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Cyclotron Institute

Steps Forward in Astatine-211 Production and Chemistry at Texas A&M University

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Cyclotron Institute, Texas A&M
University

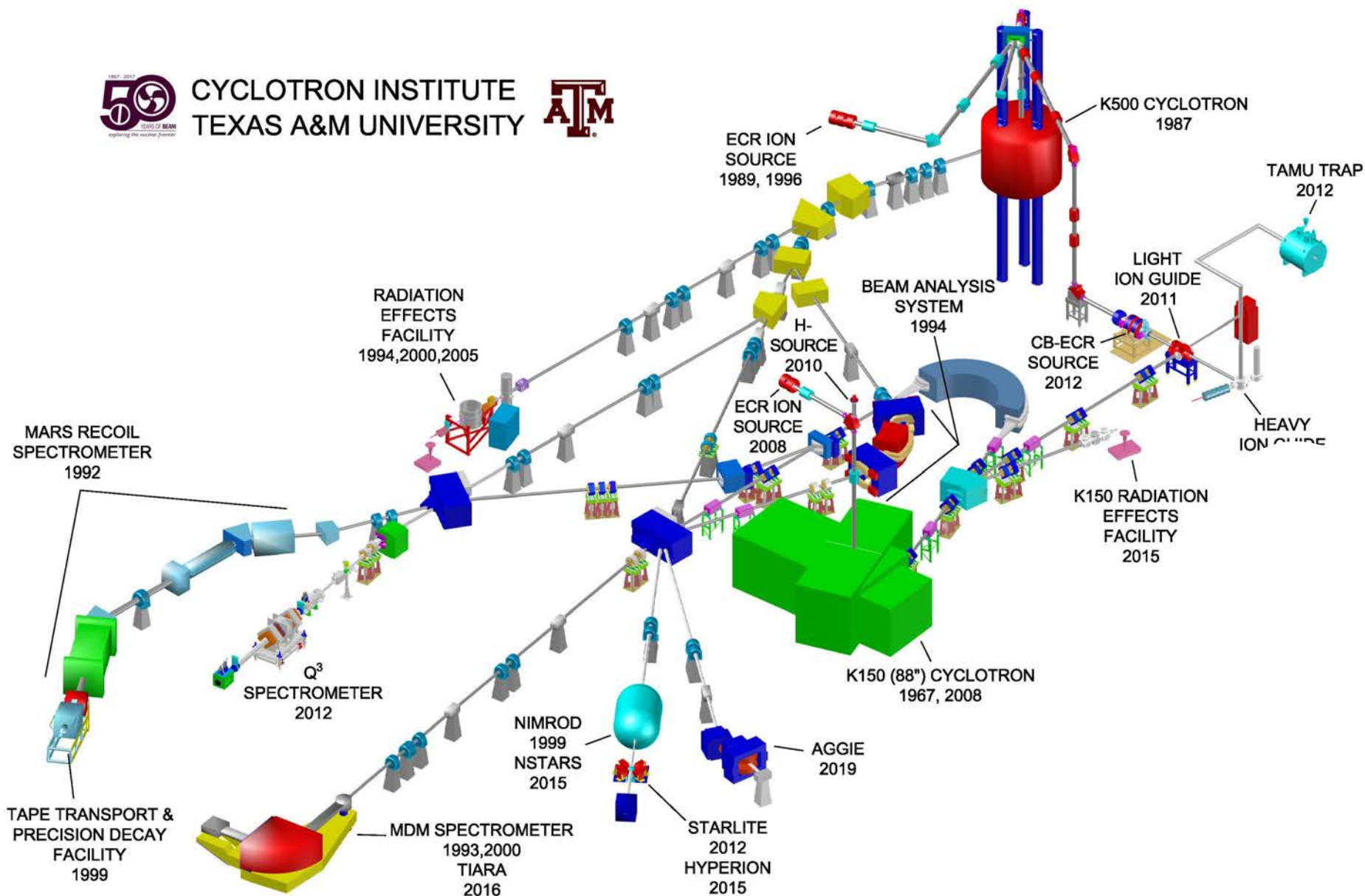


New Since 2021

- Beam Development
 - Higher Current: Up to 14 μA available overnight
 - Further Stability
- Bi Targets
 - Shallow Well
 - Working on automated system
- Dissolution & Use
 - Automated Dissolution
 - Sending dried column to collaborators
 - Chemistry

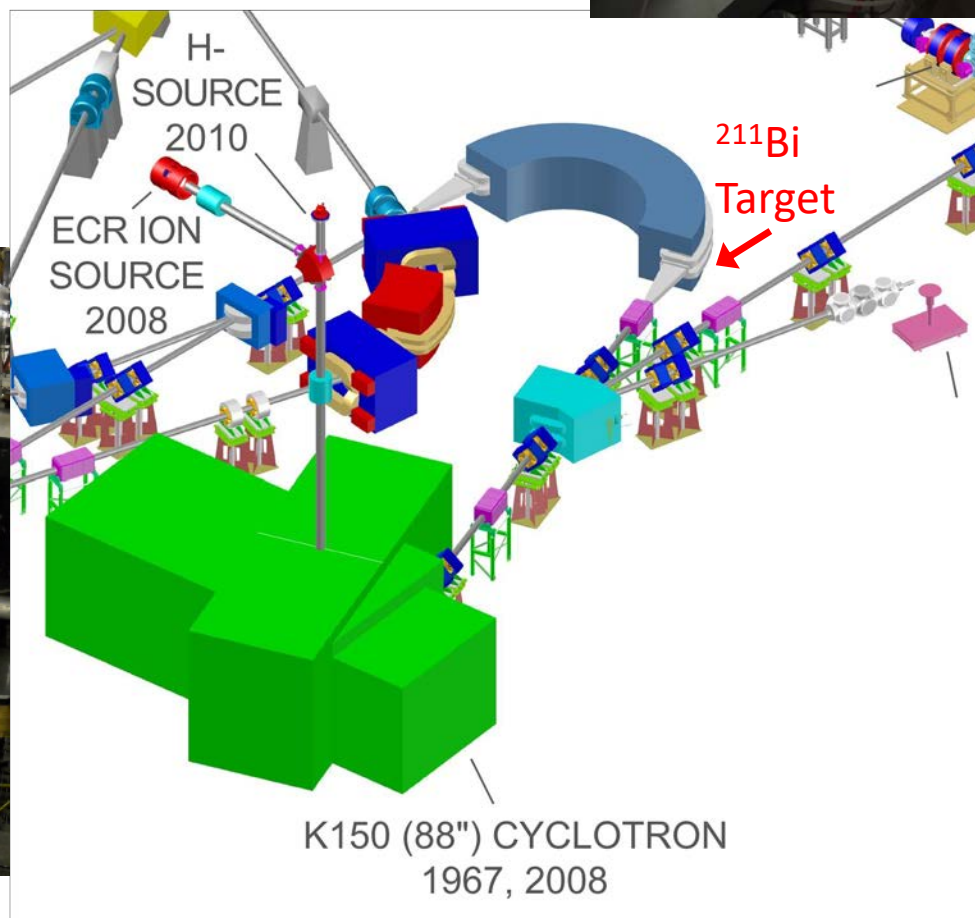
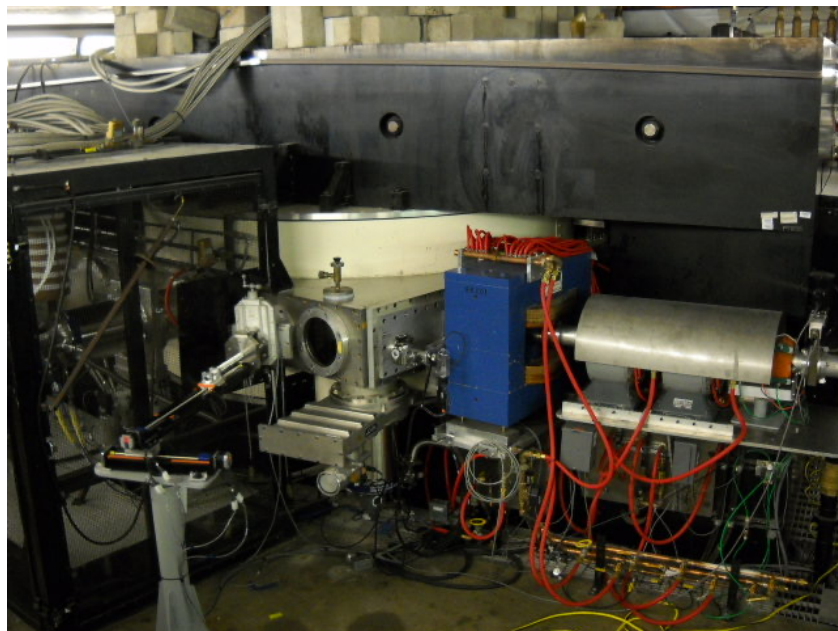


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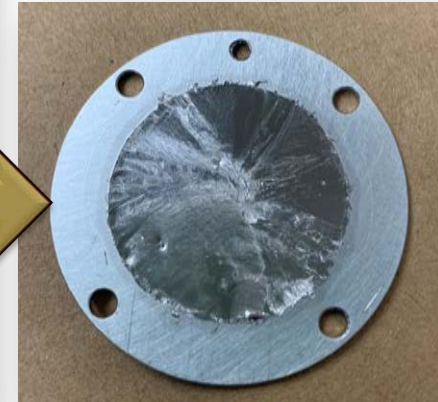
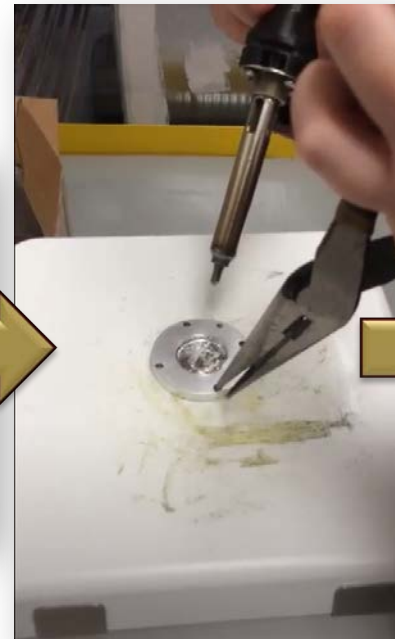
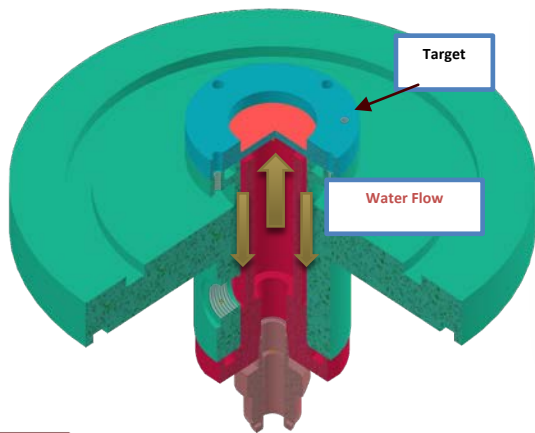
K150 Cyclotron

- $^{209}\text{Bi} + \alpha \rightarrow ^{211}\text{At} + 2n$
- Energy: 28.8 MeV
- +1 charge state

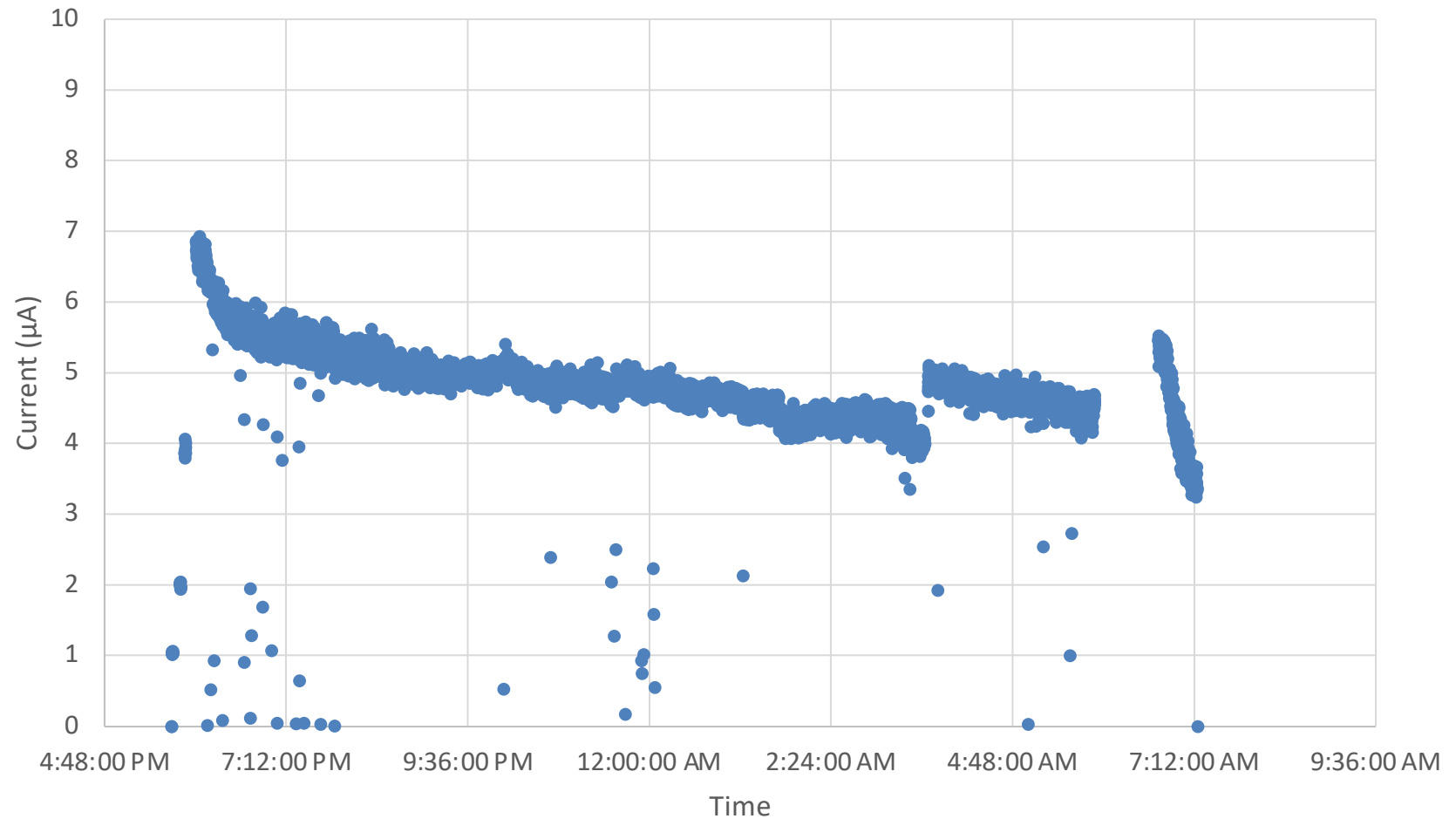


Bismuth Targetry

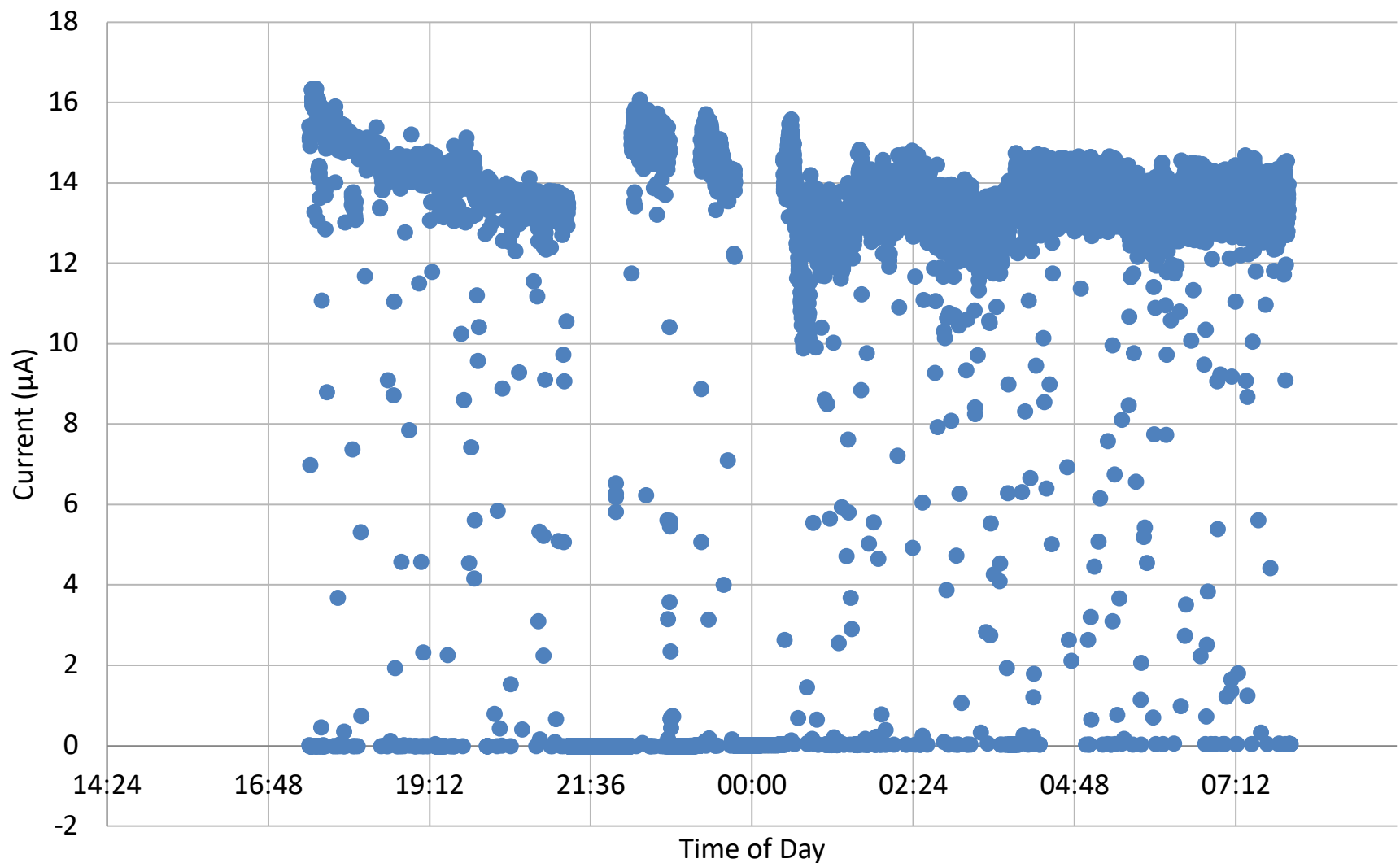
- Melting point of Bi $\sim 270^{\circ}\text{C}$
- Boiling point of At $\sim 335^{\circ}\text{C}$
- Melted on hot plate
- Ceramic spatula spreading
- Ultrasonically soldered
- $\sim 100\text{ }\mu\text{m}$
- Water cooled target backing



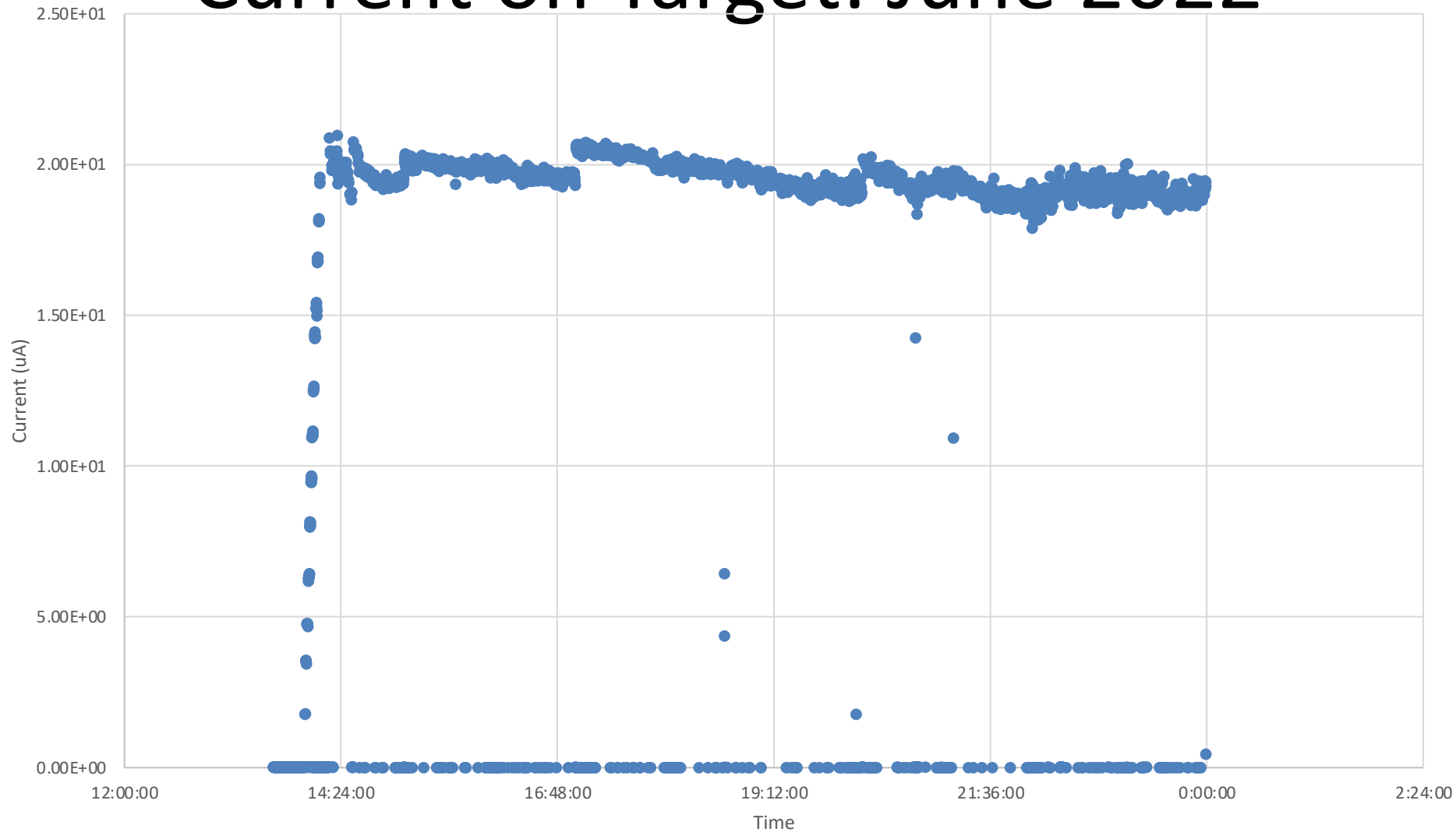
Current on Target: Dec 2020



Current on Target: July 2021



Current on Target: June 2022

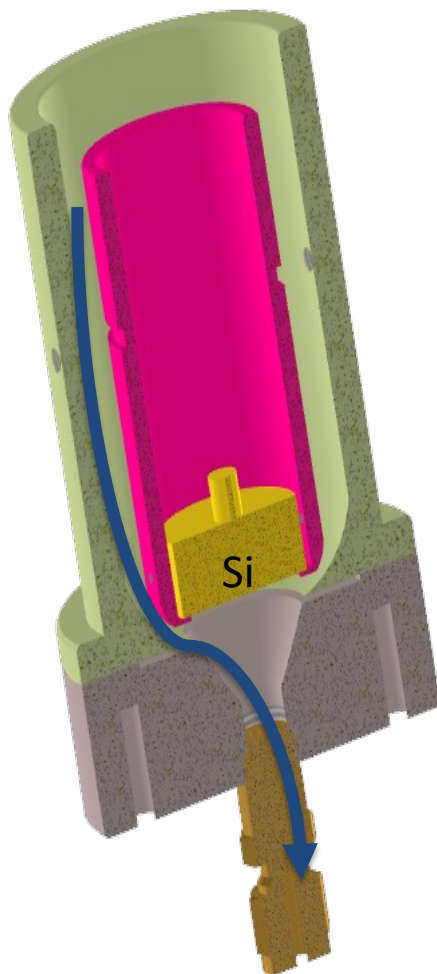


TAMU At-211 Production

	2019	2020	2021	2022
# Production Runs	1	7	9	4 (+4)
Highest Instantaneous Beam Current (pμA)	4.4	7.4	12.1	16.5
Highest Average Beam Current (pμA)	2.7	4.8	9.2	12
Highest At-211 Production (mCi)	24 ± 2	47 ± 5	60 ± 6	100 ± 10

Target Extraction

- Air Monitoring System
- Automated System in Development

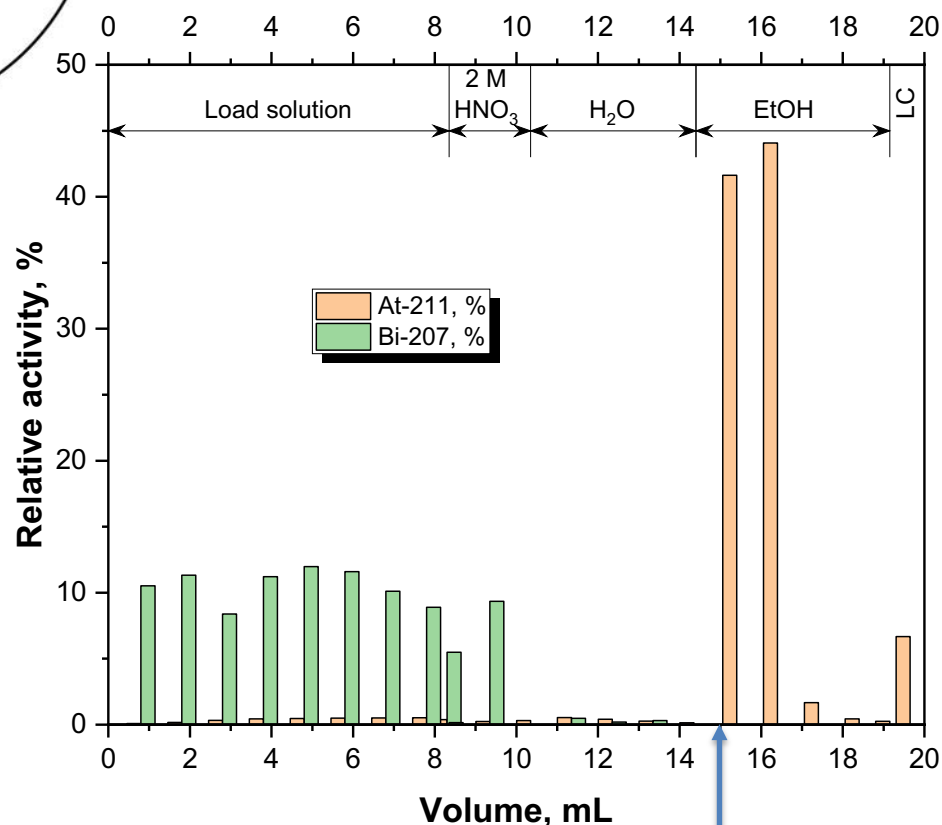
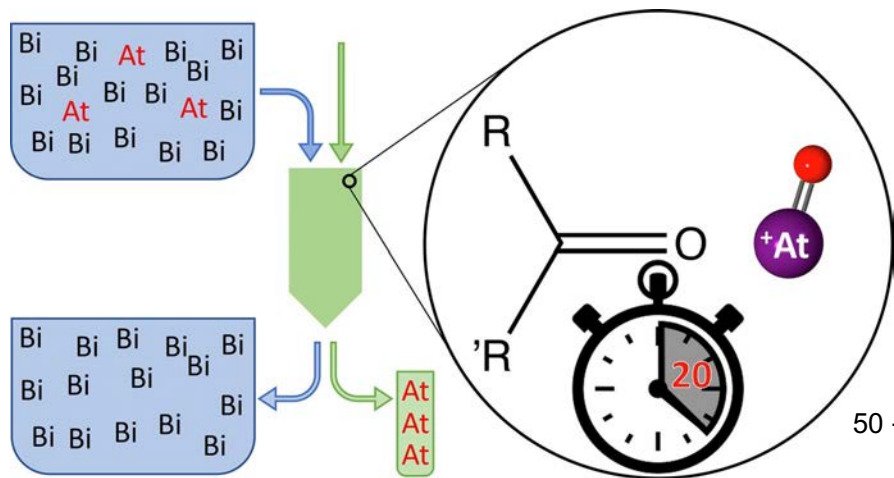


Automated system

Pending patent PCT/US21/63241

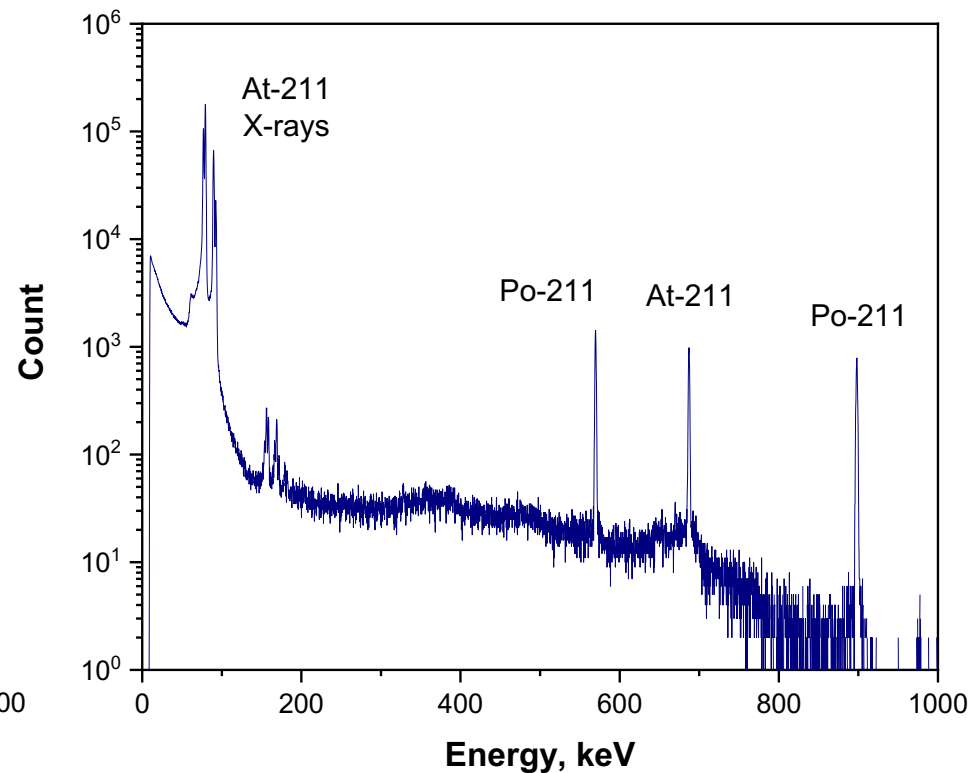
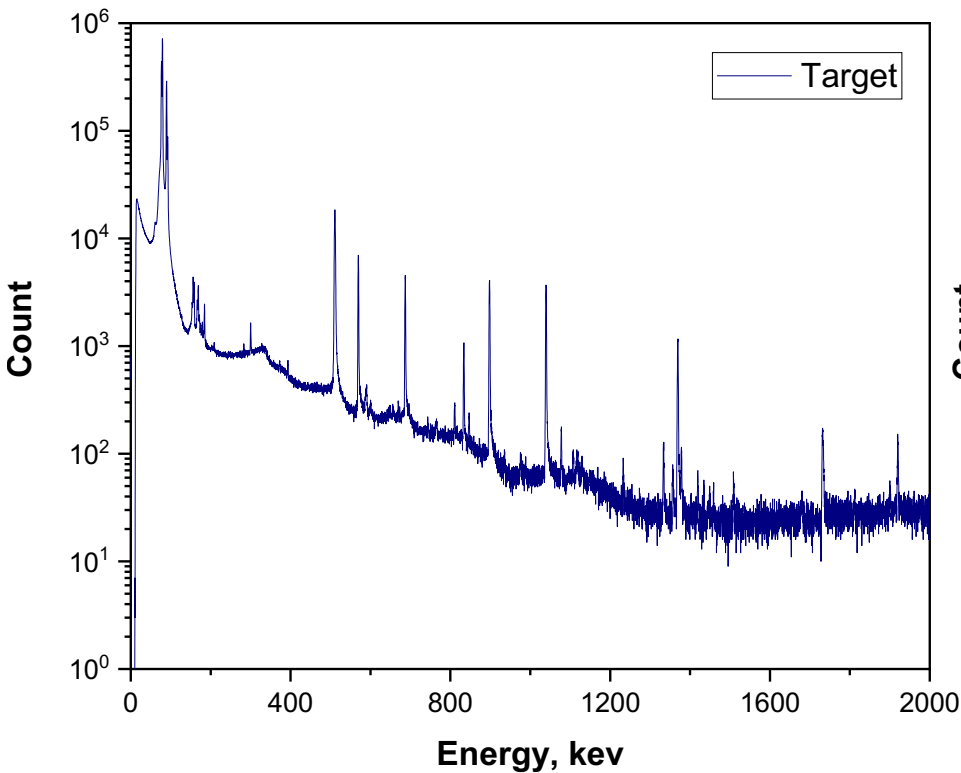


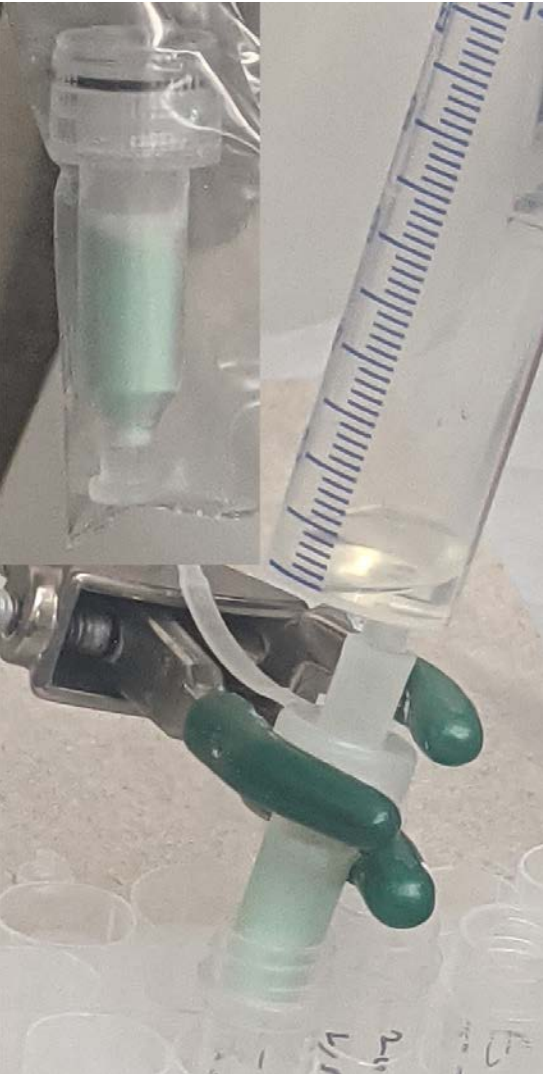
Column Chemistry



J. D. Burns *et al.*,
*Separation and
Purification
Technology*, **256**,
117794 (2021).

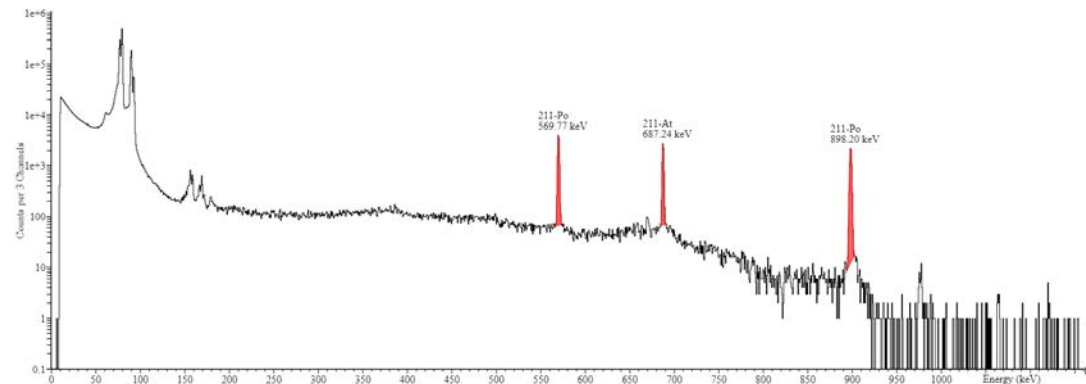
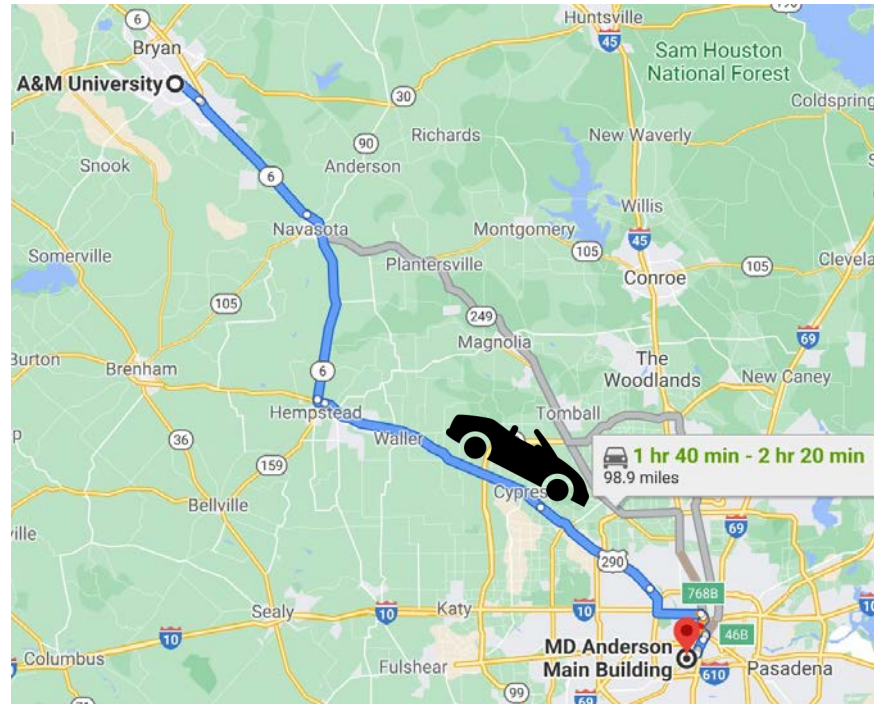
HPGe spectra





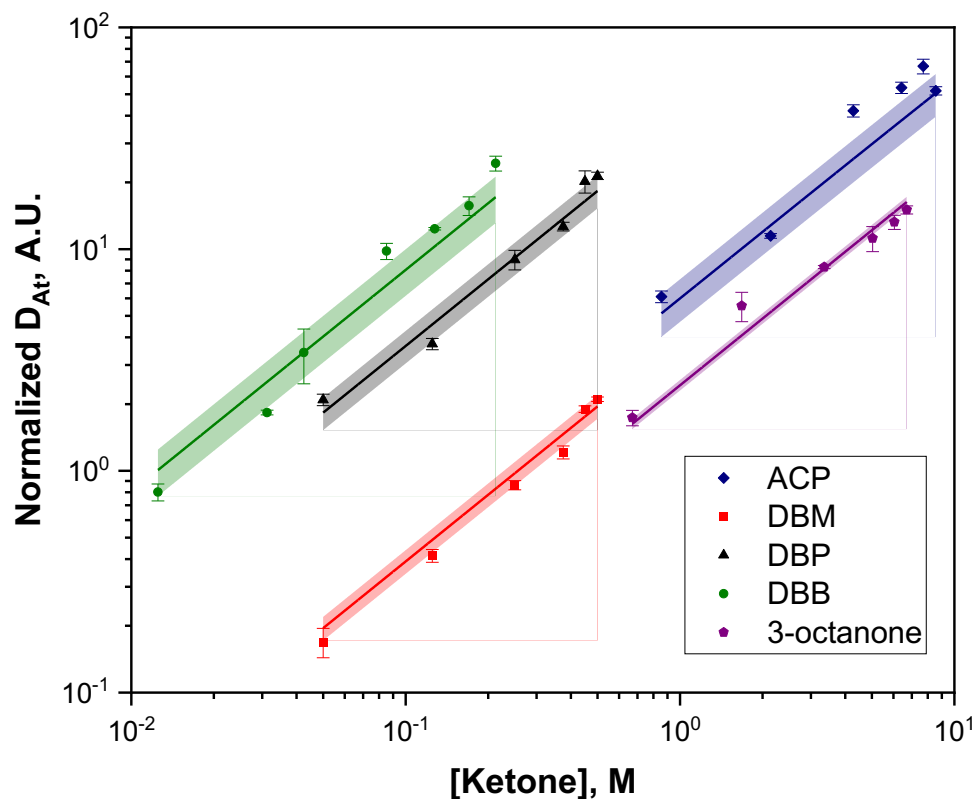
10 mCi: 2 days of
fundamental
radiochemistry

THE UNIVERSITY OF TEXAS MD Anderson ~~Cancer~~ Center

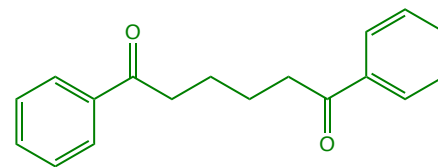


^{211}At Extraction Speciation

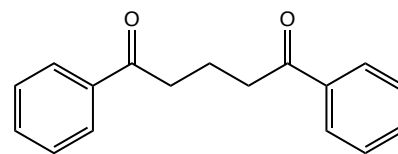
15



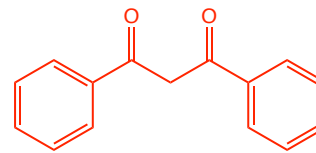
Burns, J. D. et al. *Inorg. Chem.* **2022**, 61 (31), 12087-12096.



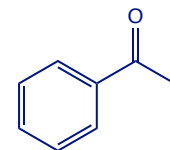
1,4-Dibenzoylbutane



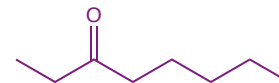
1,3-Dibenzoylpropane



Dibenzoylmethane



acetophenone

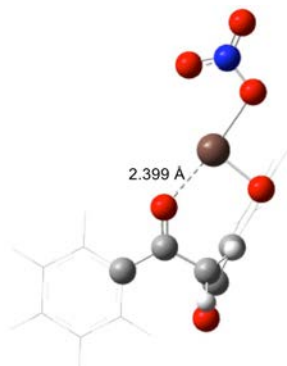
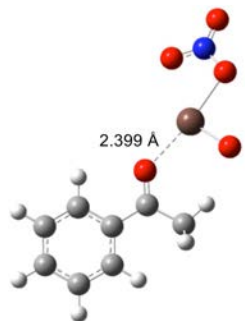


3-octanone

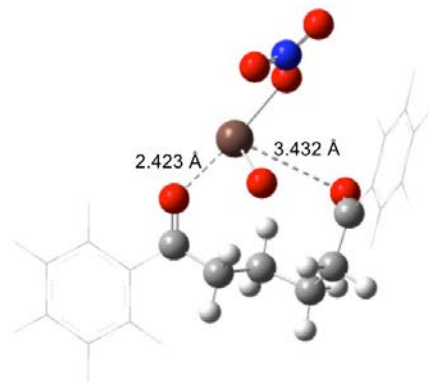
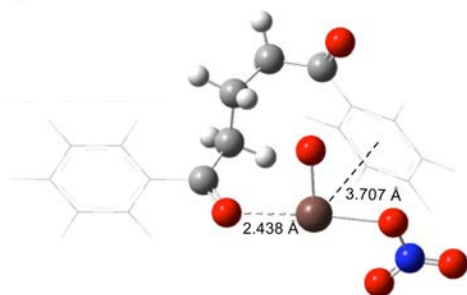
^{211}At Extraction Speciation Cont.

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Monodentate



Bidentate



Solvent	Mode	$\Delta G(\text{sol}) / \text{kcal} \cdot \text{mol}^{-1}$	$E_d / \text{kcal} \cdot \text{mol}^{-1}$
3-octanone	Mono	-11.91	4.21
acetophenone	Mono	-13.56	1.00
dibenzoylmethane	Mono	-12.06	3.23
1,3-dibenzoylpropane	Mono	-15.58	0.71
	Bi O O	-11.27	4.29
	Bi O phenyl	-14.32	7.99
1,4-dibenzoylbutane	Mono	-11.58	3.20
	Bi O O	-19.04	4.52
	Bi O phenyl	-17.86	4.39

Burns, J. D. et al. *Inorg. Chem.* **2022**, 61 (31), 12087-12096.

Summary

- Beam: Increased ^{211}At production capability.
- Targets: Automated system underway.
- Bi/At Separation: Automated system!
- Shipping: Successfully shipped to MD Anderson.
- Fundamental Chemistry: Oxidation state studies & ligand exchange experiments ongoing.
- Availability: In the future, through NIDC

At-211 Team



Jon Burns (now UAB)
Brooklyn Green (UG)
Noimat Jinadu (GS-
UAB)
Michael Jones (UG-
UAB)
Laura McCann (GS)
Gabriela Picayo (PD)
Steve Schultz (GS)
David Thomas (UG)
Alex Tabacaru (UG)
Gabriel Tabacaru
Evgeny Tereshatov
Sherry Yennello

Operations:
Dan Menchaca (RSO)
Brian Roeder (AP)

Acknowledgments

- Other TAMU personnel: A. Abbott, K. Hagel, T. Hankins, A. Hannaman, B. Harvey, A.B. McIntosh, R. Rider, M. Sorensen, Z. Tobin
- Cyclotron Operations & Rad Safety Staff
- Texas A&M University System National Laboratories Office
- Los Alamos National Laboratory
- Isotope Program: DE-SC0020958
- DOE: DE-FG02-93ER40773
- NNSA Grant: NA-DE0003841 (L.A. McIntosh)
- Bright Chair at TAMU
- TAMU Nuclear Solutions Institute
- NSF GRFP (L. McCann)



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U.S. DEPARTMENT OF
ENERGY

Office of
Science



TEXAS A&M UNIVERSITY

Cyclotron Institute

Join Our Team!!

- Radiochemistry Postdoc Position

- Investigate At-211 Chemistry
- Interface with TAMU Inorganic Chemists & other collaborators
- Flexible Research Time

- HIPPO Opportunities for Undergraduate Students

- Research in Isotope Production at 17 different U.S. Institutions
- Network with the Isotope Production Community

Contact: lmcintosh@tamu.edu

Questions?

