**Program Advisory Committee for Nuclear Physics**

**53rd Meeting, 22 January 2021**

Referee Reportby Sigurd Hofmann

to the Proposal by Vladimir K. Utyonkov

on the “Status of the first experiment at the SHE Factory and its scientific program”

If I understood correctly, one of the results from the test reactions using beams of 40Ar and 48Ca on targets of natYb, 174Yb, 170Er, and 206Pb was the unexpected broad local distribution of the reaction products in the focal plane of DGFRS-2. As a consequence the old detector system was replaced by a broader one with a size of 220 mm × 48 mm. This was certainly a major work considering the mechanical changes needed and the expansion of the connected electronics.

I further conclude that the reaction 48Ca + 243Am studied during 24 days from November 26 to December 20, 2020, was already performed using the new detector and electronic system. First results are shown in the provided slides.

The plan for 2021 (and may be with continuation in 2022) is, firstly, the continuation of the investigation of the reaction 48Ca + 243Am under various aspects, secondly, the use of a 50Ti beam in an irradiation of 244Pu, as preparation of the most important task of the SHE Factory, the search for the new elements 119 and 120, and, thirdly, the study of the chemical properties of elements 112 and 114.

I fully support this experimental program for the year 2021. It is a very ambitious program and may need to be expanded until 2022.

The reaction 48Ca + 243Am has the highest cross-section of reactions for production of spherical SHN and is, thus, well suited for fine tuning the experimental set-up in addition to the study of the reaction itself and of spectroscopy. Due to the short time between the first experiment in November-December 2020 and the January 2021 PAC meeting it is understandable that not all details of the experimental set-up could be presented. In the following I show a list of questions which could be answered possibly in a follow up publication.

The development of an intensive and stable 50Ti beam is the most important for the search experiments for elements 119 and 120. Within this framework of experiments, I suggest repeating the reaction 48Ca + 248Cm as well with the new set-up. In the case that the cross-section of the fusion reaction 50Ti + 244Pu turns out to be high enough it would be interesting to study the reaction 54Cr + 238U as well. If this reaction has also a reasonable high cross-section, it would be an alternative to use a 248Cm target in the search experiment for element 120, which is much easier to handle than a target of Cf.

It is reasonable to prepare a chemical apparatus at the new gas-filled separator DGFRS-2 at the SHE Factory. However, the main experiments should be performed at the new gas-filled separator DGFRS-3 which is already under construction and which is designed particularly as a pre-separator for chemical experiments.

Now I have a couple of questions which came into my mind when I scrolled through the slides.Detailed answers may be given in a future publication.

Questions to the detector and electronics:

What is the size of the pixels?

Are the detector chips the same for stop and box detector?

What is the energy resolution for 10 MeV alpha particles?

What is the energy resolution for stop-box alpha events?

What is the energy resolution for alphas escaping from one pixel into the

neighboring one?

Will cooling of the detector improve the resolution?

What is the efficiency of the box detector for escaping alphas?

Which company fabricated the detector and what was the price?

Are there TOF detectors? If yes, how they are prepared and what are the dimensions?

Is there a veto detector behind the stop detector?

Rough scheme of the electronics.

Was the electronics manufactured at the laboratory?

What is the maximum energy range and the lower discriminator level?

Is the beam switched off when spokes of the target wheel come into the focus of

the beam?

How fast is the switching process and how quickly comes the beam back?

Is the beam switched off when a potential decay chain is detected?

What is the signature for detection of a decay chain switching off the beam?

How long was the beam off when the decay chains of 288Mc were measured?

How do you plan to measure the alpha decay of the T1/2 = 27 h 268Db?

Slide 5:

How looks the situation background-compound nuclei in the case of 48Ca + 243Am

compared to the shown results for 48Ca + 206Pb?

Have you considered a very thin foil in front of D2 for changing the ionic charge states

of background ions and reaction products? Such a foil could possibly be used as part

of a TOF detector and as a window for a vacuum detector chamber.

Slide 6:

Beam dose = 8.5x10\*\*18

Average beam dose from Nov. 26 to Dec. 20, 2020, was 0.66 *p*μA

How many days were without beam and why?

What was the average and what was the maximum beam intensity?

How big was the consumption of 48Ca?

How were the targets controlled?

How looked the targets after irradiation?

Slide 15:

All known noble gases have the outer electron configuration s2p6.

How can relativistic effects produce such a configuration in Fl?

Slide 17:

What beam intensity do you expect for 50Ti?

What consumption of 50Ti do you expect?

Sigurd Hofmann,

GSI Darmstadt, January 09, 2021