

Supported by



Office of  
Science



# NSTX 5 Year Plan – Initial Ideas for MHD

College W&M  
Colorado Sch Mines  
Columbia U  
Comp-X  
General Atomics  
INEL  
Johns Hopkins U  
LANL  
LLNL  
Lodestar  
MIT  
Nova Photonics  
New York U  
Old Dominion U  
ORNL  
PPPL  
PSI  
Princeton U  
SNL  
Think Tank, Inc.  
UC Davis  
UC Irvine  
UCLA  
UCSD  
U Colorado  
U Maryland  
U Rochester  
U Washington  
U Wisconsin

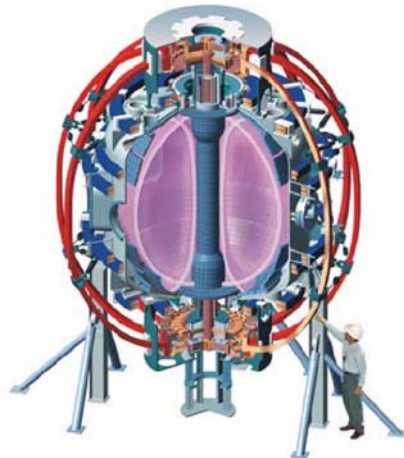
Steven A. Sabbagh  
*Columbia University*

For the NSTX Research Team

**NSTX 5 Year Plan “Kickoff” Meeting**

December 22nd, 2006

PPPL



Culham Sci Ctr  
U St. Andrews  
York U  
Chubu U  
Fukui U  
Hiroshima U  
Hyogo U  
Kyoto U  
Kyushu U  
Kyushu Tokai U  
NIFS  
Niigata U  
U Tokyo  
JAERI  
Hebrew U  
Ioffe Inst  
RRC Kurchatov Inst  
TRINITY  
KBSI  
KAIST  
ENEA, Frascati  
CEA, Cadarache  
IPP, Jülich  
IPP, Garching  
ASCR, Czech Rep

# Focused 5 year planning effort requires target goals

- ❑ General assumptions for 5 year plan goals
  - ❑ Support for NHTX: steady-state, high performance ( $\beta_N$ ) plasma
  - ❑ Support for ITER (ITPA), USBPO, CTF (ST development)
- ❑ Bridge from present (07-08) to next 5 years (2009-2013)
  - ❑ Initial RWM active control to “optimized” RWM control
  - ❑ RWM “critical rotation” to full understanding of stabilization physics
  - ❑ Plasma rotation physics/initial control to full study, active control
  - ❑ Initial NTM studies to full characterization, mitigation (stabilization?)
  - ❑ NSTX config. to targeted NHTX configuration (shape, stabilizers)
  - ❑ Disruption database studies to possible expanded disruption studies
- ❑ Questions
  - ❑ MHD section include energetic particles? “No”, based on writeup plan

---

---

# Future plans (2007 – 2008) for MHD research build upon present results

(From DOE Mid-term Review Meeting, 2006)

- ❑ Investigation of extreme elongation regime for CTF, stability studies with greater detail of  $J(r)$  from expanded MSE
- ❑ RWM / DEFC research targeting active stabilization needs for USBPO, ITER, CTF, KSTAR
- ❑ RWM research program leveraging joint experiments (ITPA) for needed physics understanding of kink/RWM stabilization
- ❑ Further attention to ITPA / ITER disruption needs (e.g.  $B$ ,  $q$  scaling of locked mode threshold, thermal quench and halo current peaking studies)
- ❑ Characterization of NTM at low  $A$ , high  $\beta$  and assessment of current drive needs for stabilization

# MHD ETG 2007 XP Prioritization: 2007-08 Plans Addressed

<input type="checkbox"/> MHD XP Presentations requesting run time		
	<input type="checkbox"/> Assessment of intrinsic error fields after TF centering (Menard)	1.0 days
	<input type="checkbox"/> RFA detection optimization during dynamic EF correction (Menard)	1.0 / 1.5 days
	<input type="checkbox"/> RWM active stabilization and optimization – ITER scenario (Sabbagh)	1.5 days
	<ul style="list-style-type: none"> <li><input type="checkbox"/> Assessment of RWM mode stiffness (Okabayashi)</li> <li><input type="checkbox"/> <math>n = 3</math> magnetic braking w/ optimal <math>n = 1</math> error field correction (Garofalo)</li> </ul>	-- days 0.5 days
5	<input type="checkbox"/> Fast Soft X-ray Camera (FSXIC) Imaging of MHD (Bush)	piggyback
days	<input type="checkbox"/> Exploration of stability limits at high $I_N$ with strong shaping (Gates)	1.0 days
<hr style="border-top: 1px dashed black;"/>		
	<input type="checkbox"/> B and q scaling of low-density locked-mode threshold at low-A (Menard)	1.5 days
	<ul style="list-style-type: none"> <li><input type="checkbox"/> Measurements of plasma boundary response to applied 3D field (Park)</li> </ul>	-- days
	<input type="checkbox"/> RWM suppression physics at low aspect ratio (Sabbagh)	1.0 days
	<ul style="list-style-type: none"> <li><input type="checkbox"/> RWM D3D+ joint experiment – <math>\epsilon</math>, <math>\beta</math>, <math>V_\phi(\psi)</math> effects on <math>\Omega_{crit}(\psi)</math> (Sabbagh)</li> </ul>	1.0 days
	<input type="checkbox"/> NTV dissipation physics: $n = 2$ perturbations and $v_i$ (Sabbagh)	0.5 days
	<ul style="list-style-type: none"> <li><input type="checkbox"/> Toroidal flow damping by island-induced NTV (Shaing)</li> </ul>	-- days
10	<input type="checkbox"/> Marginal island width of NTMs in NSTX (LaHaye)	0.5 days
days	<input type="checkbox"/> NTM threshold at low plasma rotation (Strait/Buttery/LaHaye)	0.5 days
<hr style="border-top: 1px dashed red;"/>		
	<input type="checkbox"/> Exploration of stability limits at high $I_N$ with $n=1$ control (Gates)	1.0 days
	<input type="checkbox"/> Measurement of scrape-off layer current during MHD (Takahashi)	PB / 0.5 days
	<input type="checkbox"/> RWM resonant field amplification, destabilization of $n > 1$ (Sabbagh)	1.0 days

Run time guidance: 5 – 10 run days (16.0 - 21.0 run days originally requested)

# Many approaches to fulfill 5 Year plan goals, limited by hardware and run-time constraints (I)

## ❑ RWM control

- ❑ Test optimized techniques offline '07, implement '08-'09, use '09+
- ❑ Possible sensor upgrade for optimal control
- ❑ Possible passive plate modification to test control; NHTX support
- ❑ Need for multiple mode stabilization? Internal coils?

## ❑ Plasma rotation

- ❑ Resonant damping, islands, damping mitigation for steady-state ops
- ❑ Real-time rotation evaluation for active rotation control; fast CHERS
- ❑ Density control (ion collisionality) to support physics study (ITER, etc.)

## ❑ RWM stabilization physics

- ❑ NSTX well-equipped for study – analysis/'07 run determine upgrades
- ❑ Rotation/profile,  $v_i$ , RWM active control beneficial (required) tools for study



# Many approaches to fulfill 5 Year plan goals, limited by hardware and run-time constraints (II)

## □ NTM

- Approaches for study constrained by hardware upgrades
  - “Committed” to analysis of current drive needs for stabilization
  - Suggest that NSTX leverage low A, high  $\beta$  for physics contribution
  - Suggest focus on physics, and what is needed for steady-state operation
  - Will an active stabilization system be supported? Passive studies only?
- Improve diagnostics for mode determination / stability analysis
  - MSE (in plan), SXR (mode diagnosis may alter plan), etc.

## □ Shaping / configuration

- Self-consistent current profile ( $\beta$  dependent) for steady-state ops
  - Any possible “real-time” alteration?  $\beta$ , MSE, rotation ( $E_r$ ) feedback?
- Possible NSTX device alteration to support NHTX? (plates, divertor)

## □ Disruptions

- What role (percentage effort) will NSTX take in disruption studies?

