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MHz X-ray diffraction in diamond anvil cells at the HED Instrument

Friday 30 August 2024 11:20 (20 minutes)

The advent of the first X-ray free-electron lasers (XFELs), FLASH in 2004 and LCLS in 2009, may prove to be the most profound development since the invention of the laser and, equally, the synchrotron. Sharp improvements in a number of laser parameters, most notably intensity and pulse duration, support this expectation. This brings scientific dreams within reach. Indeed, the unprecedented opportunities and expectations have triggered considerable research activities worldwide.

In my talk, I will give an overview of the experimental application of the European XFEL, in particular to explit the unique hard x-ray capabilities together with the MHz pulse train. I will highlight MHz x-ray diffraction in diamond anvil cells for materials in extreme conditions science and laboratory astrophysics.

Since May 2019, the High Energy Density Science (HED) instrument at the European X-ray Free-Electron Laser Facility in Schenefeld, Germany, allows international users to investigate a wide range of materials and systems at extreme conditions [1]. European XFEL and the HIBEF user consortium [2] form a joint group of more than 40 people for HED research, development and user operation.
To drive a sample from ambient conditions to extreme excitations, a variety of high energy drivers are available. In particular, we have three separate optical laser systems for warm- to hot-dense-matter creation, dynamic compression and laser-plasma interaction in electron-relativistic regime. These drivers allow studying various phase space parameters with time-resolution down to 10 fs, pressures into the TPa regime, and electric field strength up to 1021 W/cm, both at surfaces and in the bulk.

The unique HED instrument allows to study these systems with precise ultrafast x-ray probes including spectroscopy, x-ray diffraction, small- and wide-angle scattering as well as phase contrast imaging methods. It is fully tuneable in the photon energy range from 5 to 25 keV at different bandwidths, can be focused to a variety of diameters.

The talk will go into further detail about the diamond anvil cell platform [3] at the HED instrument, its instrumentation and capabilities. Followed by this, I will highlight examples of MHz diffraction, and also MHz emission spectroscopy and phase contrast imaging.

[1] U. Zastrau, et al., J. Synchrotron Rad. (2021). 28, 1393-1416
[2] www.hibef.de
[3] Liermann et al., J. Synchrotron Rad. (2021). 28, 688-706

I plan to submit also conference proceedings

No

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