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If an artificial energetic plasma flow similar to the solar wind were available, there must appear many applications. Among others, a cleaner and a safer D-D based advanced fusion reactor system may well have a chance to fall into the scope for the more important target rather than the present day D-T burning system. The solar wind tells us that its upper limiting speed takes the order of the electron thermal velocity of the plasma itself [1], and thereby the energy of the plasma beam achieves quite a high value of the range ~ keV. In the old experiment [2], it had been shown that such acceleration is really possible and the Deuterium plasma of the energy ~ 5 keV or more was achieved and trapped successfully in the cusp magnetic field. A detailed inspection of the data reveals the fact that all the plasma components including impurities have the same velocity in approximate sense. This suggests that the energy from the external power source is firstly given mainly to the electron component, and the ions are simply following up the electrons so as overall charge neutrality is maintained.

The core part of the present experimental system is shown schematically shown in Fig.1. The H₂ working gas is injected into the system from the left hand side end using a fast acting gas valve with the valve opening time of about 150 μsec. It was found that the super shots similar to the old experiment, were also confirmed. For achieving such a state, the timing control between the fast gas injection and the arc ignition are the most important factor as was so in the old case. We noted that the energetic plasma appears only when the case that the plasma expands freely into vacuum without passing through the cold gas precursor in the down stream. It may be said, therefore, that both the plasma expansion into vacuum and high power heat input into the plasma are concluded to be the most important items for producing the energetic beam, as was so in the old case. In the present super shot case, for example, such a high power input into the final main heating up stage in Fig.1 is estimated to be ~400 kW and lasts for more than ~600 μsec. We are interested to fact that such high power input is stably maintained in a small tube of the volume with the diameter of 3.5 mm and the length of 9 mm. These observations show that, for an energetic quasi-steady plasma beam production, a rapid pinching action as in the old experiments is not always necessary, but the most essential item must be in keeping up of quite intensive Ohmic heating.

For a fusion reactor, however, further acceleration of the beam up to the energy by an order of magnitude is necessary. The only solution for that may be found in the appropriate use of the JxB motor force [3,4]. The main topics, therefore, of the present study are said in figuring out the possibility of quite a powerful plasma acceleration system in a laboratory circumstance. A simple estimate predicts that such an energetic beam must have power density of ~10⁴ times as large as the usual beam injector of the present day electrostatic system.

This is quite an important and definite property for an actual fusion reactor, since the cross-section of the beam injection apertures can be 10³ times as small as the one for the present day system. In one sense, this is quite a natural consequence since no electro-static force drives the actual daily system.

Reference
1) Hirano, K., Phys. of Plasmas 8, (2000) 1734
4) Hirano, K., Nuclear Fusion 29, (1989) 955

Fig.1 The main part of the arcjet gun: H₂ gas is injected into the Laval nozzle in the left by the fast acting gas valve having the opening time of ~150 μs attached in the upper stream of the system. The gas through the Laval nozzle is guided into the channel of the three series of stages with the diameter 3.5 mm for production of the energetic plasma beam: the gas ionization, the plasma pre-heating and the final main intensive heating up for intensive acceleration. In the last heating up stage, the power of about 400 kW is injected to produce energetic plasma beam.