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Fast Scan Fourier Transform Michelson Interferometer System for SST-1 Tokamak

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A fast scan Fourier transform Michelson interferometer system has been installed on SST-1 tokamak. The diagnostic determines electron temperature profile and its evolution by measuring electron cyclotron emissions (ECE) from plasma. This is the first diagnostic on SST-1 to probe higher harmonics of the ECE radiations in 70-500 GHz frequency range. During plasma operation, every 17 ms the system generates an electron temperate profile with a spectral resolution of 3.66 GHz.

The paper addresses different aspects of the diagnostic which have been realized successfully to make Michelson interferometer operational for ECE measurements on SST-1 for the first time. These are - Design and development of wave collection and transport system, In-lab / absolute calibration of the diagnostic & Development and characterization of a new high temperature black body calibration source.

A new wave collection and transport system (WCTS) has been designed and employed to transport signal from SST-1 hall to diagnostics lab. To reduce transmission losses, the layout of transmission line has been done using oversized S-band waveguides and mitre bends in TE01 mode. The design and simulation of the WCTS is done using CST microwave studio. Insertion and return loss determined through simulation in the frequency range 70-170 GHz have been verified with laboratory measurements.

In-lab and absolute calibration of the diagnostics has been carried out with hot-cold technique [1, 2] in the frequency range 70-500 GHz by periodic switching between the cold source (at 77 K) and room temperature source. Digital signal filtering and coherent averaging of the raw data is done to obtain difference interferograms. The difference interferograms are Fourier transformed and by using Rayleigh-Jeans law and the sensitivity of the diagnostics is determined [1]. The in-lab and absolute calibration factors have been successfully determined and the presence of water absorption lines was observed at its expected frequencies which deteriorate the signal strength around 556 and 752 GHz. The measured calibration factor has been shown in Figure-1 with significant signal strength up to 1 THz.

To reduce the averaging time and improve the signal to noise ratio during absolute calibration, a new high temperature black body source at 873 K with silicon carbide emitter has been developed with a maximum surface temperature variation of 15 K. Radiation temperature of the calibration source has been measured and radiation losses have been calculated in the entire frequency range. Figure-2 shows the radiation temperature of the high temperature source as a function of frequency. The radiation temperature is found to be about 125 K below the black body physical temperature due to radiation losses.

The results obtained in each section above will be presented and discussed in the paper in detail. The diagnostic is ready for plasma operation during the upcoming SST-1 experimental campaign and will determine electron temperature profile and its evolution with time.

References

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[2] S. Schmuck1 , J. Fessey ,L. Figini and JET EFDA Contributors, Implication of Absolute Calibration for Michelson Interferometer ECE Diagnostic at JET for ITER

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