Development of beam emission spectroscopy system for the measurement of density fluctuations in LHD

T. Oishi, S. Kado[a], M. Yoshinuma[b], K. Ida[b], K. Yamazaki and LHD experimental group[b]

Nagoya University, Chikusa-ku, Nagoya 464-8603, Japan
[a] The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8656, Japan
[b] National Institute for Fusion Science,322-6 Oroshi-cho, Toki 509-5292, Japan

t-oishi@mail.nucl.nagoya-u.ac.jp

It is important to examine characteristics of fluctuations in plasma parameters such as turbulence or MHD oscillation, because these fluctuations have been recognized to affect the heat or particle transport and to degenerate the confinement property. As a first experimental approach of study on plasma fluctuations, it is necessary to measure the fluctuations precisely. Beam emission spectroscopy (BES) has been proposed as a method for the measurement of local plasma density fluctuations and its spatial correlation [1]. The BES system measures emissions from the collisionally excited neutral beam atoms (denoted as "beam emission"). The beam emission can be distinguished from the bulk plasma emission by taking advantage of Doppler shift. Since the observable region is the intersection of the beam line and the sightline for each fiber channel, local values and their correlations are available.

BES has been applied several tokamak experiments, and it has provided significant results in studies on the spatial structure of turbulent fluctuation or relationship turbulence and confinement properties [2]. On the other hand, it is considered to be difficult to apply BES to helical devices because of its complicated magnetic field configuration. Therefore, the authors have tried to develop the BES system in helical devices aiming at comprehensive understanding of phenomenon and physics of torus plasmas related to fluctuation and confinement.

The first trial to apply BES to a helical device succeeded in the compact helical system (CHS) [3]. Based on the achievement in CHS, we have developed a BES system in the large helical device (LHD). In the development of BES in LHD, it is necessary to scan the detectable wavelength of emission in the range of several nanometer because high energy (120 ~ 180 keV) NBI with negative ion source is used as a probe beam. Therefore, grating spectrometer is proposed as the spectroscopic device instead of the interference optical filter which has been used widely in BES. The prototype BES system in LHD has sightlines nearly parallel to the midplane and passing through the plasma in the toroidal direction, and it has the spatial resolution in the radial or poloidal direction. Taking into account the results obtained using this system and its specifications, development of a new BES system is in progress aiming at improvement of the signal intensity and the spatial resolution. The radial spatial resolution is expected to be optimized by directing the sightlines in poloidal direction which are nearly parallel to the magnetic field lines in the new BES system.

This article presents a summary of development of these two BES systems. Comparison between the new system and the prototype system and preliminary results of fluctuation measurement will be shown.

[1] R. J. Fonck et al., Rev. Sci. Instrum. **61** (1990) 3487.
[2] G. Mckee et al., Rev. Sci. Instrum. **74** (2003) 2014.
[3] T. Oishi et al., Nucl. Fusion **46** (2006) 317.