Mitigation of parallel RF potentials by an appropriate antenna design using TOPICA

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A substantial effort has been devoted in recent years to the optimization of the ITER Ion Cyclotron (IC) launcher [1], above all with the aim of maximizing the coupling performances of the antenna; good improvements have been documented by using TOPICA code [2], a predictive tool for the design and optimization of RF launchers in front of a plasma region.

Despite the progresses in the mentioned topic, this is not the only issue related to the design of IC antennas: a second crucial aspect is the impurities production which is driven by the parallel RF potentials generated by the antenna itself and by the surrounding structures. The goal of this work is to analyze a set of innovative solutions that could be implemented in the next generation of IC antennas in order to mitigate the parallel RF potentials without reducing the power delivered to plasma.

To achieve this challenging task, the TOPICA code has been adopted, taking advantage of recently introduced features. In particular, the code permits to compute the electric field distribution everywhere inside the antenna enclosure and in the plasma column, allowing to determine not only the magnitude and shape of the fields in front of the antenna, but also to evaluate their radial decay. With the help of a specific post-processing tool that computes the integral of the parallel component of the electric field along the magnetic field lines in a realistic 3D geometry, it is then possible to determine the parallel RF potentials and, even more important, to directly verify the impact of geometrical modifications of the front elements of the antenna on the RF potentials themselves. Furthermore, the capability to simulate the full 3D antenna with a high geometrical accuracy (as the one provided by commercial codes) and to account for an accurate plasma model indicates in the TOPICA code a perfect candidate for this specific task.

To lower the parallel RF potentials, two complementary approaches are outlined in the paper: the first one acts on the reduction of the electric field values, the second works on the minimization of the geometrical asymmetries of the launcher. Pros and cons of the adopted solutions are discussed in detail.

Two realistic cases have been taken into account in this work. Firstly, an ITER-like IC launcher has been adopted as a reference and optimized, then a few solutions have been proposed for the ASDEX Upgrade experiment with the final goal of testing the most promising concept for the machine in the coming years. This second activity has been carried out in collaboration with IPP-Garching and ENEA-Frascati.

[1] Nucl. Fusion, 50 (2010) 025007
[2] Nucl. Fusion, 46 (2006) S476