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## **COMPARISON OF MULTIPASS ELECTRON CYCLOTRON ABSORPTION MODELS FOR INJECTED ELECTROMAGNETIC WAVES IN PLASMA AT THE INITIAL STAGE OF DISCHARGE IN TOKAMAKS <sup>\*)</sup>**

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Electron cyclotron resonance heating (ECRH) is widely used in operating tokamaks during the quasi-stationary phase of discharge for additional plasma heating and non-inductive current drive [1]. In large tokamaks with superconducting coils (ITER, DEMO), ECRH will be applied also at the initial stage of discharge (for pre-ionization, plasma breakdown, and current ramp-up). This is due to technological issues: the foreseen toroidal electric field needed for ionization and plasma current generation is insufficient (significantly under the values used in most of the operating tokamaks) for purely ohmic breakdown [2], [3], [4].

The plasma temperature and density at the initial stage of discharge in tokamaks are such that full EC-absorption of the injected electromagnetic (EM) wave in a single pass before the reflection from the first wall is unattainable. Therefore, when simulating the initial stage of discharge in tokamaks for ECRH-assisted scenarios, it is necessary to consider multipass EC wave absorption. This simulation can be performed using various models: (1) the modified ray-tracing codes for EC heating calculations that account for multiple passes of EC waves, also taking into account for changes in the polarization of EC waves upon reflection from the wall, and wave absorption in the wall (e.g., the TORAY code [5]), this also includes ray-tracing codes simplified for initial stage of discharge conditions (using analytical absorption coefficients of EC waves in rarefied Maxwellian plasma [6]); (2) the model that considers the multipass absorption of EC waves within the approximation of isotropic and homogeneous intensity of EC radiation after the first reflection of the EC-wave from the wall of the vacuum chamber [7] (the model of the CYNEQ code for the transport of plasma-generated EC radiation at high harmonics of the fundamental EC frequency [8]) and the multi-resonator model for calculation of the stray EC radiation from unabsorbed waves injected by the ECRH system into the plasma [9].

The study compares existing approaches to modeling of the multipass EC absorption of injected EM waves in plasma at the initial stage of discharge in tokamaks.

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