

**PIERRE
AUGER**
OBSERVATORY

Outreach, Education, and Communication Initiatives at the Pierre Auger Observatory

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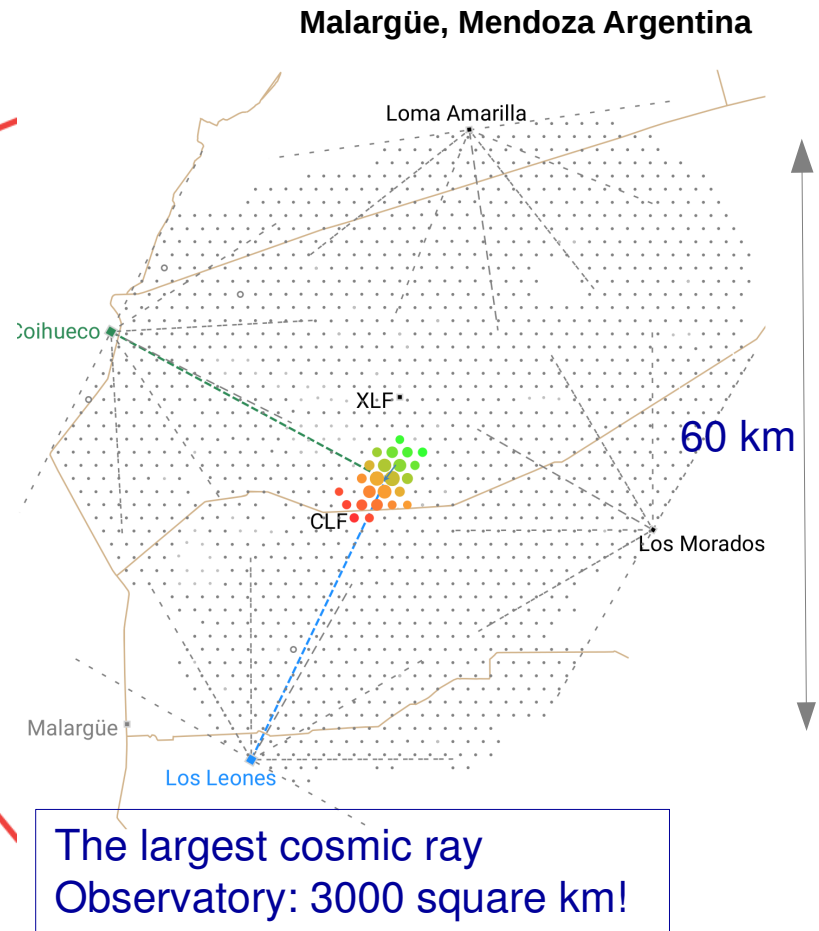
Pierre Auger Observatory

the physics case

unveil the nature and origin of Ultra-High Energy Cosmic Rays after more than 100 years since their discovery!

- Energy spectrum
- Arrival directions
- Composition
- Hadronic physics
- Multi-messenger

Observatory recently upgraded
→ new data - Phase II



Pierre Auger Observatory

the hybrid concept

Surface Detector (SD)

Density of particles at the ground:
duty cycle ~ 100%

1600 stations @ 1.5 km, 3000 km²
61 stations @ 0.75 km, 25 km²

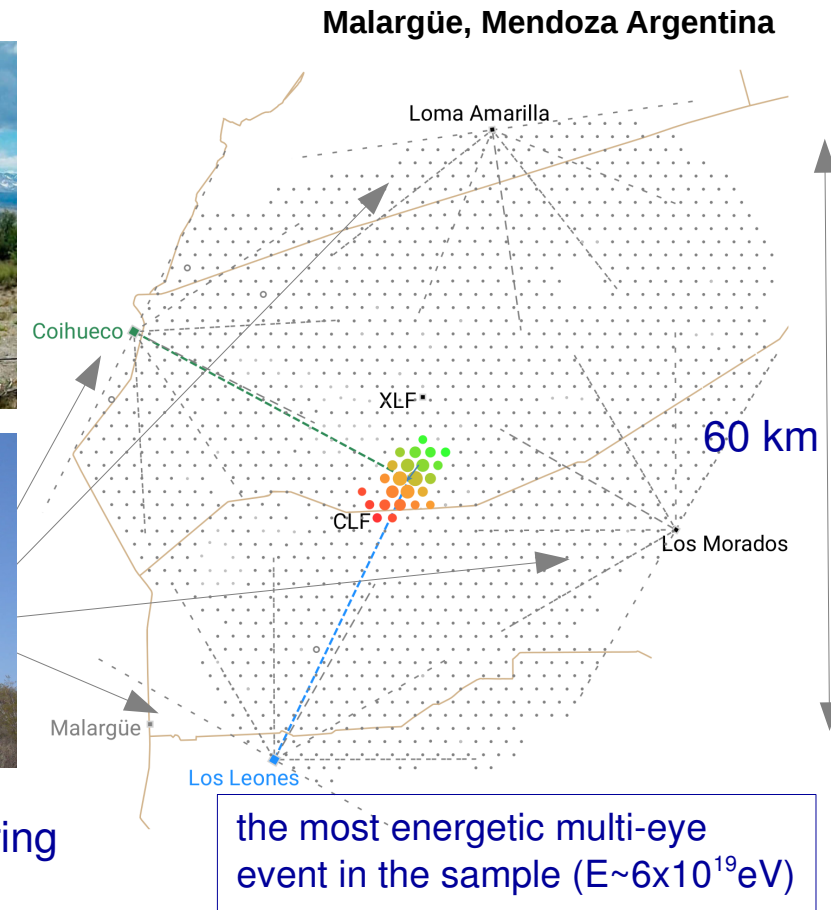
Fluorescence Detector (FD)

Longitudinal profile:
duty cycle ~ 15%

24 + 3 telescopes ~30° FoV @ 4 sites

Atmospheric monitoring devices

Laser facilities and weather stations



different detectors and many devices for atmospheric monitoring
→ diverse data sources and formats

Pierre Auger Observatory outreach program

<https://www.auger.org/>

since the beginning an extensive program developed by the proactive outreach group

- visitors center at Malargüe
- science fair
- Malargüe parade
- local initiatives at schools
- art & science contests
- worldwide open science initiatives in synergy with many international institutions
- communication and social networks
- open data

Large impact on local and world-wide students of different ages and level

→ engagement of the general public



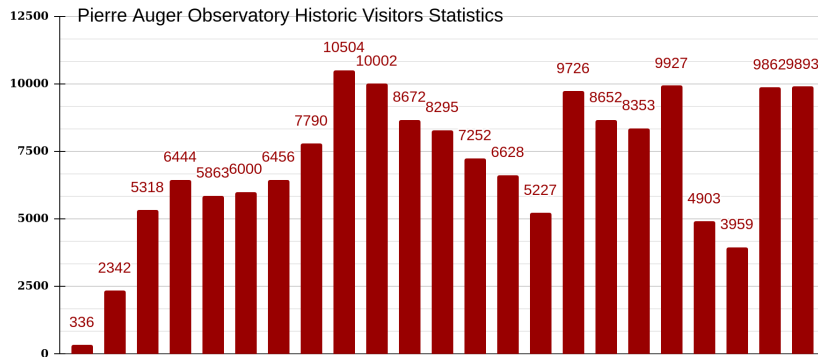
Local initiatives

Visitors Center

<https://visitantes.auger.org.ar>

Recently renewed headquarters

- models of the detectors
- interactive displays
- 3D vision and augmented reality
- guided, virtual and audio-video tours



~8000 visitors per year!



Local initiatives

Science Fair

Exhibition in Malargüe

each year involves hundreds of students from primary and secondary schools in the Malargüe province and beyond

- close co-operation between Auger staff and teachers
- Auger collaborators act as reviewers of the reports and judge the exhibition
- best realizations rewarded with prizes

→ stimulate students to pursue careers in science



Local initiatives

Malargüe parade

Malargüe anniversary celebration

each year involves thousands of people coming from all the Malargüe province

- full day of celebration in town
- Institutional and political message
- Auger section with many enthusiastic participants (both staff members and collaborators)

Celebrating together Malargüe foundation
→ strengthen ties to the local community



Pierre Auger Observatory communication

- Flyers and brochures
- Auger official web page
- Outreach page
- Wikipedia
- Youtube & social networks
- Press bulletin: Auger in focus



Observatorio Pierre Auger Malargüe
3.6K followers · 26 following

various media and online resources
→ inform about Auger initiatives



Pierre Auger Observatory

@pierreaugerobservatory9832 · 148 subscribers · 15 videos

More about this channel ...more

Subscribe

The collage features several key communication assets:

- Wikipedia:** A screenshot of the Pierre Auger Observatory article in English, showing the title, navigation tabs, and a table of contents with sections like 'Physical background', 'Earlier observatories', and 'Overview'.
- Website:** A screenshot of the Pierre Auger Observatory website, displaying the 'AUGERINFOCUS' banner and introductory text about the observatory's design and purpose.
- Brochure:** A detailed flyer titled 'PIERRE AUGER OBSERVATORY' that lists 400 scientists from 91 institutions across 18 countries. It includes contact information for Malargüe, Argentina, and a QR code. The brochure also contains sections on 'SURFACE DETECTORS', 'FLUORESCENCE TELESCOPES', and 'ULTRA-HIGH ENERGY COSMIC RAYS'.
- Facebook Post:** A screenshot of a Facebook post for the 'Observatorio Pierre Auger Malargüe' page, featuring a photograph of the observatory building and a circular logo.
- Historical Timeline:** A section titled 'A BRIEF HISTORY OF THE OBSERVATORY' detailing the project's milestones from 1991 to 2018, including the initial proposal, construction phases, and the final inauguration.
- Scientific Diagrams:** Several diagrams illustrating the observatory's components, such as the surface detector array, fluorescence telescopes, and the detection of ultra-high energy cosmic rays.

AUGERINFOCUS OBJETIVOS

The Pierre Auger Observatory receives an average of 10,000 visitors per year. During each visit, a series of questions arise that would require more detailed explanations than those provided during a tour. In this context, the Observatory decided to select specific topics that are repeated as part of the public's questions. These texts can be consulted by those interested in learning more about the research and developments of the Observatory, and in particular by teachers, as they are designed as educational and dissemination material. This is how Auger in Foco was born

WHO WE ARE

To decode the enigma of ultra-high-energy cosmic rays, the Pierre Auger Observatory, where over 400 scientists, engineers, technicians, and students from 18 countries work, measures the particle cascades that occur each time a cosmic ray collides with molecules in the upper atmosphere. This allows them to determine the energy, direction of arrival, and nature of cosmic rays of the highest observable energies. The Observatory is located in the Southern Hemisphere, in the Malargüe area, Mendoza Province, Argentina, and consists of a network of 1,660 detectors, spaced 1.5 km apart, covering a total area of 3,000 square km. The surface detector network is complemented by a set of 27 highly sensitive telescopes that, on clear nights around the new moon, scan the atmosphere to observe the faint ultraviolet light produced by cosmic ray cascades as they pass through the air.

COMMUNICATIVE STRATEGY

Information about the Pierre Auger Observatory can be found on its websites:

www.auger.org
www.auger.org.ar

In addition, an online audio guide allows you to take a virtual tour

(Spanish, English)



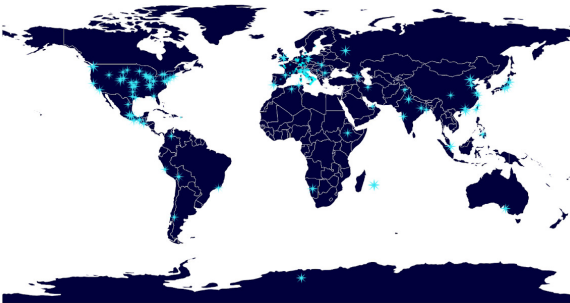
World-wide initiatives

International cosmic day

Be a scientist for one day!

Organized by DESY and partner institutions within IPPOG involves thousands of students from selected high-schools

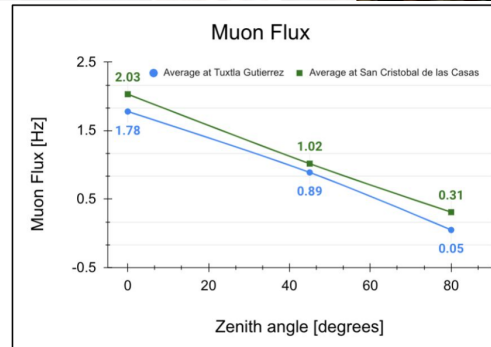
- hands on different experiments
- analysis and discussion
- printed booklet with results



~60 Countries from 4 Continents

A collage of images and data from the International Cosmic Day event. It includes:

- Photographs of students and teachers in classrooms and labs, some wearing blue and white event t-shirts.
- A large group photo of participants in front of a backdrop with the INFN logo.
- A screenshot of a video conference with multiple participants.
- A line graph titled "Muon Flux" showing the relationship between Muon Flux [Hz] and Zenith angle [degrees].
- Images of scientific equipment, including a "Fluorescence detector" and a "Radio detector".
- A close-up of a person looking at a computer monitor displaying data.



World-wide initiatives

International Masterclasses



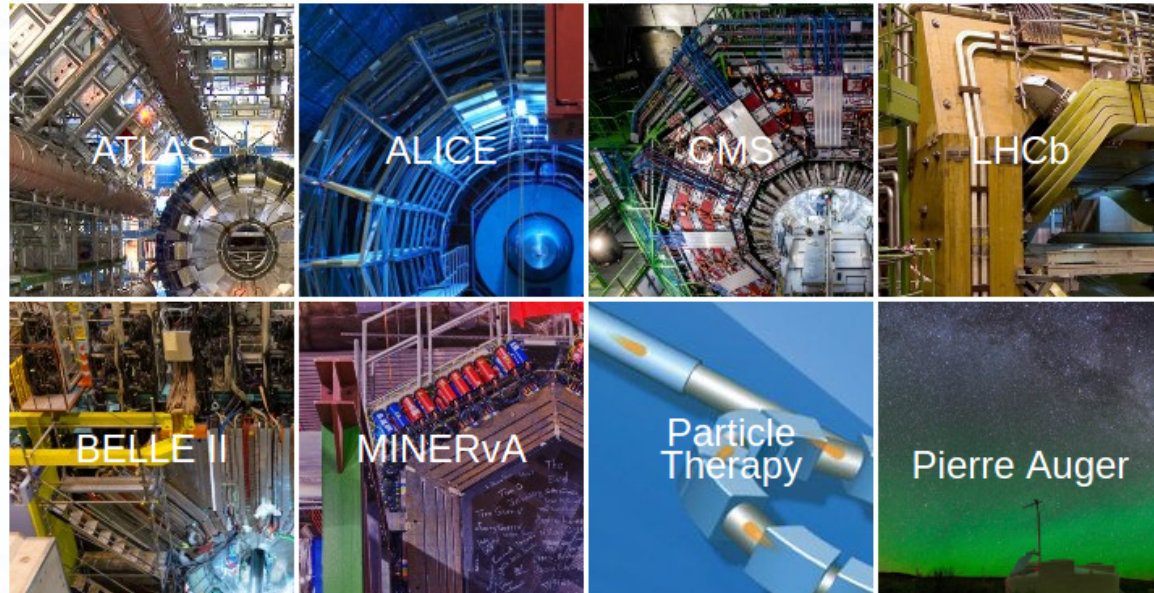
International Particle
Physics Outreach Group

Hands on particle physics!

Every year ~**13000** high-school students
from **60** countries

Auger events held in February - April

- test edition in 2022
- First edition **2023** with 3 Masterclasses events in 12 institutions (Europe/Africa)
- **2024 edition** with 5 events in 16 institutions Europe/Africa /Asia/Latin America



~ 550 students from around the world.. and we expect more!

Pierre Auger Observatory Masterclasses

hands on cosmic ray data

The scientist busy agenda

Morning: introductory talks

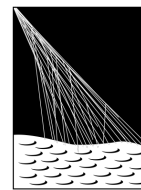
Afternoon: experimental activity with data and videoconference with Auger moderators for comparing and discussing results

user friendly 3D display interface

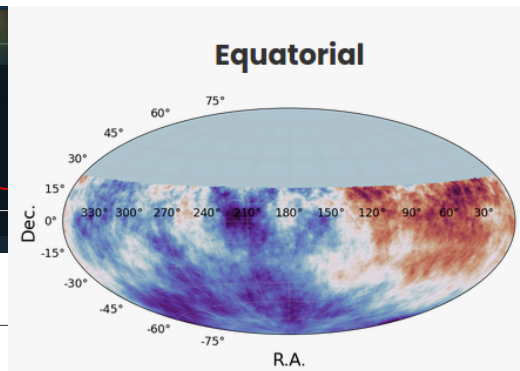
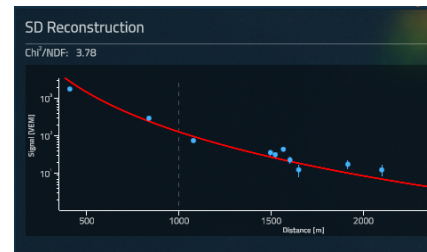
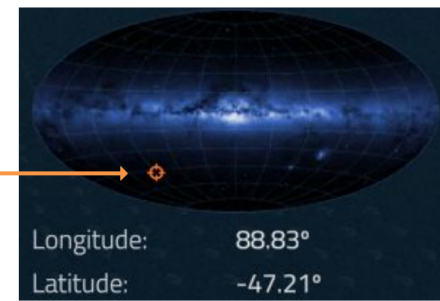
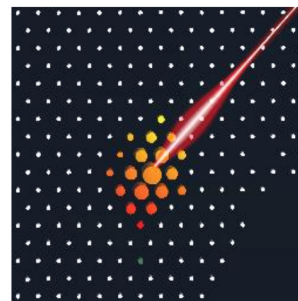
manual event reconstruction: arrival direction + energy event selection

analysis with Python notebooks

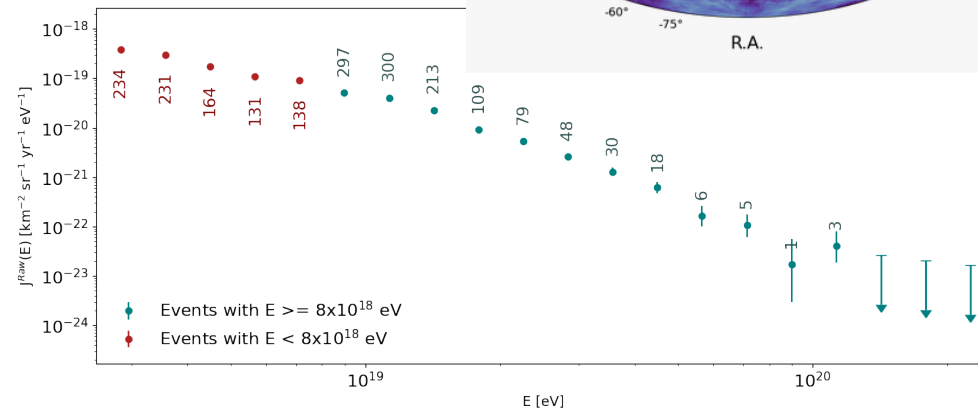
- exposure corrected sky map of selected events
- energy spectrum of selected events



PIERRE
AUGER
OBSERVATORY



Spectrum



The Open Data Portal
opendata.auger.org

Pierre Auger Observatory Open Data

March 2024 release



The Open Data Portal aim and structure

data should be accessible and reused
by the widest possible community

according to the **FAIR** principles data should be
Findable **A**ccessible **I**nteroperable **R**eusable

- detailed explanation of detectors
- **close-to-raw data** & high-level event info
- portable file format (**JSON** and **CSV**)
- **3D event visualization** tools
- **Python** code for **data analysis**
- Catalog of the **100 highest-energy** events
- Simplified **Outreach** section
- **Helpdesk** for contacting the collaboration

<https://arxiv.org/abs/2309.16294>

→ **engage professional and citizen scientists**
in world-wide educational & outreach initiatives

<https://opendata.auger.org>

Pierre Auger Observatory Open Data

March 2024 release

Following the [Auger Collaboration Open Data Policy](#), the Pierre Auger Open Data is the public release of 10% of the [Pierre Auger Observatory](#) cosmic-ray data published in recent scientific papers and at International conferences. The release also includes 100% of weather and space-weather data collected until 31 December 2020. This website hosts the datasets for download. Brief overviews of the [Pierre Auger Observatory](#) and of the [Auger Open Data](#) are set out below. An online event display to explore the released cosmic-ray events and example analysis codes are provided. An outreach section dedicated to the general public is also available.

All Auger Open Data have a DOI that you are required to cite in any applications or publications. These files are part of the main dataset whose DOI is [10.5281/zenodo.4487612](https://doi.org/10.5281/zenodo.4487612) and always points to the current version.

Datasets
[the released datasets and their complementary data](#)

Visualize
[an online look at the released pseudo raw cosmic-ray data](#)

Analyze
[example analysis codes in online python notebooks to run on the datasets](#)

Catalog
[of the highest-energy cosmic rays](#)

Outreach
[a page dedicated to the general public](#)

About the Pierre Auger Observatory

The Pierre Auger Observatory, located on a vast, high-altitude plain in the Province of Mendoza in Argentina, is the world's largest cosmic ray observatory and measures the extensive air-showers produced by cosmic rays above $\sim 10^{17}$ eV. The intensity of high energy cosmic rays (those

The Open Data Portal content

10% of cosmic-ray data

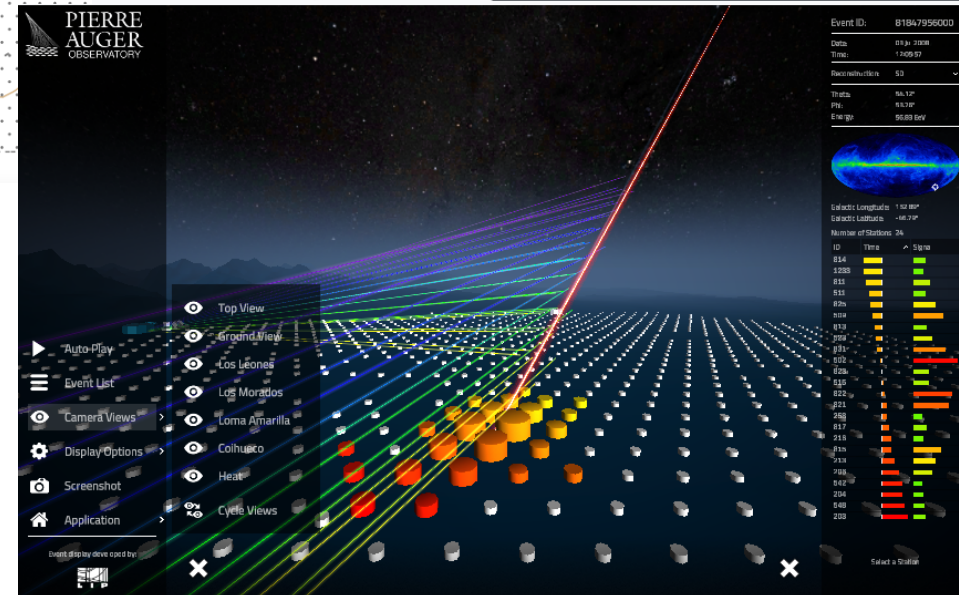
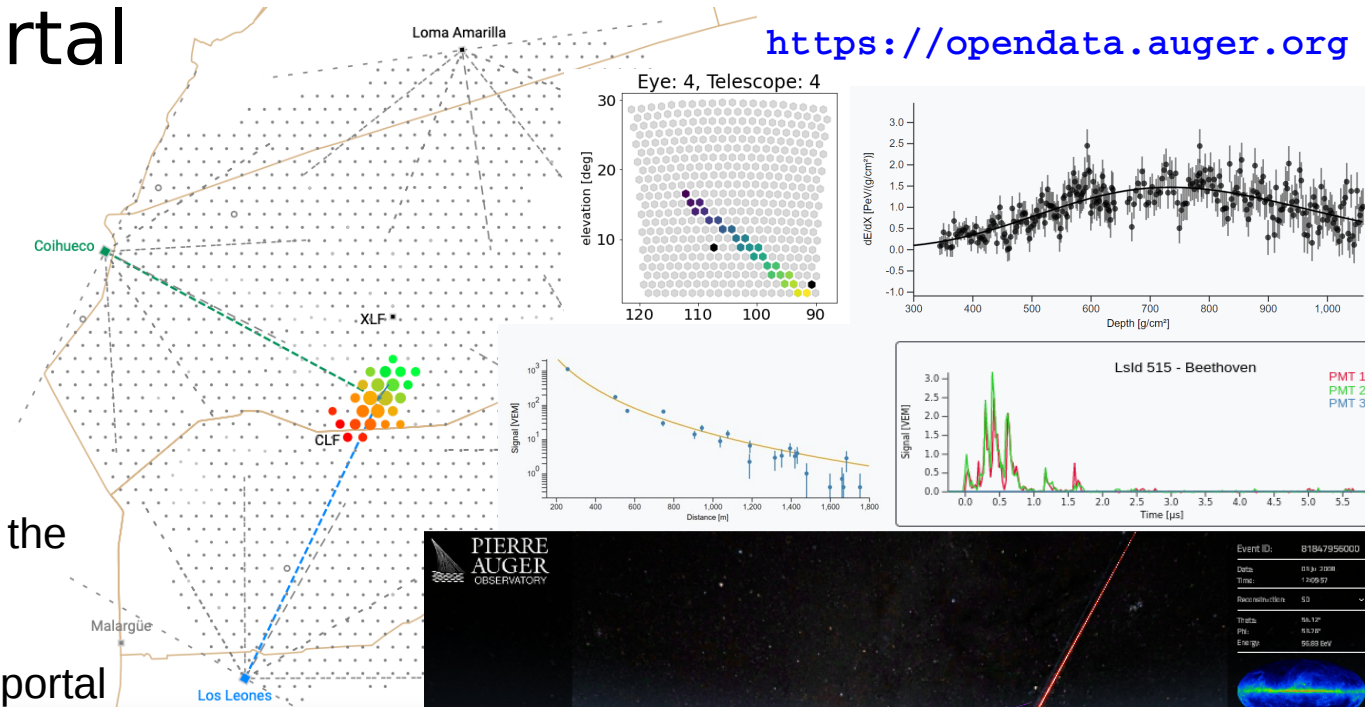
> 81000 events collected between 2004 and 2018

Dynamical content

- since the first release in 2021 the portal has been continuously extended
- task force responsible for the portal updates in synergy with the analysis tasks
- All datasets associated to a Digital Object Identifier (DOI) provided by Zenodo

→ > 40000 visits and > 3000 downloads!

<https://opendata.auger.org>



The Open Data Portal content

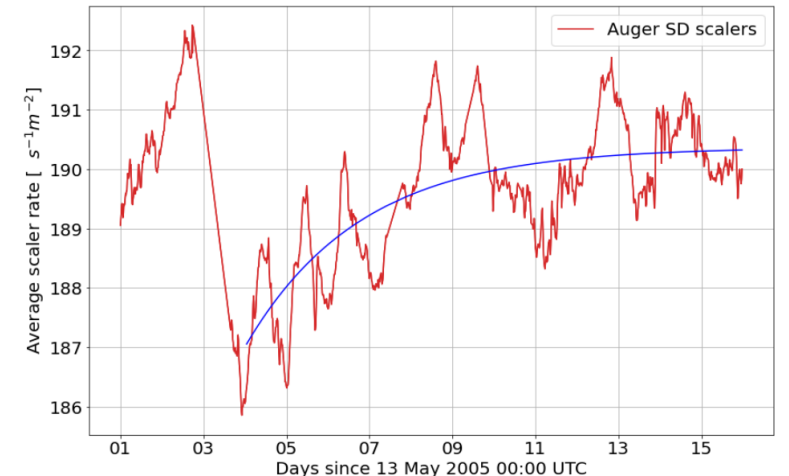
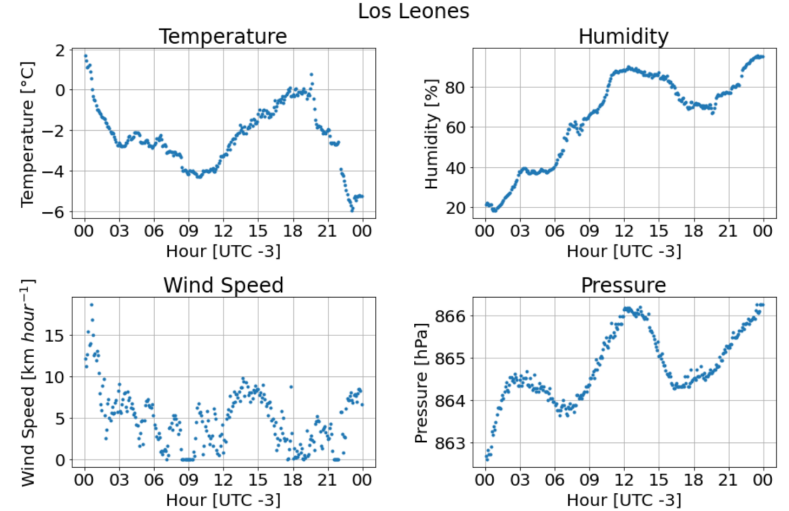
<https://opendata.auger.org>

100% of environmental and space-weather data

10^{15} events detected from March 2005 to December 2020
atmospheric monitoring data of ~ 10 years

- Weather stations data
temperature, humidity, pressure and wind speed at the Pierre Auger Observatory site
→ weather corrections
- Scaler data
scaler mode particle counters for low energy cosmic ray studies
→ forbush decrease event
- Atmospheric electricity
Observation of ELVES (light flashes during storms)
→ 2-D animations in slow motion of the light fronts

→ to be part of the environmental
and space-weather data network



The Open Data Portal

explore our data

Python notebooks

available for download or run online on Kaggle platform

- tutorial code to handle data
- plot basic variables
- learn simplified analyses
- reproduce scientific results

understanding the main scientific achievements and inspiring **own analysis**

→ **various arXiv papers and a PRD article using open data in 2023**

<https://opendata.auger.org>

Notebook Input Output Logs

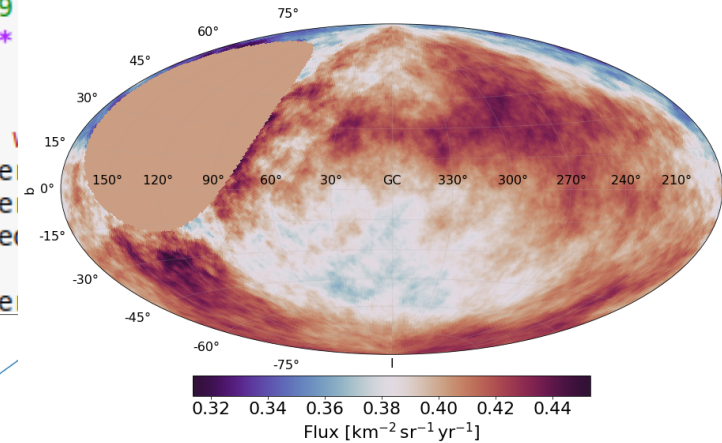
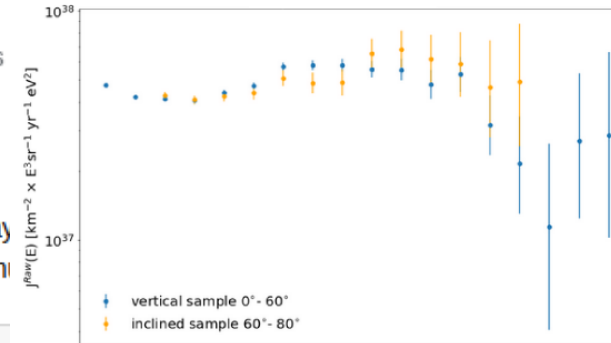
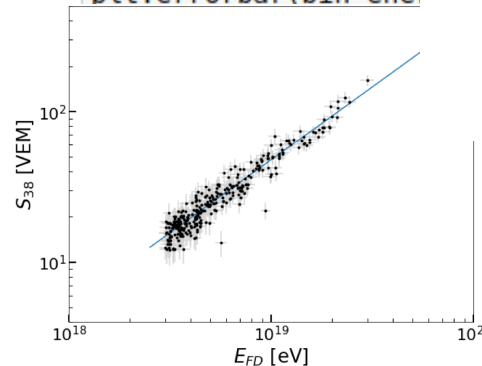
Spectrum plots

The raw energy spectrum is displayed in $\text{km}^{-2} \text{sr}^{-1} \text{yr}^{-1} \text{eV}^{-1}$ units. The n

```
: Y_0val = FC_CL * 0.9
Y_0val_i = FC_CL_i *

plt.title("Spectrum v
plt.errorbar(bin_ene
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plt.errorbar(bin_ene
```



$[\text{km}^{-2} \text{sr}^{-1} \text{yr}^{-1} \text{eV}^{-1}]$

Outreach @ the Pierre Auger Observatory

Outline

Local

Visitors center, exhibitions, guided and virtual tours, events in schools, scientific fair, Malargüe parade

→ continued effort to strengthen ties to the local community

World-wide

many initiatives dedicated to students of all degrees and to the general public

→ expanded program for global engagement in science

Open Data Portal

diverse data shared with the scientific community following the FAIR principles as part of the common effort in research

→ new policy approved: increase fraction of released CR data to 30%!



**thanks &
stay tuned!**