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P2.2007 All-optical staged acceleration of proton beams using helical coils

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All-optical approaches to ion acceleration are attracting a significant research effort internationally. Energetic ion beams can be readily generated by high intensity lasers via the target normal sheath acceleration (TNSA) process [1]. While the ion energies of such beams remain constrained by available laser intensities and limitations related to target fabrication, methods of post-accelerating the TNSA ions have lately gained significant interest. In 2016, a concept channelling the extremely high electromagnetic pulse emanating from a laser irradiated target along a miniature helical coil was demonstrated capable of post-accelerating TNSA ions from the same initial laser interaction [2]. Furthermore, synchronous propagation of the electromagnetic pulse and the protons within the helical coil reduces beam divergence during acceleration providing a collimated, narrow energy band of protons suitable for applications. Recent experiments have demonstrated pencil beams up to 50 MeV by deploying helical coil targets at petawatt-class lasers [3]. In a proof-of-principle experiment, we are currently investigating the possibility of staging helical coil modules at the Vulcan Laser of the Central Laser Facility located in the United Kingdom. The experiment employs a dual beam laser configuration and a two-stage target geometry, where each beam interacts with a separate helix target. This arrangement allows the second helix's effect on the proton beam, produced by the first helix, to be studied through varying the time delay between the two laser beams. Results from this experiment will be presented with supporting particle tracing simulations.

[1] M. Borghesi, 2014, Laser-driven ion acceleration: State of the art and emerging mechanisms, Nuclear Instruments and Methods in Physics Research A
[2] S. Kar et al, 2016, Guided post-acceleration of laser-driven ions by a miniature modular structure, Nature Communications
[3] H. Hamad, S. Kar et al, to be submitted 2019, Quasi-monoenergetic pencil beam up to 50 MeV employing laser-driven helical coil

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