NSTX

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Edge stability and pedestal characteristics of NSTX small-ELM regimes

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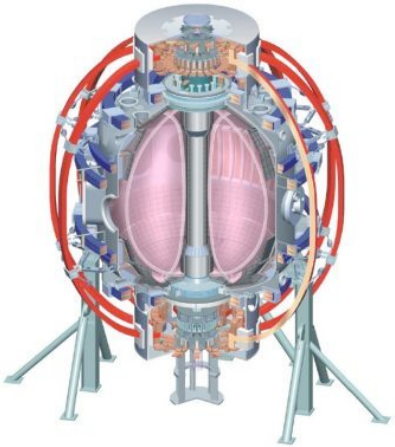
Aaron Sontag, *Oak Ridge National Lab*

CMOD/NSTX Pedestal Workshop
Sept. 7-8, 2010



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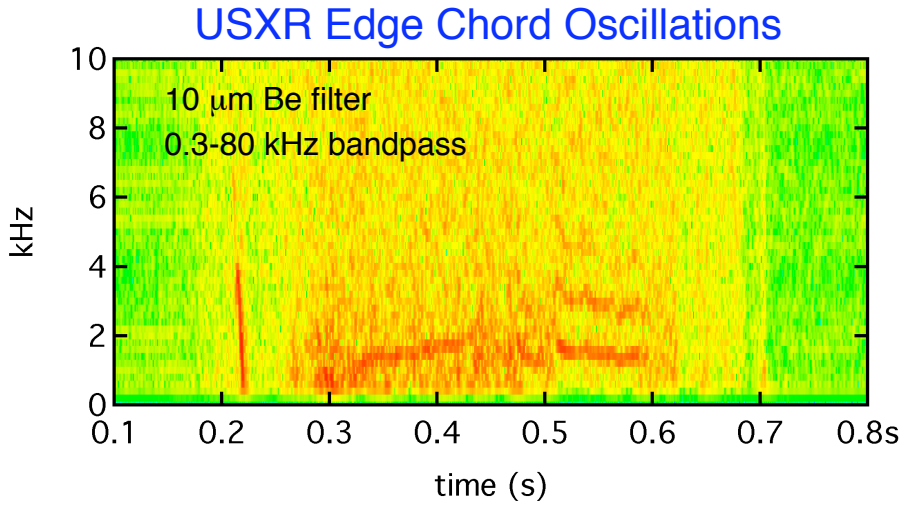
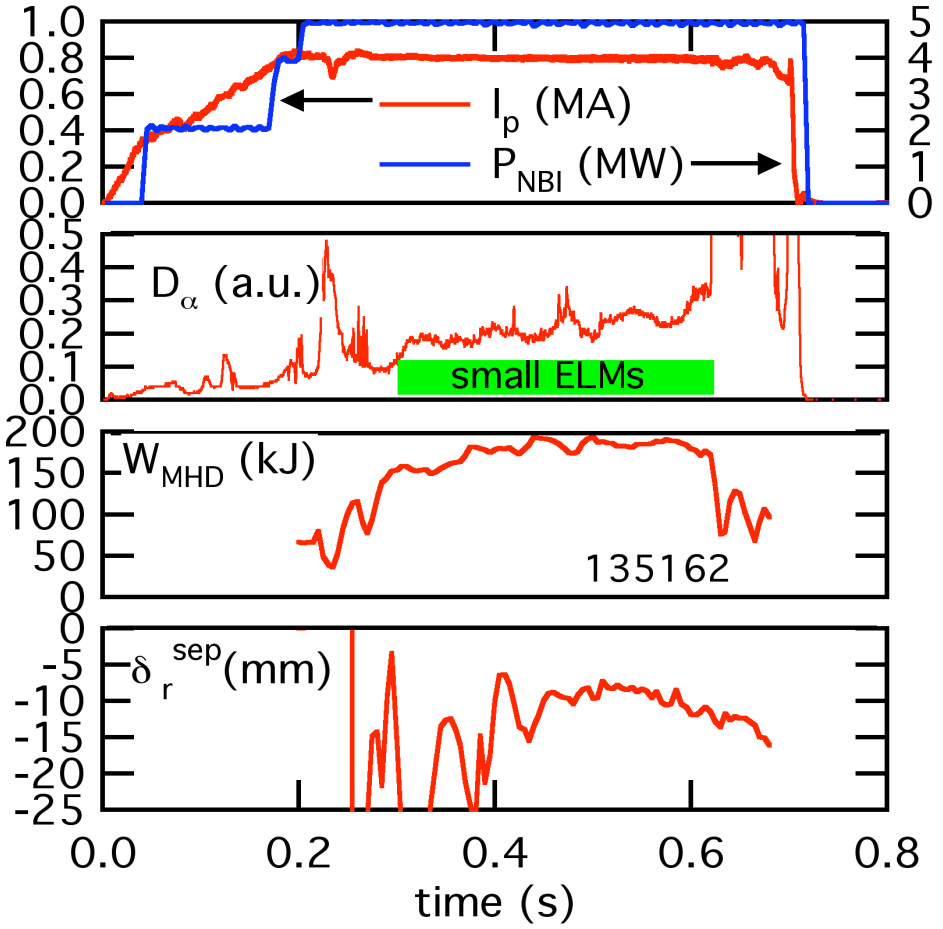
Need further understanding to project access to NSTX small-ELM regime

- NSTX observes transition to small-ELMs coincident with EHO
  - mode is being characterized
  - need understanding of stability conditions that allow it to grow and saturate
- High collisionality needed for access
- Plasmas with EHO exhibit higher edge pressure but reduced pressure gradient
  - presence of EHO leads to increased χ_e near edge
  - decreased χ_i also observed
- Stability calculations indicate EHO plasma near peeling boundary
  - need better understanding of why Type-V instead of Type-I

NSTX observes EHO coincident with small-ELMs

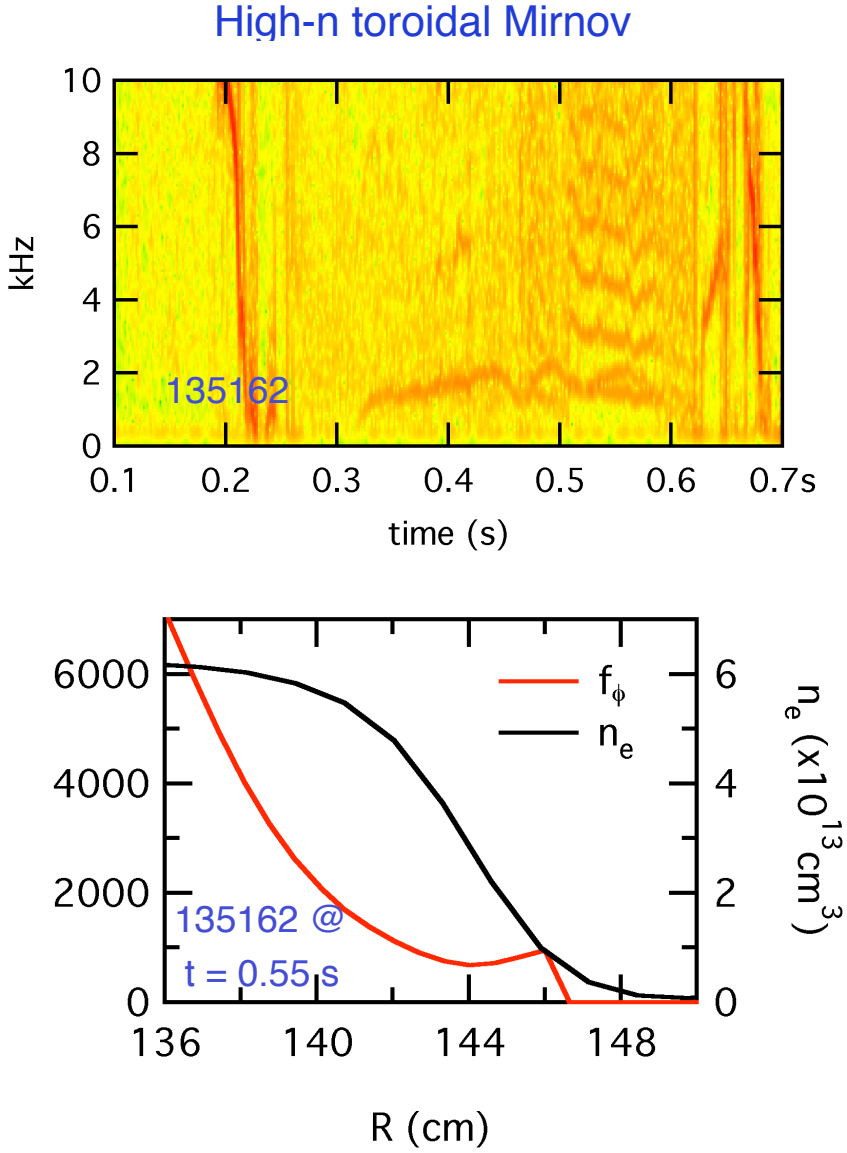
- Edge mode observed in multiple diagnostics coincident with Type -V ELM transition
  - Mirnovs give n = 1 - 3+
  - USXR shows localization just inside pedestal
- Nature and effects of mode under investigation





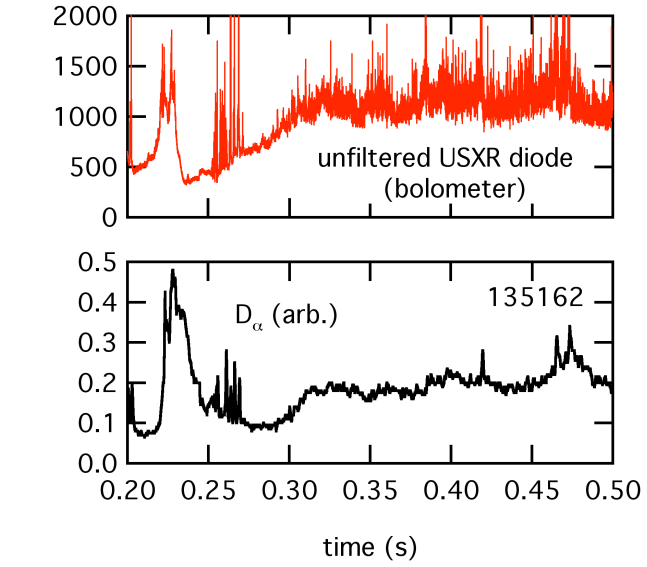
Low-f mode located at top of pedestal based on rotation, mode number

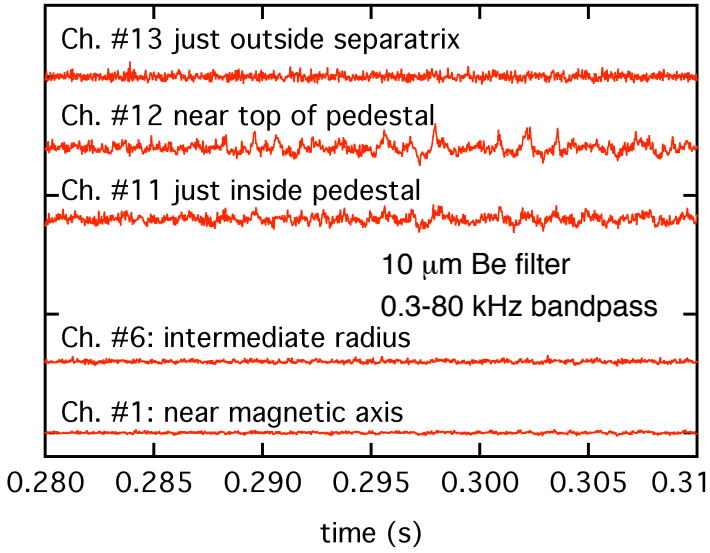
- Magnetics indicate n=1 for low-f mode
  - mode frequency = plasma rotation frequency
- Multiple harmonics observed
  - constant multiples of base frequency
- Base mode frequency ~ 1-2 kHz
  - mode located near density pedestal if rotating with plasma



USXR measurements indicate mode on NSTX is near plasma edge during small-ELMs

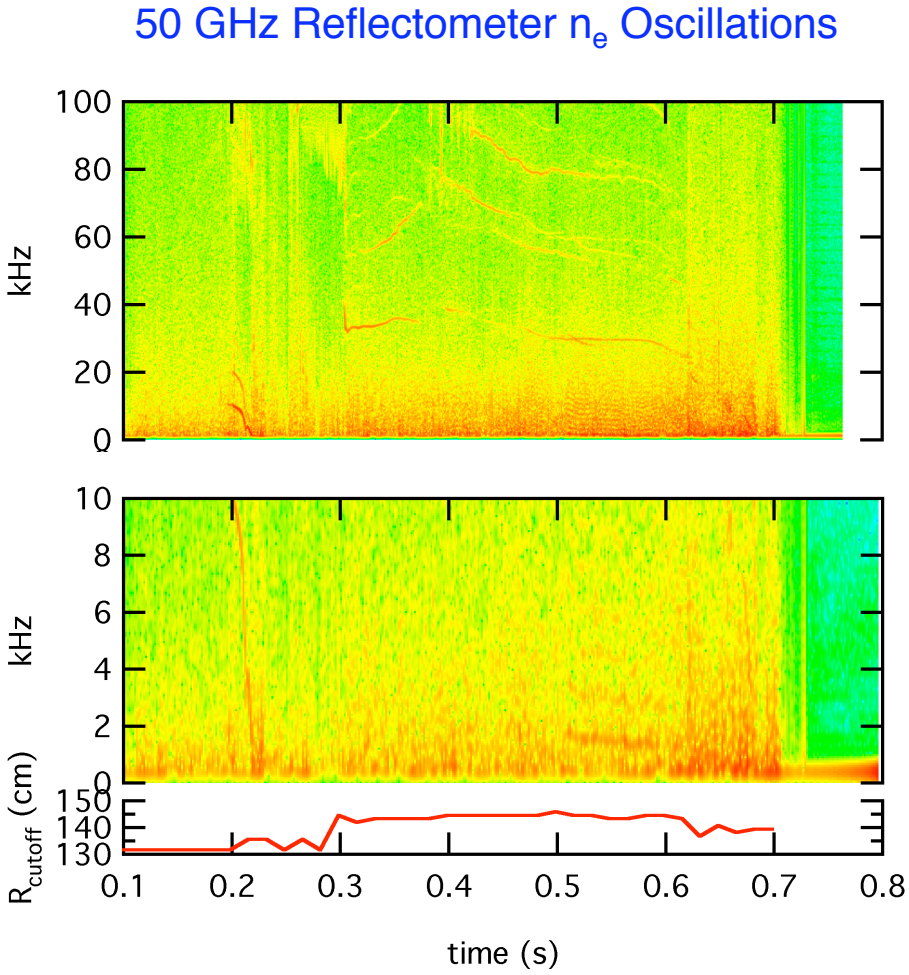
- Unfiltered diodes show small ELMs
  - signal dominated by edge radiation
  - D_α signals at bit noise level
    - δW below resolution of equilibrium reconstructions
- USXR measurements resolve instability location
  - 10 μm Be filters cut out SOL emission
  - low-f (< 5 kHz) oscillations strongest in channels with R_{tan} near pedestal
  - not observed in core channels





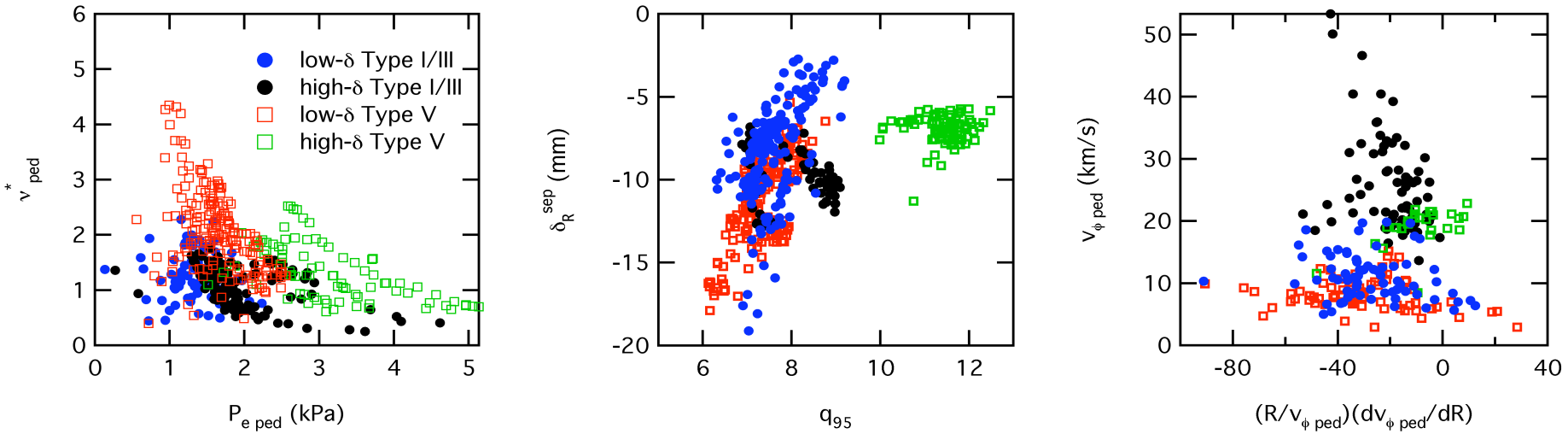
Edge mode leads to pedestal density fluctuations

- High(er)-frequency oscillations due to core modes
  - *AE & NTM?
  - R_{cutoff} ~ 144 cm (in pedestal)
- Low-f oscillations due to edge mode also observed
  - multiple harmonics at same time as observed in Mirnovs, USXR



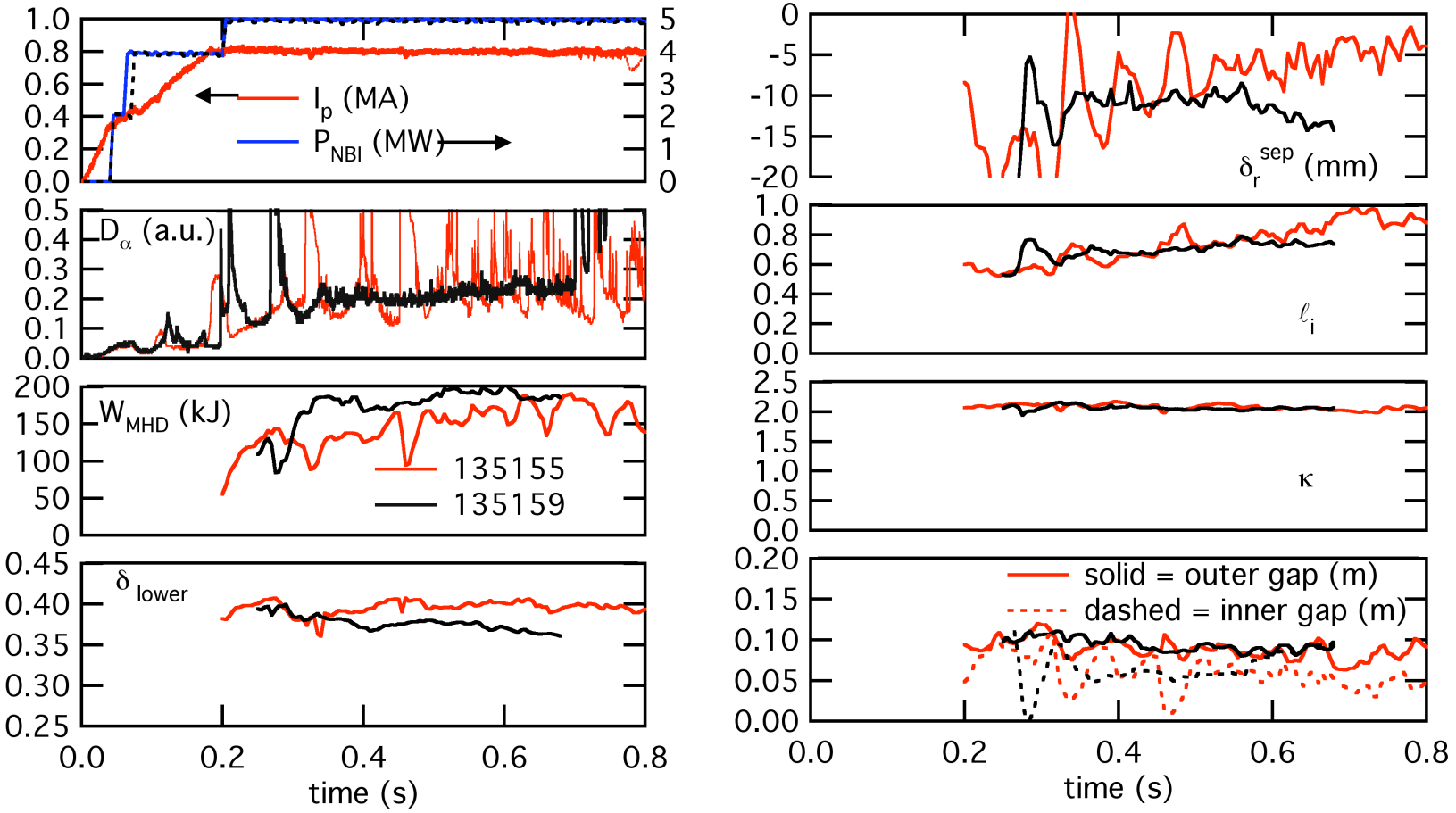
NSTX Able to Access EHO Across Wide Range of Rotation/Shear

- Toroidal rotation/shear appear to be uncorrelated with EHO
- 2 requirements for EHO/Type-V ELM access:
  - increased ν^*
  - $\delta_r^{sep} < -5$ mm
- Satisfying these still does not guarantee EHO/Type-V ELMs



Similar discharges examined to determine cause of small-ELM transition

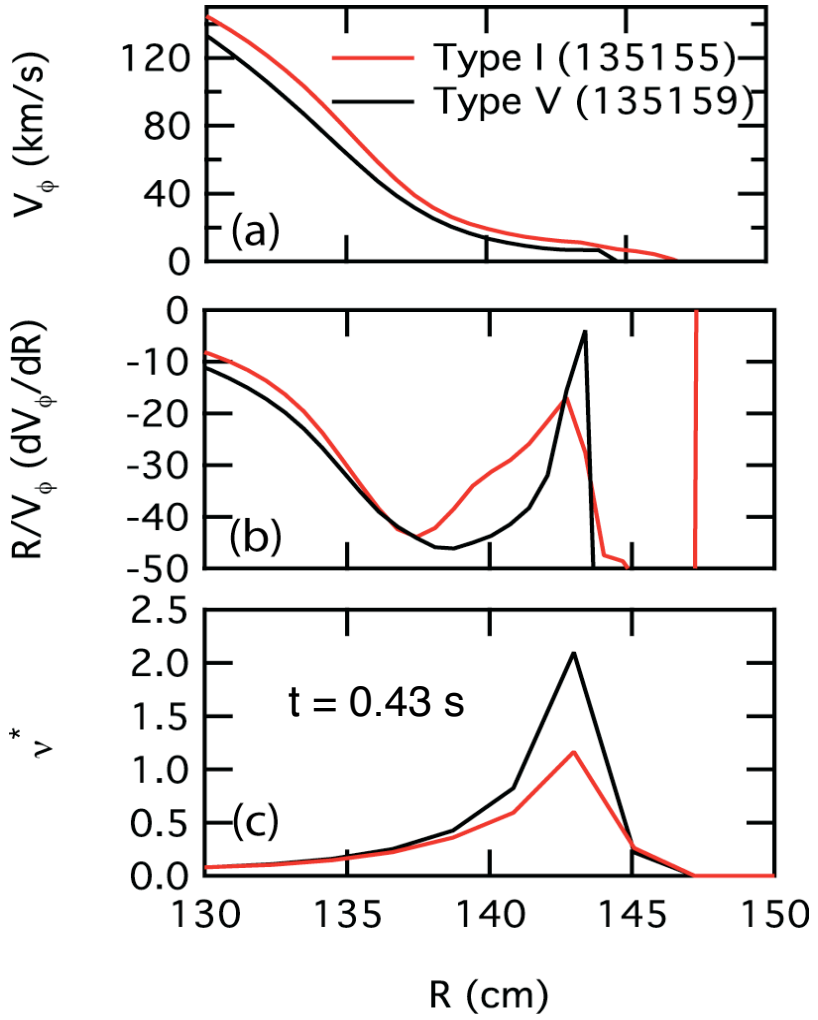
- 135155 – control shot: large Type-I ELMs
- 135159 – drop lower δ: transition to Type-V* ELMs @ 0.3 s



*Maingi, *et al.*, Nuc. Fusion **45** (2005) 264-270

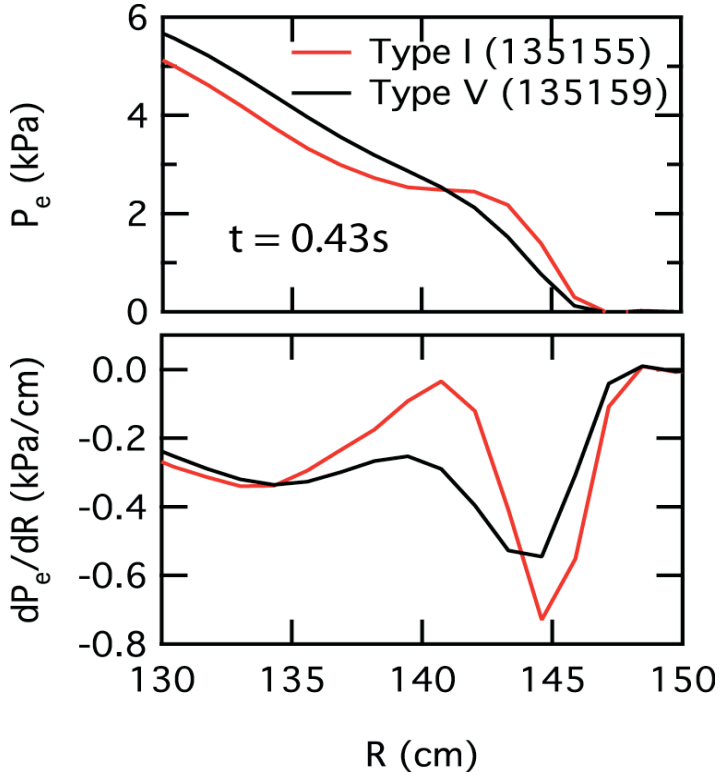
Profile comparisons show little difference in rotation

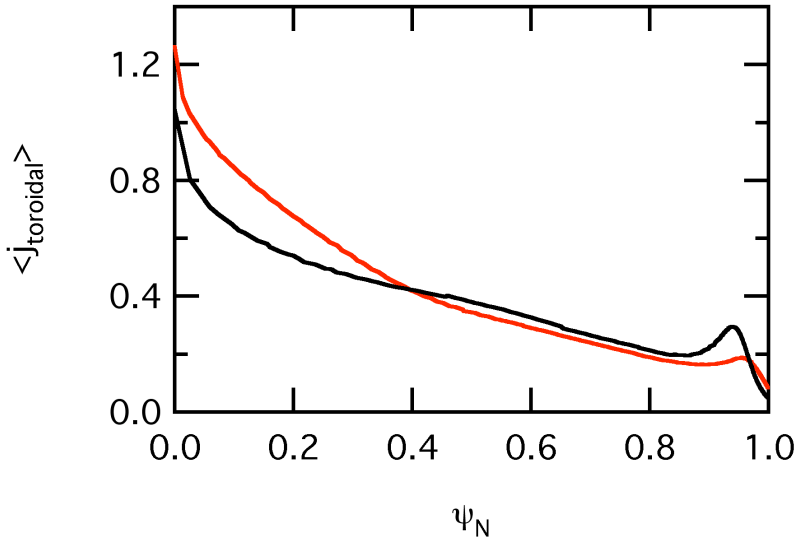
- EHO case has slightly decreased rotation, increased shear
  - large error bars on edge rotation
- Edge collisionality higher for EHO case
  - expect decreased j_{BS} from increased ν^*

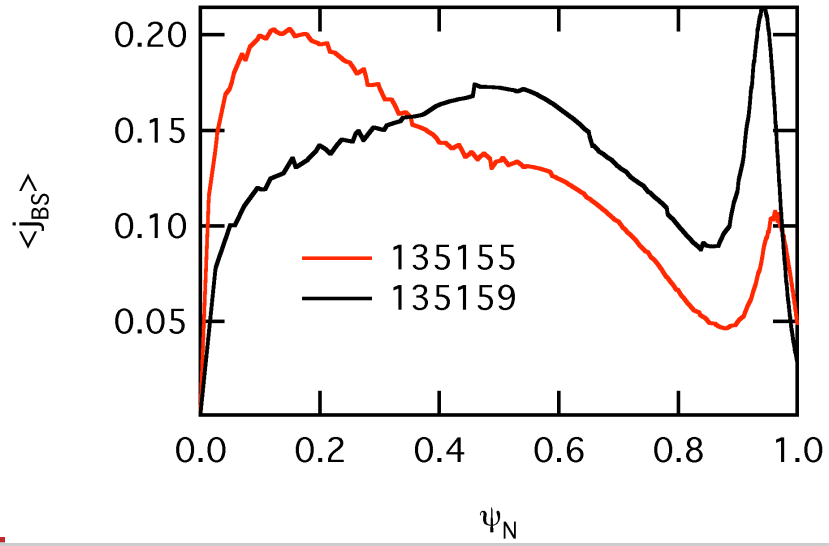


Increased dP_e/dR, decreased j_{BS} with ELMs

- Lack of large ELMs allows sustained higher pressure
- j_{BS} peak increased, moved inward

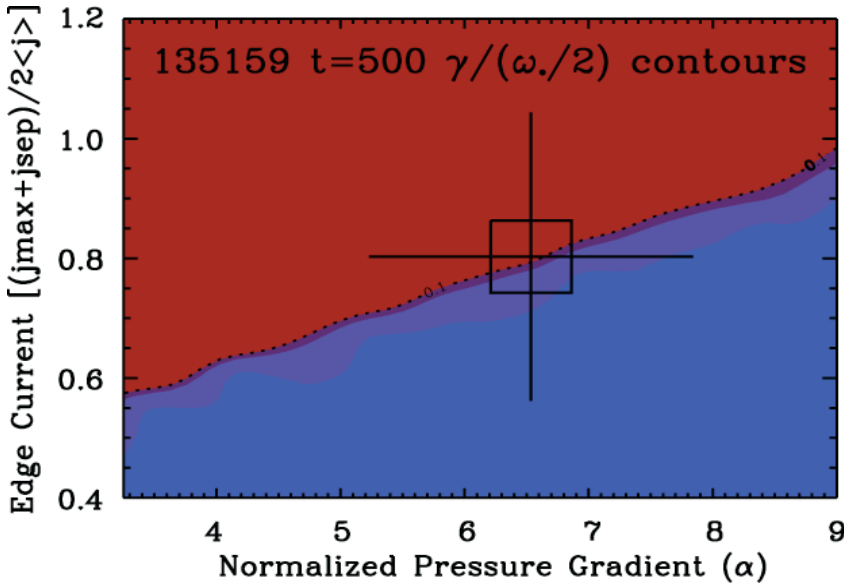


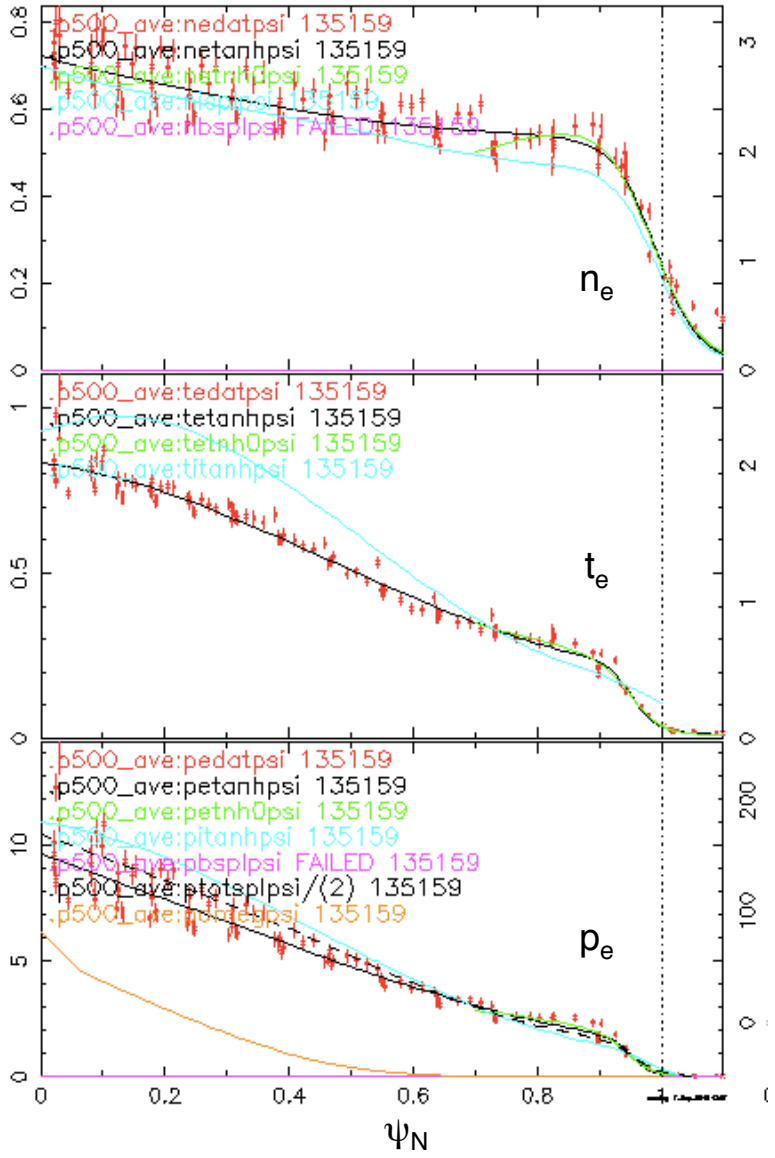




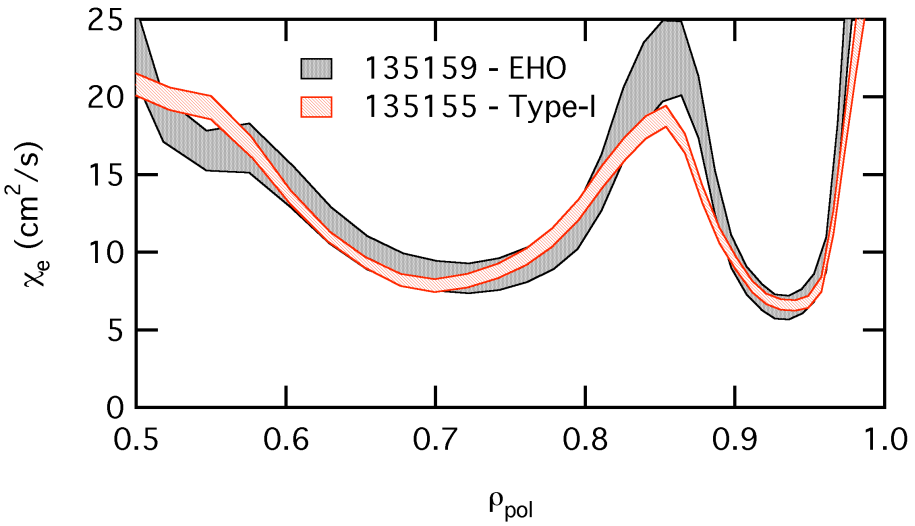
ELITE calculations show EHO plasma near peeling boundary

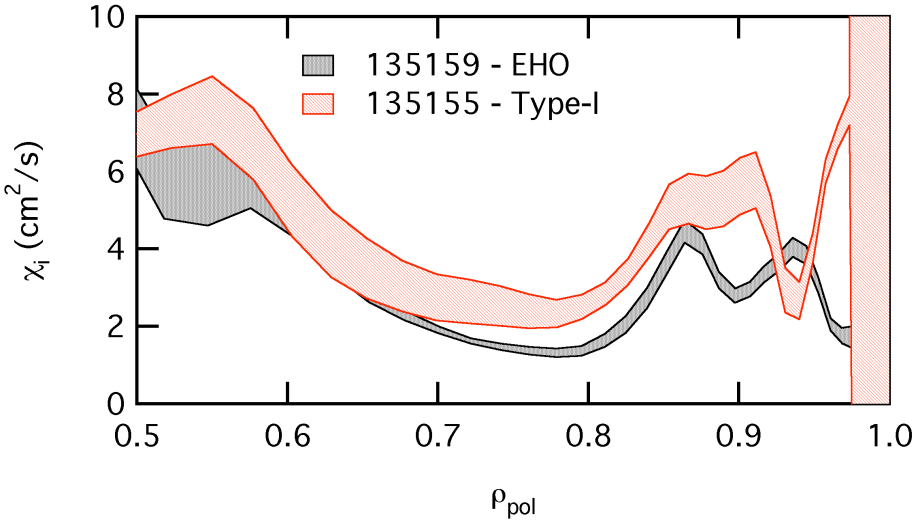
- Profile fits to data over 150 ms during small-ELM time
  - lack of large ELMs gives good profile averaging
- kinetic EFIT/varyped used to map out stability space
  - ballooning boundary still off graph

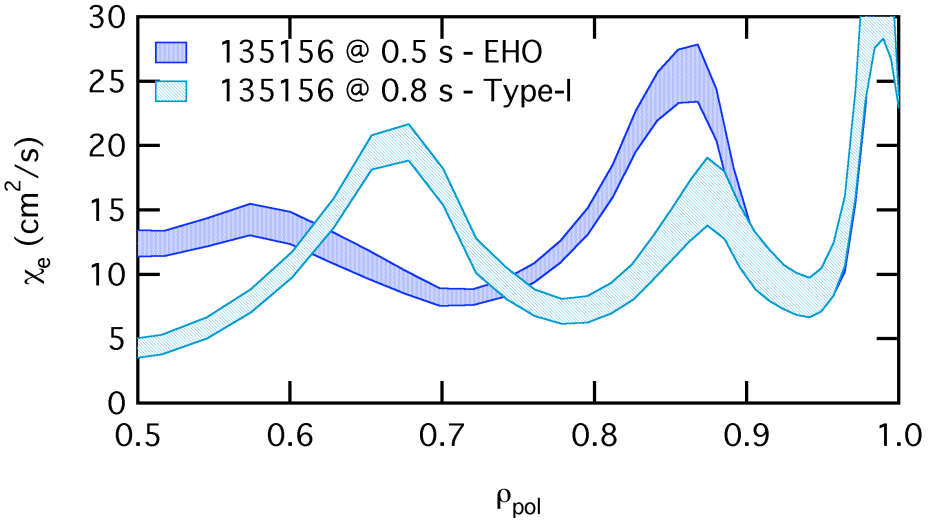


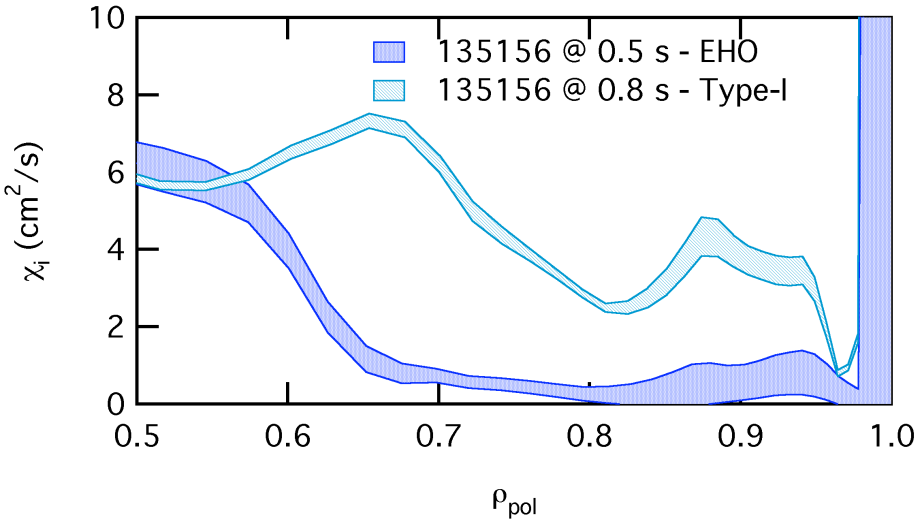


Increased χ_e , decreased χ_i near edge observed during EHO









Questions remain for NSTX Type-V ELM access

- What causes EHO to destabilize and saturate?
  - $\nu^* > 1$ and $\delta_R^{sep} < -5$mm required but why?
  - what other conditions are required?
    - ExB shear, etc.
- How does EHO modify edge stability to get Type-V instead of Type-I ELMs?
  - need further stability calculations
- What experiments can answer these questions?
  - ν^* scan
  - rotation scan
  - others?