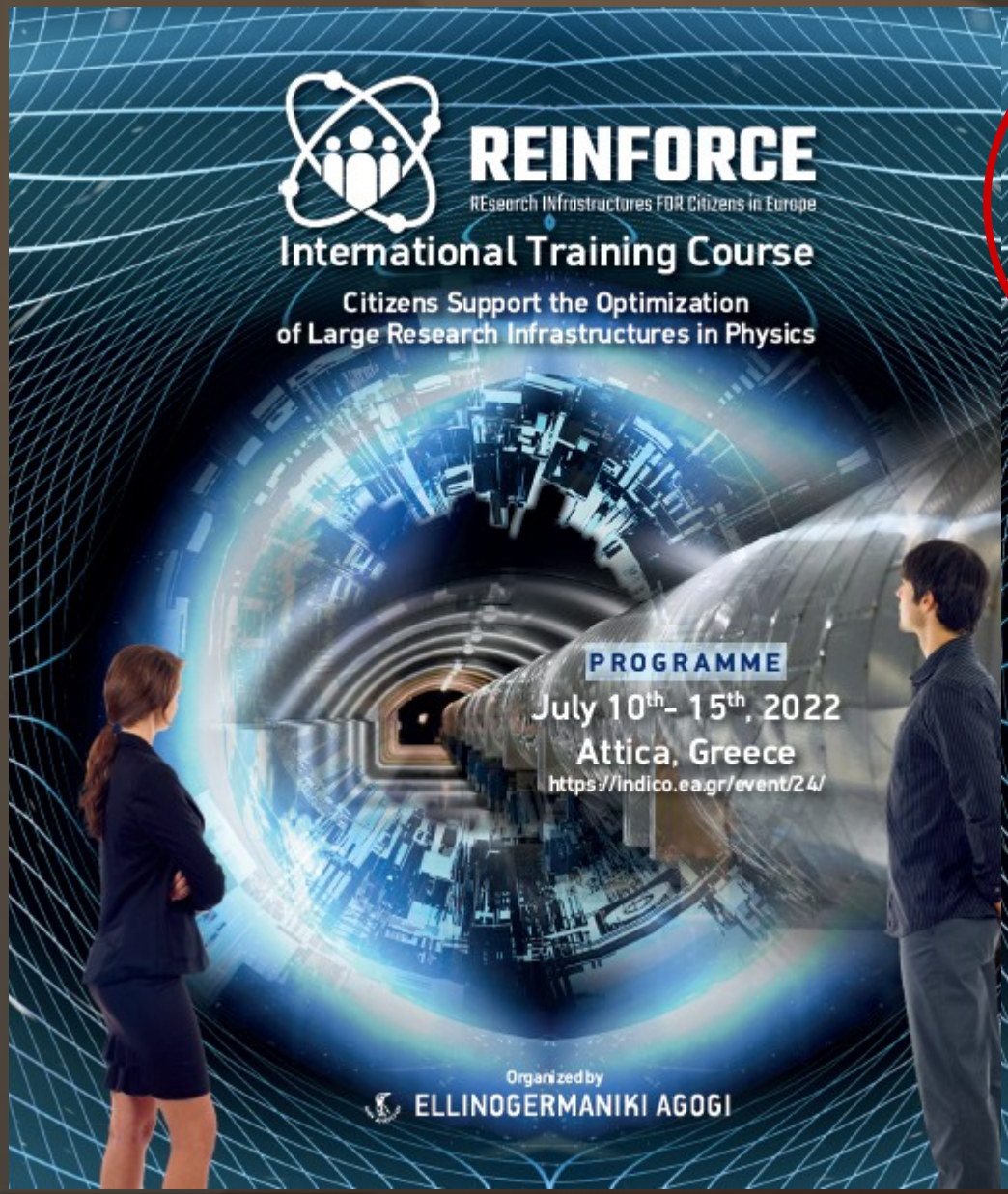
2022 REINFORCE International Training Course



EVENTS

Virtual Visit to the Pierre Auger Observatory
(July 11th, 15:00 – 16:00)

The Pierre Auger Observatory is an international cosmic ray observatory in Argentina designed to detect ultra-high-energy cosmic rays: sub-atomic particles traveling nearly at the speed of light and each with energies beyond 10^{18} eV.

Virtual Visit to the Virgo Gravitational Wave Detector
(July 12th, 12:00 – 13:00)

The Virgo Gravitational Wave Detector is a large interferometer located in Cascina, outside Pisa in Italy in the premises of the European Gravitational Observatory (EGO). Virgo is designed to detect gravitational waves predicted by Einstein's General Theory of Relativity.

Virtual Visit to the ATLAS experiment at CERN
(July 14th, 12:00 – 13:00)

ATLAS is a general-purpose particle physics experiment at the Large Hadron Collider (LHC) at CERN. It is designed to exploit the full discovery potential of the LHC, pushing the frontiers of scientific knowledge by seeking answers to fundamental questions such as: What are the basic building blocks of matter? What are the fundamental forces of nature? What is dark matter made of?

Visit to Cape Sounio, Sanctuary of Poseidon
(July 11th, 18:00 – 24:00)

Cape Sounio is a promontory located 69 kilometres from Athens, at the southernmost tip of the Attica peninsula. According to legend, Cape Sounion is the spot where Aegeus, king of Athens, leapt to his death off the cliff, thus giving his name to the Aegean Sea. The sanctuary of Poseidon, one of the most important sanctuaries in Attica, is also located at Sounio. Archaeological finds on the site date from as early as 700 BC. The temple at Cape Sounion, was a venue where mariners, and also entire cities or states, could propitiate Poseidon, by making animal sacrifice, or leaving gifts.

Visit to the Acropolis of Athens
(July 13th, 15:30 – 20:30)

The greatest and finest sanctuary of ancient Athens, dedicated to the goddess Athena, dominates the centre of Athens from the rocky crag of the Acropolis. The Acropolis of the 5th century BC is the most accurate reflection of the splendour, power and wealth of Athens at its greatest peak, the Golden Age of Pericles. In the mid-fifth century BC, when the Acropolis became the seat of the Athenian League, Pericles initiated an ambitious building project which lasted the entire second half of the fifth century BC. The architects, Ictinos and Callicrates, began the erection of this unique monument at 447 BC and the building was substantially completed by 432 BC. The visit to Acropolis will be supplemented with a tour to the New Acropolis Museum. With a total area of 25,000 square meters and exhibition space of over 14,000 square meters, the museum offers all the amenities expected in an international museum of the 21st century, including the following permanent exhibitions: The Gallery of the Slopes of the Acropolis, The Archaic Gallery, The Parthenon Gallery, Propylaia-Athena Nike-Erechtheion, from 5th century BC to 5th century AD.

Welcome to Pierre Auger Observatory

The biggest Observatory on Earth for the study of High Energy Cosmic Rays

400 collaborators; 40 staff members;

90 institution, 18 countries

R. Sato, F. Gobbi, A. Travaini, J. Velázquez, A. González, G. Ávila, B. García

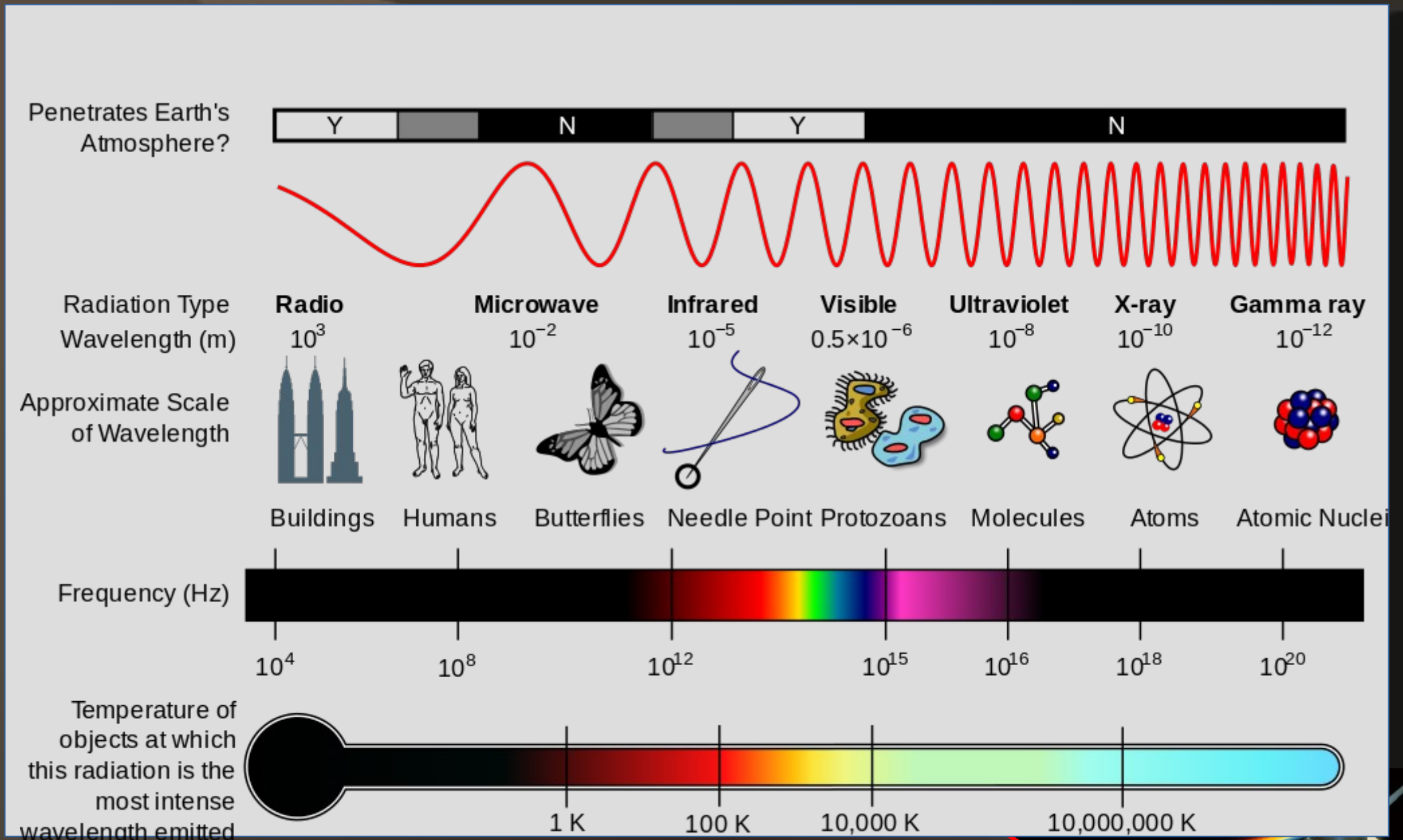
Astronomy is the study of celestial objects.

It is the study of almost all the properties of the Universe from stars, planets and comets to the largest cosmological structures.
and phenomena across the entire electromagnetic spectrum and more.

It is the study of everything that existed, exists and will exist

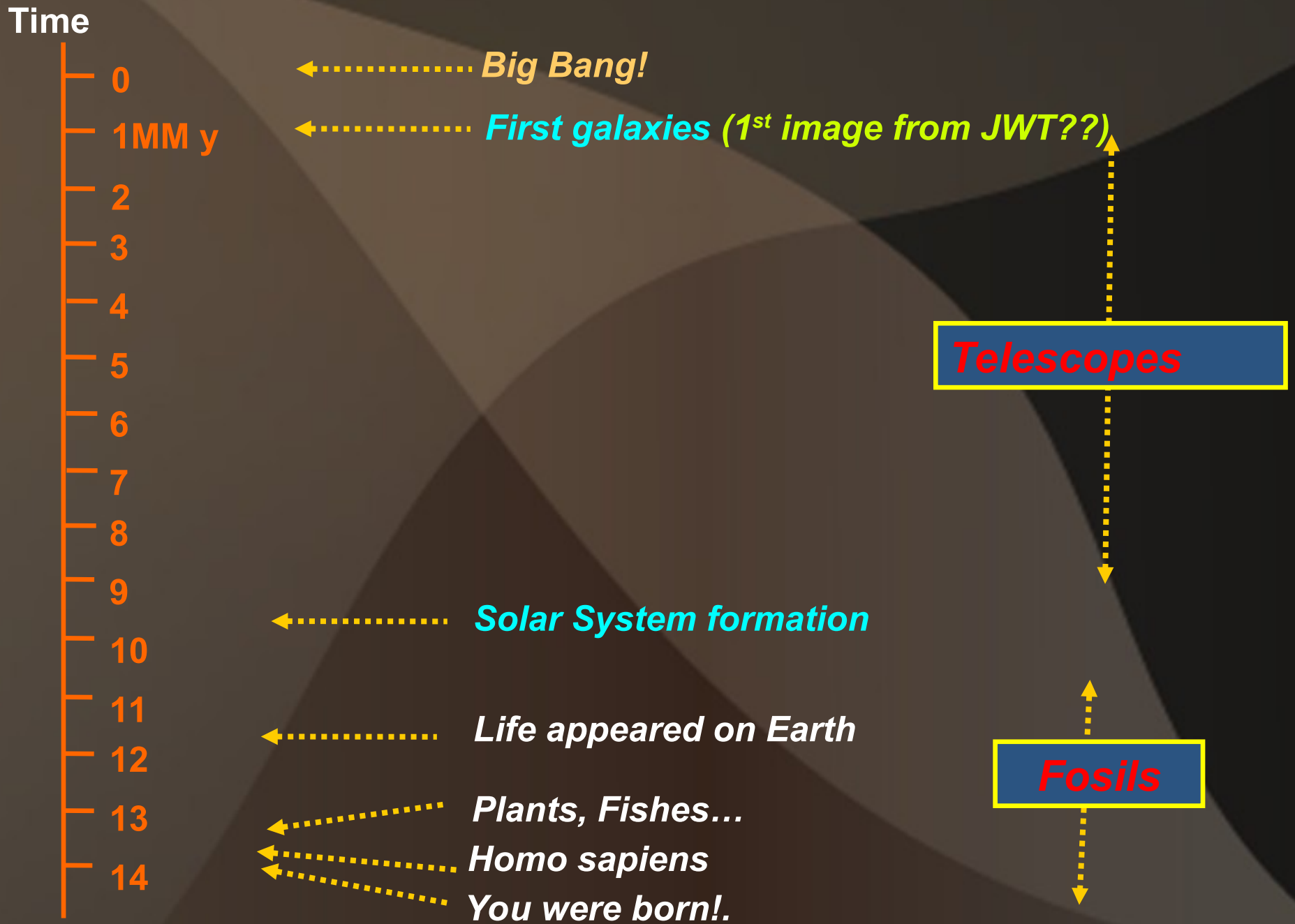
Our knowledge about Cosmos
photons from all the …

Electromagnetic Spectrum



Astophysics multiwavelength

Brief History of Universe and Life



There are more things than photons

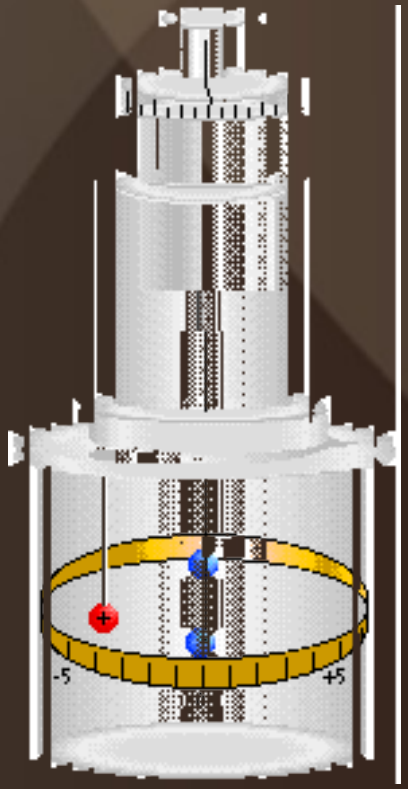
- Particles interact each other.
- Particles arrive from the cosmos and interact with the atmosphere and water.
- The interaction between particles and matter produces light.

Short History I

1785 – Charles Coulomb

Analyzed the discharge rate of electroscopes.

He could not find a satisfactory explanation.



1909 - Theodore Wulf

It was assumed that some kind of radiation may come from Earth.

Wulf analyzed if it is modified with the altitude: it measured in the Eiffel Tower, without conclusive results.

Short History II

1912 - Víctor Franz Hess

On a balloon at 5000 m.asl, discovered a "penetrating radiation" coming from the space.

- He observed the electroscopes discharge.

1932 – Robert Millikan

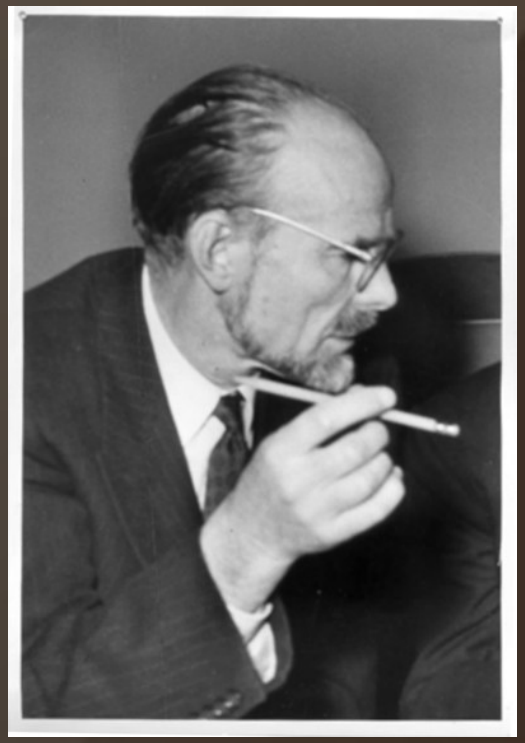
- **"Rayos Cósmicos"**

Short History III

1938 - Pierre Auger

- Geiger detectors installed on the Alps.

Discovered the "cosmic showers" cascades of secondary subatomic particles caused by the collision of high-energy primary particles with air molecules.



Showers of energies ten million times higher than any known before.

1938: It was concluded that they were mostly protons (their flux depends on the magnetic field)

What are Cosmic Rays?

* Nuclei with composition similar to those of solar system + p^+ + gammas + neutrinos

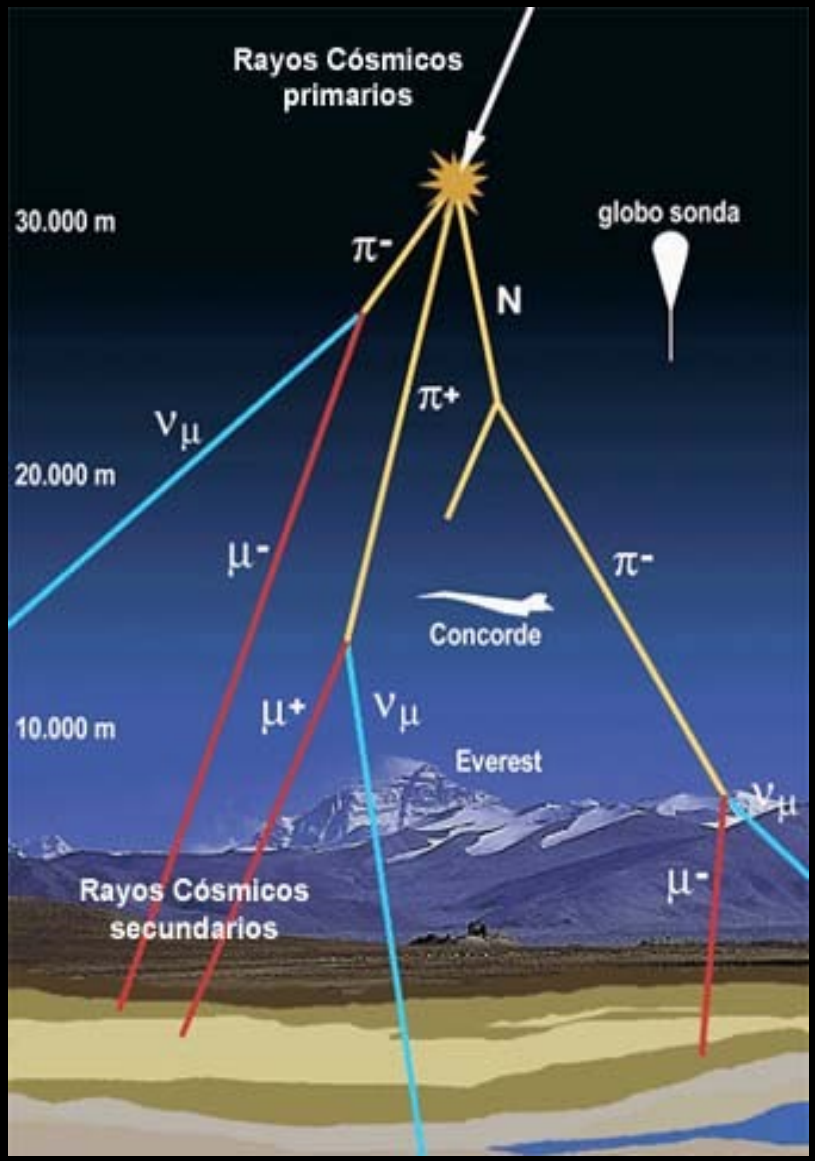
The products of the interaction and decay reach the Earth's surface

* Energy range Mev – EeV **====> several sources**

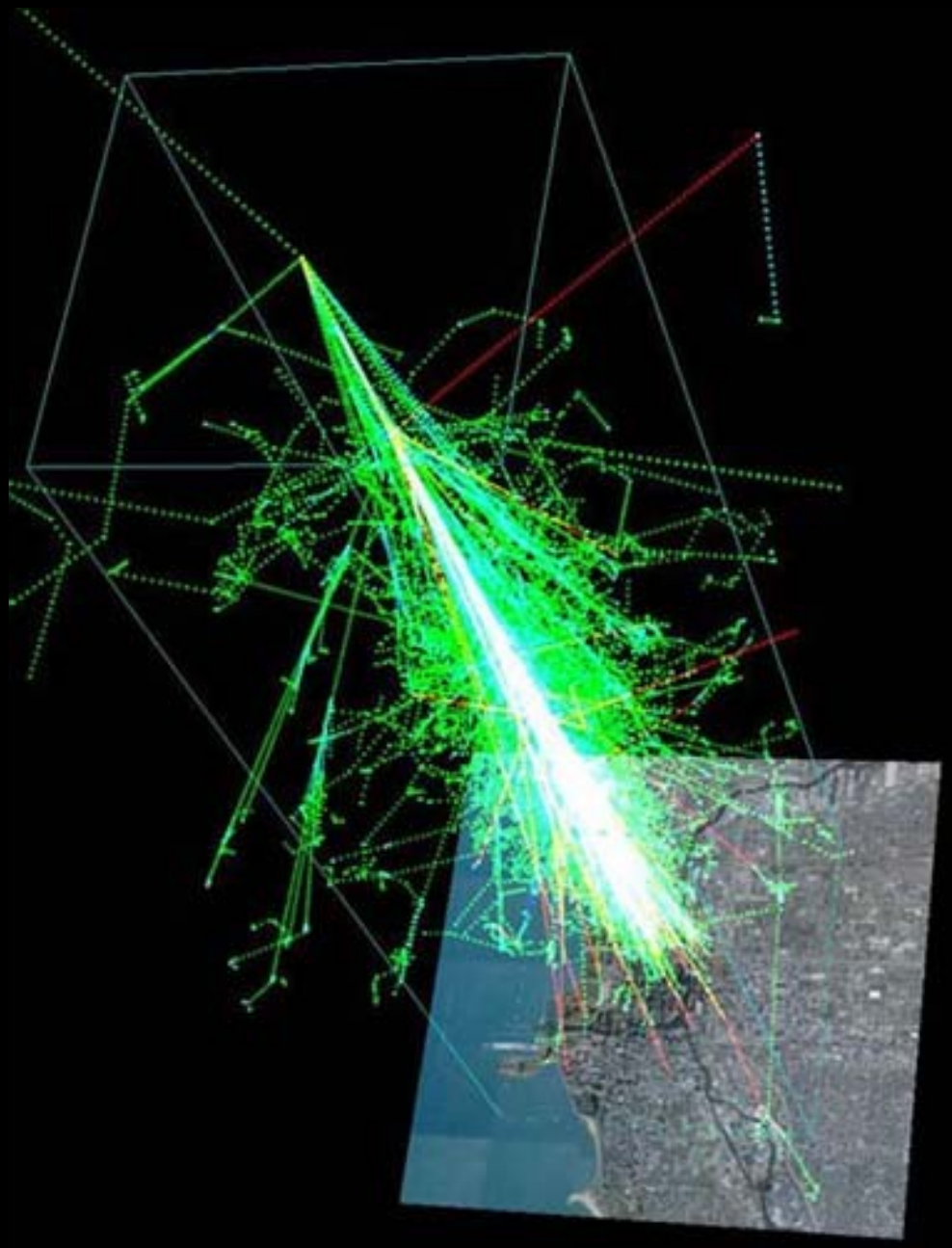
Low energies: Sun (10 => 100 MeV)
The rate at the surface 1/ seg cm^2

High energy (up 10 EeV)
Galactic sources (supernovas).
Extragalactic origin.
The rate at the surface 1/ century km^2

What the Pierre Auger Observatory studies



Atmospheric extended Showers



At high energies, the flux is so low that direct detection is almost impossible.

Indirect observations

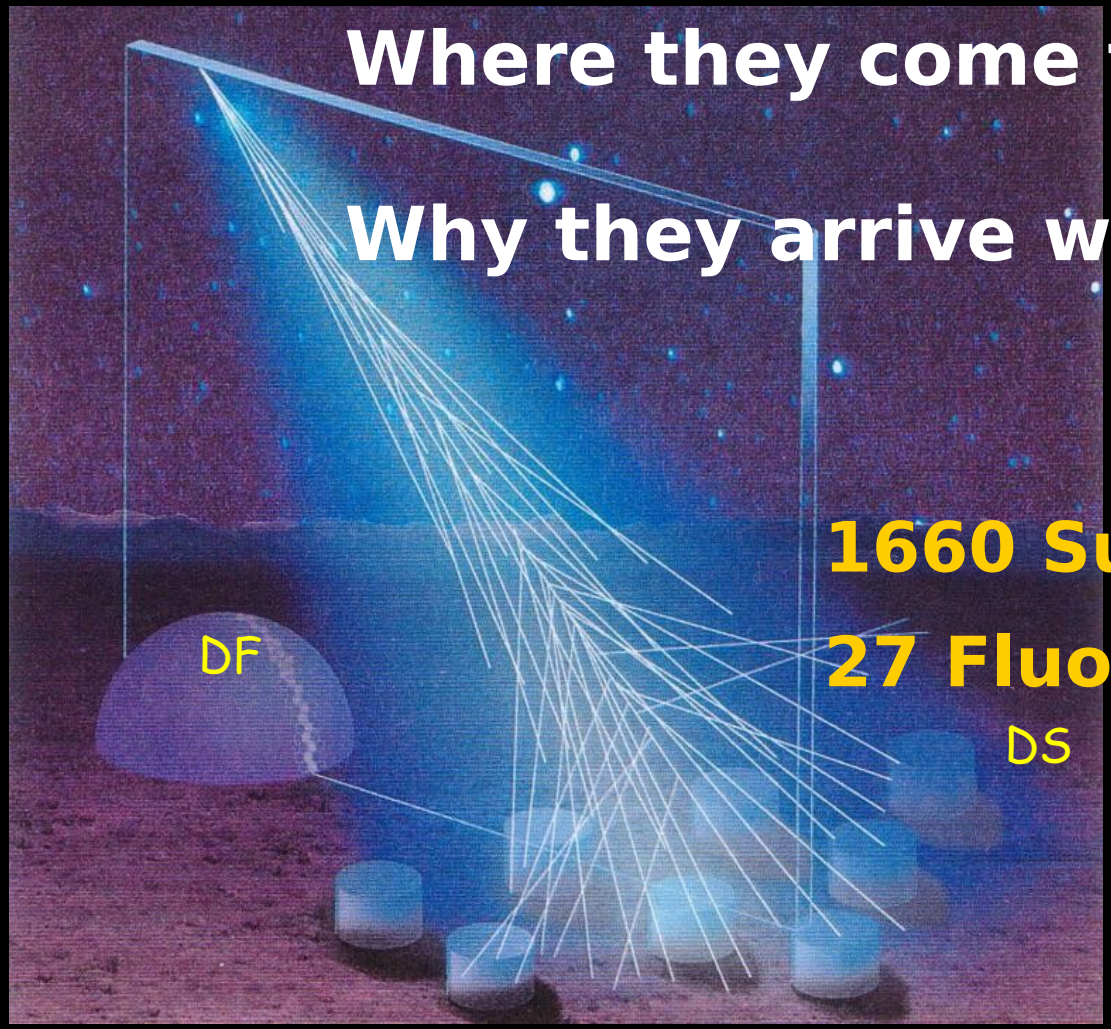
from the shower of secondary particles generated by the interaction of CR with the air

Pierre Auger Observatory

What the UHE-CR really are?

Where they come from?

Why they arrive with such high energy?



1660 Surface Detectors-DS

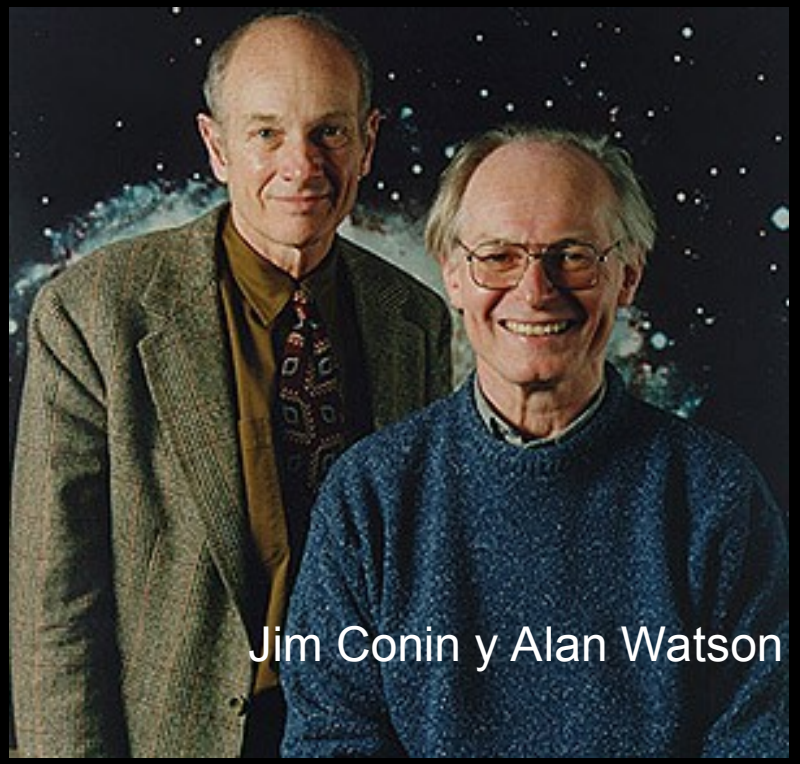
27 Fluorescence Detectors-FD

Time Line for Pierre Auger Observatory I

1991 - Concept- Giant Array Observatory, Dublin-ICRC

1995 - Feb-July Workshop for final design

1995 - November: International Collaboration creation UNESCO, París



Jim Conin y Alan Watson

Alberto Etchegoyen
Raúl Colomb

Time Line for Pierre Auger Observatory II

1999 – March,15 - MoU Mendoza

1999 – March,18. Inauguration of Malargüe site

2001 – May, 23. First Fluorescence event

2001 – July, 21. First Surface event

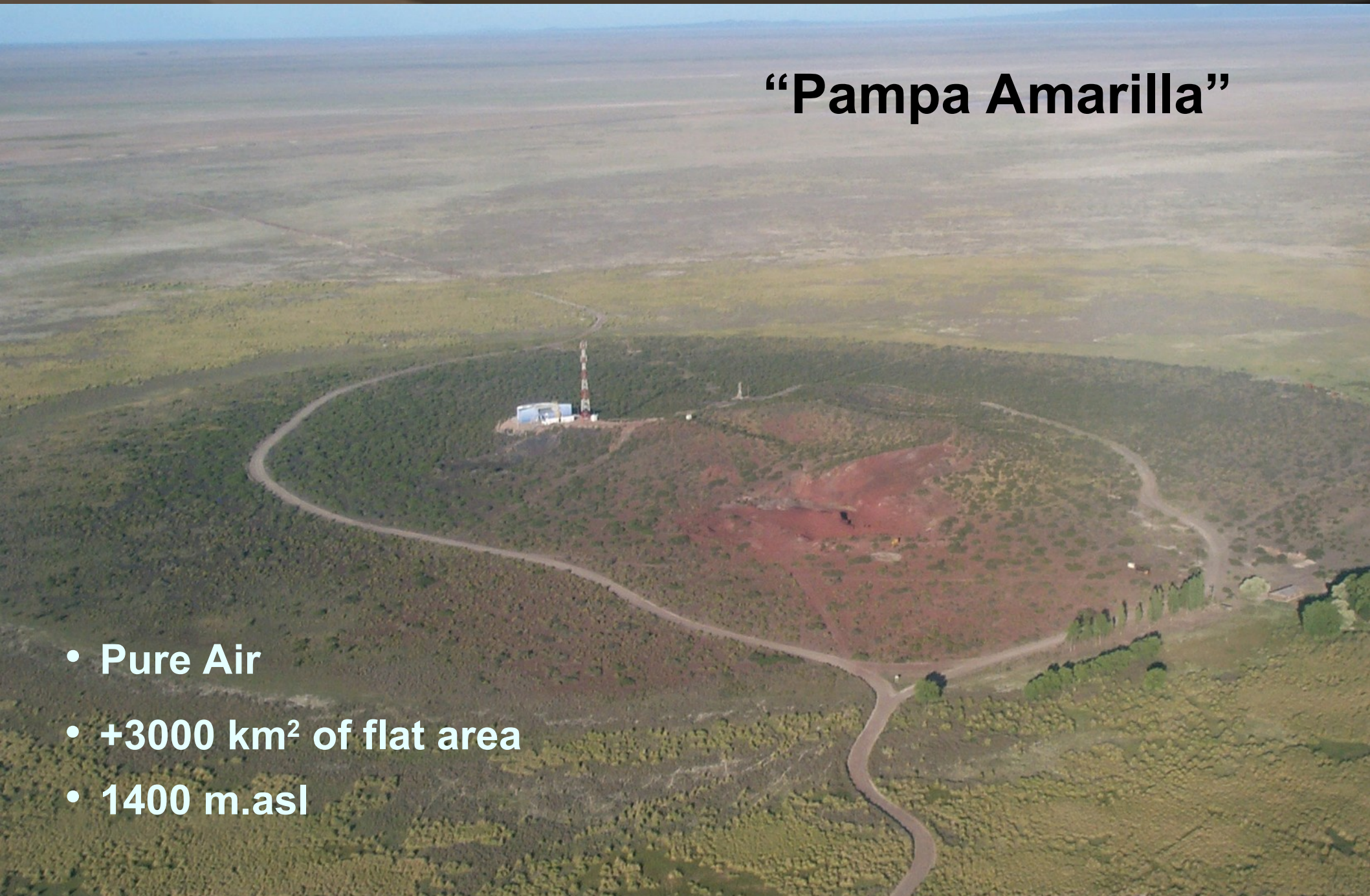
2001 – December, 9. First Hybrid event

2005 – August. First meeting about PAO results

2007 – November. First important paper

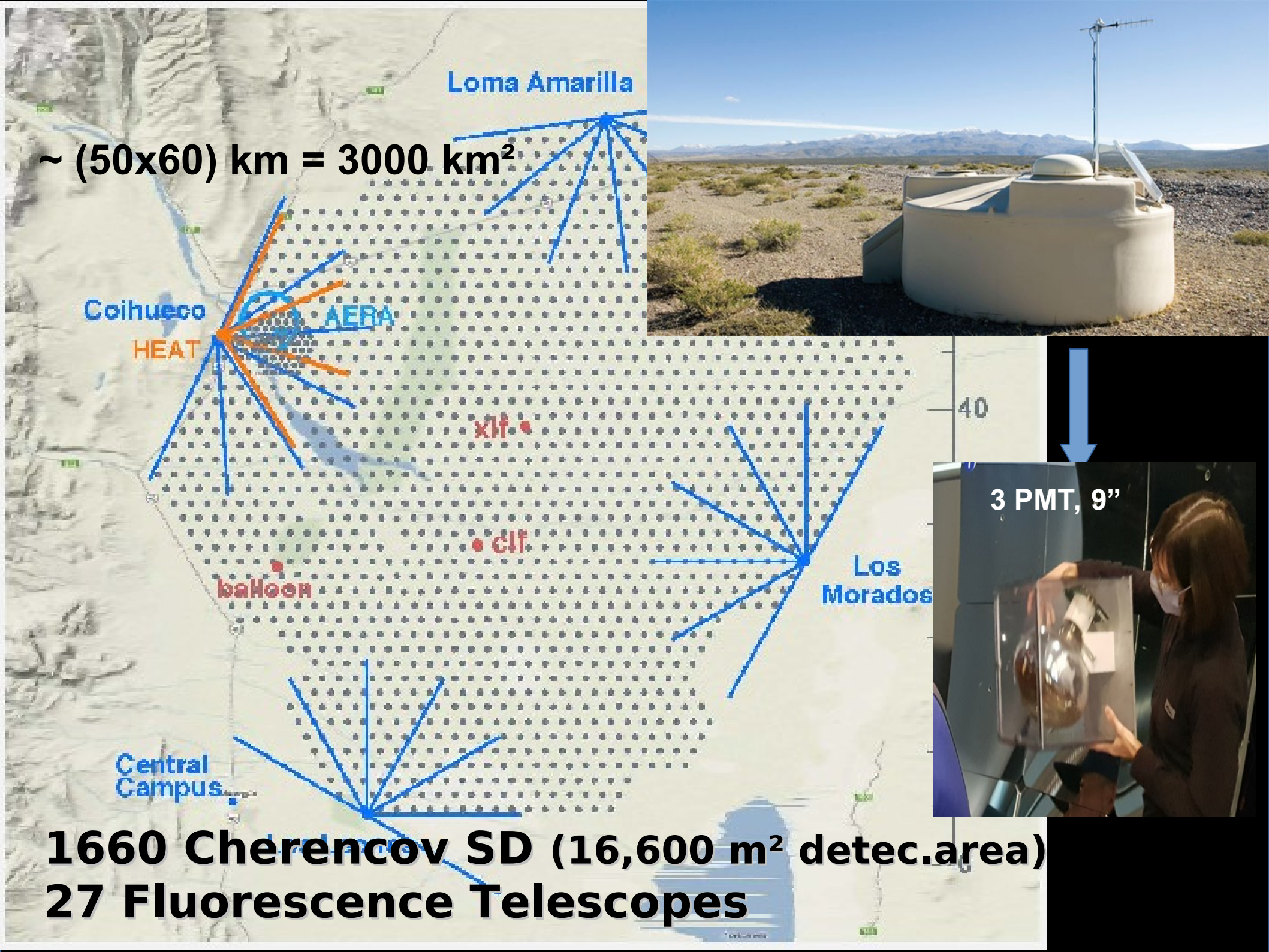
2008 – Full installation inauguration

One site: Malargüe - Mendoza

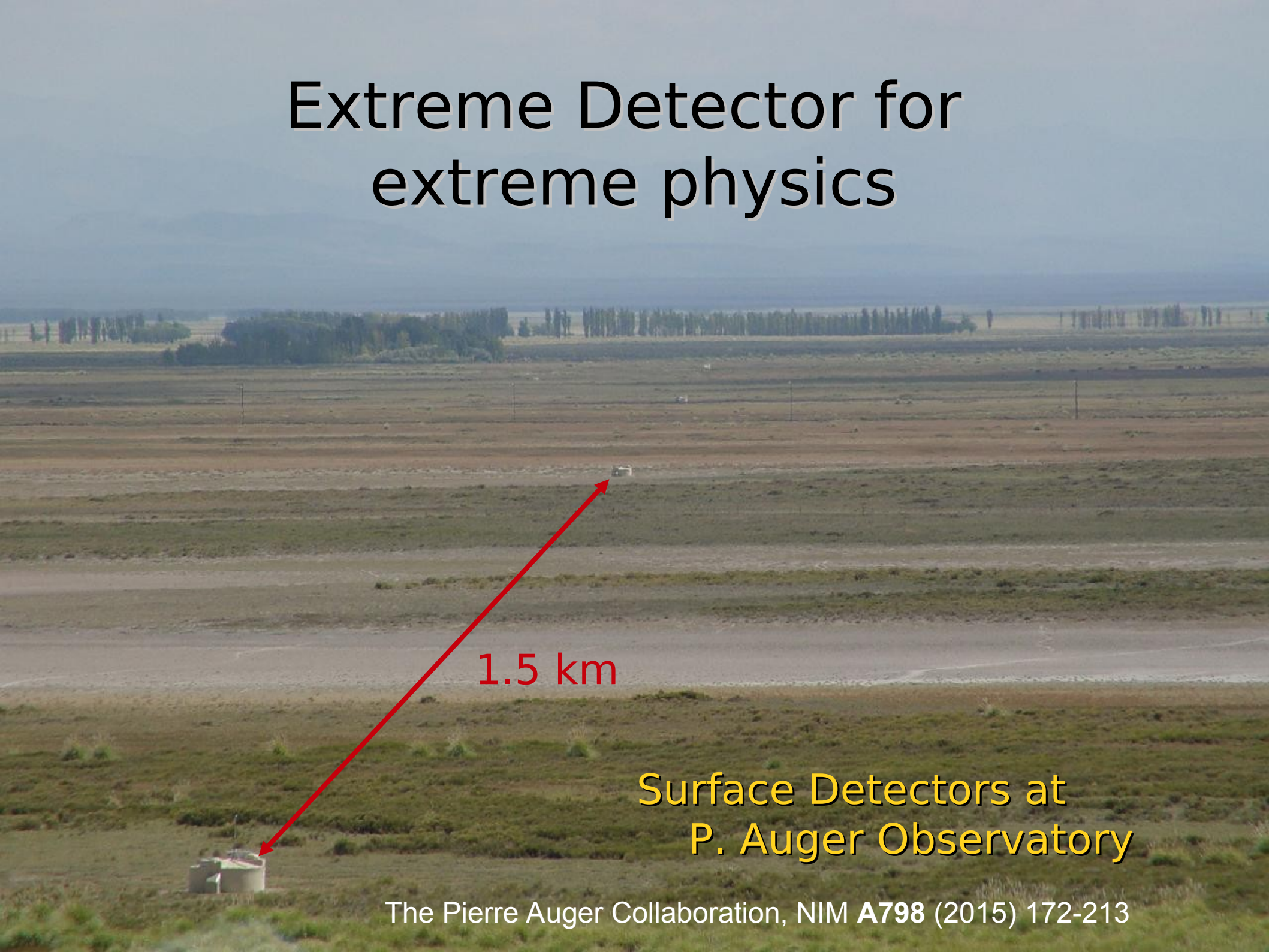


- Pure Air
- +3000 km^2 of flat area
- 1400 m.asl

Instalation of the SD

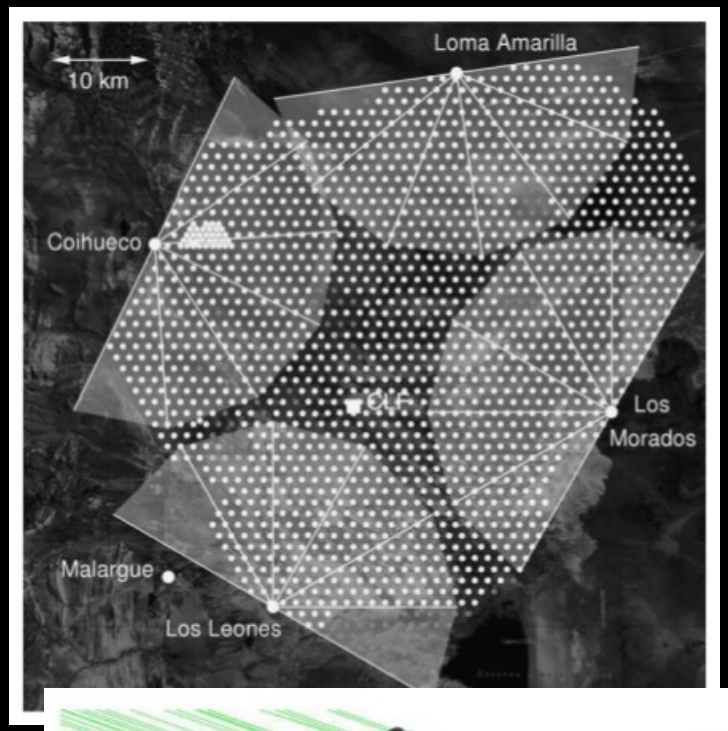

~ (50x60) km = 3000 km²
Loma Amarilla
Coihueco
AERA
HEAT
xlf
clf
balloon
Los Morados
Central Campus
40
3 PMT, 9”
1660 Cherencov SD (16,600 m² detec.area)
27 Fluorescence Telescopes

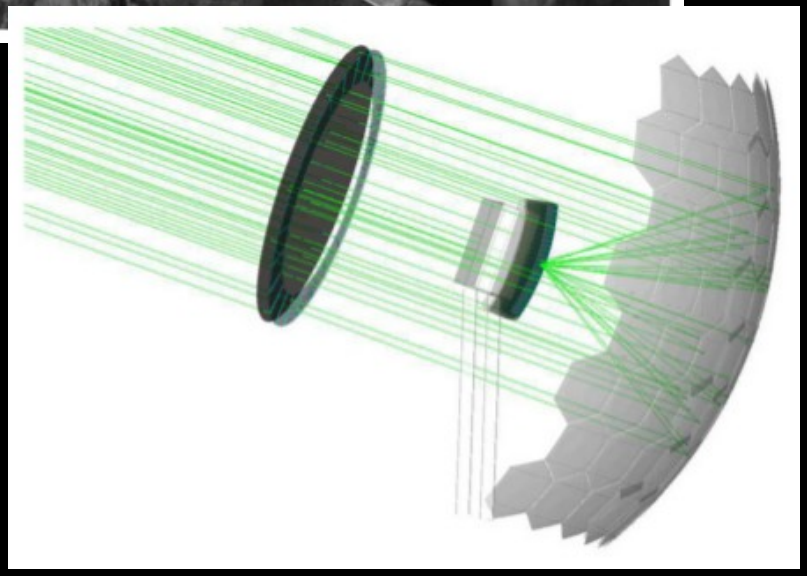
Extreme Detector for extreme physics

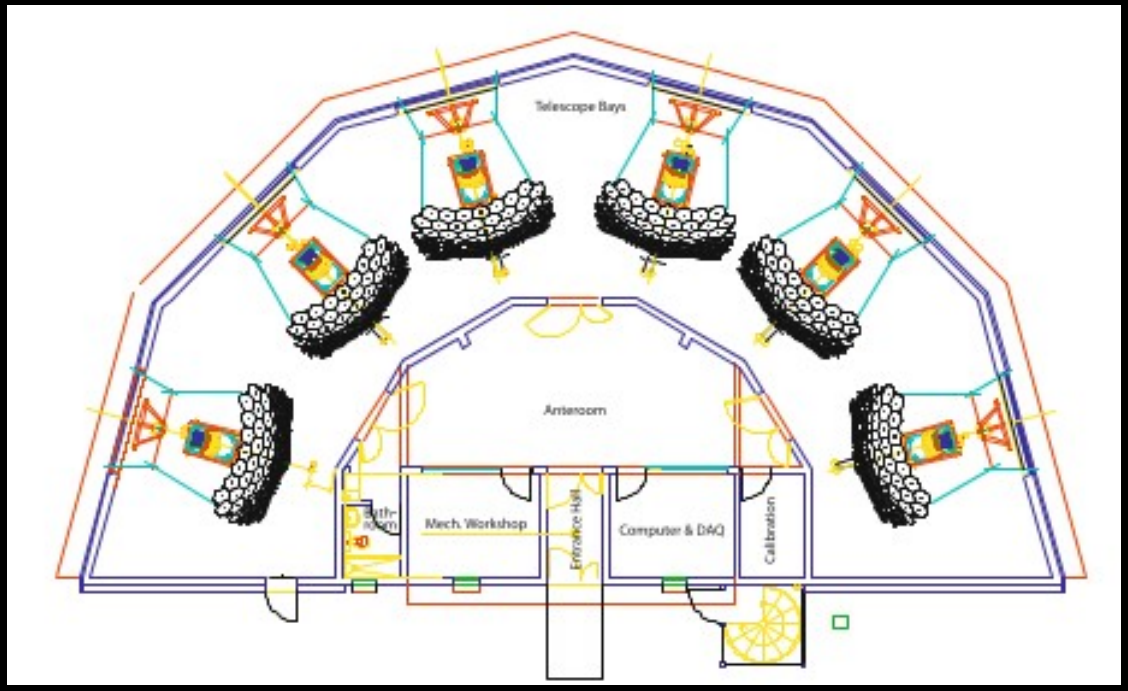


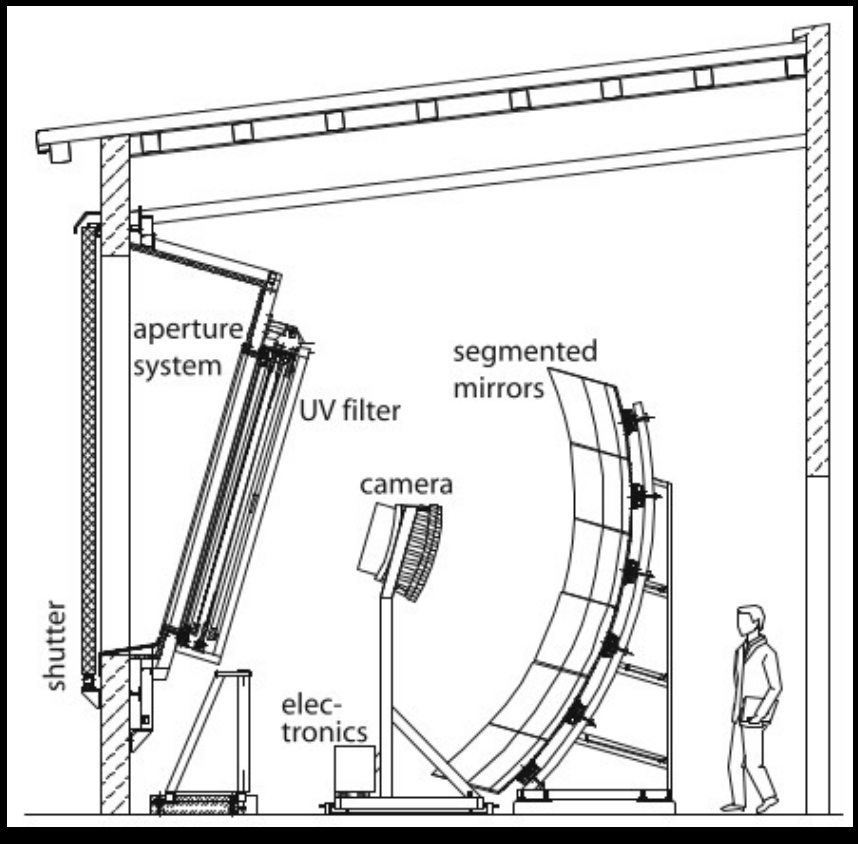
The Pierre Auger Collaboration, NIM **A798** (2015) 172-213

27 Fluorescence Detectors in 4 buildings

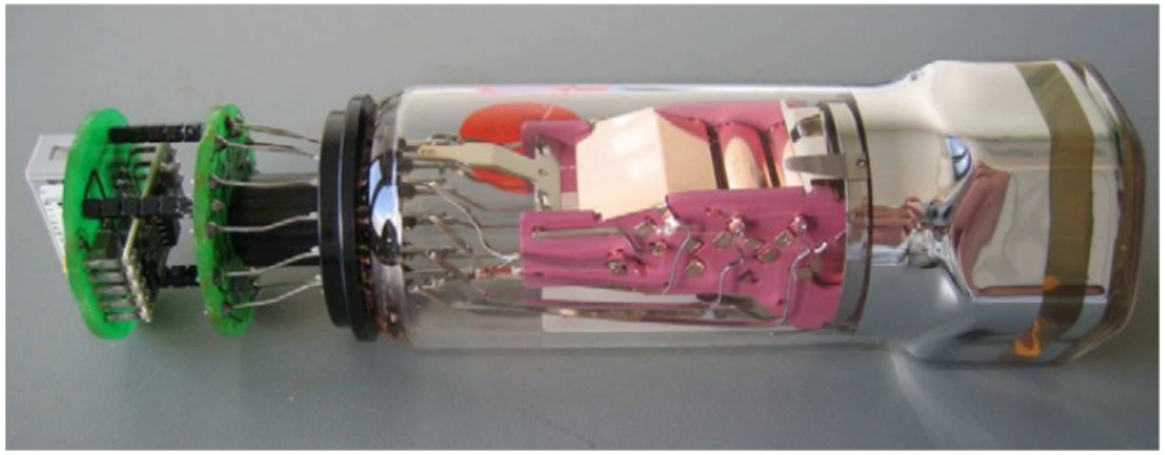




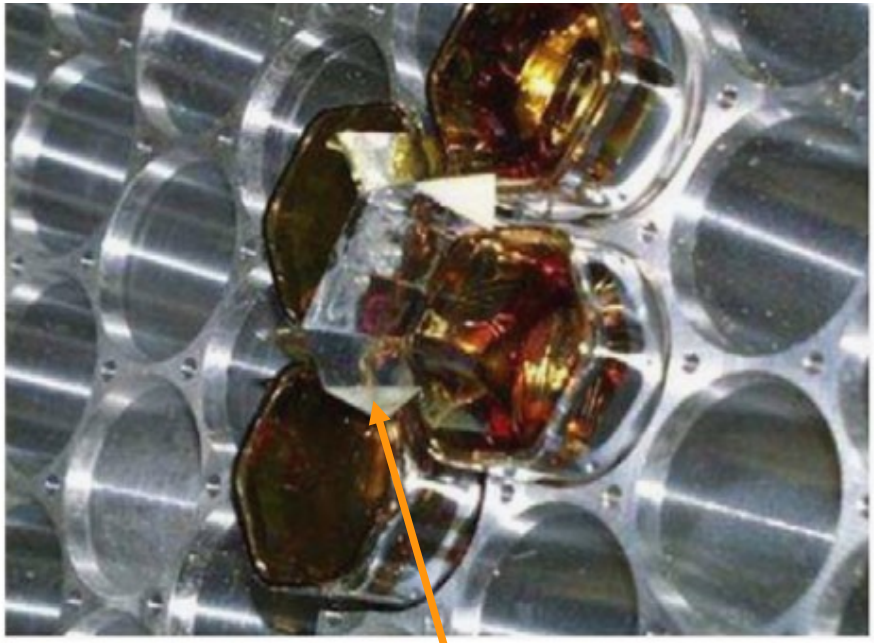




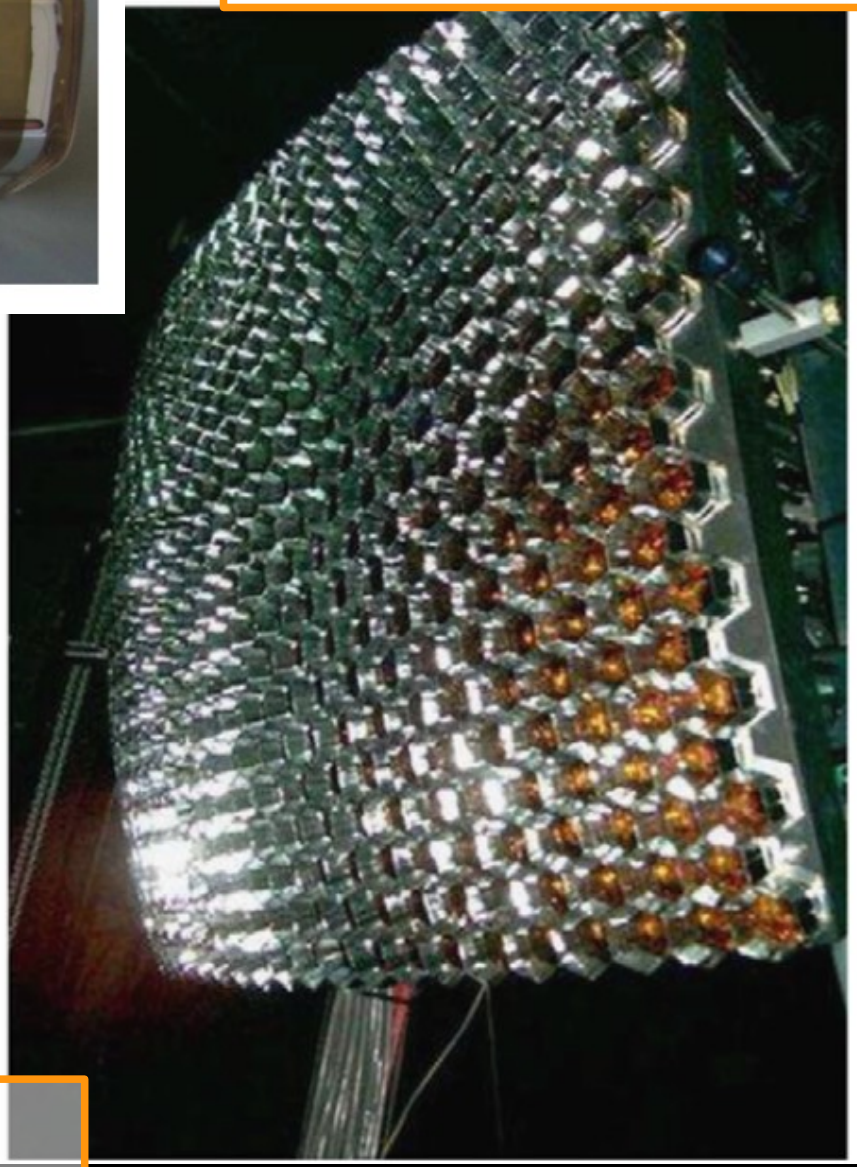
15bits (2^15=32768) @ 10 MHz (100 ns)



22x20 – FOV: 30ºx30º

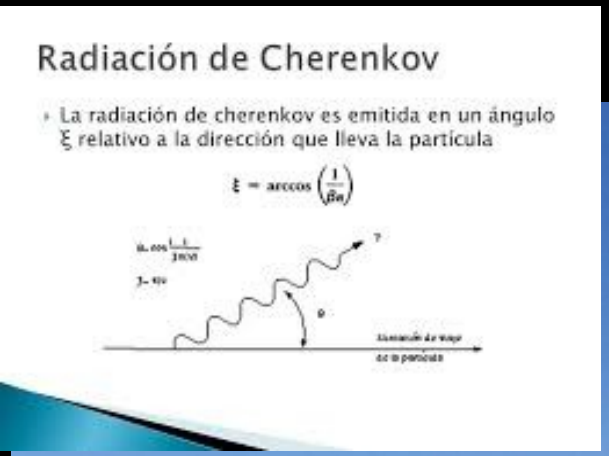


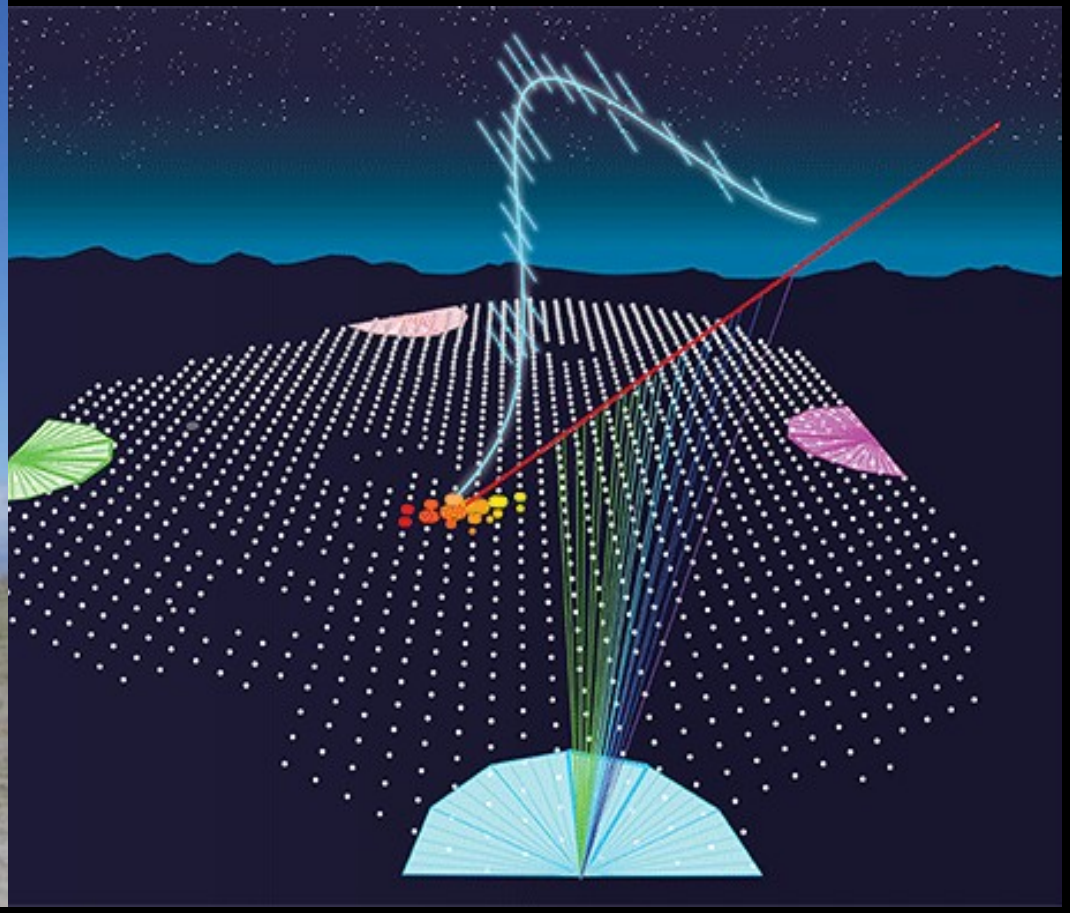
“Mercedes” Star



440 PMT Photonis XP3062 40mm,

A Hybrid Observatory

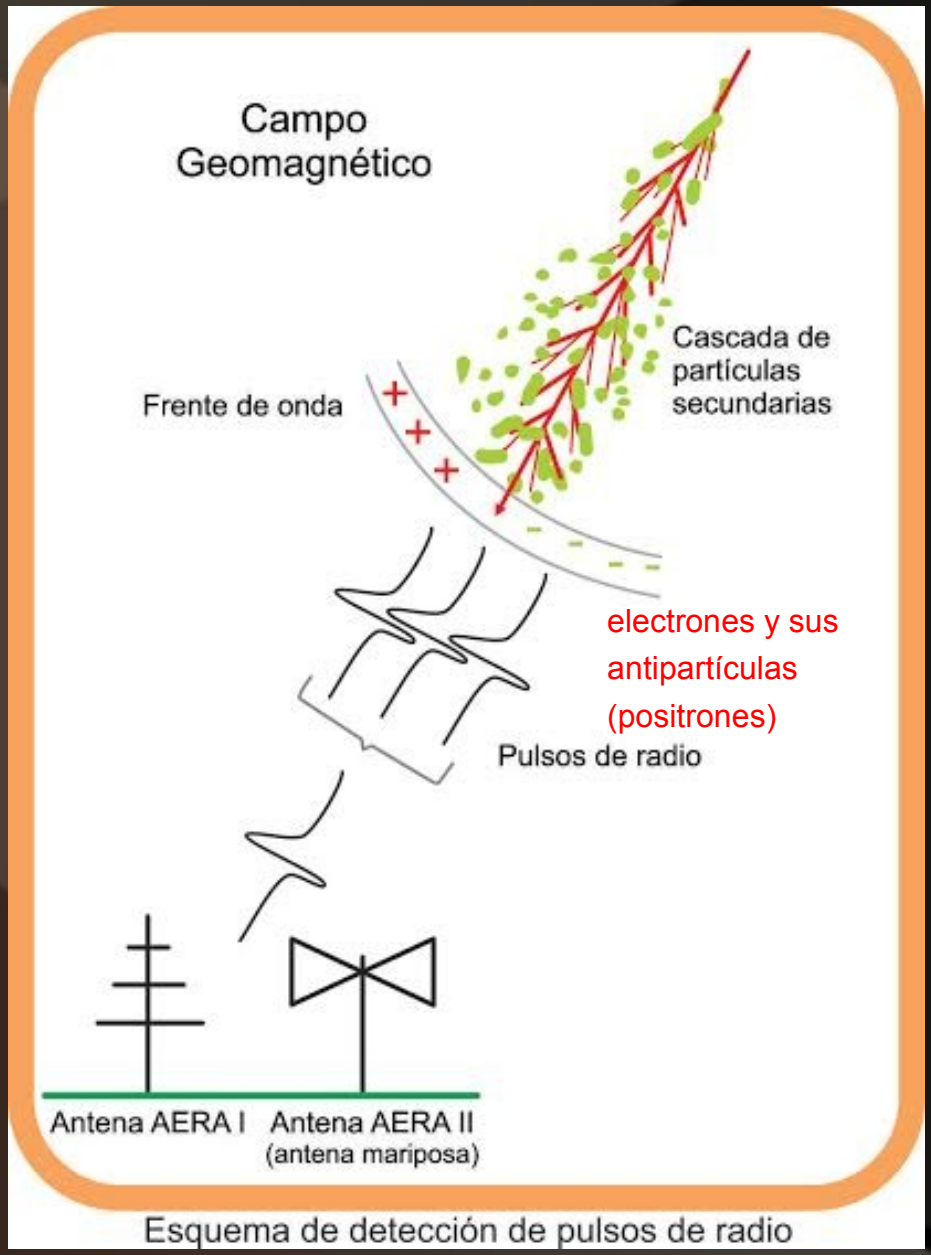




HEAT High Elevation Atmospheric Telescopes

AERA

(Auger Engineering Radio Array)



Esquema de detección de pulsos de radio

Detects the signals created when the shower of secondary particles pass through the magnetic field of the Earth.

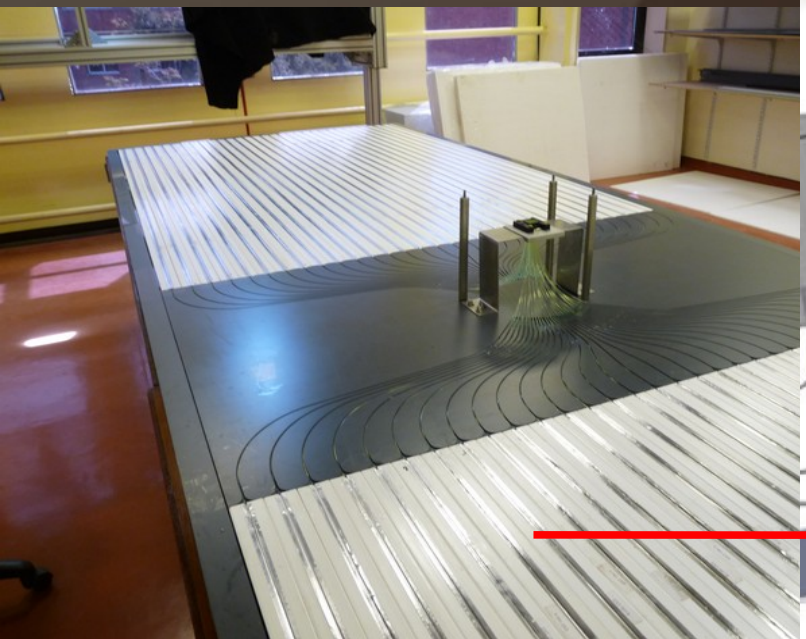
The e- e+ are deviated by the Earth's magnetic field, which creates a faint radio signal between 30 to 80 MHz.

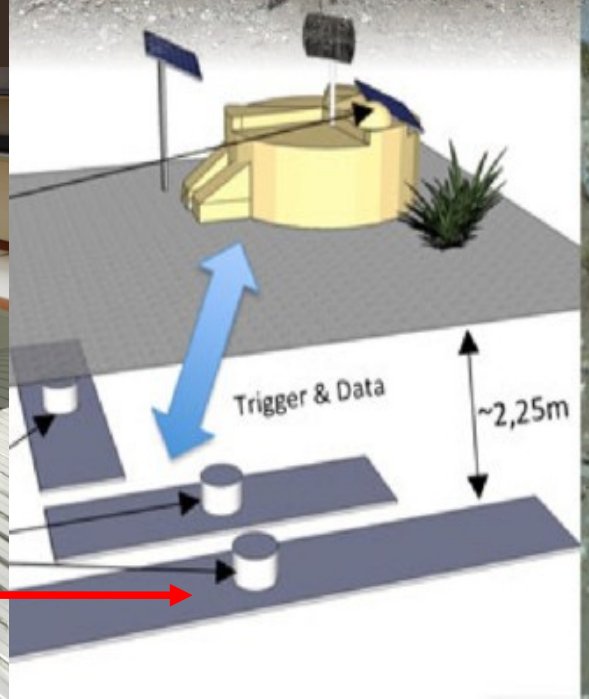
a) arrival direction and enegy is determined.
b) infomation about their nature is obtained.

AMIGA

(Auger Muon Infil for a Ground Array)

74 scintillators underground (238 modules at 2.5 m)

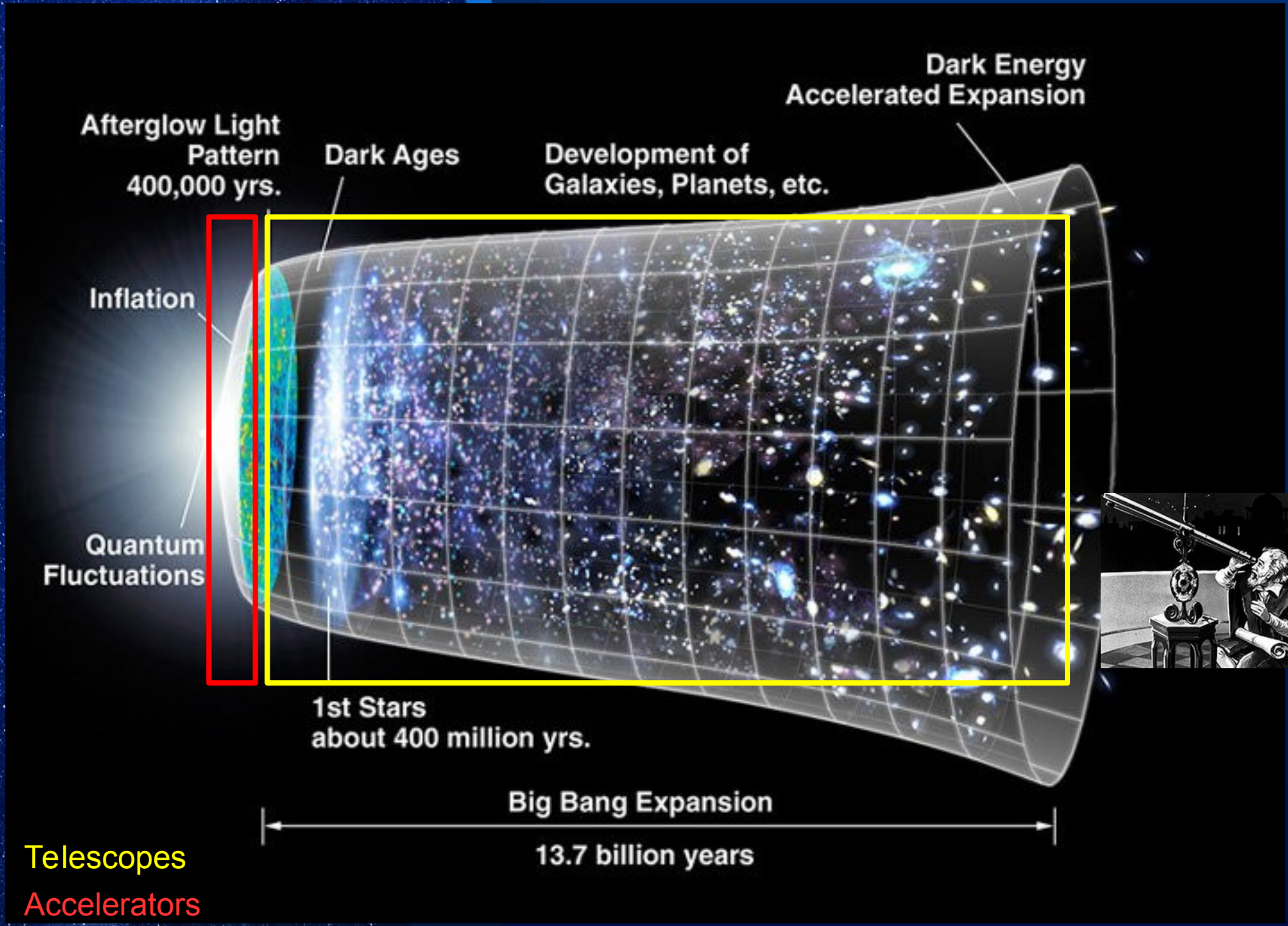




Our knowledge about Cosmos particles...

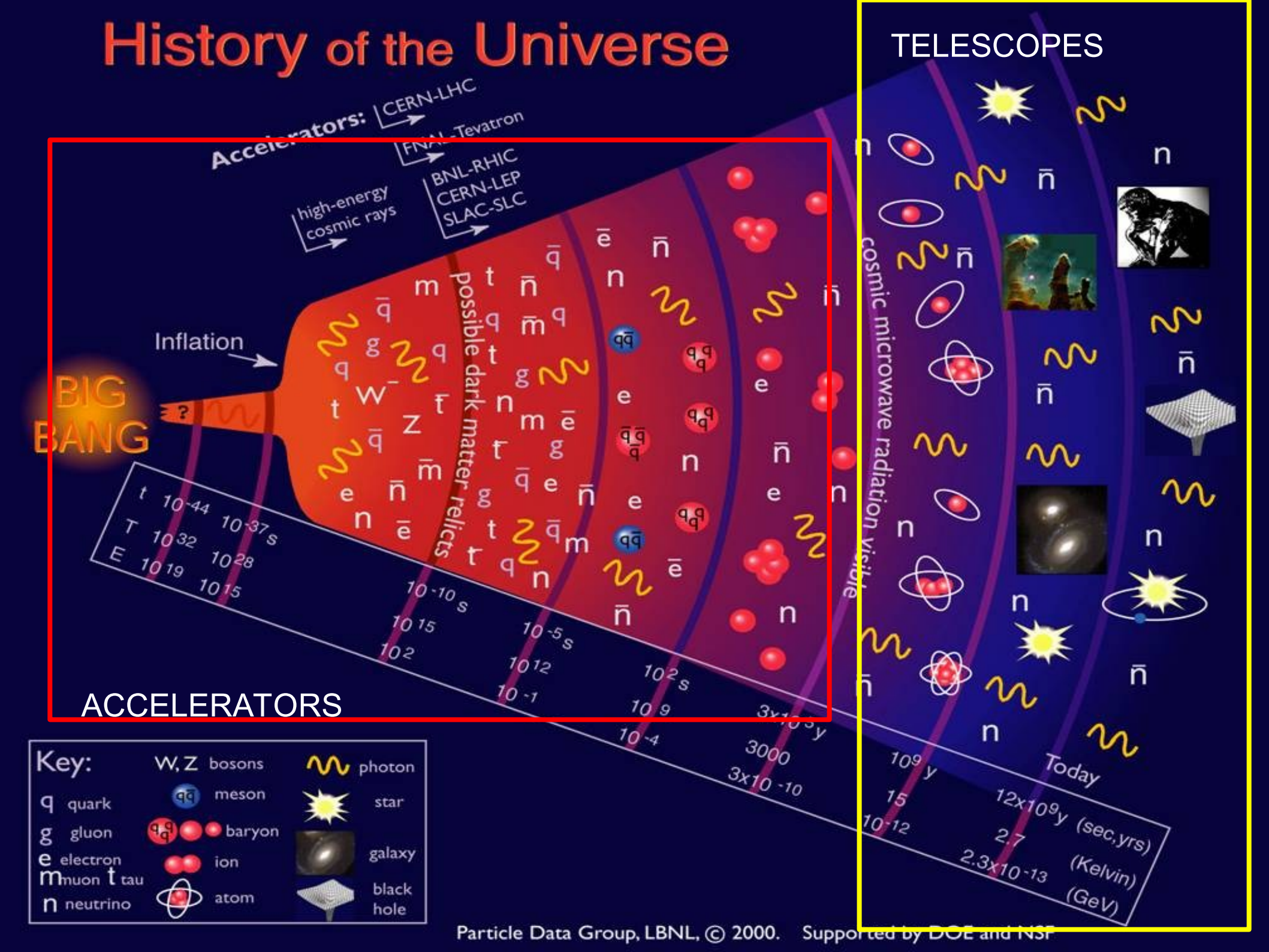
A Multi-wavelength and Multi-menssenger approach to the knowledge of the Cosmos

History of the universe

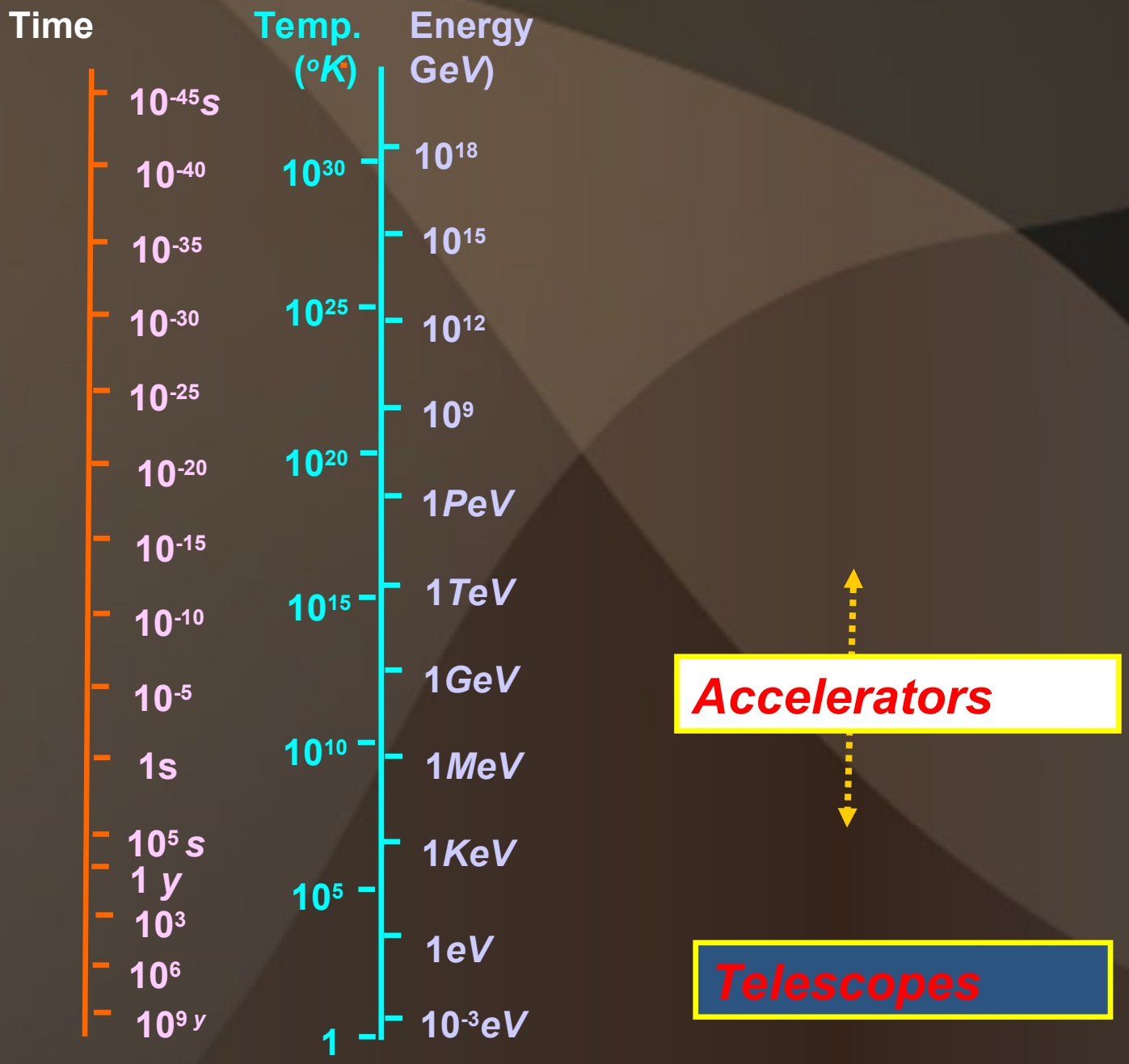


Telescopes

Accelerators

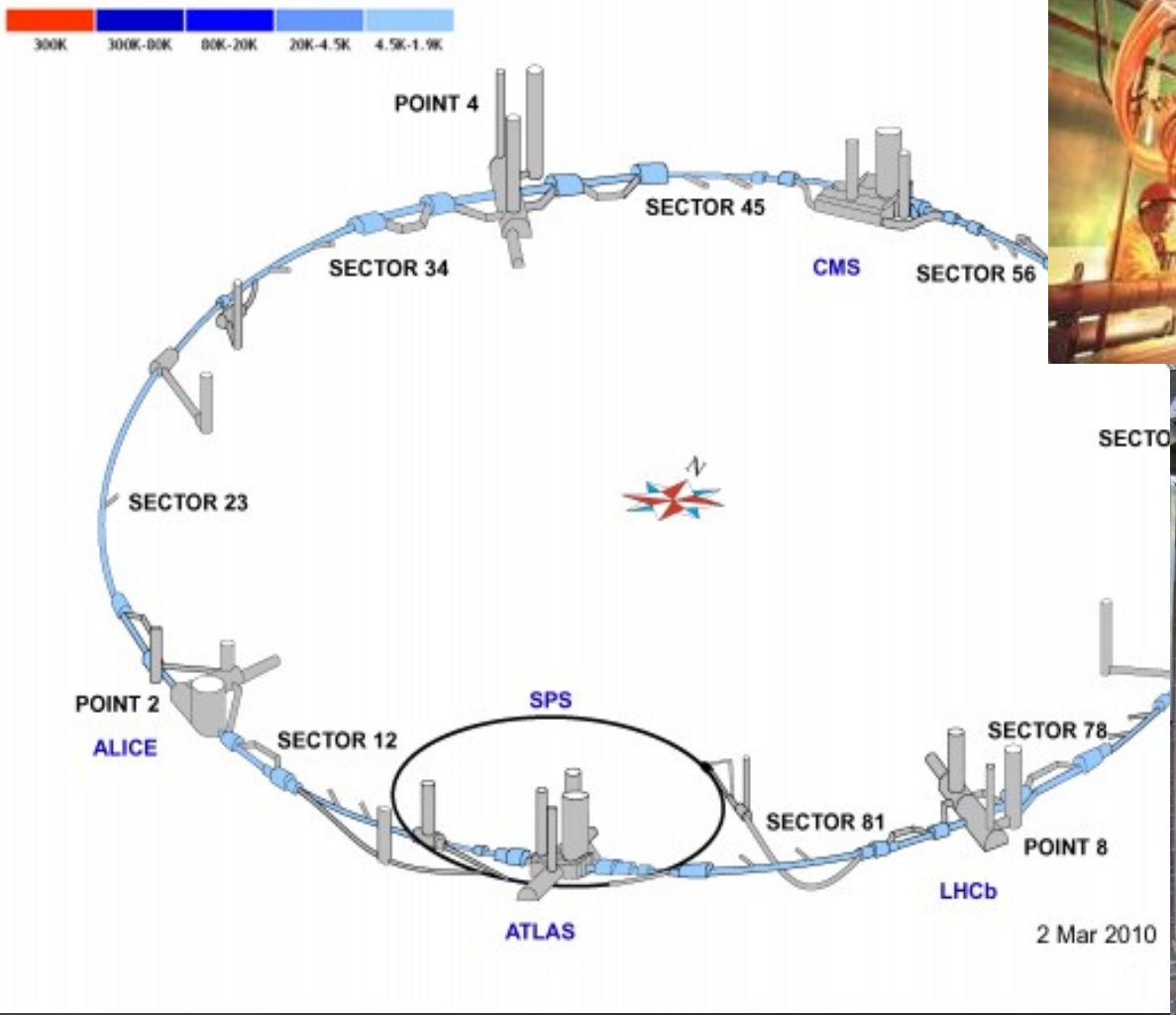

History of the Universe
TELESCOPES
Accelerators:
CERN-LHC
FNAL-Tevatron
BNL-RHIC
CERN-LEP
SLAC-SLC
high-energy cosmic rays
Inflation
BIG BANG
possible dark matter relicts
cosmic microwave radiation visible
ACCELERATORS
t 10-44 10-37 s
T 1032 1028
E 1019 1015
10-10 s
10 15
10 2
10-5 s
10 12
10 -1
102 s
10 9
10 -4
3000
3x10 -10
109 y
15
10-12
12x109y (sec,yrs)
2.7 (Kelvin)
2.3x10 -13 (GeV)
Today
Key:
q quark
g gluon
e electron
m muon t tau
n neutrino
W, Z bosons
meson
baryon
ion
atom
photon
star
galaxy
black hole
Particle Data Group, LBNL, © 2000.
Supported by DOE and NSF

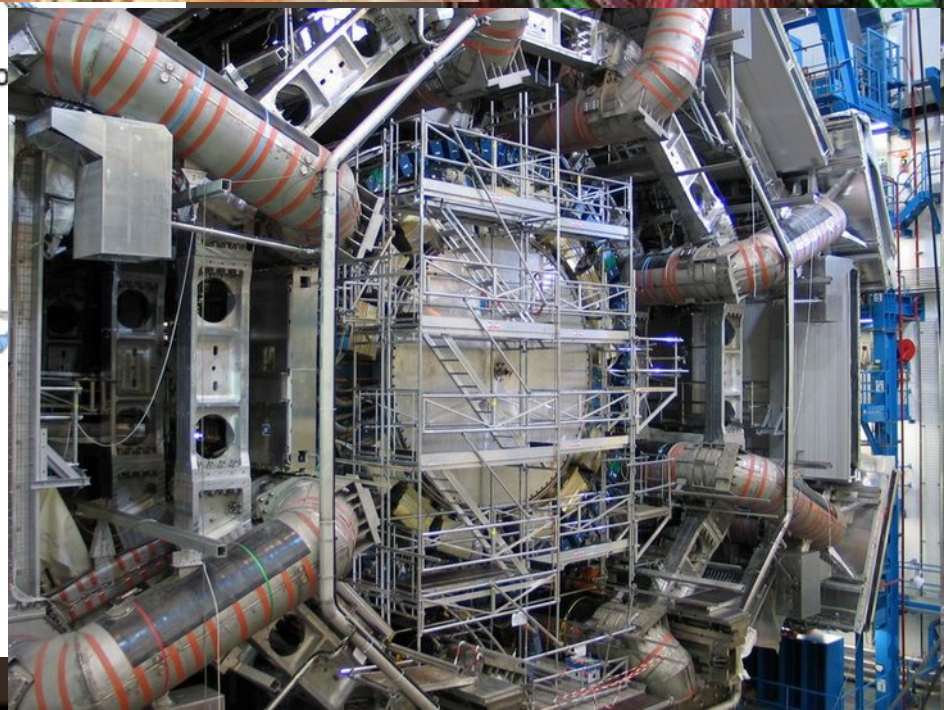
Tools to explore the Primitive Universe




CERN en Ginebra
Circunferencia de 27km
14 TeV

LHC

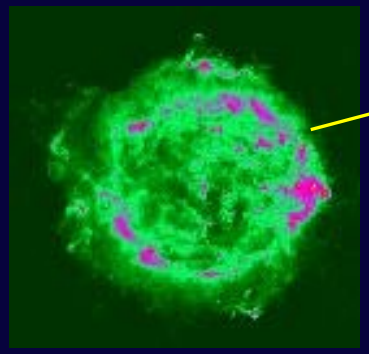

300K
300K-80K
80K-20K
20K-4.5K
4.5K-1.9K
POINT 4
SECTOR 45
SECTOR 34
CMS
SECTOR 56
SECTOR 23
SECTO
POINT 2
ALICE
SPS
SECTOR 12
SECTOR 78
SECTOR 81
POINT 8
LHCb
ATLAS
2 Mar 2010

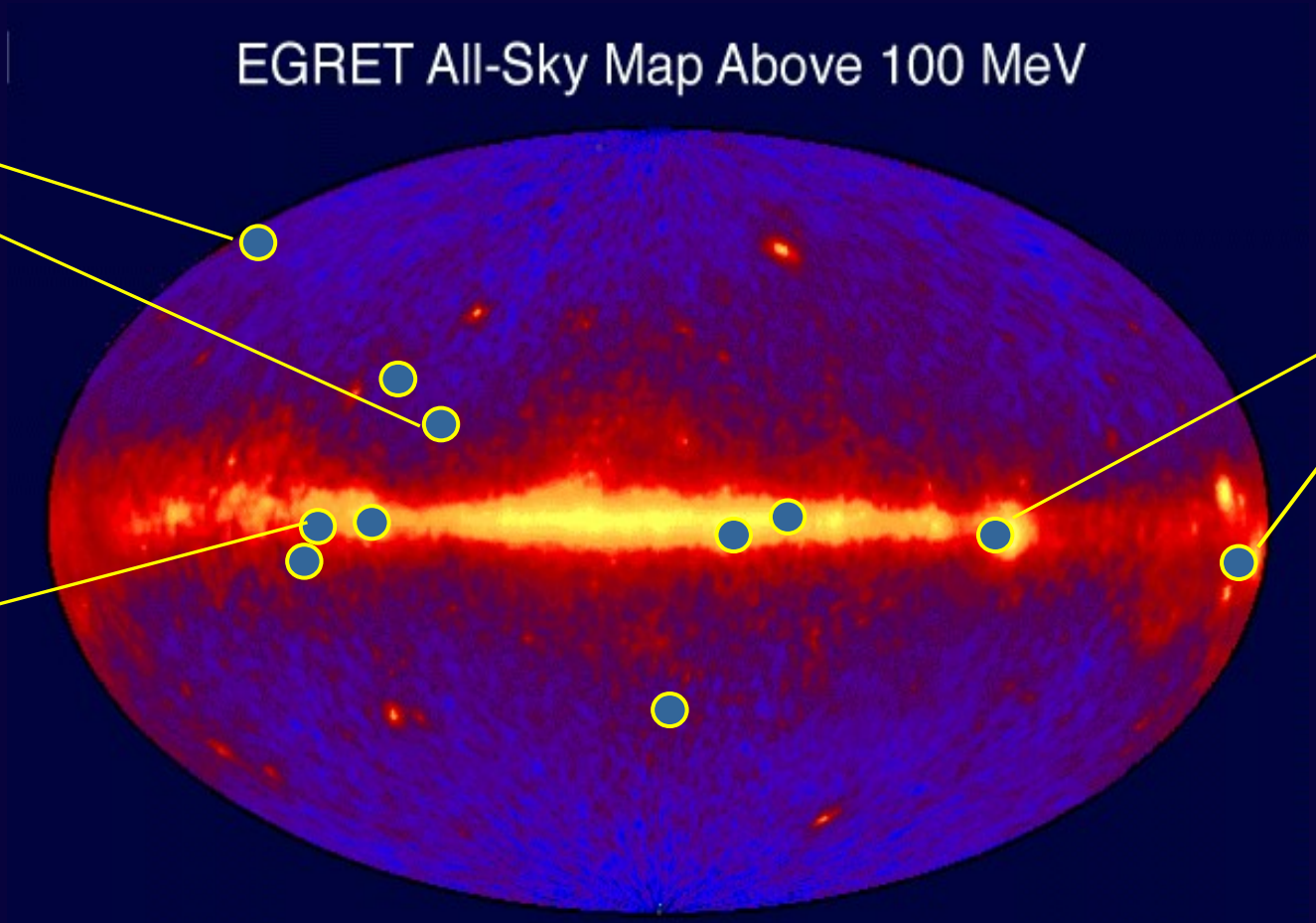


Extreme Energy Universe

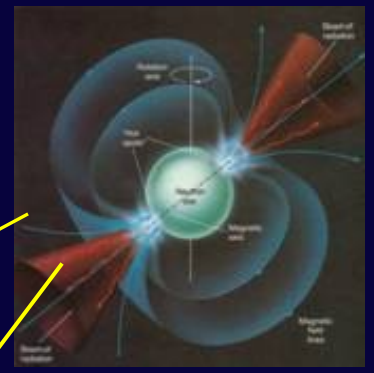
AGN

SNR

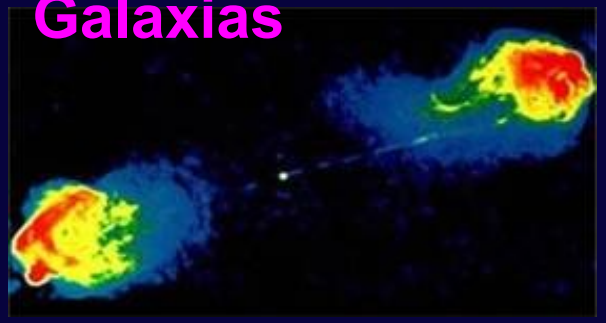




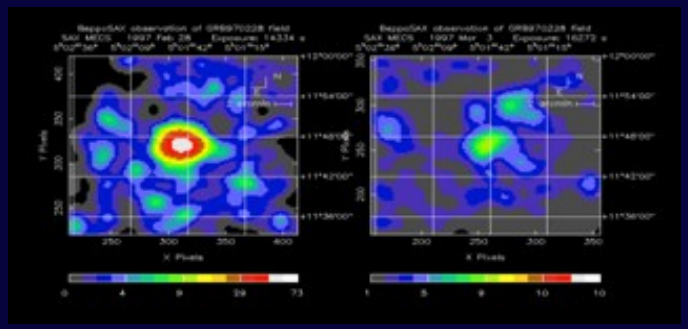
Pulsares



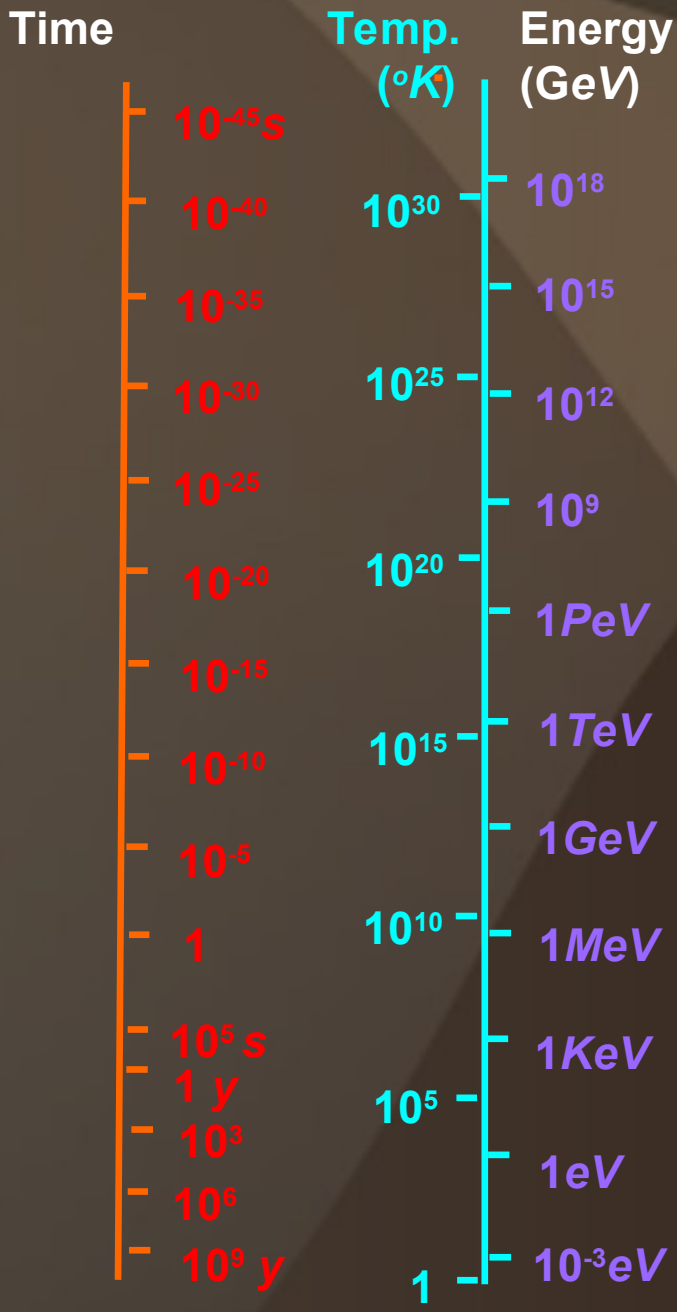
Radio Galaxias



GRB



Tools to explore the High-Energy Universe

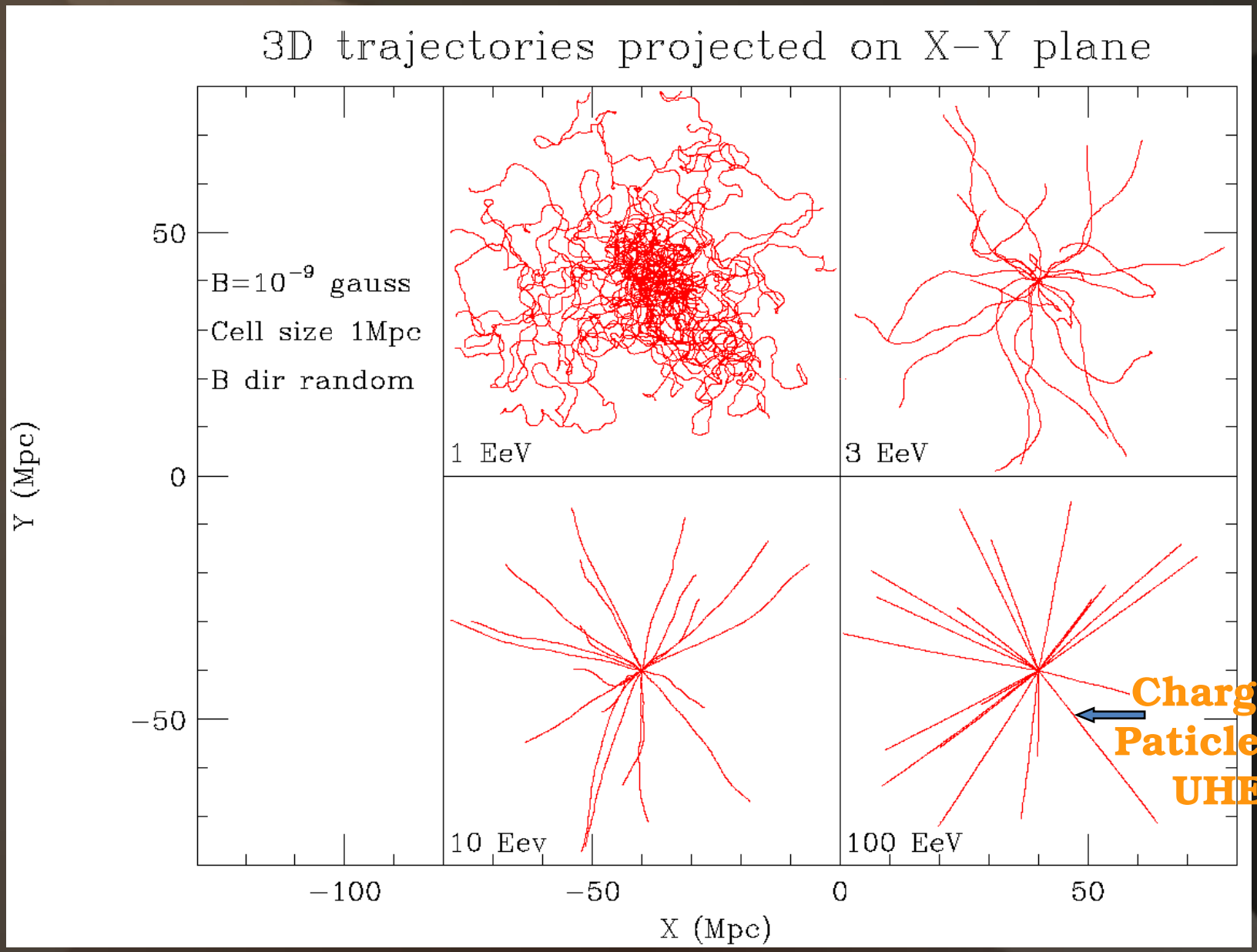


Ultra High Energy Cosmic Rays

Accelerators

Telescopes

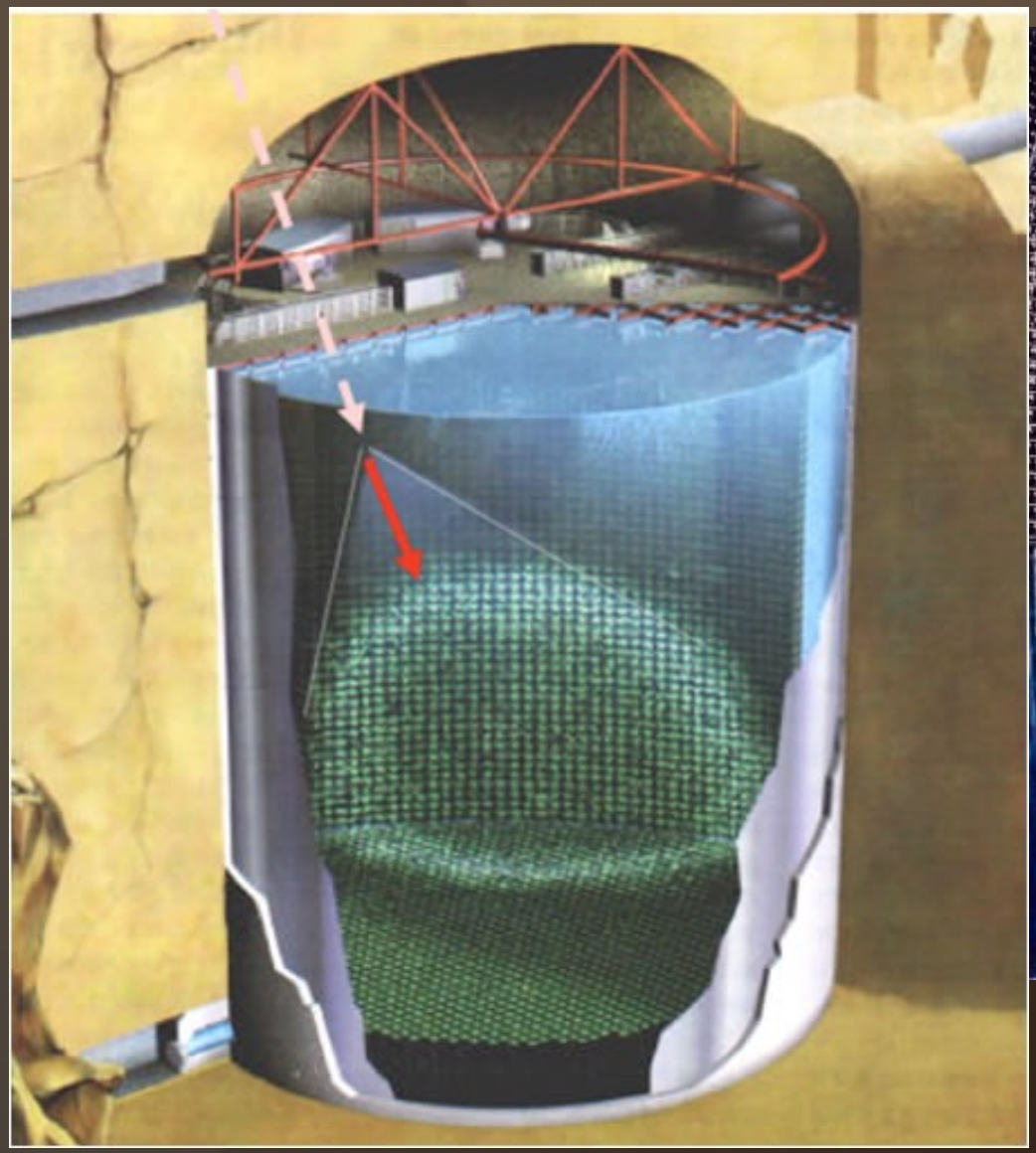
Astronomy of charged Particles

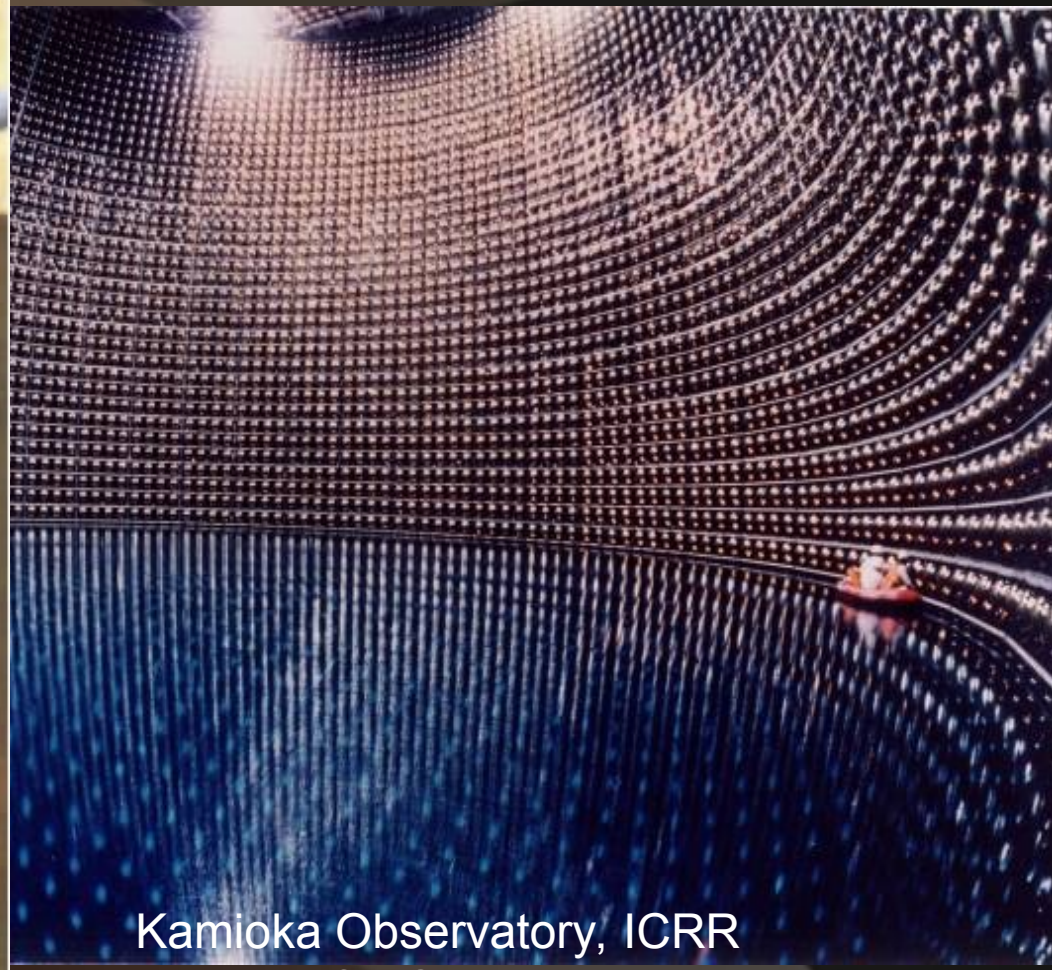


SuperkamiokaNDe

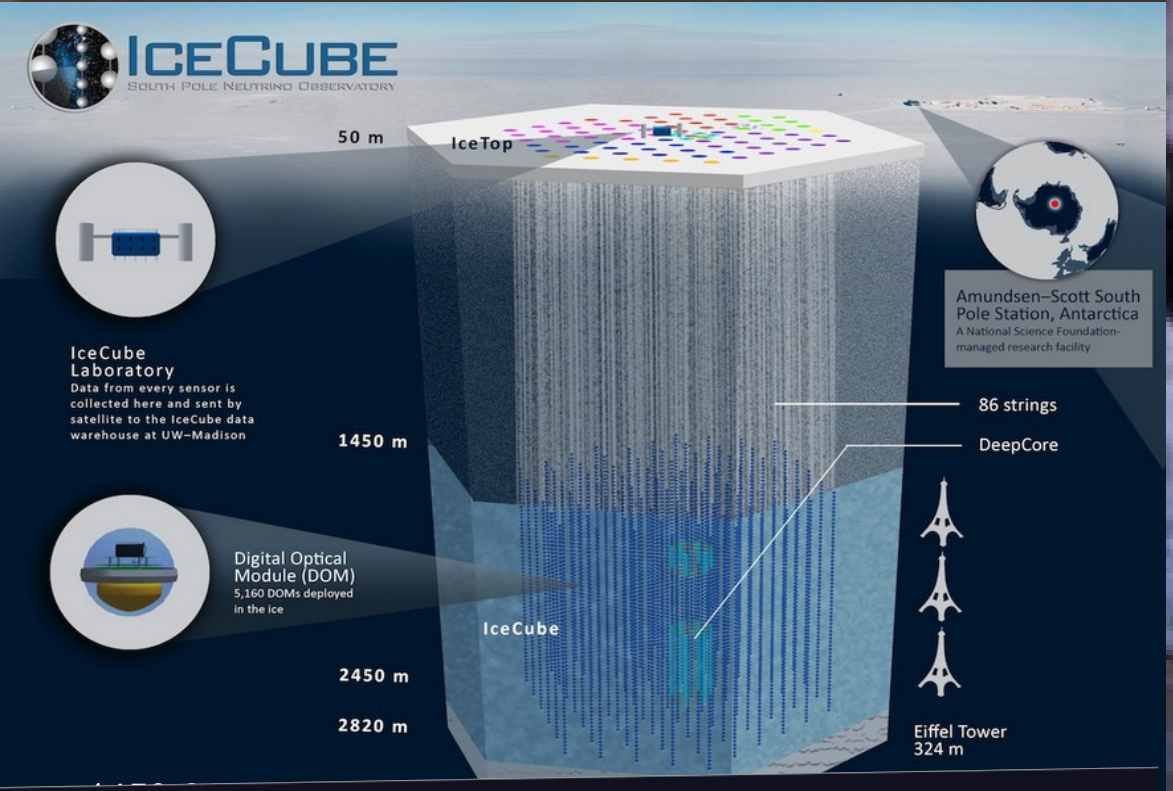
Construction 1996 -Recontruction 2006

1.000 m under.s.l, Mozum mine 50,000 tons of H_2O

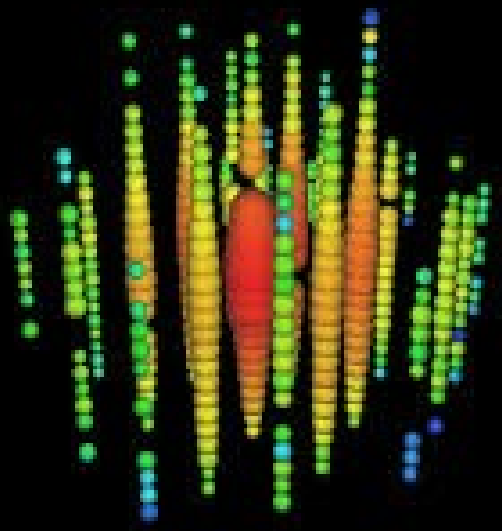




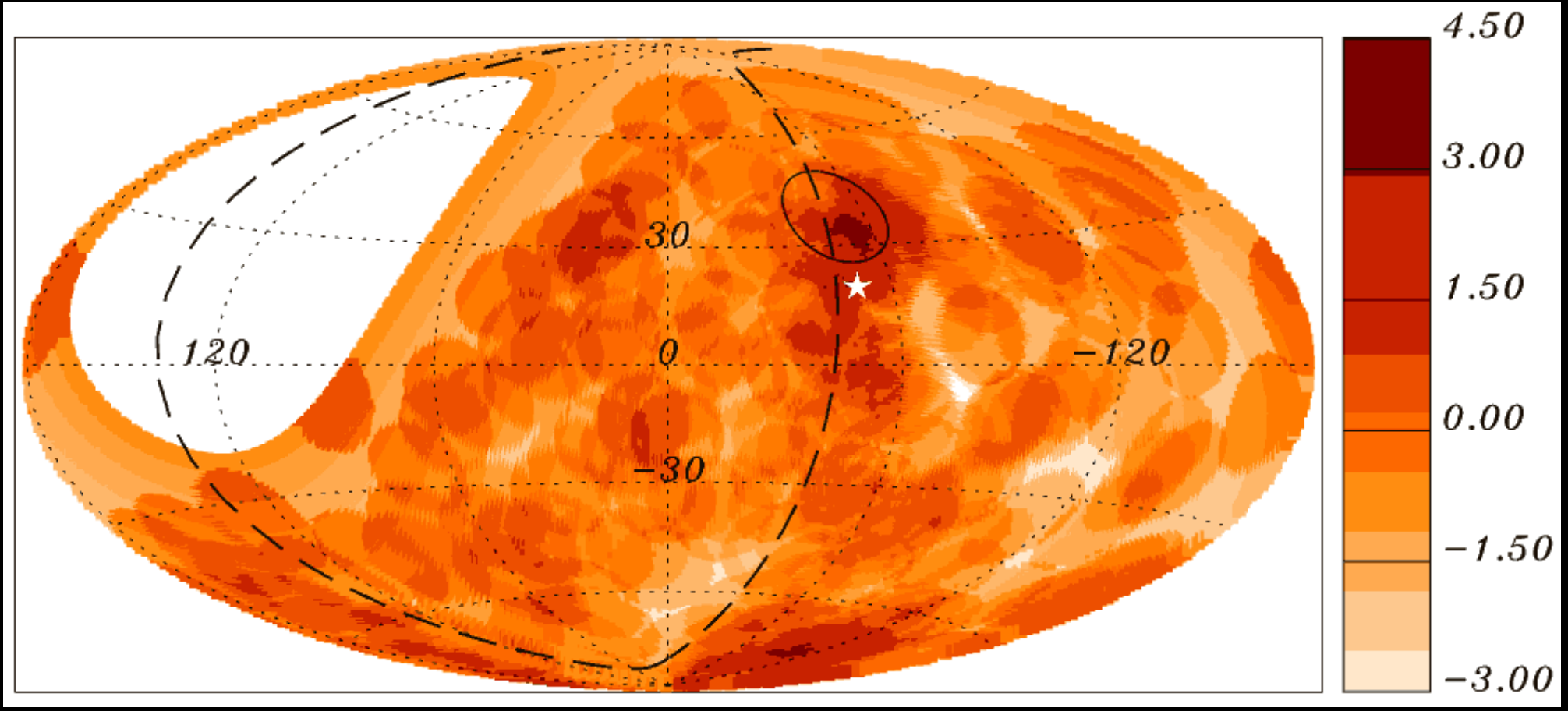
Kamioka Observatory, ICRR
(Institute for Cosmic Ray Research),
The University of Tokyo



2012-IceCube first detection 2 HEneutrinos



Search for UHECR Anisotropies

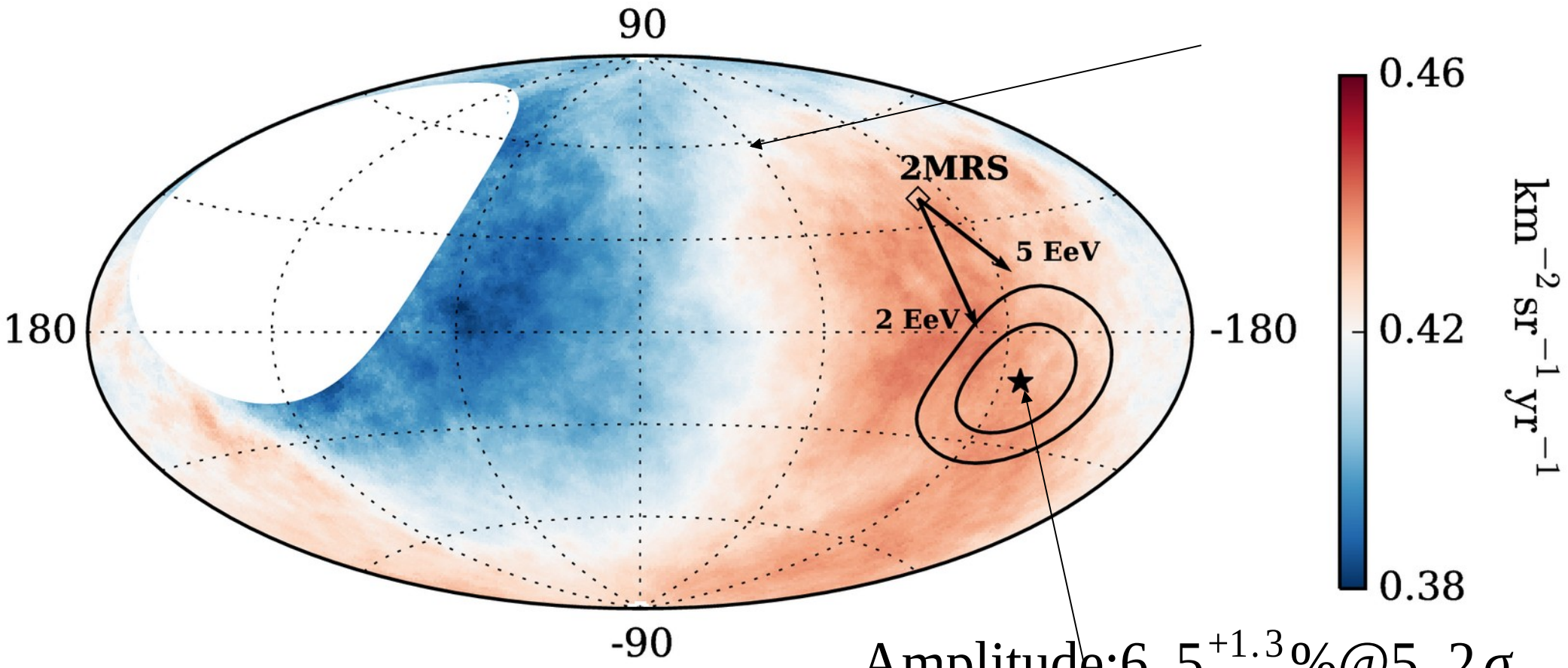


Significant excesses in 12° around E >54 EeV events

The Pierre Auger Collaboration, ApJ **804**(2015)15

50 year-old mystery has been solved: dipole a UHECR Flux Map at E > 8 EeV

The Pierre Auger Collaboration, Science **357**(2017)1266, arXiv:1709.07321 [astro-ph.HE]

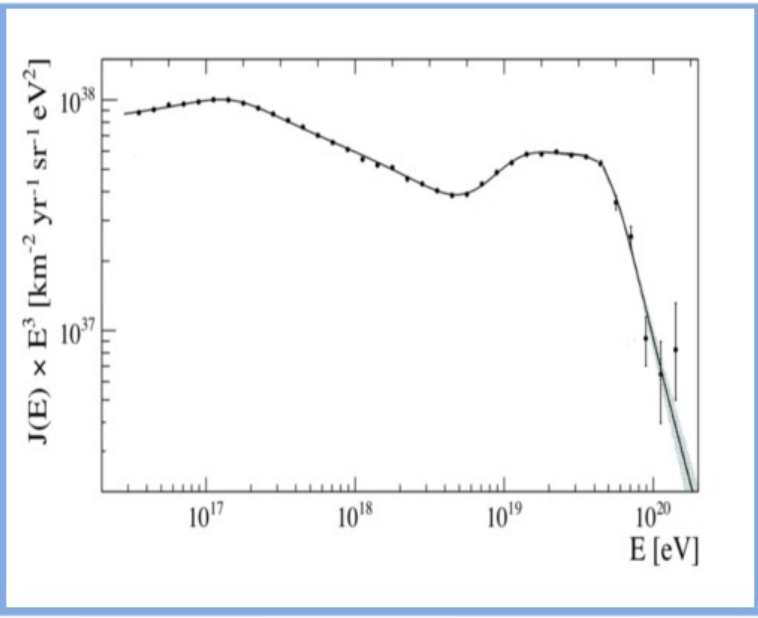


$$\text{Amplitude}: 6.5^{+1.3}_{-0.9}\%@5.2\sigma$$

$$\alpha_d = 100^\circ \pm 10^\circ; \delta_d = -24^{\circ\,+12^\circ}_{-13^\circ}$$

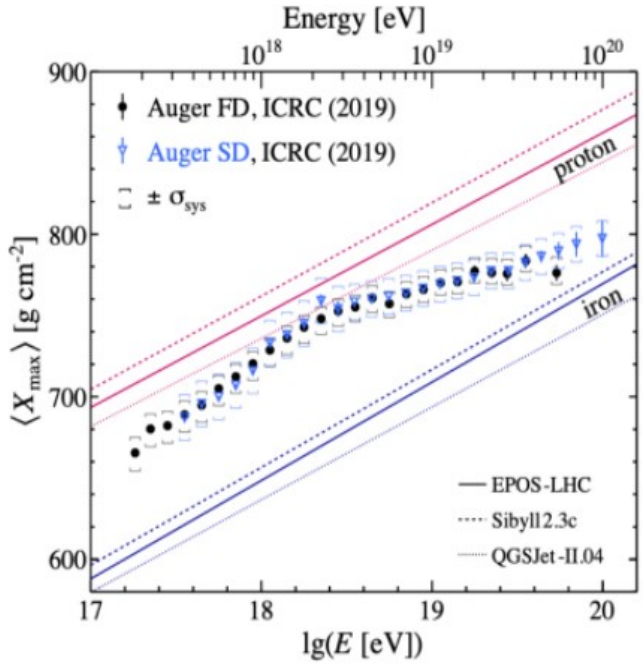
125° from GC → Extragalactic Origin of UHECR

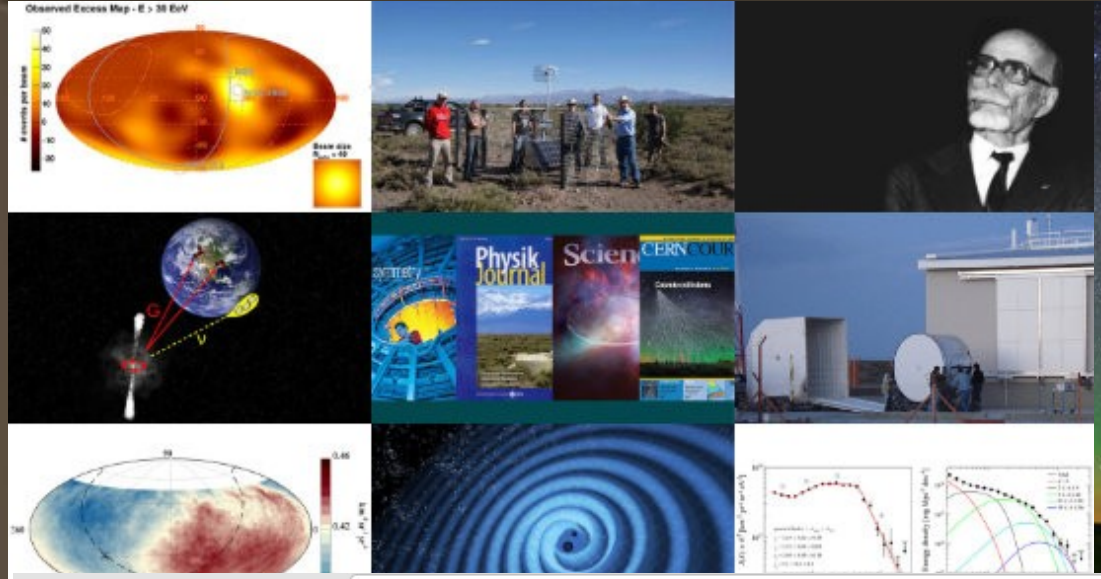
More Results



Confirmation of existence of a strong flux suppression at the highest energies.Its origin is not yet fully explained. [(ICRC2019)450].

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





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Auger Open Data

Datasets Visualization Analysis

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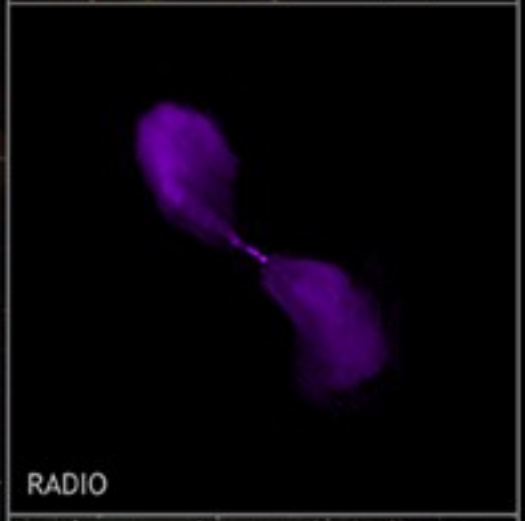
Pierre Auger Observatory

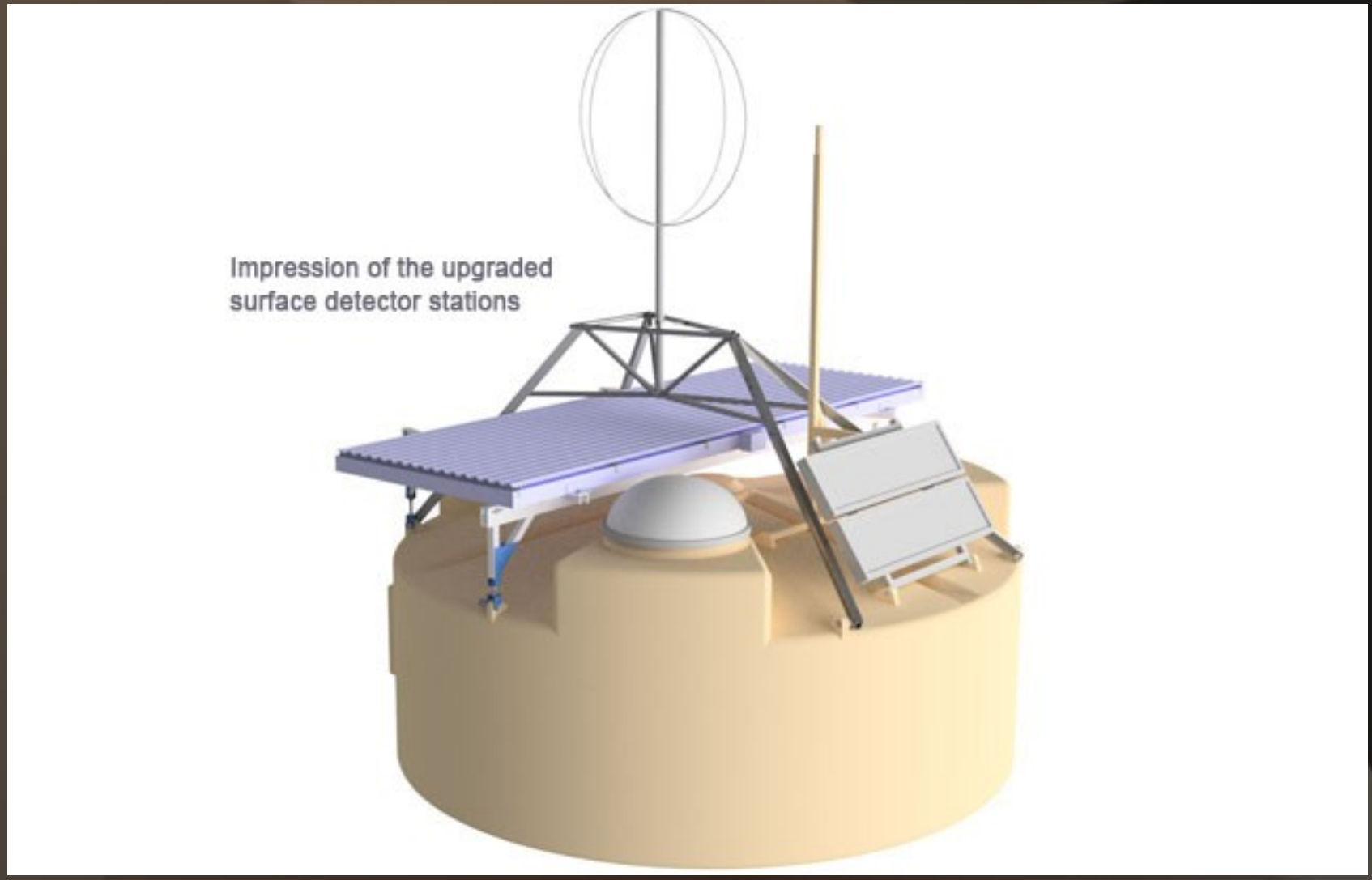
- **Why we are here?**
- **Which is the fundamental law that explains the Nature?**

Observations of the Universe of High Energy can give us totally unexpected insights



COMPOSITE

Auger Prime -The Auger upgrade



REINFORCE

REsearch INfrastructures FOR Citizens in Europe

International Training Course

Citizens Support the Optimization of Large Research Infrastructures in Physics

PROGRAMME

July 10th – 15th, 2022

Attica, Greece

https://indico.ea.gr/event/24/

Organized by

ELLINOGERMANIKI AGOGI

EVENTS

Virtual Visit to the Pierre Auger Observatory

(July 11th, 15:00 – 16:00)

The Pierre Auger Observatory is an international cosmic ray observatory in Argentina designed to detect ultra-high-energy cosmic rays: sub-atomic particles traveling nearly at the speed of light and each with energies beyond 10^{18} eV.

Virtual Visit to the Virgo Gravitational Wave Detector

(July 12th, 12:00 – 13:00)

The Virgo Gravitational Wave Detector is a large interferometer located in Cascina, outside Pisa in Italy in the premises of the European Gravitational Observatory (EGO). Virgo is designed to detect gravitational waves predicted by Einstein's General Theory of Relativity.

Virtual Visit to the ATLAS experiment at CERN

(July 14th, 12:00 – 13:00)

ATLAS is a general-purpose particle physics experiment at the Large Hadron Collider (LHC) at CERN. It is designed to exploit the full discovery potential of the LHC, pushing the frontiers of scientific knowledge by seeking answers to fundamental questions such as: What are the basic building blocks of matter? What are the fundamental forces of nature? What is dark matter made of?

Visit to Cape Sounio, Sanctuary of Poseidon

(July 11th, 18:00 – 24:00)

Cape Sounio is a promontory located 69 kilometres from Athens, at the southernmost tip of the Attica peninsula. According to legend, Cape Sounion is the spot where Aegeus, king of Athens, leapt to his death off the cliff, thus giving his name to the Aegean Sea. The sanctuary of Poseidon, one of the most important sanctuaries in Attica, is also located at Sounio. Archaeological finds on the site date from as early as 700 BC. The temple at Cape Sounion, was a venue where mariners, and also entire cities or states, could propitiate Poseidon, by making animal sacrifice, or leaving gifts.

Visit to the Acropolis of Athens

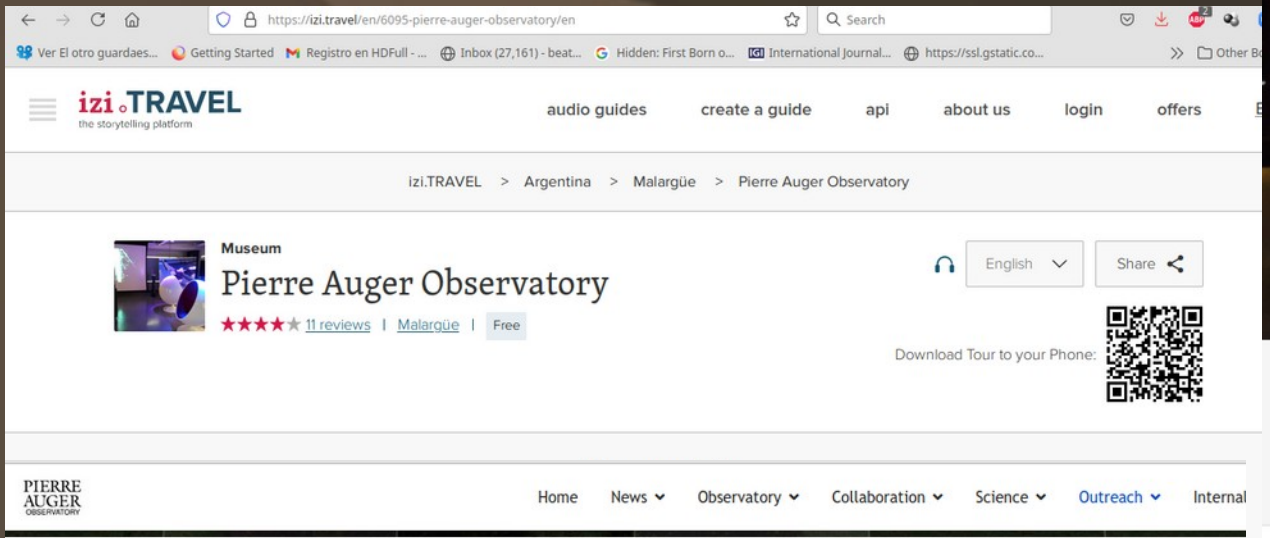
(July 13th, 15:30 – 20:30)

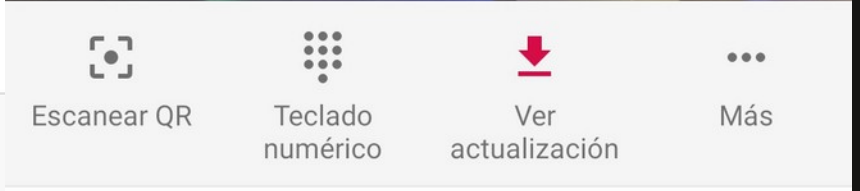
The greatest and finest sanctuary of ancient Athens, dedicated to the goddess Athena, dominates the centre of Athens from the rocky crag of the Acropolis. The Acropolis of the 5th century BC is the most accurate reflection of the splendour, power and wealth of Athens at its greatest peak, the Golden Age of Pericles. In the mid-fifth century BC, when the Acropolis became the seat of the Athenian League, Pericles initiated an ambitious building project which lasted the entire second half of the fifth century BC. The architects, Ictinos and Callicrates, began the erection of this unique monument at 447 BC and the building was substantially completed by 432 BC. The visit to Acropolis will be supplemented with a tour to the New Acropolis Museum. With a total area of 25,000 square meters and exhibition space of over 14,000 square meters, the museum offers all the amenities expected in an international museum of the 21st century, including the following permanent exhibitions: The Gallery of the Slopes of the Acropolis, The Archaic Gallery, The Parthenon Gallery, Propylaia-Athena Nike-Erechtheion, from 5th century BC to 5th century AD.

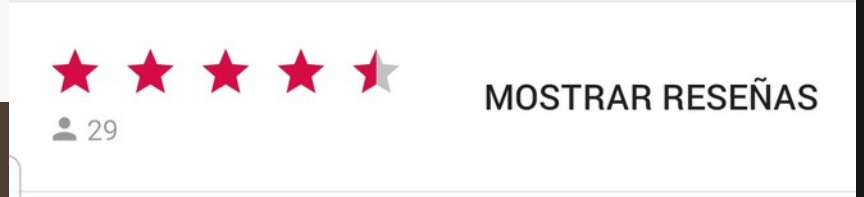
Pierre Auger Observatory
Social Impact

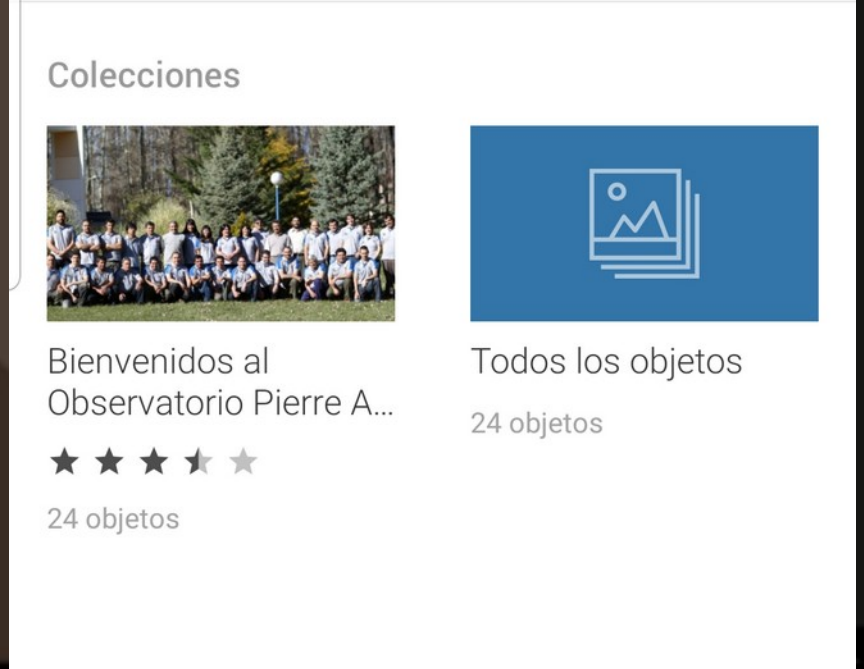
Stamp Argentina 2007

Virtual Tours









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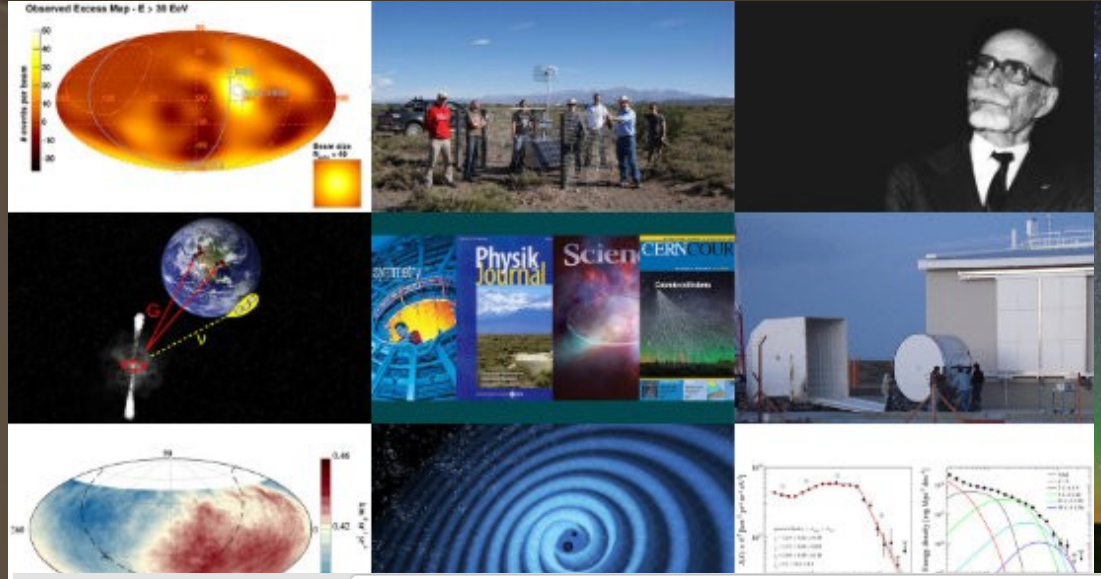

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