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Reproducibility and accuracy of actinide AMS – measurement limits from high-precision studies on ^{235}U(n,γ)^{236}U

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Actinide-AMS has grown into an important discipline for environmental and geological sciences, for oceanography, but also nuclear (astro)physics. Nuclear data requests in nuclear physics continue to challenge the present limits in accuracy and abundance sensitivity of actinide detection. Exploring these limits is the primary motivation of this presentation.
In recent years, significant effort has been spent to reduce uncertainties and regain lost knowledge in nuclear data. In particular, a major focus is to better understand the validity of the numerous cross-section data that were obtained decades ago. These activities are motivated by the urgent need for improved, safer, and highly accurate nuclear data for optimised designs of advanced reactor concepts, small modular reactors, nuclear fusion reactors, and next generation nuclear power plants (Gen IV) and accelerator driven systems (ADS).
For such nuclear applications accurate actinide data are crucial, e.g., requiring uncertainties <2-3% for capture reactions of U and some Pu isotopes. Recent data evaluations based on state-of-the-art statistical methods highlighted the importance of proper data treatment including 'complete' uncertainty analysis. Adding a new independent method for such measurements helps to identify unrecognized systematic uncertainties in the existing nuclear database: the combination of activation and subsequent AMS detection offers here a powerful and complementary tool to measure these cross sections, largely independent of previous methods as it is based on a direct count of the produced nucleus. However, AMS had been applied only very recently for measurements on actinides.
One example is the cross-section value for ^{235}U neutron-capture at near thermal energies. The thermal capture is defined as a so-called thermal neutron constant and believed to be known to better than 1%. Despite its importance, direct measurements are rare (only two older data exist for thermal energies), usually done as a ratio to fission, and they exhibit large uncertainties, thus its knowledge is based primarily on indirect information.
We present systematic investigations of neutron-capture measurements of ^{235}U and ^{238}U targets for samples irradiated with neutrons at four different facilities covering neutron energies from ultra-cold and cold to thermal. The goal was to produce cross-section data with highest accuracy, qualifying eventually as an independent reference for the neutron standard library.
Two different sets of uranium samples were activated under identical conditions for each neutron irradiation. The samples were dissolved and individual aliquots were then spiked with several independent but well-known reference isotopes (^{233,236,238}U, ^{239,242}Pu, provided by EC JRC Geel, Belgium), relative to which the neutron-produced radionuclides were measured.
To properly estimate the final data accuracy, results from six repeated AMS measurements were used, allowing to estimate the measurement reproducibility by covering unknown uncertainties beyond counting statistics and other unknown systematic uncertainties. A comparison of these data provides the present limits in the measurement accuracy of heavy-ion AMS.

Student Submission

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