

§37. Two Dimensional Divertor Spectroscopic System Using Fast Camera

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Fast camera (Ultima-SE, Photron inc.) was used to measure the fast phenomena of LHD peripheral plasma, especially the fluctuation in the divertor region. Many attempts of finding the fluctuation in peripheral plasma have been held at several tokamaks and STs. Several diagnostics would be very useful for peripheral phenomena, especially electric probe (included in fast scanning probe), magnetic probe, microwave technique, and visible camera. The advantage of fast camera is non-disturbance of plasma. On the other hand, the disadvantage of this measurement is limited to the visible light signal.

Fast camera system and data acquisition

Remote control and data acquisition of fast camera were able to carry out by IEEE1394 and SCSI. Also, the camera has video output (analog output). This year we used IEEE1394. Figure.1 shows the schematic drawings of fast camera system. The camera was installed mainly at the rear port of the vacuum duct, but it is easy to reinstall to another port. That was flexibility of this measurement.

A sensor of fast camera has 256x256 pixels and each pixel is 8bit dynamic range. The frame rate is 4500 FPS (frames per second) max. with full frame, and 40500 FPS max. with segment frame (64x64 pixels).

LHD can hold the quasi steady-state plasma for more than ten minutes. In this quasi steady-state operation, the data acquisition system for fast camera will be required to continuously transfer the image data in real-time. However, in general the data of the images are huge and unfortunately this camera cannot afford the real time data acquisition. Therefore, we will have to take a shot by the trigger of which behavior we have to research. This is further problem.

LHD plasma measurements

The intensity of visible light was changed in high β experiment. Typical time scale of this variation is about 1ms. Figure 2 (a), (b) show the light profile of two typical patters. The light profile would show near the divertor region. It seems that plasma-surface interaction varies slowly during NBI.

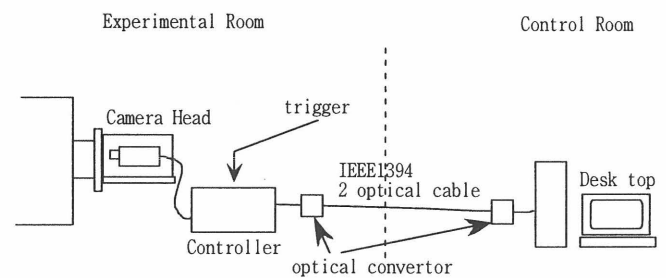
The filamentation (a light string) observed in LHD plasma during NBI. Figure 3 shows the filamentations from horizontal ports without any optical filters. The filamentation observed in tokamak plasma and ST plasma was likely along the magnetic field line. However, in this picture it could not be saying that the filamentation was along the magnetic field line. This was because the magnetic fields of helical system were complex and the camera picture was the results of the integral light along the line of sight.

The filamentation was not observed in ECH plasma due to the lack of photons. Therefore, it might not be typical phenomena in NBI plasmas. Moreover the photon number decrease by optical filters. The image intensifier will be needed to measure the filamentation clearly in low density plasma, like ECH plasma.

It is open question that the filamentation was related to L/H-mode and/or plasma confinement, but it is widely believed that above phenomenon was due to MHD instability.

Summary

- (1) The attempt to measure the fluctuation using a fast camera was done this year, and the filamentation could be observed in LHD peripheral plasma. This is believed to relate MHD instability.
- (2) In principle, it is easy to enhance the performance of this measurement system with image intensifier. We hope that this diagnostics will be one of common tools for fusion plasma experiments, such as LHD.



Fast Camera System for LHD Plasma Diagnostics

Fig.1. Schematic drawing of the installation for fast camera system in LHD

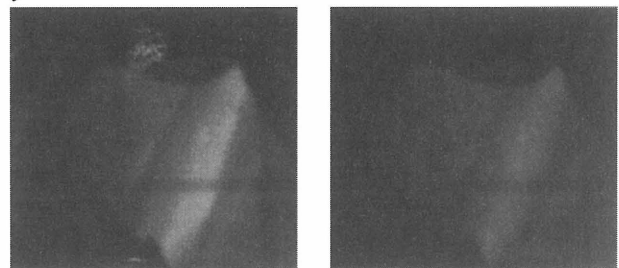


Fig.2(a) Fig.2(b)
Fig.2 Light intensity was changed during NBI. (a), (b) high β shot (#31840),

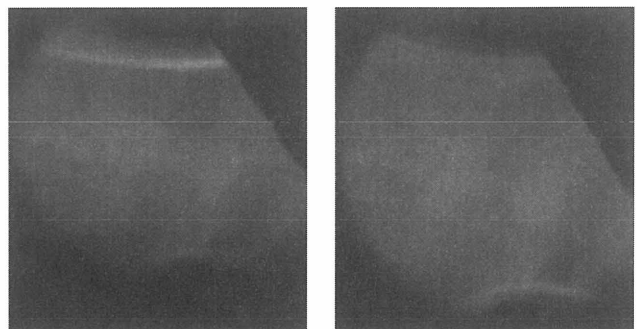


Fig.3(c) Fig.3(d)
Fig.3. Filamentations were observed in LHD plasmas. (c),(d) typical NBI shot (#34188)