SWGO
The Southern Wide-field Gamma-ray Observatory

A next-generation gamma-ray observatory powered by Machine Learning techniques

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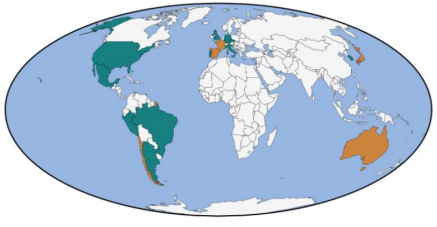
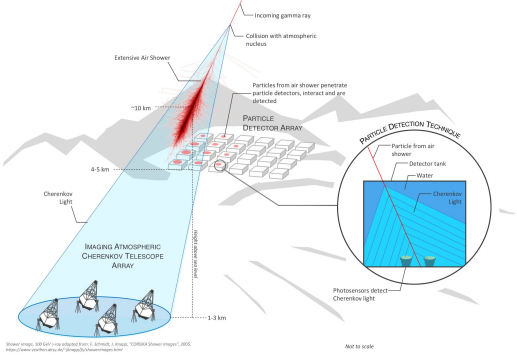
Southern **W**ide-field **G**amma-ray **O**bservatory (SWGO)

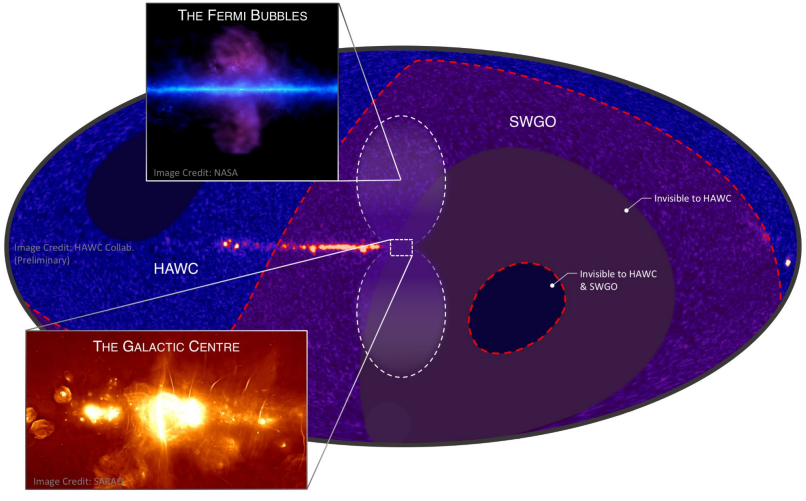
~3-year R&D project to design and plan the next generation wide field-of-view gamma-ray able to survey and monitor the Southern sky

- **S**outhern **W**ide-field **G**amma-ray **O**bservatory (SWGO)
  - Formed at July 1st 2019
  - 12 Countries
  - ~50 institutes
  - More than 100 scientists
  - To be built in South America



	SWGO R&D Phase Milestones	
✓	**M1**	R&D Phase Plan Established
✓	**M2**	Science Benchmarks Defined
✓	**M3**	Reference Configuration & Options Defined
	M4	Site Shortlist Complete
	M5	Candidate Configurations Defined
	M6	Performance of Candidate Configurations Evaluated
	M7	Preferred Site Identified
	M8	Design Finalised
	M9	Construction & Operation Proposal Complete



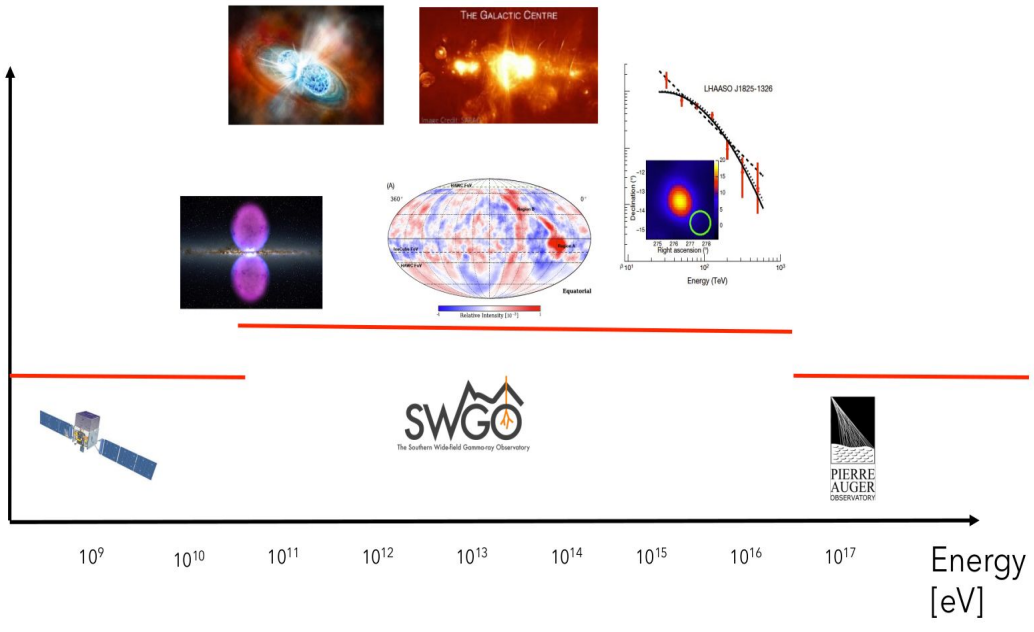


Source: https://www.swgo.org/

Energy range covered with SWGO

Lowest energies:

- High altitude
- Compact array
- Dedicated ground detector design



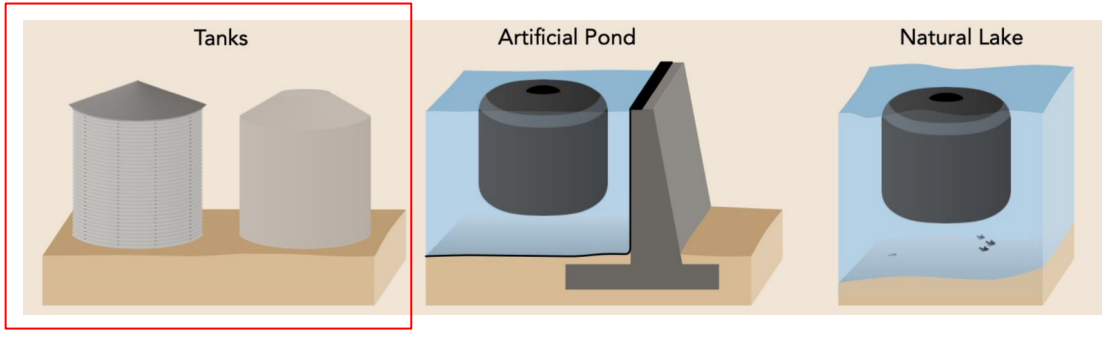
Highest energies:

- Modular
- Sparse array
- Large array area (~1 km² or more)

From many tens of GeV to many tens of PeV…

Detector design options

Possible detectors for SWGO



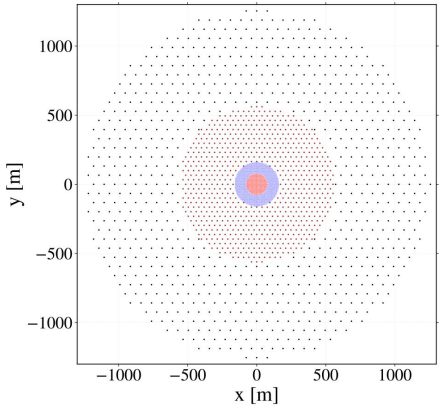
A scalable array

Phase I – very high fill factor;
area up to 20 000 m2

Phase II – low fill factor;
area up to 1km2

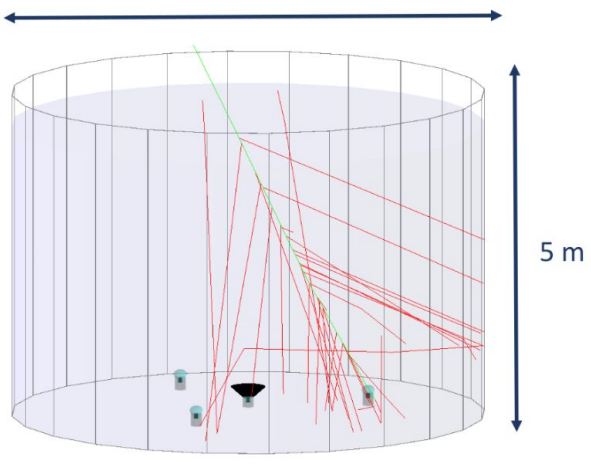
Phase III – high fill factor;
area up to 80 000 m2;

Phase IV – very low fill factor;
area up to 5km2.



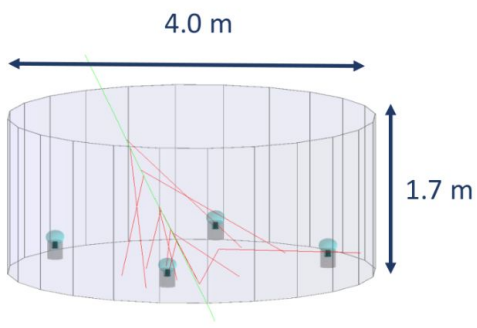
WCD options

HAWC



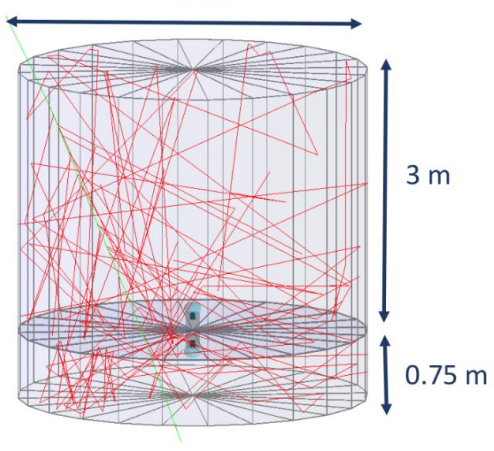
3x 8-inch PMTs
1x 10-inch PMT in the center of the tank
Water height 4,5 m (5 m total height)
Polypropylene walls

LIP



4x 8-inch PMTs
Water height 1,7 m
Tyvek walls

DLWCD



2x 8-inch PMTs
Water height 3,75 m
Tyvek walls

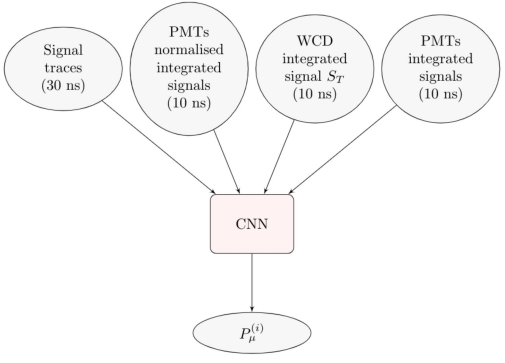
Essential to tag muons to discriminate gamma from hadron induced showers

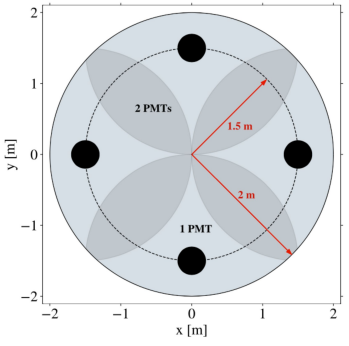
Simulation and ML model

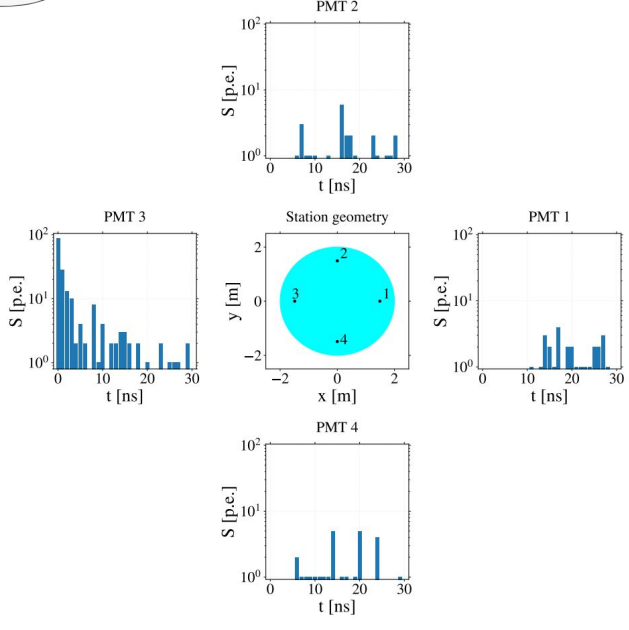
- Machine Learning model to study WCD signals.
  - Probability that a muon has passed through the WCD.
  - Convolutional Neural Network (CNN)
- Build a quantity to evaluate the gamma/hadron discrimination power and the muon quantity in the shower.

$$P_\mu = \sum_{i=1}^{N_S} P_\mu^{(i)}$$

- Good gamma/hadron discrimination at E ~ 1TeV.
  - S/sqrt(B) ~ 4 (similar to LATTES and HAWC).
  - Eur.Phys.J.C 81 (2021) 6, 542 (arXiv:2101.10109 [physics.ins-det])



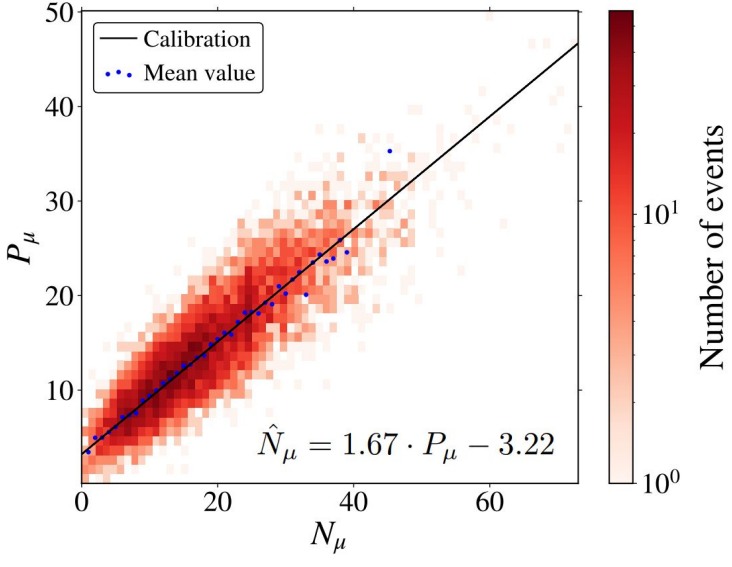




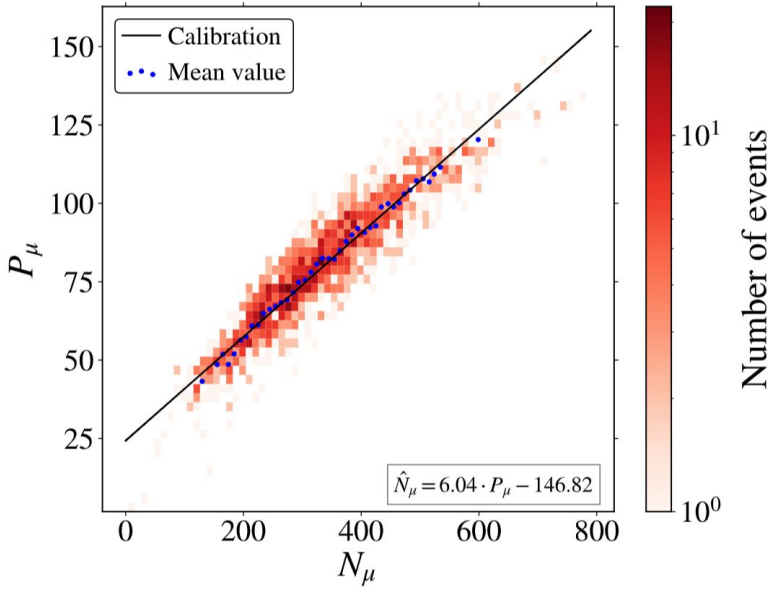
Muon counting

- Use the variable previously built to evaluate the muon quantity in the shower.

$$P_\mu = \sum_{i=1}^{N_S} P_\mu^{(i)}$$



E ~ 1 TeV

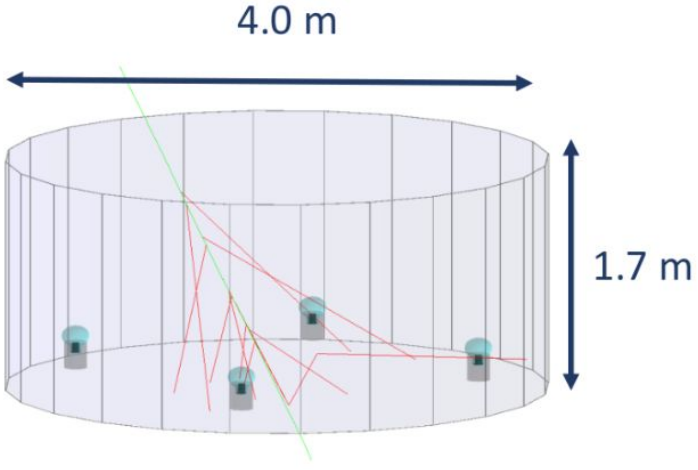


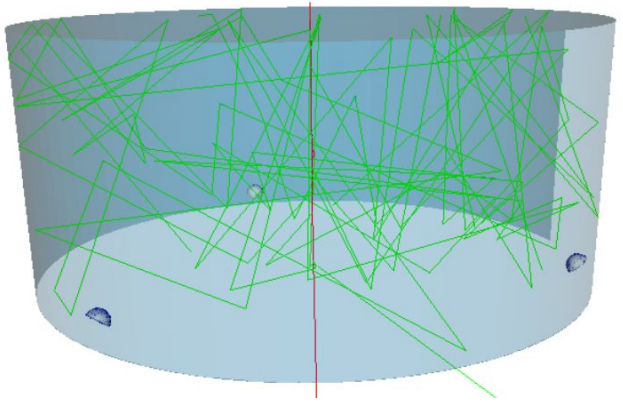
E ~ 50 TeV

Sensitive to the overall number of muons in the shower event

Small bias and the intrinsic resolution of 2%

Future steps: WCD optimisation

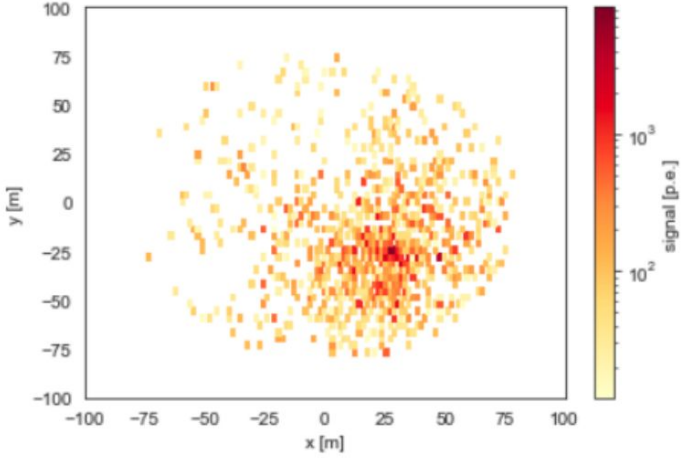




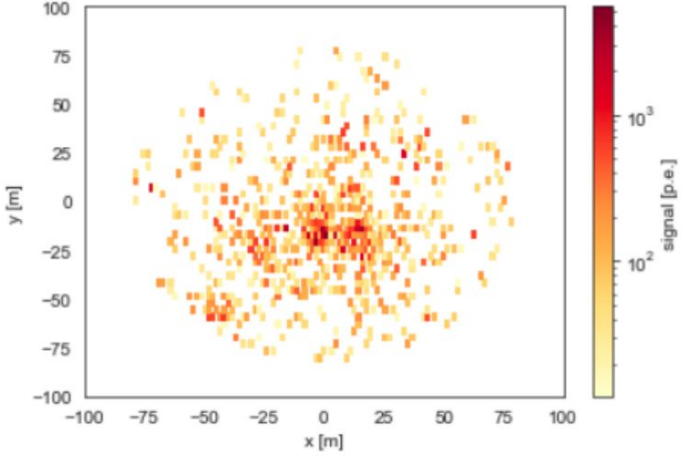
Same dimensions, less PMTs

Future steps: Enhance γ/hadron separation

Gamma

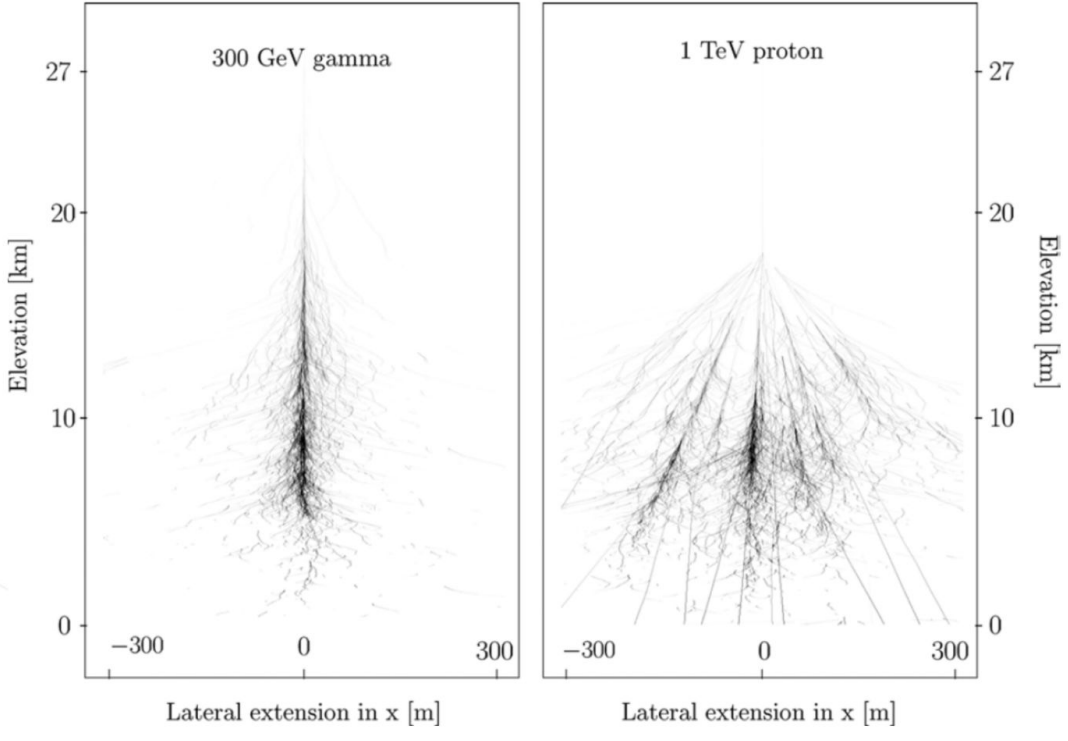


Proton



Combine muon info with shower footprint

Summary and future steps



Study of the shower physics using the reconstruction methods developed in the thesis

Thanks for your attention

Acknowledgements:

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