§20. Initial Test of 15 MW Negative-Ion-Based Neutral Beam Injection System for the Large Helical Device.(1)

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A 15 MW neutral beam injection system based on negative ions for Ho injection has been installed in the hall of the Large Helical Device (LHD). Test of the key components such as high current H- ion sources, power supplies, cryosorption pumps, control system etc, as well as total systems was performed before the first injection into the LHD. Present N-NBI system is the first one orienting for injecting into the helical device, followed by that for the JT-60U tokamak. Two (co- and counter-) 7.5 MW beam lines with 180 keV for 10 sec had been installed with a little difference of ion deflection angle (i.e. 180 reflection and ~ 20 deflection). It also aims to be operable in a quasi steady state upto 30 min within a power level of 3 MW.

-Four high current cesiated multicusp negative ion sources, (i.e., each generating 40A of H- ions at 180 keV) were conditioned on the Negative Ion Test Stand. H- ion currents of 25-26 A each with a Calorimety at ~11 m was achieved by conditioning of ion source in the source pressure of ~0.4 Pa with the energy of 100-125 keV for 1 s. As a result of those, NB-power over 3.5 MW into the LHD was injected for the first campaign of the NB-injection. For an operation of the long pulse, H- current of 12 A with 85 keV was kept constant for 10 sec on the TS. Those resulted into injecting ~0.6 MW to the LHD for a long pulse of 21 sec with one NB-system.

-One accel-power supply supplied for two ion sources, while each plasma source and extraction grid were supplied independently. With a dummy resistor for the accel-power supply outputs testing, a maximum voltage with a small current as well as a maximum current at a medium voltage were tested well for 1 sec. Figure 1 shows an observed surge voltage in a breakdown test at the one point earth of the ion sources with respect to the ground line in the LHD hall. Peak surge voltage reaches 10~15 kV for ~1 ms at the breakdown voltage of 170 kV, and the corresponding current of 1~1.5 kA. It was within a design value and no interferance was observed against the NBI-/LHD- control system

-Cryosorption pump with pumping speed of 1360 m^3/s in H_2 was composed of 360 m^3/s CSP in the ion-source vacuum vessel, and four 250 m^3/s CSPs in the beam-dump vacuum vessel. A cooling down time of the beam line (in Fig.2) takes ~10 hrs (i.e., the design value).

-Fiure.3 shows a time behavior of gas pressure in the injection port during the injection for 21 sec into the LHD. We can evaluate the beam brocking amount as well as neutral gas flown to the LHD It was observed that a temperature of the protecting wall in the injection port was raised above 500 C.

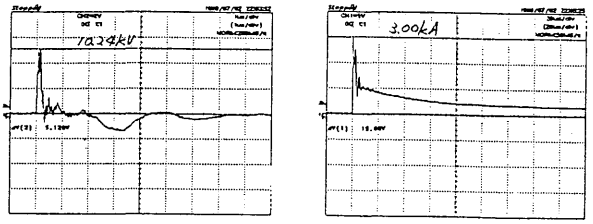

Fig.1. Observed surge voltage and current for accel-power supply.

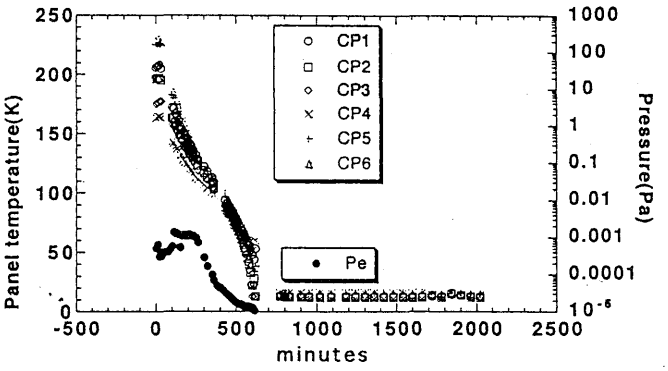

Fig.2. Cooling down curve of cryosorption system.

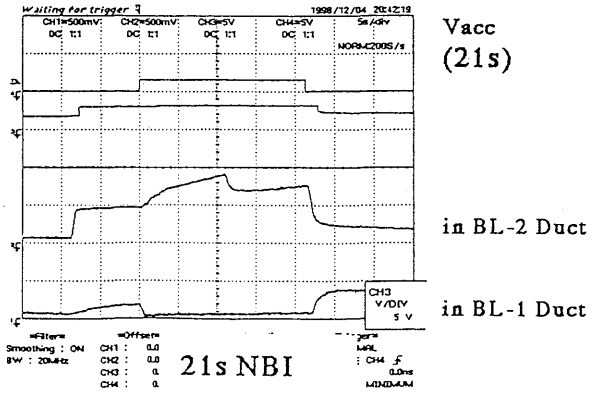

Fig.3. Time behavior of gas pressure in the injection port during 21 sec injection into the LHD.

Reference
1) Oka, Y. etal.:Poster in SOFT(1998)