First results on cosmic ray studies and their relation with the Solar activity, the Earth’s magnetic field and the atmosphere properties

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on behalf of the TRAGALDABAS Collaboration
Outlook:

1. The cosmic rays and TRASGO detectors
2. TRAGALDABAS: the first TRASGO
3. TRAGALDABAS: some preliminary results
   - Technical performances
   - Solar Physics
   - Earth’s Magnetic Field
   - Atmosphere
4. Summary & Conclusions
The cosmic ray spectrum
Primary cosmic ray: mass, direction, energy

TRASGO
TRAck reconStruc tinG bOx
- High granularity / position resolution
- High time resolution
- Track capability
- Charge measurement in all channels
- Stand alone detector (plug & play)

Question:
How much information can we get from cosmic rays and their associated fields of research with a TRASGO?
TRAGALDABAS, the first Trasgo

TRAsGo for the AnaLysis of the nuclear matter Decay, the Atmosphere, the earth B-field And the Solar activity

TRAGALDABAS detector at the Univ. of Santiago de Compostela.
TRAGALDABAS, the first Trasgo

TRAGALDABAS is located at the first floor of the Faculty of Physics building of the USC. Their measurements are slightly affect by walls, floors and the roof.
TRAGALDABAS: Un detector único para el estudio de los rayos cósmicos

Juan A. Garzón. IAFE - Buenos Aires, 11 de febrero 2015

TRAGALDABAS and other laboratories

Santiago de Compostela

290 km

U. Coimbra

CGUC: Centre for Geophysics

447 km

Guadajara: CaLMa neutron monitor

510 km
TRAGALDABAS, layout

LIP-Coimbra Marta/ P. Auger RPCs

120 cells

1.2 m

1.5 m

Resistive Plate Chamber

Pickup strip

+ HV

Glass

Gas gap (~ 0.3mm)  Avalanches

~Freon

- HV

Pickup strip

FEE

HADES-GSI FEE

LVDS

Q: charge
t0: time

Juan A. Garzon, LabCAF / Univ. Santiago de Compostela

ICRS 2016 - Torino
TRAGALDABAS, PID philosophy

Summary of performances:
- $\sigma_{x-y} \sim 3$ cm
- $\sigma_t \sim 280$ ps
- $\delta \Omega \sim 2.5^\circ$
- $\sigma_v \sim 5\%$ c
- Efficiency $\sim 99\%$

- Some particle identification: muon / proton / electron / gamma separation
- Some electromagnetic preshower calorimetry
Data stored in 5x8 (theta x phi) matrices in 10-min time intervals
TRAGALDABAS, data summary

TRAGALDABAS preliminary

Rate [Hz]

D.O.Y 2015

50 100 150 200 250 300 350

50 55 60 65 70 75 80

Juan A. Garzon, LabCAF / Univ. Santiago de Compostela
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We have still several troubles with the electronics and data acquisition.
TRAGALDABAS, data summary

Data summary
The detector is taking data regularly since ~April 1st. 2015
- Mean trigger rate ~70 Hz. ~ 7 Mevents/day
- Data stored ~ 700Gb/year, ~1.9 Gb/day
- Global efficiency > 90%

Multiplicity scope
TRAGALDABAS: a few technical performances

Histogram of number of hits in one plane

high multiplicity events?
TRAGALDABAS: a few technical performances

N. hits vs. total charge Q in one plane

Corrected N. hits vs. total charge Q

Although one plane has only 120 cells using the measured charge by all the channels it is possible to estimate multiplicities up to more than 1000 particles / m²
TRAGALDABAS: solar physics

Analisis of the Forbursh Decrease, on June 2015

CME Soho picture on Jun. 21th. 2015
TRAGALDABAS: solar physics

Analisis of the Forbursh Decrease, on June 2015
TRAGALDABAS: solar physics

Analysis of the Forbursh Decrease, on June 2015

1-day picture of TRAGALDABAS M1 data in ecliptic heliocentric coordinates
TRAGALDABAS: solar physics

Analisis of the Forbursh Decrease, on June 2015: day by day evolution

(Every picture represents the difference between each day and a reference mean of days!)
TRAGALDABAS: Earth’s magnetic field analysis

Seasonal Trend decomposition - April 2015

Tragas data ($\theta$, $\phi$):
- 5min (original)
- hourly means
- adj. aver. (25)
- STL Trend (8)
TRAGALDABAS: Earth’s magnetic field analysis

Correlation analysis between TRAGALDABAS, CaLMa & H-Z components of GMF-Coimbra

PCA analysis: Correlation coefficients between PC1-3 and CaLMa, GMF-Coimbra, P & T.
TRAGALDABAS: Earth’s atmosphere analysis

We have analyzed the possible correlations between atmosphere and cosmic ray data
TRAGALDABAS: Earth’s atmosphere analysis

6 months data between Apr. 2015 and Sep. 2015

ΔR/<R> vs. ΔT/<T>

p = 70 hPa

ΔR/<R> vs. ΔT/<T>

p = 125 hPa

ΔR/<R> vs. ΔT/<T>

p = 1000 hPa
TRAGALDABAS: Earth’s atmosphere analysis

6 months data between Apr. 2015 and Sep. 2015
TRAGALDABAS: Earth’s atmosphere analysis

6 months data between Apr. 2015 and Sep. 2015

Cloud Region

Pfotzer Maximum

Ozone Region

Muon depleted region

Altitude / m

Slope (ΔRate/ΔTemperature)

M2

M1

M3

0 10 20 30 40 45 km
TRAGALDABAS: Earth’s atmosphere analysis

The weekly analysis show many fluctuations
Summary & Conclusions

- We have a very nice tool in our hands
- but, it is very complicated (many planes, many channels, FEE’s, DAQ) and it will still requires some time until we understand it well and we develop all the calibration, reconstruction and analysis tools
- With some preliminary, 2-plane reconstructed tracks, we have seen some very interesting features related with the cosmic ray properties and their relation with Solar Physics, Geomagnetism and Atmosphere Physics. As we can access all this research areas we should be able to disentangle all their effects, improving our knowledge in such fields.
- The detectors is taking data regularly and it is still room to improve it significantly.
- We are on the way
The End
Thanks!
Members:

Research students: Damián García Castro$^{10}$, Jorge Otero Santos$^{10}$, Irma Riadigós$^{12}$

Laboratory: Tasks

2. CEN - Bordeaux, France: Fast fluctuations of the Earth’s magnetic field
3. CITEUC - U. Coimbra, Portugal: Geomagnetic field and space weather
4. IGN - Madrid, Spain: Geomagnetic field and space weather
5. LIP - Coimbra, Portugal: RPC detectors
6. Jagellionan Univ.- Cracow, Poland: DAQ electronics
7. Technische Univ. - Darmstadt, Germany: Software development
8. CERN, Switzerland: Data analysis
9. CESGA Supercomputation Center - Santiago de Compostela, Spain: Data storage and distribution
10. LabCAF - Univ. Santiago de Compostela, Spain: Data analysis
11. Dpto. Física de Partículas - Univ. Santiago de Compostela, Spain: Monitoring, Slow Control and Simulation
12. Meteogalicia - Xunta de Galicia, Santiago de Compostela, Spain: Atmosphere and Climate studies

Partners:
ATI Sistemas, La Coruña (Spain)
Hydra Technologies Spain S.L., Vigo (Spain)
Partially supported by Club para el Desarrollo de las Ciencias, Madrid (Spain)