DOI: 10.34854/ICPAF.52.2025.1.1.104

FIRST EXPERIMENTS ON PRELIMINARY IONIZATION OF WORKING GAS IN THE L-2M STELLARATOR USING WAVES OF ION CYCLOTRON FREQUENCY RANGE *)

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At many facilities, especially at spherical tokamaks and tokamaks with small aspect ratios, there is not enough space for placing inductor capable of creating loop voltage sufficient for organizing breakdown of working gas. Therefore, in tokamaks, it is necessary to create systems for preliminary ionization of working gas. The technique of preliminary ionization using waves of the ion cyclotron frequency range is poorly studied. The advantage of this technique consists in the fact that it can be implemented using equipment for the ion cyclotron plasma heating, which is available at many facilities. At the same time, power required for creating preliminary plasma is small.

The experiments were carried out at the L-2M stellarator in the ohmic heating regime. For performing preliminary ionization, the ion cyclotron heating system [1] was used. The system consists of two poloidal antenna strips located in two cross-sections spaced by 22.5 cm in the toroidal direction. RF power of 1 kW was supplied to each of strips via a separate line. The phase difference between the voltages supplied to the antenna strips was optimized. The best results were obtained in the case of supplying voltage to two antenna strips in antiphase. The voltage was supplied to the antenna 10 ms before supplying voltage to the inductor that creates the ohmic heating current.

As a result of preliminary ionization, plasma formation occurred 1.5–2 ms before it occurred in the absence of RF radiation in the stage of gas breakdown. This was recorded by the H_{α} emission diagnostics and bolometer. The Langmuir probe signals also indicated earlier plasma column formation as compared to that in the case of the absence of preliminary ionization. As a result, in shots with preliminary ionization, the flow of runaway electrons decreased in the breakdown stage, and the intensity of hard X-ray radiation (100–300 keV) also decreased by an order of magnitude.

The experiments showed that earlier breakdown of working gas occurred due to the formation of preliminary low-density plasma under the effect of RF radiation. It forms before the voltage is supplied to the inductor. The highest decrease in the intensity of hard X-ray radiation was observed in the case of supplying 20-ms RF voltage pulse to the antenna strips 10 ms before supplying voltage to the inductor.

It was also ascertained that in shots with preliminary ionization, the loop voltage decreased by $\sim 15\%$. At the same time, the plasma current increased by $\sim 15\%$.

This work was supported by the Ministry of Science and Higher Education of the Russian Federation (State Contract No. FFWF-2025-0002, "Research on plasma heating and current drive in plasma of the toroidal magnetic trap L-2M stellarator using waves with frequencies in the ion cyclotron and helicon range").

References

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^{*)} abstracts of this report in Russian