NSTX

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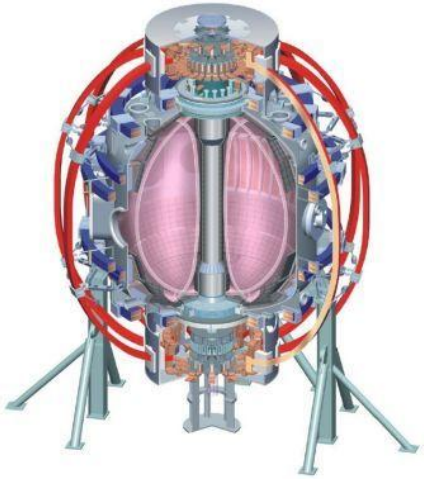
Update on NSTX Program

J. Menard

for the NSTX Research Team

NSTX Team Meeting
LSB B318 PPPL
August 9, 2011



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Outline

- Diagnostic planning for NSTX Upgrade
- PAC-30 summary
- Collaboration opportunities
- NSTX Upgrade and ST-FNSF planning and physics design

Thank you for your input on NSTX Upgrade Diagnostic Planning

- Two team-wide meetings held to discuss all ideas – July 21, 26
  http://nstx.pppl.gov/DragNDrop/Five_Year_Plans/2014_2018/diagnostic_brainstorming/meetings/2011_July/Day2_07_26_2011/
- Nearly 60 diagnostic ideas generated
- Ideas and discussion used as input to program letter, will be used for 5 year plan development
- Next steps:
  - **Each TSG** to meet & review 5 year plan draft goals – extend as needed
  - Identify key diagnostics needed to support the research plans using the diagnostic idea list as a resource
  - **PLEASE COMPLETE THIS BY: September 9, 2011**
- Input will help inform FES diagnostic collaboration proposals:
  - The due date for pre-applications is September 14, 2011
  - The due date for the full applications is October 18, 2011

PAC-30 telecon held August 1

- Discussed TF fault and implications
- Primary purpose was to review Program Letter for diagnostic collaboration on NSTX Upgrade
- *Charge to PAC-30:* Assess Program Letter from perspective of potential collaborator (using PAC knowledge of NSTX)

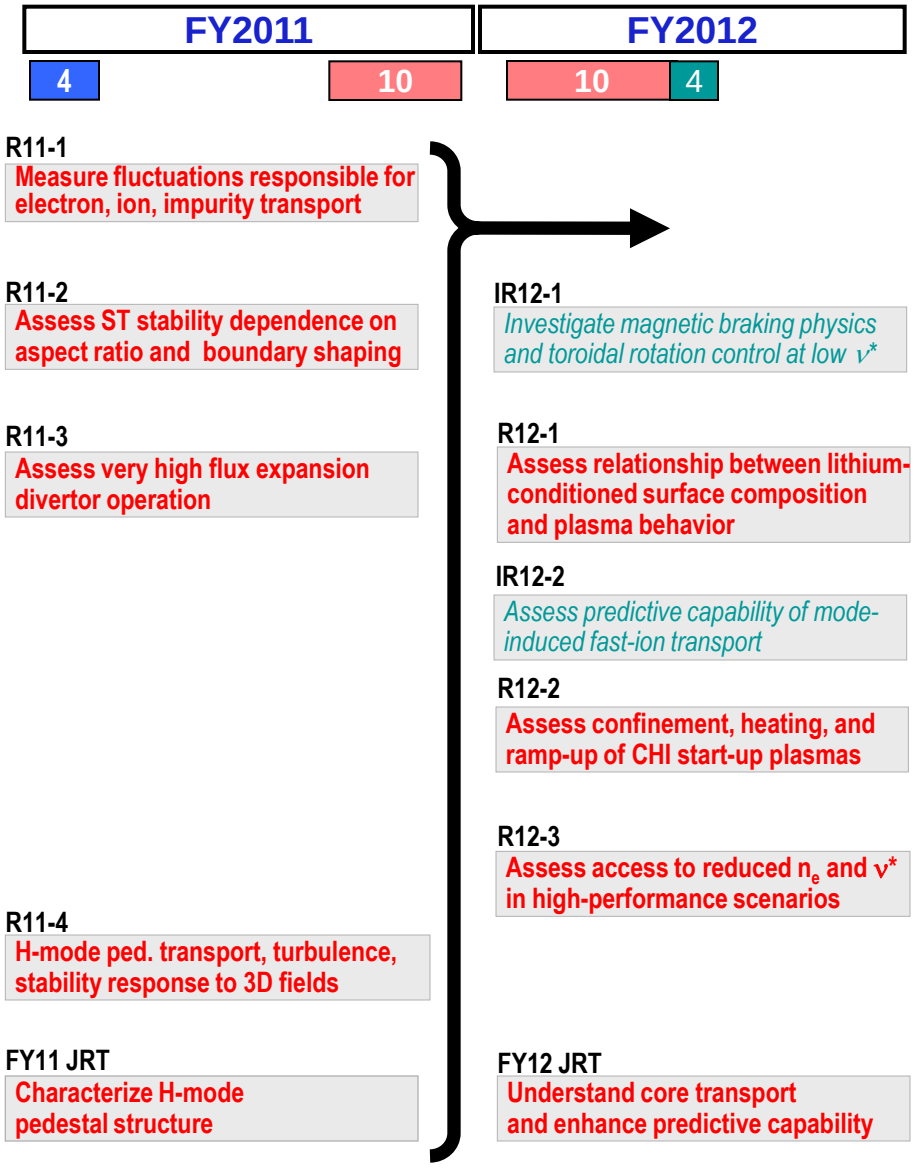
1. Does the letter well represent the program status and progress of NSTX, and the schedule, parameters, and opportunities of NSTX Upgrade?
2. Are the priorities, background, and opportunities easily understood?
3. Is there anything important missing?

PAC-30 recommendations, NSTX responses

- "The PAC urges that experiments designed to inform the needed capabilities to attain stationary, long-pulse, high-performance discharges in NSTX Upgrade remain high priority with whatever run time remains prior to the upgrade shutdown"
  - ➢Agree with high-prioritization of NSTX-U support experiments
- "In the forward part of the letter, the PAC recommends including a short description of key elements of the process that form the basis for the "record of contact" for potential collaborators"
  - ➢Good idea – description of "Record of Discussion" now included in letter
- "In the Plasma Boundary Interfaces topical area, make it more explicit that a high priority goal in this area of research is to obtain the capability for stationary, high-performance, long-pulse plasmas in NSTX-Upgrade. A solution to particle control does not yet exist, and is critical to the programmatic goal of obtaining low collisionality in NSTX-Upgrade plasmas. Upgrade will initially use Li coating as main tool for particle control."
  - ➢Explicitly ask for diagnosis of particle sources, sinks, transport near PMI

Programmatic impact of TF fault

- FY11 final 10 run weeks will not be completed in FY11
- Most recent discussions with FES indicate we should not delay start of Upgrade
- If there is FY12 run, run as much as possible through February 2012
  - Highest priority: prep for NSTX Upgrade, FY11+12 milestones, utilize new capabilities
- If there is no FY12 run:
  - FY11+12 expts → post-Upgrade
  - Start off-site collaboration in '12



Participation in DIII-D TBM experiments – fall 2011

- NSTX researchers are invited to participate in a DIII-D experiment planned for October 24-28, 2011 to assess impact of compensating the n=1 error field associated with the ITER Test Blanket Modules (TBMs).
- To address the issue of reduced rotation and confinement with the TBM, a set of experiments is to first establish optimal TBM error field correction and then document the effect on plasma rotation and H-mode confinement.
  - Additional expts assessing fast ion losses from TBM are also planned
- The research group will be led by Dr. Joseph Snipes of the IO and Dr. Michael Schaffer of General Atomics. Remote participation will be available for these experiments.
- Planning for this experiment will begin in early September
- **If you are interested, please contact J. Menard ASAP**

Offsite collaboration

- Previously identified collaborative research opportunities, facilities, researchers, and time allocations for Upgrade outage
  - Based on researcher response and follow-up discussions
- If NSTX will not operate in FY2012, collaboration schedule will be accelerated (resources and off-site capabilities permitting)

Total FTE for FY11-14 33.2	C-Mod 3.95	DIII-D 2.70	EAST 4.15	KSTAR 3.40	ITER 2.80	JET 2.10	LHD 4.30	LTX 2.30	MAST 4.10	Pegasus 1.10	PU 0.40	Purdue 0.45	Rutgers 0.15	UIUC 0.30	W-7X 1.00
Plasma Start-up										Mueller, D 0.20					
Lithium Sci/Tech			Mansfield, D 1.00 Jaworski, M 0.15					Skinner, C 0.30			Skinner, C 0.30 Kugel, H 0.10	Jaworski, M 0.30 Kugel, H 0.15	Kugel, H 0.15	Jaworski, M 0.30	
High-Z PFCs	Jaworski, M 0.40		Jaworski, M 0.10												
Core transp/turb	Mikkelsen, D 1.00	Guttenfelder, W 0.50 Ren, Y 0.55 Kaye, S 0.15	Ren, Y 0.55		Kaye, S 0.10		Mikkelsen, D 1.30 Skinner, C - Dust Guttenfelder, W 0.2		Guttenfelder, W 0.70 Kaye, S 0.10						Mikkelsen, D 1.00
Ped. transp/stab			Diallo, A 0.30						Diallo, A 0.40						
SOL, divertors	Zweben, S 1.40		Zweben, S 0.35 Visit for a week or 2 - maybe Europe? TCV, TORPEX, TJ-II, Padua - GPI												
Ener. Part., *AE		Fredrickson, E -		Fredrickson, E - fast ion diagnostic specification		Darrow, D 1.30 Kramer, G 0.80	Darrow, D 1.10 Fredrickson, E 0.75 Kramer, G 0.80		Fredrickson, E 0.75 Podesta, M 0.70 Kramer, G 0.40 Darrow, D 0.30 Fu, G 0.30						
Adv. Scen, Control		Kolemen, E 1.20 Gerhardt, S 0.20						Gerhardt, S 0.30	Kolemen, E 0.20	Kolemen, E 0.20					
MHD, Disruptions		Gerhardt, S 0.10		Park, J 0.05			Park, J 0.05								
SC Tokamak Ops			Mueller, D 0.30 Bell, M 0.30	Mueller, D 0.50	Bell, M 0.50										
Diagnostics	Bitter, M 0.05 Hill, K 0.05		Bitter, M 0.05 Hill, K 0.05 Medley, S 0.40	Bitter, M 0.05 Hill, K 0.05 Medley, S 0.40	Stratton, B 2.20		Bitter, M 0.05 Hill, K 0.05	LeBlanc, B 0.20 Bell, R 0.60 Kaita, R 0.70 Diallo, A 0.20		LeBlanc, B 0.20 Diallo, A 0.10					
ICRF	LeBlanc, B 0.75 Phillips, C 0.30		Hosea, J 0.30	Hosea, J 0.70 LeBlanc, B 0.45 Phillips, C 0.30						Taylor, G 0.20					
ECH, EBW			Hosea, J 0.30	Hosea, J 0.70 Taylor, G 0.20					Taylor, G 0.25	Taylor, G 0.20					

Example: NSTX – EAST collaboration
(discussions ongoing)

- Lithium research on HT-7, EAST to inform NSTX Upgrade decisions
- Exploration of design, fabrication of high-Z PFCs for NSTX Upgrade
- Join/observe ASIPP/PPPL design activities for ITER in-vessel coils to advance design of NCC for NSTX Upgrade
  - Plan/develop advanced scenarios for EAST
- Operation of EAST, SC tokamak control
- Assist in operation/optimization of RF systems

Need to form Upgrade divertor working group
(J. Menard will form/ID group by end of August)

- **PAC-29:** "*Develop effective strategy for particle control, e.g., perform a serious cryo-pump design study*"

- Note: NSTX may not have sufficient funding to implement cryo-pumping during first year(s) of Upgrade operation
- What duration and magnitude of pumping can we expect from lithium coatings during initial operation of NSTX upgrade?
- What divertor configurations can be effectively pumped in Upgrade with acceptable modifications to internal hardware?
- Are cryo-pumping and lithium-based PFCs compatible?
- What is highest priority/impact goal of Li-based PFCs:
  - Divertor power handling? Li wall pumping?
  - Can a Li-based divertor simultaneously handle high heat flux and pump deuterium? Could/should these capabilities be decoupled?

Advance physics/engineering design of ST-FNSF

- Submitted LDRD proposal for 2012
- FNSF studies also very useful for NSTX Upgrade planning
- Tasks and potential contributors identified:

Task	2012 fraction of task	2013 fraction of task	2014 fraction of task	Yearly Fraction Sum	Person(s) Responsible	Total Person days
Scans of device major radius at fixed minimum neutron wall loading, quantify variation in Qeng	0.6	0.3	0.1	1	Menard	10
Shift PF coils, add off midplane ducts	0.5	0.4	0.1	1	Menard, Brown	20
ST Pilot equilibrium and PF coil location	0.5	0.3	0.2	1	Menard	10
Modify design radial build parameters based on neutronics	0.4	0.3	0.3	1	Menard, Brown	20
Assess impact of SC vs. normal conducting PFs	0.4	0.4	0.2	1	Menard, Brown	20
NNBI calculations with TRANSP	0.3	0.3	0.4	1	Gerhardt, Menard	30
Assess stability of *AE and fast-ion redistribution and loss using NOVA-K/N and SPIRAL	0.2	0.4	0.4	1	Fredrickson, Gorelenkov, Kramer, Podesta	45
Plasma start-up projections: helicity injection, iron core, retractable solenoid, MIC solenoid	0.3	0.35	0.35	1	Raman, Battaglia, Voss, Zolfaghari	60
Modeling, assessment of viability of non-inductive plasma current ramp-up	0.3	0.35	0.35	1	Poli, Kessel	30
EBW current drive studies for ramp-up, sustainment	0.2	0.4	0.4	1	Bertelli, Taylor, UT Austin	25
Study of optimal NBI voltage and heating power - impact on design	0.2	0.3	0.5	1	Gerhardt	10
MHD stability assessment of scenarios	0.3	0.3	0.4	1	Gerhardt, Sabbagh	15
RWM stability assessment, controller design	0.3	0.3	0.4	1	Sabbagh, Bialek	10
Thermal confinement projections - pedestal height and width, global confinement and profiles	0.4	0.3	0.3	1	Diallo, Kaye, Guttenfelder	50
Vertical stability analysis, control requirements	0.2	0.3	0.5	1	Kolemen, Gerhardt	25
Divertor design - cryo-pumps, snowflake	0.3	0.3	0.4	1	Maingi, Canik, Soukhanovskii	25
LLD design for divertor	0.3	0.3	0.4	1	Jaworski, Kugel, Kaita	30
Super-X divertor coil positioning, divertor performance	0.3	0.3	0.4	1	Menard, UT Austin	20
Assess aluminum outer legs, incorporate if advantageous (lowers mass)	0.5	0.3	0.2	1	Brown, UT Austin	20
1D/2D neutronics for radial build requirements vs. shielding vs. wall loading for varied device size	0.5	0.3	0.2	1	El Guebaly	15
3D analysis of impact of NBI heating ports on TBR vs. device size	0.3	0.4	0.3	1	El Guebaly	25
3D modelling of neutron wall loading distribution, TBR for final conceptual design configurations	0.2	0.2	0.6	1	El Guebaly	15
From input from Alan Costley, incorporate the critical set of configuration driving diagnostic envelopes/details, similar	0.3	0.45	0.25	1	Costley, Gerhardt, Kolemen	25
Review with Peter Titus the current single assembly centerpost design and upgrade the joint and coolant details. Addit	0.3	0.35	0.35	1	Titus, Voss	30
Develop a stacked plate centerpost concept, soliciting input from P. Titus	0.3	0.4	0.3	1	Zolfaghari, Titus	45
Assess vertical maintenance capability dependence on device size	0.3	0.4	0.3	1	Brown, Voss	40
Develop horizontal maintenance concepts for blanket and divertor	0.4	0.3	0.3	1	Brown, Voss	40
Develop a first pass Pro/Mechanica FEA model to evaluate the structural support stress	0.2	0.3	0.5	1	Brown, Voss	25
Disruption analysis on vacuum vessel, internal components, PF/TF coils, blankets	0.3	0.35	0.35	1	Zhai, Titus	40