Simulating the performance of the Southern Wide-view Gamma-ray Observatory

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SWGO – The Southern Wide-field Gamma-ray Observatory

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SWGO is a next-generation wide-view gamma-ray observatory to be build in the Andes. Currently, it is in a 3 years research & development phase. We explain the strategy to optimise the design of this water-Cherenkov detector.

Framework

Build-upon the HAWC software, we are developing a flexible framework in which the impact of design choices on science benchmarks will be tested. It consists of the following components:

- Air shower simulation data base (CORSIKA).
- Detector response using GEANT4 with design and layout configurable by steering cards.
- Modular DAQ simulation and event reconstruction and classification code.
- Instrument response functions, compatible with open source tools.

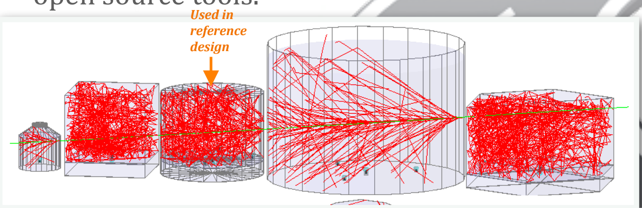
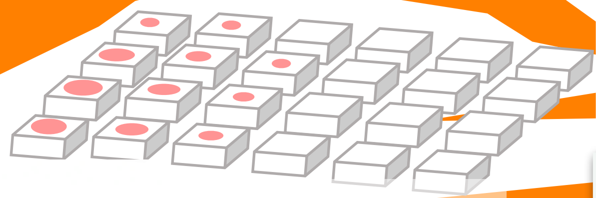


Figure 1: ***Different available GEANT4 tank types.*** *Shown are a fraction of the Cherenkov photon tracks generated by a muon traveling from left to right*

Trick: Saving detailed "detected" photon information we can simulate smaller sensors and non-reflective walls without additional dedicated simulations



A starting point

We defined a reference design:
- Cylindrical tanks with a diametre of 3.8 m, segmented in two compartments (heights: upper 2.5 m and lower 0.5 m)
- Each compartment has an 8" Photon Multiplier Tube.
- All inner surfaces are reflective, except the floor and ceiling in the upper compartment
- Inner array 80% fill factor and radius 160 m.
- Outer array 5% fill factor and outer radius 300 m.

This design is used to develop the end-to-end framework and provide us with an initial estimate of performance for a set of predefined science benchmark cases [1].

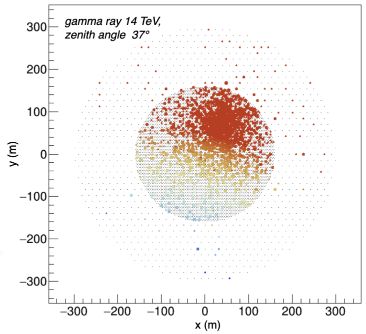


Figure 2: ***Hit times at the different units for the reference design layout.*** *The time order of the hits is from blue to red.*

The optimisation game

The total cost estimate of the reference design is used as a constraint on other component and layout options. Each option will be evaluated in the common framework and tested against science-case benchmarks. An indication of the phase-space that we will explore with this approach in the coming year is shown Figure 3.

The game is on!!!

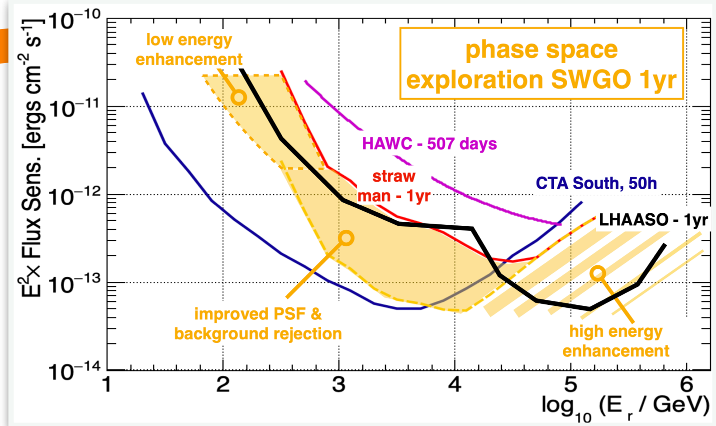


Figure 3: Differential point-source sensitivity phase-space exploration compared to other gamma-ray observatories [2,3,4,5]. *As upper bound on the sensitivity we take a straw man design based on scaled HAWC performance. For improving the low-energy (< 1TeV) performance we are investigating* ***high altitude*** *sites and* ***low threshold*** *detector units. Over the full energy range, dedicated* ***muon tagging systems*** *are explored for background rejection and* ***compact units*** *are considered to improve direction reconstruction[6,7]. The lower bound of the phase-space corresponds to an improvement over the straw man design with a factor 10 better background rejection combined with a factor of 3 improvement on the Point-Spread -Function (PSF). At the high energy domain (>30 TeV), the recent LHAASOs km2 results [] inspire us to consider options for a* ***large area*** *outer detector.*

REFERENCES

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