



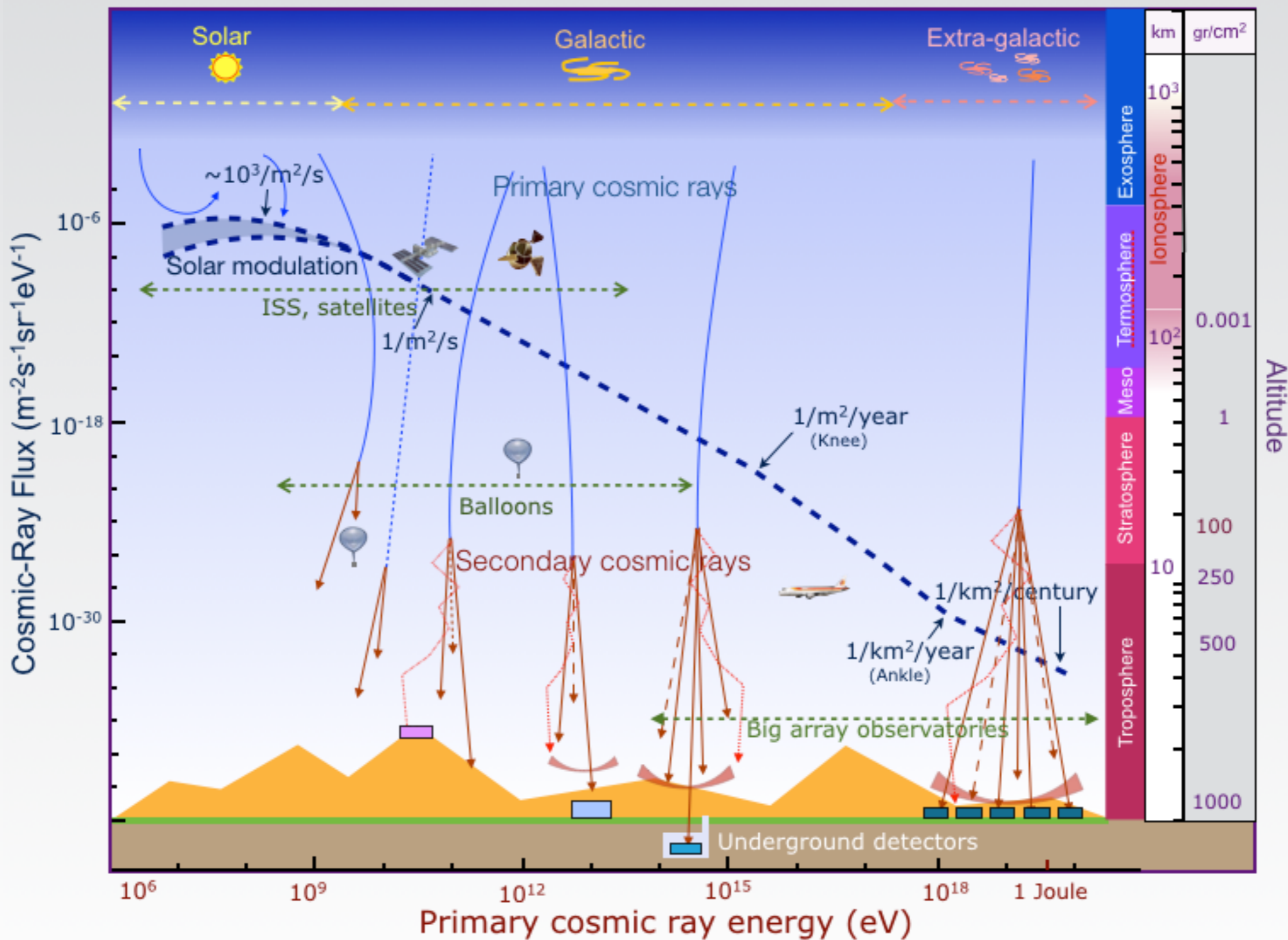
First results on cosmic ray studies and their relation with the Solar activity,  
the Earth's magnetic field and the atmosphere properties

Juan A. Garzón (LabCAF, Univ. Santiago de Compostela)  
on behalf of the TRAGALDABAS Collaboration

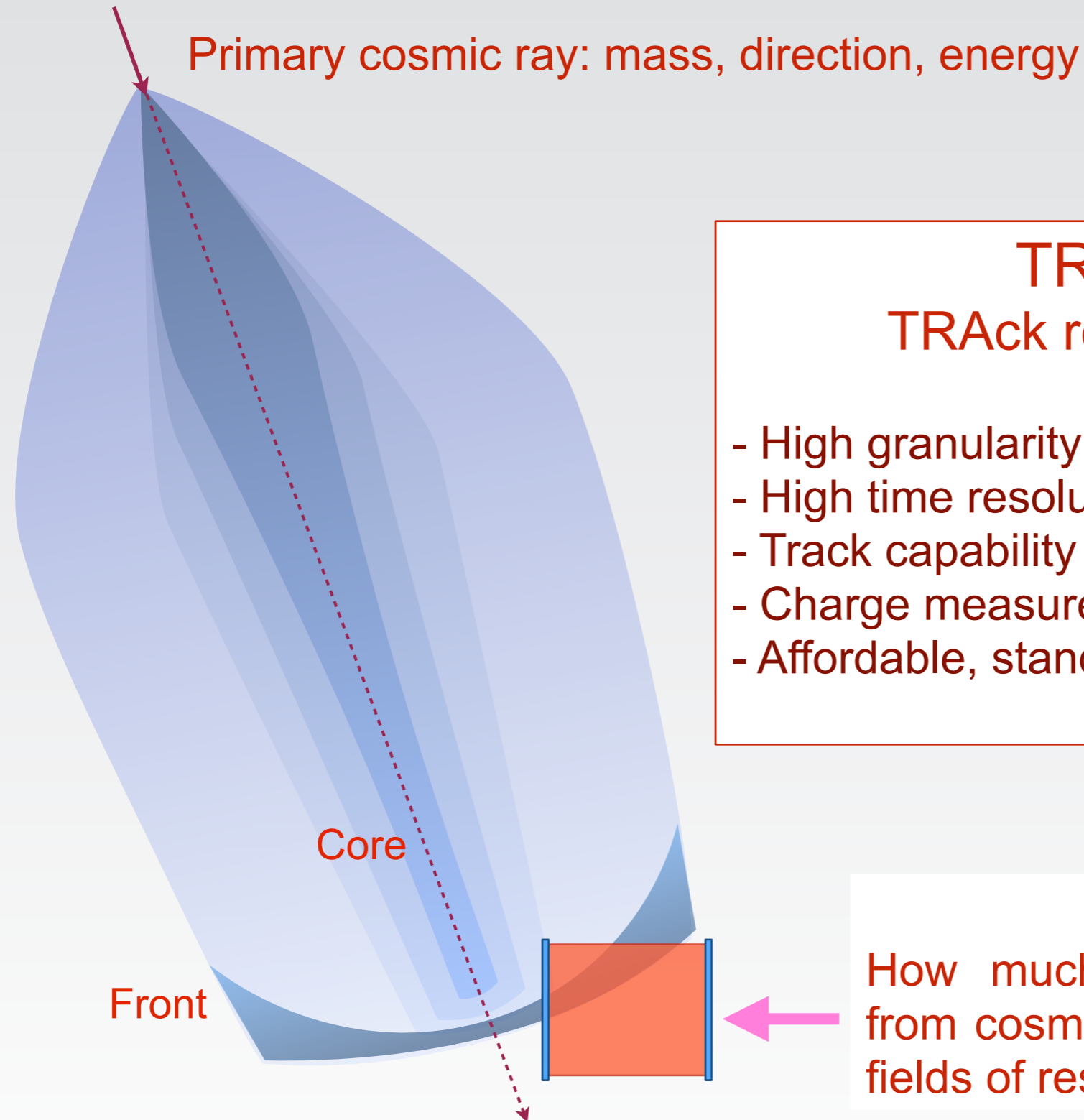
## Outlook:

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



# About TRASGOS



## TRASGO TRAck reconStructinG bOx

- High granularity / position resolution
- High time resolution
- Track capability
- Charge measurement in all channels
- Affordable, stand alone detector (plug & play)

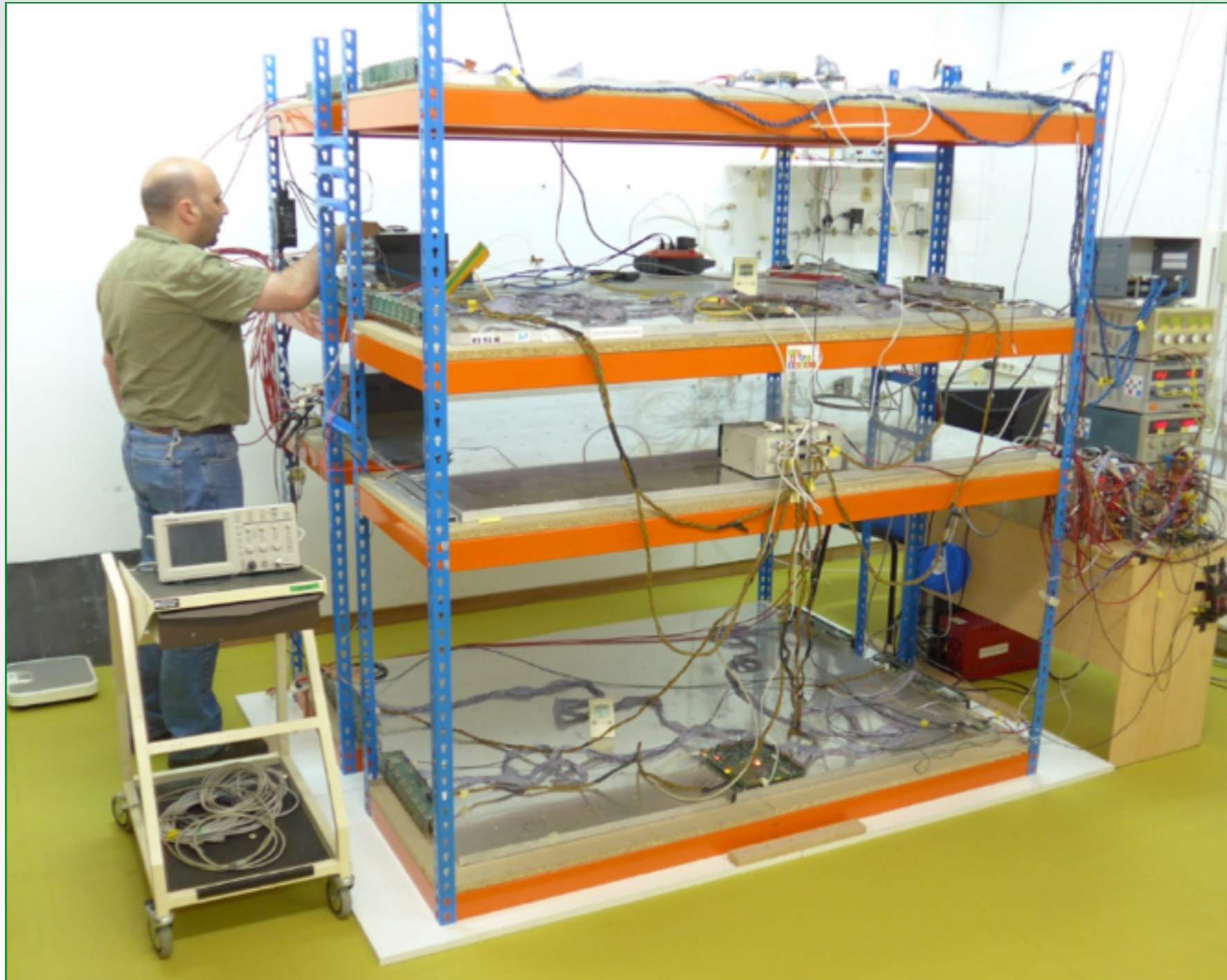
### Question:

How much information can we get from cosmic rays and their associated fields of research with a TRASGO?



# TRAGALDABAS, the first Trasgo

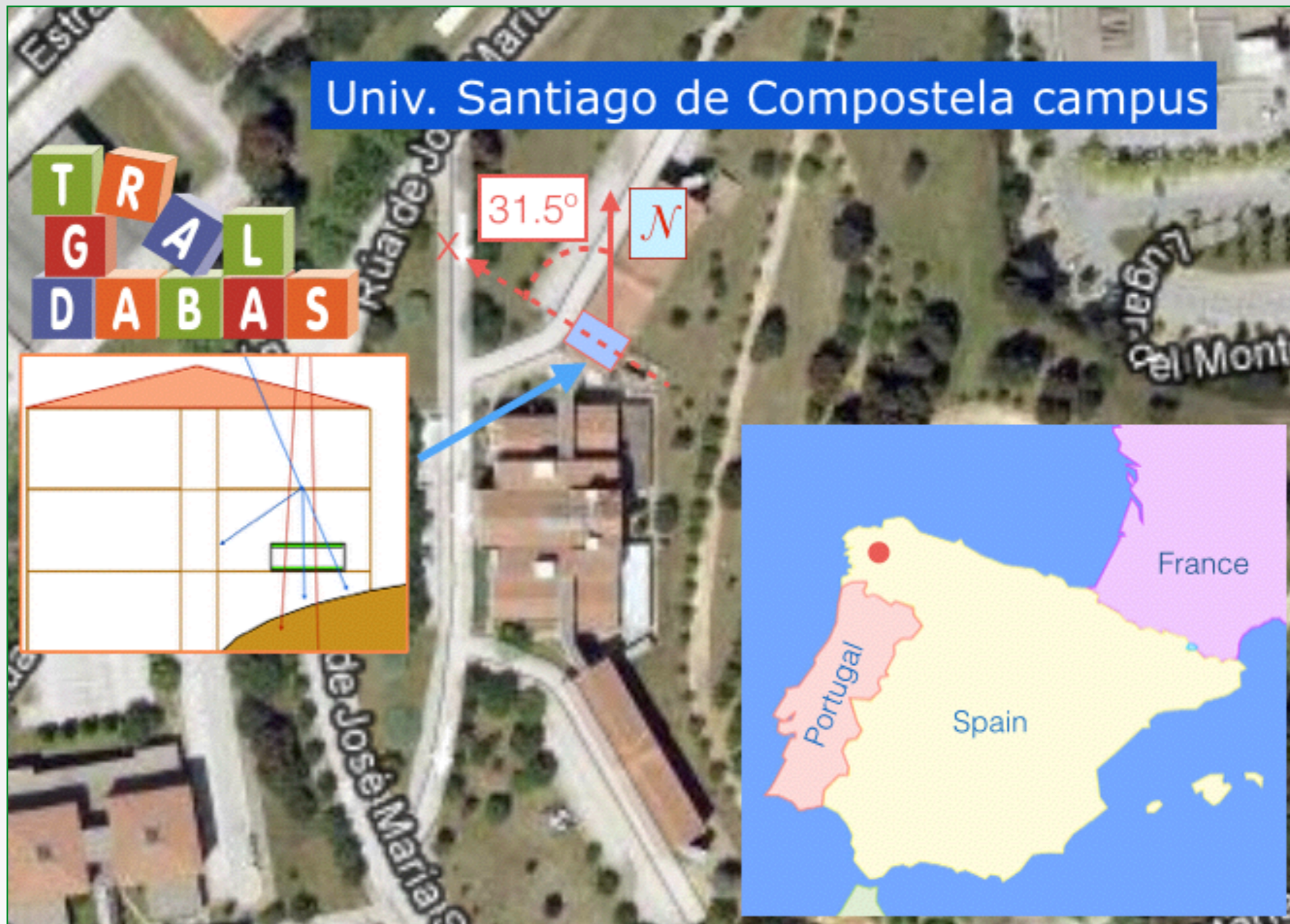
TRAsGo for the AnaLysis of the nuclear matter Decay, the Atmosphere, the earth B-field And the Solar activity



TRAGALDABAS detector at the Univ. of Santiago de Compostela.

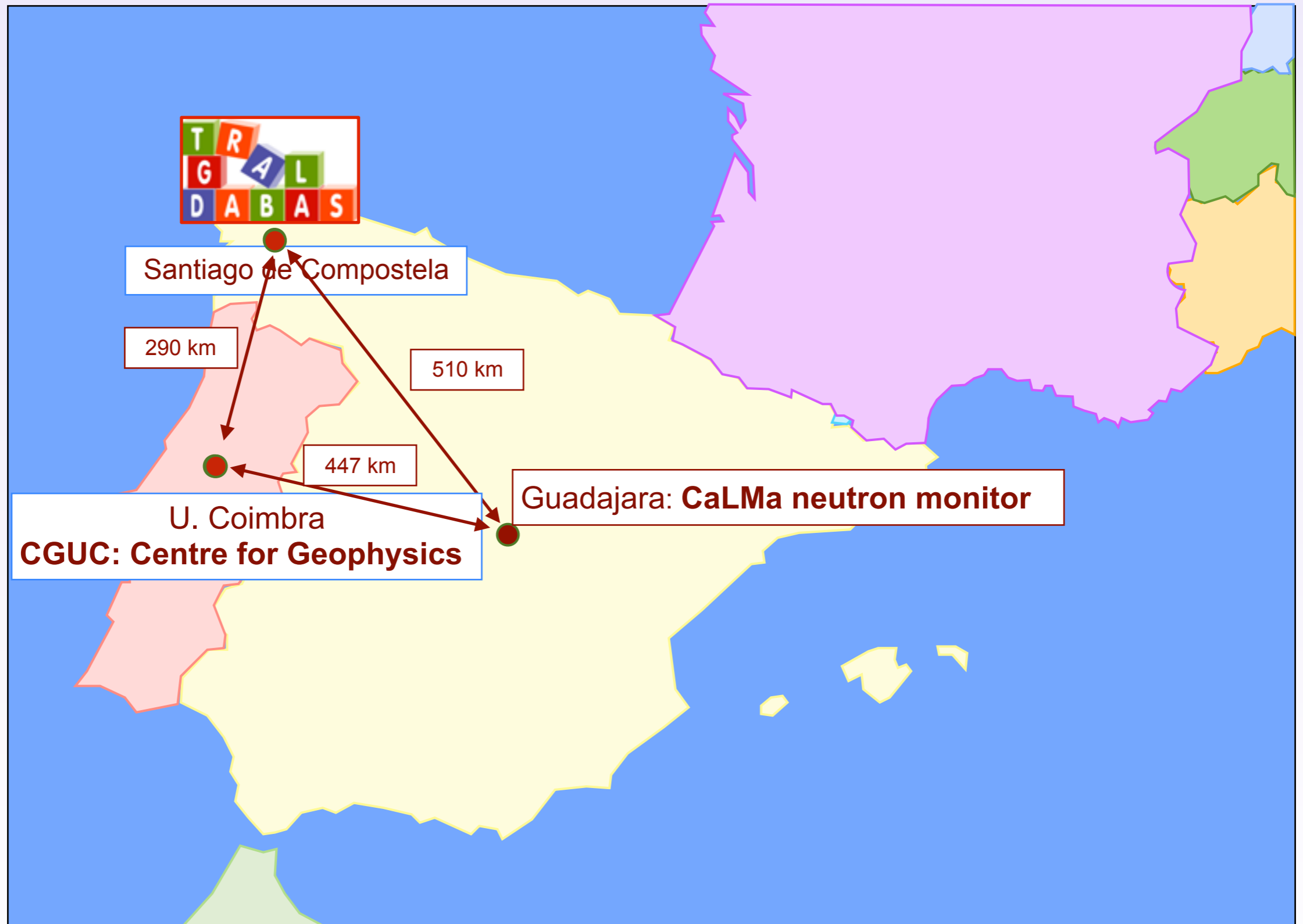


# TRAGALDABAS, the first Trasgo



TRAGALDABAS is located at the first floor of the Faculty of Physics building of the USC. Their measurements are slightly affected by walls, floors and the roof.

# TRAGALDABAS and other laboratories

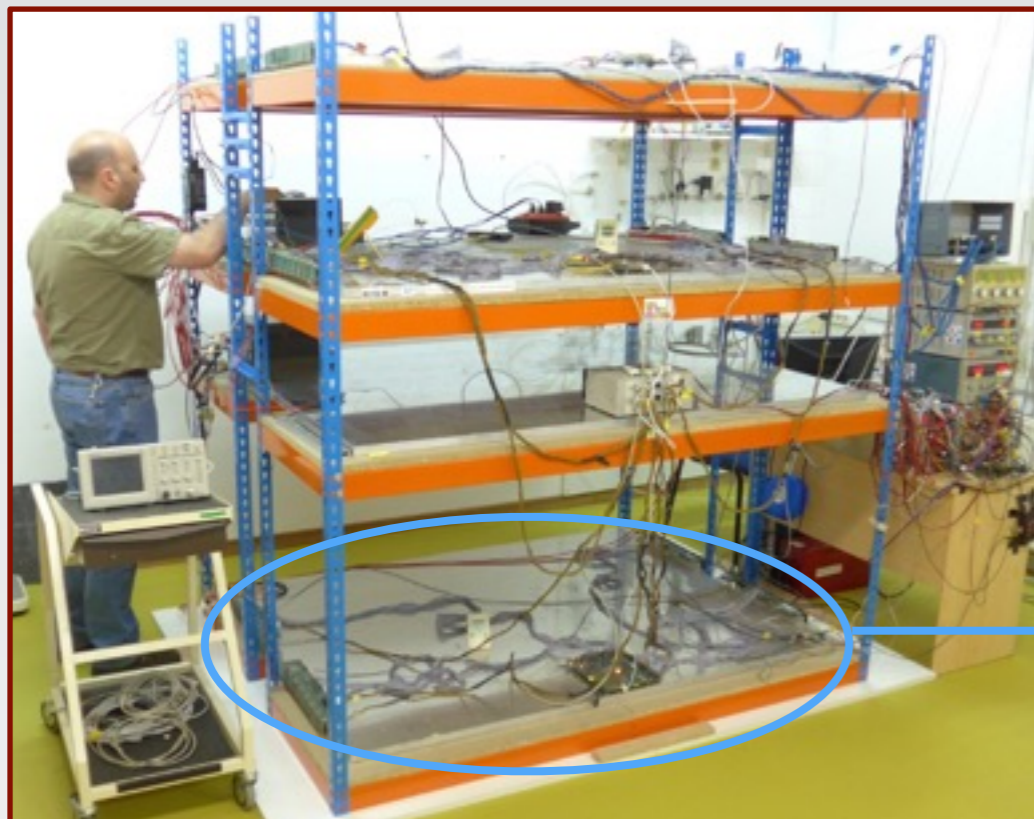


TRAGALDABAS: Un detector único para el estudio de los rayos cósmicos  
Juan A. Garzón. IAFE - Buenos Aires, 11 de febrero 2015

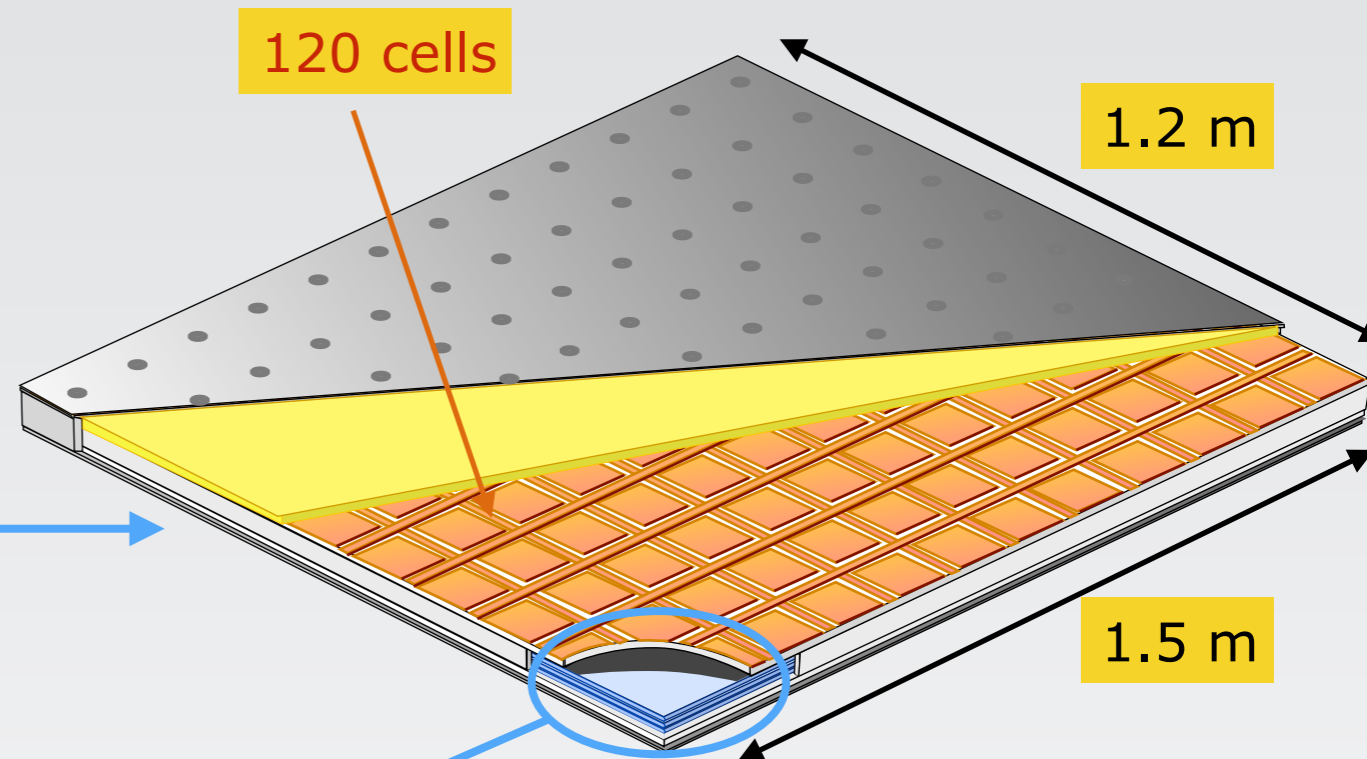




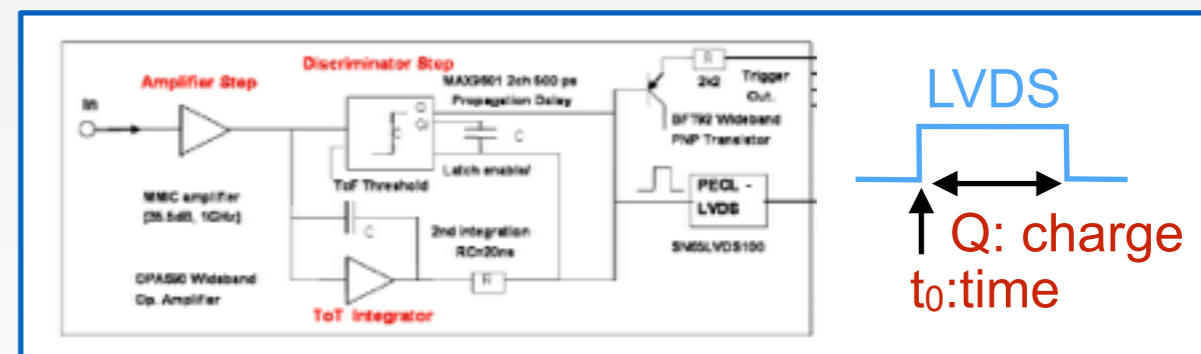
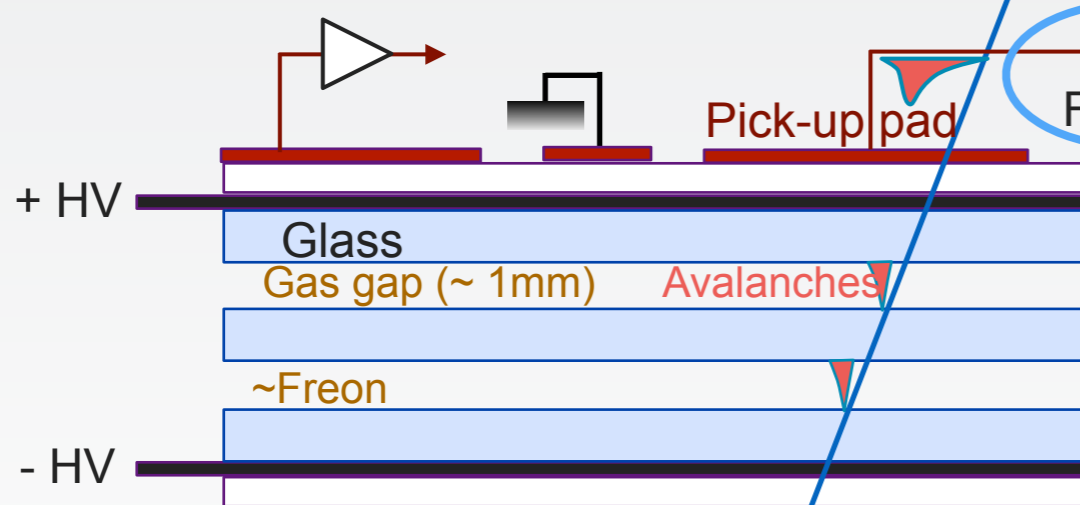
# TRAGALDABAS, layout



LIP-Coimbra Marta/ P. Auger RPCs



Resistive Plate Chamber



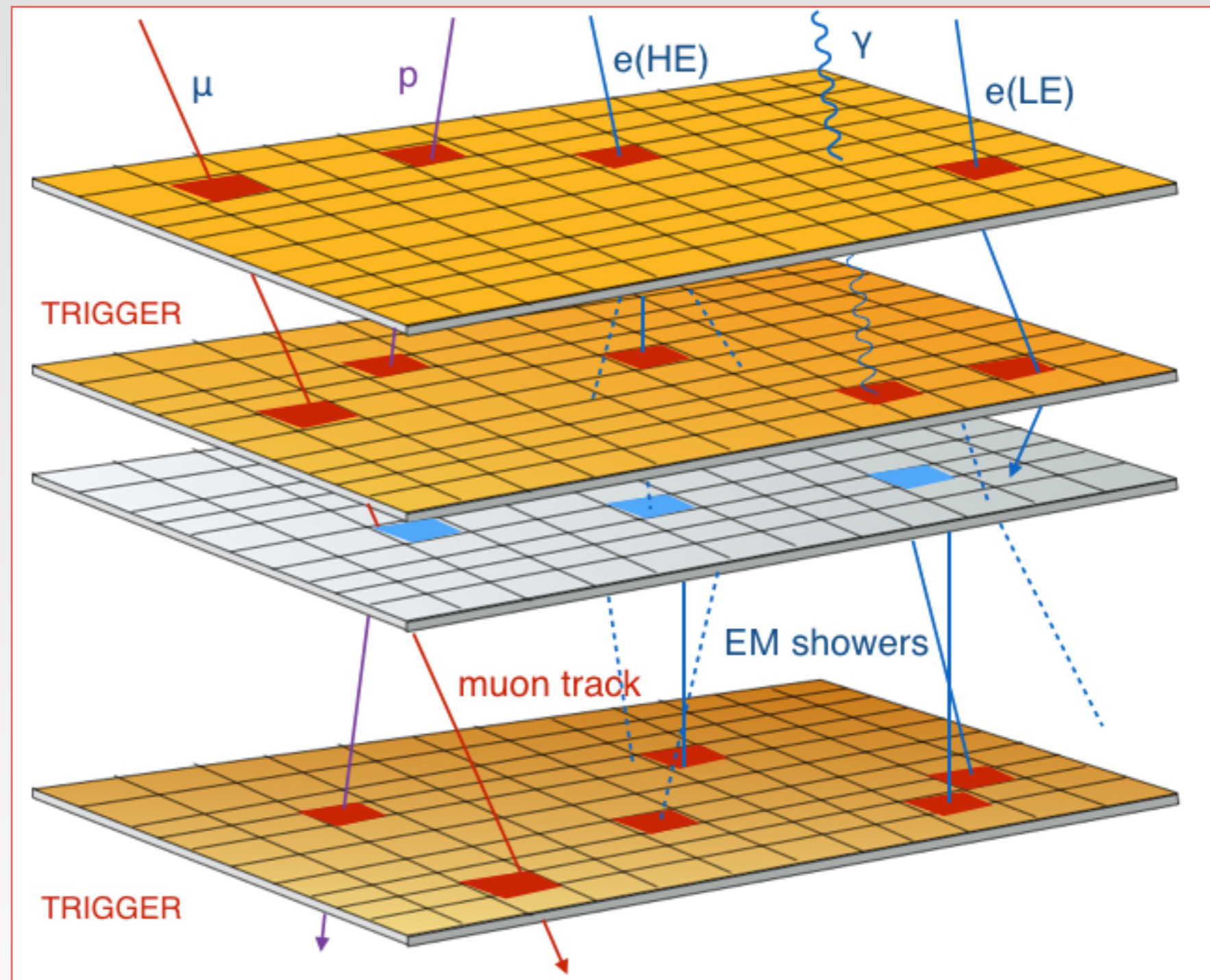
HADES-GSI FEE



# TRAGALDABAS, PID philosophy

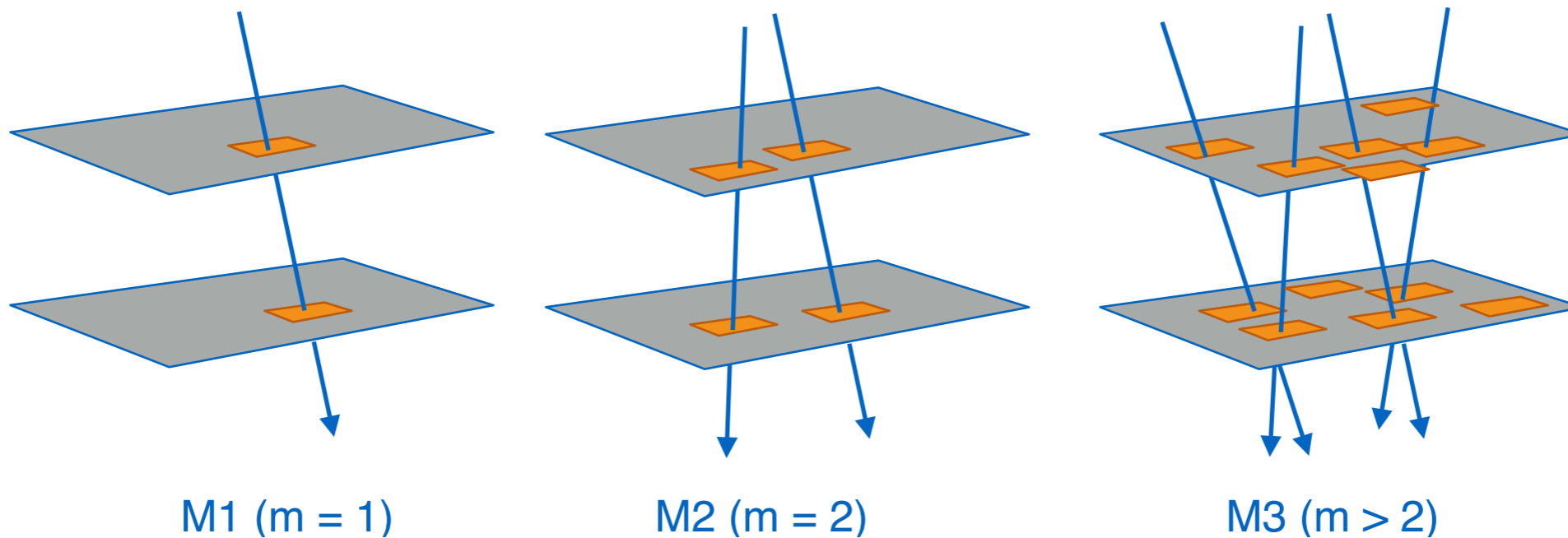
## Summary of performances:

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

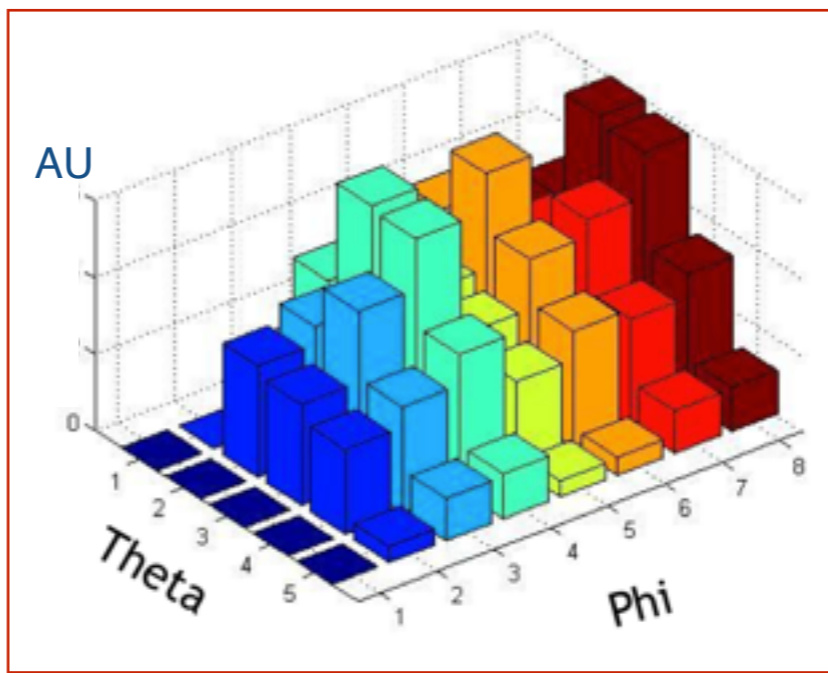
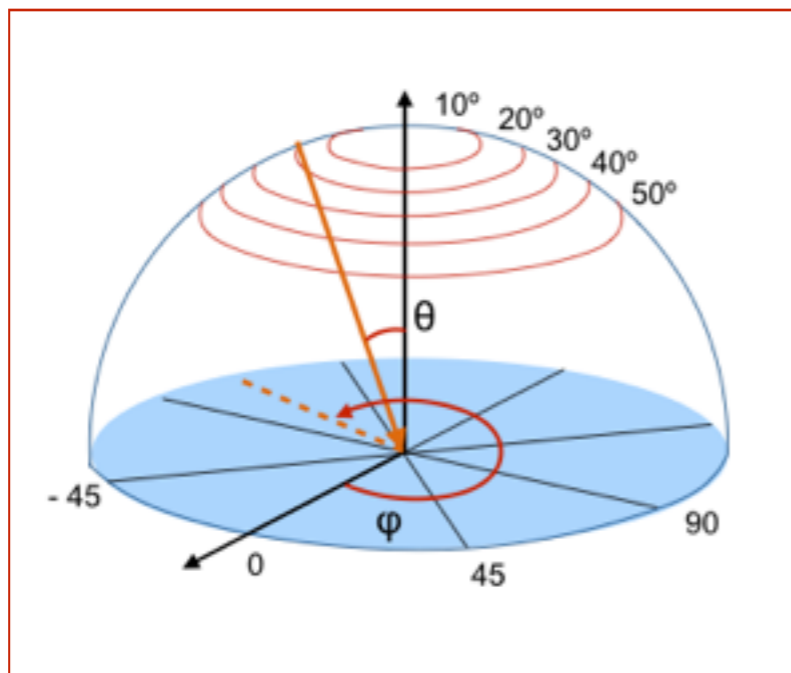


- Some particle identification: muon / proton / electron / gamma separation
- Some electromagnetic preshower calorimetry

# TRAGALDABAS, present data sample

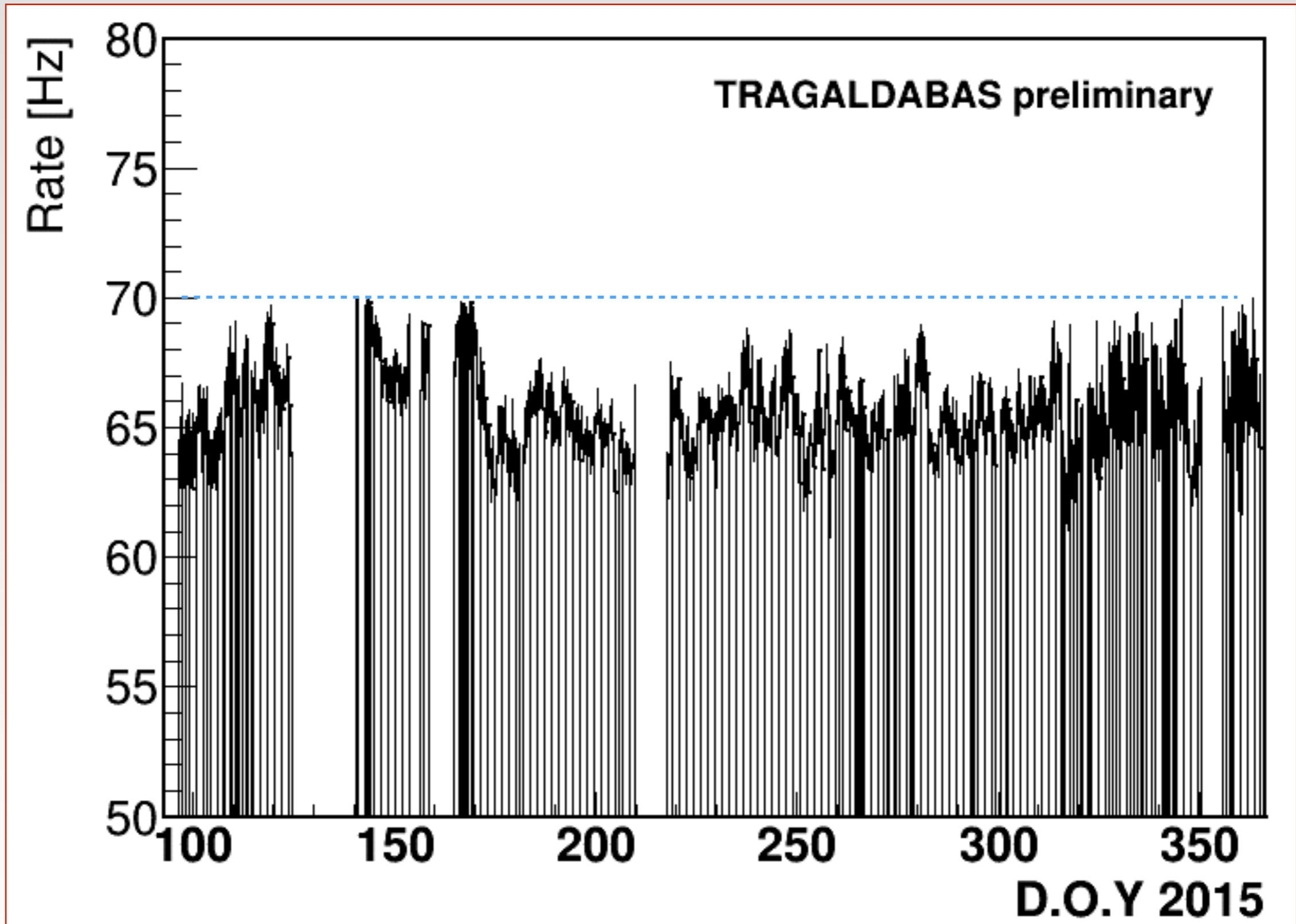


3 sets of multiplicity:  $m$



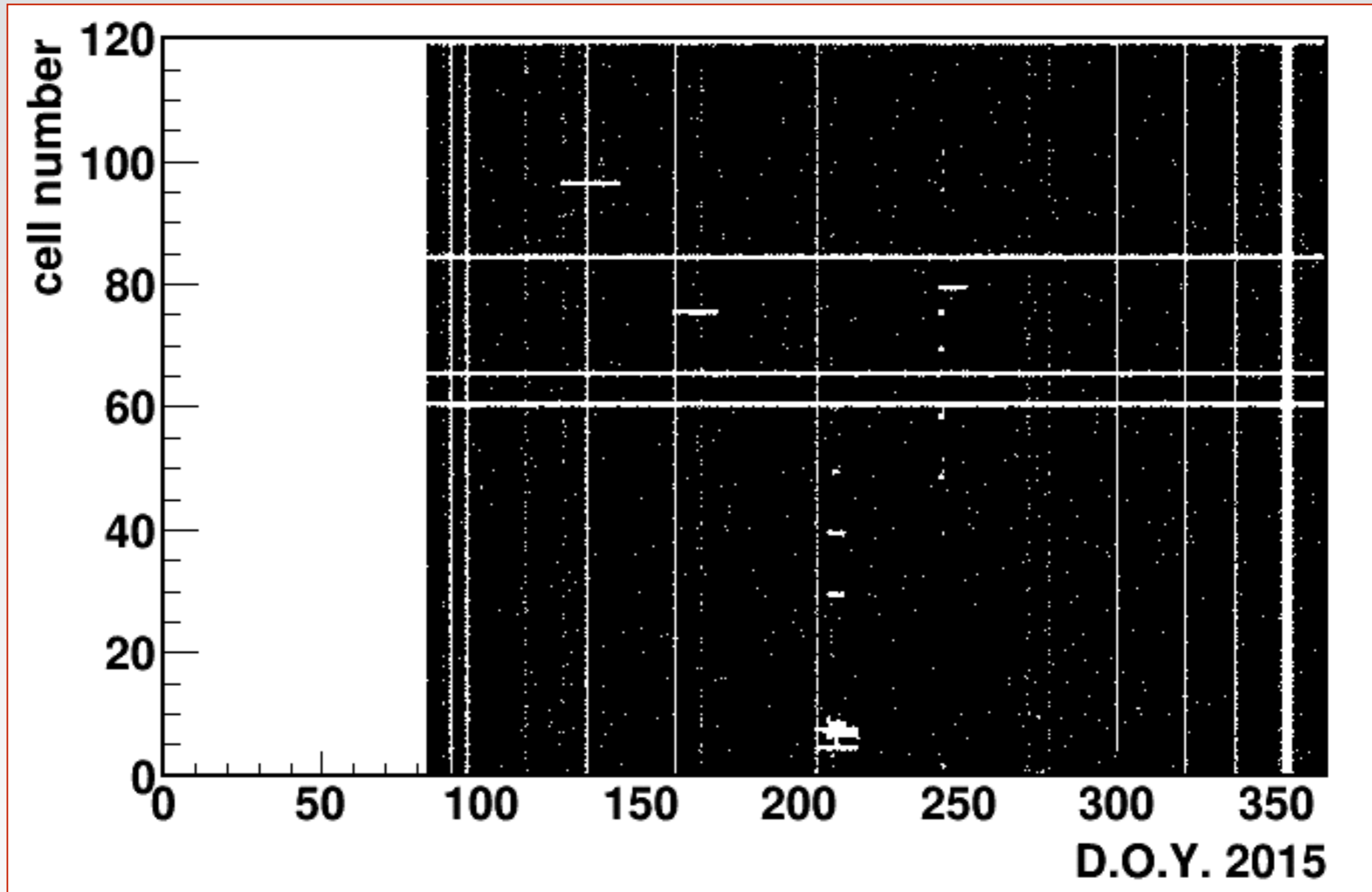
Data stored in 5x8 (theta x phi) matrices in 10-min time intervals

# TRAGALDABAS, data summary





# TRAGALDABAS, data summary



We have still several troubles with the electronics and data acquisition

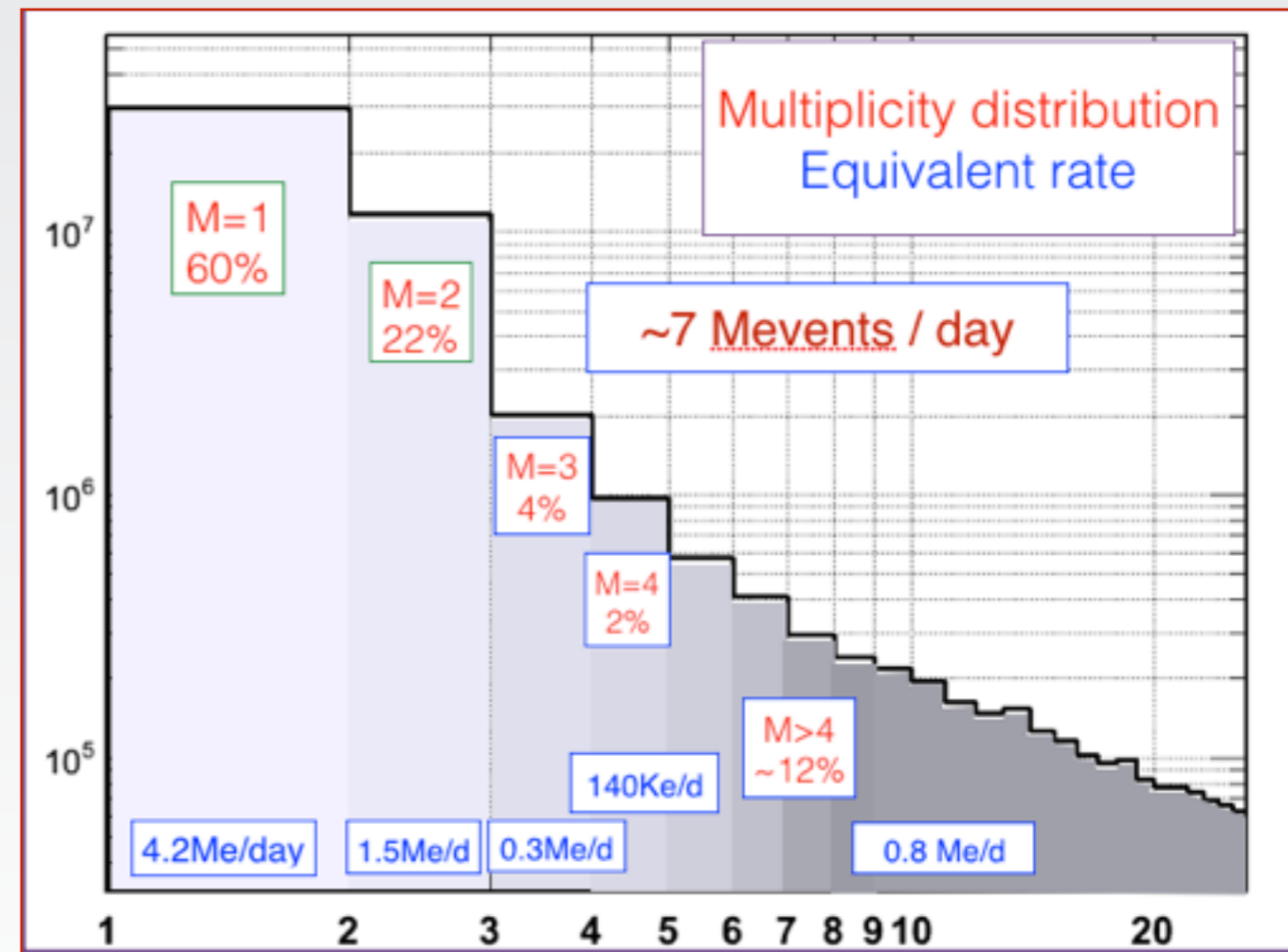
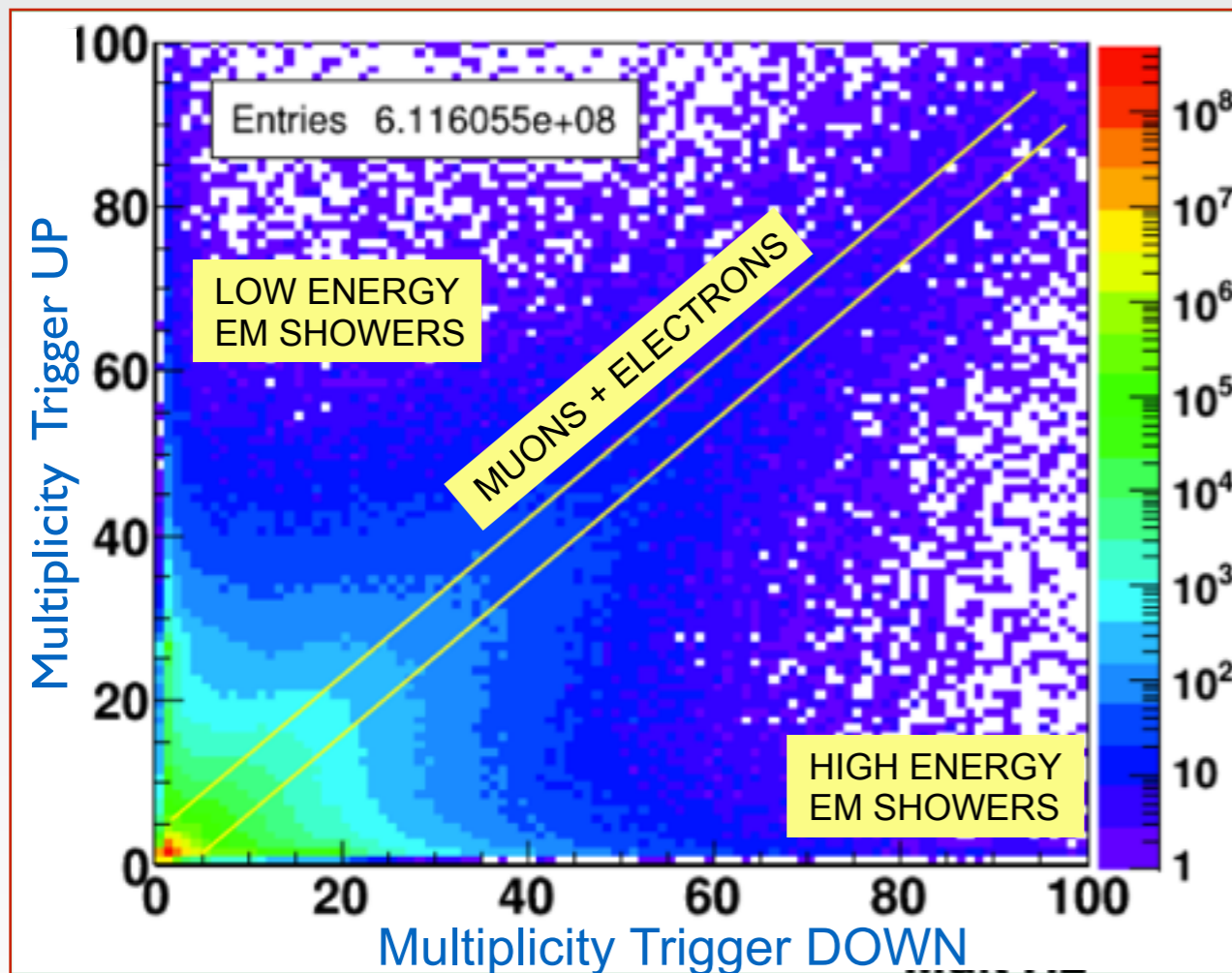
# TRAGALDABAS, data summary

## Data summary

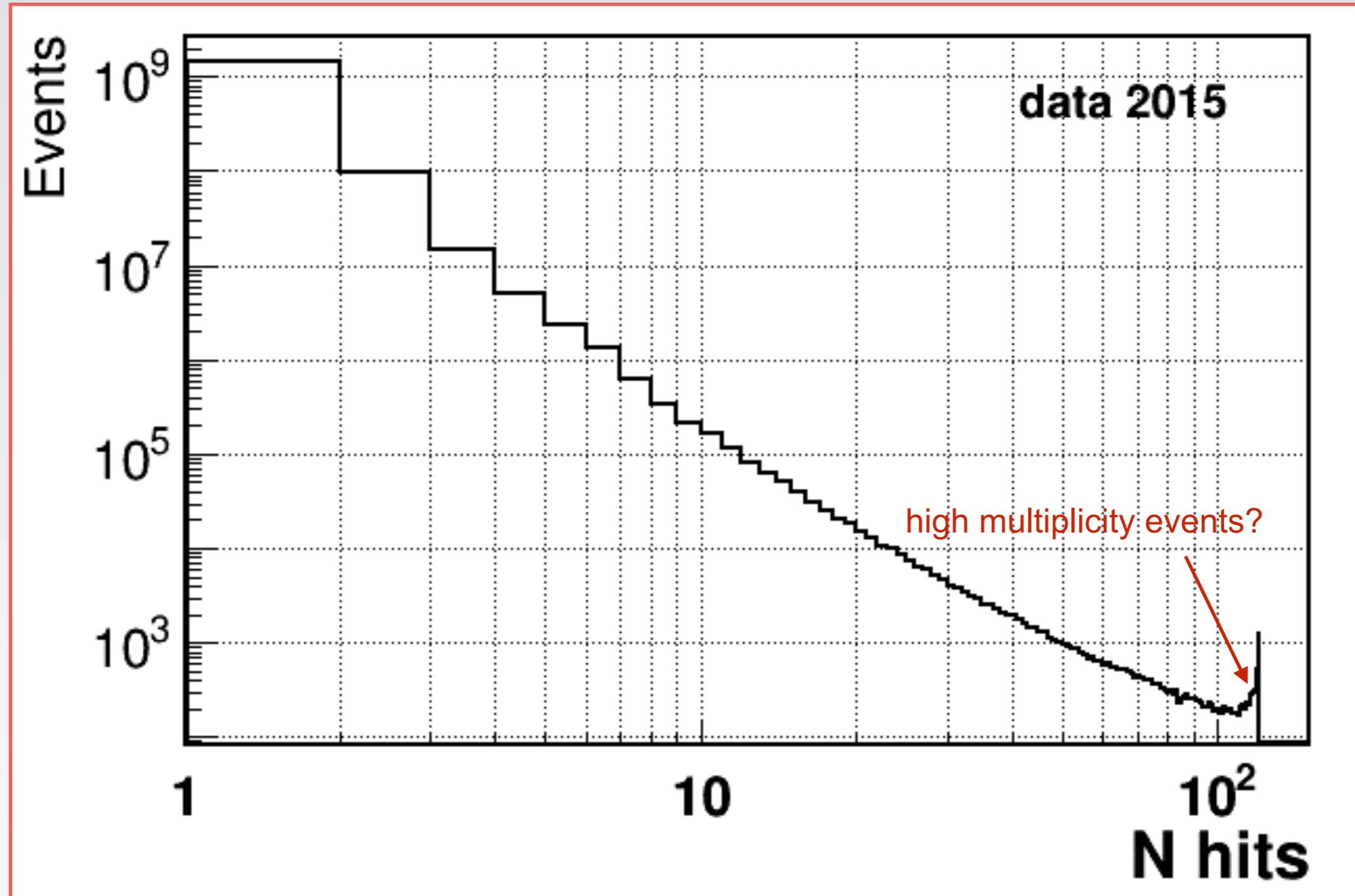
The detector is taking data regularly since ~April 1st. 2015

- Mean trigger rate  $\sim 70$  Hz.  $\sim 7$  Mevents/day
- Data stored  $\sim 700$  Gb/year,  $\sim 1.9$  Gb/day
- Global efficiency  $> 90\%$

## Multiplicity scope



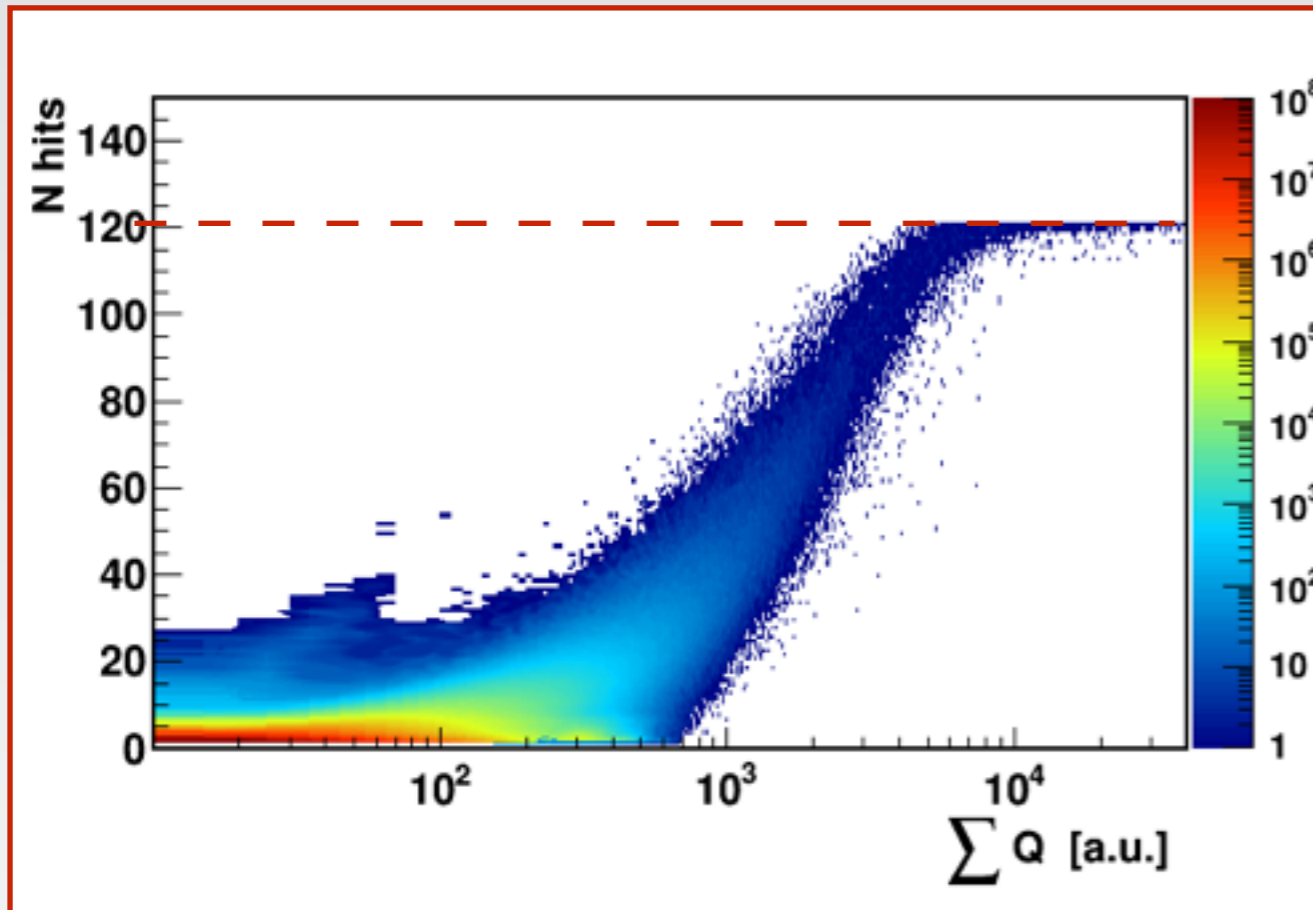
# TRAGALDABAS: a few technical performances



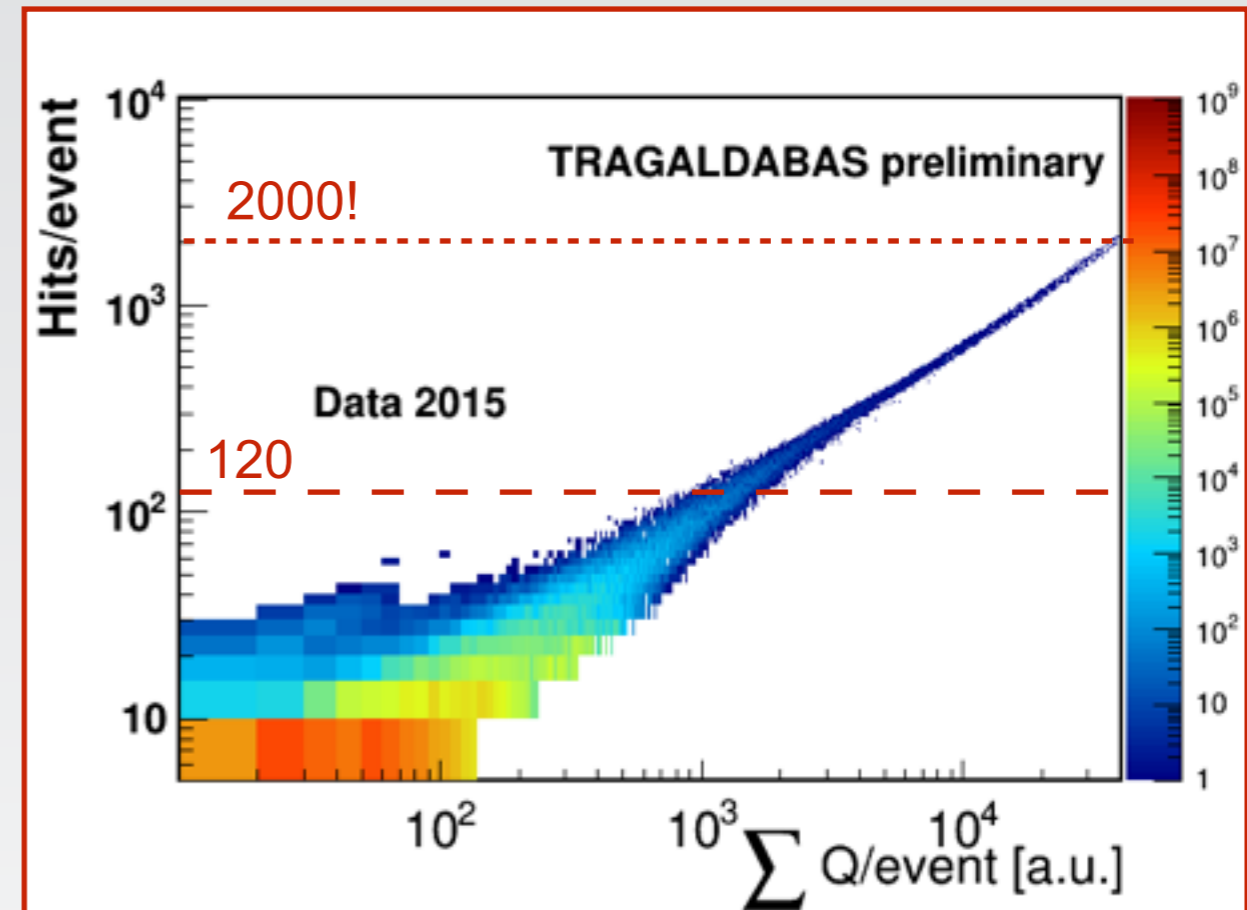
Histogram of number of hits in one plane



# TRAGALDABAS: a few technical performances



**N. hits vs. total charge Q in one plane**

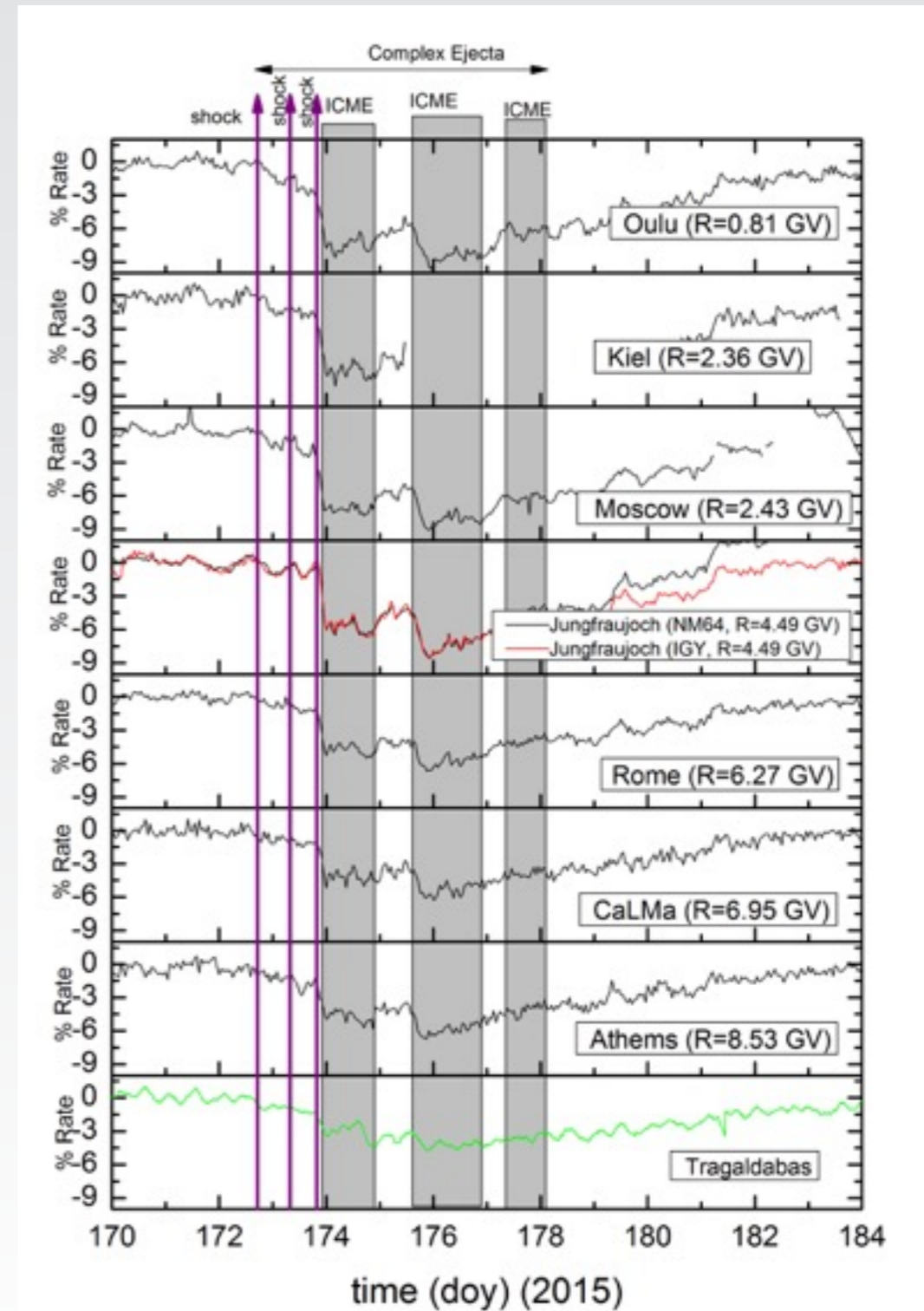
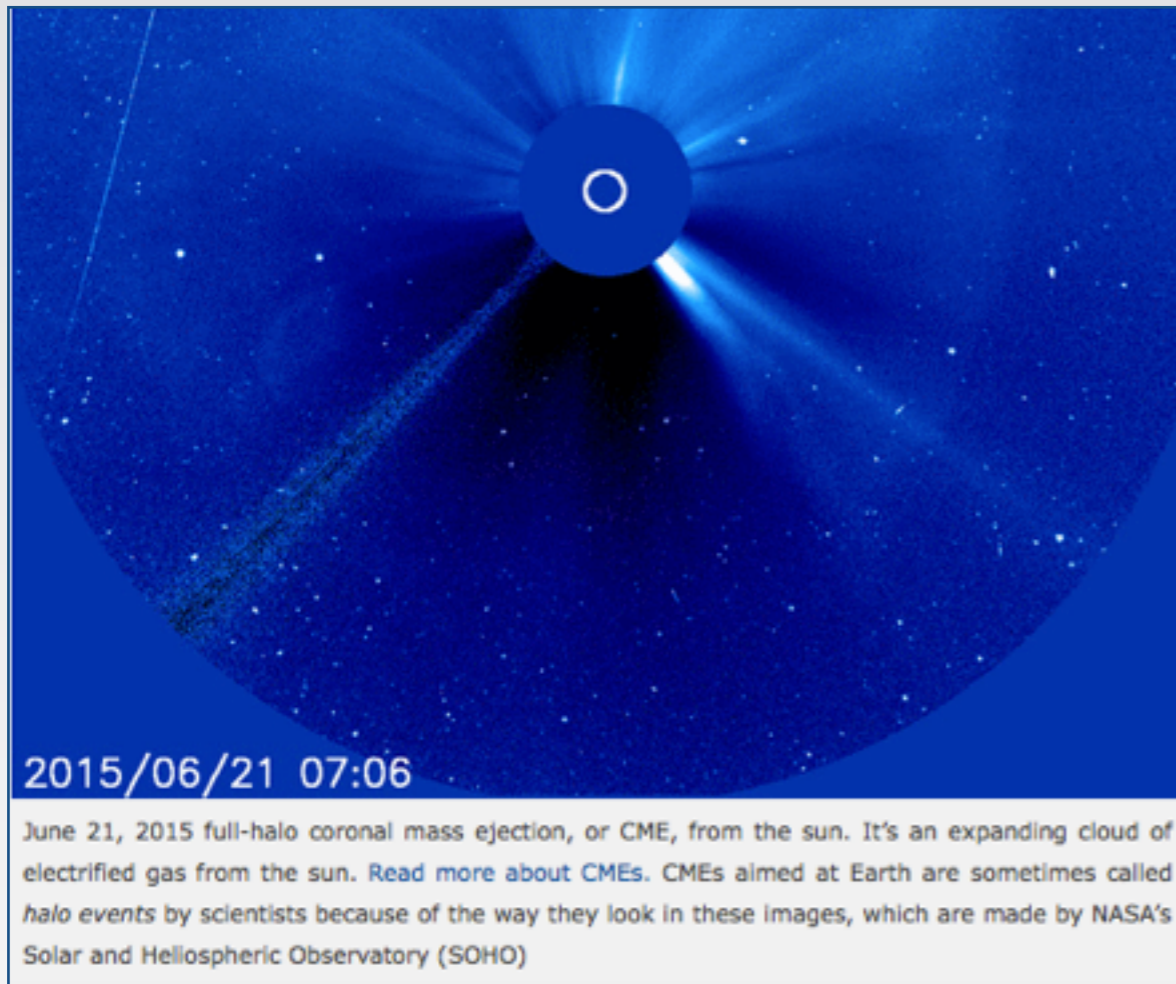


**Corrected N. hits vs. total charge Q**

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 / m<sup>2</sup>

# TRAGALDABAS: solar physics

## Analysis of the Forbush Decrease, on June 2015



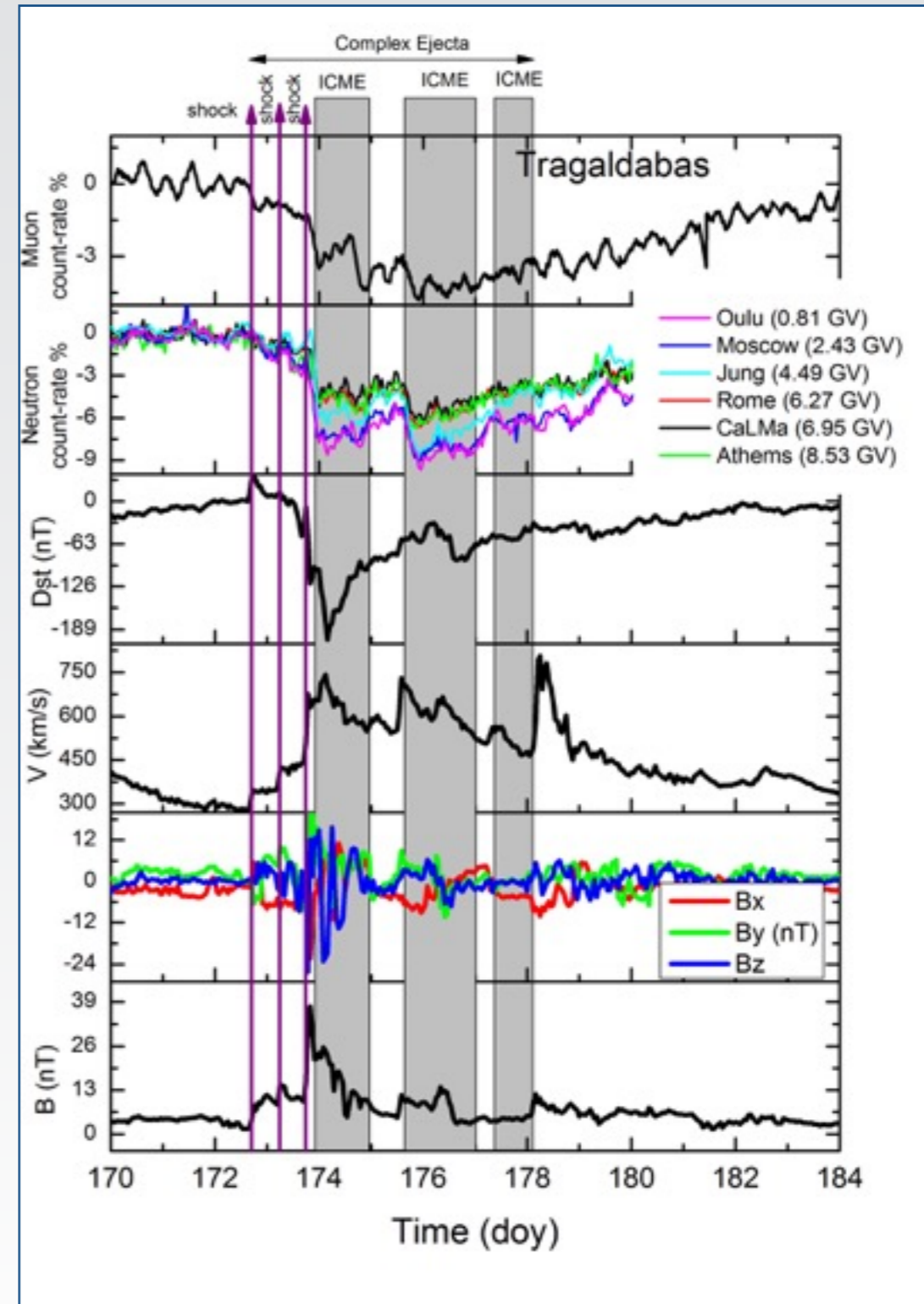
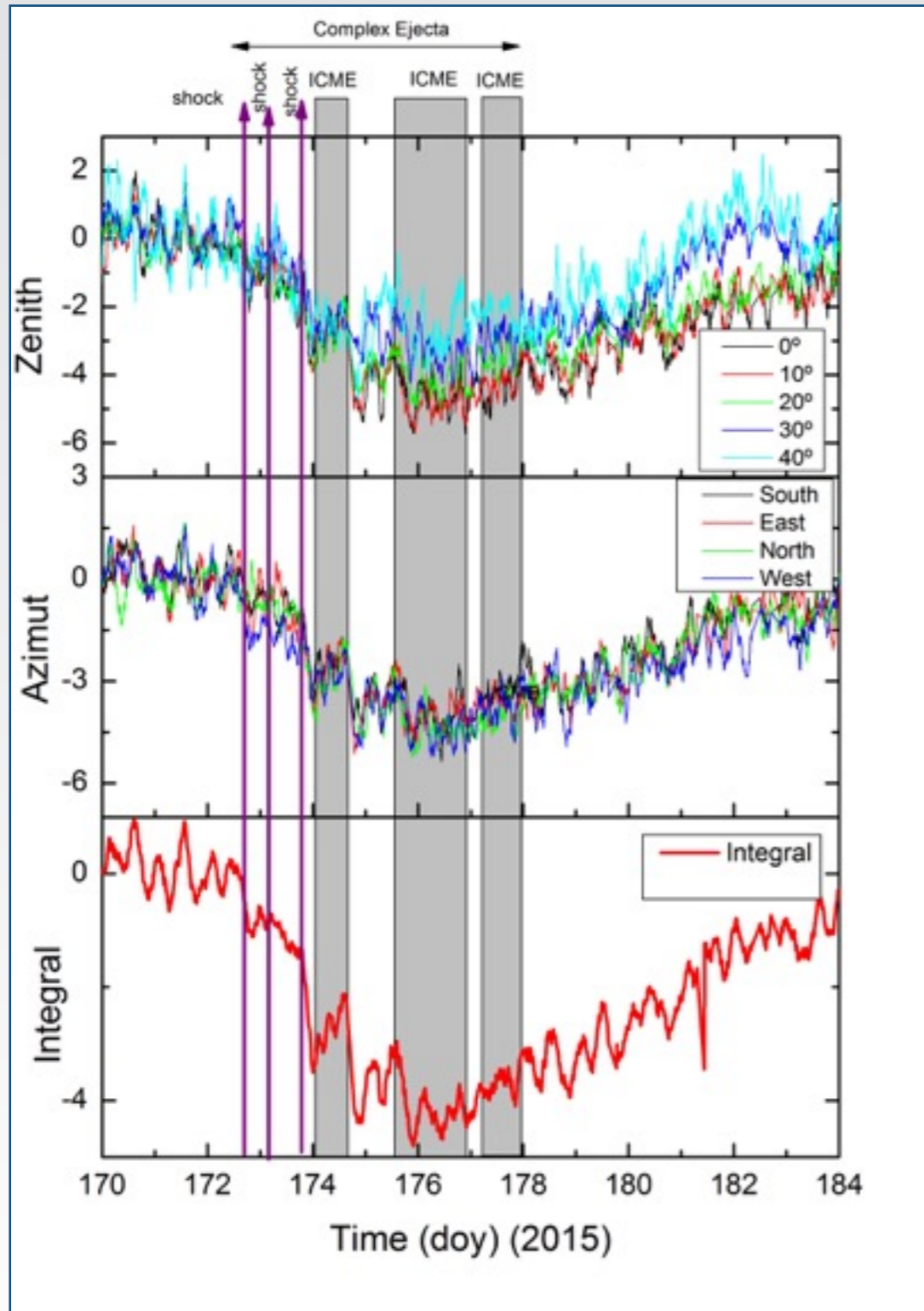
CME Soho picture on Jun. 21th. 2015





# TRAGALDABAS: solar physics

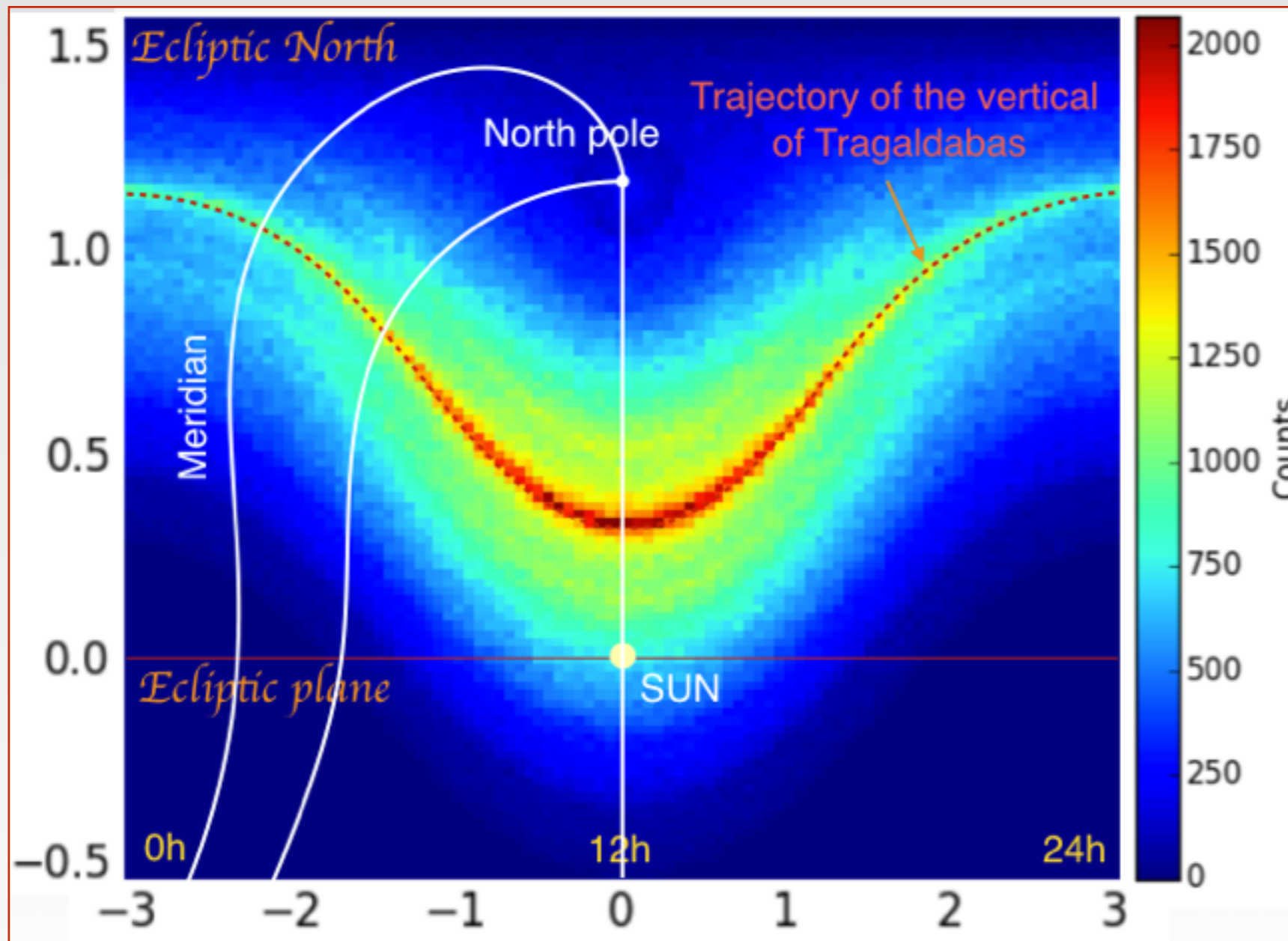
## Analysis of the Forbush Decrease, on June 2015





# TRAGALDABAS: solar physics

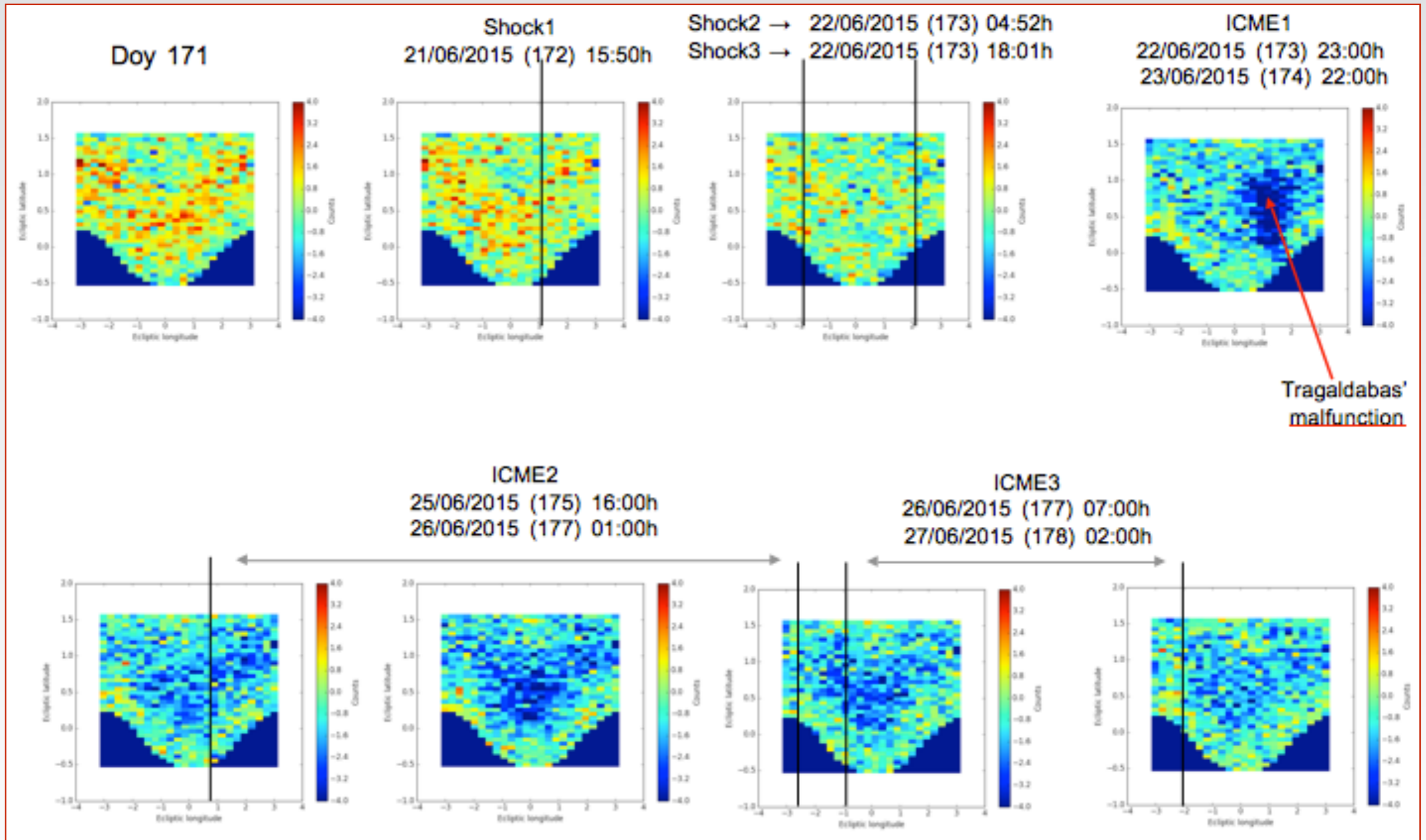
## Analysis of the Forbursh Decrease, on June 2015



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

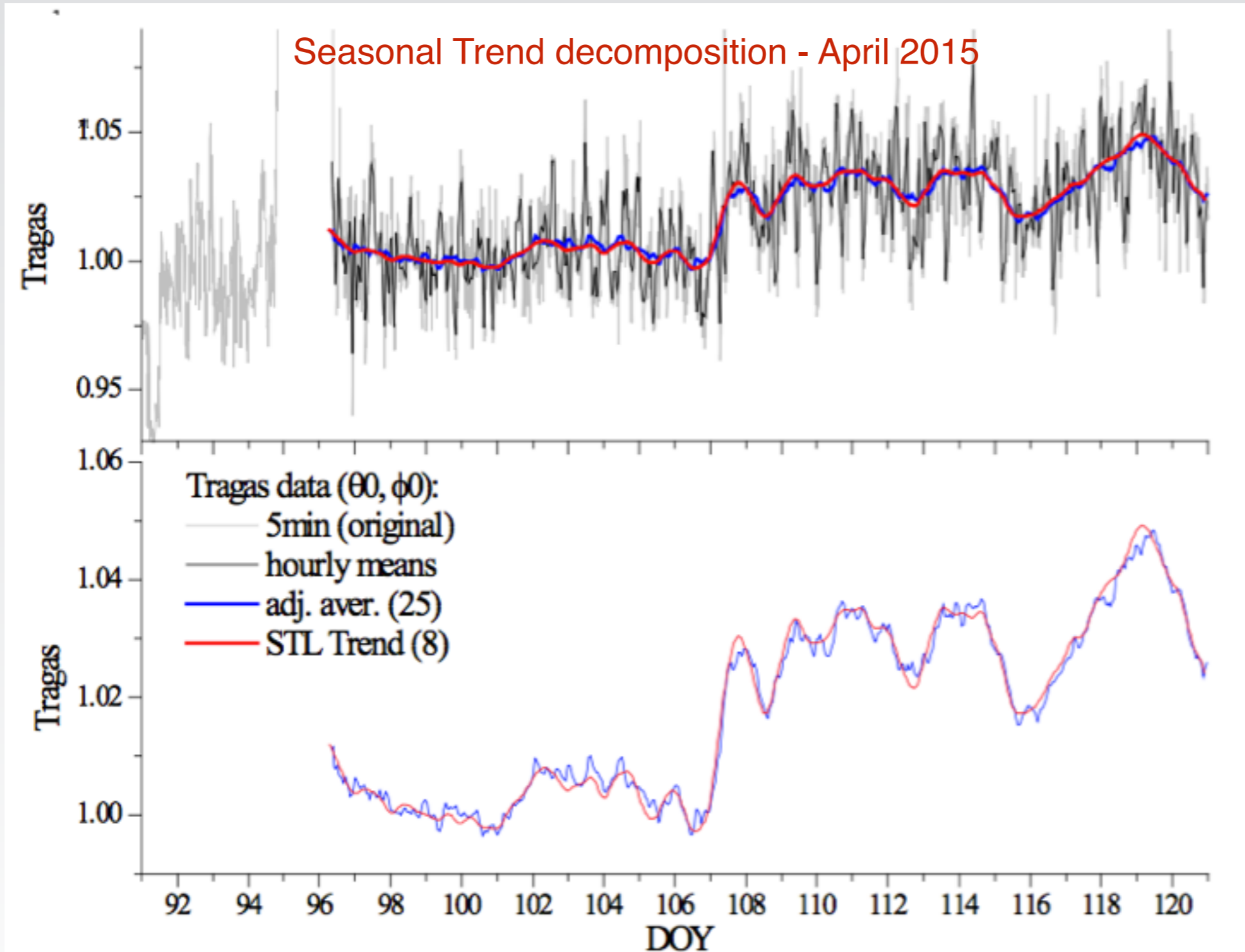
# TRAGALDABAS: solar physics

## Analysis of the Forbush Decrease, on June 2015: day by day evolution



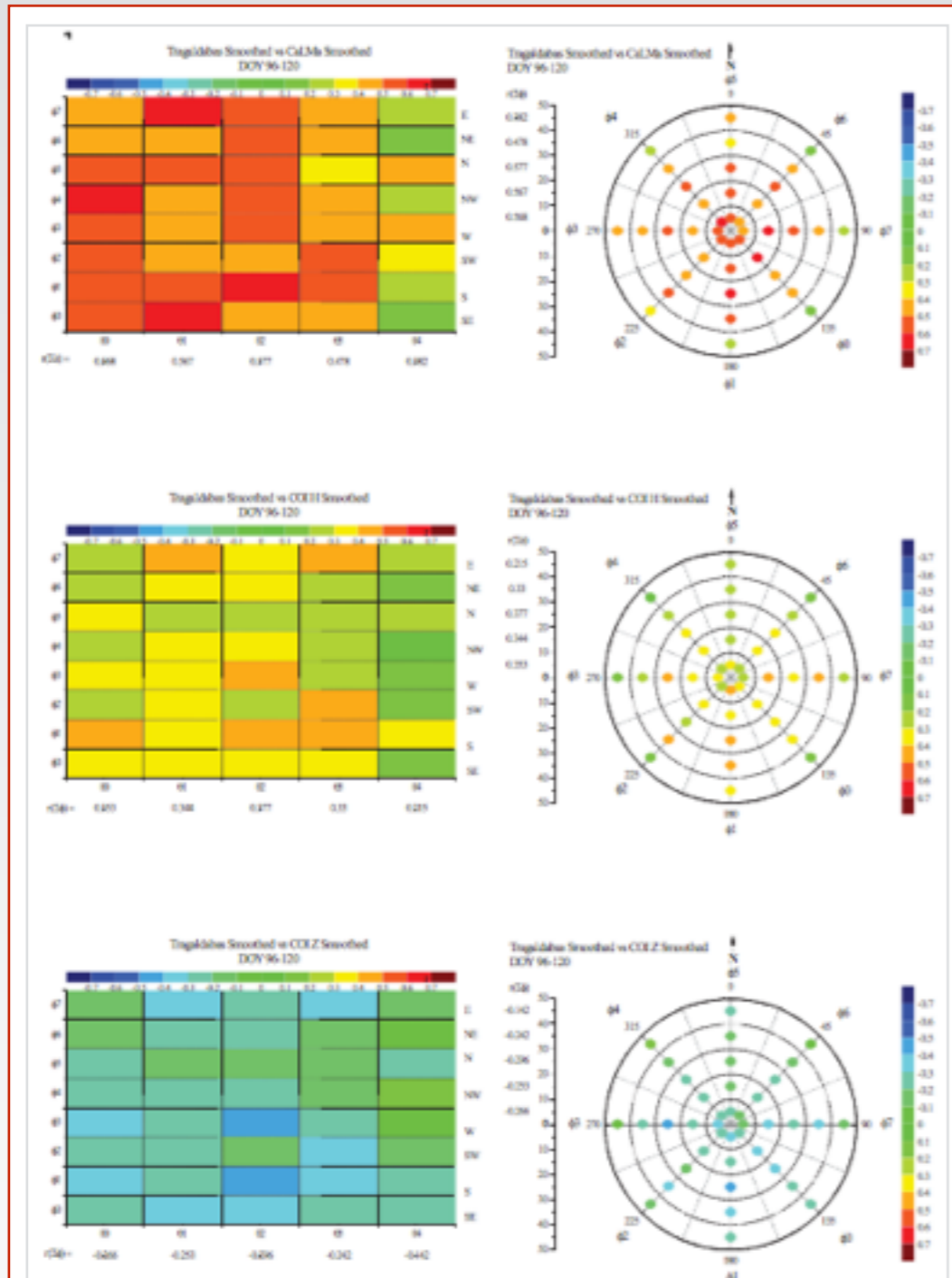
(Every picture represents the difference between each day and a reference mean of days!)

# TRAGALDABAS: Earth's magnetic field analysis

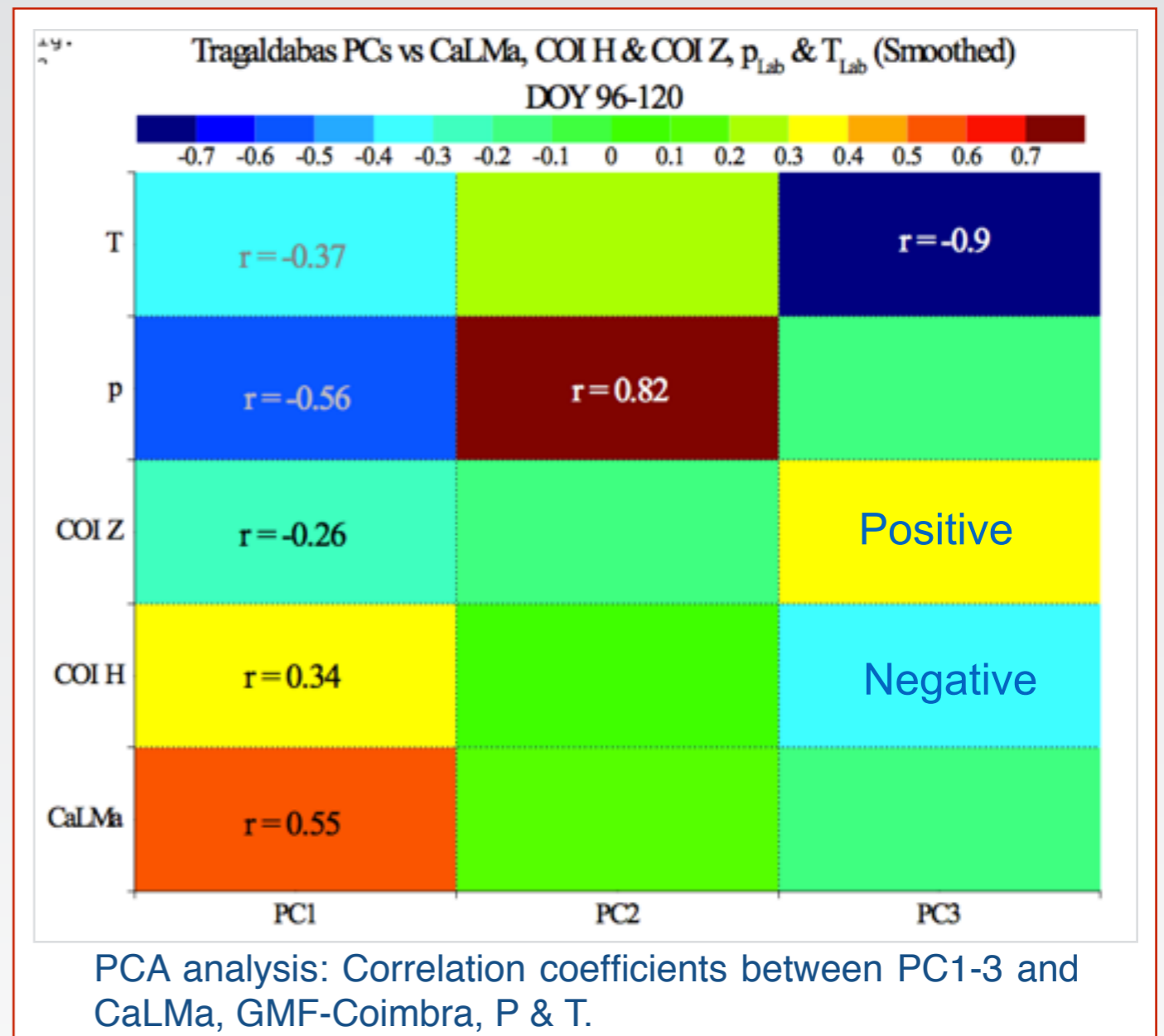




# TRAGALDABAS: Earth's magnetic field analysis



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

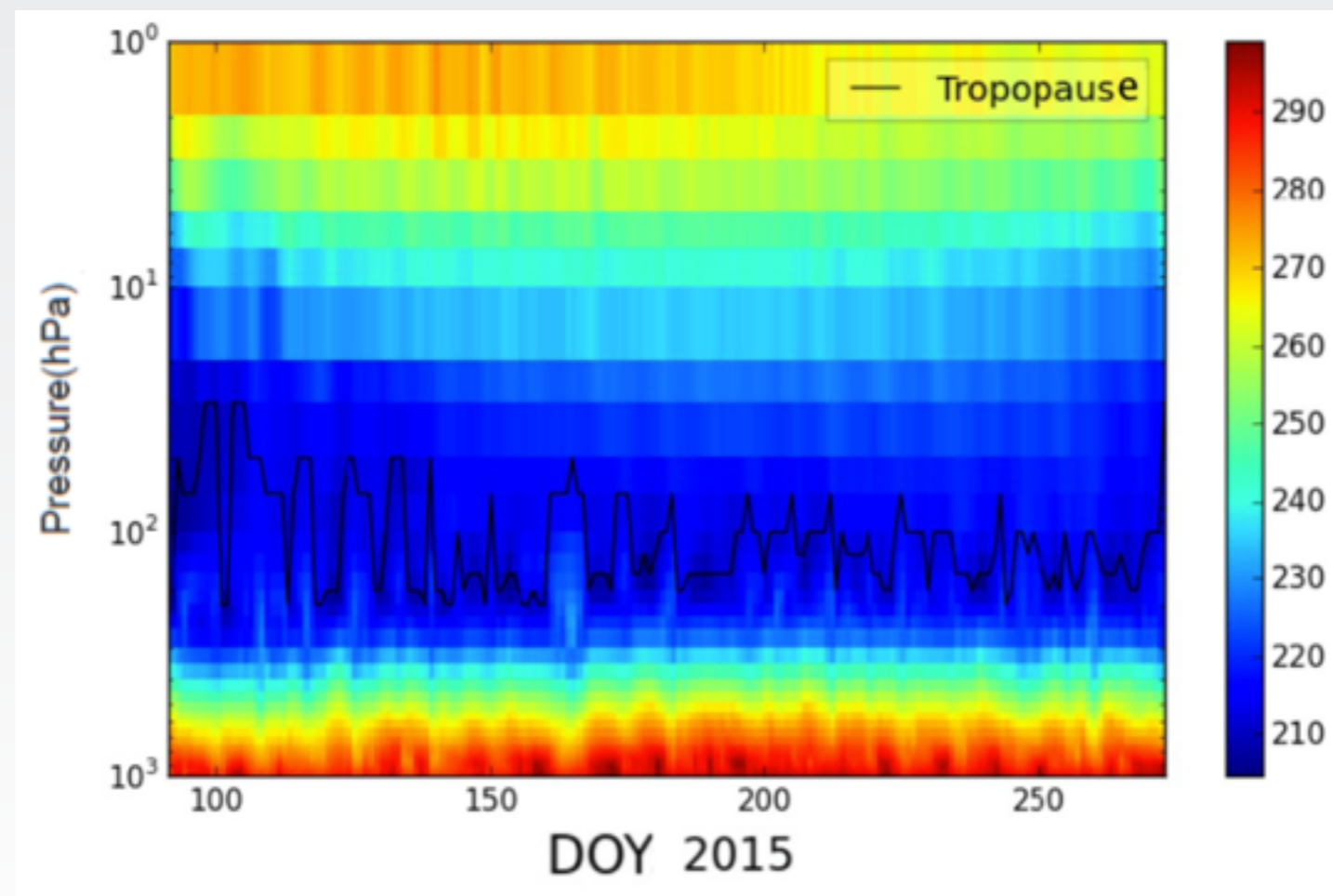


# TRAGALDABAS: Earth's atmosphere analysis

We have analyzed the possible correlations between atmosphere and cosmic ray data

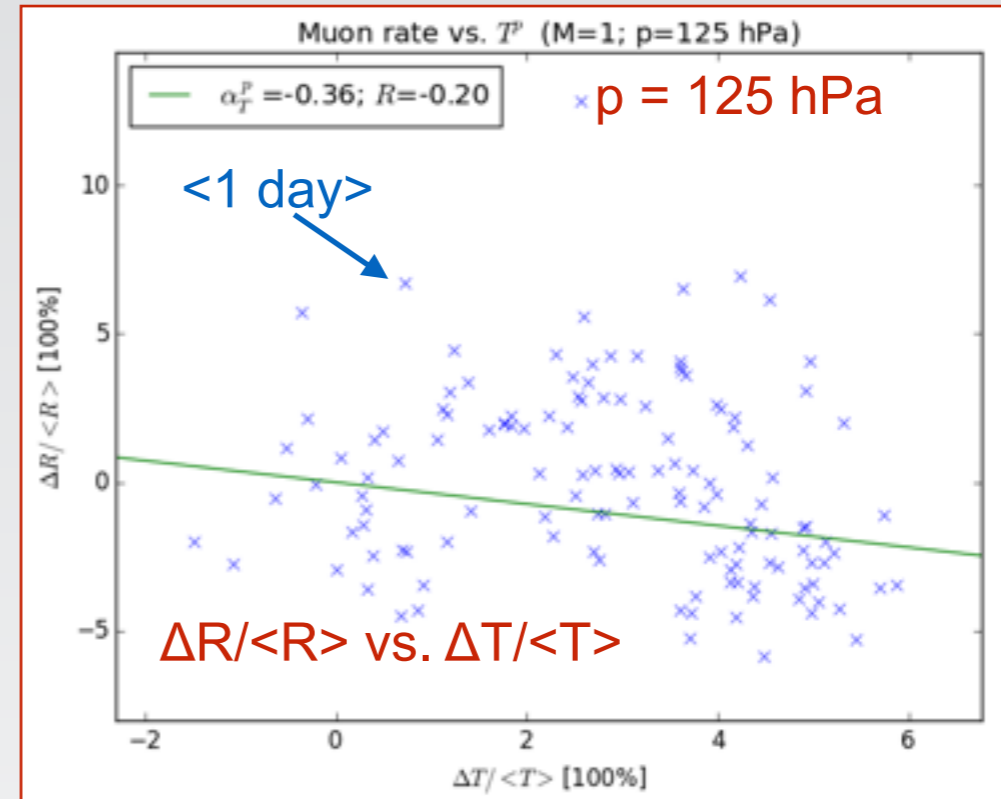
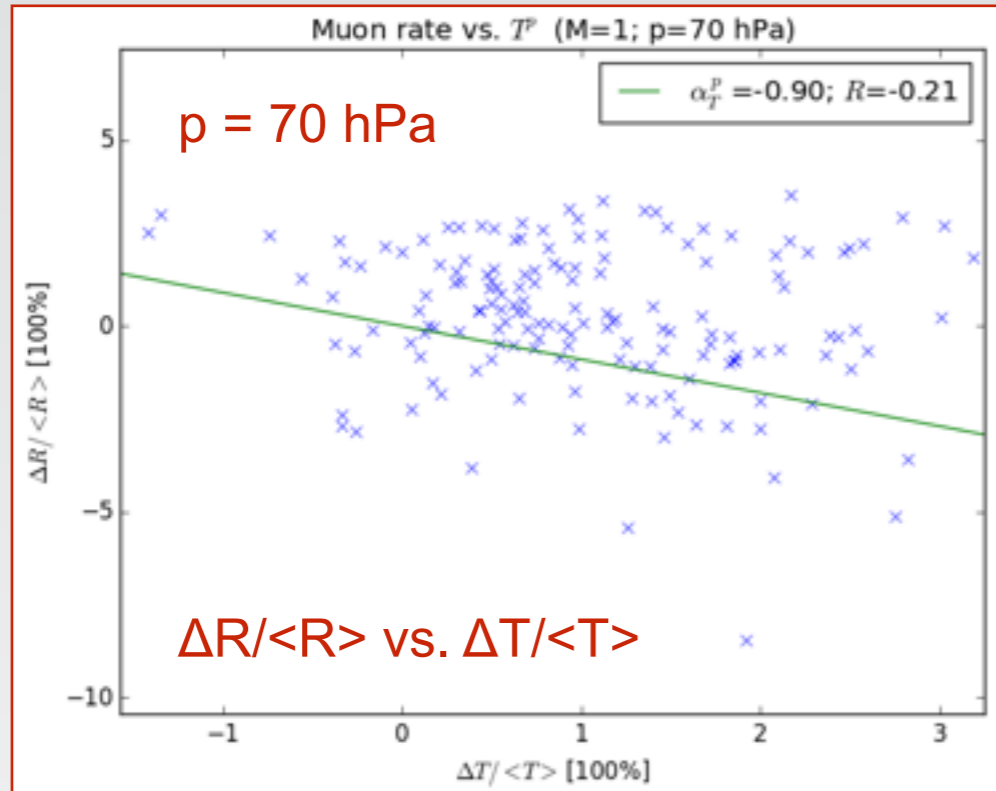


The screenshot shows the NCAR/UCAR ClimateDataGuide website. The main header includes the NCAR/UCAR logo and the title "ClimateDataGuide". Below the header are navigation tabs for "CLIMATE DATA", "ANALYSIS TOOLS", "MODEL EVALUATION", and "EXPERT CONTRIBUTORS". The main content area is titled "Climate Data" and features a sub-header for "CLIMATE FORECAST SYSTEM REANALYSIS (CFSR)". Below this, there are four tabs: "Summary" (selected), "Metadata", "Get Data (External)", and "References".

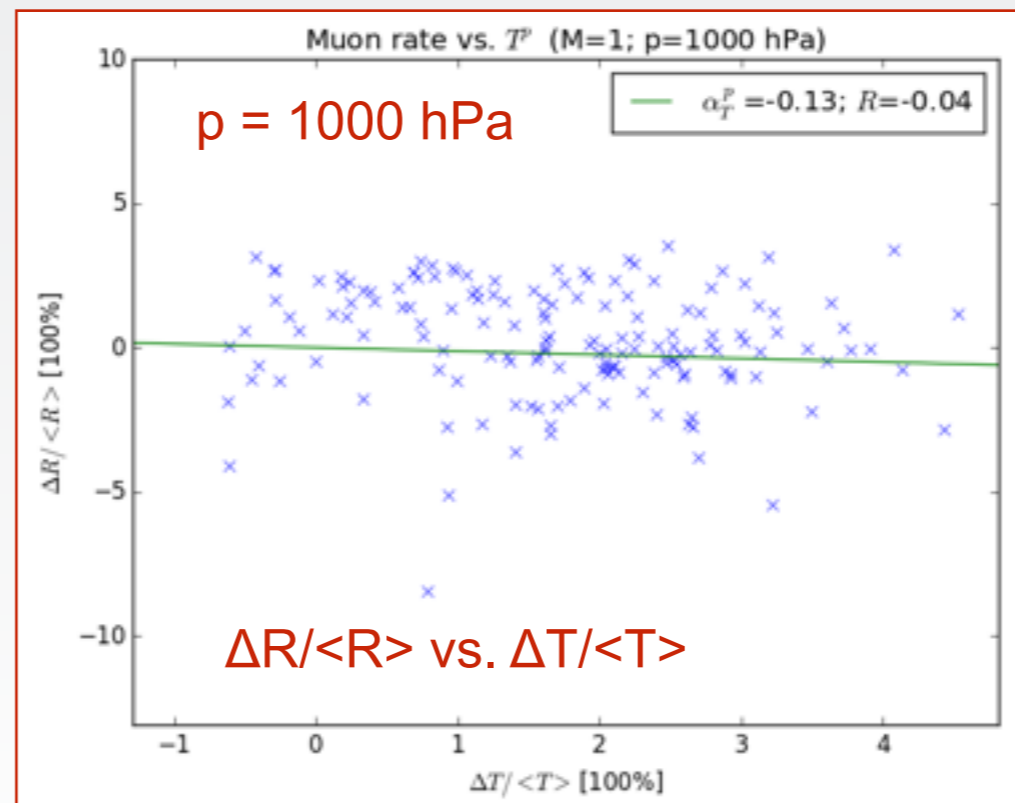


Juan A. Garzon, LabCAF / Univ. Santiago de Compostela  
ICRS 2016 -Torino

# TRAGALDABAS: Earth's atmosphere analysis

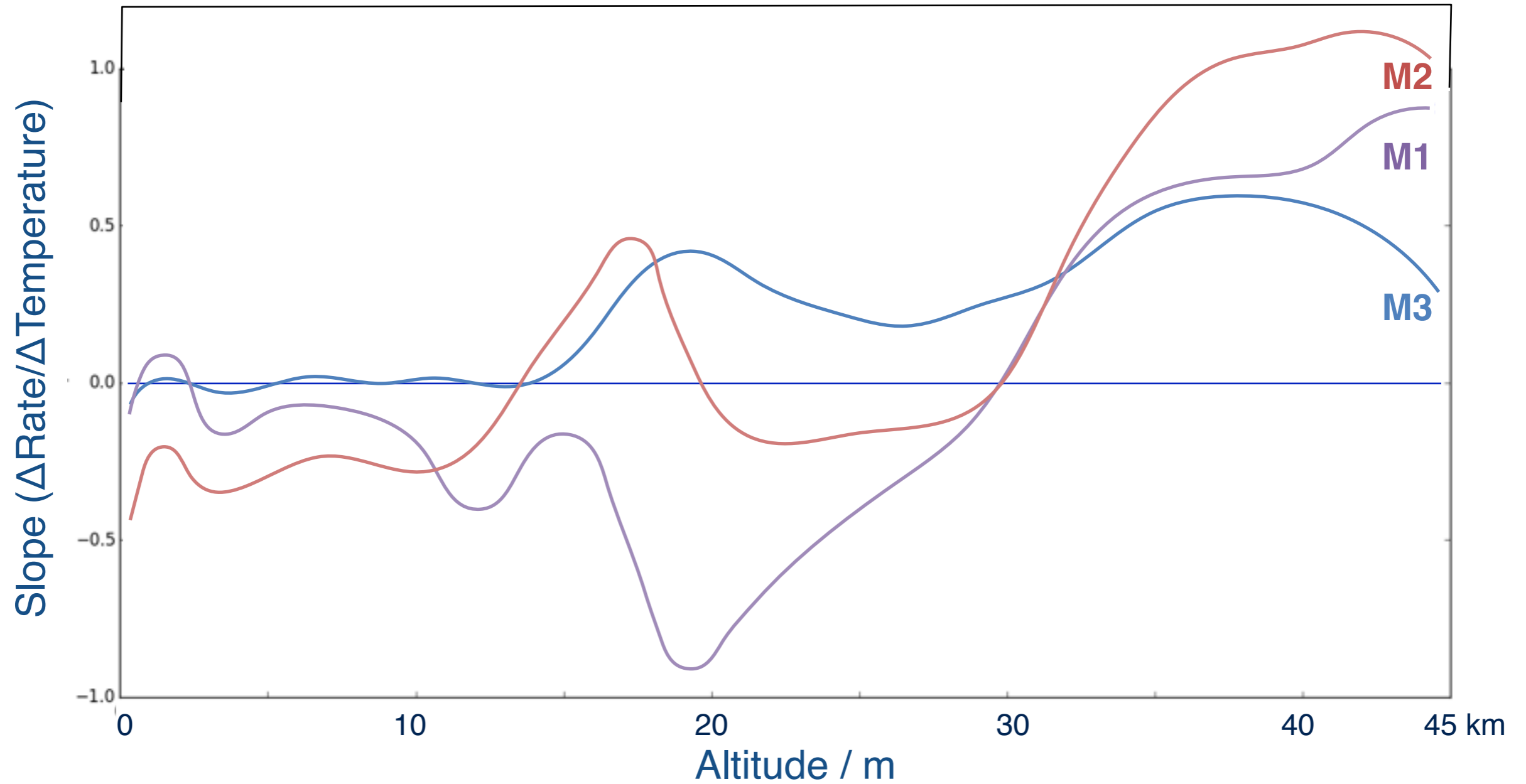


6 months data between  
Apr. 2015 and Sep. 2015



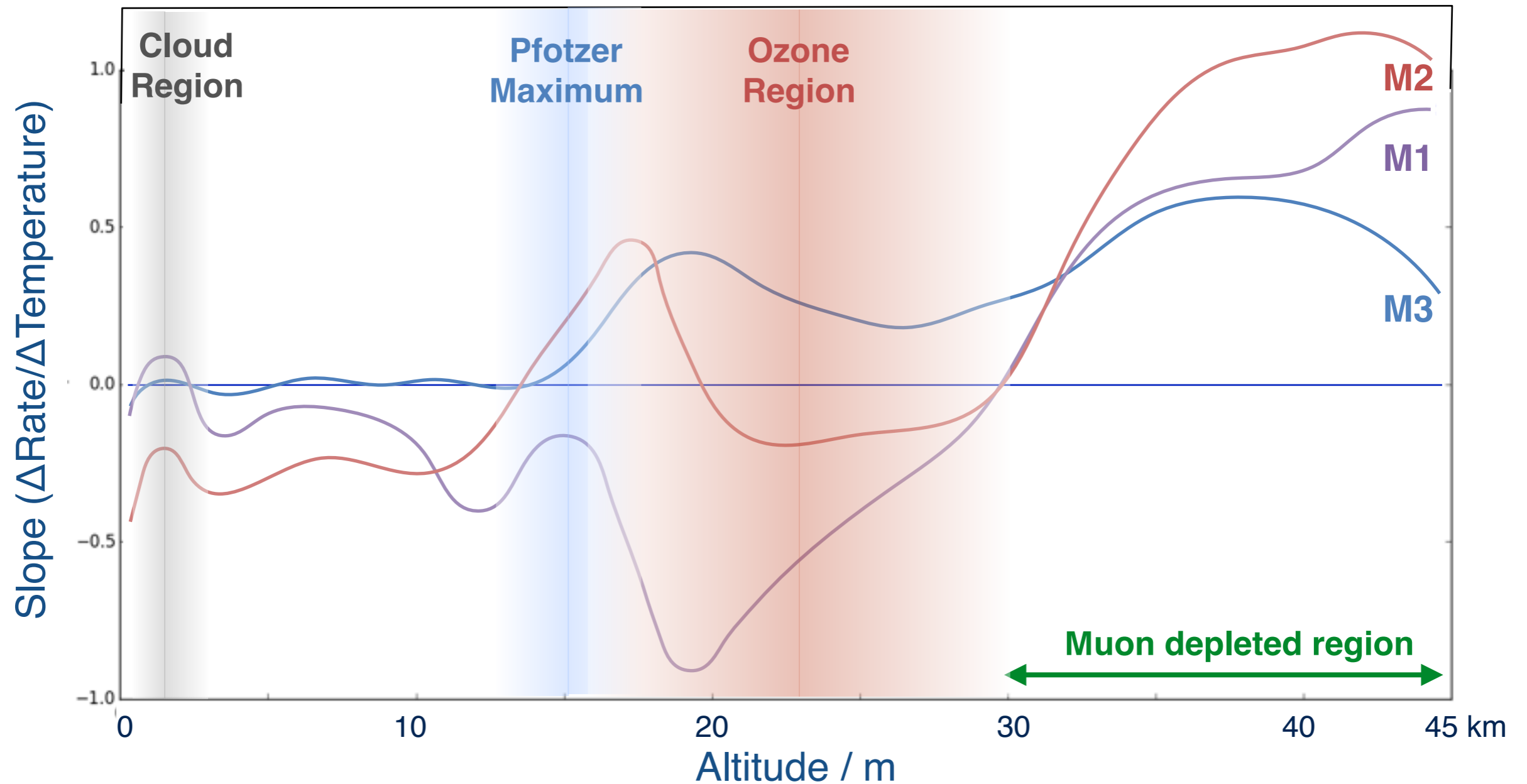


# TRAGALDABAS: Earth's atmosphere analysis



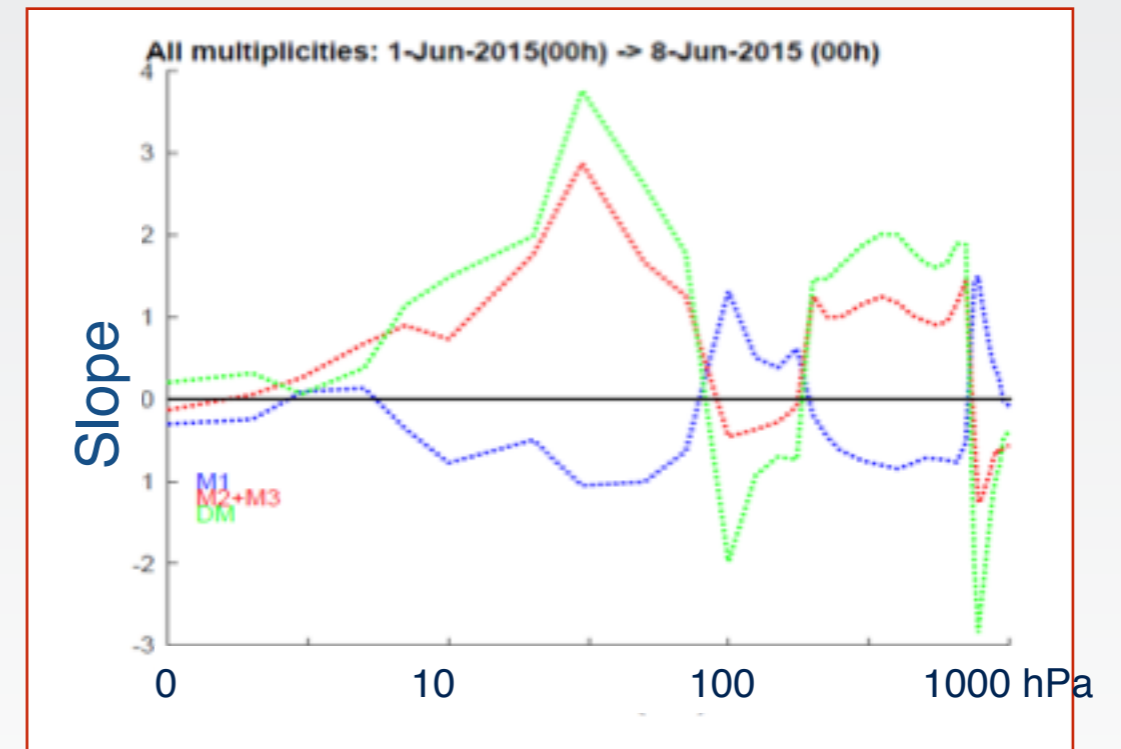
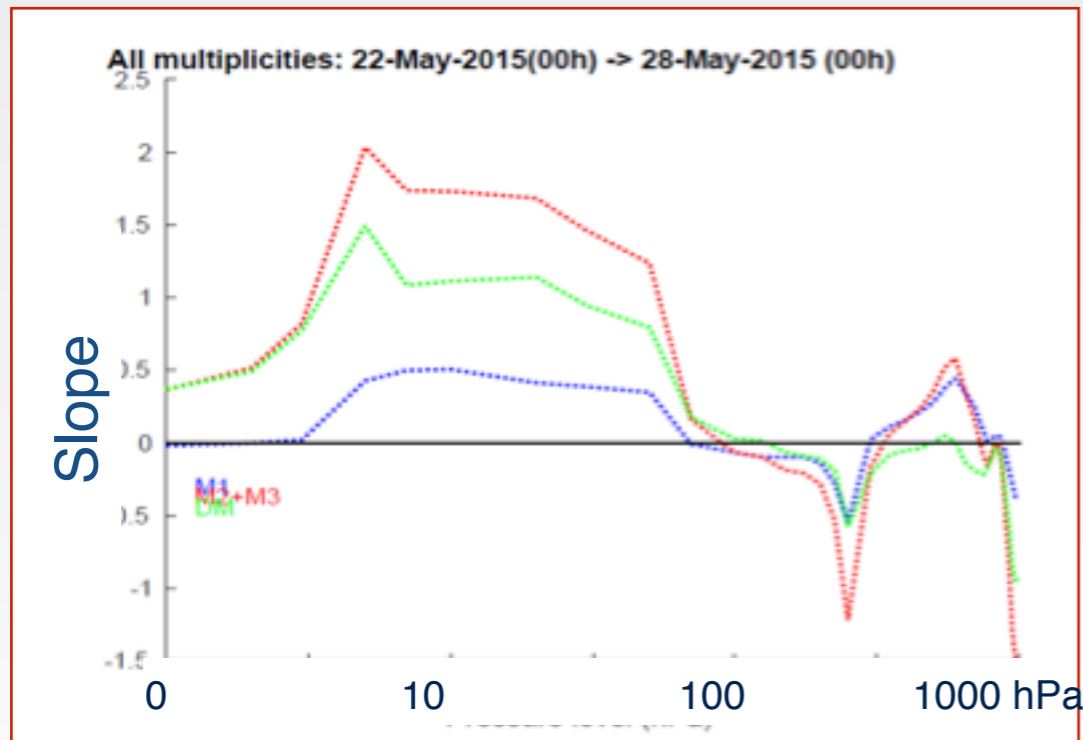
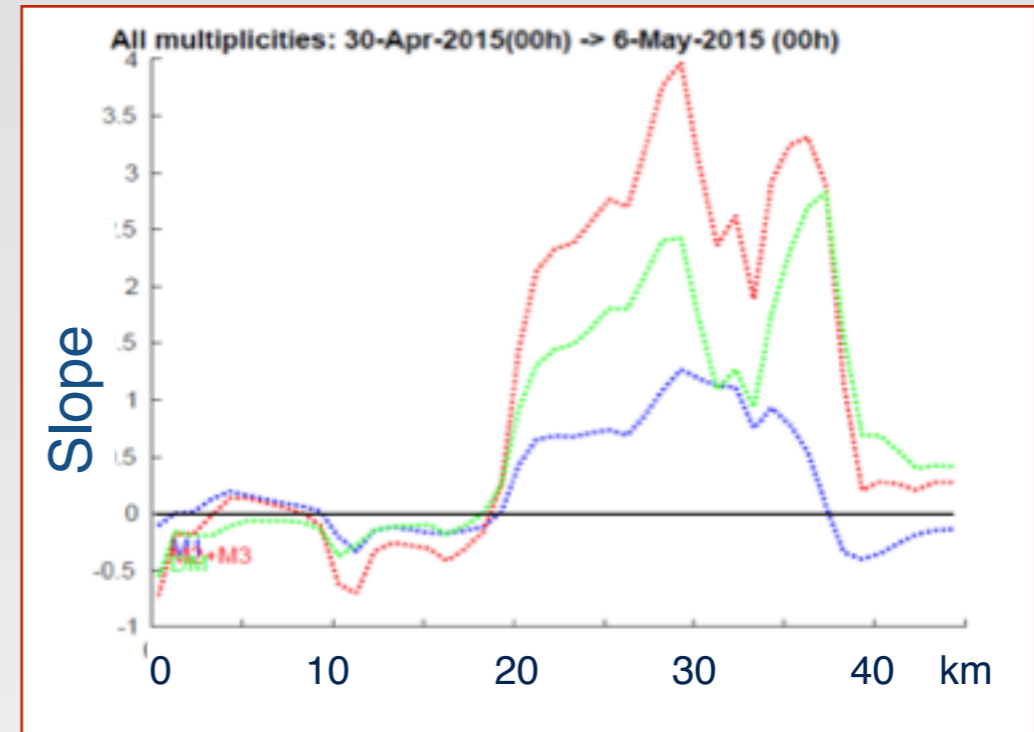
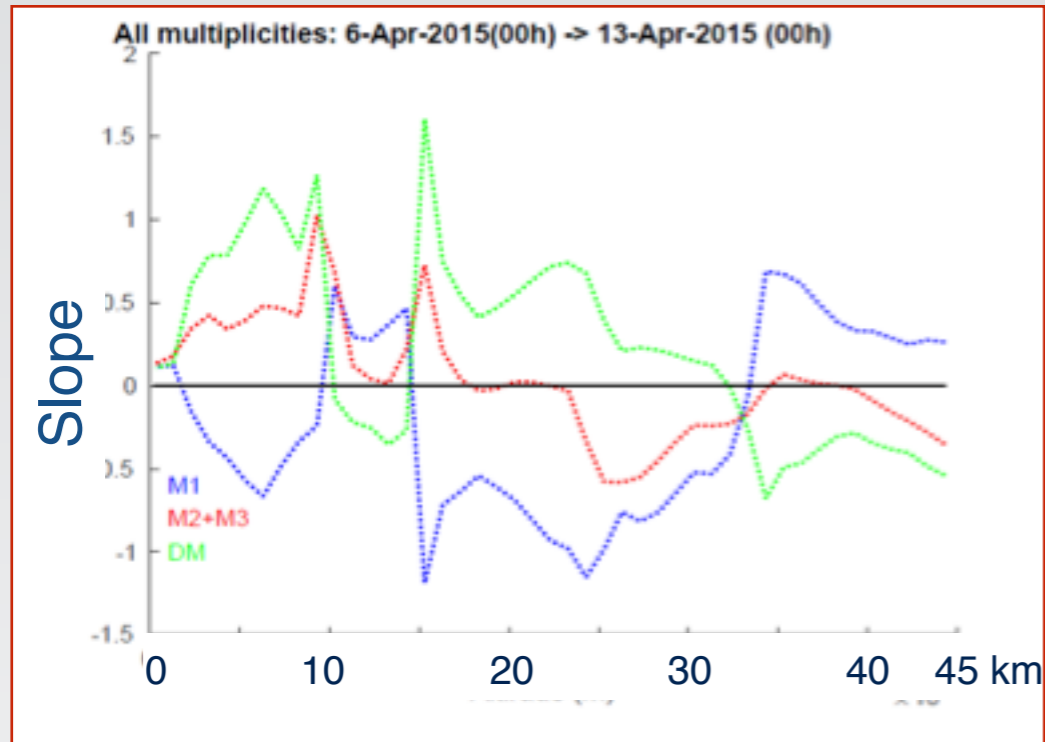
6 months data between Apr. 2015 and Sep. 2015

# TRAGALDABAS: Earth's atmosphere analysis



6 months data between Apr. 2015 and Sep. 2015

# TRAGALDABAS: Earth's atmosphere analysis



The weekly analysis show many fluctuations



- 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 fieds.
- The detectors is taking data regularly and it is still room to improve it significantly.
- We are on the way

# The End Thanks!



Juan A. Garzon, LabCAF / Univ. Santiago de Compostela  
ICRS 2016 - Torino

# TRAGALDABAS Collaboration (Sep. 2016)

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## Members:

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**Research students:** Damián García Castro<sup>10</sup>, Jorge Otero Santos<sup>10</sup>, Irma Riadigós<sup>12</sup>

## Laboratory:Tasks

1. Univ. Alcalá de Henares, Spain: **Solar Physics**
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. Jagellonian 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)