§6. Construction of a 3-Staged High Power Faraday Accelerator

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Development of high power but compact and inexpensive beam injector is one of the most important subject in fusion research. Theoretical studies [1,2] tell that by the electromagnetic acceleration the greater beam power density more than ~10^3 times as large as that by the usual electrostatic mode may be achievable. These results encouraged us to start development of the high power electromagnetic beam injector of the Faraday type as working under just the inverse process to the common MHD Faraday generator. We preferred the Faraday type better than the Hall type because the former must take much shorter time than the later to reach steady state.

The system, as in Fig.1, is of two major parts: the arcjet ion source and the 3-staged Faraday accelerator. The ion source, which is the modified one presented earlier [3], produces intensive super sonic plasma flow by inducing ~800 A arc current through 2.5 mm ø and 15 mm long quartz arc constrictor. For energizing the plasma beam effectively, we employed a 3-staged plasma accelerating system of three pairs of electrodes along the plasma flow in the pole piece gap that is made of laminated orient core of 25 μm thick.

For the power source of the device, five independent capacitor systems each having unipolar CR circuit are provided; the one for the arcjet, the three for the plasma driver and the remainder for the pole piece magnet. The unit power source equips electrolytic capacitor of 825μF, and is chargeable up to 1800 V. For each three plasma driver systems, the series resistance of 0.75 Ω is inserted while for the reminder two 1.8 Ω is used. This simply means that the plasma drivers have potential to induce ~2400 A at the maximum during the decay time of 620 μs, and the arc driver ~1000 A during 1.5 ms.

Since no multistage acceleration experiment has ever appeared, our first purpose is placed in physical understanding of the acceleration process. Note that complicated mutual interaction among the 4 driving circuit (3 the plasma and 1 the field) appears and plays decisive role to the process. By the very primitive presumptions, none the less, we estimated the parameters and put the target at production of 1 keV plasma beam of 1000 A equivalent.

References

1) Hirano, K. Journal of Plasma and Fusion Research 69 (1993) 684.
2) Hirano, K. Journal of Plasma and Fusion Research 69 (1993) 806.
3) Hirano, K., Sugisaki, K., Sato, K., Mimura, M., Fujisawa, A., Fujita, J. Fusion Engineering and Design 26 (1995) 529.

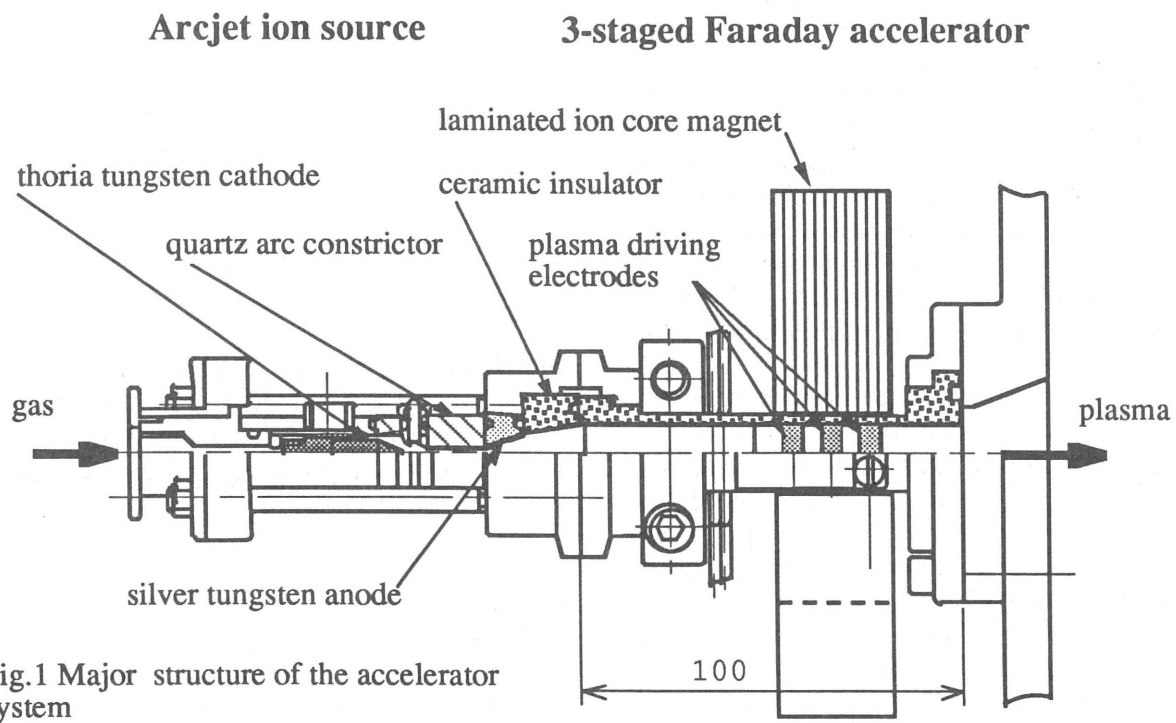

Fig.1 Major structure of the accelerator system