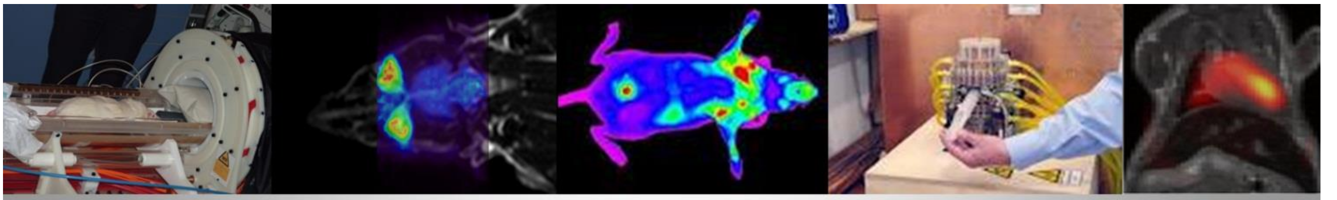


PMI Physics of Molecular Imaging Systems

HELMHOLTZ-INSTITUT
FÜR BIOMEDIZINISCHE TECHNIK

RWTH

The department of **"Physics of Molecular Imaging Systems"** (**PMI**) is exploring future molecular imaging technologies. The research areas range from new detector concepts, simulations, hardware prototypes, high speed data processing, image reconstruction algorithms to applications. Our group consists of students and researchers from different disciplines: physics, engineering, computer science, and medicine. PMI (faculties of Physics and Medicine) is part of a large international network with a close link to industry, especially Philips Research.

Development of an MRI-compatible switched capacitor power supply

PET/MRI

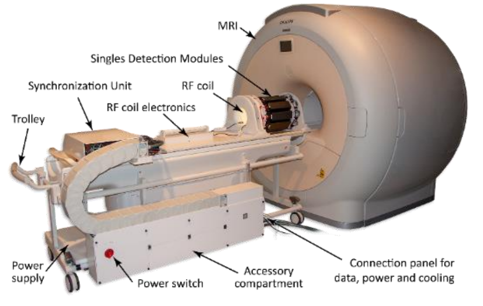
In Positron Emission Tomography (PET) imaging, a radioactively labeled tracer is applied to the patient. The radioactive decay results two high-energetic photons (singles) which are detected outside the body by a ring of PET detectors (Singles Detection Modules). By integrating these PET detectors into a Magnetic Resonance Imaging (MRI) scanner, a hybrid PET/MRI scanner is built, which is a promising hybrid molecular imaging modality as it unifies the high sensitivity of PET for molecular and cellular processes with the functional and anatomical information from MRI.

MRI Compatibility

Placing the PET detectors inside the MRI introduces several technological challenges, as the PET detectors should neither influence the MRI, nor should the MRI influence the PET detector electronics. For instance, the high static magnetic field of the MRI scanner saturates all ferrite material. Therefore, standard coils with ferrite cores lose their function and cannot be used in the PET detector. As they are typically used in switched mode power supply circuits, other power supply topologies have to be employed.

Our PET/MRI Technology

Our group developed the world's first preclinical PET/MRI insert on the basis of fully digital sensors (dSiPM), made by Philips Research in Aachen. The sensors are read out by Field Programmable Gate Arrays (FPGAs), which are directly integrated into the PET detector modules. This concept results in very high performance, but needs a power supply concept delivering multiple amps of current per module at different voltages.

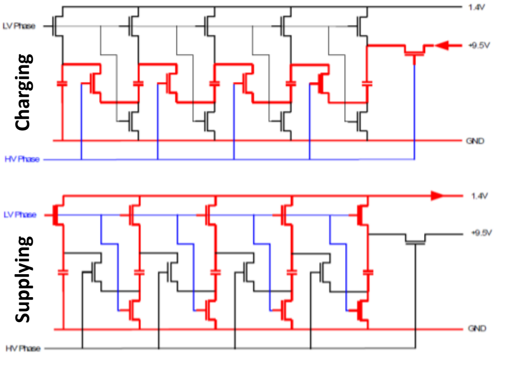


Switched Capacitors

One solution to the problem could be to charge multiple capacitors in series and then connect them in parallel to supply the detector electronics (see example schematics). As such, the needed high currents at low voltages are produced from low currents at high voltages, which can still be supplied with normal cables.

Your Master's Thesis: From Concept to Demonstrator

After understanding the challenges of MRI compatibility, you will develop a concept that can supply the PET detector. The concept will contain everything from the main topology, the cabling, the capacitors, up to the control of the switching (e.g., by a microcontroller or a discrete circuit). You will determine the needed properties of the components (e.g., for the capacitors: voltage- and current-ratings, capacitances and equivalent series resistances) and test found candidates for MRI compatibility. Finally, you will build a demonstrator that can supply at least one PET detector module and you will prove its functionality in the MRI scanner.



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