

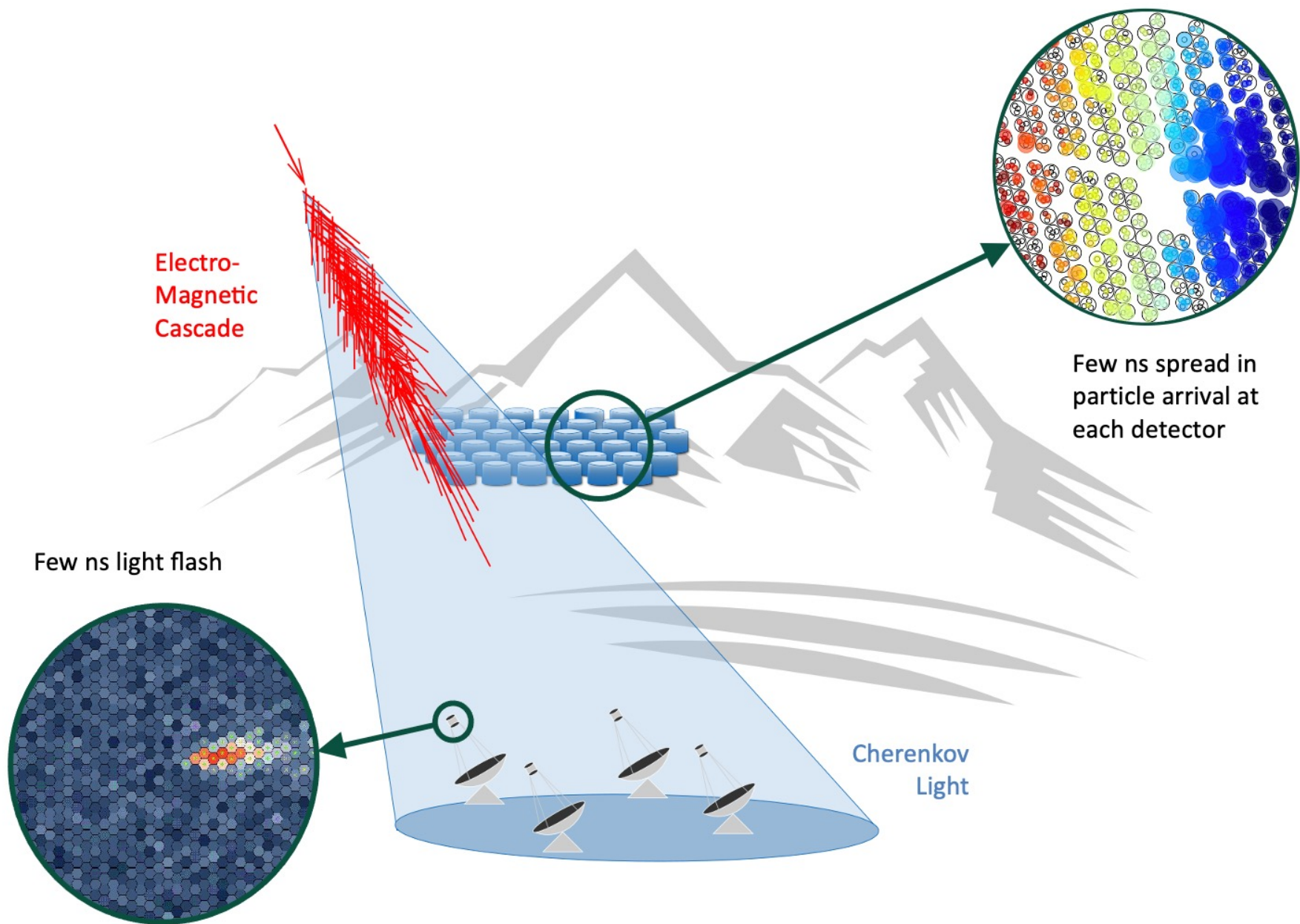
[www.swgo.org](http://www.swgo.org)

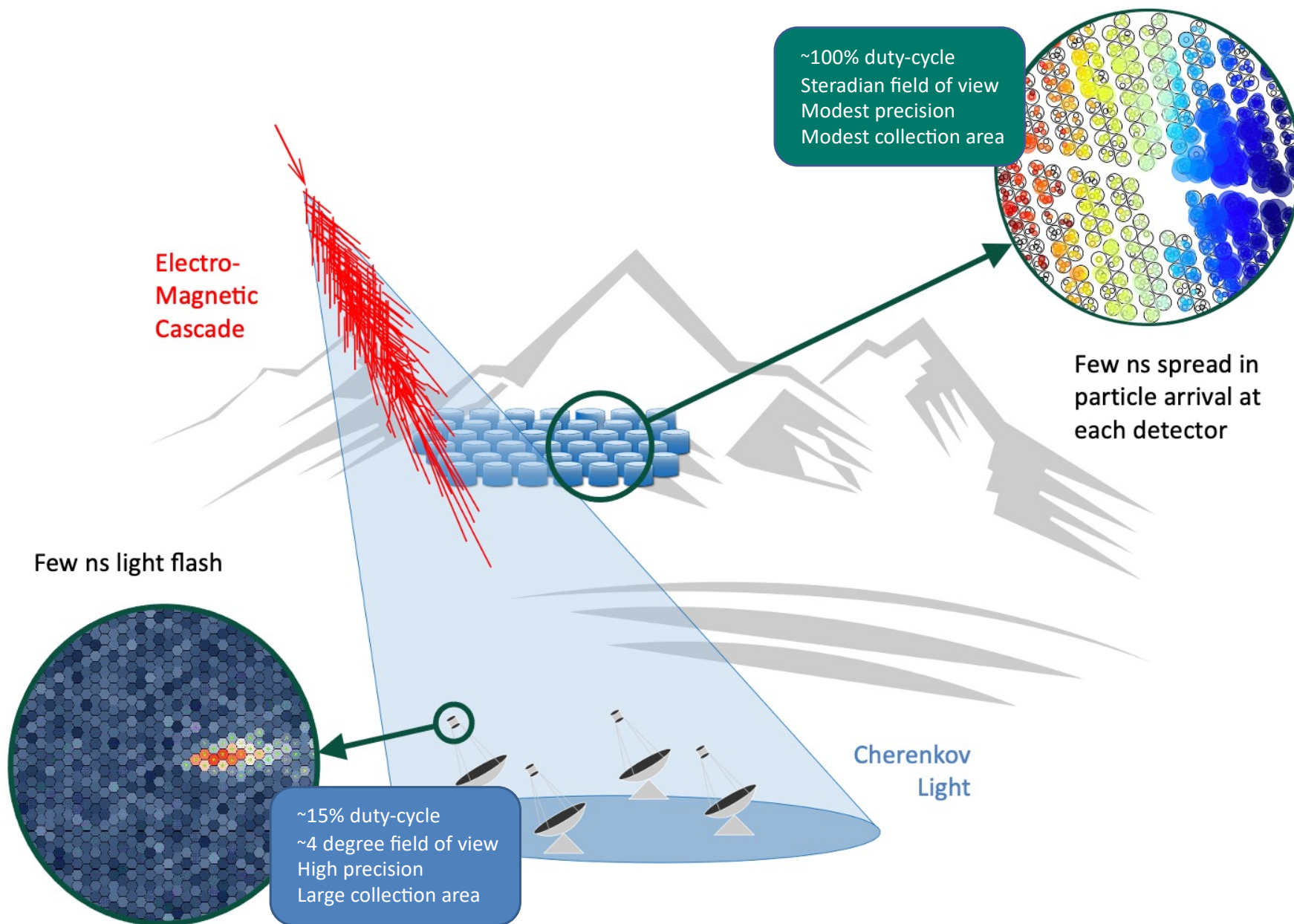


# The Southern Wide-field Gamma-ray Observatory

**Jim Hinton**

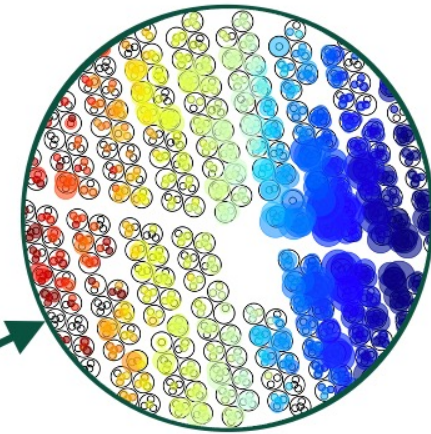






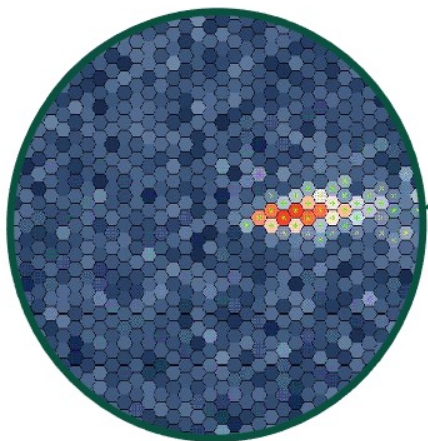
# SWGGO

Electro-  
Magnetic  
Cascade



Few ns spread in  
particle arrival at  
each detector

Few ns light flash



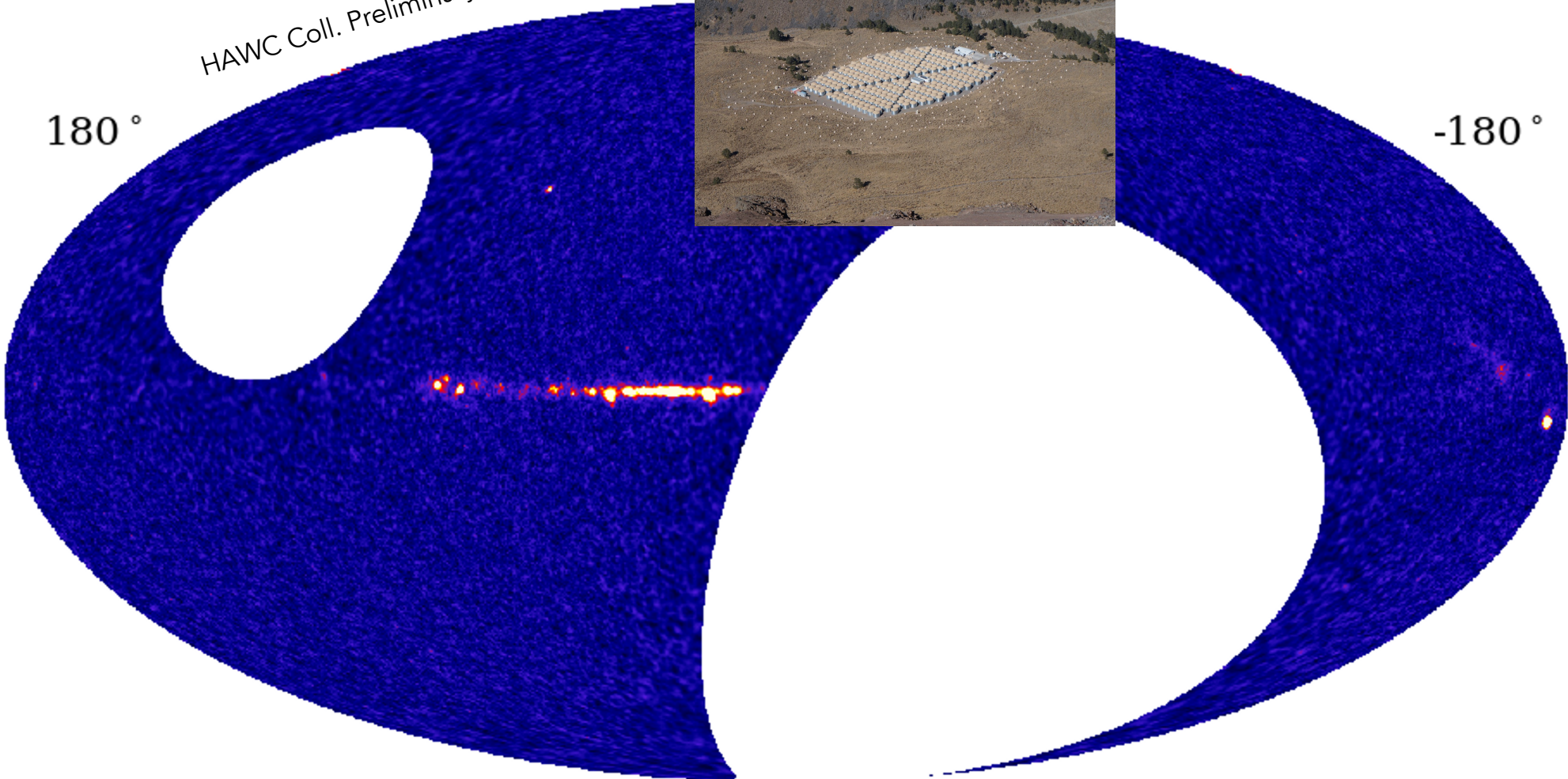
Cherenkov  
Light



HAWC Coll. Preliminary

180°

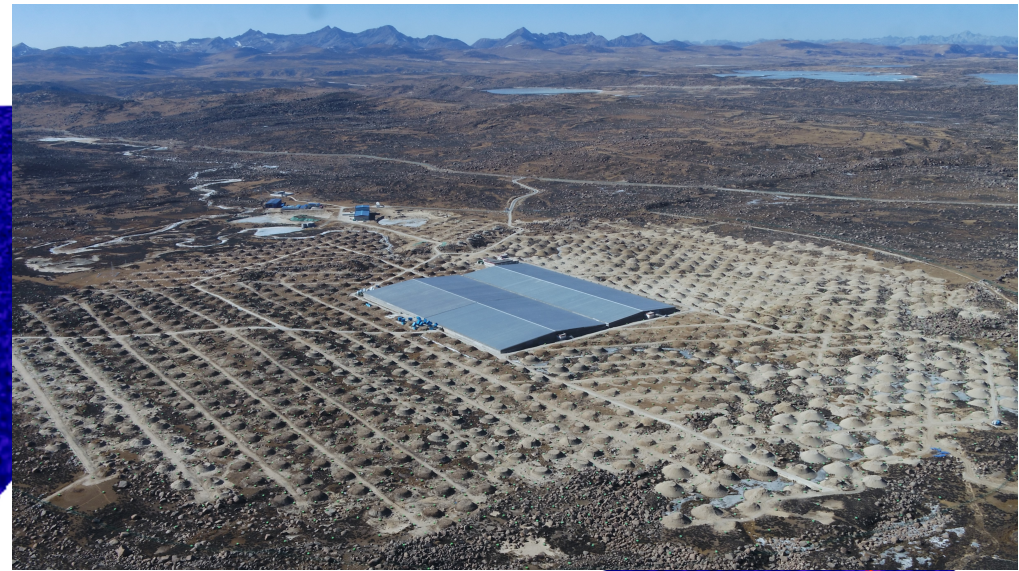
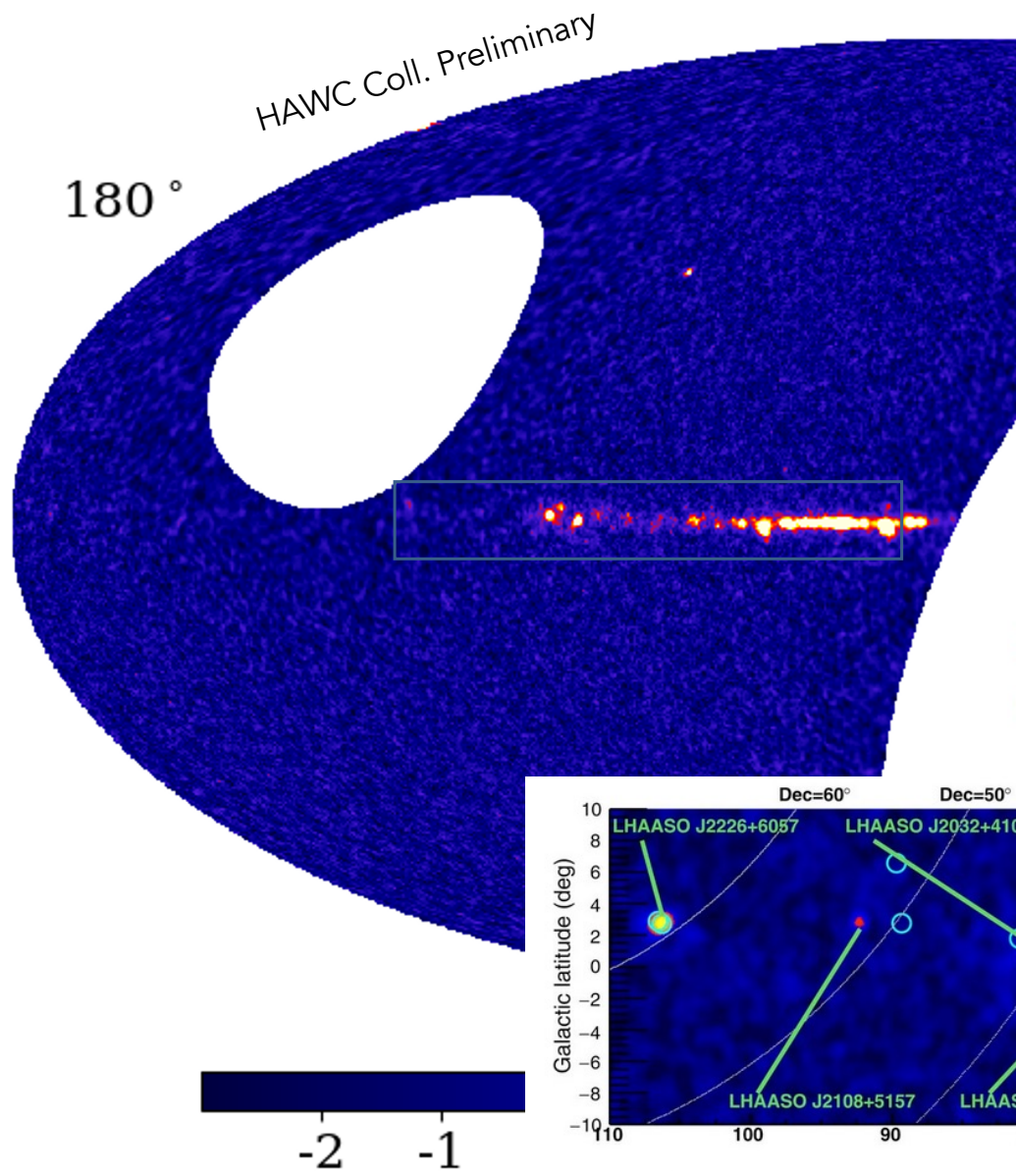
-180°



-2 -1 -0 1 2 3 4 5 6 7 8 9

significance [ $\sigma$ ]

For 0.4° sources

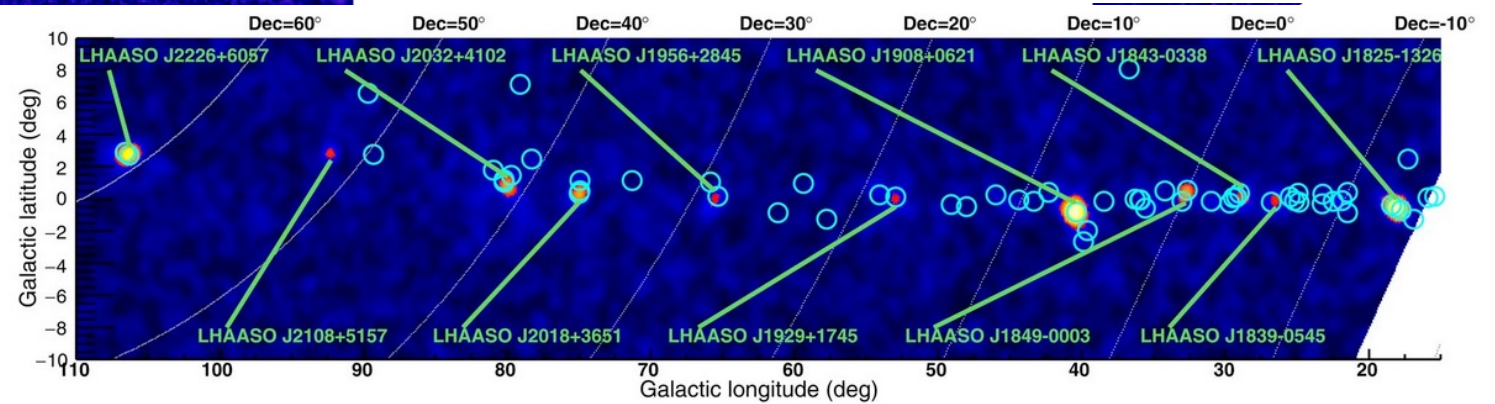


## Ultrahigh-energy photons up to 1.4 petaelectronvolts from 12 $\gamma$ -ray Galactic sources

Zhen Cao , F. A. Aharonian , [...]X. Zuo

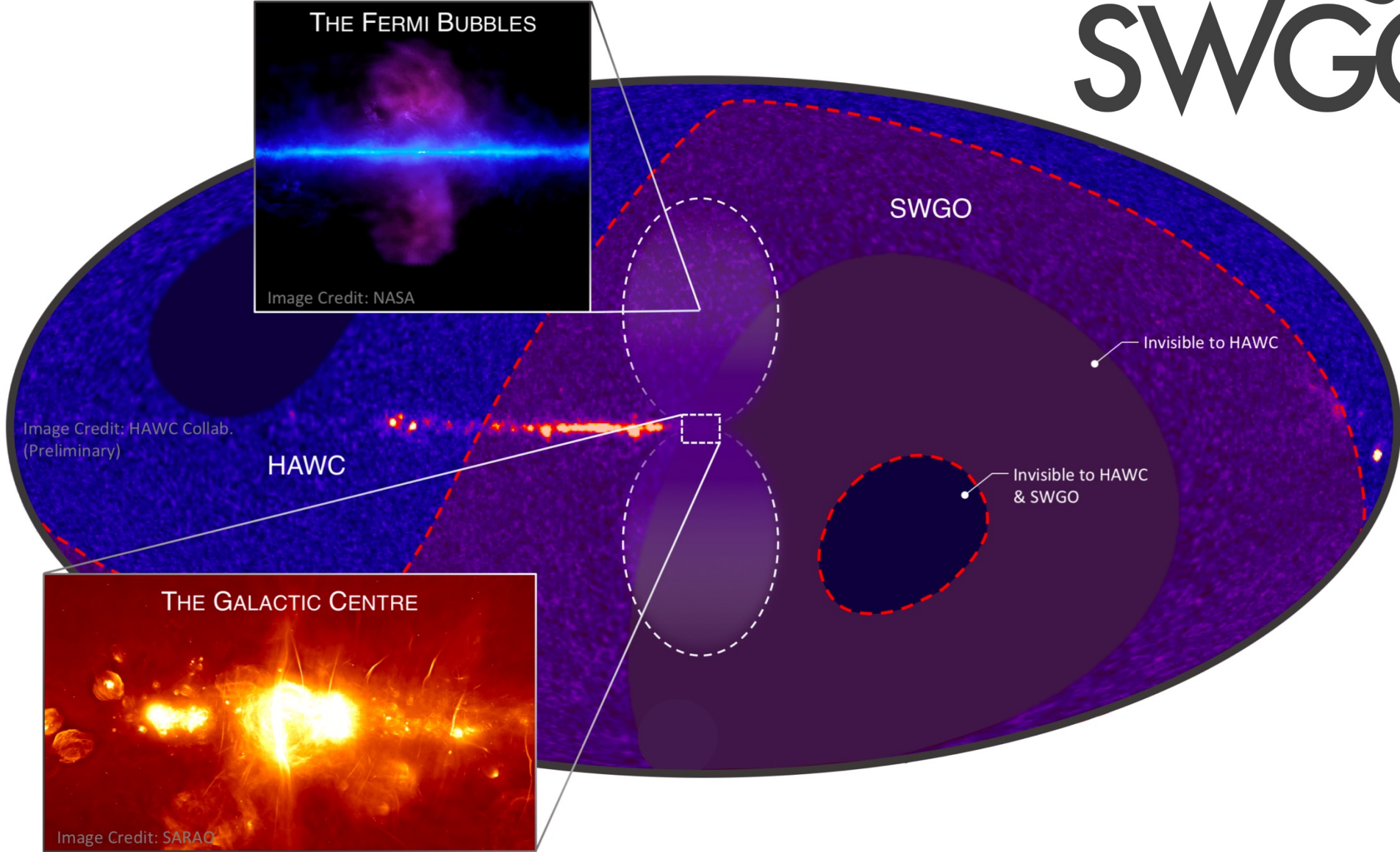
*Nature* **594**, 33–36 (2021) | [Cite this article](#)

8285 Accesses | 637 Altmetric | [Metrics](#)

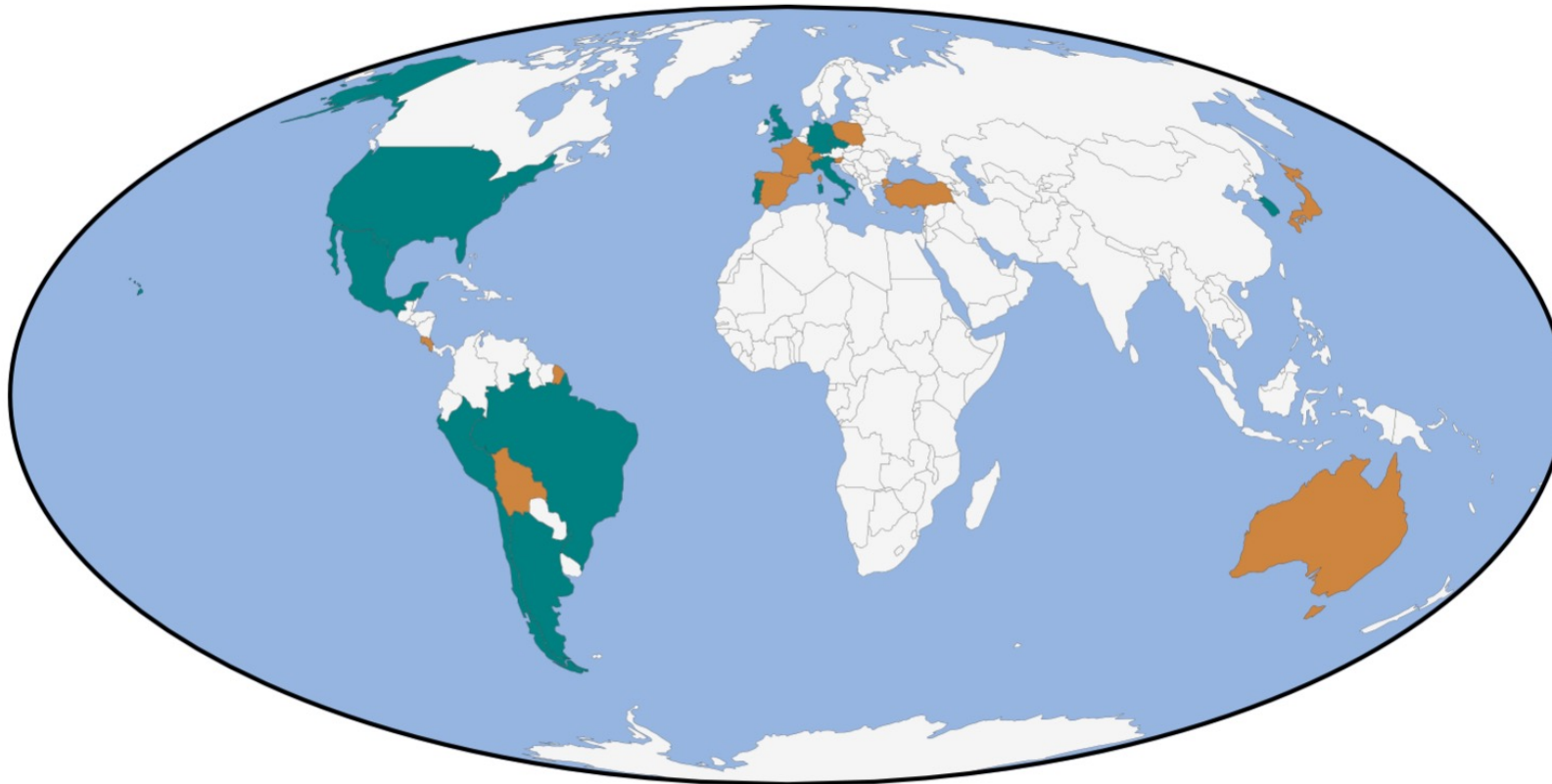


significance [ $\sigma$ ]

For 0.4° sources



# Collaboration



## 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

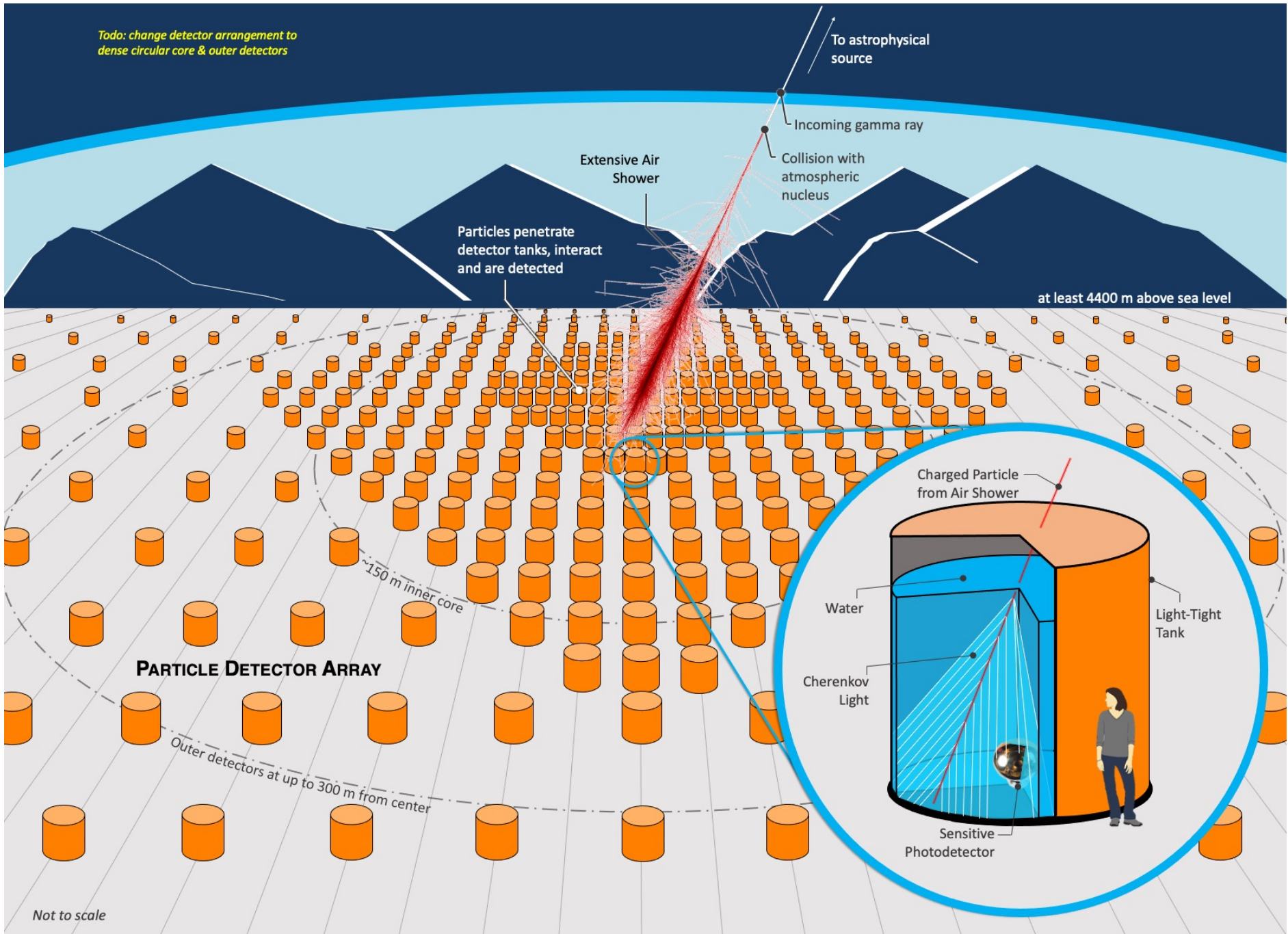
*\*also supporting scientists*

- ◎ 47 institutes in 12 countries
- + supporting scientists



Formed 2019  
~3-year R&D phase  
**Design SWGO & choose Site**





# Working Groups & Milestones

---

## SWG R&D Phase Milestones

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

- ◎ Spokespersons  
[swgo\\_spokespersons@swgo.org](mailto:swgo_spokespersons@swgo.org)
  - Jim Hinton (Germany),  
Petra Huentemeyer (USA),  
Ulisses Barres (Brazil)



**Science**

*Gwenael Giacinti & Francesco Longo*



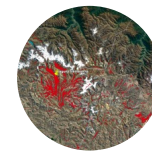
**Analysis & Simulations**

*Ruben Conceição, Harm Schoorlemmer & Andy Smith*



**Detector**

*Felix Werner & Lukas Nellen*



**Site**

*Marcos Santander & Arthur Moraes*



**Outreach & Comms**

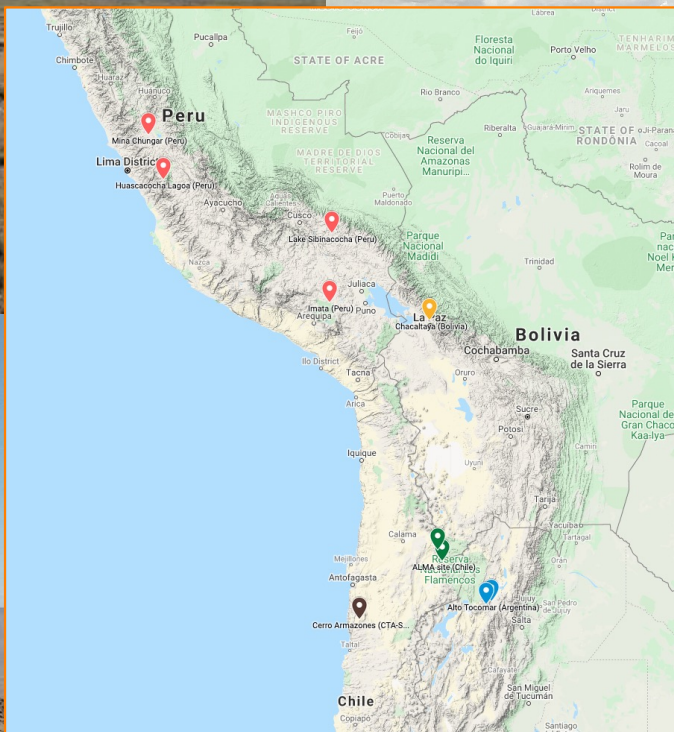
*Elisa Prandini & Ana Pichel*

**Working Group Coordinators**

Bolivia 4.7k



Chile 4.8 k



Argentina 4.8 k



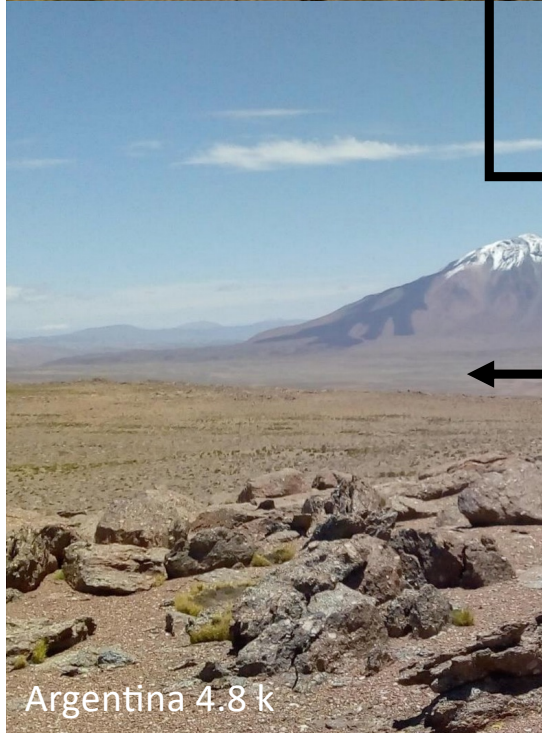
Peru 4.9 k

Bolivia 4.7k

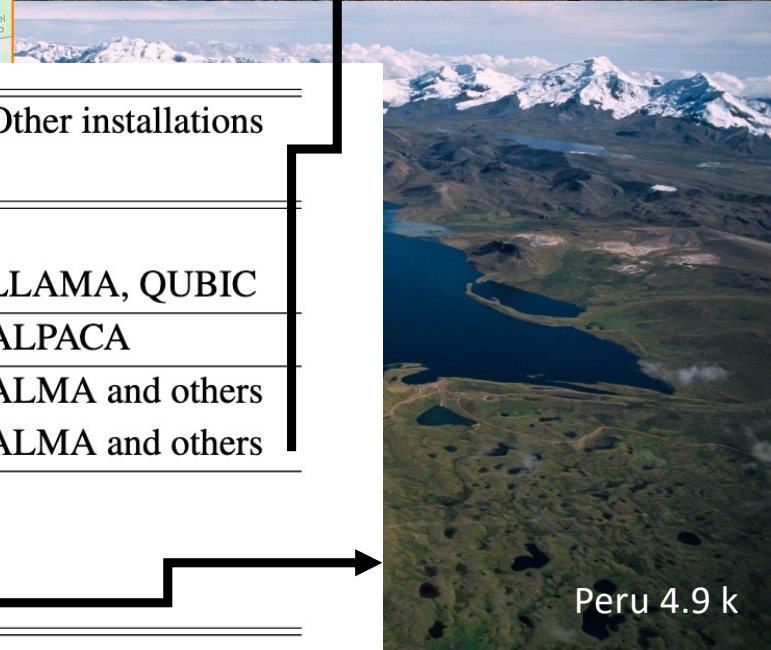
Chile 4.8 k



Country	Site Name	Latitude	Altitude [m a.s.l.]	Other installations
Argentina	Alto Tocomar	24.19 S	4,430	
	Cerro Vecar	24.18 S	4,800	LLAMA, QUBIC
Bolivia	Chacaltaya	16.23 S	4,740	ALPACA
Chile	Pajonales	22.57 S	4,600	ALMA and others
	Pampa La Bola	22.56 S	4,770	ALMA and others
Peru	Imata	15,50 S	4,450	
	Yanque	15.44 S	4,800	
	Sibinacocha	13.51 S	4,900	



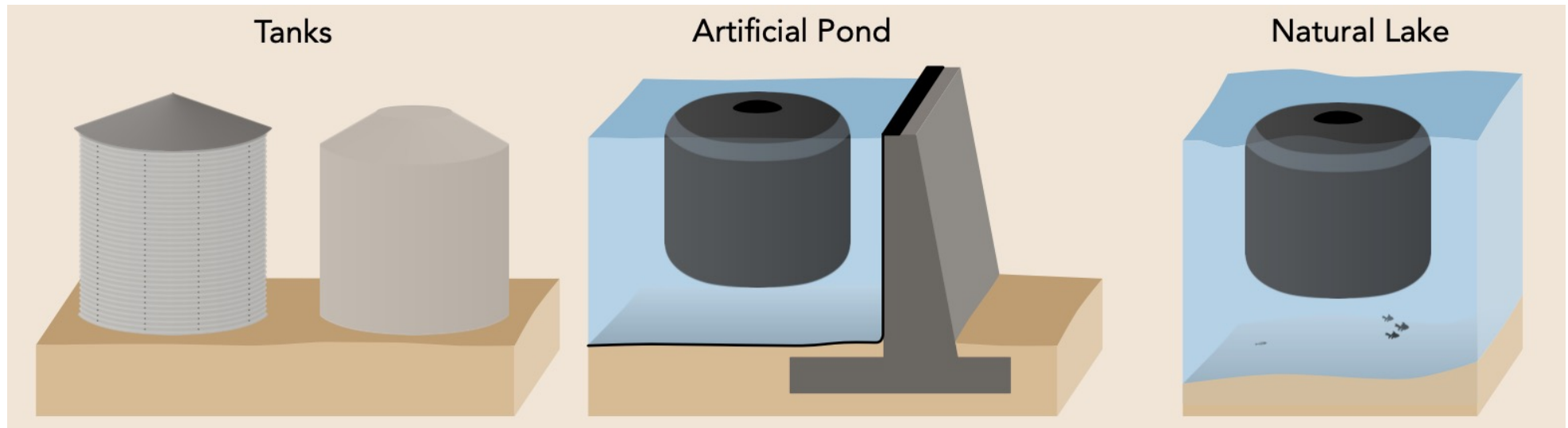
Argentina 4.8 k



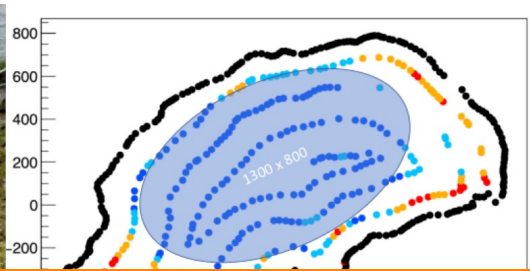
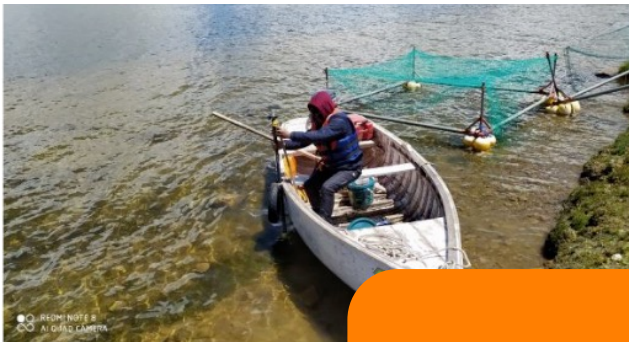
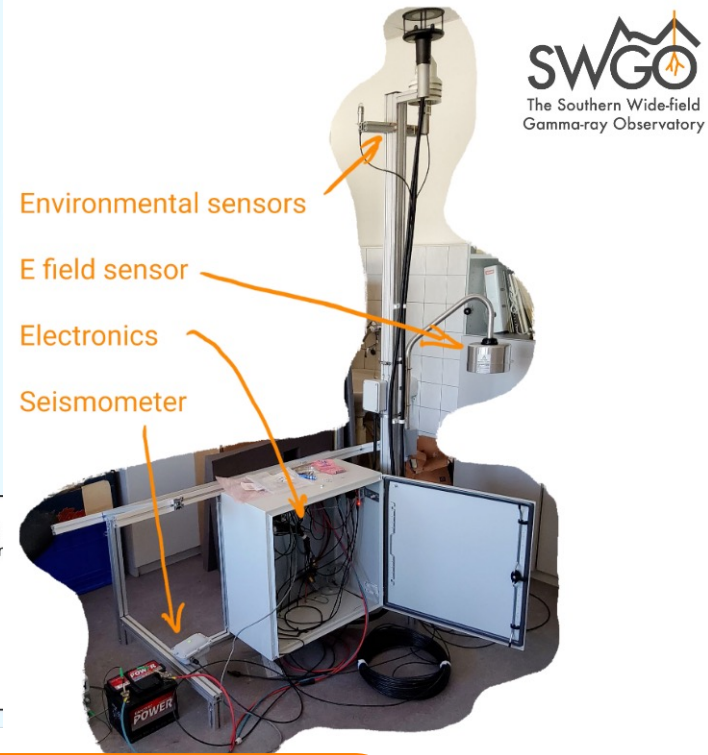
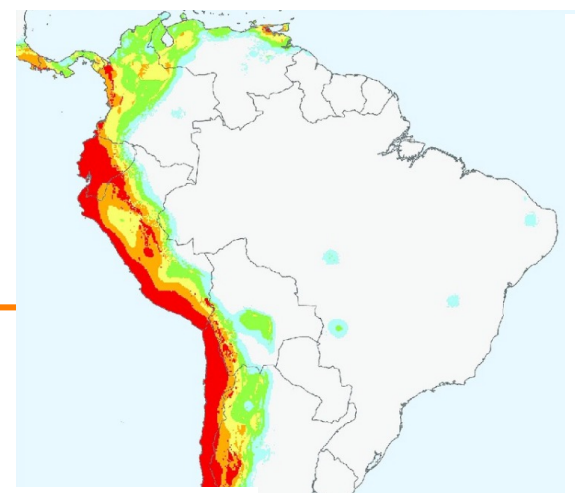
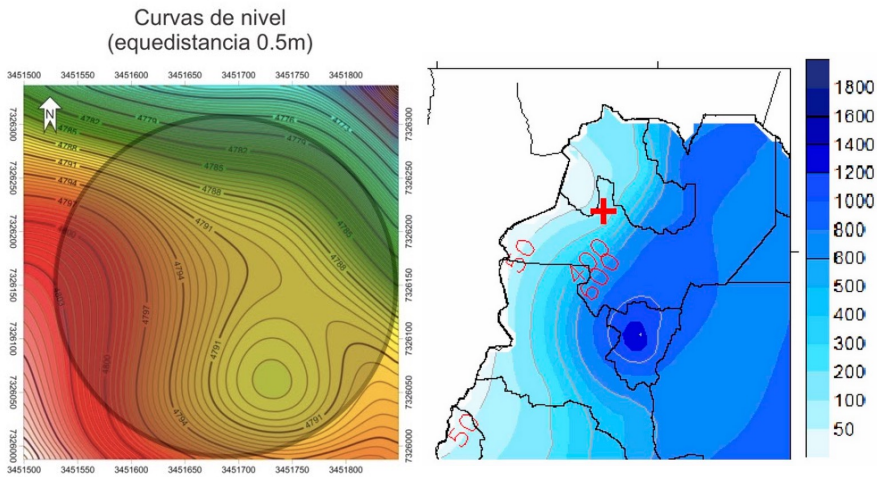
Peru 4.9 k

# Design Options

[Link to Talk](#)



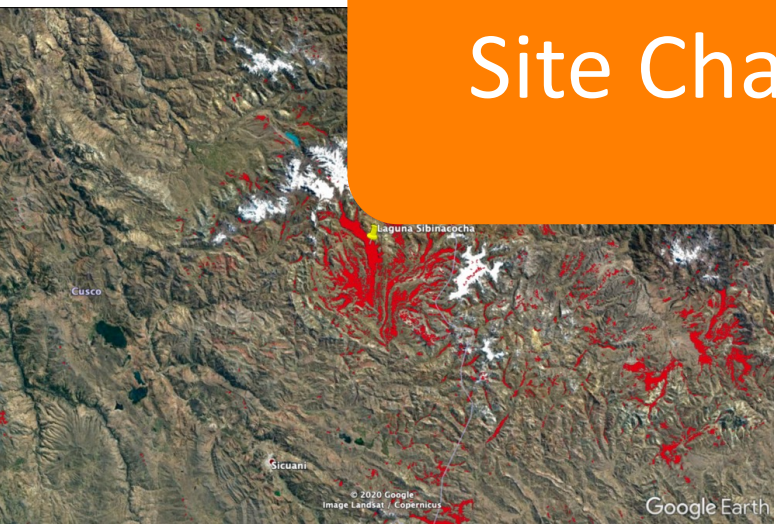
- ⊙ Exploring three concepts for the detector units
  - Tanks (like HAWC), Artificial Pond (like LHAASO) and Natural Lake
- ⊙ ...as well unit dimensions, photosensors, +++
  - Performance/cost optimisation

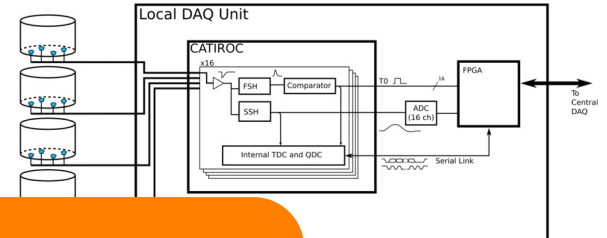
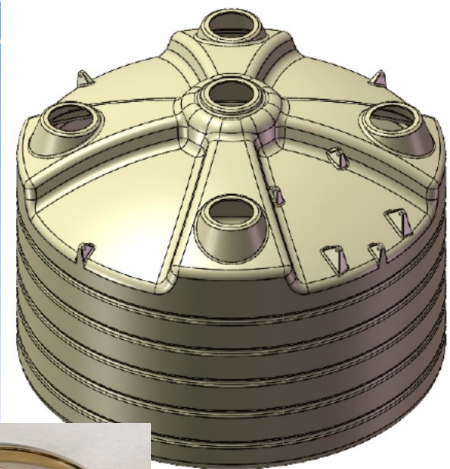
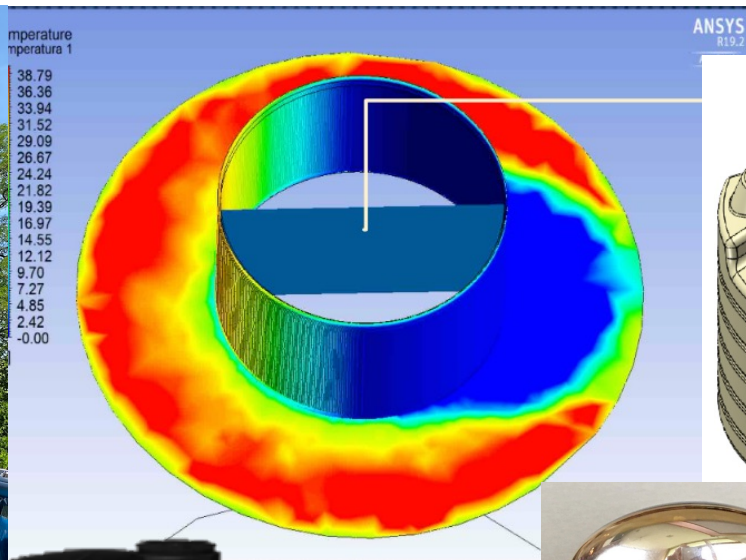


**EXPLANATION**  
Chance of slight (or greater) damaging earthquake shakir in 50 years

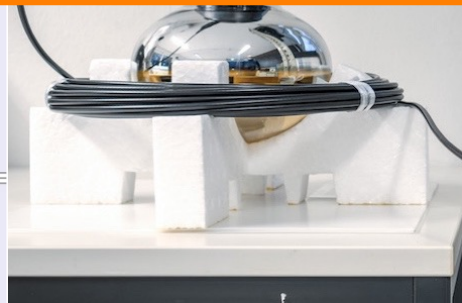
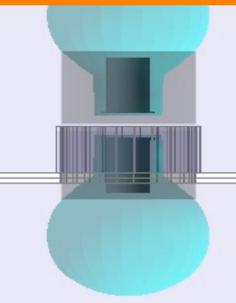
< 15%
15%-30%
30%-50%
50%-70%
70%-85%
> 85%

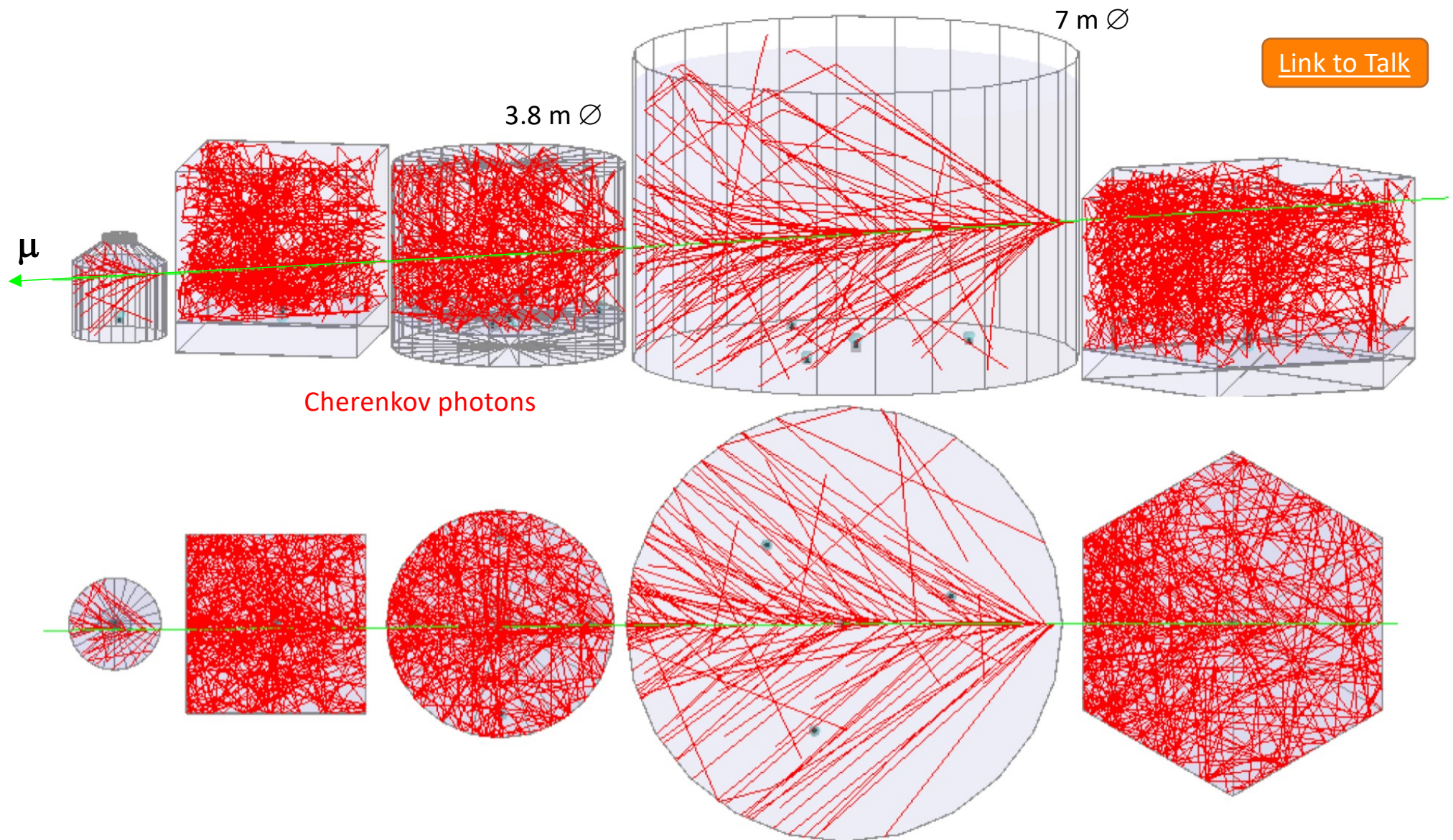
# Site Characteristion → Shortlist





# Prototyping → Baseline Design





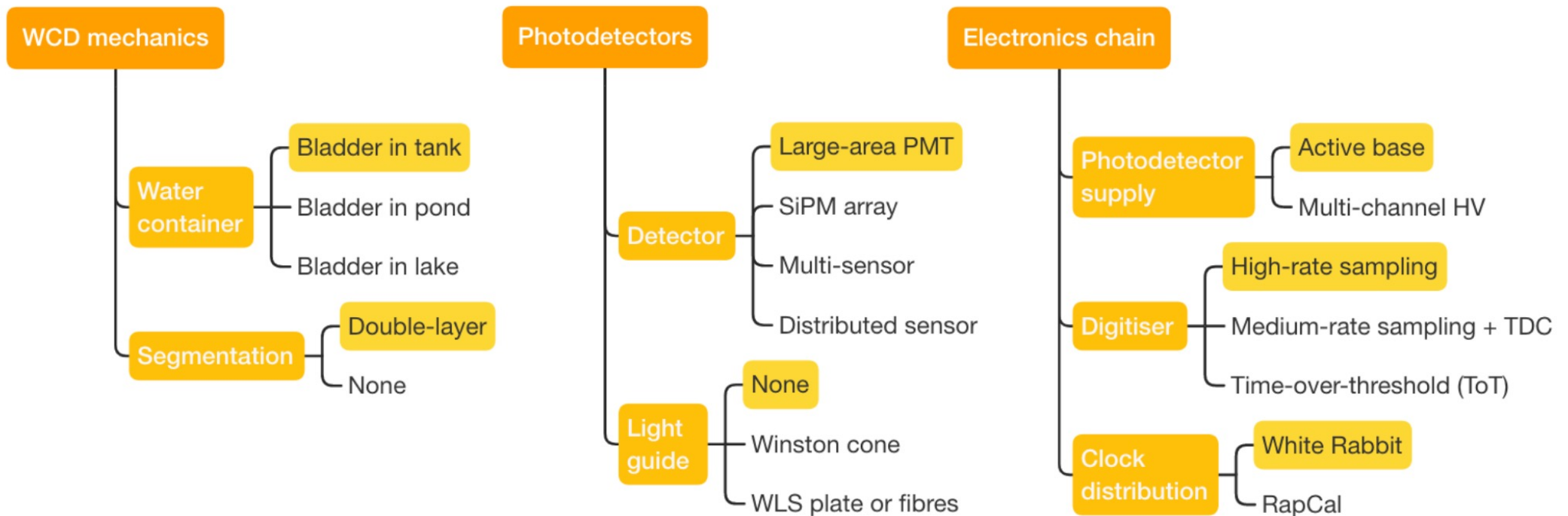
⦿ Building on the analysis and simulations framework of **HAWC**



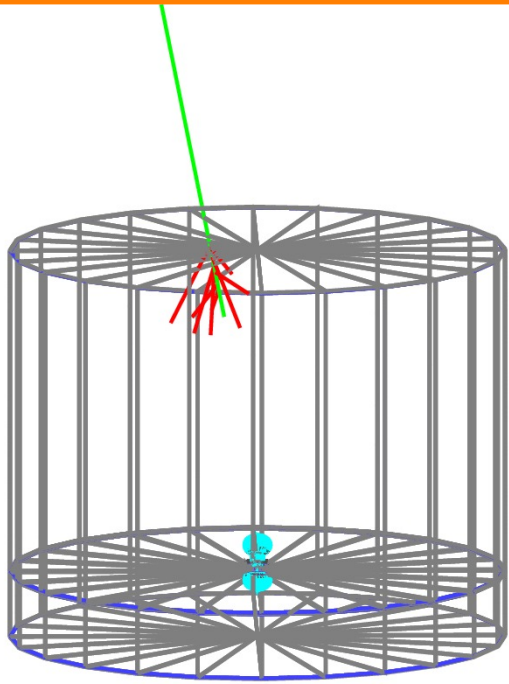
# Reference Configuration

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- Establish a plausible, costable and realisable (with existing tech) design to serve as reference to alternative approaches



# Reference Configuration



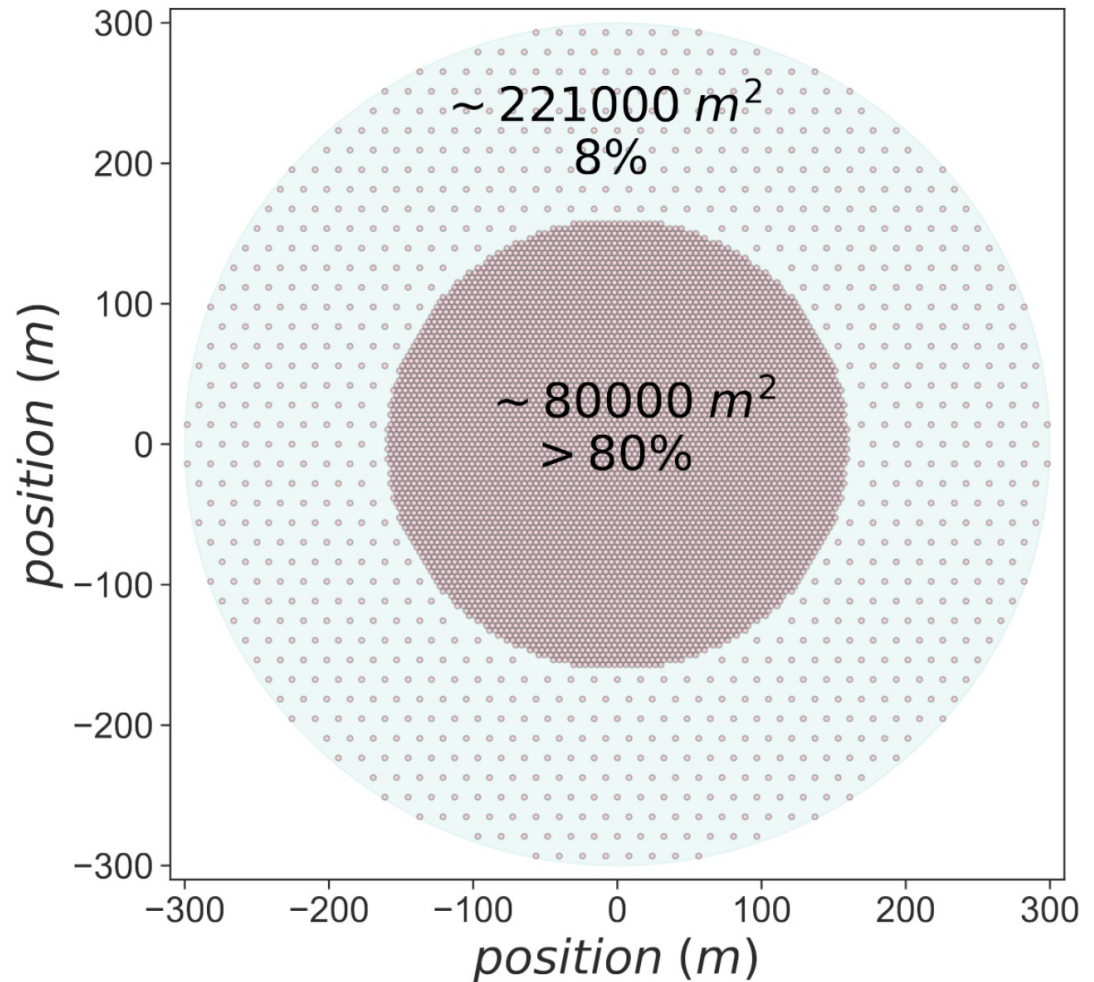
Samridha Kunwar

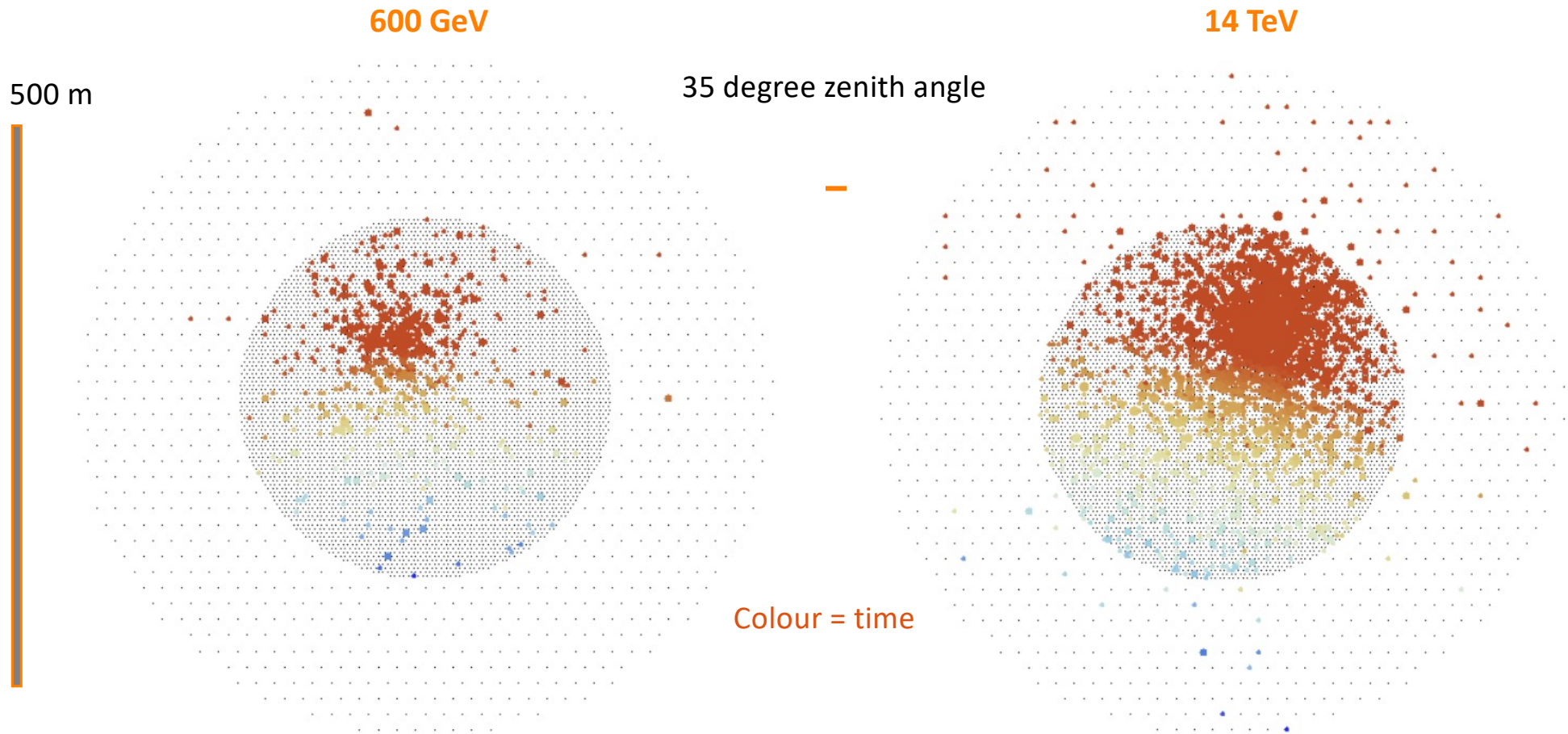
**Muon** identification a key element of background rejection

[Link to Talk](#)

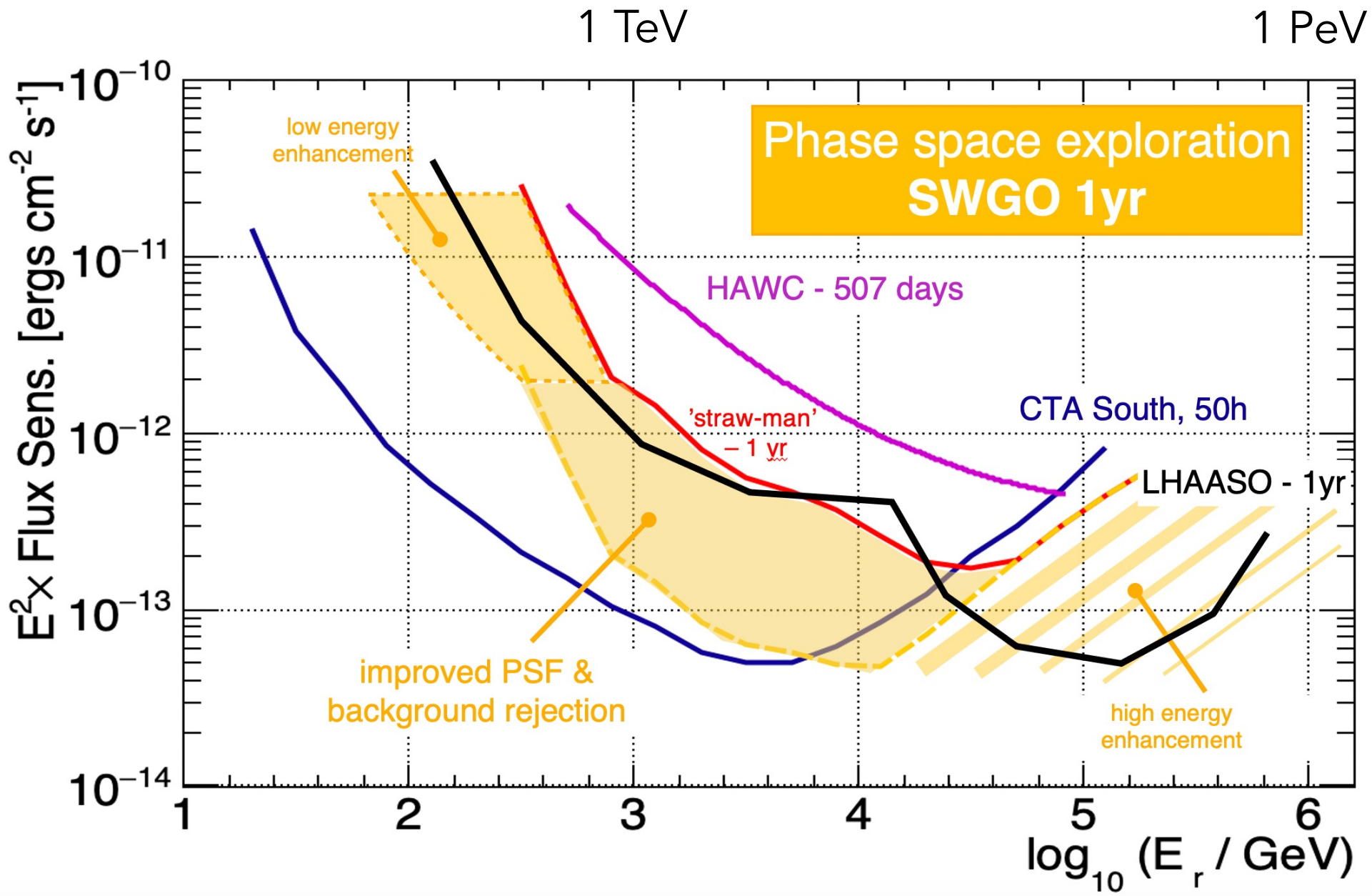
Alternative approach:

[Link to Talk](#)



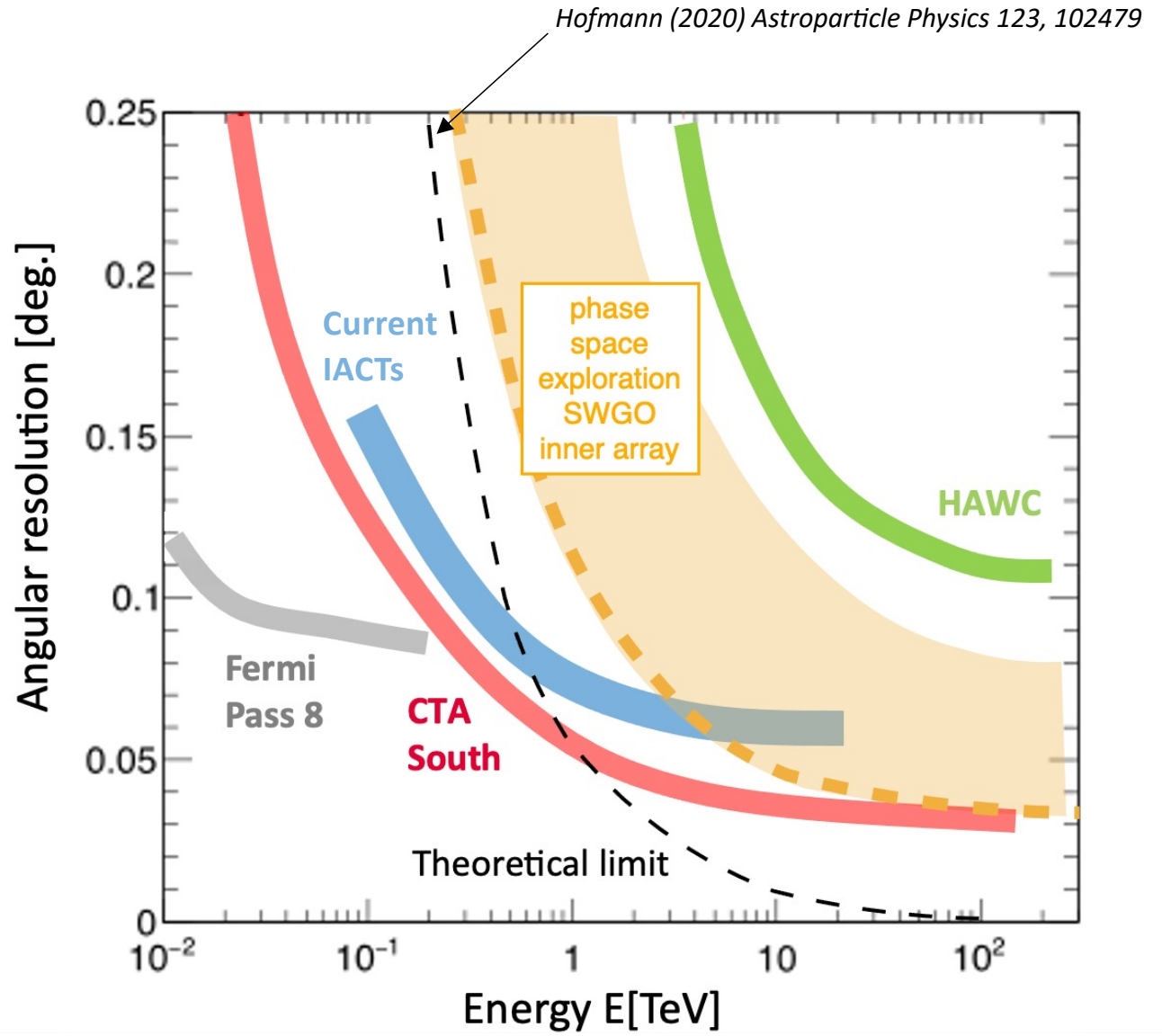


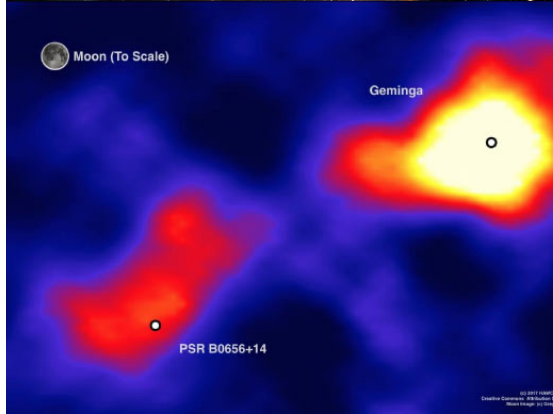
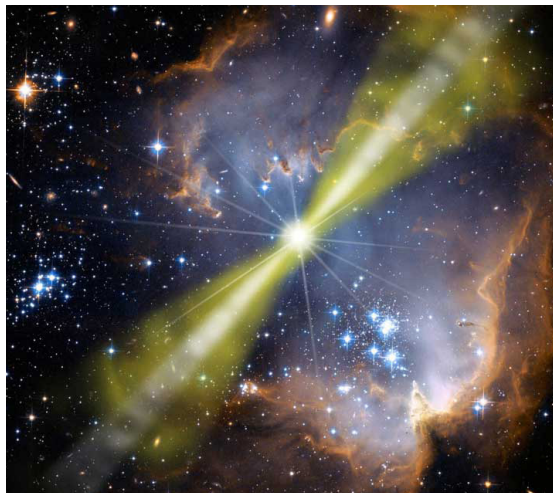
- ⊙ Larger detector array and increased altitude w.r.t. HAWC
  - Very precise measurements possible even below 1 TeV



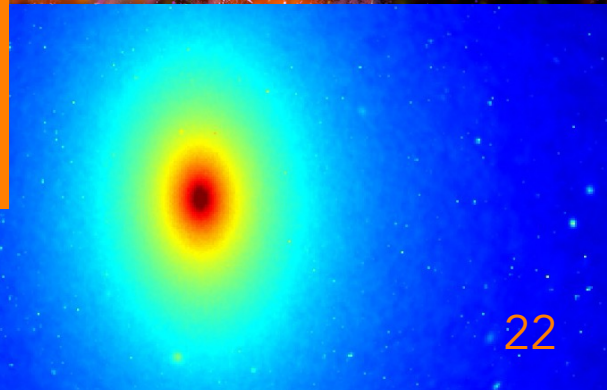
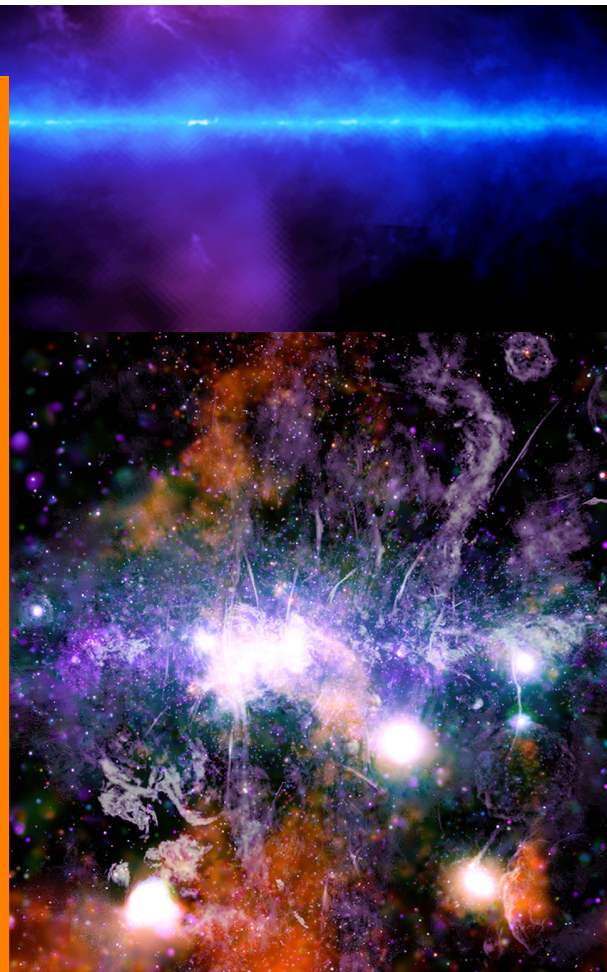
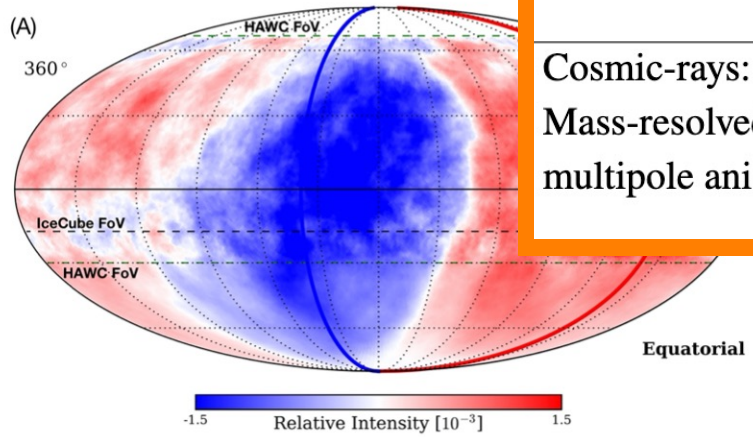
# Resolution?

Goal →  
unprecedented  
resolution for a  
wide field VHE-  
UHE instrument

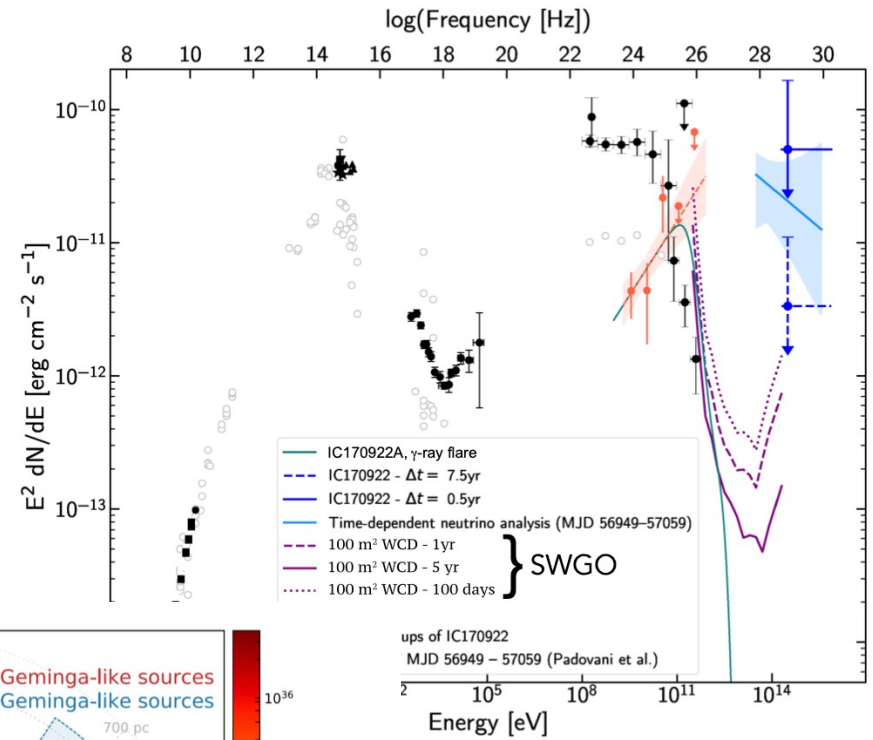
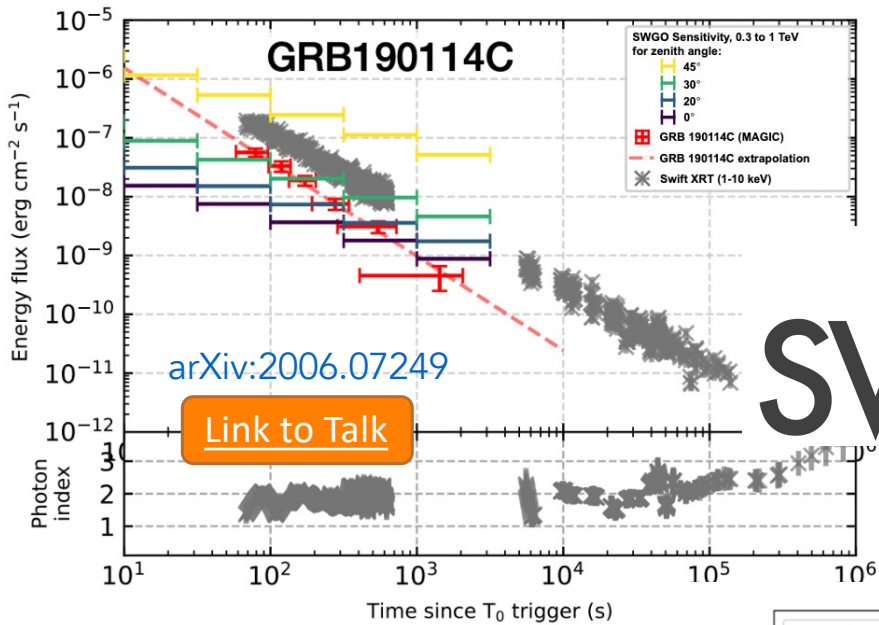




Science Case	Design Drivers
Transient Sources: Gamma-ray Bursts	Low-energy sensitivity & Site altitude <sup>a</sup>
Galactic Accelerators: PeVatron Sources	High-energy sensitivity & Energy resolution <sup>b</sup>
Galactic Accelerators: PWNe and TeV Halos	Extended source sensitivity & Angular resolution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



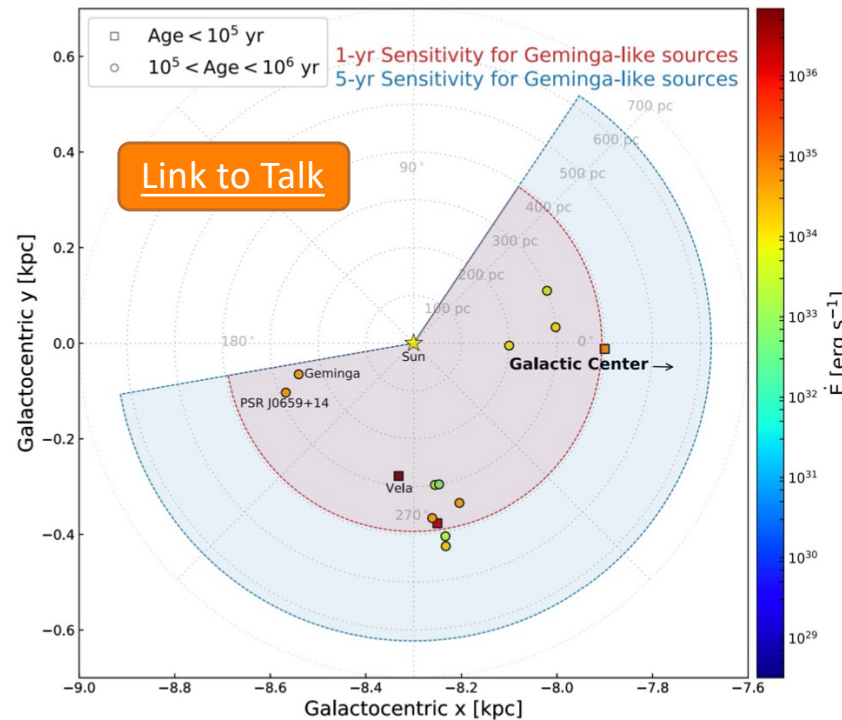
[Link to Talk](#)



Modified from arXiv: 1812.01036

⊙ Early phase  
Gamma Ray  
Bust sensitivity

⊙ Geminga-like  
PWN Halo  
Sensitivity



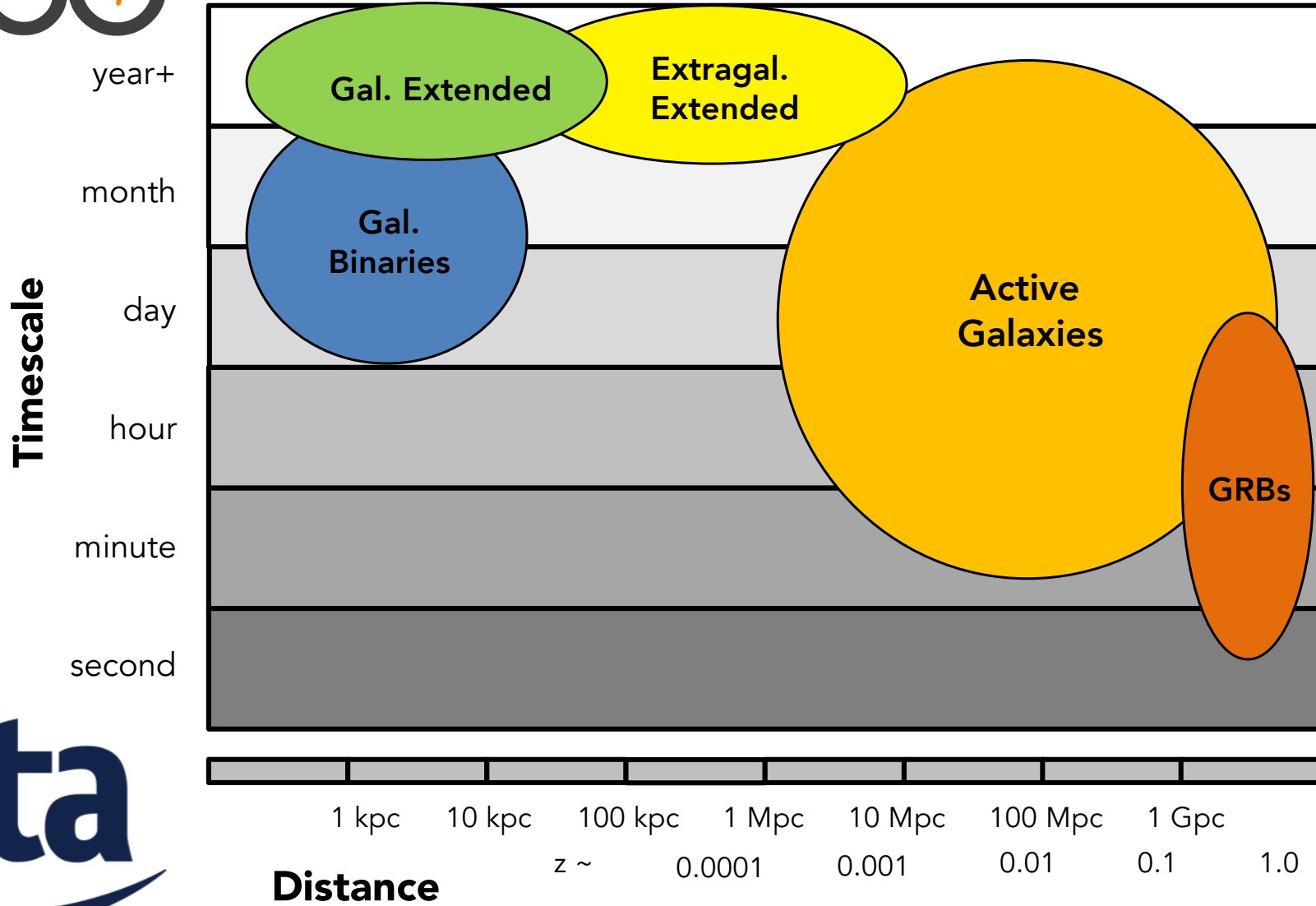
arXiv:1902.08429

⊙ SWGO  
monitoring CF  
TXS 0506+056

All with pessimistic  
sensitivity estimates



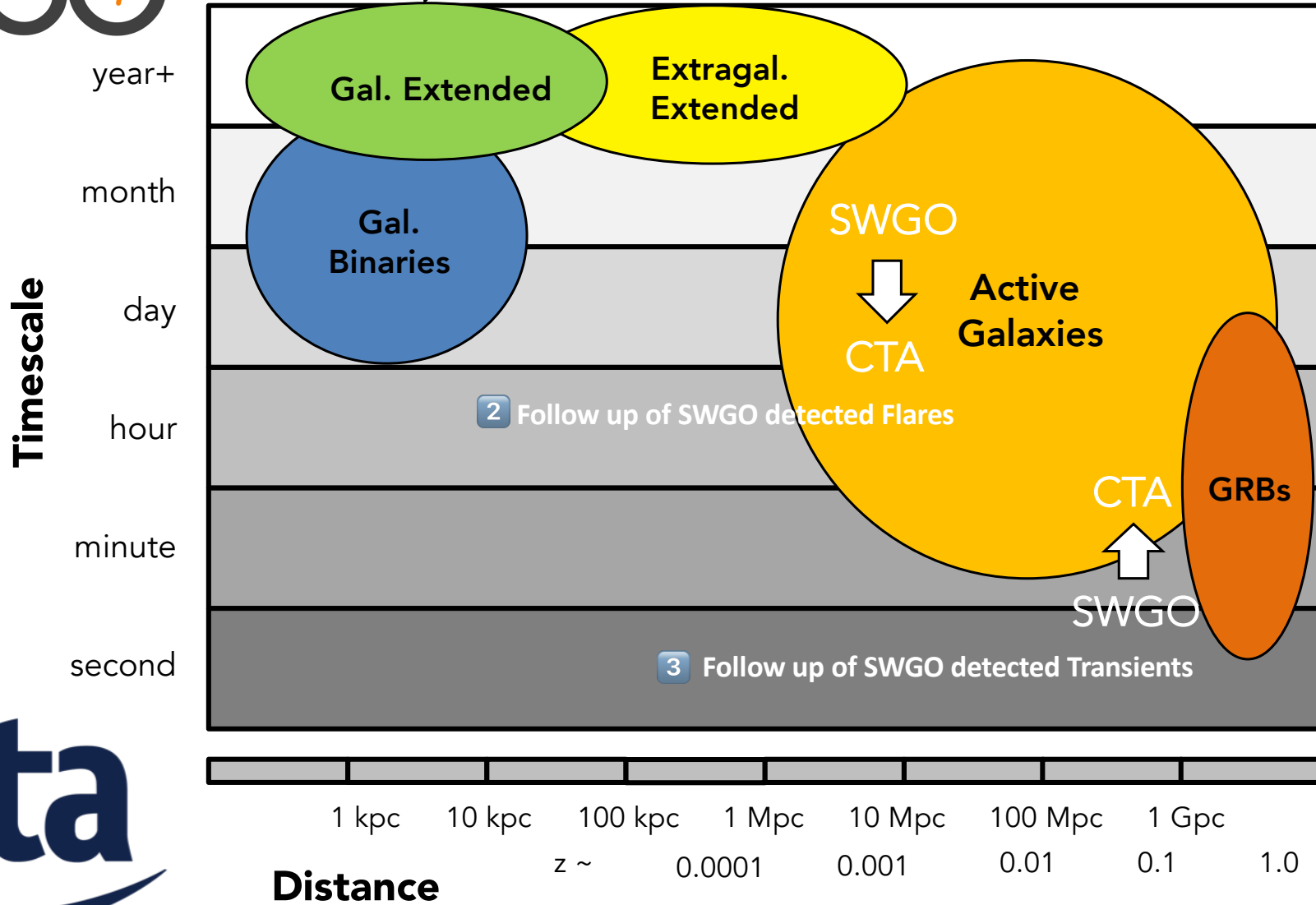
*Known VHE sources and timescales*







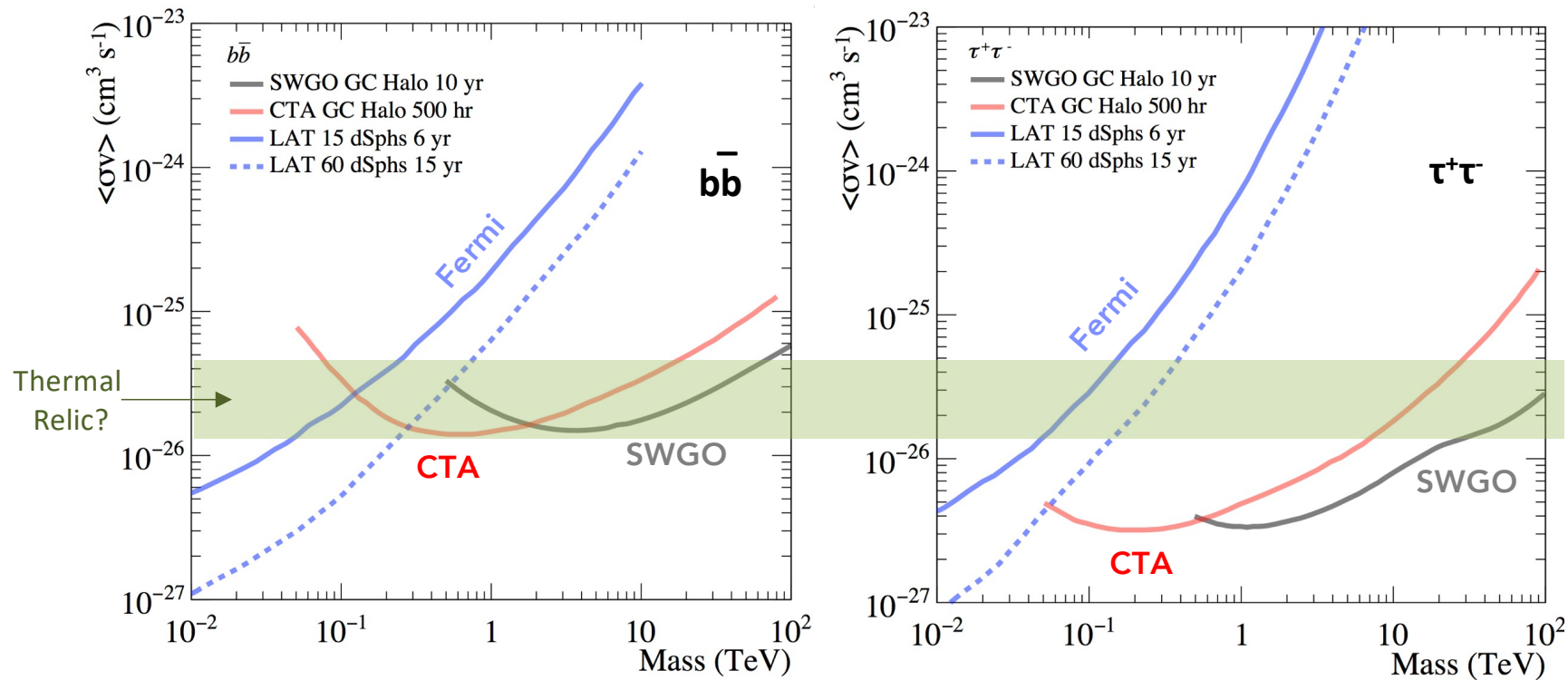
SWGO → CTA **1** Follow up of SWGO detected Galactic Sources



# Dark Matter

[Link to Talk](#)

- Thermal relic WIMP annihilation signature accessible over a very wide mass range (Galactic Centre/Halo observations @ VHE)

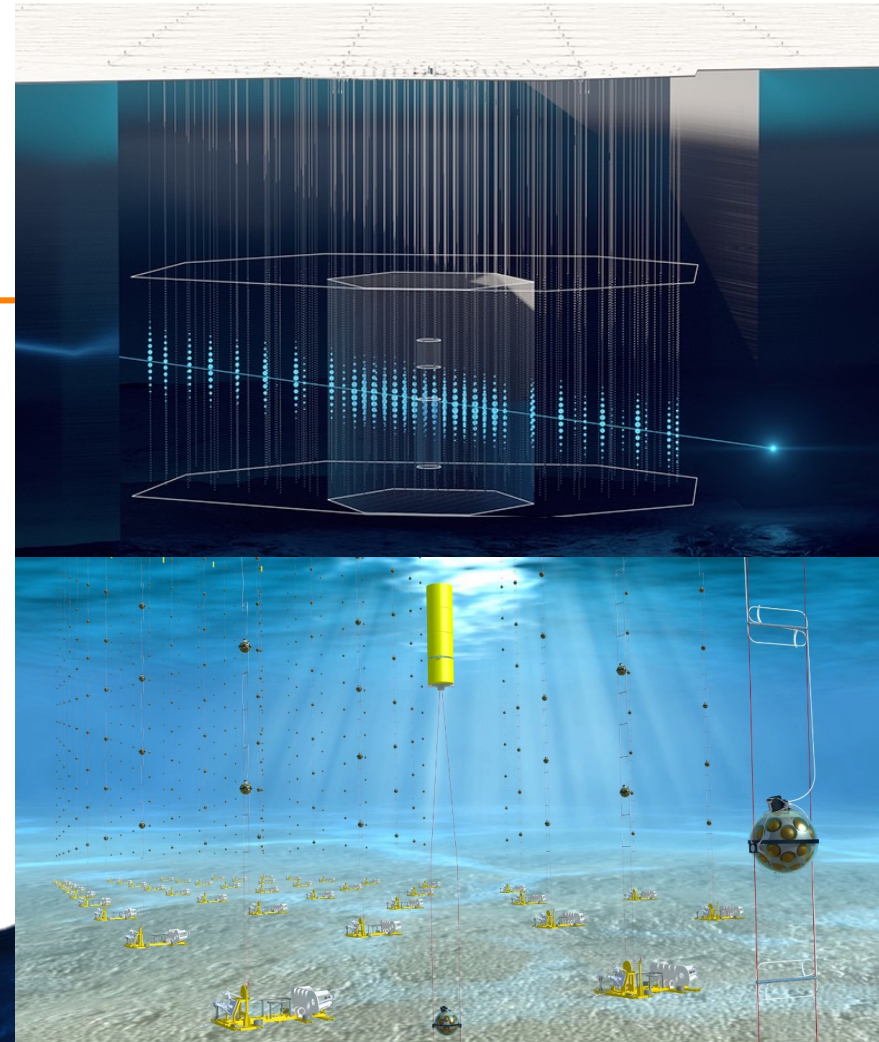
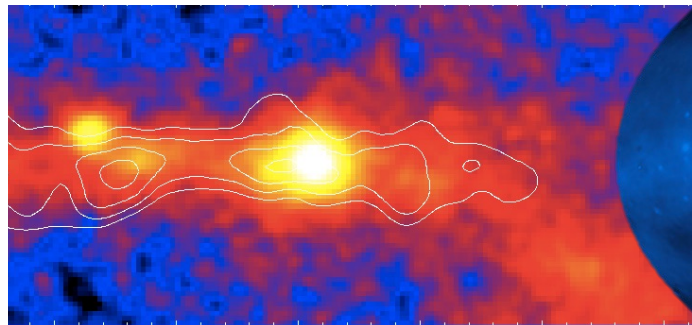
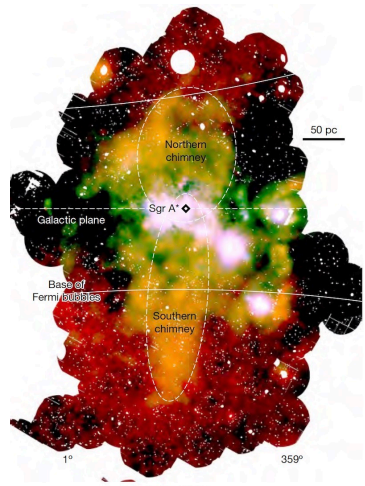


arXiv:1906.03353

NB Sensitivity improving for both CTA + SWGO – analysis improvements

# Neutrino Synergies

- ◎ SWGO+LHAASO
  - Full sky map of TeV-PeV emission
- ◎ Strongly complements new generation of neutrino instruments
  - Mapping out diffuse emission / separating IC + pion decay emission  
+++



# Conclusions

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- ◎ The Southern Sky needs a wide field VHE-UHE gamma-ray instrument!
  - Complementing LHAASO – a complete view of the TeV-PeV sky
  - Strong synergies with CTA and the new generation neutrino telescopes
  - Transient phenomena, diffuse emission, UHE sources +++
- ◎ SWGO advancing towards design and site choices
  - Despite pandemic!
- ◎ Very open for new partners and new ideas
- ◎ Looking forward to strong partnerships with LHAASO & CTA

# Thank you for listening!

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