

Electron Bernstein Wave Research on NSTX* and Pegasus**

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Spherical tokamaks (STs) routinely operate in the overdense regime ($\omega_{pe} \gg \Omega_{ce}$), prohibiting the use of standard ECCD and ECRH. However, the electrostatic electron Bernstein wave (EBW) can propagate in the overdense regime and is strongly absorbed and emitted at the electron cyclotron resonances. As such, EBWs offer the potential for local electron temperature measurements and local electron heating and current drive. A critical challenge for these applications is to establish efficient coupling between the EBWs and electromagnetic waves outside the cutoff layer.

On the National Spherical Tokamak Experiment (NSTX) located at the Princeton Plasma Physics Laboratory, two remotely steered, quad-ridged antennas have been installed to measure EBW emission (EBE) via the oblique B-X-O mode conversion process. These antennas are coupled to absolutely calibrated dual-channel radiometers, measuring fundamental (8-18 GHz), second and third harmonic (18-36 GHz) EBW emission, respectively. This diagnostic has been successfully used to map the EBW mode conversion efficiency as a function of poloidal and toroidal angles for L- and H-mode plasmas. Experimentally measured mode conversion efficiencies of $70 \pm 20\%$ have been measured for 15.5 GHz (fundamental) emission in L-mode discharges, in agreement with a numerical EBE simulation. However, much lower mode conversion efficiencies of $25 \pm 10\%$ have been measured for harmonic emission in L-mode plasmas, while EBE simulations suggest measured B-X-O coupling efficiencies of $\sim 90\%$ should be observed. H-mode B-X-O mode conversion efficiencies of $< 30\%$ for fundamental and second harmonic frequencies have also been measured. Results from recent experiments focused on finding conditions for increased B-X-O coupling from H-mode discharges will be presented. Plans for future medium power EBW coupling and heating experiments using a ~ 200 kW 15.3/28 GHz gyrotron will also be presented.

Numerical modeling of EBW propagation and damping on the very-low aspect ratio Pegasus Toroidal Experiment, located at the University of Wisconsin-Madison, has been performed using the GENRAY ray-tracing code and CQL3D Fokker-Planck code in support of planned EBW heating and current drive (EBWCD) experiments. Calculations were performed for 2.45 GHz waves launched with a 10 cm poloidal extent for a variety of plasma equilibrium configurations. Poloidal launch scans show that driven current is maximum when the poloidal launch angle is between 10 and 25 degrees, supporting a launcher placed near the midplane. Current was driven on axis primarily via the Fisch-Boozer mechanism. Modeling has also shown that off-axis current drive via the Ohkawa mechanism is possible. The Pegasus experiment provides an attractive opportunity to investigate EBW heating and current drive physics at the fundamental electron cyclotron frequency in an ST plasma, and will complement the EBW research planned for NSTX.

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