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XP743: Island-induced neoclassical toroidal viscosity and dependence on ν_i

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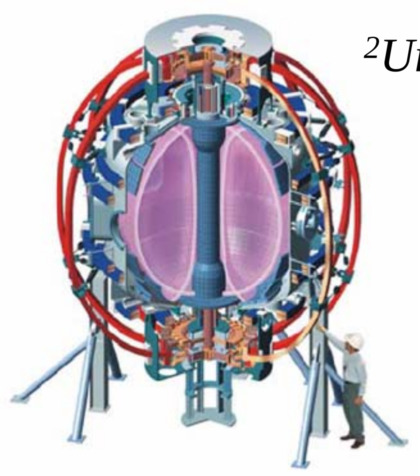

NSTX Results Review
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Princeton Plasma Physics Laboratory

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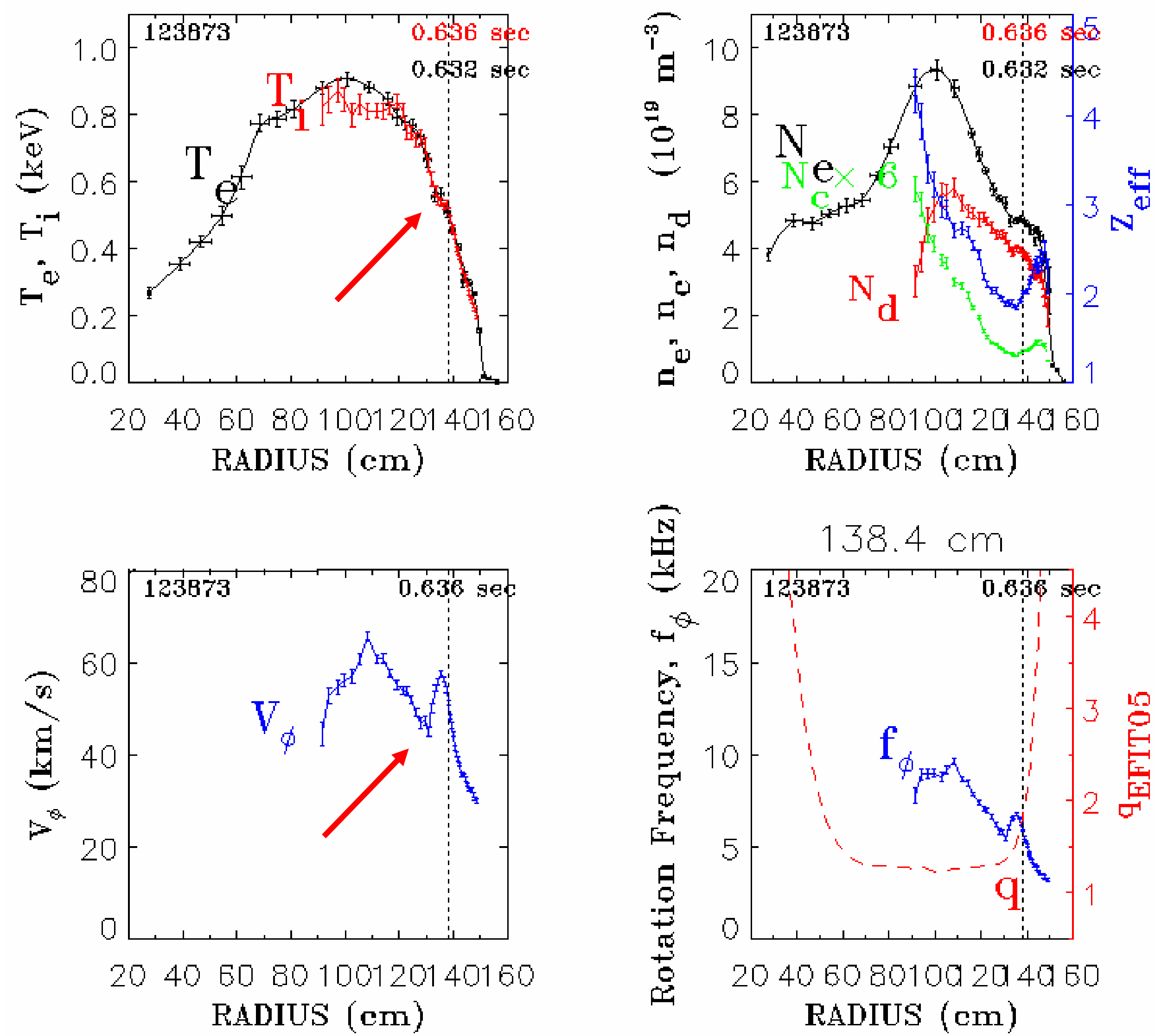
Investigate the role of islands and ν_i in neoclassical toroidal viscosity rotation damping physics

- Goals
  - Test theory of island-induced neoclassical toroidal viscosity (INTV)
  - Compare to theory of drag due to electromagnetic torque
  - Investigate damping over range of ion collisionality and island width to determine affect on rotation damping and to distinguish theories
  - Examine $1/\nu_i$ dependence of NTV without internal rotating modes
  - Determine percentage of torque from non-resonant NTV vs. INTV vs. electromagnetic
- No run time allocated - piggyback data from XPs 739/740
  - Tearing modes generated in these XPs – can examine INTV
  - No scan in ν_i, but island width changed
  - n = 3 non-resonant braking (NTV) used to slow plasma rotation
    - Usual NTV rotation damping observed before island appears
    - Damping explained by linear superposition of NTV and possible INTV?

INTV theory to be compared to experiment

- Leading theories can be distinguished
  - Non-resonant NTV theory
    - Scales as $\delta B^2 (p_i/\nu_i)(1/A)^{1.5}$, yields distinct rotation profile evolution
  - Electromagnetic torque at rational surface (R. Fitzpatrick, Nucl. Fusion **33** (1993) 1049.)
    - Scales as δB^2 (not ν_i), rotation profile evolution consistent with observation
  - Island-induced NTV (K.C. Shaing, PRL **87** (2001) 245003.)
    - Scales as δB *(island width Δw^2) due to toroidicity*, depends on ν_i
    - Theory can be evaluated quantitatively (as done for NTV)
- Experiment to vary key parameters to test theory
  - n = 1 mode most significant
    - Change ν_i at constant *q* (done successfully in XP619 - gas puffing / B_T and I_p variation); consider transitioning out of H-mode
    - Change δB by changing applied *n* = 1 field
    - Change rotating mode onset time by small change in elongation

Island appears in Te, Ti, and plasma rotation – XP739



- Island evident in USXR, T_e and plasma rotation
  - Narrow, localized rotation damping
  - Rotation evolution shows outward momentum transfer across rational surface and core rotation decay
- Flat-spot in profiles appears just inside the q = 2 surface
- INTV magnitude can at least be evaluated in such cases