Risetime at 1000 m: Searching for a new SD observable sensitive to mass composition

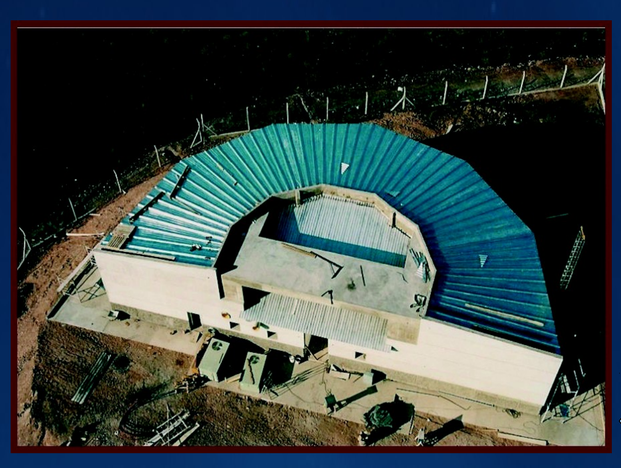
Cecilia Jarne

IFLP (CONICET- Universidad Nacional de La Plata)

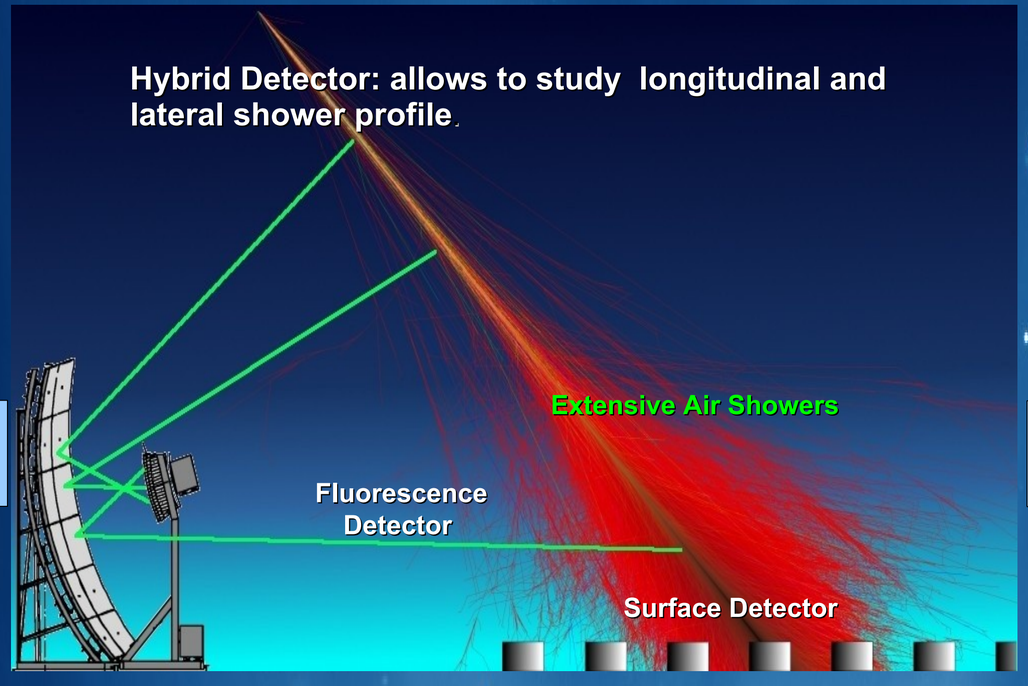
Pierre Auger Collaboration

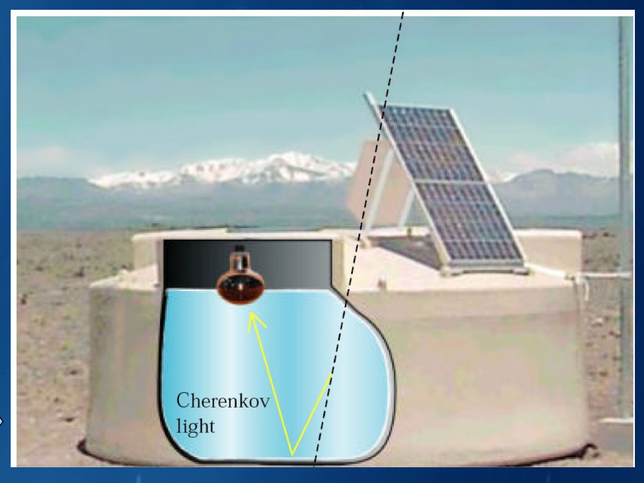
Abstract

Extensive air showers induced by cosmic rays of different species contain different number of particles (electrons and muons) at ground. It is well known that heavy nuclei have larger muon component than lighter nuclei.
The time distribution of the shower front particles reaching the ground detectors is sensitive to the muon to electron ratio and hence to primary composition. Of particular interest is the time in which the signal in the detectors rises to half of the total integrated signal (Risetime). The Risetime at 1000 m from the shower axis, obtained on event by event basis, is a robust variable to build different observables carrying information about mass composition. Here we report some ideas obtained using MC simulation.



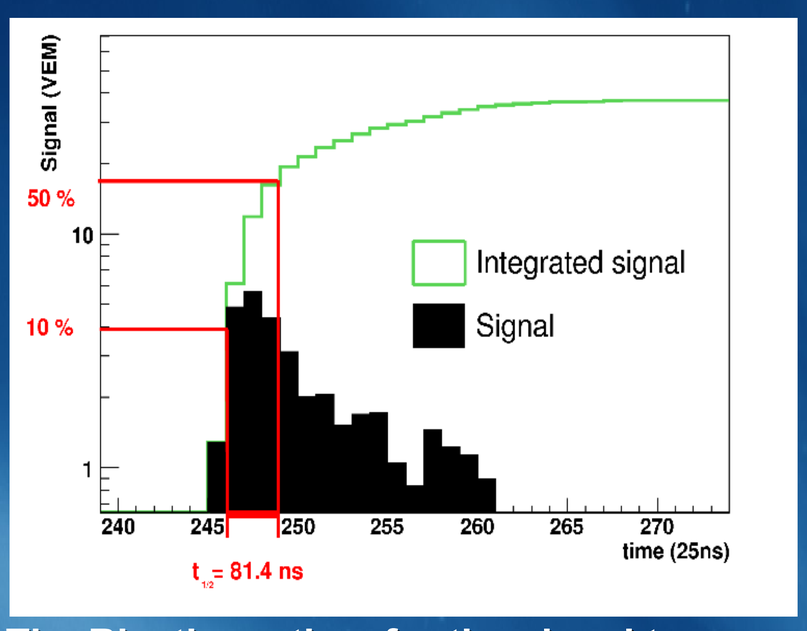
24 fluorescence telescopes placed in 4 buildings surrounding the surface array area.



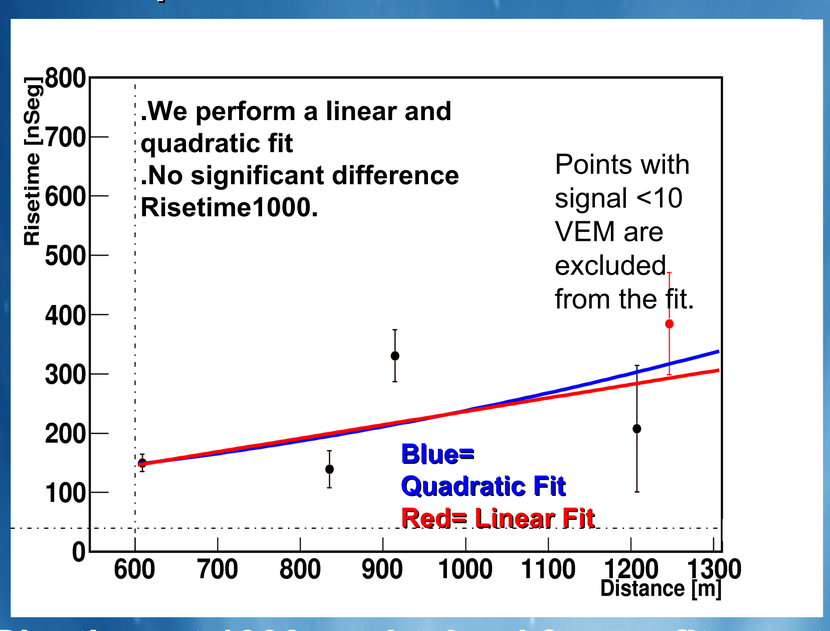


The Cherenkov light produced by the shower particles traversing the detector is viewed by three photomultiplier tubes. There are 1660 stations in a triangle grid covering 3000 km².

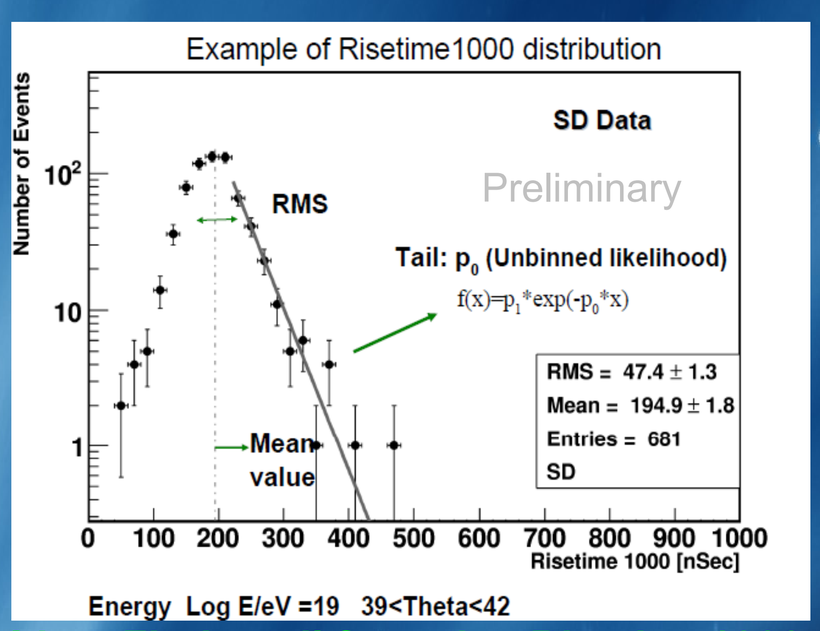
Risetime1000 : SD observable to infer mass composition



The Risetime: time for the signal to grow from 10% to 50 % of the total signal.



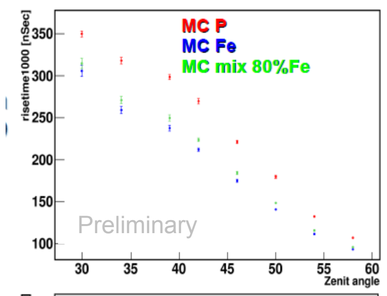
Risetime at 1000 m obtained from a fit event by event.

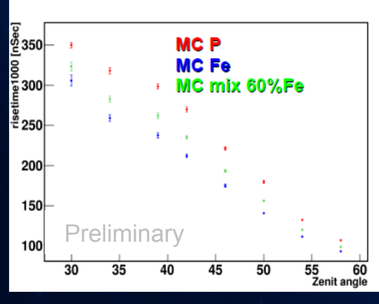


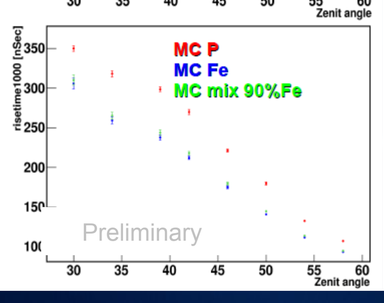
Idea: Fit the tail from the Risetime1000 distribution and use this parameter to infer Composition and Cross Section

Parameters of the risetime1000 Distribution : Pure P and Fe results compared with different mixture compositions

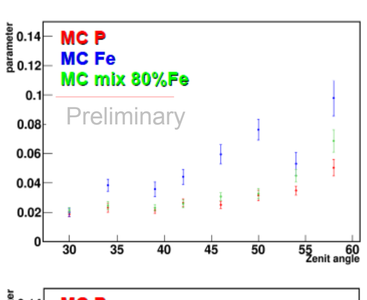
- Mean value .
- Log E/eV =19.
- Expected behavior for the mixture.

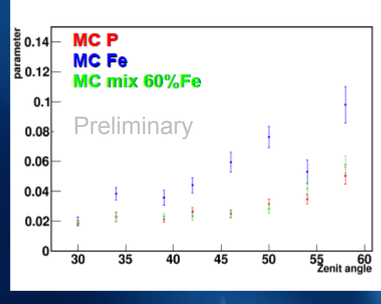


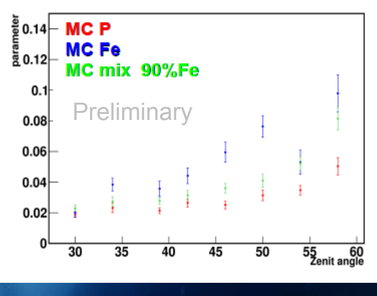




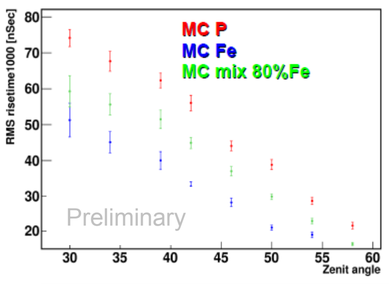
- Tail P_0
- Log E/eV =19.
- The Fe fraction is evident when it is >80% of the mixture ~

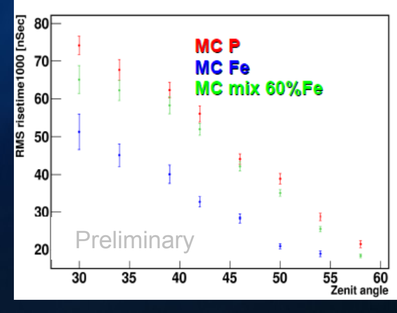


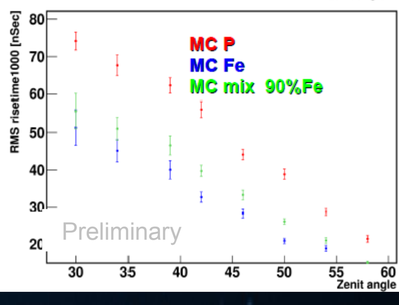




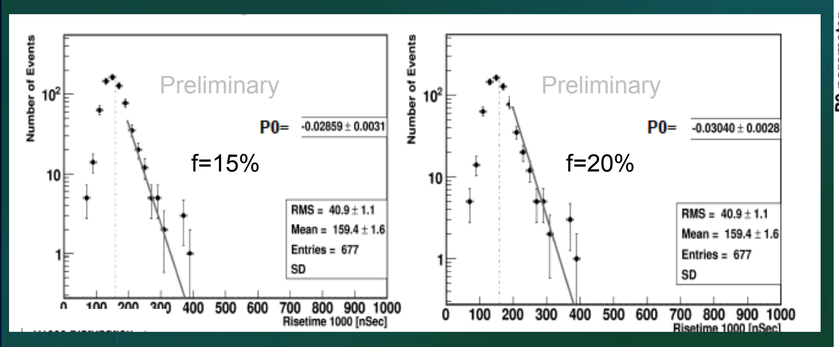
- RMS
- Log E/eV =19.
- Similar behavior than for tail.



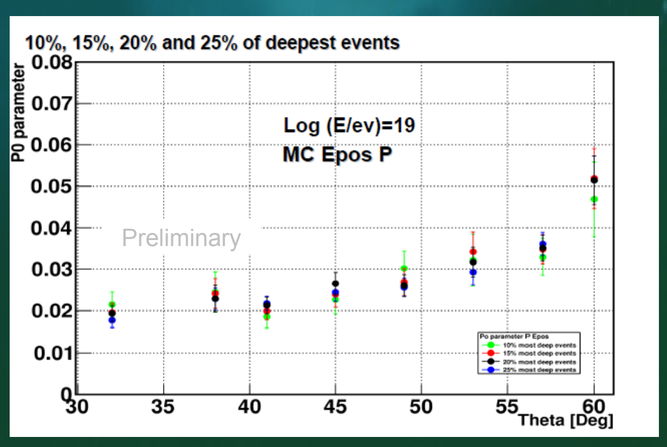




Study of the Fit Range of the distribution



f= fraction of deepest events.



Results

1) Optimization of the fit to obtain Risetime1000.
2) Study of the Risetime1000 distribution indicates:

- The mean value is sensitive to the Fe fraction but it is visible the well known muon MC/data problem.

-The RMS and the Tail are proton dominated It is necessary >70 % Fe fraction in a mixture to start to see a difference ~

Summary and outlook

We have studied the MC distributions of risetime at 1000 m at different energies. We have performed optimization of the data selection for characterizing the tails to be use as a mass sensitive observable.

References

[1] Ralf Ulrich, Johannes Blumer, Ralph Engel, Fabian Schussler, Michael Unger. March 2009. New J.Phys.11:065018,2009.
[2] Karen Salomé Caballero Mora , PHD Thesis: Composition Studies of Ultra High Energy Cosmic Rays using Data of the Pierre Auger Observatory.
[3] H. Wahlberg (por la colaboracion Pierre Auger) 31th International Cosmic Ray Conferences (ICRC 2009), July 7-15, 2009, Łódź, Poland.
[4] Studies of Cosmic Ray Composition and Hadronic Interactionmodels. ICRC July 2011. China e-Print: arXiv:1107.4804 [astro-ph.HE]