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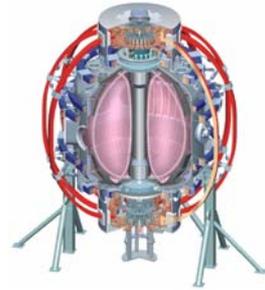


Office of
Science



NSTX

Overview of the NSTX 2006 Run



Roger Raman
For the NSTX Team

**NSTX Program Advisory Committee
(PAC 21)
PPPL
January 17-19, 2007**

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Columbia U
Comp-X
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INEL
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Lodestar
MIT
Nova Photonics
New York U
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U Colorado
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U Washington
U Wisconsin*

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KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec*

NSTX Completed 63.3 Days of Experimental Operation



- 58 days of plasma operation
- 5 days for enabling activities
 - MSE diagnostic calibration
 - Initial machine startup
 - Lithium evaporator commissioning
- Performed 30 Experimental Proposals & 5 Machine Proposals
 - Milestone related research (57%)
 - ITPA Tasks (34%)
 - ST development (100%)

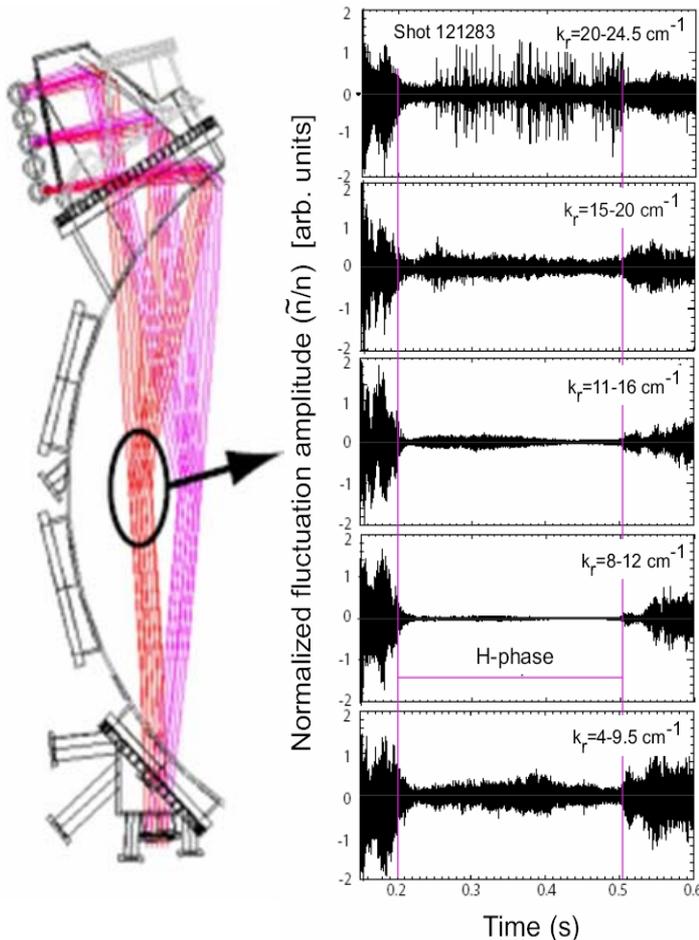
Run Breakdown by Experimental Task Groups



Boundary Physics	17 days
Transport and Turbulence	11.5 days
MHD Physics	9 days
Wave Particle Physics	7.1 days
Integrated Scenario Development	8 days
Solenoid-free plasma startup	5.4 days
Enabling activities	5.3 days
Total	63.3 days

Milestone R(06-1)

Microwave Scattering Diagnostic Measured Turbulent Fluctuations on Scale of Electron Gyro-Radius

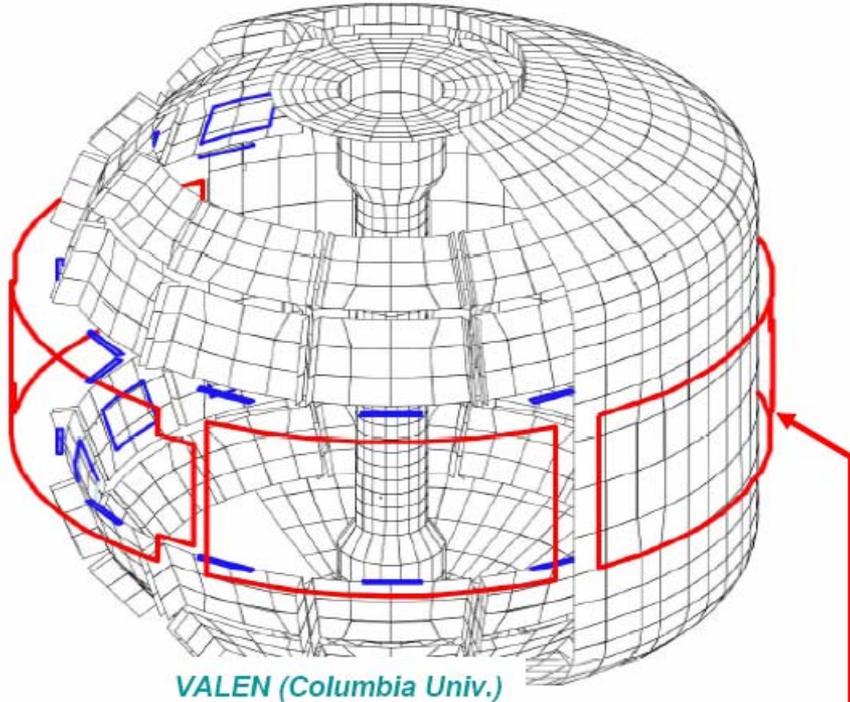


- High radial spatial resolution: $< 6\text{cm}$
- High k_r resolution: $< 1\text{cm}^{-1}$
- Ability to scan in radius from near the outer edge to the magnetic axis

$\delta n/n$ fluctuation levels in L-mode and H-mode phases of a discharge with $P_{\text{NBI}} = 2 \text{ MW}$, $I_p = 0.8 \text{ MA}$, $B_T = 0.45 \text{ T}$

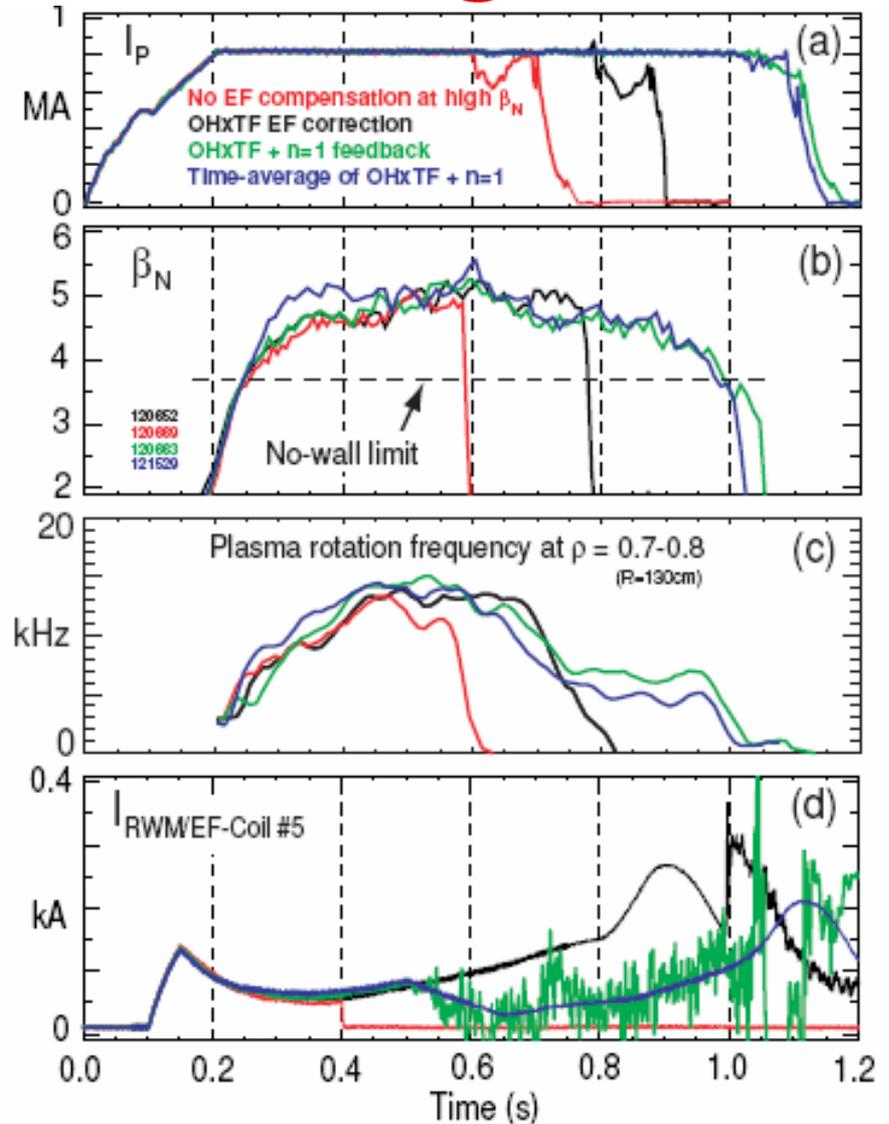
Milestone R(06-2) & ITPA-MDC6

Feedback Control of Intrinsic Error Fields Extended Pulse



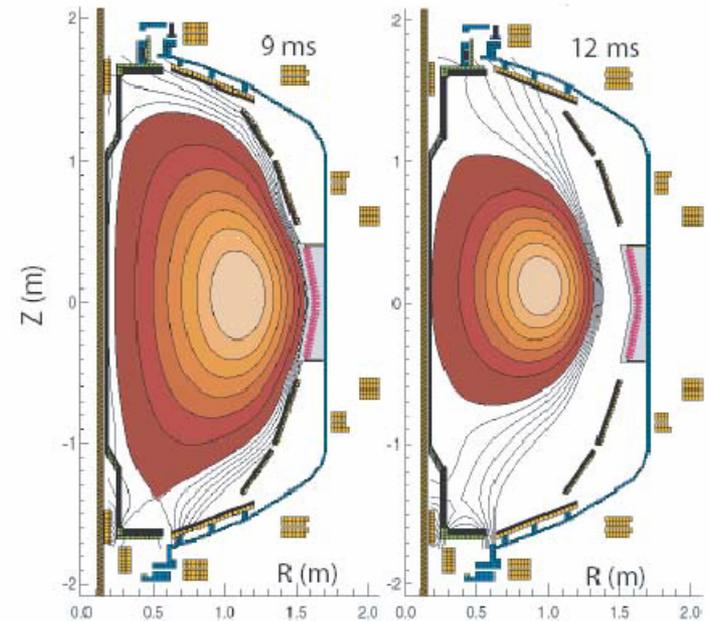
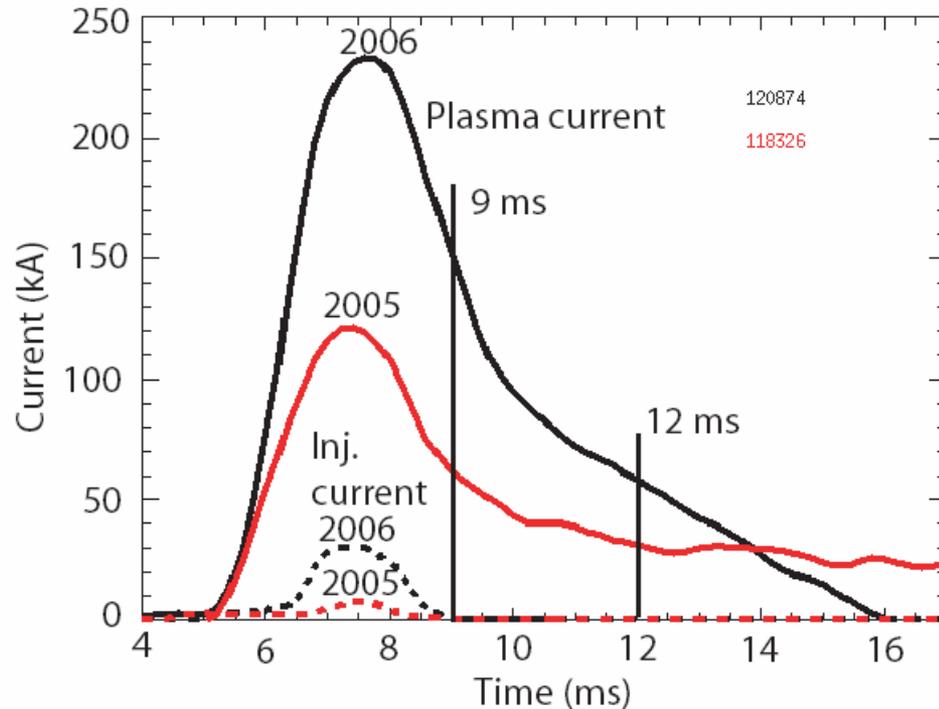
6 ex-vessel mode control coils
+ 48 in-vessel sensors

Plasma/conductor/coil geometry
similar to US proposal for ITER



Milestone R(06-3) & ST Development

Coaxial Helicity Injection (CHI) Produced Closed Magnetic Flux Surfaces at High Plasma Current

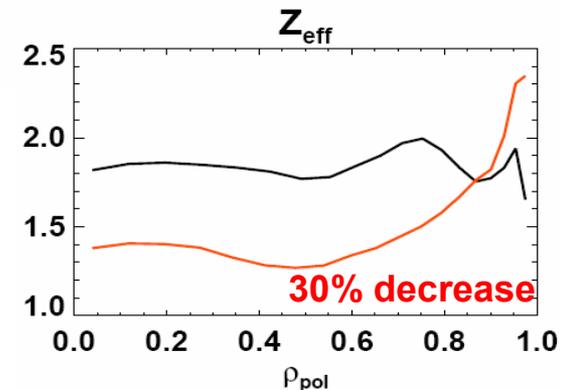
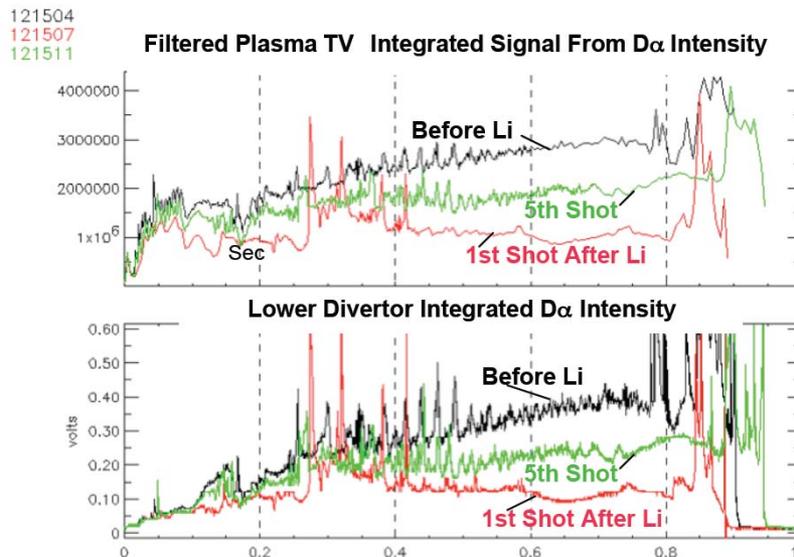
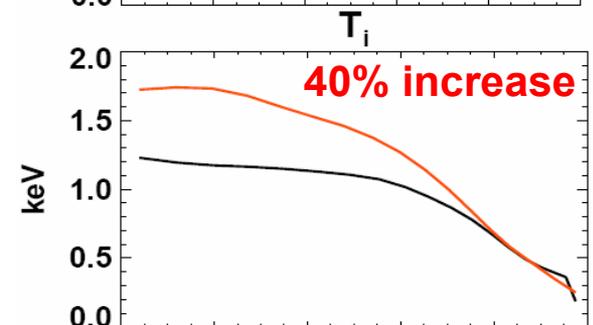
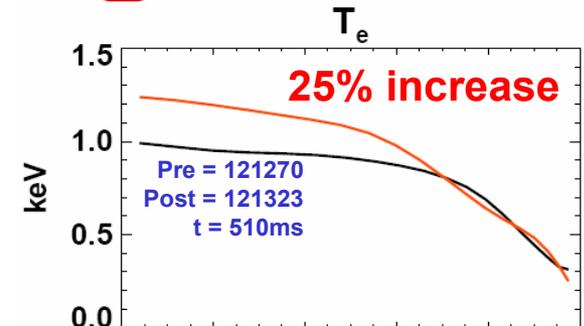
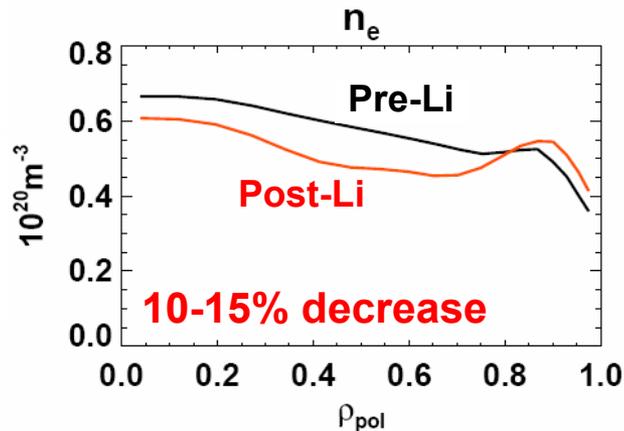
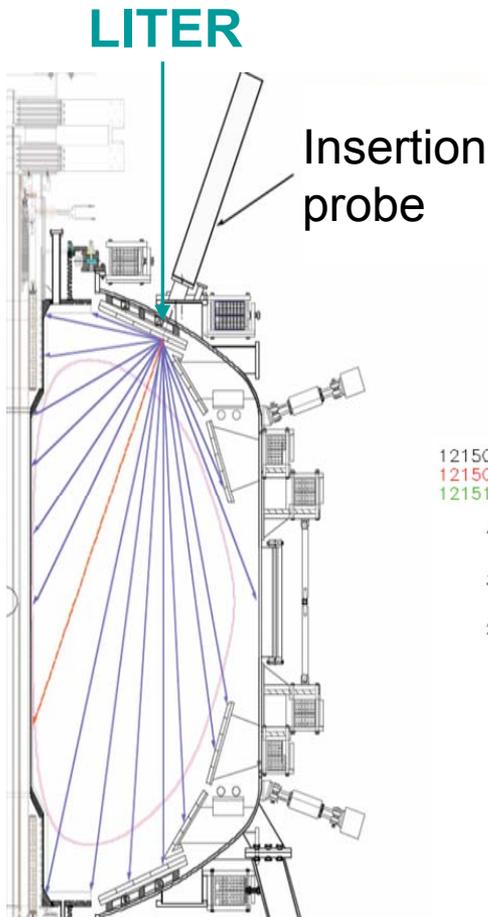


LRDFIT (J. Menard)

- 2006 discharges operated at higher toroidal field and injector flux
- Equilibrium analysis performed when no injector current is present
- Magnetic sensors and flux loops used in reconstruction

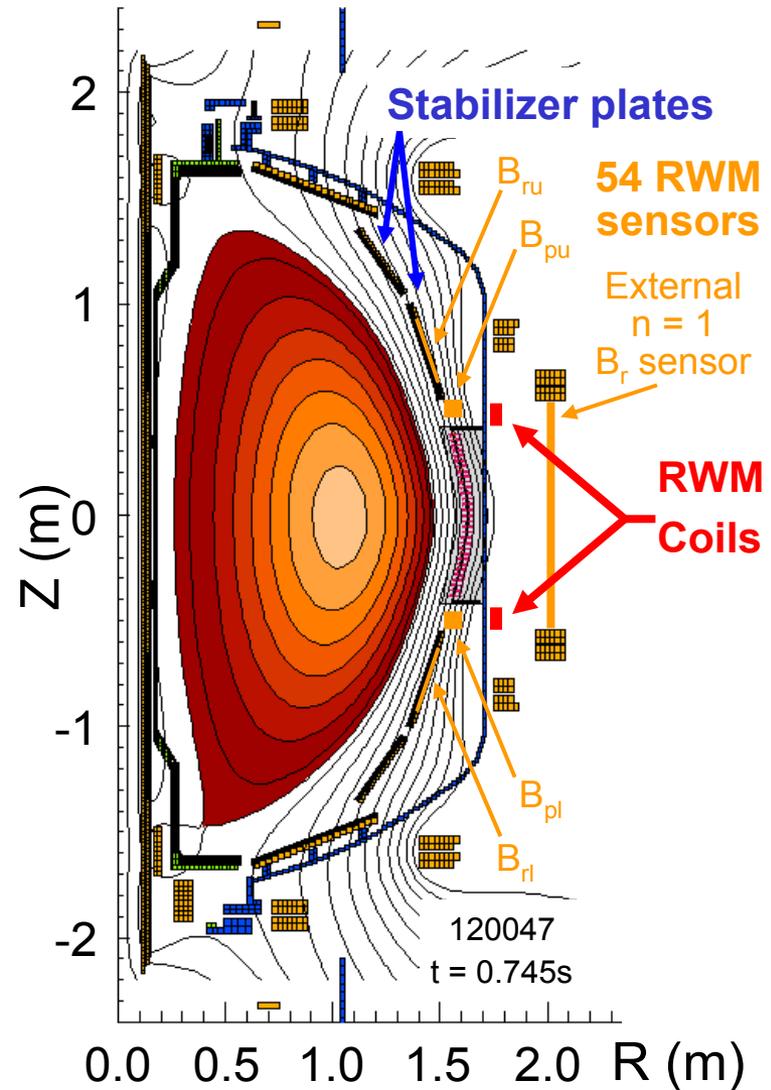
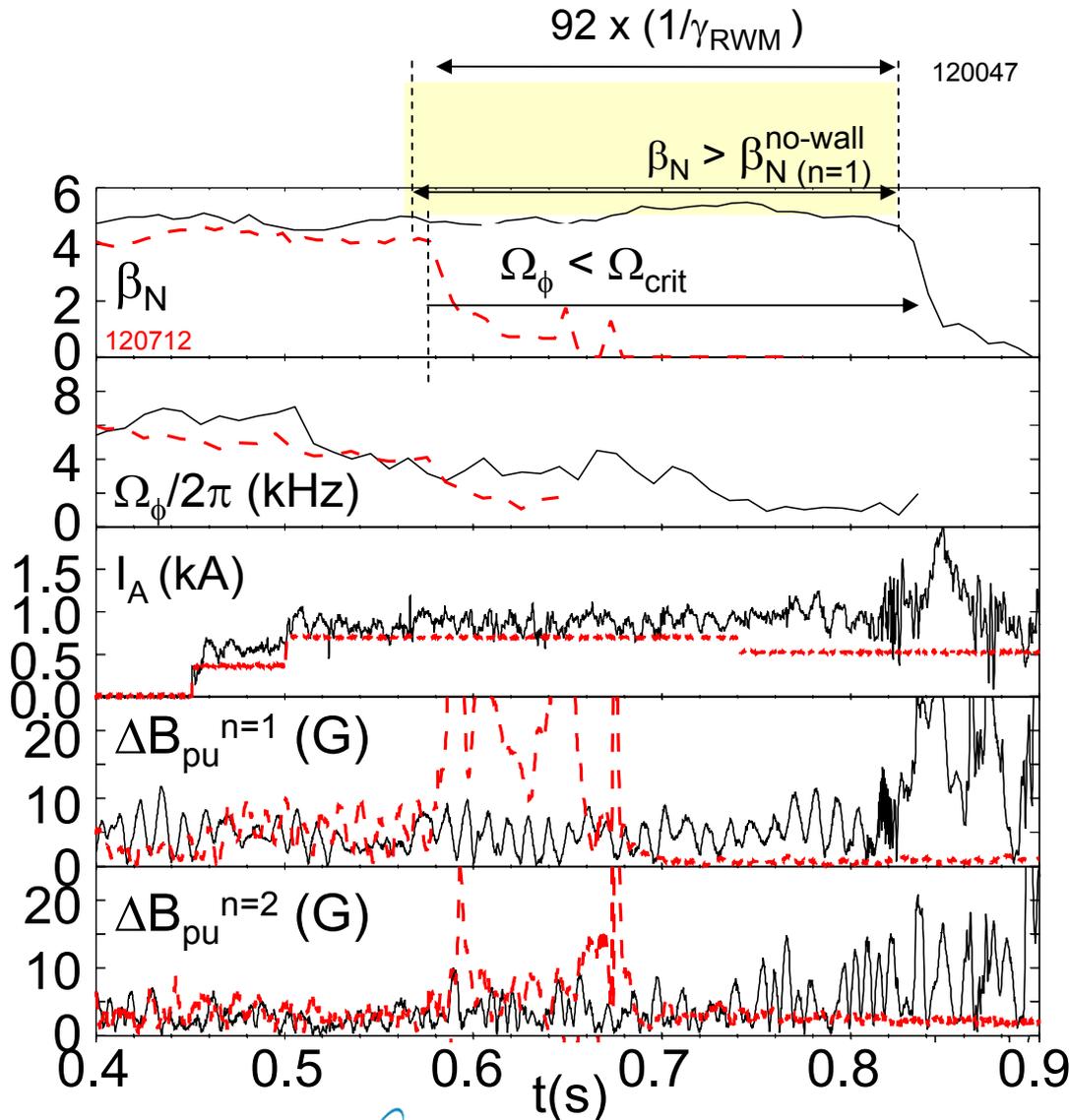
Milestone R(06-4)

Lithium Evaporator (LITER) Produced Particle Pumping and Improved Energy Confinement in H-mode



ITPA- MDC2 & Milestone for 2007

RWM Stabilized at ITER-Relevant Low Rotation for $\sim 90/\gamma_{\text{RWM}}$



ITPA- PEP9

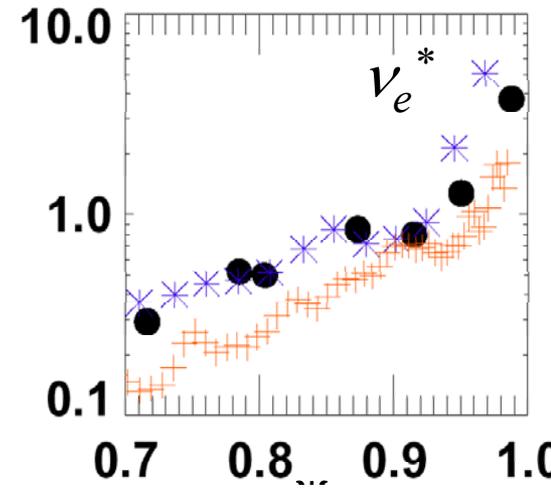
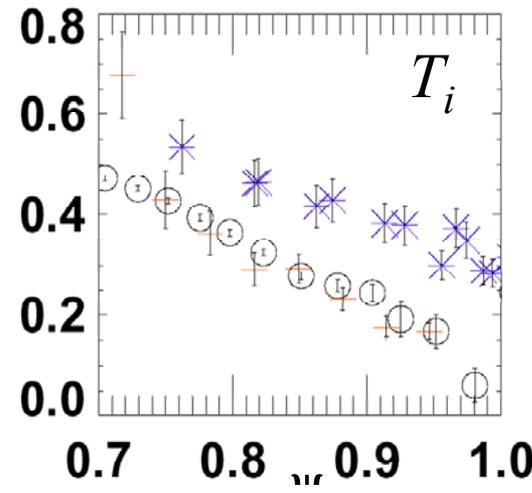
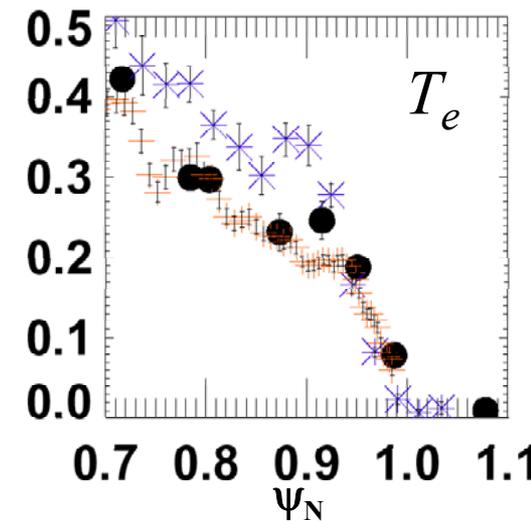
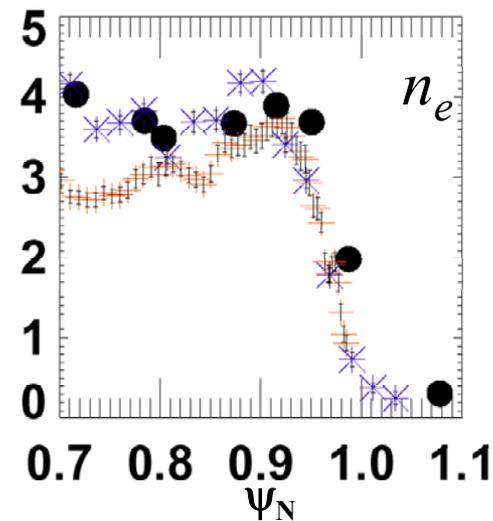
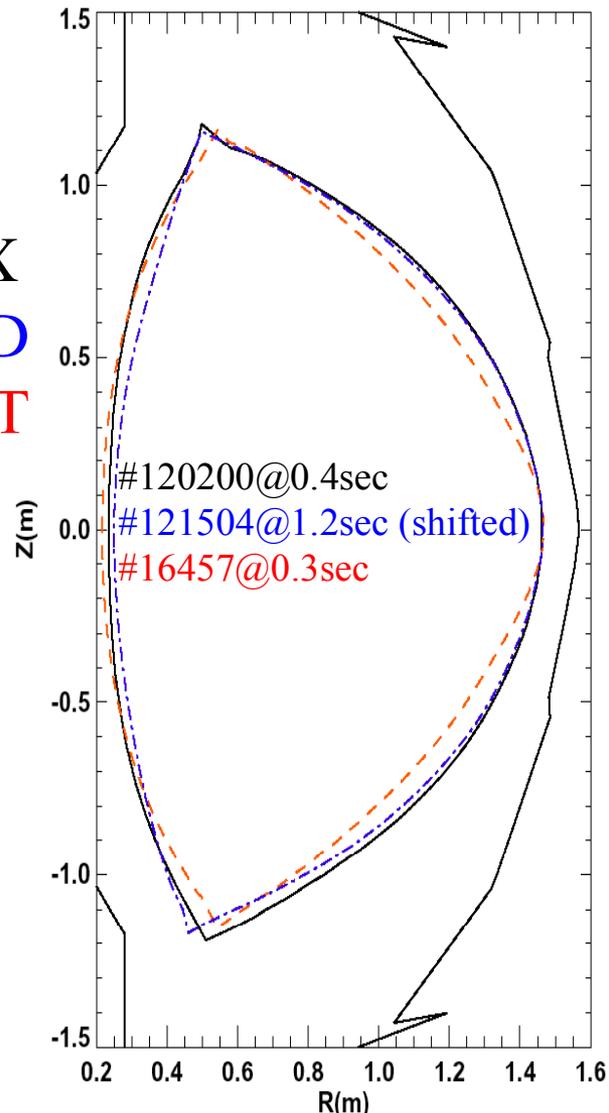
Determine if Pedestal Width and Pressure Gradient Depends on A



NSTX

DIII-D

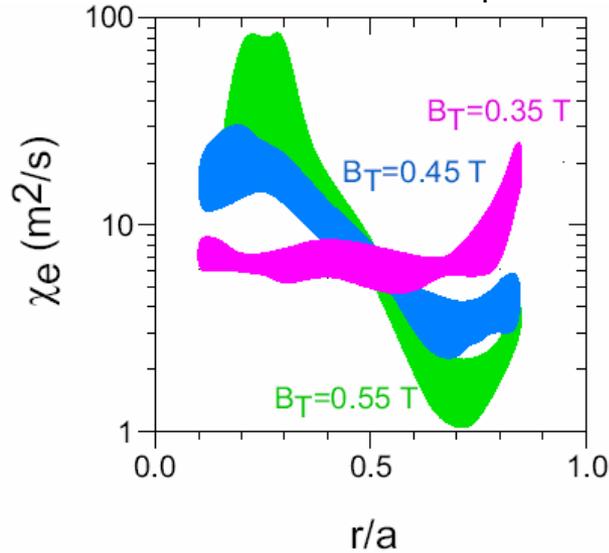
MAST



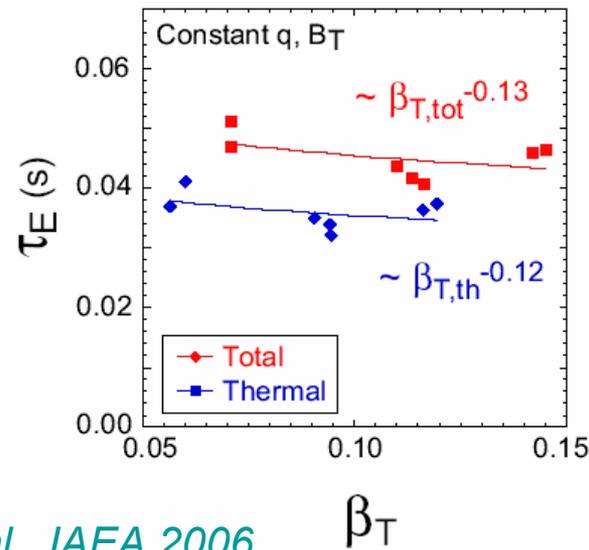
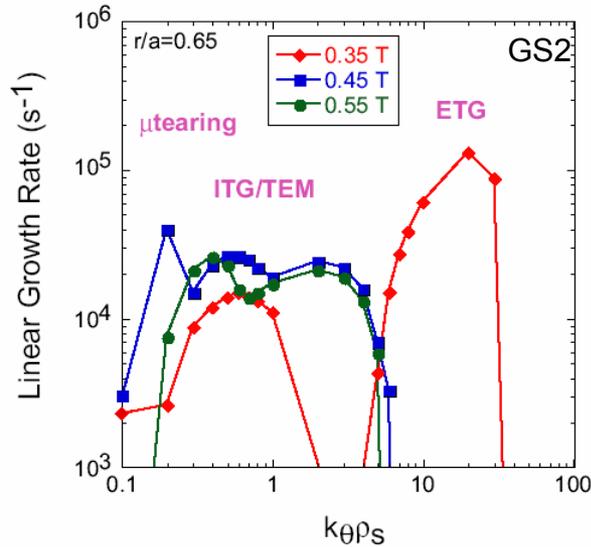
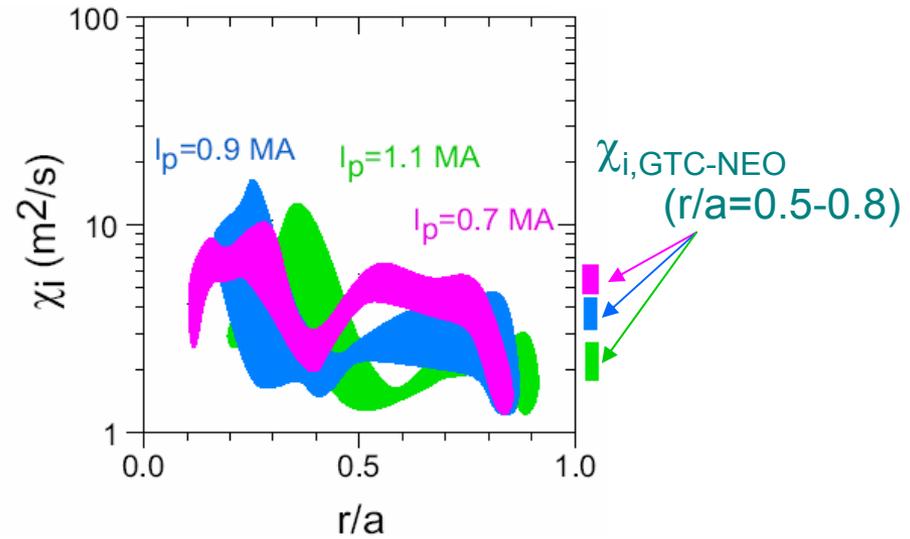
ITPA- CDB2 (on β scaling)



$\tau_E \sim B_T^{0.9}$ scaling governed by e-transport
 - ETG unstable at low B_T



$\tau_E \sim I_p^{0.4}$ scaling governed by neoclassical ion transport



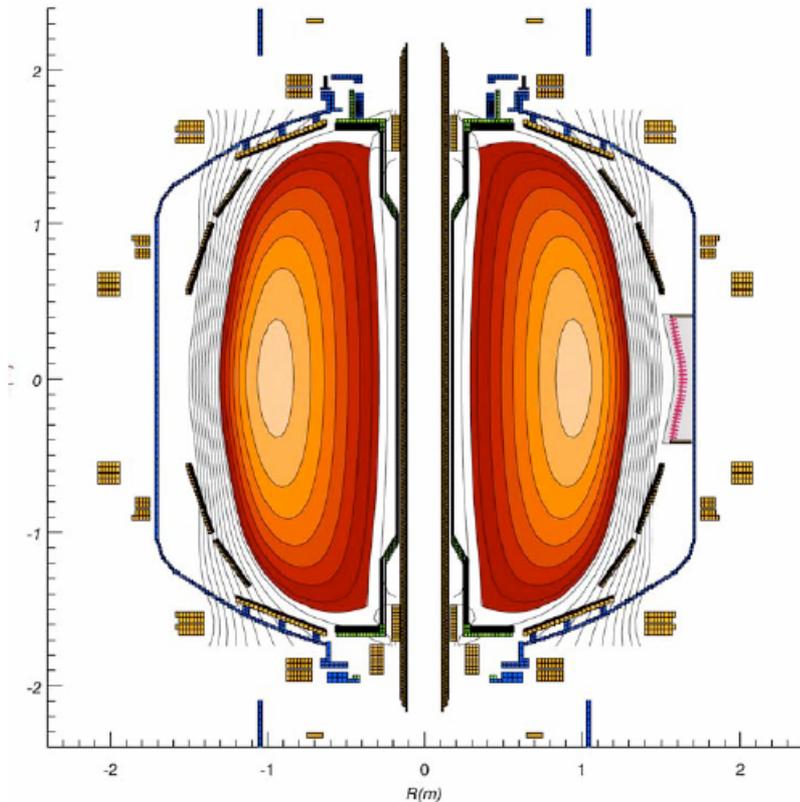
ST Development

Tested Extreme Plasma Shaping Capability of NSTX



World record elongation: $\kappa = 3$

LRDFIT09, Shot= 121241, time= 275ms



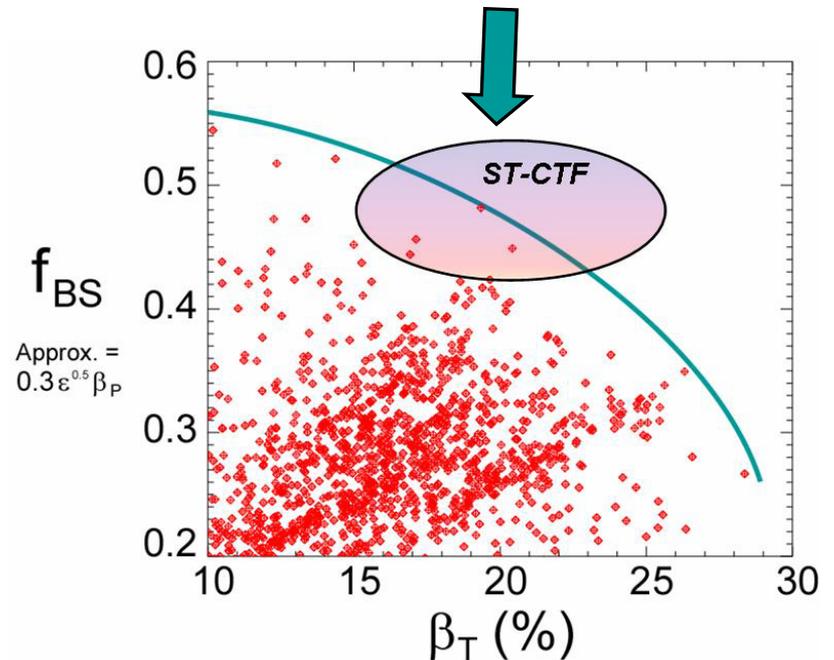
NSTX normalized performance approaching needs for ST-CTF

ST-CTF goal

$A=1.5, \kappa = 3, R_0 = 1.2m,$

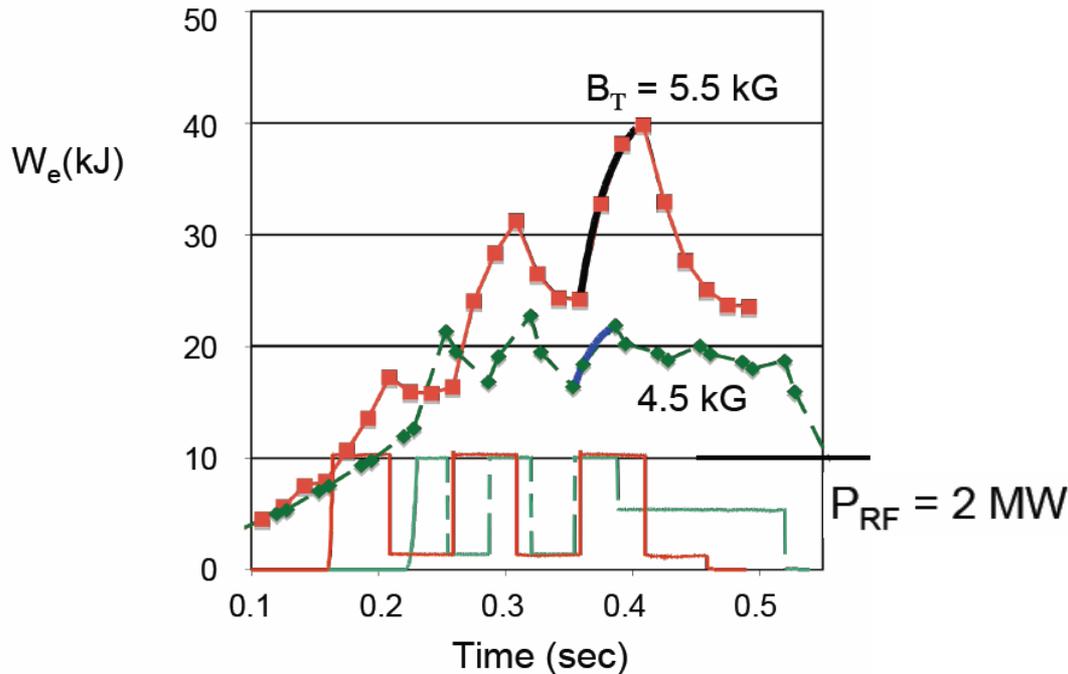
$I_P = 8-12MA, \beta_N \sim 3-5, HH=1.3,$

$\beta_T = 15-25\%, f_{BS}=45-50\%$

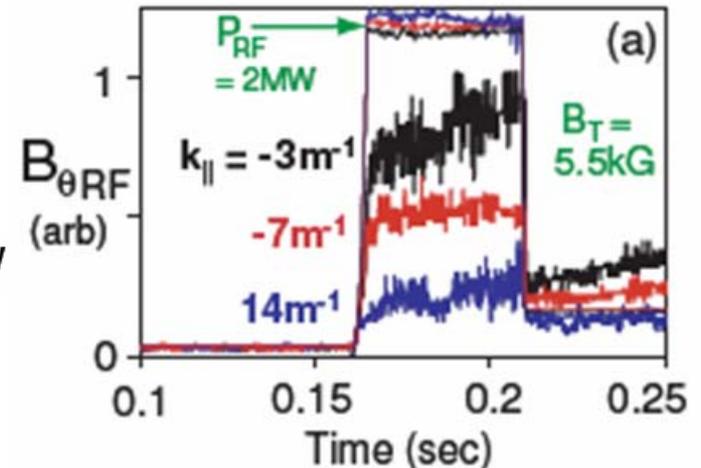


ST Development & ITER

HHFW Heating Efficiency Increased with Higher B_T and $k_{||}$



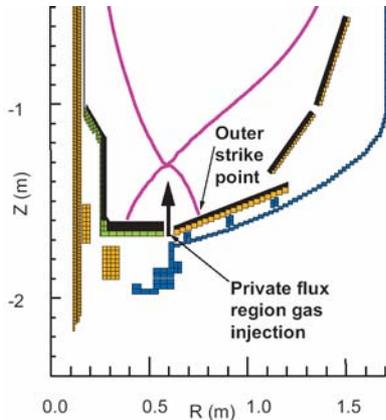
Variation with launched $k_{||}$ of RF field near plasma surface
– measured by probe toroidally opposite antenna



- Achieved high $T_e = 3.6$ keV using high $B_T = 5.5$ kG
 - Improvement consistent with reduced excitation of surface waves expected at higher B_T
 - Improves prospects for HHFW-CD during ramp-up
 - Edge RF effect important for ITER

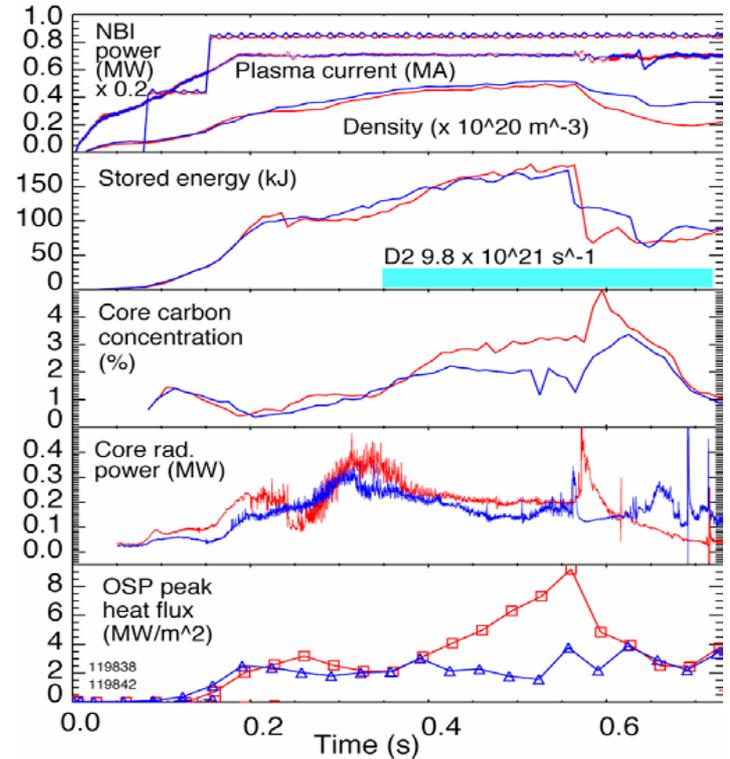
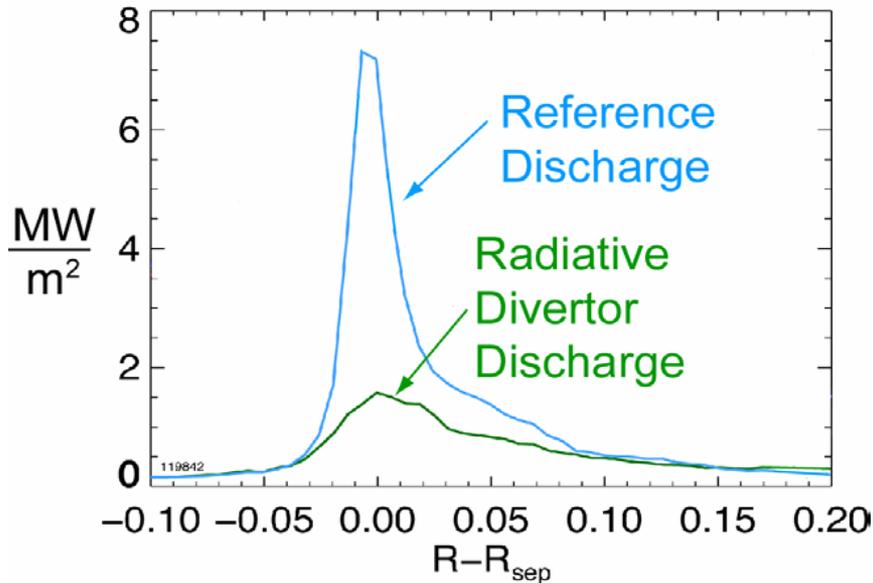
ST Development

Reduced Divertor Heat Load without Confinement Reduction



Obtained by continuous D₂ injection through divertor gap into private flux region

Heat Flux



- Outer strike point heat flux reduced to ~20%
- No change in H-mode τ_E

FY06 Research Met All Program Milestones, Contributed to Several ITPA Topics and Produced “World Leading” Results



- World record for toroidal plasma shaping
- World record for non-inductively-generated closed-flux startup current
- First demonstration of RWM stabilization in ST configuration
- First demonstration of benefits of lithium wall conditioning in H-mode
- First measurements of electron gyro-scale turbulence in a large ST
- 6 PRLs published during FY 2006
 - 61 journal publications, >9 under review
 - 5 invited talks at APS, 28 IAEA presentations (2004 & 2006)

NSTX continues to contribute to fundamental toroidal confinement science in support of ITER and future ST's