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TRAGALDABAS

A high performance Detector for the regular study of Cosmic Ray properties

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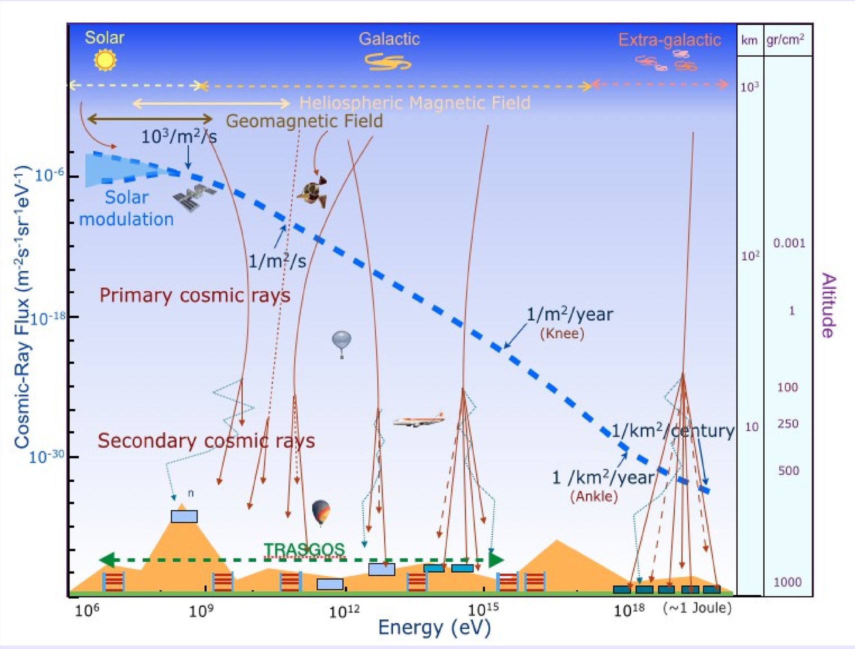
Introduction: TRAGALDABAS is a new generation, high granularity and high resolution tracking detector for the permanent survey of cosmic rays. It is installed at the Univ. of Santiago de Compostela (Spain) and is taking data regularly since March 2015 at a rate of ~70 Hz of events with, at least, one reconstructed track. An international collaboration has been organised for data analysis and maintenance of the facility.

TRAGALDABAS: GOALS



Flux of primary cosmic rays (blue dotted line) as a function of the energy together with their estimated sources and main detection techniques. Trasgos should be useful to analyse cosmic rays properties over a big range of energies

TRAGALDABAS (TRAsGo for the AnaLysis of the nuclear matter Decay, the Atmosphere, the earth B-Field And the Solar activity) is the first prototype of the TRASGO concept, a new family of high-performance tracking detectors for the study of cosmic rays. It offers multi-track capability with outstanding both angular and time resolutions. Such features do allow it to reconstruct single and bundles of particle tracks. The joint information of the arrival time profile and the density of particles will allow to analyze the primary cosmic ray properties from the lowest energies up to the knee region. TRAGALDABAS will deal with research activities in areas, such as:

- Analysis of the space-time structure of cosmic air showers.
- Regular survey of the solar activity and space weather phenomena.
- Analysis of the Earth's magnetic field.
- Go deeper into the relationship between cosmic rays and the atmosphere and possible influence of cosmic rays on climate.

TRAGALDABAS is located at the first floor of the Faculty of Physics building of the USC.

TRAGALDABAS: TECHNICAL FEATURES

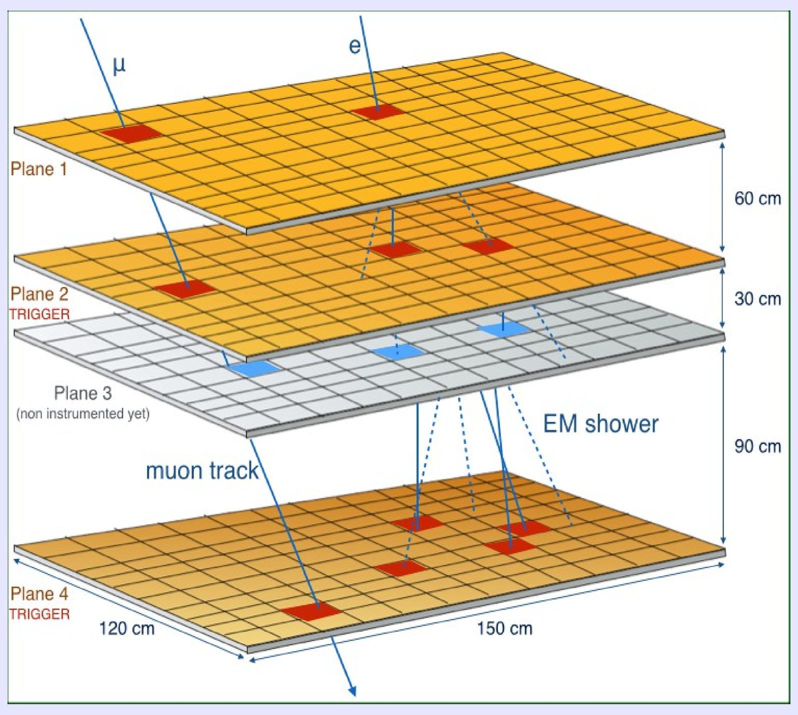
TRAGALDABAS detector at the Univ. of Santiago de Compostela. Only three of four RPC planes are instrumented. Trigger is done between planes 2nd and 4th. from the top.

The Detectors: In its present layout, TRAGALDABAS is composed by four 2-gap RPC planes . Each of them has a surface of 1.2x1.5 m^2 and 120 11.1x11.6 cm^2 cells, with a time resolution of ~340 ps. Such arrangement allows to reconstruct tracks with a time resolution <200 ps, an angular resolution <2º, and a velocity resolution ~5% for v=c particles. Planes are placed at the heights: 0, 90, 120 and 180 cm, in order to cover different angular acceptances. Trigger is done by coincidences between planes at 0 and 120 cm. A new trigger board is being designed for the triggering between any two planes. Detection efficiency per plane is ~1.

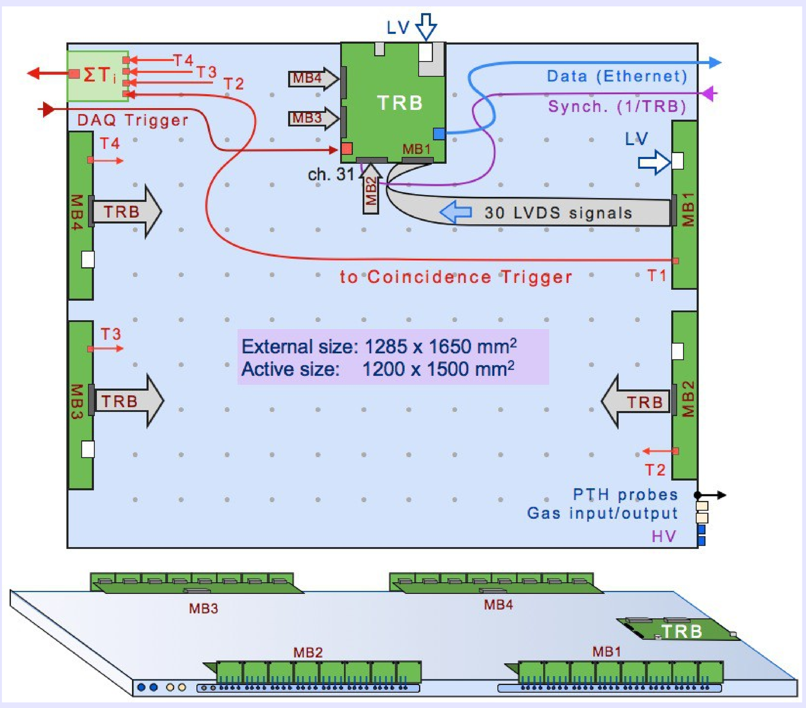
The Front End Electronics: the detector uses the same read-out electronics that is being successfully used by the HADES nuclear physics experiment, at the GSI (Darmstadt). Signals are pre-amplified and digitized in a single board, encoding in a single LVDS signal the arrival time and the deposited charge in the cell.

Slow control: Continuously, a slow control system, based on NAGIOS, is supervising the following variables: high voltage operational currents, several pressure, humidity and temperature probes placed inside the detector boxes and the both pressure and temperature of the detector room.

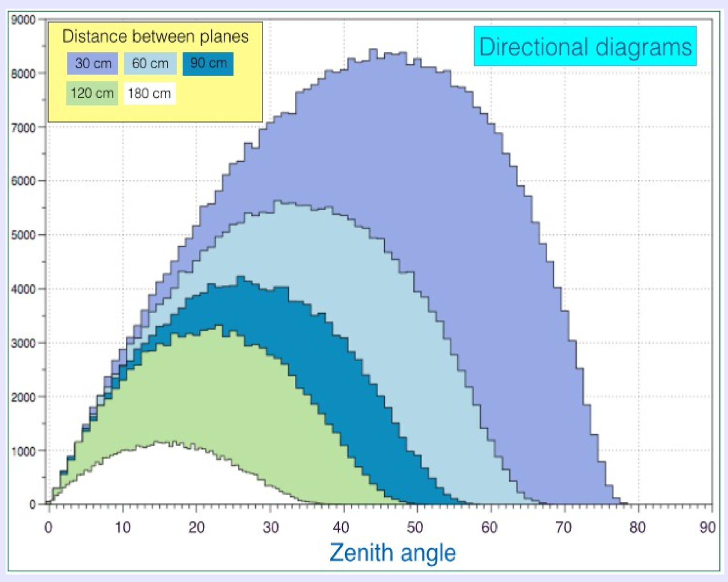
Reconstruction software: the analysis of the detector is done within a specific framework based on ROOT and written in C++.



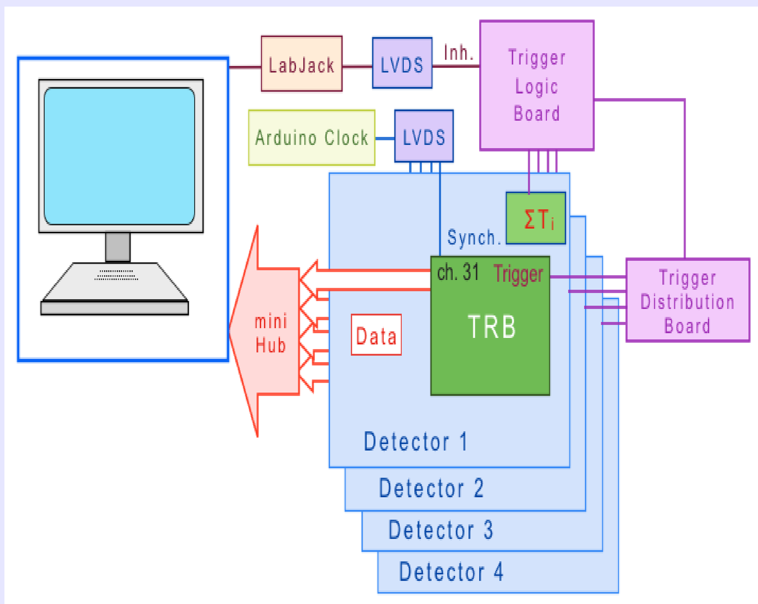
TRAGALDABAS has a multi-particle tracking capability. The detector is sensitive both to muons and to high energy electrons and other charged particles.



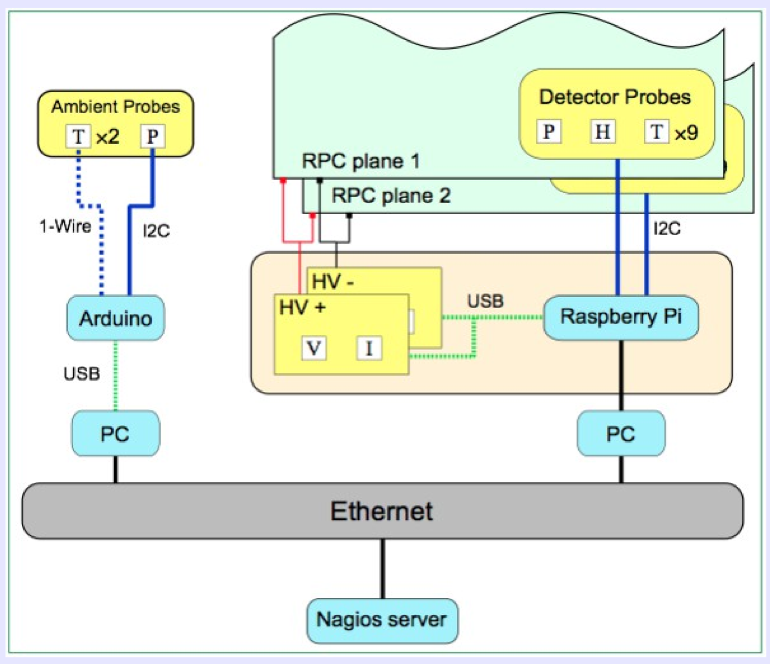
Layout of the read out electronics of one RPC plane. The trigger readout board, TRB, collects the LVDs signals from the FEE and sends them to the DAQ.



Directional diagram of the triggered events between any combination of contiguous planes.

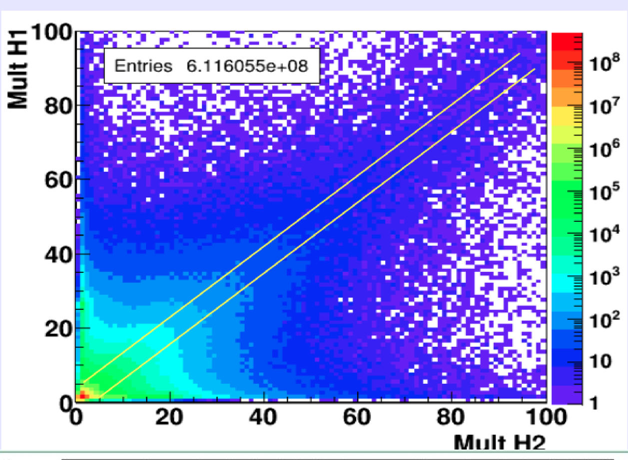


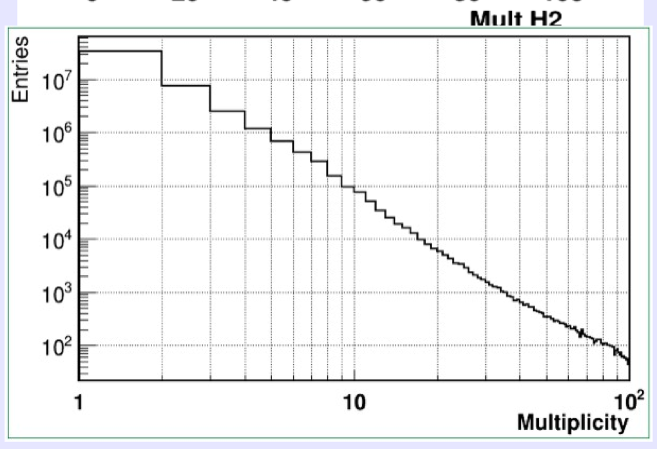
Layout of the planned trigger and acquisition logic based on a few commercial and customised boards



Block diagram of the monitoring system.

TRAGALDABAS: FIRST PRELIMINARY RESULTS





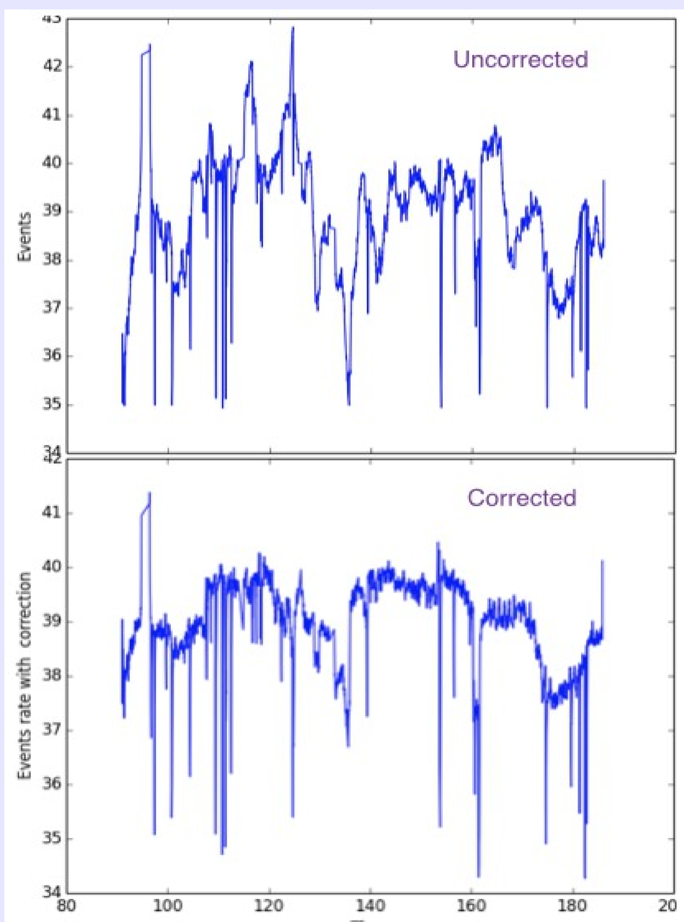
Top: plot of multplicities of both trigger planes. Botom: track multiplicity distribution in the region between the two yellow lines.

DAQ rate: After commissioning, TRAGALDABAS started to take regular data last March 2015 at a duty cycle of ~95%, at an approximate rate of 70Hz. An upgrade of the DAQ software is foreseen in order to reach ~99% duty cycle.

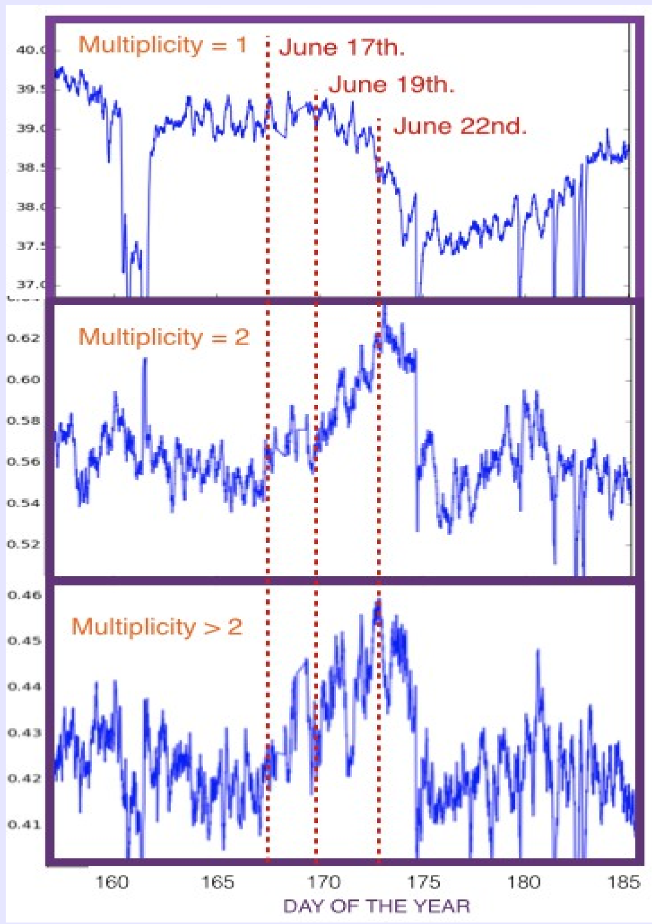
Around 40Hz correspond to events with track multiplicity M=1, ~16Hz to track multiplicity M=2 and ~14Hz to track multiplicities M >2.

Data corrections: Main corrections to the data have been done to compensate the pressure effect on the cosmic ray rate. A further small correction is needed to compensate the temperature fluctuations in the room that is kept constant at 20º +/- 1º.

Analysis of the Forbush Decrease at June 22nd,2015. A very significative FD was observed all around the world starting at June 22nd, produced by several Coronal Mass Ejection produced after June 18th. The FD produced in TRAGALDABAS a significative decrease of about -5%. An analysis of M=2 and M>2 events shows an unexpected enhancement, probably produced by high energy particles, starting at about the same time that the CMEs were ejected. The effect is currently subject of an active investigation.



Uncorrected and pressure-corrected counting rate of the detector since Mar. 23rd 2015.



Counting rates (Hz) for different track multiplicities and cleaned track samples.

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