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Intensity calibration and reduction of pile-up effect in PHA spectra measurements at W7-X

Monika Kubkowska [1], Marta Gruca [1], Sławomir Jabłoński [1], Leszek Ryć [1], Ulrich Neuner [2] and the W7-X team

1) Institute of Plasma Physics and Laser Microfusion, Hery 23, 01-497 Warsaw, Poland

E-mail : monika.kubkowska@ifpilm.pl

2) Max Planck Institute for Plasma Physics, 17491 Greifswald, Germany

The pulse-height-analysis (PHA) is a technique used at fusion devices for measurements of intensity of the X-ray spectrum. At the stellarator W7-X, this method is applied together with the application of silicon drift detectors for observation of the radiation in the energy range from about 0.5 to 20 keV [1-2]. To receive quantitative information on plasma impurity concentration several aspects should be taken into account. Firstly, the detector response curve which includes the transmission of filters and detector thickness. In this case we based on empirical method as measurements with synchrotron or other X-ray radiation was not possible. Secondly, the geometry parameters which define the observation cone of view, and finally, the pile-up effect which is a crucial point in intensity calibration. The last point depends on the digital signal processor (DSP) parameters. The pile-up effect can be minimized by the proper settings of the parameters but often it is a compromise between energy resolution and temporal resolution of the time-dependent X-ray intensity signal. The information about the number of lost photons can be derived from the ratio of number of photons incoming to the detector (measured by DSP as input count rate, ICR) to the number of photons observed in a spectrum (measured by DSP as output count rate, OCR). The most important thing in this investigation is proper determination of time interval during these photons are counted.

For the PHA system dedicated to W7-X, the pile-up effect has been well identified and is already included in the intensity spectra calibration which allows to determine the impurity concentration.

References

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[2] M. Kubkowska et al. Review of Scientific Instruments 89, 10F111 (2018)