Proton acceleration from a solid hydrogen cryogenic target

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The interaction of a high power laser and a pure hydrogen target has advantages from the experimental point of view in terms of plasma characterization, as well as for a potentially use at high repetition rates since such target is essentially debris free.

A cryogenic hydrogen ribbon (75-100 μm thick) was irradiated with the VULCAN-PW laser (0.6 kJ/1 ps) at the RAL facility. High current proton beams with energies exceeding 50 MeV were accelerated into both directions (forward and backward with respect to the incoming laser beam). The energy coupling into energetic protons was higher than standard plastic foils. This is linked to the laser absorption along the overall target thickness, which is strongly enhanced as confirmed by particle-in-cell simulations. Furthermore, quasi-monoenergetic features in the proton beam energy distribution (around 55 MeV) was shown experimentally.

Such results are very promising for future multidisciplinary applications of laser driven proton beams, e.g. hadrontherapy, both due to high energy and high charge of the proton beam, as well as technological advantages coming from the debris free nature of the used target.