# Upgrade of electron gun at the SCRIT facility

M. Watanabe,[*1] M. Wakasugi,[*1] T. Oonishi,[*1] K. Adachi,[*2] A. Enokizono,[*1,*2] T. Fujita,[*2] M. Hori,[*2] K. Kurita,[*2] S. Sasamura,[*2] N. Uchida,[*2] and K. Yamada[*2]

We have been upgrading the electron beam source of the SCRIT facility.[1)] The electron beams from this source are used for electron injection into the electron storage ring (SR2) and for photofission at ERIS[2)] (electron-beam-driven RI separator for SCRIT). Particulaly for ERIS, the electron beam power forms one of the most important parameter in order to perform the electron scattering measurements of unstable nuclei, since the power affects the efficiency required to lead to photofission to generate the target nuclei.

In a previous work,[3)] we developed a new electronic circuit board for the trigger pulse of the electron gun. The driving frequency of the electron beam injector was subsequently increased from 10 Hz to 20 Hz by the new electronics; the total electron beam power was doubled.

In this work, we report on our modifications of two parts of the electron gun. The first is concerned the voltage power supply and pulser electronics for the extractor grid. With the new power supply, it is possible to increase the extractor voltage up to 650 V; the maximum previous extractor voltage was 200 V. As regards the equipment setup, the extractor grid is located about 1-2 mm above the cathode of the gun. Therefore, the electric field due to a higher voltage results in a higher electron current from the source, which yields higher electron-beam efficiency.

Secondly, we modified the shape of the extractor-grid electrode to generate focused rather than parallel electron beams. In the original design, the electrode could not shape concave equipotential surfaces in front of the extractor grid, since the top portion of the electrode was nearly flat. Consequently, it was not possible to generate a focused electron beam towards the DC acceleration electrode. An unfocused electron beam results in beam loss at the entrance of RF cavity of the race-track microtron (RTM).

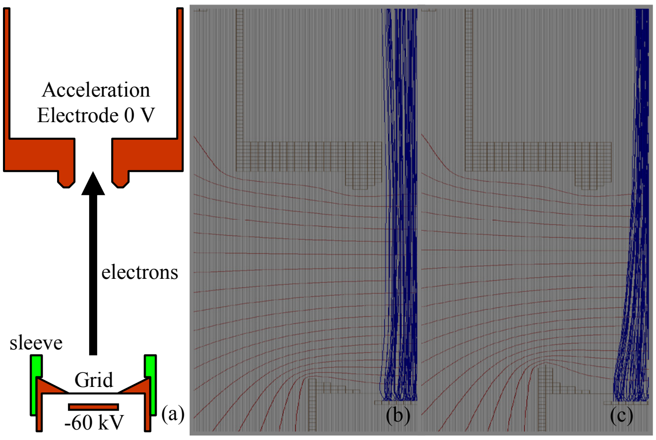


Fig. 1. (a) Schematic of electron gun, (b) simulation of electrons with original design, and simulation of electrons obtained with new grid electrode.

In order to transport the electron beam from the source into the RTM, we installed a sleeve part atop the extractor grid, and fabricated a concave equipotential surface at the position corresponding to the beginning of DC acceleration of 60 kV. Figure 1(a) shows the schematic of the electron gun area. The protruding part denotes the sleeve. Figure 1(b) shows the beam simulation result without the space-charge effect as simulated by the software SIMION for the original design of the extractor grid. The blue lines indicate the trajectories of electrons, and red lines indicate the equipotential surfaces. From Fig. 1(c), We observe that the newly designed extractor grid affords a focused electron beam with small divergence inside the acceleration electrode.

In order to utilize this modification, we had to readjust the relevant parameters of the optics of the electron beam injector. The leakage field from the RTM magnet and gauge affects the beam transport in the 60-kV low-energy area. However, appropriate steerer magnets are utilized to direct the beam back to the center axis of the optics.

As a result of the extractor modification, we could increase the beam efficiency by 50% of the previous value at the beam monitor in the RTM. In addition, by applying a higher voltage to the grid, we expect to obtain a higher total yield of electron transport from the source to the RTM. The combination of the focused electron beam and higher grid voltage promises an increase in the ratio required to produce unstable nuclei at ERIS, and improved electron scattering measurements.

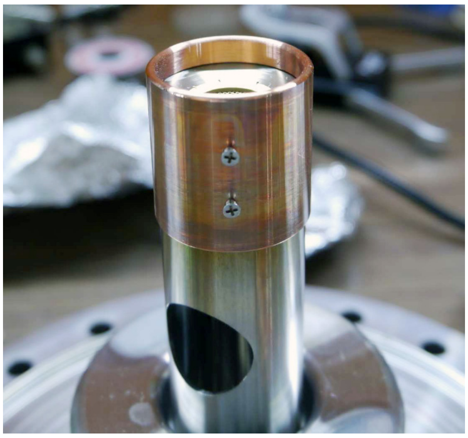

Fig. 2. Photograph of electron gun. The top cupper sleeve is the newly installed part for concave quipotential surface to generate a focused electron beam.

[*1] RIKEN Nishina Center
[*2] Department of Physics, Rikkyo University

References

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3) M. Watanabe et al., RIKEN Accel. Prog. Rep., **49**, 188 (2015).