# HIPPO

Horizon-Broadening Isotope Production Pipeline Opportunities

# Book of Abstracts

## HIPPO 2023

## Argonne National Laboratory

## Poster Session

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# P1: Edith Amason

### Post Synthetic Metal Extraction into Nanoparticles Reduces Preparation Time and Enhances Payload for Bimodal Imaging Probes

The implementation of hybrid imaging instruments, specifically dual PET-MRI, in clinical practice demands a probe with optimized functionality for both imaging types. While there is significant literature precedent for small molecule and nanoprobes for the respective imaging modalities, little work has been conducted into the development of a dual imaging probe. To address this challenge and keep up with the implementation of clinical PET-MRI instruments, I have designed a nanoprobe that alleviates the challenges associated with hybrid imaging. To do so, I have implemented the use of hollow mesoporous silica nanoparticles (MSNs) loaded with a fluorous core containing the extractant (perfluoroheptanoyl)acetone (acac-FH) in perfluoro-15-crown-5-ether (PFCE). Preliminary work demonstrates the optimization of the MSN synthesis, and successful metal ion extraction with stable iron(III) citrate. Selection of iron(III) allowed initial experiments to be conducted without radioisotopes. Due to the unique paramagnetic properties of iron(III), extraction is measured by 19F-NMR spectroscopy monitoring the phenomenon known as paramagnetic relaxation enhancement effect (PRE). As iron is extracted into the fluorous MSNs, the longitudinal (T1) relaxation time decreases from 1 sec to 500 ms, and the transverse (T2) relaxation time decreases slightly from 500 ms. Since PRE is a distance dependent effect, when iron chelates to the silanol groups on the shell of the MSN, the T2 is significantly reduced to times closer to 100 ms. This work seeks to use the information gained from iron extraction to improve upon the lengthy synthesis times associated with nuclear medicine, and the direct competition with the desirable short half-lives of medically relevant isotopes. Although the current scope of future work is focused on the implementation of imaging isotopes like 45Ti (t1/2= 3 hr), 68Ga (t1/2= 68 min), and 89Zr (t1/2= 78 hr); there is great potential for the application of this system as a theranostic probe.

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# P2: Samuel Apata

### Argonne Auger Meitner Radioisotope Microscope

The medical physics community has identified radioisotope Auger-Meitner emitters as promising candidates for cancer treatment. We are developing the Argonne Auger- Meitner Radioisotope Microscope(AARM), whose primary purpose is to measure the electron multiplicity and energies of electrons emitted in Auger-Meitner decays. We are currently assembling and testing a cryogenic cooling system for the AARM. This cryogenic cooling system will deliver an atomic beam of radioisotopes in the AARM. To efficiently deliver the radioisotopes into the AARM, the cryogenic system needs to create an environment that can reach a temperature as low as 4 Kelvin and achieve a baseline pressure of 5e-6 Torr. To accomplish this, we use a cryo compressor and cold head to remove heat from the vacuum system and a turbo-molecular pump to reach high-vacuum. To verify these conditions, we created a temperature D.A.Q to measure and plot real-time temperature data for up to 8 different locations in the cryogenic system, and an ion gauge to measure the pressure in the vacuum chamber. This project is expected to provide benchmark data for cancer dosimetry models relying on Auger-Meitner emitters and help inform searches for medical isotope candidates.

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# P3: Aidan Bender

### Evaluation of Pyridyl Benzofuran Derivative for Targeted Alpha Therapy of Alzheimer's Disease

Alzheimer's Disease (AD) is a prevalent neurodegenerative disease which has very few treatment options, none curative. It has been shown that whole-brain ionizing radiation can generate an immune response toward, and reduce the presence of, amyloid-beta plaques, a key biomarker in AD. We hypothesize that targeted alpha therapy (TAT) may generate a similar immune response and a greater reduction in amyloid-beta, while reducing dose to healthy tissue. A benzofuran-pyridyl-based targeting agent (BiBPy) was synthesized for TAT of AD and radiolabeled with $^{213}$Bi from a $^{225}$Ac/$^{213}$Bi generator. Its specific activity was 121 ± 2 GBq/µg and its LogP measured at 0.14 ± 0.03. LogP provides insight into the rate at which a compound crosses the Blood Brain Barrier (BBB), and optimally LogP = 0.1-3.5. The binding affinity of BIBPY, determined as the inhibition of Thioflavin-T, was measured as $K_i$ = 11 ± 2 nM. Brain homogenate from transgenic APP/PS1 double mutant AD mice was incubated with varying doses of [$^{213}$Bi]-BIBPY and showed a clear reduction in plaque concentration with increasing activity, with an $IC_{50}$ = 0.337 MBq. In fact, the concentration of plaques *in vitro* could be reduced below the minimum detectable limit of both ELISA and Western Blot at activities beyond 0.74 MBq. At the same time, the concentration of control protein GAPDH in the samples did not vary, suggesting that the targeted approach minimizes off-target dose. We have completed the synthesis of a bismuth-chelating small molecule which has favorable amyloid-beta binding properties and potential to cross the BBB for the treatment of AD. This targeting agent has high chemical purity and can be radiolabeled with high specific activity. Most importantly, the efficacy of targeted alpha therapy in reducing amyloid-beta plaque burden has been demonstrated *in vitro* for the first time. Future work includes *in vivo* biodistribution in AD and WT control mice to confirm uptake in the brain. This biodistribution will be accompanied by autoradiography of brain tissue to confirm *in vivo* binding, as well as immunohistochemistry to investigate the immune response to TAT.

**Authors: Aidan Bender, Emily Kirkeby, Donna Cross, Andrew Roberts, Tara Mastren**

# P4: Erick Brady

### Radiochemical Synthesis and Characterization of Theranostic Radiopharmaceuticals

Theranostics is described at the identification and treatment of a select lesion in the body via differing methods and techniques. "Radiotheranostics" is a term used in nuclear medicine to refer to the use of radioisotope (RI)-labeled agents to perform simultaneous imaging and therapy of a target lesion. This division of theranostics is unique in that it uses a targeting molecule that integrates either a therapeutic or diagnostic radionuclide (monoclonal antibody or small molecule). Commonly used terms for specific radiation therapy is Targeted Radionuclide Therapy or TRT. Imaging data is gathered from use of both Positron Emission Tomography or PET and Single-Photon Emission Computed Tomography or SPECT. These allow for analysis of absorbed radiation doses for targeted lesions. Some commonly used radionuclides include 64Cu and 89Zr for imaging and 90Y and 177Lu for therapy.

**Authors: Erick Brady Co-Authors, Support: Malick Bio Idrissou and Reinier Hernandez**

# P5: Dana Braun Szafer

### A Case for Negative Pressure Tent in Achieving High Purity $^{67}$Cu Processing

$^{67}$Cu is a widely used beta-emi3ng radioisotope produced at Argonne for delivery to treatment facilities across the US. The process involves inducing a photonuclear reaction on a zinc target to produce $^{67}$Cu. Since stable copper and zinc are common contaminants in the air, producing consistently pure $^{67}$Cu can be challenging as exposure to atmospheric Cu & Zn at any stage of the production process can substantially affect the quality of the final product. Monitoring trace contaminants in the ambient atmosphere and water jacket during the irradiation process is critical to understanding the quality of the $^{67}$Cu produced. A total internal reflection x-ray fluorescence (TXRF) instrument was used to quantify trace elements in a sample up to atomic number 92. Samples were deposited on a quartz slide for TXRF scanning. A particle size profiler was used to monitor the air in the workspace. Particle size and elemental composition were compared. The results indicate the ubiquitous presence of copper particle in the atmosphere of the radiochemical workspace. There is tentative evidence that a negative pressure tent around the glovebox will improve the purification process. We propose a further study to quantify the correlation between atmospheric Cu and particle counts in air purified using high MERV HEPA filtration systems accompanying such a tent.

**Author: Dana Braun Szafer**

# P6: Shelbie Cingoranelli

### Production and Radiochemistry of Theranostic Radioscandium Nuclides

Production of high purity radioscandium isotopes has proven challenging. The dominant production routes utilize target materials with multiple stable isotopes that produce the desired radionuclide but also co-produce 5 other radioscandium nuclides. The resulting mixture of radioscandium isotopes produced cannot be separated by conventional chemistry, yielding low radionuclidic purity radioscandium[1-4]. The characterization of enriched titanium targets, and titanium target recycling procedures are needed to produce high-purity $^{43}$Sc or $^{47}$Sc for implementation in preclinical experiments. Due to the need to make high purity radioscandium for radiochemistry development, we will explore different routes to produce these highly desired radioscandium isotopes.

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# P7: Joseph Drapal

### Reduction of Titanium-50 Dioxide to Titanium Metal

As the search for new superheavy elements continues, heavier elements must be used to create the required beam composition. Isotopically pure 50Ti is an increasingly desirable element in heavy ion beam experiments. $^{50}$Ti departs from the double-magic 48Ca, however it has a closed neutron shell of N=28. Additionally, $^{50}$Ti is the most neutron-rich stable titanium isotope. As the pure isotope can only be obtained in oxide or chloride forms, effective forms of reduction must be implemented to supply this demand. To supply this isotope, an induction furnace assembly was created to process $^{50}TiO_2$ to metallic $^{50}$Ti. Due to the relative simplicity of the process, the primary pathway of calcium hydride was selected for the reduction process. The furnace system used was an induction heater coupled with a vacuum pump and inert gas injection system. Stainless steel piping was used in conjunction with Swagelok™ valves and connectors. Quantitative testing of experimental limitations was performed through the heating of gram quantity samples. Although a full chemical reduction was not achieved, valuable insight was gained into the operation of all necessary systems to conduct such a process. Construction, modification, and operation of an induction furnace system was conducted and experience was gained in relevant areas. As our understanding of atomic physics advances, heavier elements must be synthesized to test theories and investigate unexpected behaviors. Several metallic elements are useful to further research in multiple fields. Titanium-50 is a promising candidate to progress to heavier elements. As the isotopically enriched metal cannot be acquired, a reduction from the metal oxide is required in gram quantities per year to sustain the desired beams. Lanthanide elements allow the production of medical radioisotopes, as well as neutron-rich isotopes. An established reduction system allows for the processing of these desirable materials. After processing, these elements are appropriate for use as a beam projectile and as thin film targets for future research and medical applications.

**Author: Joseph Drapal**

# P8: Oluwanife Ebiwonjumi

### Optical Model Tuning Studies for Optimized Medical Isotope Production

The demand for medical radionuclides has increased significantly over the past decade, primarily due to their success in targeted theranostic cancer applications. Therefore, knowledge regarding the methods to produce such isotopes is vital to aid in the success of the fight against cancer. Cross section data is a key component for informed production choices, However, this data is usually limited or non-existent for novel isotopes. Nuclear reaction modeling codes can predict cross section information but tend to break down for complex reactions involving heavy nuclei targets or light ion incident particles. For this reason, improvement of nuclear reaction model parameters are required to determine the most effective manner in which to produce medical isotopes. To this end we have explored the effect of optical model parameter tuning on cross section prediction using the EMPIRE[1] nuclear modeling program. Here we look into the various ways in which we can tune the EMPIRE program to produce predictive cross sections that can be used in nuclear reaction decision making.

**Authors: Oluwanife Ebiwonjumi**

# P9: Brooklyn Green

### Investigating the Production, Separation, and Chemistry of $^{211}$At

Astatine, the least abundant naturally occurring element on earth, has recently garnered interest due to its unique fundamental chemistry and its potential use as an agent in targeted alpha therapy (TAT). Further investigations into these fields rely on the cyclotron production of astatine-211. Traditional production utilizes the $^{209}$Bi(α,2n)$^{211}$At nuclear reaction pathway, requiring a medium or high- energy cyclotron which is necessary to achieve an alpha-particle beam with an energy of 28.8 MeV. Due to the limited number of facilities capable of producing $^{211}$At, the small quantity produced during irradiation, and the isotope's short half-life (about 7.2 h), recovery from the metallic bismuth target is important to continue furthering the research on $^{211}$At. One facet of this project focuses on target preparation parameters and methods of dissolution to maximize $^{211}$At recovery. The purpose of this project is to draw conclusions about the behavior of targets post-irradiation by studying the behavior of targets pre-irradiation. Additionally, with little known about the chemistry of astatine, experiments regarding the fundamental chemistry and behavior of $^{211}$At are necessary. The second part of my project focuses on experiments to expand our knowledge of astatine and its possible methods of separation. This was done through extraction chromatography column studies and radioTLC.

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# P10: Aditi Gurudutt

### Synthesis and Characterization of $\alpha$-Zirconium Phosphate Nanoplatelets

The inorganic ionic material, $\alpha$-zirconium phosphate ($\alpha$-ZrP), has been researched to better understand its effectiveness in targeted alpha therapy. The crystalline, layered compound is capable of being a drug-delivery tool due to its ion exchange properties and size. Prior research has shown that the intercalation of various metallic ions into the layers of the material is quick and has high uptake. Additionally, there is minimal leeching of less than 1% present in a human plasma-like environment. Our aim is to intercalate the particles with redox-active materials and investigate if the redox-active material leeches out from the layers. Analysis of the properties of the intercalated $\alpha$-ZrP is done by characterizing the material with potentiometric titration, Thermogravimetric Analysis (TGA), X-ray Photoelectron Spectroscopy (XPS), Ultraviolet–visible spectroscopy, Powder X-Ray Diffraction (XRPD), Scanning Electron Microscopy (SEM) imaging, and Particle Size Analysis.

**Authors: Aditi Gurudutt Mentor : Dr. Jonathan Burns**

# P11: Lauren Hoekstra

### The Conversion of Synergistic Solvent Extraction Systems to Novel Solid Phase Extractions Systems for the Separation of Lanthanides $^{161}$Tb from Enriched $^{160}$Gd Targets

In nuclear medicine, theranostic (therapeutic and diagnostic) pairs are radioisotopes that can potentially be used in treating and diagnosing diseases. Terbium-161 is a particularly interesting potential theranostic isotope due to its variety of radiological emissions; however, it can be difficult to separate it from the gadolinium target used in its production. While separating these species was proven effective using a synergistic solvent extraction system (with HTTA and DBDECMP), an alternative method using a solid phase extraction chromatography (EXC) system would be better suited for nuclear medicine applications and large-scale separations. When translated to solid-phase EXC resins, the synergistic properties of HTTA and DBDECMP in the solvent extraction systems are also present when loaded onto a resin used for solid-phase extractions.

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# P12: Jacob Jordan

### $K_D$ Studies of CU & ZN Separations for Radioisotope Production Applications

Radionuclide therapy has been drastically expanding in the medical field due to its ability to target tumors in cancer patients. Cu-67, a radioisotope used in these treatments is linked to a targeting vector and injected into the blood stream which then accumulates at cancer sites without causing harm to healthy tissues and organs in a patient. For this treatment to be effective the radioisotope must be purified for it to be used in this manner. The purification process for the Cu-67 produced at Argonne National Laboratory involves separating the radioactive copper product from the zinc target material through a two-step process. The first step utilizes a vacuum sublimation to remove the bulk of the zinc while the second step relies on a column separation with anion exchange resin. The $K_D$ and vacuum sublimation studies performed in this work helps identify which conditions are optimal for the separation of copper and zinc. These studies were tested without radiation due to lower expense and safety concerns.

**Author: Jacob Jordan**

# P13: Hong Beom Lee

### $^{76/77}$Br Production Using CoSe Cyclotron Targets for Small Molecule Radiopharmaceuticals

The diagnostic positron emitter $^{76}$Br ($t_{1/2}$ = 16.2 h) and therapeutic Auger emitter $^{77}$Br ($t_{1/2}$ = 57.0 h) are a promising pair of radionuclides compatible with small molecule radiopharmaceuticals. Compared to the radioisotopes of iodine, radiobromine has a more stable carbon bond resulting in less dehalogenation of radiolabeled compounds in vivo. Additionally, liberated bromide ions remain diffusely distributed in the blood pool rather than accumulating in the radiosensitive thyroid like iodide, resulting in a more attenuated dosimetric burden.[1] To explore radiobromine's theranostic potential, this work focuses on the development and optimization of the production of clinical quality $^{76/77}$Br. $^{76/77}$Br is produced by 40 µA, 12.5 MeV proton irradiation (GE PETtrace cyclotron) of a Co$^{76/77}$Se intermetallic target. After forming enriched Co$^{76}$Se or Co$^{77}$Se at 1100°C in sealed quartz ampoules, the amorphous CoSe is formed into a 10 mm ⌀ disc inside a graphite crucible (Fig 1.a-1.c). To complete the target coin, this disc is hot-pressed into a 19 mm ⌀ pocketed niobium disc (Fig 1.d-1.e). The $^{76/77}$Br is isolated from the target material using a vertically oriented thermal chromatographic or "dry" distillation method. In this procedure, the $^{76/77}$Br is rinsed into an H2O trap, followed by trapping on a quaternary methyl ammonium (QMA) anion exchange cartridge. It is crucial to establish that downstream small molecule synthetic radiobromination chemistry is highly sensitive to the specific pre-equilibration and elution solutions of the QMA cartridge used for [$^{77}$Br]bromide preparation.[2] Armed with this fact, the QMA-loaded $^{76/77}$Br was isolated with a new preparation and elution combination using tetraethylammonium bicarbonate ($NEt_4HCO_3$), which has established compatibility for radiochemical halogenation of iodonium ylide precursor molecules. Lastly, high purity germanium (HPGe) gamma spectrometry and dose calibrator measurements assessed the radiochemical yield of the distillation.

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# P14: Yi-Hsuan Lo

### Accelerator production of $^{71}$As from metal germanium targets and cross section measurement of $^{70}$Ge(d,n)$^{71}$As reaction

The radioisotopes $^{72}$As ($t_{1/2}$ = 26.0 h, 88% β+) and $^{71}$As ($t_{1/2}$ = 65.3 h, 28% β+), have applications in positron emission tomography (PET) imaging when bound to nanoparticle- [1–3], peptide- [4], and antibody-based [3,5] radiopharmaceuticals. These diagnostic radionuclides have theranostic potential when paired with β–-emitting therapeutic $^{77}$As or, due to the homologous relationship between arsenic and antimony, the Meitner-Auger-electron- (MAe–) emitter 119Sb. Our previous work reported new production and isolation techniques for the positron-emitter $^{71}$As. However, our measured yield of $^{71}$As does not agree well with the theoretical physical yield computed from $^{70}$Ge(d,n)$^{71}$As cross section measurement performed by K.Otozai et al. [6]. Therefore, we propose a new measurement of the $^{70}$Ge(d,n)$^{71}$As cross section at the Notre Dame Nuclear Science Laboratory

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# P15: Laura McCann

## Investigations of Production Pathways for Medically Relevant $^{149}$Tb

Targeted alpha therapy (TAT) is rapidly coming to the frontiers of radiotherapeutic cancer research due to its high cell mortality rate when localized to the cancer site via a targeting agent. A lesser known prospect for TAT is terbium-149, which decays via both positron and alpha emission, allowing it to be its own theragnostic pair, and eliminating the need for an imaging analog. However, it does not yet have a well-established production pathway suitable for isotope production and distribution. Additionally, the competing production of the metastable isomer $^{149m}$Tb ($t_{1/2}$ = 4 min) which does not decay to $^{149g}$Tb, significantly reduces its ability to be made via heavy ion reactions. Given its relatively short half-life, cross-sections for this isomer also are not currently available in the literature. In order to measure cross-sections for new potential reaction mechanisms for $^{149}$Tb, a series of experiments was performed at Texas A&M University (TAMU) using Lawrence Livermore National Laboratory's (LLNL) Hyperion, high- purity germanium (HPGe) detector array that required the production of isotopically enriched samarium, europium, and gadolinium targets. Since there are few locations with the expertise and equipment to produce such targets, a collaboration was established between TAMU and Argonne National Laboratory (ANL) to develop these targets using vapor deposition and molecular deposition techniques. The irradiated foils were then measured in situ during irradiation and immediately post-irradiation, allowing for the accurate determination of the cross- sections for numerous isotopes, in addition to the new measurement of $^{149m}$Tb cross-sections.

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# P16: Justin Peikin

## An Efficient Separation Method for Terbium and Gadolinium

Terbium-based radiopharmaceuticals currently show good potential within the field of theragnostics [1]. Specifically, $^{152}$Tb ($t_{½}$= 17.4 h, 20% β+, ec decay) and $^{155}$Tb ($t_{½}$= 5.34 d, ec decay) for diagnosis and $^{161}$Tb ($t_{½}$= 6.89 d, $\beta^-$ decay) and $^{149}$Tb ($t_{½}$= 4.12 h, 17% α, ec, β+ decay) for therapy are sought for their ability as a "theragnostic quartet." To produce pharmaceuticals containing these radiometals, an efficient separation and isolation process is necessary for Tb. Pure, no-carrier added $^{161}$Tb is produced through the $^{160}$Gd(p,n)$^{161}$Gd($\beta^-$)$^{161}$Tb reaction in nuclear fission reactors. Thus, separating terbium from massive gadolinium targets is currently a barrier to producing high specific activity terbium pharmaceuticals. This abstract proposes a separation method using LN2 extraction chromatography (EXC) resin, which has been tailored for adjacent lanthanide separation.

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# P17: Emily Putnam

## Cyclotron Production and Purification of $^{47}$Sc from Natural Vanadium Targets

Proton irradiation on natural vanadium foils was conducted to produce high purity $^{47}$Sc for radiochemical studies and development as a therapeutic isotope for the elementally matched "theranostic" pair of isotopes $^{43}$Sc and $^{47}$Sc. These "theranostic" isotopes show promising potential in PET (Positron Emission Tomography) imaging ($^{43}$Sc) and therapeutic treatment ($^{47}$Sc) of tumors, and since they are elementally matched, they would exhibit identical complexation chemistry, *in vitro binding*, and *in vivo* pharmacokinetics.

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# P18: Melanie Segura Guerrero

### Electrodeposition Methods for an $^{225}Ac/^{213}Bi$ Radionuclide Generator with Gold/Silver Nanolayers

Bismuth-213 is a short-lived ($t_{1/2}$=45.6 min) α-emitter of interest for targeted α-therapy (TAT). Due to its short half-life, on-site $^{225}Ac/^{213}Bi$ radionuclide generators are required for research and clinical use. Current $^{225}Ac/^{213}Bi$ radionuclide generators use inorganic resins that fail at activities required for clinical use (> 100 mCi) due to the high linear energy transfer (LET) of α-particles. This makes the development of novel generators with high radiolytic stability crucial to the success of $^{213}Bi$-TAT radiotherapeutics. Therefore, we are working to develop novel radionuclide generator systems utilizing the recoil effect for the separation of $^{213}Bi$ from $^{225}Ac$. We are working to achieve this goal by studying the electrodeposition of $^{225}Ac$ onto metallic foils and coating with thin Au or Ag coating to prevent $^{225}Ac$ leakage. This work investigates the ability to deposit thin films of gold and silver onto nickel and copper foils. A Monte Carlo based simulation program, Stopping Range of Ions in Matter (SRIM), was used to model the release of the $^{221}Fr$ daughters through the metal coatings. To allow the release of > 90% of $^{221}Fr$ atoms, Au coatings must be ≤ 5 nm and Ag coatings must be ≤ 10 nm. Preliminary investigations into the effects of varying the voltage, metal concentration, and electroplating time were carried out to find the optimal conditions for a uniform and thin coating. Scanning electron microscopy (SEM) analysis was done to assess the surface morphology and uniformity of the coatings. The SEM showed that the coatings done at lower concentrations were flat and generally uniform. The plated foils were also dissolved for ICP-MS analysis to obtain an average coating thickness. The optimal electroplating coating conditions found here will be tested with $^{225}Ac$ in the future to assess $^{225}Ac$ leakage, $^{213}Bi$ recovery, and long-term radiolytic stability. Ultimately this work has the potential to provide a robust $^{225}Ac/^{213}Bi$ radionuclide generator with a high radiolytic stability to meet clinical needs.

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# P19: Shefali Saini

### $[^{45}Ti]$Ti-HOPO radiochemistry for development of PET radiopharmaceuticals

Titanium-45 ($^{45}Ti$) is a radionuclide with desired physical characteristics for use in PET imaging including a moderate half-life (3.08 h), decay by positron emission (85%) and low mean positron energy of 0.439 MeV. Despite these promising characteristics, the radiochemistry for $^{45}Ti$ including the development of suitable bifunctional chelators is relatively unexplored. Previous work of radiochemistry optimization with $THP^{Me}$ and TREN-CAM chelators resulted in high specific activity labeling with $^{45}Ti$ under physiological conditions. However, evidence of instability during *in vivo* studies were observed which prompted our studies to explore additional chelators for $^{45}Ti$ [1]. Building on our prior work, HOPO was also considered as a potential chelator for $^{45}Ti$ due to its known binding affinity for hard metal ions including $^{89}Zr$. This project aimed to optimize the radiochemistry and to examine the *in vivo* stability of HOPO chelators for $^{45}Ti$.

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# P20: David Thomas

## Target Design for Autonomous Target Retrieval

Production of alpha-and beta-emitting radio-isotopes is a promising area of research for cancer treatment. A challenge faced in the production of such medical isotopes is maximizing yield, especially for those with short half-lives. High-power electron beams can be used to produce some desirable isotopes using the photonuclear reaction mechanism. This method requires as the first step stopping the electron beam in a high atomic number material such as tungsten, to convert some of the beam energy to a secondary gamma beam via the Bremsstrahlung process. The gammas can then produce the medical isotope in a target downstream of the converter. We are investigating a converter/target assembly that can be retrieved from the radioactive target area by a mobile robot. This concept will minimize the loss of short-lived isotopes, and, also, reduce the dose to accelerator staff. Challenges being addressed are: 1. Developing a “robot- friendly” mechanical concept for decoupling the converter/target module from the beamline and its associated vacuum, and 2. Developing a cooling system to maximize permissible beam power that can be used for photodisintegration irradiation. The poster presents a preliminary mechanical design for the decoupling mechanism and an initial concept for a helium gas cooling system [1,2]. This work is supported in part by the Horizon-broadening Isotope Production Pipeline Opportunities (HIPPO) program, under Grant DE-SC0022550 from the Department of Energy’s Isotope R&D and Production Program, and also, in part, by funding from the Argonne Laboratory Directed Research and Development Program [1] J. Bailey, R. Gromov, T. Petersen, S. Chemerisov, Thermal Test of 29mm and 12mm Targets, Experimental Operations and Facilities Division, Argonne National Laboratory, 2019. [2]C.P.C. Wong, C. Baxi, R. Bourque, C. Dahms, S. Inamati, R. Ryder, G. Sager, R. Schleicher, Helium cooling of fusion reactors, Fusion Engineering and Design, Volume 25, Issues 1–3, 1994.

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