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Space-resolved radiation spectrum in the 15-300 Å domain in keV plasmas of the WEST tokamak

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In magnetic fusion devices equipped with Tungsten (W) plasma-facing components (PFCs), dilution and radiation studies have become an essential feature of the experimental developments. Among several methods used to diagnose W transport and radiation in fusion plasmas, spectroscopy is one of the most powerful because it allows us to distinguish between the numerous ionisation stages of W. For example, in the visible range, it allows to assess the W sources on various PFCs and its transport in the scrape-off layer. In the VUV, it provides invaluable information on the confined plasma by resolving the mid- to high-charge ionisation stages of W [1]. However, W emission is so rich and complex that we are far from an exhaustive understanding of the measured spectra.

The WEST tokamak is equipped with a grazing incidence VUV spectrometer which has *i)* two detectors, each with an adjustable wavelength range in the 15-300 Å domain and *ii)* a line of sight which can scan the lower plasma half several times during each single plasma discharge. The wavelength interval width of each detector is relatively narrow. It varies from 23 Å to 60 Å from the short to the long wavelength end of the spectrometer domain. Therefore each pulse provides only a small window in the whole VUV emission spectrum of W. Nevertheless, it is possible to reconstruct broad spectra provided two instrumental features are taken into account: the brightness calibration and the non-uniform detector response.

The absolute brightness calibration of the spectrometer has been already performed [2]. It shows that the spectrometer sensitivity is rather flat in the 80-130 Å interval while it drops very steeply on both sides of that interval. what we focus on here is the method and results obtained about the detector response.

We have performed series of identical pulses during which the whole spectrometer domain was explored by changing the detector wavelength interval pulse after pulse. The setting of the detector position is chosen such that an overlap exists between adjacent spectra. By combining the measurements with the absolute calibration, we thus obtain the non-uniformity of the detector response. By combining it with the strongly varying brightness calibration coefficient, broad VUV spectra were obtained for each possible line of sight of the spectrometer.

Such a global spectrum can be used to better identify the numerous spectral lines observed in WEST by using time correlations between them, line brightness ratios, and line brightness dependence on electron temperature. It is also very useful to evidence the quasi-continuous features characteristic of W in WEST plasmas and compare them with theoretical computations [3].

[1] Y Liu et al., Plasma and Fusion research 13, 3402020 (2018)

[2] R. Guirlet et al., J. Instr. 12 (2017) P01006.

[3] M Y Boumendjel, Phys. Plasmas 30, 093302 (2023)

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