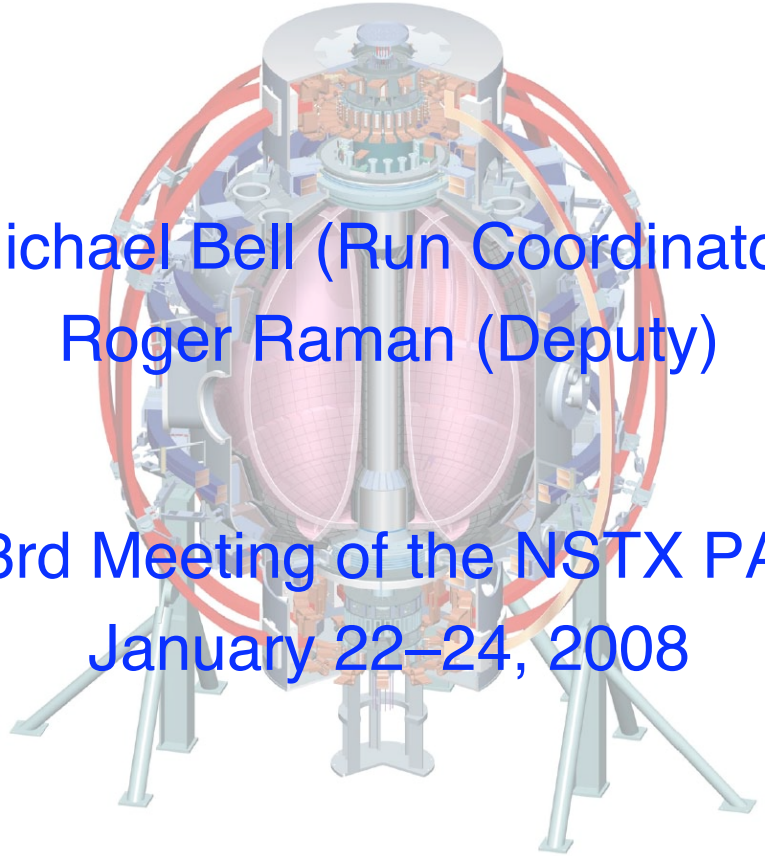
Overview of Run Plan for FY2008

Michael Bell (Run Coordinator)

Roger Raman (Deputy)

23rd Meeting of the NSTX PAC

January 22–24, 2008



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NSTX Mission

- To provide the physics basis for future ST-based devices, such as NHTX, ST-CTF, and ST-Demo
  - Emphasized by OFES through newly formed Spherical Torus Coordinating Committee (STCC)
- To broaden the physics basis for ITER, actively participating in ITPA and US BPO
  - Identify topics and issues where NSTX capabilities can contribute uniquely and effectively
- To advance the understanding of toroidal magnetic confinement
  - Utilize unique parameter regimes and capabilities to test and develop theory and modelling

Planning FY08 NSTX Run to Support 3 Year Program (FY08–10) Consistent with Mission

- FY'08 program milestones support NHTX/CTF research needs
  - **Joule milestone: Evaluate the generation of plasma rotation and momentum transport, and assess the impact of plasma rotation on stability and confinement**
  - **R(08-1): Measure poloidal rotation at low A and compare with theory**
  - **R(08-2): Couple inductive ramp-up to CHI plasmas**
  - **R(08-3): Study variation and control of heat flux in SOL**
- Agreements with ITPA and requests from ITER
  - High priority issues for resolution in early 2008 to which NSTX can make timely contributions
    - **ELM control and suppression by externally applied fields**
    - **RWM control with coils similar to ITER port-plug coil design**
    - **Vertical control requirements, VDE avoidance**

Budget and Operational Constraints

- Until mid-December, guidance was to operate NSTX for 12 weeks (60 run days, single shift)
- As a result of Omnibus Budget Act, run weeks may increase up to 18
  - Continue operation into July (3 weeks operation / 1 week maintenance)
- Allocate 2/3 of baseline runtime initially – 40 days
- Allocate ~10 days run time for commissioning new systems and "cross-cutting" developments benefiting the whole program
  - Poloidal CHERS, FIDA
  - Dual lithium evaporator (LITER) system with shutters
  - Different configurations of 6 EF/RWM coils with 3 SPA supplies
- Remainder to be allocated following a mid-run assessment and total run time decision

Held Successful Research Forum for FY08 Experiments November 27–29, 2007

NSTX

- Opening plenary session reviewed programmatic issues, including plans of other facilities (DIII-D, C-Mod, MAST, LTX)
- Proposals for experiments considered and prioritized by six Topical Science Groups (TSGs) in breakout sessions (3 serial, 2 parallel)
  - Transport & Turbulence *[Kaye, Tritz, Hahm]* *[experiment / theory]*
  - Solenoid-Free Startup and Rampup *[Raman, Mueller, Jardin]*
  - Macroscopic Stability *[Sabbagh, Gerhardt, Breslau]*
  - Wave-Particle Interactions *[Taylor, Fredrickson, Gorelenkov]*
  - Boundary Physics *[Soukhanovskii, Maingi, Stotler]*
  - Advanced Scenarios and Control *[Gates, Menard, Kessel]*
- 89 proposals submitted and considered
  - TSGs were asked to identify overlaps and suggest combinations
- Final plenary session reviewed prioritized/combined experiments from TSGs and plans for developing Experimental Proposals (XPs)

Initial Allocation of Run Days to TSGs

TSG	12(18)-week Plan	FY08 Milestones
Transport &Turbulence	7.5 (11)	Joule, R(08-1)
Boundary Physics	7 (11)	R(08-3)
Macro-Stability	7 (11)	Joule
Solenoid-free Startup & Rampup	6 (9)	R(08-2)
Wave-Particle Interactions	5.5 (8)	
Advanced Scenarios & Control	5 (8)	
ITER Design Support	2 (4)	
Cross-cutting	*10 (10)*	
Reserve	*10 (18)*	
Total	*60 (90)*	

Transport & Turbulence TSG Priorities

NSTX

- Evaluate generation of plasma rotation and momentum transport, and assess impact of plasma rotation on confinement *[Joule milestone]*
- Assess the role of flow shear in controlling plasma turbulence and transport using poloidal CHERS *[milestone R08-1]*

Transport & Turbulence Experiments

	Experiment Title	Milestone, ITPA *etc.*
Base	Dependence of energy & impurity transport on rotation	Joule, R(08-1)
	Momentum transport studies on NSTX (steady-state)	Joule, R(08-1), TP-6.3
	Modulation of core rotation to assess momentum transport	Joule, R(08-1), TP-6.3
	NSTX, DIII-D energy confinement similarity experiment	TP-9
	High-k plasma turbulence *vs* L_{Te},T_e/T_i, S, Z_{eff} – I	
	Effect of nRMP on L-H threshold	ITPA
	Magnetic shear effects on thermal and momentum transport	
	Field scaling of electron transport change with heating power	
	Investigation of ion transport with beam modulation	Thesis
Increment	High-k plasma turbulence II	
	β-scaling using lithium evaporation to suppress ELMs	CDB-2
	Neoclassical impurity transport in the high-gradient region	

Boundary Physics TSG Priorities

- Study variation and control of heat flux in SOL *[milestone R08-3]*
  - Characterize divertor heat flux and access to detachment
  - Compare divertor heat flux widths to midplane density and temperature widths and edge turbulence characteristics
- ELMs and pedestal
  - Determine relationship of ELM properties to discharge boundary shapes and lithium conditioning
  - Compare stability of pedestal and ELMs with model calculations

Boundary Physics Experiments

	Experiment Title	Milestone, ITPA *etc.*
Base	Divertor detachment in high-δ,κ H-mode plasmas	R(08-3)
	Characterize mid-plane SOL & divertor heat flux widths	R(08-3)
	Small ELM regimes in C-Mod, MAST, NSTX	PEP-16
	Dependence of pedestal structure on aspect ratio	PEP-9
	Characterize dual LITER and effect on ELMs	(FY09 prep)
	Particle accounting with and without lithium	(FY09 prep)
	Edge characterization of high performance discharges	R(08-3)
	Biased electrodes for SOL control	
	Magnetic balance & fueling effects on ELMs & power balance	PEP-6
Increment	ELM effects of RMP	
	Edge turbulence and blobs	DSOL-15
	Injection of lithium powder	(FY09 prep)
	Role of neoclassical impurity transport in the gradient region	
	Type V ELMs and edge gradients	

Macro-Stability TSG Priorities

- Evaluate MHD sources of plasma viscosity and assess the impact of plasma rotation on plasma stability, including NTM *[Joule milestone]*
- Assess active and passive RWM stabilization physics for improved mode control *[milestone R09-1]*

Macro-Stability Experiments

NSTX

	Experiment Title	Milestone, ITPA *etc.*
Base	Rotation dependence of 2/1 NTM thresholds	Joule, MDC-4
	Optimization of active RWM stabilization	Joule, MDC-2, IIC RWM-1, DCR-96
	Compare NTV among tokamaks (n=2, nu_i scaling)	Joule, MDC-12, IIC AUX-1
	Studies of the 3/2 NTM: rotation and beta rampdown	Joule, MDC-4
	RWM stabilization physics – comparison to theory	Joule, MDC-2, IIC RWM-1
	n=2 intrinsic error fields and RWM critical rotation	Joule, MDC-2, IIC RWM-1
Increment	Island-induced neoclassical toroidal viscosity	Joule, MDC-4, MDC-12, IIC AUX-1
	Deformation of RWM and multi-mode characteristics	
	Assessment of non-rigidity in RWM feedback	

Solenoid-free Startup & Rampup TSG Priorities

- Couple inductive ramp-up to CHI plasmas *[milestone R08-2]*
- Demonstrate inductive flux reduction using CHI

Solenoid-free Startup & Rampup Experiments

	Experiment Title	Milestone, ITPA *etc.*
Base	Solenoid flux saving using Transient CHI (pre-lithium)	R(08-2)
	Solenoid flux saving using Transient CHI (post-lithium)	R(08-2)
Incr.	Edge current drive with CHI	
	Relaxation current drive	

Wave-Particle Interactions TSG Priorities

- **HHFW/EBW**: Understand and improve coupling to and heating of NBI-heated, deuterium H-mode plasmas
- **Fast Ion MHD**: Assess fast ion transport from AE avalanches and compare to non-linear AE simulation

Wave-Particle Interactions Experiments

NSTX

	Experiment Title	Milestone, ITPA *etc.*
Base	HHFW phase scan & current drive in D L-Mode	
	HHFW phase scan & current drive in D NBI H-Mode	MDC-11(c)
	Fast-ion transport induced by TAE avalanches	MDC-11(a)
	Fast-ion loss with Alfvén cascade modes	MDC-11(a)
Increment	Optimization of EBW coupling from H-Mode plasmas	
	HHFW-CD ramp up from (projected) ECH D_2 target plasma	
	Fishbone-induced NBI ion loss	MDC-11(c)
	Angelfish (CAE or GAE hole-clumps) studies	MDC-11(b)
	BAAE & TAE-RSAE structure with high-k scattering	MDC-11(b)
	Vertical NPA scan with high-f MHD, with & without low-f MHD	MDC-11(a)

Advanced Scenarios & Control TSG Priorities

NSTX

- Characterize non-inductive current drive fraction versus density, shaping and q
- Achieve density control in extended pulses using improved fueling and lithium conditioning

Advanced Scenarios & Control Experiments

NSTX

	Experiment Title	Milestone, ITPA *etc.*
Base	Robustness of improved error field suppression in long discharges	
	Parametric study of high elongation plasmas	
	Impact of dual LITER system on long-pulse discharges	
	Vertical stability physics and performance limits in highly elongated tokamaks	MDC-13
Increment	Development and assessment of X-point limiter plasmas	
	HHFW into early and late diverted plasmas	
	Nonaxisymmetric coils for vertical stability control in NSTX	
	Model based multivariable shape controllers	
	Low l_i startup	
	Hybrid discharges on NSTX	SSO-2.2

Experiments Addressing ITER Requests

NSTX

Task	Experiment Title	TSG
ELM Mitigation	ELM mitigation with midplane coils using different RMPs	MS/BP
RWM Control	Optimization of active RWM stabilization	MS
	RWM stabilization physics – comparison to theory	MS
	n=2 intrinsic error fields and RWM critical rotation	MS
	Deformation of RWM and multi-mode characteristics	MS
	Assessment of non-rigidity in RWM feedback	MS
Vertical control, VDE suppression	Parametric study of high elongation plasmas	ASC
	Vertical stability and limits in highly elongated tokamaks	ASC
	Nonaxisymmetric coils for vertical stability control in NSTX	ASC
	Model based multivariable shape controllers	ASC

FY08 ITER specific / FY08 baseline / FY08 increment

First Four Weeks Will Be Run Without LITER

NSTX

- We will continue to use boronization (sparingly) during this period
- Some experiments have specifically requested runtime before using LITER, in particular
  - First phase of CHI experiments
  - Several boundary physics experiments *e.g.* baseline conditions
- Plans for experiments that do not require lithium are now being developed and reviewed

NSTX is Returning to Operation After the Outage

- Vessel bakeout in December
- Installed and conditioned 3 refurbished NB sources
  - Also performed alignment checks of new NB sources
- Completed restart procedure (ISTP)
  - Commissioned upgraded plasma control system
  - Tested all coil systems and interlocks
- Preparing for first plasmas
  - (Re)commission, check and calibrate diagnostics
  - Condition HHFW system this week
- Each TSG is holding meetings to develop and review its first XPs
- Experiments will begin in earnest in February