



U.S. DEPARTMENT OF
ENERGY

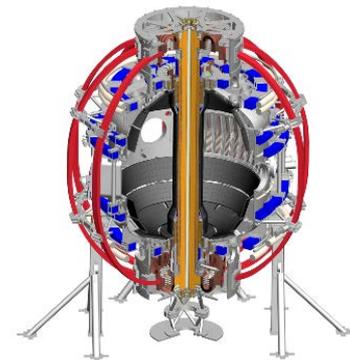
Office of
Science



Program Update: PAC-37 comments, run coordination

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NSTX-U Team Meeting
PPPL B318
February 5, 2016



PAC-37 held last week – 4 charge questions:

- Please assess the research planned to be carried out for the NSTX-U FY2016 experimental campaign
 - Are there any major missing elements, or new opportunities?
- Please assess the alignment between the NSTX-U research plans and goals and the FESAC / FES initiatives, research opportunities, and ITER urgent research needs.
- Please comment on the progress and plans for the NSTX-U / PPPL theory partnership, and how well this partnership and the broader NSTX-U research activities support “integrated predictive capability”.
- Please comment on the present team prioritization of planned facility enhancements including:
 - Divertor cryo-pump, non-axisymmetric control coils (NCC), 28GHz gyrotron, conversion to high-Z PFCs + liquid metals research

PAC Comments on 1st Charge Question

- 1. Please assess the research planned to be carried out for the NSTX-U FY2016 experimental campaign. Are there any major missing elements, or new opportunities?*
- “You commented a number of times on how the new organization structure for the NSTX-U program with three overarching science groups (core, boundary, integrated scenarios) has been effective in helping you define priorities and optimize the run plan. The PAC sees the benefits of this new organization, and we anticipate this will be a very effective foundation for the NSTX-U program going forward.”
 - “The PAC is concerned that the milestones for FY17 rely heavily on progress in FY16. The challenges for attaining sufficient progress in FY16 may be greatest in the boundary science area.”

PAC Comments on 2nd Charge Question

2. Please assess the alignment between the NSTX-U research plans and goals and the FESAC / FES initiatives, research opportunities, and ITER urgent research needs.

- “NSTX-U program is well aligned with priorities and initiatives identified in recent community strategic planning and workshops”
- “As for ITER, while the NSTX-U program is well connected via ITPA, your present research could impact ITER urgent needs:
 - Unique capability to investigate massive gas injection at different locations in the poloidal plane, **which should be highest priority**
 - The digital coil protection system (DCPS) is likely to be a good model for ITER
 - Active prediction and avoidance of disruptions in the PCS
 - Novel pellet-pacing experiments for ELM control using lithium, B4C, and vitreous graphite
 - NSTX-U is likely to produce important input to RMP control physics and development”

PAC Comments on 3rd Charge Question

3. *Please comment on the progress and plans for the NSTX-U / PPPL theory partnership, and how well this partnership and the broader NSTX-U research activities support “integrated predictive capability”*

- “The PAC is very pleased to see that the theory partnership is officially established following the one-year trial period. We strongly endorse continuing the partnership.”
- “The goal for integrated predictive capability obviously extends beyond NSTX-U and PPPL. While the partnership is founded on several flagship codes and modeling capabilities, it is essential to maintain strong collaborations for a goal as large as predictive capability, both to and from the PPPL-based research activities.”

PAC Comments on 4th Charge Question (1)

4. *Please comment on the present team prioritization of planned facility enhancements including: divertor cryo-pump, non-axisymmetric control coils (NCC), 28GHz ECH/EBW gyrotron, and conversion to all high-Z PFCs and liquid metals research.*
- “The PAC agrees that all of the planned facility enhancements could bring valuable and important new capabilities to NSTX-U.”
 - “The PAC agrees with your assessment that the divertor cryo-pump is highest priority. The plan for finalizing the physics and engineering design appears sound, but it is not conservative. The PAC urges that sufficient resources be dedicated to finalizing the design and completing the construction no later than the one-year outage planned for 2018.”

PAC Comments on 4th Charge Question (2)

4. *Please comment on the present team prioritization of planned facility enhancements including: divertor cryo-pump, non-axisymmetric control coils (NCC), 28GHz ECH/EBW gyrotron, and conversion to all high-Z PFCs and liquid metals research.*
- “Recent research, e.g., ASDEX Upgrade and JET, shows that core RF heating is essential with an all-metal-wall boundary.
 - Neoclassical transport is accentuated in the ST, and the effect of impurities related to a metal wall could be even more challenging.
 - There is presently no capability for core RF heating in NSTX-U that is compatible with large NBI heating.
 - The gyrotron opens the possibility for EBW heating, but the physics basis is still in development.
 - **The PAC strongly recommends increased emphasis on HHFW,** as described in slides following.”

Other PAC comments highlighted by JEM (1/4)

- “TRANSP should be listed in the set of flagship codes.
 - Broadening the contributions by the theory partnership to TRANSP and predictive TRANSP would be beneficial to NSTX-U and the broader community as well as to the goal of improving our integrated predictive capability.”
- “Macro-stability TSG research thrusts respond to urgent ITER needs. Hugely impressive growth in DPAM aligned with FES strategy and ITER priorities, and well coupled with Theory. Well done!”
- “In FY 16, organization of experiments around multi-TSG XPs is very effective in the investigation of the impact of major upgrades Ip/BT and 2nd NBI, covering global confinement aspects as well as local physics on multiple transport channels.”

Other PAC comments highlighted by JEM (2/4)

- “The PAC recommends emphasis be given to experiments which can also assess probability of achievement of long term goals: In particular characterization of impact of rotation (neoclassical vs turbulent) and HHFW on high Z impurities (and bulk plasma). Neon may not be sufficiently high Z.”
- “Recommend Core SG to widely look at the effect of rotation on stability. This can probably be captured parasitically. NSTX-U is likely to rotate very rapidly, so you should exploit this unique capability. Perhaps a small working group to oversee this is warranted, including theory where flowing equilibria may be needed in analysis”

Other PAC comments highlighted by JEM (3/4)

- “Commend the NSTX-U team for moving the transition to high-Z and liquid Li earlier in the 5-year plan. This is important in terms of mission of clarifying a ST-FNSF and to further establish and continue NSTX-U’s global uniqueness.”
- “The completion of some (boundary) milestones seems overly aggressive and the PAC is concerned some may not be able to completed on this aggressive schedule due to limitations of machine capabilities and availabilities. For example, can the impact of high-Z on operation scenarios in 2017 be assessed with only a single row of high-Z?”
 - The PAC recommends accelerated development of control of divertor radiation feedback, implementation of divertor radiation diagnostics, snowflake control development, as well as time to test appropriate control algorithms, in order to meet the R17-1 milestone

Other PAC comments highlighted by JEM (4/4)

- “The integrated modelling work done in preparation for experiments on plasma control and current drive studies, both using TRANSP, is impressive.
 - Examples are the preparation for experiments on several different control schemes and the modelling of fully non-inductive start-up.”
- “The run-time allocation is reasonably well balanced and addresses the main research milestones set-out for 2016. However, the time allocated to HHFW and CHI is marginal.”
 - “HHFW should have increased experimental and simulation effort to find a path to avoid SOL losses and minimize absorption on beam ions”
- “The PAC congratulates the NSTX-U Team on the design, implementation, and routine use of an active disruption avoidance scheme based on a “state machine. This is well aligned with the recommendations of the recent FES Transients Workshop, and we recommend that this continue to be used as an expanding platform incorporating additional disruption causes beyond the present VDE emphasis.”

Written PAC-37 report expected in March

- After final written report is received we will have TSG/SG meeting to discuss the recommendations and responses

Run coordination status

- XMP status – see info from Stefan
- 27 P1 XPs reviewed, 12 approved, 86 numbers assigned
- First XP(s) now being executed - get us revised XPs!
- May initiate TSG/run coordination meetings next week
 - Depends on progress on NBI, XMPs / shot development

Upcoming XMPs / XP – schedule highly subject to change

Mon 2/8	Tue 2/9	Wed 2/10	Thu 2/11	Fri 2/12
9 – 1p XMP-137: Lower PF1A Current Shot Development in NSTX-U (Battaglia)	9 – 1p XMP-138, Vertical Control Check Out (Boyer)	9 – 5p XMP-115, ISOFLUX Commissioning (Boyer)	9 – 1p XP-1506: Low Beta Locked Mode (Myers)	9 – 5p XMP-137: Lower PF1A Current Shot Development in NSTX-U (Battaglia)
1p – 5p XMP-138, Vertical Control Check Out (Boyer)	1p – 5p XMP-115, ISOFLUX Commissioning (Boyer)		1p – 5p XMP-115, ISOFLUX Commissioning (Boyer)	

Run Time Guidance for XP Prioritization (February 2016)

Similar to Research Forum, but +1 week for XMP, +1 week for XP

Baseline # run weeks: 18
 Estimated total # run days: 90
 Estimated XMP run-days: 30
 Reserve for multi-TSG XPs: 10
 Contingency / director's reserve: 5
 Nominal total days for TSG/TFs to prioritize: 55
 Minimum # run days per TSG / TF: 3.2
 Milestone weighting for FY16 and FY17 runs: 0.8

Cross-cutting commissioning, shot development, calibrations

TSG / Task Force	FY 16 Milestones	FY17 Milestones	FY16 count	FY17 count	Milestone additional runtime	Forum Idea Count Increment	Nominal TSG / TF run days for single XPs	Nominal TSG / TF run days for multi-TSG XPs	Priority #1 fraction 0.75			
									Nominal TSG / TF run days for all XPs	Nominal Priority 1 XP run time	Nominal Priority 2 XP run time	
Boundary	Pedestal	R16-1		1	0	0.8	0.5	4.5	1	5.5	4	1.5
	Divertor and SOL	R16-1	JRT-17, R17-1	1	2	1.2	1	5	1	6	4.5	1.5
	Materials and PFCs		R17-2		1	0.2	0	3	1	4	3	1
Core	Macroscopic Stability	JRT-16, R16-3		2	0	1.6	1	5.5	1	6.5	5	1.5
	Transport & Turbulence	R16-1	R17-3	1	1	1	0.5	4.5	1	5.5	4	1.5
	Energetic Particles	R16-2		1	0	0.8	0.5	4.5	1	5.5	4	1.5
Scenarios	Advanced Scenarios and Control	Notable, JRT-16, R16-2,3	JRT-17, R17-4	4	2	3.6	1	7.5	1	8.5	6.5	2
	Solenoid-Free Start-up		R17-4	0	1	0.2	0	3	1	4	3	1
	Wave Heating and Current Drive		IR17-1	0	1	0.2	0	3	1	4	3	1
Task Forces	Particle Control	R16-3		1	0	0.8	0.5	4.5	1	5.5	4	1.5
Total:								45	10	55	41	14

- Some of additional XMP time *may* go to HHFW commissioning
- SGs/TSGs should update XP run-time assignments