GAS JET FLOW CREATIon USING A PLASMA ACCELERATOR [[1]](#footnote-1)\*)

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1,2Goryainov V.Yu., 1Voronin A.V.

1Ioffe Institute Russian Academy of Sciences, 195251, 26 Polytechnycheskaya st.,  
 Saint-Petersburg, Russia, [vgoryainov@mail.ioffe.ru](mailto:vgoryainov@mail.ioffe.ru)   
2Peter the Great St. Petersburg Polytechnic University, 195251, 29 Polytechnycheskaya st.  
 Saint-Petersburg, Russia

Plasma accelerators are currently successfully used for problems of controlled thermonuclear fusion. The plasma jet is actively used for discharge initiation and fueling to devices with plasma magnetic confinement as well as for conditions simulation of plasma interaction with the first wall materials [1, 2]. At present, gas injection into plasma is also actively used to solve various problems. Thus, helium injection into hydrogen or deuterium plasma is actively used for diagnostic purposes in experiments on FT-2, COMPASS, MAST, DIII-D, TEXTOR, MST, JET, ASDEX-U, JT-60, etc. tokamaks and TJ-II, LHD stellarators [3-5]. In these experiments the gas flow velocity is limited and close to the speed of sound (~1 km/s). For deeper plasma probing there is a need to increase this speed. To this end, this paper proposes a method for generating a helium jet stream moving at a speed of more than 50 km/s. The method consisted in dense and cold plasma jet transforming into gas flow. For this purpose the plasma was passed through a 1.125 m long channel, in which as it moved it almost completely recombined. Thus, gas flow was formed at the channel outlet, the velocity of which was close to that of the plasma flow.

The studies were carried out on test bench, which is a set of diagnostics and vacuum chamber with volume of 2.5 m3 with shutter through which it was possible to connect various types of plasma sources. The jet could flow freely into the chamber. The coaxial plasma accelerator was powered from a 160-μF storage capacitor with electrode voltage up to 5 kV. Jet density and velocity at outlet reached 1016 cm-3 and 100 km/s, respectively. Along plasma jet motion coaxially with the accelerator, there were various variants of long channels in which the plasma could recombine and transform into neutral gas flow moving at a speed of several tens of kilometers per second.

The paper presents results of neutral helium flow formation using plasma accelerator and long recombination tube. In the course of the research, conditions were found under which neutral helium jet emerged from duct at speed of 50-60 km/s.

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References

1. A.V. Voronin, et al. Plasma Phys Rep V. 47, № 8, P. 763-771
2. A.N. Novokhatsky et al. Journal Problems of Atomic Science and Technology. Ser. Thermonuclear Fusion, 2017, V. 40, issue 4
3. S.I. Lashkul et al. Plasma Phys Rep, 2012, V. 38, № 11, P. 923–936
4. Ahn J.W., Craig D., Fiksel G. et al. // Phys. Plasmas. 2007. V. 14. P. 083301.
5. Goto M. // J. Quant. Spectrosc. Radiat. Transf. 2003. V. 76. P. 331

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/BR-Goryainov.docx) [↑](#footnote-ref-1)