Contract No:

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Disclaimer:

SPECTROSCOPIC METHODS FOR ULTRA-LOW ISOTOPIC ANALYSIS OF PROLIFERANT MATERIAL

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Benefit

Field-deployable instrument for real-time UF_6 isotopic (^{235}U and ^{238}U) measurements that addresses the need for improved methods of on-site detection at declared facilities.

Applications

- U enrichment verification.
- Real-time enrichment monitoring.
- Other f-element real-time isotopic analyses.

Results -TRL level 4-5

Breadboard laboratory system tested and instrument enhancements made (Fig.1)

- Added a reference cell containing N_2O for wavelength calibration and laser mode-hop correction (Fig.1).
- Determined instrument dynamic range to be 0.5% +/- 0.25, meaning the instrument can be used to measure isotopic ratios of natural and enriched UF_6 samples (Fig.2).
- Performed experiments at ORNL UF_6 test loop demonstrating measurements at a relevant facility, as well as similar spectral results using a different laser wavelength centered around the UF_6 $\nu_2+\nu_3$ band (Fig.3).
- Started fabrication of a single embedded system that incorporates data acquisition and instrument control functions.

Anticipated Final Capabilities

Field-Deployable Instrument

- $^{235}U/^{238}U$ ± 0.25% (note: TIMS ± 0.02% from IAEA-CN-184/25).
- Low-volume (c. 6 mL)
- Real-time (several minutes) analyses
- Small footprint c. 3'(l)x1.5'(w)x2'(h) in size
- Autonomous sampling and analysis
- Embedded system will allow data encryption and authentication

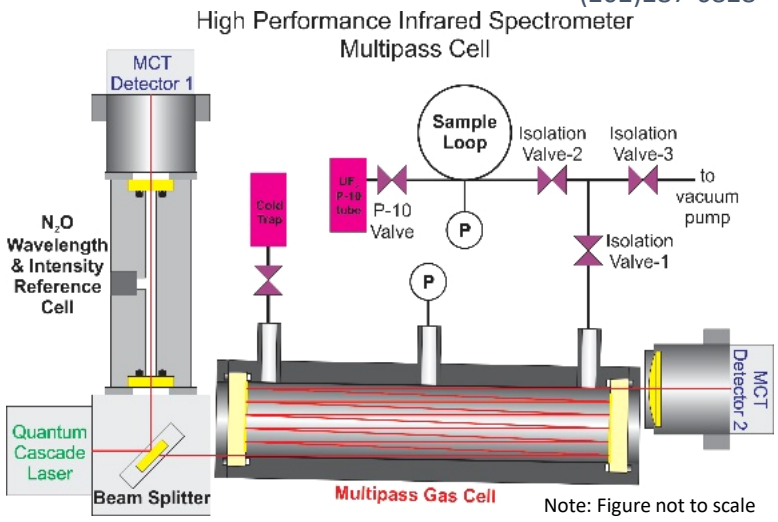

Fig. 1: Schematic of HPIR Instrument Design

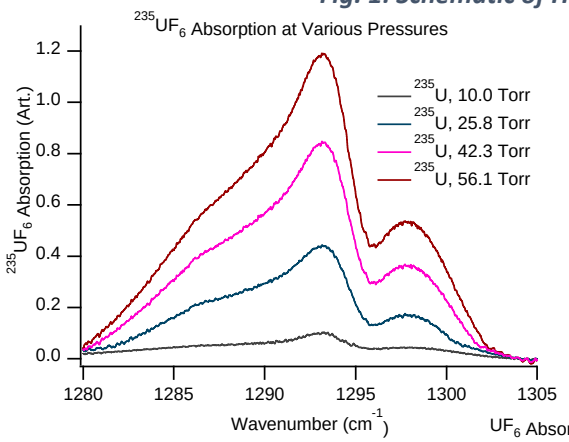

Fig. 2: HPIR spectra of UF_6 at various pressures.

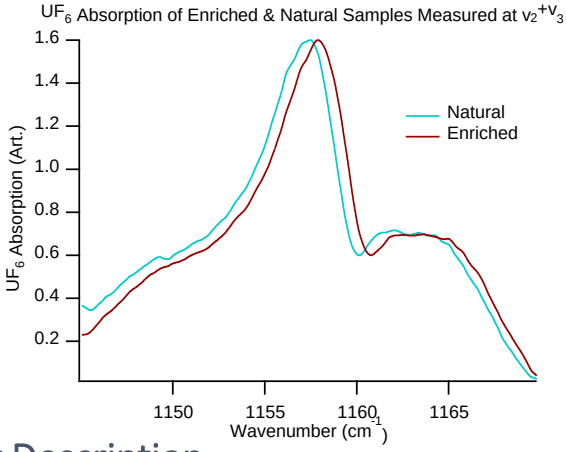

Fig. 3: HPIR spectra of UF_6 with natural isotopic abundance

Project Description

Development of a field-deployable instrument for real-time isotopic measurements of uranium in UF_6. The approach is based on a High Performance InfraRed (HPIR) spectroscopy technique that has recently been enabled by advances in laser and detector technologies

Addresses the need for improved methods for on-site detection at declared facilities.

Further Reading

Strange Fessler, K. A.; Spencer, W.; Serkiz, S.; O'Rourke, P.; DeRoller, N. 2017."Spectroscopic Methods for Ultra-low Isotopic Analysis of Proliferant Materials." Dynamic Range Report, SRNL-STI-2017-00765.

SRNL-STI-2018-00536