Kinetic study of the secondary plasma created in the ITER neutraliser

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This work presents the numerical study of the D^- beam transport through the ITER neutraliser. The main objective is to determine the properties of the secondary plasma created by the beam particles via ionising collisions with the target gas (D_2) that fills the neutraliser.

There are at least two reasons to characterise this secondary plasma. First, the plasma will screen the beam space charge, preventing the Coulomb explosion of the beam and ensuring its correct focalisation. It can also affect the electric field distribution between the accelerator and the neutralizer, and thus the trajectories of both beam particles and plasma particles. Therefore, to determine the properties of the extracted beam a detailed knowledge of this secondary plasma is required. Second, the plasma can escape from the neutralizer either backward toward the accelerating grids or forward up to the Residual Ion Dump (RID). This plasma expansion can affect the behaviour of the whole neutral beam injector; in particular it can modify the power load over the walls.

Simulations of the beam transport have been performed using a Particle-in-Cell (PIC) code implementing a Monte Carlo Collisions (MCC) scheme for the treatment of elastic and inelastic collisions. As well, the detailed analysis of the plasma particle kinetics has been realised via a 0D-Boltzmann code. From these calculations, it is possible to quantify the relative role played by the various kinetic processes and the relevant species of plasma, allowing then to identify a minimal set of kinetic processes to be included into the PIC-MCC simulation.

Our computational results show that a low-temperature plasma is created inside the neutralizer (ionization degree $\sim 10^{-3}$, electron temperature ~15 eV). This plasma is dense enough to screen efficiently the beam spatial charge, allowing its correct focalization. The plasma positive ions are mainly molecular ($D_2^+ > 90\%$) and they can escape from the neutralizer, reaching the accelerator after some μs. Simulations show that the induced current inside the accelerator depends strongly on the configuration of the electric field close to the accelerator. We have also estimated the neutral gas temperature inside the neutraliser, which is found to never exceed 600K.

Topic: **1**

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