First Mass Measurements of Projectile Fragments with a Multiple-Reflection Time-of-Flight Mass Spectrometer at the FRS Ion Catcher*

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The FRS Ion Catcher [1] is a test facility for the Low Energy Branch (LEB) of the Super-FRS at FAIR. It includes a novel cryogenic stopping cell (CSC) [2] and a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) [3, 4] for mass measurements, isobar separation and broad-band mass spectrometry for ion identification and diagnostics purposes.

In an online experiment in July and August 2012 at the FRS Ion Catcher the performance characteristics of the cryogenic stopping cell [5] have been investigated and first direct mass measurements of ^{238}U projectile fragments have been performed with a MR-TOF-MS. For three of the nuclides, ^{211}Po, ^{211}Rn and ^{213}Rn, the mass was measured directly for the first time (Fig.1, Fig.2). The successful measurement of the noble gas isotope ^{213}Rn with a half life of only 20 ms and 25 detected ions demonstrates that very short-lived nuclides can be stopped and extracted from the CSC and measurements can be performed quickly, efficiently and with high sensitivity.

Usually, in MR-TOF-MS only ions are considered, which have performed the same number of turns inside the mass analyzer, otherwise ions with different masses and turn numbers could make the mass spectrum ambiguous. At a high resolving power and a large number of turns of the ions in the analyzer, only isobars are hence available as calibrants. For measurements of nuclides with $A = 211$ isobaric ions from an internal ion source could be used as calibrants. However, for nuclides with $A = 213$, no such isobaric calibrants were available. Therefore a novel analysis method was developed, that allows calibration of a time-of-flight (TOF) spectrum without isobaric calibrants, making use of ions that have undergone a different number of turns.

Similar instruments have been developed for use as isobar separator at the TITAN facility at TRIUMF (Canada) and as a mobile high-resolution mass spectrometer in analytical mass spectrometry [6].

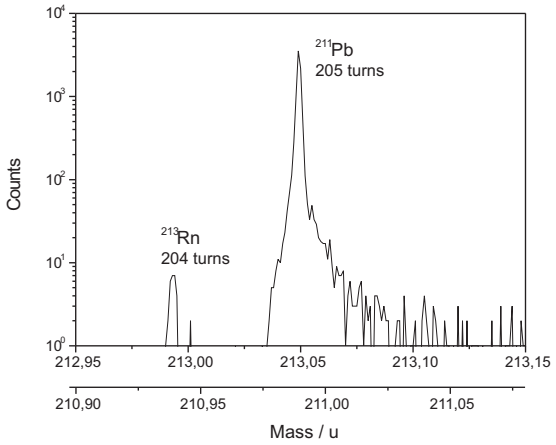

Figure 1: Mass spectrum of ^{213}Rn ions together with ^{211}Pb calibrant ions from an internal ion source.

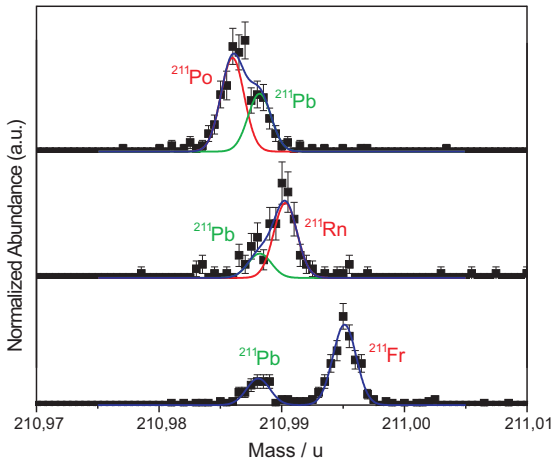

Figure 2: Mass spectrum of the mass 211 isotopes Fr, Po and Rn.

References

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