

## §1. Operation Summary of Neutral Beam Injection Systems in the 10th Campaign

Takeiri, Y., Kaneko, O., Oka, Y., Tsumori, K., Osakabe, M., Ikeda, K., Nagaoka, K., Asano, E., Kondo, T., Sato, M., Shibuya, M., Komada, S.

There are four neutral beam injectors (NBI) installed in LHD. Three NBIs of BL1, BL2 and BL3 inject high-energy beams tangentially utilizing negative ion sources with an energy of 180keV, and one NBI of BL4 injects low-energy beams perpendicularly utilizing positive ion sources with an energy of 40keV.

BL4 was designed to inject 6MW with four positive ion sources. It started the operation in the 9th campaign with half facilities, i.e., two ion sources, and 40keV-3MW injection was achieved. In the 10th campaign, we have upgraded BL4 to full specification, and injected 40keV-6.9MW at maximum. Figure 1 shows the injection history of BL4. During the operation we have observed unexpected beam focusing on the residual ion beamdump, probably due to the non-uniformity of the large-area beam, and the injection duration have to be limited below 0.5s at an injection power greater than 5MW to avoid the excess heat load of the beamdump. BL4 was also utilized for the  $T_i$  measurement with the CXRS, and the  $T_i$ -profile was successfully measured with the modulated beam injection.

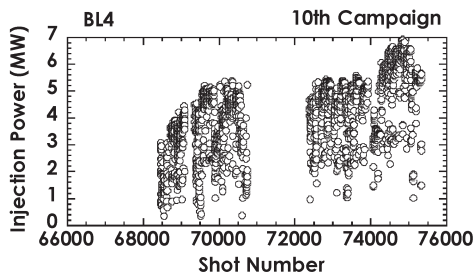


Fig. 1. History of the injection power of BL4 in the 10th campaign.

The negative-NBI systems have improved in their operation in the 10th campaign. Figure 2 shows the injection history of the total port-through injection power with three negative-NBIs in the 10th campaign, and the individual injection powers of three injectors are shown in Fig. 3. The maximum total injection power was increased to 13.8MW, and high-power beam injection of more than 10MW was constantly carried out during the 10th campaign for the LHD plasma experiments.

The negative ion sources in BL1 have been modified so that the steering grid was changed to the race-track shape from the round shape in order to suppress the vertical beam divergence with use of the multi-slotted grounded grid. As a result, the port-through efficiency was improved, and the injection power was increased to 6MW.

The operation reliability of BL2 has been improved. During the 10th campaign, the injection power was

maintained above 4MW, and 180keV-4.8MW injection was achieved at maximum.

In BL3, the aperture diameter of the grounded grid was enlarged for reduction of the grid heat load in the same way as that in BL2 done in the 9th campaign. As a result, 4.4MW of the injection power was achieved at maximum.

Now, the LHD-NBI system can inject 20MW totally and operate with high reliability, which contributes to high-performance plasma experiments in LHD.

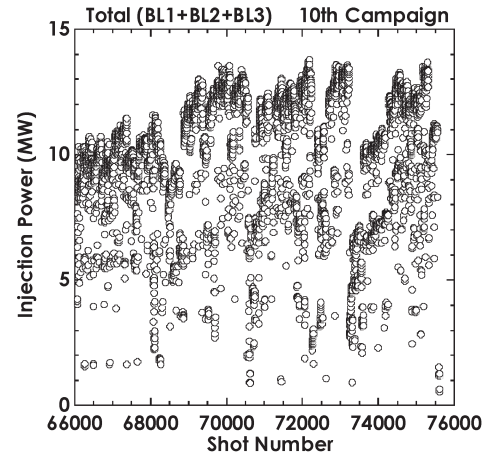


Fig. 2. History of the total injection power in the 10th campaign.

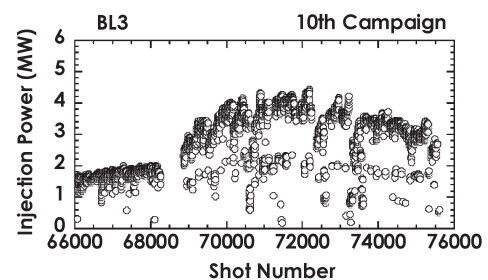
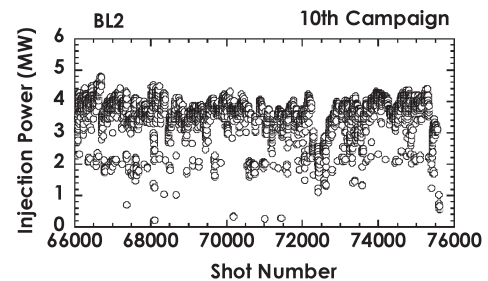
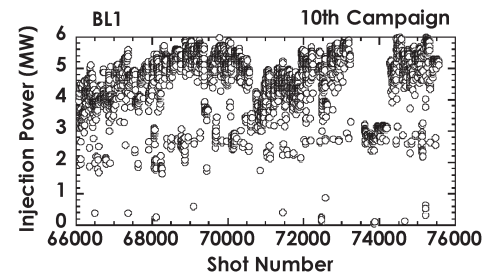


Fig. 3. History of the injection power of the individual injectors of BL1, BL2, and BL3.