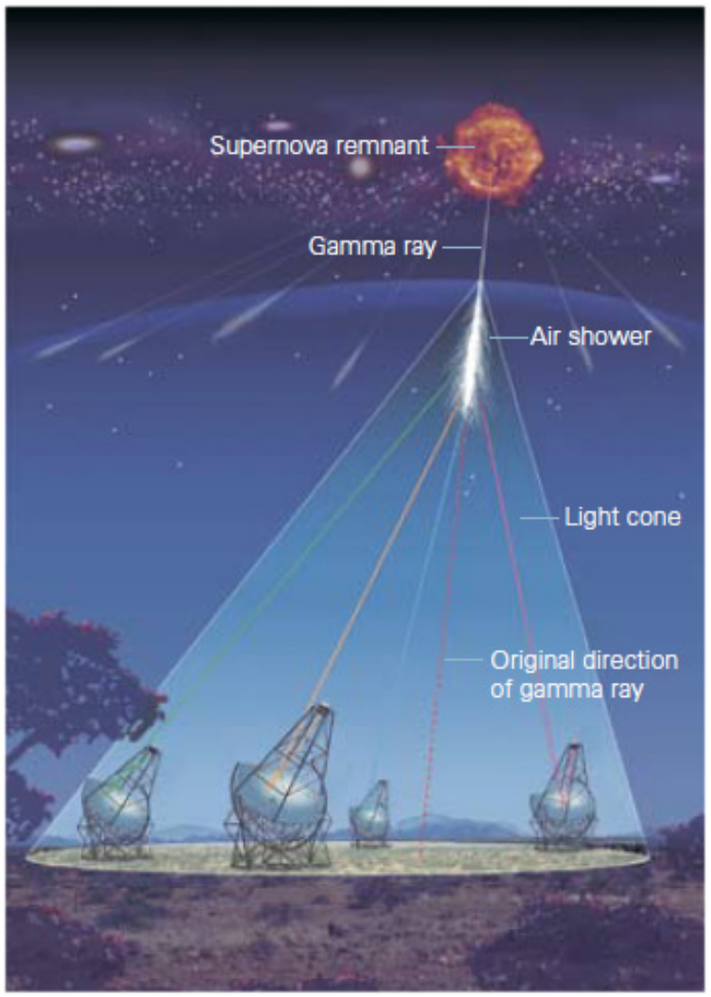
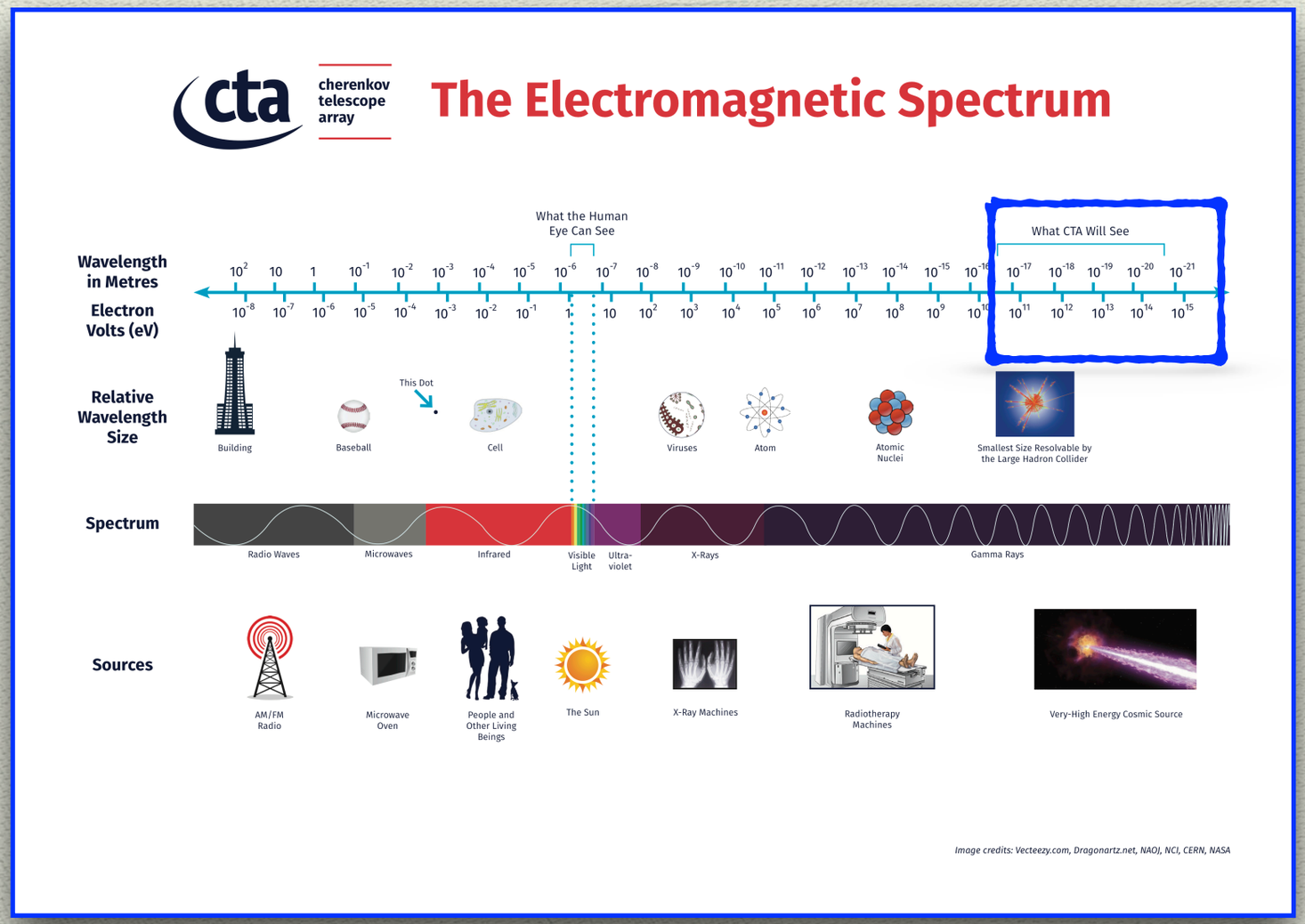
Cherenkov Telescope Array



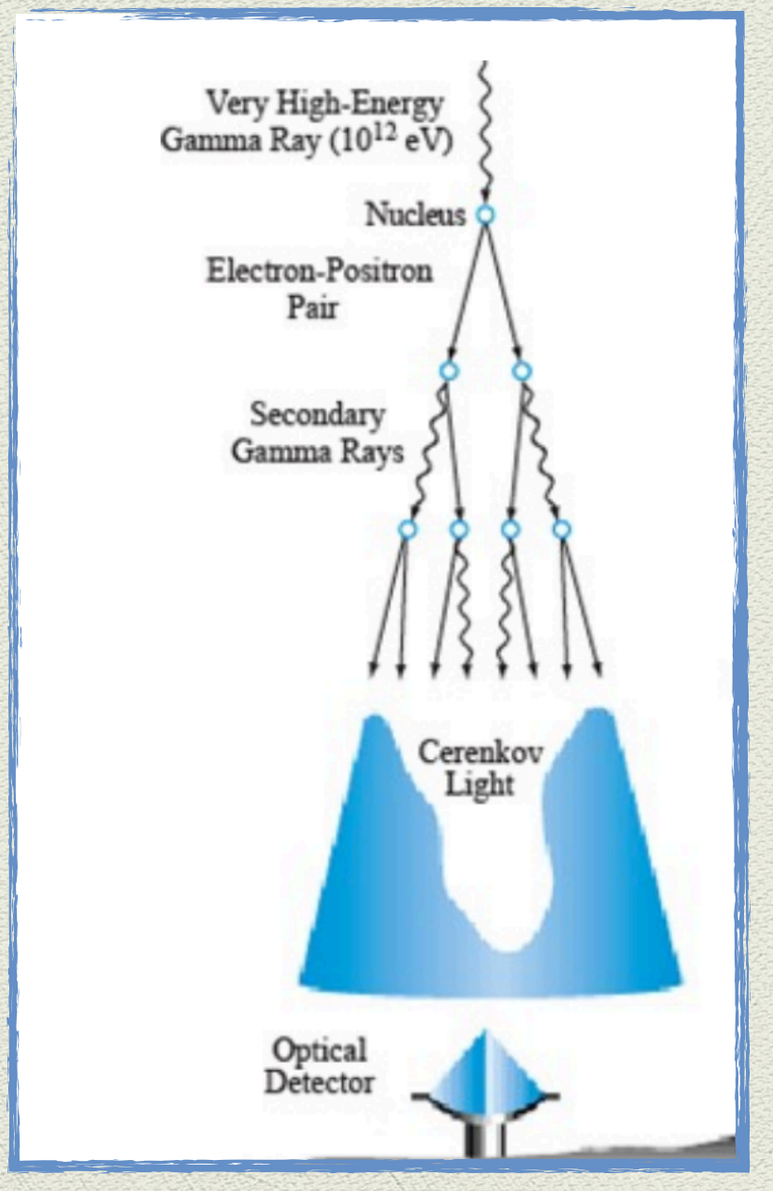


Gamma-ray and atmosphere

When a Gamma-ray enters the atmosphere , it generates a casacade of secondary particles

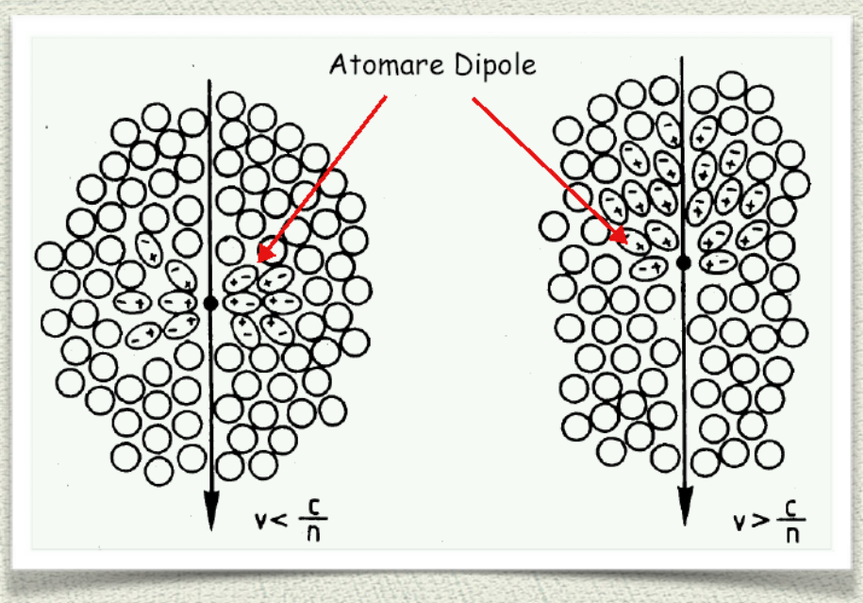
These secondary electrons lose energy mainly by bremsstrahlung radiation to produce gamma rays.

The latter may produce more pairs and the pairs produce more gamma rays



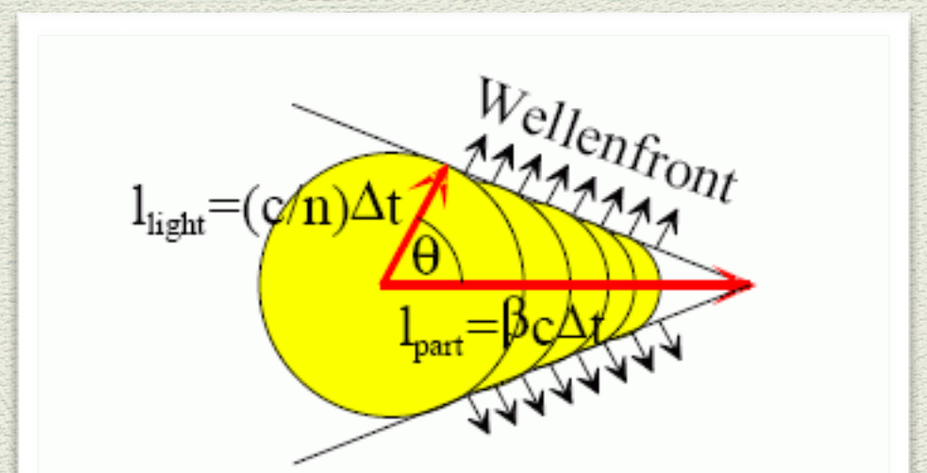
Cherenkov effect

Electromagnetic radiation emitted when a charged particle (such as an electron) moves through a medium faster (v) than **the velocity of light in that medium (c/n)**.
It occurs **only** if the particle's speed is higher than the velocity of light in the material



charged particles polarise material
time dependent dipole field → dipole radiation
v<c/n dipoles symmetric → no net radiation
v>c/n asymmetric → Cherenkov radiation

Cherenkov light is emitted under a constant angle defined by Cherenkov photons and track of particle



$$cos\theta = \frac{c}{n\beta c} = \frac{1}{n\beta}$$

If $\beta = 1, n \sim 1.00029$ (air) then $\theta \sim 1.3^0$

Cherenkov - basic formulas

- The Cherenkov angle can be used to measure beta (momentum). Ring imaging detectors in lab experiments.
- Cherenkov condition: $\beta>1/n \dashrightarrow \theta>0$
- The energy threshold (Lorentz factor) is determined by the refractive index.
- The number of photons scales with lambda^{-2}: Cherenkov light is blue in typical media such as water and air.
- The number of photons scales with $\sin^2\theta$

$$\cos\theta = \frac{1}{n\beta}$$

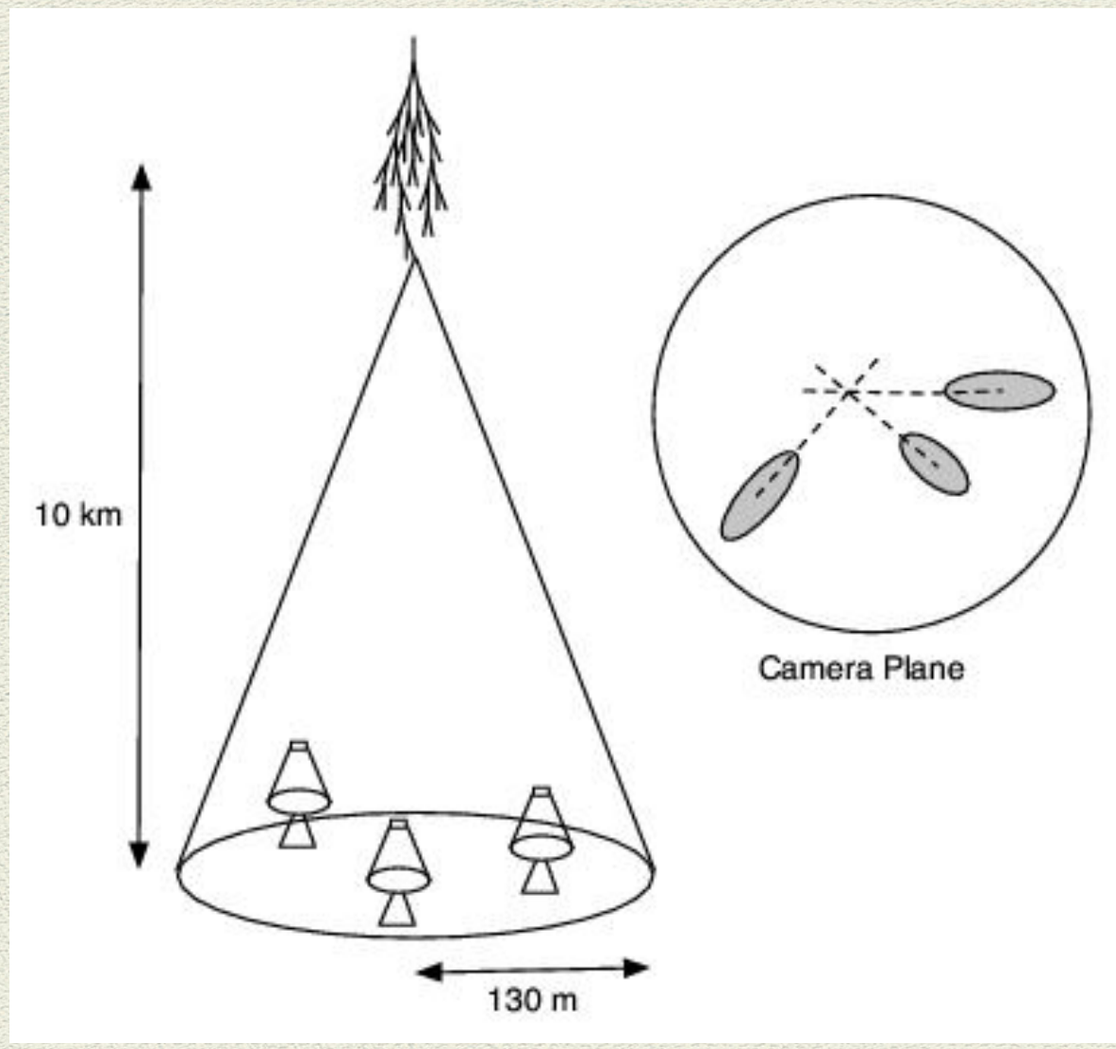
$$\gamma > \frac{1}{\sqrt{1-n^{-2}}}$$

$$\frac{dN}{dx} = 2\pi\alpha z^2 \int \left(1 - \frac{1}{n^2\beta^2}\right)\frac{d\lambda}{\lambda^2}$$

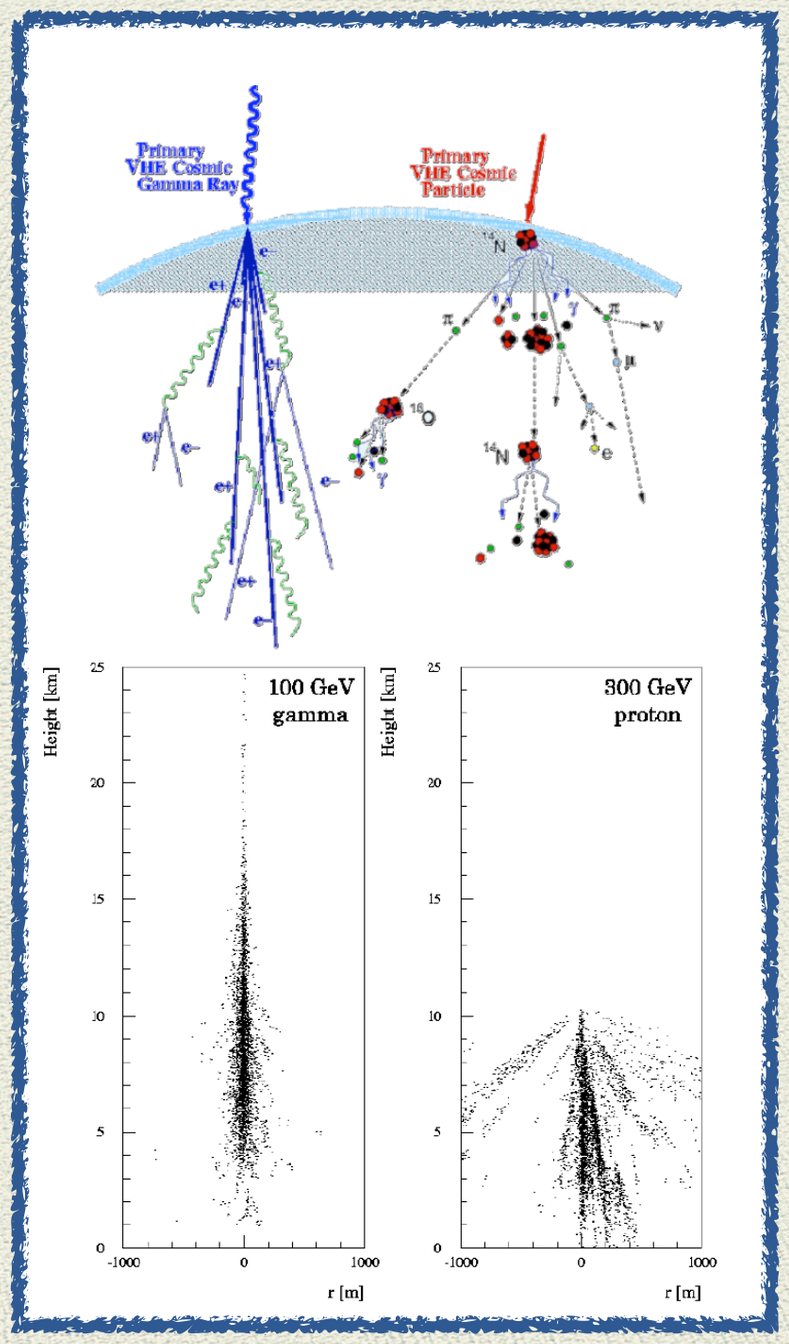
$$\frac{dN}{dx} = 2\pi\alpha z^2 \int \sin^2\theta \frac{d\lambda}{\lambda^2}$$

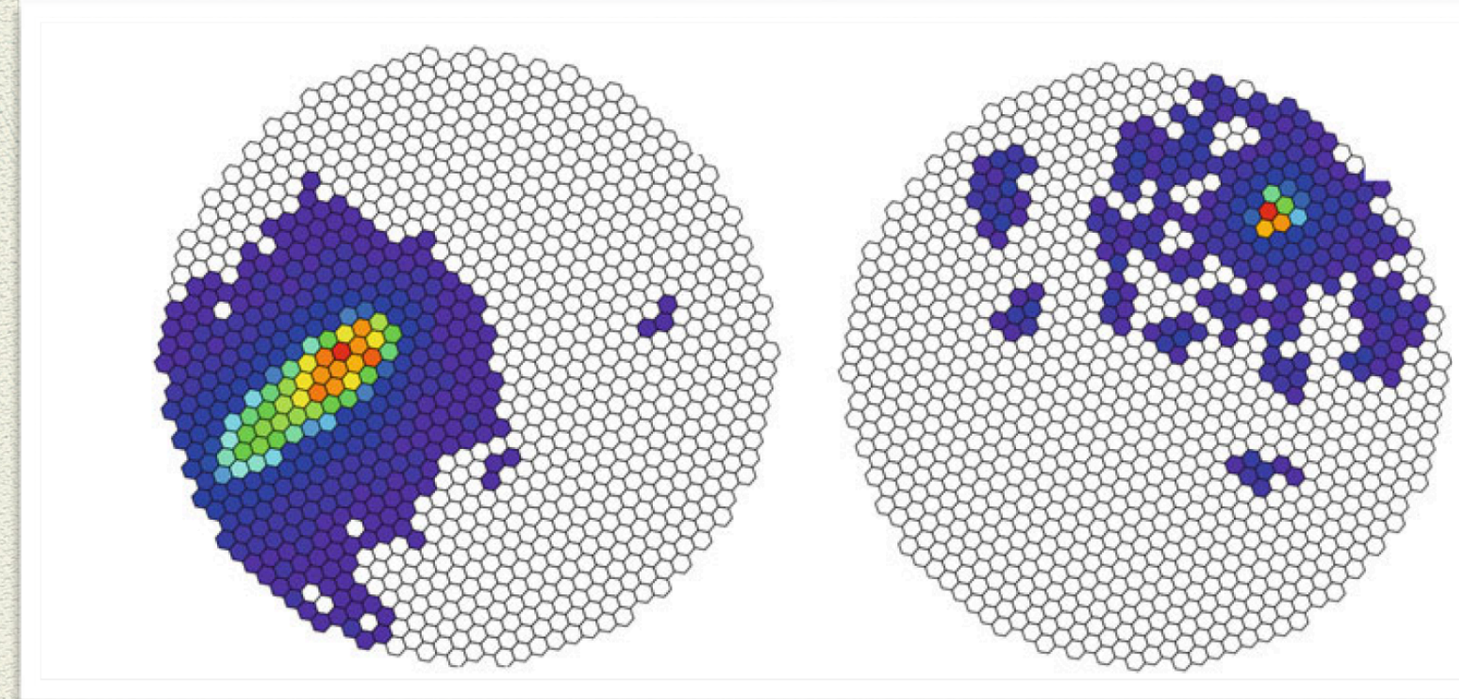
The maximum emission occurring at an altitude of ~ 10 km for primary energies of 100 GeV–1 TeV.

The photon density is typically ~ 100 photons/m^2 at 1 TeV, arriving in a brief flash of a few nanoseconds duration.

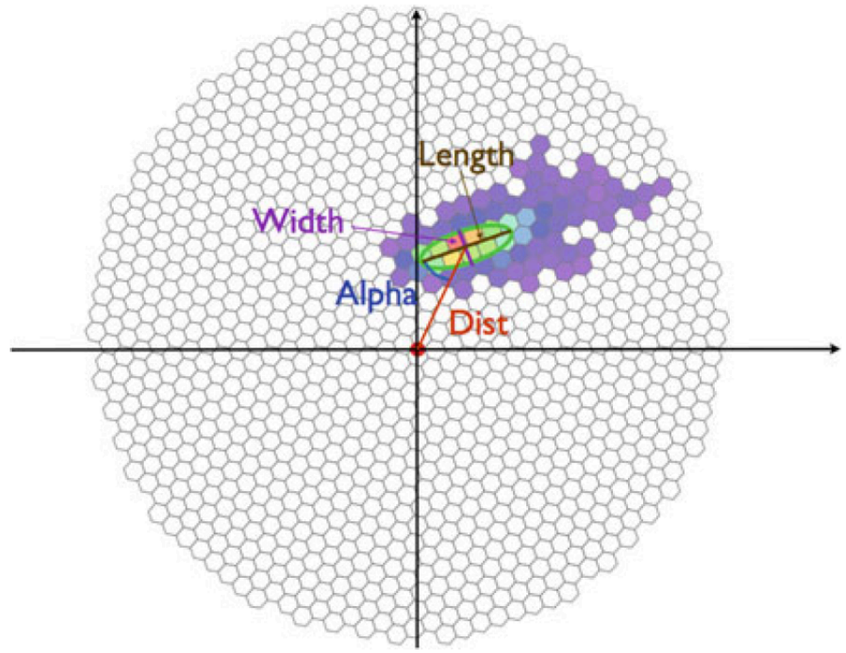


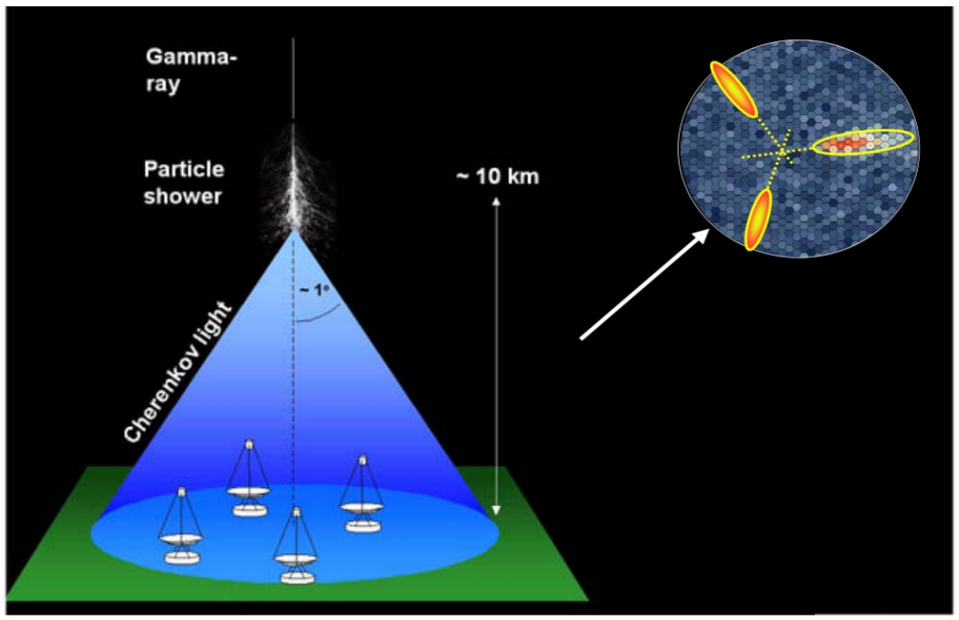
CCD cameras are simply not fast enough to detect the Cherenkov light created by an incident gamma-ray photon. Furthermore, one needs sensitive detectors to record such faint radiation. That is why the sensitive part of cameras in Cherenkov telescopes are constituted of photomultipliers.


Primary
VHE Cosmic
Gamma Ray
Primary
VHE Cosmic
Particle
^{14}N
^{16}O
^{14}N
100 GeV
gamma
300 GeV
proton
Height [km]
r [m]

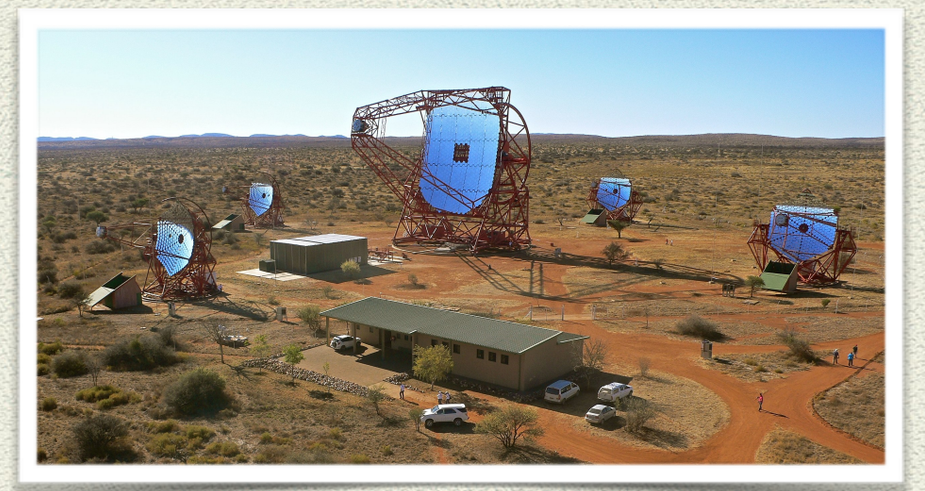


- Shape of the image : photons/hadrons
- Orientation: direction
- Intensity: photon energy





Cherenkov Telescope at work now

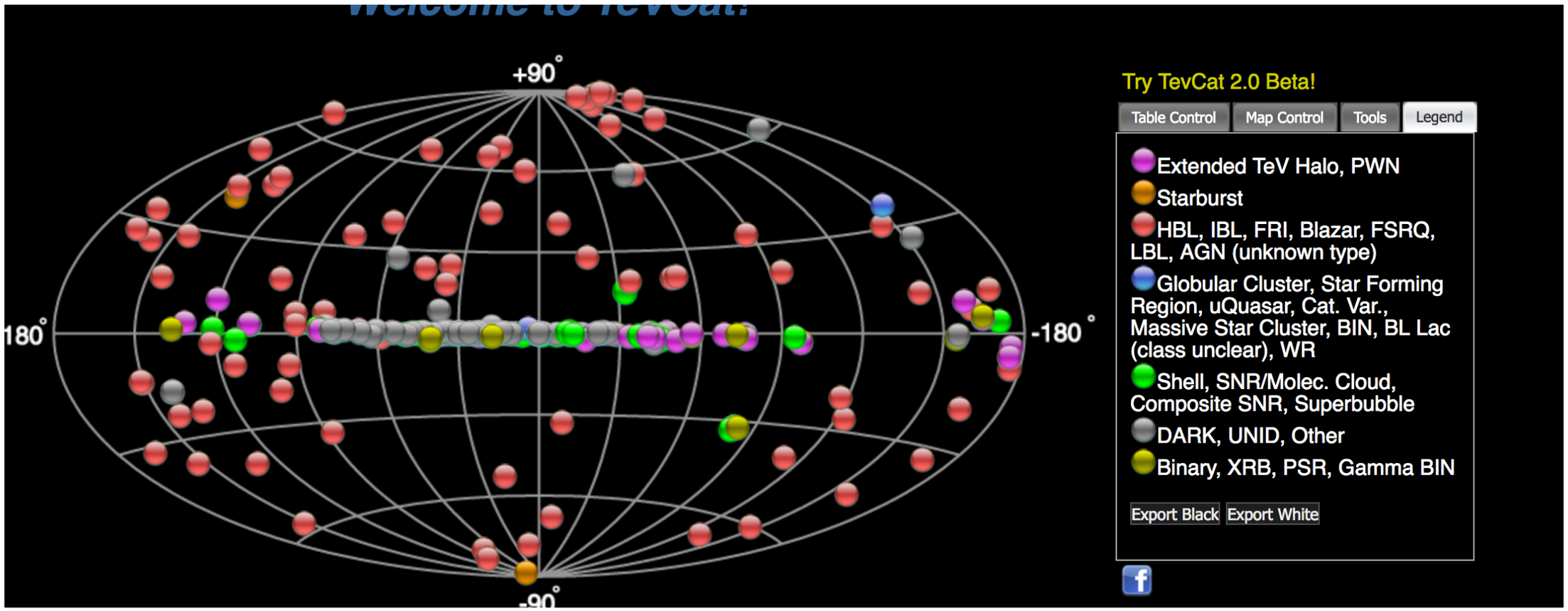


H.e.s.s.

Veritas

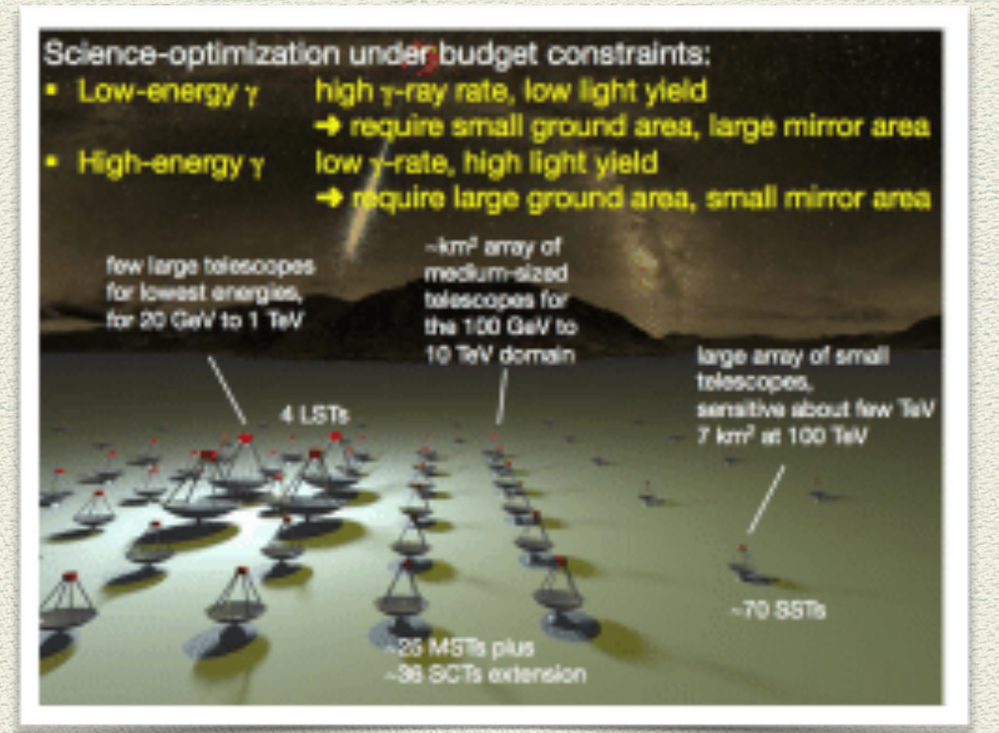
MAGIC

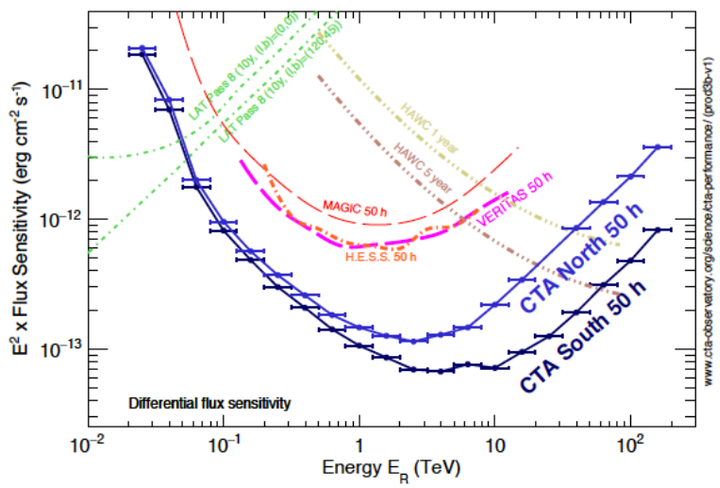
http://tevcat.uchicago.edu/

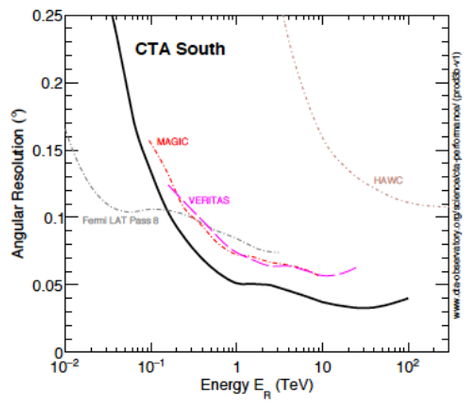


Very Soon !!!


cta
cherenkov
telescope
array
Science
with the
Cherenkov
Telescope
Array
arXiv:1709.07997v2 [astro-ph.IM] 22 Jan 2018

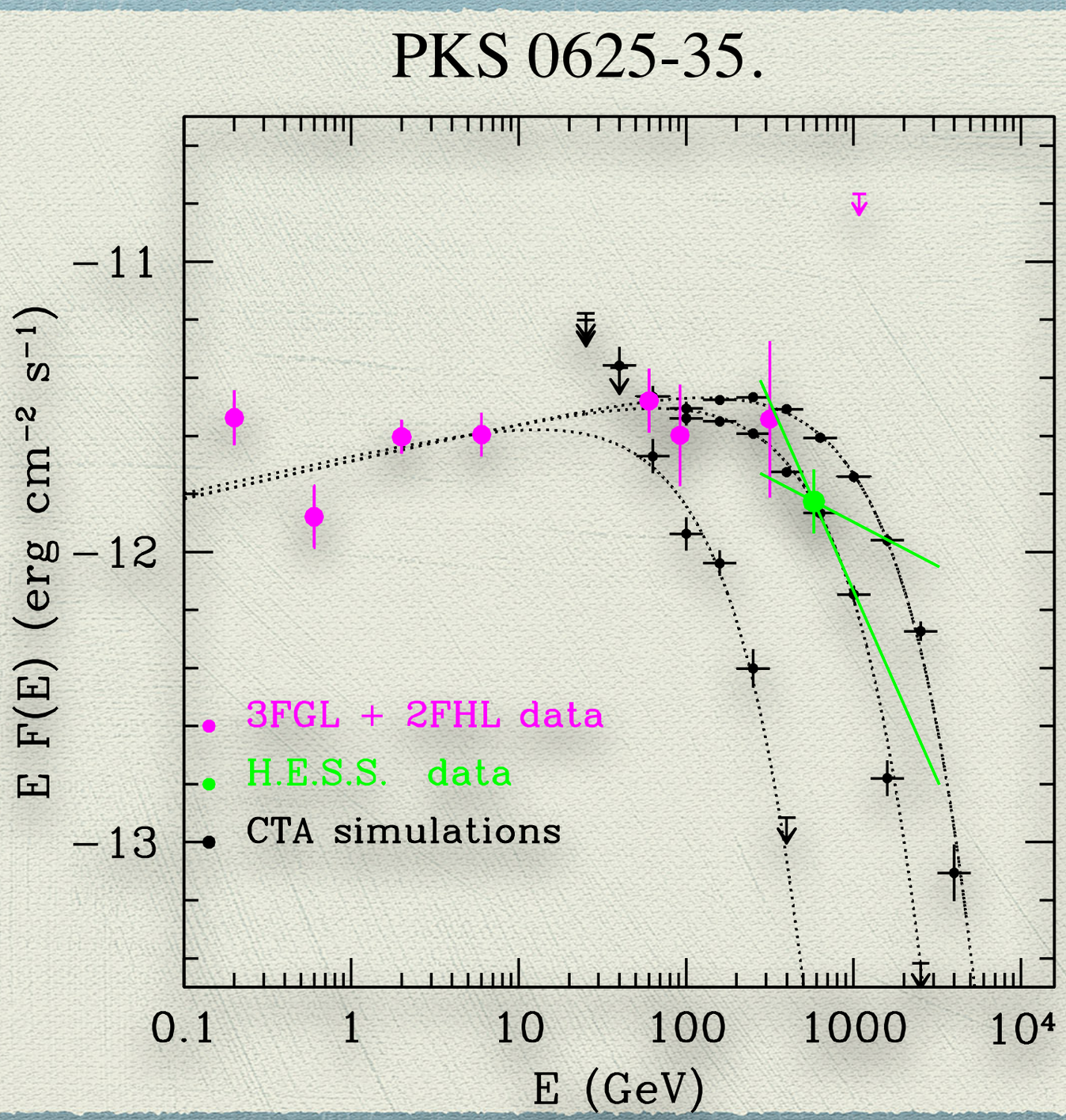






see Bulgarelli 's lesson

Testing the CTA performance



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Astroparticle Physics

Volume 92, June 2017, Pages 42-48

Radio galaxies with the Cherenkov Telescope Array

R. Angioni [1, a, b, c], P. Grandi [a], E. Torresi [a, b], C. Vignali [b, d], J. Knödlseder [e]

Show more

https://doi.org/10.1016/j.astropartphys.2017.02.010

Simulation and analysis of CTA observations

Ctools package

Data Reduction very similar to the Fermi-AGILE approach

Event file
Model of the source + background
Likelihood analysis

More details later Nicolo Parmiggiani's talk