High pressure physics in a repetitive regime at ELI-Beamlines

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Interaction of high-energy and high-power lasers with matter can generate strong shocks leading to extreme pressure and temperature conditions. While static compressions are limited to pressures of the order of 1 Mbar owing the mechanical properties of diamond anvil cells, dynamic laser-shock induced compressions give access to a much wider (*P, T*) diagram. The study of these extreme states is of high interest in many fields such as fundamental physics or material science, and also in applications to Inertial Confinement Fusion or planetology for modelling planets core interiors. Furthermore, in these extreme conditions, Equations of States (EoS), opacities, phase transitions and transport properties are strongly modified, therefore precise experimental measurements are strongly needed.

ELI-Beamlines will soon become one of the most powerful laser facilities in the world. Its experimental P3 platform for plasma physics shown in Figure 1 is expected to be particularly promising for high energy density experiments. Synchronized multiple beams (up to four) configurations will also be feasible in this P3 platform, allowing for complex experiments [1].

Of particular interest for high pressure physics is the nanosecond high-energy beam "L4n" (1.9 kJ, 0.5 – 10 ns, $\lambda = 1053$ nm). This nanosecond pulse will operate at a high repetition rate, providing up to five-six shots an hour or more. This unique repetitive feature is of strong interest for material studies as current high-energy facilities can generally provide up to one or two shots in the same time frame. The repetitive operation will thus permit to achieve significant progress by: (i) providing access to the states far from the Hugoniot adiabat; (ii) considerably decreasing the statistical error of collected data sets and (iii) improving the characterization of phase transition, as the current experiments are sometimes lacking unambiguous interpretations [2]. An overview of the first L4n experiment dedicated to EoS measurements will also be presented.

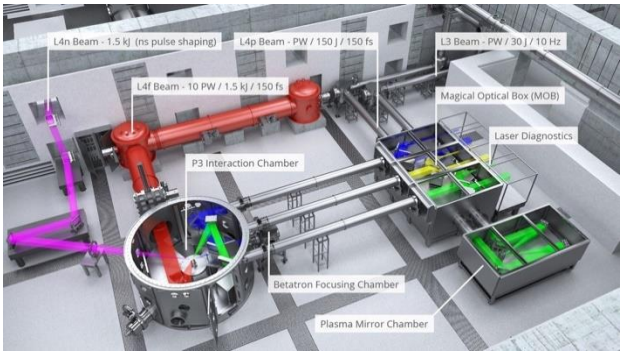

Figure 1. Experimental hall E3 at ELI-Beamlines where multiple beams experiments will be carried out.

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