The Southern Wide-field Gamma-ray Observatory

R. Conceição for the SWGO Collaboration



EPS-HEP, Online Conference, 26th July 2021



JF TÉCNICO LISBOA



Very high-energy gamma-rays

Photons extremely energetic From a few hundreds of GeV to PeV Point to production source Travel long distances Our probes for the most violent processes known in the Universe Supernovae; Active Galaxy Nuclei; Pulsars; ... Allows to perform strong tests to fundamental physics Dark matter indirect searches; Lorentz invariance; Quantum gravity; ...

- 30 M



The VHE gamma-ray Sky



Fermi Satellite



Fermi bubbles - gamma ray emission (up to ~100 GeV) in outbursts from our Galaxy

LHAASO experiment







High-energy gamma-ray detection techniques









СТА

HAWC





HESS



Planned IACT In construction Array

LHAASO







Built IACT Built Array O Planned IACT In construction Array











Complementary to the Cherenkov Telescope Array project





SWGO collaboration

~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

- Southern Wide-field Gamma-ray Observatory
 - → Formed at July 1st 2019
 - → 12 Countries
 - \rightarrow ~50 institutes
 - → More than 100 scientists



The scientific goal





SWGO collaboration



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

Countries in SWGO

Institutes

Argentina*, Brazil, Chile, Czech Republic, Germany*, Italy, Mexico, Peru, Portugal, South Korea, United Kingdom, United States*

Supporting scientists

Australia, Bolivia, Costa Rica, France, Japan, Poland, Slovenia, Spain, Switzerland, Turkey

*also supporting scientists





10

Science Case	Design Drivers
Transient Sources:	Low-energy sensitivity &
Gamma-ray Bursts	Site altitude ^a
Galactic Accelerators:	High-energy sensitivity &
PeVatron Sources	Energy resolution ^b
Galactic Accelerators:	Extended source sensitivity
PWNe and TeV Halos	& Angular resolution ^c
Diffuse Emission:	Background rejection
Fermi Bubbles	Cree Contraction
Fundamental Physics:	Mid-range energy sensitivity
Dark Matter from GC Halo	Site latitude ^d
Cosmic-rays:	Muon counting capability ^e
Mass-resolved dipole /	
multipole anisotropy	

Science capabilities





1.0

Science case - examples

Transient Events



G. La Mura et al, Mon.Not.Roy.Astron.Soc. 497 (2020) 3, 3142-3148

Indirect dark matter searches



A. Viana et al, *JCAP* 12 (2019) 061





Candidate sites







Site characterisation





Design options



Second Exploring three concepts for the detector units Tanks (HAWC/Auger like), Artificial Pond (LHAASO like) and Natural Lake Optimization of unit dimensions, number and type of photosensors, ... → Performance/cost optimization



15



Prototyping







Analysis and Simulation

- Simulation framework to compare different detector concepts
- Observe Built on the analysis and simulations framework of HAWC
- Modular framework extensively tested suitable to probe different ideas









Testing different concepts and configurations









o Double-layered water Cherenkov detector

Larger detector array with an increased segmentation and increased altitude w.r.t. to HAWC





o Goal:

- Reach an unprecedented energy and geometry reconstruction resolution for a wide field VHE-UHE instrument
- Take advantage of knowledge acquired by previous experiments (HAWC/ LHAASO) and test new ideas/methods to raise the bar
 - Astropart.Phys. 123 (2020) 102479
 - Astropart.Phys. 99 (2018) 34-42
 - Eur.Phys.J.C 81 (2021) 1, 80
 - **JCAP 01, 012 (2019)**
 - Eur.Phys.J.C 81 (2021) 6, 542
 - PoS(ICRC2021), vol. 395, p. 902, 2021

•••

Expected performance





Expected Sensitivity





o The Southern Sky needs a wied field VHE-UHE gamma-ray observatory

- Northern hemisphere
- generation neutrino telescopes
- SWGO is advancing towards the design and site choices

Summary

→ Complete view of the TeV-PeV sky: complementary to LHAASO in the

Monitor the transient sky : strong synergies with CTA and the new

Very open for new partners and new ideas



Acknowledgements











UNIÃO EUROPEIA

Fundo Europeu de Desenvolvimento Regional



