ESRF	**Experiment title:** X-Ray Resonant Magnetic Scattering study of the dynamics of the Spin Reorientation Transitions in $R_2Fe_{14}B$ systems.	**Experiment number:** HC-386
Beamline: ID20	**Date of experiment:** from: 20/l l/96 to: 25/11/96	**Date of report:** 01/03/97
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Report:

Eighteen shifts have been allocated on the ID20 beam line in order to study the dynamics of the rare-earth magnetic moments in $R_2Fe_{14}B$ by X-ray *Resonant Magnetic Scattering (XRMS).*

1) Introduction and Objectives

$Nd_2Fe_{14}B$ is a rare-earth intermetallic material well known as high performance magnet within the thermal range determined by the ferromagnetic ordering transition ($T=T_c$) and the spin reorientation transition (SRT) taking place at lower temperatures ($T=T_{SRT}<Tc$). The two Nd ions of the formula unit occupy two different cristallographic sites (4f and 4g) in the unit cell. The relative orientations of the Fe and Nd magnetic moments at and below T_{SRT} have been a controversial subject since the discovery of SRT's. The study of the relative orientations of the rare earth ions occupying two different sites as a function of temperature requires a atom-selective magnetometry and crystallographic technique as is X-ray Resonant Magnetic Scattering (XRMS). The different contribution of each rare-earth site to the diffracted intensity at some selected Bragg peaks (and consequently to the XRMS signal) would allow us to distinguish the hypothetical noncollinearity on the orientations of the two cristallographically non-equivalent rare-earth magnetic moments.

2) Experimental Details.

As result of a common effort of the users group, ID20 beamline and the sample environment laboratory at the ESRF, a "cold finger" apparatus refrigerated by a gas N_2 flux was built. This set-up allowed us to perform diffraction experiments within a switcheable magnetic field with the required geometry (the use of standard window-cryostats or displex-like systems is not possible). The geometry is depicted in Fig 1. Scattering was detected in the horizontal plane and the c-axes of the crystal (paralel to the sample magnetization in the high temperature phase) was oriented vertical. The orientation of the magnetization on the sample was switched by chanching the sign of the current through the electromagnet. Detection with "up" and "down" fields for fixed θ, energy and temperature allow us to get an "asymetry ratio" data minimising changes on incident beam conditions.

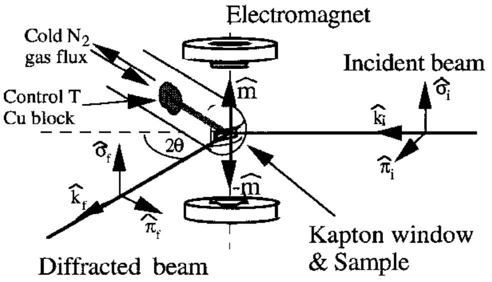

Fig. 1

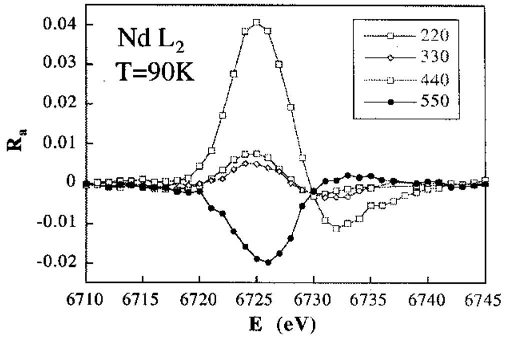

Fig. 2

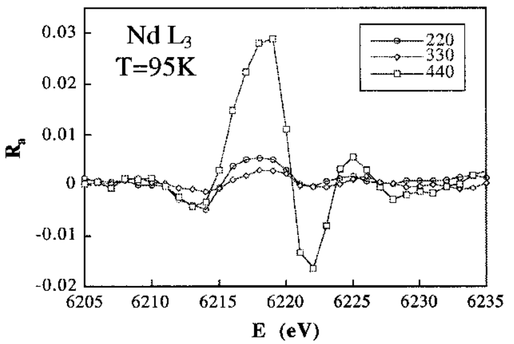

Fig. 3

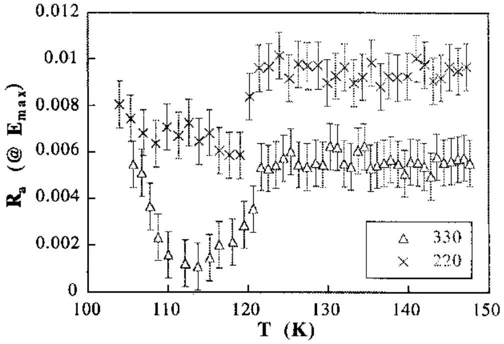

Fig. 4

3) Experimental results.

Two different types of scans were performed: energy scans at fixed temperature for several Bragg reflections, as shown in figs 2 and 3 for L_2 and L_3 edges of Nd and temperature scans at a fixed energy and scattering conditions, chosen at the maxima of different Bragg reflections for each absorption edge. Fig. 4 shows two of these latter scans in which a change on the intensity of the asymmetry ratio at (220) and (330) reflections at the L_2 edge is observed at temperatures lower than 125 K. Such kind of temperature scans were taken at every Bragg reflection for both L_2 and L_3 edges. (220) and (330) Bragg reflections carry information from 4f and 4g Nd sites almost separately due to the details of the structure factor, and the differences in its respective thermal behaviour inform us directly about the different evolution of each Nd site in the vicinity of the transition. The long acquisition times necessary to distinguish the variation of signals of the order of 10^{-3} and the poor temperature stability of the cold finger did not allowed us to perform a “complete experiment”, i.e. to measure energy scans at each Bragg reflection for a set of temperatures around T_{SRT}.

The direct comparison of these low-temperature measurements with the room-temperature data available before (experiment HC-333 on D32 “IF”, [1]) could give already some information about the mutual orientation of the two Nd ions in the crystal structure below the spin reorientation transition. The meaning of the temperature scans (Fig 4) looks difficult to understand: a shift in temperature from expected seems to appear (the change in intensity is shifted ≈ 10 K with respect to T_{SRT}) and the reorientation angle of the magnetic moments related to the evolution of the (330) reflection is much larger than expected from other macro- and microscopic measurements [2].

In order to obtain a complete set of data a continuation of this experiment will be submitted.

[1]: F. Bartolomé et al. to appear in Journal de Physique (1997) XAFS Conference proceedings.
[2]: J. Chaboy et al. Europhysics letters, 28 (2), pp.135141 (1994) and references therein.