



Contribution ID: 184

Type: talk

Experiments to observe multi-pulse laser wakefield acceleration

Tuesday, September 15, 2015 4:10 PM (20 minutes)

In multiple-pulse laser wakefield acceleration (MP-LWFA), a train of laser pulses spaced by the plasma period is used to drive a plasma wave, rather than the single pulse used in most experiments. Driving wakefields with a train of low-energy pulses has several advantages: laser-driven plasma accelerators can exploit new laser technologies which cannot deliver high-energy pulses, but which can provide ultrafast, few-mJ pulses at kHz repetition rates with high wall-plug efficiency; in principle the properties of each pulse in the train can be tuned to optimize the wake amplitude; the reduced peak intensity of each pulse could allow the use of smaller optical components; and the architecture naturally lends itself to recovery of energy left in the wakefield by a second pulse train separated from the first by an odd number of half plasma periods.

We report progress on the first experiments to observe MP-LWFA, using the Astra laser at the Rutherford Appleton Laboratory. The experiments employ frequency-domain holography to measure the wake amplitude as a function of the properties of the pulse train and target plasma, enabling studies of the effects of detuning from resonance and of ion motion.

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Session Classification: WG1 - Electron beams from plasmas

Track Classification: WG1 - Electron beams from plasmas