EUROfusion

EX / P4.1084

The dependence of confinement on the isotope mass in the core and the edge of AUG and JET H-mode plasmas

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[a]See appendix of H. Meyer et al. 2019 Nucl. Fusion 59 112014 [b]See appendix t of B. Labit et al. 2019 Nucl. Fusion 59 086020 [c]See the author list of 'Overview of JET results for optimising ITER operation' by J. Mailloux et al to be published in Nuclear Fusion Special issue: Overview and Summary Papers from the 28th Fusion Energy Conference (Nice, France, 10-15 May 2021)

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ASDEX Upgrade [1,2]

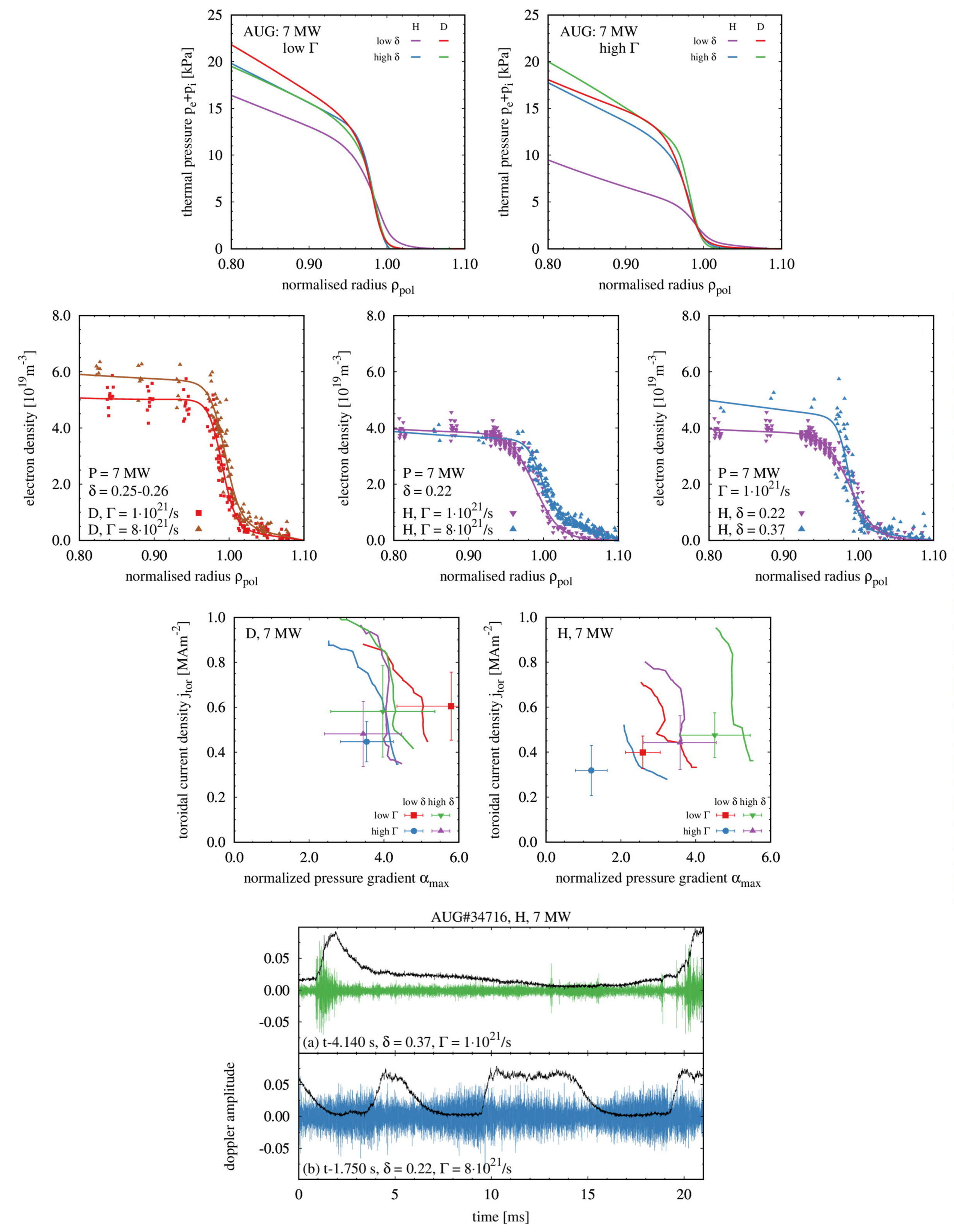
JET

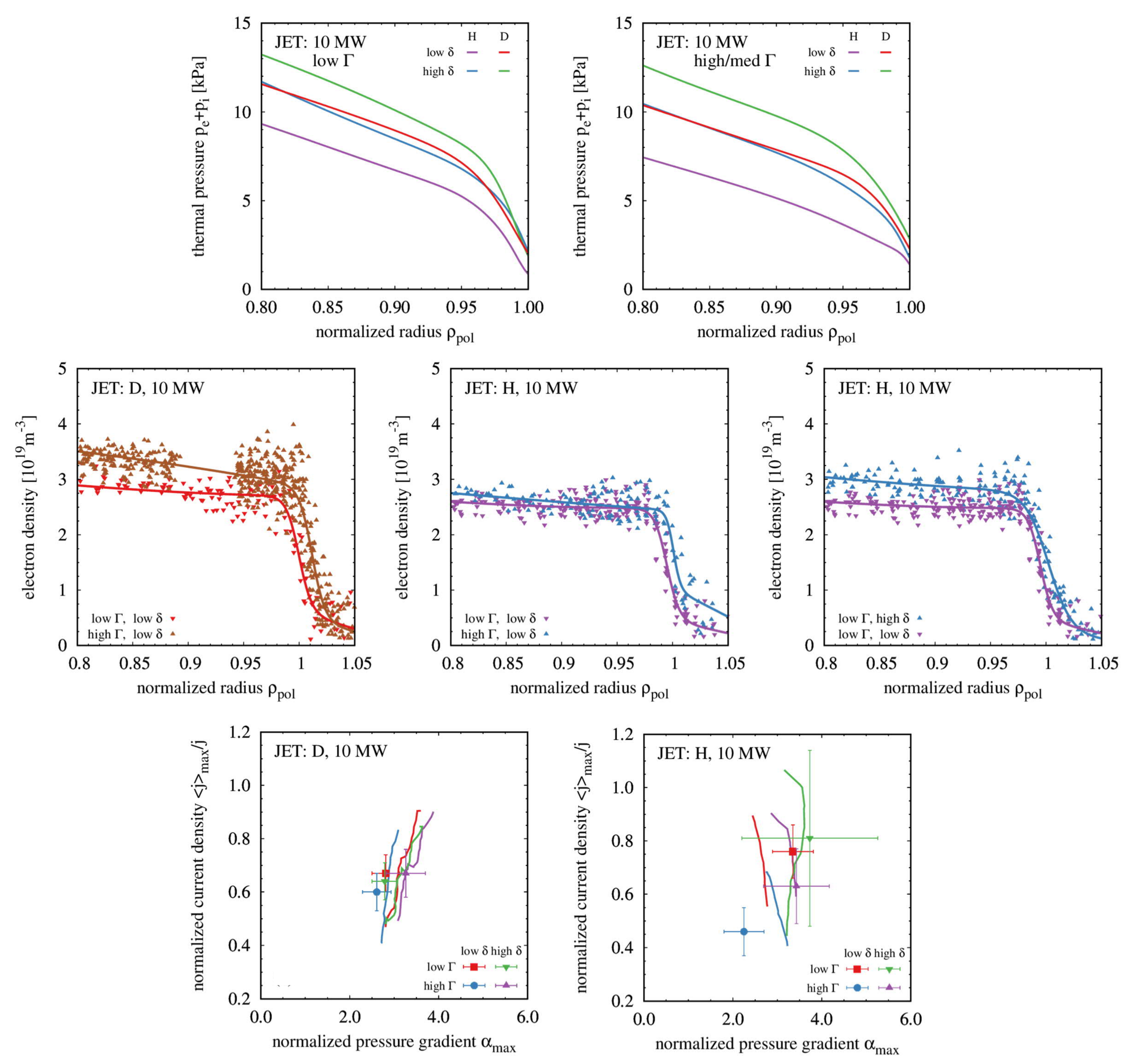
PEDESTAL

- Strong dependence of the isotope mass observed in the total pedestal pressure in H-mode - consistent with other studies [3,4] and often referred to as isotope effect.
- Difference between isotopes is enhanced with higher gas fueling Γ and can be offset with the triangularity δ
- In low δ H plasmas gas puffing does not increase the pedestal top density, instead the pedestal is degraded (reduced p, T)
- Triangularity is an actuator to modify the density in H

- D: pedestal close to peeling-ballooning stability boundary
- H, low δ, high Γ: pedestal is not limited by peeling-ballooning modes
- H, high δ: pedestal is at the peeling-ballooning stability boundary

- H, low δ, high Γ: increased amplitude of inter ELM density fluctuations observed in the pedestal
- Picture of increased turbulent transport in H edge consistent with observations in L-mode edge [5,6]

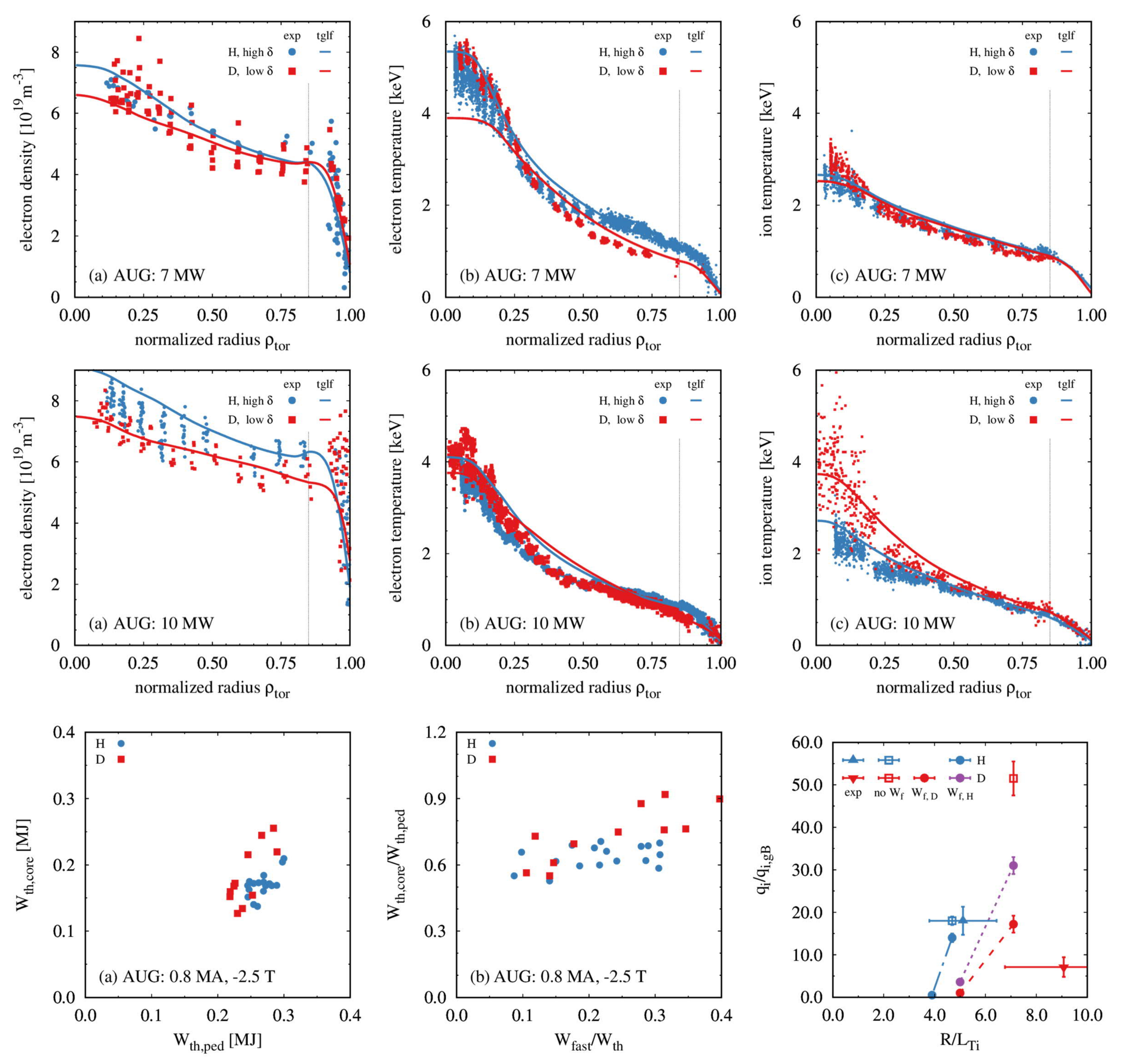


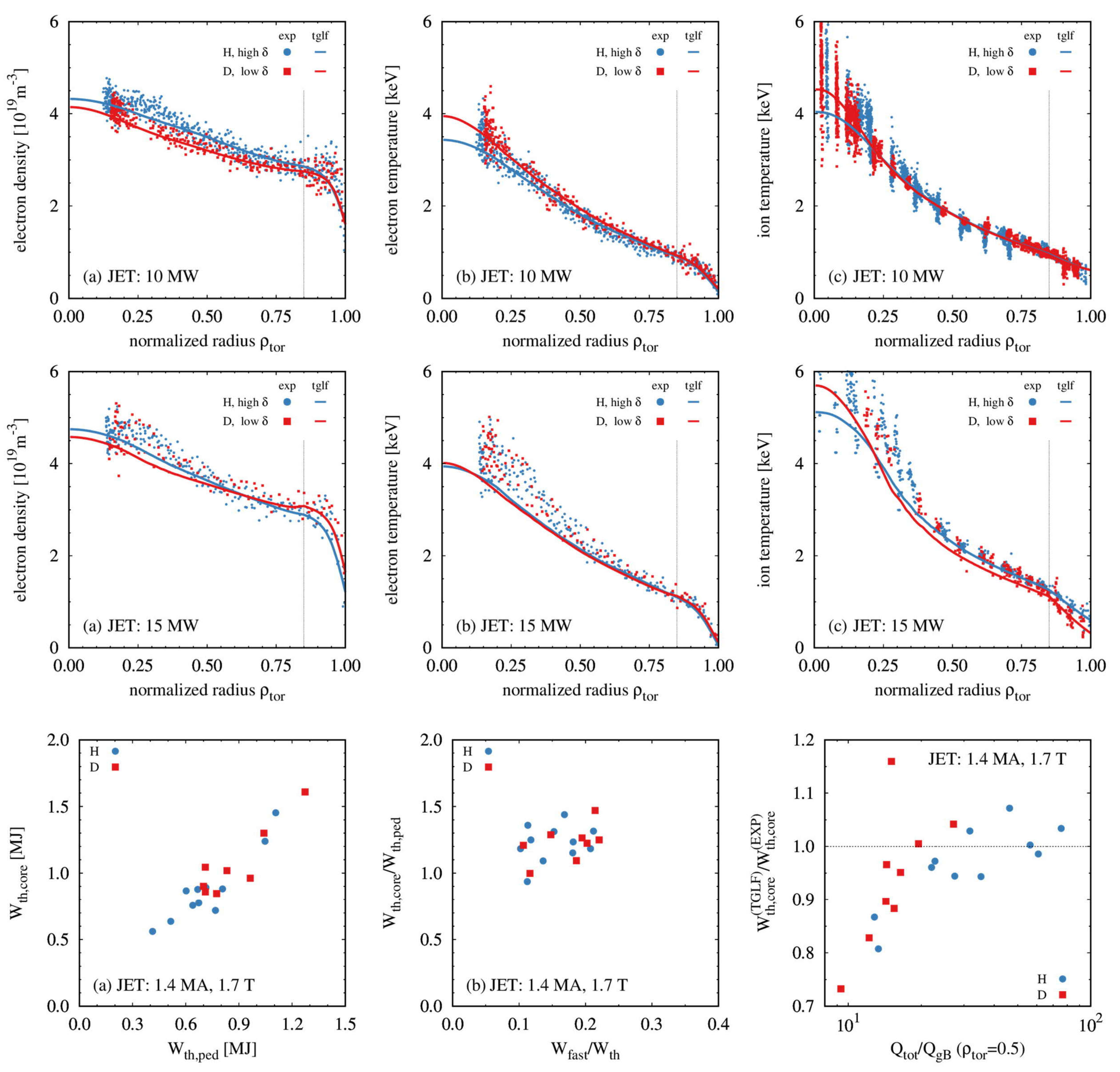


CORE

- When the isotope mass dependence at the edge is offset using different δ in H and D the core transport can be analyzed
- The TGLF [7] transport model is used within ASTRA [8] with different heating power:
- AUG, low heating: profile match and little deviation in TGLF prediction with mass
- AUG, high heating: deviation in the ion temperature, deviation reproduced with TGLF
- JET, low/high heating: no systematic mass dependence in measurement or prediction

- Strong core-edge correlation in energy contributions in AUG and JET
- AUG: Deviation $W_{th,core}/W_{th,ped}$ between H and D at higher fast-ion content
- JET: no deviation observed, but lower W_{fast}
- JET: TGLF model predicts confinement well for high heat fluxes in gB-units





SUMMARY

- Strong isotope mass dependence in the pedestal
- Reducing inter-ELM transport with increasing δ restores the pedestal in H to the level of D
- Little impact of δ on stability when the pedestal is at the ballooning limit

- No systematic impact of the isotope mass observed in AUG and JET core transport when:
  - the pedestal is matched
  - the fast-ion content is relatively low $W_{fast}/W_{th} < 1/3$
- Observations consistent between AUG and JET

- When the pedestal is not matched differences in core transport are explained by TGLF model, shortcomings of the model affect H and D plasmas in the same way
- At high fast-ion content an isotope dependence of the core transport remains – likely linked to non-linear ITG stabil.

JET ASDEX Upgrade IPP

[1] Schneider et al. NF 2021
[2] Schneider et al. PPCF 2021
[3] Laggner et al. PoP 2017
[4] Horvath et al. NF 2021
[5] Bonanomi et al. NF 2019
[6] Belli et al. PRL 2020
[7] Staebler et al. PoP 2007
[8] Fable et al. PPCF 2013

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.