Diamond Anvil Cell Setup at the HED instrument of the European XFEL

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With the opening of the new High Energy Density (HED) instrument at the European XFEL [1], a new platform for studies of matter at extreme conditions will become available to first users in early 2019. One of the main tasks of the instrument is to provide novel ways of studying matter under high pressures and temperatures, warm dense matter states, and plasma physics relevant to astrophysics and planetary science.

The unprecedented brightness offered by the European XFEL at hard X-ray energies of up to 25 keV facilitates method-development utilizing diamond anvil cells (DAC). Using rapid compression and pulsed-laser heating combined with DAC technology it is possible to create extreme states of matter, which are short lived and therefore require ultrafast probes in form of short FEL X-ray pulses. The HED instrument will feature a second interaction chamber with a setup fully optimized for research using diamond anvil cells [2]. Rapid compression reaching higher pressures and greater strain rates than in conventional DAC will be realised using a piezo-driven dynamic DAC (dDAC), potentially also combined with pulsed-laser heating. Pulsed-laser heating will be used to create warm dense matter in nanosecond timescales. The X-ray repetition rate of the European XFEL of up to 4.5 MHz will then be used to characterize these extreme states by means of scattering, imaging and/or spectroscopic methods.

We will describe the current design and implementation of the experimental setup and update on the status of the HED instrument and X-ray parameters of the FEL available for this particular experimental configuration. It will be followed by a discussion on potential first user experiments and the types of science that can be addressed by these new developments.

References

[1] Nakatsutsumi et al., Technical Design Report, Scientific Instrument High Energy Density Physics (HED), 2014

[2] HP. Liermann et al., Conceptual Design Report for Diamond Anvil Setup (DAC) at the HED instrument of the European XFEL, 2016