§40. Two Dimensional Divertor Spectroscopic System Using Fast Camera

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The plan of this diagnostics is very simple. We will use the fast camera (Ultima-SE, Photron inc.) for finding the fast phenomena of LHD plasma, especially the phenomena in the divertor region. Similar attempt of finding the fast plasma behavior in periphery were held at several tokamaks, and also it is held at NSTX at the present.

These diagnostics for the experimental fusion devices are also very useful as a plasma monitor, e.g. plasma position, NBI, ECH, other heating, pellet injection and/or gas puffing.

LHD can hold the quasi steady-state plasma for more than ten minutes. For the LHD project a long-pulse plasma experiment of one-hour duration is planned. 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.

Fast camera system

The camera used here has a sensor of 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. The segmentations depend on frame speed, and they are somewhat complicated. At this time there was no image intensifier, therefore the maximum speed was limited by light intensity from a plasma. The memory of this camera is 512MB. In general, when we use 4500 FPS, the camera works during 1.8 second.

First attempt to measure the LHD plasma

The camera was installed at the back of the vacuum duct for LHD V.V. Figure.1 shows a light string observed during NBI. In this figure, the above shows normal picture at the time of 0.608 sec. from the beginning of the discharge, and the bottom shows a light string appears after 1ms from the above picture. This string lasts within 2ms.

Figure.2 shows typical picture of the radiation collapse of LHD plasma. Many light strings were observed and it is thought that they are related to the MHD activities. Those light strings could not be seen by a normal speed video camera.

Summary

(1) The first attempt using a fast camera to observe a LHD plasma was done this year. In spite of the first trial, we had observed many fast behaviors of LHD plasma. In particular, the light strings were observed frequently during the normal discharge, and the radiation collapse. They may be related to MHD instability. In principle, it is easy to enhance the performance of this measurement system. We hope that this diagnostics will be one of common tools for fusion plasma experiments, such as LHD.

Fig.1. First view of the fast phenomena of LHD plasma. The light string in bottom region appeared suddenly and it last within 2ms. See the time in upper side of frames.

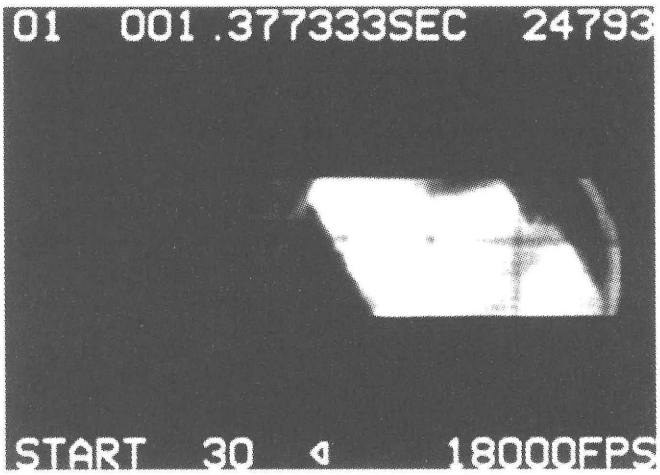

Fig.2. Fast camera view in the end phase of the radiation collapse: Many light string are moving fast.