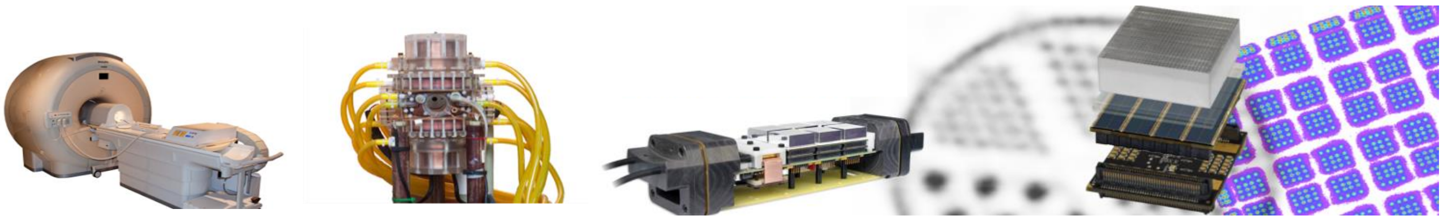
PHYSICS OF MOLECULAR IMAGING SYSTEMS

High Performance Computing



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.

# Bachelor or Master’s Thesis: Parallel Processing for a Digital PET Insert

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 subject’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 detected by underlying photosensitive detectors.

At the PMI the world’s first preclinical PET/MRI insert on basis of fully digital Silicon Photomultipliers (dSiPM) was developed [1]. A preclinical high resolution PET Scanner uses crystal scintillators with a very small pitch. Lightsharing is employed to spread the signal from one crystal to multiple sensor channels on the photon counting detector (Fig. 2) . To identify the crystal rod of the scintillation from the light distribution maximum likelihood methods are the state-of-the-art.

For real time processing of next generation PET scanners a throughput of several GBytes/s is required as well as a scalable computing architecture to allow online processing either of small, preclinical systems and clinical whole-body systems with a much larger number of detectors and required total data rate.

Together with the HPC group of the RWTH IT Center, we are investigating multi-threading frameworks (e.g. OpenMP, TBB) and new dedicated hardware (FPGA) to increase the throughput of the current implementation.
The candidate will work with a processing framework, implemented in C++. Good programming skills and knowledge of modern parallel computer architectures and parallel programming models (OpenMP and MPI) is preferred as well as interest and the ability to learn and familiarize quickly with the required PET domain knowledge to improve the underlying algorithms.

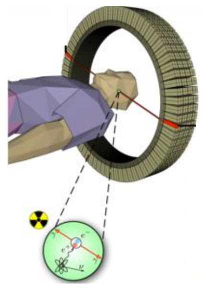


Fig. 1: In PET, two 511 keV gamma photons from a positron-electron annihilation have to be detected and correlated.

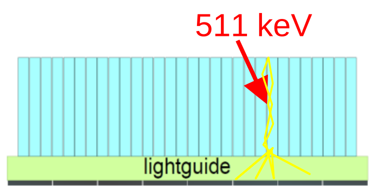
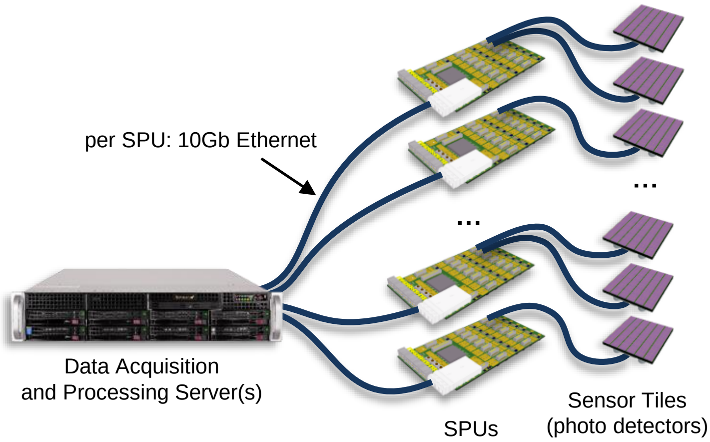



Fig. 2: The scintillation light caused by a gamma particle is spatially confined in a pixelated detector.




[1] B. Weissler *et al.*, 2015, *IEEE TMI 34 11 2258*, doi: 10.1109/TMI.2015.2427993

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