



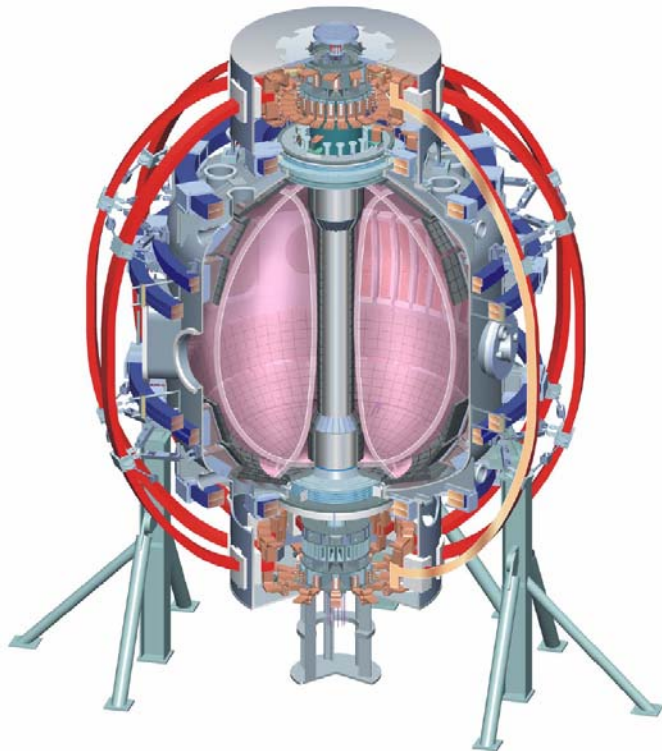
# Initial Results from XP435 - Momentum Scan & iITB Evolution

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& Many Contributing  
NSTX, MAST Team

**NSTX 2004 Results Review**

September 20 – 21, 2004  
PPPL

- Columbia U
- Comp-X
- General Atomics
- INEL
- Johns Hopkins U
- LANL
- LLNL
- Lodestar
- MIT
- Nova Photonics
- NYU
- ORNL
- PPPL
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- UC Davis
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- UCSD
- U Maryland
- U Rochester
- U Washington
- U Wisconsin
- Culham Sci Ctr
- Hiroshima U
- HIST
- Kyushu Tokai U
- Niigata U
- Tsukuba U
- U Tokyo
- JAERI
- loffe Inst
- TRINITI
- KBSI
- KAIST
- ENEA, Frascati
- CEA, Cadarache
- IPP, Jülich
- IPP, Garching
- U Quebec



# We Started to Tackle One of the Persistent Mysteries of Plasma-Fields Dynamics: Momentum Loss



- **Goals of experiment**
  - Document broad momentum scan in sustained H-mode
  - Study and understand  $\chi_\phi$  and iITB evolution
- **Scientific motivation: interplay between turbulence suppression and microinstability drive**
  - $\chi_i \sim \chi_{NC}$  over substantial zone ( $r/a \sim 0.7 - 0.9$ ), sustained
  - Coupled to high toroidal flow shear
  - Zone starts deeper ( $r/a \sim 0.5$ ) and moves out
- **Broad interest**
  - Science of Momentum Transport; ITPA
  - Identity verification with MAST, joint study
  - Comparison study with DIII-D and AUG

# About 60% of XP435 Was Carried Out, Yielding Interesting and Desired Data



- **Benefited greatly from rigorous review**
- **Thanks to excellent machine and NBI operation**
- **Allocated 5 hours, utilized 4 hours**
- **$B_{T0} = 3$  kG**
- **Executed 18 shots successfully**
- **11 shots with good data**
- **Designed 3 shots for MSE commissioning**



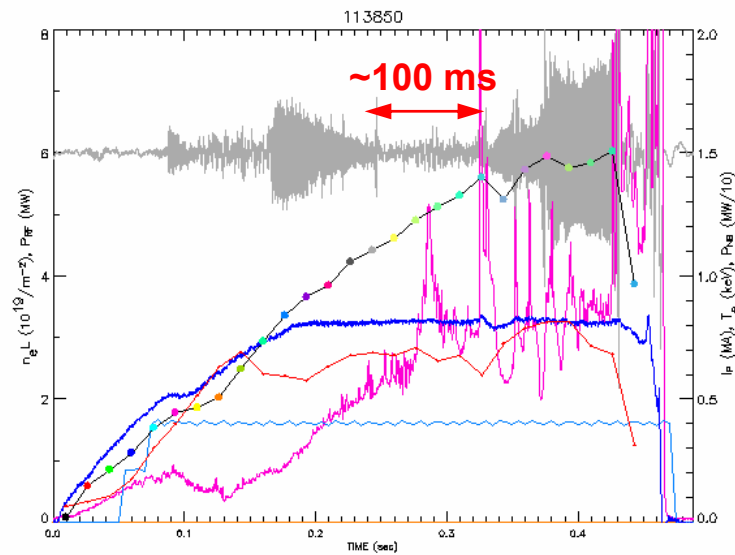
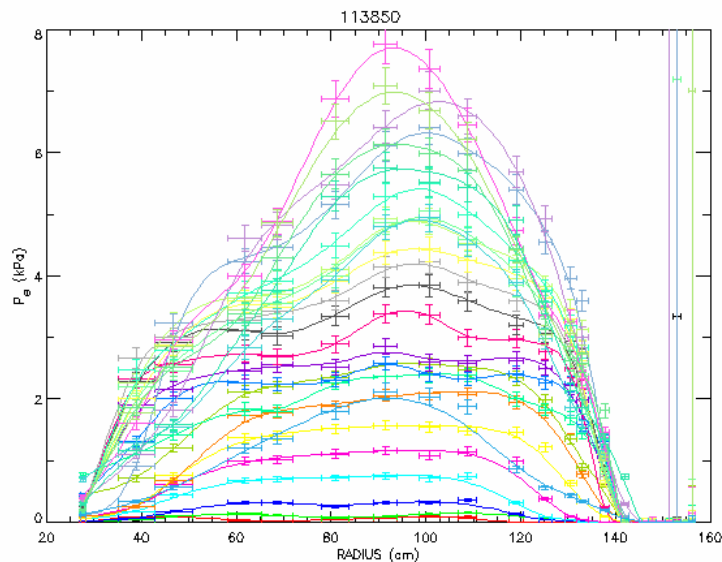
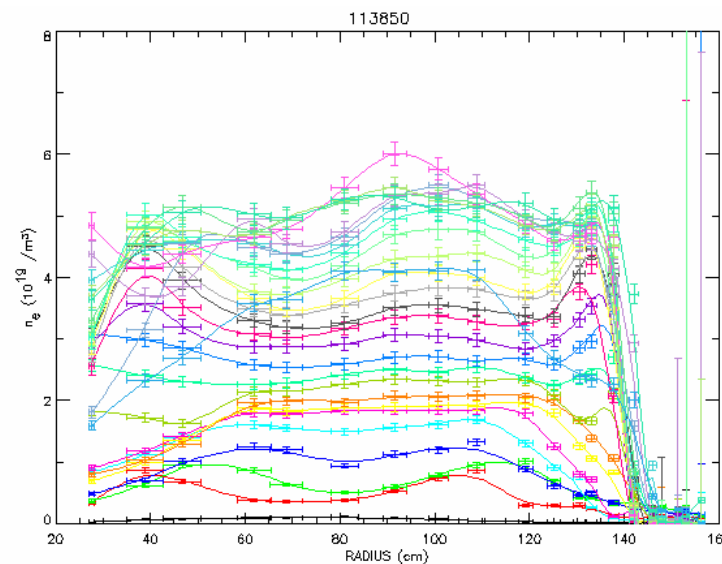
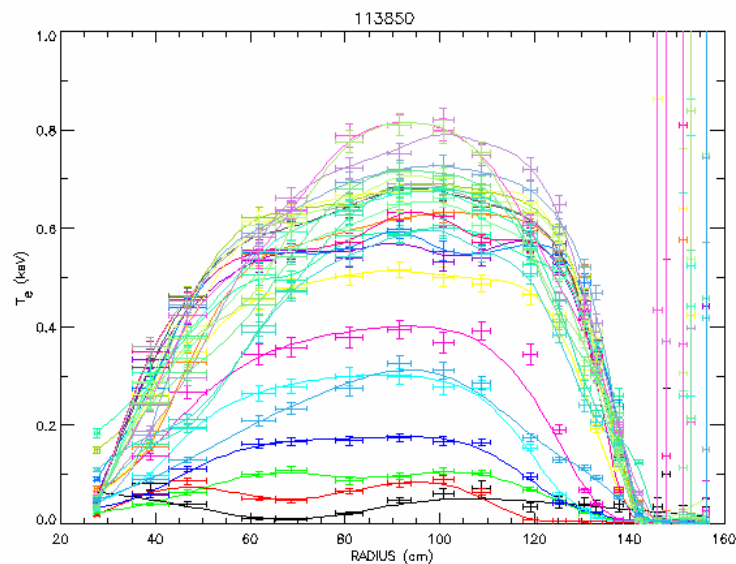
## Momentum Scan Matrix

- Combinations of [**Case: sources/energy (kV), # shots**] for constant power:

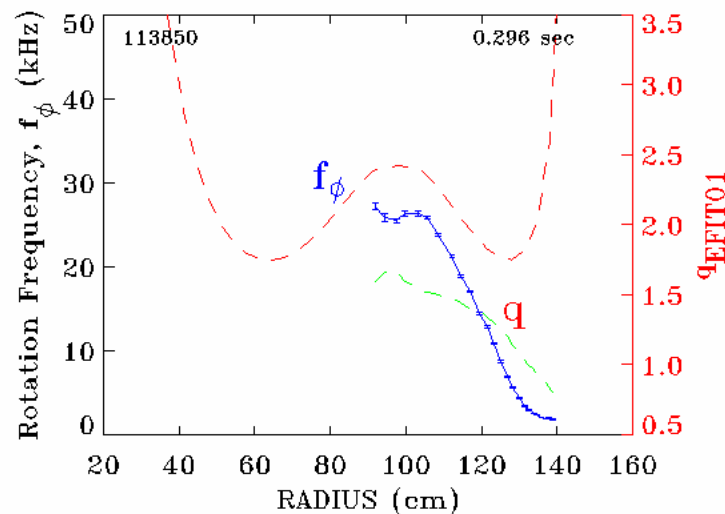
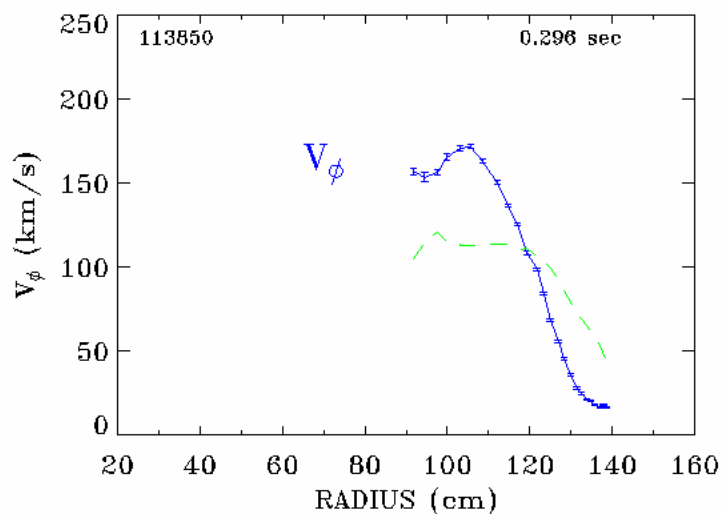
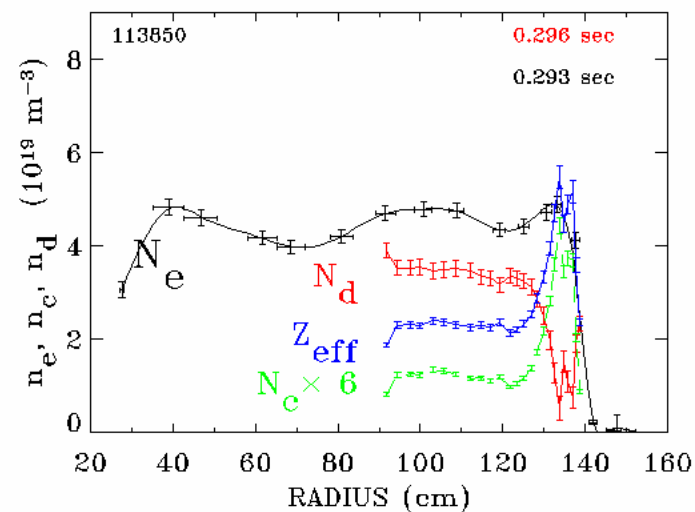
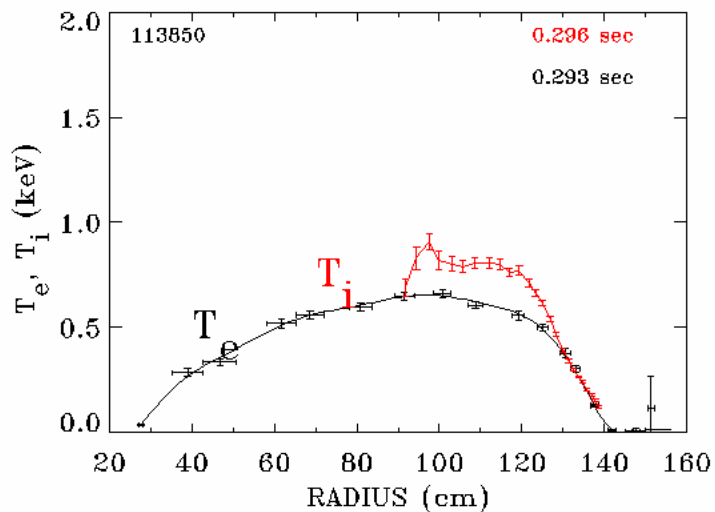
	~2.4 MW	~3.6 MW	~4.8 MW
	I: C/100, 2	II: C, 0.5B/100, 2	III: C, B/100, 2
MAST Matches	VIII: C, B/70, 2+2	IV: C, B/85, 1	V: C, B, 0.67A/85, 2
	IX: C, B, A/60, 2+2	VII: C, B, A/70, 2+2	VI: C, B, A/80, 2

- Momentum range:  $\sim E^{-0.5}$  &  $R_{\text{tang}}$  (37%) for constant power;  $\sim I_{\text{NBI}}$  (100%) for constant energy  $\Rightarrow$  produce new needed data.
- 2-sources/85-kV**  $\sim$  fiducial shot 112114, i.e., 112152 in XP401, correct shape.
- 1 or 2-sources/100-kV** = 112159, 112163, 112164, etc.  $\kappa \sim 2.1-2.2$ ,  $\delta \sim 0.6-0.7$ .
- XP411** has some momentum points, but provides only L-mode plasmas.
- Lower left 4 conditions approachable by MAST in M4.
- Run sequence for best NBI availability: 100-kV shots; 85-kV shots; 80-kV shots; 70-kV shots; 60-kV shots.
- First priority: 2.4MW & 3.6 MW shots; 2<sup>nd</sup>: 4.8MW shots; 3<sup>rd</sup>: H timing shots**

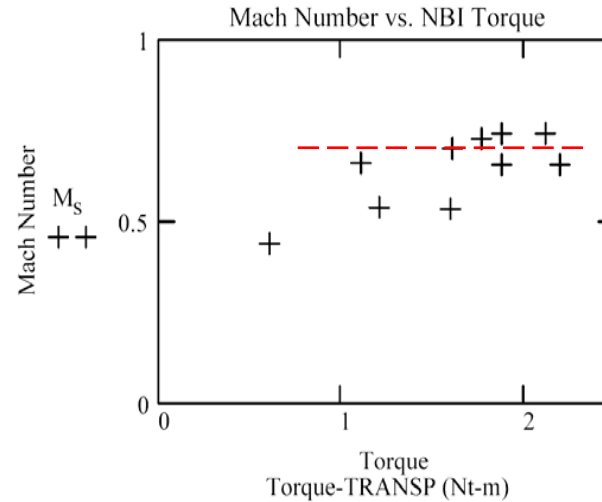
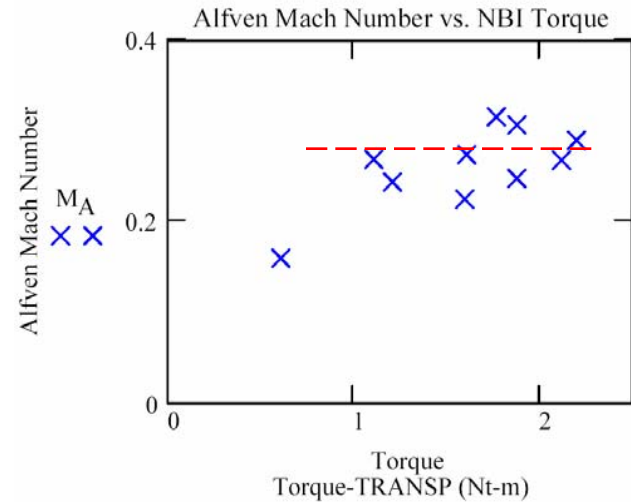
# H-Mode Plasmas Obtained with Sustained Flattop ( $>3\tau_E$ ) and Moderate MHD activities



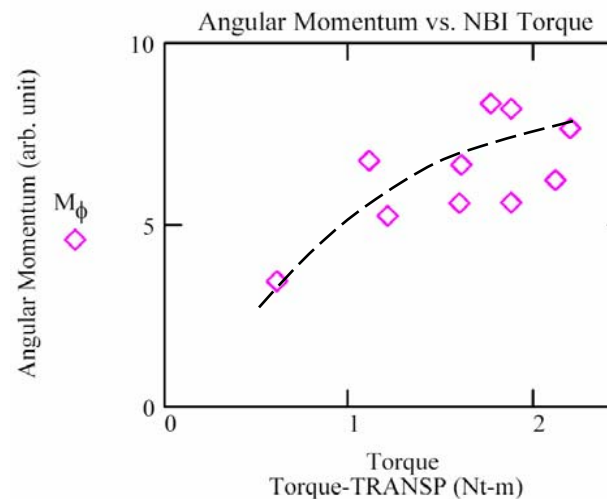
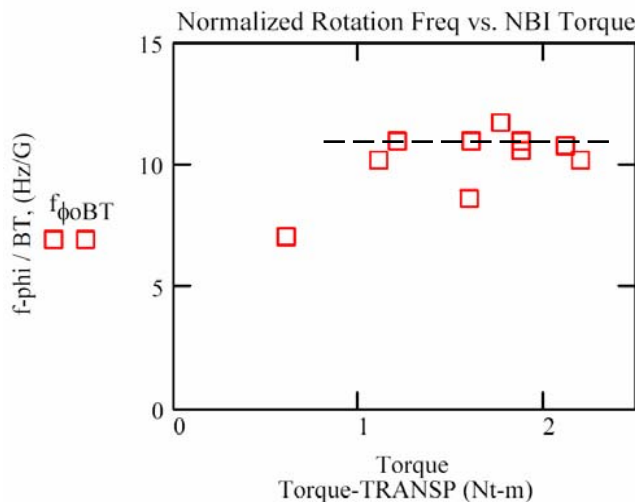
# Features of Strong Flow, Flow Shear, iITB Zone Were Produced



# Apparent Saturation in Mach Numbers and $f_{\phi}/BT_0$ vs. Torque; Angular Momentum $\propto$ Torque $^{-\alpha}$



- One point per good shot
- Only with duration  $>2tE$
- Maximum  $V_{\phi}$
- 800 kA
- $0 < \alpha < 1$



# Plans to Complete the NSTX-MAST Identity Study on Momentum Scan and iITB Evolution



- Complete XP435; include  $B_{T0} = 4.5$  kG
- Carry out similar XP on MAST in 2005
- Include appropriate existing shots from other XPs
- Identify key physics elements in iITB evolution model – D. Newman et al
- Utilize TRANSP (include EFIT with strong flow?)
- Write paper for review and journal