Proposition de sujet de thèse

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TITLE of the THESIS :

3D Modeling of the Neutrals Beam Injector for ITER

Abstract

External heating sources are needed to sustain the nuclear reactions in the future experimental fusion reactor ITER. Heating of plasma ions will be performed through the injection of energetic D° beams. ITER requires two Neutral Beam Injectors (NBI) providing 40 A of negative ions (NI) each at 1 MeV, which is converted to high energy neutrals to reach the plasma core. Hence, the NBI for ITER is composed of the NI source (D-), the accelerator (1 MV), the neutralizer (for the conversion of D- in D°), and the deflector system of charged particles removal from the beam after their partial neutralization (~20% D- and ~20% D+).
The numerical simulation work performed during the last four years at LPGP was focused on three sub-systems of the NBI, namely the NI extraction from the plasma source, the neutralizer, and the electrostatic residual ion dump (E-RID). All of them are based on Particle-in-Cell approach coupled with Monte Carlo to describe the particle collisions.

The extraction simulation code (**ONIX**) describes the 3D behaviour of the NI leaving the plasma source assuming the plasma conditions in front of the extraction aperture and taking into account the volume kinetics and surface processes.
The neutralizer and the E-RID are self-consistently treated in 3D (**OBI-3**) code giving insights of the beam conversion efficiency and the interaction of the secondary plasma that develops in the neutralizer with the high electric field of the RID.

The project is to develop the complete tool for the numerical simulation for the NBI from the extraction of the negative ions to their injection in the Tokamak. The missing part of the code is the accelerator simulation, which can be performed for the multi-grid configuration that was selected for the ITER implementation.
This new code, called OBI-4 (Orsay Beam Injector for ITER) will merge the two available code ONIX and OBI-3, at least in terms of input-output adding the accelerator modelling. It is self-consistently buil, excepting the simulation of the inductive coupled plasma source used as driver for the negative ion production.

This work will be performed in the 'Theory and Modelling of Plasmas' team of the LPGP in cooperation with the IRFM/CEA Cadarache.

Keywords :

Particle-In-Cell numerical simulations, negative ion beam, non-equilibrium plasma sources, magnetized plasmas

Financial support : CNRS (50 % support)