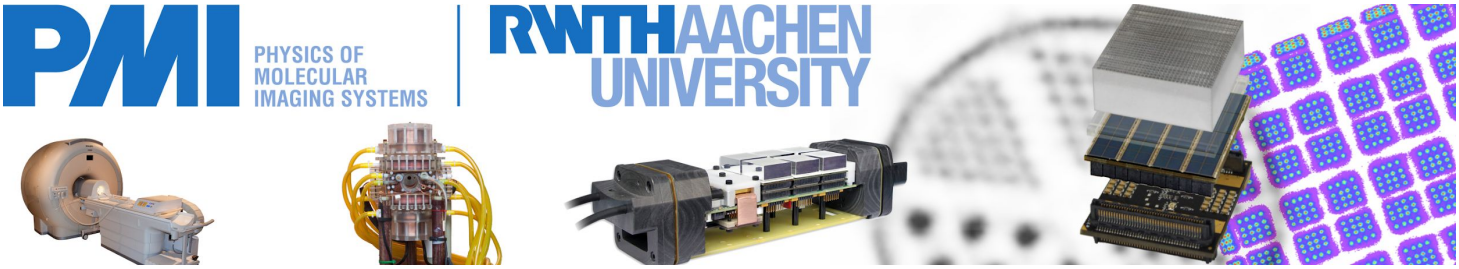
PMI PHYSICS OF MOLECULAR IMAGING SYSTEMS | RWTH AACHEN UNIVERSITY



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.

## PET Image Reconstruction using Origin Ensemble Algorithm

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.

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. Usually, the Maximum Likelihood Expectation Maximization (MLEM) algorithm is used for image reconstruction. However, this iterative approach requires several transformations from image to projection space the vice versa, which are computationally expensive.

The alternative Origin Ensemble (OE) reconstruction method calculates ensembles of possible activity distributions and their probability [1-2]. Therefore, it allows determination not only of the activity distribution, but also its variance. The latter contains valuable information for further image processing and data analysis.

### Your Thesis

You will evaluate Origin Ensemble reconstruction method in comparison to standard MLEM methods and develop extensions according to your preferences, e.g., to allow online reconstruction during the PET measurement, to exploit parallelism multi-core systems or GPUs or to improve image quality. The basic reconstruction method have already been implemented in C++ and is available as a starting point of your work. We are looking for a highly motivated student with an interest in and machine learning methods. Programming skills in Python and C++ are advantageous.

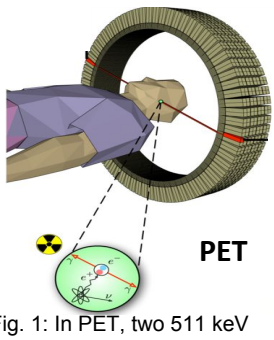



Fig. 1: In PET, two 511 keV gamma photons from a positron-electron annihilation have to be detected and correlated.

Fig. 2: Clinical PET image[3].

[1] Wülker et al. "Time-of-flight PET image reconstruction using origin ensembles." PMB 2015
[2] Sitek et al. "Reconstruction of emission tomography data using origin ensembles." Trans. Med. Imag., 2011
[3] http://www.ncpic.org/our-services/petct/oncology/

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