# T&T Experimental Priorities (NSTX 2008 Research Forum)

- Evaluate the generation of plasma rotation and momentum transport, and assess the impact of plasma rotation on stability and confinement (JOULE milestone)
- Measure poloidal rotation at low A and compare with theory (R08-1)
- XPs should also take advantage of the high-k fluctuation diagnostic for studying electron transport

# Additional NSTX Priorities Identified (5 yr. plan, STCC, PAC-23)

- Increase and understand beam-driven current at lower $n_e$, $\nu^*$
  - Next-step STs require full NICS to achieve missions, NBI CD is largest gap
  - Need to test if decreasing ne increases NBI-CD & non-inductive fraction as assumed

    (test if high $H_{98}$, $\beta_n$, $f_{bs}$, and sufficient fast-ion confinement are achievable at reduced $n_e$)
- Increase and understand H-mode confinement at low $\nu^*$
  - Electron energy transport (also ion energy transport) not sufficiently understood for high-confidence extrapolation to next step devices
  - Need to better understand underlying physics of scalings

# Initial T&T Prioritization (8+2, 10+3, 12+3)

| Title | Author | Priority | Days | Days+ 25% | Days+ 50% |
|---|---|---|---|---|---|
| Effect of Rotation on Energy/Impurity Conf. | Kaye/Delgado -Aparicio | 1 | 1 (1.5) | 1.5-0 | 1.5-0 |
| Momentum transport –n=3 braking | Solomon | 1 | 1 (1) | 1-0 | 1.5-0 |
| Momentum transport –beam blips | Kaye | 1 | 1 (1) | 1-0 | 1.5-0 |
| High-k plasma turbulence I | Mazzucato | 1 | 1 (1) | 1.5-0 | 1.5-0 |
| Energy confinement similarity (NSTX/DIII-D) | Solomon | 1 | 1 | 1-0 | 1-0 |
| Magnetic shear effects on ITBs | Yuh | 1 | 1 | 1-0 | 1-0 |
| Electron transport field scaling | Stutman | 1 | 1 (0.5) | 1-0 | 1-1/2 |
| Poloidal rotation placeholder | R. Bell | 1 | 1 | 1-0 | 1-1/2 |
| High-k plasma turbulence | E. Mazzucato | 2 | 1 | 1-0 | 1-0 |
| Role of rotation on L-H threshold | Kaye | 2 | 1/2 | 0-1 | 1-0 |
| Beta scaling | Kaye | 2 | 1/2 | 0-1/2 | 0-1/2 |
| Mean & oscillating flows | Kubota | 3 | 0 | 0-1 | 0-1 |
| Impurity transport in gradient region | Delgado-Aparicio | 3 | 1/2 | 0-1/2 | 0-1/2 |
| | | | | | |
| | | | 8-2-1/2 | 10-3-0 | 12-3-0 |

# XP Initial Results & Runtime Requests

XP812: Effect of Rotation on Confinement (JOULE) (Kaye - 1.5 days)

Use n=3 braking to slow plasma down, preferably to a new steady-state
Assess energy confinement/transport at different rotation

Difficulties: discharge reproducibility, no steady-state conditions, fine rotation control elusive (all or nearly nothing), resonant coupling of applied field to n=1 mode

Some discharges that can be analyzed, shots from XP809 (ELM destabilization) may provide additional data, no further runtime requested

XP820: Core Momentum Transport (JOULE) (Kaye - 1 day)

Use beam blips to change plasma rotation in core for various $I_p$, $B_T$
Determine perturbative $\chi_\phi$, $v_{pinch}$ if v, $\nabla$v decoupled

Difficulties: discharge reproducibility (early/late MHD), NBI blips did not effect rotation, needed to go to NBI steps

Obtained data over $I_p$, $B_T$ range: 0.7-1.1MA @ 4.5kG, 0.4-5.5kG @ 0.9 MA
Preliminary indication: $\chi_\phi$, $v_{pinch}$ determination possible
additional data obtained from XP822 (Stutman)
no further runtime requested (assess Lithium effects)

## XP813: Rot. transport using non-resonant braking (JOULE) (Solomon - 1 day)

Use n=3 braking to perturb plasma rotation profile, gradient scale length
Assess roles of diffusion vs. convection for momentum transport

Difficulties: ~2hr computer delay, n=1 MHD polluted some discharges, reproducibility

Good scan of rotational gradient scale length (16-34cm) will help discriminate between two competing theories of momentum pinch, completed $I_p$ scan at fixed $B_t$
No additional runtime requested

## XP822: $B_t$ scaling of electron transport change with $P_{NBI}$ (Stutman - 0.5 day)

Assess $\chi_e$ degradation with $P_{NBI}$ as function of $B_t$
Measure high-k fluctuations in flat & gradient region of $T_e$
Inject neon to assess corresponding particle transport

Difficulties: morning PCS difficulties (improper OH gain), high-k alignment

Scan completed at central high-k location (r/a ~ .25)
Less degradation in $\chi_e$ at high $B_t$, $T_e$ profile still flat
Particle confinement improves with high $P_{NBI}$, stronger ExB shear (mag. transport?)
Additional 0.5-1? run day requested: complete scan with high-k aligned

## XP821: High-k Turbulent fluctuations in NSTX (Mazzucato - 1 day)

Investigate plasma response to departure from marginal stability
Modify $T_e$ critical gradient by changing $Z_{eff}$ (switch from He to D) or temperature ratio using RF heating

Difficulties: locked modes (mitigated with feedback), poor RF coupling, high-k alignment

No useful shots. Anomalous signals in high-k diagnostic may indicate impending tube failure? Request 1 day run time after additional RF conditioning and coupling operations.

## "Yet-to-run" Priority 1 XPs (3.5 days)

XP829 - Magnetic shear effects on electron transport (Yuh, 1 day)

XP8?? - Ion transport with NBI modulation (Ross, 1 day*)

XP8?? - Effect of rotation on particle transport (JOULE) (Delgado, 0.5 day)

XP8?? - Poloidal rotation studies (R08-1) (Bell, 1 day)

XP8?? - Energy confinement similarity study - joint NSTX/DIII-D (TP-9) (Tritz, 1 day)

# New XP Proposals/Candidates for Re-prioritization

## Investigate relationship between Fast ions and magnetic electron transport (Stutman)

- Flat $T_e/n_e$ provides no "drive" for typical electrostatic instabilities
- Central heating + flat $T_e$ indicates strong electron transport
- High-k & Mirnov coils observe high frequency fast ion modes
- Are these modes modifying/tearing flux surfaces, enhancing magnetic transport?

## "ELM-free" beta scaling of energy confinement (Li?) (Kaye, 0.5 day)

- Previous scaling XPs show strong dependence on ELM behavior
- LITER has demonstrated high performance, ELM-free operation
- If similar effect observed during 2008 run, ELM-free beta scaling of $\tau_e$ would provide important results (especially at low $\nu^*$)

## L-H Threshold Scaling XPs - TBD (Kaye)

## If lithium allows access to low $\nu^*$, consider partial repetition of electron transport studies

# Summary

5 XPs run - 5 run days of XP time

5 XPs yet to run - 3.5 run days allocated
2 XPs need additional time - 1.5-2 run days

Successful LITER operation (low $\nu^*$, ELM-free discharges) would motivate additional XP run time to address NSTX re-prioritizations.

High-k diagnostic should be used carefully to avoid tube failure.