme during the beamtime in May 2006. These test show that the 'blanking' pulses on the grid indeed suppress one photon bunch out of two and that the magnetic and current pulses can be synchronized with the photon bunches, with a variable delay.

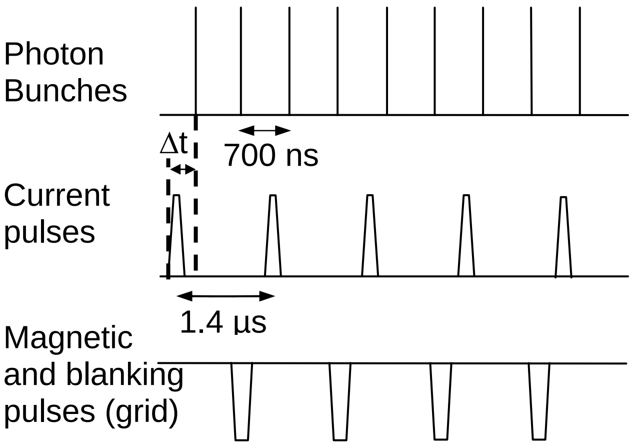

Fig. 2 : Timing schedule for the time-resolved PEEM experiments. Current pulses are synchronized with the photon pulses at ½ *f*. Magnetization dynamics during the current pulses is monitored by changing the delay between current and photon pulses. In between two current pulses, the sample is reset in its initial state by applying a magnetic pulse. Secondary electrons generated by a photon pulse that is not associated to a current pulse are suppressed by applying a negative pulse to a grid placed in front of the imaging module (microchannelplate + CCD camera).

Technical problems associated with the samples did not allow us to acquire images of current-induced domain wall motion. These samples are known to be extremely sensitive to electrical discharges, making it necessary to be very careful when mounting them. In order to obtain high-resolution PEEM images, a tension of more then 10 kV has to be put on the objective lens, which is placed only 2 mm from the sample surface. The sample and its surrounding area should therefore be as flat as possible in order to avoid field emission and discharge effects. In our samples, the contacts for the current pulses were only a few millimeters away from the center of the sample, and therefore too close to the objective lens. Discharges took place between the objective lens and the contacts, destroying the samples (Fig. 1b). We are now preparing samples with current leads much farther from the center of the samples, which will be positioned inside the Cu-coil generating the magnetic field pulses. In this way, discharges can be avoided and high-resolution magnetic imaging of our samples will be possible.

[1] M. Bonfim, G. Ghiringhelli, F. Montaigne, S. Pizzini, N.B. Brookes, F. Petroff, J. Vogel, J. Camarero, and A. Fontaine, Phys. Rev. Lett. 86, 3646 (2001).