§14. High Density Plasma Target for Beam-Plasma Interaction Experiments

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Interaction of heavy ions with dense plasma is important as a fundamental process concerning the heavy-ion inertial confinement fusion. Enhancement of energy loss of heavy ions in the plasma compared to the cold matter was first predicted by theory many years ago and recently observed by several groups. The enhancement of stopping power is governed by the effective charge state Z_{eff} of the ions. The ions passing through the plasma interact with free electrons so that the effective charge state is determined by the balance of ionization and recombination. Interesting phenomena are expected for a high-density plasma of $n_e > 10^{19}cm^{-3}$ and for low-energy beams. So we develop plasma targets of high-density which are available for the in-beam experiments. We report a laser-plasma target, which is installed to a beam line of the TIT 1.7 MV tandem.

A TEA CO2 laser of 3J energy irradiates a polyethylene plate to produce plasma. The CO2 laser has a wave length of 10 μm. Its cutoff density is $1.1x10^{19}$ cm^{-3}. The amount of ablation is estimated by weighing the polyethylene plate after several hundred shots. The number of ablated atoms is about 10^{17} per shot. The expanding plasma is optically diagnosed as a function of time and space. The electron density distribution is obtained from the Stark broadening of H_α and H_β lines. Fig.1 shows an example of density distribution along the laser beam axis. The density decreases as a power function of distance from the polyethylene surface between 0.2 and 5 mm and then keeps a constant level up to 30 mm. The decay part is consistent with the ablating expansion. The plateau is understood in terms of plasma formed by post-irradiation of ablating matter. The plateau part is a candidate of plasma target with a uniform density distribution.

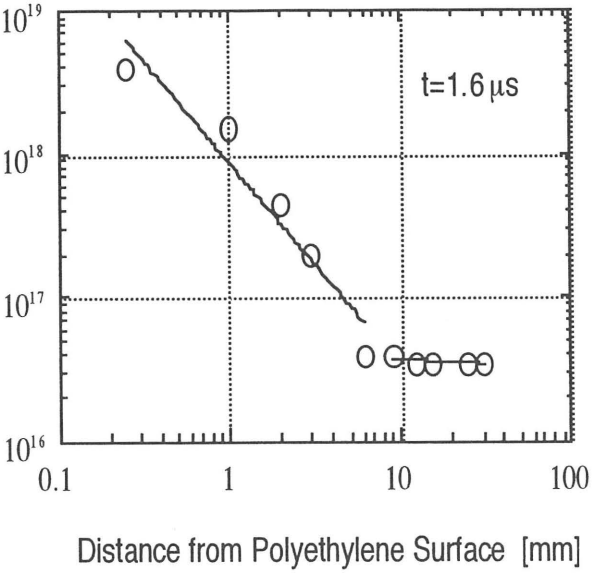

Fig.1 Electron density distribution.

Fig.2 shows a schematic layout of the apparatus for measurement of charge stripping experiment. A Li+ beam of 0.9 MeV is injected to the laser plasma. Charge stripped ions of Li++ and Li+++ are analyzed with a magnet and detected with a plastic scintillator. This experiment is now progressing.

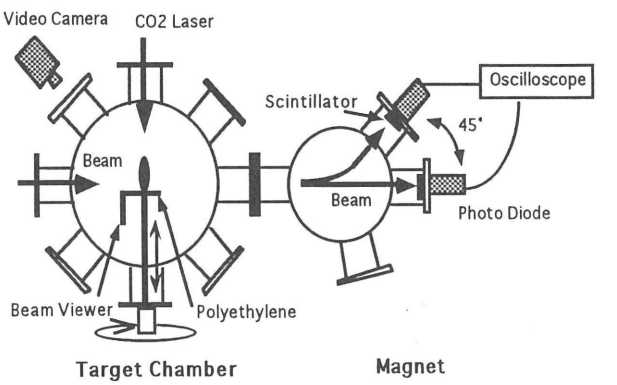

Fig. Layout of charge stripping experiment.