§9. In Situ Calibration of Neutral Beam Port-Through Power and Estimation of NB-Deposition on LHD

Osakabe, M., Takeiri, Y., Tsumori, K., Kaneko, O., Oka, Y.

The Neutral Beam (NB) heating campaign has been started on Large Helical Device (LHD) since September 1998. On LHD-NBI, the beam is tangentially injected at high energy (about 100-keV of Hydrogen for this campaign) and the system is based on negative-ion sources.

The Beam Port-Through Power ($P_{port\text{-}through}$) and the Beam Deposition Power ($P_{dep.}$) are the basic parameters in examining the energy confinement of NB-plasma. These are expressed as follows;

$$P_{port\text{-}through} = V_{beam} * I_{acc} * \eta_{injection}$$

$$= V_{beam} * I_{acc} * \eta_{H-} * \eta_{neutral} * \eta_{port\text{-}through} \quad \text{-(1), and}$$

$$P_{dep.} = (1-\eta_{shine\text{-}through}) * P_{port\text{-}through} \quad \text{-(2).}$$

where V_{beam} is the applied voltage to the ion sources for the extraction and acceleration of the beam, I_{acc} is the beam accleration current, $\eta_{injection}$ is injection efficiency, η_{H-} is the efficiency of the H^- current in the beam acceleration current, $\eta_{neutral}$ is the neutralization efficiency, $\eta_{port\text{-}through}$ is the port-through efficiency, and $\eta_{shine\text{-}through}$ is the shine-through rate.

The inejction efficiency is usually obtained by determining the each η's separately. In examining each η, we need various assumptions, such as the divergence angle, the focal length, the staring angle, the beam uniformity, the Cs-effect on η_{H-} each and so on. On LHD, the NB port-through power is measured directly using the calorie-meter array which is installed on the counter wall of NB-injection port in the LHD Vacuum Vessel. The beam deposition power is also examined from the NB Shine-Through measurement using this array. The advantage of this method is that the estimation is straight-forward and uses less assumption compare to conventional method.

Figure 1 shows the measured beam shine-through power dependence on the n_el measured by milli-meter wave interferometer. The ratio of beam shine-through power to the output power of electrical power supply ($P_{shine\text{-}through}/V_{beam}*I_{acc}$) is plotted against the n_el. The injection efficiency is determined from the data at $n_el=0$, and the n_el dependence of $\eta_{shine\text{-}through}$ is obtained from the exponential fit of the data.

The measured beam injection efficiency of 0.28 is agreed well with the estimation based on the NB test-stand results. The n_el dependence of $\eta_{shine\text{-}through}$ agree with the result of the Monte Calro calculation (FREYA)[1].

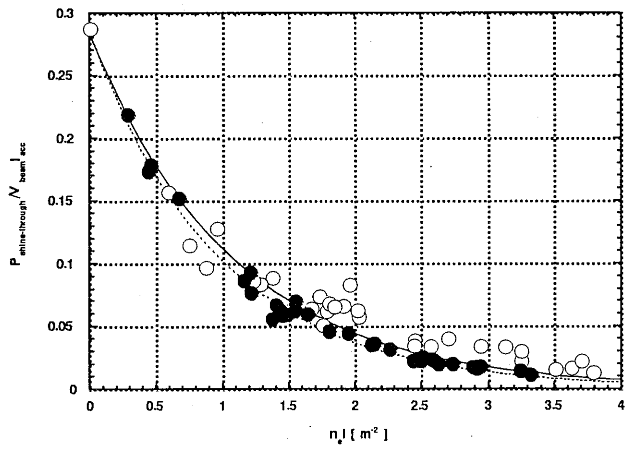

Fig. 1 The beam shine-through dependence on the n_el. The ratio of beam shine-through power to the output power of electrical power supply ($P_{shine\text{-}through}/V_{beam}*I_{acc}$) is plotted against the n_el. The open-circles show the results of Hydrogen-discharges, and the closed circles show those of Helium-discharges.

References

[1] S.Murakami, et.al., on this annual report.