Particle & Astroparticle outreach in Portugal

- Selected topics -

Catarina Espírito Santo (LIP-Lisbon)
For the LIP Outreach group
Geilo, December 2012

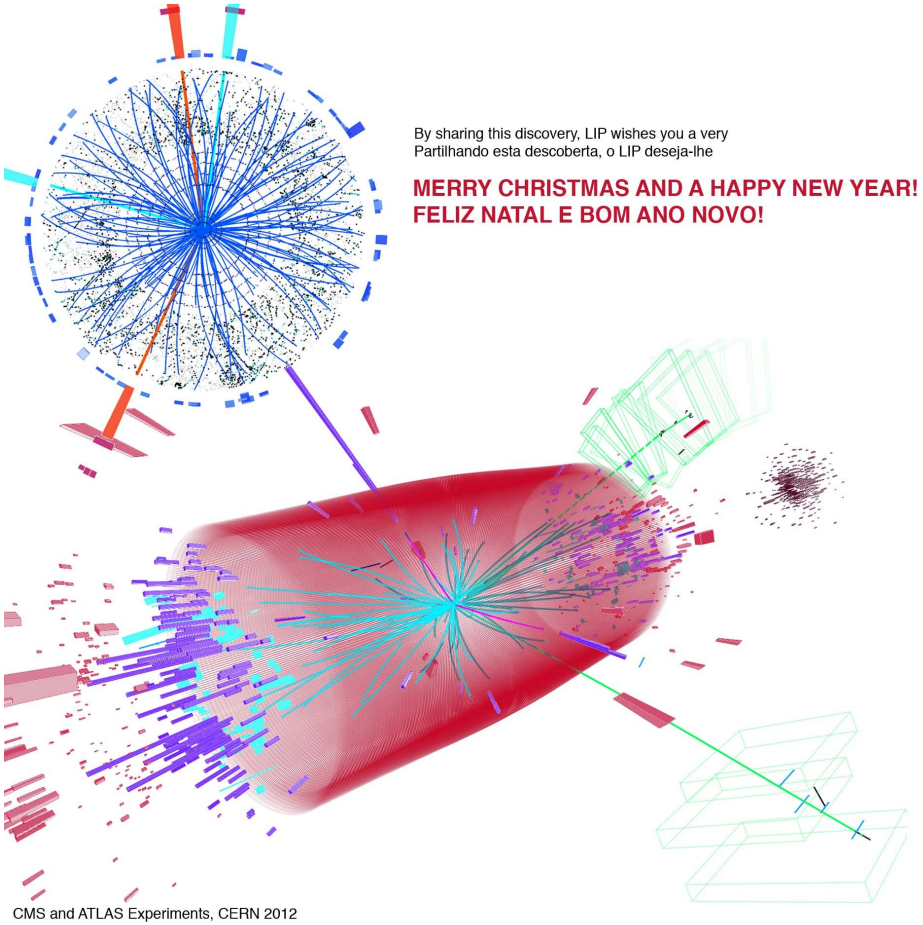
Particle Physics outreach

Well established community, network of contacts, set of activities

> CERN School for physics teachers in Portuguese Language

> IPPOG Masterclasses

> Public sessions



Contact person: Pedro Abreu
abreu@lip.pt

CERN school for physics teachers in PT

Portuguese language

> Organized by Portugal, Brazil and CERN

> Crucial in strengthening and widening the network

> Increased the participation in Masterclasses, requests for Seminars, visits to CERN, ...

IPPOG Masterclasses

8th Edition, impressive growth...

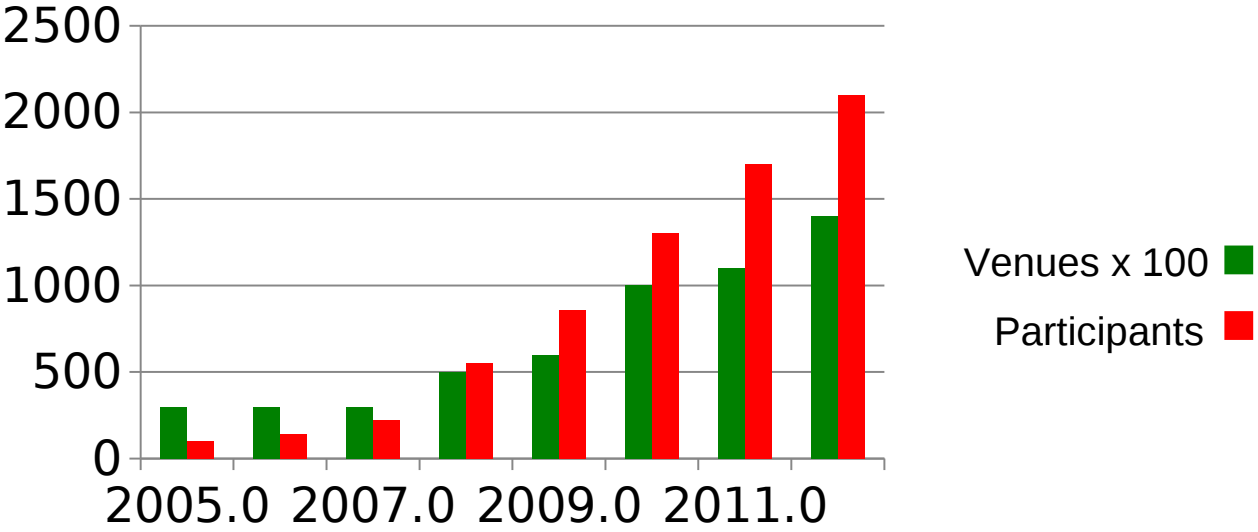
> Support from ATLAS + CMS + All LIP researchers and students

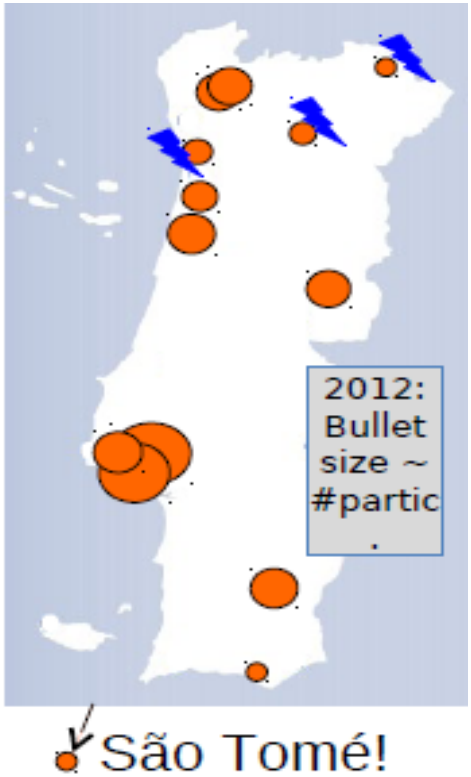
> 11 locations, over 2000 participants, sites varying from 40 to 380x2

Improve preparation work along the year?

> Seminars at schools

> What more...?

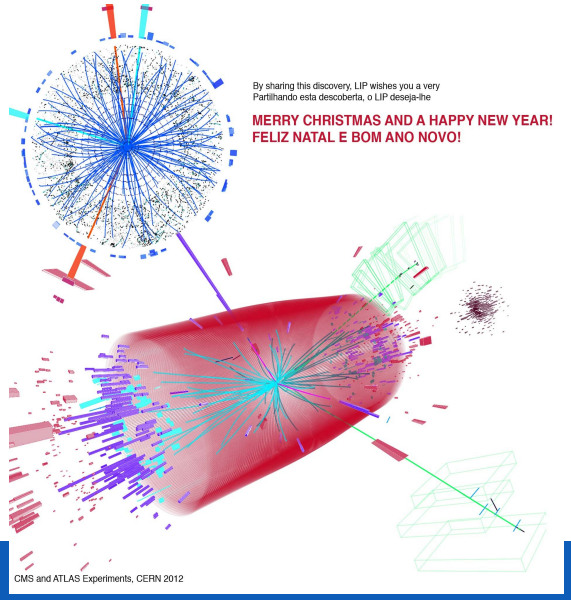




Public sessions

> Good contribution from IDPASC (International Doctorate Programme)

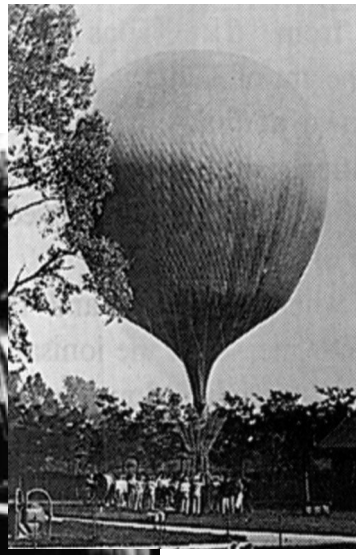
> **Quite a few Public sessions featuring the Higgs boson!**

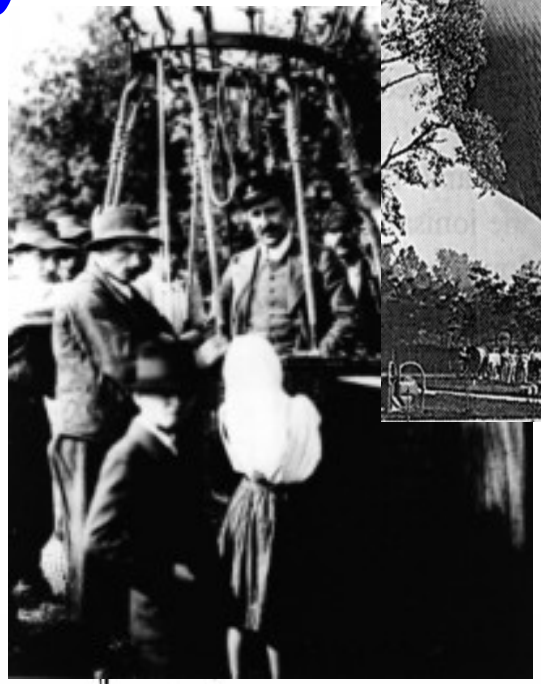


Café de Ciência na Assembleia da República
Investigação fundamental e aplicada: Contributos do bosão de Higgs

Document delivered:

Cosmic Rays



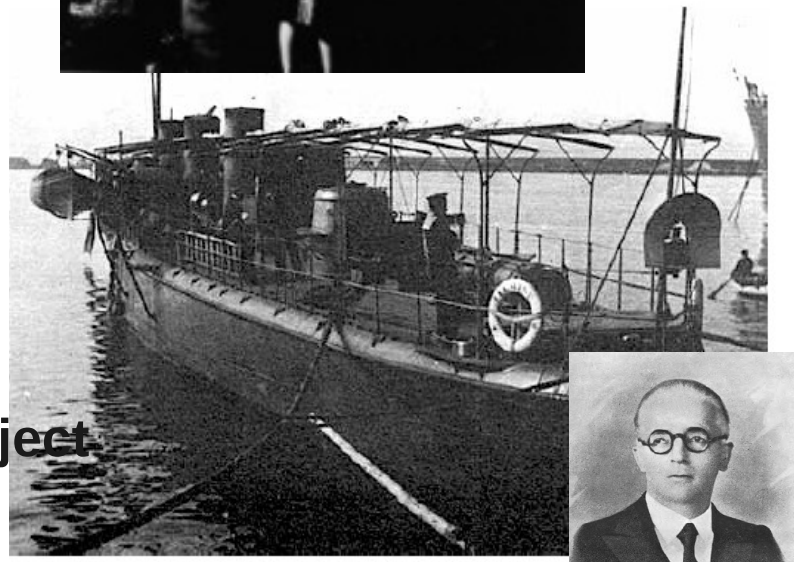


Cosmic rays have a large outreach potential

> From Particles to the Universe...

> Easy to demonstrate phenomenon

> 2012 centenary of discovery



Some topics:

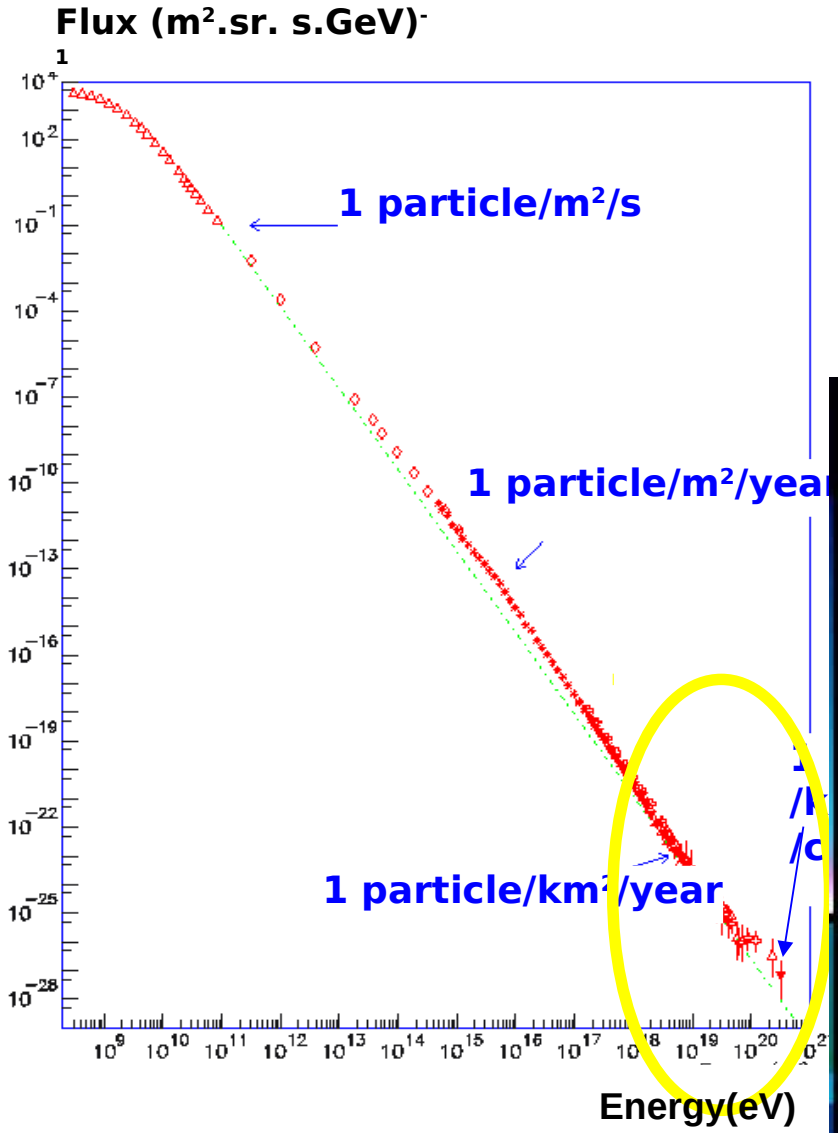
> Seminars and events in schools

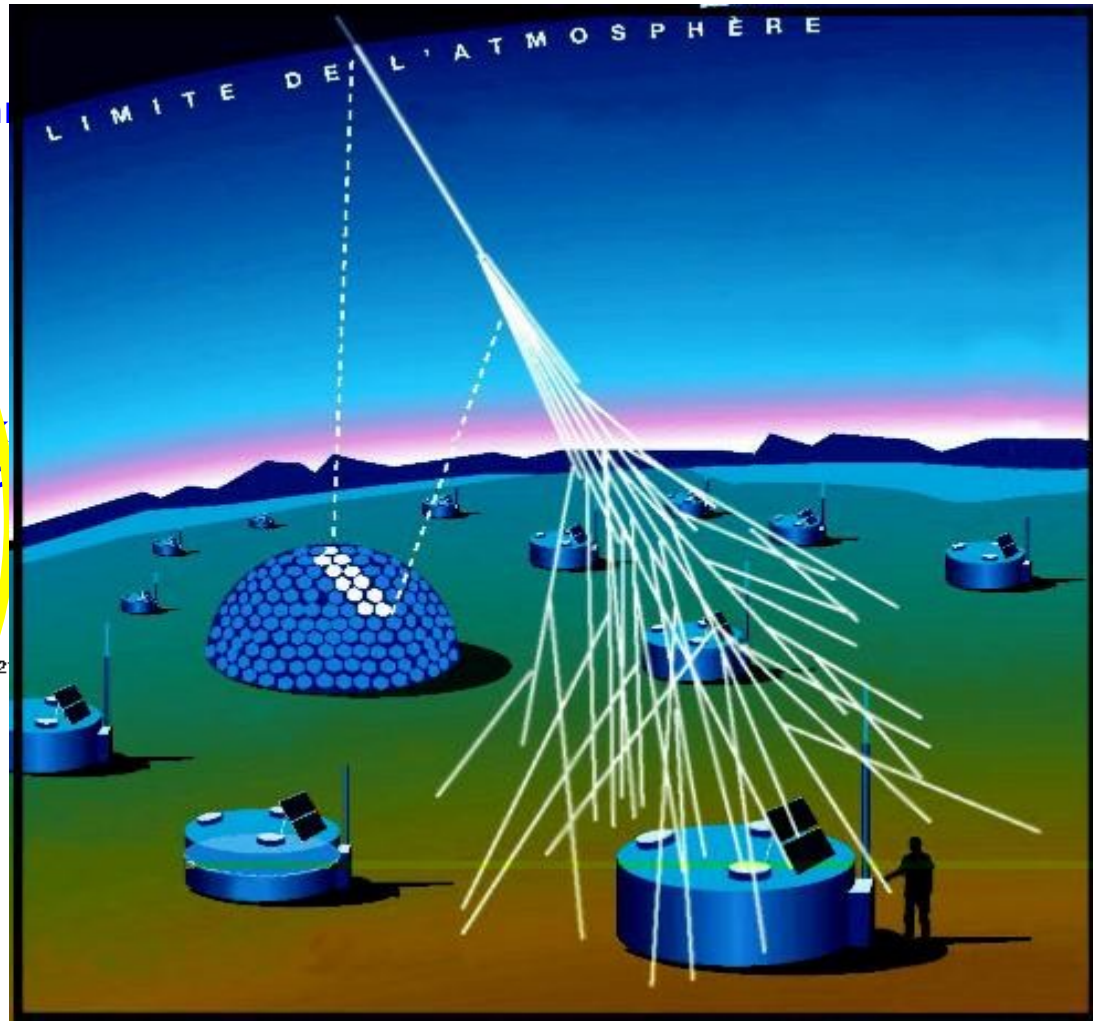
> <u>Exploring the Auger public data set</u>

> Now part of Environmental Radiation Project

> <u>Towards Masterclasses in Comic Rays</u>

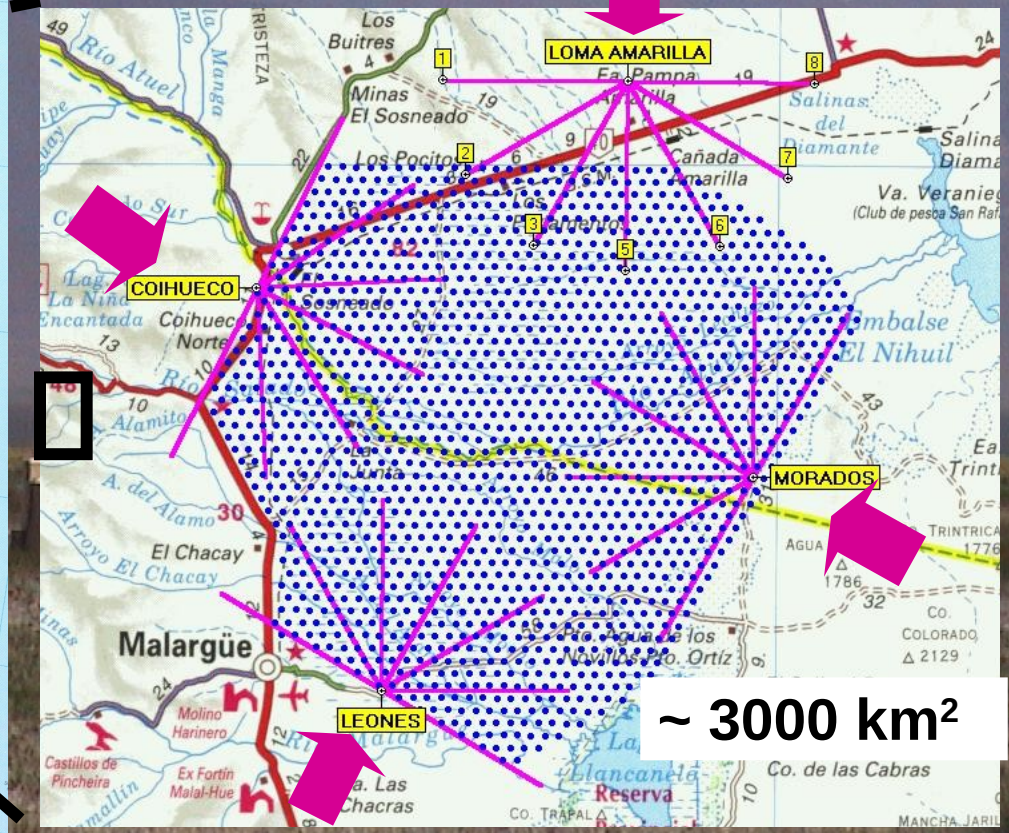
The Pierre Auger Observatory





The Pierre Auger Observatory

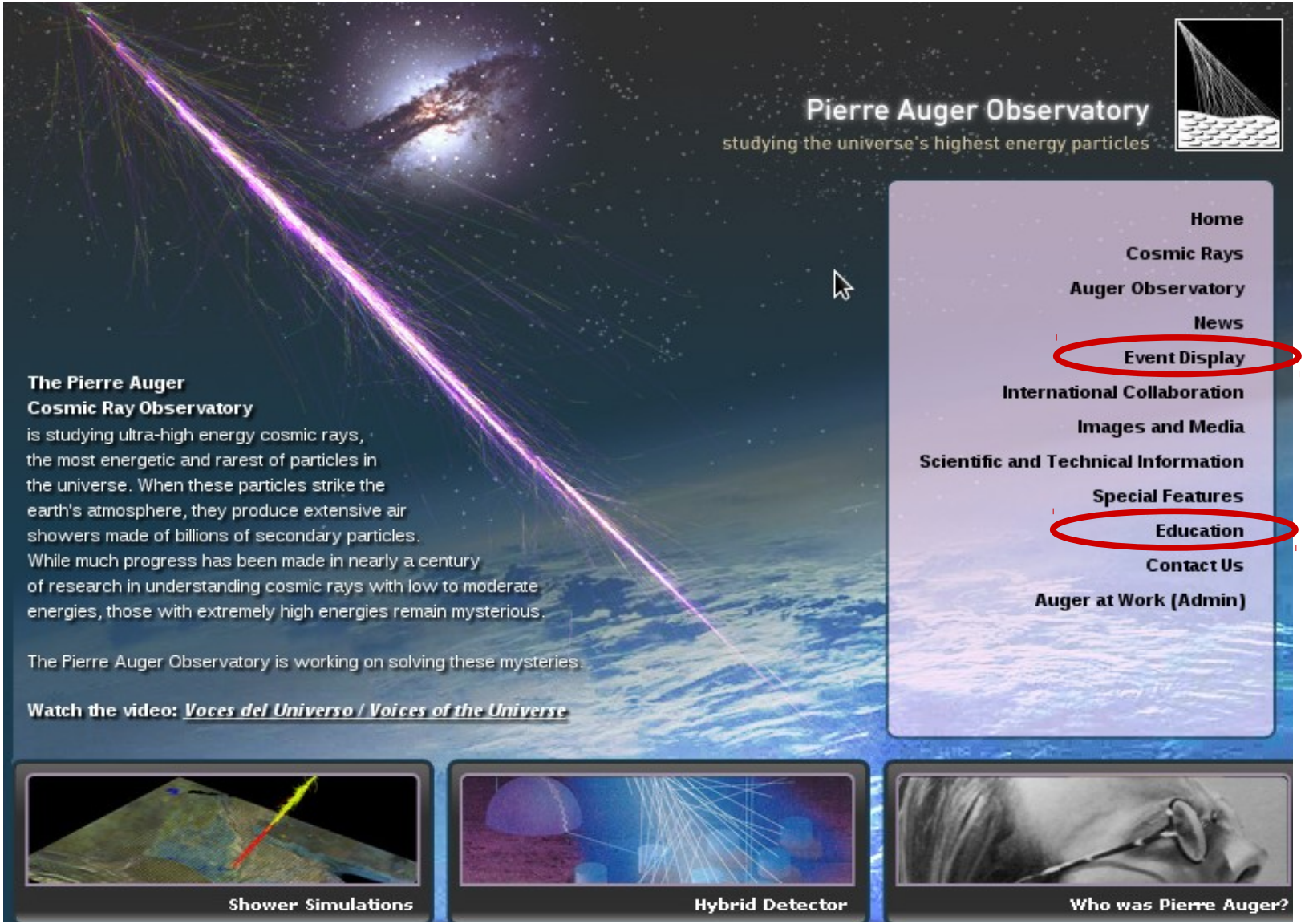
Malargüe, Mendoza (Argentina)



~ 3000 km²

Pierre Auger Observatory public data

1% of the Auger data is made public in a web page updated everyday



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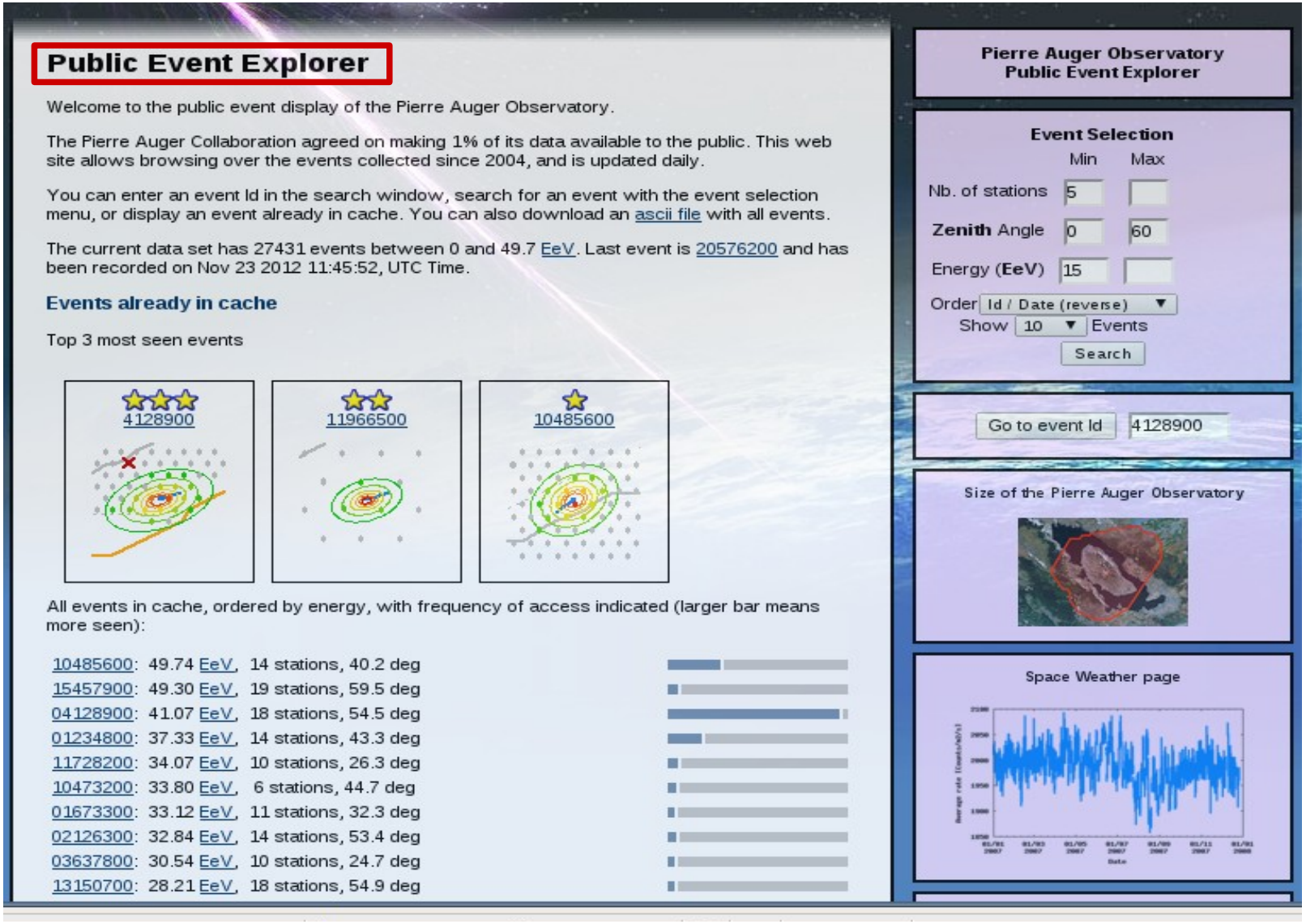


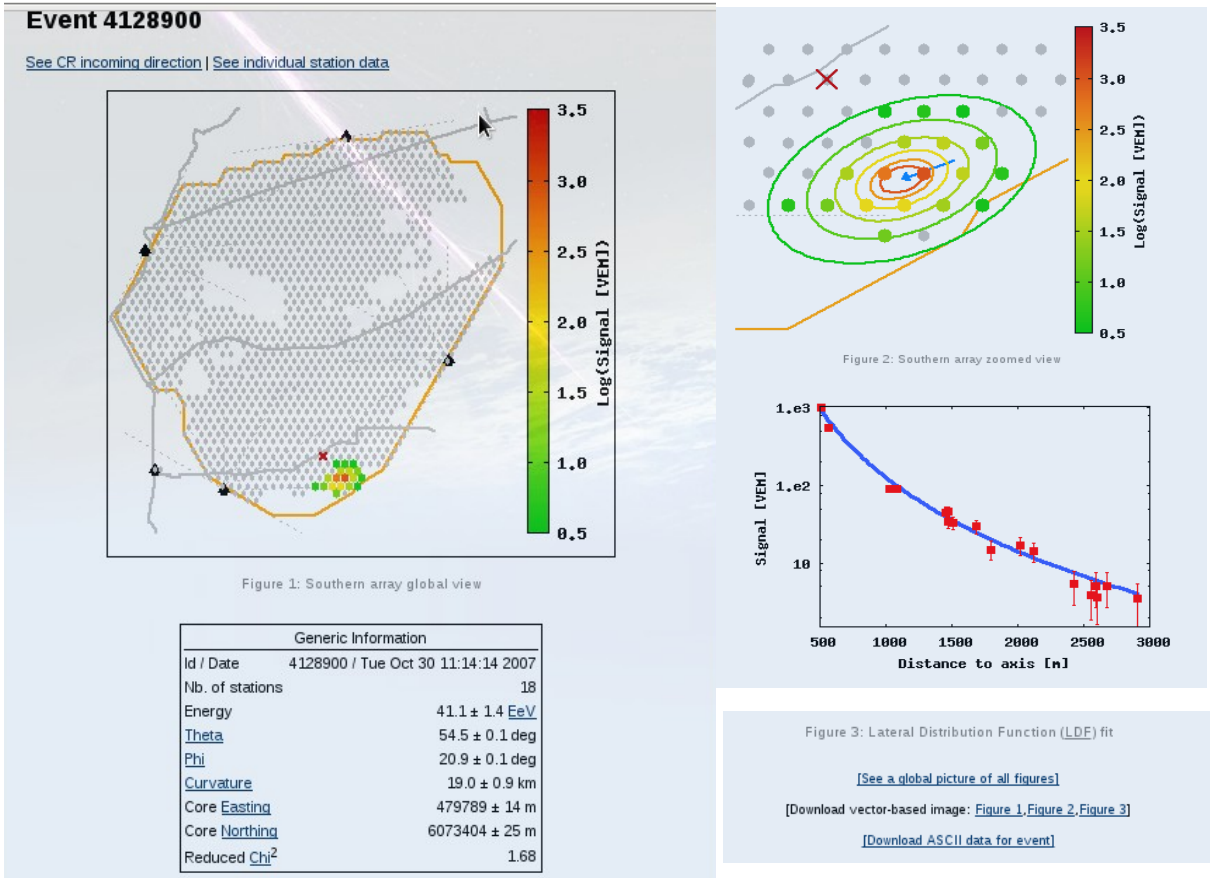
Pierre Auger Observatory public data

Event display pictures + generic info available for each event

ASCII file per event with quantities measured in each tank

Global ASCII file with reconstructed info of all events (core, direction, E)

(Surface detector only)
(Energy upper limit)



Generic Information	
Id / Date	4128900 / Tue Oct 30 11:14:14 2007
Nb. of stations	18
Energy	41.1 ± 1.4 EeV
Theta	54.5 ± 0.1 deg
Phi	20.9 ± 0.1 deg
Curvature	19.0 ± 0.9 km
Core Easting	479789 ± 14 m
Core Northing	6073404 ± 25 m
Reduced Chi^2	1.68

Searching for the origin of ultrahigh energy cosmic rays

Firefox 12.0, newer versions of Firefox, the newest versions of Google Chrome or Opera are recommended to be able to see the animations.
The animations cannot be viewed with the currently available Internet Explorer versions.

Introduction

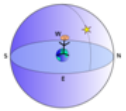
The discovery of cosmic rays

Learn about the daring balloon flights of Victor Hess

The origin of ultra-high energy cosmic rays

Get some information about the goals of the Pierre Auger Observatory

Projects



Project 1: A tool to find the origin of ultra-high energy cosmic rays: coordinate systems

Scientists of the Auger collaboration are working on different aspects of ultra-high energy cosmic rays. They need many tools and immense background knowledge to find the origin of cosmic rays. The following pages provide you with the information which is necessary to make sky maps of ultra-high energy events.

- How can one determine an object's coordinates from Earth, within or beyond our solar system?
- What are terrestrial, celestial and galactic coordinates?
- The Aitoff projection: a method to print a 3D object on paper.
- Curious about the history of earth-centric and sun-centric models?

Here you can find instructions on processing Auger data and making plots of ...

- Sky maps of Pierre Auger events.

Contact person: Maria Kamm
maria-kamm@gmx.de

Home
Victor Hess
Auger Project
Coord.systems
Terrestrial
Galactic
Celestial
Space weather
Unix Time
Projects
Ask me
Contact

Searching for th

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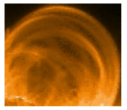


Project 2: Cosmic rays can tell about space weather

It has been well-known for a long time that the flux of cosmic rays is not constant over time. Study the possible impact of solar activity on low-energy cosmic rays and make plots of the given space weather data.

- Interested in learning something about space weather and its impacts?
- Forbush events
- geomagnetic storms
- Aurora
- The Unix time stamp... how computers encode the time of a cosmic ray event

Here you can find instructions on proces

- Forbush events with Pierre Auger s

Project 3: Earthquakes

Sometimes, there are also terrestrial eve
during the Chile earthquake.

- Cosmic ray flux rates during the Ch
- The Unix time stamp... how comput

Space Weather page

Welcome to the Space Weather public web page of the Pierre Auger Observatory.

The Pierre Auger surface detectors record every second the rate of low energy particles detected and report this information to the central data acquisition system. This event rate is related to the flux of low energy galactic cosmic rays reaching the Earth, which is modulated by the solar activity. Therefore, by measuring with great precision the flux variations, the Pierre Auger Observatory is able to contribute to the Space Weather program, in a way similar to neutron monitors.

More information about Space Weather and cosmic rays can be found on the spaceweather.com webpage. A description of the Pierre Auger scaler mode and the data presented here (15 minutes averages of the scaler rates) can be found in "JINST 6 P01003 (2011)" (open access).

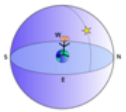
Given the peculiarity of the detector (spread over 3000 km^2), some unusual effects can be present in the data. A specific page is dedicated to them.

Should you use these data for any publication, acknowledgement to the Pierre Auger Observatory should be given and JINST 6 P01003 (2011) should be cited. You can also download an ascii file with all the dataset.

Latest scaler data

38.53 / 0.93 0.00 x 0.00 Slide 6 /

Projects



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Contact person: Maria Kamm
maria-kamm@gmx.de

Questions and answers on extreme energy cosmic rays

- A guide to explore the Pierre Auger Observatory public data -

1. The cosmic rays spectrum
2. How do cosmic ray showers develop
3. How do we detect cosmic rays
4. How do we measure extreme energy cosmic rays
5. What are these data telling us about extreme energy cosmic rays

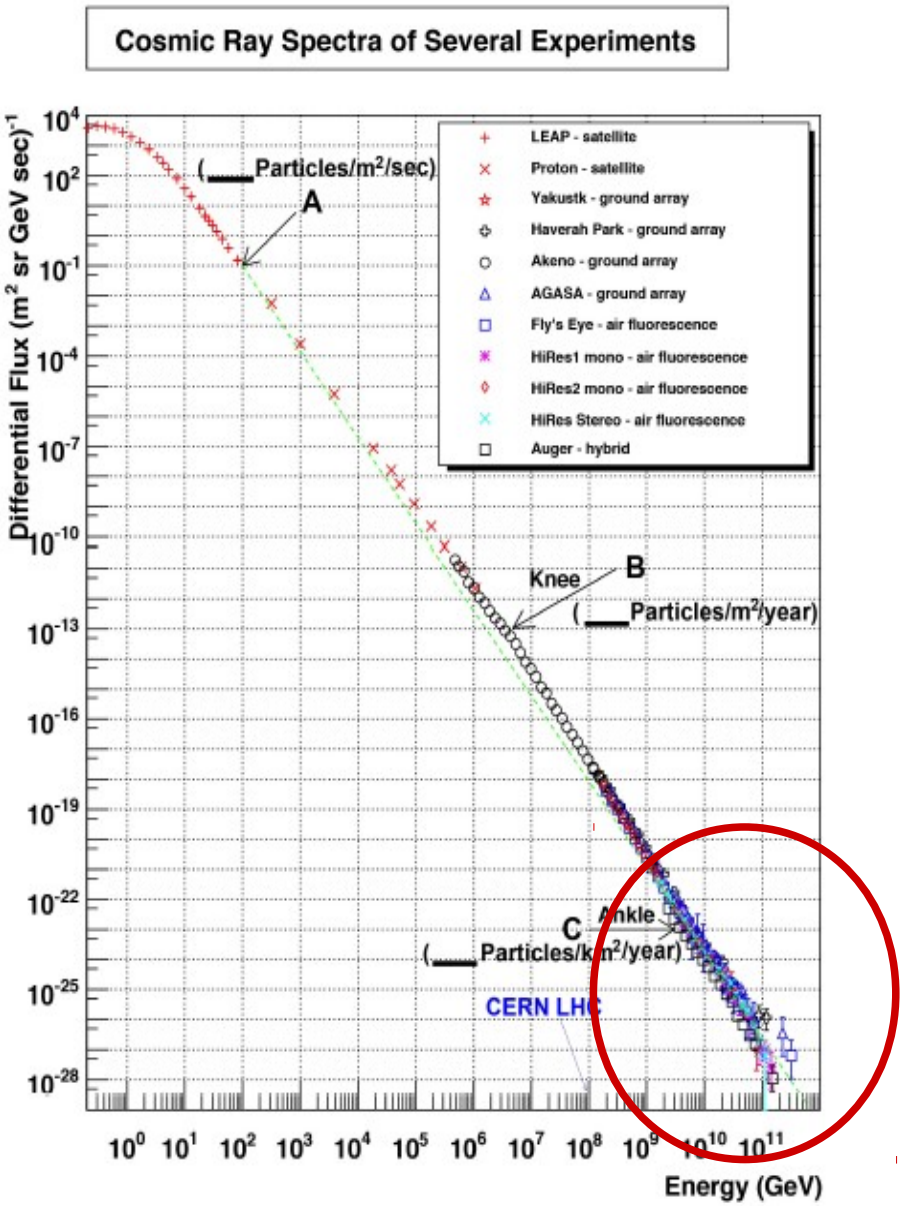
developed within LIP-Auger group as a tool to explore the Auger public data set for students in the final years of high school (15-18 years old)

1. The cosmic ray spectrum

“Warming up” section

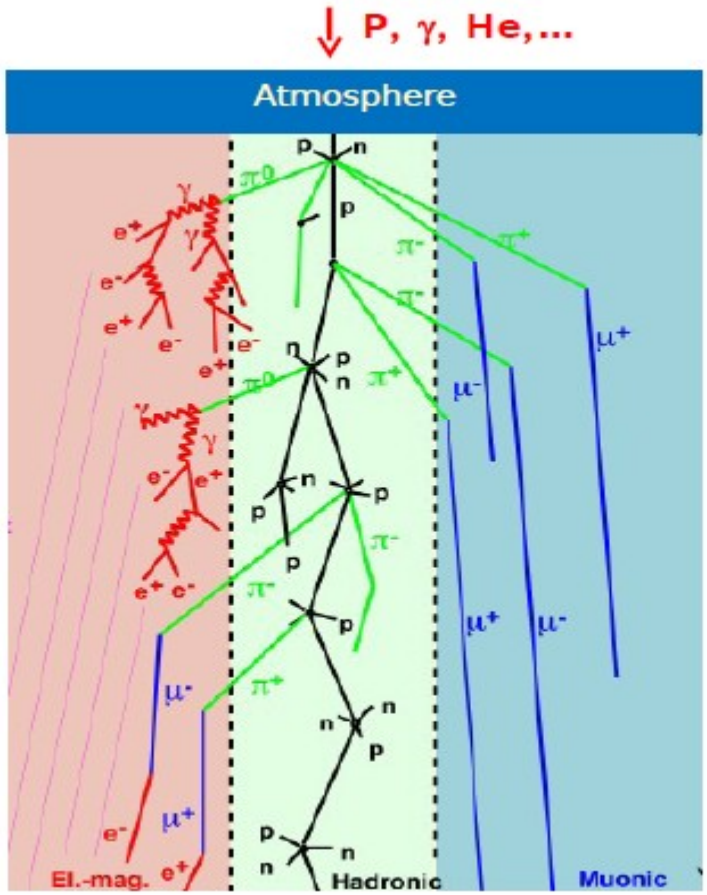
Cosmic ray basic concepts

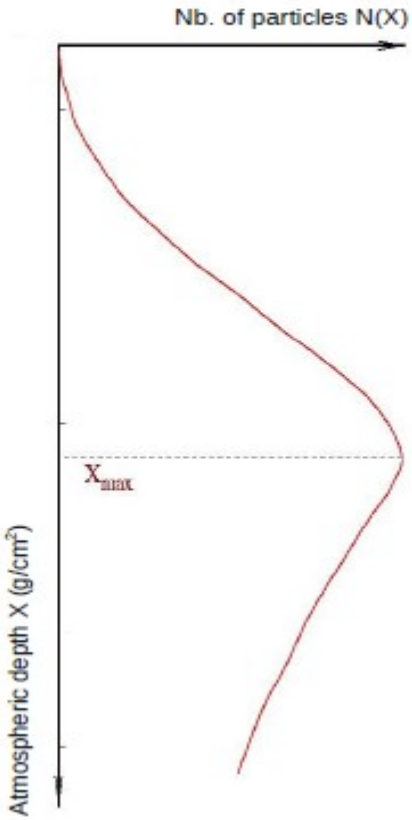
Orders of magnitude, units, fluxes, solid angles, log scales...



2. How do cosmic ray showers develop

Basics on particles and interactions for shower development
Simple models to describe cosmic ray showers in the atmosphere





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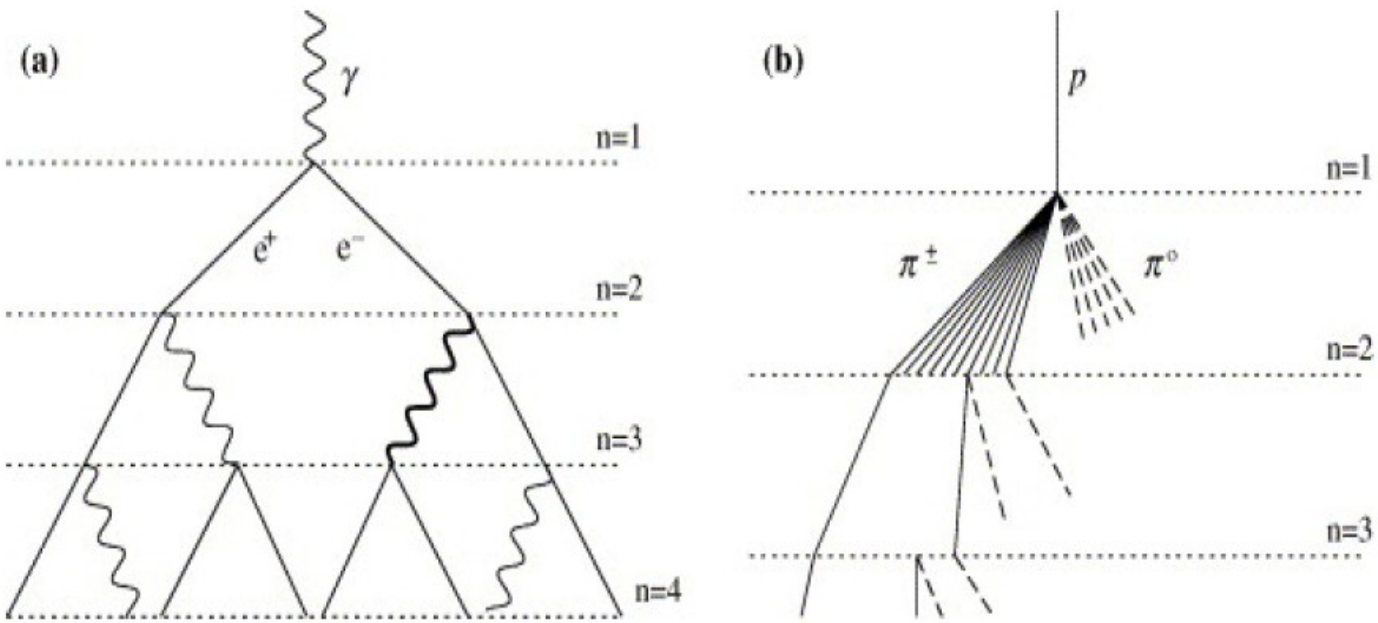


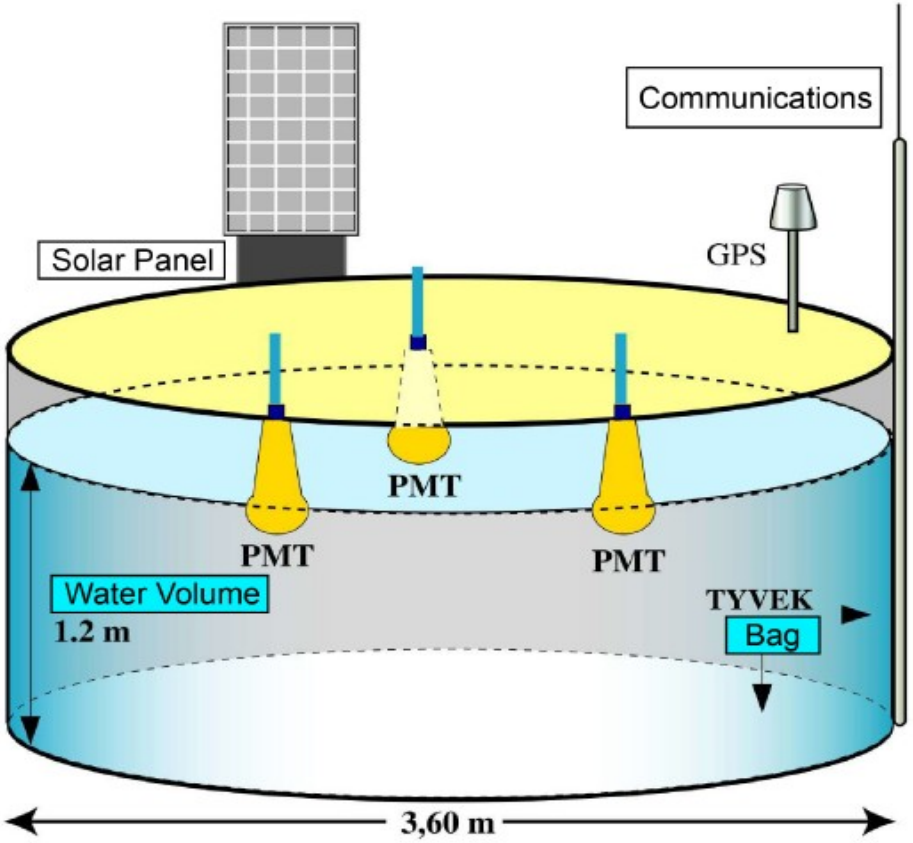
The most formal section, but can be done in “lighter” versions
some maths required (logarithms, exponentials, trigonometry)

3. How do we detect cosmic rays

Learning about detection techniques, sampling and the Pierre Auger Observatory and exploring the Observatory web site

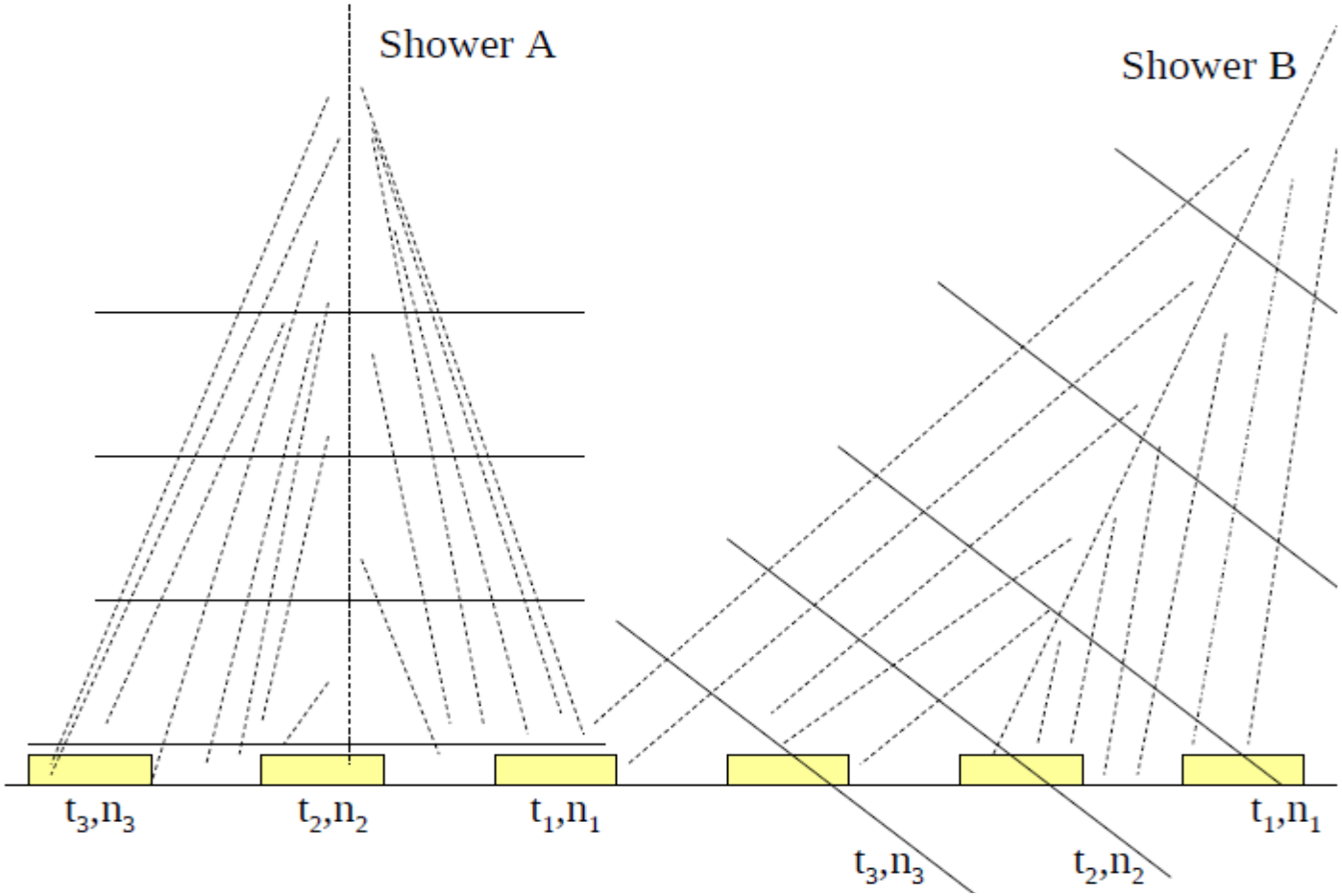
SURFACE DETECTOR:

- 1600 tanks,1.5 km spacing
- 3000 km^2 effective area
- 12 tons H_2O per tank
- 100% duty cycle
- Time resolution: 25 ns
- Angular resolution <1°
- Threshold Energy: $10^{18.3}$ eV
- 3 PMTs per tank



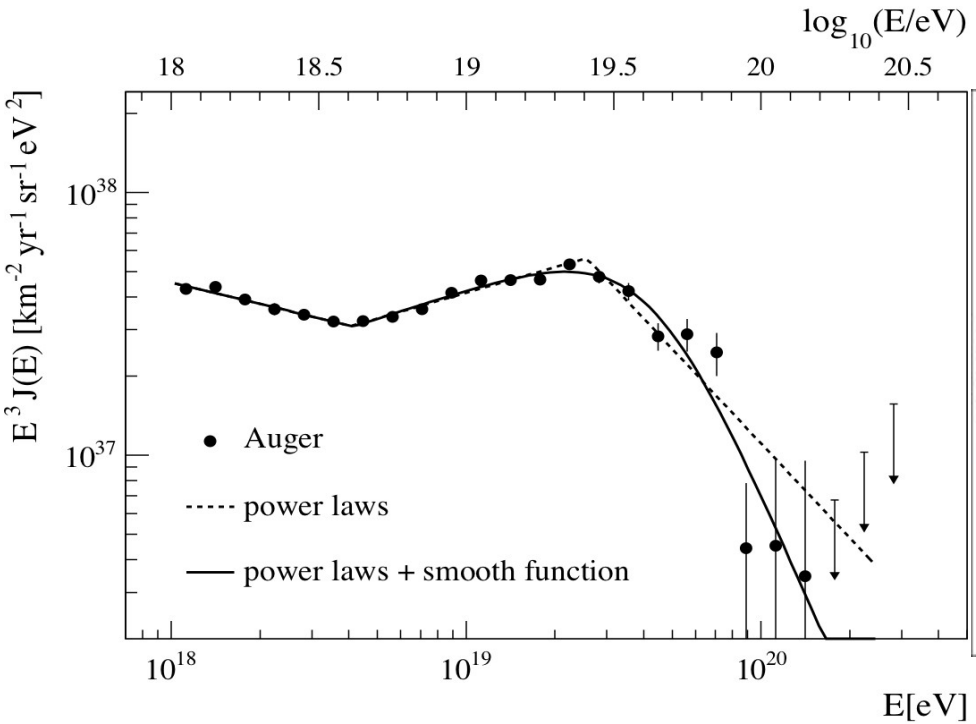
4. How do we measure extreme energy cosmic rays

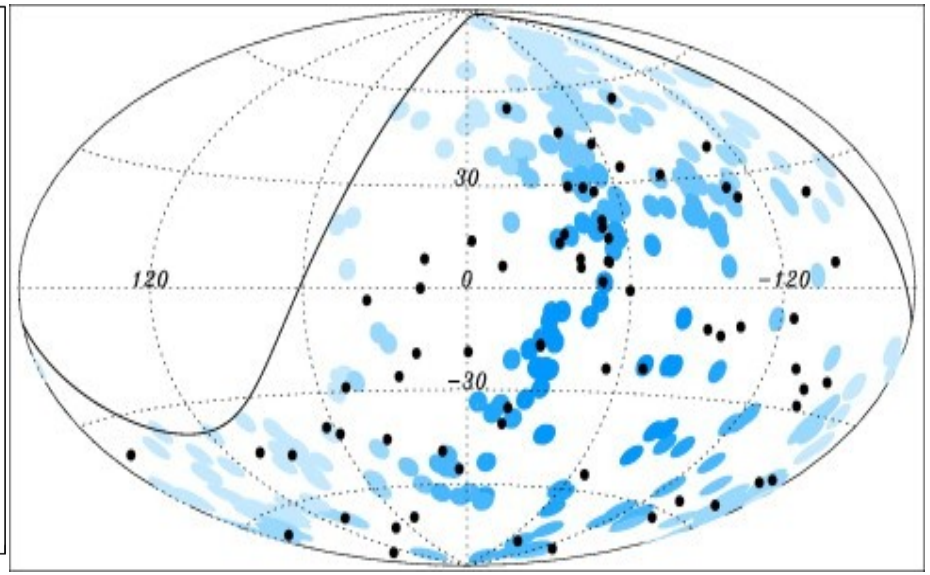
A shower by shower analysis is proposed.
How do we go from ground measurements to the primary particle?
Basics of shower reconstruction without getting into complex algorithms



5. What are these data telling us about extreme energy cosmic rays

Statistical analysis of the full set of showers
Getting closer to published Auger results (limited statistics and energy)
Histograms / Excel / ...

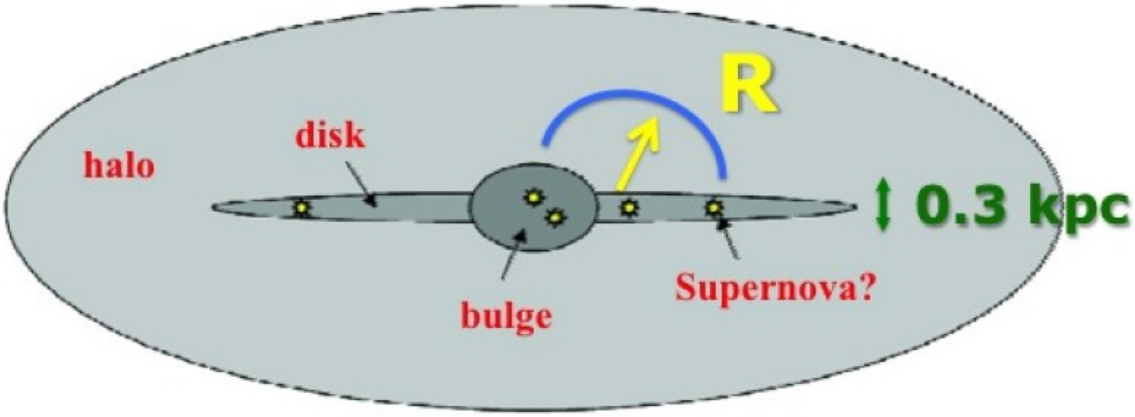




5. What are these data telling us about extreme energy cosmic rays

Statistical analysis of the full set of showers
Getting closer to published Auger results (limited statistics and energy)
Histograms / Excel / ...

Finally some simple calculations are proposed to discuss these results in light of the galactic/extragalactic origin of cosmic rays



English and Portuguese versions available

Perguntas e Respostas sobre os raios cósmicos de energia extrema Um guia para explorar os dados públicos do Observatório Pierre Auger

Há já 100 anos que sabemos que o planeta Terra é constantemente atingido por partículas que nos chegam do cosmos. Estas partículas têm energias, abundâncias e origens muito diversas, e existem ainda muitas perguntas por responder a seu respeito. Neste estudo dedicamo-nos aos raios cósmicos de energia extrema as partículas mais raras e mais energéticas que nos chegam do Universo. Quando estas partículas atingem o topo da atmosfera produzem um chuveiro de milhões de partículas, tantas mais quanto mais elevada for a energia da partícula inicial.
O Observatório Pierre Auger detecta estes chuveiros de partículas com o objectivo de resolver alguns dos mistérios relacionados com os raios cósmicos de energia extrema: que partículas são estas? De onde vêm? Onde são produzidas e como são aceleradas até atingirem energias tão elevadas? O Observatório Pierre Auger decidiu disponibilizar 1% dos dados que está a recolher desde 2004 a todos os que queiram aprender mais sobre os raios cósmicos de energia extrema. Esses dados estão disponíveis na página do Public Event Explorer, que é actualizada diariamente.
Este guia destina-se a ser um fio condutor na vossa exploração dos dados públicos de Auger, tornando-a mais rica e completa. O trabalho está organizado nas seguintes partes:

1. O espectro dos raios cósmicos
2. Como se desenvolvem os chuveiros de raios cósmicos
3. Como se detectam os chuveiros de raios cósmicos
4. Como se medem os raios cósmicos de energia extrema
5. O que nos dizem estes dados sobre os raios cósmicos de energia extrema

Links úteis:

- The Pierre Auger Observatory: http://www.auger.org
- Public Event Explorer (página dos dados públicos de Auger): http://auger.colostate.edu/ED
- Auger education page: http://www.auger.org/education/Auger_Education
- Sobre física de partículas: http://www.particleadventure.org

1

Questions and Answers on Extreme Energy Cosmic Rays

- A guide to explore the public data of the Pierre Auger Observatory -

Since 100 years, we know that planet Earth is constantly hit by particles arriving to us from the cosmos. Such particles have very diverse energies, abundances and origins, and many questions remain to be answered about them. This study is devoted to extreme energy cosmic rays - the rarest, most energetic, particles arriving to us from the Universe. When these particles reach the top of the atmosphere, they produce a shower of millions of particles: the higher the energy of the initial particle, the larger the number of particles in the shower.
The Pierre Auger Observatory detects these particle showers with the goal of solving some of the mysteries of extreme energy cosmic rays: what are these particles? Where do they come from? How are they produced and accelerated to such high energies? The Pierre Auger Observatory decided to make 1% of the data it is collecting since 2004 available to all those who wish to learn more about extreme energy cosmic rays. These data are available on the "Public Event Explorer" web page, which is updated every day.
This guide is meant to be a roadmap for your exploration of the Auger public data, making it more fruitful and complete. The work is organised in the following parts:

1. The cosmic ray spectrum
2. How do cosmic ray showers develop
3. How do we detect cosmic ray showers
4. How do we measure extreme energy cosmic rays
5. What are these data telling us about extreme energy cosmic rays

Useful links:

- The Pierre Auger Observatory: http://www.auger.org
- Public Event Explorer (Auger public data page): http://auger.colostate.edu/ED
- Auger education page: http://www.auger.org/education/Auger_Education
- Particle Physics basics: http://www.particleadventure.org

1

Find the Guide in http://www.auger.org/education/Auger Education

Contacting the authors:
Pedro Abreu (abreu@lip.pt), Sofia Andringa (sofia@lip.pt),
Francisco Diogo (fdiogo@lip.pt), Catarina Espirito Santo (catarina@lip.pt)

Using the Guide

1) Program “Science in the Summer” (Ciência Viva) 2 weeks @ LIP:

> Auger
Explore public data with the Guide + “seeing” de cosmic rays

> ATLAS
Light, fibers, cintilators + “masterclass-like” work with events
(Agostinho Gomes , agomes@lip.pt)

2) Environmental Radiation Project (Luis Peralta, luis@lip.pt)

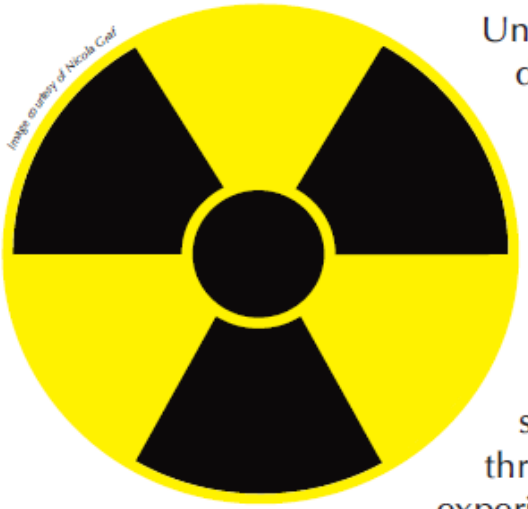
> Sending the guide to schools...

> Prepared teacher's guide with proposed answers + guidelines

> Giving training and support to teachers

3) Towards Masterclasses in Cosmic Rays

Radioactivity in the classroom



Luis Peralta, professor at the University of Lisbon's physics department, and **Carmen Oliveira**, physics and chemistry teacher at Casquilhos High School in Barreiro near Lisbon, describe the 'Environmental radiation' project, in which students become actively and enthusiastically involved in science through easy and inexpensive experiments that highlight the thrilling world of invisible particles.

+ New projects included

+ Cosmic ray projects ←

> 50 schools participated

(Luis Peralta, luis@lip.pt)

Detection of radioactivity in the rock

Becquerel´s experiment

Plants germinated from irradiated seeds

Field trip to the Nisa mines

Towards Masterclasses in Cosmic rays

A one day event:

1. Short set of introductory lectures reviewing the main concepts

2. “Hands on”: analysis of Pierre Auger Observatory real data

3. Teleconference for the presentation/discussion of the results

Proposed Activity 1:

From the measurement of a tiny fraction of the shower particles on ground, how do we get to the characteristics of the primary cosmic particle that reached the top of the atmosphere?

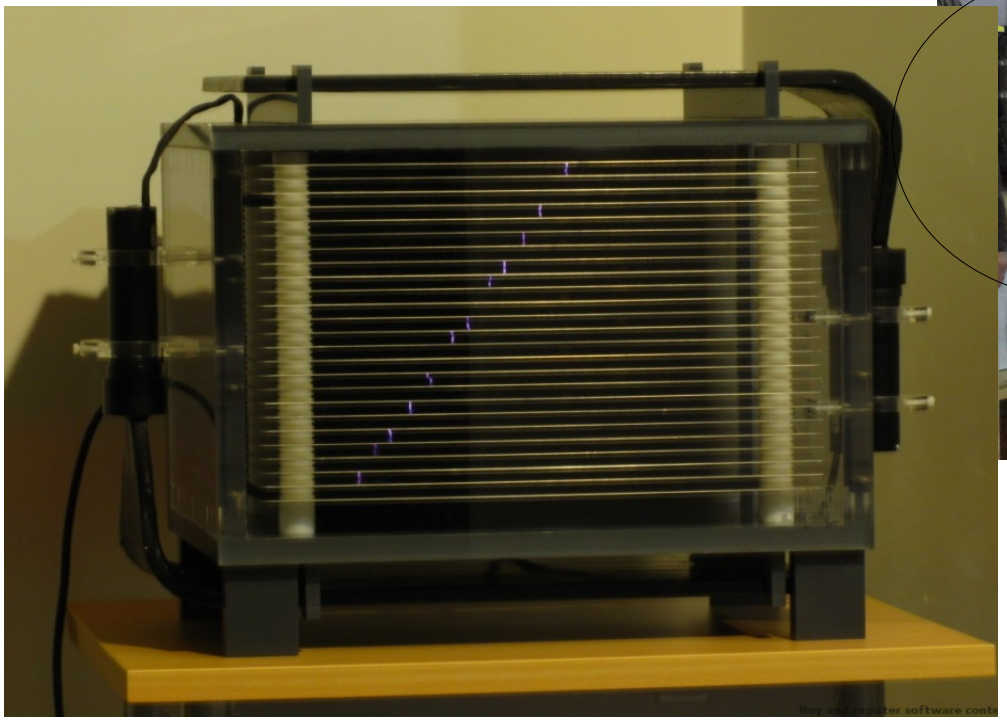
Proposed Activity 2:

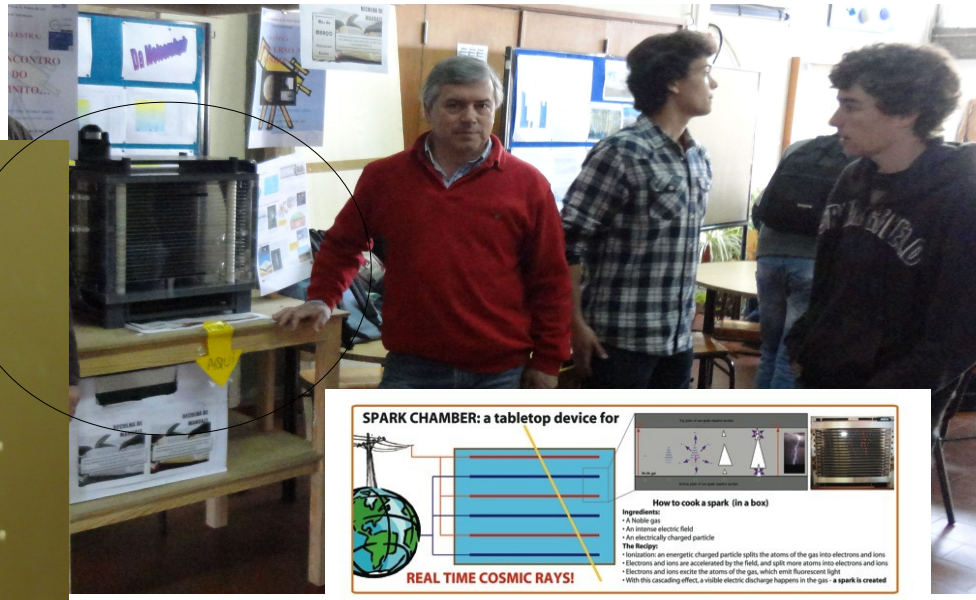
Where do extreme energy cosmic rays come from?

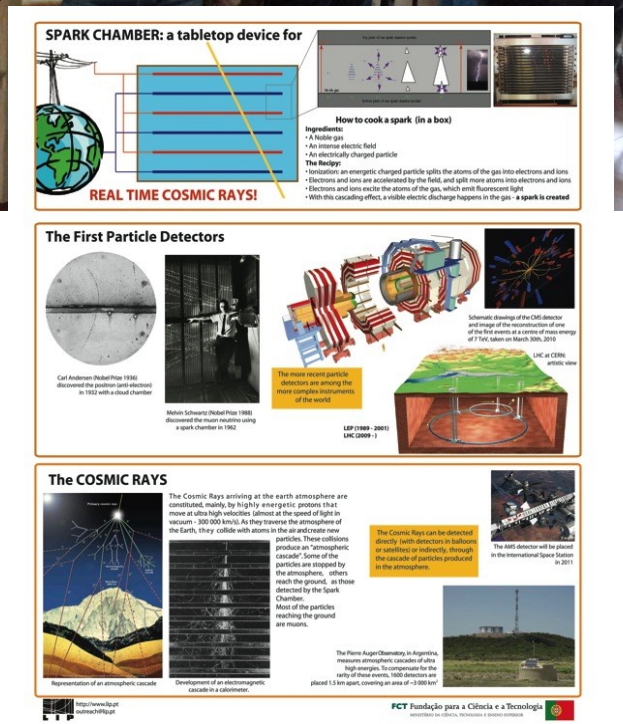
Discussions towards a joint effort ongoing...
Would like to have a “test-bench masterclass” still this academic year

Spark chambers

Made at the LIP workshop for outreach purposes







11 kEuro + taxes + tranportation

Gas (Helium): one bottle ~300 Euro enough for ~1 year