PetVision Newsletter; 3rd edition
March 2025

Welcome!
Enter the world of the PetVision Newsletter for a glimpse into an innovative project reshaping cancer diagnostic in the EU. Explore insights into the performance evaluation of panel detectors in PET imaging. Follow the early results of the assessment of photo-sensors and front-end chips.

Short overview of 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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Early results of the assessment of photosensors and front-end chips
The PetVision project is aiming to enhance current PET/CT technology by developing an advanced modular time-of-flight PET imager. The conceptually new approach is based on an excellent time resolution of the PET detectors that will be developed in the project. The targeted coincidence time resolution (CTR) of 75 ps FWHM can only be achieved by innovations in photodetectors, readout electronics, and optimized integration in a photodetector module.
The goal of the PetVision project is thus to develop custom photodetectors and electronics, closely integrate them into an optimized photodetector module, assemble an advanced PET scanner and test it in a clinical setting. To achieve these, we are working on several deep technologically innovative steps: development of a novel front-end readout ASIC, development of the next generation highly performing silicon photomultiplier (SiPM) sensor, and 2.5D integration of the two. Furthermore, the detector design, including the scintillation crystals, must be carefully optimized. To support all the decisions in the design work, simulation and experimental studies are being conducted since the beginning of the project.
Most relevant experimental tests are coincidence measurements with PET detectors employing readout electronics that will be scalable to the full system. The early studies are performed on the most basic building block of a PET scanner, a set of two single pixel detectors in coincidence. Each detector is composed of a single scintillator crystal coupled to a single SiPM. Through such measurements we can determine the lower bound of performance that can be expected in the scanner, which will be composed of many such elements.
Recently, measurements were performed using the first FastIC+ chips (available since end of 2024) that represent the current state-of-the-art in development leading to the custom PetVision ASIC. FastIC+ chips are low-power ASICs developed by the University of Barcelona in 65 nm CMOS technology that include on-chip Time-to-Digital Converters (TDC). They provide 25 ps time bin and digital backend for preprocessing and serialization. FastIC+ were combined with state-of-the-art SiPMs developed by Fondazione Bruno Kessler (FBK), optimized for improved timing resolution, and commercially available 2x2x3 mm3 LYSO:Ce:Ca crystals produced by Taiwan Applied Crystals.
The measurements were performed with two single pixel detectors in coincidence with a 22Na source of annihilation photons positioned between the two detectors. Using this setup, a CTR of 89 ps FWHM was demonstrated. To the best of our knowledge, this is the first time an ASIC with an integrated TDC achieved a sub-100 ps CTR. This represents a crucial achievement for the project as only ASICs with an integrated TDS provide the scalability required for a clinical PET system.
The presented single pixel detector experiments are used to assess the performance of the next level detector technologies being developed in the PetVision project, including the final 2.5D integrated photodetector module and improved SiPMs. The encouraging result reported above are confirming the validity of the PetVision approach and proving the capability of the modern state of the art technology to meet the requirements.

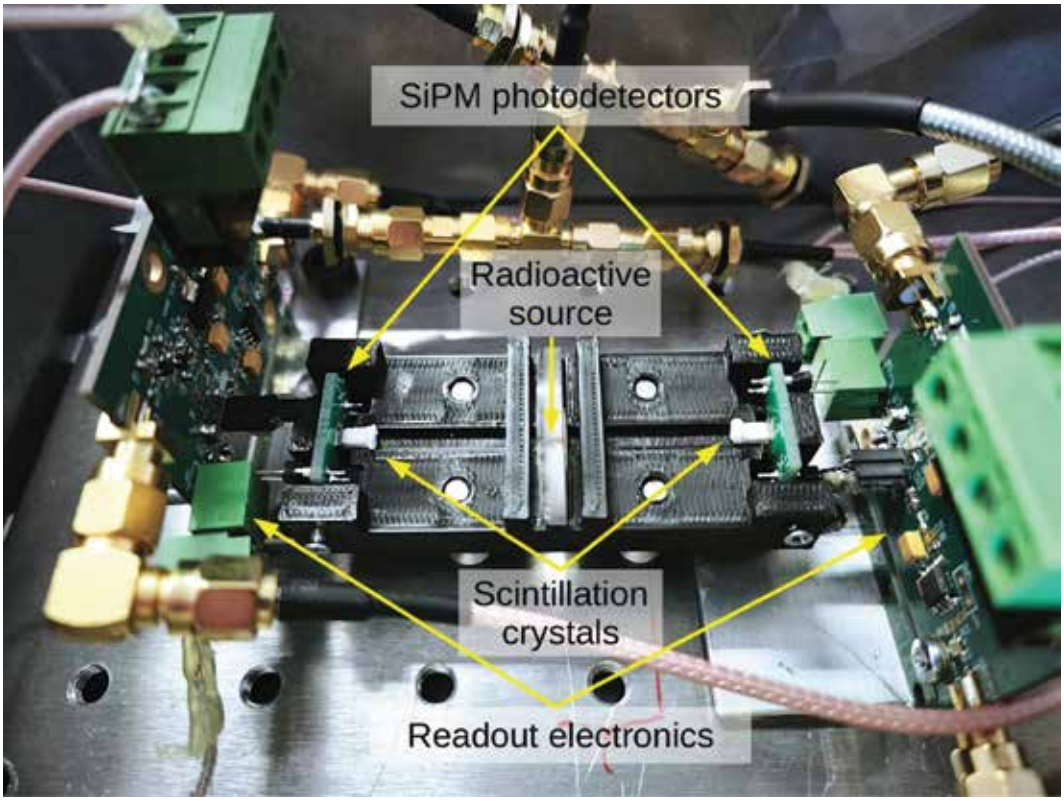

Figure: The experimental set-up used to assess performance of the photosensors and front-end chips. The labels are indicating the most important components of the system.

You can meet us here:

- Society of nuclear Medicine and Molecular imaging (SNMMI) 2025 (New Orleans, USA, June 2025)
- 2nd Symposium on New Trends in Nuclear and Medical Physics (Jagiellonian University Campus, Krakow, Poland, September 24-26, 2025)
- FATA 2025 “FAst Timing Applications for Nuclear Physics and Medical Imaging” (Catania, Italy, October 8-10 2025)
- IEEE Medical Imaging Conference 2025 (Yokohama, Japan, November 2025)

PET VISION

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