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Ohmic or low-power H-mode triggered during I_p ramp

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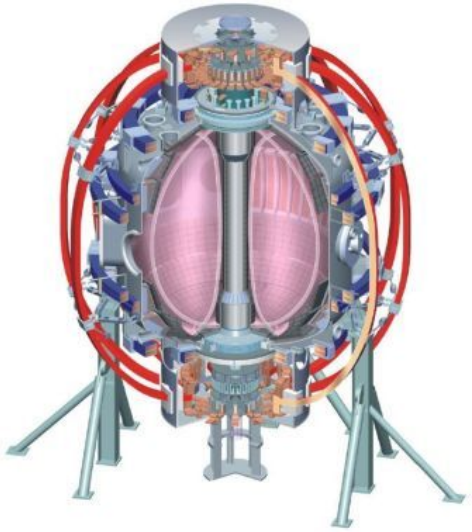

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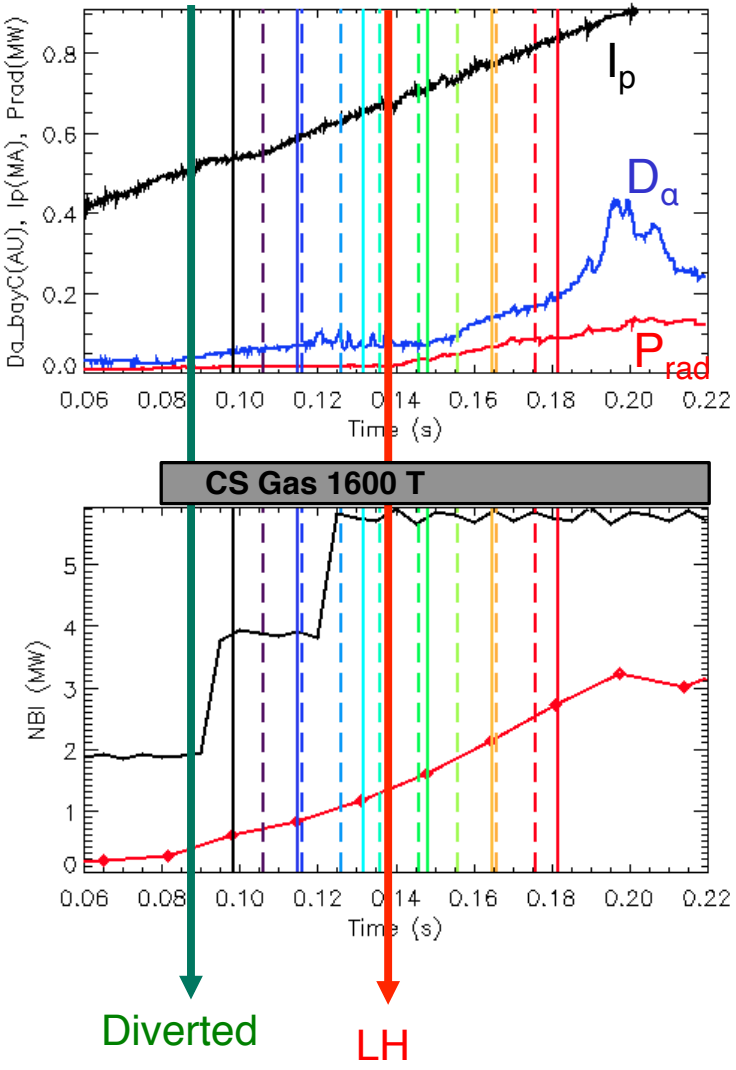
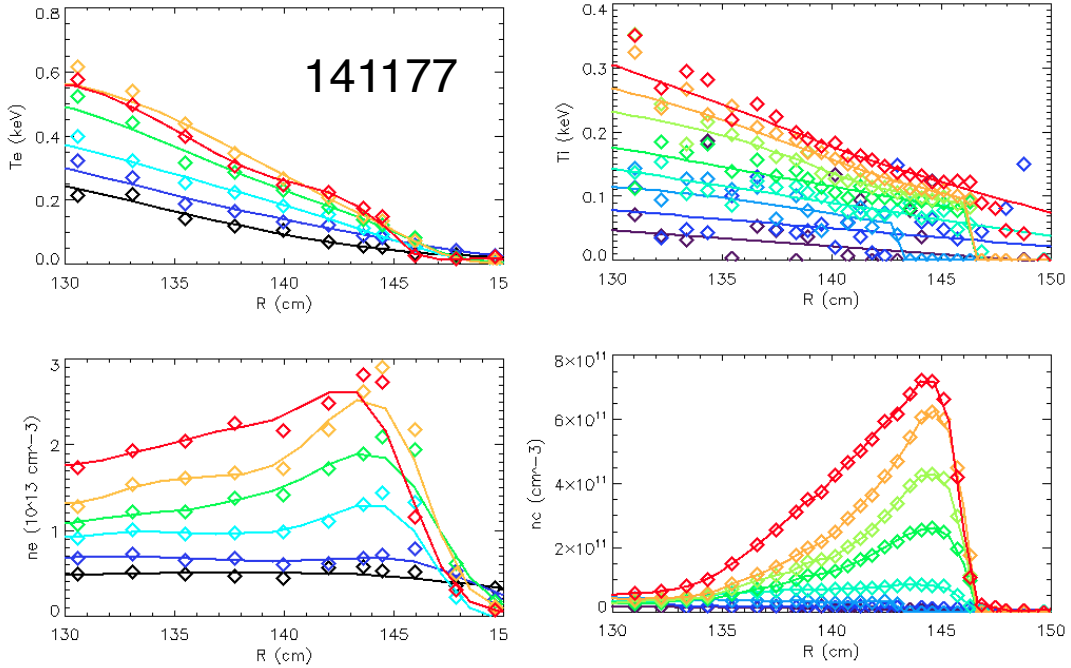
Typical recipe for H-mode access during I_p ramp: CS gas + 4-6 MW of NBI



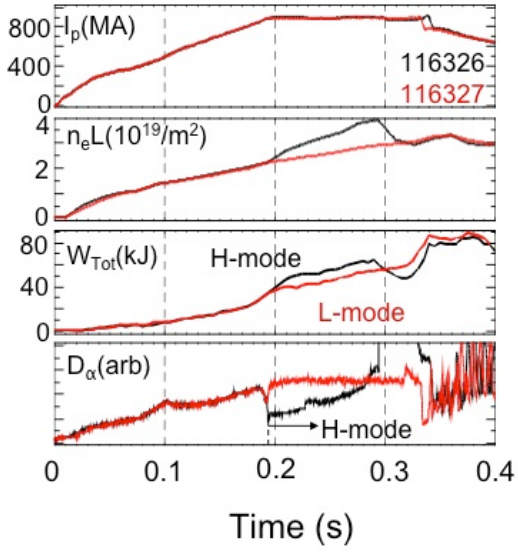
Example low density startup (141177)
No prefill or LFS gas, CS gas after 80 ms
LH transition during 6 MW of NBI (I_p ~ 650 kA)

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



Ohmic H-mode experiments induced transition with loop voltage spike at start of flattop

- LH transition observed to correlate with drop in V_{loop} for ohmic discharges (XP506)
  - Drop in V_{loop} due to knee in I_p at SoFT
  - V_{loop}: 3 V → 2.5 V (on its way to 1.5 V)

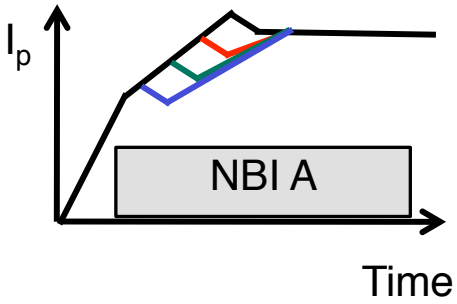


- Consistent with Shaing theory: ion loss is a source of mean poloidal flow
  - E_r, E_Φ confine most high temperature (100s eV) ions that would otherwise be lost on banana orbits in the plasma edge
  - Drop in E_Φ reduces Ware pinch, enhances non-ambipolar ion orbit loss
  - Leads to a larger source of mean poloidal flow, E_r
  - V_{loop} dependence could be unique to the ST geometry due to high trapped particle fraction

Experimental goal: establish a robust low density startup scenario with an early, low power LH transition

- Half day experiment with good vacuum conditions
  - Prefer aggressive lithium → known to lower P_{LH}
  - Prefer to have a repeatable low density startup target

- Start with 4.5 kG, 900 kA I_p ramp and 2MW source A
  - Try V_{loop} transient at SoFT – does it trigger LH?
    - Try larger V_{loop} transients until LH is observed
  - Move timing of V_{loop} transient to earlier time
    - Does it require a bigger transient?
  - Repeat until transient is too early to trigger LH



- Try adding other LH tricks
  - Low triangularity (preferred for diagnostic reasons), small X-point height, reduced density, reduced d_{rsep}, smaller plasma

Backup

Shaing and Chang theories describe edge E_r generated via ion orbit loss to divertor

- Shaing bifurcation model
  - Collisionless ions lost on banana orbits to wall or SOL collision
  - Return current via reduction in collisional ion flux out of plasma
  - L-root (H-root):
    - Solution at high (low) edge collisionality
    - Small (large) poloidal rotation (E_r) and rotation shear (E_r shear)
    - Finite (small) current
  - Both roots are valid at critical ν_{*i}, plasma state can bifurcate
  - Predicts appropriate (fast) timescale

KC Shaing, and EC Crume, PRL **63**, 2369 (1989)

- Chang X-transport model
  - X-point enhances orbit loss
  - Ions primarily lost to inner divertor
  - Current loop closes through parallel currents through SOL and conducting divertor

C.S. Chang, S. Ku, H. Weitzner, PoP **9**, No. 9, 3884 (2002)