Energy loss of laser-accelerated ions in dense ionized matter

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Synopsis Knowledge about the energy loss of heavy ion in dense ionized matter is of great importance in fields such as inertial confinement fusion, fast ignition as well as intense heavy ion beam driven high energy density physics. The energy loss of 3.4 MeV proton in TAC foam plasma was measured on the XGIII laser facility. It was found that the measured energy loss is far above the Beth prediction.

Ion stopping in dense ionized matter is the basic process in inertial confinement fusion and fast ignition. The precise knowledge about the stopping power is of great importance, since it determines the range of ions in fusion pellet. To fully understand the energy deposition process of ion in plasma, large amount of experimental and theoretical work has been carried out during the past years, but mostly restricted to high energy region. Recently, Cayzac and co-workers [1] performed an experiment to measure the energy deposition of ions in laser-generated plasma near Bragg peak and discriminate the various models. In this report, we investigated the energy deposition of laser-accelerated ions in dense C-H-O plasmas.

The experiment was carried out on XGIII laser facility in Mianyang. The ion beam was generated through TNSA process with ps laser. Through selecting energy with a magnet, short pulsed quasi mono-energetic ions were produced. The dense ionized matter was generated through heating the TAC foam with ns laser-driven gold hohlraum radiation. With such kind of scheme, large scale($\sim mm$), uniform and long-lived($\sim ns$) plasma, which has the temperature of 19eV and free electron density of $4 * 10^{20} cm^{-3}$, was produced in laboratory[2]. Since the time-scale of ion beam is several magnitude lower than the plasma living time, it can be thought that the energy loss measurement was carried out in case of stable isolated plasma.

The energy spectra of ions were measured with a Thomson Parabola, and the result is shown in Fig. 1. The solid lines indicate the theoretical tracks of different ion species. The black dots are the signal of neutral particles, the blue and red dots are protons with and without plasma target. Evident energy shift was observed. Through analysing the relative deflection distance, the energy of ions was obtained. It was found that the measured energy loss is far above the Beth prediction, and the beam intensity may play important roles in the stopping process. Details will be reported in the conference.

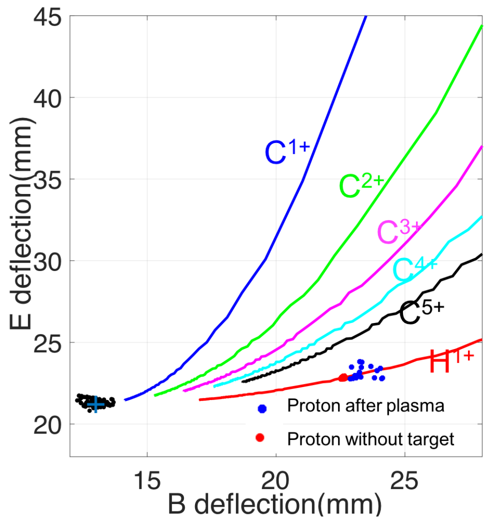

Figure 1. Thomson parabola spectrometry of protons with(blue dots) and without plasma(red dots), respectively. The solid lines are simulation lines of various species.

References

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