Contribution ID: **60** Type: **Oral**

# On-Chip Analog Neural Networks for In-Sensor Image Reconstruction Towards PET Scanners with Large Fields of View

*Tuesday, 21 May 2024 15:50 (20 minutes)*

We present a novel detector concept for emission tomography imaging based on monolithic scintillators in which the reconstruction of the scintillation coordinates is performed in real time by an artificial neural network (ANN) implemented on a silicon chip in charge domain. Each neuron sums the input values weighted by means of banks of selectable capacitors. We designed and fabricated a first proof-of-concept ASIC prototype in CMOS 0.35um process, compatible with other analog ASICs for SiPM readout, whose preliminary characterization is here reported. It implements an artificial neural network with 64 inputs (corresponding to the signals of an 8 by 8 arrays of SiPM), 2 hidden layers with 20 neurons each and 2 output neuron estimating the X and Y coordinates of the scintillation position. Quantization-aware training of the ANN was based on a simulated dataset and weights are stored in RAM cells. In simulations, the performance of the ASIC-embedded estimation is close to the computer-based one for both simulated and experimental data, with a spatial resolution below 2mm with standard PET detectors. Here we report the preliminary experimental results of the ASIC with an area and a power efficiency of 93.5 GOP/s/W. A development roadmap to improve the computational efficiency (adopting more scaled technologies and different topologies for the programmable network of neurons) of the chip and for its integration with a detector module will be presented at the conference.

## Field

Detectors and electronics

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**Session Classification:** AI enhanced PET detectors

**Track Classification:** Total body imaging