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Screen 10 - Simulation Study of an On-Chip PET System

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Organs-on-Chips (OOCs), microdevices mimicking in vivo organs, find growing applications in disease modeling and drug discovery. With the increasing number of uses comes a strong demand for imaging capabilities of OOCs. Positron Emission Tomography (PET) would be ideal for OOC imaging, however, current PET systems have insufficient spatial resolution for this task.
In this work, we propose the concept of an On-Chip PET system capable of imaging OOCs. Our system consists of four detectors arranged around the OOC device. Each detector is made of two monolithic Lutetium–yttrium oxyorthosilicate (LYSO) crystals and covered with Silicon photomultipliers (SiPMs) on multiple surfaces. We use a Convolutional Neural Network (CNN) trained with data from a Monte Carlo Simulation (MCS) to predict the first gamma-ray interaction position inside the detector from the light patterns that are recorded by the SiPMs on the detector's surfaces. With the Line of Responses (LORs) created by the predicted interaction positions, we reconstruct with Simultaneous Algebraic Reconstruction Technique (SART).
The CNN achieves a mean average prediction error of 0.78 mm in the best configuration. We use the trained network to reconstruct an image of a grid of 21 point sources spread across the field of view and obtain a mean spatial resolution of 0.53 mm.
We demonstrate that it is possible to achieve a spatial resolution of almost 0.5 mm in a PET system made of multiple monolithic LYSO crystals by directly predicting the scintillation position from light patterns created with SiPMs.

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