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NSTX Mid-Run Assessment Guidance

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for the NSTX Research Team

NSTX FY2010 Mid-run Assessment
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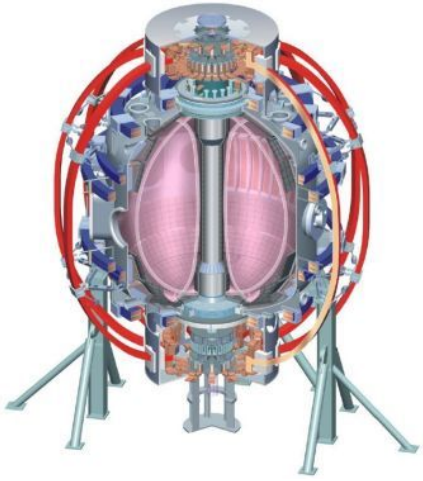

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Objectives that will influence run-time allocation for remainder of run

- Completion of milestones, other Priority 1 XPs
- Contributions to ITER and ITPA
- Get final data for IAEA, APS invited talks
- Address PAC recommendations
- Data for grad-students, post-docs, young researchers
- Follow up on new findings, test a few new ideas

Synopses of NSTX FY2010 Research Milestones

- ✓ DOE Joint Research Target: *"Improve understanding of the heat transport in the tokamak scrape-off layer (SOL) plasma"*
  - Measure the divertor heat flux profiles and plasma characteristics in the tokamak scrape-off layer in multiple devices to investigate the underlying thermal transport processes.
- ✓ R(10-1): Assess sustainable β, disruptivity near/above ideal no-wall limit
  - β_N control, optimize mode control parameters/sensors, LQG controller
    - Calculate beta limits, RWM stability/control, plasma response to 3D fields
- **R(10-2): Characterize HHFW heating, CD, ramp-up in D H-mode**
  - Develop BS overdrive ramp-up, improve e-heating in reduced-n_e H-mode
    - Power dep. / CD calcs, TRANSP analysis, analysis of fast-ion interactions
- ✓ R(10-3): Assess H-mode pedestal, ELM stability vs. ν^* and Li
  - L-to-H threshold scaling, pedestal height and barrier width, pedestal stability
    - Kinetic equil. recons, ELM stability analysis, ped transport vs neoclassical

ITER now focusing on decision-making for ELM control

- ITER pursuing cost containment
- Pellet pace-making is in the ITER baseline; in-vessel RMP coils are not (although they have been extensively studied)
  - ITER needs information to make a decision (1-2yrs) about whether ELM control coils are necessary:
    - Demonstrate RMP ELM suppression in He plasmas (in prep for DT)
    - Demonstrate broad range of q_{95} (2 to 5), include ramp-up/ramp-down
- ITER interested in alternative ELM control/mitigation methods
- NSTX contributions (FY2010-12):
  - RMP + jog pacing of ELMs, more flexible 3D spectrum FY11 (2nd SPA)
  - Improved understanding of ELM stability vs. J_{edge} and RMP
  - Interact w/ EHOs - modulated HHFW/audio-f to affect particle transport
  - Li ELM-free scenarios, with emphasis on impurity reduction
  - ELM triggering/suppression in He H-mode plasmas (w/ RF in future?)

Goals for remainder of run (1)

- Boundary Physics
  - RMP + vertical jogs for ELM Pacing for ITER support
- Lithium Research
  - Assess Li powder injection for impurity reduction
  - LLD: Plasma-condition LLD, add powder, heat last heat-able plate
- Transport & Turbulence
  - Get BES data from both views
    - LiTER overnight prior to XP to avoid to enable opening of BES shutter?
  - Parametric dependence of high-k turbulence in NSTX
  - Get some initial high-k_r / k_θ anisotropy measurements?
    - Unique NSTX capability – but is high-k (and theory) ready to support?
- MHD/BP for ITER support, NSTX Li program, FY11 milestone
  - Test PB theory: current ramps in ELMy & ELM-free, w/ and w/o n=3
    - ≤ ½ day in total - have some data with n=3 already
    - Slow current ramp before flat-top to more readily ELM & reduce impurities?

Goals for remainder of run (2)

- Wave-particle interactions
  - EP: GAE electron-transport with high-k, BES for displacement profiles
  - HHFW: Improve upon 2005-2006 low-I_P high f_{NI} results by any means available (see dedicated slide later in presentation…)
- CHI
  - Increase absorber coil current to achieve 300-400kA OH flux savings
- Advanced Scenarios and Control, Cross-cutting and Enabling
  - High non-inductive fraction plasmas with reduced impurities
  - Squareness assessment/optimization – NSTX-U, shape development
  - APS/IAEA: sustain high-β_T at high kappa, low li, beta feedback, optimized RWM control, attempt EPH triggering (toward ST pilot)

Carbon impurity reduction in Li ELM-free H-mode

- C accumulation produces high Z_{eff}, causes D dilution
- Reducing C content is cross-cutting
  - Important for viability of ELM-free/small ELM scenarios and Li program
  - PAC recommendation

- Assess Li dropper – deposit Li during, before plasma
- Snowflake starting from PF1A high δ (fiducial-like) shape
- Combine methods in ASC (XP1006)
  - Divertor gas puffing
  - Magnetic balance variation early in shot
  - n=3 pulses early in flat-top
  - Include dropper, snowflake if successful in stand-alone XPs
- Consider developing above techniques with similar target plasma to improve chances for successful integration

Suggestions for final LLD experiment(s) for FY2010

- Observations
  - Reduced I_{SAT} near strike point with LLD hot (Langmuir probe data)
    - Probably best direct evidence of local pumping in/near strike-point
  - Reflectivity change on LLD in shapes w/ high heat-flux (cameras)
    - Indicates plasma heat flux needed to remove surface impurities?
  - High recycling divertor following large evaporation (spectroscopy)
    - Impurities brought in by LITERing, or from previous Ar vent(s)?
- Need to incorporate what we've learned into final LLD XP(s)
- Example proposal elements to consider:
  - Run low-ish flux-expansion shape with high heat/particle flux on LLD
  - Sweep strike point from shot-to-shot (5-10 shots) to condition larger fraction of LLD surface area – deposit 10-20g Li night before, after?
  - Use dropper to put Li into plasma SOL, onto LLD
    - How much? does it deposit onto LLD? does it melt? does it pump?
  - Heat the last heatable plate, assess any changes in divertor, pumping

Low I_P start-up plasma development

- **Making progress important for milestone, ST development**
- 300kA target: estimated to have 55-70% BS + NBI (TRANSP)
  - So far, 1.5-2MW of HHFW in CD phasing + 3MW NBI (1MW abs?)
  - How much RFCD in these plasmas? What is total NI-CD fraction?
  - Can we push total f_{NI} to 90-100%? (i.e. better than 85% at 250kA)
- Ideas:
  - Higher HHFW power would help → requires more conditioning (almost there)
  - Higher LiTER evap could increase τ_E, peak n_e profile, increase f_{BS}
  - Density scan to optimize total NICD (RF/NBI CD efficiency vs. BS)
  - Longer shots – BS fraction increasing throughout some shots (140355A01)
  - Take highest f_{NI} 700kA NBI H-mode shot and operate at 500-600kA to assess, add HHFW after conditioning campaign at 300-500kA?
  - Boronize?
    - Is this required for effective HHFW? (was B + LiTER key to last years results?)
    - Only makes sense after most Li flakes have been removed from antenna
  - Try after other milestones/priority 1 completed? 1-2 days end of Sept?
- Limit to 2-3 run days max unless we run more than 15 run weeks

Summary

- Schedule for remainder of run should account for:
  - Goals in this presentation
  - Today's discussion, recommendations from TSG leaders