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Actinide beams by light-ion induced fusion-evaporation for mass-, decay- and optical spectroscopy at IGISOL

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The production of actinide ion beams has become a focus of recent efforts at the IGISOL facility of the Accelerator Laboratory, University of Jyväskylä, especially aimed at the measurement of nuclear properties of heavy elements using high-resolution optical spectroscopy [1]. The first successful proof-of-principle on-line experiment for the production of actinides from a light-ion fusion-evaporation reaction has recently been performed with protons on ^{232}Th targets. Several alpha-active reaction products were detected, reaching as neutron deficient as ^{224}Pa through the ^{232}Th(p, 9n)^{224}Pa with a 60 MeV primary beam. By detection of gamma-rays in coincidence with the alpha-decay, new information on the decay radiation has been obtained on nuclei including ^{226}Pa.

Direct detection of long lived actinides such as ^{229}Th which is of special interest due to the extremely low-energy isomer [2], was not possible due to low alpha-activity as well due to low Q_{EC/β^-} values, rendering separation of isotopes even with high resolution Ramsey cleaning with the Penning trap ineffective. Therefore, the novel Phase-Imaging Ion Cyclotron Resonance (PI-ICR) method [3] at JYFLTRAP is to be used for for a direct yield determination of long-lived isotopes in an upcoming experiment. This will also allow direct high-precision mass measurements creating new anchor points in the mass network calculations which currently rely on long chains of alpha decays in the actinide region of the nuclear chart.

An important aspect of these developments has been related to target manufacturing. In addition to metallic thorium targets, several new ^{232}Th targets manufactured by a novel Drop-on-Demand inkjet printing method [4] were successfully tested. These targets were provided by the Nuclear Chemistry Institute of Johannes Gutenberg-Universität Mainz who will now provide several new targets from other more exotic actinides such as ^{233}U or ^{237}Np. With these new targets we expect to access several new isotopes in the neutron-deficient actinide region for decay and optical spectroscopy as well as for mass measurements.

[1] A. Voss et al., Phys. Rev. A, 95 (2017) 032506.
[2] L. von der Wense et al., Nature, 533 (2016) 47.
[3] D. Nesterenko et al., Eur. Phys. J. A, 54 (2018) 154.
[4] R. Haas. et al., Nucl. Instr. Meth. A, 874 (2017) 43.

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