Contribution ID: **12** Type: **not specified**

Development, injection and diagnostics for LHD Injectors

Monday, 14 March 2016 11:20 (40 minutes)

Neutral beam injector (NBI) is the most powerful and reliable plasma heating device in the nuclear fusion research. The NBI is essential to sustain plasma current generating the confinement magnetic field in TOKAMAK machines such as ITER and JT-60SA. In National Institute for Fusion Science (NIFS), two positive-ion-based NBI (p-NBI) and three negative-ion-based NBI (n-NBI) are installed to improve the performances of plasma confined in Large Helical Device (LHD). The p-NBI and n-NBI are designed to inject the beams to LHD hydrogen plasmas with the energies / powers of 40 keV / 6 MW and 180 keV / 5 MW, respectively. The farmer injectors generate low temperature background LHD plasmas and are also applied for diagnostic beams to measure ion temperature. The later injectors heat up the background plasmas generated with p-NBI. The designed beam energies and powers have been successfully achieved. Using those injectors, many important achievements related to current drive, high ion temperature, L-H transition and high β plasma experiments have been achieved.
As the next phase of LHD experiment, we have scheduled deuterium plasma confinement Filament-arc discharge is applied to generate plasmas in the magnetic configuration. The energy of the p-NBI systems are increased up to 60 keV and 80 keV with the injection power of 9 MW. On the other hand, the beam energy of n-NBI systems are fixed their energy and so that the current densities of deuterium negative ions are needed to be enhanced. In order to understand the detailed mechanisms of negative ion production and its extraction, comprehensive diagnostics for the hydrogen plasma in an ion source has been started. In the beam extraction region, ion-ion plasma, whose electron density is less than 1 %, are formed by seeding caesium (Cs) in the plasma. Response of the ion-ion plasma to electrostatic field is very different from normal electron-positive ion plasma and the shielding character to the electrostatic field depends on the magnetic structure. In the diagnostics, we have measured the spatial distributions of densities, flows and temperatures of electrons, positive and negative ions. Taking into account the energy relation of incident and out going particles, parent particle of negative ion is proton using our experimental results. Electrons and positive hydrogenous ions transport via ambipolar diffusion from plasma generation region to caesieted surface for negative-ion production, plasma-grid surface. The energy of negative ion have very low energy of ~0.1 eV.
The diagnostic results indicate that the negative-ion production is not governed with particle picture and the production rate is not controllable by bias potential applied to the plasma-grid surface. This suggests that geometric or magnetic structures are necessary to change to increase negative-ion yield. A new structure of plasma grid to produce negative ion will be discussed.

If a proceedings is prepared,
</br> will you submit a contribution?

yes

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Session Classification: Morning Session (Chair: P. Veltri)