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テント型磁場配位によるJT-60負イオン源の負イオンビームの非一様性の改善

Improvement of Uniformity of the Negative Ion Beams by Tent-shaped Magnetic Field in the JT-60 Negative Ion Source

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In JT-60 Super Advanced for the fusion experiment, 22 A, 100 s D^- ions are designed to be extracted from the world largest ion extraction area. One of the key issues for producing such as high current beams is to improve the non-uniform production of the negative ions over the large ion extraction area. In order to improve the uniformity of the negative ions, a tent-shaped magnetic filter is newly being developed for JT-60SA negative ion source. In this paper, we report the design of the tent-shaped filter and the experimental results before and after the modification of the magnetic filter.

The JT-60 negative ion source has a semi-cylindrical arc chamber of 640 mm in diameter and 1220 mm in length, and ion extraction area of 450 mm × 1100 mm. In the ion source, the arc chamber is fully surrounded by asymmetric 26 rows of the permanent magnets on the wall. Figure 1 shows a cross sectional view of (a) conventional magnetic filter (PG filter) and of (b) tent-shaped magnetic filter. The tent–shaped filter is formed by symmetrical arrangement of the permanent magnets surrounding the wall without the PG current to avoid one-way magnetic drift of primary electrons in the conventional transverse magnetic filter such as the PG filter. In the tent-shaped filter, two way magnetic drifts are longitudinally formed.

The tent-shaped filter was applied to the JT-60 negative ion source and tested. The arc chamber was seeded with a small amount of cesium. The negative ions were extracted and dumped on the copper target located at 4.5 cm downstream from the extraction grids. The extracted beam profiles were measured by IR camera behind the copper target. Figure 2 shows the longitudinal profiles of the extracted H^- ion beam with the Cs seeded conditions and the arc power of 120 kW before and after the modification of the magnetic filter. In the tent-shaped filter, the H^- ion beam profile is clearly uniform in the region of Y = ±490 mm. The calculation result on the trajectories of the primary electrons indicates that the localization of the primary electrons is well suppressed in the tent-shaped filter.The parent particles of negative ions, i.e., positive ions and atoms measured in the tent-shaped showed a well uniform.

The uniformity defined as the deviation from the averaged beam intensity was reduced from 14 % of the PG filter to ~10 % without a reduction of the negative ion production by modifying the magnetic filter to the tent-shaped filter. This value fulfills the requirement of JT-60SA.

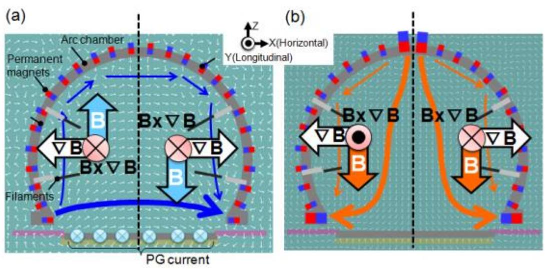

Fig. 1. Horizontally schematic view of two magnetic fields in JT-60 negative ion source; (a) a conventional PG filter (b) a new designed tent-shaped filter

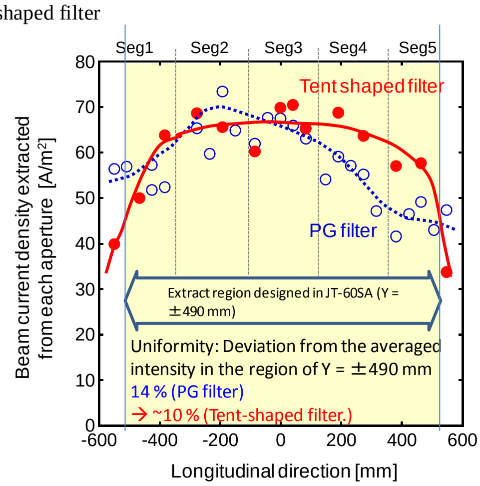

Fig. 2. Comparison of the longitudinal profiles of the beam current density extracted from each aperture measured by the IR camera in the PG filter and in the tent-shaped filter with the Cs seeded conditions.