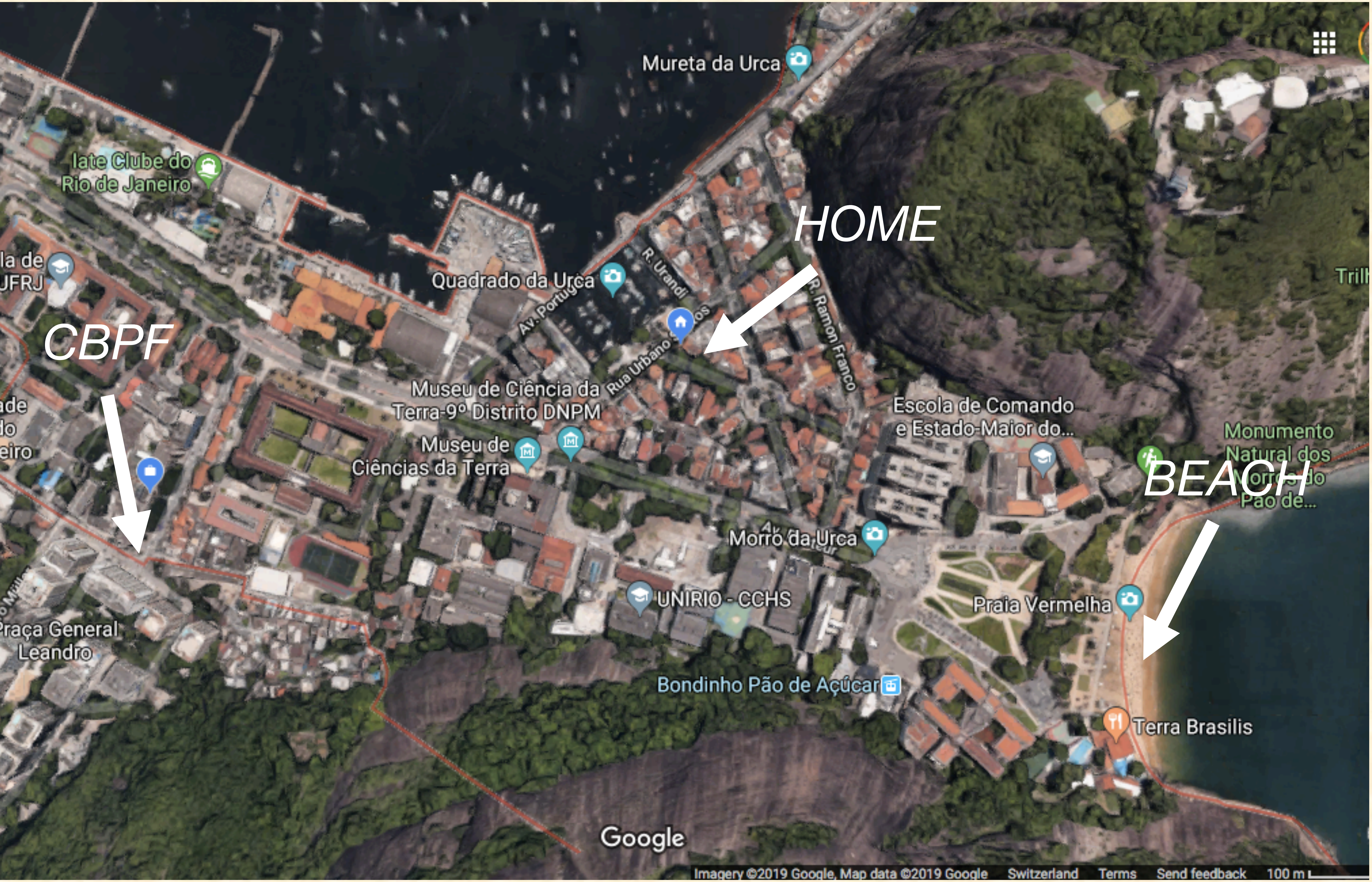
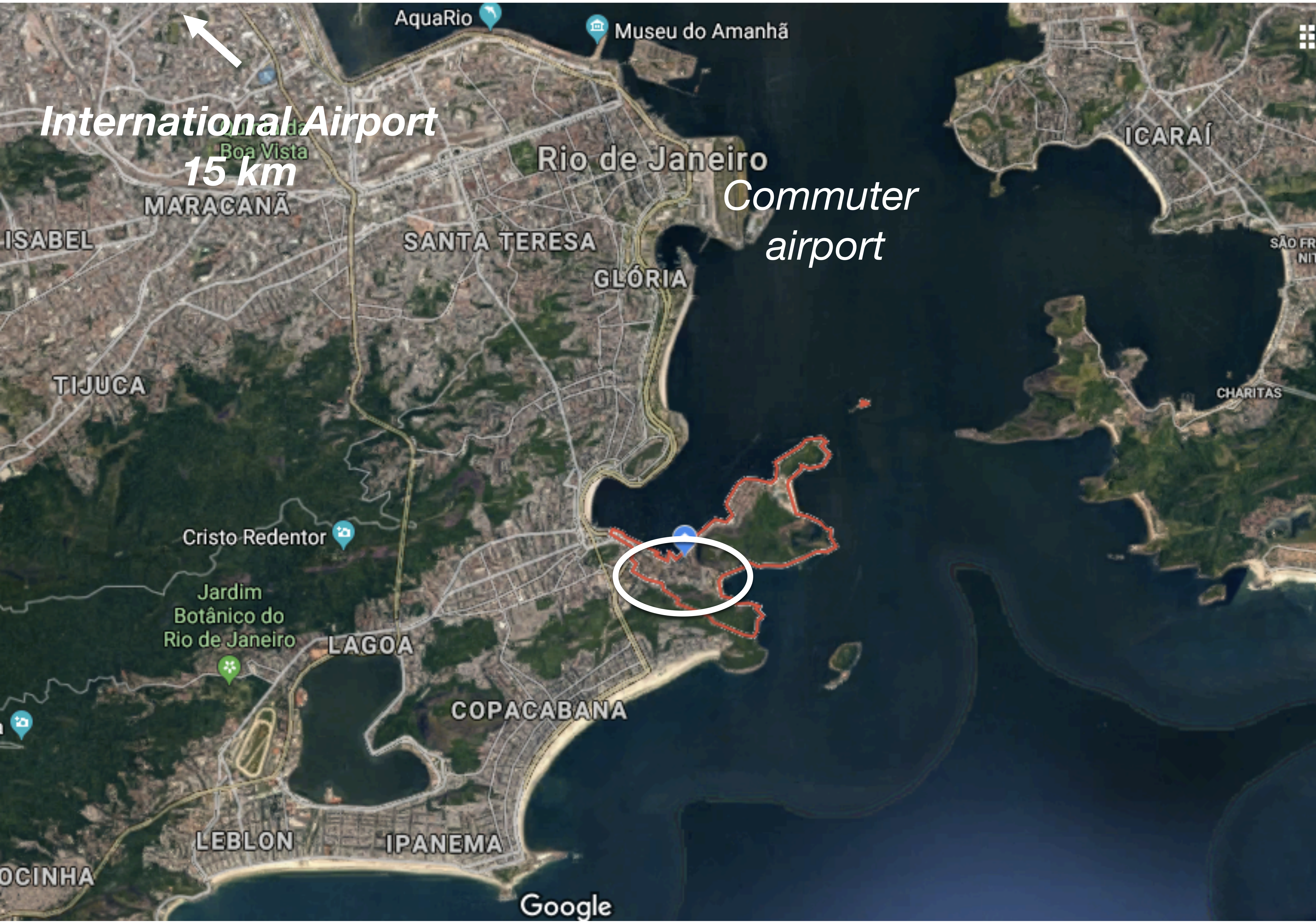
CBPF, Astroparticles South America and all that

Ronald Cintra Shellard
CBPF – Rio de Janeiro

icise
QUY NHON
VIETNAM



HOME
CBPF
BEACH
Mureta da Urca
Iate Clube do Rio de Janeiro
Quadrado da Urca
Av. Portugal
R. Urandi
R. Ramon Franco
Rua Urbano Santos
Museu de Ciência da Terra-9º Distrito DNPM
Museu de Ciências da Terra
Escola de Comando e Estado-Maior do...
Monumento Natural dos Morros do Pão de...
Morro da Urca
UNIRIO - CCHS
Praia Vermelha
Bondinho Pão de Açúcar
Terra Brasilis
Praça General Leandro
Google
Imagery ©2019 Google, Map data ©2019 Google Switzerland Terms Send feedback 100 m

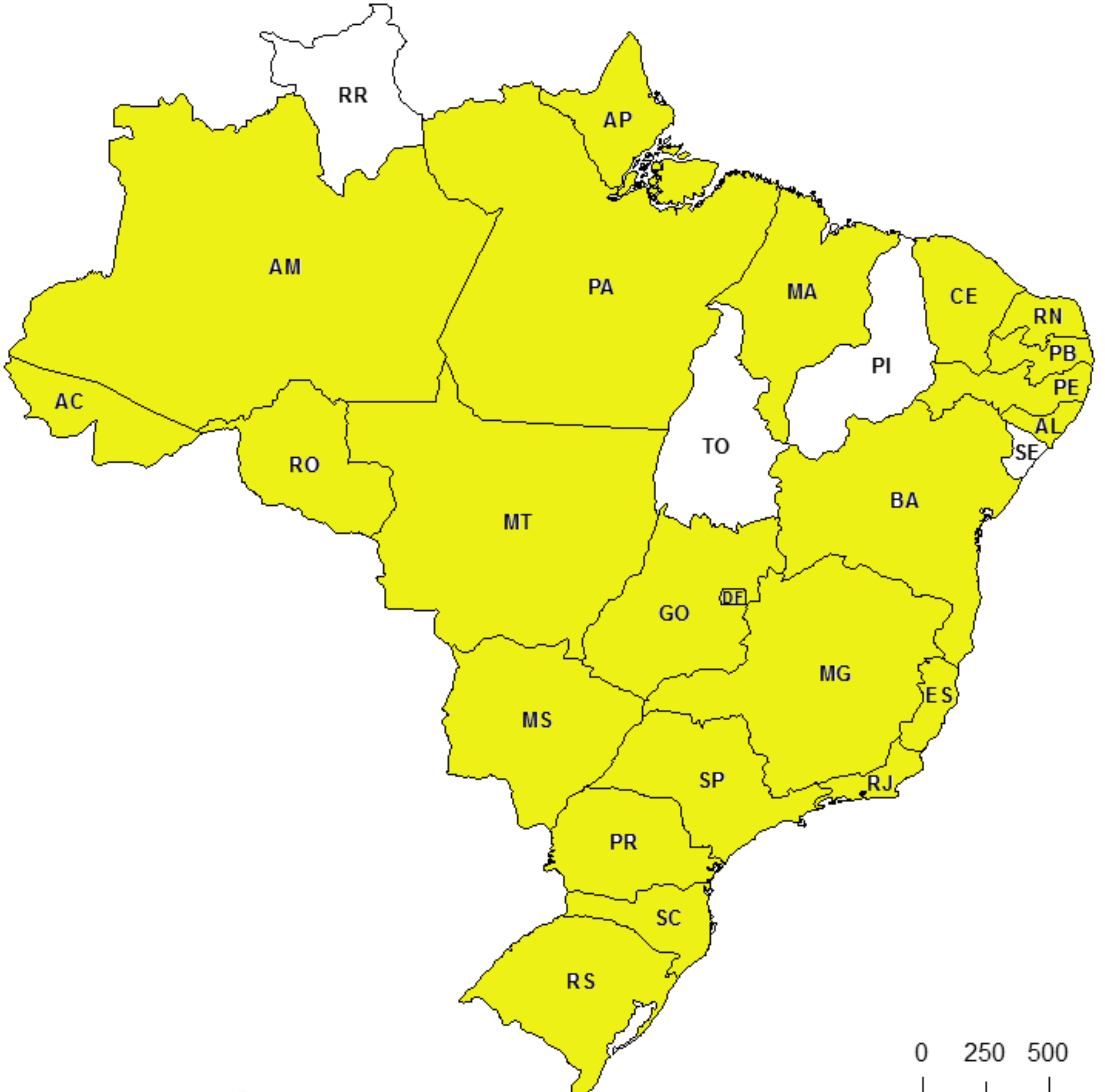


AquaRio
Museu do Amanhã
International Airport
15 km
Boa Vista
MARACANÃ
ISABEL
Rio de Janeiro
Commuter
airport
SANTA TERESA
GLÓRIA
ICARAÍ
TIJUCA
CHARITAS
Cristo Redentor
Jardim
Botânico do
Rio de Janeiro
LAGOA
COPACABANA
LEBLON
IPANEMA
OCINHA
Google

CBPF – R&D Areas

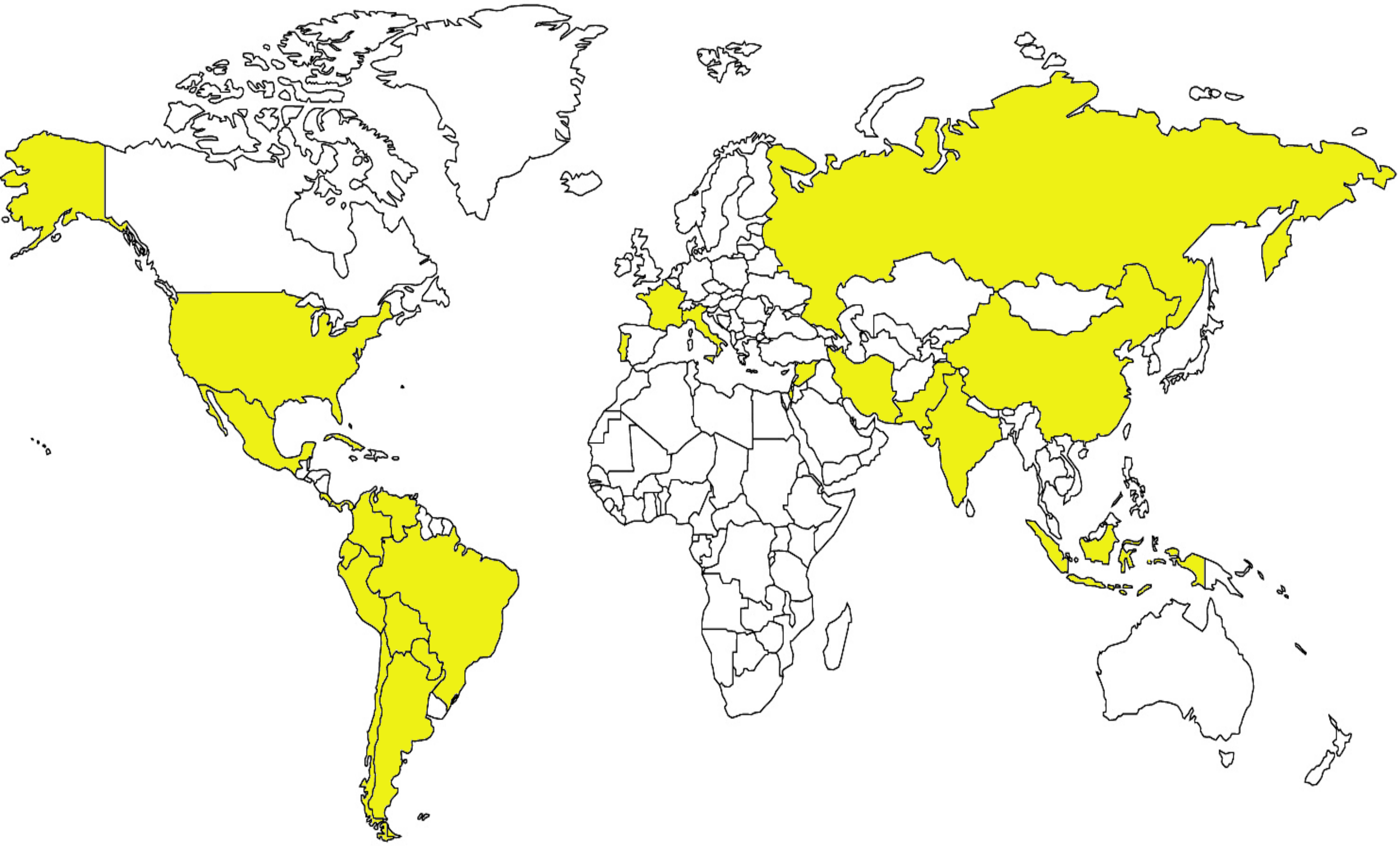
- High energy physics and astroparticle
- Cosmology and Gravitation
- Materials Science, nanoscience and nanotechnology
- Biophysics
- Quantum Information
- Statistical Mechanics and Complex systems (Tsallis Statistics)

Origin per state of students who Graduated at CBPF



ESTADO	ALUNOS
GOIÁS	7
MATO GROSSO	1
DISTRITO FEDERAL	7
ACRE	2
AMAPÁ	2
AMAZONAS	2
PARÁ	21
RONDÔNIA	1
ALAGOAS	4
BAHIA	18
CEARÁ	16
MARANHÃO	4
PARAÍBA	8
PERNAMBUCO	17
RIO GRANDE DO NORTE	8
RIO GRANDE DO SUL	35
SANTA CATARINA	10
PARANÁ	12
ESPÍRITO SANTO	25
MINAS GERAIS	46
RIO DE JANEIRO	295
SÃO PAULO	44

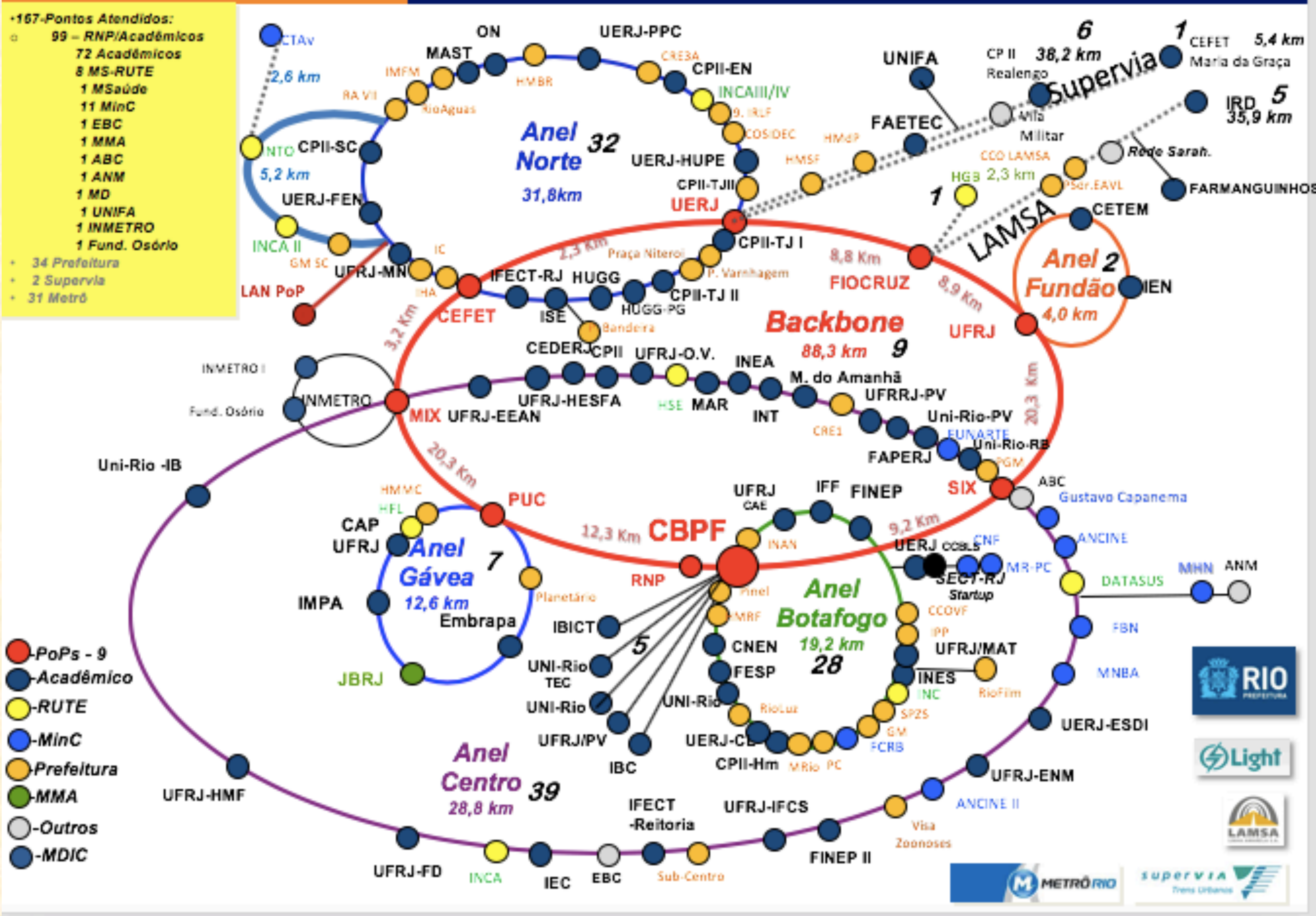
Origin of students who graduated at CBPF



Schools and Conferences

- IV Workshop da Network for bioenginneering
- Advanced School on Experimental Physics
- Workshop "NMR applied to Petrophysics"
- CTA Consortium
- 16ª Brazilian School of Cosmology and Gravitation
- VI Quantum Information School and Workshop
- Brazil Norway November Conference on Oil and Gas
- Workshop Surface Science Rio (WS2Rio)
- CBPF Python Summer Camp
- HEP Network meeting
- ...

REDECOMEP 2019



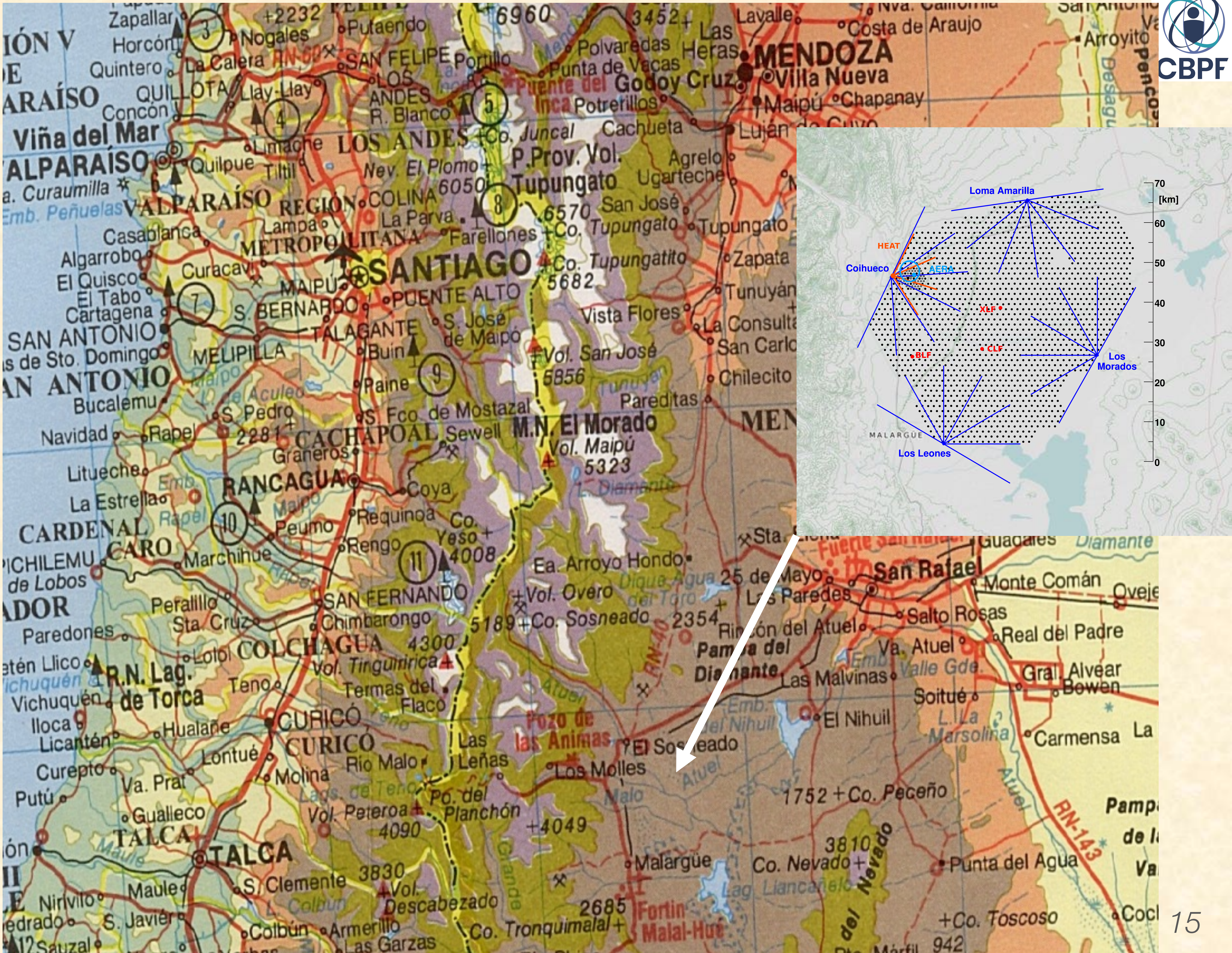
http://www.science-graffiti.cbpf.br/index.html

Tarsila do Amaral

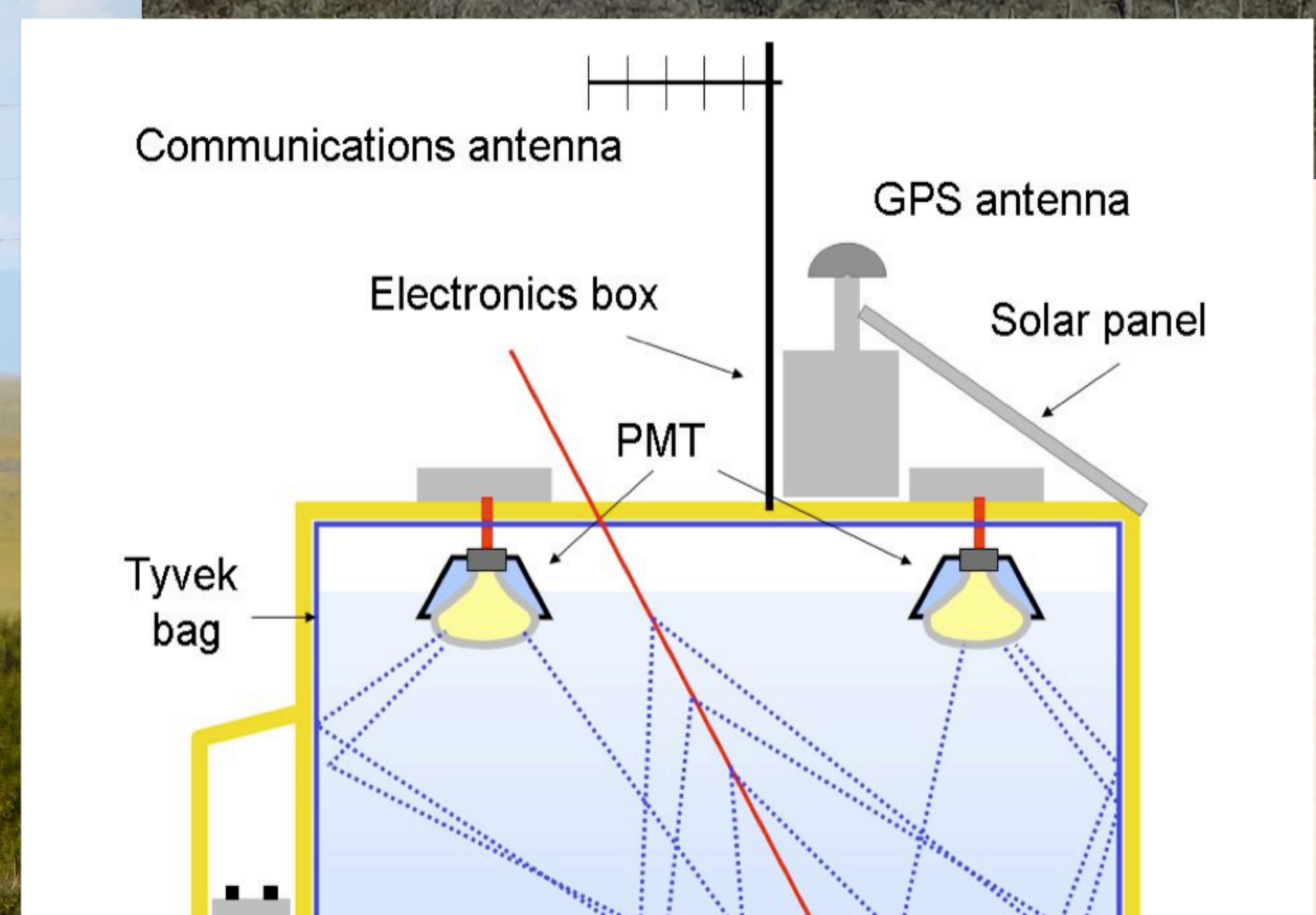
http://www.science-graffiti.cbpf.br/index.html

Some Science:

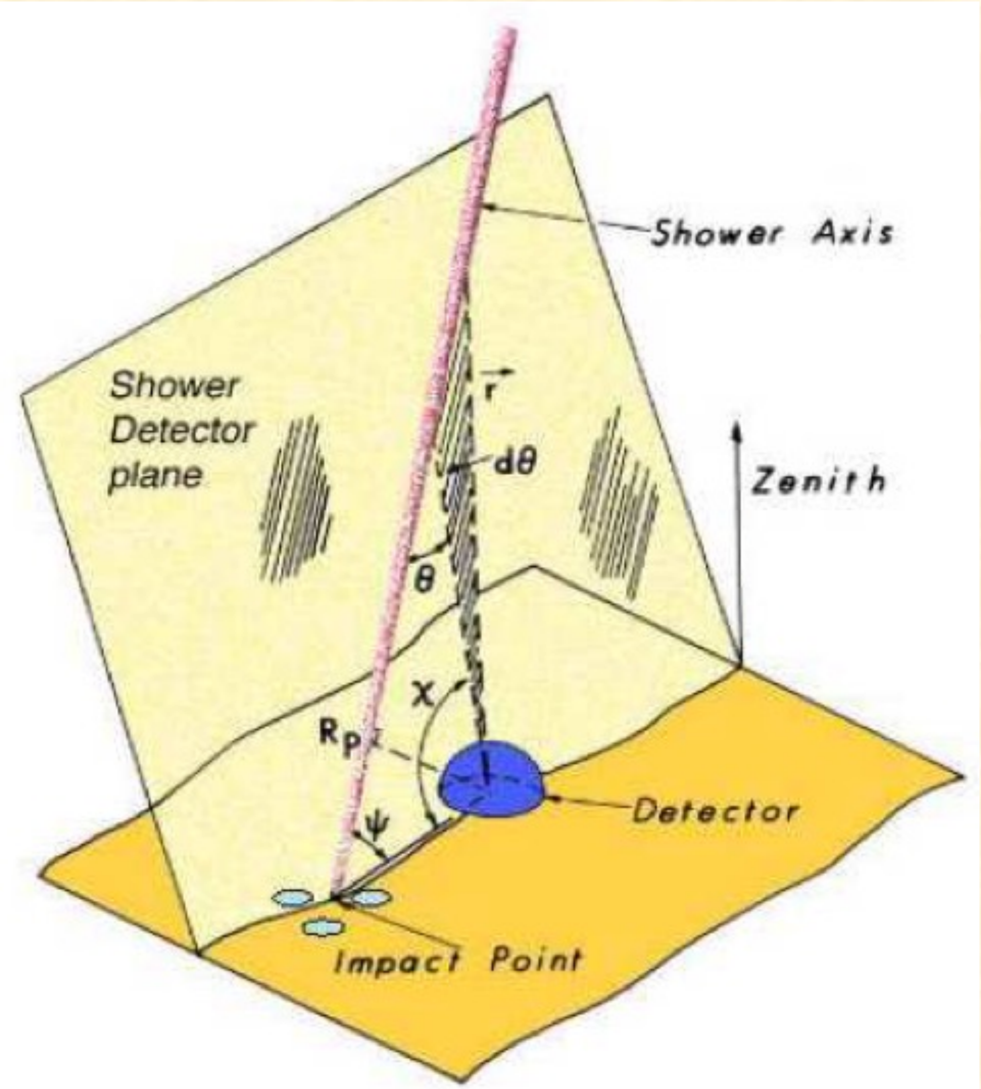
- *Pierre Auger Observatory*
- *CTA*
- *LATTES/SWGO*

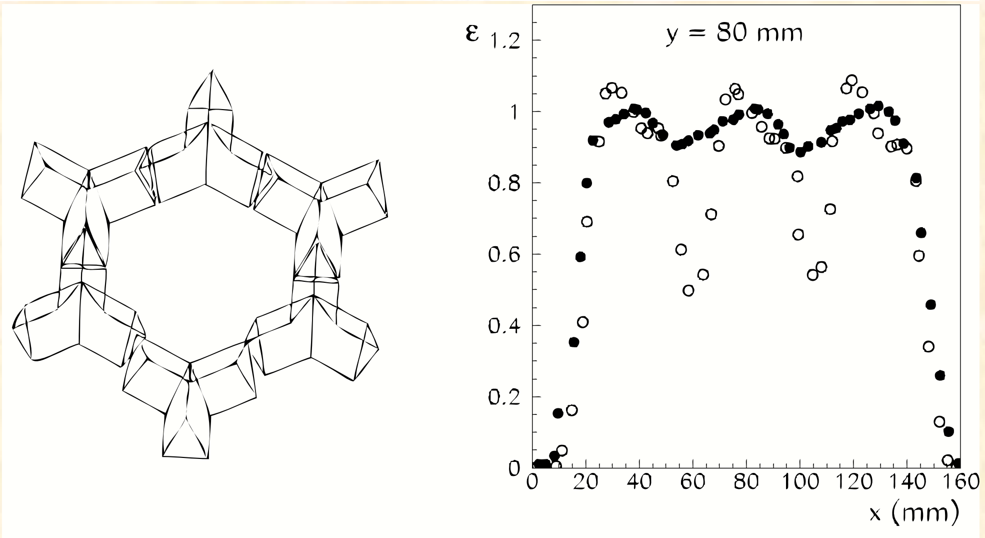

MENDOZA
Villa Nueva
Godoy Cruz
Maipú
Chapanay
Luján de Cuyo
Costa de Araujo
Lavalle
Las Heras
Arroyito
Polvaredas
Punta de Vacas
Potrerillos
Cachueta
Agrelo
Ugarteche
San José
Tupungato
Zapata
Tunuyán
Vista Flores
La Consulta
Chilecito
Pareditas
Puente del Inca
Portillo
SAN FELIPE
LOS ANDES
R. Blanco
Co. Juncal
P.Prov. Vol.
Tupungato
6570
Co. Tupungato
Co. Tupungatito
5682
Vol. San José
5856
M.N. El Morado
Vol. Maipú
5323
LOS ANDES
Nev. El Plomo
6050
6960
3452
+2232
Putaendo
Nogales
Zapallar
Horcón
Quintero
La Calera
QUILLOTA
Llay-Llay
Concón
Viña del Mar
VALPARAÍSO
Quilpue
Limache
Tiltil
Curaumilla
Emb. Peñuelas
VALPARAÍSO
Casablanca
REGIÓN
METROPOLITANA
COLINA
Lampa
La Parva
Farellones
SANTIAGO
MAIPÚ
PUENTE ALTO
S. BERNARDO
TALAGANTE
S. José de Maipo
Buin
Paine
Algarrobo
El Quisco
El Tabo
Cartagena
Curacaví
SAN ANTONIO
Sto. Domingo
SAN ANTONIO
MELIPILLA
Bucalemu
Navidad
Rapel
S. Pedro
2281
Aculeo
S. Fco. de Mostazal
CACHAPOAL
Sewell
Graneros
Litueche
La Estrella
RANCAGUA
Coya
Requinoa
Peumo
Co. Yeso
4008
Rengo
CARDENAL
CARO
Marchihue
PICHILEMU
de Lobos
Paredones
Peralillo
Sta. Cruz
SAN FERNANDO
Chimbarongo
Lolol
COLCHAGUA
4300
Vol. Tinguiririca
Termas del Flaco
Teno
Vichuquén
Iloca
Licantén
Hualañe
R.N. Lag. de Torca
CURICÓ
CURICÓ
Lontué
Molina
Rio Malo
Las Leñas
Curepto
Va. Prat
Putú
Gualleco
TALCA
TALCA
Vol. Peteroa
4090
Po. del Planchón
+4049
Maule
S. Clemente
3830
Vol. Descabezado
Nirivilo
S. Javier
Colbún
Armerillo
Las Garzas
Sauzal
Co. Tronquimalal
2685
Fortín Malal-Hue
Malargüe
Lag. Llancanelo
Co. Nevado
3810
del Nevado
Co. Toscoso
942
Punta del Agua
RN-143
Pampa de la
Carmensa
El Nihuil
Emb. del Nihuil
L. La Marsolina
Soitué
Gral. Alvear
Bowen
Las Malvinas
Va. Atuel
Real del Padre
Salto Rosas
Monte Comán
San Rafael
25 de Mayo
Las Paredes
Guadales
Diamante
Sta. Elena
Ea. Arroyo Hondo
Dique Agua del Toro
Vol. Overo
Co. Sosneado
5189
2354
Rincón del Atuel
Pampa del Diamante
Pozo de las Animas
El Sosneado
Los Molles
Atuel
Malo
1752
Co. Peceño
RN-40
L. Diamante
MEN
Loma Amarilla
HEAT
Coihueco
AERA
XLF
CLF
BLF
Los Morados
MALARGÜE
Los Leones
70
60
50
40
30
20
10
0
[km]


ARGENTINA

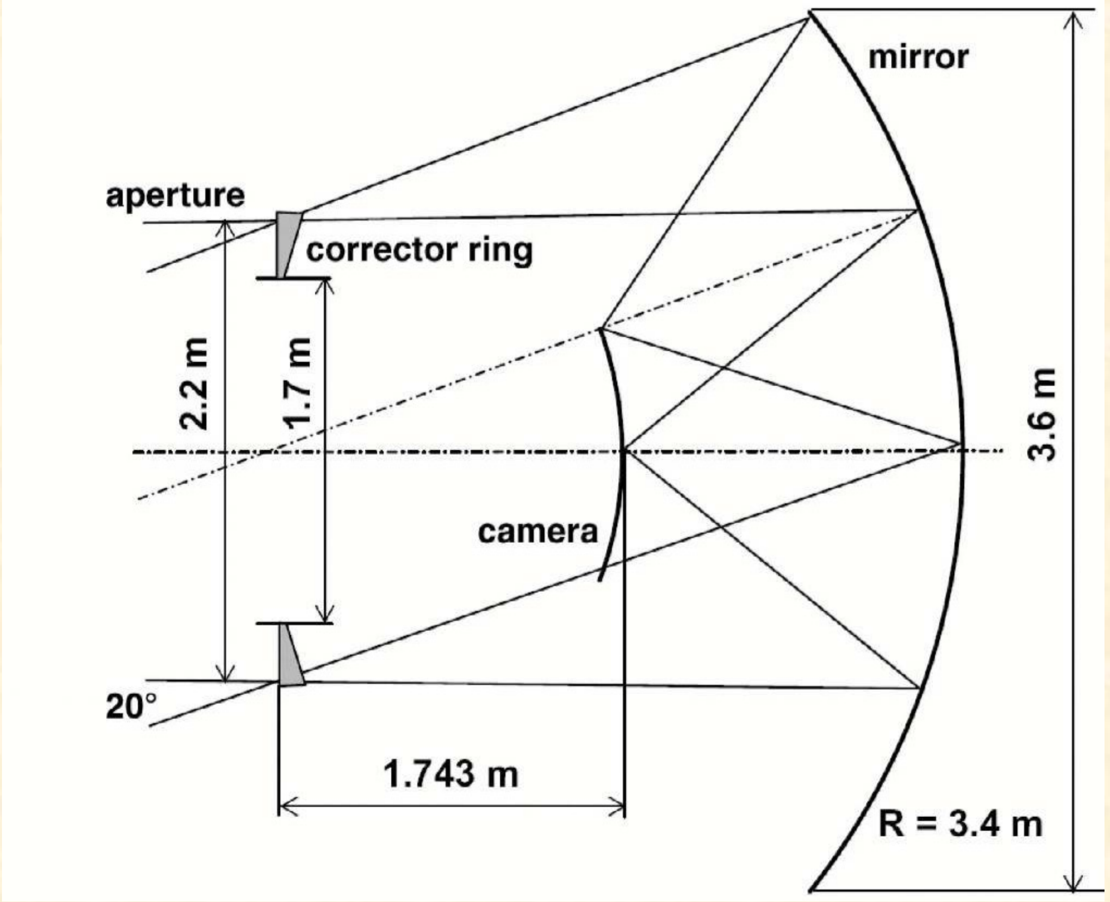

Communications antenna
GPS antenna
Electronics box
Solar panel
PMT
Tyvek bag

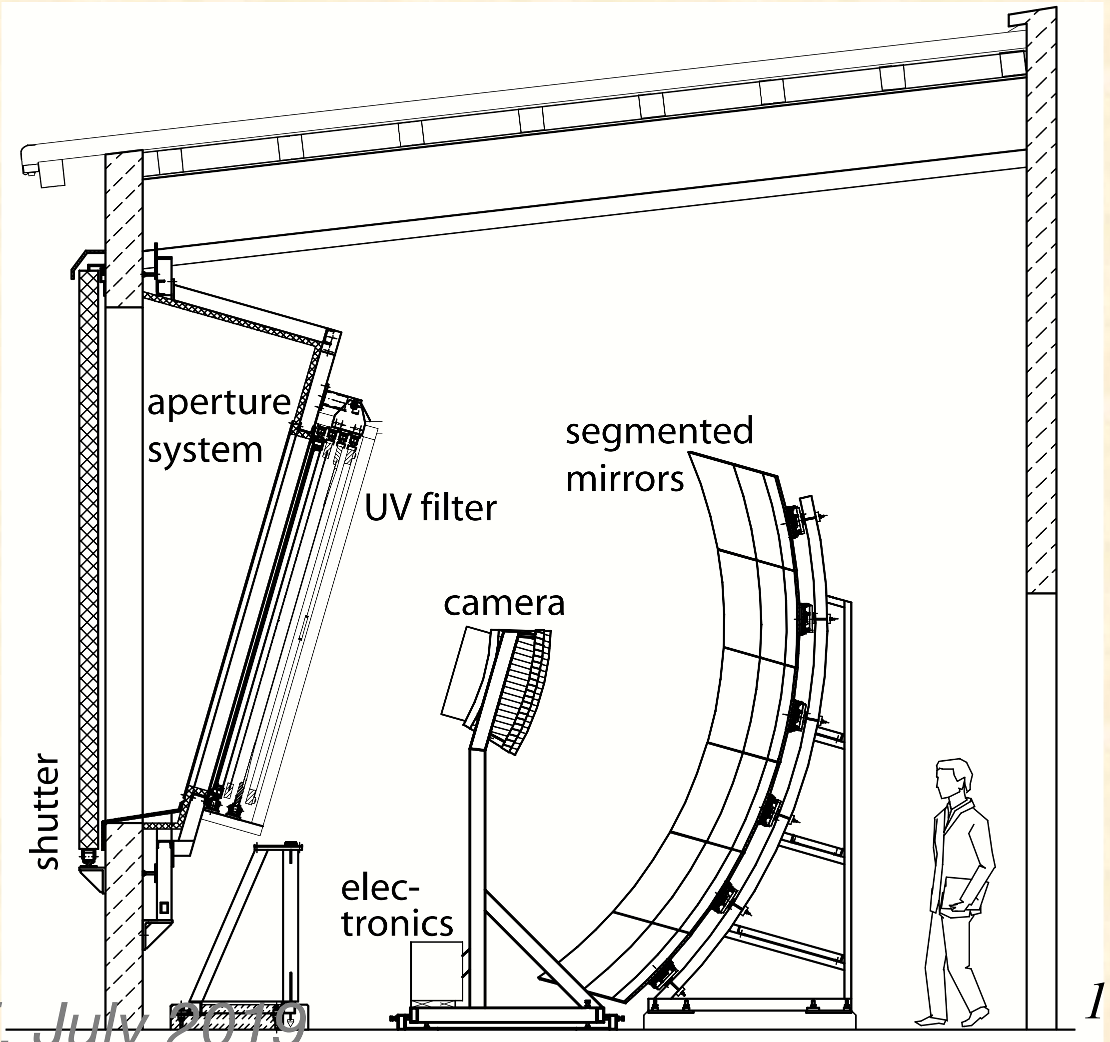
FLUORESCENCE DETECTORS



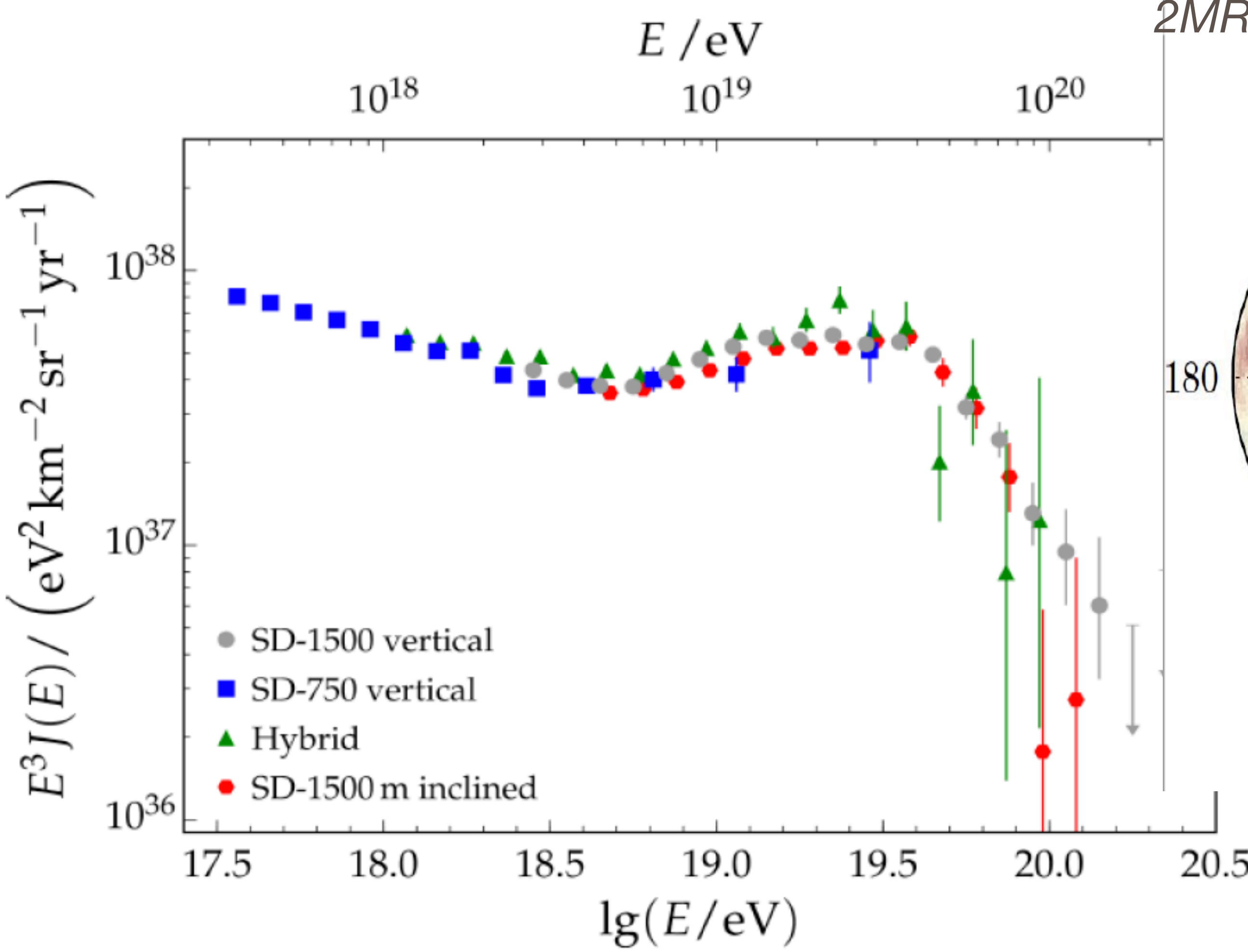


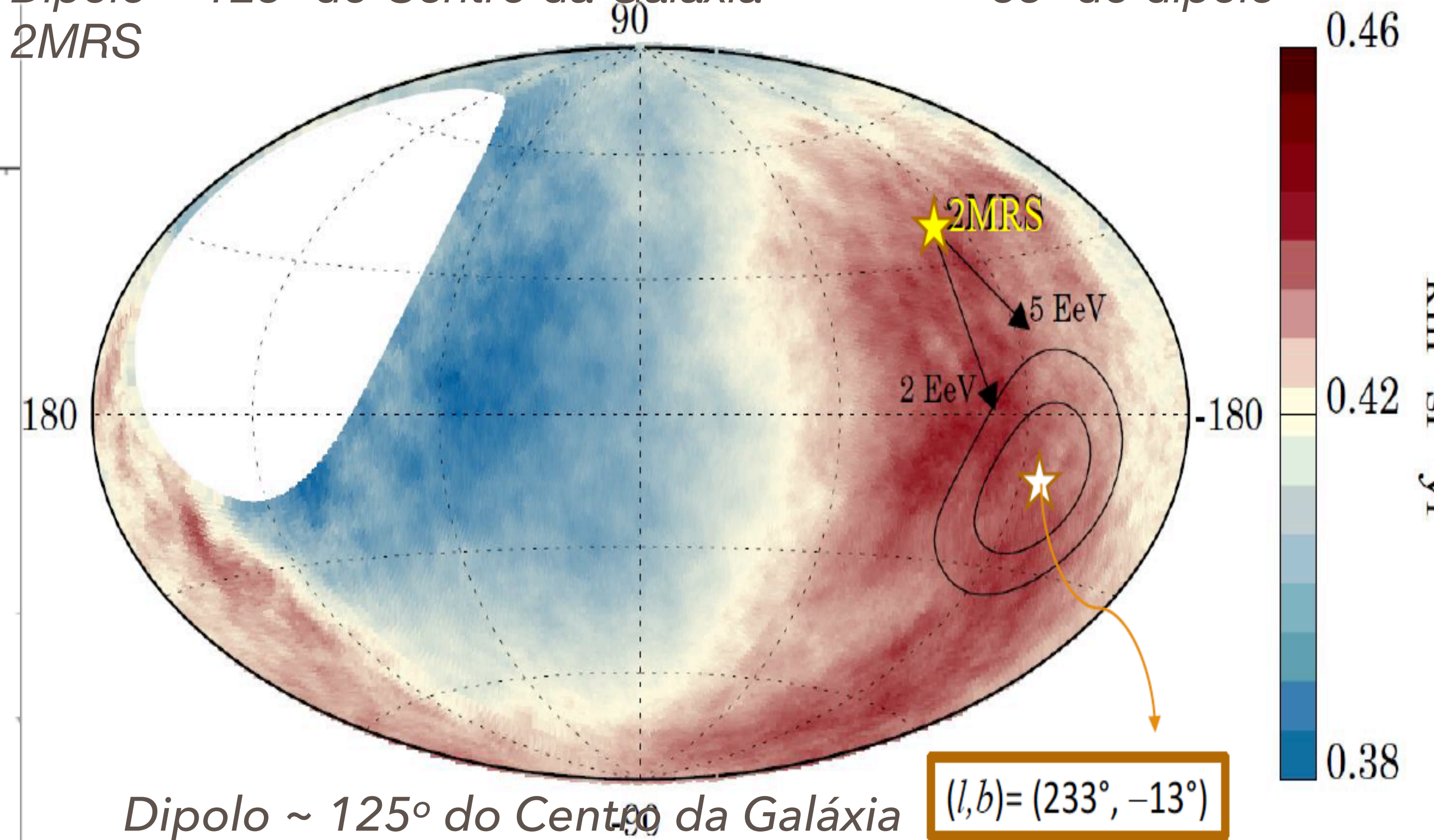
a) b)



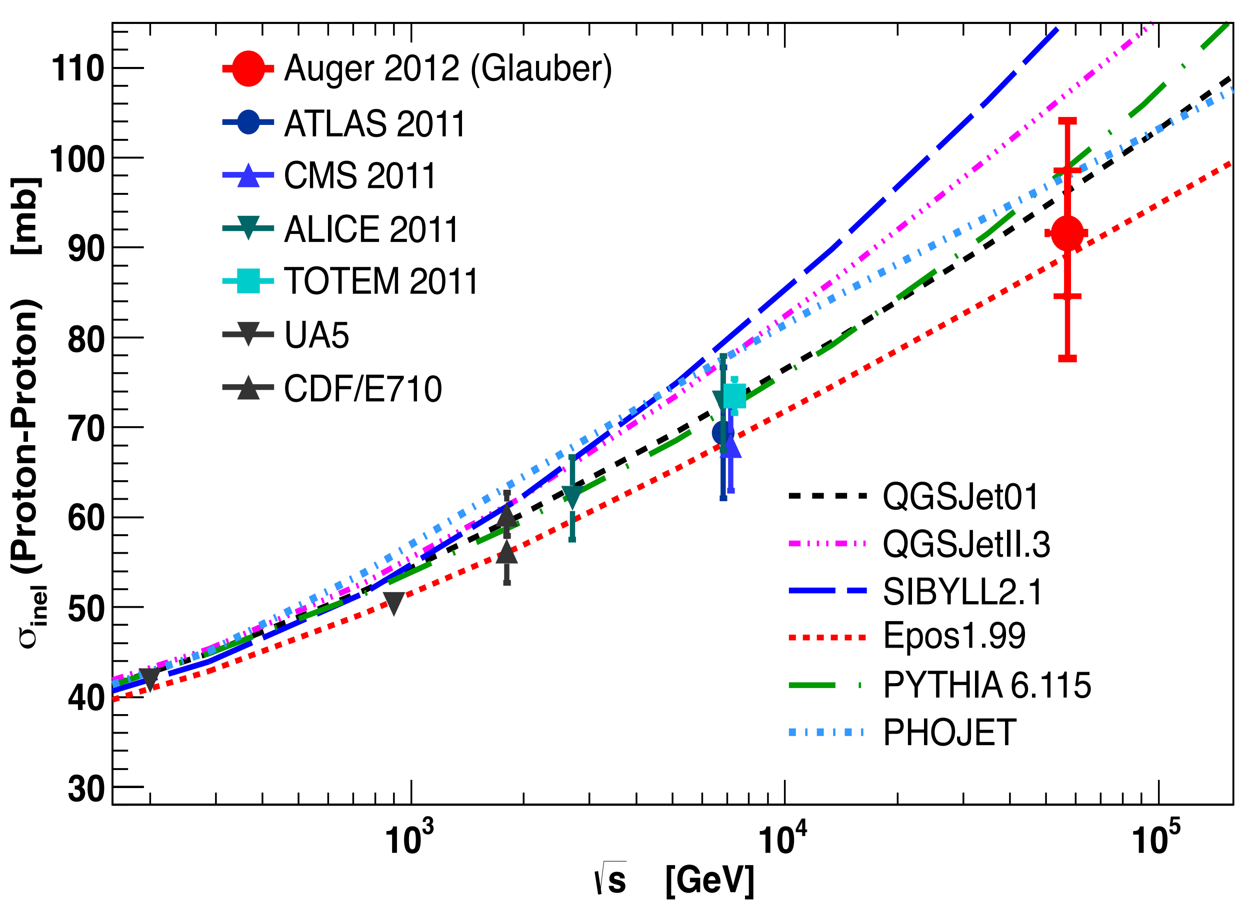


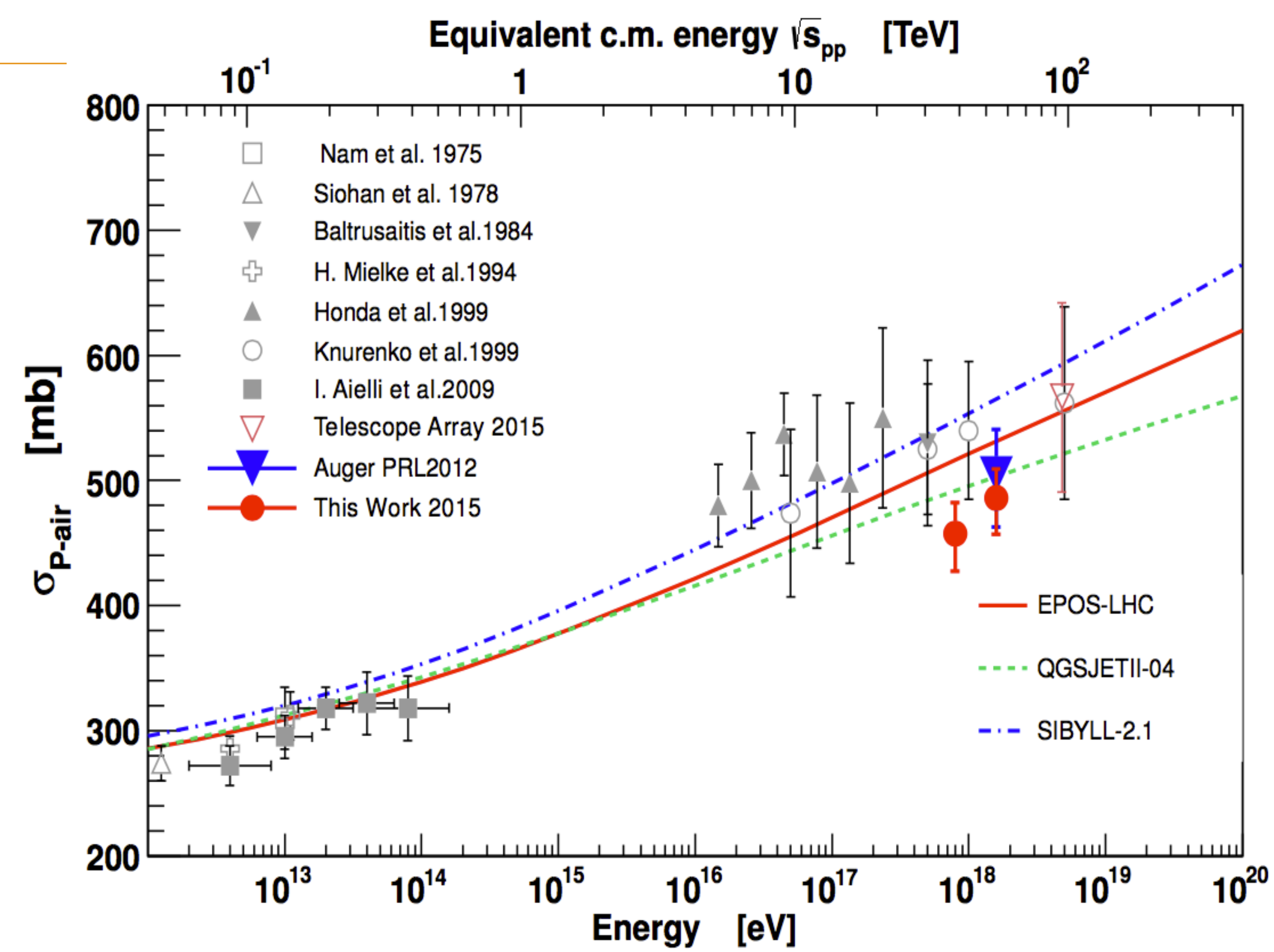
Dipolo ~ 125º do Centro da Galáxia ~55º do dipole
2MRS



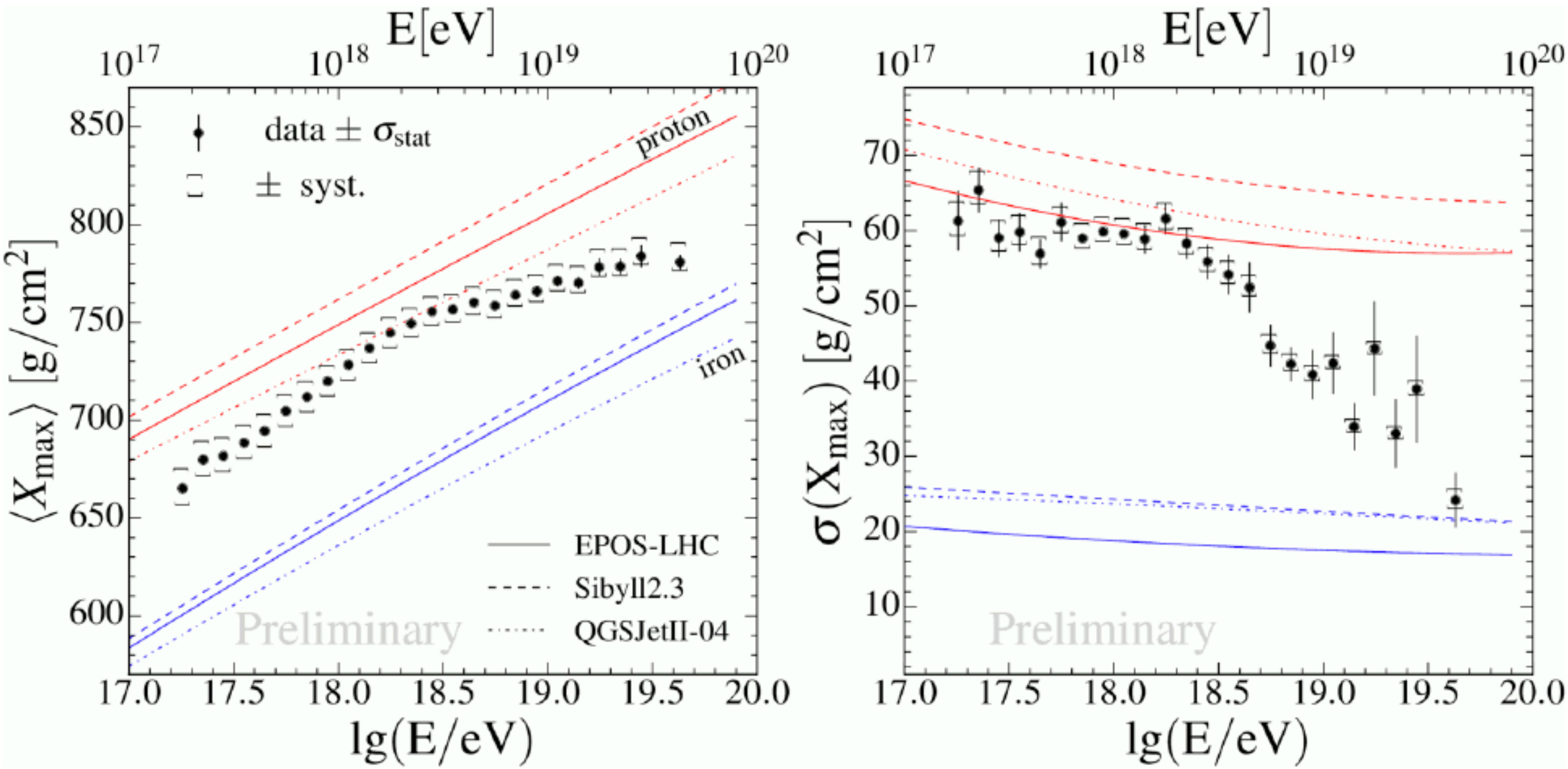


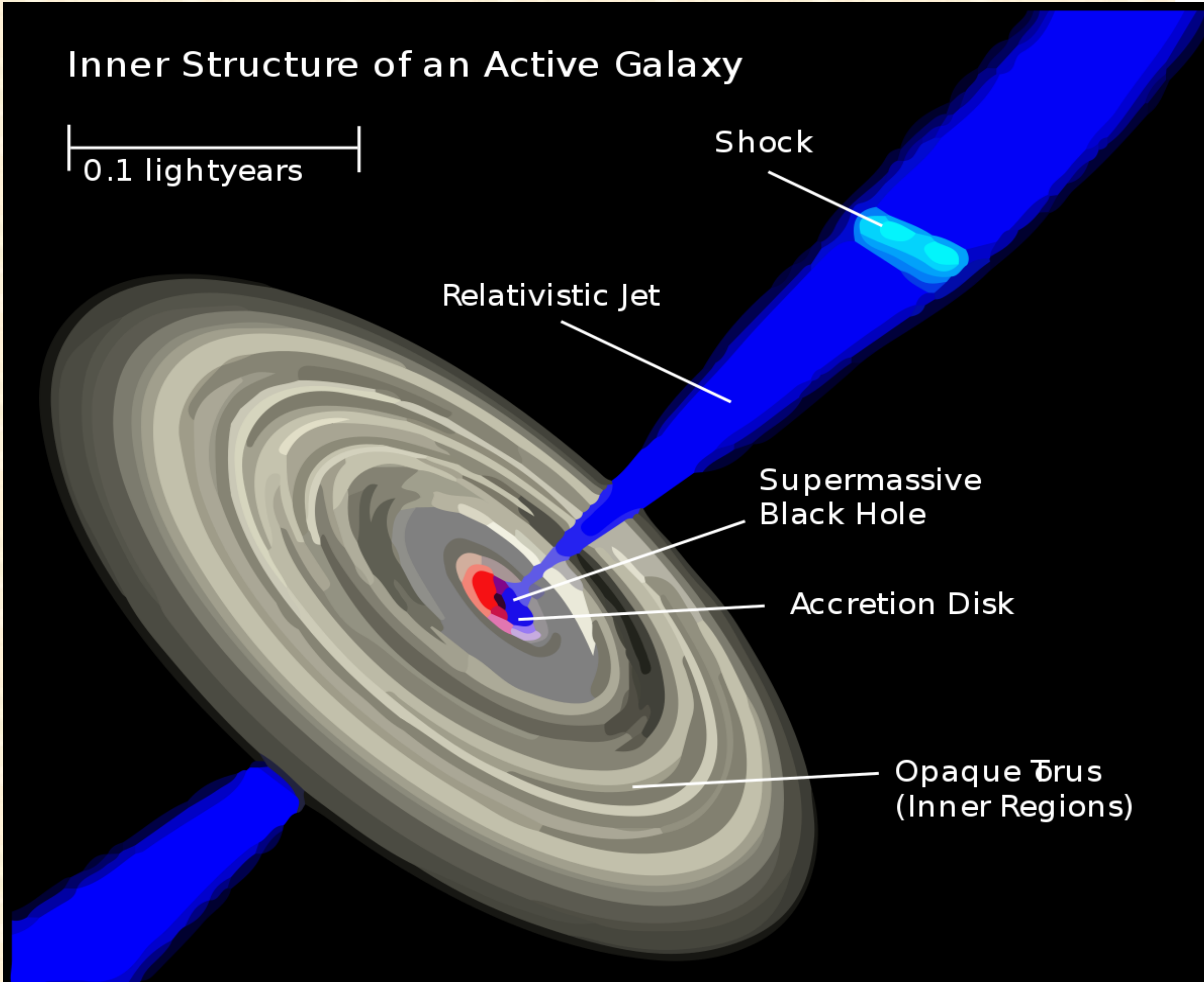
Dipolo ~ 125º do Centro da Galáxia
~55º do dipole 2MRS



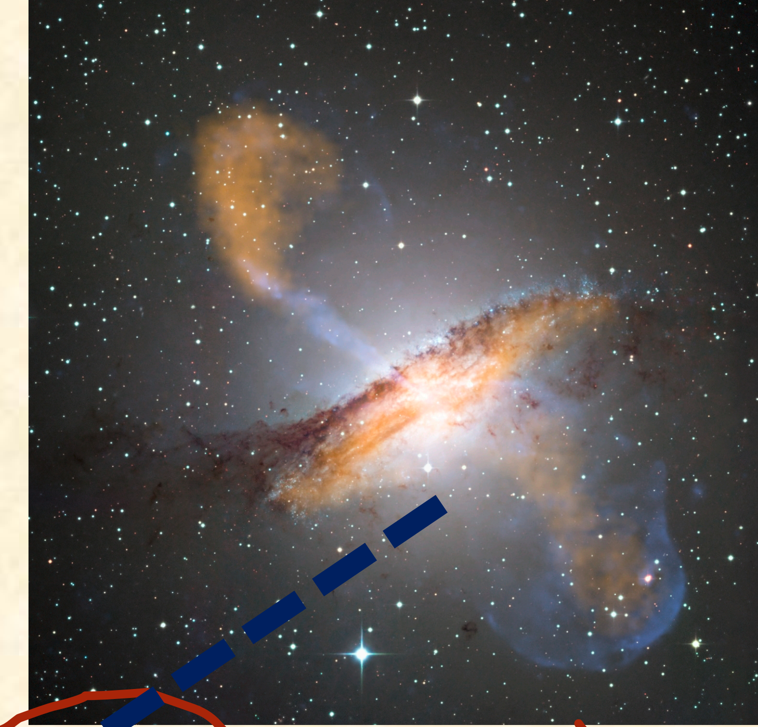


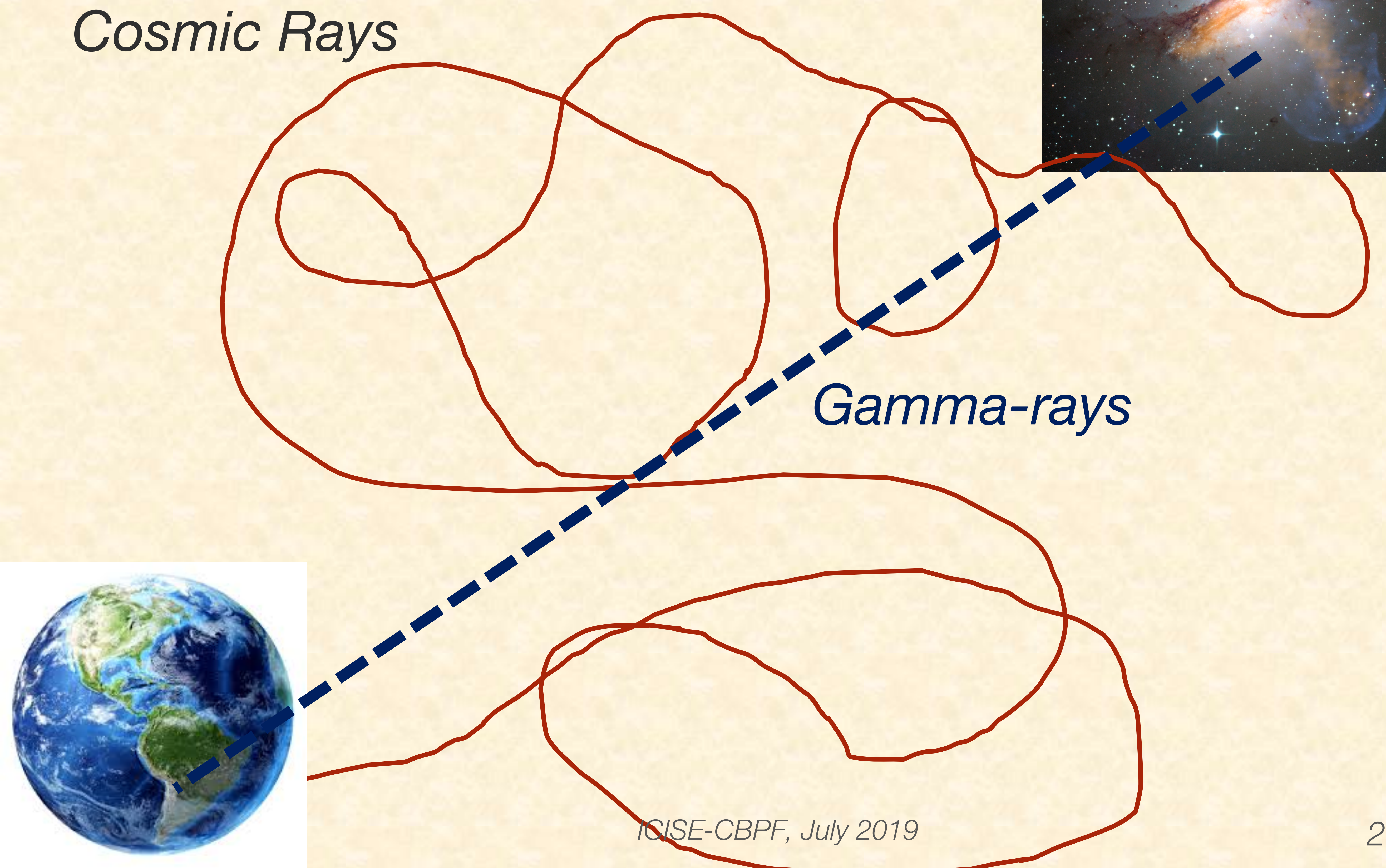
RESULTS: X_{max}




Inner Structure of an Active Galaxy
0.1 lightyears
Shock
Relativistic Jet
Supermassive Black Hole
Accretion Disk
Opaque Torus (Inner Regions)

Measure gamma-rays





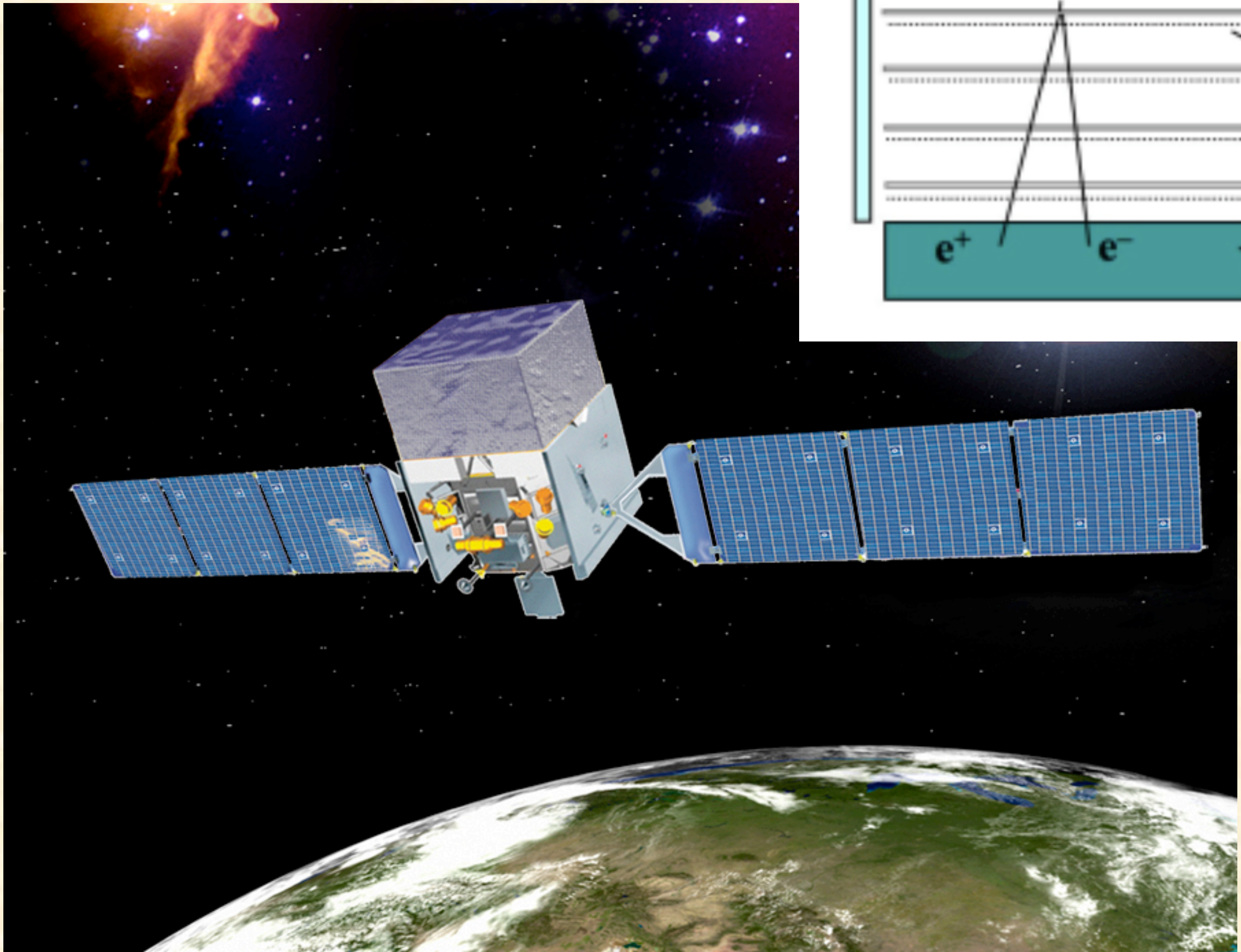
How can you detect gamma rays?

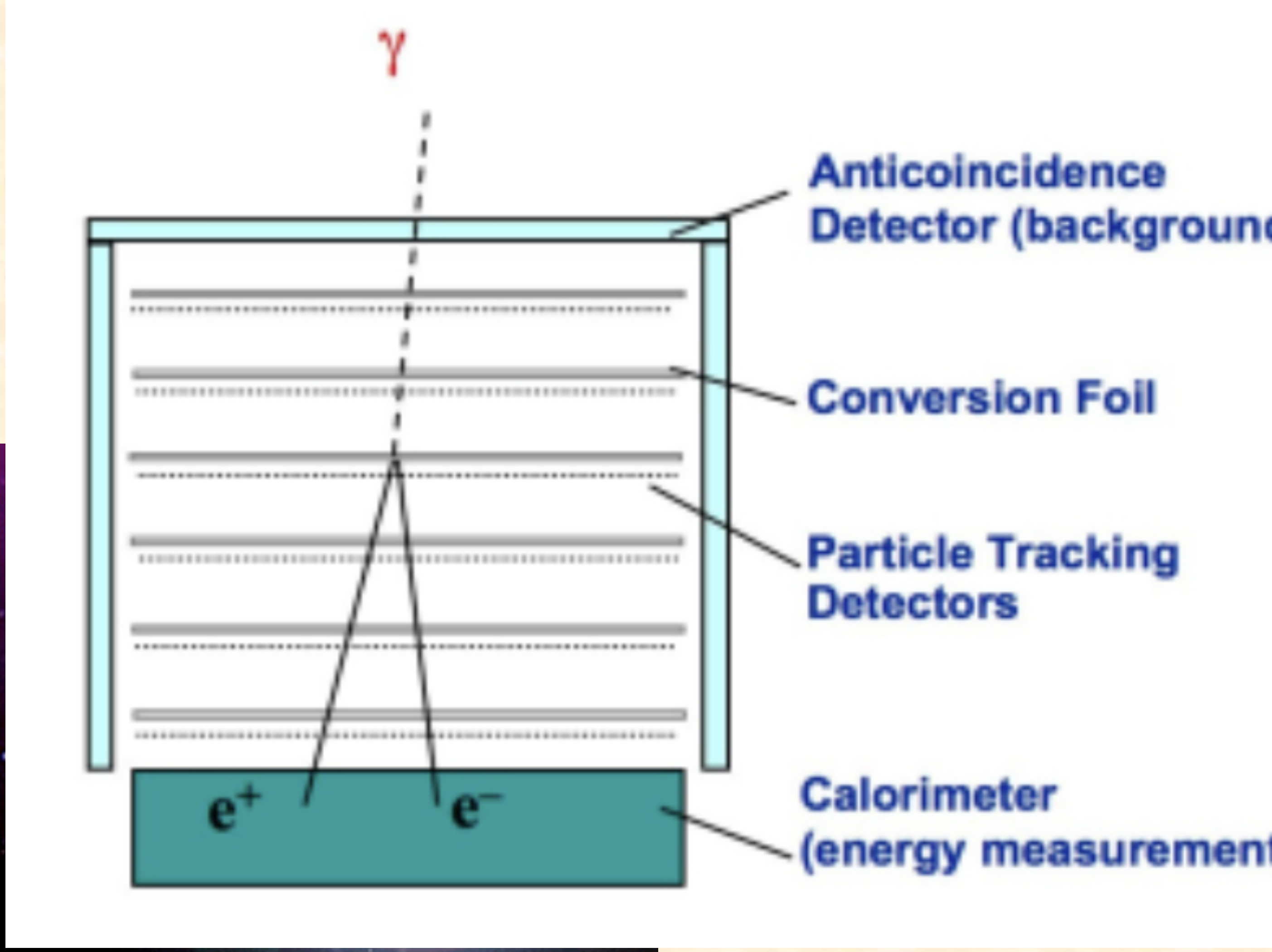
- *Go to space and setup a particle detector, so you can detect pair conversion – Fermi-LAT*

- *Look at the sky with a large mirror and detect the Cherenkov light generated by the air shower (IACT) – HESS, MAGIC, VERITAS*

- *Detect the air shower directly with a particle detector – MILAGRO, ARGO-YBJ, HAWC*

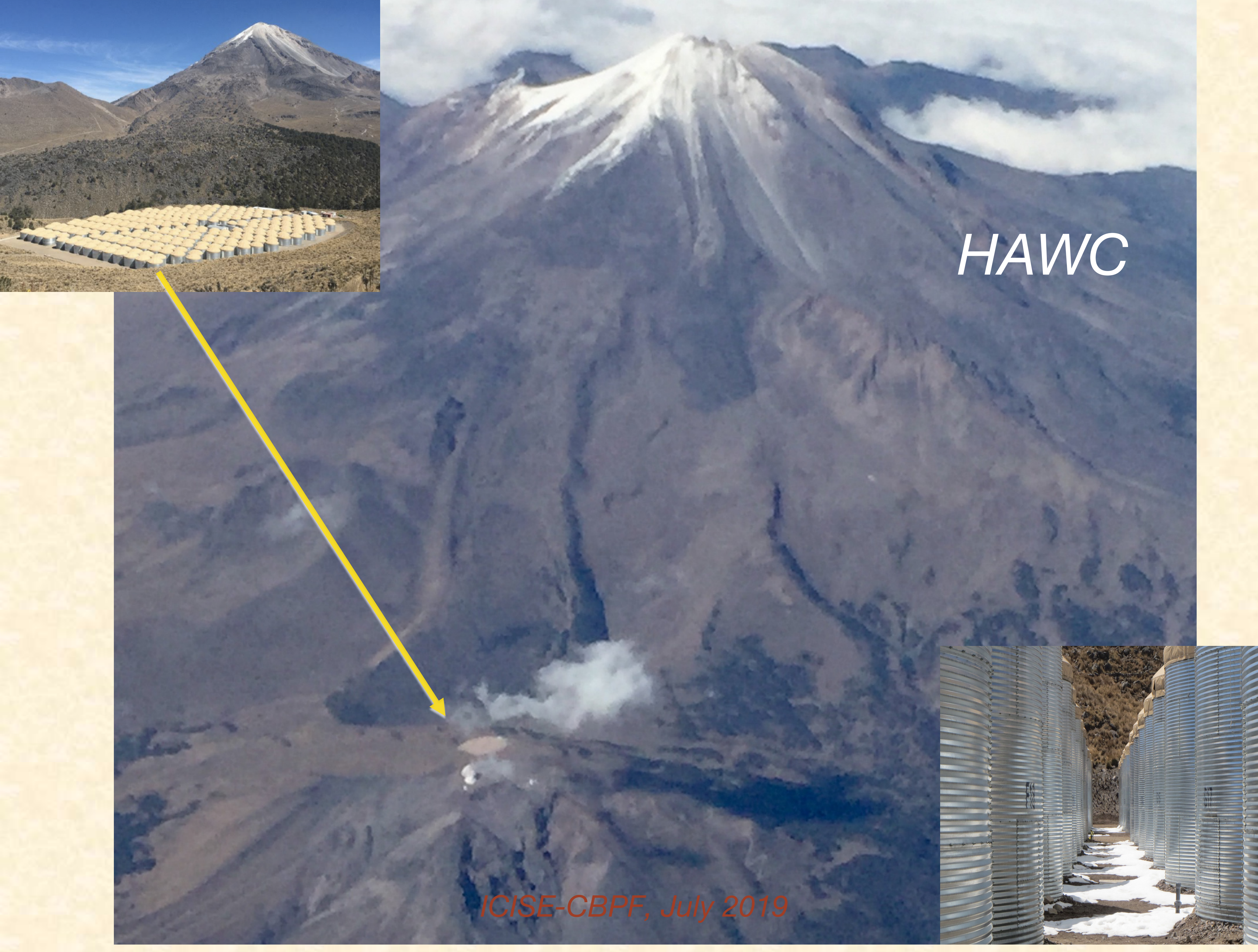
FERMI-LAT





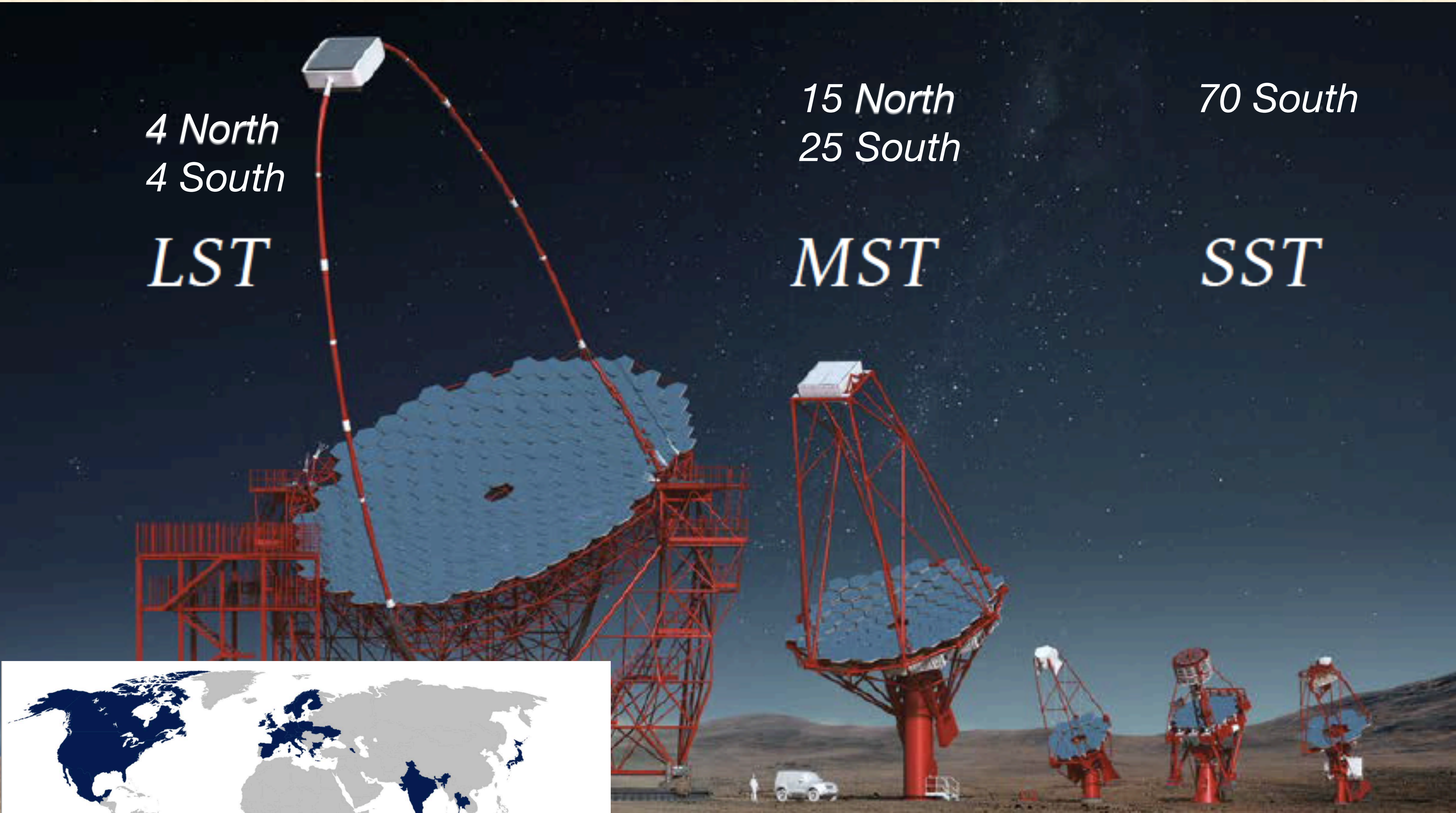
γ
Anticoincidence
Detector (backgroun
Conversion Foil
Particle Tracking
Detectors
Calorimeter
(energy measuremen
e+
e−

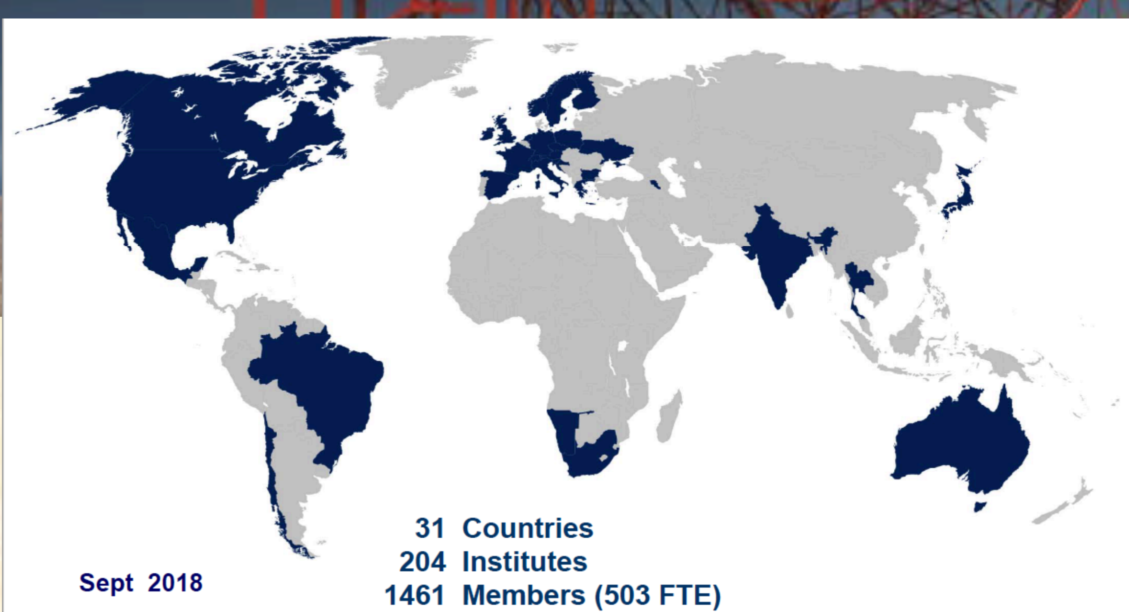
Gamma rays – IACT Ground observatories (high energies)


HAWC

Quantity	***Fermi*-LAT**	**IACTs**	**EAS**
Energy range	20 MeV–200 GeV	100 GeV–50 TeV	400 GeV–100 TeV
Energy res.	5-10%	15-20%	$\sim$ 50%
Duty Cycle	80%	15%	> 90%
FoV	$4\pi/5$	5 deg $\times$ 5 deg	$4\pi/6$
PSF	0.1 deg	0.07 deg	0.5 deg
Sensitivity	1% Crab (1 GeV)	1% Crab (0.5 TeV)	0.5 Crab (5 TeV)

CHERENKOV TELESCOPE ARRAY - CTA





S. Funk

Canary Islands

CTA Scientific Themes

arXiv: 1709.07997

Acceleration of cosmic particles

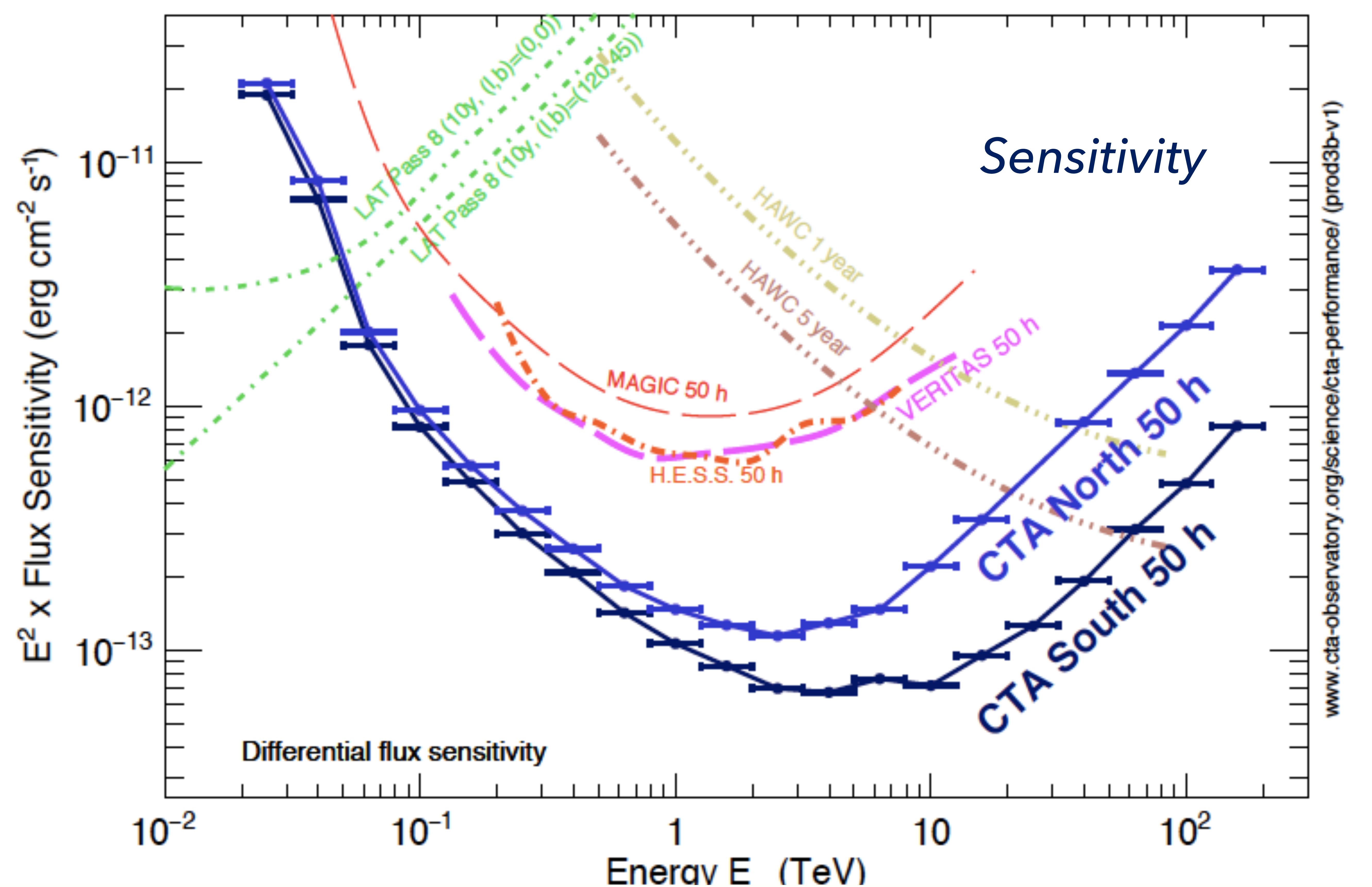
- *How they are accelerated?*
- *How they propagate?*

Exploring Extremes enviroments

- *Environment nearby neutron stars and Black holes*
- *Environment at relativisticts jets, winds, flares*
- *Environment at cosmic voids*

Frontier Physics – beyond SM

- *The nature of black matter , its distribution*
- *Photon "speed" at high energies*
- *New particles (axions, p.ex.)?*


Sensitivity
E² x Flux Sensitivity (erg cm⁻² s⁻¹)
Energy E (TeV)
LAT Pass 8 (10y, (l,b)=(0,0))
LAT Pass 8 (10y, (l,b)=(120,45))
HAWC 1 year
HAWC 5 year
MAGIC 50 h
VERITAS 50 h
H.E.S.S. 50 h
CTA North 50 h
CTA South 50 h
Differential flux sensitivity
www.cta-observatory.org/science/cta-performance/ (prod3b-v1)

Large Array Telescope for Tracking Energetic Sources

Astroparticle Physics 99 (2018) 34–42

Contents lists available at ScienceDirect

Astroparticle Physics

journal homepage: www.elsevier.com/locate/astropartphys

ELSEVIER

Design and expected performance of a novel hybrid detector for very-high-energy gamma-ray astrophysics

P. Assis[a,b], U. Barres de Almeida[c], A. Blanco[d], R. Conceição[a,b,*], B. D'Ettorre Piazzoli[e], A. De Angelis[f,g,b,a], M. Doro[h,f], P. Fonte[d], L. Lopes[d], G. Matthiae[i], M. Pimenta[b,a], R. Shellard[c], B. Tomé[a,b]

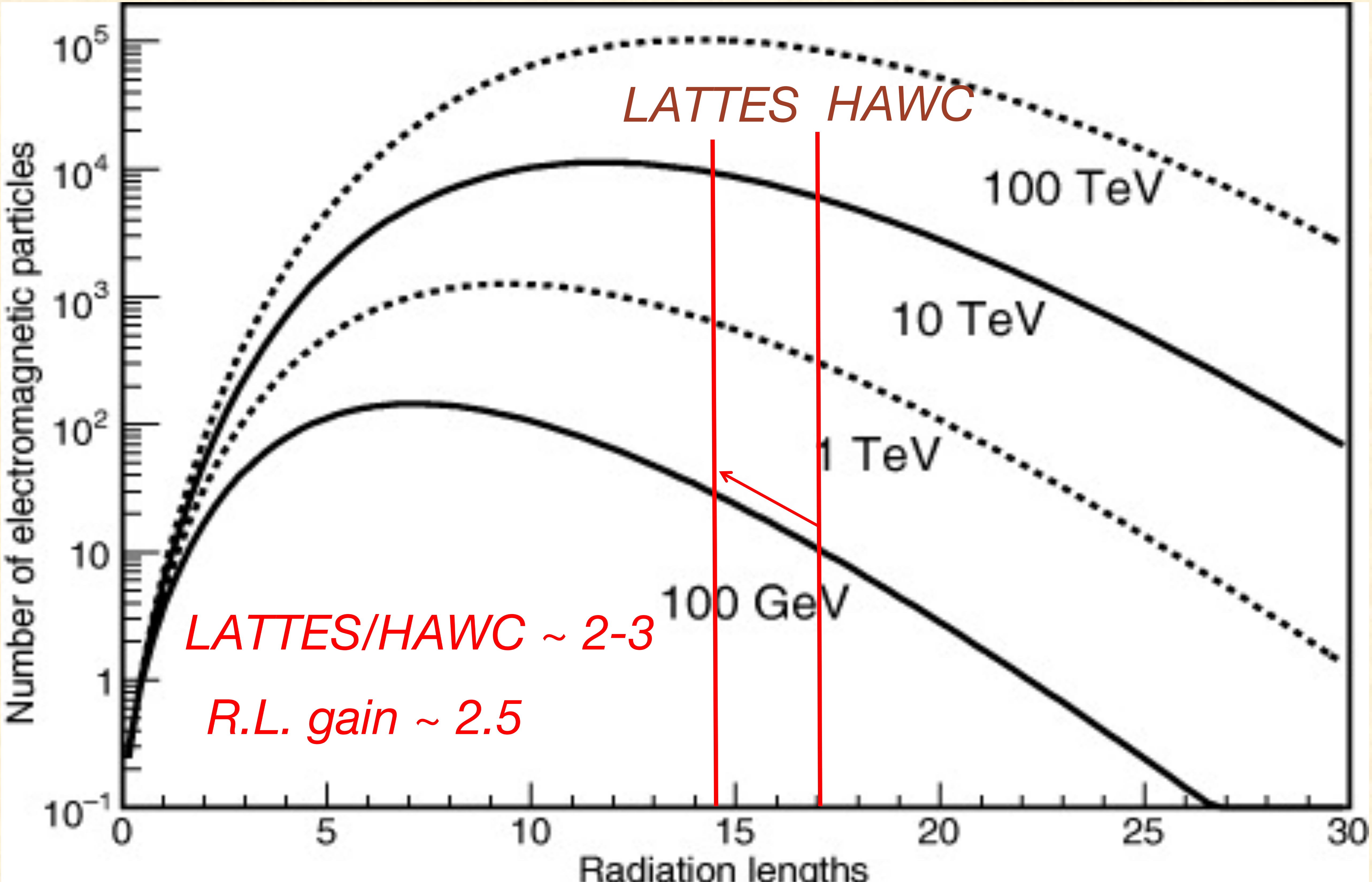
now **SWGO**

Why LATTES?

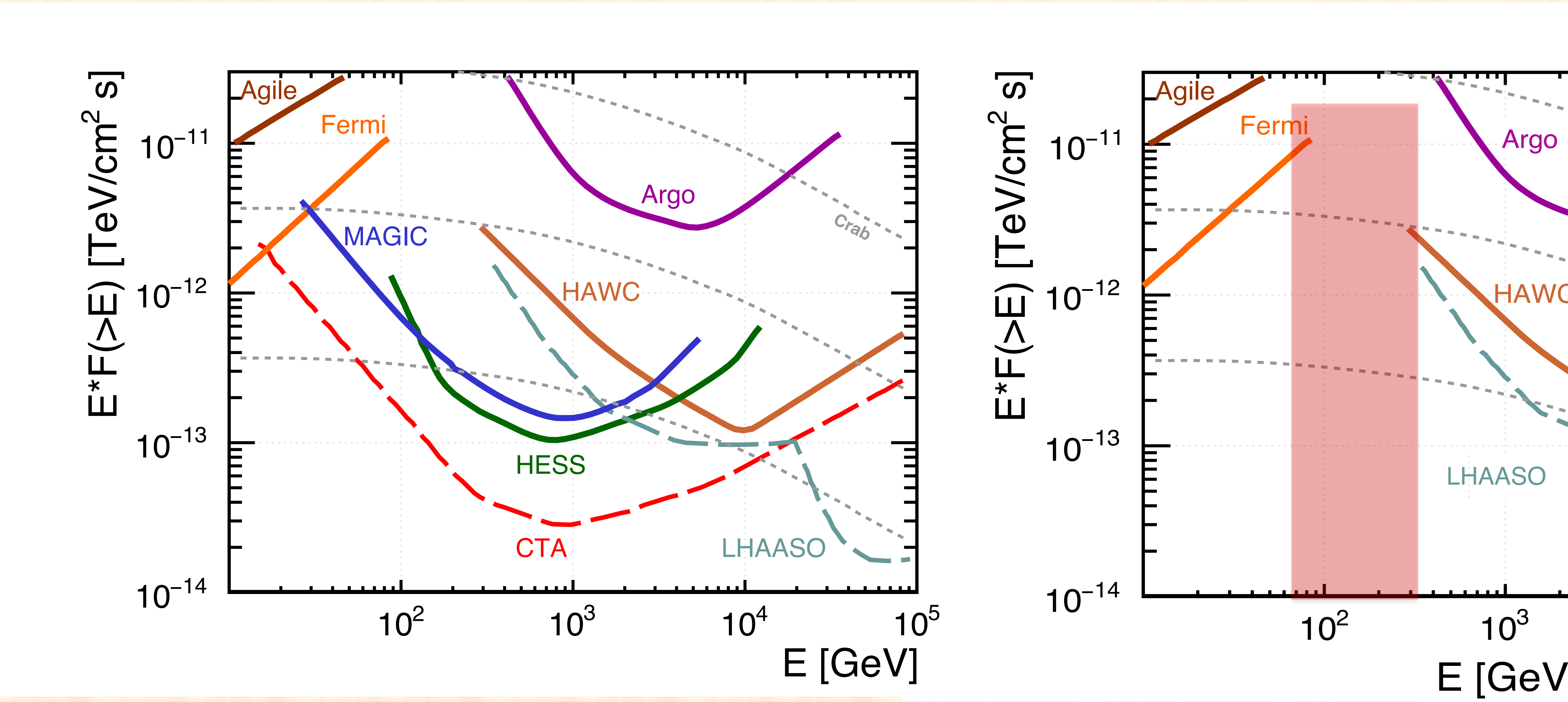
LATTES Objectives

- *Build a gamma ray detector operating 24/7, field of view of* $2\pi/3\ \mathrm{rad}^2$
- *Low energy sensitivity* ~ *100 GeV*
- *Altitude above 5.000m*
- *Capability to detect transients*
- *South America (interesting objets)*
    - *Non thermal process in the Universo*
    - *Transients*
    - *Extreme objets: SNR, AGN, GRB*

LATTES (Altitude?)



Why LATTES: Present situation



There are no large field of view experiment to:

- *Monitor the Center of the Galaxy*
- *Exploit the 100 GeV range*

Base design – Conceptual Design

CESAR

***C**alorimeter **El**ectromagnetic for **S**tudying **AiR** gammas*

Water Cherenkov detector

Measure the shower energy with good resolution

MARTA

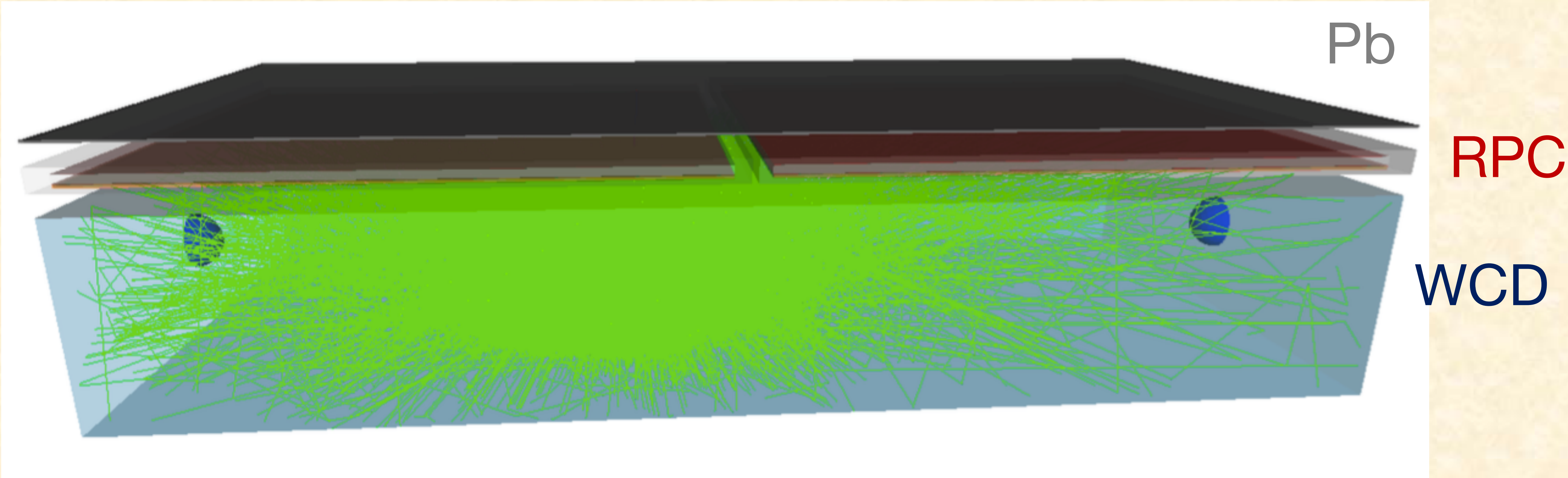
***M**uon **A**rray **R**pcs for **T**agging **A**irshowers*

Particle counter based on RPC technology

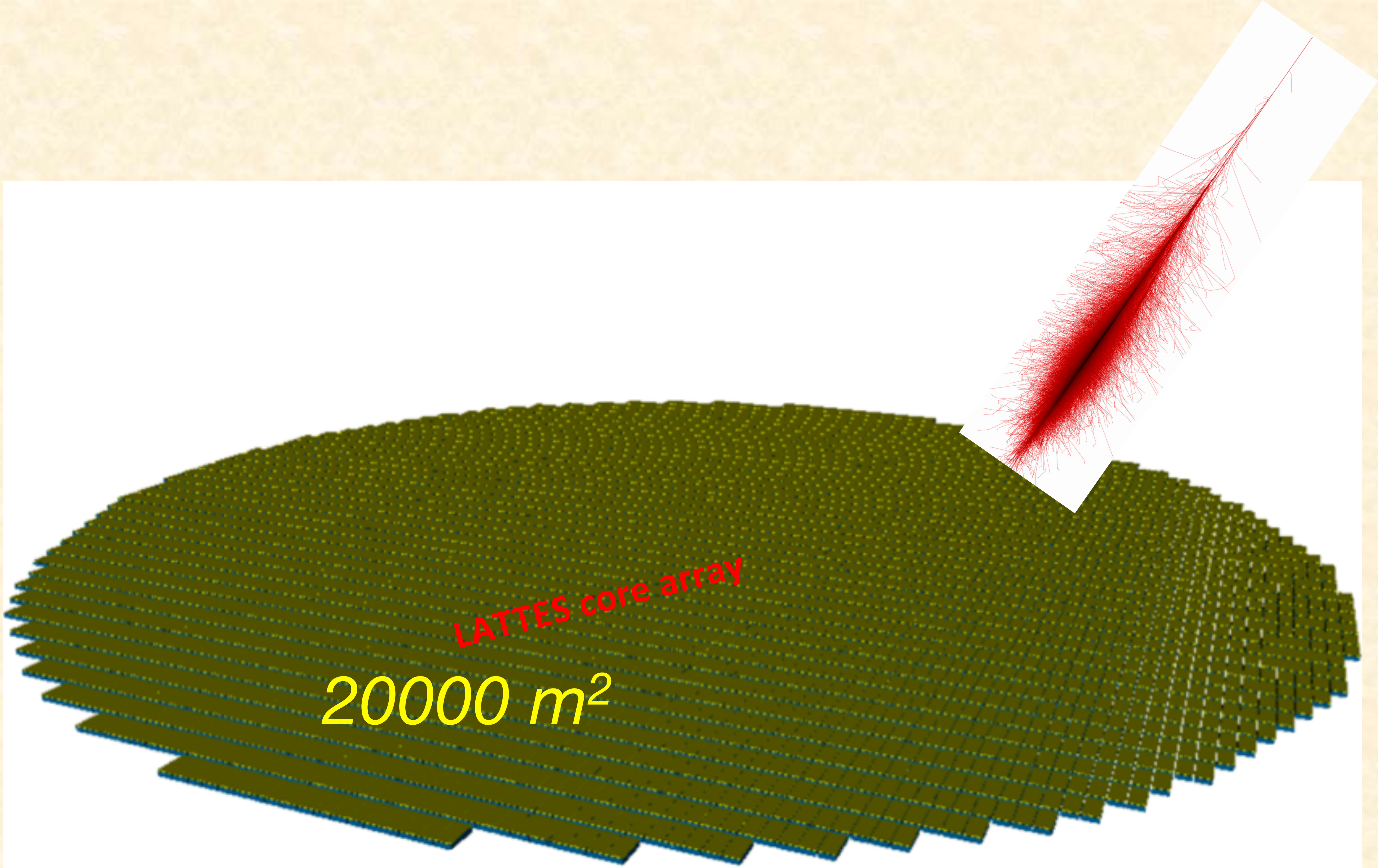
(RPC -- Resistive Plate Chamber)

Temporal resolution ~ 1 ns

LATTES Station



- Thin slab of lead (Pb)
  - 5.6 mm (one radiation lenght)
- Resistive Plate Chambers (RPC)
  - 2 RPC per station
  - Each RPC with 4X4 reading pads
- Water Cherenkov Detector (WCD)
  - 2 PMT (diameter 15 cm)
  - Dimension: 1.5 m X 3 m X 0.5 m



ICISE-CBPF, July 2019

Statement of Interest in Research and Development Towards a Southern Wide-Field Gamma-ray Observatory

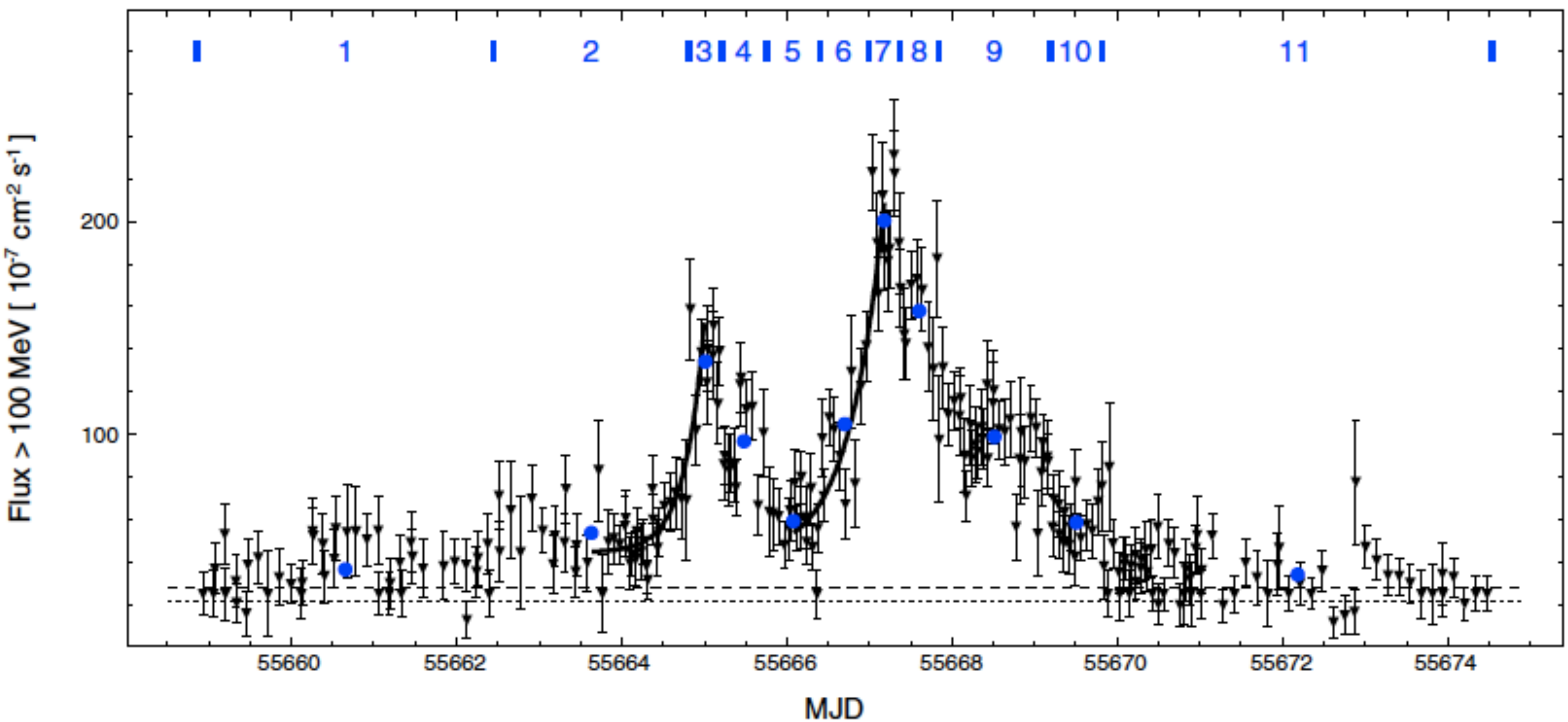
SWGO.ORG – First Meeting, Padova, Oct 2019

b) The shared concept for the future observatory is as follows
- A gamma-ray observatory based on ground-level particle detection, with close to 100% duty cycle and order steradian field of view.
- Located in South America at a latitude -30 to -10 degrees.
- At an altitude of 4.4km or higher.
- Covering an energy range from 100s of GeV to 100s of TeV.
- Based primarily on water Cherenkov detector units.
- With a high fill-factor core detector with area considerably larger than HAWC and significantly better sensitivity, with a low density outer array.
- With the possibility of extensions and/or enhancements.
- Modular and scalable.
- Targeting a cost of €40-50M.
- Organised as a collaboration, constructing the instrument and exploiting the scientific data together.
- With all data becoming publically available after a proprietary period.
- With close scientific coordination with CTA, recognising the synergy and complementarity between these instruments.

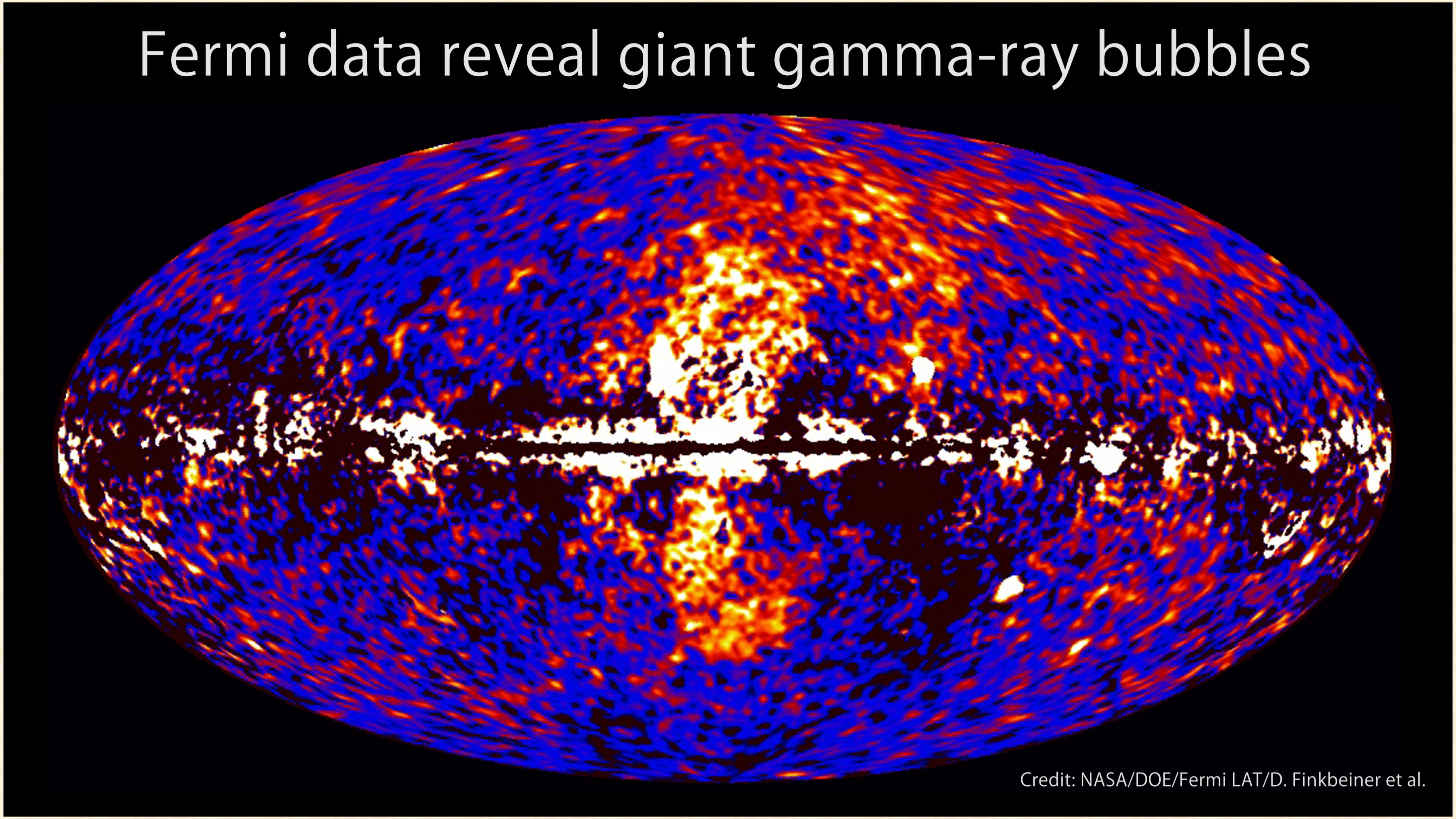

Peru
STATE OF ACRE
Brazil
Lima District
STATE OF RONDÔNIA
STATE OF MATO GROSSO
Chacaltaya
Bolivia
STATE OF MATO GROSSO DO SUL
LATTES
Paraguay
CTA
Asuncion
STATE PARAN
Chile
ANDES
STATE RIO GRA DO SU
Córdoba
Uruguay
AUGER
Santiago
Buenos Aires
Argentina
Montevideo


Pampalaram
Ch'iyar Qirini
Chacaltaya
2 km
La Paz
El Alto
LOS ANDES
Aeropuerto Internacional El Alto
Estadio Olímpico Hernando Siles
SOPOCACHI
MACRODISTRITO COTAHUMA
OBRAJES
Avenida Chacaltaya
Av. Arica
Av. Cívica

FLARES (CRAB – April 2011)



An example : the Fermi Bubbles



No Conclusion

But a Beginning