Seminar

Institute for Plasma Research

Title : 3D Monte-Carlo simulation of Aditya tokamak Scrape-off layer plasma transport with toroidally discontinuous limiters

Speaker : Mr. Bibhu Prasad Sahoo
Institute for Plasma Research, Gandhinagar

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Abstract :

Research in small and medium size tokamaks presents attractive option since many of these devices aim to achieve the conditions that might allow addressing a range of issues specific to larger, reactor like environment in more accessible setup. The experiments in original Aditya tokamak configuration as well as its upgrade are also motivated by these issues. The present work addressed a set of issues related to Scrape-off Layer (SOL) plasma transport in Aditya tokamak using the steady-state Monte-Carlo transport simulation model of the 3D transport simulation code EMC3-EIRENE [1]. The transport simulations treating plasma-fluid and kinetic neutral species are performed for both, the original poloidally continuous ring limiter (RL) and a toroidally distributed set of outboard block limiters (BL) installed on the Aditya-Upgrade configuration. In first part of the work, the 3D transport solutions and profiles simulated in this study are also applied to interpret the limited probe measurements available from the Aditya RL SOL. It is additionally noted that resulting from complexity of connection length distribution, the poloidal structure of pressure profiles obtained from steady state transport equilibrium are quasi-periodic and are source of additional vorticity by generating secondary drifts. The resulting change in the ratio DEDGE/DSOL indicates a corresponding impact on the confinement properties of EDGE and SOL region [2]. The observation in Aditya that a considerably higher anomalous diffusivity (about an order of magnitude than usual) reduces in response to a gas puff is considered in the second set of simulations with variation in edge density and diffusivity to analyze their effects on the SOL plasma transport properties [3]. The 3D poloidal variations are observed to be stronger function of diffusivity in the low density cases indicating reduced stability on open field lines. The third part of the work also implements transport in Aditya-Upgrade relevant SOL setups and explores comparison between the SOL transport in original Aditya RL and upgrade-like outboard BL configurations [4]. The central issue addressed is that of a finite diffusive flux of plasma to the main chamber wall as reported in recent observations on ALCATOR-C that might result in loss of neutral particle control. The process was identified in ALCATOR-C to affect both in moderate size as well as reactor scale devices, perhaps introducing a main chamber recycling induced density limit [5]. Using the present 3D EMC3-EIRENE simulations this mechanism is captured in a rather complex geometry of Aditya ring limiter SOL where the recycling is however accounted for only at the limiter surface. The mechanism behind the wall recycling is identified in present simulations to be operational at downstream location in Aditya RL case which has regions of long connection lengths that are also rich in recycling neutrals. The existence of the wall recycling in long connection length regions indicates its possible dominance at downstream locations in the larger devices having longer connection lengths, for example the startup limiter phase of the ITER device. Requirement of a complete 3D study which is projected which can be done by including the off-limiter wall recycling in the simulations in order to understand the issue of density limit due to main chamber recycling, as witnessed in ALCATOR-C. In the comparison with Aditya-Upgrade cases simulated in the study, the effect of an about three times smaller average connection length in upgrade relevant block limiter configuration is noted to be responsible for a much reduced wall recycling in the Aditya Upgrade which indicates an improved control and stability of the upstream plasmas.

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