Contribution ID: **115** Type: **Oral Presentation**

Production at 1000MeV/u, in-flight separation, thermalization and extraction of 238-U projectile and fission fragments from a cryogenic stopping cell

Wednesday, 13 May 2015 09:30 (20 minutes)

At the low energy branch (LEB) of the Super-FRS at FAIR, projectile and fission fragments will be produced at relativistic energies, separated in-flight, energy-bunched, slowed-down and then thermalized in a stopping cell filled with ultra-pure helium gas. The stopping cell has been developed as a cryogenic stopping cell (CSC), operated at 70 to 90 K, featuring enhanced cleanliness and high extraction efficiencies. Using an RF carpet with fine electrode spacing enables operation at high stopping gas densities.
After extraction from the CSC the ions will be delivered to the high precision low-energy experiments MATS and LaSpec. A prototype CSC for the LEB has been successfully commissioned at the FRS Ion Catcher at GSI. The FRS Ion Catcher consists of the fragment separator FRS, the CSC and a multiple-reflection time-of-flight mass-spectrometer (MR-TOF-MS).

During three FRS experiments numerous 238-U projectile and fission fragments produced at 1000 MeV/u have been stopped, thermalized and extracted from the CSC with high total efficiencies (up to 15%). For the first time 238-U fission fragments were thermalized in a stopping cell. The fragments were extracted without any significant contribution of adducts or molecular contaminants, demonstrating the excellent cleanliness of the CSC. The CSC was operated online at areal densities of up to 6.2 mg/cm^2 helium, which is about two times higher than ever reached before for a stopping cell with RF ion repelling structures (RF Carpet). Despite the high areal density the extraction time of ions from the CSC was about 30 ms, enabling the extraction of short-lived fragments, e.g. 220-Ra with a half-life of only 17.9 ms.
The ion transport along the body of the CSC and in the vicinity of the RF carpet has been studied with and without space-charge effects in detailed simulations and compared with measurements. Moreover the temperature dependence of the cleanliness and the extraction efficiency of the CSC have been investigated. As an alternative to helium, neon has been investigated as stopping gas.

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Session Classification: Session 10