Design of ion source electrode for BNCT

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Boron Neutron Capture Therapy (BNCT) is a new cancer treatment method using nuclear reaction of boron and neutron. In order to obtain the neutron flux intensity required for BNCT, it is necessary to design and develop an ion source that can stably supply deuterium ions to the reaction chamber. Therefore, in this study, we study the structure of the electromagnetic field suitable for the ion source by orbit calculation.

The disk anode is placed at the end of the device, and the cylindrical cathode is placed in the center of the device. The anode radius is 0.023 [m] and the inner radius of cathode is 0.09 [m]. The potential difference between the anode and the cathode is set to 200 V. We place a solenoid coil outside the device to generate a uniform magnetic field and Helmholtz coil inside the device to separate trapped particles from passed particles by its energy. The vector potential is calculated based on current of the solenoid coil and the Helmholtz coil, and this is spatially differentiated to obtain the magnetic field inside the device. The radius of the solenoid coil of 15 turns per 0.3 [m] is 0.15 [m], and a current of 1.0 [kA] flows through it. The Helmholtz coil has a radius of 0.12 [m] and a current is 6.83 [kA] so as to weaken the magnetic field of the solenoid coil. Deuterium ions are placed initially on the front part of the anode and their orbit is calculated by numerically integrating the equation of motion. We stop the orbit calculation when the particles collide with the cathode or reach the end of the device. In our proposal, we aim to weaken the axial magnetic field by using the Helmholtz coil and perform particle selection by trapping only the low energy ions by radial magnetic field. The weak magnetic field region is formed between Helmholtz coils. It is revealed that in the magnetic field region, the particles are governed by the movement in the direction of the electric field and are moving with almost no influence of the magnetic field. Therefore, it is found that particles cannot be selected in our proposed magnetic structure, and the particles spread radially according to the electric field. From the calculation result of this study, it is shown that the particle selection effect of ion source using Helmholtz coil cannot be expected.