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TH/P6-12: Advanced ICRF Scenarios and Antennae for Large Fusion Machines from JET to DEMO

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Recent JET ICRF experiments in ITER-like new Be chamber [1] demonstrated strongly larger Tungsten content in plasma core compared with the NBI case thus evidencing remarkable waves interaction with a boundary plasma and wall. Also it was reported the remarkable Antennae loading resistance decrease for four Antennae A2 used when compared with previous datas for Carbon wall.
We have performed extensive 3D STELION code (coupled with 2D F-P solver) modeling of the Minority ions scenarios D(H), D(He3) and Heavy minority D(Be) scenario for JET, IGNITOR, ITER and DEMO plasmas. All these scenarios demonstrate the multi pass absorption regimes with multiple FW eigen modes excitation of the Toroidal resonators thus involving some power deposition to the periphery plasmas presumably being reason for imputities release. These results are supported by accurate novel analytical formula for FW optical thickness. Extremely energetic and strongly anysotropic proton tails, dragged by electrons, in D(H) or He4(H) scenarios are demonstrated for all above machines. The Beryllium Heavy minority scenario D(Be), proposed and modelled for JET [2], is better one due to Be tails absence but still suffers by multi pass absorption regime. This last scenario permits Be content determination in plasma core by experimentally identifying the D-Be ion-ion hybrid layer position[2].
Fortunately we have found by 3D simulations, supported by analytical formulas, that minority hydrogen second harmonic scenario crucially improves the wave absorption providing the Single Pass Absorption (SPA) regime. Higher frequences (for JET's proposal [2] –57 MHz) from 57 to 352 MHz to new scenario for the above machines, starting from ITER (80 & 152 MHz), give a possibility to drasically increase the coupling antenna-plasma and a possibility to use resonators/waveguides types antennae which are much higher electrically strong, are compact and easily matched with RF generators. Problems with interloops mismatching for multi loops antennae, met for ILA on JET, and now designed for similar ITER antenna, are overcome. Concepts of these antennae for ITER and IGNITOR will be shown. The Hydrogen minority contents are 6% for D-T ITER and DEMO, 10% for IGNITOR and 15-20% for JET D-He4 plasmas. This H-scenario was succesfully explored by H.Kimura et al on JT-60 in 1990-92.

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