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Introduction

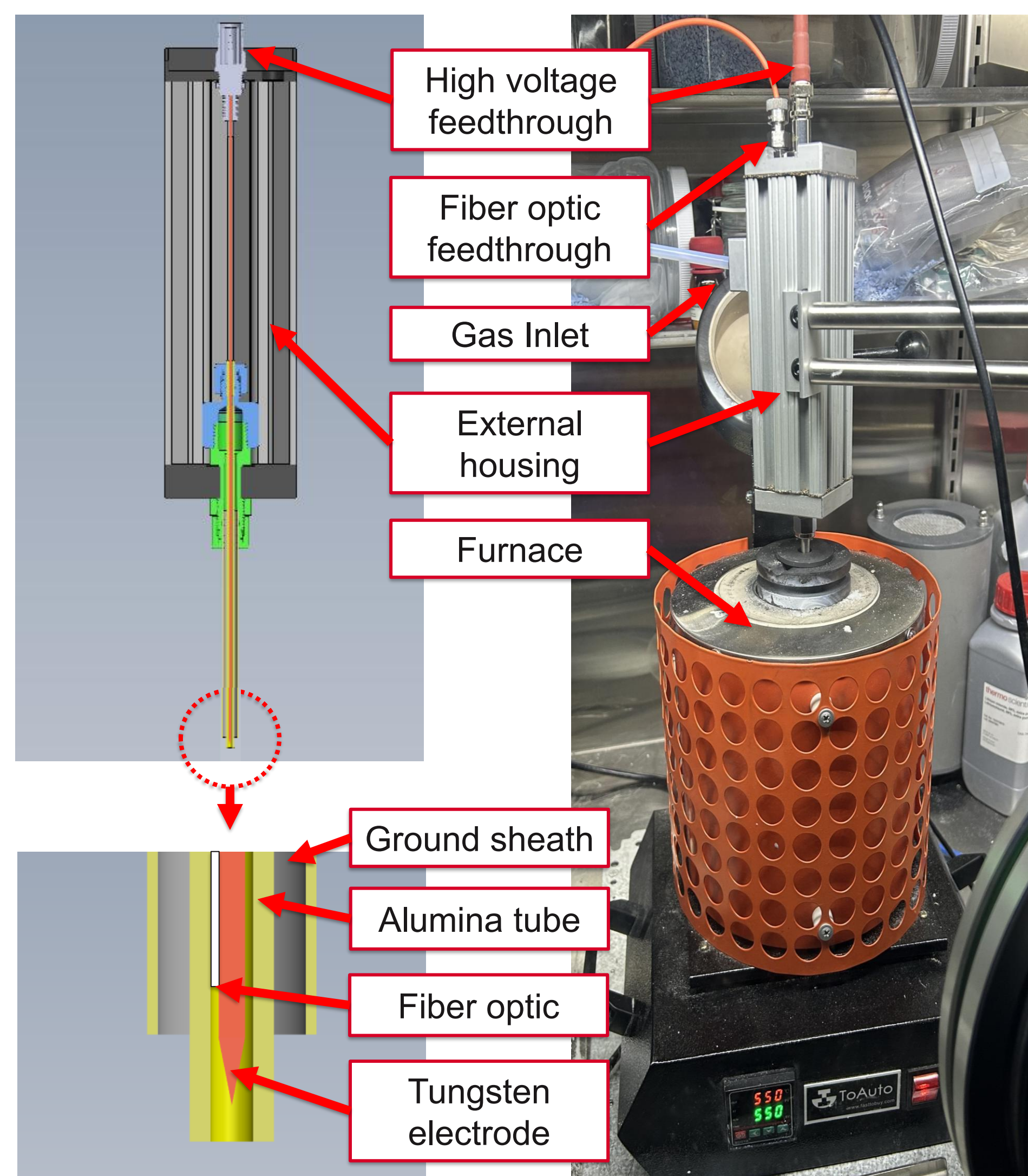
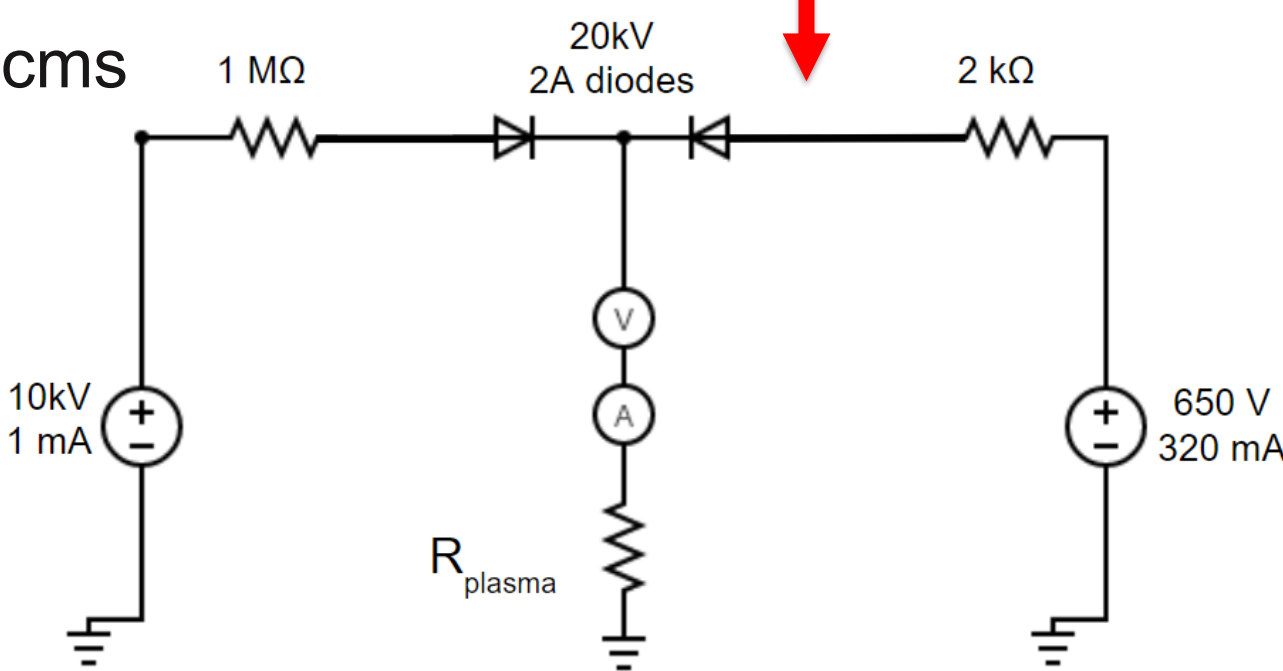
- A current challenge of pyroprocessing involves the accountability of special nuclear material (SNM).
- The current state-of-the-art involves sample removal from the bulk salt and analysis using inductively coupled plasma-mass spectroscopy (ICP-MS).
- The Submerged Plasma for Isotopic Detection and Elemental Resolution (SPIDER) probe is designed to enable real-time material quantification in molten salts.
- Key Features of the SPIDER probe:
 - Coaxial design
 - Protective gas sheath
 - Coupled fiber optic
 - The woven effluent baffle (WEB)

Experimental Design

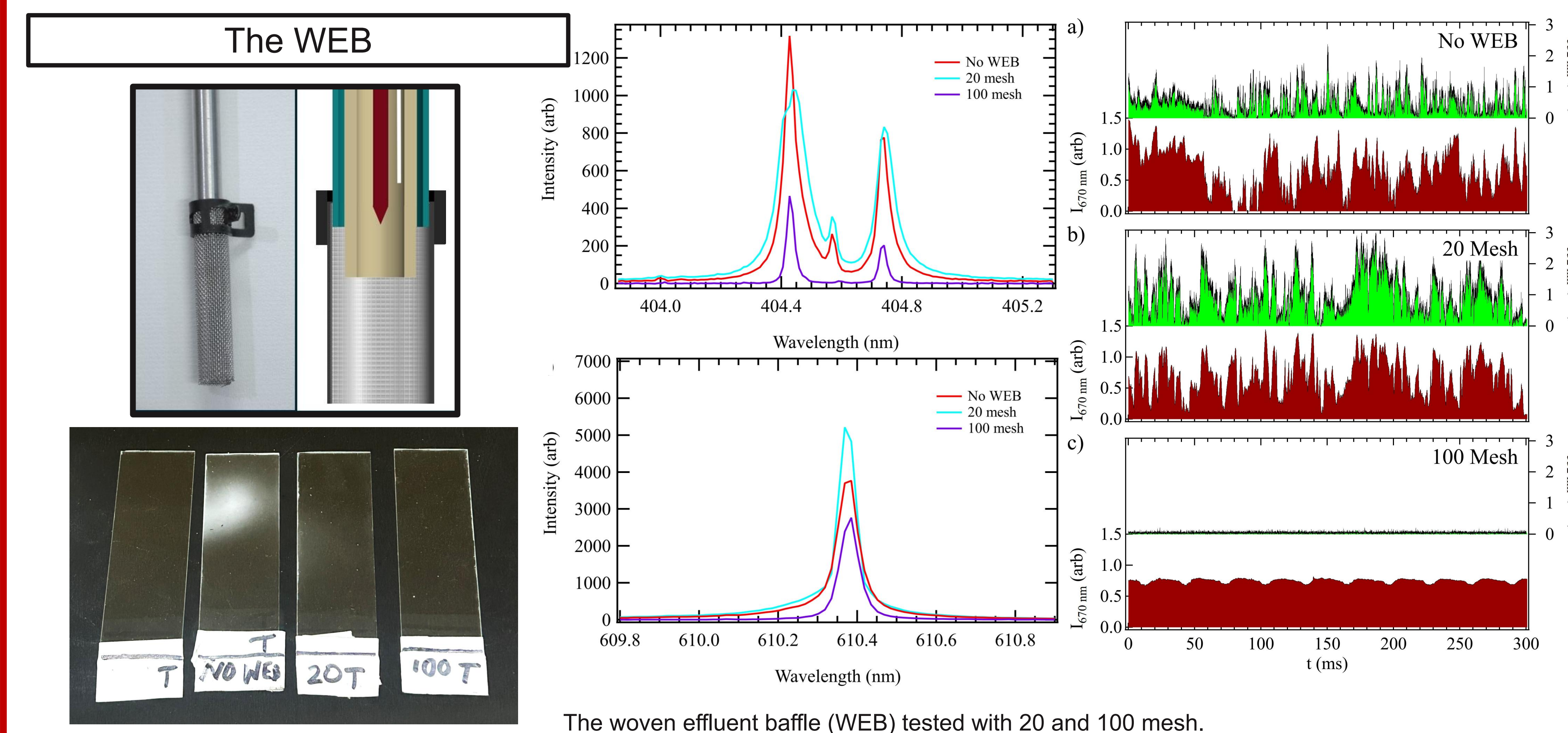
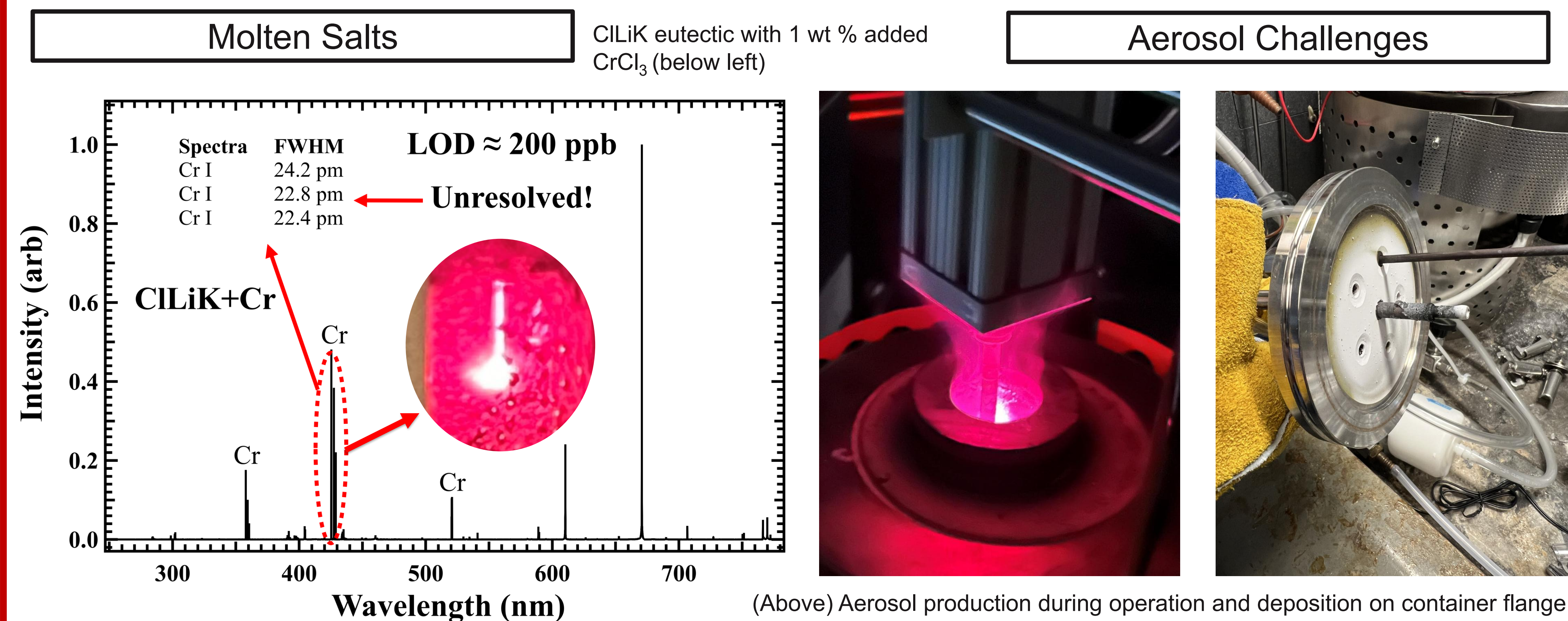
Experimental Parameters:

- Flow gas: Argon
- Flow rate: ~700 sccms
- Spectral data taken on an Echelle spectrometer with resolution $\frac{\lambda}{\Delta\lambda} \sim 20,000$

High voltage circuitry



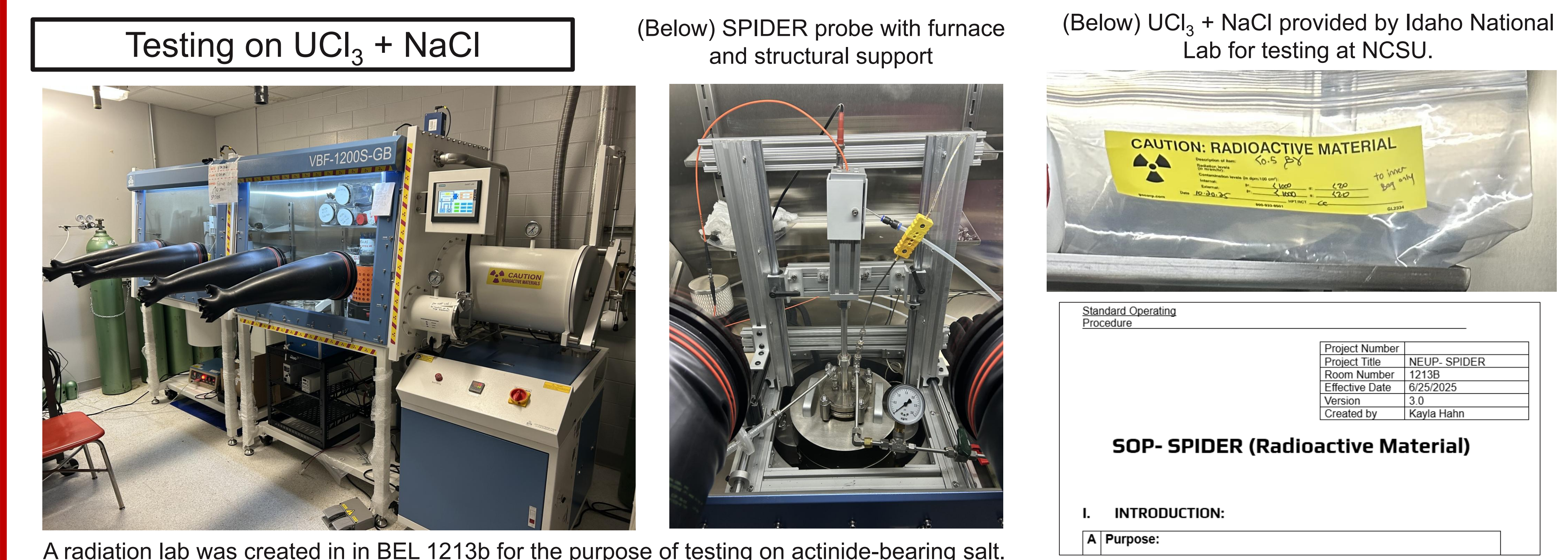
Results



Testing on $\text{UCl}_3 + \text{NaCl}$

(Below) SPIDER probe with furnace and structural support

(Below) $\text{UCl}_3 + \text{NaCl}$ provided by Idaho National Lab for testing at NCSU.



A radiation lab was created in in BEL 1213b for the purpose of testing on actinide-bearing salt.

CAUTION: RADIOACTIVE MATERIAL

Standard Operating Procedure

Project Number	NEUP_SPIDER
Project Title	1213B
Room Number	6/25/2025
E-Effective Date	3.0
Version	Created by Kayla Hahn

SOP- SPIDER (Radioactive Material)

I. INTRODUCTION:

A Purpose:

Conclusion

- Successful tests have been conducted in molten salts and exhibit spectral linewidths below the resolution limit of our spectrometer.
- However, aerosol creation would limit experimental lifetimes posing issues for long-term use.
- Introduction of the woven effluent baffle (WEB) has resulted in decreased aerosol production and increased plasma stability.
- Creation of a radiation lab in BEL 1213b has allowed for testing to begin on $\text{UCl}_3 + \text{NaCl}$ from INL.
- This will include use of the WEB and a fully sealed system.

Future Work

- In the coming weeks experiments will be conducted using actinide-bearing salts.
- This will include determining limits of detection using the SPIDER probe and investigating the longevity of our system.
- Preparations are also being made to test a twin version of the SPIDER probe at INL. This version offers some improvement on the current design including scaling down to potentially test on gram-size samples taken from the Hot Fuel Examination Facility.

Acknowledgements

- Support and resources for this experiment were provided by the Molten salt Ultrafast Spectroscopy Characterization Lab (MUSCL) and the DOE NEUP under grant numbers 21-24307 and 23-29103.
- This work is also a part of the Materials Protection and Accounting Control Technologies (MPACT) program and done in collaboration with Dr. Ammon Williams at INL.

References

Bryars, Davis, et al. "Analysis of Liquids Using the Submerged Plasma for Isotopic Detection and Elemental Resolution (SPIDER)." *Applied Spectroscopy* 80.1 (2026): 71-82.

Manuscript for WEB and actinide work in progress!