The Southern Wide-field Gamma-ray Observatory

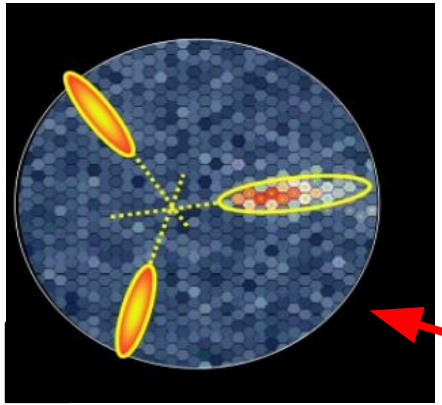
Jose Bellido

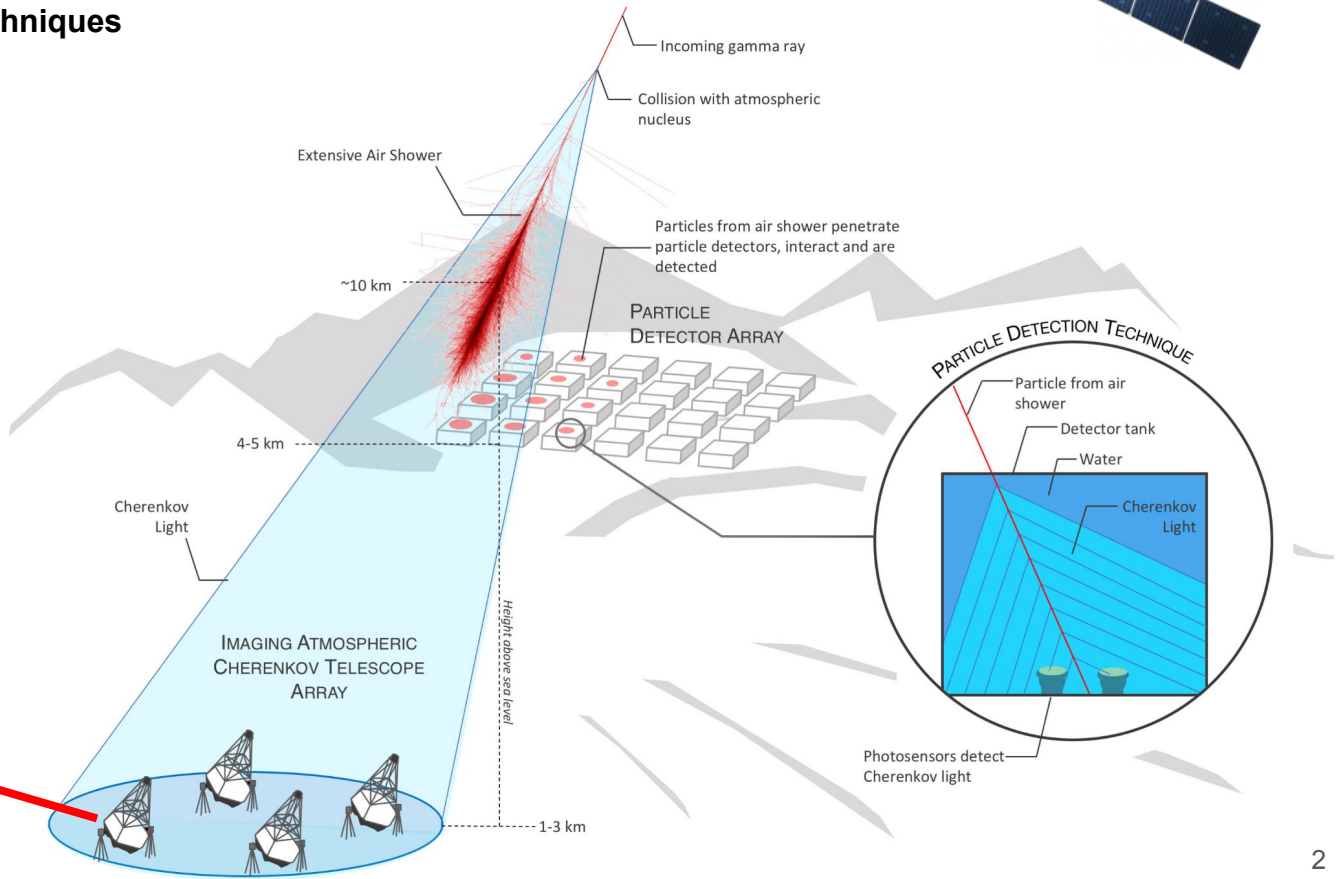
Particles and Nuclei International Conference, PANIC
5 -10 Sep. 2021, Lisbon, Portugal

Gamma-ray Astronomy

Complementary direct and indirect detection techniques

Atmospheric Cherenkov light image



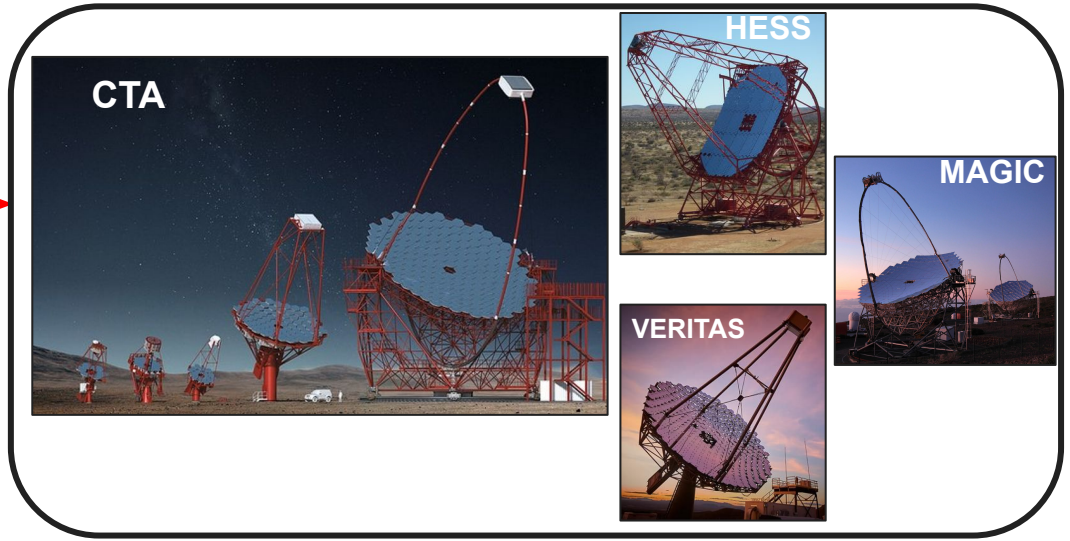


Shower image, 100 GeV γ-ray adapted from: F. Schmidt, J. Knapp, "CORSIKA Shower Images", 2005, https://www-zeuthen.desy.de/~jknapp/fs/showerimages.html

Not to scale

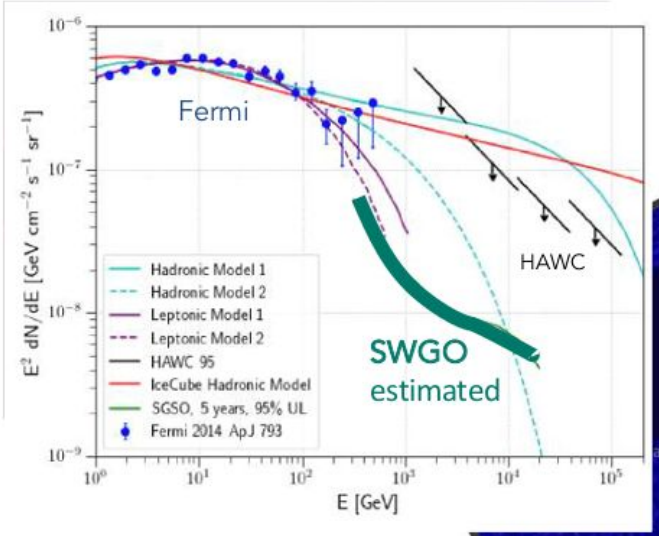
Observational Panorama

Cherenkov Atmospheric Telescopes
→ 20% duty-cycle
→ Pointing (few degrees FoV)
→ Energy threshold down to 10s GeV
→ Good energy and angular resolution



Particle Detector Arrays
→ 100% duty-cycle
→ Wide-field of View (~ steradian)
→ Energy range 100s GeV up to 100s TeV
→ Long exposure and accurate background determination

A wide-field observatory in the South



Crucial access to the Galactic Plane and the Galactic Center, and a complementary view of the sky with HAWC and LHAASO for cosmic-rays and diffuse emission studies.

Science Case: https://arxiv.org/abs/ 1902.08429

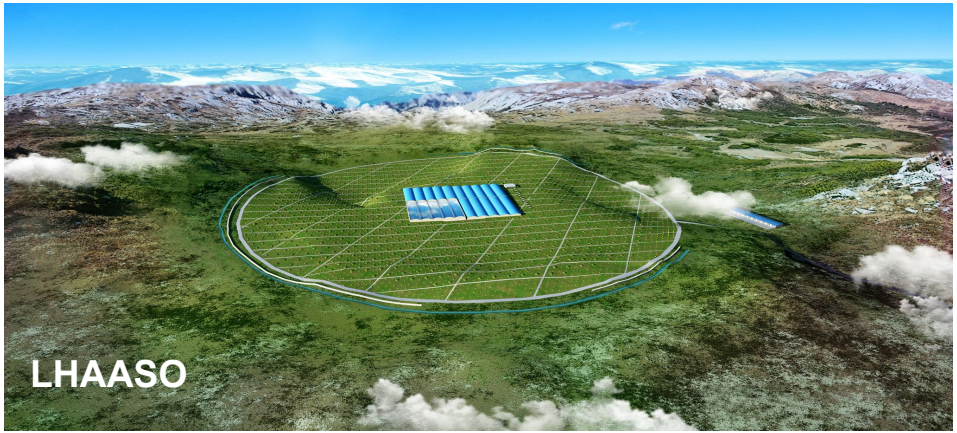
SWGO
The Southern Wide-field Gamma-ray Observatory

Science Case: **https://arxiv.org/abs/ 1902.08429**

Science Case for a Wide Field-of-View Very-High-Energy Gamma-Ray Observatory in the Southern Hemisphere

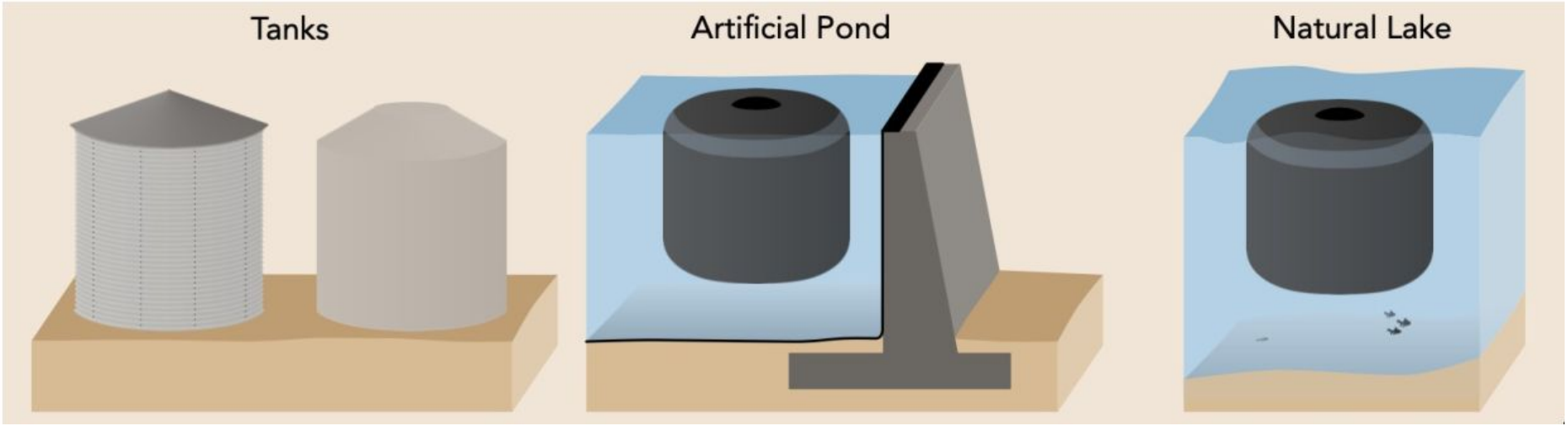
The SWGO observatory concept design is similar to that of HAWC and LHAASO observatories

SWGO will be deployed in South America in a site (not yet defined) above ~4500m



SWGO
The Southern Wide-field Gamma-ray Observatory

Three concepts for the detector units

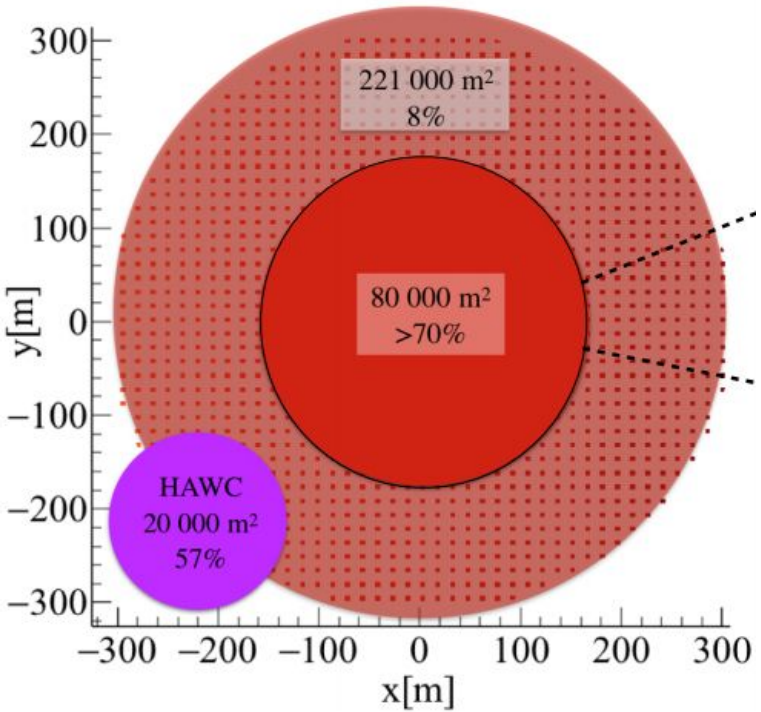


- Exploring three concepts for the detector units
  →Tanks (like HAWC), Artificial Pond (like LHAASO) and Natural Lake

- …as well unit dimensions, photosensors, +++

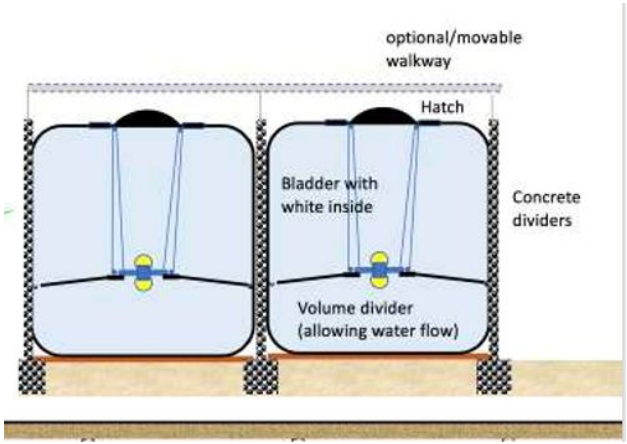
The SWGO Observatory layout design

Approximately *6500 water tanks* are required.

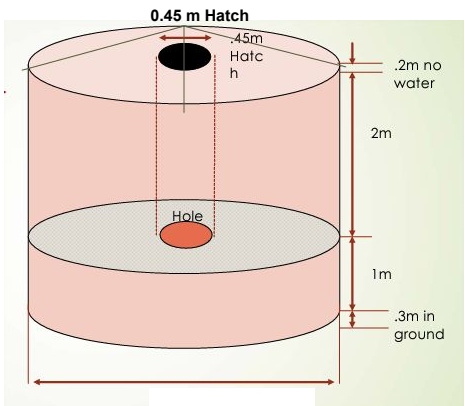


The SWGO Detector Concept

The interior will have two cavities



Reference design dimensions



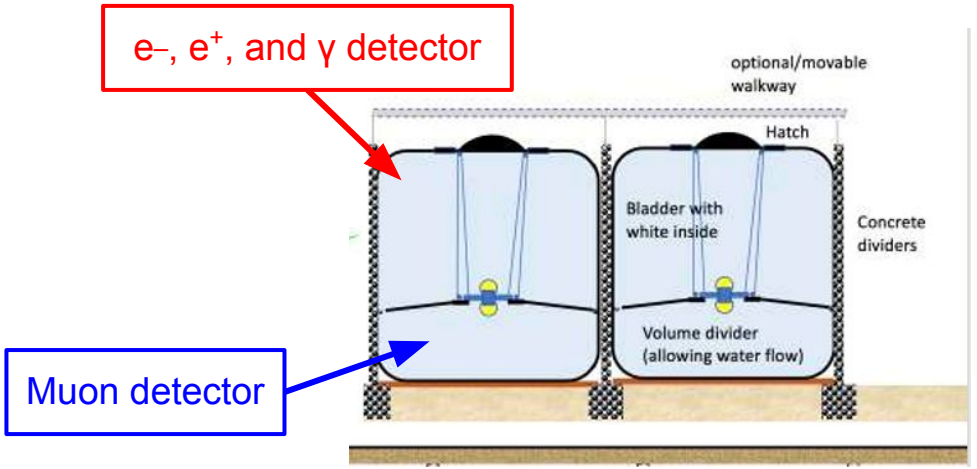
Cosmic Ray Physics with SWGO

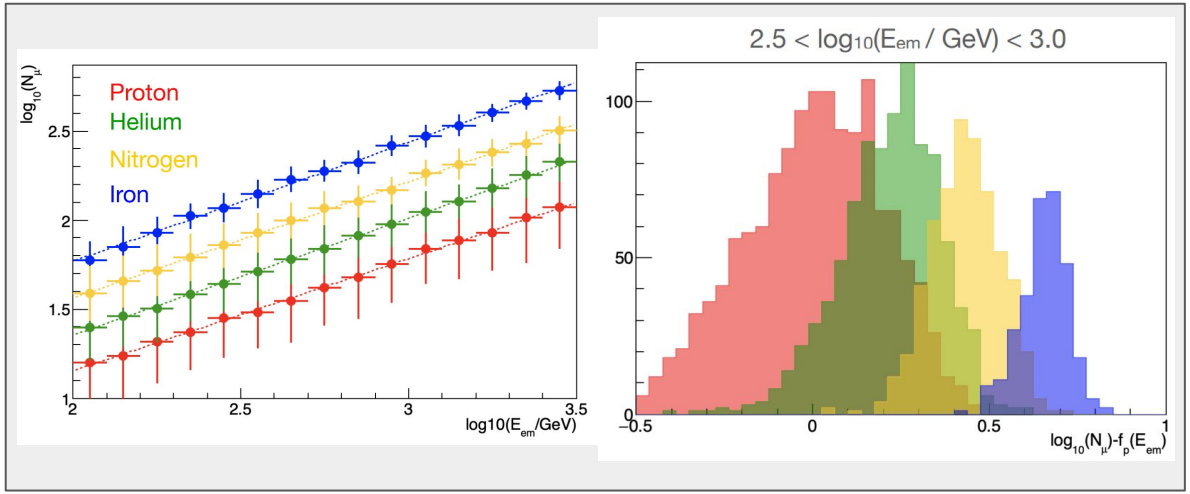
The electromagnetic and muonic components of the air shower will be recorded separately.

The muonic component will be used to discriminate between different cosmic ray species.

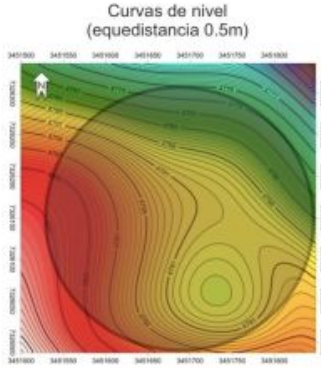
The exact relation between number of muons and the cosmic ray specie, is extracted from hadronic interaction models. Currently there are **systematic uncertainties on model predictions** that need to be improved.

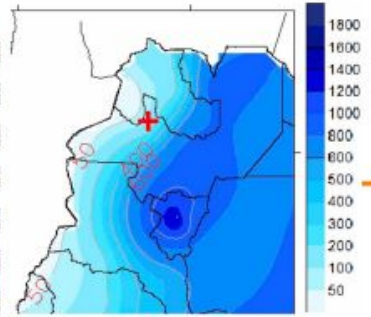
A correct hadronic model should be able to find a cosmic ray composition spectrum, that could be used to reproduce all the different observable distributions in SWGO, LHAASO, and even at high energies (e.g. the Pierre Auger Observatory).

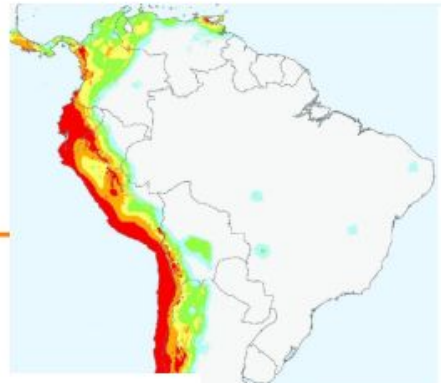


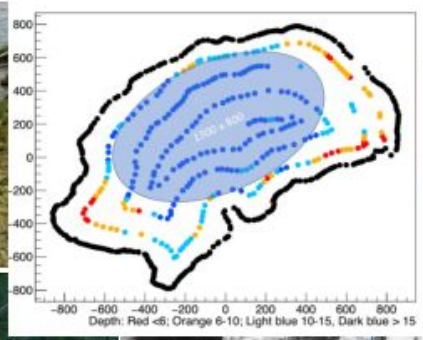



Bolivia 4.7k
Chile 4.8 k
Peru
Bolivia
Chile
Argentina 4.8 k
Peru 4.9 k

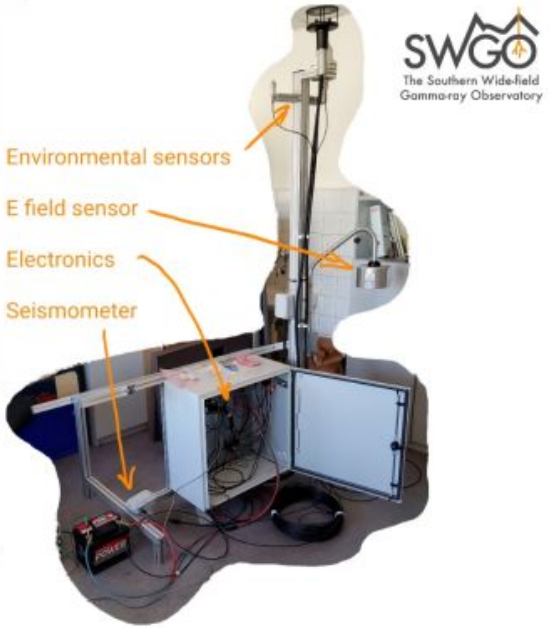

Curvas de nivel
(equedistancia 0.5m)

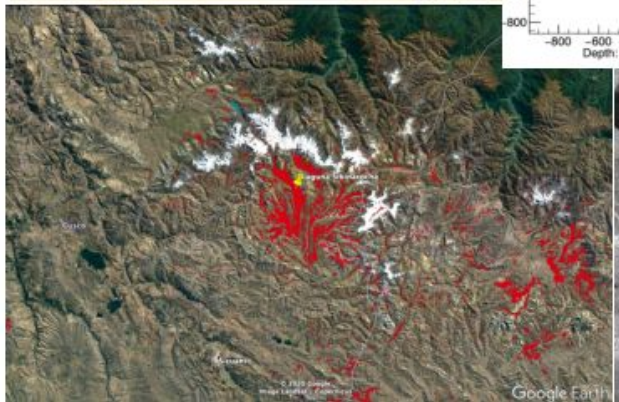

1800
1600
1400
1200
1000
800
600
500
400
300
200
100
50

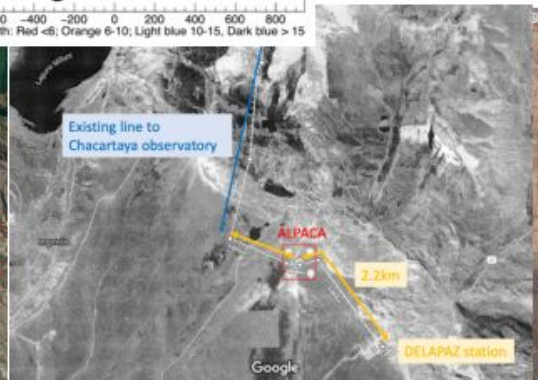



800
600
400
200
0
-200
-400
-600
-800
-800 -600 -400 -200 0 200 400 600 800
Depth: Red <6; Orange 6-10; Light blue 10-15, Dark blue > 15

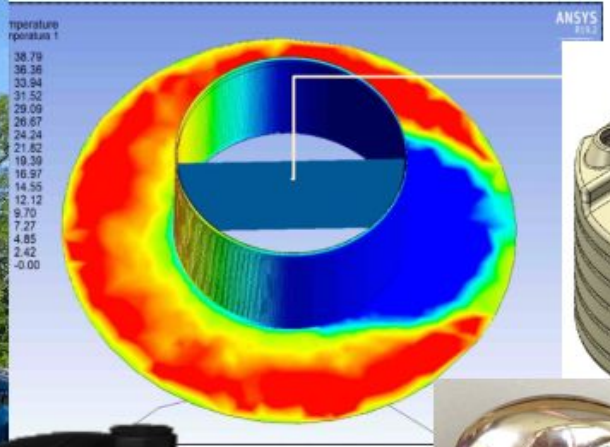
EXPLANATION
Chance of slight (or greater) damaging earthquake shaki in 50 years
< 15%
15%-30%
30%-50%
50%-70%
70%-85%
> 85%

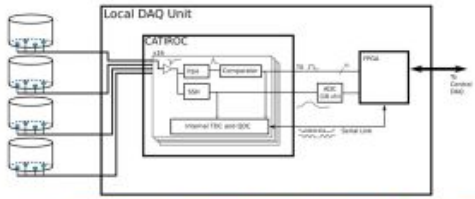

SWGO
The Southern Wide-field Gamma-ray Observatory
Environmental sensors
E field sensor
Electronics
Seismometer


Google Earth


Existing line to
Chacartaya observatory
ALPACA
2.2km
DELAPAZ station
Google


AAP


ANSYS
38.79
36.38
33.94
31.52
29.09
26.67
24.24
21.82
19.39
16.97
14.55
12.12
9.70
7.27
4.85
2.42
-0.00


Local DAQ Unit
CATROC


Rotoplas
Rotoplas
Rotoplas
Rotoplas

Prototype detectors will be deployed at a Peruvian site

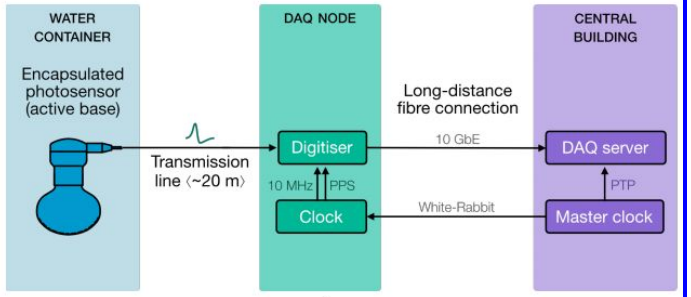
Customized water tanks are being designed by an Australian company, and 3 tanks will be delivered to Perú for installing the first SWGO detector prototype.

A DAQ node architecture will be tested at a Peruvian site (test in real conditions).

DAQ node?

Reference architecture →

- >100 DAQ nodes spread over km²
- nodes need to be maintenance-free
  - start testing critical candidate components as early as possible in realistic conditions
- test tanks in Imata are a great opportunity
  - near-target altitude & climate
  - good access & infrastructure



?

The Southern Wide-field Gamma-ray Observatory

Conclusions

◎The Southern Sky needs a wide field VHE-UHE gamma-ray Instrument!

→Strong synergies with CTA and and LHAASO
→Transient phenomena, diffuse emission, UHE sources +++

◎ SWGO advancing towards design and site choice

◎ SWGO will have capabilities to study the cosmic ray composition. For that, information from SWGO and information from experiments at higher energies (e.g. Pierre Auger) needs to be analyzed together. So, that hadronic interaction models can be improved.