	Experiment title: Spinstructure of Fe films in exchange-spring layer systems	Experiment number: SI 736
Beamline: ID18	**Date of experiment:** from: 12.12.2001 to: 17.12.2001	**Date of report:** 24.02.2002
Shifts: 12	**Local contact(s):** O. Leupold, R. Rüffer	*Received at ESRF:*

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Report:

The aim of the experiment was the determination of the spin structure in an exchange-coupled magnetic bilayer consisting of a soft-magnetic and a hard-magnetic layer. This aim has been fully accomplished. We could determine the spin structure in a 11 nm thick Fe film on a 30 nm uniaxial hard-magnetic FePt layer with a spatial resolution below 1 nm. This was achieved via nuclear resonant scattering from a 0.7 nm thick probe layer of ^{57}Fe that extended over the depth of the Fe film, as sketched in fig. 1. If the bilayer is subjected to an external field perpendicular to the magnetization of the hard layer, a spiral develops in the soft layer. While its magnetization is pinned at the FePt interface, the Fe moments can rotate more or less freely with increasing distance from the interface and align towards the external field, as shown schematically in fig. 2. By variation of the transverse displacement Δx different depths in the sample are probed. The change in the shape of the time spectra, shown in fig. 3, with increasing Δx reflects the increasing rotation angle φ relative to the incident beam. (Data acquisition times were remarkably short (10 min) due to flux enhancement via standing-wave formation in the Fe layer). From evaluation of such measurements the rotation angle can be determined with very high accuracy, as shown for various external fields in fig. 4. To our knowledge, this is the first direct measurement of such spin structures [1]. A detailed micromagnetic simulation of the results is in progress. This method opens new ways to study further aspects of exchange-coupled systems (e.g. temperature dependence, oscillatory coupling etc.). Finally, it should be mentioned that this work received the *Best Poster Award* during the Surfaces/Interfaces Workshop 14.-15.2. at the ESRF Users Meeting 2002.

[1] R. Röhlsberger, H. Thomas *et al.*, to be submitted to Phys. Rev. Lett.

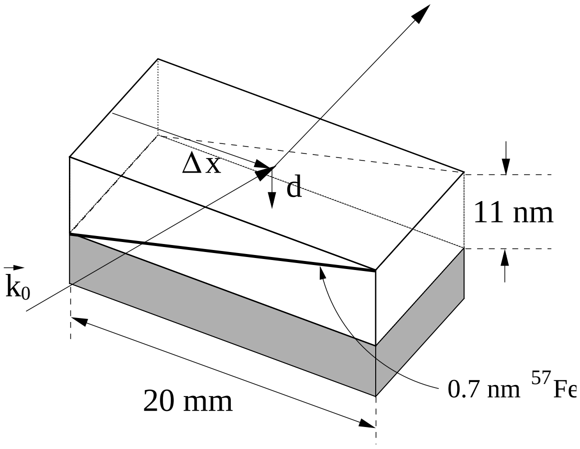

Fig. 1 Scheme of the layer system investigated here: 11 nm Fe on 30 nm FePt. A tilted probe layer that extends over the depth of the sample is used to determine the depth dependence of the magnetic properties in the soft layer.

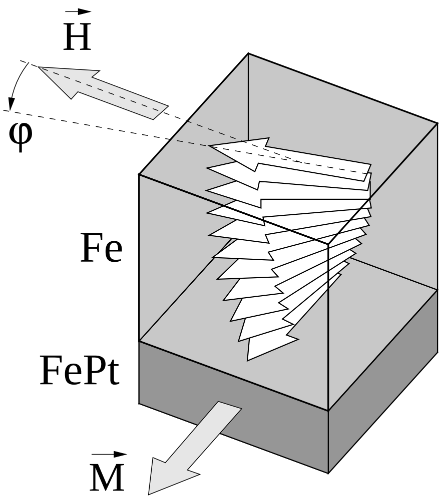

Fig. 2 Spiral magnetic spin structure that develops in a soft-magnetic film (Fe) that is pinned to a hard-magnetic layer (FePt) under the action of an external field.

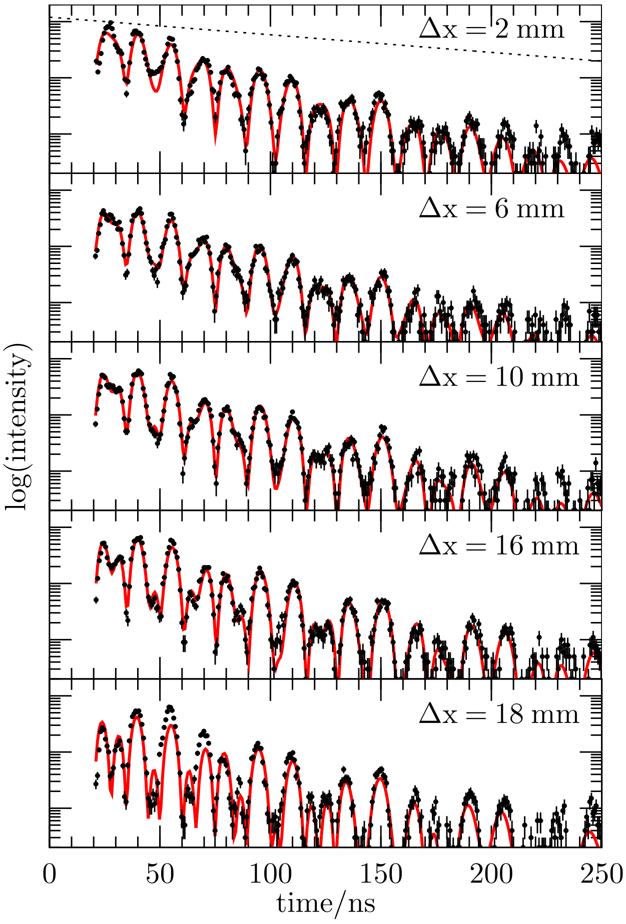

Fig. 3 Time spectra of grazing incidence reflection from the Fe/FePt bilayer for various displacements Δx at an external field of 160 mT. Solid red lines are fits to the data.

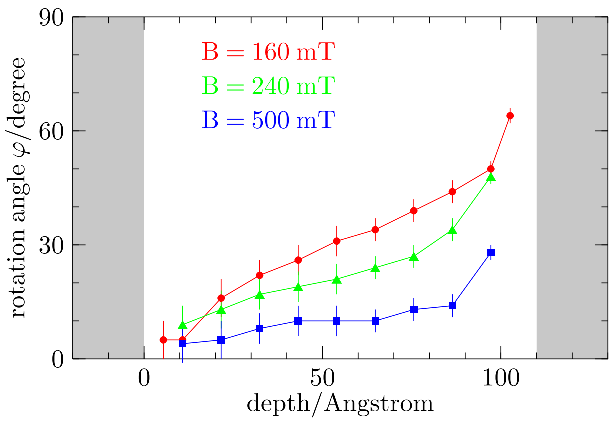

Fig. 4 Rotation angle φ of the magnetization as a function of depth in the Fe layer for various external fields, derived from evaluation of the time spectra.