上海交通大学
SHANGHAI JIAO TONG UNIVERSITY

南天大视场伽马射线天文台项目

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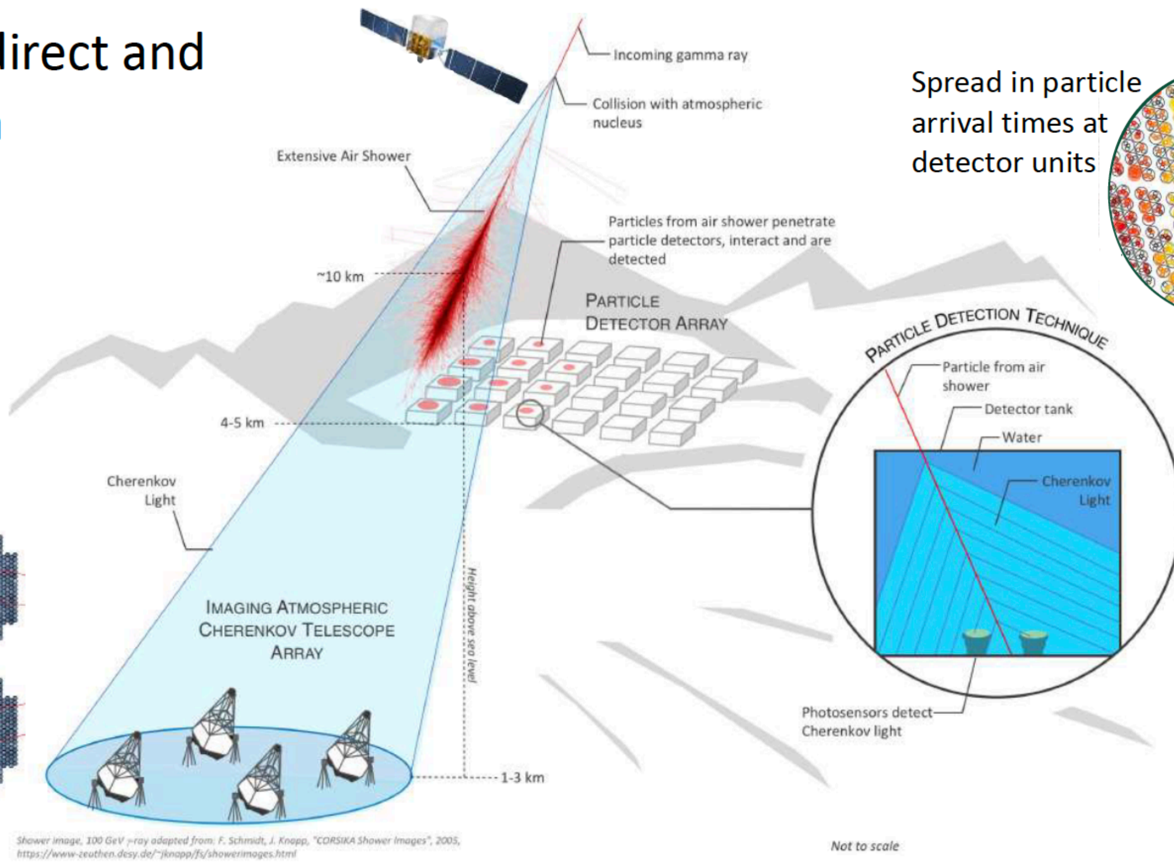
SWGO
The Southern Wide-field Gamma-ray Observatory

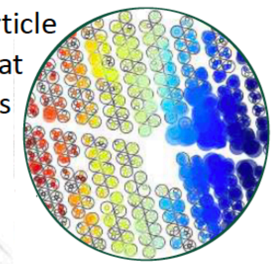
Slides from Jim Hinton and Ulisses Barres

伽马射线天文学

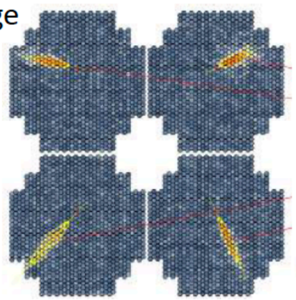
Complementary direct and indirect detection techniques



Spread in particle arrival times at detector units

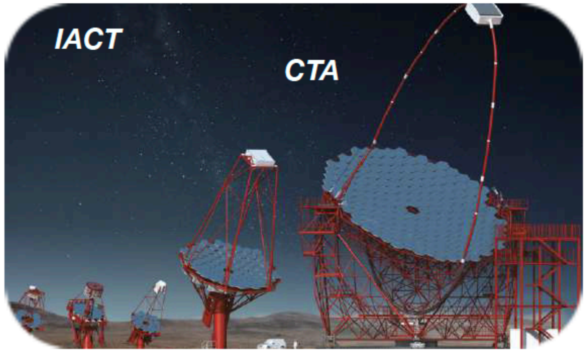


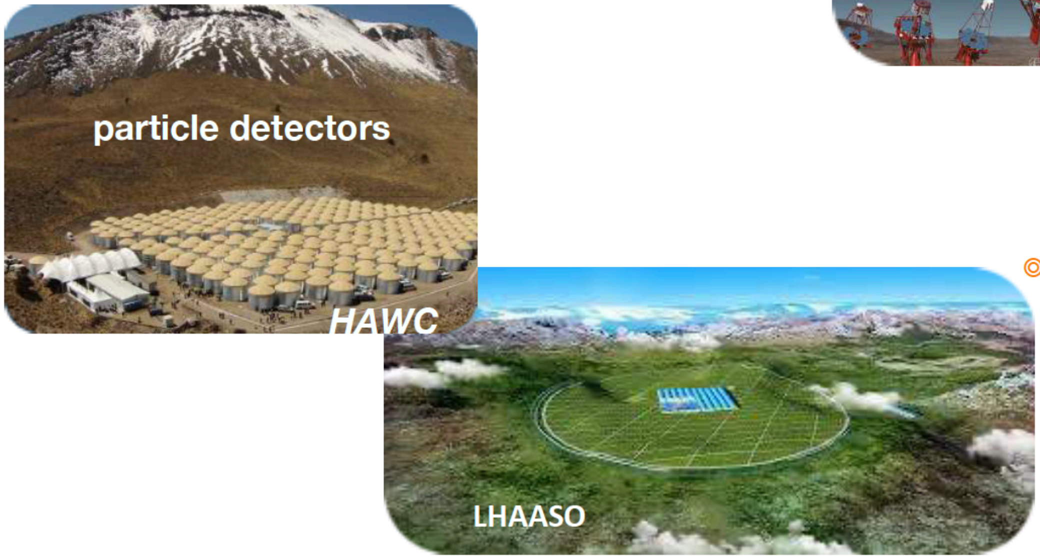
Atmospheric Cherenkov light image



伽马射线天文学

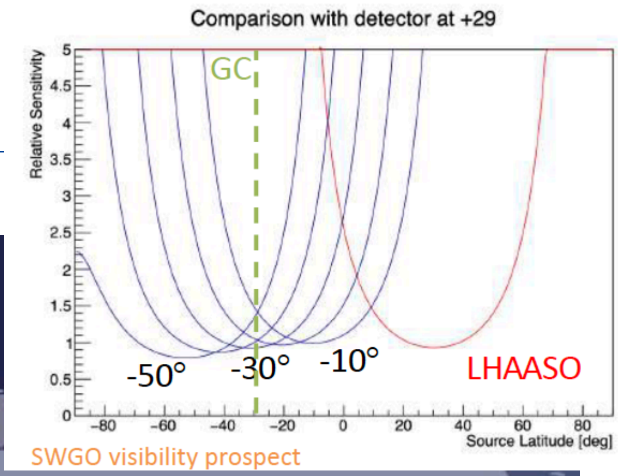
- Cherenkov Atmospheric Telescopes
  - 20% duty-cycle
  - Pointing (few degrees FoV)
  - Energy threshold down to 10s GeV
  - Good energy and angular resolution





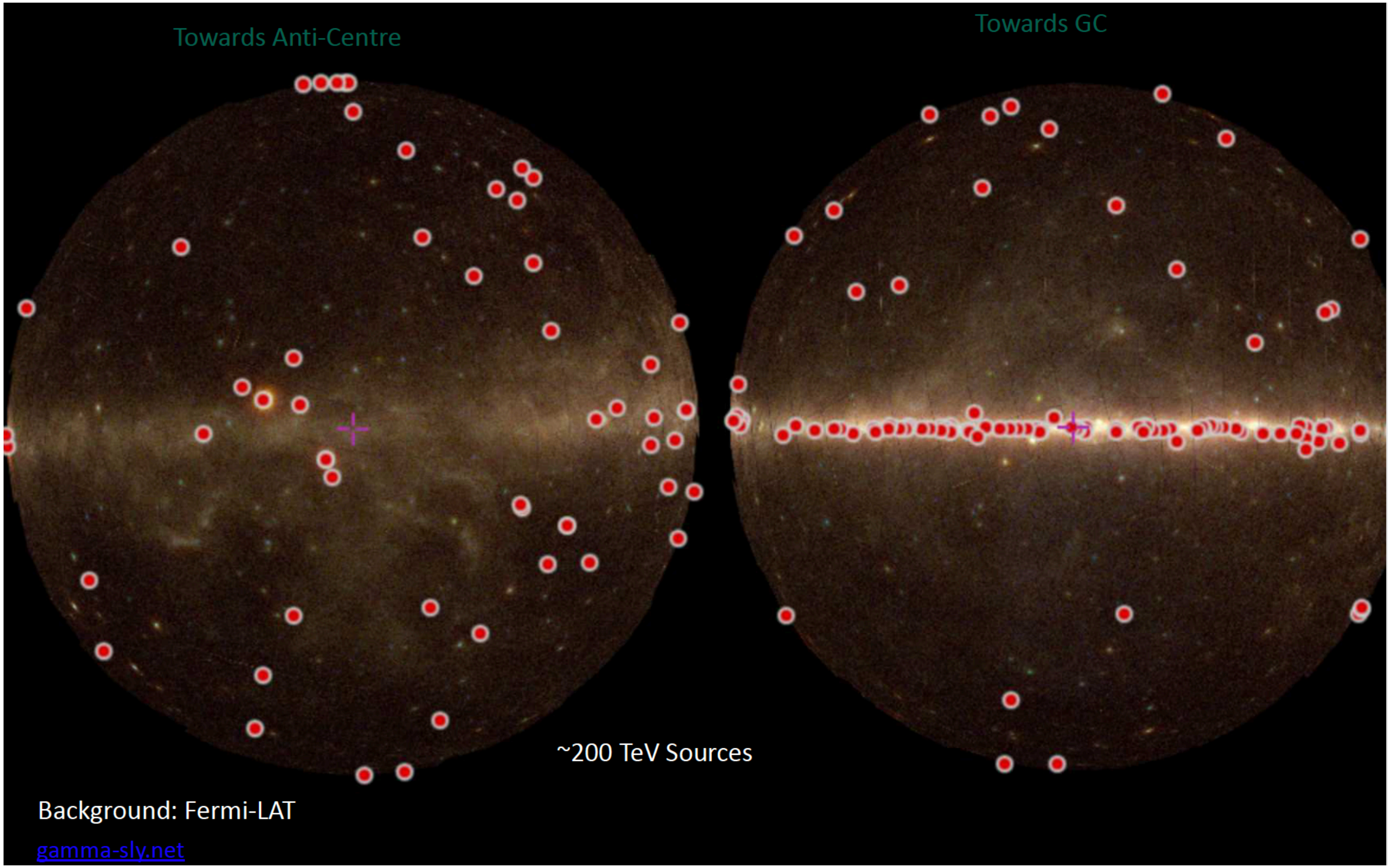
- Particle Detector Arrays
  - 100% duty-cycle
  - Wide-field of View (~ steradian)
  - Energy range 100s GeV up to 100s TeV
  - Long exposure and accurate background determination

伽马射线天文台的地理分布

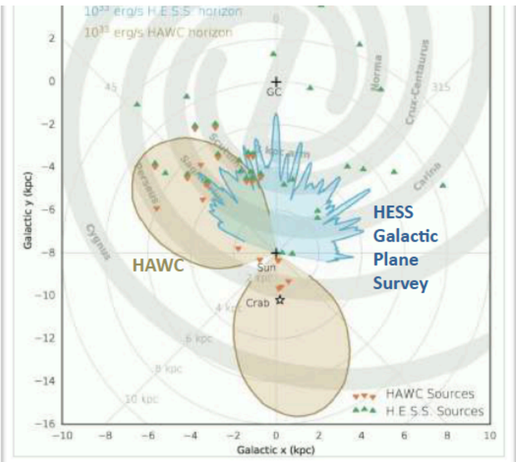


The Southern Wide-field Gamma-ray Observatory
南天区大视场伽马射线天文台

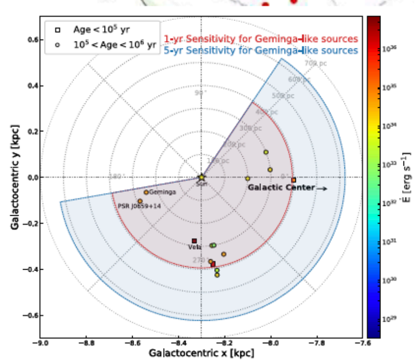
为什么要看南天?

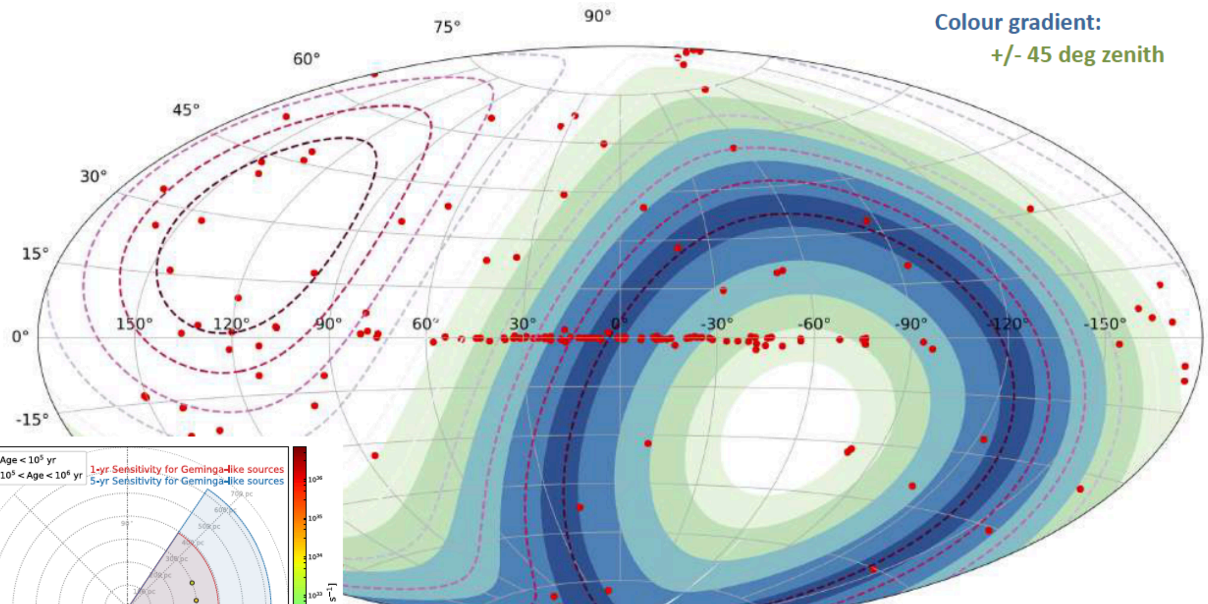

Towards Anti-Centre
Towards GC
~200 TeV Sources
Background: Fermi-LAT
gamma-sky.net

为什么要看南天？宇宙线源



SWGO will complement the view of the Galactic source population towards the highest energies and will greatly expand our reach for disclosing the full Galactic population of high-energy accelerators.

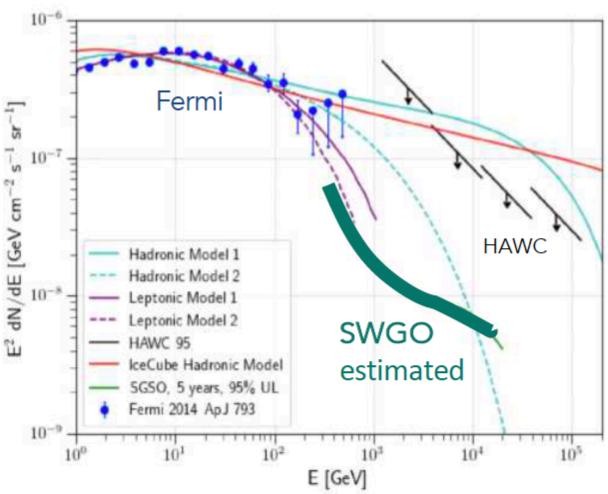


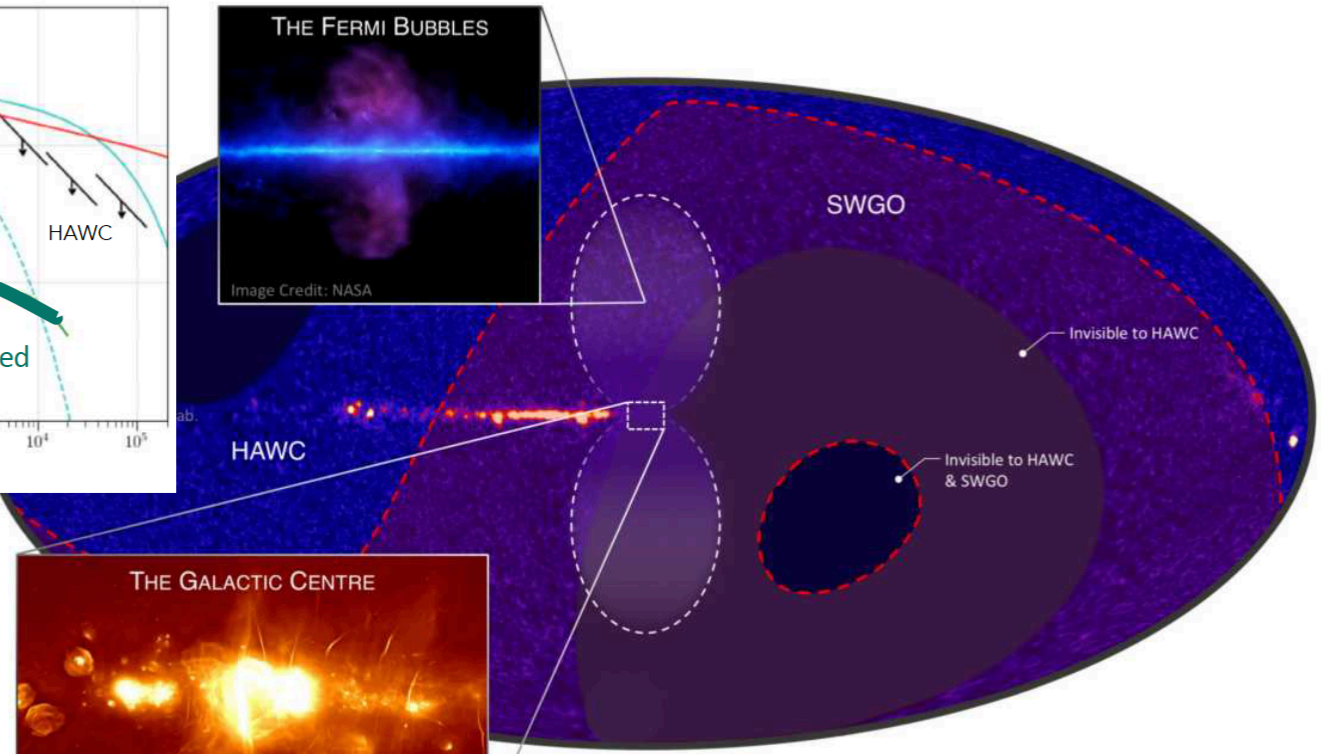


arXiv:1902.08429

25 degree south location

为什么要看南天？大尺度弥散辐射





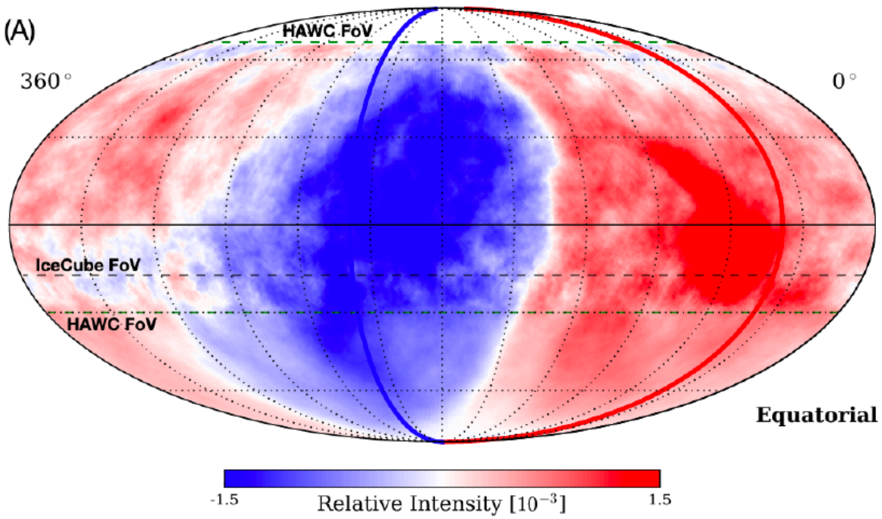
Crucial access to the Galactic Plane and GC.

Complementary view of the sky with HAWC and LHAASO for cosmic-rays and diffuse emission studies.

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

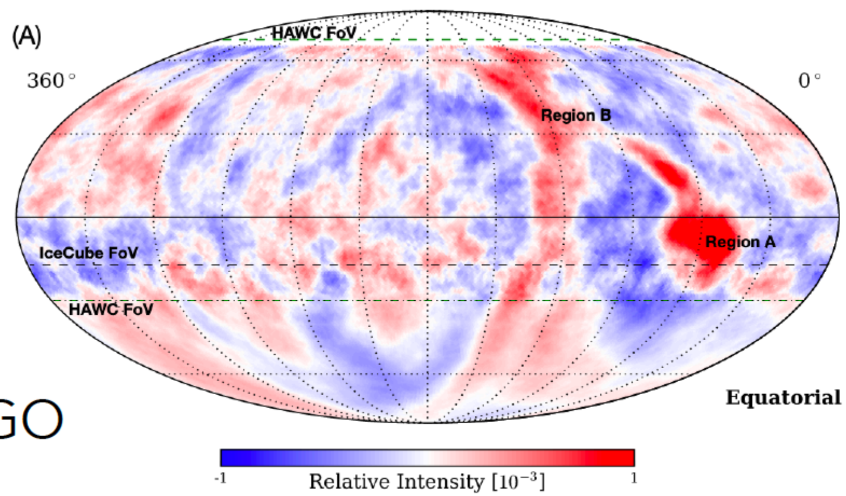
为什么要看南天？宇宙线各向异性

- In particular – **anisotropy**



→ *Understanding interstellar turbulence and local CR sources*

arXiv:1812.05682

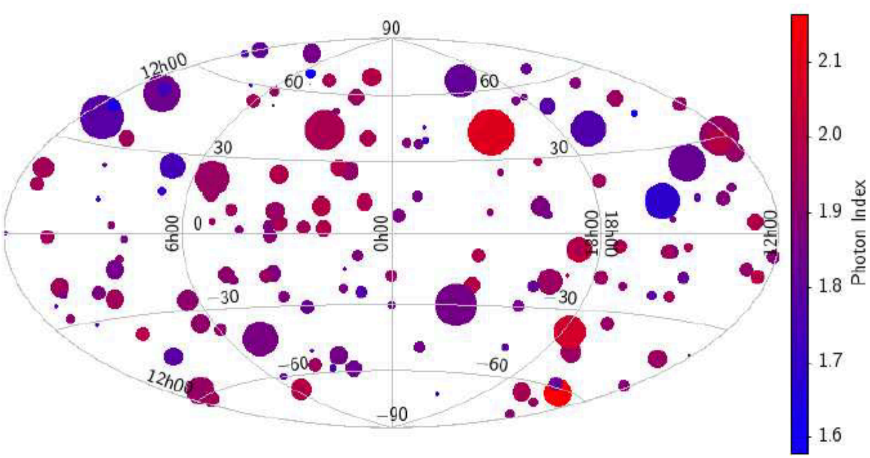


- HAWC+IceCube → LHAASO+SWGO

伽马射线时域天文

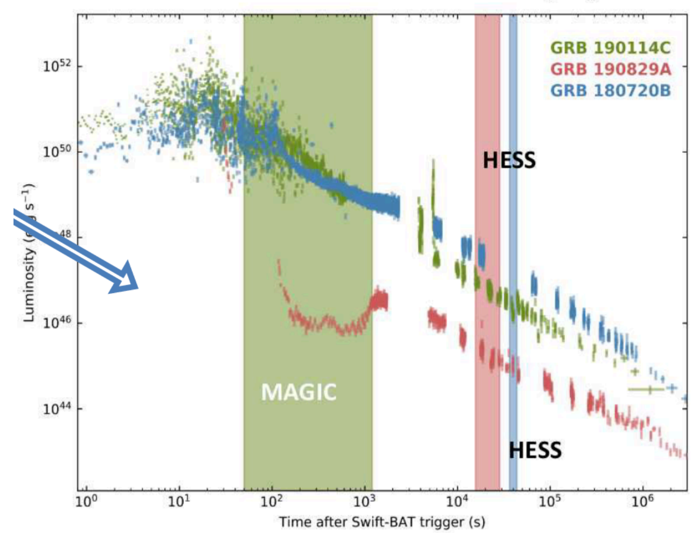
- 在南半球以低阈能、大视场开展时域天文研究
  - AGN、GRB、GW…

4FGL bright hard spectrum sources



Plot by G. La Mura

Swift X-ray Lightcurves

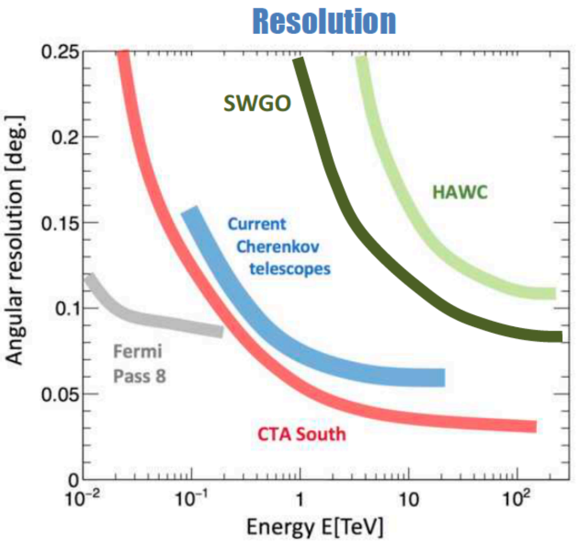


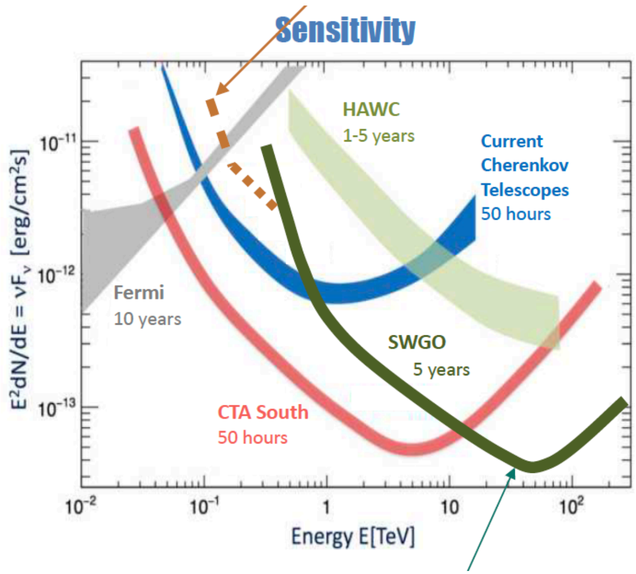
核心科学目标

- Detection of short-timescale phenomena
  - Low-energy threshold for detection of short-timescale (< 1hr) transient events down to 100 GeV
- Search for PeVatrons
  - Improved sensitivity up to a few 100s TeV to search for PeV Galactic particle accelerators.
- PWNe and Gamma-ray Halos
  - Unique potential for accessing the high-energy end of the Galactic Population.
- Dark Matter and Diffuse Emission
  - Unique access to the Galactic Center and Halo at the high-energy end of the spectrum.
- Cosmic-rays
  - Unique complement to LHAASO for anisotropy studies, with capability to reach low-angular scale.
  - Good muon tagging implies good mass resolution for composition studies up to the knee.

探测器性能要求

- High-altitude particle detector above 4.4 km a.s.l
- Latitude range between 15 and 30 degrees South
- Wide energy range reaching down to 100 GeV and 100+ TeV
- High fill-factor core (4x HAWC) for significantly better > 10x sensitivity, plus large low-density outer array
- WCD units with good muon tagging capability

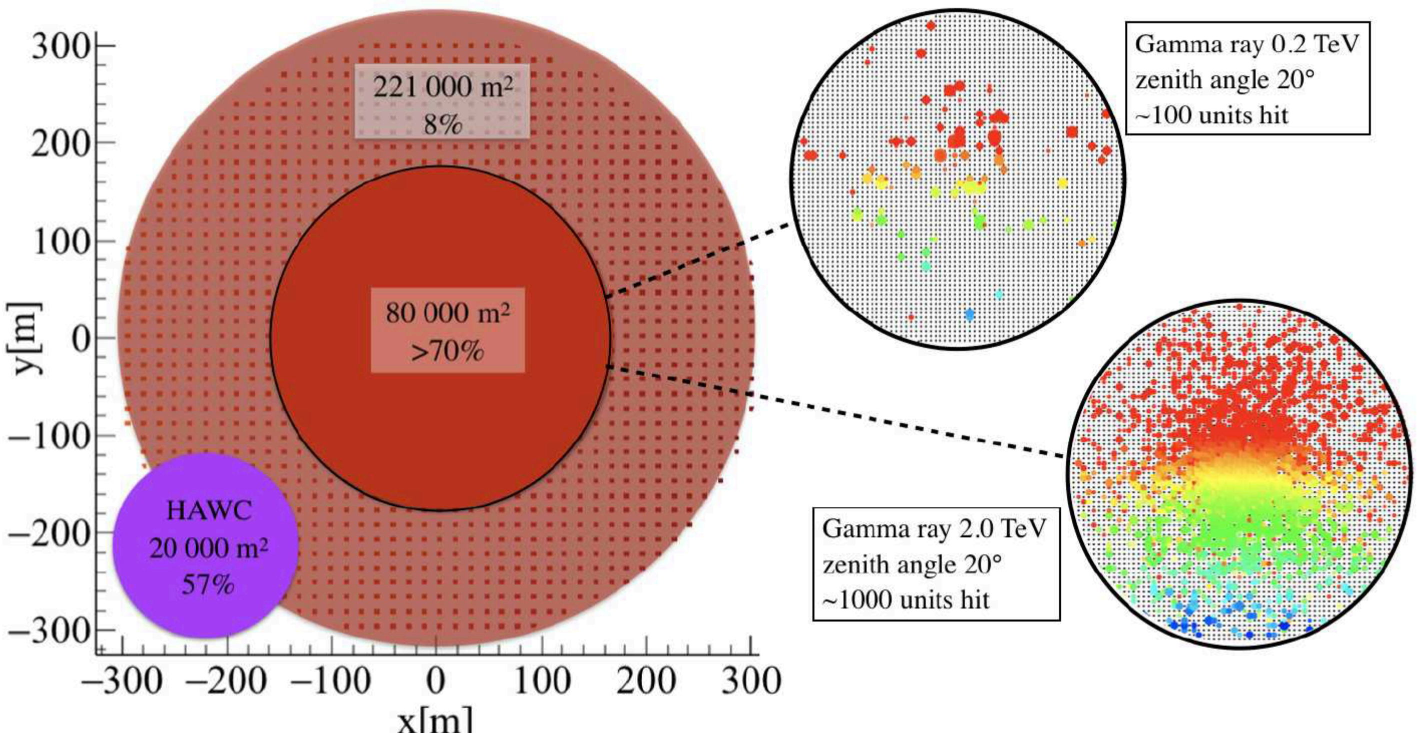




探测器布局

Detector array

- Large array for low-energy events
- Compact core with large instrumented area

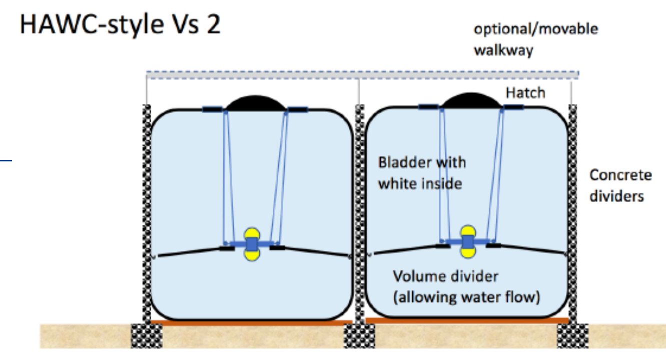


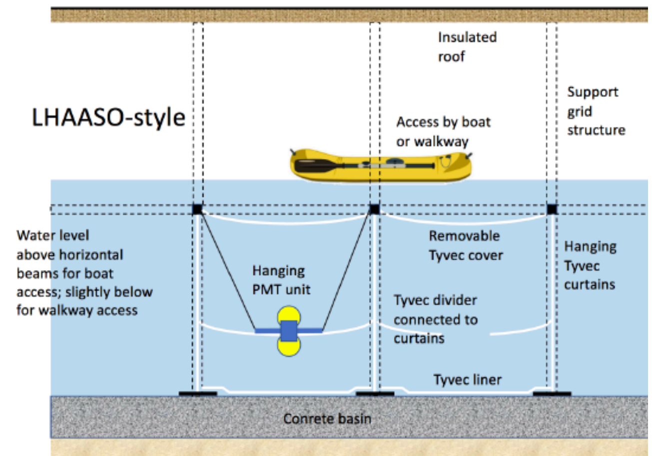
EPJ-C, H. Schoorlemmer, J.A. Hinton, R. Lopez-Coto, (2019)

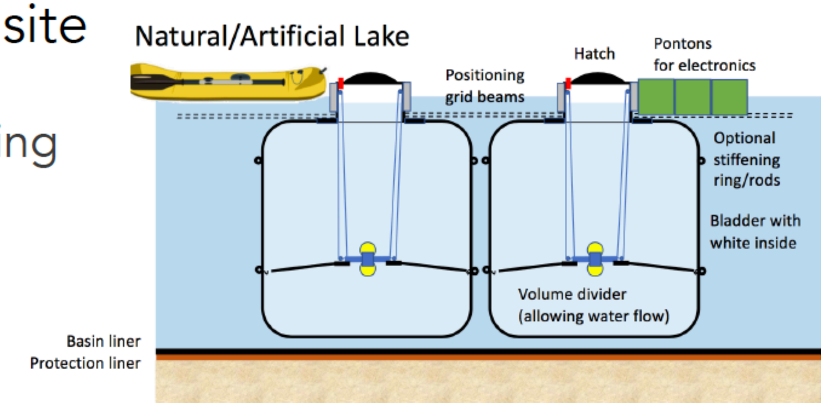
- ‘Strawman’ - reference detector layout

探测器设计

- Water Cherenkov detector units is core technology -three options under evaluation
  - Tanks, Ponds and Lake-based
- All aspects being optimised
  - Unit dimensions, wall reflectivities, photosensor nature/locations, …
- Final design will depend on choice of site
  - e.g. cost of water transportation in comparison to other costs, civil engineering costs, feasibility for lake-based solution





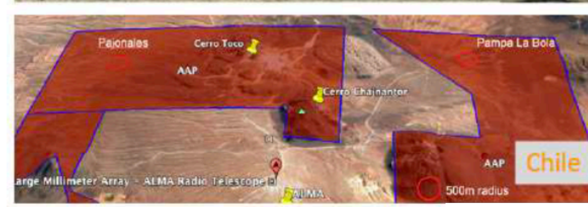


备选台址

lat. 15 S

lat. 23 S

- Alto Tocomar (Argentina)
- Cerro Vecar (Argentina)
- Chacaltaya (Bolivia)
- AAP Pajonal (Chile)
- AAP Pampa La Bola (Chile)
- Lake Sibinacocha (Peru)
- Imata (Peru)
- Sumbay (Peru)
- Peru National Observatory
- Yanque (Peru)



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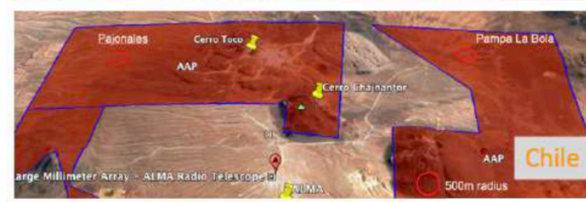
The complete list of potential sites is still under investigation, aiming at an evaluation for site choice by 2021.

Country	Elevation	Location:
Peru	4900	Laguna Sibinacocha
Peru	4450	Imata lake
Peru	4450	Imata
Peru	4140	Sumbay
Argentina	4800	Cerro Vecar
Argentina	4450	Alto Tocomar
Chile	4700	ALMA Pampa La Bola
Chile	4400	AAP Pajonales
Bolivia	4700	ALPACA area



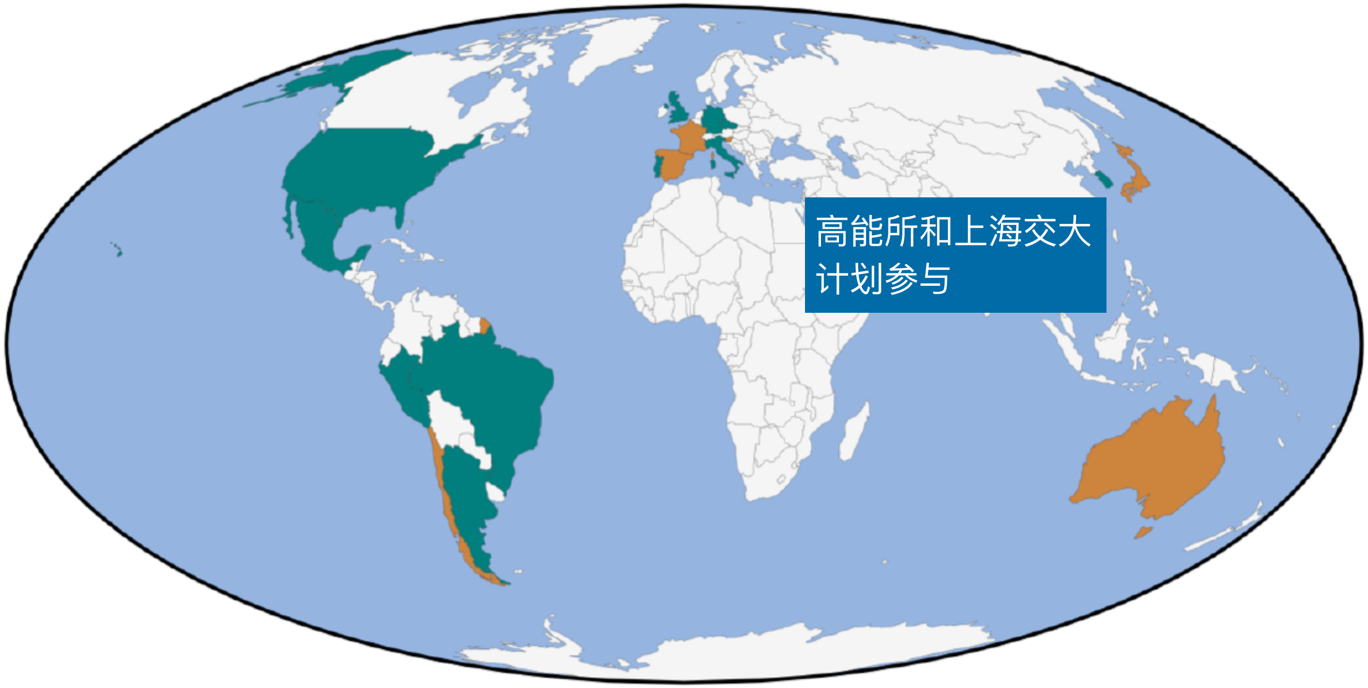
三年R&D阶段

- 2021年内，计划完成
  - M4 - 台址shortlist
  - M5 - 探测器布局候选
  - M6 - 探测器性能估计

SWGO R&D Phase Milestones	
M1	R&D Phase Plan Established
M2	Science Benchmark Cases Chosen
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

Milestone	2019	2020				2021				2022			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
R&D Phase Plan Established		M1											
Science Benchmarks Defined			M2										
Reference Configuration & Options Defined				→	M3								
Site Shortlist Complete					→		M4						
Candidate Configurations Defined							M5						
Perf. of Candidate Configurations Evaluated								M6					
Preferred Site Identified									→	M7			
Design Finalised											→	M8	
Construction & Operation Proposal Complete													M9

SWGO合作组



Countries in SWGO

Institutes

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

Supporting scientists

Australia, Chile, France, Japan, Slovenia, Spain

**also supporting scientists*

- 11 countries, 44 institutes, 193 scientists
- Expertise from HAWC, ARGO, MAGIC, HESS, Auger ++

总结和展望

- Strong motivation for a Southern-Hemisphere, wide field of view, high duty-cycle detector
  - SWGO is in the middle of its 3 year R&D period towards project launch
  - and has recently defined its science benchmarks
- Strong complementarity between SWGO & CTA
  - Detection of hard spectrum sources for CTA follow-up
  - Triggering CTA on flares and transients / multi-messenger events
  - Large scale emissions complementing CTA's detailed view of the Galaxy
- SWGO & LHAASO / HAWC
  - Huge potential for scientific and technological synergies
  - Complementary location for joint all-sky and cosmic-ray studies.