Abstract: Overdense plasmas, where the electron plasma frequency exceeds the electron cyclotron frequency, prohibit the use of electron cyclotron (EC) heating and current drive methods often used to heat fusion-grade plasmas. The electrostatic electron Bernstein wave (EBW) can propagate in overdense plasmas and is readily absorbed and emitted near EC harmonics. Additionally, EBWs do not experience a density dependent cutoff. As such, EBWs may enable local electron temperature measurements and provide local heating and current drive. EBWs cannot propagate in vacuum but can couple to electromagnetic waves, so for these applications efficient coupling between the EBWs and electromagnetic waves outside the plasma is needed. Results of the first experimental verification of EBW collisional damping and its mitigation by evaporated lithium conditioning in overdense plasmas on the National Spherical Torus Experiment (NSTX) will be presented. Initial measurements of EBW emission, coupled from NSTX plasmas via double-mode conversion to O-mode waves, exhibited < 10% transmission efficiencies. Simulations show 80% of the EBW energy is dissipated by collisions in the edge plasma. Li conditioning reduced the edge collision frequency by a factor of 3 and increased the fundamental EBW transmission to 60%. Expanding upon this work, recent results of EBW heating in the Proto-MPEX linear device, which takes advantage of resonance Doppler-broadening, will be discussed. Calculations show that by utilizing the effects of Doppler broadening resonance absorption, power deposition near the centerline of the Proto-MPEX device is possible. Significant collisional damping with neutral particles, leading to edge absorption, is expected to occur due to high neutral pressure. Experiments were designed to minimize these effects and resulted in electron temperature increase by a factor of 4 during the injection of 28 GHz microwave power when the neutral pressure is reduced below 0.13 Pa (~1 mTorr.). The results discussed are a product of active collaboration between the code development groups, experimentalists and theorists that allow our field to bridge the gap between traditional theory/modeling and the experimental community.

Biography: Dr. Stephanie Diem is a Research and Development Staff Scientist at Oak Ridge National Laboratory. Her research interests are in the area of experimental plasma physics with an emphasis on the validation of numerical models with experimental data. Dr. Diem graduated from the University of Wisconsin-Madison with a BS in Nuclear Engineering, during which she participated in undergraduate research, performing stability analysis and developing diagnostics implemented on the Pegasus Toroidal Experiment. She received her Ph.D. in Astrophysical Sciences from Princeton University, completing her dissertation research on the National Spherical Torus Experiment at the Princeton Plasma Physics Laboratory. Dr. Diem’s research efforts resulted in the first experimental observation of EBW collisional damping; additionally she developed a method to mitigate these effects via lithium evaporation on NSTX. She has extensive experience in the application of physics codes to model and predict experiments ranging from RF heating to MHD analysis in order to verify and extrapolate these models for use on larger devices, such as a fusion-based power plant. Specifically, she specializes in technically detailed electron Bernstein wave emission and heating and using integrated code suites to study transport and pellet triggered edge localized modes. Additionally, she has been trained in science communication at the Alan Alda Center for Communicating Science at Stony Brook University.