Technology Development

Physics and Technology Considerations for Electron Bernstein Wave (EBW) Heating and Current Drive on NSTX*

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The in-plasma mode conversion (MC) of electron cyclotron (EC) waves to electron Bernstein waves (EBW), offers the possibility of greatly extending the useful density range over which high frequency ECH type heating techniques and capabilities can be utilized. Thus, EBW would enhance high beta operation in NSTX. The localization of power can enable localized current and flow drive. At low density, ECH can be used for noninductive startup assist. Recent studies of EBWs, via MC to X-mode electromagnetic radiation on the CDX-U and NSTX spherical torus (ST) plasmas, indicate that high mode conversion efficiency may be possible. New EBW emission antenna designs for X-mode and O-X-B and dedicated experiments are focused on achieving > 80% MC on NSTX during the next experimental campaign.

A multi-megawatt EBW heating and current drive (H&CD) system is under consideration for NSTX that could assist plasma startup, locally heat electrons, drive non-inductive current and suppress tearing modes or other MHD that limit high β operation. There are number of physics and technology considerations and tradeoffs that influence the design and application of EBW H&CD and startup assist on NSTX. EBWs have better radial access at fundamental resonance frequencies than at higher EBW harmonics, especially at high β. Also, since the fundamental X-B and O-X-B mode conversion layer is at densities that lie in the NSTX plasma scrape off, fundamental launch would potentially allow the use of a local limiter to control the density scale length at the mode conversion layer and hence maximize the tunneling and mode conversion efficiency. The emission measurements will be used to guide the launcher antenna/plasma interface and to decide whether the antenna should be designed to accommodate both X-B (normal incidence) and O-X-B (oblique incidence). Fundamental launch at 8, 12 or 15.3 GHz and second harmonic launch at 28 GHz are all under consideration. There are high power tubes available at both 8 and 28 GHz. The possibility exists to modify the 28 GHz tubes to operate at 15.3 GHz, but likely at somewhat reduced efficiency. Further tube development would be required for optimized high power tubes at either 12 or 15 GHz.

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