Does the H-mode Power Threshold Depend on Poloidal Fueling Location? (Possible NSTX/MAST Joint Experiment)

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Background and Motivation

- Uncertainty in power threshold scaling translates into questions about ITER's ability to access H-mode
  - Predictive theory preferred (needed?)
- ST's can test physics in theories due to radically different edge topology
- Neoclassical transport prediction indicates high-field side gas fueling should lead to larger E_r and E_r' than low-field-side fueling (Helander, Fulop and Catto)
  - ¾ E_r' difference occurs due to transition between Pfirsch-Schluter and banana regimes in the edge of tokamaks
  - ¾ Effect is larger in STs than at conventional aspect ratio
- Conventional aspect ratio tokamaks generate excitement over 25% controlled variations in P_{LH}
  - ¾ Effect in NSTX probably $\geq$ 50%

Experimental Determination of the Effect of Gas Injection Location on L-H Power Threshold

Goal: determine if poloidal location of gas injection leads to a measureable difference in L-H power threshold

Execution:

- Compare P_{LH} at several different fueling rates for HFS and LFS fueling
- Measure E_r (E_r'?) with poloidal rotation and CHERs
- Compare P_{LH} at all available poloidal locations to see if effect is monotonic in poloidal angle, θ

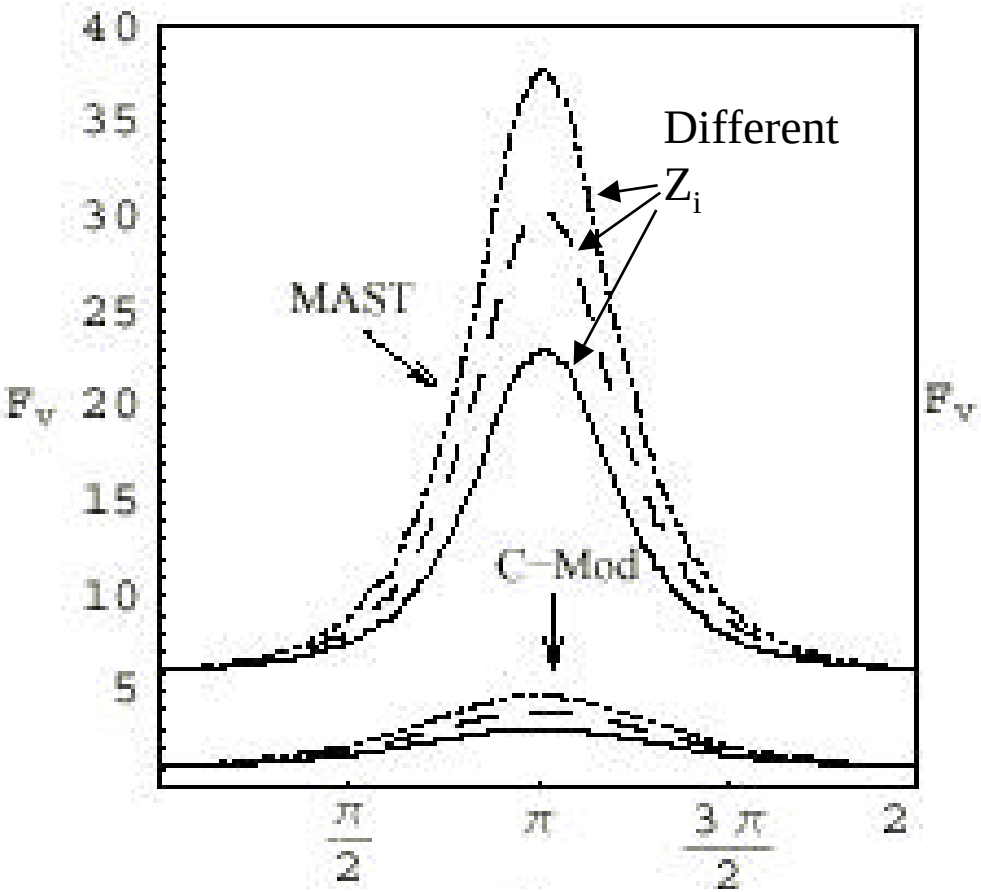
Synergy with MAST:

- MAST has better edge neutrals and E_r' measurements while NSTX has more poloidal fueling locations

Neoclassical theory predicts higher E_r in Pfirsch-Schluter and lower E_r in banana regimes for HFS fueling

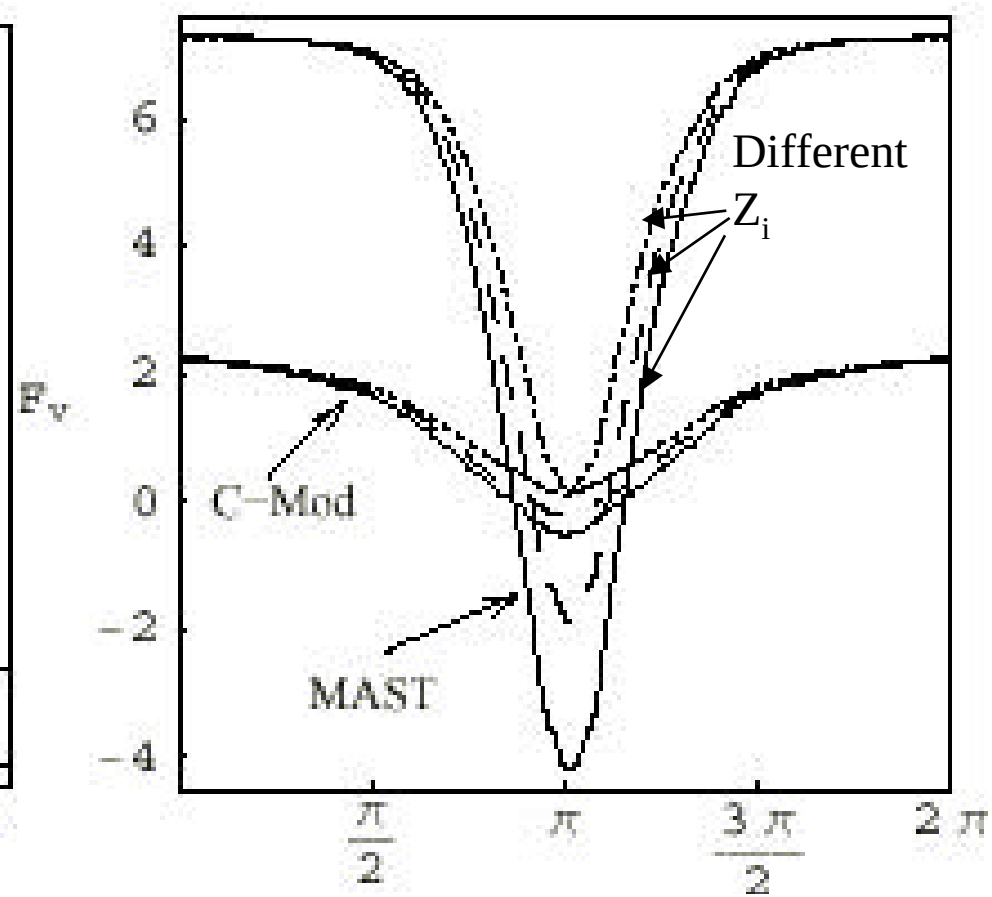
- Normalized edge toroidal rotation ~ F_v; E_r shows same qualitative trend
- Edge E_r' large due to transition between regimes; max. at θ=0 (inner midplane source)

Pfirsch-Schluter



Gas Fueling Poloidal Location, θ

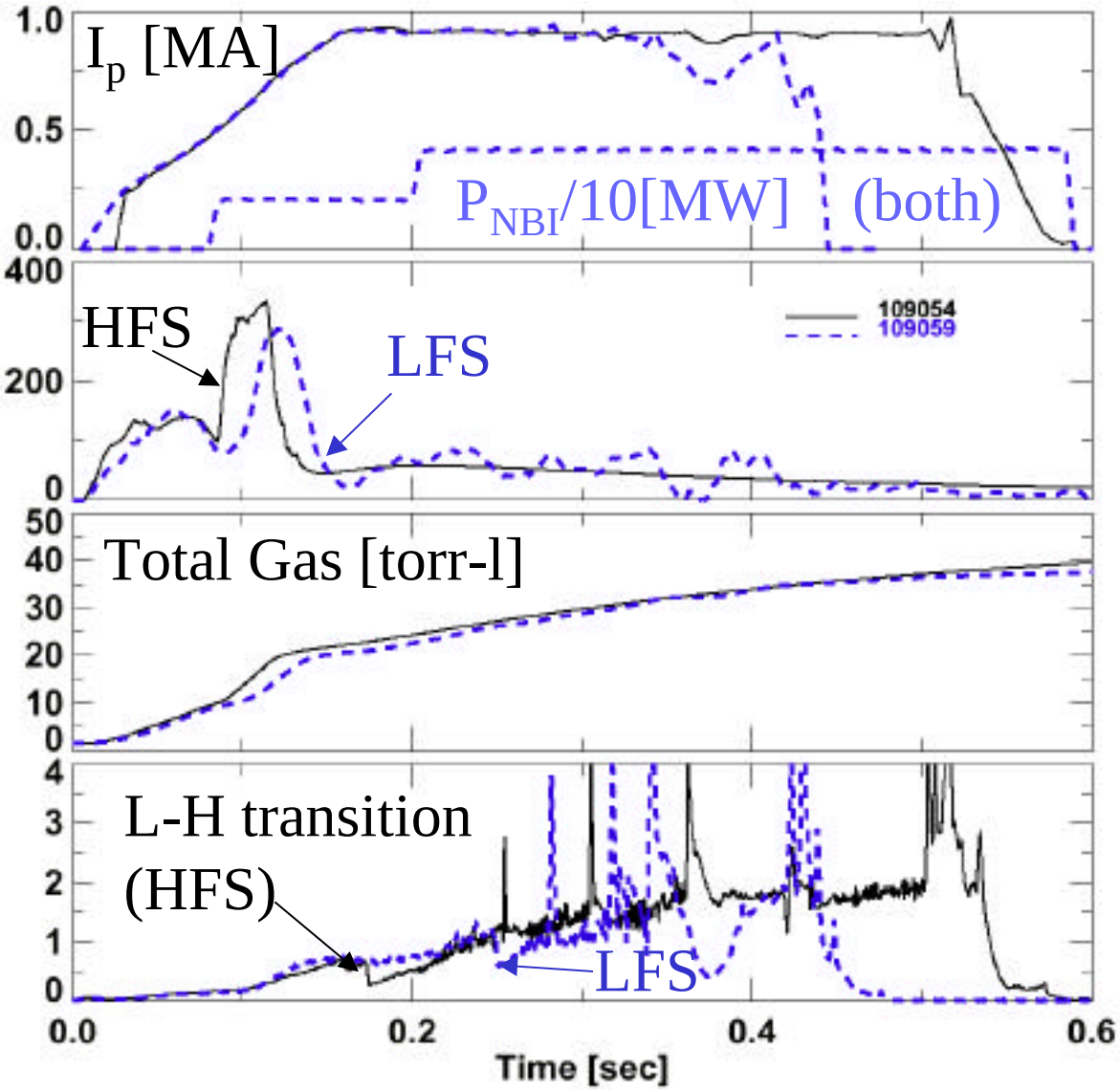
Banana

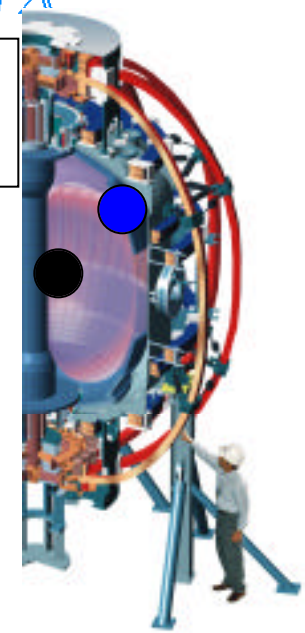


Gas Fueling Poloidal Location, θ

*Helander, Fulop and Catto, Phys. Plasma, 10/03

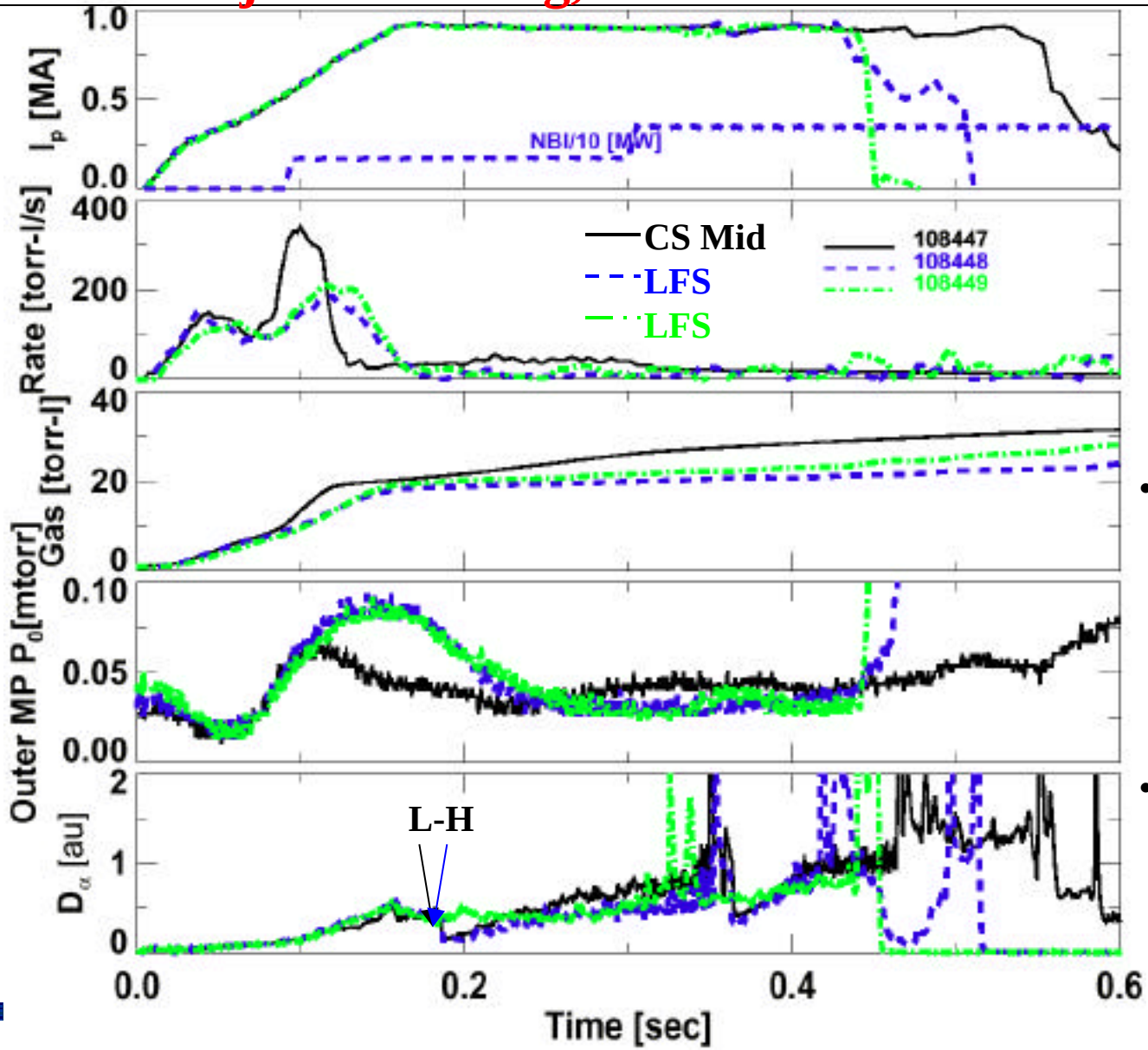
Center-stack MP Gas Injector Fueling Allows Early L-H Transition and Longer H-mode Duration

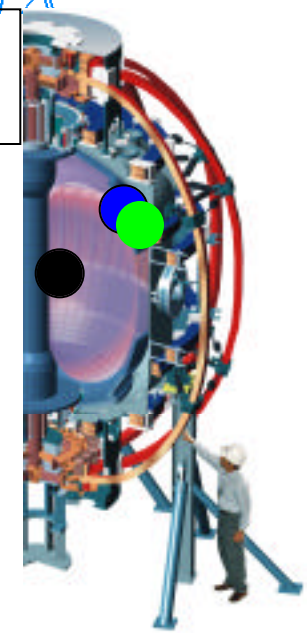




- Experiment run when L-H power threshold was < 1NBI src (*end of run 2002*)
- Note LFS shot only had L-H with 2 NBI -> **higher P_{L-H}**

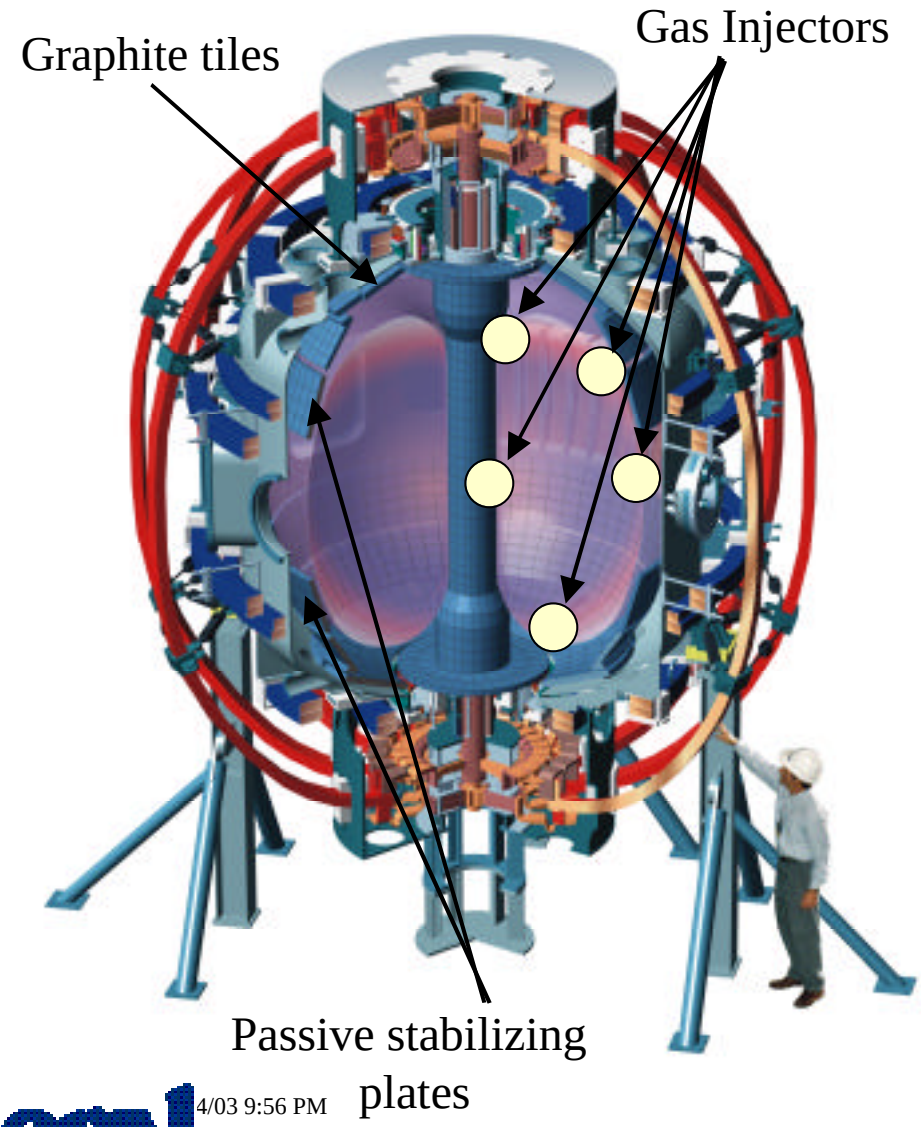
More Reproducible H-mode Access with Center-stack MP Gas Injector Fueling, even at Lower Puff Rate





- Experiment run when L-H power threshold was < 1 NBI src (*end of run 2003*)
- Note CS Mid and LFS shot had same $t_{L\text{-}H}$, but repeat LFS had no L-H -> **higher $P_{L\text{-}H}$ w/LFS?**

NSTX Explores Low Aspect Ratio (A=R/a) physics regime



Parameters	Design	Achieved
Major Radius	0.85m	A ≥ 1.27
Minor Radius	0.67m	
Plasma Current	1MA	1.5MA
Toroidal Field	0.6T	0.6T
Heating and Current Drive		
NBI (100keV)	5MW	7 MW
RF (30MHz)	6MW	6 MW

Wall Conditioning:

350 deg. bakeout of graphite tiles

Regular boronization (~3 weeks)

Helium Glow between discharges

Center stack gas injection