Electrons in the negative-ion –based NBI beamline on JT-60U

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In JT-60 Super Advance with superconducting magnets, negative-ion-based neutral beam injector (N-NBI) is required to inject 10 MW D^0 beam for 100 seconds via neutralization of the D^- ion beams produced with two ion sources, each of which is designed to produce 500 keV, 22 A D^- ion beam. One of the key issues for producing high-power and long-pulse D^- ion beams is to quantify the power distribution of the electrons into the beam-line since high-energy electrons created in the accelerator are ejected into the beam-line and dissipated in the beam-line.

The power loading of the electrons was measured in the N-NBI beamline on JT-60U. A thin stainless-steel plate with 1 mm in thickness was placed between the negative ion source and the neutralizer, where electrons are deflected downward by the stray magnetic field in the accelerator. The electron power loading was estimated from the temperature rise on the electron dump that was measured by infrared camera. When a 300keV, 3.4 A D^- ion beam was produced from an ion extraction area of 18 cm (height) x 45 cm (width), the power distribution in the beam axis has the peak value of 8 W/cm2, and was very wide. The half-value width of the peak was as large as ~1 m. This broad distribution suggests that the electron origins are widely spread in the accelerator, allowing the generated electrons to be accelerated with various energies.

To clarify the origin of the broad distribution, the trajectories of the electrons have been calculated by a three-dimensional Finite Element Method code. The calculation of the electrons inside the accelerator shows that some of the stripped electrons are accelerated with fractional energies and ejected into the beam-line. The calculation of the electron trajectory in the beam-line is also undertaken for quantitative estimation. The comparison with the measured distribution is also presented in the conference.

Topic: 2

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