

STATUS OF HIGH ENERGY DENSITY PHYSICS AT GSI

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GSI

Knowledge of basic physical properties of matter under extreme conditions of high energy density such as equation-of-state, static and dynamic electrical conductivity, stopping power and opacity is of fundamental importance for various branches of basic and applied physics. Intense beams of energetic heavy ions provide a unique capability for the HEDP research compared to traditional drivers. Using intense ion beams, one can heat macroscopic volumes of matter fairly uniformly and generate this way high-density and high-entropy states. This new approach permits to explore areas of the phase diagram that are difficult to access by other means.

Proton microscopy is a novel technique for probing the interior of thick and dense (up to 20-50 g/cm²) high-Z objects in dynamic experiments by mono-energetic beams of GeV-energy protons, and allows for determination of target areal density with sub-percent accuracy. High energy proton microscopy can provide the spatial resolution of a few micrometers over a centimeter-wide field of view with time resolution on the nanosecond scale, and therefore it is seen as a key diagnostics for the HEDP experiments at FAIR. For this purpose, a new Proton Microscope for FAIR (PRIOR) project has been started aiming to design and construct the FAIR proton microscope and to commission it in full-scale dynamic experiments at GSI using a 4.5 GeV proton beam from the existing SIS-18 synchrotron. Prior to FAIR, a worldwide unique radiographic facility may become operational at GSI that would be of a considerable interest for high energy density physics and for other research fields.

In this report we discuss various physics and technical issues of the high-energy-density physics (HEDP) research with intense heavy ion, proton and laser beams that is being performed at GSI, as well as that is to be carried out at the future Facility for Antiproton and Ion Research (FAIR) in Darmstadt. The main highlights of plasma physics and HEDP research at GSI in 2009 as well as scientific plans for the following years are addressed.