

End-To-End Optimization of the Layout of a Gamma-Ray Observatory

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The array layout design of an ultra-high-energy gamma rays water Cherenkov detector represents a big challenge at the time to reach a sensitivity in the PeV energy scale. This is the current phase where the Southern Wide-field Gamma-ray Observatory (SWGGO) collaboration is. In this work we address the array layout problem building a continuous model whose parameters are the primary particle energy and direction (E, θ, ϕ) , the shower core position (X_0, Y_0) , and the tanks positions (x_i, y_i) . Using a big dataset of gamma and proton events that covers an energy range from 100 TeV to 10 PeV, and a zenithal angle range from 0-65 deg; we perform a likelihood ratio test statistic to do the gamma/hadron classification and then we applied a stochastic gradient descent algorithm to find the optimized tanks positions. This is done finding the maximal value of a utility function which depends on the instrument resolution (reconstruction of the primary particle energy and direction), gamma-ray flux and the capability of detecting a point-like source with a fixed significance. Thus, after running the pipeline a determined number of epochs, typically where the utility function finds a stable value, any initial array layout evolves to a configuration where the performance in the PeV energy scale is improved.

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