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Separation efficiency and separation time of mass separator MASHA measured for radon and mercury isotopes

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The discovery of the Super Heavy Elements (SHE) with atomic number Z=113-118 as well as new neutron excess isotopes of the elements with Z=104-112 was one of the outstanding scientific results of the last decades. These high priority experiments were carried out on the cyclotron U400 of the FLNR (JINR, Dubna, Russia). The synthesis of the new super heavy elements stimulated works on the development of methods of their identification by means of the technique called Isotope Production On-Line (ISOL). Thereto, in the FLNR there was designed and put into commissioning the mass separator MASHA - Mass Analyzer of Super Heavy Atoms. The uniqueness of this mass spectrometer consists in ability to measure "on line" the masses of the synthesized isotopes of the super heavy elements simultaneously with detection of their alpha decays and spontaneous fission.

The main characteristics of MASHA setup is the separation efficiency and separation time. To determine these parameters two experiments by using the complete fusion reactions ^{40}Ar+^{144}Sm and ^{40}Ar+^{166}Er, E_{beam} = 5-7 MeV/n, were carried out. The experiments were carried out at the U400M cyclotron of the FLNR, JINR (Dubna). In the first experiment, the absolute cross sections of evaporation residua (radon and mercury isotopes) were obtained. In addition the absolute cross sections for p(xn) and α(xn) reactions were also measured. The method of moving absorber made of ultra-thin aluminum foils (0.8 μm), where the reaction products were stopped, was used. The alpha decay of synthesized isotopes was detected by using silicon detectors. Energy resolution of alpha-radioactive isotopes was ~ 100 keV. Time moving of aluminum absorbers between two extreme positions was 0.3 s. The using of beam interruption method allowed to measure half-life of synthesized nuclei. As a result, the method allowed reliable identification of reaction products. In the second experiment, the excitation functions of the same reactions were measured with upgraded mass separator MASHA including the modernization of rotating target assembly, solid hot catcher, ECR-ion source, beam diagnostics and DAQ system. To register the products of nuclear reactions, a multi-strip silicon detector was installed in the focal plane of the mass separator.

By direct comparison of these results, the separation efficiency and separation time of evaporation residua were determined.

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