NSTX

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MHD Stability at Very High Toroidal-β and Normalized Current

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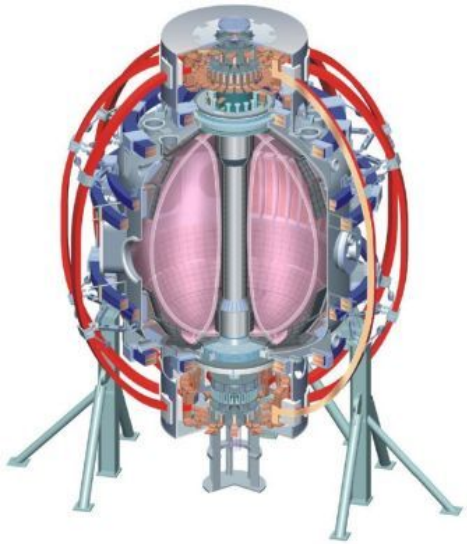
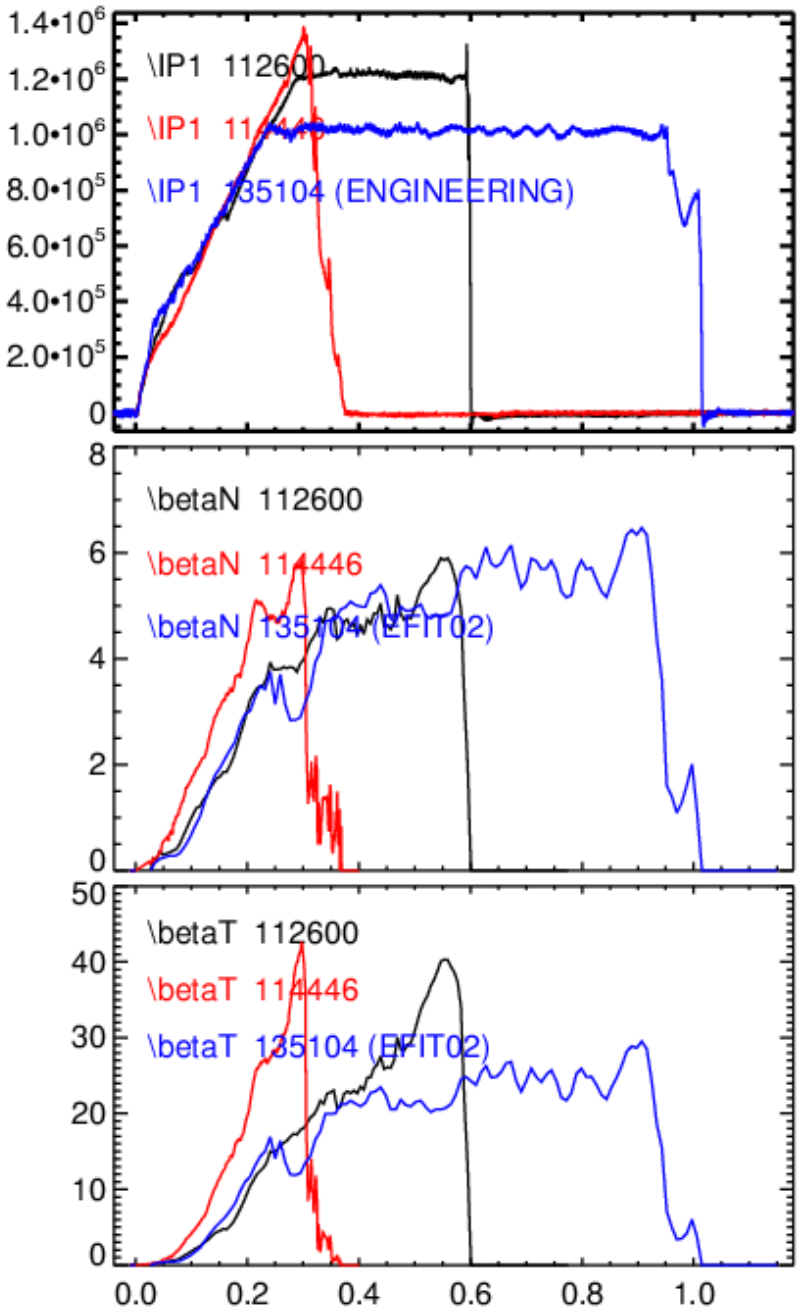
Meeting name
Location
Date

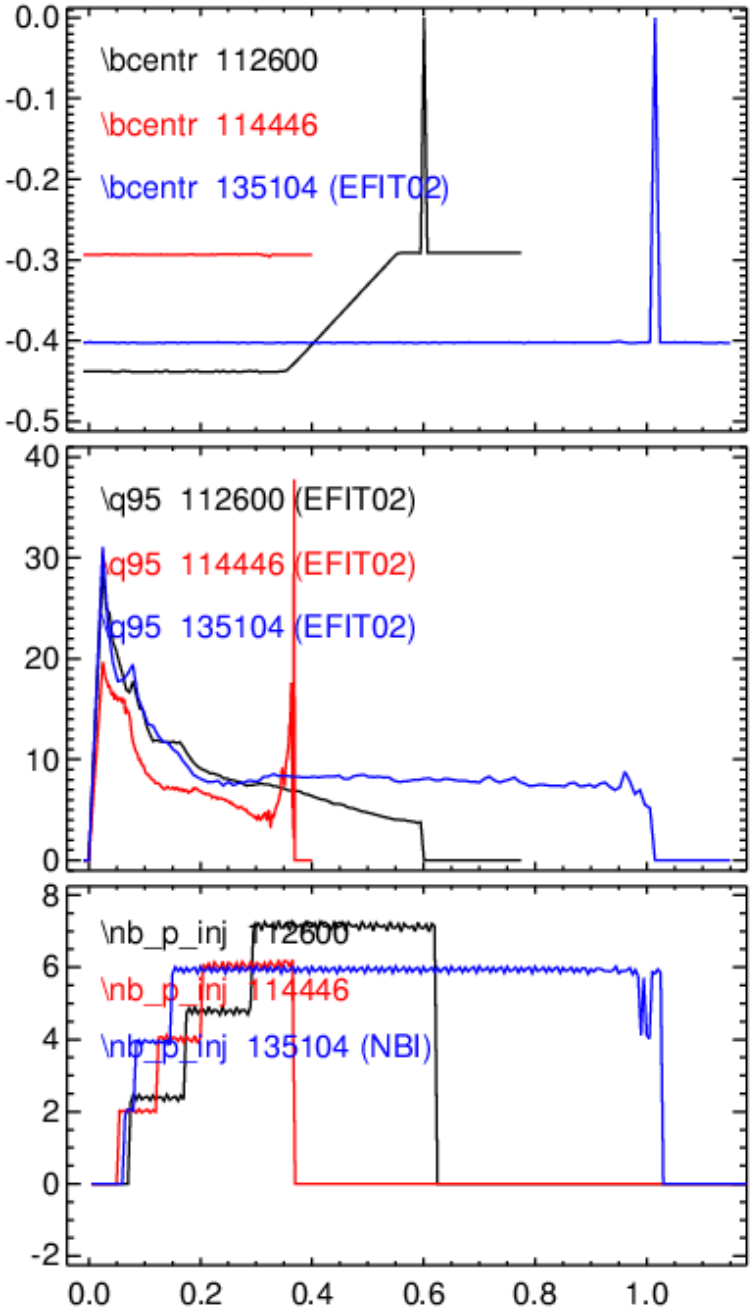


Overall

- ST reactor designs typically assume very high toroidal β.
  - PPPL Pilot: 30-39%, ARIES-ST: 50%, Culham 59%
- It may be time to revisit discharge scenarios with very high β_T.
  - We have made many improvements in control & discharge development since these were last tried.
    - Reduced PCS latency, RWM control, Li PFC conditioning, stronger shaping, better control during the I_P ramp.
  - We have many new and important diagnostics since 2005.
    - MSE, RWM sensors, better USXR systems.
  - We may have trouble making these shots again.
    - Higher aspect ratio of NSTX-U will lower ideal stability limits.
- Propose to revisit discharges in the β_T~40% regime.
  - Characterize the limiting instabilities.
    - What is the maximum stable β_T at low q* during the phase when q_{min}>~1.1 (i.e. before kink/tearing starts).
    - Can we modify this limit via the profiles? Allow l_i to peak up to improve confinement and stability?
  - Determine to what extent recent operations improvements facilitate this regime.
  - Study disruption precursors.
    - Are disruptions detectable in advance?

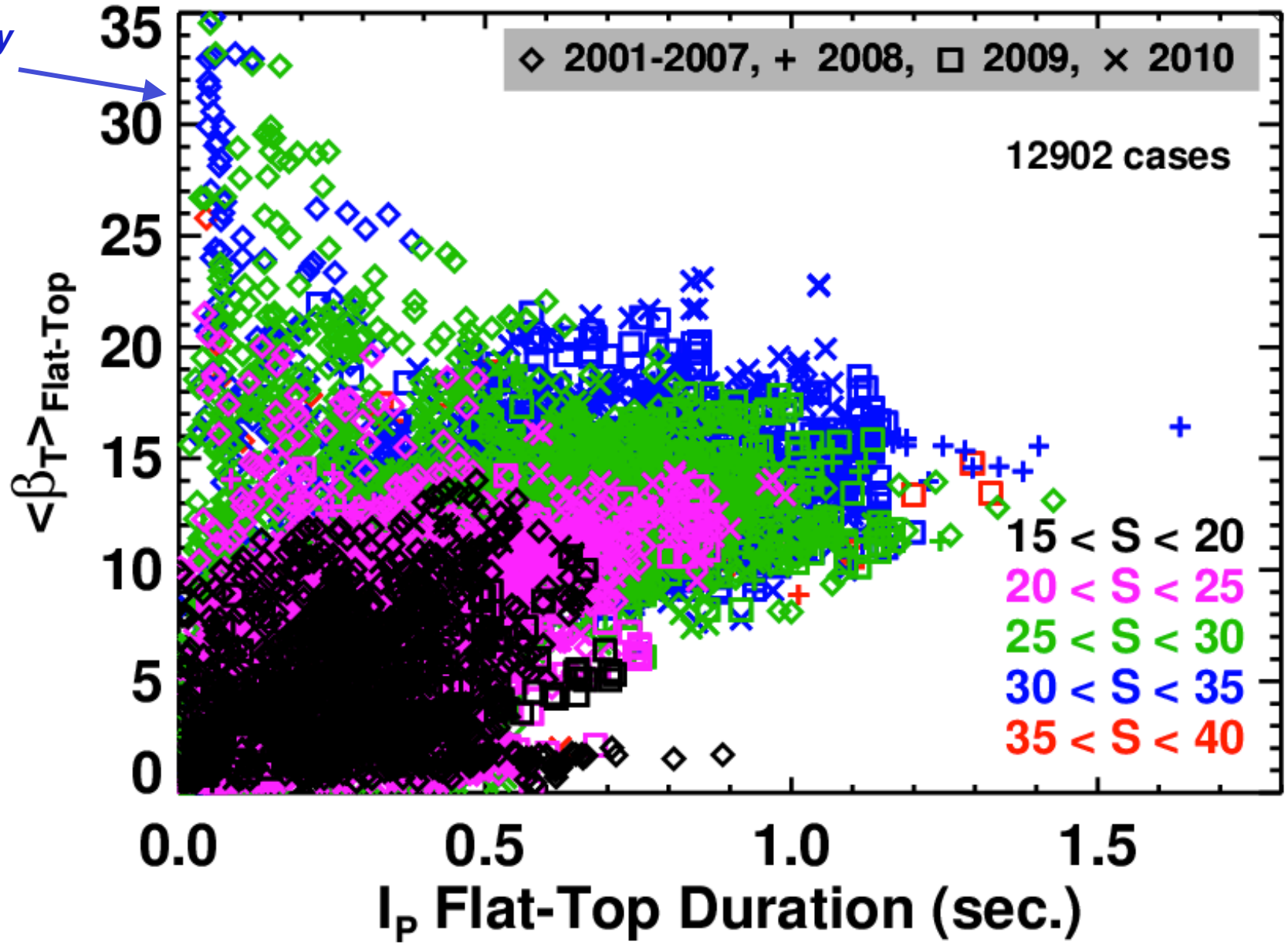
β_T up to ~40% achieved in 2005
2009 Experiments are Encouraging.



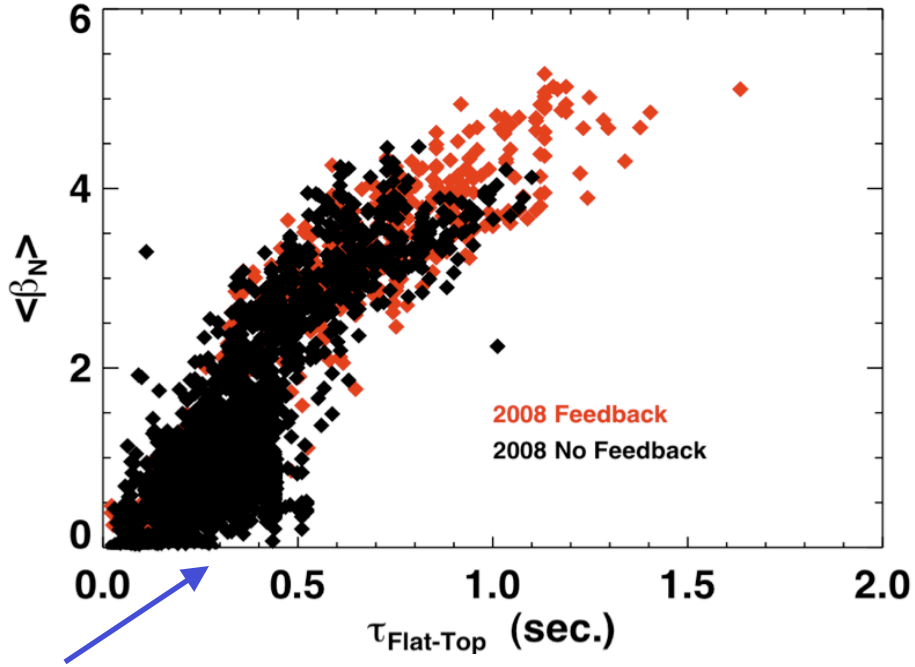


Recent Efforts Have (Legitimately) Focused on Sustaining Discharges with $15<\beta_T<25\%$

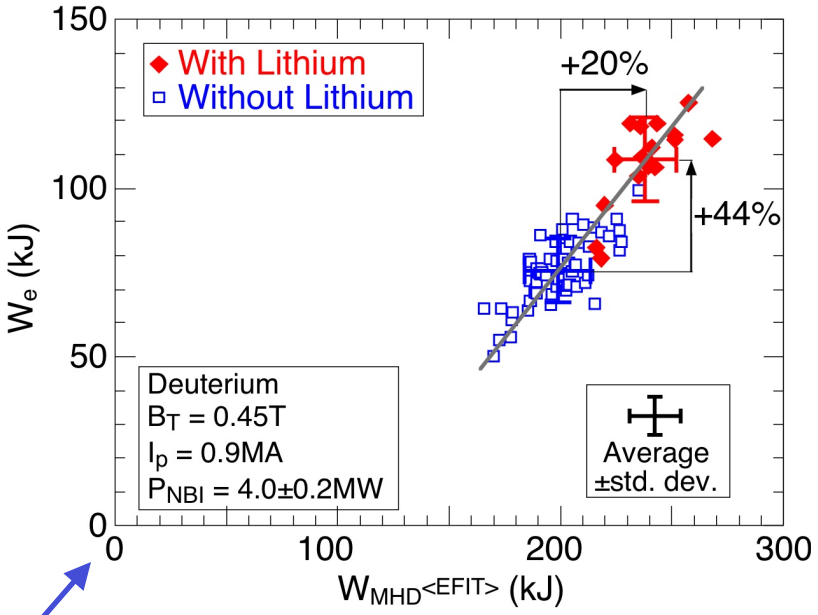
There are only diamonds in this corner! We haven't even tried!



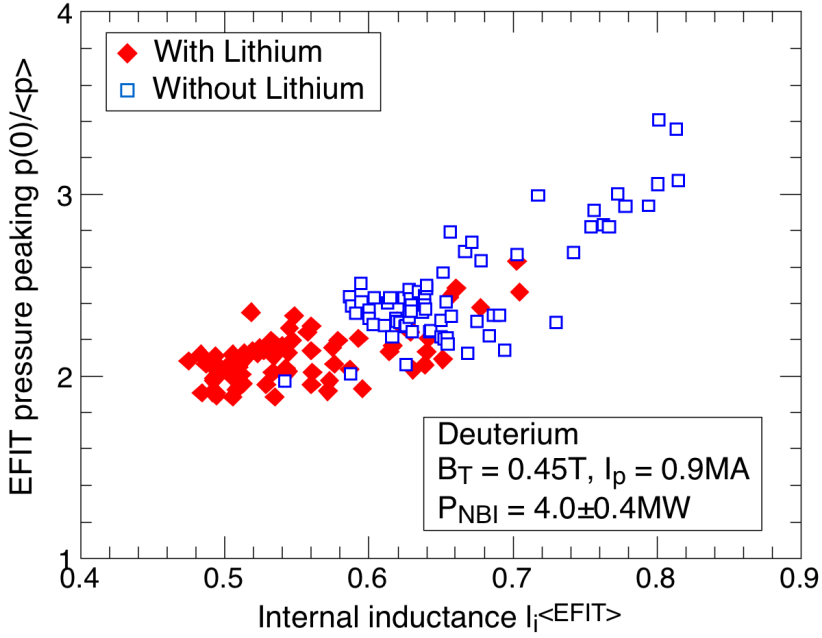
We Know that RWM Control and Lithium Conditioning Can Dramatically Improve NSTX Plasma Performance.



RWM control improves operation at high-β_N.



Lithium PFC conditioning improves electron confinement.



Lithium PFC conditioning reduces pressure peaking.

XP Proposal

- Goal: Study MHD instabilities at β_T>40 %
  - Desire to have a few 100 msec of flat-top, but no requirement for long-pulse.
    - Flat-top phase allows RWM control to come on, J profile to settle a bit.
- Plan:
  - Begin with 1100 kA, 0.4 T fiducial, 6 MW heating later phase.
  - Adjust beam timing to achieve maximum pulse length for these parameters.
  - Decrease B_T to 0.35 T, repeat optimization (decrease once in F.T.?).
  - Increase I_P to 1200 kA, repeat optimization.
- Tools:
  - Lithium PFC conditioning.
  - β_N control? RWM control? (depends on how far into flat-top we get)
- Analysis:
  - Equilibrium analysis with EFIT, LRDFIT, CHEASE, TRANSP.
  - Stability analysis with DCON and/or PEST.
- Request: 1 day.