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Experiments with 238U projectile and fission fragments at the FRS Ion Catcher

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The properties of nuclides in or close to the valley of stability are mostly well understood and described by nuclear structure models. However the theoretical predictions for properties of nuclides far away from stability differ drastically for different models. For further improvements of the models highly accurate measurements of a variety of observables of unstable nuclides are needed as input parameters and for comparisons. However, the more interesting and exotic a nuclide becomes the harder the measurement gets, because of the shorter half-life and lower production rates.
At the in-flight facility FRS at GSI nuclides of interest can be produced via projectile fragmentation and fission, but the challenge is to stop and separate the ions of interest for high precision low-energy experiments without losing too many of them due to long measurement durations and inefficiencies. This is the task for the FRS Ion Catcher. The ion cocktails, produced at energies of typically 1000 AMeV, are separated in the fragment separator FRS, energy bunched, slowed down and subsequently stopped in a helium filled cryogenic stopping cell (CSC), which is the prototype of the stopping cell for the low-energy branch of the Super-FRS at FAIR. From there the ions can be transported via an RFQ ion guide to silicon detectors or a multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS) for high resolution mass measurements and alpha-decay spectroscopy. The latter device additionally affords access to isomerically clean beams for further experiments.
Performance and possibilities of the system have been studied in several online experiments, the latest one in October 2014. The goal of these experiments was the commissioning and investigation of the CSC characteristics including rate capabilities, operation with high areal densities and stopping of fission fragments, as well as spatial separation and mass measurement of short-lived isomers with the MR-TOF-MS.
Results from this experiments will be presented. The rate capability of the CSC was tested with various beam intensities over several orders of magnitude and the CSC was operated with an areal density of up to 5.6 mg/cm2. With the MR-TOF-MS, projectile fragments such as 213Rn and 220Ra with half-lives of only 19.5 ms and 17.9 ms, respectively, and fission fragments such as 133I and 133Te in ground and isomeric states have been measured. Furthermore the spatial separation of ground and isomeric states was demonstrated and alpha-decay spectroscopy was performed. Both will be shown for the example of 211Po and 211mPo.

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