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Active stabilization in high-power laser plasma accelerators

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Owing to strong 10-100 GV/m accelerator gradients, Laser Plasma Accelerators (LPAs) have the capability to generate high-brightness and high-energy electron beams in compact facilities. The (sub)PW laser systems that drive LPAs are currently operating at 1-10 Hz repetition rates, while the next generation of multi-kHz technologies are being aggressively pursued at various R&D facilities worldwide. The robustness and stability of LPAs can largely be traced back to the laser performance. Fluctuations in laser pointing and other laser parameters directly translate to variations in electron beam parameters. Here we present results from recent techniques that mitigate laser fluctuations in a two-fold approach: (1) develop on-line and non-perturbative high-power laser diagnostics, both for the high-power laser as well as for a correlated background laser [1], and (2) implementation of active feedback systems to stabilize the high-power laser. Experimental results [2] show that through execution of these efforts at the BELLA Center LPA facilities, we have made significant improvements to the LPA electron beam and light source stability.

Footnotes

[1] F. Isono et al, High Power Laser Sci. Eng. 9, e24 (2021),
[2] C. Berger et al, Phys. Rev. AB 26, 032801 (2023)

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