

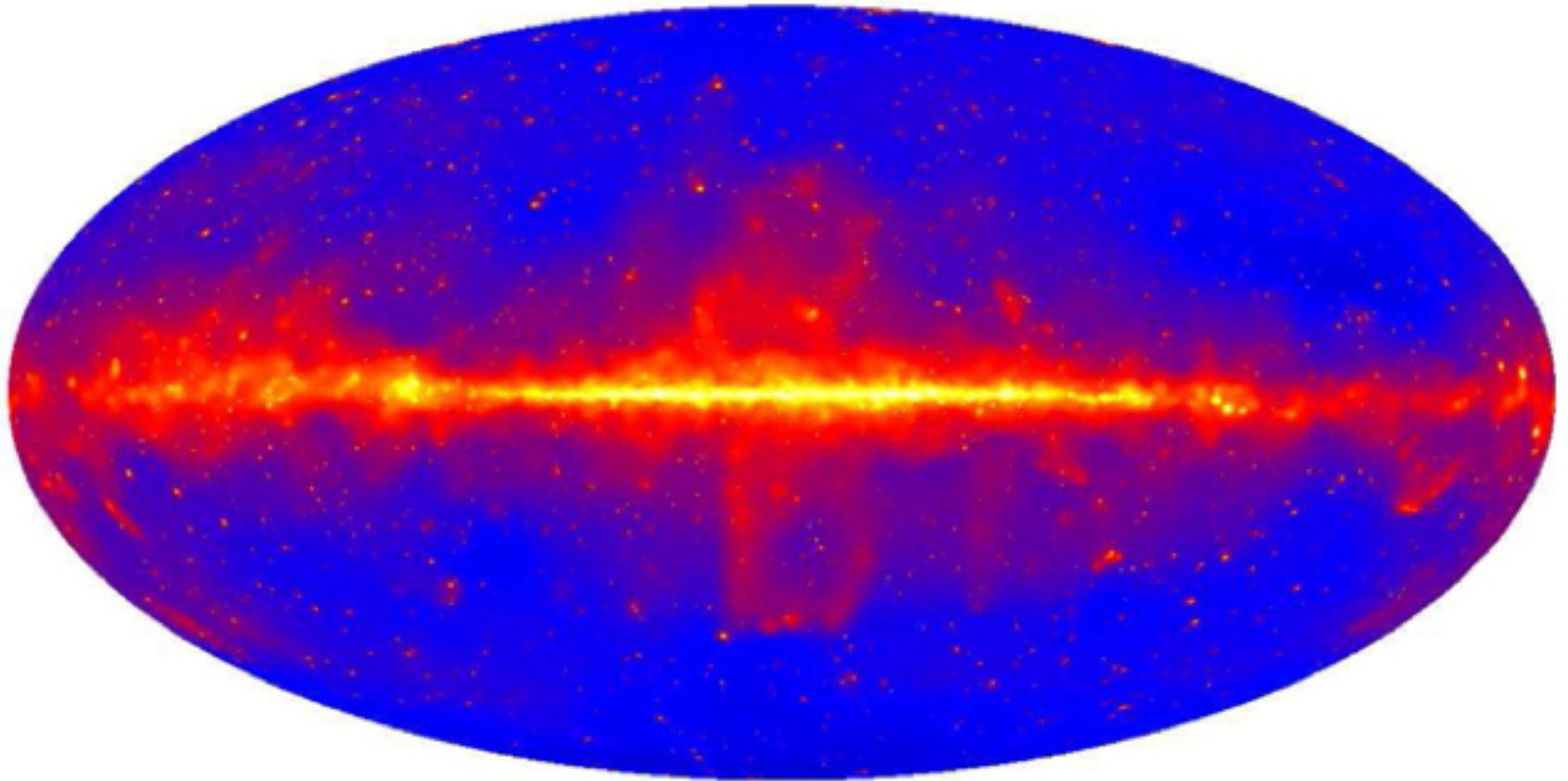
Wide field-of-view gamma-ray observatory in the Southern hemisphere

Bernardo Tomé



**TÉCNICO
LISBOA**

The sky in VHE Gamma-Rays

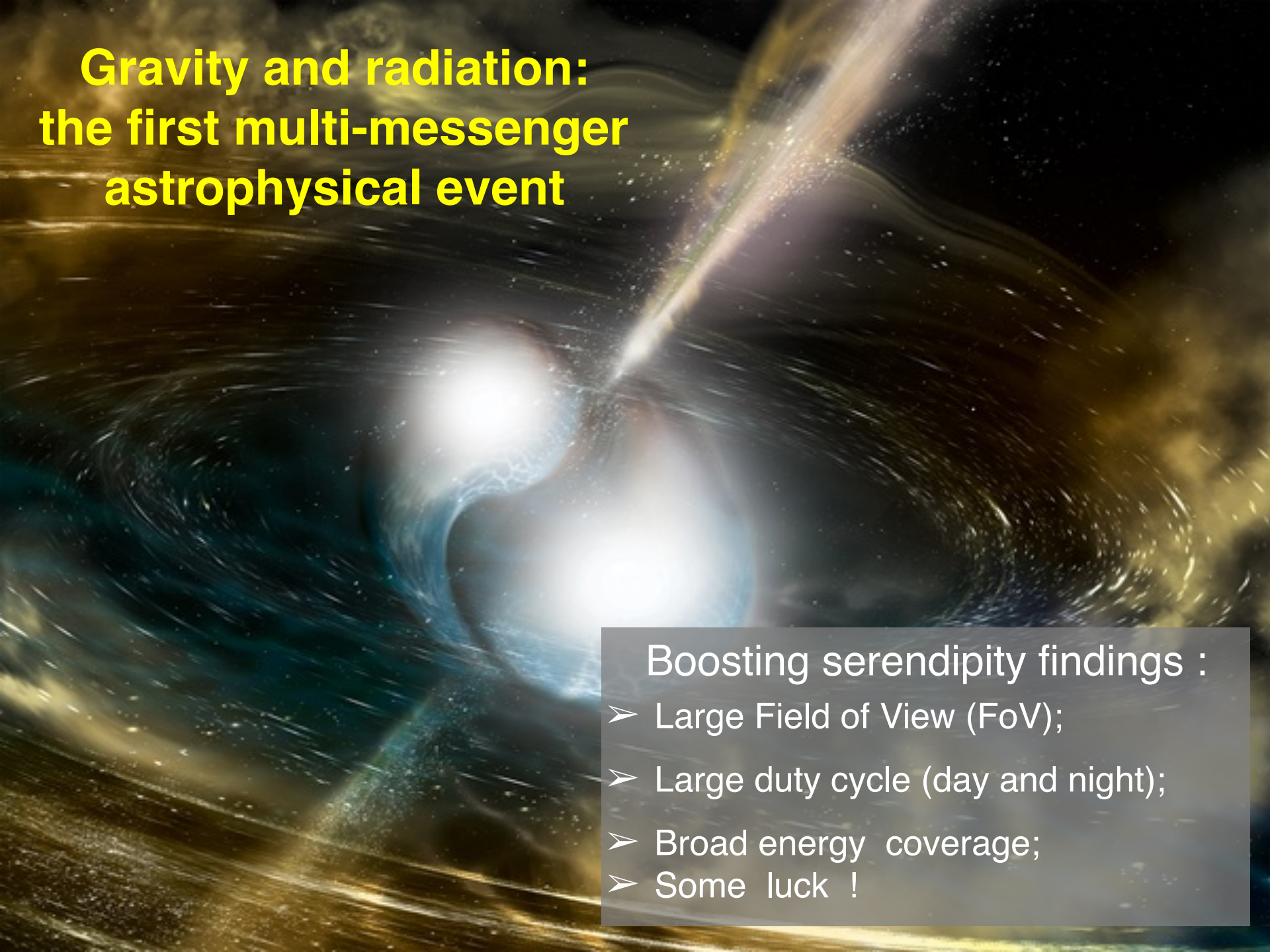


At $E > 10$ GeV we can observe the most extreme processes of the Universe:

- relativistic particles that strike our Galaxy,
- jets fired by Super Massive Black Holes
- cosmic explosions known as Gamma Ray Bursts

✧ Scientific interest:

- ✧ Key to understand the **acceleration mechanism** of cosmic rays in our galaxy
- ✧ Galactic magnetic fields
- ✧ Photon radiation fields in the Universe
- ✧ Indirect search of **dark matter** (WIMP interactions)
- ✧ Test fundamental properties of quantum gravity
- ✧ ...



Gravity and radiation: the first multi-messenger astrophysical event

Boosting serendipity findings :

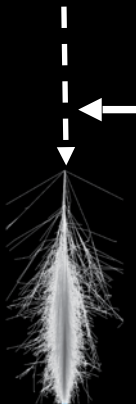
- Large Field of View (FoV);
- Large duty cycle (day and night);
- Broad energy coverage;
- Some luck !

How to detect?



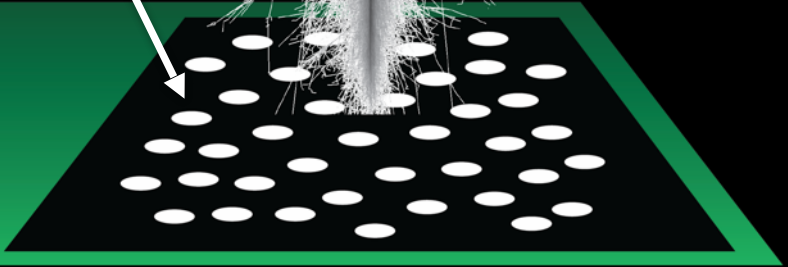
Satellite

Primary particle of
low energy high energy



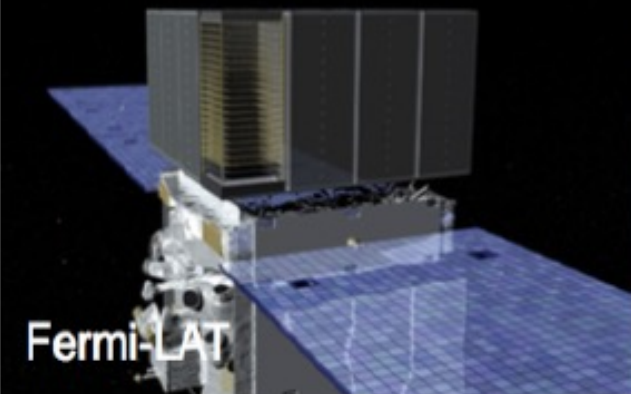
Cherenkov
Telescopes

Extensive Air
Shower (EAS)
arrays



(V)HE gamma detectors performance

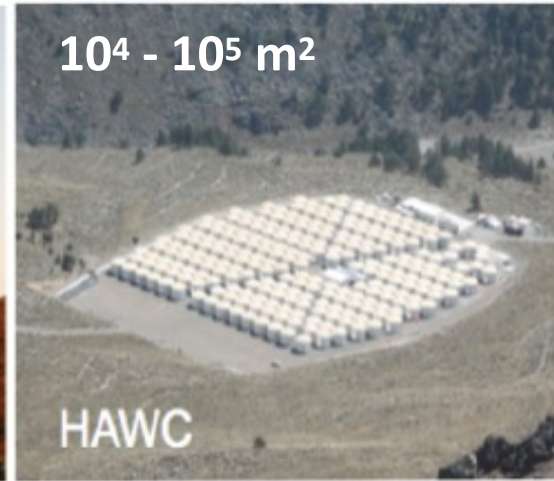
1 m²



HESS, VERITAS

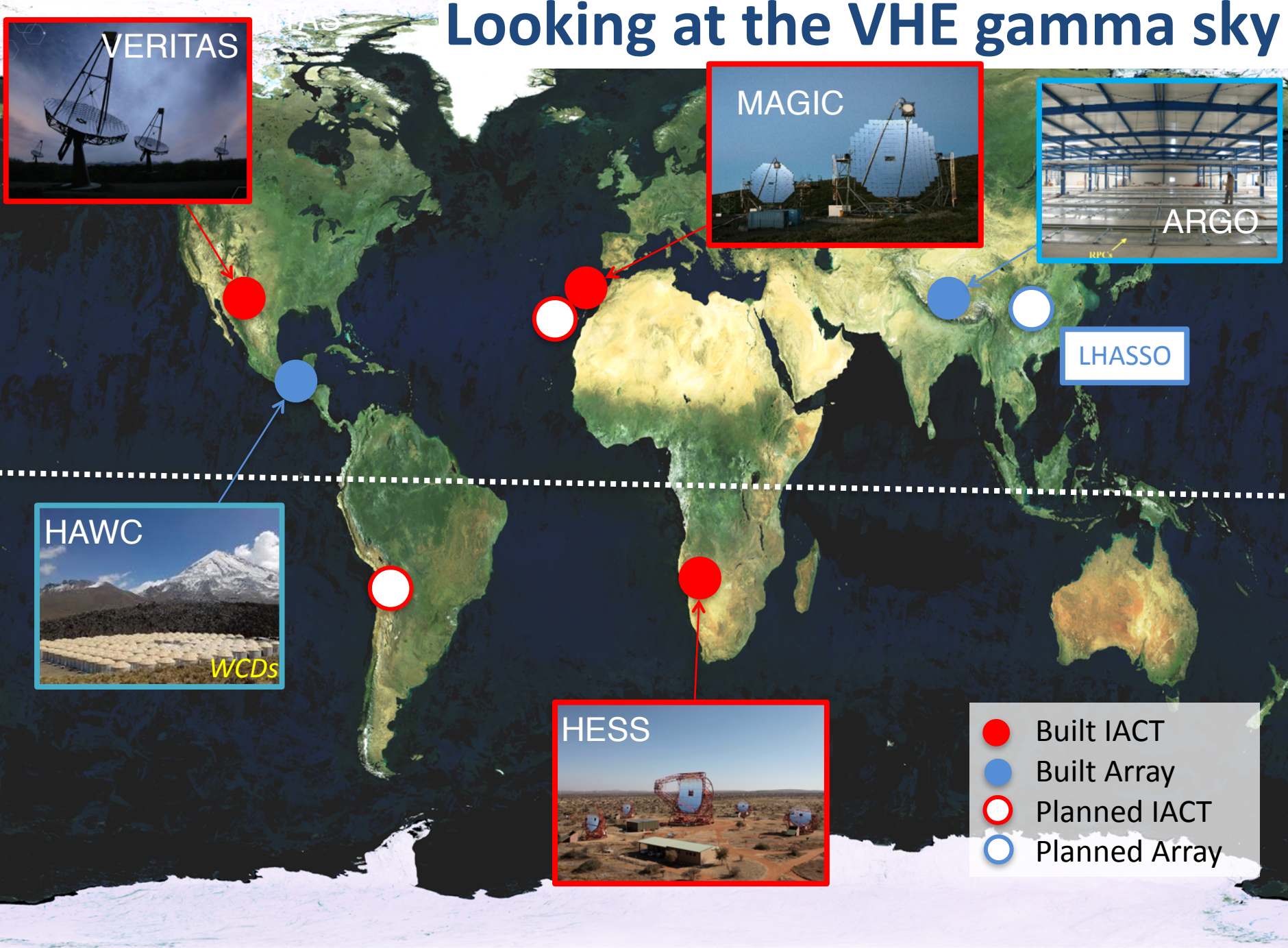


10⁴ - 10⁵ m²



| Quantity | Fermi | IACTs | EAS |
|--------------|-----------------|--------------------------|------------------|
| Energy range | 20 MeV–200 GeV | 100 GeV–50 TeV | 400 GeV–100 TeV |
| Energy res. | 5-10% | 15-20% | ~ 50% |
| Duty Cycle | 80% | 15% | > 90% |
| FoV | $4\pi/5$ | $5^\circ \times 5^\circ$ | $4\pi/6$ |
| PSF | 0.1° | 0.07° | 0.5° |
| Sensitivity | 1% Crab (1 GeV) | 1% Crab (0.5 TeV) | 0.5 Crab (5 TeV) |

Looking at the VHE gamma sky



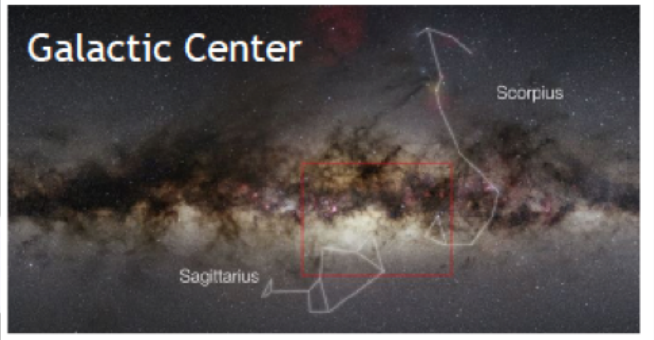
- Built IACT
- Built Array
- Planned IACT
- Planned Array

A wide field-of-view gamma-ray observatory in the southern hemisphere

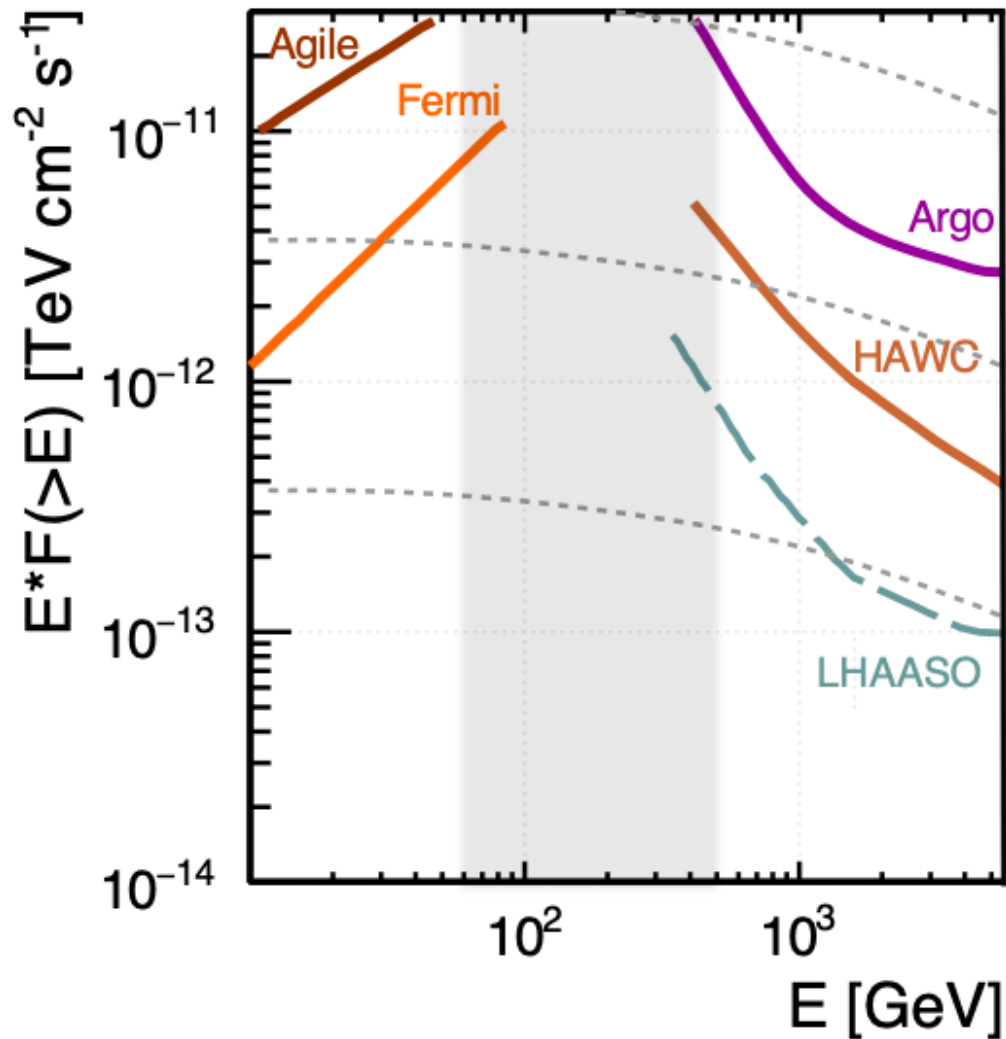


LATTES

Complementary to the powerful Cherenkov Telescope Array project



Sensitivity of Wide FoV Gamma-Ray Observatories



Low-energy, wide FoV observations... a big challenge !

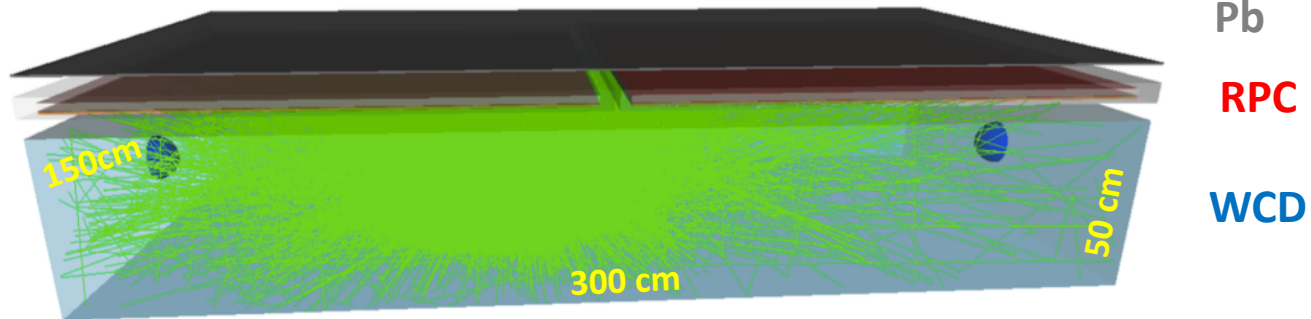
The requirements

- ✧ Large FoV
 - ✧ EAS detector
- ✧ Access the low energy (~ 100 GeV)
 - ✧ Trigger on shower
 - ✧ Few low energy photons
 - ✧ Geometry shower reconstruction
 - ✧ Time resolution better than 2-3 ns
 - ✧ High altitude (~ 5000 m)
- ✧ Autonomous / modular / compact / reduced price

LATTES : a first concept



hybrid detector



RPCs : time and spatial resolution

WCDs: e.m. energy, g/h discrimination and trigger

LATTES - end-to-end simulation and analysis

- ❖ Geant4 detailed detector simulation

- ❖ Trigger and effective area

 - ❖ Estimation of accidentals contamination

- ❖ Core reconstruction

 - ❖ WCD ; Use average LDF with 3 free parameters

- ❖ Energy reconstruction

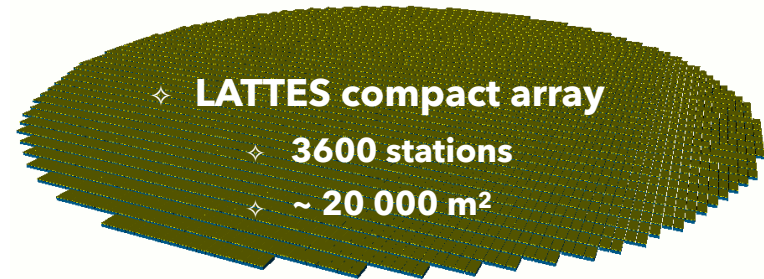
 - ❖ WCD ; Total signal calibrated to true energy

- ❖ Geometry reconstruction

 - ❖ RPCs ; Shower front reconstruction (conic fit)

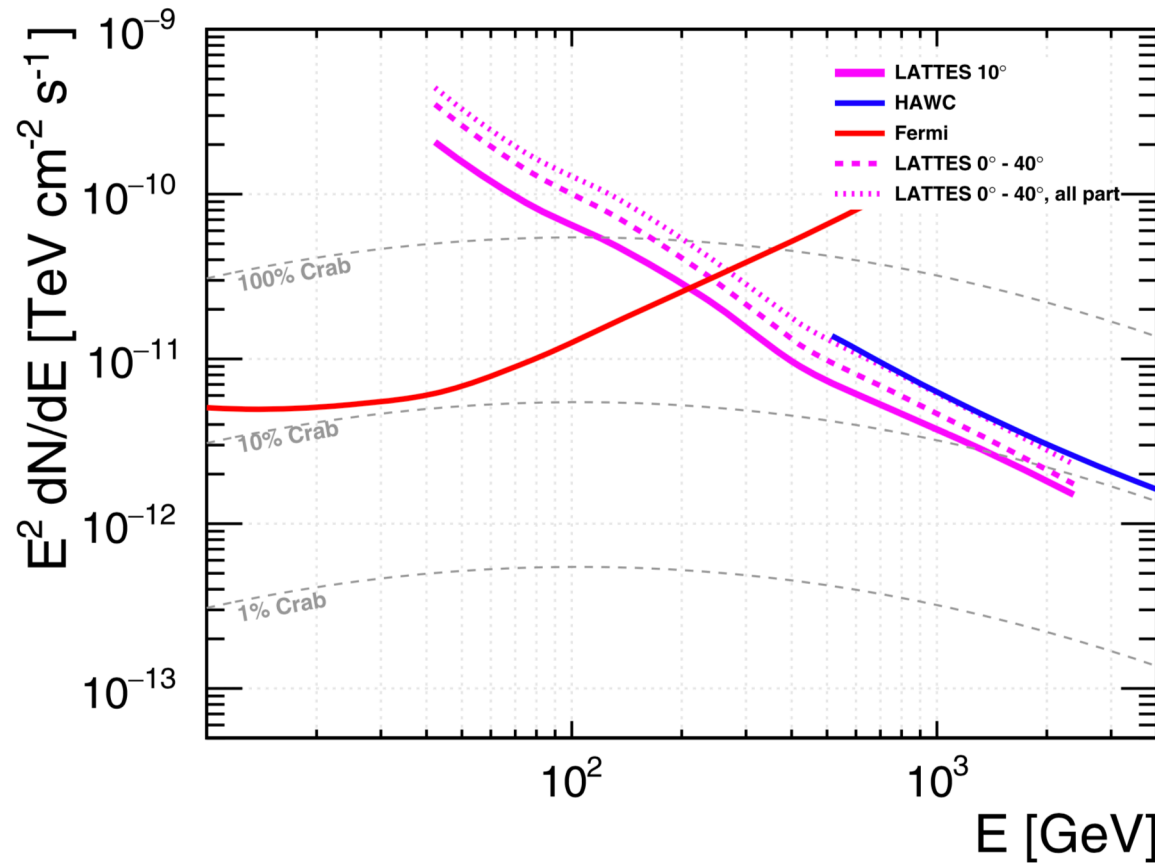
- ❖ Gamma/hadron discrimination

 - ❖ WCD ; Steepness/Bumpiness of LDF + Signal far away from shower core
(more than 40 m)



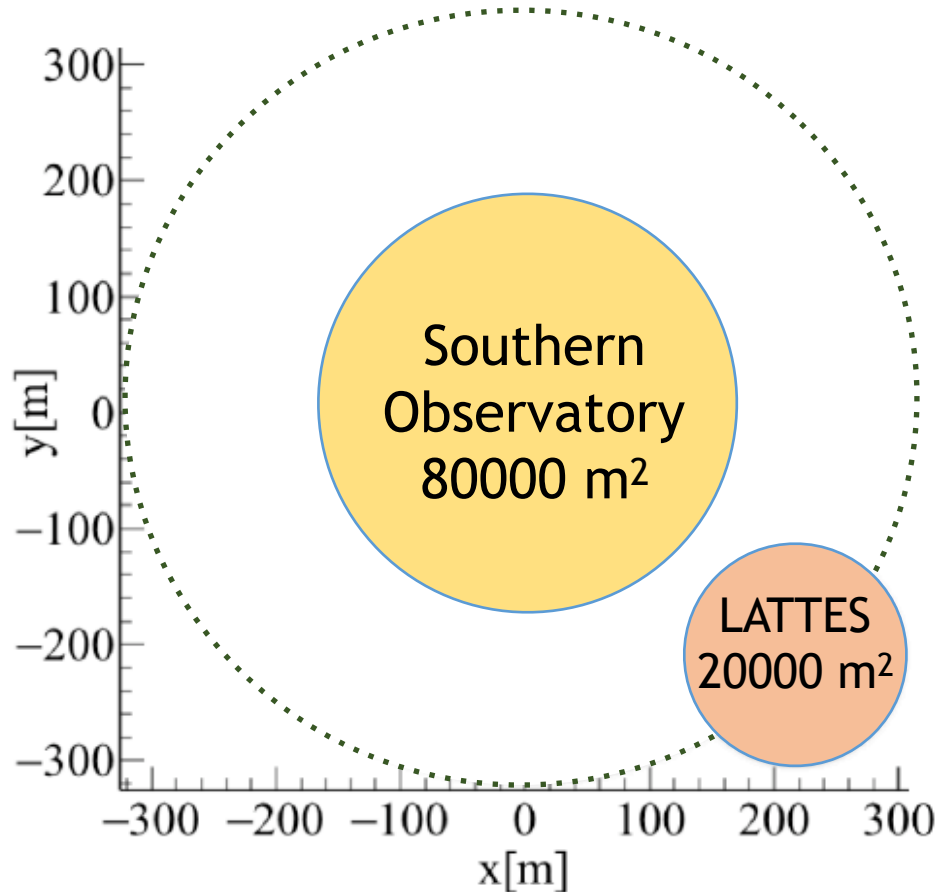
Sensitivity to steady sources

Astroparticle physics 99 (2018) 34-42



- **The low energy domain is reachable !**

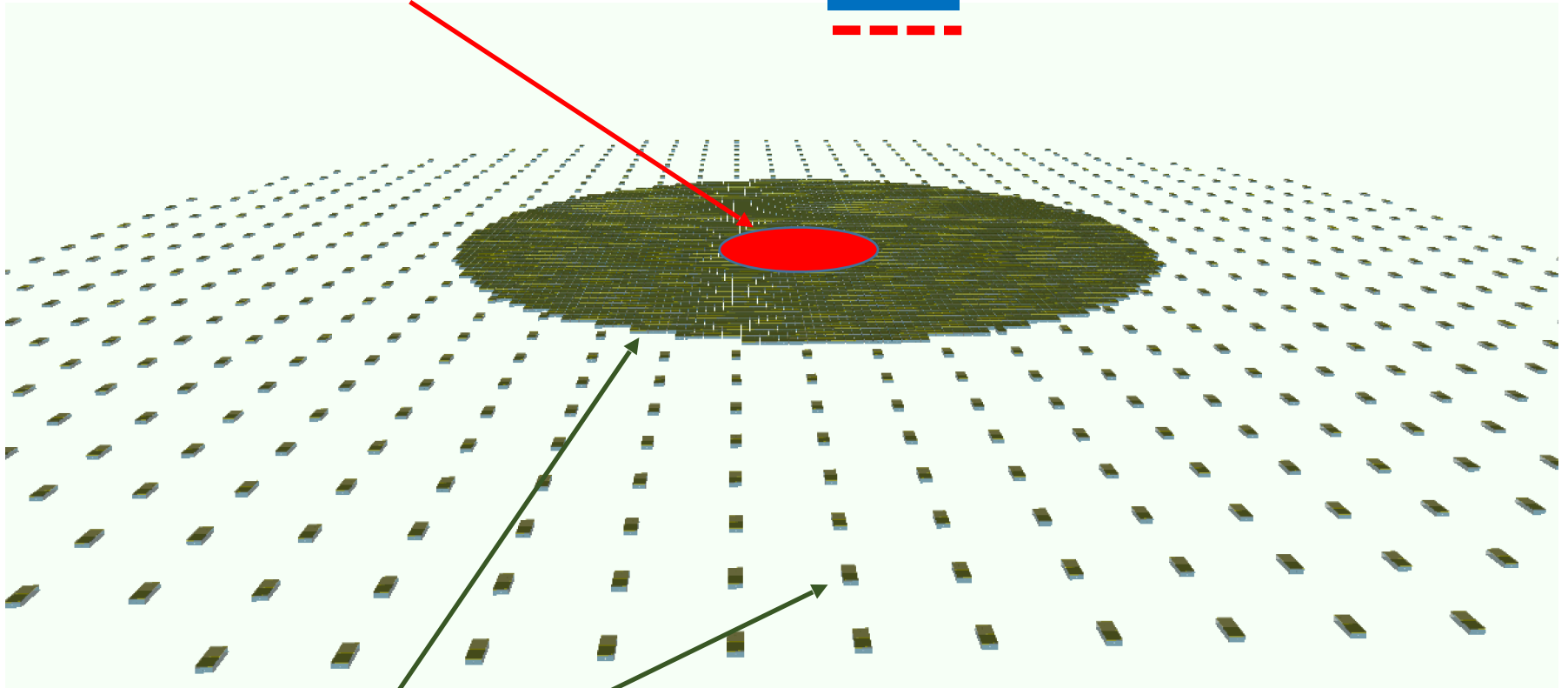
But size matters!



- ✧ Preliminary studies on science case at low energies suggest the need for a larger area

New layout ?

“ μ Telescopes” – WCDs+ RPCs



WCDs

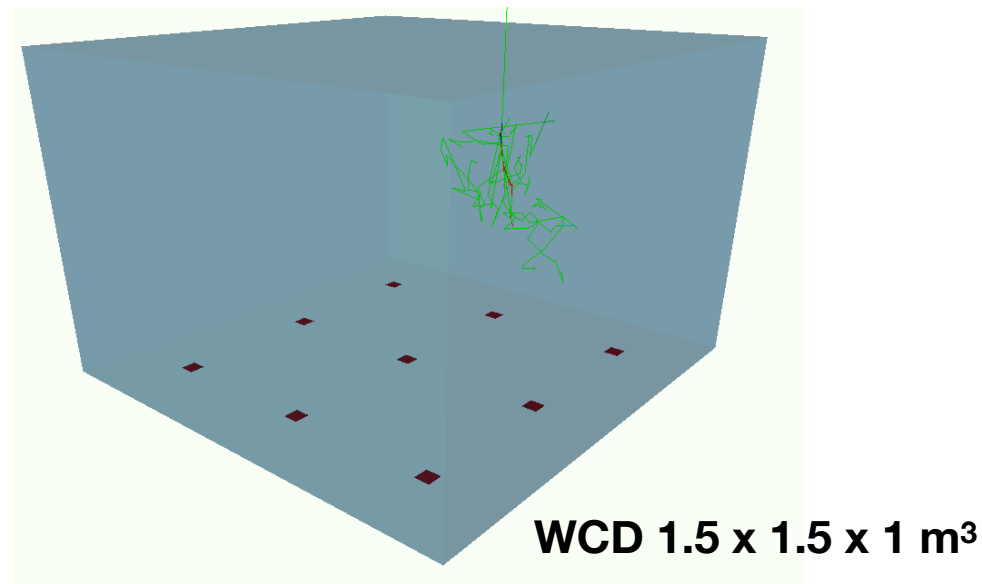


- ✧ Dense core with an area of 80000 m²
- ✧ WCD with 1 meter height

New challenges

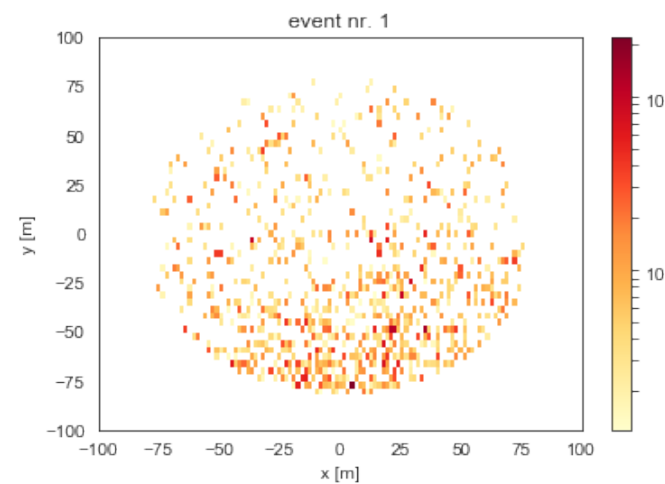
- **Timing**

- Tank should be white to lower energy threshold!!
- Access Cherenkov direct light on WCD



WCD with SiPM readout matrix at the bottom

New challenges



- **Gamma/hadron discrimination**

- Study WCD signal patterns at ground as potential discriminator
- Take advantage of Convolutional Neural Networks
- Work being done by computer science group in Coimbra
- **At higher energies muon identification is a powerful discriminant variable**
 - Use ANN techniques to analyse **time traces in WCD**
 - Granada group starting to look into simulations of new WCD concept

"Southern Wide-field Gamma-ray Observatory R&D"

- ⊙ 3 year programme to come to a recommendation on the design and site of a wide field gamma-ray observatory in the southern hemisphere
 - + Extendable with agreement of partners
- ⊙ Observatory concept
 - + Ground-particle detection based high altitude gamma-ray observatory – 100% duty cycle, steradian FoV, latitude -15° to -30°
 - + Wide energy range 100s of GeV to 100s of TeV
 - + High fill-factor core detector with area considerably larger than HAWC and significantly better sensitivity, with a low density outer array
 - + With possibility of extensions or enhancements
 - + Based primarily on water Cherenkov detector units
 - + Modular and scalable
- ⊙ R&D to reach recommendations on
 - + Site
 - + Base concept: lake, hall, tank or hybrid
 - + Detector unit design / array layout
 - + Photosensor and electronics choices, array level trigger and readout, calibration concept, ...

"Southern Wide-field Gamma-ray Observatory R&D"

- ⊙ Steering committee of national representatives
 - + One delegate per country with significant engagement
 - + Two delegates from one country possible in special cases
 - + Admission of new members possible with agreement of steering committee
 - + Countries with limited engagement may be associated
 - + Steering committee chaired by spokesperson (to be elected)
- ⊙ Steering committee roles:
 - + Overall coordination of the R&D programme
 - + Appointment of working group coordinators
 - + Science, Site study, Simulations and Analysis, Detector R&D
 - + Identification of funding opportunities
 - + Exploration of options for the framework for observatory construction and operation
 - + Organisation of international workshop at the end of R&D phase aimed at establishing a collaboration to build the instrument

Meeting in Lisboa 20-22 May

Wide field-of-view gamma-ray observatory in the Southern hemisphere

20-22 May 2019

LIP

Europe/Lisbon timezone

Overview

[Timetable](#)

[Registration](#)

[Participant List](#)

[Venue & Travel Information](#)

[Workshop Dinner](#)

[Accommodation](#)

Contact

[✉ ruben@lip.pt](mailto:ruben@lip.pt)

[✉ bernardo@lip.pt](mailto:bernardo@lip.pt)

This meeting aims to be a further step towards the construction of one wide Field-of-View Gamma Ray Observatory in the Southern Hemisphere able to cover the energy range of 100 GeV to 100 TeV.

It follows the meeting held in [Heidelberg last October](#). Both the scientific case and the different proposed designs will be reviewed and discussed.



Starts 20 May 2019, 14:00

Ends 22 May 2019, 15:00

Europe/Lisbon



LIP

Lisbon, Portugal



[Bernardo Tomé](#)
[Fabian Schussler](#)
[Harm Schoorlemmer](#)
[Michele Doro](#)
[Ruben Lopez-Coto](#)
[Rúben Conceição](#)



There are no materials yet.



Registration

You are registered for this event.

[See details >](#)

Participants from :

Argentina, Australia, Brazil, China, Czech Republic, France, Germany, Italy, Mexico, Portugal, Spain, Sweden, USA

Acknowledgements



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