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ALICE: A diffractometer/reflectometer for soft X-ray resonant magnetic scattering at BESSY II

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Abstract: Although the chamber named ALICE was designed for the analysis of magnetic hetero- and nanostructures with resonant magnetic x-ray scattering, the instrument is not limited to this technique. Static measurements involve the possibility to use scattering and spectroscopy synchrotron based techniques (photon-in photon-out, photon-in electron-out, and coherent scattering). Dynamic experiments require either laser or magnetic field pulses to excite the spin system followed by x-ray probe in the time domain from nano- to femtosecond delay times. In this temporal range, the demagnetization/remagnetization dynamics and magnetization precession in a number of magnetic materials (metals, alloys, and magnetic multilayers) can be probed in an element specific manner. The versatility of the instrument was tested by a series of pilot experiments, pointing out ALICE as one of the most demanded instruments at the Helmholtz-Zentrum Berlin.

1 Introduction

The ALICE chamber was built as a diffractometer/reflectometer for XRMS applications and is in operation since December 2002. It combines a two-circle goniometer with an accessible range of 175° in 2Θ. A magnetic field of ±7.1 kOe is available with a yoke that can rotate freely within the horizontal scattering plane. The whole chamber is mounted on a support frame and can thus be moved to various places (undulator or dipole beamlines) within the experimental hall, depending on the requirements of the experiment and beamtime allocation.
The sample holders are mounted on a cold-finger of a Janis flow cryostat that can be run with both LN_2 or LHe, where in the latter case sample temperatures down to 10 K can be reached.

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Different sample holders can be accommodated on the sample manipulator. In the most common situation the samples are fixed vertically, perpendicular to the scattering plane and can rotate in the x-ray beam from normal to grazing incidence. Use of different signal channels is provided, including Total Electron Yield (TEY), Florescence Yield (FY), photo-diode (PD), and avalanche detector for XRMS. Depending on the sample holder used, different detector signals can also be measured simultaneously.

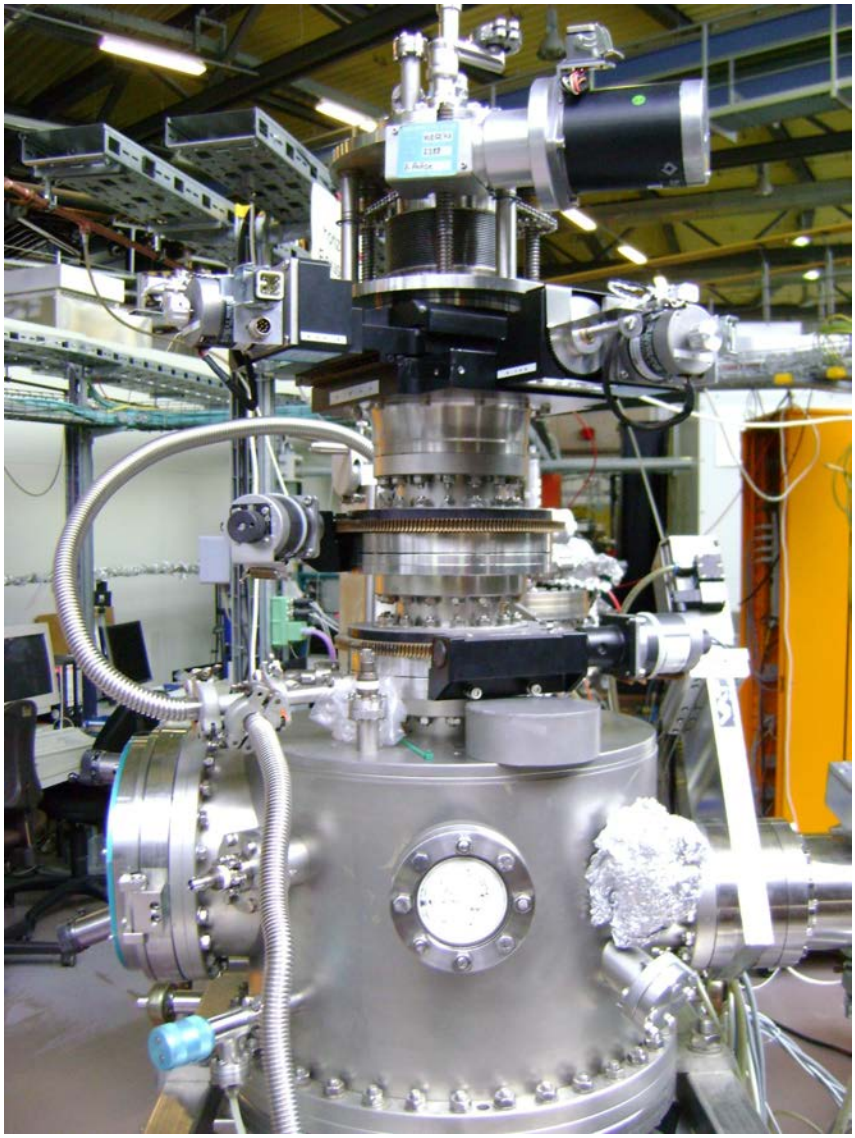

Figure 1: View of the ALICE chamber.

2 Instrument application

Samples:

- Single films
- Multilayers
- Bulk samples
- Solid samples
- Al membranes
- SiN membranes

Measurements:

- Spectroscopy (TEY, TR, FY, XMCD, XMLD)
- Scattering (XRMS, Speckles)
- Holography

Experiments:

- Static
- Dynamic (pump-probe)

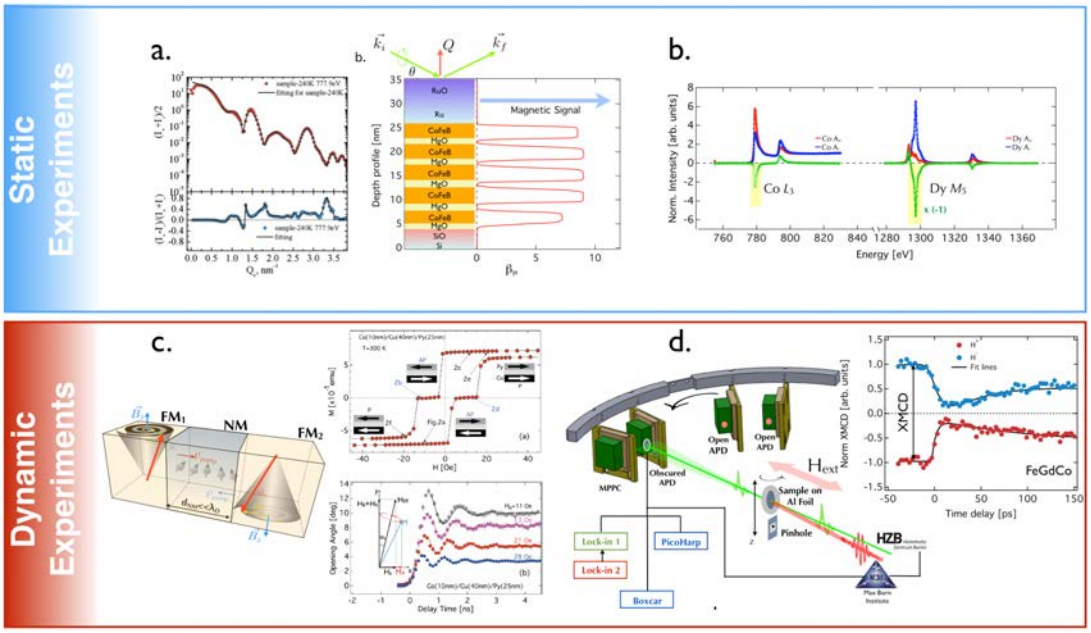

Figure 2: Static experiments consists in x-ray scattering on magnetic multilayers (a) or x-ray absorption spectroscopy in total electron yield or transmission geometry (b). Dynamic study of the magnetization precession in magnetic coupled layers (c) or laser pump x-ray probe experiments to study magnetization dynamics in magnetic alloys (d).

3 Technical data

Monochromator	Available at: dipole beamlines and undulator beamlines
Scattering Plane	Horizontal
Experiment in Vacuum	10^{-8} mbar
Temperature range (on the sample)	10 - 475 K
Angular resolution	0.005°
Detector slit	30 µm - 2 mm
Magnetic field	Up to 0.7 T
Detectors	Si diode & APD diodes
Manipulator	Motorized XYZ XY resolution 1 µm Z resolution 0.01 mm Janis cryostat

Table 1: Technical parameters of the ALICE chamber.

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