§14. LHD Plasma Emission Tomography Reconstruction

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1-D and 2-D tomography reconstruction of the total radiation power distribution was based on the data obtained from AXUV silicon photodiodes [1]. Two arrays (16 and 19 channels) installed in the normal LHD cross-section (Fig. 1) provided simple and reliable 1-D poloidally symmetric radiation profile reconstruction. The data obtained from two other arrays (20 and 20 channels) were used for 2-D reconstruction of the radiation distribution in the semi-tangential plasma cross-section (Fig. 2). A 2-D peeling away algorithm improved by a feedback procedure reconstructed several Fourier harmonics at each magnetic flux surface.

1-D emissivity reconstruction based on the AXUVD data obtained in the 8O normal LHD cross-section provides reliable profiles in the most of the discharges. A Modified Abel inversion was used for the reconstruction of the emission profile. The emission density was assumed to be constant through each of 6 magnetic flux layers. The matrix V of effective intersections between each of the layers and the sight volumes of each of 35 detectors were calculated for each magnetic configuration. Singular Value Decomposition (SVD) technique [2] was used to solve the linear equations system $C_n = V_{nm}\varepsilon_m$ (m = 1..6, n = 1..35) in order to find the emission densities ε_n. Here C_n are the chord integrated emission signals.

2-D tomography technique applied to the semi tangential cross-section data showed that the algorithm is powerful enough to reconstruct complicated asymmetric emissivity distribution. The magnetic flux contours were taken as a basis for the plasma emission profile. Then the emission at each magnetic flux surface (k=1.. 30) was assumed to be a function of the poloidal angle Θ, $\varepsilon_k(\Theta)=A_k+B_k\cos\Theta+C_k\sin\Theta+D_k\cos2\Theta$.

The number of observation directions limited the number of Fourier modes. Higher modes and $\sin2\Theta$ mode could not be distinguished using the two existing arrays. For each of 30 surfaces four chords tangent to the surface were found. The expansion coefficients are determined by means of least-square fitting to the brightness of the four chords. For the outermost surface the emissivity $\varepsilon_{30}(\Theta)$ was simply derived from four peripheral chord integrated signals. The rest of the profile was then reconstructed by the peeling away process, going surface by surface, from plasma periphery to center.

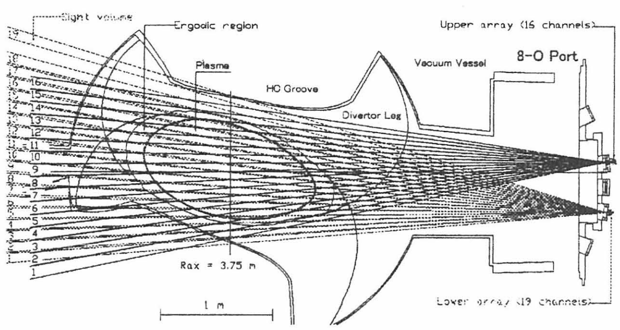

Fig. 1. Normal cross-section. Side view

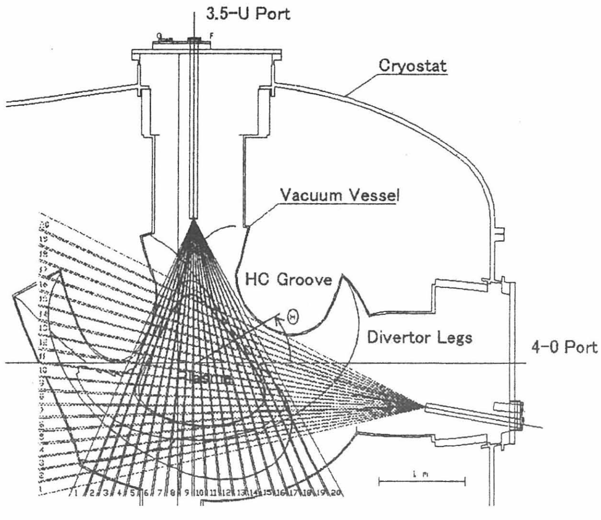

Fig. 2. Semi-tangential cross-section. Side view.

References

[1] International Radiation Detectors, 2527 West 237th Street Unit C, Torrance, CA 90505-5243, www.ird-inc.com

[2] W.H.Press, B.P.Flannery *et al.*, Numerical Recipes, Cambridge Univ. Press, (1986).