NSTX-U

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Macroscopic Stability TSG Research Forum

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NSTX-U Research Forum

February 24-27, 2015

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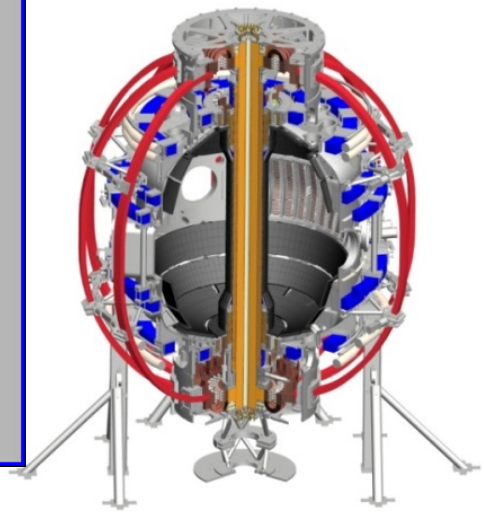

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V1.0

Highest-level goals for MS TSG for FY15 run

- Milestones
  - R15-3: Develop physics+operational tools for high-performance discharges (κ, δ, β, EF/RWM)
  - JRT15: Quantify impact of broadened J(r) and p(r) on tokamak confinement and stability
  - JRT16: Assess disruption mitigation, initial tests of real-time warning / prediction techniques
- Stability:
  - Optimize shaping, RWM/TM control (n>1 using the second SPA), validate internal mode physics, and RWM kinetic physics
- 3D Fields:
  - Optimize error field correction (n>1), dynamic correction, and understand NTV physics in reduced collisionality and controlled rotation
- Disruptions:
  - Study halo currents, disruption loads, and precursors, and test MGI or other mitigation techniques

XMP submissions

Title	Author	Days (min – max)	
NSTX-U Automatic Shutdown	Gerhardt	0.50	1.00
Commissioning the MGI Valves	Raman	1.00	1.00
Magnetics Calibration	Myers	1.50	1.50
6 SPA and Proportional RWM control Checkout	Gerhardt	0.50	0.75
RWM state-space control with 6 coils - checkout XMP	Sabbagh	0.20	0.25
XMP for MHD Spectroscopy Checkout	Berkery	0.20	0.25
	Total:	3.9	4.75

XP submissions in order of submission

Title	Author	Days (min – max)	
Make contact with NSTX for n=1 tearing mode stability	La Haye	0.5	1.0
3D plasma response data for MHD and transport code validations	Evans	1.0	1.5
Assess betaN and qmin n=1 tearing stability limits at the increased aspect ratio of NSTX-U	La Haye	1.0	1.0
RWM Stabilization Dependence on Neutral Beam Deposition Angle	Berkery	0.5	1.0
RWM Stabilization Physics at Reduced Collisionality	Berkery	0.5	1.0
RWM PID control optimization based on theory and experiment	Sabbagh	0.5	0.5
RWM state space control physics	Sabbagh	1.0	1.5
Neoclassical toroidal viscosity at reduced collisionality (independent coil control)	Sabbagh	1.0	1.0
NTV steady-state offset velocity at reduced torque with HHFW	Sabbagh	0.5	1.0
RWM control physics with partial control coil coverage (JT-60SA)	Y.S. Park	1.0	1.0
RWM state space active control at reduced plasma rotation	Y.S. Park	1.0	1.0
Multi-mode Error Field Correction with the RWM State-Space Controller	Sabbagh	0.5	1.0
Assess NSTX-U ideal-wall limit with 2nd NBI	Menard	1.0	1.5
Minimum Value of q_min/q_0 and q shear to avoid core n=1 kink/tearing	Myers	0.75	1.0
Massive Gas Injection Studies on NSTX-U	Raman	2.0	3.0
Real-time error field control using extremum seeking in NSTX-U	Lanctot	0.25	1.0
Compare the benefits of off-axis NBI for advanced scenarios in low and medium aspect ratio devices **ASC??**	Ferron	1.0	3.0
Resonant error field threshold with non-resonant braking	Park	0.5	1.0
Low-beta, low-density locked mode studies	Myers	0.5	1.0
High-beta n=1,2,3 feed-forward error field correction	Myers	0.5	1.0
Optimization of PID dynamic error field correction	Myers	0.5	1.0
Comparative study of the Electro-magnetic torque application through feedback for NTM locking avoidance in DIII-D, RFX-mod and NSTX	Okabayashi	1.0	1.0
Stabilization of radiated-induced tearing modes (RiTMs) using off-axis-heating	Delgado-Aparicio	1.0	1.0
Study of tearing mode stability in the presence of external perturbed fields	Wang	0.5	1.0
Direct measurement of kinetic plasma response using Nyquist Analysis	Wang	1.0	2.0
Disruption PAM Characterization, Measurements, and Criteria	Sabbagh	0	0
Disruption halo current studies in NSTX-U	Myers	0	0.25
	Total:	**20**	**31.25**

Draft agenda

Global Stability	Talks	Time
Menard	Assess NSTX-U ideal-wall limit with 2nd NBI	9:10am - ?
Berkery	RWM Stabilization Dependence on Neutral Beam Deposition Angle RWM Stabilization Physics at Reduced Collisionality	
Sabbagh (and for Y.S. Park)	RWM control physics with partial control coil coverage (JT-60SA) RWM PID control optimization based on theory and experiment RWM state space control physics RWM state space active control at reduced plasma rotation	
NTV		
Sabbagh	Neoclassical toroidal viscosity at reduced collisionality (independent coil control) NTV steady-state offset velocity at reduced torque with HHFW	
Error Fields		
Sabbagh	Multi-mode Error Field Correction with the RWM State-Space Controller	
Lanctot	Real-time error field control using extremum seeking in NSTX-U	
Park	Resonant error field threshold with non-resonant braking	
Myers	High-beta n=1,2,3 feed-forward error field correction Optimization of PID dynamic error field correction	
Locked / Tearing Modes		
Myers	Minimum Value of q_min/q_0 and q shear to avoid core n=1 kink/tearing Low-beta, low-density locked mode studies	
La Haye	Make contact with NSTX for n=1 tearing mode stability Assess betaN and qmin n=1 tearing stability limits at the increased aspect ratio of NSTX-U	
Delgado-Aparicio	Stabilization of radiated-induced tearing modes (RiTMs) using off-axis-heating	
Okabayashi	Comparative study of the Electro-magnetic torque application through feedback for NTM locking avoidance in DIII-D, RFX-mod and NSTX	
Wang	Study of tearing mode stability in the presence of external perturbed fields	
Plasma Response		
Wang	Direct measurement of kinetic plasma response using Nyquist Analysis	
Evans	3D plasma response data for MHD and transport code validations	
Disruptions		
Myers	Disruption halo current studies in NSTX-U	
Sabbagh	Disruption PAM Characterization, Measurements, and Criteria	
?	Controlled shutdown physics scans?	
Raman	Massive Gas Injection Studies on NSTX-U	

XP submissions in order of agenda

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Controlled shutdown physics scans			
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	Total:	**20**	**31.25**

Supporting slides follow

Collecting specific XP ideas, pre-forum (no priority order pre-assumed here)

- Stability:
  - Assess β_N and q stability limits at the increased aspect ratio of NSTX-U, with new shaping control and off-axis NBI
  - Utilize off-axis NBI to produce initial investigation determining the effect of pressure, q, and v_ϕ profile variations on RWM and NTM stability
  - Investigate the dependence of stability on reduced collisionality through MHD spectroscopy, and compare to kinetic stabilization theory
  - Establish dual field component n = 1 active control capability in new NSTX-U operational regime with 6 independent SPAs (Sabbagh)
  - Examine effectiveness of RWM model-based state space control with independent actuation of six control coils, multi-mode control with n up to 3, and plasma rotation-induced stabilization in the controller
  - Attempt initial control of internal MHD modes that appear at low density during current ramp-up
  - Determine the degree of global mode internalization by comparing diagnosis by magnetic and SXR means as a function of proximity to the mode marginal stability point
  - Utilize initial NSTX-U ME-SXR and poloidal USXR diagnostics to characterize the RWM eigenfunction by non-magnetic means

Collecting specific XP ideas, pre-forum (no priority order pre-assumed here)

- Stability:
  - XP1144: RWM stabilization/control, NTV Vf alteration of higher A ST targets (Sabbagh)
  - XP1145: RWM state space active control physics (independent coil control) (Sabbagh)
  - XP1146: RWM state space active control at low plasma rotation (Y-S Park)
  - XP1062: NTV steady-state rotation at reduced torque (HHFW) (Sabbagh)
  - XP1111: RWM PID optimization (Sabbagh)
  - XP1149: RWM stabilization dependence on energetic particle profile (Berkery)
  - XP1147: RWM control physics with partial control coil coverage (JT-60SA) (Y-S Park)
  - XP1148: RWM stabilization physics at reduced collisionality (Berkery)
  - XP1150: Neoclassical toroidal viscosity at reduced n (independent coil control) (Sabbagh)
  - Multi-mode error field correction using the RWMSC (Sabbagh)
  - Density limit study

Collecting specific XP ideas, pre-forum (no priority order pre-assumed here)

- 3D Fields
  - Low β, low density locked mode studies (Myers)
  - High β n=1,2,3 compass scans (Myers)
  - Optimization of PID Dynamic EF Correction (Myers)
  - Assess NTV profile and strength as a function of plasma collisionality, and examine the NTV offset rotation
  - Investigate the rotation and rotational shear vs. TM/NTM in NSTX-U
  - NSTX-U Tearing Mode Experiments by Varying Plasma Rotation Through NTV Torque in Presence of External Fields (Wang)
  - Plasma Response Study with Nyquist Plot in NSTX-U (Wang)
  - Understand how n=1 tearing mode stability changes with q-profile. In particular: 1. Sensitivity changes in response to error fields (to induce tearing modes) and 2. Changes to the tearing beta limit (LaHaye)
  - Investigate resonant error field effects on tearing mode onset
  - Investigate NTV physics with enhanced 3D field spectra and NBI torque profile at increased pulse lengths, and NTV behavior at reduced collisionality regime
  - Test n=1 locking threshold along with n=2-3 applied fields (Park)
  - Test single coil effects on NTV and confinement (Park)

Collecting specific XP ideas, pre-forum (no priority order pre-assumed here)

- Disruptions
  - Perform initial experiments using open-loop plasma rotation, current profile, and energetic particle control to demonstrate the ability to avoid encountering disruptive global mode stability boundaries based on kinetic RWM models
  - Commission MGI system and diagnostics, test EPI capsule injection
  - Assess total halo current fraction, toroidal structure, and poloidal width
  - Investigate high-Z gas fractions, gas transit times, the amount of gas required, and symmetry of the radiated power profile
  - Investigate halo current loading on the center column, using newly installed center column shunt tiles (Gerhardt)
  - Study spatial extent and timing of the heat deposition during VDEs
  - Construct an MHD spectroscopy database to determine the measured variation of global mode stability as a function of key parameters
  - Compare the mismatch between the RWMSC observer model and sensor measurements, and the occurrence of plasma disruptions
  - Implement and test initial disruption avoidance using the RWMSC observer model in real-time, including open-loop disruption avoidance criteria in low rotation plasmas