

Development of Sweeping Detector Phase Contrast Imaging in LHD

H. Sakai^{1*}, K. Tanaka², T. Kinoshita³

¹ *Interdisciplinary Graduate School of Engineering Science, Kyushu university,
Kasuga 816-8580, Japan*

² *National Institute for Fusion Science, National Institutes of Natural Sciences,
Toki, 509-5292, Japan*

³ *Research Institute for Applied Mechanics, Kyushu university,
Kasuga 816-8580, Japan*

Phase contrast imaging (PCI) is one of the powerful techniques to measure turbulences in magnetically confined plasma. PCI can measure electron density fluctuation with excellent sensitivity by converting small phase variation to small intensity variation giving $\pi/2$ phase shift between scattered and non-scattered component. $10.6\mu\text{m}$ CO₂ laser and liquid nitrogen cooled HgCdTe multi-channel detector array are usually used. In order to get spatial resolution along the beam axis, the magnetic shear technique is applied. The magnetic shear technique makes use of turbulence characteristics and magnetic shear. The former has a strong asymmetry in the parallel and perpendicular directions of the magnetic field. This results in turbulence propagation to perpendicular direction to the magnetic field. The latter is spatial change of the magnetic field direction. Since the magnetic field direction is known from the equilibrium calculation, the location of the turbulence can be obtained from the propagation direction of the turbulence. In two-dimensional phase contrast imaging (2D-PCI), line integrated two-dimensional pictures of turbulence are measured by two-dimensional detector array. Spatial Fourier transform of a turbulence picture decomposes the turbulences in the direction of propagation. Then, a location of a turbulence is determined from the location of magnetic field which is perpendicular to the turbulence propagation.

In 2D-PCI for LHD utilizes $6 \times 8 = 48$ channels 2D-detector. However, spatial and wavenumber resolutions are not excellent in the present 2D system due to the limit of the channel number. In order to improve spatial and wavenumber resolutions, sweeping detector PCI (SD-PCI) was developed. For SD-PCI, the laser beam was separated into two, and one is aligned into a 1D detector which has a lot of channels, and a single channel detector into another detector as reference. Then, one of them is swept to a perpendicular direction to the 1D detector array with constant velocity and by dividing the swept area. Through this way, high-resolution 2D image of turbulence is obtained for steady state plasmas. In this study, 16-channels 1D detector was used as swept detector, and a center channel of 2D-detector for 2D-PCI as reference detector. As a result, 2D picture with $16 \times 16 = 256$ elements was obtained separating the swept area into 16. By using this technique, higher spatial and wavenumber resolution was realized compared with present 48ch 2D-PCI. In this conference, the detail method of SD-PCI and a profile of turbulence will be reported.

[1] K.Tanaka et al., Rev. Sci. Instrum. 79, 10E702 (2008)

*Presenting author: h.sakai@triam.kyushu-u.ac.jp