The Southern Wide-Field Gamma-ray Observatory

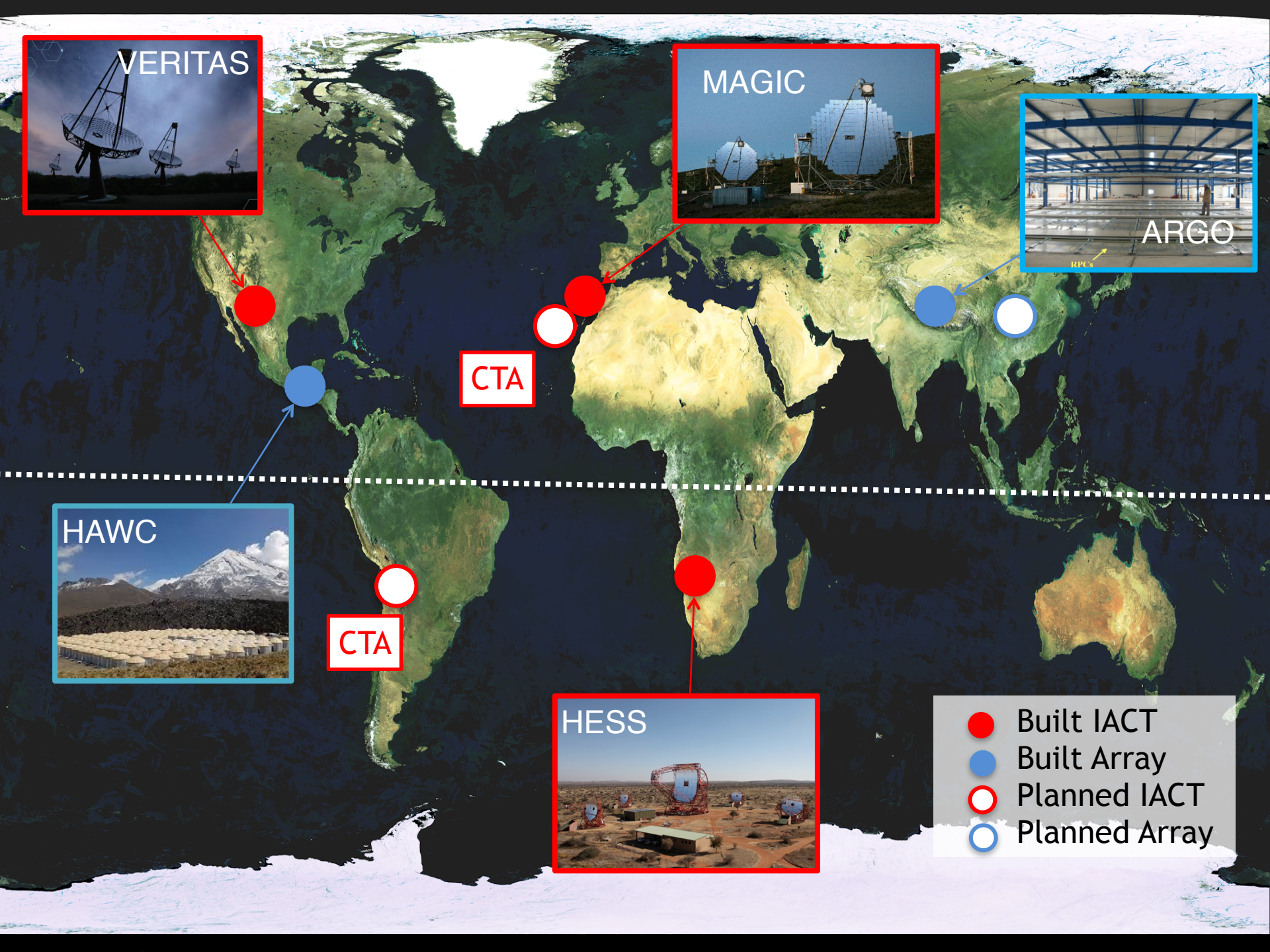
Ruben Conceição

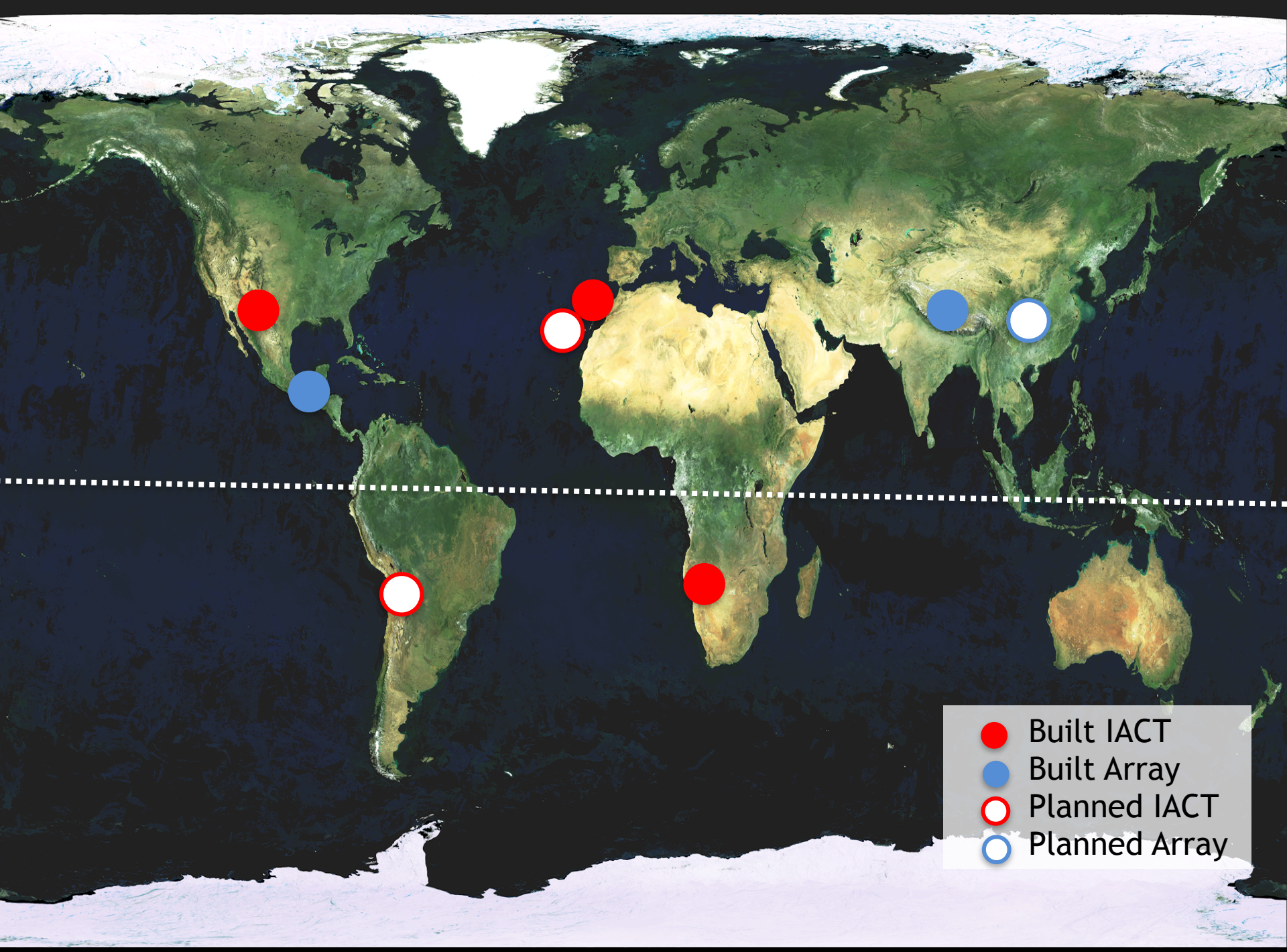
TÉCNICO LISBOA

Fifth Lisbon mini-school on Particle and Astroparticle physics, Caparica, February 7th 2020

Gamma-rays

- Photons **extremely energetic**
  - Up to 100 TeV
  - Point to production source
  - Travel long distances
- Probes for the **most violent processes** known in the Universe
  - Supernovae; Active Galaxy Nuclei;
- Allows to perform strong **tests to fundamental physics**


VERITAS
MAGIC
ARGO
RPCs
CTA
HAWC
CTA
HESS
Built IACT
Built Array
Planned IACT
Planned Array


Built IACT
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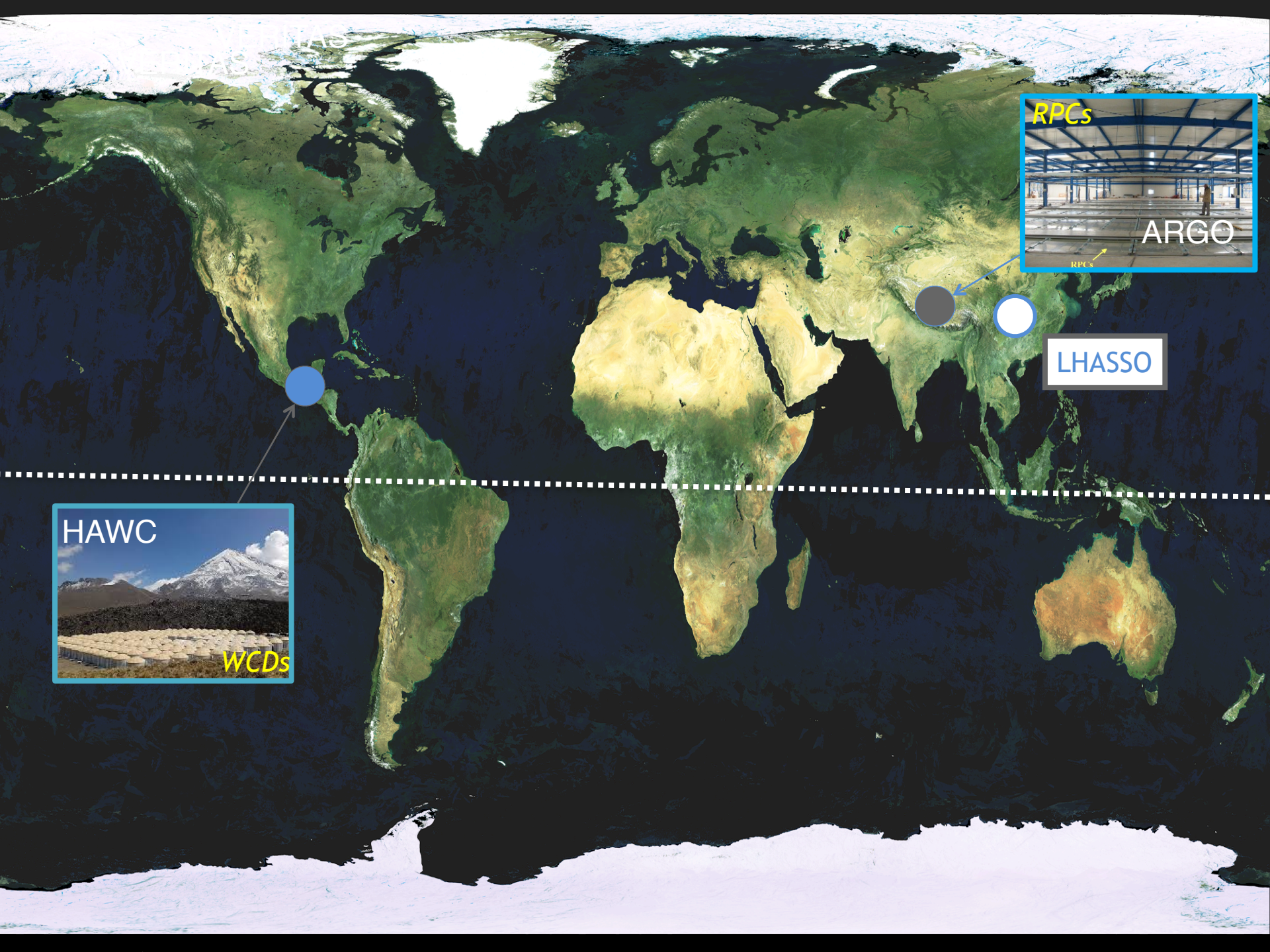
RPCs
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WCDs


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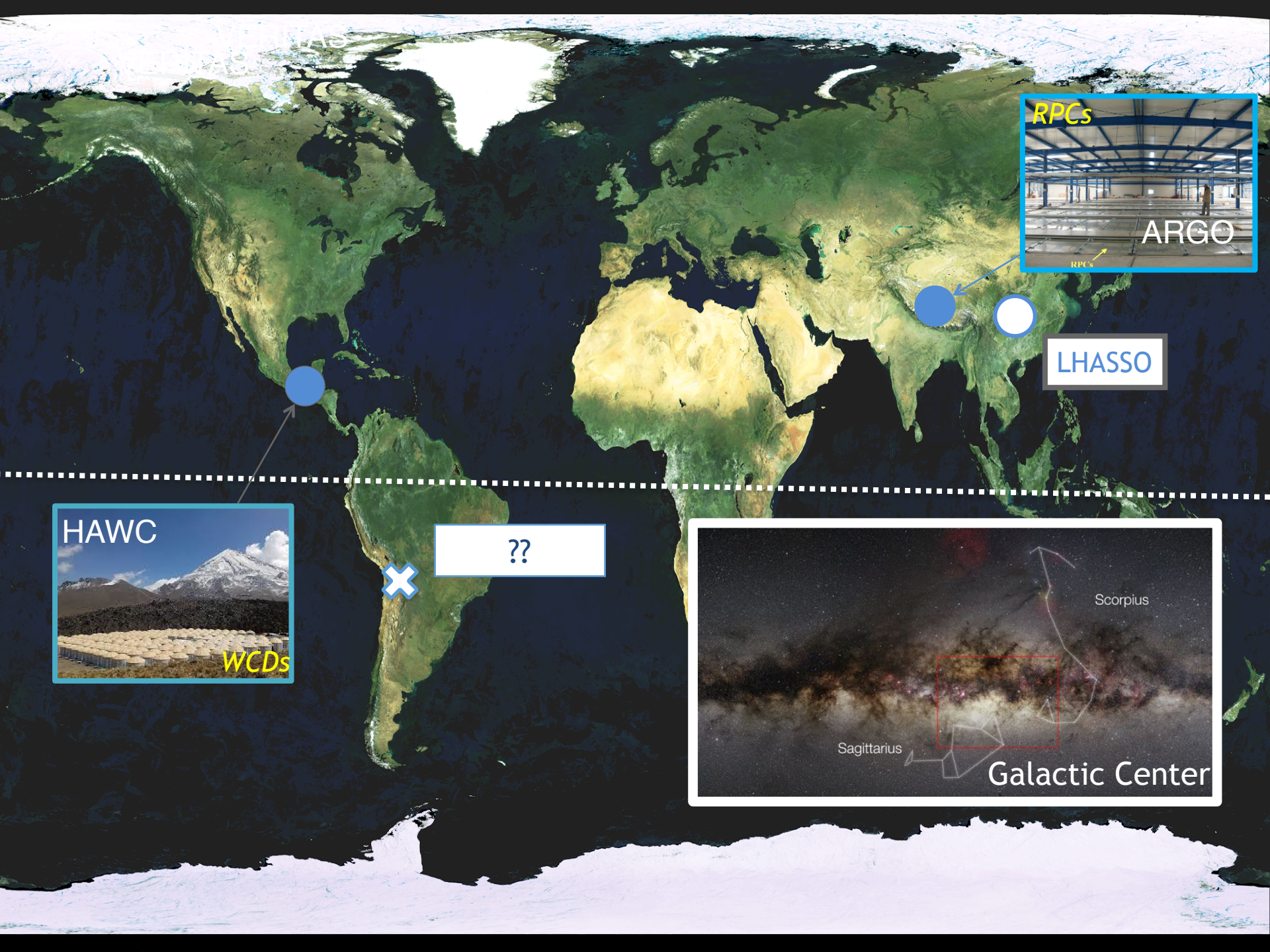
RPCs
ARGO
LHASSO
HAWC
WCDs
??
Scorpius
Sagittarius
Galactic Center

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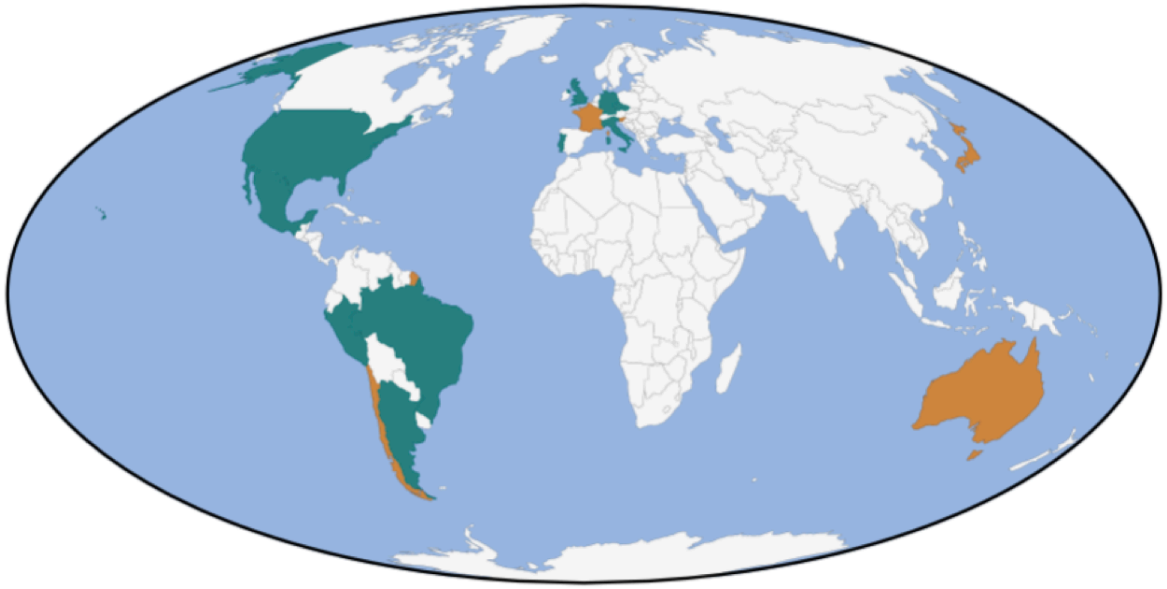
Complementary to the powerful Cherenkov Telescope Array project

SWGO collaboration

Next generation wide field-of-view gamma-ray observatory



Countries in SWGO

Institutes

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

Supporting scientists

Australia, Chile, France, Japan, Slovenia

**also supporting scientists*

3-year R&D project to design and plan the best experiment

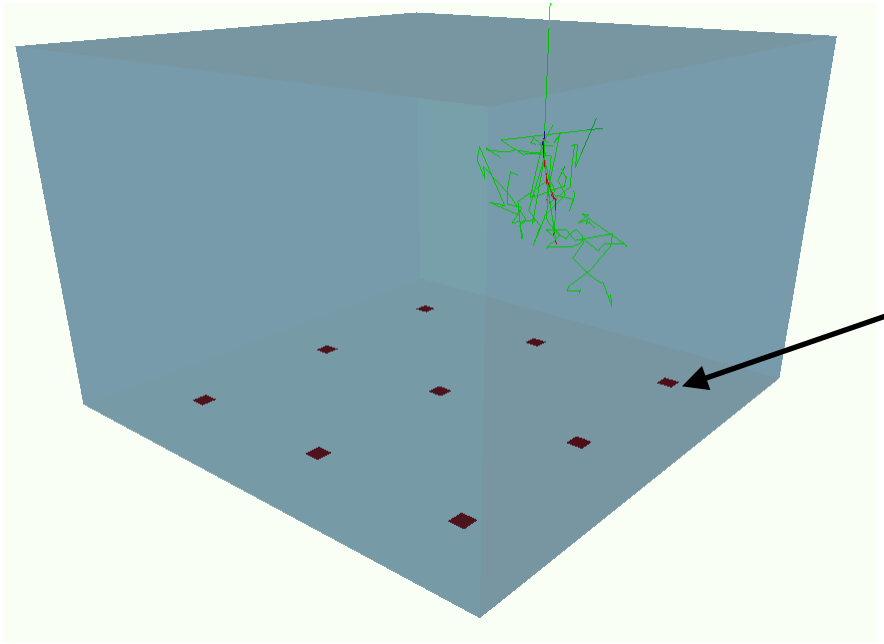
Final workshop on Autumn 2022

The challenge

Build a huge array at an altitude of **5000 m** based on the **Water Cherenkov detection** technology

Activities @ LIP

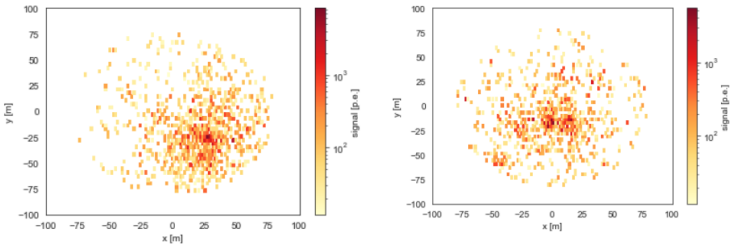
- Design of the detector unit station
  - Can the water volume be decreased having a smarter light collection?
  - New inventive readout solutions based on SiPM



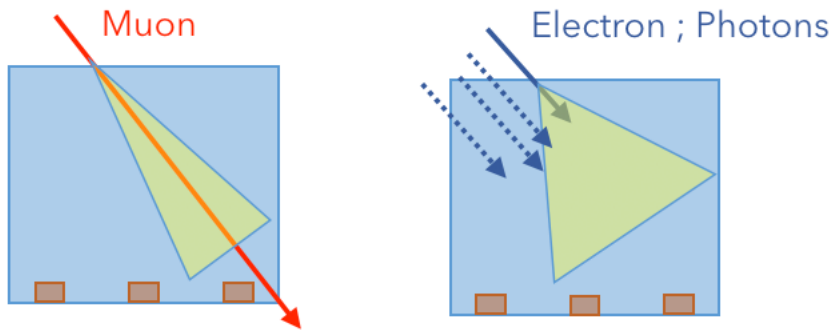
Activities @ LIP

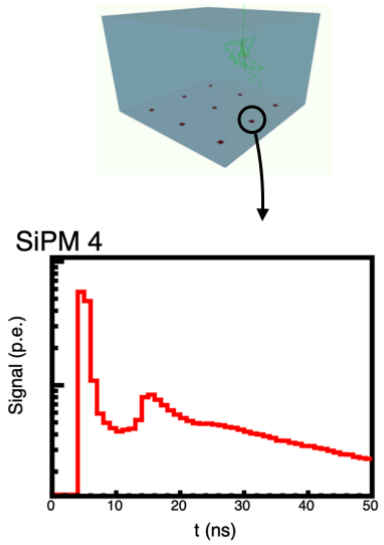
UNIVERSIDADE D COIMBRA — Computer science department

- Improve reconstruction analysis
  - Gamma/hadron discrimination
  - Analyse shower patterns at the ground with machine learning techniques
  - Explore the WCD signal time trace to identify the presence of muons



ugr Universidad de Granada

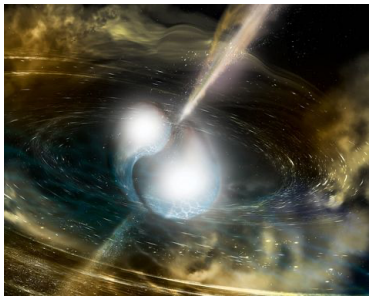


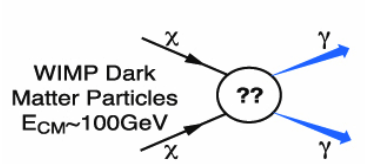


Activities @ LIP

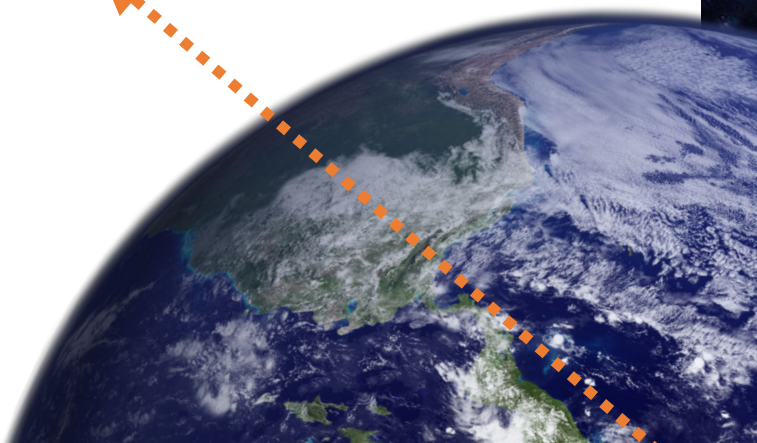
- Science capabilities
  - Studies on the sensitivity to:
    - Transient astrophysical phenomena
    - Explore hadronic interactions the forward region
    - Dark matter annihilation
    - Detect Neutrino physics
    - BSM physics

Neutron Stars Merger





tau-neutrino



SWGO

- Exciting project with an interesting timescale for a Master thesis
  - Work may be support by a grant
- The thesis can have a significant impact on the design of the experiment
- More information:
  - ruben@lip.pt, pimenta@lip.pt

Summary

- Astroparticle physics (Multi-Messengers)
  - Use astrophysical messengers and known particle physics to gain a deeper understanding of the dynamics of our Universe
  - Rapidly evolving field
  - Lots of ambitious projects
  - Will soon provide important tests to our knowledge over fundamental physics

Backup slides

Newly formed international collaboration to make this experiment possible!

NOTÍCIAS | DESPORTO | TELEVISÃO | RÁDIO | RTPPLAY

ÚLTIMA HORA — Operação Antídoto. PJ detém médicos em buscas a consultórios

RTP NOTÍCIAS

2 Jul. 2019 | 10:48

DESPORTO | PAÍS | MUNDO | POLÍTICA | ECONOMIA

PARTILHE NO FACEBOOK | PARTILHE NO TWITTER | PARTILHE NO LINKEDIN

Portugal junta-se a oito países para construir observatório de raios gama nos Andes

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Diário de Notícias

MENU

INÍCIO / LUSA

Portugal junta-se a oito países para construir observatório de raios gama nos Andes

Lisboa, 01 jul 2019 (Lusa) - Portugal e mais oito países juntam-se a partir de hoje numa colaboração internacional para construir um observatório de raios gama na região dos Andes, para procurar sinais de matéria escura no centro da Via Láctea, foi hoje anunciado.

SIC | SIC NOTÍCIAS | SIC RADICAL | SIC MULHER | SIC K

MENU — SIC NOTÍCIAS — NOTÍCIAS

MUNDO

Portugal junta-se a oito países para construir observatório de raios gama nos Andes

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INÍCIO | NOTÍCIAS | VÍDEOS | FOTOS | DIRETO | GUIA TV | DOSSIERS | EU VI

Últimas | Opinião | Sociedade | Política | Economia | Internacional | Desporto | Motores | Tecnologia | Música

Investigações Alexandra Borges | Investigações Ana Leal | Deus e o Diabo | Gente Que

Portugal junta-se a oito países para construir observatório de raios gama nos Andes

Será o primeiro observatório de raios gama no hemisfério sul. Já existe um do género, mas no hemisfério norte, no México

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CIÊNCIA › ESPAÇO | MEDICINA | ECOSFERA

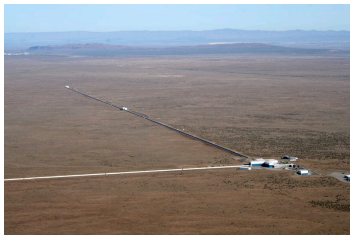
UNIVERSO

Portugal junta-se a oito países para construir observatório de raios gama nos Andes

Empreendimento marcará a edificação do primeiro laboratório de observação de raios gama no hemisfério sul. Custo da construção estimado em, pelo menos, 50 milhões de euros.

Lusa · 1 de Julho de 2019, 21:00

57 PARTILHAS





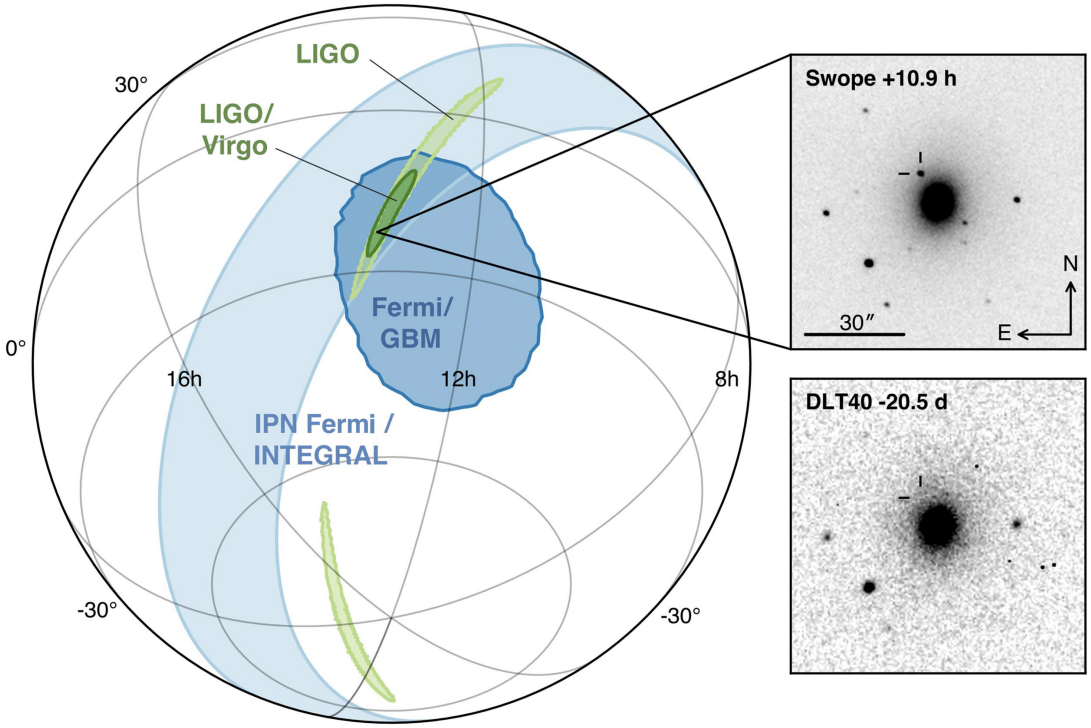
Multi-messengers

The opening of a new era…

Multi-messenger observation of a Binary Neutron Star Merger

physicsworld BREAKTHROUGH OF THE YEAR 2017

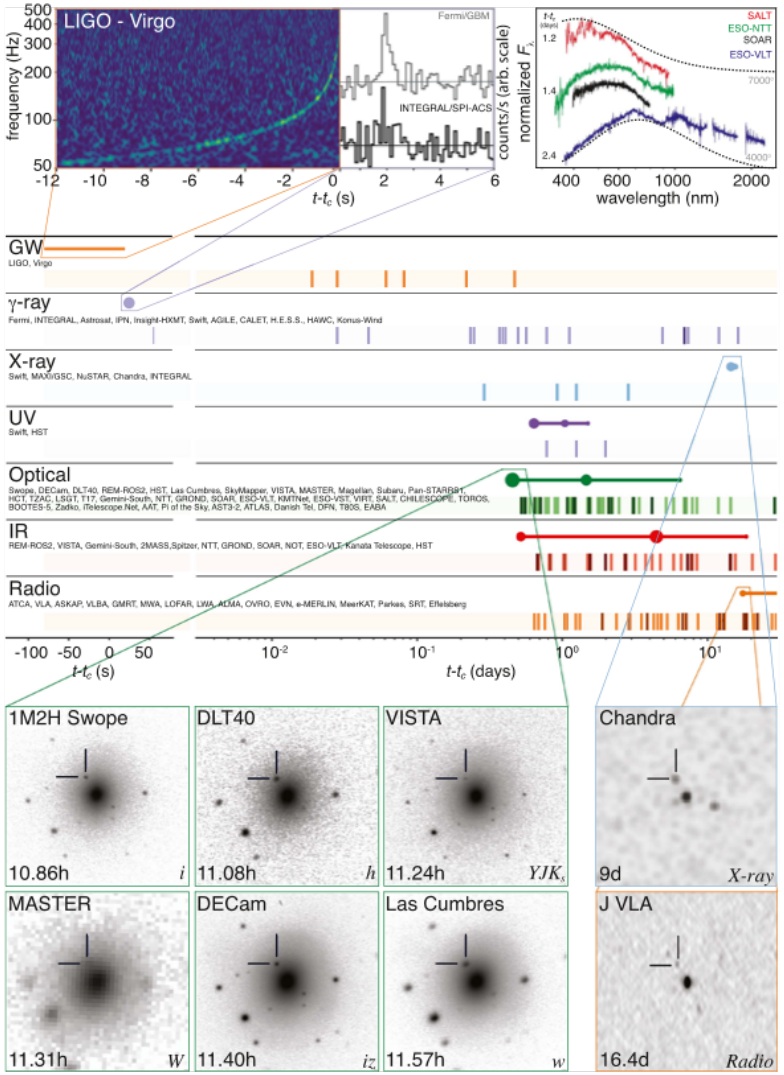
Joint publication of LIGO, VIRGO, INTEGRAL, Fermi, IceCube, Pierre Auger …



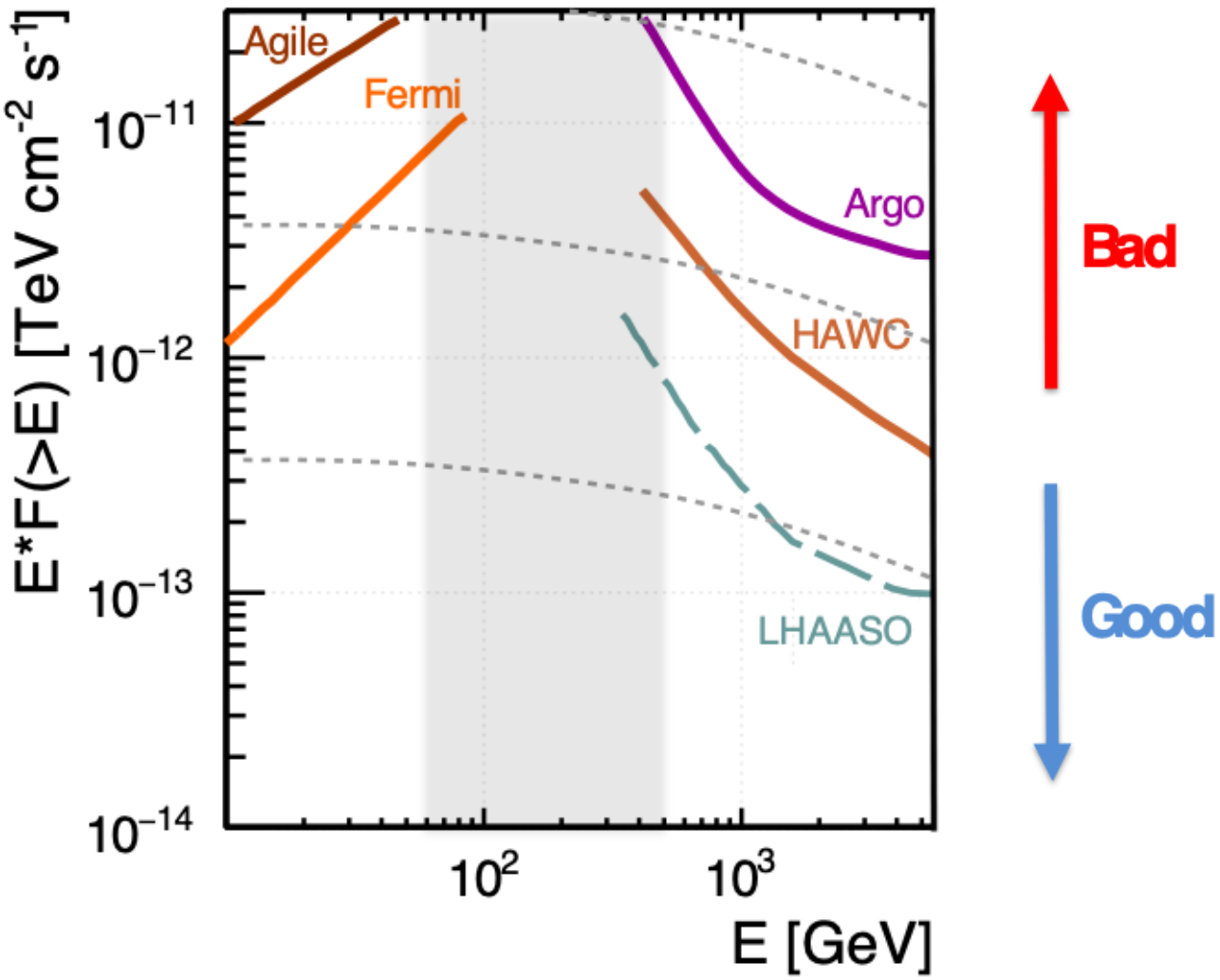
- Simultaneous observation of a Gravitational Wave + electromagnetic counter parts
- Allows to test the dynamics of our surrounding Universe
- Study of transient phenomena in all energy regions is one of the main ingredients

Multi-messenger observation of a Binary Neutron Star Merger

- Observe the same phenomenon with different instruments
- Follow the evolution in time
- Different wavelengths ⇒ different kind of interactions ⇒ different phenomena

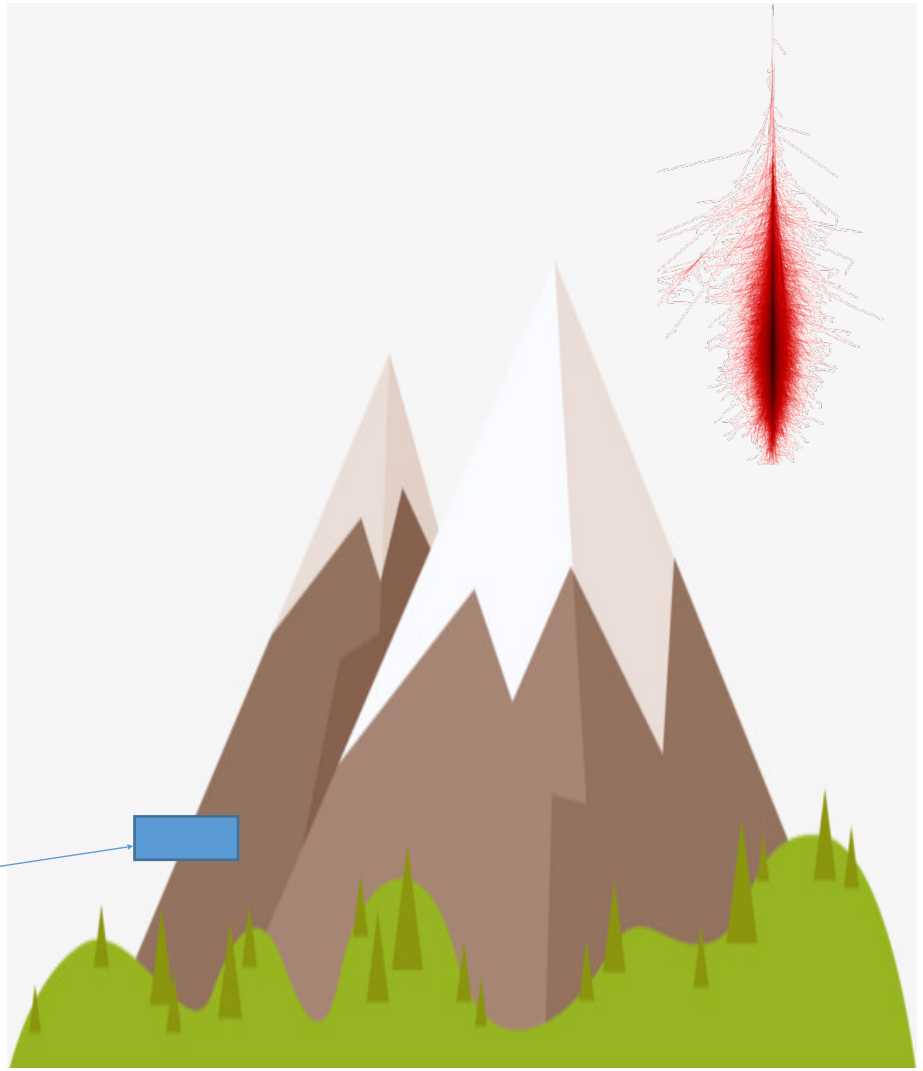


Current Wide Field-of-View Gamma-Ray Observatories



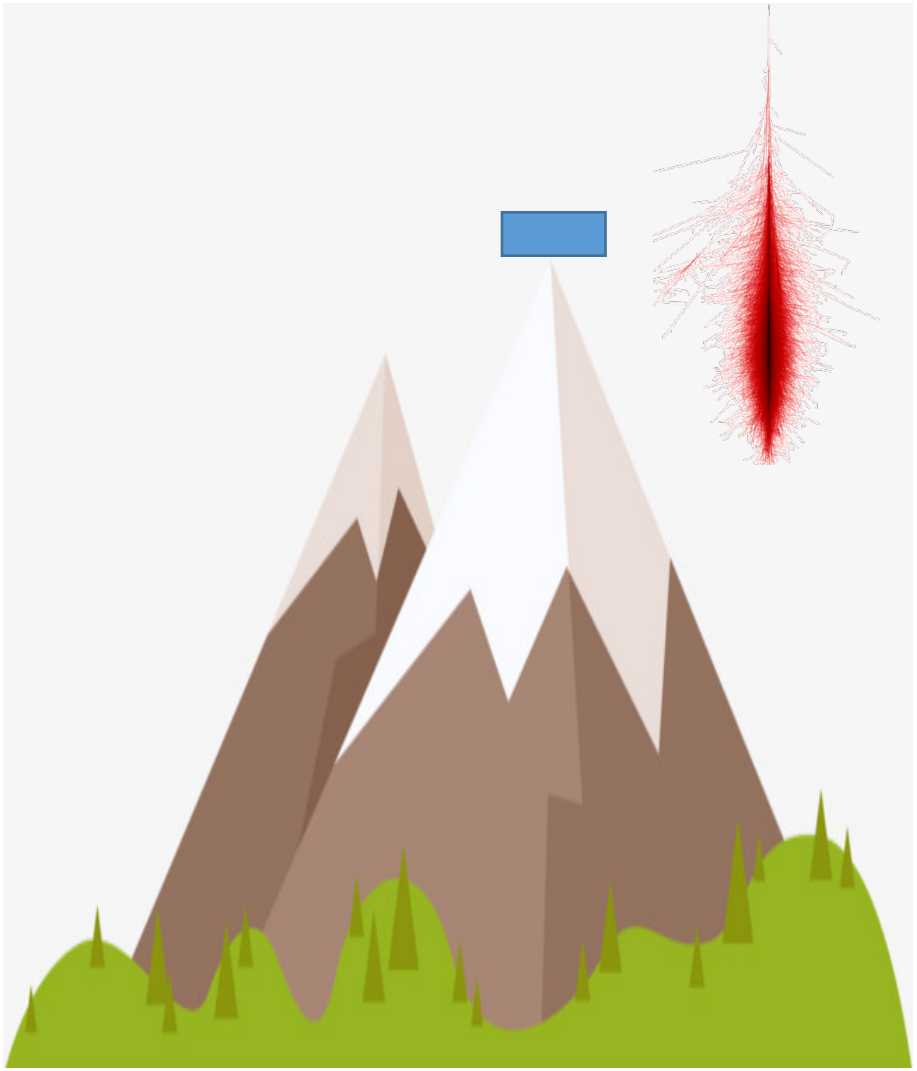
How to lower the energy threshold?

- Put the experiment at higher altitude
- Gamma-ray EAS arrays have typically 20 000 m^2



How to lower the energy threshold?

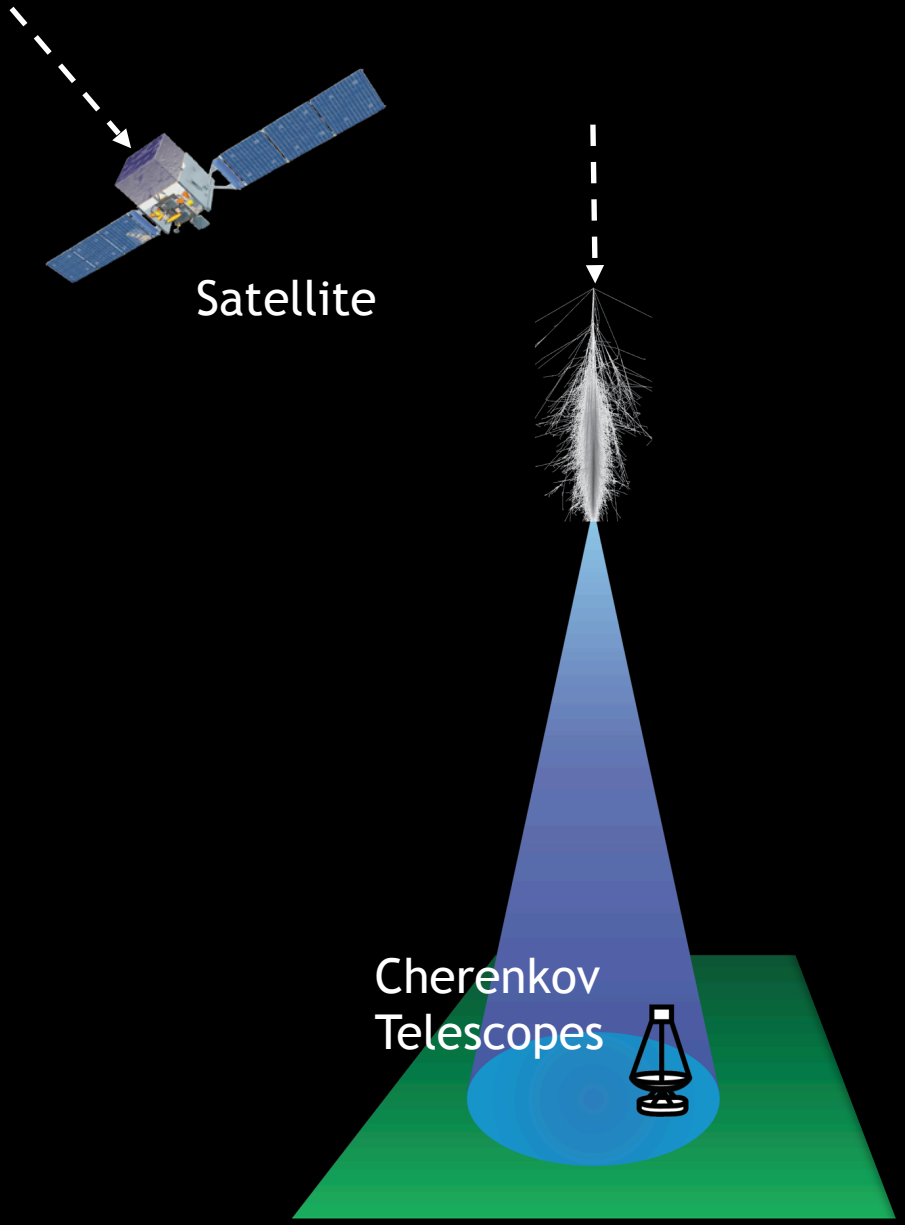
- Put the experiment at higher altitude
- Gamma-ray EAS arrays have typically 20 000 m^2
- It is possible to find sites with ≈5000 m of altitude
  - Atacama desert, Northern Chile
- *Can the detector concept be improved?*



How to detect?

Satellite

How to detect?



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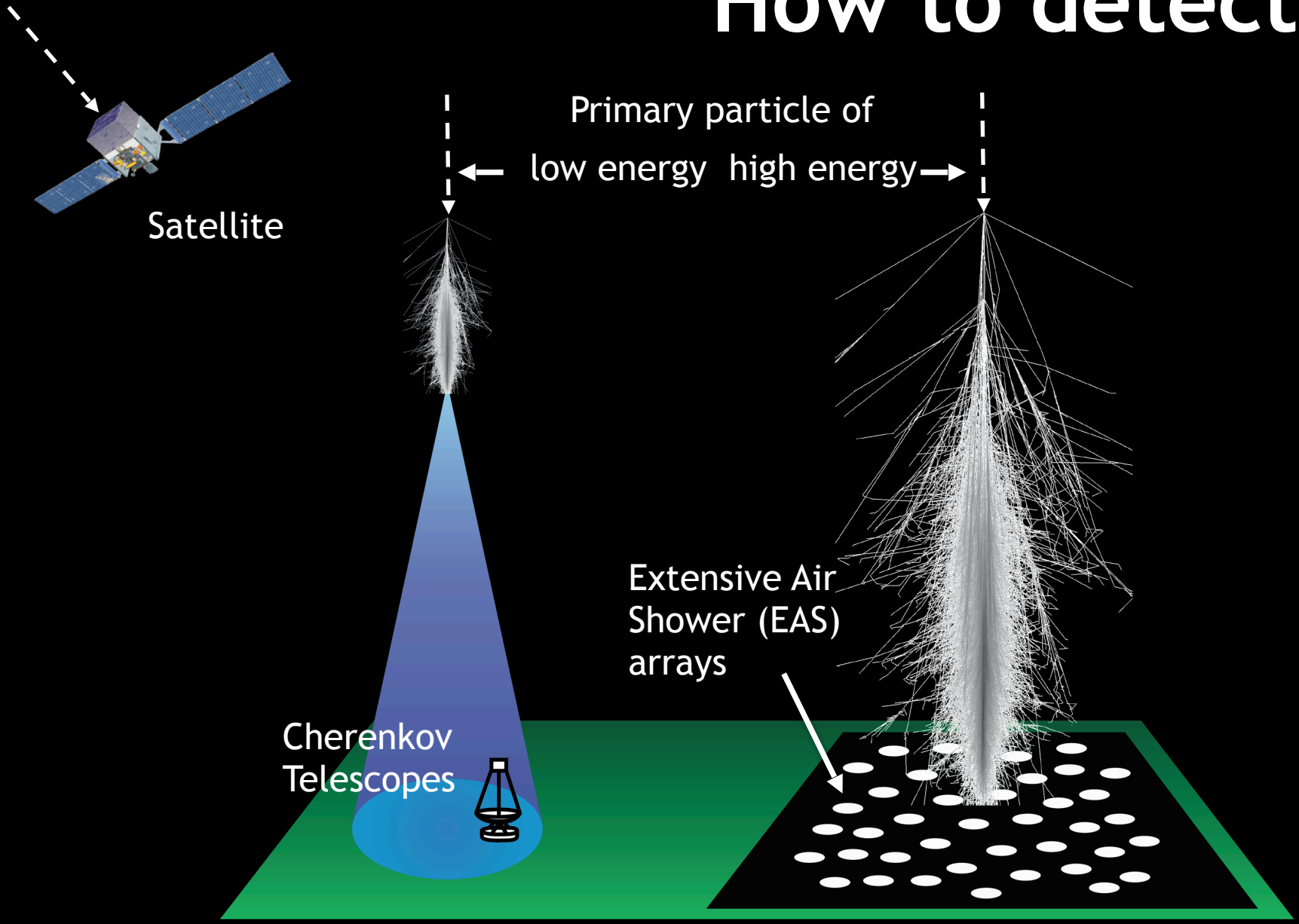
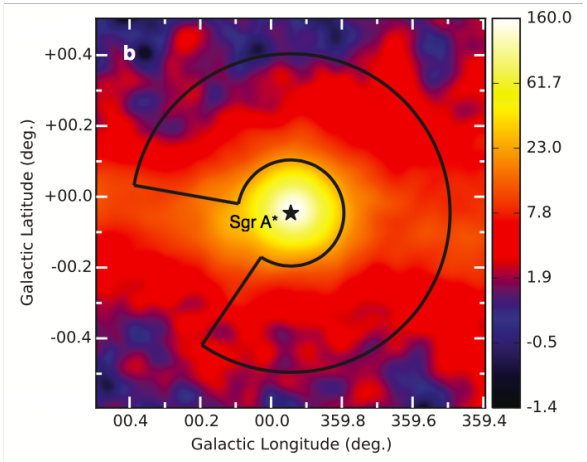
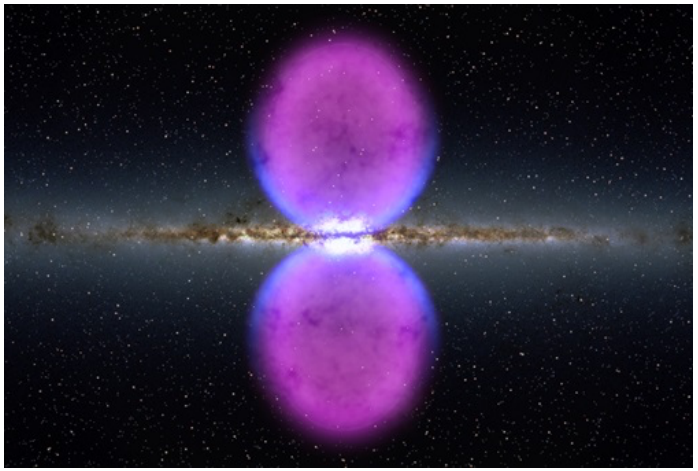


Arrays at high-altitude = large field of view + large duty cycle + low energy

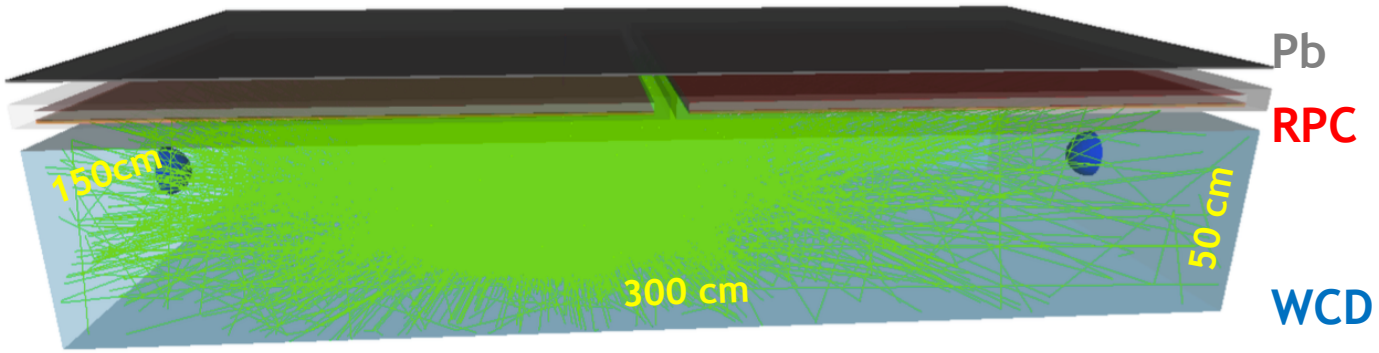
What we know so far…

- Protons are known to be accelerated in the galaxy up to PeV energies (E = 10^{15} eV)
- All current acceleration models encounter non-trivial difficulties at these energies
- HESS data suggests that there might be a PeVatron source in the galactic center
- Fermi bubbles - gamma ray emission in outbursts from our galaxy



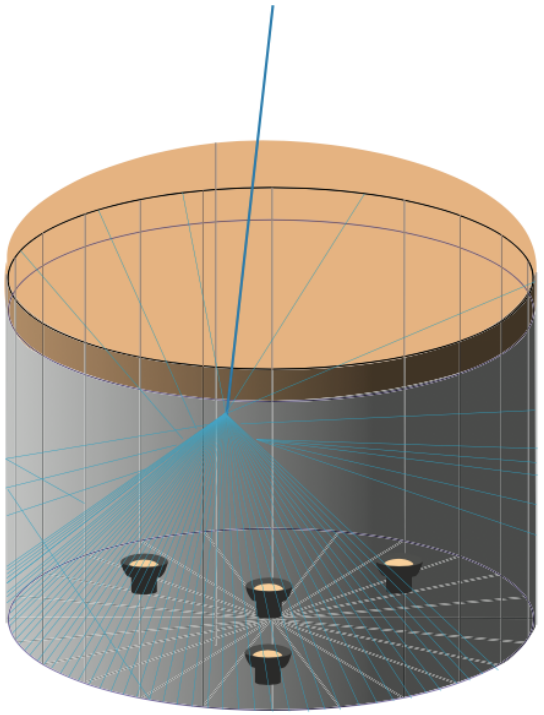


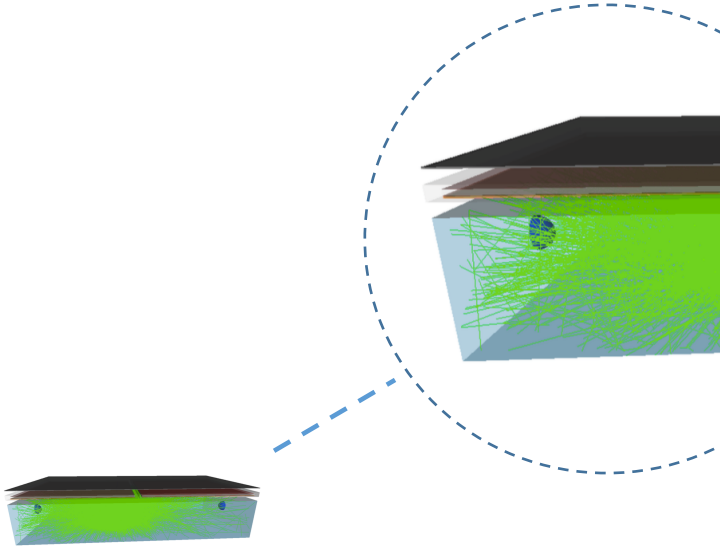
Improve detector concept!



- Thin lead converter plate **(Pb)**
  - Improve shower geometry reconstruction
- Resistive Plate Chamber **(RPC)**
  - Measure charged particles with high spatial and time resolution
- Water Cherenkov Detector **(WCD)**
  - Collect shower secondary photons/electrons to improve trigger at low energy

The station





HAWC
(present detector)

…
(next generation)

**caveat: R&D phase, which means that the detector concept continues to evolve…*