Generation of fast protons by interaction of modest laser intensities with H_2O "snow" nano-wire targets

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We report on experimental demonstration of fast protons (> 6 MeV) generated by the interaction of modest laser intensities (~10^{17} W/cm^2) with micro-structured H2O (snow nano-wire) targets. The ability to generate fast proton from small and relatively inexpensive systems is of great importance to many applications such as medical radiation treatments and others. The presented scheme of using snow nano-wires can relieve the demand for very high laser intensities, thus reducing the size and the cost of laser system.

Usually ultra high intensity laser beams produce protons above the MeV energy level when the intensity is at least 10^{18} – 10^{19} W/cm^2 and the beam irradiates targets such as thin-foils or gas jets. In this study, we examined the ability to achieve the same proton energy range with use of relatively modest laser intensity (~10^{17} W/cm^2) and a micro-structured H_2O target. Recently we have demonstrated a very efficient coupling of laser energy to frozen H_2O deposited on a Sapphire substrate [1] and the generation of 0.1 MeV multi-charged Oxygen ions measured using X-ray emission spectra [2]. For the present experiments, we used a frozen H_2O deposited on Sapphire, which were shaped as a nanometer sized elongated wires with characteristic diameter in the range of 0.01-0.1μm and length of several μm. The almost full absorption of laser radiation (>95%) and large total surface of the sponge-like H_2O target provided effective proton acceleration of both proton energy and proton yield.

We recorded protons with energies of at least 6 MeV. These were measured using CR39 stacks with various filters of different stopping powers. The protons were accelerated backward mainly along the target normal direction. We are planning to extend our study to much higher laser intensity in order to scale the proton energies to tens of MeVs.

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