

NSTX Team Meeting – Program Report

Martin Peng, August, 9, 2006



- Results Review and Run Assessment (7/27-29/06)
- DOE Q3 Review (8/2/06) – attached, thanks for extensive inputs.
- Facilities Mid-Term Review relative to the 5-Year Plans – 2-hour presentations + 1-hour discussion (9/20-21/06)
- DOE notice on research collaboration proposals from national labs (letter of Intent: 9/8/06; full proposal: 10/6/06)
- Upcoming meetings & events
 - International ST Workshop, Chengdu (10/11-13/06)
 - IAEA FEC 2006, Chengdu (10/16-21/06)
 - ITPA Topical Group meetings (10/23-26/06)
 - DPP APS, Philadelphia (10/30-11/3/06)
 - JPFS Annual Meeting, Tsukuba (11/27-30/06)
 - IEA-ITPA review & planning Workshop, Naka (11/30-12/1/06)
 - NSTX Research Forum (week of 12/4-8/06)
 - NSTX PAC-21st Meeting (1/17-19/06)

Supported by



Office of
Science



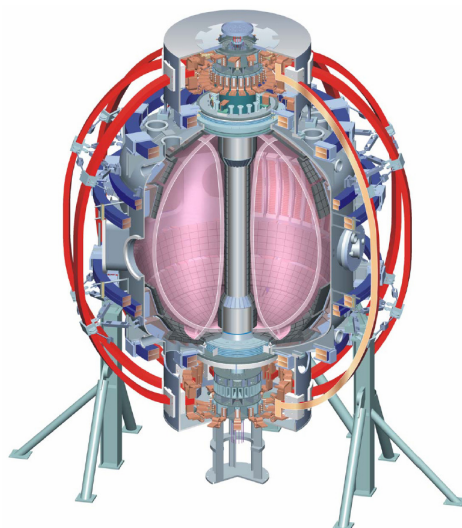
NSTX

NSTX Program FY06 Q3 Report

- Research Milestones & ITPA
- Upcoming meetings
- PAC, Collab. Proposals, Mid-Term Review

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

Martin Peng
On Behalf of the NSTX Team
NSTX FY06 Q3 Review
August 2, 2006



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

R(06-1): Perform highly localized measurements of high-k turbulence – core fluctuations



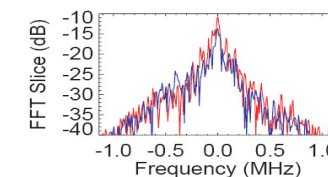
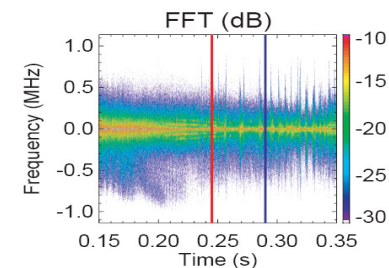
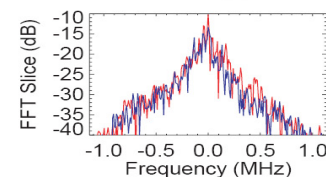
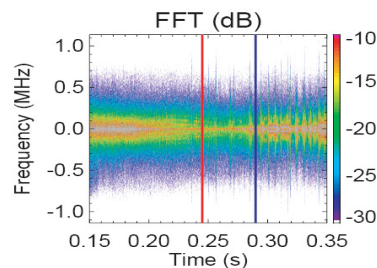
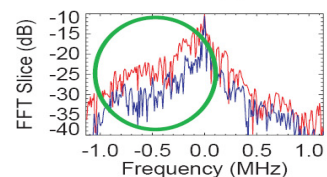
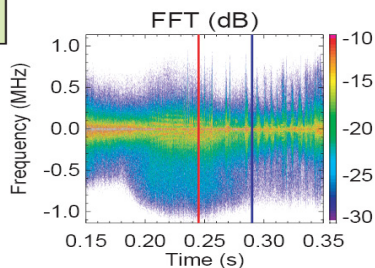
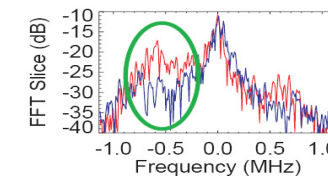
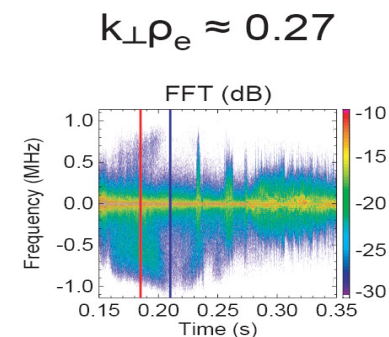
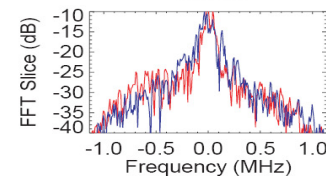
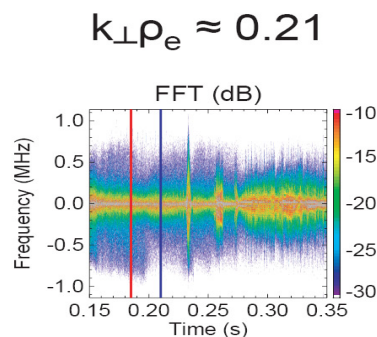
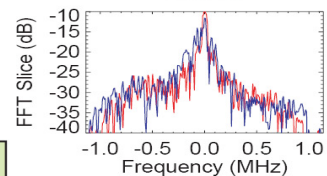
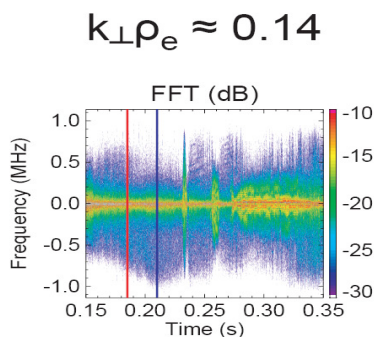
- Measured core high-k fluctuations at several k's for RS L-mode plasmas.
- Observed strong spectral asymmetry as Te rise rate decreased.

Mazzucato,
Park,
Smith, et al.

121389
"Mild" RS

red before,
blue after
Te roll over

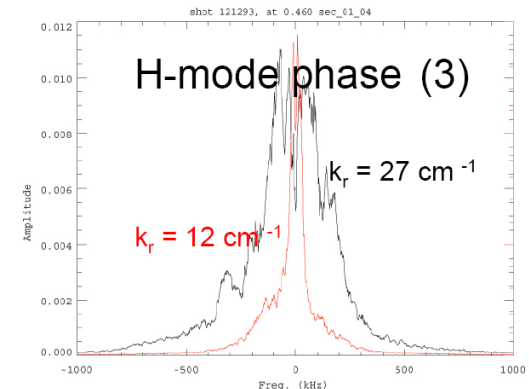
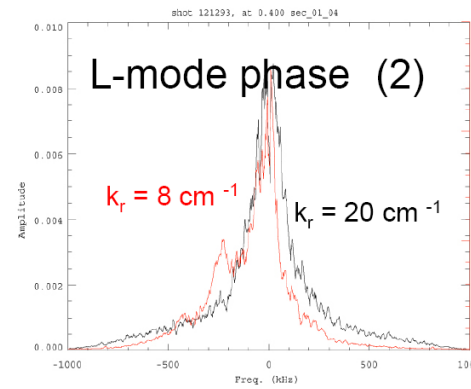
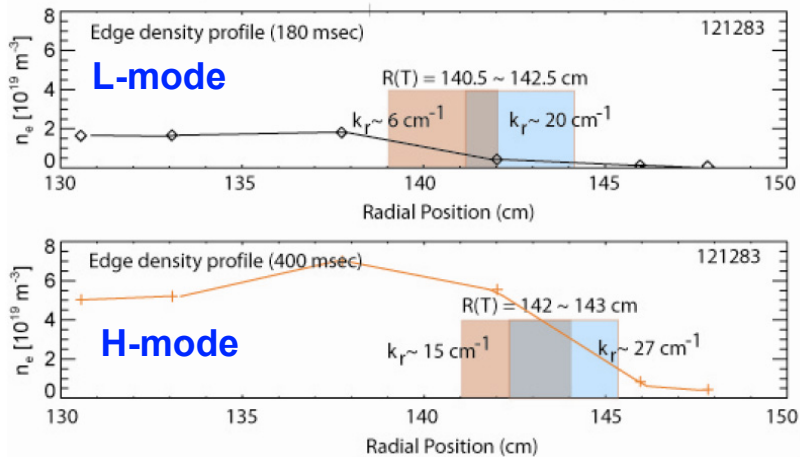
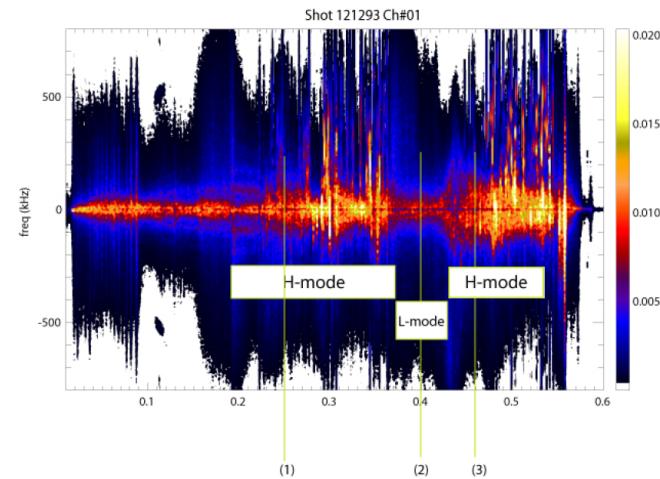
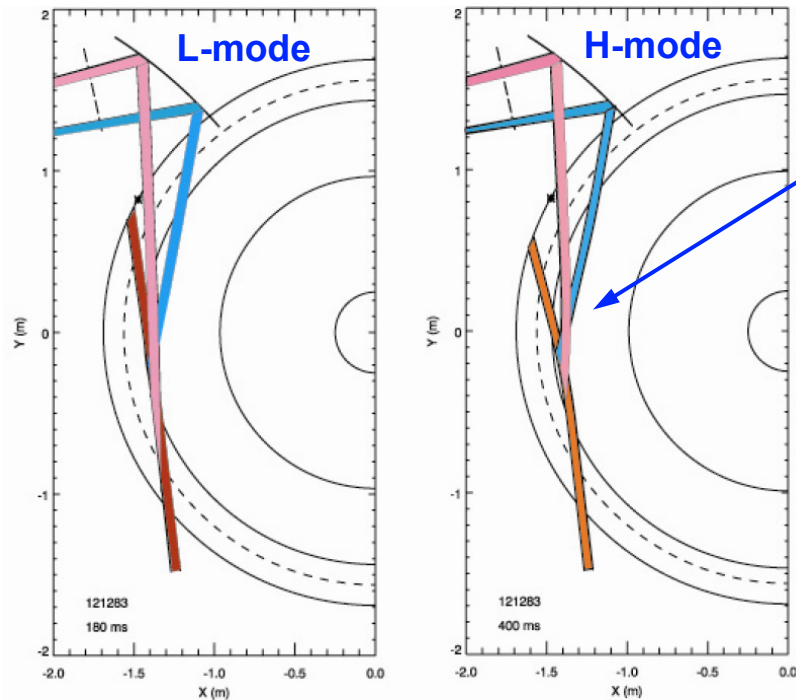
121386
"Strong" RS



Measured outboard ($\rho \sim 0.75-0.95$) fluctuations in L/H-mode plasmas; assessing effects of refraction



- Scattered signals shift to higher k
- Asymmetric spectrum remains in H-mode



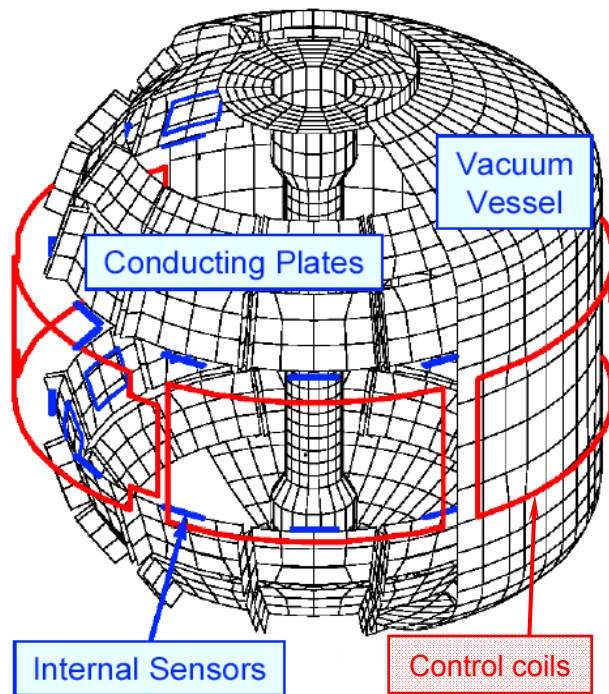
R(06-2): Characterize effectiveness of closed-loop Error Field Control with ITER-like EF/RWM Coils (also MDC-6)



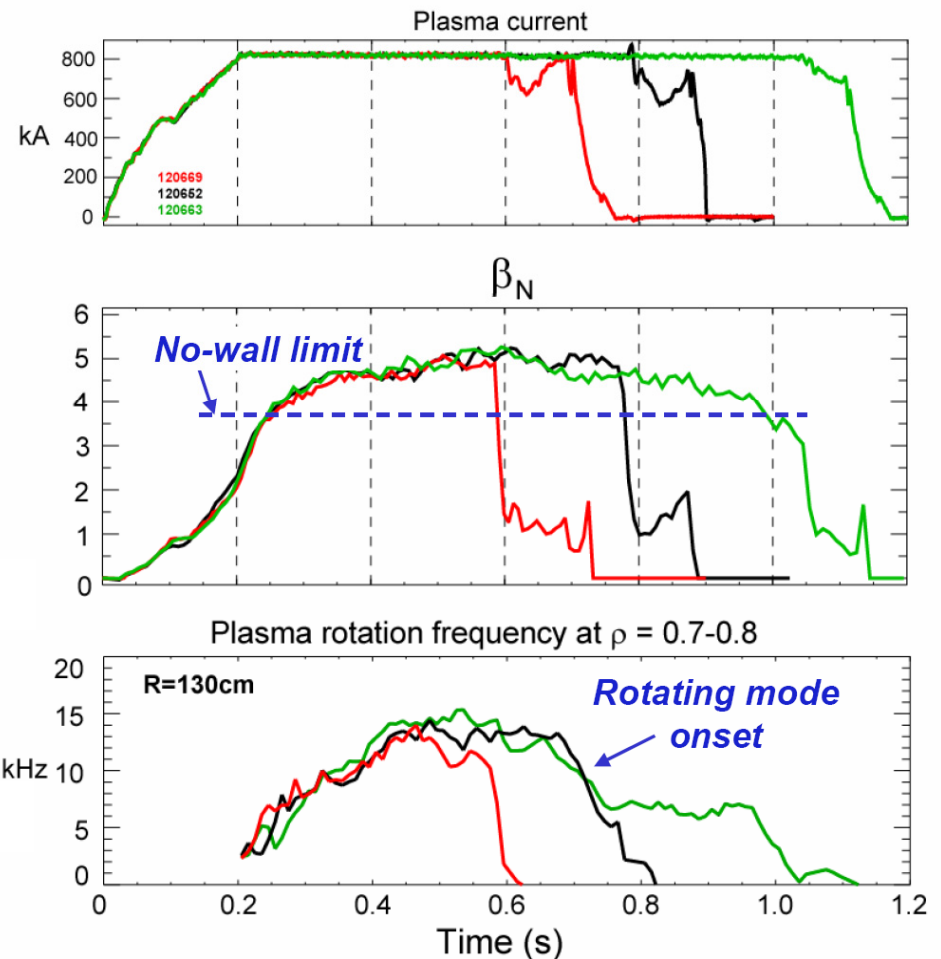
Demonstrated effectiveness of closed-loop EFC, despite large mismatch in field patterns.

- No error field control during high β_N phase
- Predictive correction of known error fields
- Predictive correction + active feedback

Menard et al.



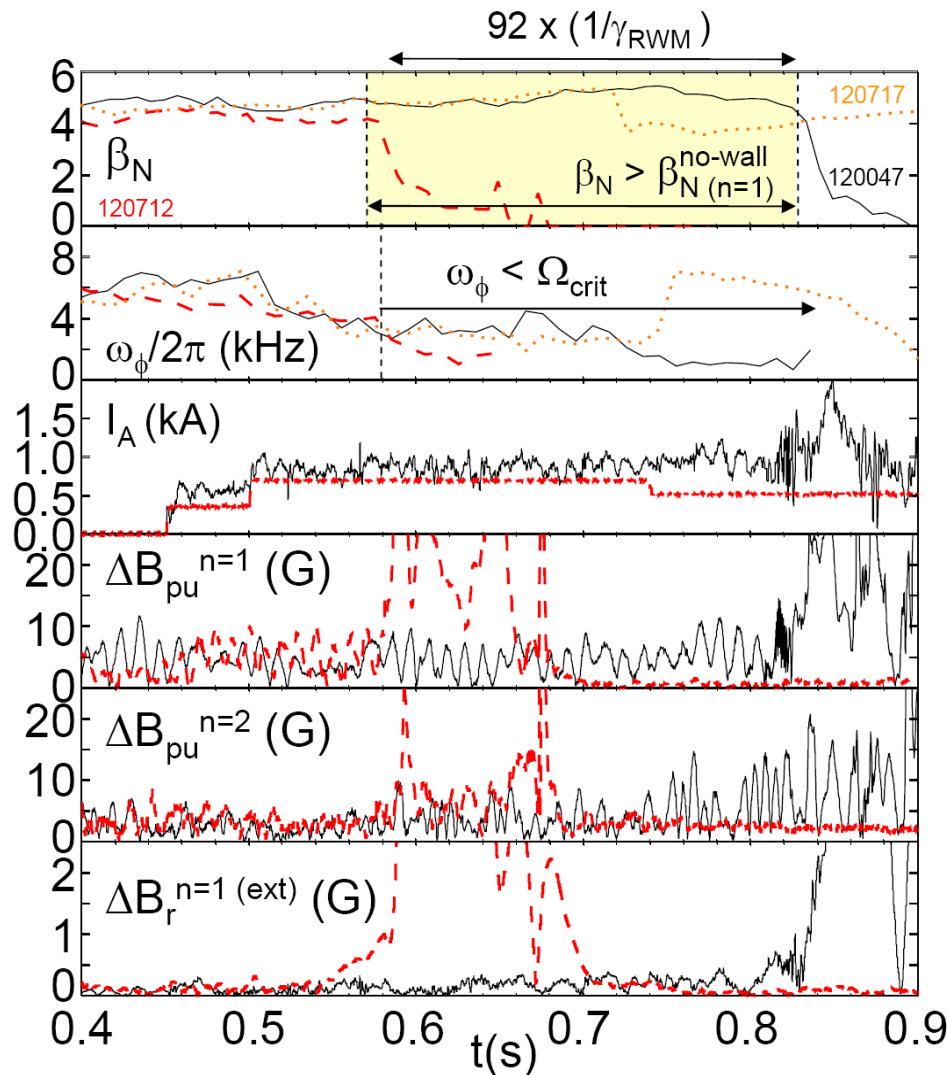
NSTX EF/RWM Configuration



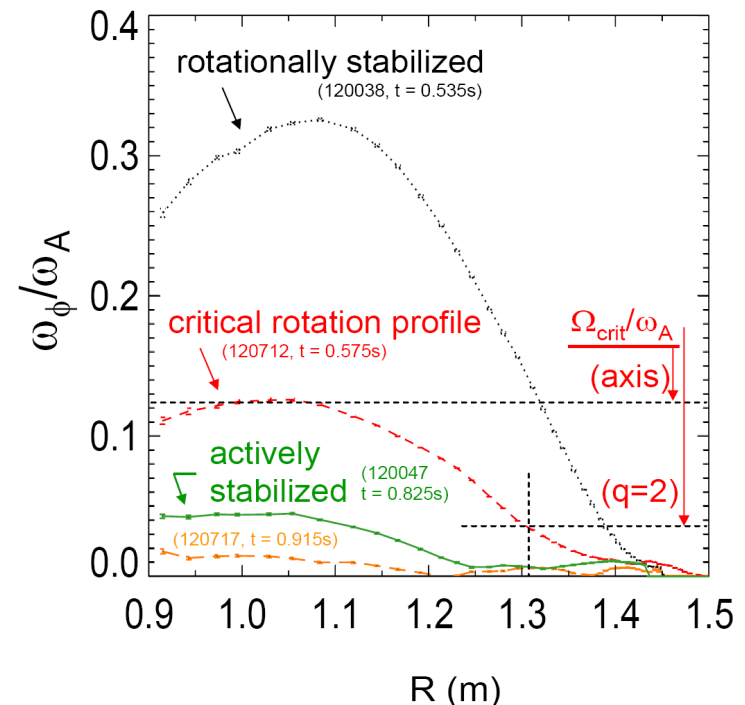
R(07-2): Characterize effectiveness of closed-loop RWM control & dependence on rotation using ITER-like control coils (also MDC-2)



Sabbagh et al.



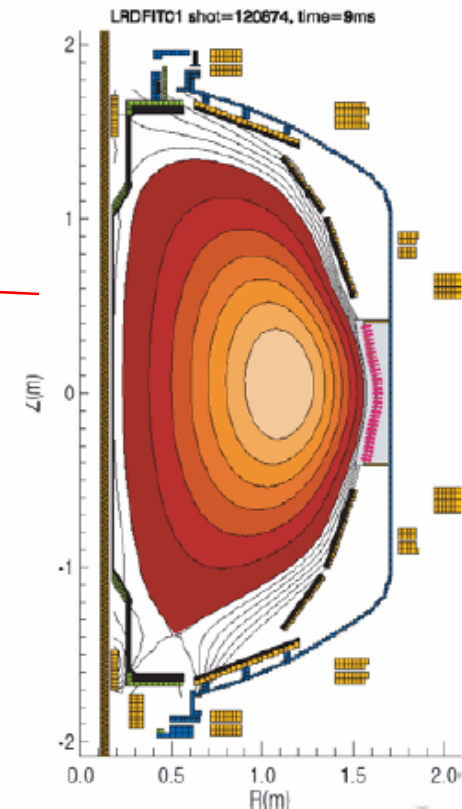
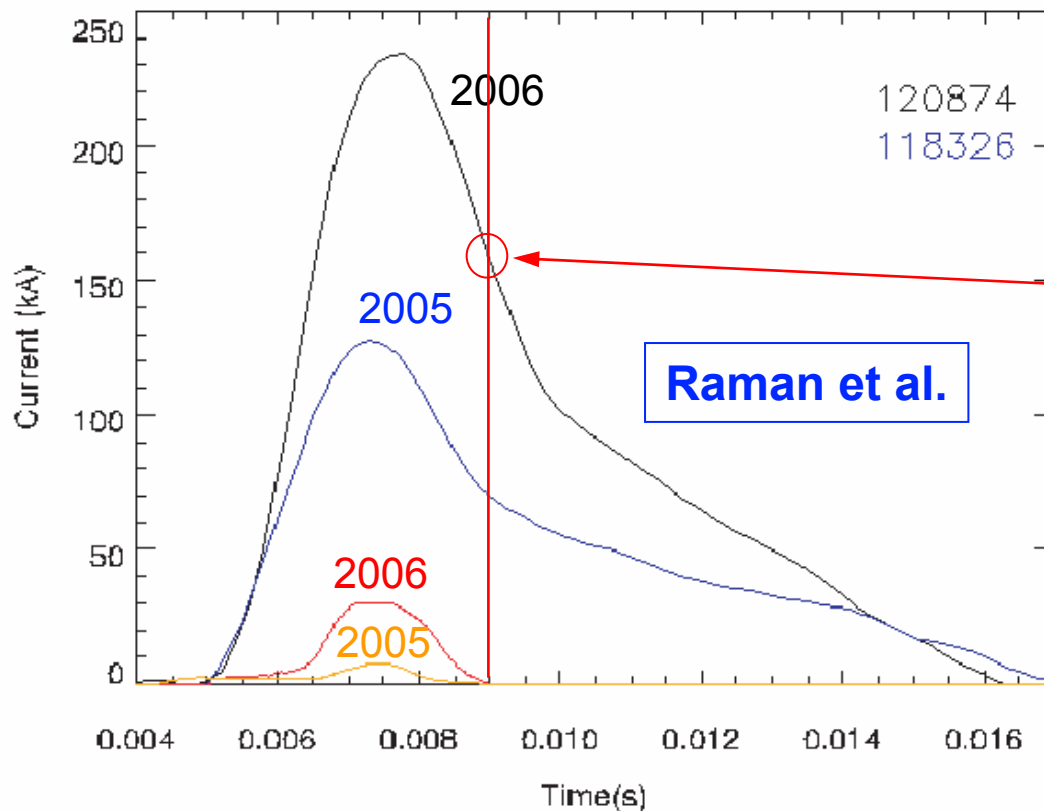
- Demonstrated closed-loop RWM control in high β , low A, low rotation plasmas ($\omega_\phi < \omega_{\text{crit}}$)
- Used $n=3$ magnetic braking
- PRL **97**, 045004 (28 July 2006)
- Ready to study ω_ϕ dependence



R(06-3): Assess Closed-Flux Generation Using Transient Coaxial Helicity Injection (CHI)



- Substantially improved closed flux current via hardware improvements.
- Verified feasibility of CHI startup to high current.
- Obtained closed flux surfaces consistent with equilibrium reconstruction.
- To optimize high current discharge

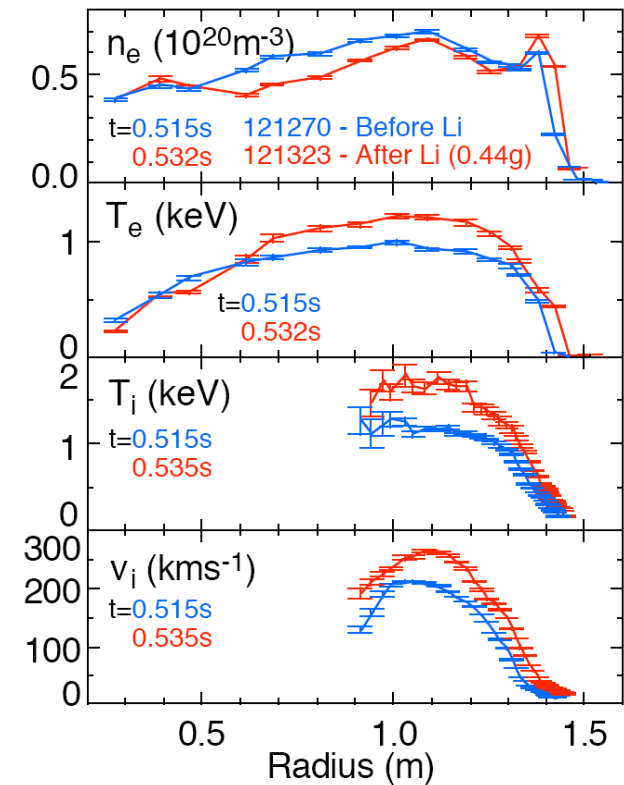
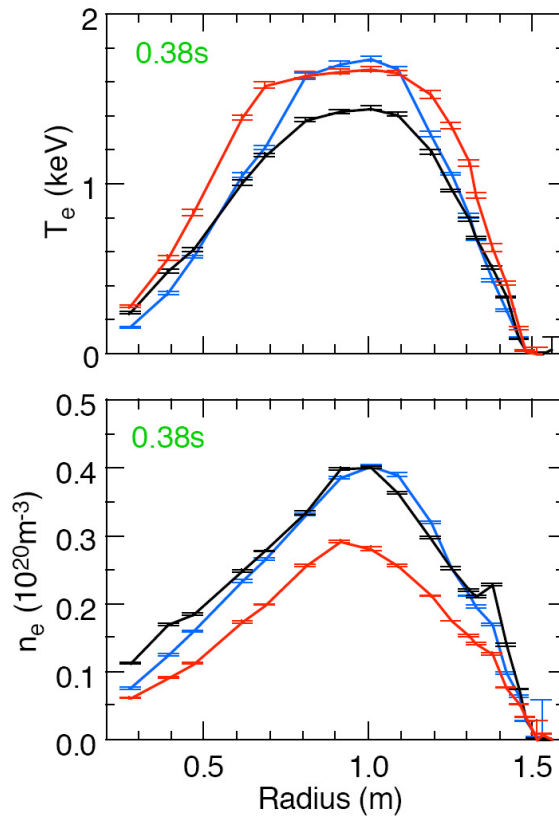
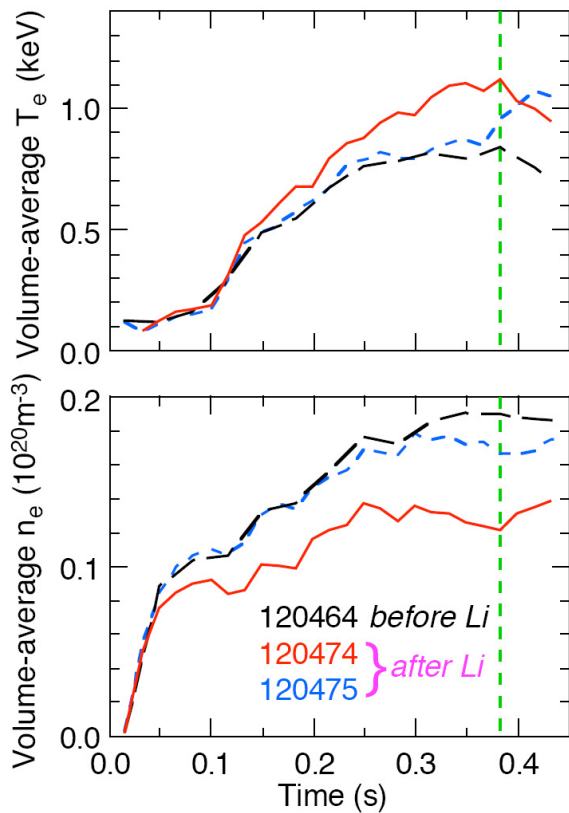


R(06-4): Characterize Effects of Lithium Wall Coating on Recycling (DOE-OFES Tracked)



Kugel et al.

- **L-mode:** Li-coating reduced particle recycling in the succeeding shot only.
- **H-mode:** measurable improvements in temperature and rotation.
- Recommend fast between-shot coating; increase area of coating on divertor.



NSTX devoted 1/3 run time to, and completed half of, the ITPA 2006-2007 Joint Experiments commitment



ID No	2006 Proposal Title	Devices	Status
CDB-2	Confinement scaling in ELMy H-modes: β degradation	AUG, DIII-D, JET, JT-60U, Tore-Supra(L), MAST, NSTX	complete
MDC-2	Joint experiments on resistive wall mode physics	DIII-D, JET, NSTX, JT-60U, AUG and TEXTOR	complete
MDC-9	Fast ion redistribution by beam driven Alfvén modes and excitation threshold for Alfvén cascades	JT-60U, JET, DIII-D, NSTX, MAST, AUG	complete
TP-8.1	ITB Similarity Experiments	MAST, NSTX	complete
PEP-9	Pedestal similarity study	DIII-D, MAST, NSTX	complete
DSOL-15	Inter-machine comparison of blob characteristics	C-Mod, NSTX, TJ-II, JET, TCV, HT-7, Tore-Supra, AUG, JT-60U	complete
DSOL-18	Impurity migration and deposition study	NSTX, AUG, JET	complete
SSO-2.2	MHD effects on q-profile and confinement for hybrid scenarios	AUG, JET, DIII-D, JT-60U, NSTX	complete
SSO-2.1	Complete mapping of hybrid scenario	JET, JT-60U, DIII-D, AUG, NSTX	complete
CDB-6	Improving the condition of Global ELMy H-mode and Pedestal databases: Low A	MAST, NSTX, DIII-D	partial
CDB-8	ρ^* scaling along an ITER relevant path at both high and low beta	JET, DIII-D, C-mod, AUG, NSTX	partial
CDB-9	Density profiles at low collisionality	JET, DIII-D, C-mod, AUG, JT-60U, TCV, Tore-Supra, MAST, FTU, NSTX, T-10	partial
MDC-5	Comparison of sawtooth control methods for neoclassical tearing mode suppression	AUG, DIII-D, JET, NSTX, TCV and HL2A, C-mod, FTU	partial
MDC-6	Low beta error field experiments	C-mod, TEXTOR, MAST, DIII-D, NSTX, JET(done)	partial
PEP-16	Small ELM regime comparison	NSTX, MAST, C-mod	partial
DIAG-1	Assessment of the effect of noise on vertical velocity measurement	JET, JT-60U, TCV, NSTX, AUG	partial
DIAG-2	Environmental tests on Diagnostic First Mirrors (FMs)	T-10, TEXTOR, Tore-Supra, JET, DIII-D, TCV, AUG, LHD, FTU, NSTX, C-mod, JT-60U	partial
MDC-4	Neoclassical tearing mode physics - aspect ratio comparison	AUG, MAST, NSTX, DIII-D	2007
TP-6.3	NBI-driven momentum transport study	DIII-D, JT-60U, NSTX, MAST, JET	2007
TP-9	H-mode aspect ratio comparison	NSTX, DIII-D, MAST, T-10	2007
PEP-10	The radial efflux at the mid-plane and the structure of ELMs	AUG, MAST, NSTX, C-mod	2007
PEP-13	Comparison of small ELM regimes in JT-60U and AUG and JET	AUG, JT-60U, JET, NSTX	2007
SSO-2.3	ρ^* dependence on confinement, transport and stability in hybrid scenarios	DIII-D, JET, AUG, JT-60U, NSTX	2007

CDB-2,6: Confinement scans in I_p & B_T (fixed n , P_{NB}) and in v^* & β (fixed q , ρ^*) were very successful

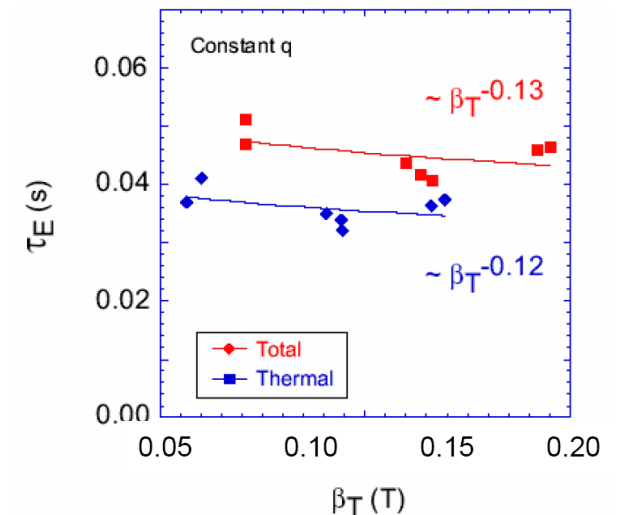
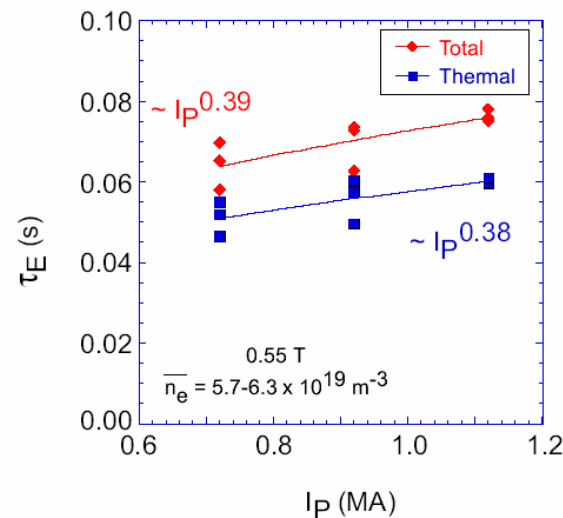
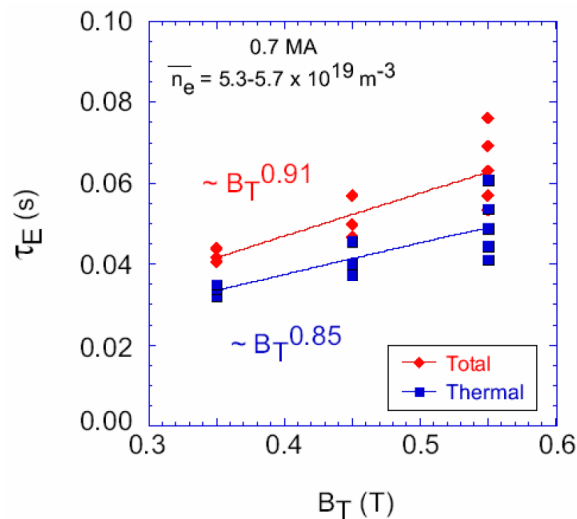


Kaye et al.

NSTX enables determination of ε & β scaling.

Initial scaling indications are favorable at constant q : (I_p or B_T)^{1.2-1.3}.

- B_T : improvement in electron transport with B_T for $\rho \geq 0.5$ – ETG?
- I_p : improvement in ion transport with I_p for $\rho \geq 0.5$ – neoclassical?
- β_T : only weak dependence – more favorable than larger A results.
- v^* : $\tau_E \sim B_T^{-1} v^{*-1}$ – due to both electron (B_T) and ion (I_p)?

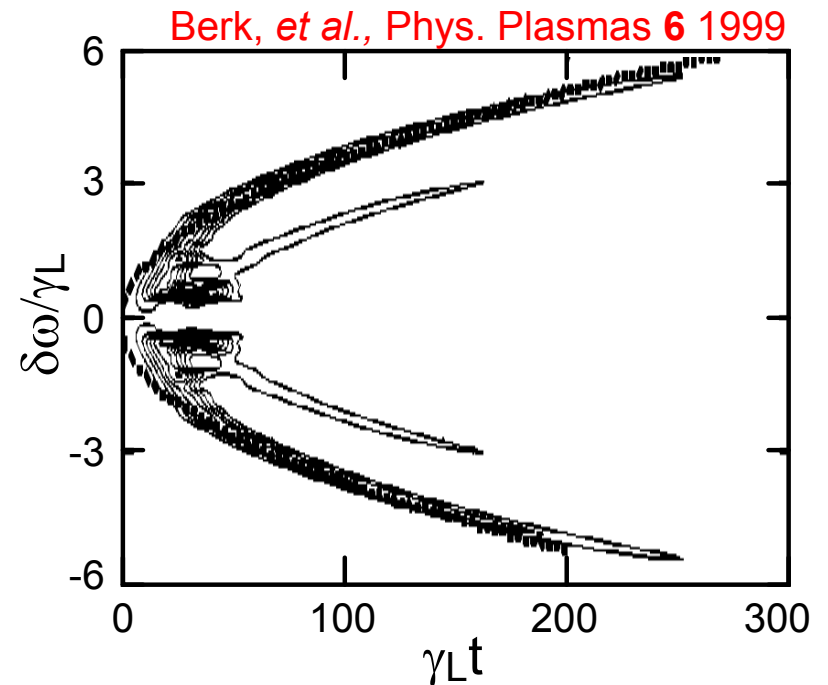
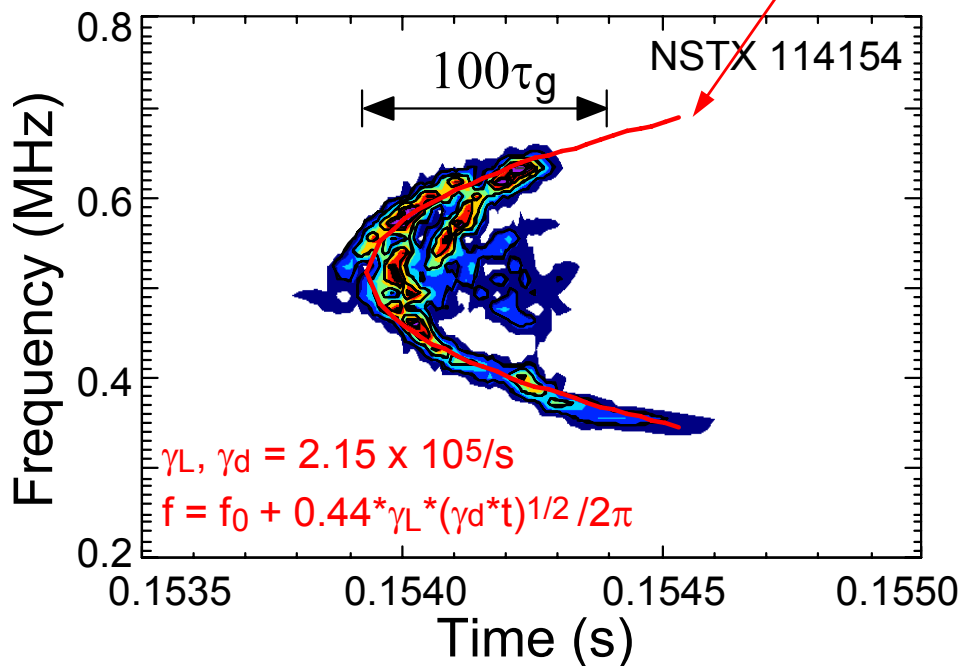


MDC-9: Fast Ion Redistribution via Alfvén Modes – NSTX Observations Verify “Hole-Clump” Theory



Fredrickson et al.

- Single parameter fit to frequency evolution using model of hole-clump pair creation in fast ion velocity distribution [Berk et al, Phys. Lett. A 234 (1997) 213].
- Paper submitted to PRL

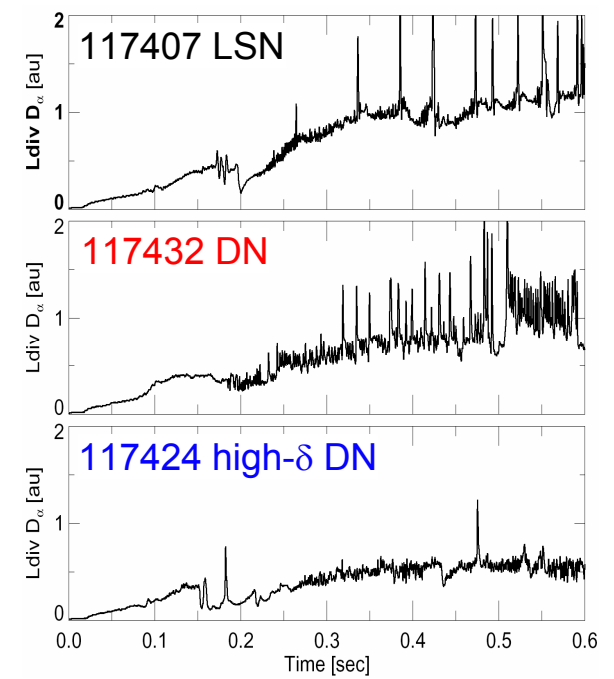
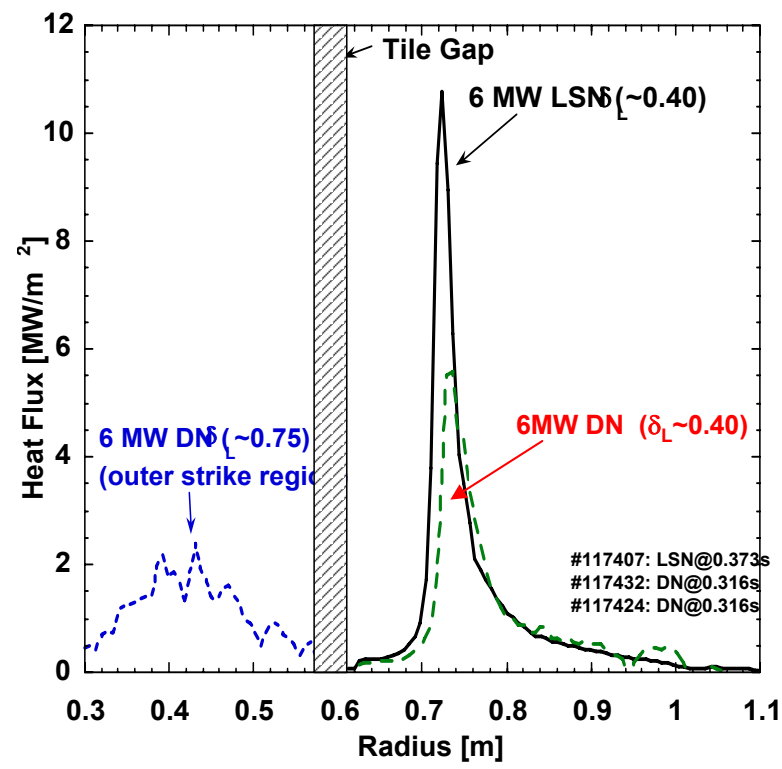
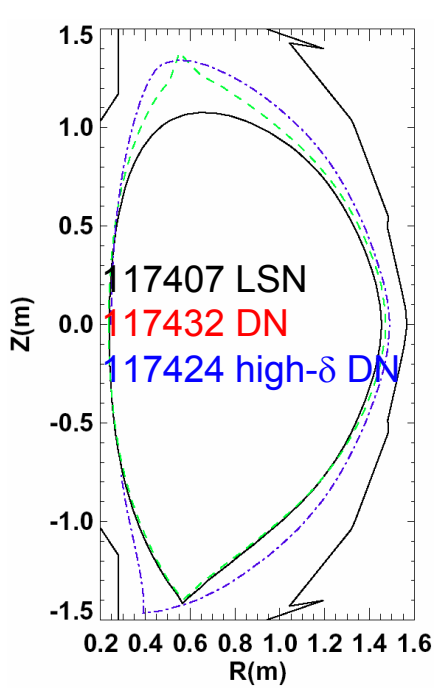


PEP-9,16: Comparison of small-ELM regimes – Increased δ Decreases ELM Magnitude and Divertor Heat Flux



Maingi et al.

Configurations	Single Null	Double Null	Double Null
δ	0.4	0.4	0.8
Peak heat flux	1	0.5	0.2
ELM Type	Type I	Mixed	Type V (small)



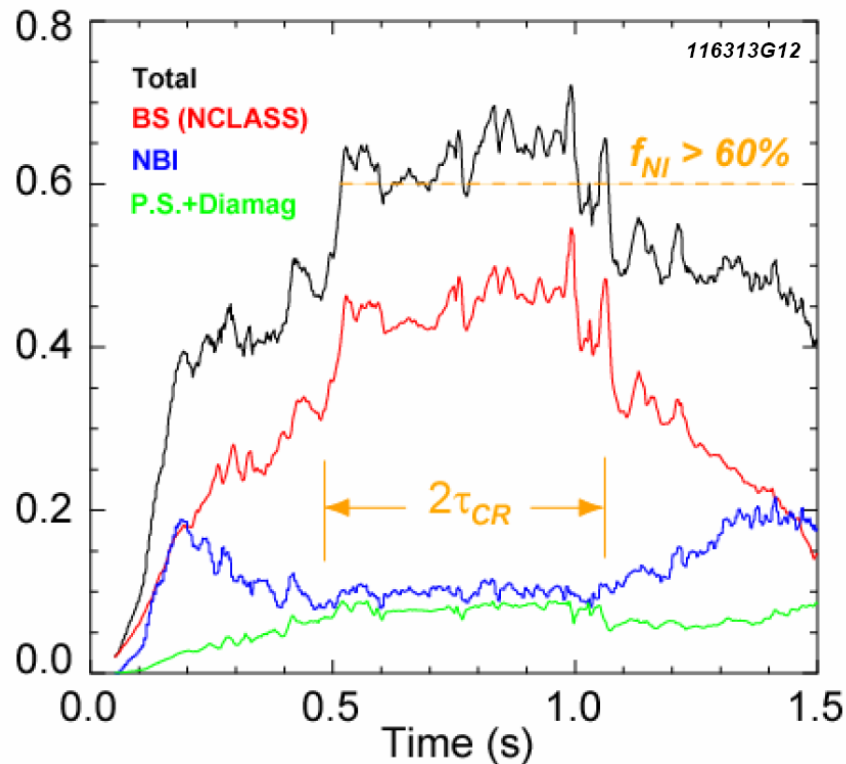
SSO-2.1-3: ITER Hybrid Mode – High Performance & f_{BS} Plasmas Sustained for ~ 2 Current Redistribution Times



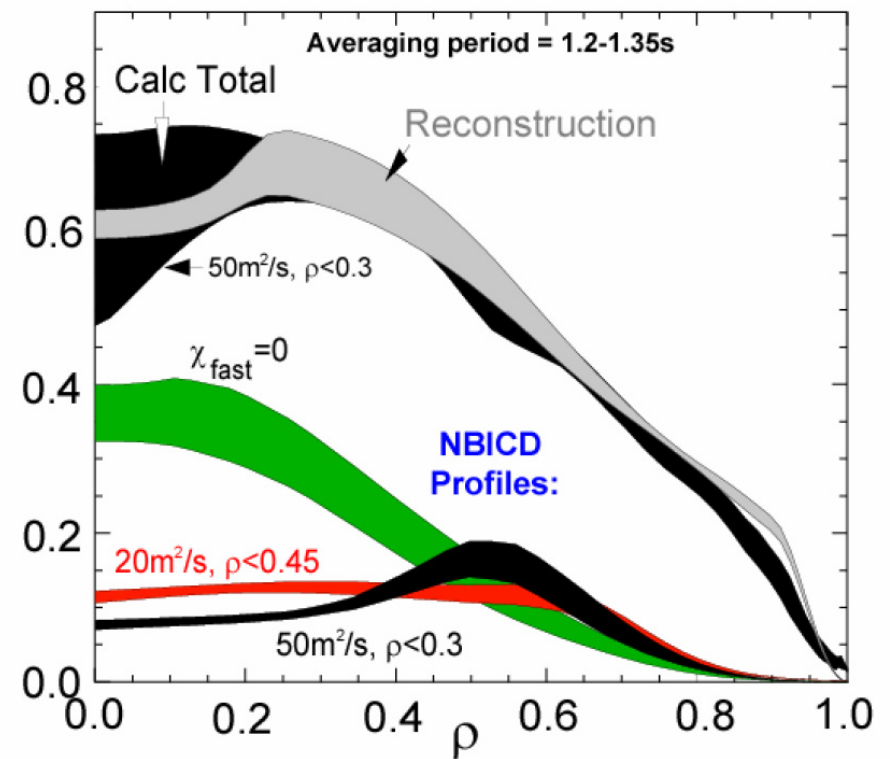
Menard et al.

- Enhanced diffusion of core fast ions needed to match the current profile inferred from MSE data. Paper to appear in PRL.

TRANSP non-inductive current fractions



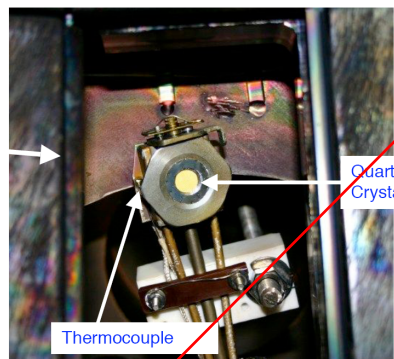
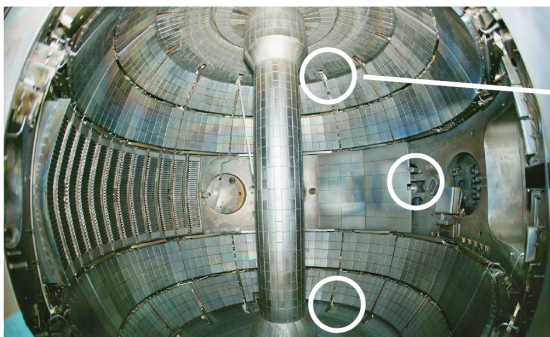
$\langle J_{\parallel} B \rangle / \langle B_{\phi} R_0 / R \rangle$ Profiles [MA/m²]



DSOL-18: NSTX leads in Quartz Micro-Balances (QMB) impurity and deuterium migration studies

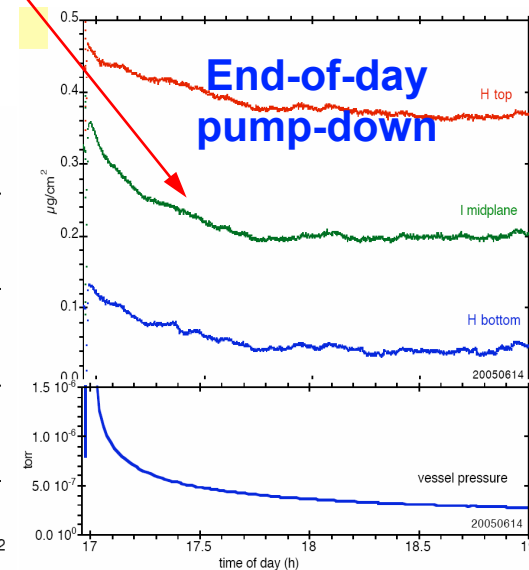
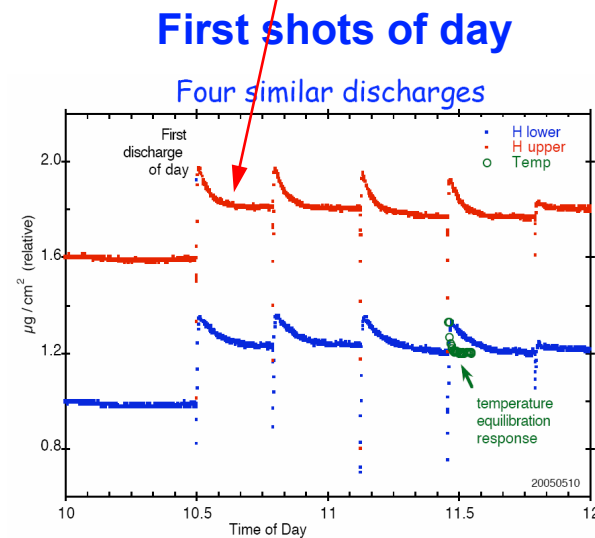
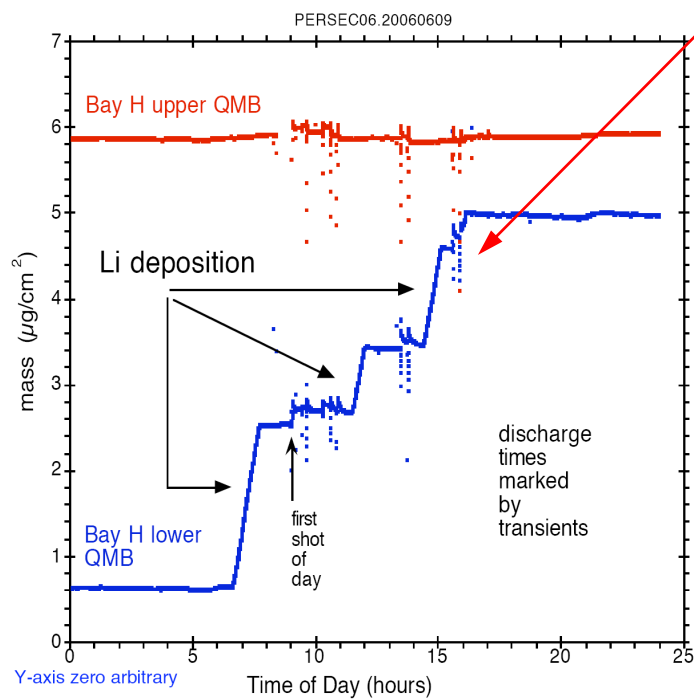


NSTX QMB's



- Monitored time-dependent deposition of Li
- Mechanism: dynamic retention of D in plasma shadowed regions determined by pump-down
- C & C_xD_y migration small in comparison

Skinner et al.



NSTX research results are well represented at the IAEA Fusion Energy Conference 2006 (10/16-21/06)



Menard, J. E.	PPPL	OV	Recent Physics Results from the National Spherical Torus Experiment
Kaye, S.M.	PPPL	EX	Confinement and Transport in the National Spherical Torus Experiment (NSTX)
Fu, G.Y.	PPPL	TH	Nonlinear simulations of fishbone instability and sawteeth in tokamaks and spherical torus
Gates, D.A.	PPPL	EX	Progress Towards Stable Steady State Operation on NSTX
Gorenlenkov, N.N.	PPPL	TH	Phase Space Gradient Drive Discrete Compressional Alfvén Eigenmodes in Tokamaks: Simulations and Observations
Harvey, R.W.	Colorado	TH	Electron Bernstein Wave Studies: Current Drive; Emission and Absorption with Nonthermal Distributions; Delta-F Particle-In-Cell Simulations
Maingi, R.	ORNL	IT	Dependence of the H-Mode Pedestal Structure on Aspect Ratio
Medley, S.S.	PPPL	EX	Investigation of collective fast ion instability-induced redistribution or loss in NSTX
Myra, J.R.	Lodestar	TH	Blob Transport Modes and Analysis of 2D Imaging Experiments
Raman, R.	Washington	EX	Solenoid-free plasma start-up in NSTX using transient CHI
Shaing, K.C.	Wisconsin	TH	Effects of Magnetic Island Induced Symmetry Breaking on Plasma Confinement and Island Evolution in Tokamaks
Sontag, A.C.	Columbia	EX	Investigation of Resistive Wall Mode stabilization physics in high beta plasmas using applied non-axisymmetric fields in NSTX
Soukhanovskii, V.	LLNL	EX	Divertor Heat Flux Reduction and Detachment in NSTX

Active participations in satellite meetings: 12th Int. ST Workshop & ITPA meetings

4 invited papers at the 2006 DPP APS Meeting (10/30-11/3/06) & 56 contributed papers



S. Sabbagh	Columbia U	Active RWM stabilization in low rotation, high beta NSTX plasmas
F. Levinton	Nova	Transport with reversed shear in the National Spherical Torus Experiment
R. Raman	Washington U	Solenoid-free plasma start-up in NSTX using transient CHI
KC Lee	UC Davis	Gyrocenter shift and H-mode transition

Recent Activities and Upcoming Reviews



- PAC-20th conference call meeting addressed Program Letter for FY 2007-2009; posted on webpage last week. PAC-21st meeting scheduled for 1/17-19/07.
- Alerted Team of Office of Science Program Announcement to National Laboratories LAB-06-21 on Fusion Research on National Spherical Torus Experiment; to distribute alert further.
- Mid-term review (9/20-21/06).
- Research Forum tentatively scheduled in early December 2006.

Summary



- All FY06 Research Milestones are projected to be achieved on schedule,
- Broad progress is made on ITPA joint experiments
- Extensive representation at upcoming meetings
- Supporting DOE in research collaboration proposals from national labs and preparing for upcoming review