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Muon identification and gamma/hadron discrimination using compact single-layered water Cherenkov detectors powered by Machine Learning techniques

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The muon tagging is an essential tool to distinguish between gamma and hadron-induced showers in wide field-of-view gamma-ray observatories. In this work, it is shown that an efficient muon tagging (and counting) can be achieved using a water Cherenkov detector with a reduced water volume and multiple PMTs, provided that the PMT signal spatial and time patterns are interpreted by an analysis based on Machine Learning (ML).

Following the same rationale, the developed analysis has been tested for two different WCD configurations with 4 and 3 PMTs. The output of the ML analysis, the probability of having a muon in the WCD station, has been used to notably discriminate between gamma and hadron induced showers with $S/\sqrt{B} \sim 4$ for shower with energies $E_0 \sim 1$ TeV. Finally, for proton-induced showers, an estimator of the number of muons was built by means of the sum of the probabilities of having a muon in the stations. Resolutions about 20% and a negligible bias are obtained for vertical showers with $N_\mu > 10$.

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