DEVELOPMENT AND TESTING OF a NEW PROBE FOR electric propulsion plume studying [[1]](#footnote-1)\*)

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The work presents a new design of the probe with a retarding potential for investigating the plume of an electric rocket engine. The use of such probes makes it possible to measure the energy spectrum of ions in the EP plume. The study of the plume makes it possible not only to diagnose the operation of spacecraft engines, but also to predict the effect of plasma on satellite on-board devices.

Existing probes use three or four grids and a current collector to measure the energy spectrum. The first grid is grounded and prevents internal grids of the probe from disturbing plasma outside the probe, which in turn prevents distortion of the results. The second grid is fed with a negative potential to cut off electrons. The third grid is kept under positive potential and forms a potential barrier for ions. This grid transmits ions with enough energy to overcome the barrier, which then reaches the collector. The dependence of the current at the collector on the potential of the third grid provides the ion energy spectrum. Sometimes there is a fourth grid in front of the collector, which is used to lock down the secondary electrons generated by the ion emission.

The effective transparency of the probe for ions varies depending on the plasma density and current density of the ions, which makes it difficult to interpret the results and can lead to uncontrolled changes in the systematic error of measurements. It is therefore necessary to use either a probe with variable geometry or several probes to diagnose the jet at all angles, which is quite difficult and inconvenient.

The probe presented in the report solves this problem and allows the energy spectrum to be measured with an error of less than 3% both on the plasma plume axis with maximum current density and on the periphery, where current density is several orders of magnitude lower. The new probe uses an ion-optical system to focus the ion beam and cut off electrons. Ions are filtered directly at the current collector, to which a positive potential is fed. Ions with insufficient energy do not reach the current collector.

The report presents the results of the numerical modelling of the probe. The influence of deviation of apertures from the coaxiality and inclination of ions in relation to the axis of the probe on the measurement error was studied. Features of the probe design and methods of measuring currents in the range from 1 nA to 1 mA on the current receiver, which is under positive potential are presented. The report also shows the results of measuring the current density dependence on the angle to thruster axis and the distribution of ions by energy at different angles of inclination to the motor. The comparison of the probe performance with the simulation results is presented.

References

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