Beam-plasma interaction in high temperature plasmas for a heavy ion beam probe diagnostics

M. Nishiura, T. Ido, A. Shimizu, V. P. Shevelko[a)], R. K. Janev[b)], T. Kato, S. Kato, H. Nakano, Y. Hamada, and LHD Experimental Group

National Institute for Fusion Science, National Institutes of Natural Sciences, 322-6 Oroshi, Toki, Gifu, 509-5292 Japan

[a)] P.N.Lebedev Physical Institute, Leninskii prospect 53,119991 Moscow, Russia

[b)] Macedonian Academy of Sciences and Arts, P.O.Box 428, 1000 Skopje, Macedonia

Heavy ion-beam probe (HIBP) is a powerful diagnostics tool to measure plasma potential and density fluctuation at a local position. These parameters are important to study the plasma transport and improvement of plasma confinements. It is essential to increase the signal-to-noise ratio of detected signals at an energy analyzer for recent high density operations at the Large Helical device (LHD). For this purpose, possible options are considered to increase the current density of heavy ion beams, as well as the optimization of the beam transport line and the improvement of beam detection efficiency.

The gold negative ion source in LHD-HIBP has made progress in Au^- beam current up to ~ 20 μA, and is being developed currently. Au^- beam is accelerated and is converted to Au^+ beam with the energy of ~ 6 MeV in the tandem accelerator. The MeV Au^+ beam is injected into plasmas. The Au^{2+} beam ionized in plasmas is detected by the energy analyzer.

Our curiosity is the possible diagnostics range under high density of ~ 10^{20} m^{-3} and high temperature plasmas of ~ a few ten keV in the LHD-HIBP system. In the previous paper [1], we pointed out the importance of electron loss processes, the electron- beam ion collision ionization and the proton-beam ion collision ionization in high temperature plasmas.

As a next step, the density and temperature profile is taken into account in the beam-attenuation calculations with the influence of atomic and molecular collision processes on the beam trajectories. These calculations are compared with experimental data. Moreover, the primary beam monitor on the first wall surface of LHD, which detects the injected Au^+ beams, is improved. The design of the primary beam monitor will be presented.

[1] M. Nishiura et al., J. Plasma and Fusion Res. (2007) in Press.