Synchrotron X-ray Experiments in Pulsed Magnetic Fields

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Intensive research on advanced materials has led to the discovery of new compounds with spectacular properties driven by quantum correlation effects. Studies of these materials under high magnetic fields are of fundamental importance since magnetic field finely tunes the delicate balance between different correlation effects. However, any realistic theoretical model of correlated electron system in a high magnetic field must be based on knowledge of the atomic arrangement because the different interactions strongly depend on it. The determination of the correct crystal structure at these extreme conditions is thus a prerequisite for the validation of any model of the ordered state and of the underlying interactions.
In the last four years, this context has motivated the intense development of x-ray techniques under strong pulsed magnetic fields at several places using synchrotron x-rays [1-4].

A portable set-up for pulsed magnetic fields developed at the LNCMP, Toulouse, has already been implemented on several beamlines at the ESRF. This provides fields up to 30T with a rise time of 4.5 ms. The load coil is mounted in a liquid nitrogen bath designed for x-ray scattering experiments. The sample is mounted in a separate He-flow cryostat so that the temperature of the sample can be controlled independently of the high field coil.
X-ray powder diffraction experiments have been carried out with great success on BM26 and ID20 using a stroboscopic method where an image plate detector is exposed only near the maximum of the magnetic field pulse.
Another X-ray technique has already been combined with pulsed magnetic fields using our mobile installation. Finite X-ray magnetic circular dichroism (XMCD) signal could be measured on ID24 using the CCD FReLoN (Fast Readout Low Noise) camera. This detector allows to record spectra with high enough frame rates and gives the possibility to track the evolution of the signal as a function of field strength during the pulse.

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