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Comparison of H-mode Plasmas in JET-ILW and JET-C with and without Nitrogen Seeding

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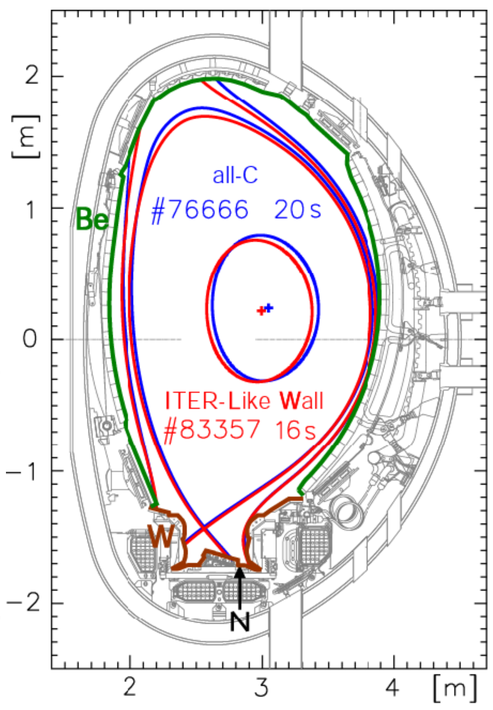
** See the Appendix of F. Romanelli et al., Proc. 25th IAEA FEC, St. Petersburg 2014*

EDGE2D-EIRENE simulations of highly shaped, H-mode plasmas in JET with the full carbon and the ITER-like wall

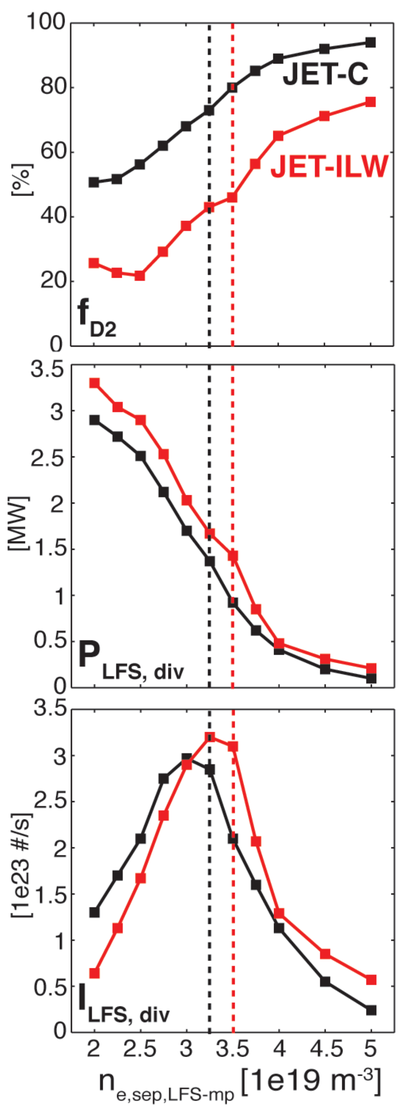
- JET was converted from an all carbon (C) device (**JET-C**) to the ITER-like wall (**JET-ILW**) [1]
  - ✓ C radiation and fuel retention reduced by 90% [2, 3]
  - ✓ Confinement reduced by 30 % in highly shaped H-modes → largely recovered with N_2-injection [4]
- **JET-C ➔ JET-ILW** reduced SOL radiation:
  - ✓ C is a strong divertor radiator
  - ✓ SOL radiation recovered with N_2
- **JET-C ➔ JET-ILW** expected to increase the atomic vs. molecular fraction in the recycling fluxes:
  - ✓ More fast deuterium reflections from W than from C
- **This study:** EDGE2D-EIRENE investigations of N_2 seeded H-mode plasmas in JET-ILW and JET-C I_p = 2.5 MA and at B_T = 2.7T with P_{in} = 16 MW [4, 6]



Lower D_2-fraction in recycling ions in JET-ILW predicted to increase target loads by 20% relative to JET-C

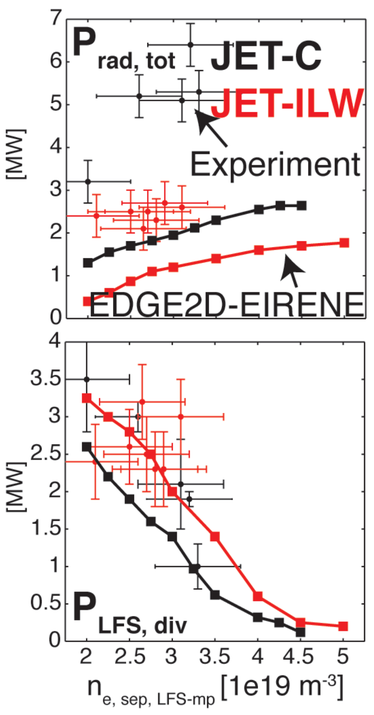
- EDGE2D-EIRENE simulations **without (any) impurities** conducted to investigate the impact of the wall recycling properties on the SOL conditions
  - ✓ Difficult to investigate experimentally, due to simultaneous change of the SOL radiation characteristics

1. **20 – 50% lower D_2-fraction** in the divertor recycling fluxes for JET-ILW than JET-C.
2. **5 – 10% lower D_0 flux** crossing the separatrix for JET-ILW than for JET-C.
3. **Deuterium radiation remains the same** within 5 – 10%.
4. **Low field side (LFS) heat deposition increased by 10 – 20%**, due to lower molecular heat dissipation.
5. **LFS peak electron temperature increased by up to 50%**
6. **Detachment threshold in density increased by 10%**.



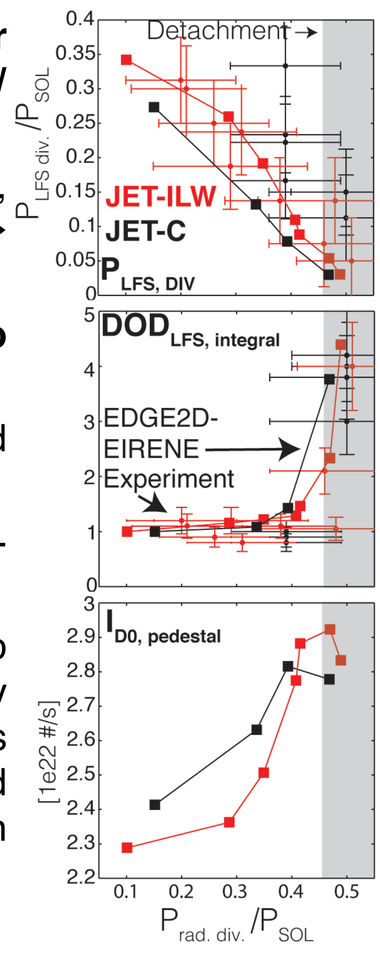
40% reduction in the SOL radiation with the change from JET-C to JET-ILW

- The simulations indicate a **40% reduction in the SOL radiated power** in unseeded conditions, similar to experiments
  - ✓ Total edge radiation underestimated by a factor of 2, similar to L-mode studies [7]
  - ✓ **Deuterium radiation remains the same** within 10 – 15%
  - ✓ **C radiation exceed Be radiation by a factor of 3 – 6** → factor of 3 – 6 higher effective radiative potential
- **Predicted LFS divertor power** deposition increased by 25 – 50%
- **Detachment threshold in density increased** by 15%.



Detachment assisted by nitrogen injection at P_{rad}^{div}/P_{SOL} ~ ½ in both JET-C and JET-ILW

- A factor of 5 reduction in the **LFS power deposition + LFS detachment** in JET-ILW and JET-C, when **P_{rad}^{div}/P_{SOL} ~ 10 → 50%.**
  - ✓ Lower intrinsic radiation in JET-ILW, compensated by stronger N radiation → **detachment at similar total radiation**
- **D_0 flux fuelling pedestal is predicted to increases with divertor radiation**
  - ✓ Divertor plasma cooling → reduced opacity to recycling neutrals
  - ✓ Pedestal n_e increase observed with N_2-injection in JET-ILW in high recycling [4].
  - ✓ In JET-C and in JET-ILW close to detachment, reduction of pedestal density with N_2-injection is observed [4]. This is presumably related to transport and pedestal stability changes not included in the model.



Conclusions

- **LFS detachment** assisted by nitrogen occurs in both JET-C and JET-ILW when about ½ of the P_{SOL} is radiated in the divertor
- **D_0 influx crossing separatrix** is predicted to increase with divertor radiation → increase of pedestal density observed experimentally in JET-ILW in high-recycling conditions with N_2
- A factor of ~2 reduction in the **intrinsic SOL radiation** with the change from JET-C to JET-ILW → up to 50% increase in the LFS divertor power
- Stronger **D_2-fraction in divertor recycling** can reduce the LFS power in JET-C by 10 – 20% relative to JET-ILW

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References

[1] G F Matthews, *et al.*, Phys. Scr. **T145** (2011) 014001.
[2] S Brezinsek, *et al.*, Jour. Nucl. Mater. **438** (2013) S303 – S308.
[3] S Brezinsek, *et al.*. Nucl. Fusion **53** (2013) 093023.
[4] C Giroud, *et al.*, Nucl. Fusion **53** (2013) 113025.
[5] G Maddison, *et al. 40th* EPS conference, Helsinki, (2013).
[6] G Maddison, *et al.*, Nucl. Fusion **54** (2014) 073016.
[7] M. Groth, *et al.*, Nucl. Fusion **53** (2013) 093016.

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