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Laser Acceleration of Protons in Hydrogen Gas Targets using 2 TW laser

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In this study, the acceleration of proton beams from gas targets, formed by converging shock nozzles and utilising a 1 Hz laser with limited pulse energy, has been demonstrated.

Energetic ion beams are routinely generated in laser-driven ion acceleration experiments in PW-class laser-foil experiments but are limited by slow repetition rate of these laser systems. New opportunities of developing more compact ion sources are offered by emerging multi-terawatt high-repetition rate lasers and utilisation of liquid leaf targets. However, there is still a demand for easy-to-handle and debris-free laser-driven ion acceleration. Therefore, high density gas targets have attracted great attention in recent years.

The proton acceleration experiments were performed using a few-cycle 12 fs SEA laser at ELI-ALPS with 8 mJ of pulse energy focused at a spot of 2.9 µm x 2.1 µm FWHM on the target. The high-density region of the 9×10^19 cm^-3 hydrogen gas target was formed by intersecting shock waves of a supersonic nozzle manufactured using hybrid 3D laser machining technology from fused silica. 4 x10^5 protons per 1000 shots, with an energy of tens keV were registered on CR-39 plates, within the angle of 70 degrees in the propagation direction of the laser beam.

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