

§4. A Large Negative Ion Source Immersed in the Vacuum Vessel

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A new 1/3 scaled  $H^-$  ion source (i.e., 125keV x 15A beam) has been tested/beam-conditioned on the negative-ion-based neutral beam teststand for the LHD NBI, in which the ion source is immersed in the vacuum vessel in order to reduce the stripping loss of  $H^-$  ions, and to make the ion source simple and compact. A  $H^-$  current scaling for pure hydrogen discharge mode and the engineering problems for the full performance were studied.

Ion source is composed of multicusp tandem plasma source and two stage accelerator with multiholes over the area of 250x500mm<sup>2</sup>. The discharge chamber is separated by 8 rods of permanent magnets to create a magnetic filter field.

The plasma source was operated at the arc current upto 2.5kA and the arc voltage of 40-90V under the filling pressure of 0.14-3Pa. Filament number was optimized for an efficient plasma production.

Beam conditioning without cryopumps was made for pulse length upto 400msec. In the beam extraction, a thin plasma existing outside of the ion source in the vacuum vessel was examined. It was found (in Fig.1) by the charged particle measurement that the density of the thin plasma was an order of  $10^5$ - $10^7$ ele/cm<sup>3</sup>.

The beam conditioning was progressed by shielding the ion source from the thin plasma around the vacuum vessel. The negative ion with the energy up to 85keV and a current level of 1A was extracted for 100msec without high voltage breakdown (in Fig.2). The  $H^-$  yield as well as the plasma parameters were basically scaled for pure volume production with a conventional 1/3  $H^-$  source at the atmosphere. We are preparing the powerful/long-pulse beam experiment with cryopumps.

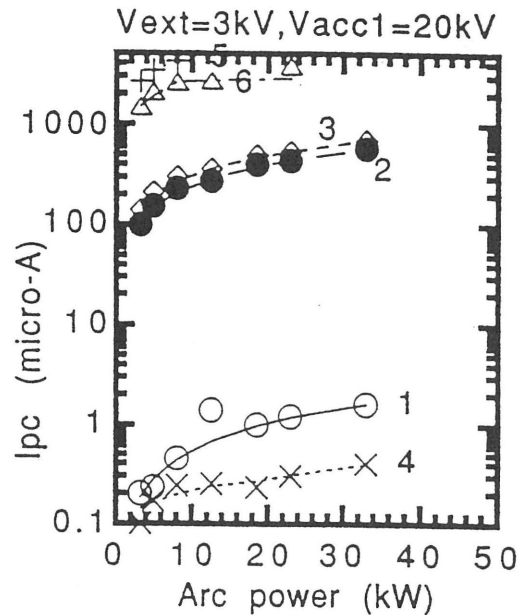


Fig. 1. Charged particle collector current at a 90V bias vs arc power.  $p=0.26$ Pa,  $V_{ext}=3$ kV,  $V_{acc1}=20$ kV.

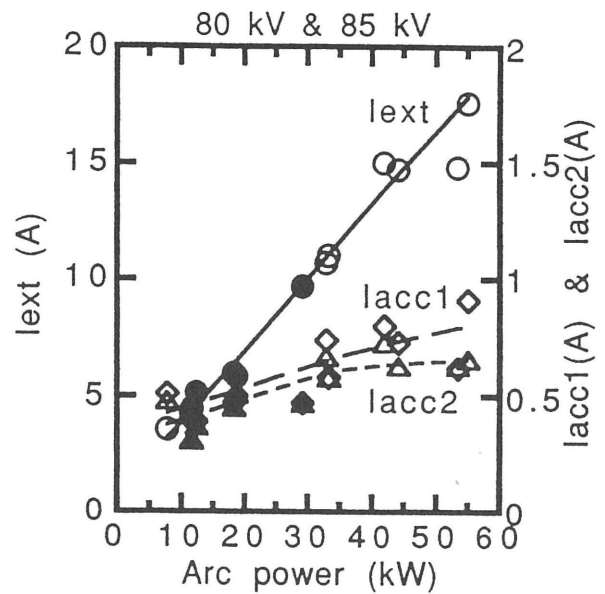


Fig. 2. H- V. drain currents vs arc power for a two stage accelerator system.  $P=1$ Pa,  $V_{bias}=5$ V,  $V_{supp}=1$ kV. Total acceleration voltage is 80-85kV. Pulse length is 100ms.

References

- 1) Y. Oka et al., Rev. Sci. Instrum. 65, 1192 (1994).
- 2) Y. Oka et al., ITC-5 Toki Conference, Heating and Current Drive, Nov. 1993.