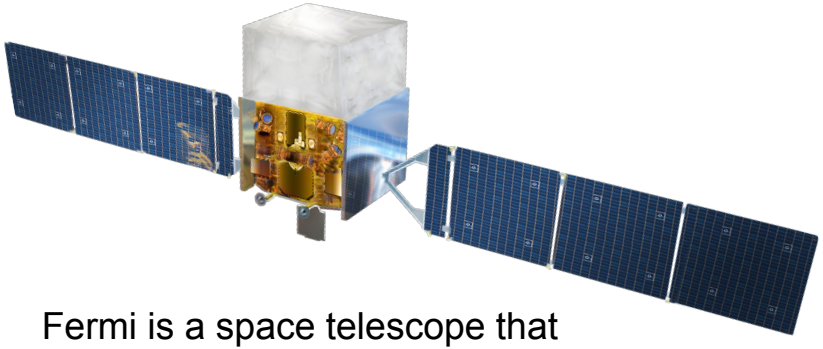
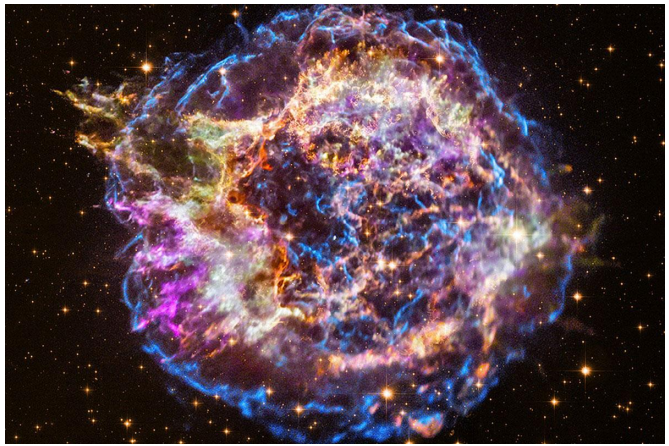
Development of Novel Reconstruction Techniques for Low-energy Gamma-ray Showers

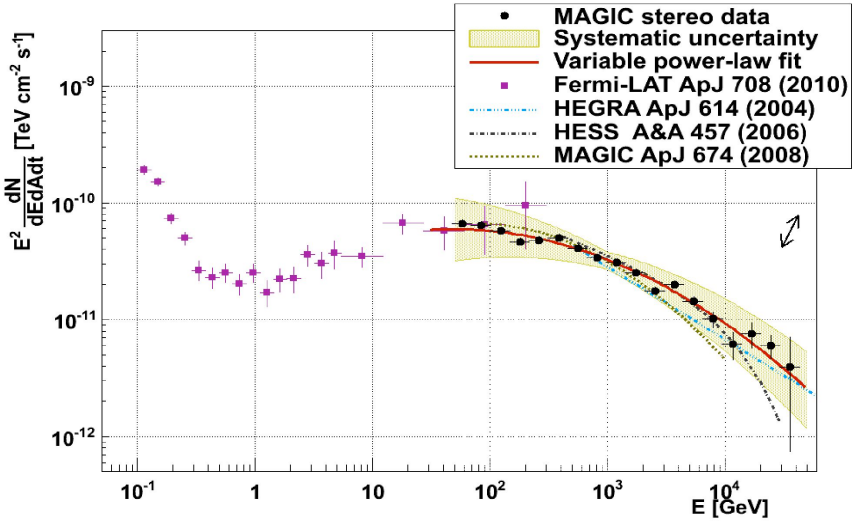
Cosmic gamma-rays



Fermi is a space telescope that detects cosmic gamma-rays

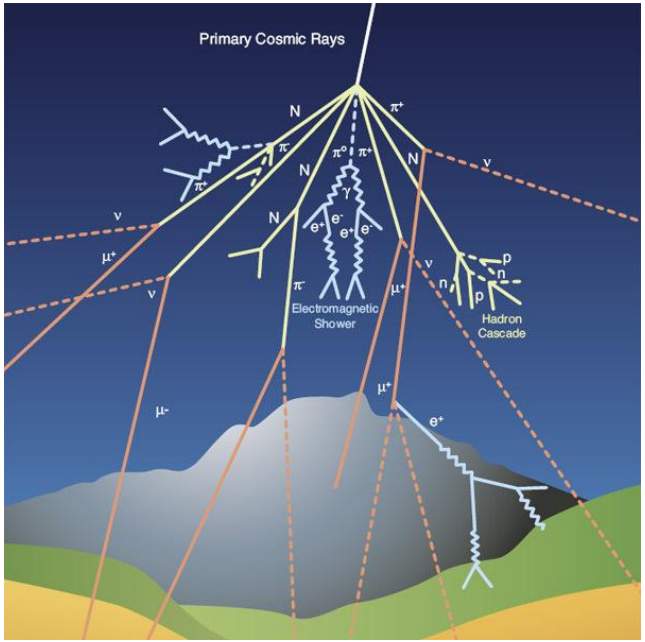


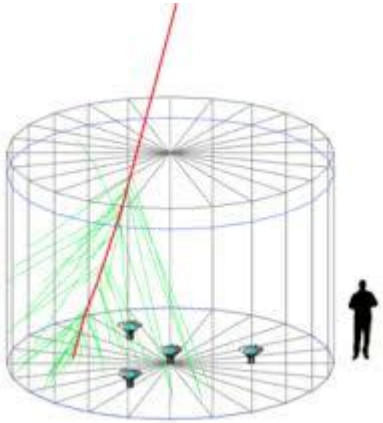
Main source of cosmic gamma-rays in our galaxy are supernova remnants



Cosmic gamma-ray flux decreases with particle energy (Crab Nebula)

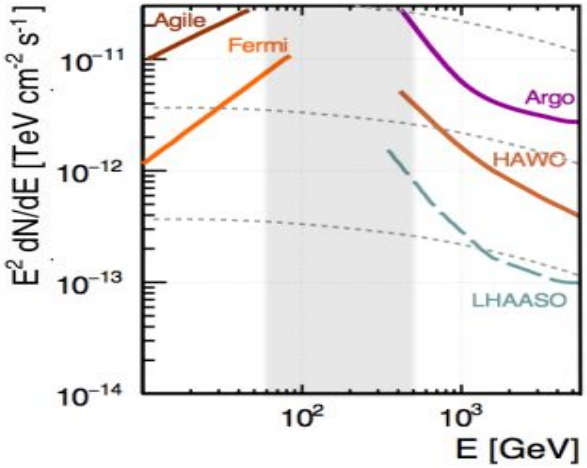
Particle showers and ground detectors



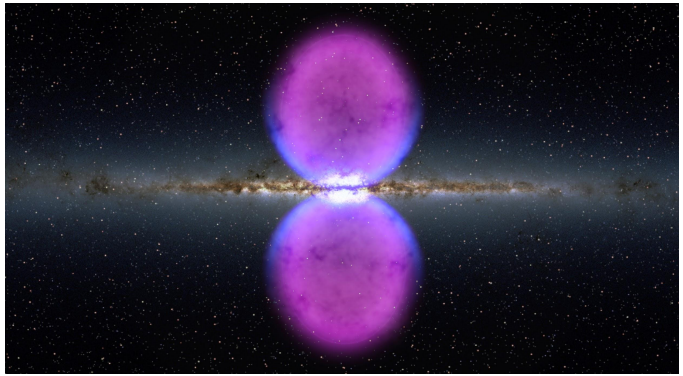


Ground detectors form arrays with very large areas (example of HAWC experiment). These detectors can't detect cosmic rays directly, only the resulting shower of their interaction with the atmosphere.

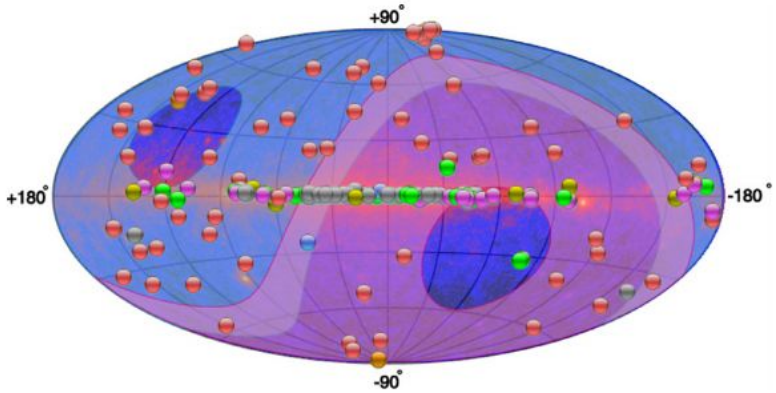
The need for a new detector



Energy gap filled by the new detector

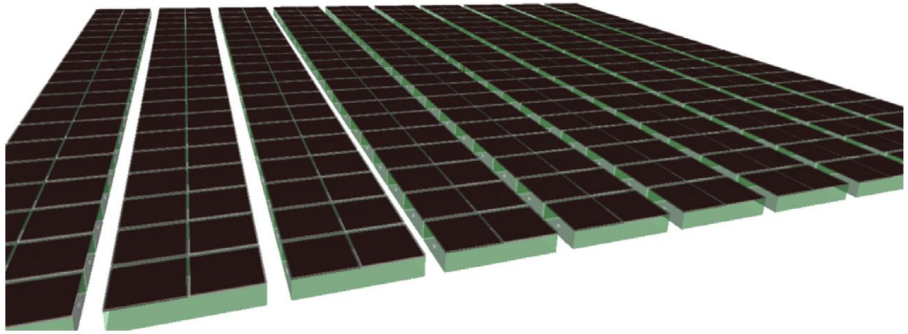


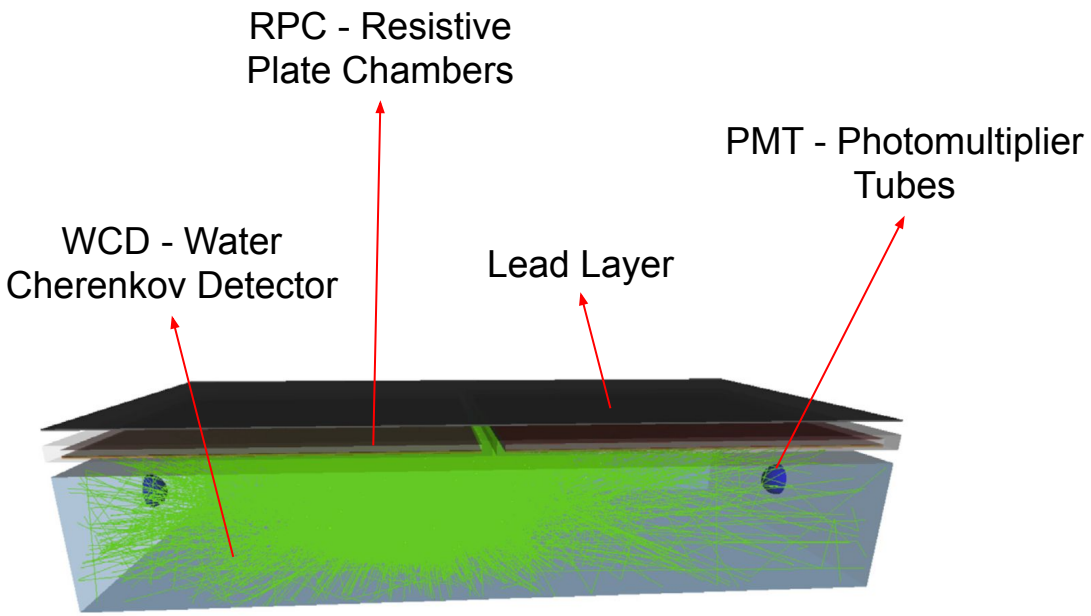
Fermi Bubbles found by the fermi telescope

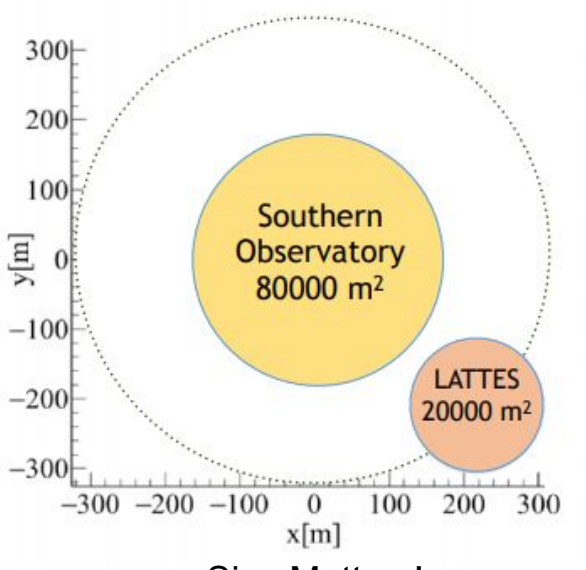


Very High Energy Emissions in Galactic Coordinates - The blue area is visible from the Northern hemisphere and the pink area from the Southern hemisphere

LATTES - hybrid concept

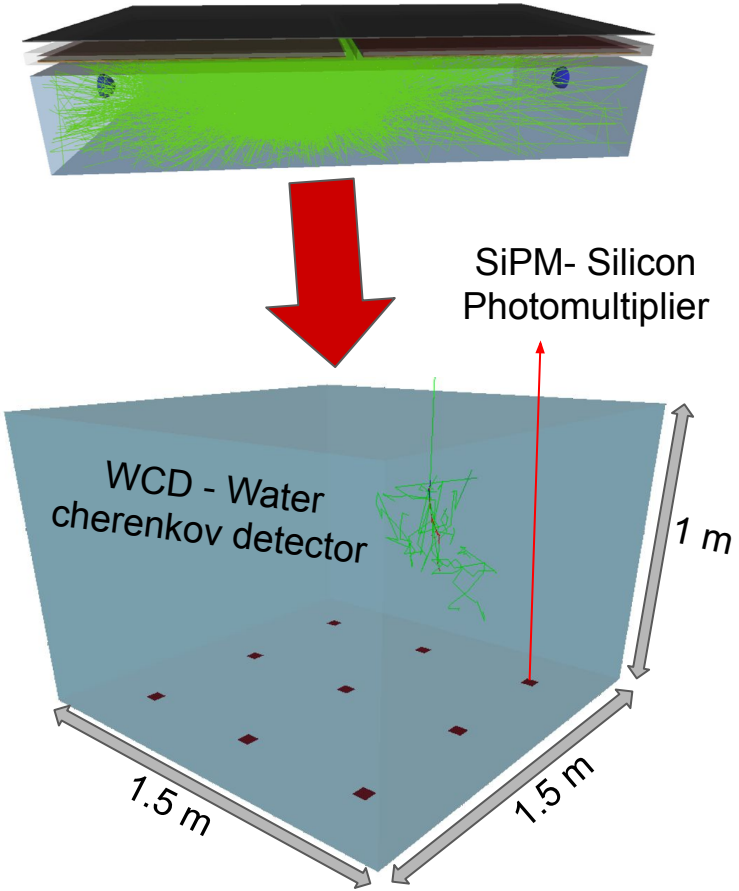




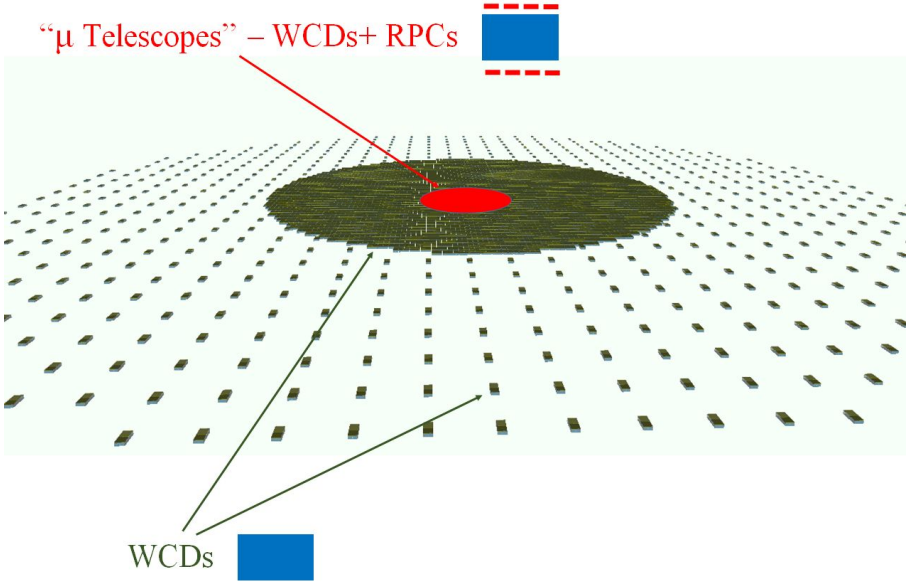


Size Matters!

SWGO - new concept



With a bigger array, less sophisticated detectors must be used in order to reduce costs and maintenance work.



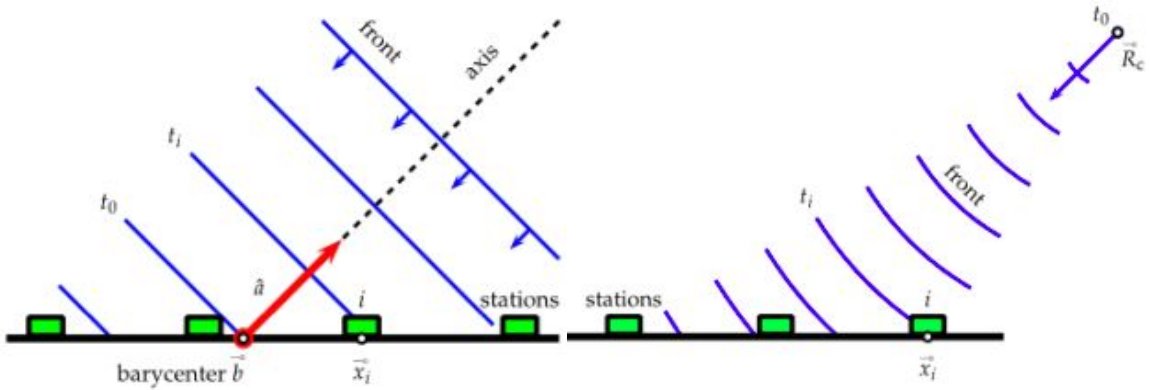
The new challenge is to have measurements with the same precision as before with these simpler detectors.

Reconstruction of Shower Geometry

RPC hit time
(1ns time resolution)

- Apply quality cuts - Only consider triggered WCD stations;
- Shower plane front fit and remove late arrivals (mainly low energy electrons);
- Shower conic front fit.

Shower Core Position and Direction



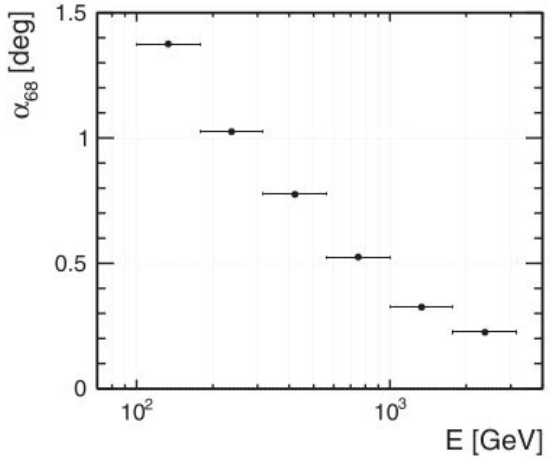
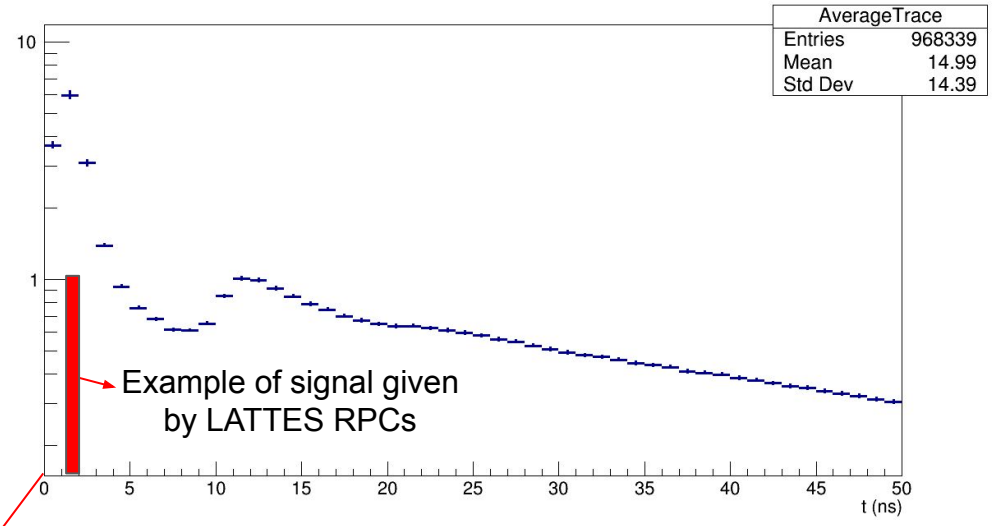


Fig. 7. Angular resolution for gamma-ray primaries with zenith angle $\theta = 10°$, as a function of the reconstructed energy.

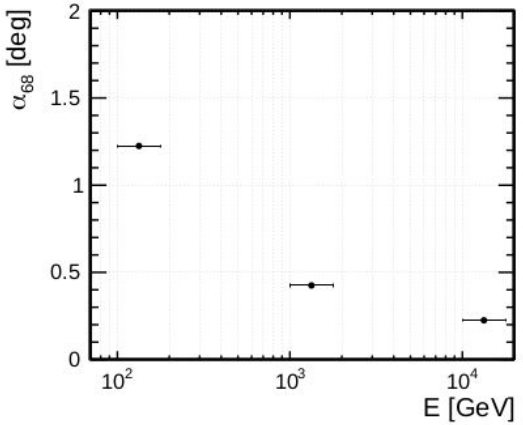
Time measurements



Start Time given by simulation

SiPMs give a signal with initial peak and exponentially decreasing peaks from reflected light.
We must find a way to measure time with a precision of at least 2 ns.

Angular resolution with Start Time



Estimators being tested at the moment:

$$< t >= \frac{\sum_i t_i s_i}{\sum_i s_i}$$

$$t_{max} : \forall t, s(t_{max}) \geq s(t)$$