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Directional search for UHE photons using the surface detector of the Pierre Auger Observatory

In addition to its capabilities for precise measurement of ultra-high-energy (UHE, $E > 10^{17}$ eV) cosmic rays with the observation of extensive air showers, the Pierre Auger Observatory also encompasses the potential of effectively detecting UHE photons. These are closely connected to the origin or propagation of hadronic cosmic rays. Moreover, such UHE photons are also theorized to be emitted during transient events, offering an additional channel in the context of multimessenger astronomy. Several efforts by the Pierre Auger Collaboration have utilized the Observatory's various detector systems to search for UHE photons. Although no UHE photons have been unambiguously identified so far, stringent upper limits have been established on both the diffuse photon flux and the flux from specific arrival directions, including near source candidates. During my PhD studies, I aim to design a new direction-dependent UHE photon search, based on air-shower universality. With this approach, data of the Surface Detector (SD) can be used to reconstruct central quantities like primary energy and atmospheric depth of the shower maximum, which are essential for primary particle classification, with a significantly improved precision. Moreover, with sole dependence on the SD, one can take advantage of its extensive duty cycle for a UHE photon search. The ongoing work and forthcoming steps involved in constructing such an analysis will be discussed in this contribution.

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