NSTX

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# NSTX Mid-Run Assessment Guidance


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**NSTX FY2009 Mid-run Assessment**
**PPPL, NSTX Control Room Annex**
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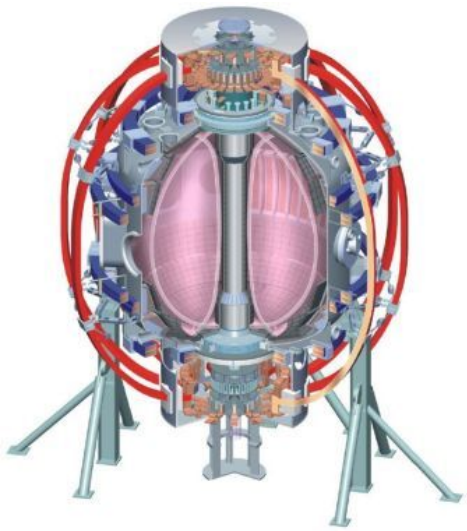

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# Objectives that will influence run-time allocation for remainder of run

- Completion of milestones
- Finish other Priority 1 XPs
- Contribute to ITPA and ITER
- Follow up on new findings, test some new ideas
- Address PAC recommendations

# Synopses of NSTX FY2009 Research Milestones

- DOE Joule milestone: *"Conduct experiments on major fusion facilities to develop understanding of particle control and hydrogenic fuel retention in tokamaks"*
  - *…identify the fundamental processes governing particle balance by systematically investigating a combination of divertor geometries, particle exhaust capabilities, and wall materials.*
  - *…NSTX is pursuing the use of lithium surfaces in the divertor…*
- R(09-1) Understand the physics of RWM stabilization and control as a function of rotation
  - RWM stabilization mechanisms will be characterized over a wide range of plasma rotation and collisionality conditions
- R(09-2) Study how j(r) is modified by super-Alfvénic ion driven modes
  - Emphasis on the effects of AE modes on the beam CD profile
- R(09-3) Perform high-elongation wall-stabilized plasma operation
  - Assess BS current at high $\kappa$ and q, and NBICD at low density - operating near the ideal-wall limit, preparing to implement NBI beta feedack

# In FY2009-10, NSTX will support several high priority research tasks identified by ITER Organization

- ELM modification, suppression, control
  - Important for ITER divertor survivability at high fusion gain
  - NSTX: Understand ELM stabilization with Li, destabilization with RMP
    also RMP ELM control at lower $q_{95}$, reduced $\nu^*$ (HHFW, LLD), vertical jogs

- Impact of He (and possibly H) operation on H-mode
  - Important for commissioning phase of ITER operation
  - NSTX: Examine L→H threshold, global confinement, ELM stability

- Validate neoclassical toroidal viscosity flow damping theory
  - Important for minimizing mode locking during ITER RMP ELM control
  - NSTX: Additional expt/theory comparisons at varied $\nu^*$, rotation, RMP spectrum

- Simulation of ITER test blanket module impact on plasma
  - Important for understanding impact of large predicted error fields
  - NSTX: Assess use of EF/RWM coils to approximate TBM spectrum

## *NSTX PAC-25 in February 2009 requested some*
# Hypothetical FY2009 Research Highlights:

- NSTX achieves significant advances in non-inductive sustainment & ramp-up
  - Li + high-$\kappa$, high-$\beta_P$ scenario enables access to NICD fraction ~80% at high $\beta_N$
  - Improved fast-wave heating produces low-$I_P$ (~300kA) 100% NICD (transiently)
- NSTX observes electromagnetic effects important for electron transport
  - Link between GAE and core e-transport established
  - X-ray spectrometer measures fast electron transport from $\mu$-tearing, GAE, …
- Fast particle contributions to RWM stability measured for first time
  - Kinetic stabilization effects strong in ST, and important for ITER burning plasmas
- Researchers controllably trigger edge modes to control edge confinement
  - Optimized mix of n-numbers, $q_{95}$, boundary shape, Li controls ELM size
- Improved start-up techniques important for ST developed on NSTX & DIII-D
  - NSTX: Improved CHI operation saves significant volt-seconds during ramp-up
  - DIII-D: high ECH power key to successful inductive ramp-up without solenoid
- Hopefully some surprising results we didn't anticipate!

# Goals for remainder of run (1)

- Boundary Physics
  - Optimize ELM pacing for smaller/controllable ELMs (almost)
  - Replace HFS gas completely with SGI, including early fueling – in prep for LLD (done)
- Lithium Research
  - Finish retention Joule milestone (done)
  - Assess Li dust in breakdown phase, flat-top
- Transport & Turbulence
  - High-k measurements of GAE
  - More measurements of k-scaling of ETG turbulence
  - LH thresh. vs. n=3, rotation, Li (done) – need He or H data
- MHD
  - Rotation and fast-ion effects on RWM stability (done)
  - NTM physics (done), more on NTV scaling vs. n-number, etc?

# Goals for remainder of run (2)

- Wave-particle interactions
  - HHFW: Try to heat plasma to Te = 6-7keV
  - HHFW: Core heat NBI H-mode to suppress impurities
  - EP: Definitively determine whether *AE causes J redistribution
- CHI
  - 100kA flux savings coupling to OH (done), 200kA possible?
- Advanced Scenarios and Control
  - Increase NI fraction (done?) + reduce flux consumption at high $\beta_N$ (done)
  - Demonstrate strike-point control (done), beta feedback control
  - Sustain toroidal beta = 20-25% for 2-4 $\tau_{CR}$
- Cross-cutting (w/ ASC, LR, BP)
  - Assess impurities vs. $I_P$ and gap in ELM-free scenarios (done)
    → Further optimize early outer gap evolution, NBI, fueling
  - Develop more stable low-$n_e$ scenarios for LLD (optimize early EFC, NBI)

# Preliminary guidance for reversed $B_T$
## (all subject to change!)

- Start technical preparation NOW
- Attempt & assess operation w/ reversed $B_T$ during last 2 days of week before last week of run (i.e. early Aug.)
  - If problematic, back out over weekend, only lose 2 days
  - If things go well, ready for full final week of reversed $B_T$
  - 2 prep days + 5 physics operation days
- Priorities:
  - L-H power threshold physics
  - SOL and divertor transport and turbulence changes
    - PDD with enhanced heat-flux reduction?
  - HHFW coupling physics, and EP (FIDA discrepancy)
  - Compare confinement, density evolution for long-pulse shots
    - "Enhanced L-mode" w/ good thermal confinement, better $n_e$ control?