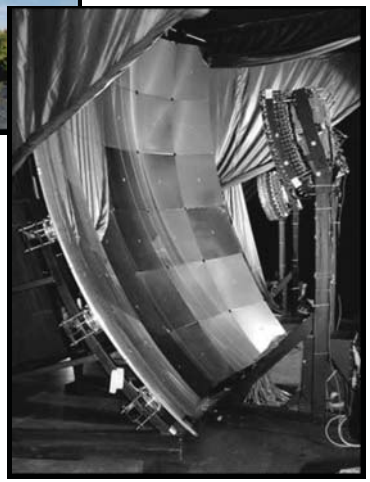
SURFACE DETECTORS

Covered area: 3000 km².
Water-Cherenkov
Detectors: 1660.
Distance between detectors: 1.5 km.
Type of detectors: water-Cherenkov, each of 10 m² and 1.2 m deep, filled with 12000 liters of purified water and viewed by three 9 inch photomultipliers.

FLUORESCENCE TELESCOPES



Telescopes: 27 located in 4 buildings.
Range: greater than 30 km for cosmic rays of 10^{20} eV.
Mirrors: 3.6 m x 3.6 m spherical surface with 30° x 30° opening.
Cameras: 440 photomultiplier tubes of 4 cm each.

PIERRE AUGER OBSERVATORY

400 Scientists.
91 Institutions.
18 Countries.

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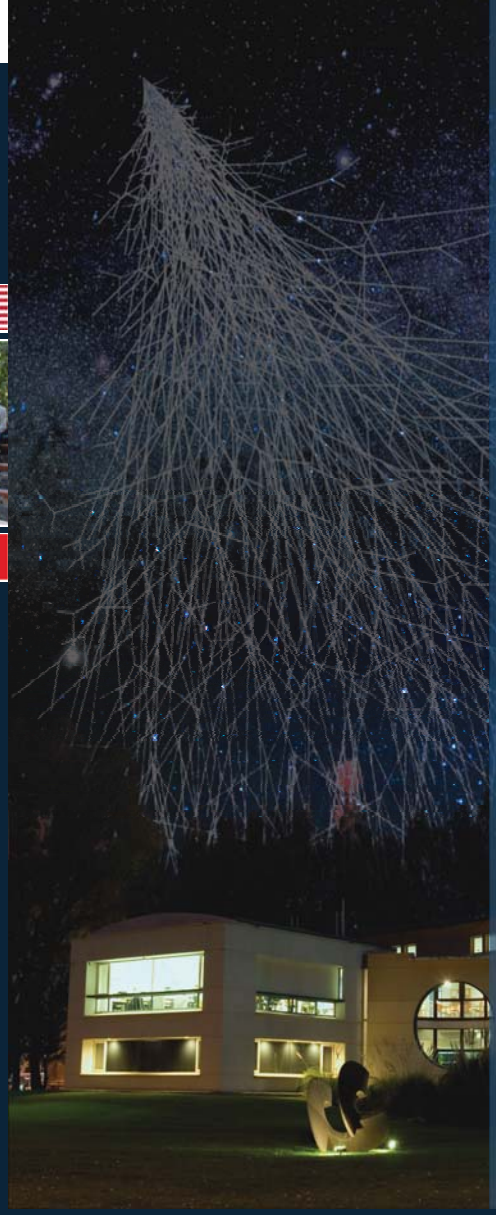
Observatorio Pierre Auger Malargüe

The Pierre Auger Observatory

@augerobs

Pierre Auger Observatory



PIERRE AUGER OBSERVATORY

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ARGENTINA

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ULTRA - HIGH ENERGY COSMIC - RAYS

Cosmic rays are charged particles that constantly bombard the Earth and are one type of the cosmic messengers that help us understand our Universe. At the highest energies, the deflection of the trajectories by the Galactic and extragalactic magnetic fields is reduced, thus opening a new window of charged-particle astronomy. The goal of the Pierre Auger Observatory is to study the nature and origin of these Ultra-Energy Cosmic-Rays with unprecedented accuracy and statistical precision.

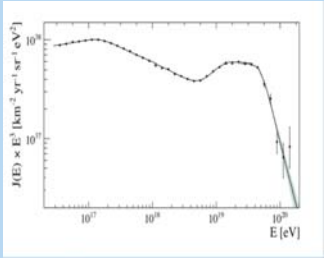
A BRIEF HISTORY OF THE OBSERVATORY

The Pierre Auger Observatory was conceived in the 1990s by Jim Cronin, Alan Watson and other colleagues, to address the mysteries of the origin and nature of the highest-energy particles. It was clear that only a very large detector would provide the exposure to collect enough events to answer the questions raised during nearly a century of earlier experiments.

The Observatory design evolved to a “hybrid” detector system consisting of an array of 1660 particle detectors, deployed over 3000 km^2, and overlooked by 27 telescopes used to detect the auroral-like emission from the atmosphere, detectable on dark nights. This ‘so-called’ fluorescence radiation enables the energy of the events to be determined without assumptions about the nature of the primary particles or off the hadronic interactions involved.

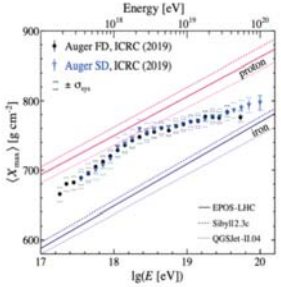
1991. Concept of the Pierre Auger Observatory developed.
1993. Collaborators recruited.
1995. Six-month design study at Fermi Lab.
1995. Argentina selected as the country to host the site of the Observatory during meeting at UNESCO in Paris.
1999. 19 March, Ground-breaking Ceremony and International Agreement signed in Malargüe.
2001. Construction initiated with the Engineering Array.
2004. 1 January: Science data taking started.
2008. June: Construction completed, with Inauguration later in year.
2015. International Agreement renewed.
2016. First upgraded-detectors positioned on the Pampa.
2019. A bright future beckons with start of full-scale construction of the upgrade.

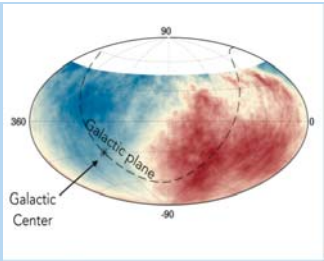
MAIN RESULTS OF THE OBSERVATORY



Confirmation of existence of a strong suppression of the flux of the highest energy particles. Its origin is not yet fully understood. [(ICRC2019) 450].

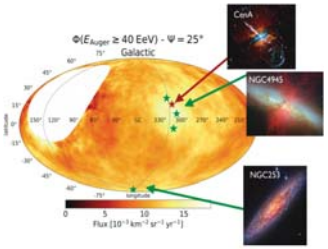
First indication that the primary composition of ultra-high energy cosmic-rays is getting heavier at higher energies. [(ICRC2019) 482].

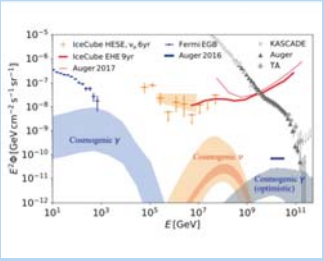




Discovery of a large-scale anisotropy in the arrival directions of ultra-high energy cosmic rays indicating that their origin is outside our Galaxy. [Science357 (2017) 1266].

Intermediate scale anisotropies suggested by correlation with different astrophysical catalogs. [ApJL 853:L29, 2018].





Best upper limits on the flux of UHE neutral primaries and a key role in the field of multi-messenger astrophysics. [JCAP 1910 (2019) 022], [JCAP 1704 (2019) 009].

A BRIGHT FUTURE

Spurred by the science results obtained so far, the Observatory is currently undergoing an upgrade (”AugerPrime”), aimed mostly at improving the sensitivity of the surface detector to primary mass composition. New electronics are being installed with a small PMT in each water-Cherenkov detector. With additional complementary detectors with the aim of a better separation of the electromagnetic and muonic components on an event-by-event basis, with three types of detectors.

The new detectors are:

* a slab of scintillators, over the surface detectors,
* radio antennas (30-80 Mhz), recording the radio signal from extensive air showers, both to be installed atop of the existing stations,
* an array of buried muon counters in the dense part of the array.

The additional observables are critical to the selection of the subset of showers likely to arise from lighter primaries, which in turn may hold the key to identifying and studying the cosmic accelerators outside our own galaxy.

More generally, the data collected with AugerPrime will be used to explore fundamental particle physics at energies beyond those accessible at terrestrial accelerators, and perhaps allow the observation of new physics phenomena.