LATTES

A next generation detector concept for (very-)high-energy gamma-rays

Ruben Conceição

(on behalf of the LATTES team)

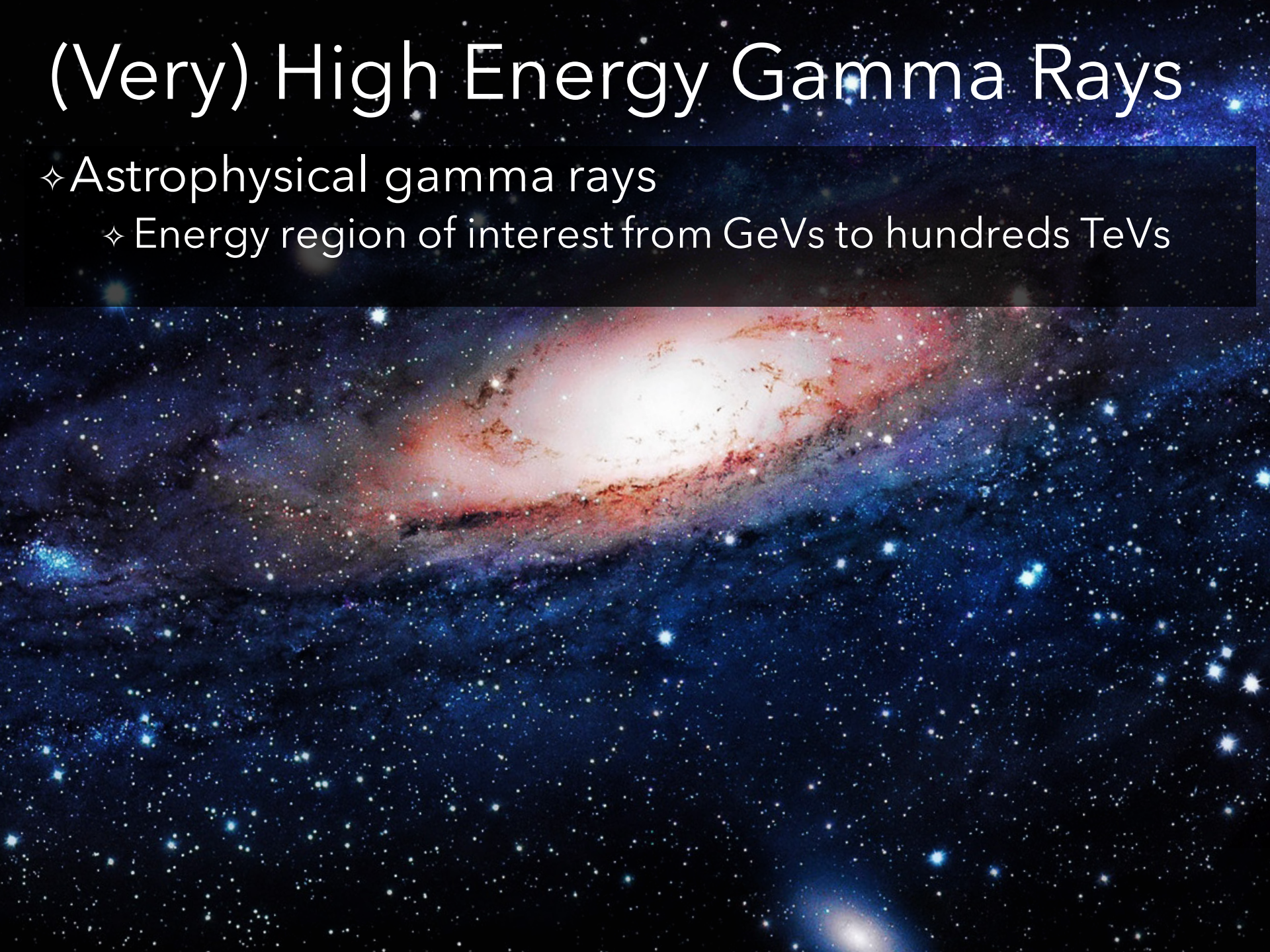
LIP

TÉCNICO LISBOA

1st IGFAE/LIP joint workshop, Braga, May 4th 2018

(Very) High Energy Gamma Rays

- Astrophysical gamma rays
  - Energy region of interest from GeVs to hundreds TeVs



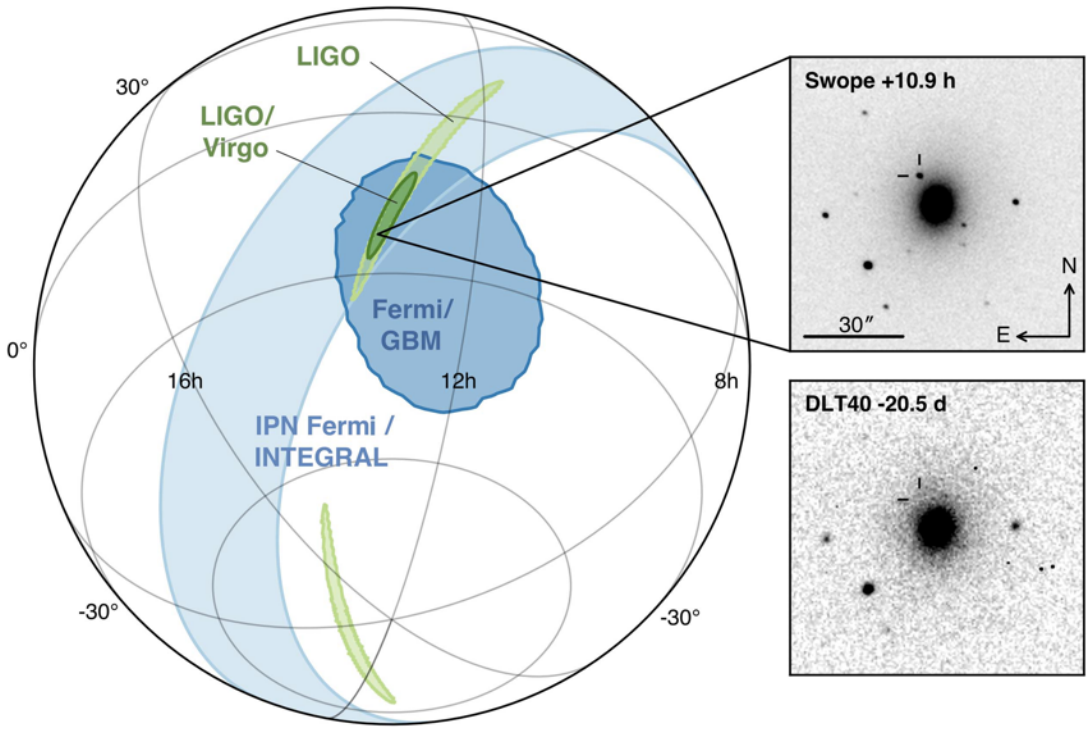
(Very) High Energy Gamma Rays

- 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
  - …

The era of multi-messenger observations

physicsworld BREAKTHROUGH OF THE YEAR 2017

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

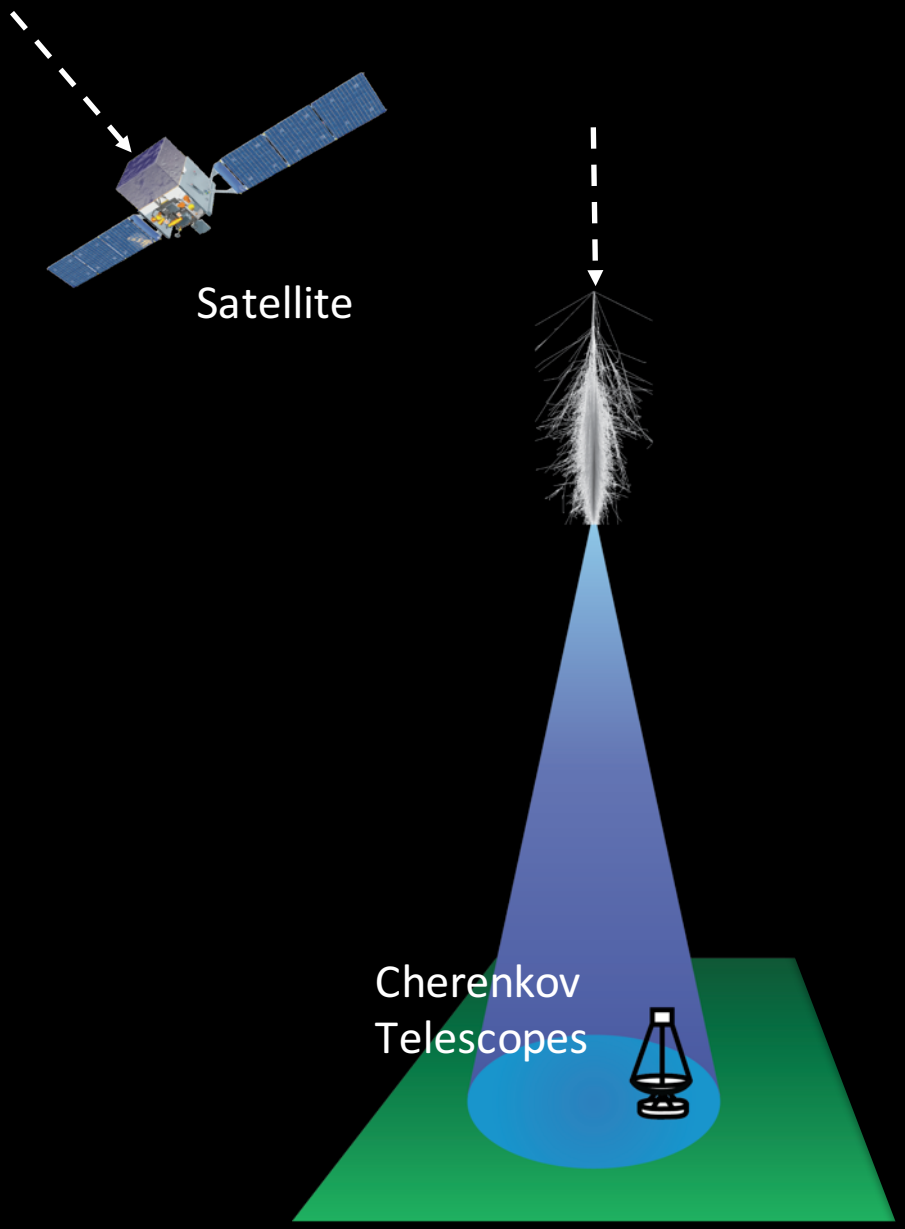


- Simultaneous observation of a Gravitational Wave + electromagnetic counter parts
- Allows to test the dynamics of our surrounding Universe
- Observation of transient phenomena in all energy windows is one of the main ingredients

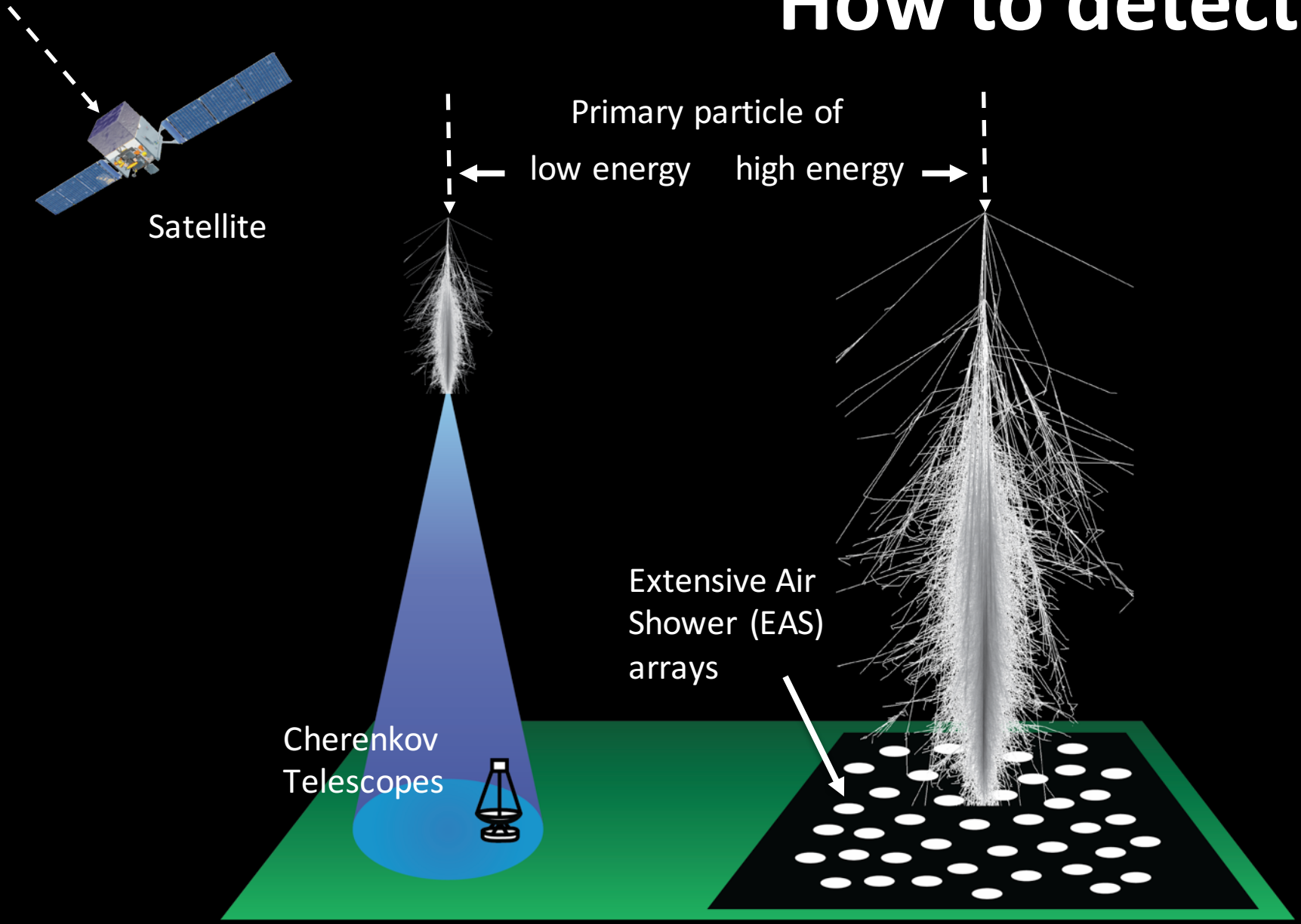
How to detect?

Satellite

How to detect?

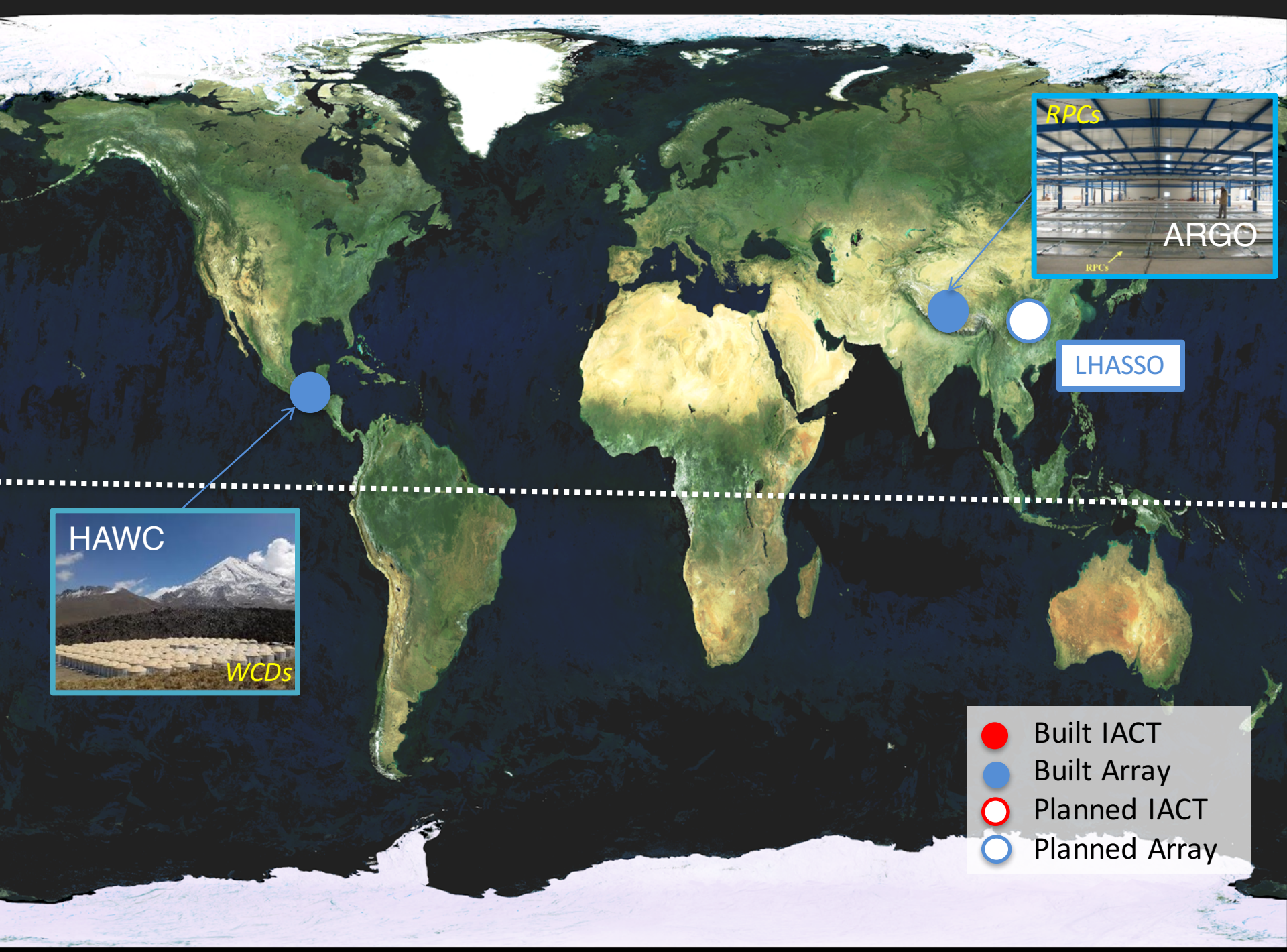


How to detect?



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


VERITAS
MAGIC
RPCs
ARGO
RPCs
LHASSO
HAWC
WCDs
HESS
Built IACT
Built Array
Planned IACT
Planned Array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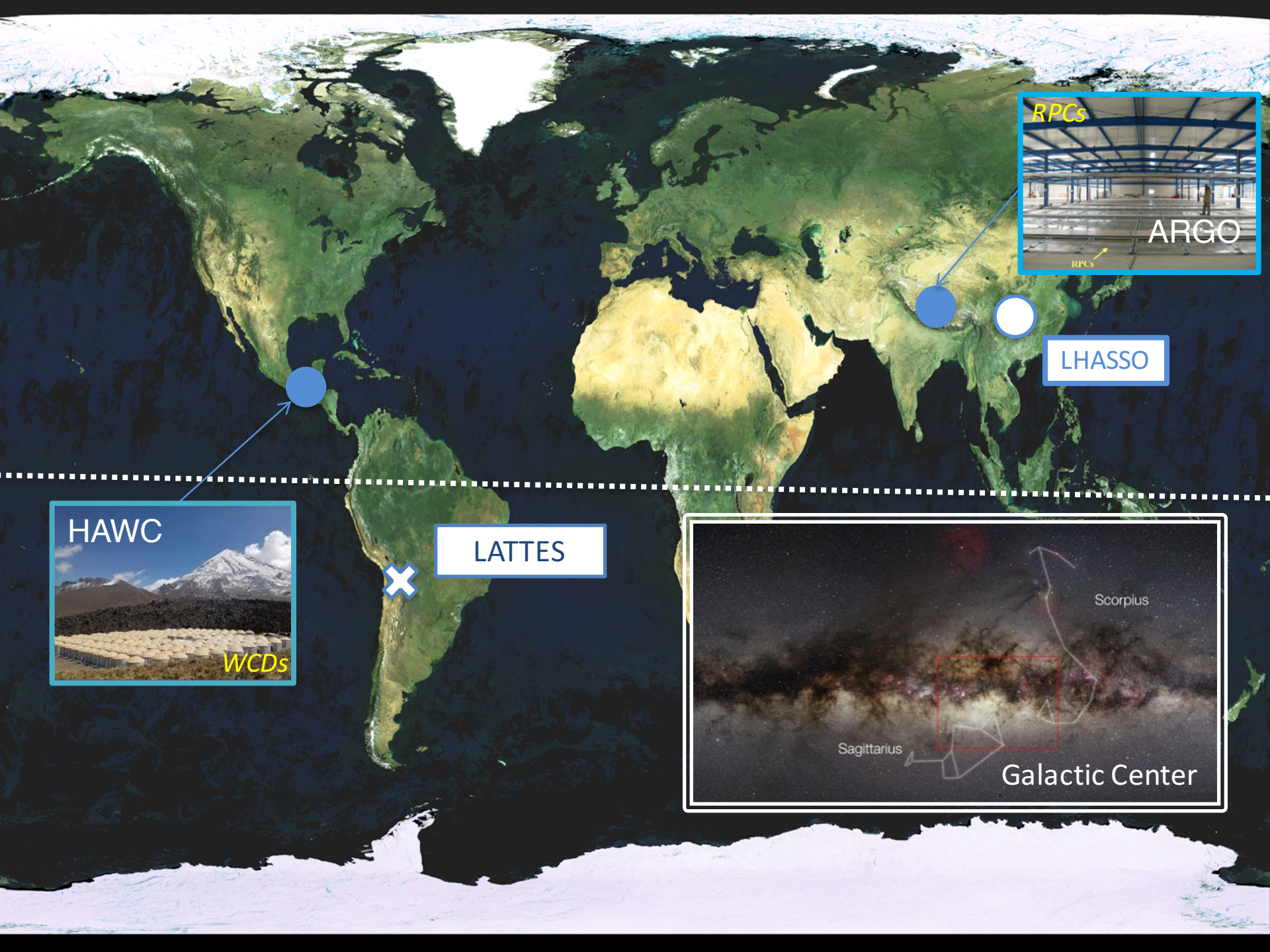
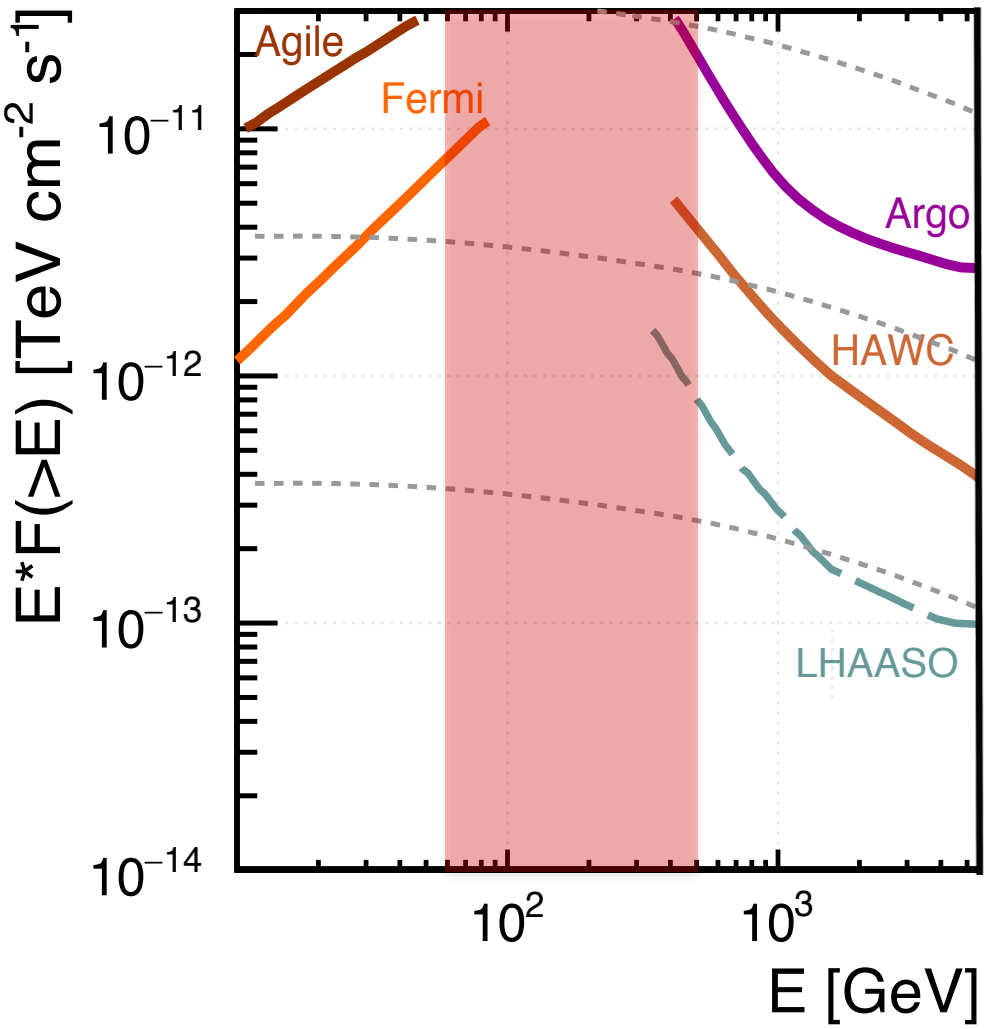

RPCs
ARGO
RPCs
LHASSO
HAWC
WCDs
LATTES
Scorpius
Sagittarius
Galactic Center

LATTES

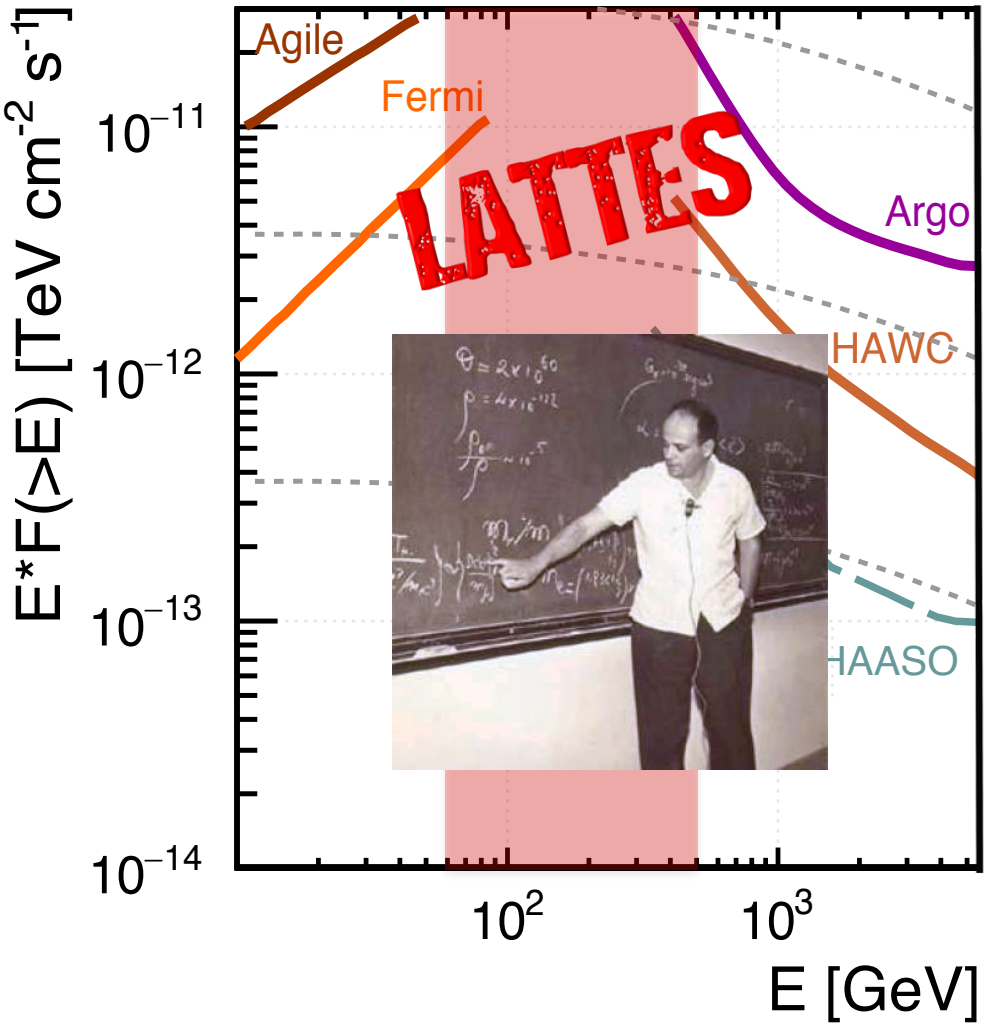
Complementary to the powerful Cherenkov Telescope Array project

Requirements to build a Wide FoV gamma-ray observatory



- Located in the South Hemisphere
- Low energy threshold:
  - High altitude
  - Next generation detector concept

Requirements to build a Wide FoV gamma-ray observatory



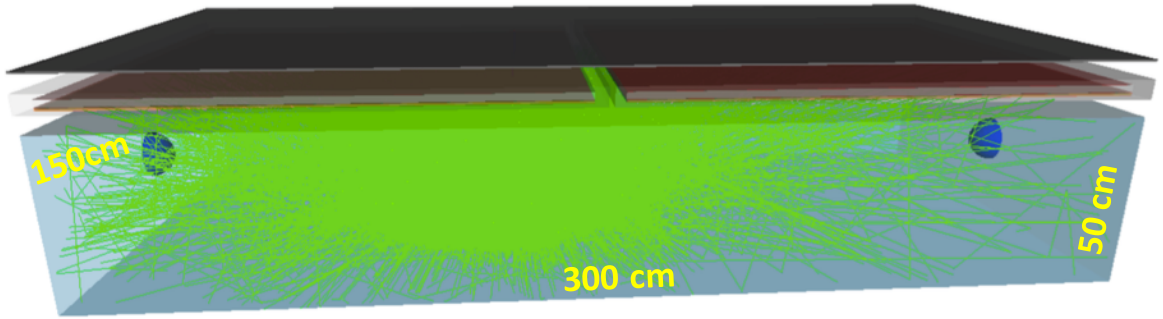
- Located in the South Hemisphere ✓
- Low energy threshold:
  - High altitude ✓
  - Next generation detector concept ✓

LATTES @ ALMA site

Large Array Telescope for Tracking Energetic Sources

- Joint Brazil / Italy / Portugal initiative
- Czech group joined recently
  - Next LATTES meeting in Prague, 28-29th May
- Possible site:
  - Atacama Large Millimeter Array site
  - Chajnantor plateau
  - 5200 meters altitude in north Chile
  - Good position to survey the Galactic Center

The concept: a hybrid detector



Pb

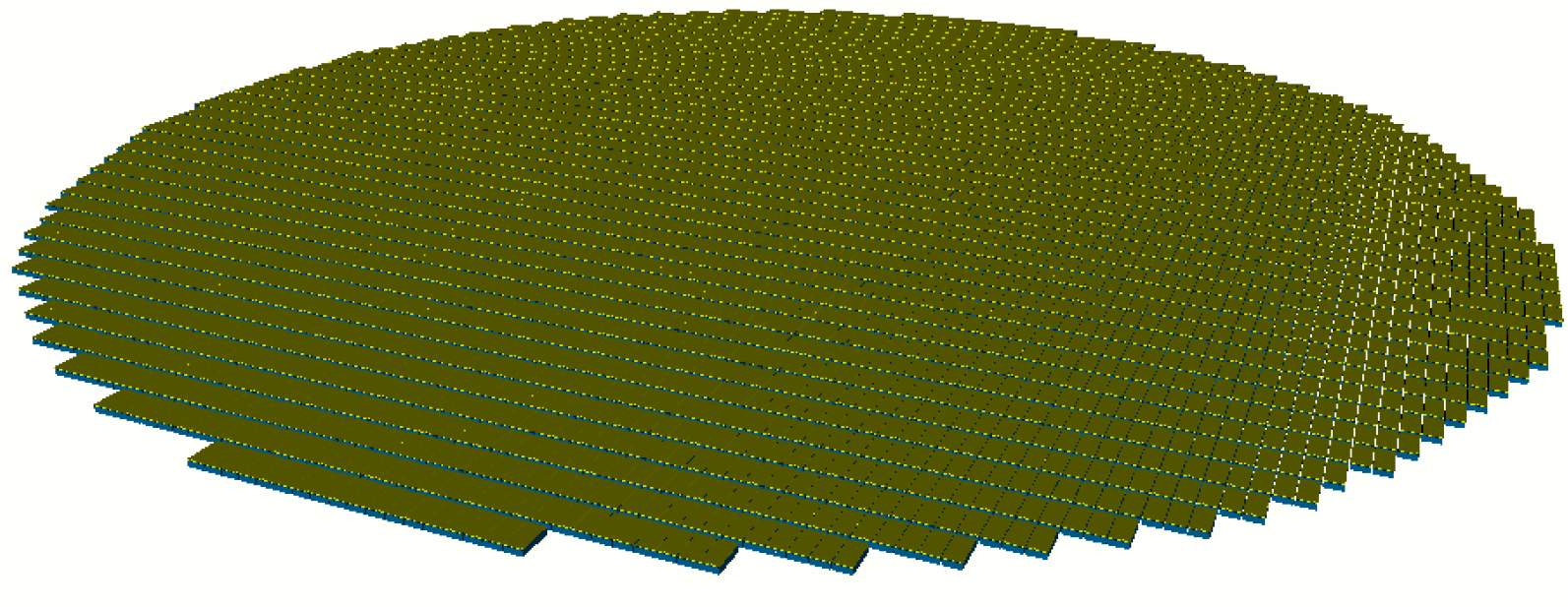
RPC

WCD

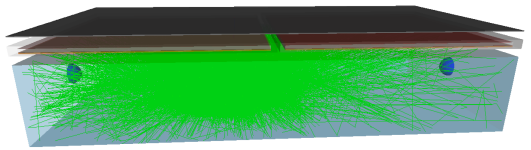
RPCs : time and spatial resolution

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

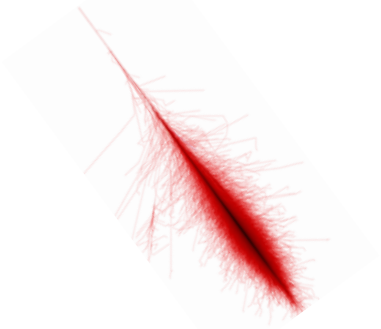
Array configuration



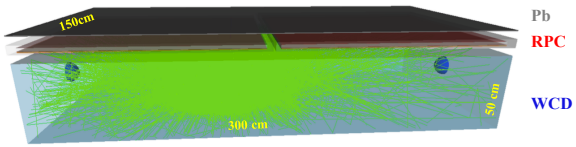
- LATTES compact core array
  - 3600 LATTES stations
  - Array of roughly 20 000 m^2



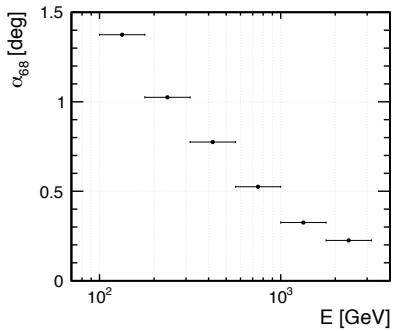
Towards LATTES sensitivity…



Shower simulation (CORSIKA)



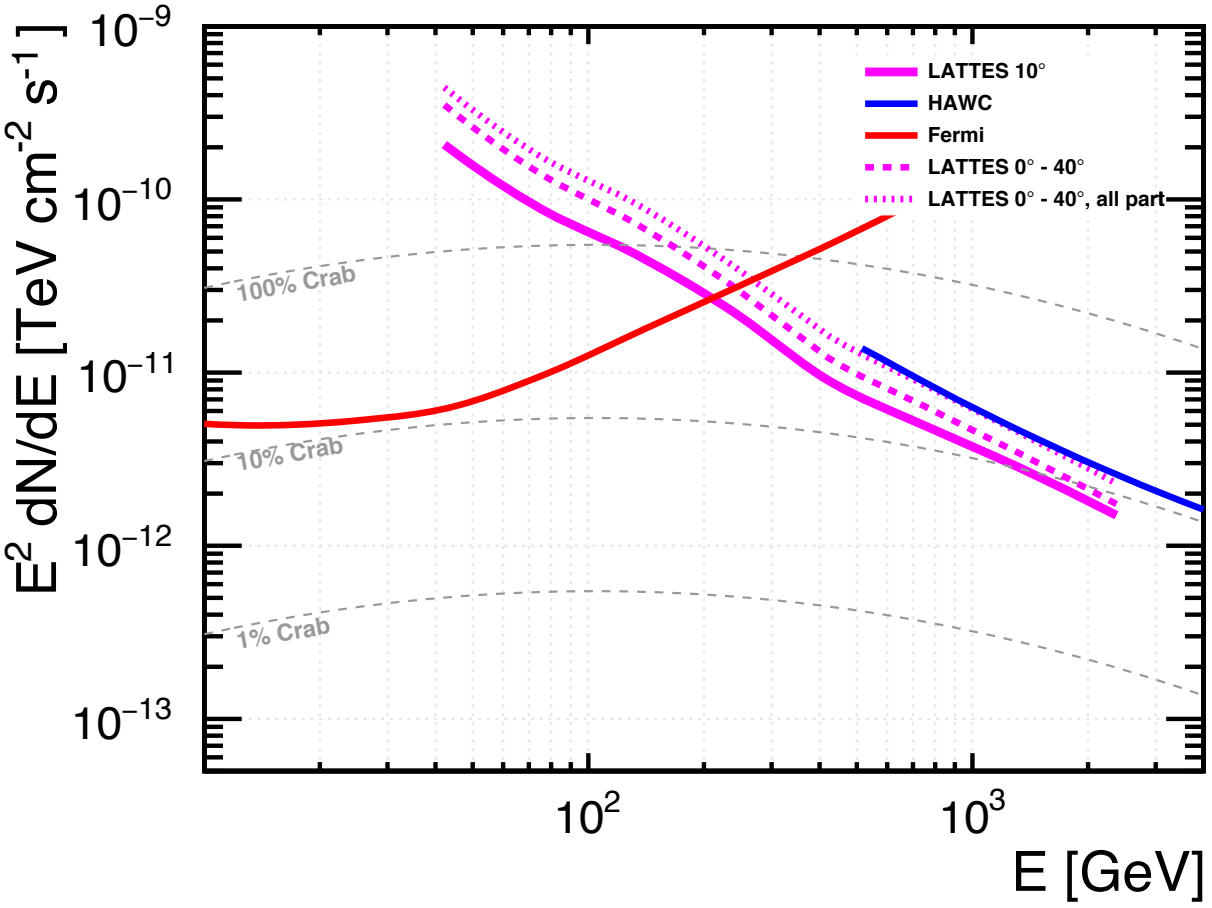
Detector simulation (Geant4)



Shower reconstruction (LATTESrec)

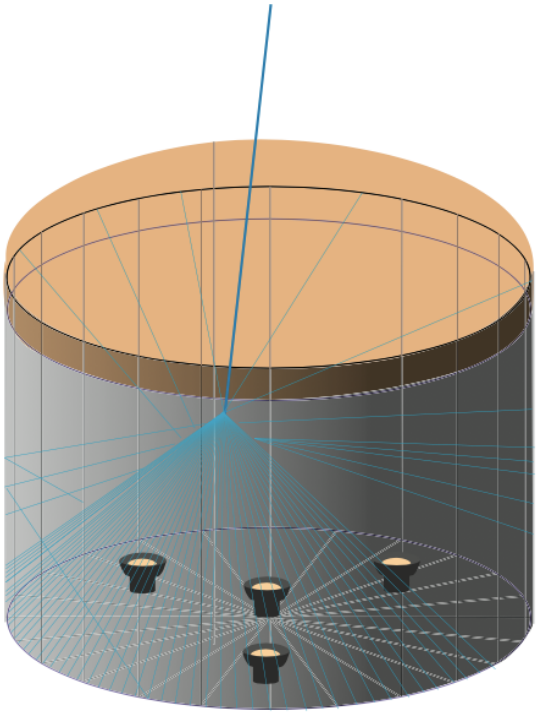
LATTES sensitivity

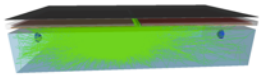
(Astropart.Phys. 99 (2018) 34-42)

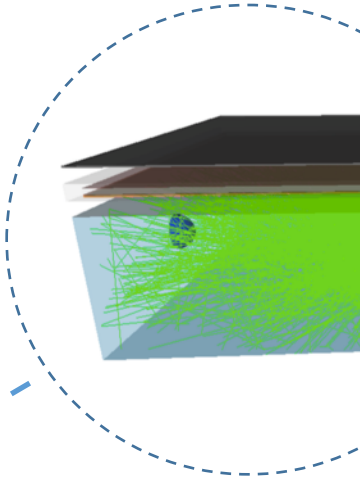


LATTES concept **can cover the energy gap** between satellite borne and ground base experiments

Station: HAWC vs LATTES





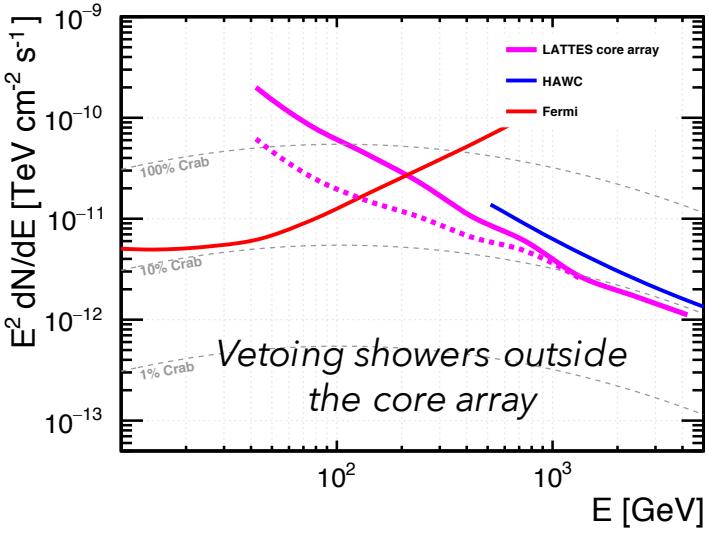


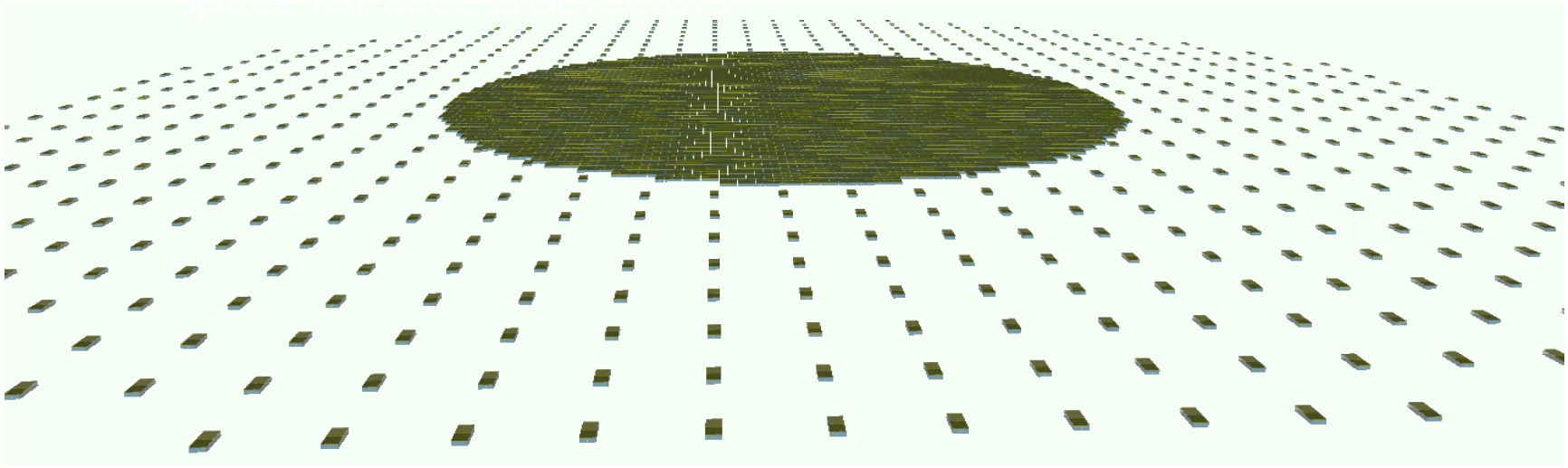
HAWC
(present detector)

LATTES
(next generation)

The future…

- LATTES is a novel detector concept for gamma-rays able to cover the energy gap between satellite borne and ground base experiments
- Capabilities of the LATTES concept are far from explored
- High-energy extension with a sparse array is being studied
  - Energies up to 100 TeV





Acknowledgements

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MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA

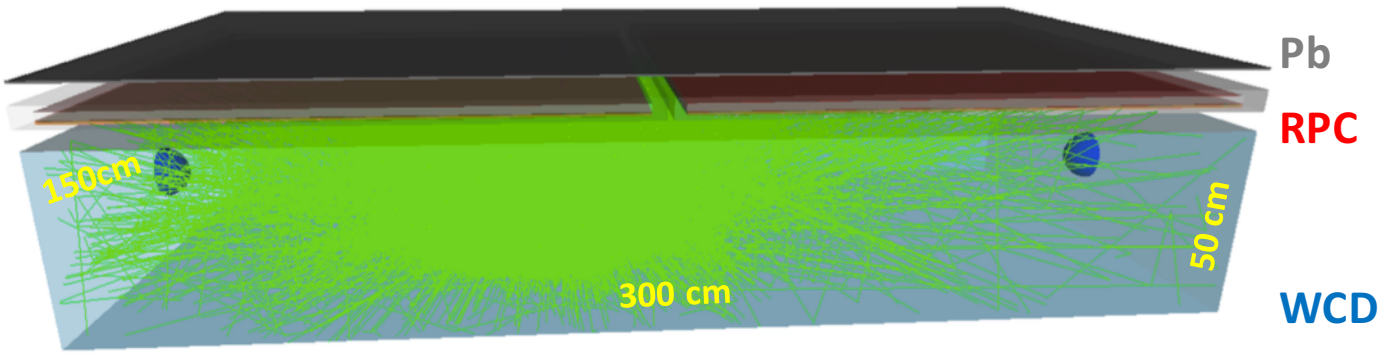
REPÚBLICA PORTUGUESA

LIP

TÉCNICO LISBOA

Backup slides

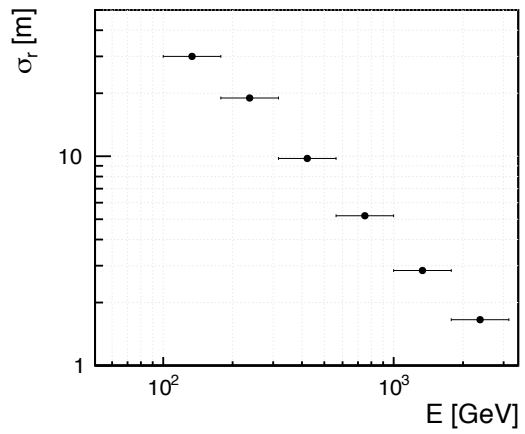
Improve detector concept!



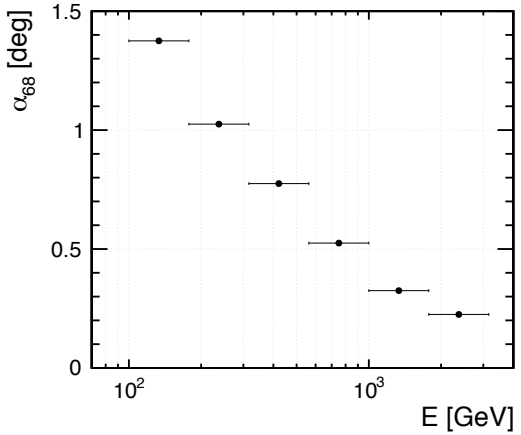
- Thin lead converter plate **(Pb)**
  - Improve shower geometry reconstruction
- Resistive Plate Chamber **(RPC)**
  - Measure charged particles with high spatial and time resolution
- Water Cherenkov Detector **(WCD)**
  - Collect shower secondary photons/electrons to improve trigger at low energy

LATTES performance at glance

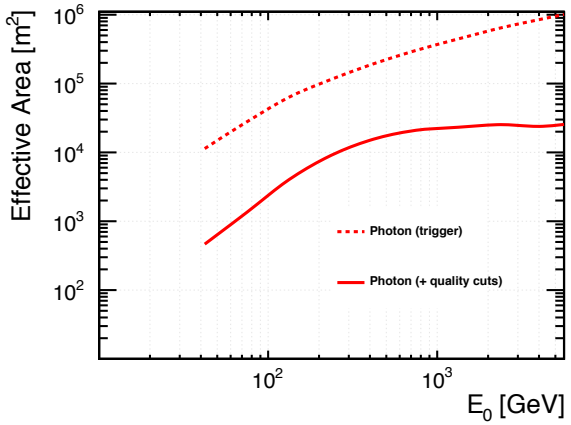
Shower Core Rec



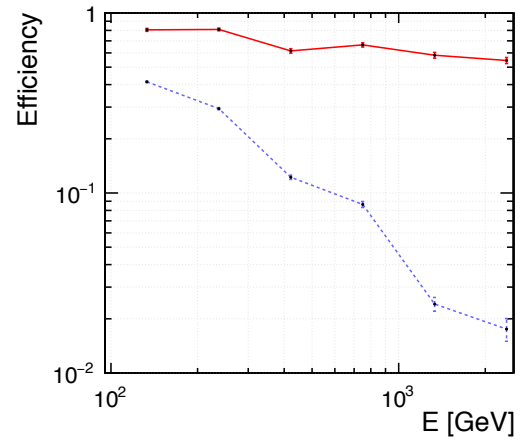
Shower Geometry Rec



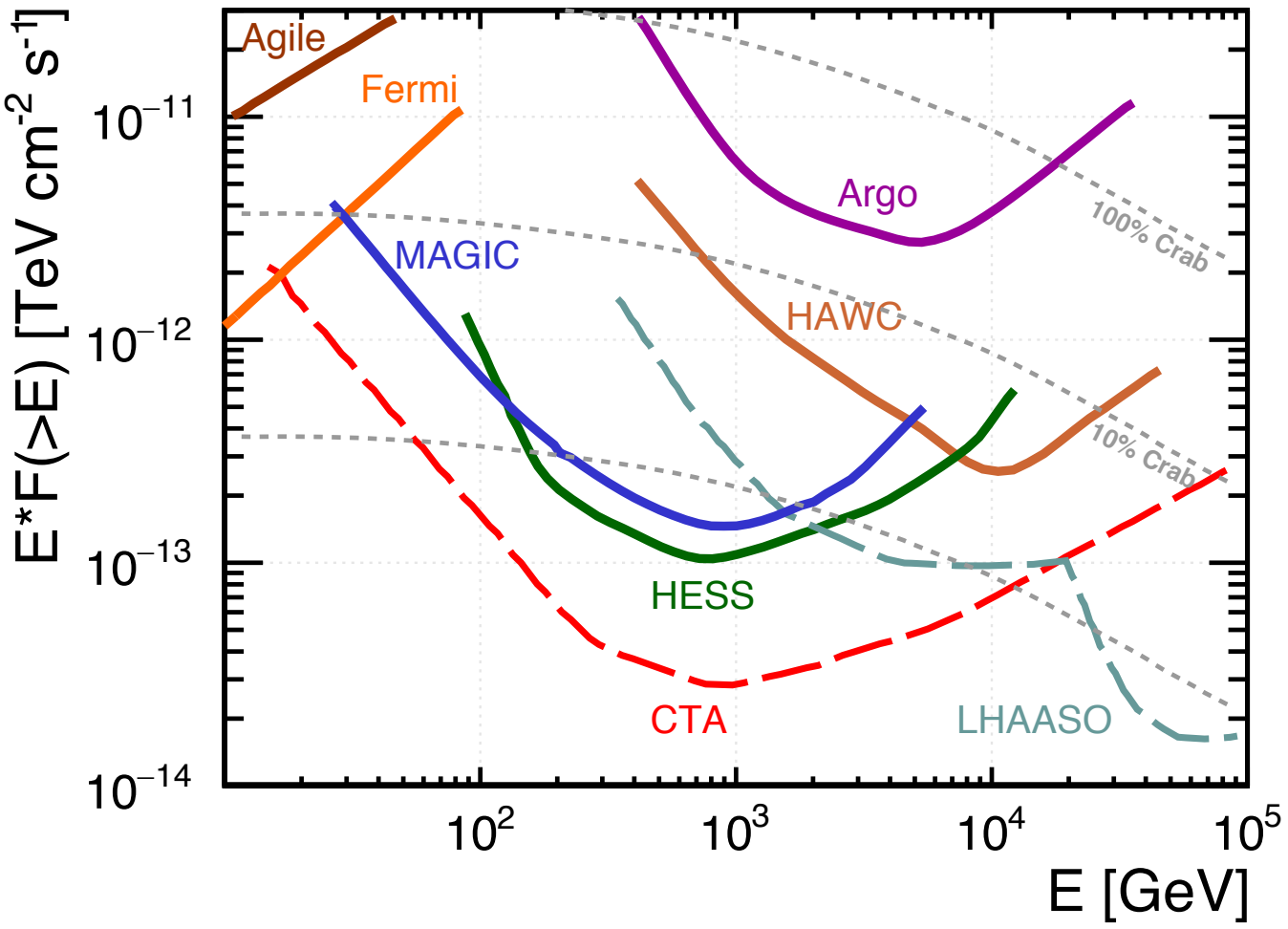
Effective Area



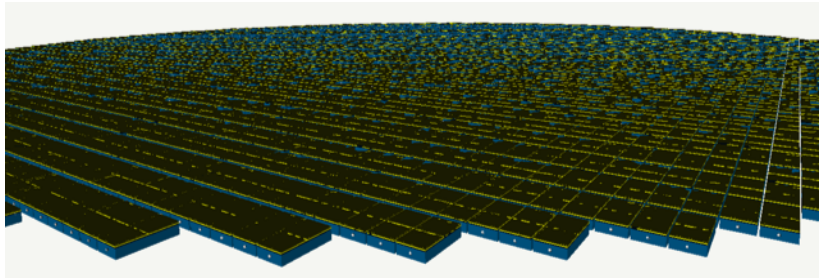
G/H Discrimination

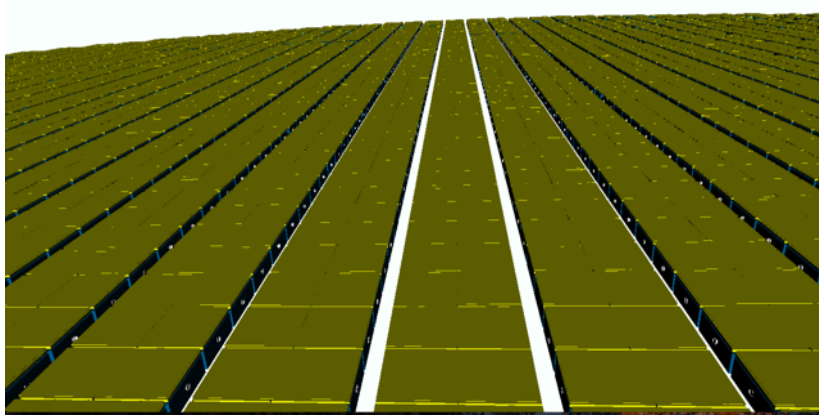


(Very) High-Energy Gamma-Rays

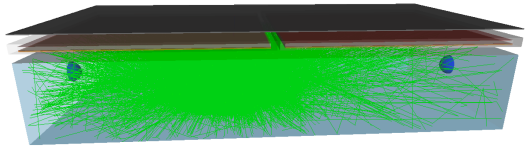


Array configuration



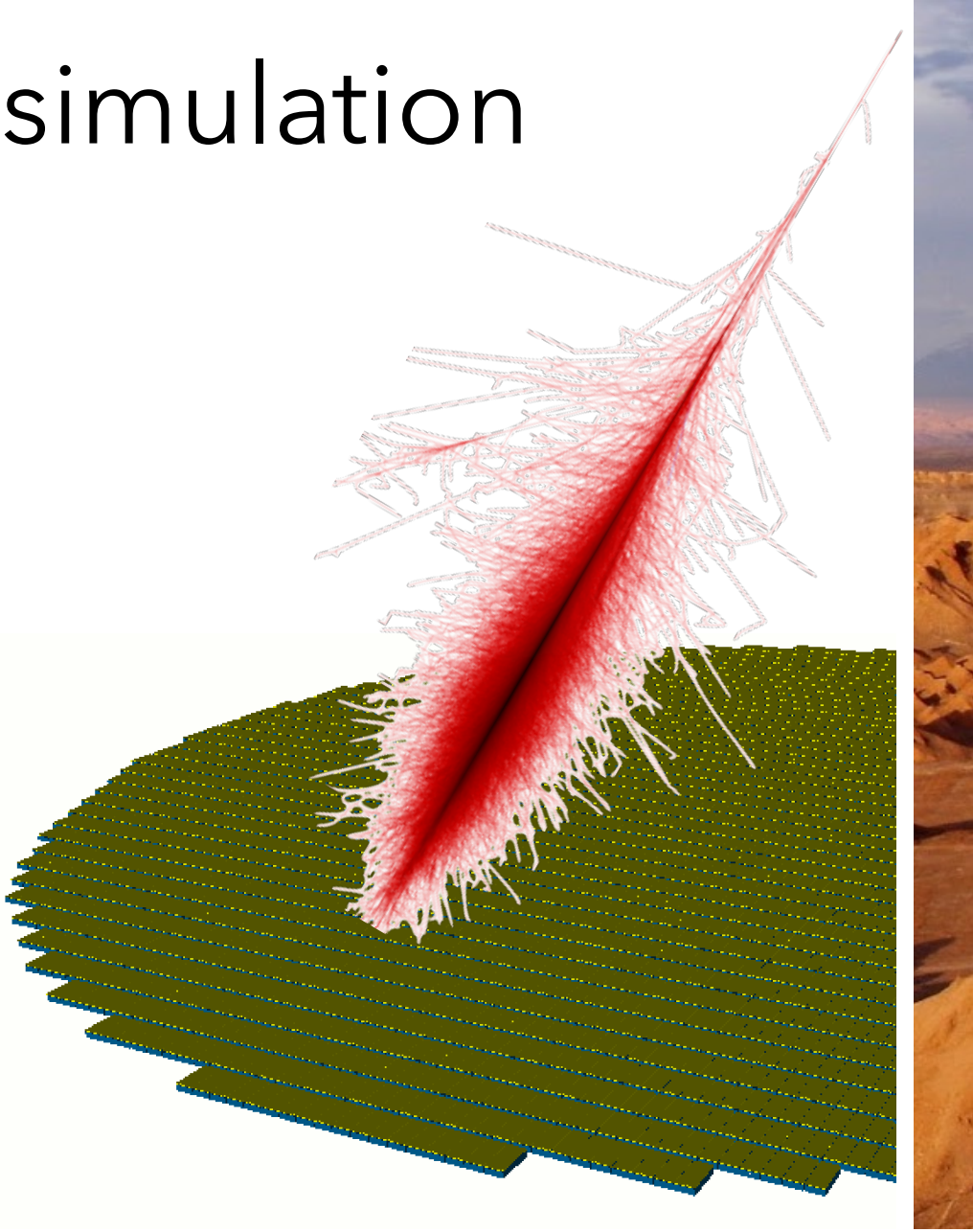


- LATTES compact array
  - 3600 LATTES stations
  - Circular array of radius 70 m
  - Array of roughly 20 000 m^2
  - 0.5 m space for access detectors



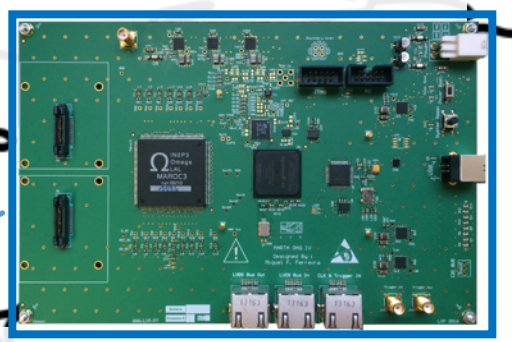
Detector simulation

- 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



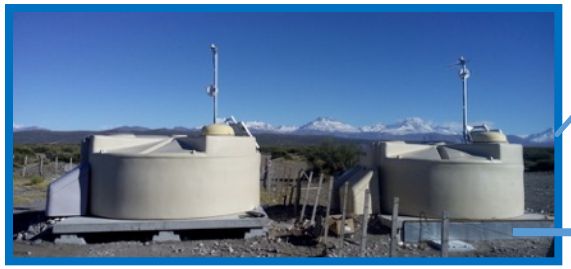
DAQ Engineering prototype

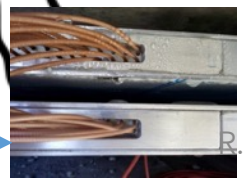
RPC based muon hodoscope for precise studies of the Auger WCD

Construction and Assembling

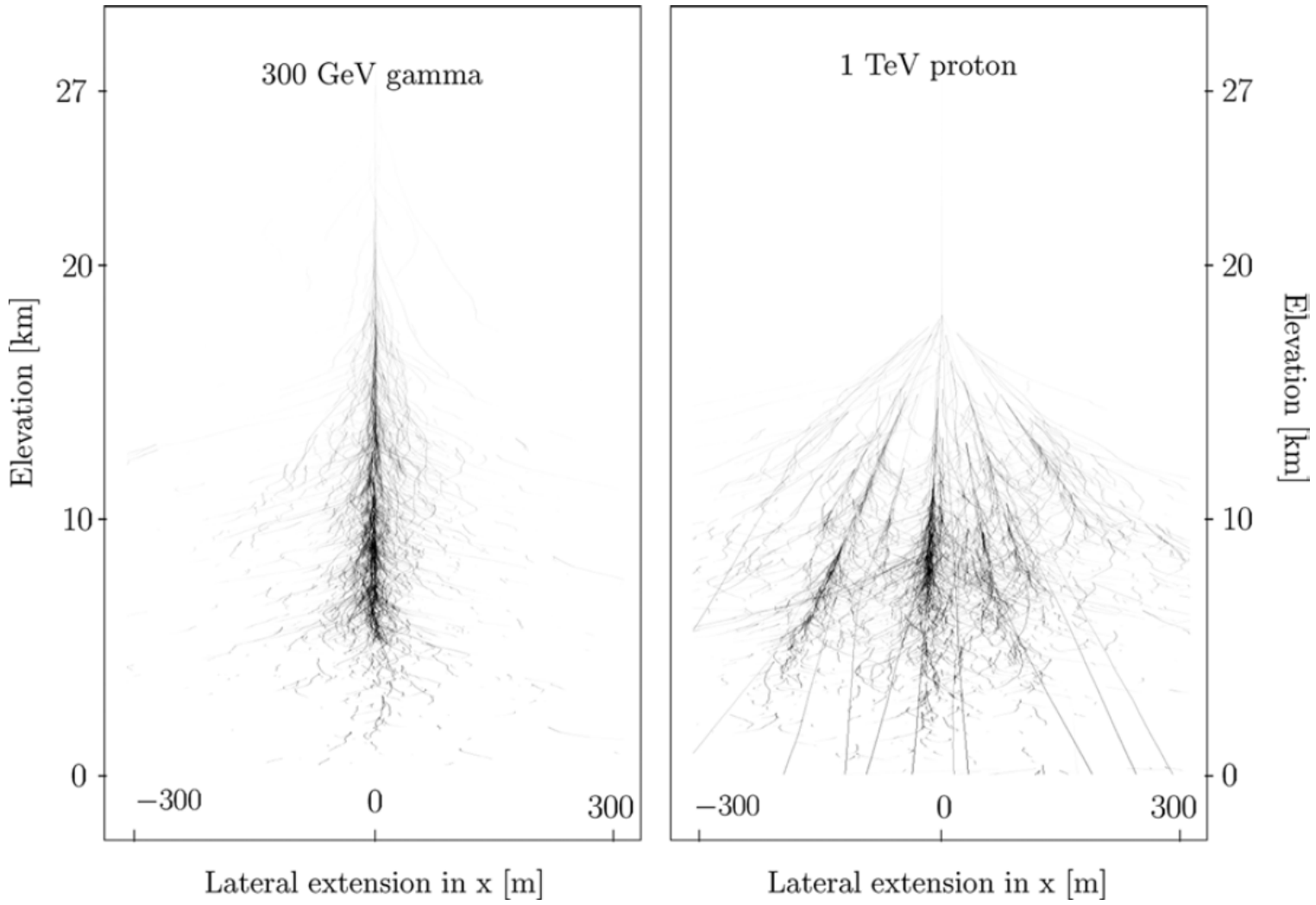
RPC hodoscope

RPCs in the field @ Auger



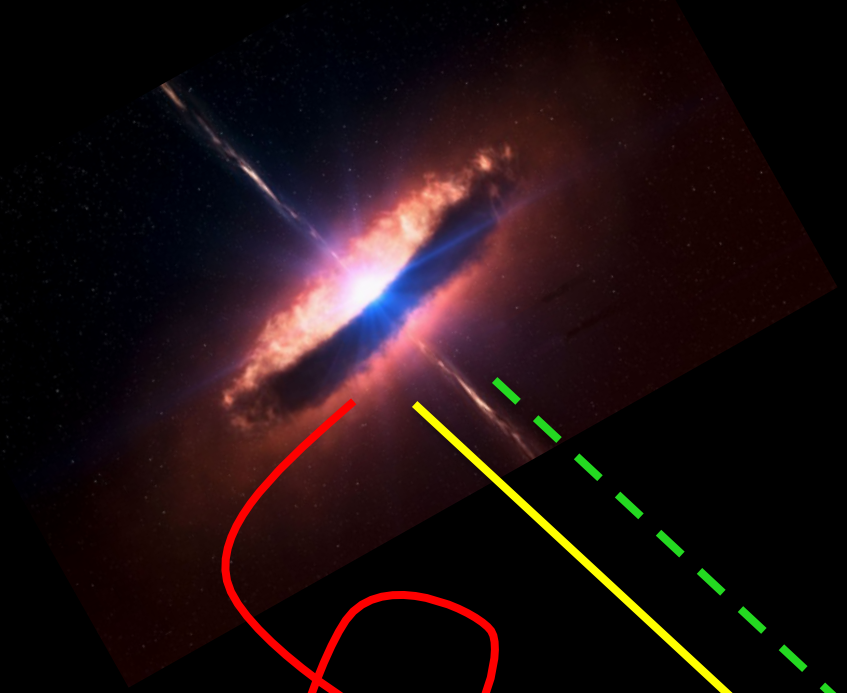


Strategies for primary discrimination



Explore differences in shower development

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