



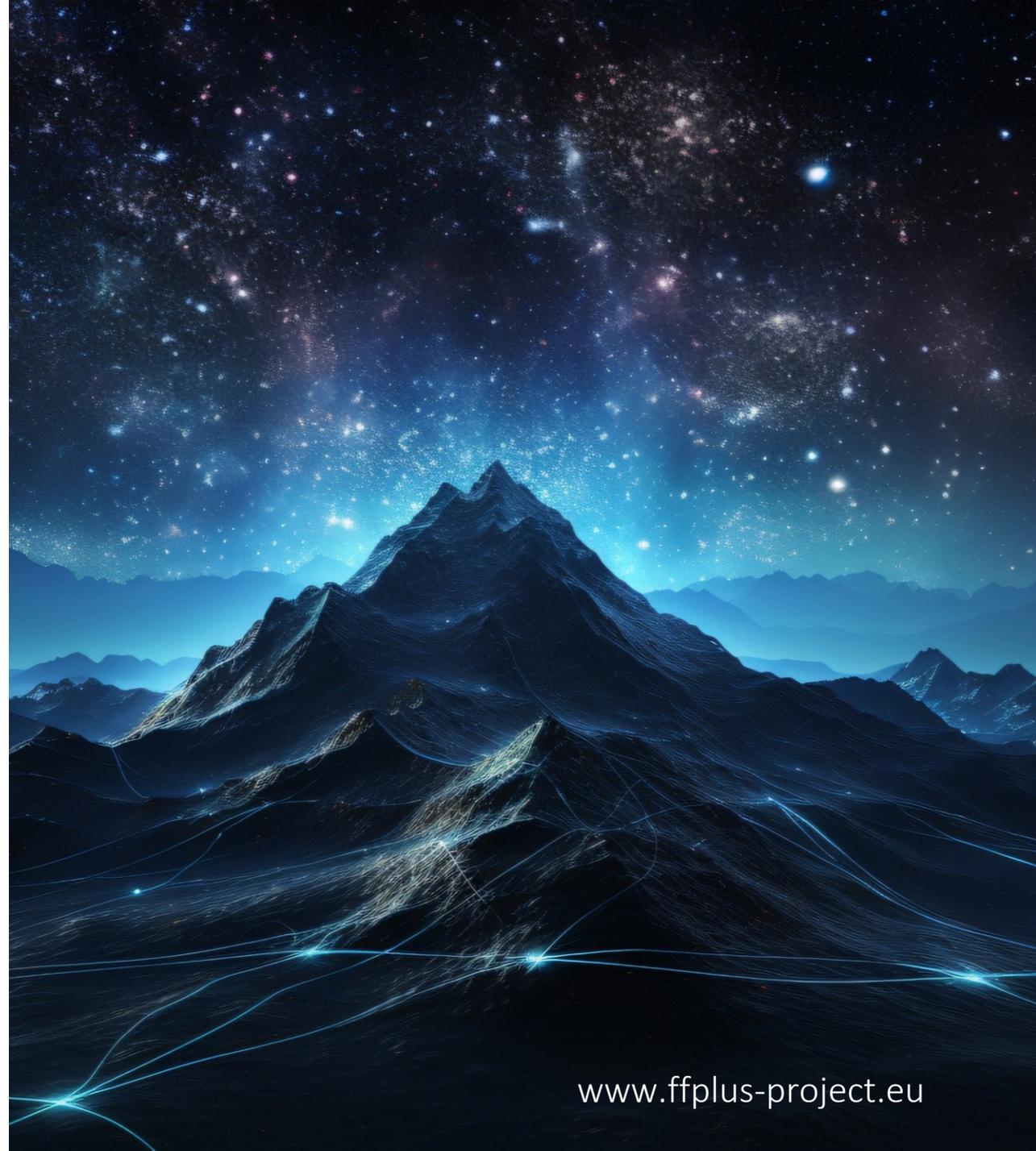
FORTISSIMO
PLUS

1204 - ΔosimetrEYE: A GenAI-based tool for 3D preclinical dosimetry from 2D dynamic imaging

Sub-projects' review – 12 February 2025 (online)

Panagiotis Papadimitroulas
Co-Founder & SW Advisor
BIOEMTECH

11 February 2026



www.ffplus-project.eu

Consortium & Roles

Panagiotis Papadimitroulas, BIOEMTECH



Partners

BIOEMTECH: End-user & Main Applicant
GRNET: HPC Expert (Greek NCC)
ALETHIA: XAI Expert

 BIOEMTECH



BIOEMTECH Coordinator: ***Dr. Panagiotis Papadimitroulas***
Deputy coordinator: ***Dr. Valentina Paneta***
ALETHIA representative: ***Dr. Neo Christopher Chung***
GRNET representative: ***Dr. Ilias Hatzakis***

Roles & expertise required in the project:

Technicians, Imaging Scientists, Bioinformatics, Physicists, SW Engineers, AI - MC experts

About BIOEMTECH

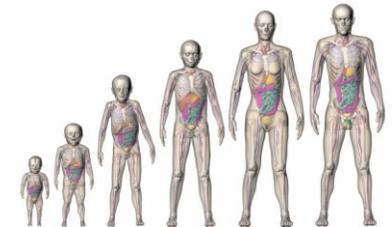
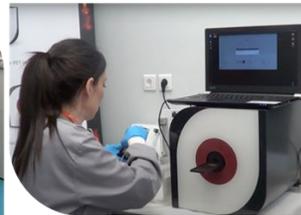
Panagiotis Papadimitroulas, BIOEMTECH



BIOEMTECH develops and offers innovative solutions in pharmaceutical and medical physics and biotechnology research

We focus on **molecular imaging, dosimetry & biomedical engineering:**

- Design and construction of screening imaging systems, the *eyes*TM
- Preclinical CRO for testing new radiolabelled compounds
- Computational tools for medical imaging and dosimetry



Business Problem

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Annually **115 million animals** are sacrificed in **biomedical experiments**.

Small animal imaging and dosimetry prediction tools can enable the effective **reduction of over 80%** animal sacrifice and **drastically speed** up the assessment of drug delivery studies.



- **Dosimetry assessment** currently is based on **rough estimations**.
- **MC simulations** provide the ground truth but **are time consuming**.
- **Anatomical variations** are important in preclinical dosimetry and can lead to **significant lack of accuracy (appropriate for drug discovery)**.

The goal is to utilize the ground truth dosimetry (MC simulations) with GenAI and HPC resources to develop a prediction tool for 3D dose assessment based on 2D preclinical imaging.

Solution Approach

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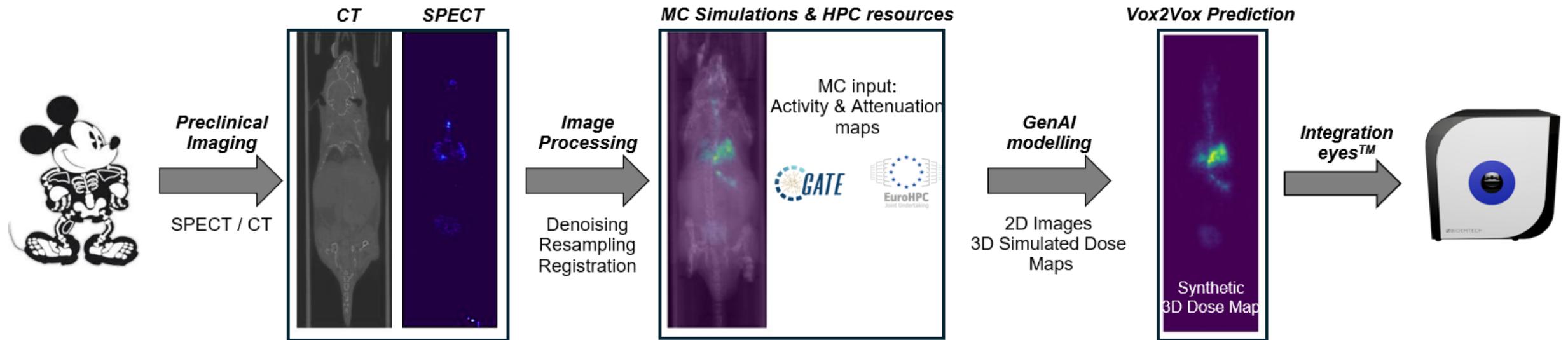
Our innovative approach is based on the deep knowledge of MC simulations, image processing tools, GenAI algorithms and XAI methods.

To develop a prediction dosimetry SW tool for our imaging devices, we need to:

- i. **Collect & harmonise imaging data** from different systems (3D SPECT/CT/2D planar).
- ii. **Execute highly demanding MC simulations (HPC use)** with the use of pairs (SPECT/CT) to extract the 3D dose maps (dosimetry per organ).
- iii. **Develop the final GenAI model to generate the 3D Dose Map (HPC use)**, providing as input the pairs 2D planar/3D dose maps.
- iv. **Apply XAI methods** for analysing the parameters most contribute to the generation of the dose maps for increasing their robustness/trustworthiness.

Solution Approach - Methodology

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HPC-Access

Panagiotis Papadimitroulas, BIOEMTECH



EuroHPC JU Access: AI and Data-Intensive Applications

Project Duration:
Jan. 2025 – Jan. 2026

Resources allocation:
50000 node hours on Leonardo Booster (CINECA, Italy)

Usage:
Execution of both MC simulations & GenAI models



EuroHPC
Joint Undertaking

Main Achievements

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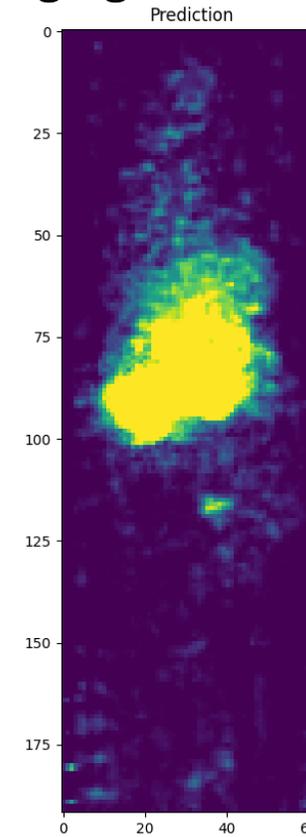
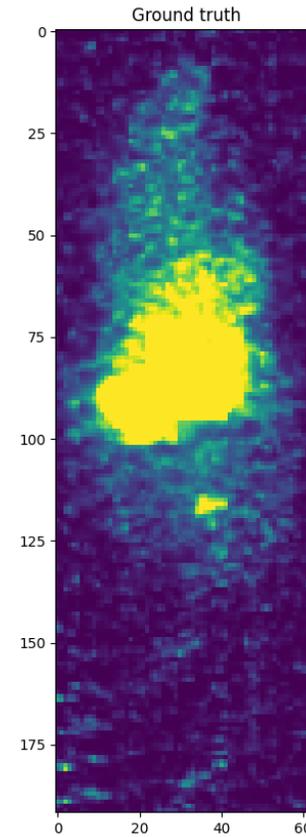
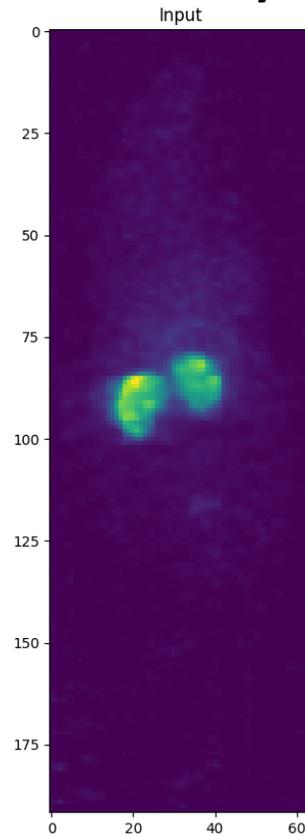
- ✓ Creation of a comprehensive preclinical dosimetry database
- ✓ Development of the first GenAI-based model for 3D dose prediction
- ✓ Integration of Explainable AI and quality-control mechanisms
- ✓ Demonstration of HPC-enabled scalability and efficiency
- ✓ Establishment of a sustainable AI-driven business model for preclinical imaging
- ✓ Reduction of animal use and promotion of ethical research
- ✓ Active dissemination and international visibility
- ✓ Strengthened collaboration and capacity building among partners

Main Achievements – The Tool

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Perform **GenAI Dosimetry** in parallel with **in vivo Imaging!!!**

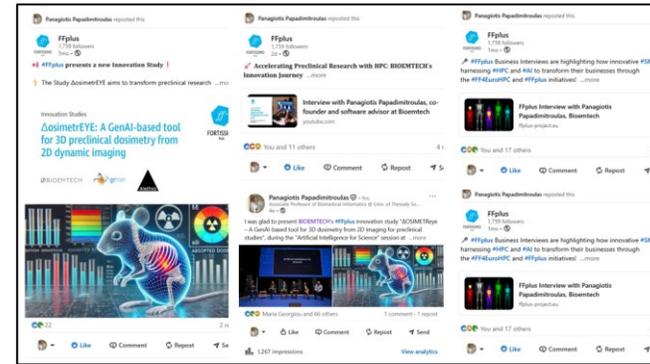


Main Achievements - Dissemination



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- ✓ 3 Presentations (invited talks)
- ✓ 3 International Conference (oral/poster presentations)
- ✓ 1 Publication (proceedings)
- ✓ Social Media, Blog post, Interview by FFPlus
- ✓ 1 Industrial Exhibition



The meeting will be held in person in NCSR 'DEMOKRITOS' ATHENS. You can find more information about the venue on the attached page.
To participate, please register before March 15 and do not hesitate to propose a presentation (oral/poster) concerning your last advances with the GATE platform.
Best regards,
The OpenGATE collaboration



Don't hesitate to contact us for any further information:
Dr. Valentin Panets
Dr. Panagiotis Papadimitroulas



ΔosimetrEYE – concept

METHODOLOGY

- > Install **GATE v10** in HPC 'LEONARDO CINECA'
- > Collect **preclinical imaging triplets** of data (CT – SPECT – 2D) for In-111
- > Simulate SPECT/CT and create **3D dose maps** (~1000)
- > Utilize different biotopographies (aligned datasets)
- > Create a **NEW dataset 2D imaging & 3D simulated dose maps** (~1000)
- > Apply **pix-to-vox GenAI** techniques.

Currently we have collected 380 imaging triplets & standardized the GATE acquisition in HPC



BIOEMTECH: FORTISSIMO industrial HPC uses cases in healthcare

Panagiotis Papadimitroulas
Training Director & Co-Founder
BIOEMTECH



Safeguarding Generative AI Applications in Preclinical Imaging through Hybrid Anomaly Detection

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Abstract
Generative artificial intelligence (GenAI) holds great potential to automate and enhance data synthesis in nuclear medicine. However, the high-stakes nature of biomedical imaging necessitates robust mechanisms to detect and manage unexpected or erroneous model behavior. We report development and implementation of a hybrid anomaly detection framework to safeguard GenAI models in BIOEMTECH's 'eye' system. Two applications are demonstrated: PoseXray, which generates synthetic X-rays from photographic mouse images, and DosimetrEYE, which estimates 3D radiation dose maps from 2D SPECT/CT scans. In both cases, our outlier detection (OD) enhances reliability, reduces manual oversight, and supports real-time quality control. This approach strengthens the industrial viability of GenAI in preclinical settings by increasing robustness, scalability, and regulatory compliance.

2 System Overview
The proposed outlier detection pipeline is implemented in Oke AI [12] input samples are inspected and their features are extracted and logged by our open-source Python library¹. Integrated with our full-stack app², a user can visualize features, detect outliers, and manage the project on the web dashboard.

2.1 CAMM of First Order Features: To identify out-of-distribution (OOD) samples in preclinical imaging data, we investigated a suite of first-order statistical features (POFs) from each sample. POFs such as entropy, median, variance, and uniformity capture essential aspects of the data distribution while maintaining computational efficiency and interpretability.

To model the typical variation in the data, we fit a Gaussian Mixture Model (GMM) using the extracted POFs from the training dataset [11]. The GMM effectively learns the underlying distribution of the distribution samples in the POF space. Then, new samples in production are projected, and their likelihood under the GMM is evaluated. Samples whose likelihood falls below 1 percentile of the GMM distribution are declared outliers. This threshold is empirically chosen to adjust for sensitivity and specificity.

PCA of Visual Language Embeddings: We use the CLIP model to convert each image in the training dataset into high-dimensional embedding vectors [12]. Alternatively, a user can choose to use a wide range of ViTLMs to explore the 'bugging face'. These embeddings serve as a compact yet information-rich representation of image content. Once the embeddings are obtained, we perform Principal Component Analysis (PCA) to identify a lower-dimensional subspace that captures the majority of variance within the training data [9]. The reconstruction loss for each sample is defined as the squared Euclidean norm between the original embedding vector v_i and its projection \hat{v}_i onto the subspace spanned by the top r PCs.

A GenAI model for 3D preclinical dosimetry from 2D 111In imaging

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¹BIOEMTECH, ²University of Thessaly, Larissa, ³University of Thessaly, Larissa, Athens

Introduction: Preclinical dosimetry by using radiation is of great interest in preclinical research, which is the 3rd phase of clinical drug discovery. Internal dosimetry is inherently challenging—requires both resource intensive with prior image or nuclear medicine procedures.

Methodology: We used 18 preclinical 111In SPECT/CT datasets, 68 111In SPECT/CT scans, and corresponding 3D dose maps. We used a GAN to generate 3D dose maps from 2D 111In SPECT/CT scans. We used a GAN to generate 3D dose maps from 2D 111In SPECT/CT scans. We used a GAN to generate 3D dose maps from 2D 111In SPECT/CT scans.

Results: The model generated 3D dose maps from 2D 111In SPECT/CT scans. The model generated 3D dose maps from 2D 111In SPECT/CT scans. The model generated 3D dose maps from 2D 111In SPECT/CT scans.

Conclusion: This work presents a methodology for developing a GenAI model that generates 3D dose maps from 2D 111In SPECT/CT scans. The proposed pipeline can be generalized and implemented for a variety of radiopharmaceuticals and is to be validated in clinical practice, applied to preclinical imaging and dosimetry.

Business Impact

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- ✓ **Product Innovation & Differentiation:**

Development of δ -eye for 3D preclinical dosimetry based on 2D imaging, significantly reduces animal models usage.

- ✓ **Commercial Expansion:**

The company's **product portfolio can now include AI-enhanced dosimetry**, appealing to pharmaceutical, CRO, and clinical customers worldwide.

- ✓ **Strategic Collaborations:**

HPC competency served as a magnet for **further collaborations and EU funding proposals**.

- ✓ **Efficiency & ROI:**

Faster simulation times and increased automation led to **reduced product development cycles**.

Simultaneous preclinical imaging and dosimetry **improves research throughput**, minimizing experimental time and cost.



A Polish start-up establishing its XAI platform (SaaS) on real healthcare use –cases.



Exploit their HPC expertise in industrial sector – real business case for NCC.

Business Impact - Benefit

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The **GenAI dosimetry tool** reduces computation time from 5–10 hours per MC simulation to under 20 seconds, a >99% reduction in processing time. Expected to increase CRO service efficiency by up to 60%, shorten client delivery times by 3 times, and open new market opportunities. With an annual volume of ~200 dosimetry studies, this equates to **yearly savings of about 120k€ and an additional 200–250k€ of extra service revenue due to higher throughput.**

XAI & QC mechanisms make **DosimetrEYE** suitable for regulatory and industrial environments, strengthening customer confidence and aligning the product with EU AI Act requirements for transparency and accountability. The XAI tools are now ready for deployment in other regulated AI projects across healthcare and industrial applications.

The expected licensing and consulting revenue is estimated **at 80–100k€ per year.**

Challenges

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- **Collection of large experimental preclinical imaging data.**
Retrospective data utilized.
- **Generalization to other radiopharmaceuticals.**
Within the study GenAI dosimetry applied for In-111, while we aim to generalize the tool.
- **Time limitation for further optimization and evaluation.**
Tool development and integration to the imaging devices for routine evaluation.



Outlook & Next Steps

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- ✓ Generalization of the tool for multiple radioisotopes (Lu-177, Ga-68, F-18, Tc-99m, I-131)
- ✓ Fully integration of **DosimetrEYE** GenAI dosimetry model into **eyes™** preclinical imaging systems.

END-USERS: Preclinical imaging labs, CROs, pharma companies, and academic researchers performing radiopharmaceutical development or toxicity evaluation.

-
- ✓ Data inspection modules by **ALETHIA** will be further validated within **DosimetrEYE** pipeline.
 - ✓ **ALETHIA** will continue enhancing its **Obz AI** platform by integrating XAI, interpretability features and outlier-detection modules, expanding their use in other healthcare and industrial AI applications

END-USERS: AI developers, regulators, and biomedical SMEs integrating AI tools under EU AI Act or ISO 27001 frameworks.



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Thank you!

Panagiotis Papadimitroulas

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EuroHPC
Joint Undertaking

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