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SAFIR-II: Design and performance of a high-rate preclinical PET-MR System

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The SAFIR collaboration has developed a high-performance PET insert compatible with a Bruker BioSpec 70/30 MRI scanner. This system, named SAFIR-II, was designed to acquire data at activities of up to 500 MBq, enabling truly simultaneous preclinical PET-MR imaging for mice and rats using image acquisition times of up to 5 s.
We present an overview of the system's design, as well as several performance evaluations done using low and high activity measurements. SAFIR-II features an axial FOV of 145 mm covered by 11'520 LYSO crystals ($2.0\times2.0\times13$ mm^3), which are coupled one-to-one to Hamamatsu SiPM arrays. PETA8 ASICs developed at the University of Heidelberg are used to digitize the SiPM's analog signals, and read out using Xilinx Kintex7 FPGAs and 10 GBit SFP+ optical Ethernet links. All data analysis is handled offline using custom coincidence sorting software, and reconstructed using STIR. Custom MR-compatible DC-DC converters and LDO voltage regulators are used to condition the system's internal voltages.
SAFIR-II exhibits a coincidence timing resolution of 217 ps FWHM and a coincidence energy resolution of 11.8 %, with a peak sensitivity of 2.23 % observed following the NEMA-NU4 standard. It is capable of resolving 1.8 mm hot rods within a Derenzo phantom filled with up to 500 MBq ^{18}F. We furthermore present an evaluation of the system's image quality determined using a NEMA IQ-phantom, and an evaluation of its MRI-compatibility.

Field

Detectors and electronics

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