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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

- ❖ $^{235}U/^{238}U \pm 0.25\%$ (note: TIMS $\pm 0.02\%$ 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

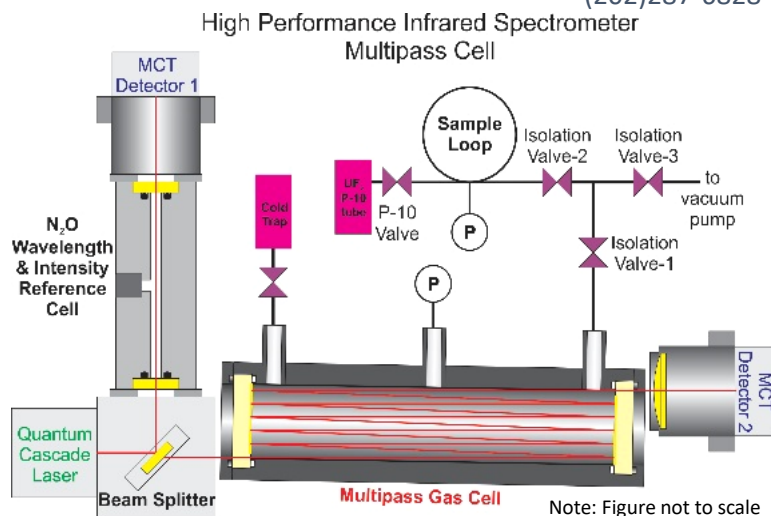


Fig. 1: Schematic of HPIR Instrument Design

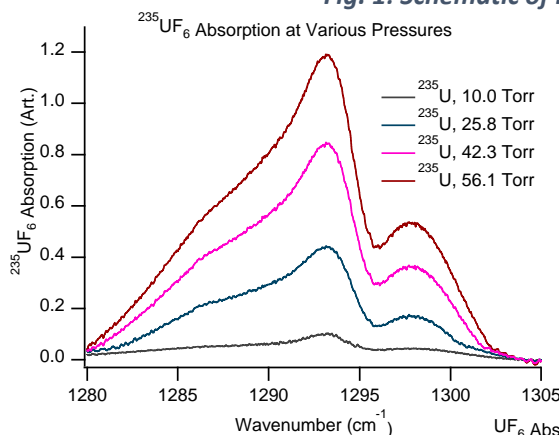
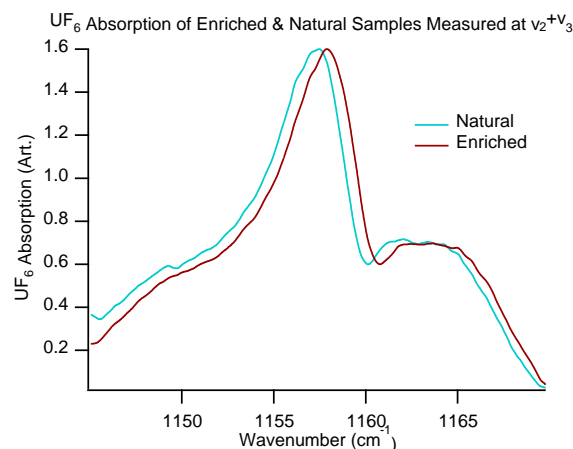


Fig. 2: HPIR spectra of UF_6 at various pressures.

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.



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