ELM Studies in NSTX - Needs: Experiments and Measurements

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(1) ELM behavior on NSTX

(2) Important ELM studies

(3) Required diagnostics and plans

Transport Breakout Session
NSTX Five Year Plan Ideas Forum
Princeton Plasma Physics Laboratory
Princeton, June 25, 2002

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Wide Spectrum of ELM Characteristics Realized on NSTX

- Variety of ELM behavior observed in NSTX:

- From Grassy to Giant ELMs to ELM-Free

- Long Pulse ELM-free and ELMy (> 500 ms)
  -- Steady-state ELMY possible

- ELMs w/DN and LSN

- ELMs w/NBI and RF

- Precursors? -Possibly seen by GPI

- Frequency: from < 135 Hz to > 600 Hz

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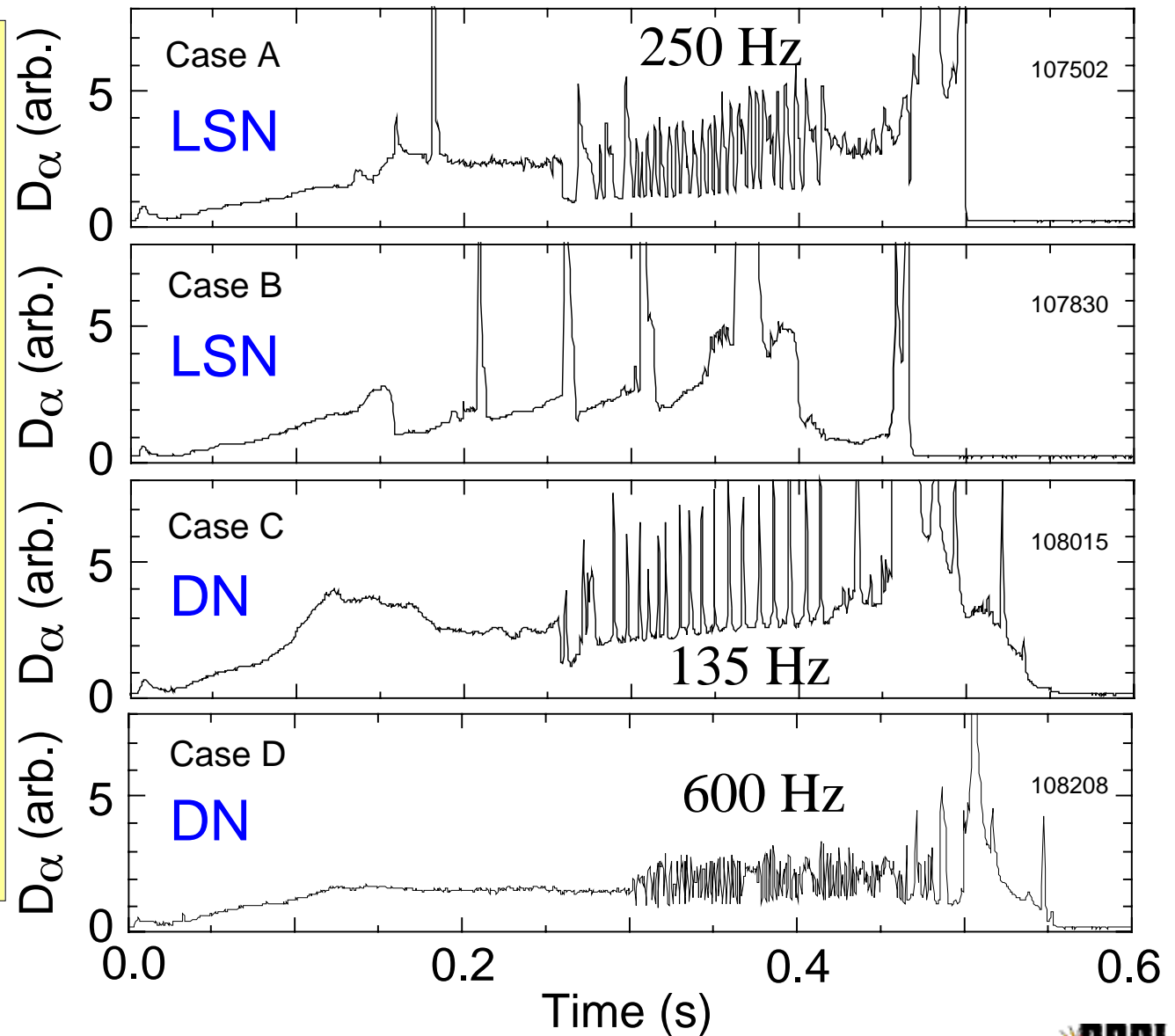
Large ELMs dump edge plasma and effect is radially deep into plasma

- Effect to r/a ~ 0.4, edge $\Delta ne/ne > 50$ % observed. Can return to sustained L-mode.

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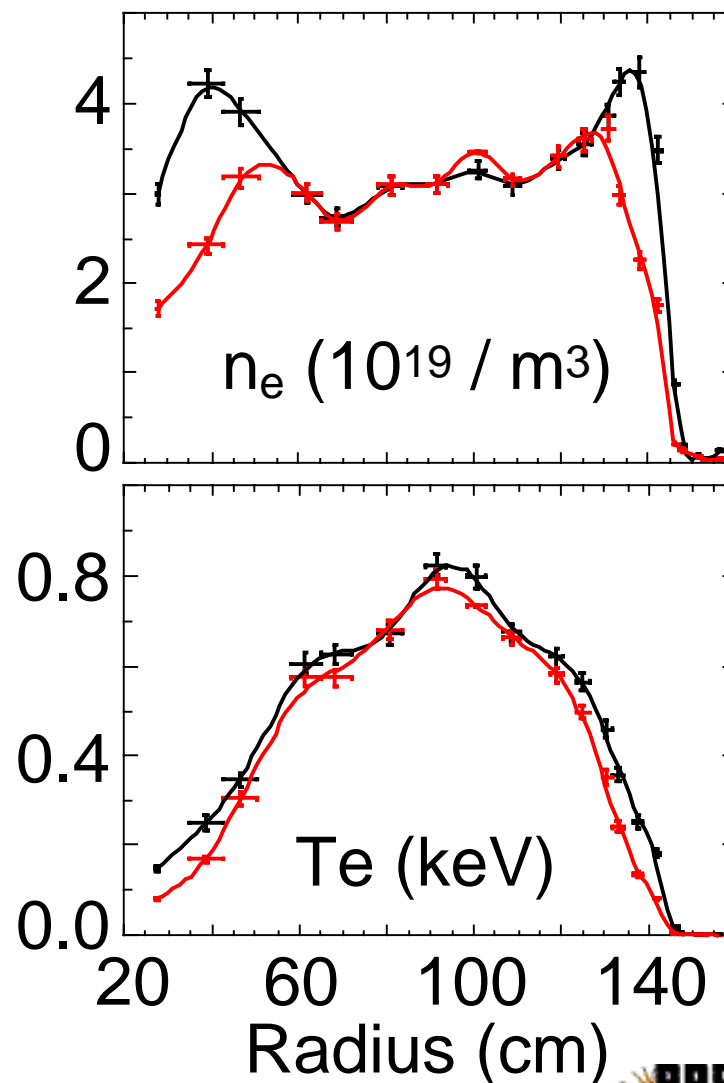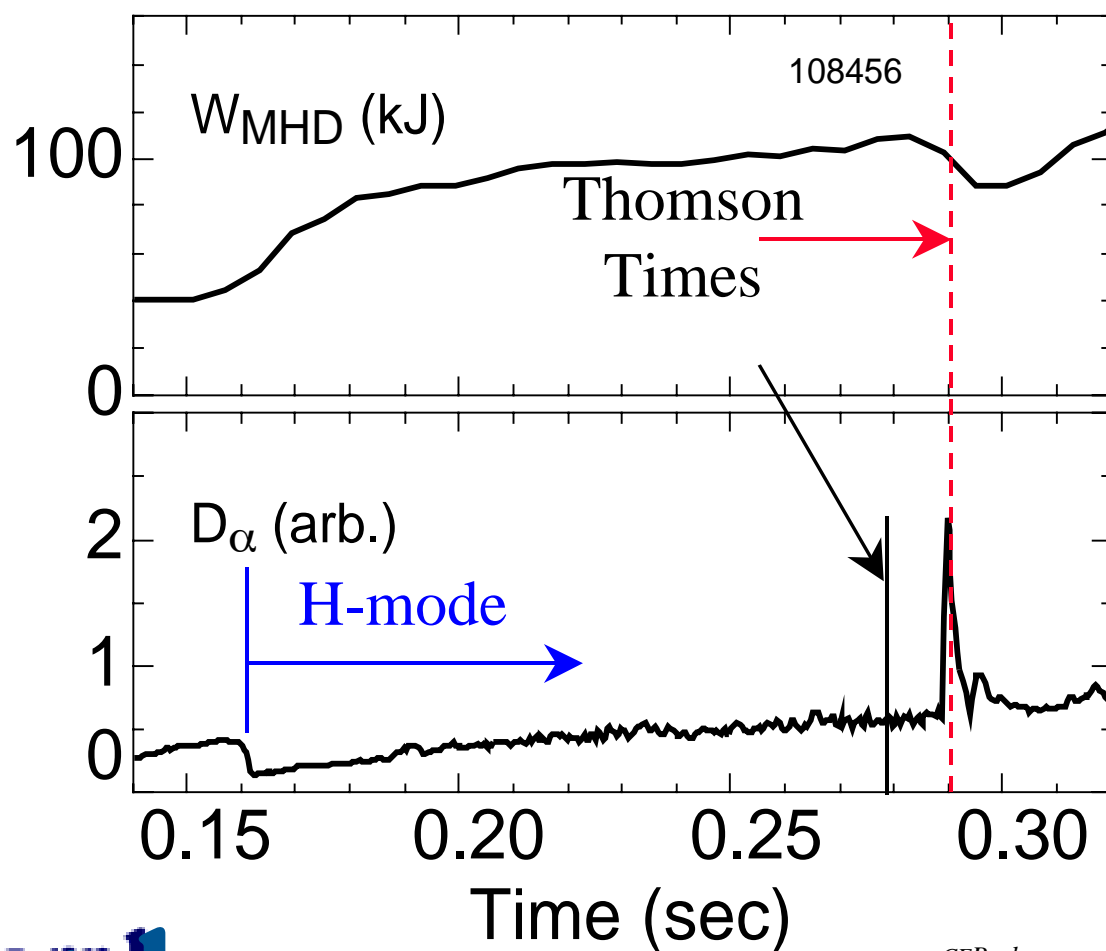
What ELM Studies are Needed?

- **<u>Keep in mind:</u>**
  - ELM studies have just begun on NSTX
  - Need control of ELM parameters, divertor loading, accumulation
  - Must scale ELM behavior to next generation ST - and ST reactor
  - Is ELM behavior the same for Tokamak and ST?

- **<u>Studies needed:</u>**
  - Stability - Determination of precursors - Mode numbers, n
  - Scaling of energy loss per ELM
  - Particle loss per ELM - n_e and impurity control
  - ELM control - Variation of ELM with ST scenario

Studies, Measurements, and Plans:

ELM Stability (Only measurements - Talk by P. Snyder follows):

- Theory for ELM trigger - Combined ∇p and J(edge) / n-number
  - MSE or calculate bootstrap from edge n_e, T_e, T_i profs.
  - Mode number of any precursors - Magnetics, USXR, BES, other?
- *New* - possible precursor detection using GPI

ELM Losses $\Rightarrow$ Measure power and particles expelled:

  $\Rightarrow$ Important for wall loading at divertor plate
- Fast n_e, T_e, T_i measurements $\Rightarrow$ across ELM
  (Thomson, CHERS, and edge scanning reflectometer)
- Fast magnetics $\Rightarrow$ Reconstruct equilibrium

Diagnostic Schedules drive 5 yr plan for ELMs:

Fast n_e, T_e, T_i measurements
- Thomson - Future (2004), 45 points, 3 lasers for 90 Hz, 5 to 7 mm resolution.
- CHERS - Ultimately 10 msec, resolution at edge of few mm.
- Divertor IR camera, 1D CCD camera, reflectometer, GPI
- MSE - 10 channels - (Year 2003)

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