Mass Measurements of Proton-Rich Light Lanthanides via High Precision Mass Spectrometry Using Mean Range Bunching

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The structure and properties of drip-line nuclei are highly significant, as they offer insight into the limits of nuclear binding. In the light lanthanide region, nuclear properties are influenced by large beta-decay Q-values, low or negative proton separation energies, and the Coulomb barrier's confining effects [1]. By accurately measuring masses, differential quantities like proton and neutron separation energies can be calculated, providing valuable information about various phenomena such as beta-delayed particle emission channels, proton radioactivity, two-proton radioactivity, and exotic pairing phenomena [2]. Nuclei between 100Sn and 150Lu were produced at relativistic energies, separated by the fragment separator FRS at GSI, and then identified through their proton number and mass-to-charge ratio. After slowing down in the Cryogenic Stopping Cell (CSC), their masses were measured using a Multiple-Reflection Time-Of-Flight Mass Spectrometer (MR-TOF-MS) [3, 4].

Isotope tagging by high-resolution mass spectrometry, enabled the FRS particle identification to discover new isotopes towards the proton drip-line in the region between Nd and Tb. Using a new variable wedge-shaped degrader system situated at the final focal plane of the FRS, the simultaneous measurement of more than 35 nuclides in a single setting has been achieved via the, so called, mean range bunching method. The new experimental approach allowed for mass measurements of more than 10 nuclides for the first time and significantly reducing the mass uncertainties of more than 10 nuclides. Mean range bunching allows covering large regions on the chart of nuclides with stopped or thermalized nuclides, enabling large scale decay and laser spectroscopy in addition to mass measurement campaigns. The results provide valuable insight into nuclear structure and allow for the tracking of the proton drip-line between 100Sn and 150Lu. In this contribution, we will discuss these recent results and the new technical approaches used.

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