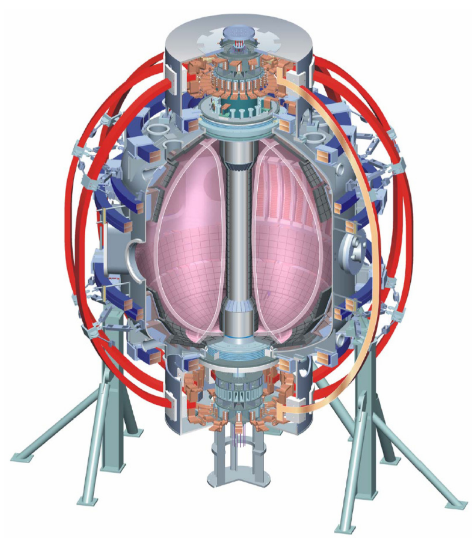
NSTX Presentations

Martin Peng: Strategy and Priorities
Jon Menard: Research Results & Plans
Masa Ono: Facility & Budget Plans

FY 2008 OFES Budget Planning Meeting

Gaithersburg Marriott Washingtonian Center
March 14 – 15, 2006

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



54 Institutions, 214 researchers

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
TRINITI
KBSI
KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep

NSTX Strategy Is to Address Issues Important for ST and for ITER, and Maximize Synergy

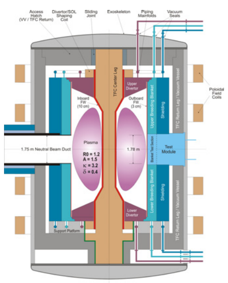
- **Explore physics of Spherical Torus / Spherical Tokamak to provide basis for attractive U.S. Component Test Facility (CTF) and Demo.**
- **Support preparation for burning plasma research in ITER using physics breadth provided by ST; support and benefit from ITPA.**

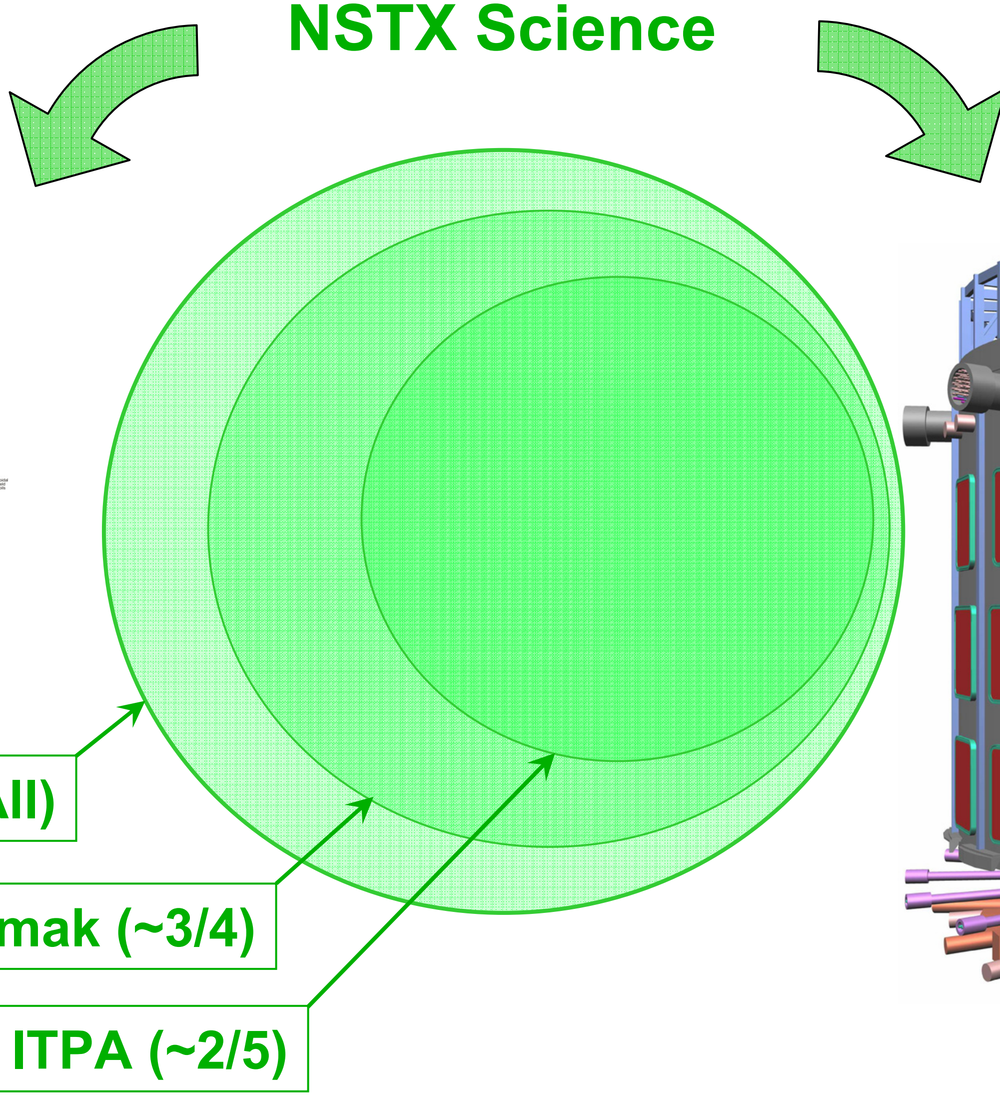
Complement and extend tokamak physics experiments; maximize synergy in investigating key scientific issues of toroidal fusion plasmas

NSTX Science Naturally Supports ST Specific and Burning Plasma Needs with Strong Synergy

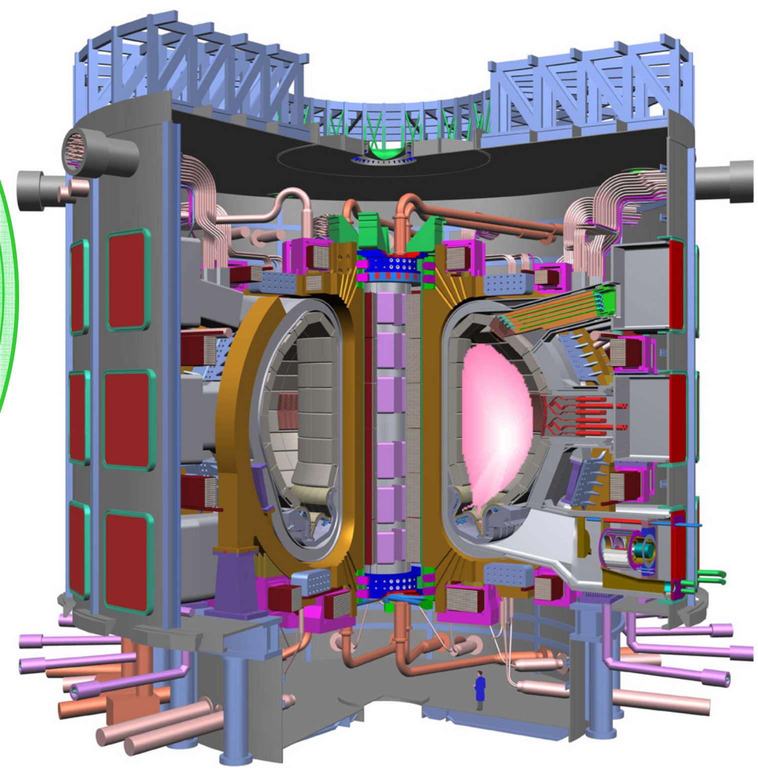
NSTX Science

ST CTF





ITER (ITPA)

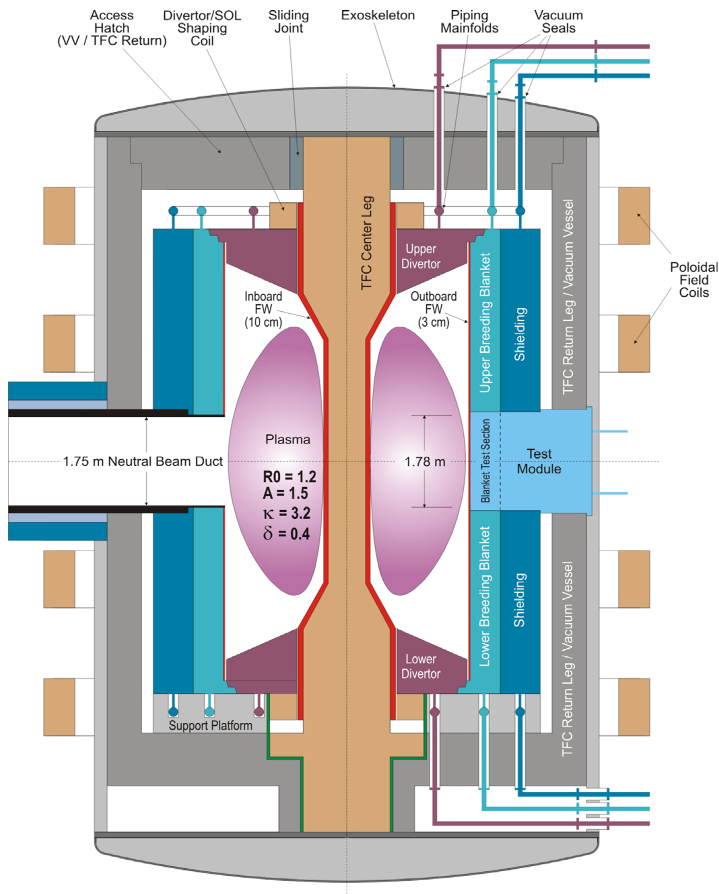


NSTX Research Supports a Strategic CTF Option for the U.S.

R_0 = 1.2 m, a = 0.8 m, κ = 3.2,
I_p ~ 10 MA, $W_L \leq$ 2 MW/m^2,
Full Remote Maintainability

CTF

- Is required to develop the engineering and technology basis for practical fusion energy.
- Is to "complete first round of testing" by 2025 in DOE Strategic Timeline.
- Achieves 6 MW-yr/m^2 (= 20 x ITER) without exhausting world tritium supply.
- Contributes database for ST Demo.

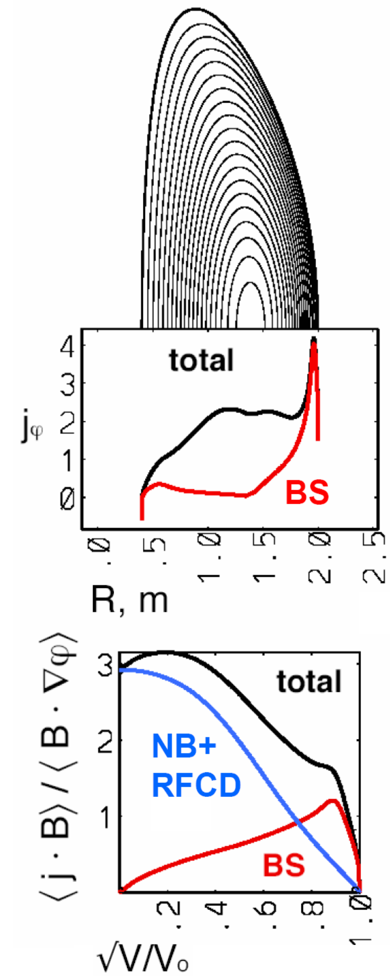


NSTX Research Addresses Critical CTF Science in Stability, Fast Ions, Confinement, Solenoid-Free Operation & Divertor

NSTX

Sustained Parameters	CTF	NSTX
β_T (%)	≤24	≤25
Elongation, κ	~3.2	≤2.7
Avg. a/ρ_i ($=1/\rho_i^*$)	~90	~60
Super-Alfvénic V_{fast}/V_A	3	1 – 4
Internal inductance, ℓ_i	0.5	≥0.6
Avg. collisionality, ν^*	**~0.001**	**~0.08**
n/n_{GW}	**~0.2**	**0.3 – 0.8**
$I_{NB+RFCD}$, I_{BS} fractions	**0.5, 0.5**	**0.1 – 0.2, 0.5**
$\mu_0 \ell_i R I_p$ (Wb)	**≥3.8**	**~0.26**
P/R (MW/m)	**≥30**	**≤9**

Stable CTF Equilibrium
β_N=3.9, β_T=24%, ℓ_i=0.5



ST Research Supports, Supplements, and Benefits from ITER

NSTX

Spherical Torus	Supports	Supplements	Benefits from
Stability	Stabilization with active feedback & variable flow; physics and scaling.	Extends studies to higher beta, flow, S (qI/aB), low aspect ratio. Current startup.	ELMs at low collisionality ν^*
Energetic Particles	$V_f/V_A > 1$ relevant to ITER at normal operating point – with MSE.	Extends alpha physics to higher V_f/V_A. Efficient EBW current drive.	Nonlinear alpha physics, burn control.
Transport	Tests turbulence with dominant electron transport, unique diagnostics.	Extends transport studies to higher beta and flows.	Transport at low collisionality ν^*
Plasma-wall	Tests very high P/R, pedestal physics.	Tests much greater flux expansion, lithium edge.	Long pulse at high P/R.

NSTX Makes Important Contributions to ITPA, Which Also Benefit ST Research – I

ID No	Topical Group	2006 Proposal Title	Devices
CDB-2	Conf DB & Mod	Confinement scaling in ELMy H-modes: β degradation	AUG, DIII-D, JET, JT-60U, Tore-Supra(L), MAST, **NSTX**
CDB-6	Conf DB & Mod	Improving the condition of Global ELMy H-mode and Pedestal databases: Low A	MAST, **NSTX**, DIII-D
CDB-8	Conf DB & Mod	rho* scaling along an ITER relevant path at both high and low beta	JET, DIII-D, C-mod, AUG, **NSTX**
CDB-9	Conf DB & Mod	Density profiles at low collisionality	JET, DIII-D, C-mod, AUG, JT-60U, TCV, Tore-Supra, MAST, FTU, **NSTX**,T-10
TP-6.3	Transport Physics	NBI-driven momentum transport study	DIII-D, JT-60U, **NSTX**, MAST, JET
TP-8.1	Transport Physics	ITB Similarity Experiments	MAST, **NSTX**
TP-9	Transport Phsyics	H-mode aspect ratio comparison	**NSTX**, DIII-D, MAST,T-10
PEP-9	Pedestal and Edge	Pedestal similarity study	DIII-D, MAST, **NSTX**
PEP-10	Pedestal and Edge	The radial efflux at the mid-plane and the structure of ELMs	AUG, MAST, **NSTX**, C-mod
PEP-13	Pedestal and Edge	Comparison of small ELM regimes in JT-60U and AUG and JET	AUG, JT-60U, JET, **NSTX**
PEP-16	Pedestal and Edge	Small ELM regime comparison	**NSTX**, MAST, C-mod
DSOL-15	Divertor & SOL	Inter-machine comparison of blob characteristics	C-Mod, **NSTX**, TJ-II,JET, TCV, HT-7, Tore-Supra, AUG, JT-60U
DSOL-18	Divertor & SOL	Impurity migration and deposition study	**NSTX**, AUG, JET

NSTX Makes Important Contributions to ITPA, Which Also Benefit ST Research – II

NSTX

MDC-2	MHD, Disruptions & Control	Joint experiments on resistive wall mode physics	DIII-D, JET (experiments scheduled Feb 06), **NSTX**, JT-60U, AUG and TEXTOR
MDC-4	MHD, Disruptions & Control	Neoclassical tearing mode physics - aspect ratio comparison	AUG, MAST, **NSTX**, DIII-D
MDC-5	MHD, Disruptions & Control	Comparison of sawtooth control methods for neoclassical tearing mode suppression	AUG , DIII-D, JET, **NSTX**, TCV and HL2A, C-mod, FTU
MDC-6	MHD, Disruptions & Control	Low beta error field experiments	C-mod, TEXTOR, MAST, DIII-D, **NSTX**, JET(done)
MDC-9	MHD, Disruptions & Control	Fast ion redistribution by beam driven Alfvén modes and excitation threshold for Alfvén cascades	JT-60U, JET, DIII-D, **NSTX**, MAST, AUG
SSO-2.1	Steady-State Operation	Complete mapping of hybrid scenario	JET, JT-60U, DIII-D, AUG, **NSTX**
SSO-2.2	Steady-State Operation	MHD effects on q-profile and confinement for hybrid scenarios	AUG, JET, DIII-D, JT-60U, **D42**
SSO-2.3	Steady-State Operation	ρ* dependence on confinement, transport and stability in hybrid scenarios	DIII-D, JET, AUG, JT-60U, **NSTX**
DIAG-1	Diagnostics	Assessment of the effect of noise on vertical velocity measurement	JET, JT-60U, TCV, **NSTX**, AUG
DIAG-2	Diagnostics	Environmental tests on Diagnostic First Mirrors (FMs)	T-10, TEXTOR, Tore-Supra, JET, DIII-D, TCV, AUG, LHD, FTU, **NSTX**, C-mod, JT-60U

ST Science and ITPA Needs Guide NSTX Research

NSTX

	FY06	FY07	FY08
Exp. Run-Weeks:	11	12	10

1) Transport & Turbulence: Physical processes that govern heat, particle and momentum confinement

FY06	FY07	FY08
Measure local high-k turbulence magnitude	Study variation of local high-k turbulence with plasma conditions	Measure poloidal rotation at low A to constrain theory

2) Macroscopic Stability: Role of magnetic structure on plasma pressure and bootstrap current

FY06	FY07	FY08
Characterize effectiveness of closed-loop EF control using ITER-like control coils	Characterize effectiveness of closed-loop RWM control & dependence on rotation using ITER-like control coils	

3) Wave-Particle Interaction: Role of electromagnetic waves & modes in sustaining and controlling hot plasmas

FY06	FY07	FY08
	Measure, identify & characterize modes driven by super-Alfvénic ions	

4) Start-up, Ramp-up, Sustainment & Physics Integration

FY06	FY07	FY08
Assess requirement for CHI creation of closed magnetic flux		Perform long-pulse plasmas in conditions relevant to CTF

5) Boundary Physics: Interface between fusion plasmas and normal temperature surroundings

FY06	FY07	FY08
Characterize effects of Li wall coating on recycling		Study edge/divertor at low ν^* with ITER-level heat fluxes

Decisions: Core fueling & adv exhaust EBW & pre-ionization source (end of FY06)

Decision: Major next-step fluctuation diagnostics (end of FY07)

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