Consiglio dei laboratori Preventivi 2021

7 Luglio 2020

SAMADHA

South Atlantic Magnetic Anomaly Dosimetry at High Altitude

26 participants in 5 INFN sections

Torino, Trieste, Frascati, Firenze, Napoli

LNF contribution

Roberto Bedogni (30%), Claudio Cantone (30%),
Alessandro Lega laureando (100%), Jose-Maria Gomez-Ros associato (50%),

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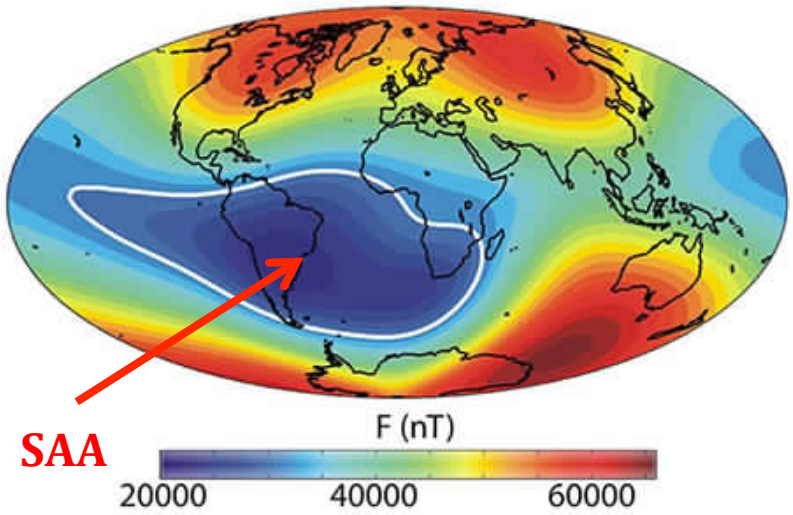
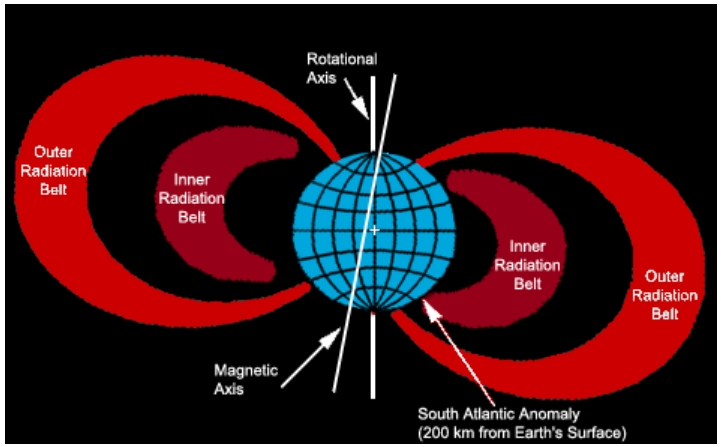
Geomagnetic field South Atlantic Anomaly and Van Allen belts



- Earth's magnetic field can be approximated by a dipole
- The dipole centre is displaced by about 500 km with respect to the Earth center
- This causes a region with lower geo magnetic field: the South Atlantic Anomaly.

- Van Allen belts are two toroidal regions where the Earth's magnetic field trap energetic electrons (outer) and protons (inner) in a "bouncing" periodical trajectory
- Their altitude is minimum (200 km) in SAA
- Pamela measured protons up to few GeV. The highest energies were found in SAA.
- Satellites in low altitude orbit in SAA experienced higher astronauts doses and damage to the instrumentation.



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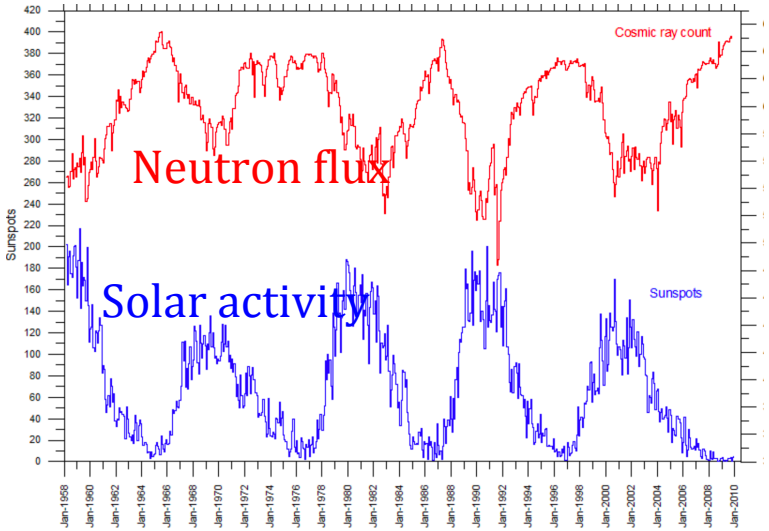
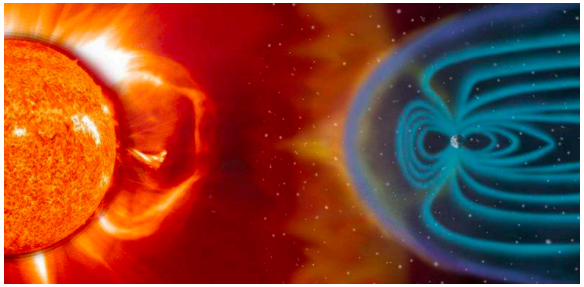
Particle precipitations in the atmosphere

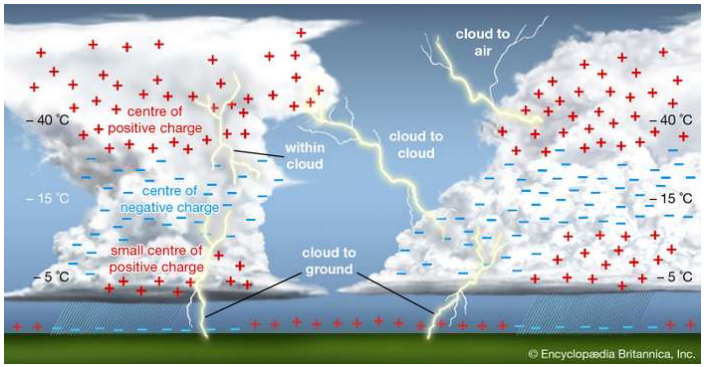
- Van Allen belts properties and related precipitation of particles in the atmosphere depend on **the solar activity**
- **Secondary neutrons from cosmic rays** are inversely correlated with solar activity (25th solar cycle just started).





Magnetic storms perturb the belts and may increase particles precipitation in the atmosphere

- Electric fields in atmosphere during thunderstorms accelerate charged particles from cosmic rays air showers, causing increases in secondary neutrons.
- These phenomena are not well understood. No data above 4300 m elevation.



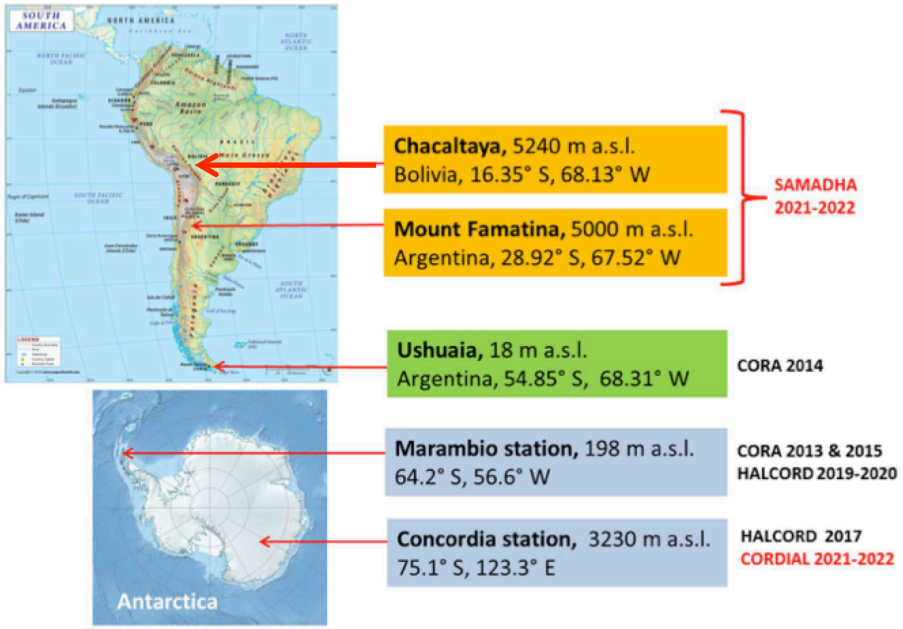
SAMADHA scientific objectives

Secondary neutrons produced by the interaction of cosmic particles with Oxygen and Nitrogen in atmosphere **account for about one half of the effective dose** received by humans at high-altitudes (ex. commercial flights 5000-7000 m).

SAMADHA is planning ambient dosimetry campaigns at high-altitude in SAA:

Chacaltaya Lab (5240 m) Bolivia
Mt. Famatina (5000 m) Argentina

- Study the relation between **dose rate** and **space weather / atmospheric phenomena** in a region where few or no data are available
- Complement dosimetric measurements obtained in other locations by other projects: CORA 2013-2015, HALCORD (2019-2020), and CORDIAL (PNRA 2021-2022).



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Instruments

Direct measure of the cosmic-ray induced secondary fields:

Water filled Neutron spectrometes **(WAFINES)** (25 meV **<** E_n < 5 GeV)

Various rem meters

Portable gamma dose meters

LET Spectrometer

Gamma ray NaI(Tl) detectors

Passive dosemeters

Etched-track detectors

^{209}Bi fission stack for high-energy neutrons

Thermoluminescence detectors TLD 100, 600 e 700

Electric and magnetic field instruments

In-situ equipment:

Neutron Monitor and Solar Neutron Telescope (Chacaltaya)

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Task assignment

Torino	Cosmic rays, space weather, atmosphere physics, measurements with portable gamma and neutron instruments
Trieste	Geophysics, Sun physics, space physics, satellite data, passive dosimetry
Frascati	Neutron physics, real-time spectrometric measurements
Firenze	Cosmic rays and simulations
Napoli	Passive thermo-luminescence dosimetry

Schedule

2021 January-September
Equipment design / set up / purchase
Testing (*Testa Grigia 3480 m* and *Zugspitze 2650 m*)

2021 September
Shipment to South America

2021 October - 2022 December
Measurement campaigns / Analysis

Laboratorio Testa Grigia
Cervinia 3480 m a.s.l. 46.0° N, 7.7° E

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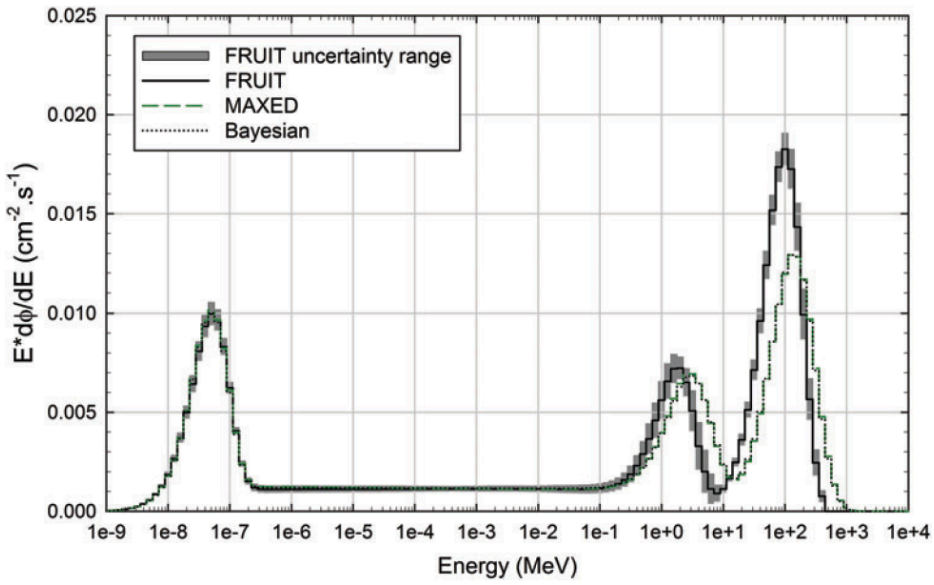
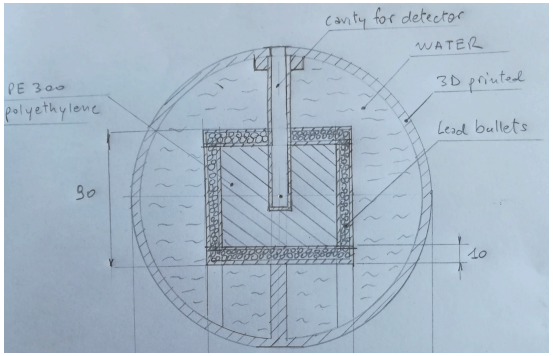
LNF contribution

- A critical step forward, with respect to previous ambient neutron campaigns, would be measuring the energy distribution of the neutron field, ranging from millieV to few GeV (12 orders of magnitude).
- Bonner spheres are the traditional tool for that, BUT the remote location of the high-elevation labs (and the high shipment costs) require compact and light instruments
- WAFINES: Water filled neutron spectrometer: 3D printed spherical shells to fill with water.
- WAFINES will work as an usual 8-spheres highly sensitive BSS with ^{3}He counters (3 cm^{3} x 10 bar) , leading to one spectrum every one-two days





Richieste

Servizi LNF: SPCM 1.5 MU di progettazione e 3D print

Richieste LNF alla csn5 per il 2021 (sui 90 k€ totali)

22.5 k€ consumi (di cui 11k€ solo per i rivelatori ad ^{3}He)
3 k€ spedizioni materiali
9 k€ totale missioni

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