

TSG review of NSTX-U 5 year plan outline

Wednesday, July 25, 2012

PPPL – B318

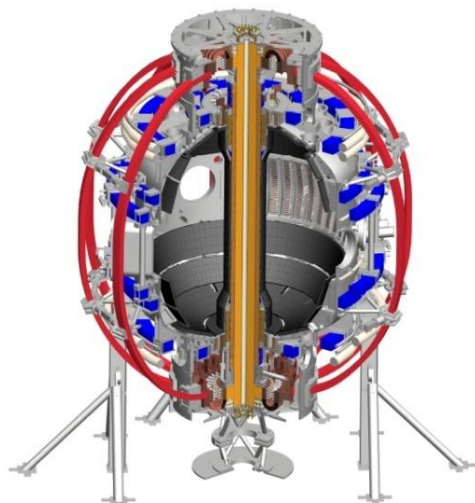
9:30AM	J. Menard	Overview
10:00AM	J. Park	Macroscopic Stability
10:40AM	Y. Ren	Transport and Turbulence
11:20AM	Vlad S.	Boundary Physics
11:55AM		Break / BPO res comm/ lunch
1:30PM	M. Jaworski	Plasma-Material Interactions and Plasma Facing Components
2:10PM	M. Podestà	Energetic Particles
2:50PM	G. Taylor	Wave Heating and Current Drive
3:30PM	R. Raman	Plasma Formation and Current Ramp-up
4:10PM	S. Gerhardt	Advanced Scenarios and Control

Overview of 5 year plan process

Jon Menard
For the NSTX-U Team

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Coll of Wm & Mary
 Columbia U
 CompX
 General Atomics
 FIU
 INL
 Johns Hopkins U
 LANL
 LLNL
 Lodestar
 MIT
 Lehigh U
 Nova Photonics
 Old Dominion
 ORNL
 PPPL
 Princeton U
 Purdue U
 SNL
 Think Tank, Inc.
 UC Davis
 UC Irvine
 UCLA
 UCSD
 U Colorado
 U Illinois
 U Maryland
 U Rochester
 U Tennessee
 U Tulsa
 U Washington
 U Wisconsin
 X Science LLC



Culham Sci Ctr
 York U
 Chubu U
 Fukui U
 Hiroshima U
 Hyogo U
 Kyoto U
 Kyushu U
 Kyushu Tokai U
 NIFS
 Niigata U
 U Tokyo
 JAEA
 Inst for Nucl Res, Kiev
 Ioffe Inst
 TRINITI
 Chonbuk Natl U
 NFRI
 KAIST
 POSTECH
 Seoul Natl U
 ASIPP
 CIEMAT
 FOM Inst DIFFER
 ENEA, Frascati
 CEA, Cadarache
 IPP, Jülich
 IPP, Garching
 ASCR, Czech Rep

Schedule for 5 year planning preparation

- April/May: Presented initial ideas to PAC-31, got feedback
- June-August 2012 – formulate/finalize plan elements and outline, identify/finalize authors, begin writing chapters
- October 2012 – First drafts of plan chapters due
- Nov-Dec 2012 – internal review/revision/editing of plan
- Jan/Feb 2013 – 5 yr plan presentation ‘dry-run’ to PAC-33
- Plan presented to review committee and FES Mar/Apr 2013

Near-term schedule for 5 year plan preparation

- Early July: J. Menard distributed overall chapter outline including main topics and tentative lead/responsible authors
- First ½ of July: TSG leaders modified/extended outline and held TSG meetings as needed to discuss
- Second ½ of July: Team-wide meeting(s) led by JEM and all TSG leaders to review/finalize the overall 5 year plan outline
- July/August: Initiate chapter writing
 - First task (by end of August) for each chapter writer will be to draft a chapter introduction summarizing how NSTX-U research program will:
 - Support burning plasma science
 - Address critical challenges for long-pulse/steady-state operation including plasma-wall interactions and materials
 - Address fusion materials science and harnessing fusion power (i.e. FNSF)

Goals for this meeting

- Want a good enough outline so we can begin writing chapters and minimize any wasted effort
- Goal today is to review plan for consistency and organization
 - Try to eliminate redundancy
 - Make sure we don't miss important elements/ideas for plan
- At this meeting, we'd like the chapter leaders to present:
 - 1-2 page summary of your high-level research thrusts/goals
 - 1 page (or more) timeline(s) showing physics goals + needed tools
 - Quickly page through chapter outlines indicating the topics & authors
- JEM and Chapter/TSG leader(s) will take notes of discussion to capture any important decisions/revisions

Chapter structure

- Overview of goals and plans
 - Establish predictive capability for the performance of FNSF and ITER
 - Overview of Research Thrusts
- Research Plans
 - Generally, organized by thrusts, and temporally for each topic
- Tool Summary
 - Don't need extensive descriptions of tools
 - Rely primarily on Timeline graphic

Next-steps

- Following this meeting, chapter authors should revise their chapters incorporating comments from this meeting
- Revised chapter outlines due 1 week from today
- JEM will then review the changes, and generate full revised outline no later than mid August
 - **Will then circulate to entire team for comment**
 - **Chapter authors should begin drafting text**
 - **Should also incorporate comments from PAC report**
- May need 1 more team-wide meeting to discuss facility plans
- Jon/Stan/Masa will request periodic TSG meetings throughout Aug/Sept/Oct for chapter writing status reports
- Aug/Sep are good months for writing (i.e. before IAEA, APS)

Draft timeline of long-range plan for NSTX-U

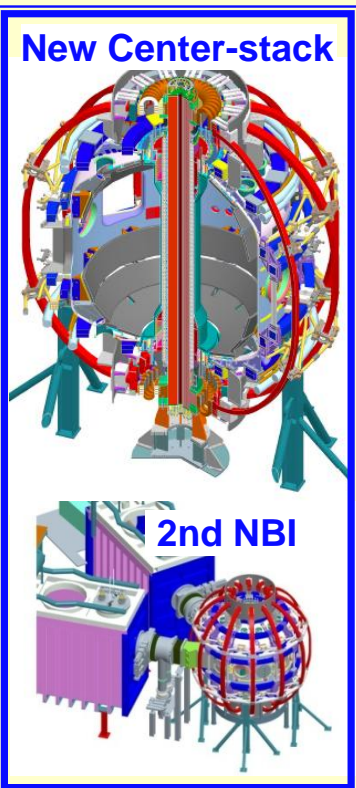
2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
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Upgrade Outage

1.5 → 2 MA, 1s → 5-10s

Advanced PFCs, 5-10s → 20s

- New Center-Stack ●
- 2nd NBI ●



0.3-0.5 MA CHI ●	0.5-1 MA CHI ●								
0.2-0.4 MA plasma gun ●			up to 1 MA plasma gun ●						Extend NBI duration or implement 2-4 MW off-axis EBW H&CD ●
ECH/EBW ●	1MW →			2 MW ●					
	Divertor cryo-pump ●		Divertor Thomson ●						Diagnostics for high-Z wall studies ●
U or L Mo divertor ●	U + L Mo divertor ●			All High-Z PFCs ●					Hot High-Z FW PFCs ●
● Li granule injector	● Upward LITER			● Flowing Li divertor or limiter module					● Full toroidal flowing Li divertor
Enhanced RFA/RWM sensors ●		NCC coils ●							NCC SPA upgrade ●
High k_{θ} ●		● δB polarimetry							● PCI or other intermediate-k
● HHFW feedthru & limiter upgrade			● HHFW straps for EHO, *AE						● Dedicated EHO or *AE antenna
● Rotation control	● q_{\min} control		● q_{divertor} control		● pedestal control				● Control integration

U.S. FNSF conceptual design including aspect ratio and divertor optimization

Notes on Chapter timelines

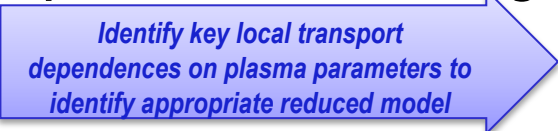
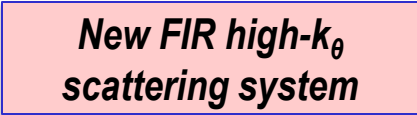
- You do NOT need to write extensive dedicated text for tools
 - This is what the timelines are for
- For activities that literally point/lead to a 5 year goal, or continue throughout the 5 year plan period after being initiated, use a right arrow:
- For activities/tools that have a definite start/end/completion year, use a rectangle:
- Rectangles are good in that they indicate activities we plan to actually "finish" in a definite time period
 - Use arrows for physics activities are more open-ended
- Use multiple time-lines if you cannot fit it all onto 1 page
- Ideally, each chapter timeline would be “square” to fit well into written plan (Word/portrait) & presentations (PPT/landscape)

Table of contents : Chapter indexing and suggested authors

First author listed is responsible for chapter organization, assigning/overseeing sub-chapter co-authorship, and overall completion of chapter

1. Overview of the NSTX Upgrade Research Plan for 2014-2018
 - a. **Menard**, Kaye, Ono, TSG leaders
2. Research Goals and Plans for Macroscopic Stability
 - a. **Park**, Berkery, Boozer, Sabbagh, Menard, Gerhardt
3. Research Goals and Plans for Transport and Turbulence
 - a. **Ren**, Guttenfelder, Hammett, Kaye, Yuh, Smith
4. Research Goals and Plans for Boundary Physics
 - a. **Soukhanovskii**, Diallo, Stotler, Chang, Maingi, Skinner, Jaworski, Canik, Ono
5. Research Goals and Plans for Plasma-Material Interactions and Plasma Facing Components
 - a. **Jaworski**, Skinner, Maingi, Ono, Soukhanovskii, Diallo, Stotler, Chang, Canik
6. Research Goals and Plans for Energetic Particles
 - a. **Podesta**, Fredrickson, Gorelenkov, Crocker, Heidbrink
7. Research Goals and Plans for Wave Heating and Current Drive
 - a. **Taylor**, Hosea, Perkins, Phillips, Bertelli
8. Research Goals and Plans for Plasma Formation and Current Ramp-up
 - a. **Raman**, Mueller, Jardin, Taylor, Gerhardt
9. Research Goals and Plans for Plasma Sustainment: Advanced Scenarios and Control
 - a. **Gerhardt**, Kolemen, Gates, Mueller, Erikson
10. NSTX-U Facility Status and Proposed Upgrades
 - a. **Ono**, Gerhardt, Kaita, Stratton, TSG leaders
11. NSTX-U Collaborator Research Plans by Institution
 - a. Existing and potential NSTX-U collaborators, edited by **Menard**

1. Overview of the NSTX Upgrade Research Plan for 2014-2018

- 1.1. Introduction
- 1.2. Mission elements of the NSTX-U research program (Menard)
 - 1.2.1. Advance ST as candidate for Fusion Nuclear Science Facility (FNSF)
 - 1.2.2. Develop solutions for plasma-material interface
 - 1.2.3. Advance toroidal confinement physics predictive capability for ITER and beyond
 - 1.2.4. Develop ST as fusion energy system
- 1.3. Unique Parameter Regimes Accessed by NSTX and NSTX-U (Menard + TSGs)
 - 1.3.1. Macroscopic Stability (Park)
 - 1.3.2. Transport and Turbulence (Ren)
 - 1.3.3. Boundary Physics
 - 1.3.3.1. H-mode ped. formation (LH), transport, stability (Kaye, Diallo, Maingi)
 - 1.3.3.2. SOL physics (Zweben)
 - 1.3.3.3. Divertor physics (Soukhanovskii)
 - 1.3.3.4. Particle control
 - 1.3.4. Plasma Material Interactions and Plasma Facing Components
 - 1.3.4.1. Lithium-based plasma facing component R&D (Jaworski, Skinner)
 - 1.3.4.2. High-Z PFC R&D (Jaworski, Maingi, Soukhanovskii)
 - 1.3.5. Energetic Particles (Podesta, Fredrickson, Gorelenkov)
 - 1.3.5.1. *AE instability drive
 - 1.3.5.2. Importance of *AE to NBI
 - 1.3.6. Wave heating and current drive (Taylor, Phillips)
 - 1.3.6.1. High-harmonic fast wave
 - 1.3.6.2. ECH/EBW
 - 1.3.7. Plasma formation and current ramp-up (Raman, Mueller)
 - 1.3.8. Plasma sustainment, advance scenarios and Control (Gerhardt)
- 1.4. Contributions to tokamak physics and ITER (Kaye)
 - 1.4.1. ITPA – physics basis for ITER
 - 1.4.2. Contributions to ITER Design and Operation
- 1.5. Fusion Energy Science Applications of the ST (Menard, Ono)
 - 1.5.1. Development and prototyping of advanced divertor and first-wall solutions
 - 1.5.2. ST-based Fusion Nuclear Science Facility / Component Test Facility
 - 1.5.3. ST-based Pilot Plant
- 1.6. Gaps Between Present and Future STs (Menard)
- 1.7. Summary of Research Goals and Opportunities in NSTX-U (Menard + TSGs)
 - 1.7.1. Overview
 - 1.7.2. Macroscopic Stability
 - 1.7.3. Transport and Turbulence
 - 1.7.4. Boundary Physics
 - 1.7.5. PMI and PFC
 - 1.7.6. Energetic Particles
 - 1.7.7. Wave heating and current drive
 - 1.7.8. Plasma formation and current ramp-up
 - 1.7.9. Plasma sustainment, advanced scenarios and control
- 1.8. NSTX-U Long-term Goals (Years 5-10) (Menard, Ono, Kaye)
- 1.9. NSTX-U Scientific Organizational Structure (Menard, Kaye)