§6. Study of the Physics of IDB Plasma and the Density Limit in Helical Devices

Kitajima, S., Sasao, M., Okamoto, A., Ishii, K., Kanno, M., Sato, Y., Tachibana, J. (Dept. Eng. Tohoku Univ.), Takayama, M. (Akita Prefectural Univ.), Sakamoto, R., Morisaki, T., Nishimura, K., Masuzaki, K., Suzuki, Y., Yokoyama, M., Takahashi, H.

In stellarators, there is no hard limit of the high-density operation, unlike the Greenwald density limit in tokamaks, which is one of great advantages for future reactor operation. Especially in LHD the operation condition for the IDB (Internal Diffusion Barrier) plasma was discovered and the high density/high pressure plasma was successfully produced. Therefore, it is important to study high-density plasma production and to explore the high-density operation in stellarators.

In experiments on the TU-Heliac, the role of the radial electric field on the transition to improved modes has been investigated by electrode-biasing experiments. The high-density plasma was produced ($>10^{19}m^{-3}$) using a titanium (Ti) or vanadium (V) or gold (Au)-coated palladium (Pd-Au) electrode after the hydrogen gas charging in the negative electrode biasing[1-3]. Negative biasing experiments using a hydrogen storage electrode have the potential to realize high-beta experiments in some small-sized devices.

In this campaign, in order to measure the radial distribution and the time evolution of a density in the extremely high-density biased plasma we prepared a spectrometer using the interferance filters (HeI, 667.8 nm, 728.1 nm) and to measure the radial profile of an ion temperature and a poloidal flow velocity we prepared a high resolution spectrometer with 5 lines of sight made of a quartz bundle fiber. Figure 1 shows the experimental set-up of the spectrometer using the

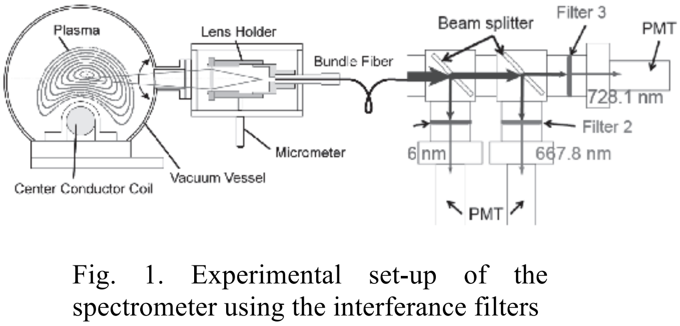

Fig. 1. Experimental set-up of the spectrometer using the interferance filters

interferance filters. For preliminary experimets we tried to measure the density by the spectrometer using the interferance filters in the biased plasma with LaB_6. The time evolution of the density was shown in Fig. 2 and the densities measured by the microwave interferometer (6 mm) and the Langmuire probe were also shown. These results agree well within 30 % of error.

Figure 3 shows the radial profiles of the poloidal flow velocity measured by the Doppler shift in the HeII line (468.6 nm). The magnetic axis located at z = 0.073 m and we can see that the sign of the velosity was changed at the magnetic axis position.

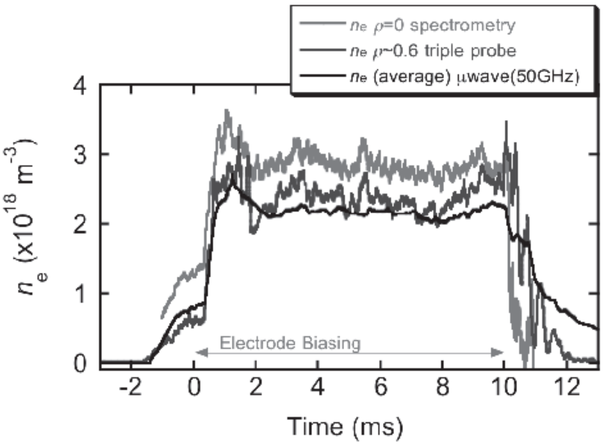

Fig. 2. The time evolutions of the density measured by the spectrometer using the interferance filters, the microwave interferometer (6 mm) and the Langmuire probe

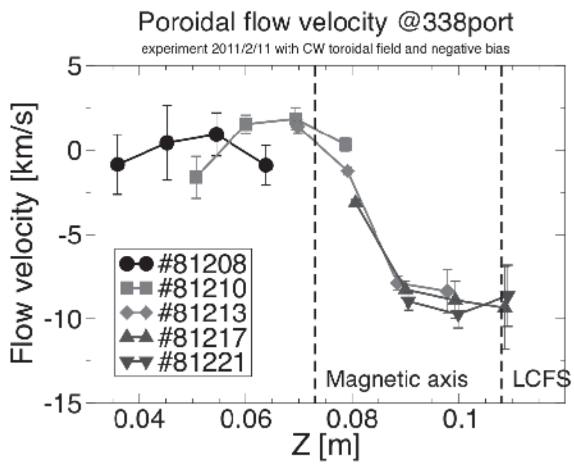

Fig. 3. The radial profiles of the poloidal flow velocity measured by the Doppler shift in the HeII line (468.6 nm)

1) H. Utoh *et al., Proceedings of the 32nd EPS Conference on Plasma Physics* P2_066 (2005).
2) H. Utoh *et al., Fusion Sci. Tech*. **50** 434 (2006).
3) H. Utoh *et al., Journal of Physics: Conference Series* **123** 012024 (2008).