Seminar

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Institute for Plasma Research

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Title: Reflectometry studies of plasma electron density profiles for Aditya Upgrade Tokamak

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Abstract

Achievement of high densities, temperatures and energy confinement times are the essential ingredients for the success of any magnetic confinement device for plasmas as defined by the fusion triple product. For tokamaks, measuring electron density profiles is amongst the most important plasma diagnostics as the steepness of the density pedestal is a direct measure for plasma confinement. One of the characteristic of a fusion grade plasma in a tokamak is transition from a parabolic to sheer edge density pedestal with enhanced energy confinement, reduced turbulence and improved stability to what is called the Low to High confinement mode (H-mode). Reflectometry is an important diagnostic which is capable of measuring such an L-H transition. First ever plasma electron density profiles have been measured using a K-Band and Ka-Band FMCW reflectometer operating in the O-mode. In this thesis, requirements for the diagnostic and its implementation is discussed in detail. Starting from the physics of reflection in a plasma and need for phase delay measurement we discuss the selection of phase detection scheme, need to sweep ultra-wide bands in ultra-fast sweep times and finally the sub-systems developed to enable measurements. Characterization of the developed reflectometer system is discussed exhaustively. A code for extraction of phase due to plasma from the total measured phase has been written from scratch. First ever measurements of density profiles for Aditya-U using the diagnostic are presented and results discussed.

Reflectometry is a versatile technique which can also measure density fluctuations in the tokamak. A pseudo-spectral computational fluid dynamics code which qualitatively solves a simple turbulence model for the edge tokamak plasma is also developed. The Charney Hasegawa Mima (CHM) model takes homogeneity due to the plasma density gradient as an input. We solve CHM model for ideal parabolic density and also profiles measured using reflectometry. Wave number spectra of the edge turbulence is obtained numerically. A broadband turbulence spectra is observed along with a drift along the θ-like direction. The obtained k-spectra can serve the dual purpose of input for designing the fluctuation reflectometer for Aditya-U tokamak and also to understand the physics behind the observed spectra.