In hot pursuit of a deployable primary standard for the massic activity of mixed-radionuclide samples

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We combine cryogenic decay energy spectrometry (DES) and electrostatic force gravimetry as a primary standardization method for massic activity of multi-radionuclide samples without chemical separation.

Ultra-cold sensors, such as Transition Edge Sensors (TESs) and Magnetic Microcalorimeters (MMCs) offer exquisite sensitivity to thermal pulses. Our efforts focus on TESs fabricated at NIST. By embedding radioactive material in an energy-absorber thermally connected to the sensors, DES can be achieved with high energy resolution and efficiency (100 % for alpha decay). In this way, radionuclides are identified and quantified by their DES signatures.

Measuring sample mass is critical for absolute DES since many applications require assay of the massic activity (Bq/g) of a starting solution. Since ultra-cold sensors need to be kept as small as possible, only small (few mg) masses of solution can be sampled. Accurately measuring such small masses of dispensed solution has been achieved by advancing drop-on-demand methods and leveraging the redefinition of the kilogram within the SI to create a new dispensing balance traceable to electrical quantities. In separate experiments involving a mass spectrometry-based method and liquid scintillation counting, the new approach was shown to be consistent with traditional gravimetric methods.

We have demonstrated these advances at NIST and will discuss prospects for deploying them more widely to solve outstanding measurement challenges in quantitative imaging, targeted radionuclide therapy, low-level alpha standards for computing (including quantum computing), nuclear energy, environmental monitoring, and security.