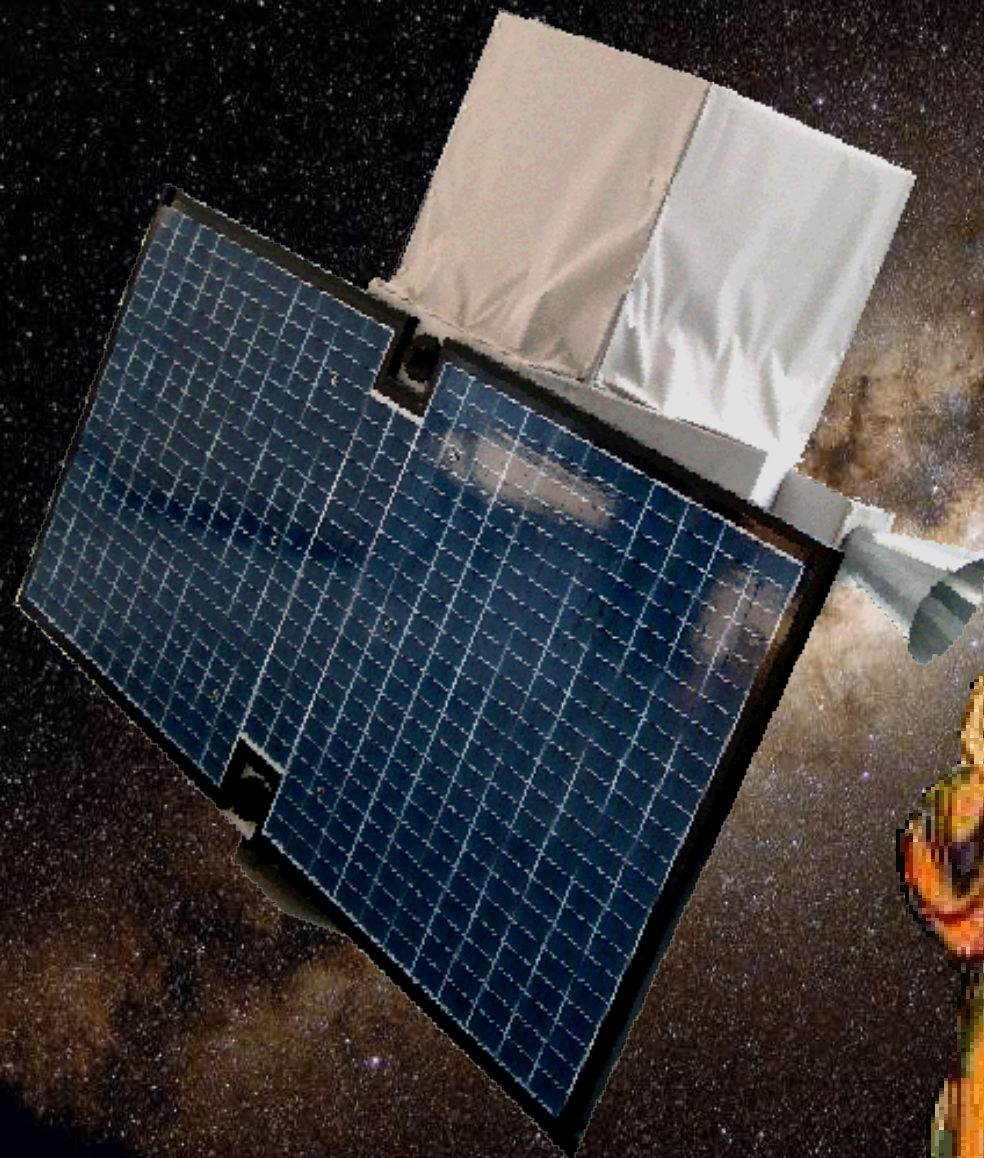


# Finalmente AGILE



**A. Giuliani**

**Astrosiesta**

**11/10/2007**

**S.Firmino**

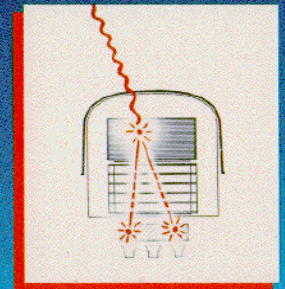
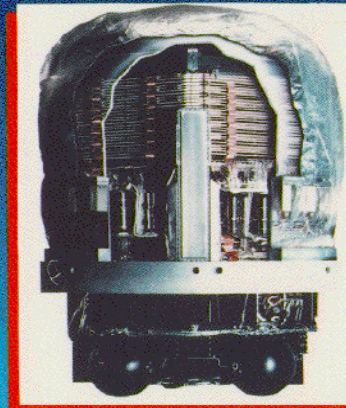


# C'era una volta...

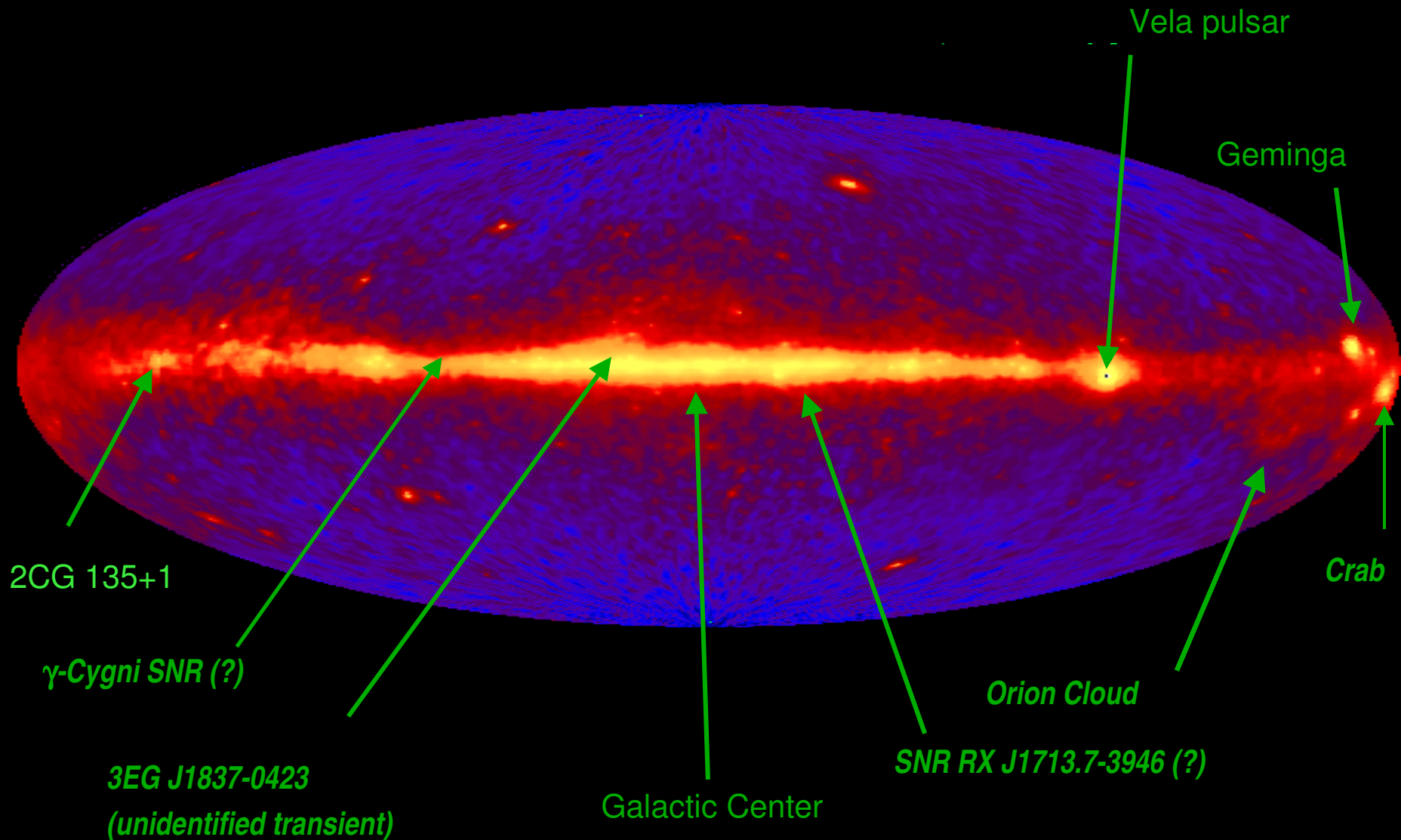


## ...EGRET

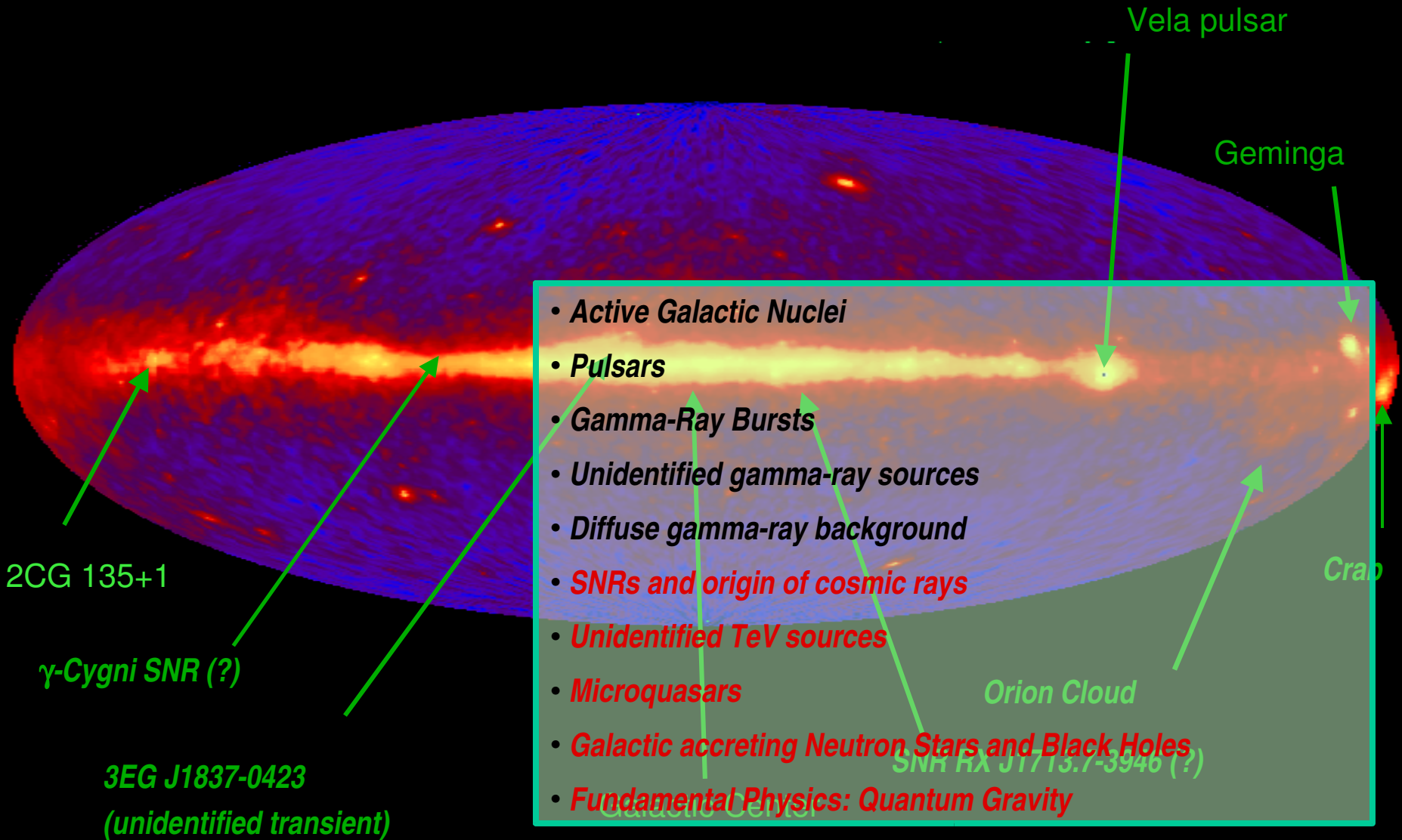
Energetic Gamma Ray Experiment  
Telescope (EGRET)




# The $\gamma$ -rays sky



# The $\gamma$ -rays sky



A 3D cutaway rendering of the AGILE satellite payload. The satellite is white and cylindrical, with a large gold-colored solar panel extending from its side. The top section is cut away, revealing internal components including a stack of detector modules and various electronic boards. The background is a dark blue space filled with stars and a bright purple and white star in the lower foreground.

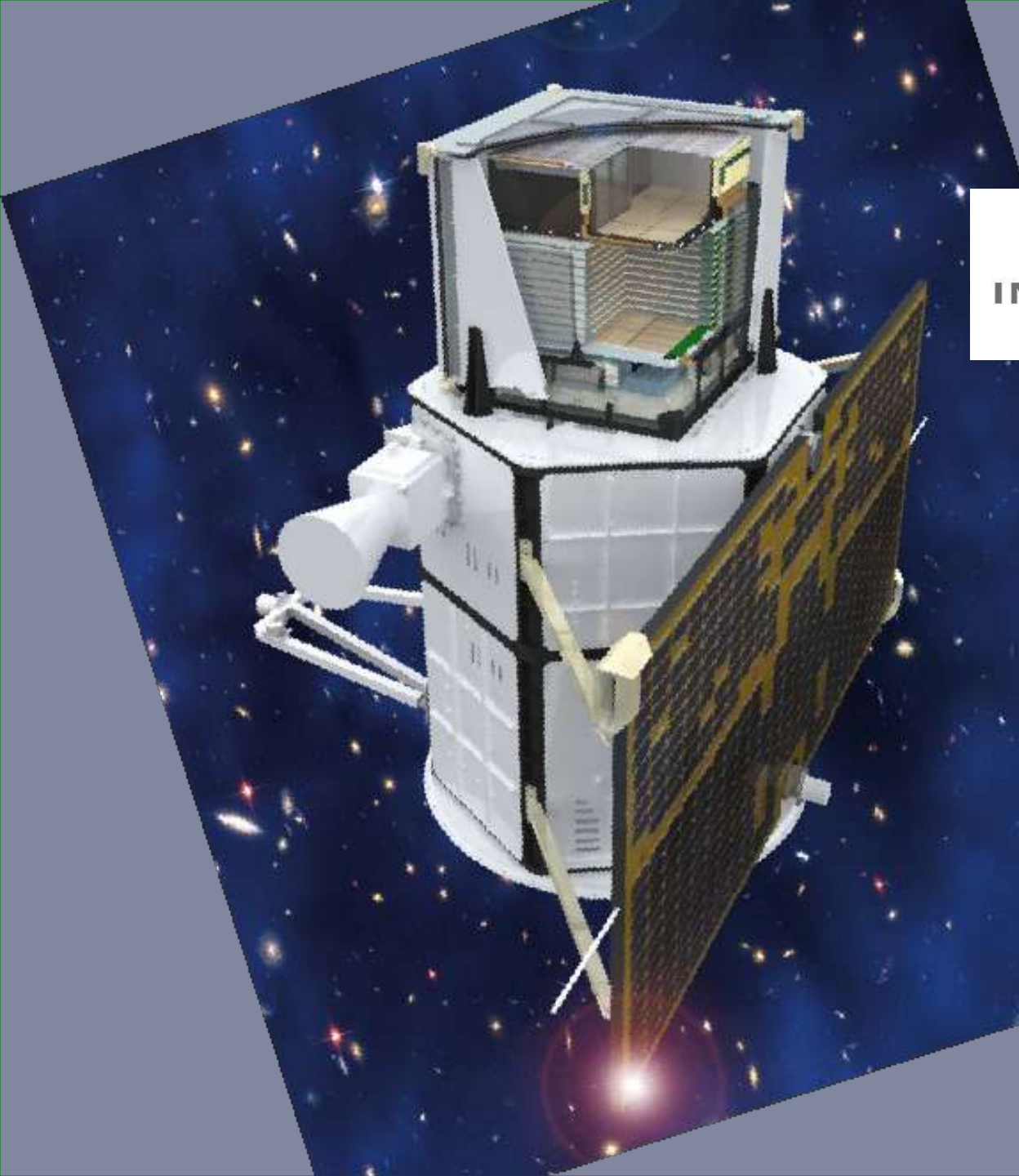
## The AGILE Payload: the most compact instrument for high-energy astrophysics

It combines for the first time a

**gamma-ray imager**  
(30 MeV- 30 GeV)

with a

**hard X-ray imager**  
(18-60 keV)





**The AGILE spinoffs:**

**Hexagonal bus  
(ideal for small  
fairings)**

**400 W power system**

**1-2 arcmin pointing  
resolution**

# AGILE: inside the cube...

**ANTICOINCIDENCE**  
**INAF-IASF-Mi (F.Perotti)**

**HARD X-RAY IMAGER**  
**(SUPER-AGILE)**

**INAF-IASF-Rm**  
**(E.Costa, M. Feroci)**

**GAMMA-RAY IMAGER**  
**SILICON TRACKER**

**INFN-Trieste**  
**(G.Barbiellini, M. Prest)**

**(MINI) CALORIMETER**  
**INAF-IASF-Bo, Thales-**  
**Alenia Space (LABEN)**

**(G. Di Cocco, C. Labanti)**





# Astrorivelatore Gamma a Immagini **LE**ggero

AGILE



**SuperAGILE :**

- **Ultra-light coded mask**
- **15 - 40 keV**

• **GRID instrument :**

- **Si tracker + CsI calorimeter**
- **30 MeV - 50 GeV**
- **Optimal PSF**
- **Large FOV (2.5 sr)**

**Scientific Instrument mass: 120 kg (!)**

# Astrorivelatore Gamma a Immagini **LE**ggero

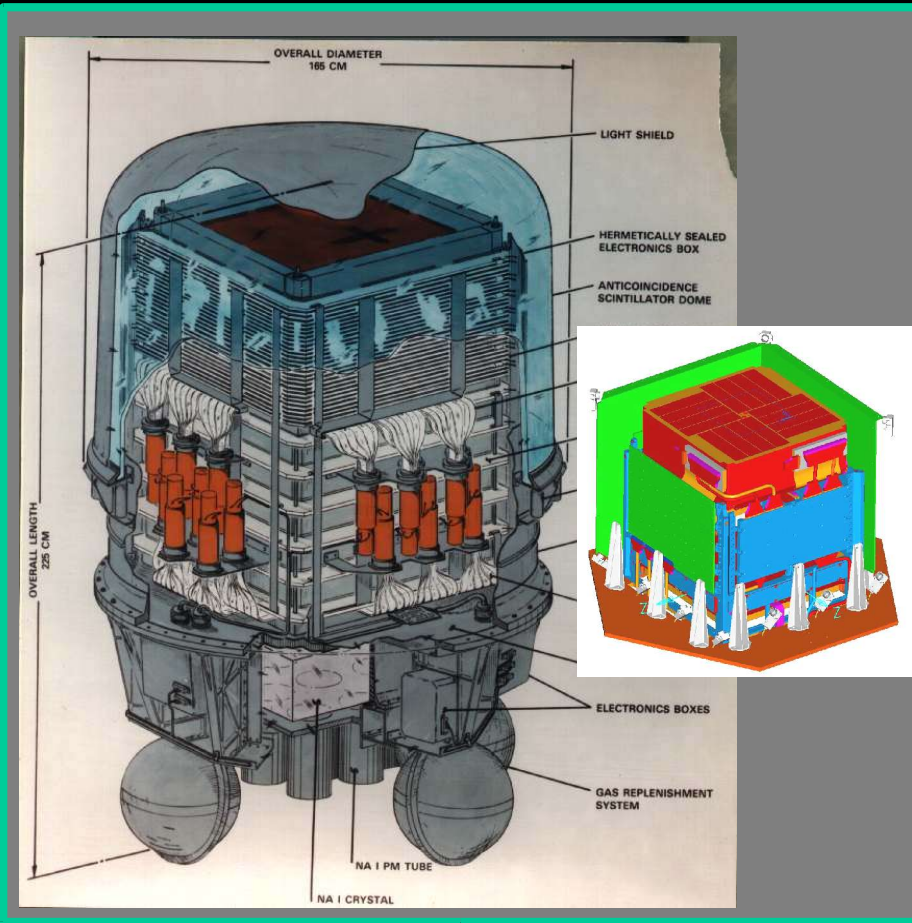
## *SuperAGILE :*

- *Ultra-light coded mask*
- *15 - 40 keV*

## *GRID instrument :*

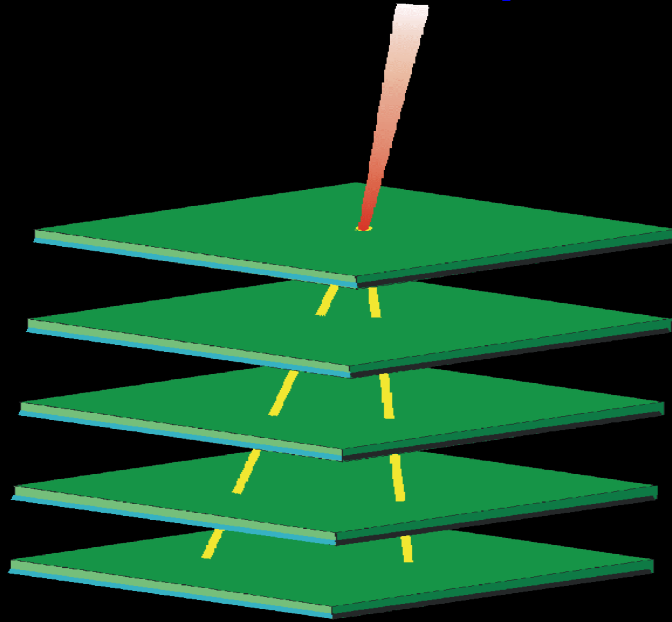
- *Si tracker + CsI calorimeter*
- *30 MeV - 50 GeV*
- *Optimal PSF*
- *Large FOV (2.5 sr)*

*Scientific Instrument mass: 120 kg (!)*



# Detection in pair production telescopes

$$\gamma \rightarrow e^+e^-$$

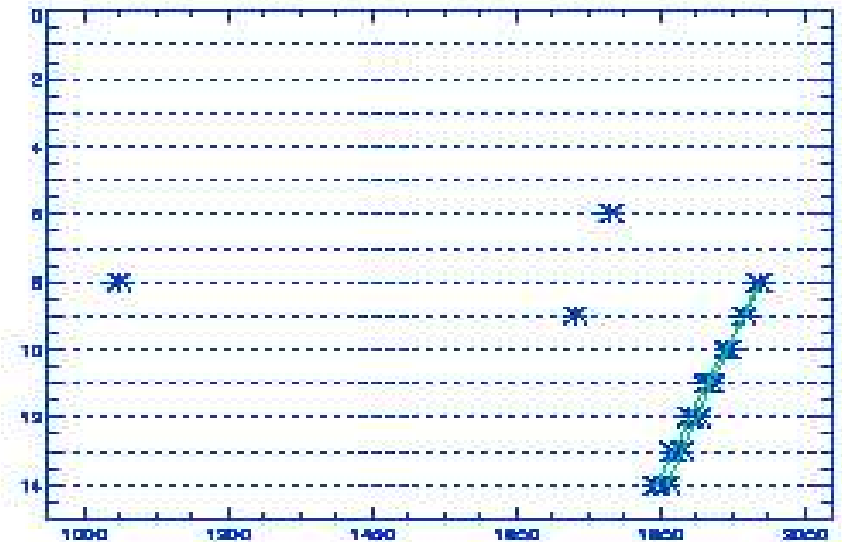
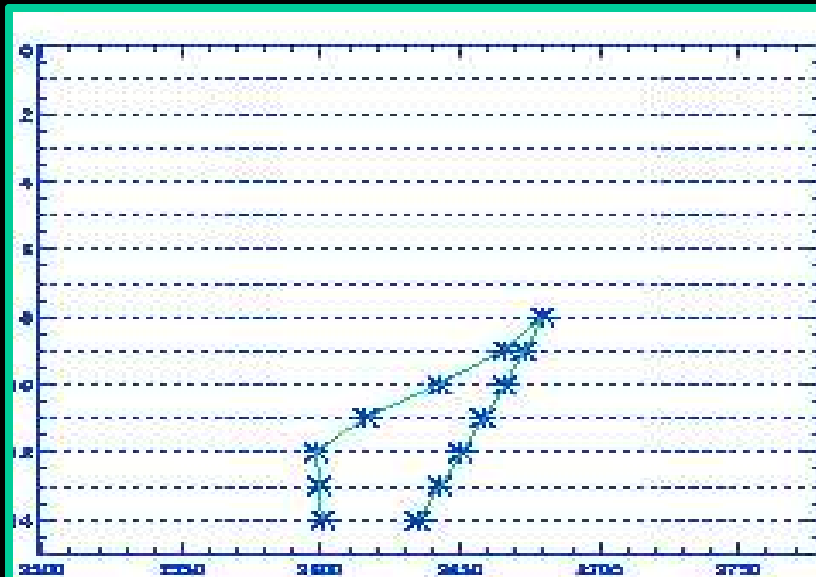


*but:*

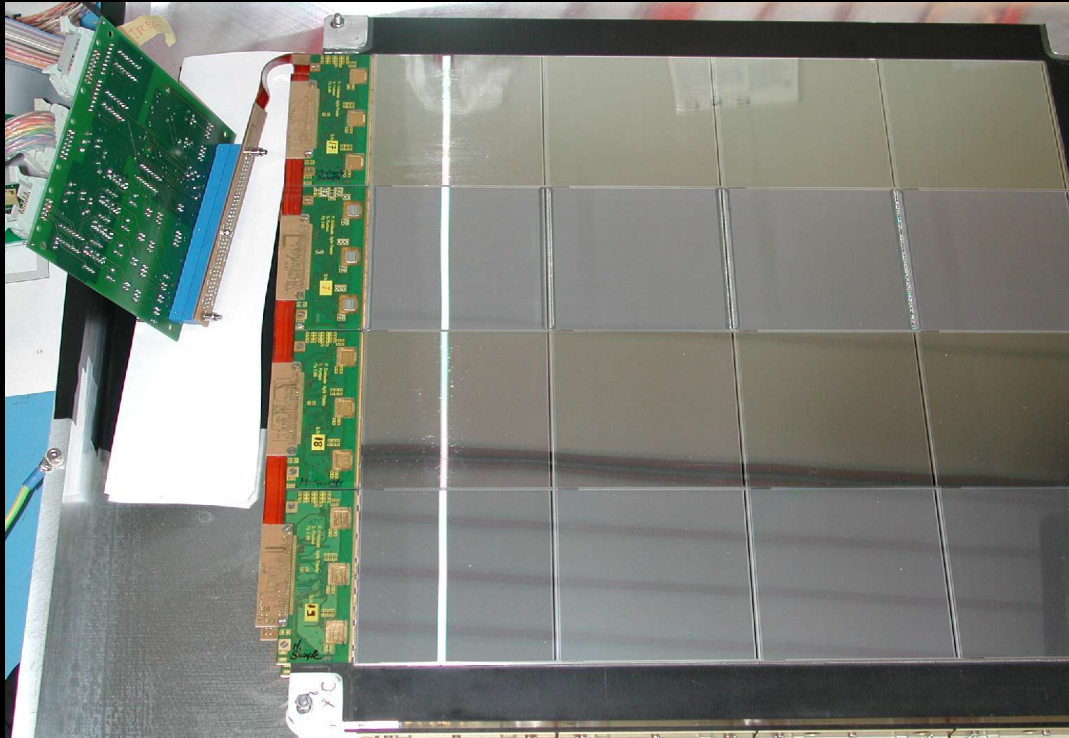
**Only projection information**

**Multiple Scattering**

**Noise hits**



# W-Si Tracker



The AGILE Silicon Tracker developed  
by **INFN Trieste**.

In the **MIPOT** laboratories before being  
delivered to **LABEN** on June 30, 2005.

2 planes with :

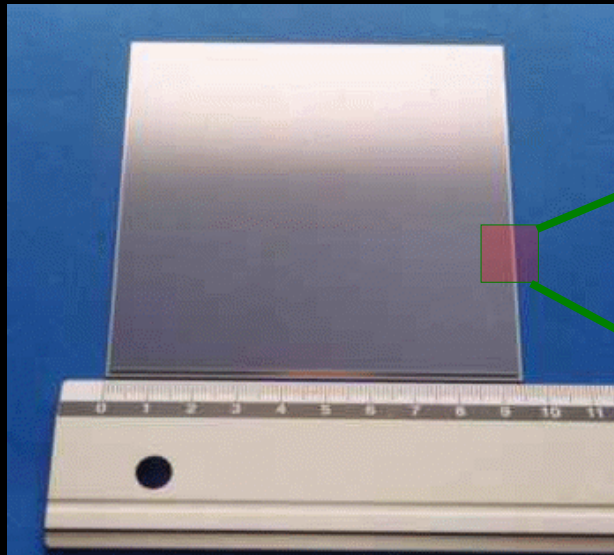
W converter ( **$0.07 X_0$** )

Si microstrip (pitch  
 **$121 \mu\text{m}$** )

Spatial Resolution:  **$40$**   
 **$\mu\text{m}$**

Total thickness:  **$0.8 X_0$**

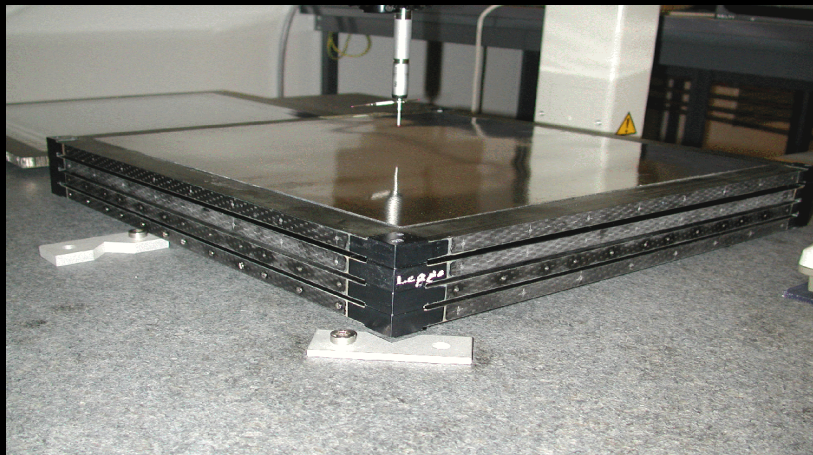
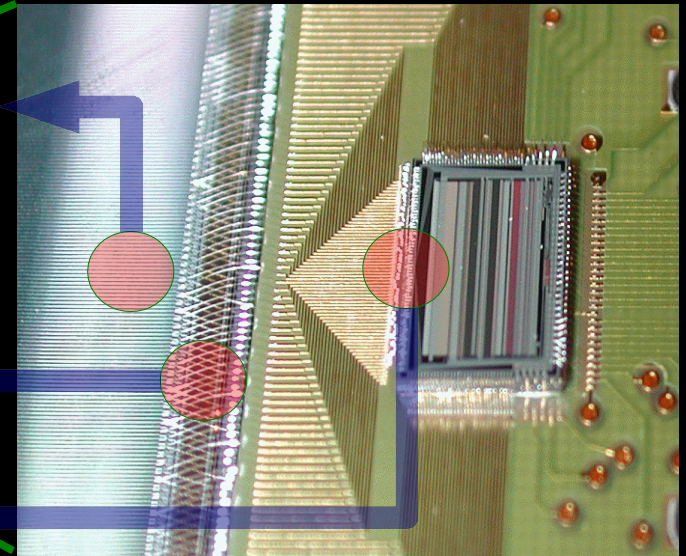
# Tracciatore al silicio



$\mu$ -strip di silicio

Bonding

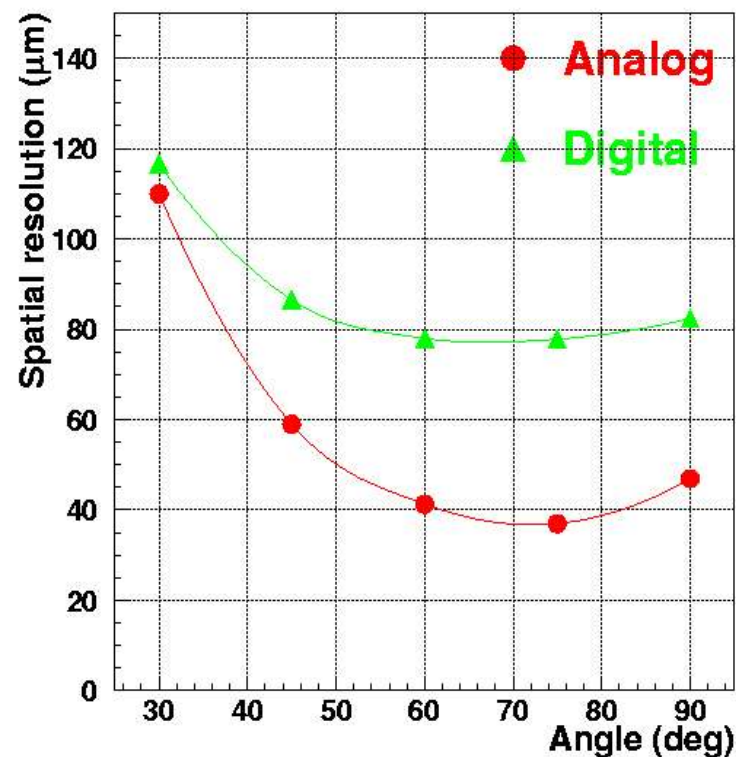
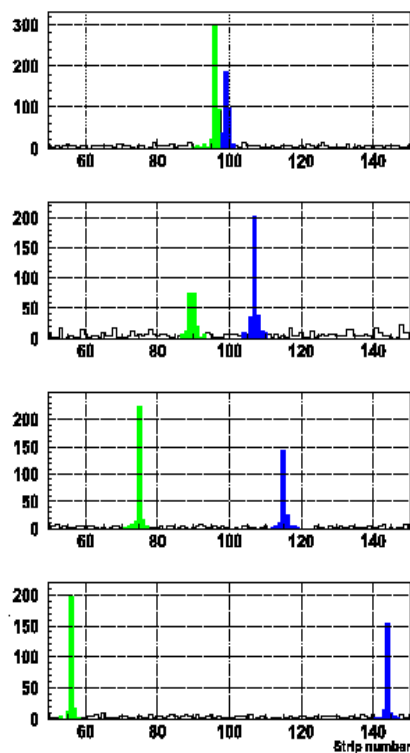
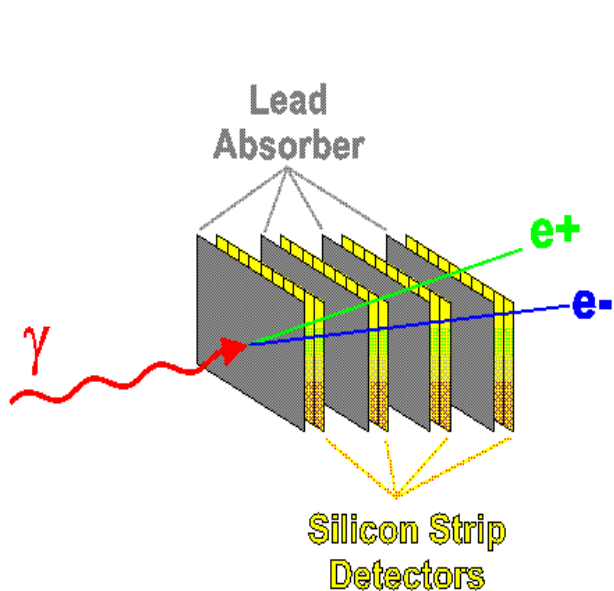
Elettronica di lettura



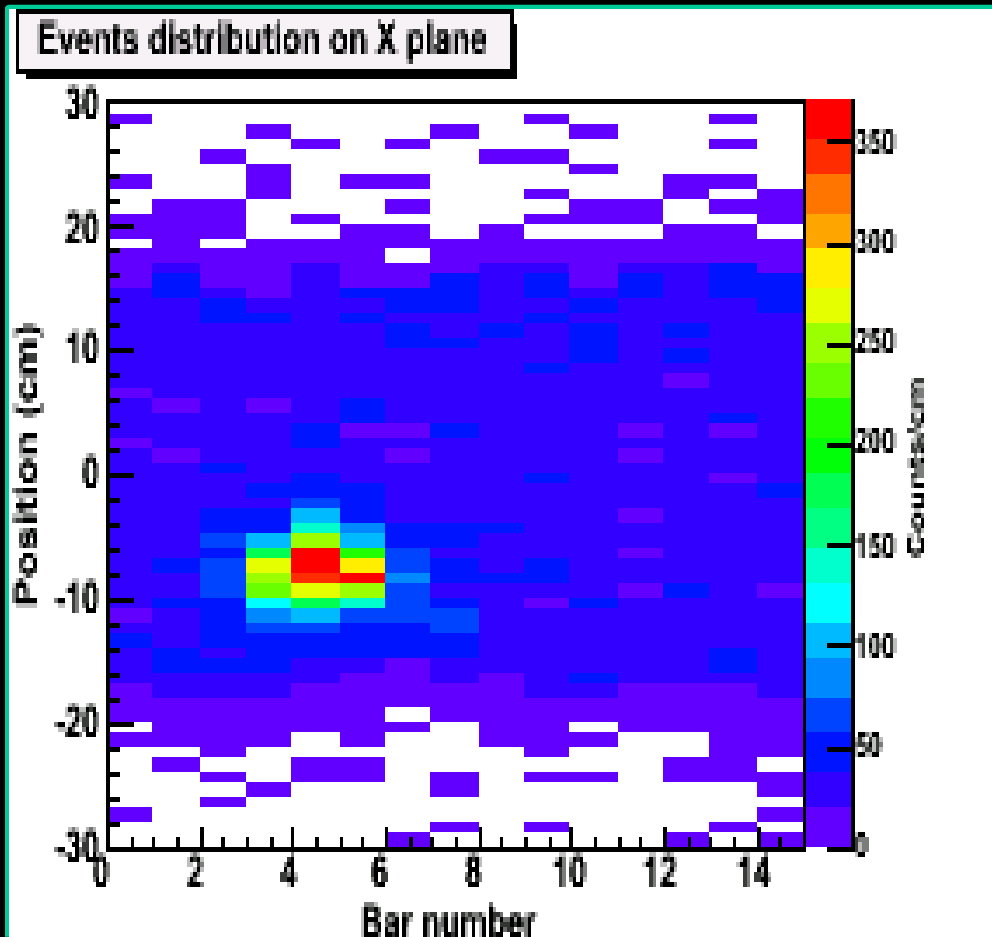
Prototipo meccanico di "vassoio" (struttura meccanica, convertitore e rivelatore)

# Tracciatore al silicio

## Risultati test-beam al CERN



# MiniCalorimetro



*The AGILE MiniCalorimetro developed by IASF  
Bologna (INAF) and LABEN.*

*Thickness :  $1.5 X_0$*

*30 **CsI** bars on 2 layers,  
60 readout channels*

*Energy range : **300 keV – 100 MeV**  
(GRID mode)*

*Energy resolution : **13%** @ 1 MeV  
(single bar)*

*Independent **GRB** search*

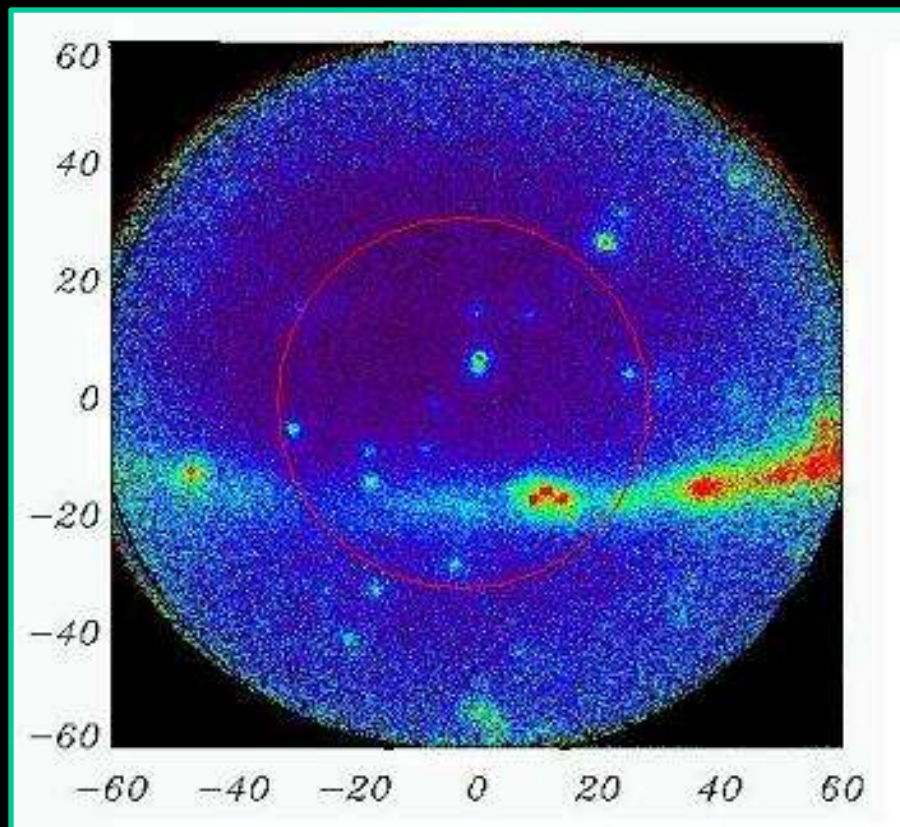
*Effective area : **400 cm<sup>2</sup>***

*Energy range : **400 KeV -10 MeV***

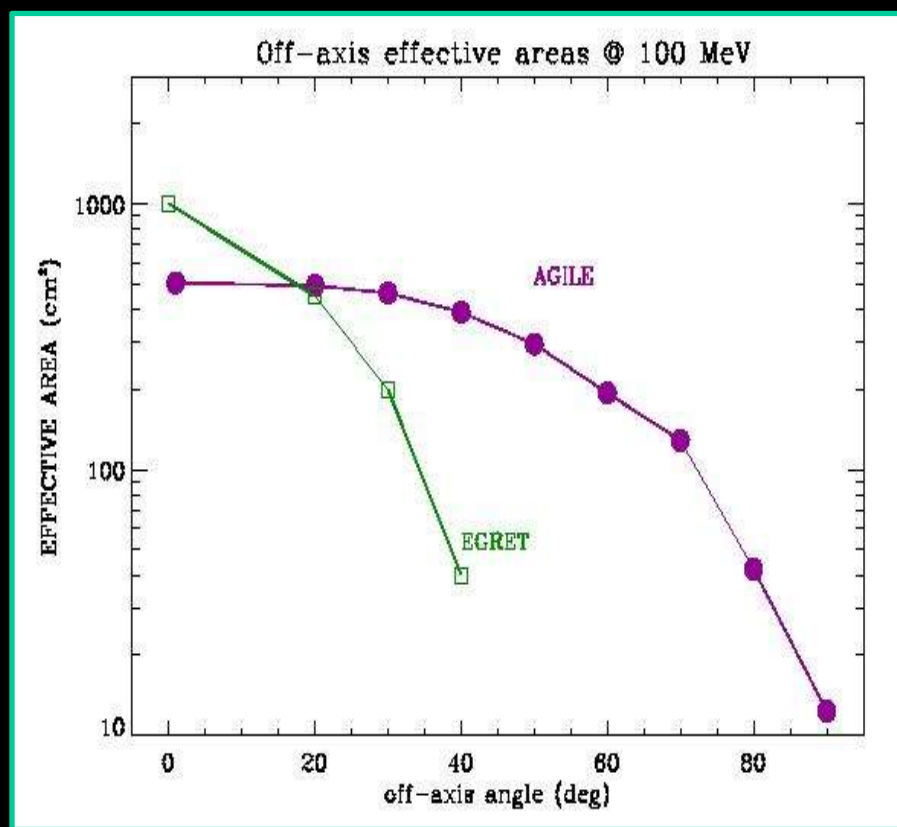
*Field of View :  **$4 \pi$  sr***

# GRID performances: field of view

*Field of view:  $\sim 3$  sr*

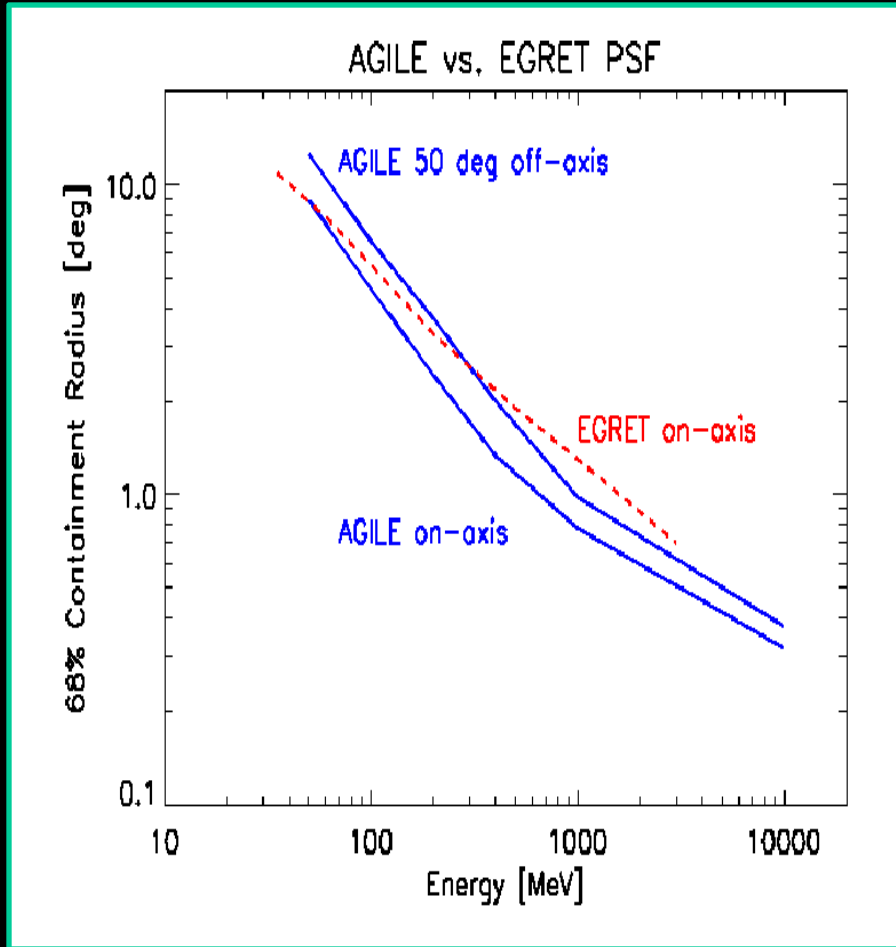


*Off-axis Effective Area*

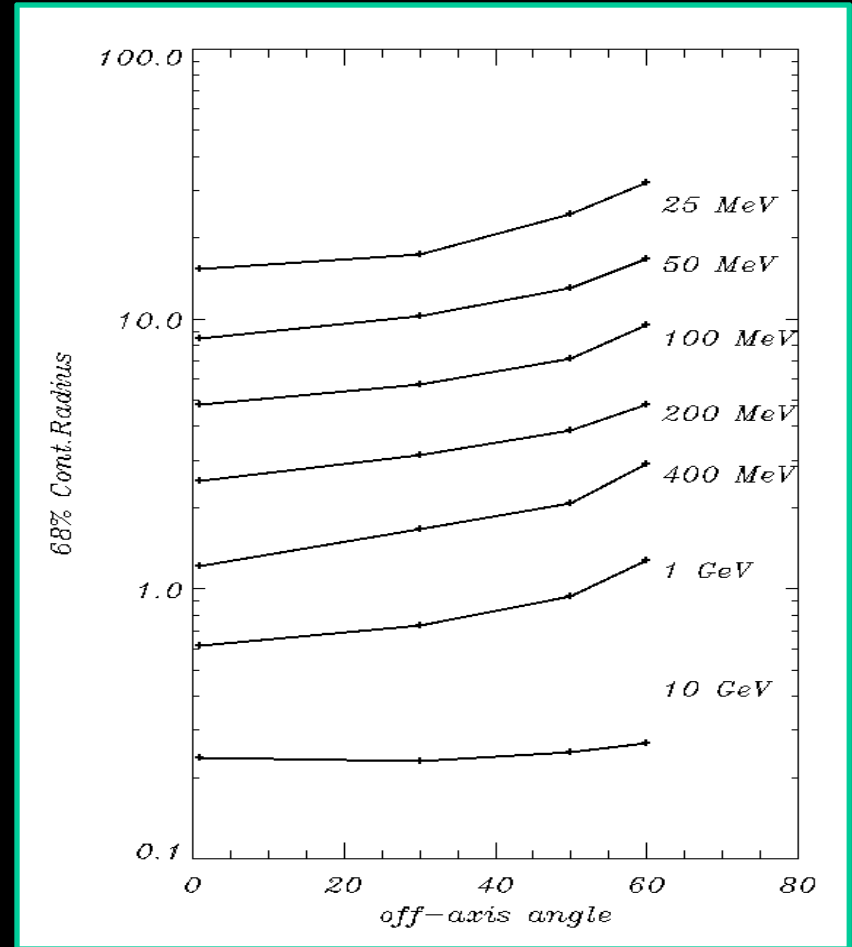




# GRID performances: Angular resolution



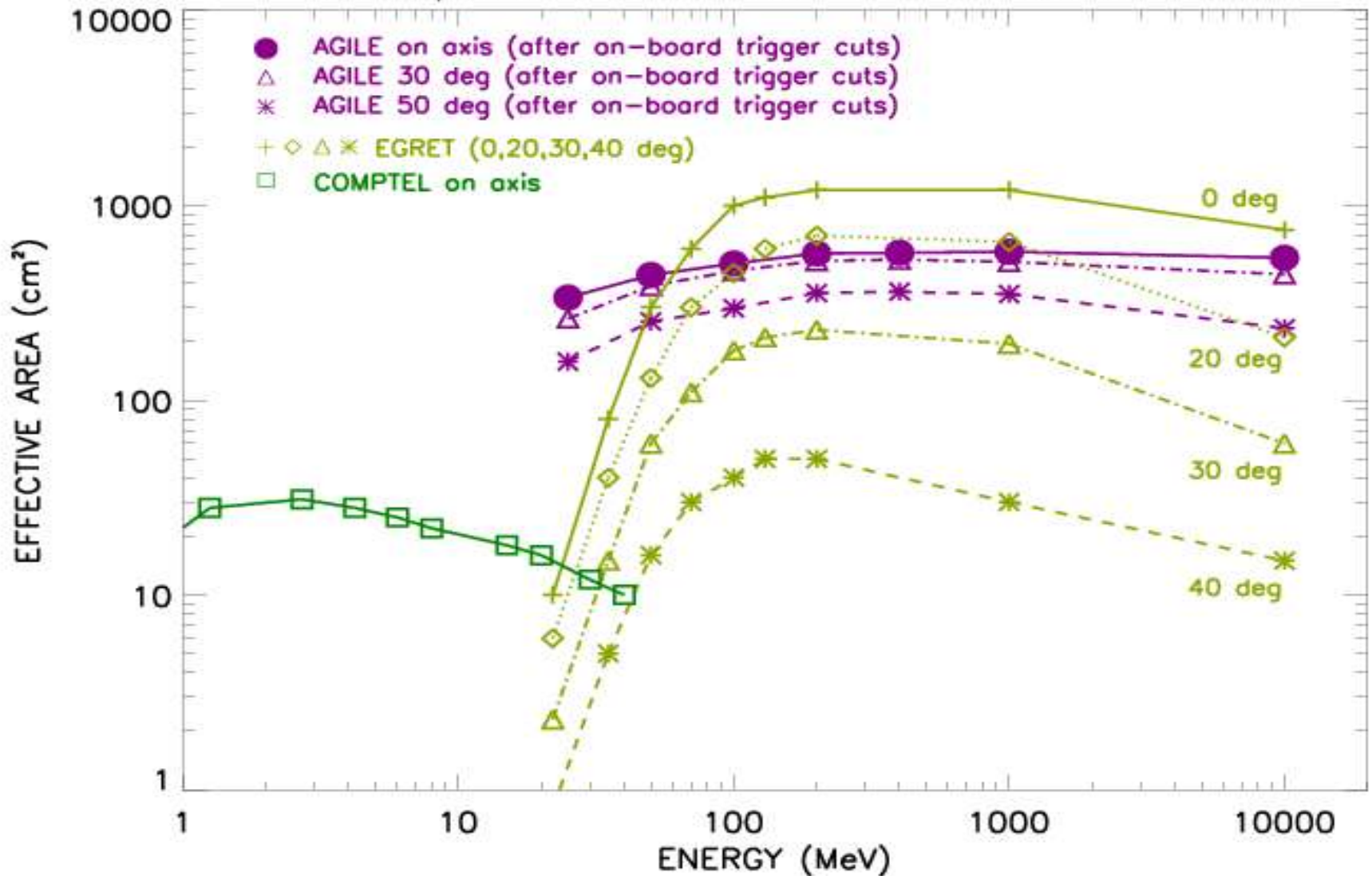
*2 times better than EGRET*



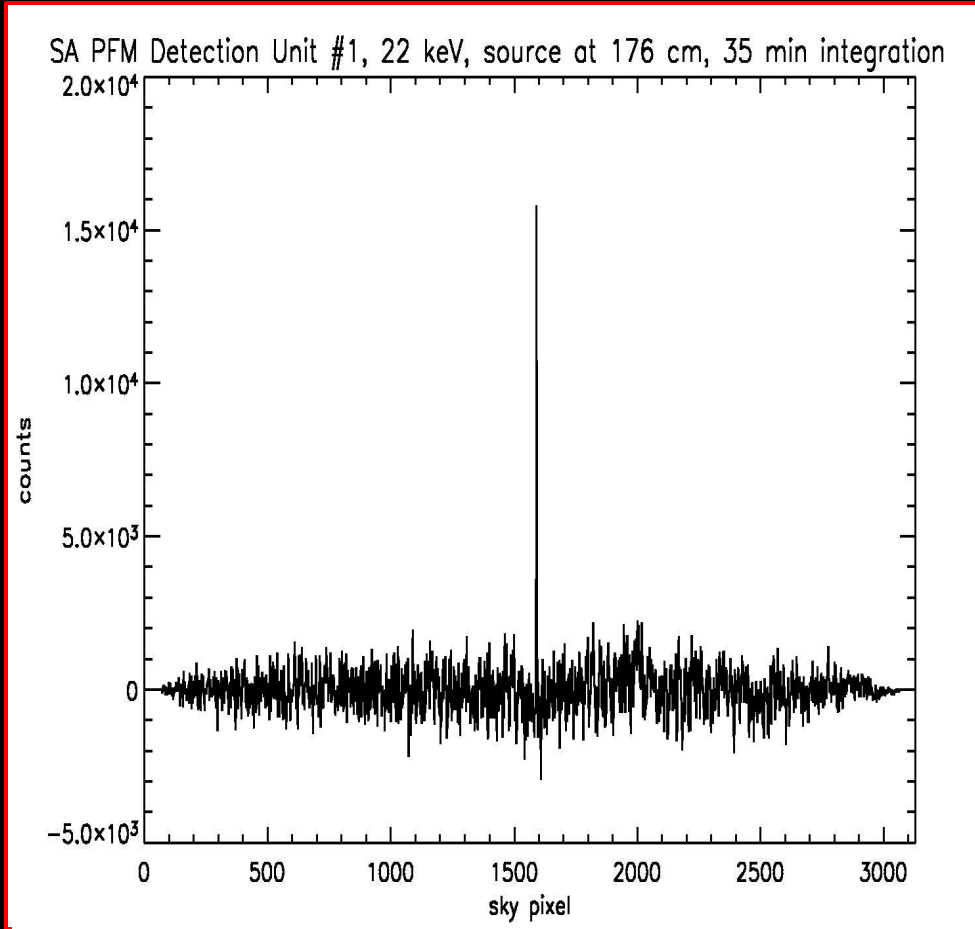
*Weak dependence on off-axis angle*

# GRID Effective Area

## AGILE, EGRET & COMPTEL EFFECTIVE AREAS



# SuperAGILE



**SuperAGILE developed by IASF Roma (INAF).**

**Detector : 410 um Silicon microstrips,  
121  $\mu\text{m}$  pitch, 1D position sensitive**

**Energy range : 15 – 40 keV**

**Geometric Area : 1444 cm<sup>2</sup>**

**Effective Area : ~300 cm<sup>2</sup> (on axis, 13  
keV)**

**Energy Resolution : 7-8 keV**

**Angular Resolution : 6 arcmin**

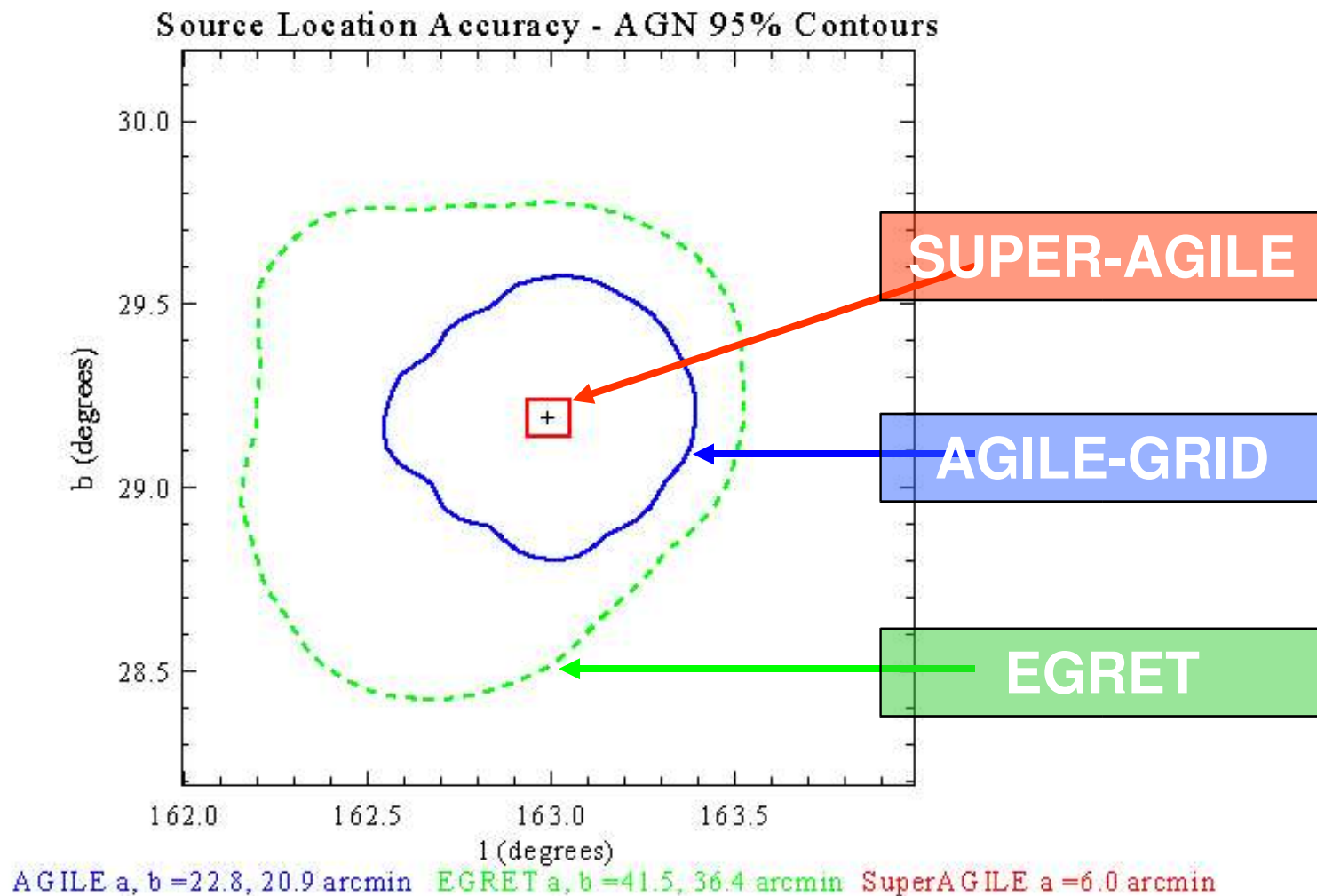
**Source location Accuracy : 1.5 arcmin for  
bright sources**

**FOV : 2x(107x68) deg<sup>2</sup> FWZR**

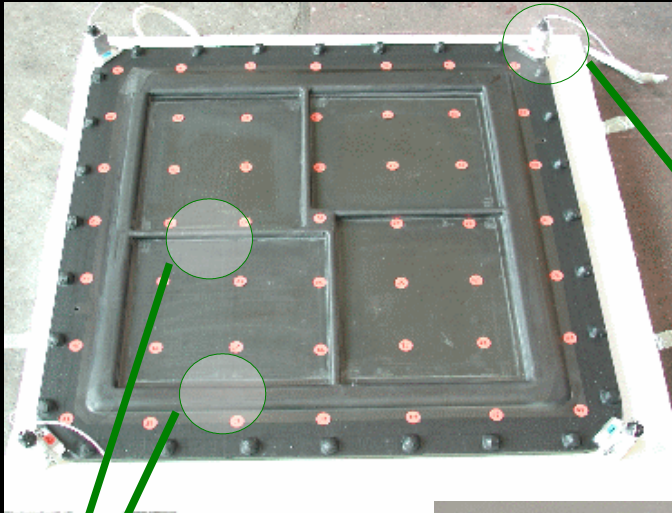
**Timing Accuracy : ~5 $\mu\text{s}$**

**Sensitivity : ~12 mCrab (50ks, on axis)**

# Gamma-ray source positioning (example: off-axis AGN)

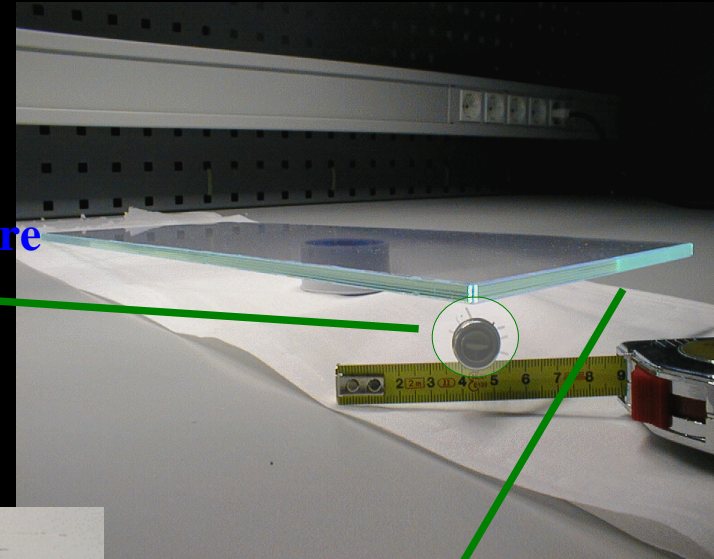


# Il sistema di anticoincidenza (2)

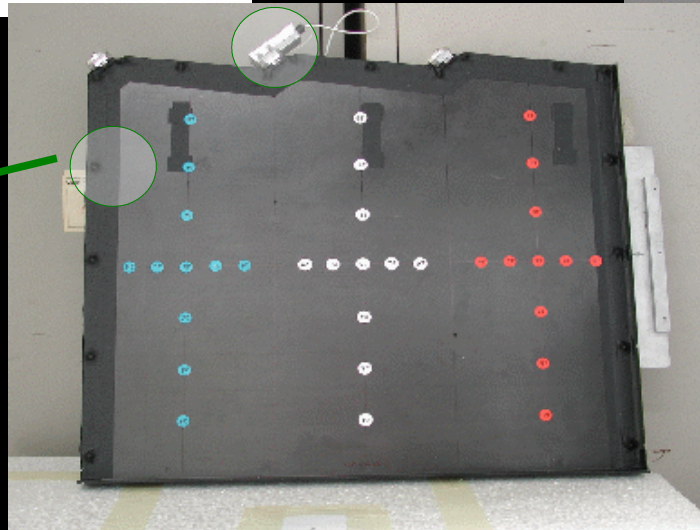


Fibra di carbonio  
(strutturale)

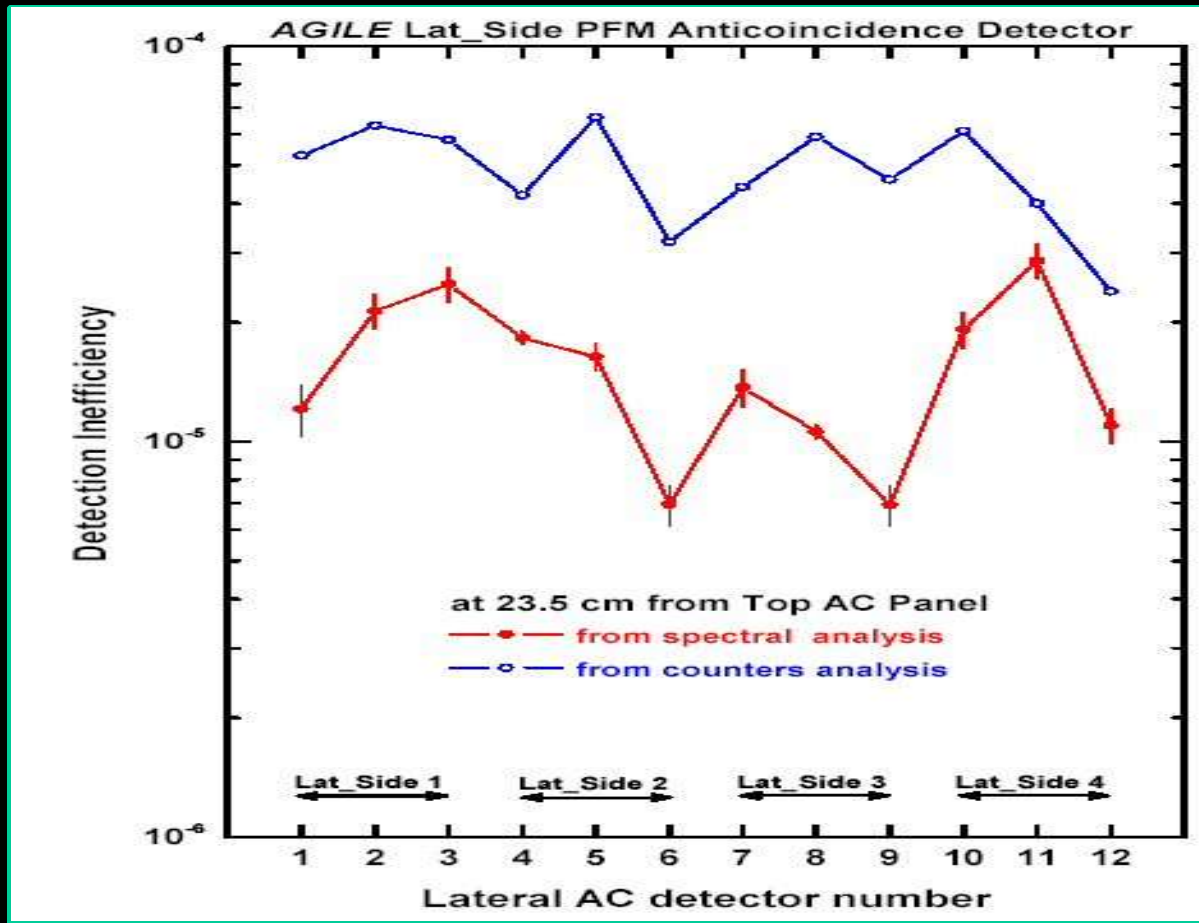
Fotomoltiplicatore  
(attivo)



Scintillatore plastico con  
fibre ottiche per lo shift  
in lunghezza d'onda  
(attivo)



# Anticoincidence System



*The AGILE Anticoincidence System developed by IASF Milano (INAF) during the vibration test campaign (January 2005).*

# AGILE test sequence & calib. data

3-Nov-05	21-Nov-05	INFN Frascati	Calibraz GRID	2000	2578	578
<b>2006</b>						
9-Jan-06	11-Feb-06	IABG	IPL AIV	3501	4594	1093
15-20 Feb. 06		ITAR crisis				
				10200	10606	406
30-May-06	26-Jul-06	IABG	SAT Env test	10611	11304	693
				11400	11741	341
20-Sep-06	5-Nov-06	ITAR change				
				11800	11952	152
<b>2007</b>						
27-Jan-07	6-Mar-07	IABG	SAT Env test	11300	13647	2347

Runs # > 10000  
with sat EGSE+SC

# Il Tracker

estate 2005





Laben (Milano)

autunno 2005



# Laben (Milano)

30 ottobre 2005

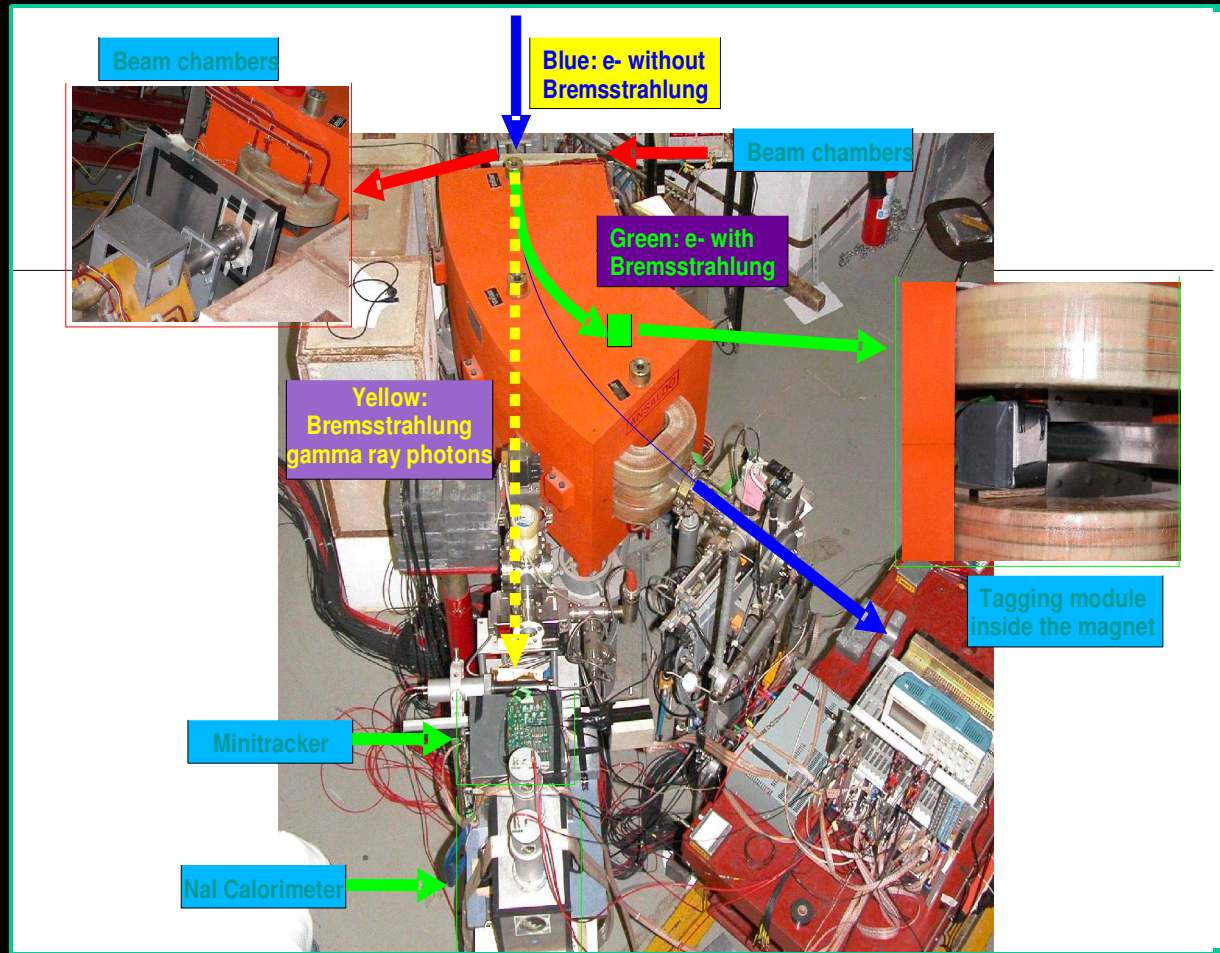


# AGILE Scientific Calibration

AGILE  
 $\gamma$ -ray calibration

Laboratori  
Nazionali  
Frascati

(November 2005)  
BTF facility



# *Beam Test Facility*

(November 2005)



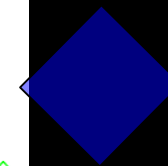
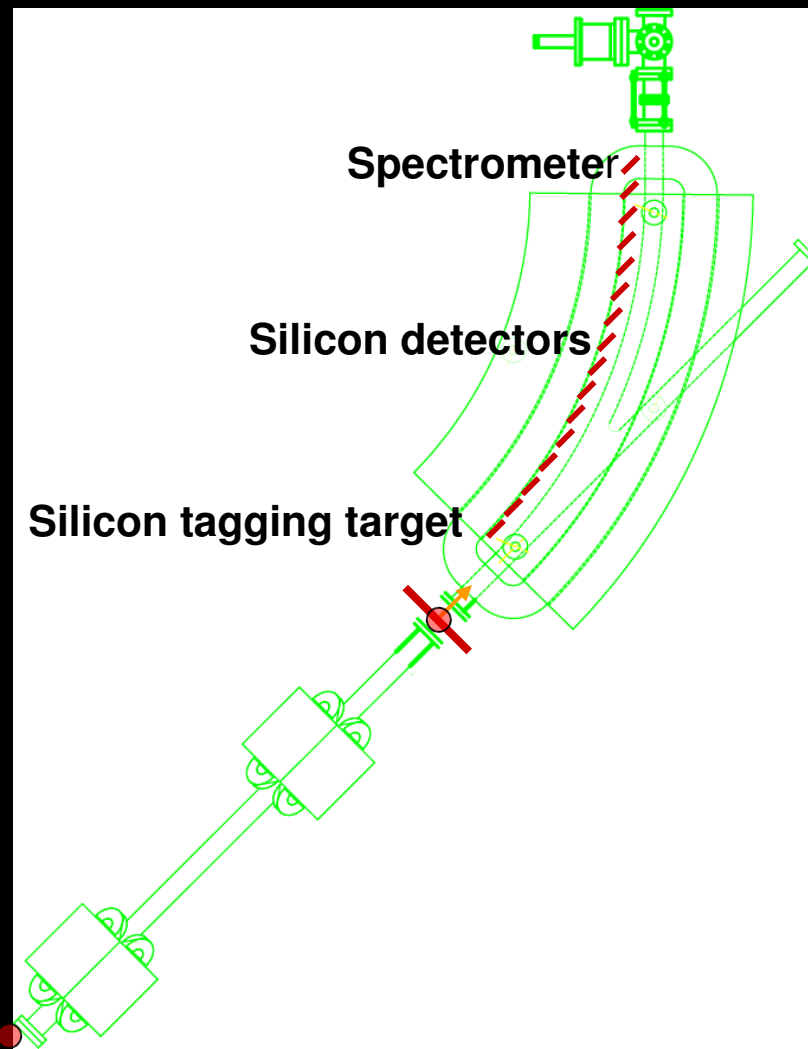
# The DAΦNE Beam Test Facility & AGILE Calibration (November 2005)



*BTF webcam live view*

# INFN-LNF-BTF Photon-Tagged Source AGILE GRID Photon Calibration

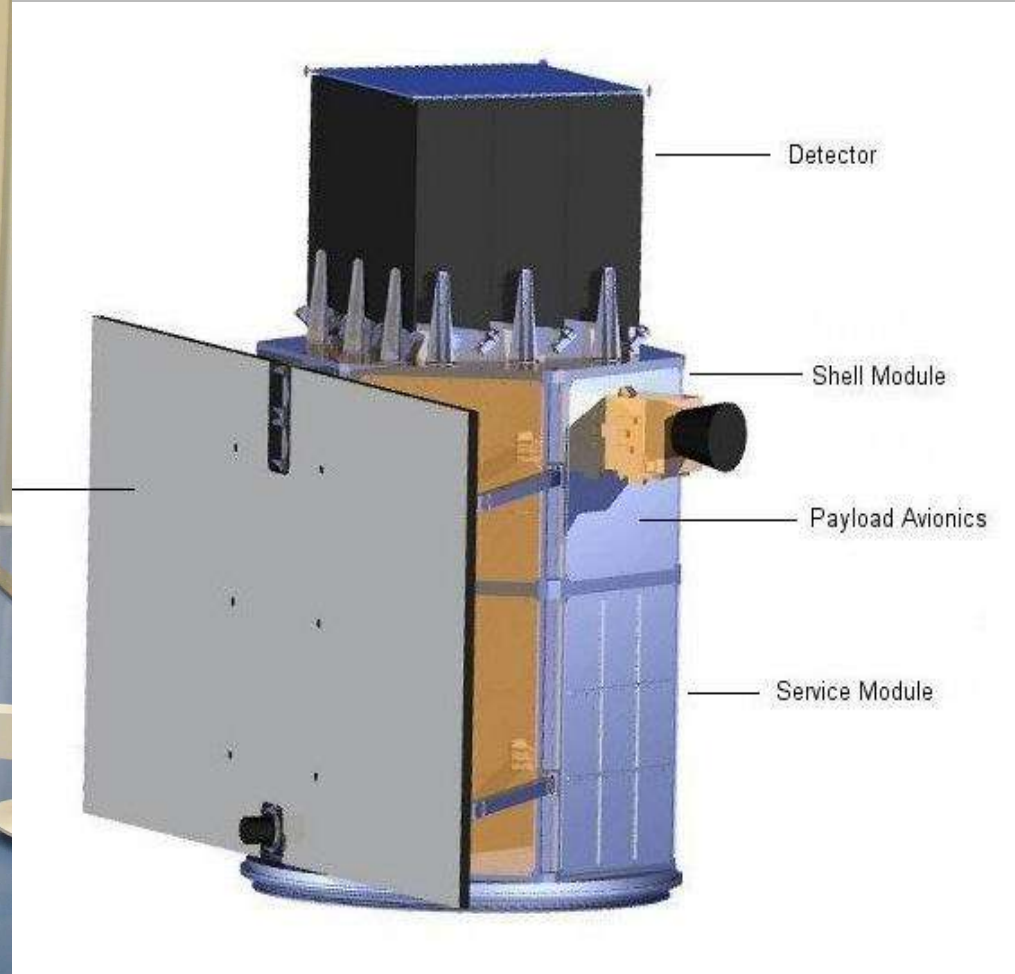
*The AGILE Gamma Ray Imaging Detector calibration at BTF is aimed at obtaining data for all relevant geometries and background conditions. BTF can provide data in the energy range (30-700 MeV)*



**AGILE  
Payload**

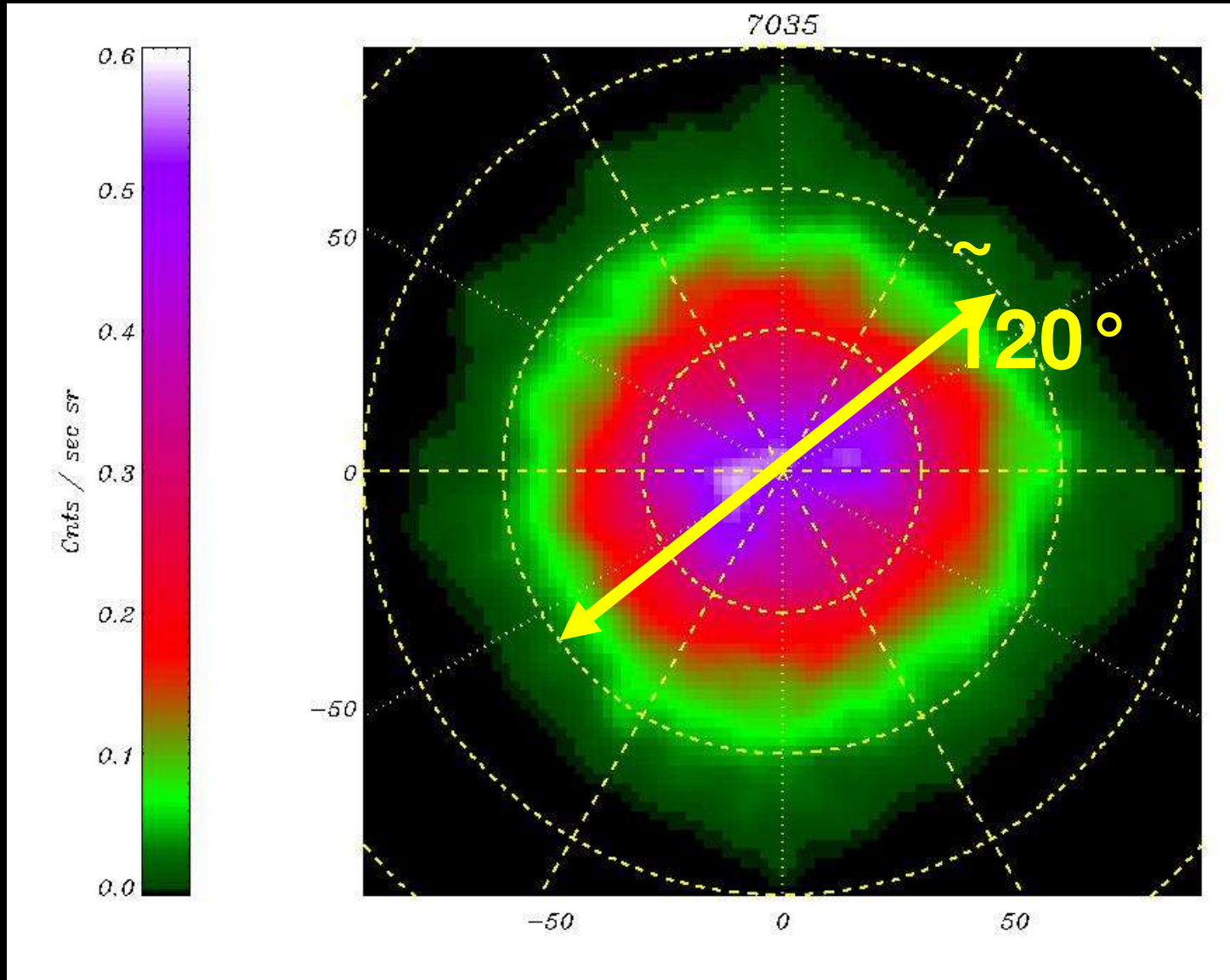
*BTF-AGILE Schedule  
photon tagging system (PTS)  
spectrometer PTS calibration  
final equipment test (Oct.)  
AGILE calibration,  
2-3 weeks of data collection*

*We are ready !*



AGILE Satellite Flight Model  
(CGS, Tortona, mid-December 2005)

# AGILE detection of the natural $\gamma$ -ray background (Tortona, 2006)





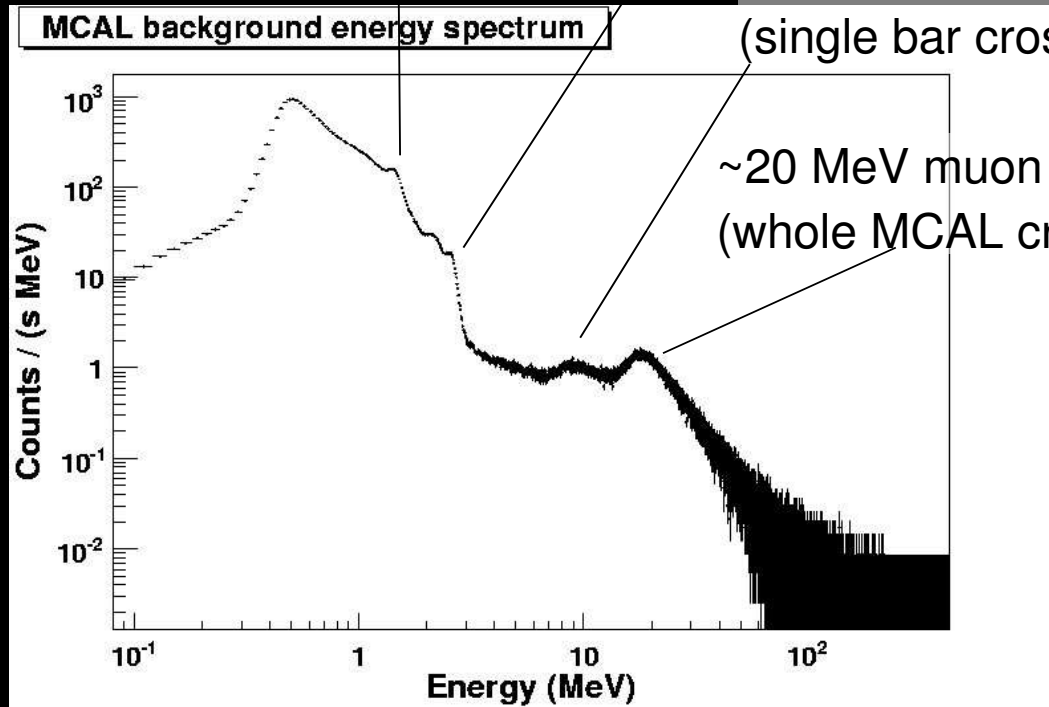
# MCAL Spectra

1.46 MeV  $^{40}\text{K}$  photopeak

2.61 MeV  $^{208}\text{Bi}$  photopeak  
( $^{232}\text{Th}$  serie)

$\sim 10$  MeV muon peak  
(single bar crossed)

$\sim 20$  MeV muon peak  
(whole MCAL crossed)



$\Delta E/E = 13\%$  FWHM at  
1.275 keV

$\sigma_x = 1.8$  cm at 1.275  
keV

Background MCAL spectrum  
obtained in Tortona, Italy, at  
Integrated Payload level

# *We are ready !*



# I A B G (Munchehen)

primavera 2007

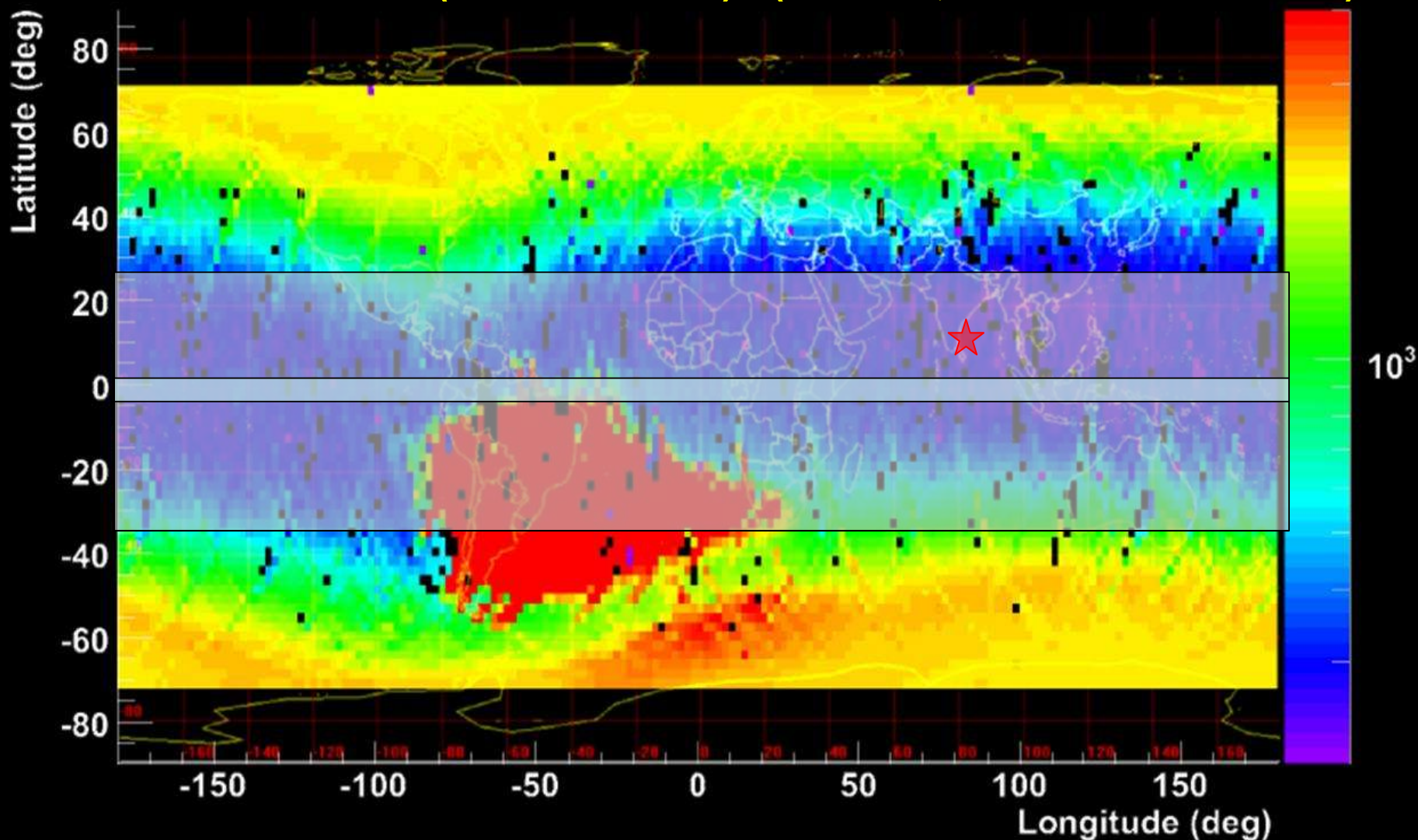


## The AGILE launch campaign (April, 2007)

- Leaving Munich on March 25, 2007
- Arriving in Chennai (India) on March 30, 2007
- **Arriving in Sriharikota on March 30th.**
- Functional tests in clean room (April 1-10).
- Integration on PSLV-C8 rocket (April 11-16)
- Final functional tests (April 17)
- “Coconuts ceremony”, PSLV on launch pad (April 19)
- Launch preparation (April 19-23)
- Countdown (April 22-23)
- **Liftoff (April 23)**

(S11\*S12) [hit/time]

**PAMELA first results on low-energy cosmic rays  
(h=400-500 km) (Picozza, Casolino et al. 2006)**

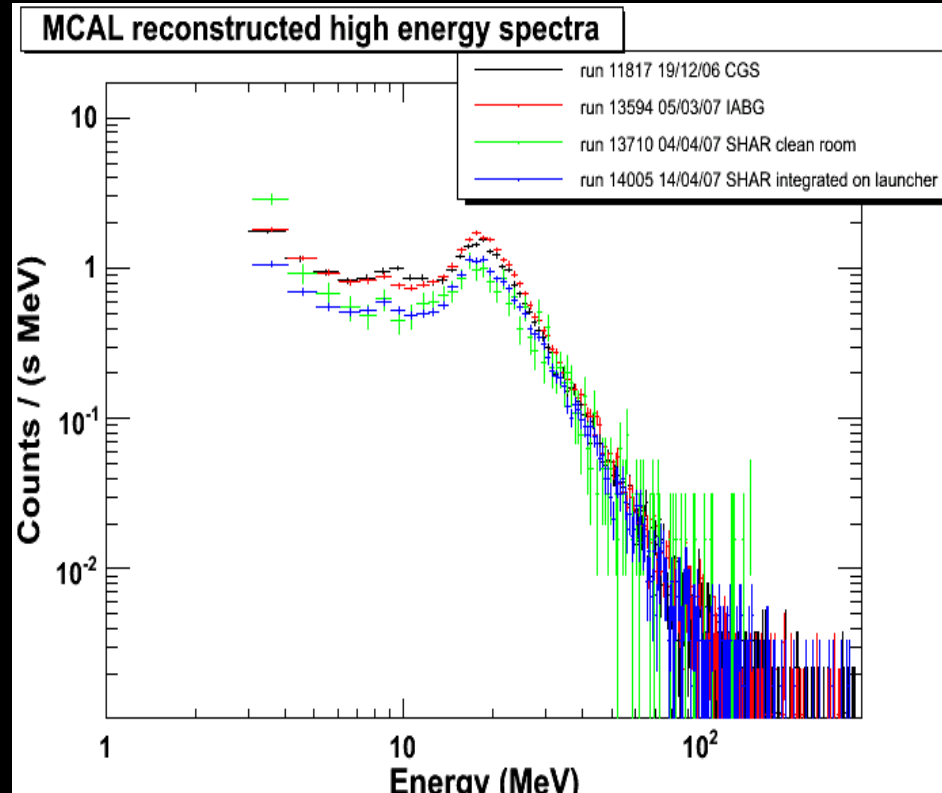
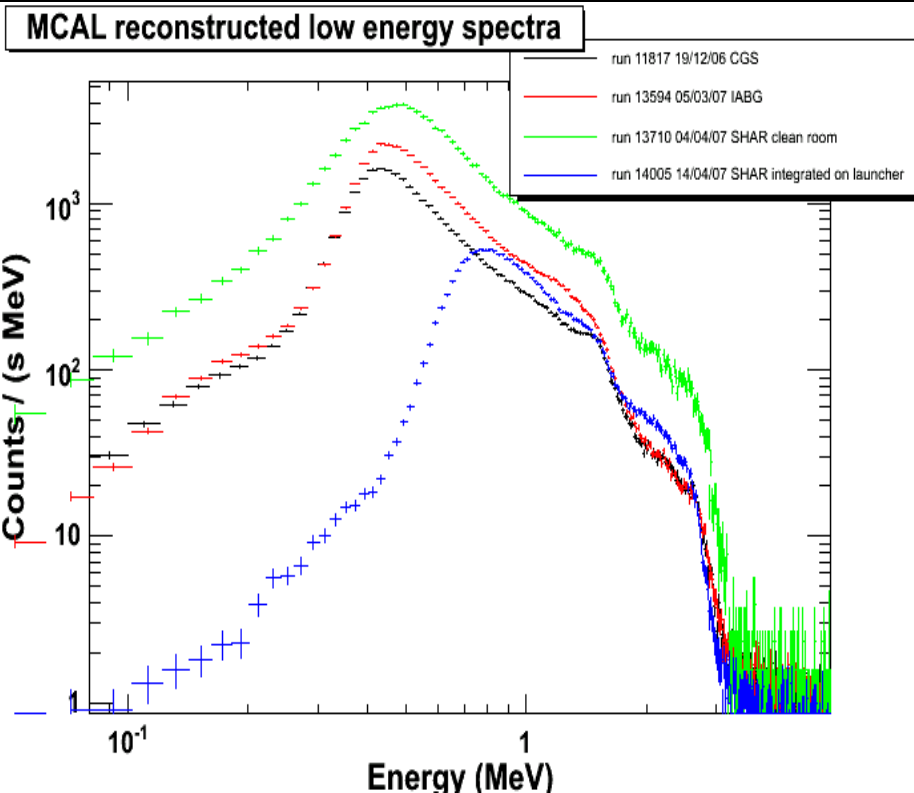


**36 MeV p, 3.5 MeV e-**





# Background Measurements on Earth...



Background count spectra measured by MCAL in four different locations: Tortona (Italy), Munchen (Germany), SHAR (India) in the clean room, SHAR (India) after integration on launcher.

The blue curve is the last MCAL spectrum taken on Earth...







## ISRO Goes Global

India's smaller rocket  
PSLV to loft 352kg  
satellite AGILE  
from Sriharikota

24x7

MY NEWS galore: No Honking Please! ● MY 7: Sania Speak: Ba

Hotel mgt degree(AICTE)& paid internship at  
Switzerland. CALL9933049428

LIVE  
Sriharikota



School of  
Hotel  
Management

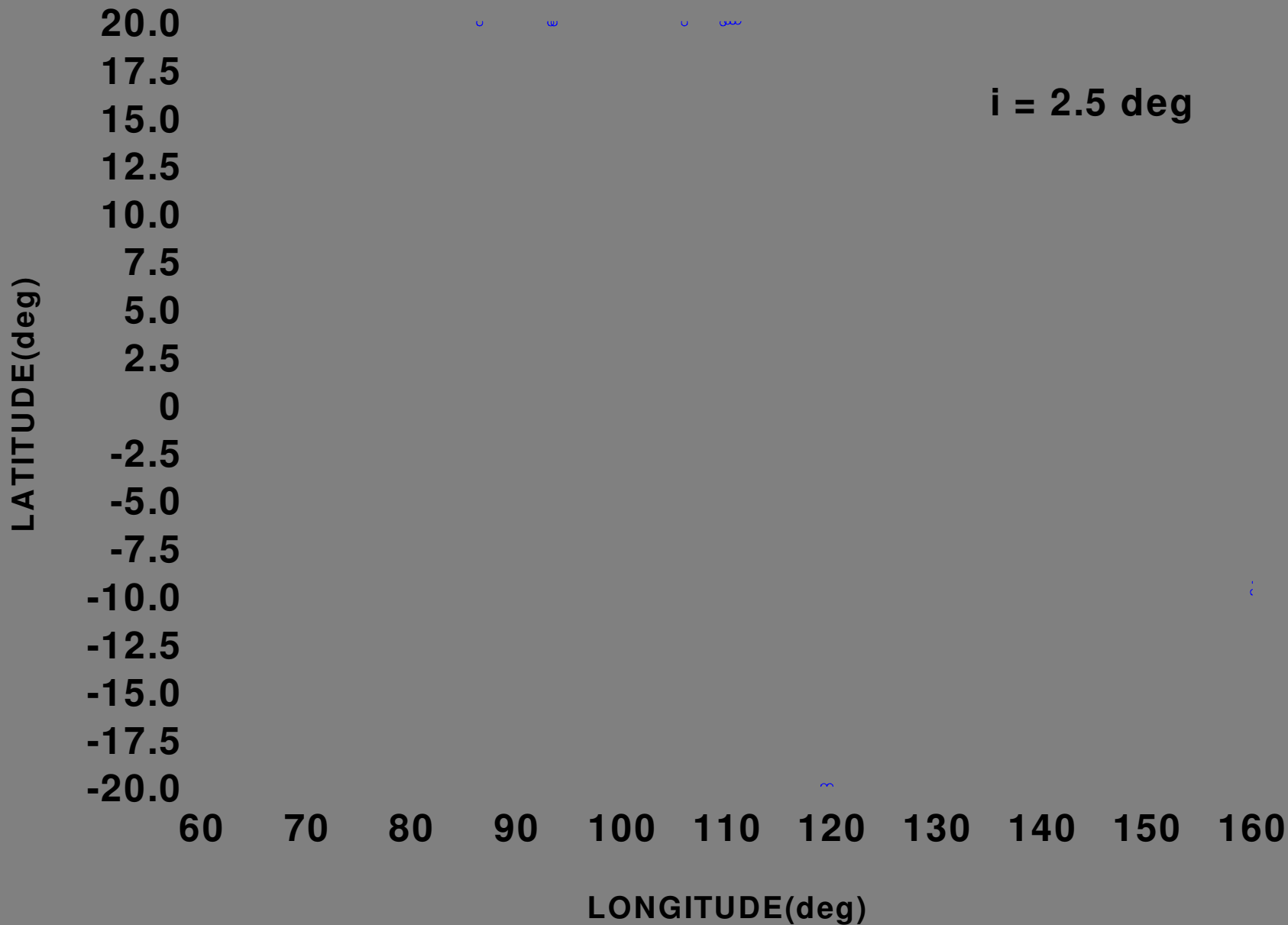
# Orbital requirements for AGILE

**Low-Earth Orbit,  $h = 550$  km**

**Quasi equatorial,  $\alpha < 3^\circ$**

- **minimize particle background**
- **use of the ASI Malindi ground station**

# PSLV C8:



# AGILE orbital parameters

**Semi-major axis: 6922.5 km ( $\pm 0.1$  km)**

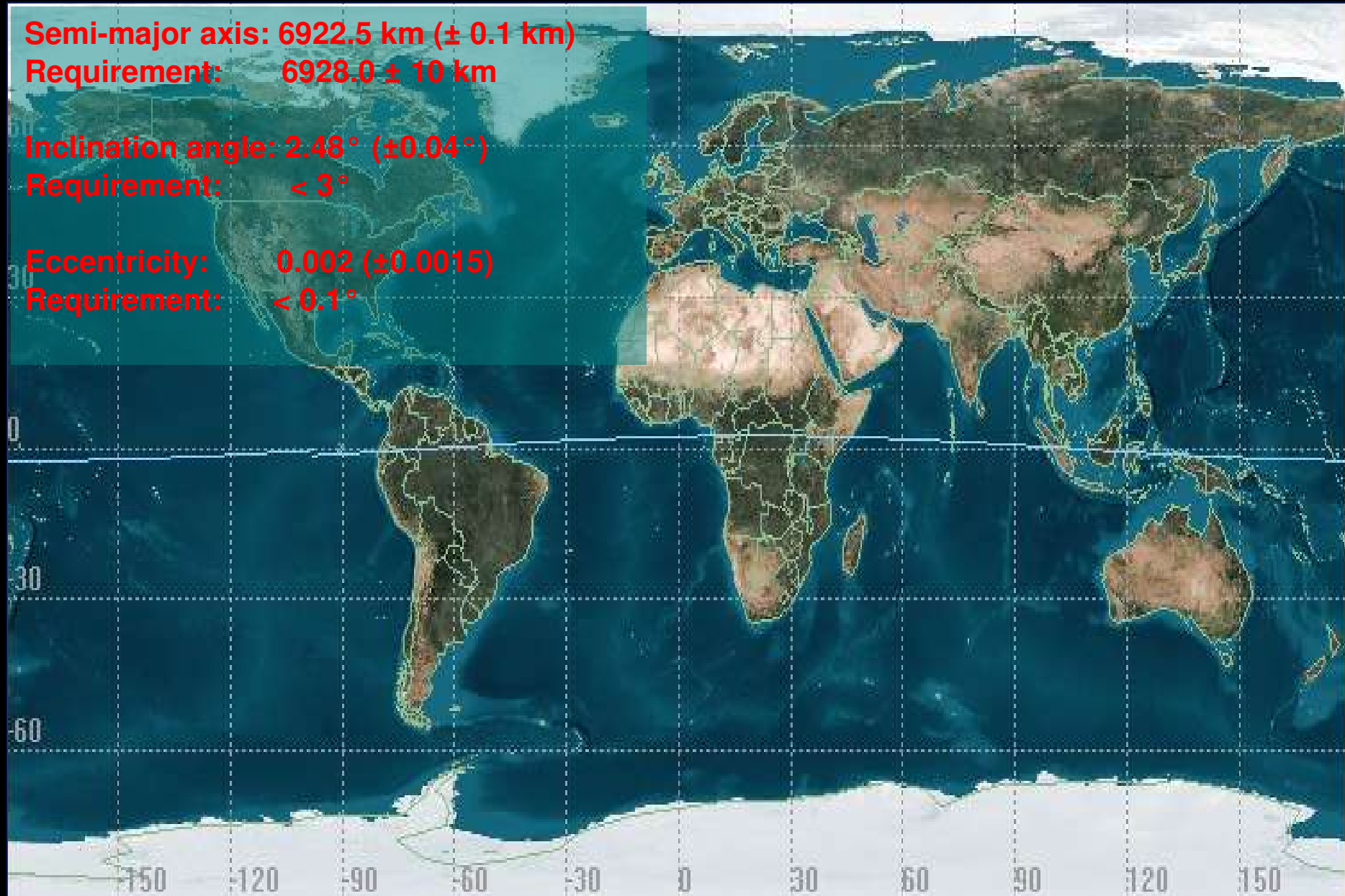
**Requirement: 6928.0  $\pm$  10 km**

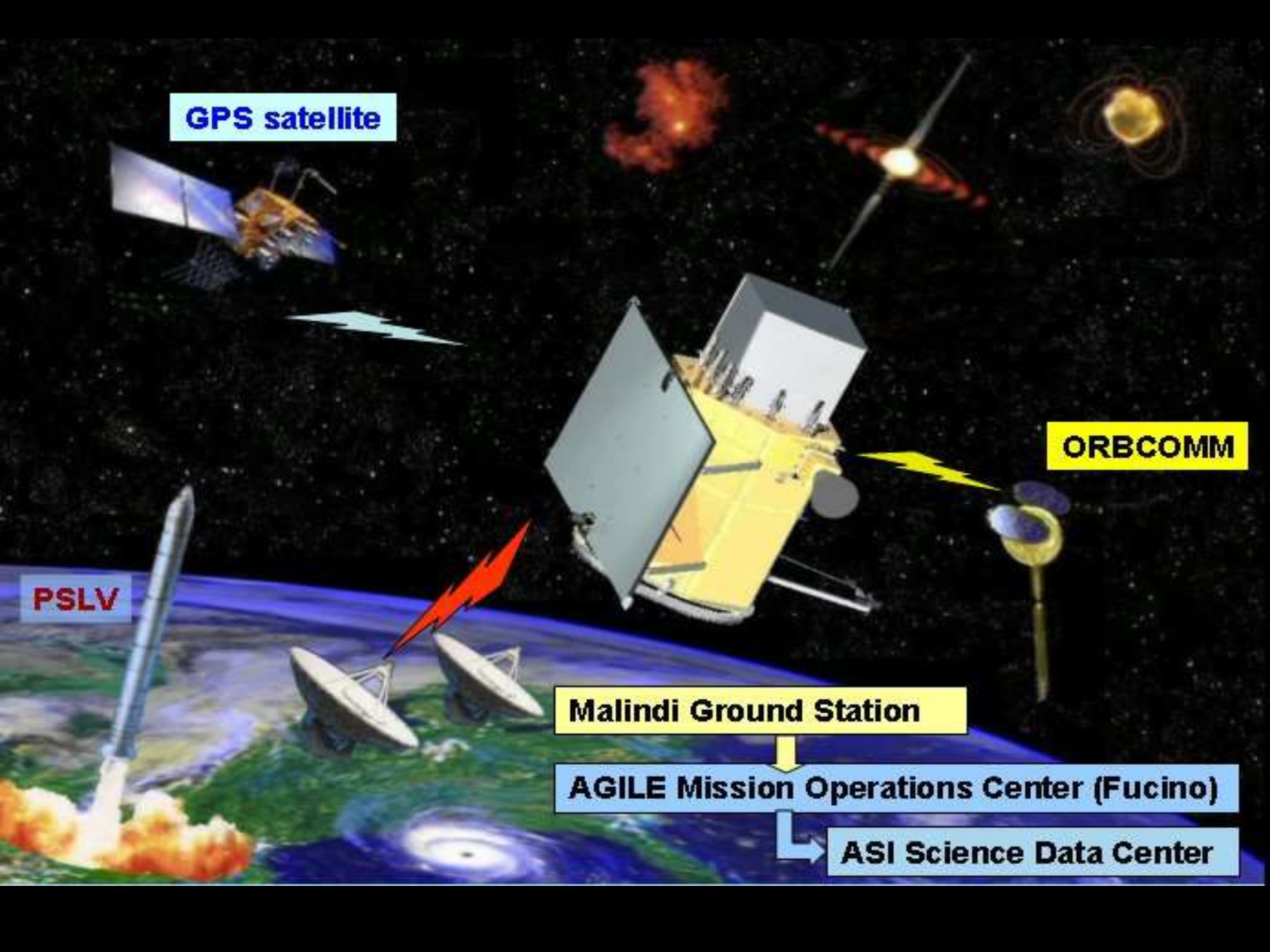
**Inclination angle: 2.48° ( $\pm 0.04^\circ$ )**

**Requirement:  $< 3^\circ$**

**Eccentricity: 0.002 ( $\pm 0.0015$ )**

**Requirement:  $< 0.1^\circ$**





**GPS satellite**

**ORBCOMM**

**PSLV**

**Malindi Ground Station**

**AGILE Mission Operations Center (Fucino)**

**ASI Science Data Center**

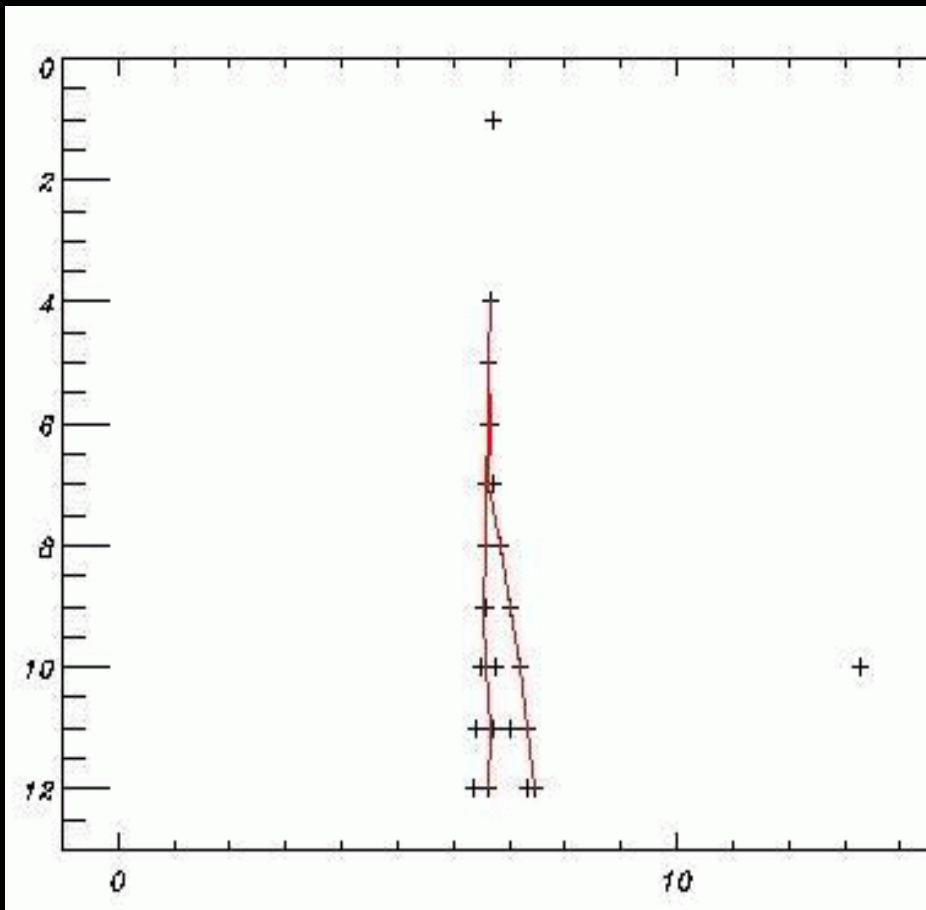
# Il primo fotone !

May 9, 2007

First AGILE cosmic photon.

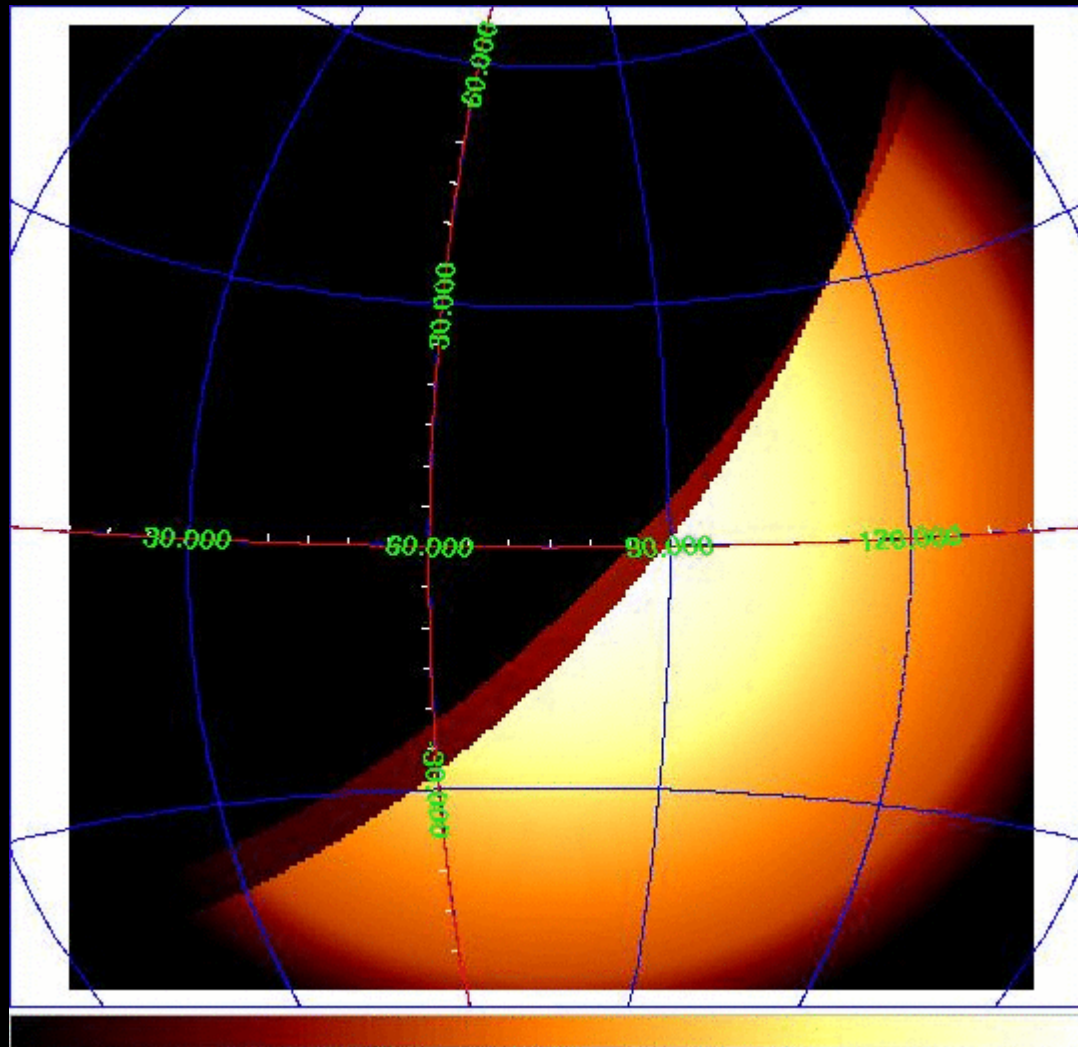
Yesterday AGILE detected its first cosmic photon during a test calibration of the Gamma-Ray Imager (Silicon Tracker).

The figure below is a view of the track left by the electron-positron pair produced by the incoming photon and recorded in the twelve silicon layers of the detector.

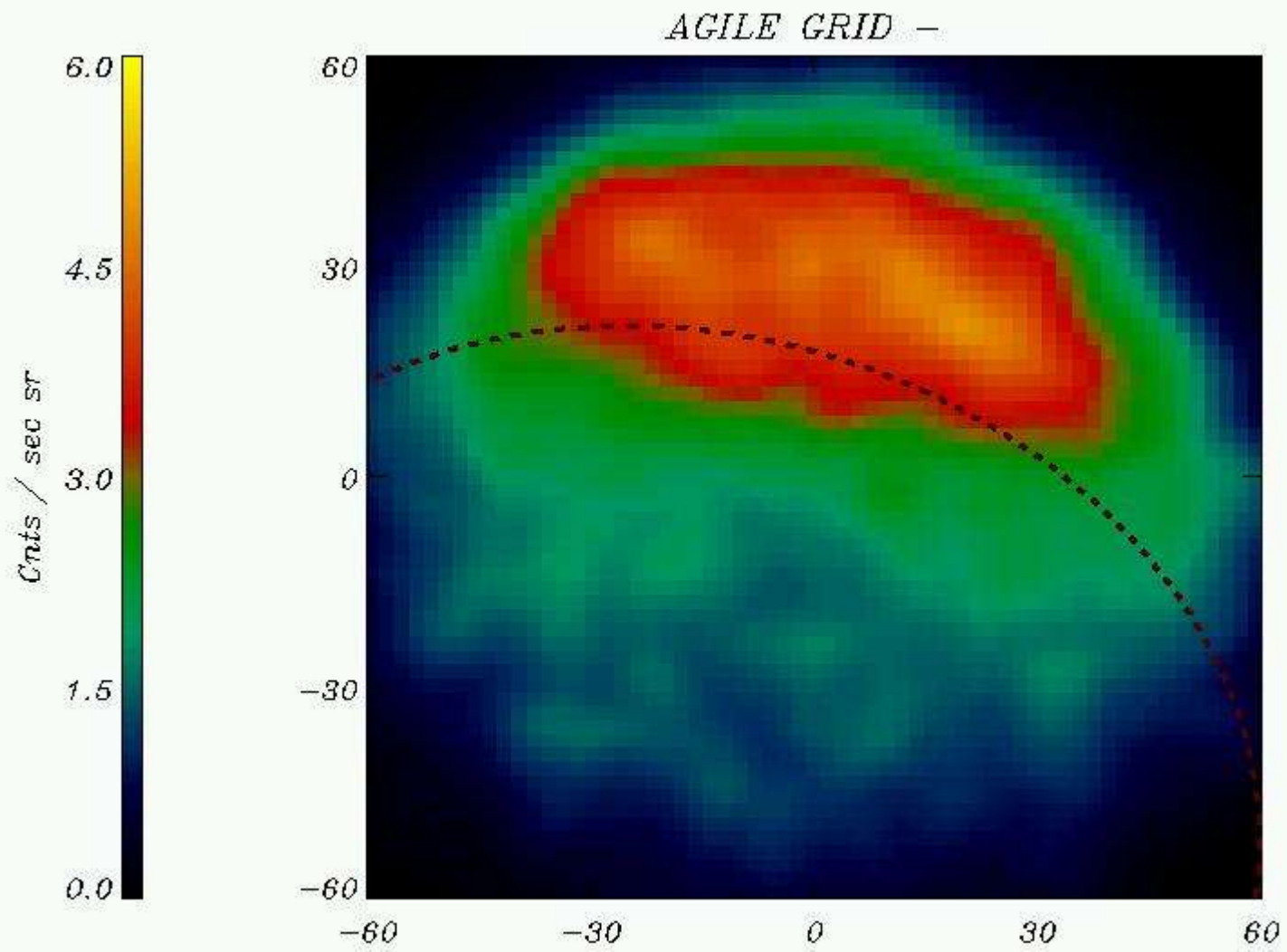


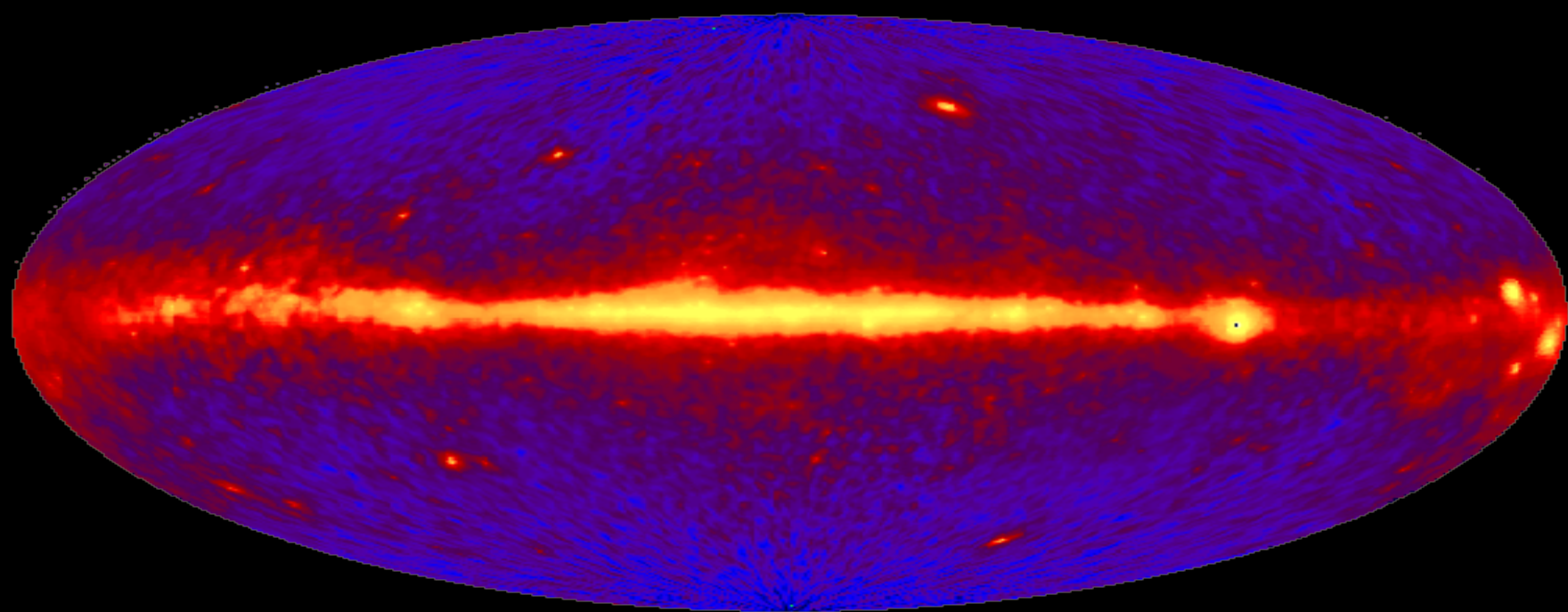
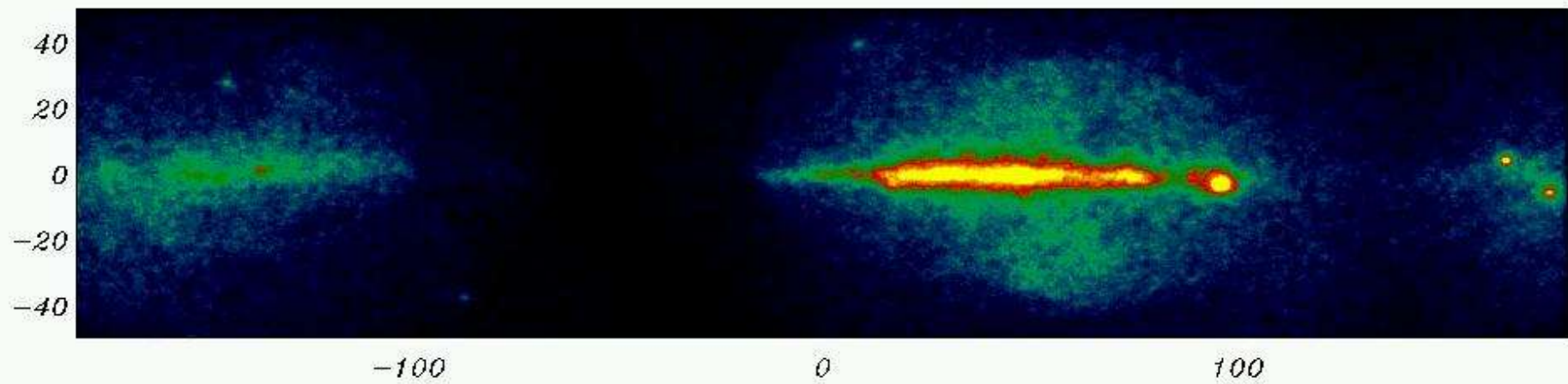


# Albedo Filtering

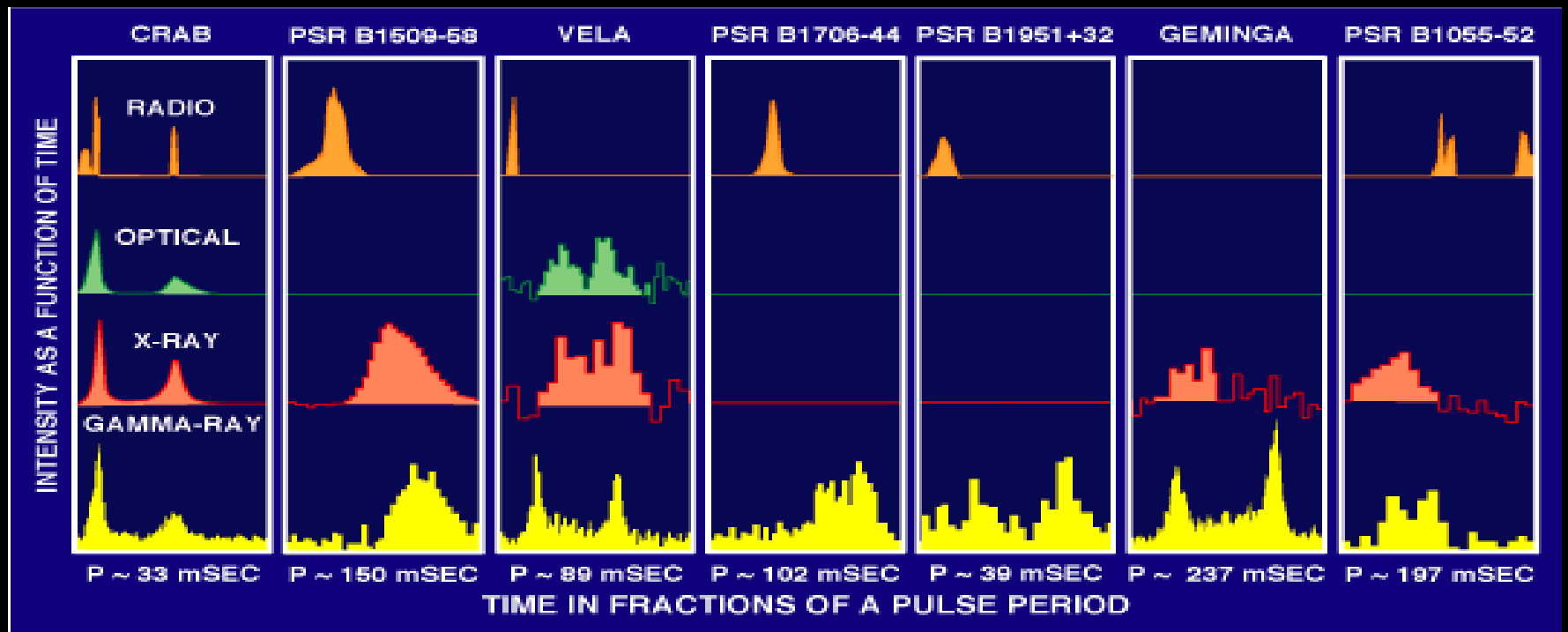


# La prima sorgente

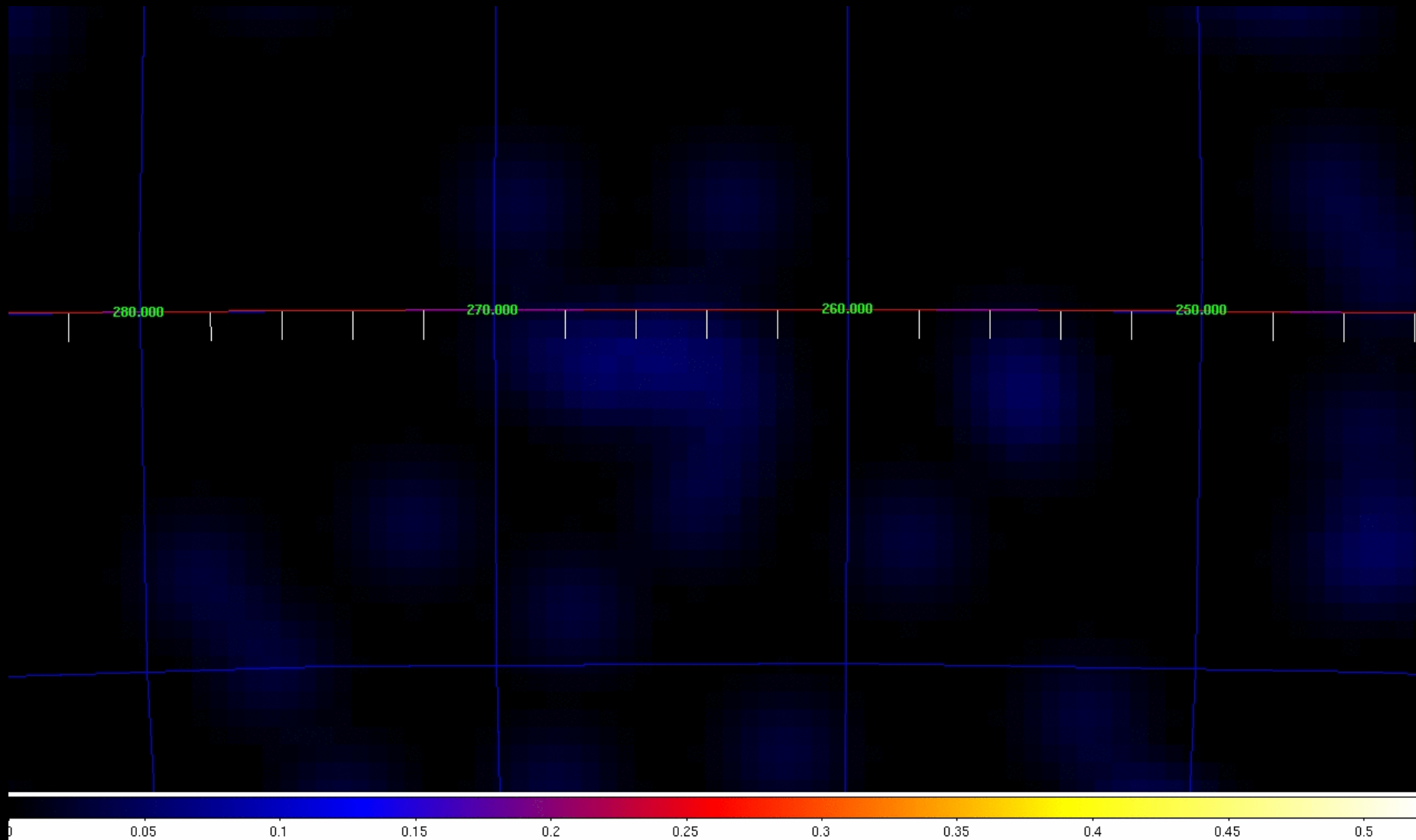


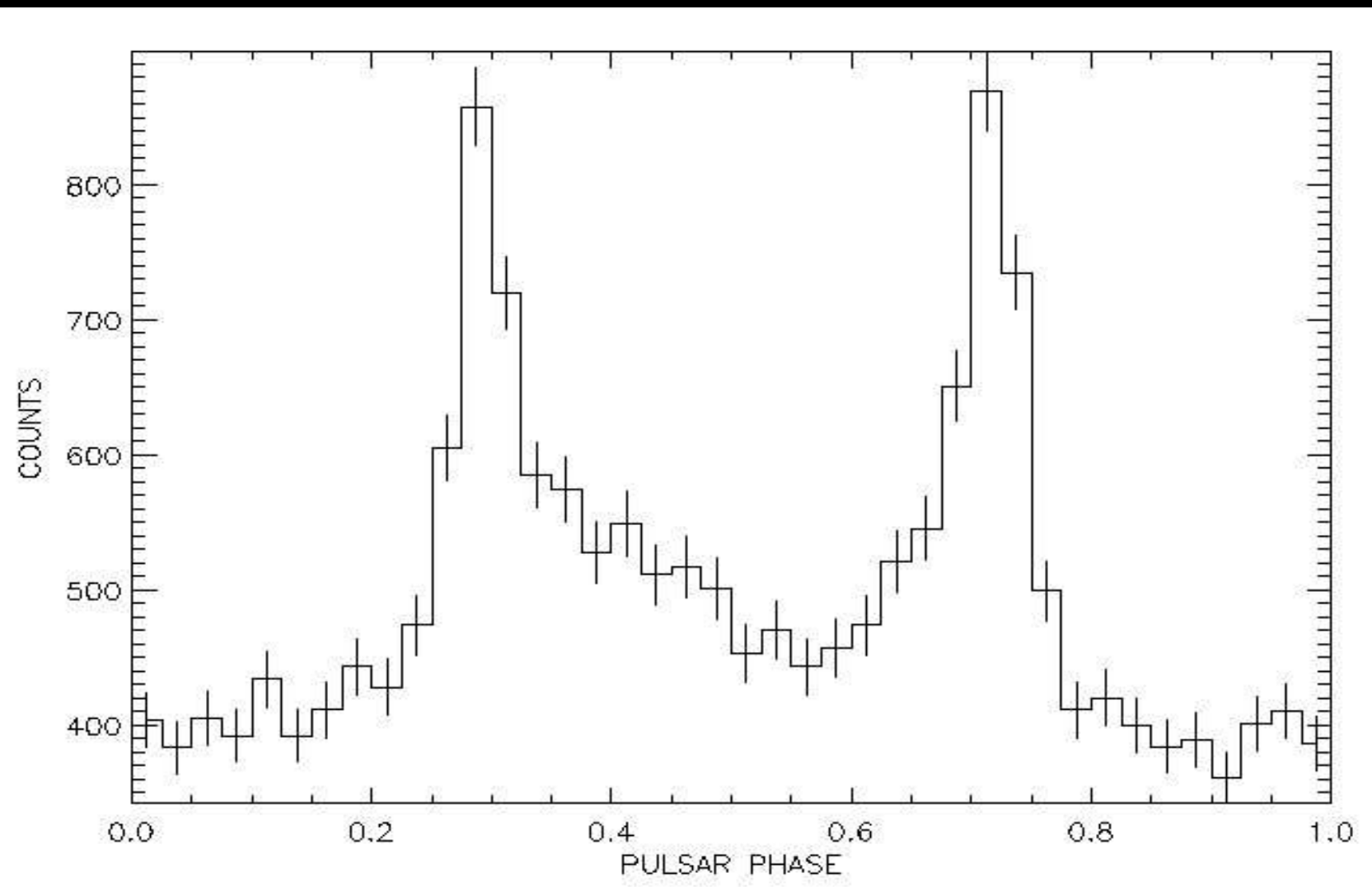


# Pulsars

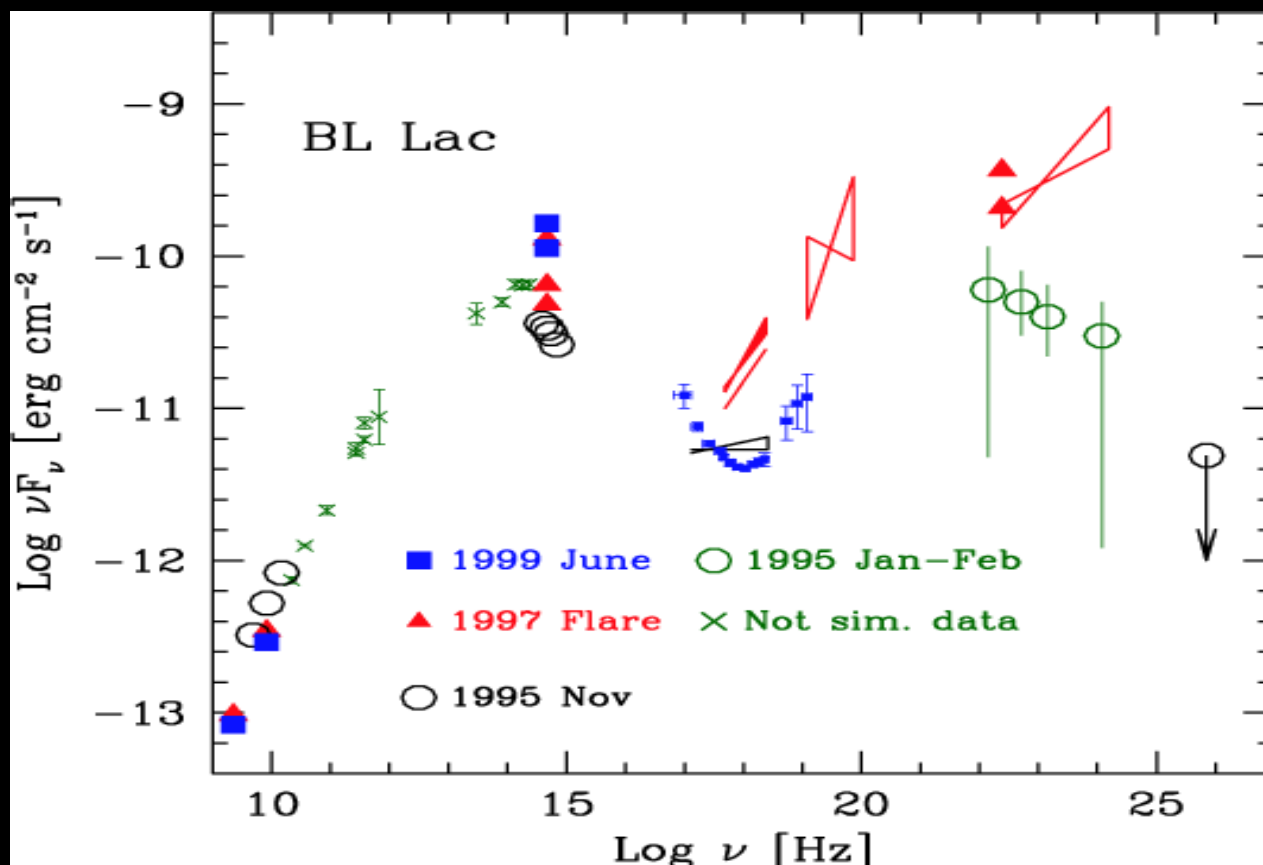


# VELA Pulsar





# Blazars

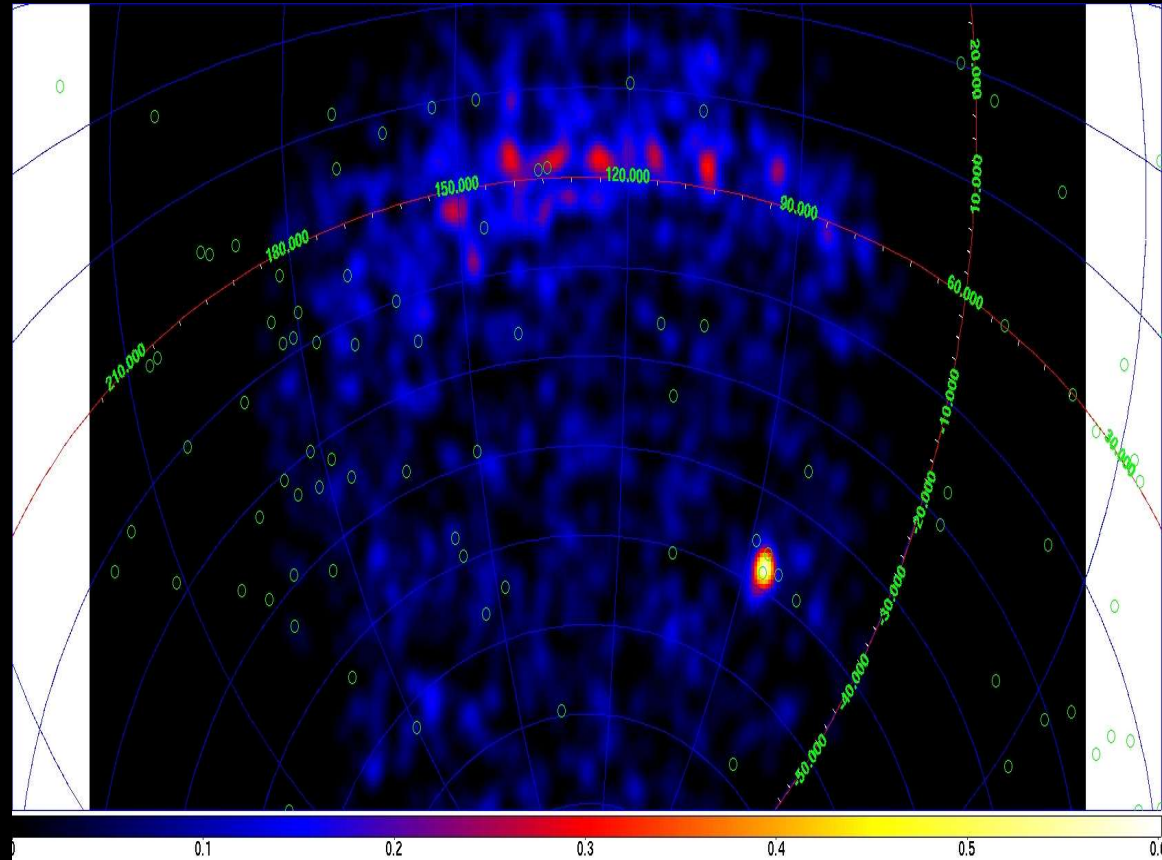


# 3C 454.3

2007-07-24 to 2007-07-30

$F = (3 \pm 1) \times 10^{-6}$  ph/cm<sup>2</sup>/s  
 $E > 100$  MeV

detection : 9.9 sigma



AGILE gamma-ray detection of the Blazar 3C 454.3

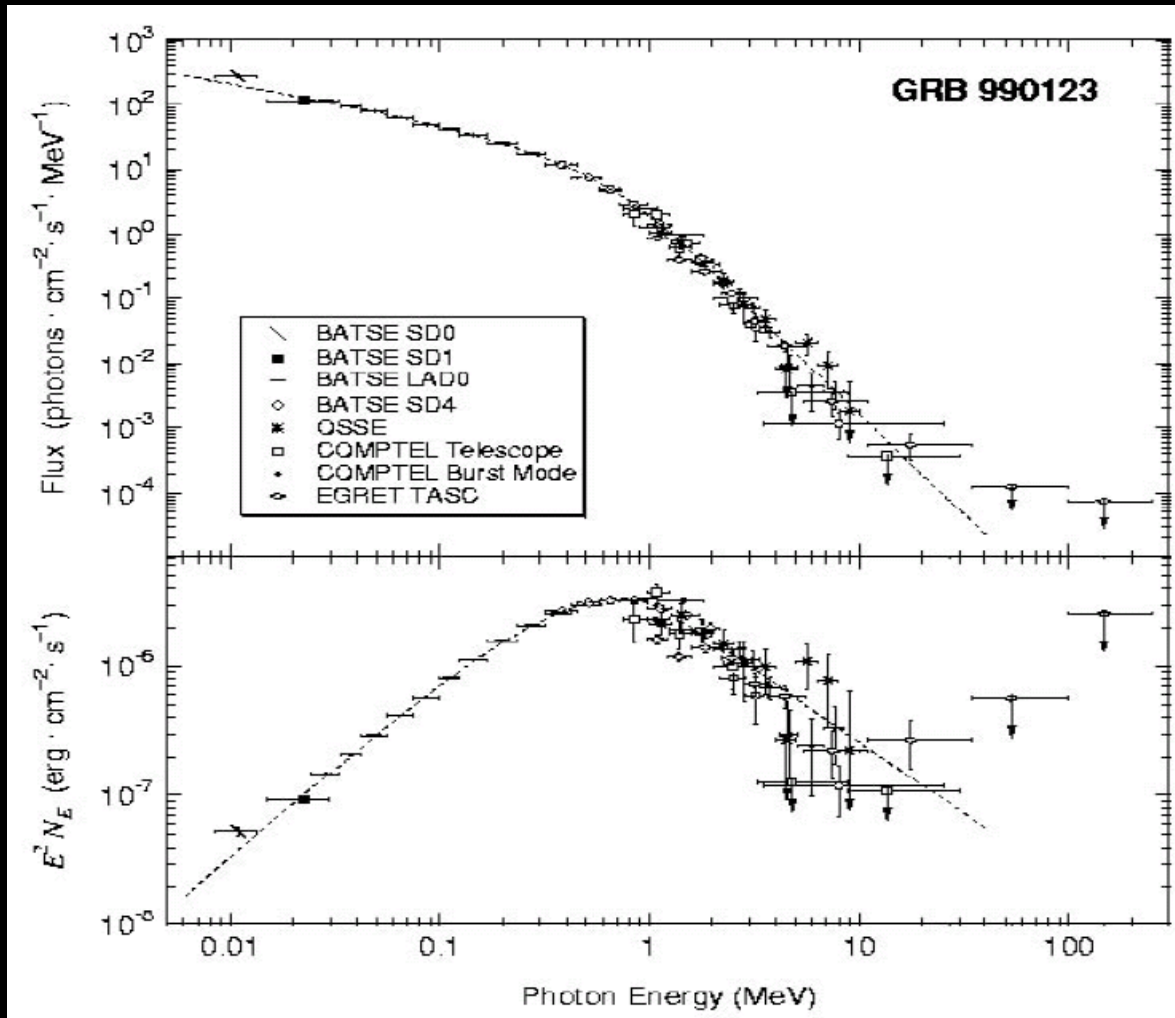
ATel #1160; S. Vercellone et al.

AGILE pointing at 3C 454.3: end of the observations and preliminary results.

ATel #1167; A. Bulgarelli et al.



# GRB



# GRB 070724b

Niente gamma (nel tracker) !

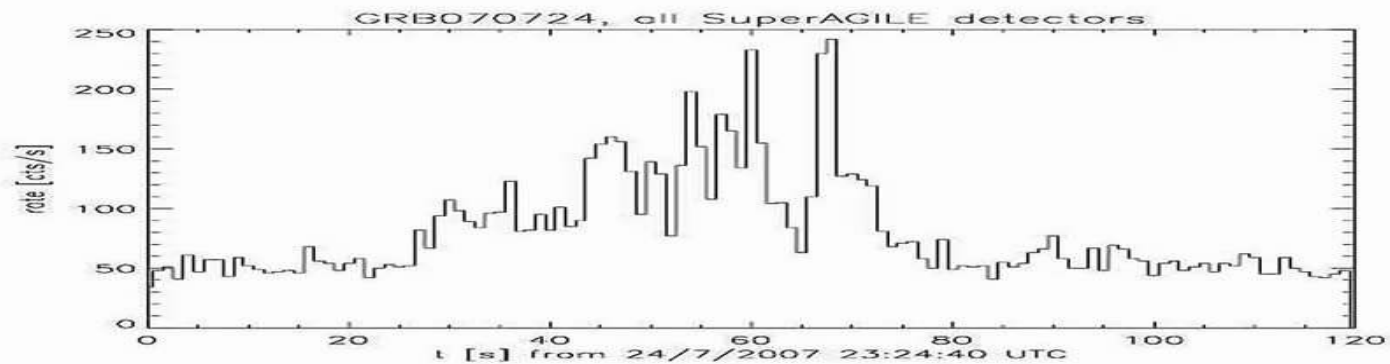
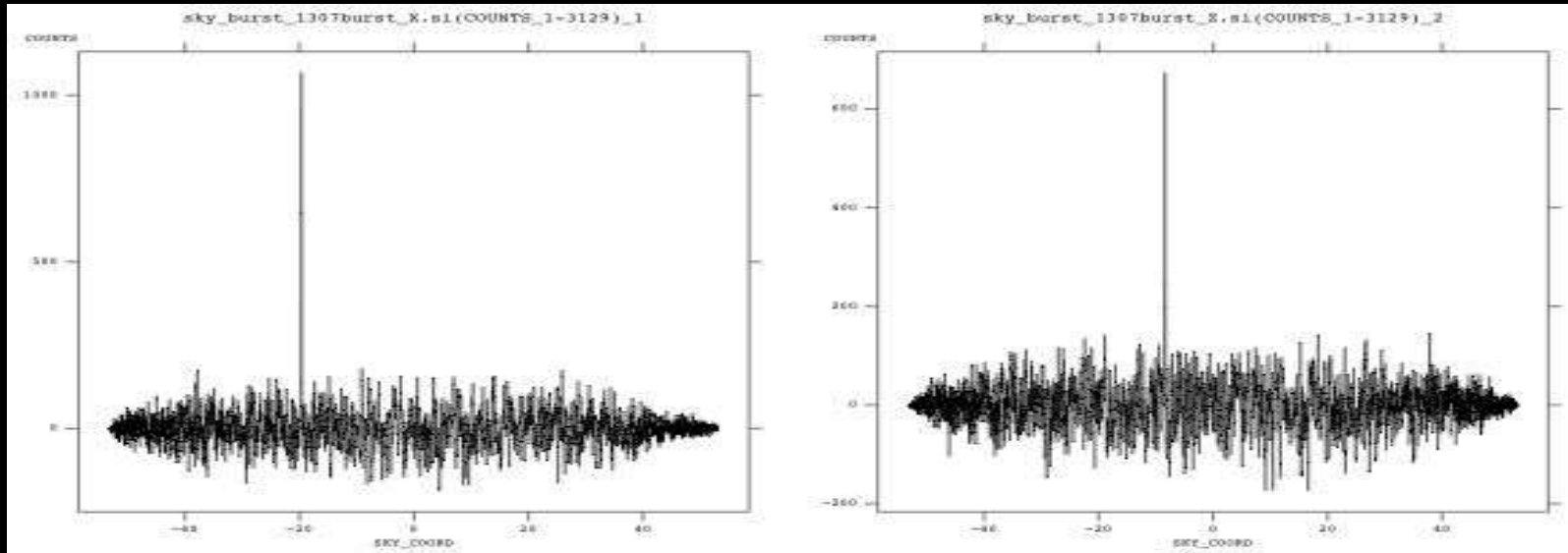
GCN CIRCULAR 6670

GRB 070724B: Analysis of AGILE gamma-ray data

Chen et al.

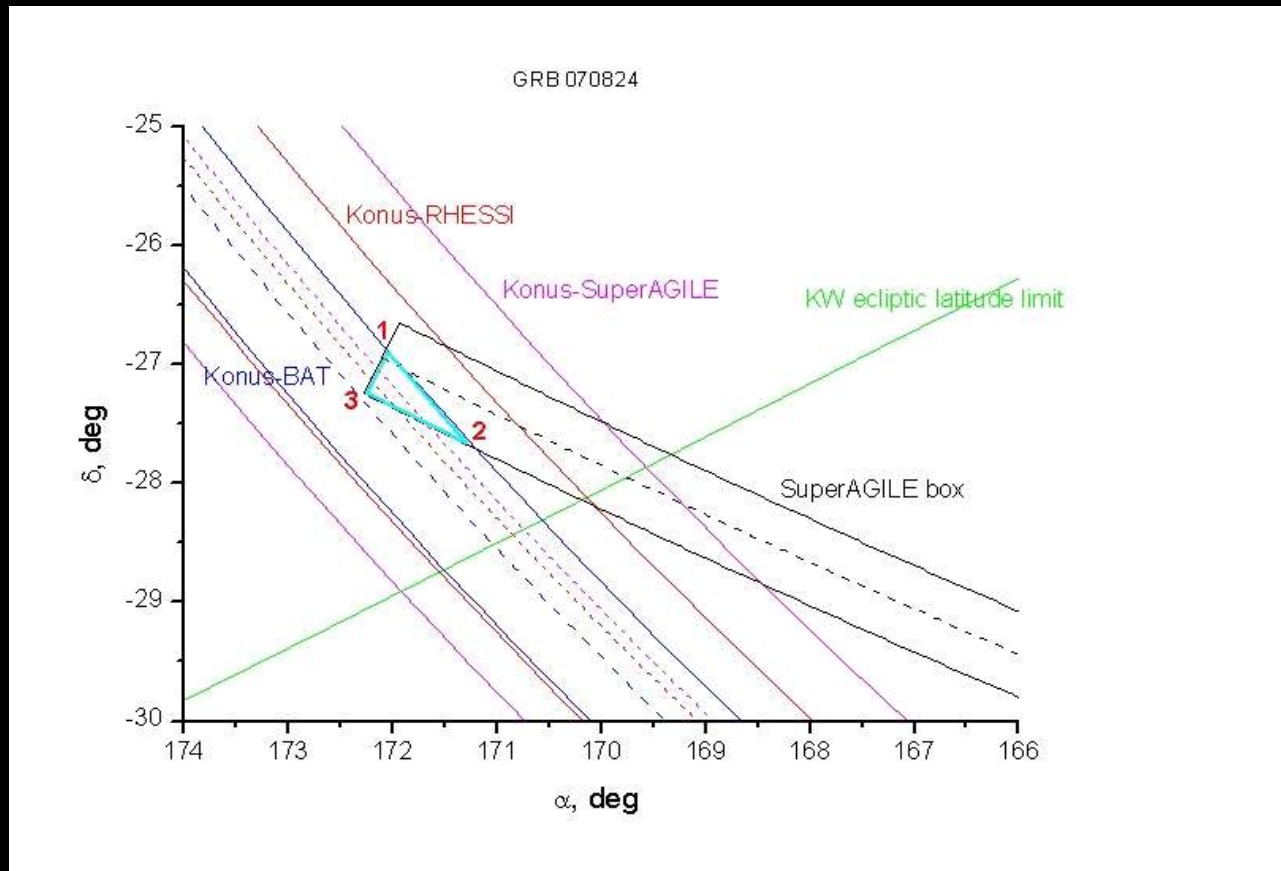
# GRB 070724b

First Gamma Ray Burst Localization by SuperAGILE onboard AGILE



# GRB 070824

## Combined SuperAGILE/IPN Localization

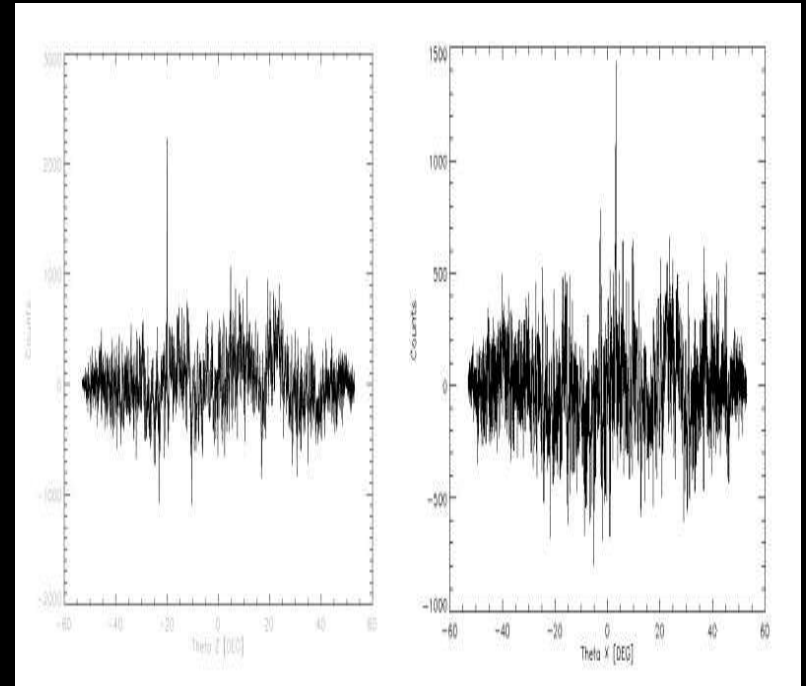


# Altri transienti

## GX301-2

SuperAGILE first light

The hard X-ray imager SuperAGILE clearly detected a flare from the source



## SGR 1806-20

AGILE-ACS position for the July 27 burst

GCN CIRCULAR 6688

F.Perotti et al.

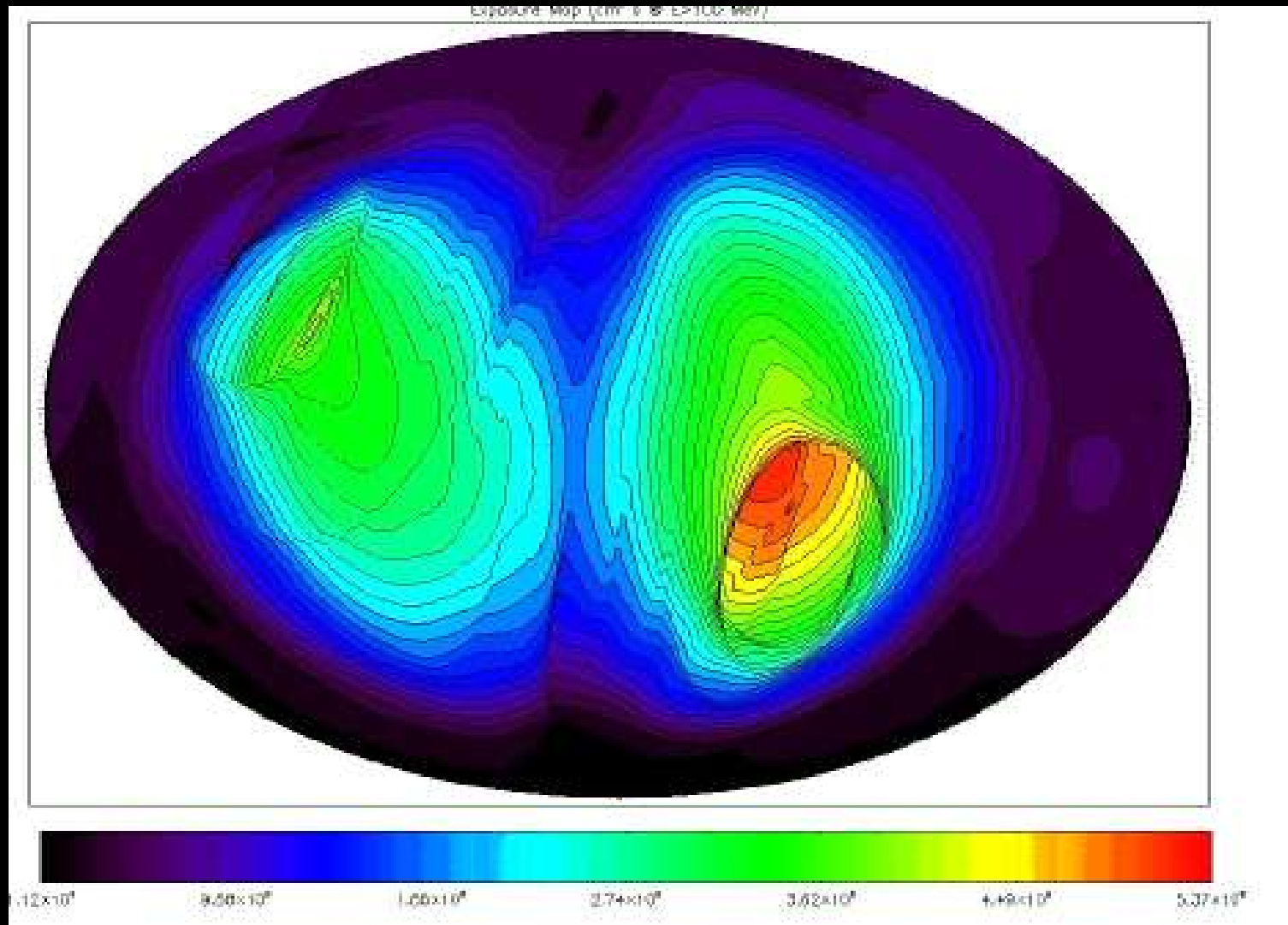
# AGILE Science Program

- **AGILE Guest Observer Program (Cycle-1)**
  - Announcement of Opportunity.
- **Multi- $\lambda$  Programs (AGNs, PSRs, GRBs...)**
- **AGILE Science Workshops:**
  - September Science Workshop
  - December Conference

# AGILE Guest Observer Program

*<http://agile.asdc.asi.it/ao.html>*

# AGILE Cycle 1





# Conclusions

- **AGILE is doing very well, and its on-board testing phase is completed**

**The Science Verification Phase lasts until the end of September (calibration with the Crab)**

- **The Cycle-1 scientific program starts at the end of 2007.**
- **Exciting to have both AGILE and GLAST in orbit in 2008 !**