Development of mini-linear cooler buncher for PALIS

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In the previous beam time (2022.3), we observed RIs as a low-energy ion beam.[1)] However, as the high-energy RI-beams implanted to the PALIS gas cell included many kinds of RIs, the nuclides of interest for laser ionization could not be confirmed due to the signal produced by many other RIs. Therefore, a particle identification device for extracted RI-beams in PALIS is essential. For this purpose, we require a Mini-linear Cooler Buncher (MCB) and MRTOF; the development of the MCB has been a particular focus of this year.

Because the incident ion energy is significantly lower than that provided by ISOL, the size of cooler buncher could be miniatured. The longitudinal length of the MCB is 70 mm. One electrode unit comprising four planar electrodes that make a square of 5 mm side inside the buncher. In total, seven electrode units were arranged along on the ion beam axis, in addition to the entrance and exit electrode. All electrodes contact through thin insulators, forming a closed structure for filling up with helium gas.

Figure 1 shows the simulation results of the cross sectional view of the MCB with simulated ion trajectories in different stages (top: injection, middle: accumulation, bottom: extraction).

In order to accumulate the ions as a bunched beam, a deep trap potential is necessary. This trap potential can be produced by the voltage parameters applied for each electrode, as noted in Fig. 1. After some accumulation period (5 ms), the trapped ions are extracted by removing the potential wall, owing to the fast switching circuit. Figure 2 shows the experimental and simulated results for the time of arrival at the detector at approximately 20 cm from the exit of the MCB, while the start time (0) is when the voltage parameters are switched for the extraction. In the experiment, the ions were produced by a discharge in an argon gas cell, and there were several impurities including in this one peak. The RF and DC voltage parameters were the same as those noted in Fig. 1. In the simulation, the slew rate for fast-switching circuit and gas pressure were set as 10 ns (for falling), 100 μs (for rising), and 5 Pa respectively. Presently, the simulation provides a narrower signal compared to that with the experimental result. This is because in the simulation, a single mass is used, and the shape of the channeltron detector is not accounted for.

A study on the extraction efficiency for bunched ion beams in MCB and the development of the MRTOF is in progress.

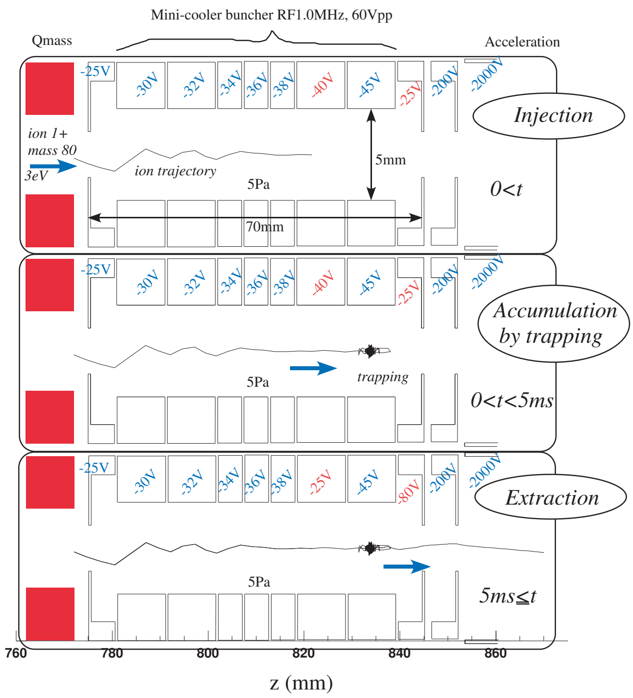

Fig. 1. The ion trajectories for continuous process in ion bunching by a Monte-Carlo simulation.

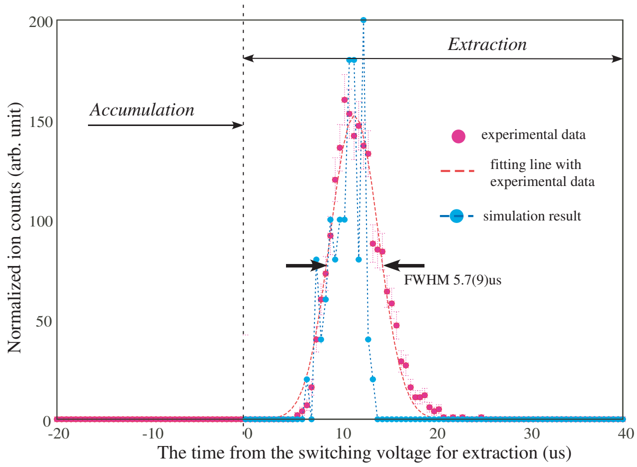

Fig. 2. The time distribution after switching voltage for extraction (simulation and experiment results).

Reference

1) T. Sonoda *et al.*, RIKEN Accel. Prog. Rep. **56**, 95 (2022).

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