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Ion beam current density measurements of a focused high-current-density low-energy ion beam by using electrostatic probes

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A spontaneous-focusing of low energy ion beam (around 100 eV) having the high current density (up to ~5 mA/cm^2) without actively supplying electrons was observed using three sets of concave electrodes with nominal focal length of 350 mm [1-5], where the ion and electron current density profiles were measured by Faraday cups in an ion beam propagation vacuum chamber, to which the ion beam is injected from an ion source [6]. To study this mechanism of spontaneous-focusing phenomenon, a pair of electrostatic double probes with a unique structure have been installed. Namely, the probe is covered both by a dielectric of boron-nitride and a molybdenum pipe which covers the dielectric except for the tip of tungsten pins, to prevent from ion charge accumulation by the ion beam. Two pairs of double probes compose totally 4 tungsten tips which are installed in perpendicular and parallel directions to the ion beam, respectively.

In this study, the electron density and temperature of background plasma in the propagation chamber, and the ion beam current density have been measured before and after the transition to the focusing state. Simultaneously, by inserting an extremely high impedance resistance between the tungsten tip and ground line in the system, we measure the space potential of the back ground plasma.

It is possible to measure radial profiles of those values by sweeping the probe up and down perpendicular to the ion beam direction. Faraday cups are also installed to measure the ion beam current. Those system is illustrated in Fig. 1.

At the conference, we will present these probe system in some detail, and compare the results on profiles of electron density, electron temperature, and space potential before and after the transition to the focusing state. It will be shown that the ion beam current density is successfully measured by the double probe, whose value almost agrees with that obtained by the Faraday cup measurement.

Possible mechanism of the focusing phenomena will be discussed by using these results.

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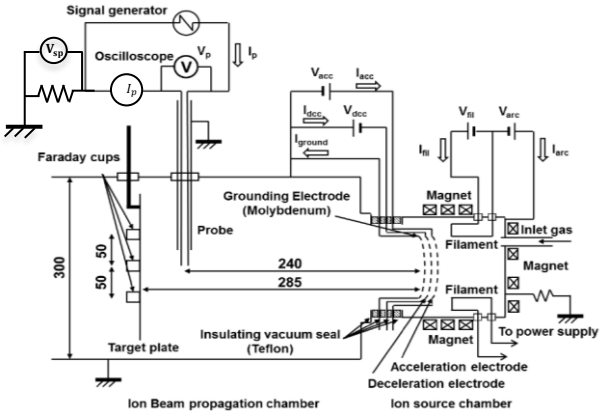

Fig. 1. Schematic drawing of the ion beam system, electrostatic probes, and Faraday cups.