High Energy Density Physics with Petawatt class Laser at GSI-Darmstadt

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The Helmholtzzentrum for Heavy Ion Research GSI in Darmstadt, Germany operates a worldwide unique large-scale accelerator facility for heavy ions. The best-known results are the discovery of six new chemical elements and the development of a new type of tumor therapy using ion beams. Together with Nuclear physics, Atomic physic, Biophysics and Material research, Plasma physics with intense heavy ion and laser beams is one of the important research pillows. The future Facility for Antiproton and Ion Research (FAIR), one of the largest research projects worldwide, will provide an unprecedented variety of experimental possibilities for all research directions including High Energy Density Physics.

Nowadays, high energy density plasma physics at GSI is strongly profiting from the unique combination of the Petawatt class laser and heavy ion beams, which can be delivered well synchronized to the target area. The Petawatt High-Energy Laser System for Ion beam eXperiments – “PHELIX”, flash lamp-pumped Nd:glass system, is constructed in close cooperation with Lawrence Livermore National Laboratory and the Commissariat à l'Energie Atomique to explore various fields of science mostly related to plasma physics and atomic physics.

In the talk, most important investigations, employing nanosecond and femtosecond frontends of PHELIX-laser system will be reported.

Experiments with fs-laser pulse duration providing relativistic laser intensities are aimed on creation and investigation of warm dense matter states, obtained via isochoric heating of solid targets by laser generated electron beams and optimization of novel laser based sources of energetic photons and particles for further diagnostic applications at FAIR.

The worldwide unique combination of the PHELIX laser beam and heavy ion beam from the UNILAC accelerator allow investigating crucial for ICF problem of the ion energy loss in dense plasmas. Both ion stopping range shortening and its increase compared to non-ionized cold matter are possible depending on plasma parameters.