Pulsed magnetic field setup for temperature dependent dynamics studies

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Studies of externally excited ultrafast magnetic dynamics in condensed matter using coherent X-ray scattering techniques are subject of interest for decades. An important challenge in time-resolved magnetic studies concerns the ground-state symmetry breaking, and monitoring the recovery back through different transients. Combination of pump excitation and the possibility of probing both structural and electronic ordering in ultrafast XFEL experiments is a crucial aspect.

For these studies a pulsed magnetic field setup was designed to be employed at the Materials Imaging and Dynamics instrument (MID) at the European XFEL, based on previous version from ESRF [1]. The system has been successfully tested at beamline P09 at Petra III (figure 1). The liquid nitrogen cooled split-pair solenoid reaches a maximum field of 15 Tesla for total pulse duration of a few ms. The bunch clock of the FEL is used to synchronize a 4.5 MHz 2D detector (AGIPD), thus scattering is collected over the duration of the field pulse or offset with respect to the field. The synchronization of a single AGIPD module and B-field has also been successfully achieved at P09. The sample is cooled in an independent helium flow cryostat which is inserted into the bore of the magnet. The flow cryostat has a temperature range from ~5 to 250 K. Recently the first tests with this setup were carried out at MID with a Si(111) crystal.

Using this setup it is planned to study field-induced dynamics of the mesoscopic structure associated with the charge-density wave (CDW) that co-exists with the spin-density wave (SDW) in antiferromagnetic chromium (Cr). There has been a lot of debate about the connection between the SDW and the CDW that has a period of half the SDW and is either due to a magnetically induced lattice distortion or a purely electronic effect based on nesting of the Fermi surface [2,3].

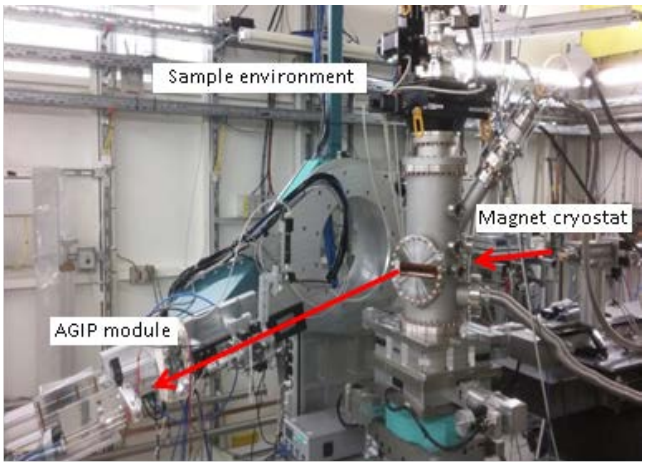

Figure 1: Experimental setup with the pulsed magnetic field apparatus mounted on a Huber diffractometer in EH2 at P09.

References

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