Preparations towards X-Ray Fingerprinting of Element 115 Decay Chains*

U. Forsberg[1], P. Golubev[1], L. G. Sarmiento[2], J. Jeppsson[1], D. Rudolph[1], L.-L. Andersson[3,4], D. Ackermann[5], M. Asai[6], M. Block[5], K. Eberhardt[7], J. Even[4,7], Ch. E. Düllmann[4,5,7], J. Dvorak[4], J. M. Gates[8], K. E. Gregorich[8], R.-D. Herzberg[3], F. P. Heßberger[4,5], E. Jäger[5], J. Khuyagbaatar[4], I. Kojouharov[5], J. V. Kratz[7], J. Krier[5], N. Kurz[5], S. Lahiri[9], B. Lommel[5], M. Maiti[9], E. Merchán[5], J. P. Omtvedt[10], E. Parr[3], J. Runke[5], H. Schaffner[5], M. Schädel[5,6], and A. Yakushev[5]

[1]Lund University, Lund, Sweden; [2]Universidad Nacional de Colombia, Bogotá, Colombia; [3]University of Liverpool, Liverpool, United Kingdom; [4]Helmholtz Institute Mainz, Mainz, Germany; [5]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany; [6]Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Japan; [7]Johannes Gutenberg-Universität Mainz, Mainz, Germany; [8]Lawrence Berkeley National Laboratory, Berkeley, USA; [9]Saha Institute of Nuclear Physics, Kolkata, India; [10]University of Oslo, Oslo, Norway

In preparation for an approved experiment aiming at X-ray fingerprinting of element 115 decay chains to unambiguously determine the atomic number of the involved nuclei, a number of final tests were performed in June 2011. The main experiment is designed to measure the energies of characteristic X-rays emitted following de-excitation via internal conversion in coincidence with α decays into excited states. ^{287}115 will be produced in the ^{243}Am(^{48}Ca,4n) reaction, isolated in the gas-filled recoil separator TASCA [1], and guided to the TASISpec setup [2].

In this experiment we studied which of the two ion-optical modes of TASCA [1] is more beneficial to use together with TASISpec. Previously, TASISpec has been used with TASCA in the "Small image mode" (SIM) with good results. However, simulations and experiments [4] have shown that insertion of slits inside TASCA can decrease the background in "High transmission mode" (HTM) significantly. To investigate the performance of TASISpec with TASCA in HTM, the reaction ^{208}Pb(^{48}Ca,2n)^{254}No was used (for details, see [3]). First, the previously determined optimal TASCA SIM quadrupole magnet settings for TASISpec were confirmed to yield the maximum transmission. Secondly, a series of HTM tests using the nominal TASCA focal-plane detector confirmed that a strong background suppression can be achieved by inserting slits in TASCA. Thirdly, the HTM magnet settings were optimized to give the best transmission of ^{254}No into TASISpec. This optimization was guided by simulations [5] of the trajectories of ^{254}No through TASCA. Relative experimental transmissions were derived from the number of events recorded in the α peak from ^{254}No in the TASISpec implantation detector, normalized to the beam integral. The optimal settings were found within the range of magnet settings suggested by the simulations.

The spacial distribution of ^{254}No events over the TASISpec implantation detector with TASCA in HTM is illustrated in Fig. 1(b), showing data from a simulation of the experiment. The implantation profile is elongated in the horizontal direction, as expected in HTM. Since the ions have to pass a cylindrical tube on their way to TASISpec, the best use of the two focusing quadrupoles turned out to be when the horizontal focusing is somewhat stronger than the vertical one. The optimized settings established in this experiment can be used for determining how to tune the magnets in other experiments using TASISpec with HTM.

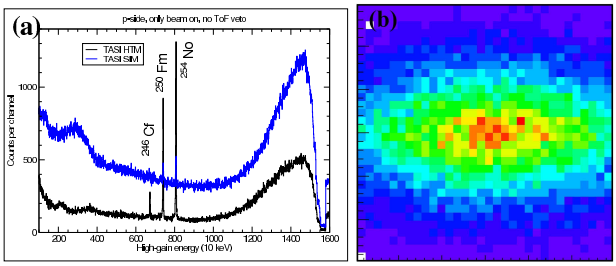

Figure 1: (a) Energy spectra accumulated using SIM (blue) and HTM (black). (b) Simulated distribution, in HTM, of ^{254}No in the TASISpec implantation detector [3].

The transmission to TASISpec with TASCA in HTM was ~80% of the one achieved in SIM. The main advantage in HTM is the excellent background suppression. Fig. 1(a) shows beam-on energy spectra from SIM (blue) and HTM with slits inserted (black). The clean HTM spectrum implies that it is possible to search for α-X-ray coincidences in the beam-on periods as well as in the beam-off periods, even without using a veto detector, such as a MWPC, for implanted particles. In SIM, only beam-off data can be used when no MWPC is installed, due to too high background rates during beam-on periods. Since the beam-on data accounts for 25% of the events due to the duty cycle of the beam, the total amount of TASISpec data is comparable for HTM and SIM.

References

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