

ITPA T&ITB Topical Group Data Requests and Preparation – Opening Team Discussion

**Martin Peng, Ron Bell, Ed Synakowski, Ben LeBlanc,
Jon Menard, Dan Stutman, Steve Sabbagh, etc.
(and would like to suggest a few more)**

PPPL
July 30, 2003

T&ITB Issues Present Important & Timely Opportunities for NSTX Team to Contribute



- Many important issues are being identified by T&ITB Topical Group to be resolved
- Some initial examples of contributions in preparation
- Near-term issues to resolve
 - Clarify physical mechanisms for measured behavior
 - Prove or disprove formation of ITB in NSTX before H-mode transition
 - Identify physics features for transport evolution after H-mode transition
 - Suggest XPs for 2004 campaign
- We are very interested in suggestions and contributions

Suppressed χ_i allows reduced R , B_{T0} , I_p for next ST steps

Scope of T&ITB Work

- Enable comprehensive tests of theory-based transport models and simulations of burning plasmas
 - *Generate, manage and analyze experimental ITB database*
 - *Test physics basis and transport models using turbulence measurements*
- Predict transport and ITB conditions in burning plasmas
- Identify experiments to address critical ITB issues
 - *Address formation and access conditions, particle transport, fueling, core-edge, profile control, stability, etc., with $T_i \sim T_e$*
 - *Identify and facilitate inter-machine comparisons:*
 - * *Non-dimensional similarity experiments: ρ^* -scaling, etc.*
 - * *Flexibility requirements; common definition of “ITB”*
- Outline potential physics program for burning plasma device
 - *Generate operating scenarios based on demonstrated regimes*
- Coordinate with other topical groups

Research Items

1-2 Years

- Improve experimental understanding of critical issues of burning plasmas with ITB: $T_i \sim T_e$, low V_ϕ , high & flat density profile, $Z_{\text{eff}} < 2$
 - *ITB formation, evolution, and sustainment conditions*
 - *Impurity accumulation*
 - *Compatibility with divertor requirements*
- Develop, manage, and analyze new experimental ITB database
- Test simulation and modeling of ion transport
 - *e.g., JT-60U “box-like” ITB T_i profiles, JET $(r/a)_{\text{ITB-foot}}$ evolution, etc.*

Medium-Term:

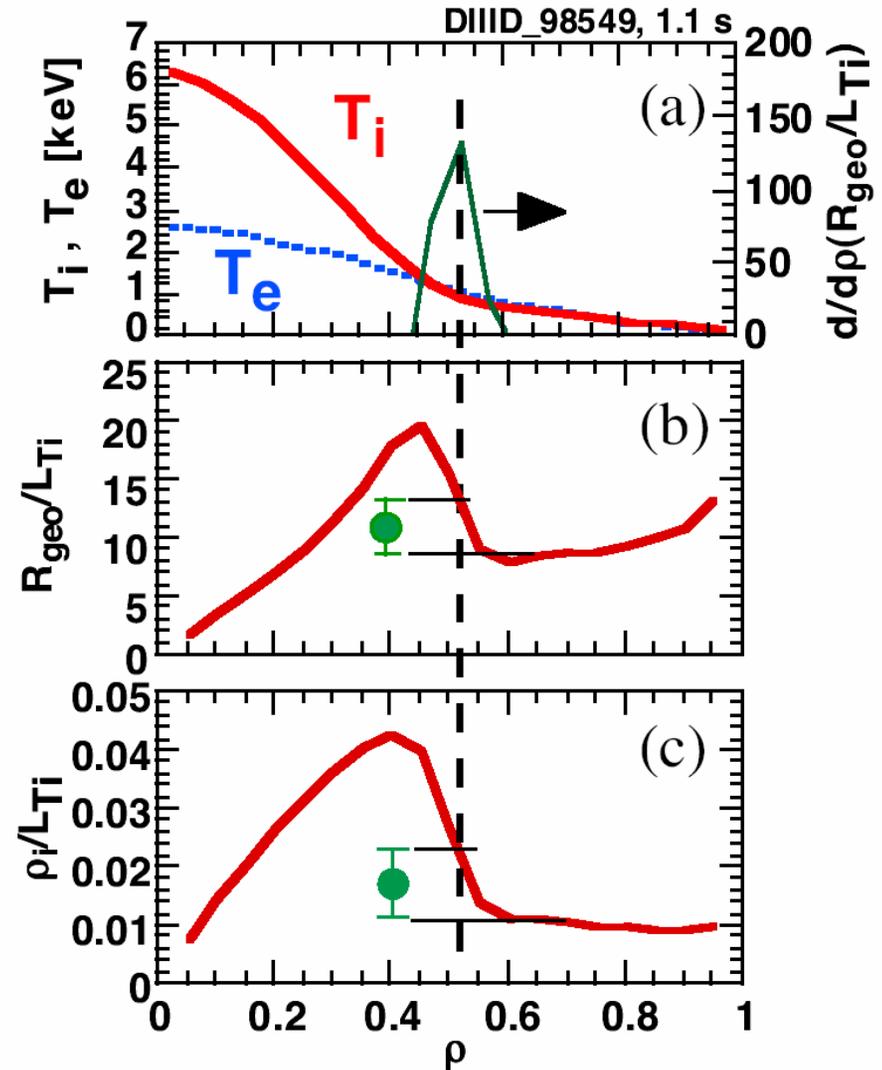
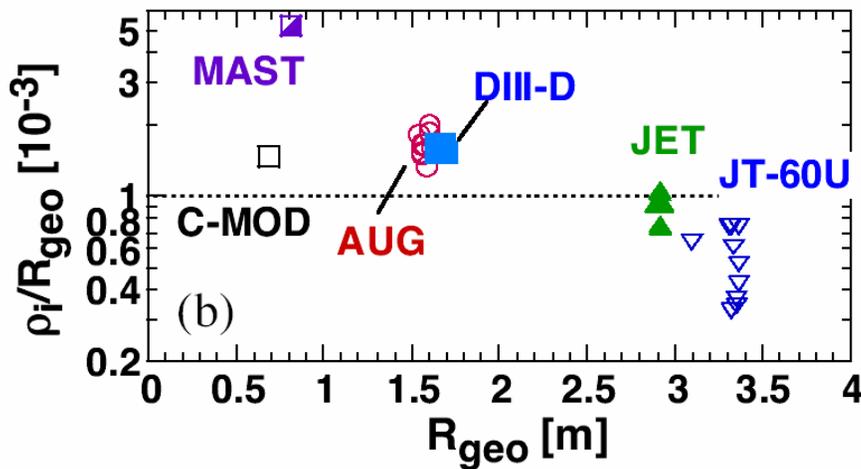
- Simulate burning plasma conditions using physics-based models
- Mature ITB database and increase physics utilization
- Improvement understanding of electron thermal, particle, and momentum transport

Long-Term

- Validate theory/modeling and provide predictive capability
- Demonstrate equivalent burning plasma regimes in today’s devices

Recent EPS Poster on ITB Provided Improved Definition of the ITB Behavior During Formation

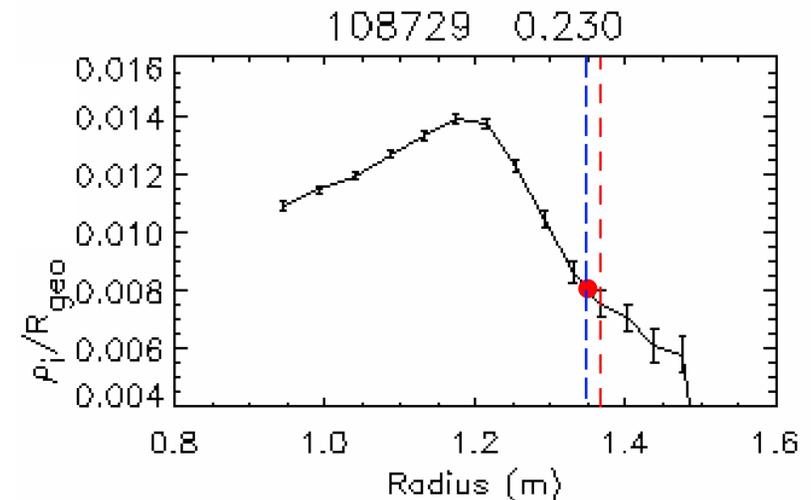
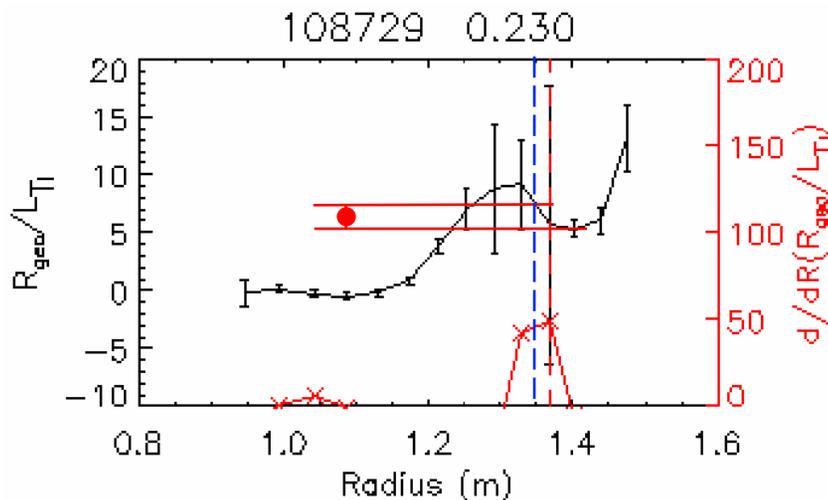
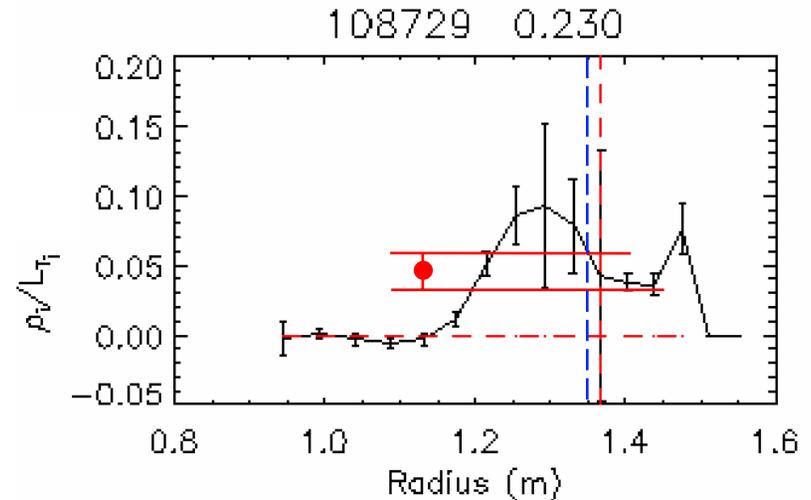
- “ITB foot” is located by **peak of $(d/dR)(R_0/L_{Ti})$** , \sim **peak of dL_{Ti}/dR**
- Critical values are defined for the “ITB foot”
 - R_0/L_{Ti} & $\rho_i^* = \rho_i/L_{Ti}$
- Also value of ρ_i/R_0 at “ITB foot”



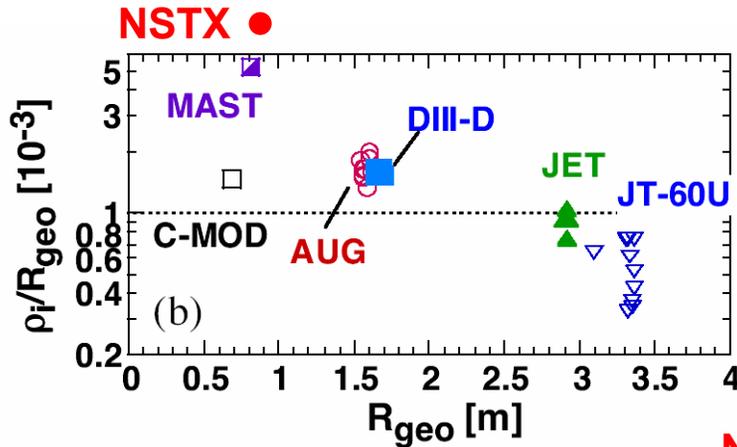
NSTX Routinely Exhibit Similar Behavior Under NBI Before H-Mode Transition



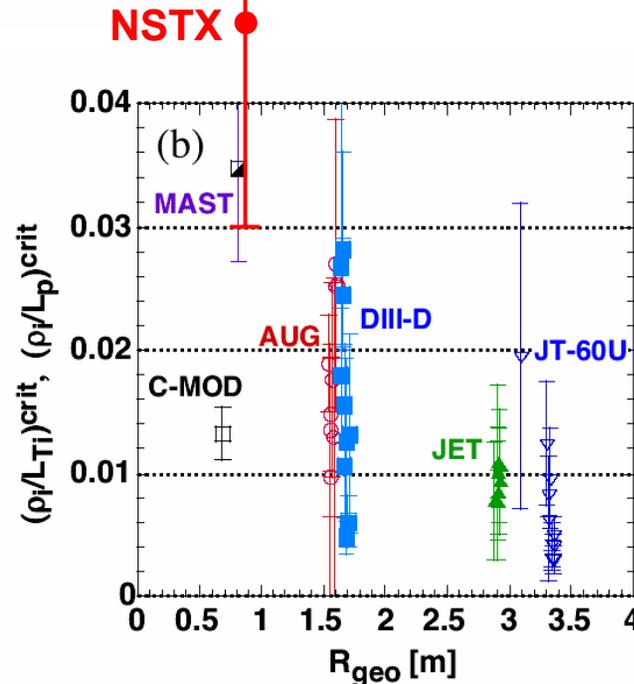
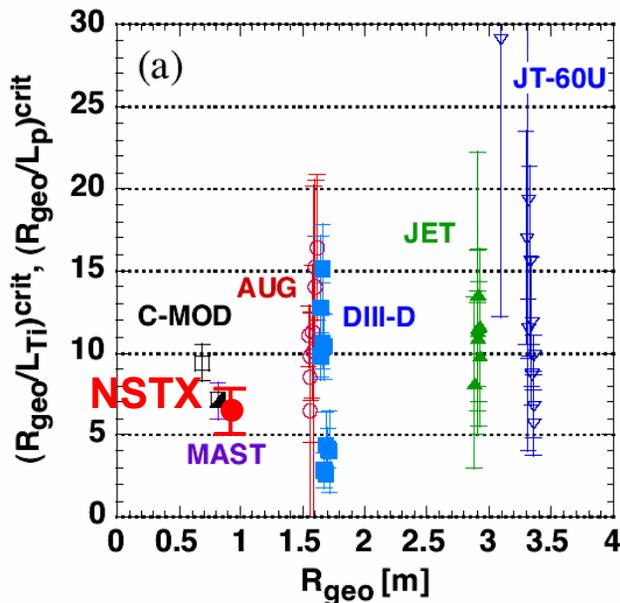
- >20 ms before H-mode transition after 2 NBI source power
- Peak (dL_{Ti}/dR) is clearly located
- Critical values measured
 - R_0/L_{Ti} & $\rho_i^* = \rho_i/L_{Ti}$
- And value of ρ_i/R_0



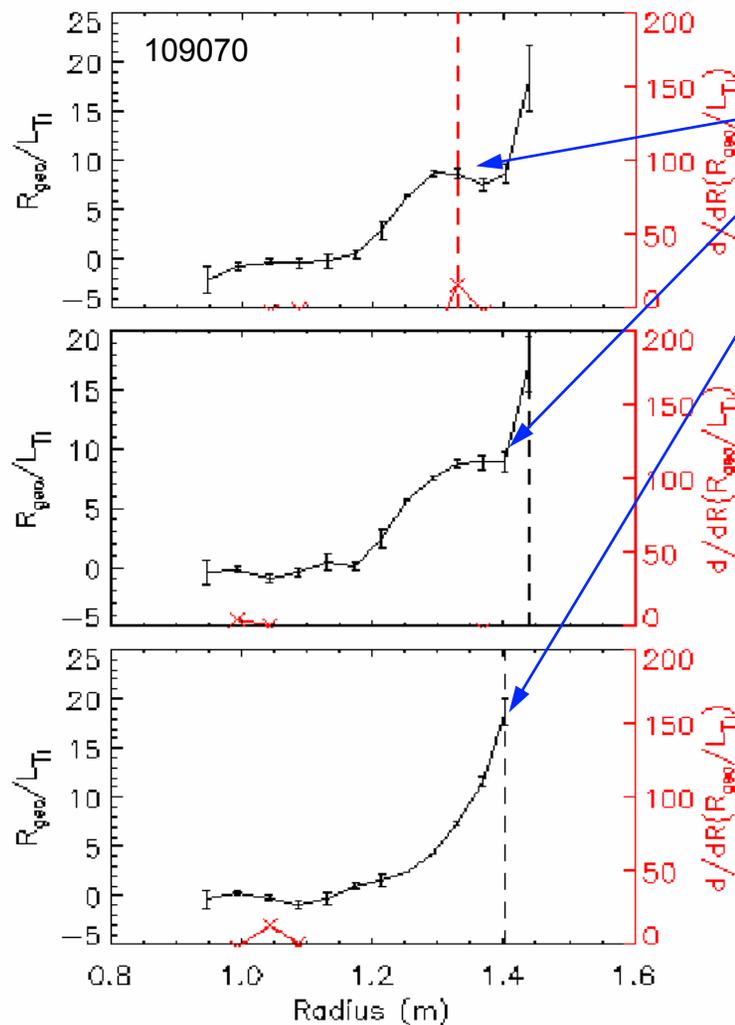
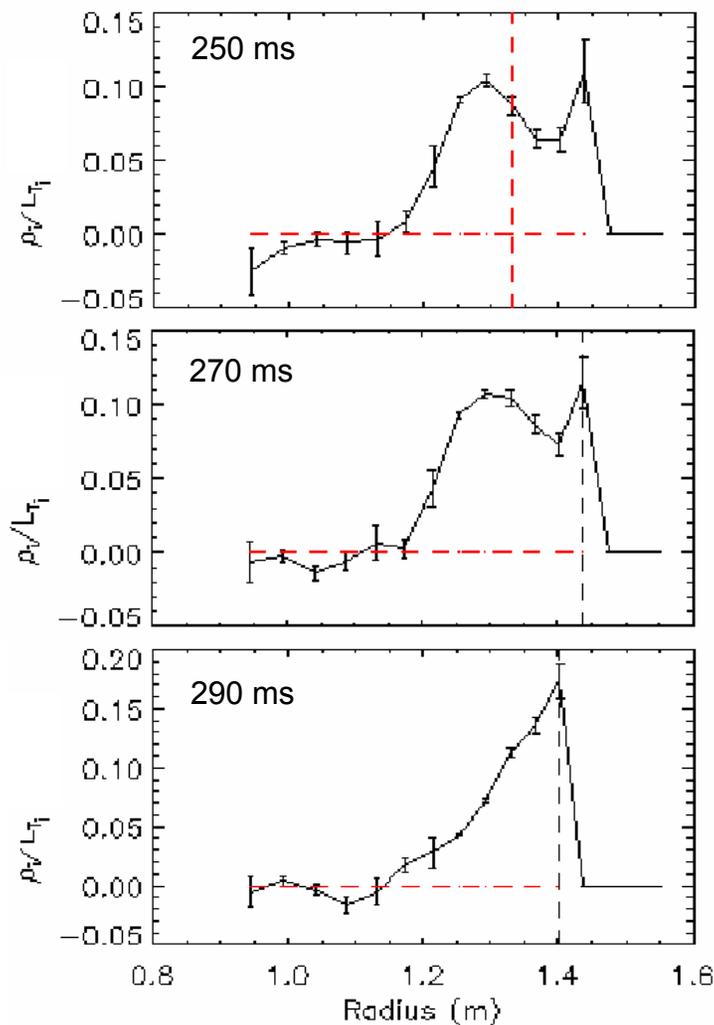
NSTX Data Generally Near or Beyond the Boundary of the Tokamak Range



“It is suggested that critical values of ρ_i/L_{Ti} depends on other quantities than ρ_i and L_{Ti} ” – Fujita

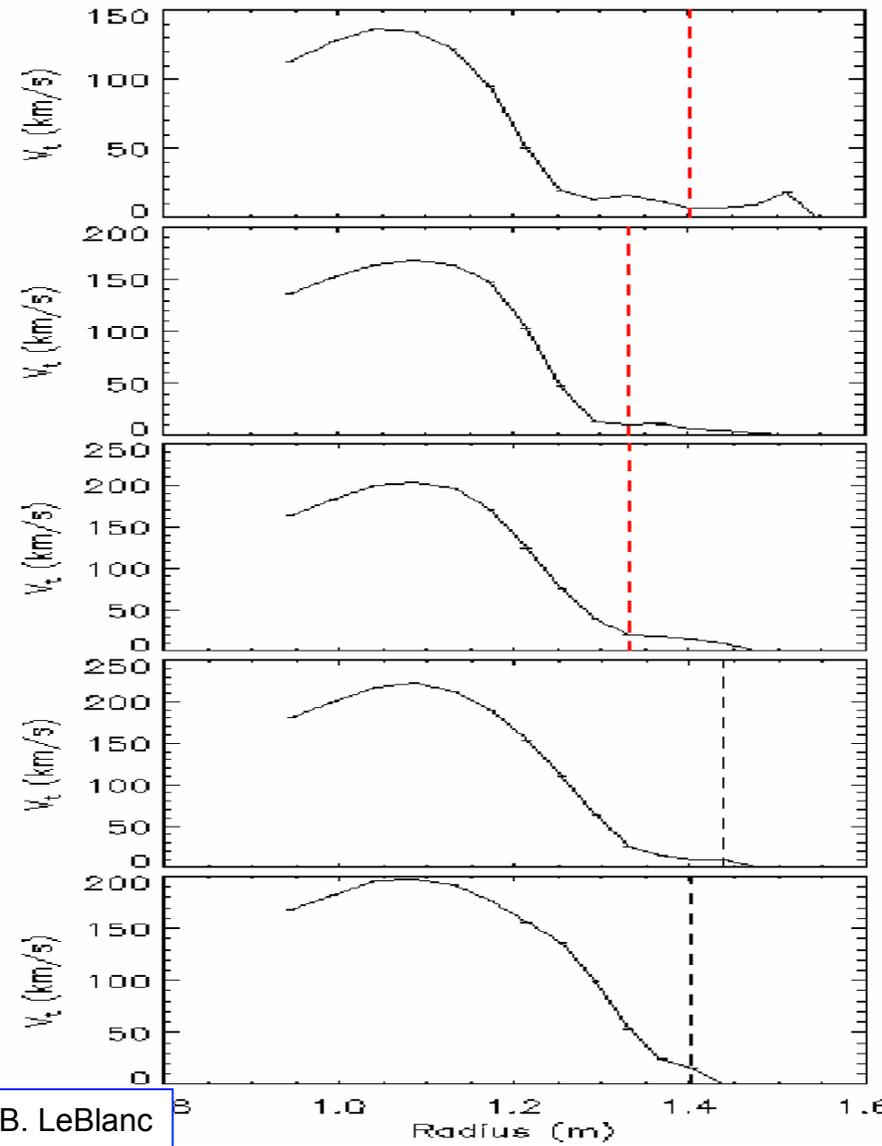
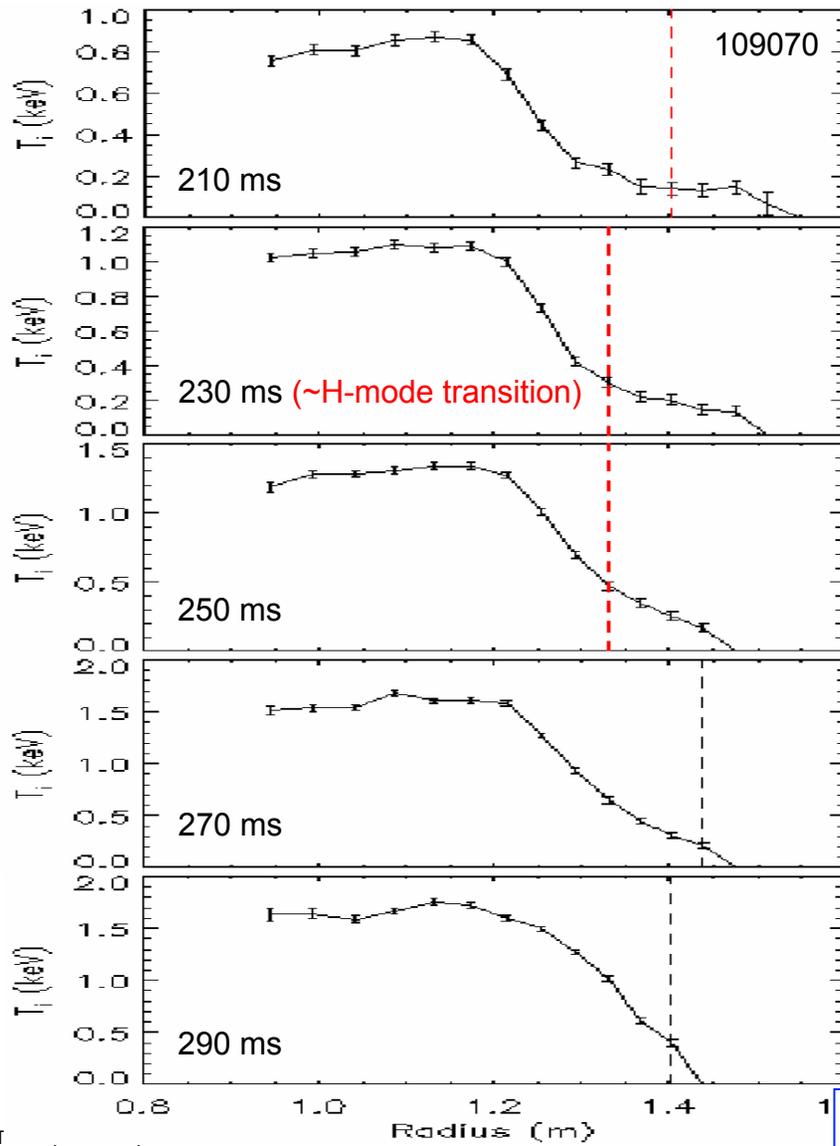


The Peak (dL_{Ti}/dR) Location Moves to Plasma Edge in ~50 ms After H-Mode Transition; Why?



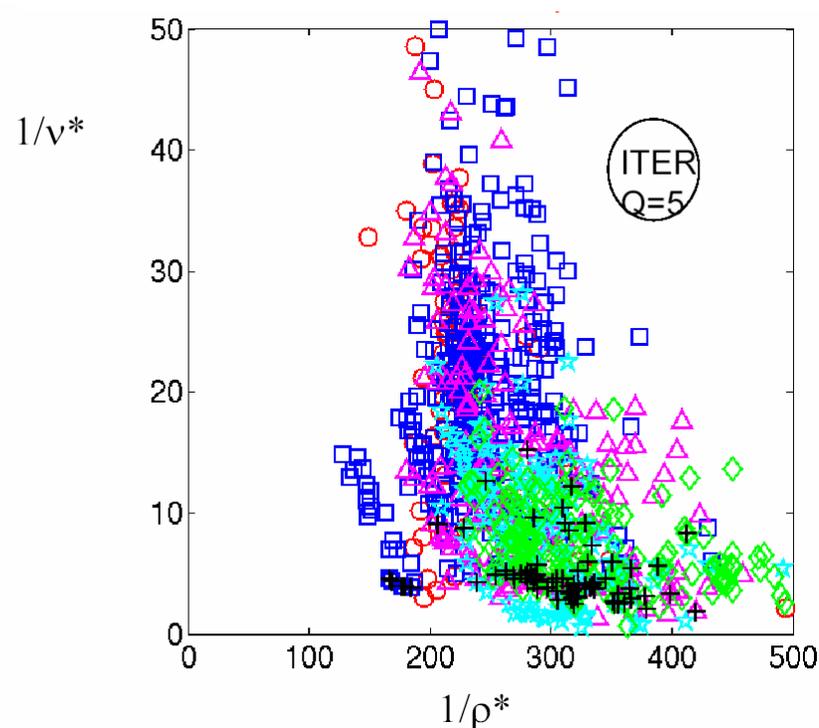
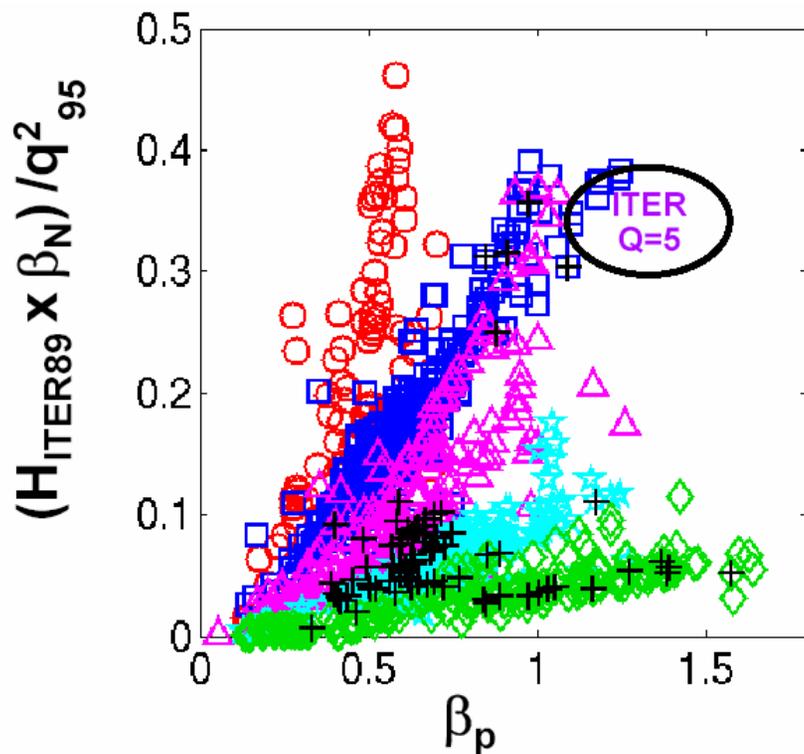
Need edge CHERS and $q(R)$.

Location of Steep T_i & V_ϕ Gradients Broadens and Moves Outward Following H-Mode Transition

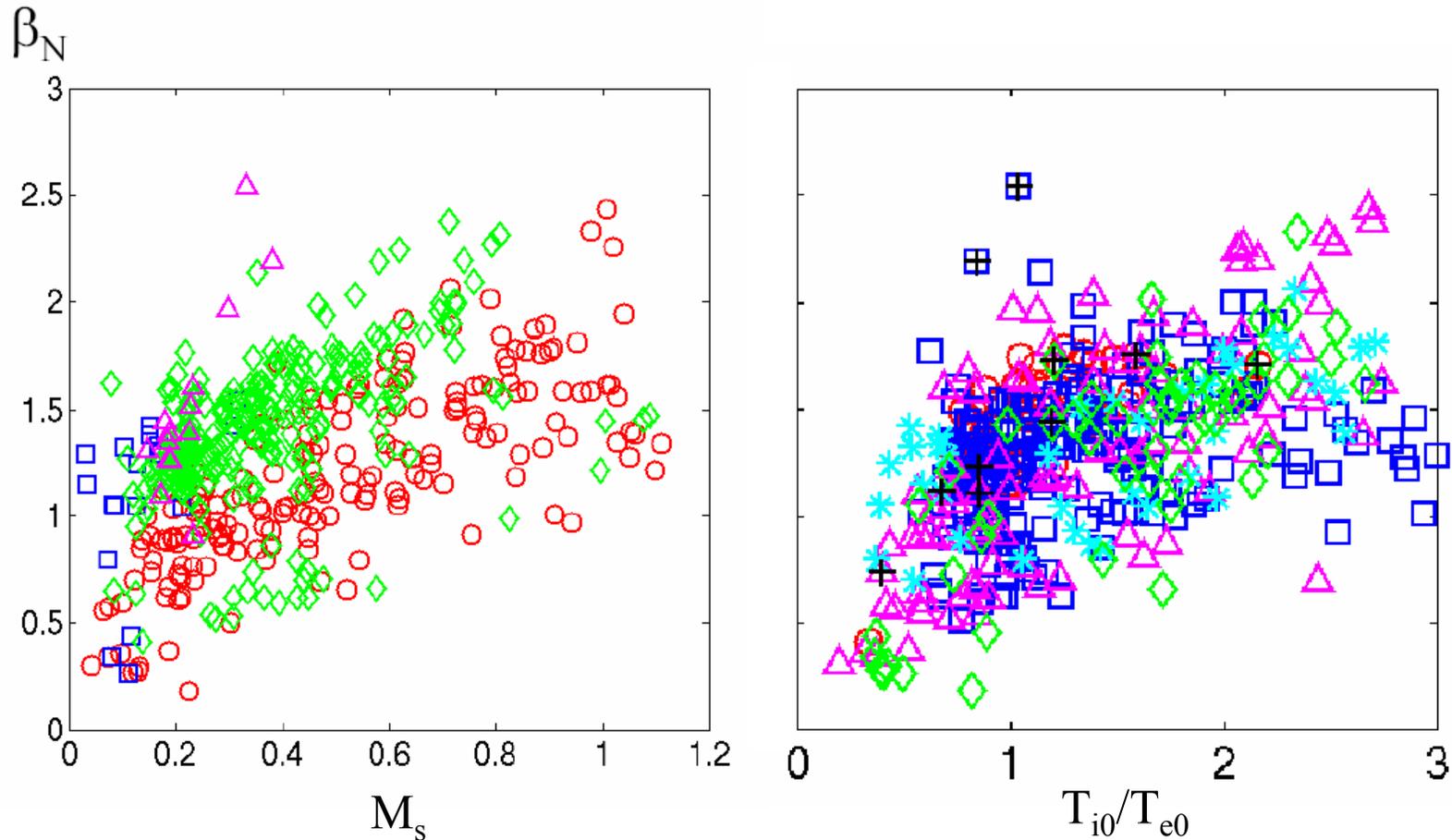


T&ITB Group Has Requested Data on “Advanced Regime” Plasmas over Wide Parameter Ranges (I)

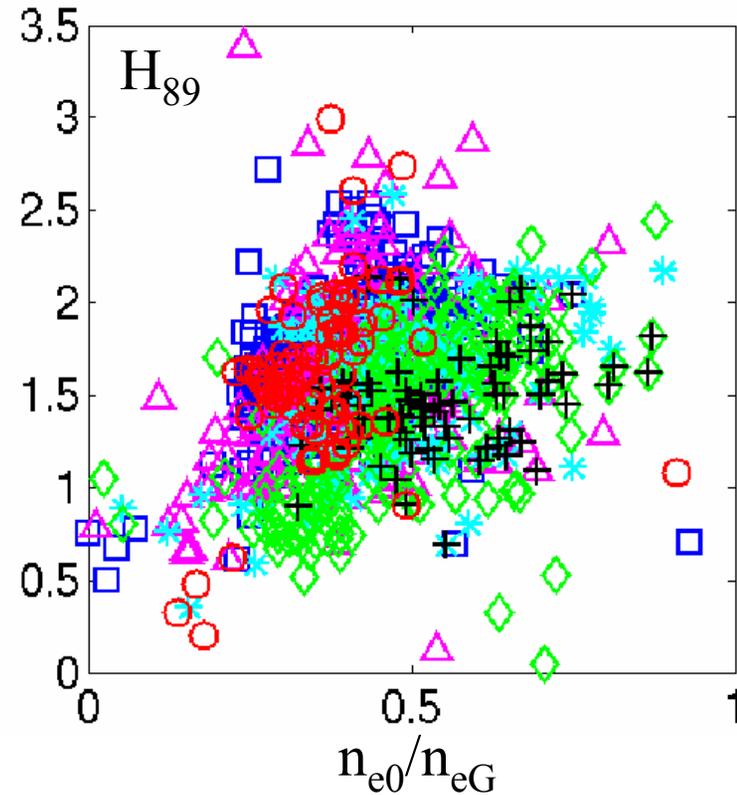
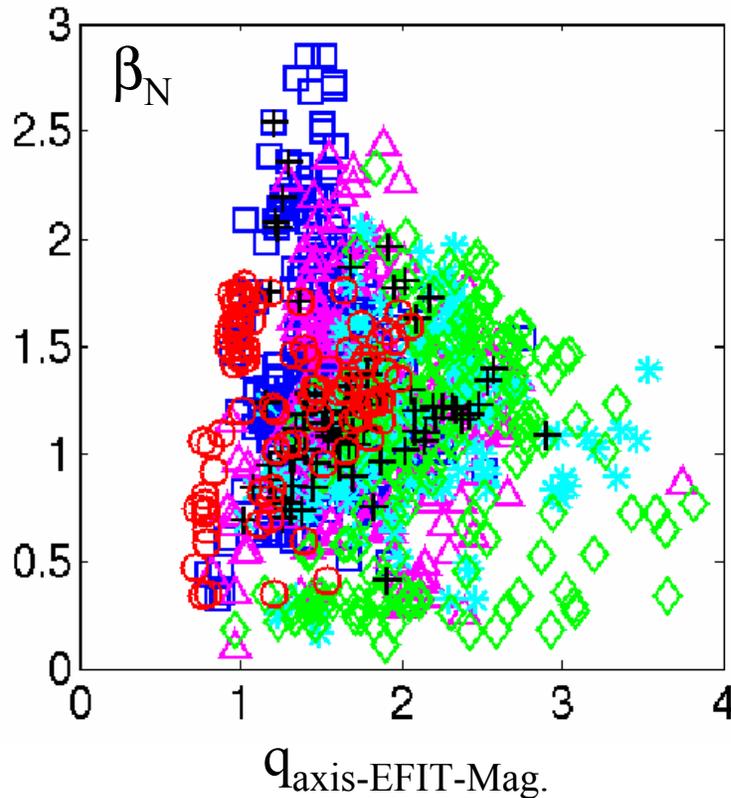
- $2.8 \leq q_{95} < 3.4$ + $\langle \delta \rangle > 0.4$
- $3.4 \leq q_{95} < 4$ ☆ $5 \leq q_{95} < 6$
- △ $4 \leq q_{95} < 5$ ◇ $q_{95} \geq 6$



T&ITB Group Has Requested Data on “Advanced Regime” Plasmas over Wide Parameter Ranges (II)

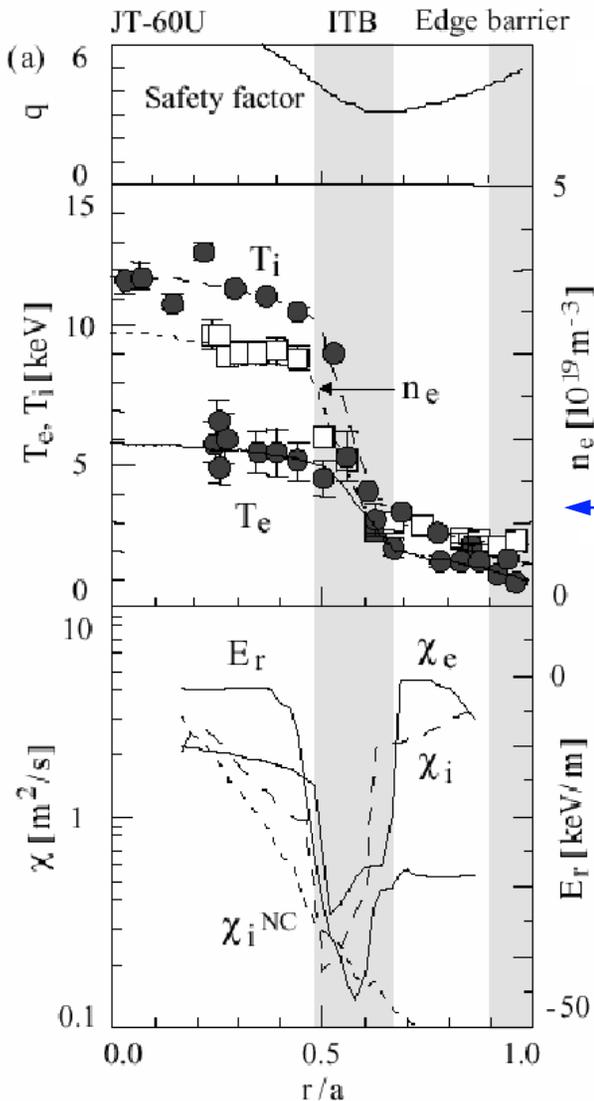


T&ITB Group Has Requested Data on “Advanced Regime” Plasmas over Wide Parameter Ranges (III)



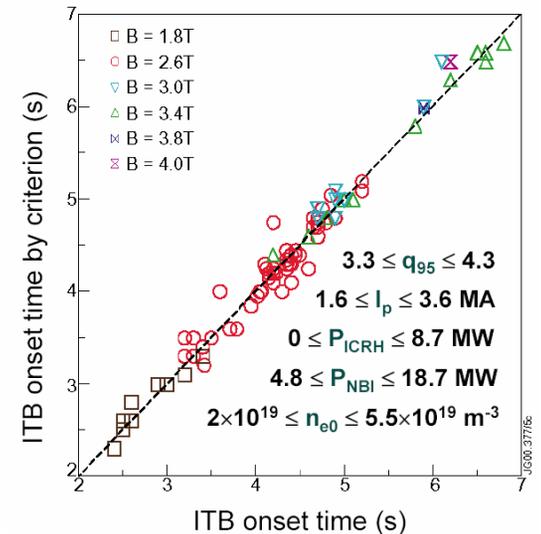
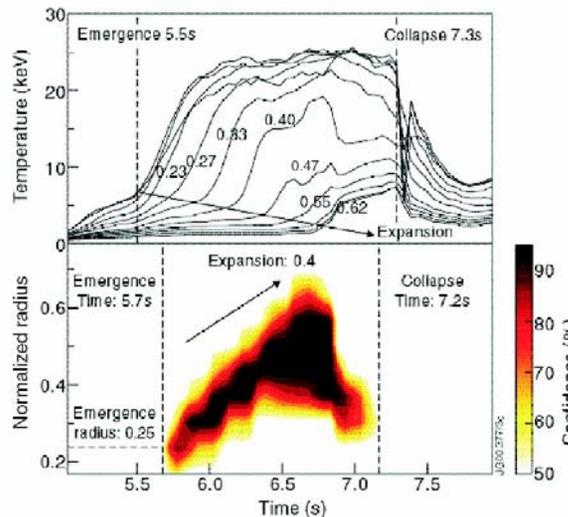
Parameter space will be expanded by NSTX data.

Additional Requested Data



Koide, PoP, 1997

- 0-D analysis: cf separate file
- ITB criterion (Tresset, NF, 2002):
 - Onset time and location according to JET $(\rho/L_{Ti})_{critical} \sim 0.014$
 - Onset time and location according to $T(t,R)$ traces
 - Toroidal field, etc.
- Suggest appropriate criterion (χ_i, χ_{NC} , etc.)



J600-3776

T&ITB Issues Present Timely Opportunities for NSTX Team to Contribute Strongly



- Many important issues are being identified to be resolved
- NSTX is ready to select and contribute initial data as requested
- Near-term issues to resolve
 - Clarify mechanisms for measured behavior
 - Prove or disprove formation of ITB in NSTX: χ_i , χ_{NC} vs. R , etc., before and immediately following H-mode transition; TRANSP
 - Clarify key physics features for evolution after H-mode transition
 - Suggest key XPs for 2004 campaign
- We are very interested in suggestions and contributions

NSTX Routinely Exhibit Similar Behavior Under NBI Before H-Mode Transition



- >20 ms before H-mode transition after 2 NBI source power
- Minimum L_{Ti} is clearly located
- Critical values measured
 - R_0/L_{Ti} & $\rho_i^* = \rho_i/L_{Ti}$
- And value of ρ_i/R_0

