TEXAS A&M UNIVERSITY
Cyclotron Institute

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

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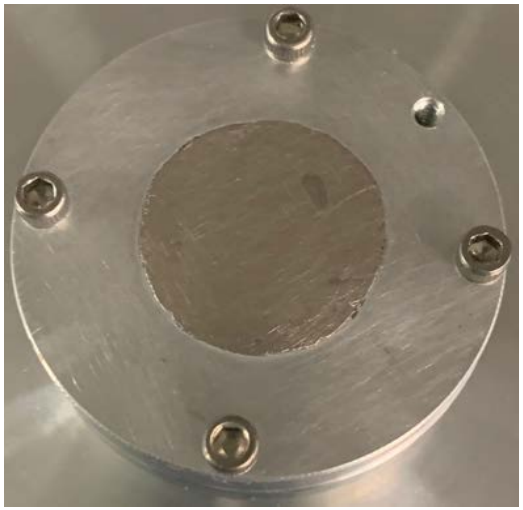
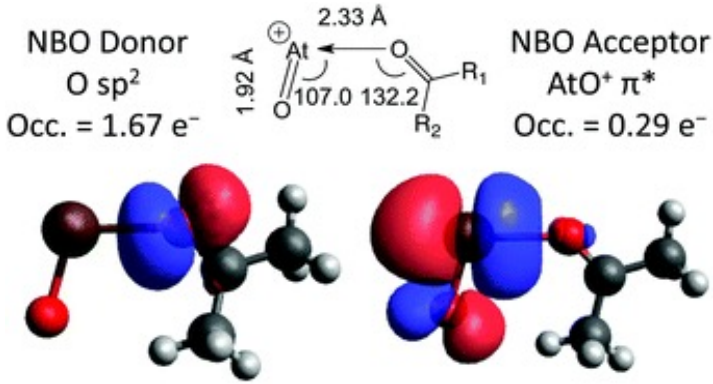
New since 2020

- Beam Development
  - Higher Current (over 8 uA overnight)
  - Stability
- Target Development
  - Thinner, Less Bismuth, Ultrasonic Soldering Iron
  - 90º from beam, Directly Cooling Back
- Target Extraction:
  - Air monitoring system
- Dissolution & Separation:
  - Column can capture ~95% of astatine activity from >50mCi dissolved activity
  - 86% of the captured activity eluted in 1st 2 mL EtOH strip

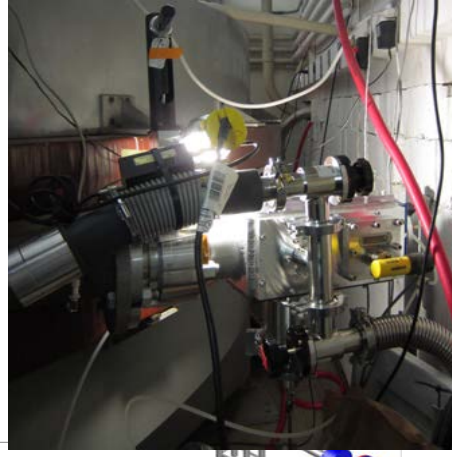


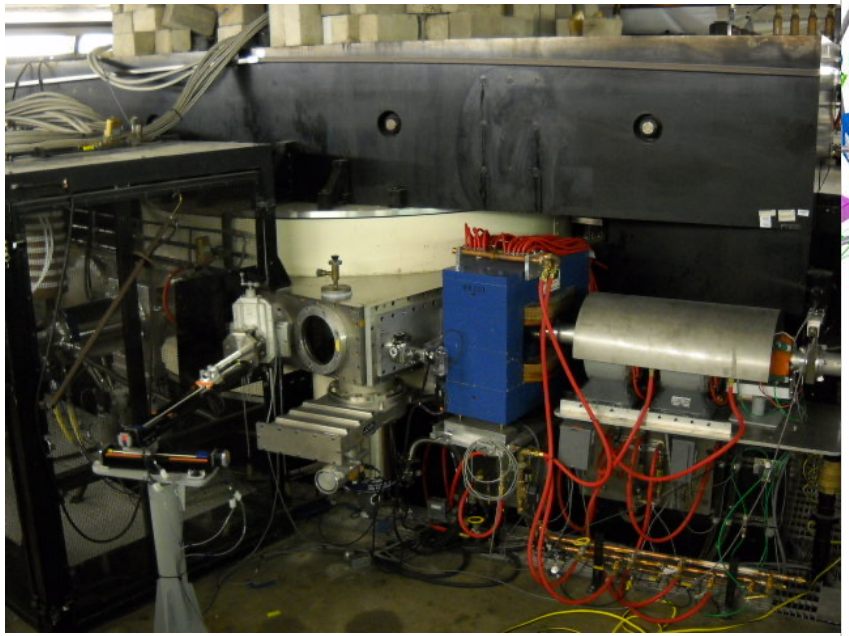


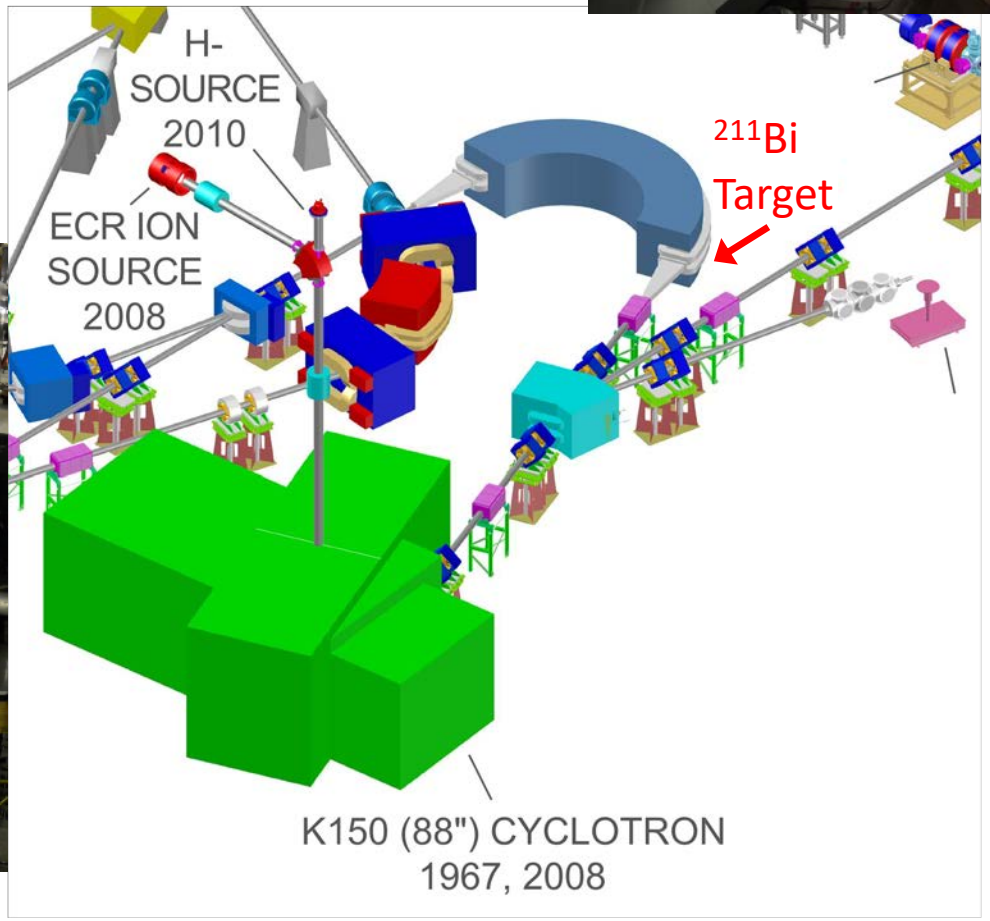
J. D. Burns, et al., Chem. Commun., 2020, **56**, 9004-9007.

K150 Cyclotron

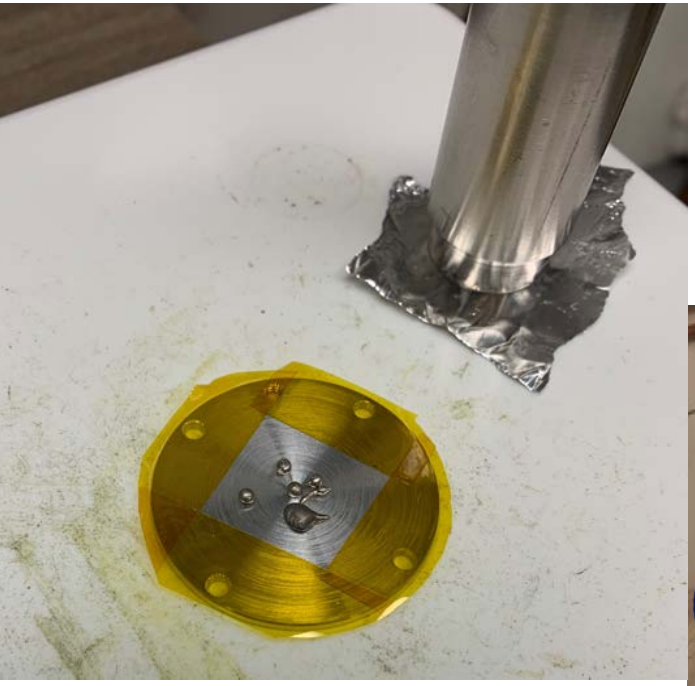
- $^{209}Bi + \alpha \rightarrow {}^{211}At + 2n$
- Energy: 28.8 MeV
- +1 charge state



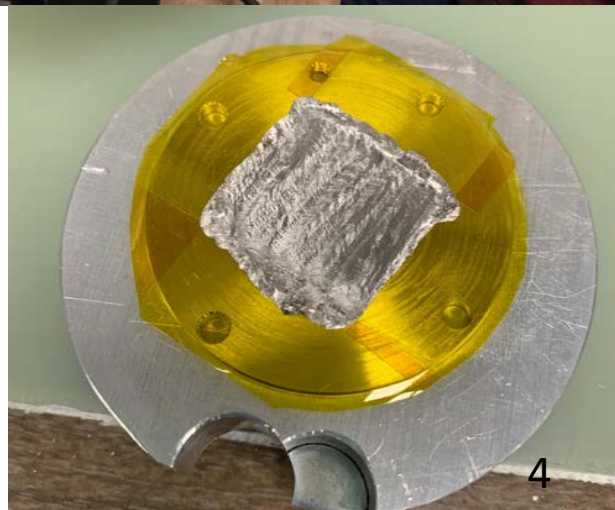




Bi-209 Targets



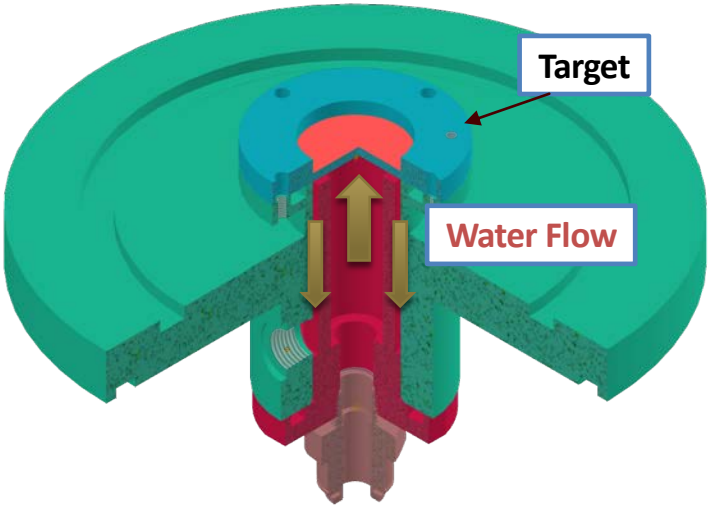
- Bi pellets
- Hot plate
- Ultrasonic soldering iron

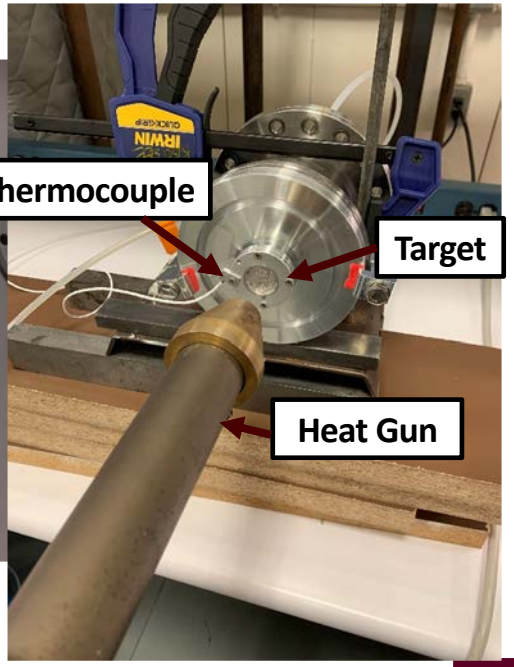


Target Apparatus

Water directly on target

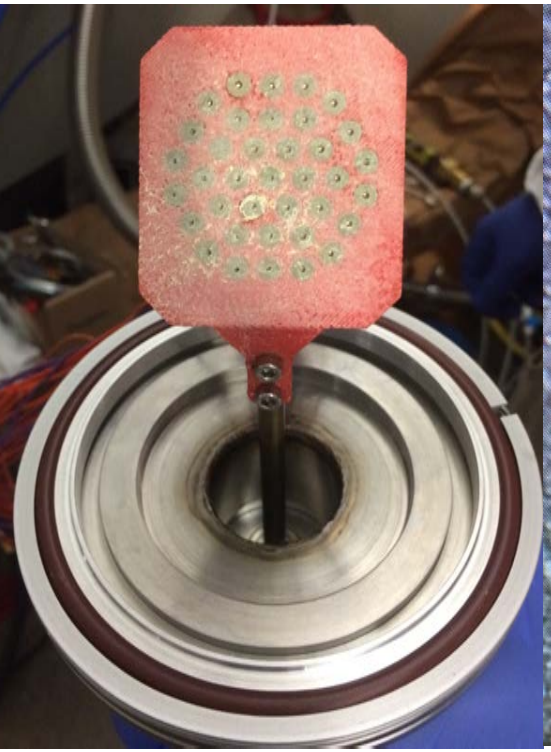
Tested with an industrial heat gun and thermocouple

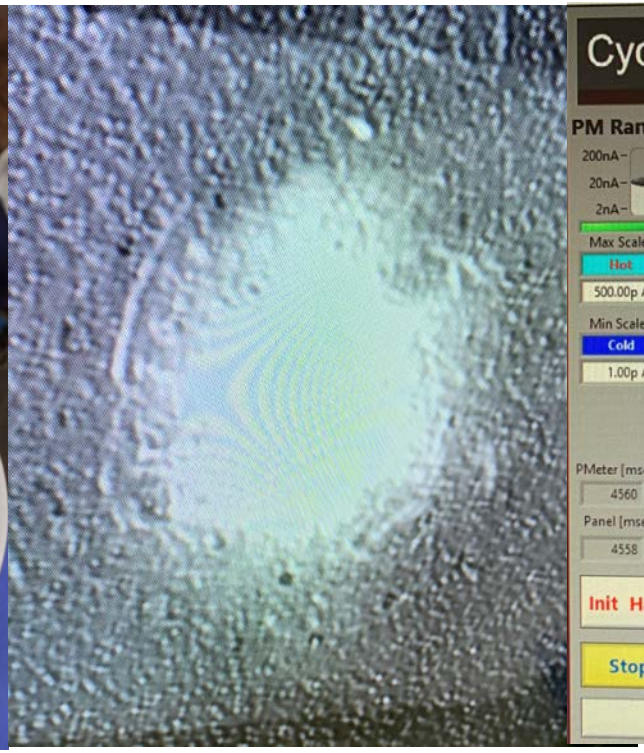


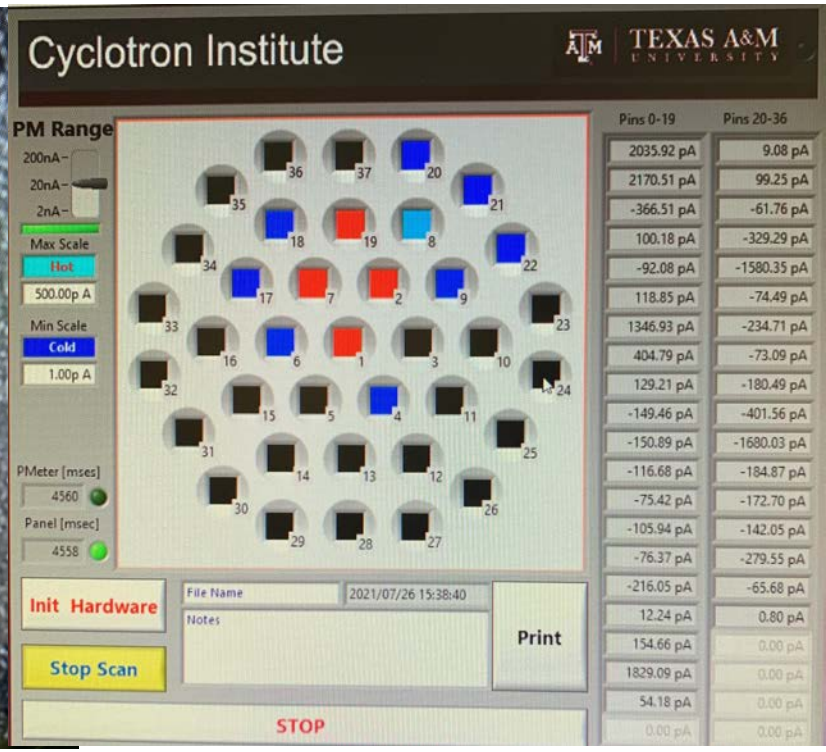


Beam Uniformity

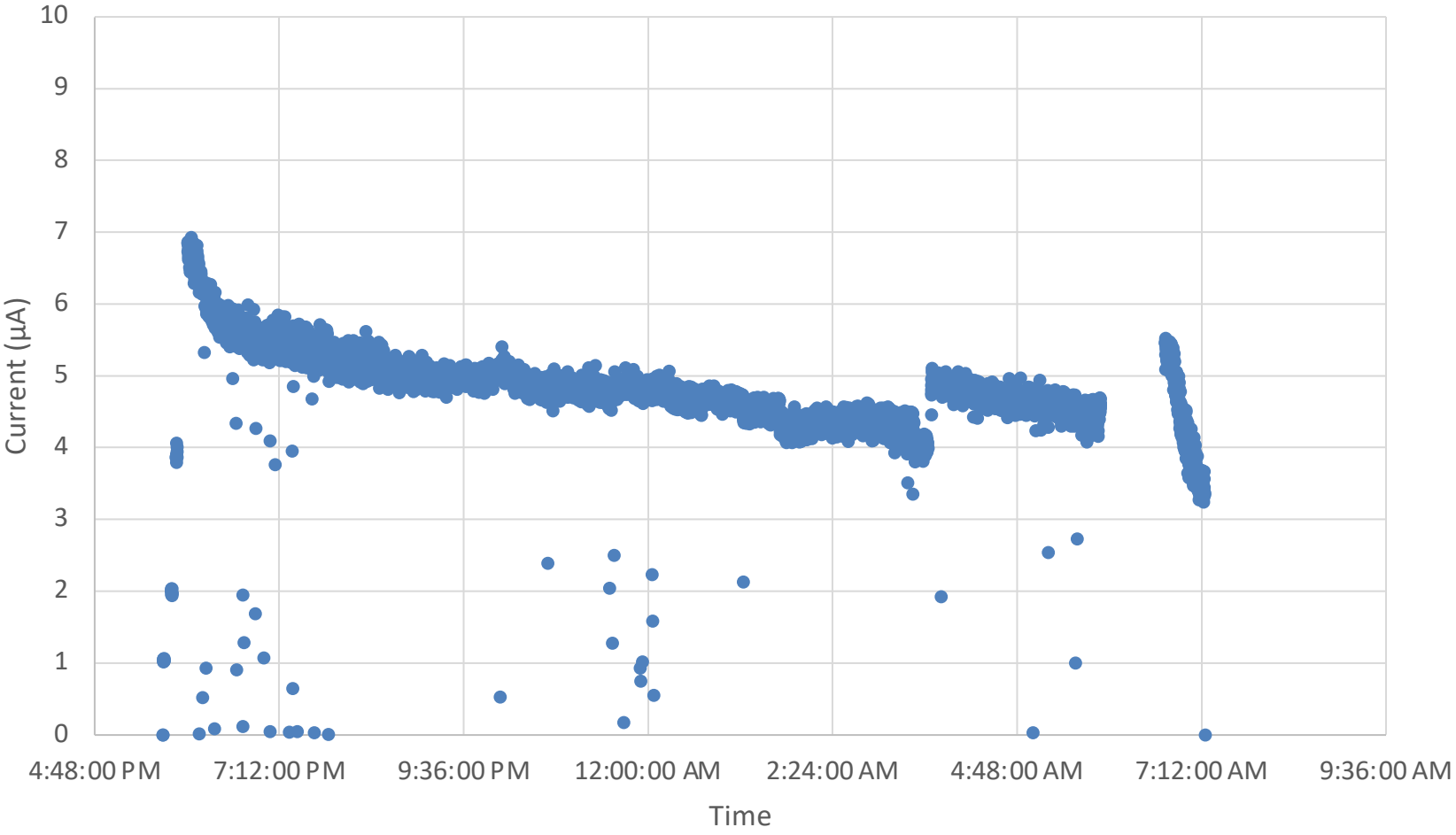
- 37 Faraday Cups
- 5 s read time



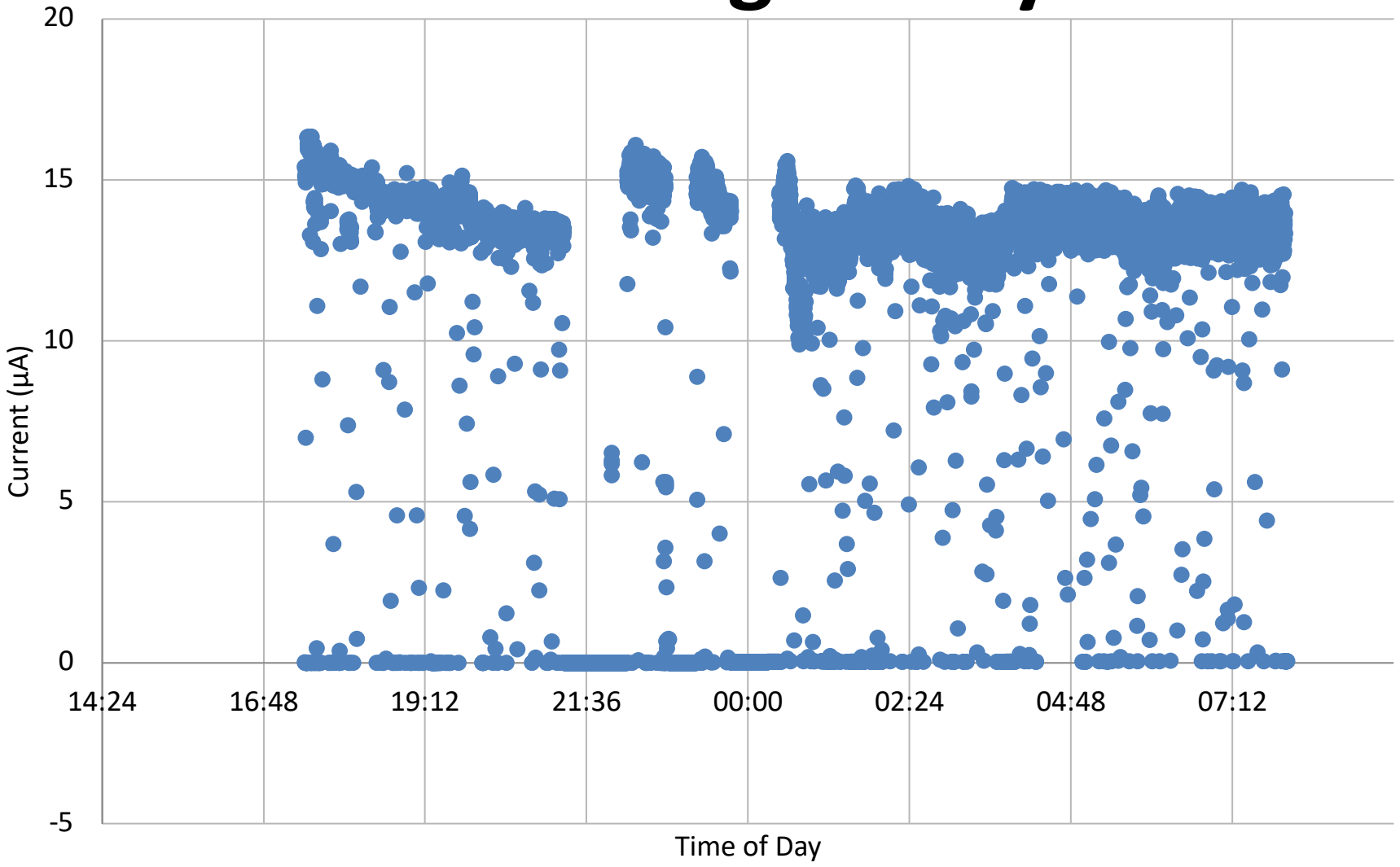




Current on Target: Dec 2020

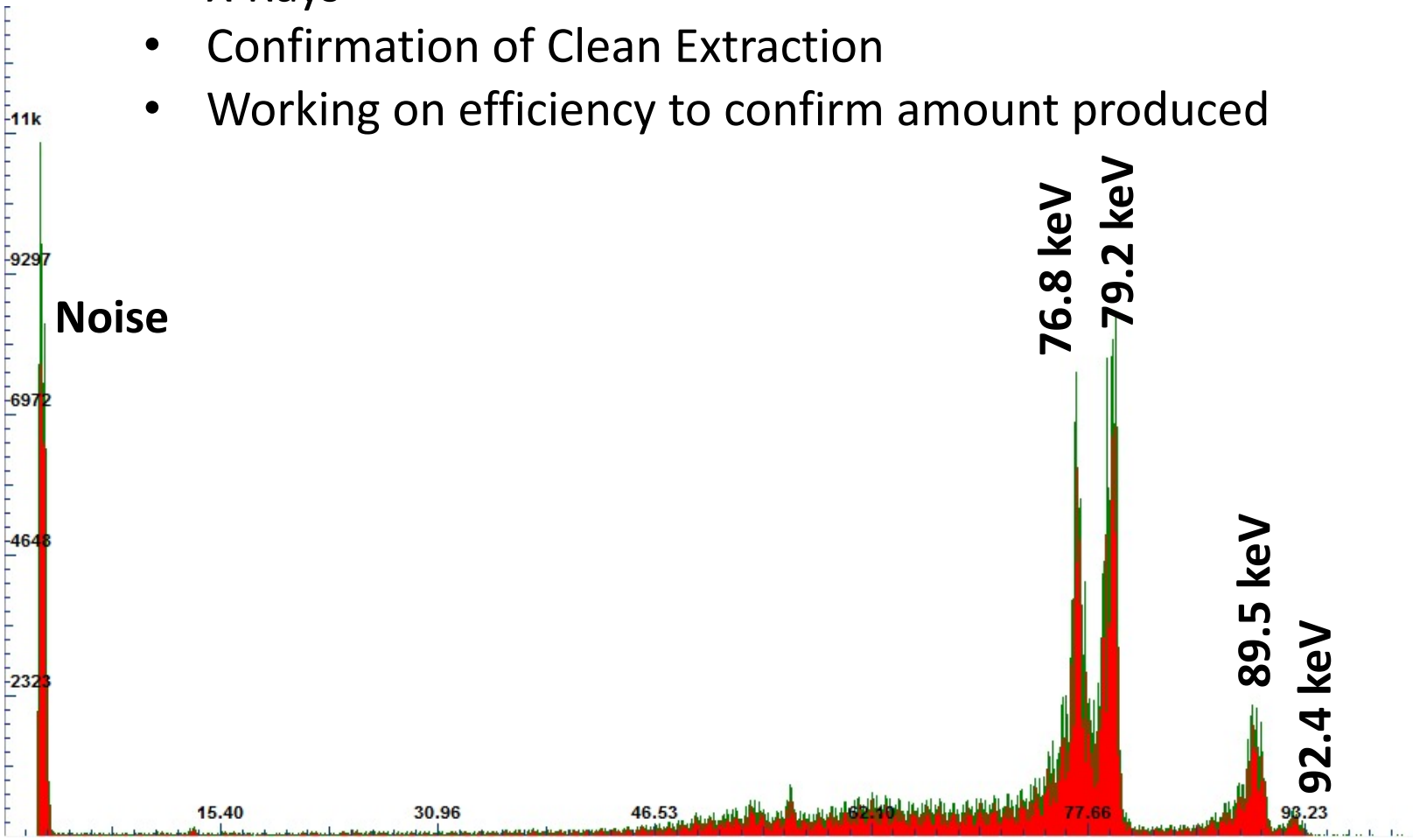


Current on Target: July 2021



CdTe Detector

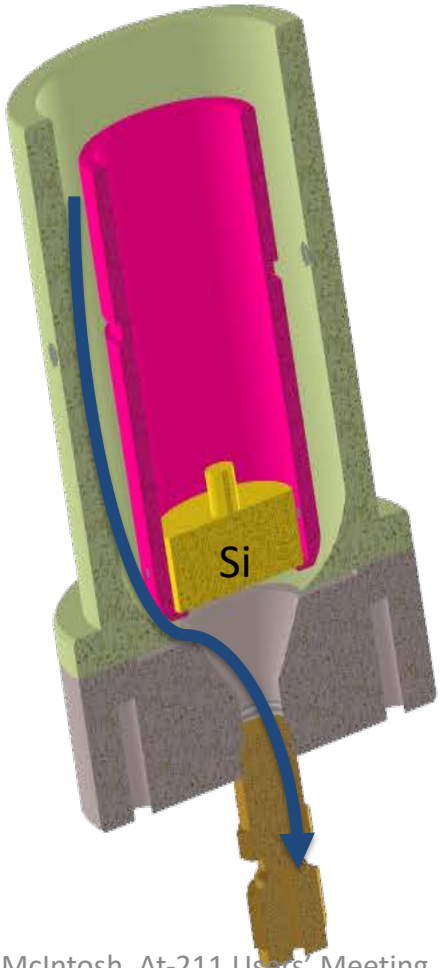
- X-Rays
- Confirmation of Clean Extraction
- Working on efficiency to confirm amount produced



End of Beam (EOB) ~20 min

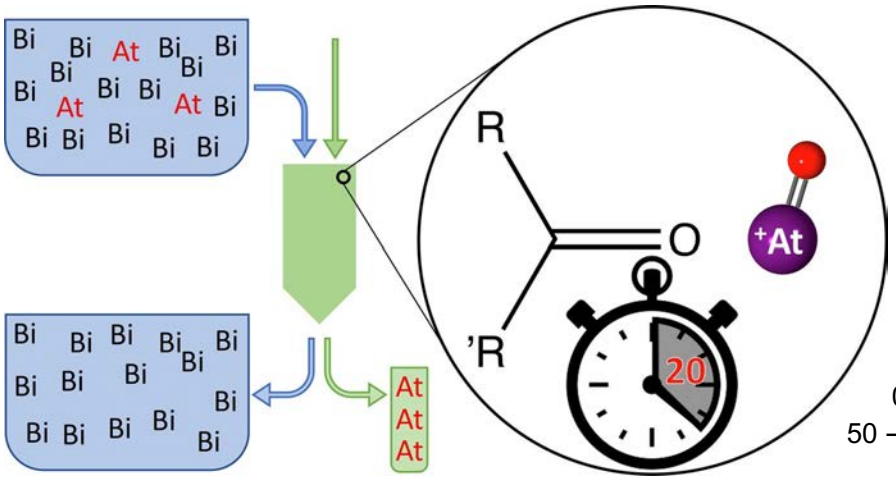
Target Extraction

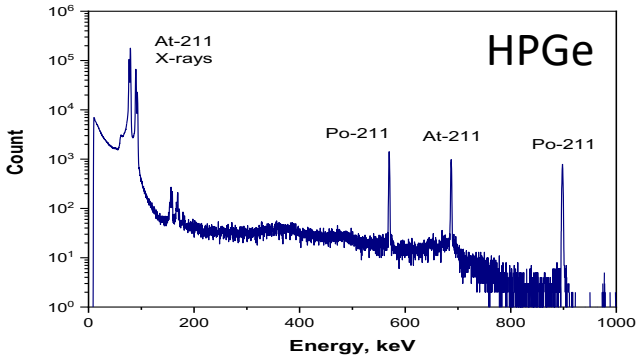
- ALARA
- Air Monitoring System

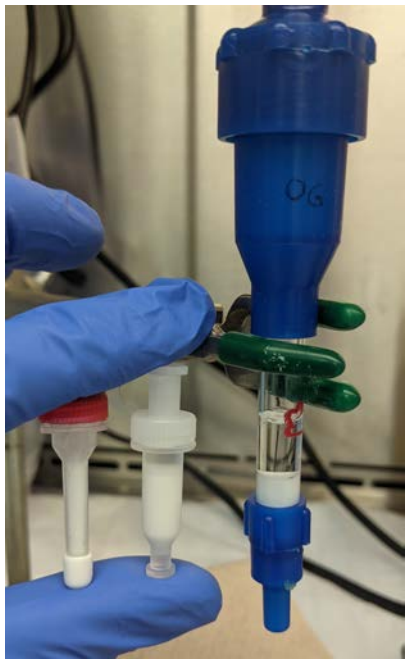


Irradiations	Highest Instantaneous Beam Current (pμA)	Average Beam Current (pμA)	Irradiation Length (h)	At-211 Activity at EoB (mCi)
December 2019	4.4	2.7	8	24 ± 2
March 2020	3.5	3.2	9	41 ± 3
June 2020	4.5	2.1 (Unstable)	9.4	8.0 ± 1.3
August 2020	2.6	2.4	9.6	21 ± 2
September 2020	7.4	5.1	7.3	22 ± 2
October 2020	5	4 .0	7.9	12 ± 1
November 2020	7.2	4.2	9.7	24 ± 2
December 2020	6.8	4.8	13.6	47 ± 5
April 2021	8.2	5.6	15.6	17 ± 5
May 2021	7.0	4.8	14.2	14 ± 1
June 2021 a	8.6	7.0	14.8	24 ± 2
June 2021 b	11.7	8.8	14.8	42 ± 4
July 2021 a	11.9	7.59	15	60 ± 6
July 2021 b	12.1	9.2	19.7	53 ± 5

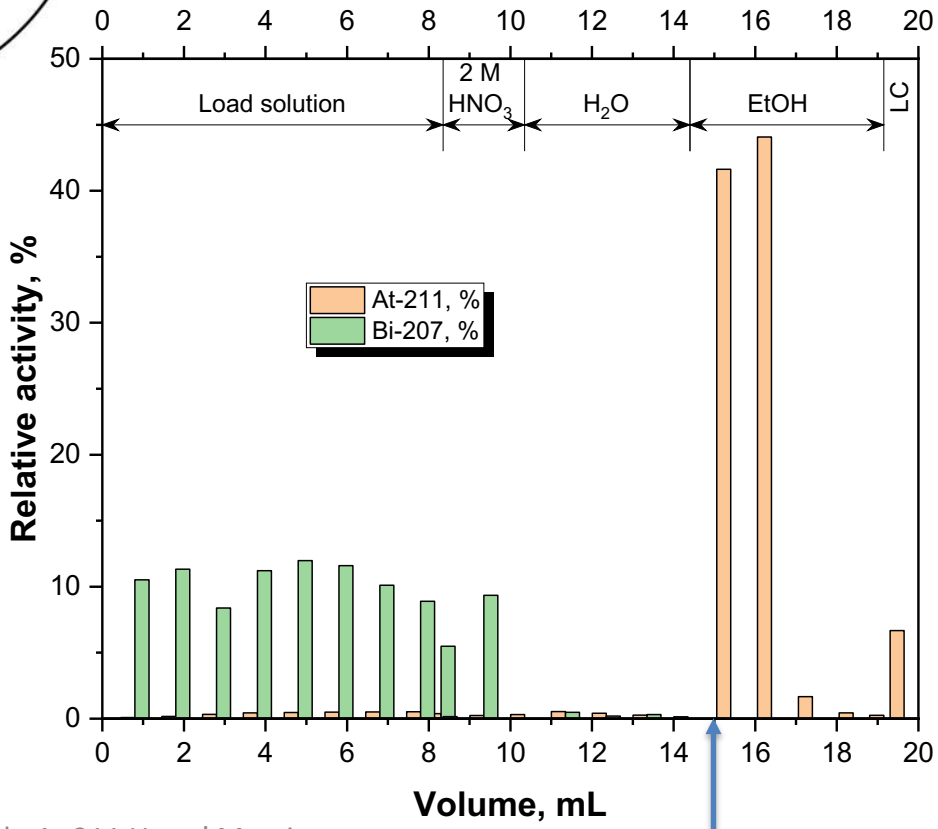
Column Chemistry





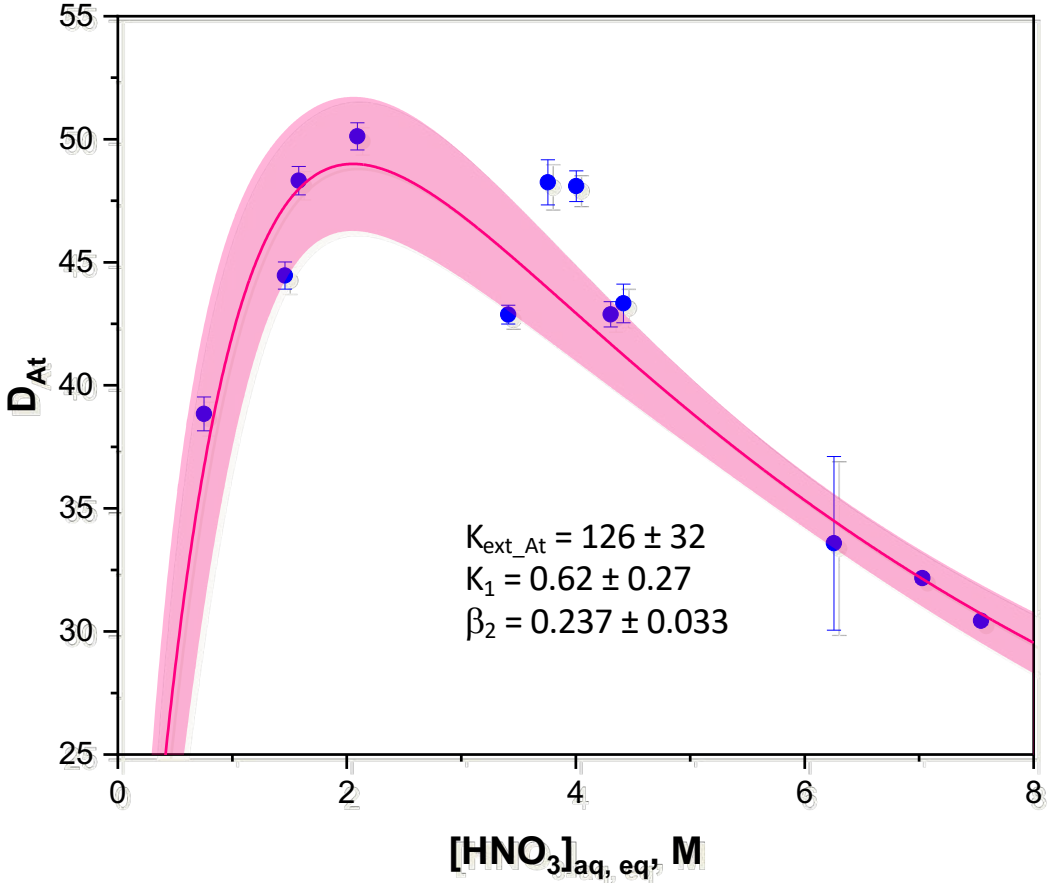


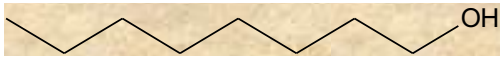
J. D. Burns *et al.*, *Separation and Purification Technology,* **256**, 117794 (2021).



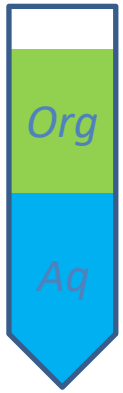
Column sat for 3.5 hours.

Continued studies of liquid-liquid astatine extraction





1-octanol



$D=C_{org}/C_{aq}$

Summary

- **Beam and Targets:** Approximately doubled ^{211}At production capability in the past year.
- **Separation:** Column extracts At-211 from Bi quickly, automated system underway.
- **Shipping:** Successfully shipped to MD Anderson.
- **Fundamental Chemistry:** Oxidation state studies & ligand exchange experiments ongoing.
- **Availability:** In the future, through NIDC

TAMU At-211 Team

Jon Burns (now UAB)
Evgeny Tereshatov
Gabriel Tabacaru
Laura McCann (GS)
Kylie Lofton (UG)
Alex Tabacaru (UG)
Steve Schultz (GS)
Sherry Yennello

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

Acknowledgments

- Other TAMU personnel: A. Abbott, G. Avila, M. Berko, E. Engelthaler, K. Hagel, A. Hannaman, B. Harvey, A. Hood, M. McCarthy, A.B. McIntosh, M. Sorensen, Z. Tobin, A. Vonder Haar
- 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
- T3 Grant from TAMU
- TAMU Nuclear Solutions Institute
- NSF GRFP (L. McCann)

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Questions?