Parallel ion flow velocity measurement using laser induced fluorescence method in an electron cyclotron resonance plasma

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Plasma acceleration along magnetic field has been a topic of interest in space and astrophysical plasma researches and the development of electric thrusters based on plasma propulsion. Recently, the acceleration of ions has been studied in a laboratory electron cyclotron resonance (ECR) plasma with a diverging magnetic field configuration in connection with the effect of plasma rotation [1]. A directional Langmuir probe has been used to measure ion flow velocity in our previous work. Here we report the application of laser induced fluorescence (LIF) method as a complementary diagnostic tool for measuring ion flow velocity. The experiments have been performed with the HYPER-I device, which is a cylindrical ECR plasma device with weakly diverging magnetic field. A tunable dye laser has been used to excite metastable argon ions, and the photons emitted by de-excitation have been detected by a photomultiplier tube. In order to measure parallel ion flow velocity, a laser beam should be injected into the plasma along the axis through a window located at an end of the device. The incident beam, however, is inevitably subjected to the reflection by a microwave injection window located at another end. The LIF induced by this reflected beam will interfere with that by the incident beam, which causes undesirable broadening of obtained LIF spectrum. We avoid this interference by making a slight angle to the incident laser beam (Fig. 1). This enables us to discriminate two LIF spectra obtained by incident and reflected laser beams and to determine the absolute ion flow velocity from the Doppler shift (Fig.2).

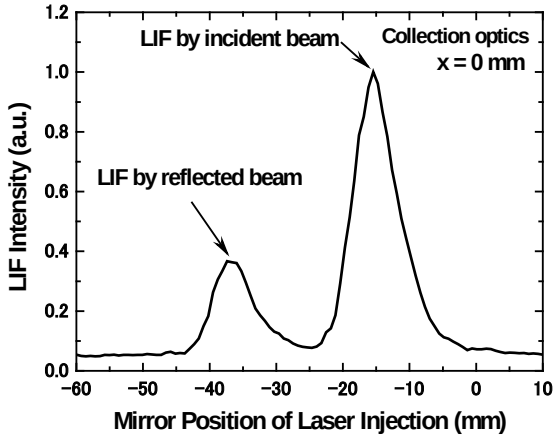

Fig. 1 LIF intensity measured at a fixed position is shown as the function of the mirror position of laser injection. Two LIF peaks are clearly separated.

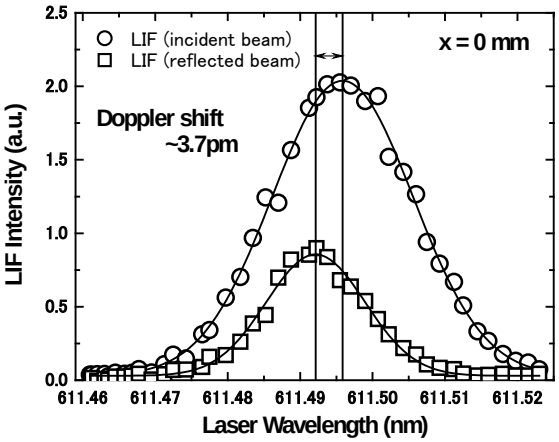

Fig. 2 LIF spectra obtained by incident and reflected laser beams. The half of the Doppler shift corresponds to the parallel ion flow velocity of 0.9 km/s.

[1] K. Terasaka et al., J. Plasma Fusion Res. SERIES **8** (2009) 15.