Short thesis for the degree of doctor of philosophy (PhD)

Palladium-103 for Targeted Auger Electron Therapy: From Cyclotron Production and Innovative Separation to In Vivo Generator Evaluation and Preclinical Imaging

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I. Introduction and Objectives

Radiopharmaceutical therapy is an established modality in nuclear medicine that enables the selective delivery of ionizing radiation to tumor tissues using radiolabeled targeting vectors. By coupling radionuclides to biologically active molecules such as peptides, antibodies, or particulate carriers, radiation can be delivered directly to malignant cells while minimizing exposure to surrounding healthy tissues. This targeted approach has demonstrated significant clinical success, particularly with β-emitting radionuclides such as ^{90}Y and ^{177}Lu, as well as α-emitting radionuclides such as ^{225}Ac.

Despite these advances, conventional β- and α-emitting radionuclides present inherent limitations. β-particles exhibit relatively long penetration ranges in tissue, typically in the millimeter scale, which can result in irradiation of adjacent healthy tissues and associated toxicity. α-particles release high-energy particles that deposit dose over millimeters, sufficient for treating bulky tumors, but frequently causing collateral damage in surrounding healthy tissue. These limitations highlight the need for radionuclides capable of delivering radiation with subcellular precision.

Auger electron–emitting radionuclides have emerged as promising candidates for highly localized radiotherapy. Upon decay via electron capture or internal conversion, these radionuclides emit cascades of low-energy electrons with nanometer-scale ranges. As a result, energy deposition is highly confined to the immediate vicinity of the decay site. When localized in close proximity to critical cellular targets such as DNA, Auger electrons can induce complex and often lethal damage while minimizing irradiation of surrounding healthy tissues. This unique radiophysical property makes Auger emitters particularly attractive for targeting micrometastases, disseminated tumor cells, and minimal residual disease.

Among the available Auger electron–emitting radionuclides, palladium-103 (^{103}Pd) represents a promising theranostic candidate. ^{103}Pd decays via electron capture with a half-life of approximately 17 days, producing low-energy X-rays in the range of 20–23 keV and emitting Auger electrons. This combination of emissions provides both imaging capability and localized cytotoxicity, supporting its potential use as a theranostic radionuclide. While ^{103}Pd has been widely used in brachytherapy, its application in targeted radionuclide therapy remains limited.

One of the major challenges hindering the broader application of ^{103}Pd is its production and radiochemical processing. Cyclotron production of ^{103}Pd via the ^{103}Rh(p,n) ^{103}Pd nuclear reaction is well established; however, the subsequent separation of palladium from rhodium targets is difficult due to the high chemical inertness of rhodium. Conventional wet-chemical separation methods are often associated with low yields, prolonged processing times, and the generation of significant amounts of radioactive waste, limiting their suitability for routine and scalable production.

To address these limitations, a dry-distillation–based radionuclide separation approach was developed in this work. This method exploits the differences in vapor pressure and diffusion behavior between palladium and rhodium at elevated temperatures, enabling selective volatilization and recovery of ^{103}Pd under high-vacuum conditions. The development of a dedicated radionuclide separation equipment (RSE) allowed the implementation and optimization of this process, providing an efficient and scalable alternative to conventional separation techniques.

In addition to production and separation challenges, the translation of ^{103}Pd into targeted radionuclide therapy requires the development of suitable radiochemical strategies and in vivo validation. Chelation of palladium with biofunctional chelators such as NOTA and DOTA derivatives enables the attachment of ^{103}Pd to biologically relevant targeting vectors, including peptides, antibodies, and particulate systems. Furthermore, preclinical evaluation using molecular imaging techniques such as SPECT/CT is essential to assess biodistribution, stability, and targeting performance.

In this context, the present work aims to establish a complete and integrated workflow for the production, separation, recovery, purification, radiolabeling, and preclinical evaluation of ^{103}Pd. By combining advances in nuclear physics, radiochemistry, materials science, and molecular imaging, this study seeks to demonstrate the feasibility of ^{103}Pd as a theranostic Auger electron–emitting radionuclide for targeted cancer therapy.

The overarching objective of this PhD research is to establish and validate palladium-103 as a theranostic Auger electron–emitting radionuclide for targeted radionuclide therapy through the development of an integrated, scalable, and efficient production–to–preclinical evaluation workflow. To achieve this overarching goal, the specific objectives of this research are:

1. **To optimize the cyclotron production of ^{103}Pd** via the ^{103}Rh(p,n)^{103}Pd nuclear reaction by identifying irradiation parameters that maximize production yield while maintaining high radionuclidic purity.

2. **To investigate palladium–rhodium interdiffusion mechanisms** through controlled multilayer experiments and depth-profiling analysis, and to determine diffusion coefficients relevant to the dry-distillation separation process.

3. **To design, construct, and optimize a diffusion-driven dry-distillation radionuclide separation equipment (RSE)** capable of selectively separating ^{103}Pd from irradiated rhodium targets by exploiting intrinsic differences in vapor pressure, thereby providing a robust alternative to conventional wet-chemistry separation methods.

4. **To enhance separation efficiency and recovery yield** through systematic optimization of RSE operational parameters, deposition substrates, and recovery methodologies, while ensuring the structural integrity and reusability of rhodium target foils.

5. **To quantify residual (cold) palladium in rhodium foils before and after RSE treatment** using ICP-MS, and to evaluate the impact of pre-irradiation palladium removal on the achievable specific activity of cyclotron-produced ^{103}Pd.

6. **To assess the radionuclidic purity and activity of separated ^{103}Pd** using high-resolution γ-spectroscopy and ionization chamber measurements throughout the separation and recovery workflow.

7. **To investigate the release dynamics of the daughter radionuclide ^{103m}Rh** from chelator-bound [^{103}Pd]Pd–DOTA-TOC complexes in the ^{103}Pd/^{103m}Rh in vivo generator system, and to quantify daughter release fractions in relation to Auger electron emission processes.

8. **To assess the therapeutic and safety implications of Auger electron emission and daughter radionuclide release**, integrating nuclear decay physics, radiochemistry, and biological considerations to evaluate the feasibility of ^{103}Pd for targeted Auger electron–based theranostic applications.

9. **To evaluate the radiochemical stability and chelation behavior of ^{103}Pd** using clinically relevant chelators (NOTA and DOTA-TATE), including quality control, and stability assessment.

10. **To perform preclinical in vivo evaluation of ^{103}Pd-radiolabeled constructs**, including biodistribution and SPECT/CT imaging in murine models and translational assessment in a spontaneous canine cancer model.

II. Methodology

II.1. Cyclotron Production of ^{103}Pd

The radionuclide ^{103}Pd was produced via the proton-induced nuclear reaction ^{103}Rh(p,n) ^{103}Pd using a cyclotron. Rhodium metal foils (99.85% purity; thicknesses of 6, 12, 25, and 125 μm) were arranged in a stacked-foil configuration and mounted on a copper backing plate serving as the target holder. Irradiation experiments were systematically performed to optimize production yield and radionuclidic purity. Initial irradiations were conducted at 14.5 MeV and 10 μA for 2 h, followed by 10 MeV and 10 μA for 5.5 h, and subsequently at 11 MeV with 20 μA for up to 8 h.

II.2. Preparation of Pd–Rh Multilayer Samples and Diffusion Studies

To investigate palladium diffusion behavior in a rhodium matrix, multilayer Pd/Rh samples were prepared. Rhodium foils (6 μm thickness) were coated with a 100 nm layer of natural palladium using magnetron sputtering deposition under high-vacuum conditions. The multilayer samples were thermally annealed at 600, 700, 800, and 900 °C for 10 minutes under vacuum conditions to promote interdiffusion. Diffusion profiles were analyzed using secondary neutral mass spectrometry (SNMS), enabling high-resolution compositional depth profiling and quantitative determination of palladium diffusion coefficients as a function of temperature.

II.3. Design and Operation of the Radionuclide Separation Equipment (RSE)

A dedicated radionuclide separation equipment (RSE) was designed and constructed to enable diffusion-driven dry distillation of ^{103}Pd from irradiated rhodium targets. The separation principle is based on the difference in vapor pressures between palladium and rhodium at elevated temperatures, allowing selective volatilization of palladium while rhodium remains in the solid phase. Irradiated rhodium foils were placed inside a high-temperature crucible under high-vacuum conditions, and the system was heated at 1200 °C to promote diffusion and evaporation of ^{103}Pd. The volatilized palladium was transported and condensed onto a designated collection substrate.

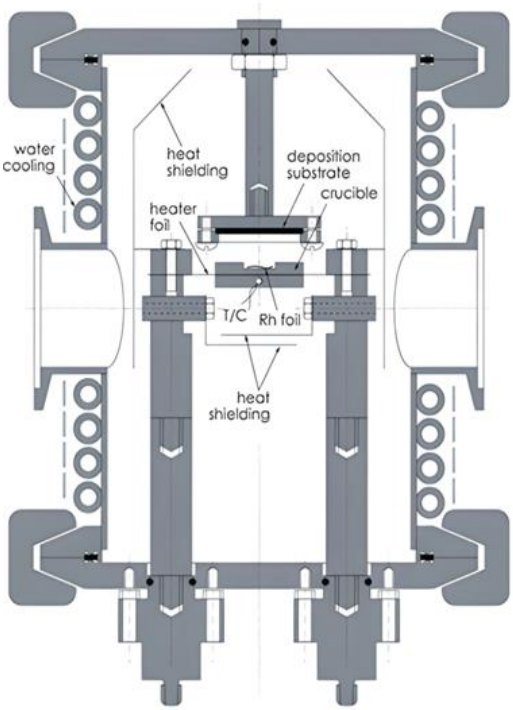


Figure 1. Conceptual schematic of the radionuclide separation equipment illustrating the main components.

Systematic optimization of the RSE, including thermal management, substrate design and material, and vacuum conditions, was performed to enhance separation efficiency and recovery yield.

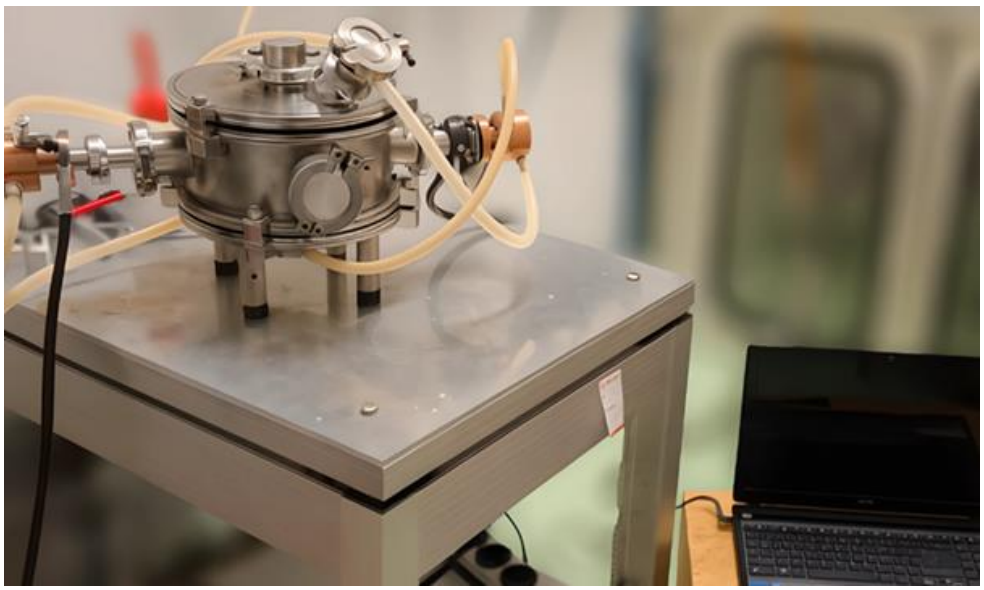


Figure 2. Upgraded, remotely controlled radionuclide separation equipment (RSE) incorporating improved components.

II.4. Recovery and Purification of ^{103}Pd

Following dry distillation, the deposited ^{103}Pd was recovered from the collection substrate using an optimized acid-based procedure. The recovered solution was subjected to anion-exchange chromatography to purify the radionuclide and remove metallic impurities. Purified ^{103}Pd was eluted using ammonium hydroxide, followed by evaporation and reconstitution in appropriate acidic media for subsequent radiolabeling.

II.5. Quantitative Measurement of ^{103}Pd Activity and Chemical Characterization

Radionuclidic purity and activity measurements were performed using a high-purity germanium (HPGe) detector and an ionization chamber. Gamma spectra were analyzed using Genie-2000 software. Inductively coupled plasma mass spectrometry (ICP-MS) was used to quantify residual palladium content in rhodium foils before and after RSE processing, enabling evaluation of pre-irradiation purification and specific activity enhancement. Surface morphology and structural changes of rhodium foils were examined using scanning electron microscopy (SEM).

II.6. Radiolabeling of ^{103}Pd with NOTA and DOTA-Based Chelators

Radiolabeling was performed using clinically relevant chelators, including NOTA and DOTA-TATE. Chelation reactions were carried out in acetate buffer (pH ~5.5) under elevated temperature conditions to ensure efficient complexation. [^{103}Pd]Pd–NOTA were conjugated with Macroaggregated Serum Albumin (MAA) particles, for lung-targeted deposition studies. Radiochemical purity was evaluated using instant thin-layer chromatography (iTLC) and solid-phase extraction (SPE)–based affinity chromatography.

II.7. Experimental Evaluation of ^{103m}Rh Daughter Nuclide Release

The release of the daughter radionuclide ^{103m}Rh from [^{103}Pd]Pd–DOTA-TOC complexes was investigated to evaluate the behavior of the ^{103}Pd/^{103m}Rh in vivo generator system. For evaluation of the in vivo generator system, ^{103}Pd was complexed with DOTA-TOC at a concentration of 10^{-3} M in 0.4 M ammonium acetate buffer (pH 5.5). The mixture was incubated at 90 °C for 1 h in a thermomixer. The SPE columns loaded with [^{103}Pd]Pd–DOTA-TOC were eluted daily with 0.01 M EDTA over four consecutive days to remove unbound metal ions and ensured retention of only chelator-bound complexes. Elution volumes were 0.8

mL for Strata-X and 5 mL for Strata-C18 columns. Radioactivity in the columns and eluates was measured using gamma spectroscopy to quantify the fraction of released daughter radionuclide. This approach allowed determination of daughter release fractions and assessment of the influence of Auger electron emission on complex stability.

II. Preclinical In Vivo Evaluation

Radiolabeled ^{103}Pd complexes were evaluated in vivo using murine models and a spontaneous canine cancer model. Biodistribution and imaging studies were performed using SPECT/CT to assess tracer stability, targeting behavior, and therapeutic potential. These studies provided insight into the pharmacokinetics, biological distribution, and potential clinical applicability of ^{103}Pd-based radiopharmaceuticals.

III. New Scientific Results

III.1. Optimized Cyclotron Production of ^{103}Pd

Cyclotron production of ^{103}Pd via the ^{103}Rh(p,n) ^{103}Pd nuclear reaction was systematically optimized by varying irradiation parameters, including proton energy, beam current, and irradiation duration. The optimal irradiation conditions were identified at a proton energy of 11 MeV, with a beam current of 20 µA and an irradiation time of 30 hours, yielding approximately ~6 GBq of ^{103}Pd at end of bombardment (EOB). This energy range corresponds to the maximum of the excitation function for the ^{103}Rh(p,n) ^{103}Pd reaction, ensuring a favorable balance between production yield and radionuclidic purity while minimizing the formation of undesired by-products.

III.2. Experimental Determination of Palladium Diffusion in Rhodium

The diffusion behavior of palladium within a rhodium matrix was experimentally investigated using multilayer Pd/Rh systems prepared by magnetron sputtering and subjected to controlled thermal annealing at temperatures ranging from 600 °C to 900 °C. Depth profiling using secondary neutral mass spectrometry (SNMS) enabled the quantitative determination of palladium diffusion profiles and supported the estimation of intrinsic diffusion coefficients. These results provided fundamental experimental validation for the diffusion-driven separation mechanism employed in the dry-distillation process.

III.3. Development and Optimization of Dry-Distillation Radionuclide Separation (RSE)

A dedicated radionuclide separation equipment (RSE) was designed and engineered based on a diffusion-driven dry-distillation principle exploiting the significant difference in vapor pressures between palladium and rhodium at elevated temperatures. Under optimized conditions (~1200 °C and high vacuum of 3–5 × 10^{-5} mbar), selective volatilization of ^{103}Pd from irradiated rhodium foils was achieved. The upgraded RSE system, incorporating improved thermal management, optimized crucible design, substrate material, and enhanced vacuum stability, achieved separation efficiencies of 64–86%, representing a substantial improvement over earlier configurations and conventional wet-chemical methods.

III.4. High Recovery Yield and Chemical Purity of ^{103}Pd

The recovery and purification workflow, including optimized substrate collection and acid-based extraction, resulted in overall recovery yields of 81–94%. Surface analysis using SEM–EDS confirmed the high chemical purity of the deposited palladium layers, with no significant rhodium contamination detected, demonstrating the effectiveness of the dry-distillation separation process.

III.5. Enhancement of Specific Activity via Thermal Pre-Treatment

Inductively coupled plasma mass spectrometry (ICP-MS) measurements demonstrated that thermal pre-treatment of rhodium foils using the RSE significantly reduced residual (cold) palladium content. This process confirmed that preheating of rhodium targets is an effective strategy for improving radionuclide quality, enabling the increase of the specific activity of cyclotron-produced ^{103}Pd.

III.6. Reusability of Target Foils and Deposition Substrates

Scanning electron microscopy (SEM) analysis revealed that rhodium foils retained their structural integrity and surface morphology after high-temperature processing in the RSE. Similarly, deposition substrates remained intact after radionuclide recovery. These findings demonstrate that both rhodium targets and collection substrates can be reused in multiple irradiation–separation cycles, significantly improving the economic and environmental sustainability of the process.

III.7. Experimental Evaluation of ^{103}Pd/^{103m}Rh In Vivo Generator System

The release of the daughter radionuclide ^{103m}Rh from chelator-bound ^{103}Pd complexes was experimentally investigated to evaluate the feasibility of the ^{103}Pd/^{103m}Rh in vivo generator system. Measured release fractions were 10.5 ± 2.7% for Strata-X and 12.0 ± 0.5% for Strata-C18 systems. These values indicate low and limited daughter release compared to theoretical yield and other radionuclide generator systems, suggesting favorable retention of the daughter nuclide and supporting the potential of ^{103}Pd for targeted Auger electron therapy.

III.8. High Radiochemical Purity of [^{103}Pd]Pd–Labeled Complexes

Radiolabeling of ^{103}Pd with clinically relevant chelators (NOTA and DOTA-TATE) was successfully achieved with radiochemical purity exceeding 95%, as confirmed by iTLC and SPE–based affinity chromatography analyses. These results demonstrate the feasibility of stable chelation of palladium and suitability for in vivo application.

III.9. Preclinical SPECT/CT Imaging in Murine Models

In vivo evaluation of [^{103}Pd]Pd–NOTA–MAA constructs in NMRI Nu/Nu mice demonstrated stable biodistribution and consistent tracer uptake over multiple time points, confirming the in vivo stability of the radiolabeled complexes. SPECT/CT imaging enabled longitudinal monitoring of tracer distribution, supporting the applicability of ^{103}Pd for theranostic imaging.

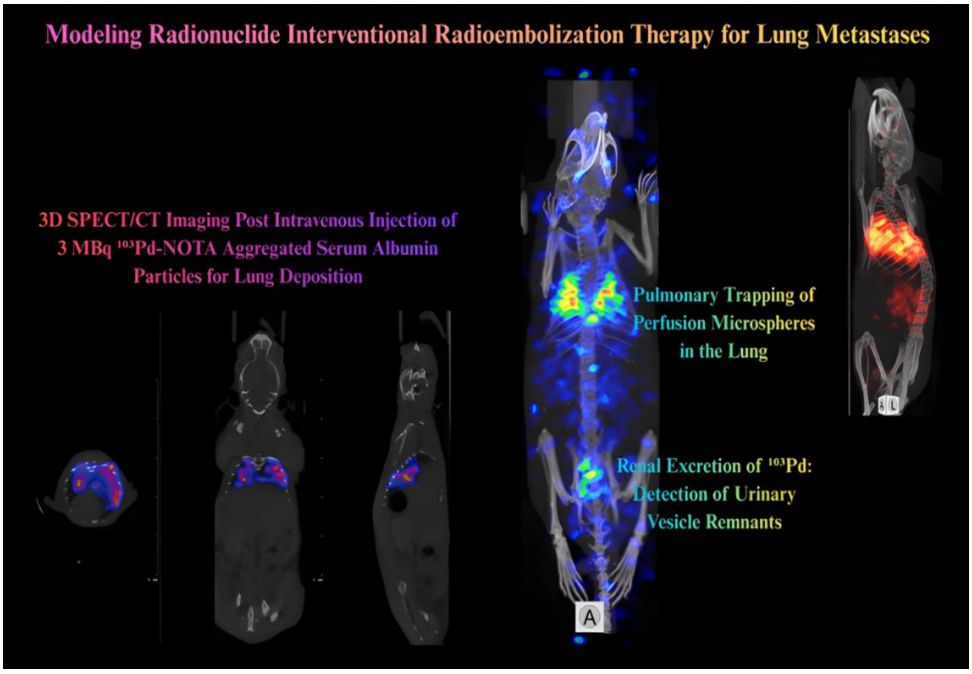


Figure 3. SPECT/CT images of [^{103}Pd]Pd–NOTA–MAA particles in a murine model, illustrating in vivo biodistribution in the lungs and excretion of decomposition products via the urinary system. The color scale represents SPECT activity, while grayscale corresponds to X-ray CT image reconstructions.

III.10. Translational Evaluation in a Canine Tumor Model

A preliminary translational study was conducted in a canine model with spontaneous liver malignancy. Administration of [^{103}Pd]Pd–DOTA-TATE enabled in vivo imaging and therapeutic evaluation, demonstrating tumor localization and early indications of therapeutic response. These findings represent an in vivo demonstration of [^{103}Pd]Pd–based radiopharmaceuticals in a large-animal model, highlighting its potential for clinical translation.

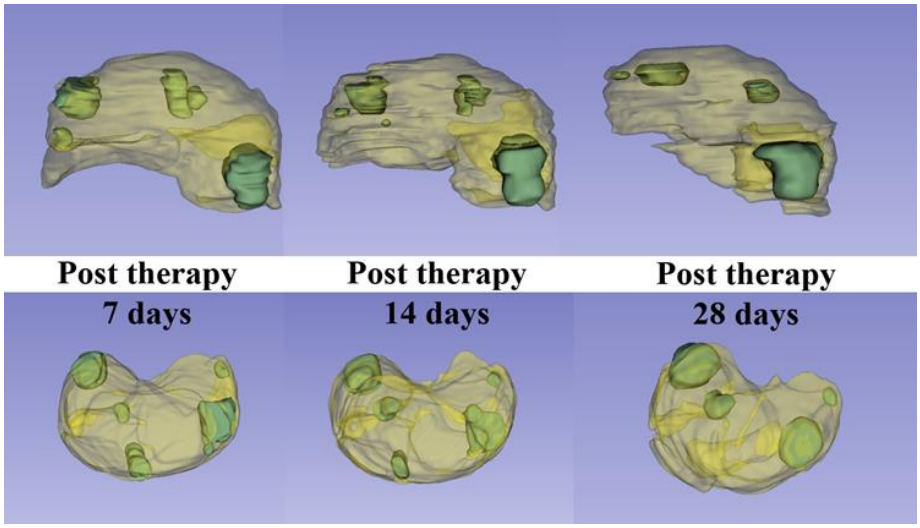
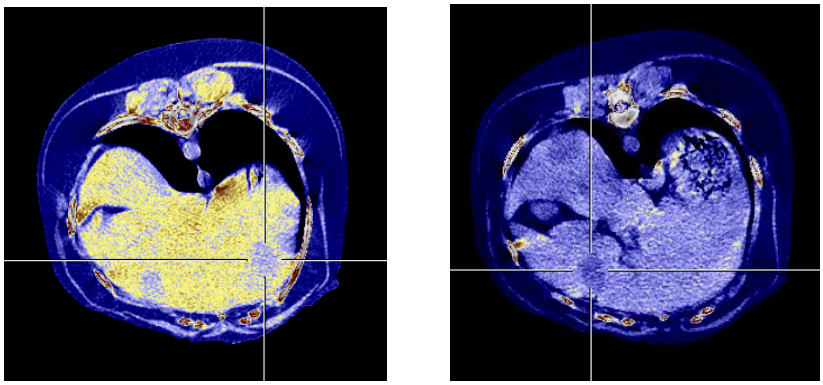


Figure 4. Threshold-based X-ray CT segmentation of metastatic liver tumor lesions in the dog at different time points post-therapy (7, 14, and 28 days). Red circles indicate tumor lesions that exhibited a reduction in size, blue circles indicate lesions that increased in size, and orange circles indicate lesions that remained stable without significant size change over the observation period.



(a) **(b)**

Figure 5. X-ray CT cross-sectional images of metastatic liver tumor lesions in the canine model acquired (a) 1 day and (b) 1 week after therapy, illustrating early post-treatment morphological changes.

Presentations Related to the Dissertation

- Poster presentation: Radioisotope Separation of Platinum Group Elements for Potential Applications in Targeted Cancer Therapy. IAEA International Symposium (ISTR-2023), Vienna, Austria, April 2023.
- Poster presentation: Study of Diffusion Dynamics in Pd/Rh Alloy. 4th Young Researchers' International Conference on Chemistry and Chemical Engineering (YRICCCE IV), Debrecen, Hungary, June 2023.
- Poster presentation: Novel Process of Pd-103 Production for Targeted Cancer Therapy. Optimizing Imaging and Dose-Response in Radiotherapies Workshop, Erquy, France, October 2023.
- Oral presentation: Cutting-Edge Methodology for Manufacturing Pd-103 Brachytherapy Device in Precision Cancer Therapy. Őszi Radiokémiai Napok 2023, Balatonszárszó, Hungary, October 2023.
- Invited oral seminar: Innovative Approach to Producing Palladium-103 for Auger-Emitting Radionuclide Therapy: A Proof-of-Concept Study. HUN-REN Institute for Nuclear Research (ATOMKI), Debrecen, Hungary, March 2024. Presentation delivered following selection of the publication as "Article of the Month" at ATOMKI.
- Oral presentation: Innovative Approach to Producing Palladium-103 for Auger-Emitting Radionuclide Therapy: A Proof-of-Concept Study. Őszi Radiokémiai Napok 2024, Balatonszárszó, Hungary, October 2024.
- Poster presentation: Scaling Up the Production of Radiopharmaceuticals for Nuclear Medicine at HUN-REN ATOMKI. Healthy Living Symposium, Budapest, Hungary, September 2025.
- Oral presentation: Palladium-103 as a Theranostic Auger Electron Emitter for Targeted Radionuclide Therapy: From Cyclotron Production to In Vivo SPECT/CT Imaging. Őszi Radiokémiai Napok 2025, Balatonszárszó, Hungary, October 2025.
- Poster presentation: The potential of ^{103}Pd-radionuclide for Auger Electron Therapy based on ^{103m}Rh-daughter release and micro-dosimetry evaluation. 8th Theranostics World Congress, Cape Town, South Africa, January 2026.

Schools and Workshops Attended Related to the Field of Research

- Train-the-Trainers course: Medical Application of Nuclear and Radiation Technologies and Related Educational Programmes. Rosatom Technical Academy, 12–16 December 2022.
- PRISMAP Summer School on Radionuclide Production, Leuven, Belgium, 27–31 May 2024.
- PRISMAP Radiolanthanides Workshop, Paul Scherrer Institute (PSI), Villigen, Switzerland, 3–5 September 2024.
- PRISMAP School: Current and Innovative Radionuclides for Medical Imaging and Therapy, University of Latvia, Riga, Latvia, 19–21 February 2025.

Honor Related to the Field of Research

MAGYAR KÉMIKUSOK EGYESÜLETE MKE HUNGARIAN CHEMICAL SOCIETY

OKLEVÉL

A Vértes Attila Alapítvány, az MTA Radiokémiai Tudományos Bizottsága és a Magyar Kémikusok Egyesülete közreműködésével lebonyolított
„Vértes Attila Ifjúsági Nívódíj" ösztöndíj pályázaton

AICHA NOUR LAOUAMERIA

doktorandusz

„PALLADIUM-103 AS A THERANOSTIC AUGER ELECTRON EMITTER FOR TARGETED RADIONUCLIDE THERAPY: FROM CYCLOTRON PRODUCTION TO IN VIVO SPECT/CT IMAGING"

című pályázatával és előadásával

Nívódíjat nyert.

Az eredményhez gratulálunk, és további sikeres tudományos munkát kívánunk!

Balatonszárszó, 2025. október 14.

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Subject: PhD Publication List

Candidate: Aicha Nour Laouameria
Doctoral School: Doctoral School of Chemistry
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List of publications related to the dissertation

Foreign language scientific articles in international journals (2)

1. **Laouameria, A. N.**, Driver, C. H. S., Buys, M., Kurakina, E. S., Hunyadi, M., Zeevaart, J. R., Szűcs, Z.: Evaluation of Daughter Radionuclide Release from the 103Pd/103mRh In Vivo Generator for Targeted Auger Therapy.
Pharmaceuticals. 19 (1), 1-16, 2026. EISSN: 1424-8247.
DOI: http://dx.doi.org/10.3390/ph19010126
IF: 4.8 (2024)

2. **Laouameria, A. N.**, Hunyadi, M., Csik, A., Szűcs, Z.: Innovative Approach to Producing Palladium-103 for Auger-Emitting Radionuclide Therapy: A Proof-of-Concept Study.
Pharmaceuticals (Basel). 17 (2), 1-13, 2024. EISSN: 1424-8247.
DOI: http://dx.doi.org/10.3390/ph17020253
IF: 4.8

List of other publications

Foreign language scientific articles in international journals (1)

3. **Laouameria, A. N.**, Fizir, M., Touil, S., Richa, A., Benamara, N., Douba, H., Wei, L., Aouameur, D., Rezala, H., Csík, A., Fodor, T.: Alginate-Aluminosilicate Clay Beads for Sustained Release of Chlortetracycline Hydrochloride: Development and In Vitro Studies.
Gels. 11 (11), 1-25, 2025. EISSN: 2310-2861.
DOI: http://dx.doi.org/10.3390/gels11110921
IF: 5.3 (2024)

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Foreign language conference proceedings (2)

4. **Laouameria, A. N.**, Hunyadi, M., Máthé, D., Bergmann, R. K., Zeevaart, J. R., Szűcs, Z.: Palladium-103 as a Theranostic Auger Electron Emitter for Targeted Radionuclide Therapy: From Cyclotron Production to In Vivo SPECT/CT Imaging.
In: Őszi Radiokémiai Napok 2025, Balatonszárszó, 2025. október 13-15. A konferencia programja és előadás-kivonatai. Szerk.: Jószai István, [MTA Radiokémiai Tudományos Bizottsága], [Balatonszárszó], 1-6, 2025. ISBN: 9786156018335

5. **Laouameria, A. N.**, Hunyadi, M., Csik, A., Szűcs, Z.: Innovative Approach to Producing Palladium-103 for Auger-Emitting Radionuclide Therapy: A Proof-of-Concept Study.
In: Őszi Radiokémiai Napok 2024, Balatonszárszó, 2024. október 14-16. A konferencia programja és előadás-kivonatai. Szerk.: Jószai István, [MTA Radiokémiai Tudományos Bizottsága], [Balatonszárszó], 1-7, 2024. ISBN: 9786156018267

Foreign language abstracts (4)

6. **Laouameria, A. N.**, Hunyadi, M., Szűcs, Z., Csik, A.: Novel Process of Pd-103 Production for Targeted Cancer Therapy.
Bulletin du Cancer. 112 (4), 1-1, 2025. ISSN: 0007-4551.
DOI: http://dx.doi.org/10.1016/j.bulcan.2025.02.001

7. **Laouameria, A. N.**, Hunyadi, M., Szűcs, Z., Csik, A.: Cutting-Edge Methodology for Manufacturing Pd-103 Brachytherapy Device in Precision Cancer Therapy.
In: Book of Abstracts, Őszi Radiokémiai Napok 2023.október 16-18. A konferencia programja és előadás-kivonatai. Szerk.: Jószai István, [MTA Radiokémiai Tudományos Bizottsága], [Balatonszárszó], 1-1, 2023.

8. Szűcs, Z., **Laouameria, A. N.**, Hunyadi, M.: Radioisotope Separation of Platinum Group Elements for Potential Applications in Targeted Cancer Therapy.
In: Book of Abstracts: International Symposium on Trends in Radiopharmaceuticals (ISTR-2023). Eds.: IAEA Headquarters, [IAEA Headquarters], [Wienna], 143-143, 2023.

9. **Laouameria, A. N.**, Hunyadi, M., Szűcs, Z.: Study of Diffusion Dynamics in Pd/Rh Alloy.
In: Programme and Book of Abstracts: 4th Young Researchers' International Conference on Chemistry and Chemical Engineering (YRICCCE IV), Hungarian Chemical Society, Debrecen, 62-62, 2023. ISBN: 9786156018168

DEBRECENI EGYETEM Egyetemi és Nemzeti Könyvtár

Total IF of journals (all publications): 14,9
Total IF of journals (publications related to the dissertation): 9,6

The Candidate's publication data submitted to the Tudóstér have been validated by DEENK on the basis of the Journal Citation Report (Impact Factor) database.

02 March, 2026