Laser-induced quenching diagnostics of hydrogen in tokamak plasma [[1]](#footnote-1)\*)

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1Gorbunov A.V., 2Mukhin E.E., 2Kurskiev G.S., 2Tolstyakov S.Yu., 1Letunov A.Yu., 1Lisitsa V.S., 1Levashova M.G., 1Vukolov K.Yu.

1NRC Kurchatov Institute, alexeygor@mail.ru,
2Ioffe Institute, e.mukhin@mail.ioffe.ru

Laser-induced quenching (LIQ) [1,2,3] technique is proposed for diagnostics of hydrogen atoms (deuterium, tritium) in tokamak and stellarator plasmas. LIQ combines benefits of both laser-induced fluorescence (LIQ) [4,5] and photoionization (LII) [6,7] used for hydrogen density measurements: the sensitivity of LIQ is comparable to laser fluorescence and due to the difference between pumping and viewing wavelengths as in LII laser stray-light can be easily reduced.

LIQ is based on partial decreasing the most intensive hydrogen line in the visible range *Hα* (656.3 nm, transition *n* = 3 → 2) by laser excitation in one of the Paschen series lines. Laser pumping in the transition *n* = 3 → *nUp* (*nUp* ≥ 4) reduces the population of *n* = 3 group of states and proportionally decreases the *Hα* intensity. The local density of hydrogen atoms can be calculated with collision-radiative model (CRM) from amplitude of the quenching signals.

100 Hz pulsed optical parametric oscillator based laser (OPO) used for the first tests in Globus-M tokamak plasma [3] pumped hydrogen line 1005 nm (*n* = 3 → 7). The experiments have confirmed the possibilities of diagnostic implementation in tokamak conditions.

The CRM calculations show that pumping the 1875 nm line (*n* = 3 → 4) requires minimum power spectral density of laser radiation (*PSat* < 1 W/cm2pm) to saturate the quenching signals comparing to other Paschen series lines. The low laser power required to quench the line allows using 1875 nm time-modulated thulium fiber laser (tunable range 1873-1877 nm) with peak power of 5 W. The first measurements with this laser were carried out in ohmic discharges in the equatorial plane near the inner wall of tokamak. The minimum measured hydrogen density was *na* ≈ 1015 m-3 averaging over 10 ms in steady state discharge stage. In case of higher density *na* > 1016 m-3 averaging over 1.0-2.5 ms was sufficient.

LIQ basics, experimental features in tokamak conditions are described. The experimental results of hydrogen density measurements in the scrape-of-layer Globus-M plasma are presented.

References

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