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Poster 2.10

H-mode power threshold experiments in mixed ion species plasmas on TCV

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Summary

- **Goals:**

- Document the conditions for L-H transitions in TCV for NB heating plasmas and complement previous work on ohmic transitions [1]
- Clarify the role of He doping in H plasmas: JET [2] and DIII-D [3] showing a strong reduction while no effect found on AUG [4]

- **Results (preliminary):**

- Indications of unfavorable scaling with q_{95} for P_{LH}
- $P_{LH}/P_{scal,08}$ ~1 for D and q_{95}<5
- Larger threshold then prediction for H and He
- No positive effect of Helium doping

- **ITPA scaling [5]**

$$P_{scal,08} = 0.049\overline{n_e}^{0.72} B_T^{0.8} S_\perp^{0.94}$$

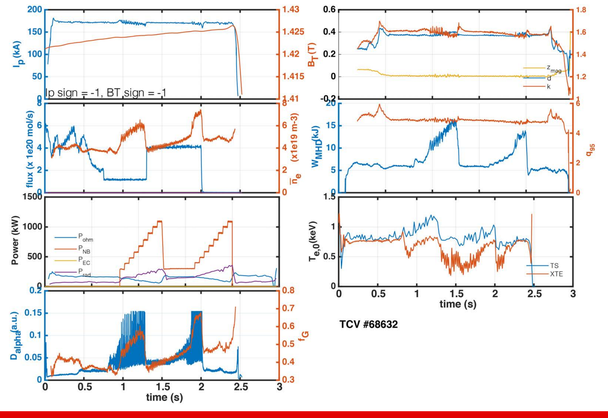
- **Main ion dependence [6]**

$$P_{L-H}^{H} \approx 2.14 \times P_{scal,08}$$
$$P_{L-H}^{He} \approx 1.41 \times P_{scal,08}$$

Experimental scenario

Fixed shape: LSN – I_p=170kA, B_T=1.4T, δ=0.4, κ=1.6 – All data collected w/o baffles – Sessions not attached to fresh boronisations

NB power steps from 0.2 to 1.3 MW at given density



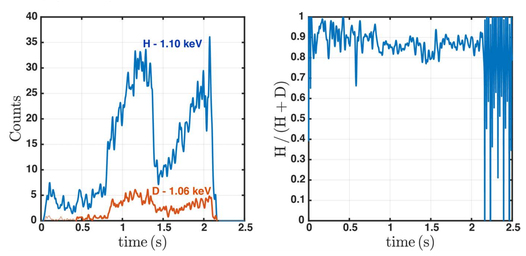
Analysis

Interpretative modelling with ASTRA

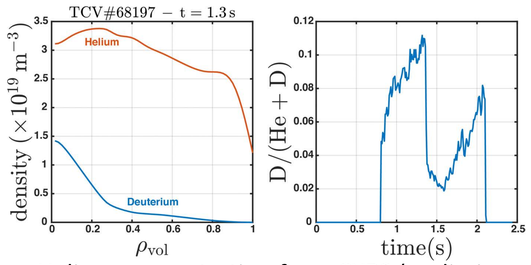
$P_{LH} = P_{loss} = P_{NBI}^{abs} + P_{ohm}$ - dW/dt (core radiation not subtracted)

Plasma content estimates:

- H/(H+D) from CNPA

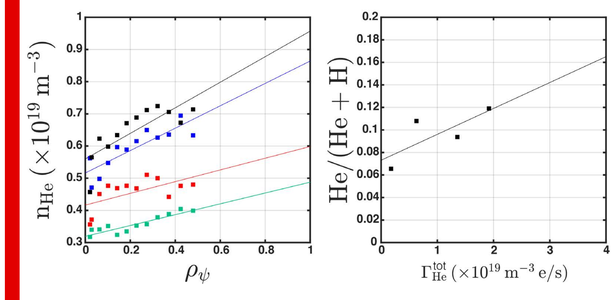


- D/(He+D) from FI density: D/(He+D) <30%

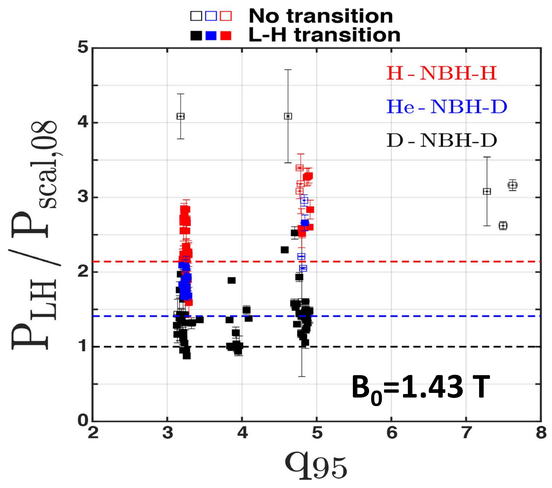


- Helium concentration from CXRS (preliminary)

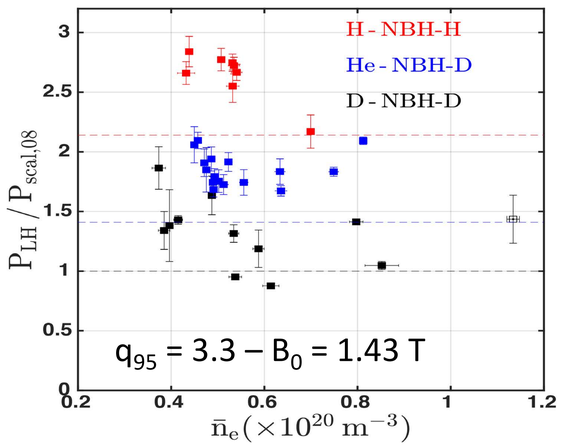
Absolute emission intensity of He II n=4 – n=3 transition at λ = 4686 Å measured. 'Passive' emission subtracted (NBI glitches). He III density estimated from 'active' signal, and collisional-radiative calculations for the NBI evolution. Linear relationship with total injected flux.



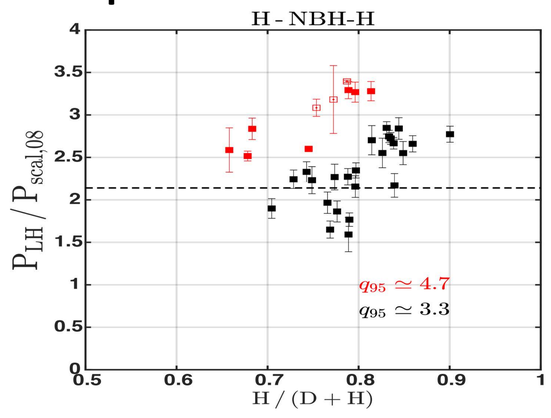
P_{LH} depends on q95



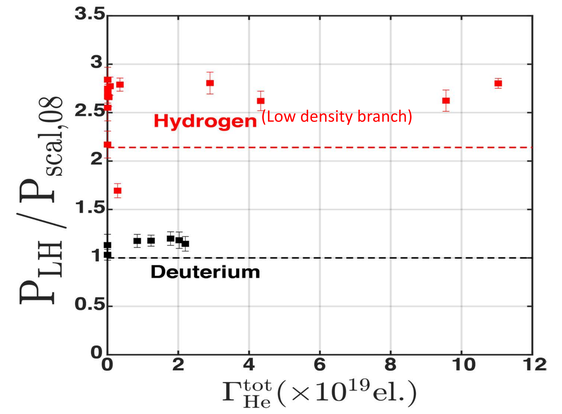
P_{LH} larger than scaling for Hydrogen and Helium



Hydrogen: P_{LH} decreases with plasma dilution



Threshold not reduced with He doping (H/(D+H)>0.8)



References

[1] R. Behn et al, PPCF, 2015 [2] J. Hillesheim et al, IAEA FEC 2018 [3] L. Smichtz et al, IAEA FEC 2021 [4] U. Plank et al, NF, 2020 [5] Y. R. Martin et al, JPCS, 2008 [6] D. McDonald et al, PPCF, 2004 [7] F. Ryter et al, NF, 2014 [8] T. Eich et al, NF, 2021

Next steps

+ Hydrogen: threshold for high density branch and He doping
+ Low density branch & heating mix: complete database and assess role of ion heat flux [7]
+ Role of drift-interchange Alfven turbulence: $n_{e,sep}$ vs $T_{e,sep}$ domain as done in AUG [8]
+ Refine analysis for He concentration

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