Seminar

Institute for Plasma Research

Title: ECRH in plasma and 82.6GHz-400kW ECRH system on Tokamak SST-1

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Venue: Seminar Hall, IPR

Abstract

The Electron Cyclotron Resonance Heating (ECRH) is most demanding heating system for tokamak plasma, it is used for breakdown, heating, current drive and NTM control, etc. In superconducting tokamaks ECRH is an essential heating system for plasma start-up and current ramp-up. Normally, fundamental O-mode and second harmonic X-mode is launched from the low field side of tokamak to carry out various ECRH experiments. The fundamental O-mode has limitations of density cut-off while fundamental X-mode has better absorption but it is not accessible from the low field side. The fundamental O-mode needs lower power for plasma breakdown while second harmonic demands higher power for reliable and sustainable breakdown and current ramp-up in tokamak.

An 82.6GHz-400kW ECRH system has been commissioned on tokamak SST-1 to carry out various experiments related to plasma breakdown and ECR heating at fundamental (2.6T to 3.0T) and second harmonic (1.5T). The system consists of a Gyrotron, transmission line and a quasi-optical launcher. The 82.6GHz Gyrotron has been commissioned successfully and tested on dummy load for full power 400kW for full duration 500ms. The Gyrotron delivers 400kW power at -48kV cathode voltage and anode voltage is +21kV. The beam current is around 21A. The burn pattern at the exit of gyrotron ensures good Gaussian beam (TEM00 mode).

The transmission line (circular corrugated waveguide with inner diameter 63.5mm) consists of a matching optic unit, two DC breaks, bellows, corrugated waveguide, polarizer, bends, waveguide switch and window. The launcher consists of two mirrors one focusing and other plane mirror. The launcher is designed to optimize the beam diameter at plasma diameter and the beam diameter at plasma centre is 100mm. After testing the Gyrotron on dummy load, entire transmission line connected with tokamak. The high power test of transmission line is also carried out, microwave power gradually increased from low power short pulse to higher power (~350kW) for long pulse up to 400ms. In order to check the alignment of launcher mirror, a special test with actual Gyrotron power has been carried out inside the tokamak. The thermal paper is installed at the inboard side wall of tokamak and power launched to check the actual position of microwave beam after minor adjustment of launcher mirror the ECRH beam is aligned to the mid plane of tokamak.

In the recent SST-1 campaign, ECRH is launched and successful breakdown is also achieved at fundamental harmonic. The dedicated ECRH experiments will be carried on SST-1 using this 82.6GHz ECRH system in forthcoming campaigns. The talk will explain about the ECRH theory, its applications in tokamak plasma, preferred modes of launched etc. and discusses on the recently commissioned 82.6GHz-400kW ECRH system on SST-1.