FAST CALCULATION OF SYNTHETIC IMAGES FOR ITER VIDEO CAMERAS USING INTERPOLATED RAY TRANSFER MATRIXES [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.244

1Neverov V.S., 1,2Khusnutdinov R.I., 3Polevoi A.R., 3Imbeaux F., 3Schneider M., 3De Bock M.

1NRC “Kurchatov Institute” Russia, [neverov\_vs@nrcki.ru](mailto:neverov_vs@nrcki.ru)   
2NRNU “MEPhI”, Russia  
3ITER Organization, France

A method for fast calculation of synthetic images for ITER video cameras equipped with optical filters in the visible wavelength range is proposed. The resulting images take into account the reflection of radiation from the metal first wall of the vacuum vessel. The monochromatic ray transfer matrices [1] pre-calculated using ray tracing are used to generate the images. These matrices contain the coefficients describing the transformation of the signal from individual sources of unit emissivity (cells of a three-dimensional spatial grid) to pixels of the CCD matrix of a video camera. The size of ray transfer matrices can reach hundreds of gigabytes. To efficiently store them in the ITER database and when used in the RAM of single node of the computing cluster, the matrices were split into two parts. The first part takes into account only the direct signal, that is, radiation without reflections, and the second − the reflected radiation. The first part is calculated for a fine spatial grid of sources, and is stored in a sparse form, since it contains mostly zeros. The second part is calculated only for selected cells of the spatial grid, which serve as interpolation knots (a similar method, but for neutron flux diagnostics, was proposed in [2]). The interpolation knots are selected according to an algorithm, which takes into account that the ray transfer matrix for reflected radiation is a sharp function of the spatial coordinate near the observed areas of the first wall, as well as at the boundaries of the shadowed zones located mainly in the divertor. The ray transfer matrices obtained in this way can be used with any spatial distribution of plasma radiation and are ten times smaller in size compared to the non-optimized ray transfer matrices.

Synthetic images are calculated by convolving the spatial plasma emissivity profiles with ray transfer matrices. For the direct signal, the emissivity profile is interpolated to the cells of the grid of the ray transfer matrix for non-reflected radiation, and for the reflected signal, the ray transfer matrix for the reflected radiation is interpolated to the cells of the grid of the emissivity profile. Comparison of the proposed method of calculation with the ray tracing for a given spatial emissivity profile showed the images obtained by both methods are the same, while convolution of the emissivity profile with interpolated ray transfer matrices is hundreds of times faster than ray tracing.

The IMAS (Integrated Modeling & Analysis Suite) [3] data dictionary was updated to support this method of fast calculation of synthetic images for ITER video cameras.

References

1. S. Kajita, E. Veshchev, R. Barnsley, M. Walsh, Contrib. Plasma Phys., 2016, 56, 837.
2. A.O. Kovalev, A.R. Polevoi, E.I. Polunovskiy, L. Bertalot, Yu.A. Kashchuk, D.V. Portnov, A. Loarte, M. Loughlin, S. D. Pinches, J. Fusion Energy, 2020, 39, 40.
3. F. Imbeaux, S.D. Pinches, J.B. Lister, Y. Buravand, T. Casper, et. al., Nucl. Fusion, 2015, 55 123006.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/E/ru/JD-Neverov.docx) [↑](#footnote-ref-1)