**Status of the first experiment at the SHE Factory and its scientific program**

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In 2020, a series of test experiments was performed with an aim to determine the optimum parameters of the DGFRS-2 gas-filled separator for transporting reaction products of 40Ar and 48Са ions with natYb, 174Yb, 170Er and 206Pb. From the systematics of the experimental results, as well as from the calculations of ion trajectories in the separator, the optimum values of magnetic field have been obtained to be implemented in experiments on synthesis and study of superheavy nuclei (SHN). Experiments have shown that more efficient collection of nuclei requires an increased size of the detector in the focal plane of the separator. A new system of detectors measuring 48 mm×220 mm has been developed and tested; this system makes it possible to increase the efficiency of collecting reaction products by a factor of almost 1.5.

At the end of November 2020, an experiment was launched to study in detail the properties of Mc (Z=115) isotopes and their production cross sections in the complete fusion reaction 243Am(48Ca,2-5n)286-289Mc. The energy of 48Ca particles in the first experiment was 243 MeV, which corresponds to the maximum cross section of the 3n reaction channel. By mid-December, we have detected 21 decay chains of 288Mc. In addition, we detected 4 289Mc decay chains, although to produce this isotope with the maximum yield, the energy of 48Ca should be 2-3 MeV lower.

Since the cross section of the reaction243Am+48Ca is one of the highest of all the 48Ca-induced reactions with the actinide target nuclei, this experiment allows to more accurately measure the average charge of Mc ions, which is necessary to refine the systematics of ion charges of heavy atoms. As well, the value of the DGFRS-2 transmission can be estimated experimentally and compared with the results of calculations, together with the width of the distributions of recoil nuclei on the detector surface, and background conditions can be evaluated.

Moreover, the results will provide answers to a number of scientific questions.

1. Measurement of the excitation function of the 2n reaction channel is important for more reliable theoretical calculations of reaction cross sections near the fusion barrier and prediction of cross sections for the production of elements 119 and 120. In addition, it is of interest to observe the  decay of 281Rg, since its properties allow assessing more definitely the channel with formation of 289Mc.

2. The channel with the evaporation of three neutrons leading to 288Мс is interesting for a number of reasons. First, it is possible that 276Mt has two states with different half-lives. The existence of isomers in the transition region between superheavy nuclei and the region of deformed nuclei near N=162 and Z=108 is predicted in various theoretical nuclear models. Second, it is possible to estimate the cross-section level of pxn channels. For instance, about 100 decay chains of 288Mc have been already observed. However, 288Fl, the p2n channel product has not been detected. Establishing the cross-section level of the pxn channel is important, since this channel opens up prospects for synthesizing more neutron-rich isotopes. The experiment also allows estimating the magnitude of the branch of electron capture in the 288Mc and 284Nh that leads to 288Fl and 284Cn, respectively. Since the background conditions when using the new separator are considerably better compared with the DGFRS-1, we can look for the 268Db  decay, which leads to the new isotope 264Lr.

3. An interesting, but apparently more difficult task is an attempt to obtain the product of the 5n channel 286Mc. This product was observed as two chains only in the entire history of studying the SHN. Both the properties of the nuclei in the 286Mc decay chain and the reaction cross-section are of importance, since the latter is largely determined by the probability of survival of the nucleus during de-excitation, which, in turn, depends on the fission barrier.

Among the key issues in the field of SHE is the study of the chemical properties of elements 112 (Cn) and 114 (Fl). Carrying out such experiments requires preliminary separation of the synthesized atoms from the background reaction products. The DGFRS-2 will be used as a pre-separator before a chemical setup where atoms can be deposited on gold-coated detectors with different temperature. The reaction 242Pu+48Ca will be used for synthesizing Cn and Fl. Running experiments at the new accelerator complex SHE-Factory allows to study the heaviest elements at an essentially new statistical level. From the obtained distributions of atoms over the detectors, it is possible to determine the adsorption properties of the elements Cn and Fl and thus to obtain data on the thermodynamic characteristics of these elements compared with their light homologues: mercury and lead, respectively. The research results allow to experimentally determine the influence of relativistic effects on the chemical properties of the heaviest elements. This will clear up the degree of compliance of the chemical behavior of the SHE with the law of periodicity of properties.

One of the most important tasks of the SHE-Factory is the synthesis of new elements heavier than Og. These experiments require using particles heavier than 48Ca. For example, elements 119 and 120 can be produced in the reactions 249Bk, 249-251Cf+50Ti. However, the cross-section of fusion reactions with 50Ti may be significantly lower than with 48Ca, as a significant drop is expected in the probability of formation of a compound nucleus. To obtain more realistic estimates of the cross sections of reactions with 50Ti, it is intended to run an experiment on the synthesis of the isotopes 290,291Lv in the reaction 244Pu+50Ti. A comparison of the probabilities of production (cross sections) of these nuclei in this reaction and in the reactions 245,248Cm+48Ca in which Lv isotopes were synthesized will make it possible to more reliably estimate the cross sections of reactions with 50Ti.