NSTX-U Waves & Energetic Particles Theory/Experiment Joint Research Topics

Gary Taylor

Mario Podestà

Nikolai Gorelenkov

NSTX-U Theory & Computation Brainstorming Meeting

March 2, 2012

PPPL PRINCETON PLASMA PHYSICS LABORATORY

Topic #1: AE stability calculations

Topic	*Description*	*Notes*
Improve and validate tools for *AE stability calculations	Improve and validate existing tools for *AE stability calculations, with emphasis on ST geometry (low aspect ratio). Possible further improvements would be to include externally-driven perturbations into existing codes (NOVA, M3D-K, HYM, SPIRAL) to guide the design of antennae and their use in experiments to characterize AE stability properties. Perturbations range from sub-kHz (from external coils) up to CAE/GAE frequency range, including TAE band. Examples: NOVAK code, improve treatment of fast ion distribution (import Fnb from NUBEAM?). M3D-K, validate against NSTX data and extend to NSTX-U scenarios. Couple IPEC to SPIRAL and/or M3D-K, or include *AE antenna models in RF codes, HYM and M3D-K.	Very important for R(14-2). Some aspects in common with Macro-TSG (e.g. IPEC code). Very general tool for NSTX-U.

Topic #2: Evolution of fast ion distribution in TRANSP

Topic	*Description*	*Notes*
Improve computation of fast ion distribution evolution in TRANSP	Improve the tools currently available in TRANSP to model/predict the evolution of the fast ion population. New tools would fall under two main and complementary categories. (1) Develop and validate models for *AE-induced fast ion transport, given a set of modes (e.g. from experiment or codes). Possible models may include quasi-linear model, ORBIT, SPIRAL or reduced/phenomenological models. (2) Use experimental data from fast ion diagnostics (NPA, ssNPA, FIDA, neutrons, sFLIP, etc.) to constrain the evolution of the fast ion distribution in TRANSP/NUBEAM. Closing the loop between (1) and (2) is the ultimate, long term goal to achieve self-consistent predictive capability on the fast ion evolution.	Both (1) and (2) would be powerful tools for TRANSP analysis, not limited to WEP-TSG or to NSTX-U. (1) is an important part of WEP milestone R(14-2). Both are good topics for collaborations with other facilities (DIII-D, MAST, perhaps other?).

Topic #3: RF Power Losses in SOL During H-Mode

Topic	*Description*	*Notes*
Model RF power losses in scrape off layer in NSTX-U H-modes	Extend RF models to include realistic model of the scrape off layer to predict dependence of surface wave power flows to the divertor region, RF sheaths, and parameteric decay instability (PDI). The spectral solver AORSA has already been extended to the wall in NSTX. An alternate approach is to couple core spectral solvers (TORIC and AORSA) to either finite element method (FEM) or particle-in-cell (PIC) codes. The FEM codes can be used to accurately describe the 3D solid geometry of the RF launchers and vacuum vessel, and the PIC codes can be used to simulate nonlinear effects such as RF sheaths or possibly PDI.	Important for optimizing HHFW coupling to H-mode plasmas and to quantify power losses to compare to divertor diagnostic measurements.

Topic #4: Model HHFW Current Drive in H-Mode

Topic	*Description*	*Notes*
Model HHFW current drive in HHFW and HHFW+NBI H-mode regime	Compare predictions of RF current drive density profile from CQL3D Fokker-Planck, and TORIC and AORSA full-wave codes and benchmark to MSE current density profile measurements in NSTX-U HHFW+NBI an HHFW H-mode plasmas.	Supports long-term goal of developing 100% non-inductive operation.

Topic #5: HHFW Interaction with Fast-Ions

Topic	*Description*	*Notes*
Model HHFW interaction with neutral beam fast-ions	Use ORBIT-RF/AORSA, sMC/AORSA and the new CQL3D finite-orbit-width (FOW) code to model fast-wave acceleration of fast-ions and fast-ion losses and compare to FIDA and NPA/ ssNPA data. Compare calculated spectra of energetic particles going to the wall, with fast-ion detectors there. The couplings between AORSA and the finite obit FOW code ORBIT RF and the FOW CQL3D will also be carried out with the HHFW version of TORIC.	Supports long-term goal of developing fully non-inductive HHFW-heated NBI H-modes. This would be a joint RF/EP research goal.