GTS simulations of NSTX L- and H-Mode Plasmas

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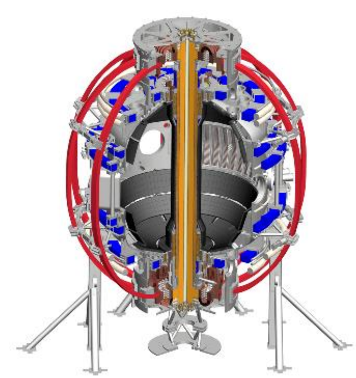
NSTX-U Results Review
September 21st – 22nd, 2016

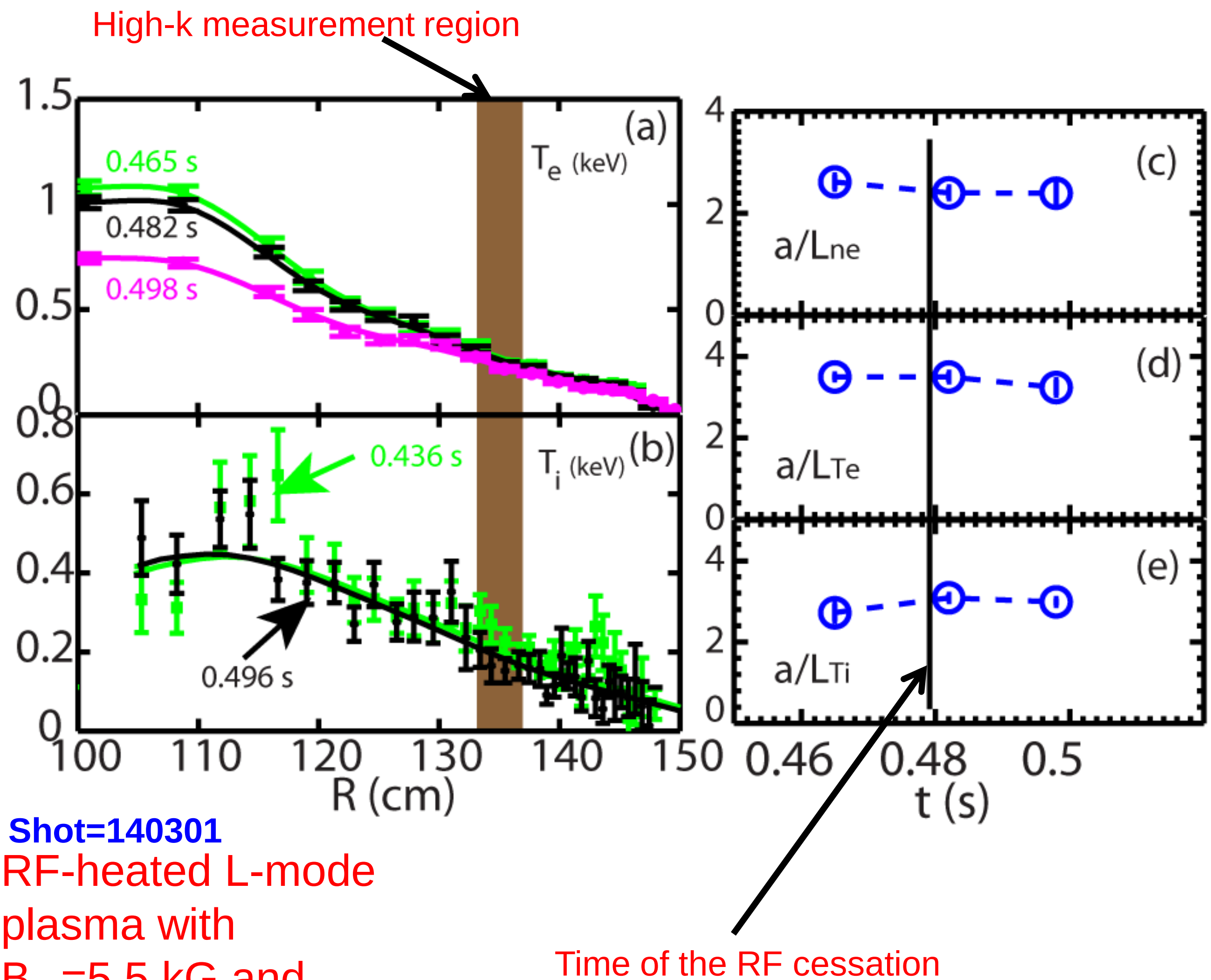


Why are Global Effects Important?

- Global effects are considered to be important for STs
  - Local assumption of flux tube simulations based on $\rho^*\sim 0$
  - Large ρ^* of STs due to weaker toroidal field compared to conventional tokamaks ($\rho^* \sim 0.01$ for NSTX)
  - Global effects, i.e. turbulence spreading, requiring global GK codes
- Study of global effects are important for achieving predictive capability for future STs
  - Need to validate first principle model for developing reduced transport model with global effects
- Serious validation efforts applying global GK codes to ST plasmas are still lacking

NSTX L-mode plasmas

GTS Simulations were Carried Out to Assess Thermal Transport before and after RF Cessation



Shot=140301

RF-heated L-mode plasma with B_T =5.5 kG and I_p=300 kA

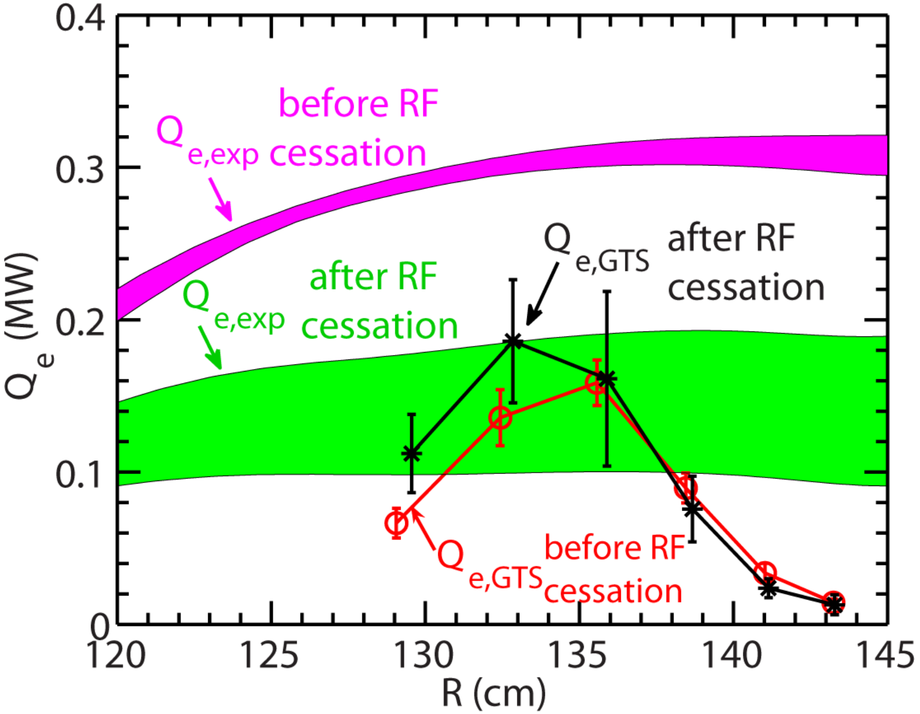
- <15% variation in equilibrium quantities in the high-k measurement region before and right after the RF cessation (over 17 ms)
- Equilibrium quantities not expected to change significantly on the time scale on which the turbulence changes (0.5-1 ms)
  - Energy confinement time~ 10 ms

Ren et al., PoP 2015

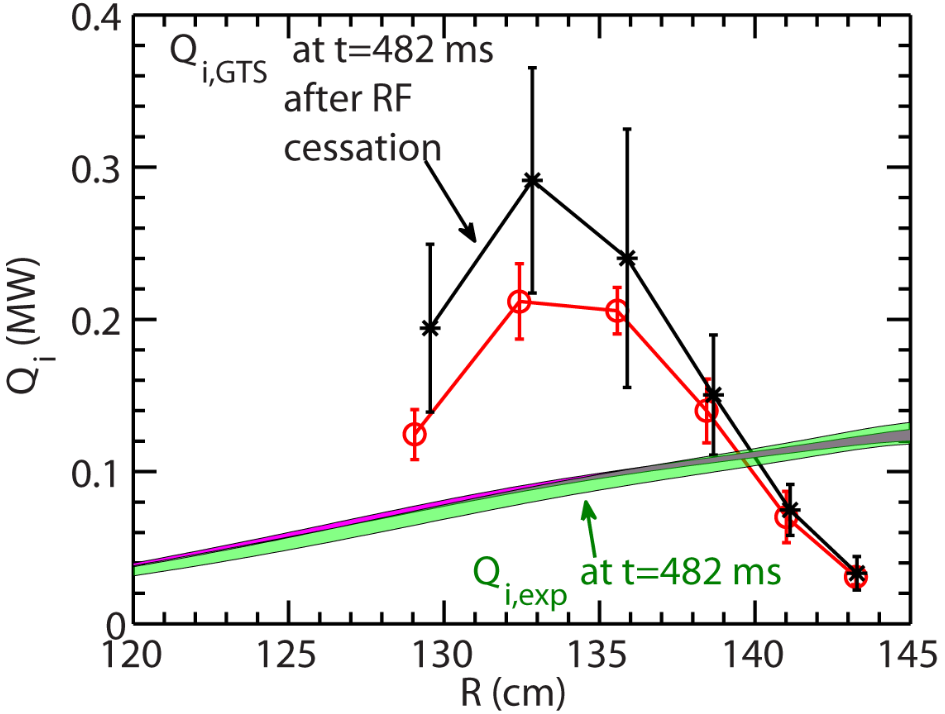
Similar Energy Fluxes from GTS are Seen before and after the RF cessation

- Electron energy flux matches experimental value after the RF cessation but not before
  - Experimental values from TRANSP+TORIC analysis
- Ion energy flux is over-predicted

Electron thermal transport



Ion thermal transport



NSTX H-mode plasmas

Current Ramp-down in NSTX H-mode Plasma Leads to Core Density Gradient Increase

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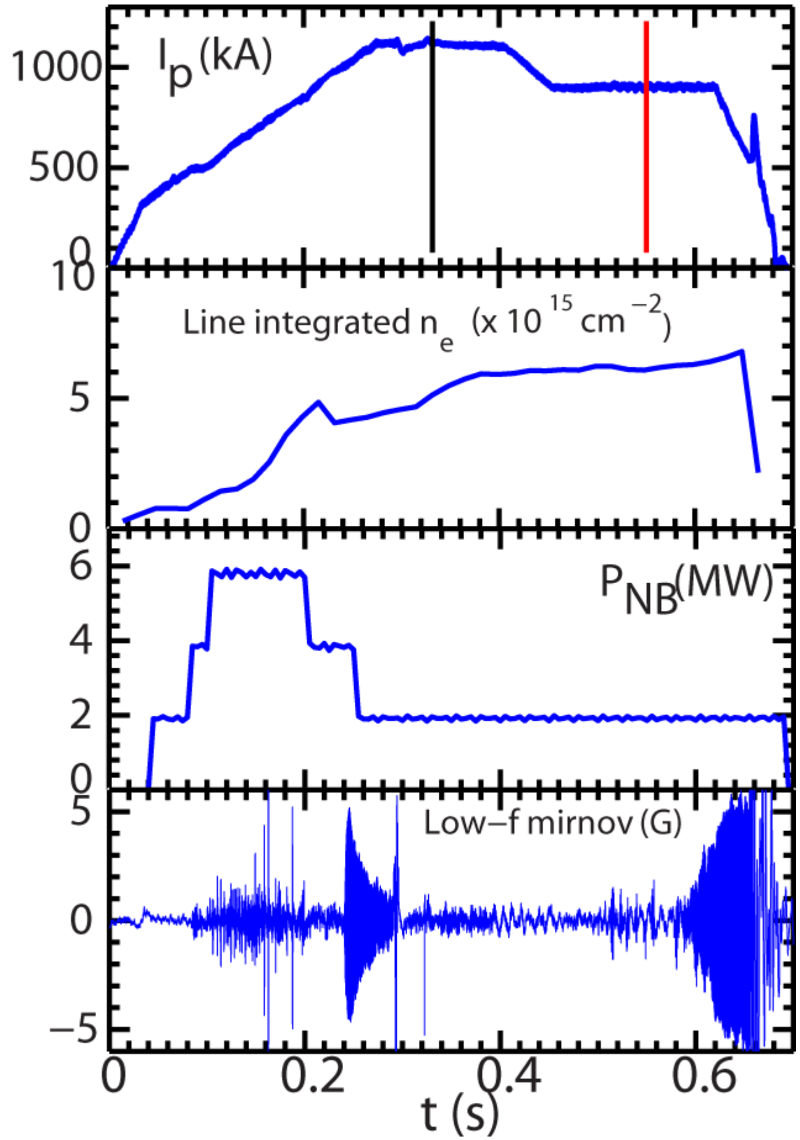
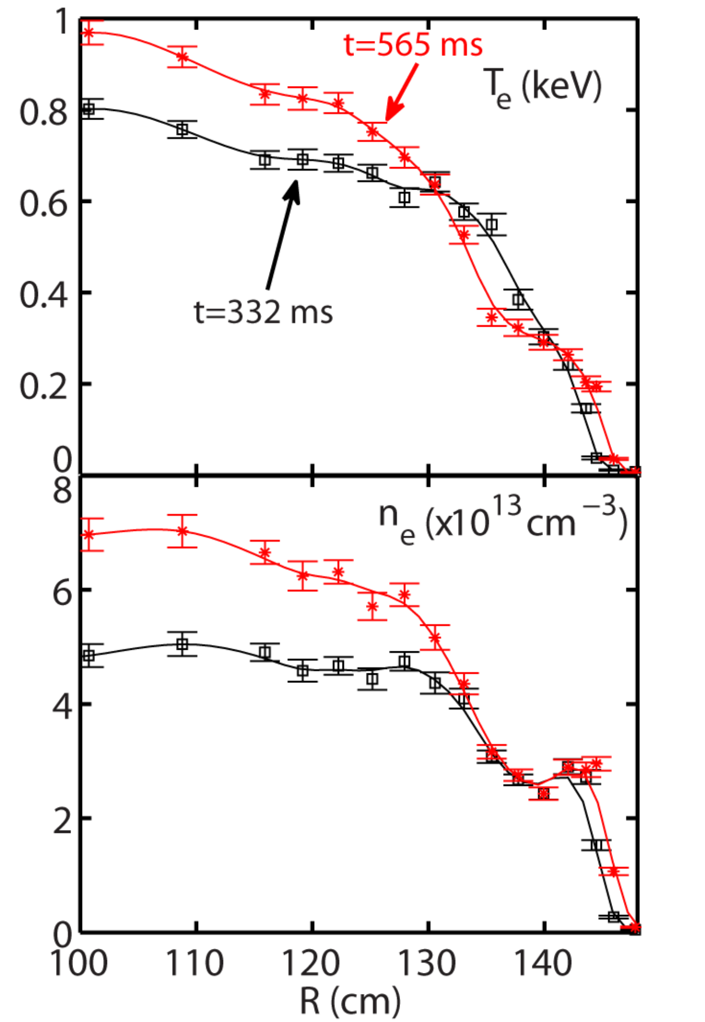
NBI-heated L-mode plasma with B_T =5.5 kG

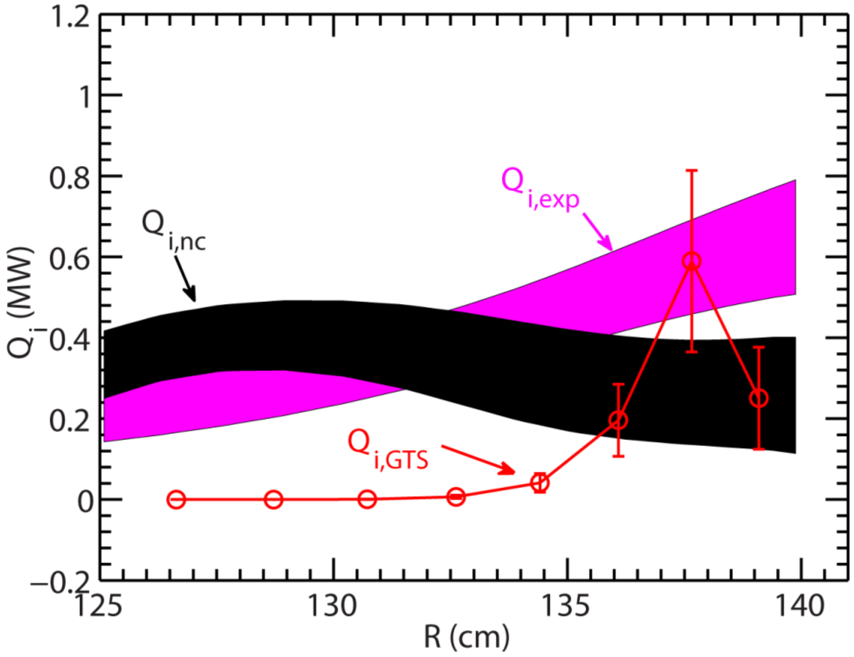




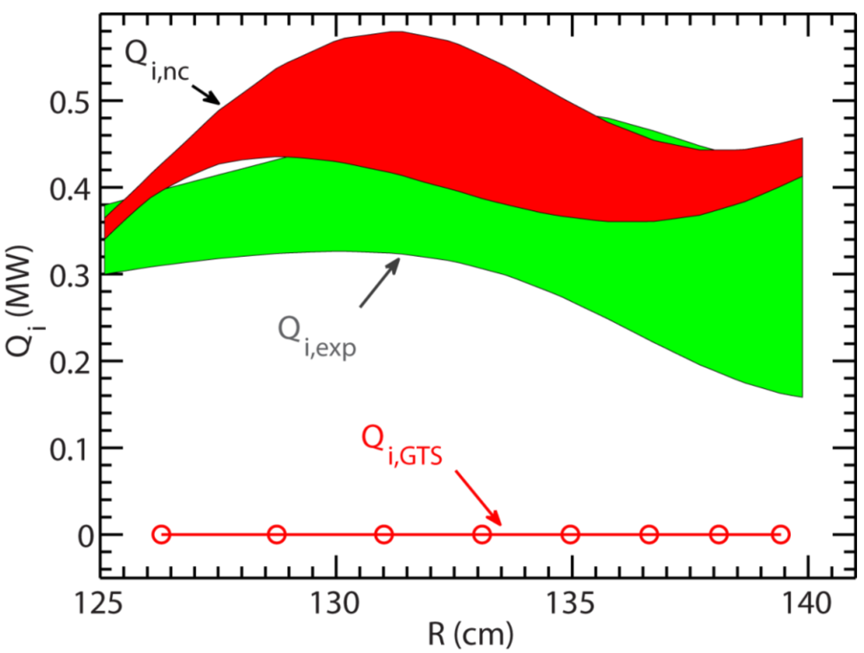
Ruiz-Ruiz et al., PoP 2015

Ion Energy Flux from GTS Is in Agreement with Experiment

t=332 ms



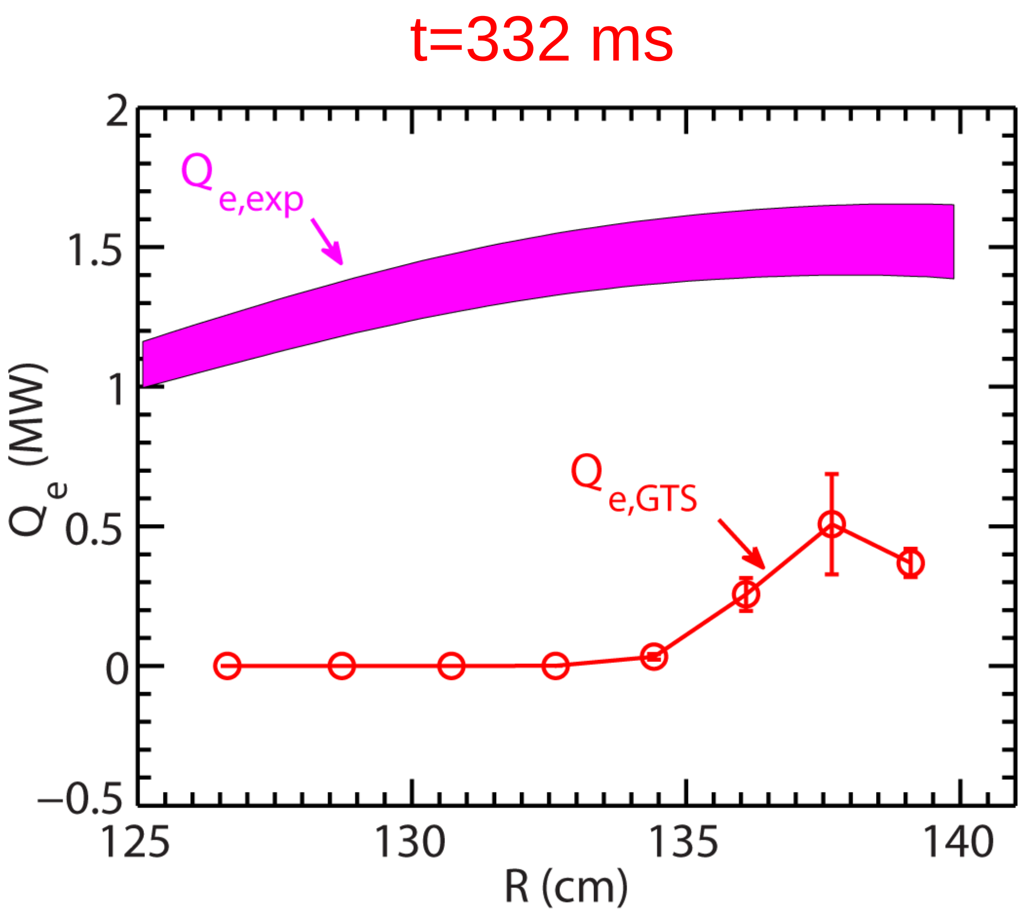
t=565 ms



- Ion energy flux from ion-scale turbulence contributes significantly at R>135 cm

- Neoclassical ion thermal transport can account for experimental ion thermal transport
- Ion-scale turbulence suppression due to ExB shear

Electron Thermal Transport is Significantly Under-predicted by GTS

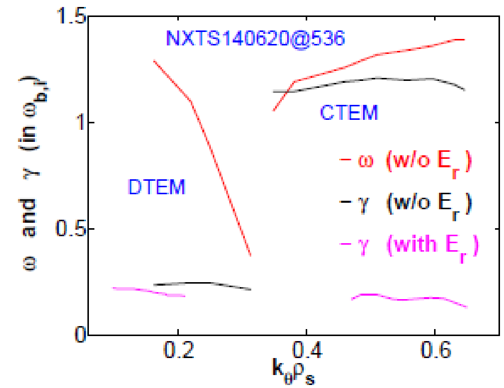


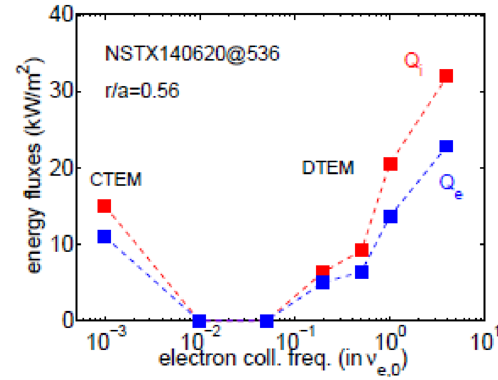
- Electron energy flux from GTS is only significant at R>135 cm
  - Much smaller than experimental electron thermal transport
- Contribution from ETG and electromagnetic effects may be important

Dissipative-TEM May be Important for NSTX H-mode Plasmas

- Dissipative-TEM found due to strong ∇n in an NSTX H-mode right after ELM
  - Capable to survive Strong E × B shear
  - Drives experimentally relevant transport
  - DTEM-transport increases with ν_e
  - CTEM strongly suppressed by collisions in STs
  - C/DTEM-free regime in low collisionality

  (possibly relevant to NSTX-U & ST-FNSF)





- Roles of DTEM further investigated over broad NSTX discharges