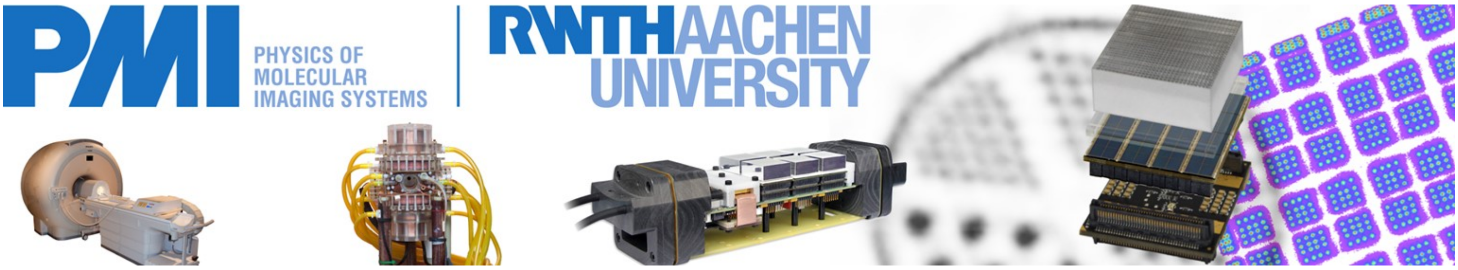

Research focus of the department of "Physics of Molecular Imaging Systems" (**PMI**) is on exploring the physical limits of current and future molecular imaging technologies. These areas range from simulations of new detector concepts, hardware prototypes, high speed data processing, image reconstruction 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.

Total-Body Position Emission Tomography (PET): Simulation & Image Reconstruction

Introduction to PET

PET is widely considered the most sensitive technique available for noninvasively studying physiology, metabolism, and molecular pathways in the living human being. Most PET scans are performed in oncology where radioactive atoms are embedded into specific molecules (e.g. sugar) that bind to tumor cells. A positron that originates from an atom annihilates with an electron in the surrounding tissue. This creates two gamma particles that propagate through the body in opposite directions. We detect the gamma particles using scintillators in combination with fully-digital silicon photomultipliers (SiPMs) [1] and reconstruct the annihilation position along the line that connects both detector elements ("line of response", LOR) using the time difference between the detector measurements ("time of flight", TOF). This allows us to determine the 3D distribution of activity that is directly linked to tissue metabolism.

Fig. 1: Clinical PET image [2]

Total-Body PET

Typical PET scanners provide an axial field of view (FPV) of approx. 20cm and are typically moved along the patient to obtain an image of the full body (Fig. 1). New scanners employ a FOV of 2m to cover the whole patient (Fig. 2). This approach increase the sensitivity by a factor of about 40 for total-body imaging or a factor of about 4–5 for imaging a single organ such as the brain or heart. However, the reconstruction software has to be adapted to the new requirements.

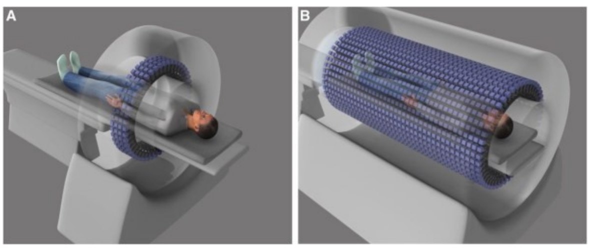

Fig. 2: Clinical PET (A) vs. total-body PET [2]

Your thesis

Your responsibility is to identify and solve problems that could deteriorate the image quality when using total-body PET systems. To identify possible pitfalls and estimate their influence you set up a Monte-Carlo simulation of a total-body PET scanner based on existing simulations of clinical PET systems using Gate [3]. Based on the simulated data you start the reconstruction with the open-source software CASToR [4]. Programming skills in C++ are beneficial to further improve CASToR and obtain quantitative images.

Due to the successive work packages the topic is suitable for a master's thesis.

[1] B. Weissler *et al.*, 2015, *IEEE TMI 34 11 2258*
[2] http://www.ncpic.org/our-services/petct/oncology/
[3] http://www.opengatecollaboration.org/
[4] http://www.castor-project.org/

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