Simulation of CXRS Diagnostics Using Ray-Tracing Engine [[1]](#footnote-1)\*)

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1A.Yu. Shabashov, 2M. De Bock, 1S.V. Serov, 1S.N. Tugarinov

1Institution «Project Center ITER»
2ITER Organization

Simulation code “cxrs” was developed for simulation of spectra registered via CXRS (Charge eXchange Recombination Spectroscopy) diagnostics on ITER [1, 2]. This diagnostic measures line emissions of several low-Z impurities in the plasma due to their interaction with a diagnostic neutral beam (DNB). It is used to determine density and ion temperature of impurities along with plasma bulk motion velocity. Python programming language was chosen for this code along with Raysect [3] ray-tracing engine and CHERAB [4] plasma modelling framework. Developed code can be used to simulate plasma emission spectra with reflections considered.

Simulation was done with plasma parameters at the core: electron density $n\_{e}=10^{20} m^{-3}$; impurity density (Be and Ne) $n\_{Be}=n\_{Ne}=0,005 n\_{e}$; electron temperature $T\_{e}=16 KeV$; ion temperature $T\_{i}=14 KeV$ [5]. Diagnostic neutral beam was simulated with parameters: power 2 MW and energy 100 KeV.

Results of the simulation were compared with spectra made using SOS code [6]. Comparison of Bremsstrahlung emission power showed a difference of 10%. This difference can occur due to different methods of definition of the plasma geometry done in two codes. Difference is active charge exchange emission power was 22%. This difference can be linked to different atomic data used in codes.

To study how reflected light affects simulated spectra, simulation was done with inclusion of reflective wall and without it. Fraction of reflected light for different types of emission was noticeably different. This fraction is much larger for Bremsstrahlung emission than for active charge exchange emission and also depends on the line-of-sight it comes from.

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References

1. S.N. Tugarinov et al*.* Development of the Concept of Charge-Exchange Recombination Spectroscopy for ITER // Plasma Physics Reports, Vol. 30, No. 2, 2004, pp. 128–135. Translated from Fizika Plazmy, Vol. 30, No. 2, 2004, pp. 147–154.
2. S.V. Serov, S.N. Tugarinov, M. von Hellermann. ITER plasma spectra modelling for charge exchange recombination spectroscopy// Proc. of 45nd EPS Conference on Plasma Physics 2 – 6 July 2018. 42A. –– European Physical Society, 2018. –– P4.1012.
3. *Dr Alex Meakins, & Matthew Carr.* (2018, August 7). raysect/source: v0.5.2 Release (Version v0.5.2). Zenodo. <http://doi.org/10.5281/zenodo.1341376>
4. *Dr Carine Giroud, Dr Alex Meakins, Dr Matthew Carr, Dr Alfonso Baciero, & Mr Corentin Bertrand.* (2018, March 23). CHERAB Spectroscopy Modelling Framework (Version v0.1.0). Zenodo. <http://doi.org/10.5281/zenodo.1206142>
5. L. Garzotti et al 2019 Nucl. Fusion 59 026006
6. *M. von Hellermann et al.* Simulation of Spectra Code (SOS) for ITER Active Beam Spectroscopy. — В: Atoms 7.1, 2019. — doi: 10.3390/ atoms7010030
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/E/ru/HP-Shabashov.docx) [↑](#footnote-ref-1)