

Design and testing of X-mode reflectometry system for coupling studies of lower hybrid waves in ADITYA-U tokamak

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A new passive active multijunction antenna (PAM) has been designed and is in advance stages of fabrication for ADITYA-U tokamak. The PAM antenna has the ability to couple lower hybrid waves (LHW's) in to the plasmas near cut-off densities. The coupling of LHW's depends on plasma density and its profile near the mouth of the antenna. To determine these plasma parameters, experimentally, an X-mode reflectometry system has been designed and is under fabrication. The reflectometry system is designed to operate in the frequency range from 26 GHz to 36 GHz and would cover a density range from SOL to $5 \times 10^{18} \text{ m}^{-3}$ with a toroidal magnetic field between 1 T and 1.5 Tesla. The total frequency band is swept in 100 microsecond to improve density profile reconstruction. The ADITYA reflectometer is built to operate in frequency modulation continuous mode (FW-CM) or at a fix frequency mode for density fluctuation study. The reflectometry consists of two parts, i.e., the transmitter and the receiver. The transmitter mainly consists of microwave source, amplifier, a single sideband modulator (SSBM), frequency multiplier and a horn antenna to launch x-mode in to the plasma. Similarly the receiver consists of horn antenna, amplifier, mixer and de-modulator. In the de-modulator section, a quadratic demodulation (IQ) is used to extract in-phase and quadrature-phase information from the reflected signal. These measurements provides the density profile information. Finally, an ADC with 12 bit resolution will convert the analog signal in to a digital signal which will be processed through a FPGA based data acquisition system. Sectorial E-plane horn antenna is designed using commercial available software for transmitting/receiving microwave signal to/from the plasma and has an input cross-section of $7.112\text{mm} \times 3.556\text{mm}$ and output cross-section of $7.112\text{mm} \times 63.64\text{mm}$. The length of antenna is 120mm. The analysis of the antenna meets our design requirement of high gain (16dB), low insertion loss and low VSWR (1.1). As the sectorial E-plane antenna is placed inside the tokamak, the above mentioned gain is significant. The details of the reflectometry system focusing on the design of sectorial E plane horn antenna, microwave hardware, test result of different microwave components, along with the density profile reconstruction technique will be presented in this paper.

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Author: Mr KUMAR, Jagabandhu (InIPR)

Co-authors: Mr PATEL, Amit (Charotar University of Science and Technology, Changa, Anand, Gujarat, India); Mr VIRANI, Chetan (InIPR); Mr MAHANT, Keyur (Charotar University of Science and Technology, Changa, Anand, Gujarat, India); Mr AMBULKAR, Kiran (InIPR); Dr SHARMA, Pramod (InIPR); Mr JAIN, Yogesh (InIPR)

Presenter: Mr KUMAR, Jagabandhu (InIPR)

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