Battery-operated compact ion source for beam transport test

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An ion source for a beam transport test at the SLOWRI beamline[1)] has been desgined and assembled. The beamline was constructed to transport slow rare isotope (RI) ions extracted with an accelerating voltage of a few tens of kilovolts from the PALIS apparatus[2)] or RF gas cell.[3)] PALIS and the gas cell are systems used for catching, thermalizing, and accumulating RIs produced at BigRIPS. At present, neither PALIS nor the gas cell is completed, and no ion can be extracted. Instead of those systems, an ion source is necessary to examine ion transport at the SLOWRI beamline. However, there is no room for installing a usual ion source at the upstream end of the beamline, since PALIS has been already installed at that place, *i.e.*, the F2 chamber of the BigRIPS facility.

The newly designed ion source is used as a side-inserted-type device. It can be installed at any of the particular CF114 flanges for the beam-profile monitor on the duct (see Fig. 1). The system consists of an ion emitter part and extraction part. The former is biased at an accelerating voltage of a few tens of kilovolts so that it is isolated with a CF70 isolating nipple. A comercial thermal-ionization-type alkali ion emitter (HeatWave Labs, Model 101139 Cs^+)[4)] surrounded with a 50 mmϕ repeller electrode is mounted at the end of the isolated rod (see Fig. 2). The emitter, which contains a heater inside, has a cylindrical shape of 6.35 mmϕ and 9.9-mm length, and its end side is coated with alkali compounds. Note that the center hole of the repeller is 10 mmϕ, which is slightly larger than the emitter, to avoid thermal contact. The position of the emitter is designed to be on the axis of the beamline duct. The heater power of the emitter is supplied by a lithium-ion battery (GlobalTech, GANGAN GT5)[5)] with an output regulating circuit. The battery and circuit are housed in an acrylic box mounted on the top of the isolating nipple; thus, they are isolated from the GND potential. Therefore, it is easy to apply a high voltage bias to the ion emitter part. The battery, when fully charged, can operate the ion source for more than ten hours under usual conditions. The extraction part is assembled on the CF114 flange at the GND potential. It has two electrodes, *i.e.*, an extractor with a 6 mmϕ aperture and a “collimator” with a replacable aperture plate. One can adjust the emittance of extracted ions by changng the aperture size of the “collimator,” though the extracted intensity decreases as the emittance decreases. A 4 mmϕ aperture is set currently.

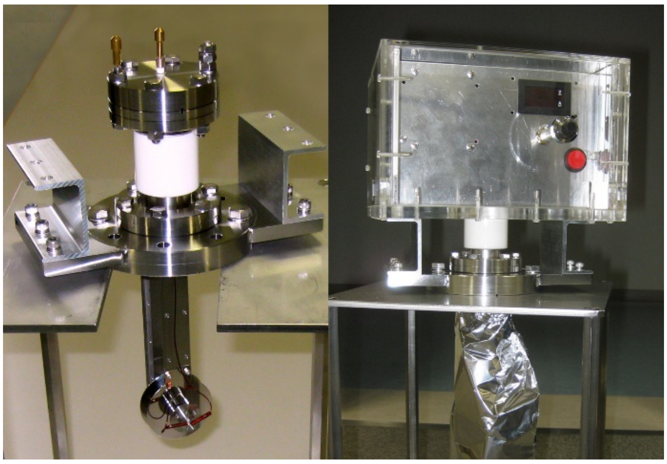

Fig. 1. Left: The assembled ion source without the heater controller. Right: The heater controller set on the top of the CF70 isolating nipple.

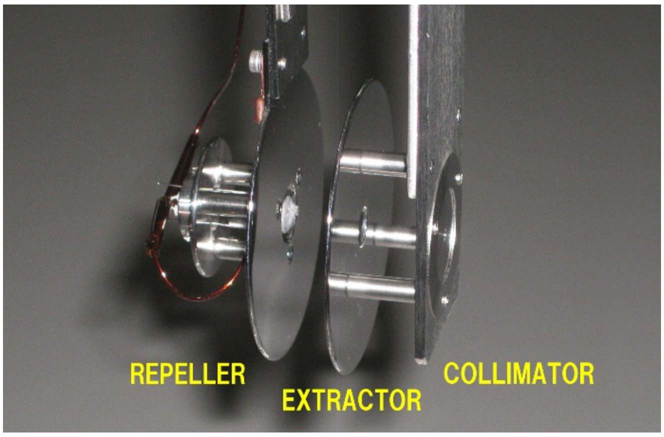

Fig. 2. Photograph of the electrode arrangement of the ion source. The coated alkali compounds of the ion emitter are seen at the center of the repeller.

The ion source was tested at a very short (40 cm) region of the beamline, which includes only one 20-cm-long electrostatic quadrupole between the ion source and a Faraday cup. With 10-kV acceleration and 6.8-W heater power, the ion current extracted through the 4 mmϕ “collimator” was about 1 nA on the Faraday cup at 40 cm downstream when the electrostatic quadrupole was optimized. The intensity is sufficient for our purpose. In addition, a higher intensity is expected with a higher power since the rated power of the heater is 11.3 W.

With this ion source, the ion-transport properties of the beamline will be examined and adjusted.

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References

1) M. Wada *et al.*, RIKEN Accel. Prog. Rep. **47**, 203 (2014).
2) T. Sonoda *et al.*, Prog. Theor. Exp. Phys. **2019**, 113D02 (2019).
3) M. Wada *et al.*, Nucl. Instrum. Methods Phys. Res. B **204**, 570–581 (2003).
4) https://www.cathode.com/i_alkali.htm.
5) https://g-tech.jp/gt5. (in Japanese)