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§9. Microwave Imaging Reflectometry for the LHD Edge Plasma

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A reflectometer part of a new diagnostic tool for simultaneous measurements of the temperature and density fluctuations was installed at LHD during last campaign. The main aim of this diagnostic is to extend the range and detail of turbulence measurement capability in fusion plasmas. Both the Microwave Imaging Reflectometry (MIR) and ECE Imaging techniques take advantage of large aperture optics to form an image of the reflecting layer onto an array of detectors located at the image plane, enabling localized sampling of small plasma areas.

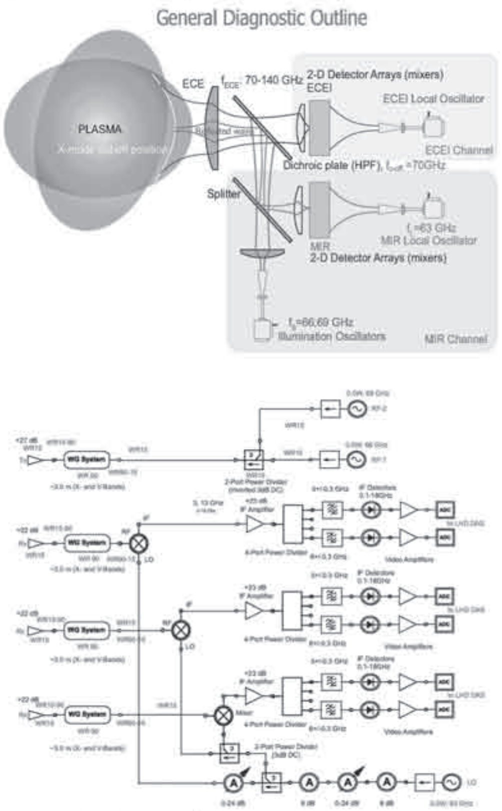

Fig.1. Schematic layout of the combined MIR and ECEI systems (top); microwave layout of the 3-channel reflectometer (bottom).

Based on LHD edge plasma densities the reflectometer utilized frequencies of 66, 69 GHz (V-band) for the probing the plasma with X-mode polarized radiation. The basic schematic of system is depicted in the Fig.1. The focusing elements of the microwave imaging system are consisting of main focusing elliptical mirror and one plane reflector. Both mirrors are located inside the LHD vacuum chamber. For the test run the MIR system was exclusively occupied the LHD 4O-CC01 diagnostic port. In spite of not optimal plasma conditions (low electron plasma density) the system shows the strong reflected signal from the LHD plasmas. Because of using the heterodyne receiving technique (Fig.1) for signal detection with combination of high powered launching oscillators the test run shows the capability of the receiving system to acquire the plasma reflected signals in the range of -45 to -50 dB. For 2004-2005 LHD campaign MIR was operated as 3-channel system. The channels were focusing at three different plasma locations, which are separated in radial, azimuthal and toroidal directions. This allows performing the auto- and crossing correlation analysis of the obtained data.

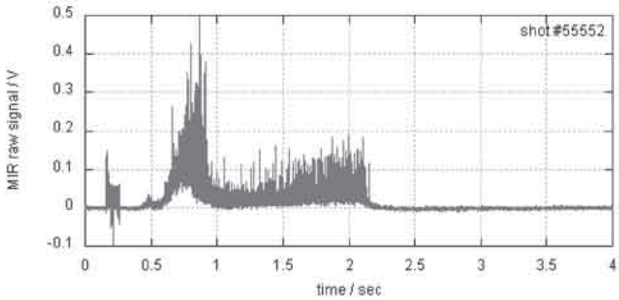

Fig.2. Time evolutions of the reflected RF signal; shot #55552

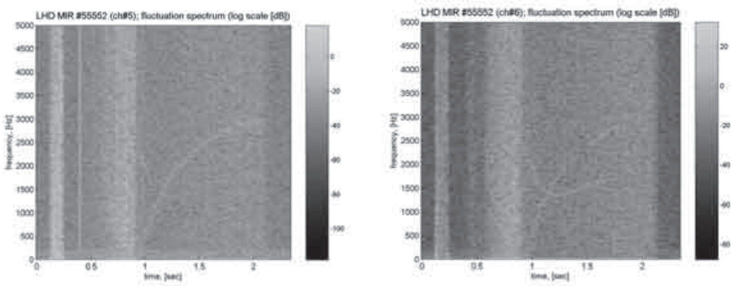

Fig.3. Spectrograms of the reflected signals at 66 GHz for the central (left) and radial for 69 GHz (right) of the MIR for the LHD plasma; shot #55552

The Fourier spectrums for the data windows of 100 μs are plotted in the Fig.3. Based on current data the cross-correlation for the *center* and *poloidal* channel was calculated. From the Fourier analysis the time of τ_{corr} = 1.5 sec the partial correlation of 2.5 ms is obtained. We can estimate the poloidal rotation velocity from the values of poloidal correlation length and poloidal correlation time $V_0 \propto L_0/\tau_{corr} = 0.11/2.5\times10^{-3} = 44 m/s$.

Those low frequencies and rotation velocities could not be considered as the evidence of the any drift waves. One of the possible origins is General Acoustic Modes (GAM), but it must be confirmed by future measurements.

It is become clear that a new elliptical focusing mirror has to be installed. This mirror has to be able to change the focusing point in both toroidal and poloidal directions. Thus, it will expand the ability of present system operate under a wider range of plasma parameters.