Post-ablation evolution of the tungsten VUV/XUV spectra in JET

and JET Contributors*

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Introduction
We suggest that the introduction of tungsten into fusion plasmas significantly changes their behaviour due to considerable cooling of the pedestal. Study of this hypothesis depends on understanding both the transport of tungsten in the fusion plasma and its radiative properties.

Experiment overview
The presence of sawteeth can dominate the transport and introduce non-local $T_e$ effects [1], so in this experiment tungsten is ablated into JET L-mode, low temperature effects [1], so in this experiment tungsten is ablated into JET L-mode, low temperature effects [1].

- Four JET pulses: #92284, #92285, #92286, #92293, ablation at 3.1 s in octant 6
- #92286 pulse data: B = 3T, I = 1.55 MA at 3.1 s, 1.7 MA from 3.5 s.
- NBI 1 MW, $Z_{eff}$ = 1.3 (no visible change due to ablation)

Measurement setup
Four spectrometers used:
- Vertical l-o-s: 15–140 nm KT7/1, 14–45 nm KT7/2, 4–7 nm, KT7/3
- Horizontal l-o-s: 10–104 nm, KT2

Results – spectroscopy
- Spectra preparation - average of five frames before ablation subtracted to show only ablated tungsten features
  - Evolution: VUV – maximum amplitude just after ablation, decay:
    - horizontal: time constant 160 ms
    - vertical: $t_1$ 200 ms
  - XUV features: increase – first 100 ms; decay – $t_1$ 470 ms

Results – bolometry reconstruction
- Just after ablation radiation localised along the separatrix, originates from many species, esp. deuterium
- after ~100 ms (time of increase of the XUV feature) maximum radiation in the plasma core (apart from divertor) and then start of the decay, $t_1$~500 ms

Modelling – overview
- Transport is modelled with neoclassical edge convection and turbulent core diffusion (resulting core $n_e$ insensitive to modulation)
- Measurement of line-integrated radiation is used to constrain the transport model
- Synthetic methyl of the total radiated power and spectral radiance can be used to assess the W cooling function $L_{rad}$

Radiation modelling
- W cooling function between 0.8 – 2 keV from baseline (Pütterich [2]) atomic data is smoothly increasing with temperature
- With updates to the total line power (PLT) coefficients [3] and an (over-)estimate of the dielectronic rate coefficient enhancements [4], the cooling function can feature structure within this temperature region
- By using inverted bolometry measurements to determine $P_{VUV}/n_e$ across the plasma radius, $L_{rad}/n_e$ can be assessed as a function of temperature
- $n_e$ is modelled using JETTO [5] to understand the contribution of $n_e$ to the $P_{VUV}/n_e$ measurement

Spectroscopic features – discussion
- XUV feature comes from W23+ – 26+ [2]
- VUV features are emitted by W23+–26+ ions and are sensitive to the configurations included in the collisional radiative population model and to the ionization balance
- Modelling of W ion emission between Z=23-26 has been calculated previously [2, 6]
- Work is ongoing to assess the contribution to the emission feature from W23+–26+

Summary
- We have introduced tungsten by ablation in a L-mode low temperature (<2 keV) plasma without sawteeth and performed measurements and data treatment to obtain VUV and XUV spectra of ablated tungsten and reconstruction of the spatial distribution of the radiated power
- Modelling results of $P_{VUV}/n_e$ suggest that the current baseline set of ionisation, recombination, and line power coefficients do not recover the experimental results between $T_e$ 0.6 – 1.3 keV
- An enhanced baseline data set better recovers the flatter radiation profile at lower temperature but work is ongoing to deliver new dielectronic rate coefficients
- Spectral fitting is an ongoing work for W23+–26+ with data already available for W23+–26+
- A finalised set of atomic data producing $L_{rad}$ should provide consistency over both the total radiation and VUV emission profile

References