§24. Electron Beam Dump for the LHD-NBIs

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Electron beam component which is accelerated together with the H- ions within a stray magnetic field of the negative ion source has been studied on the Test Stand to develop the electron beam dump for the LHD-NBIs. Until now basic data of the beam component such as the detection of the beam and the profile of the beam were integrated by the one-third H- ion source of the LHD-NBI ion source with thermocouple arrays.

In FY '97, we studied about (1) the effectiveness of deflecting magnetic field, (2) the measurement of the total heat to design the cooling structure required, (3) x-ray dose rate, (4) design of the dump for the LHD-injectors. A full size 40 A H- ion source with the grid area of 25 x 125 cm^2 was used on the Test Stand.

Four copper plates which simulated the beam dump were lined inside a connecting duct between the ion source and the vacuum chamber in the Test Stand. The location of the plates were decided experimentally by our previous result. Each plate had independently a calorimeter system and the thermocouples. A pair of coils produced a deflecting magnetic field up to 50 G over the area of 50 x 150 cm^2 at the exit of the duct.

When the magnetic field was applied up to ~ 30 G for H- current of 10 ~ 20 A with an energy of ~ 100 keV, the temperature profile on each plate was measured. Along the vertical location of the plate at the sides of the duct, the temperature profile (in Fig.1a) has a broad peak in the direction of the lower(left) part and does not depend on the magnetic field. While the temperature profile on the bottom plate along the beam (in Fig.1b) changes with the magnetic field. The temperature of the plate at the end far from the ion source is the highest. It is understood that the electron beam is deflected expectedly by the magnetic field into the bottom plate.

Total power entering into the bottom plate was evaluated to be less than a few percent of H- beam power with the calorimetry. This fraction was also the similar value evaluated by an integration of the temperature rise profile. On the way of beam conditioning of ~ 25 A x 100 keV beam for 10 sec, the maximum temperature of the plate reached above 250 C. Inevitably all the dump plates had to be water-cooled to remove the heat for powerful beam.

As we understood the behavior of the electron beam component, we could put the radiation shield of the x-rays effectively at a localized area. It has made the x-ray leak through the duct reduce by a factor of ~ 20 compared with that without the dump plates (Yamanishi K and Miyake H).

The electron beam dump at the bottom of the duct (in Fig.2) for the LHD-NBI was fabricated without the use of deflecting magnet. The channel of the ion source gate valve locating at the duct had to be protected by the dumps from the electron beam during the beam-acceleration, while the dump slid back the channel during shutting the gate valve, i.e., the electron beam dump had a sliding mechanism synchronized with the open and shut of the gate valve.

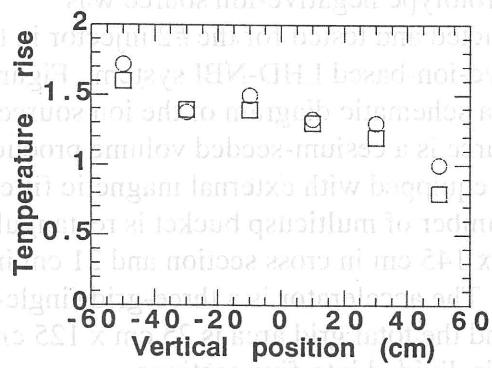

Fig.1(a). Temperature profile on the vertical electron beam dump plate along the vertical position. With (□) and without (○) the magnetic field.

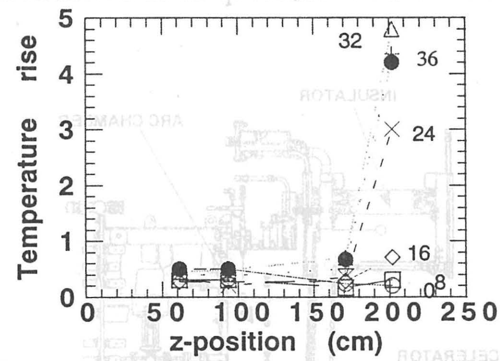

Fig.1(b).Temperature profile on the bottom electron beam dump plate along the z(beam)-position. Parameter is the coil current(A) of the deflecting magnet.

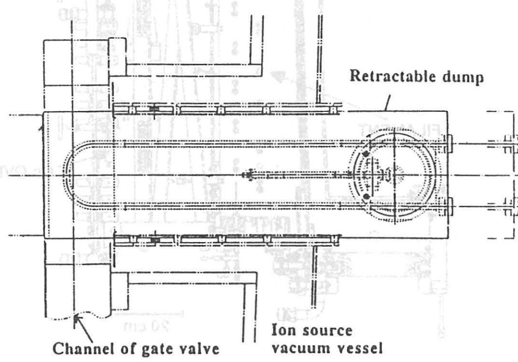

Fig.2. A schematic drawing of the elecron beam dump at the bottom for the Beam-Line 2 of LHD-NBIs.