



PIERRE
AUGER
OBSERVATORY

Pierre Auger Observatory

Status Report

C. Newman-Holmes

cnh # 1

PAC

12 Nov 2004

The PAO Collaboration

TANDAR, La Plata, Bariloche, UTN – Mendoza and San Rafael (**Argentina**), Adelaide (**Australia**), Campinas, São Paulo, CBPF-Lafex (**Brazil**), Prague (**Czech Republic**), Collège de France, Paris 6, IPN Orsay, LAL Orsay, Besançon (**France**), Karlsruhe IK, Karlsruhe IPE, Karlsruhe IEKP, Wuppertal, Max Planck Institute (**Germany**), Catania, L'Aquila, Milano, Napoli, Roma, Torino (**Italy**), Puebla, CINESTAV, UNAM, Michoacana (**Mexico**), Krakow, Lodz (**Poland**), Nova Gorica (**Slovenia**), Santiago de Compostela, UAH, UCM (**Spain**), Leeds (**UK**), UCLA, Colorado, Colorado State, Fermilab, LSU, MTU, New Mexico, Ohio State, Northeastern, Chicago, Utah, Nebraska, Case Western, Minnesota (**USA**)

Outline

- Overview
- Status Report
 - Surface Detector
 - Fluorescence Detector
 - Communications and Infrastructure
- Schedule, Funding
- Data Analysis
- Conclusions



PIERRE
AUGER
OBSERVATORY

cnh # 2

PAC

12 Nov 2004

Overview

- Pierre Auger Observatory (PAO) project is designed to study ultra-high energy cosmic rays ($E > 10^{19}$ eV).
 - High energy particles cause “Extensive Air Showers” in the earth’s atmosphere.
 - Measure energy, arrival direction and composition.
- Two Large Air Shower Detectors
 - Southern observatory – near Malargüe, Argentina, now under construction.
 - Northern observatory – will be in the USA.
- Hybrid detector
 - Surface Detector (SD): 1600 water Čerenkov detectors, 1.5 km spacing, covering an array of about 3000 km².
 - Fluorescence Detectors (FD): 24 telescopes overlooking the Surface Detector.
- SD and FD complement each other:
 - SD has 100% duty cycle, but requires simulation to extract energy.
 - FD – energy measurement more straightforward, but only 10% duty cycle and requires understanding of the atmosphere.



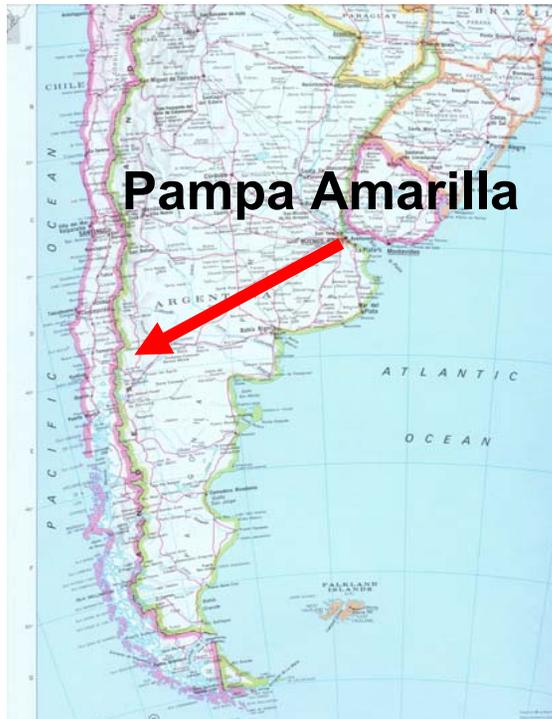
PIERRE
AUGER
OBSERVATORY

Southern Site – Mendoza Province, Argentina

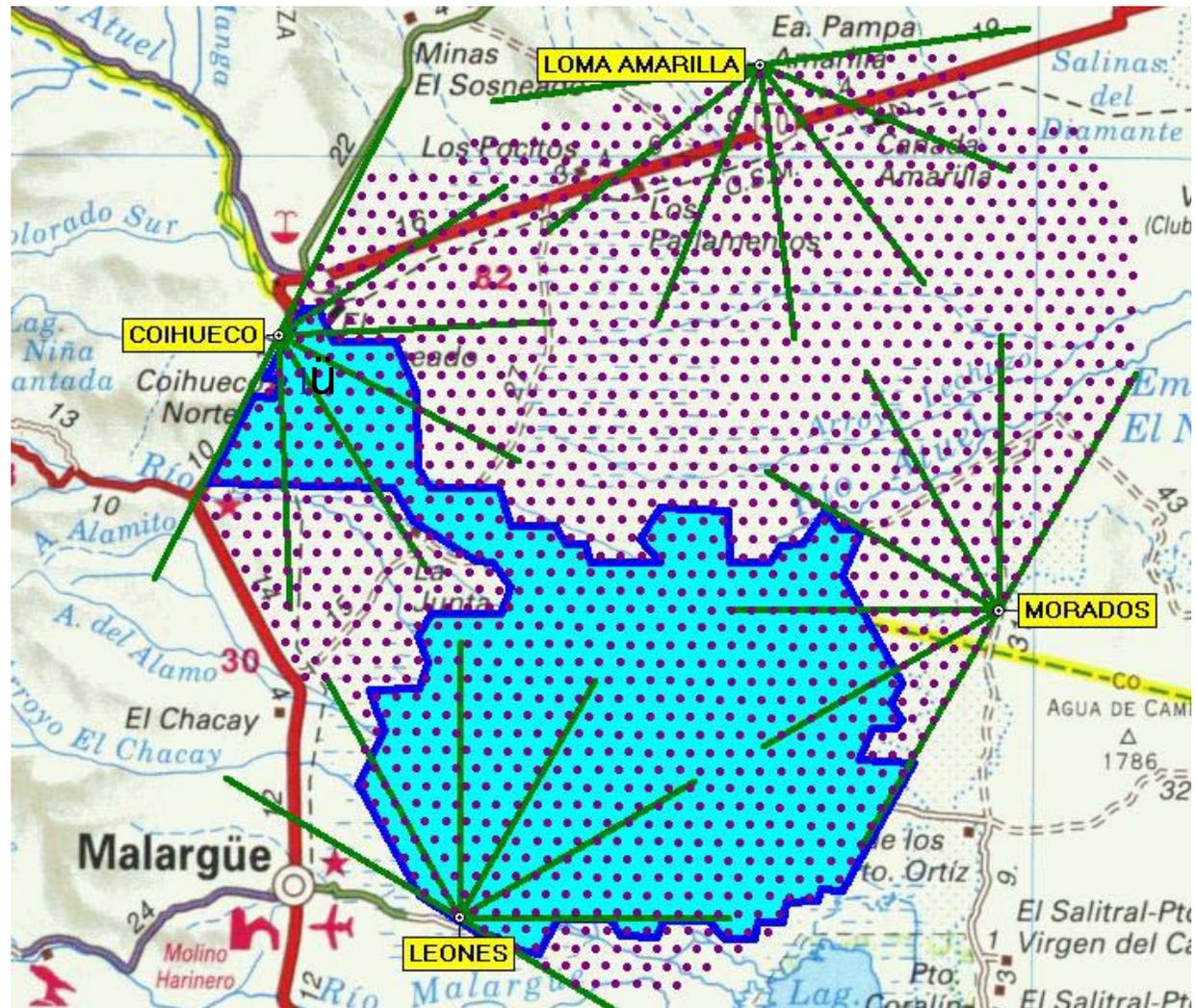
cnh # 3

PAC

12 Nov 2004



1.5 km altitude, clear dry
nights for air fluorescence
observation.





PIERRE
AUGER
OBSERVATORY

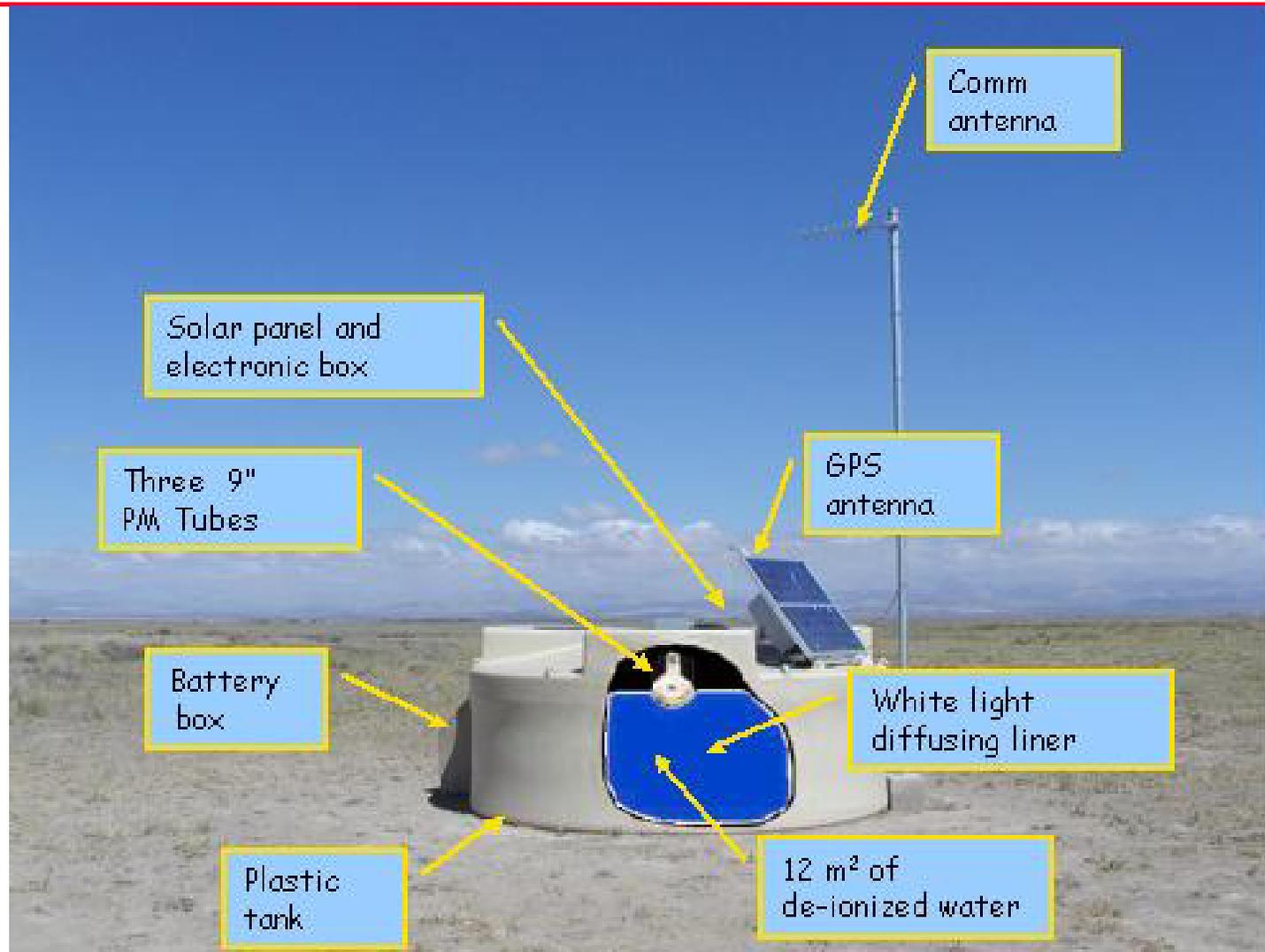
cnh # 4

PAC

12 Nov 2004

Auger Surface Detectors

- Rotationally molded polyethylene tanks.
- 3000 gallons of purified water.
- Čerenkov light collected by three 9" PMTs.
- Solar power system.
- Electronics and communications.





Surface Detector Progress

- All SD parts are in production (or finished).
- Now have three vendors qualified to make the tanks.
- Liner production : UTN - Mendoza.
- PMT Enclosures: All done, at Malargüe.
- Electronics
 - Unified Board – France.
 - Front-end board – USA has been ordering them – possible funding from Germany.
 - Tank Power Control Board – USA has been ordering them.
 - Cables and electronics enclosures: ordering as we go along.
 - Radios: All done, final batch being tested at Leeds.
- PMT potting and electronics testing in progress at Malargüe.
- Solar Panels and batteries: commercial items.



PIERRE
AUGER
OBSERVATORY

cnh # 6

PAC

12 Nov 2004

Surface Detector Status

As of 9 November 2004:

tanks deployed: 590

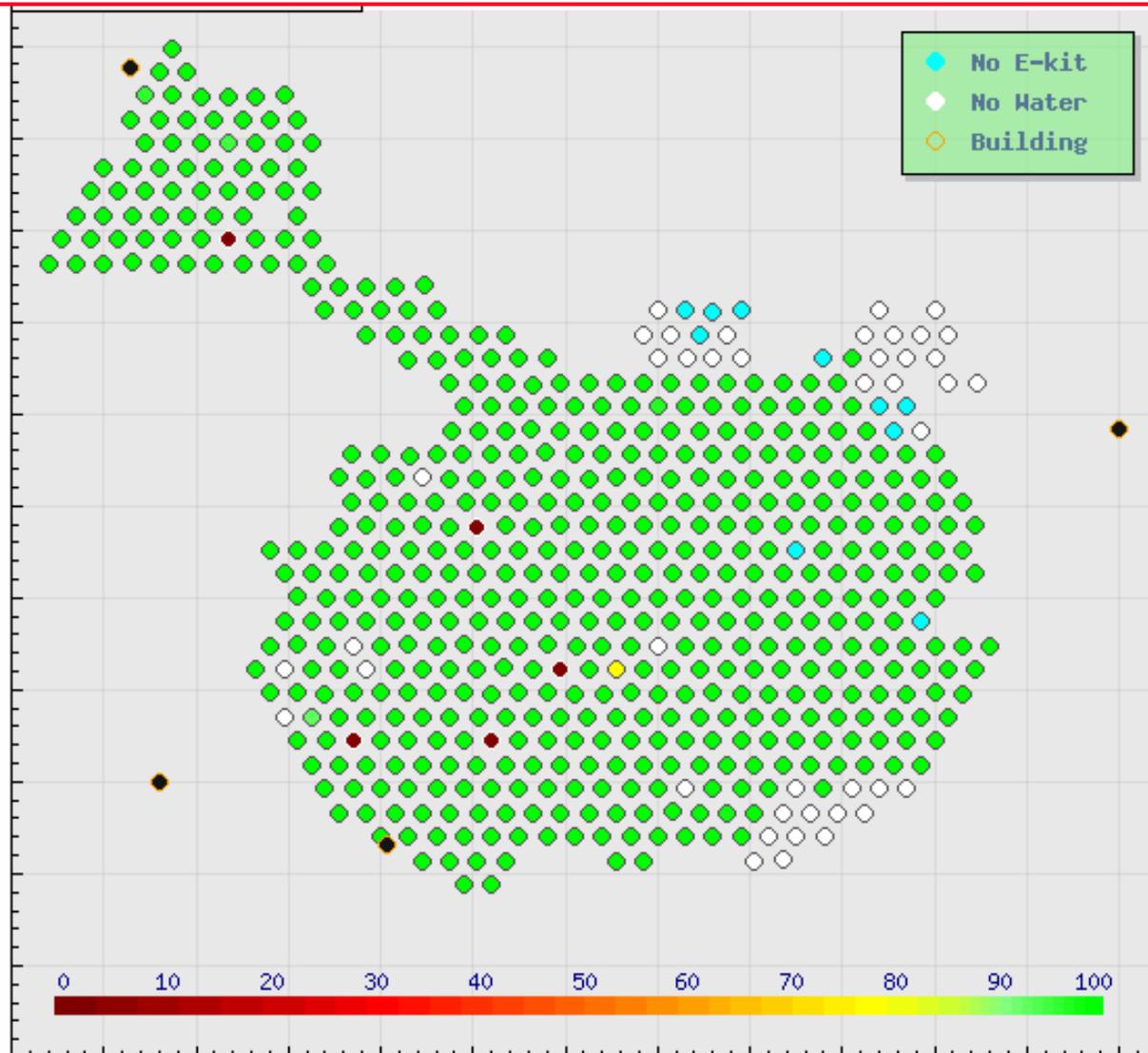
with water: 544

with electronics: 535

Recently, the array has been extended toward the Coihueco building where fluorescence telescopes are installed.

The SD array has been working very reliably:
~ 94% up time.

Picture from 30 Oct 2004.





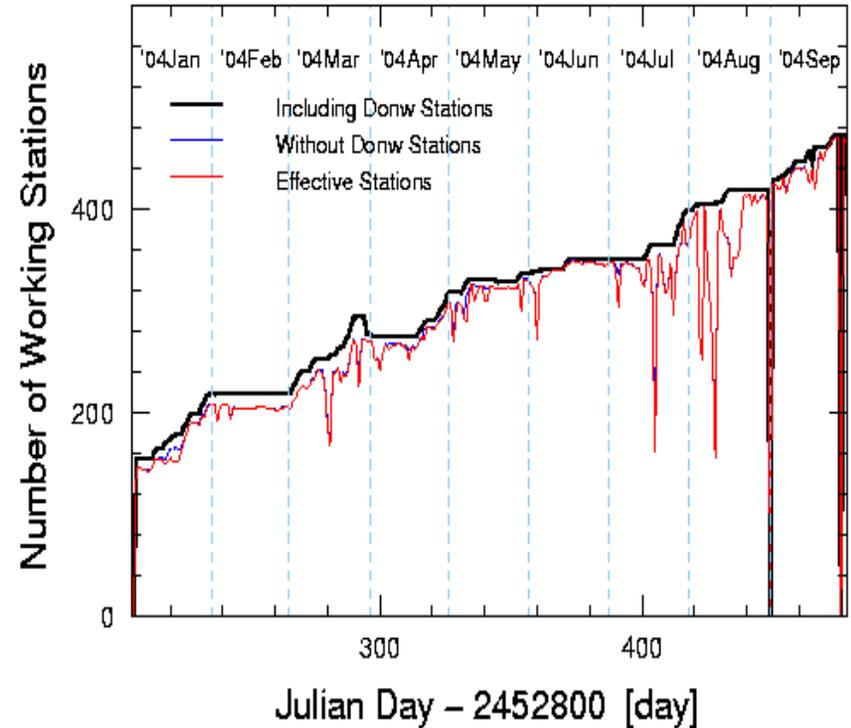
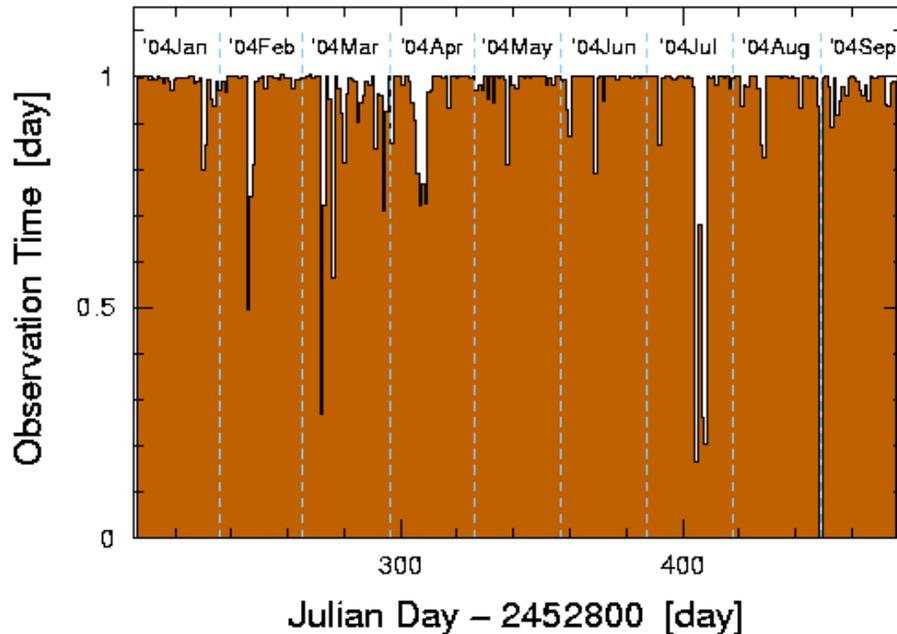
PIERRE
AUGER
OBSERVATORY

cnh # 7

PAC

12 Nov 2004

Surface Detector Operations



- Down time in above figures mostly due to problems with communications or software changes.
- SD performance may be monitored remotely using a web-based program.



PIERRE
AUGER
OBSERVATORY

The Auger Fluorescence Detectors(FD)

cnh # 8

PAC

12 Nov 2004



- Measure N_2 fluorescence from the EM portion of the shower which carries 90% of the shower energy.
- 4 FD buildings, each with 6 telescopes.
- Each telescope views a $30^\circ \times 30^\circ$ piece of the sky.
- FD buildings are at higher elevation to avoid ground fog.
- Central Laser Facility in the center of the array – can fire laser shots viewable by FDs.

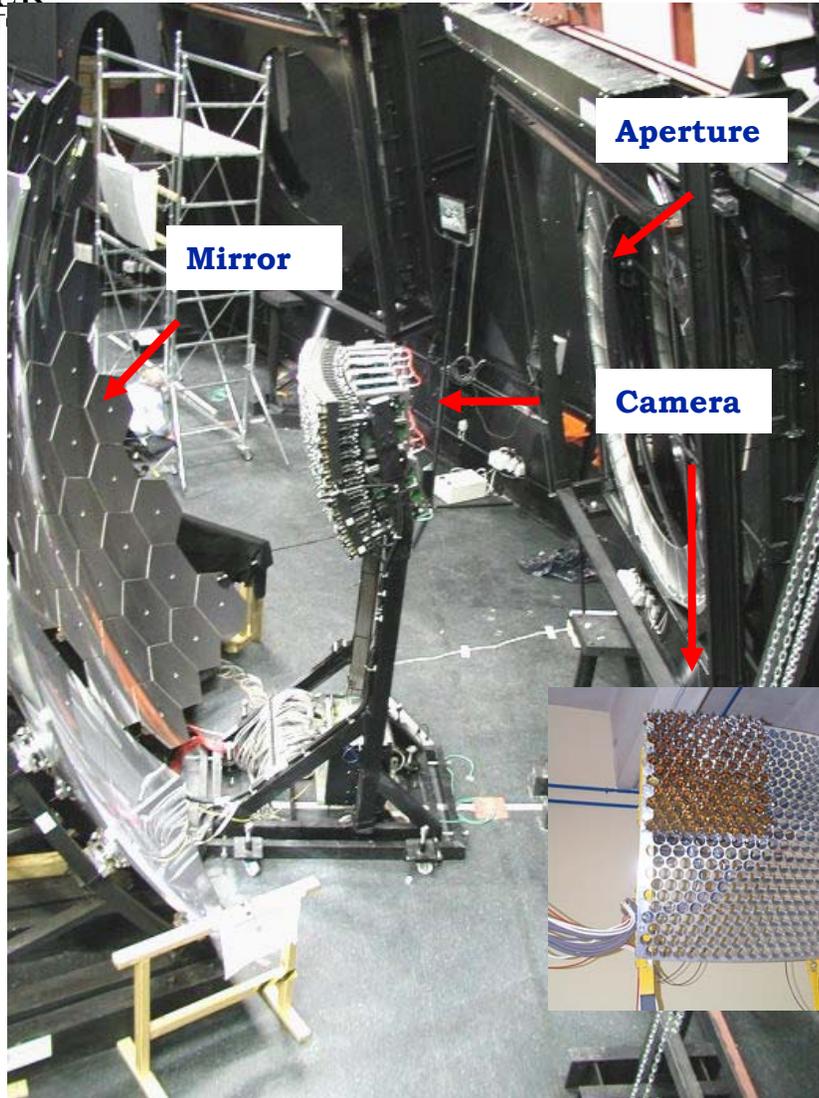
The Auger Fluorescence Detectors (FD)

cnh # 9

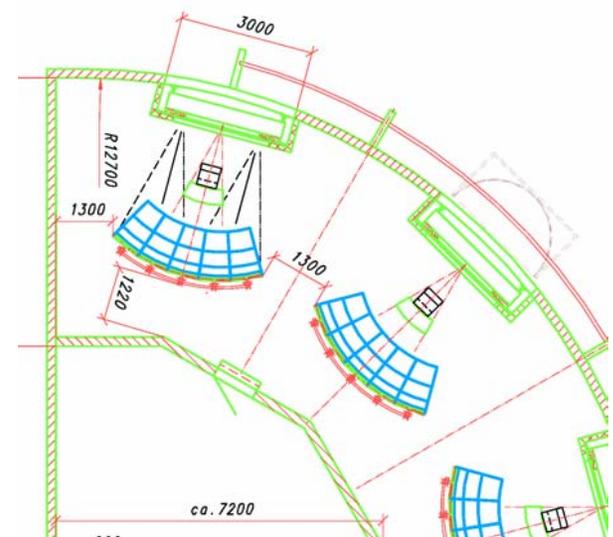
PAC

12 Nov 2004

PIERRE
AUGER
OBSERVAT



- 3.4m diameter mirror,
- 440 pixel camera (PMTs)
- All parts for all 24 telescopes are in hand or ordered.
- Telescopes at Los Leones and Coihueco are fully operational.





Communications and Infrastructure

- Communications
 - Comms towers complete at Los Leones, Coihueco and Morados.
 - Hope to have 4th tower at Loma Amarilla done ~ Dec, 2004.
- FD Buildings
 - Buildings complete and fully instrumented at Los Leones and Coihueco.
 - Third FD building at Los Morados is being dedicated today!
 - Fourth FD building at Loma Amarilla - start ~ January, 2005, finish ~ summer 2005.
- Water deployment
 - Surface detector array progress is limited by water deployment.
 - Water plant capacity now 72 tanks/month; should get to 80 tanks/month with addition of a second storage tank.
 - A third water transport tank is being built and a fourth will be finished in February, 2005.
 - This will make water delivery capability 4 tanks/day.

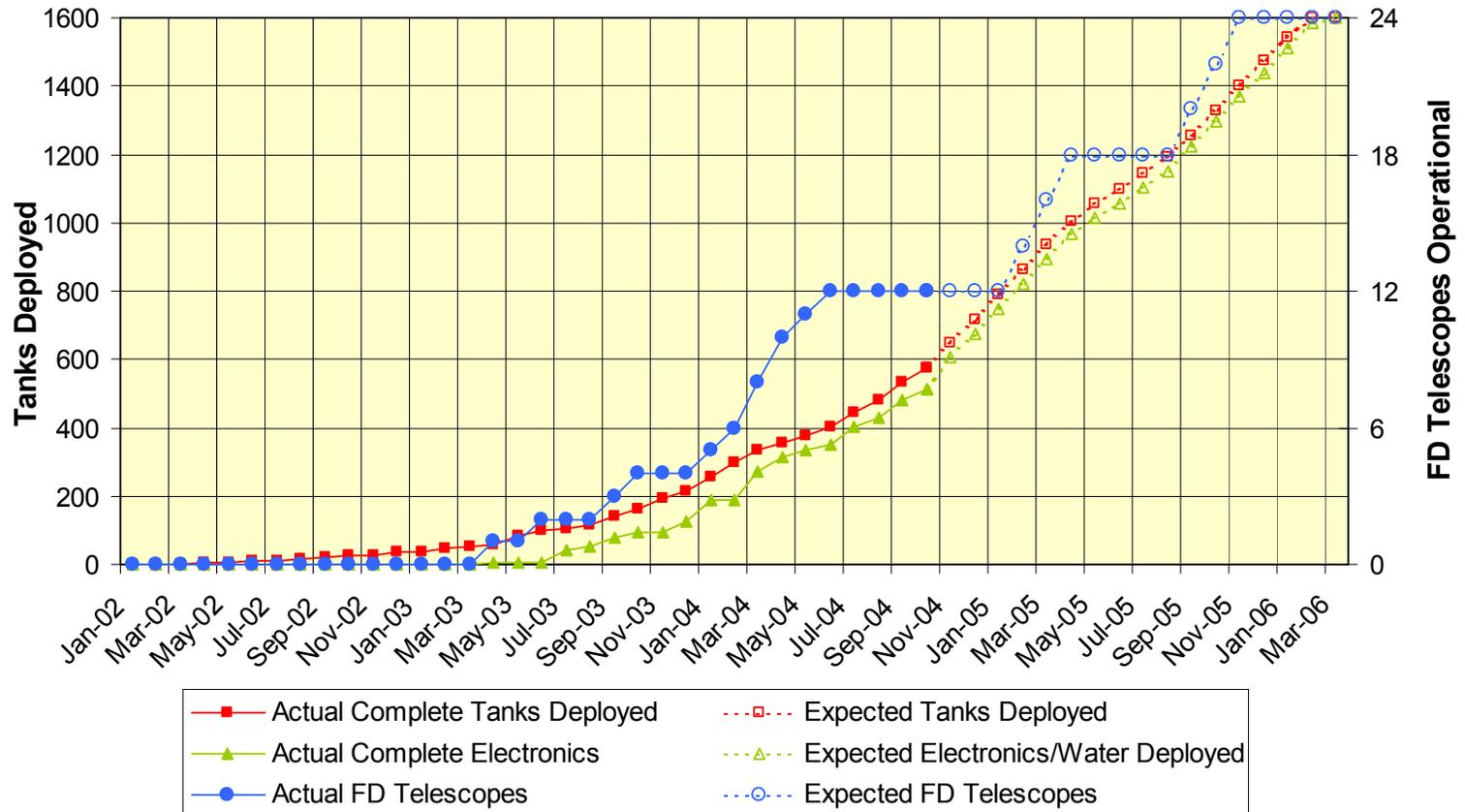


PIERRE
AUGER
OBSERVATORY

cnh # 11
PAC
12 Nov 2004

Schedule

Pierre Auger Project Schedule Chart
Updated 28-Oct-04





Schedule Notes

- Schedule assumes we are not funding-limited.
- But currently, we only have commitments to get to ~1100 SD tanks (out of 1600).
- We have no tanks orders at two of the vendors after December, 2004.
 - Concern that if the vendors stop production, it will be time-consuming to restart.
 - The critical path is ordering resin (tank material); must do this in advance of tank production.
- Many items (e.g. front-end boards) can be ordered ~100 –200 at a time without a big price penalty, but this does make managing the construction more challenging.



Funding Shortfall

Date	Total Cost, including Contingency (M\$)
October, 2001	53.8
October, 2004	46.6

- Overall, the cost of the Pierre Auger southern observatory has decreased over the last few years, but contributions from some countries have been much less than anticipated.
- New funding has been identified from many collaborating countries, but there is still a shortfall.
- Also problems with cash flow needed to keep tank production going.

Funding Shortfall, May 2003	\$10.0M
New funding received	\$4.5M
Additional new funding expected	\$3.6M
Remaining shortfall	\$1.9M



PIERRE
AUGER
OBSERVATORY

cnh # 14

PAC

12 Nov 2004

Data Analysis

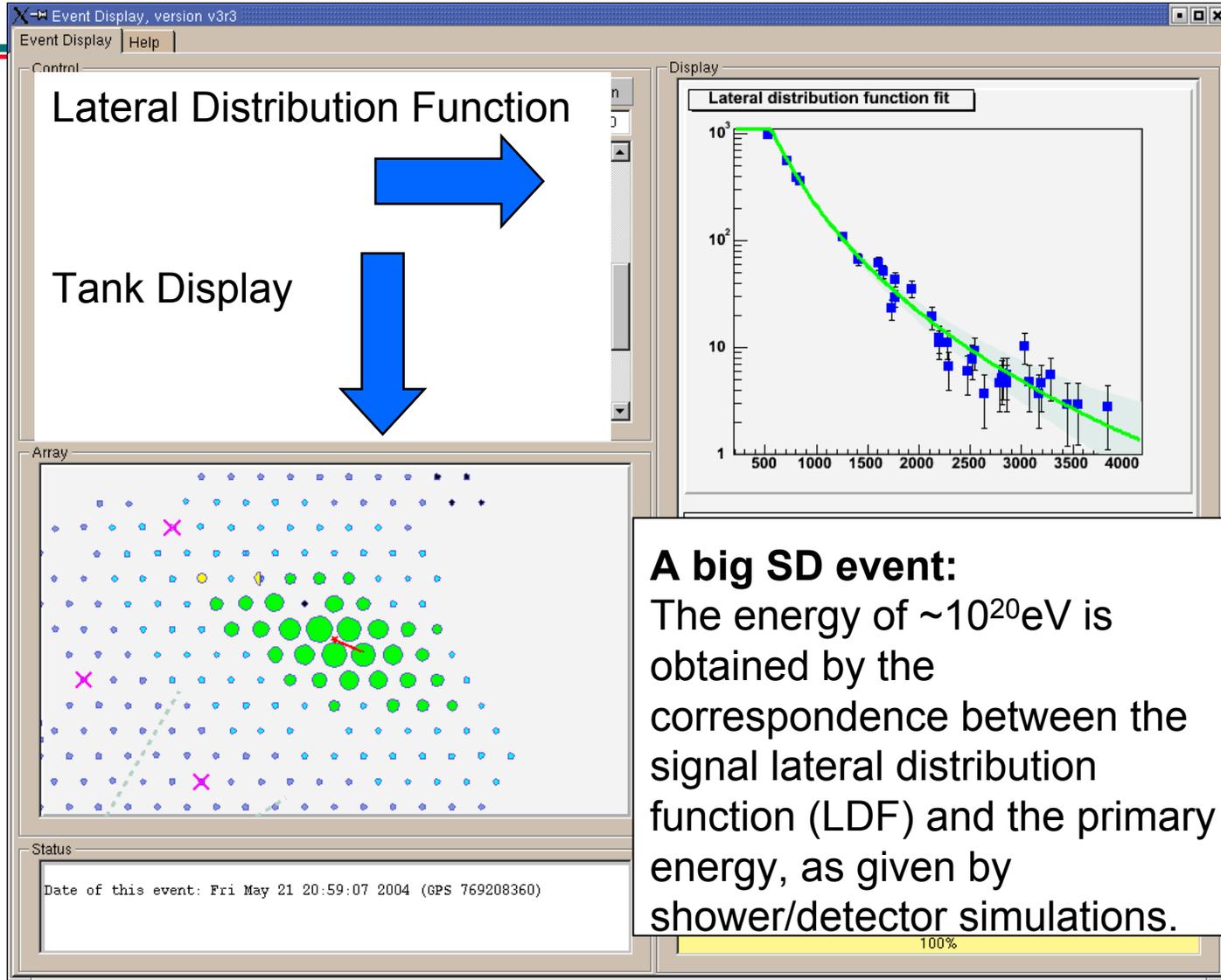
- Data Analysis framework – in use now after large effort.
 - Same user interface for simulation and real data.
 - Modular structure easily allows comparison of different algorithms.
 - Flexible, configurable.
- Databases under construction
 - Atmospheric monitoring.
 - Surface Detector monitoring and calibration.
- Many analysis efforts underway with the goal of first public results at 2005 International Cosmic Ray Conference.



PIERRE
AUGER
OBSERVATORY

cnh # 15
PAC
12 Nov 2004

Surface Detector Event



A big SD event:

The energy of $\sim 10^{20}$ eV is obtained by the correspondence between the signal lateral distribution function (LDF) and the primary energy, as given by shower/detector simulations.



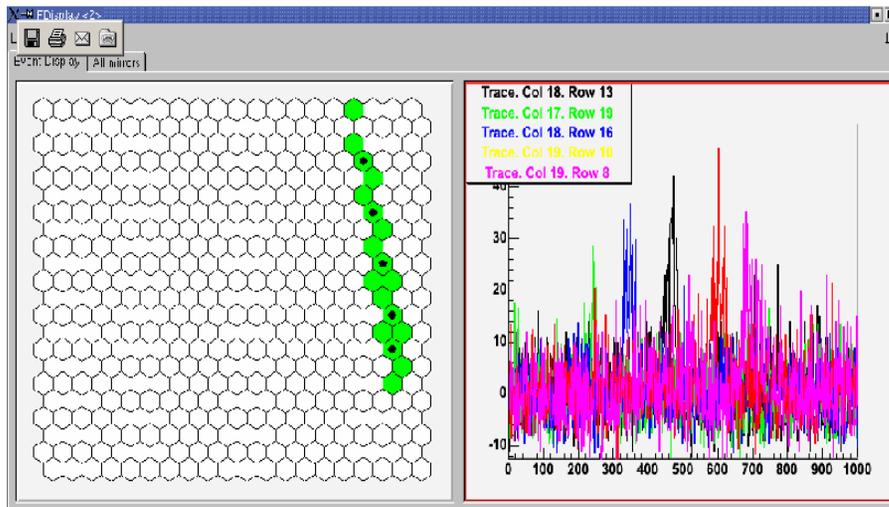
PIERRE
AUGER
OBSERVATORY

cnh # 16

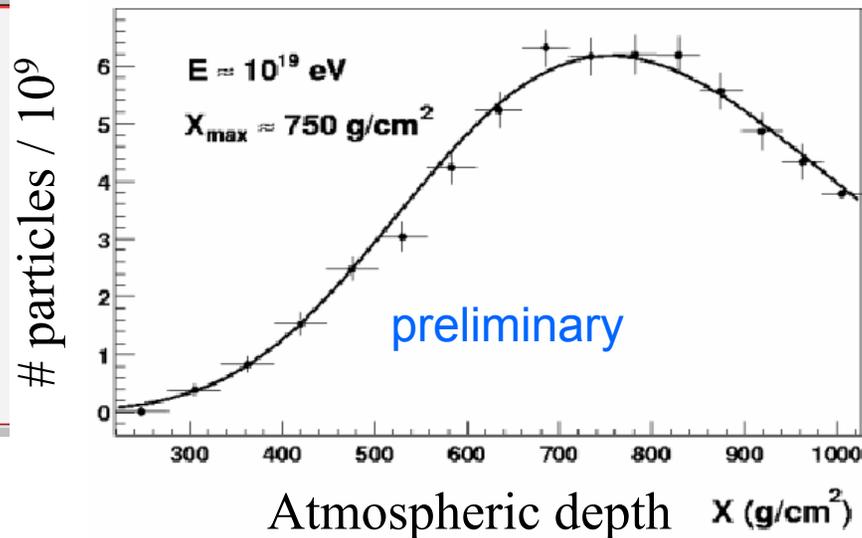
PAC

12 Nov 2004

FD Reconstruction



A Shower profile (Auger data)



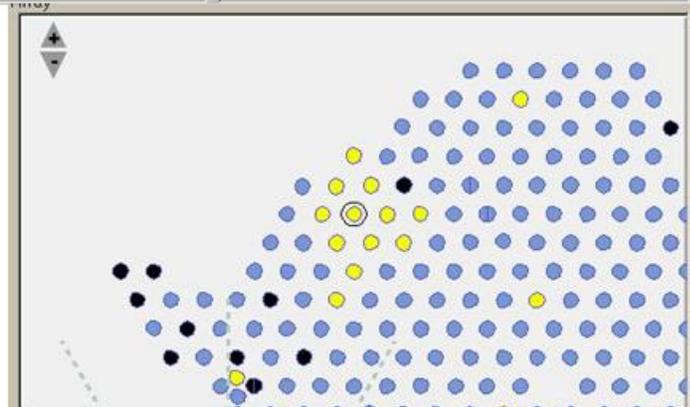
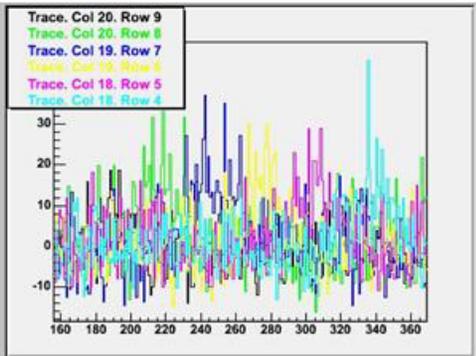
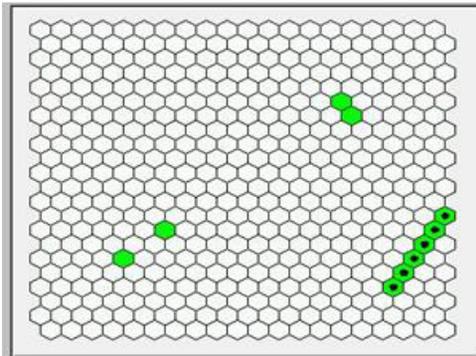
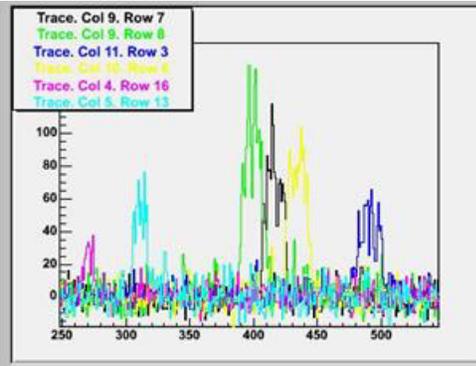
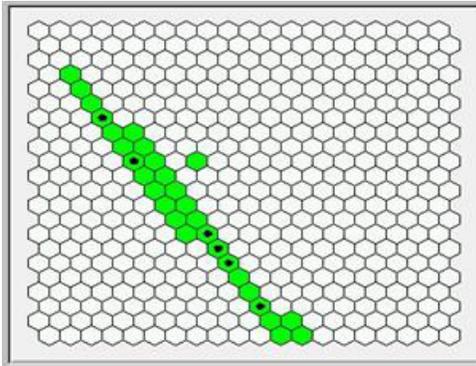
- The geometry is reconstructed from the signal arrival time in each pixel.
- FADC traces of each pixel are integrated to get the signal profile.
- Using 1) N_2 fluorescence yield per tracklength; 2) measured atmospheric attenuation; 3) telescope light collection efficiencies: the signal profile is converted to a MIP# profile.



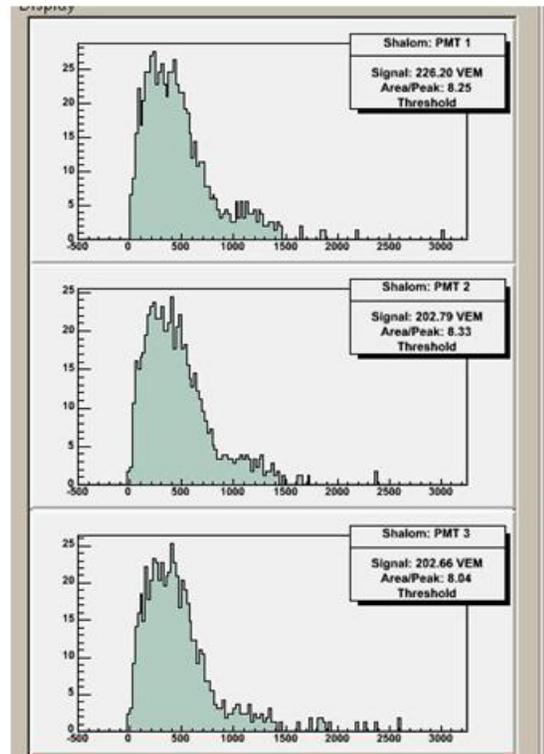
PIERRE
AUGER
OBSERVATORY

Hybrid Stereo Event

cnh # 17
PAC
12 Nov 2004



Platinum Event
#673411
(10 tanks in fit)





Conclusions

- Pierre Auger Observatory (southern site) is making excellent progress in Argentina:
 - All components in production.
 - Fluorescence detector is half done (12 telescopes out of 24).
 - Surface Detector is approaching 600 tanks (out of 1600).
 - Lots of effort in data analysis – first results summer, 2005.
- Funding shortfalls may slow down the Surface Detector progress:
 - Continue working with collaborators to identify new funding.
- Ongoing discussions on the Northern array:
 - Candidate sites in Utah and Colorado.
 - Important to finish the southern array and get results.
- The Auger project continues to receive excellent support from Fermilab.