First experiments on the investigation of the generation of negative hydrogen ions with the use of CW ECR discharge at GISMO facility [[1]](#footnote-1)\*)

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Negative hydrogen ion (H-) sources are of great demand for particle beam production for accelerators and storage rings and for neutral beam formation for plasma heating systems for fusion. This work is devoted to the two-stage generation of H- ions in the plasma volume. The first stage consists in the excitation of high vibrational levels of hydrogen molecules as a result of collision with the “hot” electrons (E ≈ 30 — 100 eV), and the second one consists in the dissociative electron attachment of “cold” electrons (E ≤ several eV) to excited molecules. Studies on the volumetric Н- ions generation based on a quasi-gasdynamic plasma of pulsed ECR discharge sustained by microwave gyrotron radiation showed the promise of the approach and the possibility to obtain H- beams with current density up to 80 mA/cm2 [2]. Plasma radiation in vacuum ultraviolet (VUV) range is an important indicator of the processes occurring in low-temperature hydrogen plasma [3]. Investigation of VUV emission provides an opportunity to evaluate the plasma characteristics and to optimize the negative ion source. Initial studies of the VUV radiation of pulsed ECR discharge plasma were carried out, demonstrating the possibility of the use of the method to optimize H‑ ions production [4].

We investigated negative ion production in a two-stage volume generation mechanism based on the quasi-gasdynamic CW ECR plasma discharge sustained by gyrotron radiation (28 GHz / 10 kW) and confined in a system of two magnetic traps: a probkotron and a cusp, connected to each other. Plasma was generated in the first trap under ECR resonance conditions and flowed into the second through the metal plate, which prevented the further microwave radiation propagation into the second trap, which made it possible to implement two spatially separated stages of the volumetric mechanism of generation of Н- ions. We studied the VUV plasma radiation along the system axis in three ranges: the atomic Lyɑ line (122 ± 10 nm) and molecular radiation in the Lyman band (160 ± 10 nm) and the molecular continuum (180 ± 20 nm).

The VUV plasma emisson study made it possible to analyze the plasma parameters and optimize the conditions of negative hydrogen ions production. The optimization of the extraction system and the volume of the H- generation zone was carried out. The maximum current density of negative hydrogen ions was obtained (j = 44 mA/cm2 in CW regime) together with the optimization of system parameters: neutral gas pressure and gyrotron power.

References

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