§8. Soft X-ray Detector Array System for LHD

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Since the sawtooth oscillations on soft X-ray signals were discovered in a tokamak plasma, a soft X-ray detector array or soft X-ray camera has got an important position as standard diagnostics for a fusion-oriented plasma. The soft X-ray signal in the range from several hundreds eV to several tens keV gives us information on electron temperature, electron density and amount of impurities, and also that on MHD instabilities. In LHD we are planning to study the following subjects by using the soft X-ray diagnostics:

(1) measurements of radial profiles of soft X-ray emission, electron temperature and radiation power density,
(2) measurement of macroscopic quantities related to MHD equilibrium, such as the magnetic axis position, cross-section of magnetic surface and so on,
(3) study of low frequency MHD fluctuations such as interchange modes and sawtooth oscillations,
(4) study of radial propagation of heat and cold pulses produced by sawteeth, auxiliary heating, pellet injection and so on.

If the soft X-ray detectors are arranged to view the poloidal cross section of a plasma at various poloidal angles, a tomographic reconstruction of the soft X-ray emission can be obtained. The tomography is very useful to clarify MHD equilibrium suffered from MHD instabilities.

We have constructed a soft X-ray detector array system which consists of a set of PIN photodiode array, CAMAC modules for data acquisition and a set of vacuum pumping systems. We have adopted a linear array of 20 PIN photodiodes without any cover window (Fig.1). This was originally developed by the WT-3 tokamak group in Kyoto University and Hamamatsu Photonics K.K. The diode is sensitive for photons from 300 eV to 30 keV. The array with 20 diodes connected to a 20-channel DC amplifier of 300 kHz band-width is mounted in an aluminum shield box. Twenty output signals of the array are transferred by a driver unit to newly developed 14 bit analog-to-digital (AD) converters about 100 m away from the detector array. The AD converter has capability of 2 MHz maximum sampling rate, where 128 kW digital memory area is allotted per channel. The AD converter module includes a set of DC amplifier and low pass filter per one channel.

At the present plan, the arrays are arranged only on limited poloidal positions as shown in Fig.2. This is a reason why all of detector arrays are arranged to easily avoid long time irradiation from powerful long pulse plasma. We will optimize the arrangement of the arrays to be more suitable for tomographic measurements, developing a new detector holder protected against high heat load.

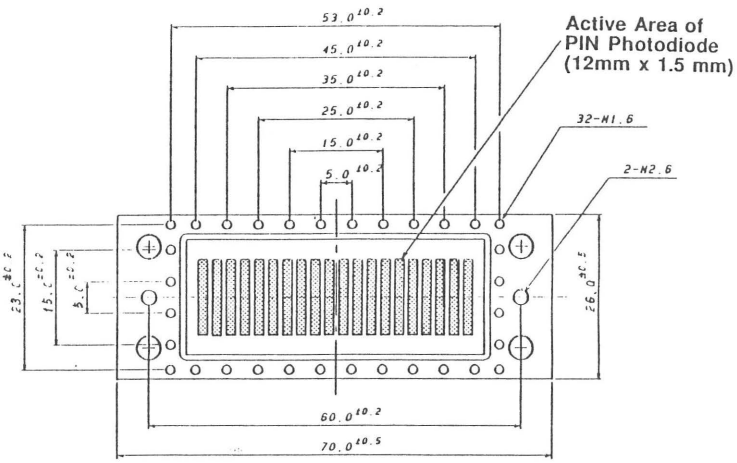

Fig.1 Geometrical structure of the front surface of a linear array of 20 PIN photodiodes, where it is shown in mm units.

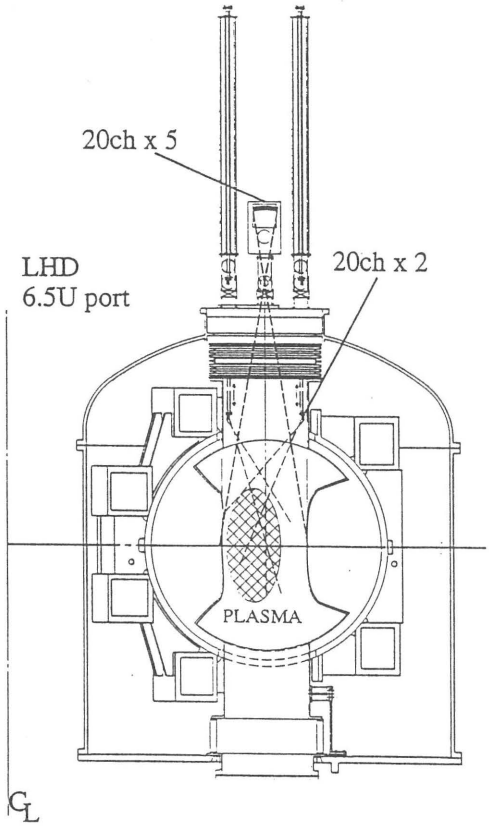

Fig.2 Soft X-ray detector arrays arranged on the upper port in LHD. A fix fan array mounts 100 detectors and the other two having 40 detectors respectively are movable in the vertical direction of 2 m.