NSTX-U

NSTX-U is sponsored by the
U.S. Department of Energy Office of Science
Fusion Energy Sciences

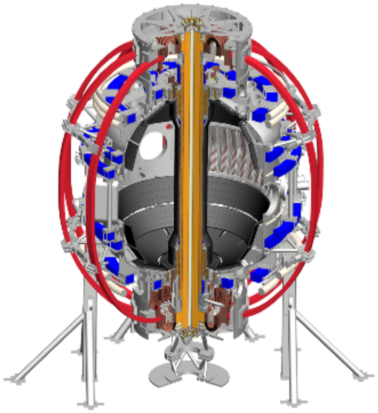
EP-TSG
Status of Research Milestone R17-4

M. Podestà

for the EP Topical Science Group

PPPL, B318
May 25th 2017

PPPL



Status of R(17-4): Assess high-frequency Alfvén Eigenmode stability and associated transport

Done:

- PRL (Fredrickson) on "GAE suppression by 2nd NB line" accepted – *congrats!*
- Results from HYM studies of CAE/GAE resonant drive (Lestz, Belova)
- Results from "Parametric investigation of CAE/GAEs in NSTX/NSTX-U and effect on thermal confinement" presented by S. Tang (UCLA) as Plenary Talk at TTF-2017
- NF (Crocker) on "CAE/GAE δn perturbations and implications for thermal transport" - ready for submission
- Draft on "Validation of CAE3B code vs NSTX plasmas" - under review by co-authors

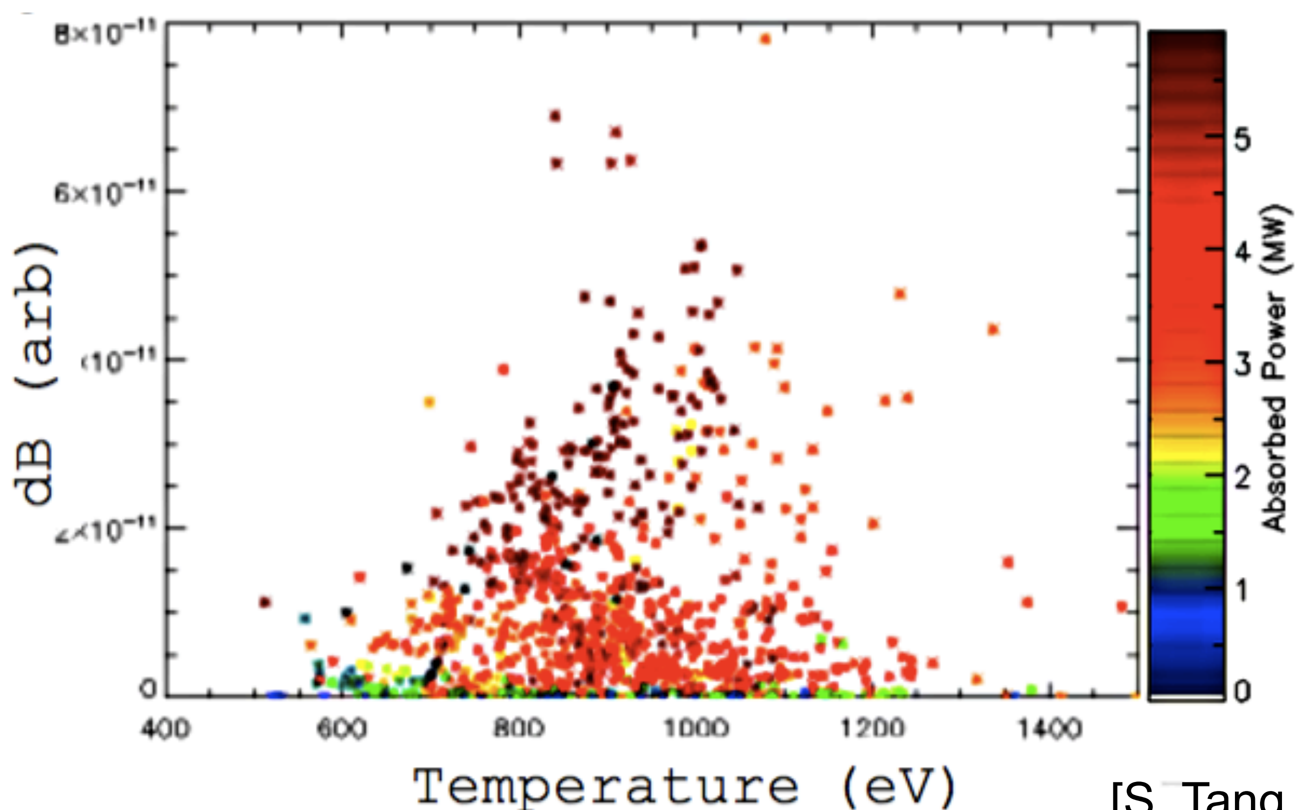
Ongoing:

- NF draft (Fredrickson) on emission at Ion Cyclotron frequencies in preparation
- Analyzing high-k data for evidence of CAE coupling to kinetic Alvén waves
- High-f AE experiment on DIII-D (planned July 2017)
  - Some data from single source, B_T ramp shots have been obtained in piggyback
  - Useful data about CAE stability thresholds vs P_{NB}, V_{inj}, injection angle, n_e, B_t

Main results since March '17 status meeting: improved analysis, expanded CAE/GAE characterization

- Compiled CAE/GAE database from 2010 NSTX Run
  - Expand previous database by Fredrickson with mode spectrum & amplitude info, background parameters
  - Look for correlation of mode activity with thermal plasma properties, profiles

  > Implementing "multiple regression" analysis



[S. Tang, TTF '17 Plenary]

Main results since March '17 status meeting: improved analysis to extract δn from reflectometers

- Remove approximation of wave reflection localized *at* cut-off (*mirror approximation*)
- New method provides more accurate reconstruction of displacement, $\delta n/n$
- Results in larger perturbations
  - Improved comparison with GAE amplitudes required for substantial thermal transport (cf. Gorelenkov, NF 2010)
  - But: still insufficient to explain observed transport

>*More physics required (e.g. KAW coupling)?*

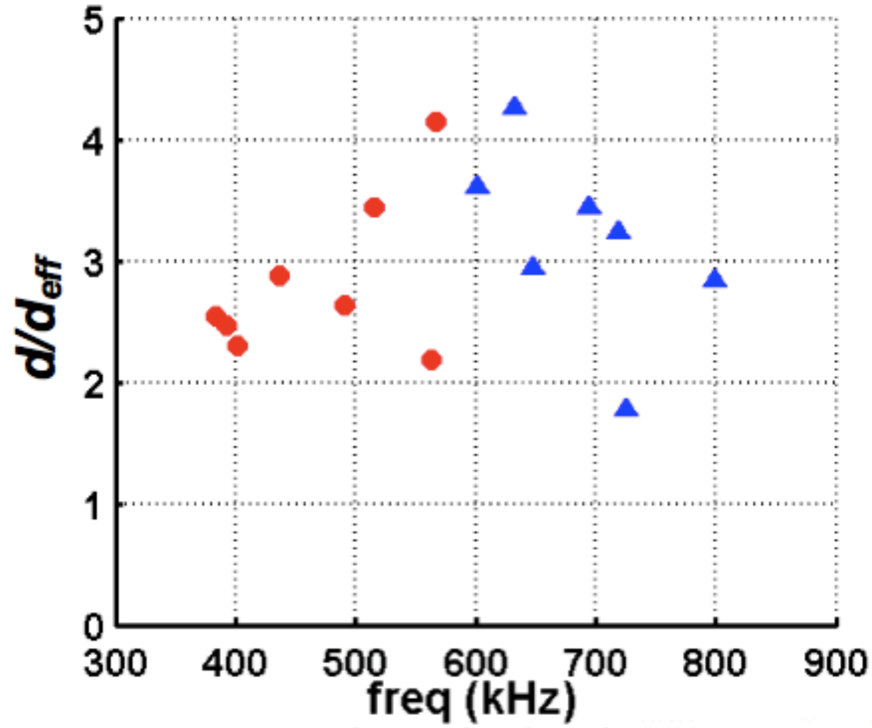


Figure 7: Ratio of density contour displacement from inversion, d, to effective displacement, d_{eff}, at $R = 1.15$ m. symbols Δ or o used for modes with $f >$ or $<$ 600 kHz, respectively.

[N. Crocker, NF (submitted)]

R(17-4): Assess high-frequency Alfvén Eigenmode stability and associated transport

Experiments and modeling on NSTX have indicated the potential of Compressional and Global Alfvén Eigenmodes (CAE/GAE) to induce both fast-ion redistribution/loss and enhanced electron thermal transport. More flexible NBI heating capabilities in NSTX Upgrade (NSTX-U) enable more comprehensive studies of CAE/GAE physics and support a goal of assessing CAE/GAE stability as a function of the injected NBI source mix. Initial results from the FY-2016 run campaign have already shown a clear dependence of GAE behavior on NBI from specific sources. For example, complete GAE suppression has been observed when a small fraction of NB power from the new 2nd NBI line is added to the total power. Simulations with the HYM code will be used to investigate these initial NSTX-U results and to predict expected CAE/GAE behavior on NSTX-U as the experimental heating power, plasma current, and toroidal field are increased up to their nominal maximum values. Further validation of HYM will be pursued through comparison with experiments from NSTX/NSTX-U and planned experiments from the DIII-D National Campaign. In parallel with CAE/GAE studies, an initial assessment of Ion Cyclotron Emission (ICE) observations from NSTX-U will be performed to characterize the distinctive features of ICE versus sub-ion-cyclotron frequency AEs. For example, ICE features observed on NSTX-U appear different than those observed on conventional tokamaks in that NSTX-U ICE originates near half-radius, i.e. not near the plasma edge. These observations can provide insight into theoretical models of ICE, which are crucial for the potential exploitation of ICE as a confined fast ion diagnostic for ITER. The main goals for ICE studies are: (i) to assess possible correlations with fast ion properties such as the radial profile and the energy dependence of the distribution function, and (ii) to identify which improvements to existing codes (e.g. HYM) are required to properly model ICE.