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Title: Forensic Signatures for Atomic Vapor Laser Isotope Separation

Abstract

Atomic Vapor Laser Isotope Separation (AVLIS) is a promising method of uranium enrichment that utilizes the resonance shift between different isotopes to selectively ionize U-235. It is a highly efficient process, typically only requiring a single pass to enrich to a desired level and requiring less energy than gas centrifuges. Its efficiency allows for the creation of an operational AVLIS facility with a small physical footprint and energy signature. As such, it is both a promising method for producing nuclear fuel and a potential proliferation risk. We are therefore interested in developing tools for the inspection of potential AVLIS facilities as well as understanding forensic signatures of AVLIS-enriched uranium.

We analyze the feed, product, and tails streams and show that several key machine operating parameters can be determined purely through analysis of these streams. We show that AVLIS-enriched uranium can be distinguished from centrifuge-enriched uranium through comparison of the U-234/U-238 ratios. We further demonstrate that small-scale variations in feed assay of U-234, observed to occur between various uranium mines, correspond to small-scale variations in AVLIS product assay of U-234, serving as a potential forensic signature. These small-scale variations are corrected for the decay of U-234 to Th-230 over time, which is used to determine enrichment capabilities and estimate the time of the most recent enrichment more accurately.