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Measurement of MeV-energy ions accelerated via magnetic reconnection driven by dual ps high-intensity laser incidence.

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Recently magnetic reconnection attaches large attention because of the possibility to effectively accelerate charge particles in space plasmas. In our experiment on laser driven magnetic reconnection two co-propagating in parallel laser beams from LFEX (240 J, 1.5 ps) separated by a distance of 50 µm are incident obliquely on a low-density foam target. We have observed 14 MeV protons accelerated toward the laser propagation direction, which is different from TNSA. In the presentation experimental results will be compared with 2-D PIC simulation.

1. Introduction

Ion acceleration, driven by relativistic intensity laser pulses recently attaches large attention due to large varieties of different application. High energy ions could be applied for proton cancer therapy, neutron production, proton radiography and deflectometry, and many other purposes. The most common laser driven acceleration technology is so called target normal sheath acceleration (TNSA). During this process ions are accelerated by the strong electric field, established between ions on the rear side of the target and electrons, accelerated by the laser and attempt to escape to vacuum. Accelerating electric field strength is ~10 MV/cm and acceleration length is only several micrometers.

Latest computer simulation [1] on laser driven fast magnetic field reconnection using two co-propagating relativistic intensity laser beams demonstrate significant growth of the electric field in a region between two after magnetic field annihilation. This field exceeds 60 MV/cm and has length about 20 um. Computer simulation also shows efficient electron acceleration by this field in backward direction. In our work we will investigate the possibility of the same electric field to accelerate ions forward.

2. Experimental setup

Magnetic reconnection experiments were performed using two beams LFEX laser in Osaka University [2]. Two laser beams (~240 J on target, 1.5 ps) were separated on 50 µm distance and has an oblique incidence on low density (30 mg/cc) thick (~140 µm) CD foam target. Obtained ion beam energy and spatial distribution were investigated by using Thompson parabola (TP) and radio cromic film (RCF).

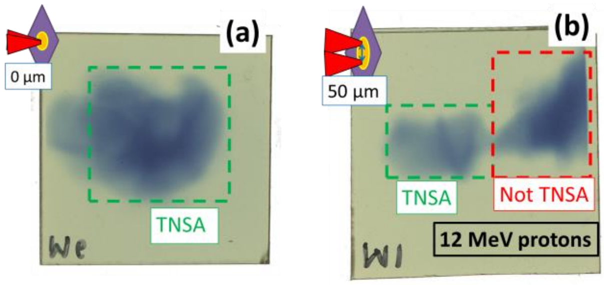

Fig. 1 Spatial ion distribution, obtained with RCF detector for (a) two laser beams focused in one spot and (b) two laser beams separated in vertical plane.

3. Results

Fig. 1 demonstrates results, obtained with RCF detector for different laser configuration. Fig. 1 (b) shows significant shift of the ion distribution in laser propagation direction after separation of two laser beams. This acceleration mechanism is clearly different from TNSA where ions are accelerated normal to the rear side of the target. Results from TP placed on laser axes also show proton energy increasing after beam separation. This could be the evidences of protons acceleration from the magnetic field annihilation region.

In the presentation, we will discuss the result of the experiments in more detail.

Acknowledgments

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Reference

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