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ITR/P1-15: Development of ITER Scenarios for Pre-DT Operations

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In preparation for the full deuterium-tritium (DT) operation in ITER, a significant period of experimentation will be dedicated to plasma operations that generate no or minimal activation products. This operation would utilize plasmas with helium (He) or hydrogen (H) gas species since these generate no fusion reactions producing tritium or neutrons that result in materials activation. Present planning also includes consideration for deuterium (D) operation with possibly short pulse duration to limit the production of tritium and activation from DD fusion reaction neutrons. Low-activation operation is needed to qualify all major mechanical and electrical subsystems before reliance on remote handling capability. Access to and sustainment of the high-confinement mode (H-mode) must be demonstrated with sufficient control of edge localized modes to limit the power flow to the divertor. Results from time-dependent 2-dimensional equilibrium with 1-dimensional transport predictive simulations explore possible operating scenarios. Simulations in current flat top evaluate steady performance to determine the parameter operating space at full plasma current IP=15MA and magnetic field BT=5.3T and for reduced performance at 7.5MA and 2.65T. In addition to baseline neutral beam injection and electron cyclotron heating, techniques for application of ion cyclotron heating under steady conditions are presented. Full duration time-dependent simulations with start-up limited on the inside wall, IP ramp up to full current, flat top burn, and IP ramp down to develop controllable operating scenarios in H and D are presented. With present understanding of H-mode threshold scaling, the proposed auxiliary heating power level of 63MW (nominal) should allow access to H-mode operation in helium at 7.5 MA/ 2.65 T. Access to H-mode in pure H-plasmas would be, at best, marginal. Time-dependent free-boundary equilibrium simulations using controllers for the baseline operation indicate there is sufficient capability in the coil system to produce and control short pulse flat top plasmas suitable to validate physics and engineering systems before DT operation. These simulations are completed under a joint modeling effort in the Integrated Operations Scenarios (IOS) group of the International Tokamak Physics Activity (ITPA).

Country or International Organization of Primary Author

ITER Organization

Collaboration (if applicable, e.g., International Tokamak Physics Activities)

ITPA Integrated Operations Scenarios

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