PetVision Newsletter; 4th edition
August 2025

Welcome to the 4th edition of the PetVision Newsletter!
As the PetVision project approaches its second year, we are proud to share the exciting progress and scientific breakthroughs achieved by our consortium. In this issue, we take you deeper into the heart of the project through exclusive interviews with key researchers and institutions, highlighting the motivation, roles, and technological innovations that are shaping the future of PET imaging.
From developing ultra-fast gamma-ray detectors and advanced SiPM technology to enabling affordable, high-resolution total body PET scans — PetVision is redefining what is possible in molecular diagnostics. Read on to meet our partners, learn about their contributions, and discover how we are turning a bold vision into clinical reality.

About the project
Over 2.7 million people in the EU were diagnosed with cancer in 2020, while 1.3 million people lost their lives to it. Cancer cases are predicted to increase by 24% by 2035, making it the leading cause of death in the EU. The current leading imaging diagnostic technique sensitive to cancer is Positron Emission Tomography (PET). Due to the high implementation cost of PET, this highly sensitive diagnostics is only available in less than 0,5 % of the medical centers in the world. One of the main components of the overall cost is the cost of PET scanners. The main objective of PetVision EIC Pathfinder project is to develop a flexible, modular PET scanner, based on planar detector panels with exquisite time-of-flight (TOF) resolution and sensitivity. It will enable affordable, fast and precise dynamic scanning, and hence improve access to early cancer detection and therapy follow-up, paving the way for personalized medicine.

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Presentation of selected project partners
Klinikum Rechts der Isar der Technischen Universität München (TUM-MED): PetVision is an interdisciplinary research group developing an exciting new technology with significant potential for new preclinical and clinical applications. TUM University hospital will participate in the clinical testing of the new PET-Detections, specifically for detection of prostate cancer metastases with PSMA radioligands.

Fondazione Bruno Kessler (FBK): FBK chose to participate in PetVision for two primary reasons. Firstly, the project's focus on Time-of-Flight PET (ToF-PET) applications aligns directly with a core research pillar at FBK: the development of advanced Silicon Photomultipliers (SiPMs). Secondly, the consortium is composed of leaders in their respective fields. This collaboration creates a highly synergistic environment that fosters innovation and maximizes the project's potential for success.
In the PetVision project, FBK's primary role is to develop the core single-photon sensors: highly optimized Silicon Photomultipliers (SiPMs) that incorporate state-of-the-art performance and advanced interconnection technology. Additionally, FBK is responsible for the 2.5D integration of these sensors with the readout ASICs, a process that culminates in the creation of the final PetVision Photon Detection Module.

Presenting the project and participating institutions through Q&A

What is the primary goal of the PetVision project?
Georges El Fakhri (YALE): One of the primary goals of the PetVision Project is to harness the spectacular improvement in coincidence timing resolution to revolutionize the field of PET by being able to form a high quality diagnostic image without the need for a full ring of detectors, but by using a robust system of two back to back flat panels.

Rok Pestotnik (Jožef Stefan Institute - JSI): The PetVision project aims to advance functional molecular medical diagnostics through ground-breaking technological innovation. Its core objectives include the development of an ultrafast gamma-ray detector that can significantly enhance image resolution and sensitivity. A key milestone is the construction of a prototype PET imager that integrates these novel detection capabilities. The project also focuses on thorough evaluation and validation of the imager’s performance to ensure clinical relevance. Together, these efforts promise to improve the precision and effectiveness, affordability and global dissemination of clinical PET imaging.

PetVision is funded by the EIC Pathfinder Open program. How does PetVision align with the EIC Pathfinder mission?

Rok Pestotnik (JSI): PetVision aligns closely with the mission of the EIC Pathfinder Open program by targeting breakthrough technological innovations with high-impact potential, combining very high performance with affordability. The project's development of an ultrafast gamma-ray detector and a next-generation PET imaging prototype represents a bold, high-risk approach that, if successful, could revolutionize clinical diagnostics. By fostering deep-tech research through strong interdisciplinary collaboration, PetVision exemplifies the EIC Pathfinder's goal of supporting visionary science that leads to radically new technologies. Its focus on transforming medical imaging directly addresses global healthcare challenges—one of the central pillars of the EIC Pathfinder mission.

With PET being a well-established imaging modality, what are the main advantages the PetVision aims to bring?

Georges El Fakhri (YALE): PetVision allows to take advantage of the ~75ps timing resolution to achieve a full tomographic PET image without the need to collect all angles along a 360 degree ring of detectors as the field has been doing for the past 50 years. The image quality is projected to be superior to current whole body PET scanners. This opens the way to an order of magnitude more affordable total body PET systems by tiling the flat detectors along the axial direction. This also has the potential to make widely available pharmacokinetics of the entire body as well as total body dosimetry with a sensitivity that is far superior to whole body PET. Brain body interactions, whole body PK/PD and ultra low dosimetry studies become suddenly available at a fraction of the cost of current total body PET scanners.

What breakthrough innovation of the PetVision system will make it possible to reach this aim?

Stan Majewski (external advisor): The major enabling breakthrough of the project is that for the first time ever since the TOF performance was identified by the imaging community as being of key importance in getting the best PET imaging results such as highest sensitivity and quality of images, it shows the path to achieving systemic TOFPET performance better than 100 ps FWHM TOF resolution, that was shown in simulations as providing major increase in performance. It is indeed a critical enabling factor across the full spectrum of PET scanners, starting from the limited angle tomography devices used in surgical applications, to the upright mobile brain imagers, and to the affordable total body scanners, to list a few examples.

Time-of-Flight (TOF) is available in several commercial PET systems. What timing resolution is required for the breakthrough of the PetVision system, and how will it be achieved?

David Gascon (University of Barcelona - UB): Achieving a time resolution below 100 picoseconds represents a transformative milestone for Time-of-Flight Positron Emission Tomography (ToF-PET) detectors, enabling a new paradigm in medical imaging. Realizing this level of precision at the system level, however, demands substantial advancements across multiple domains—including photosensor technology, front-end electronics, system integration, synchronization, and data acquisition (DAQ). Our research addresses all of these areas in parallel. A particularly critical development is the vertical integration of photon sensors with front-end ASICs, which promises to significantly enhance timing performance and compactness. Ultimately, our goal is to engineer front-end electronics with a floor jitter as low as 30 picoseconds, setting a new benchmark for the field.

What type of detectors are used in the PetVision system to achieve the target timing resolution?

Jorge Álamo (Oncovision): PetVision is pushing the limits of the timing resolution improving all components.

1. Ultra-fast scintillators: LSO/LYSO (lutetium-orthosilicate) type crystals, known for their rapid light emission and high efficiency, will be used. These materials already allow resolution times of around <80 ps in small laboratory prototypes.
2. Cutting-edge photodetectors used in PetVision (SiPMs with TSV): Silicon Photomultipliers (SiPMs) are compact devices that combine high quantum efficiency (>40%), low time dispersion (jitter), and allow dense packaging without dead spaces thanks to TSV (Through-Silicon Via) technology developed by FBK.
3. Fast electronics and custom ASIC: A multi-channel ASIC (FastIC / FastIC+) is being designed with a) very high-speed analog front-end, b) built-in time-to-digital (TDC) converter with picosecond resolution, and c) low latency and moderate consumption.

The result are crystal + SiPM composite modules with very fast electronics. The aim is to manufacture prototypes with down to ~75 ps coincidence resolution (CTR), approaching the intrinsic limit of the scintillators/photodetectors used.

Please describe the role of the scintillator crystals and the related PetVision requirements.

Gašper Razdevšek (JSI): The scintillator crystals are the first element in the detection chain: they must stop 511 keV annihilation photons and convert their energy into as many scintillation photons as possible, as quickly as possible, to maximise both energy and timing resolution. This demands high-stopping-power, high-light-yield materials such as L(Y)SO:Ce:Ca or LGSO, segmented into 3 × 3 mm pixels for state-of-the-art spatial resolution (higher 1.5 x 1.5 mm segmentation will be used in the next stage). By making the arrays thinner than standard, the parallax error is minimized, and optical-photon paths are shortened, boosting timing performance while reducing crystal volume and cost. Using 10 mm thick crystals enables coincidence-timing resolution below 100 ps, crucial for distortion-free imaging in PetVision's open two-panel geometry, while maintaining high detection efficiency.

PetVision system will use Silicon Photomultipliers (SiPMs) as photon detectors. Why are they preferred to traditional photomultiplier tubes (PMTs)?

Alberto Gola (Fondazione Bruno Kessler - FBK): Silicon Photomultipliers (SiPMs) offer numerous advantages over traditional Photomultiplier Tubes (PMTs), including higher sensitivity to scintillator light, greater compactness and ruggedness, significantly lower bias voltage requirements, and near-insensitivity to magnetic fields. The SiPMs being developed for the PetVision project are designed to achieve state-of-the-art performance, with a target Photon Detection Efficiency (PDE) of 65% at 410 nm and a Single Photon Time Resolution (SPTR) down to 20 ps FWHM at the microcell level. These metrics are crucial for realizing the excellent timing performance expected from the PetVision PET system. To further enhance these capabilities, FBK will develop advanced interconnection technology for the SiPMs by incorporating Through Silicon Vias (TSVs). This TSV technology enables the efficient tiling of SiPMs with minimal loss of light-sensitive area and ensures excellent signal integrity to the readout ASIC, which is vital for improving the overall timing performance.

Another key component is electronics and data acquisition system (DAQ). What are the main challenges to meet the PetVision requirements?

Noriel Pavon (Instituto de Instrumentación para Imagen Molecular - CSIC-I3M): To meet the PetVision requirements, we need to handle a massive number of analog channels (almost 20,000) that must be digitized, processed, filtered, transmitted, and stored at very high speed (100 Mcps). We are dealing with extremely small time scales, very high-speed signals, and the generation of a massive data flow that must be transmitted and stored outside the device using advanced communication protocols. It is a challenge as complex to address as it is exciting.

The design must necessarily be built with a modular approach that allows us to create robust functional blocks on a small scale (50 mm x 50 mm), ensuring signal integrity (V≈100 mV, t≈60 ns) as well as the synchronization and fine-tuning of the acquisition chains (t<10 ps), while sharing coincidence signals (t≈4 ns) that define the validity of paired events across different blocks operating in parallel. These blocks are mechanically and functionally scalable to enable the system to reach a useful operational dimension in sizable devices, such as the PetVision scanner, which consists of two 30 cm x 30 cm detector panels positioned face to face about 40 cm apart.

The novel geometry of the PetVision system will require dedicated image reconstruction algorithms. Can you briefly describe the PetVision approach to image reconstruction?

Gašper Razdevšek (JSI): PET scanners with limited angular coverage, or open-geometry systems such as 2-panel designs, tend to produce distorted 3D images with artefacts. Integrating time-of-flight (TOF) information from ultrafast timing detectors into the reconstruction largely eliminates these distortions, yielding high-quality images. The TOF-MLEM algorithm reconstructs list-mode data, and tagging each event with the precise position and orientation of the detecting panel enables accurate fusion of data acquired from panels positioned at different distances and angles around the patient. Spatial resolution is further enhanced by incorporating position-dependent point-spread-function (PSF) modelling into the system matrix.

Modularity and flexible design are some of the main advantages of the PetVision system. How would you describe the resulting imaging flexibility, and what are the expected clinical or preclinical benefits?

Wolfgang Weber (Klinikum Rechts der Isar der Technischen Universität München - TUM-MED): The PetVision project will enable entirely new detector geometries that can streamline existing PET applications and enable new applications. Examples include intraoperative PET imaging or PET imaging in an intensive care unit (ICU). This can facilitate the use of radiopharmaceuticals for intraoperative guidance (e.g. PSMA positive small lymph node metastases) and for scanning of acutely ill patients (e.g. patients with sepsis of unknown origin).

You can meet us here:

- IEEE Medical Imaging Conference 2025 (Yokohama, Japan, November 2025)

PET VISION

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