STATUS OF HIGH ENERGY DENSITY PHYSICS AT GSI

Serban Udrea

GSI, Germany

The study of physical properties such as equation-of-state, static and dynamic electrical conductivity, stopping power and opacity of matter under extreme conditions of high energy density is highly significant to 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. Intense ion beams can heat macroscopic volumes of matter fairly uniformly and generate high-density and high-entropy states. This 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, which allows for the determination of the 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 HEDP experiments. For this purpose, the PRIOR project has been started at GSI aiming to design and construct a proton microscope for full-scale dynamic experiments using 4.5 GeV proton beams delivered by the SIS-18 synchrotron. A worldwide unique radiographic facility will thus become operational at GSI and at the future Facility for Antiproton and Ion Research (FAIR), that would be of a considerable interest for high energy density physics and other research fields.

In this report we discuss various issues of the high-energy-density physics (HEDP) research with intense heavy ion, proton and laser beams performed at GSI, as well as that is to be carried out at FAIR. The main highlights of plasma physics and HEDP research at GSI in 2010 as well as scientific plans for the following years are addressed.