

New perspectives for high energy density science studies using FEL light sources

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Free-electron laser facilities (FEL) enable new applications in the field of time-resolved studies. First FELs operated in the VUV regime (FLASH and FERMI), but since a few years, FELs in the hard X-ray regime are available to the general user community (LCLS, SACLA, SwissFEL, PAL-XFEL and European XFEL). With the principle of pump-probe experiments, reactions of materials can be studied with a time resolution down to femtoseconds.

One important application is in high energy density (HED) science, since the short pulsed nature and the high intensity of the FEL allows to probe snapshots of highly excited, extremely short lived states of the material. At LCLS and SACLA and soon also at European XFEL, high power optical lasers are installed at dedicated beamlines which allow to drive samples to extreme states of matter. X-ray techniques to study the samples at extreme pressures and temperatures include spectroscopy and imaging methods as well as diffraction. The short lived nature of the samples imposes new challenges on instrumentation and synchronization.

In this contribution, we present state-of-the-art techniques for HED science studies using FELs showing recent examples. On top of that, we will outline plans for the HED science instrument at European XFEL. This instrument is dedicated to HED studies and will become open to users early 2019.