ESRF	**Experiment title:** ***XDMR IN TRANSVERSE GEOMETRY : HETERODYNE MIXING IN THE FREQUENCY DOMAIN***	**Experiment number:** **MI-851**
Beamline: **ID-12**	**Date of experiment:** from: 13-DEC-2006 to: 18-DEC-2006	**Date of report:** 23-JAN-2008
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1. HETERODYNE MIXING IN THE FREQUENCY DOMAIN

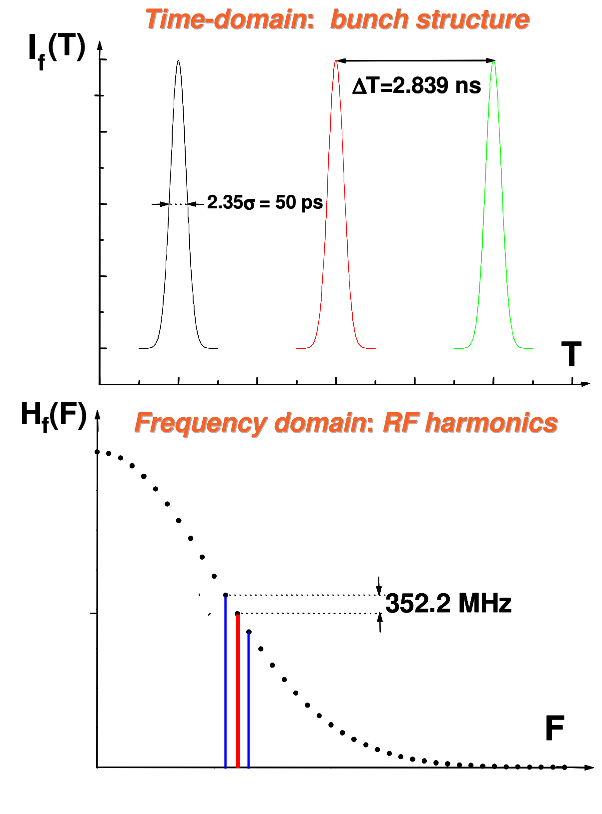
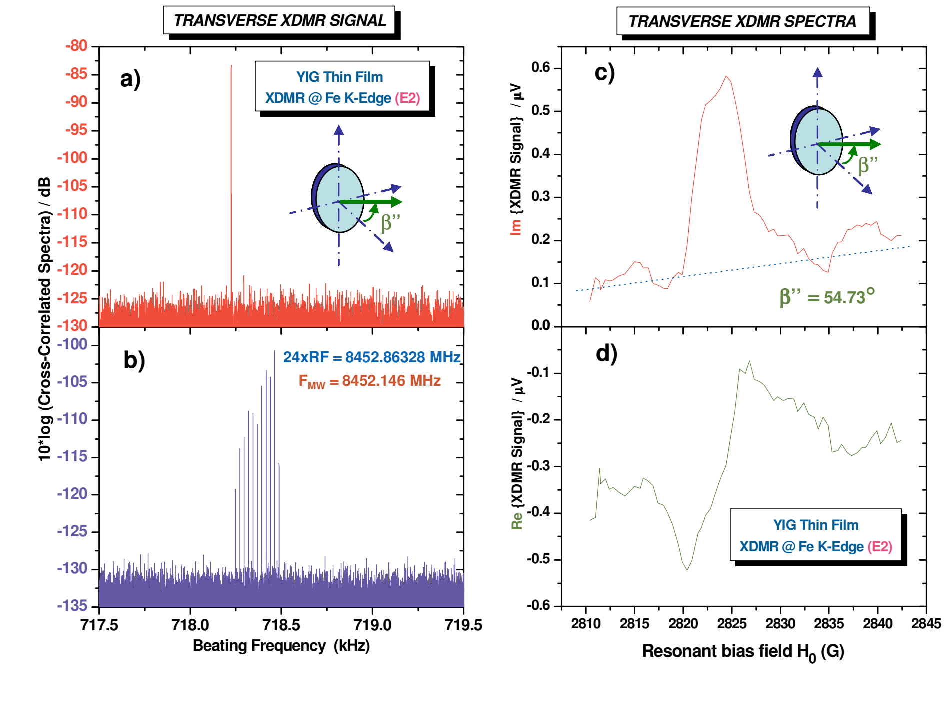


Figure 1

In the ***time domain***, the structure of the ESRF X-ray beam is known to consist of discrete bunches of *pseudo* periodicity: ΔT = 1/RF = 2.839 ns in which RF = 352.2023 MHz is the RF clock frequency of the Storage Ring. Let us assume that the X-ray bunches have a Gaussian shape, with a fwhm length of *ca.* 2.35σ = 50 ps. On Fourier Transforming the time structure of the X-ray beam, one obtains in the ***frequency domain*** a Gaussian envelope of high order RF harmonics NxRF. Note that the half-width at half maximum of this Gaussian distribution would typically correspond to : 25 x RF = 8.8 GHz, which is in the microwave X-band.

The aim of the project was to check whether one could detect the beating signature of the transverse XDMR signal with the closest harmonics of the RF frequency. Recall that the transverse XDMR signal is oscillating at some microwave frequency in the X-band (8-12 GHz). In the frequency domain, heterodyne mixing of the XDMR signal with a Local Oscillator at N x RF would result in a ***down conversion*** which should simplify considerably the detection of the XDMR signal because the IF beating signal could be detected with a low capacitance Si photodiode equipped with a transimpedance preamplifier.

2. RESULTS



Figures 2

We have reproduced in Figures (2a,2b) the Fe K-edge XDMR signals recorded in the transverse geometry with a YIG thin film rotated at the magic angle.

The heterodyne mixing detection method is shown to be very sensitive to small corrections of the RF frequency (Fig. 2b). This re-quired us to correct as well the microwave frequency in order to keep the beating frequency constant (Fig. 2a). Note the excellent dynamic range (*ca.* 45 dBV) of the XDMR signatures recorded in the transverse geometry.

Field scanned XDMR spectra associated with either Im $\{I_{XDMR}\}$ or Re $\{I_{XDMR}\}$ are also reproduced in Figures 2c,2d.

The experiments performed on beamline ID12 as part of proposal MI-851 provide us with a typical illustration of the remarkable potentiality of measurements carried out in the *Frequency Domain*. Indeed, a special instrumentation had to be developed in order to take full benefit of the heterodyne mixing method. Further improvements should concern the automatic compensation of the undesirable corrections of the RF frequency which is taken as an adjustable parameter by the Physicists of the ESRF Accelerator and Source Division. Unfortunately, we have to admit that there is a risk that such RF corrections could spoil the present determination of the phase of the precession. Further work is now in progress to recover a fully reliable phase information.

From the XDMR point of view, the unprecedented dynamic range reported here at the Fe K-edge seems to be consistent with the important point that the oscillating magnetization component M_t measured in the *transverse* geometry arises from a 1rst order perturbation, whereas the steady-state component ΔM_z measured in the *longitudinal* geometry is only 2^{nd} order. This consideration will surely stimulate further XDMR studies in the transverse geometry.

The results obtained as part of proposal MI-851 were included in a scientific article[1] published early in 2007. These results were briefly discussed at a Gordon Research Conference (X-Ray Physics 2007) and were presented at two international workshops held in 2007.

REFERENCE

[1] J. Goulon, A. Rogalev, F. Wilhelm, Ch. Goulon-Ginet and G. Goujon,
Element-selective X-ray detected magnetic resonance: a novel application of Synchrotron Radiation.
J. Synchrotron Radiation **14**, (2007), 257-271.