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Achieving I-mode on NSTX

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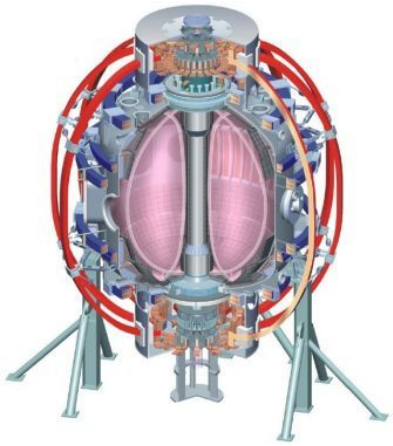
June 8, 2011



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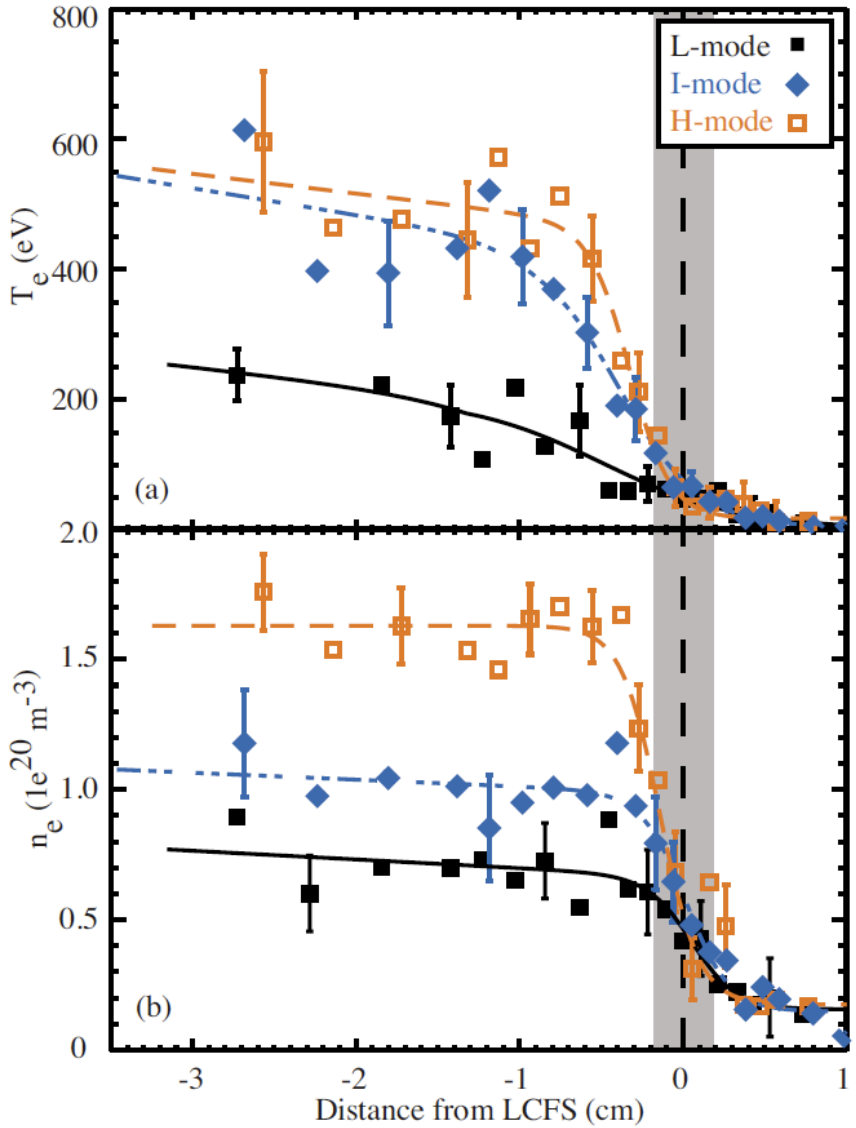
I-mode is an attractive operating regime with H-mode energy confinement and L-mode particle confinement

- Operating regime found on C-MOD
  - H-mode like T_e pedestal
  - L-mode like density profile
- Typically achieved via:
  - Operating in the "unfavorable" grad-B drift direction (USN)
  - Low q_{95} (< 5 on C-MOD)
    - high I_p moreso than low B_t
  - High δ
  - Strong edge pumping
- NSTX is expected to have a narrow operational window to achieve I-mode

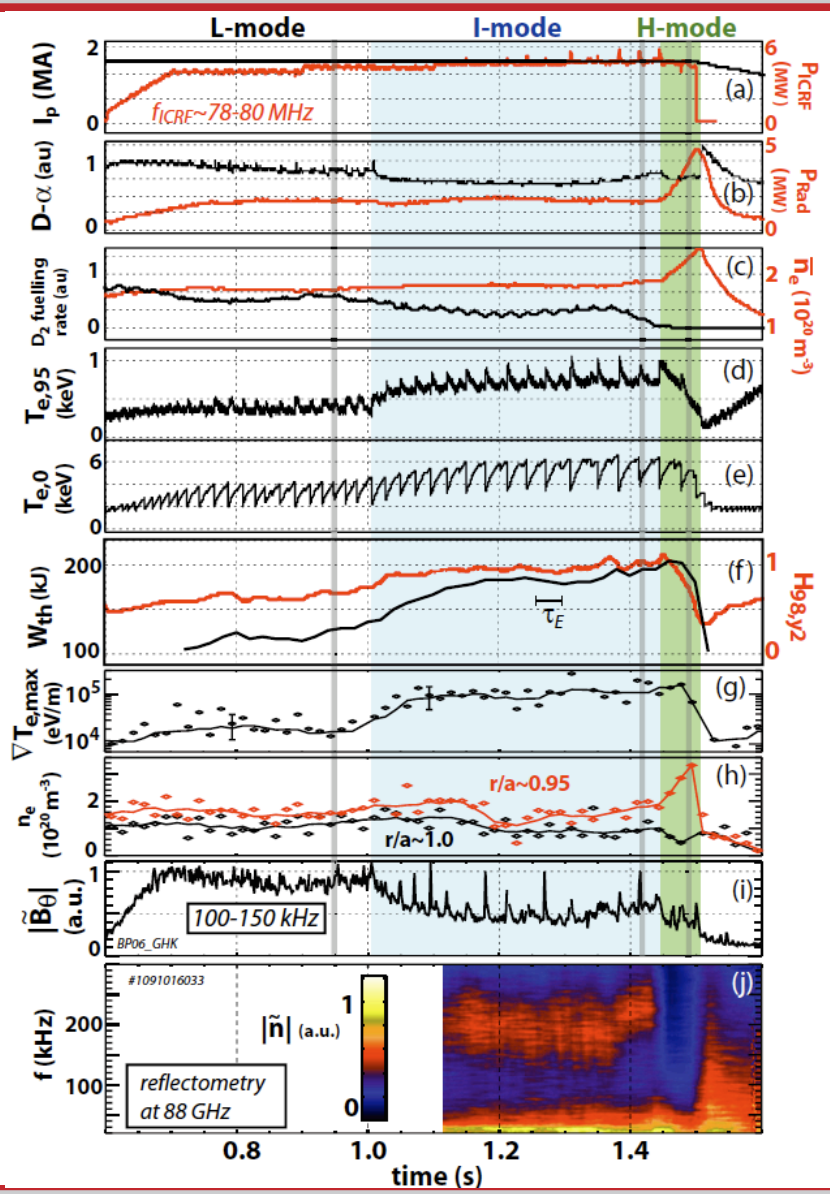


McDermott, PoP **16** (2009) 056103

How to identify I-mode?

1. H-mode like T_e and L-mode like n_e
2. Appearance of a high frequency, weakly coherent mode
   - > 100 kHz
3. Must not show the typical indicators of an H-mode transition
   - Abrupt decrease in D_α or
   - Positive increase in core density

[DG Whyte, NF. **50** (2010) 105005]



Proposed Shot Plan – Search for I-mode

- Begin with fiducial discharge [2 shots]
  - I_p = 0.9 MA, P_{nbi} = 4 MW, ~150mg lithium deposition, $\delta r_{sep} \sim 0$
  - Shot 141445 and 141454 as basis
- Slow δr_{sep} ramp to scan δr_{sep} and prevent early H-mode transition [2 shots]
  - Ramp up ~ 0 to >+ 10 mm from 100—300 ms
  - Ramp down ~ 10 to 0 mm from 300—500 ms
- Adjust discharge fueling downward to minimize edge neutral density [2 shots]
  - Roughly 200 Torr increments
- Adjust neutral beam power to avoid H-mode [4 shots]
  - Use the β_N controller set to ~ 2—3, or
  - Pre-programmed beam timings if necessary
- Increase I_p and repeat to scan q_{95} in USN (1.1, 1.2 MA) [5 shots]
  - Decrease I_p = 0.7 for completeness (high q_{95})

If I-mode is identified during the slow δr_{sep} ramps …

- Stop δr_{sep} ramps and document discharge conditions
- Attempt a long pulse I-mode using conditions found in δr_{sep} ramp (I_p, P_{nbi}, fueling, etc)
- Fixed δr_{sep} scan at these conditions [2-4 shots]
  - Nominally δr_{sep} = +5, +10 mm (Use δr_{sep} found during the ramps)
  - Optimize P_{NBI} again if necessary
- Repeat above discharges with δr_{sep} ~ 0 for reference [2 shots]
- Return to δr_{sep} ramps at other conditions to explore the parameter space if time allows

BACK-UP

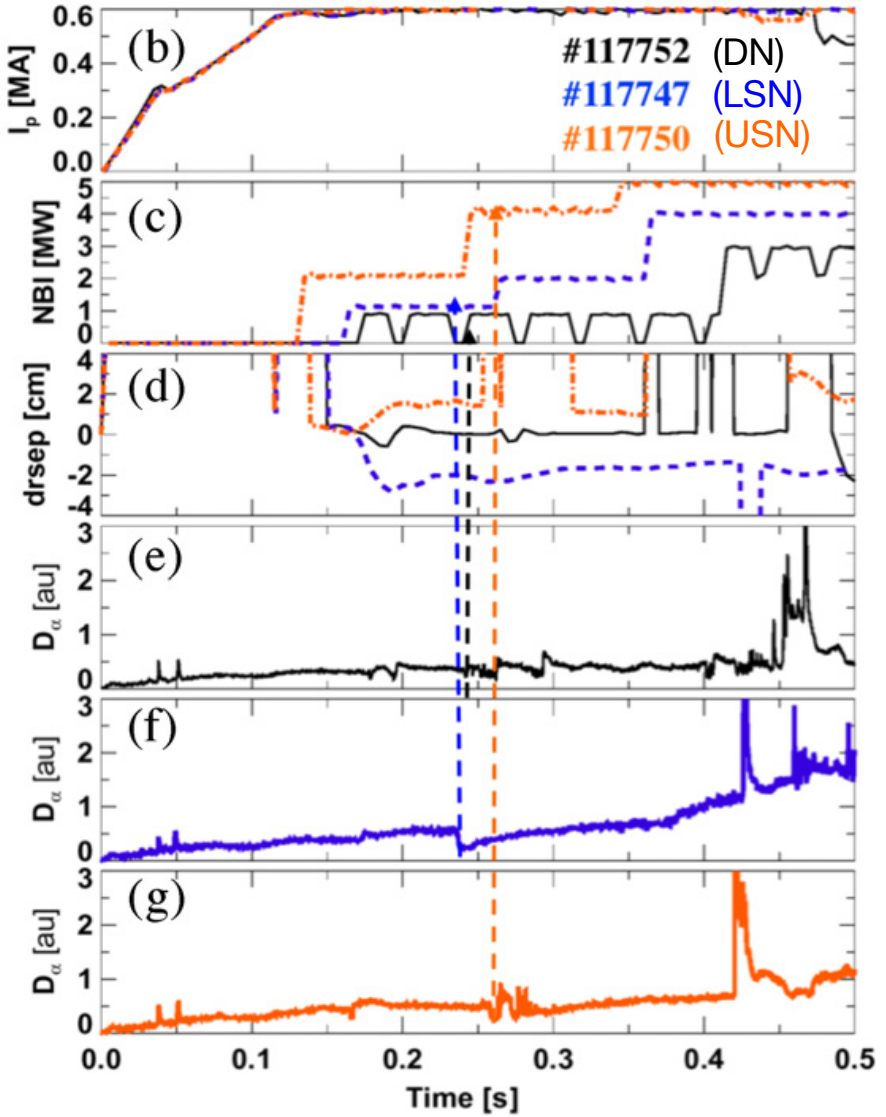
Run Plan: Adjusting Neutral Beam Power

β_N Controller

- Set β_N ~ 2—3 to avoid H-mode
  - Will likely require de-rating the beam voltage in order to modulate the beams

Pre-programmed timing

- Similar beam timing has been used before for H-mode studies
- Use programmed ramps in NBI power as shown for USN and LSN discharges
- Or, programmed beam modulation as was done for DN discharges



[R. Maingi, NF. **50** (2010) 064010]