Divertor Thomson Scattering in Tokamak-Reactor [[1]](#footnote-1)\*)

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An important part of experimental program for currently developed tokamak-reactors will be operational modes with large heat fluxes through the last closed magnetic surface. In such regimes, the limiting factors will be physical limitations of the thermal load on first wall and elements of divertor. The divertor is the most energy loaded and, therefore, the most critical element of any tokamak-reactor. That is why it is necessary to pay attention for studying Scrape-of-Layer plasmas, plasma-wall interactions, research and control of hydrogen recycling, control of the regimes with complete or partial plasma detachment characterized by a significant reduction in the thermal load on divertor targets. High power density of additional heating of the tokamak reactor will lead to extremely high loads on the divertor region, which will increase the risk of a serious accident. The operating modes of the divertor, their optimization and tracking during operation are of particular importance for protecting the reactor from accidents. Modeling of near-wall divertor plasmas, as well as regimes with plasma detachment has not been fully developed. When developing the operating modes of the divertor, reliable experimental data on the distribution of the electrons, ions, and neutrals (*Te,ne,Ti,ni,nHe/H/D/T*) will be required to validate theoretical models and numerical codes [1].

The rates of reactions involving electron component *Te, ne*, such as ionization, recombination, and radiation, play an important role in plasma cooling. The parameters of the ion component and the neutral density *Ti, ni, nHe/H/D/T*are important in estimating the rates of ion-neutral collisions.

The entire set of plasma parameters in the region of the X-point, their change from the X-point along the separatrix to the outer divertor target and along the surface of the outer divertor plate is proposed to be solved using combined laser diagnostics of Thomson scattering (TS) and Laser Induced Fluorescence (LIF) [2]. One of the most important diagnostic functions will be to test the model assumptions of the plasma behavior in the divertor and its detachment from the divertor plates. The emphasis on the study of the outer divertor leg is explained by the fact that the complete detachment of plasma from the inner divertor target usually occurs earlier than in the outer one, as well as by the complexity of laser measurements in the inner leg.

The set of parameters measured by the combined diagnostics TS/LIF will allow:

- provide control of the divertor operating mode by determining areas of predominant ionization/recombination in the divertor plasma by measuring the local values of the rate coefficients of ionization and recombination (Te ne n\*He/H/D/T);

- calculate the friction forces of plasma flows against the neutral component (Ti, ni, n\*He/H/D/T);

- calculate the change in pressure along the outer leg of the divertor (Te ne Ti ni);

- determine the density ratio of hydrogen isotopes n\*H/D/T,

- determine the density (pumping efficiency) of helium - a product of fusion reactions.

References

1. E.E. Mukhin, et al Physical aspects of divertor Thomson scattering implementation on ITER 2014 Nucl. Fusion 54 043007 https://doi.org/10.1088/0029-5515/54/4/043007
2. E.E. Mukhin et al Integration of Thomson scattering and laser-induced fluorescence in ITER divertor 2019 Nucl. Fusion 59 086052 https://doi.org/10.1088/1741-4326/ab1cd5

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