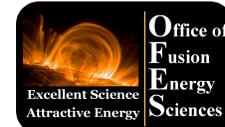


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NSTX Facility and Budget Plans – FY04-06

In Support of the NSTX Research Program

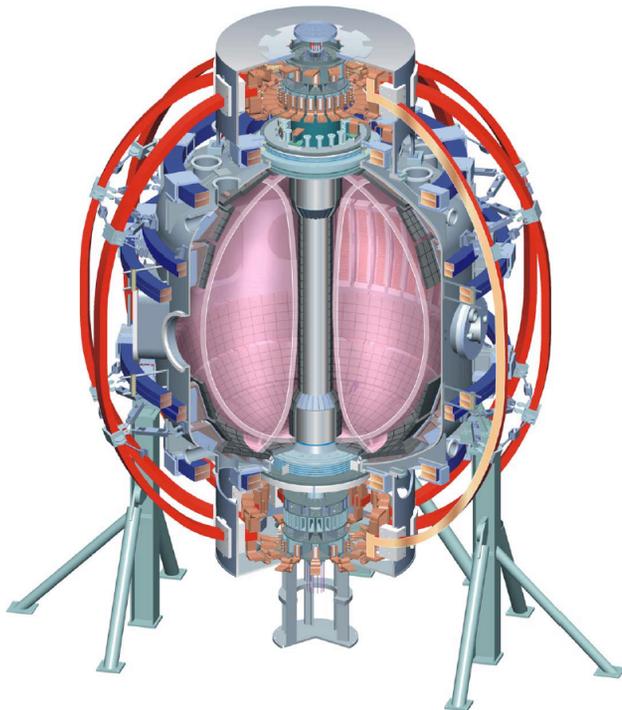
Masayuki Ono

Princeton Plasma Physics Laboratory
For the NSTX Research Team

Budget Planning Meeting – FY 2006
Office of Fusion Energy Sciences
Department of Energy

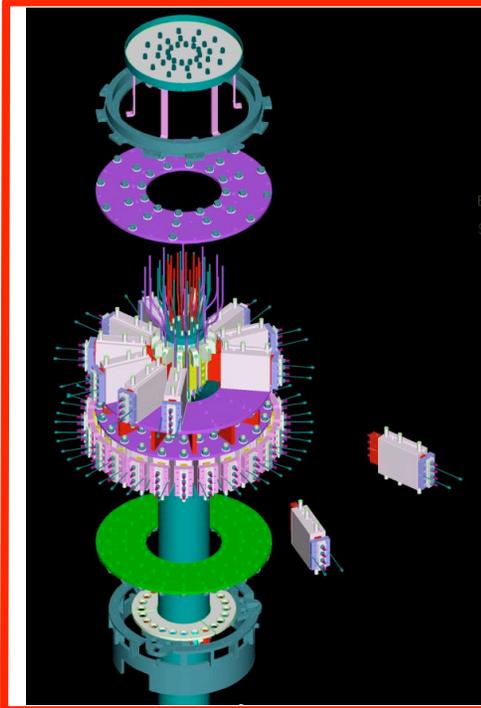
March 16-17, 2004

Gaithersburg, Maryland



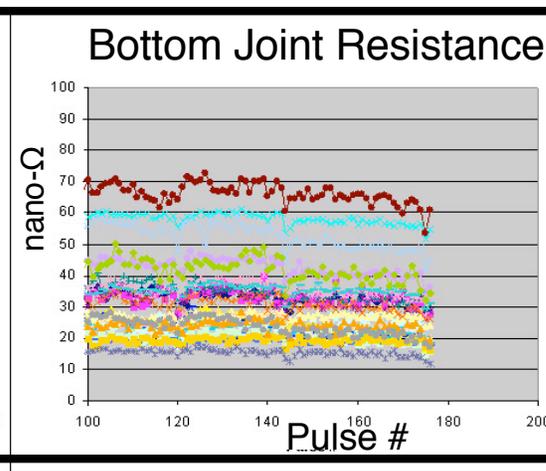
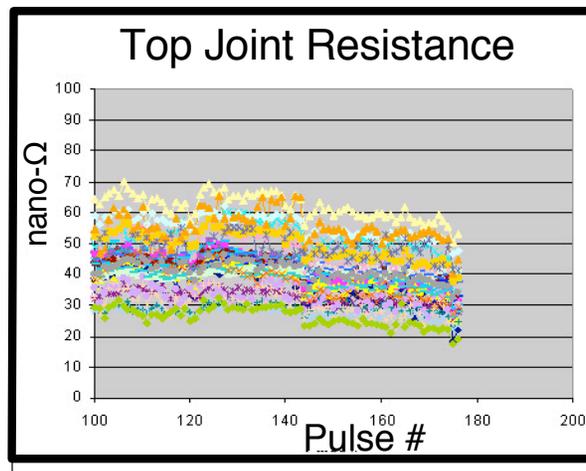
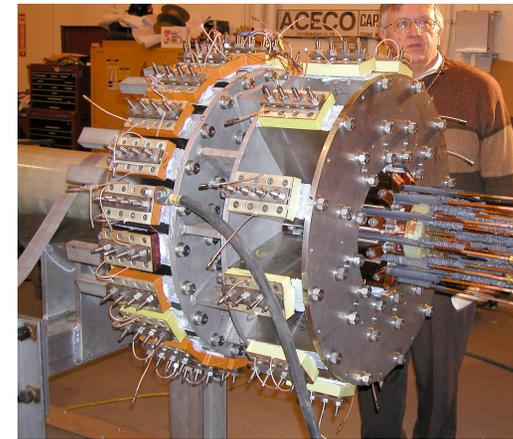
Columbia U
Comp-X
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
NYU
ORNL
PPPL
PSI
SNL
UC Davis
UC Irvine
UCLA
UCSD
U Maryland
U New Mexico
U Rochester
U Washington
U Wisconsin
Culham Sci Ctr
Hiroshima U
HIST
Kyushu Tokai U
Niigata U
Tsukuba U
U Tokyo
JAERI
Ioffe Inst
TRINITI
KBSI
KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
U Quebec

New TF Joints Are Performing Well



- New TF design solves the concerns of previous design with sufficient safety margins
- Performed extensive prototype testing to verify the design

- Increased technical oversight and quality assurance



- Monitoring all the joints all the time
- Joints look good at 4.5 kG

FY 04 Run Is Going Well



- Plasma operations started in the week of Jan 20 about one month ahead of schedule - completed 5 weeks of plasma operations
- High power ~ 7MW NBI operations started on Jan. 27 rapidly established high Q capability ($Q_T \sim 35\%$ and $Q_N \sim 7$)
- rtEFIT used to control the x-points and shape in an H-mode experiment
- Scheduled to complete the 18 run weeks in July

Facility Utilization	PPPL	Non-PPPL
Researchers	54	100*
Post Doc	2	3
Grad. Students	3	8
Undergrad. Students	2	1

* Includes over 30 international collaborators

MHD Mode Stabilization

Opportunity Areas are Shaping and RWM Controls.



Plasma Operations	FY 04	FY 05	FY 06
MHD Diagnostics & Analysis Tools	<ul style="list-style-type: none"> ● Wall-mode sensors (Columbia) ● Ultra-soft x-ray arrays (JHU) ● Fast MHD sensors ● Improved magnetics ● EFIT with Plasma Rotation (Columbia/GA) <ul style="list-style-type: none"> ● Fast X-ray cameras (Frascati, JHU, PSI) 		
Shape Control Higher Elongation	<ul style="list-style-type: none"> ● Real Time EFIT (GA) 	Coil Fabrication / Install	● PF 1A Modification
Res. Field & RWM Control System	<ul style="list-style-type: none"> Coil Fab./Instal SPA Procurement 	<ul style="list-style-type: none"> ● Error Field Reduction / Plasma Rotation Control (Columbia) 	<ul style="list-style-type: none"> ● Six-Element RWM External Coils with a SPA Supply (Columbia)

● - Base
● - Available

Confinement and Transport

Exciting Opportunities For Advanced Fluctuation Diagnostics



Plasma Operations	FY 04	FY 05	FY 06
	● Tor. CHERS (51 ch)	● Edge Pol CHERS	● - Base
Profile	● Edge Rotation Spect.	● ERS Upgrade	● - Available
Diagnostics	● MPTS 20 ch, two laser	● MPTS 30 ch	● MPTS Third laser
	● FIReTIP 4 ch (UCD)	● FIReTIP7 ch (UCD)	
Energetic Particles	● MSE/CIF 3 ch (Nova)	● MSE/CIF 10 ch (Nova)	● MSE / CIF 19 ch (Nova)
	● Fast Loss Ion Probe	● Neutron Collimator	● MSE / LIF (Nova)
Fluctuation Diagnostics	● Low k Reflectometer (UCLA)	● Prototype High k Microwave Scattering(UCD)	● Low k Imaging Reflectometer
	● Gas-puff Imaging(LANL, PSI)		
	● Reciprocating probe (UCSD)		

Non-Inductive CD Systems

Enhancement Opportunity areas are EBW and Solenoid-free Start-up



Plasma
Operations

FY 04	FY 05	FY 06
-------	-------	-------

HHFW
(6MW)

● HHFW Feed Improvement

● Plasma Feed-back Phase Control

● - Available
● - Base
■ - Incremental
◊ - Decision Point

EBW System Construction

EBW -E / -CD

O-X-B EBW Emission Expts
System Design / Costing
DIII-D/MAST Collaboration Expts.



● Prelim Design
● Begin Site Prep



Complete Site Prep
Procure 1st Tube

CHI
($I_T = 0.5$ MA)

● Transient CHI Capacitor Bank (U. Washington)

● Dynamo-head For Helicity-Transport (UCSD)

PF Coil Start-up

● PF 4 Energization



PF 5 Bi-Polar Power Supply

Boundary Physics

Exciting Enhancement Opportunity in Core Fueling and Boundary Physics



Plasma Operations

FY 04	FY 05	FY 06
-------	-------	-------

Wall Conditioning
(Gas/plasma Boronization, Between-shot GDC)

- Li Pellet Injector
- Lithium Evaporator
- Hot-boronization
- Between-shots boronization

- - Available
- - Base
- - Incremental
- ◊ - Decision Point

Power / Particle Control

- Divertor IR Camera (ORNL)
- Divertor Probe
- Vert. Divertor Bolometer
- Fast IR Camera (ORNL)
- Horiz. Divertor Bolometer
- Div. Spectrometer
- ◊ Divertor Cryopanel / Li liquid module

Fueling
(In-board gas injectors)

- Supersonic Gas injector
- Pellet injector in "suitcase" (ORNL)
- CT injector Lab. Test

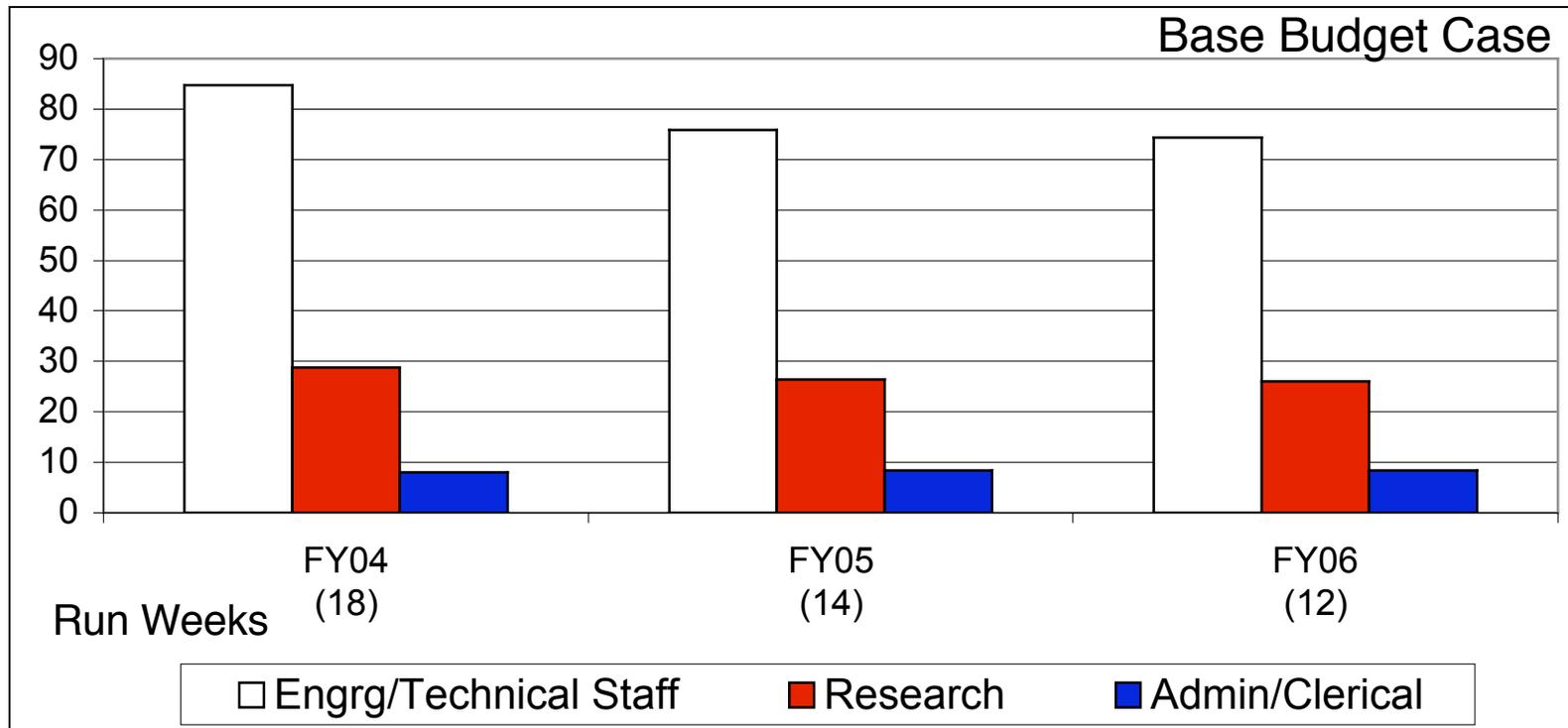
NSTX Budget Summary (\$M)



	FY 04	FY 05			FY06		
Budget Cases	Base	10% Cut	Base	Request	10% Cut	Base	Request
Run Weeks	18	11	14	21	9	12	18
Facility Ops	17.46	15.36	16.75	17.90	15.38	16.84	18.01
Facility Upgrades	1.17	0.42	0.73	1.58	0.43	0.63	2.61
Facility Total	18.63	15.78	17.48	19.48	15.81	17.47	20.62
PPPL Research	9.81	8.90	9.80	10.38	8.97	9.81	10.40
Diag Upgrades	0.78	0.54	0.75	1.13	0.44	0.75	0.99
Coll Diag Interf	0.48	0.46	0.50	0.55	0.47	0.51	0.56
Collaborations	4.77	4.29	4.77	5.24	4.29	4.77	5.24
Science Total	15.84	14.19	15.82	17.30	14.17	15.84	17.19
NSTX Total	34.47	29.97	33.31	36.78	29.97	33.31	37.81

- Facility budget for FY05 reduced by \$1.1M and kept constant in FY06 resulting in fewer run weeks in FY05 (14) and FY06 (12)
- Science & Collaboration budget kept constant
- Additional \$1M / year effective budget reduction due to inflation

NSTX PPPL Personnel Staffing (FTEs)



- 11 FTE reduction in FY 05 as a result of reduced facility budget and flat funding for science (effect of inflation)
- Further 3 FTE reduction in FY06 due to flat funding (effect of inflation)
- Admin/Clerical includes 5 FTE of allocations (Material and Environmental and Health Physics Services)

NSTX Budget Summary (\$M)

Facility Upgrades



Facility Upgrades	FY04		FY 05			FY 06	
	Base	10% Cut	Base	Request	10% Cut	Base	Request
CHI Pwr Supplies	0.29						
RWM	0.88	0.18	0.22	0.22			
EBW System		0.10	0.10	0.10	0.14	0.34	1.72
PF1A Upgrade		0.14	0.31	0.31	0.19	0.19	0.19
Lithium Coatings			0.10	0.10	0.10	0.10	0.10
Pellet Inj				0.20			0.10
Outer PF Start-Up				0.25			
Spare OH Solenoid				0.40			0.40
CT-Injection							0.10
Total	1.17	0.42	0.73	1.58	0.43	0.63	2.61

- EBW CD system the highest priority longer term upgrade
- PF 1A upgrade central to the near term adv. ST research
- Power and particle control capability crucial for sustained adv. ST regimes
- Spare OH solenoid to mitigate risk of highest stress component

NSTX Budget Summary (\$M)

Diagnostic Upgrades



Diagnostic Upgrades	FY04		FY 05		FY 06		
	Base	10% Cut	Base	Request	10% Cut	Base	Request
Tangential Scattering	0.35	0.06	0.06	0.06			
MPTS 20-30 ch	0.09	0.22	0.22	0.22			
Edge Rotation Diag.	0.07	0.08	0.08	0.08			
Edge Poloidal CHERS	0.17	0.18	0.29	0.29			
Neutron Collimator	0.10		0.10	0.10	0.04	0.08	0.08
Imaging Reflectometer					0.28	0.28	0.28
MPTS Addl Laser					0.12	0.14	0.14
Fast IR Camera						0.18	0.18
Deposition Monitor						0.08	0.08
CS & Div. Probe Arrays				0.22			
Vert Div Bolo				0.17			
Div Visible Spect							0.12
Horiz Div Bolo Upgrade							0.12
Total	0.78	0.54	0.75	1.13	0.44	0.75	0.99

- Critical profile diagnostics supported (pedestal, V_p)
- Fluctuation diagnostics (high k and imaging) pursued as high priority
- Struggling to fund high priority boundary physics diagnostics

Requested Incremental Funding will Greatly Enhance NSTX Science Output



- **Increase Facility Utilization:**
 - 21 run weeks in FY 05 and 18 run weeks in FY06
- **Improve Facility/Diagnostic Capabilities:**
 - Start construction of EBW 1MW System (FY 06 - 08)
 - Implement Deuterium Pellet Injector (FY 05 & FY06)
 - Outer PF Start-up System (FY 05)
 - Implement Critical Boundary Physics Diagnostics (FY 05 - 06)
- **Improve Facility Reliability and Availability**
 - Spare OH (FY05 & FY06)
 - Preventative Maintenance and critical spare parts

Consequences of 10% Budget Cut in FY 05



- Further reduction in runtime (from 14 to 11 weeks)
- NSTX staff reduction of ~ 15 FTE relative to FY 05 base
 - Severance costs could result in additional reductions
- Non-labor reduction of ~ 20%
 - Diagnostic components, spare parts, energy, travel, *etc.*
 - Only corrective maintenance and replacement of failed components
- Facility and diagnostic upgrades reduction of ~ 30%
 - PF 1A upgrade scaled back, lithium evaporator deferred
 - Poloidal CHERS, neutron collimator deferred
- Similar impact on all collaborations
- Research slows by 30%

10% cut in FY 06 results in similar impacts relative to FY 06 Base Plan

Facility and Budget Summary

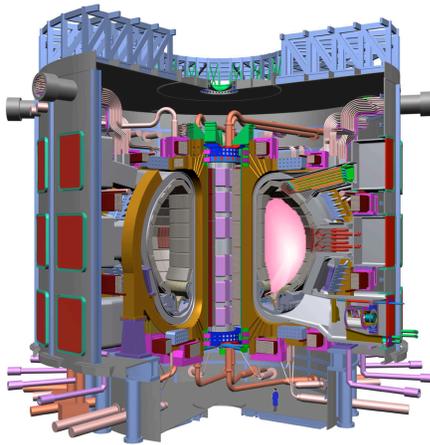


- The NSTX Five Year Plan identified an exciting program requiring additional run time and tools
 - Funding shortfall will delay the program
 - Physics capability rapidly ramping
- FY04 research operation of 18 run weeks started:
 - New TF joint performing well
 - New capability implemented to support the program
 - Far more experimental proposals than available run time
- FY05 and FY06 base budget very tight: \$1.1 M cut + inflationary reduction of ~ \$ 1 M per year
 - Facility not fully utilized; 14 and 12 run weeks in FY05 and 06
 - Only allows modest upgrades of ~ 4.5% of budget
 - Dire consequence of additional 10% cut
 - Requested budget to help restore the research program toward the 5 Year Research Plan

NSTX Team Contributes to Fusion Energy on a Broad Front Through Scientific Investigations



Burning Plasma (ITPA)



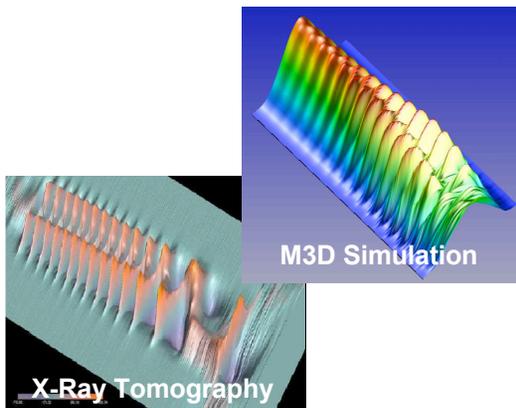
NSTX Team



Configuration Optimization



Fundamental Understanding



Scientific Topics

- Turbulence
- Stability
- Waves & Energetic Particles
- Magnetic Flux Generation
- Boundary Physics
- Integration

Materials, Components, Technologies (NSST & CTF)

