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ITR/P1-06: Optimization of the EC Heating and Current Drive Capabilities

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A 24MW CW Electron Cyclotron Heating and Current Drive (EC H&CD) system operating at 170GHz is to be installed for the ITER tokamak. The ITER EC system will represent a large step forward in the use of microwave systems for plasma heating and current drive applications. Present day systems are operating in relatively short pulses (≤10s) and installed power levels of ≤4.5MW, while the ITER EC system parameters are CW operation and 20MW injected power. The technical challenge facing the development and installation of the EC system is further complicated due to the harsh ITER in-vessel environment and complicated procurement strategy. The ITER EC international community has confronted these challenges, aiming at integrating the modifications proposed from the 2007 ITER design review and further enhancing the EC system capabilities. These changes have not only simplified the technical design, but have also simplified the procurement interfaces and increased the functional capabilities for plasma heating and current drive applications. The functional improvements include increasing the access of the EC power from ~50% to nearly ~90% of the plasma cross section. In particular the UL has been modified to allow power deposition over the range of ~0.3≤ρT≤~0.9 compared to previous access of ~0.55≤ρT≤~0.85 (where ρT is the square root of the normalized toroidal flux). This allows the UL to be applicable for a broader access for stabilization of neoclassical tearing modes (NTMs) and sawtooth instability. The EC heating is functionally limited in magnetic field region depending on the resonant harmonic. The heating access in ITER was assumed to be applicable over ~33% of the range from 2.3T to 5.3T, regions of fundamental and second harmonics. Recent analysis associated with the EL has demonstrated that the EC system is applicable over a much broader range: ~75% for central heating (ρT≤~0.5) and ~90% for L to H-mode assist (ρT≤~0.85). Further improvements to the EC system are now being considered, which include adapting the PS to accommodate future higher power gyrotrons (≥1.2MW) and modifying the sweeping direction of the EL from a toroidal to poloidal steering more than doubling the driven current in the region of 0.4≤ρT≤0.6. These and other improvements under study will be reviewed in this paper.

Country or International Organization of Primary Author

ITER Organization

Author: Mr HENDERSON, Mark (ITER)

Presenter: Mr HENDERSON, Mark (ITER)

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