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Simulation of an extraction system on a proton source for a proton linac

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1. Introduction

Ion source can be used a various injector as linac, cyclotron, implanter, etc. In the case of the proton linac of PEFP(Proton Engineering Frontier Project), this ion source has some requirements such as an injection beam energy of 50keV, a beam current of above 30mA, higher proton fraction of above 80%, and a low emittance of 0.2 pi mm mrad. Duoplasmatron ion source for PEFP was developed and used to supply a 20MeV proton linac with RFQ and DTL.[1] Another type of ion source for a long time operation was considered such as a microwave ion source and the extraction system the ion source has been studied.

2. Simulation codes for an ion extraction

Since emitting boundary is variable depended on plasma parameters such as plasma density and temperature, simulation code of electrons extraction is not proper to that of ions. Even though some code of IGUN[2] use a very simple plasma modeling, these codes show reasonable results of ions extraction simulation.

2.1 Input geometry and condition for the emittance calculation

To check a reasonable code of the ion extraction, we have calculated the emittance of the codes because the emittance is extremely depended on some input parameters such as numbers of the particles and mesh. Input geometry is shown in figure 1 and this geometry is based on a duoplasmatron ion source.

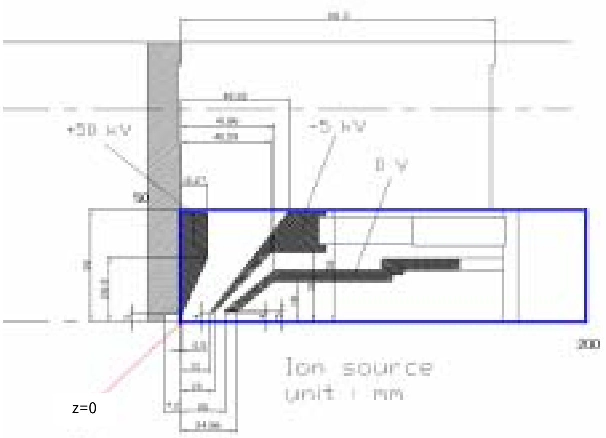

Fig. 1. Drawing of the input geometry of the duoplasmatron ion source.

The size of the plasma aperture is 6mm and the gap distance is 12.5mm. Extraction and bias voltage are 50kV and -5kV and extraction current is 30mA. Ion temperature is 1eV.

2.2 Mesh and particle dependency on IGUN

IGUN is based on EGUN which is a code of an electron gun and just included plasma modeling called maniscus. As shown in figure 2, total beam emittance has some errors from beam noises and halo effects. Normalized RMS emittance saturated around 0.02pi mm mrad of 90% beam fraction with increasing the number of mesh and particle.

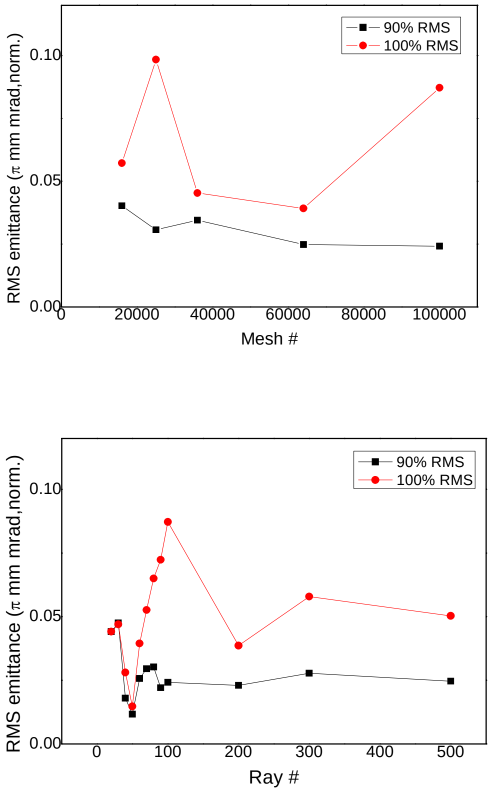

Fig. 2. Emittance with a variance of mesh number and particle number (IGUN)

3. Design of the ion extraction using IGUN

To decide reasonable geometry to meet previous requirements, we calculated a few cases depended on plasma aperture size and gap distance. As shown in figure 3, enough gap distance is needed to sustain low emittance. Aspect ratio(r/d) is less than 0.3. Beam divergence is need to more gap distance to be low divergence.

Since low 10^{11} /cm^3 of plasma density at plasma aperture of 5mm can be supported to ion extractors, gasp distance should be more than 11mm to get low emittance and divergence.

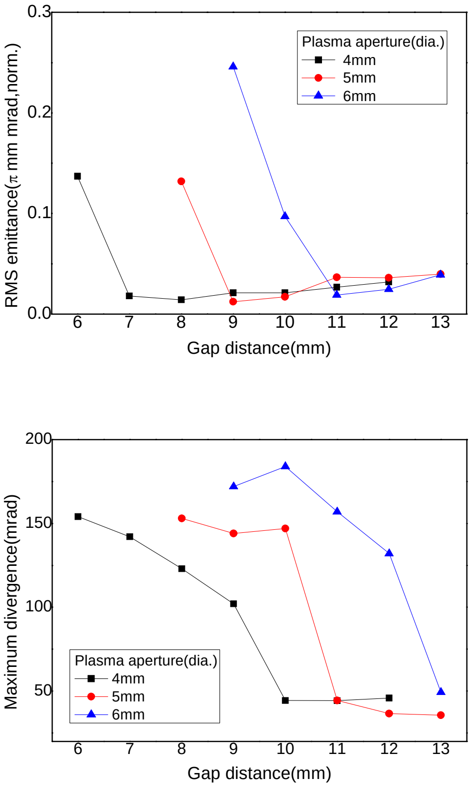

Fig. 4 Emittance and maximum divergence with a variance of gap distance.

REFERENCES

[1] H.J. Kwon, et. al., this proceeding to be published.
[2] Becker, R., W.B.Herrmannsfeldt, Rev. Sci. Instrum. Vol 63, 2756 (1993)..