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Autoencoders for Anomaly Detection and Output Reduction on the Edge (AADORE)

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Detectors at next-generation high-energy physics experiments face several daunting requirements: high data rates, damaging radiation exposure, and stringent constraints on power, space, and latency. To address these challenges, machine learning (ML) in readout
electronics can be leveraged for smart detector designs, enabling intelligent inference and data reduction at-source. Autoencoders offer a variety of benefits for front-end readout; an on-sensor encoder can perform efficient lossy data compression while simultaneously
providing a latent space representation that can be used for anomaly detection. Results are presented from low-latency and resource-efficient autoencoders for front-end data processing in a futuristic silicon pixel detector. Encoder-based data compression
is found to preserve good performance of off-detector analysis while significantly reducing the off-detector data rate as compared to a similarly sized data filtering approach. Furthermore, the latent space information is found to be a useful discriminator
in the context of real-time sensor defect monitoring. Together these results highlight the multi-faceted utility of autoencoder-based front-end readout schemes, and motivate their consideration in future detector designs.

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