About Trasgos and Microscopes

Juan A. Garzón (LabCAF, Univ. Santiago de Compostela)

Outlook:

1. The team
2. Cosmic rays. The Tragaldabas experience
3. The TRASGO project
4. The MICROSCOPE
5. About the future

The team

Staff members:
Juan A. Garzón

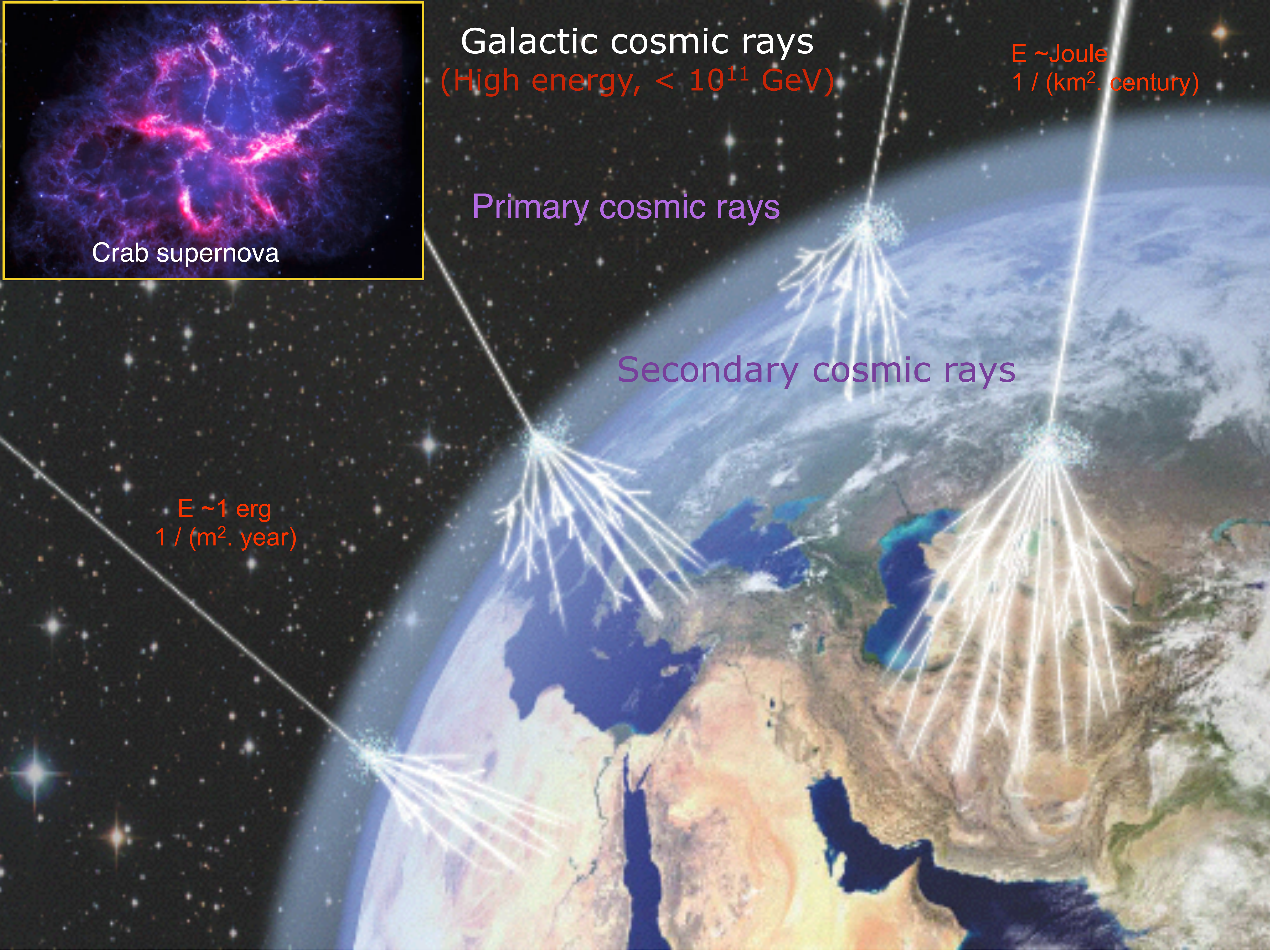
Ph. D. students:
José Cuenca
Yanis Fontenla
Damián García Castro
Irma Riadigós

Collaborators (from IGFAE)
Hector A. Pol
Pablo Cabanelas
Diego Glez. Díaz
Antonio Pazos
Marcos Seco

Main research area:
Multidisciplinar Cosmic Ray studies

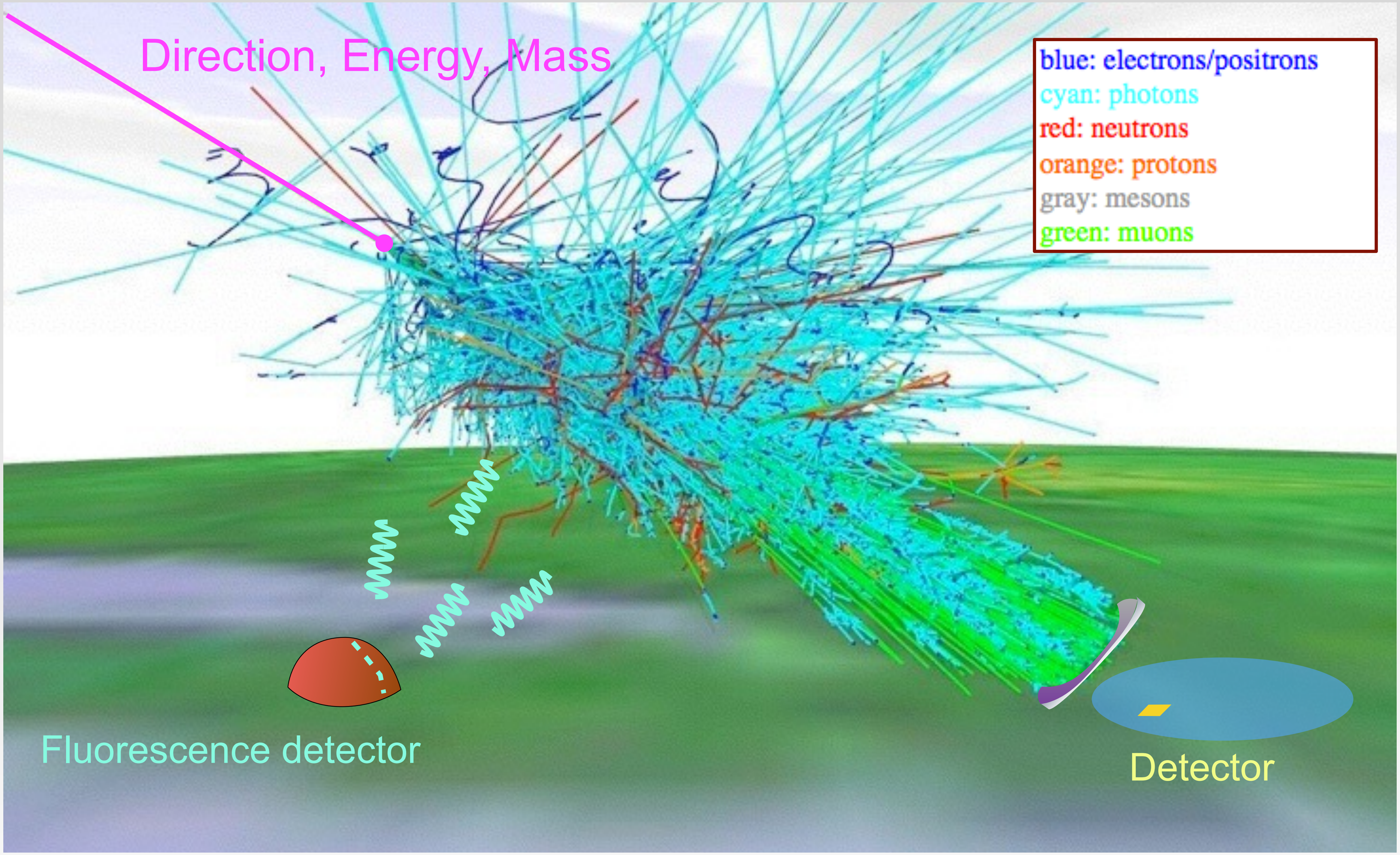
Open Collaborations:
HADES experiment (GSI)
MEPHI (Moscow)
Centro Fermi (Italy)
IGN: Instituto Geográfico Nacional (Madrid)

Cosmic rays



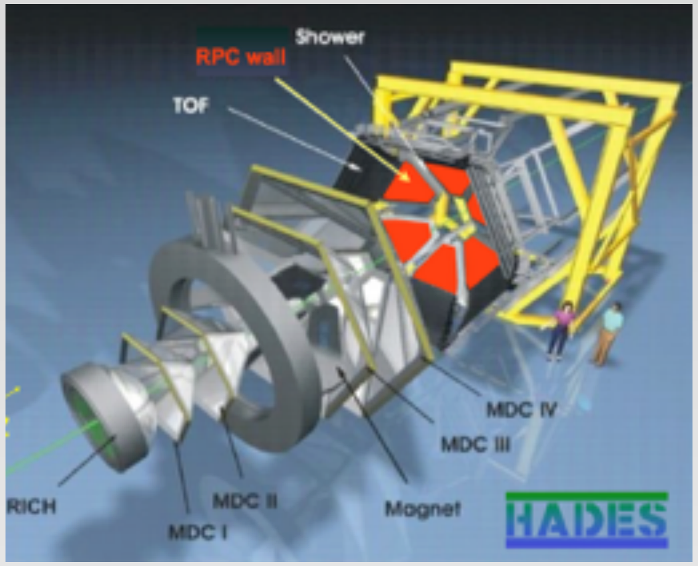
Galactic cosmic rays
(High energy, < 10^11 GeV)
E ~Joule
1 / (km^2. century)
Crab supernova
Primary cosmic rays
Secondary cosmic rays
E ~1 erg
1 / (m^2. year)

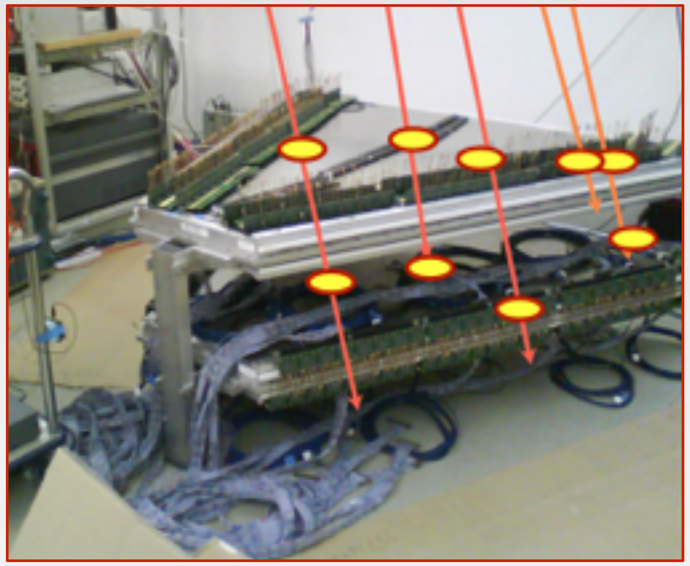
EAS: Extended Air Shower

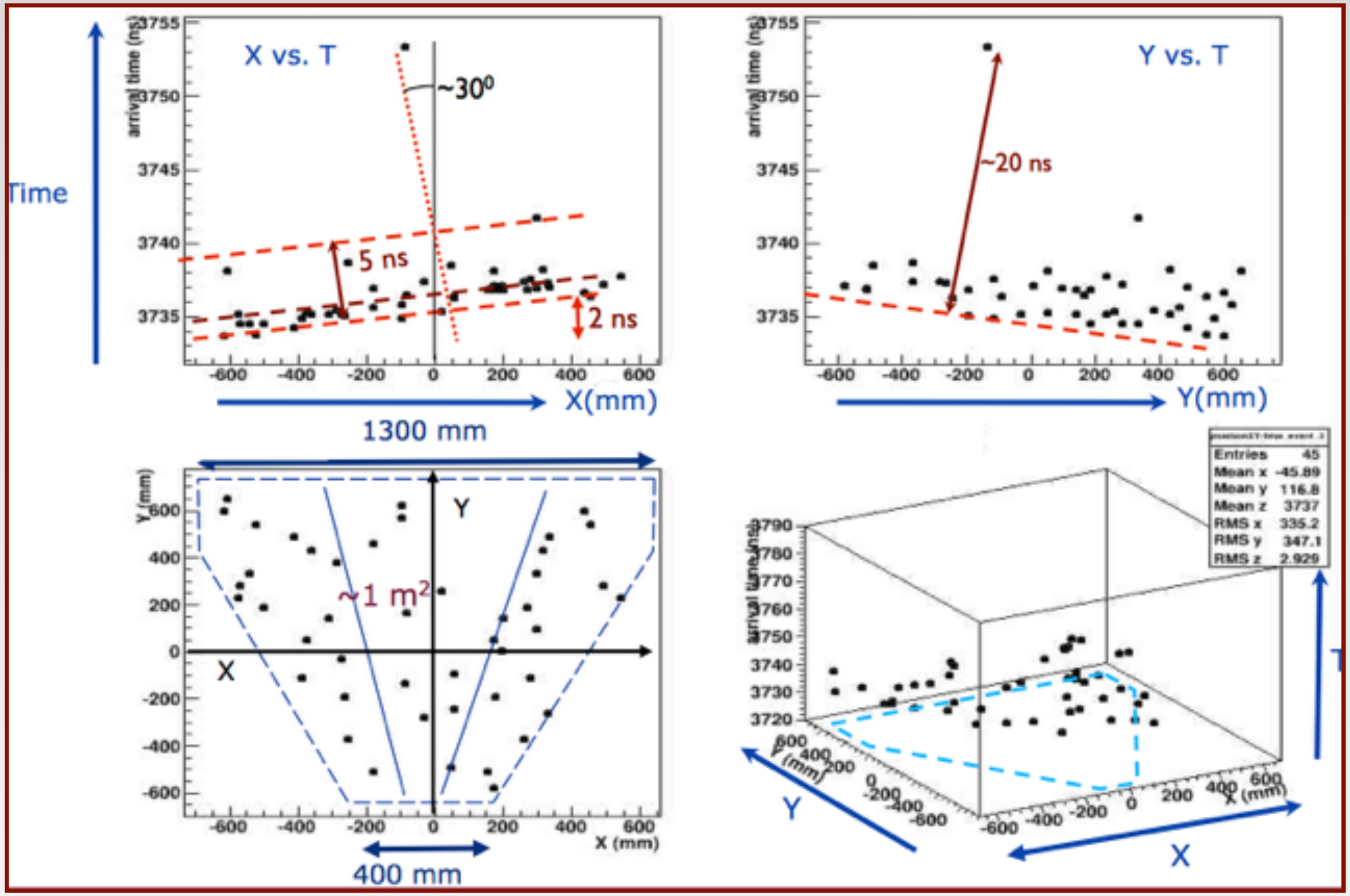


EAS (Extended Air Shower) simulation

Our experience in the HADES experiment at GSI (Darmstadt)







δT ~ 150 ps, δS ~ 5 cm², δθ ~5º

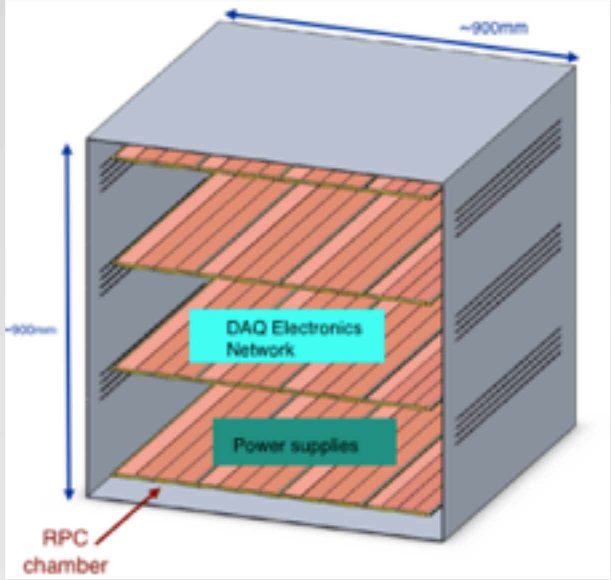
Never cosmic rays were observed at the Earth's surface with such accuracy!

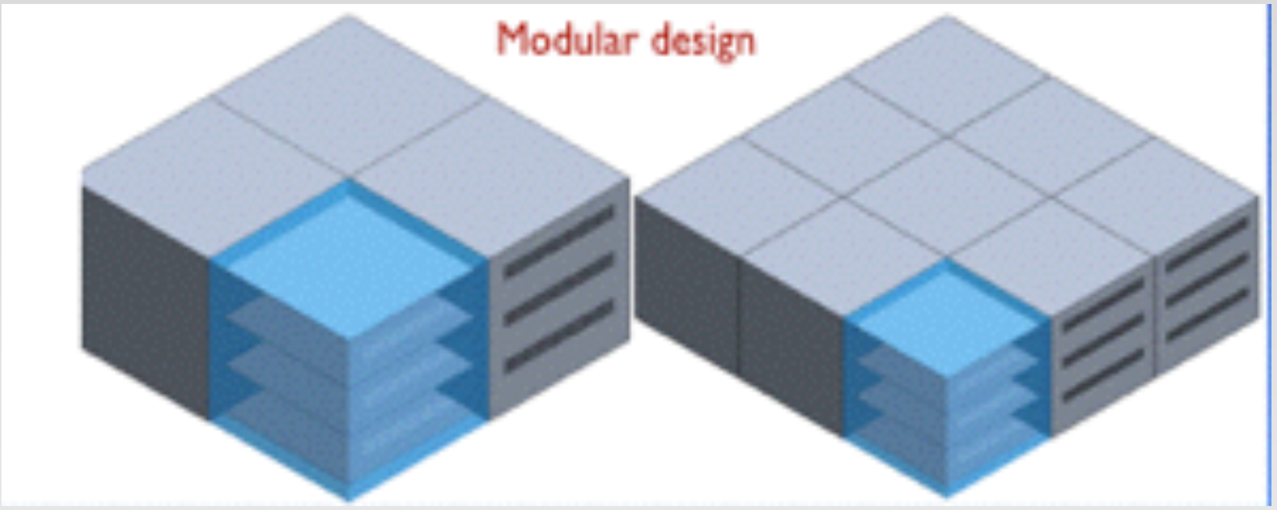
Proyecto

trasgo

Project

The concept

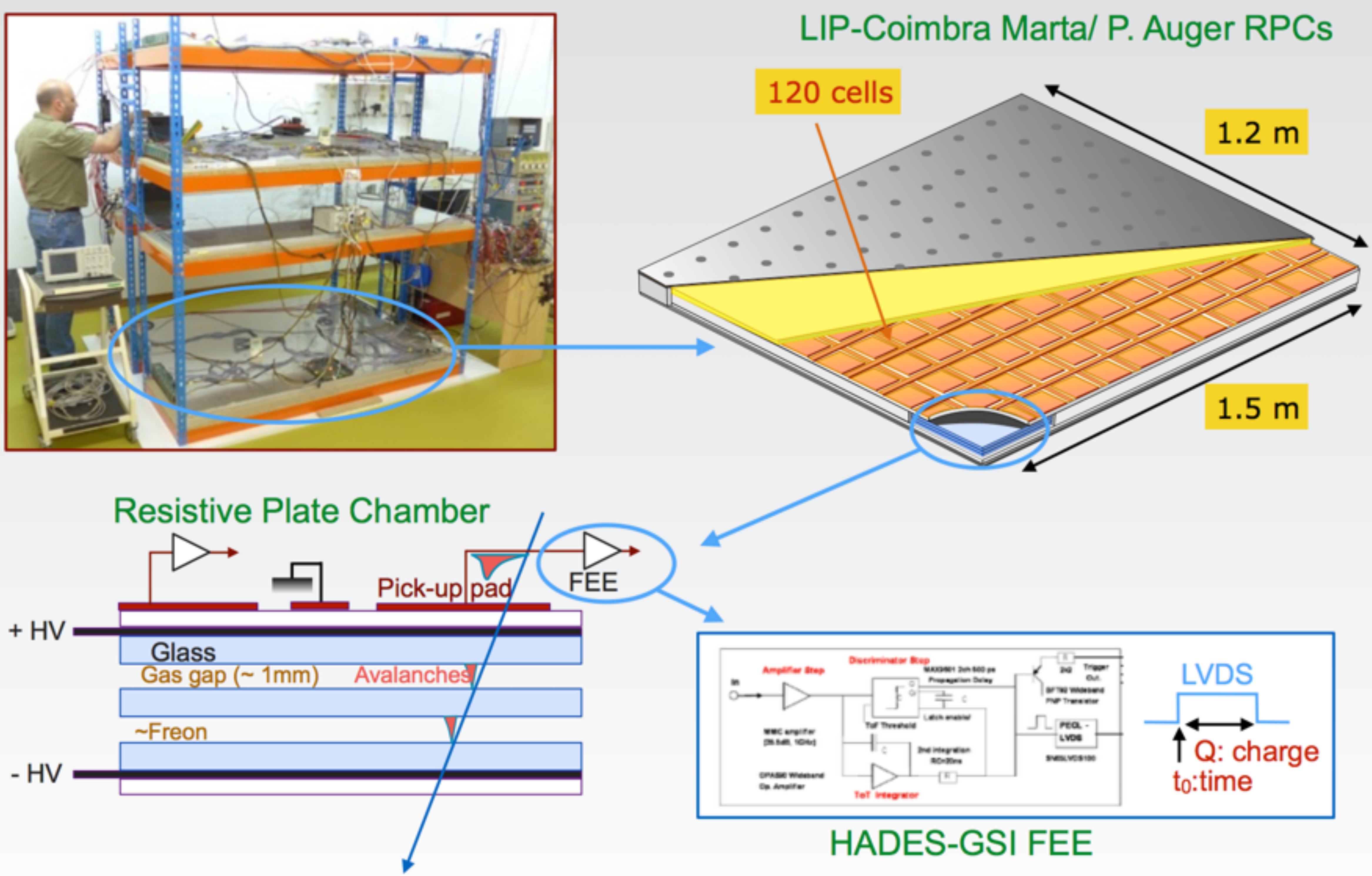




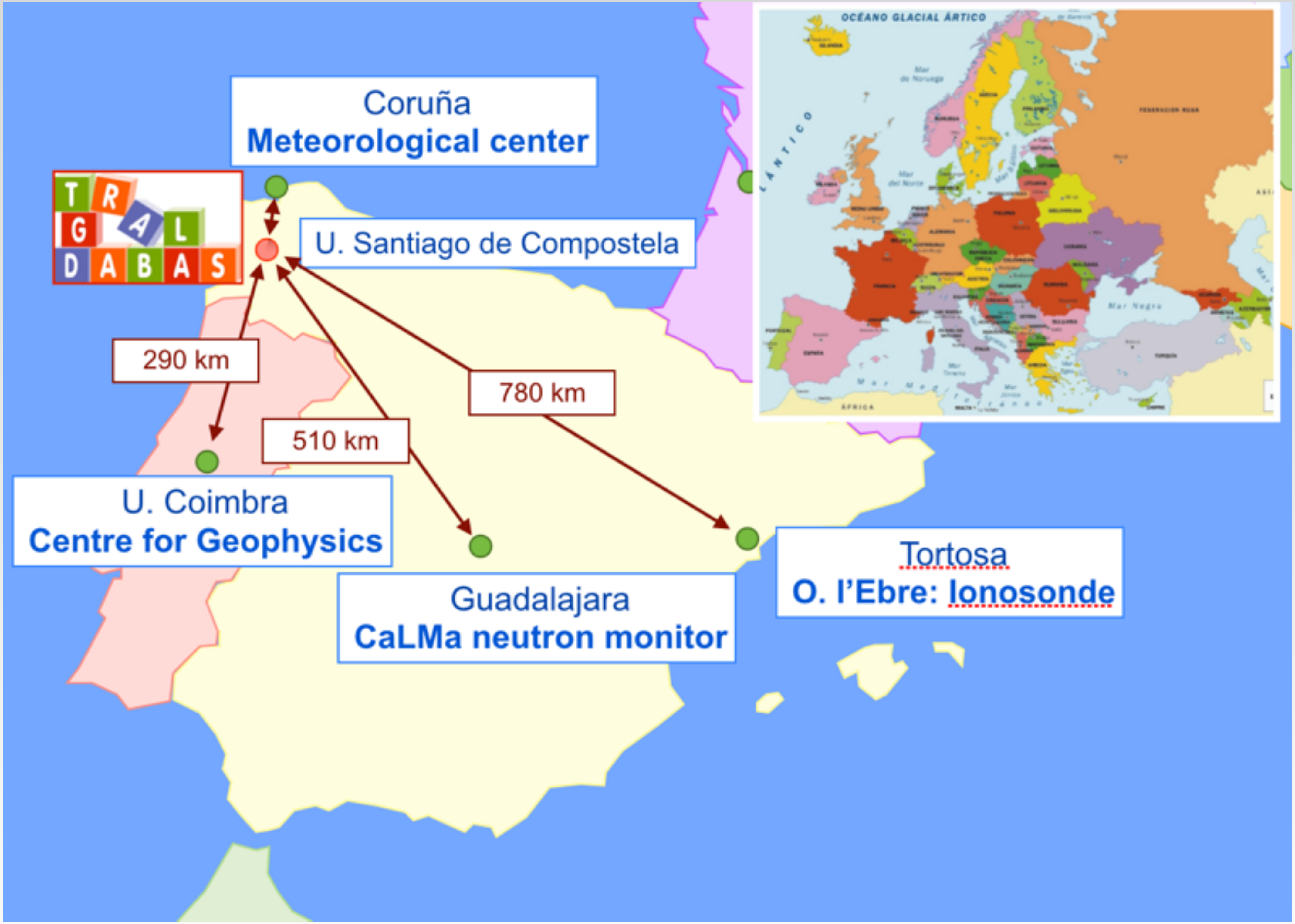
The TRASGO (TRAck and time reconStructinG bOx)

- Tracking detector based on RPCs (Resistive Plate Chambers)
- High granularity
- Sensitive to muons, electromagnetic showers and other particles
- Small size and modular concept

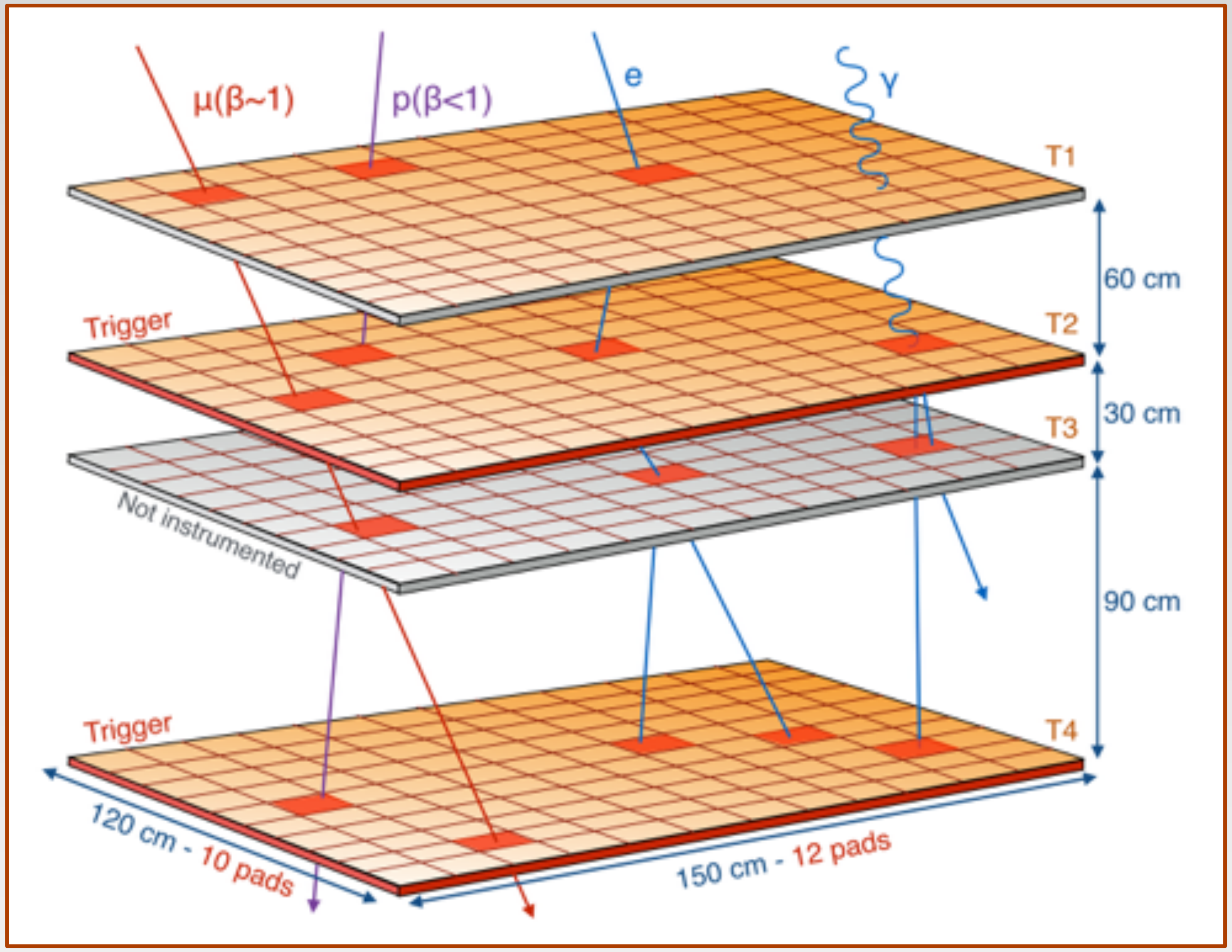
The first Trasgo: TRAGALDABAS / USC

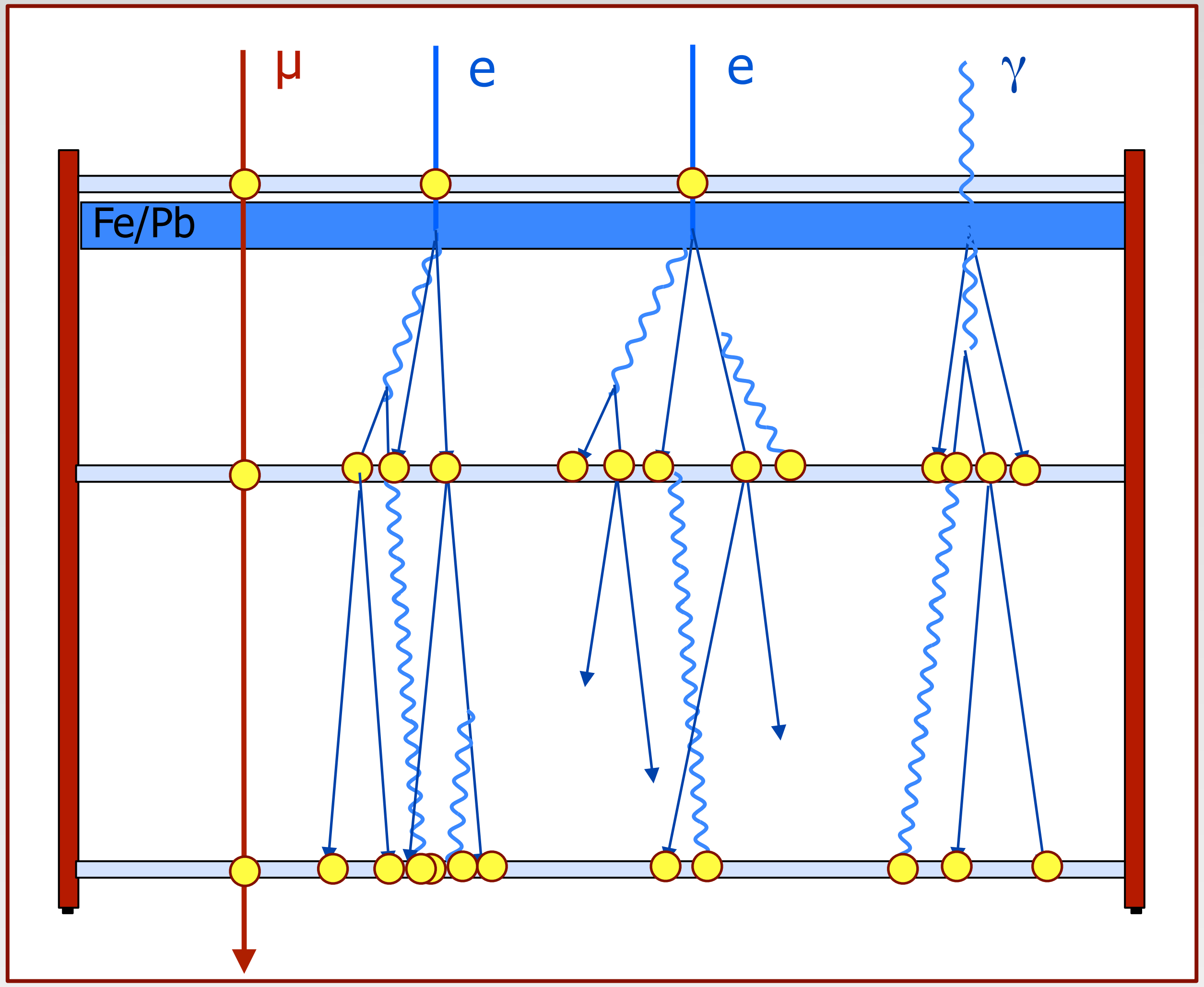


TRAGALDABAS: location respect other important facilities



TRAGALDABAS: PID capability

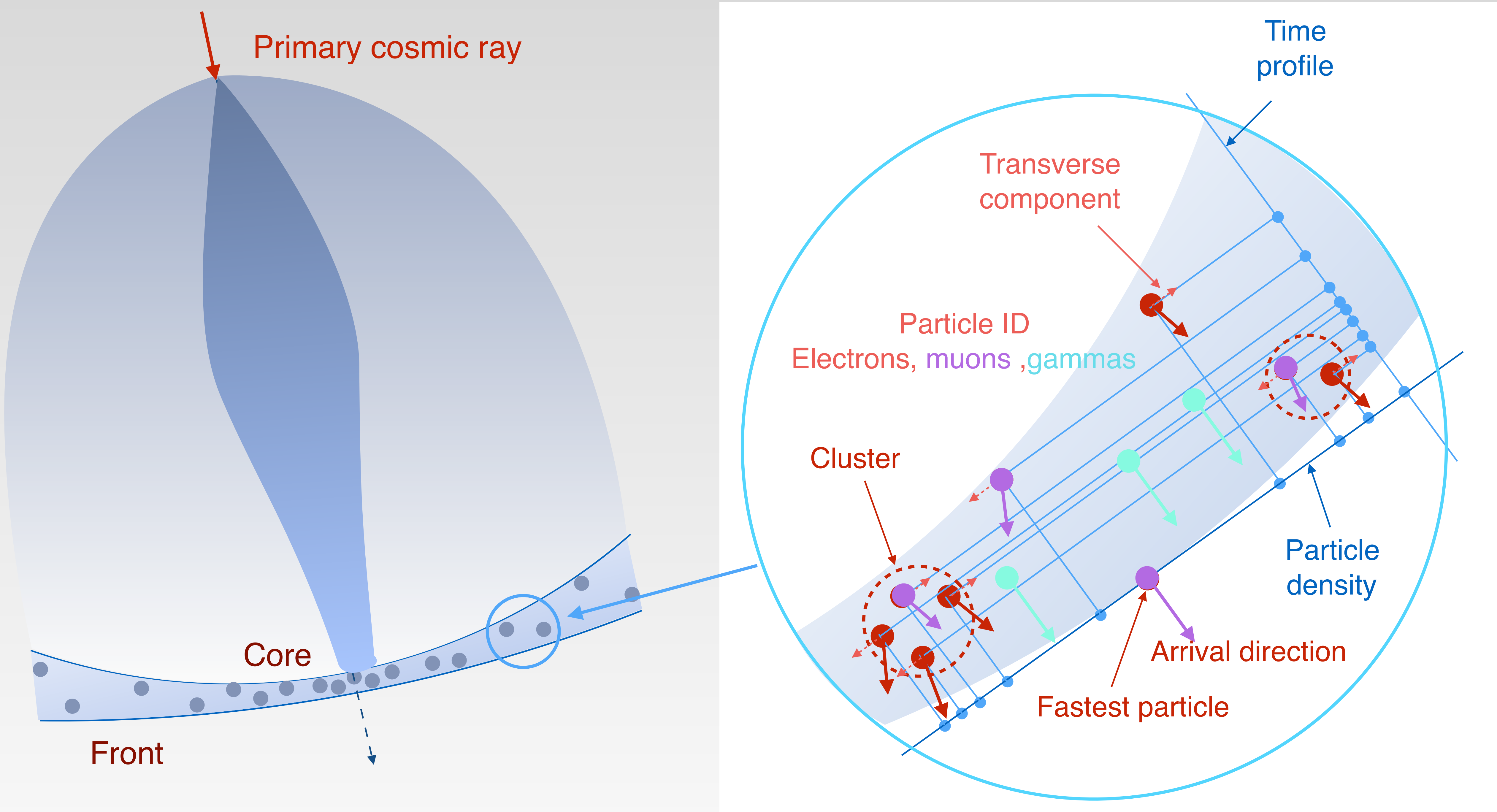




Performances:

- 4 planes of avalanche RPCs (only 3 instrumented yet)
- σ_t ~ 300 ps
- $\delta\Omega$ ~ 2º - 3º
- Efficiency ~ 99%

TRAGALDABAS: new accesible observables



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], 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 / Software development
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 / **Cosmic rays physics**, software and tracking
11. GFNL - Univ. Santiago de Compostela, Spain / **Atmosphere Physics and Climate**

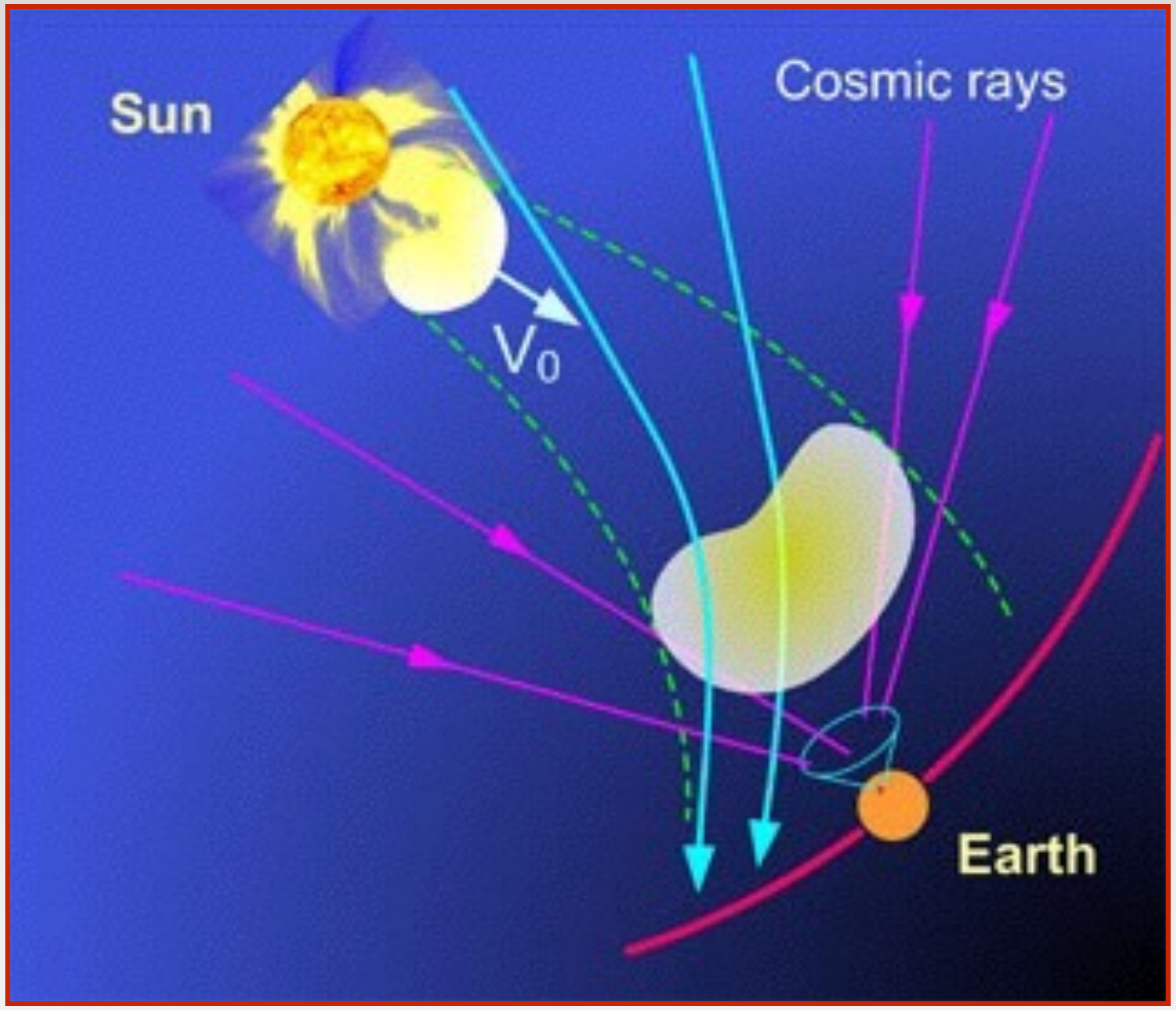
Other partners:

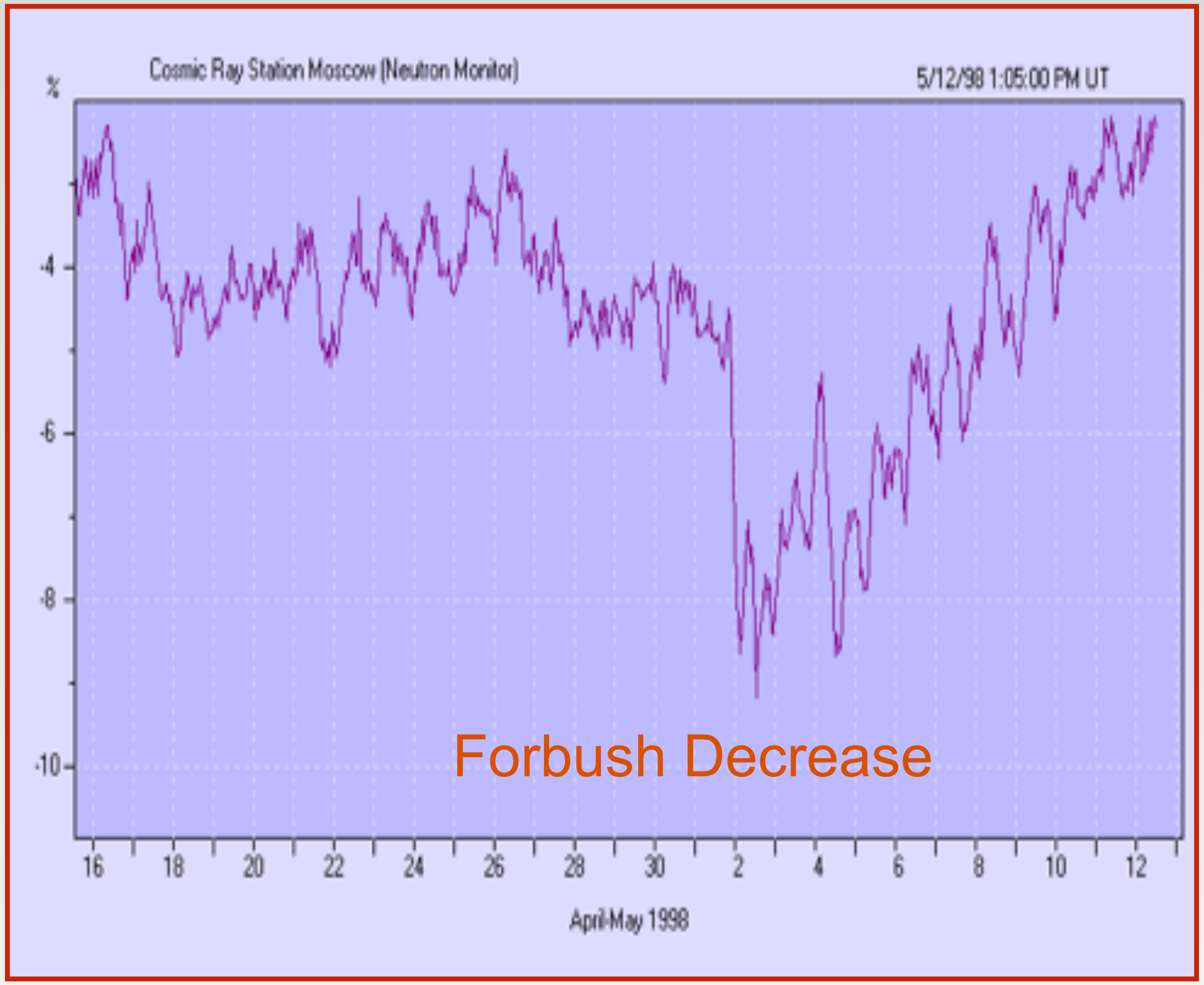
ATI Sistemas. La Coruña, Spain

Club Desarrollo de las Ciencias, Madrid, Spain

Hydra Technologies Spain S.L. Vigo, Spain

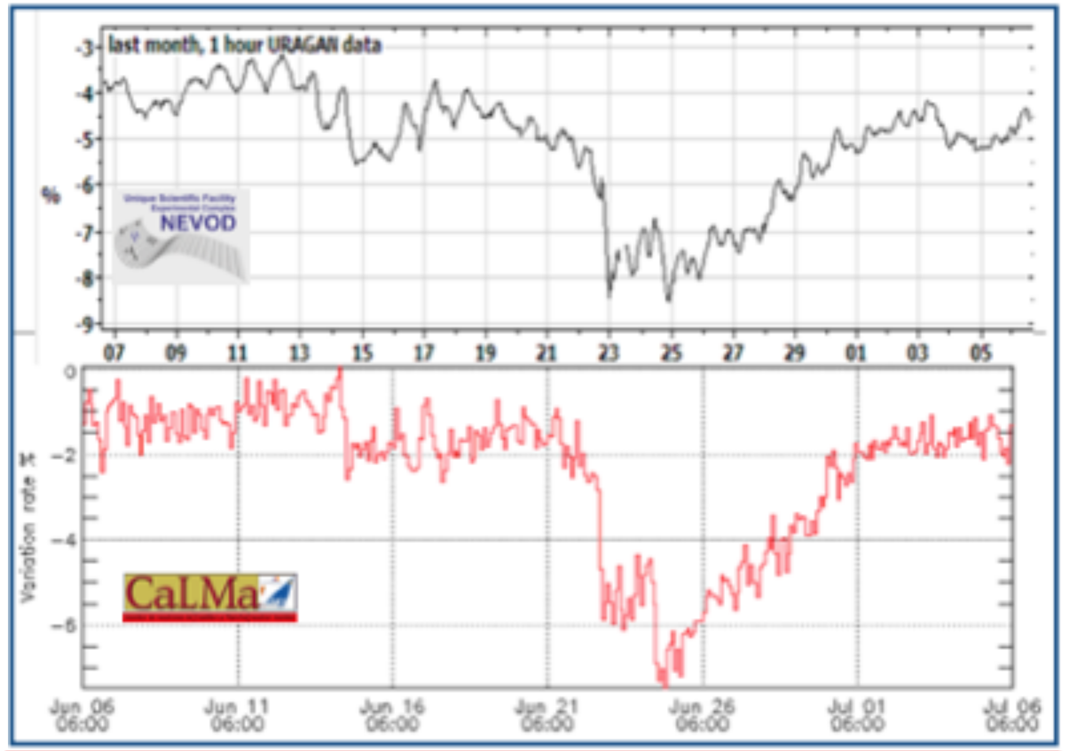
Example of preliminary result: the Forbush Decrease of June 22nd. 2015

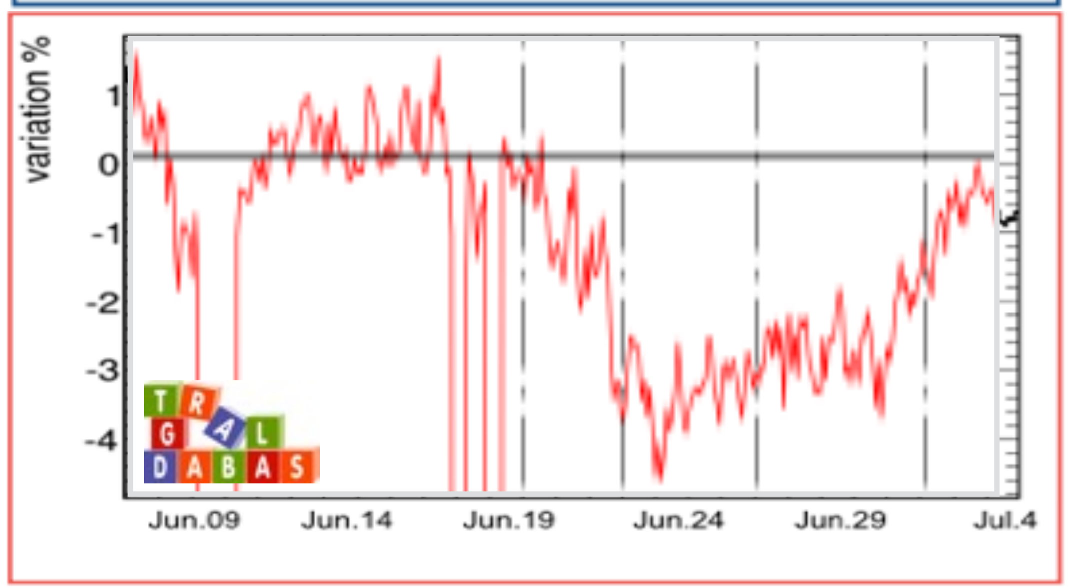




Example of preliminary result: the Forbush Decrease of June 22nd. 2015

Detector | **% Rate** | **Area / Cost**





~32 m^2 / ~M€

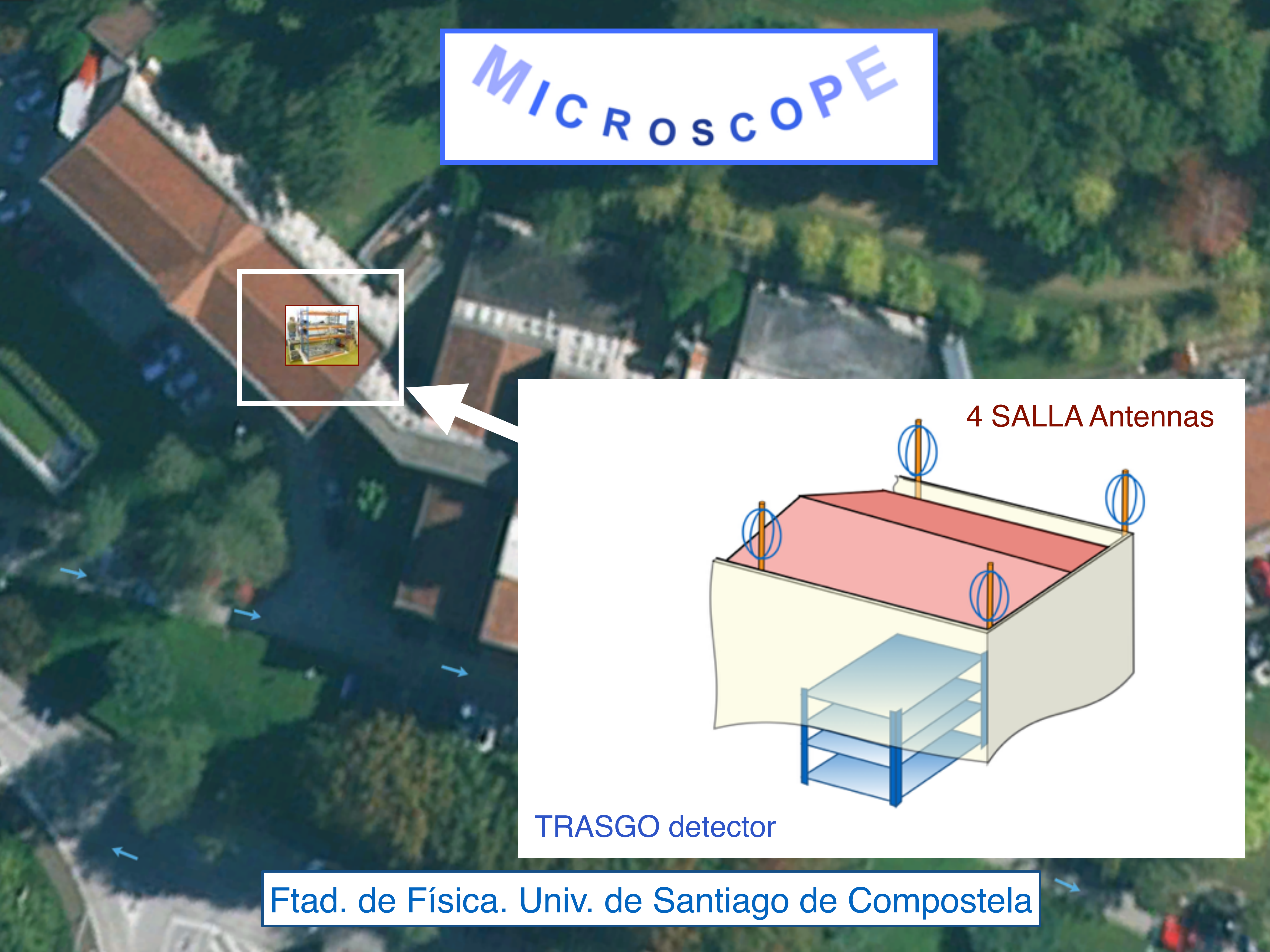
~20 m^2 / ~0. 25M€

~1.8 m^2 /0.03 M€

FD of Jun 22nd. 2015 seen at the USC by the trasgo Tragaldabas together with the results of URAGAN at Nevod-Moscow and CALMA Neutron Monitor -Guadalajara

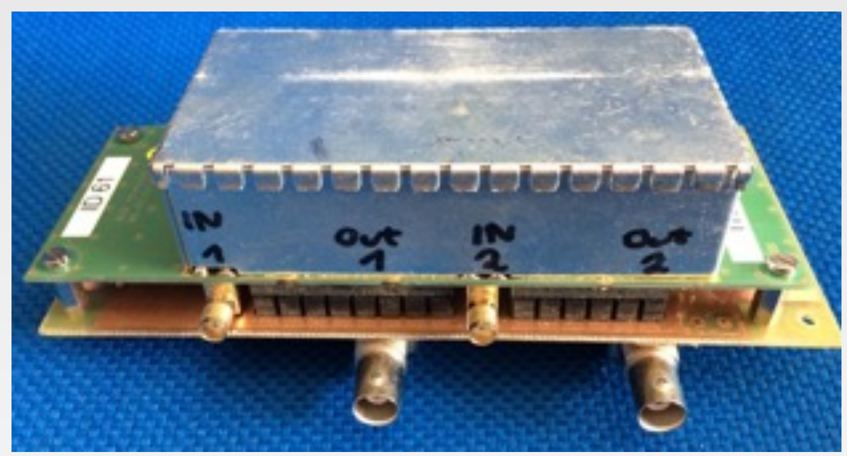
MICROSCOPE

MIni **C**osmic **R**ay **O**bservatory of **S**antiago de **CO**m**P**ost**E**la


MICROSCOPE
4 SALLA Antennas
TRASGO detector
Ftad. de Física. Univ. de Santiago de Compostela

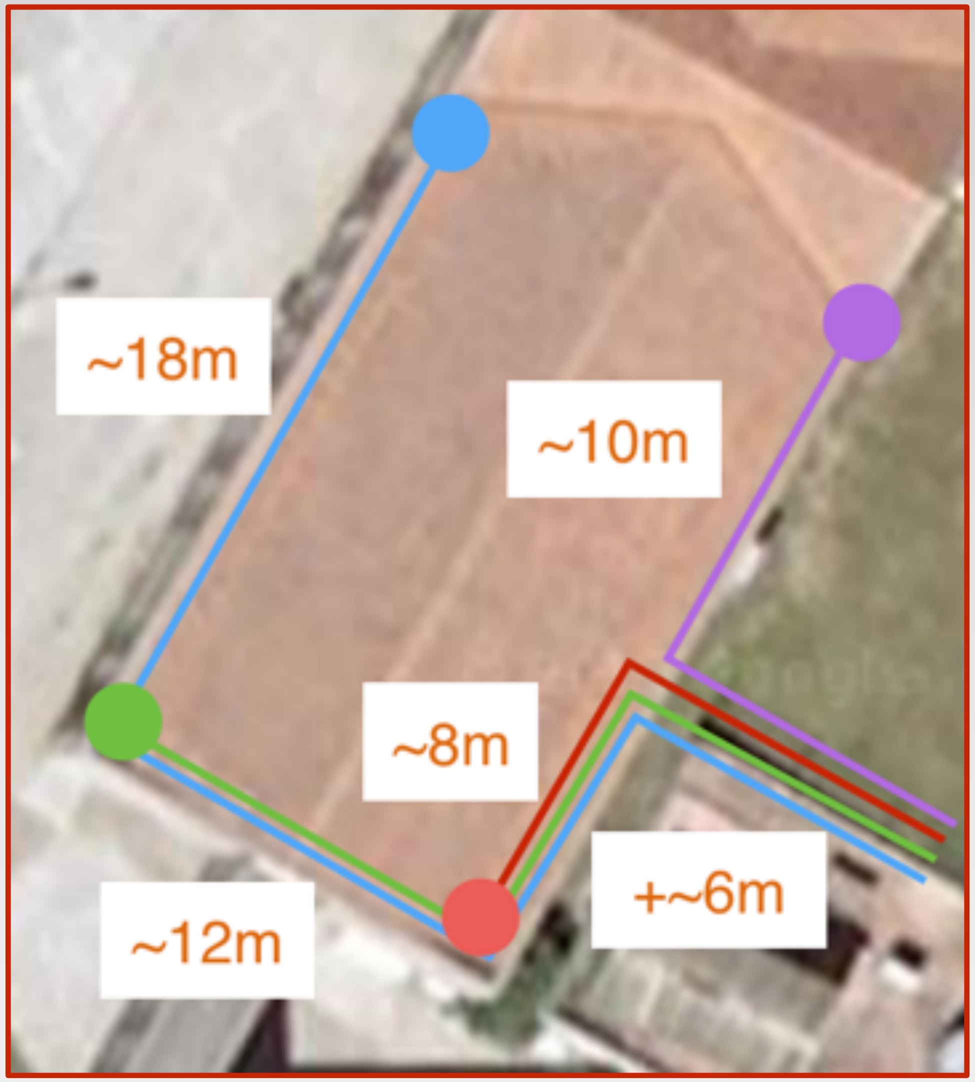
MICROSCOPE

SALLA antennas already available



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

SALLA Antennas



Model Used:	WMM2015						
Latitude:	42º 52' 48" N						
Longitude:	8º 32' 28" W						
Elevation:	235.0 m Mean Sea Level						
Date	**Declination (+ E | - W)**	**Inclination (+ D | - U)**	**Horizontal Intensity**	**North Comp (+ N | - S)**	**East Comp (+ E | - W)**	**Vertical Comp (+ D | - U)**	**Total Field**
2016-12-22	-2º 32' 37"	57º 48' 59"	24,263.5 nT	24,239.6 nT	-1,076.8 nT	38,554.2 nT	45,553.8 nT
Change/year	0º 8' 3"/yr	-0º 1' 33"/yr	26.1 nT/yr	28.6 nT/yr	55.5 nT/yr	2.8 nT/yr	16.3 nT/yr
Uncertainty	0º 20'	0º 13'	133 nT	138 nT	89 nT	165 nT	152 nT

SALLA Antennas

Daily rate of clusters of secondaries at sea level for different primary energies (NKG parametrization)										
Energy	Flux of primary cosmic rays			Daily rate of clusters/m^2.sr, for different multipiplicies M						Energy
E/GeV	/GeV.m^2.sr.s	IF/m^2.sr.s	IF/m^2.sr.day	M=3-5	M=5-10	M=10-20	M=20-30	M=30-40	M > 40	E/eV
1.00E+06	1.1E-12	6.8E-07	5.9E-02	296	166	60	15			1.00E+15
1.78E+06	2.4E-13	2.6E-07	2.2E-02	222	130	54	17			1.76E+15
3.16E+06	5.1E-14	9.0E-08	7.8E-03	156	95	46	18			3.16E+15
5.62E+06	3.5E-14	5.6E-08	4.8E-03	193	122	69	32			5.62E+15
1.00E+07	6.3E-15	3.8E-08	3.3E-03	264	174	114	66	51	31	1.00E+16
1.78E+07	1.1E-15	1.2E-08	1.0E-03	127	86	59	34	27	17	1.76E+16
3.16E+07	2.0E-16	3.8E-09	3.3E-04	61	43	30	17	14	10	3.16E+16
5.62E+07	3.5E-17	1.2E-09	1.0E-04	29	21	16	9	8	5	5.62E+16
1.00E+08	6.3E-18	3.8E-10	3.3E-05	14	11	8	5	4	3	1.00E+17
1.78E+08	1.1E-18	1.2E-10	1.0E-05	6	5	4	2	2	1	1.78E+17
3.16E+08	2.0E-19	3.8E-11	3.3E-06	3	2	2	1	1	1	3.16E+17
5.62E+08	3.5E-20	1.2E-11	1.0E-06	1	1	1	0	0	0	5.62E+17
1.00E+09	6.3E-21	3.8E-12	3.3E-07	1	0	0	0	0	0	1.00E+18
1.78E+09	1.1E-21	1.2E-12	1.0E-07	0	0	0	0	0	0	1.78E+18
3.16E+09	2.0E-22	4.6E-13	3.9E-08	0	0	0	0	0	0	3.16E+18
TOTAL		1.1E-07	9.8E-02	1,373	858	462	216	107	69	TOTAL
E/A.GeV	Flux	FluxIAS	IF/m^2.s	M=3-5	M=5-10	M=10-20	M=20-30	M=30-40	M > 40	E/A.GeV

Expected rates of showers of different multiplicities and at different energies.

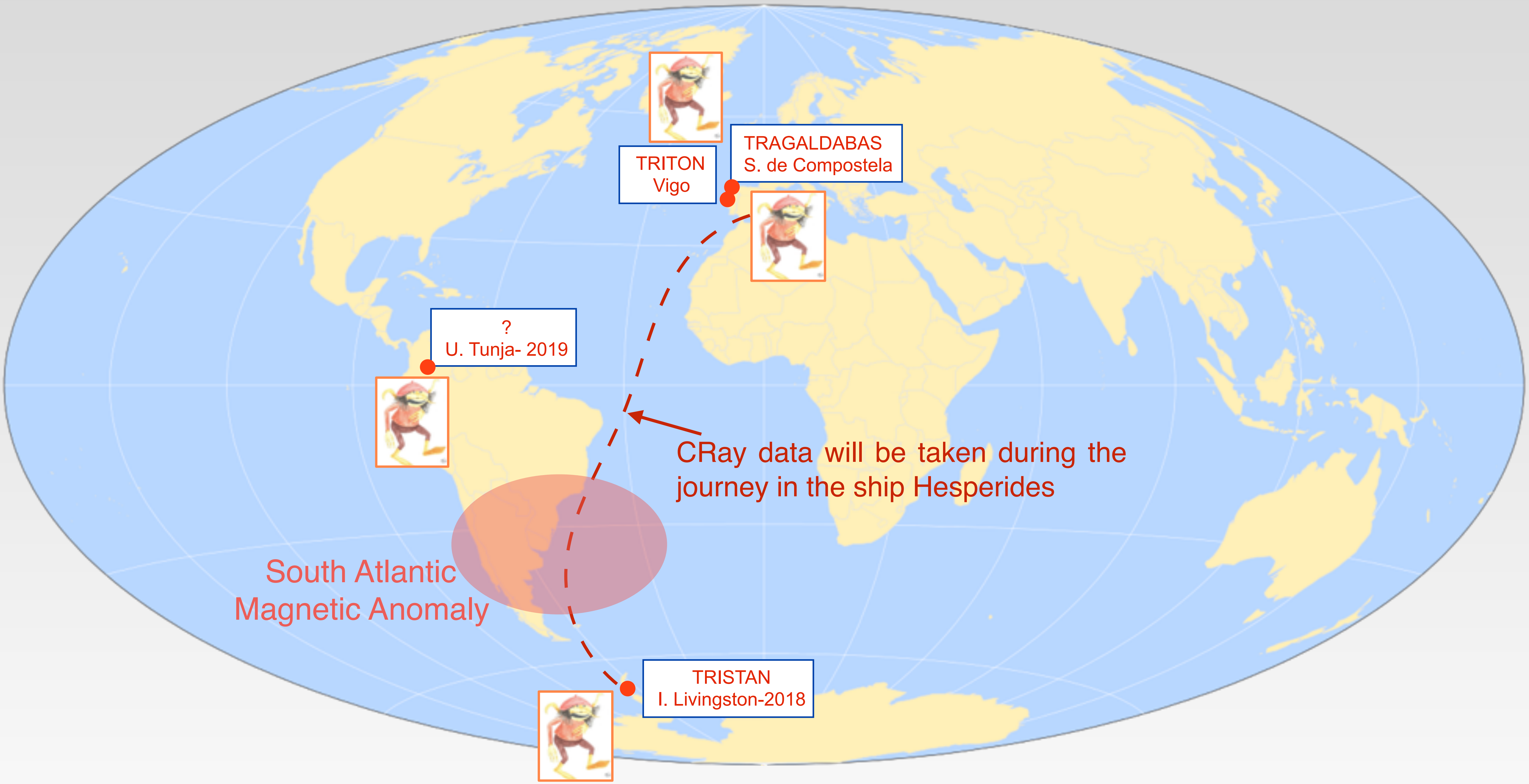
Around 500 daily triggers of showers with E> 10^{16} eV!!

The MICROSCOPE facility in Santiago de Compostela will allow to analyze the microscopic structure of cosmic ray air showers allowing a better understanding of the EAS dynamics and, as a consequence, to define new observables allowing a better estimation of the parameters associated with primary cosmic rays.

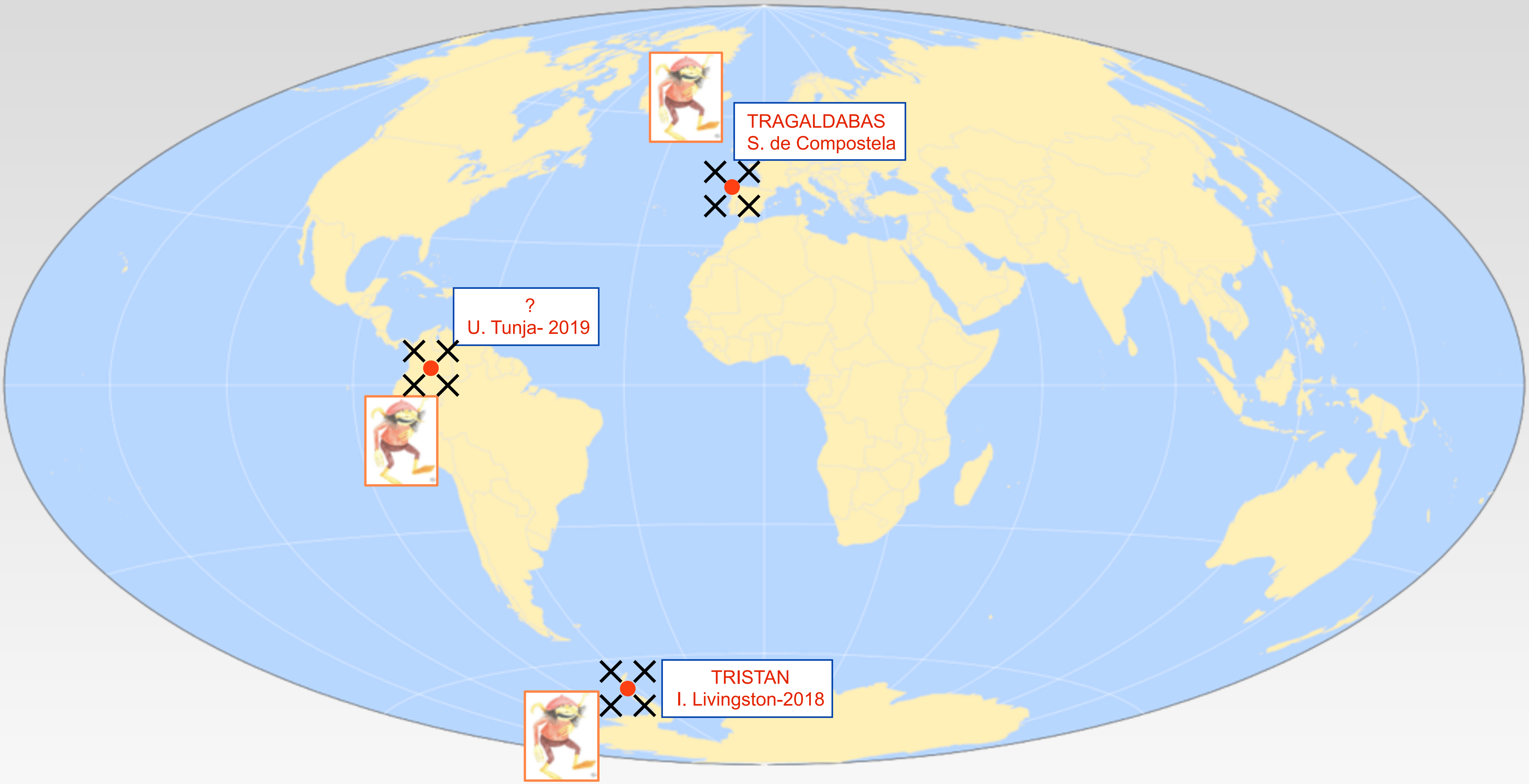
Next steps and Summary

Next steps & Summary

The TRASGO project: to install new Trasgos in the Antarctic and in U. Tunja / Colombia



Deploy a future MICROSCOPEs network?



The end

Thanks!

EAS: Mass

Atmospheric depth of the first interaction for different primary masses in Santiago de Compostela (Corsika simulation)								
Energy	Proton		Helium		Carbon		Iron	
E/A.GeV	H/(g/cm2)	sH/(g/cm2)	H/(g/cm2)	sH/(g/cm2)	H/(g/cm2)	sH/(g/cm2)	H/(g/cm2)	sH/(g/cm2)
1.00E+01	60.0	55.8	46.1	45.9	26.2	26.1	13.4	13.3
1.33E+01	58.9	50.1	45.9	45.7	26.2	26.2	13.4	13.4
1.78E+01	62.5	62.4	45.9	45.7	26.3	26.3	13.4	13.4
2.37E+01	63.0	63.0	45.9	46.1	26.3	26.3	13.4	13.4
3.16E+01	62.7	62.8	46.0	46.0	26.1	26.2	13.3	13.3
4.22E+01	62.9	62.6	45.7	45.8	26.3	26.3	13.4	13.3
5.62E+01	63.0	63.4	45.8	45.8	26.2	26.1	13.3	13.3
7.50E+01	63.5	63.7	45.3	45.4	26.2	26.2	13.3	13.3
1.00E+02	90.4	89.8	42.9	42.6	26.2	26.2	13.1	13.1
1.78E+02	88.4	88.6	42.3	42.3	25.9	25.9	12.9	12.9
3.16E+02	86.7	86.7	41.6	41.5	25.6	25.6	12.9	12.9
5.62E+02	88.2	94.8	42.1	44.1	25.1	25.2	12.1	11.9
1.00E+03	87.9	81.9	42.5	41.3	25.4	25.4	13.4	13.1
3.16E+03	88.4	78.3	38.8	39.3	24.8	24.0	12.9	13.6
1.00E+04	80.1	88.6	37.9	36.7	23.3	23.7		
3.16E+04	76.8	73.4	36.0	35.0	24.2	24.2	11.7	11.1
1.00E+05	76.9	69.3	35.8	36.3	23.6	23.9	11.9	12.1
3.16E+05	64.5	64.9	35.6	34.1	22.6	23.1		

[Yanis Fontenla 2017]