An in-situ approach to direct quantification of ^{238}Pu by triple quadrupole Inductively Coupled Plasma-Mass Spectrometry (ICP-QQQ-MS)

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The triple quadrupole ICP-MS has been an emerging technique for analysis of radio-isotopes due to its capability of discriminating interferences with the use of a reactive gas and additional mass filter (Q2), enhancing selectivity of ions passing through the mass filter. Determination of plutonium and its isotopic composition have been of significant interest in the field of nuclear forensics. Traditional radiometric techniques such as alpha spectrometry has been the common approach for determination of Pu-containing materials and rapid determination of the grade of Pu materials respectively. However, alpha spectrometry involves extensive radiochemical separation and same-day reporting is a challenge.

The use of mass spectrometric technique faces serious isobaric interferences which is the main bottle neck for most analysis with mass spectrometry. Ubiquitous natural uranium has been the main problem for complete analysis of Pu using ICP-MS and therefore the use of both radiometric and non-radiometric techniques are often required.

Herein, an in-situ determination of ^{238}Pu is reported with the use of mass spectrometric technique, ICP-MS.

In this work, we aim to overcome isobaric issues with the use of a reactive gas, CO_2 . However, unlike NH_3 ,CO_2 shows poorer selectivity in its reaction with both U and Pu. To overcome this problem, we adopted an 'in-situ' approach with the use of an internal standard ^{242}Pu. Due to the same chemical properties of the isotopes, we are able to optimise the CO_2 flow rate, removing all uranium at m/z 238 and correct for the ^{238}Pu that is present based on conversion % of ^{242}Pu. This work is validated with the use of reference materials with certified amount of ^{238}Pu and ^{242}Pu. Uncertainties involved in this work are calculated based on the guidelines for General Uncertainty Measurement (GUM) workbench.