The Pierre Auger Project

Capturing Messengers from the Extreme Universe

A progress report

P. Mantsch
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Over the past 40 years, approximately 15 events with energy greater than $10^{20}$ eV have been observed. The highest energy event was recorded by the Fly's Eye in Utah in 1991, with an energy of $3.2 \times 10^{20}$ eV.
Cosmic Ray Data at the highest energies
Possible Sources

**Conventional – Bottoms-Up**
- Hot spots in radio galaxy lobes?
- Accretion shocks in active galactic nuclei?
- Colliding galaxies?
- Associated with gamma ray bursts?

**Exotic – Top-Down**
- Annihilation of topological defects?
- Wimpzillas – heavy dark matter?
- Z bursts?
- New physics?
The Pierre Auger Project

A High Statistics Study of
The Highest Energy Cosmic Rays
>10^{19} \text{ eV}
Energy Spectrum - Direction – Composition

Two Large Air Shower Detectors
Argentina (under construction)
USA

Collaboration: 15 Countries/50 institutions
The Auger Collaboration

Argentina
Australia
Brazil
Czech Republic
France
Germany
Greece
Italy

Mexico
Poland
Slovenia
Spain
United Kingdom
USA
Vietnam

50 Institutions, >250 Scientists
Air Showers and the Atmosphere as Calorimeter

Shower Max

10^{11} Particles at surface

Sea level

N

Depth in the Atmosphere

γ ~ 89%

e^± ~ 10%

μ ~ 1%

10 MeV

1 GeV

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Air Shower Detector Techniques
And their features

**Particle Detector Array**
- 100% duty cycle
- Uniform sky coverage
- Simple robust detectors
- Mass determination using rise time, muon/em
- Energy determination depends on simulation

**Fluorescence Detector**
- Calorimetric energy measurement
- Direct view of shower development
- Good angular resolution (< 1°)
- Need correction for atmospheric attenuation
- 10% Duty factor
Pierre Auger Observatory

Combines strengths of

Surface Detector Array and
Fluorescence Detectors

Hybrid detector:
- Independent measurement techniques allow cross calibration and control of systematics
- More reliable energy and angle measurement
- Primary mass measured in complementary ways
- Uniform sky coverage
Auger Observatory
Southern Site

1600 Detector Stations
1.5 Km spacing.
7000 km² str

24 fluorescence telescopes
in four enclosures

The Engineering Array

10^{20} eV Shower

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The Auger Surface Detector
Surface Detector Station with curious local residents
Fluorescence Detector Building at Los Leones
Auger Fluorescence Detector

24 telescope units
3.4 meter dia. Mirrors
440 PMTs per camera
Fluorescence Building at Coihueco
The Auger Campus

Cerenkov detector tanks being prepared for deployment

Detector Assembly Building
Auger Center Building
Observatory Staff
Observatory Construction Plan and Project Status

- **Engineering Array** – two years -complete
  - 32 surface detector stations
  - 2 fluorescence detector prototype telescopes
  - 80 hybrid events
  - Surface array in operation for > one year
- **Full Construction** – three to four years – underway
  - Designs refined based on experience with the engineering array.
  - Pre-production of 100 sets of surface detector components nearly complete.
  - Deployment of pre-production detector stations underway – 46 tanks deployed.
  - Two (of four) fluorescence buildings complete – installation of the first 12 telescopes underway.
Engineering Array Events

Auger data: 2548 events of all energies, 60 deg exclusion zone in green

Galactic Latitude

Galactic Longitude
Carmen and Miranda
Event 308314
Zenith angle 5.8 degrees
Event 308314
Zenith angle 5.8 degrees

Easting = 460987 ± 13m
Northing = 6085438 ± 46m
dt = 12.6ns

Theta = 5.8 ± 0.5 deg
Phi = -58.6 ± 4.2 deg
R = 8.3 ± 0.8 Km

S(1000) = 64.59 ± 3.77 VEM
E = 14.55 EeV ± 6%
Event 193485
Zenith angle 75.8 degrees
Event 193485
Zenith angle 75.8 degrees

Easting: 458900 ± 184m
Northing: 6084974 ± 78m
dt = 10.0 ns

Theta = 75.8 ± 0.5 deg
Phi = 11.6 ± 0.4 deg

R = 27.1 ± 11.6 km
S(1000) = 2.64 ± 0.57 VEM
E = 5.40 EeV ± 21%
Hybrid Event

3 EeV
Auger at Fermilab

- Project management office
- Surface detector development
- Surface detector electronics development
- Data acquisition – data mirror site

Physicists:
  Aaron Chou (RA)
  Hank Glass
  Carlos Hojvat
  Paul Mantsch
  Cathy Newman-Holmes
  Lou Voyvodic (retired)

Project management staff:
  Marc Kaducak – project engineer
  Chez Jach – cost & schedule
  Jamie Blowers – QA (part time)
  Rafael Coll – ES&H (part time)
  Sarah McCook - clerical
Management Organization

Spokesperson Emeritus
J. Cronin (USA)

Spokesperson
A. Watson (UK)

Cospokesperson
H. Bluemer (Germany)

Collaboration Board
Chairman: T. Dova
Cochairman: P. Sommers

Site Spokesperson:
Northern
D. Nitz (USA)
Southern
A. Etchegoyen (Argentina)

Site Managers:
Northern Site
B. Fick (Acting)
Southern Site
G. Avila

Technical Board

Project Manager
P. Mantsch (USA)
Deputy: C. Hojvat (USA)

Project Office:
- Systems Engineering
- Quality Assurance
- Cost & Schedule
- Environment Safety & Health
- Administrative Support

Site Spokesperson:
Northern
D. Nitz (USA)
Southern
A. Etchegoyen (Argentina)

Mendoza Site
Central Data Acquisition
A. Letessier-Selvon

Fluorescence Detectors
J. Kleinfeller
P. Privitera

Fluorescence Detector Electronics
M. Kleifges
D. Camin

Surface Detectors
I. Allekotte
P. Mazur

Array Response Simulations
J. Matthews
B. Dawson

Surface Detector Electronics
J. Beatty
T. Suomijarvi

Array Response Simulations
J. Matthews
B. Dawson

Communications
P. Clark

Data Processing and Analysis
S. Argiro
S. Sciutto

Shower Simulations
J. Knapp

Education/Public Relations
G. Snow
B. Garcia

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Summary

• Exciting physics – Addresses one of the eleven science questions for the new century – NAS – “Connecting Quarks with the Cosmos”.
• A strong collaboration.
• The Engineering Array is finished
• The detector performance exceeds original expectations.
• Full construction is underway.
• We will finish in 2005 – funding flow permitting.