Observations on electron transport in beam heated L-mode NSTX discharges

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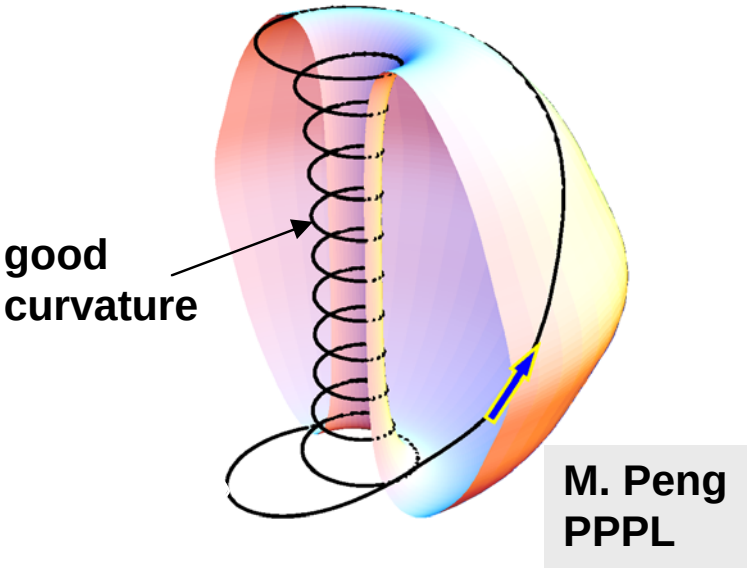
Transport in NSTX versus conventional tokamak

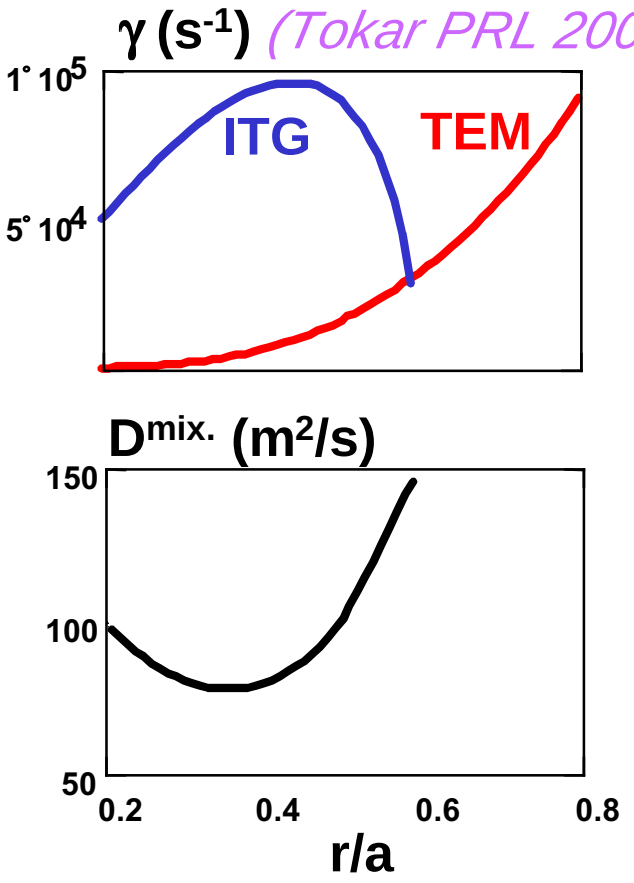
R/a ≈ 1.5

B_t ≈ a fraction of a T

β ≈ tens of %

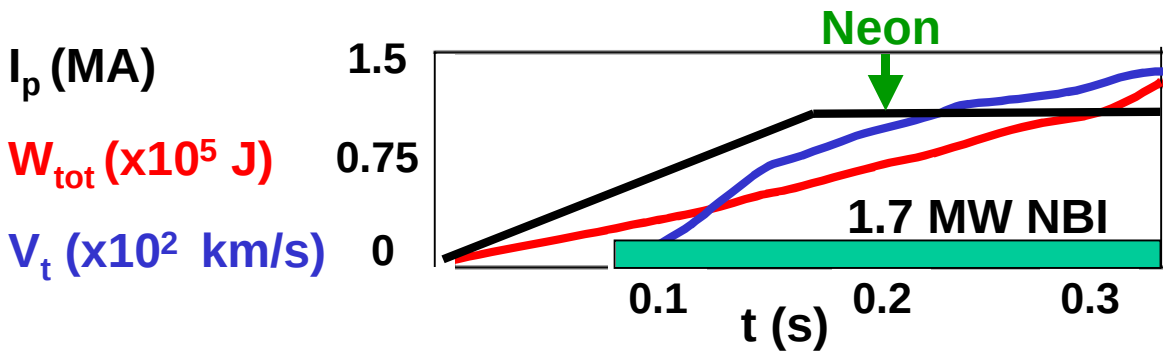


M. Peng
PPPL

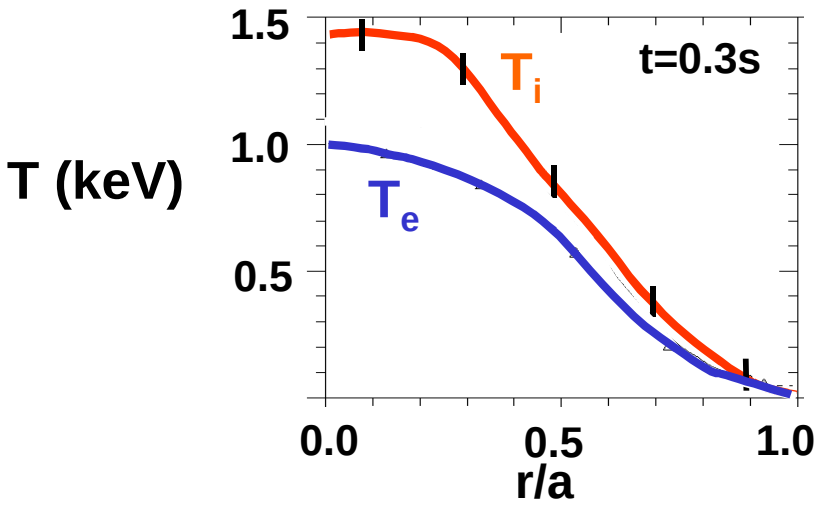


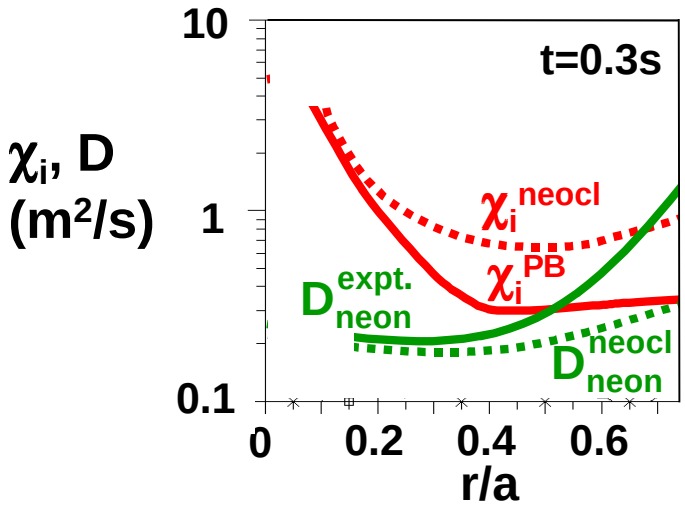
- Low R/a, large ω_{ExB} and high β predicted to improve μ-stability
- Improvement needed: $D^{mix.} \geq$ 10s of m^2/s assuming tokamak-like γ's
- Good global confinement observed ($\tau_E \lesssim 0.12$ s)

Ion transport is low



1 MA/4.5 kG
'slow-evolving L-mode'

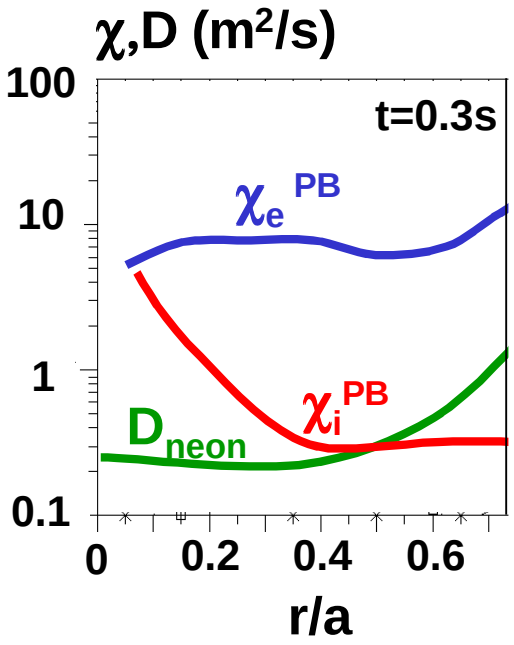




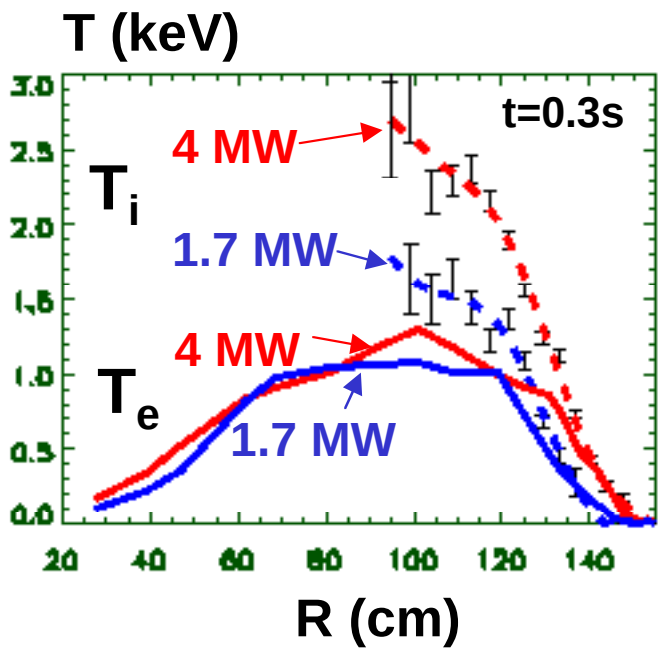
- $T_i > T_e$ when most of the beam heats the electrons
- χ_i, D_{neon} fall to ≈ neoclassical in these discharges (PB difficult)
- Turbulent ion transport appears suppressed in the core

Electron transport is dominant

1 MA/4.5 kG

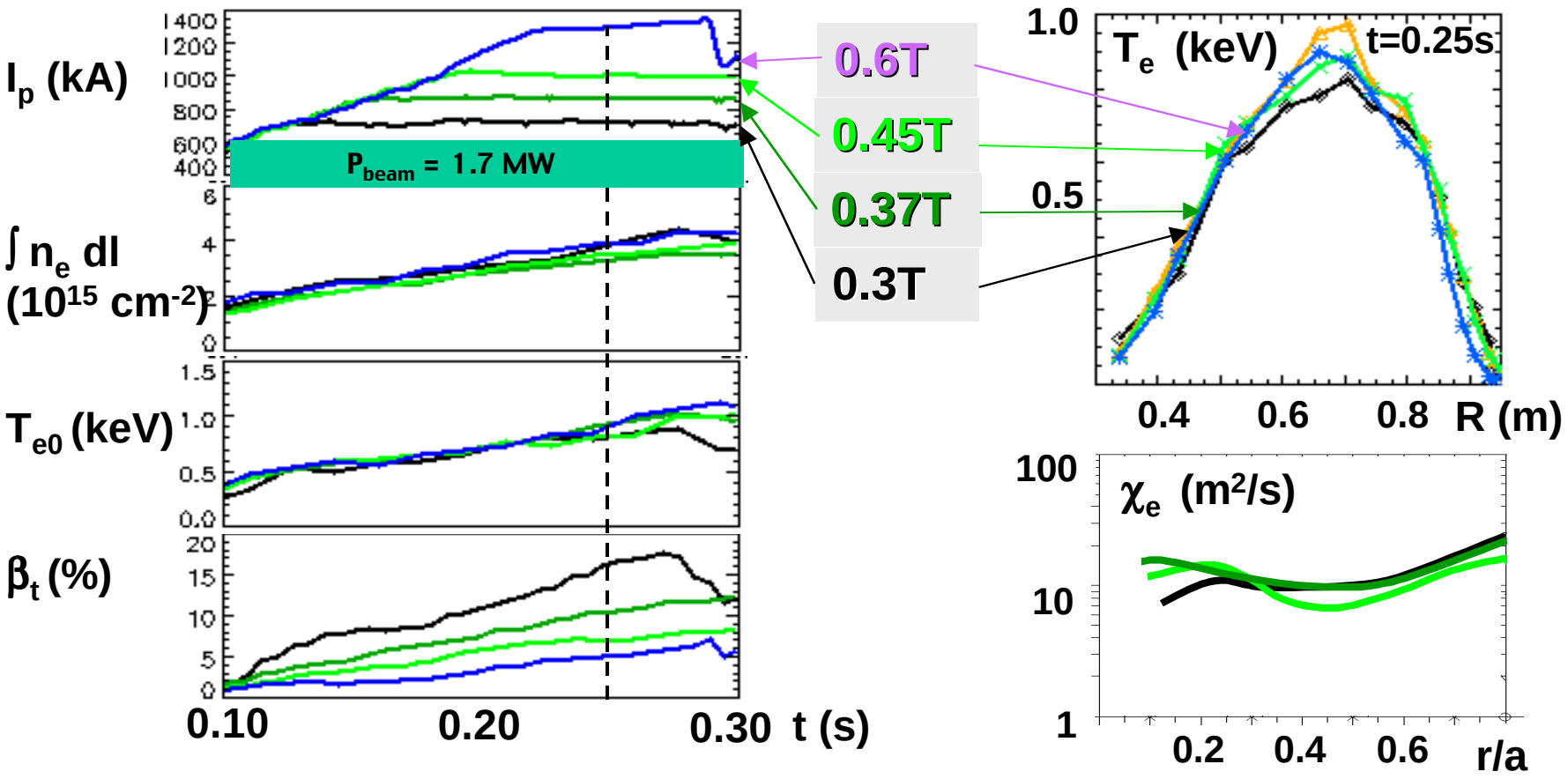


1.3 MA/6 kG



- $\chi_e >> \chi_i, D_{impurity}$ ($\chi_e \approx \chi_i \approx D_{impurity}$ in tokamak L-mode)
- Stiff T_e profiles although beam heats mostly electrons
- T_i profiles respond to increased P_{beam}
- Hints that electron 'stiffness' may be q-dependent

T_e profiles do not change with B at fixed q_{cyl}



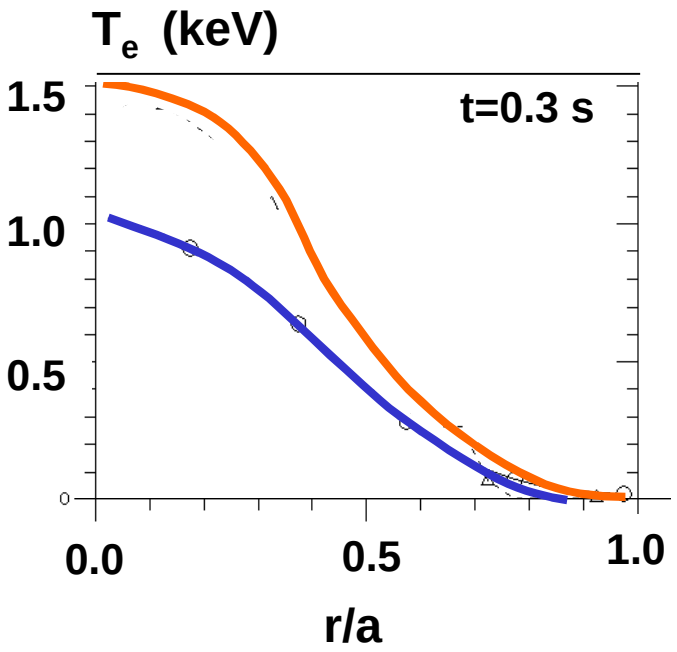
- Factor of two B_t, I_p scan at fixed B_t/I_P and beam power
- T_e, χ_e, unaffected by large change in B -> ETG driven transport ?
- Strong ETG instability predicted in NSTX (C. Bourdelle, M. Redi)

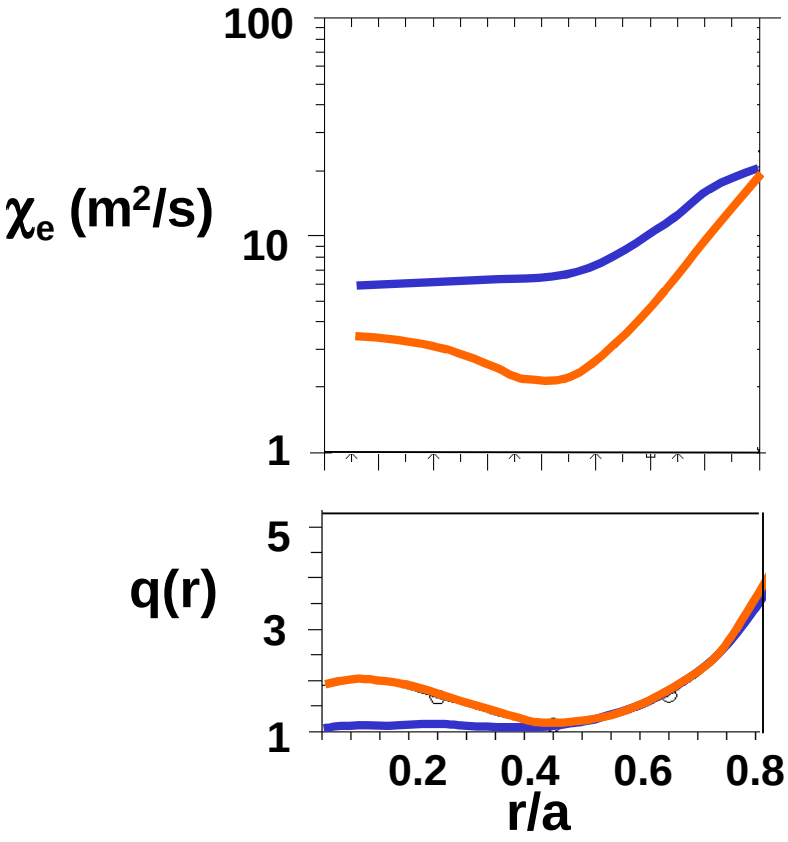
Electron transport reduced when s < 0 ?

1 MA/4.5 kG

$\langle n_e \rangle = 2\ 10^{13}$

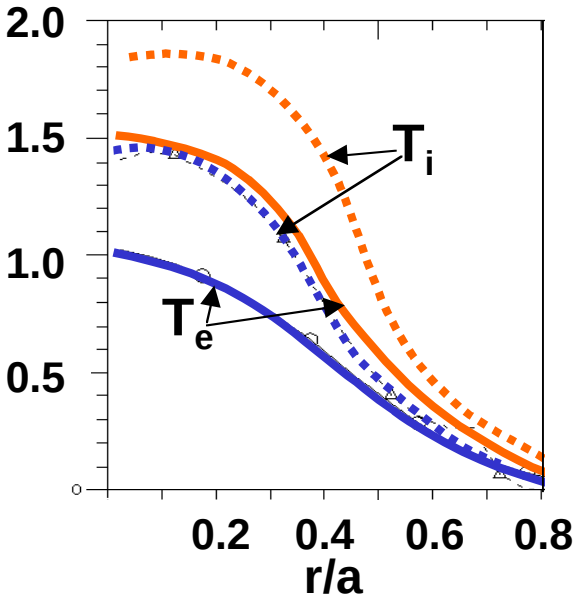
$\langle n_e \rangle = 4\ 10^{13}$

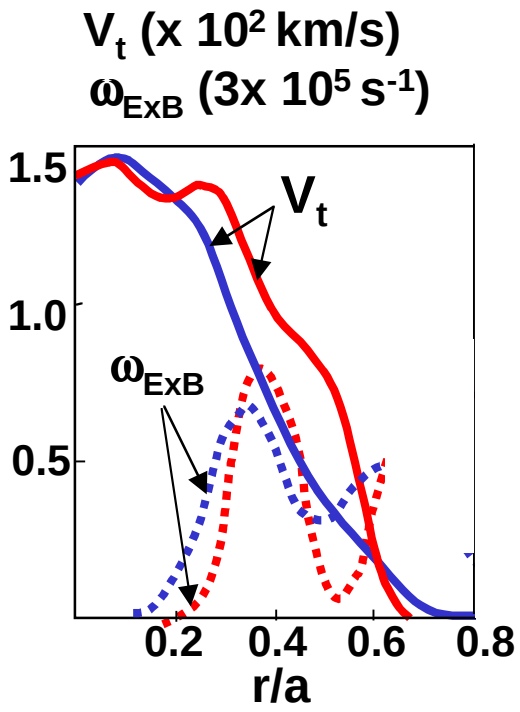


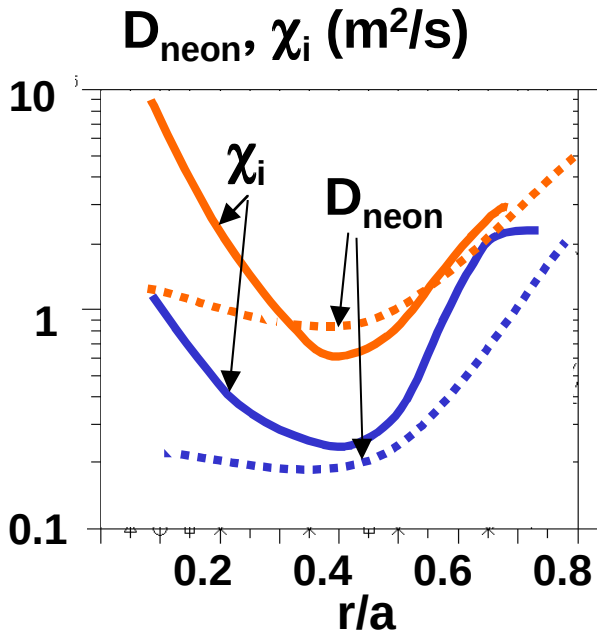


- **Shear reversal inferred from USXR data and TRANSP simulations**
- **Strong ETG suppression predicted in these discharges for $s \lesssim 0$ (C. Bourdelle)**

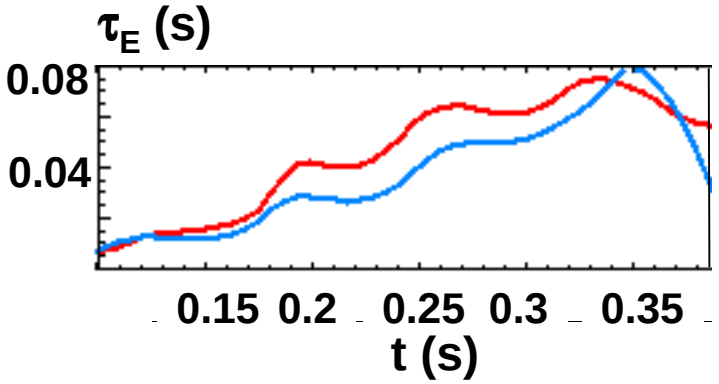
At the same time ion transport increases







- Reduced T_i / T_e -> ITG ↑ ?
- Lower n_e -> trapped modes ↑ ?
- Reduced core ω_{ExB} ?
- Global confinement nevertheless increases



Summary of observations

- **Good global confinement in 'slow-evolving' L-mode discharges**
- **Near neoclassical ion transport**
  - turbulent ion transport probably suppressed
- **Strong and stiff electron transport**
- **Electron transport independent of B**
  - ETG at play ?
- **Improved electron transport when s < 0 inferred**
  - strong ETG suppression predicted
- **Increased ion transport at the same time**
  - Decreased T_i / T_e ? Lower ExB shear ?
- **Very good confinement in NSTX if electron channel is improved**