# Seminar

# Institute for Plasma Research

**Title :** Design and Development of Microwave Interferometer and Reflectometer Systems for Plasma Diagnostics in Tokamak

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**Date :** 29th January 2019 (Tuesday)

**Time :** 04.00 PM

**Venue :** Seminar Hall, IPR

## Abstract :

The microwave interferometry and reflectometry have been widely used to measure plasma density and its fluctuations in different tokamaks and other plasma machines all over the world. The tokamak has become the predominant research tool in the world-wide endeavour to develop useful electrical power based on controlled thermonuclear fusion. This is the most successful scheme for confining plasma magnetically.

The present work aims to design and development of microwave interferometer and microwave reflectometer systems for plasma diagnostics in tokamak. A seven channel microwave interferometer (at 100 GHz) is designed, developed and used to measure the radial profile of the plasma density ($n_e$) in Aditya Tokamak. The resolution of the density measurement is $n_e = 2.0 \times 10^{11} cm^{-3}$. The spatial and time resolutions are 7 cm and 10 µs, respectively. The chord-averaged measurements of plasma density in Aditya Tokamak from seven channels are carried out. Abel inversion is used to obtain the radial profile of the plasma density. Plasma density measured by the microwave interferometer is well matched with that measured by the Thomson scattering diagnostics.

The centre channel of this interferometer is modified making a quadrature circuit by using phase shifters and magic tees to measure the electron density online at the central chord of Aditya Tokamak, unambiguously. This is used to produce the sine/cosine fringe signals. These outputs are amplified and converted into pulses and passed to wired logic up/down fringe counter. Digital synchronous logic circuit is implemented in a Complex Programmable Logic Device (CPLD), followed by digital to analog converter (DAC) and scaler which produce a voltage proportional to increase or decrease in plasma density in real time. Microwave interferometer system is used to measure the plasma density at Aditya Tokamak.

Magnetohydrodynamics (MHD) has been studied using microwave interferometer system MHD) modes and sawtooth activities are observed in many discharges in 100 GHz interferometer signal in Aditya Tokamak. Two types of discharges have been observed, one with a single dominant mode and the other with multiple modes during the current flat top of discharge. Time frequency and the bispectral analysis of these discharges of the interferometer signals allow studies of mode coupling and its role in sustenance and termination of discharges. Role of mode coupling in determining the disruption phenomena in Aditya Tokamak discharges using microwave interferometer diagnostics is reported.

A fixed-frequency (*O-mode*) microwave reflectometer at 22 GHz ($n_c = 6 \times 10^{12}$ $cm^{-3}$) is designed, developed and used to measure plasma density fluctuations. These fluctuations from $r$=11 to 22 cm for different central electron densities have been measured. The evolution of reflectometer output signal is studied and compared with the microwave interferometer signal. The measured autocorrelation time of the reflectometer signal is ~8 µs. The power-spectrum analysis shows that the frequency spectrum is broadband. The radial variation of the fluctuation level is observed from 5 to 22% for the minor radius 11 to 22 cm.