Supported by Office of Science

NSTX

Overview of the 2007 NSTX Experimental Campaign

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

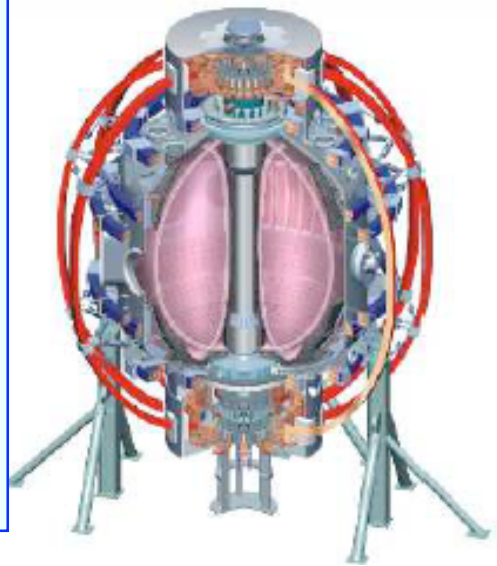
presented by

David Gates, for the NSTX Team

at the

49th Annual meeting of the APS-DPP, Orlando Florida

November 12, 2007

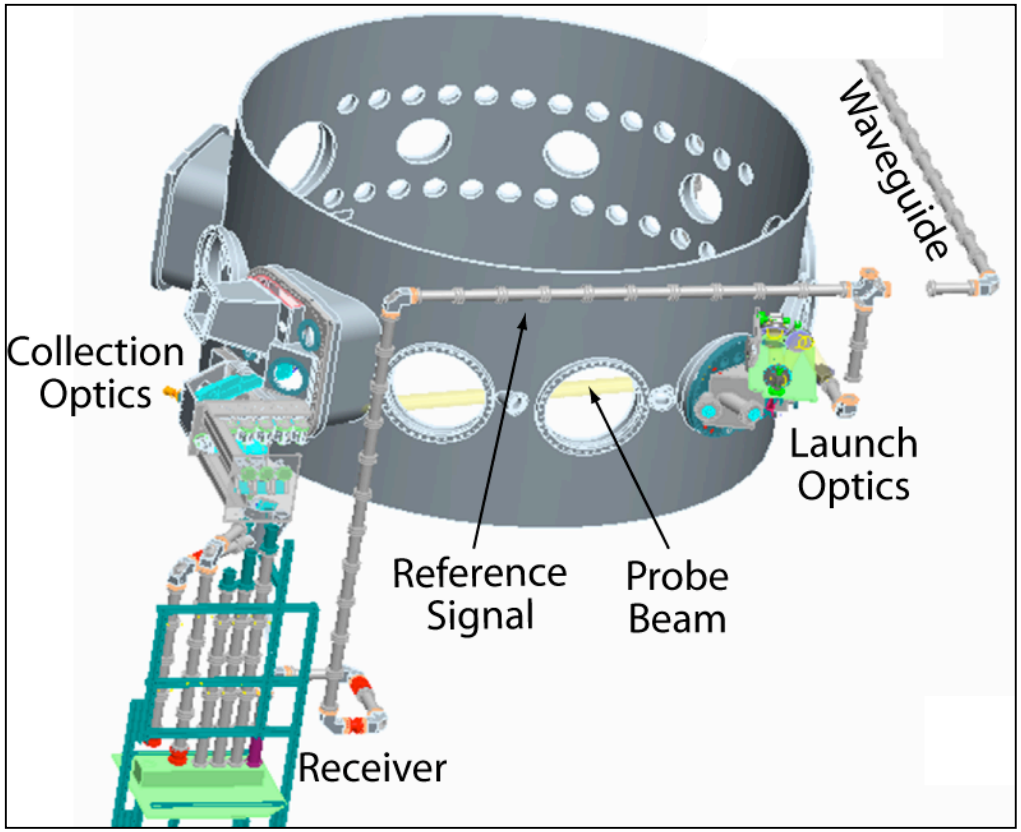


Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep

NSTX facility enhancements enable exciting research program

- Absolutely calibrated high-k scattering diagnostic with simultaneous measurement of multiple k values.
- RWM feedback and error field correction for multiple n values using large multi-component sensor array
- MSE measurements with strong super Alfvenic particle population
  - Relevant to ITER
- Able to study wave physics in the over-dense regime
- Only diverted toroidal device studying lithium as a first wall material

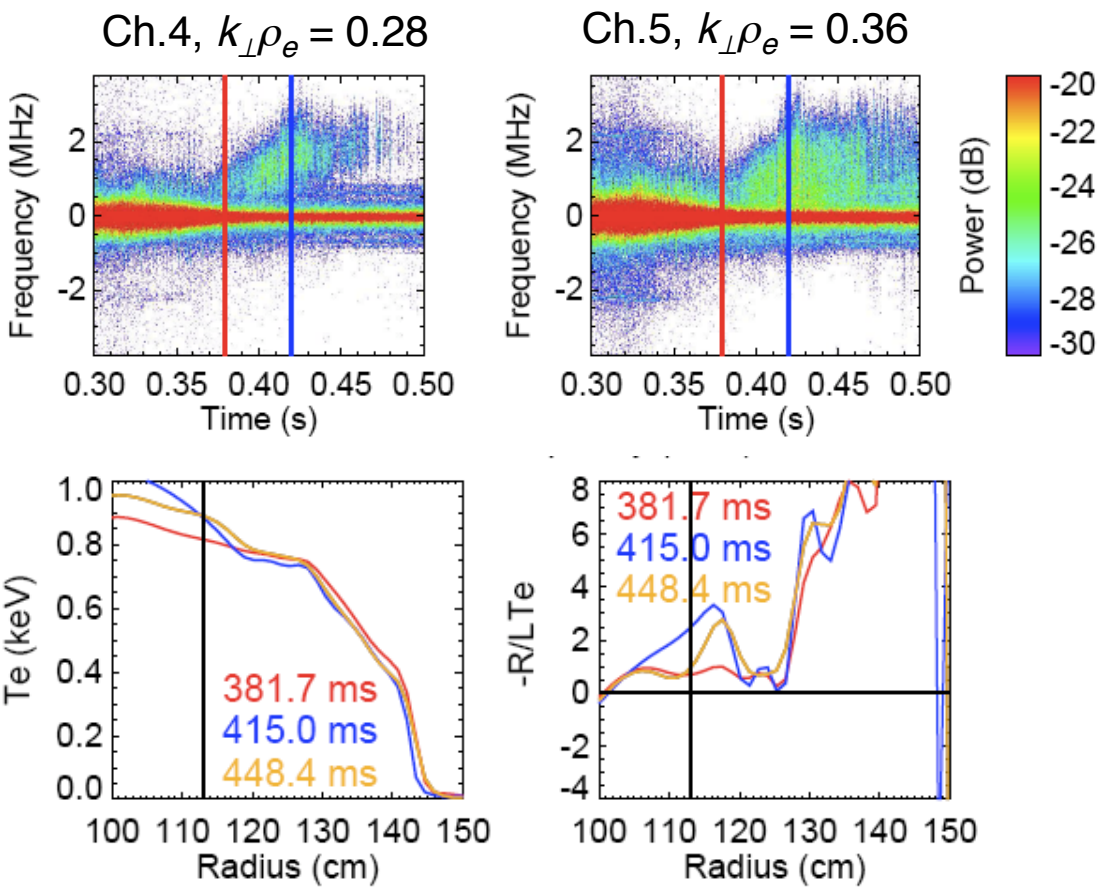
NSTX "high-k" scattering system measures density fluctuations up to $k_\perp \rho_e \cong 0.6$



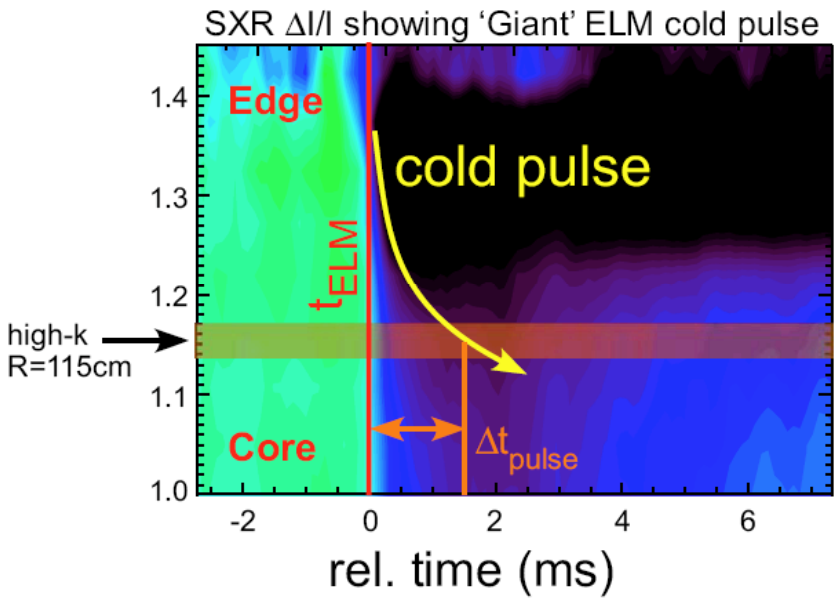
High-k scattering results are beginning to unlock the mystery of anomalous electron transport

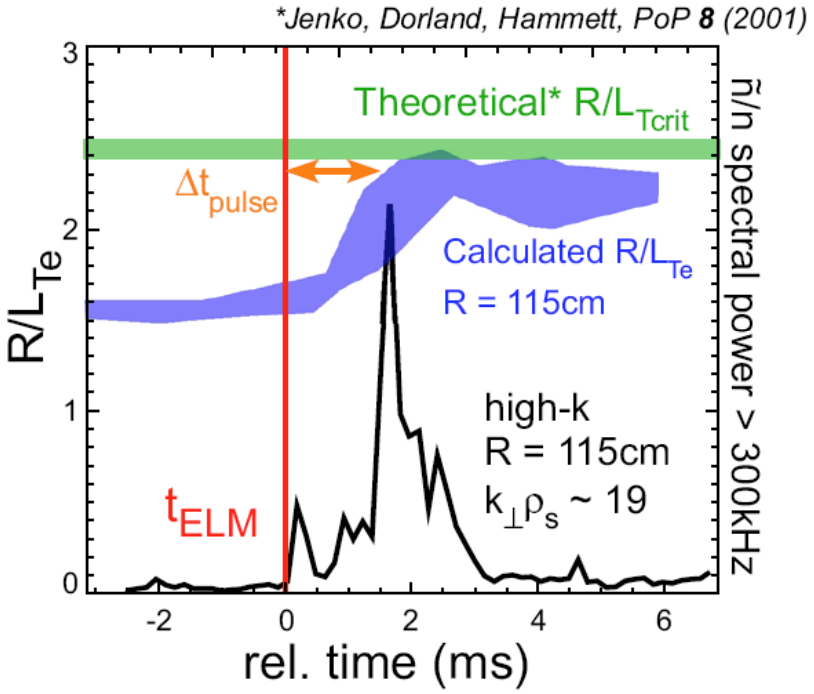
- Correlations observed between measure R/L_{Te} and fluctuation levels
- Data being compared to predictions of ETG theory (Jenko-Dorland, GS2)
- *See next talk in this session (Mazzucato)*
- *Also see poster by D. Smith and H. Park - in NSTX poster session TP8 Thursday*

- 124885: 4 MW NBI, 0.7 MA, 5.5 kG, D fuel
- High-k measurements at R ≅ 113 cm, r/a ≅ 0.25



Core high-k measurements suggest enhanced electron transport during Giant ELM cold pulse





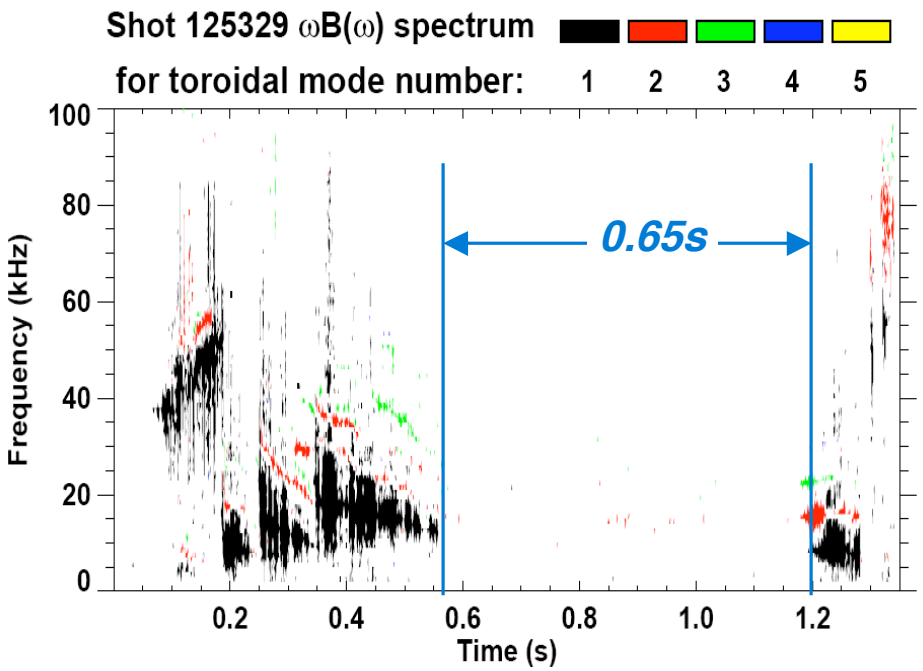
- Low steady state Te gradient suggests stable ETG
- Cold pulse increases the Te gradient during propagation
- Core high-k measurements show increased fluctuations during cold pulse propagation

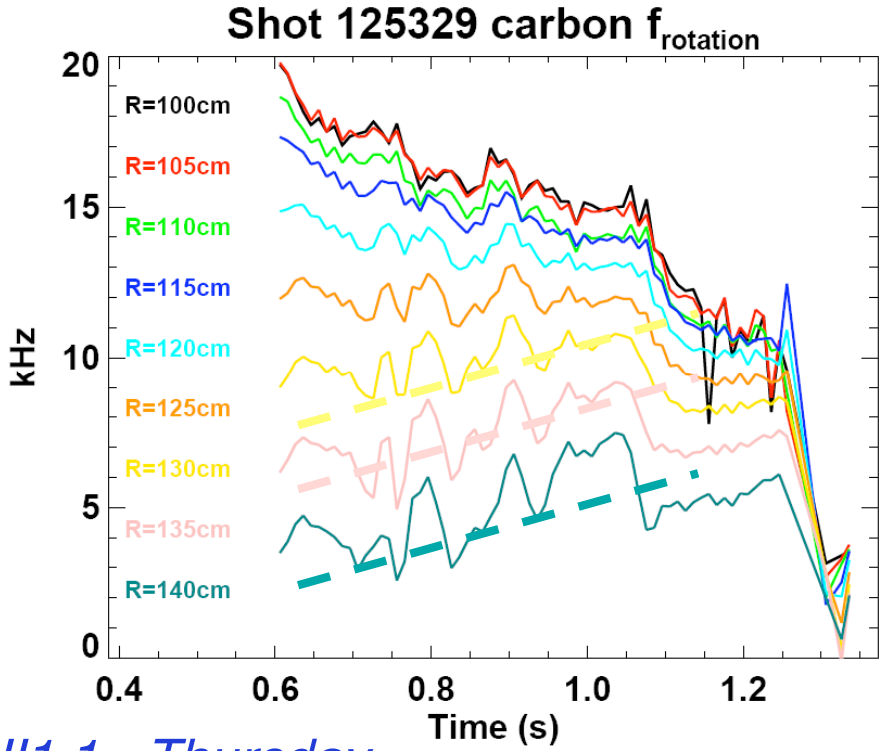
- *See invited talk by K. Tritz NI1.5 - Wednesday*

Simultaneous multiple-n correction improves performance
(Active feedback control of n=1 RFA + pre-programmed n=3 correction)

- Long period free of core low-f MHD activity
- Plasma rotation sustained over same period
  - Core rotation decreases with increasing density (f_{GW} → 0.75), but…
  - R > 1.2m rotation slowly ***increases*** until large ELM at t=1.1s

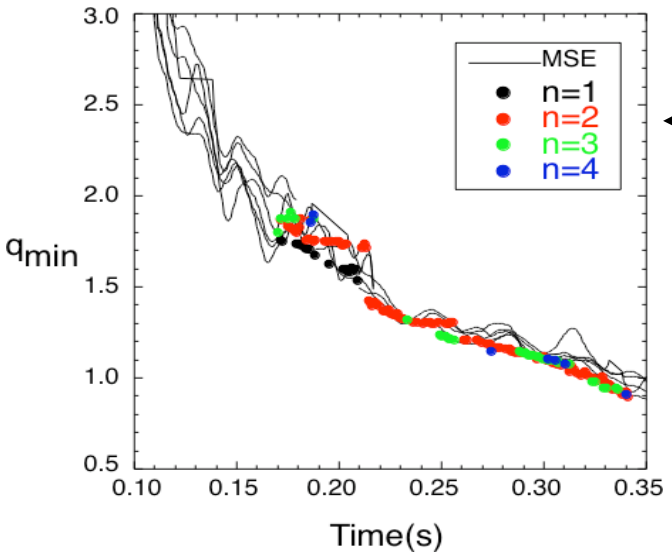
→ Record pulse-length at I_P=900kA



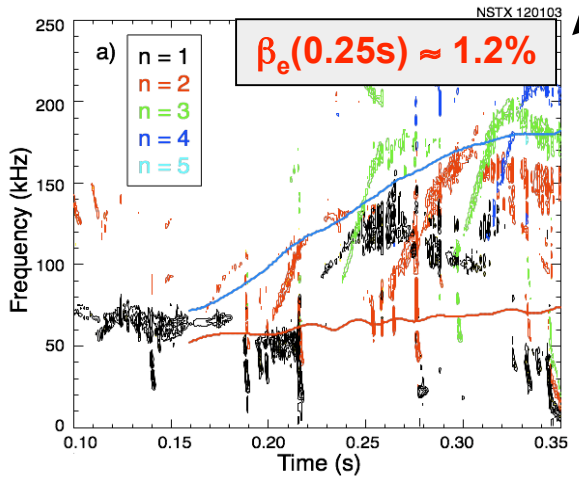


- *See invited talk by Menard UI1.1 - Thursday*

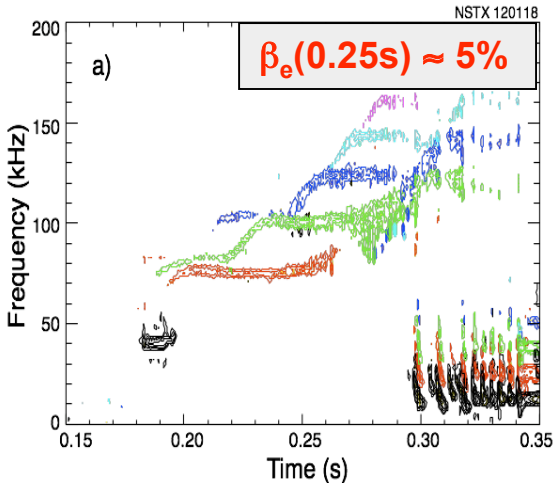
NSTX observations support recent theoretical models of Alfvén Cascade modes coupling to Geodesic Acoustic Modes



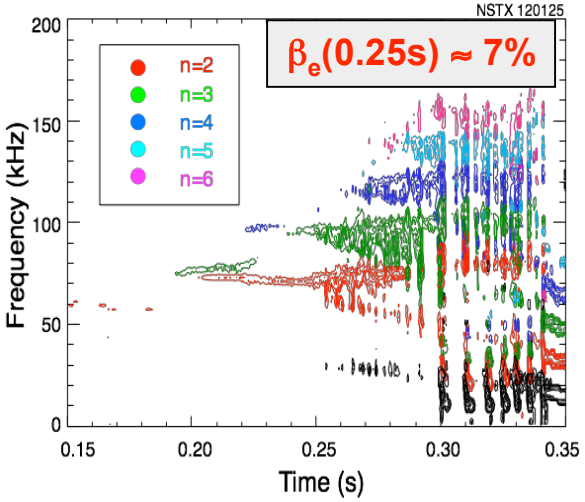
- MSE data agrees with q_{min} deduced from mode frequency sweeps
- Range of frequency sweep is reduced as β is raised, in agreement with theory ($\beta \sim C_s^2/V_A^2$)
- Mode frequency evolution:
  - Onset near GAM frequency (lower red curve)
  - Frequency sweeps upwards
  - Saturates near TAE frequency (blue curve)



Largest frequency sweep



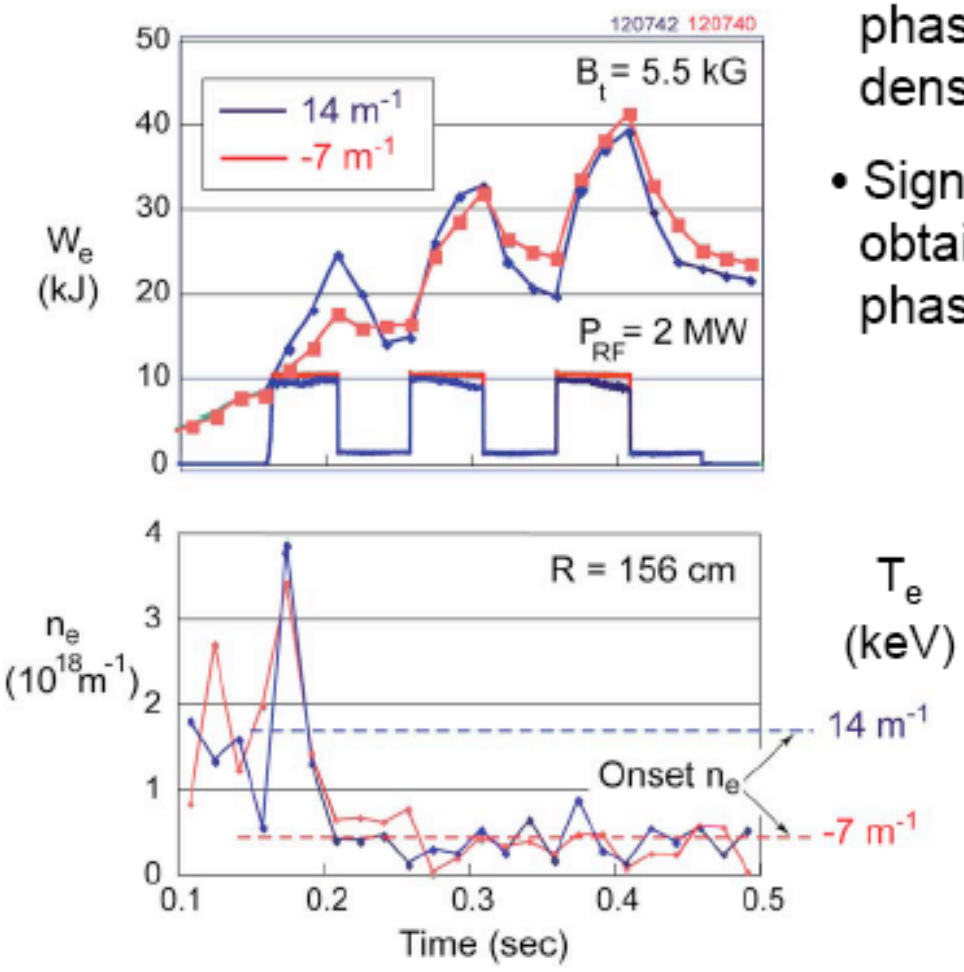
Frequency sweeps reduced



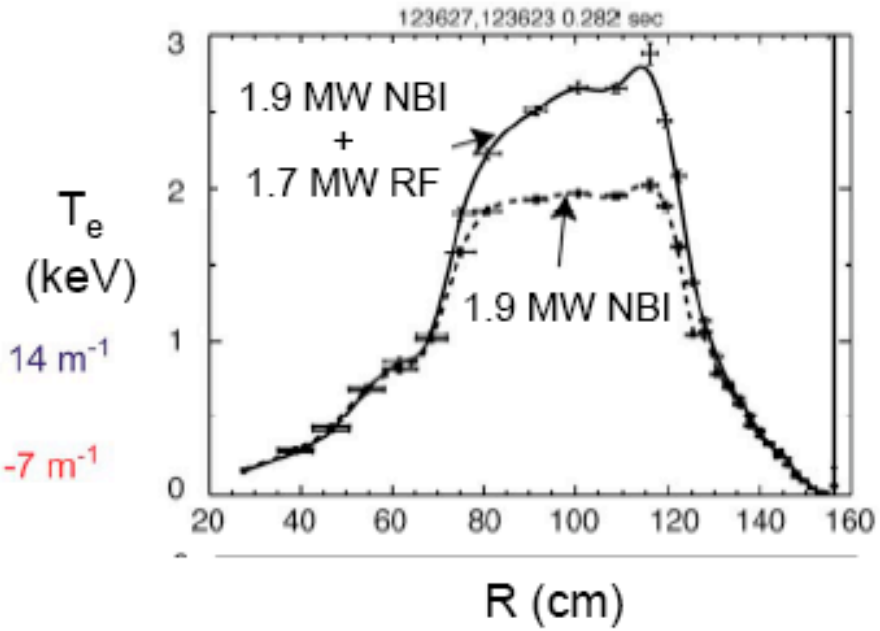
Frequency sweeps absent

For more AC/GAM coupling - See Invited talk by Crocker JI1.2 Tuesday

HHFW Coupling is improved when plasma near the antenna is below surface wave onset density



- Improved HHFW coupling for CD phasing obtained by lowering edge density **4.6 keV achieved with CD phase**
- Significant core electron heating now obtained in L-mode for CD antenna phasing during NBI at $B_t(0)$ = 5.5 kG

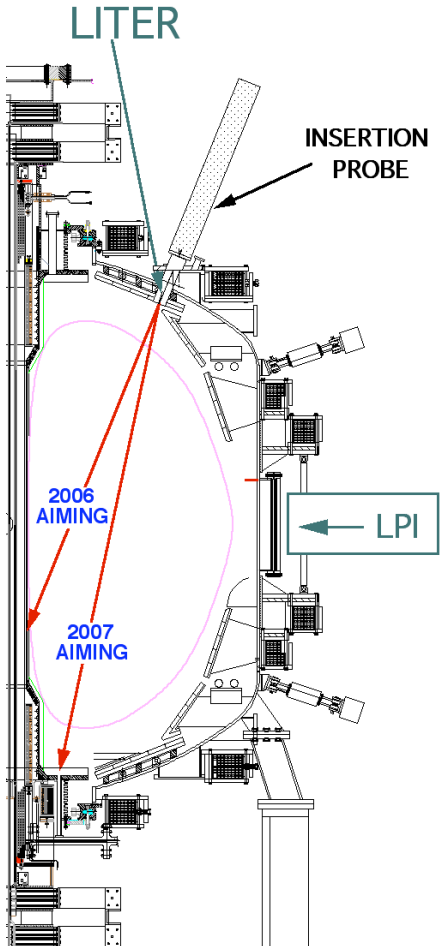


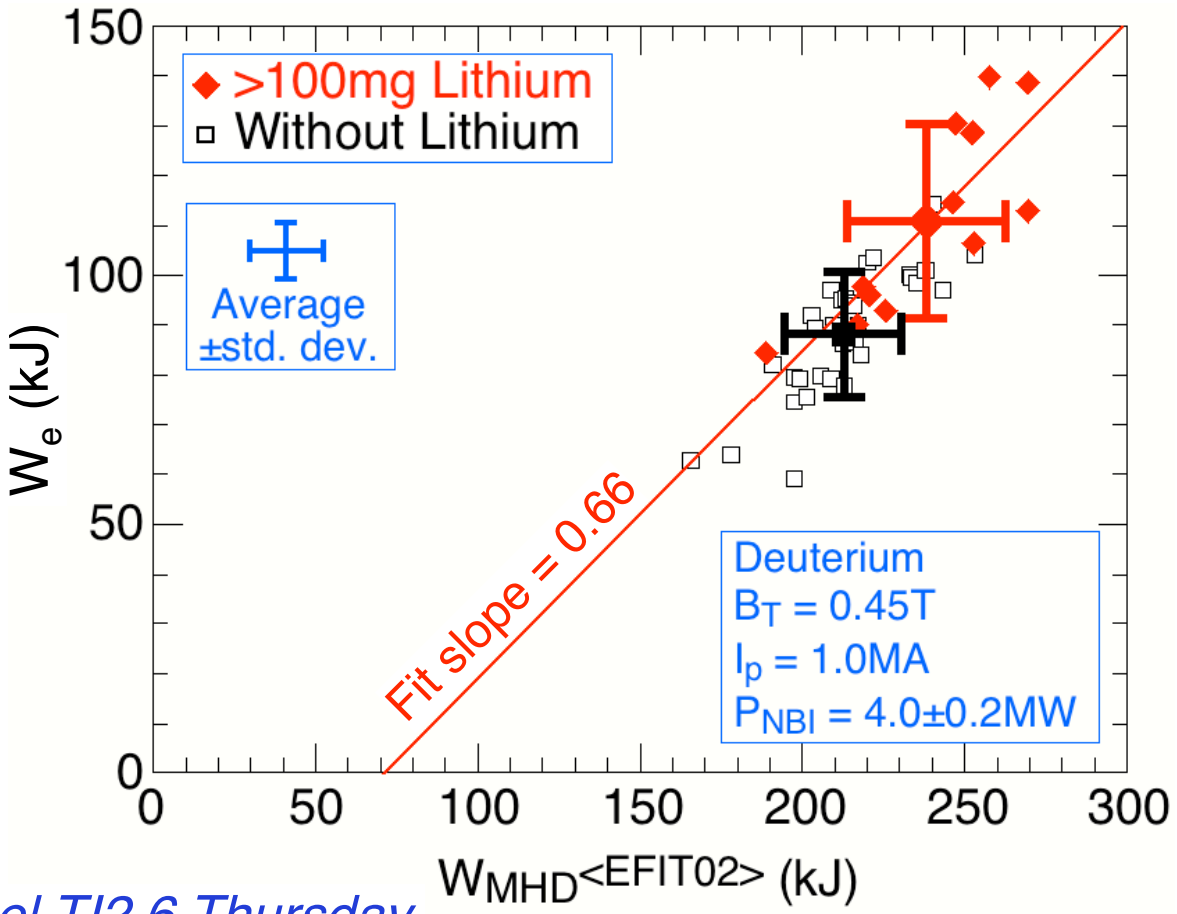
ORNL

- *See invited talk by Hosea JI1.5 Tuesday*

Lithium Evaporator (LITER) improves energy confinement time

- Improved energy confinement in H-mode plasmas 10-20%
- Much of the increase comes from electrons (broader T_e)





- *See invited talk by Kugel TI2.6 Thursday*

Summary of NSTX results from 2007

(items in red not covered in this talk, see other NSTX talks and posters for info)

- Measured high-k fluctuation spectrum in a variety of plasma conditions
  - Gaining insight into electron energy transport mechanisms
- Measured & modeled electron, particle, and angular momentum transport
- Improved RWM and EF feedback, discovered n > 1 EF, characterized tearing mode thresholds
- Measured & modeled fast ion redistribution, TAE stability, AC/GAM coupling, BAAE (new mode)
- Improved understanding of HHFW and EBW coupling efficiency vs. edge parameters
- Enhanced confinement and pumping with Li, reduced and elucidated divertor heat flux
- Initial results coupling CHI to transformer in NSTX
- Developed plasma shape and elevated q profile toward fully non-inductive scenarios

NSTX Presentations at the 2007 APS-DPP

NSTX Research Forum, Nov. 27-29, 2007
http://nstx-forum-2008.pppl.gov/index.html

NSTX Invited Talks

- **BI1.5-Mon. 11:30AM, V. Soukhanovskii** - Divertor Heat Flux Reduction and Detachment in the National Spherical Torus eXperiment
- **JI1.2-Tues. 2:30PM, N. A. Crocker** - Alfven Cascade modes at high beta in the National Spherical Torus Experiment - structure and suppression
- **JI1.5-Tues. 4:00PM, J. Hosea** - HHFW Heating Efficiency and Current Drive Enhancement at Longer Wavelengths on NSTX
- **NI1.4-Wed., 11:00AM, K.-L. Wong** - A quantitative account of electron energy transport in an NSTX plasma
- **NI1.5-Wed. 11:30AM, K. Tritz** - The Relationship between Type I ELM Severity and Perturbed Electron Transport in NSTX
- **TI2.6-Thurs. 12:00PM, H. W. Kugel** - Lithium Surface Coatings and Improved Plasma Performance in NSTX
- **UI1.1-Thurs. 2:00PM, J. E. Menard** - Progress in understanding error-field physics in NSTX spherical torus plasmas

NSTX Oral Session

- 2:12PM- "Experimental investigation of turbulent fluctuations with the scale of collisionless skin depth in NSTX plasmas", E. Mazzucato
- 2:24PM- "Internal transport barriers in NSTX reversed-shear plasmas", H. Yuh
- 2:36PM- "Beta Scaling and Momentum Transport Studies in NSTX", S. Kaye
- 2:48PM-"Gyroradius-Scale Ion Gradients in NSTX", R.E. Bell
- 3:00PM-"Active Resistive Wall Mode Feedback with Expanded Sensors in NSTX", S.A. Sabbagh
- 3:12PM-"Toroidal Alfven Eigenmode Avalanches on the National Spherical Torus Experiment", E. Fredrickson
- 3:24PM-"Dependence of the L-H power threshold on magnetic balance and heating method in NSTX", R. Maingi
- 3:36PM-"Overview of Transient CHI Plasma Start-up in NSTX and HIT-II", R. Raman
- 4:00PM-"Recent EBW Emission Results on NSTX", S.J. Diem

NSTX Poster Session

- Session TP8 - Thursday Morning