

## Proton beam optimization by innovative target schemes

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All-optical approaches to particle acceleration are currently attracting a significant research effort internationally. A recently developed concept of a versatile, miniature linear accelerating module to achieve simultaneous focusing, energy selection and post-acceleration of the proton beams will be discussed. In a proof-of-principle experiment on a 200 TW university-scale laser, we demonstrated post-acceleration of  $\sim 10^8$  protons by  $\sim 5$  MeV over less than a cm of propagation –i.e. an accelerating gradient of  $\sim 0.5$  GeV/m, already beyond what can be sustained by conventional accelerator technologies, with dynamic beam collimation and energy selection. Employing this technique recently at the Vulcan Petawatt, UK and Titan laser, LLNL, USA, produced narrow band pencil beams of up to 50 MeV, where preliminary analysis indicates a fast scaling of the post-acceleration gradient with laser power. Due to the possibility of deploying this modular device in a multi-stage scenario, these results open up new opportunities for the development of extremely compact and cost-effective ion accelerators for both established and innovative applications.

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