Prospettive future della
Gamma - Ray Astronomy

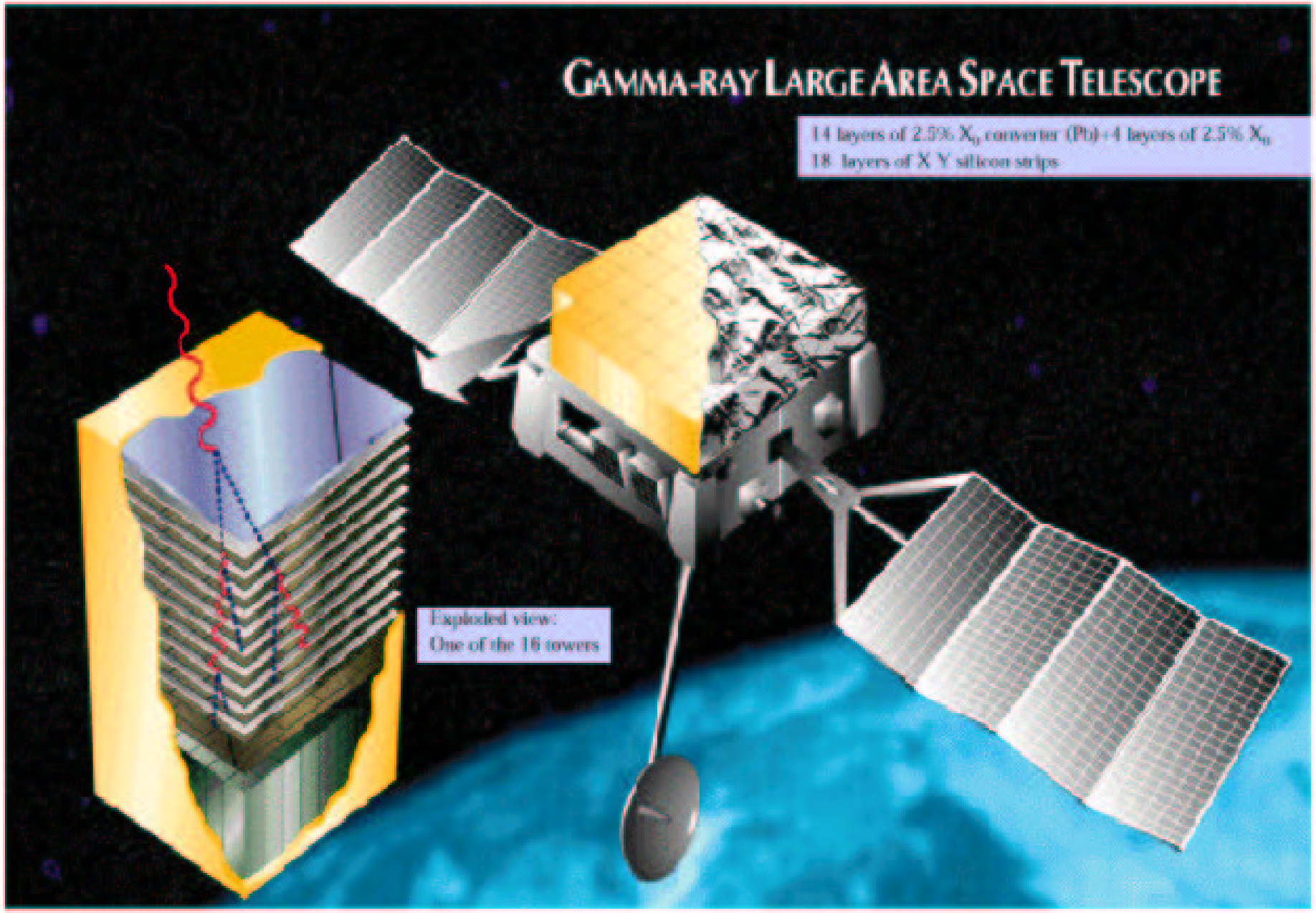
1) Rivelatori su satellite

2) Rivelatori Cerenkov

3) Particle Detector Array

Nuovi rivelatori su satellite

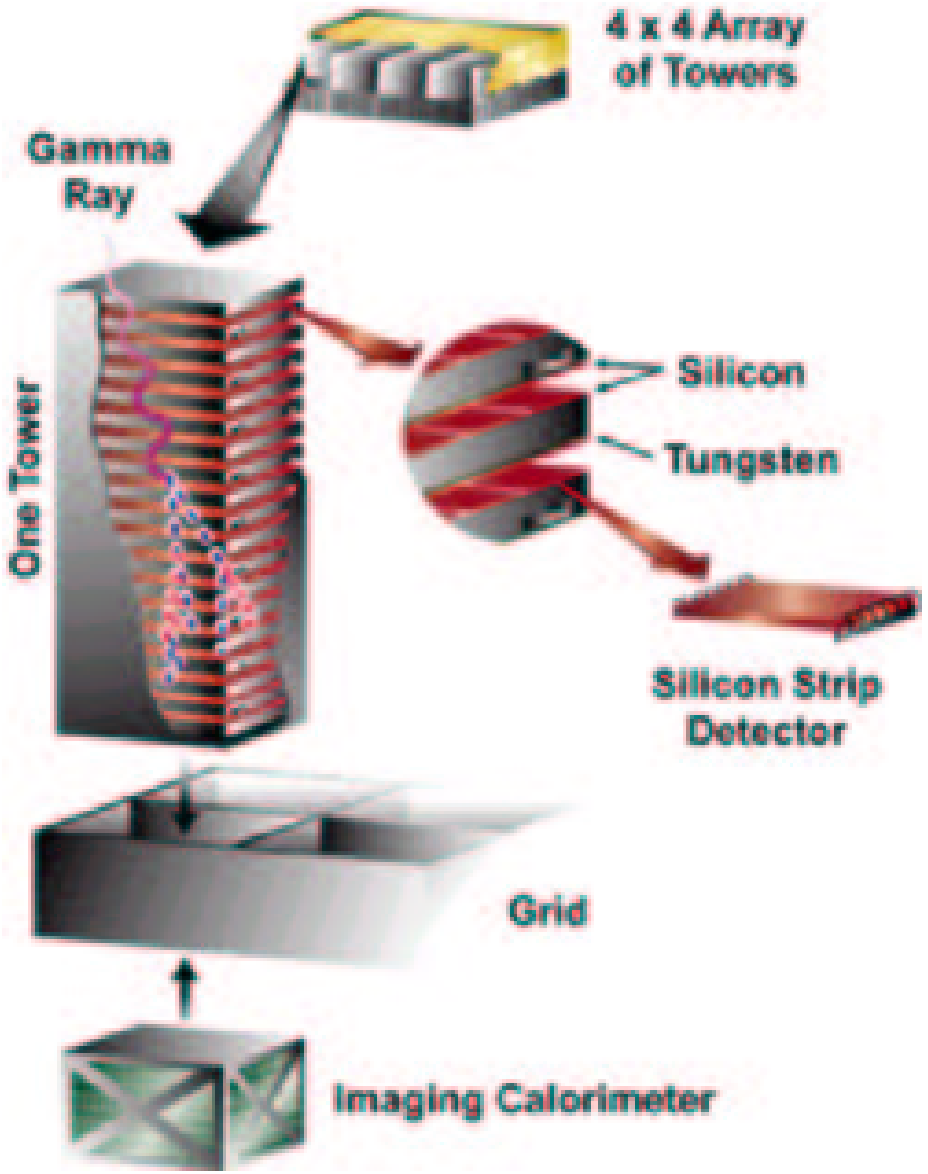
- **GLAST** (lancio nel 2005)
- **AGILE** (lancio inizio 2002)
- **AMS**
- **PAMELA** (lancio fine 2002)


GAMMA-RAY LARGE AREA SPACE TELESCOPE
14 layers of 2.5% X_0 converter (Pb)+4 layers of 2.5% X_0
18 layers of X Y silicon strips
Exploded view:
One of the 16 towers

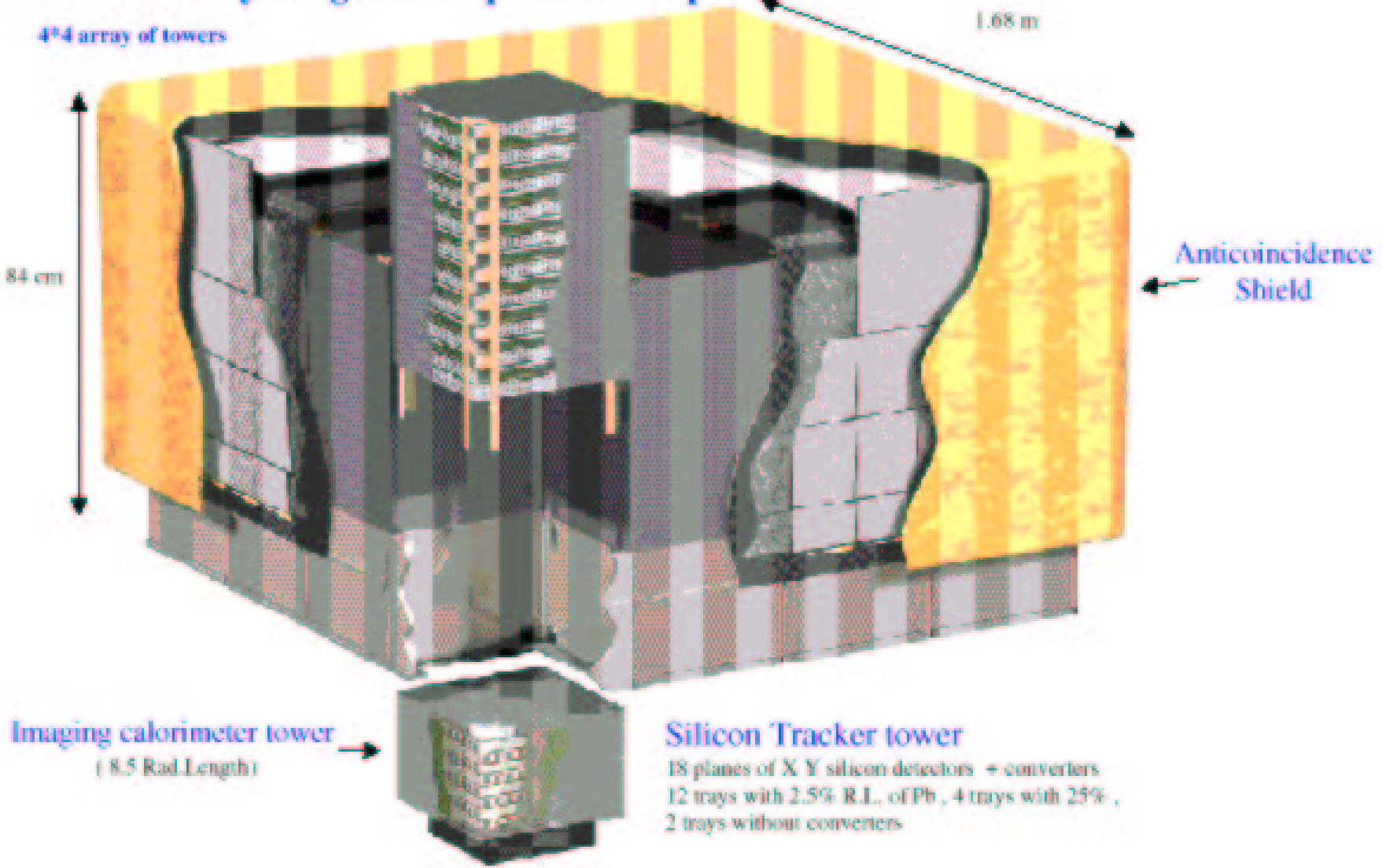
GLAST

Rivelatore “tracking”

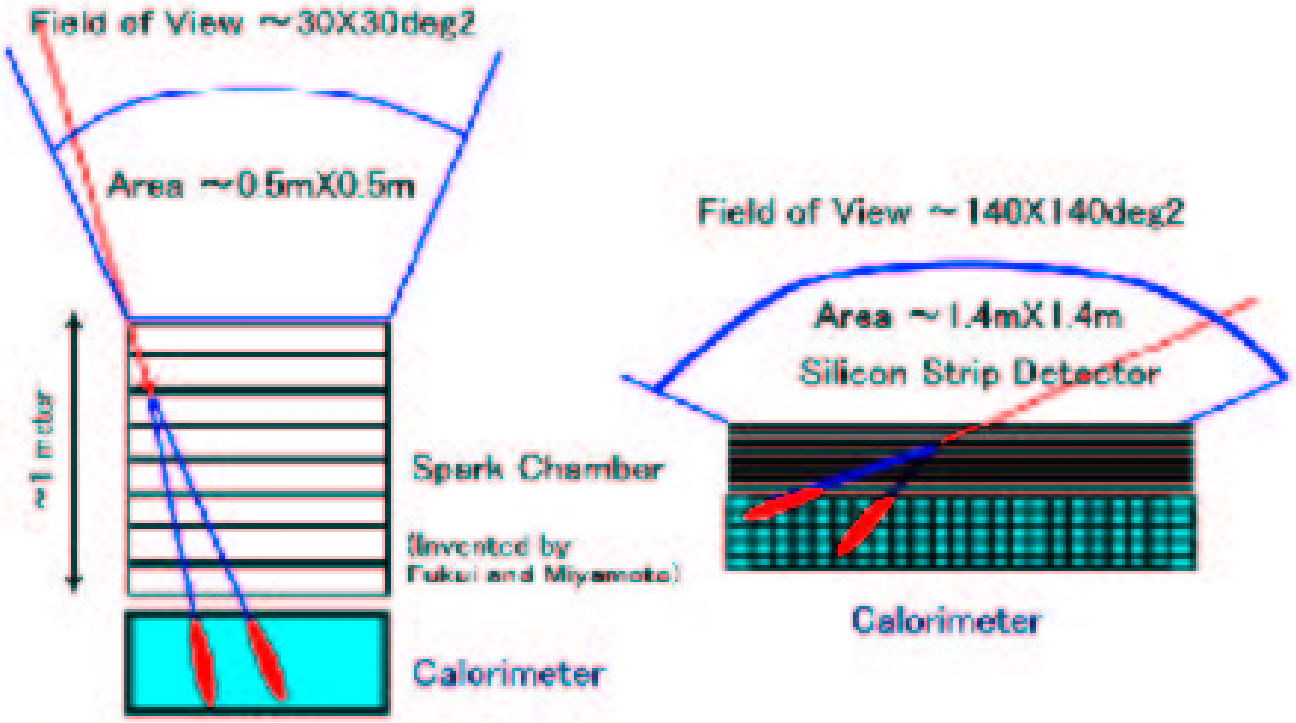
Rivelatore “Calorimetro”



Gamma-Ray Large Area Space Telescope



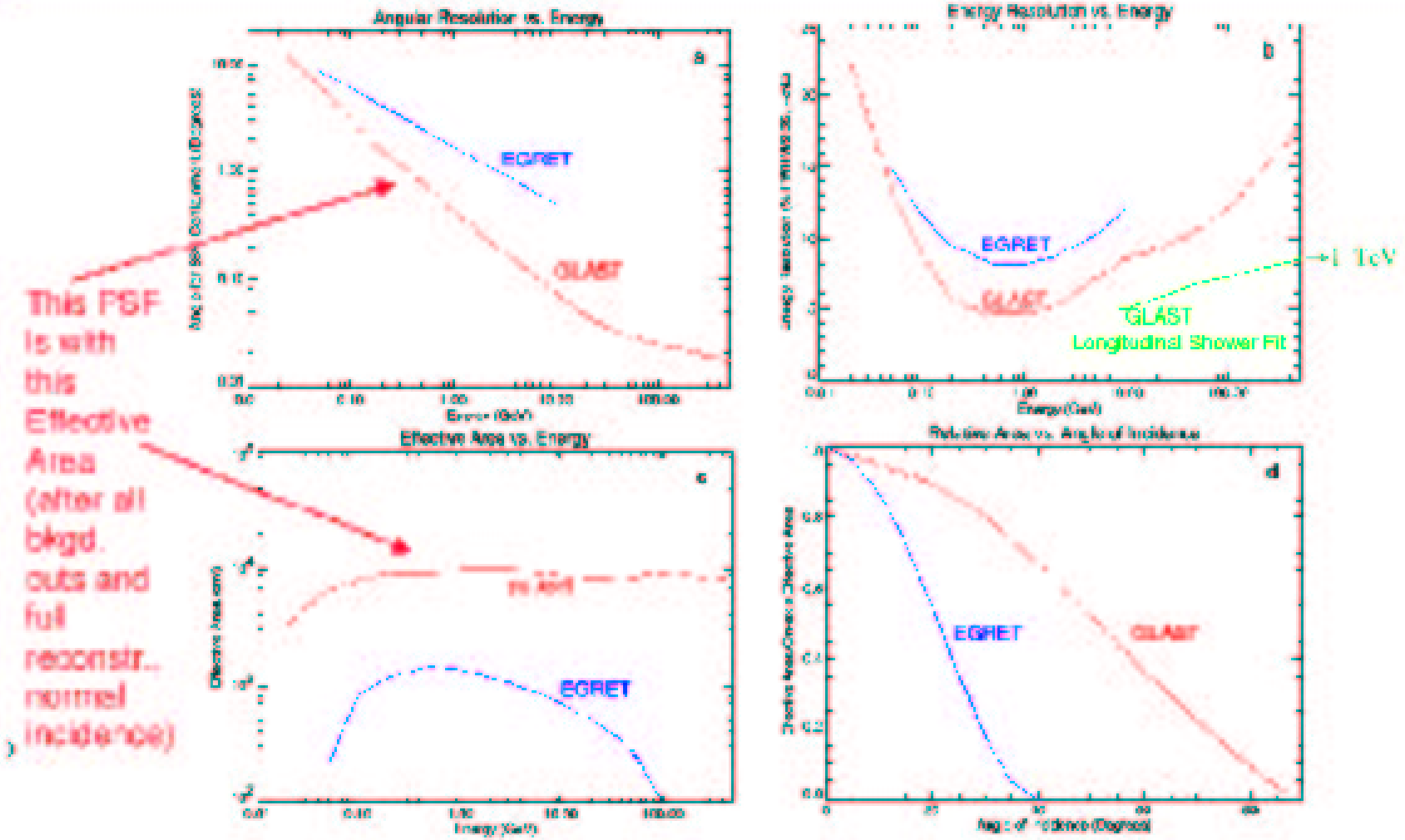
EGRET(Spark Chamber) VS. GLAST(Silicon Strip Detector)



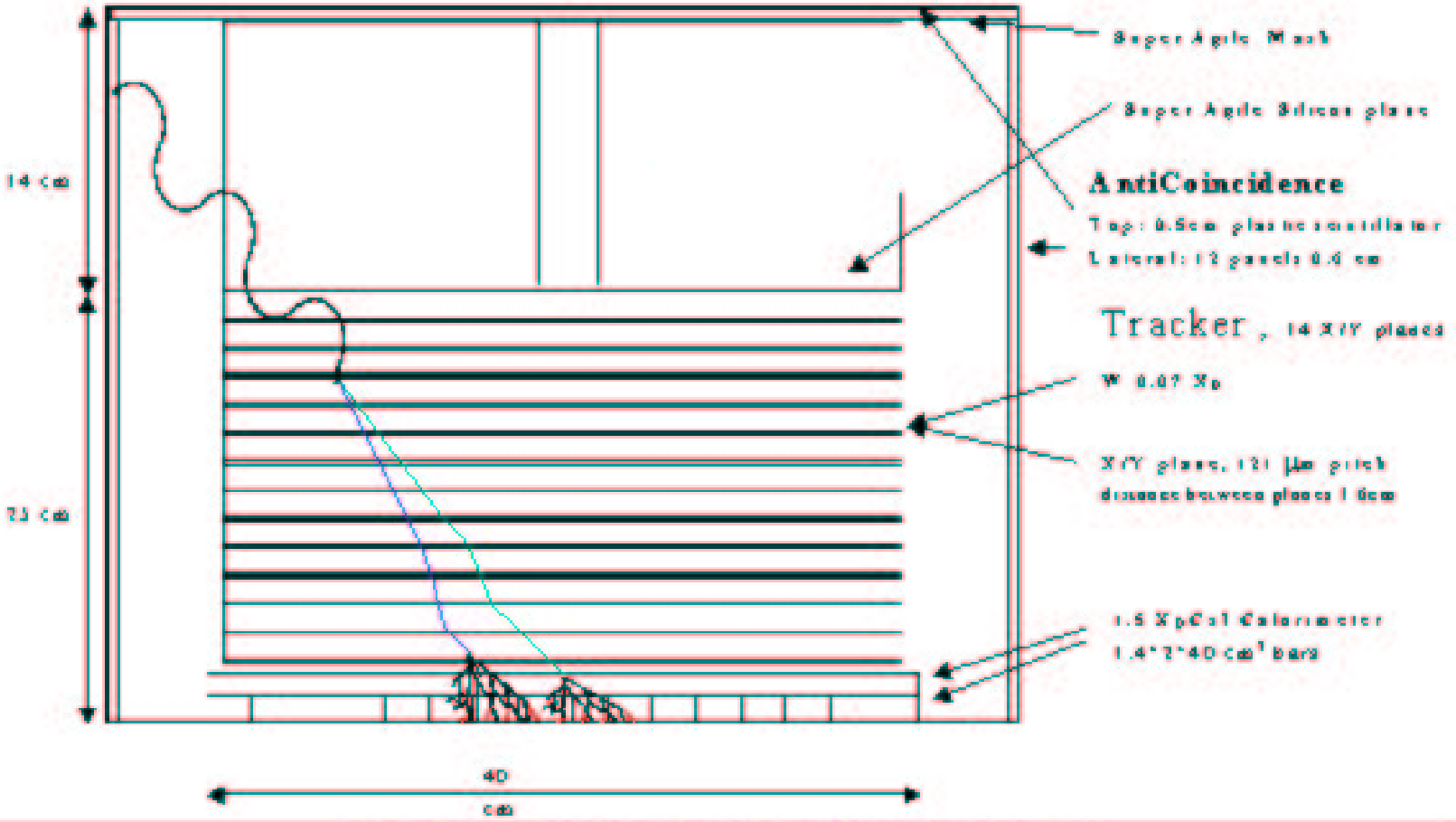
EGRET on Compton GRO
(1991-2000)

GLAST Large Area Telescope
(2006-2015)

GLAST Performance



AGILE


14 cm
23 cm
40
cm
Super Agile Mask
Super Agile Silicon planes
AntiCoincidence
Top: 0.5cm plastic scintillator
Lateral: 12 panels 0.5 cm
Tracker, 14 X/Y planes
W 0.07 X0
X/Y plane, 121 µm pitch
distance between planes 1 cm
1.5 X0 CsI Calorimeter
1.4*2*40 cm3 bars

Agile

GLAST

Astro-rivelatore Gamma a Immagini LEggero

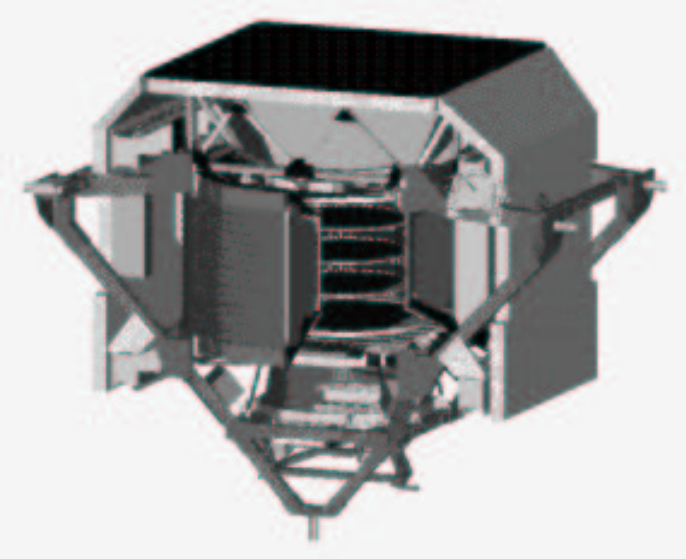
Energy Range :	20 MeV - 50 GeV	
Field of view :	3 sr	
Energy Resolution	~1 at 300 MeV	
Point source Sensitivity:	0.1 GeV	5×10^{-8}
(ph cm^{-2} s^{-1})	1 GeV	5×10^{-9}
	10 GeV	5×10^{-9}
Event deadtime	< 100 μs	
Peak Effective Area	600 cm^2	
Orbital Parameters	Equatorial, 550 Km	
Possible Earth Station	Malindi (Kenia)	
Required Power	65 W	
Payload Weight	65 Kg	
BUS + Payload	200 Kg	

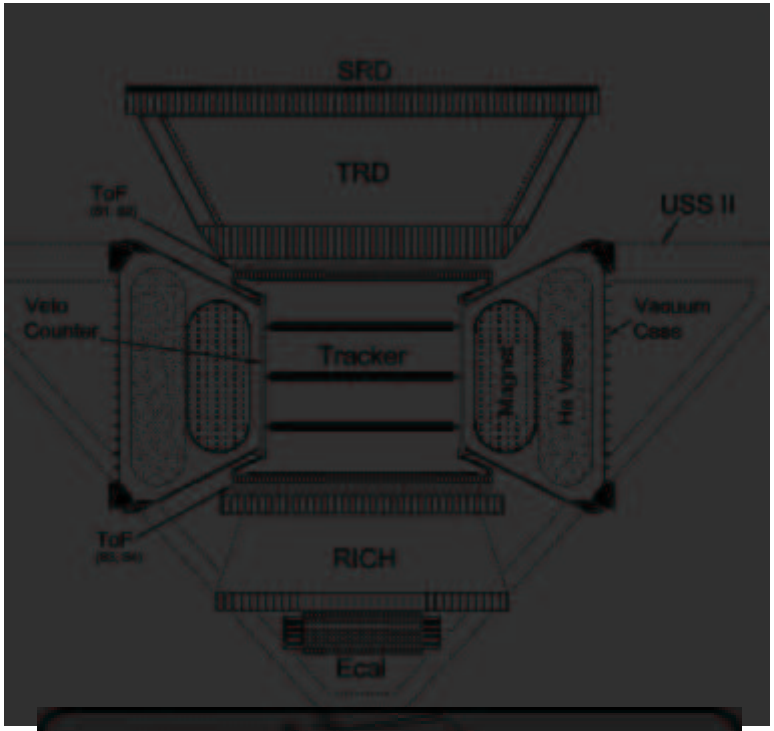
Gamma-Ray Large Area Space Telescope

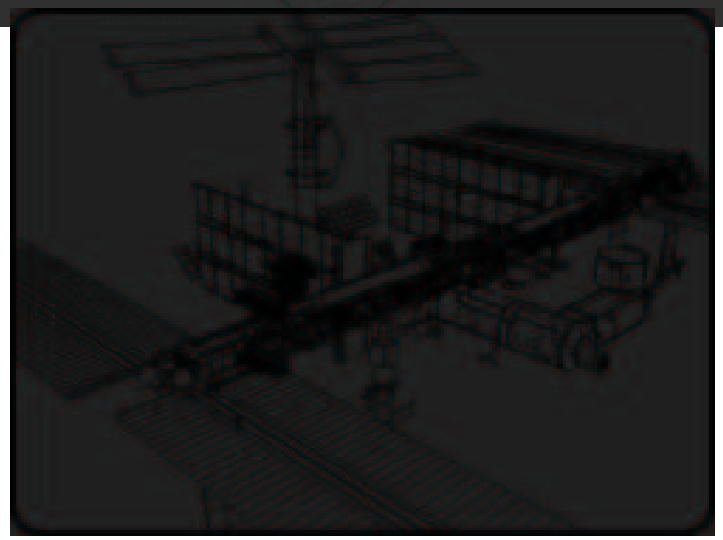
Energy Range :	20 MeV - 300 GeV	
Field of view :	3 sr	
Energy Resolution	5% at 1 GeV	
Point source Sensitivity:	0.1 GeV	2×10^{-9}
(ph cm^{-2} s^{-1})	1 GeV	2×10^{-10}
	10 GeV	1×10^{-10}
Event deadtime	~20 μs	
Peak Effective Area	10000 cm^2	
Orbital Parameters	28°, 600 Km	
Required Power	600 W	
Payload Weight	3000 Kg	

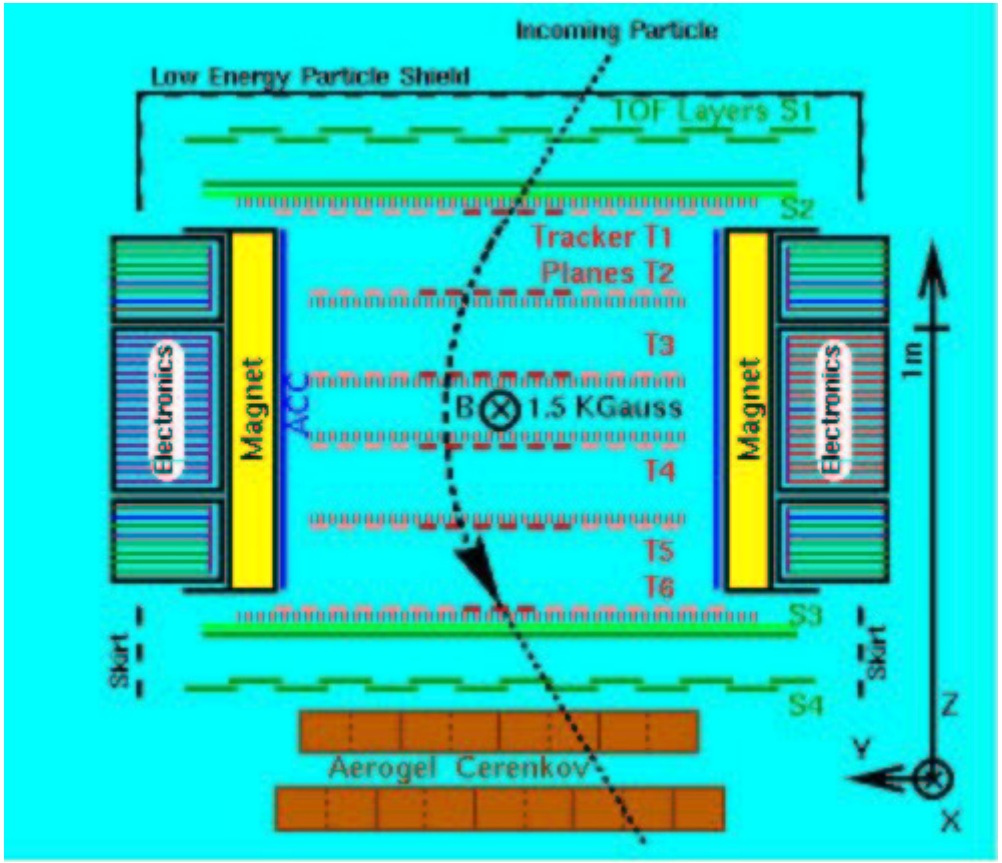
The Alpha Magnetic Spectromer

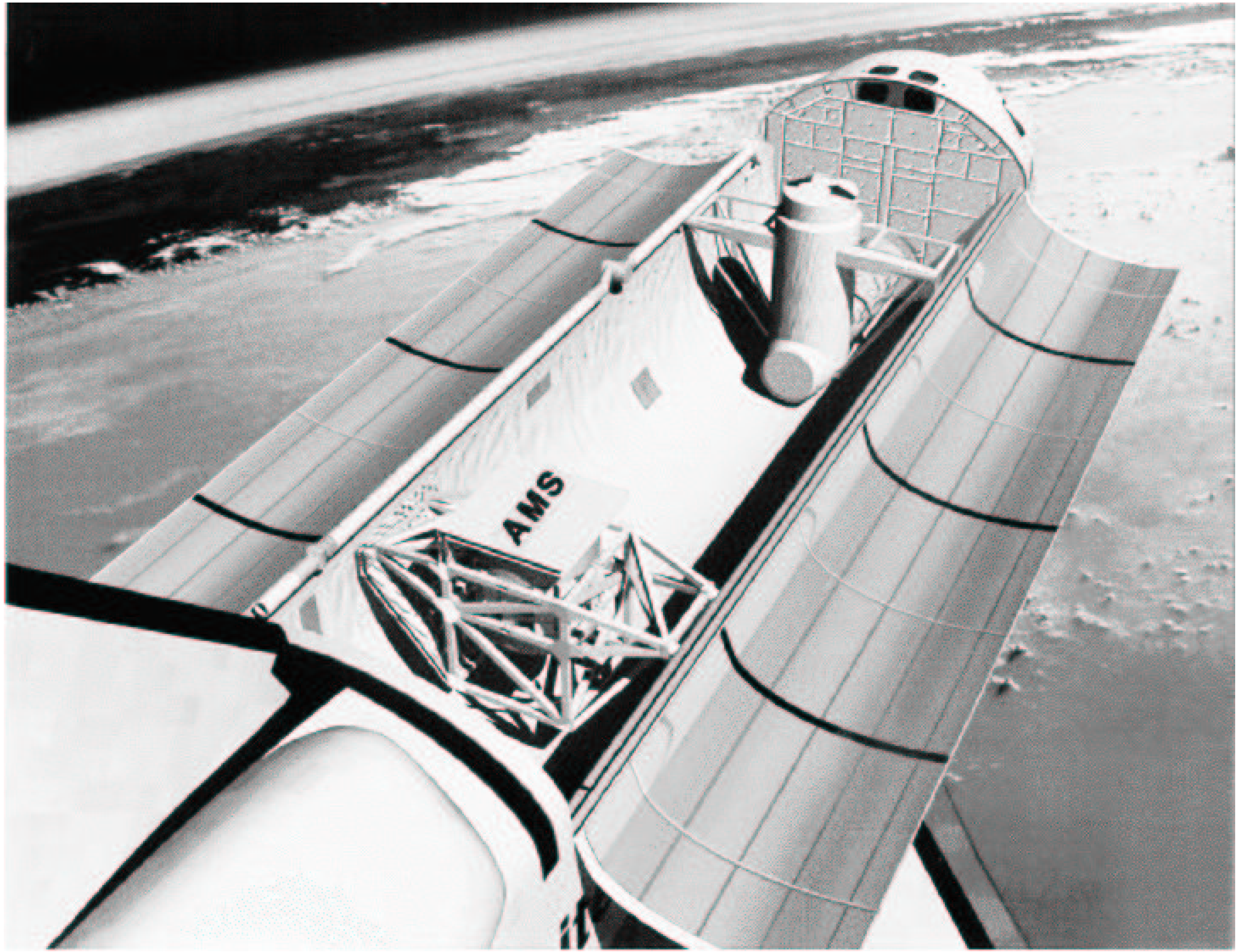
AMS








Incoming Particle
Low Energy Particle Shield
TOF Layers S1
S2
Tracker T1
Planes T2
T3
B 1.5 KGauss
T4
T5
T6
S3
S4
Electronics
Magnet
ACC
Magnet
Electronics
Skirt
Skirt
Aerogel Cerenkov
1m
Z
Y
X


AMS

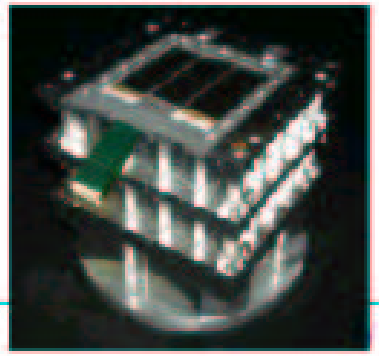
PAMELA

Physics Objectives

- AntiProton spectrum : 80 MeV - 180 GeV
- Positron spectrum : 50 MeV - 200 GeV
- Search for Antinuclei
- $e^+ + e^-$ up to 1 TeV

- Multi TeV electrons
- Solar and Trapped Cosmic Rays
- Solar Energetic Particles
- Long Term Solar Modulation
- Radiation Belts Transient Phenomena

Bare Mass: 450 Kg
Total Mass: ~750 Kg
Power: 350 W
GF: 21 cm^2sr
MDR: 740 GV/c



RESURS-DK1 Satellite
Mass: 10500 Kg
Elliptical Orbit 70.4 °incl.
300-600 Km altitude
Launch: December 2002
Mission Life > 3 Yr.
Launcher : Soyuz-TM

PAMELA,

un magnete permanenete attrezzato con diversi rivelatori specializzati:

•Spettrometro magnetico

•Calorimetro e.m. con strip di silicio

•TRD

•TOF

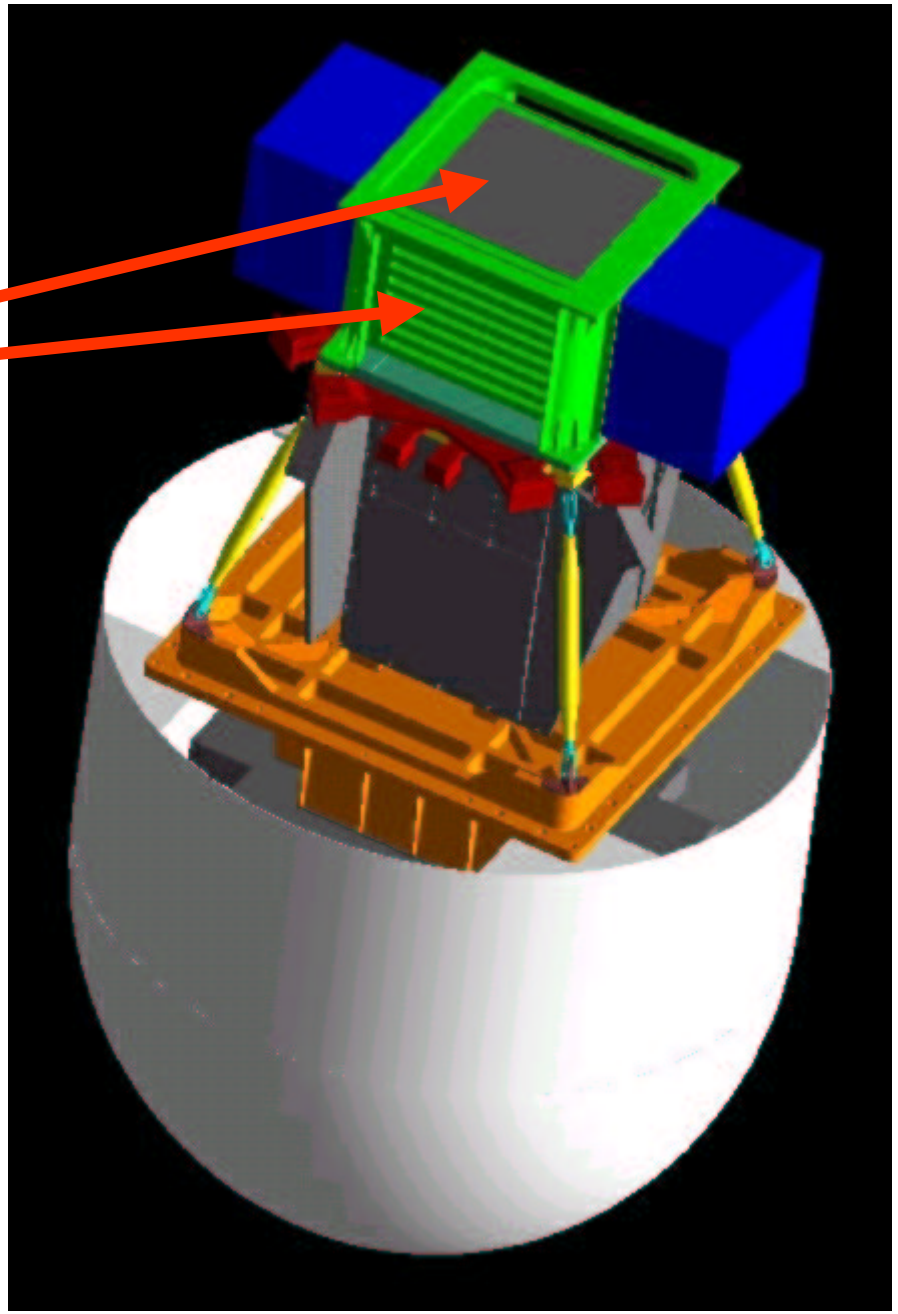
•Obiettivi di fisica :

•raggi cosmici

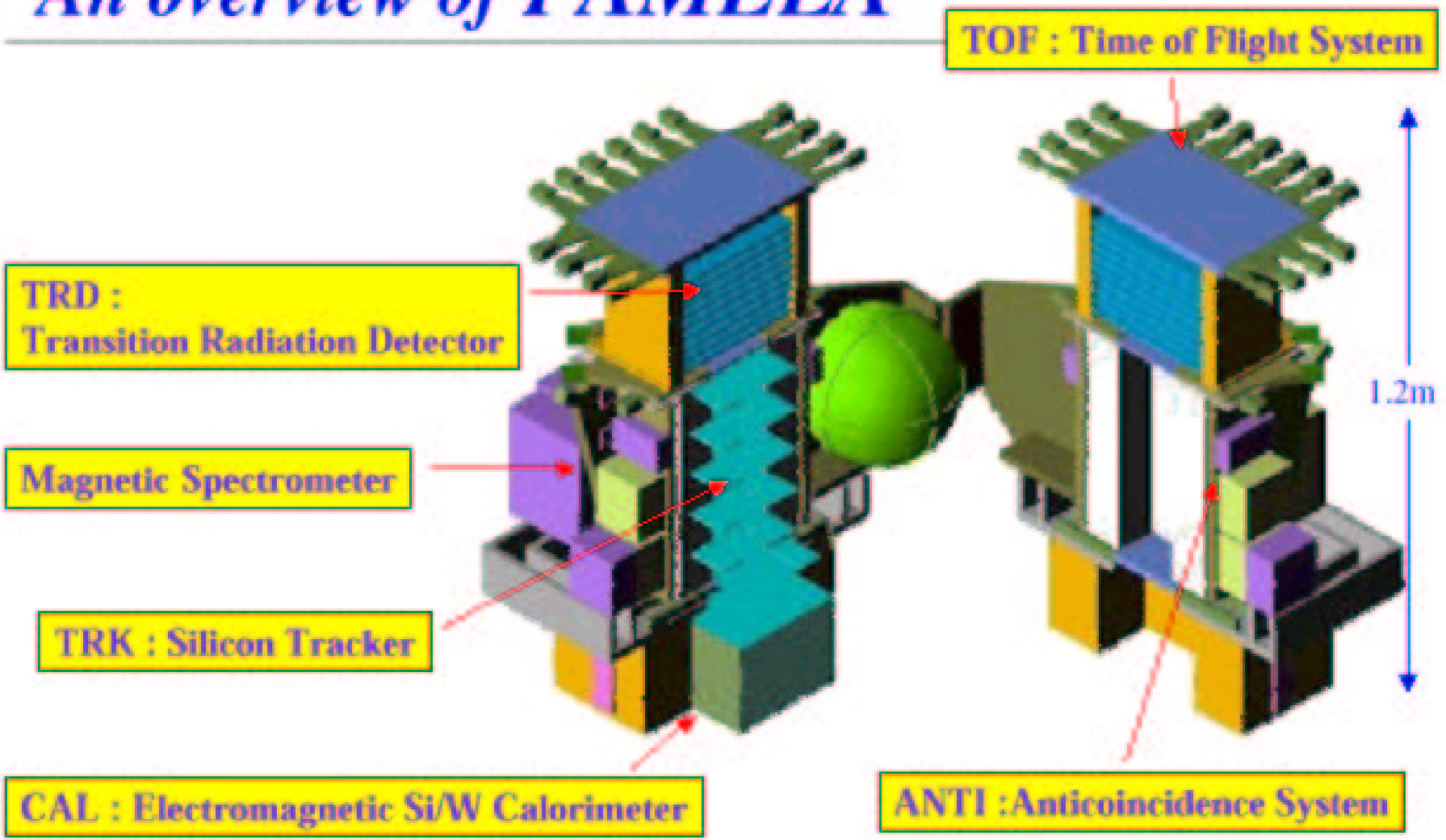
•antimateria

•materia oscura

PAMELA volerà a bordo del satellite russo Resusrs che verrà lanciato nel dicembre 2002 in un orbita tra 300 e 600 km di altezza,



An overview of PAMELA

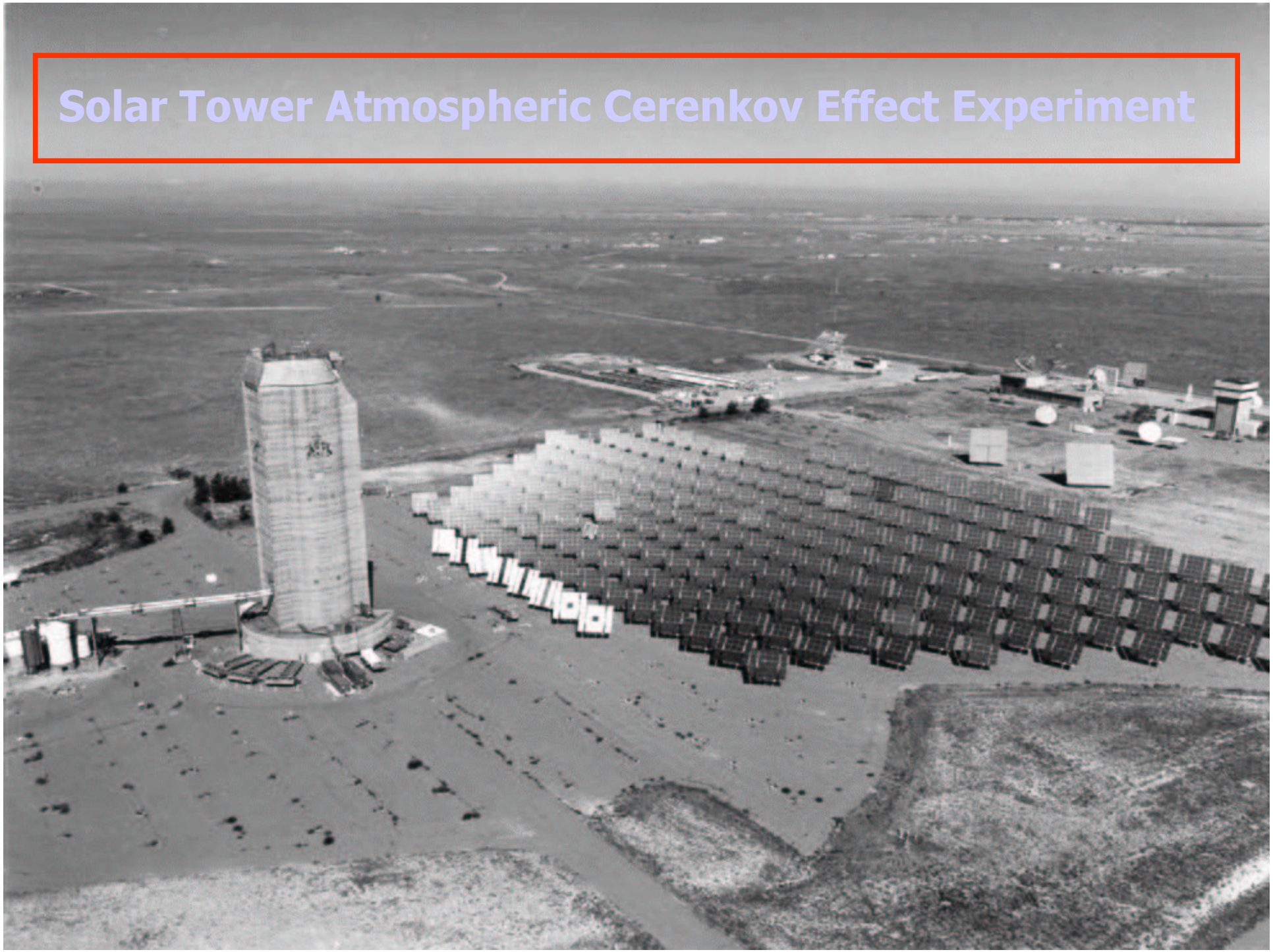


Nuovi rivelatori
AIR CERENKOV TELESCOPE

- **STACEE.** USA solar array 70->50 GeV
- **CELESTE, Fr** solar array 50-> 25 GeV
- **VERITAS ,** USA 7 x 10m 80 GeV
- **MAGIC ,** Spagna 17 m 30-15 GeV
- **HESS,** Namibia 4x12m 60 GeV

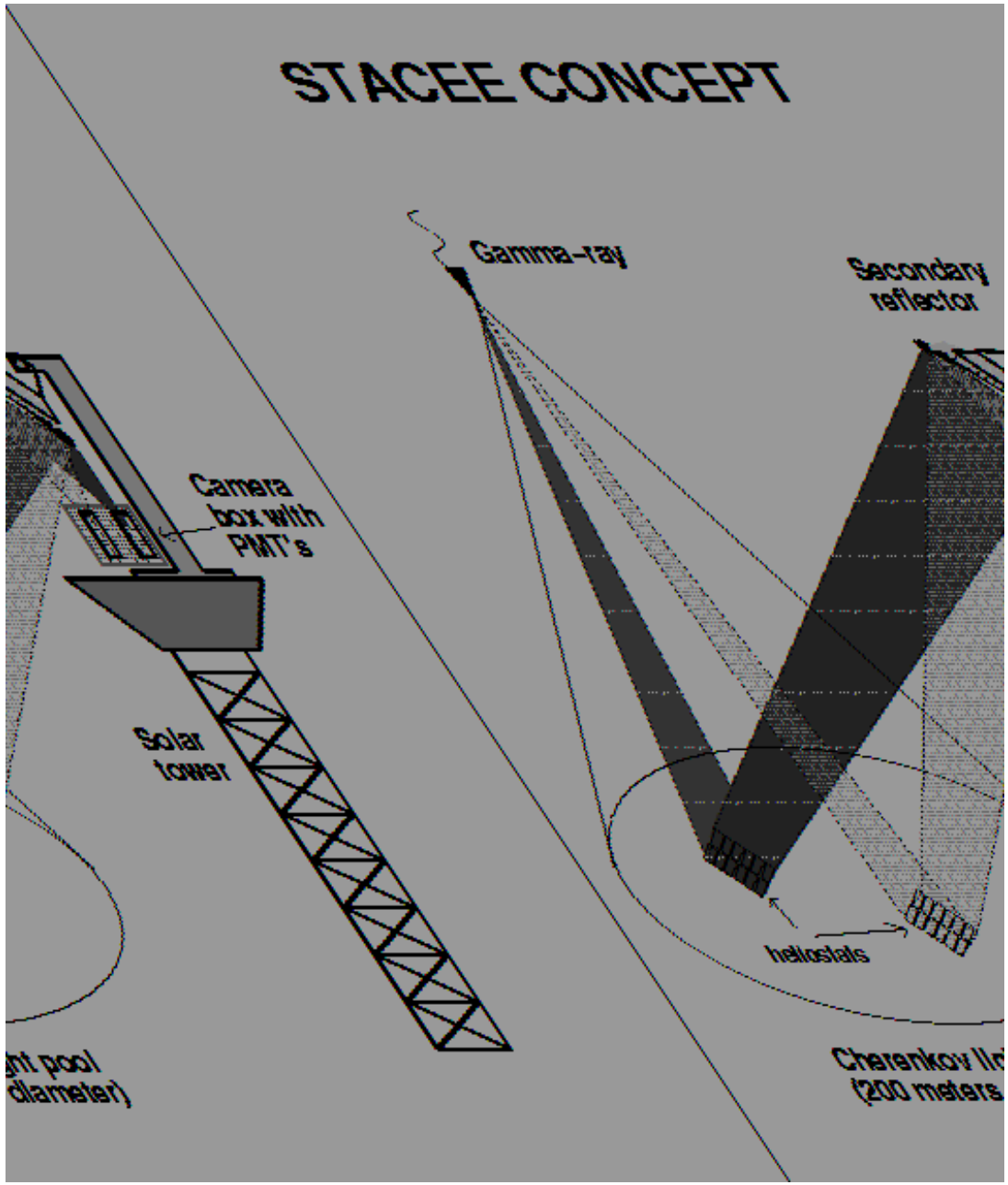
Ottima separazione h/g, grande area di raccolta luce, bassa soglia.

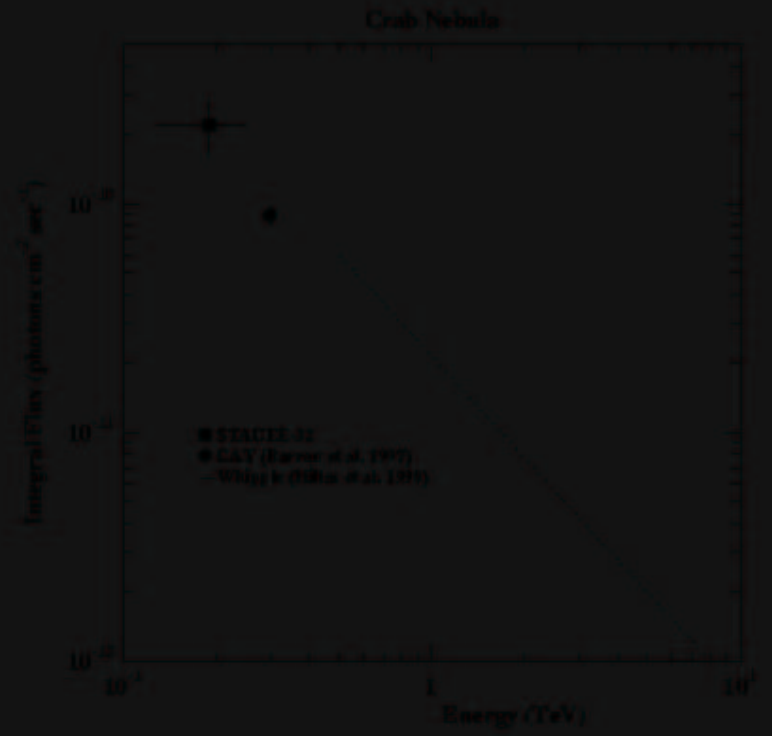
Solar Tower Atmospheric Cerenkov Effect Experiment



Caratteristiche di STACEE
ex Solar Plant

- Area rivelatori 2000 m^2 con soglia di 30 GeV
- Area occupata dai rivelatori 20000 m^2
- Tecnologia ottica ad alto livello
- Fast Read-out: 40 ADC 1GHz per la ricostruzione degli EAS





Measured Crab Integral Flux

$$E_{th} = 190 \pm 60 \text{ GeV}$$

$$I(E > E_{th}) = (2.2 \pm 0.6 \pm 0.2) \times 10^{-10} \text{ photons cm}^{-2} \text{ s}^{-1}$$

Conclusions

- STACEE-32 sees solid statistical excess from the Crab Nebula.

  Statistical significance $= +6.75\sigma$
  First detection for new instrument, technique

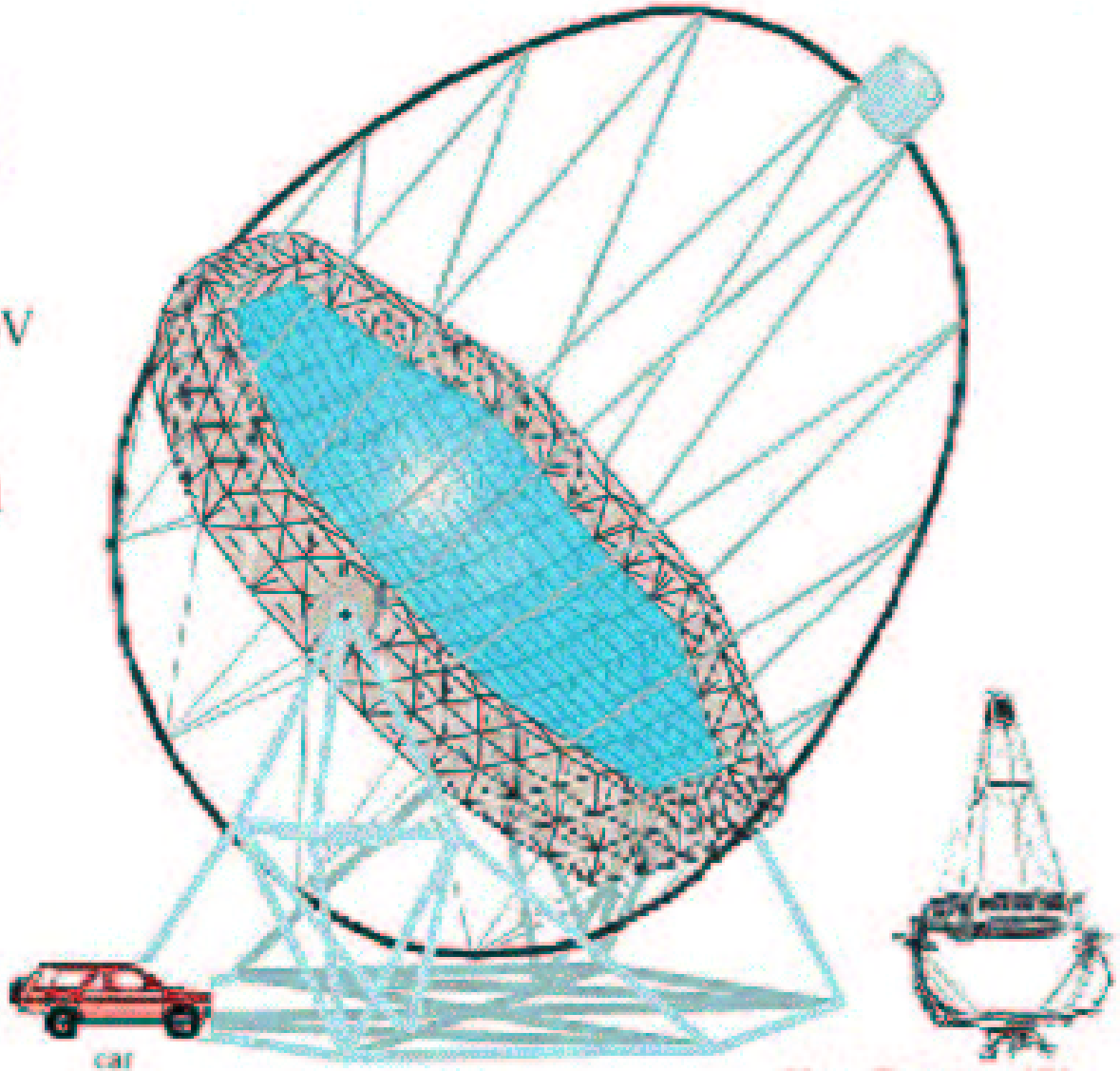
- Energy threshold $= 190 \pm 60$ GeV.
- $I(E > E_{th}) = (2.2 \pm 0.6 \pm 0.2) \times 10^{-10}$ photons cm^{-2} s^{-1}.
- No evidence for pulsed emission.
- Pulsed Fraction Limit: 5.5% at 90% C.L.
- Construction of STACEE continuing, 50 GeV threshold within reach by year's end.

The MAGIC Telescope Project

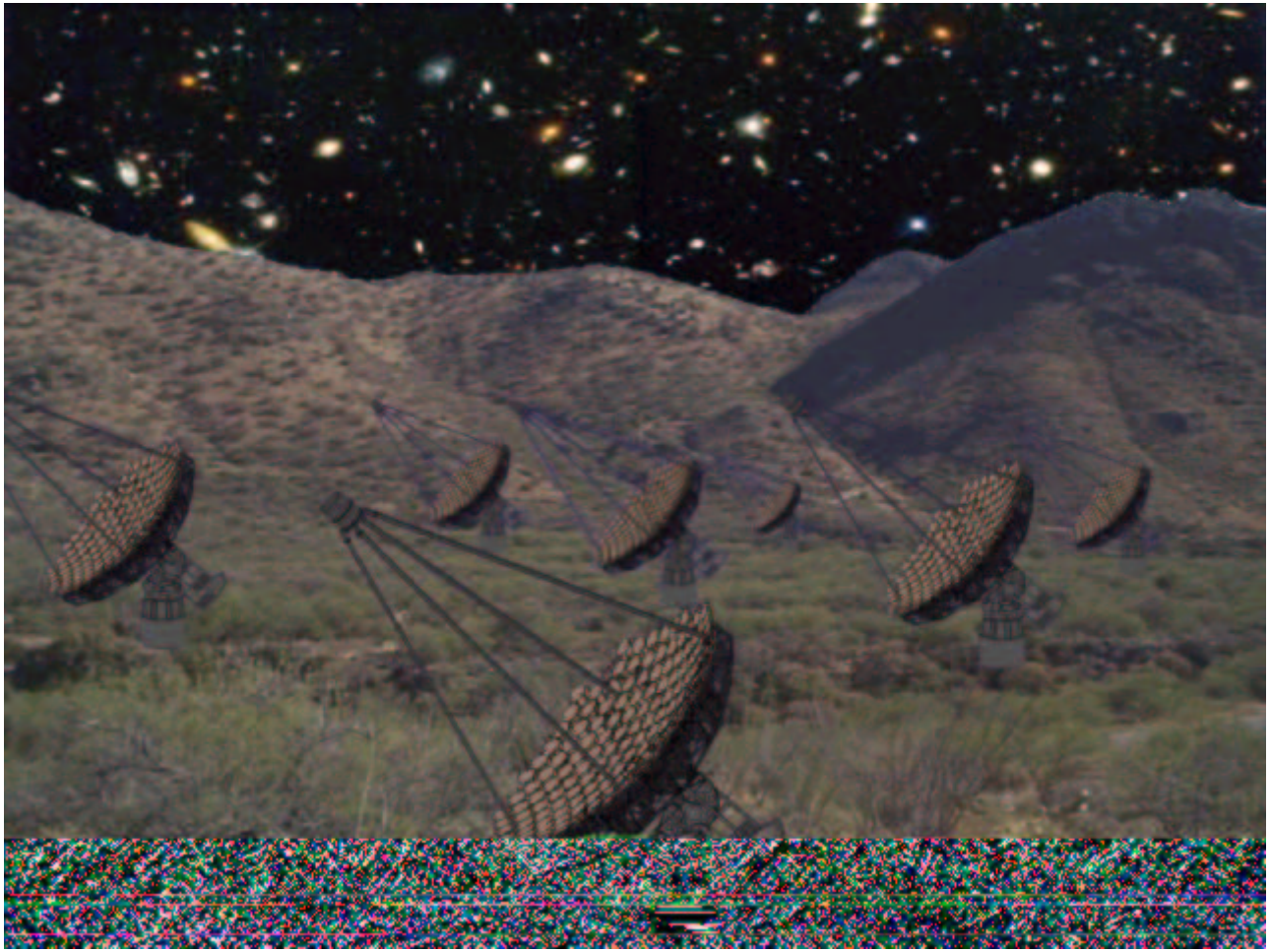
MAGIC's original construction goal (in 1998): first light recorded in summer 2001

MAGIC

220 m^2 mirror area
E =10 GeV - 300 GeV
Location: La Palma
(Canary Islands)
Scheduled June 2001



VERITAS



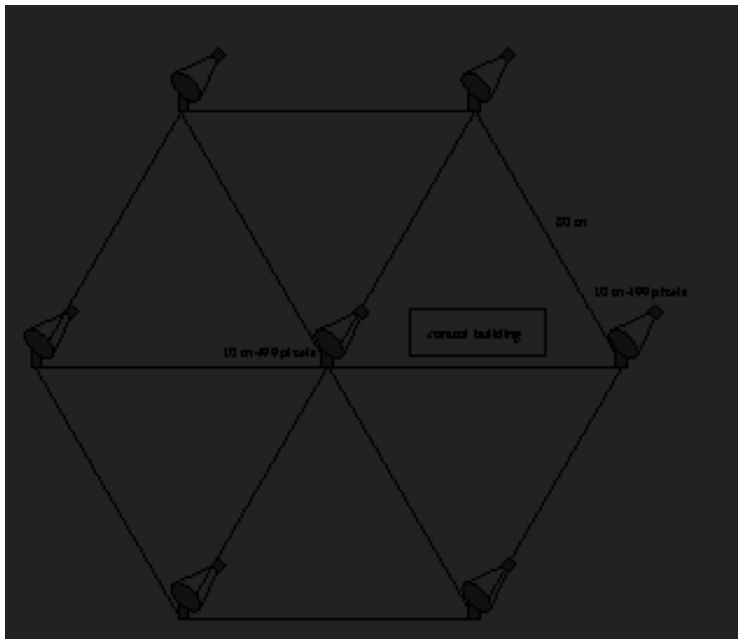
VERITAS

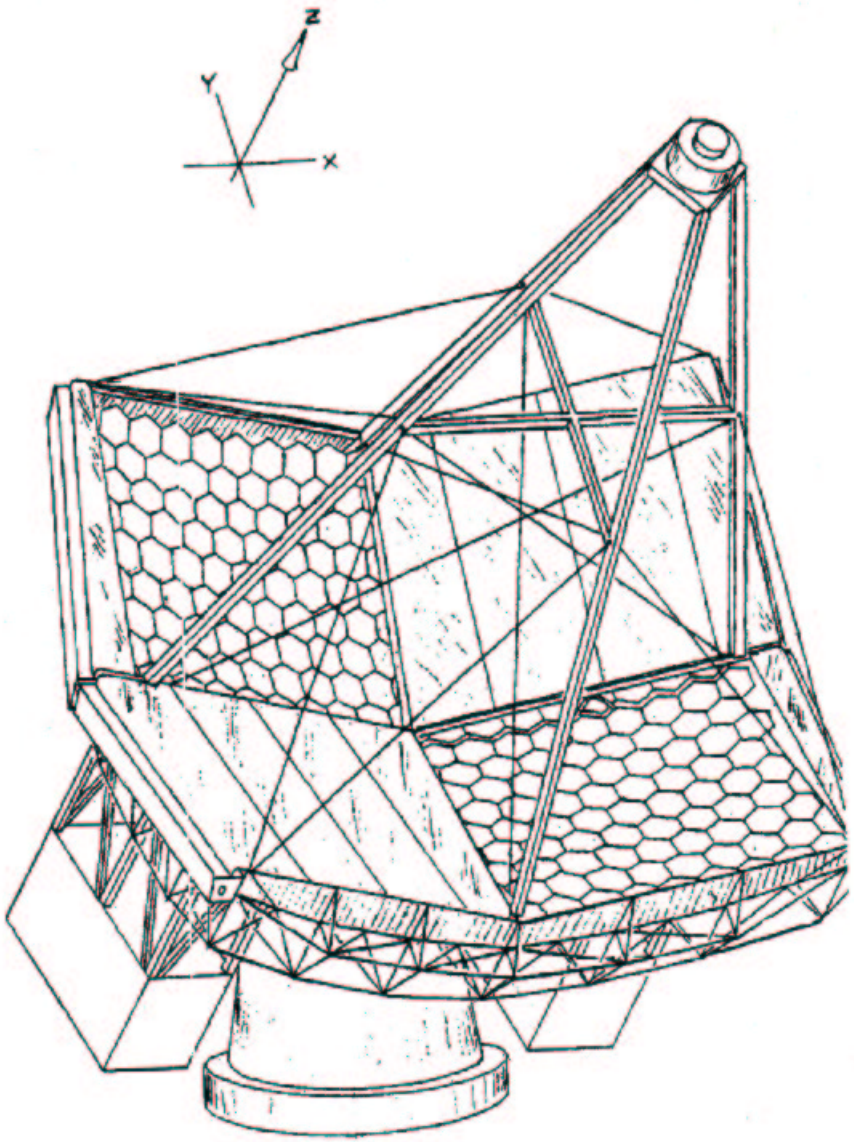
The array will consist of seven 34-foot-aperture optical telescopes placed at the corners and center of a hexagon with 279-foot-long sides. Each large reflector will have a sophisticated camera at its focus.

Threshold Energy 50-70 GeV

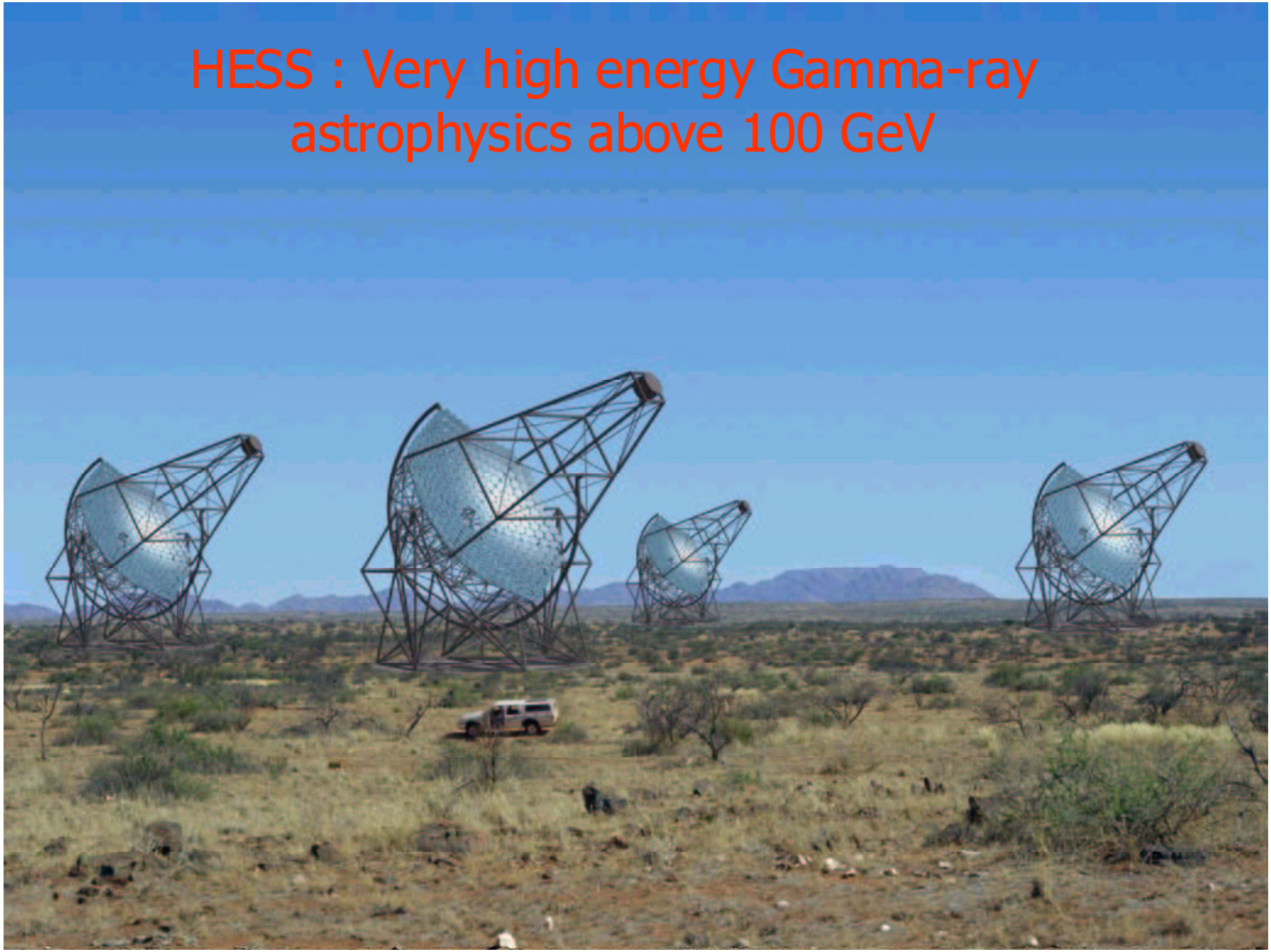
Angular resolution 0.05 deg

Energy resolution 15%




Z
Y
X

HESS : Very high energy Gamma-ray astrophysics above 100 GeV



Nuovi rivelatori
Particle Detector Array

- **MILAGRO**
- **TIBET III**
- **ARGO-YBJ**

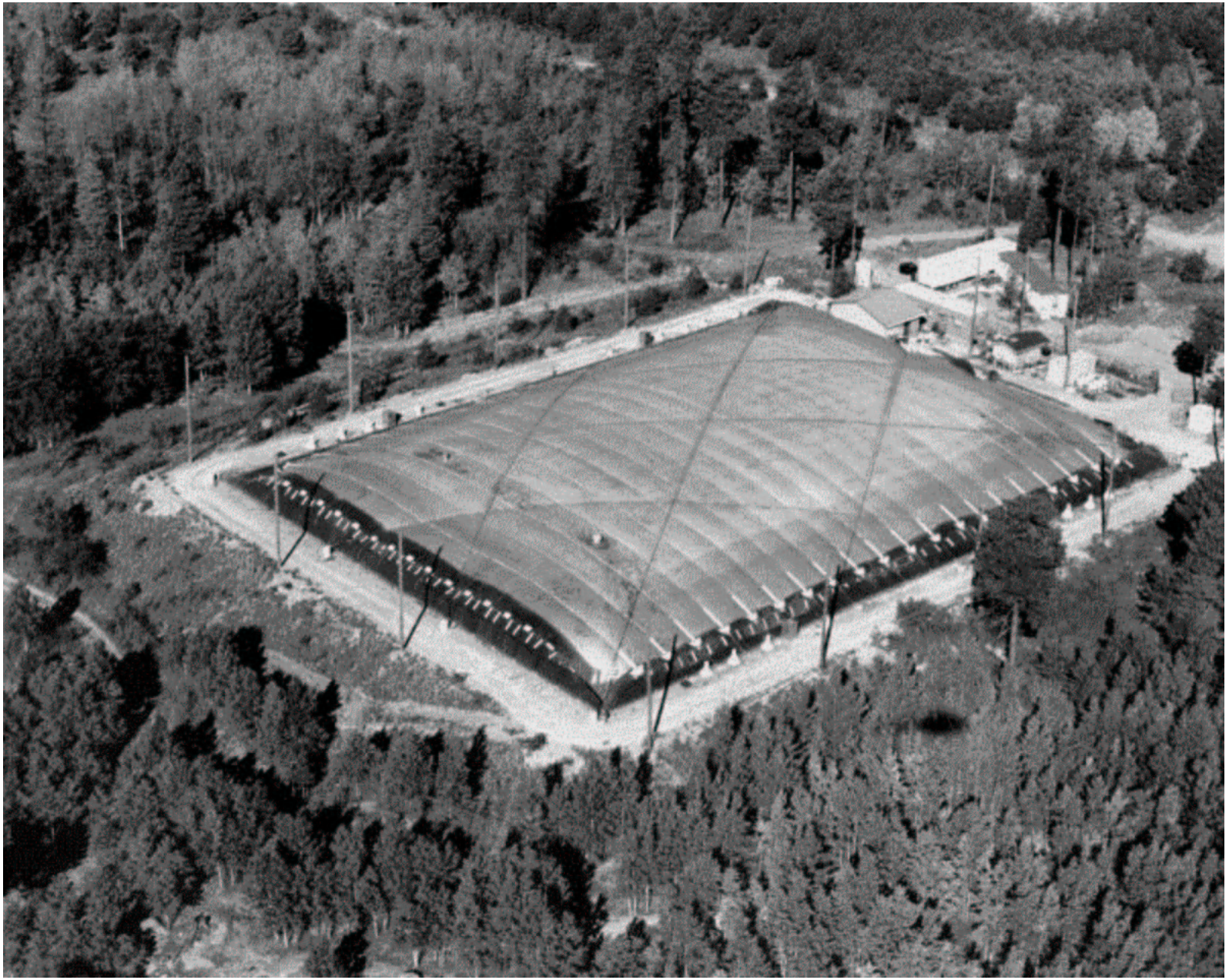
Physcs with MILAGRO

- **AGN**
- **GRB**
- **Solar Physics**

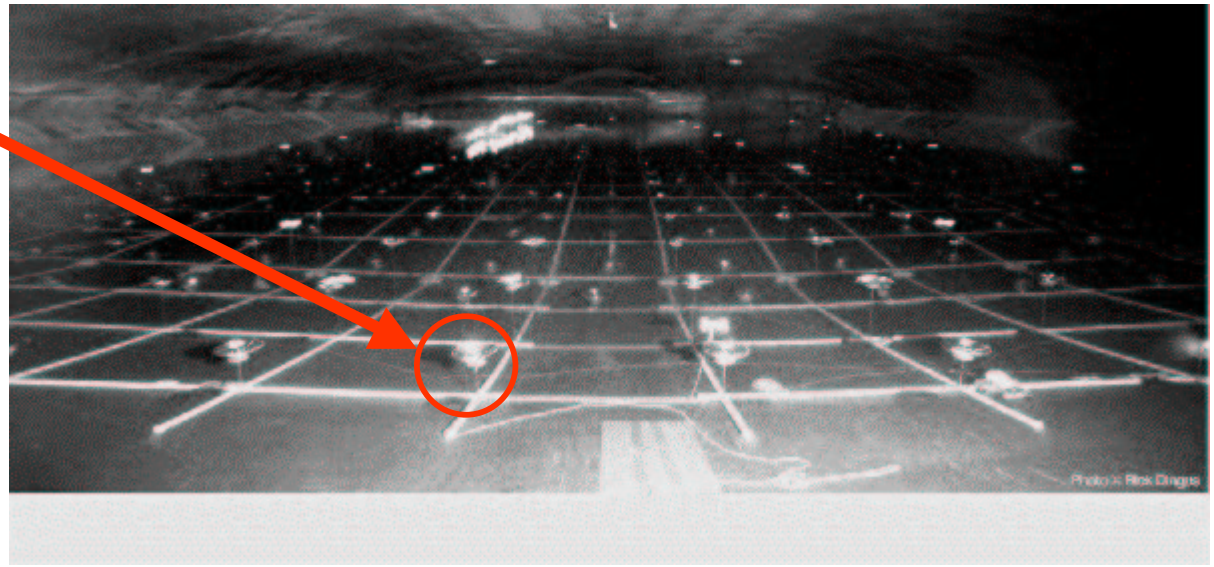
MILAGRO

L'apparato Milagro consiste di una grande vasca (delle dimensioni di un campo di calcio) riempita d'acqua, e sigillata a tenuta di luce. Nella piscina sono installati 723 PMT.

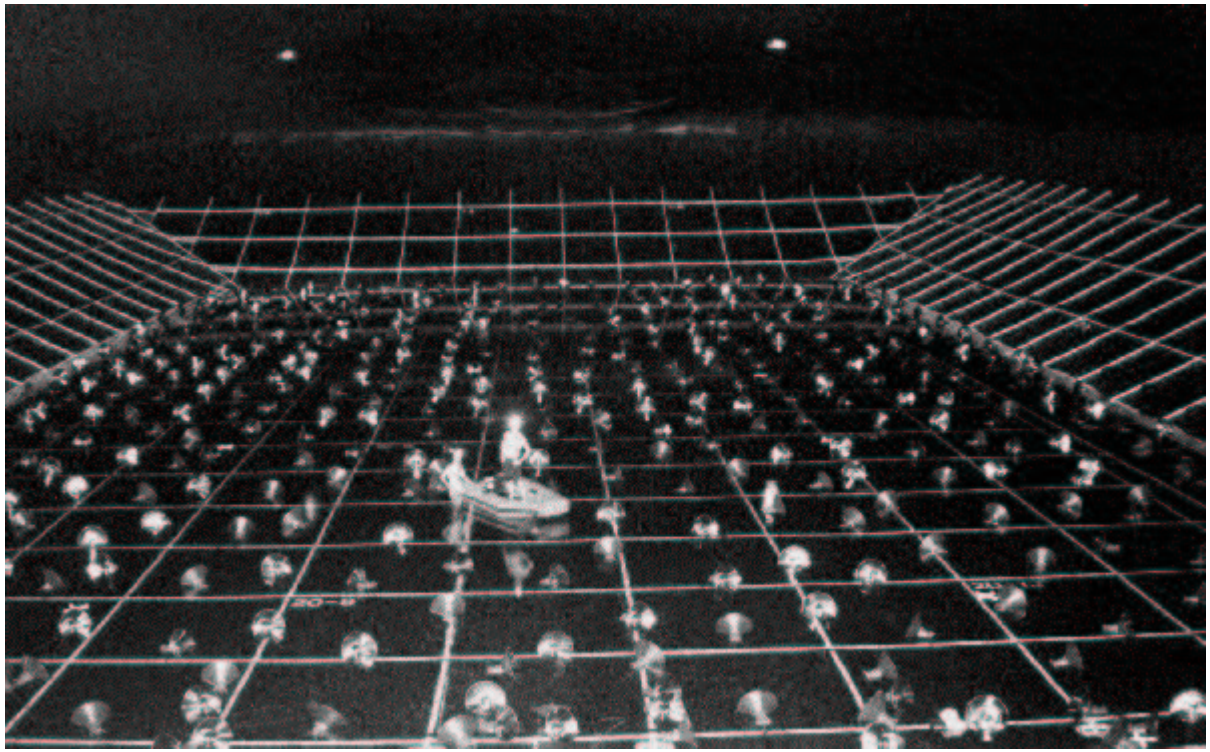
Il principio di funzionamento è quello di rivelare i fotoni Cerenkov emessi dalle particelle veloci che attraversano la piscina.

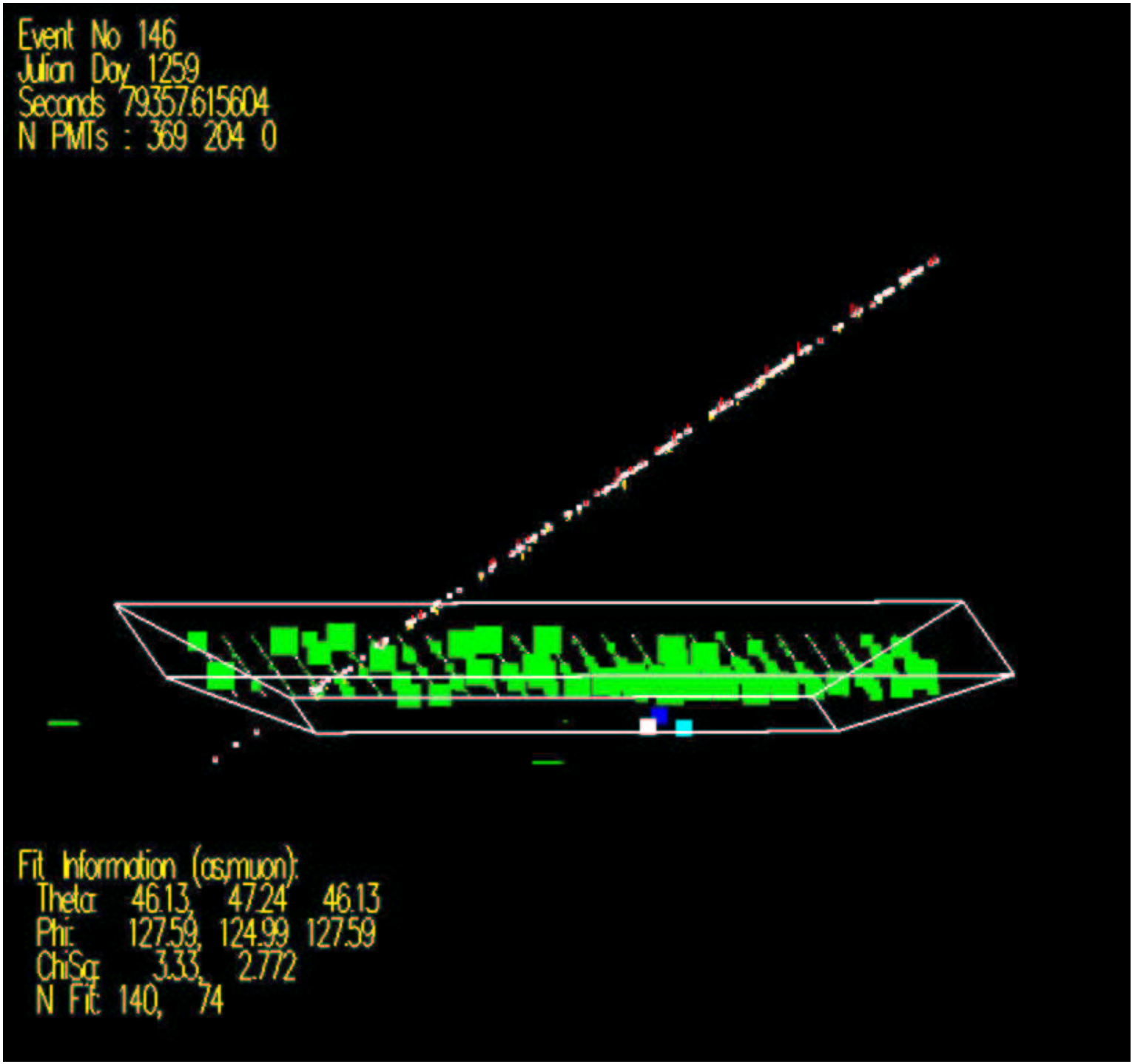


PM



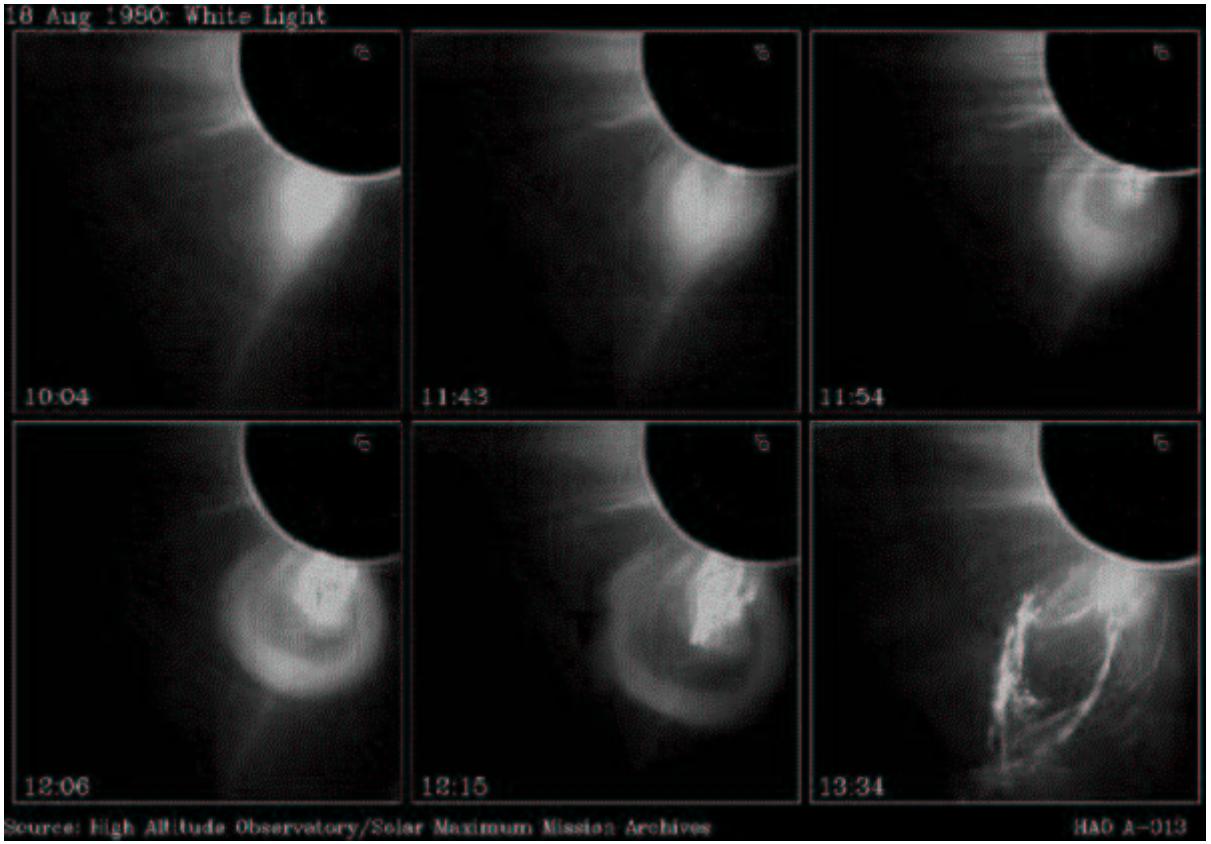
Interno del rivelatore Milagro primo del riempimento d’acqua




Event No 146
Julian Day 1259
Seconds 79357.615604
N PMTs : 369 204 0
Fit Information (os,muon):
Theta: 46.13, 47.24 46.13
Phi: 127.59, 124.99 127.59
ChiSq: 3.33, 2.772
N Fit: 140, 74

Fisica Solare

Durante i periodi di forte attività solare vengono emesse particelle nel range dei GeV, che possono essere rilevate dall'apparato MILAGRO

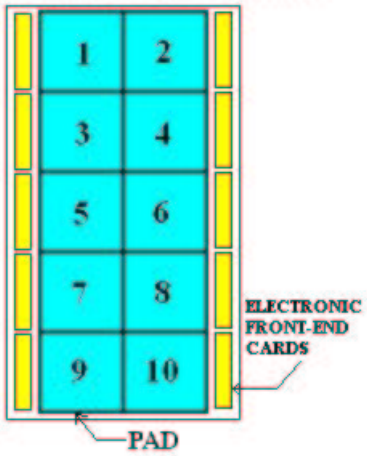


Evento di Coronal Mass Ejection (CME)

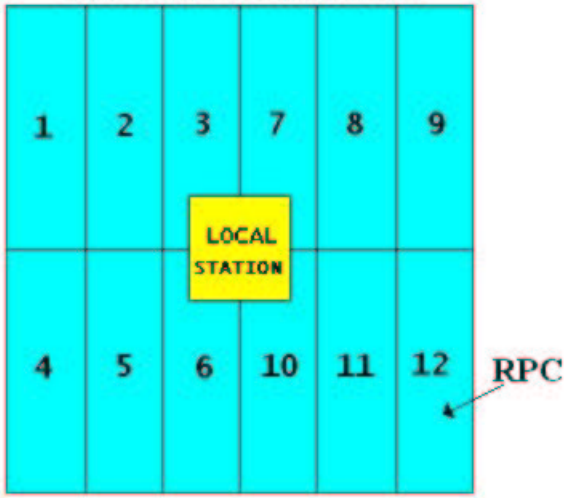
ARGO - YBJ

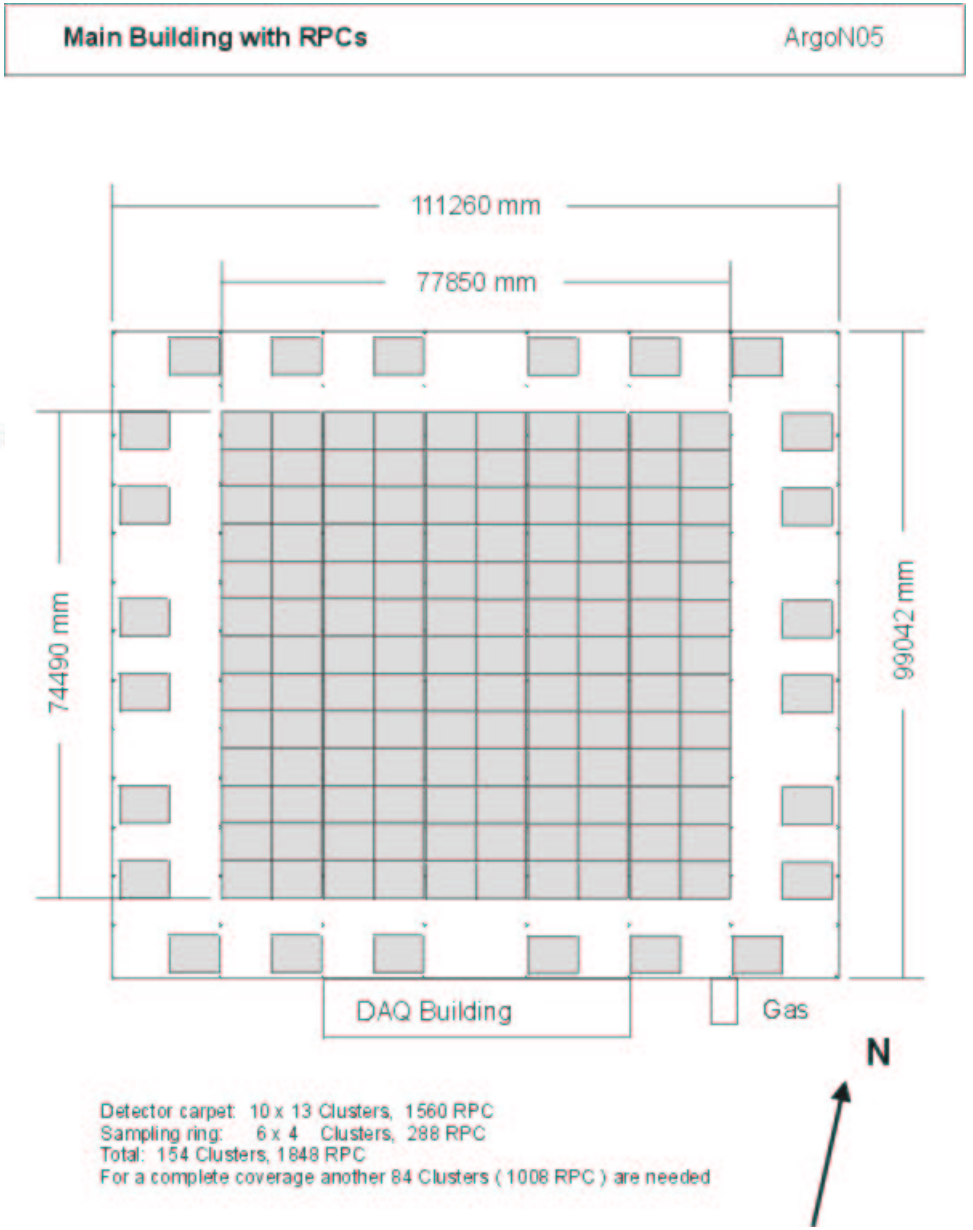
ARGO-YBJ

One ARGO RPC detector

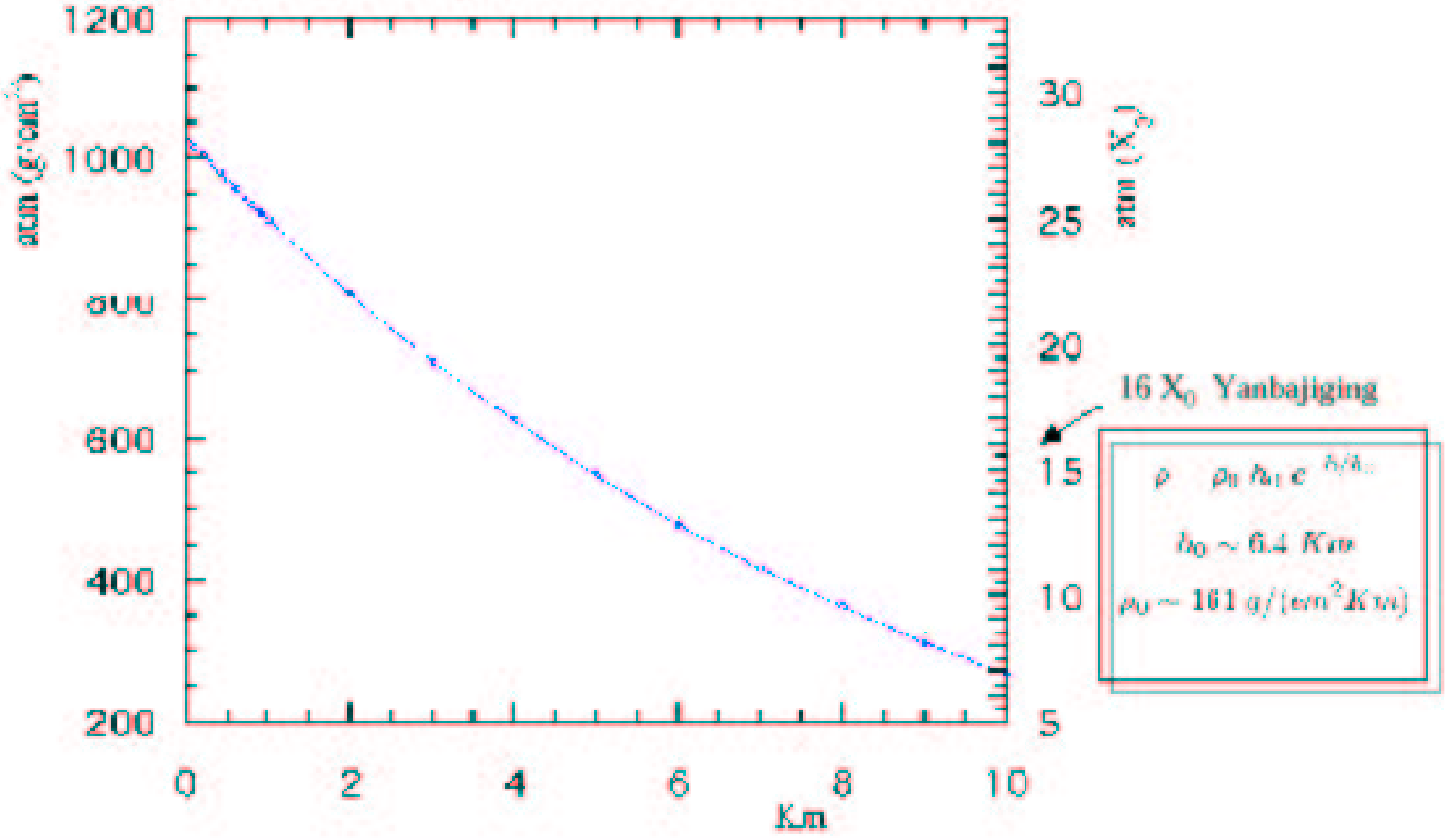


One ARGO Cluster detector





Relation between altitude, number of Radiation Length and g/cm² traversed



Physics with ARGO-YBJ

1) **Gamma-ray astronomy** at a ~100 GeV threshold energy. Several galactic and extagalactic point candidate sources can be monitored, with a sensitivity to unidentified sources better than 10% of the Crab flux.

2) **Diffuse Gamma Rays** from the Galactic plane, molecular clouds and SNR at E_γ >100 GeV.

3) **Gamma-Ray Burst physics** with a sensitivity allowing the extension of the satellite measurements over the full GeV/TeV energy range.

4) **Anti-p/p ratio** at energies from 300 GeV to TeV not accessible to satellites, with a sensitivity adequate to distinguish between models of galactic or extragalactic anti-proton origin.

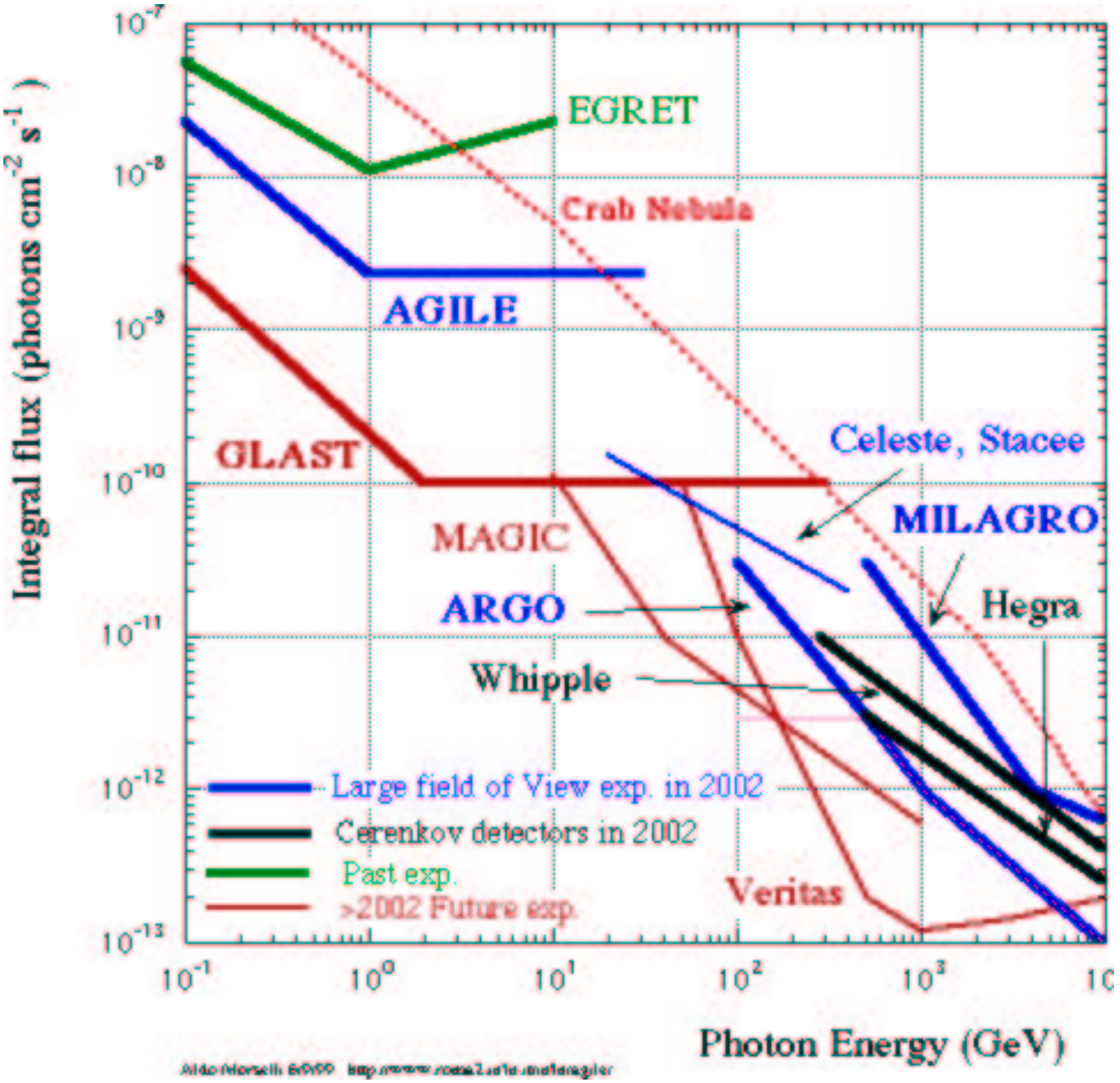
5) **The primary proton spectrum** in the 10 - 200 TeV region, with sensitivity sufficient to detect a possible change of the slope of the energy spectrum.

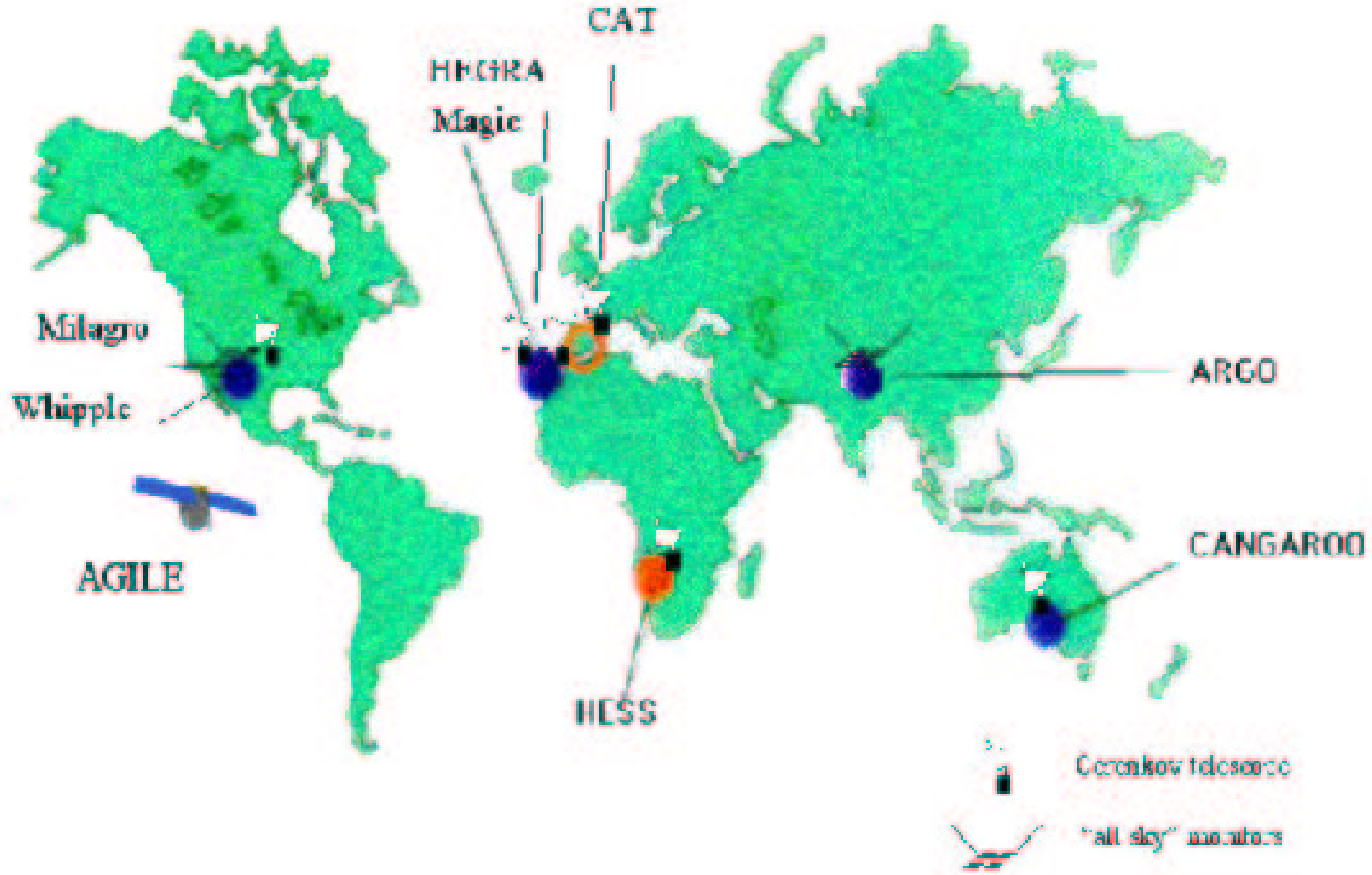
6) **Sun and Heliosphere physics** including cosmic ray modulations at 10 GeV threshold energy, the continuous monitoring of the large scale structure of the interplanetary magnetic field and high energy gamma and neutron flares from the Sun.

Additional objectives come from using ARGO-YBJ as a traditional EAS array covering the full energy range from 10^{11} to 10^{16} eV. Since he detector provides a high granularity space-time picture of the shower front, detailed study of shower properties as, for instance, multicore events, time and lateral distributions of EAS particles, multifractal structure of particle densities near the core, can be performed with unprecedented resolutio

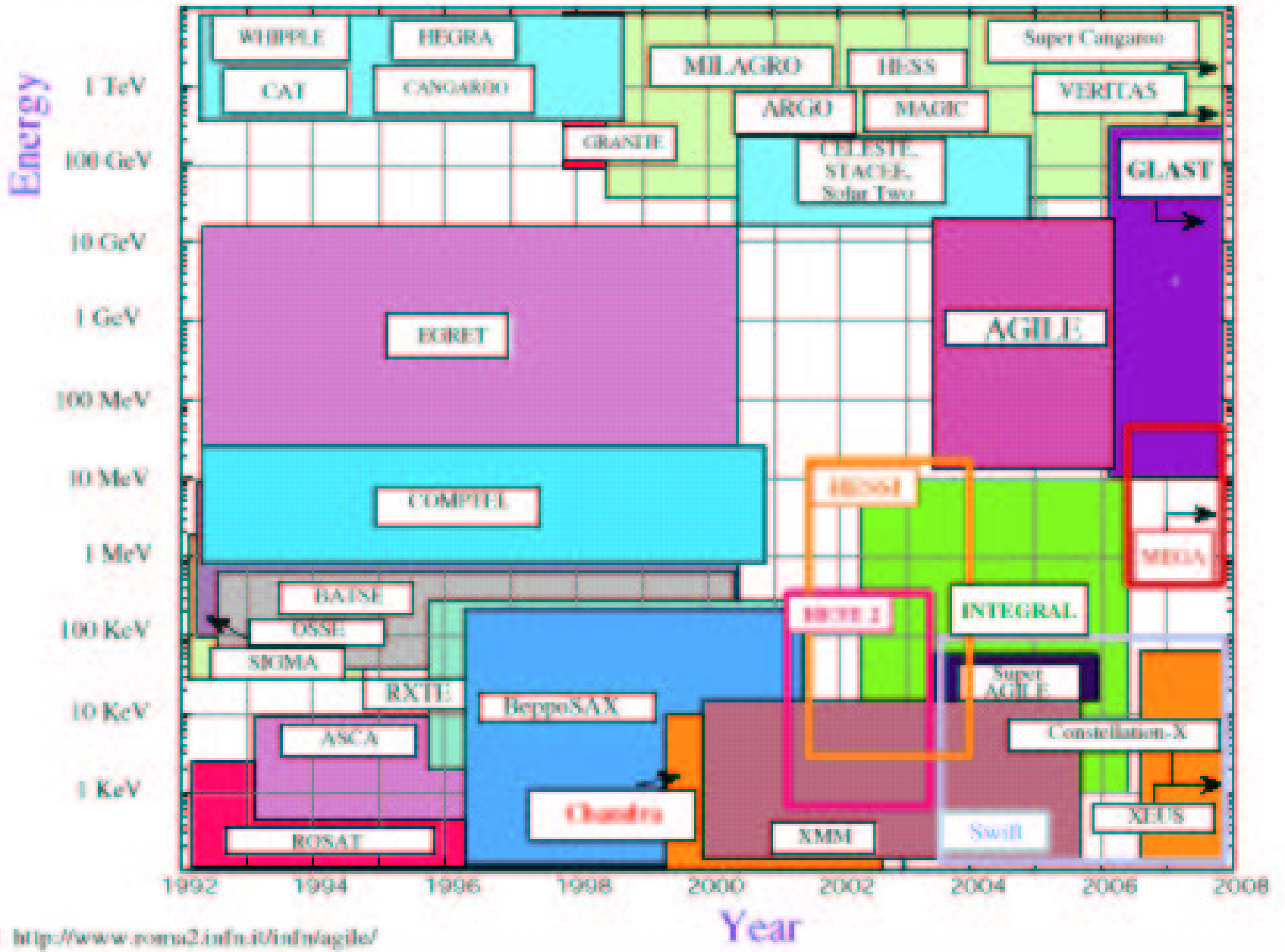
At an altitude > 4000 m a.s.l. the electron size of the shower produced by primaries energies 10^{15}-10^{16} eV, around the 'knee' of cosmic ray spectrum, is practically independent of their mass. This fact could be exploited to get information about the composition at the knee by measuring other parameters distinguishing showers developed by primaries of different mass.

MAGIC sensitivity based on the availability of high efficiency PMT's All sensitivities are at 5σ. Cerenkov telescopes sensitivities (Veritas, MAGIC, Whipple, Hess, Celeste, Stacee, Hegra) are for 50 hours of observations.
Large field of view detectors sensitivities (AGILE, GLAST, Milagro, ARGO are for 1 year of observation.




CAT
HEGRA
Magic
Milagro
Whipple
AGILE
ARGO
CANGAROO
HESS
Cerenkov telescope
"all sky" monitors

Energy versus time for X and Gamma ray detectors



elli 7/01 http://www.roma2.infn.it/infn/agile/

Astronomia - gamma
Conclusioni

- Enormi progressi negli ultimi anni. Attualmente siamo in una fase di attesa per la costruzione di nuovi telescopi
- Crab sorgente di calibrazione
- Le osservazioni attuali concordano su un meccanismo di accelerazione di elettroni seguito da IC. No "*Smoking gun*" per meccanismi adronici
- Le sorgenti di RC (SNR) non danno forti segnali gamma. Dove sono le sorgenti di RC?
- Gli AGN mostrano fenomeni di *Flaring* la cui origine è oscura
- L'astronomia gamma nella regione GeV/TeV e' oggetto di un intenso programma di ricerca che darà i suoi risultati a breve