Contribution ID: **79** Type: **not specified**

Hybrid Electron Acceleration in Plasma-Based Accelerators

Wednesday 28 January 2026 15:30 (15 minutes)

Direct laser acceleration (DLA) is a leading mechanism of generating high-energy electron beams in underdense plasma with high total charge. Multi-petawatt facilities enable acceleration of hundreds of nC to energies of several GeV. In this study we employ 3PW laser pulses to explore how varying the laser pulse duration influences the interplay between DLA and Laser wakefield acceleration (LWFA). By systematically adjusting the laser pulse duration, we investigate its effects on the properties of the accelerated electrons. Our research reveals that as the pulse duration becomes comparable to the plasma wavelength, a unique regime emerges where both DLA and LWFA can accelerate electrons simultaneously. In this hybrid regime, the interaction between the laser and plasma enables more effective injection and acceleration of electrons, resulting in higher energy gain and improved beam quality. We demonstrate the importance of laser pulse duration for controlling the acceleration process within the advanced laser-driven electron sources.

Field of Research/Work

Plasma and Solar Physics, Accelerators and Beams

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