Deuterium ion beam focusing for a point-like neutron source development [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2020.47.1.127

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The presented work is aimed at development and production of a point-like neutron source based on the D-D fusion reaction occurring when a focused deuterium ion beam hits a deuterium containing target. Such approach is perspective for creation of a simple and compact device allowing to satisfy modern requirements of neutron tomography applications. Size of the neutron source is a parameter which determines the quality of a neutronographic image in this type of neutron generator. In its turn, the neutron source size is determined by the quality of ion beam focusing to the target. Consequently, there is a task of obtaining of the smallest beam diameter in the focal plane.

In the conducted experiments the gyrotron microwave radiation with power up to 100 kW and frequency of 37.5 GHz operating in a pulse mode with the pulse duration of 1.5 ms was utilized for an ECR-discharge plasma production. Plasma was confined in an open magnetic mirror trap formed by a pair of solenoids also operating in a pulse mode. The magnetic field value corresponding to an ECR resonance is 1.34 T, the maximum field value in the magnetic mirrors was 4 T. The two-electrode extraction system consisting of plasma electrode and puller electrode was used for ion beam formation. The voltage up to 60 kV was applied to electrodes. The magnetic lens providing ion beam focusing was placed after the extraction system. The gas injection system located on the system axis near the first magnetic plug was integrated into the electrodynamic system of microwave radiation coupling into plasma. Deuterium was used as a working gas.

A system of movable orthogonal slits with size of 0.5 mm was used for the transverse beam size diagnostics and for the whole current measurements. The slits system was placed in the vacuum volume inside the diagnostic chamber after the focusing lens. The majority of the ion beam extracted from the plasma reached the collector (screen) placed in the front of the slits that gave the whole beam current values. A part of a beam passed through the hole formed by the slits reached the second electrode that allowed to obtain the current density distribution in the transverse direction. The slits position was controlled by the automated system allowed to shift the hole with the step of 0.15 mm. The transverse distributions of deuterium beam current density with the width at half-maximum less than 1 mm were obtained. The full beam current reached values of 150 mA.

The results of numerical modelling conducted with an IBSimu code are also presented. The ion beam focusing using a combined focusing system (electrostatic and magnetic) is discussed. In the framework of this method it is suggested to place an additional electrode after the extraction system for the parallel ion beam formation that will allow to significantly improve its transport and focusing by magnetic lens. It was demonstrated that this approach could allow to focus the beam in the region with size of 0.13 mm.

The work was supported by the project of the Russian Science Foundation # 16-19-10501.

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