NSTX-U

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Minimize density at start of flattop

D. J. Battaglia, S. P. Gerhardt, R. Maingi, S. Kaye
D. Mueller …

and the NSTX Research Team

2015 NSTX-U Research Forum
Particle Control Parallel Session

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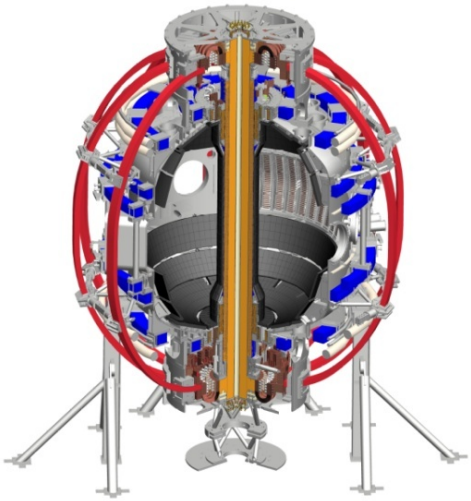
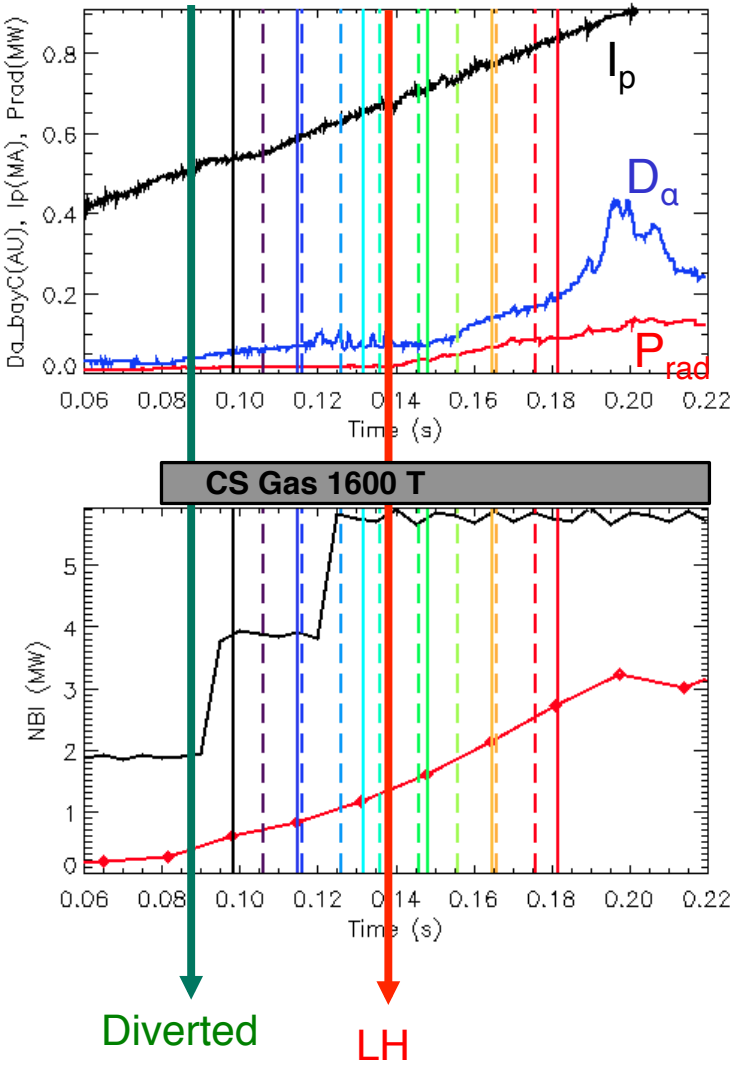
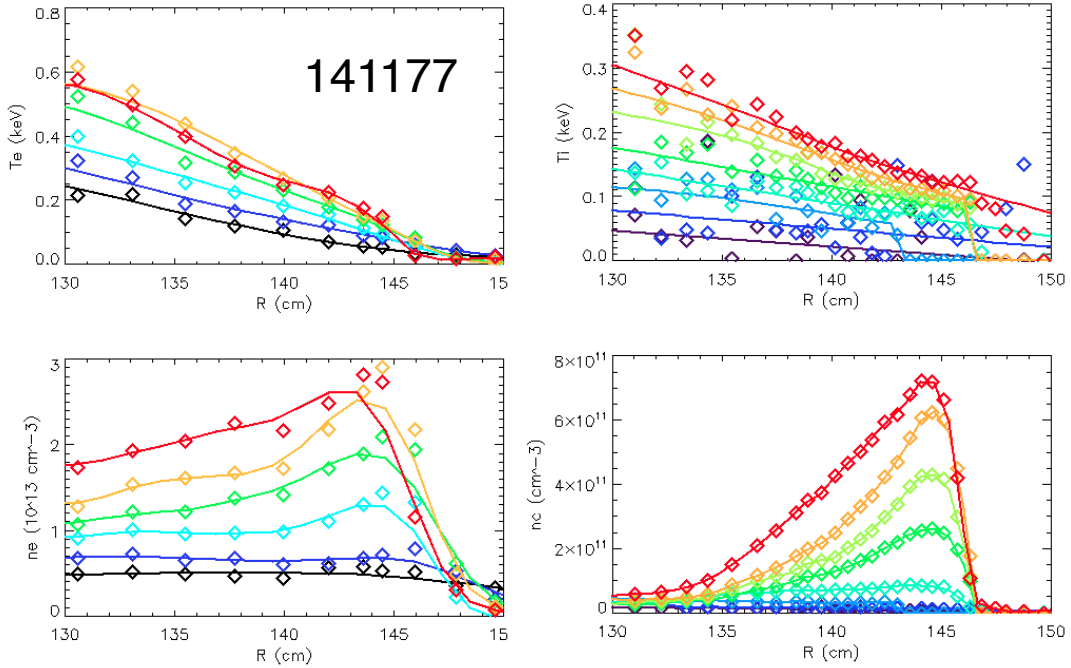


Typical recipe for H-mode access during I_p ramp: CS gas + 4-6 MW of NBI

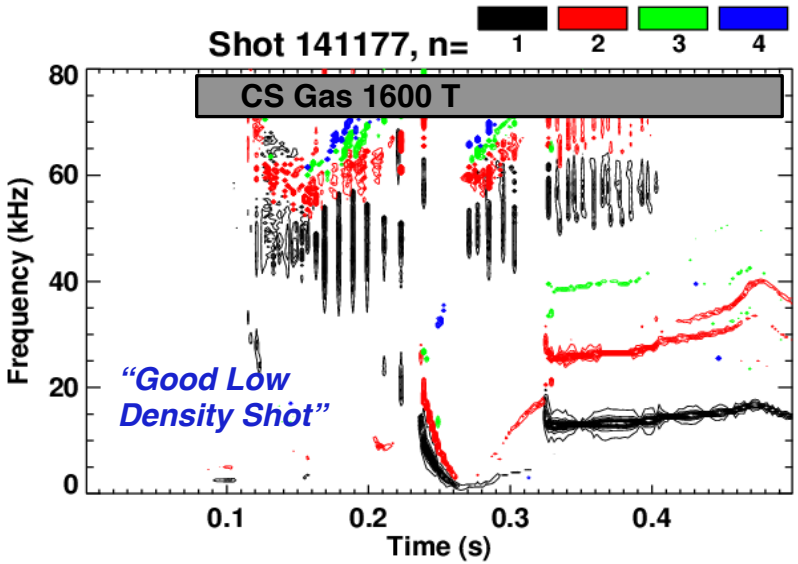


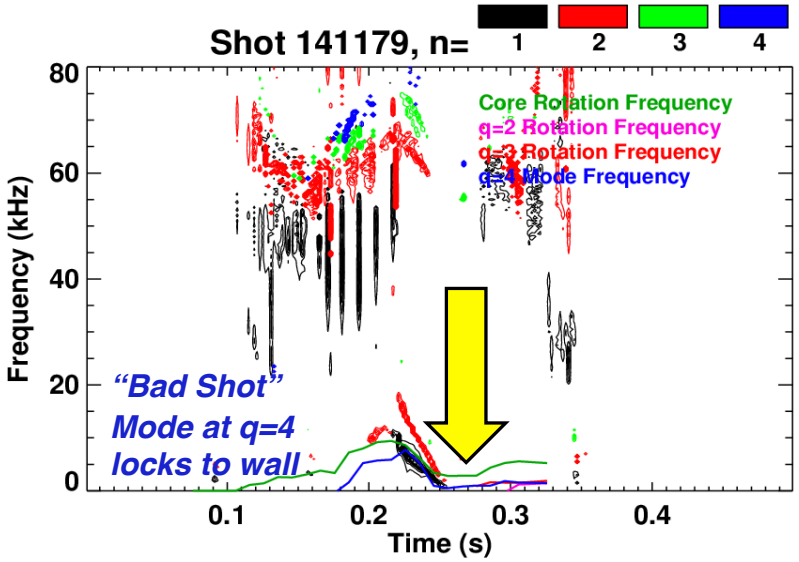
Example low density startup (141177)
No prefill or LFS gas, CS gas after 80 ms
LH transition during 6 MW of NBI (I_p ~ 650 kA)

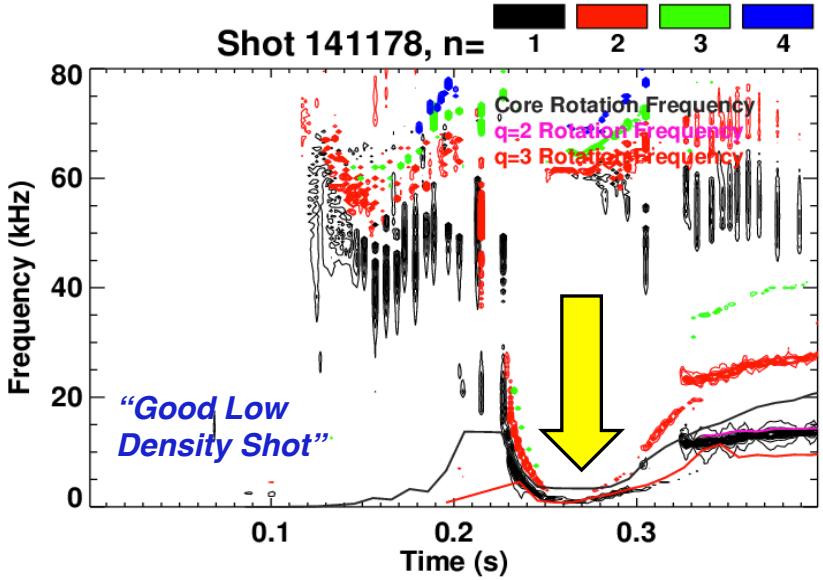
Low density startup would benefit from LH transition with reduced CS gas and lower NBI

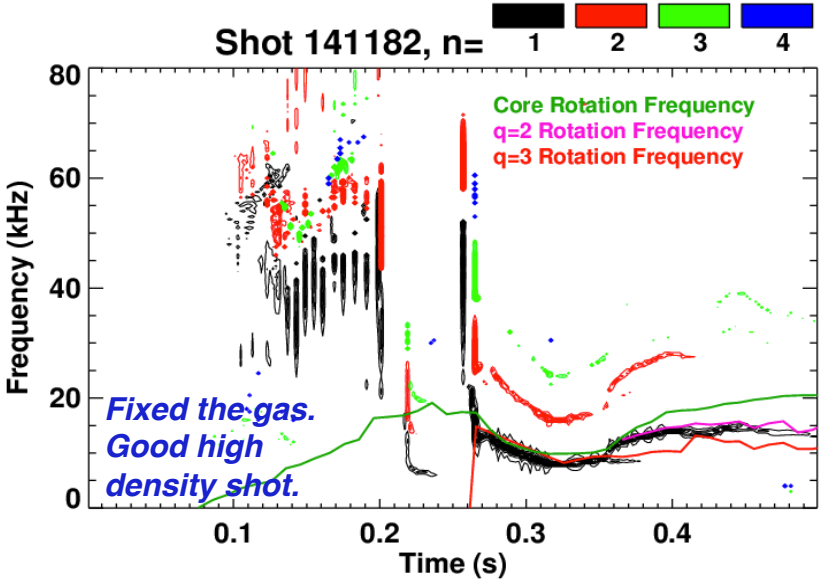


Low n_e Shots Fail When Rotating Modes Lock, Avoid this Issue by Adding Early Gas









NSTX I_p Ramp-up Was Designed to Save Flux

- Flux saving measures
  - Early LH to increase T_e, reduce l_i
    - CS gas, divert around 0.1s (500 kA)
    - Large beam heating during ramp
  - "Fast" I_p ramp to flattop (3 – 6 MA/s)

- Gas programming built around these desires
  - CS puff valve gave reliable H-mode transition
    - Puff valve with long tube injects gas well after the LH transition
  - Prefill and LFS gas to hold off mode locking
    - Hypothesis: edge neutrals cool edge, allow current penetration to a more stable current profile

First Proposal: Explore Minimum Early Gas versus Fueling Locations and LH Transition Timing

- Establish fueling requirements for LH at 500kA in I_p ramp with 6 MW NBI
  - Explore CS gas requirements for reliable (not dithering) LH transition with different CS injection systems
    - First test of larger diameter tubes for faster pumpout
    - Shoulder vs midplane injection gas requirement
  - Minimize pre-fill and LFS gas for suitable breakdown and locked-mode avoidance
  - Investigate utility of I_p hold or dip to induce LH transition with less gas
- Delay step from 4MW to 6MW for LH at 900 kA in I_p ramp
  - Reevaluate minimum CS and LFS gas required for LH transition and MHD avoidance
- Other ideas to incorporate if time…
  - SGI vs CS
  - Impact of NBI preheat level and timing and mix (edge rotation is good)
  - Diverting time, kappa and triangularity during ramp

Second Proposal: Characterize Minimum Density versus I_p Ramp Rate

- Establish minimum fueling requirements for a fast (3 MA/s) and slow (1 MA/s) I_p ramp > 400 kA
  - Does a slower ramp reduce LFS gas loaded needed for locked-mode avoidance or reduce CS gas for LH transition?

- Investigate trade-offs in early ramp rate (I_p < 400 kA)
  - High-voltage (CHI-like) to get fast rise, large R_p, low l_i
  - Low-voltage for improved current penetration

Considerations

- Experiment focuses on front-end of discharge
  - Back end is available for additional physics
    - For example: ASC long pulse development

- Could be performed in B or Li
  - Might want an optimized I_p ramp scenario for both conditions