# 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:** Spin Structure in $FeF_2$/Fe Exchange Bias Bilayers probed by Nuclear Resonant Scattering of Synchroton Radiation | **Experiment number**: HE-1487 |
|---|---|---|
| **Beamline**: ID22 N | **Date of experiment**: from: 11 May 2003 to: 21 May 2003 | **Date of report**: 26 August 2003 |
| **Shifts:** 11 | **Local contact(s)**: Dr. Rudolf Rueffer | *Received at ESRF:* |


**Names and affiliations of applicants** (* indicates experimentalists):

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**Report:**

We applied the method of nuclear resonant scattering to investigate the depth profile of magnetic properties in exchange bias bilayers of $FeF_2$/Fe as well as $MnF_2$/Fe. The results point to significant changes of the interfacial spin structure upon cooling through the Néel temperature of the antiferromagnet (Fig. 2). This was the first study where the spin structure in a ferromagnetic layer in contat to an antiferromagnetic film was investigated at different depths on the same sample. Such an approach is not feasible with CEMS because of the lower countrate. The high sensitivity of the method combined with its high spatial resolution allowed us to measure on samples with an $Fe^{57}$ wedge, which covers different depths in the FM layer (cf Fig.1).

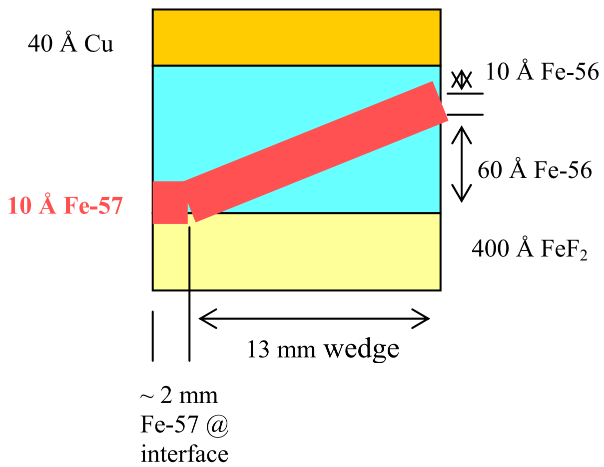


*Fig. 1Sketch of the wedge sample MXJF17A. The $Fe^{57}$ wedge layer allows to probe the spin structure in different depths of the same ferromagnetic layer.*

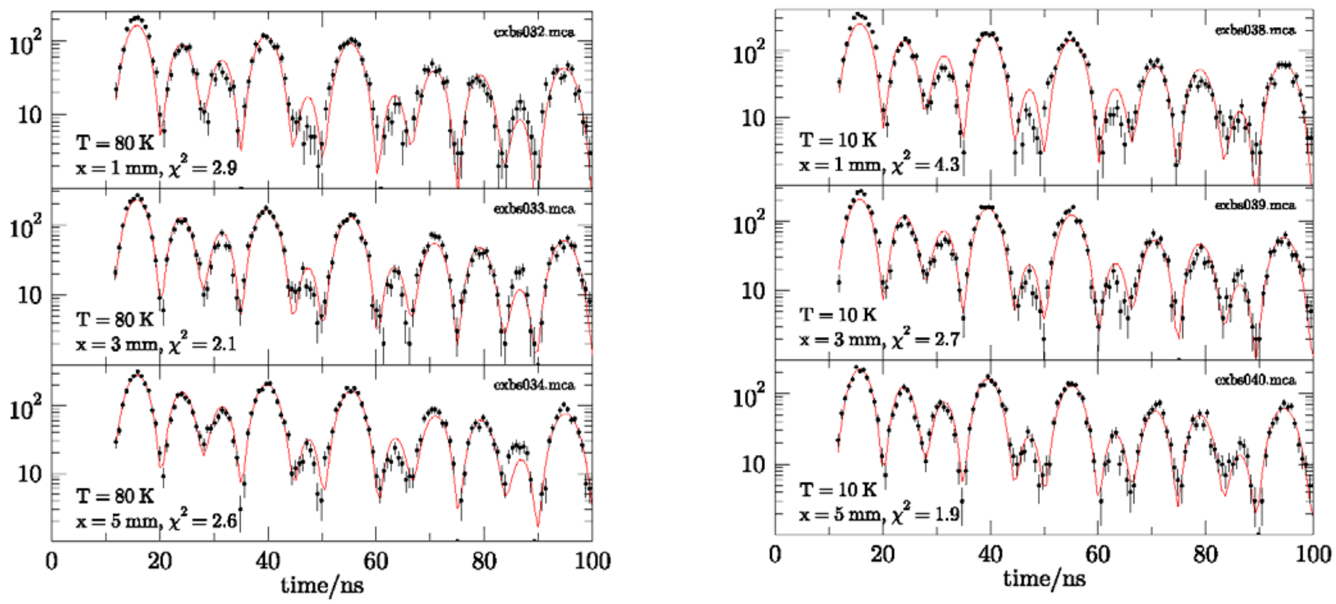


*Fig. 2:. Time spectra of wedge sample MXJF17A above and below the $FeF_2$ Néel temperature for different distances from the ferromagnetic/antiferromagnetic interface. The coordinate x refers to the distance from the left-hand side edge of the wedge, as sketched in Fig.1. The sample was field cooled in 200 mT perpendicular to the scattering plane and parallel to the sample surface. Measurements at zero field were taken at temperatures of 80 K (left-hand side) and 10 K (right-hand side). The black dots are the measured time spectra and the red solid lines show simulations based on a single-valued unidirectional hyperfine field. To quantify the quality of the fit, the $\chi^2$ value is given in each picture. Particularly, at small x-values x=1mm, i.e. close to the interface, and at temperature T=10 K, i.e. below the Néel temperature of $FeF_2$ ($T_N$=78 K), the high $\chi^2$ value indicates a significantly different spin distribution which cannot be approximated by a simple unidirectional hyperfine field. To solve this issue additional measurements with different direction of the incident beam are required.*

However, at the present stage the results are not conclusive. Due to a lack of beam time, the required number of systematic measurements for different directions of the incident beam and different applied magnetic fields could not be performed and several of the prepared samples could not be measured at all. The reason for this is that the experiment was scheduled at beamline ID22N instead of ID18 as originally proposed. Therefore the x-ray flux at the sample position was a factor of 5 - 10 less than expected. Particularly, measurements of the spinstructure at different points of the magnetic hysteresis loop are required for a more conclusive understanding of the influence of the spin structure in the ferromagnetic layer on the exchange bias effect of the whole system. To complete the promising and unique investigations we will apply for a continuation beam time. For these experiments at ID18 we estimate a count rate of 10 - 20 Hz from samples with probelayer at the interface. This leads to a data acquisition time of 30 - 60 min per spectrum and thus should allow for a conclusive set of data within a beam time of 15 shifts.