Contribution ID: **208** Type: **talk**

A novel ultra-high gradient travelling wave ion accelerator driven by intense lasers

Wednesday, 16 September 2015 18:00 (25 minutes)

The key to the growing interest in laser based ion accelerators lies in their cost effectiveness and compactness, which,coupled to ongoing technological developments, makes the prospects for all-optical accelerators very promising and appealing. Among various shortcomings to overcome, the challenge is to produce a high energy pencil beam of narrow band spectrum.
High power lasers are capable of generating kiloampere current pulses with unprecedented short duration. The large electric field from such localised charge pulses can be harnessed in a travelling wave particle accelerator arrangement. By directing the ultra-short charge pulse along a helical path surrounding a laser-accelerated ion beams, one can achieve simultaneous beam shaping and re-acceleration of a selected portion of the beam by the components of the associated electric field within the helix. Here we show the core concept of the novel scheme in a proof-of-principle experiment using a200TW university scale laser, achieving almost 100% reduction of beam divergence in a narrow energy bandwidth and post-acceleration of ~10^8 protons by ~5MeV over less than a cm of propagation–i.e. an accelerating gradient ~0.5GeV/m which is already beyond what can be sustained by conventional accelerator technologies.

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Session Classification: WG2 - Ion beams from plasmas

Track Classification: WG2 - Ion beams from plasmas