Proyecto trasgo Project

Cosmic ray physics with the TRAGALDABAS detector

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LabCAF, IGFAE. Univ. Santiago de Compostela

on behalf of the

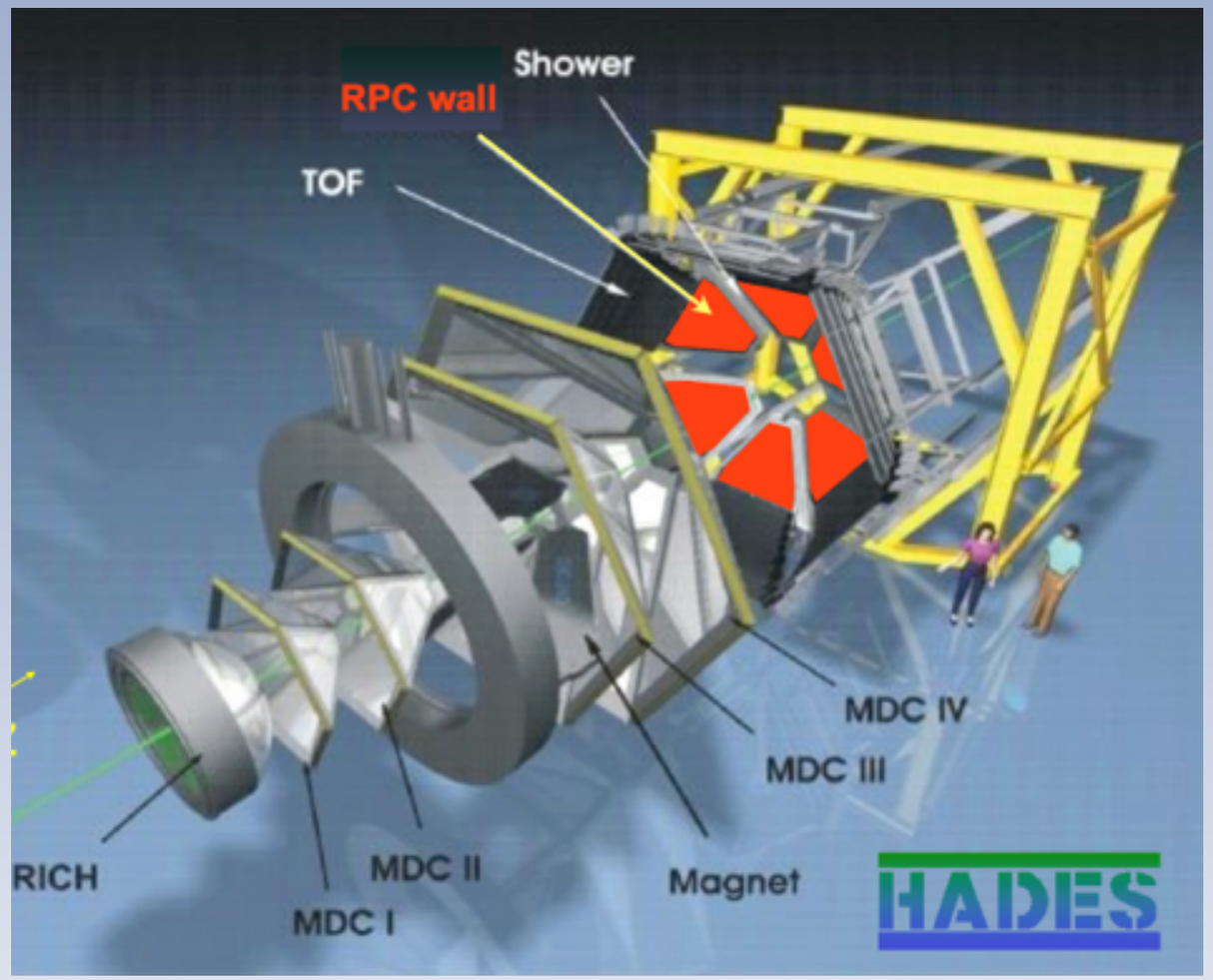
TRAGALDABAS Collaboration

Outlook:

1. The beginning
2. The TRASGO Project
3. The first TRASGO: TRAGALDABAS
4. TRAGALDABAS: preliminary results
   - FD June 2015
   - Atmosphere analysis
5. The TRASGO Project: Next steps & Summary

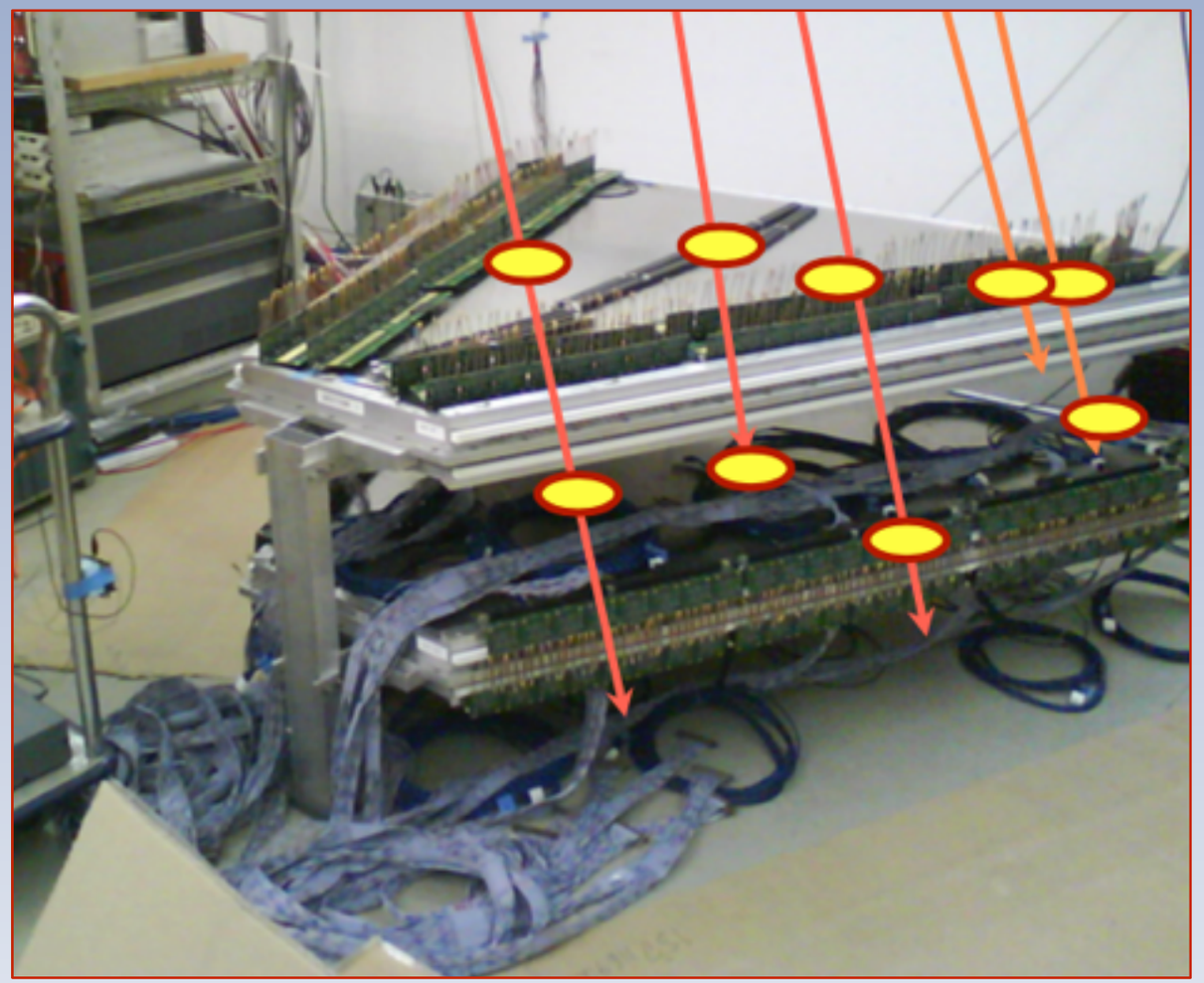
The beginning

The Nuclear Physics HADES experiment



The HADES spectrometer at GSI-Darmstadt

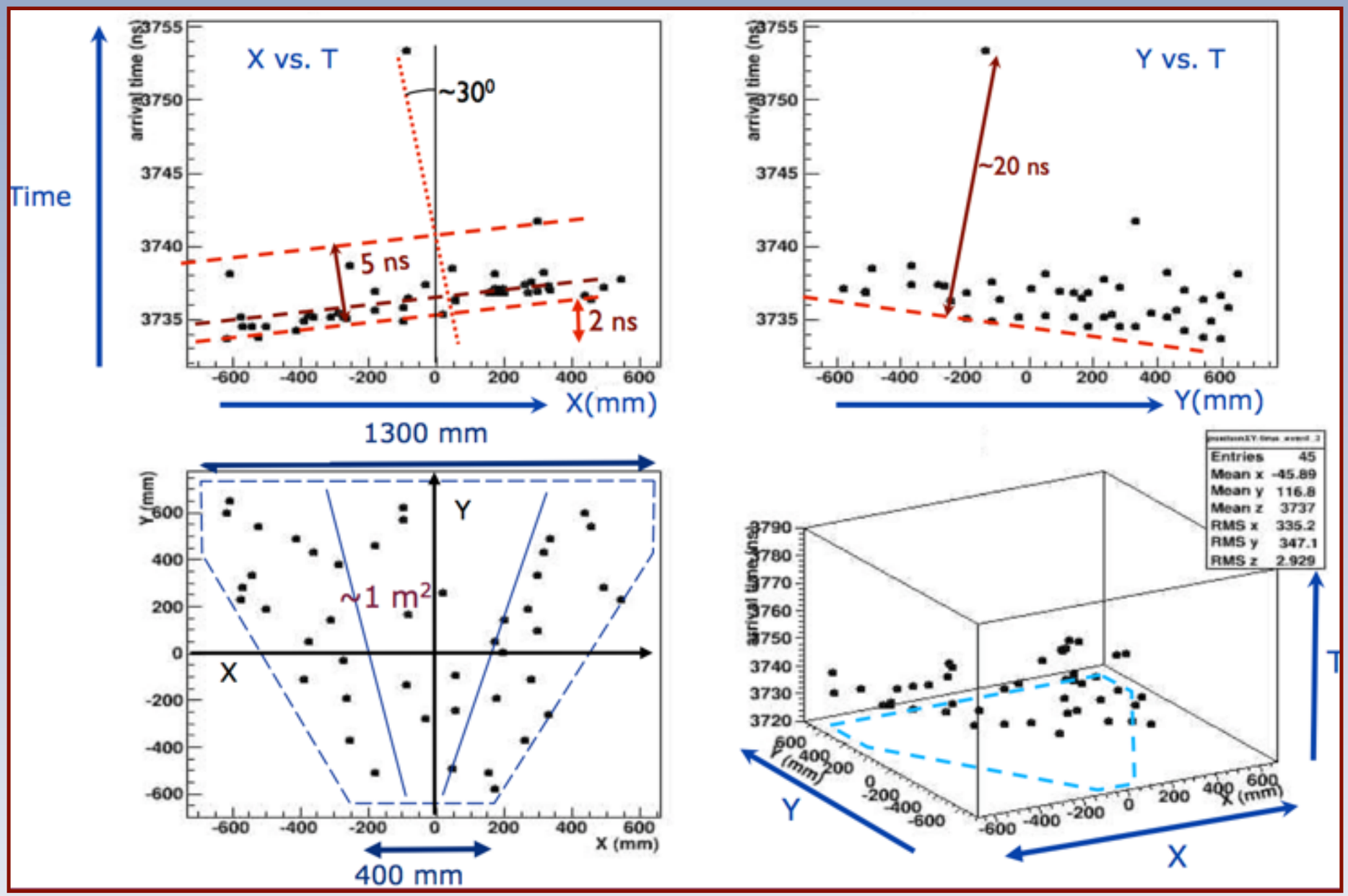
The RPC wall commissioning



RPC commissioning with cosmic rays

The beginning

A cosmic ray shower picture using the HADES RPC detectors

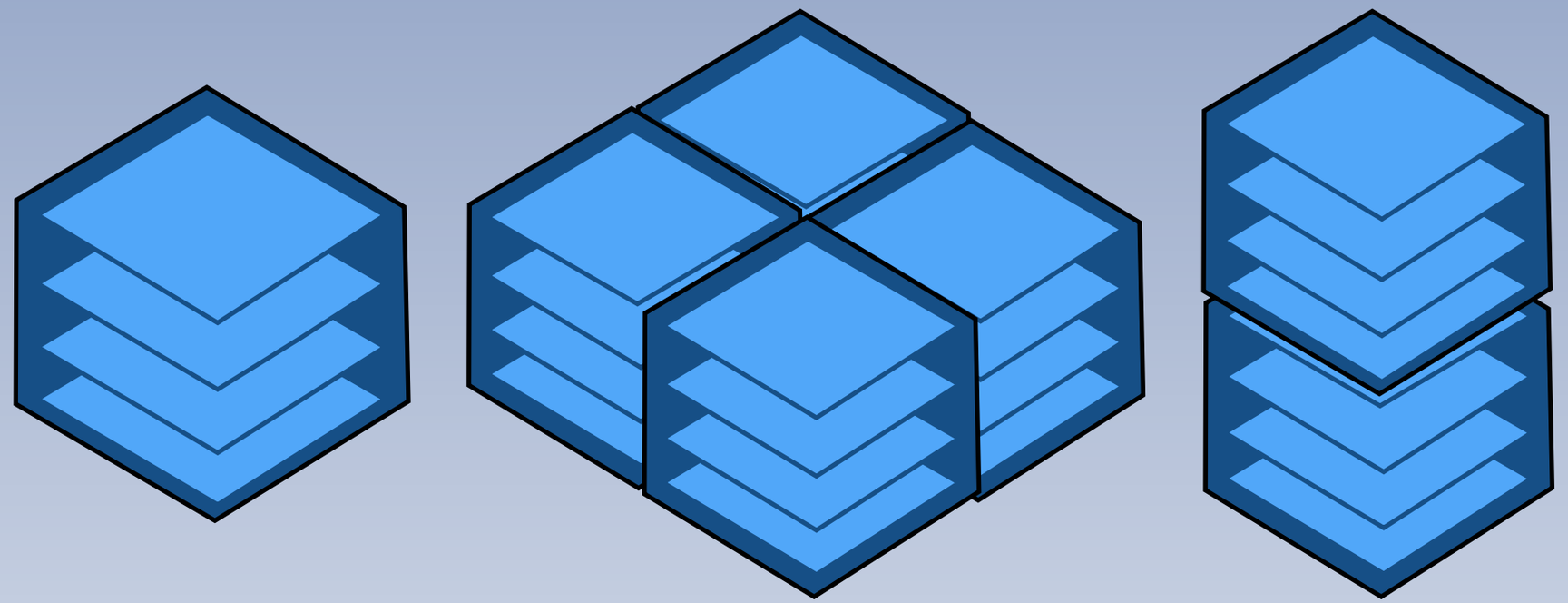


$\delta T \sim 150$ ps, $\delta S \sim 5$ cm^2, $\delta\theta \sim 5^\circ$

Never cosmic rays were observed at the Earth's surface with such accuracy!

The TRASGO project

The idea: why not developing modular cosmic ray tracking detectors?

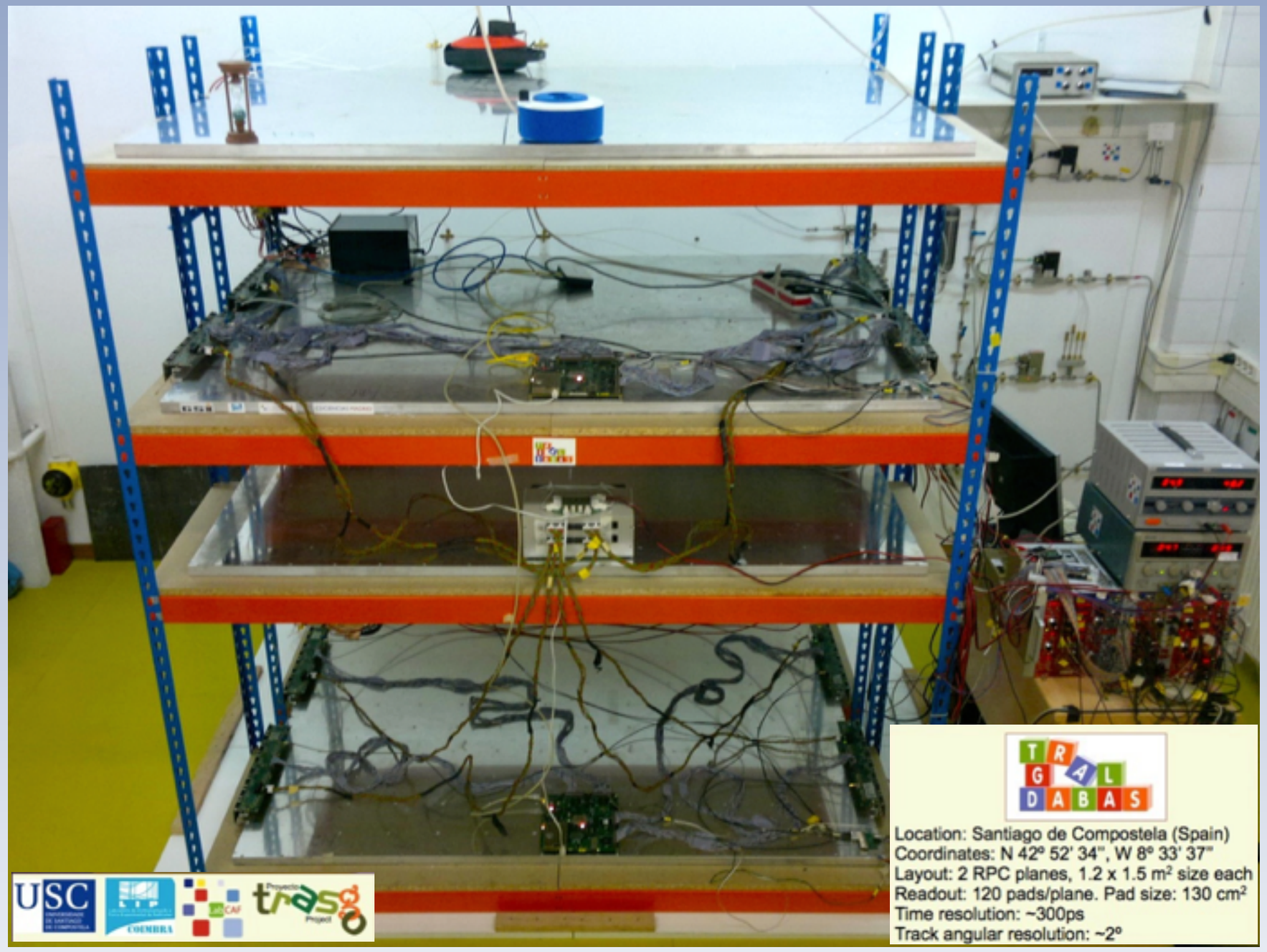


The solution: TRASGO (= pixie, goblin) : TRAck reconStructinG bOx

- Multi-channel Tracking detector
- Modular concept
- Sensitive to both muon and electromagnetic showers (software PID)
- Stand-alone Plug&Play very affordable detector (RPC-based)

The first Trasgo: TRAGALDABAS

(Pronuntiation: *trugul*dubus)



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

The first Trasgo: TRAGALDABAS

The TRAGALDABAS Collaboration

H. Alvarez-Pol[8], A.Blanco[4], J.J.Blanco[1], P.Cabanelas[8], F.Clemencio[4], J.Collazo[10], J.Cuenca[10], P.Fonte[4], Y.Fontenla[10], D.García Castro[10], J.A.Garzón[10], A.Gómez-Tato[7], A.Gomis[6], D.González-Díaz[9], G.Kornakov[5], T.Kurtukian[2], L.Lopes[4], C. Loureiro[4], A.Morozova[3], J.C.Mouriño[7], M.A.Pais[3], A.Pazos[9], V.Pérez Muñuzuri[11], P.Rey[7], I.Riádigos[11], M.Seco[9], V. Villasante[6].

Laboratory / Task

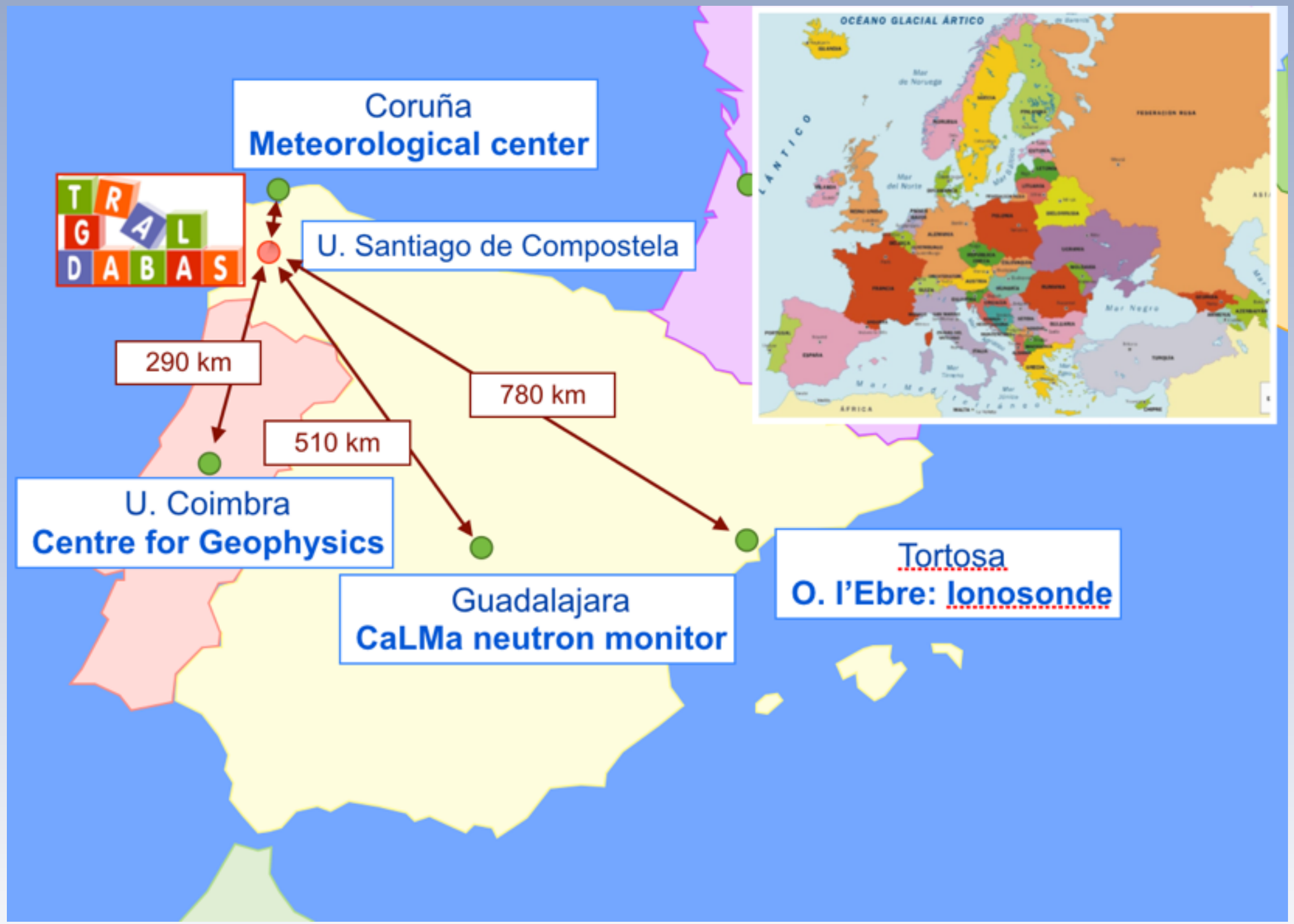
1. Univ. Alcalá de Henares, Spain / Solar Physics
2. CEN - Bordeaux, France / Nuclear and Solar Physics
3. CITEUC - U. Coimbra, Portugal / Geomagnetic field and Space Weather
4. LIP- Coimbra, Portugal / RPC detectors and instrumentation
5. Technische Univ. Darmstadt, Germany / Geomagnetic field
6. IGN - Madrid, Spain / Geomagnetic field
7. CESGA Super-computation Center - Santiago de Compostela, Spain / Data storage and distribution
8. GENP - Univ. Santiago de Compostela, Spain / Software development and simulation
9. IGFAE - Univ. Santiago de Compostela, Spain / Monitoring and Slow control
10. LabCAF - Univ. Santiago de Compostela, Spain / Track reconstruction and data analysis
11. GFNL - Univ. Santiago de Compostela, Spain / Atmosphere Physics and Climate

Other partners:

ATI Sistemas. La Coruña, Spain
Hydra Technologies Spain S.L. Vigo, Spain
Club Desarrollo de las Ciencias, Madrid, Spain

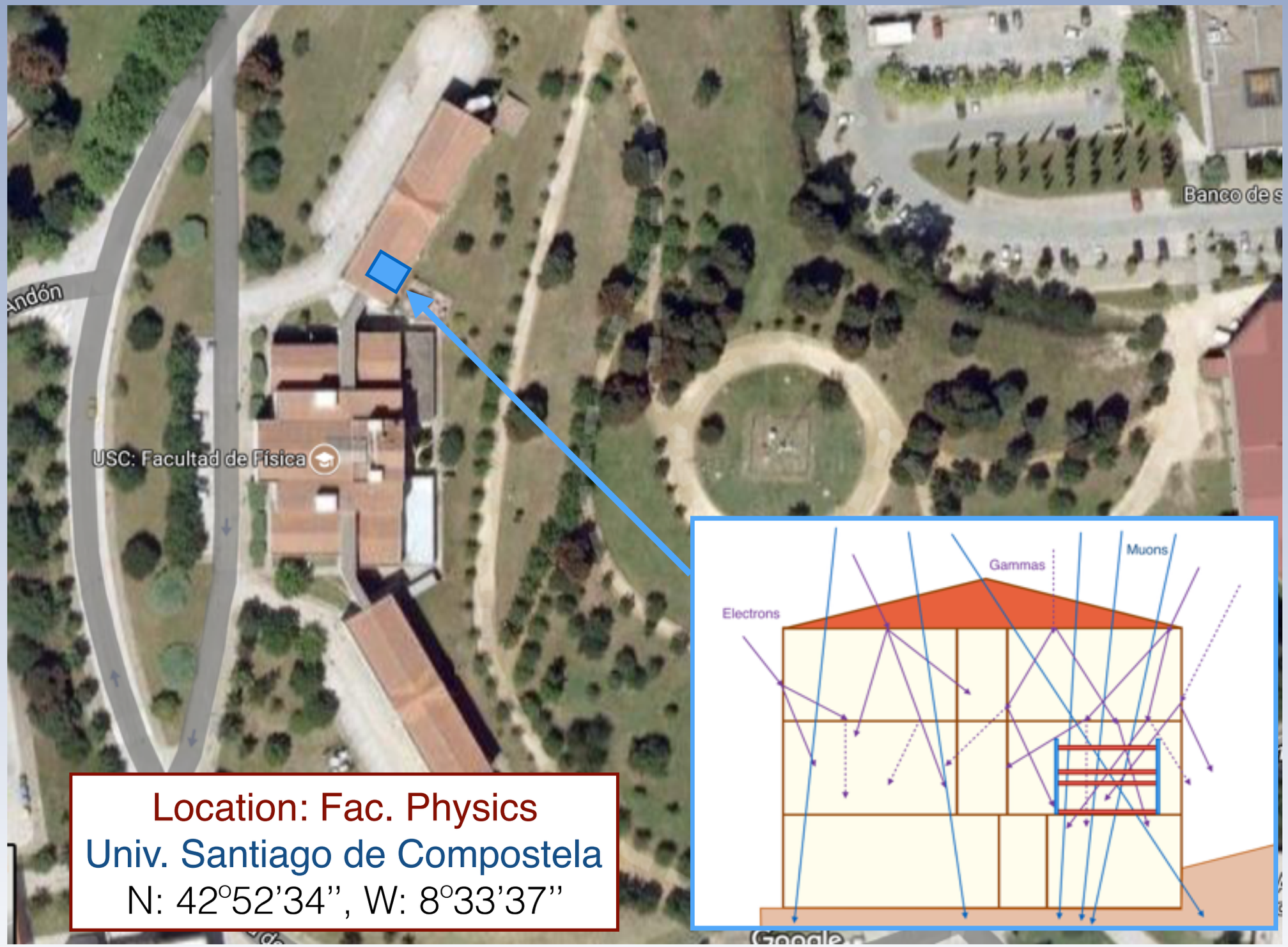
The first Trasgo: TRAGALDABAS

Location



The first Trasgo: TRAGALDABAS

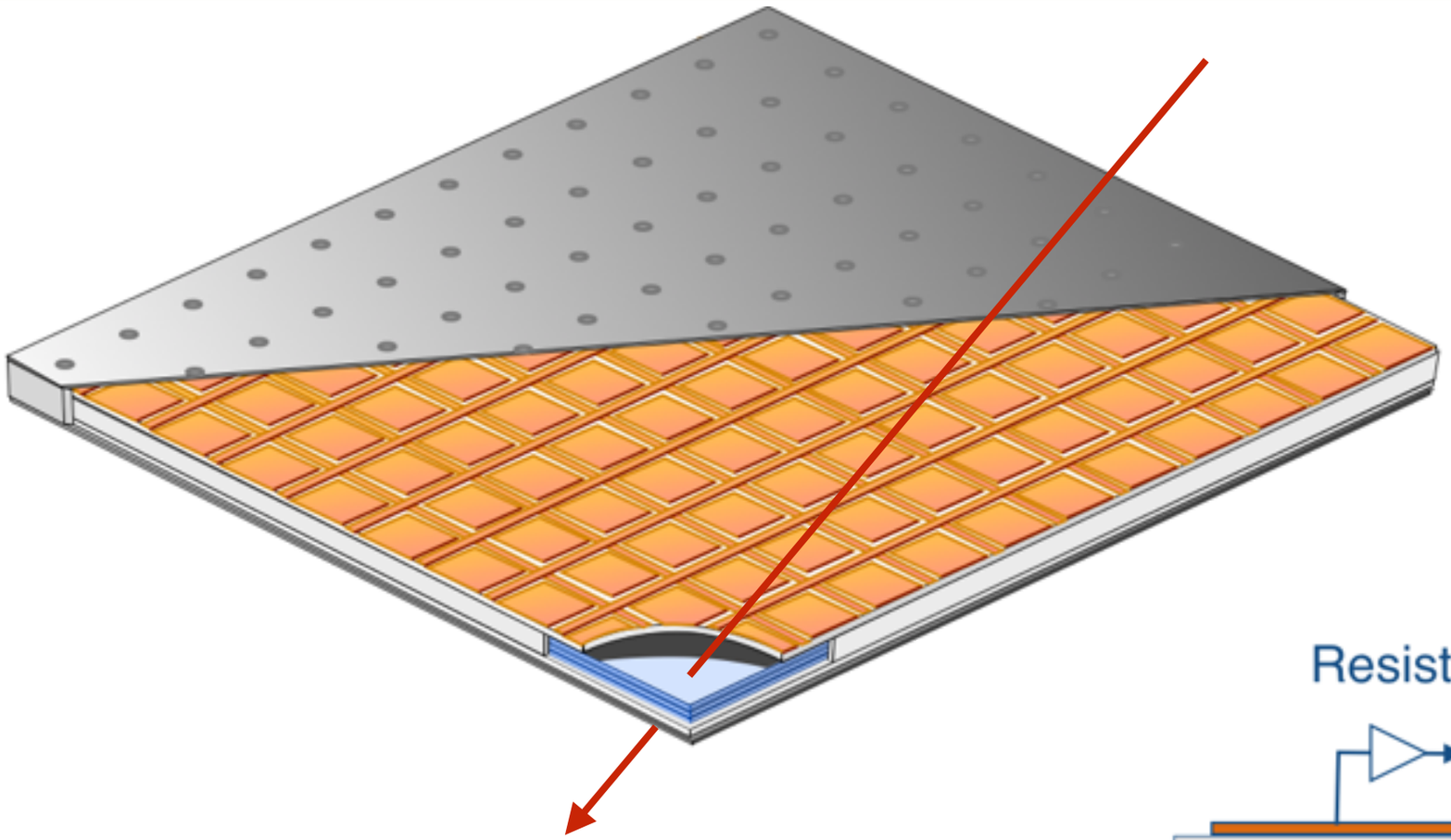
The site

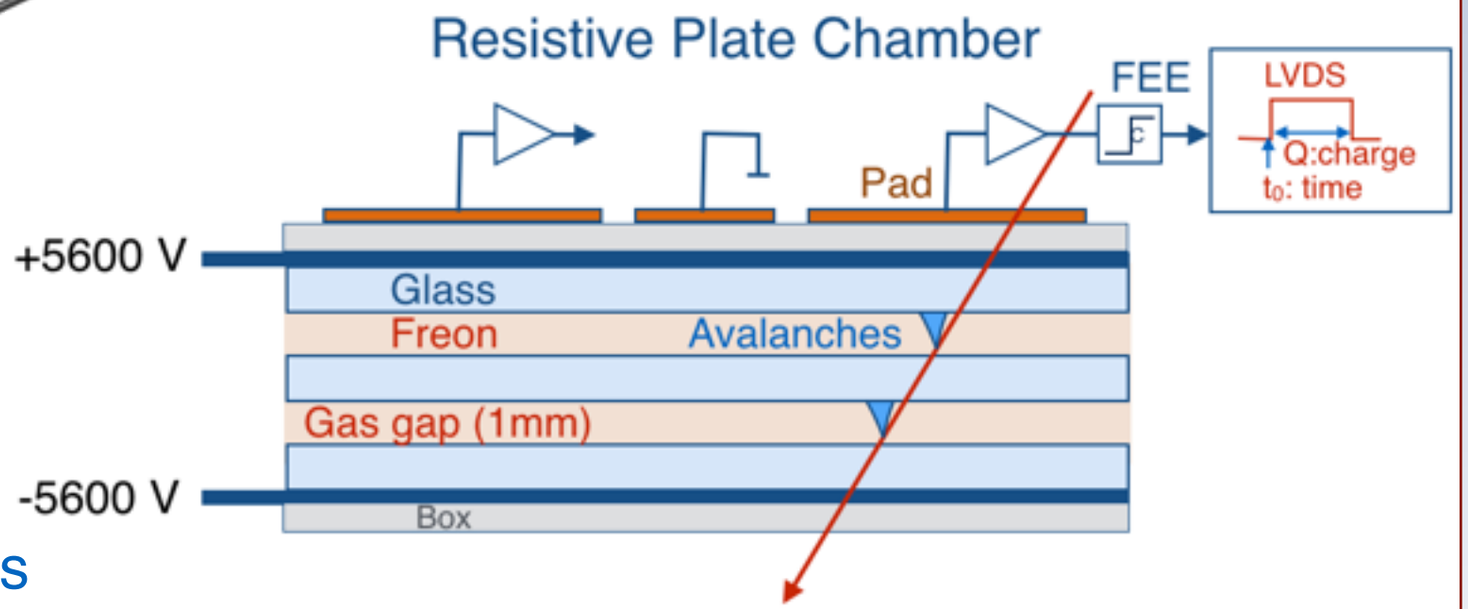


Location: Fac. Physics
Univ. Santiago de Compostela
N: 42°52'34'', W: 8°33'37''

The first Trasgo: TRAGALDABAS

The timing RPC technology



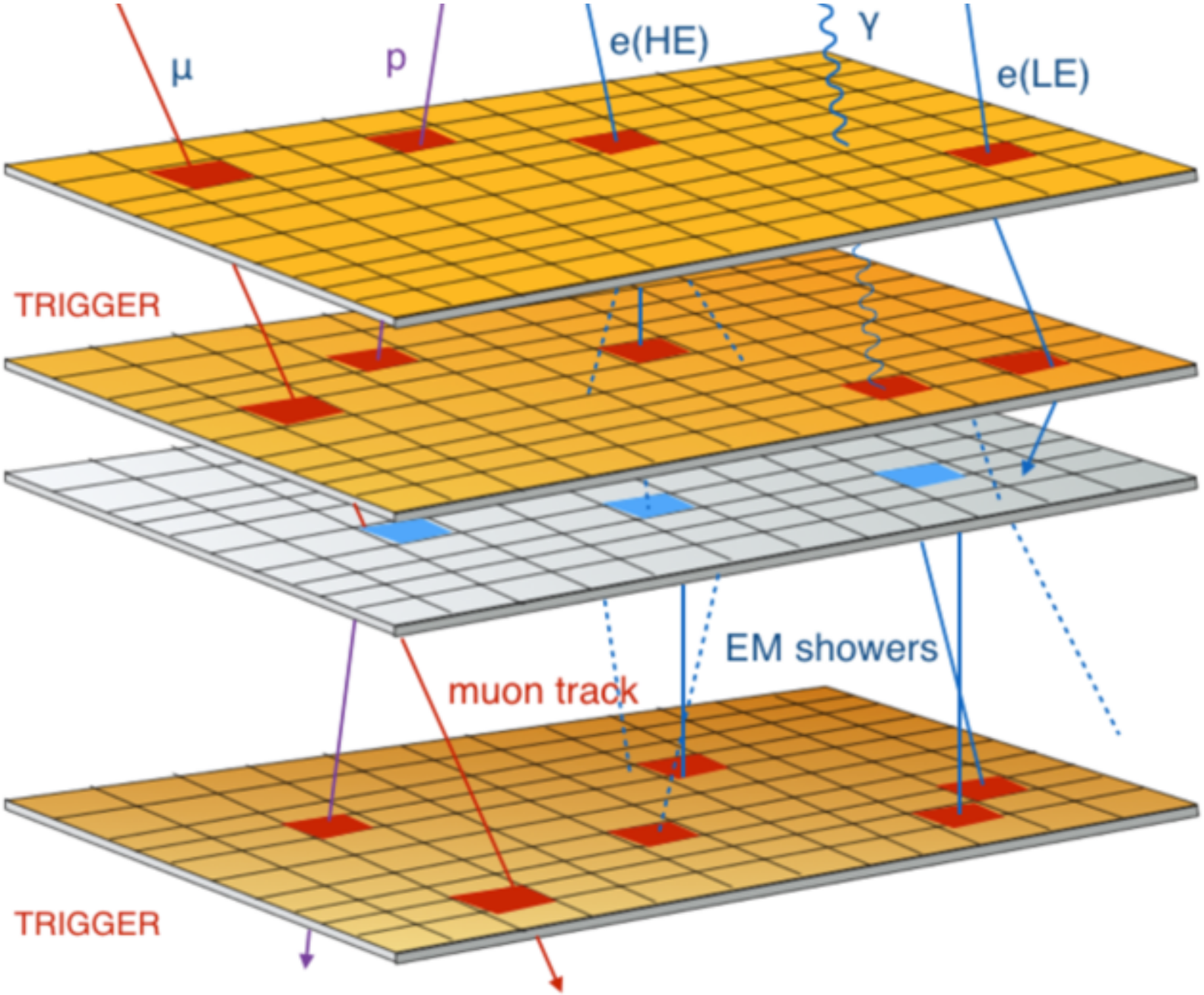


Main features:

- Very affordable technology
- Very good time resolution: ~0.5 ps
- 120 (10x12) channels (~11x11 cm^2)
- 1.8 m^2 (1.2 x 1.5 m^2) planes

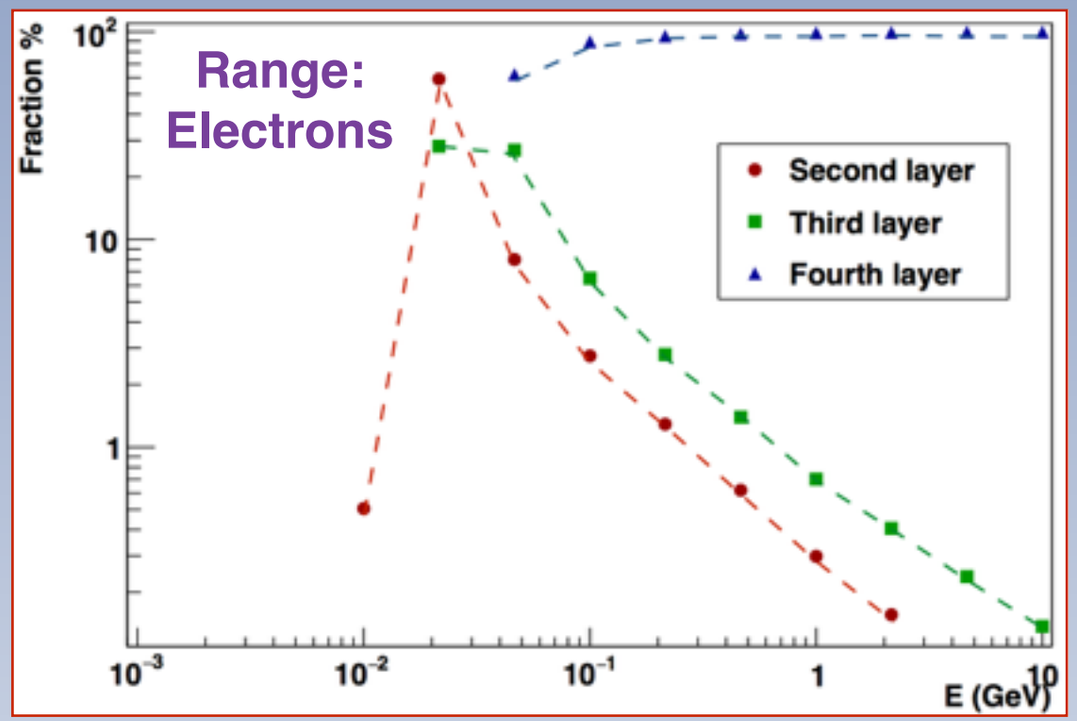
The first Trasgo: TRAGALDABAS

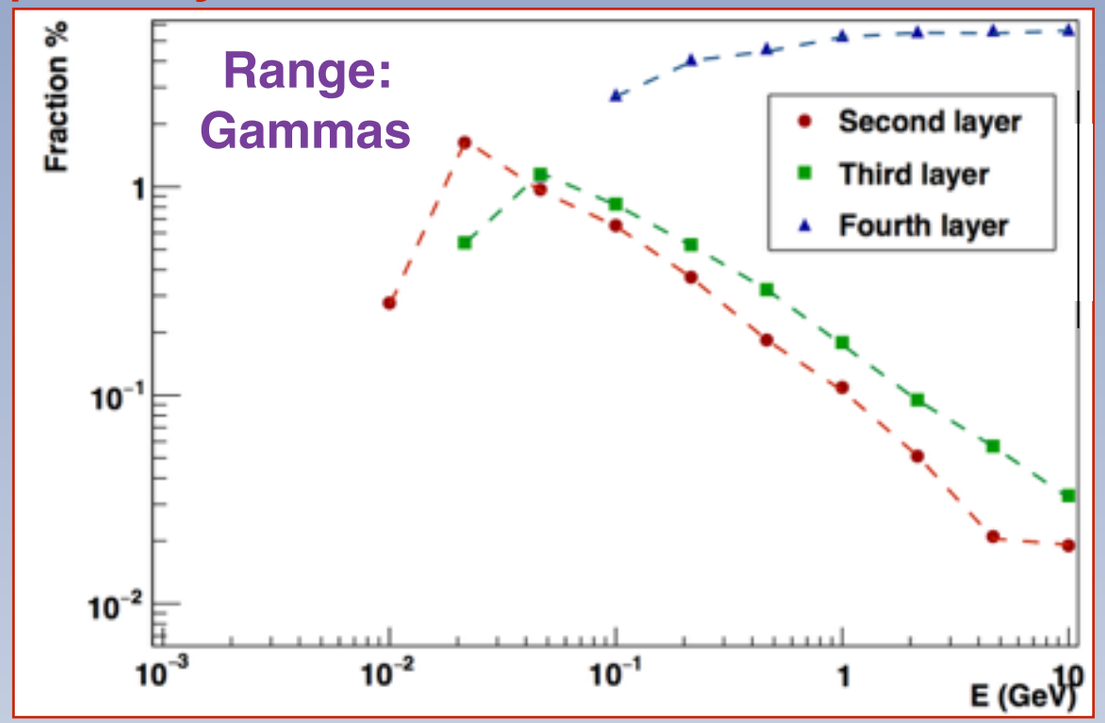
PID capability

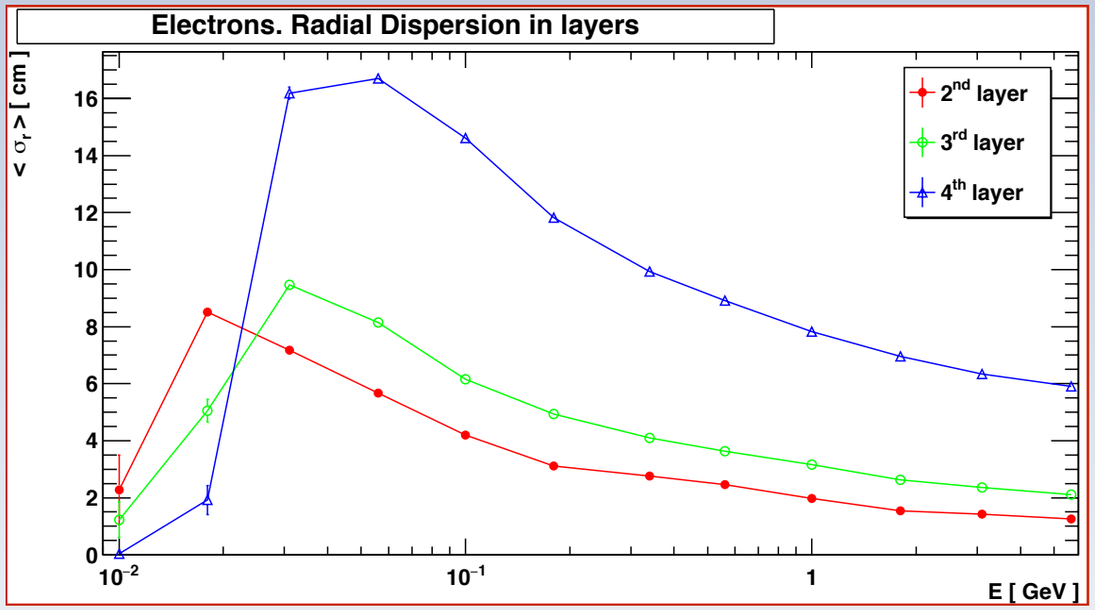


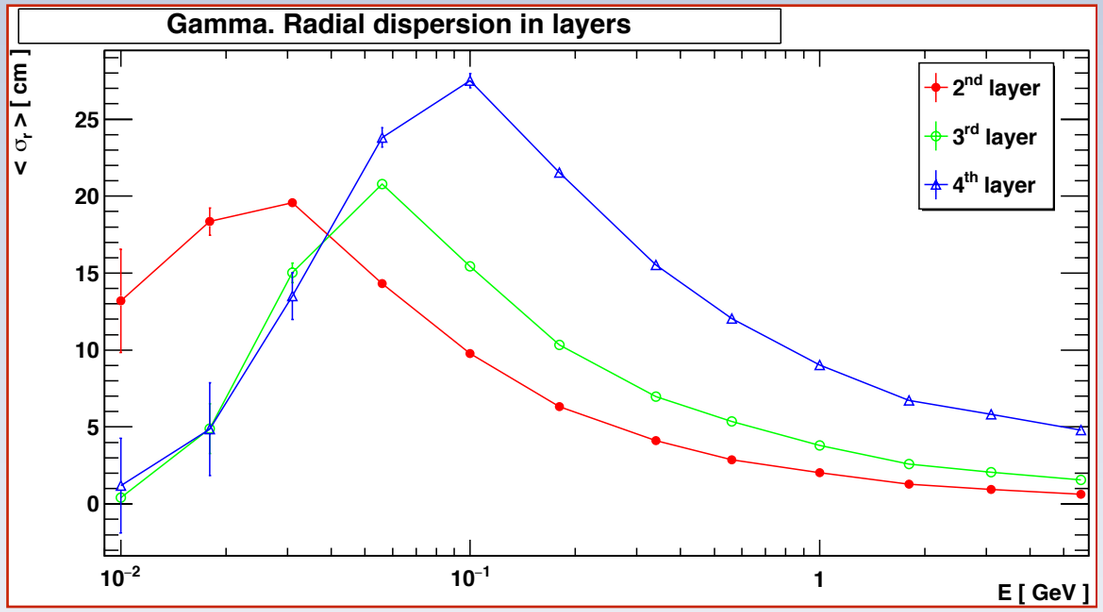
The first Trasgo: TRAGALDABAS

PID capability





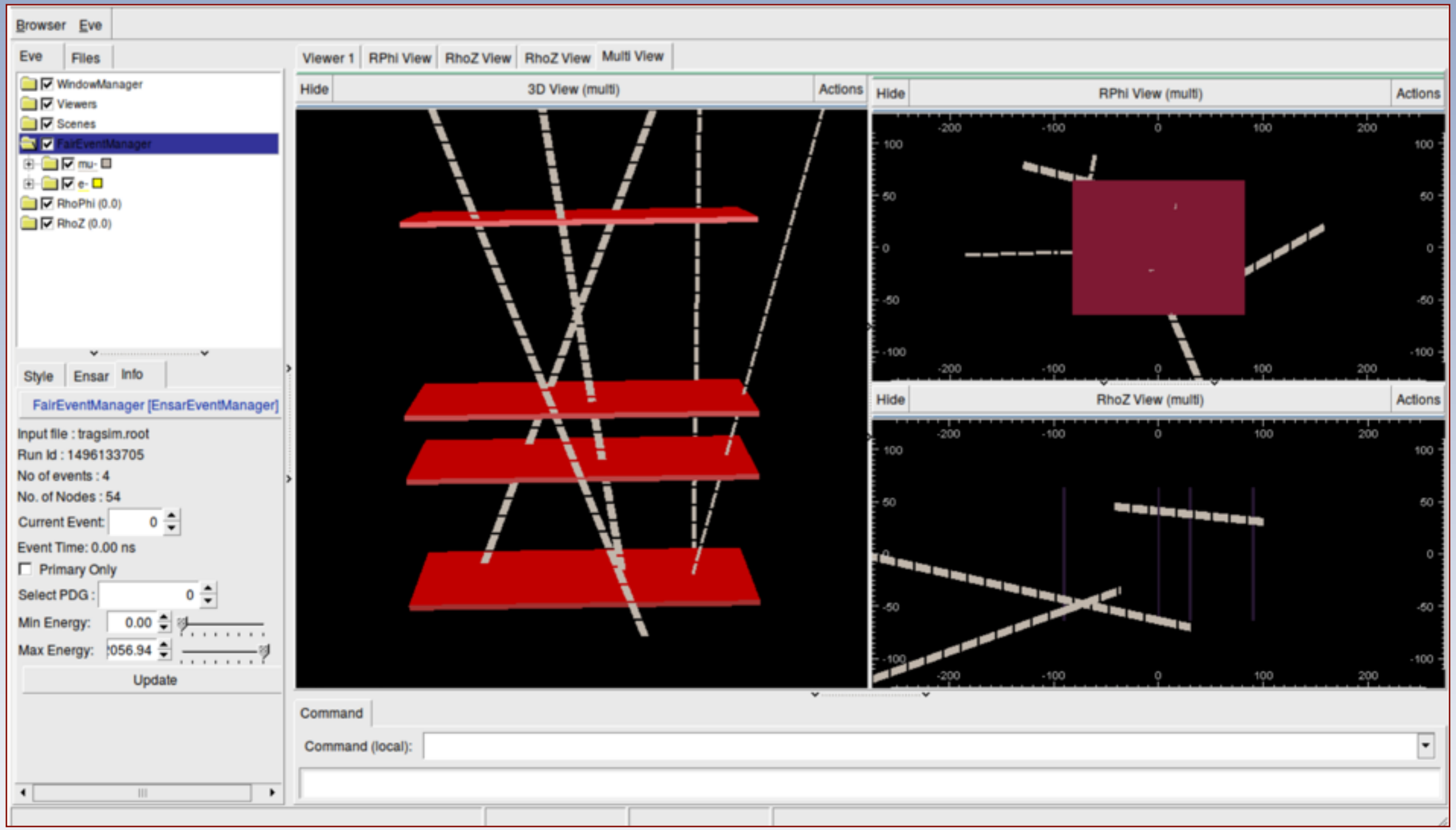




Gamma showers are broader than electron showers

The first Trasgo: TRAGALDABAS

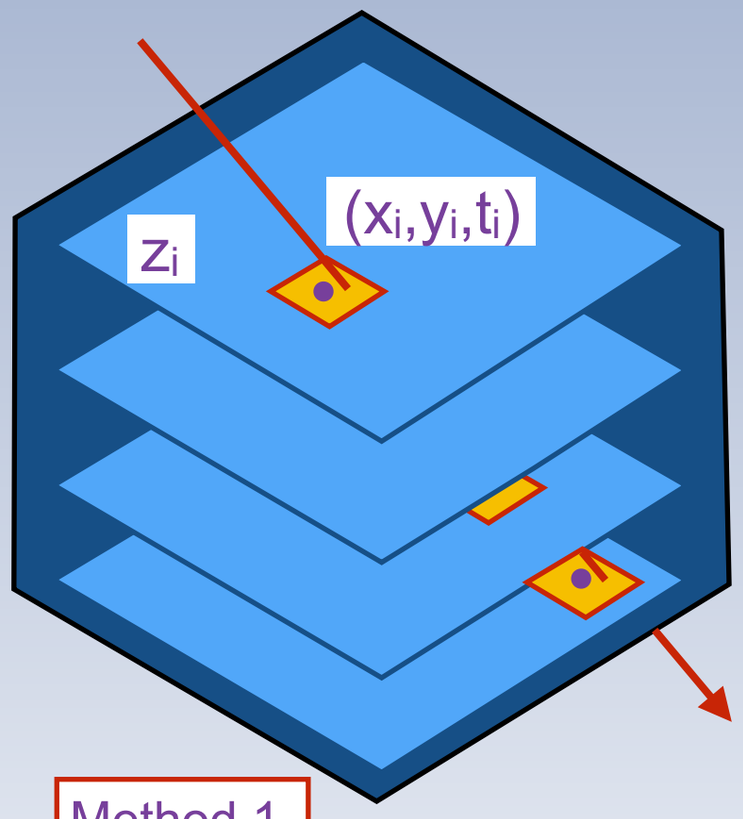
EnsarRoot based detector simulation



The first Trasgo: TRAGALDABAS

Tracking strategies based on TimTrack

data, **d** → *timtrack* + fitting models: **m** → (X_0, X', Y_0, Y' T_0, V) parameters



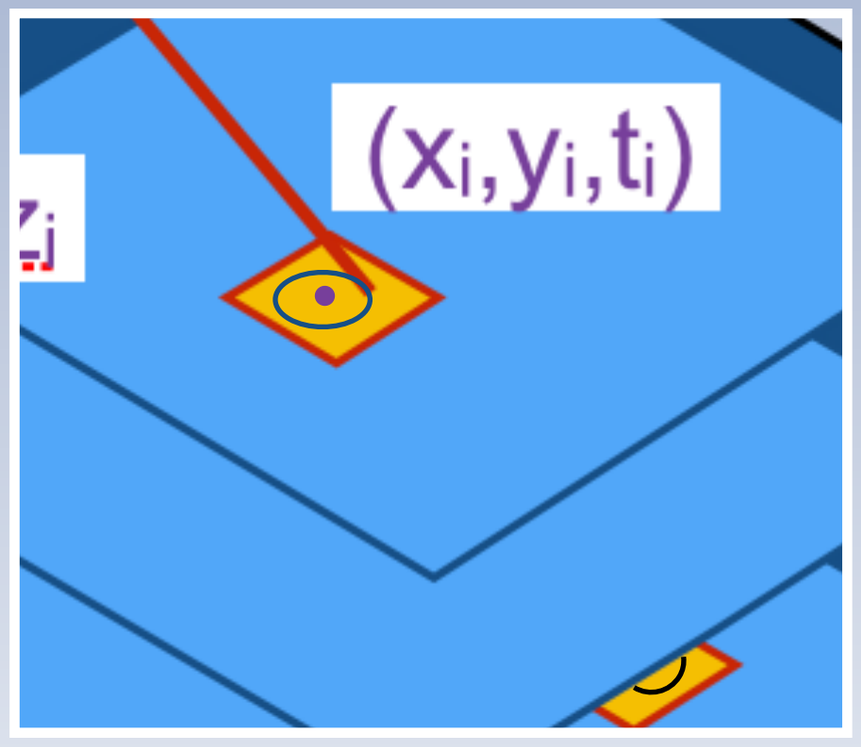
Method 1.

$x_i = X_0 + X' \cdot z_i$

$y_i = Y_0 + Y' \cdot z_i$

$t_i = T_0 + \sqrt{1+X'^2+Y'^2} \cdot z_i / V$

Direct fit to 6 parameters!



Method 2.

We are trying to implement a new method including the drift time of electrons in the electrodes.

Still, convergence problems! :(

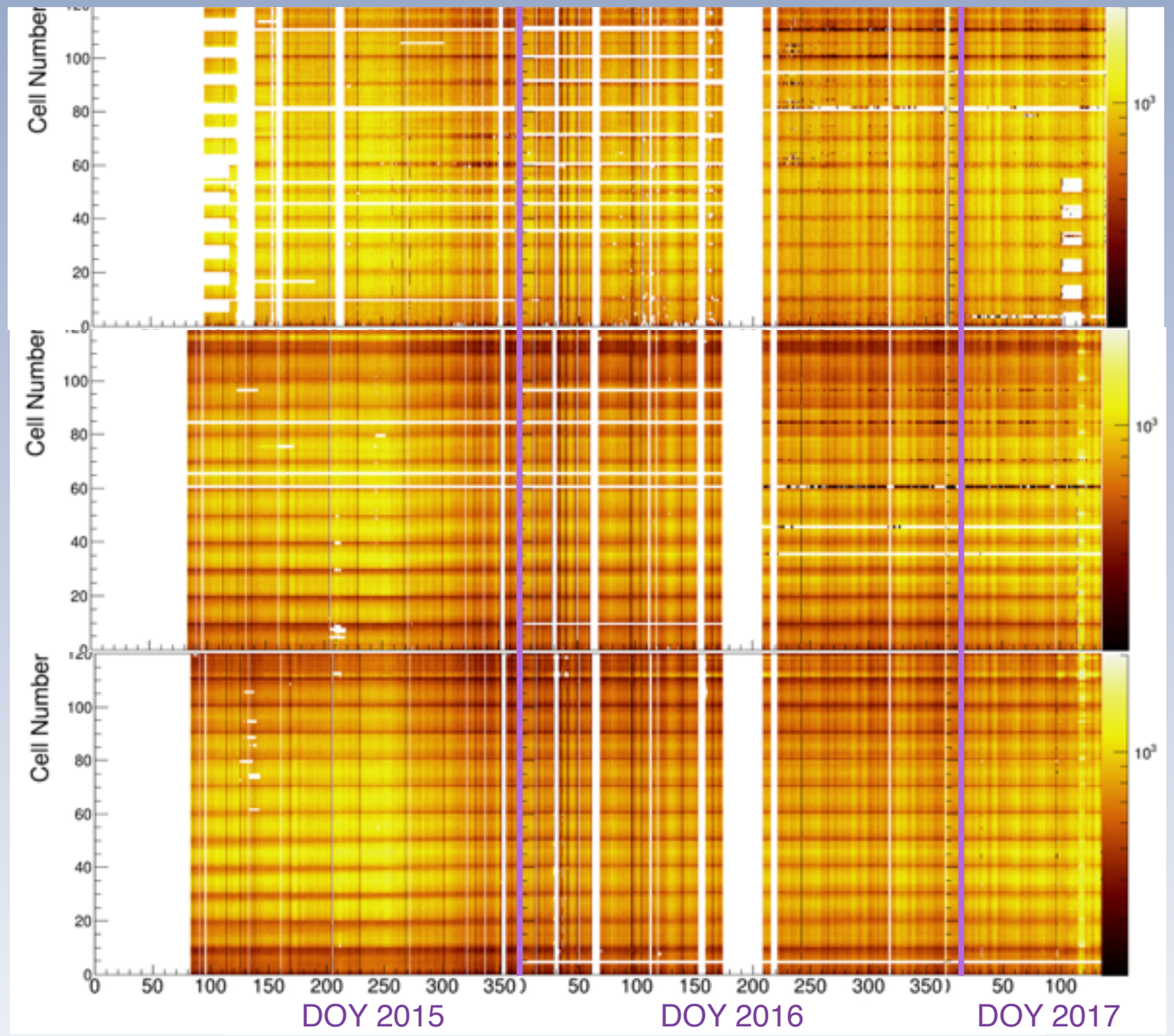
TRAGALDABAS: preliminary results

Data sample: fired cells map

Plane T1

Plane T2

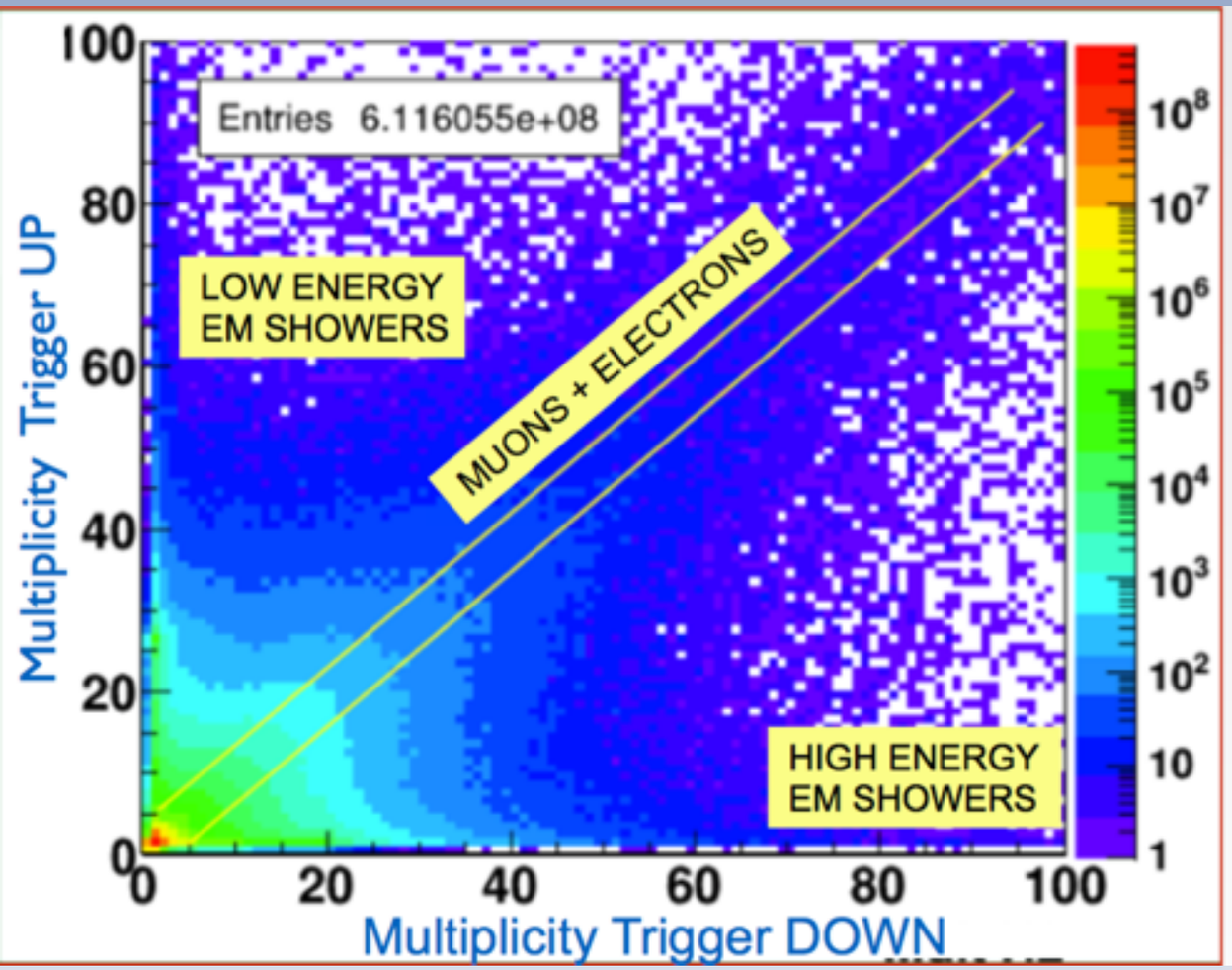
Plane T4

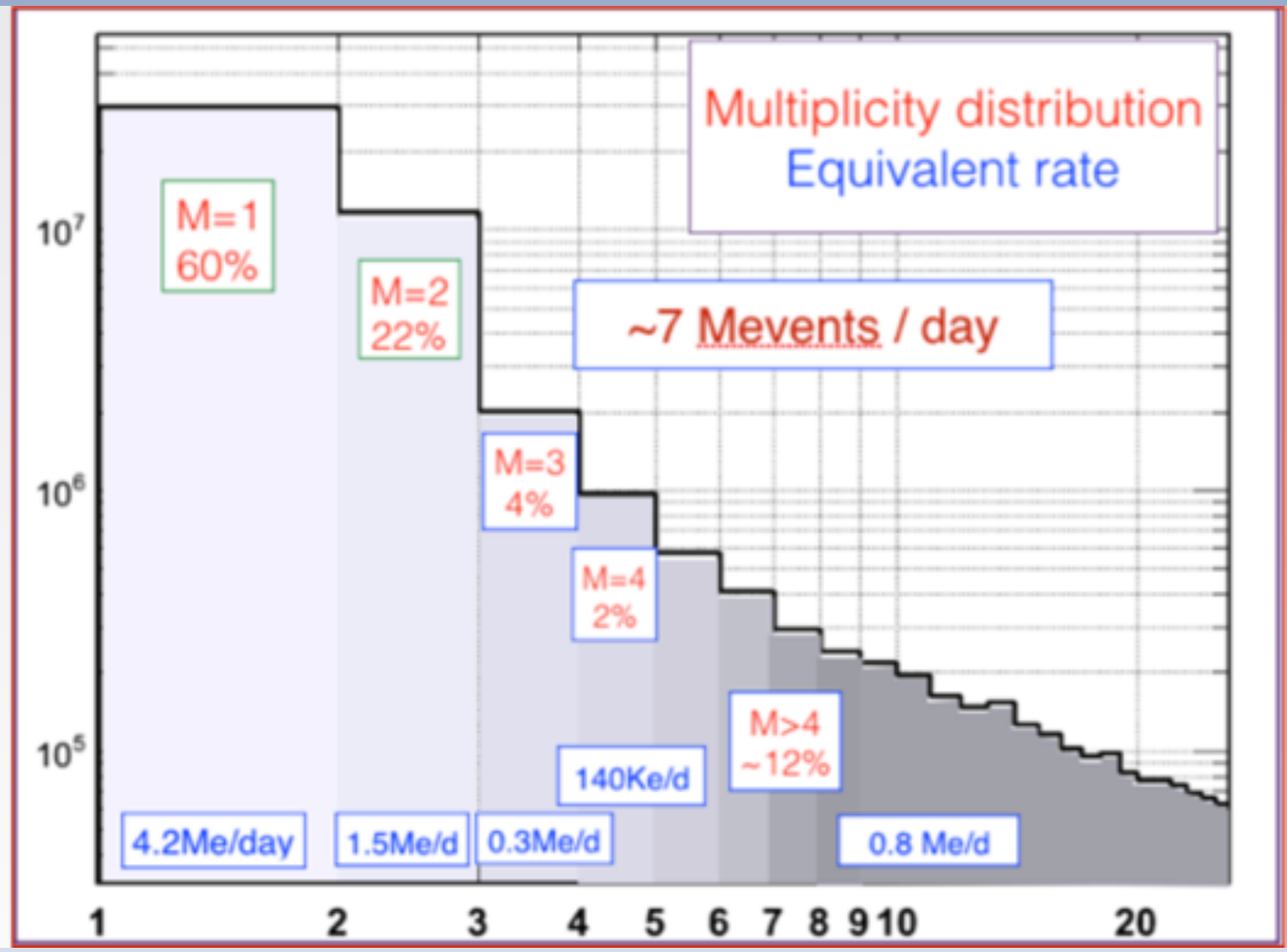


2 years of data collected: ~ 5· 10^9 events!

TRAGALDABAS: preliminary results

Trigger summary





Trigger rate: ~ 70 Hz.
Event rate: ~ 7Mevents /day
Storage rate: ~ 0.7 Tb / year (1.9 Gb /day)
Mean duty time: > 90%

TRAGALDABAS: preliminary results

2 year rate behaviour (pressure corrected)

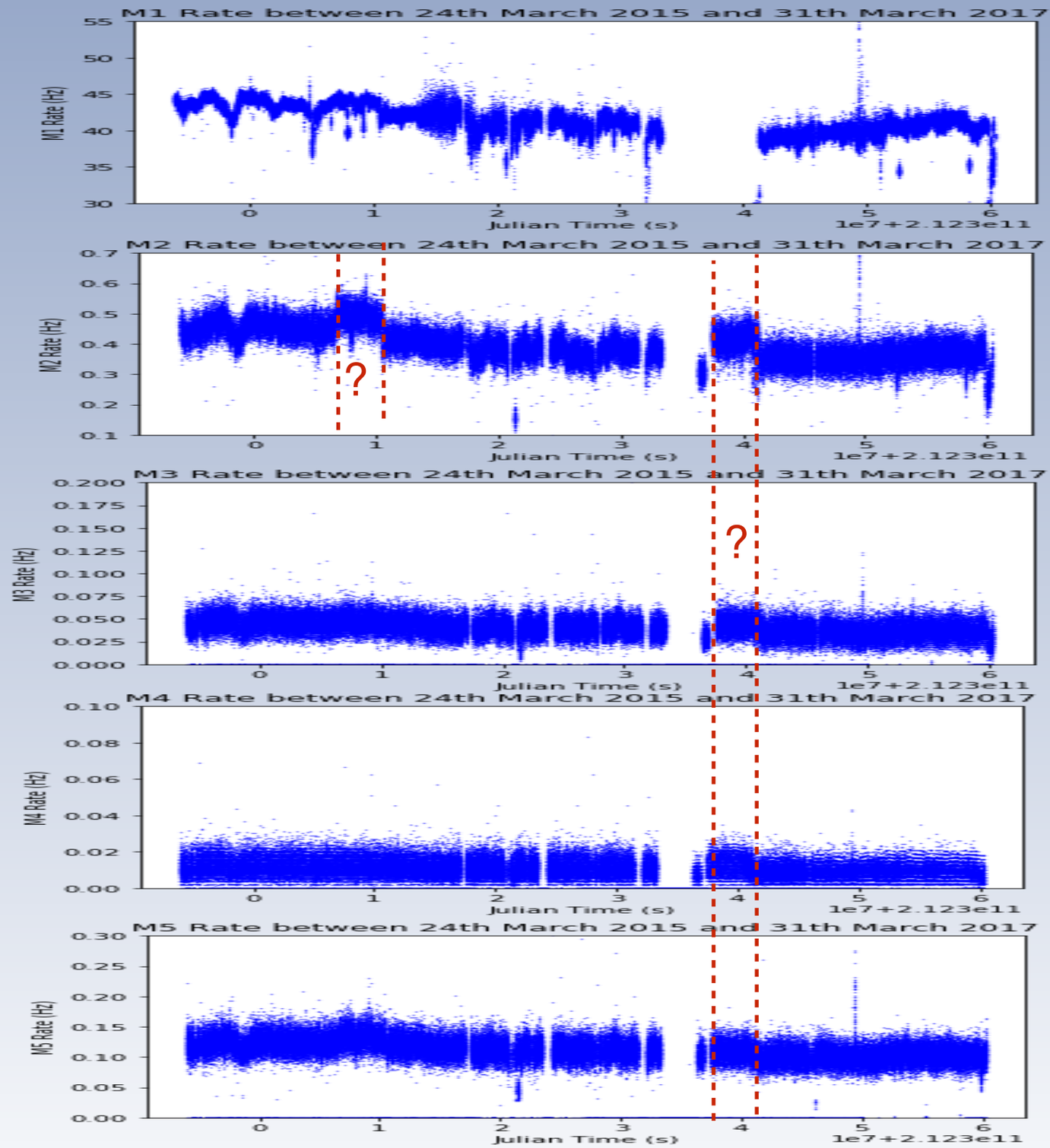
Multiplicity M=1

Multiplicity M=2

Multiplicity M=3

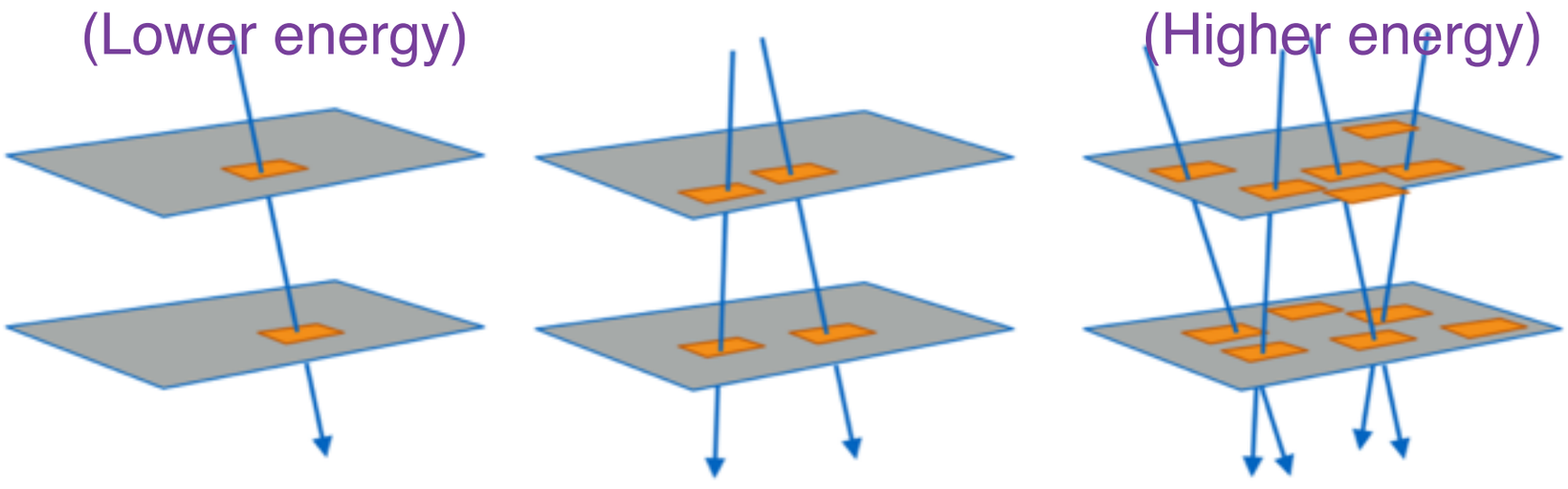
Multiplicity M=4

Multiplicity M>4

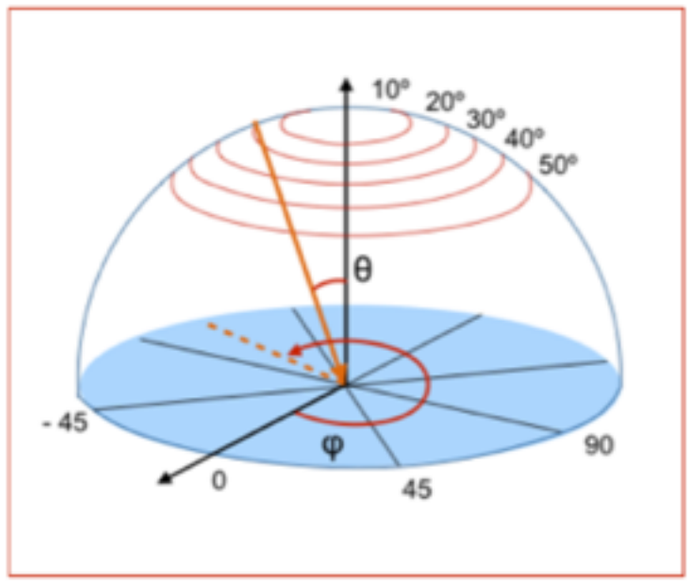


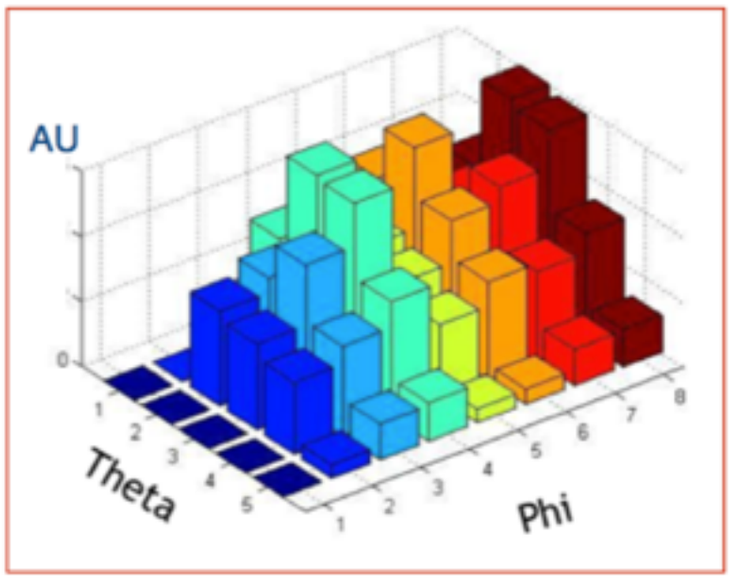
TRAGALDABAS: preliminary results

Preliminary reconstructed data sample



3 sets of multiplicity: m

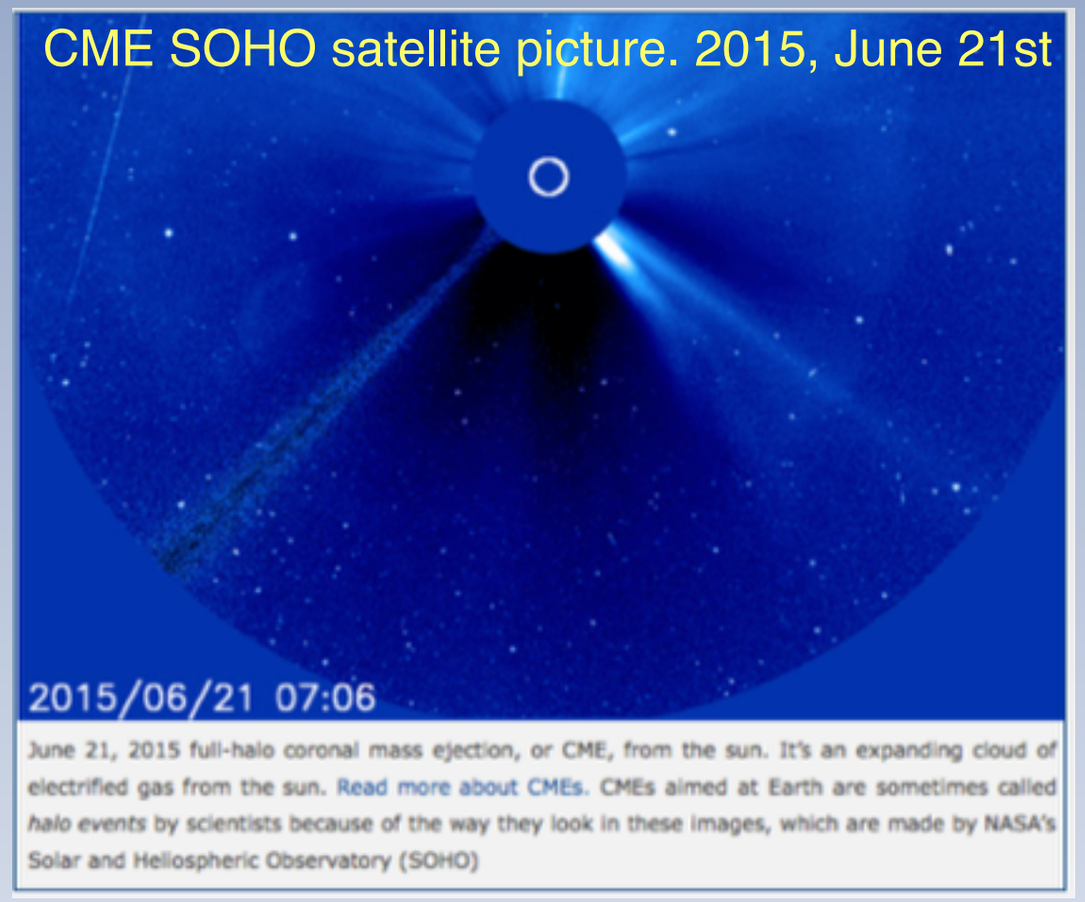


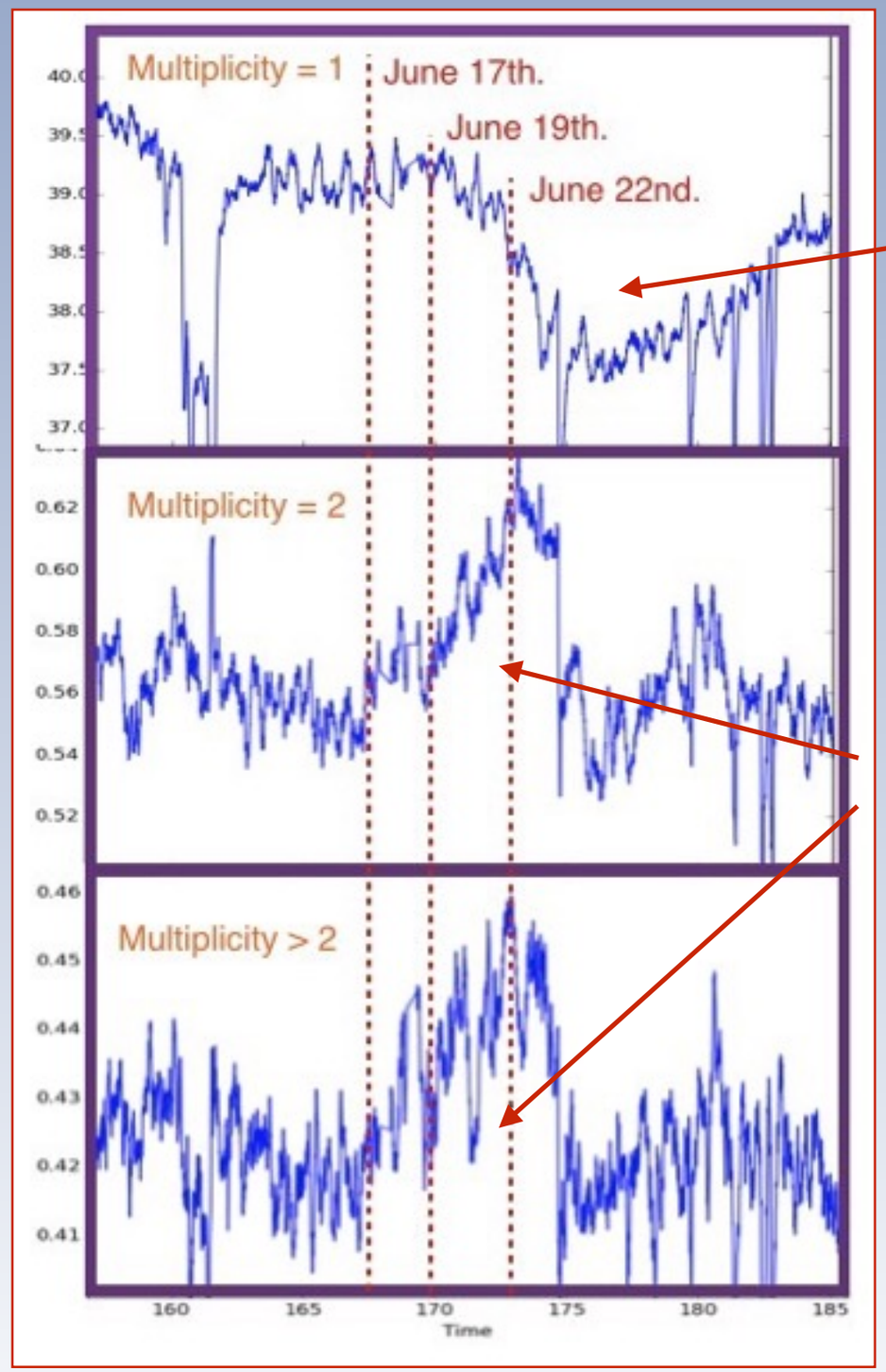


Data stored in 5x8 (theta x phi) matrices in 10-min time intervals

TRAGALDABAS: preliminary results

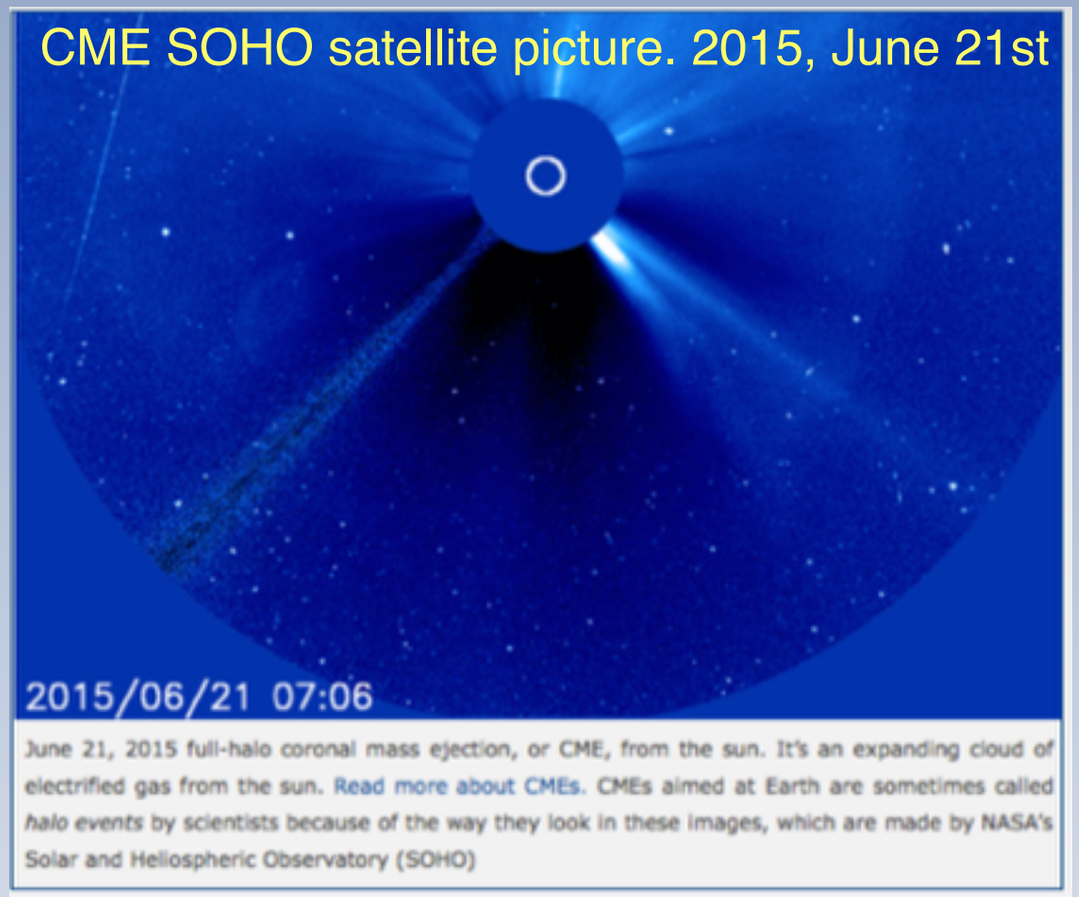
Analysis of the FD of June 2015

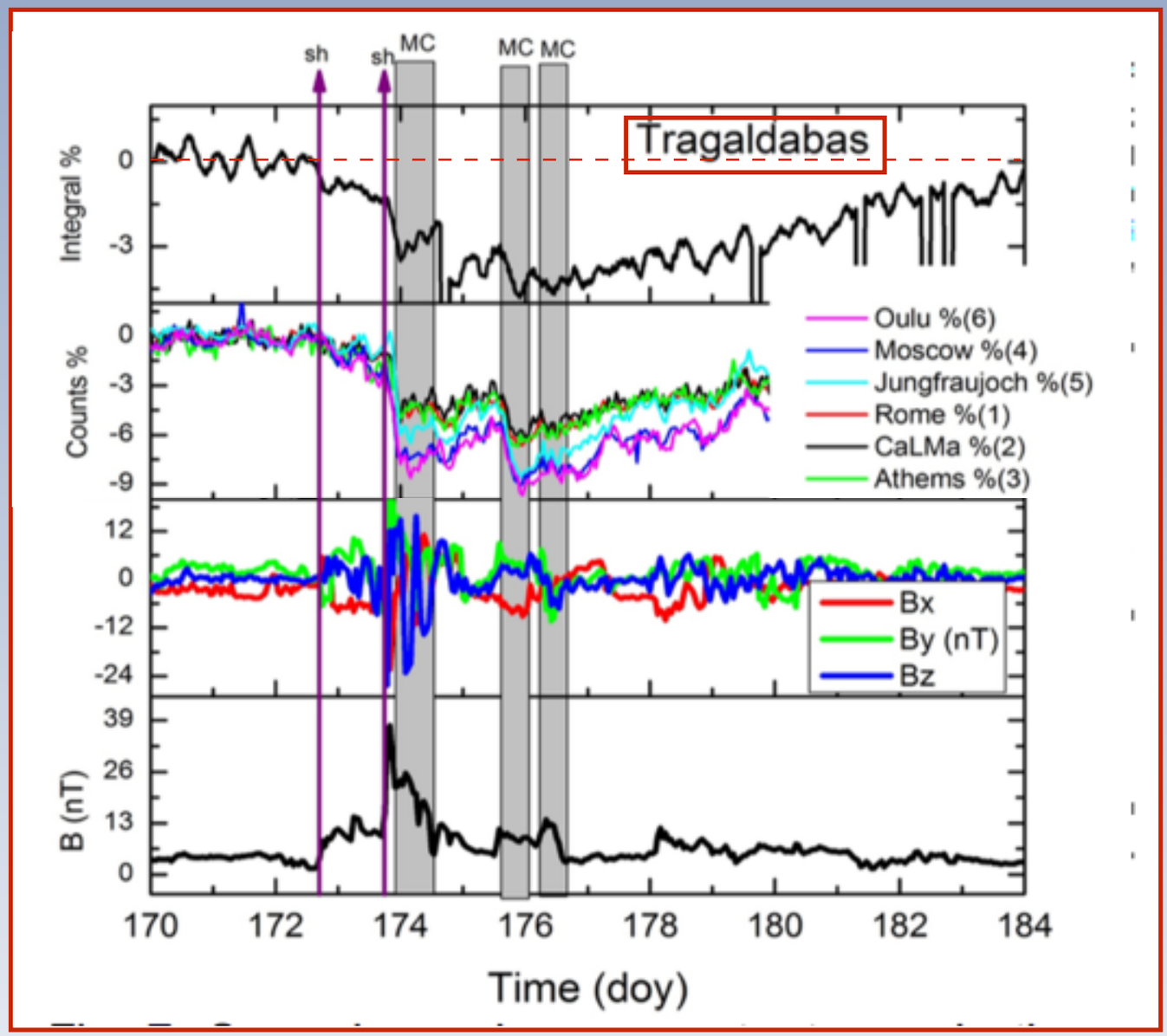




TRAGALDABAS: preliminary results

Analysis of the FD of June 2015

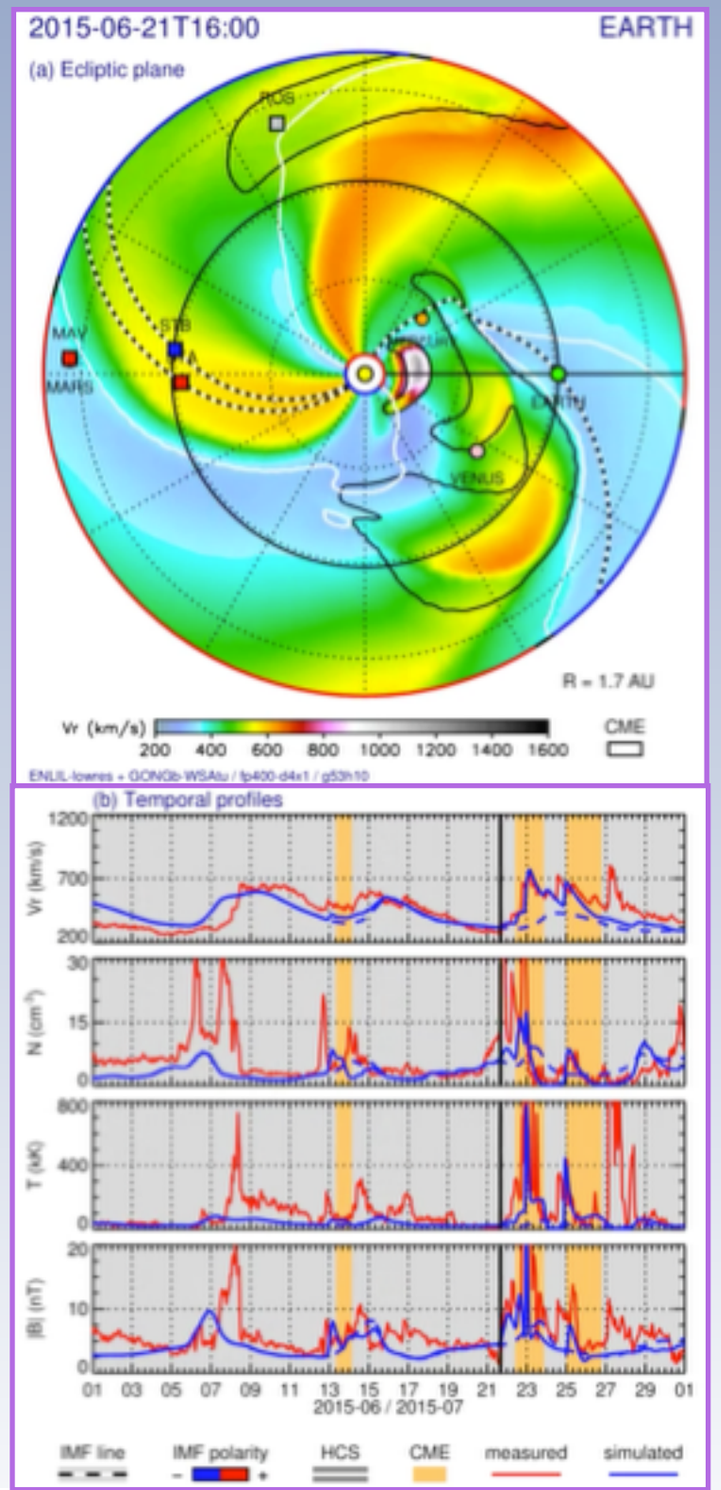


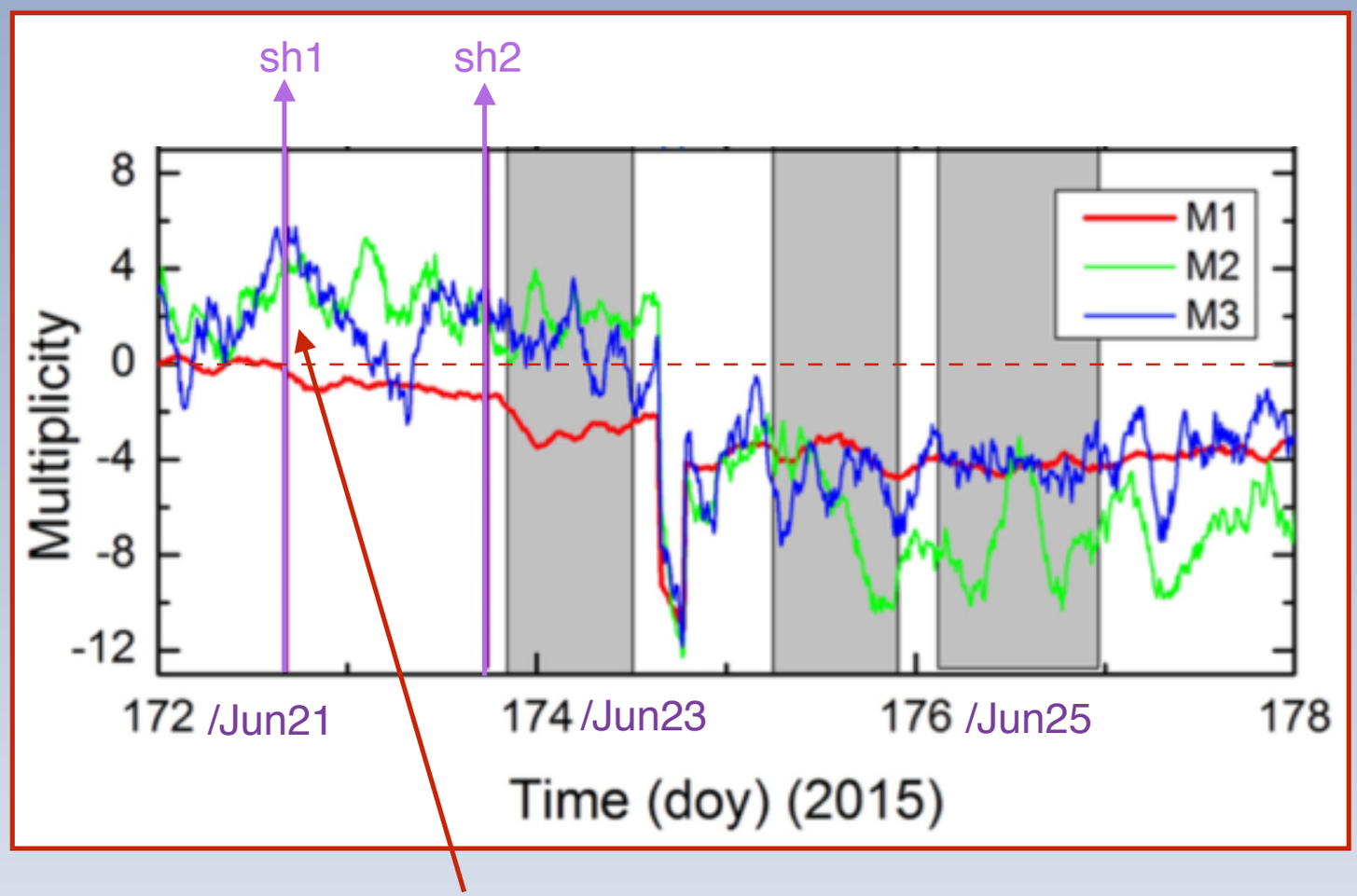


FD is observed very well with a roughly 2 m^2 detector !

TRAGALDABAS: preliminary results

Analysis of the FD of June 2015

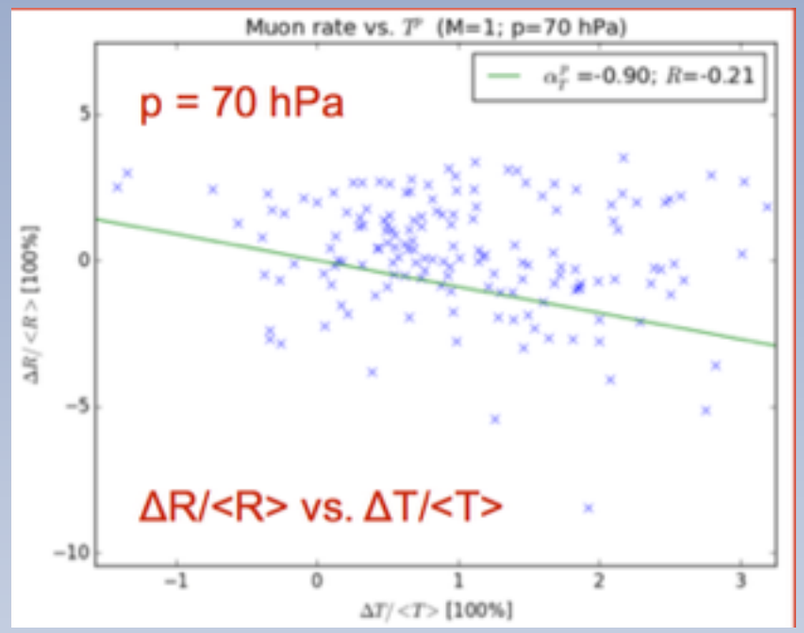


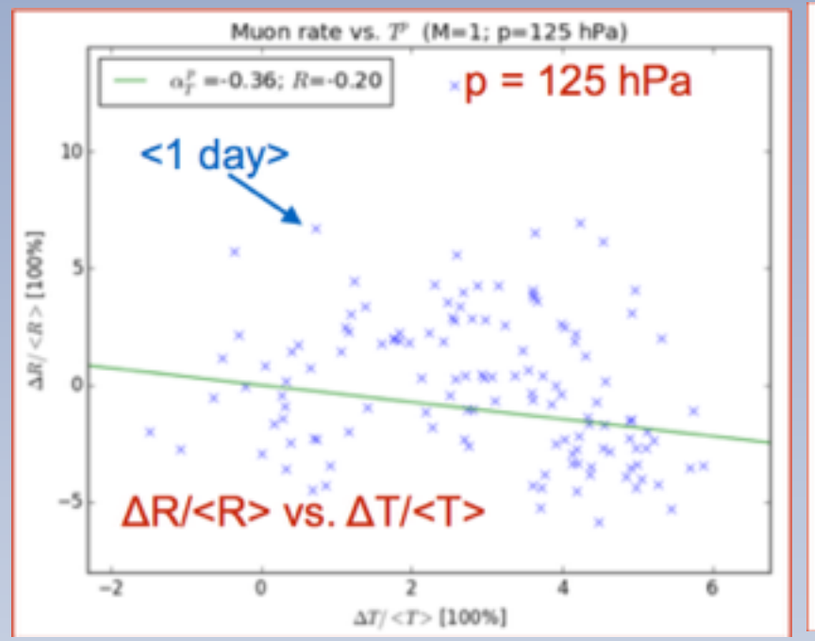


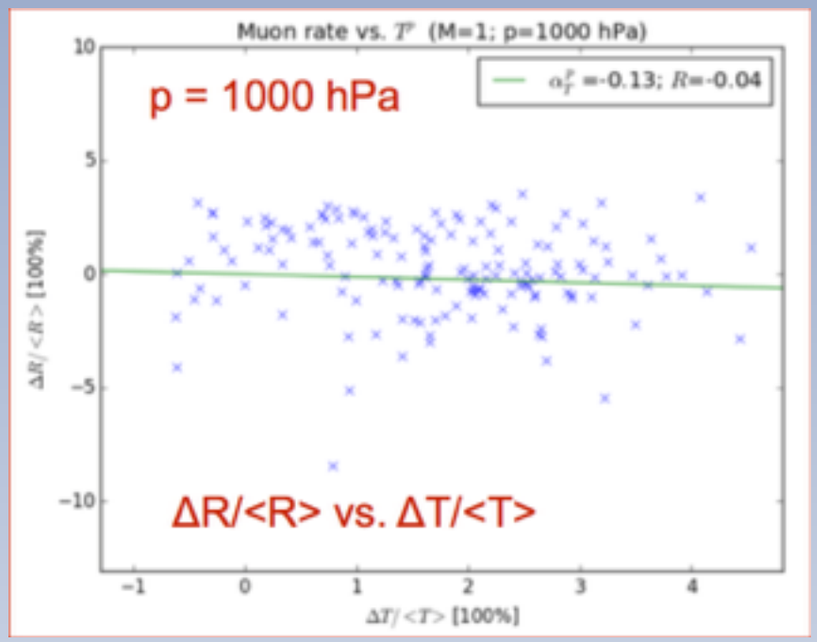
Interesting feature: high multiplicity excesses seem to be associated with the first magnetic shock!

TRAGALDABAS: preliminary results

Atmosphere slope analysis



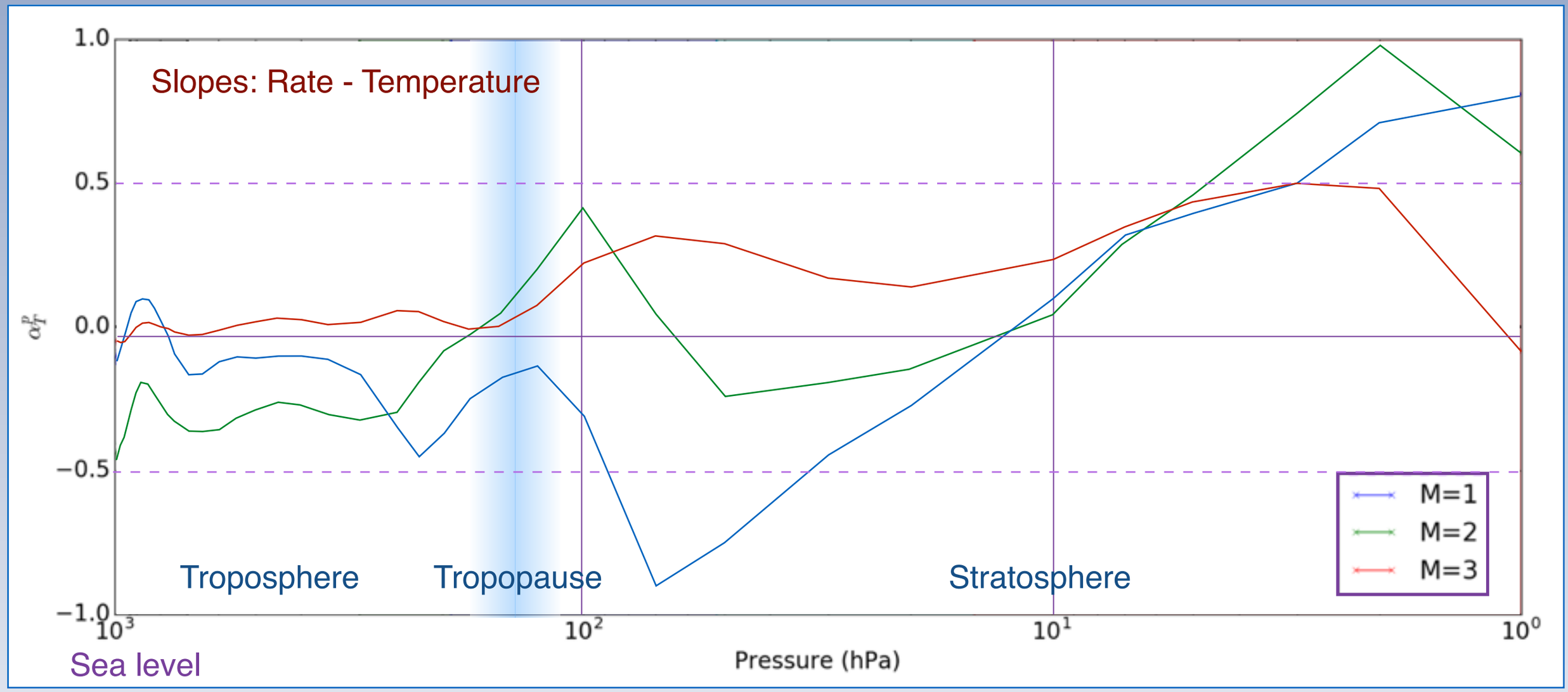




Slopes of linear fits of the relative rate changes (dR/R) as a function of the relative temperature changes (dT/T) at different pressure levels

TRAGALDABAS: preliminary results

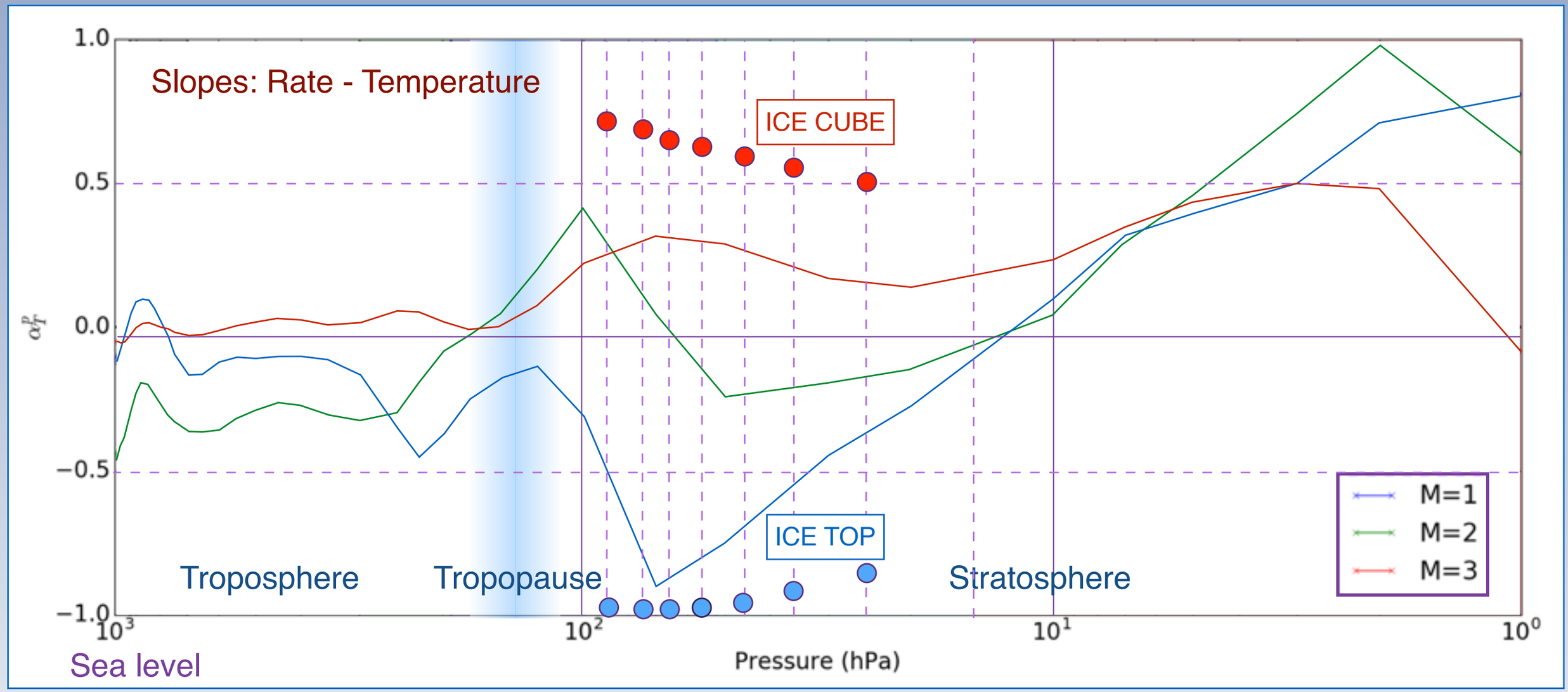
Atmosphere slope analysis



Different multiplicity (energy) events show a different behaviour respect temperatures at the different heights of the atmosphere

TRAGALDABAS: preliminary results

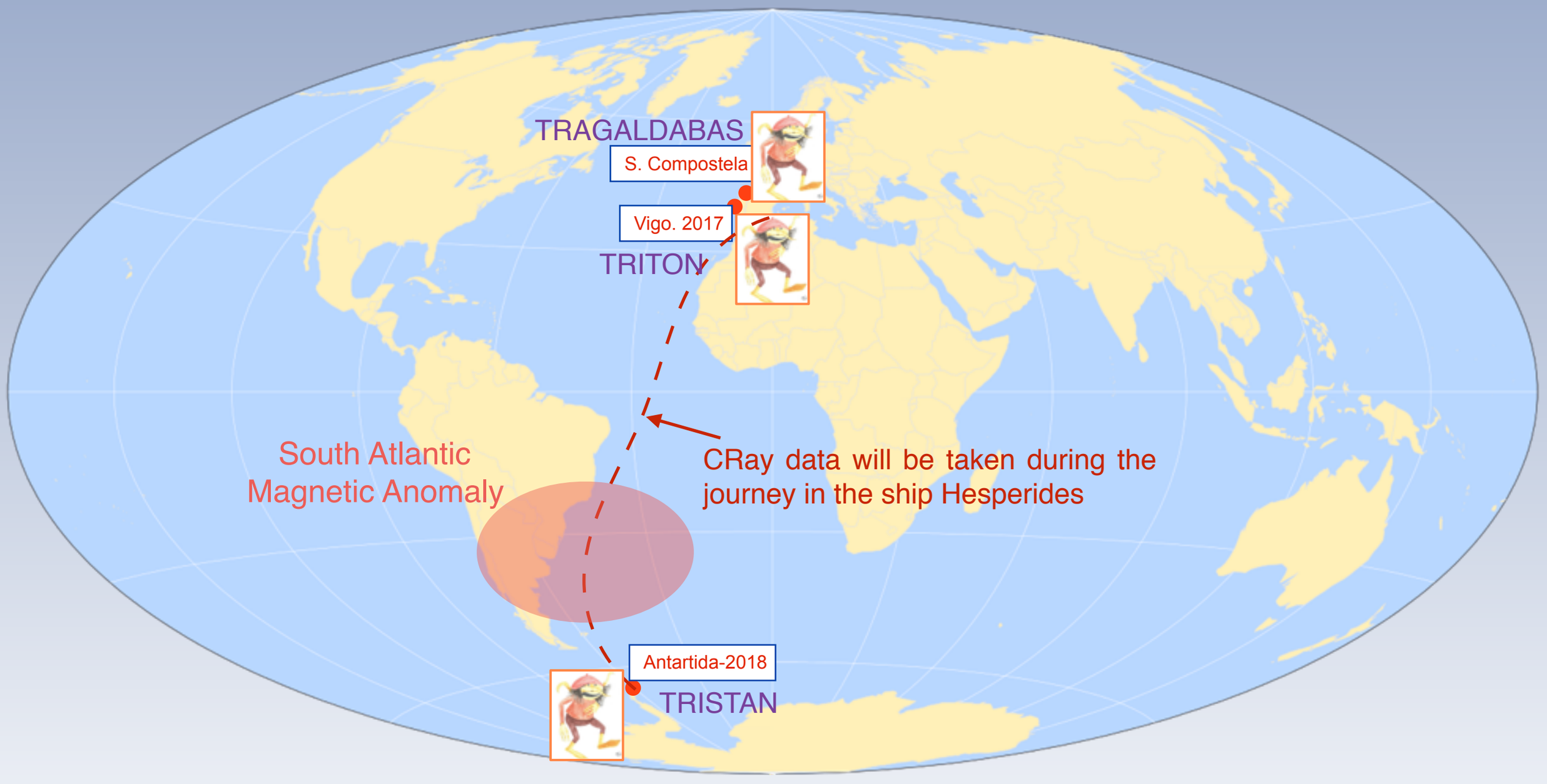
Atmosphere slope analysis



We observe similar trends that the ones observed in the IceTop - IceCube observatory for low and high energy muons

The TRASGO proyect: next steps

- Install new Trasgos in other places: Vigo & Spanish Antarctic Base



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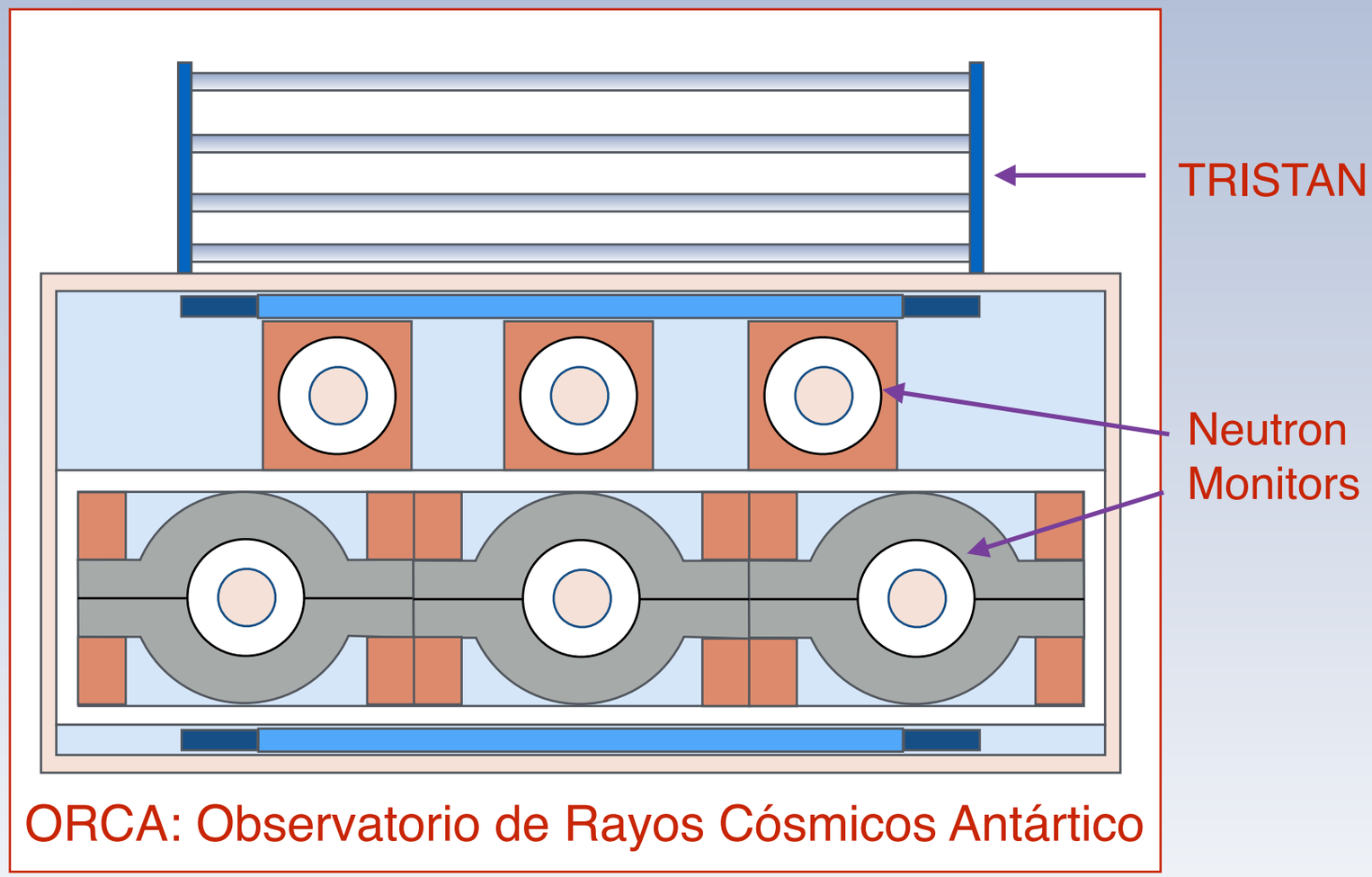
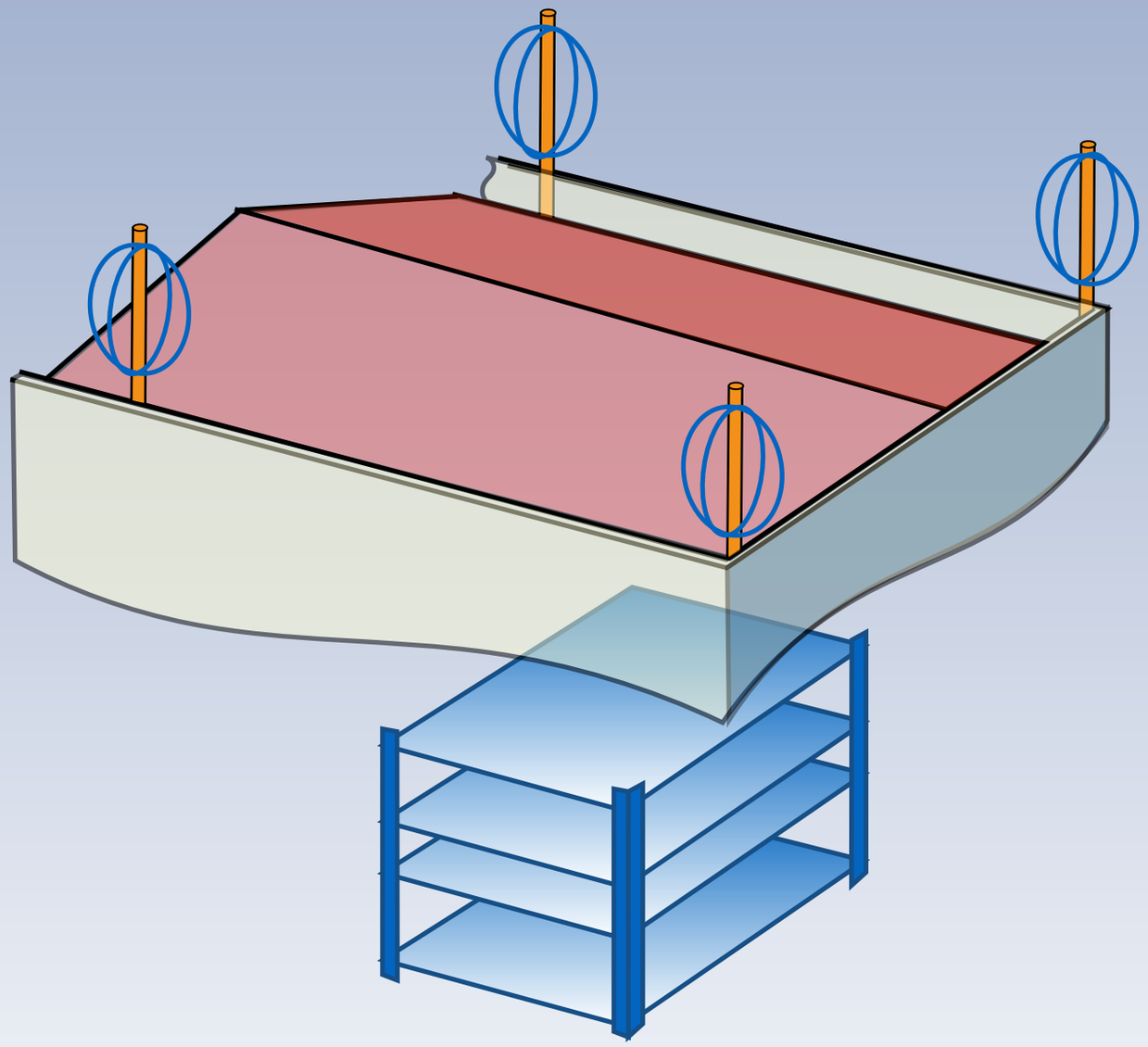


ORCA: Observatorio de Rayos Cósmicos Antártico

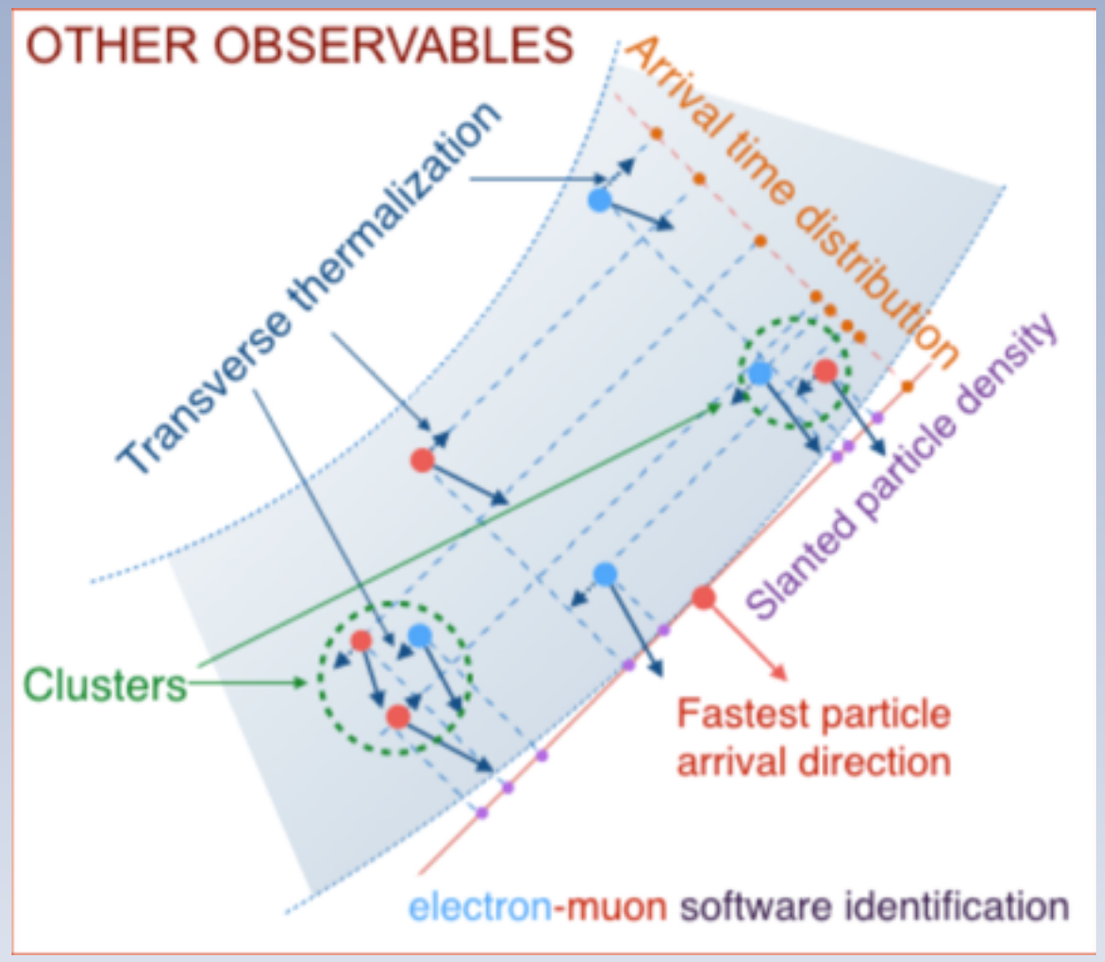
The TRASGO proyect: next steps

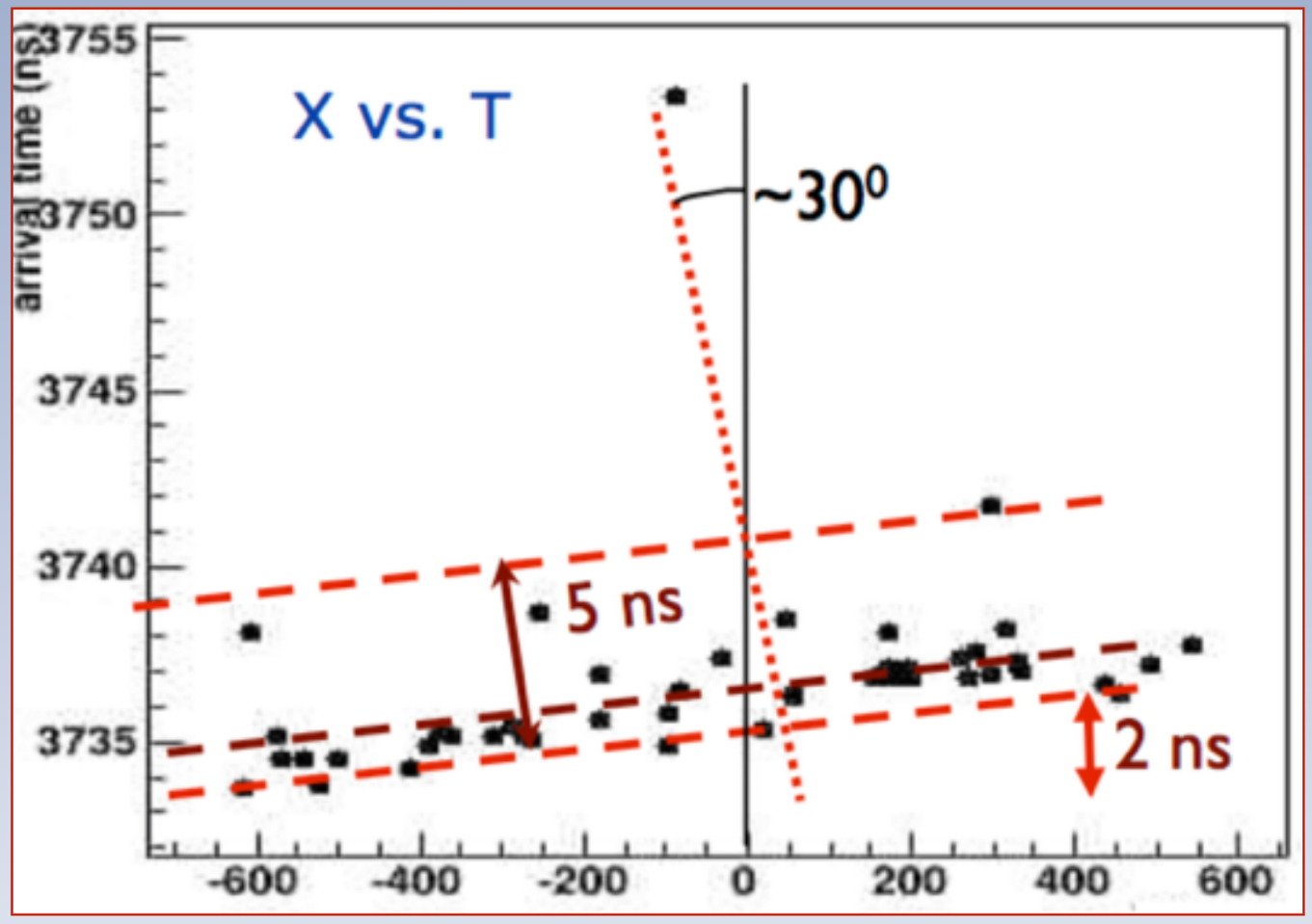
- Install four SALLA radio-antennas provided by KIT (Karlsruhe), on the roof for identifying high energy air showers.



The TRASGO proyect: next steps

- Look for new signatures allowing a better measurement of primary cosmic rays





Summary

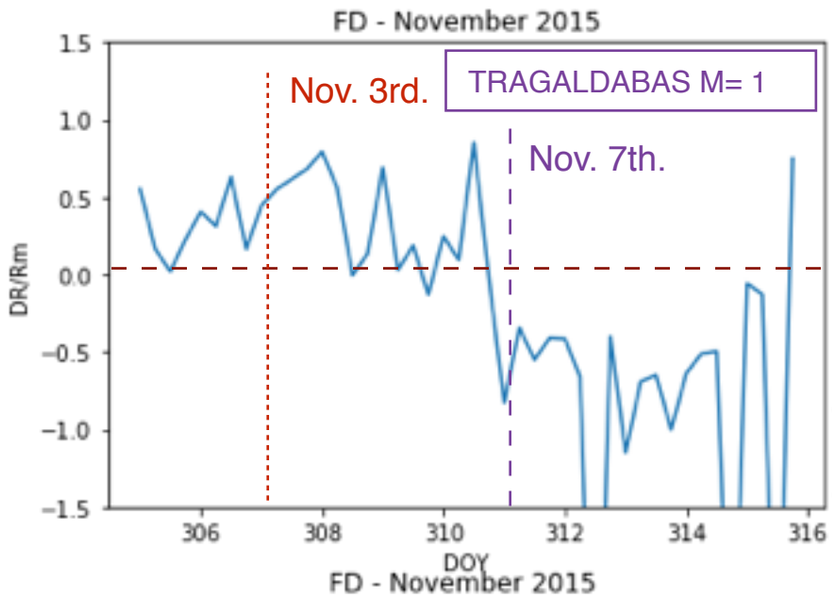
- TRASGOS are very interesting devices that may allow us to improve significantly our knowledge on many cosmic rays aspects.
- Preliminary results are very encouraging
- TRASGOS are complicated devices and still several problems should be fixed
- A first detector is operative and taking data regularly at the Univ. of Santiago de Compostela. Soon other TRASGOS will be operative in other places providing new data

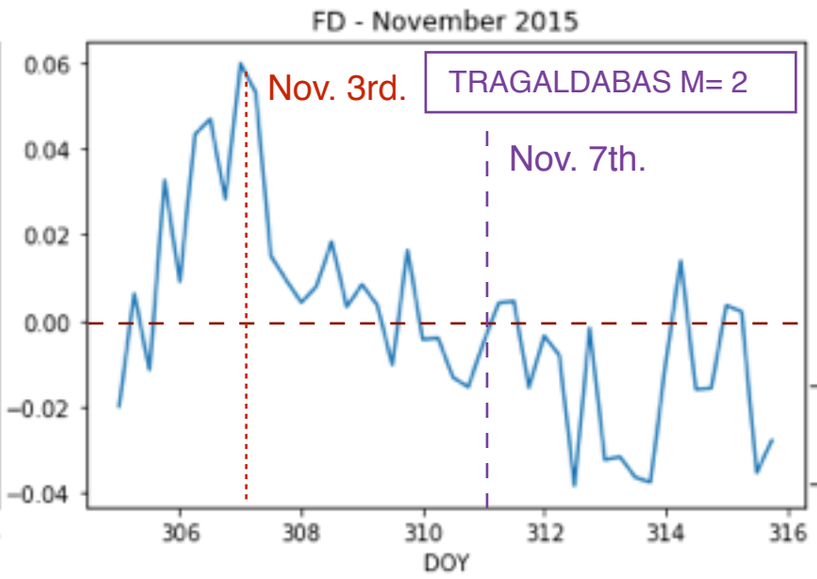
the end

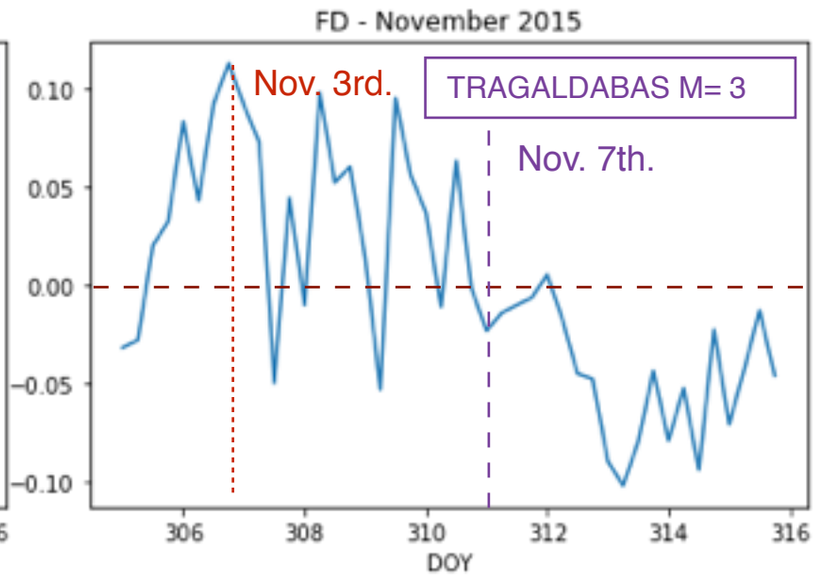
Thanks!

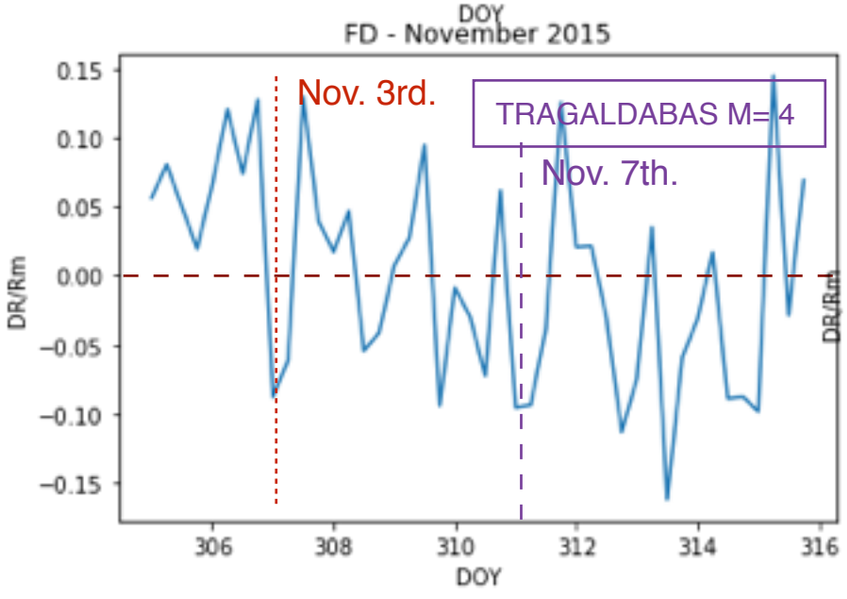
TRAGALDABAS: preliminary results

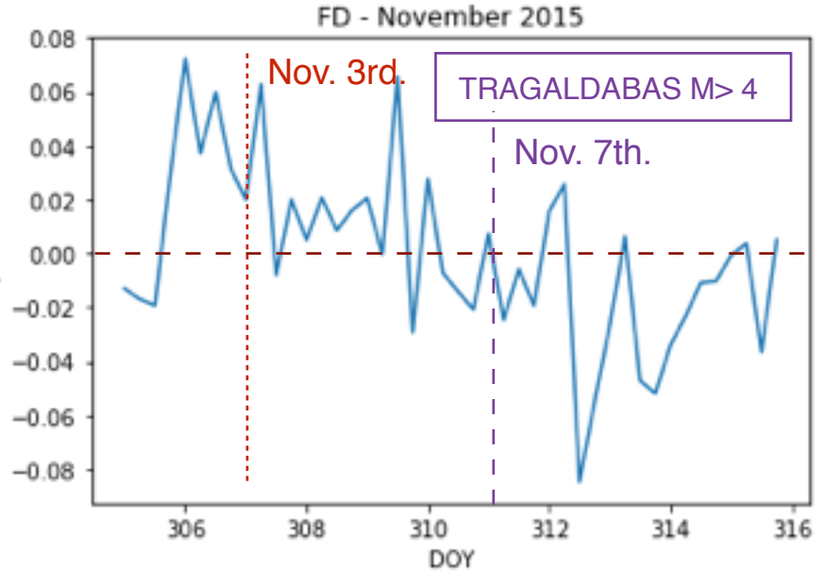
Analysis of the FD of November 2015

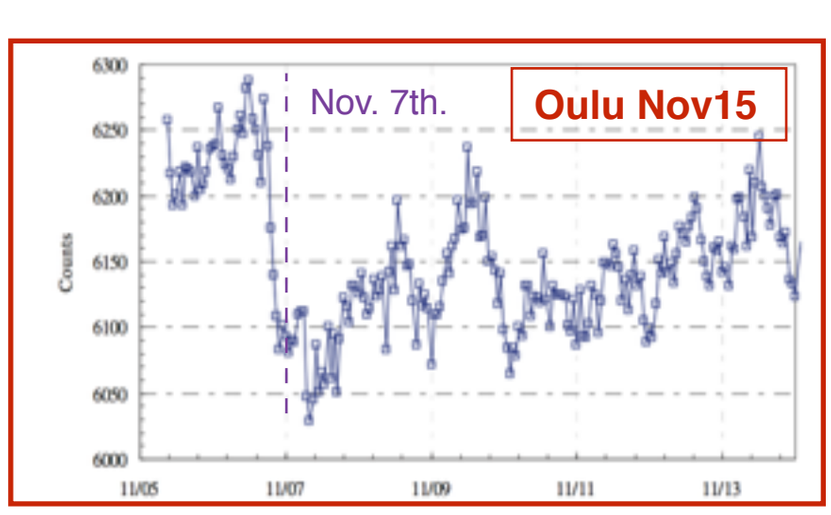












TRAGALDABAS: preliminary results

Analysis of the FD of November 2015