Supported by
Office of Science

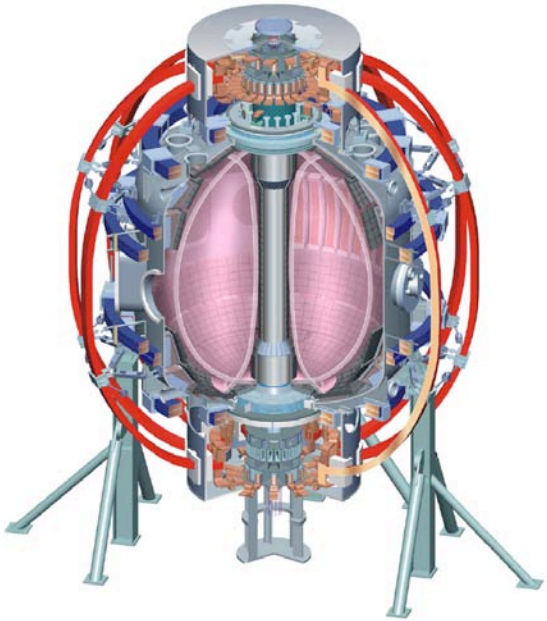
N01.00001: Research directions and highlights from the 2006 NSTX experiments

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

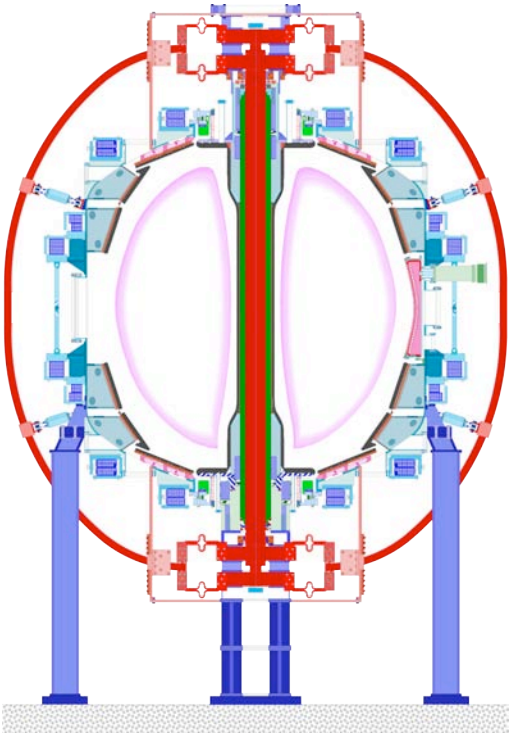
Roger Raman, Univ. of Washington
For the NSTX Team

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
U Quebec

48th Annual Meeting of the DPP
Monday–Friday, October 30–November 3, 2006
Philadelphia, Pennsylvania



NSTX Facility/Diagnostic Improvements since 2005



- Active Error Field control / RWM Feedback control
- I_{CHI} ~ 160 kA (with zero injector current)
- Lithium Evaporator

Major Radius R_0	0.85 m
Aspect Ratio A	1.3
Elongation κ	2.8 - 3
Triangularity δ	0.8
Plasma Current I_p	1.5 MA
Toroidal Field B_T	0.55 T
Pulse Length	1.5 s
NB Heating (100 keV)	7 MW
$\beta_{T,tot}$	up to 40%

Diagnostic Systems
Additions and Upgrades during 2006

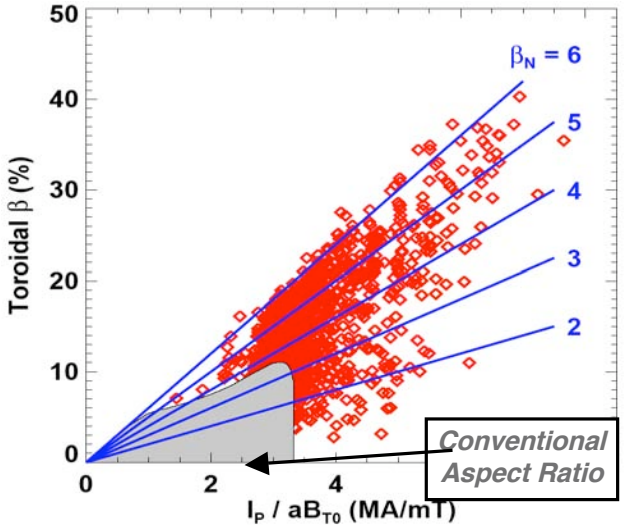
Multi-pulse Thomson scattering (30 ch)
FIReTIP interferometer (6 ch, 600 kHz)
Multi-color USXR fast Te(r)
MSE-CIF (12 ch)

MHD/Fluctuation/Waves
RF/TAE Wave reflectometers (edge/core)
Tangential microwave scattering
Dual Electron Bernstein wave radiometer

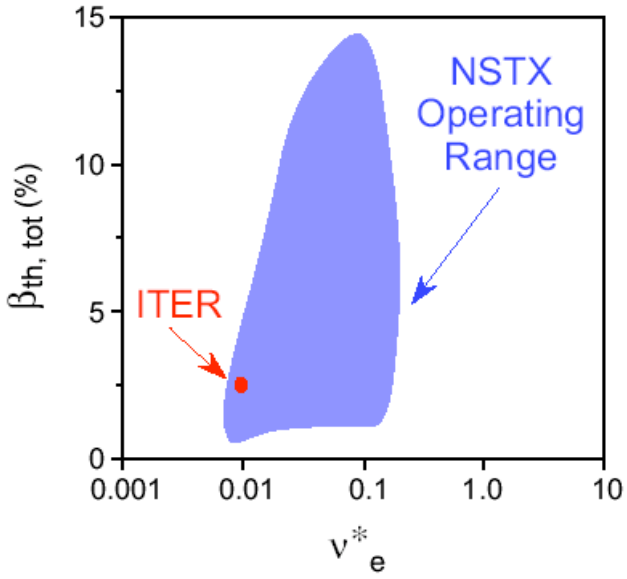
Edge/divertor studies
IR cameras (30Hz) (3)

NSTX/ST Offers Access to Wide Tokamak Plasma Regimes

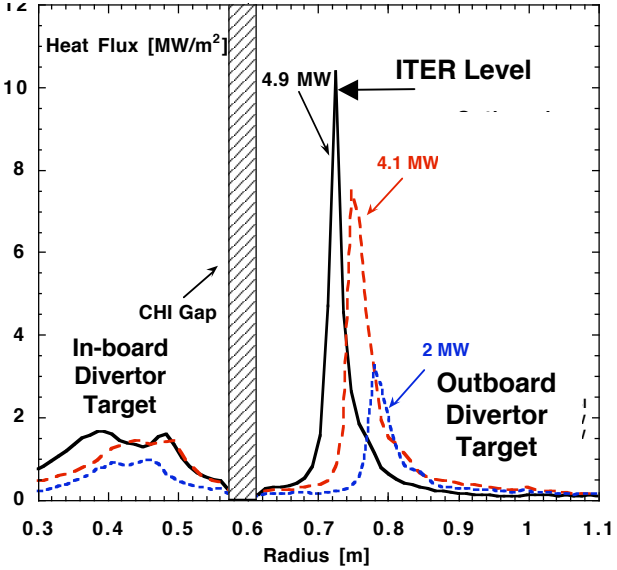
Wide range of β_T up to ~ 40 %.



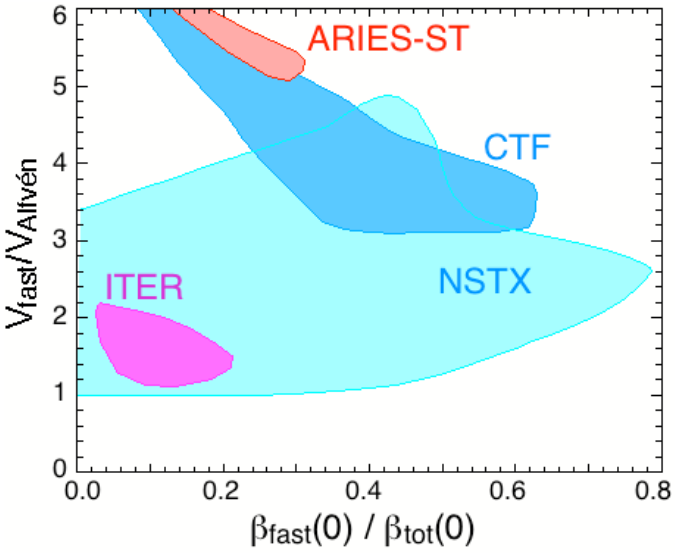
β Confinement Scaling, Electron Transport



Boundary physics with ITER-level heat flux



Unique Energetic Particle Physics Capability



- Full set of diagnostics: including MSE for j(r)

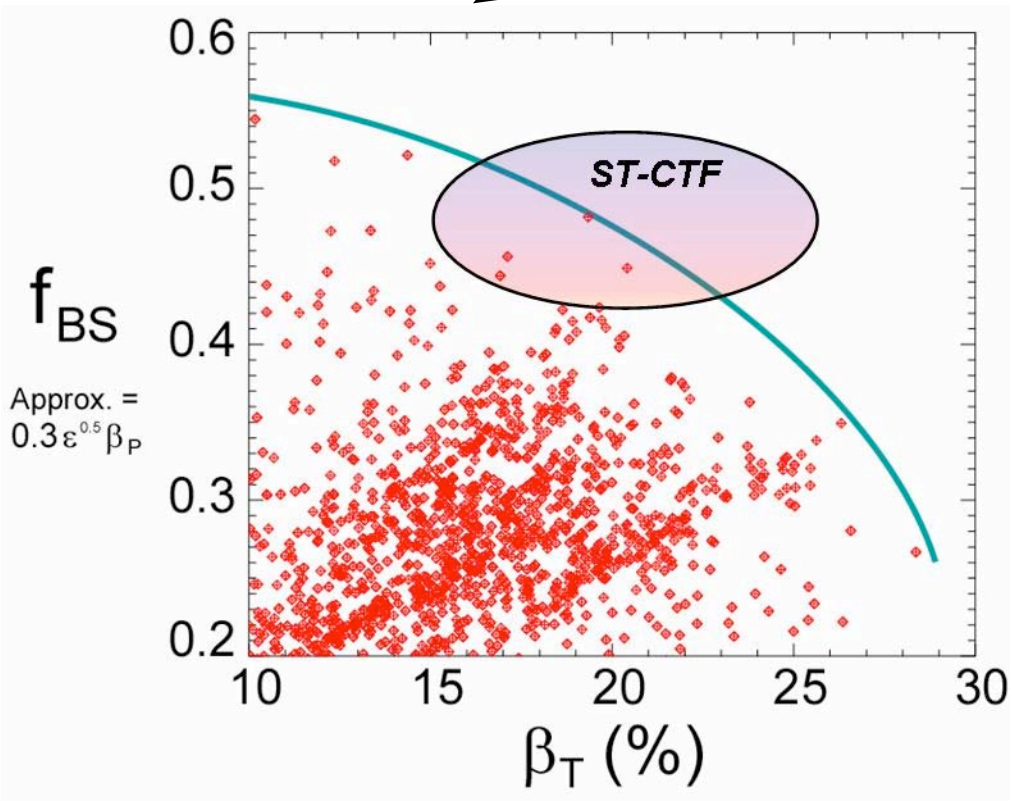
NSTX plasmas approach the normalized performance levels needed for a Spherical Torus Component Test Facility (ST-CTF)

NSTX

ST-CTF goal

A=1.5, κ = 3, R_0 = 1.2m, I_P= 8-12MA, $\beta_N \sim 5$, HH=1.3,

β_T = 15-25%, f_{BS}=45-50%

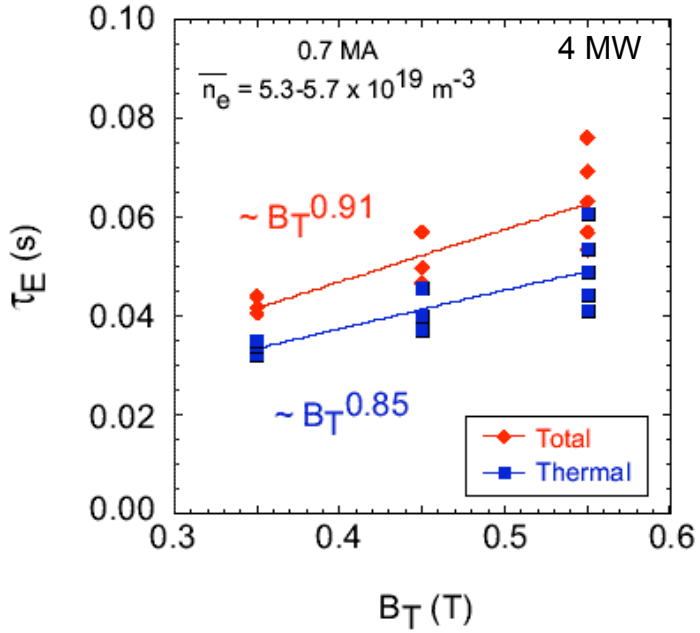


Gates, N01.00006

Dedicated H-mode Confinement Scaling Experiments have isolated differences

Strong dependence on B_T

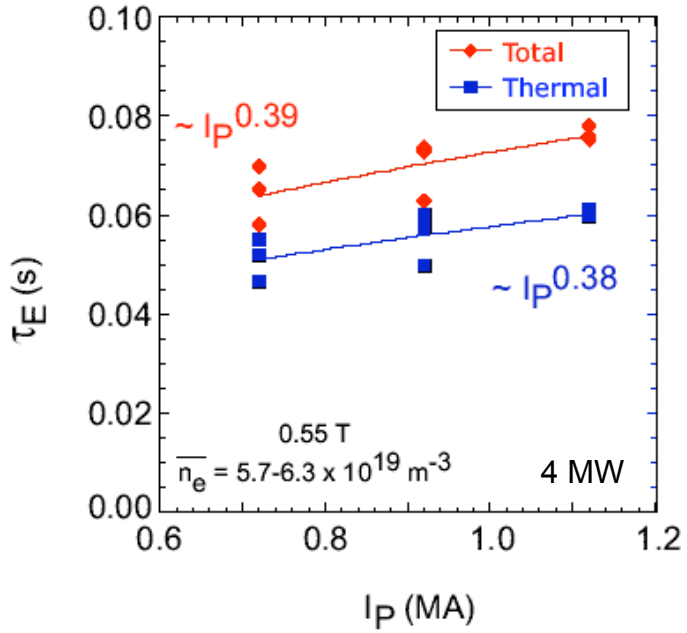
$H_{98y,2}$ ~ 0.9 → 1.1 → 1.4



$\tau_{E,98y,2} \sim B_T^{0.15}$

Weaker dependence on I_p

$H_{98y,2}$ ~ 1.4 → 1.3 → 1.1



$\tau_{E,98y,2} \sim I_p^{0.93}$

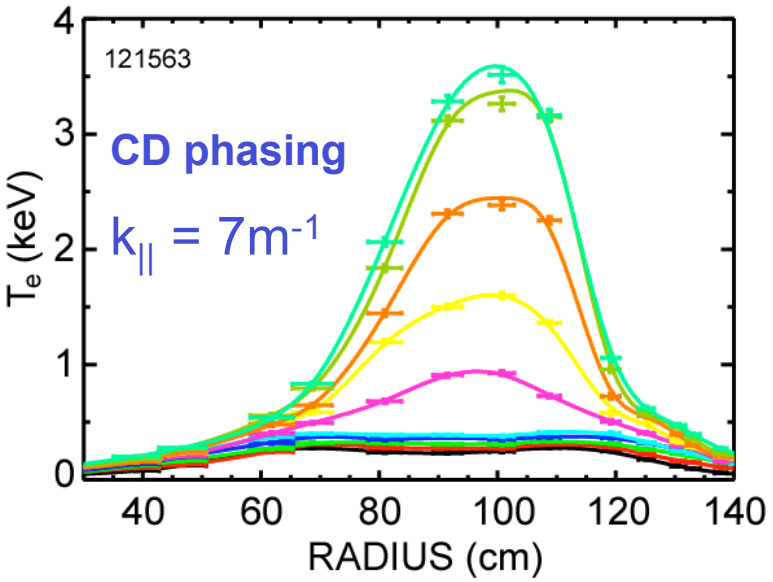
$\tau_E \sim I_p^{1.3\text{-}1.5}$ at fixed q

$\tau_{E,98y,2} \sim I_p^{1.1}$ at fixed q

Kaye, et al., NF 46 (2006) 848 & QP1.00008

HHFW Heating Efficiency Improved with B_T

- Achieved high T_e=3.6keV in current drive phasing for using high B_T = 5.5kG
  - Improvement consistent with reduced Parametric Decay Instability and surface waves expected at higher B_T
  - Expect similar improvements from **higher $k_{||}$**
    - Useful for HHFW-CD during ramp-up
    - Useful for HHFW heating at high-β

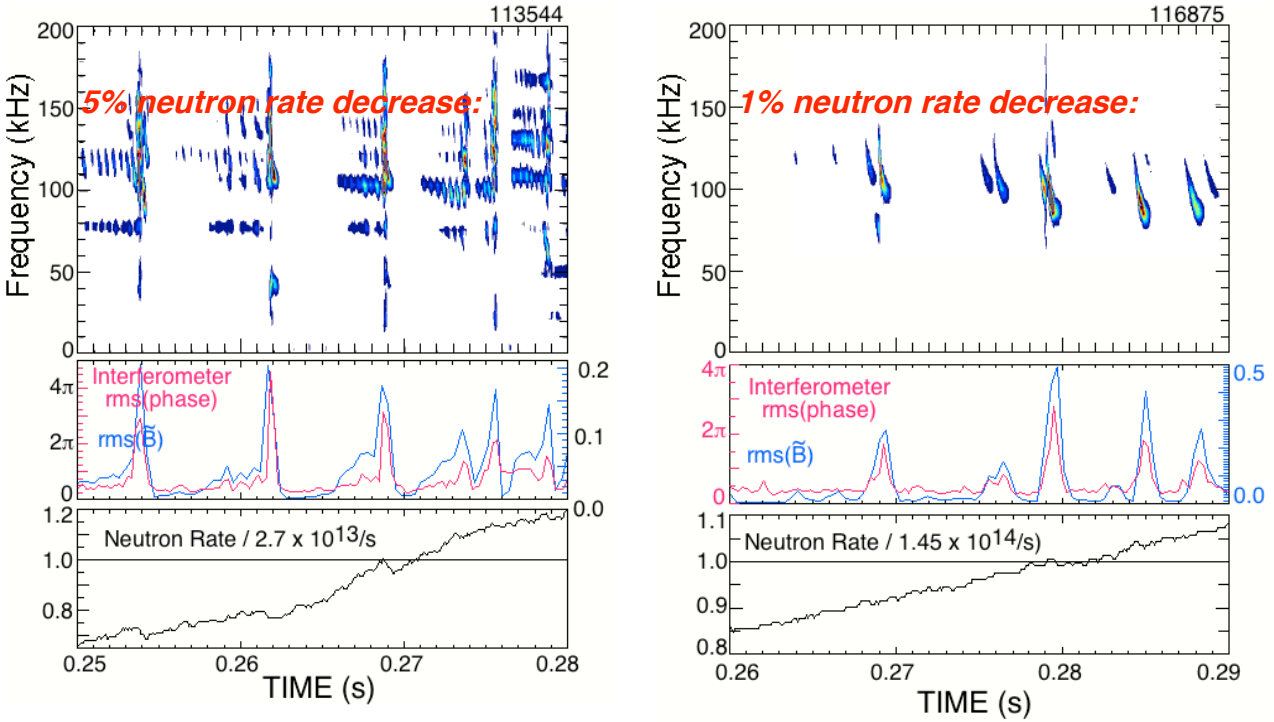


Hosea, NO1.00011

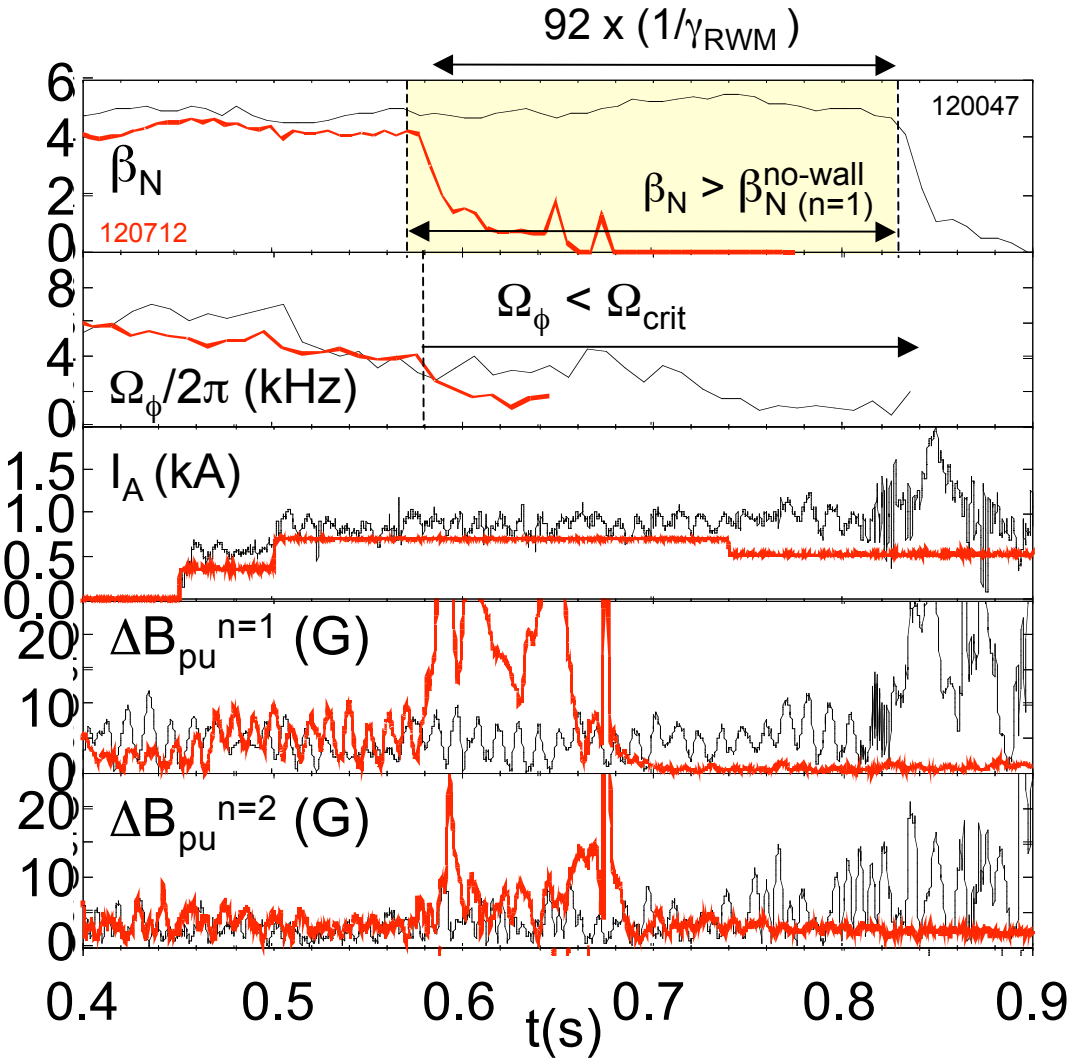
Fast ion transport in ITER expected from interaction of many modes

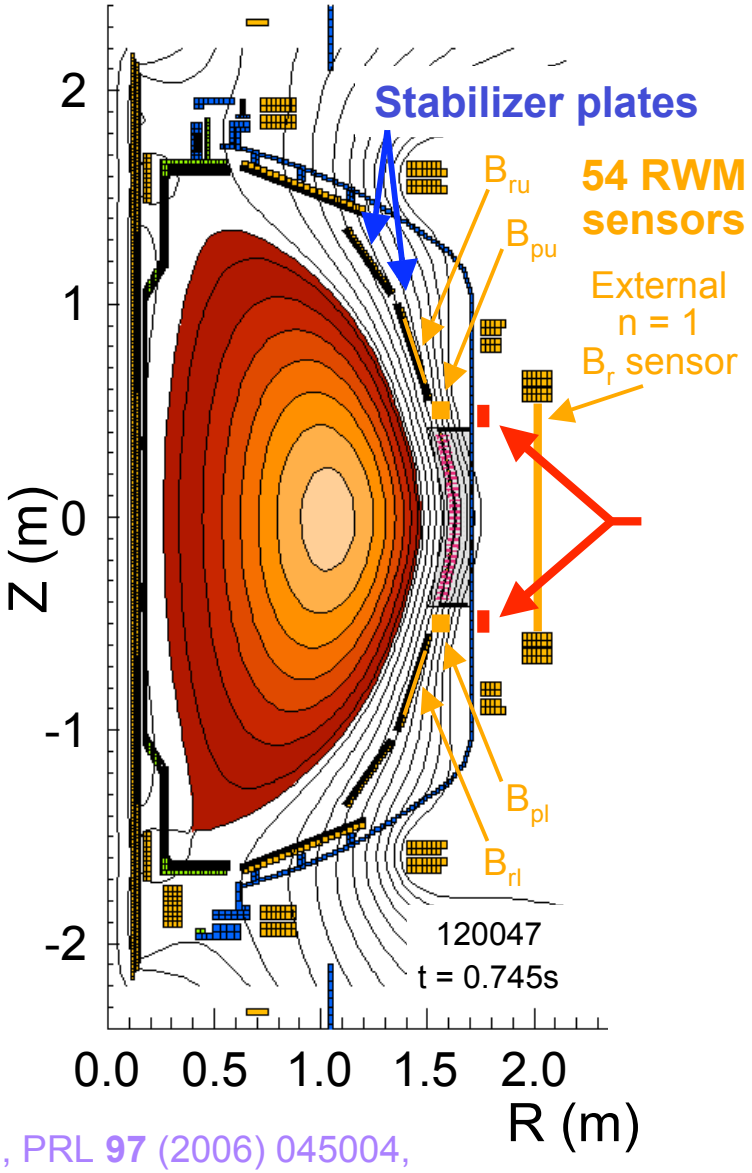
NSTX can study multi-mode regime while measuring MSE q profile

- **NSTX observes that multi-mode TAE bursts induce larger fast-ion losses than single-mode bursts:**



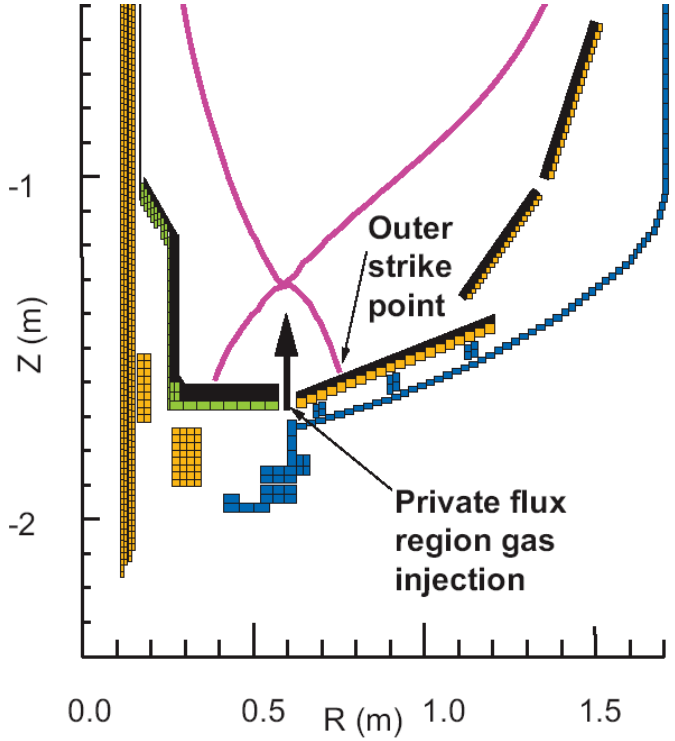
RWM stabilized at ITER-relevant low rotation for ~ 90/γ_{RWM}



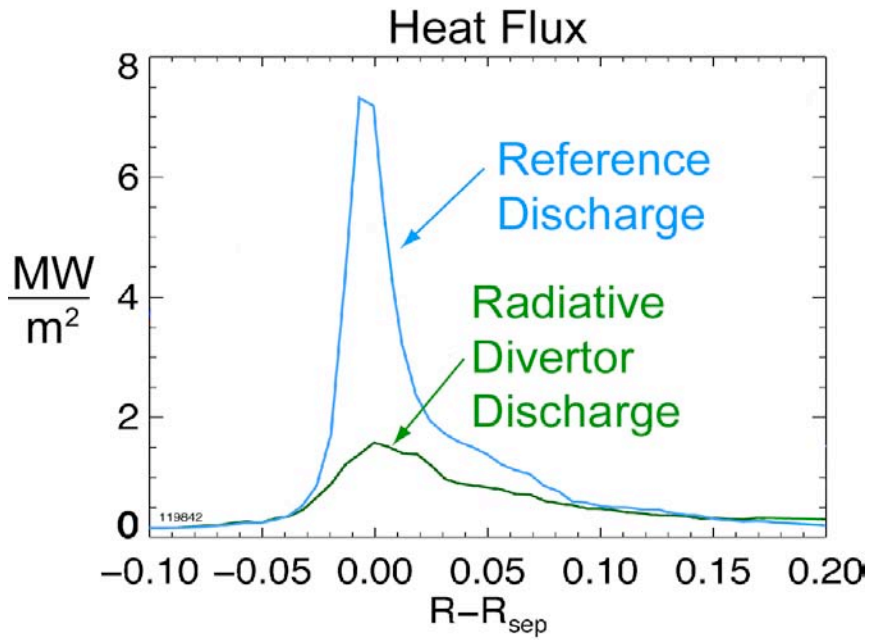


Sabbagh, et al., PRL **97** (2006) 045004,
Invited Talk: VI2.0001, Thursday, 2pm

Reduced Peak Heat Flux by Radiative Divertor



Obtained by steady-state D_2 injection into private flux region

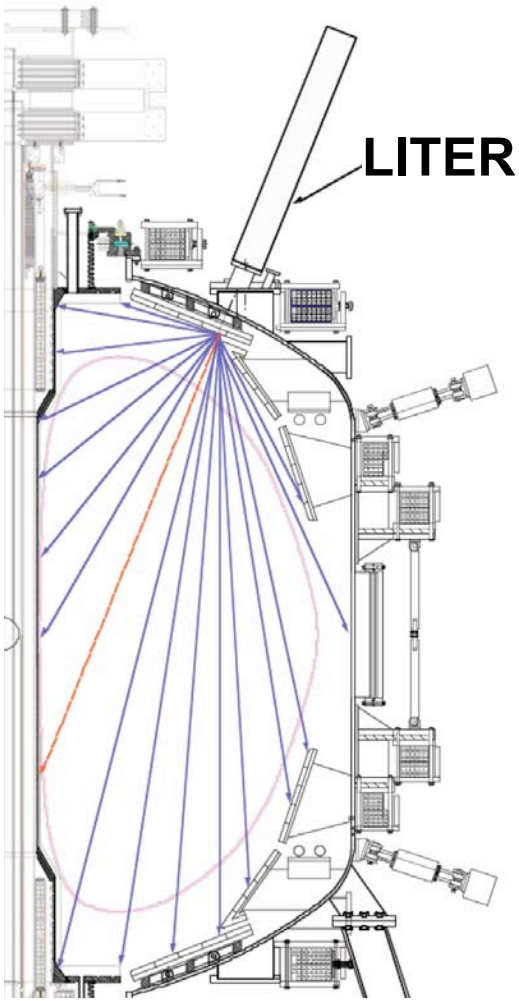


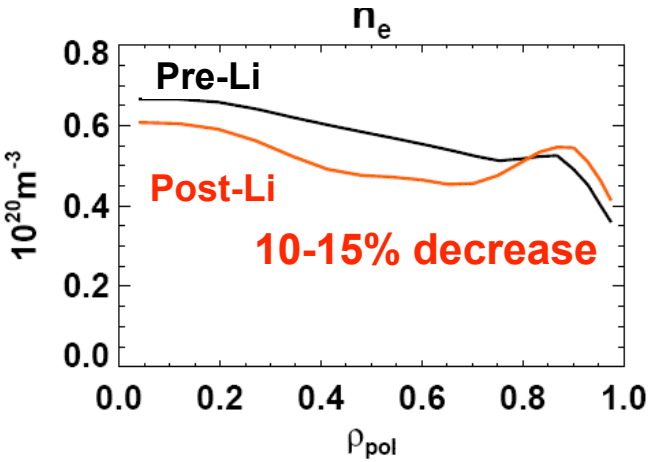
– Outer strike point heat flux reduced by 4-5

– No change in H-mode τ_E

Soukhanovskii, et al., IAEA FEC2006, EXP4-28

In 2006, Lithium Evaporator (LITER) Experiments Improved Particle Pumping and Energy Confinement in H-mode



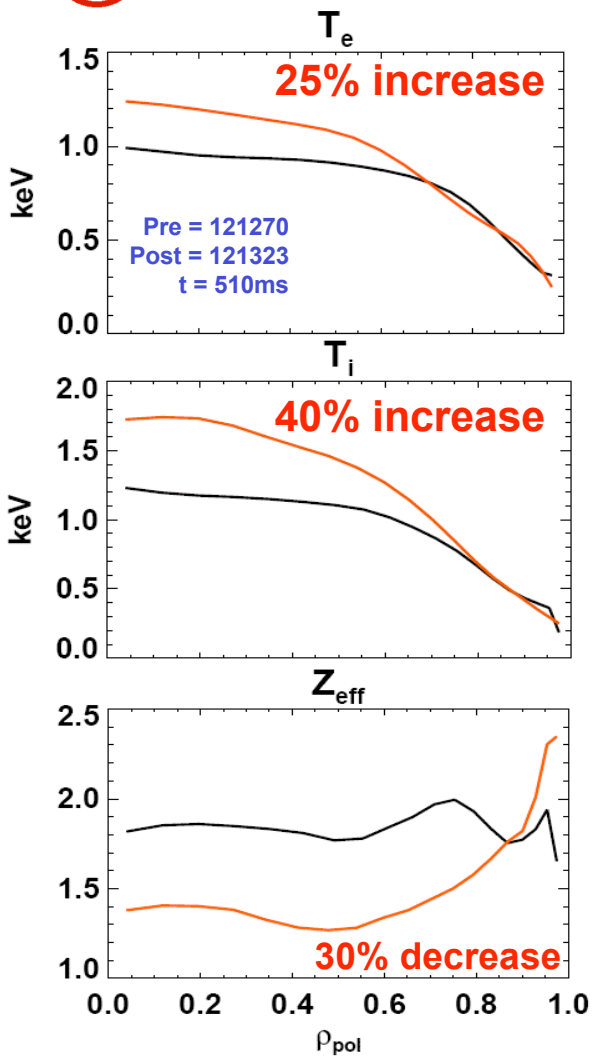


TRANSP analysis:

W_{TOT} 20% higher post-Li
(reaches β-limit w/ same P_{NBI})

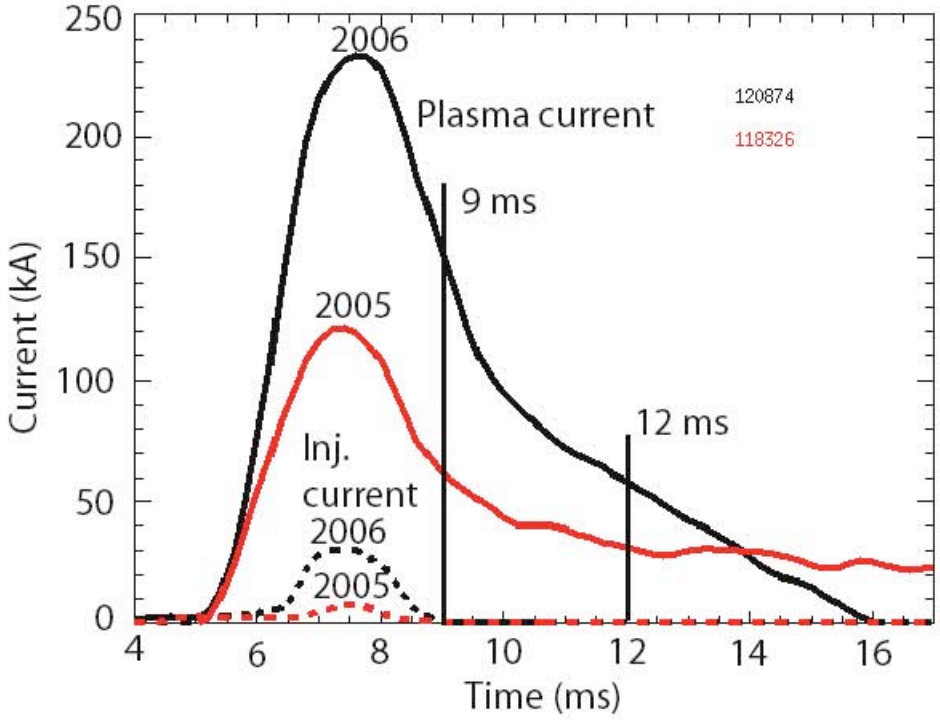
HH_{98y} = 1.07 → 1.25 post-Li

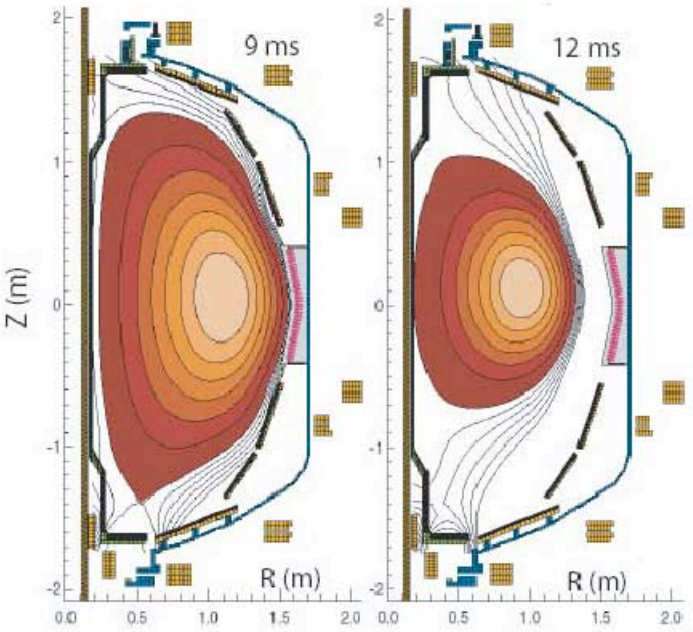
Divertor D_α emission dropped by a factor of 3-4



Kugel, N01.00002

Coaxial Helicity Injection (CHI) has convincingly demonstrated the formation of closed poloidal flux at high plasma current





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

LRDFIT (J. Menard)

Univ. of Wash.

R. Raman, B.A. Nelson, MG.Bell, *et al.*, PRL **97**, 175002 (2006)

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

- NSTX normalized performance approaching ST-CTF level
- Only ST in world with advanced mode stabilization tools and diagnostics
- Unique tools for understanding transport and micro-turbulence
- Broad ITER and CTF-relevant boundary physics research program
- Uniquely able to mimic ITER fast-ion instability drive with full diagnostics
- Demonstrated 160kA closed-flux plasma formation in NSTX using CHI
- **ST offers compact geometry + high β attractive for CTF & reactor**

NSTX Poster Session: Today 2PM, Session QP1