Optimization of optical dumps for H-alpha spectroscopy in ITER in the frameWORK of synthetic diagnostics

A.G. Alekseev1, E.N. Andreenko1, A.B. Kukushkin1,2, and V.S. Neverov1

1National Research Centre Kurchatov Institute, Moscow, Russia, vs-never@hotmail.com
2Moscow Engineering Physics Institute, Moscow, Russia

The ITER Main Chamber H-alpha (and Visible Light) Spectroscopy diagnostics faced a challenge of separating the useful signal, which is the light emitted by the scrape-off-layer (SOL) plasma in the main chamber, from the total signal, in which the contribution of the so-called divertor stray light (DSL) (which spectrum is close to that of the useful signal) emitted in the divertor and reflected by the all-metal first wall, may dominate [1, 2]. A bifurcated-track measurements scheme was proposed to address this issue [1]. This scheme should be implemented as the simultaneous observation of two neighboring spots on the first wall with a noticeable or strong difference in the light reflection coefficient, *Rw* This will allow one to “subtract” the unknown contribution of the DSL, under the following conditions: (i) the spectral intensities of the useful signals are the same on the both tracks; (ii) the normalized spectral intensity (the line shapes) of the DSL are the same on the both tracks. The differenceof the *Rw* value may be caused by the natural landscape of the first wall or may be assured by using the optical dumps. The dependence of the light suppression ratio of optical dump on the direction of incident light was shown in [3]. This may lead to a difference between the line shapes of the DSL measured on the tracks within the above-mentioned couple, under conditions of the strong local inhomogeneity of the plasma emissivity in the divertor and the anisotropy of the light emitted by atoms in a strong magnetic field. The first calculations of the DSL spectrum distorted by the reflection from the optical dumps under the ITER conditions, for the Balmer-alpha line of deuterium (D-α), were carried out in [4] using the software package “Zemax Optical Studio”. The data of predictive modeling of the flat-top stage of the inductive mode of ITER operation (with Q=10), calculated by the SOLPS4.3 (B2-EIRENE) code [5-7] (with modifications [8]) were used to calculate the spectral and angular distribution of the DSL falling on the optical dumps.

In this paper the efficiency of few designs of optical dumps is analyzed in the framework of "synthetic diagnostics”, which simulates the "phantom" experimental data, using the data of the above-mentioned simulation of the main plasma parameters. Thus, for the bifurcated-track measurement, we estimated, using the calculations of light reflection from the optical dump following the algorithm [4], the accuracy of the separation of the spectral contribution of the SOL plasma emission near the high-field side of the first wall to the total registered signal as a function of (a) the fraction of the DSL in the total signal, (b) the geometry of optical dump and (c) the location of the dump on the first wall. The results enabled us to evaluate the efficiency of the optical dumps of each design for various locations of the spot on the first wall.

References

1. A.B. Kukushkin, et al., Proc. 24th IAEA Fusion Energy Conference, San Diego, USA, 8-13 October 2012, ITR/P5-44.
2. S. Kajita, et al., Plasma Phys. Contr. Fusion, 2013, 55, 085020.
3. E.N. Andreenko, et al., Int. Conf. on Fusion Reactor Diagnostics, Varenna, Italy, September 9-13, 2013, AIP Conf. Proc., 2014, 1612, 171.
4. E.N. Andreenko, et al., ХVI Russian conference “Diagnostics of High-Temperature Plasma”, Zvenigorod, June 7-11, 2015 (in Russian).
5. A.S. Kukushkin, et al., Fusion Eng. Des., 2011, 86, 2865.
6. B.J. Braams, PhD thesis, Utrecht: Rijksuniversitet, 1986.
7. D. Reiter, M. Baelmans, P. Börner, Fusion Sci. Tech., 2005, 47, 172.
8. S.W. Lisgo, P. Börner, et al., J. Nucl. Mater., 2011, 415, S965.