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Trapping Swift Divergent Ions with Stacked Rings

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Study on exotic nuclei has become one of the research frontiers in nuclear physics. They can be produced by bombarding an energetic (MeV˜GeV) projectile onto a target. Among various products, the ions of interest can be promptly and efficiently selected by in-flight separation. To precisely measure their properties, it is preferable to couple a low-energy (eV˜keV) experimental terminal to the separation beam line. A gas-filled stopping cell is usually adopted as the first stage to thermalize the relativistic ions. However, the supersonic gas jet bursting out of the submillimeter orifice will accelerate the ions and result in a divergent beam. It is therefore important to confine the swift (a few eV) ions before they are diluted by diffusions in the residual gas. Sometimes it is also necessary to bunch the ions before sending them to the next experimental stage, which entails trapping the ions in three dimensions. In this contribution, we will present a unified solution with stacked rings to meet all the above requirements. The proposed ion cooler and buncher consists of a stack of ring electrodes with varying apertures to fit its geometric boundary to the envelope of a focused beam. The pitches of the rings are adjusted accordingly to produce a consistent pseudopotential barrier in the radial direction and a deep enough pseudopotential well for ion bunching at the exit where the swift ions are expected to be thermalized already. All the rings will be driven by a square-wave radio-frequency (RF) to avoid the requirement of resonance tuning as typically used for sinusoidal guiding fields. An RF-only traveling wave is employed to shorten ions'axial diffusion times. This device is being developed within the NEXT project at University of Groningen towards the aim of mass measurements of Neutron-rich EXotic nuclei produced in multi-nucleon Transfer reactions. It can be used, for example, as an injector for a Multi-Reflection Time-of-Flight Mass Spectrometer (MR-ToF MS).

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