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Development of Poly- and Monochromatic X-Ray Imaging Techniques for Phase-0 and FAIR

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Intense uranium ion beams that will be available after commissioning of the new synchrotron SIS100 in Darmstadt will be used for volumetric heating of any type of material and generation of extreme states of matter with Mbar pressures and some eV of temperature. Investigation of their EOS is one of the main goals of the plasma physics program at FAIR. Diagnostic of such extreme states of matter demands development of new diagnostic methods and instruments, which are capable to operate in an environment with a high level of radiation damage. The precise knowledge of the energy density distribution of the U-beam on the target is a very important input parameter for numerical simulations of the hydrodynamic response of the target on deposited energy. Simulations are crucial during the planning of experiments and for the interpretation of obtained experimental data. To investigate the energy density distribution, we propose to use the target and heavy ion beam X-ray fluorescence for imaging of the target expansion and mapping of the heavy ion beam distribution in the interaction region with a high spatial resolution of at least 100 μm. First pilot experiments on measurements and characterisation of the heavy ion and target fluorescence using pinholes, X-ray CdTe-diodes and dispersive systems have been carried out in 2016 and 2019 at the UNILAC Z6 experimental area in collaboration with the Plasma Physics Group of GSI, Darmstadt, the Institute for Optics and Quantumelectronics of the Friedrich-Schiller_University, Jena and the Institute for Theoretical and Experimental Physics, Moscow. The obtained results can be scaled to high heavy ion energies available at SIS18 and SIS100.

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