Chacaltaya, Bolivia,
5400 m a.s.l.
-16° 21’ S; -68° 07' W

Plateau Rosa, Italy,
3600 m a.s.l.
45°56'02" N ; 7°37'54" E

Marambio, Antarctica, Argentine
210 m a.s.l.
64°14'S; 56°37' W

CONTINUOUS MONITORING OF SECONDARY COSMIC RAYS

At high altitude observatories

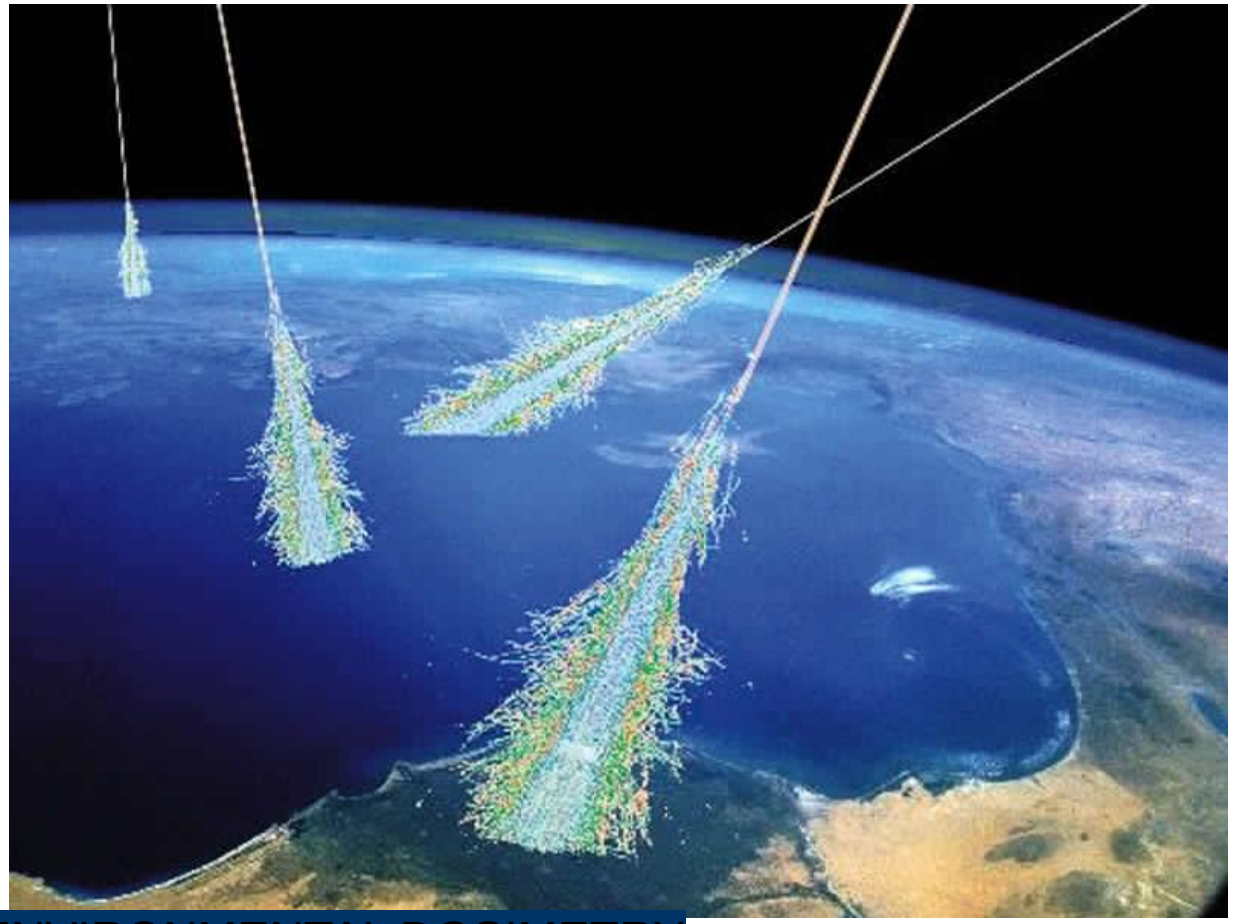
Italy-Argentine-France collaboration

Alba Zanini INFN Torino (Italy)

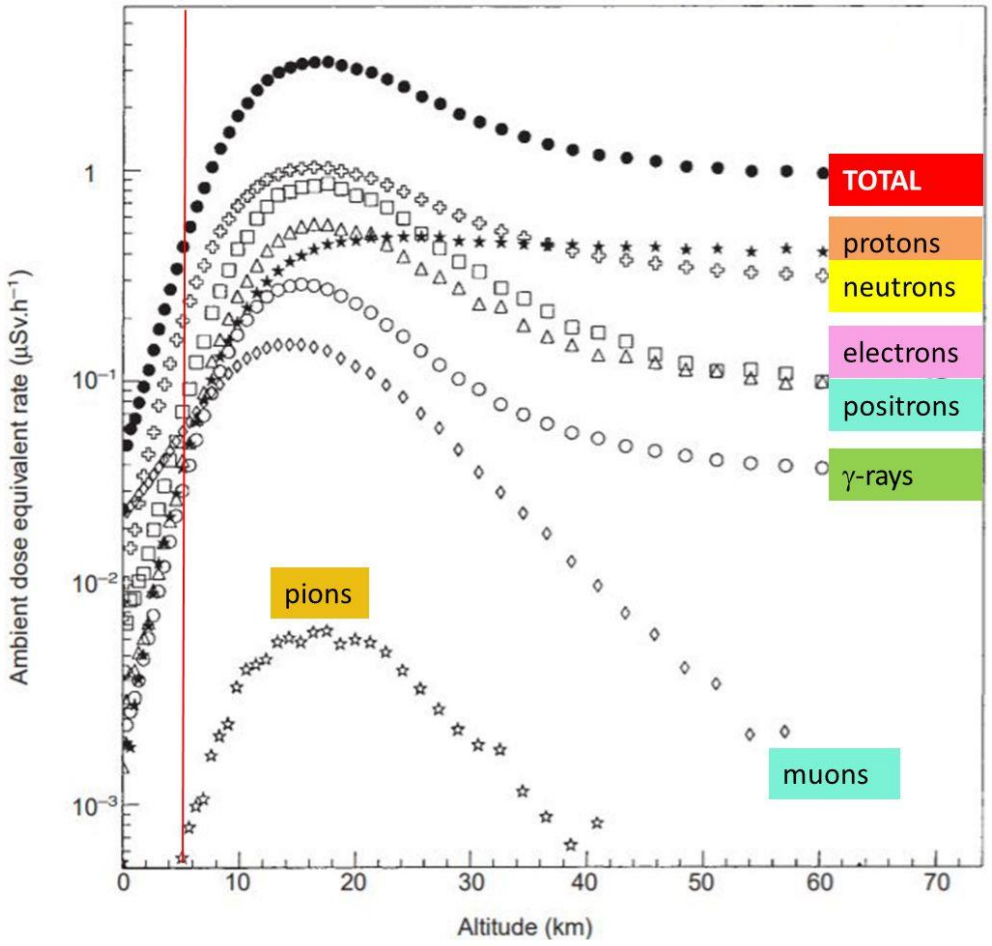
Concordia, Antarctica,
France-Italy 3233 m a.s.l.
75°06’ S, 123°21’ E)

Chilecito, Argentine,
5000 m a.s.l.
29.162° S; 67.4974° W

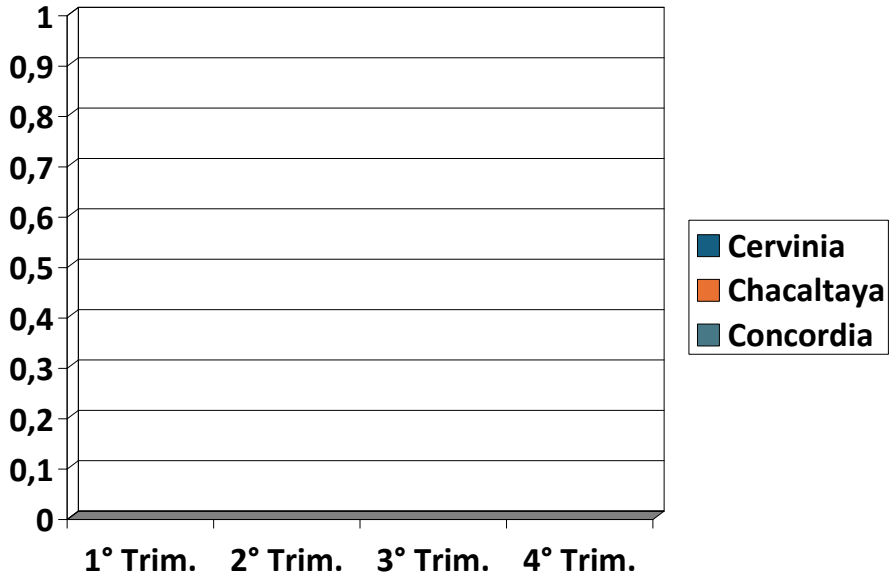
Secondary Cosmic Rays in Atmosphere



ENVIRONMENTAL DOSIMETRY

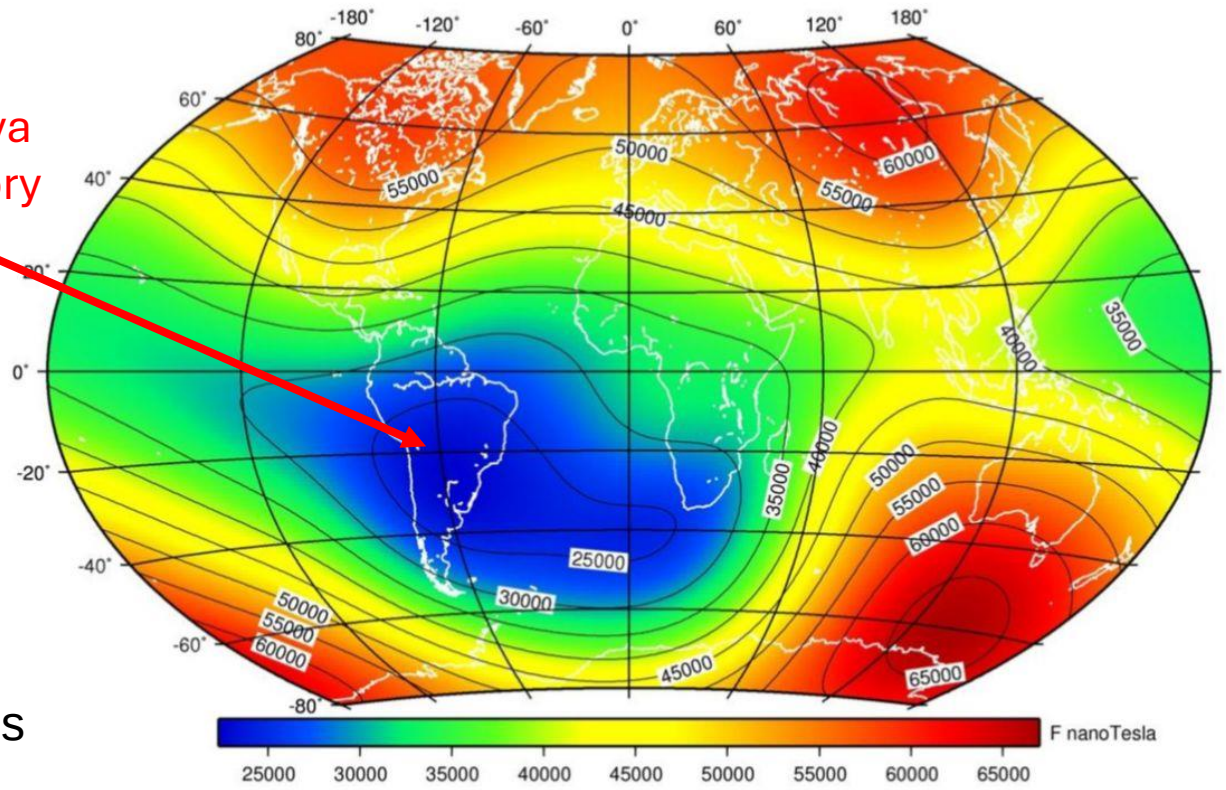


Cosmic rays interact with the atmosphere nuclei producing cascades of secondary particles: gamma-rays, electrons, muons, neutrons, mesons. The particles that reach the ground contribute to the total dose of ionizing radiation received by the population. In particular, neutrons contribute significantly to the effective dose, because of the higher damage they can cause to human tissues.


1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
1° Trim.
2° Trim.
3° Trim.
4° Trim.
Cervinia
Chacaltaya
Concordia

Project **SAMAHDA (INFN)** 2022-2025

- **SAMAHDA (INFN)** -**S**outh **A**tlantic **M**agnetic **A**nomaly **D**osimetry at **H**igh **A**ltitude
- www https://samadha.to.infn.it/

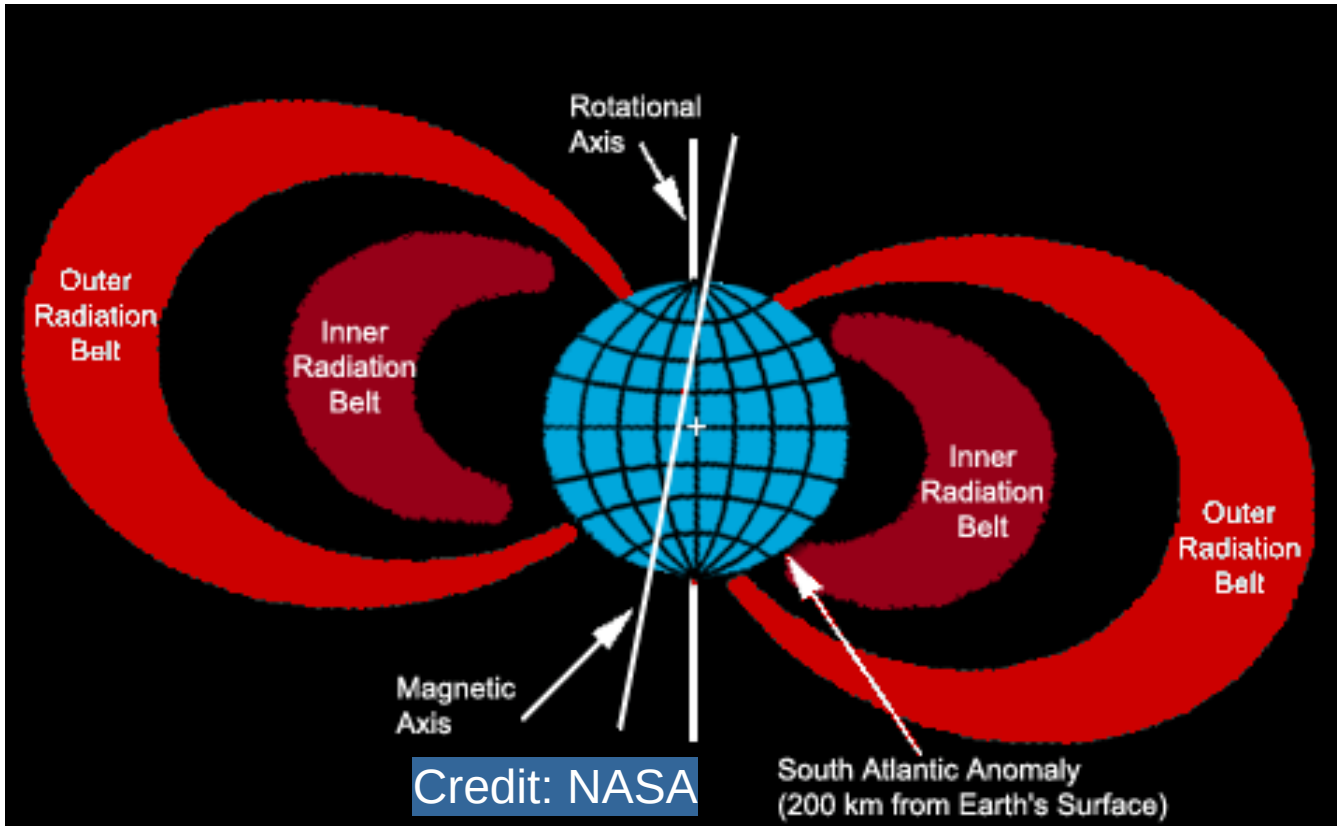


Map of the geomagnetic field intensity on the Earth's surface. The field has minimum values (blue region) in South America and in the adjacent Atlantic Ocean.

Due to this geomagnetic field asymmetry, the SAA is the region where the Van Allen Belts are closest to the Earth's surface.

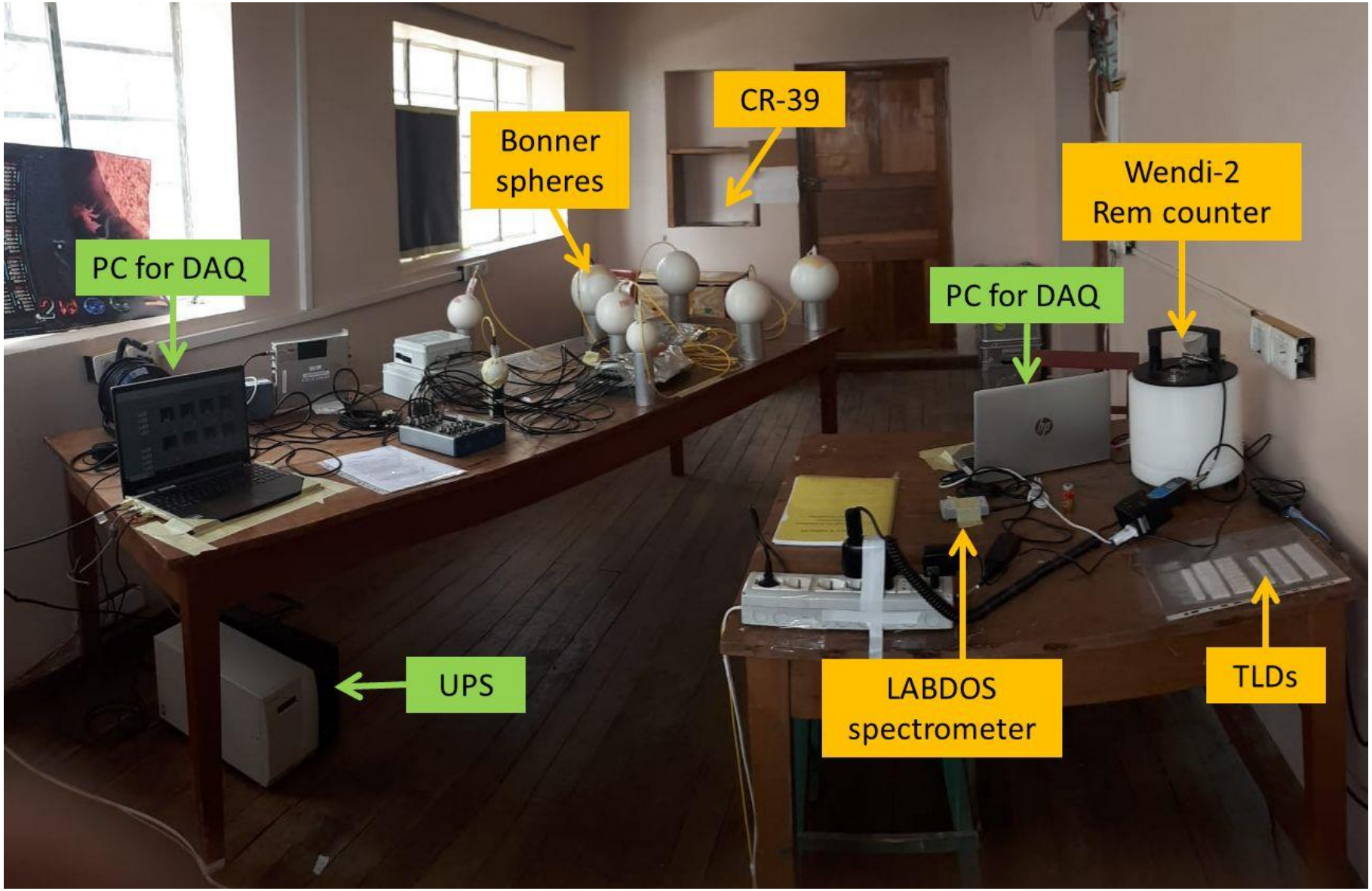
Credit: British Geological Survey (bgs.ac.uk)

Van Allen Belts



In the SAA region, the extreme points (called *mirror points*) of the inner Van Allen Belt approach the Earth's surface up to a distance of about 200 km, generating a reservoir of energetic particles above the upper layers of the atmosphere.
Solar activity, by perturbing the geomagnetic field, influences the extension and flux of particles in Van Allen Belts, favoring sudden releases of particles from the trapping regions.

Various dosimetric instruments installed at Chacaltaya Laboratory




SOUTH AMERICA
NORTH AMERICA
Caribbean Sea
NORTH ATLANTIC OCEAN
NORTH PACIFIC OCEAN
SOUTH PACIFIC OCEAN
SOUTH ATLANTIC OCEAN
Equator
Tropic of Capricorn
VENEZUELA
COLOMBIA
ECUADOR
PERU
BOLIVIA
BRAZIL
PARAGUAY
CHILE
ARGENTINA
URUGUAY
Amazon Basin
Mato Grosso
Brazilian Highlands
Guiana Highlands
Andes
Patagonia
Chacaltaya, 5240 m a.s.l.
Bolivia, 16.35° S, 68.13° W


Testa Grigia, 3480 m
Italy, 45.93° N, 7.71° E
Munich
Salzburg
Zurich
Innsbruck
AUSTRIA
SWITZERLAND
Bern
Bolzano
Trento
SLOVENIA
Bergamo
Milan
Lake Garda
Verona
Trieste
Venice
Adige
Po
Ferrara
Turin
Parma
Bologna
Genoa
Ravenna
SAN MARINO
Ligurian Sea
Pisa
Florence
Nice
Livorno
Siena
Perugia

Intercalibrated Instrumentation

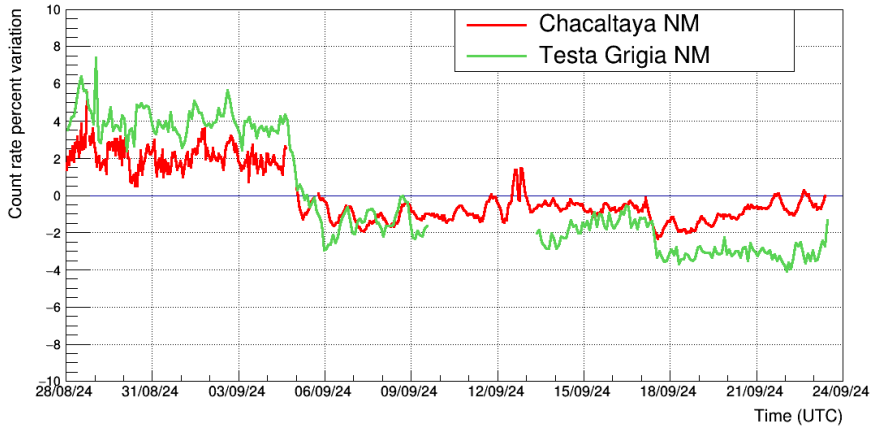
- A set of intercalibrated instruments, tested at CERN facility CERF are installed at Testa Grigia, Chacaltaya and Concordia.
- Also a neutron monitor system is available in all the stations
- It is possible the intercomparison of data in the different locations

Bonner sphere system for neutron spectrometry (0.25 eV-1 GeV)

Wendy Rem Counter for Neutron dosimetry (0.25 eV-5 GeV)

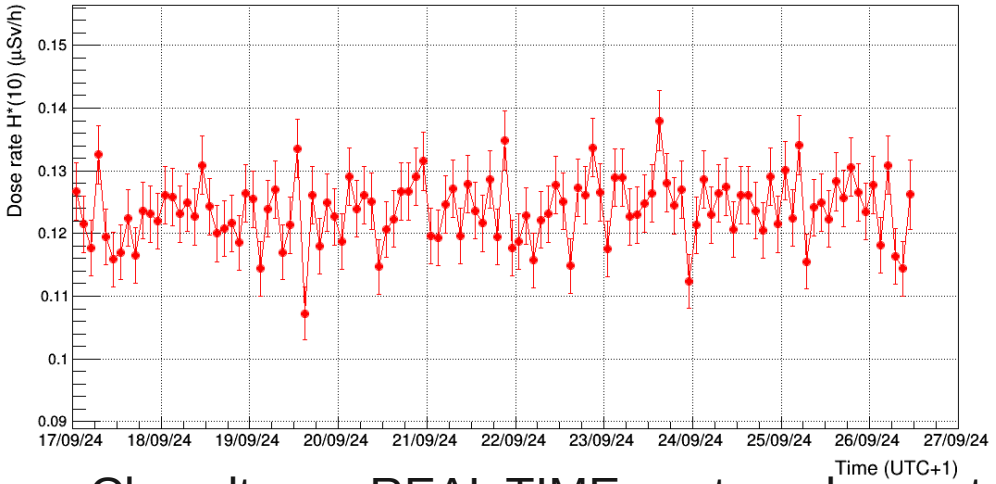
The instrumentation at Chacaltaya

Neutron monitor system at Chacaltaya



Variability of primary cosmic rays measured by Neutron monitor at Chacaltaya and Testa Grigia

Wendy Rem Counter for Neutron dosimetry



Chacaltaya REAL TIME neutron dose rate - Last 10 days (each point = 2 hour average)

Mean value
0.125 µSv/h

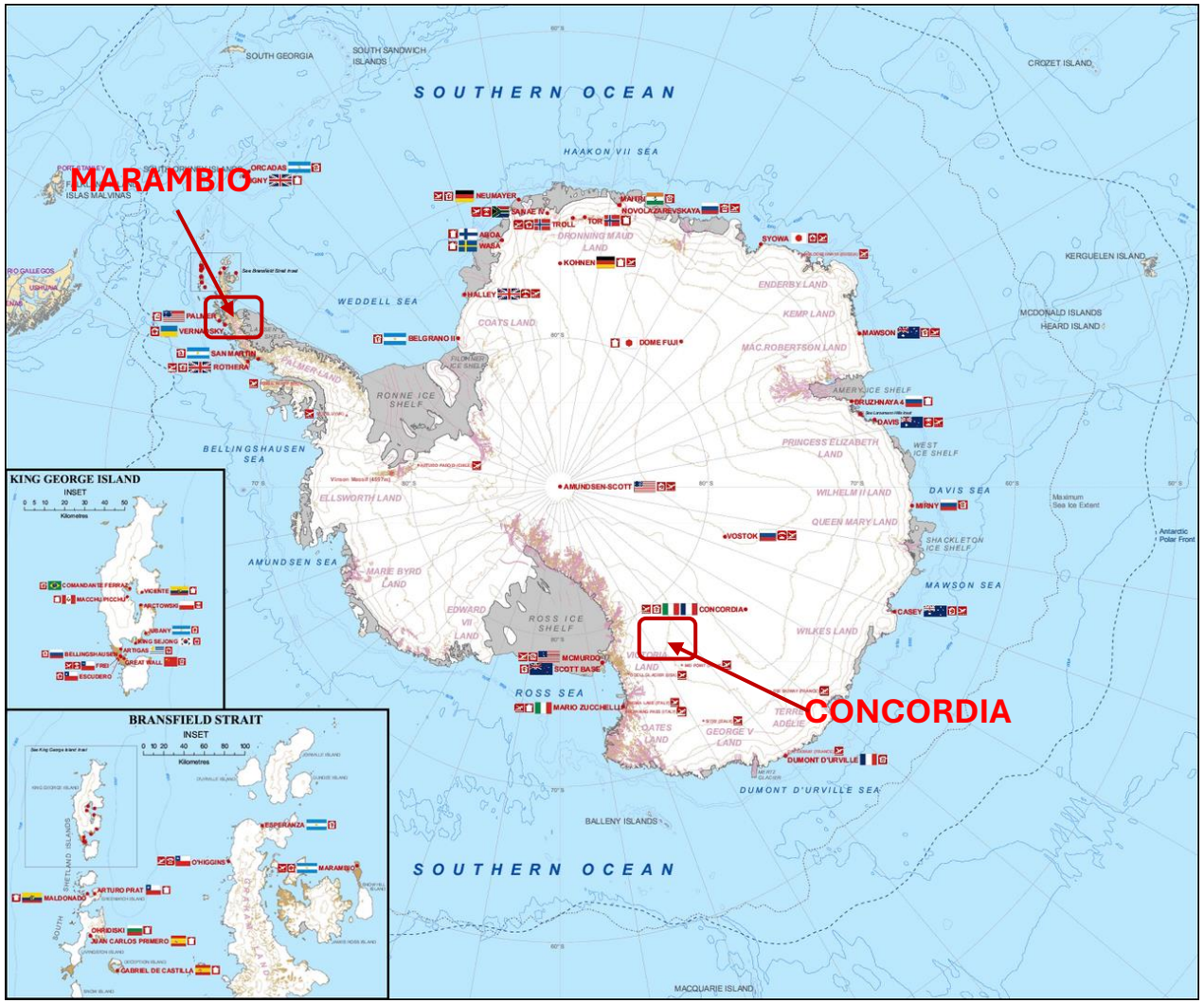
CORDIAL (PNRR 2022-2025)

COsmic **R**ays **D**osimetriy in **A**ntarctic **L**atitudes

funded by

Programma **N**azionale **R**icerche in **A**ntartide

Concordia, Antarctica,
France-Italy 3233 m a.s.l.
75°06’ S, 123°21’ E)

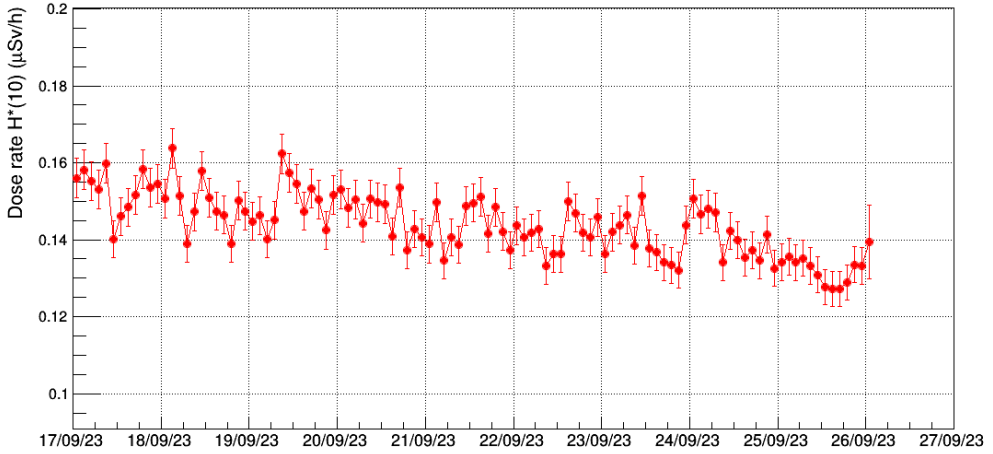


Concordia Station (Italy-France)

Marambio Station (Argentina)

Instrumentation at Concordia

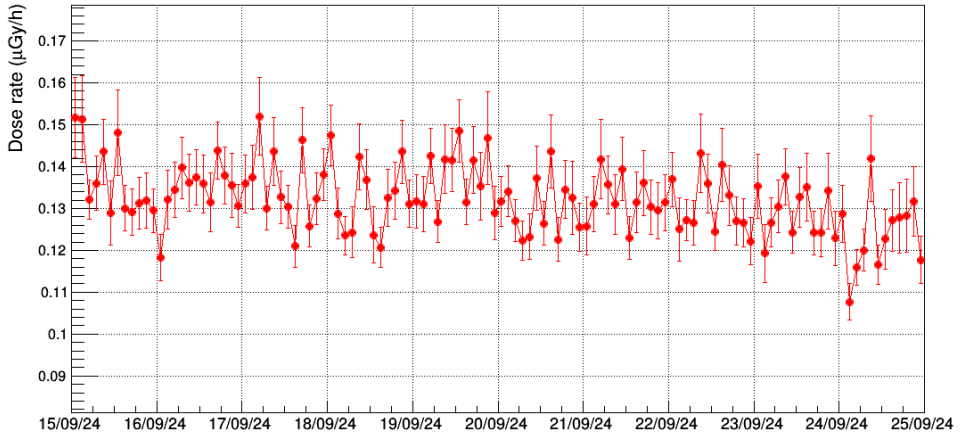
Rem Counter Thermo WENDI-2
Neutron dose equivalent rate



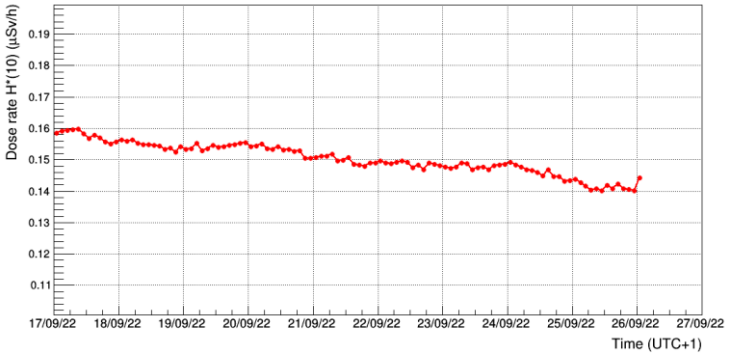
REAL TIME neutron dose rate by WENDI-2 rem counter - Last 10 days (each point = 2 hour average)

Automess 6150AD-b dosimeter, sensitive to X and gamma rays in 23 KeV - 7 MeV

LABDOS spectrometer
energy deposited in a Silicon diode by ionizing radiation



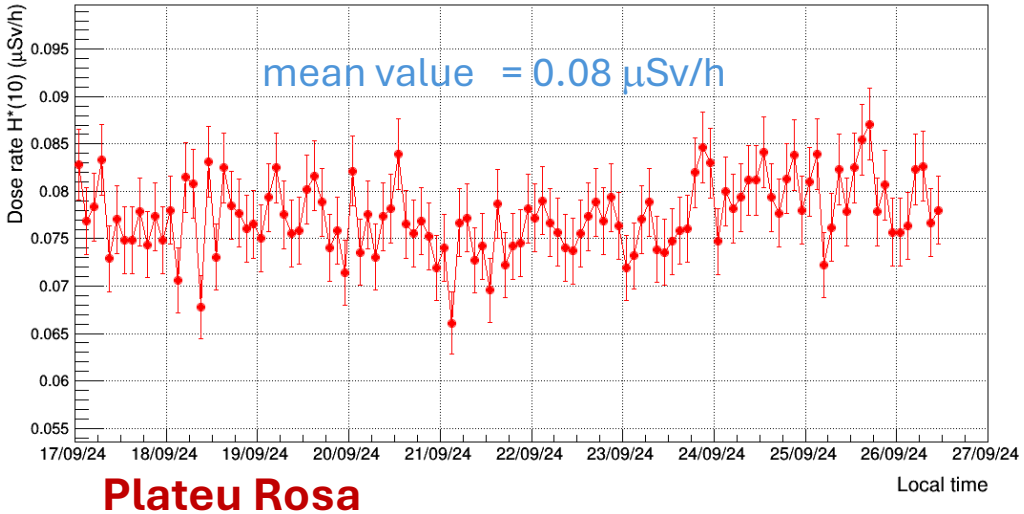
REAL TIME deposited energy LABDOS Spectrometer- Last 10 days (each point = 2 hour average)



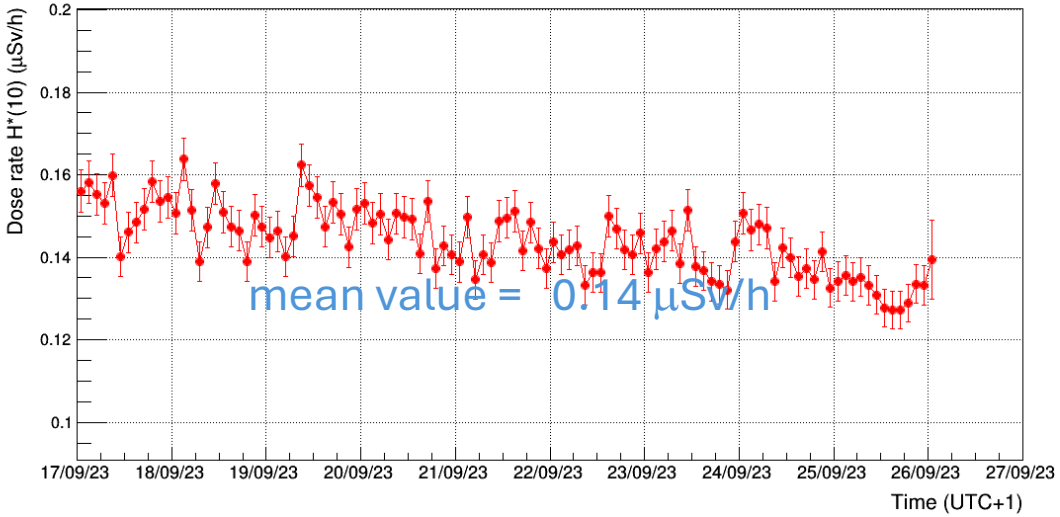
REAL TIME gamma-ray dose rate - Last 10 days each point = 2 hour average

Comparison

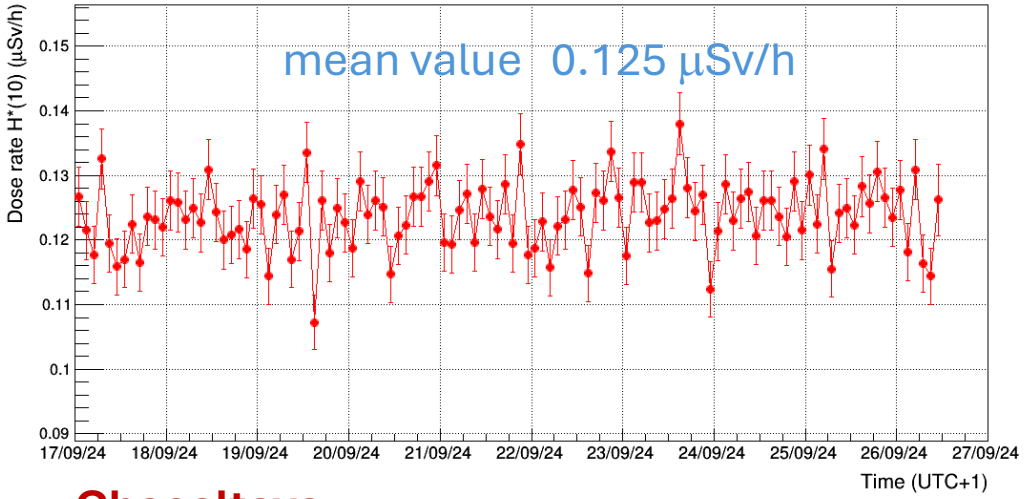
REAL TIME neutron dose rate by WENDI-2 rem counter - Last 10 days each point 2h average



Plateu Rosa



Concordia



Chacaltaya

A significant difference in the mean value of neutron dose equivalent rate is evdent in the three locations, due to differents geophysical and geomagnetic conditions

Work in progress