WeS1-4.

High energy ion generation via magnetic vortex acceleration

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Laser ion acceleration has caught significant attentions due to its various applications such as medical applications, ion beam fast ignition, and proton radiography. For medical applications, laser ion acceleration is expected to realize a compact and reliable ions source for the cancer therapy. One of the critical issues on laser-driven ion source is the enhancement of laser-accelerated ion energy, where protons with maximum energy of 200 MeV are requested from the medical point of view. The mechanism known as a target normal sheath acceleration (TNSA) has been widely investigated theoretically and experimentally, and it is shown that a relatively high power laser such as PW-class laser is needed for generating 200 MeV protons. Recently, high energy ions are observed from gas-cluster targets with relatively small laser energy [1], where 20 MeV/u ions are generated by using 4 TW laser pulse. We consider that these high energy ions, the energy of which is roughly one order higher than the TNSA energy scaling, are generated via formation and evolutions of magnetic dipole vortex [2]. In this paper, we investigate a detail of the ion acceleration via magnetic dipole vortex and derive an ion energy scaling. By the propagation of an intense laser pulse thorough underdense plasma, a dipole vortex is induced when the laser energy is almost depleted. In Fig.1(a), an ion distribution is plotted when a magnetic dipole vortex is formed. Electrons and resultant ions are pushed outward from the vortex, forming an ion shell around the vortex and wall along the vortex axis. Electron, ion and electric field distributions along the axis are plotted in Fig.1(b). The ion distribution has a sharp spike and electrons are located in front of it, which results in generation of strong electro-static field. This structure moves to the right together with expanding dipole vortex. This leads to an ion acceleration by moving electric field. We modeled the magnetic dipole acceleration and obtained energy scaling, which predicts that a 100 TW laser can generate 200 MeV protons by magnetic dipole acceleration.

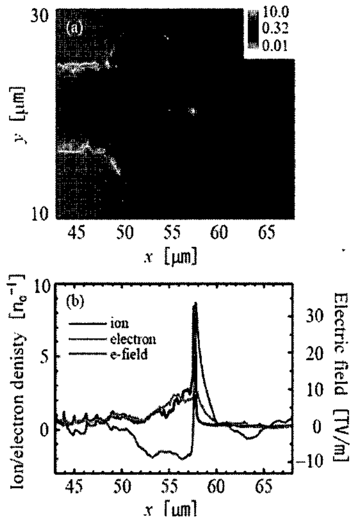

Fig.1 (a) Ion density distribution around the magnetic dipole vortex. (b) Distributions of ion, electron and electric field along vortex axis

References

[1] Y.Fukuda,et al., Phys.Rev.Lett.130,165002 (2009).
[2] S.V.Bulanov, et al.,Plasma Phys. Rep. 31, 369 (2005).

WeS1-5.

Hollow microspheres – A novel target for staged laser-driven proton acceleration

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Laser-driven proton acceleration generates particle beams with interesting properties such as multi MeV energies and a very low longitudinal and transverse emittance. Its potential future applications range from proton imaging to proton cancer treatment and fast ignition in inertial confinement fusion.