# Astrofisica Nucleare e Subnucleare

## GeV Astrophysics II

# Exercise #4

- Find the web sites of AGILE and Fermi/LAT
- Check the status of future gamma-ray detectors (CALET, DAMPE, Gamma-400(?), HERD)

# AGILE


http://agile.rm.iasf.cnr.it/

# AGILE

Space Science Data Center

Home | About SSDC | News and Communication | Quick Look | Missions | Multimission Archive | Catalogs | Tools | Links | Bibliographic services | Helpdesk | Privacy

AGILE Science Data Center

AGILE Home | About AGILE | ASI HQ AGILE | AGILE News | AGILE Data Archive | Public Software | AGILE Pointings | AGILE Catalogs | Restricted Area | Guest Observer Program | User Feedback Form | AGILE Workshops | Agile Helpdesk

## Welcome to the AGILE Data Center Home Page at SSDC

These pages provide updated information and services in support to the general scientific community for the mission AGILE, which is a small Scientific Mission of the Italian Space Agency (ASI) with participation of INFN, IASF/INAF and CIFS .

AGILE is devoted to gamma-ray astrophysics and it is a first and unique combination of a gamma-ray (AGILE-GRID) and a hard X-ray (SuperAGILE) instrument, for the simultaneous detection and imaging of photons in the 30 MeV - 50 GeV and in the 18 - 60 keV energy ranges. After more than 13 years of operations, AGILE is working nominally, providing valuable data and important scientific results.

AGILE operations:
Launch date 23 April, 2007
Planned Nominal Phase: 2 + 2 extended years
Elapsed: 13 years in orbit completed on 23 April, 2020
Current Extended Phase: ASI extended AGILE operations up to 31 May, 2022

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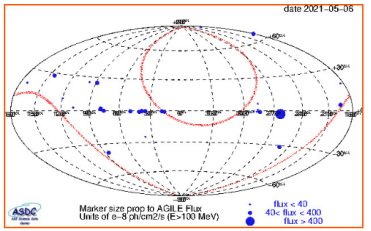
The AGILE Mission Board (AMB) has executive power overseeing all the scientific matters of the AGILE Mission and is composed of:

- AGILE Principal Investigator: Marco Tavani, INAF Rome (Chair)
- ASI Project Scientist: Paolo Giommi, ASI
- ASI Mission Director: Fabio D'Amico, ASI
  (Former ASI Mission Directors: Luca Salotti, up to September 20, 2010 and Giovanni Valentini up to January 22, 2015)
- AGILE Co-Principal Investigator: Guido Barbiellini, INFN Trieste
- 1 ASI representative: Elisabetta Tommasi di Vignano
  (Former ASI representative: Sergio Colafrancesco up to June, 2010)

- INAF Project Scientist: Carlotta Pittori (from November 10, 2020)

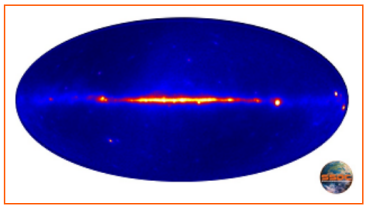
## AGILE current spinning sky view

(Click here for previous pointing details)




**Click here to access the AGILE Spinning FOV plotter**

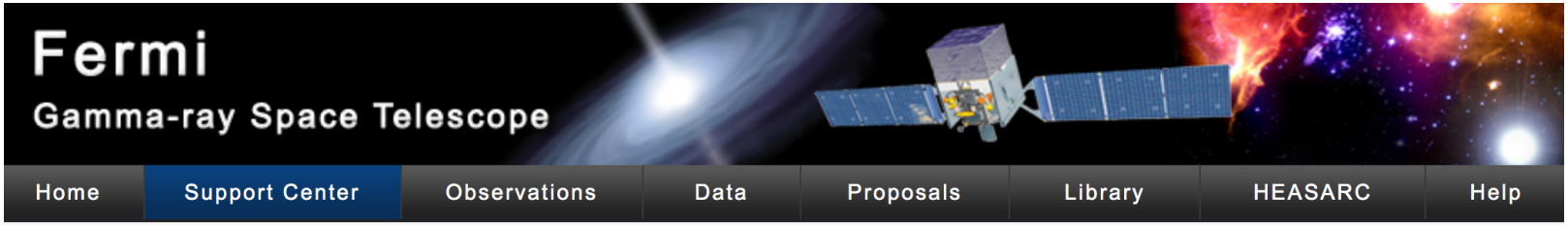
**Click here to access the AGILE Real Data FOV Plotter**



**AGILE total intensity map up to Sep. 30, 2017.**

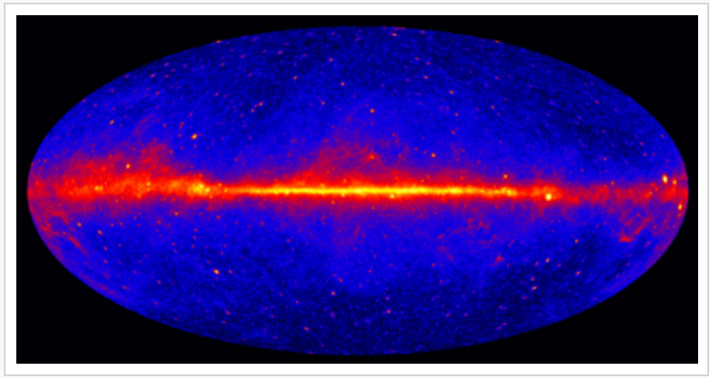
https://agile.ssdc.asi.it/

# Fermi/LAT




Home | Support Center | Observations | Data | Proposals | Library | HEASARC | Help

The Fermi Science Support Center (FSSC) runs the guest investigator program, creates and maintains the mission time line, provides analysis tools for the scientific community, and archives and serves the Fermi data. This web site is the portal to Fermi for all guest investigators.



This view shows the entire sky at energies greater than 1 GeV based on five years of data from the LAT instrument on NASA's Fermi Gamma-ray Space Telescope. Brighter colors indicate brighter gamma-ray sources.
*Image Credit: NASA/DOE/Fermi LAT Collaboration*

Look into the "Resources" section for finding schedules, publications, useful links etc. The "Proposals" section is where you will be able to find the relevant information and tools to prepare and submit proposals for guest investigator projects. At "Data" you will be able to access the Fermi databases and find the software to analyse them. Address all questions and requests to the helpdesk in "Help".

## Fermi Observations for MW 675

Mission week 675 starts with a continuation of the asymmetric rocking +50/-60 profile from the previous week. On day of year 126 (2021-05-06) at 01:59 there is a 10 minute freeze observation during which an updated asymmetric profile is loaded. This profile continues until DOY 129 (2021-05-09) at 03:01 when there is a 10 minute freeze observation during which a symmetric +/-50 deg. profile is loaded. This profile continues until the end of the week. Note that positive rock angles are south, and negative angles are north.

» More Timeline Info

## Latest News

» Fermi Sky Blog
» Fermi Blog

**Apr 20, 2021**

**Updated Spacecraft Position and History Files Available**

The updated files include the addition of the SC_VELOCITY column. This column contains a vector with the spacecraft velocity in meters per

https://fermi.gsfc.nasa.gov/ssc/

# Fermi/LAT

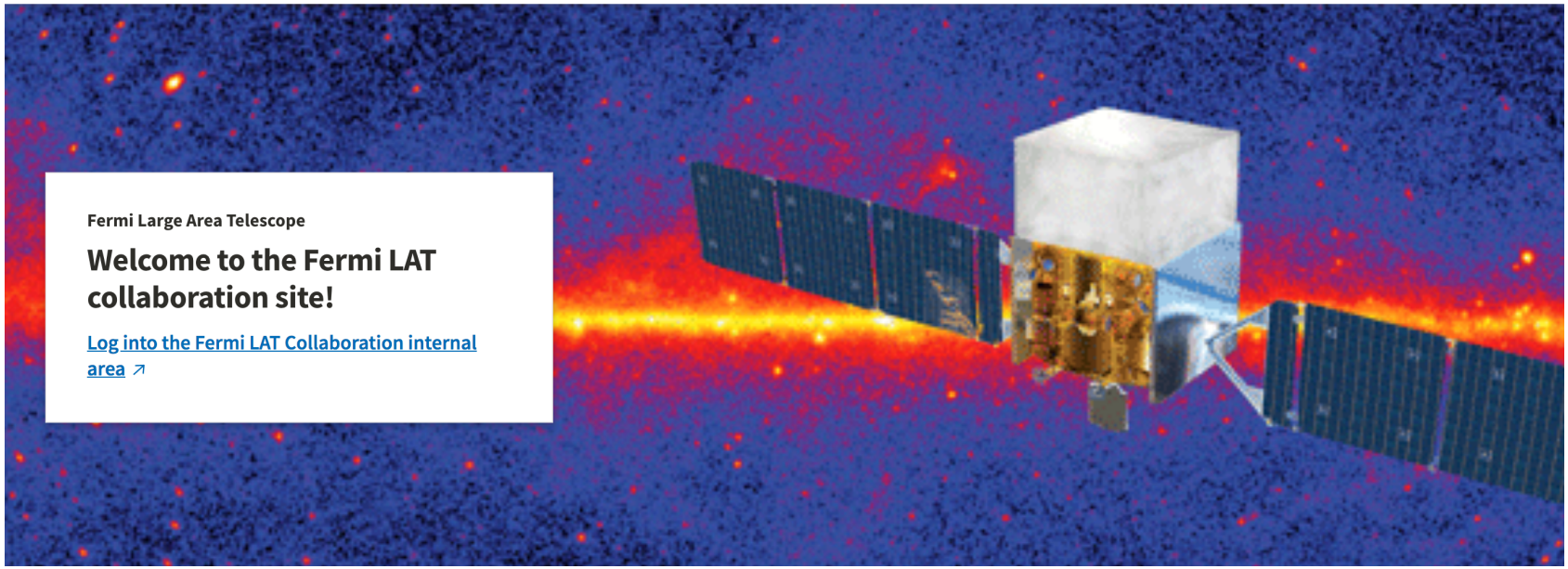
Stanford | The Fermi Large Area Telescope

Search this site

Home About News Opportunity Board Add an Opportunity Fermi LAT Mentoring Program Fermi LAT CMs Events

Past Events LAT Pictures LAT documents LAT Rapid Publications LAT Publications Fermi Overview Presentation

Resources Latest Results




https://glast.sites.stanford.edu/

# CALET

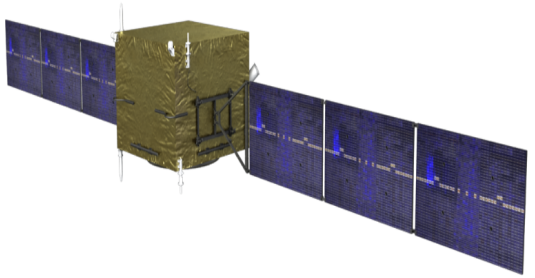

http://calet.pi.infn.it/

# DAMPE

## DArk Matter Particle Explorer

- Home
- PSD
- STK
- BGO
- NUD
- News
- Publication
- The DAMPE Collaboration

DAMPE has been launched the 17th December 2015 at 00:12 UTC!




http://dpnc.unige.ch/dampe/

# HERD

**HERD**
**The High Energy cosmic Radiation Detection facility**

Search

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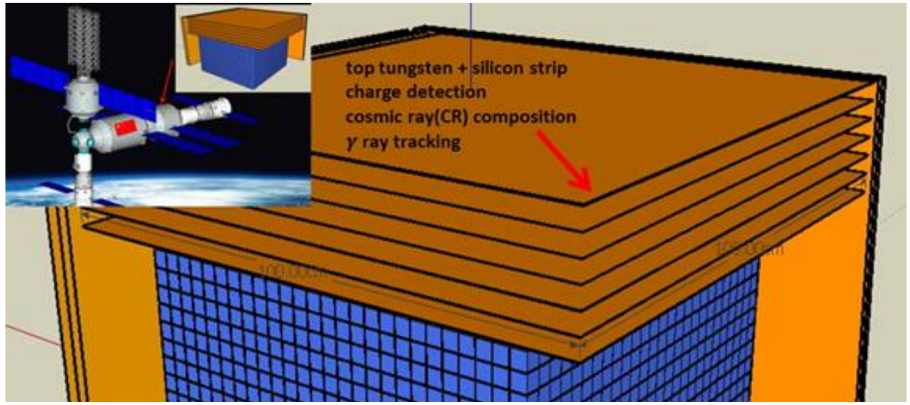
## The High Energy cosmic Radiation Detection facility (HERD)

HERD(High Energy Cosmic Radiation Detection) facility is one of the Cosmic Lighthouse Program onboard China's Space Station, planned to be launched and assembled in 2020. The main science objectives of HERD onboard china's space station are detecting dark matter particle, study of cosmic ray composition and high energy gamma-ray observations. The main constraints imposed on HERD are: total weight less than around 2 tons and total power consumption less than around 2 kilowatts.

To achieve HERD's science objectives, HERD must have the capability of accurate electron and gamma-ray energy and direction measurement (tens of GeV – 10TeV), adequate cosmic ray energy measurement with charge determination (up to PeV).




## News

The 3rd international workshop on HERD was held in Xi'an during Jan. 19-20, 2016.

### External Links

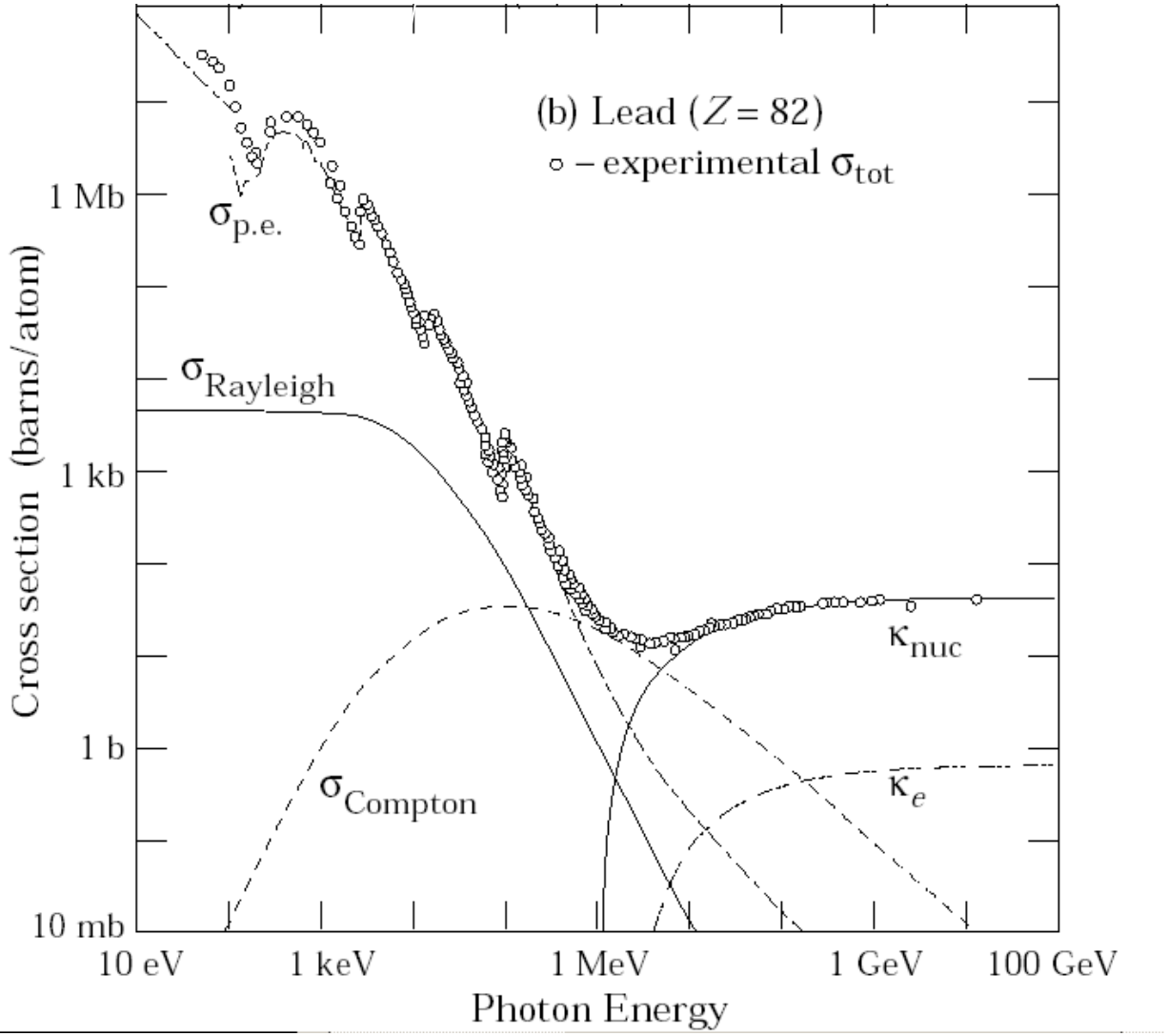
IHEP
China Space Station wiki
LHAASO
CR observatory in Tibet
HXMT
POLAR

http://herd.ihep.ac.cn/

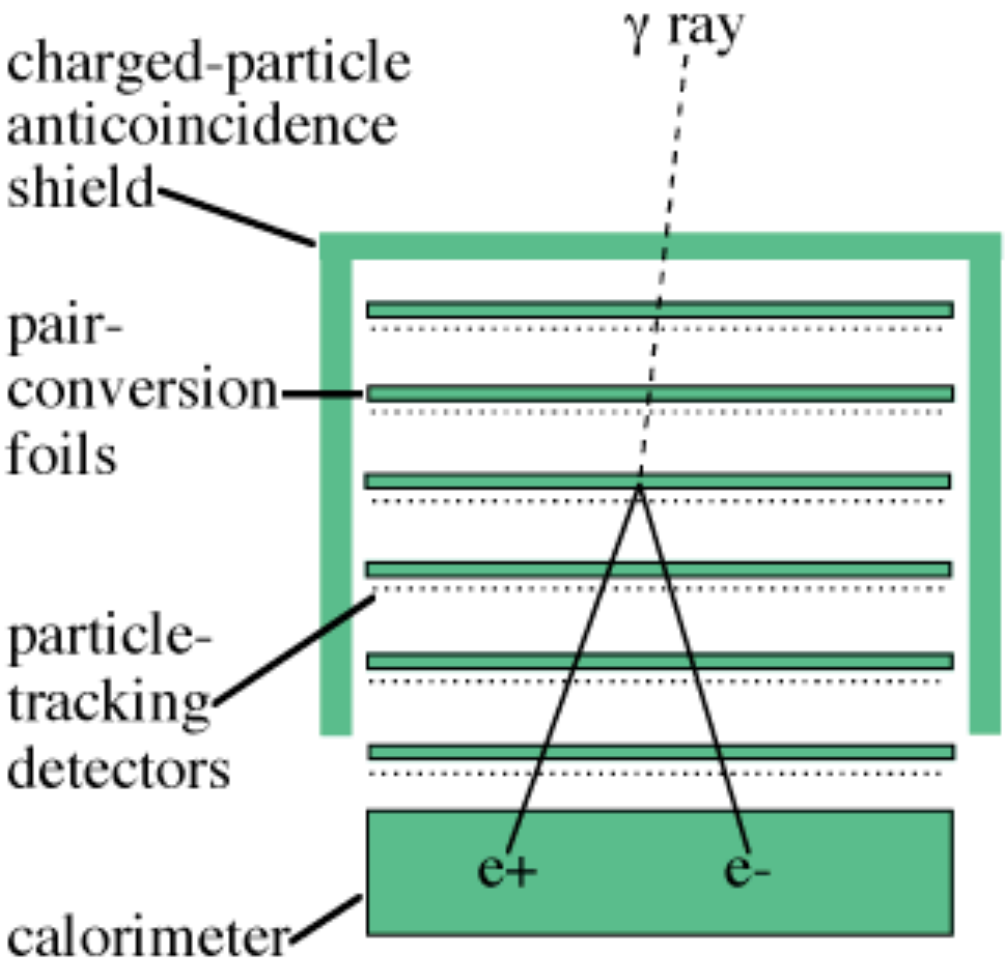
# Gamma-400


https://gamma400.lebedev.ru/indexeng.html

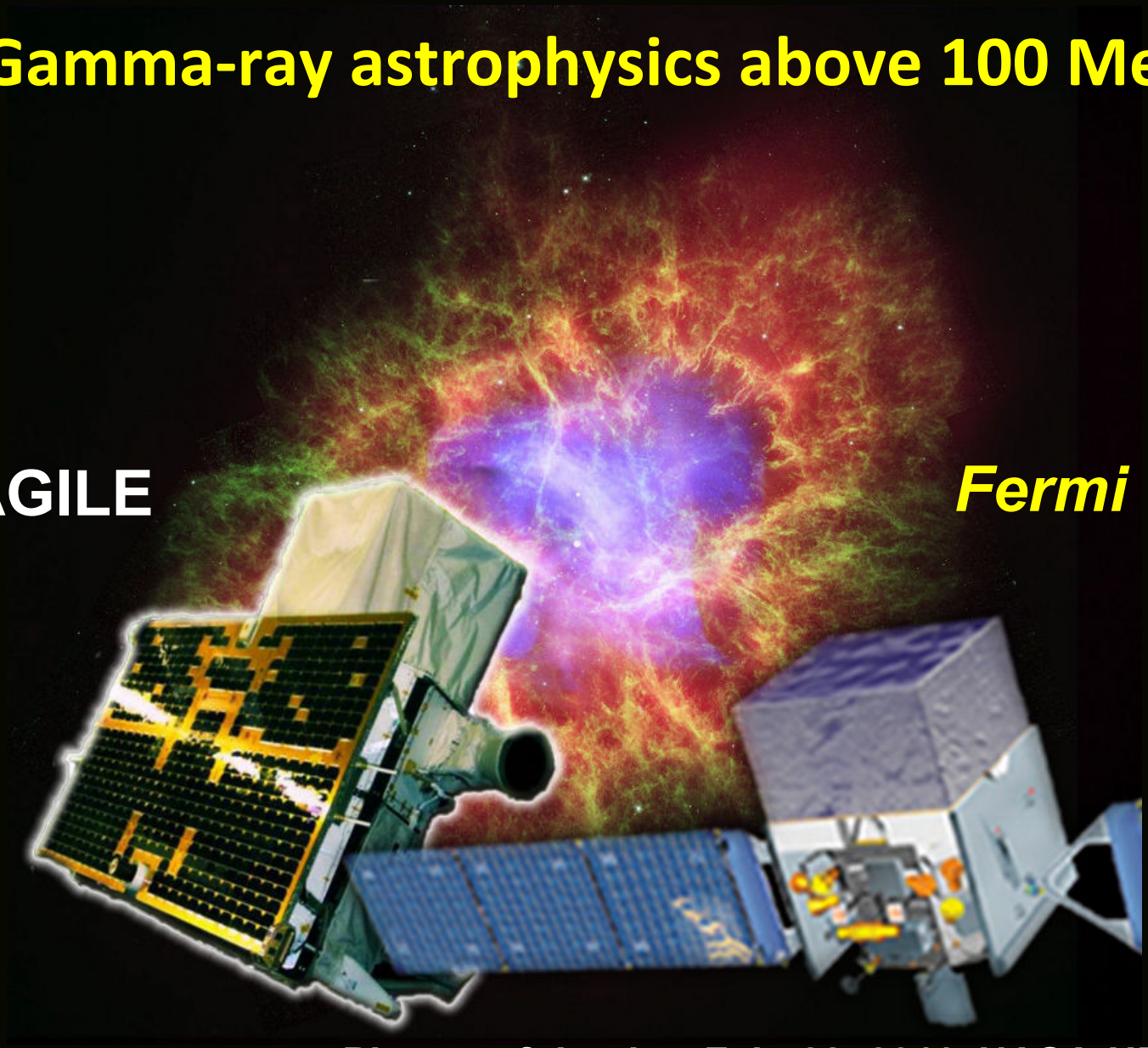
# Photon Interactions



# Detector Project



# Gamma-ray astrophysics above 100 MeV

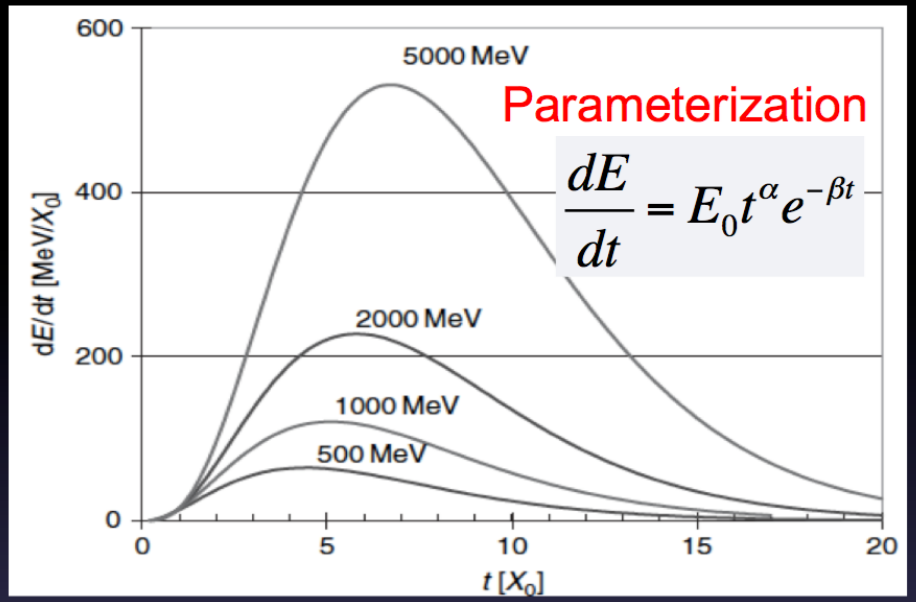


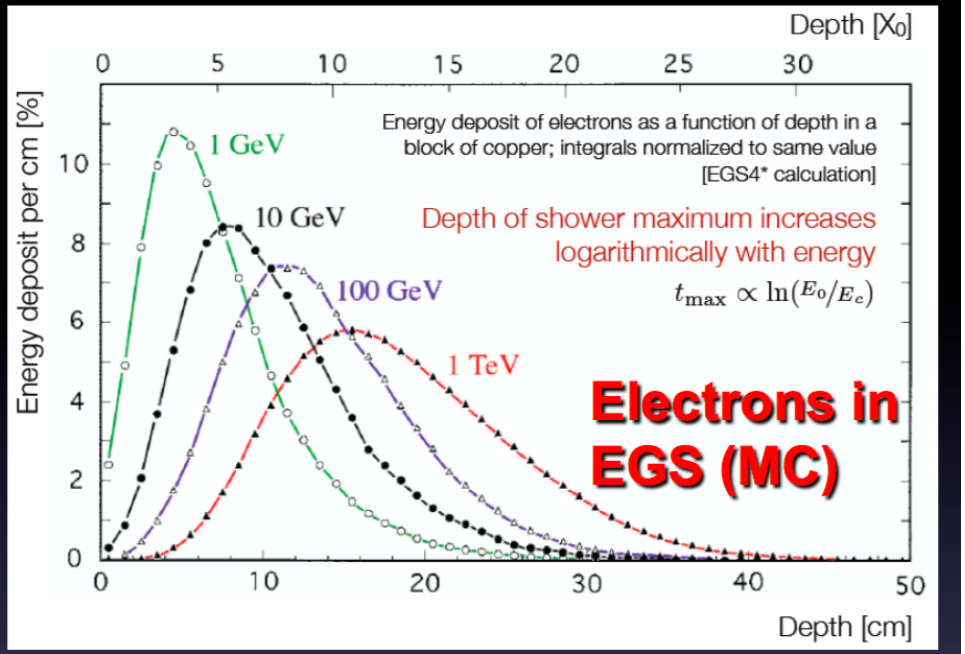

Picture of the day, Feb. 28, 2011, NASA-HEASARC

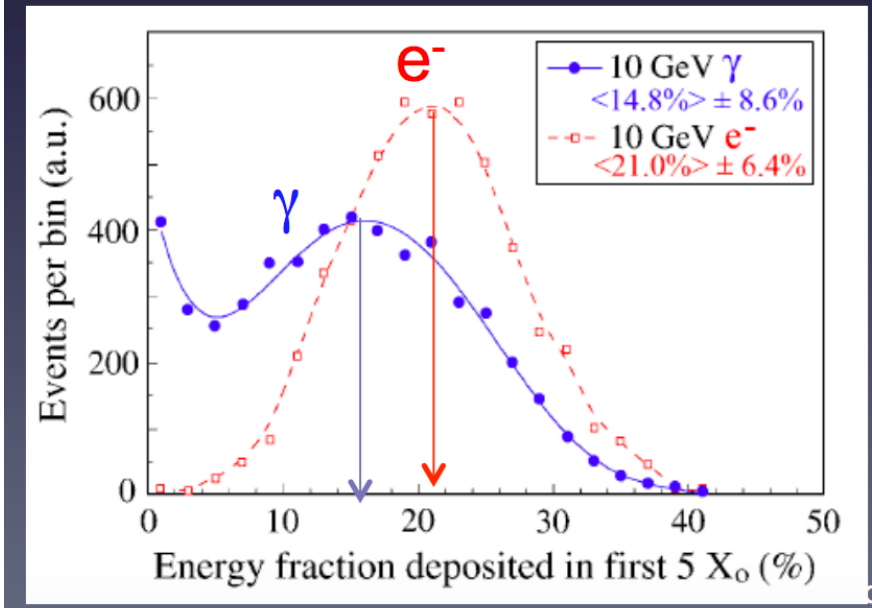
# Astrofisica Nucleare e Subnucleare

## Electromagnetic Showers

# Longitudinal shower distribution



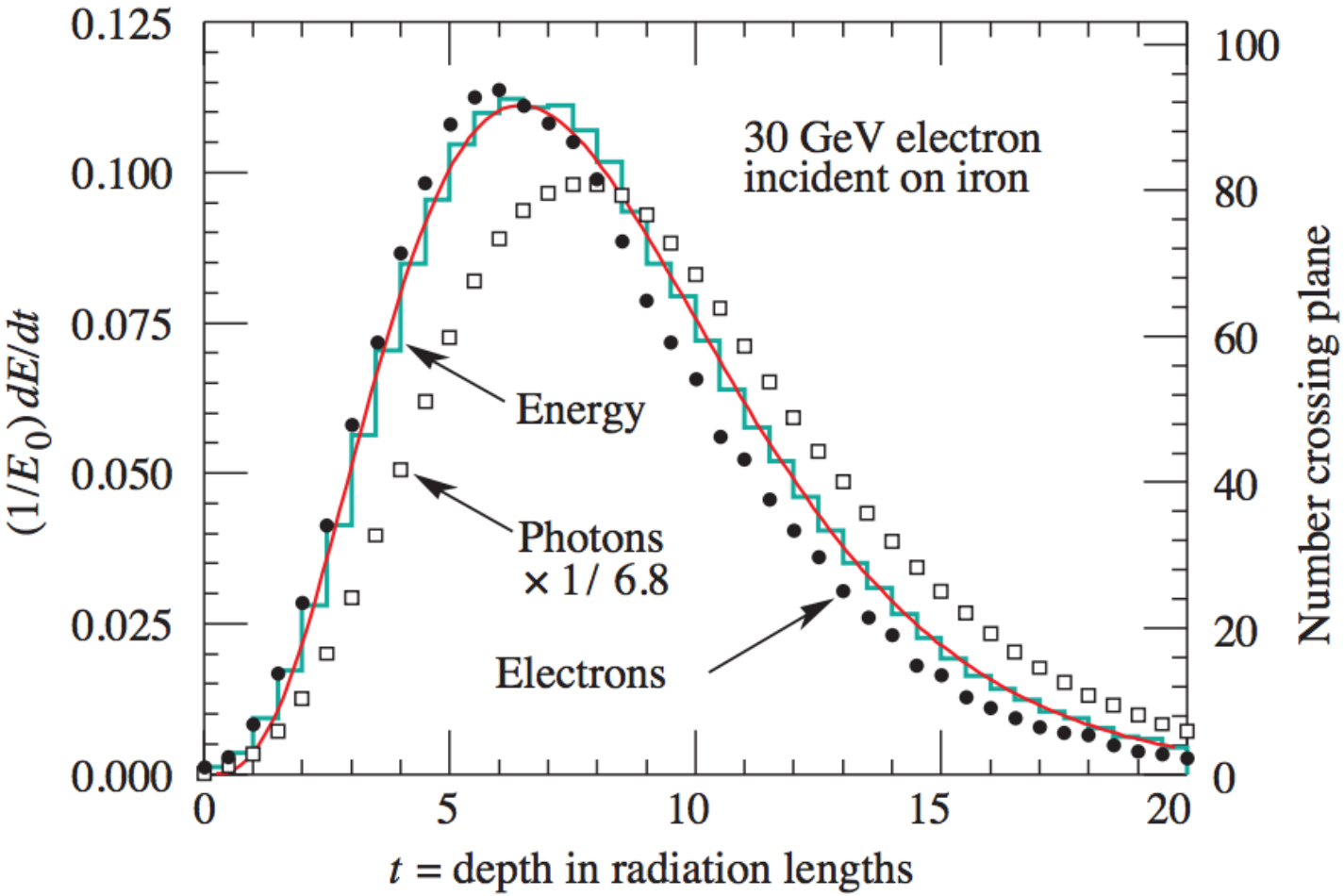




- Differences between electrons and photons generated showers
- Some photons penetrating (almost) the entire slab without interacting (peak at 0)

$$t_{max} = \ln\left(\frac{E_0}{E_c}\right) + C_{e\gamma}$$

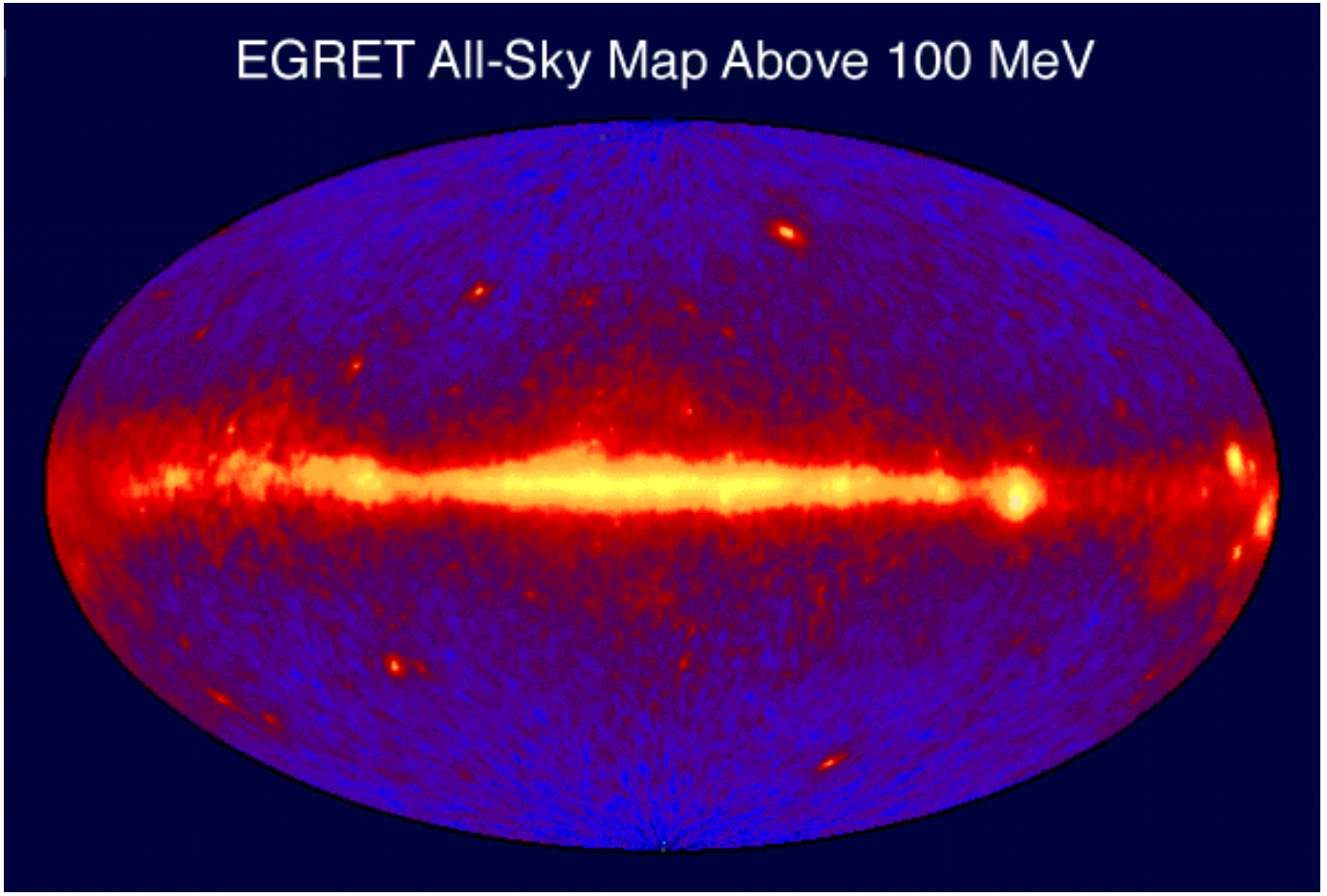
$C_{e\gamma}$=-0.5 for photons
$C_{e\gamma}$=-1 for electrons

# Electromagnetic Showers

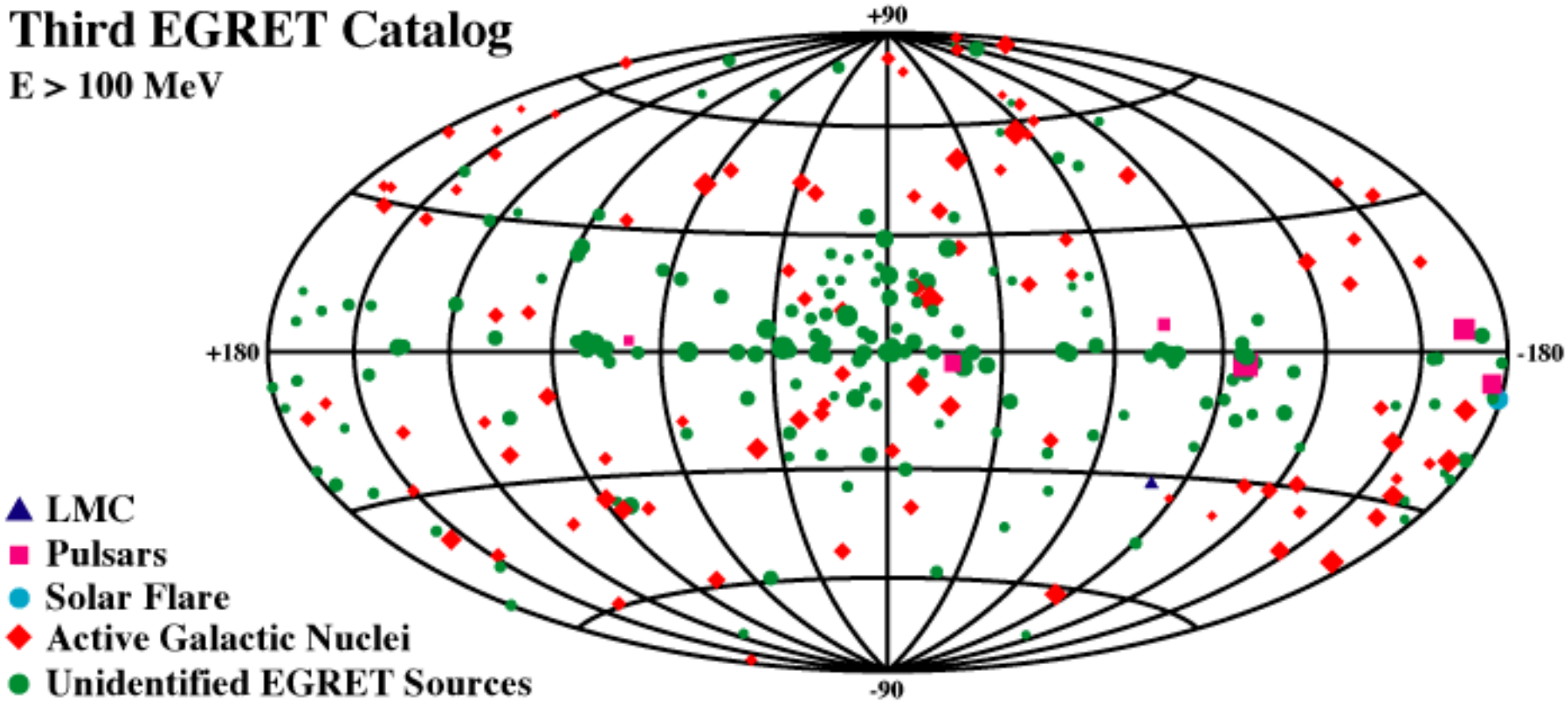


# HE Gamma-ray Astrophysics
# The EGRET legacy

# The HE sky from EGRET

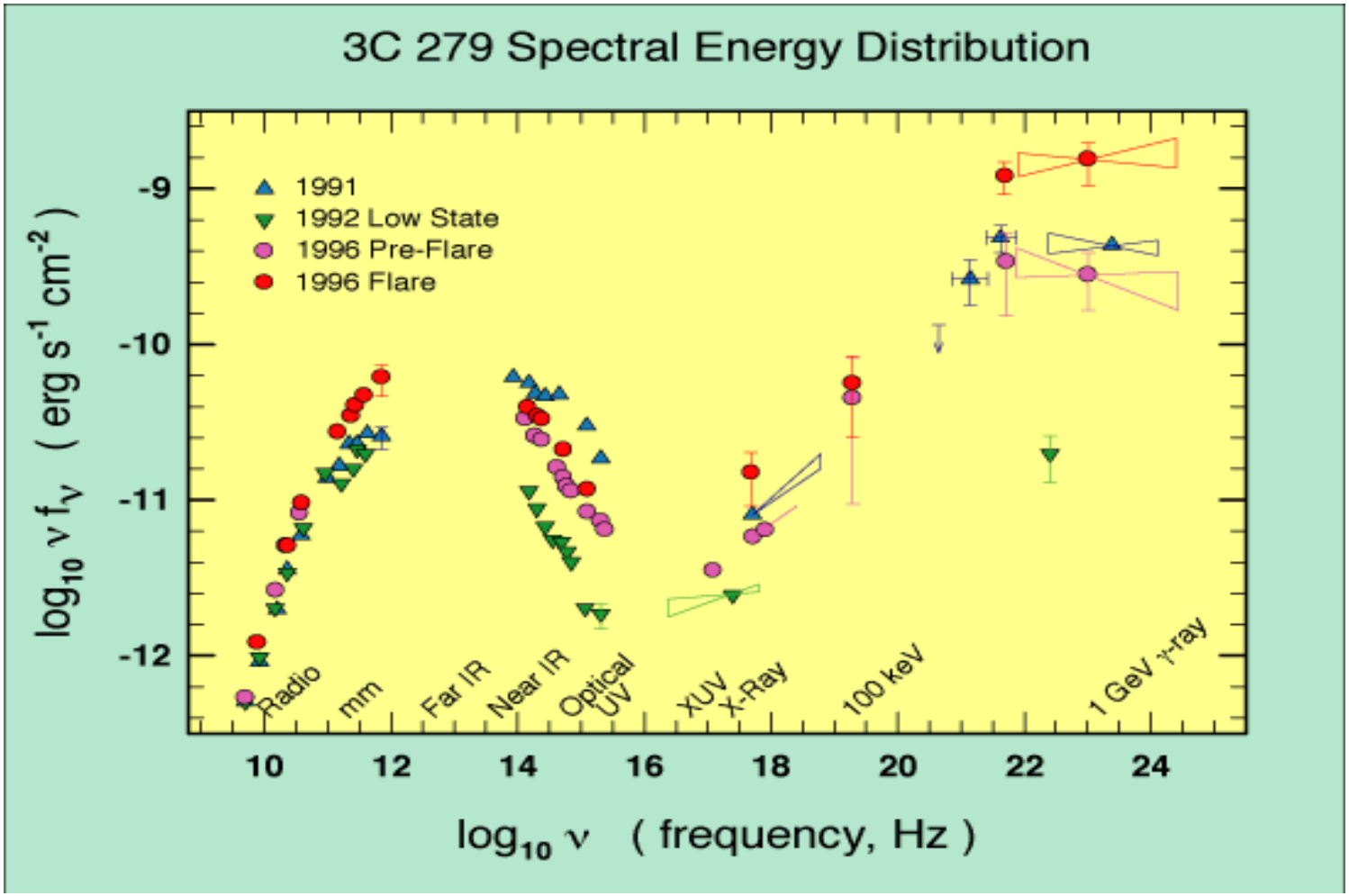


# EGRET Gamma-ray Sources



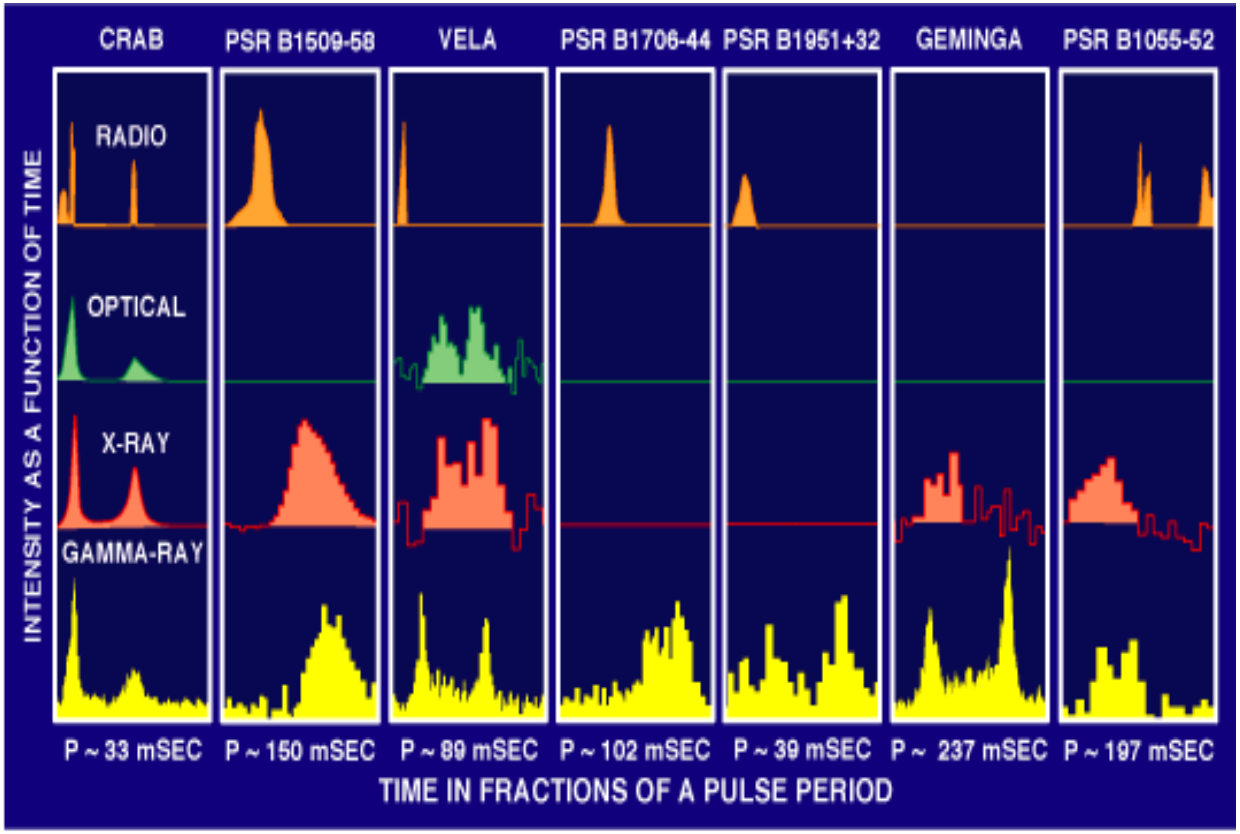
# Challenge # 1

- Need simultaneous multiwavelength data to study variability and emission processes



# Challenge # 2

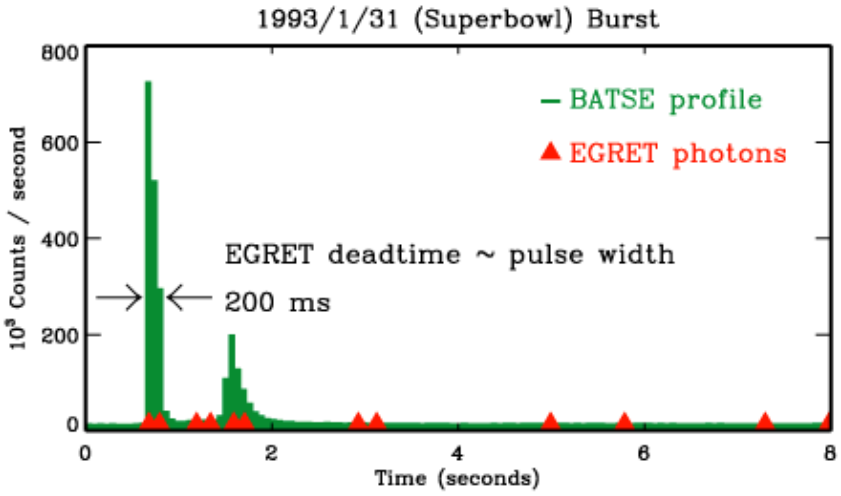
- Need more exposure and optimal timing (and radio monitoring) to discover more gamma-ray PSRs.



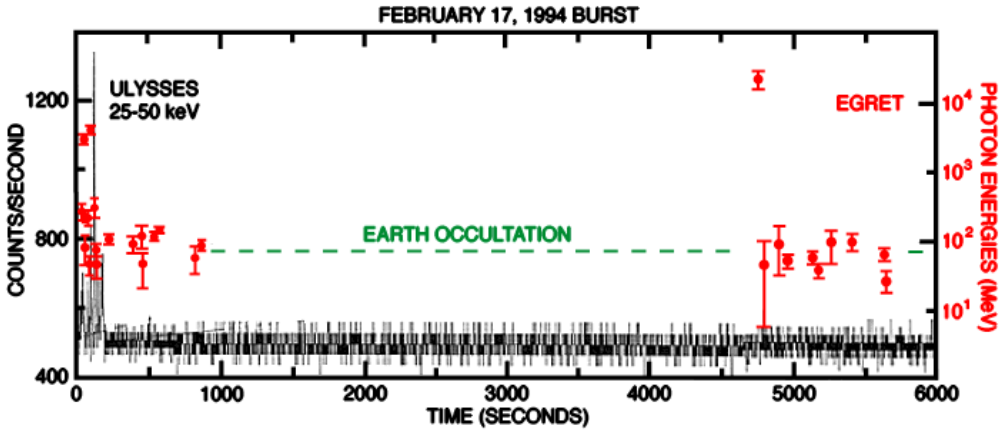
# Challenge # 3

- Need fast timing for gamma-ray detection (improving EGRET deadtime, 100 msec → 100 microsec or less).

Prompt Emission (GRB 930131)

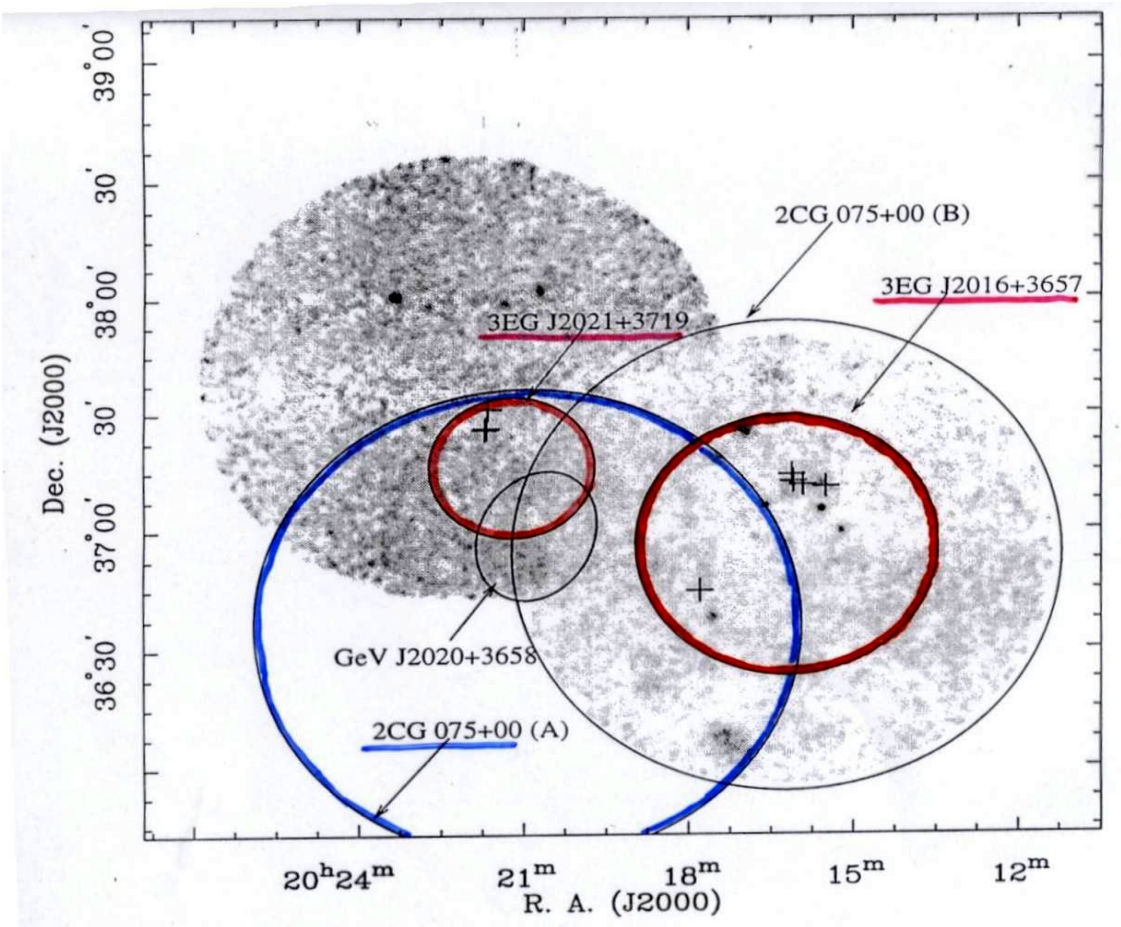



Delayed Emission (GRB 940217)



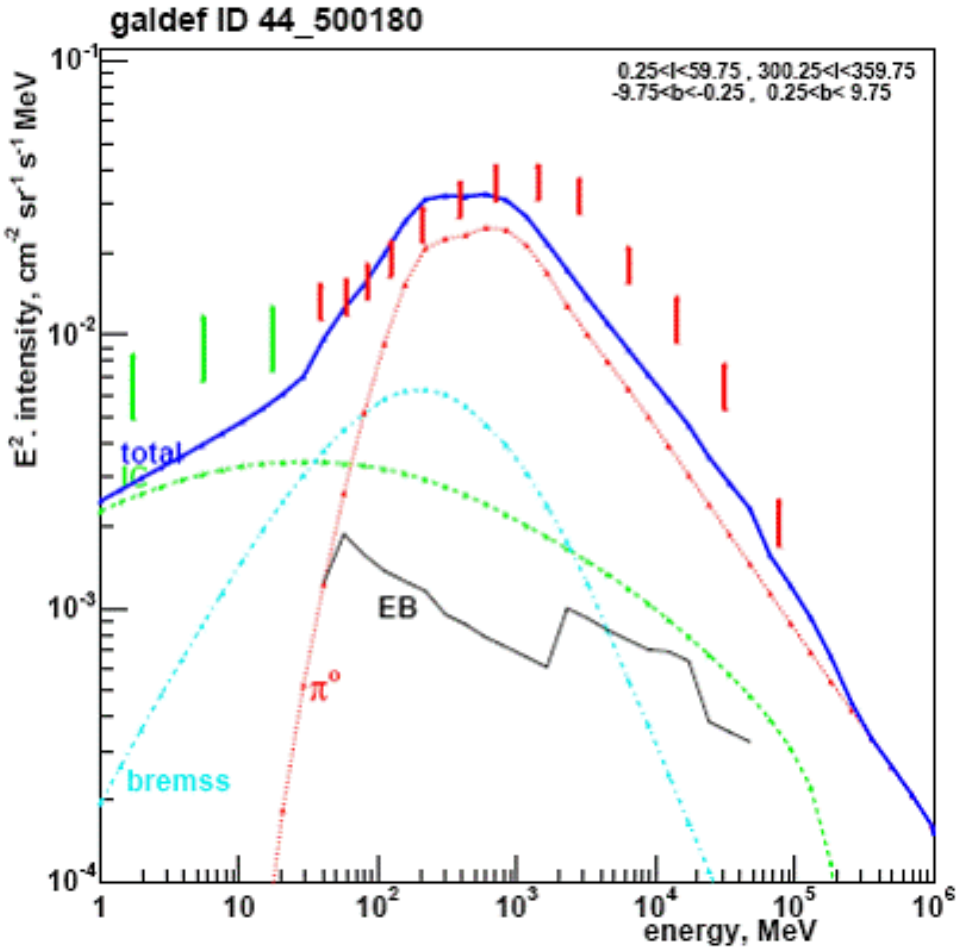
# Challenge # 4

- Need arcminute positioning of gamma-ray sources (improving EGRET error box radii by a factor of 2-10).

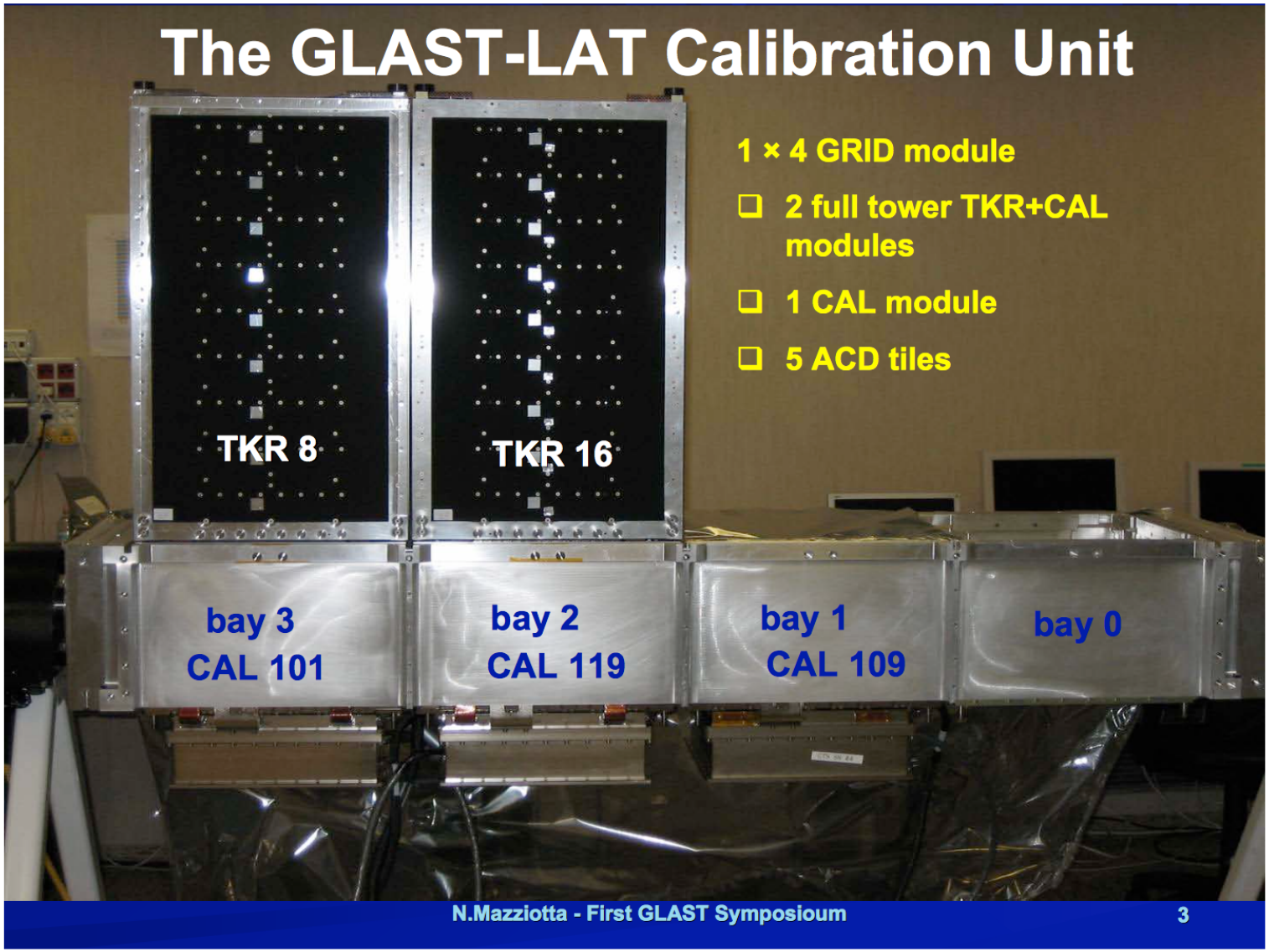


# Challenge # 5

- Need improvements in Spectral Resolution fo check for DM signals

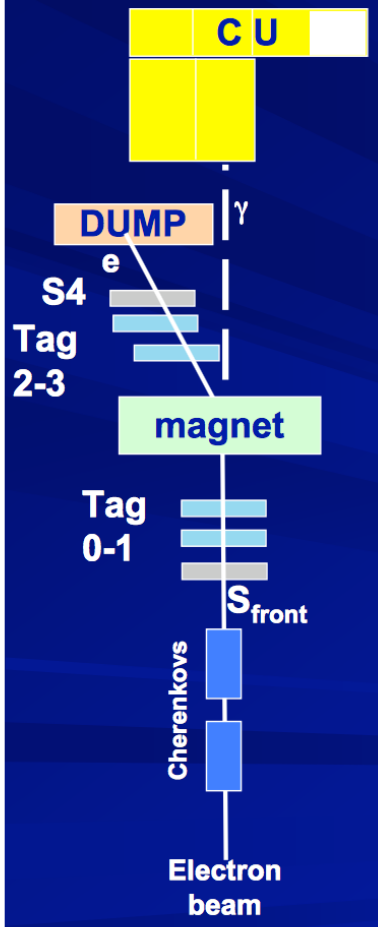


# Beam test


The GLAST-LAT Calibration Unit
1 × 4 GRID module
2 full tower TKR+CAL modules
1 CAL module
5 ACD tiles
TKR 8
TKR 16
bay 3
CAL 101
bay 2
CAL 119
bay 1
CAL 109
bay 0
N.Mazziotta - First GLAST Symposioum
3

# Beam test

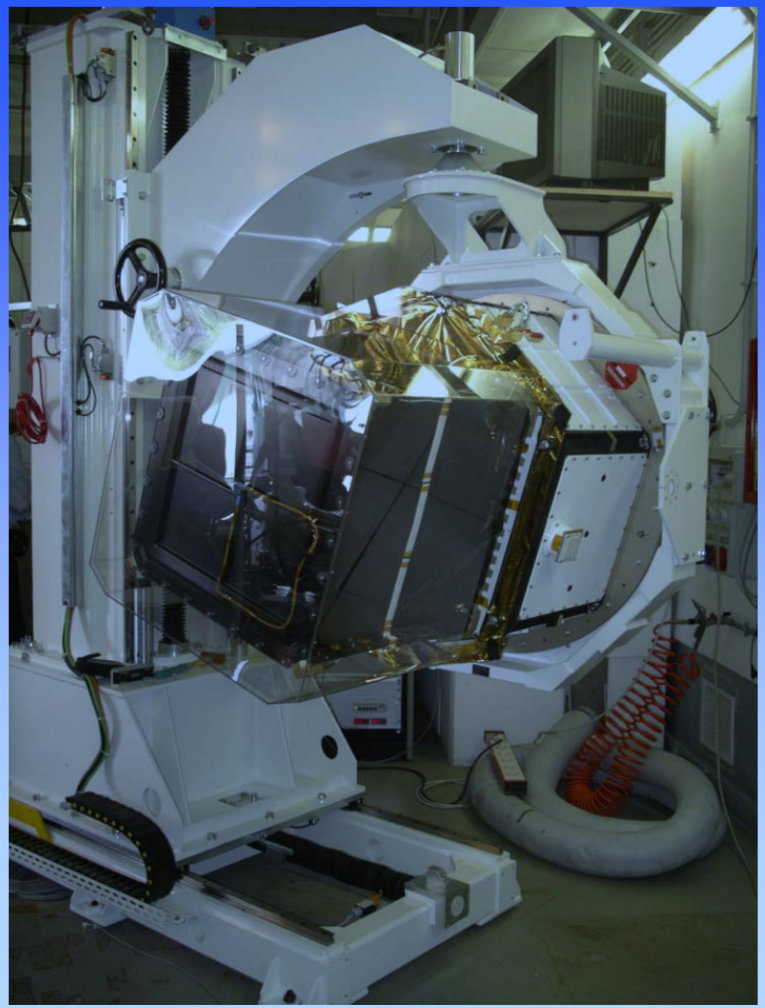
## Photon configuration set-up




**The gamma ray beam at the CERN PS T9 line was produced by bremsstrahlung between electrons and the upstream materials. A magnet has been used to well separate electrons from photons. Finally a beam dump has been used to stop electrons.**

- Tagged photon beam
  - An external tracker (4 x-y view silicon strip detector) was used to track electrons upstream and downstream the magnet, read-out by means of an external DAQ
  - Trigger on S4&$S_{front}$ & Cherenkovs
  - External DAQ was synchronized with the CU one, then the data have been merged with the CU one
  - Different electron beam energy in the range 0.5-2.5 GeV and magnetic field intensity have been used to provide a gamma spectrum to the CU below 2 GeV
- Not tagged photon beam
  - Trigger on $S_{front}$ & Cherenkov
  - Full bremsstrahlung spectrum from 2.5GeV/c electron beam

# AGILE calibration

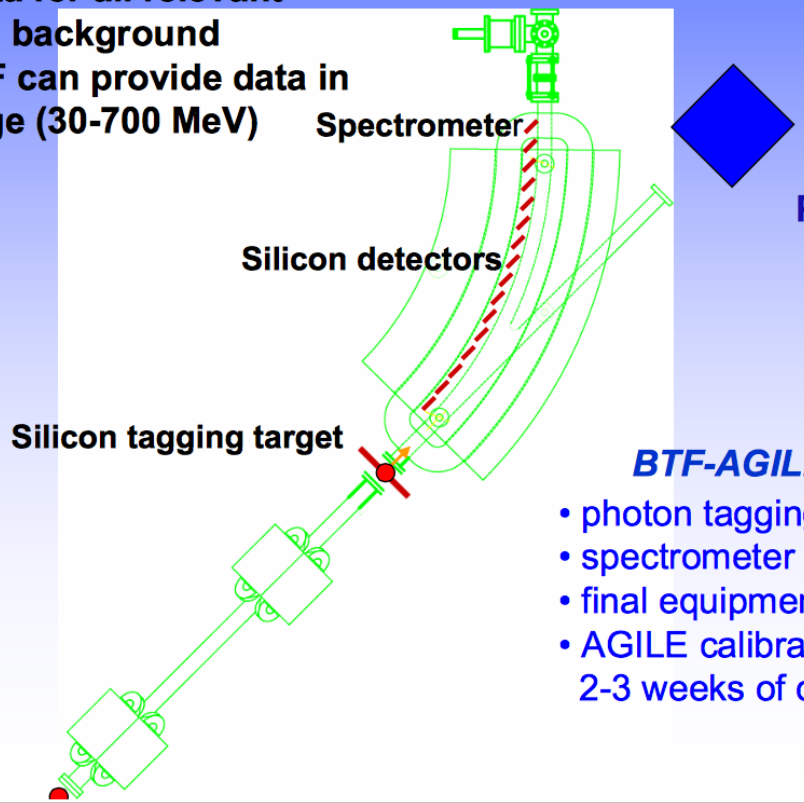


# AGILE calibration

**INFN-LNF-BTF Photon-Tagged Source**

**AGILE GRID Photon Calibration**

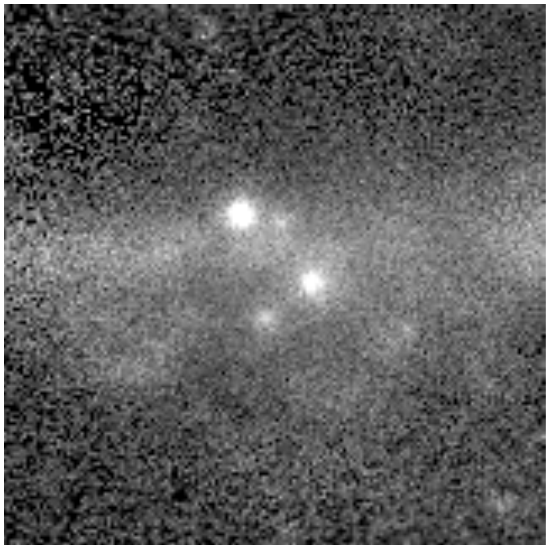
**The AGILE Gamma Ray Imaging Detector calibration at BTF is aimed at obtaining data for all relevant geometries and background conditions. BTF can provide data in the energy range (30-700 MeV)**

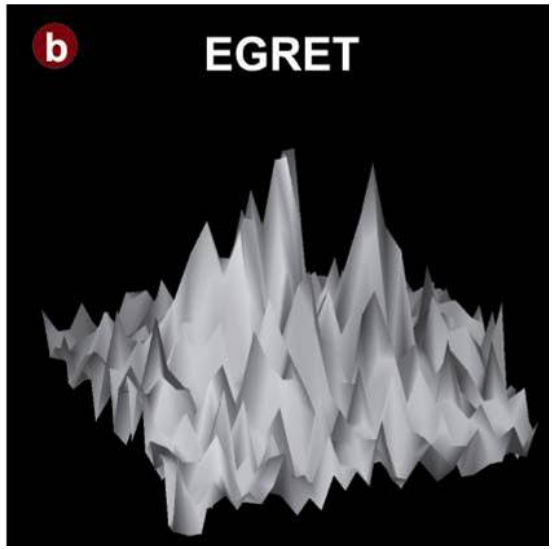


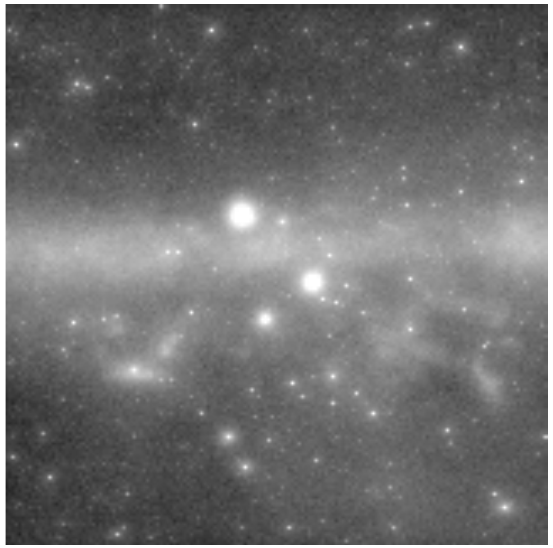

***BTF-AGILE Schedule***

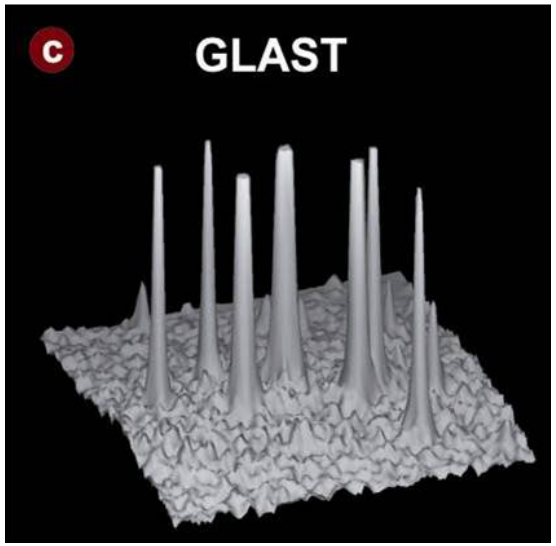
- photon tagging system (PTS)
- spectrometer PTS calibration
- final equipment test (Oct.)
- AGILE calibration, 2-3 weeks of data collection

# Technology impact -- PSF








*Cygnus region ($15^0$ x $15^0$), $E\gamma > 1$ GeV*

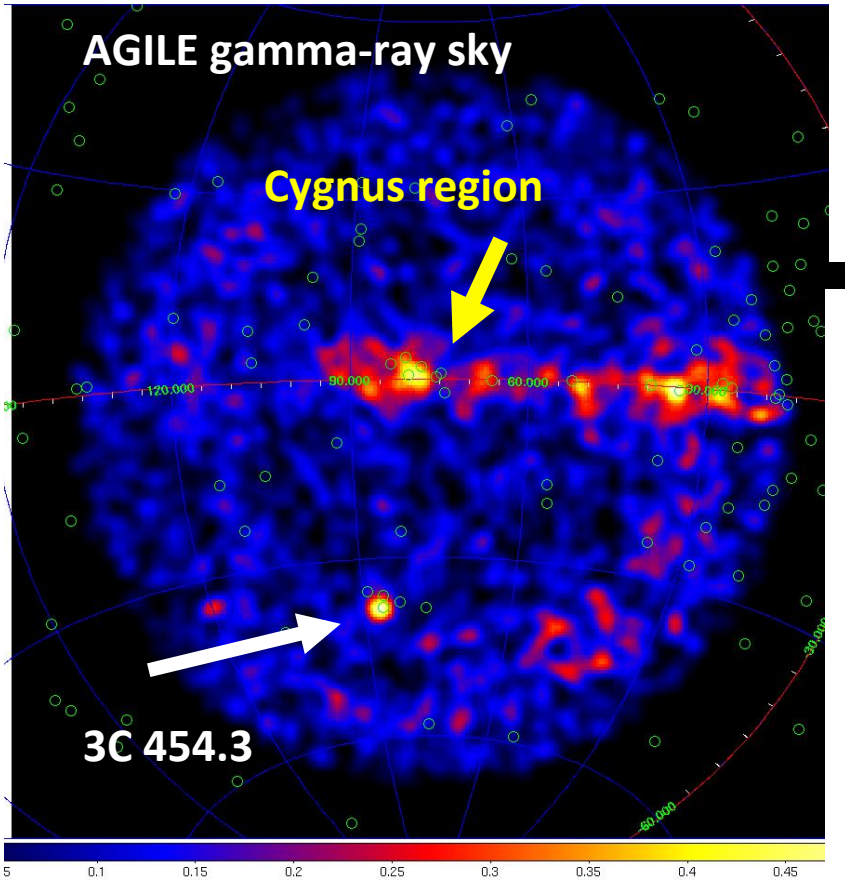
**EGRET**
**(1991-2000)**
Phases 1-5

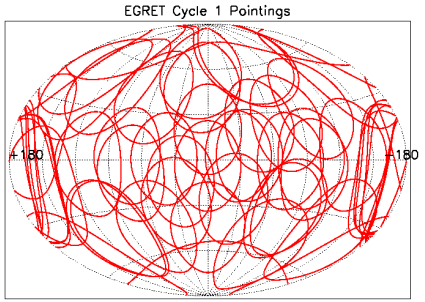
**Spark chamber**
- **sense electrode spacing ~mm**
- **sensitive layer depth ~cm**
  - ***up to 28 hit over >1m***

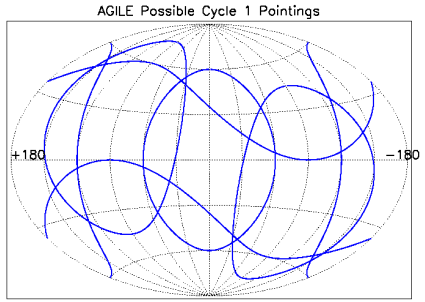
**LAT**
**(2008- >2013)**
1-yr simulation

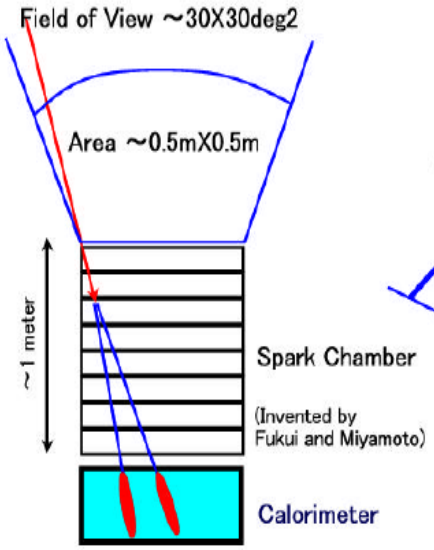
**Si-strip detectors**
- **sense electrode spacing ~0.2mm**
  - ***better single hit resolution***
- **sensitive layer depth ~0.4mm**
  - ***up to 36 hit over 0.8m***
  - ***converter proximity to minimize MCS***

# Technology impact - FoV

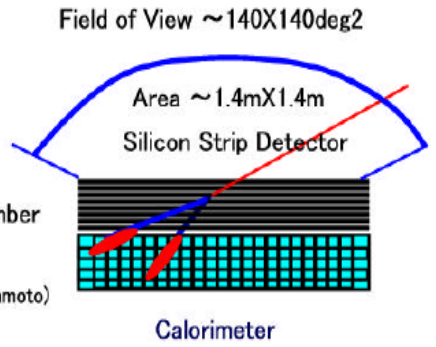


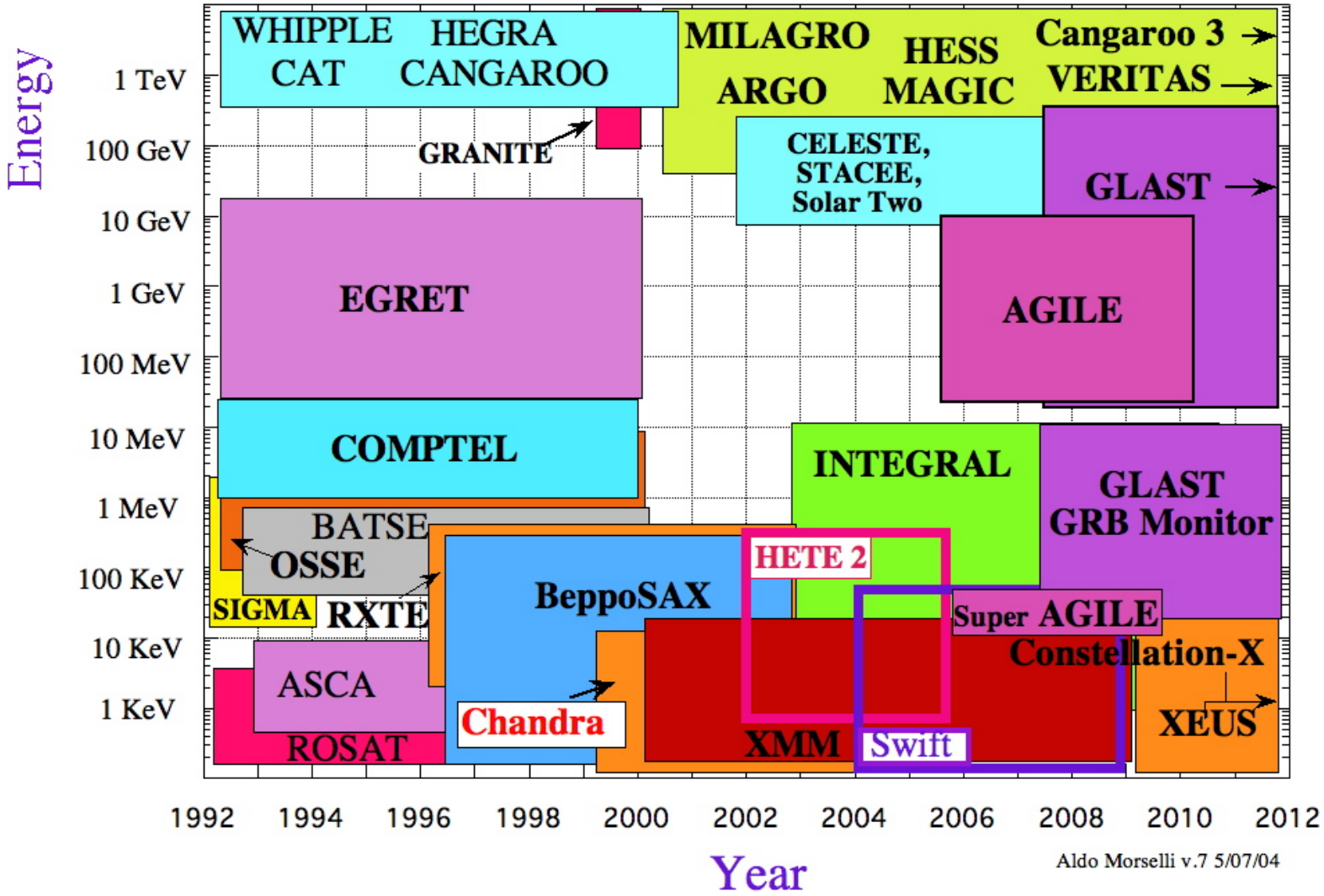




EGRET on Compton GRO




GLAST Large Area Telescope

# After a long story ...



# AGILE

# AGILE

agenzia spaziale italiana

INAF

INFN

CARLO GAVAZZI

Carlo Gavazzi Space SpA

OERLIKON CONTRAVES

ALCATEL ALENIA SPACE

An Alcatel/Finmeccanica company

telespazio

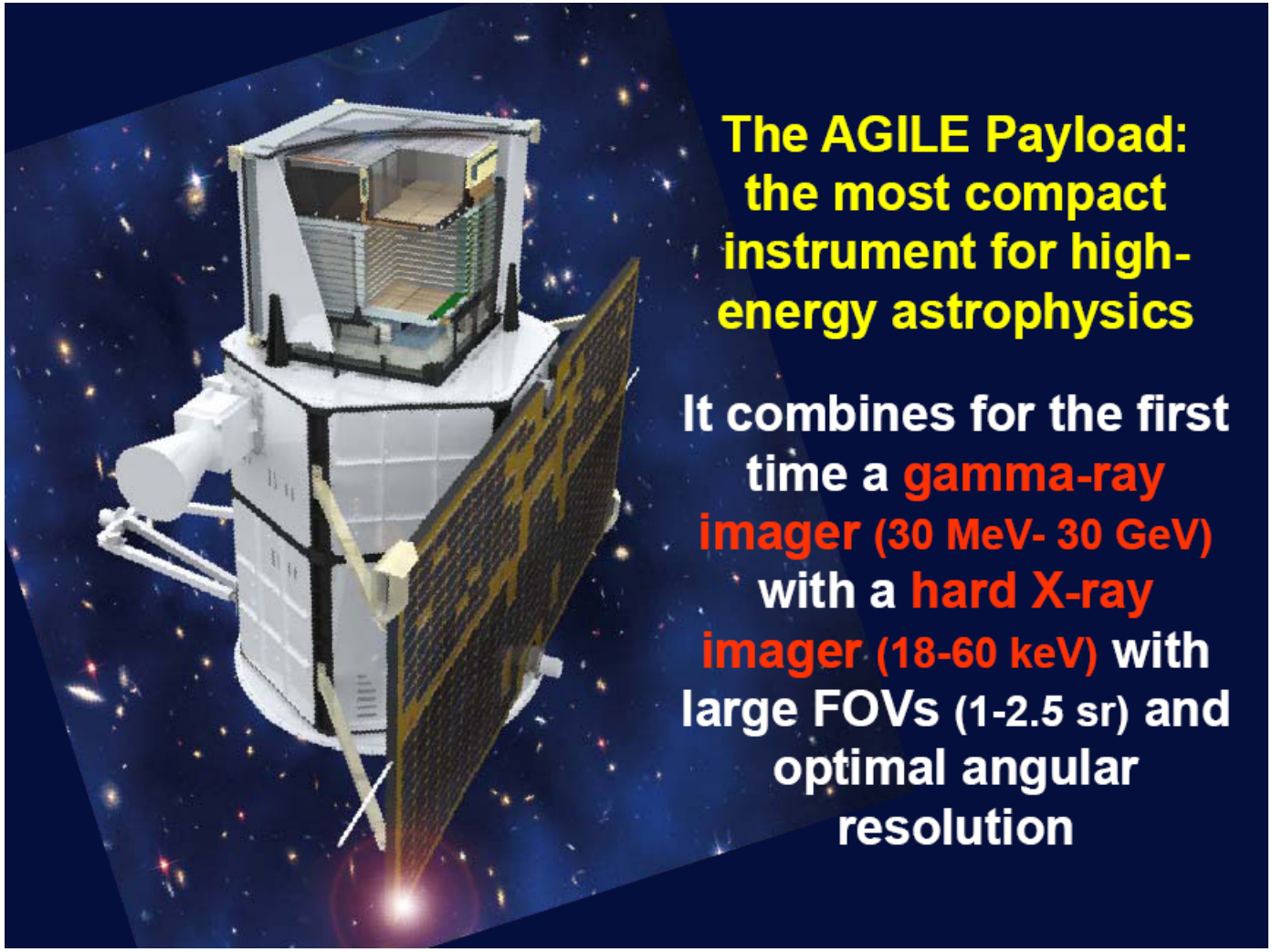
A Finmeccanica/Alcatel company

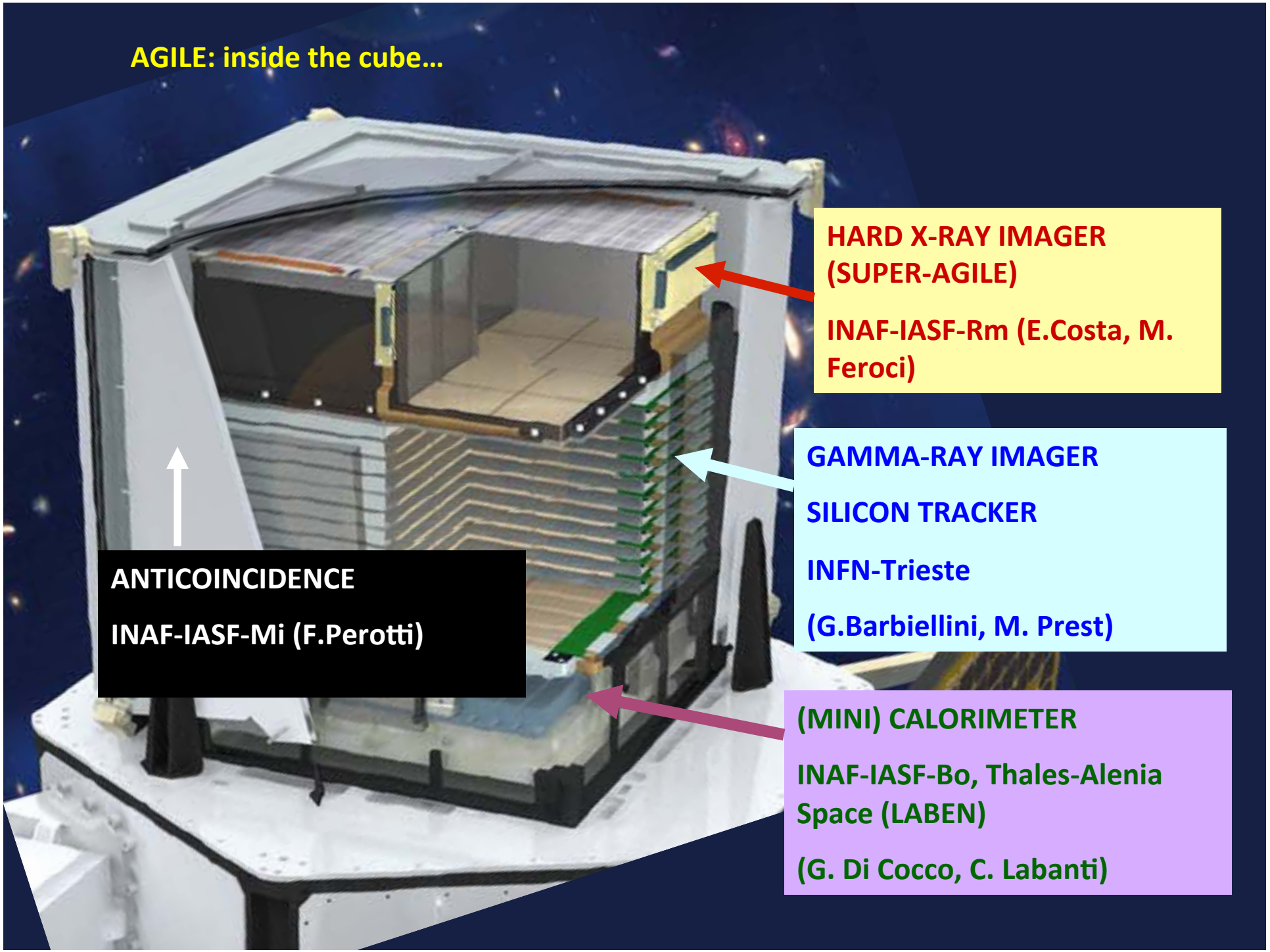
Galileo Avionica

MIPOT

ENEA

# AGILE instrument




AGILE: inside the cube…
HARD X-RAY IMAGER (SUPER-AGILE)
INAF-IASF-Rm (E.Costa, M. Feroci)
GAMMA-RAY IMAGER
SILICON TRACKER
INFN-Trieste
(G.Barbiellini, M. Prest)
ANTICOINCIDENCE
INAF-IASF-Mi (F.Perotti)
(MINI) CALORIMETER
INAF-IASF-Bo, Thales-Alenia Space (LABEN)
(G. Di Cocco, C. Labanti)

# The Silicon Tracker

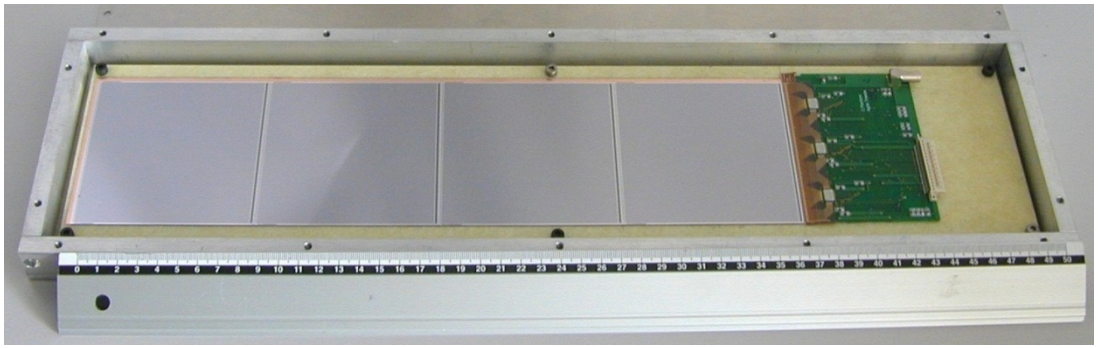
## The AGILE silicon detectors

Detector specifications:

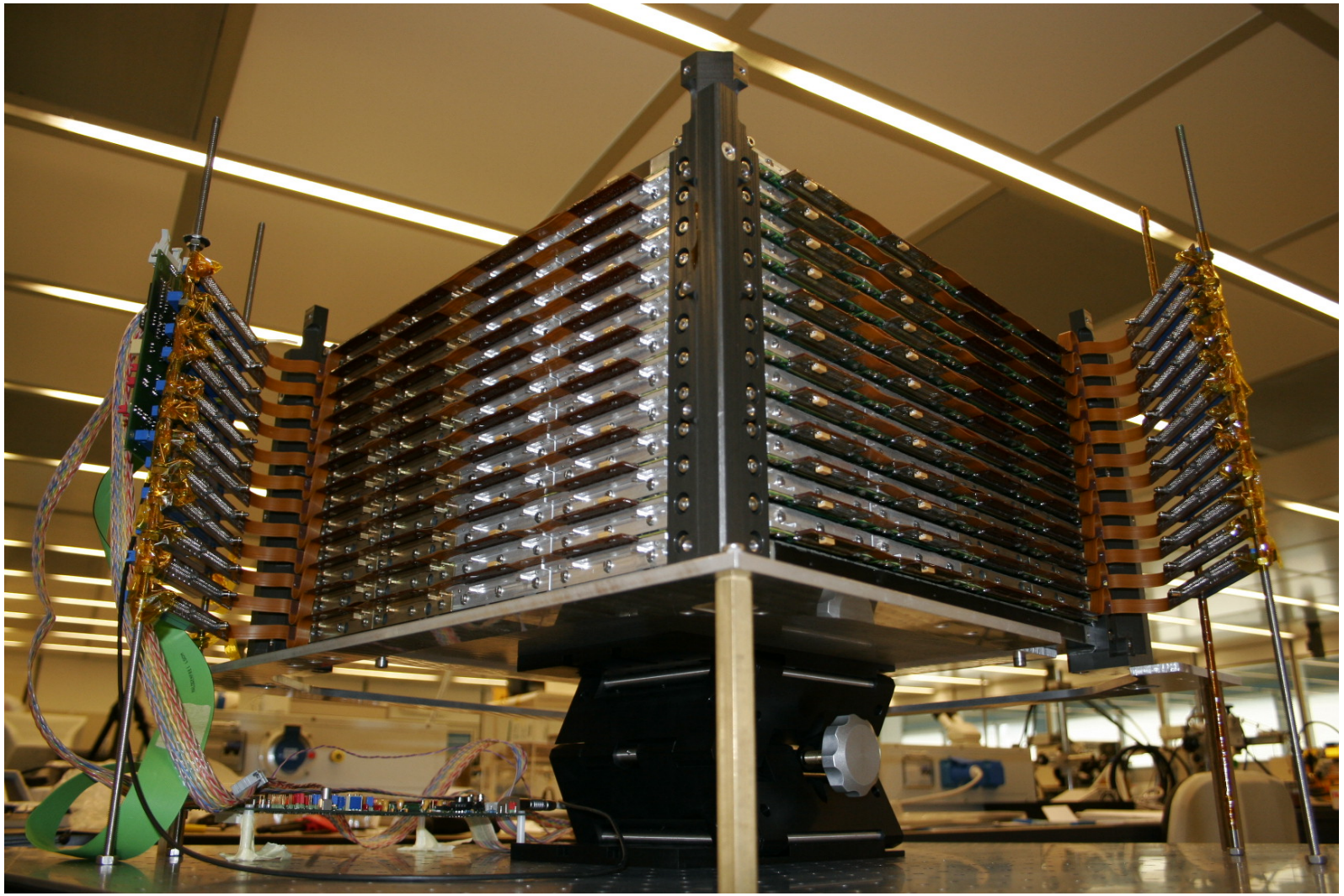
- dimension: 9.5x9.5 $cm^2$
- thickness: 410 μm (6 inch technology )
- readout pitch: 242 μm;
  physical pitch: 121 μm (one floating strip)
- number of strips/ladder: 384
- Single side and AC-coupled
- leakage current: 2 $nA/cm^2$ at Vbias=2.5*$V_{FD}$ =200 V
- polarization resistor: 40 MΩ
- coupling capacitor: 55 pF/cm
- Al strip resistance: 4.3 Ω/cm
- max number of bad strips: <1%
- average number of bad strips: <0.5%

## The AGILE frontend chip: TA1 → TAA1

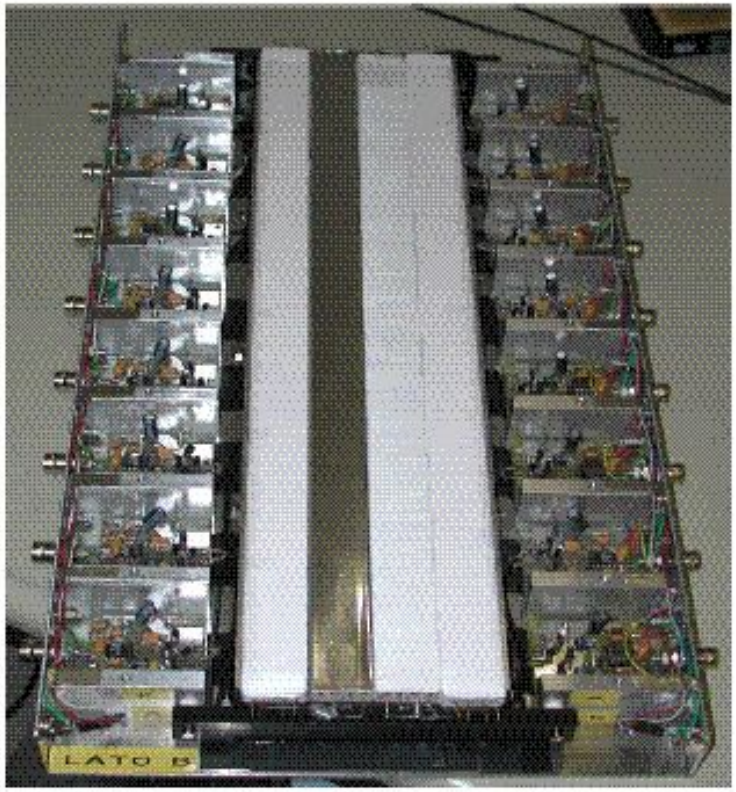
- low noise, low power, SELF-TRIGGERING
- technology: 1.2 μ CMOS, double poly, double metal (final: 0.8 μ BiCMOS on epitaxial layer )
- features:
  - 128 channels
  - gain: 25 mV/fC; range: 18 fC
  - noise ($e^-$ rms): 165+6.1/pF for $T_{peak}$=2 μs
  - power: <0.4 mW/channel
  - power rails: ±2 V
  - readout frequency: 5 Mhz
  - gain spread: <1.5%
  - threshold offset spread (TA1): 20% (in TAA1 will be implemented a 3 bit DAC per channel)



# The AGILE TRK



# The CsI Mini-Calorimeter



## MINI-CALORIMETER

**DETECTOR**

30 CsI bars wrapped with tight diffusion material organized in 2 orthogonal trays

- bar dimension: 40x2.3x1.5 $cm^3$
- total radiation length: $1.5X_0$ (in axis)

**FRONTEND ELECTRONICS**

- 1 photodiode on each side of the bar
- optically coupled

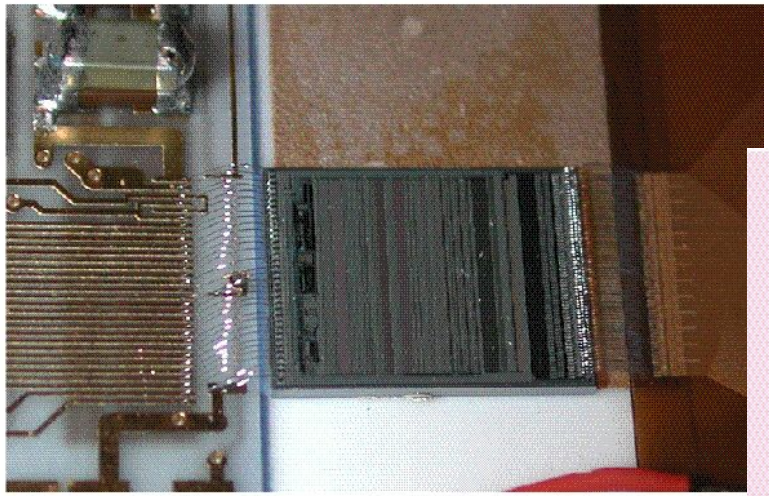
**GOAL**

- measure energy deposit of the photon conversion pair (GRID mode)
- detect GRBs and transients in the range 0.25-250MeV (BURST mode)

**SCIENTIFIC FEATURES**

- energy resolution: 22-24%(FWHM) @ 1MeV
  0.7% @ 100MeV
- spatial resolution: 15mm @ 1MeV
  2mm @ 100MeV
- timing resolution: 2$\mu$s (BURST mode)

# SuperAGILE X-ray detector



## SUPER-AGILE

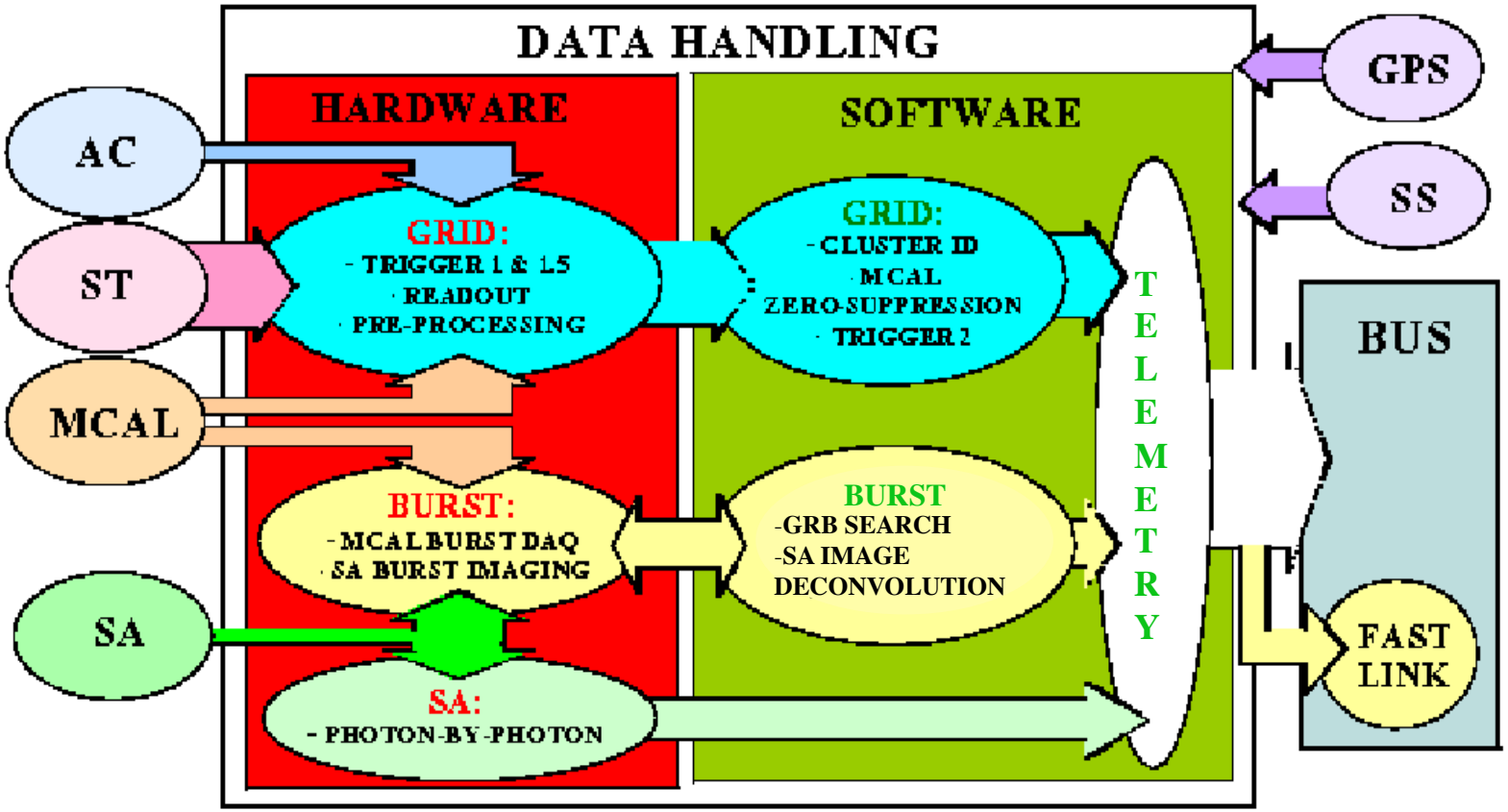
**DETECTOR**
- plane with 16 silicon tiles organized in 4 1D detectors
- each detector: 1536 readout strips (0.121mm pitch)
- a coded mask system

**FRONTEND ELECTRONICS**
- 12 self-triggering readout ASICs (128 channels each) per each detector, positioned on a kapton-FR4 hybrid

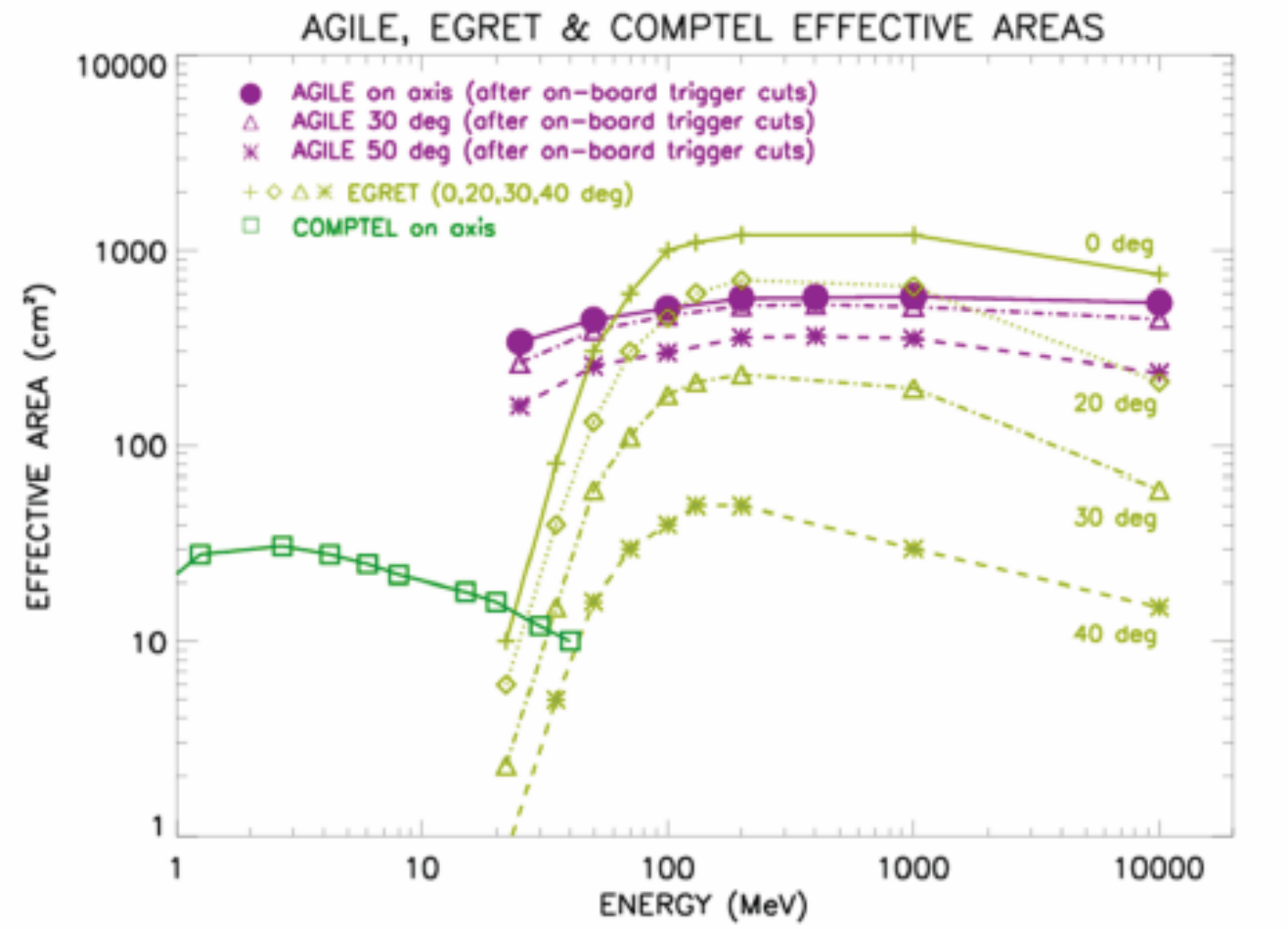
**GOAL**
measure X-rays in the energy range 10-40keV to detect GRBs, transients, galactic and extra-galactic sources

**SCIENTIFIC FEATURES**
- imaging: 1'-3' at ~20mCrab
- timing resolution: 5μs
- energy resolution: 4keV (FWHM)
- flux sensitivity: ~5mCrab (15keV)

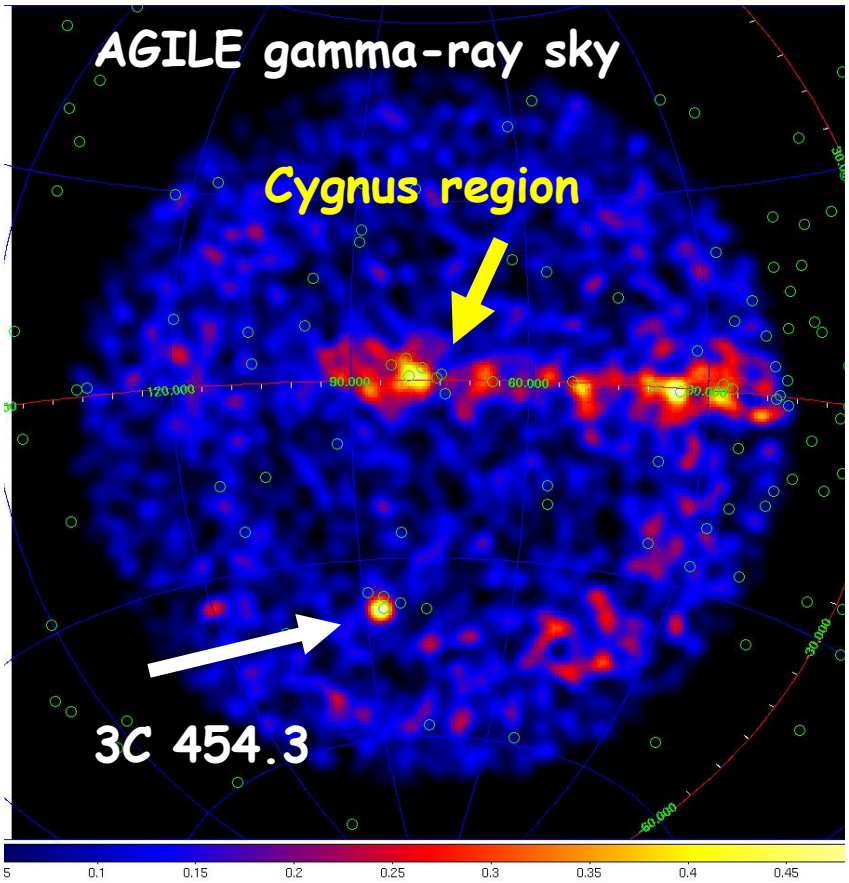
# On Board AGILE Trigger

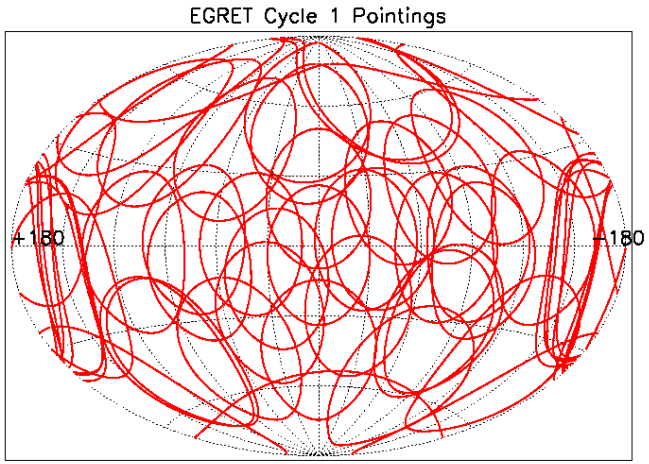


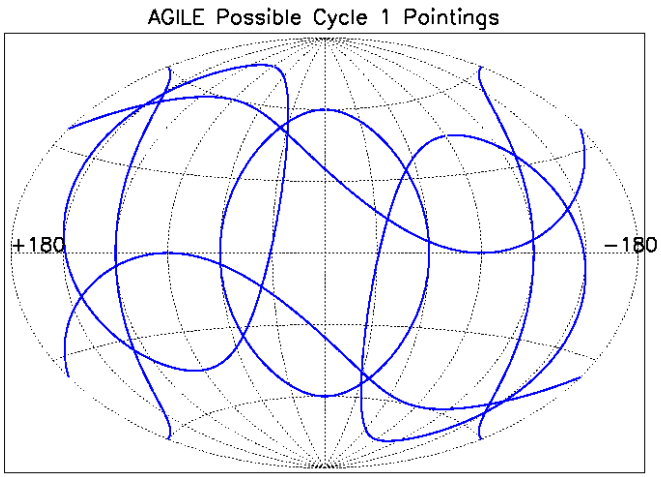
# Performance



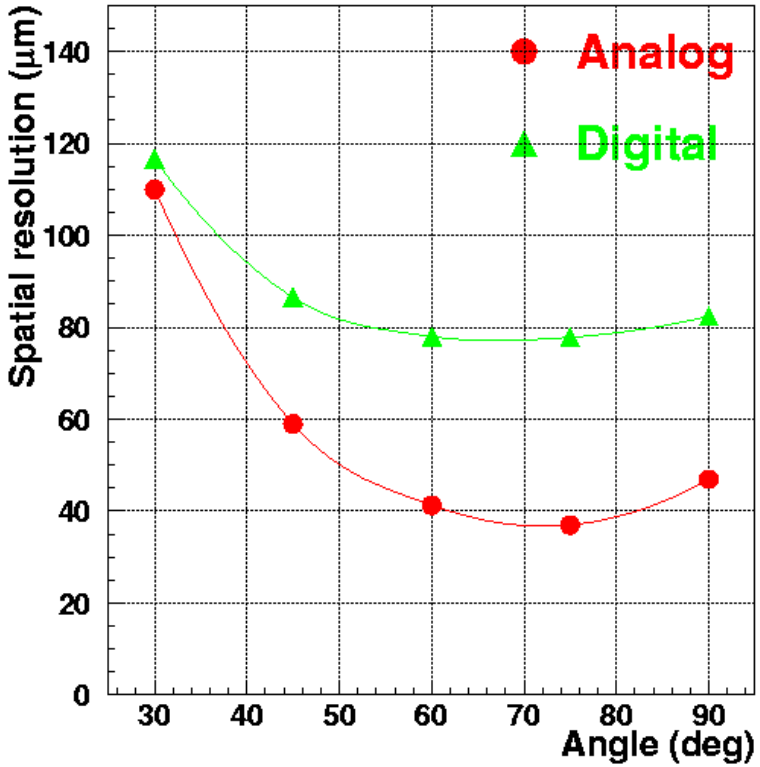
# Si Self Trigger and FoV

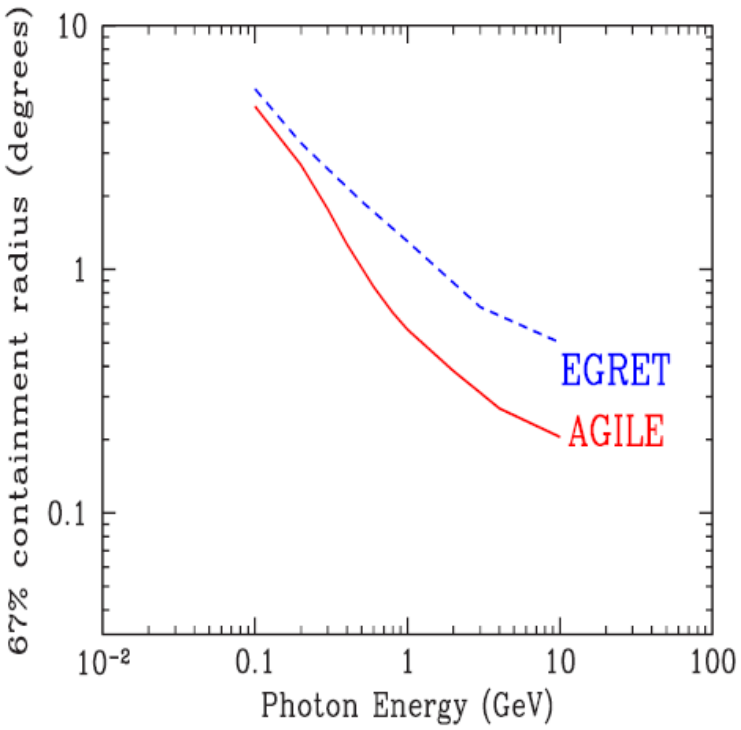


# Analog readout and PSF



# The AGILE launch