Project of LIF diagnostic for Globus-M spherical tokamak

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Diagnostic on the basis of Laser-induced fluorescence (LIF) in plasma devices can be used for local measurements of atoms/ions densities and temperatures [1,2], macroscopic plasma formation motion velocities [2], for study of the kinetics of the atomic processes [3], for measurements of the electric and magnetic fields based on spectral line profiles [4,5] and other tasks. The method is based on laser pumping of the allowed transition between the excited states of the atom/ion and subsequent registration of the fluorescent radiation of the same or other transition.

Tunable in visible and near ultraviolet spectral ranges dye lasers, optical parametric oscillators (OPO), Ti:Sapphire lasers can be used as the impulse pump sources. Nd:YAG laser with the OPO system is preferred for the density measurements due to simplicity of its design, broad spectral line and wide operating range 210 – 2500 nm. Dye lasers allow to obtain both a narrow (3-5 pm) and a wide (up to 300 pm) lines and are used in the applications requiring continuous tuning of laser wavelength (measurements of temperatures, velocities, etc.). Spectrometers with the bandpass filters are usually used to observe the signals on the interesting lines due to their high transmission, while photomultiplier tubes (PMT) allow registering the signals in visible and ultraviolet ranges.

Measurements of the helium atoms distributions (addition injection or in He-regimes) using LIF diagnostic are planned to study the ionization-recombination processes in the divertor region of the Globus-M tokamak. Electron density and temperature may be estimated in case of sufficient level fluorescent signals and simultaneous observing of the singlet and triplet He I lines. In case of high level of the impurities in the divertor region, primarily carbon ions, it is also planned to measure density and possible temperature of carbon ions. Thompson scattering (TS) diagnostic optical elements will be used to enter LIF-beam into the tokamak vacuum chamber through the lower port. TS optics also will be used to collect the fluorescent signals. Combined location of TS and LIF diagnostics equipment on Globus device will ensure work through the ITER integration scheme.

The report describes the physical tasks of LIF diagnostic and the provisions for their implementation, the equipment mix and layout at the facility, also the optical scheme of probing diverter plasma is provided, as well as estimations of the fluorescent signals.

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