Optical probing during an experiment on proton acceleration from a cryogenic hydrogen ribbon

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Multidisciplinary applications of laser-driven ion beams, especially medical ones, have strict requirements for ion beam parameters. Some of them can be achieved by using a specially tailored target. In particular, pure proton beams (without contaminants) can be produced from cryogenic solid-hydrogen targets which could be capable of both refreshable and debris free operation at high repetition rate making this target ideal for laser-based protontherapy.

This contribution reports acceleration of protons from relatively thin (75 and 100 μm) solid-hydrogen ribbon employing the petawatt arm of the VULCAN laser at Rutherford Appleton Laboratory with emphasis given on optical probing of the unstable ribbon target. Firstly, optical probing was used for characterizing the ribbon itself, and the laser focus position with respect to the target front surface. Obtained data are directly correlated with the energy of forward accelerated ions measured with radiochromic films and Thomson parabola ion spectrometer. In addition, the electron density distributions of hydrogen plasma are presented after being retrieved from interferometry snapshots taken with various delays with respect to the arrival of the main laser pulse.

Monoenergetic features observed in the energy spectra measured with Thomson parabola ion spectrometer and radiochromic films stack will be also presented and compared with supporting PIC simulations with aim to explain the features origin.