§12. Bolometer Studies at NIFS

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This report details research activity during the 1997 fiscal year in preparation for bolometer measurements on the Large Helical Device (LHD) at the National Institute for Fusion Science (NIFS). These activities can be divided between testing and installation of conventional metal film resistive bolometers and development of a new concept, the Infra-Red Imaging Bolometer (IRIB).

Preparatory activity with the PTS bolometers involved calibration and installation on LHD of 28 channels in preparation for the beginning of experiments. Calibration was carried out in a vacuum test stand using a helium neon laser to illuminate the carbon blackened PTS bolometers. This resulted in a measurement of each detector's sensitivity and thermal decay time. 20 channels were then installed in an array at a lower port viewing the main plasma and the lower inboard divertor region with a spatial resolution of approximately 10 cm at the mid plane (Fig. 1). Two additional arrays of 4 channels each were installed at outer ports for use as wide angle bolometers for measurement of total radiated power.. One of the 4 ch arrays Additional work was performed to install amplifiers, control systems, cabling and shutter and gate valves to insure a bolometer diagnostic which was operational from the first plasma in LHD.

A prototype of the IRIB[1] was designed, fabricated and tested in a vacuum test stand prior to being installed in CHS for preliminary measurements. This concept is based on a thin metal foil which is sandwiched between two copper masks with matching two dimensional patterns of holes, exposing the foil on both sides. The front side of two dimensional array of foils views the plasma through a pinhole, while the backside of the array is blackened for viewing with an IR camera. Therefore the temperature rise of the foil resulting form the radiation and neutral particles from the plasma is measured with the IR camera. Gold foils with diameters varying from 3 mm to 13 mm and thicknesses ranging from 0.5 to 2 microns were tested by illuminating them with a helium neon laser in vacuum and compared to a model based on the time dependent solution to the heat flow equations. This comparison showed that the sensitivity of the foils and their thermal decay times were approximately twice as large as those predicted by the model. This discrepancy may be due to poor heat conduction to the copper mask at the edge of the foil and the Gaussian profile of the laser beam used in the investigation (compared to the uniform illumination assumed by the model). Preliminary experiments on CHS showed promising signal levels, but precise analysis was postponed to FY 1998 when we could replace the Amber (LANL) IR camera having video output with the Agema (NIFS) IR camera having 12 bit digital output.

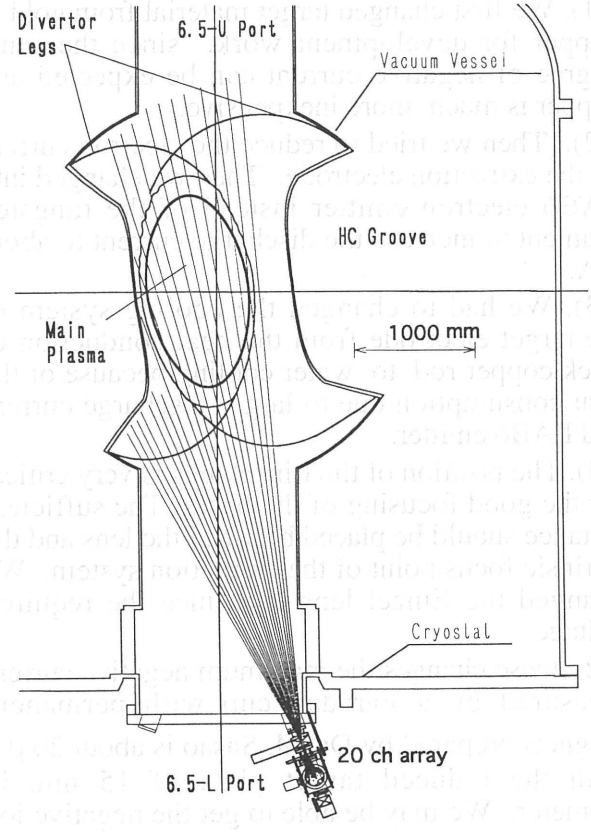

Fig. 1 Bolometer array installed at Port 6.5-L.

References

[1]G.A. Wurden, et al., "Design of an imaging bolometer system for the Large Helical Device", Rev. of Sci. Instrum. 68, 766-769 (1997).