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Installation of the Multi Reflection Time Of Flight (MR-TOF) mass separator at the ANL CARIBU facility

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The low-energy beam line at the Californium Rare Isotope Breeder Upgrade (CARIBU) [1] was recently upgraded with the installation of a Multi Reflection Time-Of-Flight (MR-TOF) mass separator. The MR-TOF is a scaled-up version of the ISOLDE MR-TOF [2], realizing the same operation principle of a single in-trap lift electrode. The mass separation is performed by multiple reflections of the ions between two electrostatic mirrors, composed from 6 pairs of voltage-adjustable electrodes, in which different masses are separated by their time of flights in the kilometers-long folded trajectory.
Fission product beams from CARIBU 252Cf source are extracted, thermalized, accelerated, and mass separated in the CARIBU gas catcher, RFQ cooler and the compact isobar separator that provides a mass resolving power of around 14000. The ~36 keV beam is then injected into the RFQ cooler-buncher that delivers pulsed beams of ~3 keV to the MR-TOF. A high mass-resolving power can be achieved in the MR-TOF by reflecting the ions back and forth in the device, and the desired mass is selected by using a fast Bradbury-Nielsen Gate (BNG) to deflect contaminate ions in the ejected beam.
To achieve high mass selectivity, precise voltages, to the level of ppm, have to be applied to the 6 pairs of electrodes. The optimization of the mirror voltages, as well as emittance matching, has been performed via SIMION simulations, showing a potential mass resolving power of more than 50000 following 1000 cycles.
The higher mass-separated beams provided by the MR-TOF and delivered to the Canadian Penning Trap (CPT) will provide access to further measurements of neutron-rich nuclei along the astrophysical r-process path [3].
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