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### Novel Modification of Hall-Type Ion Source (Study and the First Results)

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We describe the original approach to use the plasma accelerators with closed electron drift (Hall-type ion sources), which, unlike traditional accelerators with metal and dielectric walls, have open (gas) walls and can be applied for creation cost effective low maintenance plasma devices based on plasma lens configuration for production converging towards axis accelerated ion beams. Based on the idea of the continuity of current transferring at the system in the frame of one-dimensional model, exact analytical solutions describing electric potential and electron density distribution along acceleration gap are found. It was shown that potential distribution is parabolic for different operation modes in low-current mode, as well as in high current quasi neutral plasma mode, and does not depend on electron temperature. It is found that, under conditions for which all electrons originated within the gap by impact ionization only, and go out towards anode due to classical mobility in transverse magnetic field, the condition of full electric potential drop in the accelerating gap corresponds to the gap length equality to the anode layer thickness.

Experimental model of cylindrical Hall-type plasma ion source that produced ion plasma flow converging towards the axis system was created. The current-voltage characteristics of the accelerator in different operating modes were defined. In high-current quasi neutral plasma mode of accelerator operation, plasma jet is observed. It is shown that along the jet axis potential drop arise which can be used for ion beam accelerating. It is noted the power ion plasma flow increases with discharge current density growth. Note also, the ion current density at the jet axis can reach up to 2-3% of total discharge current. The obtained experimental results are in qualitative agreement with theoretical consideration.

Note also, the described plasma ion source can be attractive for many different high-tech applications, e.g., for creation effective plasma lens with positive space charge cloud for focusing negative intense charged particle beams (electrons and negative ions) and for potential devises of low cost and compact thrusters.

### References

Alexey Goncharov Invited Review Article: The Electrostatic Plasma Lens, Rev. Sci. Instrum. 84, 021101 (2013).

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