Automated Preparation of ^{211}At for Targeted Alpha Therapy Applications

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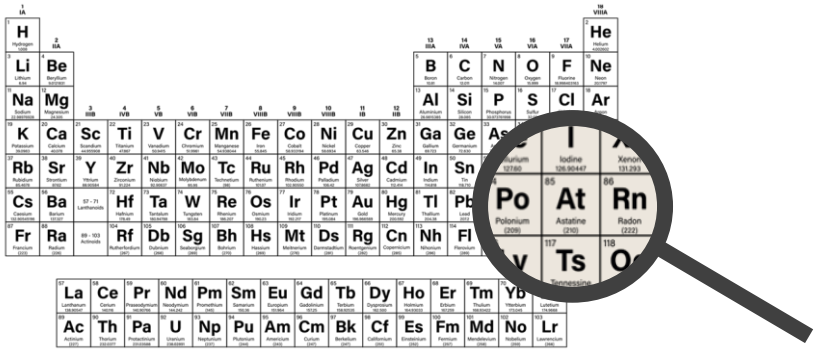
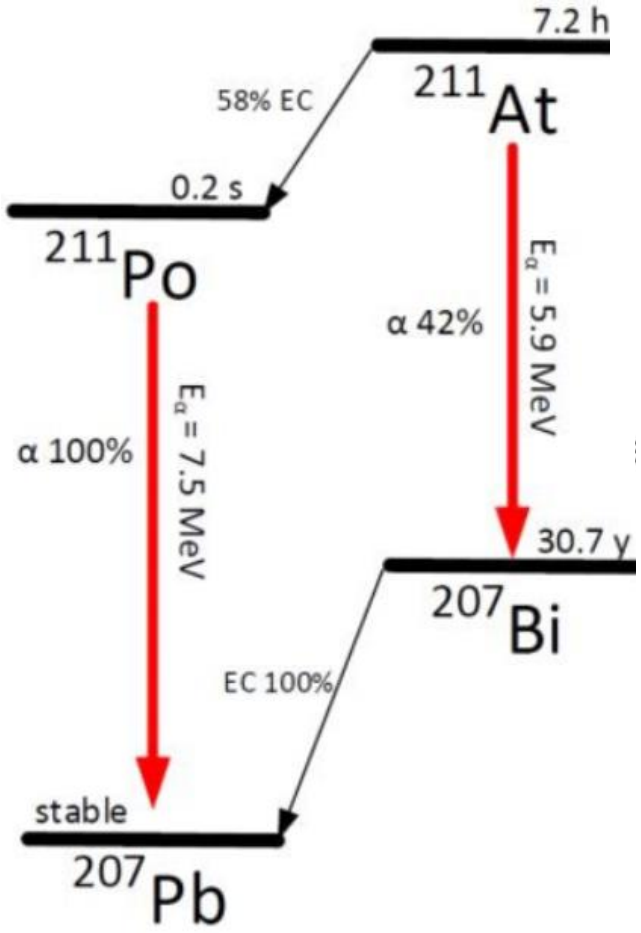
^{211}At





NIDC | NATIONAL ISOTOPE DEVELOPMENT CENTER

MANAGED BY THE U.S. DEPARTMENT OF ENERGY ISOTOPE PROGRAM

Present US cyclotrons capable of producing ^{211}At

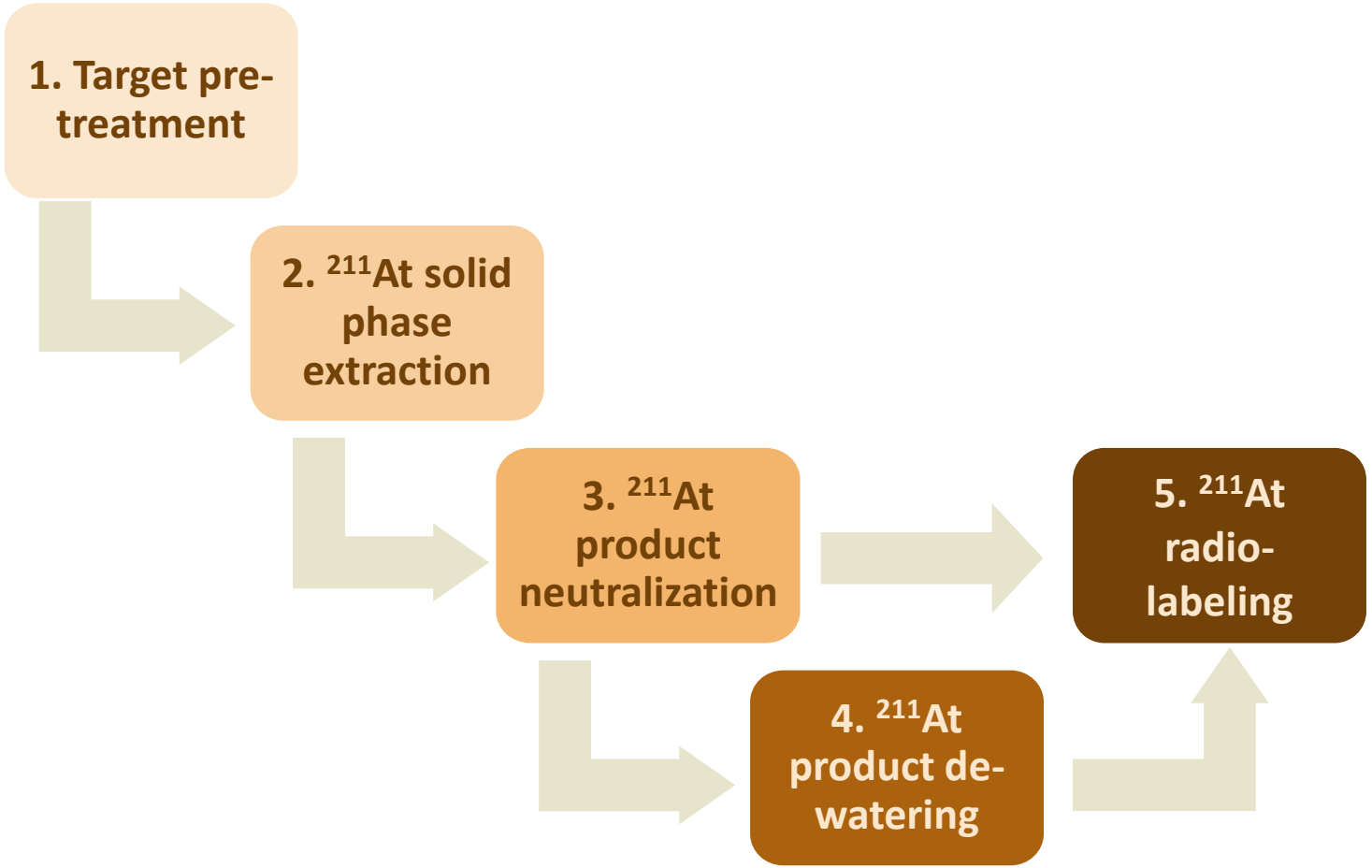
University of Washington
Texas A&M
Duke University
University of Michigan
Penn Medicine
Crocker Nuclear Laboratory, UC Davis
NIH – Bethesda

Objective

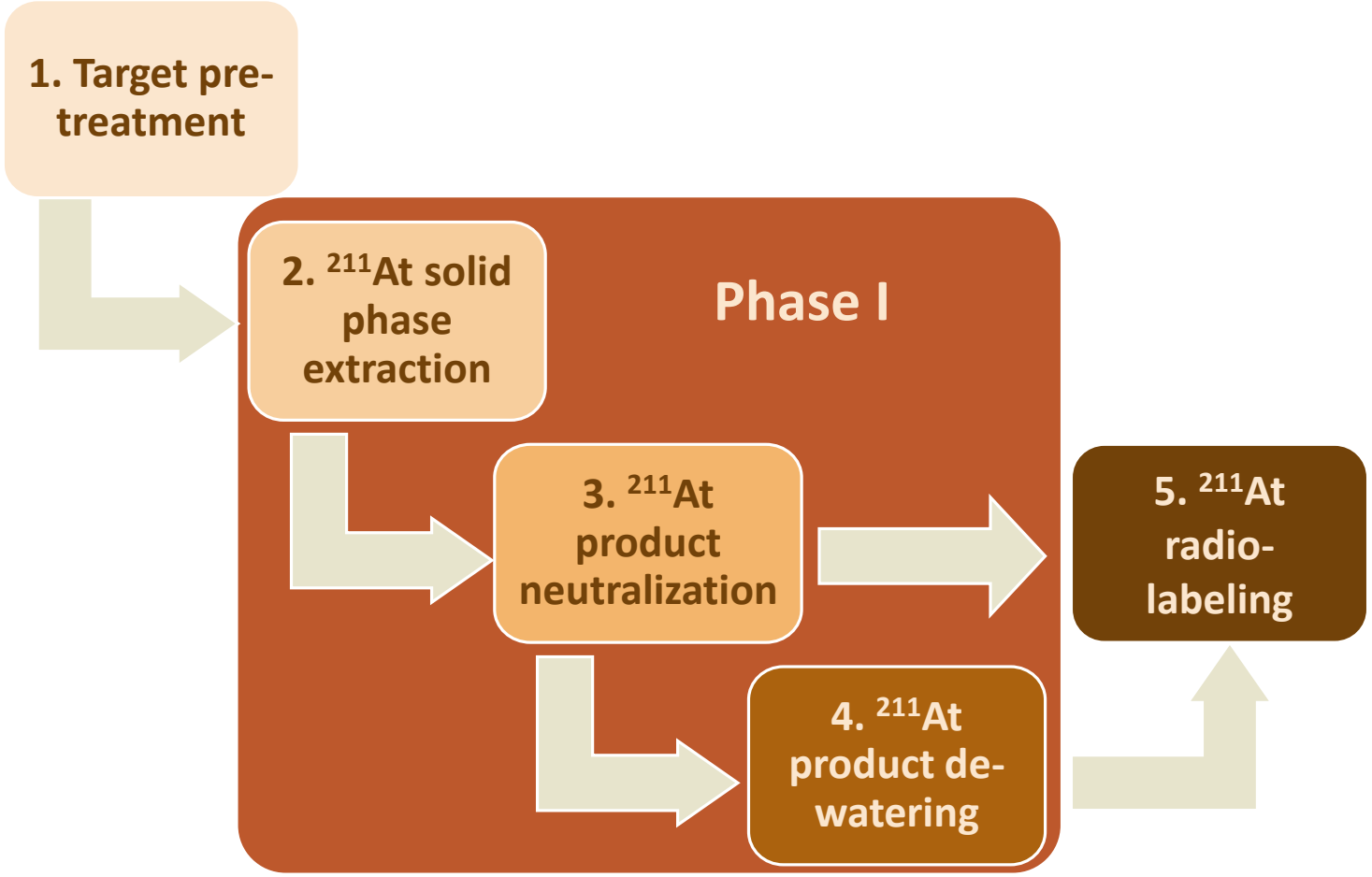
DOE Isotope Program primary goal - support research and development of methods and technologies that assure availability of critical radioisotopes.

Objective of this work – Develop a platform that will isolate both research and therapeutic quantities of ^{211}At in a rapid, automated, and safe manner

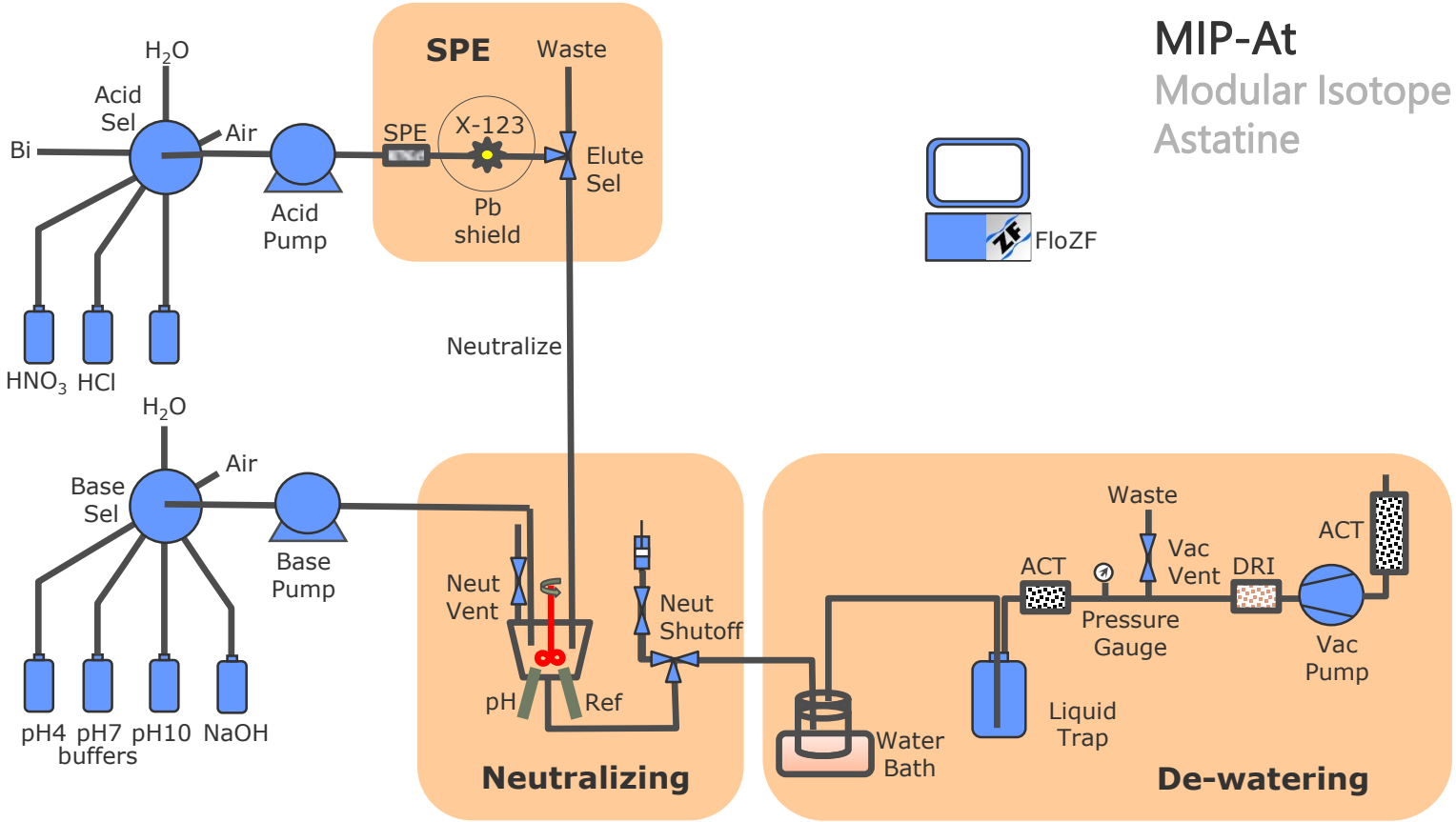
Purification scheme



Phase I


1. Target pre-treatment
Phase I
2. ^{211}At solid phase extraction
3. ^{211}At product neutralization
4. ^{211}At product de-watering
5. ^{211}At radio-labeling

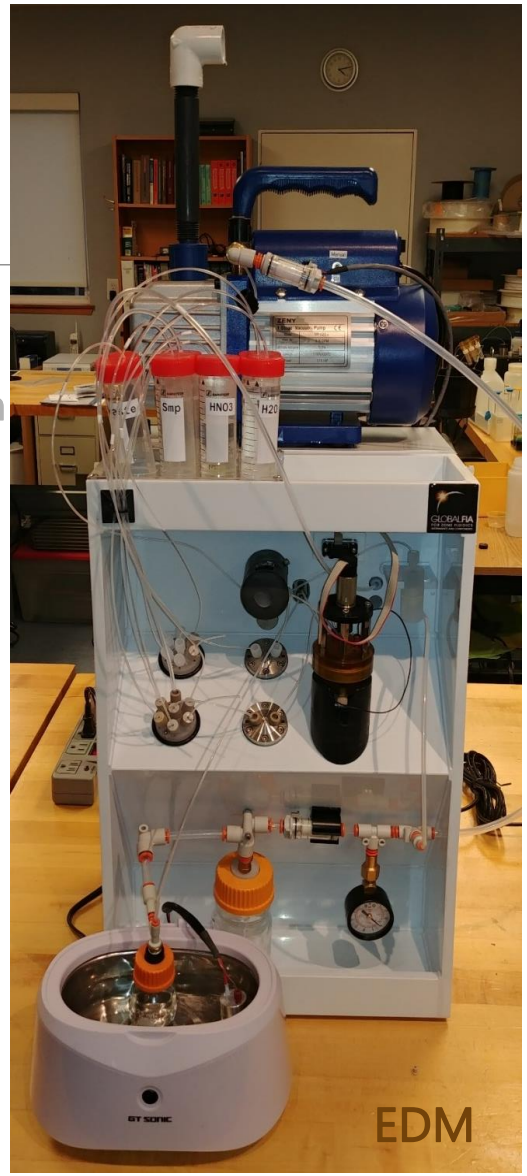
Engineering Development Model



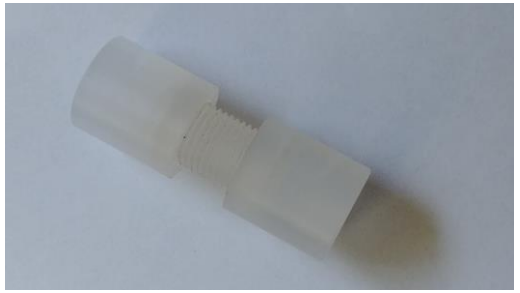
FloZF

MIP-At

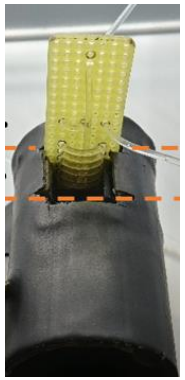
Modular Isotope Purification
Astatine



Solid Phase Extraction (SPE)

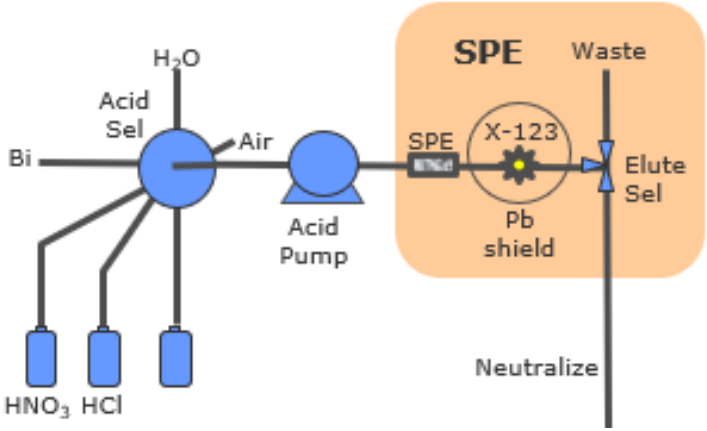


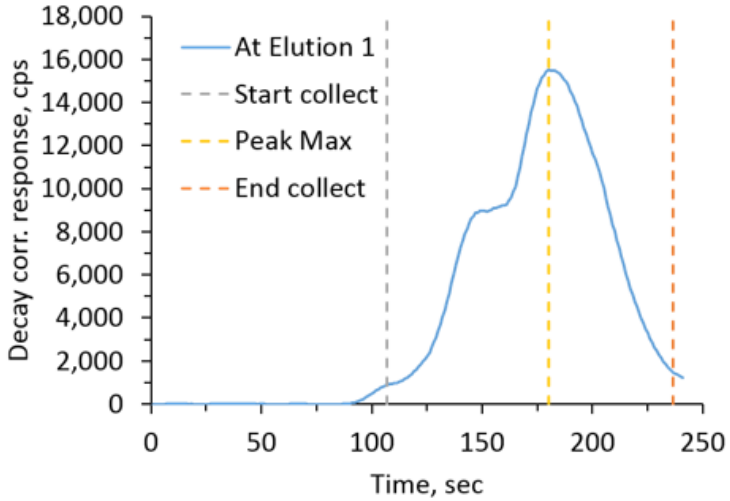
Column



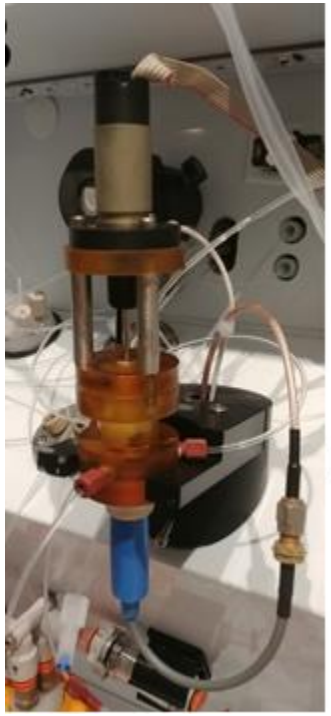
Detector & shielded flow cell

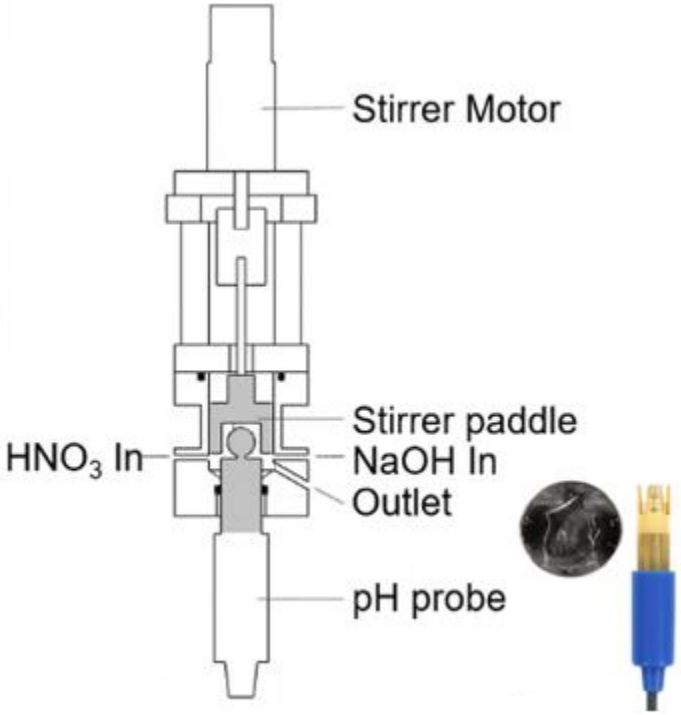
Solenoid Valve

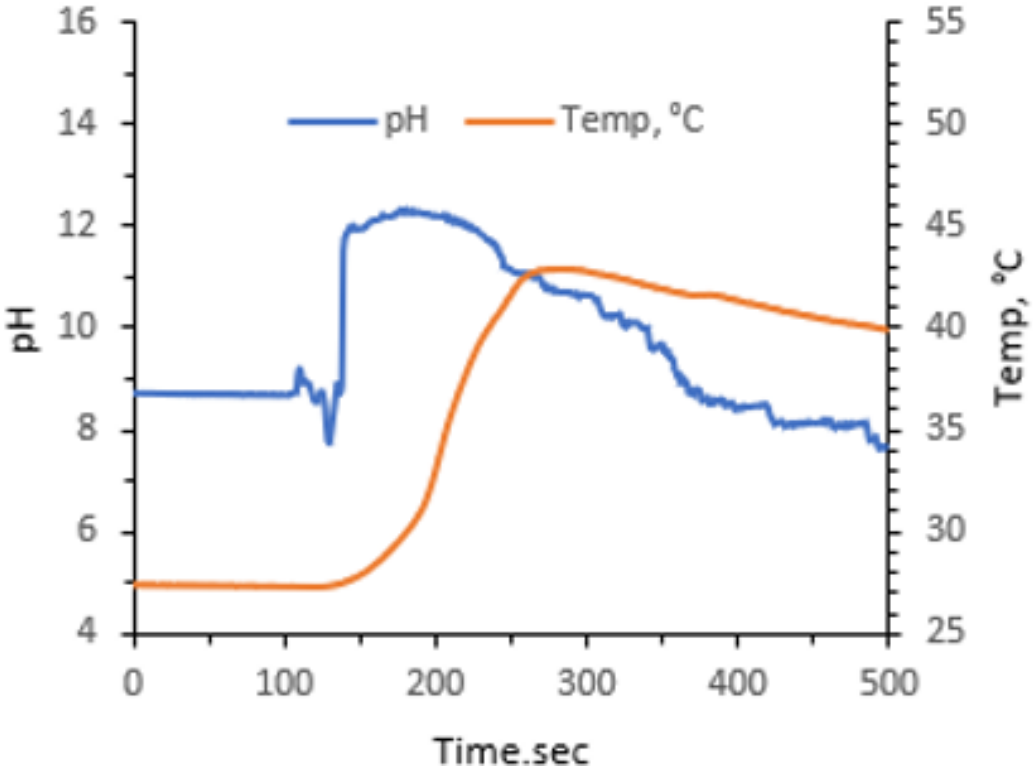




Neutralization

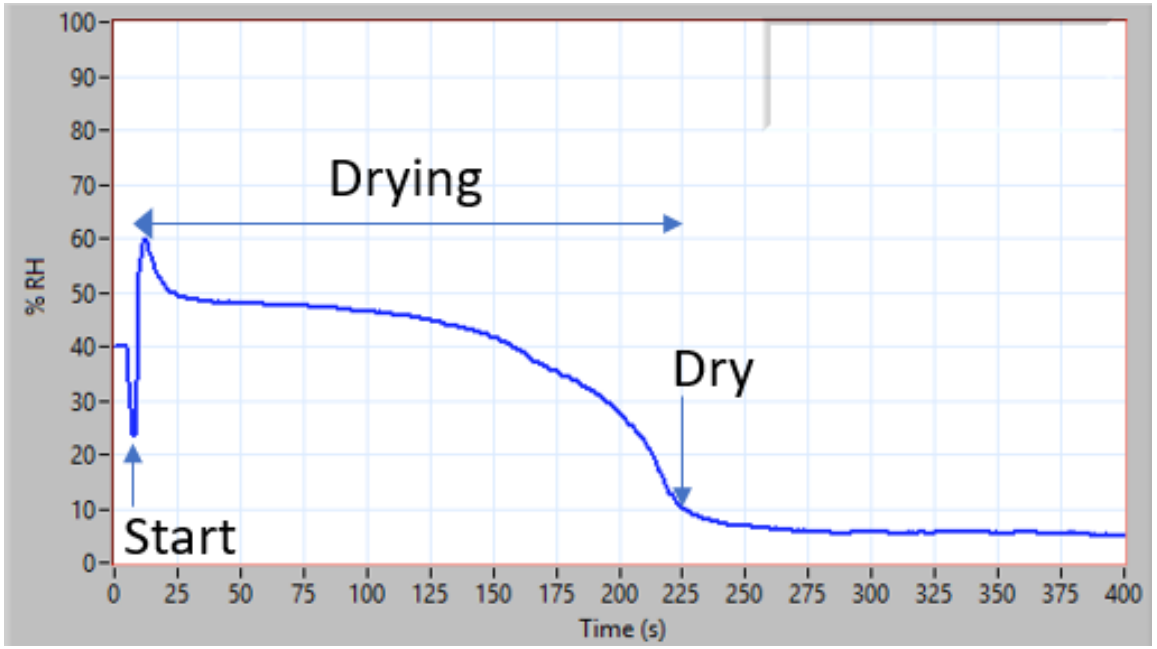




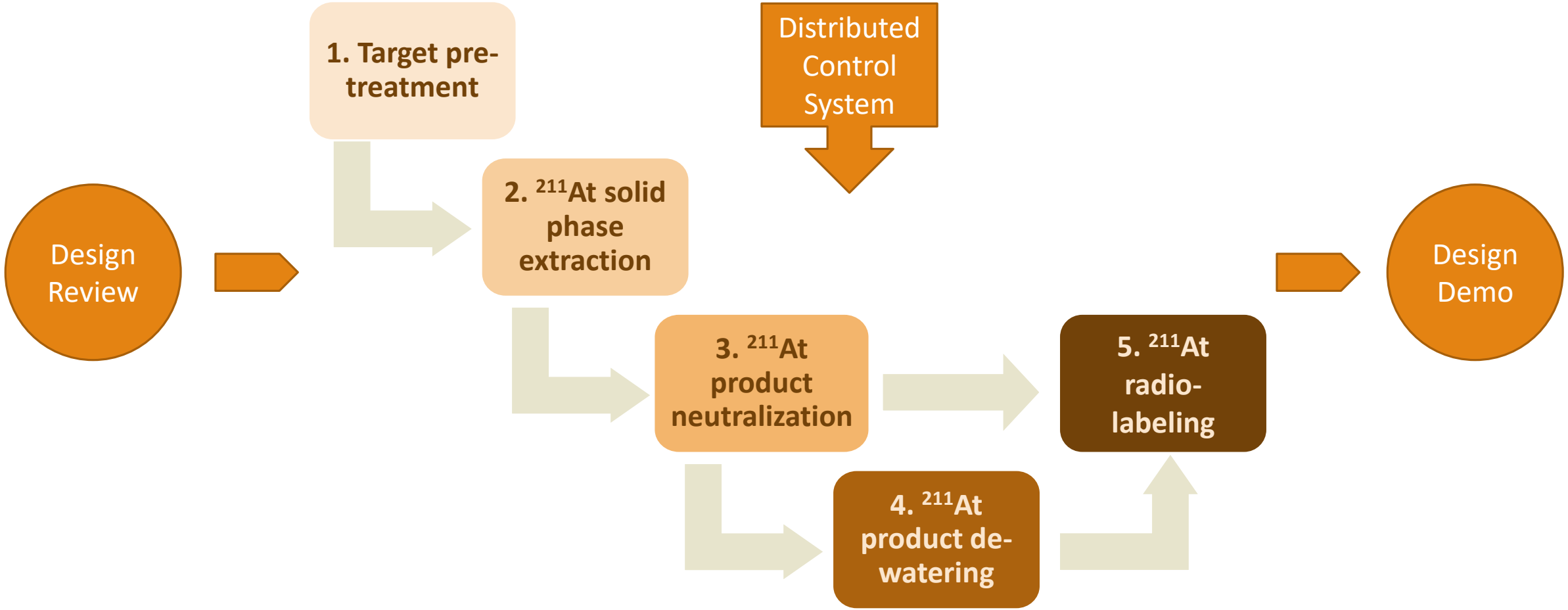


De-watering

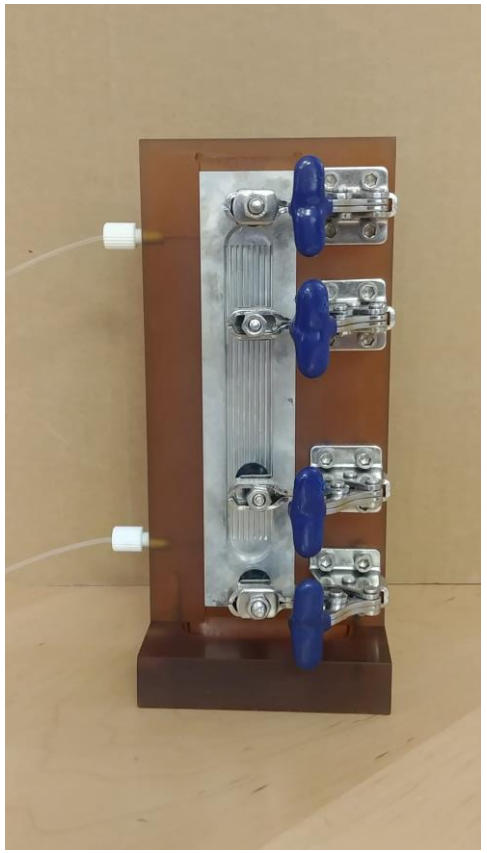
Experiment	1	2	3
With ^{211}At	No	No	Yes
Recovered salt			
Evaporation time, min	24	24	15
Vol of solution, mL	4	4	1.7

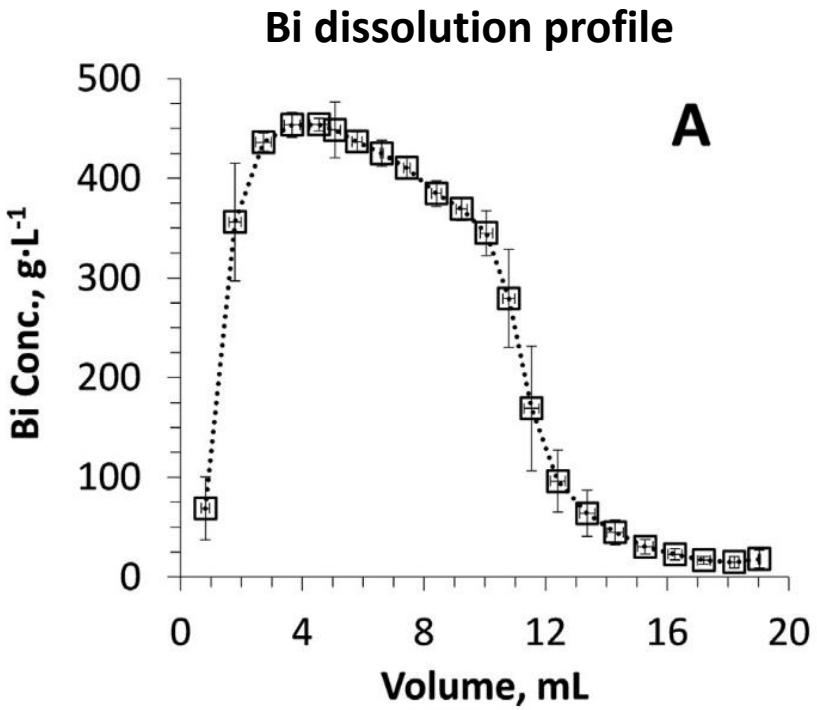


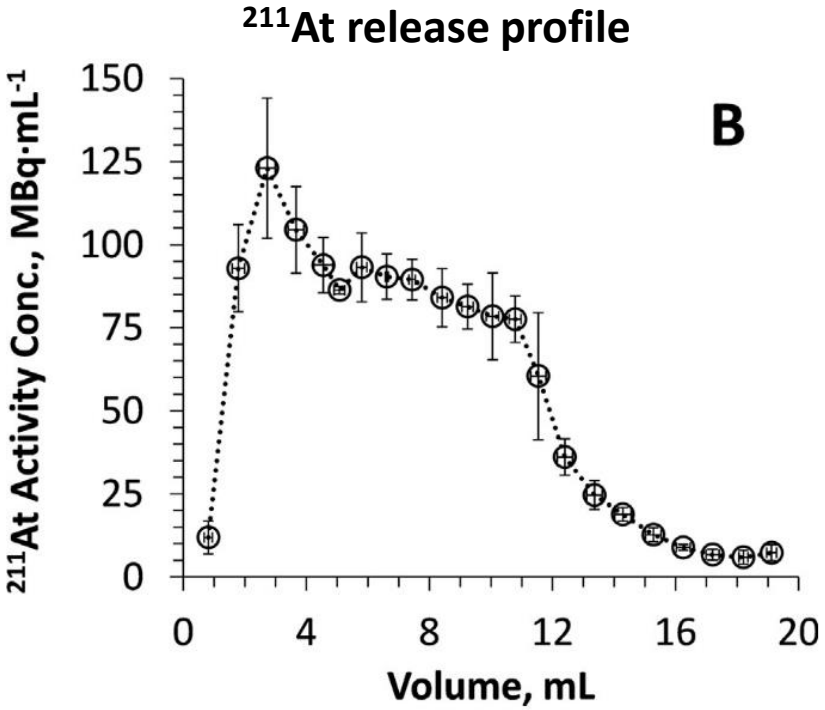
Phase II


Design Review
1. Target pre-treatment
2. ^{211}At solid phase extraction
Distributed Control System
3. ^{211}At product neutralization
4. ^{211}At product de-watering
5. ^{211}At radio-labeling
Design Demo

Target Dissolution







O'Hara, M. J., A. J. Krzysko, et. al. 2017. *Applied Radiation and Isotopes* **122**: 202-210.

Matrix Conversion & Solid Phase Extraction

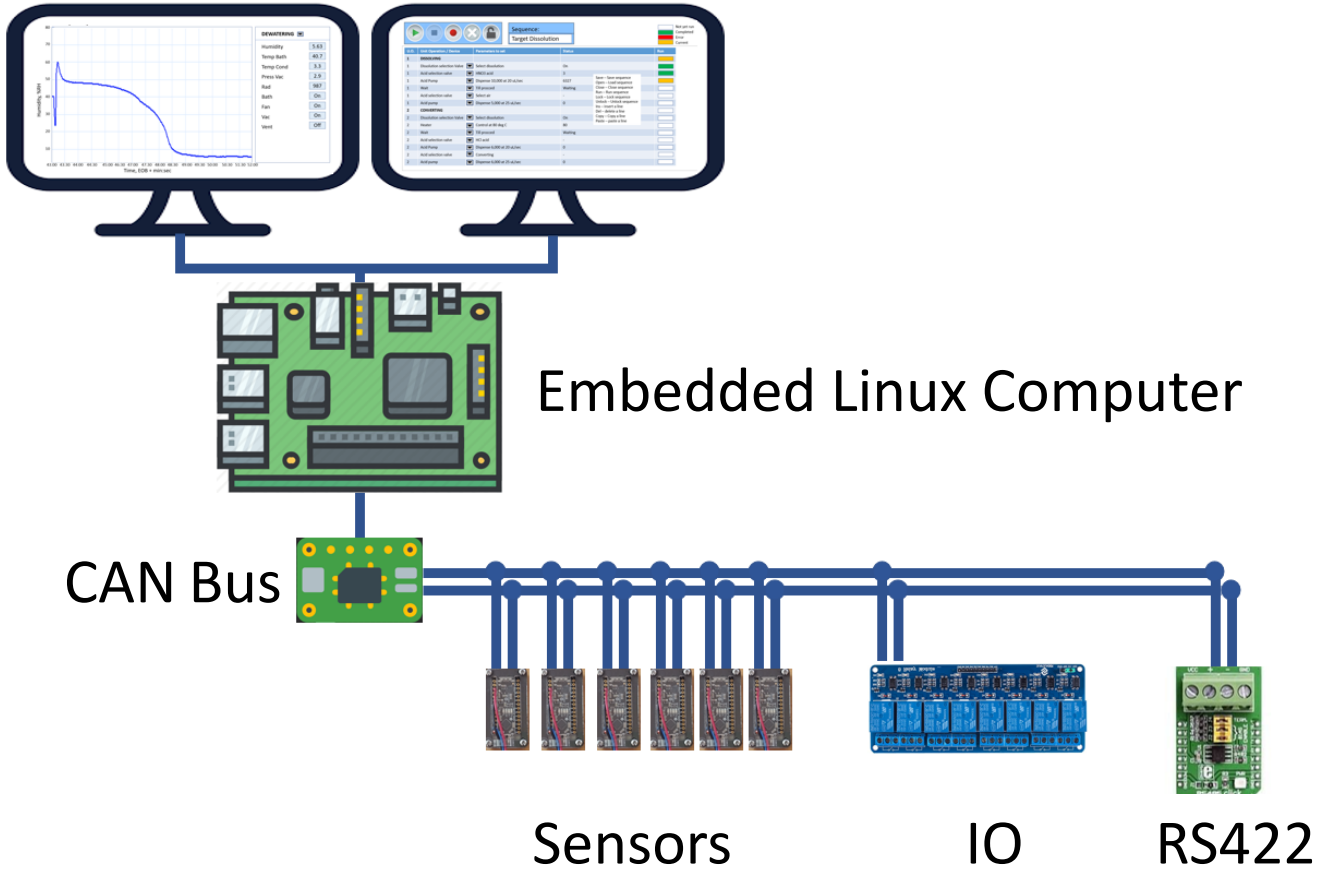
Matrix conversion

- Distillation
- Reduction
- Nitrate destruction

Solid Phase Extraction (SPE)

- Optimization of extraction conditions
- Systematic evaluation of column geometry
- Evaluation of a less costly and more robust triggering sensor

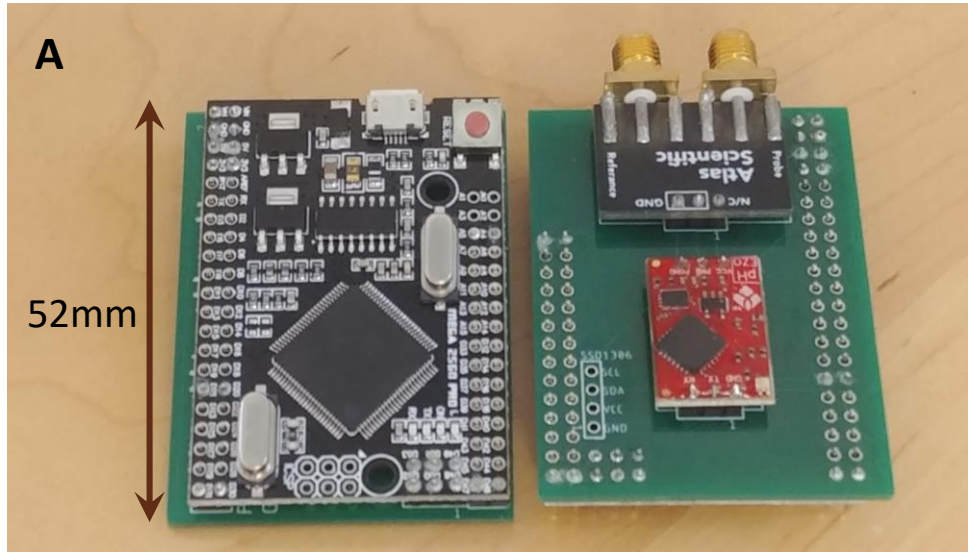
Distributed Control System (DCS)

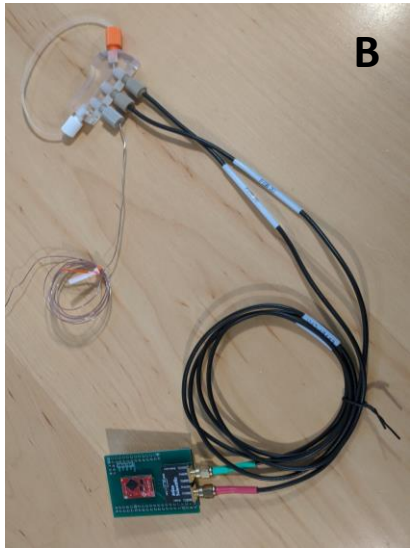


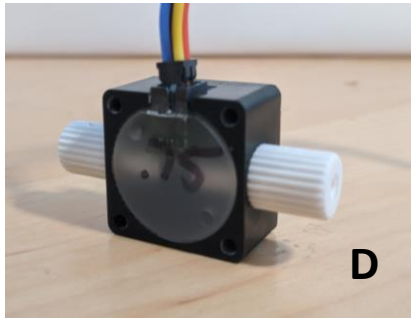
– Sensor Toolbox

A: Arduino Mega Pro mini 2560 & pH board
B: pH sensor
C: Temperature sensor and heater controller
D: Pressure sensor

Sensor / COMS	Purpose
Radiation	Monitor passage of ^{211}At
Pressure	Monitor flow conditions and vacuum conditions
Conductivity	Leak detection
Temperature	Condensers, heaters, and titration monitoring
pH	Neutralization monitoring
%RH	Dryness
RS422	Device control
IO	Device control
Brushless DC	Stirrer motors







Acknowledgements

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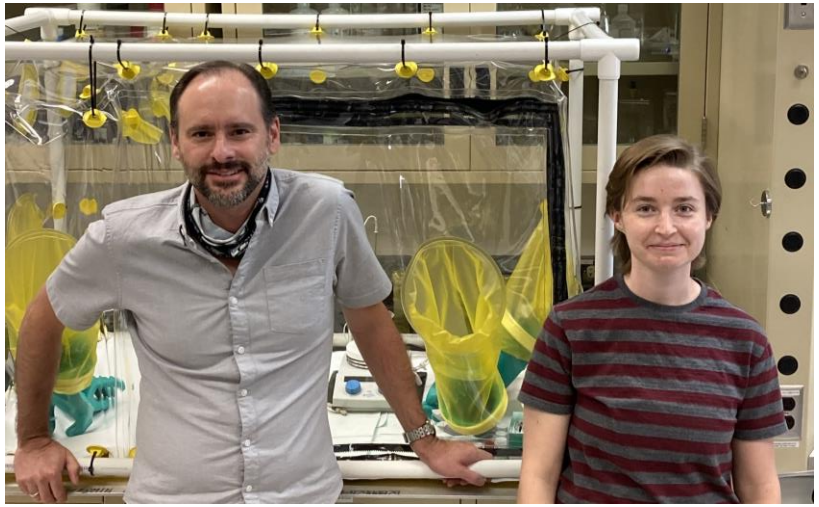

PNNL team

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Global FIA team

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