helicon plasma source
with inhomogeneous magnetic field [[1]](#footnote-1)\*)

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At the BINP SB RAS, work is underway to study plasma generation at a facility with an RF plasma source based on a helicon discharge. Expected application of this source is plasma generation in linear magnetic traps and linear plasma systems for plasma-material interaction studies (PMI). PMI studies are important in the researches of materials that are supposed to be used as the first wall of fusion reactors. A number of requirements are imposed on plasma sources for such installations, such as high plasma density, absence of impurities, and stationary operation. One of the most suitable sources are RF plasma sources with high plasma generation efficiency and long operating time.

 In a helicon plasma source, the discharge chamber is a quartz tube of 110 mm in diameter and 400 mm in length. The discharge in the chamber was created using an external half-wave helicon antenna with an azimuthal wave number m = ± 1 and length of 150 mm. The external magnetic field of the source was formed by a system of five solenoids with a field decreasing in the antenna region by approximately two times in order to create a field gradient in the discharge generation zone. Industrial COMDEL CX25000-S generator with a frequency of 13.56 MHz and a power of up to 25 kW was used as a power source.

In the experiment, stable matching of the generator with the plasma load was achieved, and the dependence of the density on the applied power was obtained in the range of 5–25 kW. Various regimes of plasma generation were studied with a magnetic field in the range of 100–600 G in the antenna region at a gas pressure in the discharge chamber of 10–45 mTorr. The radial and longitudinal distributions of the electron temperature and plasma density are measured. The plasma has a bell-shaped density profile with a maximum on the axis and a saddle-like temperature distribution with maxima at the periphery and minimum on the axis. It was found that as the contribution of power to the discharge increases, the inhomogeneity of the density profile grows with a sharpening of the maximum on the axis. Experiments on the plasma compression in the strong field at the distance of 40 cm from the antenna center were performed to optimize the source by the plasma spatial distribution and to match the source magnetic field with typical PMI facilities fields (~1000-2000 G). Plasma parameters were measured using triple Langmuir probes and plasma cutoff microwave diagnostics. Plasma density of ~1013 cm-3 with electron temperature of 7-10 eV is achieved in experiment.

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