DETERMINATION OF THE RADIAL STRUCTURE OF THE PLASMA FLOW IN qUASI-STATIONARY PLASMA ACCELERATOR [[1]](#footnote-1)\*)

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In connection with the modification of quasi-stationary plasma accelerator QSPA [1], in order to create a prototype of a plasma thruster, measurements of the radial distributions of the electron temperature and concentration, the glow of the plasma flow were carried out. The obtained values of the plasma parameters and the plasma flow velocity are of interest for calculating the thrust characteristics and efficiency of plasma thruster prototypes.

Spatial-temporal distributions of temperature and concentration were obtained using the probe method. This method of plasma diagnostics based on multi-pin probes is successfully used to measure electron temperature and concentration, plasma potential, Mach number under conditions of unsteady high-speed strongly ionized flows generated in plasma accelerators [2] and pulsed capillary discharges [3]. Thin tungsten rods placed in a ceramic casing were used as electrodes. The electrical circuit includes constant voltage sources for creating a fixed potential difference between pairs of rods, shunts for measuring the currents in the probe circuits. This measurement scheme provides low sensitivity to electromagnetic interference and does not require measurement of the full probe I – V characteristic. These features of the scheme improve the accuracy of the method and make it attractive for diagnostics of fast plasma processes, in particular, pulsed plasma accelerators. With the help of a multi-electrode probe, the spatial-temporal profiles of temperature and electron concentration were obtained for the first time under conditions of a quasi-stationary high-current accelerator. For a hydrogen plasma flow, the average values of the temperature and concentration of electrons, calculated on the basis of the theory presented in [4], were 7.6 eV and 2 × 10-16 cm-3, respectively.

The spatial-temporal distributions of the plasma flow radiation were obtained using the high-speed video camera Phantom v2512 with a frame rate of 660,000 fps. For a detailed measurement of the internal structure of the plasma flow, the spatial-temporal distribution of radiation was compared with that of the concentration and temperature.

The velocity of the hydrogen plasma flow generated in the QSPA at a fixed value of the energy deposited into the discharge was estimated by two independent methods. First, the experimentally obtained value of the plasma flow velocity using high-speed recording was 40 km / s. Secondly, the speed was measured based on the registration of currents on longitudinally and transversely oriented probes [2]. This configuration is due to the fact that the saturation ion current to the transversely oriented probe depends on the plasma flow velocity. The speed values obtained by the described methods are in good agreement.

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References

1. Климов Н. С. и др., ВАНТ. Сер. Термоядерный синтез, 2019, В. 3, С. 52-63
2. Eckman R. et al., J. Propul. Power, 2001, V. 17, P. 762-771
3. Pashchina A. S., Karmatsky R. E., J. Phys. Conf. Ser., 2018, V. 1112, P. 012023
4. **Chen S. L., Sekiguchi T., J. Appl. Phys., 1965, V. 36, P. 2363-2375**

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