Research focus of the department of “Physics of Molecular Imaging Systems” (PMI) is on exploring the physical limits of current and future molecular imaging technologies. These areas range from simulations of new detector concepts, hardware prototypes, high speed data processing, image reconstruction algorithms and applications using our research imaging prototypes. Our group consists of students and researchers from different disciplines: physics, engineering, computer science and medicine. PMI is part of a large international network with a close link to industry, particularly to Philips Research.

Master’s Thesis: Characterization of the TOFPET2 ASIC for high-performance Time-of-Flight PET/MRI applications

In Positron Emission Tomography (PET) imaging (Fig. 1), a patient or animal is injected with a radioactive substance emitting positrons during decay. The positron annihilates with an electron from the patient’s body, thus producing two photons which propagate through the body in opposite directions. These photons are detected outside the body using a ring of PET detectors. These PET detectors are typically scintillators, converting the 511 keV gamma photon to a high number of optical photons, which are coupled to photosensitive detectors.

Our group developed a high-performance PET platform that can be operated inside a Magnetic Resonance Imaging (MRI) system [1, 2]. In the current version, it employs digital SiPMs as a photosensor. These are highly integrated photosensitive devices produced by Philips Digital Photon Counting. In recent years, analogue SiPMs have seen big improvements with the newest generation being promising candidates to build photosensitive and MRI-compatible PET detectors. With the large variety of different geometrical layouts, analogue SiPMs can be specifically selected for the targeted application.

To digitize the analogue electronic SiPM signals, a dedicated application-specific integrated chip (ASIC) is needed which accurately measures the height of the SiPM signal and assigns a high-resolution timestamp (picosecond range) to it (Fig. 2). The company PETsys (www.petsyselectronics.com) recently announced the latest generation of their TOFPET2 ASIC specifically designed for time-of-flight PET.

The goal of this work is to evaluate the TOFPET2 ASIC with regard to high-performance PET/MRI applications using an evaluation KIT provided by PETsys (Fig. 3). The candidate will develop an analysis software which allows a detailed characterization of the ASIC with regard to its basic behaviour and its performance in combination with different SiPMs attached to scintillators. In a further step, the candidate shall evaluate the possibilities and requirements to incorporate the bare ASIC into our existing MRI-compatible PET platform.

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