Masterclass with the Pierre Auger Observatory

Cosmic rays
what are they?

- A cosmic muon observed in a spark chamber… what is its origin?

Cosmic rays
what are they?

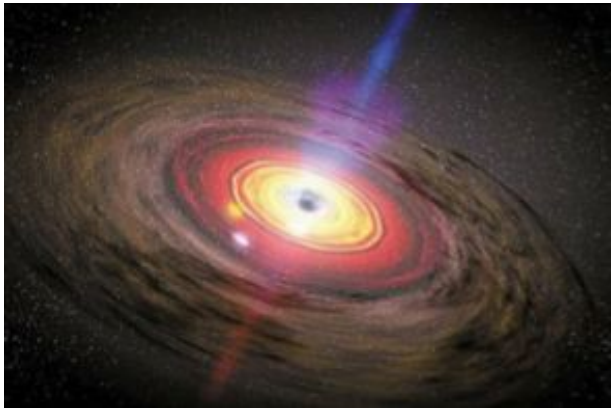
- They were discovered more than a century ago
- They have astrophysical origin
- They are protons and other nuclei

Ultra-high-energy cosmic rays
what are they?

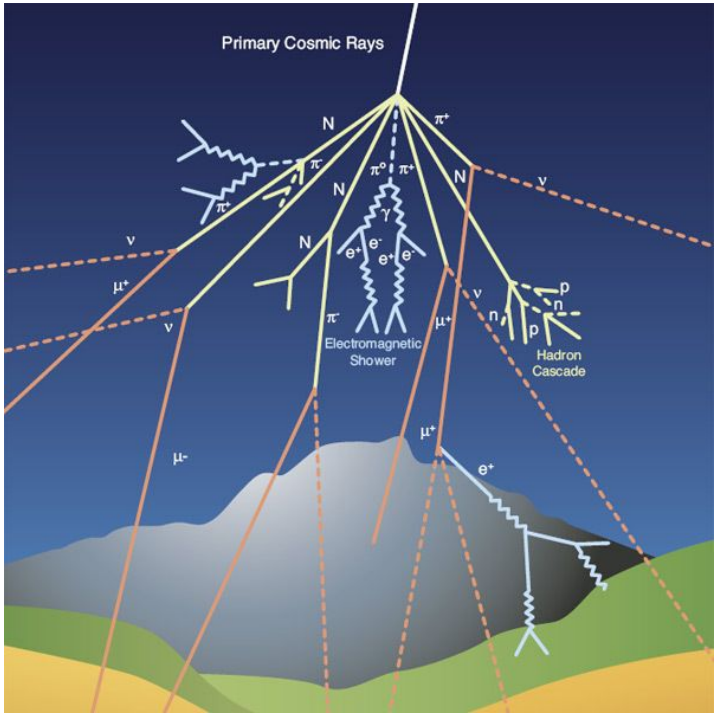
- **They are the most energetic particles in the Universe!**
- They are also extremely rare

1.5 eV

100 000 000 000 000 000 000 eV



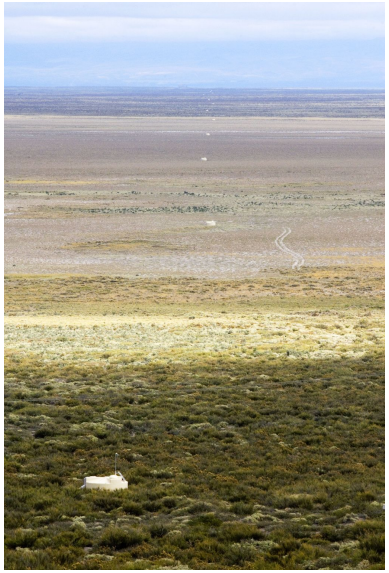
Ultra-high-energy cosmic rays
atmospheric showers of particles



Ultra-high-energy cosmic rays
how can we observe them?

PIERRE AUGER OBSERVATORY

3000 km^2



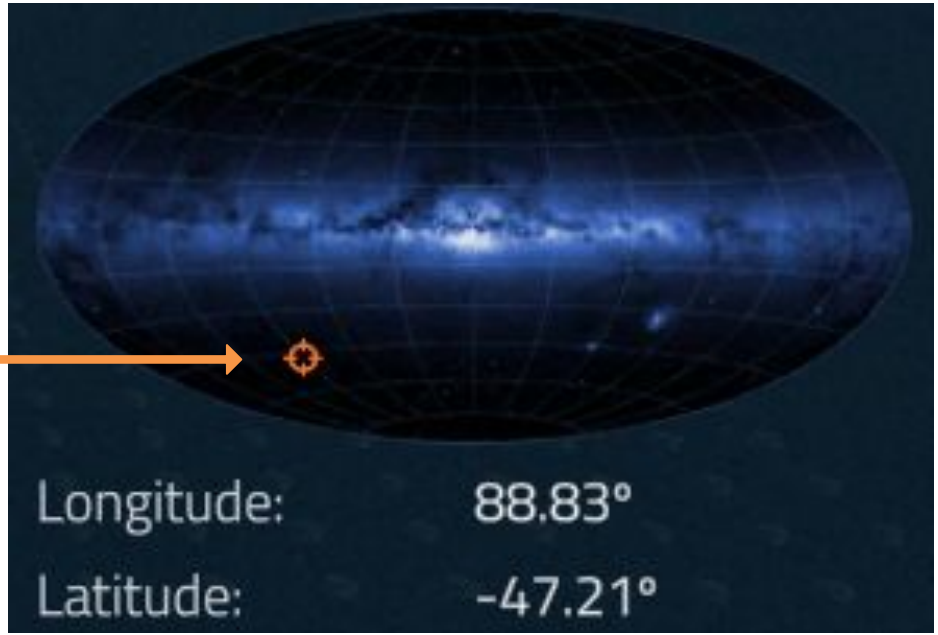
Ultra-high-energy cosmic rays
how can we observe them?

- A virtual *“tour”*…

Pierre Auger Observatory

Ultra-high-energy cosmic rays
where do they come from?

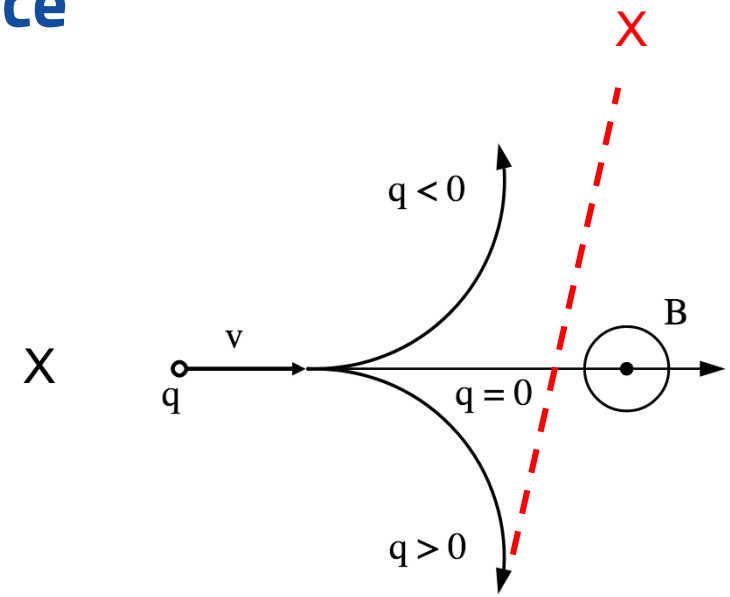
the arrival direction points here



Galactic Plane

We need to pay attention to magnetic deflection!

Lorentz force



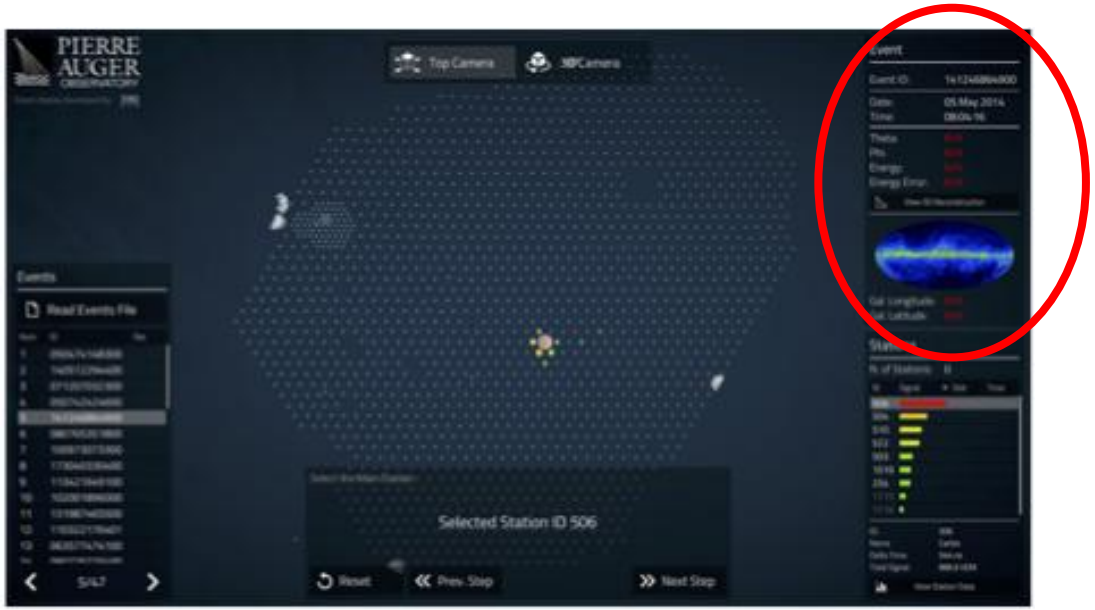
Solution: analyze the directions of only the most energetic particles, which are little deflected!

Experimental activity
be a scientist for a day!

- Each participant will analyze up to 50 real events from the Pierre Auger Observatory
- What can we say about the origin in the Universe of these particles?

Experimental activity
be a scientist for a day!

- You will not be provided any other information about events beyond the data collected by the detectors!



Experimental activity
data analysis

- Analysis in 4 steps:

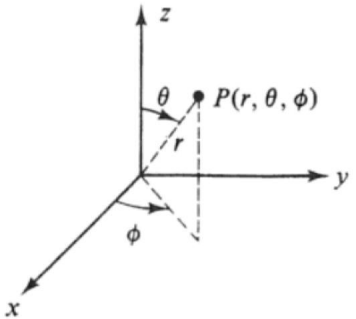
  1) Select the event stations

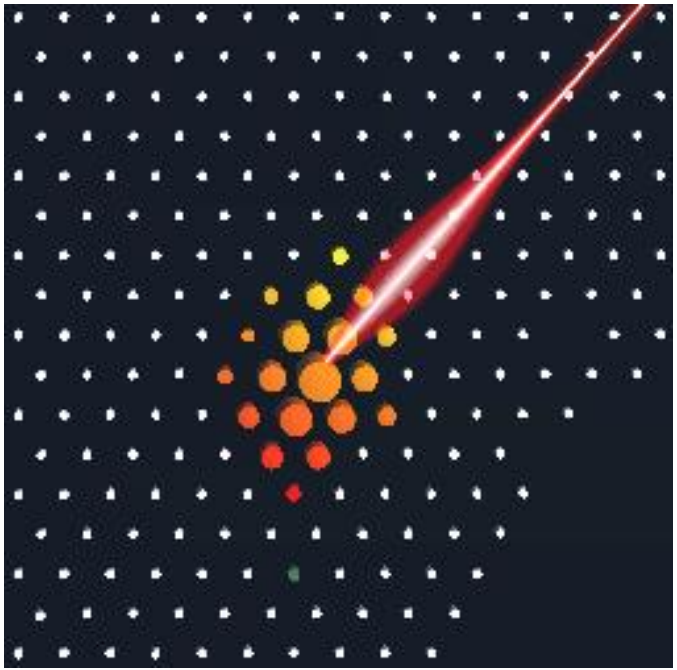
  - more event stations give more information and thus a better reconstruction

  - but be careful not to include stations that are background!

Experimental activity
data analysis

2) Determine the azimuth and zenith angles

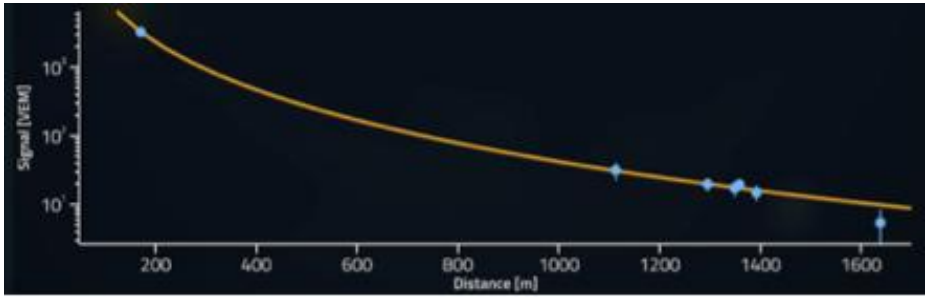




Experimental activity
data analysis

3) Determine the energy

- fit a function to experimental points to get the size of the shower, i.e. the signal at 1000 m which is (after corrections) proportional to the energy



Experimental activity
data analysis

4) Does the event meet the selection criteria?

- if so, accept the event and keep its arrival direction
- if not, reject the event

Experimental activity
data analysis

- Now we just need to repeat the procedure for the remaining events!
- At the end, we will have a joint discussion of the results

Questions? Let’s get to work!