

Pierre Auger Observatory Open Data and the Auger International Masterclasses



Eva Santos¹, for the Pierre Auger Collaboration²

¹FZU - Institute of Physics of the Czech Academy of Sciences, Prague, Czech Republic

²Observatorio Pierre Auger, Malargüe, Argentina

13th Cosmic-Ray International Studies and Multi-messenger Astroparticle Conference

Trapani, Italy, June 17 - 21, 2024



Co-funded by
the European Union



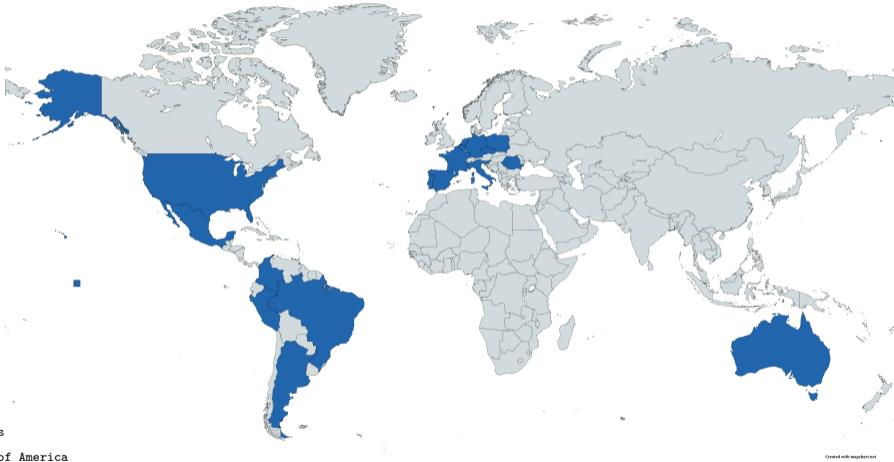
Pierre Auger Observatory



Pierre Auger Collaboration

About 400 authors from nearly 90 institutes from 18 countries

- Argentina
- Australia
- Belgium
- Brazil
- Colombia
- Czech Republic
- France
- Germany
- Italy
- Mexico
- Peru
- Poland
- Portugal
- Romania
- Slovenia
- Spain
- The Netherlands
- United States of America



Pierre Auger Observatory

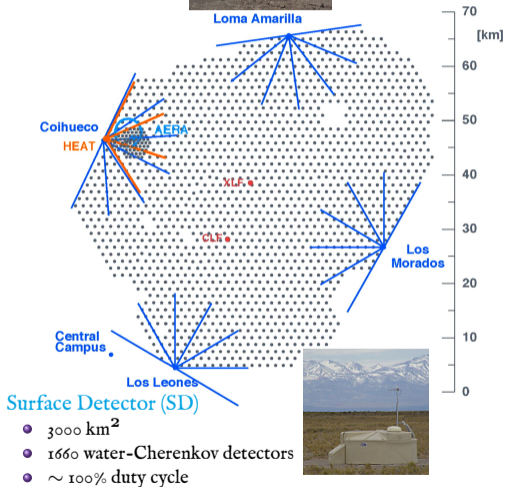
Malargüe, Province of Mendoza, Argentina

35.2° S, 69.5° W, ~ 1400 m a.s.l.



Fluorescence Detector (FD)

- 27 Schmidt telescopes
- ~ 15% duty cycle

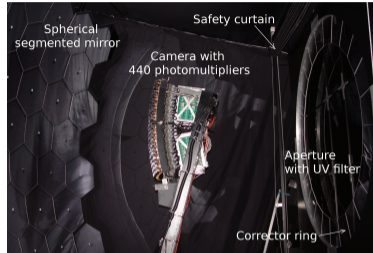


Surface Detector (SD)

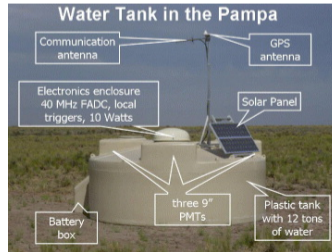
- 3000 km²
- 1660 water-Cherenkov detectors
- ~ 100% duty cycle

A hybrid detector

Fluorescence Detector



Surface Detector station



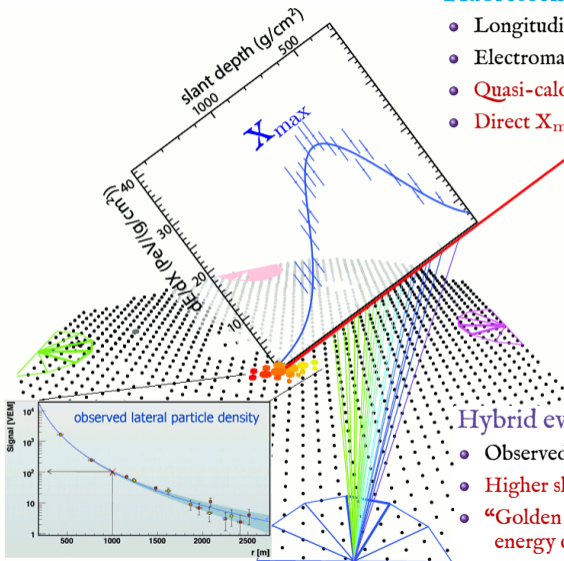
A hybrid detector (II)

Fluorescence Detector

- Longitudinal shower profile
- Electromagnetic component
- **Quasi-calorimetric energy estimation**
- **Direct X_{\max} measurement**

Surface Detector array

- Lateral particle distribution
- Electrons, muons, high-energy photons
- **High statistics**



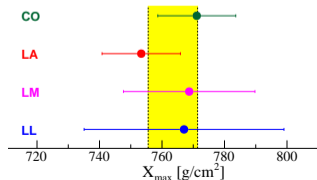
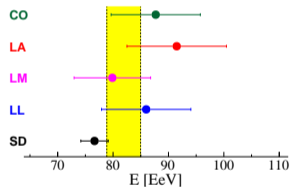
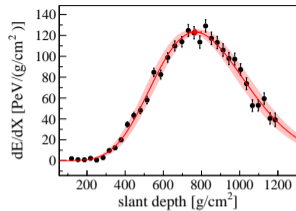
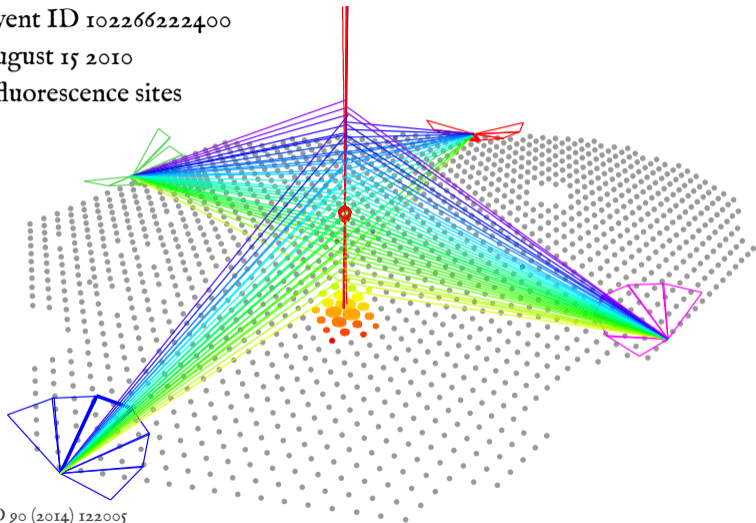
Hybrid events

- Observed by both detectors
- **Higher shower reconstruction accuracy**
- **“Golden hybrid” events provide the energy calibration of the SD array**

Measurement of the depth of the shower maximum X_{\max}

Real Auger Hybrid event:

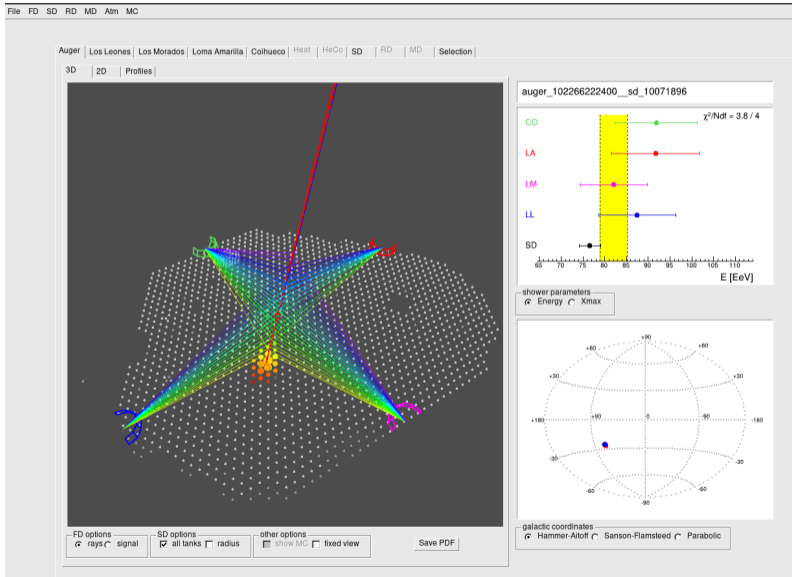
- Event ID 102266222400
- August 15 2010
- 4 fluorescence sites



Phys. Rev. D 90 (2014) 122005

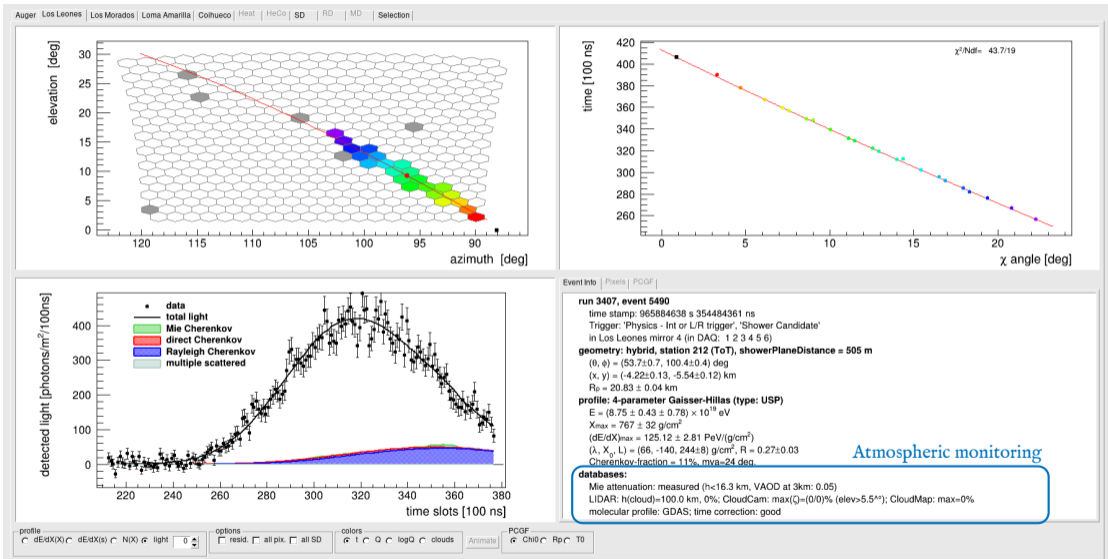
Phys. Rev. D 90 (2014) 122006

Quadruple event in EventBrowser: 3D view

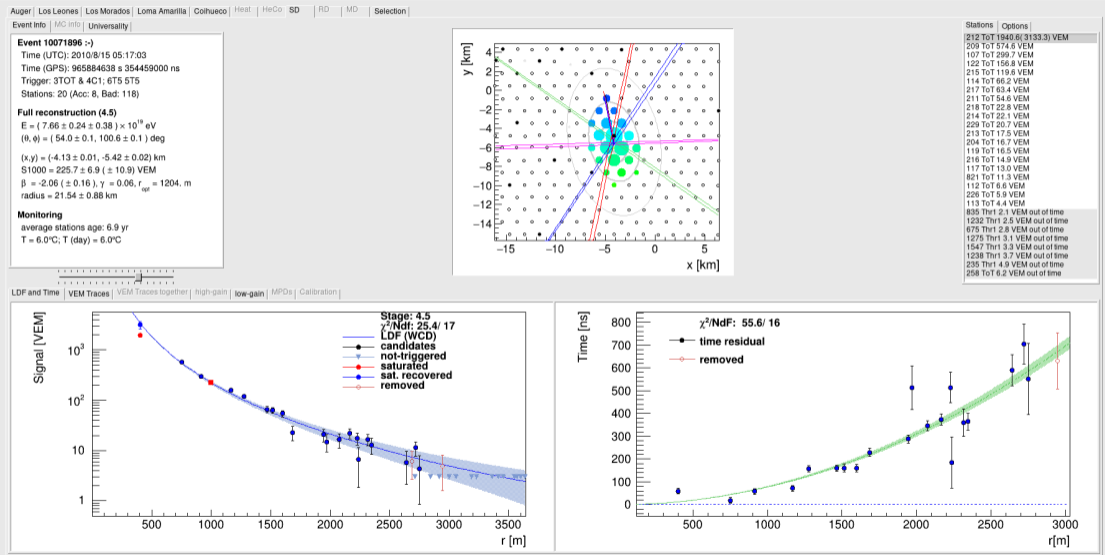


- Menus with more display options
 - Tabs for detectors & event selection
- ⇐ All reconstructed energies & X_{\max}

Quadruple event in EventBrowser: Los Leones FD site



Quadruple event in EventBrowser: SD view



Auger Open Data portal

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

Auger Open Data

[Datasets](#) [Visualization](#) [Analysis](#) [UHECR Catalog](#) [Outreach](#) [Contact](#)

Pierre Auger Observatory Open Data

March 2024 release



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Pierre Auger Observatory Open Data

March 2024 release

Pierre Auger Open Data Policy

- To be used by a wide community:
 - Professional and citizen scientists
 - Education and Outreach
 - General public
- Auger Public Data:
 - 10% of Phase I high-quality cosmic-ray dataset used on Auger publications
 - 100% of weather and space-weather collected until 31 December 2020
 - Different complexity levels
 - Software tools for analysis

Yearly updates during the whole lifetime of the Pierre Auger Observatory

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All Auger Open Data have a DOI provided by Zenodo that must be cited by the users

Current DOI: [10.5281/zenodo.4487612](https://doi.org/10.5281/zenodo.4487612)

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Navigating through the Auger Open Data portal

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

Pierre Auger Observatory Open Data

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.

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[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

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Auger Open Data portal - Datasets


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↓ Download cosmic-ray dataset



[Cosmic-ray dataset](#)


 [How are they produced](#)


 [File contents](#)

 [Semantics](#)

↓ Download other datasets and files

 [Scaler dataset](#)

 [Atmospheric dataset](#)

 [Auxiliary files](#)

Auger Open Data portal - Datasets

List of releases:

- **Feb 15, 2021: release 1, DOI [10.5281/zenodo.4487613](https://doi.org/10.5281/zenodo.4487613)**
 - 10% of vertical (zenith angles $0^\circ - 60^\circ$) SD 1500 m and hybrid (SD 1500 m and FD) well reconstructed events from the dataset used in 2019 ICRC
 - Basic event display, tutorials and physics notebooks following the main Auger results
- **Oct 26, 2021: release 1.1, DOI [10.5281/zenodo.5588460](https://doi.org/10.5281/zenodo.5588460)**
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- **Dec 22, 2022: release 2, DOI [10.5281/zenodo.6867688](https://doi.org/10.5281/zenodo.6867688)**
 - 10% of SD 1500 m inclined (zenith angles $60^\circ - 80^\circ$) well reconstructed events from the dataset used in ICRC 2019
- **Mar 20, 2024: release 3, DOI [10.5281/zenodo.10488964](https://doi.org/10.5281/zenodo.10488964)**
 - 10% of SD 750 m array (zenith angles $0^\circ - 40^\circ$) well reconstructed events from the dataset used in Eur. Phys. J. C 81, 966 (2021)
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Auger Open Data portal - Datasets

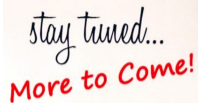
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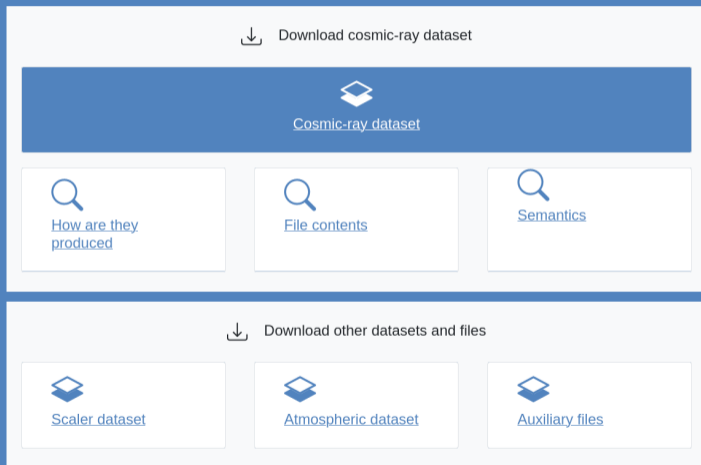
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stay tuned...
More to Come!


Auger Open Data portal - Cosmic-ray dataset


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




↓ Download cosmic-ray dataset



[Cosmic-ray dataset](#)



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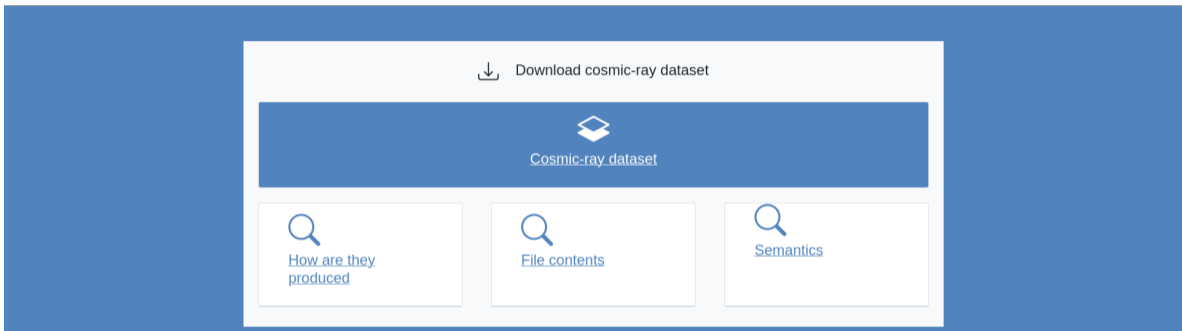

[Scaler dataset](#)


[Atmospheric dataset](#)


[Auxiliary files](#)

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March 2024 release:

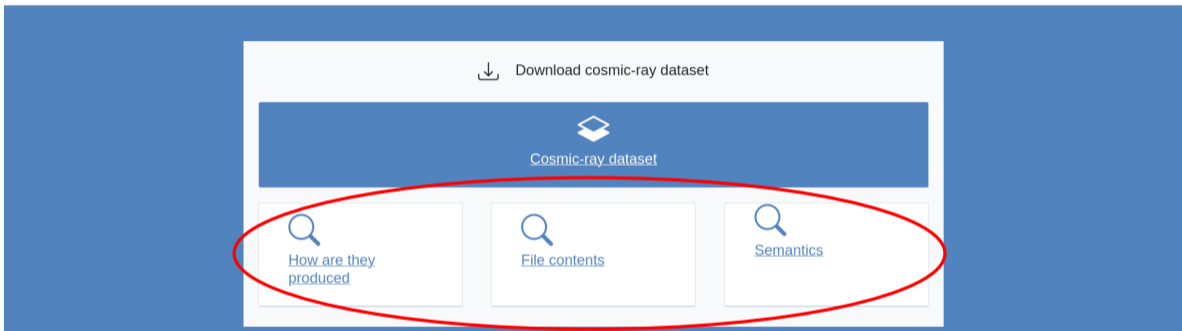
- Comprises 81,121 cosmic-ray events, of which:
 - 25,086 were measured with the SD 1500 m array
 - 54,481 were measured with the SD 750 m array **NEW!**
 - 3,348 are hybrid events
 - 197 were measured with the HEAT-Coihueco telescopes **NEW!**

Dataset available in two formats:

- **Pseudo-raw data**
 - JSON file
- **High-level data for the reconstructed events**
 - CSV file

Auger Open Data portal - Cosmic-ray dataset

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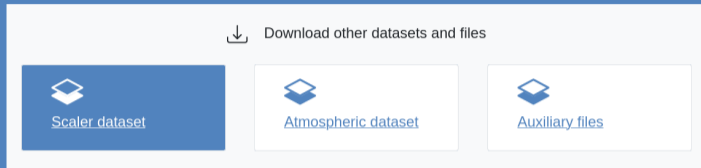


Detailed documentation of the available data:

- Details on how data were selected
- Description of the content of files
- Semantics for each data field

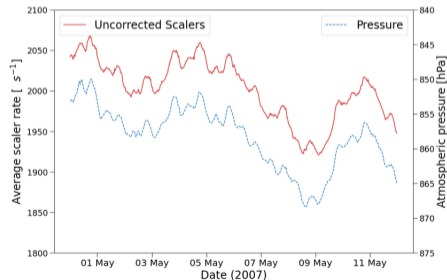
Auger Open Data portal - Scaler dataset

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



Available since the Oct 26, 2021 release:

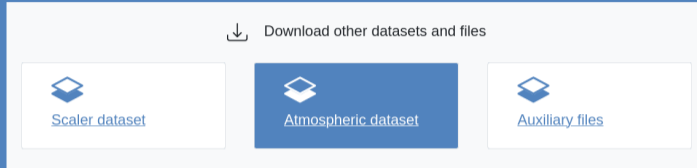
- More than 10^{15} events detected between March 2005 and December 2020
 - Detection of particles from 10 GeV to \sim TeV cosmic rays
- Studies of terrestrial and extra-terrestrial phenomena
- Transient events
- Forbush decrease
- Solar modulation of the cosmic-ray flux



From the Outreach Jupyter Notebook:
"Explore the scaler data"

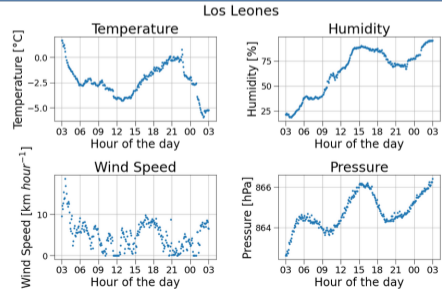
Auger Open Data portal - Atmospheric dataset

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



Available since the Oct 26, 2021 release:

- Weather conditions measured at 5 or 10-minute intervals at 5 different locations
 - Time, temperature, pressure, density, average density, relative humidity, average wind speed
- **Relevant for the energy calibration of the SD array**



From the Outreach Jupyter Notebook:
"Explore weather stations data"

Auger Open Data portal - Visualize

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Visualization

This page provides the Event Browser, that can be used to display any cosmic-ray event in the data release. Events can be selected by providing their id or by selecting the value of some of their main properties. Some example events can also be selected from the menu below. Once an event is selected its components can be browsed in different tabs.

[Visualize some example events.](#)

Take a look at a small selection of our nicest events

	Nb of stations	Energy [EeV]	Zenith Angle [deg]	Time [gps]
Min.	<input type="text" value="1"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="756950413"/>
Max.	<input type="text" value="35"/>	<input type="text" value="1000"/>	<input type="text" value="60"/>	<input type="text" value="1261872018"/>
Event type	<input type="text" value="SD Vertical"/>		<input type="button" value="Select"/>	<input type="text" value="22727 selected events"/>

Select an event by id:

1500m array 750m array

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Select an event by id:

1500m array 750m array

Browse for a specific event by giving its ID

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Visualize some example events ▶

Or apply cuts to the Open Data cosmic-ray dataset

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Select an event by id:

1500m array 750m array

040034054600
040184443900
040202296800
040224091700
040300846100
040342062100
040353663900
040406048600
040431561500

Auger Open Data portal - Visualize

[Event 172657447200](#)

[Ground array view](#)

[SD traces](#)

[SD reconstruction](#)

[FD camera view](#)

[FD reconstruction](#)

[3D view](#)

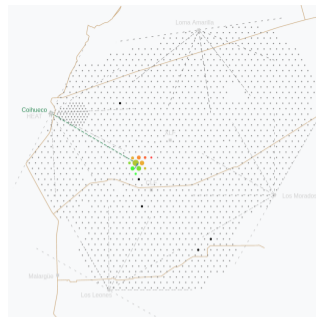
Golden Hybrid event 2

A high energy hybrid seen at a large distance by one FD.

Event 172657447200 is a 16.1 EeV, 35.8 degrees zenith angle hybrid event recorded on Sep 23 2017 08:41:27.

Different views of the event are available by selecting the corresponding tabs.

You can also directly [download the JSON data file](#) corresponding to the pseudo-raw data. An [example notebook](#) able to process the file is provided.



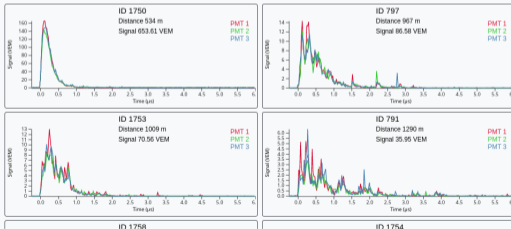
Event detection: “pseudo-raw” data

SD traces:

[Sort by signal](#)

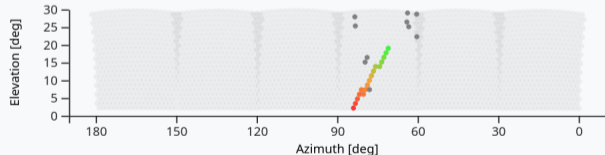
[Sort by arrival time](#)

Stations used for reconstruction



FD camera view:

Camera view for Coihueco



Auger Open Data portal - Visualize

[Event 172657447200](#)

[Ground array view](#)

[SD traces](#)

[SD reconstruction](#)

[FD camera view](#)

[FD reconstruction](#)

[3D view](#)

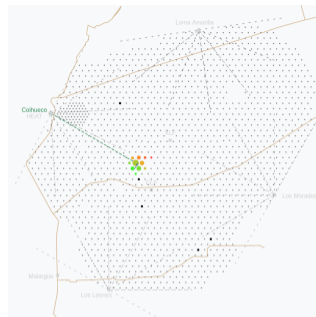
Golden Hybrid event 2

A high energy hybrid seen at a large distance by one FD.

Event 172657447200 is a 16.1 EeV, 35.8 degrees zenith angle hybrid event recorded on Sep 23 2017 08:41:27.

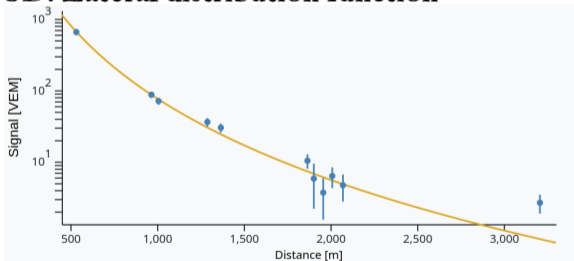
Different views of the event are available by selecting the corresponding tabs.

You can also directly [download the JSON data file](#) corresponding to the pseudo-raw data. An [example notebook](#) able to process the file is provided.



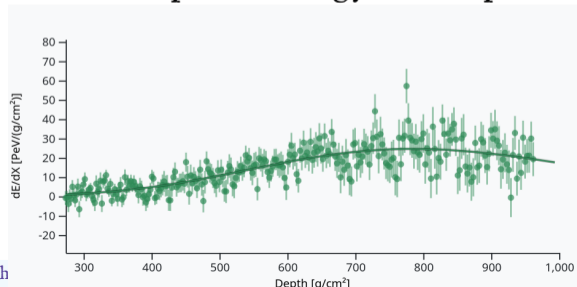
Event reconstruction

SD: Lateral distribution function



FD:

Profile of deposited energy in atmosphere



Auger Open Data portal - UHECR Catalog

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

Pierre Auger Observatory Open Data

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

Auger Open Data portal - UHECR Catalog

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

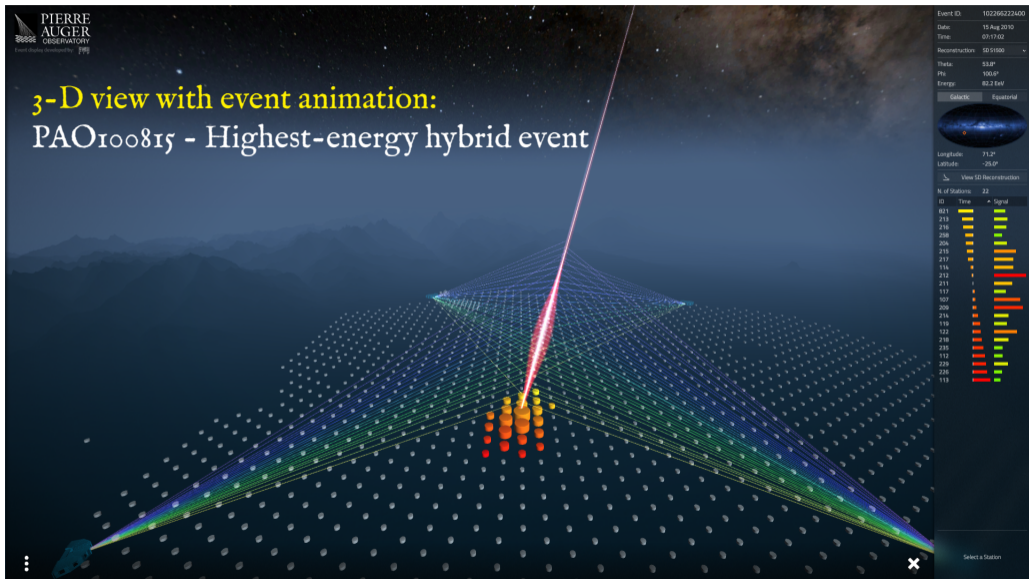
◉ Catalog of the Highest-Energy Cosmic Rays recorded during Phase I of Operation of the Pierre Auger Observatory

This page provides access to the catalog of 100 highest-energy events recorded at the Pierre Auger Observatory between 2004 January 1 and 2020 December 31. They are part of the events used in the study of the arrival directions of events above 32 EeV published in [ApJ, 935, 170 \(2022\)](#). Additionally, nine very energetic events used in the [energy calibration](#) procedure are included. The catalog of the 109 events is discussed in [ApJS, 264, 50 \(2023\)](#).

March 2024 release:

- Catalog of the 100 highest-energy events detected with the Auger Phase I data, published in [ApJS, 264, 50 \(2023\)](#)
 - Data taken during January 1, 2004 and December 31, 2020
 - Dataset comprises a fraction of the events used in the study of the arrival directions of events above 32 EeV published in [ApJ, 935, 170 \(2022\)](#)
- Also available are 9 very energetic Golden-hybrid events used in the calibration of the SD array

Auger Open Data portal - UHECR Catalog



Auger Open Data portal - Analyze

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

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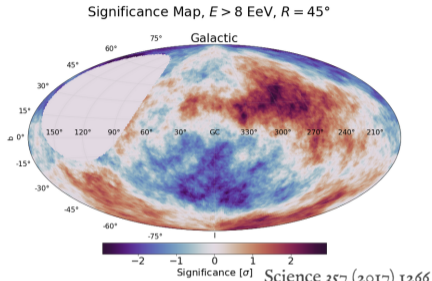
a page dedicated to the general public

Auger Open Data portal - Analyze

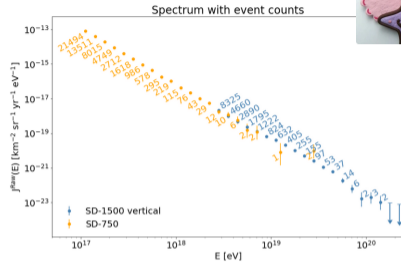
Jupyter Notebooks containing code snippets of our analyses



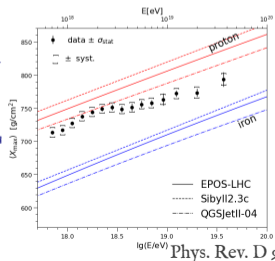
↗ The UHECR sky



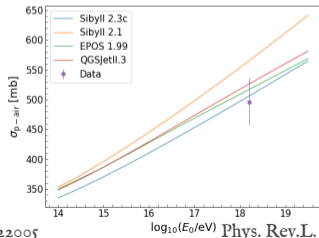
↗ The energy spectrum



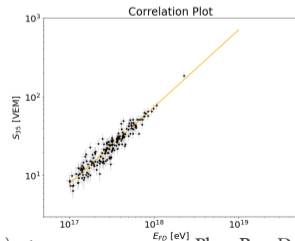
↗ The depth of $\langle X_{\text{max}} \rangle$



↗ p-air cross-section



↗ Energy calibration

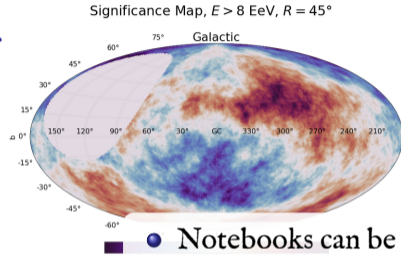


Auger Open Data portal - Analyze

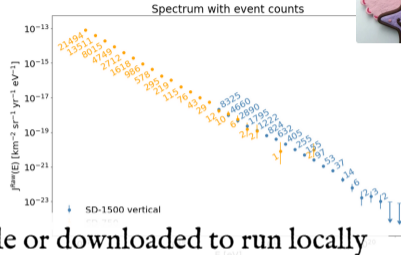
Jupyter Notebooks containing code snippets of our analyses



The UHECR sky

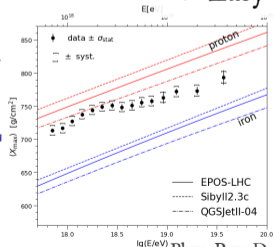


The energy spectrum



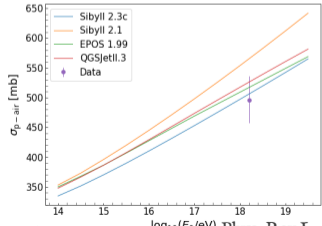
- Notebooks can be run in Kaggle or downloaded to run locally
- Easy to modify for new features in the proposed analyses

The depth of $\langle X_{\max} \rangle$



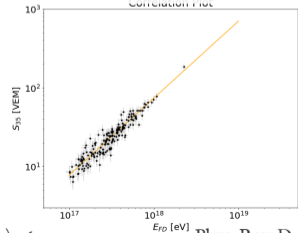
Phys. Rev. D 90 (2014) 122005

The p-air cross-section



Phys. Rev. L. 109 (2012) 0622002

Energy calibration



Phys. Rev. D 102 (2020) 062005

Auger Open Data portal - Outreach

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

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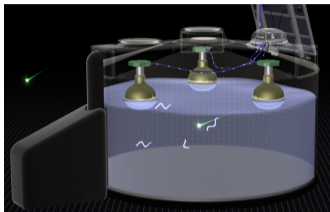
a page dedicated to the general public

Auger Open Data portal - Outreach

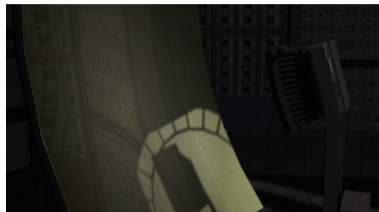
Introduction to cosmic rays, videos, documentation for citizen scientists



Air shower animation



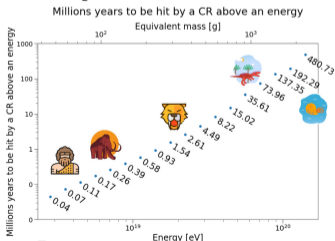
Cherenkov light inside a SD station



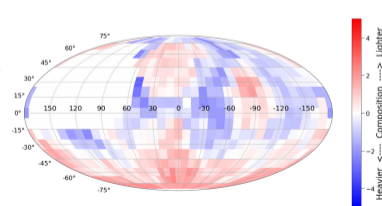
Fluorescence light inside a telescope

Jupyter Notebooks containing simplified analysis code and tutorials on how read the data files from all datasets

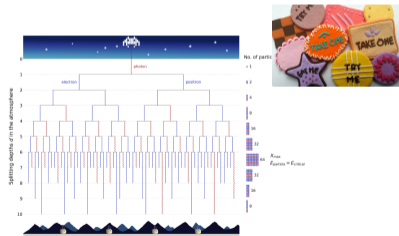
A few examples:



[Explore the SD data](#)



[Explore the hybrid data](#)



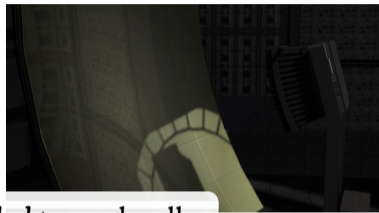
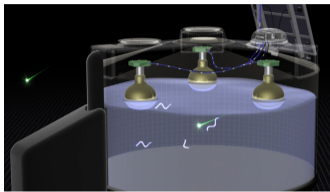
[Explore the shower development](#)

Auger Open Data portal - Outreach

Introduction to cosmic rays, videos, documentation for citizen scientists

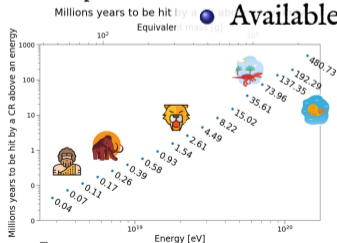


Air shower animation

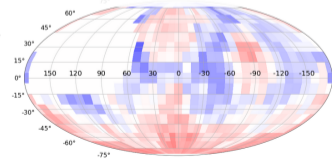


- Notebooks can be run in Kaggle or downloaded to run locally
- Easy to modify for new features in the proposed analyses
- Available in 8 languages!

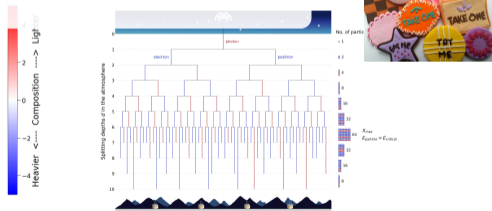
Jupyter Notebook
A few examples:



Explore the SD data



Explore the hybrid data



Explore the shower development

Welcome to the

PIERRE
AUGER
OBSERVATORY

Masterclasses

International Masterclasses

“Be a scientist for one day with the hands on particle physics”

- Yearly activity typically held from February - March
 - More than 13,000 high-school students from
 - 60 countries
 - 225 universities and research centers
- Morning lectures about particle physics and experiments
- Measurements with real data from particle physics experiments
- International video conference with scientists



INTERNATIONAL
MASTERCLASSES
hands on particle physics

International Masterclasses
20th International Masterclasses 2024

ATLAS ALICE CMS LHCb
BELLE II MINERvA Particle Therapy Pierre Auger

<http://physicsmasterclasses.org>

Auger Masterclasses

Successful debut in 2023



<https://augermasterclasses.lip.pt>

- Experimental activity for high-school students on astroparticle physics
- Analyze Auger public data using a friendly interface
 - Based on the tools available in the Auger Open Data portal
- Reach students worldwide by benefiting from the IPPOG contact network for the International Masterclasses Program



Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR





<https://augermasterclasses.lip.pt>

What is the origin of ultra-high-energy cosmic rays?

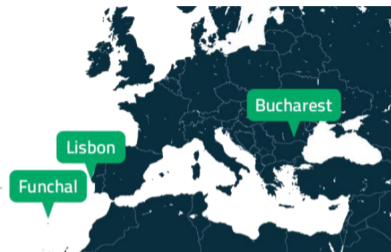
Students are challenged to look for answers to this question by analyzing data of the Pierre Auger Observatory. The measurement includes:

- Visualization of events using an interactive display of the observatory
- Separation of surface-detector stations with signal from those with background
- Visual reconstruction of the arrival direction of the primary cosmic ray
- Fitting the data to determine the energy of the primary cosmic ray
- Application of criteria to select events which point to the source
- Interpretation of sky maps in different coordinate systems

Auger Masterclasses - Two very successful editions

2023 Edition

- 534 students
- 3 Masterclasses events
- 5 countries from 2 continents
 - 12 institutions
 - of which 2 are non-Augur institutions



March 24



April 4



Auger Masterclasses - Two very successful editions

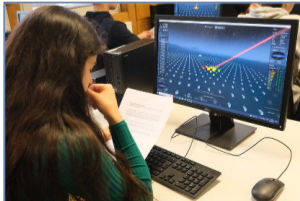
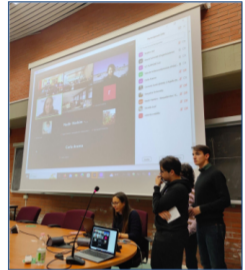


2024 Edition

- 550 students
- 5 Masterclasses events
- 10 countries from 4 continents
 - 16 institutions
 - of which 6 are non-Augur institutions

Auger Masterclasses - Two very successful editions

Some photos from the 2024 edition



Auger Masterclasses - Day Schedule

The Masterclass suggested timetable:

(Check the participating Institutions table to check your timezone)

10:00 – 10:15	Registration and welcome
10:15 – 10:30	Introduction
10:30 – 11:45	Particle and astroparticle physics
11:45 – 12:15	Coffee break
12:15 – 13:00	Experiments in astroparticle physics
13:00 – 14:00	Lunch
14:00 – 16:00	Data analysis
16:00 – 17:00	Video conference with the Pierre Auger Observatory*
17:00 – 17:15	Farewell

Auger Masterclasses - Documentation and Materials

- Preparatory meetings with participating institutions
- Complete list of available resources for the preparation of the activity

SOFTWARE

		
↓ WINDOWS WINDOWS 7, 10, 11	↓ LINUX UBUNTU 18.04+, CENTOS 7	↓ MAC MACOS 10.13+
		
↓ PACKAGE 30 .ZIP	↓ PACKAGE 60 .ZIP	↓ PACKAGE 90 .ZIP
DOWNLOAD SINGLE DATASETS	DOWNLOAD SINGLE DATASETS	DOWNLOAD SINGLE DATASETS

DOCUMENTATION

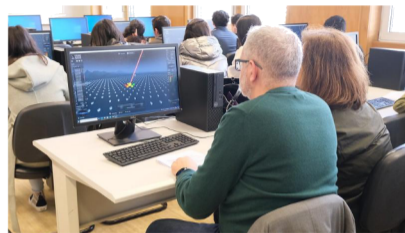
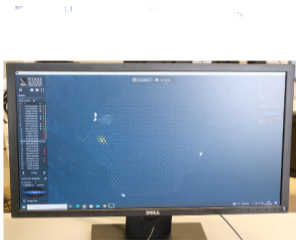
General instructions to participating institutes	↓
Checklist for participating institutions	↓
Slides introduction to the measurement	↓
Slides tutorial for the analysis	↓
Student activity guide	EN PT RO IT CZ
Video conference guide	↓

<https://augermasterclasses.lip.pt/downloads>

Auger Masterclasses - Morning activities



Auger Masterclasses - Hands-on activity



Auger Masterclasses - Hands-on activity

The screenshot displays the Pierre Auger Observatory software interface. The main window shows a 3D visualization of the detector stations, with a central yellow dot representing the event location. The interface includes several panels:

- Events Panel (Left):** Lists 13 events with their IDs. Event 3 (ID: 070717920900) is selected.
- Events for Analysis Panel (Bottom Left):** Shows the number of events for analysis (0) and options for Galactic and Equatorial views.
- Event Details Panel (Right):** Displays event information: Event ID: 70717920900, Date: 13 Mar 2007, Time: 10:00:08, and various parameters (Phi, Theta, Energy, Ch/NDP) all set to "N/A".
- Stations Panel (Bottom Right):** Shows a list of 18 stations with their status (Selected/Total: 1/18) and a "Select a Station" button.
- Distance and Time Range Panel (Bottom Center):** Allows selection of the distance and time range around the main station. The distance is set to 4307 m and the time to 139 ns.

1. Select the stations belonging to the event

Auger Masterclasses - Hands-on activity

The screenshot displays the Pierre Auger Observatory software interface. The main window shows a starry sky with a cluster of yellow and orange dots representing an event. A red arrow points to the cluster, and a green arrow points to the shower axis. The interface includes a 'Top Camera' and '3D Camera' view selector, an 'Event' panel on the right, and a 'Select the Approach Angle' dialog box at the bottom. The 'Event' panel shows the following details:

- Event ID: 70717920900
- Date: 13 Mar 2007
- Time: 10:00:08
- Phi: 0.0
- Theta: 0.0
- Energy: 0.0
- Ch/NDF: 0.0

The 'Stations' panel shows a table of station data:

Station	Signal	Dist	Time	Dir
889	██████████	██████████	██████████	██████████
896	██████████	██████████	██████████	██████████
841	██████████	██████████	██████████	██████████
830	██████████	██████████	██████████	██████████
1471	██████████	██████████	██████████	██████████
848	██████████	██████████	██████████	██████████
839	██████████	██████████	██████████	██████████
834	██████████	██████████	██████████	██████████
846	██████████	██████████	██████████	██████████
849	██████████	██████████	██████████	██████████

The 'Select the Approach Angle' dialog box shows an angle of 356.5°.

1. Select the station

2. Reconstruct the shower axis

Auger Masterclasses - Hands-on activity

The image displays three overlapping screenshots of the Pierre Auger Observatory software interface, illustrating the steps of a hands-on activity:

- Top Screenshot:** Shows the 'Events' list on the left with columns for 'Num', 'ID', and 'Rec'. The selected event is 3, with ID 070717920900. The 'Event' panel on the right shows 'Event ID: 70717920900' and 'Date: 13 Mar 2007'.
- Middle Screenshot:** Shows the 'SD Reconstruction' plot. The y-axis is 'Signal [VAD]' on a logarithmic scale from 10 to 100. The x-axis is 'Distance [m]' from 0 to 3000. A green line represents the fit, and blue dots with error bars represent data points. The plot title is 'SD Reconstruction' and the fit quality is 'Chi²/NDF: 1.42'. Below the plot are sliders for 'S1000' (set to 273.06) and 'Beta' (set to -2.32).
- Bottom Screenshot:** Shows the 'Event' panel on the right with 'Event ID: 70717920900', 'Date: 13 Mar 2007', 'Time: 10:00:08', 'Phi: 356.48°', 'Theta: 17.03°', 'Energy: NA', and 'Chi²/NDF: NA'. Below this is a 'View SD Reconstruction' section with 'Galactic' and 'Equatorial' views, and a 'Stations' table.

The 'Stations' table shows the following data:

ID	Signal	Dist	Time	Stat
B33	████████	████████	████████	████████
B76	████████	████████	████████	████████
B41	████████	████████	████████	████████
B30	████████	████████	████████	████████
B13	████████	████████	████████	████████
1371	████████	████████	████████	████████
D48	████████	████████	████████	████████
B39	████████	████████	████████	████████
B74	████████	████████	████████	████████
B46	████████	████████	████████	████████
B36	████████	████████	████████	████████

1. Select the station

2. Reconstruct

3. Adjust the LDF and estimate the energy of the event

Auger Masterclasses - Hands-on activity

The screenshot displays the Pierre Auger Observatory software interface. The main view is a 3D visualization of the detector array, showing a grid of stations represented by small cylinders. A red laser beam points to a specific station, which is highlighted with larger, colorful cylinders (yellow, orange, green). The interface includes a top navigation bar with 'Top Camera' and '3D Camera' options. On the left, there is a sidebar with the 'Pierre Auger Observatory' logo, a list of events, and a section for 'Events for Analysis'. On the right, there is an 'Event' information panel and a 'Stations' table. A central message box states: 'This event has been reconstructed according to your inputs. Now you can look at the Event Information and decide if it's a good event for the Analysis.' Below this message is a '+ Add Event To Analysis' button. At the bottom, there are navigation buttons: 'Uninteresting', 'Reset', and 'Prev. Step'. A 'Select a Station' prompt is visible at the bottom right.

Event Information:

- Event ID: 70717920900
- Date: 13 Mar 2007
- Time: 10:00:08
- Phi: 356.48°
- Theta: 17.03°
- Energy: 51.55 EeV
- Chi²/NDF: 1.4

Stations Table:

ID	Signal	Dist	Time	Sel
833	High	Green	Green	A
836	High	Green	Green	A
841	High	Green	Green	A
830	High	Green	Green	A
1371	High	Green	Green	A
848	High	Green	Green	A
839	High	Green	Green	A
834	High	Green	Green	A
846	High	Green	Green	A
1426	High	Green	Green	A

4. An animation appears if all the previous steps were successful

Auger Masterclasses - Hands-on activity

The screenshot displays the Pierre Auger Observatory's event reconstruction interface. The main window shows a 3D visualization of the detector array with a reconstructed event direction indicated by a red laser beam. A central panel titled "Events for Analysis" shows the event has been reconstructed in equatorial coordinates. The interface includes a sidebar with event lists, a top navigation bar with camera controls, and a right-hand panel with event details and station selection.

Events for Analysis

N° of Events: 1

Galactic Equatorial

This event has been reconstructed according to your inputs.
Now you can look at the Event Information and decide if it's a good event for the Analysis

Remove Event From Analysis

Event Information

Event ID: 70717920900
Date: 13 Mar 2007
Time: 10:00:08
Phi: 356.48°
Theta: 17.03°
Energy: 51.55 EeV
Chi²/NDF: 1.4

View SD Reconstruction

Galactic Equatorial

Longitude: 357.69°
Latitude: -6.97°

Stations

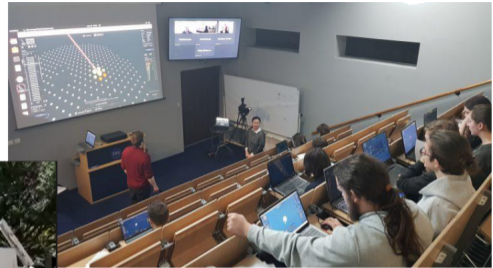
Selected/Total: 14/18

ID	Signal	Dist	Time	Stat
833	██████████	+	+	A
836	██████████	+	+	A
841	██████████	+	+	A
830	██████████	+	+	A
1371	██████████	+	+	A
848	██████████	+	+	A
839	██████████	+	+	A
834	██████████	+	+	A
846	██████████	+	+	A
1426	██████████	+	+	A

Select a Station

Example of successfully reconstructed event with arrival direction in Equatorial Coordinates

Auger Masterclasses - Video conference and final quiz



Which of these particles are not produced in cosmic ray showers?

1 / 136 Full Questions view Chart view Participants view

89 26 7 9

Option	Count
Questions	89
All questions	26
Photos	7
Points	9

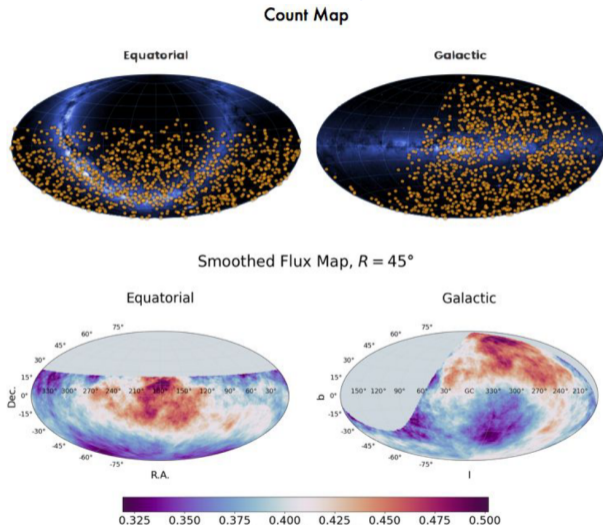
Rank	Name	Points
1	Imagine too	1870
2	Carlos del Jun	1840
3	Sofia e Guilherme	1780
4	Margarida Guilherme	1710
5	Toni de Costa	1200
6	Guilherme	1080
7	Padrao	1040
8	Arabella	1020

QUIZZ Go to [johngyall.com](https://www.johngyall.com) and enter: 935 887

Auger Masterclasses - Results

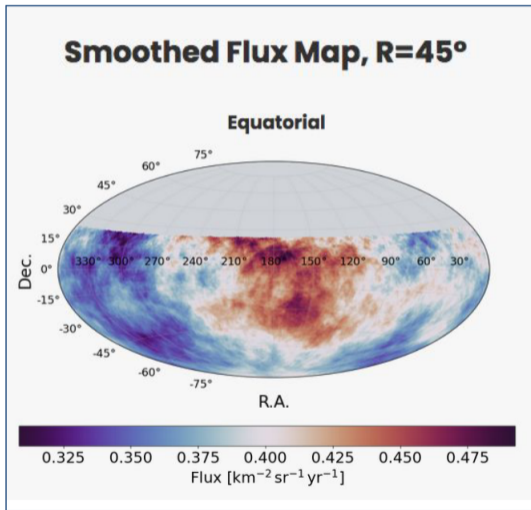
Combined results from one institution at the Masterclasses 2023:

- 1130 reconstructed events
- Dipole pattern emerges from the combined results even though having low statistical significance

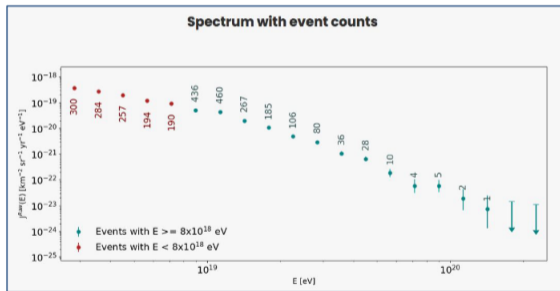


Auger Masterclasses - Results

Results from the Masterclasses 2024:



The spectrum analysis was added!



Available online:

<https://augermasterclasses.lip.pt/activities>

Conclusions and Outlook

- The Auger Open Data portal is the culmination of a long and demanding commitment to make data public
 - A gateway and a first step for data preservation
 - Public data distributed in several formats allowing its usage for:
 - the scientific community as part of the multi-messenger effort at different levels
 - outreach and educational activities
- Yearly updates, new and larger datasets during the lifetime of the Collaboration
- Auger International Masterclasses integrated in 2023 in the IPPOG network program
 - Two successful editions held in 2023 and 2024
 - Rapid dissemination of the Auger Masterclasses in 2024, reaching 10 countries in 4 continents
 - Strong synergy with the Auger Open portal
- Further editions planned for the forthcoming years
 - New analyses foreseen exploiting the materials available in the Auger Open portal

A night sky scene featuring a vibrant green aurora borealis. In the foreground, a satellite dish is mounted on a structure, and a tower with two red lights stands on the horizon. A complex white wireframe tree structure is overlaid on the scene, extending from the top left towards the center. The text "Thank you very much for your attention!" is written in a white, monospaced font across the middle of the image.

Thank you very much
for your attention!