Development of an Ion Deflector in the Diagnostics of Nanosecond Laser Ablation Plasmas

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1. Background

Nanosecond laser ablation has been widely employed as a methodology in the fields of ion source development, thin film production, and mass spectrometry. One of the simplest methods in characterizing ions produced by nanosecond laser plasmas is via time-of-flight mass spectrometry (TOFMS). The TOFMS can be of linear type, where the detector is placed along the beam axis. For this type of TOFMS, a challenge is the relatively poor resolution of the detected ions resulting to a broad distribution. Methods in improving the resolution involve increasing the flight path, as well as energy and velocity focusing by introduction of electrostatic ion mirrors. This work involves the development of a deflection apparatus in characterizing the extracted beam from the laser ion source.

2. Research Summary

A Q-switched Nd:YAG laser (wavelength = 1064 nm, pulse repetition rate 10 Hz, spot size = 1 mm) is incident on a cylindrical graphite target surface at a 15º from the target normal, as shown in Fig. 1. The beam is accelerated by an aluminum plate placed at a distance of 13 mm from the surface. A hollow Faraday cup (FC 6) with a 15 mm diameter aperture is placed 37 cm from the target to collect the initial stream of ions along the beam axis. The beam is deflected and directed towards a FC array, consisting of five FCs arranged perpendicular to the beam propagation axis with 18 mm distance between each FC axis. All FCs are connected to an oscilloscope terminated by a 50 Ω resistor, which displays the TOF. Electron suppression magnets are placed in front of the FC array with around 300 G magnetic flux density 5 mm in front of the array. Particle beam trajectories of the deflection region are simulated by AMaze program.

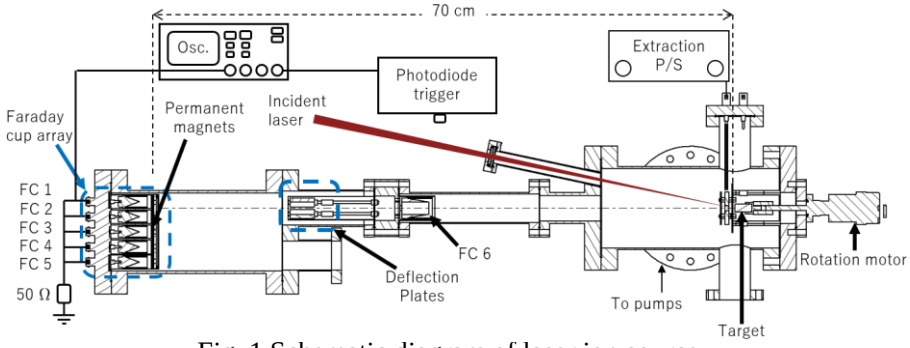

Fig. 1 Schematic diagram of laser ion source

3. Preliminary Results

The beam deflection trajectory simulation results for a 2 keV beam is shown in Fig. 2. A bias potential of 150 V is shown to correspond to approximately 6º deflection from the beam axis.

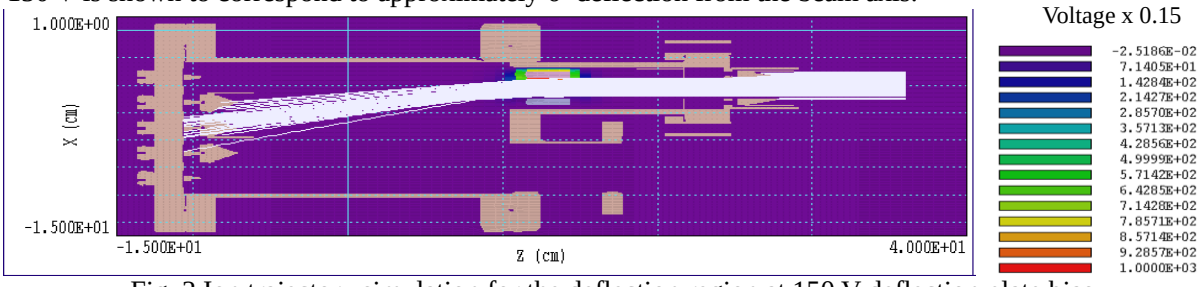

Fig. 2 Ion trajectory simulation for the deflection region at 150 V deflection plate bias