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Review Article

P3: An installation for high-energy density plasma physics and ultra-high intensity laser–matter interaction at ELI-Beamlines

S. Weber*, S. Bechet, S. Borneis, L. Brabec, M. Bučka, E. Chacon-Golcher, M. Ciappina, M. DeMarco, A. Fajstavr, K. Falk, E.-R. Garcia, J. Grosz, Y.-J. Gu, J.-C. Hernandez, M. Holec, P. Janečka, M. Jantač, M. Jirka, H. Kadlecova, D. Khikhlukha, O. Klimo, G. Korn, D. Kramer, D. Kumar, T. Lastovička, P. Lutoslawski, L. Morejon, V. Olšovcová, M. Rajdl, O. Renner, B. Rus, S. Singh, M. Šmid, M. Sokol, R. Versaci, R. Vrána, M. Vranic, J. Vyskočil, A. Wolf, Q. Yu

ELI-Beamlines, Institute of Physics, Academy of Sciences of the Czech Republic, 18221 Prague, Czech Republic

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Abstract

ELI-Beamlines (ELI-BL), one of the three pillars of the Extreme Light Infrastructure endeavour, will be in a unique position to perform research in high-energy-density-physics (HEDP), plasma physics and ultra-high intensity (UHI) ($>10^{22}\mathrm{W/cm^2}$) laser–plasma interaction. Recently the need for HED laboratory physics was identified and the P3 (plasma physics platform) installation under construction in ELI-BL will be an answer. The ELI-BL 10 PW laser makes possible fundamental research topics from high-field physics to new extreme states of matter such as radiation-dominated ones, high-pressure quantum ones, warm dense matter (WDM) and ultra-relativistic plasmas. HEDP is of fundamental importance for research in the field of laboratory astrophysics and inertial confinement fusion (ICF). Reaching such extreme states of matter now and in the future will depend on the use of plasma optics for amplifying and focusing laser pulses. This article will present the relevant technological infrastructure being built in ELI-BL for HEDP and UHI, and gives a brief overview of some research under way in the field of UHI, laboratory astrophysics, ICF, WDM, and plasma optics.

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1. Introduction

Ever since the invention of the laser there has been a constant push for ever higher power-levels and correspondingly higher intensities of the focused pulse. Since the invention of chirped-pulse-amplification (CPA), the power available has increased many orders of magnitude [1–3]. In parallel the scientific demand for multiple, synchronized laser beam in the same interaction chamber has increased in order to be able to perform sophisticated pump-probe experiments. In this context ELI (Extreme Light Infrastructure) is the latest large-scale effort in Europe to push for new, state-of-the-art, high repetition rate laser systems. ELI is part of the European ESFRI (European Strategy Forum on Research Infrastructures) roadmap. ELI is expected to be the first worldwide laser facility to provide an unprecedented power-level of 10 Petawatt. These new laser

* Corresponding author.
E-mail address: stefan.weber@eli-beams.eu (S. Weber).
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