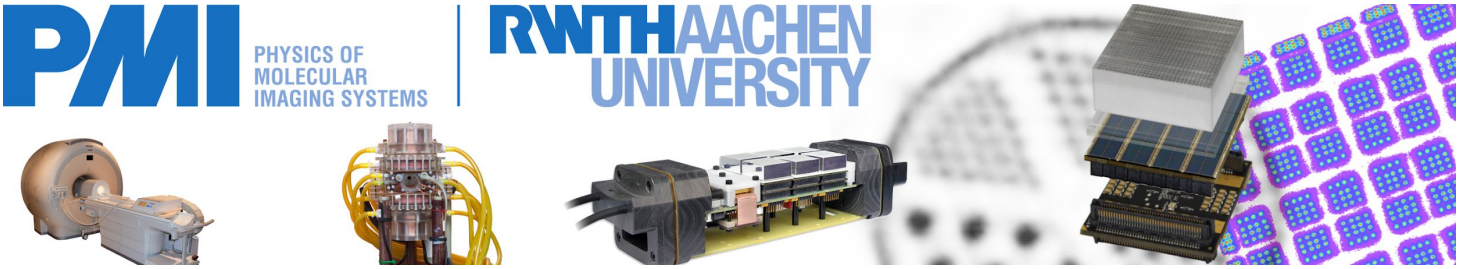
PMI PHYSICS OF MOLECULAR IMAGING SYSTEMS | RWTH AACHEN UNIVERSITY



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: Positron Emission Tomography Reconstruction

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 gamma photons which propagate through the body in opposite directions. These gammas 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.

The goal of the measurement is to determine the three-dimensional distribution of activity inside the patient. The two detected positions of the two gammas form a line of response (LOR), somewhere along which the original positron annihilation must have occurred. The problem of determining the most likely activity distribution from all measured coincident gammas is called image reconstruction. Most modern PET image reconstruction methods use Maximum Likelihood Expectation Maximization to fit expected simulated data to the measurement.

Our group developed the world’s first preclinical PET/MRI scanner on basis of fully digital Silicon Photomultipliers (dSiPM) [1]. We are currently working on multiple prototype PET scanners, that all require well performing PET reconstruction. The goal of the master thesis will be to evaluate the use of open source frameworks for PET reconstruction such as STIR [2] and CASToR [3] with our PET scanner. You will use these frameworks to implement and test reconstruction algorithms. The performance of the reconstruction is then evaluated using measurement data of our PET scanner and simulation data of our future scanners.

You should bring programming skills in C++ or at least the motivation to learn them. During the thesis you will think a lot about geometry, a bit about linear algebra and statistics and more about programming well-performing numerical code. In principle, the scope of the thesis is very open and basically any ideas regarding PET image reconstruction can be investigated and implemented in any way you like.

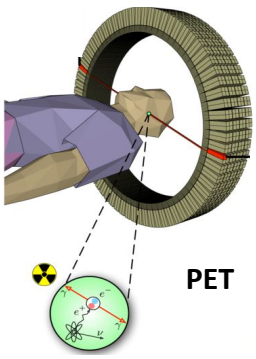


Fig. 1: In PET, two 511 keV gamma photons from a positron-electron annihilation have to be detected and correlated.

[1] B. Weissler *et al.*, 2015, *IEEE TMI 34 11 2258*, doi: 10.1109/TMI.2015.2427993
[2] http://stir.sourceforge.net/
[3] http://www.castor-project.org/

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