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TIME OF FLIGHT SIMULATION OF A CRYOGENIC GAS STOPPING CELL DESIGNED TO STUDY THE PROPERTIES OF SUPERHEAVY ELEMENTS

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The mass is a fundamental property of an atom comprising all information on its constituents and their interactions. Thus, it carries information on the internal structure of the nucleus, reveal the quantum mechanical shell structure within complex nuclei and determine the energy available for nuclear transformations in radioactive decay processes. Mass measurements allow us to benchmark nuclear models and thus contribute to investigations of the nature of the strong interaction itself. With the aim of high-precision mass measurement (HPMM) of heavy and super heavy elements, a new experimental setup is being built in FLNR, Dubna. The setup consists of the following parts: target unit; gas-filled separator of complete fusion reaction products; cryogenic gas stopping cell (CGSC); a radio-frequency system for transporting and cooling a low-energy beam; and a multi-reflection time of flight mass spectrometer (MR-TOF MS). CGSC is responsible for the final slowing down and thermalizing the energy-bunched fragments produced and selected in the Gas Filled Separator. The thermalization is achieved in a volume filled with ultra-pure helium gas at cryogenic temperatures. After the thermalization, the fragments are extracted and transported with a radio frequency quadrupole (RFQ) to the MR-TOF MS. The stopping and thermalization of the incoming fusion-evaporation residuals (EVRs) is a key step in HPMM of the heaviest elements. Due to the typically low incoming ion rates and low particle integrals CGSC has to be as efficient as possible. Only the ions that are stopped within the active gas volume of the CGSC can be extracted. The stopping efficiencies for EVRs cannot be verified online and must be relied upon by simulations. To use the CGSC on ion beam the optimal entrance window foil thickness for every reaction is necessary to evaluate. Simulations were performed to determine the efficiency and extraction time from a cryogenic gas ion cell for products arising in the following complete fusion reactions: 40Ar+144Sm->184Hg, *40Ar+166Er->206Rn*, 48Ca+197Au->245Es, *48Ca+208Pb->256No*, 48Ca+209Bi->257Lr*and 48Ca+242Pu->290Fl.* Based on the software packages SRIM2013, GEANT4, ROOT, SIMION and COMSOL, two programs were created. The first program calculated the efficiency of capture of reaction products as a function of the thickness of the entrance window and the helium pressure in the cryogenic gas ion trap. The second program determined the efficiency and extraction time of the captured products. To test a gas trap without a beam using an alpha source, the efficiency and extraction time from the trap of the progeny of the alpha source were calculated. The calculations were carried out for different helium pressures and depending on the position of the alpha source in the gas ion trap.

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