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Internal transport barriers in NSTX reversed-shear plasmas

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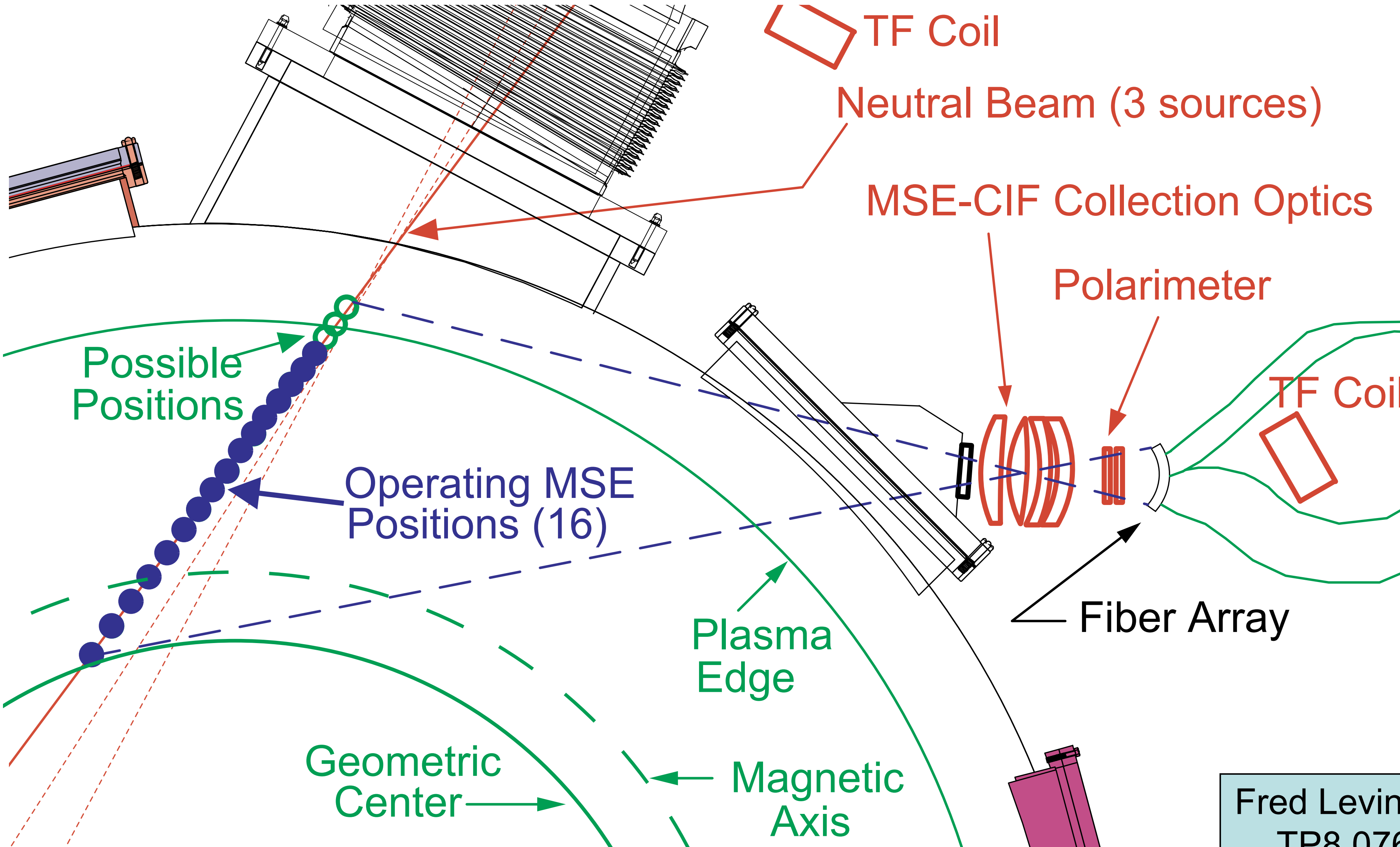
16 ch MSE constrains reconstruction of dynamic NSTX current profiles

- Low field Lyot filter based MSE system expanded to 16 channels for 2007
- Views heating beam, diagnoses a high percentage of NSTX plasmas
- Provides full coverage from edge to well past magnetic axis

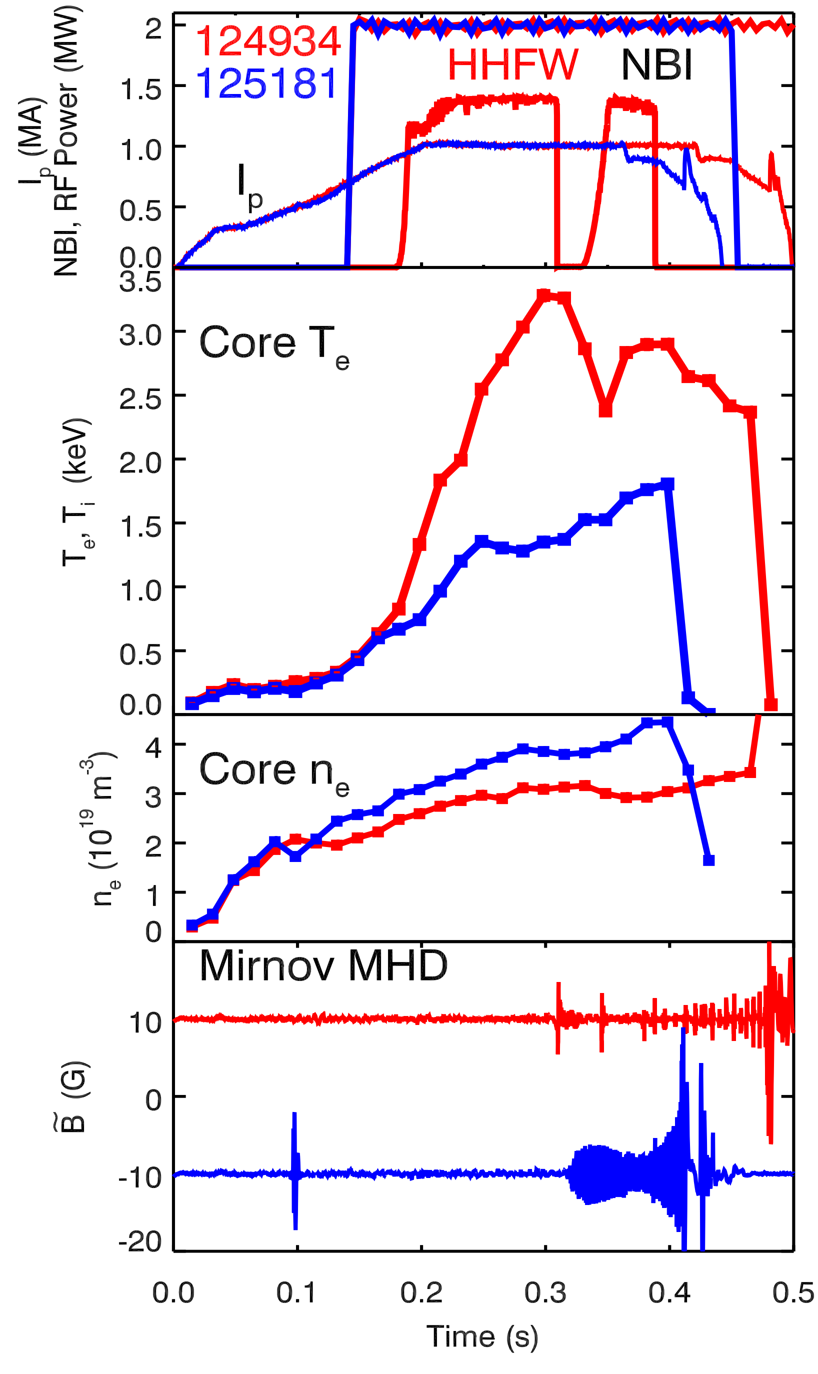


Fred Levinton
TP8.076

High core T_e, T_i observed in reversed shear, L-mode plasmas at 5.5kG

- Reversed shear plasmas optimized using beam timing
- Electron temperature gradients increased using additional high harmonic fast wave heating
- Data taken from low MHD activity portion of discharge

- ITB profiles
- Correlation between magnetic shear ($\hat{s}=r/q\ dq/dr$) and T_e gradient ($R/L_{Te}=R/T_e\ dT_e/dr$)
- Correlation between toroidal velocity ($E\times B$) shear and T_i gradient
- Negative shear suppression of ETG fluctuations



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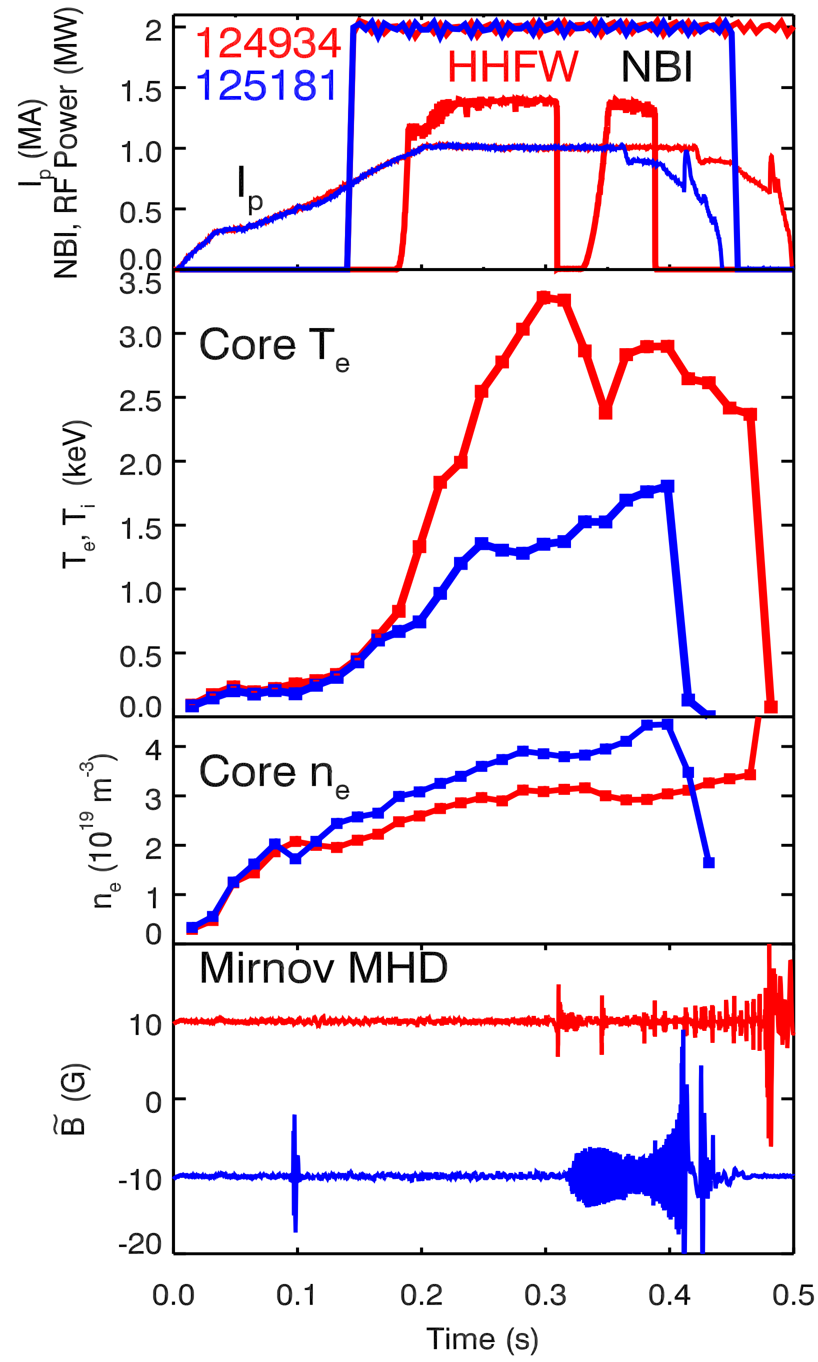

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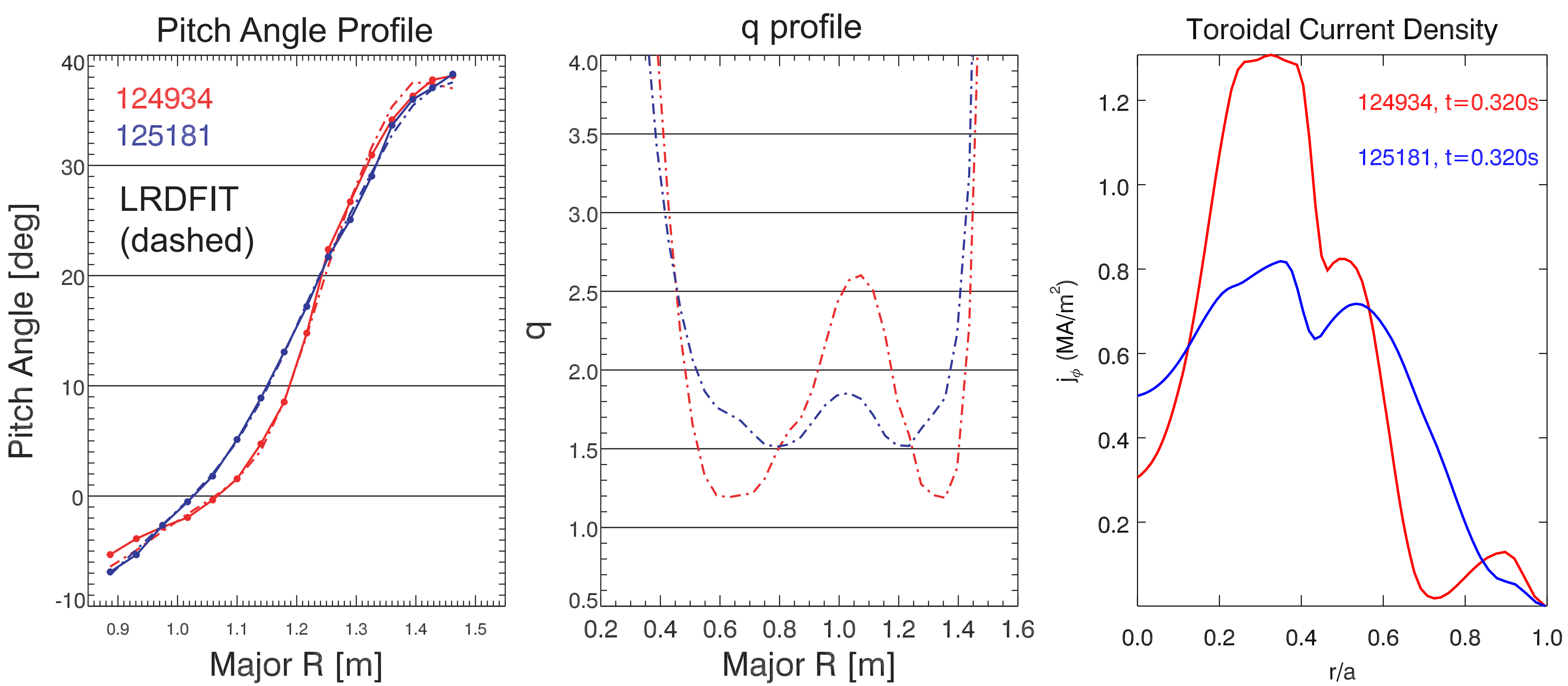
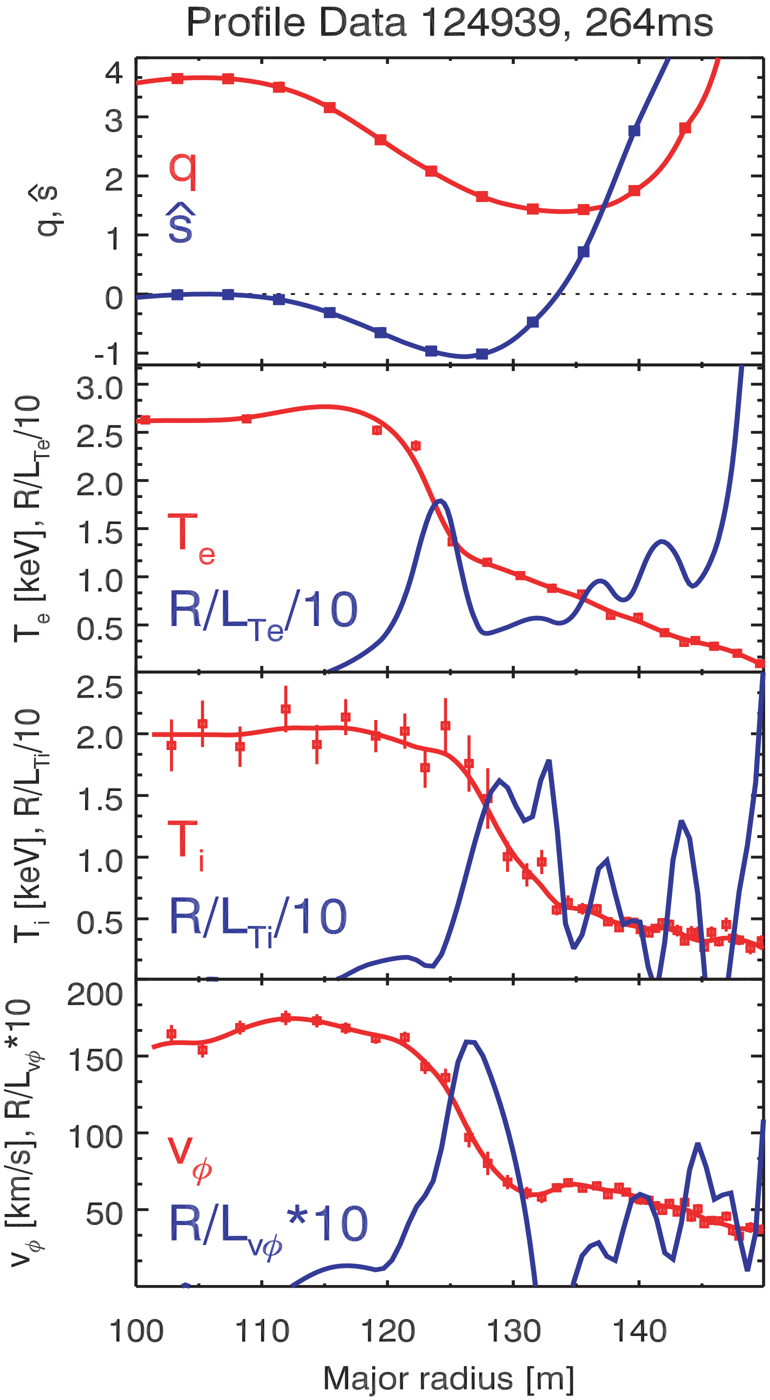
q and j profiles of reversed shear profiles



- Minimization of flux consumption on NSTX plasma startup favors low ℓ_i, reversed shear plasmas

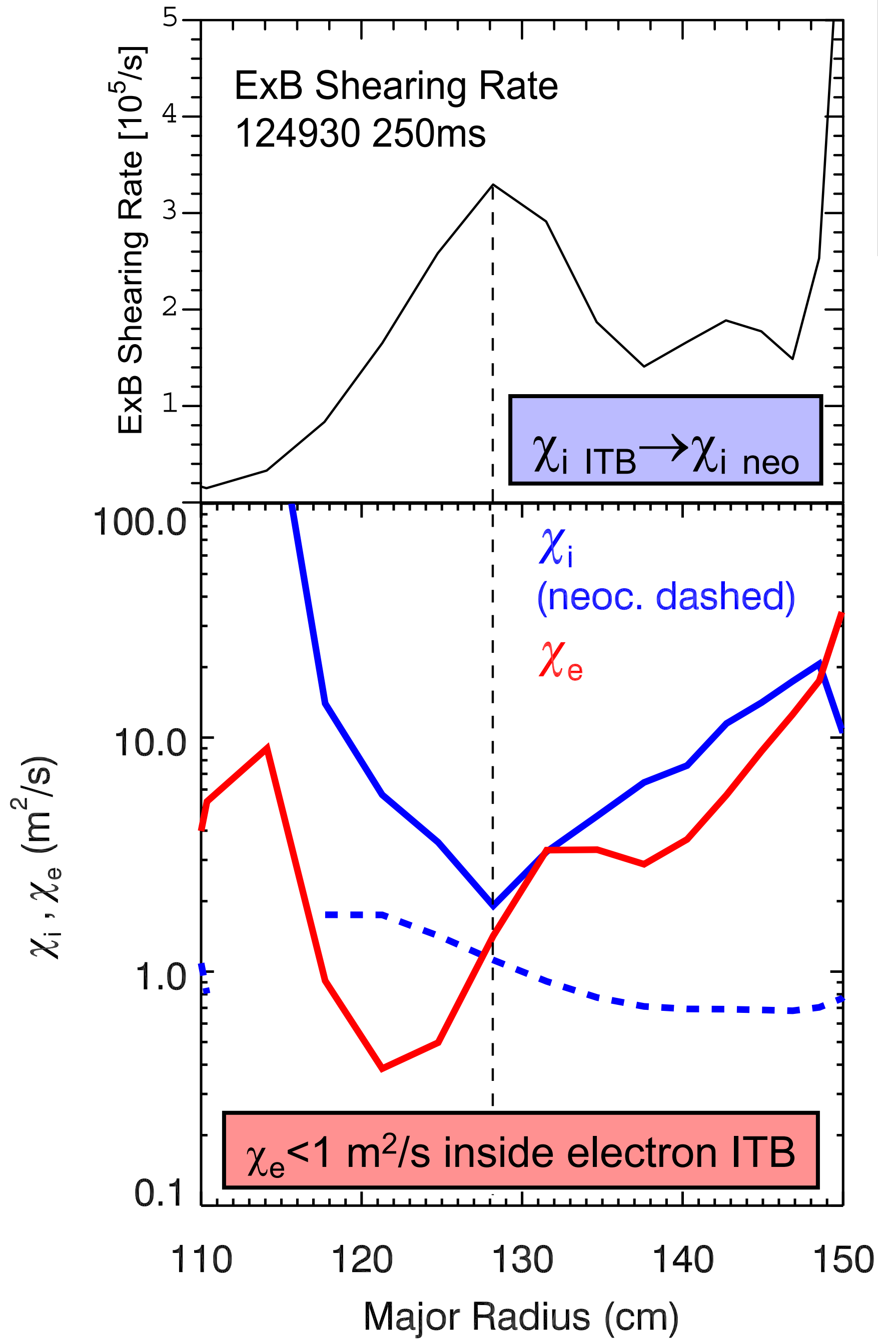
Internal transport barrier in T_e, T_i, v_ϕ profiles



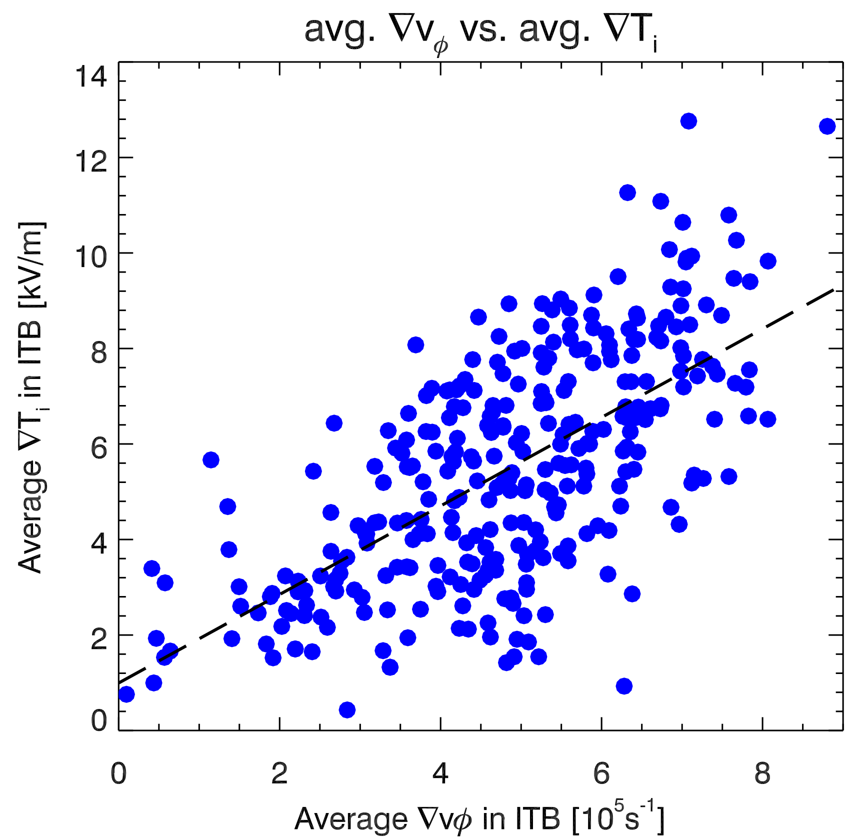
- Steeper core gradients in electron and ion temperatures, and toroidal velocity
- Electron density evolution essentially unchanged with ITB
- NSTX profile diagnostics
  - 51 channel CHERS
  - 30 channel TS
  - 16 channel MSE

2MW NBI
1.6MW HHFW

Ion ITB occurs at maximum E×B shear



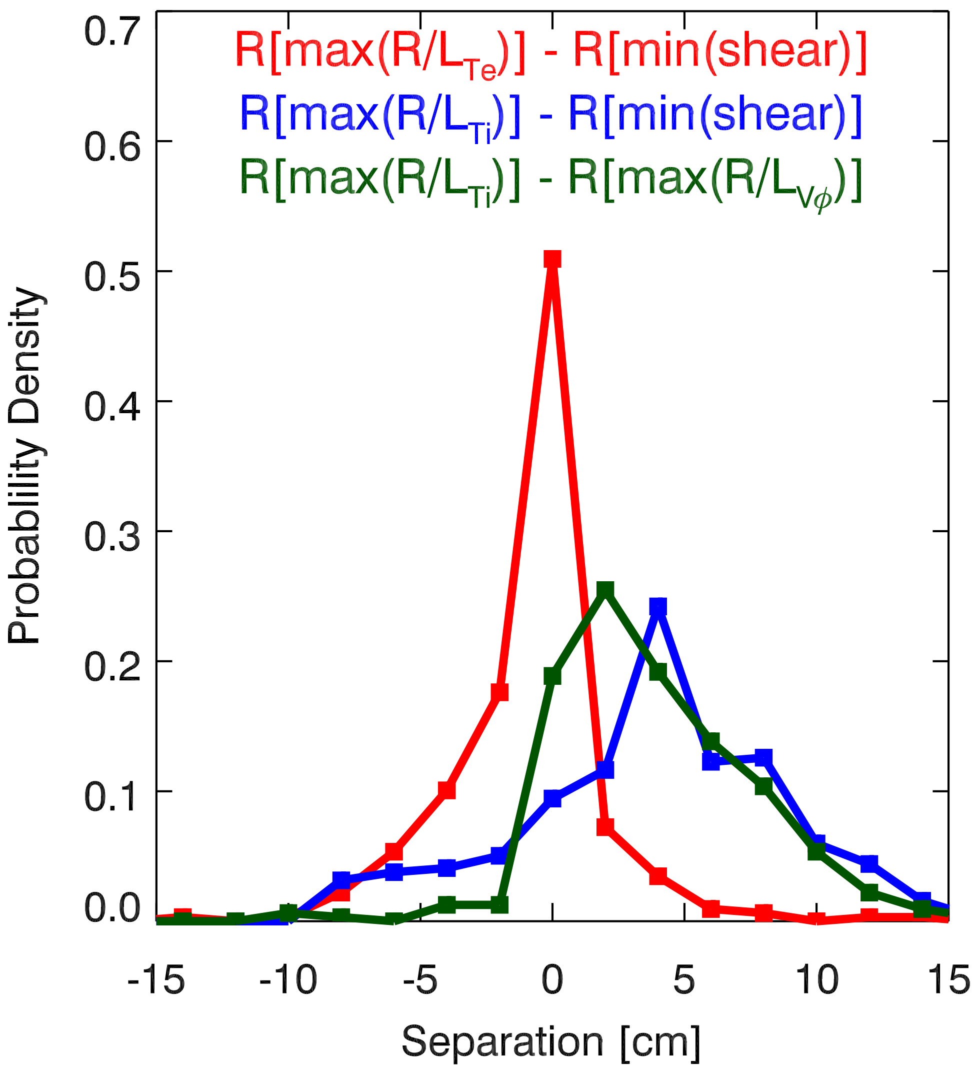
- Ion ITB coincides with peak E×B shearing rate but… electron ITB does not
- Use ∇v_ϕ as a proxy for E×B shear
- >200 timeslices from >30 shots



TORIC HHFW power deposition profile still required in TRANSP

Peak R/L_{Te} location highly correlated with ŝ minima

Radial separation of
norm. gradient maxima



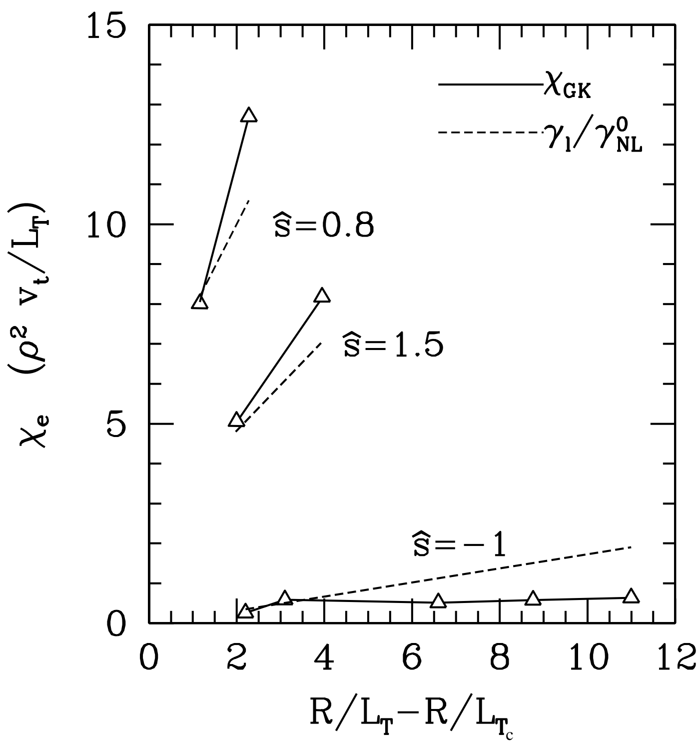
- R/L_{Te} highly correlated in location with ŝ minima location
  - Magnetic shear important for improvement in electron transport

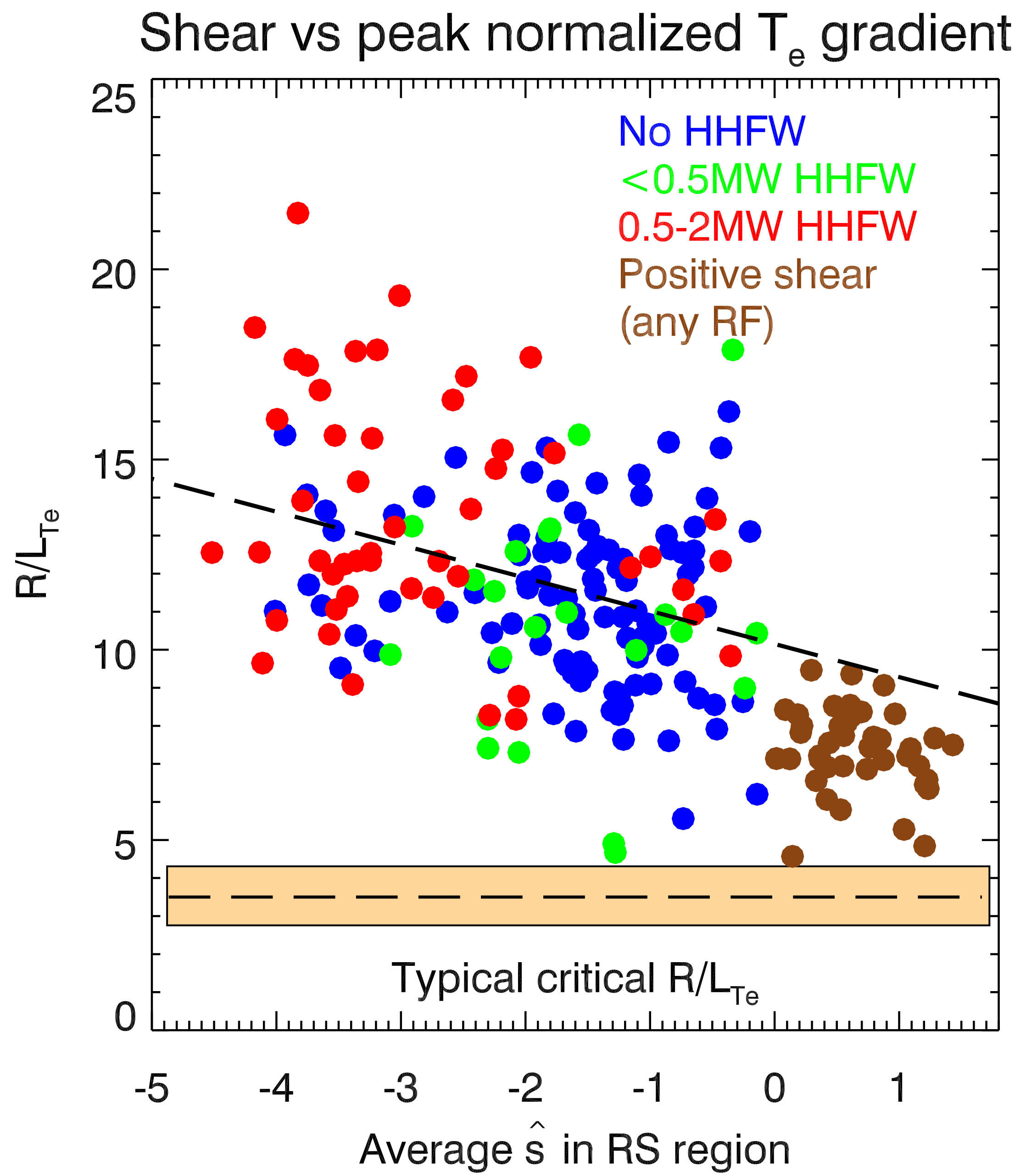
- R/L_{Ti} not aligned with ŝ minima, shows average separation
  - Magnetic shear less important for ion transport

- Ion ITB better aligned with velocity shear
  - Velocity (E×B shear) important in suppressing ion transport

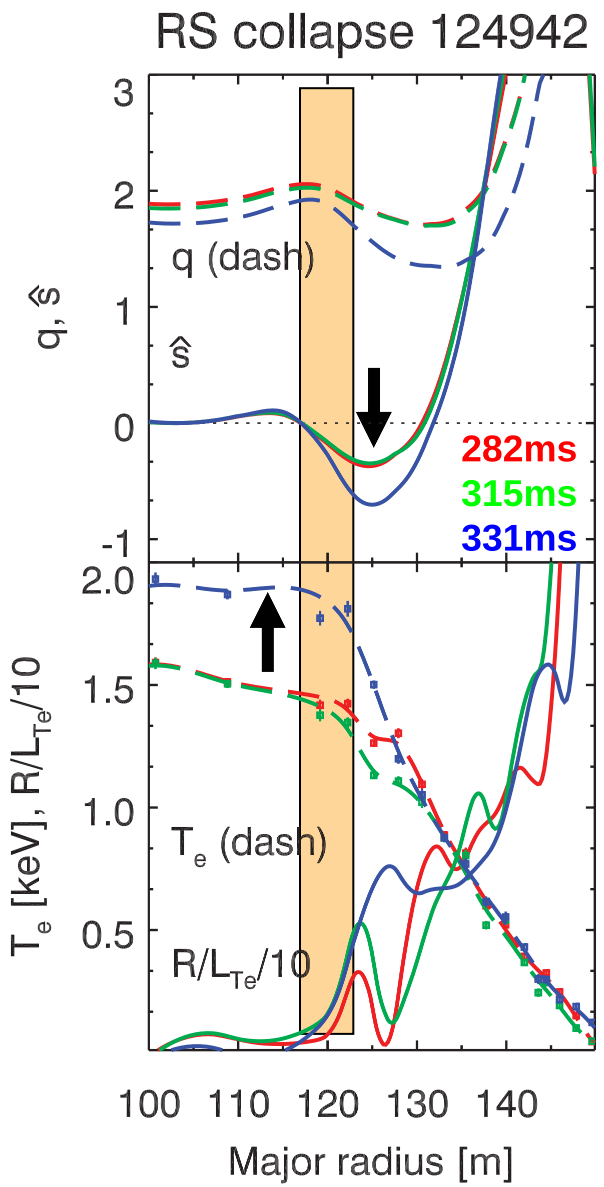
Low transport in RS plasmas even when ETG critical gradients exceeded

- GS2 calculated critical T_e gradients exceeded in RS
- Positive shear does not reach similar gradients
- Consistent with Jenko, Dorland nonlinear GS2 predictions [PRL **89**, (2002)]



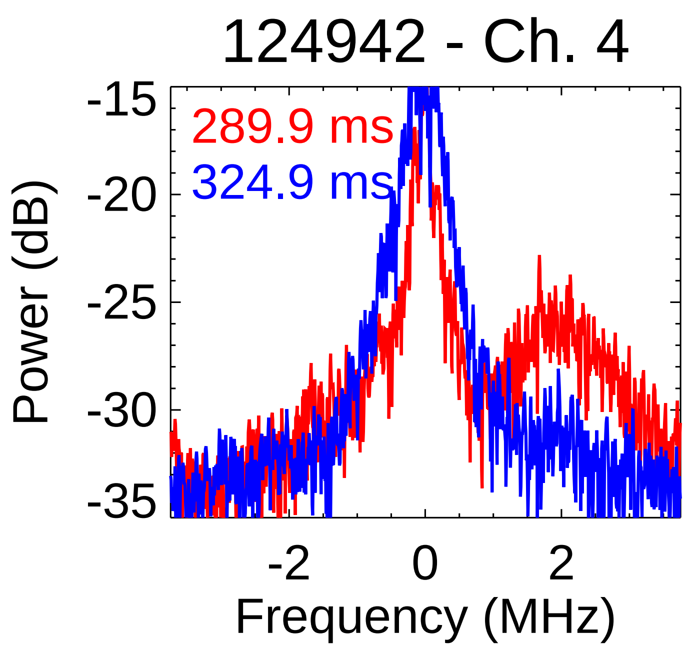


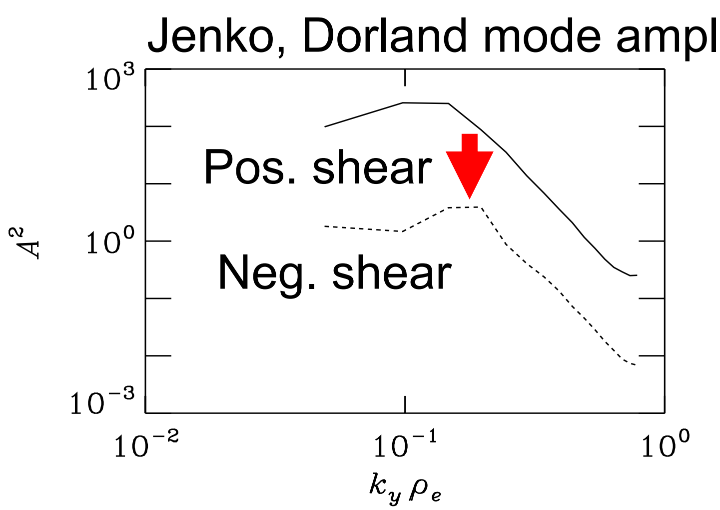
Decrease in ŝ suppresses ETG turbulence



- High-k diagnostic measures turbulence growth after a reverse shear collapse due to a discrete MHD event
- When RS is reestablished, fluctuation amplitude diminishes and plasma reheats
- No MHD activity observed on x-rays and Mirnovs at any comparison time

$k_\perp \rho_e = 0.23$
Matches predicted fastest growing mode





H.K. Park TP8.069
D.R. Smith TP8.070

Negative magnetic shear → electron ITB
E×B shear → ion ITB

- Electron ITB location strongly correlated with minima of negative magnetic shear
- Ion ITB does not occur at $\hat{s}$ minima, but at maximum E×B shear location
- Critical ETG gradients exceeded in electron ITB region without corresponding transport
- Measured high-k fluctuation suppression with deepened shear reversal
- Confirms nonlinear GS2 predictions of ETG mode amplitudes for negative magnetic shear