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

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Since 1999, we have been developing a new active particle diffusion measurement by combining a visible-light tomography with 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 fast particle diffusion measurement in MHD time scale. The 2-D visible light tomography system was designed to measure directly its ion diffusion, temperature and velocity. It is being applied to LHD to measure (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 2001, we installed all of 2-D visible light tomography system at LHD and measured ion temperature profiles of LHD, using its HeII light emissivity. We also completed a novel velocity reconstruction (tomography) software by Doppler shift / broadening of plasma line spectrum, in addition to the 3-D tomography and the 1-D/2-D ion temperature tomography developed last year. It enables us to reconstruct 2-D velocity profile based on an assumption that the plasma is incompressible ($\nabla \times \mathbf{v} = 0$). We tested / optimized this software using a numerical simulation and concluded that six-direction system is most cost effective for velocity reconstruction of LHD.

In LHD, a polichrometer, optical fibers, optical lens systems and a CCD camera (Fig. 1) were used to measure the line integrated signals of line spectrums and then those signals were converted into the local spectrums through the tomography or Abel inversion software. Figure 2 shows the measured axial profile of ion temperature in the He discharge experiment of LHD. Though its spatial resolution and S/N ratio were not finalized yet, it was clearly observed that the ion temperature of LHD was 300-350eV and that it peaked around the magnetic axis. This initial result indicates that the whole system works correctly as designed initially. .

Based on those results, we are improving sensitivity and spatial resolution of the tomography system for the next velocity measurement. We will also extend the present ion temperature measurement to the particle diffusion measurement. If the CT injector is installed in LHD, we will start optimized diffusion measurement by combining the tomography system with the CT injection.

References
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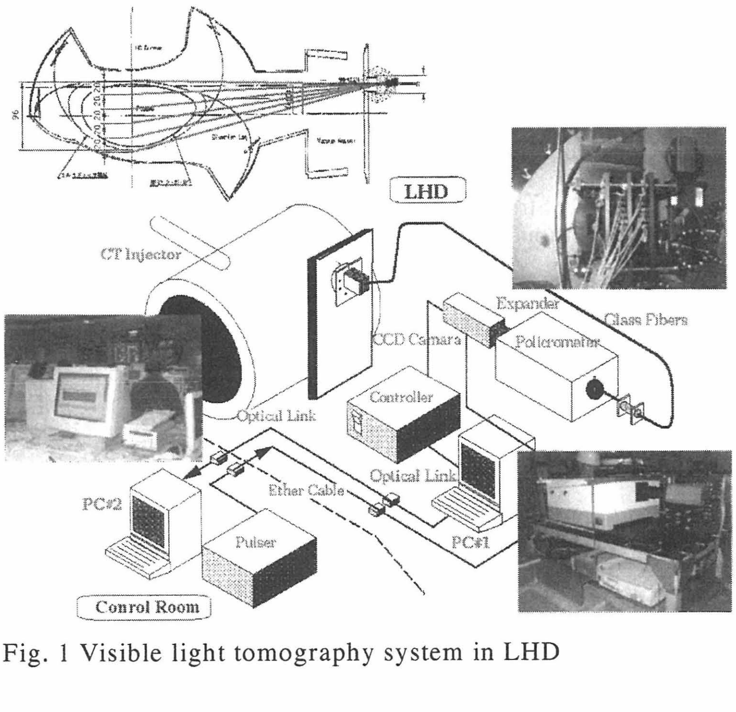

Fig. 1 Visible light tomography system in LHD

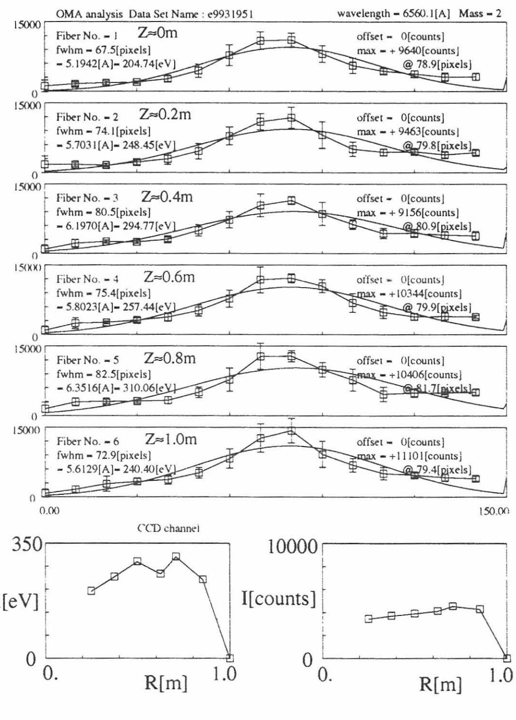

Fig. 2 Axial profiles of HeII light spectrum and ion temperature in LHD (He discharge)