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Actinides measurements on the 1 MV AMS system at the Centro Nacional de Aceleradores (CNA, Seville, Spain): How far can we go?

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The AMS technique was implemented for the first time in Spain in 2005, with the arrival at the Centro Nacional de Aceleradores (CNA, Seville) of the first compact and multi-elemental system put in the market by High Voltage Engineering Europa (HVEE, Amersfoort, The Netherlands). Since then, actinides measurement techniques have been in constant development at the CNA. To date, ^{236}U , ^{237}Np , ^{239}Pu , ^{240}Pu and ^{241}Pu can be considered consolidated radionuclides and are routinely measured in a variety of samples [1,2]. Recently, the AMS technique has been setup for ^{233}U [3] and ^{244}Pu [4] analysis. The limelight is now put on Am and Cm analysis.

The compact design of the spectrometer constraints the abundance sensitivity that can be obtained for those nuclides neighbored in mass by naturally occurring isotopes. This is the case of ^{236}U , neighbored by ^{235}U and ^{238}U , and ^{233}U , neighbored by ^{232}Th , ^{234}U and ^{235}U , for which background isotopic ratios of 10-10 (i.e. $^{236}\text{U}/^{238}\text{U}$) and of 5×10^{-11} (i.e. $^{233}\text{U}/^{238}\text{U}$) have been demonstrated, respectively [3,5]. It has been observed that the survival of molecular isobars in 3+ charge state can limit the sensitivity of the technique if the stripper gas settings are not properly adjusted. This can be especially critical for the extremely minor ^{244}Pu , due to the survival of the diatomic trication $^{232}\text{Th}^{12}\text{C}^{3+}$ [4]. Recent studies on Am (^{241}Am and ^{243}Am) and Cm (^{244}Cm , ^{245}Cm and ^{246}Cm) isotopes point out to detection issues related to the presence of lanthanides (mostly Dy isotopes) in the sample, due to occurrence of pile-up events from 2+ molecular fragments mimicking the electronics signal of 3+ actinides ions in the detector (e.g. $^{162}\text{Dy}^{2+}$ and $^{243}\text{Am}^{3+}$). Thus, the best performance of the AMS technique for actinides analysis in environmental samples can be achieved if: i) the AMS technical parameters are thoroughly adjusted in every case (i.e. slits settings and stripper gas pressure), and ii) the radiochemistry of the samples is optimized so that Th is suppressed from the U, Np and Pu samples, and lanthanides from the Am and Cm samples [7].

At the CNA, a synergy between both research fields, AMS technique and radiochemistry, has been achieved, so that the most minor and demanding actinides radionuclides can be analysed in a variety of environmental matrixes. In this work, the overall performance of the technique will be presented. Besides, examples of the most recent studies carried out at the CNA illustrating the potential of the U, Pu and Am isotopic vectors to gain information on the anthropogenic sources of actinides to the environment will be given.

- [1] M. López-Lora, E. Chamizo, I. Levy, M. Christl, N. Casacuberta, T.C. Kenna, ^{236}U , ^{237}Np and $^{239,240}\text{Pu}$ as complementary fingerprints of radioactive effluents in the western Mediterranean Sea and in the Canada Basin (Arctic Ocean), *Sci. Total Environ.* 765 (2021) 142741. <https://doi.org/10.1016/j.scitotenv.2020.142741>.
- [2] M. López-Lora, G. Olszewski, E. Chamizo, K. Pettersson, M. Eriksson, Plutonium Signatures in a Dated Sediment Core as a Tool to Reveal Nuclear Sources in the Baltic Sea, *Environ. Sci. Technol.* (2023). <https://doi.org/10.1021/acs.est.2c07437>.
- [3] E. Chamizo, M. López-Lora, M. Christl, Performance of the 1 MV Accelerator Mass Spectrometry system at the Centro Nacional de Aceleradores for the analysis of ^{233}U at environmental levels, *Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater. Atoms.* 533 (2022) 81–89. <https://doi.org/10.1016/j.nimb.2022.10.019>.
- [4] E. Chamizo, M. López-Lora, I. Levy, V. Lérída, Reaching environmental levels of ^{244}Pu by Accelerator Mass Spectrometry at the Centro Nacional de Aceleradores, *J. Environ. Radioact.* (submitted (2024)).
- [5] E. Chamizo, M. López-Lora, Accelerator mass spectrometry of ^{236}U with He stripping at the Centro Nacional de Aceleradores, *Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater. Atoms.* 438 (2019) 198–206. <https://doi.org/10.1016/j.nimb.2018.04.020>.

[7] M. López-Lora et al., This conference: Sequential extraction of U, Np, Pu and Am from sediment samples for AMS studies at the Centro Nacional de Aceleradores (CNA, Spain).

Student Submission

No

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