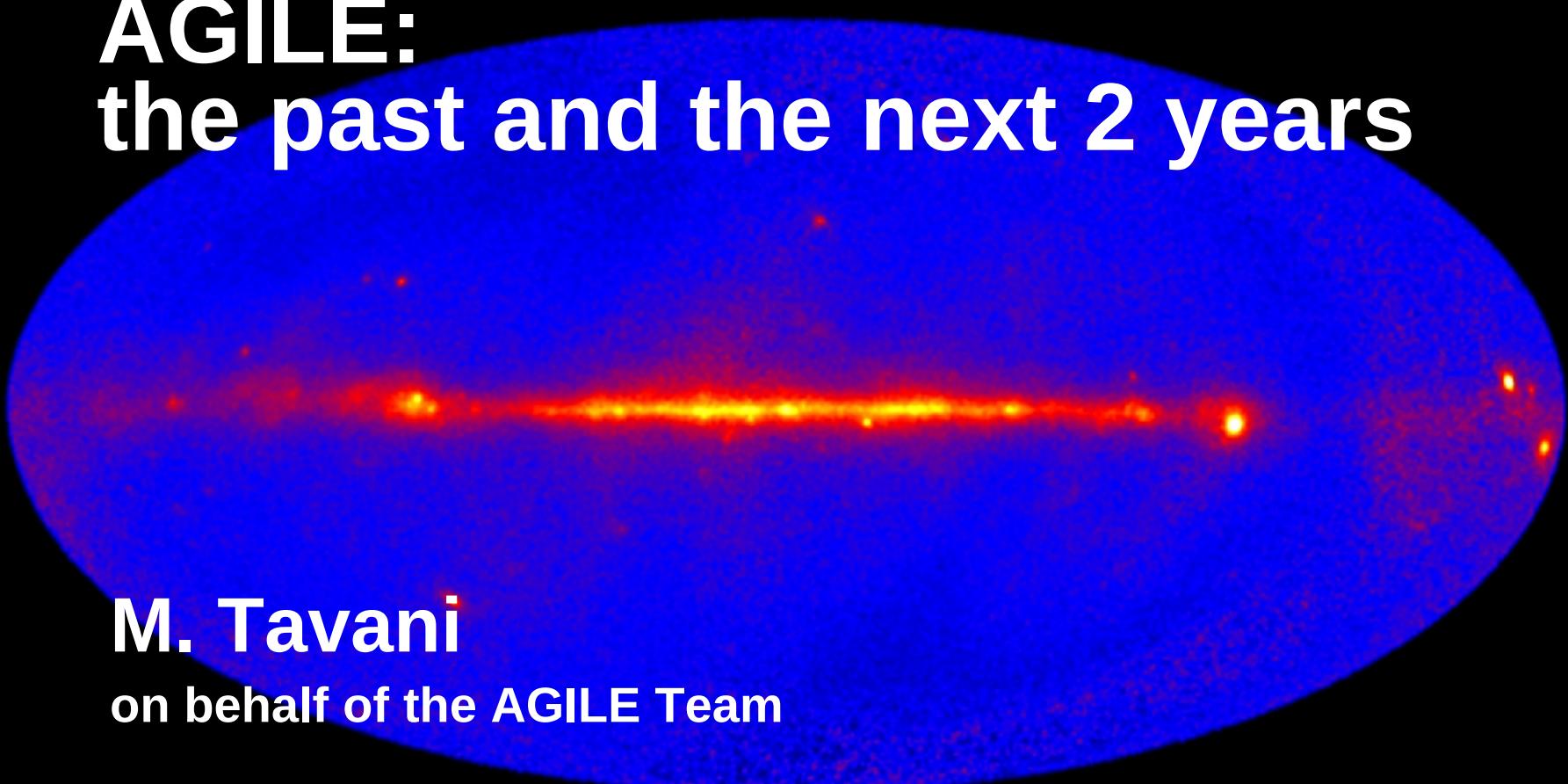


AGILE: the past and the next 2 years

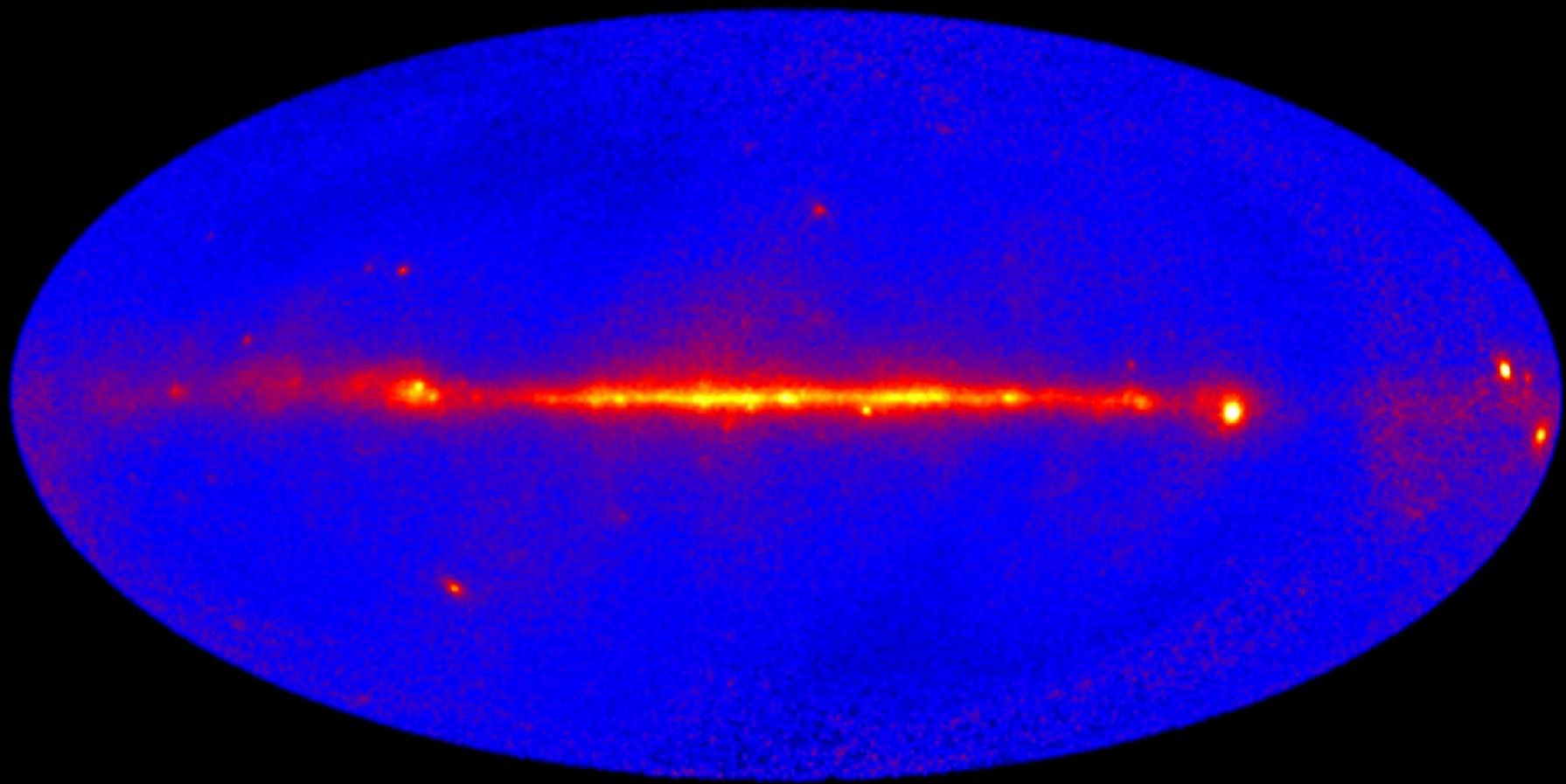


M. Tavani
on behalf of the AGILE Team

7th AGILE Workshop, Sept. 29, 2009

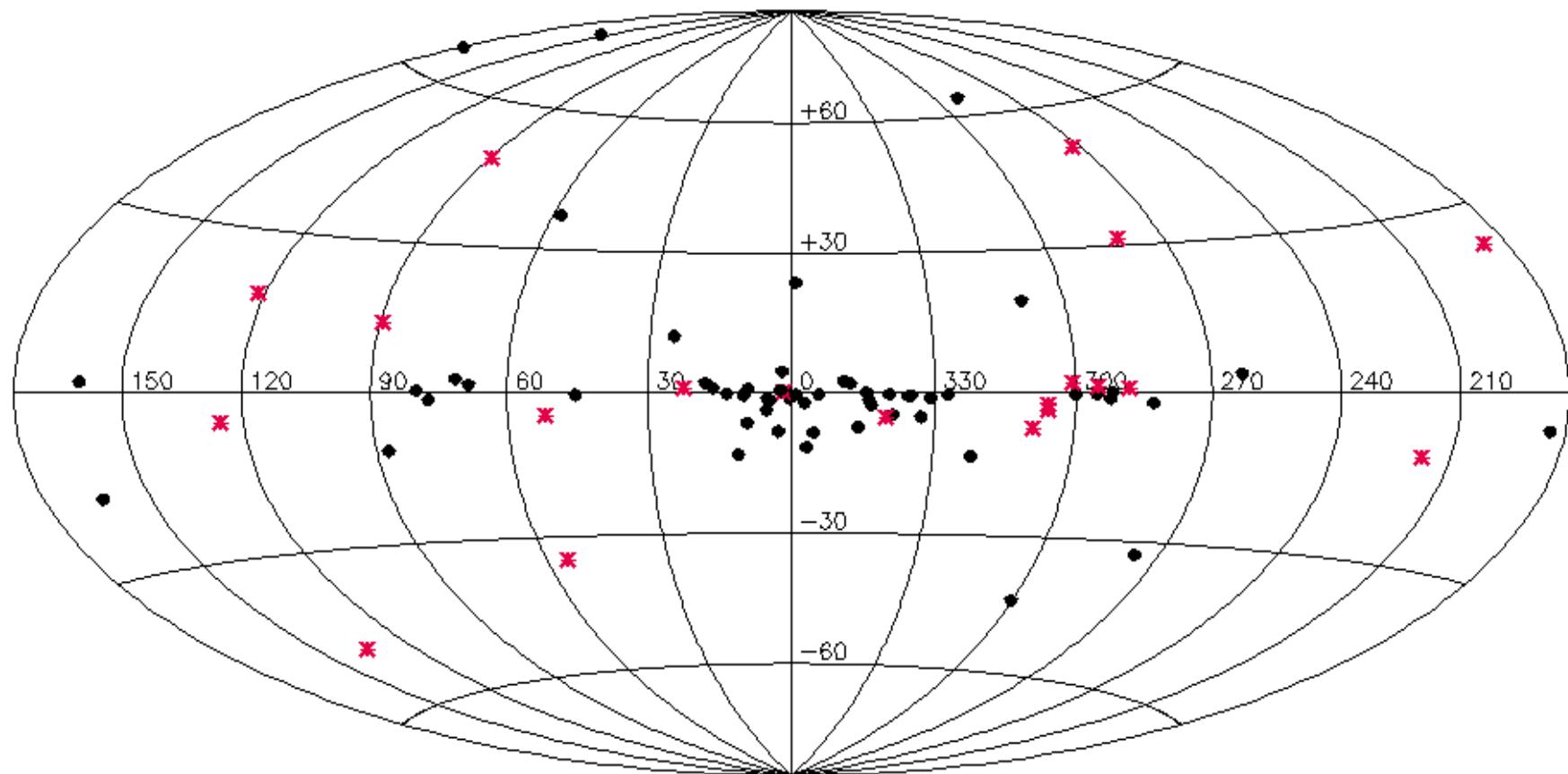
The AGILE gamma-ray sky ($E > 100$ MeV)

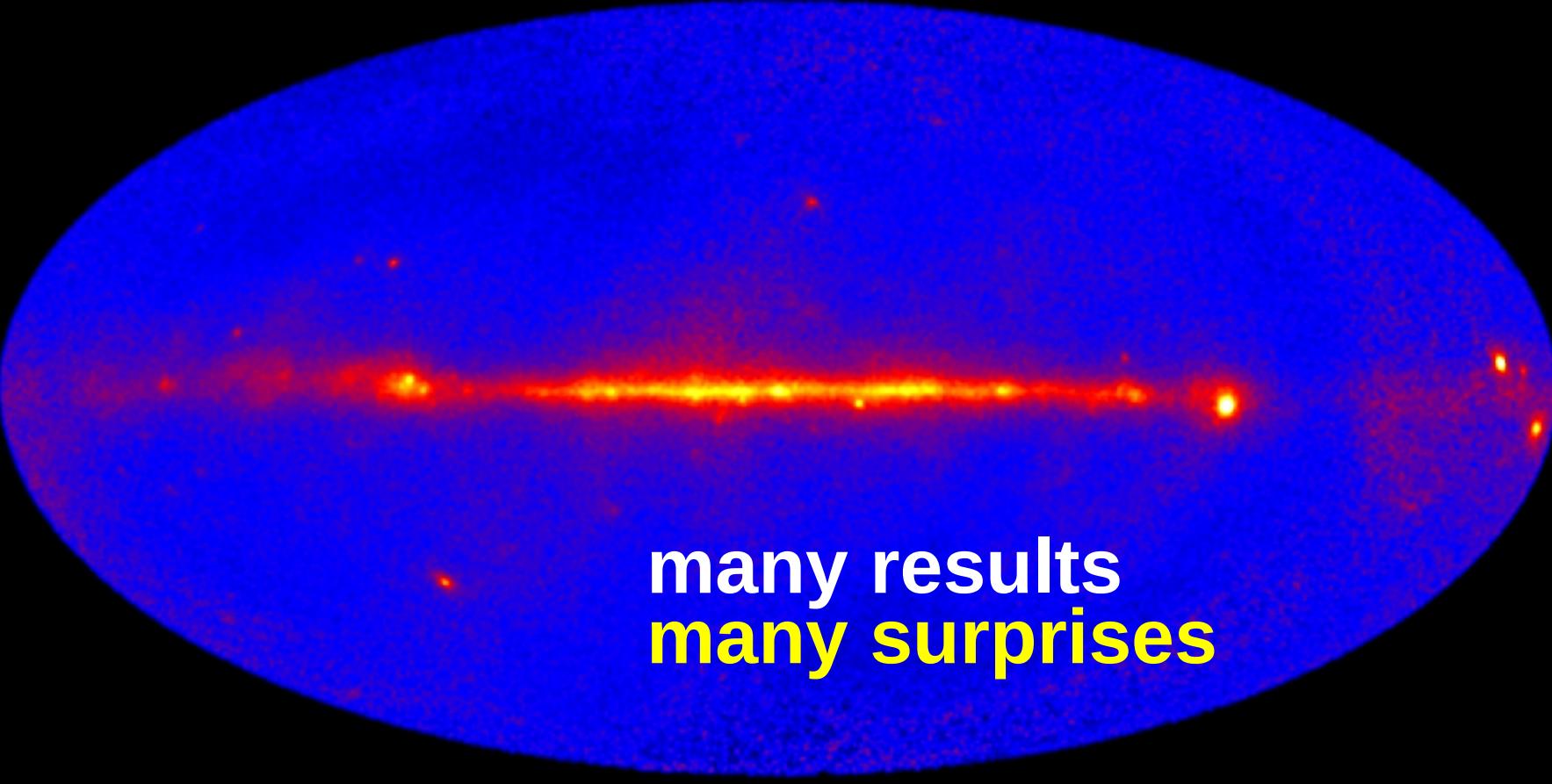
2 year exposure: July 2007 – June 2009



hard X-ray sources (18-60 keV), 2 years

SuperAGILE OBSERVED SOURCES





**many results
many surprises**

Gamma-ray astrophysics missions (above 30 MeV)

SAS-2	NASA	Nov. 1972 – July 1973
COS-B	ESA	Aug. 1975 – Apr. 1982
CGRO	NASA	Apr. 1991 – Jun. 2000
AGILE	ASI	April 23, 2007
FERMI	NASA	June 11, 2008

AGILE: 2 and 1/2 years in orbit...

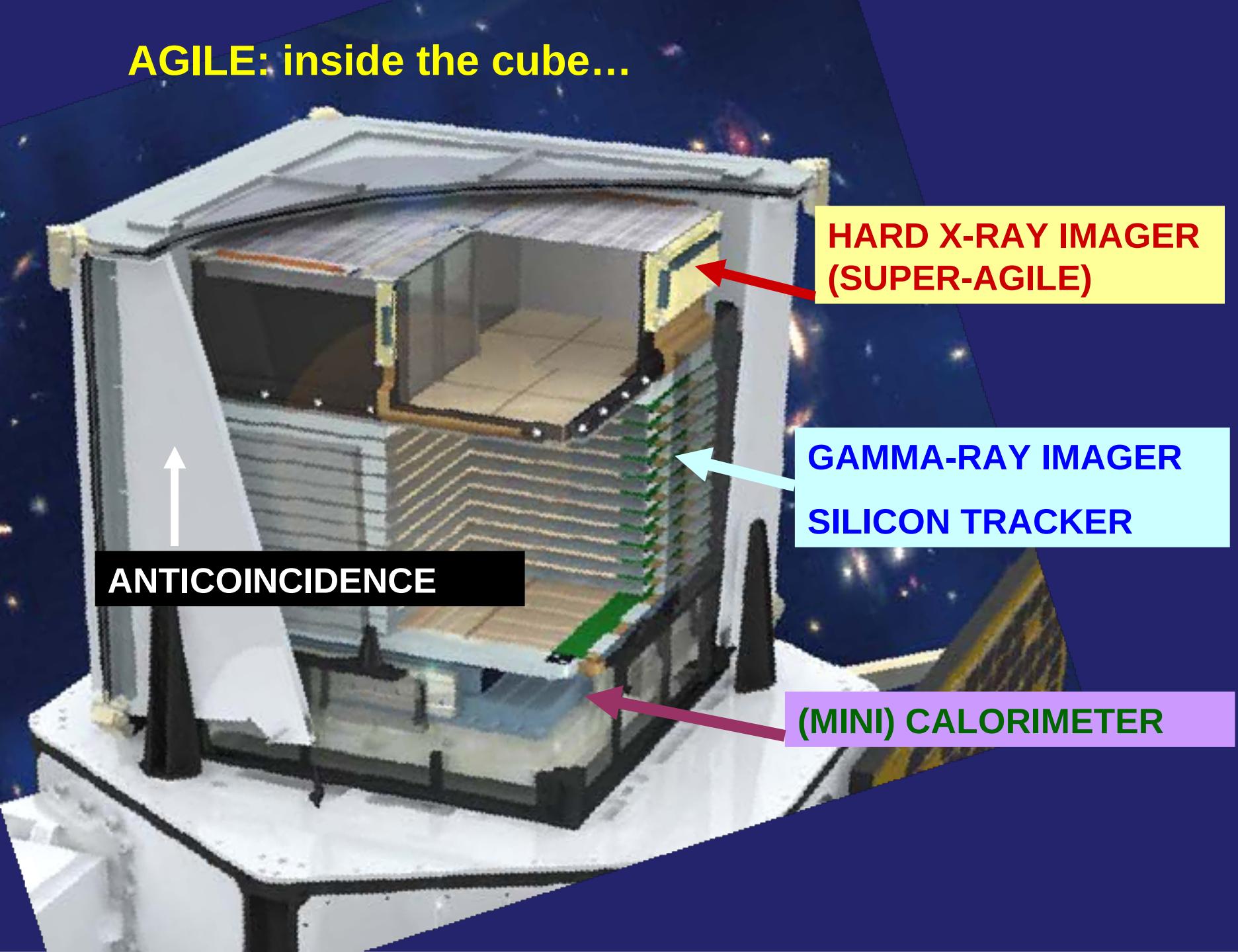
- ~ 12.600 orbits, September 29, 2009.
- very good scientific performance
- Cycle-1: Dec. 2007- Nov. 2008
- Cycle-2: Dec. 2008- Nov. 2009
- approved funding: 2010-2011



**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) with
large FOVs (1-2.5 sr) and
optimal angular
resolution**

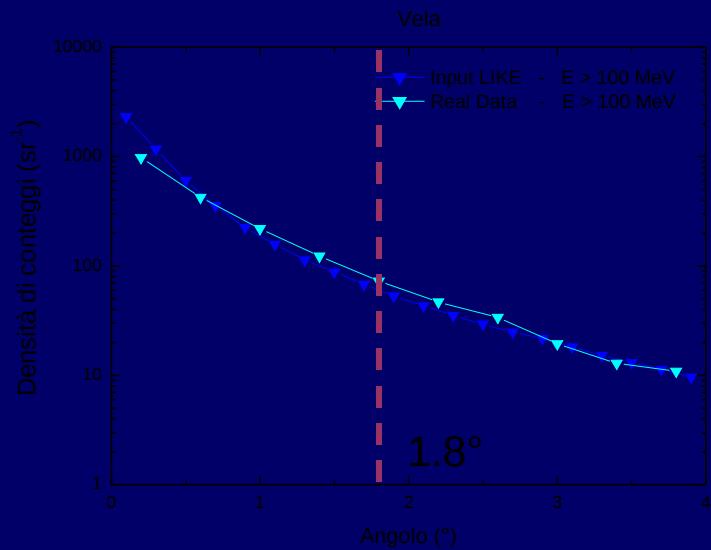
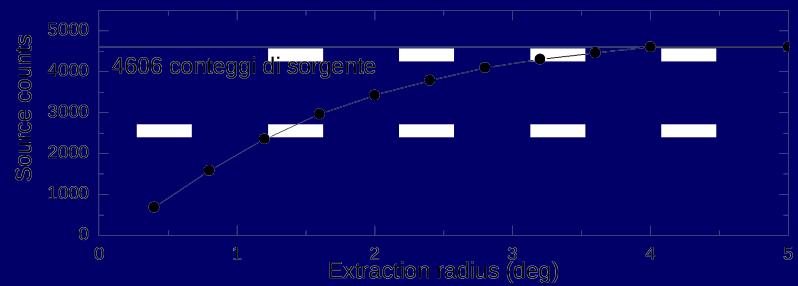
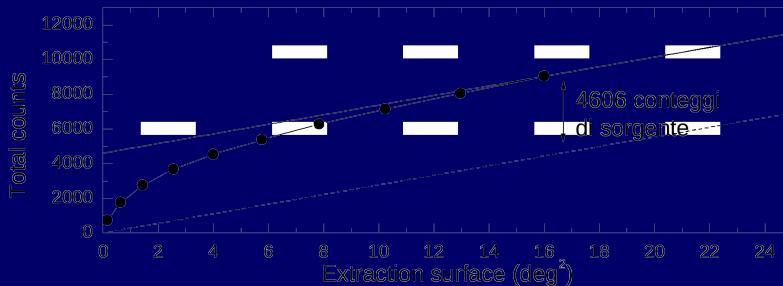
AGILE: inside the cube...



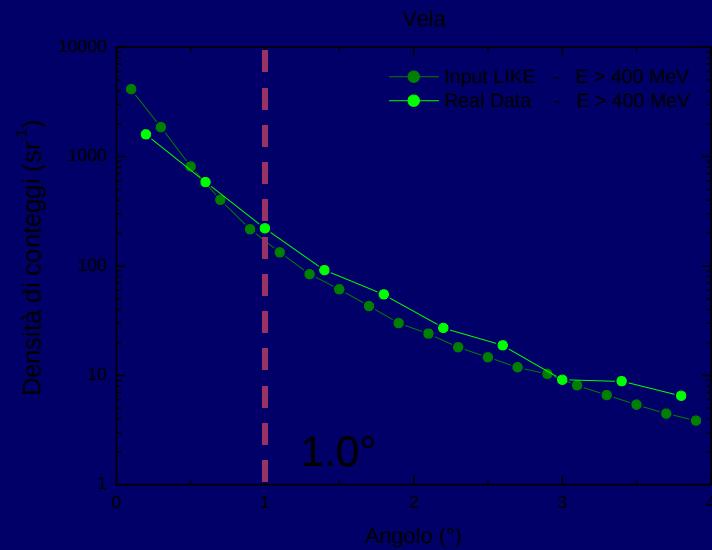
A quick comparison

	AGILE	FERMI/LAT
A_{eff} (100 MeV) (cm ²)	~400	~ 1000-2000
A_{eff} (1 GeV) (cm ²)	500	~ 8000-10000
FOV (sr)	2.5	2.5
sky coverage	1/5	whole sky
Energy resolution (~ 400 MeV)	50 %	10 %
PSF (68 % cont. radius) 100 MeV 1 GeV	$3^{\circ} - 4^{\circ}$ $< 1^{\circ}$	$4^{\circ} - 5^{\circ}$ $< 1^{\circ}$

PSF: real data vs. simulations (G.Pucella, A.Giuliani, A.Chen)

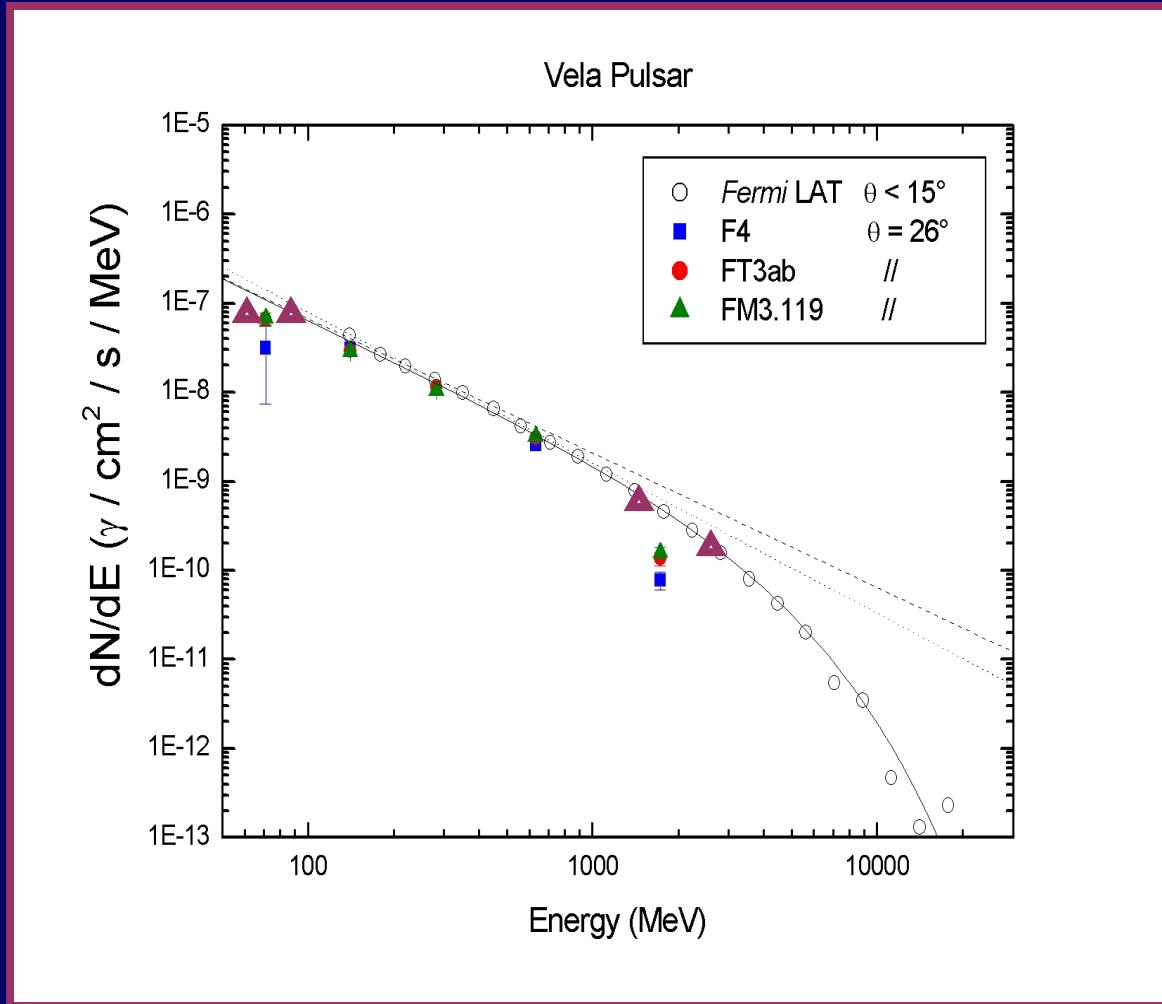


E > 100 MeV



E > 400 MeV

a spectral comparison with Fermi-LAT



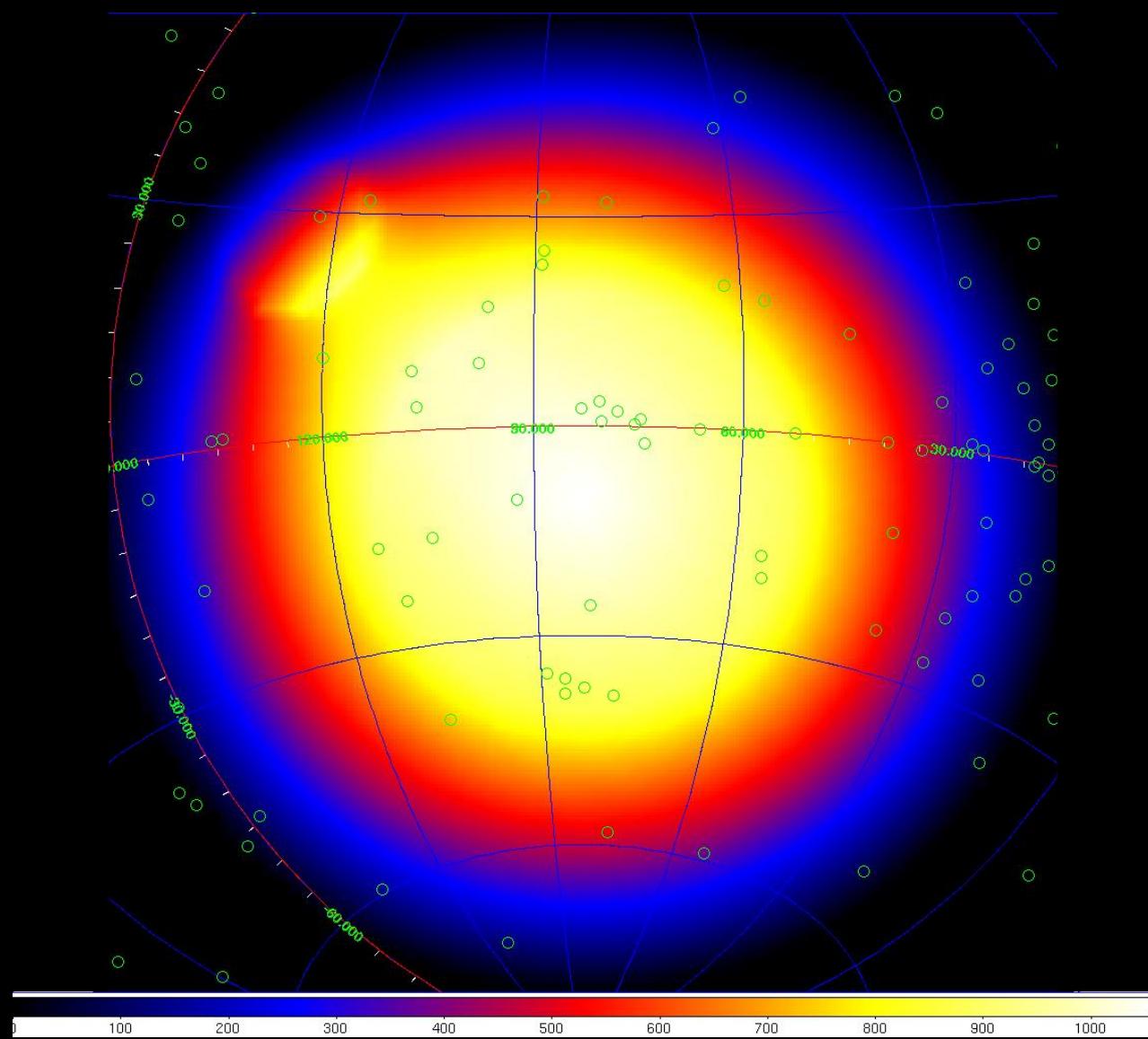
$$\frac{dN}{dE} = A \times E^{-\Gamma} e^{-E/E_c}$$

$$\Gamma = 1.51 \quad ; \quad E_c = 2.9 \text{ GeV}$$

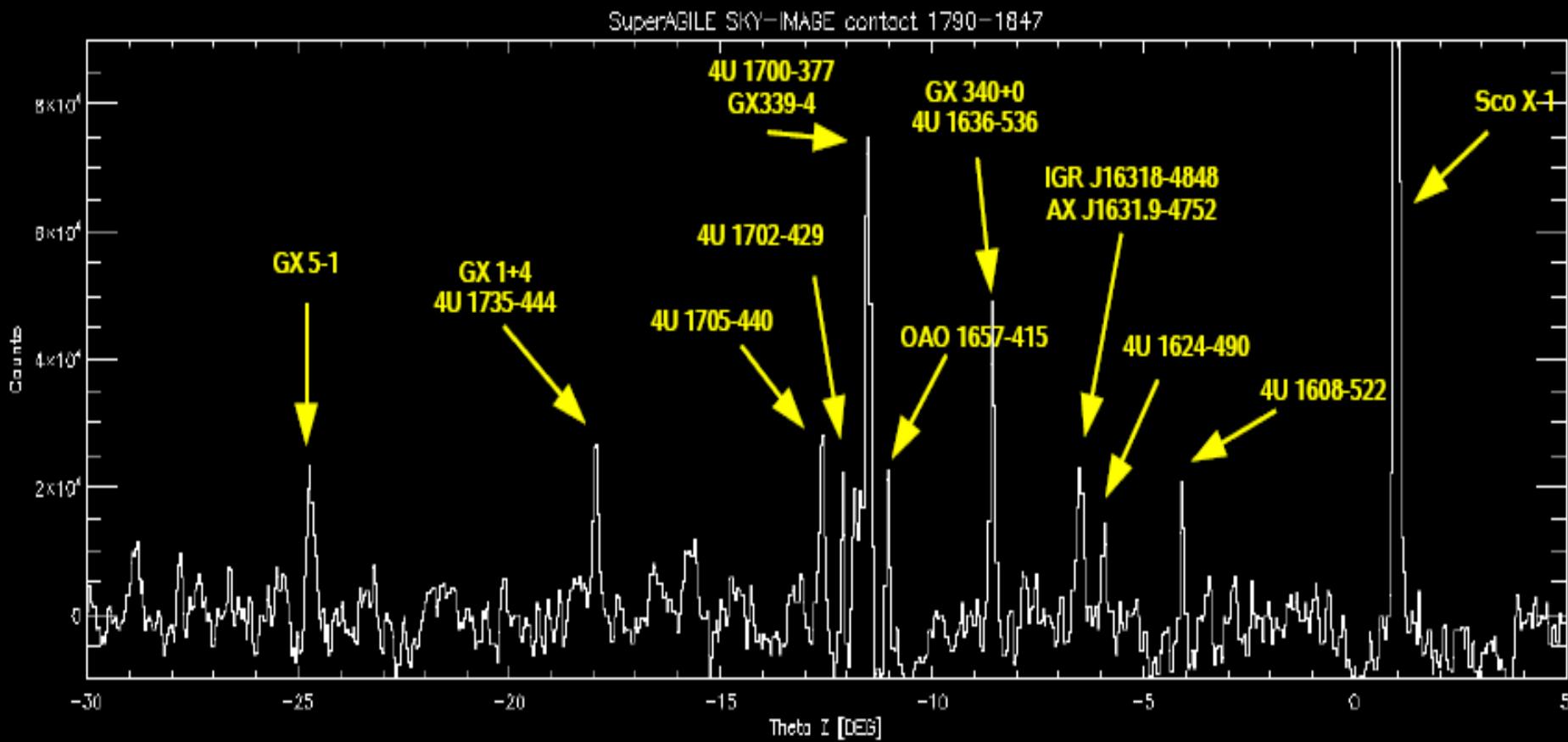
a comparison: 1-day exposure

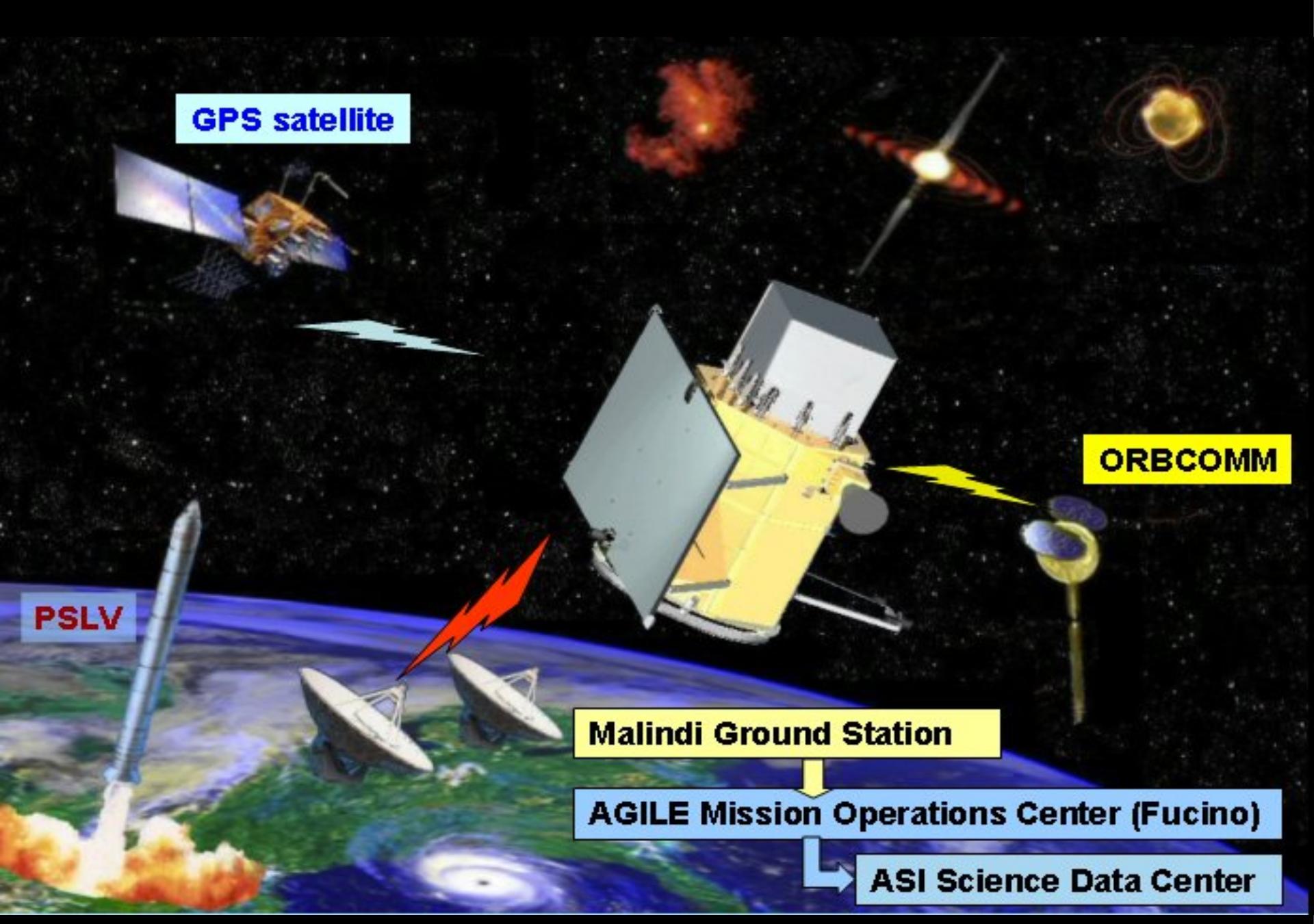
	AGILE (GRID)	FERMI (LAT)
FOV (sr)	2.5	2.5
sky coverage	1/5	whole sky
Source livetime fraction	~ 0.5	~ 0.16
1-day exposure (30 degree off-axis, 100 MeV)	~ 2 10^7 cm² sec	~ (1-2) 10^7 cm² sec
Attitude	fixed	variable

The AGILE 1-day exposure ($E > 100$ MeV) (30 Nov. 2008)



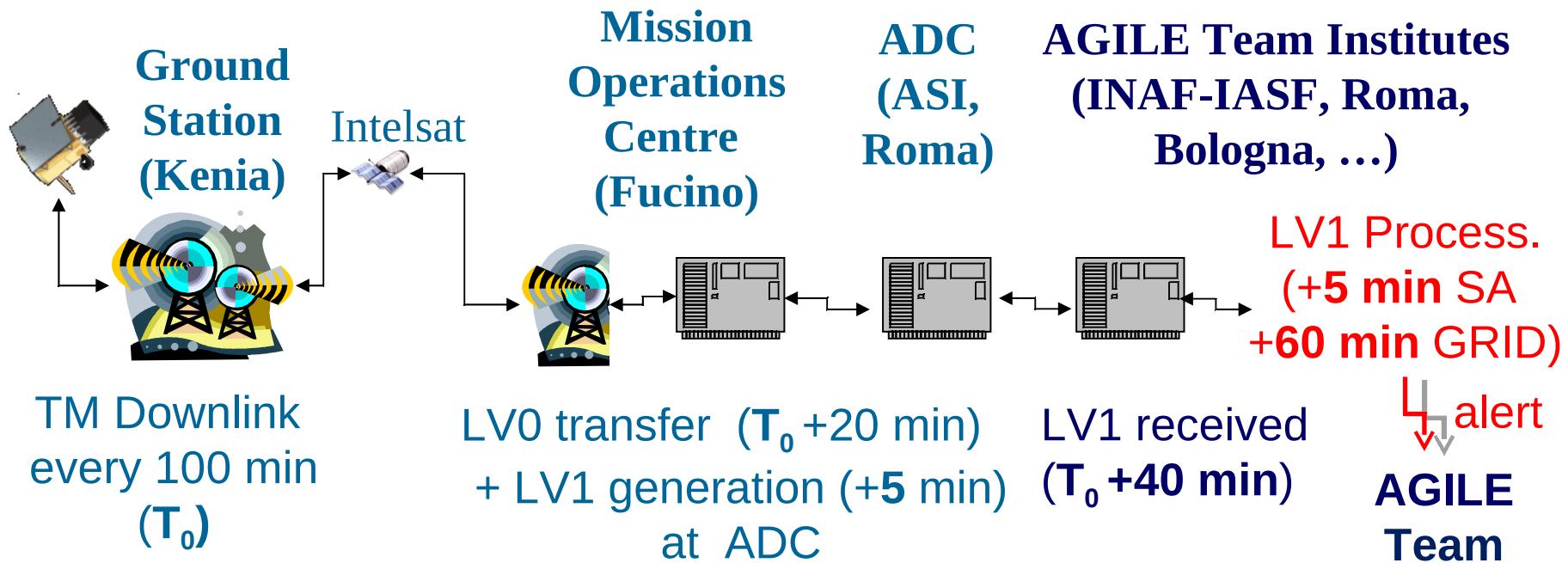
Example of the Super-AGILE View of the Galactic Plane (3.6 days, l=337, b=8)



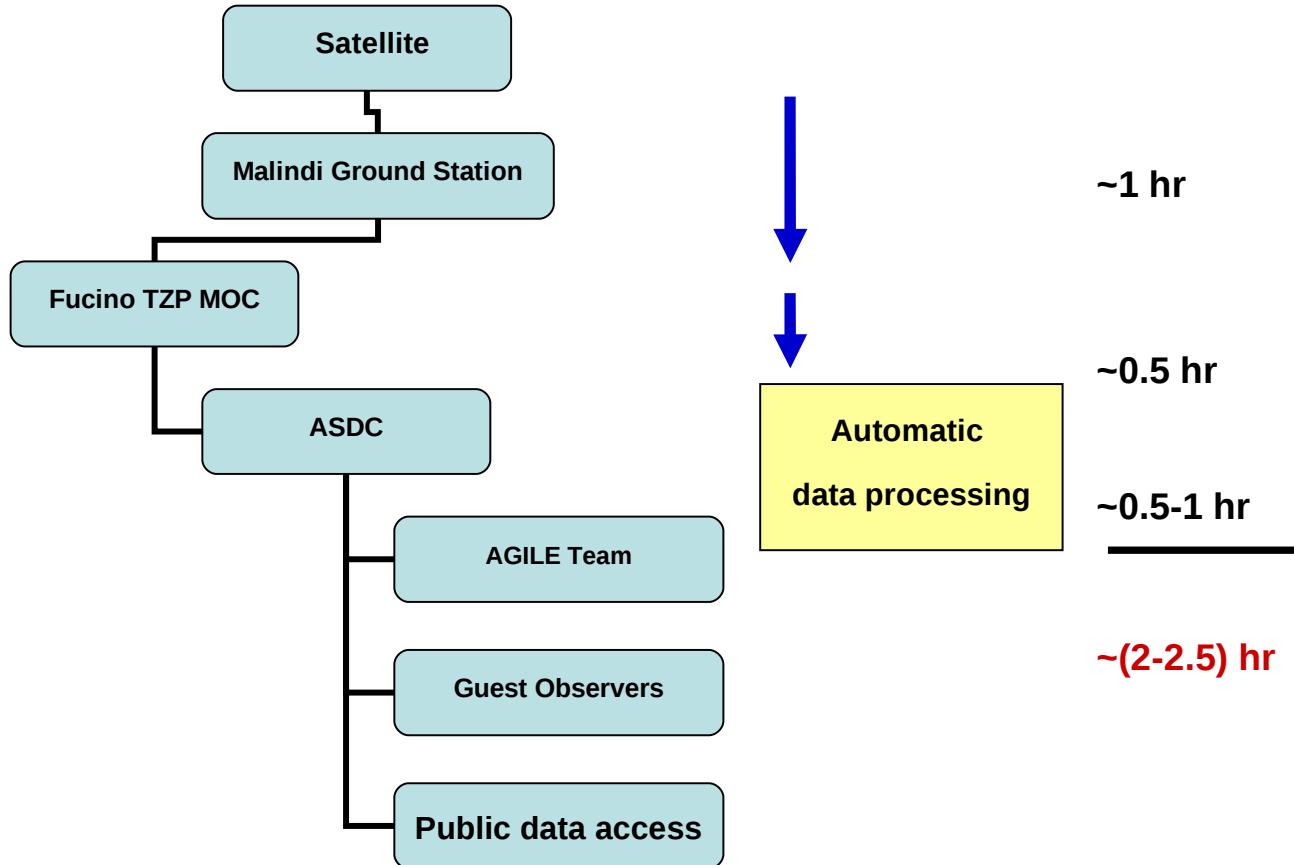


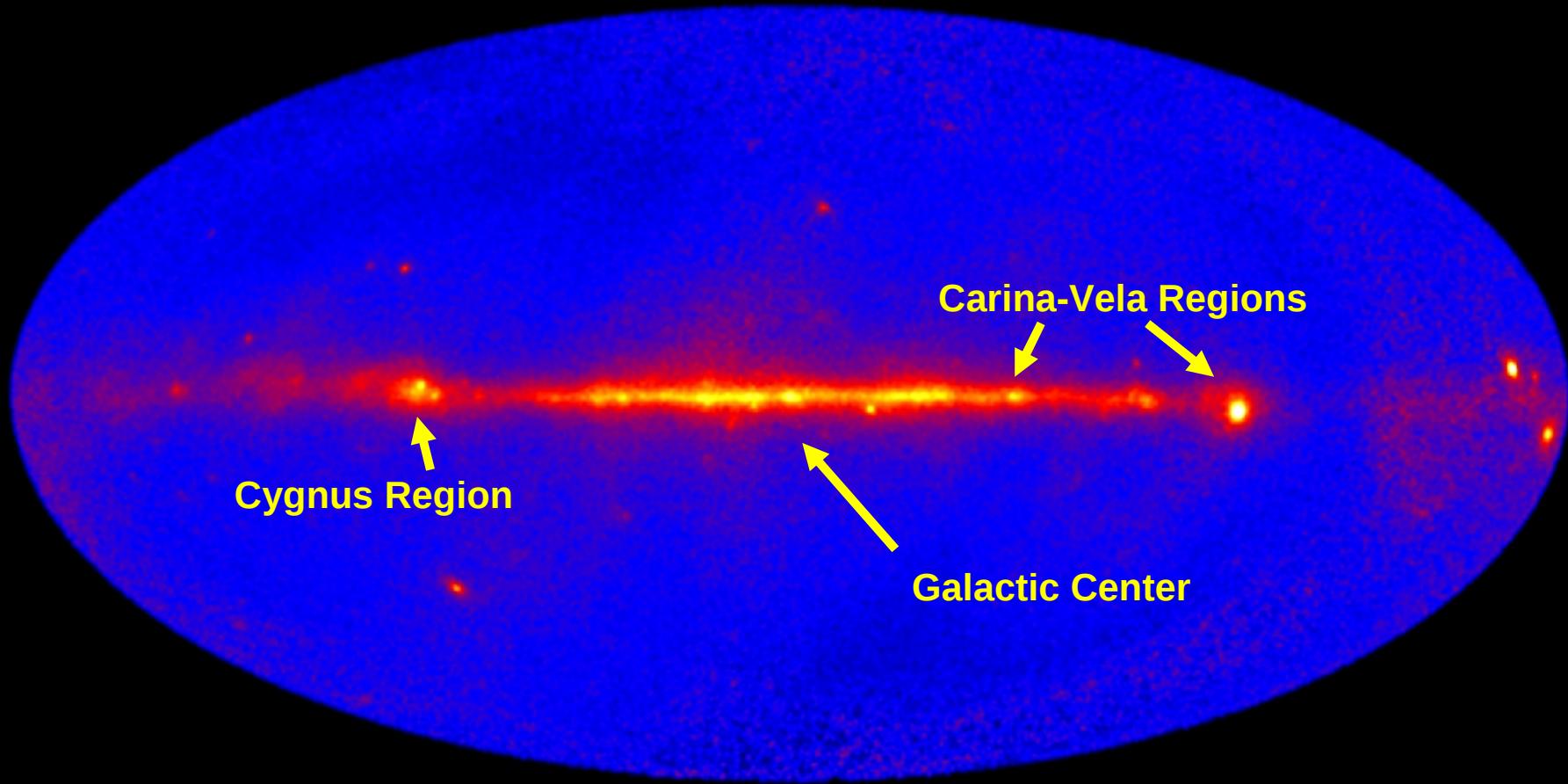
ASAS Architecture

- The system is distributed among the ADC @ ASDC and the AGILE Team Institutes
- Automatic Alerts to the AGILE Team are generated within $T_0 + 45 \text{ min (SA)}$ and $T_0 + 100 \text{ min (GRID)}$



AGILE Ground Segment



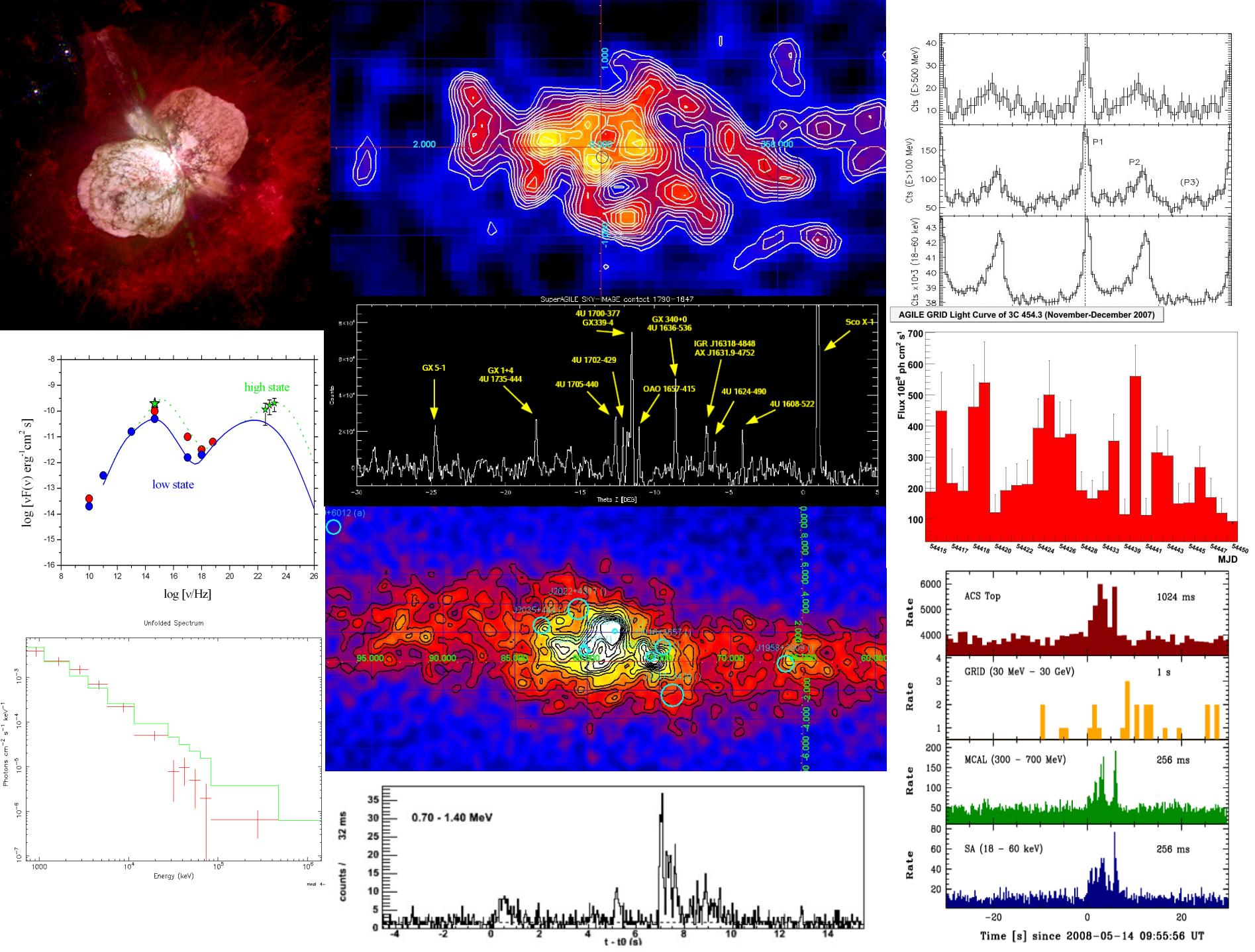


Main topics and discoveries

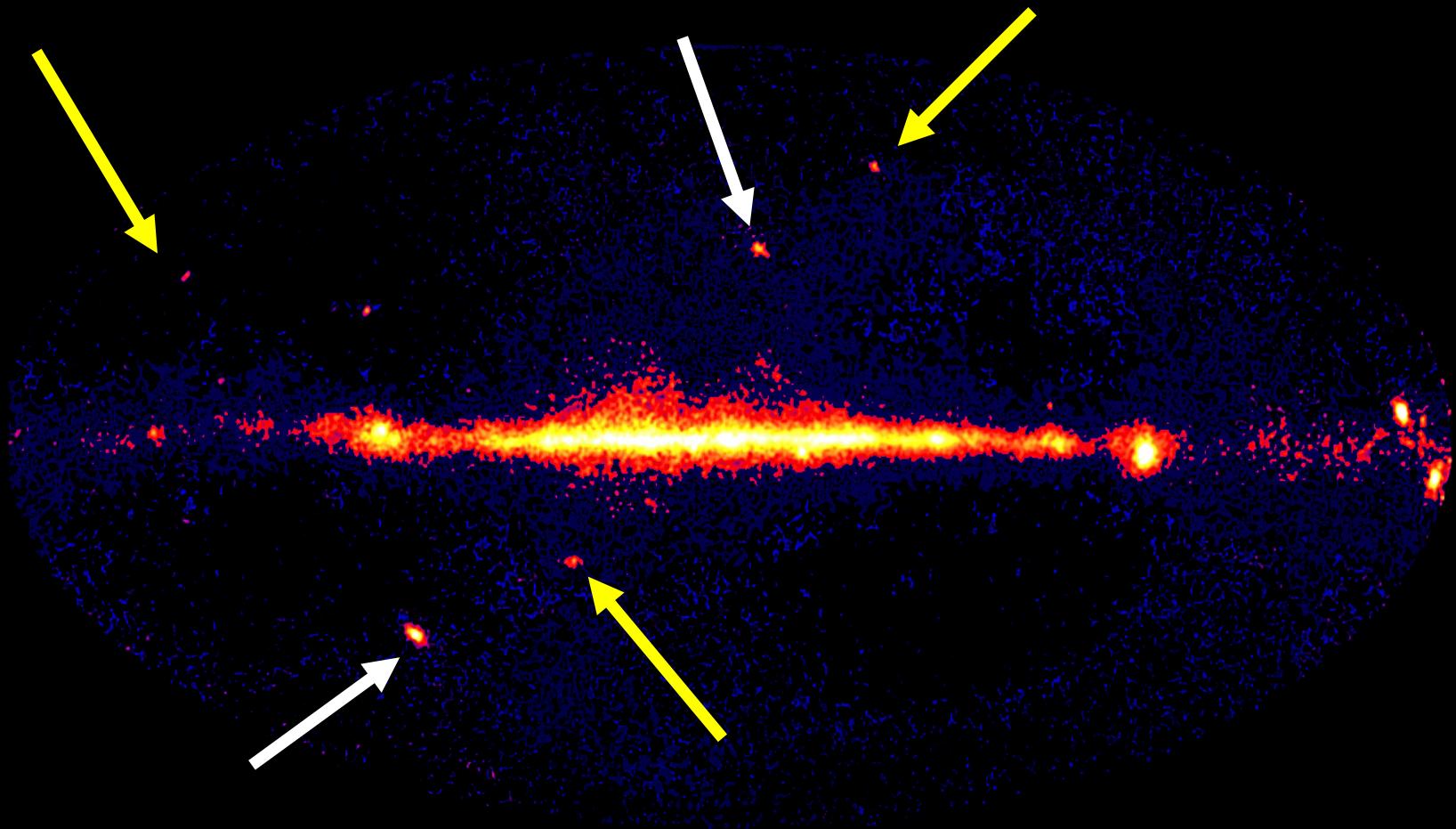
- Bright gamma-ray blazars
(3C 454.3, PKS 1510-089, TX 0716+714)
- several (~10) new Pulsars and PWNs
- discovery gamma-ray transients in the Galaxy
- microquasar studies, Gamma-ray emission from Gal. compact objects
- SNRs and origin of cosmic rays
- gamma-Ray Bursts, Millisecond triggers,
Terrestrial Flashes

Multifrequency science

- **AGILE, FERMI**
- **Radio Telescopes (VLA, Mojave, Michigan)**
- **Optical Obs. Networks (GASP, REM, ...)**
- **SWIFT, Suzaku, XMM**
- **INTEGRAL**
- **TeV (MAGIC, HESS, VERITAS)**



The brightest Gamma-ray blazars detected by AGILE



3C 454.3: the Crazy Diamond

July 2007

**~10 sigma
in 5.8
days**

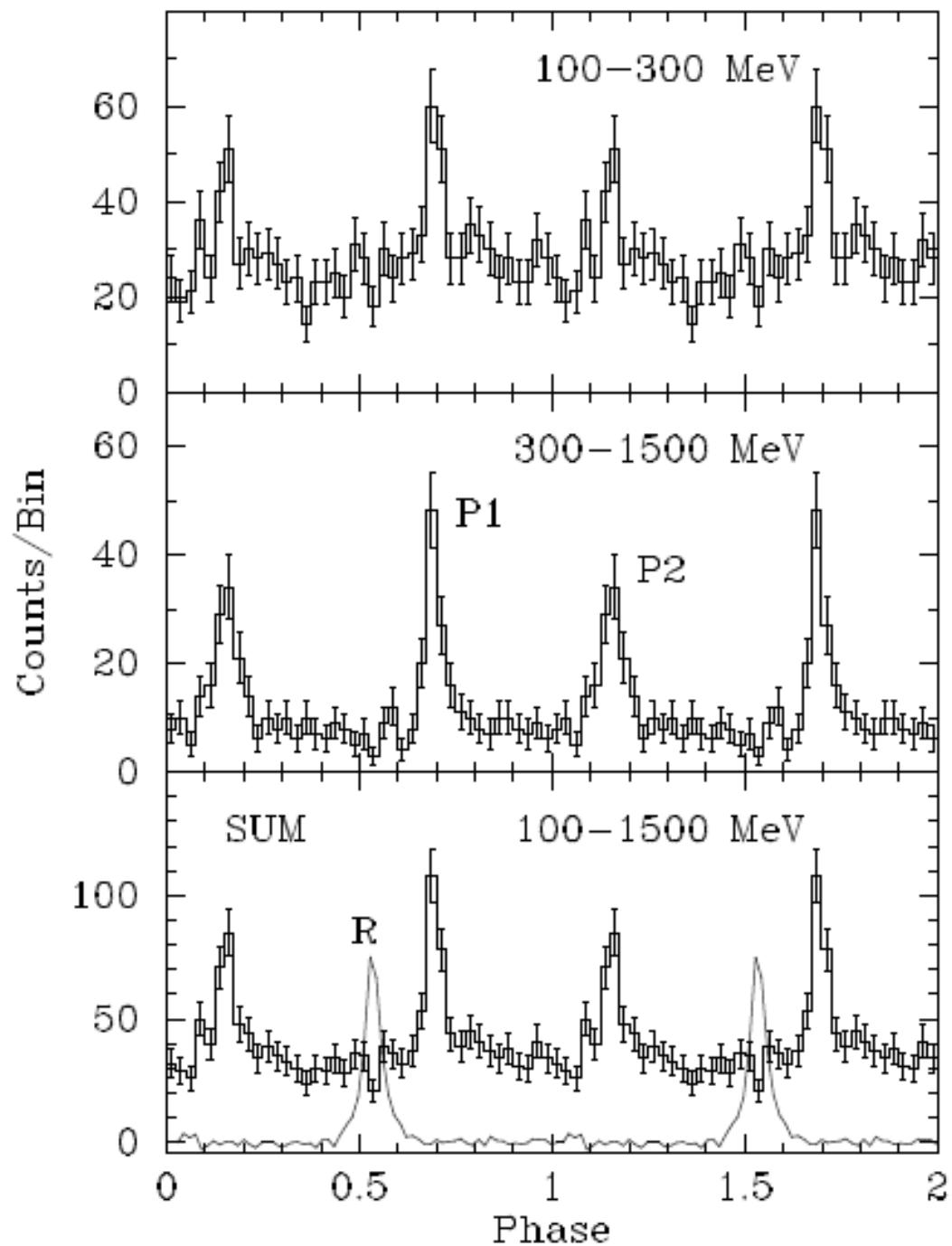
The brightest gamma-ray blazars detected by AGILE

- **3C 454.3**
- **HB 1510-089**
- **TXS 0716+714**
- **3C 279**
- **3C 273**
- **Mrk 421**
- **PKS 0537-441**

- spectral properties
- radio/optical/X-ray vs. gamma
- BL Lacs and BZ limit
- **why always the same blazars ?**

**AGILE new
gamma-ray PSR
(Halpern et al.
2008)**

PSR J2021-3651



New Gamma-Ray Pulsars

J2229+6114, J2021+3651, ...: Vela-like

J1513-5908: High B pulsar



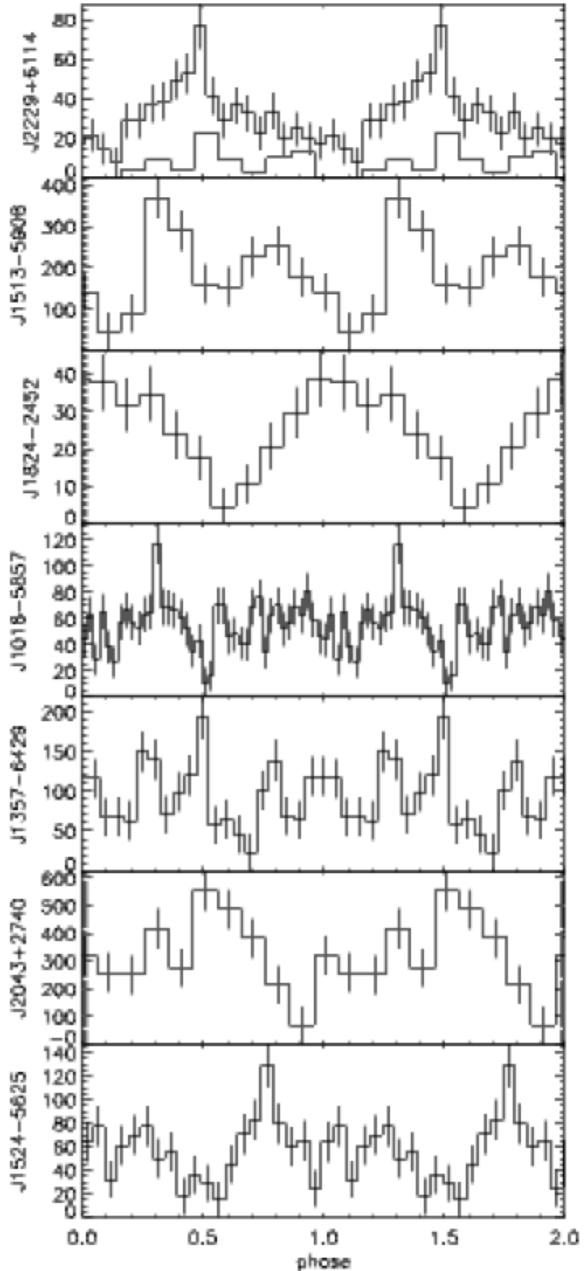
J1824-2452: ms PSR in Globular Cluster

J1016-5857: possibly 3EG source

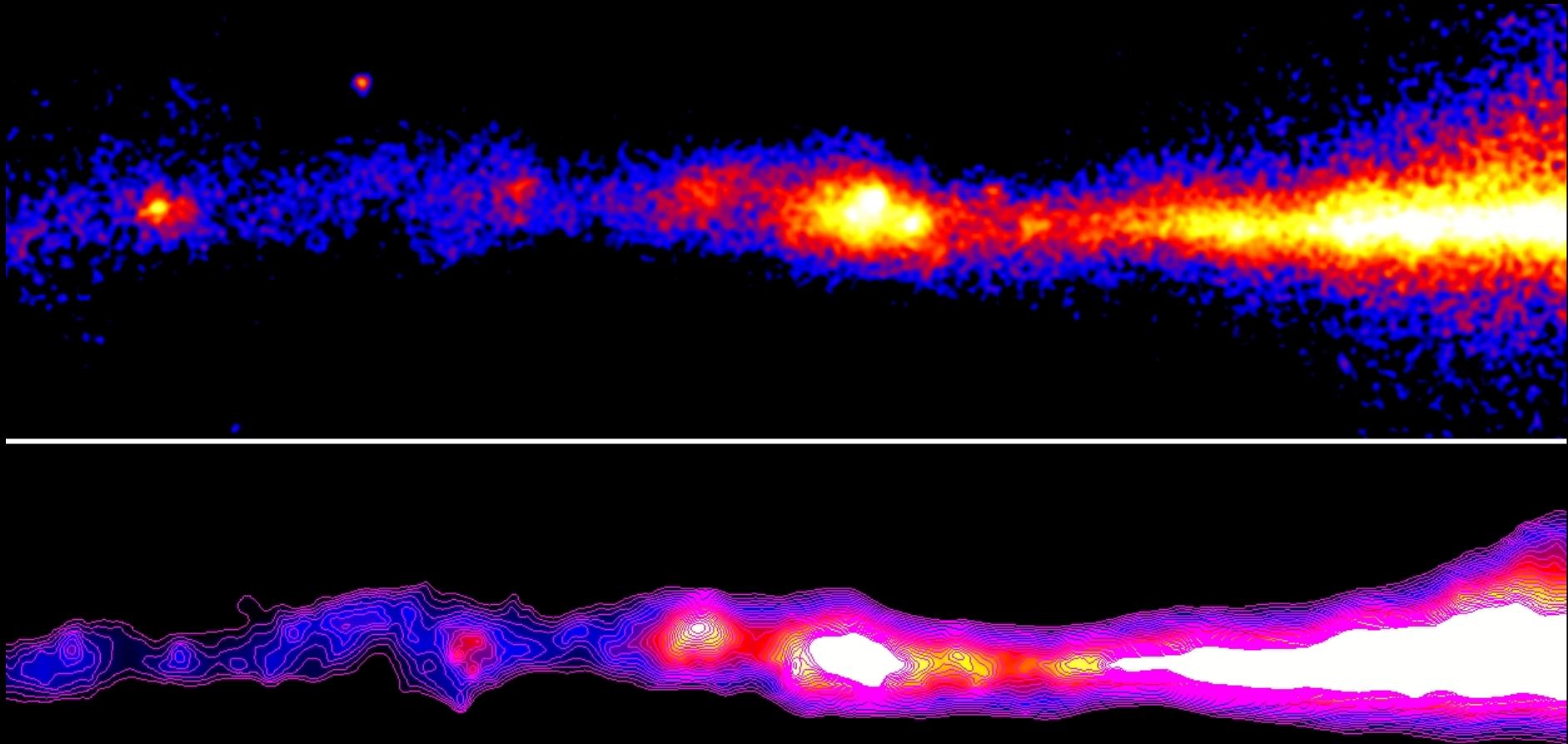
J1357-6429

J2043+2740: oldest gamma-ray pulsar

J1524-5625



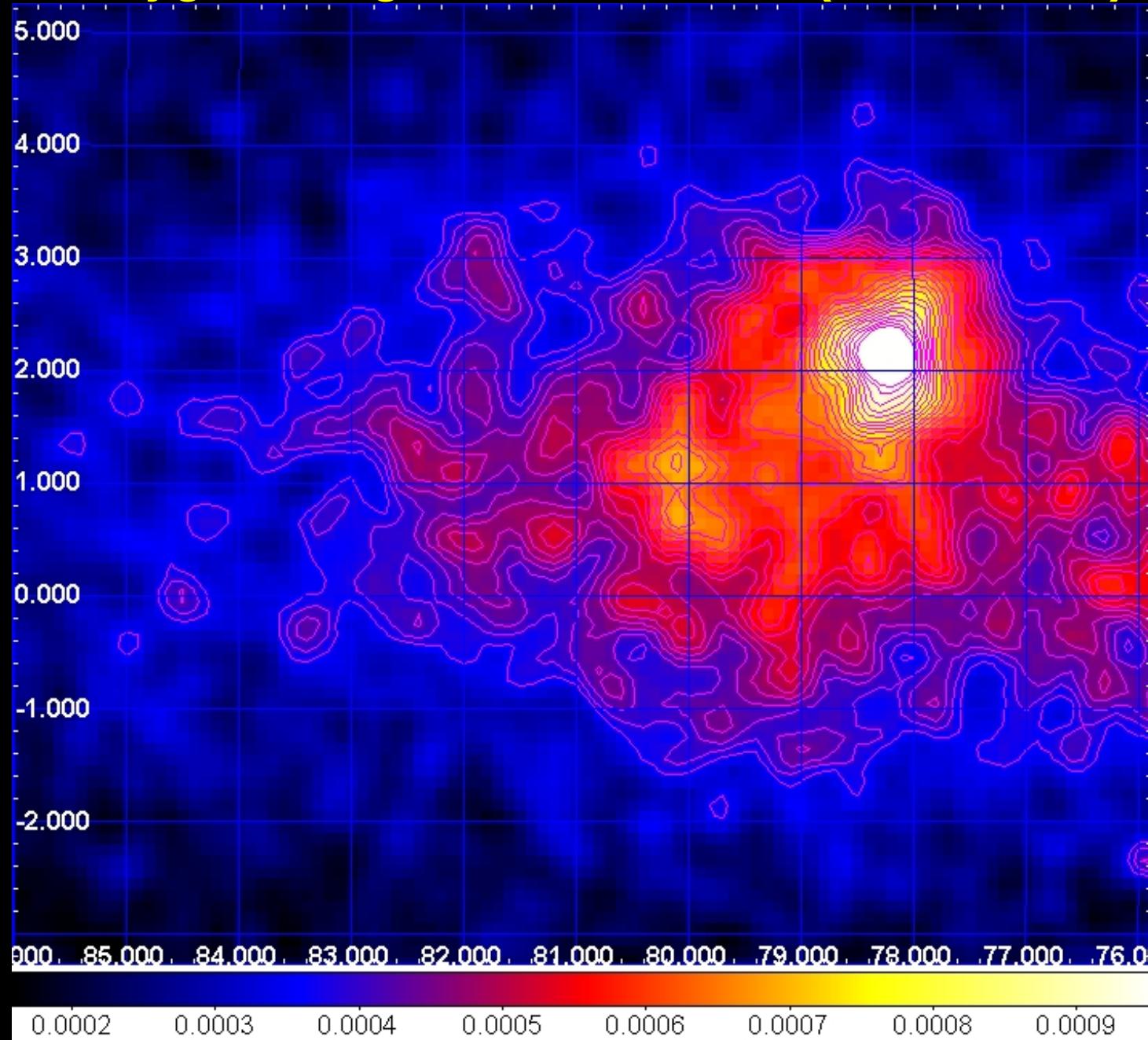
Cassiopeia-Cygnus Region



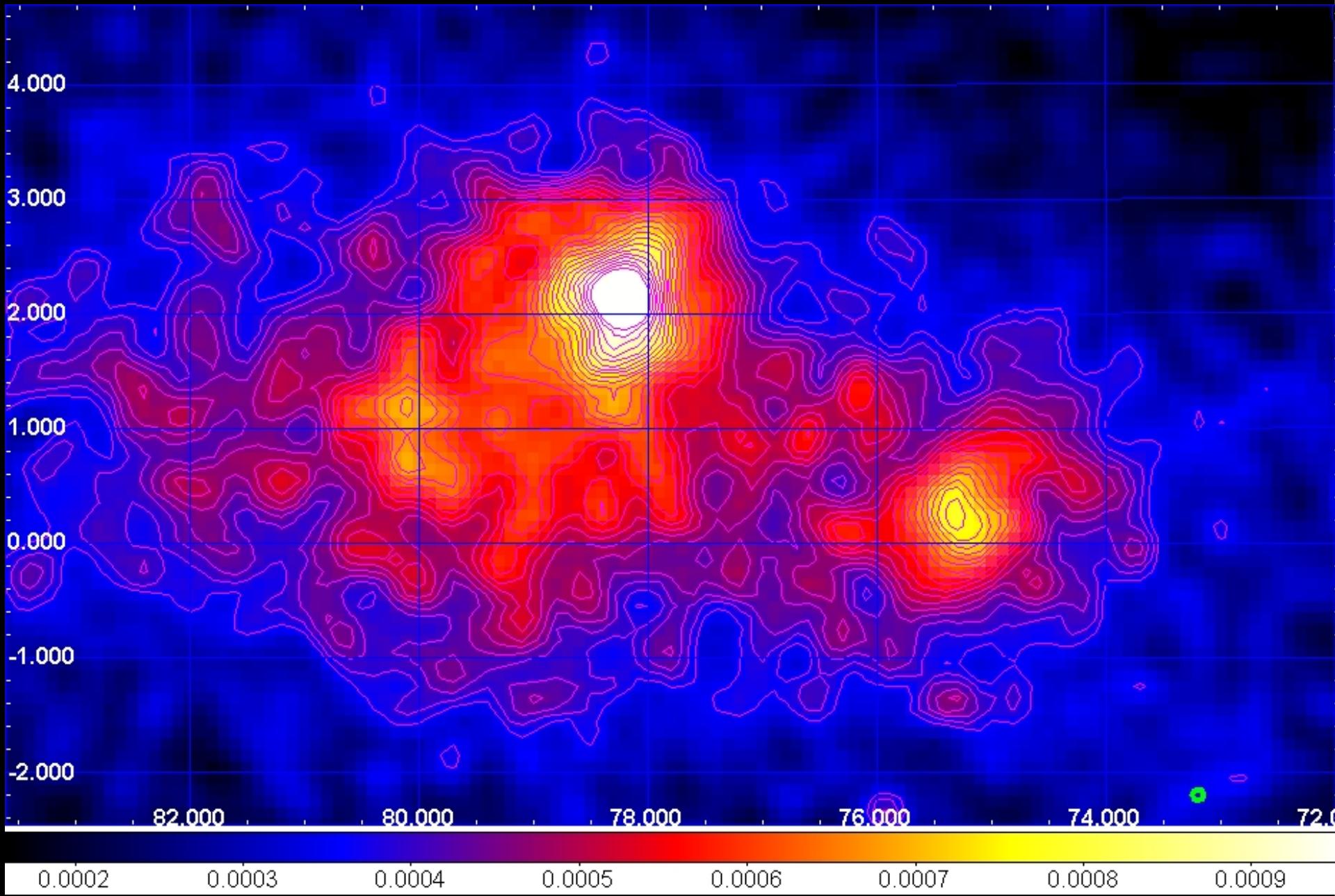
Cygnus Region, IRAS and Canadian GP Survey



Cygnus Region, AGILE-GRID ($E > 100$ MeV)



Cygnus Region, AGILE-GRID ($E > 100$ MeV)



Galactic gamma-ray transients: an AGILE discovery

- GC region
- Cygnus region
- Carina region
- Crux region
- AGILE observes variability and detects new transients on time scales of 1 day at flux levels of $10^{-6} \text{ cm}^{-2}\text{s}^{-1}$, even in crowded, high diffuse emission Galactic plane regions.
- NO detectable simultaneous hard X-ray emission ($F < 20\text{-}30 \text{ mCrab}$, 18-60 keV, 1-day integration)

- very good imaging capability
(in the range 100-400 MeV)
- several Galactic transient candidates (usually low-energy)
 - Examples, 24 Nov. 2007, Eta-Car, other transients
- statistically sound detection method identified, pre-trial vs. post-trial CL...

AGILE facts and surprises

- in general, no obvious X-ray source, Super-AGILE or INTEGRAL source
- some SWIFT follow-ups: no detections, (except one...)
- but...Eta-Car and Cygnus X-3 examples

Energetics...

- Gamma-ray luminosity above 100 MeV

$$L = 7 \times 10^{34} d_{\text{kpc}}^2 \text{ erg/s}$$

Energetics...

- **Gamma-ray luminosity above 100 MeV**
 $L = (\text{a few}) \times 10^{34} d_{\text{kpc}}^2 \text{ erg/s}$
- **Compatible with WR/CWB expectations**
 - It could be a class of WR/CWB or flaring stars
- **But also it could be a NEW CLASS of (non-accreting or low X-ray) sources**

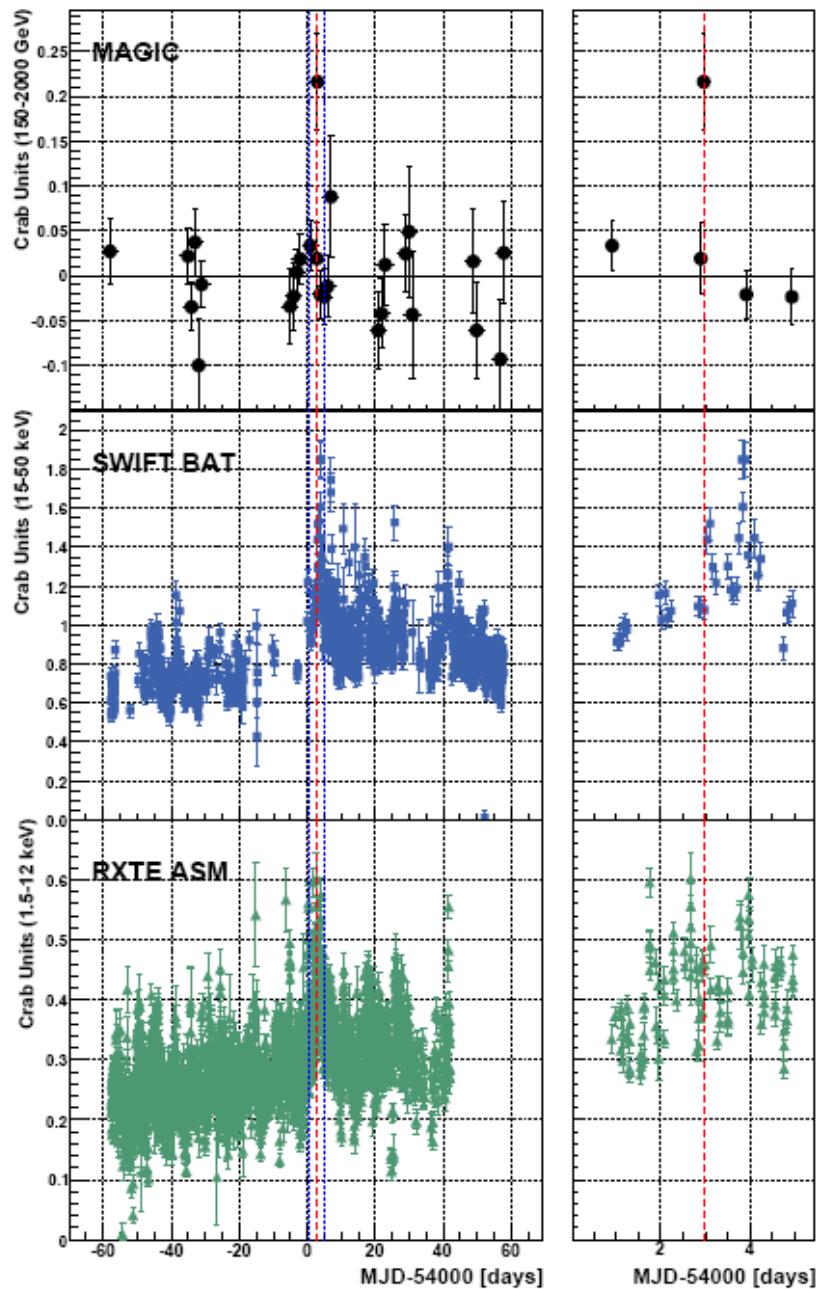
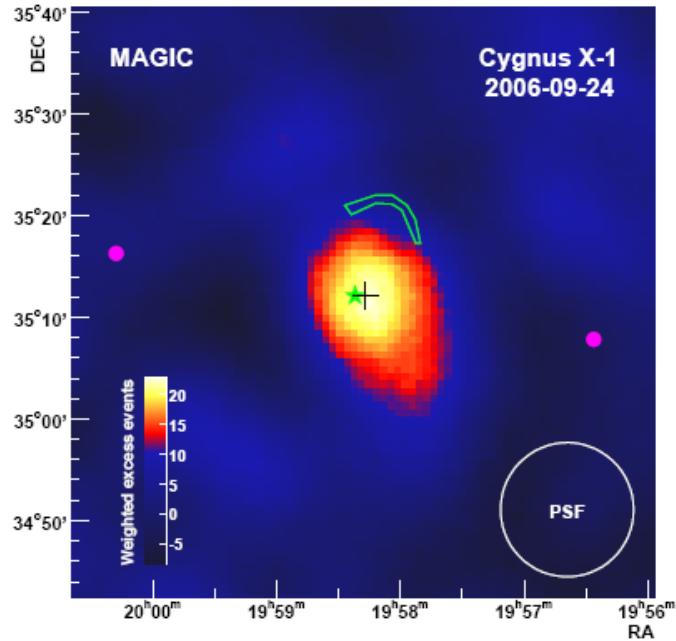
monitored Micro-QSOs

- Cyg X-1
- Cyg X-3
- GRS 1915+105
- SS 433
-

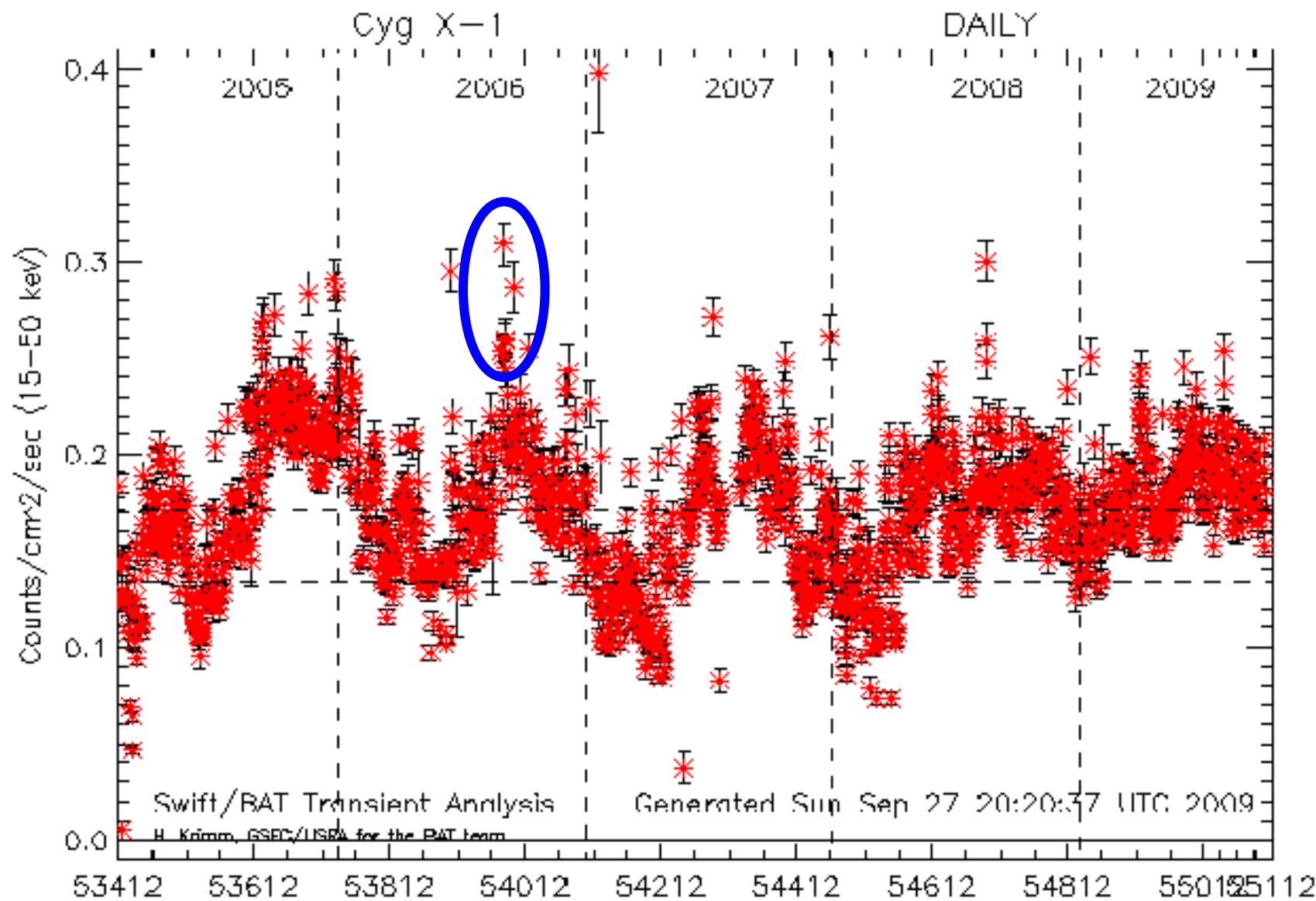
Galactic “Micro-QSOs” (radio “jet” sources)

	Θ (degrees)	β	Γ	L_x/L_E	γ/TeV
Cyg X-1	?	?	?	0.1-1	~5 MeV yes
Cyg X-3	< 14	> 0.8	> 1.6	0.1-1	?
SS 433	< 70	0.26	1.03	0.01	no
GRS 1915+104	70	0.92	2.5	0.1-1	no
GRO J1655-40	> 70	0.9	2.5	1	no
GRS 1758-258	?			0.1-1	no
XTE J1550-564	60-70	> 0.8	1.5	0.1-1	no
Sco X-1	> 70	> 0.8	> 1.6	0.1-1	no
LS 161 303	?	?	?	10^-4	yes

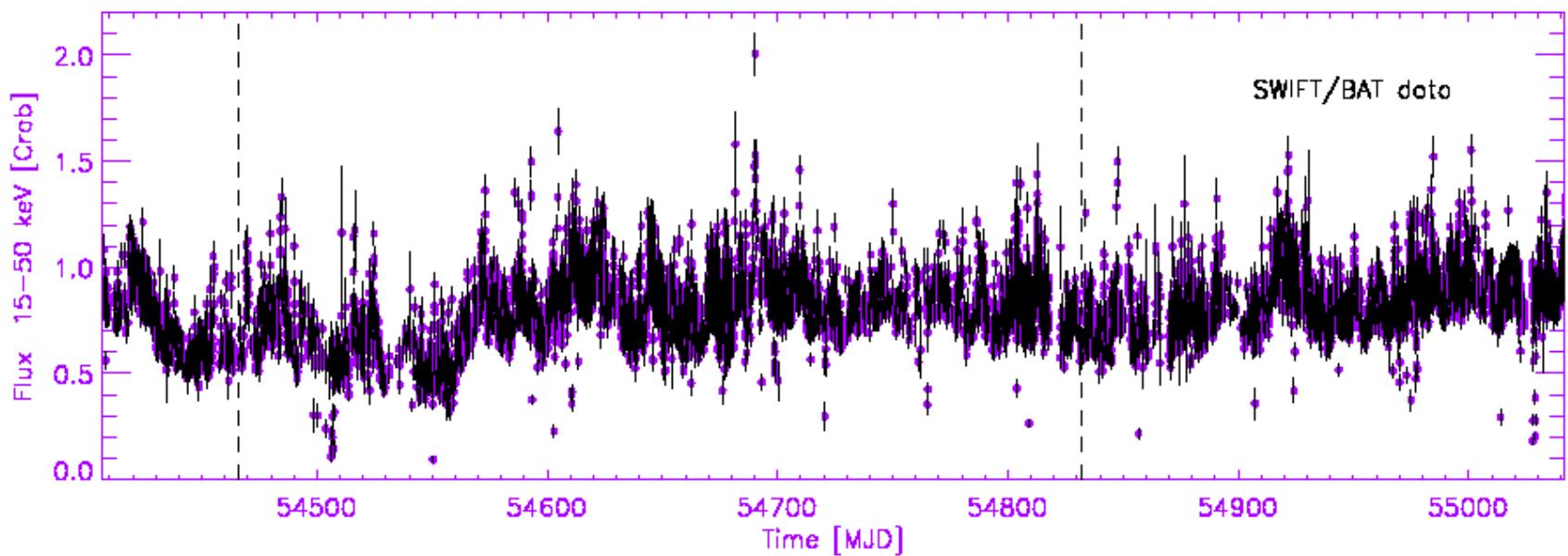
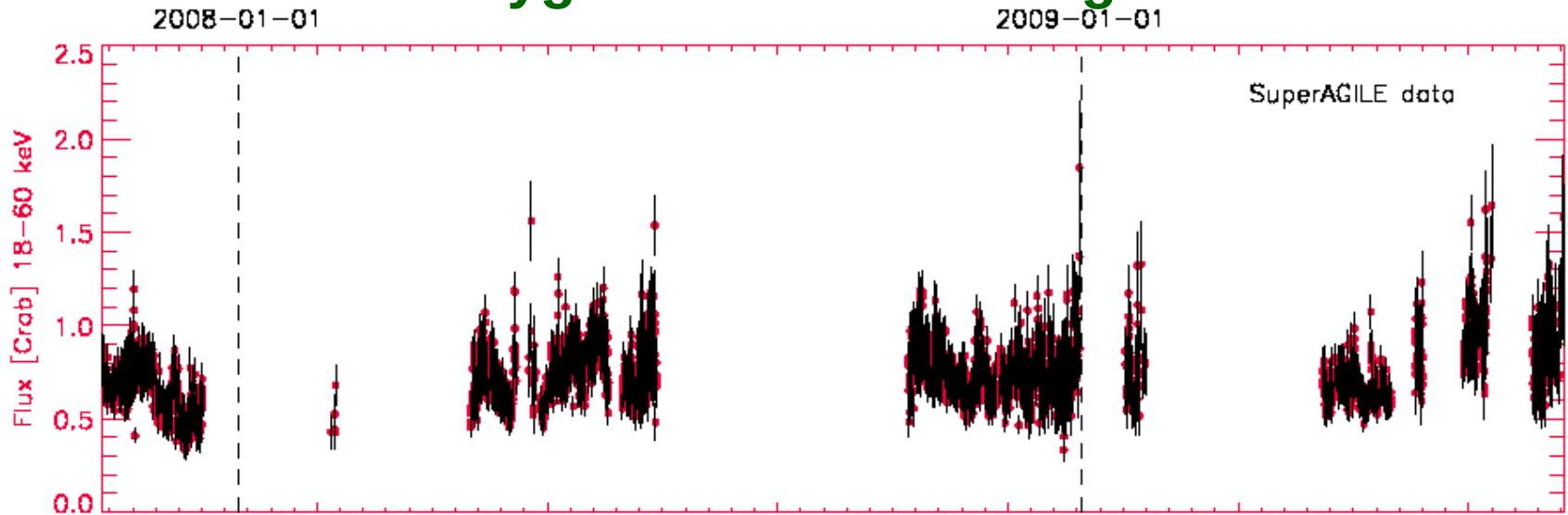
MAGIC single isolated detection of Cyg X-1, 24 Sept. 2006, ~ 79 min. TeV flare



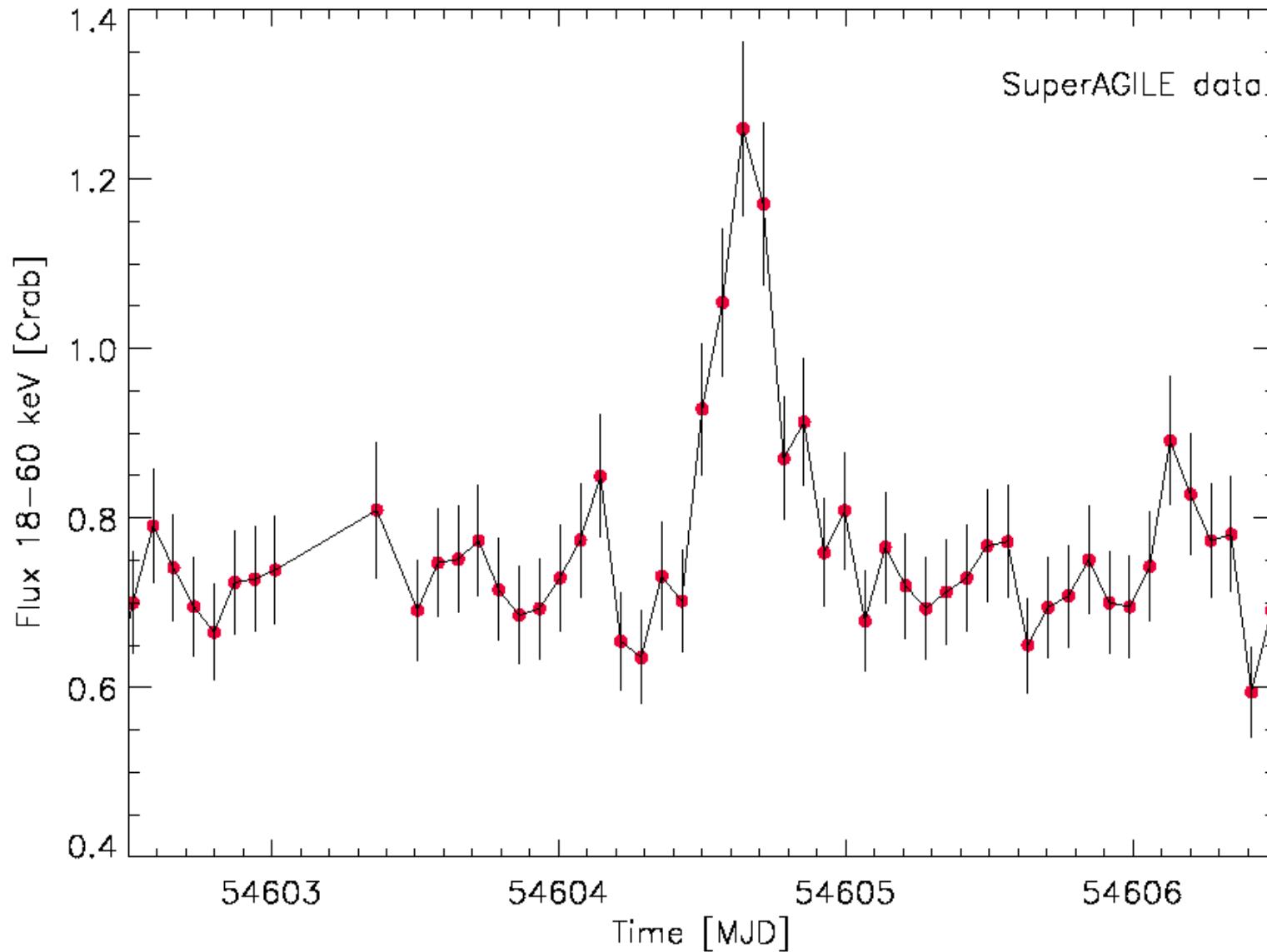
Cyg X-1 hard X-ray flux, Swift/BAT (15-50 keV)



Cygnus X-1 monitoring



Cygnus X-1 monitoring



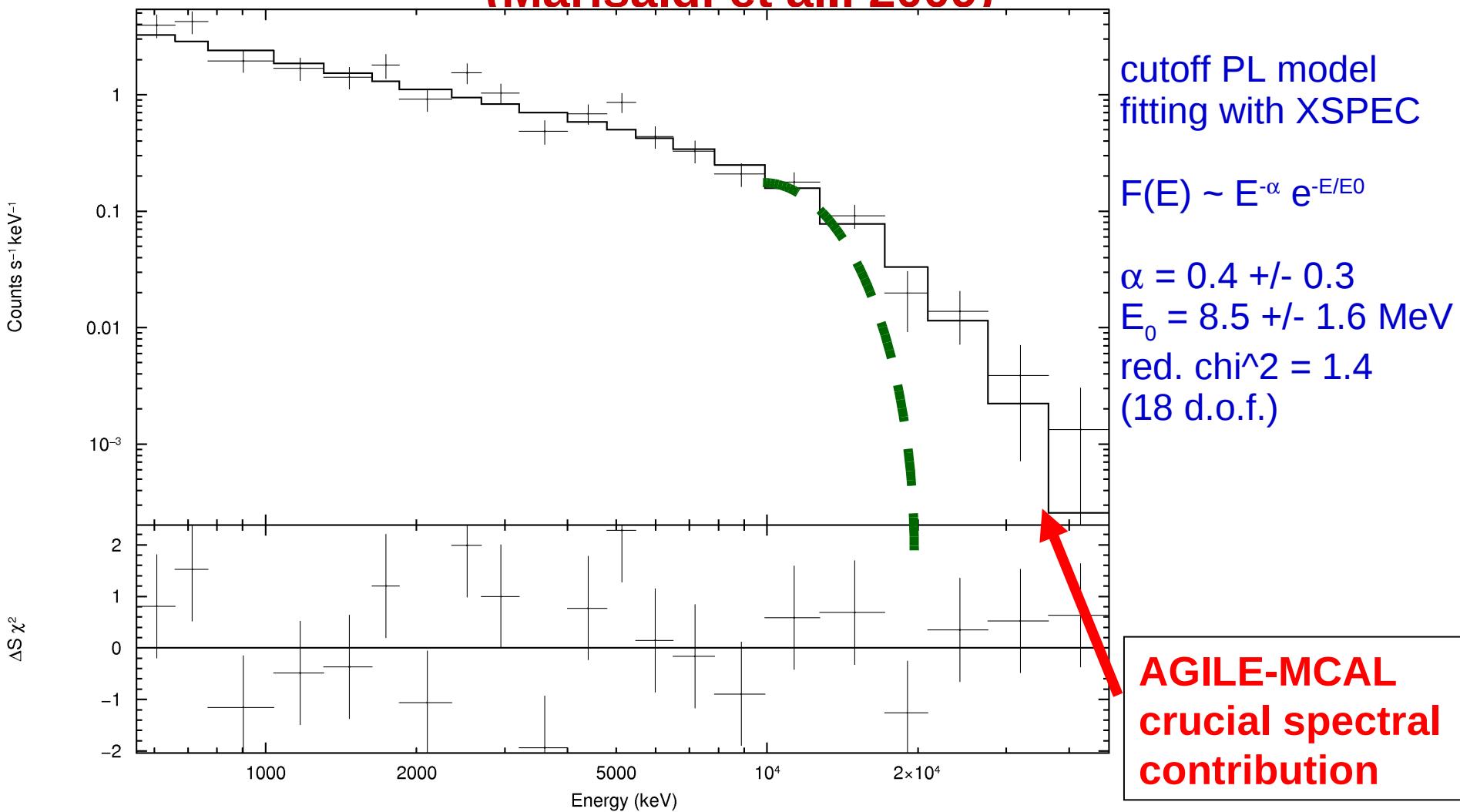
Challenges...

- are Cyg X-1-like fast transients common ?
- detect gamma-ray variability within 1 day...or even less
- what are the gamma-ray transients ?
- Cyg X-3 remarkably detected in special states...and the others ?

GRBs and Flashes

- only a few GRBs detected so far above 100 MeV
- AGILE very good timing capability, millisecond trigger
- Terrestrial Gamma-Ray Flashes (TGFs)

MCAL TGF cumulative spectrum (Marisaldi et al.. 2009)



- Normal lightnings involve a potential difference
 $DV \sim 500$ kiloVolts
- Terrestrial Gamma-Ray Flashes (TGF) involve
 $DV > 100$ Mega Volts

Conclusions

- Very exciting time for gamma-ray astrophysics
- AGILE focused on 100 MeV phenomena and simultaneous hard X-ray emission (or lack thereof...)
- AGILE and FERMI will provide a wealth of data on a variety of sources... be ready for variability !
- Special attention to Galactic microquasars and transients during the AGILE Cycle-3 observations
 - * Quicklook and alert system
- Millisecond events, cosmic events and TGFs