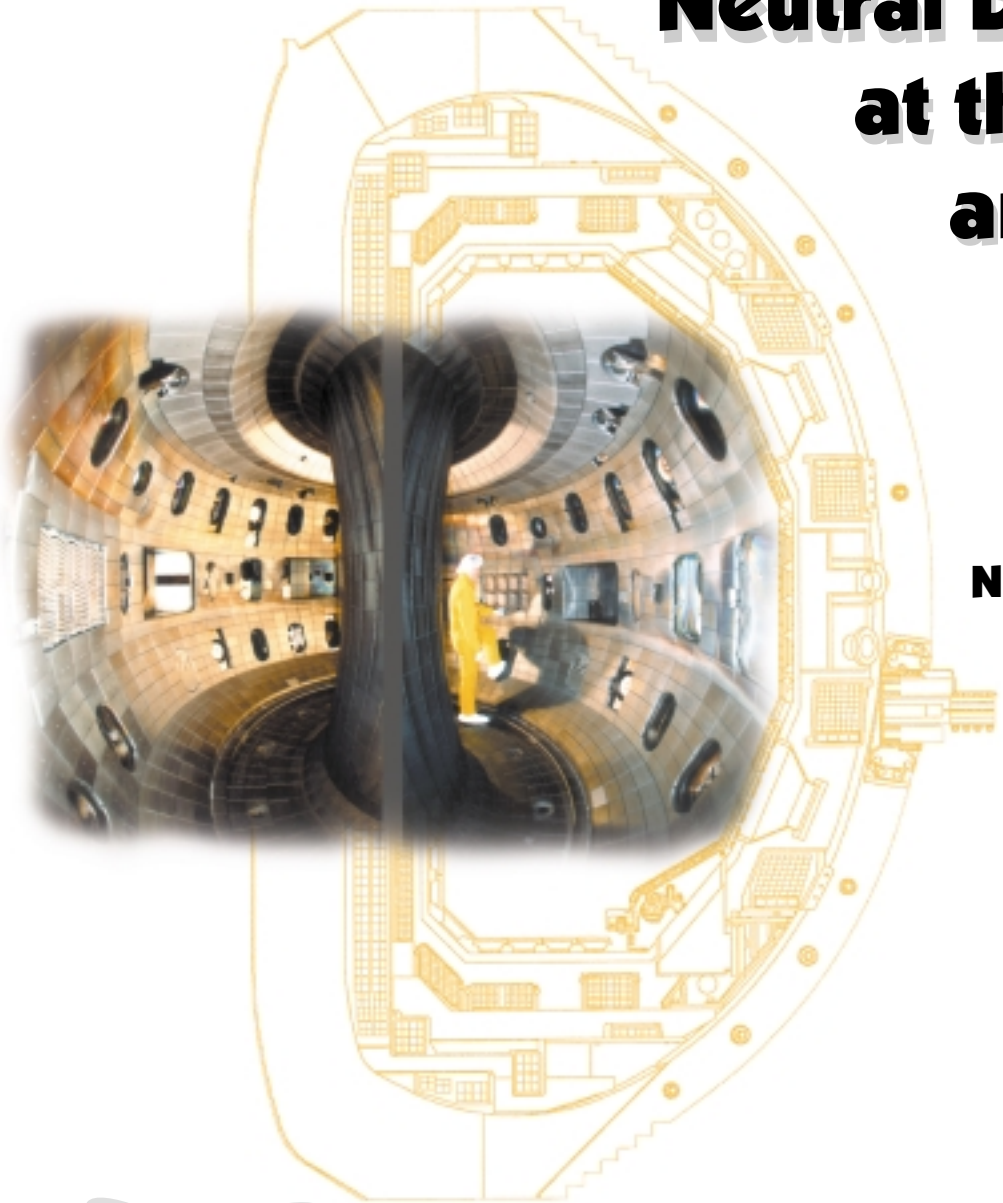

Neutral Density Measurements at the Midplane of DIII–D and Effects of Neutrals on the L–H Transition

by

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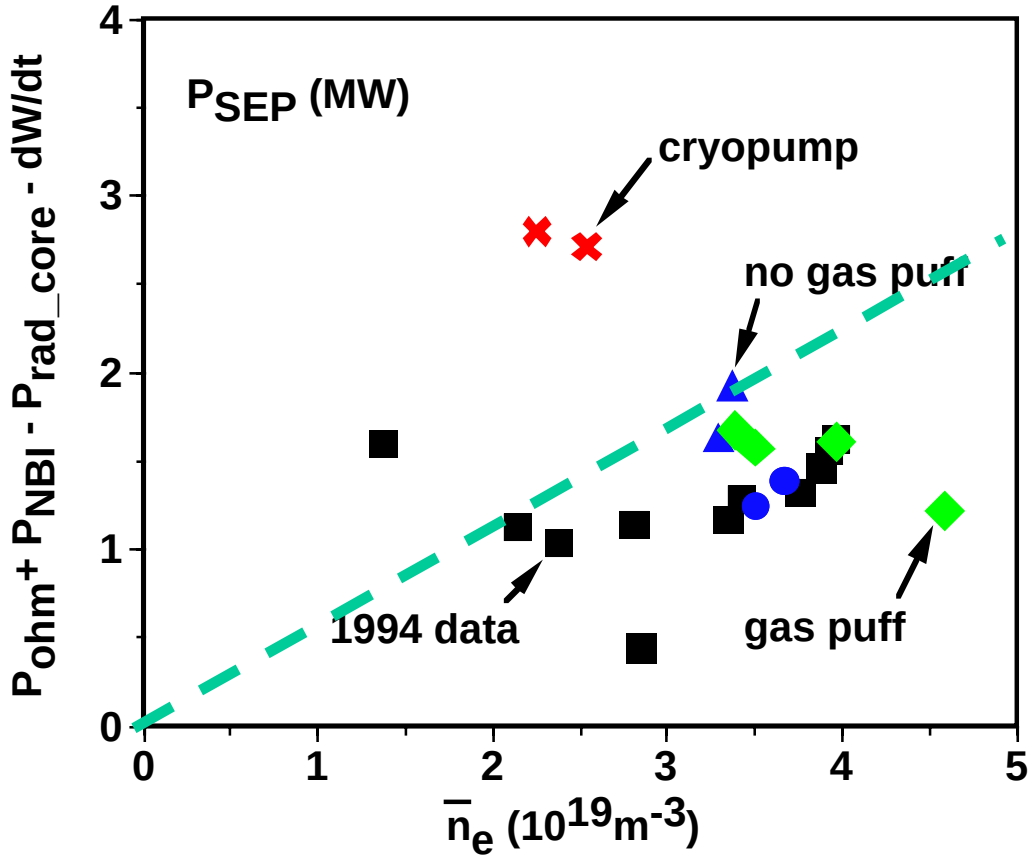
The L-H Transition Power Threshold Increases with Cryopumping

[Carreras, et al., Phys. Plasma **5** (1998) 2623]



How Can Neutrals Affect the L-H Transition?

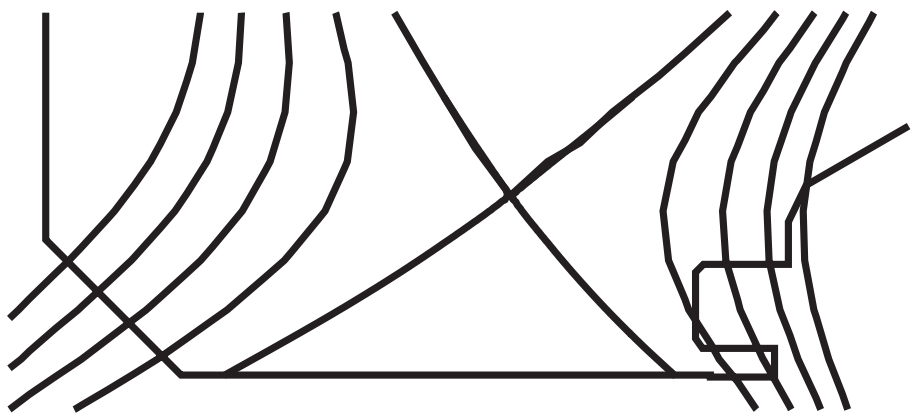
- Neutral particle damping of the plasma rotation tends to stabilize instabilities.
  - This can increase the L-H power threshold. [Itoh, et al., Nucl. Fusion 29 (1989) 1031 + many others]
  - 2-D modeling suggests that n_o becomes important when $n_o \sim 10^{11}$ cm^{-3}. [Mahdavi, 1990 - Itoh, 1989 - Shaing 1995 - Carreras, 1998]
- Neutral densities are highest in the divertor near the X-point. [Carreras, et al., Phys. Plasma **5** (1998) 2623]

Effect of Neutrals on the L-H Transition

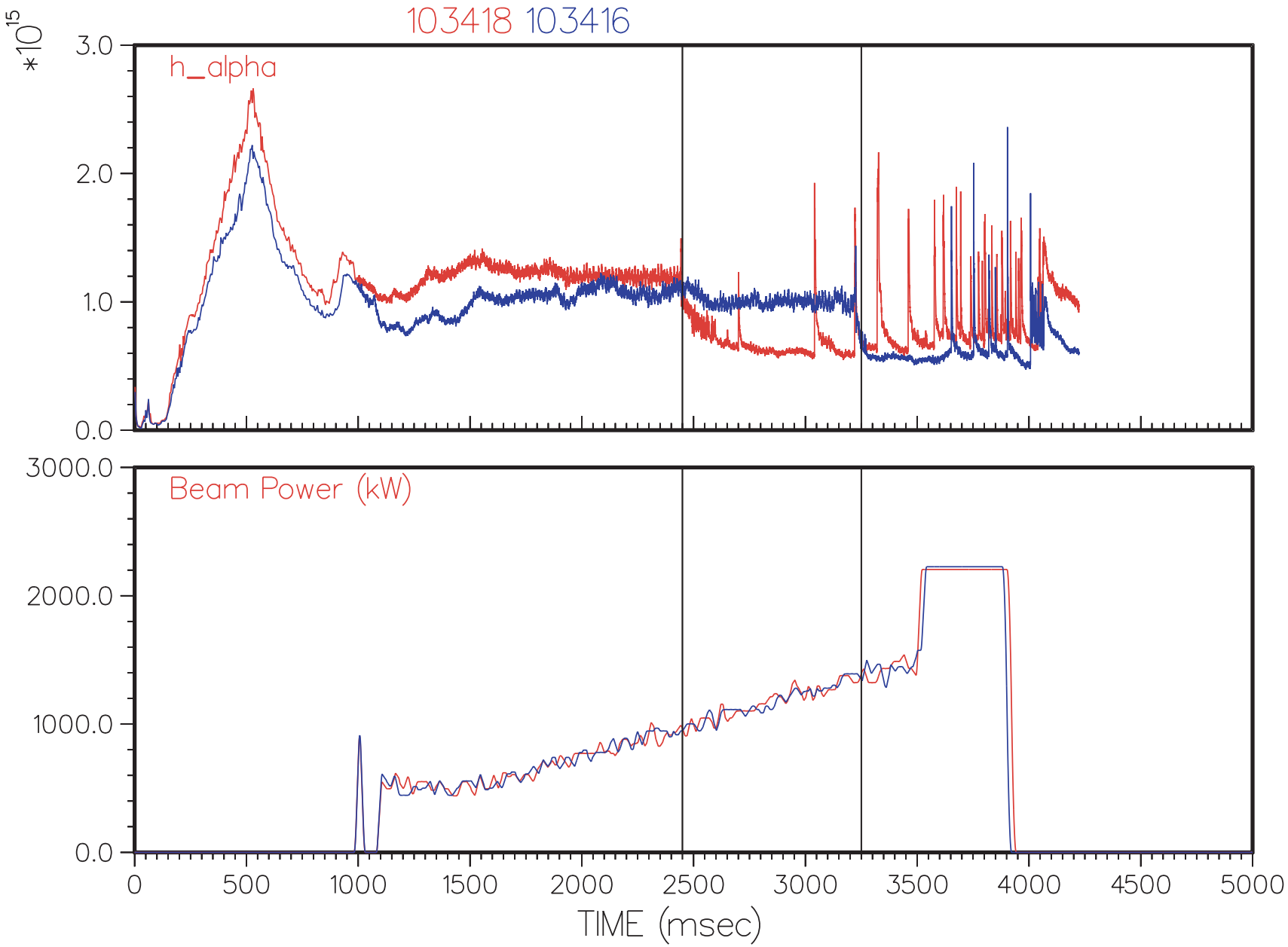
- **Goal:** Determine if neutrals affect the L-H transition.
- **Method:** Measure the neutral densities at the midplane and divertor with the cryopump off and on. [Colchin et al., Nucl Fus. 40 (2000) 175, Colchin et al.,27th EPS Conf., June 2000]

Results

- With the outer separatrix leg near the lower cryopump entrance, the L-H threshold power was increased by 460 kW when the pump was on.

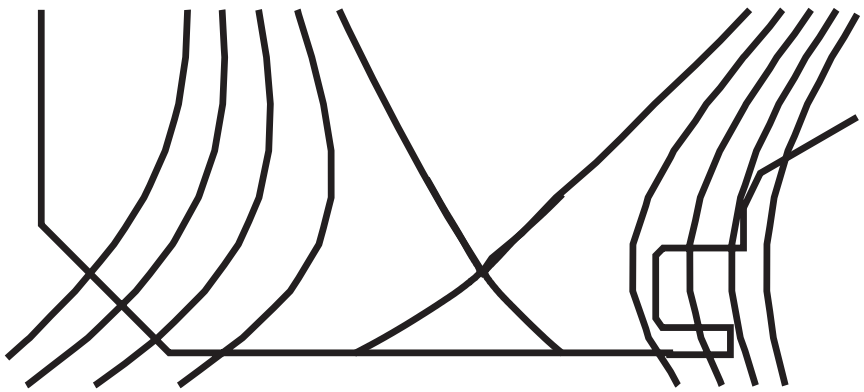


Cryopump on/off Changes the L-H Transition

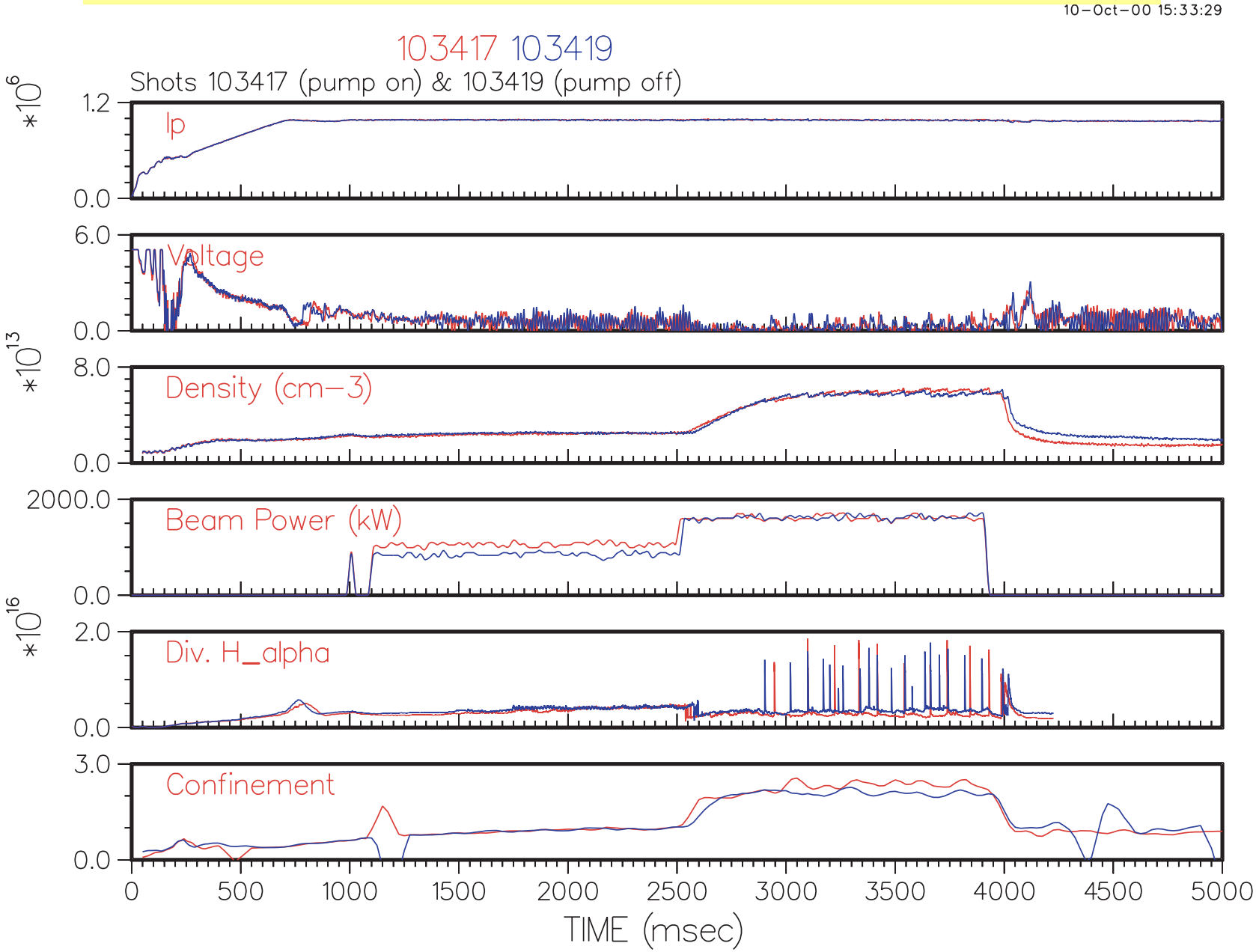


Effect of Neutrals on the L-H Transition

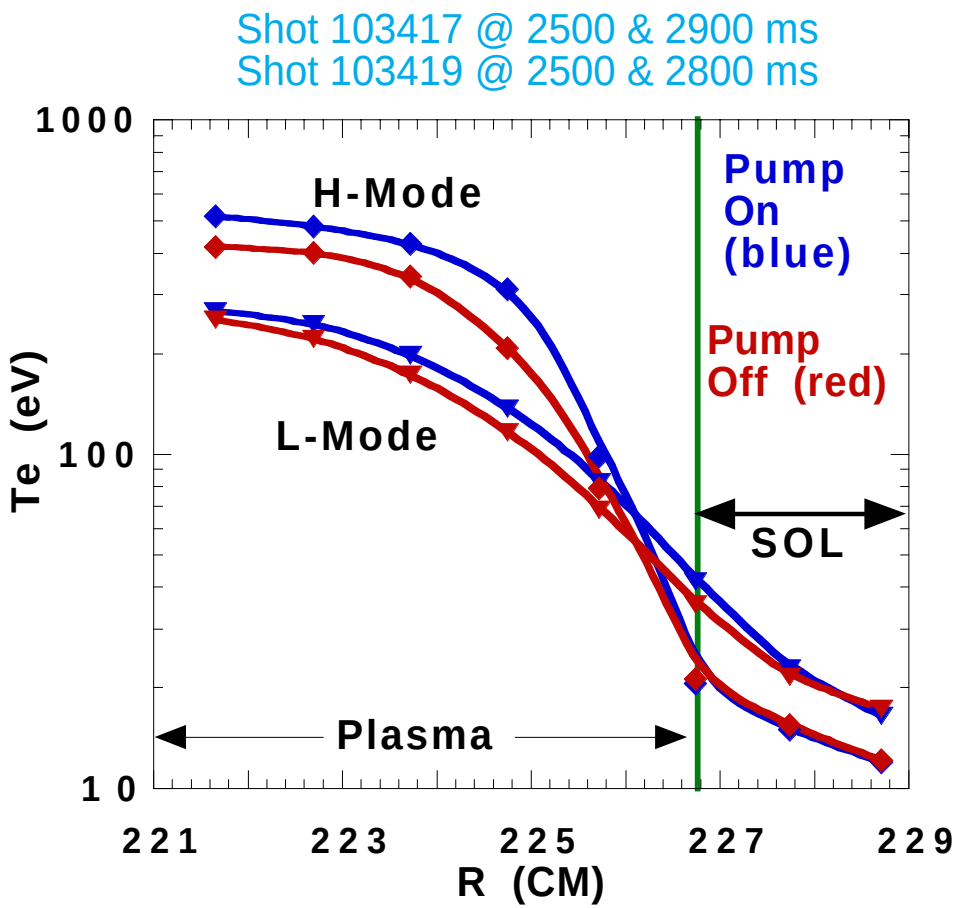
- With the outer separatrix leg away from the cryopump entrance, there was no change in the L-H transition power.

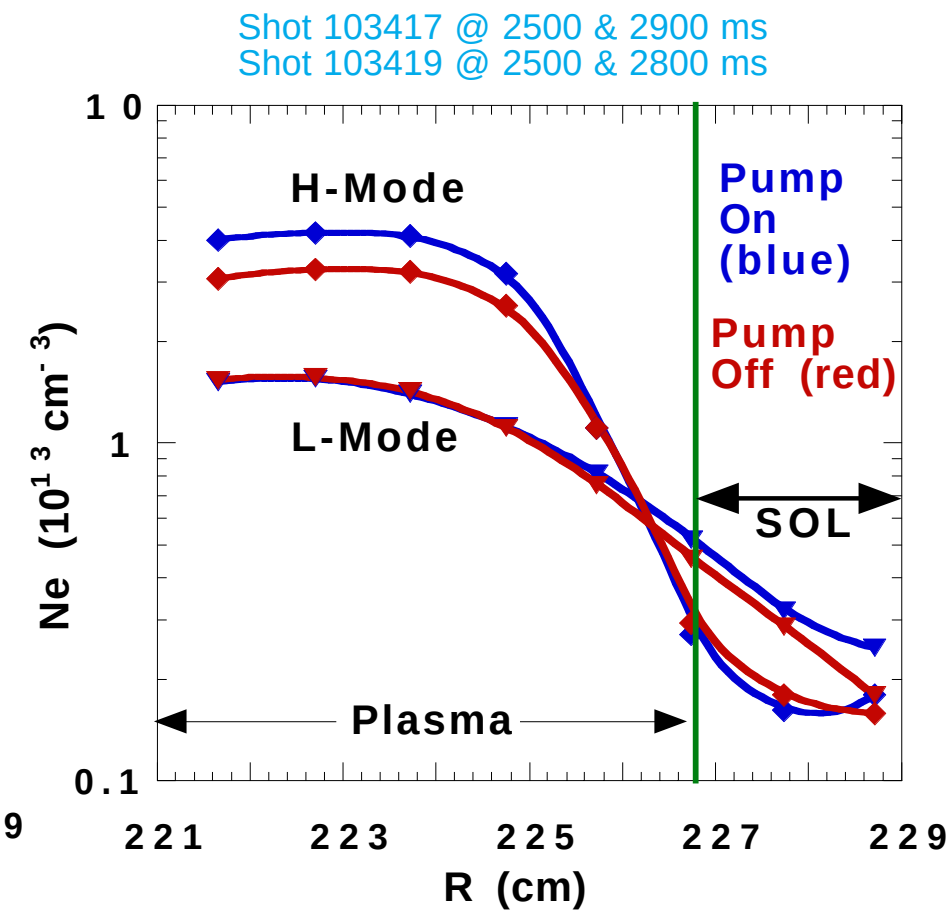


Cryopump on/off Shot Comparison



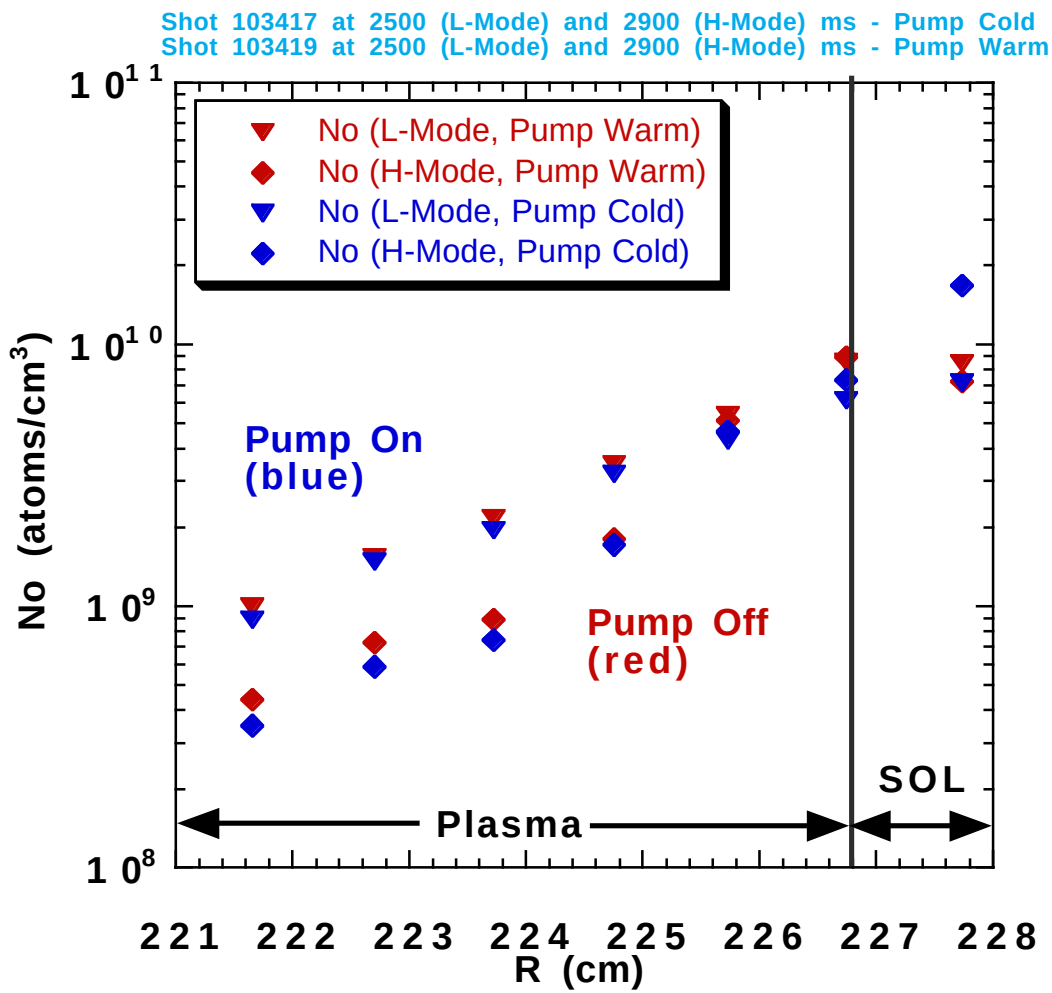
Midplane Edge Electron Temperatures and Densities



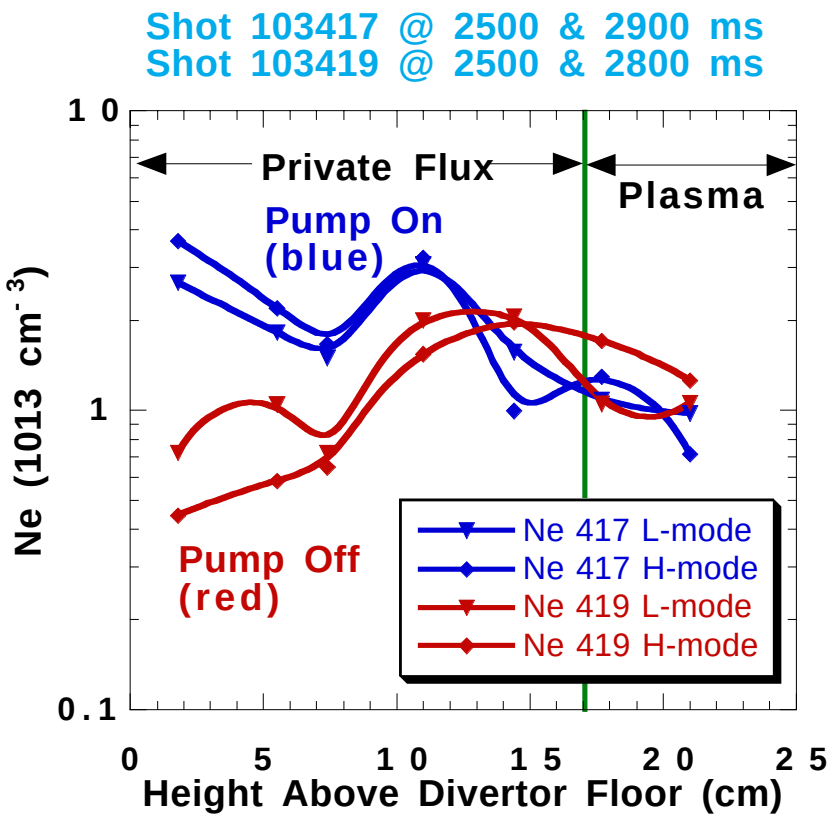


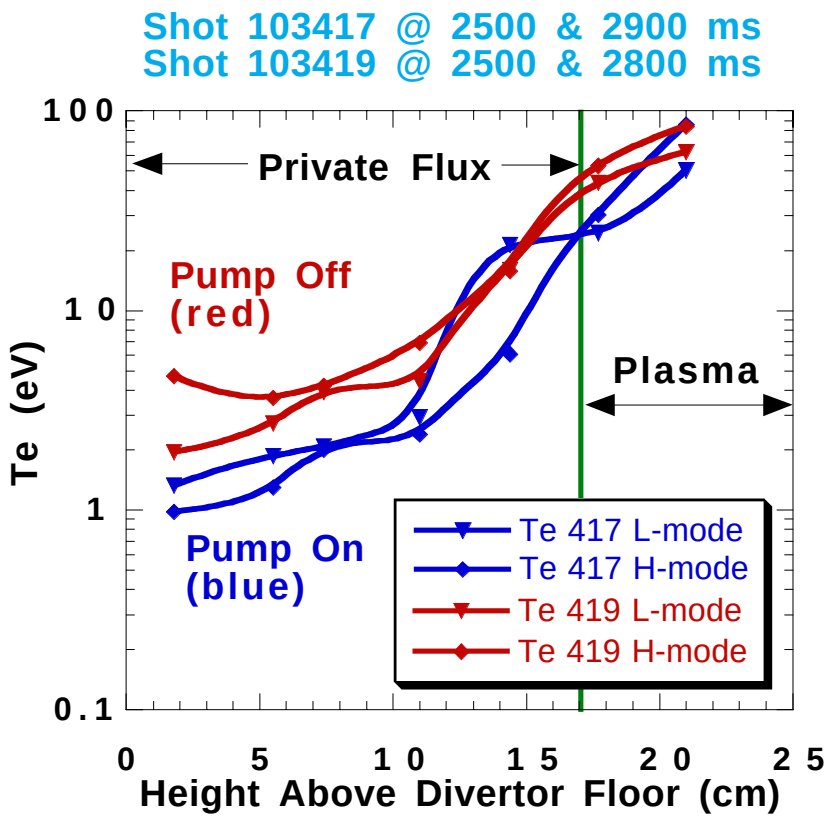
Midplane Neutral Densities Show Little Cryopumping Dependence

- **Neutral Densities at the outer midplane -**
  - Neutral densities are lower in the H-Mode, inside the plasma.
  - Almost no difference between cryopump warm/off (red) and cold/on (blue) neutral densities.



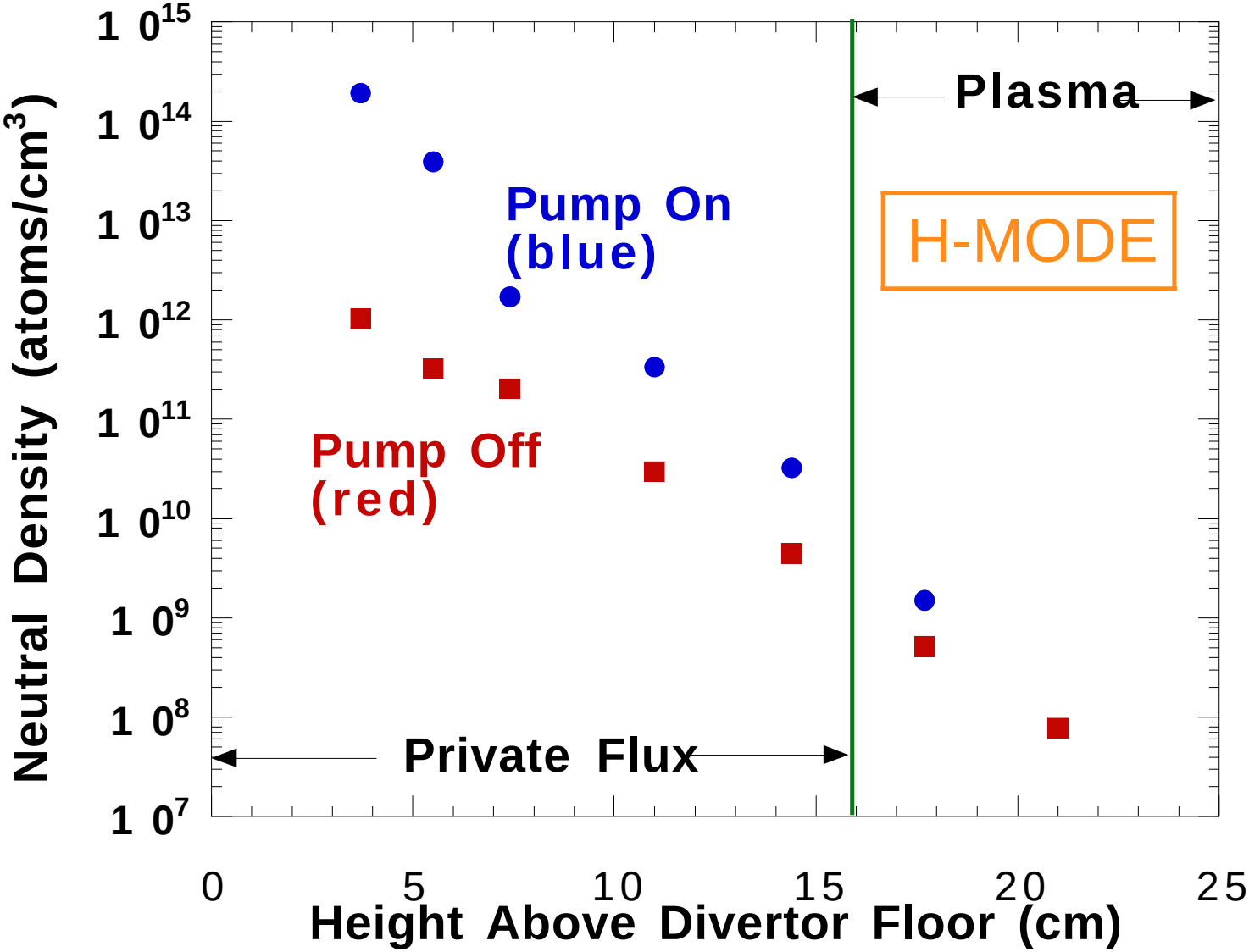
Divertor L & H-Mode Temperatures and Densities





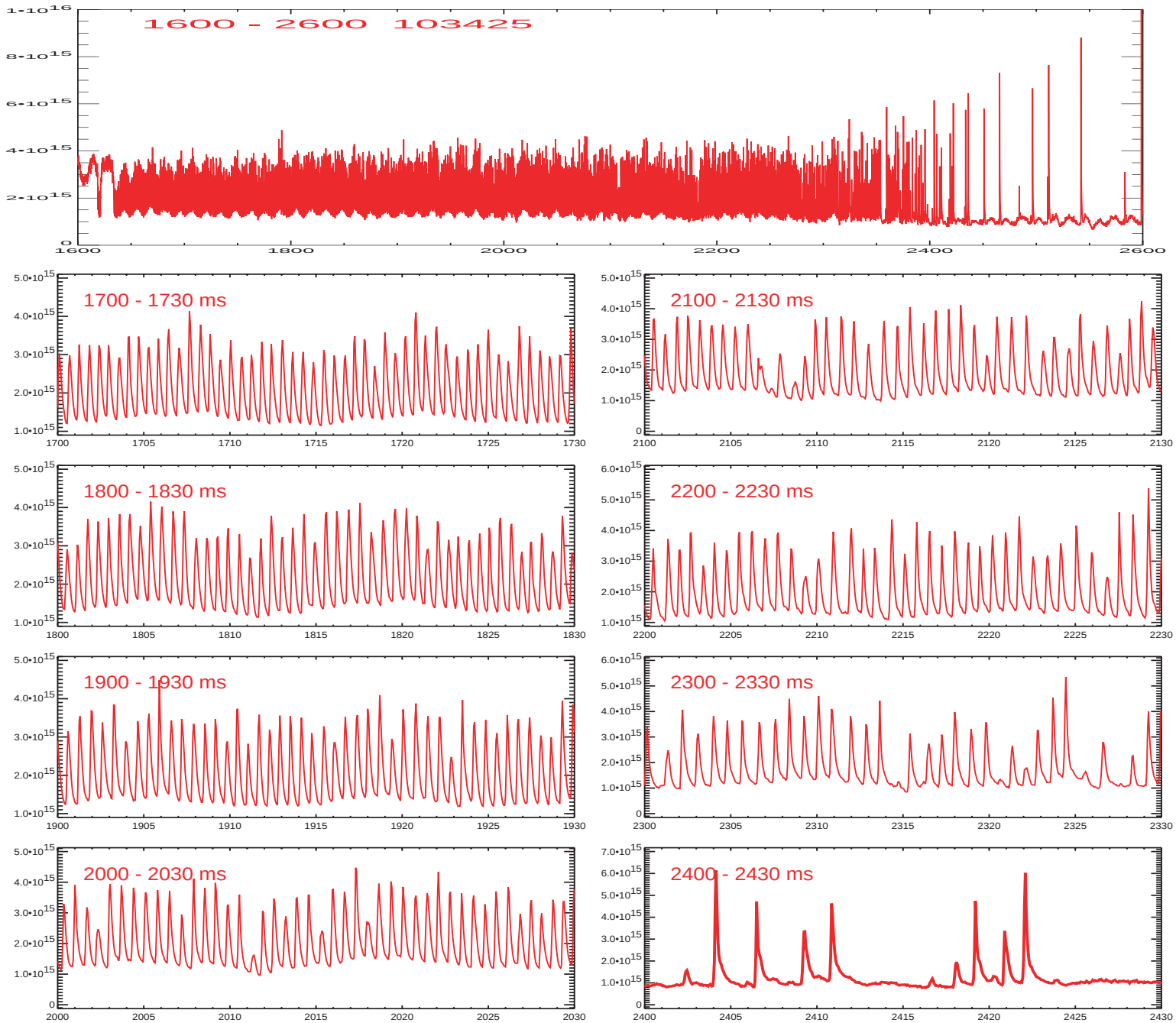
Divertor Neutral Densities are Higher with the Cryopump On

Shots 103417 @ 2800 ms & 103419 @ 2750 ms



Neutrals Measurements Conclusions

- Neutral densities at the midplane are nearly the same with and without cryopuping.
- H-mode neutral densities in the divertor are higher in the H-mode with cryopumping.
- This is consistent with divertor neutrals raising the L-H transition power.
- There is other evidence of neutrals involvement in the L-H transition…


1600 - 2600 103425
1700 - 1730 ms
2100 - 2130 ms
1800 - 1830 ms
2200 - 2230 ms
1900 - 1930 ms
2300 - 2330 ms
2000 - 2030 ms
2400 - 2430 ms

Neutrals Oscillations Summary

- Neutral density oscillations are observed following the L-H transition.
- These oscillations are largest in the lower divertor region.
- These oscillations evolve into type III ELMs, and limit the confinement increase.
- The shape of the waveforms suggest relaxation or predator/prey type oscillations.