§36. Active Particle Diffusion Measurement of Helical Plasmas by Use of Compact Torus Injection

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Since 1999, we have developed a new active particle diffusion measurement by combining a visible-light tomography and a well-controlled compact toroid (CT) injection. The coaxial plasma gun will deposit impurity plasma at an arbitrary spatial position of the Large Helical Device (LHD) plasma at an arbitrary time. Its injection time is much shorter than the conventional pellet injection, leading us to a new active particle diffusion measurement. The 2-D visible light tomography system was designed to measure directly its particle diffusion, temperature and velocity. Our main research subjects are

(1) impurity transport of helical plasmas, such as heavy impurity accumulation and
(2) global instabilities of high-ß helical plasma, especially localized reconnection activity of ballooning mode.

In the fiscal year 2000, we measured for the first time 2-D profile of ion temperature using the completed visible light tomography system. We also moved about the half of the system to LHD for the next phase experiment and completed two important tomography softwares to reconstruct 3-D emissivity profile and 1-D/2-D ion temperature profiles. As shown in Fig. 1, this system uses 6x6 optical fibers to reconstruct the 2-D profiles of the ion temperature and velocity. A polichrometer, optical fibers, optical lens systems and a CCD camera are used to measure the line integrated signals of line spectrums and then those signals are converted into the local spectrums through the tomography or Abel inversion software. This software has been tested / optimized using the ion heating phenomenon of two merging tokamaks in the TS-3 device.

Figure 2 shows the r-z contours of the ion temperature around the reconnection pint (X-point) of two merging tokamaks in the TS-3 experiment. Though the current sheet tilted because of our tentative setup, it was clearly observed that the ion temperature in the plasma outflow region was higher than that around the X-point. This fact indicates that the reconnection outflow is the main cause for the anomalous ion heating effect of reconnection under the present experimental condition.

Based on those results, we will complete installation of the visible light tomography system for LHD and will start the ion temperature and hopefully velocity measurement. If some impurity lines are available, we can expect its extension to initial particle diffusion measurement. After the CT injector is installed in LHD, we will start optimized diffusion measurement by combining the tomography system to the CT injection.

References
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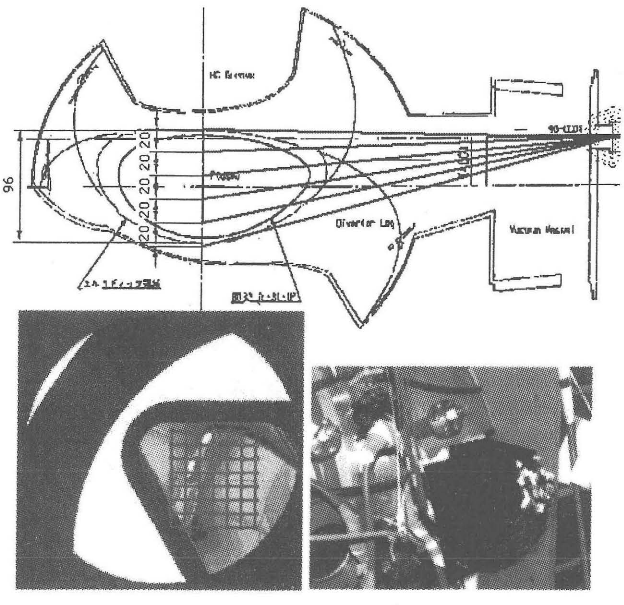

Fig. 1 Visible light tomography system in LHD (Viewing lines in LHD and photo of fiber system in TS-3)

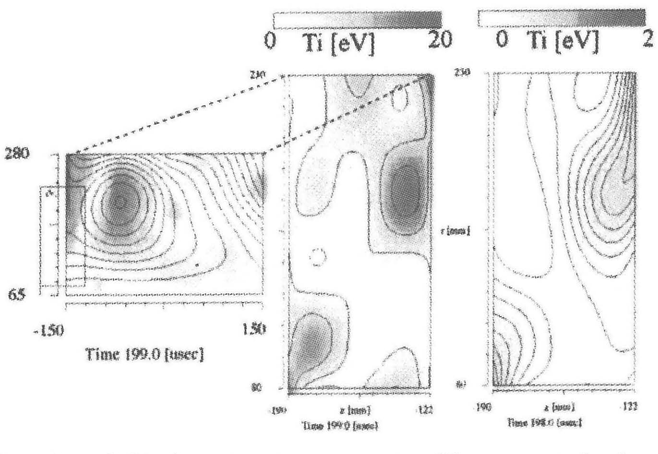

Fig. 2 2-D ion temperature profiles around the magnetic reconnection point of two merging tokamaks together with their flux and j_t contours (TS-3)