View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by National Institute for Fusion Science (NIFS-Repository)

§68. Development of Multi-channel Spectroscopic System for Fine Resolution Computed Tomography

Fujisawa, A., Nagashima, Y. (Kyushu Univ.),
Shimizu, A.

A diagnostics able to measure the whole plasma cross-section with fine resolution is absolutely necessary to advance the understanding of plasma turbulence [1,2]. Computed tomography (CT), using plasma light emission, ,is one of the candidates. The requirement is to resolve fine structure in space and time, *i.e.,* comparable to ion Lamor radius and drift wave frequency, respectively. Accordingly, a large number of spatial channels and excellent reconstruction procedure are essential to realize such a diagnostics based on CT. The proposed method has been developed both in the aspects of soft- and hardware. The purpose of the proposal is to develop a prototype system of the diagnostics for QUEST and other magnetized plasmas.

A number of numerical procedures to obtain reconstructed image has been proposed, for example, Algebraic Reconstruction Technique (ART), Maximum Likely-Expectation Method (MLEM) and fitting function methods. These methods of CT has been tried for supposed emission distributions under an assumption that a data set is obtained with 101 channel detectors set around a cylindrical plasma at eight azimuthal positions, totally 808 channels. The results are shown in Fig. 1; left, middle and right ones represent the assumed emission profile, the reconstruction images with ART (middle) and with Maximum Likely-MLEM (right), respectively.

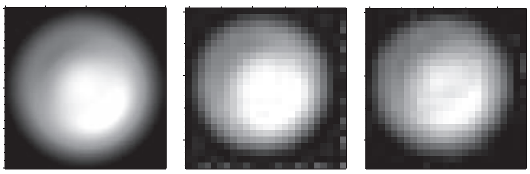

Fig. 1. (left) Assumed distribution of emission. (middle) Reconstructed view using ART, and (right) reconstructed view using MELM.

Regarding the hardware, a prototype system is installed on a linear cylindrical device, PANTA, in Research Institute for Applied Mechanics (RIAM), Kyushu University. Four sets of the prototype detector systems are set at four azimuthal angle positions separated by 45 degree. Each detector system contains four arrays, each of which consists of 33 channels, totally 132, to observe four bands of lights in different wavelength using optical filters.

The prototype system is composed of collimators, optical filters, optical feed-through that transfers the filtered plasma light to the atmosphere side. The light passing through the optical feed-through is transferred through fibers to the array of detectors using photodiode. The detectors are located sufficiently away from the plasma, therefore, the electric interference can be avoided, and this property is advantageous in improving the signal-to-noise ratio of the system. The length of the fibers after the optical feed-through is 10 m. Interface components are made to connect the optical feed-through precisely to the transmission fibers. Each light signal transferred through a fiber is converted into voltage signal by using the photodiode amplifier. The gain and frequency bandwidth are 10^8 V/A and up to 50 kHz, respectively.

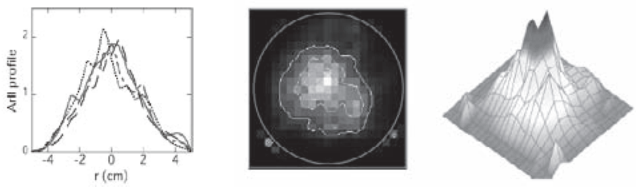

Fig. 2. (left) Line-integrated profiles of emission obtained by the prototype detector in PANTA, (middle)Reconstructed two-dimensional plot, and (right) surface plot.

In this experiment, the blue ArII line (nm) are used for the measurements. The diameter of PANTA plasma is 10 cm, while an array on the line of the same wavelength light cover the 16 cm including the plasma center. An example of the result is shown in Fig. 2; the left figure shows the line-integrated profiles of emission, while the middle and right ones do the two-dimensional plot and surface plots of local emission profile.

As for the possibility of detecting the fluctuation, Fast Fourier Transform (FFT) is applied on the line-integrated signals. Figure 3 shows examples of the power spectra from two different parameter regions of plasmas; the left and right figures shows the fluctuation power spectra of lower (1mTorr) and higher (3mTorr) filing gas pressure, respectively. As is shown in the figures, the signal-to-noise ratio is sufficiently high, and it is found that several peaks corresponding to coherent mode is superposed on turbulent background.

Finally, the basis to reconstruct the patterns of fluctuation is well prepared in addition to local emission profile, and actual application on torodail device using visible, UV and X-ray is expected.

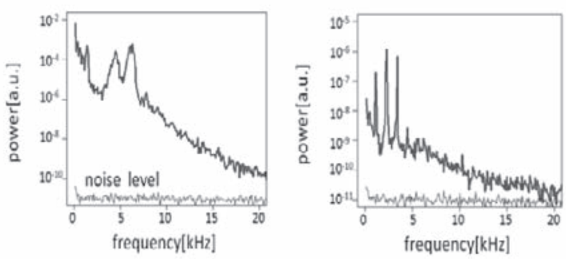

Fig. 3. Examples of fluctuation power spectra. (left) Power spectra of filling gas pressure of 1mTorr, and (right) that Power spectra of filling gas pressure of 3mTorr.

[1] A. Fujisawa, Nuclear Fusion **49** 013001(2009)
[2] A. Fujisawa, PFR **5** S1005 (2010)