

Metrology and modern isotope amount ratio measurements

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What is "metrology" and how is it important for isotope amount ratio measurements?

While there are multiple types of metrology, the focus here will be on scientific or fundamental metrology. Scientific metrology is concerned with the definition of units of measurement, how those units of measurement are realized in practice and how the measurements can be linked and made traceable back to isotopic reference materials (iRMs) and ultimately the SI. In other words, it is the science that seeks to ensure that when an isotopically homogeneous sample is sent to different labs, they all report the same value for the analyte of interest, within their own stated uncertainty. Unfortunately, such an ideal scenario is often not the case, making it difficult if not impossible to compare highly precise but inaccurate isotopic data from one study or lab with similar data from another.

The most direct traceability link available to research and bench scientists is the use of internationally recognized iRMs. All raw measured isotope amount ratios (hereafter referred to as isotope ratios) are biased during measurement or separation by amounts ranging from 0.1 % to as high as 10 %. As our ability to discern smaller and smaller isotope ratio differences increases, so must our ability to ensure comparable levels of accuracy in those measurements.

This presentation will focus on recent advances in producing calibrated (absolute) isotopic ratios that are traceable to the SI and have levels of uncertainty lower than those possible using the "Atomic Weights" approach. These improvements are an outgrowth of techniques developed for absolute Si molar mass measurements of high purity silicon enriched in ²⁸Si that supported an international effort to redefine the kilogram in terms of the Planck constant. Examples of the impact of these novel approaches for other Si iRMs will be presented. The extension and application of these novel approaches to other isotopic systems will be discussed.