ELECTRON BERNSTEIN WAVE RESEARCH ON OVERDENSE PLASMAS IN THE NATIONAL SPHERICAL TORUS EXPERIMENT*

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Magnetically confined spherical torus (ST) plasmas may offer an attractive design option for a high β fusion reactor, however this will only be a viable option if the plasma can be sustained with 100% non-inductive current. Since ST plasmas are inherently overdense, having a local electron plasma frequency that far exceeds the local fundamental electron cyclotron frequency over most of the plasma profile, conventional ECCD is not possible in ST plasma devices. Electron Bernstein wave current drive (EBWCD) can efficiently generate off-axis current that may be critical for sustaining solenoid-free ST plasmas. Fokker-Planck and 3-D EBW ray-tracing models [1-3], together with EBW emission diagnostics [4] are being employed to study electron Bernstein wave (EBW) coupling, propagation, damping and current drive physics in the National Spherical Torus Experiment (NSTX) at Princeton University. This research supports the design of a 4 MW, 28 GHz EBWCD system planned for NSTX. Modeling and emission measurements support ~100% EBW mode conversion from obliquely launched O-mode polarized electromagnetic waves and efficient local off-axis current generation via Ohkawa [5] current drive in a region of the NSTX plasma dominated by magnetically-trapped electrons. Intrinsic Doppler broadening of EBWs in the plasma is predicted to preclude core access at 28 GHz, however the off-axis EBWCD needed to support sustained high β operation in NSTX appears viable. EBWCD modeling for plasmas with β of 20-40% and launch frequencies of 14-28 GHz predicts current drive efficiencies of 40-50 kA/MW and EBW-driven current densities that peak at a normalized minor radius ~ 0.7 on the outboard side of the magnetic axis [1]. The EBW coupling efficiency at 16-18 GHz has been measured to be 80±20%, in agreement with modeling [3, 4].

References

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