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, $Z_{eff} < 2$
  - *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 $(r/a)_{ITB\text{-}foot}$ evolution, etc.*

Medium-Term:

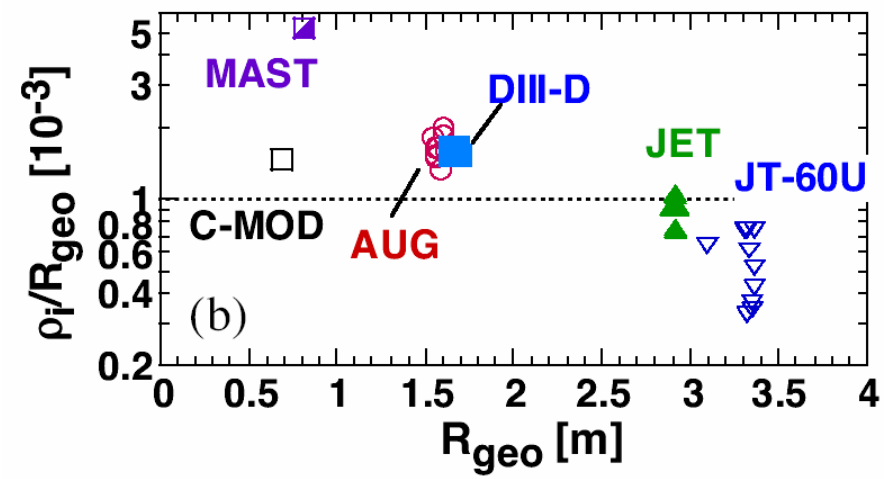
- Simulate burning plasma conditions using physics-based models
- Mature ITB database and increase physics utilization
- Improvement understanding of electron thermal, particle, and momentum transport

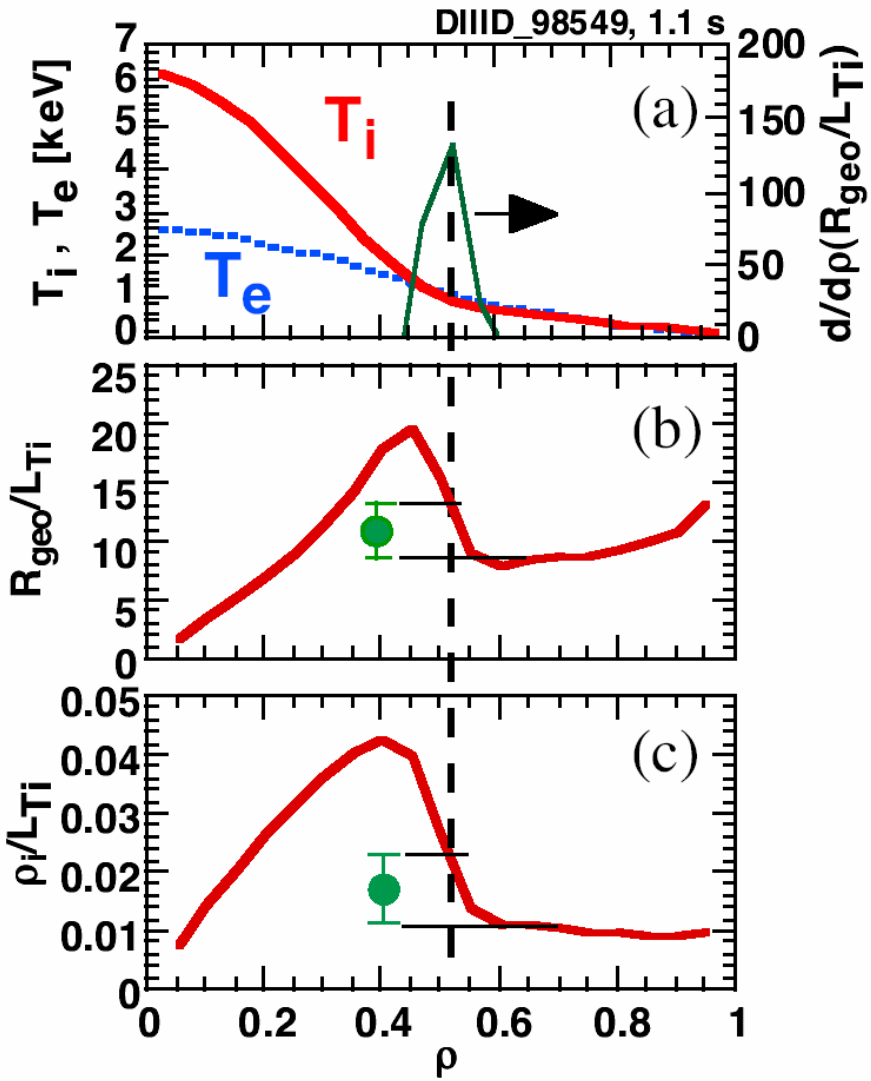
Long-Term

- 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 $(d/dR)(R_0/L_{Ti})$, ~ 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"

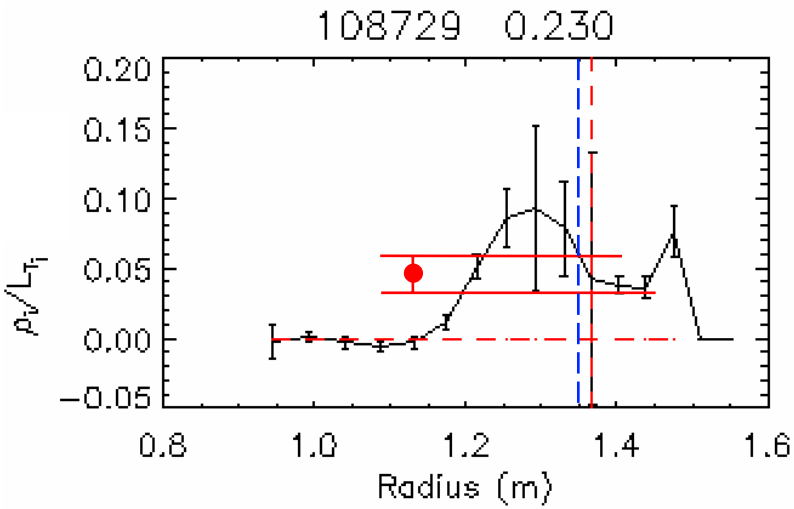


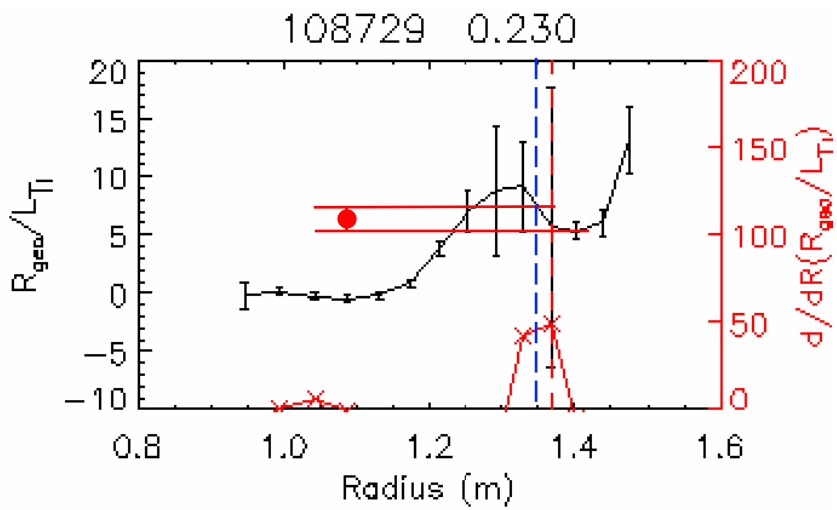


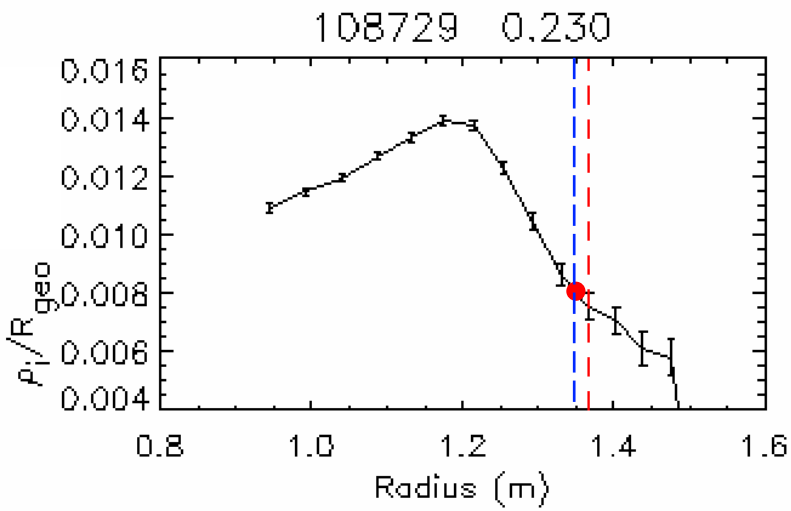
Fujita, EPS P.2-131, plot from DIII-D weak shear ELMy H-mode plasma

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







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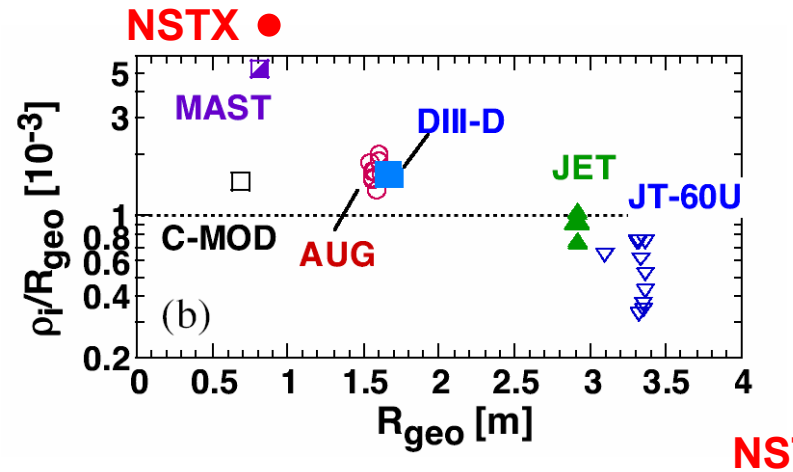
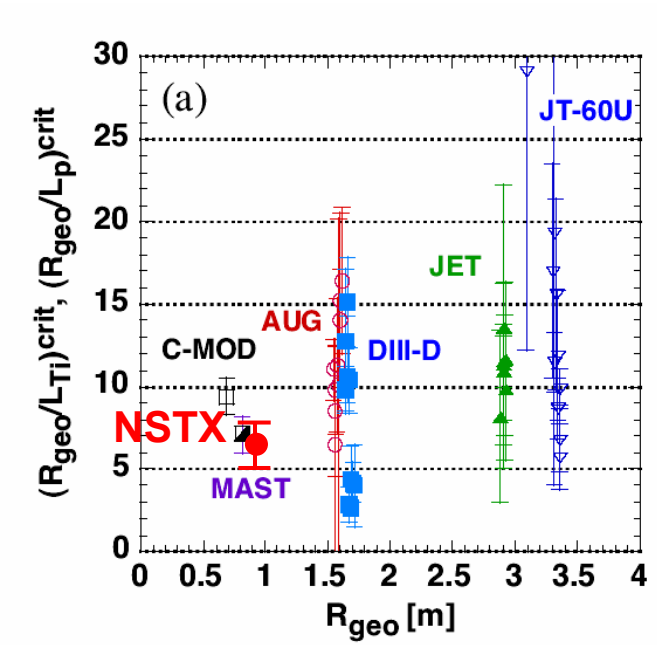
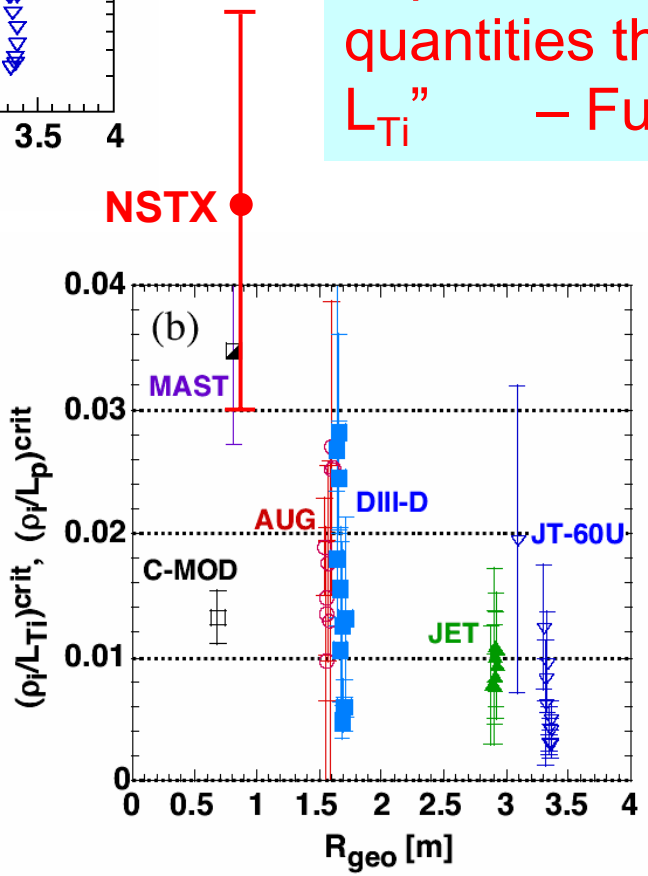
NSTX Data Generally Near or Beyond the Boundary of the Tokamak Range

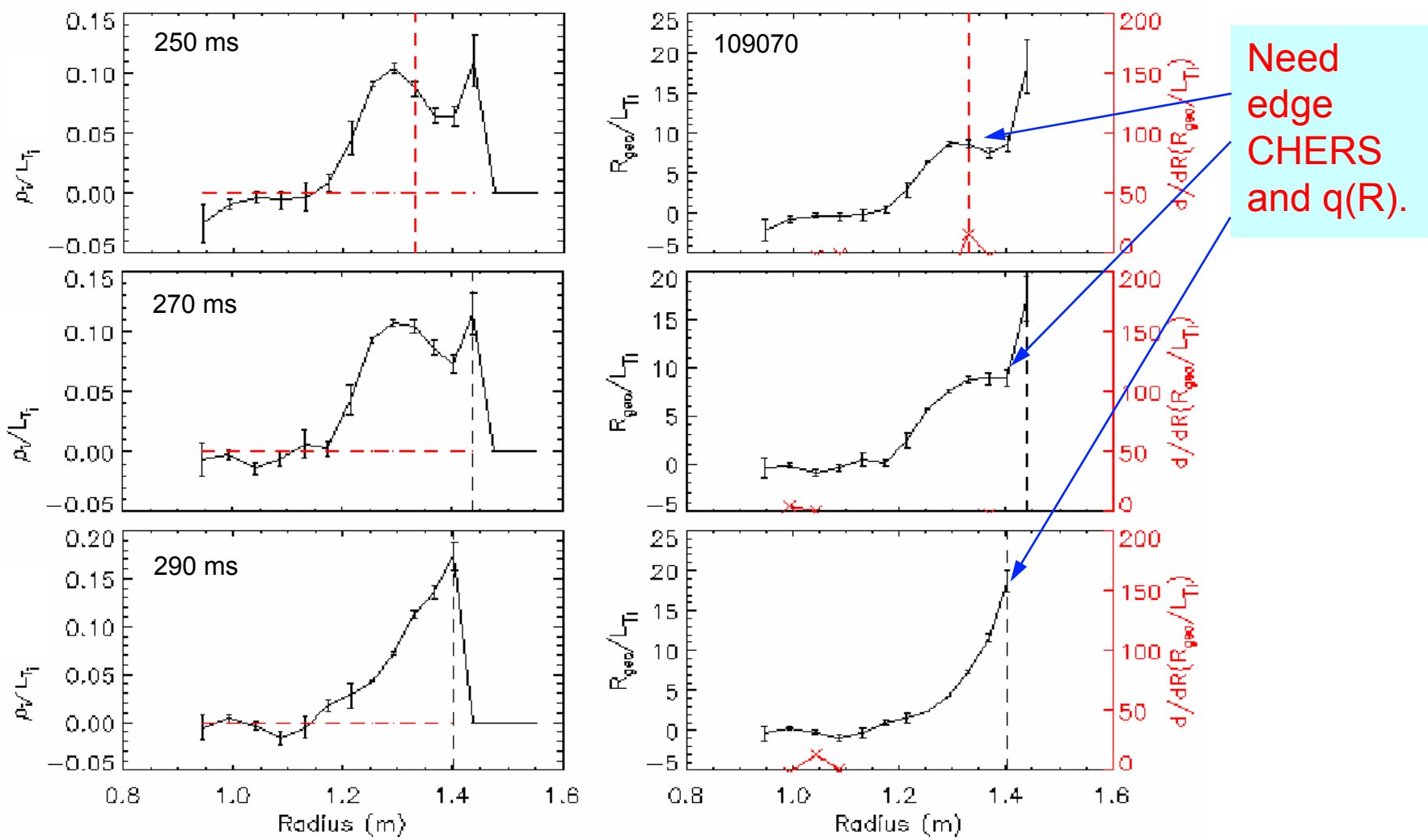


"It is suggested that critical values of ρ_i/L_{Ti} depends on other quantities than ρ_i and L_{Ti}" – Fujita





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



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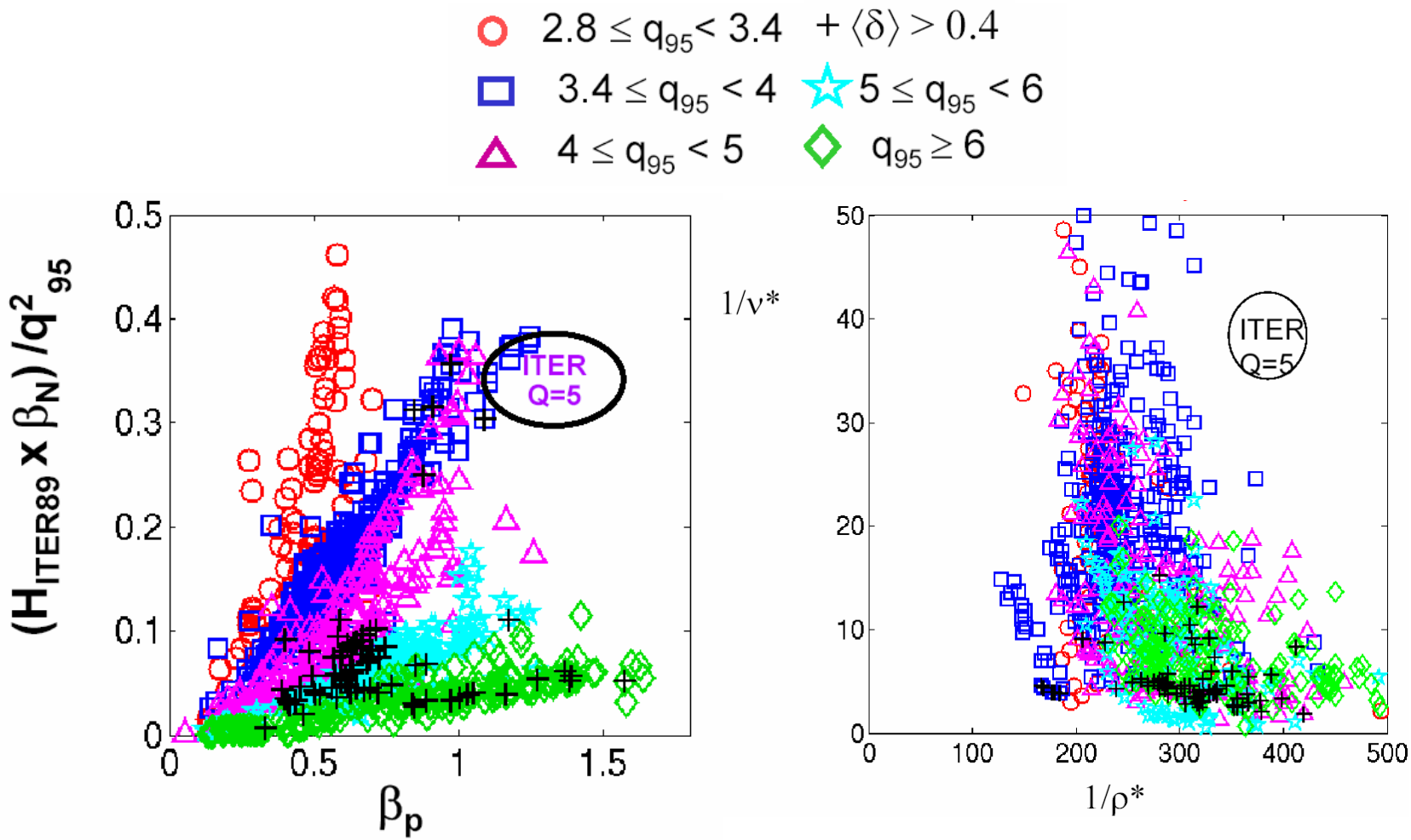
T&ITB Group Has Requested Data on "Advanced Regime" Plasmas over Wide Parameter Ranges (I)



Litaudon, 4th Mtg of ITPA Topical Group on T&ITB, Apr. 2003

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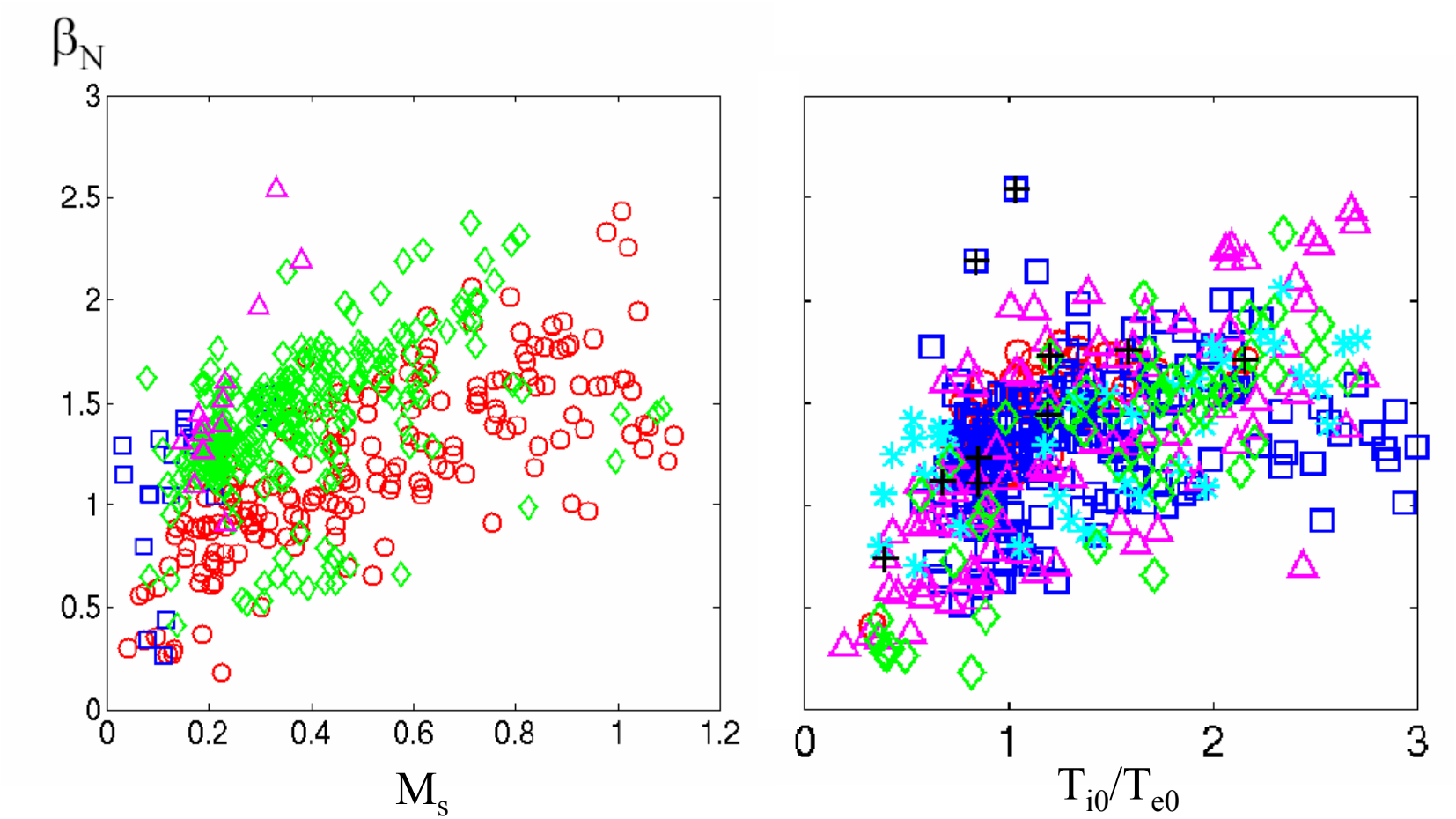

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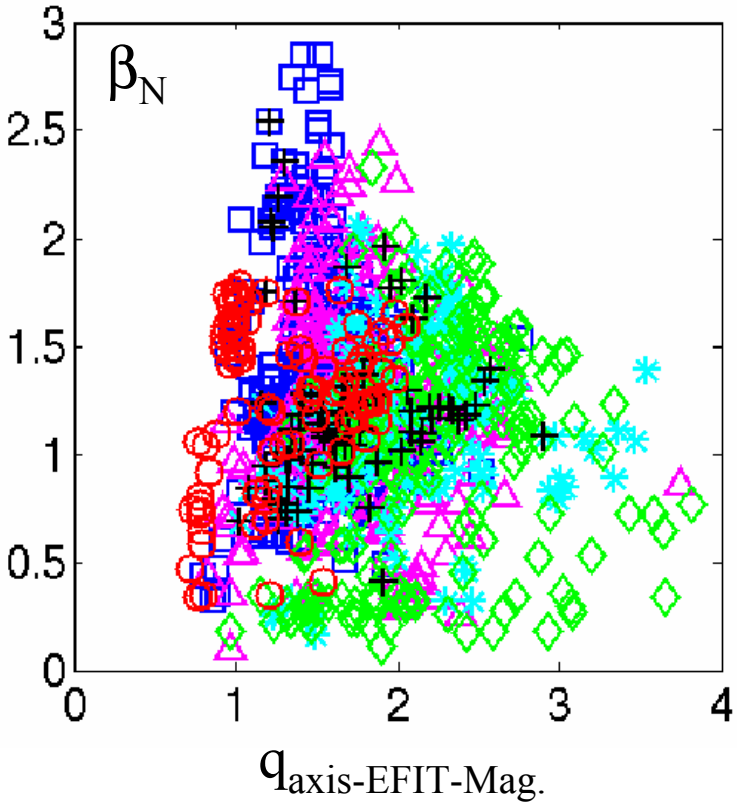
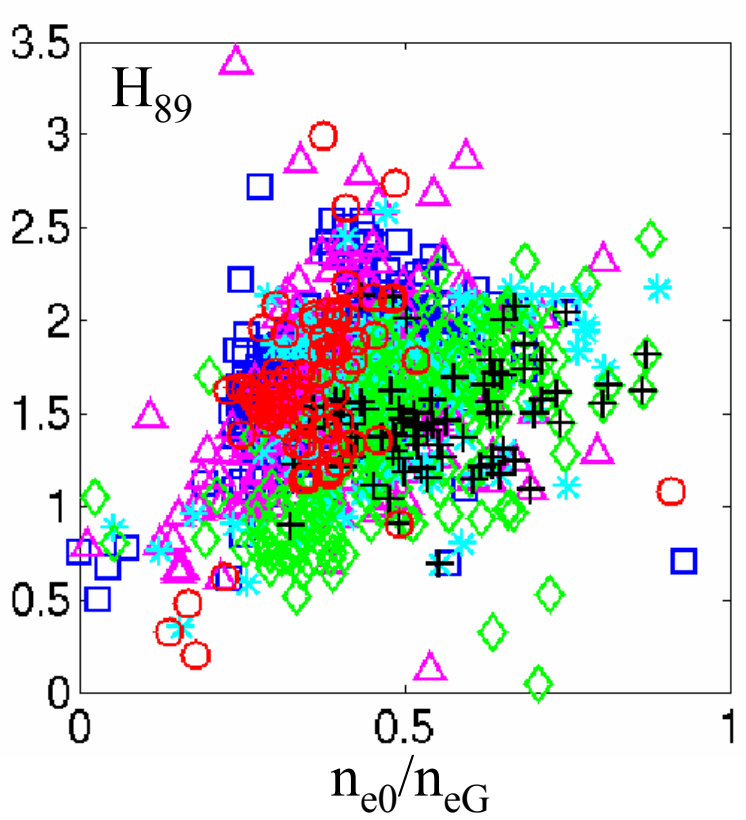
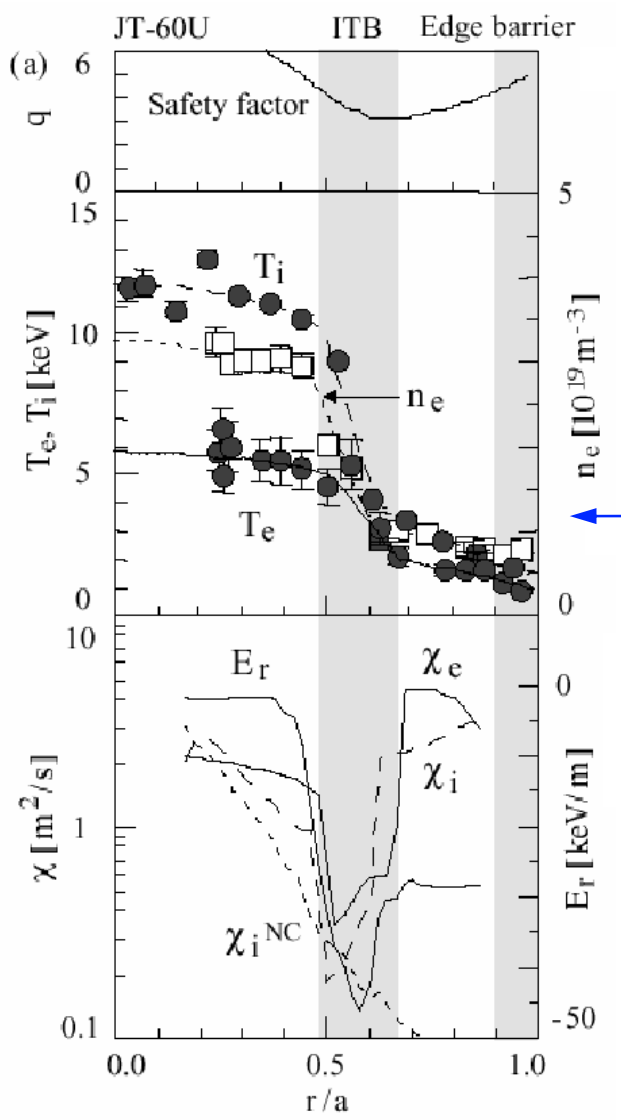




Parameter space will be expanded by NSTX data.

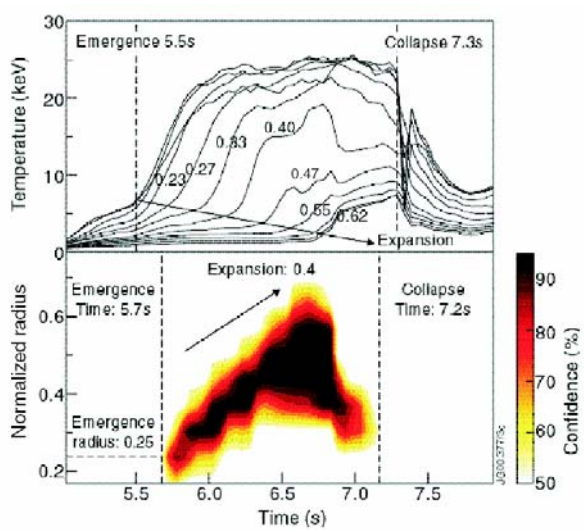
Litaudon, 4th Mtg of ITPA Topical Group on T&ITB, Apr. 2003

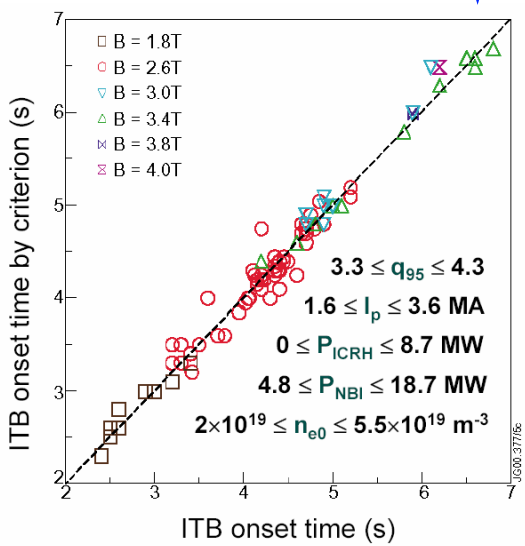
Additional Requested Data



Koide, PoP, 1997

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





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 H-mode transition
  - Clarify key physics features for evolution after H-mode transition
  - Suggest key XPs for 2004 campaign
- We are very interested in suggestions and contributions

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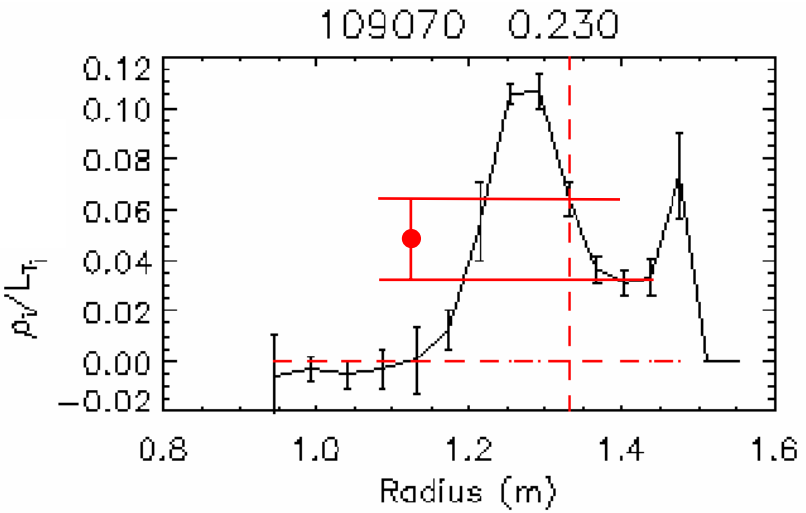

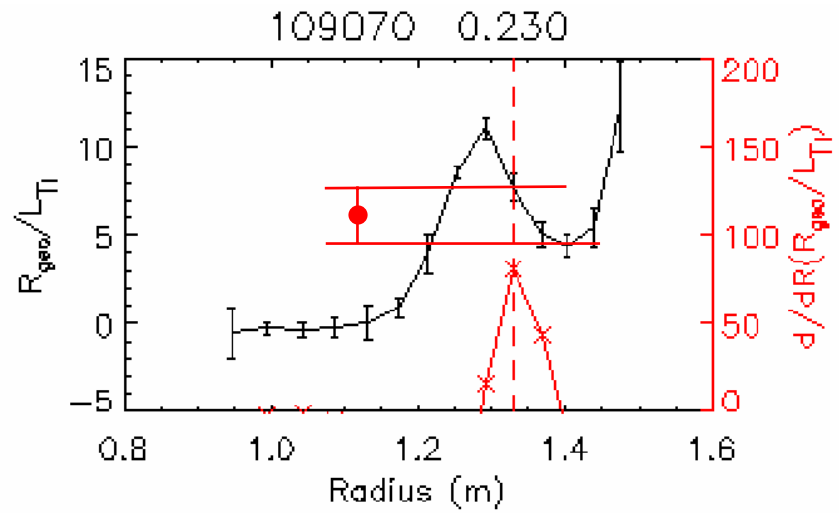

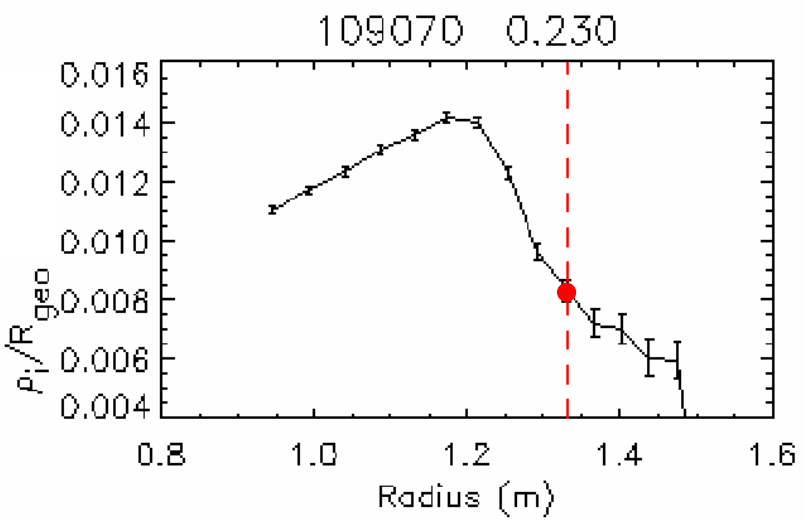

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