Seminar

Institute for Plasma Research

Title : Simulation study on Lower Hybrid Current (LHCD) efficiency for KSTAR Tokamak

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Date : 23 January 2012, Monday
Time : 3:30 PM
Venue : Seminar Hall, IPR

Abstract:

Lower hybrid (LH) waves have been proved one of the most efficient methods of non-inductive current drive (CD) and off-axis current profile control in tokamak experiments such as Tore Supra, TRIAM-IM, FTU, JET, JT-60U and HT-7. It is the key element of all the present devices addressing long pulse issues, as it exhibits the highest CD efficiency in present devices at low plasma temperatures. The off-axis current driven by the LH waves can create broad or even hollow current profiles required in an advanced tokamak (AT) scenario by introducing negative magnetic shear. In order to have a commercial fusion reactor, the requirement of steady state operation of a tokamak is realized, for e.g in advanced tokamak operation modes. LH waves have been successfully utilized for electron and ion plasma heating as well as to sustain and ramp up toroidal plasma current for inductive flux saving needs. It is also used to stabilize sawteeth in tokamaks during LHCD experiments

The talk will be focused on simulation results of 5 GHz LHCD efficiency for KSTAR tokamak. LHCD efficiency calculated using parallel wave number spectrum given by Brambilla coupling code followed by theoretical expression given for it. LH wave driven current and CD efficiency determined using Lower hybrid simulation code (LSC) for 5 GHz KSTAR LHCD. Scan of different parameters of lower hybrid grill launcher and plasma parameters have been done. The KSTAR 5 GHz steady state system is designed to couple 1.5 MW power for 300 seconds by four 500 kW CW klystrons. The plasma equilibrium parameters for the KSTAR tokamak used for calculation are given as toroidal magnetic field $B_T = 2 - 3.5T$, plasma current $I_p \sim 2$ MA, central plasma density $n_{e0} \sim n_{i0} = 0.2 - 2.0$ x

$10^{20}m^{-3}$ and central electron temperature $T_{e0} \sim T_{i0}$ = 1 - 20 keV. A significant effect of plasma density and temperature along with their profile has been observed on RF-driven current and CD efficiency. The on-/off-axis current profile controllability is also investigated through parame tric scan, and small negative magnetic shear is seen at the narrow region of the off-axis for ve ry high temperature regime. In order to achieve the same for lower temperature regime, I_p has to be lower and also for higher LH-power compromising with CD efficiency in this case. Also, the expected results of the CD efficiency and total RF-driven current are presented for initial stage of KSTAR LHCD on the basis of current design of LHCD launcher and present operating condition of plasma density and temperature. Perhaps, the current approximately 200 kA/MW (off-axis deposition position r/a $\geq$ 0.3) is expected to obtain with CD efficiency 0.1 x 10^{20} $m^{-2}AW^{-1}$ in initial LHCD operation phase for KSTAR. The central plasma density and central electron temperature are expected to be of the order of $\sim$ 0.5 x 10^{20} m^{-3} and $\sim$ 1- 5 keV respectively using $N_{||}$ = 1.8 - 2.4 for it.

Detailed results for CD efficiency and current deposition profile along with their discussion will be presented in the talk.