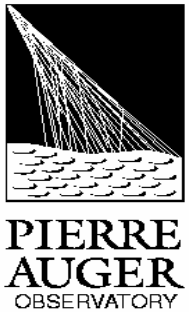
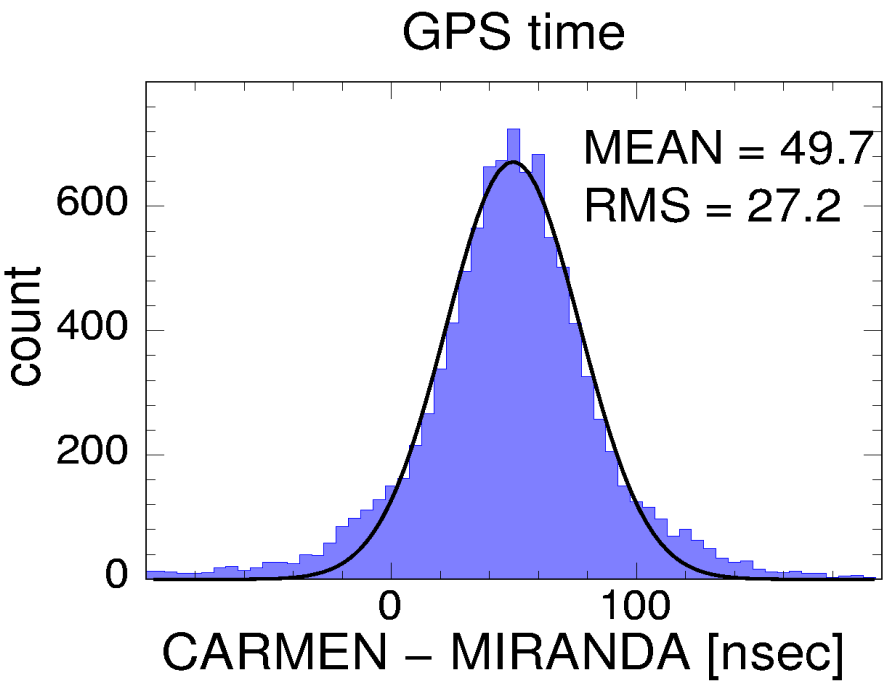
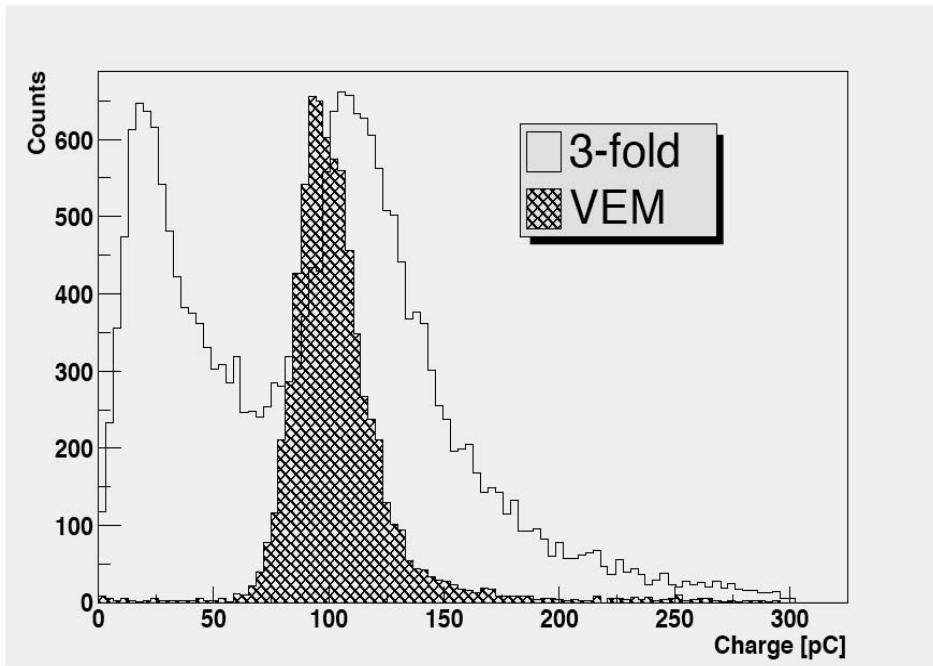


Pierre Auger Observatory

Performance

Surface Detector





GPS timing precision

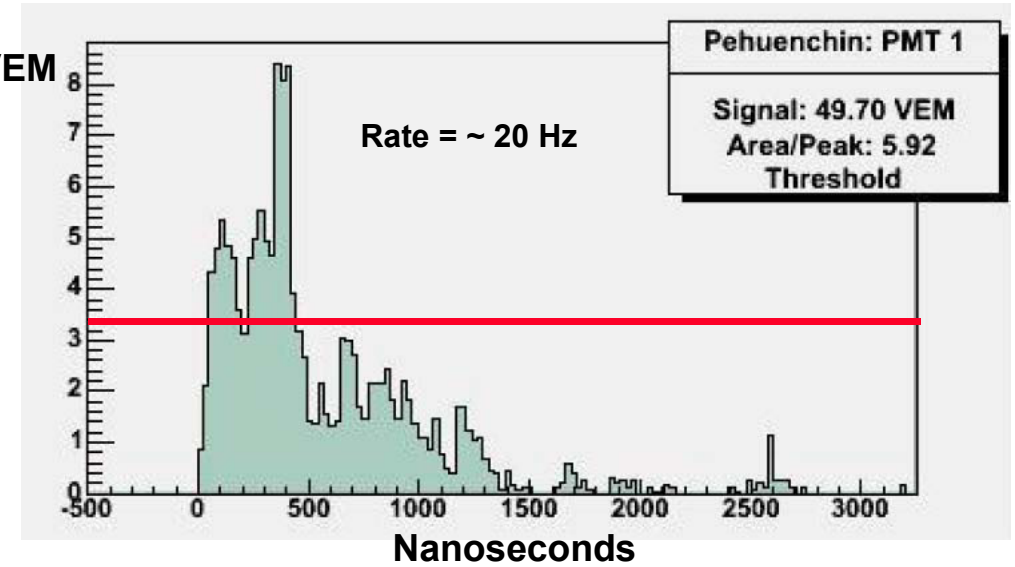
Cosmic Muon Calibration

Tank triggers

PIERRE AUGER OBSERVATORY

Threshold trigger:

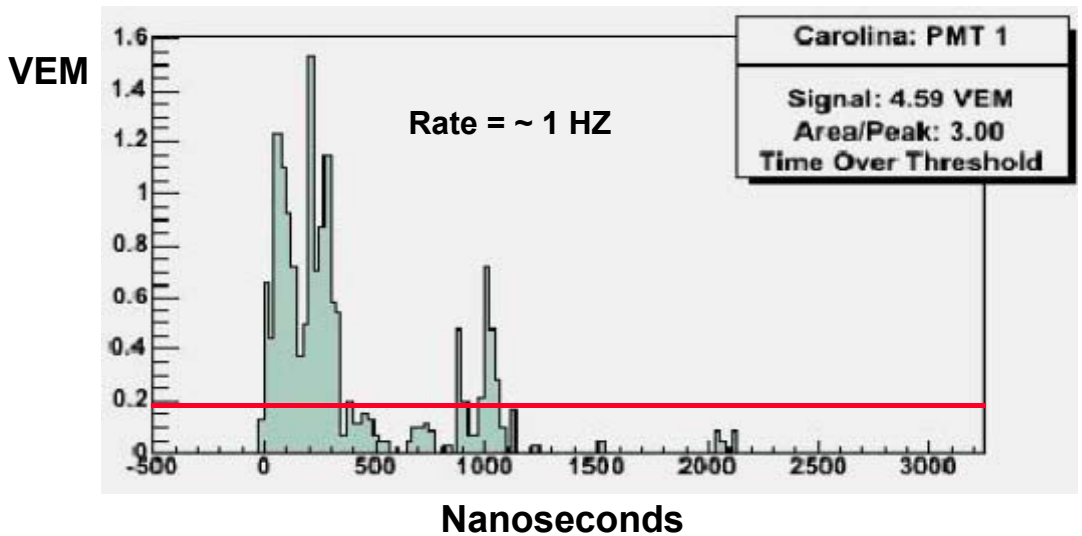
One or more FADC counts above 3.3 VEM in each of 4 or more tanks.



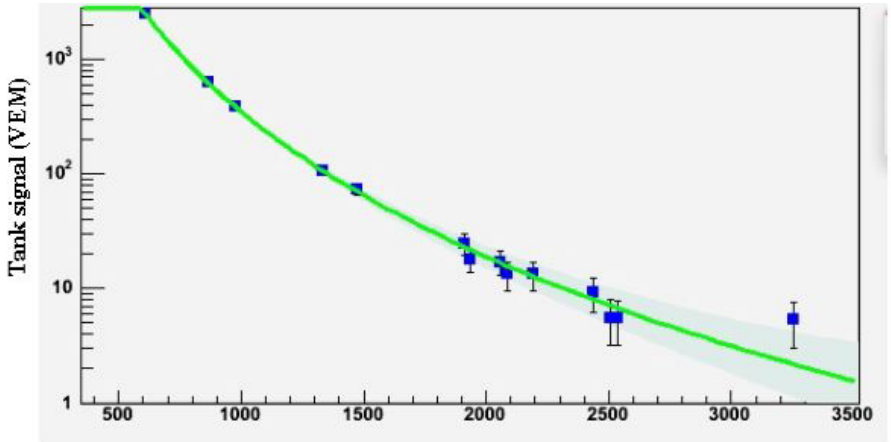
Time over threshold trigger:

12 FADC bins more than 0.2 VEM in sliding window of 3 μ sec in each of 3 or more tanks.

FADC bins are 25 nsec wide



PIERRE AUGER OBSERVATORY



Mon Dec 29 09:23:45 2003
Easting = 470343 ± 21 m
Northing = 6095432 ± 25 m
dt = 126.8 ns

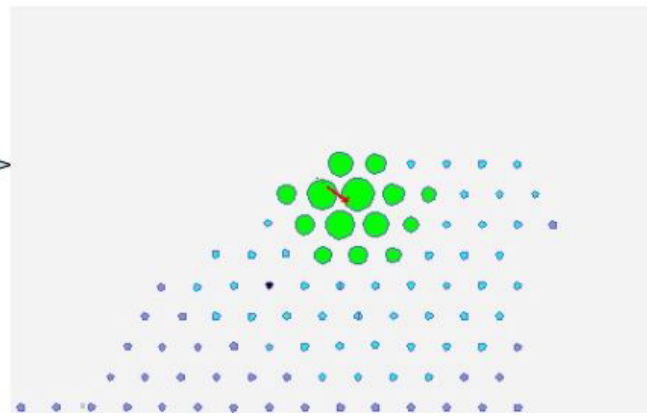
Theta = 34.4 ± 0.3 deg
Phi = 140.1 ± 0.3/sin(Theta) deg

R = 12.5 ± 0.8 km

S(1000) = 347.8 ± 8.43 VEM
E = 75.2 EeV ± 3%
(stat. error only)
PRELIMINARY

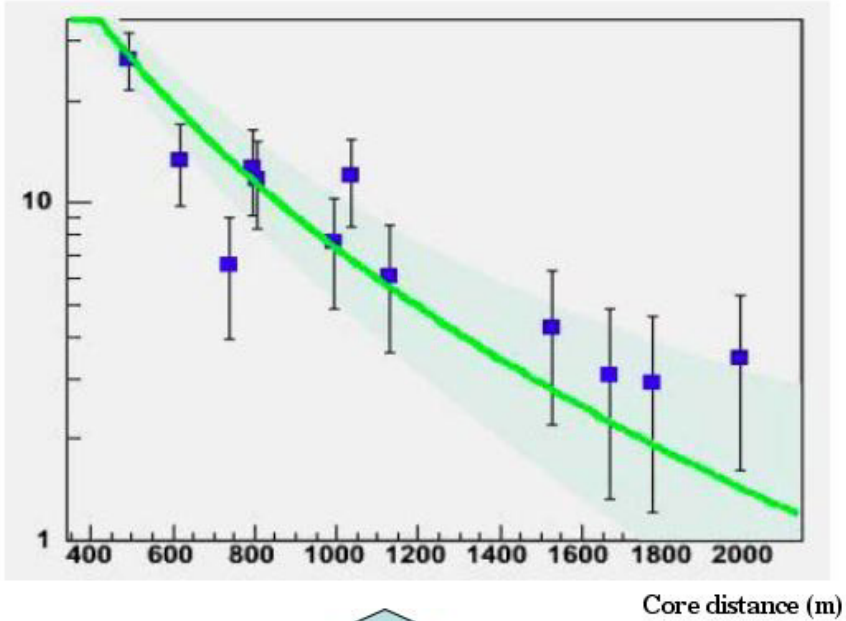
Lateral Distribution Function Fit

Surface Array view



A young shower (vertical)

PIERRE AUGER OBSERVATORY



Mon Feb 16 21:57:03 2004
Easting= 477789 ± 120m
Northing= 6083293 ± 173m
dt= 49.1ns

Theta= 71.3 ± 0.4 deg
Phi= 51.3 ± 0.3/sin(theta) deg

R= 30.3 ± 8.3 km

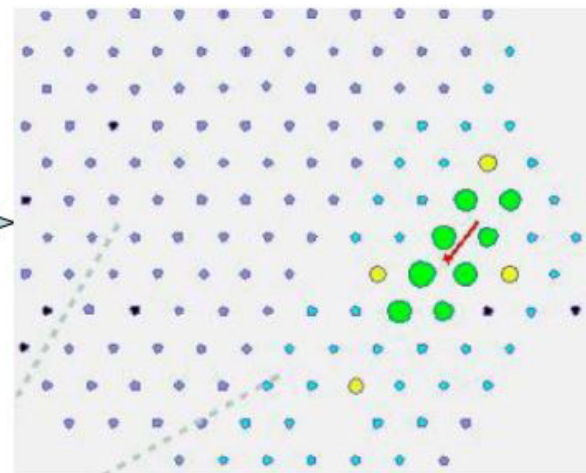
Energy estimate preliminary

S(1000)= 7.31 ± 0.70 VEM
E= 10.52 EeV ± 10%

Error statistical only

Lateral Distribution Function Fit

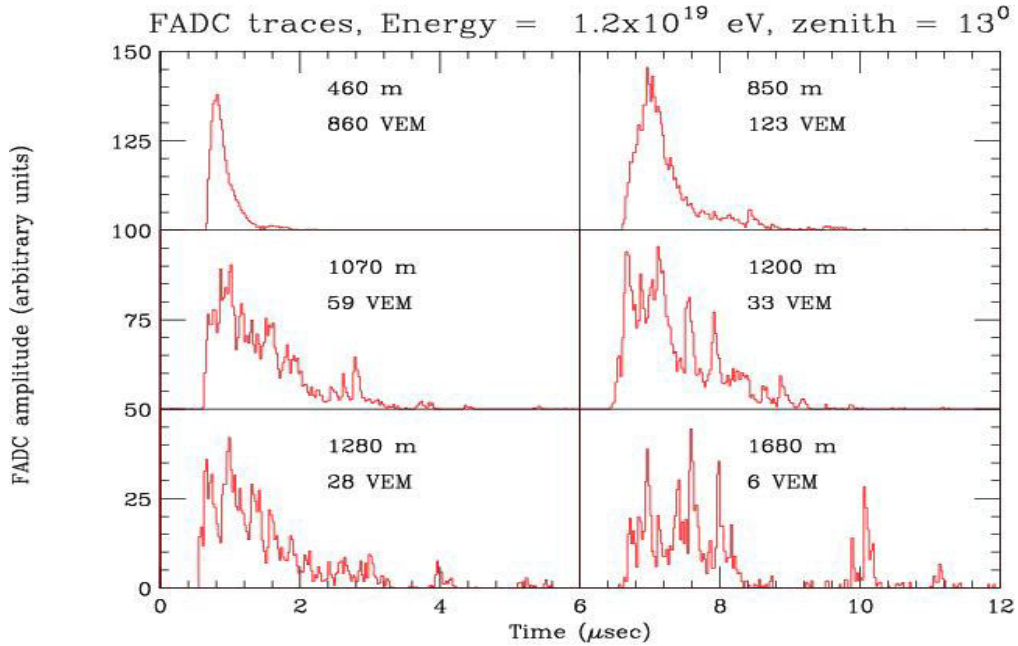
Surface Array view



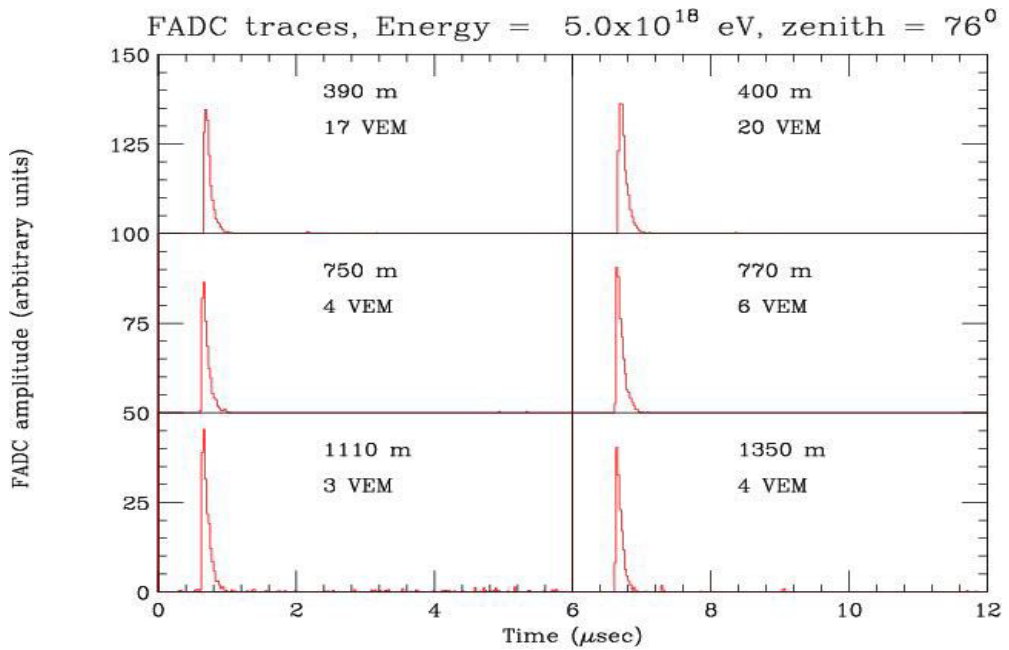
An old shower (inclined 71 deg)

PIERRE AUGER OBSERVATORY

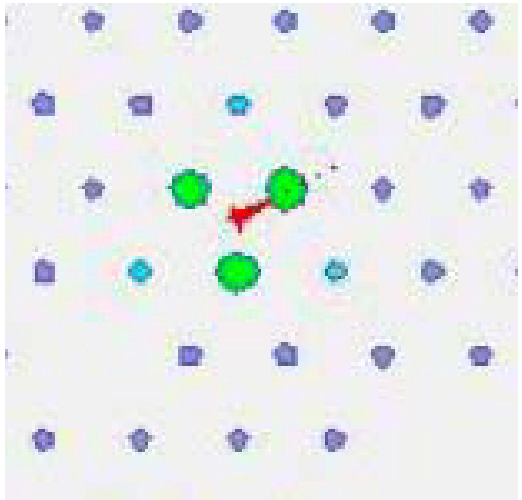
Young Shower
(zenith < 50 deg)



Old shower
(zenith > 70 deg)



PIERRE AUGER OBSERVATORY



Footprint: 3 fold time over threshold trigger

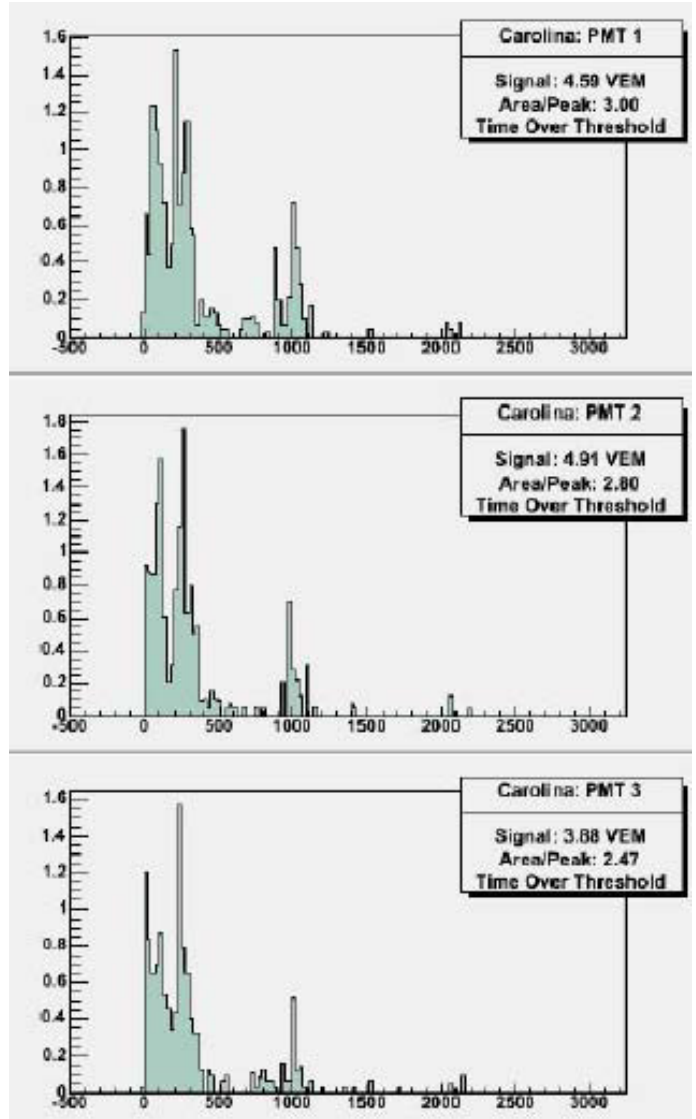
Sun Jan 25 10:51:18 2004
Easting= 476133 ± 107m
Northing= 6084877 ± 91m

Theta= 21 ± 1 deg
Phi= 29 ± 1/sin(theta) deg

Energy Estimate Preliminary

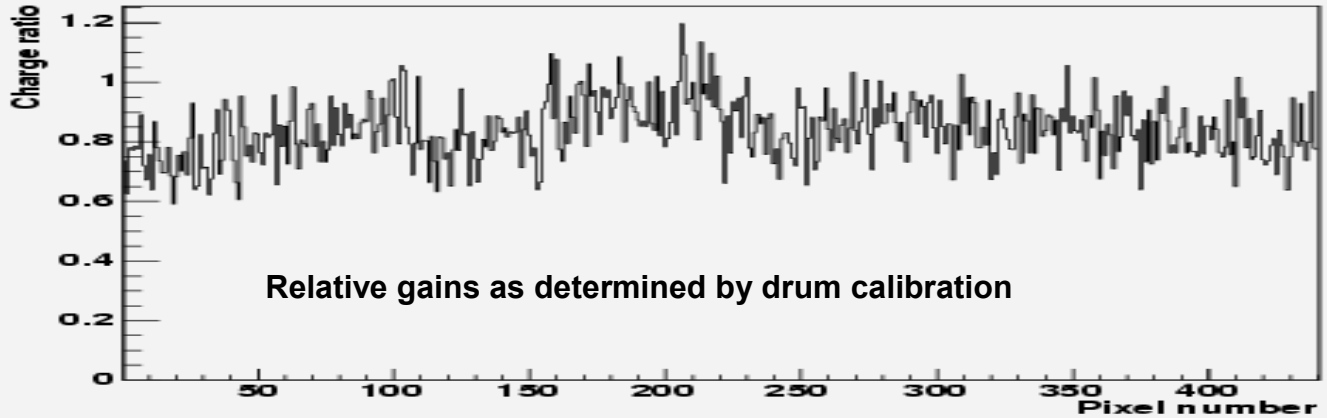
S(1000)= 2.40 ± 0.64 VEM
E= 0.34 EeV ± 28%

Errors statistical only

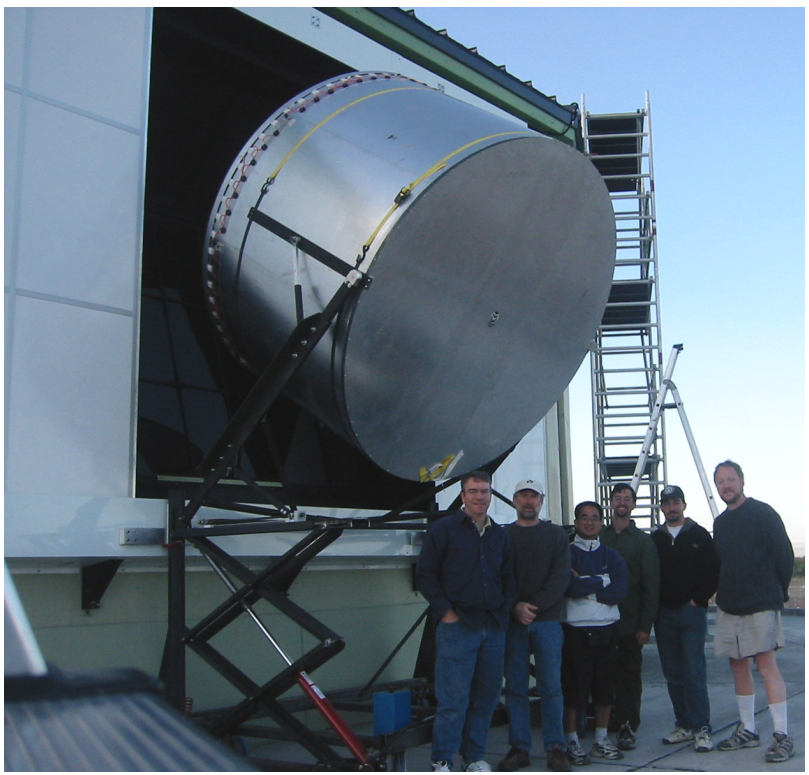


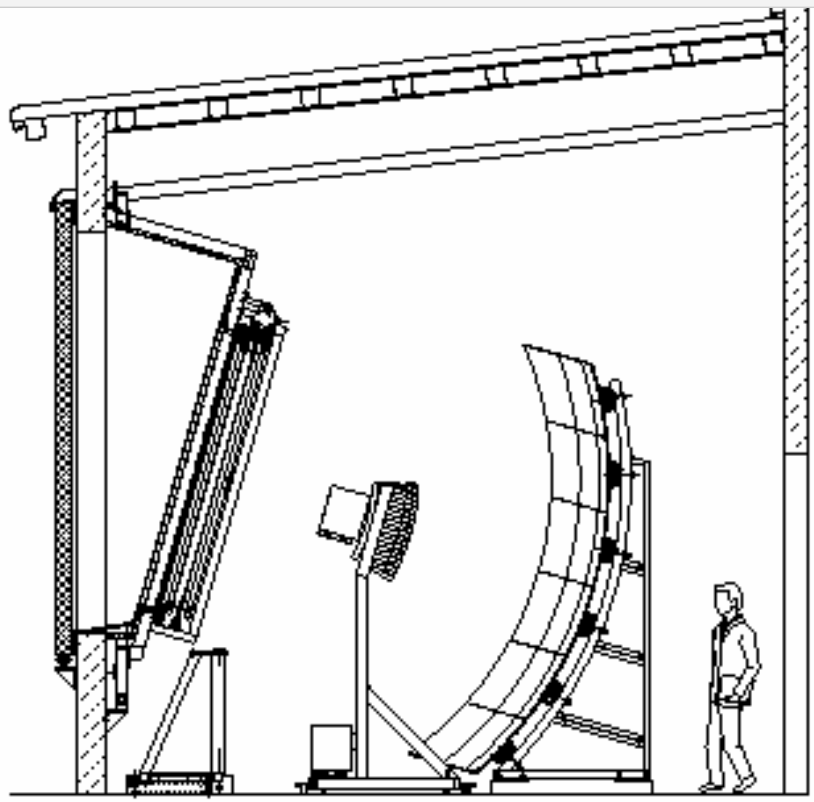
Flash ADC traces for southern station

PIERRE AUGER OBSERVATORY



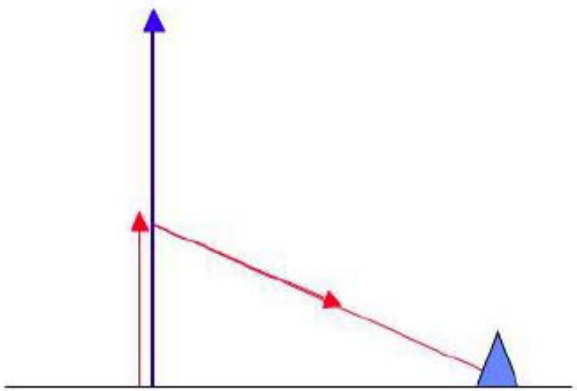
Relative gains as determined by drum calibration



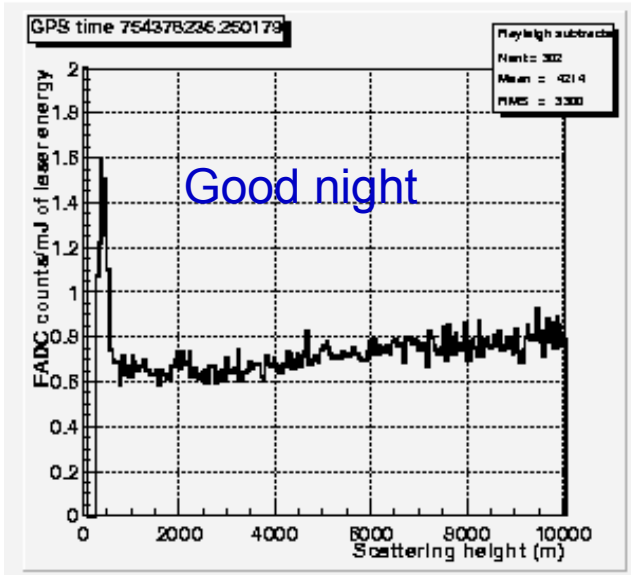


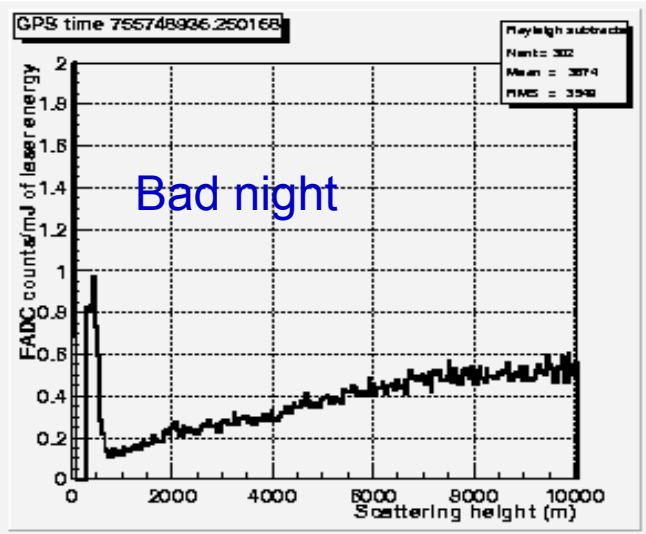
PIERRE AUGER OBSERVATORY

VAOD is jargon for Vertical Aerosol Optical Depth



CLF atmospheric monitoring





Atten. length 47239.9 m
Scale height 3008.7 m
VAOD 0.06

Atten. length 10060.1 m
Scale height 1606.3 m
VAOD 0.16

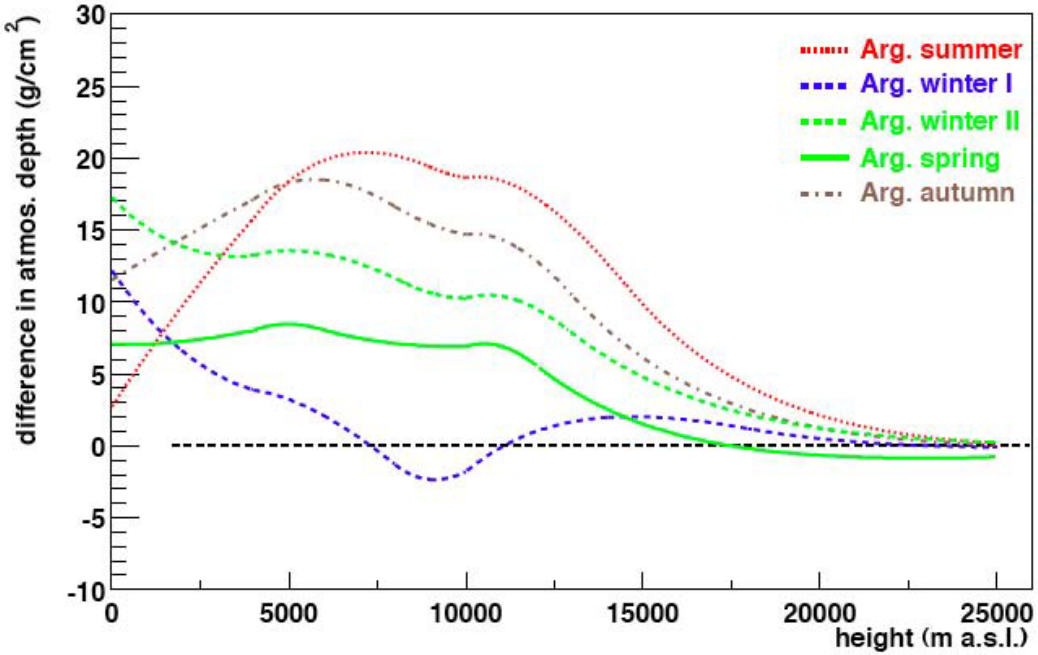
<- Celeste

Central Laser Facility (vertical beam + optic fiber to Celeste)

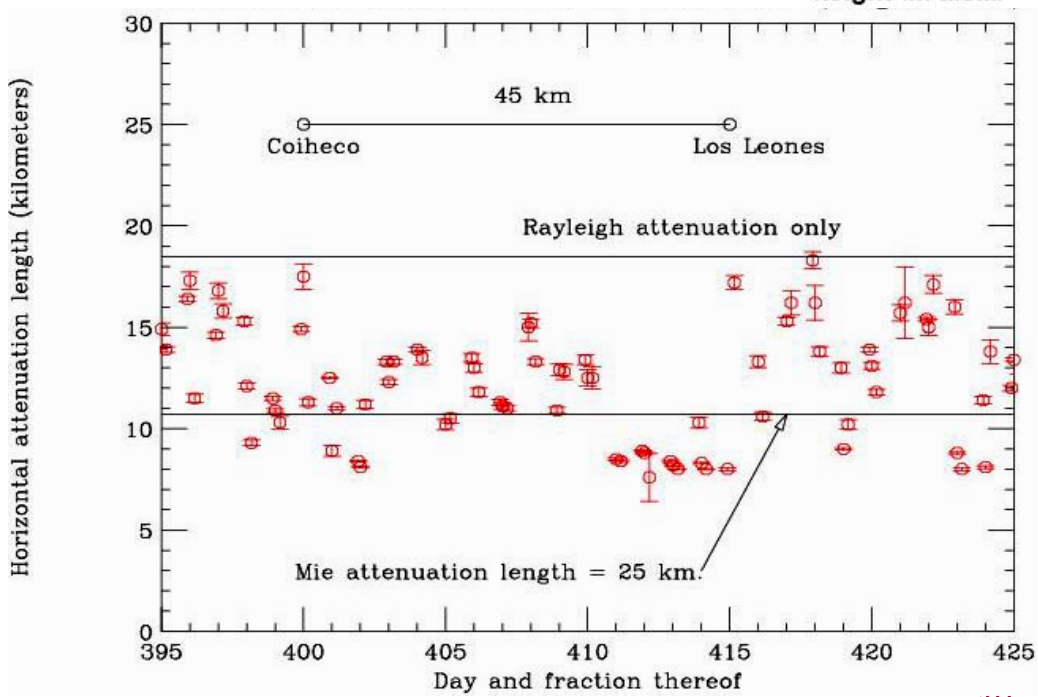
SAGENAP April 2004.
J. Cronin

PIERRE AUGER OBSERVATORY

Measurements at Malargue of the deviation of grams/cm^2 with respect to US std atmosphere

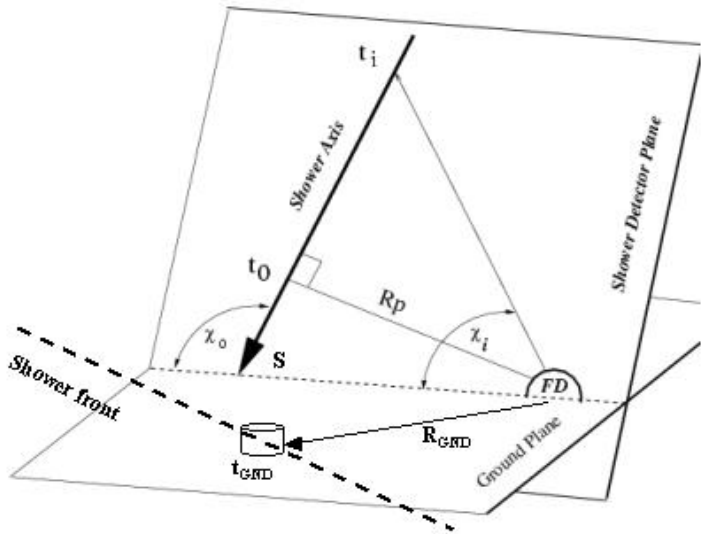


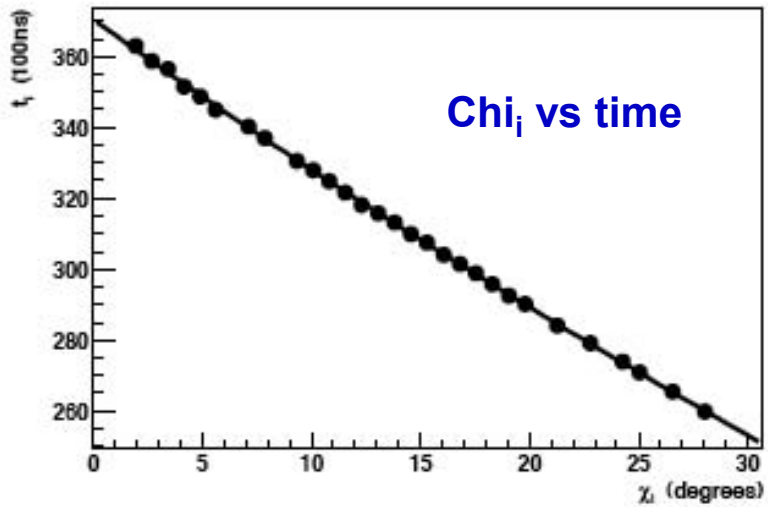
Measurement of horizontal attenuation of the atmosphere at the Auger site. Attenuation varies between 8 km and 18.5 km



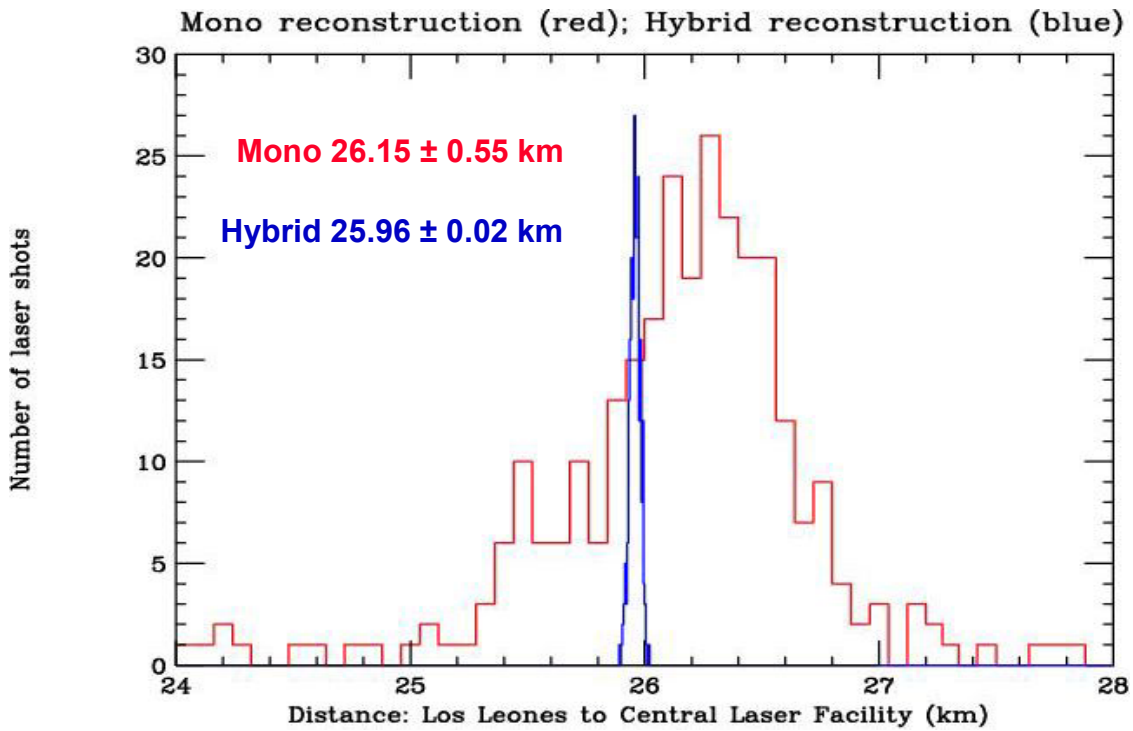
Taking average values compromises precision.

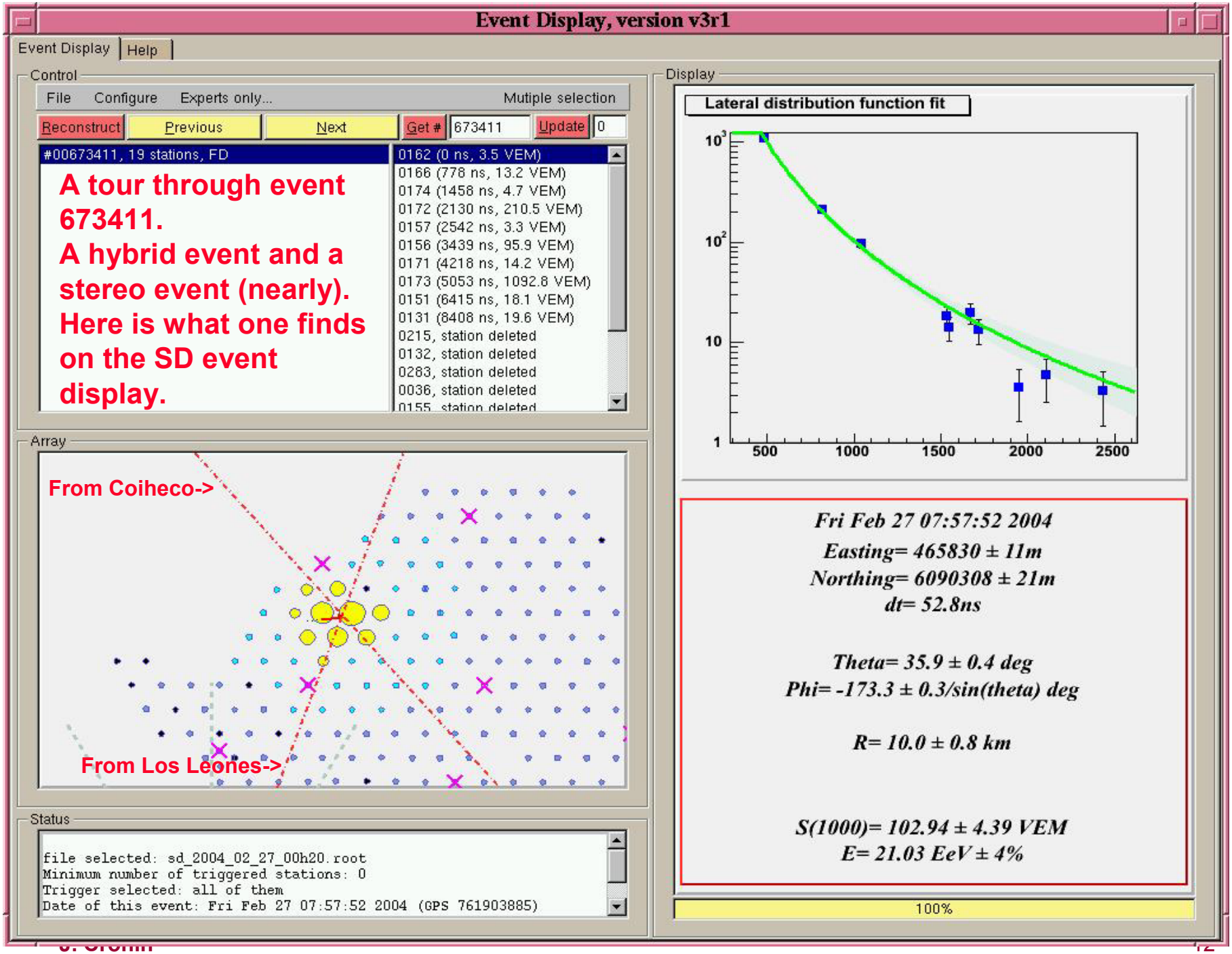
PIERRE AUGER OBSERVATORY





Calibration with central laser facility and Celeste

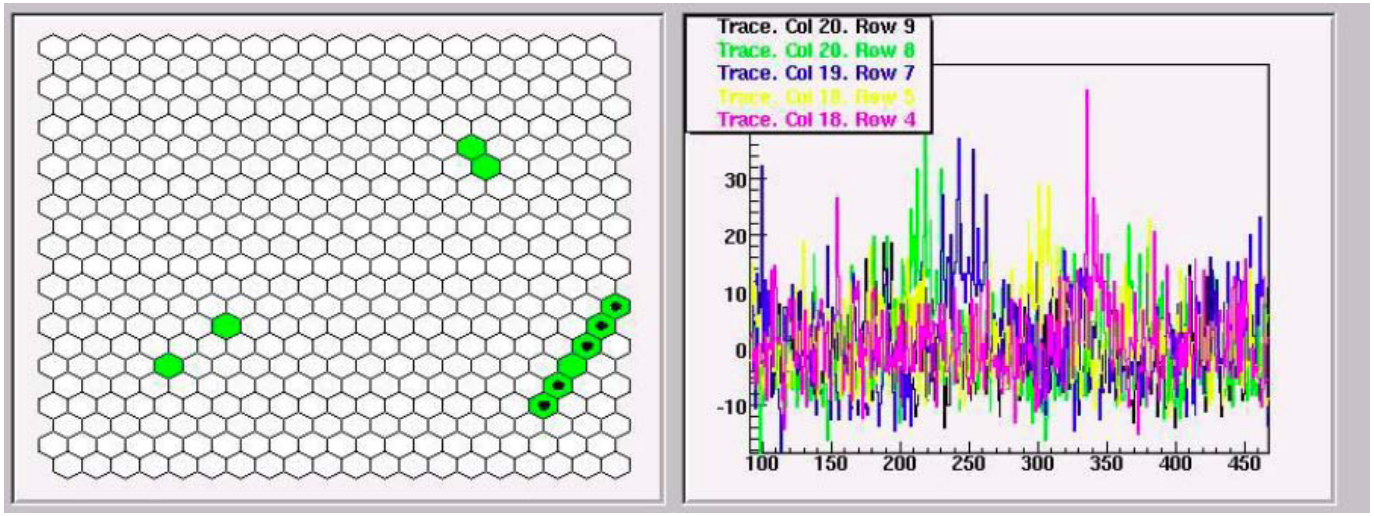



Event Display, version v3r1
Event Display
Help
Control
File
Configure
Experts only...
Mutiple selection
Reconstruct
Previous
Next
Get #
673411
Update
0
#00673411, 19 stations, FD
0162 (0 ns, 3.5 VEM)
0166 (778 ns, 13.2 VEM)
0174 (1458 ns, 4.7 VEM)
0172 (2130 ns, 210.5 VEM)
0157 (2542 ns, 3.3 VEM)
0156 (3439 ns, 95.9 VEM)
0171 (4218 ns, 14.2 VEM)
0173 (5053 ns, 1092.8 VEM)
0151 (6415 ns, 18.1 VEM)
0131 (8408 ns, 19.6 VEM)
0215, station deleted
0132, station deleted
0283, station deleted
0036, station deleted
0155, station deleted
A tour through event 673411.
A hybrid event and a stereo event (nearly).
Here is what one finds on the SD event display.
Array
From Coiheco->
From Los Leones->
Status
file selected: sd_2004_02_27_00h20.root
Minimum number of triggered stations: 0
Trigger selected: all of them
Date of this event: Fri Feb 27 07:57:52 2004 (GPS 761903885)
Display
Lateral distribution function fit
10^3
10^2
10
1
500
1000
1500
2000
2500
Fri Feb 27 07:57:52 2004
Easting= 465830 ± 11m
Northing= 6090308 ± 21m
dt= 52.8ns
Theta= 35.9 ± 0.4 deg
Phi= -173.3 ± 0.3/sin(theta) deg
R= 10.0 ± 0.8 km
S(1000)= 102.94 ± 4.39 VEM
E= 21.03 EeV ± 4%
100%

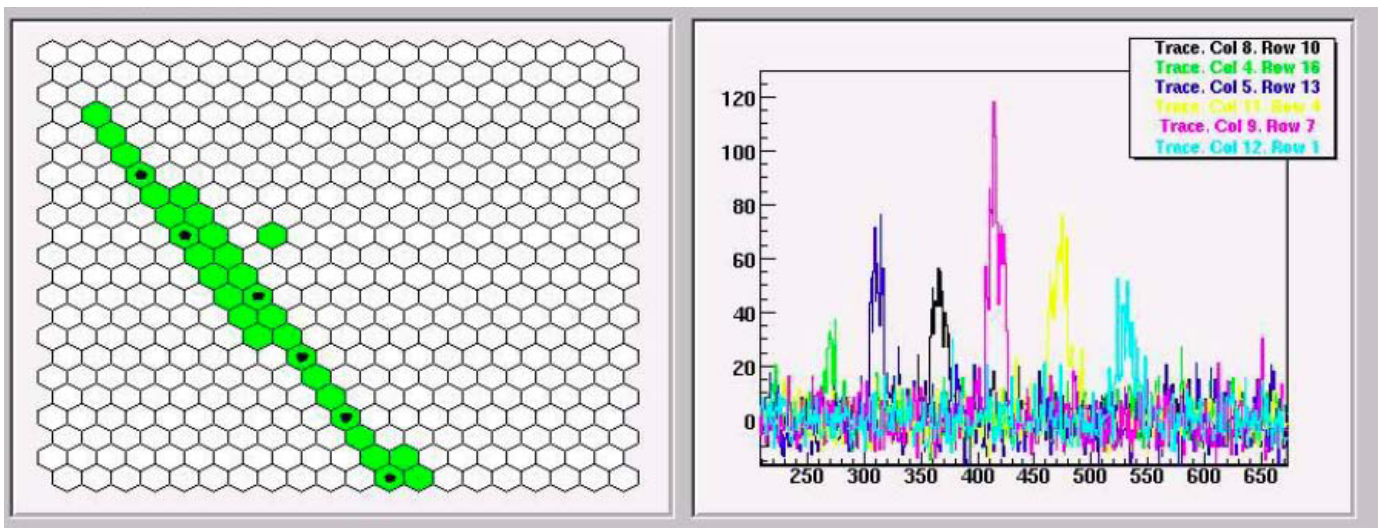
Event 673411

Fluorescence Display

PIERRE AUGER OBSERVATORY



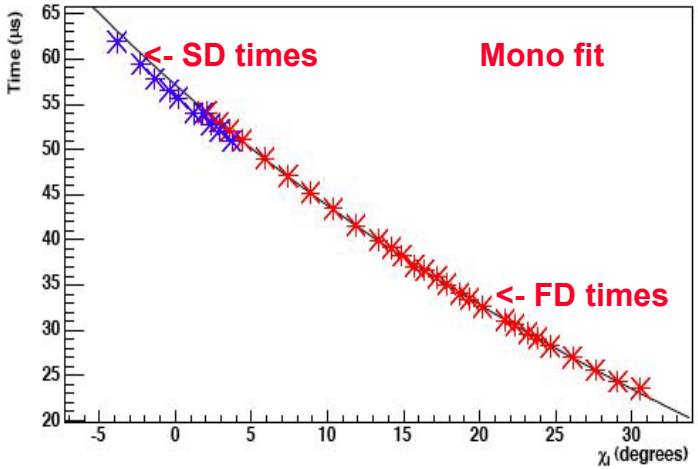
Coiheco (6 pixels)

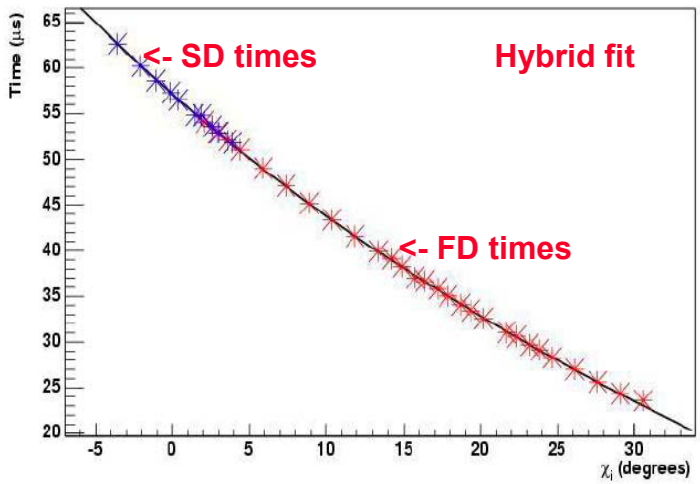


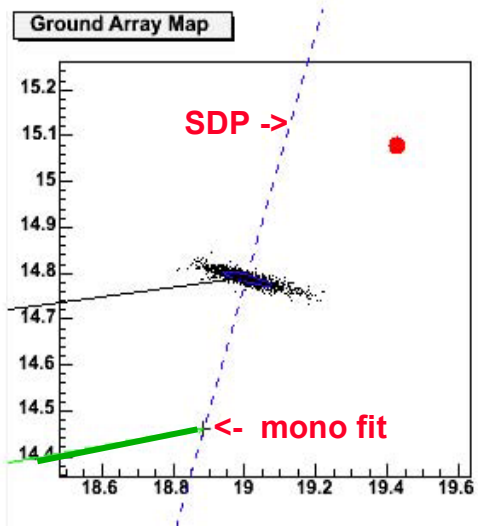
Los Leones (29 pixels)

Event 673411

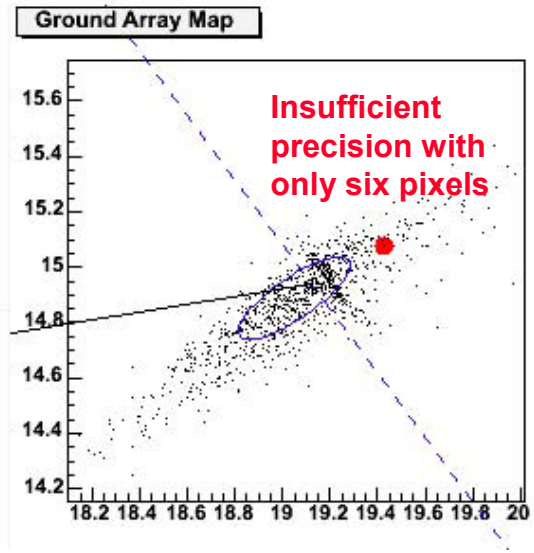
Hybrid Reconstruction







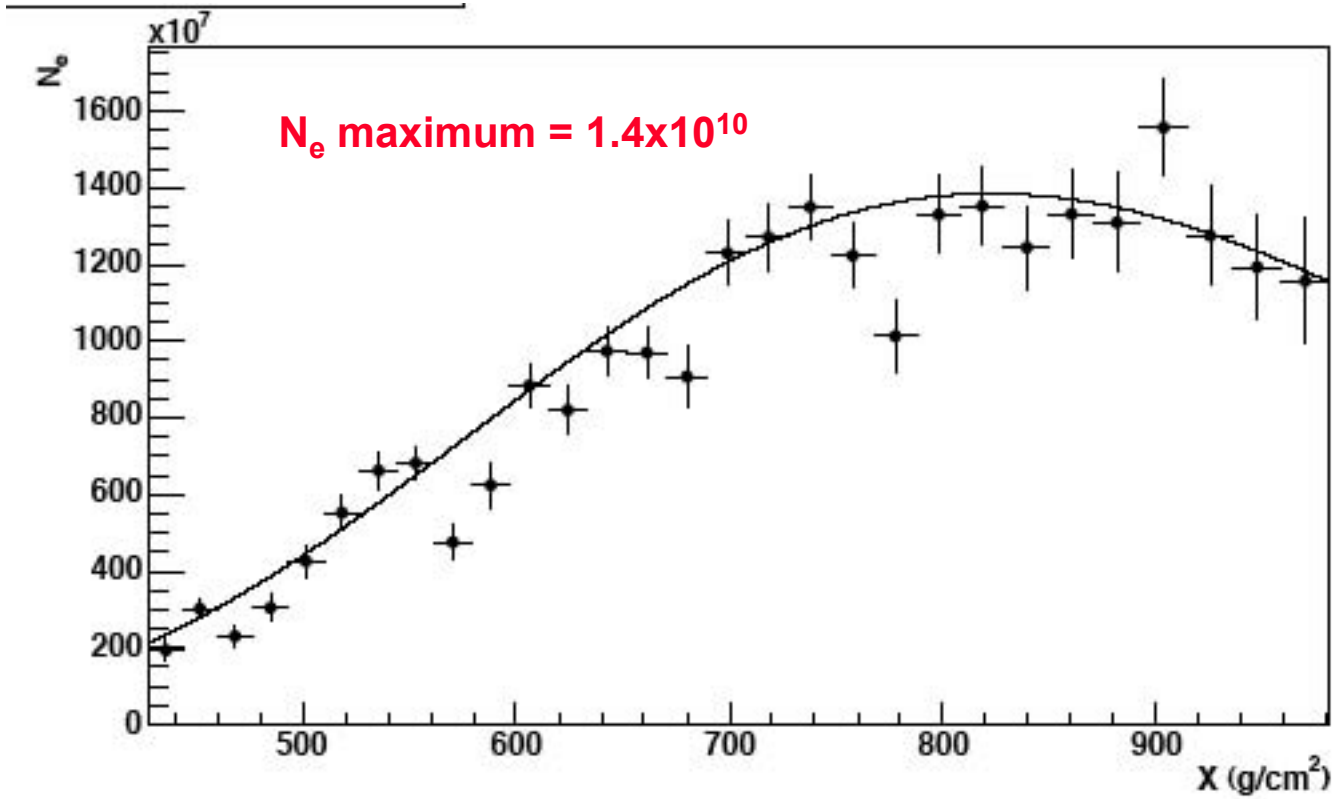
Los Leones (29 pixels)



Coiheco (6 pixels)

	Hybrid (Los Leones)	Surface	Difference
Easting	465960 ± 80	465830	130 m
Northing	6090234 ± 20	6090308	-74 m
Theta	36.7 deg	35.9 deg	0.8 deg
Phi	185.8 deg	186.7 deg	-0.9 deg

PIERRE AUGER OBSERVATORY



N_e maximum ~ 7×10^{10} for energy = 10^{20} eV

FD energy ~ 2×10^{19} eV

(preliminary)

SD energy = 2.1×10^{19} eV

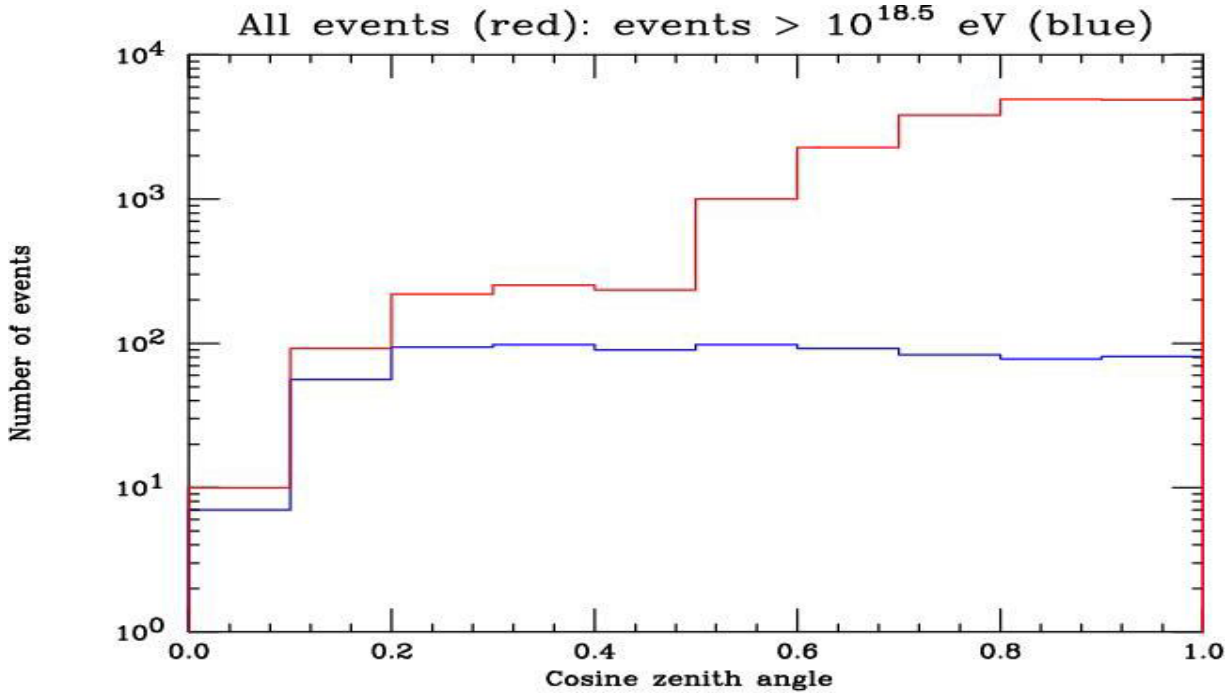
PIERRE AUGER OBSERVATORY

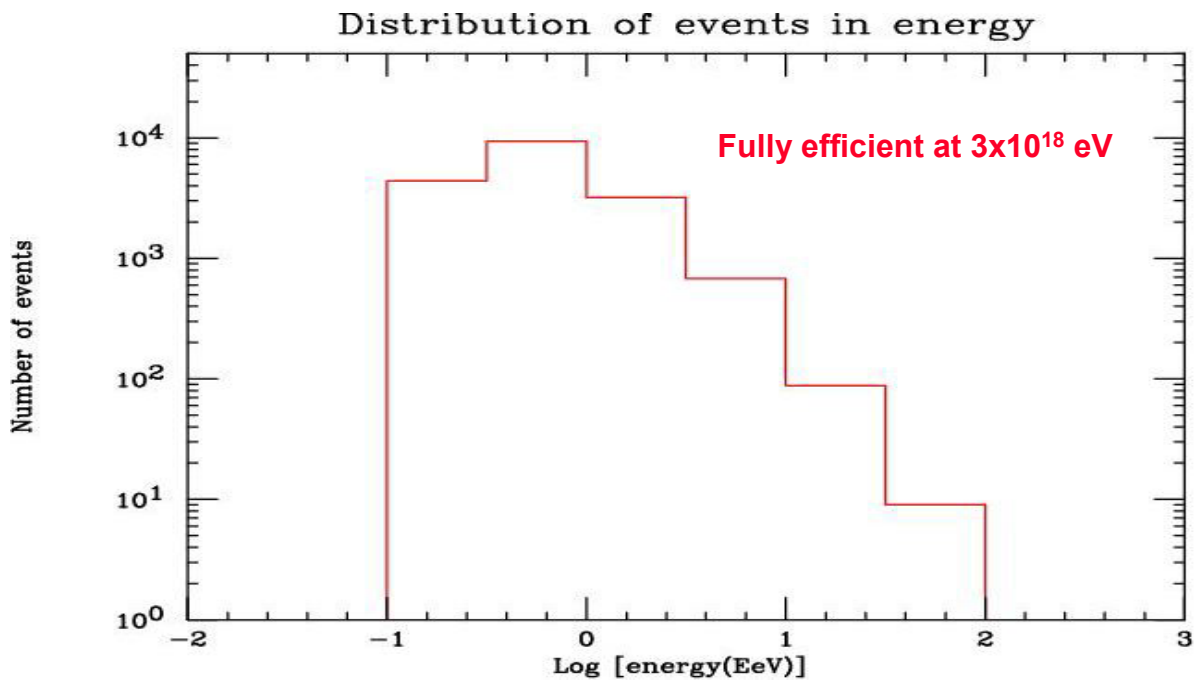
December 18, 2003
to March 25,2004

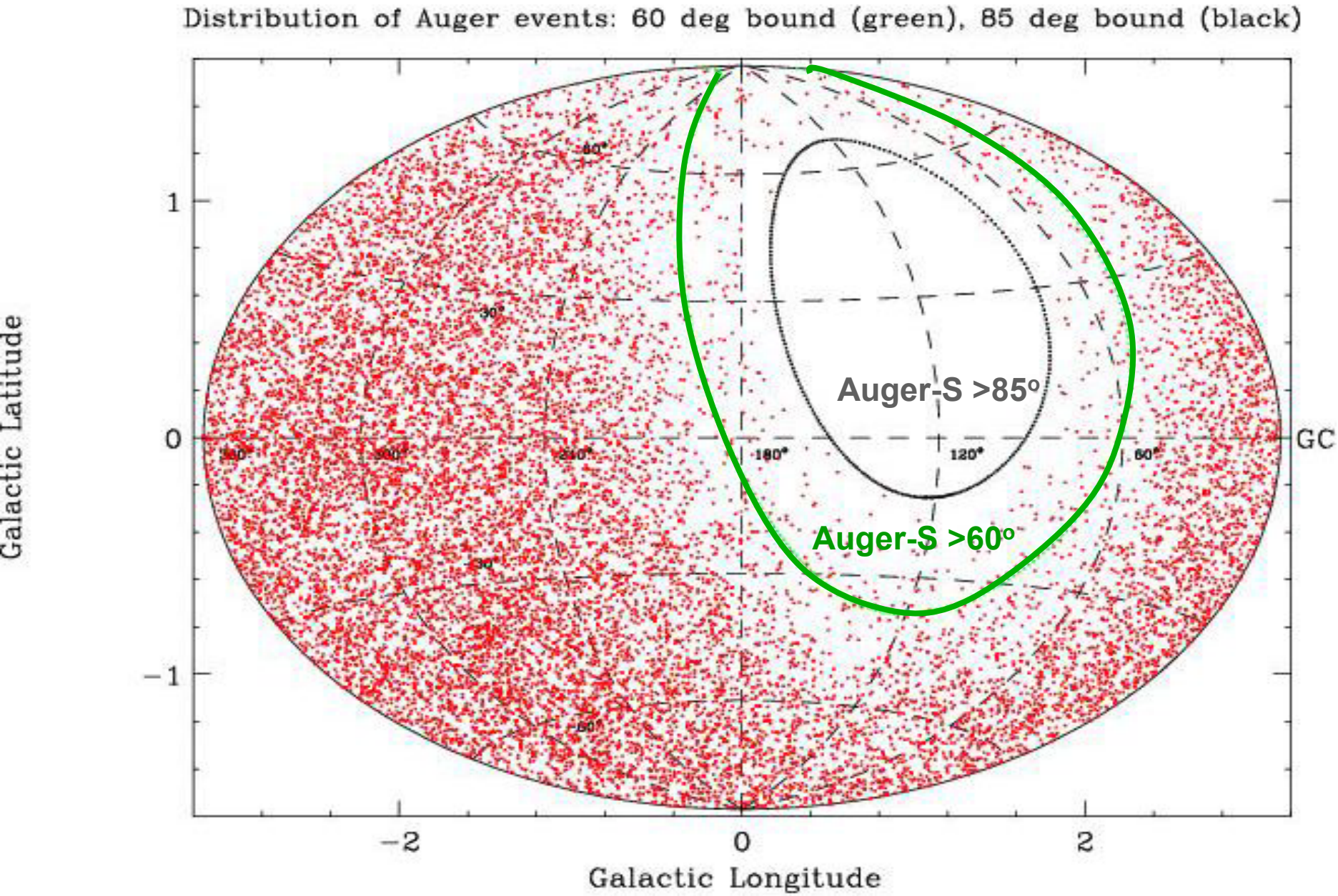
17688 events
<180> tanks active
~1 event/tank/day

Energy estimates preliminary!

Not a spectrum






Distribution of Auger events: 60 deg bound (green), 85 deg bound (black)
Auger-S >85°
Auger-S >60°
GC
Galactic Latitude
Galactic Longitude
1
0
−1
−2
0
2
60°
30°
0°
330°
300°
240°
180°
120°
60°
30°
0°
−30°
−60°

Conclusion

PIERRE AUGER OBSERVATORY

Technical performance excellent

Expect: **~445000 events/year 10^{17} - 10^{18} eV**

~125670 events/year 10^{18} - 19^{19} eV

~3150 events/year > 10^{19} eV

10% of these are hybrid

(scaling from present yields)

Greatest Problem:

Cash flow from Western Hemisphere!