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Using an Optical Processing Unit for tracking and calorimetry at the LHC

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The High Luminosity Large Hadron Collider is expected to have a 10 times higher readout rate than the current state, significantly increasing the computational load required. It is then essential to explore new hardware paradigms. In this work we consider the Optical Processing Units (OPU) from LightOn, which compute random matrix multiplications on large datasets in an analog, fast and economic way, fostering faster machine learning results on a dataset of reduced dimension. We consider two case studies.

1) "Event classification": high energy proton collision at the Large Hadron Collider have been simulated, each collision being recorded as an image representing the energy flux in the detector. Two classes of events have been simulated: « signal » are created by a hypothetical supersymmetric particle, and « background » by known processes. The task is to train a classifier to separate the signal from the background. Several techniques using the OPU will be presented, compared with more classical particle physics approaches.

2) "Tracking": high energy proton collisions at the LHC yield billions of records with typically 100,000 3D points corresponding to the trajectory of 10.000 particles. Using two datasets from previous tracking challenges, we investigate the OPU potential to solve similar or related problems in high-energy physics, in terms of dimensionality reduction, data representation, and preliminary results.

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