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Creating and probing dense plasmas at PALS/ELI-Beamlines facilities: applicability to plasma physics program at FAIR

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Various advanced, efficient and unconventional combinations of the high-power laser beams are available at the PALS facility and being under construction at the ELI Beamlines, delivering a radi-ant energy in short and ultra-short pulses under various geometries and with adjustable timing [1,2]. In addition to that, the near-infrared lasers can pump the XUV/x-ray lasers, other sources of ener-getic photons (Kα sources, betatron-like sources, high-order harmonics, and so on) and produce and further accelerate energetic charged particles, i.e., electrons, protons and other ions. All the primary and secondary sources are intended to be combined to investigate dense plasmas, both hot dense matter (HDM) and warm dense matter (WDM), relevant to various problems of high-energy-density physics, esp. in the area of inertial fusion and astrophysics. The conventional approaches and stand-ard infrastructures of plasma physics and technology do not routinely enable to generate and diag-nose very dense plasmas. Contrary to that, the high-power focused laser beams (and secondary sources driven by them) are able to generate and diagnose plasma with a high electron density under well-defined experimental conditions. Especially short-wavelength (XUV/x-ray) lasers are proven to perform the volumetric heating of solids forming the plasma with an electron density comparable to an electron density in the solid state (see for example refs [3,4]). The intense XUV/x-ray radiation can also be utilized to visualize and diagnose such plasmas. Both approached benefit from the strong dependence of the plasma critical density on the wavelength of electromagnetic radiation. The completion and implementation of the multiple-source and multiple-beam infrastructure of PALS (see for example refs [1,3]) and ELI Beamlines (an overview is given in ref. [2]) will enable to combine all the above-mentioned beams and sources to a well-defined dense plasma generation and an accurate and reliable determination of its characteristics on a wide variety of conditions and properties. The combination of short and ultra-short pulses of laser systems available at PALS and ELI Beamlines makes it possible to study the formation and evolution of dense plasmas on various time scales. This gives us unique opportunity to participate in solving the major problems of inertial confinement fusion, astrophysics, planetology and related disciplines. We are going to compare our plans with projects intended to be focused on very dense plasmas at FAIR to identify areas of com-mon interest and trigger prospective collaborations.

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