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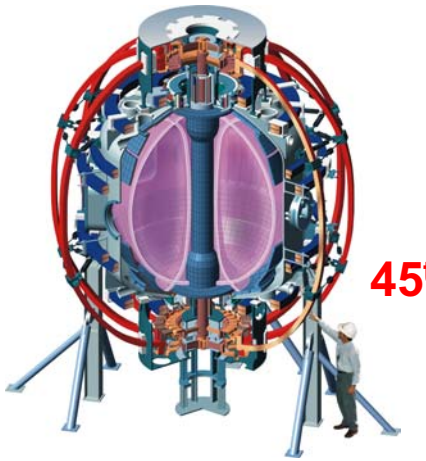

Enhanced electron confinement in low density beam heated NSTX discharges

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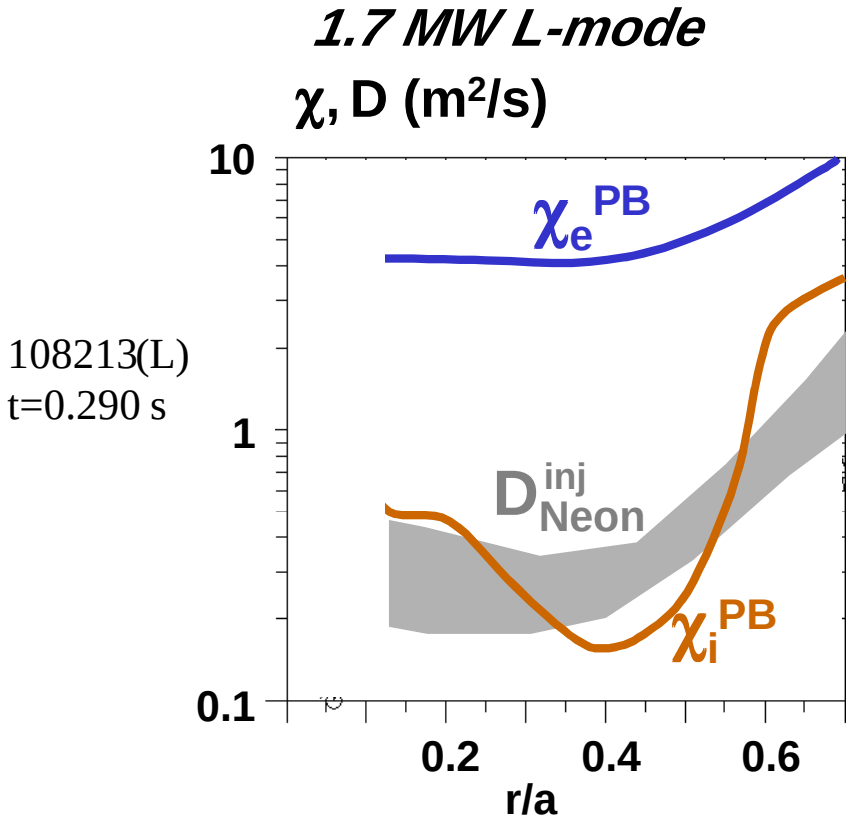
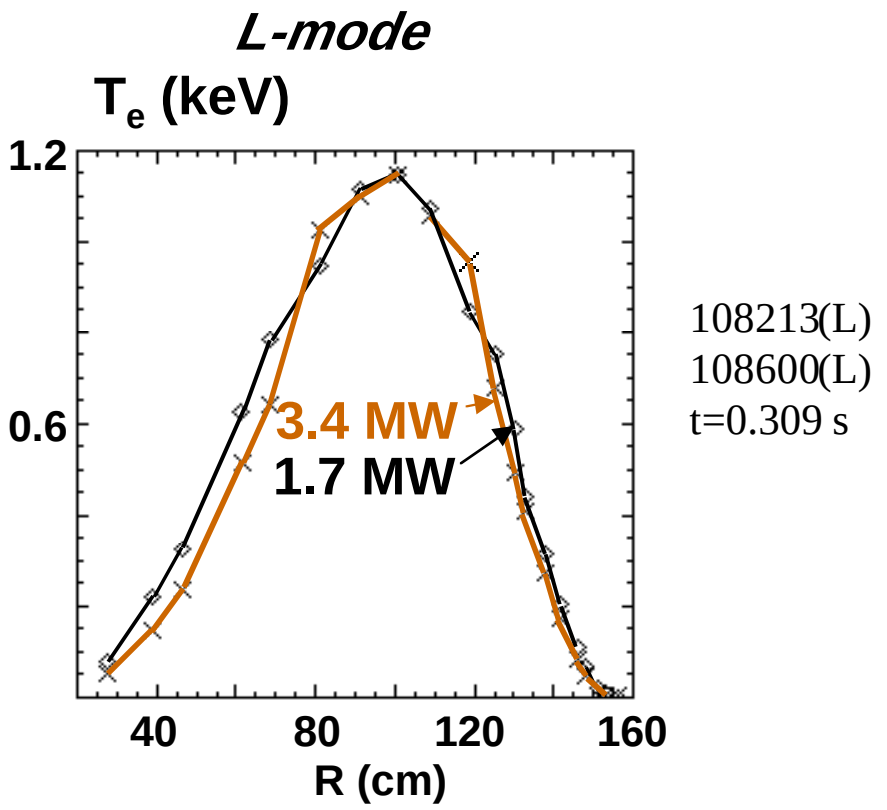
Outline

- **Improved electron confinement in low density L-mode**
- **Evidence for magnetic shear reversal**
- **Comparison with microstability predictions**
- **Ion transport in improved electron confinement regime**

Electron transport typically dominates in NSTX

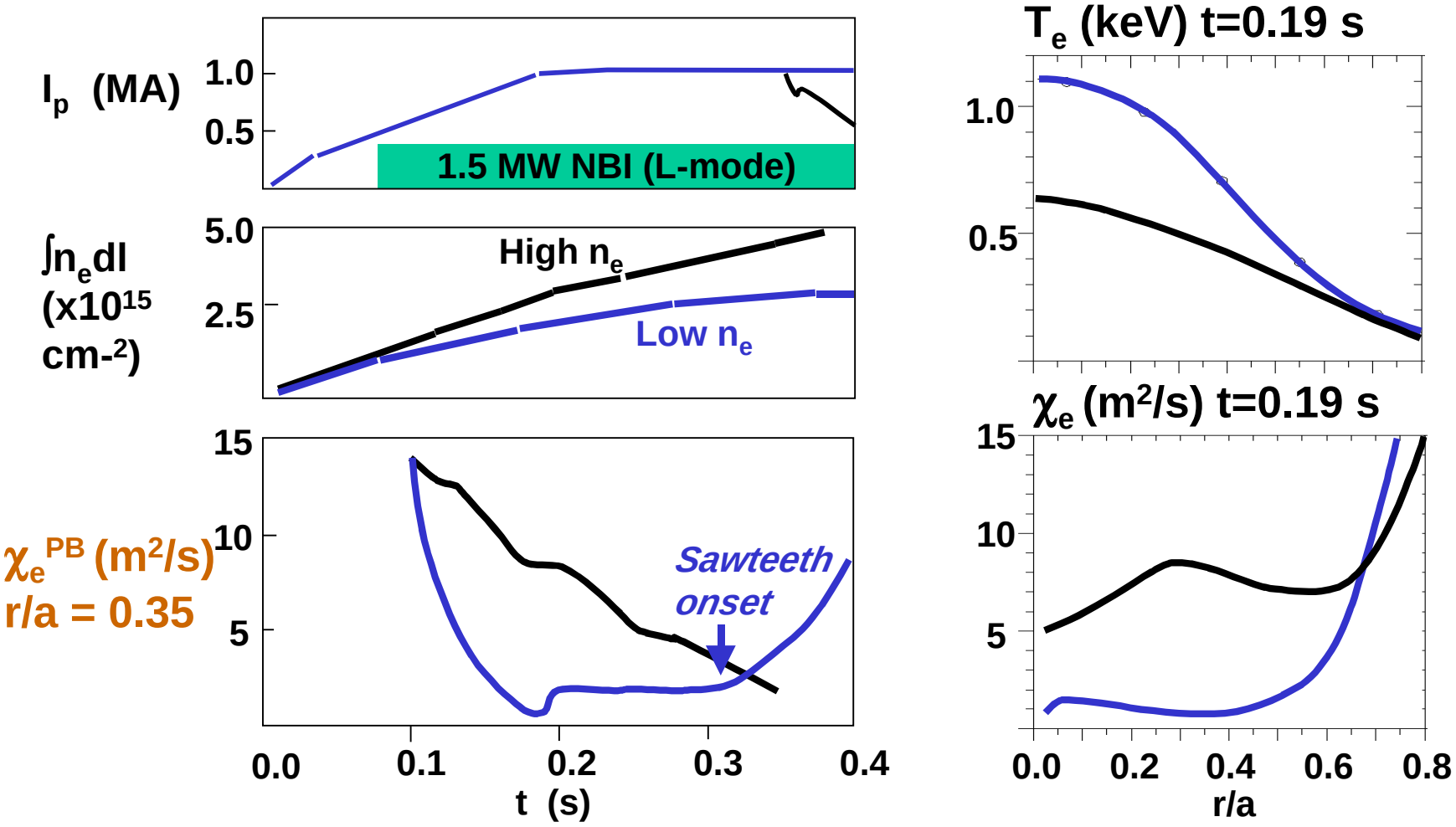




- χ_i, D_{imp} < 1 m²/s (≈ neoclassical)
- χ_e > several m²/s

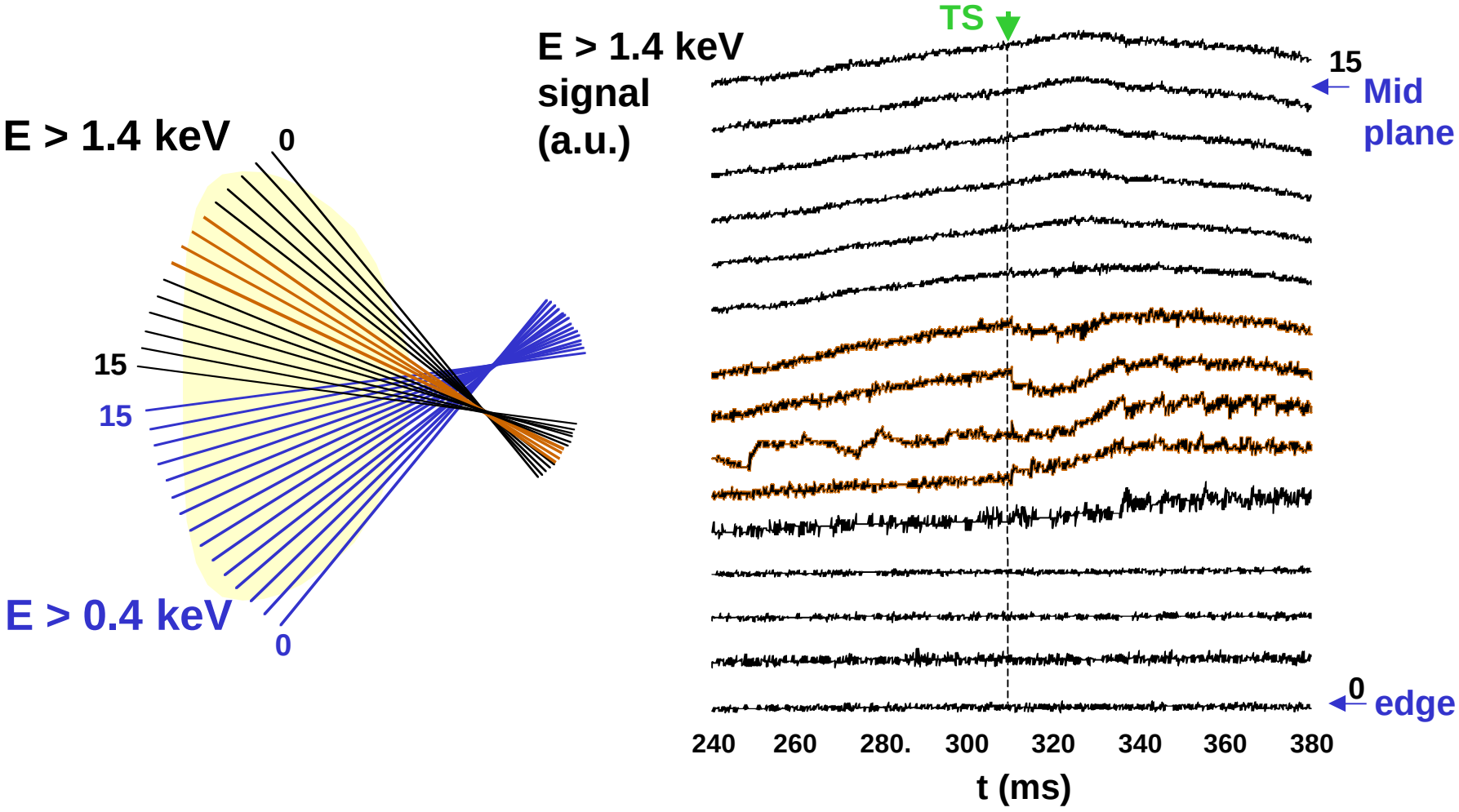
- Stiff T_e profiles

Reduced electron transport regime observed



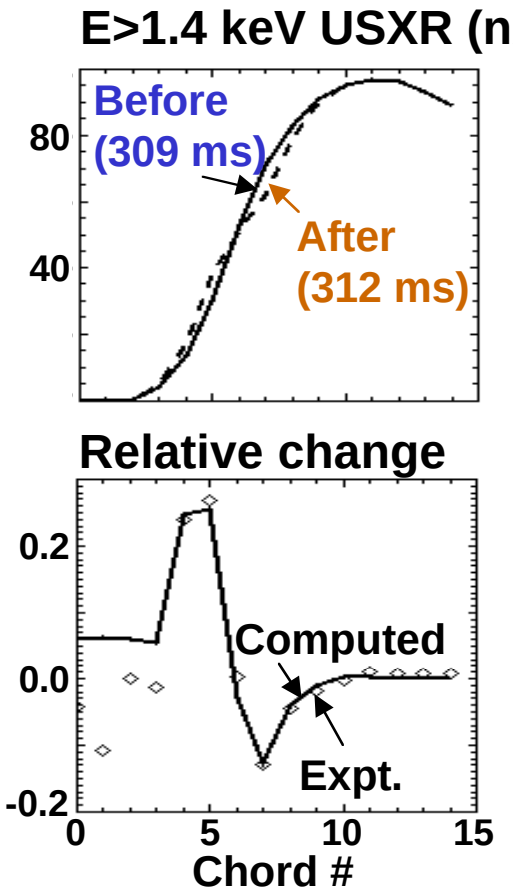
- Large χ_e decrease with early NB injection into low n_e discharge
- χ_e slowly decreases also in high n_e shot

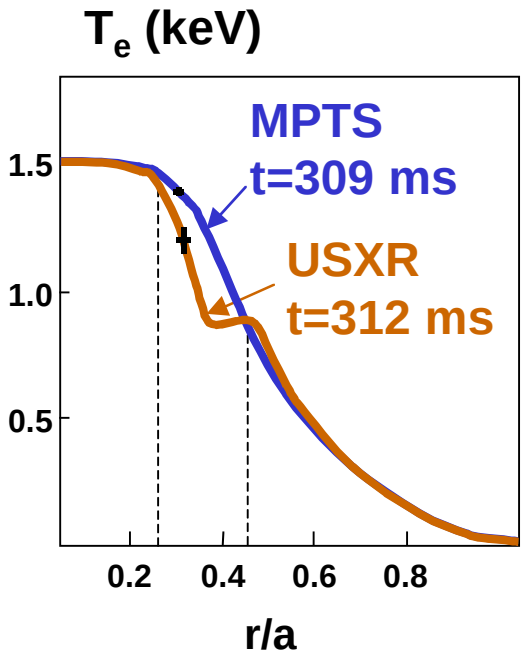
Evidence for shear reversal in low n_e regime



- USXR/magnetics/TRANSP analysis for q(r) estimate
- Off-axis 'sawteeth' in USXR emission from low n_e discharge
- 'Two-color' measurement enables unfolding T_e, n_e perturbation

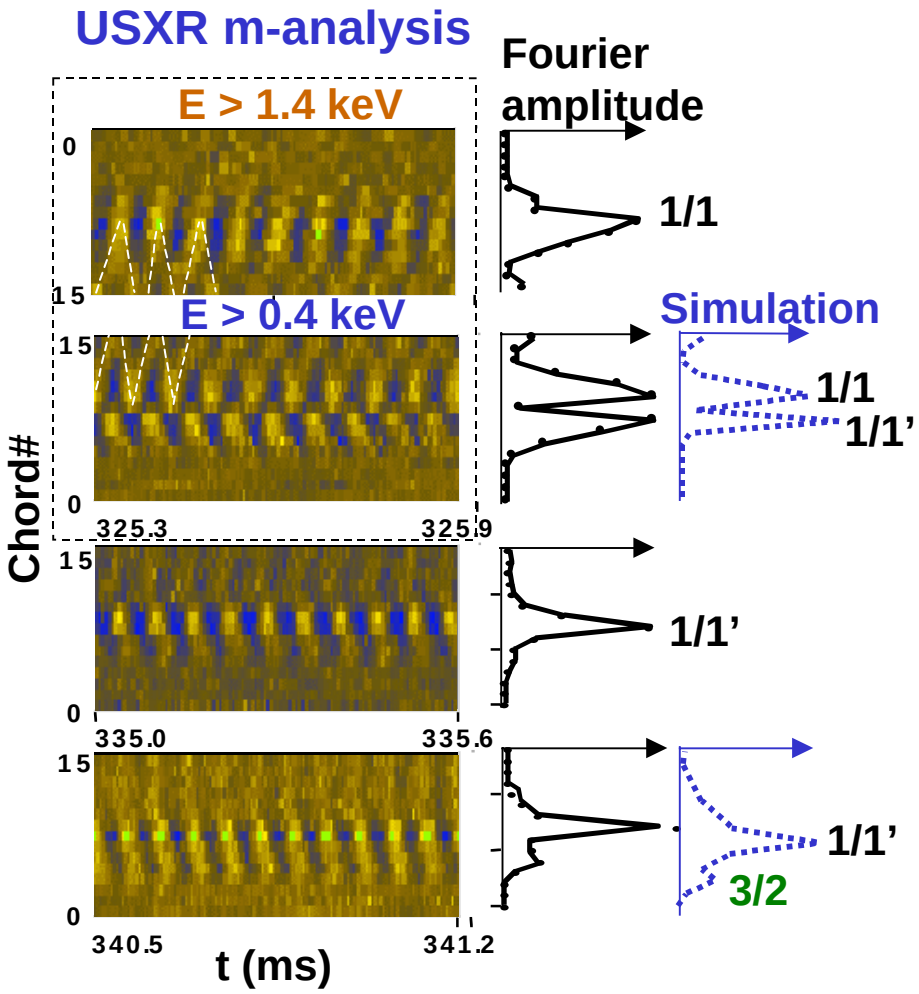
USXR modeling indicates off-axis T_e crashes

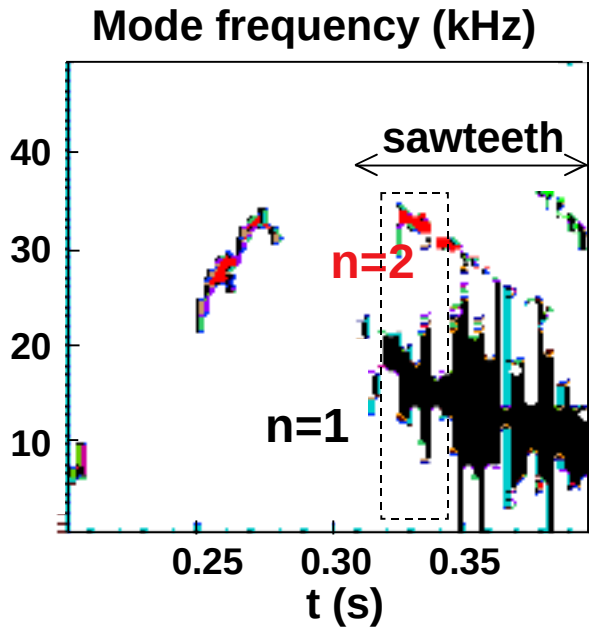




- T_e profile after crash from MIST modeling *of "two-color"* USXR data
- Off-axis (0.25<r/a<0.45) T_e crashes suggest reversed q-profile

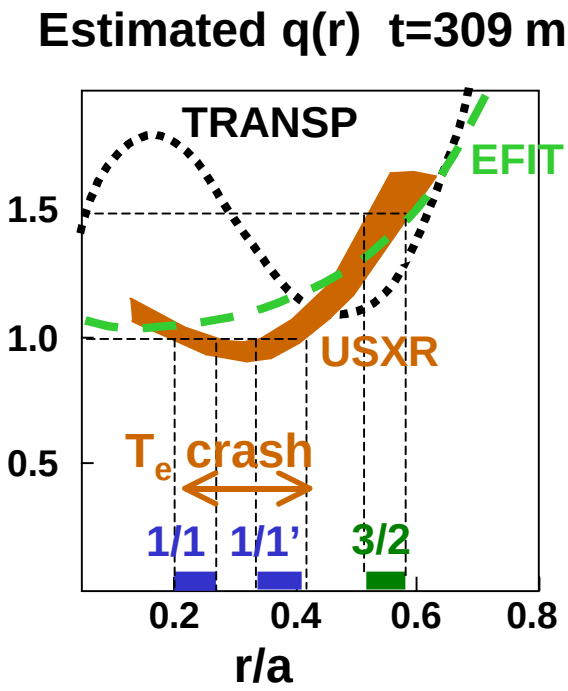
Mode analysis indicates two 1/1 surfaces

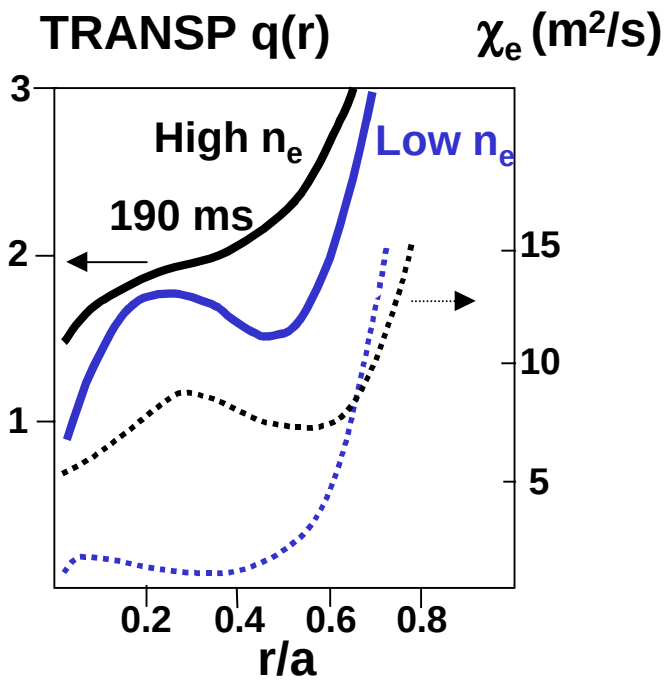




- Fourier analysis of USXR and magnetic data for mode localization
- Two 1/1 modes at r/a ≈ 0.22 and r/a ≈ 0.36
- 3/2 mode around r/a ≈ 0.55

Estimated q-profile is reversed

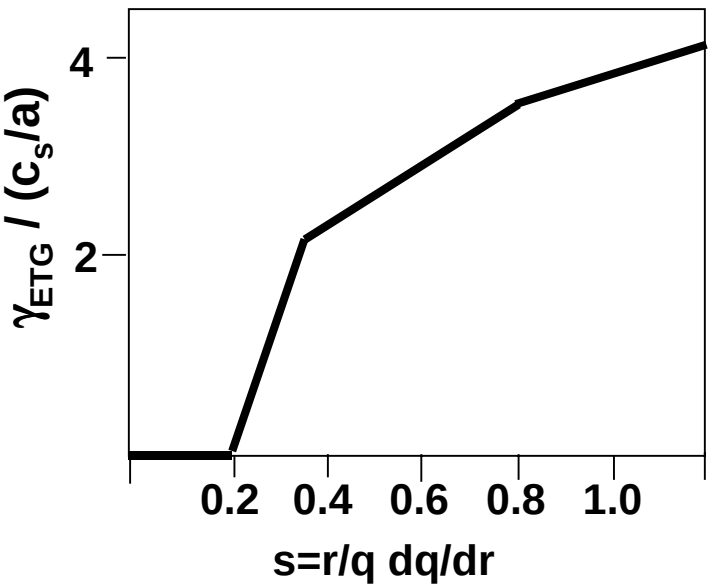




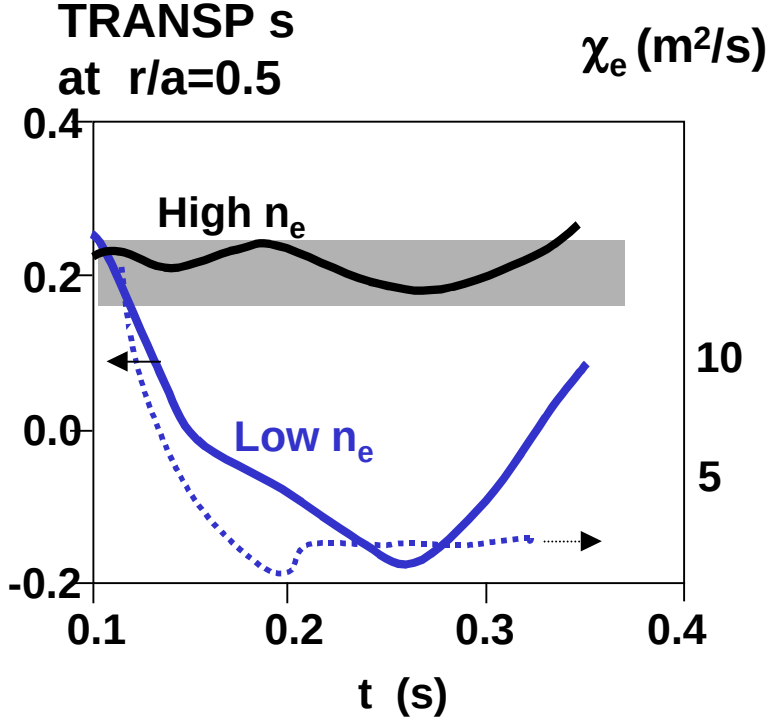
- Both USXR and TRANSP estimate negative/low shear
- USXR q_0 is lower (likely due to current penetration at reconnections)
- Large difference in early q-profiles (TRANSP) correlates with large difference in early χ_e
- Slow χ_e reduction in high n_e shot also correlates with decreasing shear
- $s \lesssim 0$ at mid-radii likely cause for improved electron confinement

Theory predicts ETGs suppressed by reversal

ETG growth rates at r/a=0.5
(C. Bourdelle, GS2)

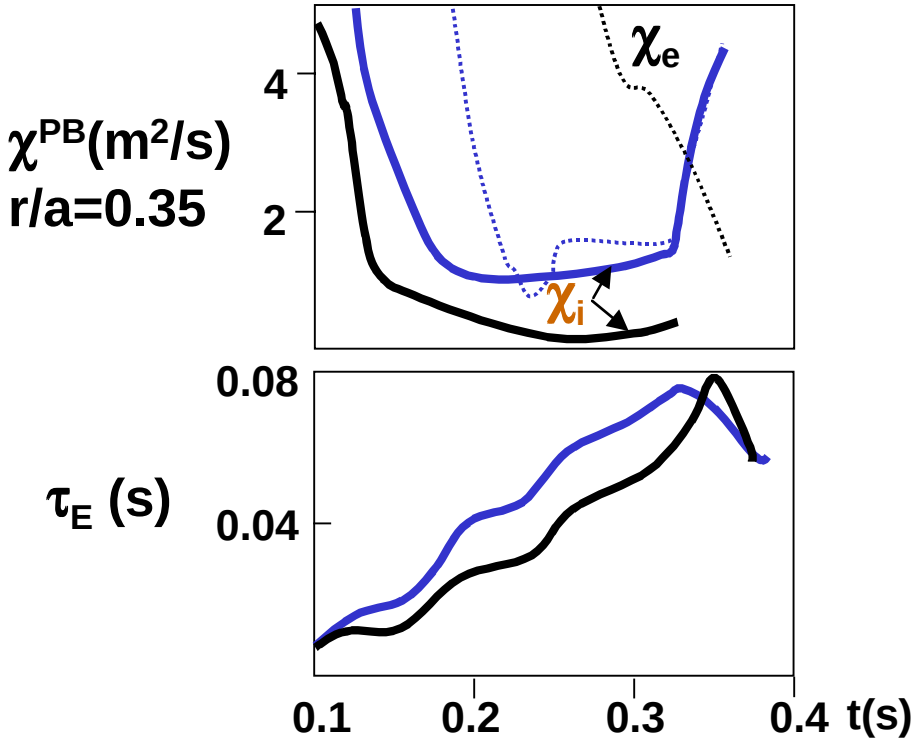


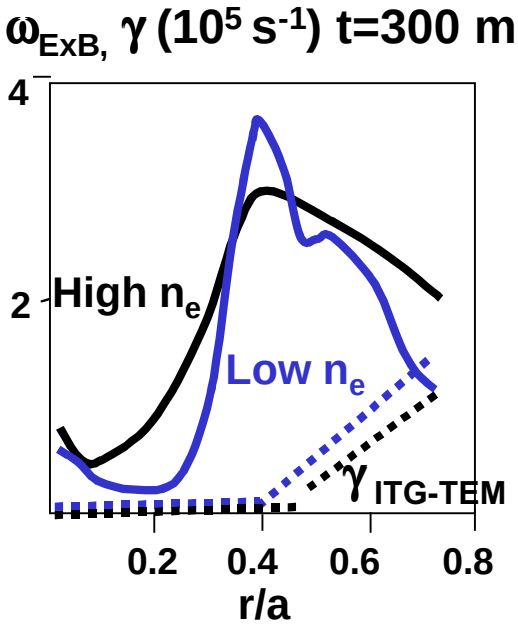
TRANSP s
at r/a=0.5



- Microstability calculations indicate step-like ETG dependence on shear
- χ_e evolution roughly consistent with GS2 and TRANSP predictions
- ETG modes likely drive for NSTX electron transport
- χ_e invariant with magnetic field *(Stutman et al APS02)* also consistent with ETG scaling

Ion transport increases in reduced χ_e regime





- χ_i, D_{Neon} increase to ≈ χ_e in low density discharge
- Global confinement nevertheless increases (up to ≈ 2.5x $\tau_{89\text{-}P}$)
- Decreased core ω_{ExB} in low n_e shot (flatter V_t profile)
- ITG-TEM growth rates increase 30-40% (decreased T_i/T_e)
- However, ω_{ExB} still exceeds $\gamma_{ITG\text{-}TEM}$ over most of the radius
- Inverse correlation between electron and ion turbulence ?

Summary

- Much improved electron transport when $s \lesssim 0$ inferred
- Strong ETG suppression predicted for negative/low shear
- Magnetic shear may be the determining factor for NSTX global confinement
- Very accurate q(r) diagnostic needed if ETG growth rates have predicted steep dependence on s
- Increased ion transport at the same time
  - not well explained by modest increase in ITG-TEM growth rates and decrease in ExB shear; other mechanisms ?
- Very good confinement in NSTX if electron channel is improved; shear reversal followed by β' stabilization ?