

LATTES

A new detector concept for gamma-ray astrophysics

Ruben Conceição

(on behalf of the LATTES team)



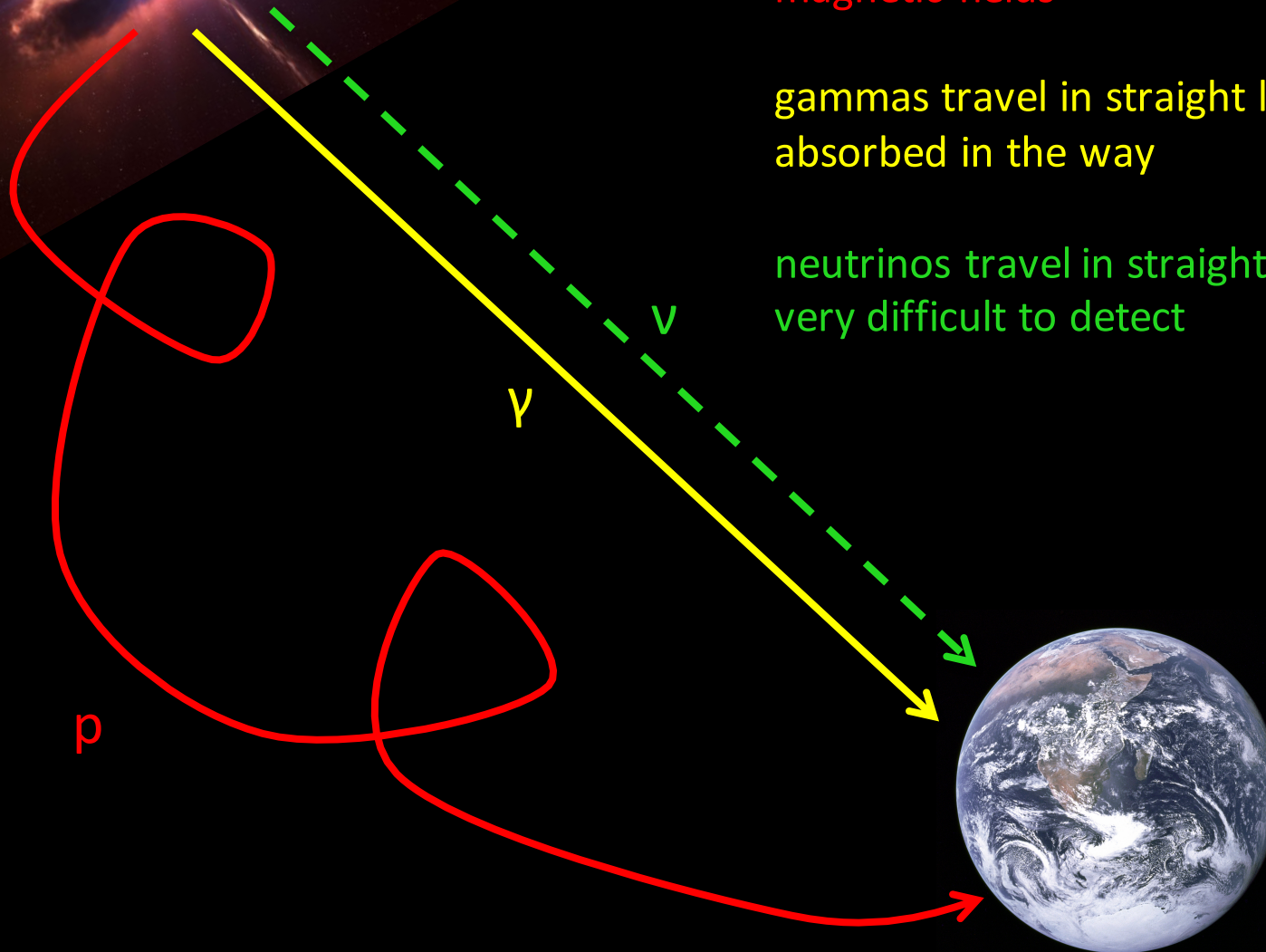
**TÉCNICO
LISBOA**

Why gamma rays?

protons are deflected by the galactic magnetic fields

gammas travel in straight lines but can be absorbed in the way

neutrinos travel in straight lines but are very difficult to detect

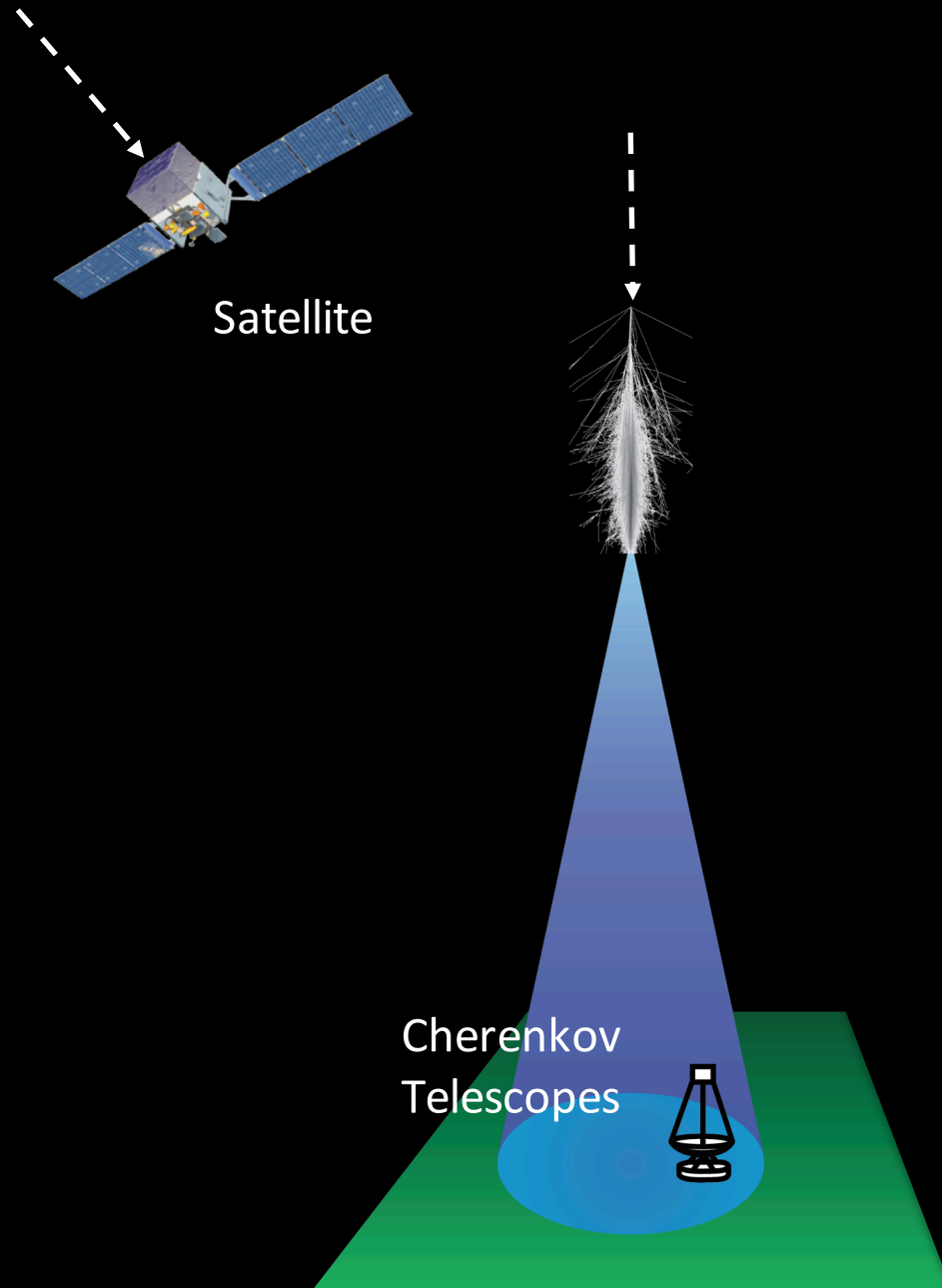


How to detect?

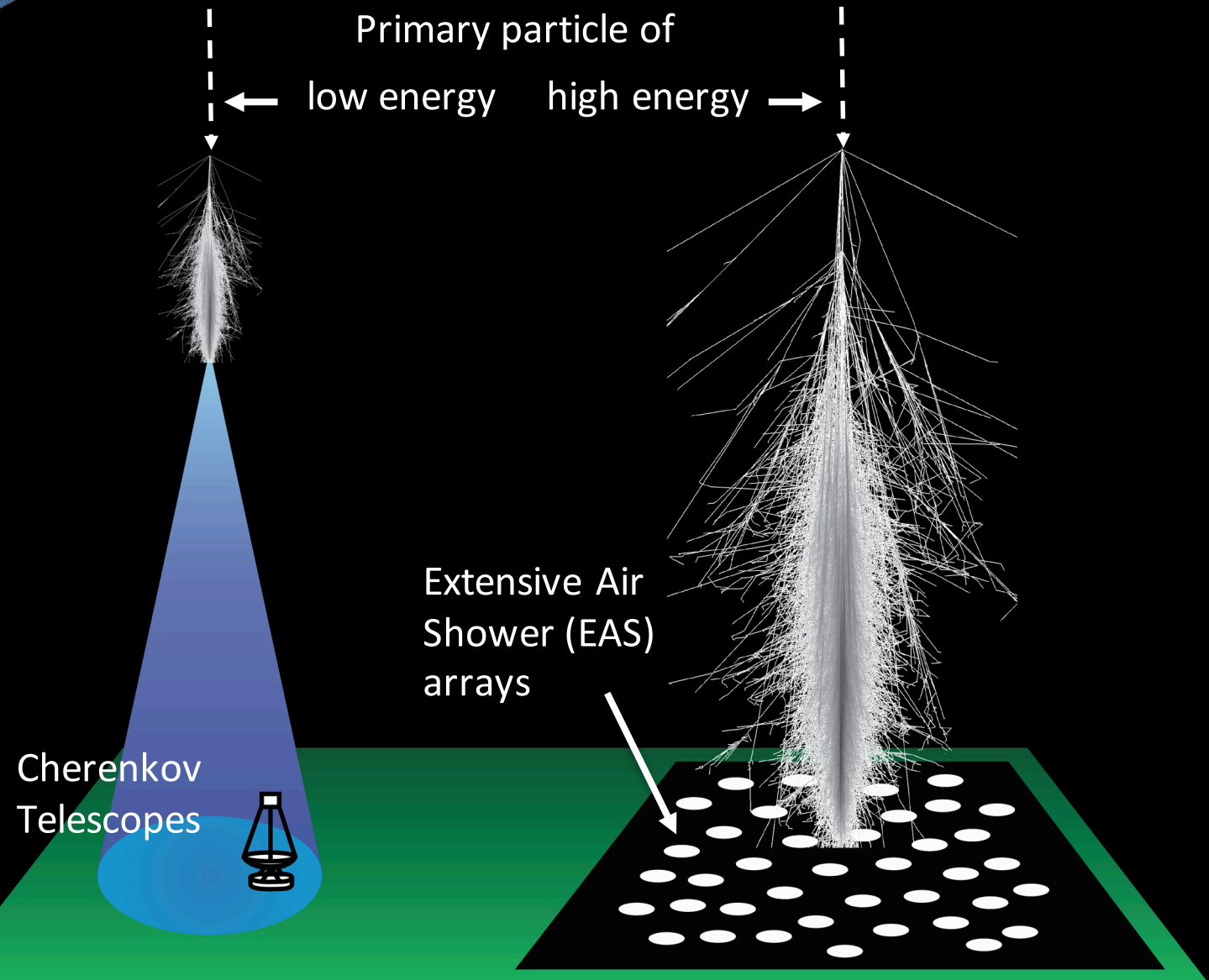


Satellite

How to detect?

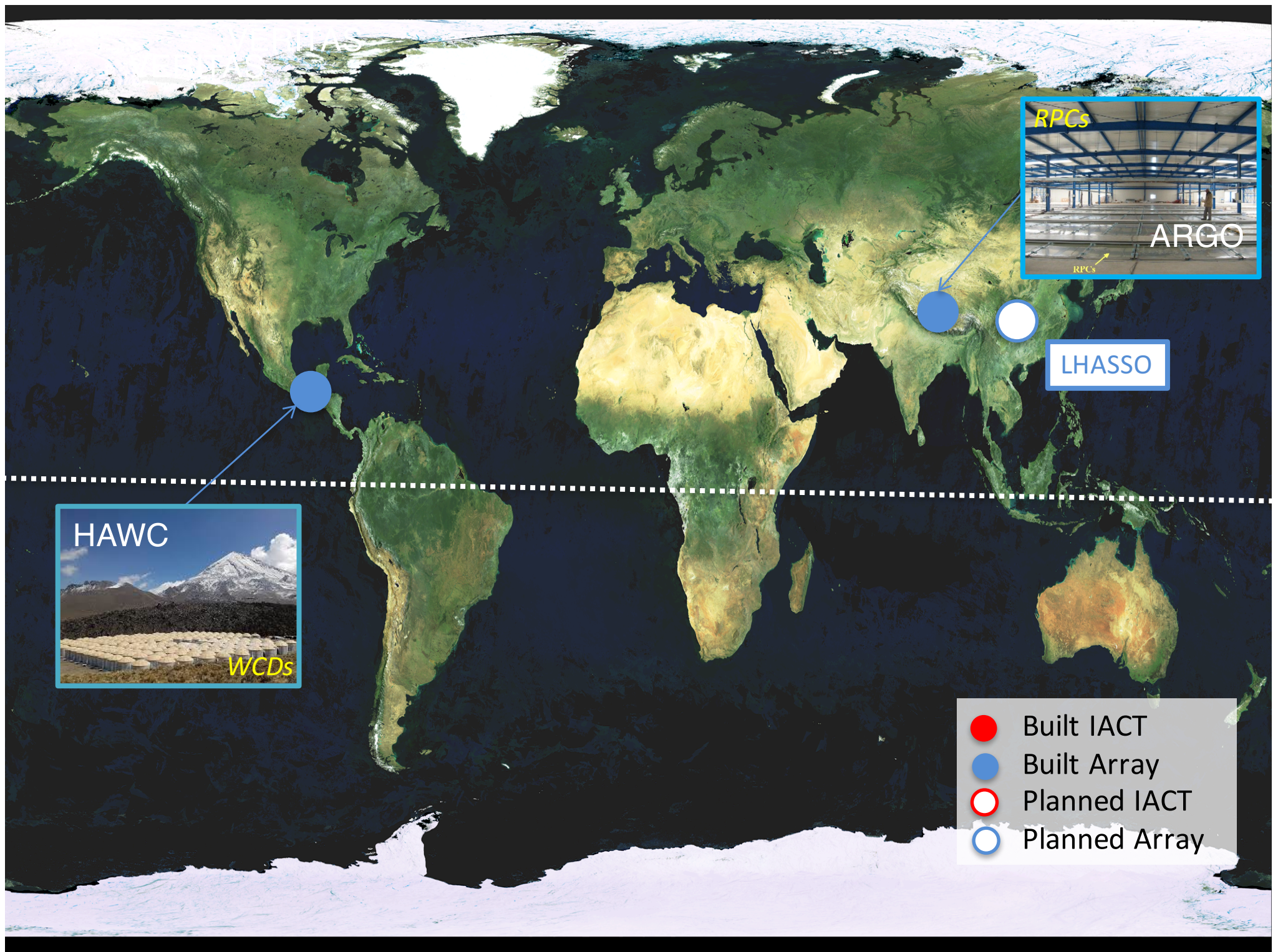


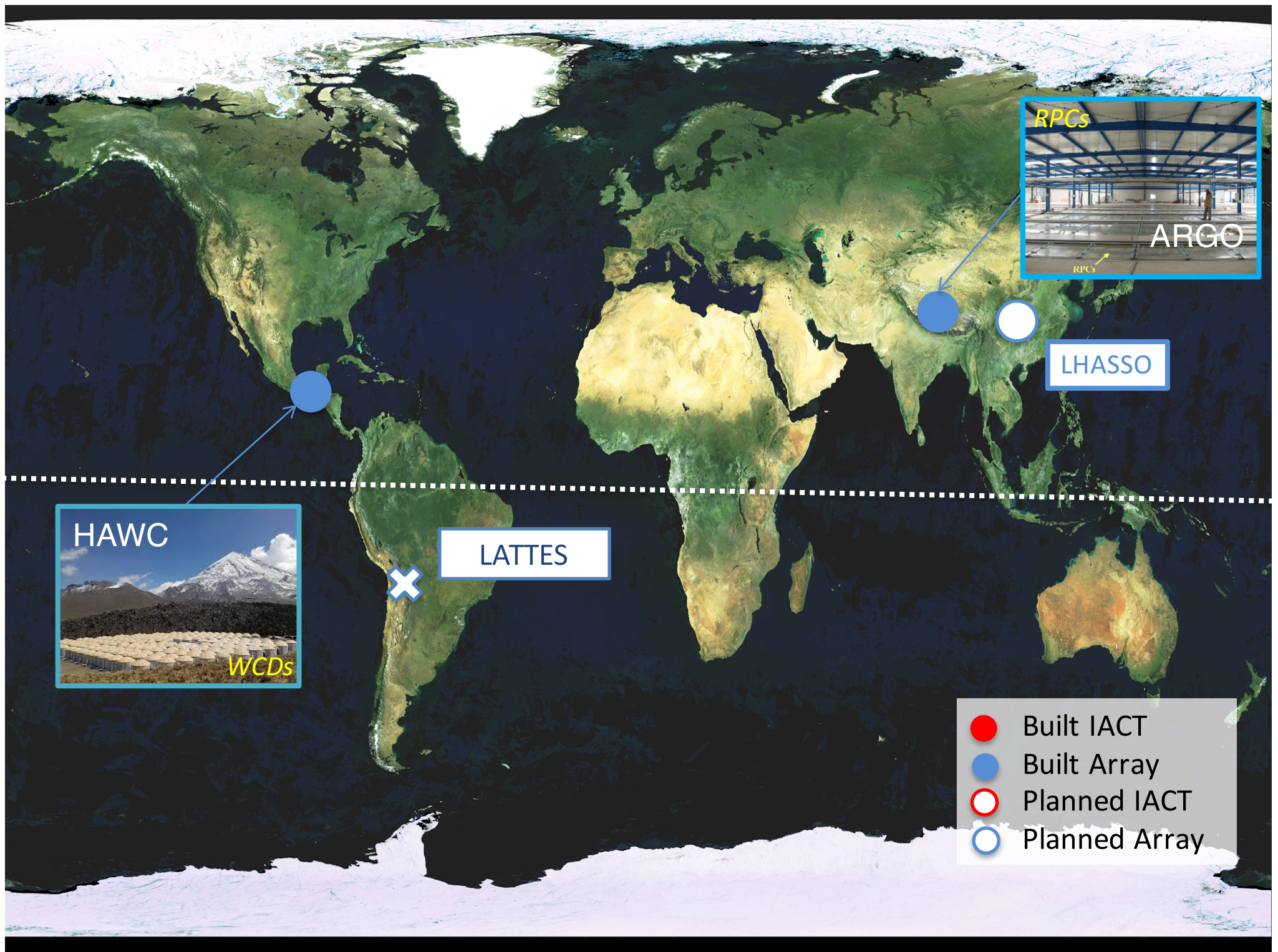
How to detect?





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





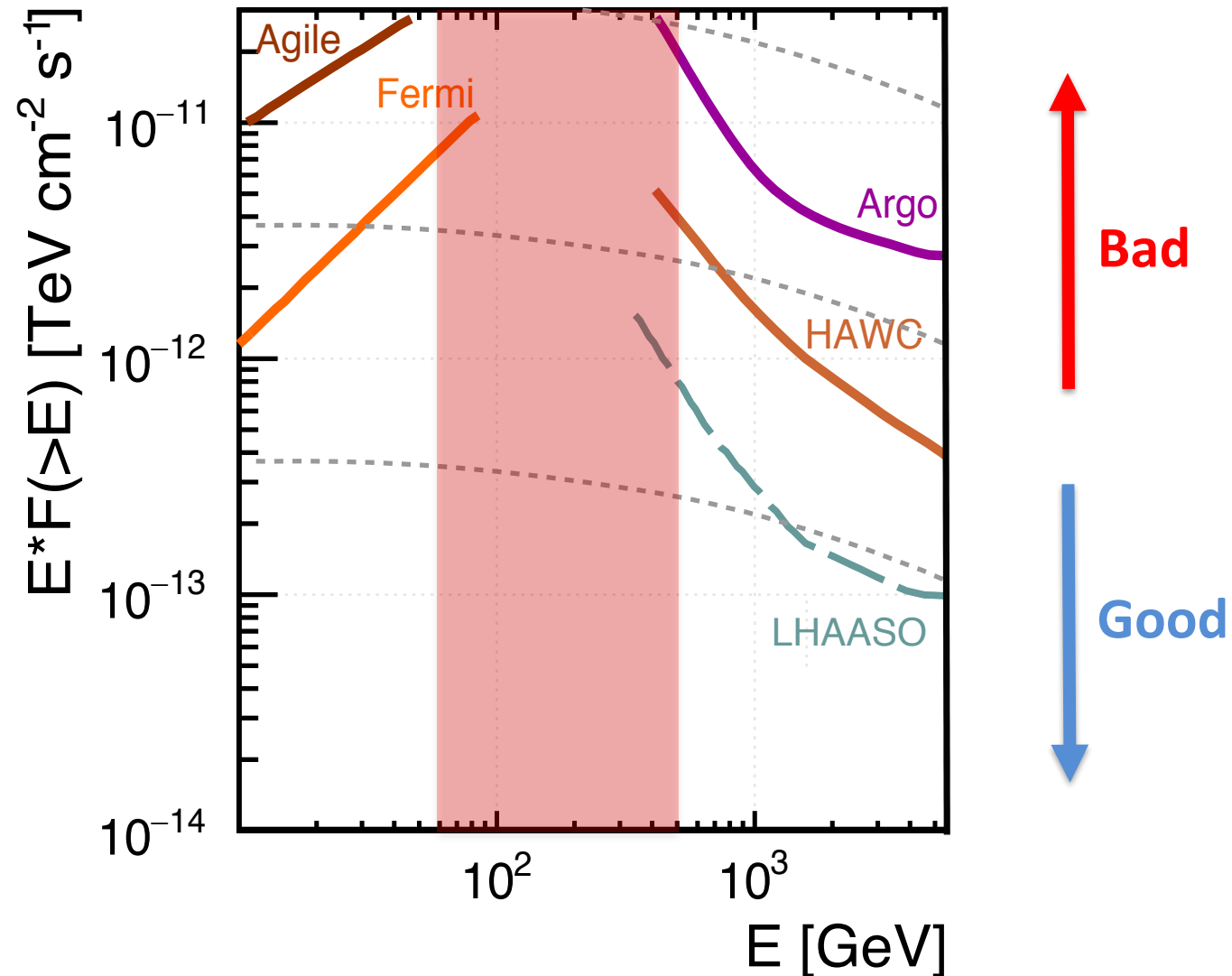


LATTES



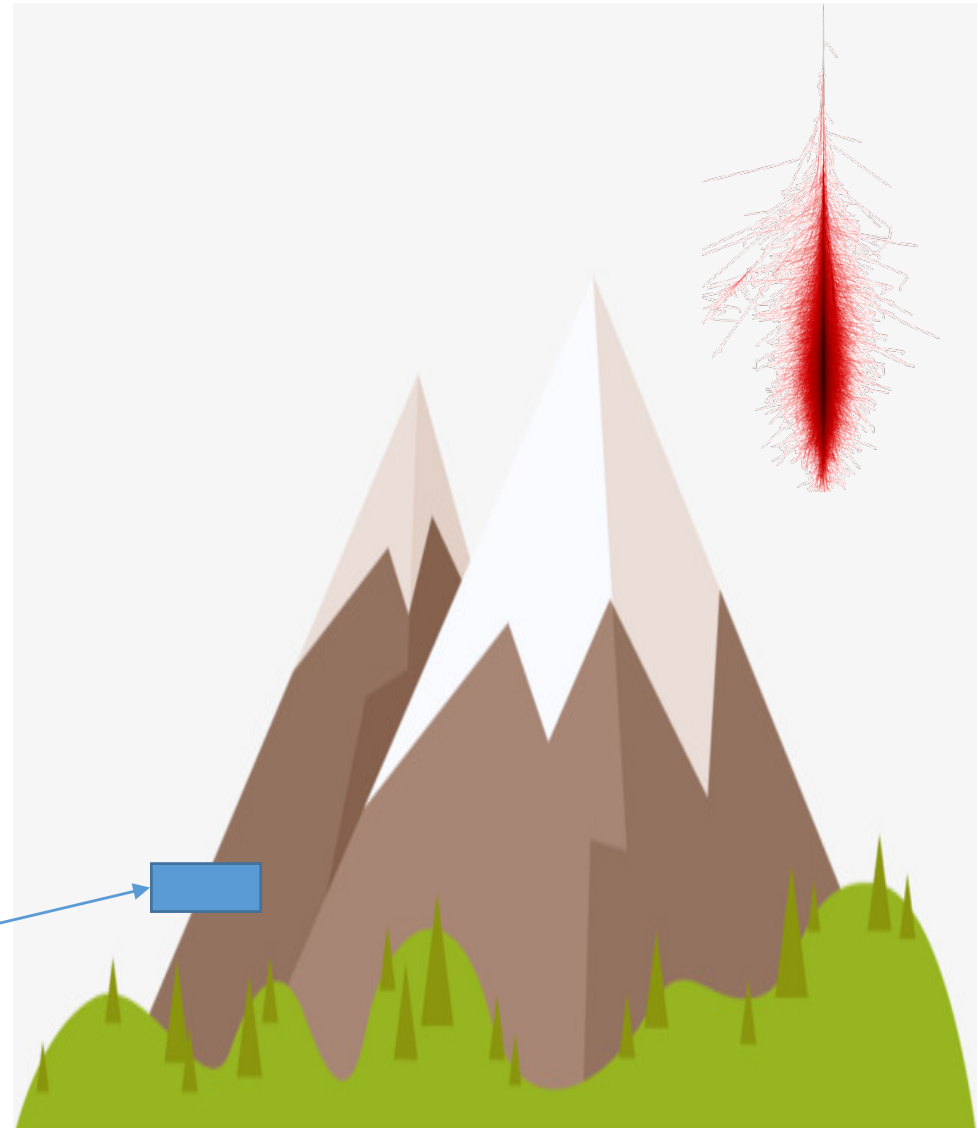
- Built IACT
- Built Array
- Planned IACT
- Planned Array

Current Wide Field-of-View Gamma-Ray Observatories



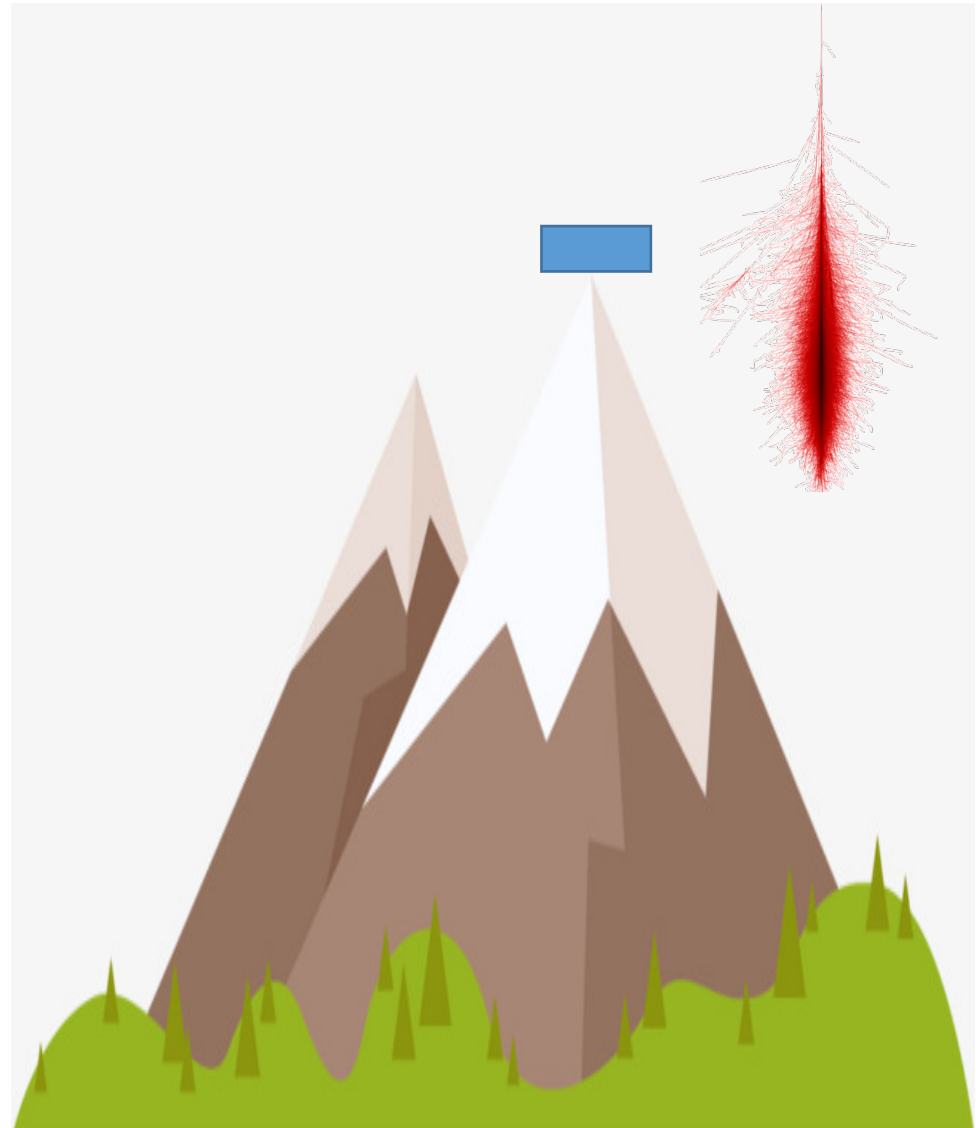
How to lower the energy threshold?

- ✧ Put the experiment at higher altitude
- ✧ Gamma-ray EAS arrays have typically 20 000 m²

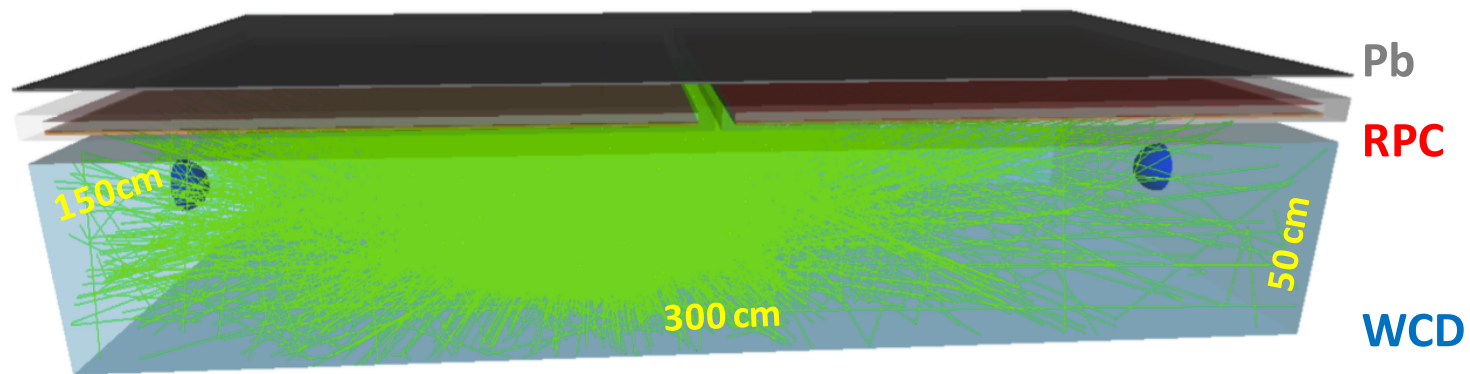


How to lower the energy threshold?

- ✧ Put the experiment at higher altitude
- ✧ Gamma-ray EAS arrays have typically 20 000 m²
- ✧ It is possible to find sites with ≈ 5000 m of altitude
 - ✧ Atacama desert, Northern Chile
- ✧ *Can the detector concept be improved?*

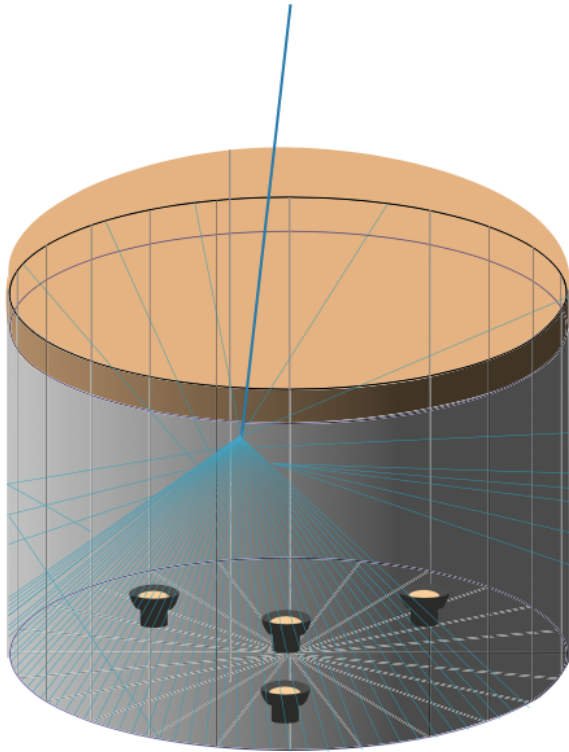


Improve detector concept!

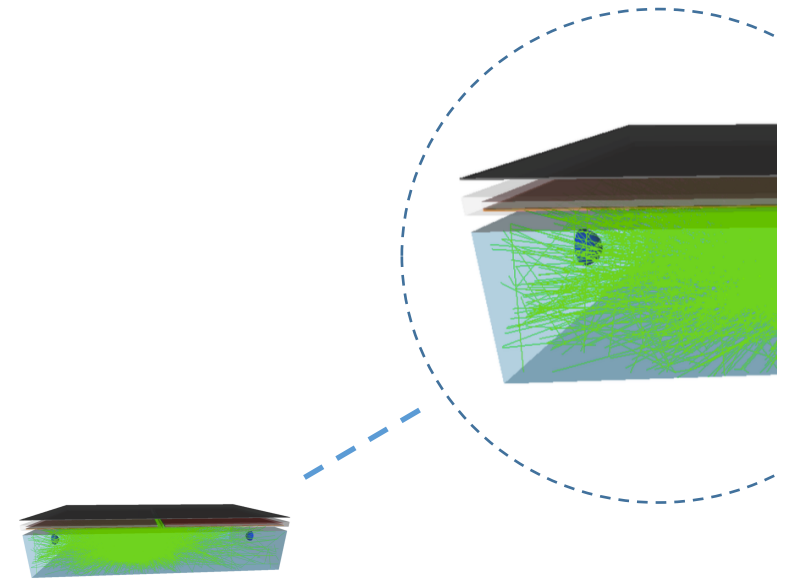


- ✧ Thin lead converter plate (**Pb**)
 - ✧ Improve shower geometry reconstruction
- ✧ Resistive Plate Chamber (**RPC**)
 - ✧ Measure charged particles with high spatial and time resolution
- ✧ Water Cherenkov Detector (**WCD**)
 - ✧ Collect shower secondary photons/electrons to improve trigger at low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

Station: HAWC vs LATTES

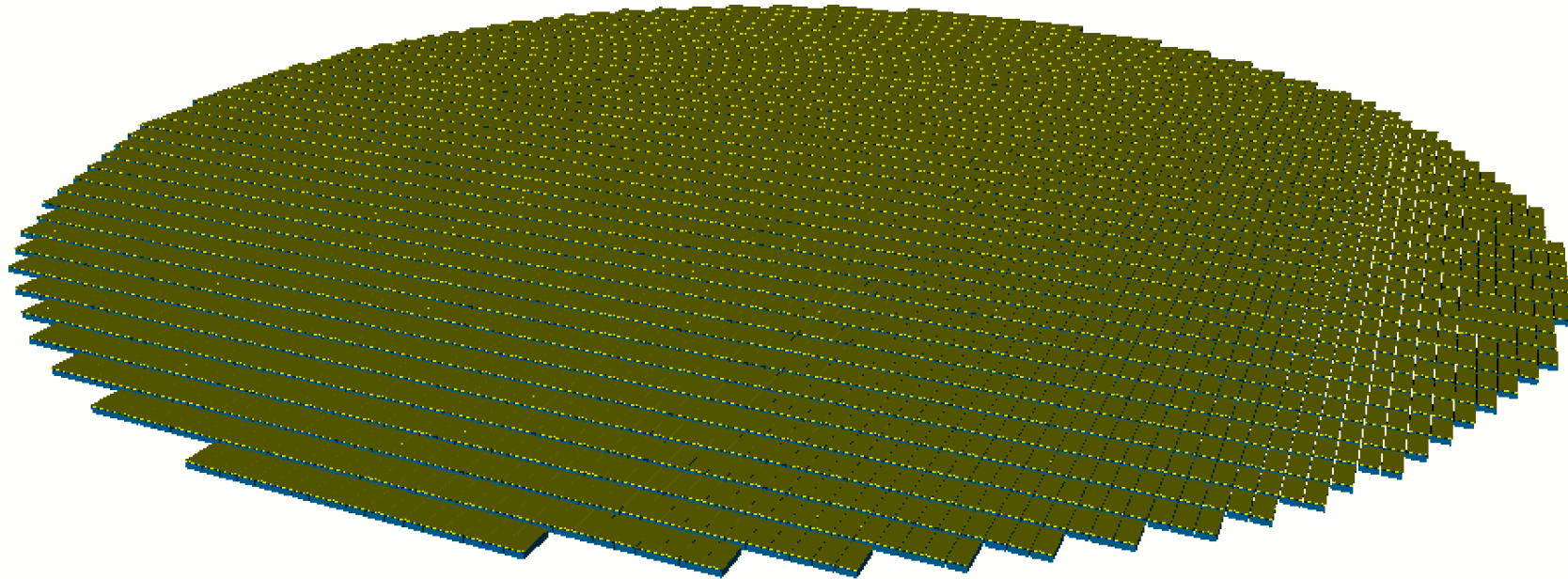


HAWC
(present detector)

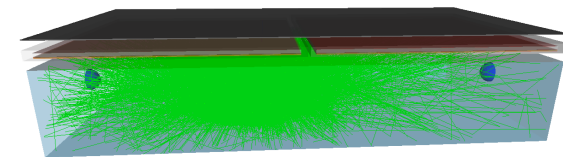


LATTES
(next generation)

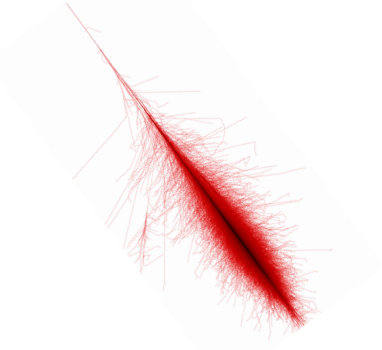
Array configuration



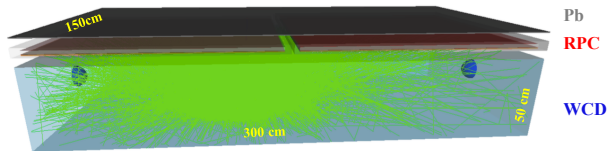
- ✧ LATTES compact array
 - ✧ 3600 LATTES stations
 - ✧ Array of roughly 20 000 m²



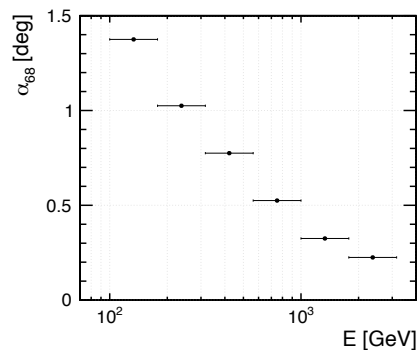
Towards LATTES sensitivity...



Shower simulation



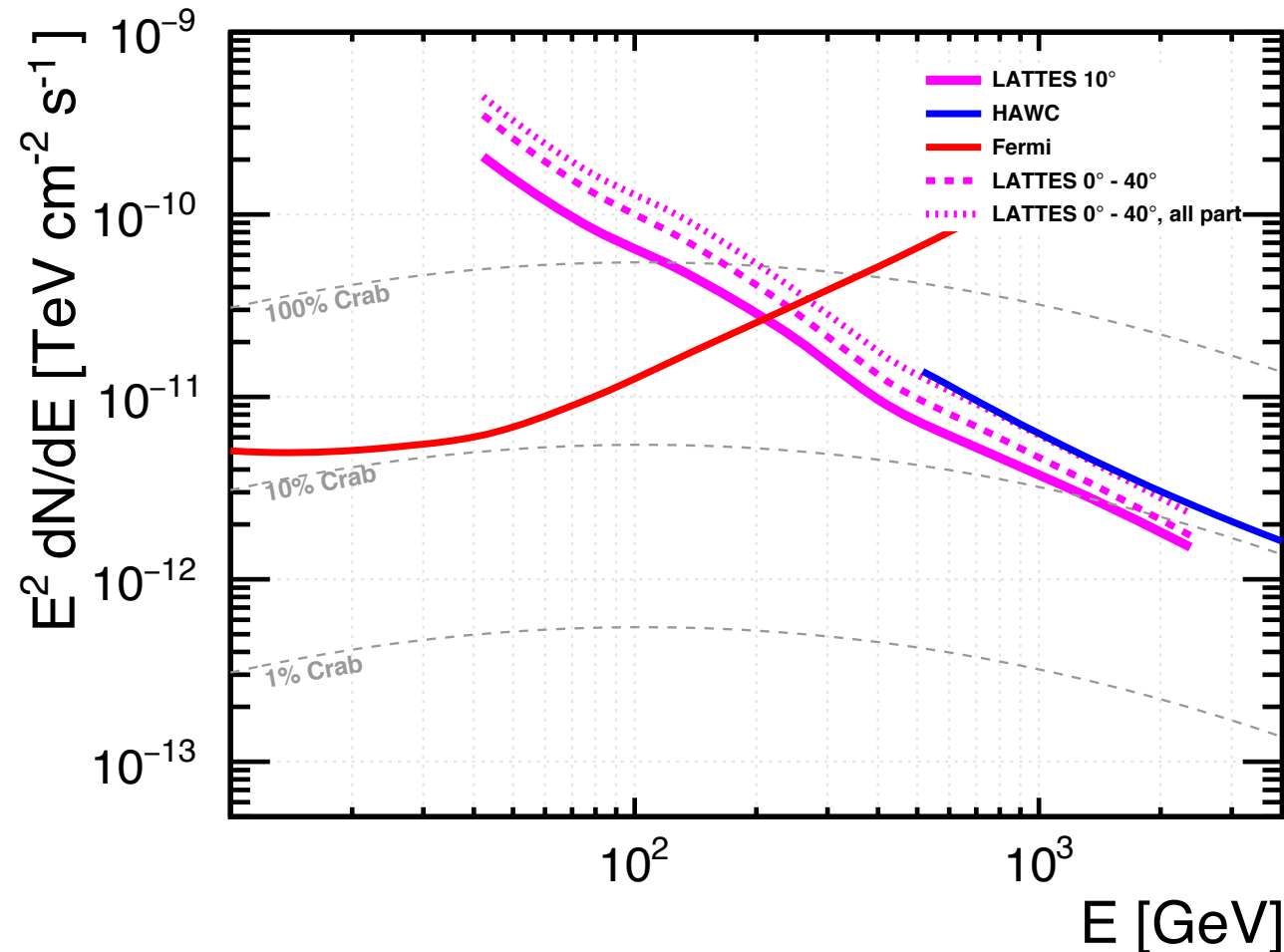
Detector simulation



Shower reconstruction

LATTES sensitivity

(submitted to *Astropart. Phys.*)



LATTES concept **can cover the energy gap** between satellite borne and ground base experiments

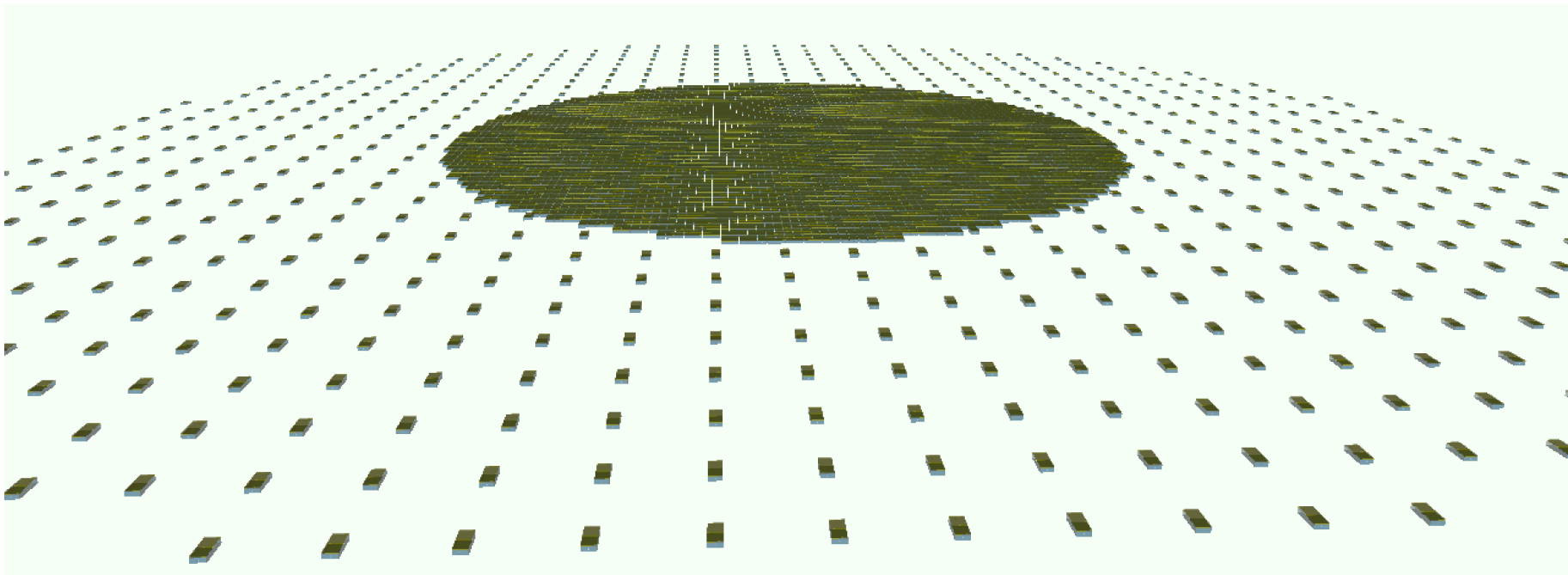
The future...

✧ Hybrid detector:

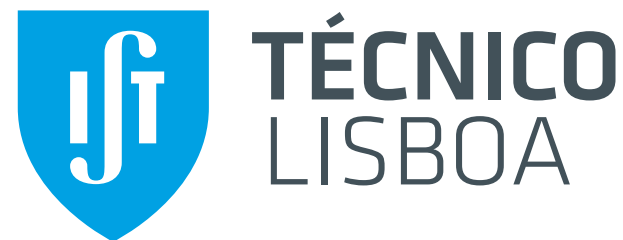
- ✧ *LATTES simulation and reconstruction framework is ready to be used!*
- ✧ *Need of good ideas to fully explore LATTES concept*

✧ High-energy extension with a sparse array

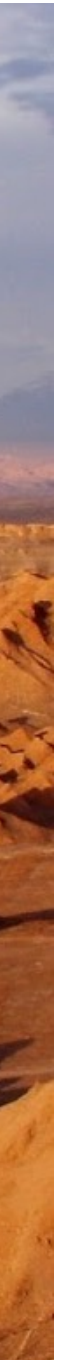
- ✧ *Energies up to 100 TeV*



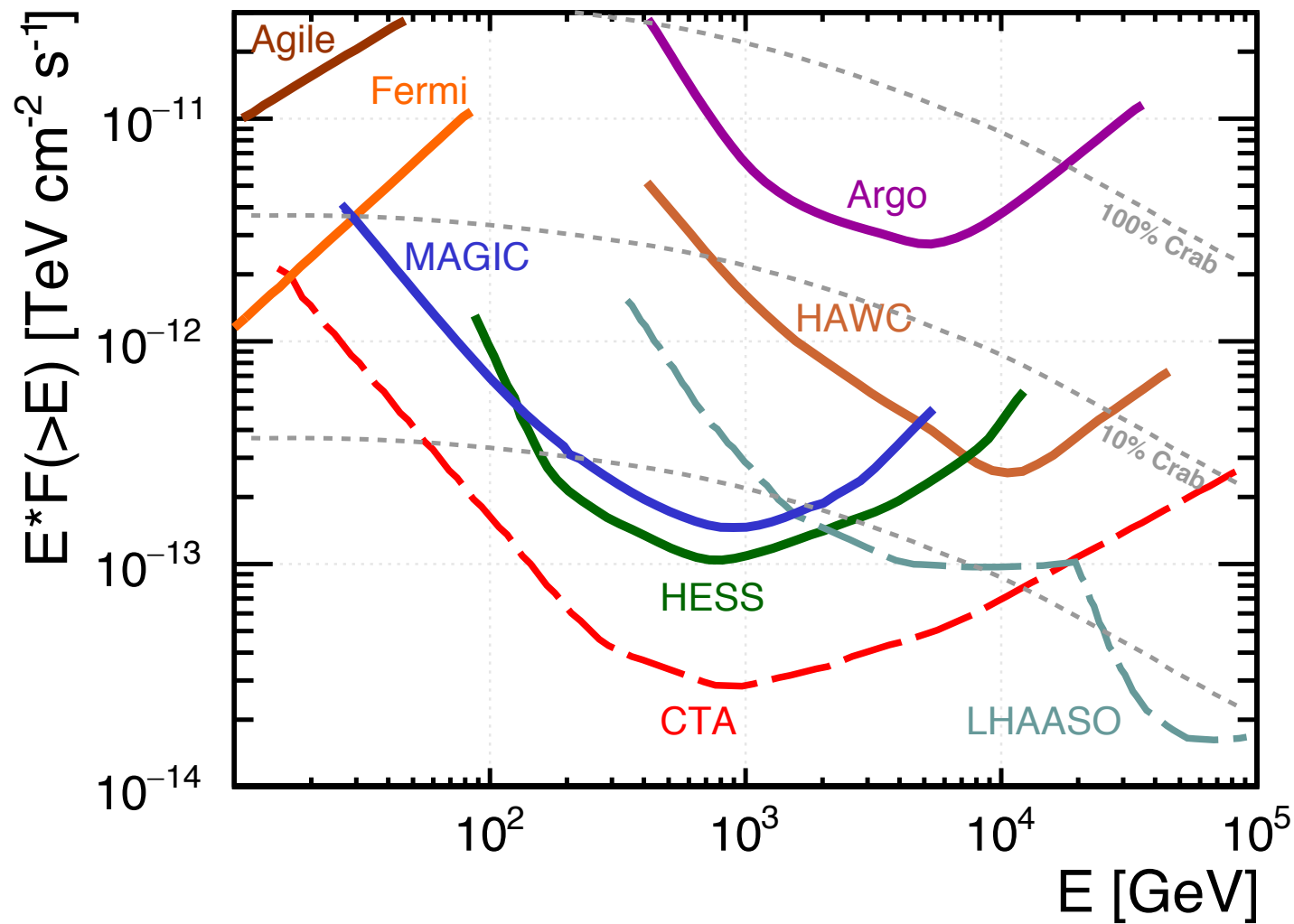
Acknowledgements



Backup slides



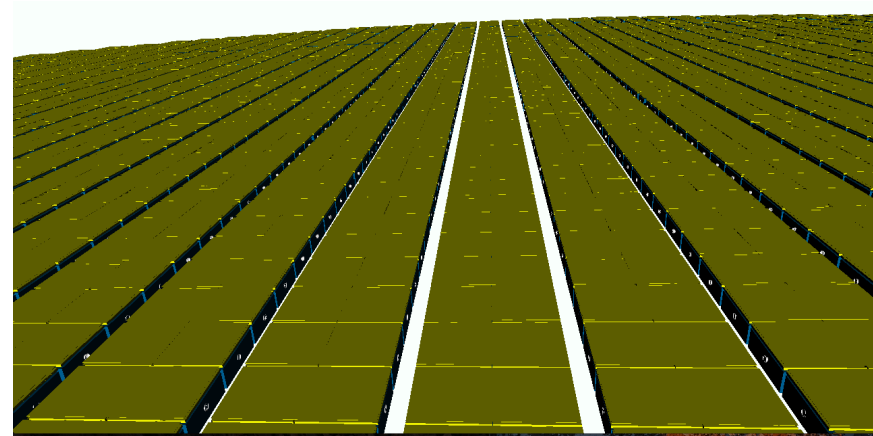
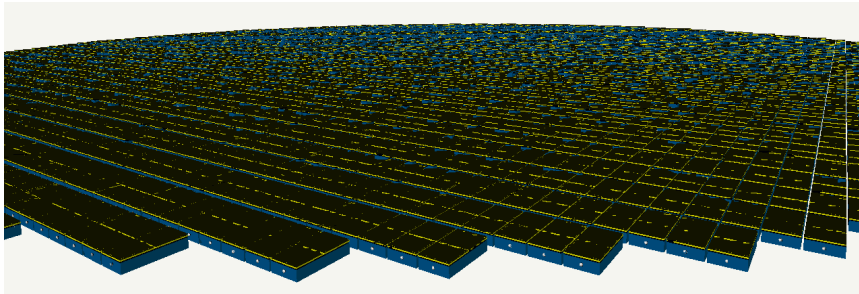
(Very) High-Energy Gamma-Rays



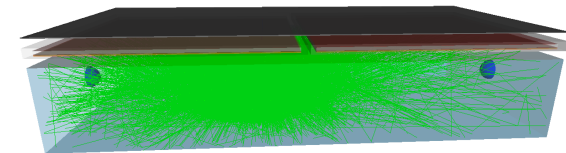
(Very) High Gamma Rays

- ✧ Astrophysical gamma rays
 - ✧ Energy region of interest from GeVs to hundreds TeVs
- ✧ Scientific interest:
 - ✧ Key to understand the **acceleration mechanism** of cosmic rays in our galaxy
 - ✧ Violent astrophysical phenomena: pulsars and black holes
 - ✧ Galactic magnetic fields
 - ✧ Photon radiation fields in the Universe
 - ✧ Indirect search of **dark matter** (WIMP interactions)
 - ✧ Test fundamental properties of quantum gravity
 - ✧ ...

Array configuration

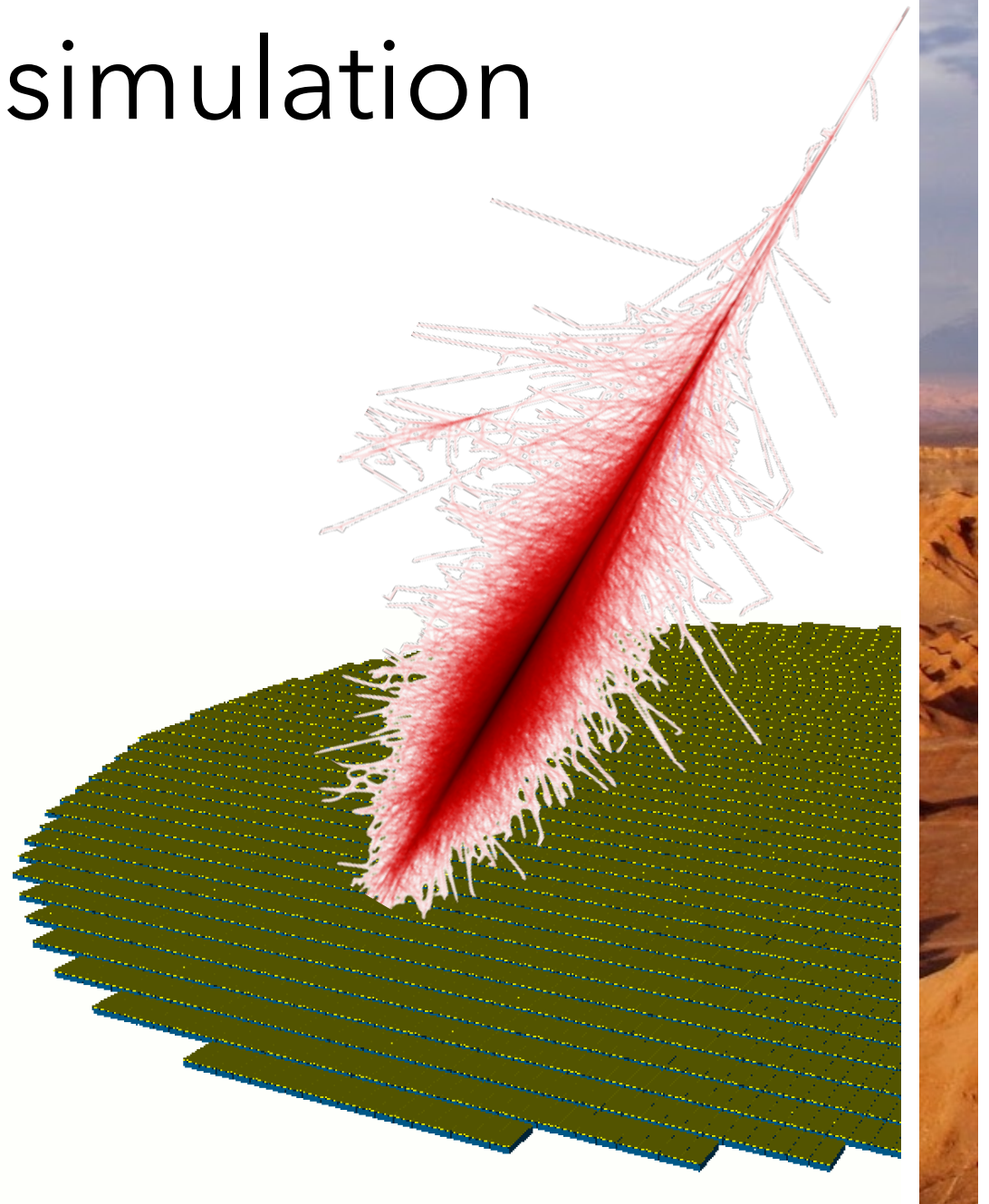


- ✧ LATTES compact array
 - ✧ 3600 LATTES stations
 - ✧ Circular array of radius 70 m
 - ✧ Array of roughly 20 000 m²
 - ✧ 0.5 m space for access detectors



Detector simulation

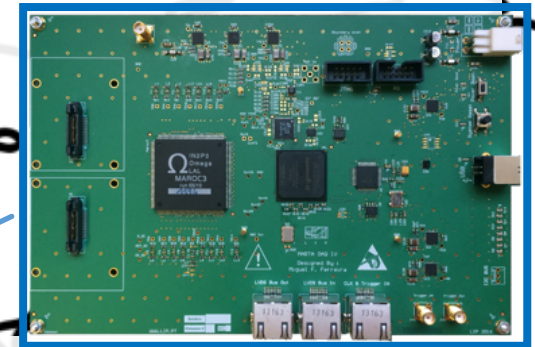
- ✧ LATTES detector simulation package
 - ✧ Based on the Geant4 toolkit
 - ✧ Interfaced to read directly CORSIKA simulations output binary files
 - ✧ Resampling of the showers with randomized core



Ongoing developments and tests on RPCs, electronics and read-out systems



ents



DAQ Engineering prototype

RPC based muon hodoscope for precise studies of the Auger WCD

Construction and Assembling



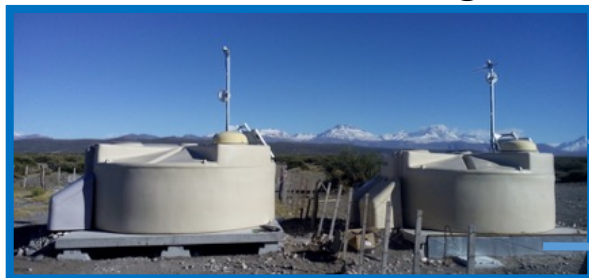
Top RPC

Gianni Navarra WCD

Bottom RPC



RPCs in the field @ Auger

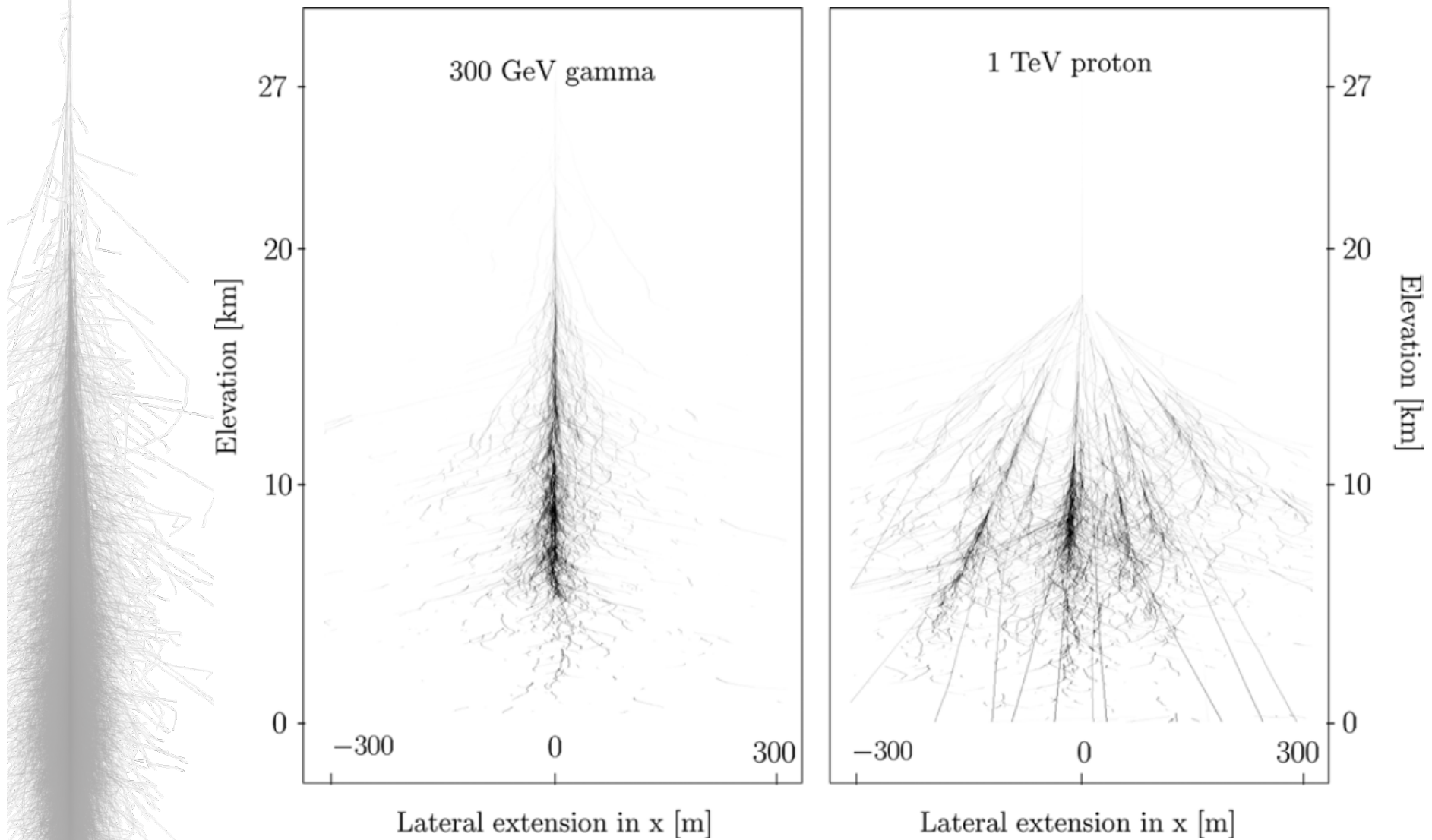


RPC hodoscope



R Conceição

strategies for primary discrimination



Explore differences in shower development