

# Macroscopic Stability TSG Research Forum

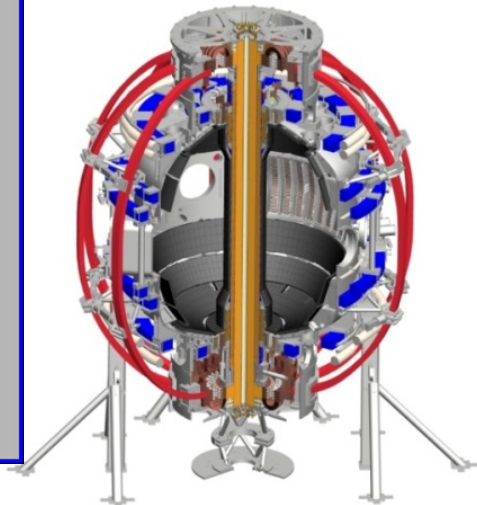
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**NSTX-U Research Forum**

**February 24-27, 2015**

**PPPL**



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# From Rob La Haye:

## **Sta Bil Ity**

Words (mostly) and Music by Woody Guthrie

Oh, if you ain't got the **sta-bil-ity**, folks, you ain't got the **sta-bil-ity**,  
Why, you better go back to beautiful Texas, Oklahoma, Kansas, Georgia, Tennessee.  
California is a garden of Eden, a paradise to live in or see;  
But believe it or not, *you won't find it so hot*  
If you ain't got the **sta-bil-ity**.

# Guidance

## □ Run Days

- Single TSG XPs: 5
- Multi TSG XPs: 1
- Priority 1: 4.5
- Priority 2: 1.5

## □ Programmatic considerations for prioritization:

- Viability of proposal given available NSTX-U capabilities
- OFES Joint Research Targets / Milestones: Carry out JRT-15, preparatory experiments for JRT-16 (disruptions)
- NSTX-U Research Milestones and other ST high priority research
- NSTX-U Facility Enhancement design needs: High-Z tiles, cryo, NCC, high-k scattering, future (ECH, DBS/CPS, ...)
- ITER: Direct IO requests, ITPA: NSTX-U is lead/prominent experiment
- Experiments leading to high-profile publications/presentations: PRL, Science, Nature; Invited talks: IAEA, APS, EPS, Sherwood, ...
- Career development: PhD thesis, post-doctoral research
- Any good idea generated during run – potential “break-thru” ?
- Maximize institutional / researcher breadth of XP leadership: Spread the wealth, get co-authors, help/mentor the less experienced

# Highest-level goals for MS TSG for FY15 run

## □ Milestones

- R15-3: Develop physics+operational tools for high-performance discharges ( $\kappa$ ,  $\delta$ ,  $\beta$ , 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 <b>ASC??</b>	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

# XP submissions in order of submission

Title	Author	Days (min – max)	
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
Measure effect of extrinsic asymmetry (poloidal location of injector) on VDE mitigation	Izzo	0.5	1.0
Study 3D and 0D aspects of locked mode mitigation	Izzo	0.5	1.0
Using private flux MGI as super-radiative divertor for disruption mitigation	Eidietis	0.25	0.5
Effect of snowflake on divertor heat flux during disruption	Eidietis	0.25	0.5
Increased CHI Start-up Currents through Imposed Non-axisymmetric Perturbations	Nelson	0.25	0.5
RMP NTM interaction	Kolemen	1.0	1.0
Expand the operational limit by real-time adaptive EFC	Kolemen	0.5	1.0
Tearing onset through driven reconnection across rational surfaces	Paz-Soldan	0.5	1.0
Investigation of Plasma Disruptions during Current Rampdown	Jardin (Raman)	0.5	1.0
NTM entrainment	Y.S. Park	0.5	1.0
	<b>Total:</b>	<b>24.75</b>	<b>39.75</b>

Global Stability	Tasks	Time
Menard	Assess NSTX-U ideal-w all limit w ith 2nd NBI	9:10 – 9:14
Berkery	RWM Stabilization Dependence on Neutral Beam Deposition Angle RWM Stabilization Physics at Reduced Collisionality	9:14-9:22
Sabbagh (and for Y.S. Park)	RWM control physics w ith 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	9:22-9:50
<b>NTV</b>		
Sabbagh	Neoclassical toroidal viscosity at reduced collisionality (independent coil control) NTV steady-state offset velocity at reduced torque w ith HHFW	
<b>Error Fields</b>		
Sabbagh	Multi-mode Error Field Correction w ith the RWM State-Space Controller	9:50-9:54
Park	Resonant error field threshold w ith non-resonant braking	
Kolemen	Expand the operational limit by real-time adaptive EFC	
La Haye for Lanctot	Real-time error field control using extremum seeking in NSTX-U	
Myers	High-beta n=1,2,3 feed-forward error field correction Optimization of PID dynamic error field correction	10:00-10:04
<b>Locked/Tearing Modes</b>		
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	
Delgado-Aparicio	Stabilization of radiated-induced tearing modes (RiTM) 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	10:04-10:20
La Haye	Make contact w ith NSTX for n=1 tearing mode stability Assess betaN and $q_{min}$ n=1 tearing stability limits at the increased aspect ratio of NSTX-U	10:20-10:24
Paz-Soldan	Tearing onset through driven reconnection across rational surfaces	10:24-10:28
Kolemen	RMP NTM interaction	10:30-10:38
Sabbagh (for Y.S. Park)	NTM entrainment	10:38-10:42
Wang	Study of tearing mode stability in the presence of external perturbed fields	10:42-10:46
<b>Plasma Response</b>		10:46-10:50
Wang	Direct measurement of kinetic plasma response using Nyquist Analysis	10:50-10:58
Evans	3D plasma response data for MHD and transport code validations	
Nelson	Increased CHI Start-up Currents through Imposed Non-axisymmetric Perturbations	
<b>Disruptions</b>		
Sabbagh	Disruption PAM Characterization, Measurements, and Criteria	11:06-11:10
Myers	Disruption halo current studies in NSTX-U	11:10-11:14
Raman (and for Jardin)	Investigation of Plasma Disruptions during Current Rampdown Massive Gas Injection Studies on NSTX-U	11:14-11:22
Eidietis	Using private flux MGI as super-radiative divertor for disruption mitigation Effect of snowflake on divertor heat flux during disruption	11:22-11:30
Izzo	Measure effect of extrinsic asymmetry (poloidal location of injector) on VDE mitigation Study 3D and 0D aspects of locked mode mitigation	11:30-11:38



# Supporting slides follow

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