Research Activities selected by EP Topical Group of the BPO for their Impact on ITER

Research Activity #1

Goal: Quantify losses of fast ions in ITER in presence of AEs and TF ripple for

(i) a range of regimes (inductive, hybrid and SS plasmas) AND

(ii) start up plasmas scenarios

This goal relates to ITER design tasks as approved by the IO

- ITER design task ITER WG1-2.6.7 AE assessment: The effect on AE stability due to degraded machine parameters such as: reduced TF (20%), reduced current (20%)…

- ITER design task ITER WG1-3.1 ripple assessment: What level of fast ion loss to the walls is expected with the current level of optimized TF ripple in ITER with Ferritic inserts and TBMs…?

Research Activity #1: Status and Needs

1. AE stability for inductive, hybrid and s.s. plasma being assessed:
   N. Gorelenkov - DOE Joule milestone for US theory program

   We plan to leverage this activity to accomplish task # 1?

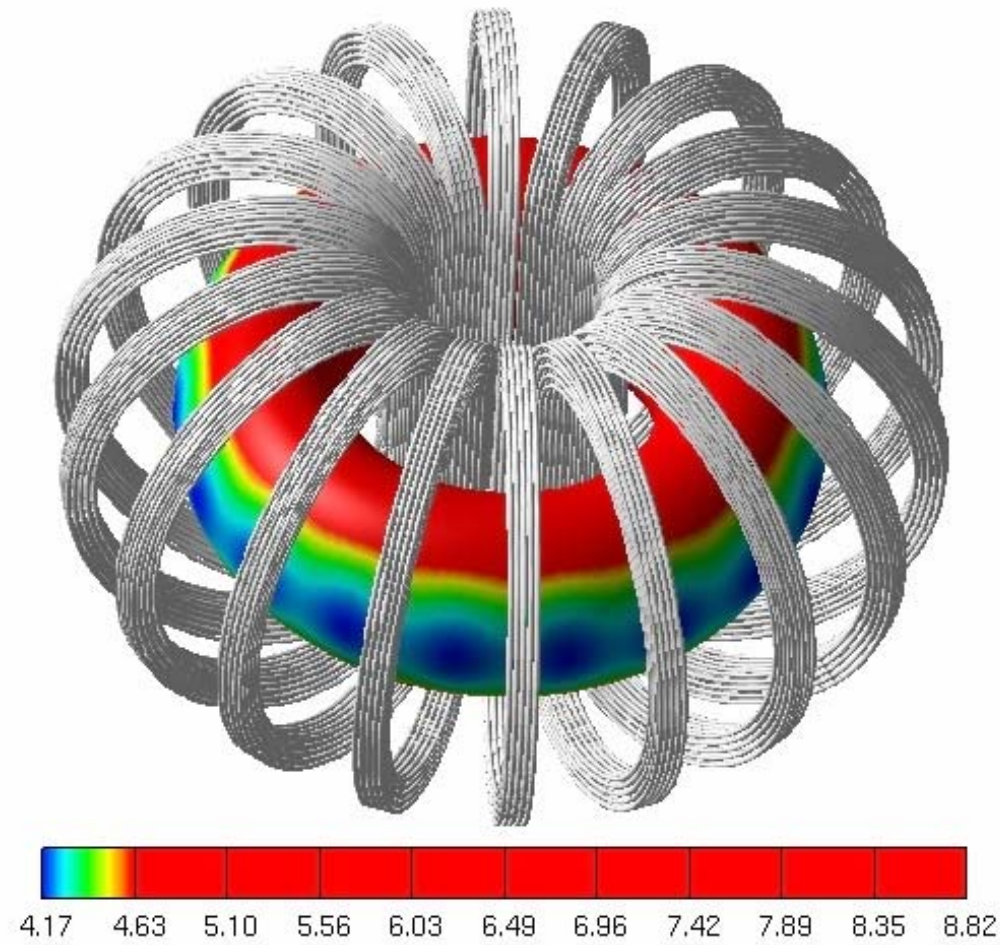
2. Combined field ripple with AEs will be addressed by US codes
   e.g. ORBIT -R. White etc….

3. Also, self consistent ripple field with finite beta is being addressed.
   VMEC - D. Spong

   However

   3-D |B| field with ferrite inserts is needed from the ITER IO. Still waiting for this input - HAWRYLUK is the US liaison for this input

Sample: ITER Zero Beta Equilibrium with TF Ripple and no ferritic inserts - D. Spong



- Next step: PF currents needed for finite beta analysis
  - TSC input from C. Kessel

Research Activity #2: Fast Ion Diagnostic Assessment for ITER

Part 1: Assessment of fluctuation measurement capability of US-led diagnostics

- ECE, reflectometry, CO2 interferometer-US

Part 2: Assessment of unassigned fast ion diagnostics

- ICE, lost alpha -US, collective scattering, gamma ray spectroscopy-Int.

Goals of Research Activity #2

Goals: (i) Quantify present capabilities of US ITER diagnostics for AE measurements, (ii) assess confined and lost fast ion diagnostics.

- key issues for ITER science mission and ITPA high priority issues

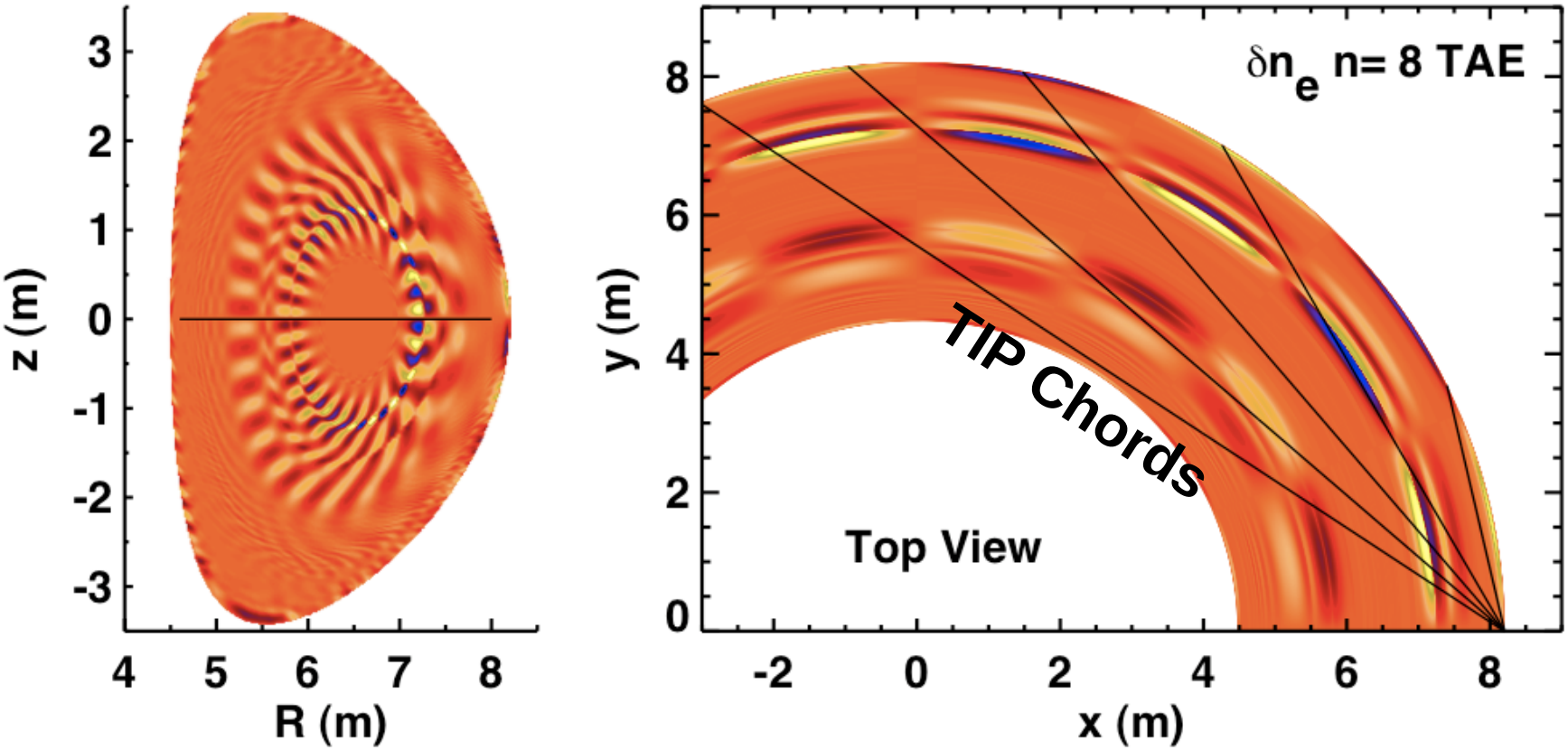
Goal (i) is strongly related to presently funded US-IPO activities.

- CO2 interferometer, ECE, Reflectometer - funded design activities
- IPO Funded activities are specifically for bulk plasma measurements; not for fluctuation measurement capability (role for BPO and TTF)

Goal (ii) is not supported by US IPO at present

- lost alpha, confined fast ions - unfunded activities, unassigned systems (role for BPO and TTF)

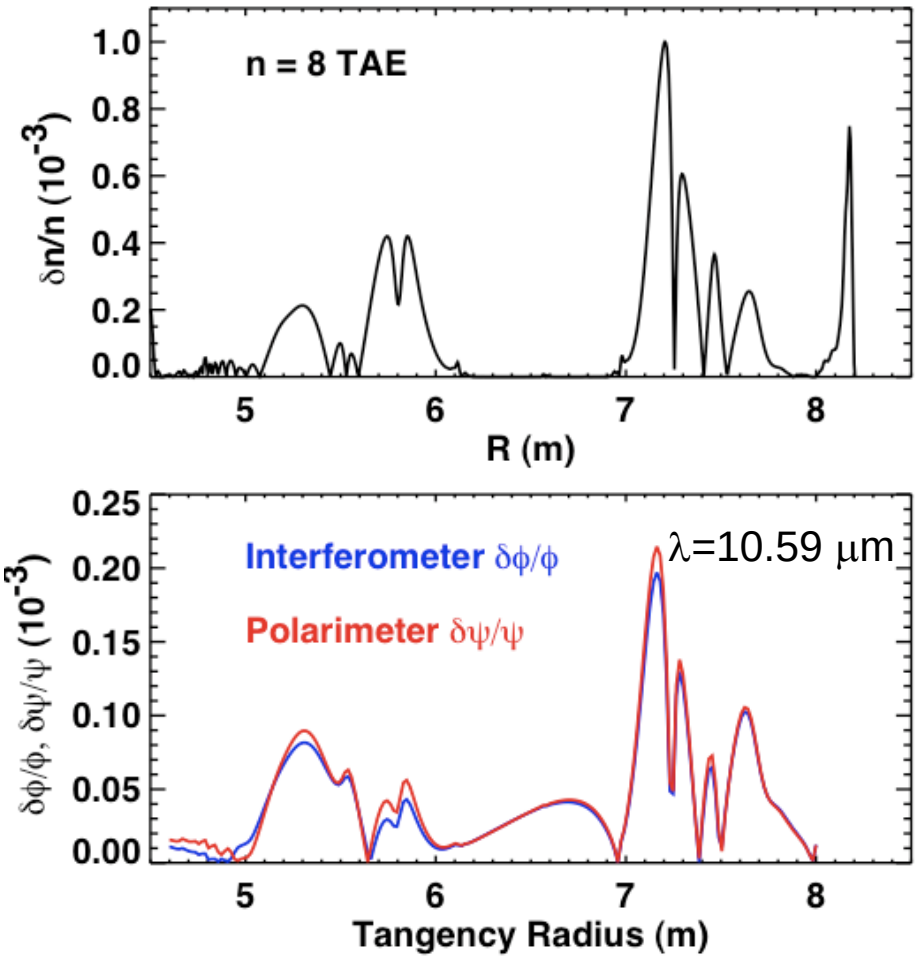
Sample: NOVA Calculations Are Being Used to Simulate ITER TIP Response to Alfvén Eigenmodes



- Eigenmodes of ITER Scenario 4 plasma are calculated
- Displacement is used to determine δn_e profile
- δn_e and $\delta \mathbf{B}$ are mapped onto TIP ray trajectories

M. Van Zeeland

Interferometer and Polarimeter Line-Integrated Response Exhibit Spatial Profile Similar to Eigenmode



Interferometer

$$\delta\phi \propto \int \delta n_e dL$$

Polarimeter

$$\delta\psi \propto \int \delta n_e B dL + \int n_e \delta B dL$$

- Polarimeter Response appears to be dominated by $\delta n_e B$ term
- Multiple closely spaced channels on low field side would potentially provide straightforward measurements of mode structure
- Due to large densities and path lengths interferometer fluctuation signals will be large (~ 1° or more) for $\delta n/n = 10^{-3}$

M. Van Zeeland

Future Directions

Task 1: Ripple + AE study will get done, provided input from IO is obtained (Motivated experts ready to make assessment)

Task 2: Need to form a US task group (made up of Transport, Diagnostics, Fast Ion Physics experts) to perform this diagnostic assessment

- present level of effort is uneven, but encouraging progress is being made.

Strong coordination with TTF, ITPA and ITER needs to be developed to raise the visibility of these tasks