NSTX-U

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NSTX-U Program Update

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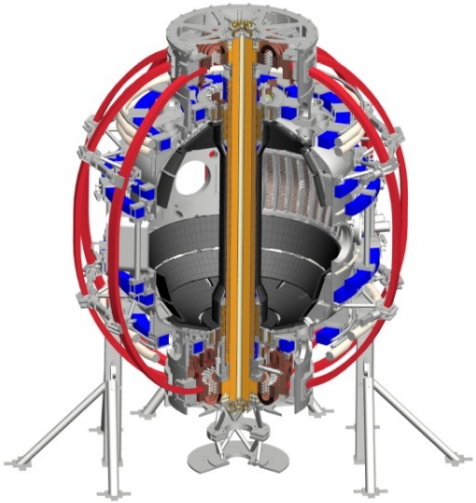
For the NSTX-U Research Team

NSTX-U Team Meeting
PPPL LSB B318
August 15, 2014



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Outline

- PAC-35
- FESAC strategic planning
- Research Forum

NSTX-U PAC-35 held June 11-13, 2014

Charge Questions:

1. Assess the operational preparation and research priorities and preliminary plans for the first two run-years of NSTX-U with emphasis on the first run year
2. Please comment on and/or expand the preliminary set of ideas to make NSTX-U more attractive/available to university scientists – including early career researchers and students
   - Background: NSTX has been asked by Fusion Energy Sciences to develop/implement ideas to "Expand engagement with university scientists to enhance the NSTX-U program".
3. Comment on progress and plans for establishing and expanding the partnership between the NSTX-U program and the PPPL Theory department

PAC comments favorable, recommendations very helpful

- "The PAC congratulates the team for undertaking successful collaborations during the Upgrade outage period. This plan has been successful, and the impact is clear in key metrics for scientific productivity (publications, invited talks, etc.) Indeed, these collaborations have brought back to NSTX-U new ideas and new capabilities, e.g., advanced plasma control."
- "The PAC is very pleased to see the strengthened connection between the NSTX-U experimental program and the PPPL Theory Department through the new Partnership."
  - "PAC recommends that PPPL maintain the partnership regardless of the continuation of the incremental funding that was used to seed it"
  - "PAC also suggests that the NSTX-U/Theory partnership produce a set of target milestones for theory work in the next three fiscal years especially highlighting the synergy with the experimental milestones"
- PAC had 57 recommendations – Program/Project/TSGs have already formulated action plans addressing recommendations

PAC-35 recommendations on program / ops:

- "The PAC anticipates that the past practice of relatively short-term scheduling is likely to be insufficient now and for the future NSTX-U program. We therefore recommend adopting a new planning process that incorporates a longer term run schedule. This will:
  1. Better support integrated / increased collaborations anticipated for the NSTX-U program
  2. Help develop the rationale that drives the hardware schedule
  3. Maximize the productivity of the 1st year of ops, which clearly has a very tight schedule."

  NSTX-U Response: in 2011 we had a run-plan for up to 2 months in advance, and this seems reasonable for FY15 given the likely variability in facility / diagnostic readiness. In FY16 we will attempt to schedule even farther in advance.

- "Particle control remains a critical issue in achieving low-collisionality, long-pulse discharges in NSTX-U. The PAC strongly recommends developing a clear plan to understand particle transport and particle sources and sinks to ensure confidence in the design and implementation of the cryo pump."

  NSTX-U Response: Agree this is critical, and intend to implement Li granule injector + additional LiTER coverage to flush/reduce C impurities, and we are forming a particle control task force to plan and achieve particle control for FY15-16

Candidate ideas from PPPL / NSTX-U to PAC-35 to increase university engagement in NSTX-U

- Support consideration of all 3 ideas for FES
  - Stabilize funding (in progress), encourage student participation in collaboration solicitations, non-tenure-track ECRP (difficult)
- Several NSTX-U/PPPL ideas could be high impact
  - Students: senior thesis projects, visits/travel, targeted run-time
  - Universities: joint proposals, short-term direct grants, enhanced collaboration tools (remote control room)

➢ Idea: NSTX-U Innovative Research Award (NIRA)

- Target innovative / breakthrough R&D – fund primarily universities
  - High-impact science and/or address critical NSTX-U / ITER / FNSF needs
- Encourage early-career and student participation / leadership
- Fund from (supplemented) NSTX-U science budget: $0.5-1M / year
- Typical award level: up to ~100-200k / year for up to 3 years
  - Awards granted twice per year, annual progress review and funding renewal
- Review: NSTX-U management + small committee + FES concurrence

PAC response to ideas from NSTX-U / PPPL (1)

- “The PAC applauds the concerted effort to engage NSTX-U collaborators in a fruitful planning discussion on expanding engagement with university scientists. While this is a specific request from FES to the NSTX-U program, it is in fact a larger fusion community issue.”
- The PAC was informed that the planning discussion was organized through three meetings jointly with 22 FES-funded NSTX-U collaboration grantees (university, laboratory, industry).
- The specific suggestions identified for possible FES and PPPL action are good examples that are either essential to stabilize or to improve the environment for university collaborations on NSTX-U”

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FESAC – Developing a 10 year strategic plan

- The FY 2014 Omnibus Appropriations Act requires the Department to submit a strategic plan for the FES program by January 2015 with the following guidance:
  - "The ten-year plan should assume U.S. participation in ITER and assess priorities for the domestic fusion program based on three funding scenarios with the fiscal year 2014 enacted level. Funding baseline: (1) modest growth, (2) budget growth based only on a cost-of-living-adjusted fiscal year 2014 budget, and (3) flat funding…."
- Public comment/input provided in June and July
- Final report due to DOE by October 1
  - FESAC sub-panel writing report now
  - **Submit your whitepapers ASAP! (right now is almost too late)**

NSTX-U team-members had strong showing at July FESAC strategic planning panel meeting

1. **Menard**, NSTX-U: ST research to accelerate fusion development
2. **Majeski**, LTX: Exploring the advantages of liquid lithium walls
3. **Fonck**, Initiatives in non-solenoidal startup and edge stability dynamics at near-unity aspect ratio in the PEGASUS experiment
4. **Raman**, Simplifying the ST and AT concepts
5. **Crocker / Guttenfelder**, Validating electromagnetic turbulence and transport effects for burning plasmas
6. **Sabbagh**, Critical need for disruption prediction, avoidance, mitigation in tokamaks
7. **Podesta**, Development of tools for understanding, predicting and controlling fast-ion-driven instabilities in burning plasmas
8. **Maingi**, A liquid-metal plasma-facing-component initiative
9. **Jaworski**, Liquid metal plasma-material interaction science and component development toward integrated demonstration
10. **Allain**, Establishing the surface science and engineering of liquid-metal plasma--facing components

If you haven't submitted your INITIATIVE WHITEPAPER, do it TODAY!

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Overview of FY2015-16 NSTX-U research activities

- FY2015
  - Research Forum to solicit experimental proposals for FY2015 run campaign tentatively planned for Jan-early Mar 2015
    - Pending successful CS completion, will Doodle by early Sept
  - Complete CD-4 for NSTX Upgrade Project early in CY15
  - Previously planned research milestones unchanged
  - Obtain first data at 60% higher field/current, 2-3× longer pulse:
    - Re-establish sustained low l_i / high-κ operation above no-wall limit
    - Study thermal confinement, pedestal structure, SOL widths
    - Assess current-drive, fast-ion instabilities from new 2nd NBI
- FY2016
  - Extend NSTX-U performance to full field, current (1T, 2MA)
    - Assess divertor heat flux mitigation, confinement at full parameters
  - Access full non-inductive, test small current over-drive

NSTX-U research milestones target exploitation of new Upgrade capabilities, exploration of new regimes in FY15-16

	FY2014	FY2015	FY2016
Expt. Run Weeks:	**0**	**12-16** **Up to 18**	**16** **20**
Macroscopic Stability	R14-1 Assess access to reduced density and ν^* in high-performance scenarios (with ASC, BP TSGs)		
Transport and Turbulence		R15-1 Assess H-mode τ_E, pedestal, SOL characteristics at higher B_T, I_P, P_{NBI} (with BP, M&P, ASC, WEP TSGs)	R16-1 Assess τ_E and local transport and turbulence at low ν^* with full range of B_T, I_P, and NBI power
Boundary Physics		Develop snowflake configuration, study edge and divertor properties (with ASC, TT, MP) IR15-1	R16-1 Assess scaling, mitigation of steady-state, transient heat-fluxes w/ advanced divertor operation at high power density
Materials & PFCs			R16-2 Assess high-Z divertor PFC performance and impact on operating scenarios
Waves+Energetic Particles	R14-2 Assess reduced models for *AE mode-induced fast-ion transport	R15-2 Assess effects of NBI injection on fast-ion f(v) and NBI-CD profile (with SFSU, MS, ASC TSGs)	R16-3 Assess fast-wave SOL losses and core thermal and fast ion interactions at increased B_T, I_P
Solenoid-free Start-up/ramp-up			R16-4 Develop high-non-inductive fraction NBI H-modes for ramp-up & sustainment (Joint ASC+SFSU)
Adv. Scenarios and Control	R14-3 Assess advanced control techniques for sustained high performance (with MS, BP TSGs)	R15-3 Develop physics+operational tools for high-performance discharges (with CC, ASC, MS, BP, M&P TSGs)	
ITER Needs + Cross-cutting			
Joint Research Target	Quantify plasma response to non-axisymmetric (3D) magnetic fields in tokamaks	Quantify impact of broadened current and pressure profiles on tokamak confinement and stability	Assess disruption mitigation and warning / prediction techniques (+ additional theory contribution)

Other program notes

- TSG leaders asked to provide year-end report text by Aug 27
  - Please help them if/when they ask for input on research highlights
  - Also provide publication/presentation information to Stan Kaye
- Regrets to DOE Lab people not allowed to attend FEC 2014
  - Thank you for your efforts to find alternative speakers/presenters
  - Should still write conference and especially Nuclear Fusion paper
- And should be working on IAEA and APS talks/papers now…
  - (Or right after your vacation…)

Thank you!

BACKUP SLIDES

PAC response to ideas from NSTX-U / PPPL (2)

- "The PAC agrees the NSTX-U Innovative Research Award (NIRA) is a good idea that should be implemented.
  - We were informed through the question-answer period that university-based collaborations involving NSTX-U research are already substantial, e.g., totaling 76 individuals.
  - Hence, if targeted exclusively to university researchers, the NIRA would increase university collaborations 10-20% beyond that which is currently underway.
  - The PAC advises that in considering support for collaborative Ph.D. student research, duration of more than three years might be necessary to make such support tenable."

PAC-35 ideas to increase university engagement

- **"Structuring the scientific management of the NSTX Program to include university faculty/researchers** would help demonstrate scientific leadership and integrate university participation with less concern for additional financial support, i.e., the university faculty member(s) becomes an integrated, co-leader of the Research team. **We note that university scientists already hold leadership positions in the Topical Science Groups**."
- "Guaranteed financial support for startup and initial salary can significantly influence hiring decisions. **PPPL and/or FES could seek to establish tenure-track positions through such support, perhaps targeting universities in close geographic proximity** to facilitate graduate student educational needs."
- "We recommend that PPPL/NSTX help drive a national conversation on the role of universities in fusion and plasma physics research, together with other laboratories and universities."