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Unique Scientific Facility Experimental Complex NEVOD

URAGAN & TRAGALDABAS:

Two complementary approaches for the regular survey of Cosmic Rays

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&
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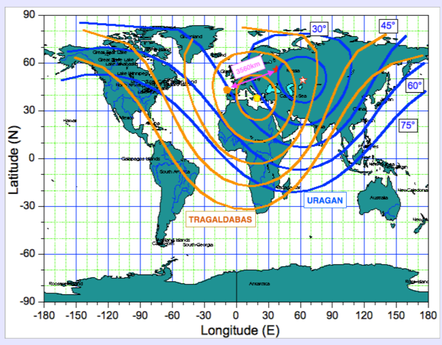
Introduction: Cosmic Rays are very useful for getting a real time information of many Earth's surrounding phenomena as solar activity, magnetic clouds and the high atmosphere dynamics, among others. In order to improve our knowledge in those fields, URAGAN (MEPhI, Moscow) and TRAGALDABAS (S. Compostela, Spain) have decided to join their efforts. Both detectors, based on different technologies, do offer a very good angular resolution, allowing a regular and coordinated survey of of the arrival of cosmic ray over a big region of the North hemisphere.

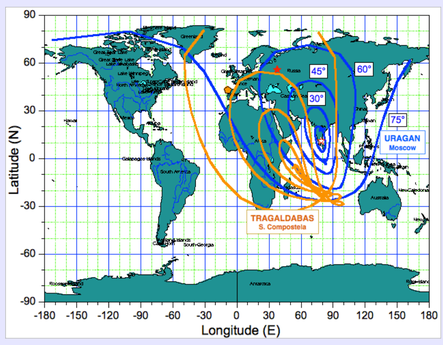
URAGAN & TRAGALDABAS

The analysis of the variation of the rates of secondary cosmic rays arriving to Earth's surface provides very valuable information about many phenomena as the Solar activity, the Space Weather, the atmosphere and the Earth's magnetic field, among others. Because of these reasons, cosmic rays are regularly monitored around the World by many detectors based on different techniques.

URAGAN, placed at MEPhI, in Moscow (Russia) and TRAGALDABAS, placed at the U. of Santiago de Compostela (Spain) are two singular detectors, very different in size and performances, but offering both a tracking capability with an angular resolution below 2º. Both are placed in the same hemisphere, at a distance of about 3600 km, allowing to scan regularly, in stereoscopic mode, one third of the atmosphere at the Tropopause level. Such feature will allow the tandem of both detectors to disentangle atmosphere, solar and interplanetary phenomena from the cosmic ray background.

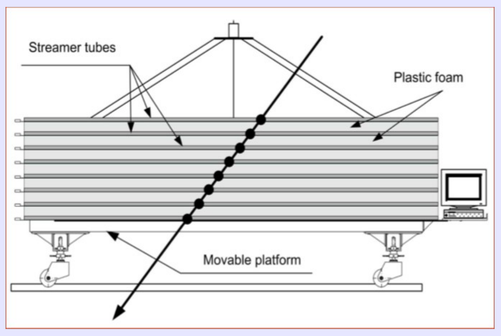


Asymptotic regions for different arrival angles of muons produced by average energy cosmic protons in both detectors.



Asymptotic regions for different arrival angles of muons produced by solar protons in both detectors.

URAGAN



Scheme of a single muon detection in one Super Module (SM) or URAGAN. Arrival direction is built using the two orthogonal projections of the track.

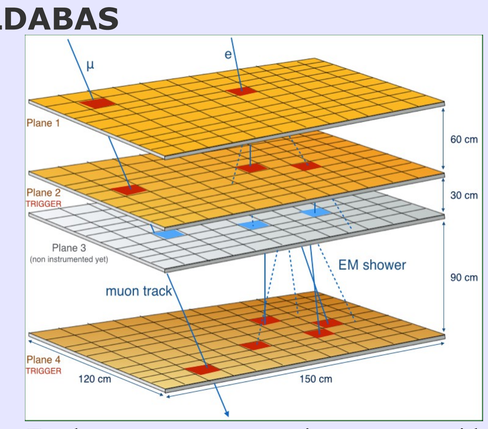
Two of the three Super Modules (SMs) that are regularly taking data in URAGAN, on top of the NEVOD Cherenkov detector.

URAGAN is located at (55.7ºN, 37.7ºE) and at 173 m a.s.l, in the NEVOD research complex of the National Research Nuclear University, MEPhI (Moscow). It is composed by three Super Modules, SM, with a total area of 11.5 m^2, each.

Main performances:
No. of Super Modules: 3, sensitive to muons
Active size of each Super Module : 3.4 x 3.4 x 0.5 m3
Tipe of detectors: Streamer tubes (10mm x 10mm x 3500 mm)
Number of planes: 8, with 320 streamer tubes, each. Pitch = 1.2cm
Number of channels: 320 X-coor. + 288 Y-coor. / plane
Maximum zenith angle coverage: 75º
Track angular resolution: < 1º
Energy threshold for accepted muons: 200 MeV – 600 MeV
Trigger: At least 4 active planes in each X and Y coordinate
Typical counting rate /SM : 1300 Hz. Duty cicle: ~90% (54s/ min)

TRAGALDABAS

Present layout of TRAGALDABAS. Only three RPC planes are instrumented. Trigger is done between planes 2nd and 4th.

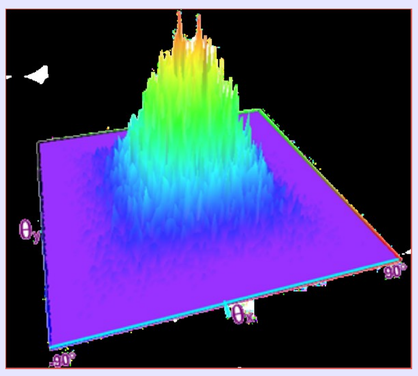


Track reconstruction with TRAGALDABAS. Each track is defined by the direction and its arrival time. EM showers can be identified in the analysis

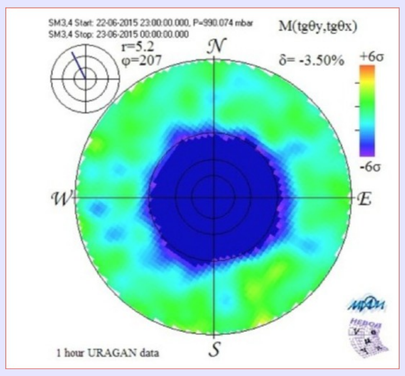
TRAGALDABAS is located at (42.9ºN, 8.6ºW) and at 240 m a.s.l., in the Faculty of Physics of the Univ. of S. de Compostela. It is composed of four planes of RPCs (Resistive Plate Chambers).

Main performances:
Size of the detector: 1.5 x 1.2 x 1.8 m3 sensitive to charge particles
Tipe of detector: 2-gap Resistive Plate Chamber (RPCS).
Number of planes: 4, with 10x12 pads / plane. Pad size 11.1 x 11.6 cm2
Time resolution: 340ps / cell, ~200ps / track.
Particle velocity resolution <6% , for v = c.
Maximum zenith angle coverage: 45º
Track angular resolution: <2º
Trigger: coincidence between planes 2nd and 4th from the top
Typical counting rate: 70 Hz. Duty cycle: ~99%

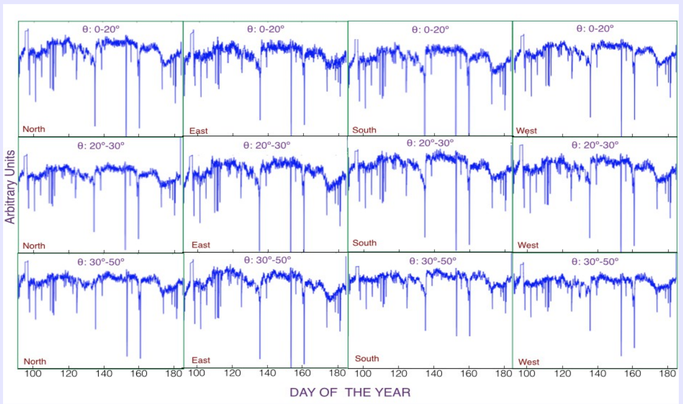
Preliminary analysis of the Forbush Decrease on June 22nd. 2015



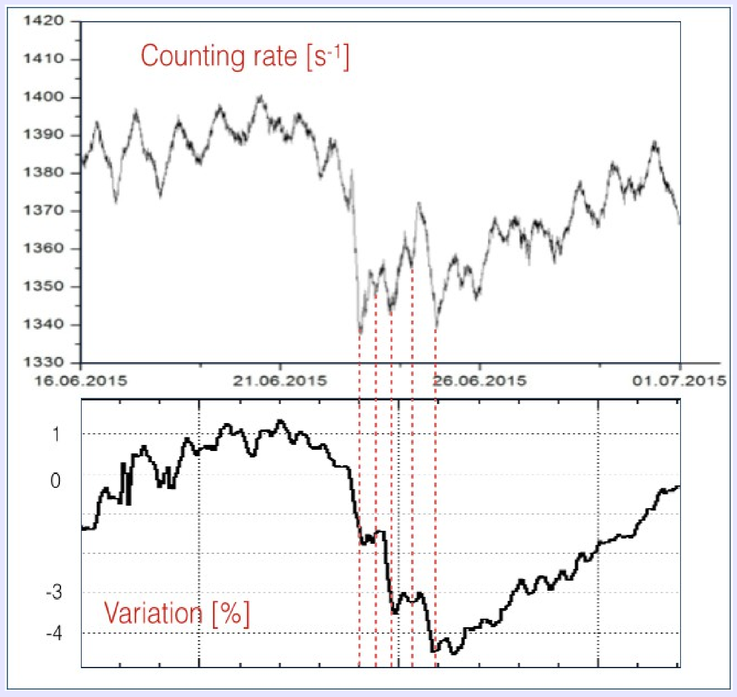
Matrix of one-minute data taken with the three SM of URAGAN.



Angular distribution of muons (muonography) measured during 1 hour by URAGAN at the minimum of the FD on June 23rd.



Variation in the counting rate measured by TRAGALDABAS between March and June 2015 at different zenith angle regions, (0º-20º),(20º-30º) and (30º,50º) and at the four geographic quadrants. Big minima correspond to maintenance or upgrading periods.



URAGAN (top) and TRAGALDABAS (bottom) counting rate evolution before and during the Forbush Decrease at June 22nd 2015.

As an example of the joint capabilities provided by URAGAN and TRAGALDABAS, we present some of the pictures and counting rales provided by both detectors during a big Forbush Decrease (FD) started on June 22nd produced by a big CME held several hours before. Despite the big distance between the detectors and the very different rigidity thresholds, the rate behaviour of both detectors offers many similarities and differences that will inform about the properties of the solar cloud that caused the effect. The stereoscopic analysis of the angular distributions provided by both detectors, should give new information about the shape and dynamics of the cloud.

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