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TH/P6-25: Benchmarking of Codes for Spatial Profiles of Electron Cyclotron Losses with Account of Plasma Equilibrium in Tokamak Reactors

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Potential importance of electron cyclotron (EC) wave emission in the local electron power balance in the steady-state regimes of ITER operation with high temperatures and in DEMO reactor suggested accurate calculations of the local net radiated power density, PEC(rho). When central electron temperature increases to ~30 keV the local EC power loss can become a substantial part of heating from fusion alphas and is close to the total auxiliary heating. The first benchmarking of the codes for calculating the spatial profiles of EC power losses was carried out with the codes SNECTR, CYTRAN, CYNEQ, and EXACTEC in a wide range of temperature and density profiles expected in reactor-grade tokamaks, for a homogeneous magnetic field, B(rho) = const (Albajar F., Bornatici M., Engelmann F. and Kukushkin A.B. 2009 Fusion Science and Technology 55 76-83). The benchmarking has shown good agreement of results within two different tasks: (i) specular reflection in a circular cylinder (SNECTR, EXACTEC), and (ii) diffuse reflection in any geometry or any type of reflection in noncircular toroids (SNECTR, CYTRAN, CYNEQ). Here we extend the above benchmarking to the case of an inhomogeneous profile of magnetic field, which is calculated with allowance for plasma equilibrium. This extension covers comparison of CYNEQ results with those from the RAYTEC code, for prescribed temperature and density profiles, and from CYTRAN and EXACTEC for plasma profiles, including electric current density profile, obtained in the frame of self-consistent 1.5D transport simulations in the frame of the ASTRA and the CRONOS suit of codes, respectively. This enables us to evaluate the role of plasma equilibrium effects (Shafranov shift, 2D plasma shape) on the PEC(rho) profile. The role of plasma equilibrium is analyzed also in application to the to the similarity of normalized PEC(rho) profiles, formerly observed in the calculations for the case of a constant magnetic field B(rho) = const. The role of this universality for an independent, additional benchmarking of the codes, and for accuracy assessment, is analyzed. The present benchmarking makes a substantial step towards practical tasks of reactor-grade tokamaks ITER and DEMO.

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