

P2.2009 Self-modulated laser wakefield acceleration driven by CO₂ laser in hydrogen plasma

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See the full abstract here:

<http://ocs.ciemat.es/EPS2019ABS/pdf/P2.2009.pdf>

Developments in CO₂ laser technology at BNL Accelerator Test Facility (ATF) has opened the possibility of exploring CO₂ laser driven wakes, a regime capable of producing large accelerating structures, enabling better probing of wakes and precise external injection. 3D numerical simulations motivated by laser wakefield accelerator experiment AE71 being conducted at the BNL ATF are presented. Parallel relativistic Particle-in-Cell code SPACE has been used in these studies. SPACE implements novel atomic physics algorithms to resolve ionization, recombination and other atomic physics transformations on the grid and transfer them to particles [1, 2, 3]. Simulations investigate the interaction of a powerful CO₂ laser with hydrogen jets and the characteristics of induced wakes in the self-modulated regime at previously inaccessible densities ($\sim 10^{17} - 10^{18} \text{cm}^{-3}$). Simulations show that the front portion of the long ($\sim \text{ps}$) CO₂ laser undergoes self-modulation instability and the rear portion self-channels when the ionization model with mobile ions is used. Growth rate of self-modulation instability has been characterized for several gas number densities. Effects of variation in laser energy and focus position on the intensity of Stokes and anti-Stokes waves have been studied and compared with experimental results. Simulations show that the highest intensity sideband signals are observed when the laser is focused close to the beginning of the jet. Multi-mode laser beams have been utilized to mimic the experimental laser imperfections and comparisons with perfectly Gaussian beams have been presented. In addition, self-injection and trapping of electrons into the self-modulated wakes has been observed and analyzed. Simulations have shown accelerated electron bunches with total charge on pC-scale having multi-MeV peak energies.

References

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