



Contribution ID: 204

Type: talk

Multi-GeV electron acceleration from self-guided laser wakefield accelerators with extended focussing geometry

Monday, 25 September 2017 18:18 (18 minutes)

Recent experimental electron acceleration results in the self-guiding, self-injecting regime from the 250 TW Gemini laser are presented. Employing an extended $f/40$ focussing geometry instead of an $f/20$ resulted in maximum single stage energy gains of up to 2.5 GeV, a more than twofold increase. The generated electron beams carry hundreds of millijoules of energy, with more than 50 % of the total beam energy in electrons with energies beyond 1 GeV. Three-dimensional particle-in-cell simulations revealed the differing dynamics of self-focussing in the extended focal geometry. Smoother transverse self-focussing provides stable self-injection into the wake in a phase with extremely high accelerating fields, resulting in enhanced acceleration in a quasi-stable ion cavity.

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Session Classification: WG1_Parallel

Track Classification: WG1 - Electron Beams from Plasmas