

# Smart Pixels: A Machine Learning Approach Towards Data Reduction in Next-Generation Particle Detectors

Pixel detectors are highly valuable for their precise measurement of charged particle trajectories. However, next-generation detectors will demand even smaller pixel sizes, resulting in extremely high data rates surpassing those at the HL-LHC. This necessitates a “smart” approach for processing incoming data, significantly reducing the data volume for a detector’s trigger system to select interesting events. As charged particles pass through an array of pixel sensors, they leave behind clusters of deposited charge. The shape of these charge clusters can be useful, especially when fed into customized neural networks, which can extract the physical properties of the charged particle. The weights and biases of these neural networks can then be later implemented on-chip (onto ASICs) for integration at future pixel detectors.

We propose a “feature regression network”, which uses TensorFlow and QKeras and takes as an input the 2-D shape of the charge clusters at different slices of time. These inputs are passed through a convolutional network and dense network to regress 14 quantities. As a result, we can predict the position ( $x$ ,  $y$ ), incidence angle ( $\cot \alpha$ ,  $\cot \beta$ ), and their covariance matrix. So far, this customized model has been trained and evaluated on 7 different sets of pixel geometries (varying their pitch in  $x$ ,  $y$ , and thickness) placed in a  $13 \times 21$  pixel array, where their performance is analyzed through residual, uncertainty, and pull distribution studies.

## Focus areas

HEP

**Primary author:** JIANG, David (Univ. Illinois at Urbana Champaign (US))

**Presenter:** JIANG, David (Univ. Illinois at Urbana Champaign (US))