Characterising W radiation in JET-ILW plasmas


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* See the Appendices of F. Romanielli et al., Proceedings of the 25th IAEA Fusion Energy Conference 2014, Saint Petersburg, Russia

MOTIVATION FOR STUDY: pedestrian in JET-ILW colder tan in JET-C

- JET-ILW with W divertor: typically T_e,ped > 0.7-1.2 keV; JET-C (CFC divertor) T_e,ped < 1.5-2 keV [1,2]
- This is due in part to the much larger fuelling rates required to maintain the ELM frequency up and avoid W events and accumulation. At larger fuelling, pedestals have lower T_e,ped.
- That explanation is insufficient: at some fuelling levels, pedestals remain colder, particularly at higher densities.
- Non-classical transport: H-mode pedestal can be a W accumulator. W is given in by inward pinch from T_e,ped but once it reaches the top of T_e,ped it would penetrate much more slowly by diffusion.
- W can accumulate in between ELMs, near T_e,ped. W-associated radiation would slow down the rise of T_e,ped while density continues to rise until an ELM is triggered, resulting in colder pedestals.

W Ablation into L-mode plasma: JET 90472, 2 MA, 2.4 T, 1.2 MW NBI

3.3 < I_p < 8

• Hollow n_e profile
• D, V adjusted to simulate W, e, SOL

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W RADIATION, COOLING FUNCTIONS L(T_e)

W is generally a very good radiator in the 0.5-2 keV T_e,ped range. Calculation is challenging.

3.3 < I_p < 8

For low and medium 2 impurities (C, Be), N radiation is a decreasing function of T_e,ped from 250 eV: burn through.

Convection needed to match radiation data near ρ = 0.6 changes with atomic models: V_tor changes with atomic models: V_tor.

As a first cut on the data, we plot P_rad,TP as a function of T_e,ped from 11.1 s. The n_e profile is convolved with these curves, but excepting the first timeslice, all Experimental observations indicate major flaw in dielectronic recombination (DR) coefficients for mid-range ions with an open 4f shell in the ground state. This can increase DR rates in W by a factor of 10. It would significantly move the ionisation balance to higher T_e,ped with the expectation that structure would emerge in ln(T_e,ped/T_0) near ~600 eV. Work is in progress to incorporate these effects

SUMMARY, PRELIMINARY CONCLUSIONS, FURTHER WORK

• W injection can produce detachment and a radiating mantle in the outer 10 cm inside the separatrix.
• Sawteeth can transport W inward to the core and back out.
• Transport models required to match observed radiation data require less manipulation of the convection terms compared to theory when there is structure in ln(T_e,ped/T_0) near ~600 eV.
• We hope to carry out more W ablation experiments into non-O devote plasmas

BOLOMETRY, time averaged +/- 5 ms, kW/m^2

Due to flatness of n_e in that region provides the best match to the theoretical pinch.

REFERENCES


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