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Two bunch proton acceleration from intense laser solid interaction

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The acceleration of high energy ion beams up to several tens of MeV from the interaction of an ultra-short, intense laser pulse with solid targets is one of the leading fields of research in recent years owing to its vast applications including laser-based hadron therapy, fast-ignition scheme of laser induced fusion experiments, etc. Mechanisms leading to forward-accelerated, high quality ion beams, operating at currently accessible laser intensities (up to 10^{21} W/cm^2) in laser-matter interactions are mainly associated with large electric fields set up at the target rear interface by the laser-accelerated electrons leaving the target. The emitted ion pulses, and in particular, the proton pulses contain a large number of particles (up to 10^{13}) with energies in excess of several MeV, having a pulse duration ~ ps, and a source size of tens to hundreds of μm [1-3].

In this study, we report experimental observations of MeV protons from an intense laser pulse-solid interaction. A laser pulse of peak intensity 3×10^{20}Wcm^{-2} interacting with 2μm thick solid targets (Al, Ti and Au) leading to acceleration of protons up to 18MeV via TNSA mechanism is observed. A ring structure on top of typical TNSA imprint of protons is observed on the RCF diagnostic at lower proton energies with all the three targets. The observed ring structure is attributed to protons that originate from the front surface of the target which are deflected by huge magnetic fields generated inside the target. EPOCH 2D simulations are also performed to qualitatively account for the experimental observations.

References

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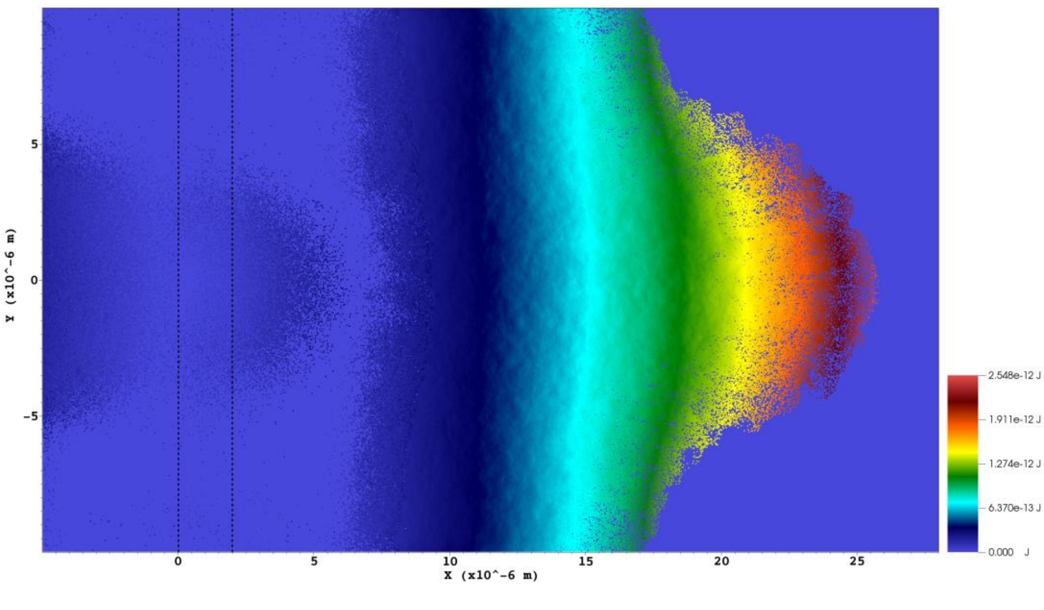

Fig1. The distribution of protons with respect to their energy. The dotted lines indicate the position of the front and rear surface of the target. The proton distribution showing a prominent bunch with typical TNSA distribution and a secondary proton bunch with lower energy originated at the front surface, moving out of the rear surface.