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Classifying photon- and proton-induced air-showers with a transformer-based approach at the Pierre Auger Observatory

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The Pierre Auger Observatory is the world's largest detector for ultra-high-energy (UHE) cosmic rays, capable of observing particles with energies exceeding 10^{20} eV. Only the most extreme cosmic events can accelerate particles to such energies. Detecting an accompanying flux of UHE photons would deepen our understanding of these extreme cosmic events, probe the GZK suppression mechanism, and potentially reveal signatures of exotic scenarios like super-heavy dark matter.

In this work, a transformer-based approach to classify simulated air showers induced by photons and protons will be presented. Transformer networks, with their ability to capture complex patterns in sequential data, offer a promising tool for distinguishing between these signals. The current transformer network uses the photomultiplier tube signals from the water Cherenkov detector stations of the surface detector array as its primary input.

This approach demonstrates the potential of transformer networks to enhance the identification of UHE photon events, possibly advancing our understanding of the most energetic phenomena in the universe.

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