§55. Application of Tomographic Imaging to Photodiode Arrays in LHD

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To improve the understanding of radiative processes such as radiation collapse, transport of heavy trace impurities injected into the plasma, a fast AXUVD (Silicon absolute extreme ultraviolet diode) has been applied to supplement the standard foil bolometer diagnostic for radiated power measurements on the Large Helical Device (LHD).[1]

AXUVD allows measurements on time scales as short as 10^{-4}s with continuous sensitivity from the near infrared into the soft x rays. Using multiple AXUVD emission viewing chords through the plasma, a spatial resolution of about 5cm can be obtained over a rectangular region of about 3 by 3m, providing a means for following the formation and subsequent evolution of a radiation structure in plasma in two dimensions. Several tomographic techniques have been used to reconstruct the radiation profile. A number of experimental situation have been explored in a detailed way from the AXUVD imaging system. Results are presented of the fast radiation process during impurity injection and of the highly localized radiation loss in the self-sustained detachment regime.

To take full advantage of the available information in our limited number of line integrated measurements, the local radiation emissivity is obtained by inverting the measured brightnesses with linear (Tikhonov-Phillips) or nonlinear (maximum entropy) regularisation methods which are more flexible than the hybrid method we used before.[2] The most important features of these improved methods are the capability of reconstructing radiation distributions without any symmetry assumptions, built-in smoothing, and useful reconstructions with relatively few detectors.

The plasma radiation distributions in a variety of discharge conditions have been visually characterized. Figure 2 shows a rotating radiation structure observed in a discharge of self-sustained detachment. The tomography method allows us to investigate in detail the temporal and spatial evolution of the rotating radiated belt, providing quantitative information to the studies of the mechanism of the formation of a self-sustained detachment regime.

2-D tomography techniques applied to the semi-tangential cross-section data showed that the algorithms are powerful enough to reconstruct complicated asymmetric emissivity distributions. They are used in the examination of impurity emission images during TESPEL injection and used to study the radiation distribution during a self-sustained detachment regime on LHD.

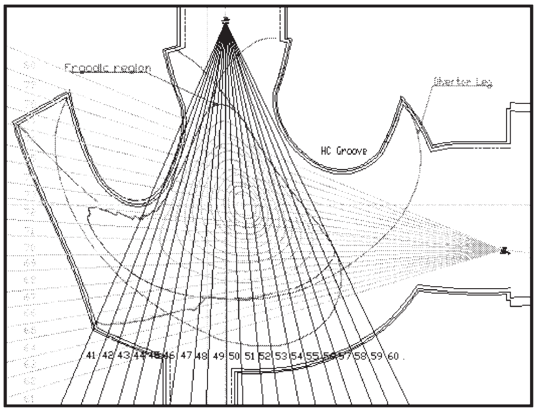

Fig. 1. Layout of the lines of sight of the AXUVD tomography system on LHD.

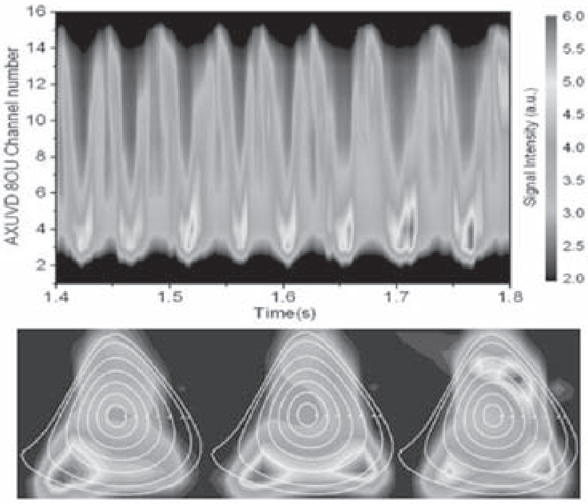

Fig.2 Reconstructed radiation distribution at three time slices (t_a=1.584s, t_b=1.600s, t_c=1.608s), the upper contour shows the time evolution of AXUV signals during self-sustained detachment.

References
1)B.J.Peterson et al.,Plasma. Phys.Controlled.Fusion.45(2003)1167.
2) Y.Liu et al., Rev.Sci.Instrum.74 (2003) 2312.