§19. Development of Tangential Soft X-ray Camera

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A tangential soft X-ray(SX) camera has many advantages over the conventional SX diode array system. 1) It can provide 2-D image directly without uncertain assumptions in reconstruction, e.g. the solid rotation of the plasma. 2) Perturbed structures in fluctuations are usually parallel to the magnetic field. Since the sightlines of the tangential camera are nearly parallel to the magnetic field lines, the spatial resolution for the fluctuations with higher m number is much better than that in tomographic reconstruction where the sightlines are almost perpendicular to the magnetic field.

We have been developing a tangential SX camera since 1997 and had installed on TEXTOR-94 Tokamak[1] last year. A block diagram of this system is shown in Fig. 1. Soft X-ray radiation from the plasma is converted to visible light by a fast phosphor (P-47) screen. The light is guided by a plastic bundled fiber (2 m in length) to a image intensifier (Hamamatsu V4440 U-mod), which is surrounded by an iron box to eliminate the stray magnetic field from TEXTOR. The output image is amplified and recorded by an ICCD camera equipped with a fast shutter (Hamamatsu C4077). The video signal from the camera is digitized by CAMAC ADC (LeCroy 6810) and the data are acquired by a windows NT workstation.

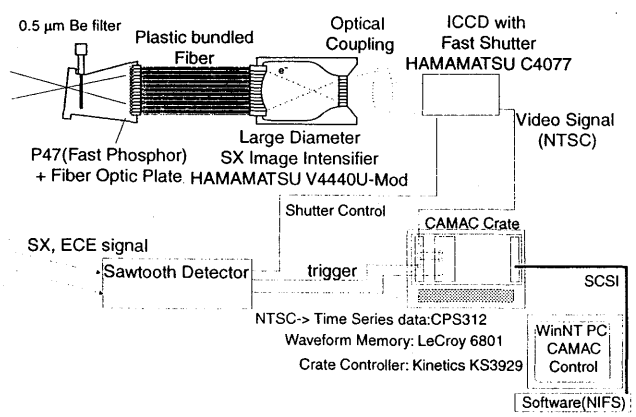

Fig. 1. The conceptual diagram of our tangential SX camera.

The complexity of this system is caused by the need for photons. In order to study a fast phenomena, e.g. the sawtooth crash, the exposure time for one frame should be very short. We need a large diameter (100 mm) phosphor screen to obtain a good S/N ratio. Photons collected by this system are enough for a fast shutter ($\Delta t = 1 \sim 10\mu s$) without loosing the spatial resolution (3cm in plasma typically) in auxiliary heated plasmas.

Series of the images obtained in the initial experiments are shown in Fig. 2. An NB is injected between two frames. Increase in the SX intensity and the outward shift of the plasma can be seen.

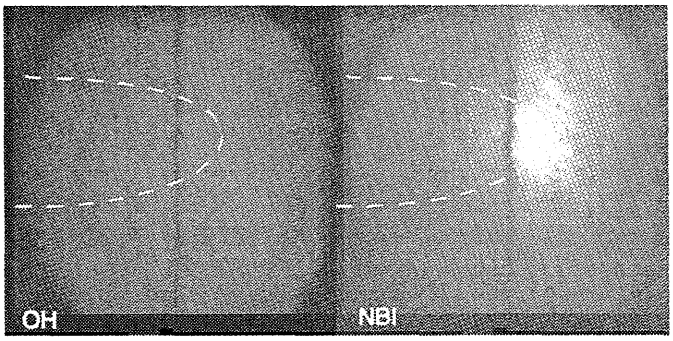

Fig. 2. SX radiation profile from a tangential port. Magnetic axes are estimated and plotted as a reference. Vertical lines in the images are shadows from a stainless wire in front of the camera.

There are several points to be improved. One is a trigger system. We take only eight sequential frames at every 30ms now. A new controller (sawtooth detector in Fig.1.) will make the exposure time synchronized with the sawtooth; we will be able to study the process of sawtooth crashes in detail with new controller. Another important issue is the interpretation of the measured data. Softwares to reconstruct the 2-D image of the SX emission are under development[2].

After the experiments on TEXTOR-94 in this fiscal year, this system will be transferred and will be installed on LHD in the 4th (or later) experimental campaign.

References

1) S. von Goeler, *et al.* , Rev. Sci. Instrum., **70**, 599 (1999)
2) G. Fuchs, *et al.* , in Proc. 26th EPS Conference on Controlled Fusion and Plasma Physics, Maastricht, to be published