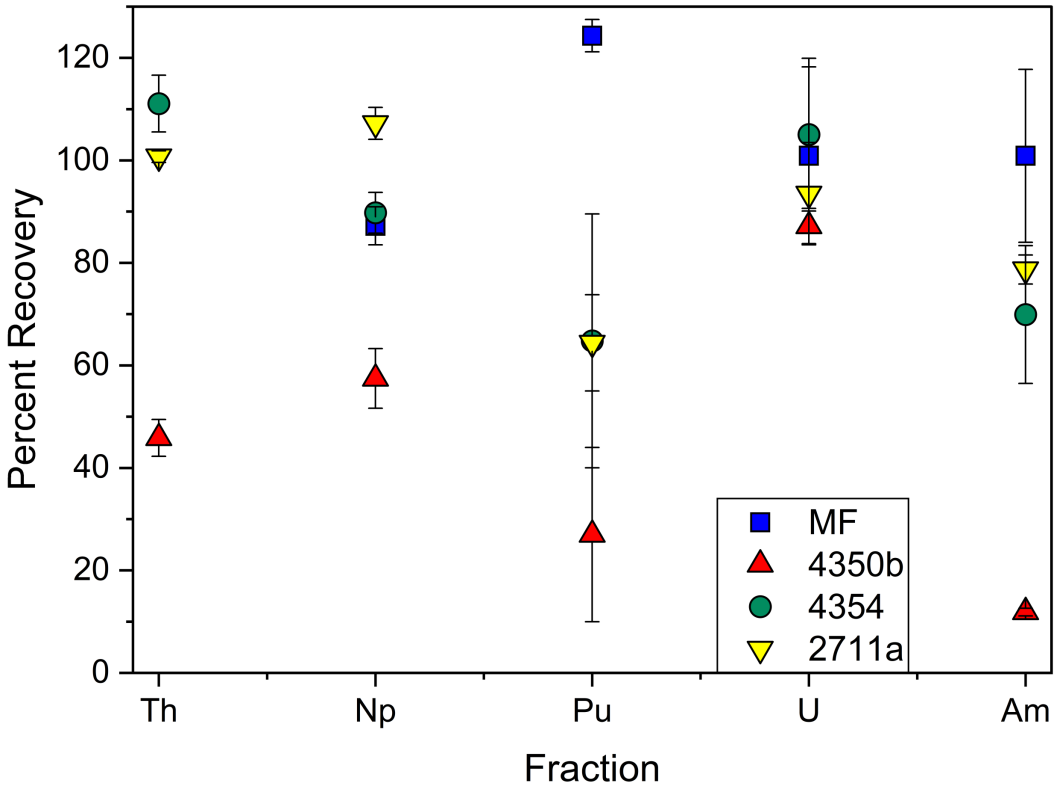
NUCL 4398192

Rapid chromatographic separation of actinides from complex matrices with a UTEVA/DGA double stack

***Matt Comins**, matthew.comins@pnnl.gov, Kelly C. McHugh, Amanda French, Caleb Allen, Samuel Emmons, Hilary Emerson, Jose M. Veleta, Nicolas E. Uhnak, Staci Herman. Pacific Northwest National Laboratory, Richland, Washington, United States*

High-precision mass spectrometric analyses, including thermal ionization mass spectrometry (TIMS) and multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS) often require purification of elements to generate quality results due to the presence of isobars and adduct species. This is particularly true for actinides in post-detonation nuclear forensics samples, where isobars are especially common, making both purity and timeliness a priority. Alpha spectroscopy (or alpha energy analysis, AEA) serves as a complementary technique to mass spectrometry, namely for short-lived actinides where higher activities are possible despite lower concentrations, and whose half-lives may be too fleeting for analysis by MS.

The separation of actinides (Th, U, Np, Pu, and Am) was investigated using the UTEVA/DGA double-stack in the presence and absence of soil matrices at relatively high soil loading (~100 mg) to test for robustness (separation efficacy) with simulated post-detonation samples. The effect of matrix was explored both in its ability to impact the separation itself (e.g., saturating the resin) and its ability to interfere with mass spectrometric and radiometric quantification of ultra-trace actinides. High actinide recoveries (in excess of 80%) were generally achieved with standard reference materials 4354 and 2711a. The separation in the presence of 4350b (River Sediment Environmental Radioactivity Standard) yielded overall lower recoveries, though generally still high enough for quantification. The UTEVA/DGA double-stack has proven to be a rapid and effective method for separating actinides for precise, reliable analyses.



Percent recovery of actinides separated with the UTEVA/DGA double-stack in the presence and absence of standard reference materials as soil matrix. MF = matrix-free. Uncertainty is the standard deviation of triplicate measurements.

NUCL 4401040

New radiochemical methods and tracers for PET neuroimaging

***Neil Vasdev**, neil.vasdev@utoronto.ca. Brain Health Imaging Centre, Centre for Addiction and Mental Health, Toronto, Ontario, Canada*

This presentation will focus on some non-traditional approaches to develop radiopharmaceuticals from "bench to bedside" for medical imaging using positron-emission tomography (PET) to image the living human brain. Specifically, cutting-edge approaches and radiochemical methods for imaging receptors and signal transduction pathways with PET, as well as our recent work to expand beyond the “amyloid cascade hypothesis” of Alzheimer’s disease, including tauopathies, will be presented. Several of the neuroimaging agents have also been applied as oncology probes, and examples where we have been “learning from cancer” imaging research will be discussed. An outlook with examples of how academic-pharma partnerships have shaped our imaging program and the vision for a Canada-wide training program for radiopharmaceutical and medical imaging sciences will also be highlighted. The intricacies of transitioning labeled compounds to PET radiopharmaceuticals and our aspiration to work towards the

ultimate, albeit impossible, goal in the field: to radiolabel virtually any compound for PET will be raised as points for discussion.

NUCL 4401059 - Withdrawn

NUCL 4401059 - Withdrawn

NUCL 4401588

Molecular consequences of low-dose radiation: An epigenetic perspective on cell phenotype

Abhishek Sahoo[1]*, abhisheksahoo532@gmail.com, Sandra Davern*[2]*, Anuj Kapadia*[2]*, Greeshma Agasthya*[3]*, Belinda Akpa*[4]*, Rachel McCord*[5]*. (1) University of Tennessee Oak Ridge Innovation Institute, Knoxville, Tennessee, United States(2) Oak Ridge National Laboratory, Oak Ridge, Tennessee, United States(3) Georgia Institute of Technology, Atlanta, Georgia, United States(4) The University of Tennessee Knoxville Tickle College of Engineering, Knoxville, Tennessee, United States(5) University of Tennessee Oak Ridge Innovation Institute, Oak Ridge, Tennessee, United States*

Low dose radiation (LDR) from environment (radon) or from medical diagnostics and occupational situations (X rays and gamma rays) is rapidly being recognized for its epigenetic rather than mutagenic effects. Emerging data from literature reveals that LDR can remodel chromatin and DNA methylation patterns, potentially impacting gene expression without affecting the DNA sequence. The primary research void is the absence of a coherent set of multi-omic data, linked to cellular phenotypes, at a total dose and dose rate that meets the criteria of LDR as agreed upon by the National Academy of Sciences. Our study aims to investigate the phenotypic and the underlying epigenetic, 3D genome structure, and transcriptomic changes that occur when different types of lung cells (fibroblasts, epithelial, and endothelial) are exposed to low doses (5 mGy/hr for 2 - 20 hours, 5 total doses-10 to 100 mGy) of alpha particles (Ac-225, Bi-213) and gamma rays (Cs-137). Post irradiation, we are assessing key phenotypic changes in the cell types. We have found that high doses (2 Gy) of radiation expresses fibrosis markers such as smooth muscle alpha actin. Translating this to LDR, we are measuring the DNA damage, fibrosis, and epithelial to mesenchymal transition by immunofluorescence and ELISA. We employ an IncuCyte SX5 to assess cell viability, apoptosis, and reactive oxygen species. We then aim to connect these phenotypes to molecular changes by collecting transcriptomic data after LDR and measuring histone modifications and key genome architecture protein binding sites using CUT&RUN. We correlate these epigenetic and gene regulatory changes with 3D genome data obtained by genome wide chromosome conformation capture (Hi-C). Our previous work indicates that acute high doses of radiation can alter the 3D structure of chromosomes. We are currently exploring the concept that extended low-dose radiation causes alterations in epigenetic marks along DNA, which can encode a memory of the cellular exposure even as cells divide and grow. Using methyl Hi-C, we are investigating areas where linear epigenetic modifications align with alterations in the 3D genome. Our molecular

and phenotypic data will contribute to computational models to improve our understanding of the mechanisms underlying the biological effects of low dose radiation.

NUCL 4401588

Molecular consequences of low-dose radiation: An epigenetic perspective on cell phenotype

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NUCL 4401918

Design, radiochemistry and preliminary biological evaluation of a novel mTOR/PI3K radioligand, [^{11}C]Me-GNE-317

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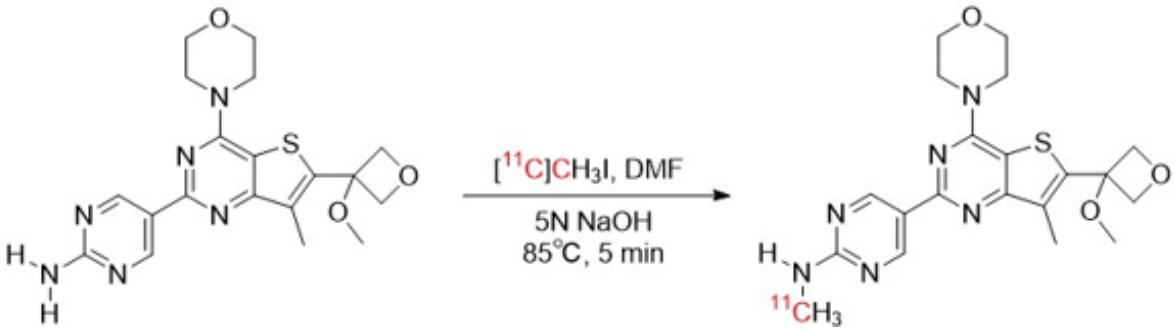
Mammalian target of rapamycin (mTOR) dysregulation has been associated with several neurological disorders. mTOR inhibitors are also being studied in Alzheimer's disease (AD) trials as potential treatments. While there are several PET tracers reported to track mTOR, none of them have been clinically validated in AD models. GNE-317 was identified as an mTOR/PI3K inhibitor with favorable blood brain barrier (BBB) characteristics. Here we present preliminary *in silico* and *in vivo* data to image the mTOR/PI3K pathway with [^{11}C]Me-GNE-317 for the first time.

Molecular docking studies were performed using the Glide module present in Schrodinger software suite, using human mTORC1 PDB code from the data bank. [^{11}C]Me-GNE-317 was produced by [^{11}C]CH_3I-based methylation of primary amine via NaOH/DMF (**Scheme 1**). The final product was purified with C18 prep-HPLC and reformulated with HLB SPE. The non-radioactive standard was characterized with HPLC-MS and ^{1}H NMR. The final radiotracer was authenticated via QC-HPLC. [^{11}C]Me-GNE-317-based 1 h whole-body PET/CT scans were acquired in healthy BALB/c mice (9 mo, n=4). Standard uptake values (SUVs) were calculated for the whole-brain, hippocampus, and cortex using PMOD software.

In silico studies showed that both GNE-317 and Me-GNE-317 bind to same binding pocket of mTORC1 protein, with similar binding affinities (−5.376 vs. −5.379 kcal/mol), preserving lead molecule characteristics. [^{11}C]Me-GNE-317 was obtained with a radiochemical purity of >99% and an uncorrected radiochemical yield of 6.4%. PET imaging showed robust brain uptake (**Figure 1**), peaking at 5-10 min and flushed by 60 min, with SUVs for whole brain = 0.58±0.01, cortex = 0.36±0.2, and hippocampus = 0.27±0.01.

[^{11}C]Me-GNE-317 shows high brain uptake and favorable pharmacokinetics; highlighting its potential as a novel mTOR-targeted radiotracer for preclinical studies of mTOR dysregulated neurological disorders.



Scheme 1: Fully automated radiosynthesis of [^{11}C]Me-GNE-317.

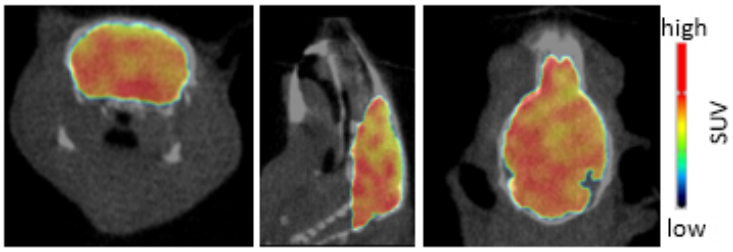


Figure 1: Representative axial, sagittal, and transverse PET/CT images of [^{11}C]Me-GNE-317 in healthy mouse brain.

NUCL 4401944

^{212}Pb production pathways: Evolution of generator technologies for targeted alpha therapy

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The clinical translation of lead-212 (^{212}Pb) targeted alpha therapy relies on reliable and scalable production routes. While ^{212}Pb is commonly obtained via thorium-228 or radium-224-based generator systems, a variety of approaches have been developed over the past decades, reflecting both technical innovation and shifting clinical demand. This presentation will provide a historical overview of ^{212}Pb production and generator technologies, from the early uranium-based sources, through ion-exchange and extraction chromatography systems developed in the 1980s–2000s, to today's clinical-grade generators supporting ongoing trials. The focus will be on developing separation chemistries, enhancing yield, and increasing purity.

By revisiting this trajectory, we can better appreciate the progress that enables current ^{212}Pb radiopharmaceutical development and identify opportunities for next-generation production strategies.

NUCL 4403260

Characterization of Thin ^{nat}Sn targets for nuclear reaction experiments

Layla R. Koon[2,1]*, koo0243@pennwest.edu, Jillian K. Tung*[2,3]*, Charles M. Folden*[2,3]*. (1) Chemistry, Mathematics, and Physics, Pennsylvania Western University, California, Pennsylvania, United States(2) Cyclotron Institute, Texas A&M University, College Station, Texas, United States(3) Chemistry, Texas A&M University, College Station, Texas, United States*

At the Texas A&M University's Cyclotron Institute, thin ^{118}Sn targets (250-500 mg●cm^{-2}) are used for ^{118}Sn(^{40}Ar, 6n)^{152}Er and ^{118}Sn(^{40}Ar, 5n)^{153}Er reactions to calibrate detectors. To develop a procedure to fabricate ^{118}Sn targets, resistive heating of ^{nat}Sn was utilized at the Advanced Nuclear Target Laboratory for Experimental Research (ANTLER). The fabricated ^{nat}Sn targets' thickness, surface uniformity, and composition were characterized through α-particle energy loss measurements, energy dispersive spectroscopy (EDS), scanning electron microscopy (SEM), and x-ray photoelectron spectroscopy (XPS). The targets had thicknesses that fell near the desired range and surfaces that displayed mostly uniform features with some defects. EDS and XPS indicated that the targets' composition was mostly metallic tin with a thin oxide layer on the surface. Future work will apply this methodology to begin ^{118}Sn target fabrication.

NUCL 4403260

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NUCL 4403281

Overcoming diffusion limitations to rapidly purify ^{225}Ac

Shruti Krishna Radhakrishnan[1]*, sxr1114@case.edu, Bernadette Schneider*[1]*, Todd N. Poe*[2]*, Cathy S. Cutler*[2]*, Christine E. Duval*[1]*. (1) Chemical and Biomolecular Engineering, Case Western Reserve University Case School of Engineering, Cleveland, Ohio, United States(2) Isotope Research and Production, Brookhaven National Laboratory, Upton, New York, United States*

Actinium-225 (^{225}Ac) supply remains globally constrained by bottlenecks in its production. Resin-packed columns are the state-of-the-art purification method to isolate ^{225}Ac from other isotopes with either ion-exchange or diglycolamide (DGA)-based resins achieving the final separation. Though resin-based systems are reliable, they exhibit mass transport limitations which pose some practical challenges when operating at high flowrates. For example, these diffusion limitations were highlighted in our column experiments where increasing the flow rate from 0.5 to 5 mL/min caused a 78% drop in adsorption capacity, though higher flow rates are essential to fasten purification so that ^{225}Ac can be produced and delivered to patients more quickly for treatment. We hypothesize that functionalized membrane adsorbers will overcome the diffusion limitations of resins by exhibiting convection-dominated transport through their microporous structures, such that binding performance remains independent of flow rate.

In our previous work, we synthesized functional membrane adsorbers by electrospinning poly(vinylbenzyl chloride) fibers mats and covalently attaching tetrahexyldiglycolamide (THDGA) to the fiber surfaces. Distribution coefficients calculated from batch equilibrium studies with ^{225}Ac, and stable lanthanum exhibited similar trends to branched DGA (TEHDGA) resins, showing a potential for separating ^{225}Ac. To test our current hypothesis, dynamic column studies with ^{225}Ac are being performed at Brookhaven National Laboratory. Here, THDGA membranes are mounted in custom 3-D printed membrane housings. Then, dynamic adsorption experiments were performed at flow rates of 0.5- 5 mL/min under 4, 6, and 10 M nitric acid. ^{225}Ac loading and elution were quantified by collecting effluent fractions and analyzing activity using gamma-spectroscopy and elemental concentrations using ICP-MS/OES to generate breakthrough curves and determine changes in dynamic binding capacities. In parallel, batch uptake experiments with radiolanthanum (^{135}La) are being conducted at equimolar concentrations to directly compare Ac/La selectivity in THDGA membranes to that of the conventional DGA resins. Data from ongoing experiments will be presented to evaluate whether THDGA membranes will offer a rapid purification platform for ^{225}Ac, addressing the intrinsic transport limitations of resin-based systems.

NUCL 4404959

XANES simulation of uranium-bearing zircon at various pressures using different density functional theory methods

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Actinide elements, with their partially filled 5f and 6d subshells, display intricate electronic structures and diverse coordination environments that pose significant challenges for investigation. X-ray absorption spectroscopy (XAS), particularly in the near-edge region (XANES), has become a powerful tool for probing actinide oxidation states, coordination numbers, and electronic hybridization, despite long-standing challenges in interpretation. In this study, we present systematic simulations of the LIII-edge XANES of uranium-bearing zircon under varying pressures using a suite of density functional theory (DFT)-based methodologies to improve the interpretation of spectral features. Computational strategies employed include supercell core-hole approximation, time-dependent DFT (TD-DFT), and comparisons with classical muffin-tin DFT approach. The simulations reveal the critical role of 5f–6d orbital hybridization in shaping edge features and demonstrate how pressure alters local bonding environments in zircon. Results obtained from the N+1 approximation, validated against muffin-tin calculations, provide a computationally efficient yet accurate route to reproduce experimental XANES spectra. Collectively, these findings establish a robust framework for high-fidelity XANES simulations of actinide-bearing minerals, offering new insights into their electronic structure, bonding characteristics, and pressure-dependent behavior relevant to geoscience, nuclear materials, and environmental chemistry.

NUCL 4405642

Novel methods for separation of titanium from scandium

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Titanium-45 (^{45}Ti, $t_{1/2}$ = 3.08 h, β^+ = 85%) is an attractive radioisotope for positron emission tomography (PET) owing to its nuclear characteristics including intermediate half-life, high positron branching ratio, and a low mean positron energy (0.439 MeV). This radioisotope can be routinely produced on medical cyclotrons through the ^{45}Sc(p,n)^{45}Ti route utilizing natural scandium foils. Previous studies have developed separation methods with promising results, but key limitations include long separation times and unfavorable final chemical forms. This work seeks to develop a novel separation that recovers ^{45}Ti in dilute HCl. HCl matrices avoid time-consuming buffer/ligand exchanges that arise in citrate or oxalate systems. Non-chloride systems form strong Ti(IV) complexes, compete with metal chelators, and add additional purification steps limited by the 3-hour half-life. To expand Sc/Ti separation efficacy and enhance ^{45}Ti availability while unlocking novel eluents that enable improved downstream chemistry, this work sought to elucidate the feasibility of implementing ionic liquid-impregnated resins.
We developed and evaluated a novel ionic liquid-impregnated resin utilizing Cyphos IL

104 on an Eichrom scaffold (100-150 μm), named E104. Distribution coefficient (D) studies were conducted to determine optimal load/rinse conditions using both HCl and H_2SO_4 media. At 0.1 M HCl, we observed the most effective separation with a separation factor of 367.38 between Sc and Ti, and D values (mL/g) of 2185.2 and 57.78 respectively. Additional studies with chromatography columns were conducted utilizing 5 M HCl and 1 M H_2SO_4 as eluents. In 5 M HCl, Ti recovery was 90.51% while in 1 M H_2SO_4, Sc recovery was 41.06%.
This design and its performance will be evaluated against current protocols to quantify differences in processing times, purity, and materials. Building upon that foundation, our project enables dilute-HCl elution to allow for streamlined chelation of next-generation chelators.
Future work will focus on improving separation parameters to increase recovery yields for both scandium and titanium. Additionally, scaling of column experiments will be performed with anticipated production volumes to validate processing efficiency. Further efforts will include the evaluation of long-term reusability of the resin across multiple cycles, as well as quantifying its adsorption capacity under varying conditions to guide process optimization and lifecycle performance.

NUCL 4407026

Characterization of transactinide homolog chemistry with self-assembled monolayer-coated detectors

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Due to low production cross sections and short half-lives, the transactinide elements (Z ≥ 104) require “single-atom-at-a-time” techniques for chemical characterization. One such technique is isothermal gas chromatography, where the deposition profile of the produced elements is measured on different surfaces (typically Si or Au) at a constant temperature, allowing for the determination of ΔH_{ads}. A chemically selective technique to broaden the range of surfaces for ΔH_{ads} measurements is under development at Texas A&M University. Au-coated Si detectors have been further coated with a variety of organic self-assembled monolayers (SAMs), which have terminal groups available for ΔH_{ads} measurements. SAMs have been shown to produce monolayers with high surface coverage, and result in thin layers that are ideal for α-spectrometry. This has been demonstrated in online gas-phase experiments for Ir, Er, and At with both 1-(11-mercaptoundecyl)imidazole and 12-mercaptododecanoic acid (MDDA) in our laboratory.

A detector array called the SAMs Polonium Isotope Detector ARray (SPIDAR) is in development. This detector array has been used to measure the adsorption enthalpy of

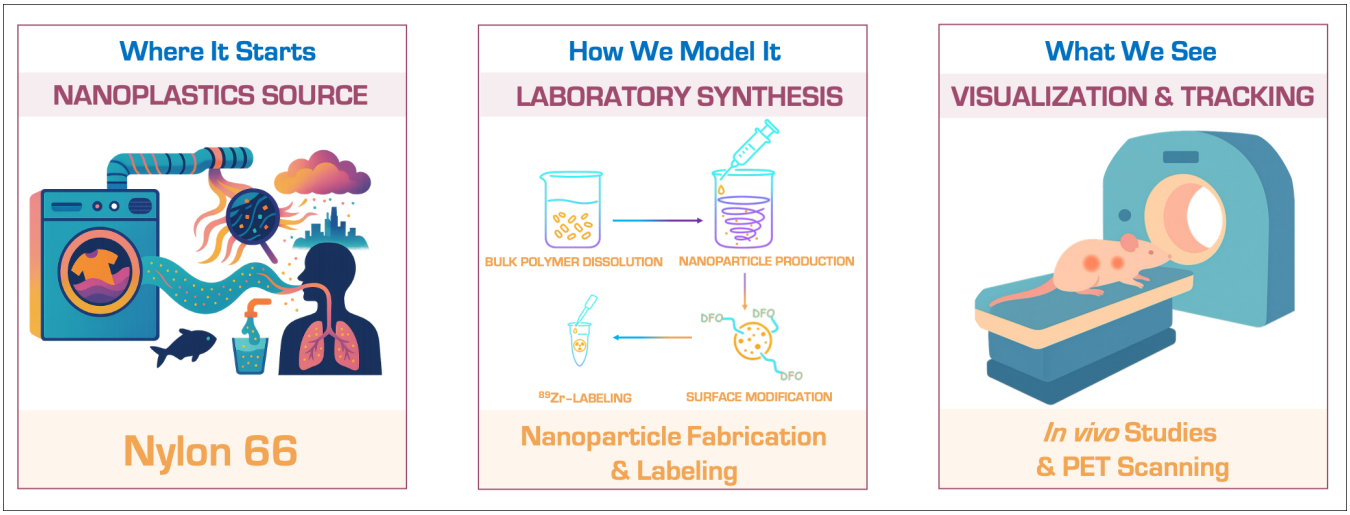
Po and At, which are lighter homologs of the transactinides Lv and Ts, on MDDA. Offline, ^{216}Po (from the decay of ^{228}Th) was extracted into a recoil transfer chamber (RTC), which was then used to test SPIDAR. Online, Po, Er and At have been produced and extracted into the SPIDAR via the ^{160}Dy(^{40}Ar, *x*n) (*x* = 2-5), ^{118}Sn(^{40}Ar, *x*n) (*x* = 5,6) and ^{165}Ho(^{40}Ar, *x*n) (*x* = 6,7) reactions respectively. The reaction products were spatially separated from the primary beam and reaction by-products using the gas-filled recoil separator AGGIE and thermalized with a simple RTC, after which SPIDAR is placed. Isothermal chromatograms for Po, Er and At have been measured on three Si-detector surfaces: bare Si, bare Au and MDDA. This talk will discuss our latest results and future plans.

NUCL 4410067

Signal woven in: Synthesis of ^{89}Zr-Labeled nylon 66 nanoparticles for pet tracking and biodistribution studies

***Olga Khaybullina**, okh@uab.edu, Outi Keinanen. Chemistry, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States*

Textile shedding is a major indoor source of plastic particulates, yet the biodistribution of nanoscale nylon fragments remains largely unknown. Here, we aimed to develop a method to produce real-world mimicking, traceable nylon 66 nanoplastic particles for biodistribution and bioaccumulation studies.
Nylon 66 nanoparticles of irregular shape (355 ± 91 nm, PDI ~ 0.2) were prepared by solvent-switch nanoprecipitation and then minimally amino-functionalized to introduce desferrioxamine (DFO) chelators for subsequent ^{89}Zr-labeling. The produced particles preserved the intrinsic properties of nylon 66 as showcased by zeta potential, Fourier transform infrared spectroscopy (FTIR) and X-ray photoelectron spectroscopy (XPS) measurements. Radiolabeling with ^{89}Zr-oxalate was achieved in high radiochemical yield. We benchmark radiostability in various biological liquids, such as simulated lung, gastric, and intestinal fluids, mouse serum and phosphate-buffered saline (PBS) at physiological conditions (37 °C, up to 120 h) using radio-iTLC.
The ^{89}Zr-labeled nylon 66 particles provide a practical entry point for exposure-relevant mapping of these particles. Our signal “woven in” approach delivers radiochemically stable nylon 66 nanoparticles for visualization and quantitative tracking with positron emission tomography (PET) and radiochemical methods. Preserving native particle properties enables accurate environmentally relevant route-of-exposure and bioaccumulation investigations of textile-derived nanoplastics.



NUCL 4411169

Comparative evaluation of lu-177 and Pb-212 labeled FAP targeted radiotherapeutics

*Tullio V. Esposito[1], Roberto De Gregorio[5,1], Olivia Kunkle[1], Rachel Payne[1,4,5], Tuan Tran[3], Kyle Stewart[3], Serge Lyashchenko[3], Teja M. Kalidindi[1], Lukas Carter[2], Jason S. Lewis[5,1,4], **Nagavarakishore Pillarsetty**[1,6], npillarsetty@gmail.com. (1) Radiology, Memorial Sloan Kettering Cancer Center, New York, New York, United States(2) Medical Physics, Memorial Sloan Kettering Cancer Center, New York, New York, United States(3) Radiochemistry and Molecular Imaging Probes Core, Sloan-Kettering Institute, New York, New York, United States(4) Pharmacology, Weill Cornell Medicine, New York, New York, United States(5) Program in Molecular Pharmacology, Sloan-Kettering Institute, New York, New York, United States(6) Radiology, Weill Cornell Medicine, New York, New York, United States*

Introduction: Fibroblast activating protein (FAP) has emerged as an important target in cancer because of its universal high expression in tumor stroma across different tumor types and some tumor cells. Small molecule-based FAP targeting radiopharmaceuticals have displayed promise as diagnostic agents but have shown limited efficacy in therapeutic setting. This is due to rapid dissociation of the bound radiopharmaceutical from the tumor site which results in limited dose deposition with long lived isotopes such as Lu-177, Tb-161 or Ac-225 ($t_{1/2}$ ~7-10 d). We rationalized short lived isotope such as Pb-212 ($t_{1/2}$ ~0.45 d) would be more ideal to deposit the dose and achieve similar efficacy. The purpose of the current study was to conduct head to head comparison of [^{177}Lu]Lu-FAP2286 vs [^{212}Pb]Pb-FAP2286 in highly aggressive U87 tumor xenograft model.

Methods: FAP-2286 was radiolabeled with Lu-177 and Pb-212 and purified using Sep-Pak C18 cartridge using well established protocols. The purity of the compounds was established using radio-ITLC and/or analytical radio HPLC. Binding specificity was

assessed using bead binding assay. Biodistribution studies at multiple time points were performed on mice bearing U87 tumor xenografts administered with [^{177}Lu]Lu-FAP2286 or [^{212}Pb]Pb-FAP2286 to obtain pharmacokinetic and dosimetry profile. In therapy cohorts, U87 tumor xenograft bearing mice were administered with saline or [^{177}Lu]Lu-FAP2286 (1 mCi) or [^{212}Pb]Pb-FAP2286 (40 and 80 µCi) and tumor growth curves and survival was monitored.
Results: Both [^{177}Lu]Lu-FAP2286 or [^{212}Pb]Pb-FAP2286 displayed similar biodistribution profile showing highest uptake at 1 h time point in the tumor that was rapidly released from reaching to 25% of highest uptake value (%ID/g) by 24 h. In therapy studies, [^{177}Lu]Lu-FAP2286 did not provide any tumor control or median survival benefit when compared to saline controls (12 d). However, there was dose dependent reduction in tumor growth in mice treated with [^{212}Pb]Pb-FAP2286 and improved median survival benefit of 20 and 34 days in mice treated at 40 and 80 µCi dose levels respectively.
Conclusions: Despite washoff observed for FAP ligands, [^{212}Pb]Pb-FAP2286 has significant therapeutic benefit in mice owing to short half-life that results in rapid dose deposition. Therefore short $t_{1/2}$ therapeutic isotopes are advantages for FAP targeed small molecule radiotherapeutics.

NUCL 4411288

Selective extraction of $^{241}Am^{3+}$ from $^{152\text{-}154}Eu^{3+}$ using a 3,3'-butyloxy-bis-1,2,4-triazinyl-2,6-pyridine receptor in a hydrocarbon diluent

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Efficient separation of long-lived trivalent actinides from chemically similar lanthanide fission products remains a significant challenge in nuclear waste management. In solvent extraction processes, phase modifiers such as Cs-7SB [1-(2,2,3,3-tetrafluoropropoxy)-3-(4-sec-butylphenoxy)-2-propanol] are commonly employed to enhance the solubility of extractants in aliphatic diluents and to suppress third-phase formation. In this study, a pyridine-based bis-triazinyl complexant was evaluated for the extraction of $^{241}Am^{3+}$ over $^{152\text{-}154}Eu^{3+}$. The effect of the phase modifier Cs-7SB in an isopar/$HNO_{3(aq)}$ system was systematically investigated, with a 10:1 isopar:Cs-7SB ratio significantly improving complexant solubility and extraction efficiency while suppressing the formation of precipitates, emulsions, and third phases. Extraction studies conducted up to 2 M $HNO_{3(aq)}$ confirmed high selectivity for Am^{3+}, as well as excellent resistance of the complexant to hydrolytic degradation. These findings highlight the promise of this complexant–solvent system for advanced partitioning applications aimed at closing the nuclear fuel cycle and reducing the long-term radiotoxicity of spent nuclear fuel. This presentation will emphasize the role of Cs-7SB, equilibrium behavior, the influence of acid and complexant concentrations, and decomplexation studies, underscoring the potential for advanced nuclear waste management strategies.

NUCL 4411318

Building a legacy of radiopharmaceutical Research at UCSF

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The University of California San Francisco (UCSF) has a strong preclinical and clinical radiopharmaceutical program, supporting multiple investigators across many clinical trials. This talk will outline the history of the radiopharmaceutical research program at UCSF and highlight the contributions that Henry VanBrocklin has made to make the program successful.

NUCL 4411803

Optimization of a ^{44}Ti/^{44}Sc generator using ^{44}Ti recycling techniques

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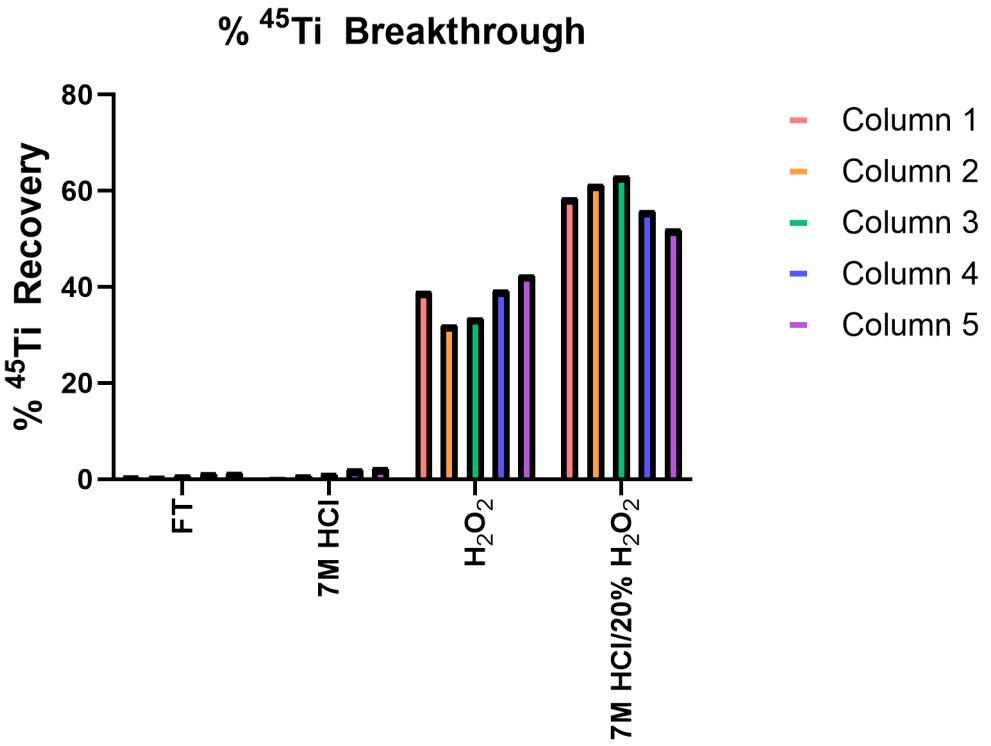
Introduction: Theranostics (**thera**peutic + diag**nostic**) refers to a technique that diagnoses and treats a specific cancer or disease using radiopharmaceuticals. One radioisotope of interest is ^{44}Sc ($t_{1/2}$=4.04 h), which is the Positron Emission Tomography (PET) diagnostic counterpart to the therapeutic ^{47}Sc ($t_{1/2}$=3.35 d). A method for obtaining ^{44}Sc is harnessing the decay of long-lived ^{44}Ti ($t_{1/2}$=59.1 y) by creating a radionuclide generator. Titanium-44 decays 100% to ^{44}Sc to produce non-carrier added ^{44}Sc. Previously, ^{44}Ti/^{44}Sc generator systems have relied on hydroxamate based resins. However, prolonged use has resulted in ^{44}Ti breakthrough. A ^{44}Ti generator using fresh columns each cycle was investigated to ensure high radiochemical purity of ^{44}Sc.
Methods: Development and optimization used shorter-lived ^{45}Ti ($t_{1/2}$=3.08 h) and ^{47}Sc radioisotopes. In preliminary studies, the primary loading solution contained 444.7 MBq of ^{45}Ti spiked with 185 kBq of ^{47}Sc to mimic the ingrowth of ^{44}Sc. This was loaded onto a 1 mL column containing 146.78±2.0 mg of ZR resin. After the flow through was collected, a 5 mL elution of 7M HCl was used to collect remaining the scandium. The ^{45}Ti was eluted using a wash of 5 mL of H_2O_2 followed by 5 mL of 7M HCl/20% H_2O_2. These washes were dried down, reconstituted in 7M HCl, and recycled onto a fresh column.
Results: A comprehensive system using five consecutive columns was tested to mimic elution cycles of the ^{44}Ti/^{44}Sc generator. The columns retained 99.27±0.37% of ^{45}Ti in the flow through and 98.85±0.88% of ^{45}Ti in the first elution. The H_2O_2 and 7M HCl/20% H_2O_2 washes collected 95.18±1.97% of the ^{45}Ti for recycling purposes.
Conclusions and Future Work: This method shows a promising alternative to current ^{44}Ti/^{44}Sc generator systems. Future work includes continuing the optimization of generator parameters with the goal of creating a small-scale preclinical generator using ^{44}Ti.



%^{45}Ti breakthrough in each fraction on 5 consecutive columns.

NUCL 4411954

Reactions of uranium hexafluoride

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Uranium hexafluoride (UF6) has many advantageous material properties which have made its use ubiquitous in uranium enrichment processes. Unfortunately, UF6 is highly reactive and behaves as both a strong oxidizing agent and a strong fluorinating agent. Despite heavy use for over 70 years, the chemistry behind UF6 reactions is still poorly understood. The hydrolysis of UF6 has received the most attention but neither experimental nor computational approaches have garnered much success, leaving the exact nature of the hydrolysis reaction still unresolved. Smaller experimental efforts have been put forth studying other UF6 reactions but there is little computational support outside of the hydrolysis reaction. Here we use cryogenic trapping and infrared spectroscopy to observe reaction intermediates in multiple UF6 reactions to better understand UF6 chemistry.

NUCL 4411993

^{134}Ce/La radiopharmaceuticals for imaging and Therapy applications

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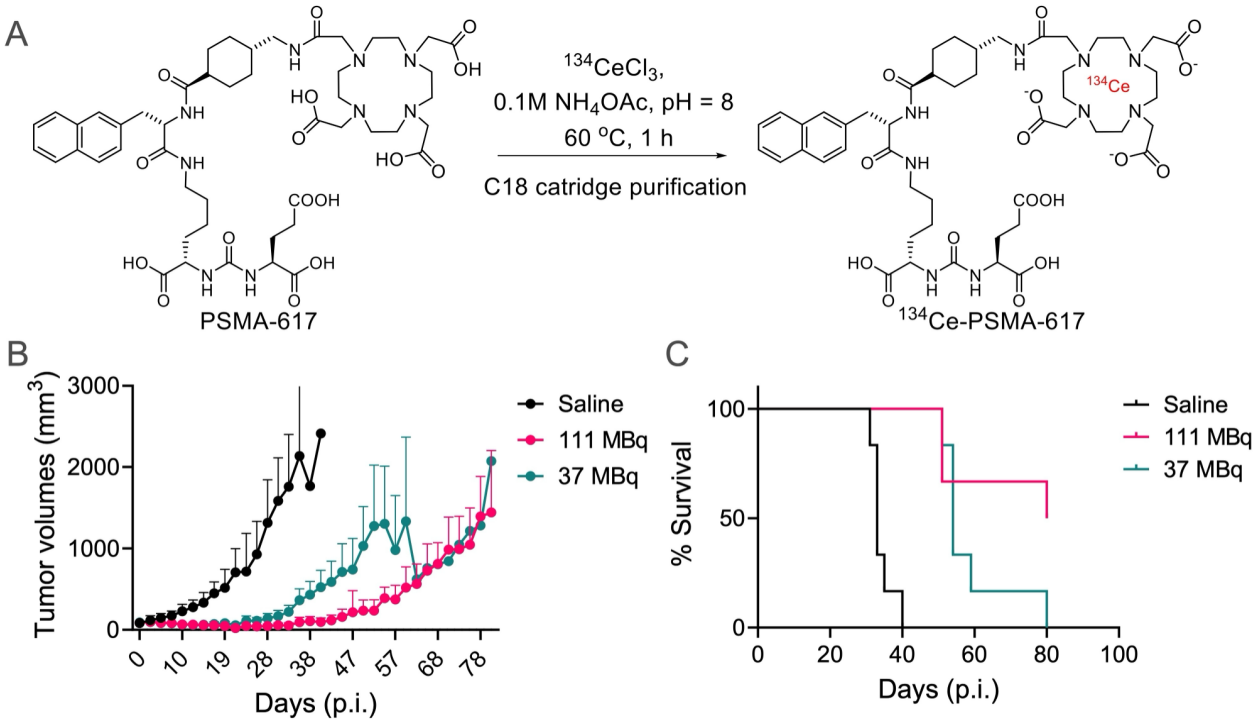
^{134}Ce ($t_{1/2}$ = 3.2 days) decays via 100% electron capture (EC) to ^{134}La, which subsequently undergoes positron emission (64%) to stable ^{134}Ba. Due to its relatively long half-life, ^{134}Ce is well-suited for imaging larger macromolecules, such as antibodies or nanoparticles. Moreover, because of its chemical similarity to ^{225}Ac, ^{134}Ce/^{134}La can serve as a theranostic-matched pair for ^{225}Ac-based targeted alpha therapies, potentially addressing dosimetric challenges associated with ^{225}Ac. In the first report, Bailey et al. demonstrated the successful production of ^{134}Ce/^{134}La, established radiolabeling processes with DOTA and HOPO chelators, and proposed its use as an imaging surrogate[1]. However, these chelators require extreme labeling conditions(~40 ^{o}C), making them unsuitable for sensitive biomolecules like antibodies. To overcome these limitations, Bobba et al. optimized ^{134}Ce radiochemistry using the Macropa chelator (1:1 M:L) at room temperature[2]. The resulting ^{134}Ce-Macropa-PEG$_4$-YS5 antibody conjugate exhibited tumor uptake and tissue distribution comparable to that of ^{225}Ac-Macropa-PEG$_4$-YS5 conjugates. In a separate study, Bauer et al. highlighted that for slow-internalizing vectors (e.g., ^{134}Ce/^{225}Ac-mcp-PEG$_8$-5B1), ^{134}Ce may not be an ideal surrogate for ^{225}Ac due to the redistribution of the ^{134}La daughter [3]. Bobba et al. [4] recently showed that single doses of 37 or 111 MBq of ^{134}Ce-PSMA-617 significantly inhibited tumor growth in PC3-PIP (PSMA-positive) xenografts, exploiting the Auger electrons emitted during ^{134}Ce decay, compared with saline controls (Figure 1). Overall, these studies suggest that ^{134}Ce/La is a promising surrogate for ^{225}Ac-based therapies and a true theranostic agent, though further evaluation of its radiobiological effectiveness and clinical translation is needed.



A) Reaction scheme for radiolabeling ^{134}Ce-PSMA-617, followed by C18 cartridge purification. A single-dose treatment study was conducted using ^{134}Ce-PSMA-617 at 37 and 111 MBq, with saline as a control, in PC3-PIP tumor xenografts. B) Average tumor volumes over time for the treatment and control groups. C) Percent survival as a function of time for the treatment and vehicle cohorts (n = 6).

NUCL 4412005

Innovation in the field of radionuclides: From the cyclotron to the patient

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Radiotheranostics has emerged as a rapidly growing field attracting significant investment and research attention. However, most current therapies remain non-curative, raising critical questions: Are we using optimal radionuclides, and are our targeting molecules appropriately designed for therapeutic applications?
Recent advances in radiometal production and chemical separation have advanced promising candidates like ^{161}Tb and ^{212}Pb toward clinical phase II trials. Yet current production methods using conventional cyclotrons and reactors limit both the variety and quantity of available isotopes.
Spallation facilities offer a transformative alternative. These facilities use high-energy proton beams striking heavy targets to generate a broader spectrum of radionuclides, including alpha emitters with significant potential for targeted cancer diagnosis and therapy. New facilities at CERN, the Paul Scherrer Institute, the European Spallation

Source, and TRIUMF will enable systematic production and testing of novel radionuclides.
Simultaneously, emerging evidence suggests that tumor-targeting molecules require substantial pharmacokinetic optimization to fully realize radiotheranostic advantages. This presentation will discuss initial preclinical and clinical data for promising new radionuclides including ^{44}Sc and $^{149/152/155/161}$Tb.

NUCL 4412180

Theranostic matched pair suitability of ^{89}Zr and ^{177}Lu-labeled L804-LLP2A analogues

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Versatile chelators that bind multiple radiometals are valuable for creating matched theranostic pairs. We previously showed that the macrocyclic 1,2-HOPO chelator, L804 coordinates both ^{177}Lu, a β^- emitter for radiotherapy, and ^{89}Zr, a β^+ emitter for PET imaging with a 80 kDa minibody. Here, we evaluated whether an L804-based ^{89}Zr radiotracer of the VLA-4–targeting peptidomimetic LLP2A could serve as a diagnostic surrogate for the corresponding ^{177}Lu agent in melanoma, and whether tracer performance could be enhanced with an albumin-binding pIBA moiety.
L804-LLP2A (**1**) and L804-pIBA-LLP2A (**2**) were synthesized and radiolabelled with ^{89}Zr and ^{177}Lu in >99% yield at 25 °C within 20–30 min. Lipophilicity measured by $LogD_{7.4}$ was increased by pIBA: −0.67 ± 0.06 ([^{89}Zr]Zr-**2**) and −1.05 ± 0.10 ([^{177}Lu]Lu-**2**) vs −1.67 ± 0.19 ([^{89}Zr]Zr-**1**) and −1.26 ± 0.12 ([^{177}Lu]Lu-**1**) ($p < 0.0001$). VLA-4 affinity was preserved, with similar K_d values: [^{89}Zr]Zr-**1** vs [^{89}Zr]Zr-**2** (2.2 ± 0.2 vs 1.6 ± 0.2 nM) and [^{177}Lu]Lu-**1** vs [^{177}Lu]Lu-**2** (8.4 ± 1.0 vs 10.8 ± 2.6 nM).
In B16F10 melanoma-bearing mice, [^{89}Zr]Zr-**1** and [^{177}Lu]Lu-**1** cleared rapidly from blood but showed differing distributions. [^{89}Zr]Zr-**1** exhibited higher retention in tumor, kidney, and spleen to 48 h, whereas [^{177}Lu]Lu-**1** cleared more quickly, yielding higher tumor-to-background ratios except in muscle. By contrast, [^{89}Zr]Zr-**2** and [^{177}Lu]Lu-**2** displayed similar pharmacokinetics, with prolonged circulation, elevated tumor uptake, and greater distribution to non-tumor tissues. Both cleared gradually, with [^{89}Zr]Zr-**2** showing slightly higher tumor and kidney retention than [^{177}Lu]Lu-**2** at 96 h.
Incorporation of an albumin-binding moiety not only extended tracer half-life but also harmonized the in vivo behavior of the ^{89}Zr and ^{177}Lu analogues. Consequently, [^{89}Zr]Zr-**2** serves as a more accurate diagnostic surrogate for [^{177}Lu]Lu-**2** than the non–albumin-binding analogue. These results highlight albumin-binding motifs as a strategy to improve matched theranostic design in oncology.

NUCL 4413142

Novel PET tracer for Imaging AMPAR Auxiliary Subunit TARP-γ-8

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AMPA-type glutamate receptors (AMPARs) mediate rapid excitatory signaling in the brain, with auxiliary proteins tuning their trafficking and pharmacology. Among these, TARP-γ8 is highly enriched in hippocampal circuits and has gained interest as a therapeutic target in neurological and psychiatric disease. Yet, tools for noninvasive quantification of TARP-γ8 in humans remain lacking. We describe the development of [^{18}F]TARP-2306, a selective positron emission tomography (PET) tracer for TARP-γ8. The probe displayed robust brain penetration, with binding patterns matching known TARP-γ8 distribution and confirmed by pharmacological and genetic validation. In preclinical epilepsy models, it sensitively detected regional decreases in TARP-γ8 expression. Translation to primates and humans yielded high-contrast hippocampal images with reliable quantification in clinical settings. These results position [^{18}F]TARP-2306 as a suitable PET tracer for TARP-γ8, enabling mechanistic studies, therapeutic monitoring, and precision imaging of excitatory circuits in the living brain.

NUCL 4413416

Matched radionuclides for theranostic applications

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The theranostic concept where similar or identical radiopharmaceuticals are used for tandem imaging and therapeutic strategies has been paradigm shifting for the field of nuclear medicine. The theranostic isotope pairing in FDA approved radiopharmaceuticals typically consists of two different radionuclides, for example ^{68}Ga for imaging and ^{177}Lu for therapy. A disadvantage of using this pair is that ^{68}Ga and ^{177}Lu are chemically different, which may result in different pharmacokinetics of radiopharmaceuticals labelled with these two compounds. The ideal theranostic pair would include radioisotopes of the same element (isotope pairs) but with different emissions (i.e., one suitable for diagnosis and the other for therapy). To this end, our group has focused on the production of ^{43}Sc and ^{47}Sc as a true matched theranostic pair for imaging and therapy as well as methods for production of ^{203}Pb as an imaging analogue for the therapeutic isotope ^{212}Pb. More recent work has focused on imaging analogues of F-block radionuclides including ^{155}Tb and ^{140}Nd, Additional research has developed chemistry to incorporate these radioisotopes into new imaging radiopharmaceuticals for preclinical and eventually clinical imaging studies.

NUCL 4413451

Radiopharmaceutical chemistry through the years: Tc and Re to As

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Radiopharmaceuticals are drugs containing a radioactive atom in their structure. Depending on their mode of radioactive decay, they are used for either diagnostic imaging or radiotherapy. Penetrating radiation (e.g., γ rays) is used for imaging and particulate radiation (e.g., α or β^-) is used for cell destruction because of its ionizing power. It turns out that the majority of radionuclides with nuclear properties suitable for either imaging or radiotherapy are metals. For example, ^{99m}Tc (6 h half-life, 140 keV γ) is the most widely used radionuclide for diagnostic imaging, and accounts for >80% of nuclear medicine scans performed. Lutetium-177 (6.6 d half-life, 0.5 MeV β^-) is an example of a therapeutic radionuclide with approved radioactive drugs for neuroendocrine and prostate cancers. The inorganic and radiochemistry of technetium, rhenium and other radiometals relevant to radiopharmaceutical development will be discussed.

NUCL 4413513

Chelators for Pb-203/Pb-212: Something old, something new

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Since initially reported in the literature over 35 years ago, there has been a resurgence of interest in the isotope Pb-212 ($t_{1/2}$ = 10.6 h; 100% beta minus) as an *in vivo* generator of the alpha-emitter Bi-212 ($t_{1/2}$ = 60.6 min). Pb(II), a borderline soft Lewis acid in the context of HSAB, has a $6s^2$ inert pair of electrons that contribute to its polarizability, and the coordination environment is either hemidirected (ligands arranged on one side) for chelators with lower coordination number (4-6), or holodirected (symmetrically) for higher coordination ligands. Additional challenges as originally reported by Mirzadeh, Kumar, and Gansow in 1993 are that the electron conversion occurring with the beta minus decay of Pb-212 results in a highly ionized state of Bi-212 that results in ~36-40% release from DOTA, with other researchers showing similar behavior with TCMC, and PSC. Here we report on characterization of Pb-203 and Pb-212 complexes of the gold standard TCMC compared to cyclen-based chelators having combinations of acid, amide, and picolinate arms, with the goal of improving Bi-212 release from the chelator. Conjugation to the very late antigen-4 targeted molecule, LLP2A and biological behavior will be presented.

NUCL 4413549

Evaluating the scalability of an extraction chromatographic separation of gadolinium, terbium, and dysprosium

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To improve upon clinically utilized ^{177}Lu-based radiopharmaceuticals, ^{161}Tb has been investigated as an alternative therapeutic radionuclide payload, offering enhanced efficacy due to additional emission of higher linear energy transfer Auger and conversion electrons. No carrier added ^{161}Tb is produced in nuclear fission reactors via the ^{160}Gd $(n,\gamma)^{161}$Gd $(\beta^-)^{161}$Tb pathway and decays into stable ^{161}Dy. The challenge of purification is separation of neighboring lanthanides Gd, Tb, and Dy, which exhibit nearly identical chemical behaviors.

Our recent work reports an effective, computer-controlled, three-column procedure for separation of 50 µg quantities of Tb from 100 mg quantities of Gd_2O_3 target material using commercially available extraction chromatography resins (Figure 1). The 4.0 ± 0.6 h procedure has a Tb radiochemical yield of 80 ± 8% in 1.3 mL of 0.01 M HCl, a Gd decontamination factor of > (1.2 ± 0.3) × 10^5, and a Gd_2O_3 target recycling yield of 92 ± 11%. The developed radiochemical procedure is well suited for the preparation of high molar activity ^{155}Tb/^{161}Tb from 100 mg enriched $^{155}Gd_2O_3$/$^{160}Gd_2O_3$ targets irradiated with high intensity protons/neutrons.

In this work, we aim to scale this separation procedure from 100 mg toward gram-scale Gd_2O_3 targets. We evaluate LN2 resin capacity. We will also quantify Dy co-elution to assess its elution profile from the multi-step separation procedure. Ultimately, this work aims to provide insight into the feasibility of scaling Tb purification to production-relevant quantities using LN2 resin.

NUCL 4413610

Development of novel [^{89}Zr]Zr-DFO-Fab8 for immunoPET imaging of human pan-macrophages

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Macrophages are attractive imaging targets for diagnosis, monitoring disease progression or evaluating treatment response in inflammatory diseases. We report the development of a synthetic human Fab as a novel positron emission tomography (PET) radiotracer for imaging human CD68 (huCD68), the clinically established pan-macrophage marker.

We discovered Fab8, a novel Fab antibody fragment specific to huCD68. Fab8 was conjugated to p-SCN-Bn-DFO and radiolabeled with ^{89}Zr. The radiotracer's specificity for huCD68 in vivo was evaluated in mice bearing bilateral antigen plugs consisting of huCD68 plug and a bovine serum albumin (BSA) plug as a negative control on the contralateral side (**Figure 1A**).

Shown in Figures 1B and C are the maximum intensity projection (MIP) and the axial view, respectively. [^{89}Zr]Zr-DFO-Fab8 demonstrated specific uptake in the huCD68-plugs with minimal uptake in the contralateral BSA-plugs at 1- and 4- h p.i. (**Figure 1D**; $p = 0.0099$, $p < 0.0001$ respectively). The SUVR of [^{89}Zr]Zr-DFO-Fab8 in the huCD68-plug was 0.99 ± 0.20 and 2.15 ± 0.14 at 1 and 4 h p.i., respectively (**Figure 1D**). In contrast, the SUVR in the BSA-plug was 0.43 ± 0.10 and 0.92 ± 0.14 at 1 and 4 h p.i., respectively. Notably, the distribution of the tracer in both antigen plugs was heterogenous, yet voxel intensities were greater for huCD68 than that for BSA (**Figure 1E**). In conclusion, [^{89}Zr]Zr-DFO-Fab8 is a promising radiotracer for noninvasive imaging of macrophage burden in inflammatory diseases.

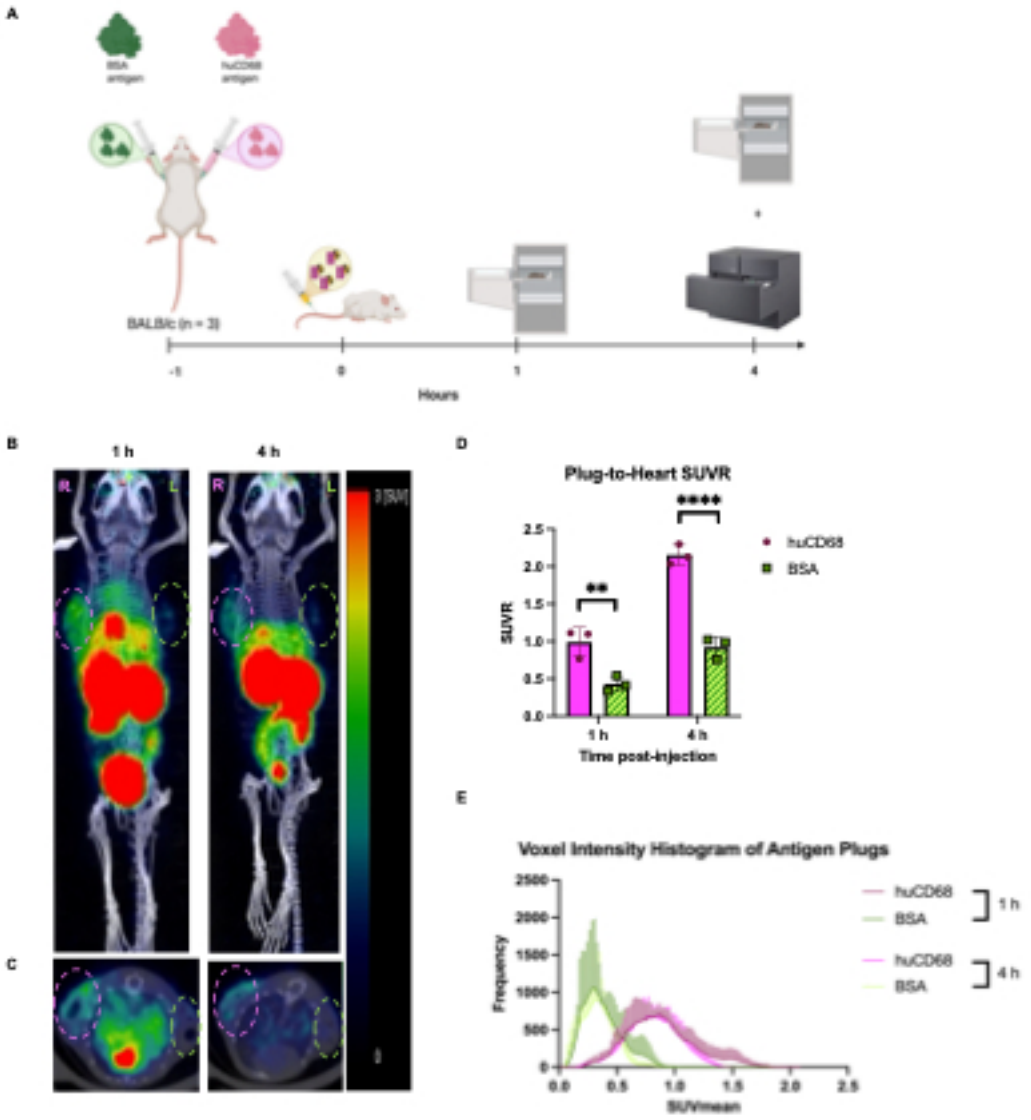

Figure 1: **PET/CT imaging of huCD68 and BSA antigen plugs**. **A.** Experimental design**. B.** Representative MIP **C.** Representative axial view. **D.** Plug-to-Heart SUVR over time post-injection. Significant differences at $p < 0.05$ indicated by **, $p = 0.0099$ ****, $p < 0.0001$ **E.** Voxel intensity histograms of antigen-plug SUVmean over time. R – right (huCD68) in pink L – left (BSA) in green. Circles with dotted lines highlight antigen plugs.

NUCL 4414046

Advancement of medically relevant radioisotopes

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The most typical technologies to produce medical isotopes are focused on cyclotron and reactor facilities. While continued production at these sites is integral to continued

growth within the field increasing access to a varied library of isotopes is necessary for additional advancement. This access can be in the form of the production of radionuclide generators to allow use of shorter-lived radioisotopes in facilities further away from cyclotrons and reactors. This can also be in the form of increasing the understanding of how to handle more exotic isotopes. Finally, it can be in the form of developing ligands to further the *in vivo* use of an isotope of interest. This talk will focus on the advancement of novel isotopes for medical applications.

NUCL 4414491

Development of theranostic radiopharmaceuticals

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Theranostics is a combination of the term's therapeutics and diagnostics. Theranostics is the term used to describe the combination of using one radioactive drug to identify (diagnose) and a second radioactive drug to deliver therapy to treat the main tumor or metastatic tumors. Recently, this field has grown tremendously as many agents have been translated to humans and a few reaching FDA approval. These theranostic agents generally comprise of a targeting vector, a linker, a radiometal chelator, and either the diagnostic or therapeutic radionuclide. The targeting vector must bind to its target with high affinity after modification, while the labeling kinetics, thermodynamic stability, charge, and lipophilicity must all be considered when designing a chelator and how these might affect in vivo biodistribution of the biological vector. Finally, the half-lives of the diagnostic and therapeutic radionuclides must be considered as well as the emissions of each. This presentation will give examples of the evaluation of several of these agents in preclinical models of cancer.

NUCL 4414584

Leveraging click chemistry to improve radiopharmaceuticals

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Over the past two decade, radiopharmaceuticals have cemented their pivotal place in the clinical management of cancer. The same time period has played witness to the remarkable advent of 'click chemistry', a family of molecular transformations that has had wide-sweeping impacts across the chemical sciences. In this lecture, I will cover several of the ways in which my lab has leveraged click chemistry to build better tools for the nuclear imaging and targeted radionuclide therapy of cancer.

NUCL 4414689

Studying ferrous iron dysregulation in vivo with 18F-TRX and positron emission tomography: Preclinical validation and first human experiences

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Redox cycling of iron powers various enzyme functions crucial for life, making the study of iron acquisition, storage, and disposition in the whole organism a worthy topic of inquiry. However, despite its important role in biology and disease, imaging iron in animals with oxidation-state specificity remains an outstanding problem in biology and medicine. To address this challenge, we developed a first in class reactivity-based probe of labile ferrous iron (18F-TRX) suitable for positron emission tomography studies in live animals and humans. Mechanism studies show tissue uptake of 18F-TRX is depedent on ferrous iron concentrations. Moreover, radiotracer uptake is detectable in diseases driven by known regulators of iron metabolism, like mTORC1. 18F-TRX can be used to identify tumor types most likely to respond to ferrous iron activated prodrugs. Lastly, we recently opened a clinical trial at UCSF testing 18F-TRX in patients with solid tumors, and tumor uptake of the radiotracer has been documented. In summary, these data provide the first snapshots of ferrous iron concentrations in vivo toward better understanding and exploiting therapeutically iron dysregulation in human diseases.

NUCL 4415129

Nuclear chemistry Summer School at San José State University

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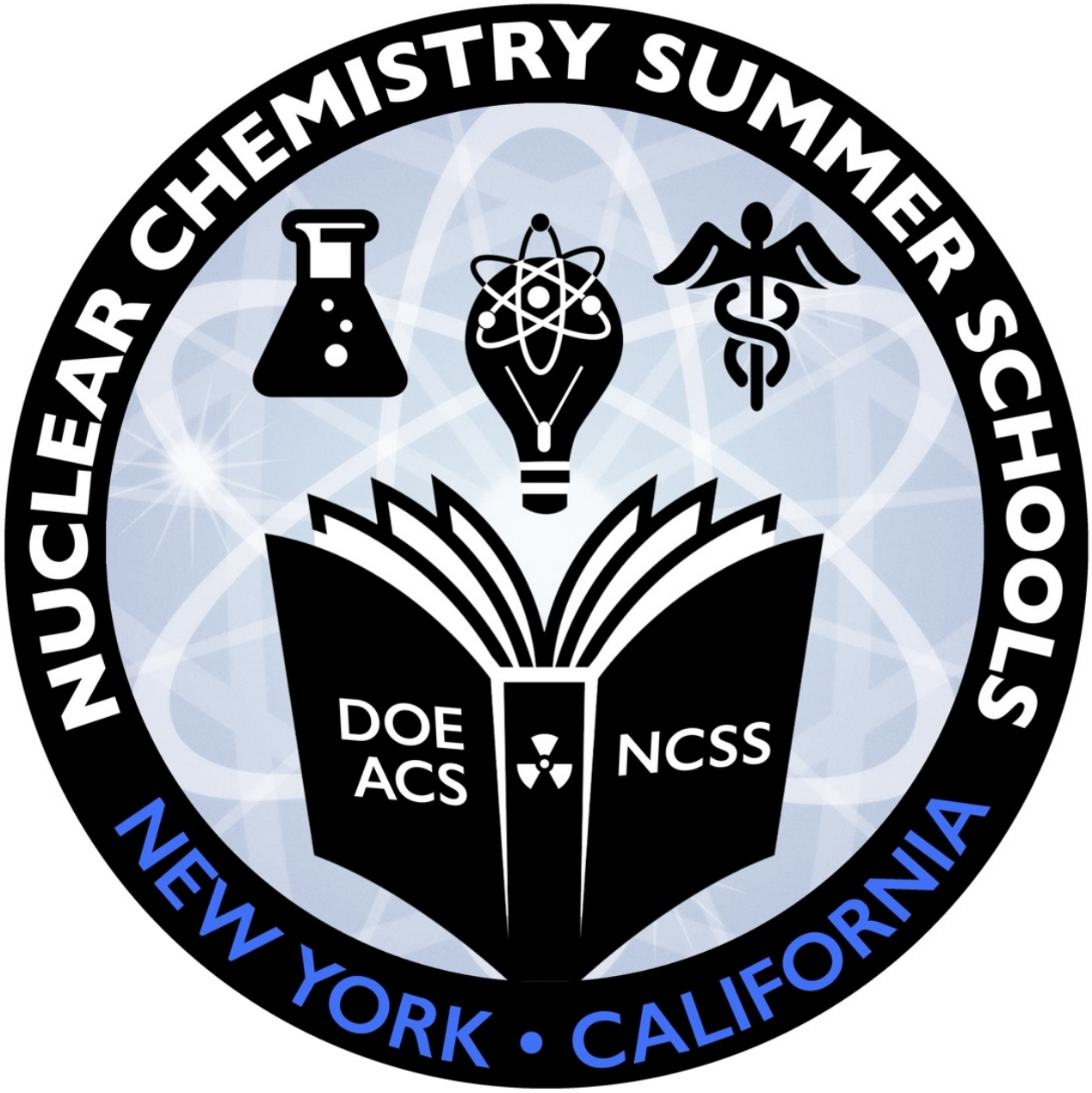
The Nuclear Chemistry Summer School (NCSS) is an intensive, six-week program designed to introduce advanced undergraduate students to the fundamentals of nuclear and radiochemistry through a series of in-classroom lessons and laboratory experiments. Supported by the Department of Energy (DOE) Office of Science and the ACS Nuclear Division, hundreds of students have been through NCSS at San José State University (SJSU) since its inception in 1984. The NCSS consists of a lecture course which introduces fundamental topics in nuclear & radiochemistry as well as spotlighting modern efforts including nuclear medicine, nuclear power, nuclear forensics, and related fields. Lab work is designed to introduce students to state-of-the-art instrumentation and techniques used in basic and applied nuclear science. We also feature a wide-ranging guest speaker series and field trips to nuclear science research institutions in the Bay Area including Lawrence Berkeley National Laboratory (LBNL), Lawrence Livermore National Laboratory (LLNL), and the University of California San Francisco (UCSF). Many of our graduates are now working as nuclear chemists at universities and national laboratories, and in private industry. Student feedback has consistently indicated that the NCSS is a transformative experience in their lives. This

presentation will discuss the origin, history, and evolution of the NCSS at SJSU. Most significantly, it will address the important question, “How can nuclear chemistry be so much fun?”



NUCL 4415134

Adventures in molten salt structure and reactivity in the molten salts in extreme environments energy frontier research center

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Molten Salt Reactors (MSRs) are a potentially game-changing technology that could enable cost-competitive, safe, and more sustainable commercial nuclear power generation. MSRs employ molten salts in the temperature range of 500 – 900 °C as coolants for solid-fueled reactors, or in other cases the nuclear fuel is dissolved in the salt as combined coolant and fuel. The development of reliable MSRs requires a comprehensive understanding of the physical properties and chemistry of molten salts and of their interfacial interactions with reactor materials. The mission of the Molten Salts in Extreme Environments EFRC is to provide fundamental and predictive understanding of molten salt bulk and interfacial chemistry that will establish robust principles to guide the technologies needed to deploy MSRs. MSEE addresses this challenge through coordinated experimental and theoretical efforts to elucidate the atomic basis of molten salt behavior, including interactions with solutes and interfaces, under the coupled extremes of temperature and radiation. This talk will describe how MSEE is using state-of-the-art instrumentation and computational capabilities to paint a detailed picture of how molten salts are structured on the atomic level and how that structure controls the speciation and properties of solute metal ions. The chemical effects of radiation on salts and solutes will be described through the reaction mechanisms of primary radical species.

NUCL 4415166

Developing HER2 positive targeting radiotracers with in vivo PET generator pair ^{140}Nd/^{140}Pr

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Theranostic strategies, where radiopharmaceuticals are used for targeted imaging and therapy often rely on F-block therapeutic isotopes including ^{225}Ac, ^{177}Lu, and ^{161}Tb. While there are only a few F-block PET imaging isotopes, the in vivo PET generator pair ^{140}Nd ($t_{1/2}$: 3.4 d, EC)/ ^{140}Pr ($t_{1/2}$: 3.4 min, 51% β^+) offers a potential theranostic imaging counterpart to these therapeutic radionuclides. In this study, we investigated the radiolabeling of Macropa and DOTA, and their Trastuzumab conjugates, with ^{140}Nd, and evaluated both ^{140}Nd-conjugates in vitro.
High-purity ^{140}Nd was produced at UAB's cyclotron facility via the ^{141}Pr(p,2n)^{140}Nd reaction and purified using an in-house method with DGA normal resin. Radiolabeling of Macropa and DOTA with ^{140}Nd was conducted at 37°C in 1M NH_4OAc buffer(pH 7).

Stability was assessed in PBS, saline, mouse serum, and human serum for up to five days at 37°C. Both Macropa and DOTA were conjugated to Trastuzumab in a 0.1M Na_2CO_3 buffer(pH 9), radiolabeled with ^{140}Nd, and their stability was evaluated. In vitro studies, cell uptake and internalization assays were performed using HER2 positive BT474 and HER2 negative MDA-MB-468 cells.
The highest molar activities obtained were 8.47 MBq/nmol for [^{140}Nd]Nd-Macropa and 8.05 MBq/nmol for [^{140}Nd]Nd-DOTA. [^{140}Nd]Nd-DOTA complexes remained >95% intact in all tested media over five days. [^{140}Nd]Nd-Macropa showed >95% stability in PBS, saline, and mouse serum but decreased to 77% in human serum. Macropa-Trastuzumab(32µg), DOTA-Trastuzumab(96µg) conjugates resulted in 100% radiochemical yields with 3.7 MBq of ^{140}Nd. The [^{140}Nd]Nd-DOTA-Trastuzumab complex maintained >95% integrity in all tested media over seven days, whereas [^{140}Nd]Nd-Macropa-Trastuzumab showed reduced stability, in mouse serum(65%) and in human serum(24%), while remaining stable (>95%) in PBS and saline. Uptake in HER2 positive BT474 cells was significantly higher($P<0.0001$) for both [^{140}Nd]Nd-Macropa-Trastuzumab(100.6±10.1% bound/mg, 0.1nM) and [^{140}Nd]Nd-DOTA-Trastuzumab(101.8±9.6% bound/mg, 0.1nM) compared with HER2 negative MDA-MB-468 cells, which showed 2.7±2.0% bound/mg and 4.7±2.9% bound/mg uptake, respectively. Blocking experiments with excess Trastuzumab significantly reduced tracer uptake in BT474 cells ($P<0.0001$), confirming target-specific binding. Future studies will assess the biodistribution and imaging properties of these agents in animal studies bearing HER2 positive and HER2 negative xenografts.

NUCL 4415402

Nanocarrier-mediated delivery of actinium-225 for precision targeted alpha therapy

Shaquria Funchess[1]*, shaquria@students.alcorn.edu, Zerykk Lee*[1]*, Thomas J. Ondera*[1]*, Cathy S. Cutler*[2]*. (1) Chemistry and Physics, Alcorn State University, Lorman, Mississippi, United States(2) Isotope Production and Research, Brookhaven National Laboratory, Upton, New York, United States*

Targeted Alpha Therapy (TAT) harnesses the potent cytotoxicity of alpha-emitting radionuclides to eradicate malignant cells with minimal collateral damage. Actinium-225 (Ac-225), with its favorable decay profile and high linear energy transfer, is a leading candidate for TAT. However, its clinical utility is constrained by challenges in systemic stability, daughter radionuclide retention, and tumor-specific delivery. We report the design and evaluation of a nanocarrier-based delivery system for Ac-225, engineered to enhance tumor targeting, radiochemical stability, and in vivo safety. The platform integrates biocompatible nanoparticles functionalized with tumor-homing ligands and multilayered encapsulation strategies to sequester radioactive decay products. This work underscores the potential of nanotechnology to overcome key limitations in alpha-emitter radiotherapy and paves the way for next-generation theranostic agents. Our findings support further translational development toward clinical application in metastatic and hematologic malignancies.

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NUCL 4416160

Tracing the legacy of Lynn Francesconi: From inspiration to collaboration - leveraging technetium chemistry expertise for nuclear forensics and isotope production

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The foundational work of Lynn Francesconi on technetium chemistry has long been a driving force behind my own research on technetium complex formation and thermodynamic data. Our paths crossed repeatedly, with numerous discussions and attempts to collaborate, particularly where my solvent extraction studies intersected with Lynn's investigations into polyoxometalate-technetium interactions. Ultimately, it was the critical need for advanced separation processes in nuclear forensics that brought our expertise together. This presentation will highlight how our combined strengths in technetium separation and inorganic chemistry have yielded innovative solutions for nuclear forensics and isotope production applications, and will discuss the ongoing collaborative projects that have emerged from this synergy.

NUCL 4416252

CD46 targeted theranostics for imaging and treatment of prostate cancer

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Molecular imaging and radiopharmaceutical therapy utilizing agents targeting prostate specific membrane antigen (PSMA) has transformed the standard of care in prostate cancer. However, as with all cancer imaging agents and therapies, there are notable limitations including heterogeneous or low target expression in some patients. This challenge has spurred great interest in studying new targets in prostate cancer with differential expression profile, with many demonstrating promise. We have recently identified CD46 as a targetable antigen in prostate cancer, with particularly high expression in aggressive disease including metastatic adenocarcinoma and neuroendocrine cancer phenotypes (Figure 1A, B). The YS5 antibody was developed which targets a cancer specific epitope present on tumor associated CD46, but not normal tissue antigen [1]. We have utilized this antibody to develop antibody drug conjugate (ADC), ^{89}Zr-labeled immunoPET [2], and ^{225}Ac labeled radiopharmaceutical agents [3], which have demonstrated great promise in preclinical studies (Fig 1B, C). More recently, the antibody drug conjugate and immunoPET agents have been translated into the clinic, with encouraging PSA responses seen in phase 1 dose escalation for the ADC (Fig 1D), and promising initial PET images observed in men with mCRPC (Fig 1E). Taken together, these results demonstrate promise for both imaging and treatment of prostate cancer targeting CD46.

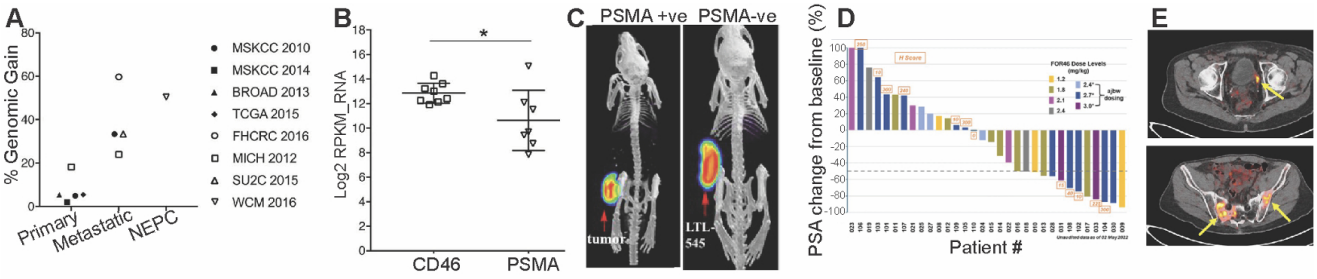

Figure 1. **CD46 is a promising target for theranostic development in prostate cancer.** (**A**) mCRPC shows high genomic gain for CD46 as compared to primary tumor. Data are from a public database. Studies were conducted by MSKCC, Broad Institute; The Cancer Genome Atlas; Fred Hutchinson Cancer Research Center; University of Michigan; Stand Up To Cancer; WCM. (**B**) Prostate cancer patients who have undergone CD46 genomic gain/amplification show significantly higher levels of CD46 mRNA expression. (**C**) PET/CT with [^{89}Zr]DFO-YS5 probe for PCa xenograft model imaging. (**D**) (Unpublished data) Waterfall plot from the phase 1 dose escalation trial of the CD46 ADC (FOR46), indicating a PSA50 response in 45% of patients. (**E**) (Unpublished data) PET/CT fusion images obtained in a man with mCRPC obtained 5 days after administration of [^{89}Zr]DFO-YS5 demonstrate high uptake in small a left pelvic sidewall lymph node (top) and right sacrum and left ilium osseous metastases (below).

NUCL 4416382

Radioterbium production and processing at the University of Missouri

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Terbium possesses four medically relevant radioisotopes, which are often referred to as the “Swiss Army knife” of nuclear medicine due to their versatile applications. Among these, therapeutic ^{161}Tb and diagnostic ^{155}Tb are a promising elementally matched theranostic pair, offering a potential alternative to the clinically established ^{177}Lu/^{68}Ga theranostic pair. Production pathways for ^{161}Tb and ^{155}Tb include the ^{160}Gd(n,γ)^{161}Gd→^{161}Tb and ^{153}Eu(α,2n)^{155}Tb nuclear reactions, respectively. However, various factors beyond the production route must be considered when developing new radionuclide products, such as chemical separations and enriched target material recycling. This presentation will highlight our efforts across the full radionuclide production cycle toward establishing domestic supplies of these promising radioisotopes of terbium.

NUCL 4416538

Near-quantitative recovery of ^{211}At via redox chemistry drives high-yield radiolabeling

Jehan S. Perera[1]*, jsperera@uab.edu, Jennifer Pyles*[1]*, Avinash K. Srivastava*[1]*, Christine Lawrence*[2]*, Marcus Le*[2,3]*, Laura McCann*[2,3]*, Justin Tobar*[2]*, Gabriel Tabacaru*[2]*, Lauren McIntosh*[2]*, Sherry Yennello*[2,3]*, Jonathan D. Burns*[1]*. (1) Chemistry, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States(2) Texas A&M University Cyclotron Institute, College Station, Texas, United States(3) Chemistry, Texas A&M University College of Arts & Sciences, College Station, Texas, United States*

Our investigations advance the fundamental chemistry of the short-lived, promising radionuclide ^{211}At with an eye toward targeted alpha therapy (TAT) applications. Given the limited number of production sites, ^{211}At is routinely shipped from the Texas A&M University Cyclotron Institute on 3-octanone–impregnated columns to Birmingham, AL. During transit, formation of a stable C–At adduct is observed, attenuating reactivity and depressing labeling efficiency. Conventional acid/base treatments, irrespective of molarity, were ineffective at recovering ^{211}At from the organic phase. By contrast, redox protocols proved effective: hydroxylamine provided ~70% recovery, whereas oxidants such as ceric ammonium nitrate, potassium permanganate, and sodium hypochlorite afforded near-quantitative recovery. DFT calculations support these observations and implicate 4-astato-5-hydroxy-octan-3-one as the most probable compound formed via AtO^+ addition to 3-octanone. Importantly, we recently found that redox reactivation of ^{211}At enables high-yield radiochemical labeling and provides a practical platform for next-generation, efficient radiopharmaceuticals for TAT.

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NUCL 4416569

Characterizing non-equilibrium ensembles and reaction cascades within concentrated alkaline electron ion networks

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The Ion Dynamics in Radioactive Environments and Materials (IDREAM) Energy Frontier Research Center (EFRC) seeks to master the cascade of radiation chemistry that drives far from equilibrium speciation and reactivity in chemically complex environments. IDREAM has uncovered new insights into precipitation and dissolution processes that are a grand challenge for processing the millions of gallons of legacy highly radioactive waste at the Hanford site, where plutonium was produced for the Department of Energy's weapons program. IDREAM has revealed the complex, multiscale behavior of ion networks in concentrated electrolytes in thermodynamic equilibrium and is now focused on reaction pathways that are only accessible when ionization/excitation provides a source of new chemical species in irradiated solutions. Key knowledge gaps include (1) how transient reactive species emerging from initial events lead to subsequent changes in ion and hydrogen-bonding networks, thus affecting longer-range solution structure, (2) the local chemical structures and reaction mechanisms leading to nonequilibrium distributions of redox states for elements such as techenium-99 (^{99}Tc), and (3) the processes by which these reactions occurring in irradiated electrolytes on "chemical reaction" time and length scales (nanosecond and nanometers) lead to long-lived (e.g., seconds to decades) nonequilibrium states. IDREAM is addressing these knowledge gaps through an integrated experimental and computational approach, providing a foundation to manipulate waste chemistry for resilient new processing schemes and establishing new paradigms for reactivity in extreme environments. We use redox active species, such as ^{99}Tc, as probes of redox response to radical generation and reaction in solutions upon exposure to radiation. After their formation, the radicals diffuse through the solution, altering local solvation structures and reacting with solute species to cause a reaction cascade of other radicals and short-lived species that can alter oxidation states as a function of time, dose, radical source, and solution concentration. We measure solution speciation using a combination of nuclear magnetic resonance, electron paramagnetic resonance, and X-ray absorption spectroscopy, and use these data as a basis for simulations of oxidation state changes and reaction pathways based on local ion-network structure and composition.

NUCL 4416940

Simulation of damage to reactor and target materials at high rates due to heavy ion irradiation

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Studying the changes in the physical properties of materials due to radiation exposure is a crucial aspect of design for both fusion and fission reactors, as well as high power target design. One way to quantify the damage induced via radiation exposure is by using a quantity known as displacements per atom (DPA). DPA quantifies how many times, on average, each atom in a material is displaced from its lattice site due to energetic particle collisions. Using a heavy ion such as tungsten to irradiate the target

allows for a much higher rate of DPA when compared to light ion beams like proton beams. Because of this, damage can occur at lower energies, avoiding the production of a radioactive target after irradiation, complicating the tear down of the experiment and post irradiation characterization. Using Monte Carlo simulations of damage we can design specific radiation configurations that produce a uniform DPA through the thickness of a thin foil, enabling the study of the physical properties of the target as the damage occurs. Additionally, if the beam and target materials are both tungsten, there will be no contamination of the target which may affect the measuring of the properties. After simulating this uniform damage, we aim to create this damage in a particle accelerator with heavy ion capabilities. The central goal of this experiment is to examine the physical properties of the material as the damage occurs. For example, both the thermal conductivity and electrical resistivity of tungsten targets can be measured in real time as a function of DPA, with resistivity offering a simple proxy for damage in future applications. These data will be useful in predicting the ability of the tungsten target to withstand high power proton beam irradiation without overheating.

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NUCL 4416995

Evolution of modern radiochemistry, from automation to zirconium-89!

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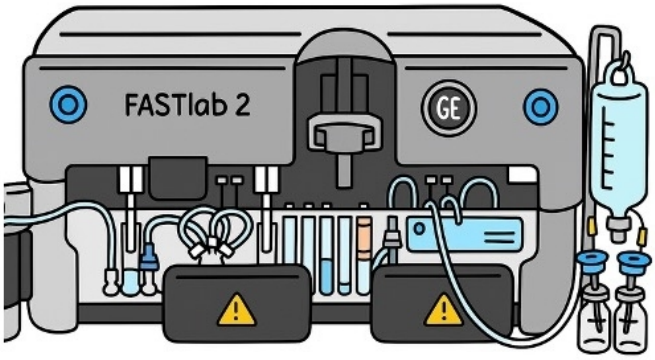
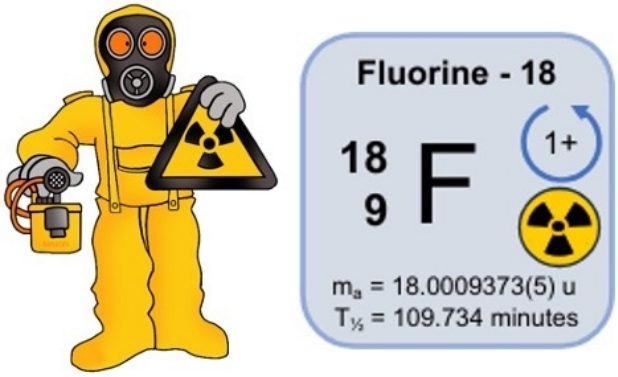
The last 25 years have witnessed unprecedented growth in nuclear medicine, from amyloid PET for diagnosis of Alzheimer's disease to the theranostics that are revolutionizing personalized cancer care. Underpinning all of this is the art and science of radiochemistry that has gone through several periods of transformation to keep pace with the growth in clinical utilization, and Dr. Henry VanBrocklin has been a thought leader in all of these different areas.

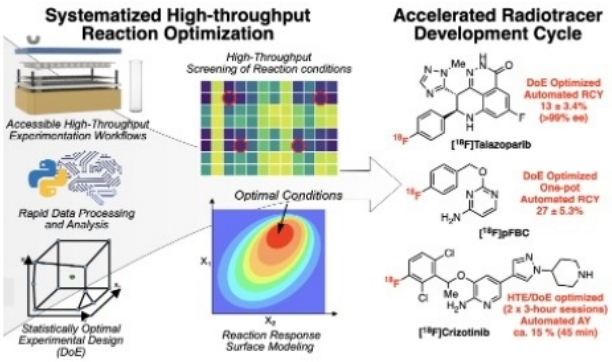
In honor of Dr. VanBrocklin winning the Seaborg Award in 2026, this presentation will provide a historical overview of PET radiochemistry from the earliest days of manual radiosyntheses to the state-of-the-art methods in use today. New developments that will be discussed include: modern automation, the introduction of 21CFR212 and the cGMP regulations for PET drugs, the development of new late-stage radiolabeling approaches for complex chemical space, the latest strategies for producing radiometals in cyclotrons, FDA-approval of modern theranostics, and the emerging use of high-throughput experimentation, data science techniques and artificial intelligence that are expected to drastically accelerate radiopharmaceutical development timelines in the future.



Automation

Regulatory Oversight





Radiochemistry

Artificial Intelligence

NUCL 4417052

From nuclear to radiochemistry; the path to improving health

Sherry J. Yennello[1,2], *yennello@mail.chem.tamu.edu, Jonathan D. Burns*[3,4], *Lauren McIntosh*[1], *Gabriel Tabacaru*[1], *Evgeny Tereshatov*[1]. *(1) Cyclotron Institute, Texas A&M University, College Station, Texas, United States(2) Chemistry, Texas A&M University, College Station, Texas, United States(3) Nuclear Engineering and Science Center, Texas A&M University, College Station, Texas, United States(4) Chemistry, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States*

With nearly 60 years of experience in nuclear chemistry and two cyclotrons Texas A&M has become a place for advancements and new discoveries with astatine. With a beam of 28.8 MeV alpha particles, an interdisciplinary team of chemists and physicists has developed a program to produce, purify and probe the chemistry of ^{211}At. We have developed a novel process for separation and delivery of astatine on a column that enables us to be a driver for radiochemical investigations toward the implementation of

astatine for Targeted Alpha Therapy. In addition to our own studies, we have partnered with radiochemists at leading research and cancer institutes to provide them with astatine for radiopharmaceutical development. This program will be described along with a Cogswell-connection flashback and a tribute to Ivor Preiss.

NUCL 4417151

From industry to academia: catalytic pathways toward sustainable chemicals

***Cheng Zhang**, cheng.zhang@liu.edu. Natural and Life sciences, Long Island University, Brookville, New York, United States*

In honor of Dr. Francesconi's Kinard Award, I will share highlights from my industrial and academic research experience, focusing on two catalytic systems for sustainable chemical transformations. First, I will present the direct synthesis of H_2O_2 from H_2 and O_2 over Pd–Pt nanoparticles, which advanced from research development to commercial demonstration (NxCat™ technology). By precisely controlling particle size, structure, composition, and dispersion, we achieved a selective and stable catalyst. Scale-up challenges such as colloid excess and support attrition were resolved, enabling a low-cost, green, and commercially viable process for H_2O_2 production. Second, I will discuss CO_2 hydrogenation using carbon nanosphere (CNS)–encapsulated Fe catalysts. The CNS–Fe system features ~40 nm Fe-based cores within ~10 nm graphitic carbon shells, offering stability and tunable reactivity. Characterization confirmed mixed Fe species within the core and defect-rich carbon shells. The catalysts displayed promising activity at ambient pressure, yielding CO and light hydrocarbons. These examples demonstrate how nanostructured catalysts can translate from fundamental design to real-world application, advancing green and sustainable chemistry.

NUCL 4417418

Claudin-4-targeted peptide theragnostic for pancreatic ductal adenocarcinoma

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Pancreatic ductal adenocarcinoma (PDAC) remains one of the deadliest cancers, with a five-year survival rate of only 8% and limited options for diagnosis or treatment. Claudin-4, a tight junction protein, is significantly overexpressed in PDAC and precursor lesions, making it a promising biomarker and therapeutic target. Our preliminary spatial transcriptomic and proteomic analyses showed a 16-fold increase in Claudin-4 expression in PDAC compared to normal pancreas, confirming its accessibility on the surface of tumor cells. Nuclear imaging techniques, such as positron emission tomography (PET), have advanced cancer detection, enabling the identification of Claudin-4 expression within tumors. Based on this, we propose a peptide-based

theragnostic approach to enable early detection and targeted therapy. Method: We synthesized three Claudin-4 peptides using solid-phase peptide synthesis and assessed their binding affinity with the biolayer interferometry (BLI) technique. The peptide structures were conjugated to a metal chelator (DOTA) through pegylated linkers and tested for serum stability. The peptides were radiolabeled with 68Ga and 64Cu radionuclides and evaluated preclinically in transgenic PDAC-KPTC mice model using PET/CT imaging technique. Results: We successfully synthesized the targeted peptides and confirmed their nanomolar binding affinity to the Claudin-4 protein. The serum stability results showed that tracers with longer PEG groups are more stable. We observed that tumor uptake of the tracers gradually increased during the first hour of the dynamic scan, exceeding 10% ID/g at 40 minutes post-injection (Figure 1). This uptake correlated with TdTomato expression, which marks cells expressing CLDN-4 in our genetically engineered model. Further studies are ongoing to evaluate the use of preclinical imaging with 64Cu-labeled peptides.

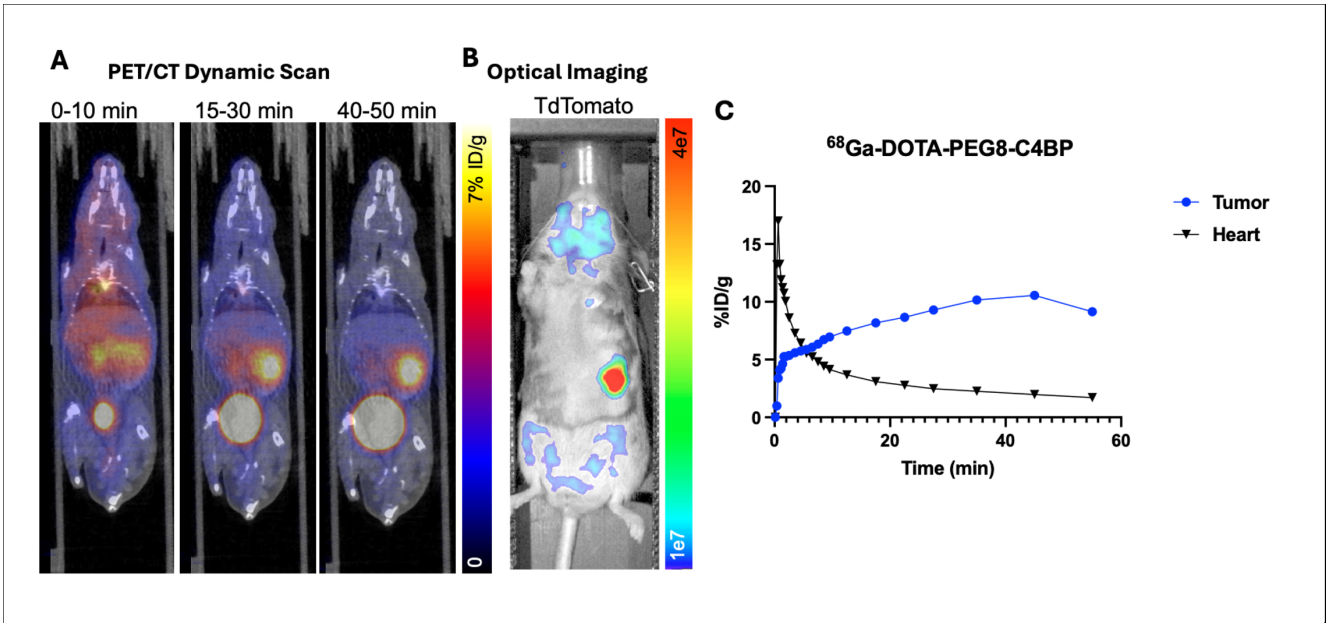

Figure 1. Preclinical evaluation of 68Ga-DOTA-PEG2-C4BP, a Claudin-4–specific peptide, in the KPTC transgenic mouse model. (A) PET/CT dynamic scans at different time points. (B) In vivo optical imaging of Claudin-4 expression. (C) Quantitative analysis of tumor and heart uptake, expressed as percentage injected dose per gram (%ID/g).

NUCL 4417611

Quest for an ^{18}F-labeled PET MPI agent: From fish toxins to fluorescent dyes

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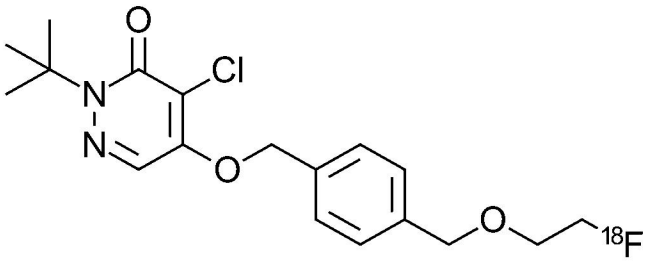
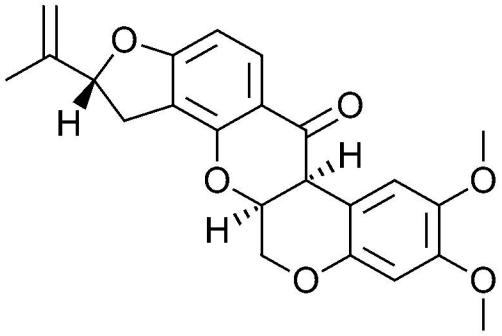
Since the introduction of ^{99m}Tc-MIBI for the evaluation of myocardial perfusion in the 1980s and the first PET scan in the 1970s, there has been considerable interest in the development of a PET radiopharmaceutical for the evaluation of myocardial perfusion. This interest is motivated by the fact that PET offers several important advantages over single-photon imaging including simpler attenuation corrections, higher spatial resolution, and the ability to do quantitative measurements of tracer uptake in the tissue of interest, all of which are important in the evaluation of myocardial perfusion.

Several PET agents are approved for the evaluation of myocardial perfusion including [^{13}N]NH_3 and ^{82}Rb, but these agents each suffer limitations to their widespread use including the short half-life of ^{13}N (10 min), which restricts its use to facilities with cyclotron access, the high cost of the ^{82}Sr/^{82}Rb generator, which restricts its use to the facilities with high patient throughput, and the high energy of the ^{82}Rb positron, which decreases image resolution. In contrast, the longer half-life of ^{18}F (110 min) allows its distribution from central production facilities, the cost is relatively low, and the lower positron energy of ^{18}F provides higher resolution images. These properties have fueled interest in the development of an ^{18}F-labeled myocardial perfusion imaging (MPI) agent.

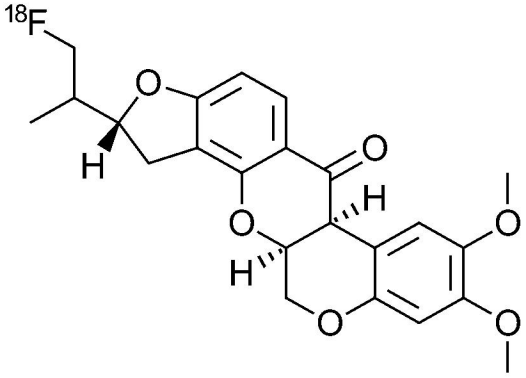
Efforts to develop an ^{18}F-labeled MPI agent have included ^{18}F-labeled tetraalkyl ammonium and tetraphenyl phosphonium compounds and rhodamine derivatives, lipophilic cations analogous to ^{99m}Tc-MIBI, and ^{18}F-labeled derivatives of rotenone, a piscicide (fish toxin), that binds to mitochondrial complex I, which presaged the development of ^{18}F-fluorpiridaz, the first FDA-approved ^{18}F-labeled compound for PET imaging of myocardial perfusion (Figure 1). The path to the first successful ^{18}F-labeled MPI radiopharmaceutical, including Dr. VanBrocklin's role in this path, will be the focus of this discussion.



Flupiridaz



Rotenone



Fluorodihydrorotenone

NUCL 4417711

Research on isotope production leading to unique isotopes and radiopharmaceuticals

Cathy S. Cutler*, ccutler@bnl.gov, Vanessa A. Sanders, Dmitri G. Medvedev. Isotope Research and Production, Brookhaven National Laboratory, Upton, New York, United States*

As the field of theranostics has advanced to deliver precision medicine. The vectors that have been derived to maximize delivery to the target and mitigate normal tissue uptake have become more precise and led to the search for novel isotopes that can be used to image for longer times and facilitate assessing the dosimetry of the resulting radiopharmaceutical as well as therapeutic radionuclides with a wider variety of nuclear properties such as half-life and energy that can be paired with the vector to deliver higher doses to the desired target and minimal dose to normal tissues.

These novel isotopes require more challenging production and handling methods with unique targetry and separations to meet the specifications required to be used in clinical trials. This talk will highlight the production of isotopes used for imaging and therapy in theranostics highlighting some of the challenges that have been overcome to provide these on the scale needed for clinical evaluations.

NUCL 4417717

Pivotal insights into lanthanide polyoxometalate complexes from the *oeuvre* of Lynn Francesconi

***Mark R. Antonio**, mark.ricci.antonio@gmail.com. Chemistry, Colorado School of Mines, Golden, Colorado, United States*

Today's knowledge of the chemistry of heteropolyoxoanions with lanthanide cations has its foundation in the research orchestrated by Lynn Francesconi. Nearly three decades ago, in 1997, she and her team (including Bartis, Dankova, Luo, Howell, Jing, Burton-Pye, just to mention a few former scholars) published explicative articles about the synthesis, stoichiometry, spectroscopy, and solution structures of α-1 and α-2 isomers of Wells-Dawson clusters with lanthanides. The work resolved conflicting and contradictory perspectives—making sense of the historical literature in deliberate and comprehensive fashion with insights that are still of contemporary relevance, especially in chemical separations. I will highlight Francesconi's influence and the impact of her epic campaign of polyoxometalate science with select projects involving electrochemistry and X-ray absorption studies from our collaborative endeavors (1998–2010). In looking backwards, but with an eye to her current recognition by the NUCL Division Kinard Award, it is easy to see how Francesconi's creative genius propelled her professional trajectory through technetium and lanthanide chemistry of polyoxometates to the present symposium.

NUCL 4417752

Reflecting on a half century's journey in inorganic chemistry and radiometal chemistry

***Lynn C. Francesconi**, Lfrances@hunter.cuny.edu. Chemistry, Hunter College, New York, New York, United States*

I am very honored to receive the 2024 W. Frank Kinard Distinguished Service Award. My seminar will reflect on my journey in inorganic chemistry and radiochemistry over the past 50 years and briefly the projects that I have worked on and people that I have worked with. After graduating from Ithaca College in 1974, I began my graduate studies in inorganic chemistry at the University of Illinois, Urbana. This experience led to a job in industry (Stauffer Chemical Company, inorganic phosphates) followed by a postdoctoral position (Columbia University and the University of Illinois, Urbana). This postdoc

opened an avenue to perform research in two relatively new areas for inorganic chemists in the early 1980's, specifically radiopharmaceutical science and Magnetic Resonance Imaging (MRI) agents in industry (Squibb). I was lucky to work with the fascinating transition element, technetium, for development of diagnostic imaging agents and gadolinium, for development of MRI agents. After Squibb, I continued to work with radiometals in the Department of Radiology, Hospital of the University of Pennsylvania. In spring, 1992, I joined the faculty of Hunter College of the City University of New York and embarked on a continuing 33+ year experience conducting research on technetium and other radiometals, polyoxometalates and lanthanides. I started the radiochemistry program at Hunter and I work with the Department of Energy and American Chemical Society Nuclear Chemistry Summer School, as its National Director. On these adventures, I met many colleagues and friends, who have driven the collaborative science and contributed to the enjoyment of this research. This journey has been made even more gratifying by sharing with my family, whose support and cheeky sense of humor, keep me grounded and living my best life.

NUCL 4417884

Spectroscopic study of activation product extractant systems: A story of Iron(III) and tributyl phosphate

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This study investigates the coordination behavior of nuclear activation products, specifically transition metal systems, to improve radiochemical separations and nuclear forensics. Understanding how metal-ligand complexes are formed is crucial for better separating radioactive materials and interpreting experimental results in nuclear forensics. The coordination behavior of activation products can be complex, especially in the presence of other metal ions, high acid concentrations and mixed-ligand systems. This presentation highlights some of the nuances and peculiarities of tributylphosphate (TBP) - Fe(III) extraction systems, probed by ^{31}P Nuclear Magnetic Resonance, x-ray Absorption, and Infra-red spectroscopies. The collaborative nature of this work is presented and experimental results compared to computational approaches.

NUCL 4417933

Navigating the ever changing regulatory climate of radiopharmaceutical production

***Cathy S. Cutler**, ccutler@bnl.gov. Isotope Research and Production, Brookhaven National Laboratory, Upton, New York, United States*

Radiopharmaceuticals are becoming ever more important as tools to aid physicians in diagnosing disease and how it functions, to choosing the right targeting vector and isotope for treatment and monitoring patient response. The ability to noninvasively assess disease and response has revolutionized how we treat patients and improved their quality of life. As radiopharmaceuticals are made as needed and are injected right away in small quantities, often nanomolar, their risks are negligible compared to traditional drugs.

The regulatory environment for radiopharmaceuticals has changed with time with the FDA establishing 21 CFR Part 212 for the manufacturing of PET radiopharmaceuticals. With 21 CFR Part 211 covering the manufacturing of other radiopharmaceuticals and the growing development of therapeutic radiopharmaceuticals requiring further engagment with the FDA to guide the advancement of these agents into clinical trials.

This talk will provide an overview of the regulatory requirements for radiopharmaceuticals, how things have changed with time and the challenges that are ongoing as the demand for radiopharmceuticals grows and the interest in big pharma in advancing new imaging and therapeutic agents.

NUCL 4417980

Minor actinide extraction leveraging complexant design in concert with phase modifiers: An effective synergy for SANEX

*KRISHNA P. GNYAWALI, **Jesse D. Carrick**, jdcarrick442@gmail.com. Chemistry, Tennessee Tech University, Cookeville, Tennessee, United States*

Global modernization and expansion of advanced computing platforms will drive energy demand into the 22nd century. Nuclear power is strategically positioned to meet the current and future needs of established and developing economies. A significant drawback to the expansion of nuclear power is the mitigation of spent nuclear fuel (SNF). Strategies based on selective actinide extraction (SANEX), specifically to remove the minor actinides (Am, Cm, and Np) can diminish the long-term radiotoxicity of SNF from thousands to hundreds of years while simultaneously decreasing the volume of SNF to be housed in a geologic repository. Selective extraction of the minor actinides from the chemically similar lanthanides is not trivial. Similar physical properties at the atomic level create numerous challenges. Work in the last decade in this laboratory has sought to define an appropriate tridentate, soft-Lewis basic, N-donor complexant for selective extraction of the minor An from Ln as an extension of the seminal work of Kolarik. Contemporary results have demonstrated the critical role alkoxy-substituent positioning on the bis-1,2,4-triazinyl-2,6-bipyridine core can have on conferring competency to successfully traverse the organic/aqueous interface of biphasic extraction systems. Recent examples have also shown the promise phase

modifiers can have on improving extraction systems towards industrial preferences including solubility in nonpolar diluents, fast complexation times, stability to high nitric acid concentration, as well as ease of recyclability. Current progress towards the aforementioned goals will be disseminated.

NUCL 4418033

Development of the Molten Salt Thermal Properties Database Thermochemical (MSTDB-TC) to describe complex salt chemistries through CALPHAD-based thermodynamic models

Zachary K. Gardiner*, zgardiner04@gmail.com, Jorge Paz Soldan Palma, Juliano Schorne-Pinto, Clara M. Dixon, Ronald E. Booth, Aiswarya Padinhare Manissery, Jack Wilson, Pandu Wisesa, Annabelle Husek, Lianna Eaton, Theodore M. Besmann. Nuclear Engineering Program, Mechanical Engineering Department, University of South Carolina, Columbia, South Carolina, United States*

This research supports the development of CALPHAD (Calculation of Phase Diagram) models for molten salt reactor (MSR) applications. The computational technique relies on experimental and computational thermochemical data, which are essential for constructing accurate Gibbs Energy Functions and phase diagram assessments. By centralizing these data in a standardized .json format, we enable a more efficient and reliable workflow for developing a multicomponent CALPHAD database. Within our research group, this data is used to expand, refine, and reinforce the Molten Salt Thermal Properties Database Thermochemical (MSTDB-TC), strengthening its role in the community as a reliable tool for thermodynamic predictions in complex melt chemistries.

NUCL 4418430

Award Address (Glenn T. Seaborg Award for Nuclear Chemistry sponsored by the ACS Division of Nuclear Chemistry and Technology). Reflections on a forty-year nuclear chemistry/molecular imaging career

Henry F. VanBrocklin*, henry.vanbrocklin@ucsf.edu. Radiology and Biomedical Imaging, University of California San Francisco, San Francisco, California, United States*

It is a cherished honor to receive the 2026 Glenn T. Seaborg Award for Nuclear Chemistry. During this award presentation, I will highlight my career journey along with my significant accomplishments in research and mentoring. I will honor my mentors and colleagues who played invaluable, supportive, and guiding roles throughout my career.

NUCL 4418668

Zirconium phosphate nanoplatelets as a potential radionuclide delivery mechanism: Uptake and binding affinity of ion relevant to radiopharmaceuticals

Brahamanage Don Imansha Madhushan[1]*, bimansha@uab.edu, Adrianna Orsi*[1]*, Jennifer Pyles*[1]*, Gabriel Tabacaru*[2]*, Lauren McIntosh*[2]*, Sherry J. Yennello*[2,3]*, Jonathan D. Burns*[1]*. (1) Department of Chemistry, The University of Alabama at Birmingham, Birmingham, Alabama, United States(2) Texas A&M University Cyclotron Institute, College Station, Texas, United States(3) Texas A&M University Department of Chemistry, College Station, Texas, United States*

The growing interest in Targeted Radionuclide Therapy (TRT) brings with it much potential, but many challenges still exist, especially in the area of binding and targeting of radionuclides. To address this, we investigated α-zirconium phosphate (α-ZrP), a layered nanomaterial, as a carrier for these radionuclides. The high inherent ion exchange capacity of α-ZrP and its plate-like morphology make it suitable for transport within biological systems. The pristine material exhibits an interlayer spacing of 7.6 Å, which can be enlarged by exchanging alkali metal cations (e.g., K^+, Rb^+, Cs^+) in place of protons. The ion exchange behavior of the A-ZrP derivatives with a variety of radiopharmaceutical surrogates, including transition metals, lanthanides, U, Th, along with ^{211}At, has been investigated. Uptake kinetics, ion binding affinity and retention, and stability against carbonate, phosphate, and HEPES buffers will be discussed in detail.

NUCL 4418668

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NUCL 4418851

Polyoxometalates as metal oxide mimics that probe technetium-99 oxidation state stability

Donna M. McGregor[1,2]*, donna.mcgregor@lehman.cuny.edu, Benjamin P. Burton-Pye*[1,2]*, Ramsey Salcedo*[2]*, Hossam Elshendidi*[1,2]*, Rachel E. Greenberg*[1,2]*, Ivana Radivojevic*[3]*, Lynn C. Francesconi*[2]*. (1) Chemsitry, Lehman College School of Natural & Social Sciences, New York, New York, United States(2) Chemistry, CUNY Graduate Center, New York, New York, United States(3) New York City College of Technology, New York, New York, United States*

Polyoxometalates (POMs) are nanosized metal oxide clusters that can be tuned to create coordination sites with specific properties. In this research we use the POMS to probe the oxidation state chemistry of Technetium-99 (Tc-99). Tc-99 ($t_{1/2}$: 2.1 x 10^5 years; b_{max}: 293.7 keV) is a high-yield by product of uranium-235 fission (6%) and a high-yield product found in legacy waste tanks at the Hanford National Lab site. Its long half-life and multiple oxidation states make its separation from other isotopes in spent nuclear fuel and from legacy waste tanks, highly challenging. During the PUREX (Plutonium Uranium Reduction EXtraction) process for example, the liquid-liquid extractions of U and Pu from nitric acid using tributylphosphate (TBP) in an organic solvent often result in the co-extraction of ^{99}Tc, which complicates reprocessing efforts. Furthermore, the radiation fields present in the waste tanks can result in both changes to the oxidation state of Tc and continual changes to its coordination environment. Separation of ^{99}Tc and then long-term storage both require a fundamental understanding of its redox chemistry. In this presentation we will focus on how the specific coordination environments of the plenary ($P_2W_{18}O_{62}^{6-}$) and lacunary Wells-Dawson ($P_2W_{17}O_{61}^{10-}$) and Keggin ($PW_{12}O_{40}^{3-}$) POMs stabilize different Tc oxidation states.

NUCL 4419059

Synthesis of monazite-type phases as potential nuclear waste forms

Jinyunping Zhou*, jz18@email.sc.edu, Hans Conrad zur Loye. University of South Carolina, Columbia, South Carolina, United States*

The safe management of high-level radioactive waste requires durable waste forms that ensure long-term isolation. Monazite-type ($LnPO_4$) materials are excellent candidates, with the hydrated precursor rhabdophane ($LnPO_4\,xH_2O$) playing a key role in their synthesis. However, the conventional rhabdophane-to-monazite transformation demands high temperatures (~1000 °C).
Here, we report a mild hydrothermal, acid-promoted route for synthesizing monazite phases, with reaction conditions probed as a function of pH and time. In situ X-ray diffraction provides insight into the structural transformation. To enable detailed structural characterization, high-temperature flux growth was employed to produce high-

quality binary, ternary, quaternary, and quinary monazite single crystals, while microwave-assisted synthesis enabled preparation of bulk samples. Finally, scaled-down flux conditions were adapted for $AmPO_4$, successfully producing single crystals from reactions using only ~1 mg of americium oxide. These results demonstrate practical strategies for generating monazite-type waste form compositions, including compositions that can simultaneously contain multiple actinide elements, under accessible experimental conditions.

NUCL 4419059

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NUCL 4419345

Targeting cytokines for PET imaging of cancer response and inflammation

***Nerissa T. Viola**, nviola@wayne.edu. Oncology, Wayne State University School of Medicine, Detroit, Michigan, United States*

The cytokines interleukin-23 (IL23) and interferon-γ (IFNγ) exert pleiotropic influences during innate and adaptive immune responses. Applications of detecting these soluble cytokines via immunoPET imaging in various tumor immunotherapy and inflammatory settings (e.g., inflammatory bowel disease) will be presented.

NUCL 4419755

3,4,3-(Li-1,2-HOPO) and its derivatives as common chelators for radiometal-based theranostic agents

Melissa A. Deri[1,2]*, melissa.deri@lehman.cuny.edu. (1) Chemistry, Lehman College, New York, New York, United States(2) PhD Programs in Chemistry and Biochemistry, CUNY Graduate Center, New York, New York, United States*

The 3,4,3-(LI-1,2-HOPO) ligand has a history of use in heavy metal sequestration with a strong affinity for tri- and tetravalent metals, particularly plutonium. Consisting of four hydroxamate groups on an acyclic backbone, this ligand is well suited for hard metal cations and can offer an octadentate coordination environment. These useful properties led to an interest in repurposing 3,4,3-(LI-1,2-HOPO) for radiopharmaceutical applications which necessitated the development of a bifunctional version for conjugation to targeting vectors. The bifunctional chelator, p-SCN-Bn-HOPO, was developed and evaluated extensively with zirconium-89 for use in positron emission tomography imaging. The ^{89}Zr-HOPO complex was found to radiolabel with ease under mild conditions and be highly stable both in vitro and in vivo. Since these initial investigations began, this promising chelator has been further evaluated with a range of both diagnostic and therapeutic radionuclides including $^{43/44/47}$Sc, ^{45}Ti, ^{134}Ce, ^{177}Lu, ^{225}Ac, ^{227}Th, and more. Variants of different backbone lengths to alter the cavity size and shape have been explored more recently as well. An overview of these studies will be presented demonstrating the broad range of possible applications of the 3,4,3-(LI-1,2-HOPO) and p-SCN-Bn-HOPO ligands.

NUCL 4419824

Structural and thermochemical evaluations of molybdenum binding

Kaithlyne Nguyen[1]*, Kaithnguy23@gmail.com, Emily Willis*[1]*, Jackson Stanley*[3]*, Charles Peterson*[2]*, Howard L. Hall*[3]*, Deborah A. Penchoff*[1]*. (1) Chemistry, University of Central Florida, Orlando, Florida, United States(2) Office of Advanced Research Computing, University of California, Los Angeles, California, United States(3) Institute for Nuclear Security, University of Tennessee, Knoxville, Tennessee, United States*

Molybdenum (Mo) is a transition metal with significance across multiple fields. It serves as a precursor for medically relevant compounds, supports advancements in the semiconductor industry, and acts as a valuable model system in nuclear chemistry. When reacted with fluorine gas, molybdenum forms molybdenum hexafluoride (MoF6), a compound characterized by its strong reactivity and chemical versatility. MoF6 is frequently studied as a safer substitute to other metal hexafluorides, which are critical in the nuclear industry. Its use enables researchers to explore the hydrolysis and behavior of hexafluoride compounds under various conditions.
This research focuses on understanding how molybdenum interacts with ligands through complexation. High-performance computing (HPC) and artificial intelligence (AI) tools are used to investigate binding selectivity, thermochemical stability, and coordination preferences. These insights not only deepen our knowledge of Mo-binding

behavior but also advance the design of safer experimental approaches and enhance applications of molybdenum in the nuclear field.

NUCL 4419883

Overview of the horizon-broadening isotope production pipeline opportunities (HIPPO) program

Lauren McIntosh[1], *lmcintosh@tamu.edu, Eszter Boros*[15], *Jonathan D. Burns*[2], *Melissa A. Deri*[3], *Paul Ellison*[4], *Jonathan W. Engle*[4], *Nicholas E. Esker*[5], *Lynn C. Francesconi*[6], *Reinier Hernandez*[4], *Suzanne E. Lapi*[7,2], *Veronika Mocko*[8], *Tara Mastren*[9], *Jorge Munoz*[10], *Jerry Nolen*[11], *Ellen O'Brien*[12], *Jennifer Shusterman*[13], *C E. Vermeulen*[12], *Sherry J. Yennello*[1,14]*. (1) Cyclotron Institute, Texas A&M University, College Station, Texas, United States(2) Department of Chemistry, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States(3) Chemistry, Lehman College, New York, New York, United States(4) Medical Physics, University of Wisconsin-Madison, Madison, Wisconsin, United States(5) Chemistry, San Jose State University, San Jose, California, United States(6) Chemistry, Hunter College, New York, New York, United States(7) Radiology, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States(8) Chemistry, Los Alamos National Laboratory, Los Alamos, New Mexico, United States(9) Nuclear Engineering, The University of Utah, Salt Lake City, Utah, United States(10) Physics, The University of Texas El Paso College of Liberal Arts, El Paso, Texas, United States(11) Physics, Argonne National Laboratory, Lemont, Illinois, United States(12) Isotope Program, Los Alamos National Laboratory, Los Alamos, New Mexico, United States(13) Nuclear and Chemical Sciences Division, Lawrence Livermore National Laboratory, Livermore, California, United States(14) Chemistry Department, Texas A&M University, College Station, Texas, United States(15) Chemistry, University of Wisconsin-Madison, Madison, Wisconsin, United States*

The Horizon-broadening Isotope Production Pipeline Opportunities (HIPPO) program was developed in response to a call from the Department of Energy's Isotope Production (DOE-IP) to develop the workforce necessary for the next generation of isotope production. Led by Texas A&M University, the program is made possible by principal investigators at Argonne National Laboratory, the City University of New York, Lawrence-Livermore National Laboratory, Los Alamos National Laboratory, San Jose State University, University of Alabama at Birmingham, University of Texas El Paso, University of Utah, and University of Wisconsin, Madison. Each summer since 2022, graduate and undergraduate students from across the country have been selected to take part in research at these institutions or supporting affiliates across the country, including Brookhaven National Laboratory, Michigan State University, and Oak Ridge National Laboratory. Student research projects encompass topics critical to the production and application of radionuclides for medical, industrial, and scientific purposes, including irradiation target materials science, low energy nuclear science, elemental nuclear chemical separations, and inorganic and organic radiochemistry. Near the summer end, students spend a week at one of several "HIPPOcampus"

summer schools at HIPPO institutions, focused on a topic of particular interest to DOE-IP, including accelerator isotope production, reactor isotope production, and targetry. The last week of the summer students and PIs attend a “HIPPOmoot,” hosted by a DOE national laboratory. A series of talks and tours introduce students to programs and opportunities at several DOE national laboratories with emphasis on activities at the host lab. Students also present their work from the summer. Successes and lessons learned will be discussed.

NUCL 4420299

Enhancing translational fidelity in radiopharmaceutical development through patient-derived xenograft models

***Denis Beckford Vera**, denis.beckford@gmail.com. Champions Oncology Inc, Hackensack, New Jersey, United States*

Radiopharmaceutical development depends on understanding not only chemistry and targeting design but also how these agents behave in biologically complex tumors. Highly characterized patient-derived xenograft (PDX) models, which preserve tumor heterogeneity, microenvironment, and prior treatment history, offer a translationally relevant platform to study biodistribution, dosimetry, and efficacy. By combining radiopharmaceutical approaches with well-annotated PDX libraries, researchers can capture variability in antigen expression, vascularization, and radiosensitivity, generating insights that guide compound selection, optimize dosing, and align preclinical findings with clinical reality. This talk will highlight how integrating PDX models into radiopharmaceutical evaluation can enhance translational fidelity and reduce risk in clinical development pathways.

NUCL 4420322

Development of a HOPO-based bifunctional ligand for PET imaging with ^{45}Ti

***Ama Panvilawaththe**[1,4], apanvilawaththe@gradcenter.cuny.edu, Grace Liles[2], Nvs Dinesh K Bhupathiraju[3], Lynn C. Francesconi[3,4], Suzanne E. Lapi[2], Melissa A. Deri[1,3]. (1) Chemistry, Lehman College, New York, New York, United States(2) Chemistry, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States(3) Chemistry, Hunter College, New York, New York, United States(4) PhD Program in Chemistry, CUNY Graduate Center, New York, New York, United States*

The development of novel imaging agents is essential for advancing positron emission tomography (PET) and fully realizing the potential of emerging radiometals. Among these, titanium-45 has attracted significant interest due to its half-life of 3.08 hours being well-matched to the biological kinetics of antibody fragments or nanobodies, as well as its favorable positron branching ratio of 84.8%. Despite this promise, the lack of robust bifunctional ligands capable of stably coordinating Ti(IV) under physiological conditions

has limited the translation of these isotopes into clinical radiopharmaceuticals. Previously, the bifunctional ligand p-SCN-Bn-HOPO was used to coordinate the PET imaging isotope ^{89}Zr and conjugate to the monoclonal antibody trastuzumab (^{89}Zr-HOPO-trastuzumab). This demonstrated that hydroxypyridinone (HOPO)-based scaffolds form exceptionally stable complexes both *in vitro* and *in vivo*, significantly reducing nonspecific bone uptake compared to the clinically used chelator DFO. More recent studies supported by the HIPPO program evaluating HOPO-based ligands with varying polyamine backbones (C-8, C-9, and C-10) identified the C-9 scaffold as the most promising candidate for ^{45}Ti, demonstrating 100% intact complex formation and stability over six hours in metal-challenge assays, as well as robust radiolabeling efficiency of 2.8 MBq with maintained integrity after six hours.
Herein, we describe the design, synthesis, and characterization of a new bifunctional ligand scaffold specifically tailored for ^{45}Ti. The architecture is built on a C9-polyamine backbone functionalized with four hydroxypyridinone (HOPO) pendant arms. The pendant arms form stable five-membered rings with the metal center, and the ligand coordinates in an octadentate fashion, maximizing stability. The linker incorporated into the framework enables modular conjugation to biomolecules such as nanobodies or antibody fragments, paving the way for targeted imaging applications. Synthetic routes were optimized to efficiently access the ligand, and the product was fully characterized using ^{1}H and ^{13}C NMR spectroscopy as well as mass spectrometry.
Future work will focus on conjugating the bifunctional chelator onto a PSMA-targeting nanobody, radiolabeling the construct with ^{45}Ti under mild aqueous conditions, evaluating *in vitro* serum stability, and performing *in vivo* biodistribution and imaging studies in small animal models.

NUCL 4420322

Development of a HOPO-based bifunctional ligand for PET imaging with ^{45}Ti

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The development of novel imaging agents is essential for advancing positron emission tomography (PET) and fully realizing the potential of emerging radiometals. Among these, titanium-45 has attracted significant interest due to its half-life of 3.08 hours being well-matched to the biological kinetics of antibody fragments or nanobodies, as well as its favorable positron branching ratio of 84.8%. Despite this promise, the lack of robust bifunctional ligands capable of stably coordinating Ti(IV) under physiological conditions has limited the translation of these isotopes into clinical radiopharmaceuticals. Previously, the bifunctional ligand p-SCN-Bn-HOPO was used to coordinate the PET imaging isotope ^{89}Zr and conjugate to the monoclonal antibody trastuzumab (^{89}Zr-

HOPO-trastuzumab). This demonstrated that hydroxypyridinone (HOPO)-based scaffolds form exceptionally stable complexes both *in vitro* and *in vivo*, significantly reducing nonspecific bone uptake compared to the clinically used chelator DFO. More recent studies supported by the HIPPO program evaluating HOPO-based ligands with varying polyamine backbones (C-8, C-9, and C-10) identified the C-9 scaffold as the most promising candidate for ^{45}Ti, demonstrating 100% intact complex formation and stability over six hours in metal-challenge assays, as well as robust radiolabeling efficiency of 2.8 MBq with maintained integrity after six hours.
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Future work will focus on conjugating the bifunctional chelator onto a PSMA-targeting nanobody, radiolabeling the construct with ^{45}Ti under mild aqueous conditions, evaluating *in vitro* serum stability, and performing *in vivo* biodistribution and imaging studies in small animal models.

NUCL 4420476

Development of high-throughput radiochemistry for theranostic radiometal combinations

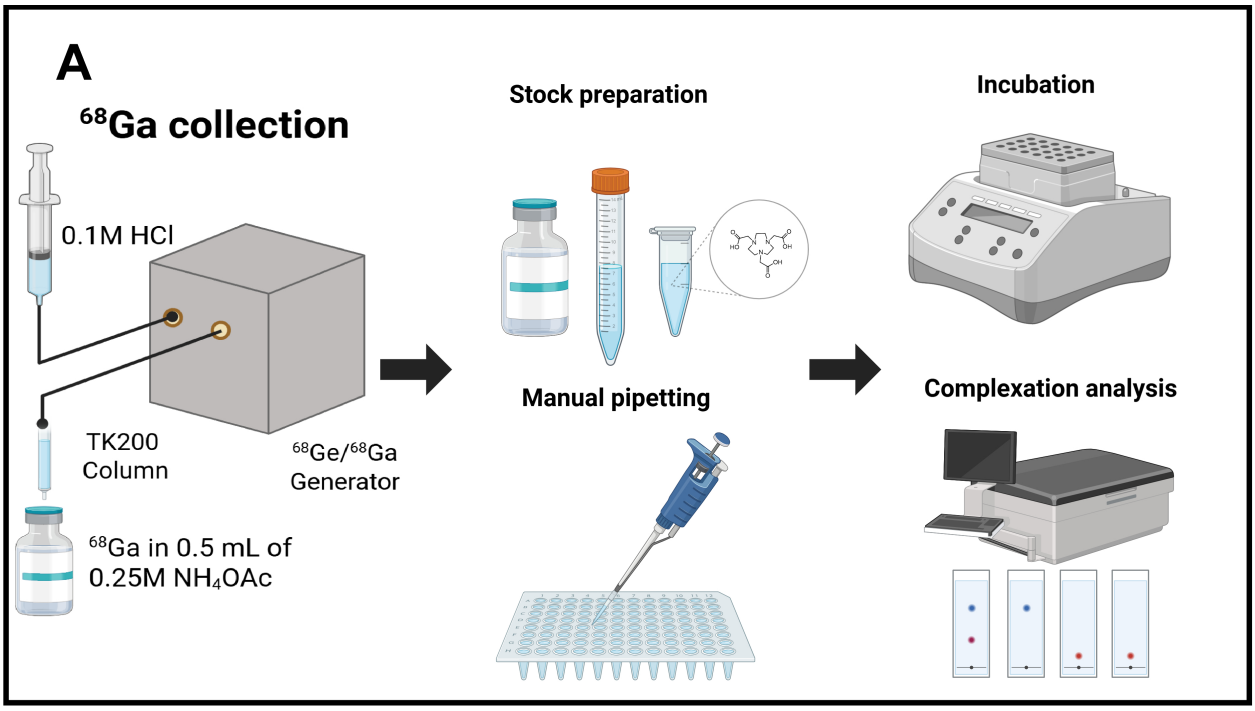
Shelbie Cingoranelli[1]*, cingoran@med.umich.edu, Samantha Boisvert*[2]*, Gregory D. Bowden*[3]*, Eric W. Webb*[1]*, Allen F. Brooks*[1]*, Melanie S. Sanford*[4]*, Peter Scott*[1,2,5]*. (1) Radiology, University of Michigan Michigan Medicine, Ann Arbor, Michigan, United States(2) Medicinal Chemistry, University of Michigan, Ann Arbor, Michigan, United States(3) Experimental Neurooncological Radiopharmacy, Helmholtz-Zentrum Dresden-Rossendorf Institut fur Radiopharmazeutische Krebsforschung, Leipzig, SN, Germany(4) Chemistry, University of Michigan, Ann Arbor, Michigan, United States(5) Pharmacology, University of Michigan, Ann Arbor, Michigan, United States*

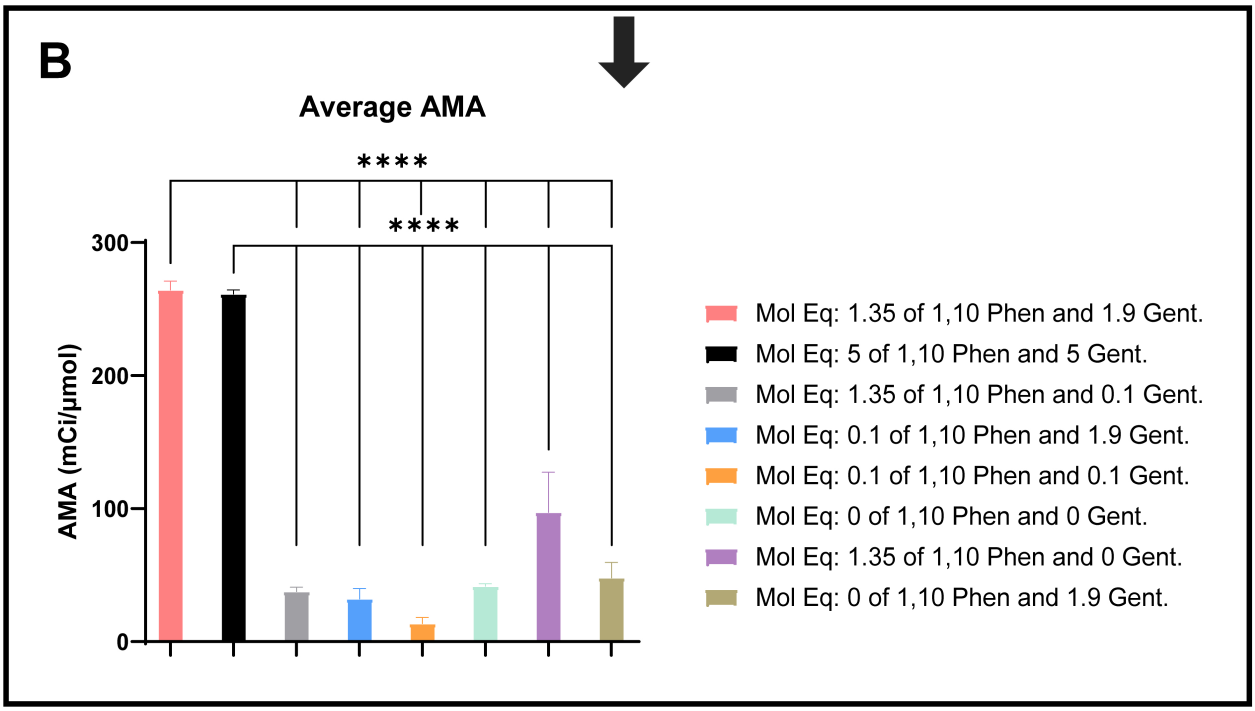
Theranostic radiopharmaceuticals, which integrate diagnostic imaging with targeted radiotherapy, are transforming personalized cancer treatment. However, realizing their full potential requires faster methods for optimizing diagnostic-therapeutic pairs. A major bottleneck is the lack of high-throughput experimental (HTE) platforms for systematically evaluating key variables, such as chemical structure, specific activity, radionuclide availability, and radiochemical behavior.
We have previously introduced methods for HTE radiochemistry. Here, we extend the concept to radiometals and present a scalable HTE platform using generator-derived ^{68}Ga, designed to accelerate screening of chelation conditions. Using 96-well PCR plates on a thermomixer, we systematically varied parameters including ^{68}Ga

concentration, chelator type (NOTA/DOTA) and amount, and formulation additives. Radiochemical conversion was measured using instant TLC with gamma counting, and validated by radioTLC scanning of select wells.

In one screen, varying molar equivalents (0.1-5) of 1,10-phenanthroline and gentisic acid significantly enhanced apparent molar activity for NOTA (62.5–0.02nmol), particularly at higher additive concentrations after incubation at 95°C for 30 min. These findings demonstrate the platform's ability to rapidly identify favorable conditions for ^{68}Ga complexation.

Ongoing efforts aim to expand this system for the multiplexed screening of chelators and Prostate Specific Membrane Antigen-targeting vectors, integrate fully automated pipetting and PET-based analysis, and simultaneously evaluate conditions for ^{68}Ga- and ^{177}Lu-labeling. Future work will include *in chemico* and *in vitro* screening of the top-performing radiopharmaceuticals identified, supporting the rational selection of optimized theranostic pairs. This approach offers a promising route to accelerate the development of next-generation theranostic agents.





NUCL 4420724

23 years of teaching nuclear chemistry at the University of Wisconsin-La crosse

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Teaching nuclear chemistry at a four-year comprehensive university to students with minimal background in physical science and mathematics is challenging. Student populations in nuclear chemistry classes at UW-La Crosse are dominated by Nuclear Medicine Technology majors. This degree program only requires college algebra and introductory science classes before the students take nuclear science courses in physics, biology, and chemistry. This presentation will discuss ways of overcoming these challenges while enhancing student learning. Teaching methods and tools, as well as assessment results, will be presented. Specifically, the integration of laboratory with lecture and the evolution of a textbook for teaching nuclear chemistry at the sophomore level will be discussed.

NUCL 4420938

Frontiers of isotope separations: Past innovations and future directions

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Isotope production relies on chemical separations, which determine yield, purity, and downstream utility in radiolabeling, generator systems, and the development of radiopharmaceuticals. Chemists bridge the gap between production and end-use by designing and validating methods that ensure quality and reproducibility. Chromatography resins remain central for selective purification, while exploiting acid concentration gradients enables precise control of elution profiles. Past efforts, such as the use of polyoxometalates, illustrate how classical coordination chemistry strategies have been applied to address challenging separations.
Looking ahead, automation represents the next frontier in isotope separations. By combining advanced chromatography resins with programmable flow systems, automation reduces error, accelerates processing, and enables reproducible, scalable workflows. These developments highlight how established chemical principles can be translated into high-throughput solutions, defining the future of isotope separations and strengthening their role in advancing medicine, research, and energy.

NUCL 4421434

Legacy of innovation: The future of radiochemical separations in honor of George K. Schweitzer

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The selective separation of lanthanides and actinides remains a significant challenge with broad implications in national security and economic competitiveness. This presentation highlights the development and application of high performance computing (HPC) and artificial intelligence (AI) protocols to optimize separations. By employing predictive modeling, we accelerate the design of novel extraction systems and enhance selective binding processes for two vital areas: the separation of rare earth elements, and the selective binding to lanthanides and actinides for nuclear forensics and nonproliferation applications. Integrating these HPC- and AI-driven techniques provides a powerful framework for optimizing separations. This presentation, given in honor of Professor George K. Schweitzer, builds upon his foundational contributions to radiochemical separations, illustrating how his legacy of innovation inspires the integration of modern computational tools to solve enduring challenges in radiochemistry.

NUCL 4421546 - Withdrawn

NUCL 4421546 - Withdrawn

NUCL 4421828

Ion-exchange separation of astatine-211 from bismuth targets: Expanding the 'wet-harvesting' toolkit

Steven Schultz[1,2,3]*, sjschultz@tamu.edu, Evgeny Tereshatov*[1]*, Lauren McIntosh*[1]*, Jonathan D. Burns*[4]*, Sherry J. Yennello*[1,2]*. (1) Texas A&M University Cyclotron Institute, College Station, Texas, United States(2) Chemistry, Texas A&M University, College Station, Texas, United States(3) C-IIAC, Los Alamos National Laboratory, Los Alamos, New Mexico, United States(4) Chemistry, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States*

Efficient purification of astatine-211 (^{211}At) from irradiated bismuth (Bi) targets remains a key challenge for producing research- and therapy-grade ^{211}At, given its short half life and complex, redox-sensitive speciation. We investigated ion-exchange strategies that exploit differences in the sorption behavior of ^{211}At and Bi in nitric acid media. This work presents (i) distribution coefficients (K_d) for ^{211}At and Bi on a panel of candidate resins—including strong-base anion exchangers, strong-acid cation exchangers, and soft-donor sulfur-functionalized resin—over a wide range of HNO_3 conditions; and (ii) translation of the most promising resin/chemistry combinations to column chromatography suitable for routine target processing. We map regions where At and Bi exhibit pronouncedly different K_d trends, enabling practical separation windows. Column chromatography experiments demonstrate selective retention/elution schemes that deliver ^{211}At free of Bi and organic extractants. As the demand for ^{211}At grows, so too will the need for a broader “wet-harvesting” and separations toolkit.

NUCL 4421884

Update on the University of Iowa Graduate Certificate Program in Radiochemistry: Lessons learned from year 1 and plans for the future

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The field of radiochemistry is critical across a diverse range of areas, yet challenges persist in meeting workforce needs at both the national and global scale. Radiochemists contribute essential expertise in a variety of sectors including nuclear energy, medical diagnostics and therapy, environmental monitoring and remediation, national security, nuclear forensics, and preparedness and response. To address this challenge, we have developed and launched the Radiochemistry Graduate Certificate Program at the University of Iowa, in partnership with the Association of Public Health Laboratories, a first in the nation program that offers a continuing education opportunity for those currently in the workforce. This program offers asynchronous online courses and an intensive two-week laboratory experience as a continuing education opportunity for laboratory workers, while also providing advanced training for graduate students at the University of Iowa. Here we will describe what we learned from running the program during the 2024-2025 academic year and how we are growing the program with plans to expand to other areas of radiochemistry beginning in Fall 2026. Preliminary results from newly implemented pre- and post-content assessments, from currently enrolled students, as well as data from a six month follow-up survey for the first class of program graduates will be discussed to provide insight into student outcomes. Moreover, takeaways from initial stakeholder meetings across radiochemistry sectors will be highlighted, in terms of areas to cover in new modules, with a chance for the community to provide feedback as well.

NUCL 4421886

Neutronics behavior of lithium-beryllium fluoride molten salt systems with highly enriched uranium cores: Implications for naval and aerospace reactors

John-Ryan Lawrence[1,2]*, john-ryan.lawrence@students.tamuk.edu, Jingbo L. Liu*[3]*, Sajid Liu*[3]*. (1) Electrical Engineering, Texas A&M University-Kingsville, Kingsville, Texas, United States(2) Chemistry, University of North Texas, Denton, Texas, United States(3) Chemistry, Texas A&M University-Kingsville, Kingsville, Texas, United States*

Molten salt systems based on lithium-beryllium fluoride (FLiBe) have long been considered for advanced reactor concepts due to their favorable neutronic and thermophysical properties. In this work, we present a theoretical neutronic analysis of a compact highly enriched uranium (HEU) core moderated and cooled by Li-Be-F. Using Monte Carlo methods, we investigate reactivity coefficients, neutron spectra, and moderation behavior under a range of core geometries and enrichment scenarios. Comparisons with conventional thermal-spectrum molten salt reactor configurations

reveal distinct trade-offs in neutron economy and breeding potential. While this study is framed as a theoretical exploration, the results suggest possible future applications in compact naval or aerospace reactor systems, where high power density and thermal resilience are critical. These findings provide insight into the fundamental neutronics of HEU-LiBeF systems and identify directions for further study in advanced nuclear propulsion and power generation.

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NUCL 4425569

"Hot" Seat: Getting to know people in the field of nuclear and radiochemistry

Dustin W. Demoin[1]*, dustin.demoin@ezag.com, Outi Keinanen*[2]*, Vanessa A. Sanders*[3,4]*. (1) Radiochemistry, Eckert & Ziegler Isotope Products Inc, Valencia, California, United States(2) Chemistry, The University of Alabama at Birmingham College of Arts and Sciences, Birmingham, Alabama, United States(3) Isotope Research and Production, Brookhaven National Laboratory, Upton, New York, United States(4) Production, Eckert & Ziegler Analytics, Atlanta, Georgia, United States*

A rapid-fire Q&A format called **“Hot" Seat** (radioactive pun intended). Each player (radiochemist) will have to answer a series of short, prewritten questions about their career, field outlook, mentoring style, work, hobbies—the usual “how do you do it?” questions people want to know.

The catch?
The player answers briefly—unless someone in the audience follows up with a “Why?”
The questions are pre-written but not revealed to the player until the session, to keep it authentic and less polished.
We will include a mix of career stages from various places within the workforce.

It will be a fun, fast-paced way to engage with researchers in nuclear and radiochemistry and share some real talk.

NUCL 4426226

Synthesis of polydentate verdazyl ligand for the characterization of uranyl-radical complexes

***Anna Buryachenko**, anna.buryachenko@sjsu.edu, Jesus Tamayo, Katherine Liu, David J. Brook. Chemistry, San Jose State University, San Jose, California, United States*

Verdazyl ligands have demonstrated viability in studying radical coordination complexes, as they
are redox-active and maintain this activity when coordinated to metal ions. They have also
shown strong magnetic exchange interactions between the radicals and the coordinated metal
ions. Together this has resulted in electronic structures that exhibit unusual properties such as
valence tautomerism (in which isomers differ in the distribution of electrons between the metal
and ligand) and redox induced spin-state switching. Actinides have the potential for novel
coordination chemistry because of their spatially extended 5f orbital, with actinide coordination
compounds offering many potentially exciting avenues for exploration, especially with radical
ligands. We are reporting on our ongoing work to design a polydentate verdazyl ligand for the
synthesis and characterization of actinide-radical complexes.
To test the coordination capacity of such a polydentate ligand with actinides, we are using a
polypyridine-hydrazone ligand. It was synthesized via a condensation reaction between
2,6-pyridinedicarboxaldehyde and hydrazinopyridine to coordinate to a uranyl ion. The success
of the coordination is investigated using IR spectroscopy and x-ray diffraction, and the magnetic
behavior is measured using a vibrating sample magnetometer.
Preliminary studies with the polypyridine-hydrazone ligand provide the foundation for

verdazyl
polypyridine ligand synthesis and uranyl coordination. Success with studying the uranyl-radical
complex will allow for further studies with other actinides. This actinide coordination work is
supported by HIPPO, with the goal of further developing actinide specific ligands to continue
investigating the chemical and physical properties of these radical complexes.

NUCL 4426239

Nuclear targetry at SJSU

Nicholas E. Esker*, nicholas.esker@sjsu.edu, Brandon Barrios, Willem Botha, Alexandra Brilz, Emily Foreman, Sofia Malmhall, Dlijah Mylius-Aceves, Gabriel Preciado, Simar Randhawa, Phu Vo, Justice Wilkes. Chemistry, San Jose State University, San Jose, California, United States*

The SJSU Nuclear Targetry Lab is an accelerator-independent nuclear targetry lab that was recently established at San José State University. Isotope production and the broader experimental nuclear science community have long been dealing with a limited supply of well-made targets. This is brought on by the sparse pool of early career personnel, the retirement of many seasoned targetry professionals, and the closure of several legacy targetry labs. In siting this laboratory at a primarily undergraduate institution (PUI) and being a partner institution for HIPPO, our team seeks to create exciting opportunities for supporting undergraduate student research in isotope production through accessible and impactful targetry projects. In this way, we hope to help strengthen and broaden the next generation of the isotope production & nuclear science workforce.
We present our group's broad program of stable and radioactive target production. Focusing on thin film targets, the SJSU targetry group is able to make and characterize nuclear targets for a variety of experimental applications. Current production techniques include physical vapor deposition (PVD), electrochemical deposition including the molecular plating of rare isotopes, cold rolling of ductile materials, solvent casting for deuterated plastic targets, and others. SJSU's target characterization capabilities include microscopy for surface morphology, FTIR / ICP-OES for elemental and chemical analysis, and α-energy loss for film thickness. We demonstrate these capabilities through recent successes including the production of radioactive $^{238}UF_4$ targets via PVD, a near-unique capability for a PUI.

NUCL 4430886

Improving target production for astatine-211 production at texas a&m's cyclotron institute

Kaiser Himmelberg[2]*, khimmelberg@hillsdale.edu, Emily Burhans*[1,3]*, Marcus Le*[1,3]*, Lauren McIntosh*[1]*, Sherry J. Yennello*[1,3]*. (1) Cyclotron Institute, Texas A&M University, College Station, Texas, United States(2) Chemistry, Hillsdale College, Hillsdale, Michigan, United States(3) Chemistry, Texas A&M University, College Station, Texas, United States*

Astatine-211 has shown much promise as an isotope for targeted alpha therapy, which is a way to treat cancer by supplying alpha radiation directly to the cancerous cells, while minimizing damage to healthy tissue. Targets are currently produced at TAMU by melting a puddle of bismuth onto an aluminum target. This can be improved by electrodeposition of bismuth directly onto the aluminum. Electrodeposition is an improvement as less bismuth oxide forms on the target and it is easier to dissolve the target once irradiated. This electrodeposition has been shown effective when pretreating the aluminum in a molybdate solution. This is, to the author's knowledge, a novel way to produce bismuth-plated aluminum. To facilitate this pretreatment the aluminum was first scrubbed with a wire brush to make deep groves for a stronger bond, followed by an etching with dilute sodium hydroxide to remove the oxide layer. The aluminum was then treated with a dilute sodium molybdate solution in acetic acid, followed directly by an acidic bismuth nitrate solution for electroplating. This yields a stable plating up to 400mm which is resistant to flaking and can be sanded down. Different methods of protecting some of the aluminum in the electroplating bath are being tested, so only a portion of the aluminum gets plated. The current best method involved covering the aluminum where the plating is not desired in a thin layer of petroleum jelly. This bismuth-plated aluminum has promise for other areas in materials science beyond targets for isotope production.

NUCL 4430886

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NUCL 4430898

Mesoporous silica-based resin for selective separation of ^{86}Y from strontium using single-column chromatography

Penafrancia Monte[1,2]*, pmonte@gradcenter.cuny.edu, Nvs Dinesh K Bhupathiraju*[2]*, Caitlin Quinn*[3]*, Marc Florent*[4]*, Samuel L. Groveman*[5]*, Eduardo Aluicio-Sarduy*[6]*, Jonathan W. Engle*[6,7]*, Paul Ellison*[6]*, Jennifer Shusterman*[8]*, Lynn C. Francesconi*[1,2]*. (1) PhD Program in Chemistry, CUNY Graduate Center, New York, New York, United States(2) Chemistry, Hunter College School of Arts and Sciences, New York, New York, United States(3) Chemistry and Biochemistry, University of Delaware, Newark, Delaware, United States(4) Chemistry and Biochemistry, The City College of New York, New York, New York, United States(5) Chemistry and Environmental Science, Medgar Evers College, New York, New York, United States(6) Medical Physics, University of Wisconsin-Madison, Madison, Wisconsin, United States(7) Radiology, University of Wisconsin-Madison, Madison, Wisconsin, United States(8) Nuclear and Chemical Sciences Division, Lawrence Livermore National Laboratory, Livermore, California, United States*

The growing demand for efficient and selective radionuclide separation methods in nuclear medicine underscores the need for advanced solid-phase extractants. For example, the production of ^{86}Y, which is used for positron-emission tomography, requires it be isolated from ~100 mg quantities of proton-irradiated ^{86}SrO. In this study, a synthesized and characterized mesoporous silica resin functionalized with diglycolamide ligands (SBA-DGA-I) was evaluated for separating ^{86}Y from bulk Sr. The resin's performance was evaluated through single-column chromatography experiments using 100-200 mg of resin loaded with 120 mg $SrCO_3$,~4 MBq of ^{86}Y. Sr was eluted in HCl and HNO_3, while Y was stripped in an HCl-EDTA mixture. An ionization chamber (Capintec CRC-15R) was used to quantify the elution of ^{86}Y and Microwave-Plasma Atomic Emission Spectrometry (MP-AES, Agilent MP4200) was used to measure Sr. The resin demonstrated high selectivity for ^{86}Y, attributable to strong complexation via the DGA ligand, with minimal binding to Sr, allowing for a large separation factor. Columns on average yielded greater than 80% of the purified ^{86}Y, with decontamination factors on the order of $1x10^3$. These results highlight the potential of SBA-DGA-I as a

resin for radiochemical purification processes, supporting its utility in medical isotope production.

NUCL 4430898

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NUCL 4430922

Advancements in REMAFS processing using potassium fluoride

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Rare earth elements (REE) are vital to modern technologies and national security, particularly in permanent magnets used for generating strong magnetic fields in different applications. Neodymium (Nd), praseodymium (Pr), terbium (Tb), and dysprosium (Dy) are especially important for these applications. With rising demand and recent supply chain disruptions, attention has turned to re-establishing domestic REE sources. As of 2024, one foreign country produces over 69% of global REE materials and controls 90% of the industry for refining REE into metals[1].
Rare Earth Metals via Alternative Fluoride Salts (REMAFS) is a patent-pending method that uses Na-RE-F feedstock for metallization, eliminating hydrofluoric acid and offering a safer, cost-effective pathway[2]. The process, developed in the Critical Materials Innovation (CMI) Hub uses sodium fluoride (NaF) which showed promise but required high water input, raising a potential rare earth metals scalability concern. As part of the CMI Hub Internship Program, potassium rare earth fluoride (K-RE-F), with higher solubility, has been developed as a potential alternative. This study investigates the structural and thermal properties of K-RE-F (RE = Pr, Nd, Dy, Tb) as feedstock for rare earth metal production.

NUCL 4437565 - Withdrawn

NUCL 4473279

The legacy of George Schweitzer: Radiochemistry and critical material from the Manhattan project to the present

***John Auxier**, john.auxier@srnl.doe.gov. Savannah River National Laboratory, Aiken, South Carolina, United States*

George Schweitzer, the Guiness World Record Holder for longest serving faculty member ever, has left an indelible mark on the field of chemistry through his groundbreaking work, spanning from his pivotal role in the Manhattan Project to his significant contributions to the study of critical materials, including rare earth elements. During the Manhattan Project, Schweitzer was a graduate student helping to develop the chemical separations of U and Th, applying his expertise to solve complex problems that were crucial to the success of this historic endeavor. His work laid the foundation for modern nuclear chemistry and influenced the trajectory of post-war research and technological innovation around the back-end of the nuclear fuels cycle.

In the subsequent decades, Schweitzer shifted his focus to the study of critical materials, addressing the increasing global demand for rare earth elements that are essential for various high-tech applications. His research delved into the properties, extraction methods, and potential uses of these elements, significantly advancing our understanding of their role in modern technology (e.g. PET scan detector materials like LSO). Schweitzer's pioneering efforts have contributed to the development of

sustainable extraction and recycling methods, mitigating the environmental impact of mining activities and ensuring a secure supply of these valuable resources. Schweitzer's legacy is characterized by his relentless pursuit of scientific knowledge and his ability to anticipate and address the critical needs of society. His work continues to inspire new generations of chemists, highlighting the importance of interdisciplinary research and the impact of chemistry on both historical and contemporary technological advancements. This presentation will explore how my own career was made possible by Schweitzer's remarkable career, emphasizing his contributions to nuclear chemistry, critical materials research, and their lasting impact on the field of chemistry.

This presentation will cover work that is being done at SRNL that is seeking to understand aspects of the back-end of the nuclear fuels cycle, science to help further the US ability to support the growing energy needs from AI/data storage, and how best to leverage the spent fuel as an alternative source of critical materials.

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TBD

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TBD

NUCL 4473302

Discussion: The Schweitzer Legacy in research and education

***Deborah A. Penchoff**[1], deborah.penchoff@ucf.edu, **John Auxier**[2], john.auxier@srnl.doe.gov, **James Burn**[3], burn.james@epa.gov. (1) University of Central Florida, Orlando, Florida, United States(2) Savannah River National Laboratory, Aiken, South Carolina, United States(3) US Environmental Protection Agency National Analytical Radiation Environmental Laboratory, Montgomery, Alabama, United States*

This discussion will provide an opportunity to honor the extraordinary life and career of Professor George K. Schweitzer. Spanning over 70 years of service, Dr. Schweitzer’s legacy entwines groundbreaking research in radiochemistry with a unique educational approach that captivated generations of students.

NUCL 4473317

Actinium and lanthanum complexation for purification and applications in radiotherapeutics

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Actinium-225 (Ac-225) is a promising radioisotope for targeted alpha therapy, particularly for the localized treatment of small tumors or metastases that are virtually undetectable due to their size. In the development of Ac-225 based radiotherapeutics, current challenges in understanding the coordination behavior of Ac-225 during isotope production and applications center on influences of competing ions in the processes. Similar in charge density and size, lanthanum mirrors the behavior of Ac-225, however, subtle differences can be observed. In this work, computational approaches are employed to investigate the selective binding behavior of actinium and lanthanum in order to inform and optimize separation strategies. High-performance computing and molecular modeling techniques are further utilized to analyze the thermochemical properties and binding affinities of actinium-containing complexes with selected chelators relevant to isotope purification and targeted tumor delivery. The results of this study focus in advancing the efficiency of Ac-225 purification processes and support the development of improved chelation strategies for therapeutic applications.

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NUCL 4473321

Thermochemical and structural analysis of actinide selective binding

Brittany Stieferman[1]*, brittany.stieferman@ucf.edu, Deborah A. Penchoff*[1]*, Penafrancia Monte*[4]*, Benjamin P. Burton-Pye*[3]*, Lynn C. Francesconi*[2]*, Nathalie A. Wall*[1]*. (1) University of Central Florida, Orlando, Florida, United States(2) Hunter College, New York, New York, United States(3) Lehman College, New York, New York, United States(4) The City University of New York, New York, New York, United States*

Actinide selective binding is critical in energy and national security needs. Analysis of actinide binding reactions via their chemical behavior can provide key insight in separation processes and aid in the optimization of selective binding. Computational modeling of binding reactions is distinctly advantageous compared to the high costs and resources required of an experimental lab setting. Using electronic structure theory modeling, high-performance computing (HPC), and artificial intelligence (AI), evaluations of actinide complexation can be performed. This work focuses on electronic structure theory methods evaluations alongside structural and thermochemical properties of uranium, americium, and curium binding.

NUCL 4473321

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NUCL 4473325

Plutonium binding for optimization of actinide separations

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Neptunium and Plutonium are two actinides involved in the nuclear fuel cycle. The separation of Np/Pu is a way to reduce waste and maximize the use of resources, especially for nonproliferation needs. Due to the limited availability and radioactivity of

actinides, computational modeling is necessary to optimize the separation process. Through applications of electronic structure theory in high performance computing and AI, structural and thermochemical calculations are used to understand Pu-containing complexes. This study addresses Plutonium binding relevant to optimization of actinide-separations by evaluating metal-ligand interactions in Pu-containing complexes.

NUCL 4473325

Plutonium binding for optimization of actinide separations

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