BENCHMARKING OF ECH CODES FOR ITER*

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The design of the International Thermonuclear Experimental Reactor (ITER) includes power at the electron cyclotron frequency for plasma heating and current drive. Optimal design and use of this electron cyclotron heating (ECH) system requires that accurate and relatively quick computer codes be available for prediction of wave coupling, propagation, damping, and current drive at realistic levels of EC power. To this end, a number of codes have been developed in laboratories world-wide. A detailed comparison of these codes is desirable since they use a variety of methods for modeling the behavior and effects of the waves. The codes include the ray tracing codes BANDIT-3D, CQL3D, GENRAY, TORAY-GA, and TORAY-FOM and the Gaussian beam codes GRAY, OGRAY, and TORBEAM. BANDIT-3D, CQL3D, and OGRAY obtain absorption and current drive from a quasilinear solution of the Fokker-Planck equation, while the other codes use various analytic models. The approach used in this benchmarking study is to apply these codes to a single case using the equilibrium and kinetic profiles of the ITER Scenario 2 (15 MA, 5.3 T, Q=10) case. Following minor remedial work on some codes, the agreement between codes is excellent. The largest systematic differences are found between codes with weakly relativistic and fully relativistic evaluation of the resonance condition, but even there the differences amount to less than 0.02 in normalized minor radius. Quasilinear effects are not significant under ITER conditions. Since some of the codes have been well validated against experiment under conditions not too far from the ITER conditions [1,2], it seems that the fully relativistic codes are well qualified to predict the EC performance in ITER. The Gaussian beam codes are better suited in cases where the focus of the EC beam lies well inside the plasma.

References

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