NSTX

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Modeling of beam ion losses during H-mode TAE avalanches

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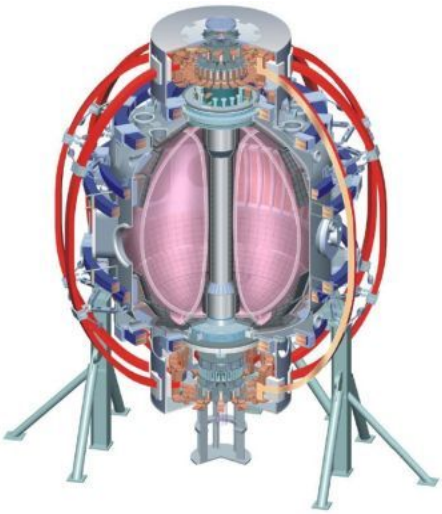
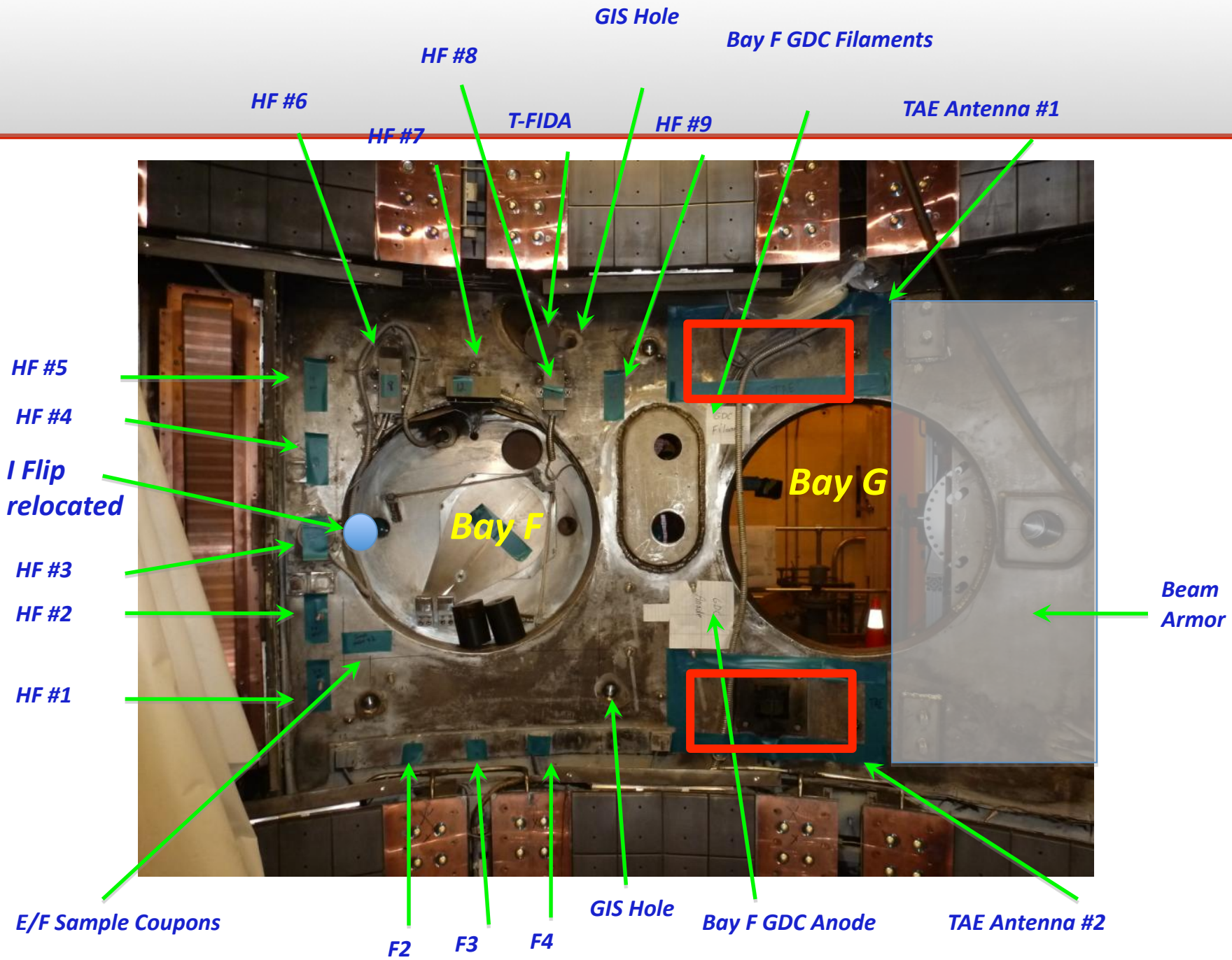
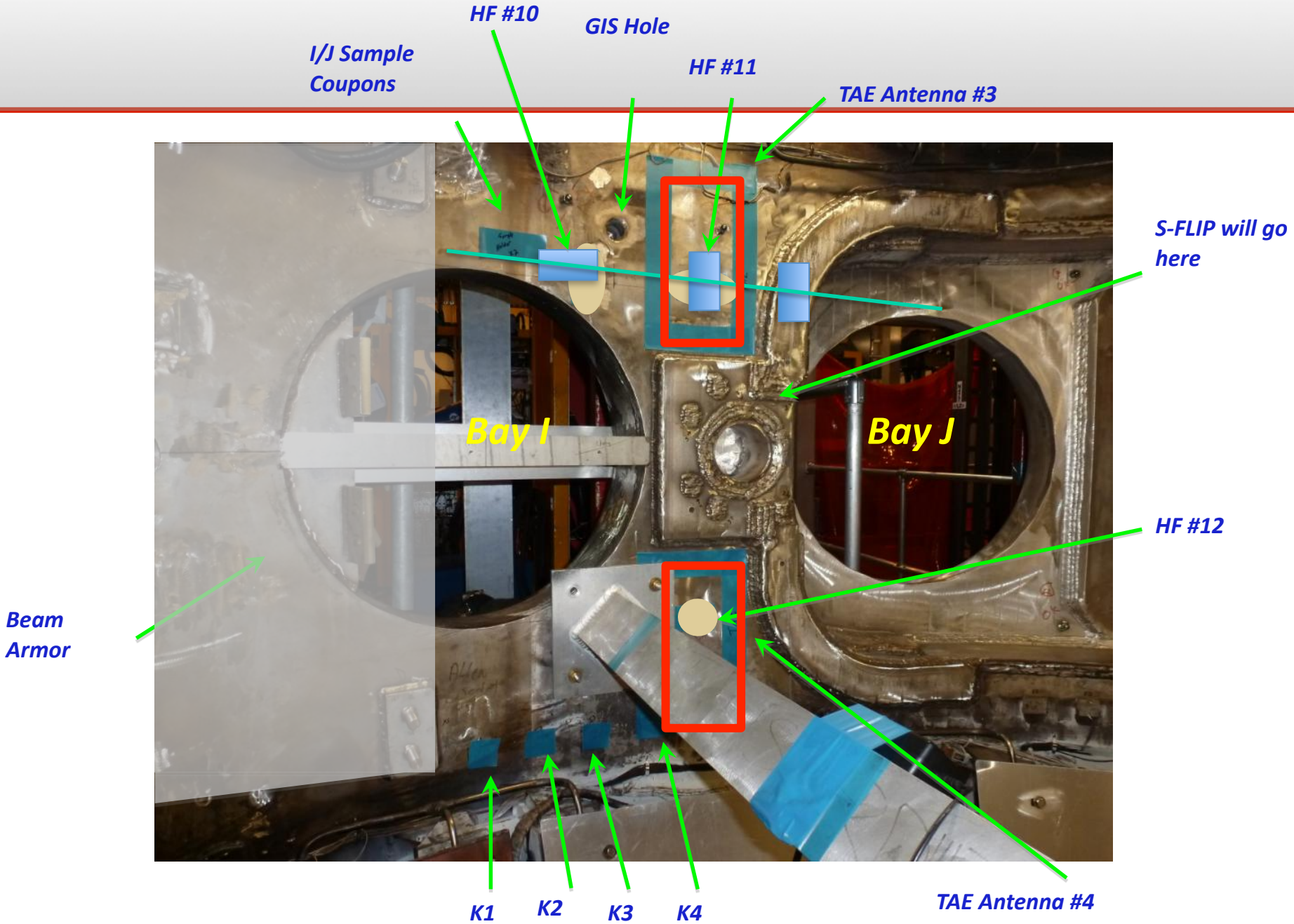


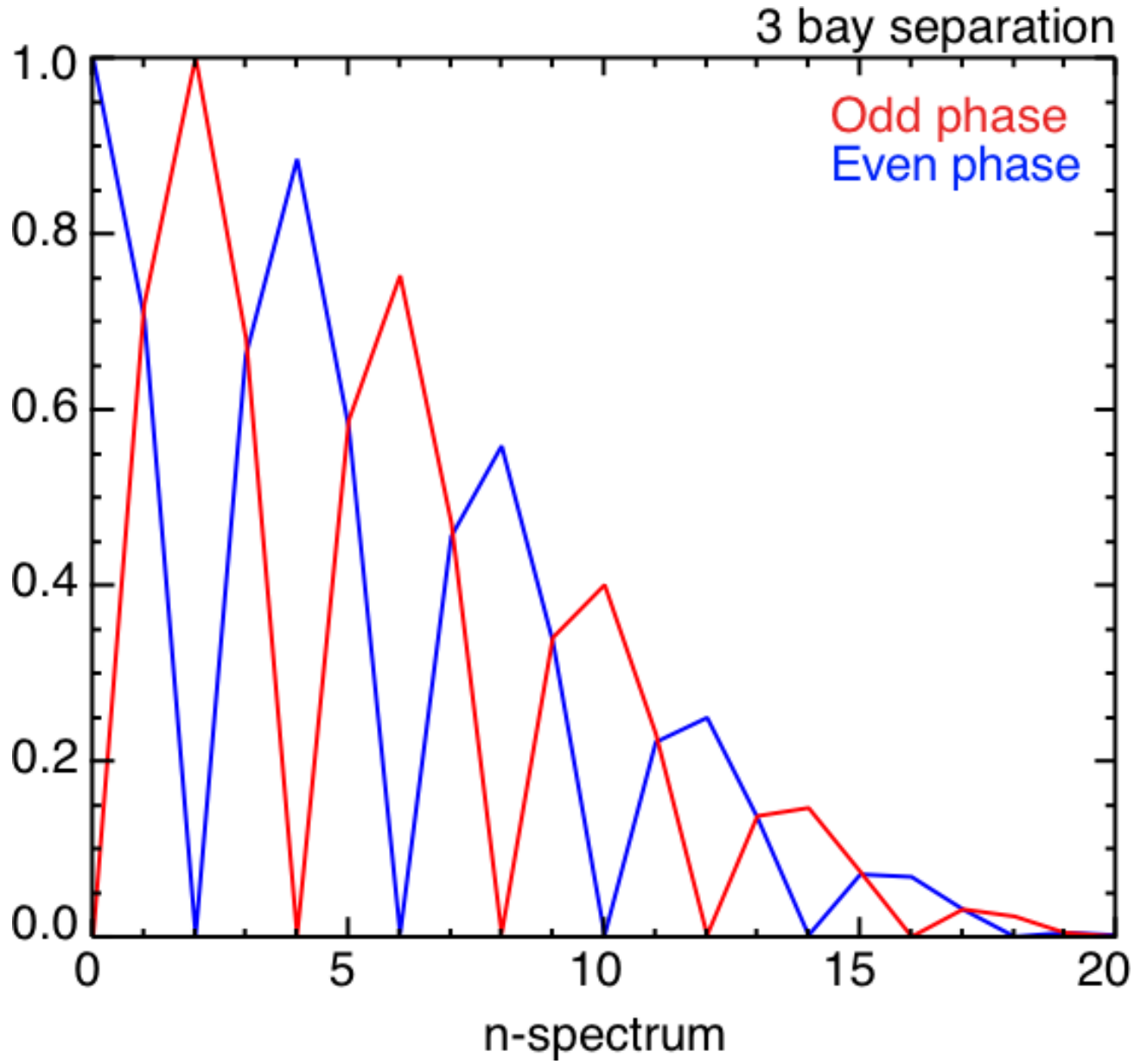
Theory support would is nearly required to plan and interpret experiments in frequency ranges from TAE to CAE

- Initial experiments likely to focus on exciting TAE resonances in non-beam (ohmic or rf-heated) plasmas:
  - measurement of damping rates would be most likely useful result
  - need theory support to interpret (validation exercise).
  - can we find creative ways to explore EPM-TAE-EAE coupling seen in beam-heated plasmas?
- Antennas should be technically capable of operation up to the cyclotron frequency (or higher).
- HYM and TORIC are uniquely capable of modeling modes at these frequencies:
  - TORIC can model waves launched from antenna
  - HYM finds natural, fast ion excited, eigenmodes
  - both can make valuable contributions towards interpretation of experimental results.
  - revisit stochastic heating with HYM/TORIC/SPIRAL/GYROXY


GIS Hole
Bay F GDC Filaments
HF #8
HF #6
HF #7
T-FIDA
HF #9
TAE Antenna #1
HF #5
HF #4
I Flip relocated
HF #3
HF #2
HF #1
Bay F
Bay G
Beam Armor
E/F Sample Coupons
F2
F3
F4
GIS Hole
Bay F GDC Anode
TAE Antenna #2

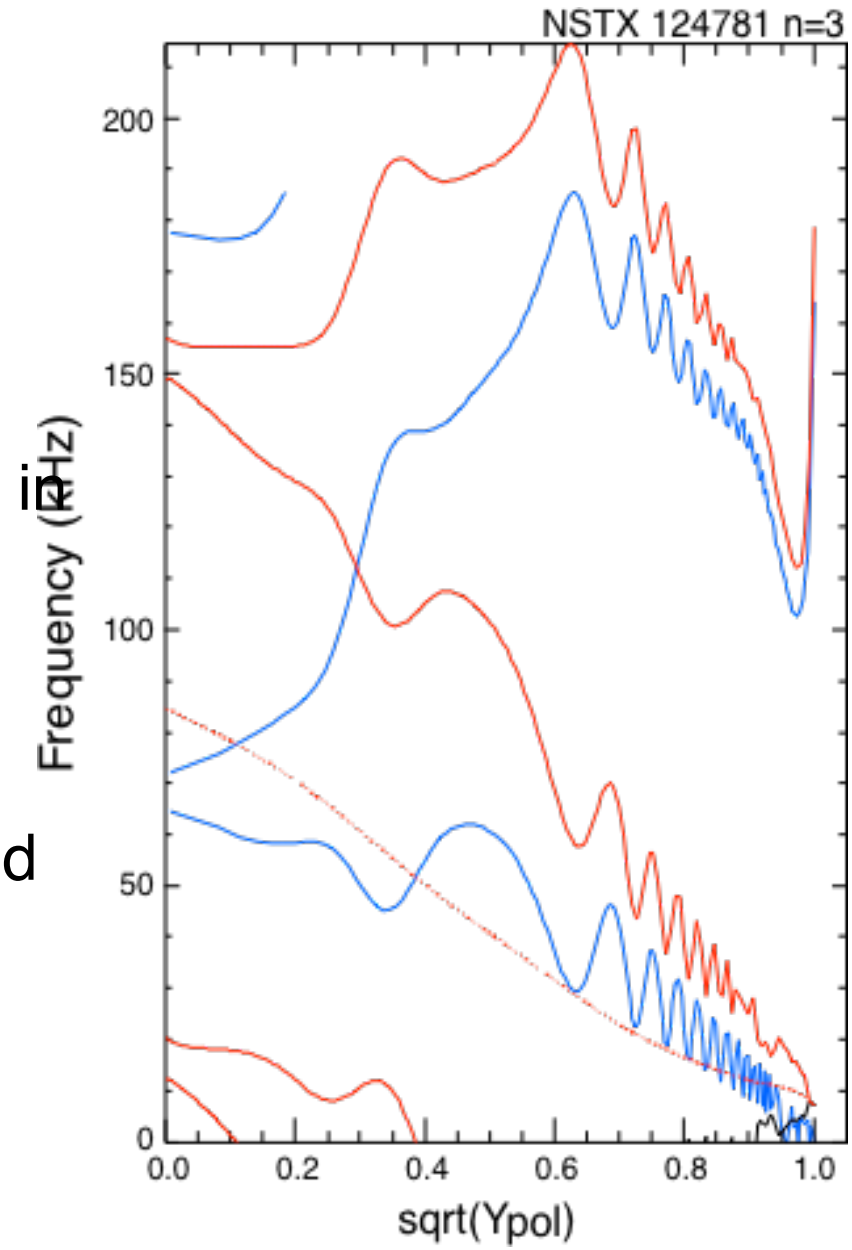

HF #10
GIS Hole
I/J Sample Coupons
HF #11
TAE Antenna #3
S-FLIP will go here
Bay I
Bay J
HF #12
Beam Armor
K1
K2
K3
K4
TAE Antenna #4

Approximate antenna pattern for exact 3-Bay separation

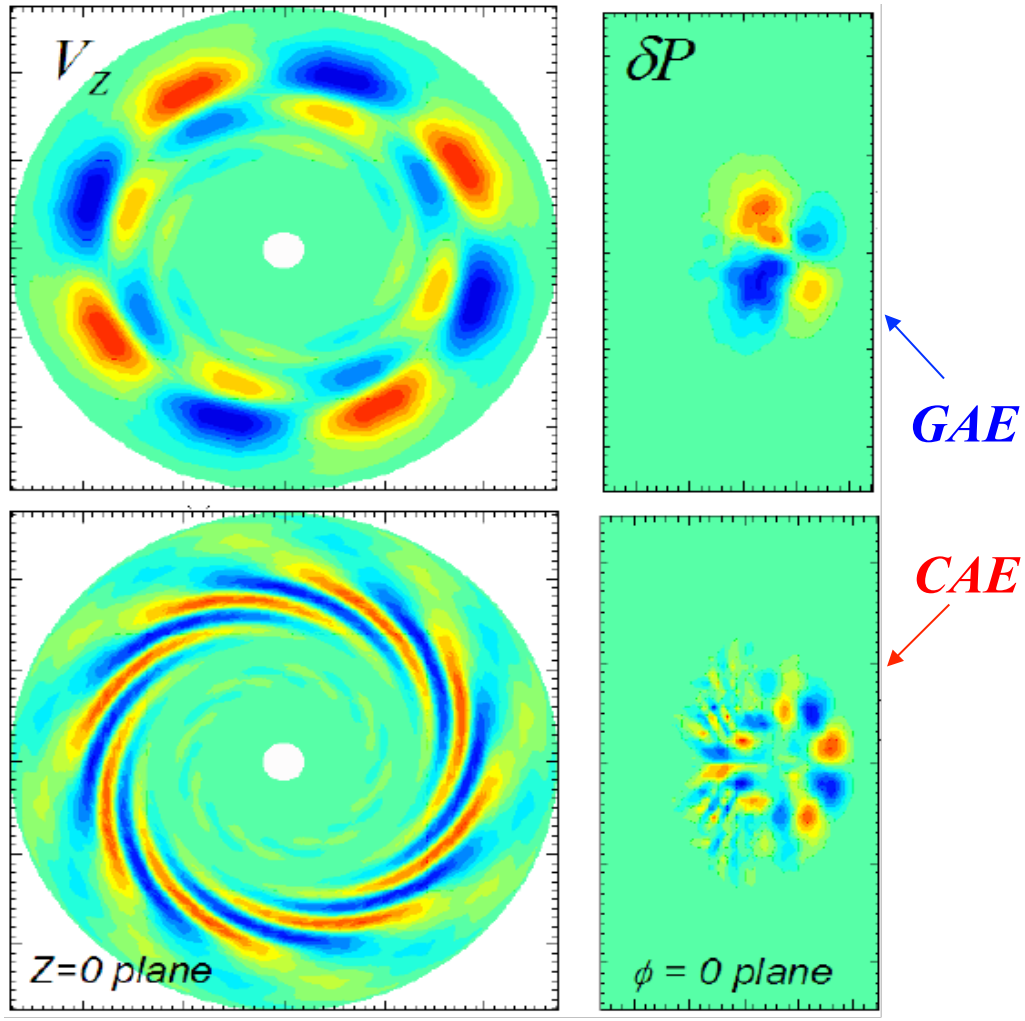


The principal result expected from the new TAE antennae would be measurements of damping rates in ohmic plasmas

- TAE excited with antenna have reasonably validated stability code predictions for conventional tokamaks.
- Could M3D-k be modified to calculate damping rates for modes in ohmic plasmas?
- Could NOVA be modified to model antenna coupling?
- Ohmic plasmas lack strong sheared rotation which in STs affects:
  - coupling between TAE and EPM
  - coupling between TAE and EAE
  - strong continuum interactions



Capitalize on unique theoretical capability (HYM, low frequency TORIC) to interpret, plan CAE/GAE studies



Better estimates of mode amplitudes needed:

revisit stochastic heating threshold (possible with HYM?)

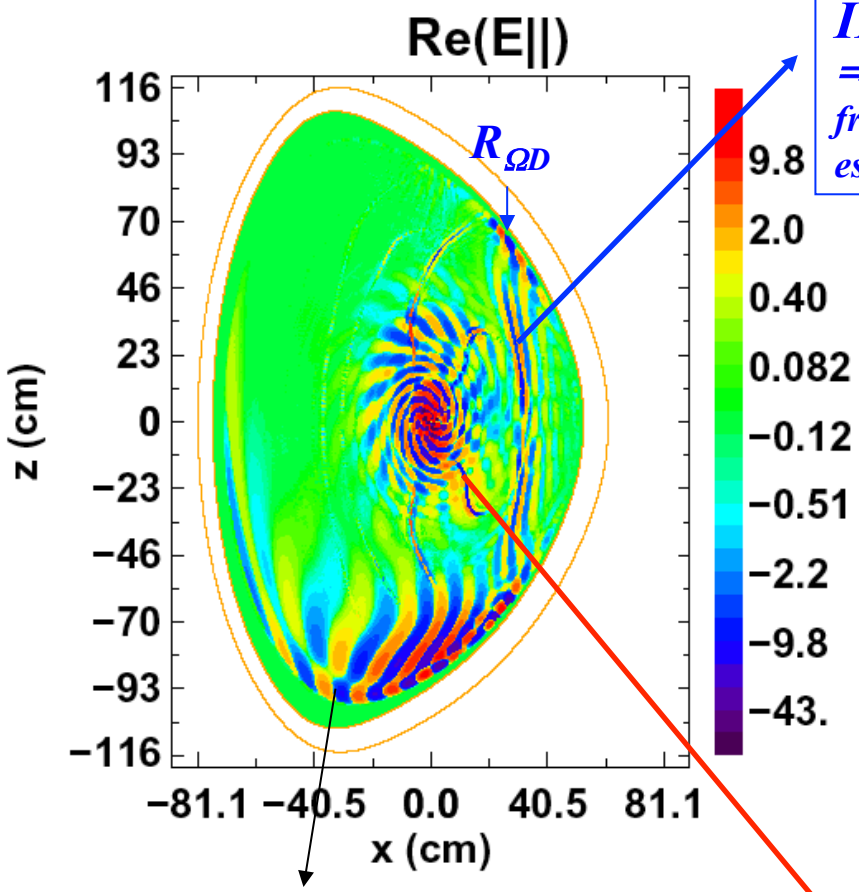
estimate coupled power needed to reach detectable mode amplitudes, stochastic heating threshold

Develop analytic stochastic threshold model.

Couple HYM results with TORIC? Predicted structure of fast particle modes is commensurate with TORIC resolution capabilities

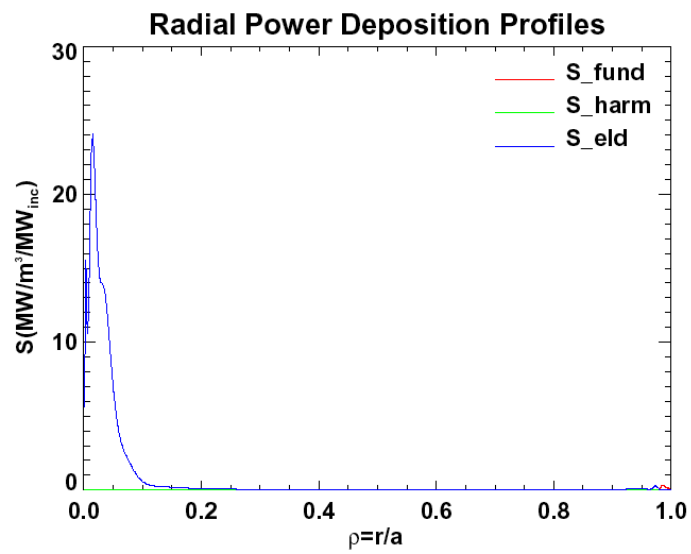
17th Topical Conference on Radio Frequency Power in Plasmas
May 7-9, 2007, Sheraton Sand Key Hotel, Clearwater Florida, USA

TORIC finds antenna-driven modes in addition to the fast wave in NSTX with $f_0 \sim f_{CD}$



IBW: $K_{xx} = 0$ $\Rightarrow \lambda_\perp \leq 7$ *cm from simple estimate*

Power is damped mostly on electrons by the core mode



TORIC damping calculations could be benchmarked with HYM

Compare mode structures as calculated with TORIC and HYM.

GAE? Simple dispersion relations indicate 'slow wave' can propagate in the core

(New results are available from Cynthia)

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Theory support is needed for TAE and CAE/GAE frequency ranges

- Measurement of TAE damping rates is the principle goal experimental goal with antenna.
  - use experimental damping rates to validate NOVA
- Short-term goal for GAE/CAE frequency range are:
  - determination of coupling efficiency
  - identification of eigenfrequencies
  - measurement of damping rates
- Longer-term goals include:
  - determination of stochastic heating threshold
  - determination of RF power needed to reach stochastic threshold
  - use of antenna to stimulate “alpha-channeling”
  - use of antenna to control electron pressure profile?