Assessment of Alpha Physics in NSOs: ITER Assessment

Main Issue: First wall damage due to localized losses

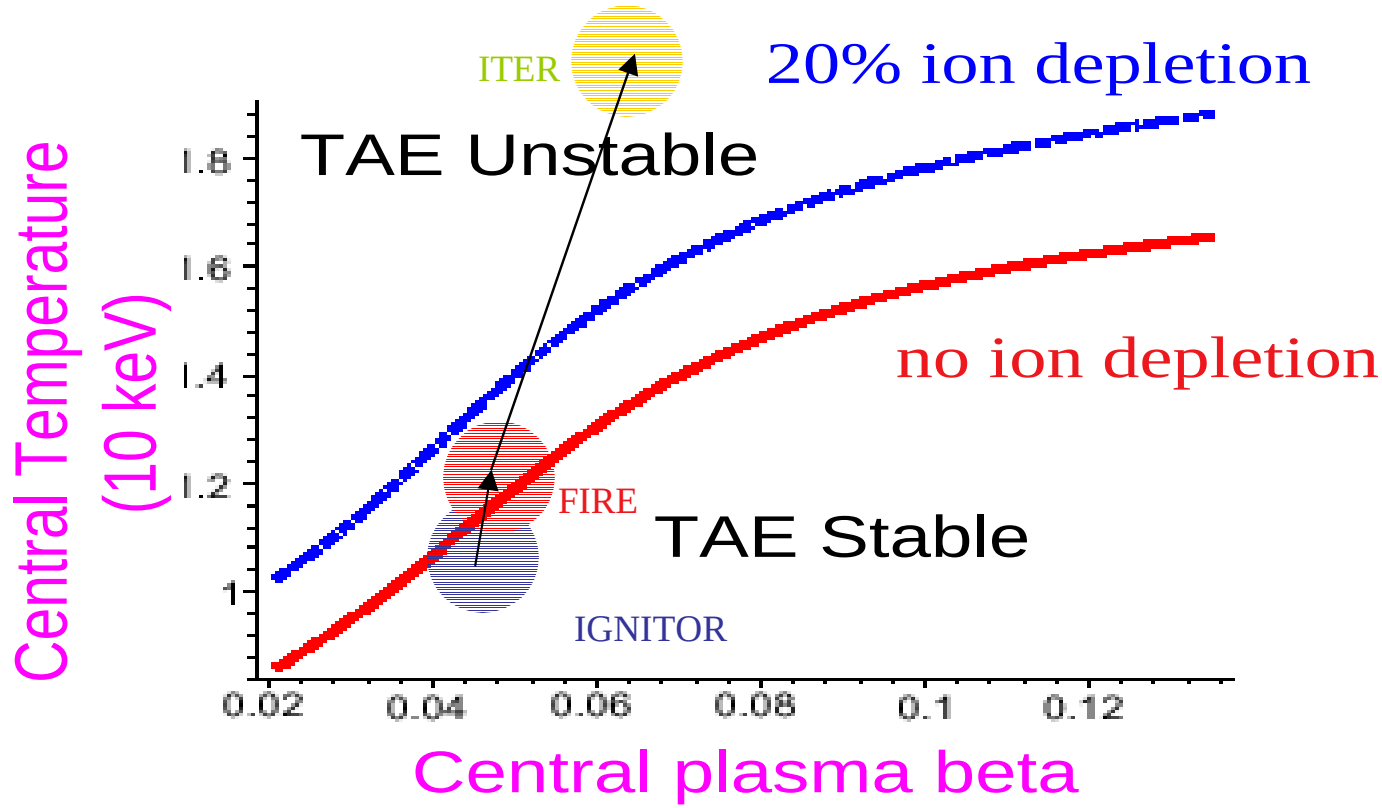
- Ripple o.k. with Ferritic inserts in ITER
  (21%->0.75% loss in AT regime *with flat alpha profile*)
- MHD (NTMs, sawteeth) with ripple induced loss
  (o.k. if redistribution radius inside ripple loss boundary)
- AEs with/without ripple in standard and reverse shear plasma

Numerical tools for nonlinear saturation and transport are not available

Quantitative Assessment is based on linear mode stability:
Results

- Fishbones are stable or do not couple to ripple loss region
- local analysis of EPMs suggest stability
  (however theory is premature for this assessment)
- linear analysis of TAEs, EAEs, NAEs provides necessary condition for alpha loss

Critical temperature for TAE stability depends only on beta: Independent of device

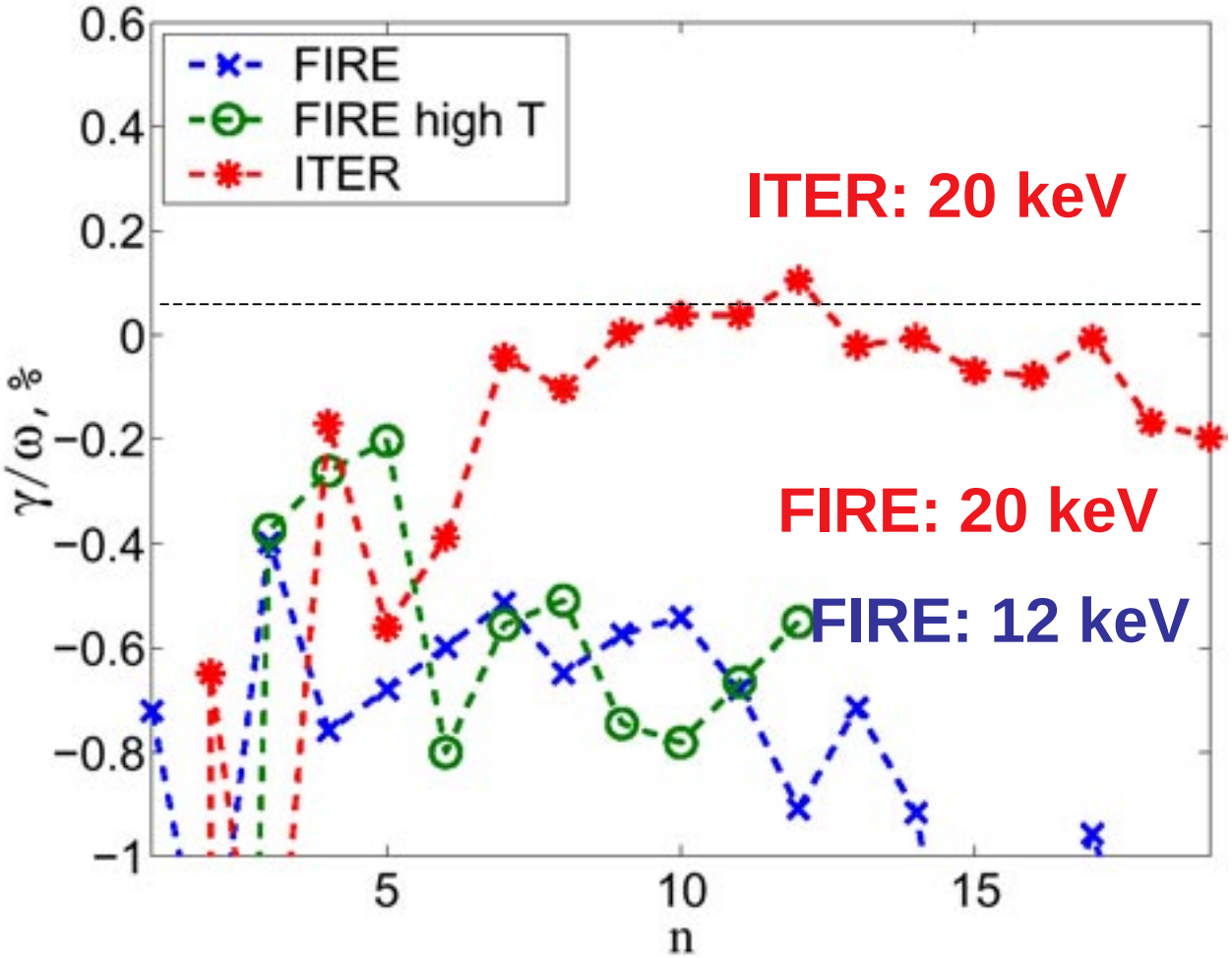


- ITER closest to threshold for AEs of all three devices
- Temperature control is the key for investigating AE stability

*Calculations underestimate critical temperature

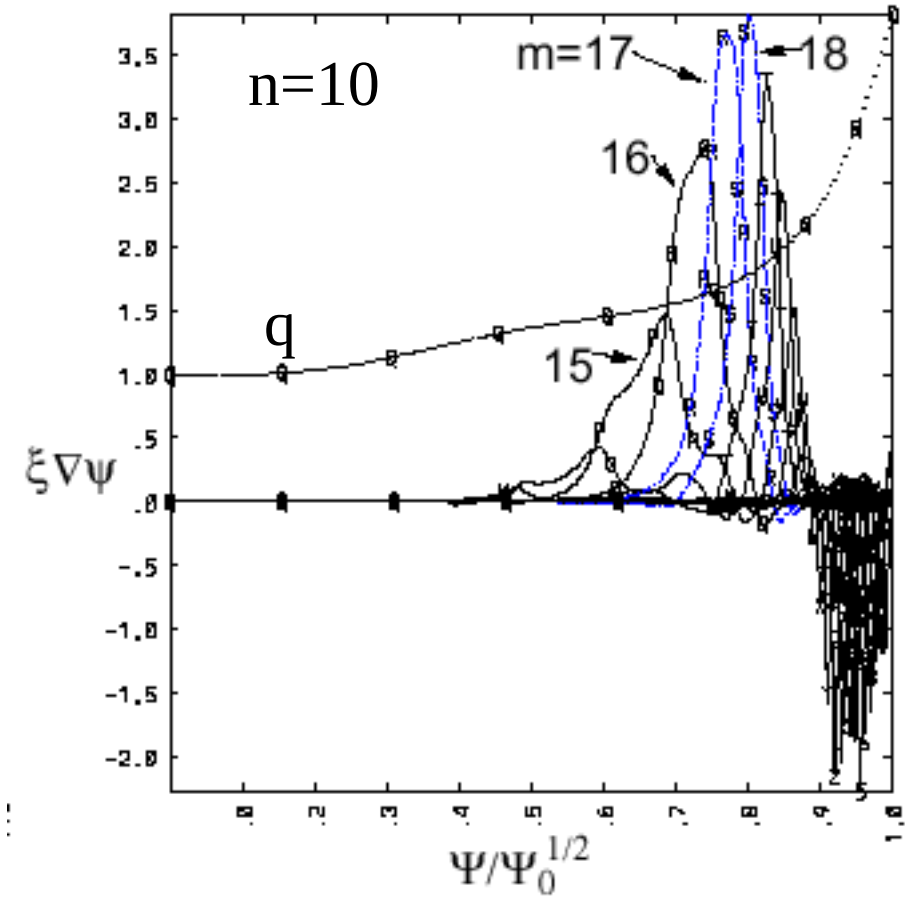
- Ion Landau damping included. **Radiative damping not included!**

Global Analysis Indicates Marginal Stability for ITER Standard Regime: Stability for FIRE and IGNITOR



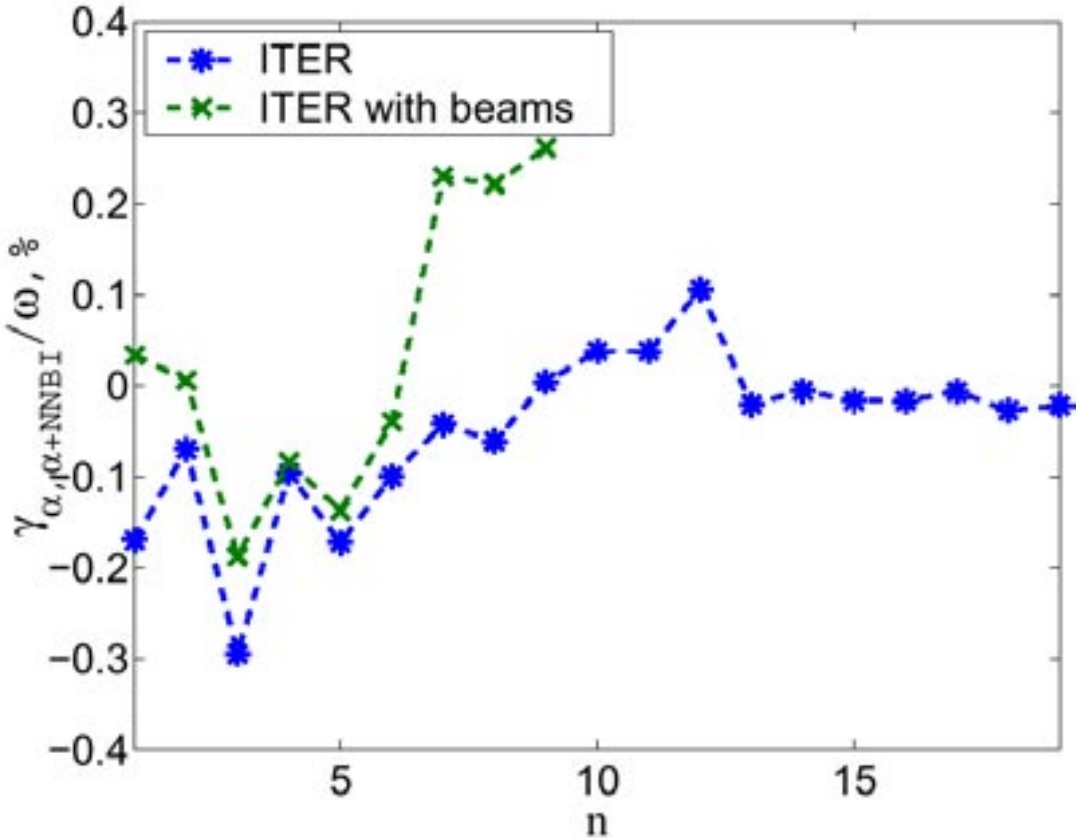
=> Multi-mode resonance overlap is most likely for ITER at higher temperatures

Peak Drive Occurs in Outer Half Plasma Radius in ITER: May lead to Localized Heating of First Wall



- Modes may overlap with ripple loss boundary
- Edge damping method may block alpha loss to the wall (can be studied in existing experiments)

1 MeV NNBI is destabilizing to TAEs in ITER: May be used to simulate alphas in Hydrogen Phase

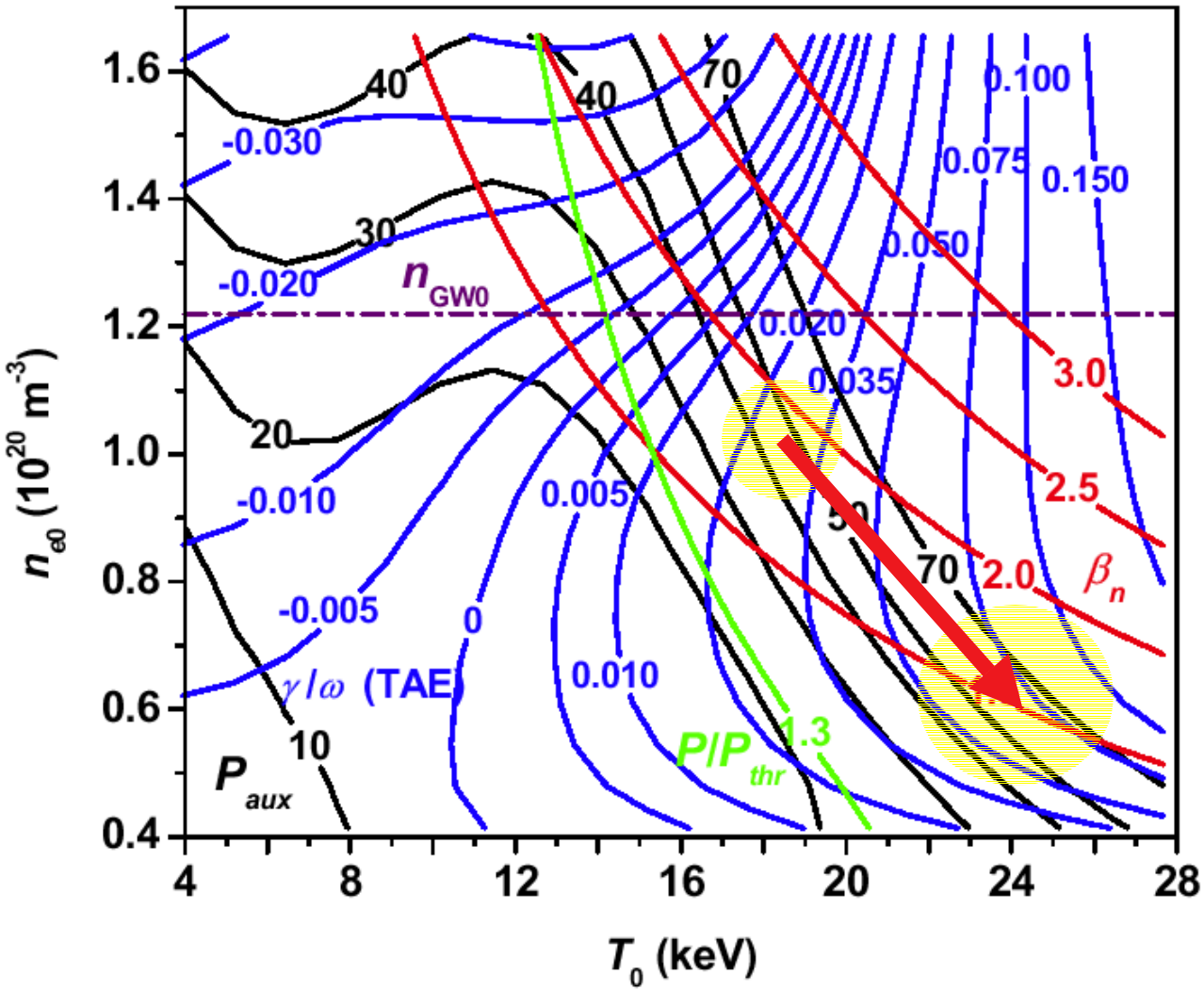


- Beam ion loss may be an issue!

- Lower energy edge localized beams may be an effective control tool to stabilize TAEs in ITER

Temperature Flexibility is the Key to a Scientific Experiment
Density Control and Central ECH are Key Tools

ITER, H(y,2) = 1.0, n_0 / <n> = 1.03, T_0 / <T>$_v$ = 2.0



- Modest increase in temperature gives access to strong instability drive and assessment of stability boundaries

John Mandrekas, 07/03/02

ITER Assessment

• ITER can effectively explore stability boundaries with only a modest temperature variation

- ECH is an effective tool (does not generate fast ions)
- NNBI is an effective tool for alpha simulation in H-phase
- density control is needed but particle transport is not so well understood

• Modes most likely occur in outer half of the plasma radius.

- NBI control may be effective to prevent alpha loss

• Multi-mode resonance overlap regime of alpha driven Alfvén eigenmodes is most easily accessed on ITER