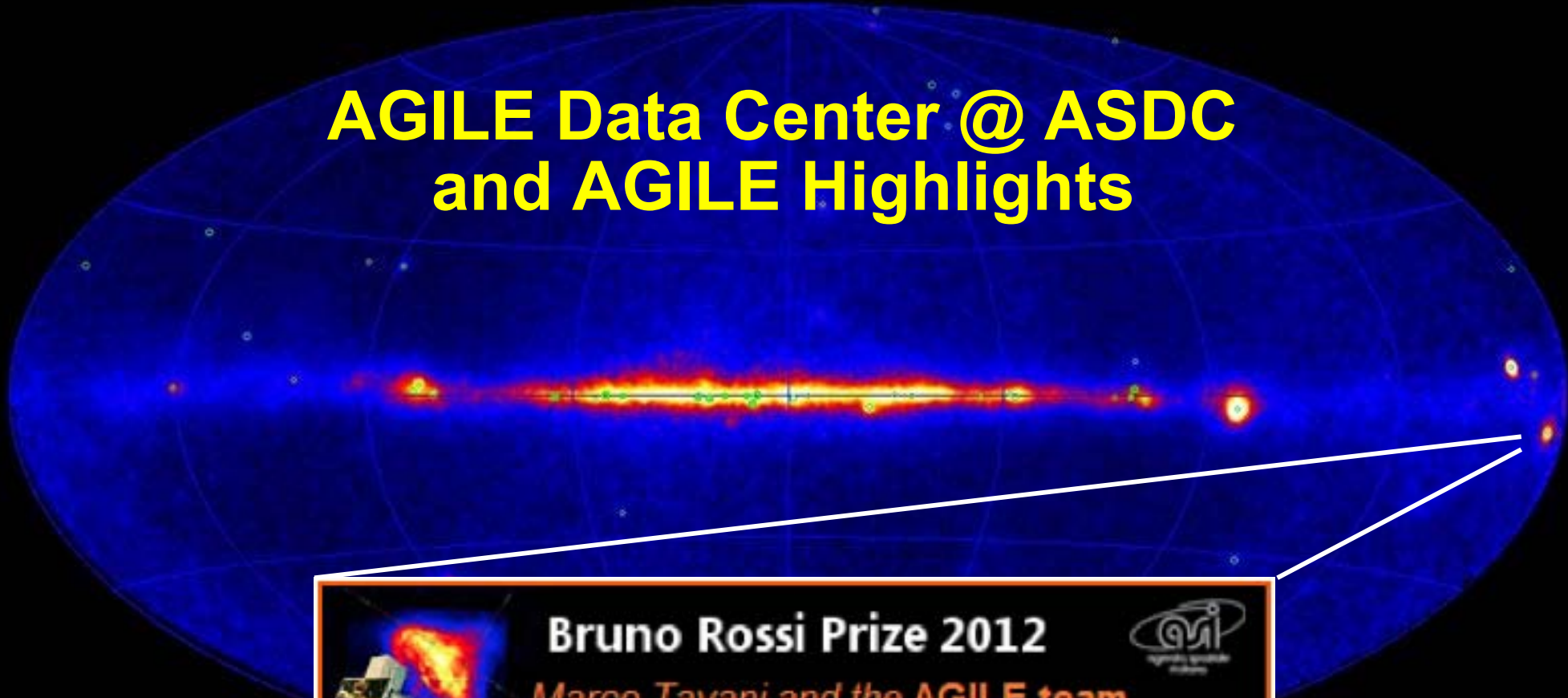




AGILE Data Center @ ASDC and AGILE Highlights



 **Bruno Rossi Prize 2012** 
Marco Tavani and the AGILE team

SciNeGHE 2012

9th Workshop on Science with the New Generation of High Energy Gamma-ray Experiments
From high energy gamma sources to cosmic rays, one century after their discovery
20-22 June 2012 , Lecce (Italy)

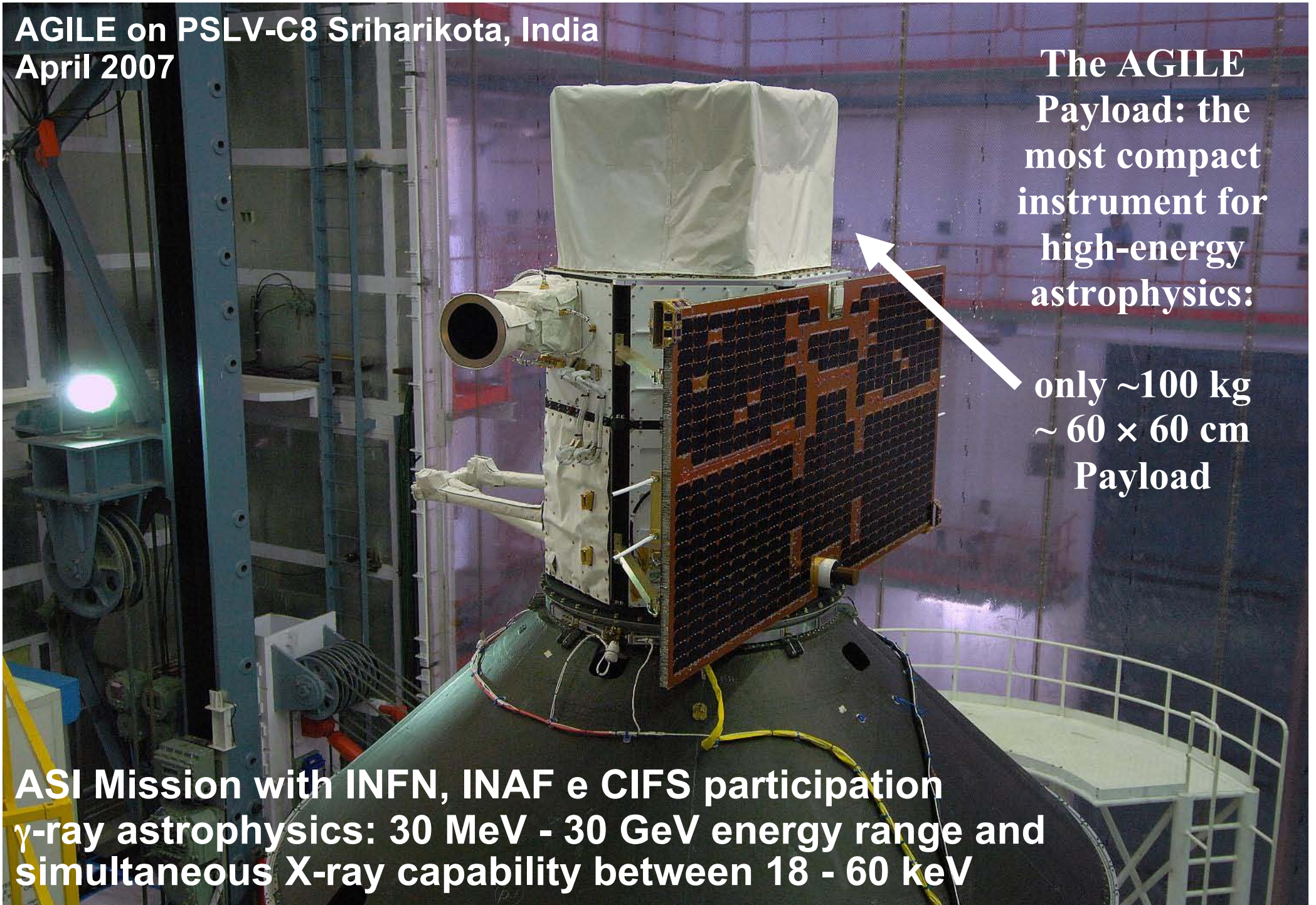
**Carlotta Pittori, on behalf
of the AGILE Collaboration**

**AGILE on PSLV-C8 Sriharikota, India
April 2007**

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

**only ~100 kg
~ 60 × 60 cm
Payload**

**ASI Mission with INFN, INAF e CIFS participation
γ-ray astrophysics: 30 MeV - 30 GeV energy range and
simultaneous X-ray capability between 18 - 60 keV**



AGILE: inside the cube...



**HARD X-RAY IMAGER
(SUPER-AGILE)**
Energy Range: 18–60 keV

**SILICON TRACKER
GAMMA-RAY IMAGER (GRID)**
Energy Range: 30 MeV - 30 GeV

(MINI) CALORIMETER
Energy Range: 0.3–100 MeV

↑
ANTICOINCIDENCE

AGILE orbital parameters

Launch: April 23, 2007 from India

Baseline equatorial orbit: 550 Km, 3° inclination

Semi-major axis: 6922.5 km (± 0.1 km)

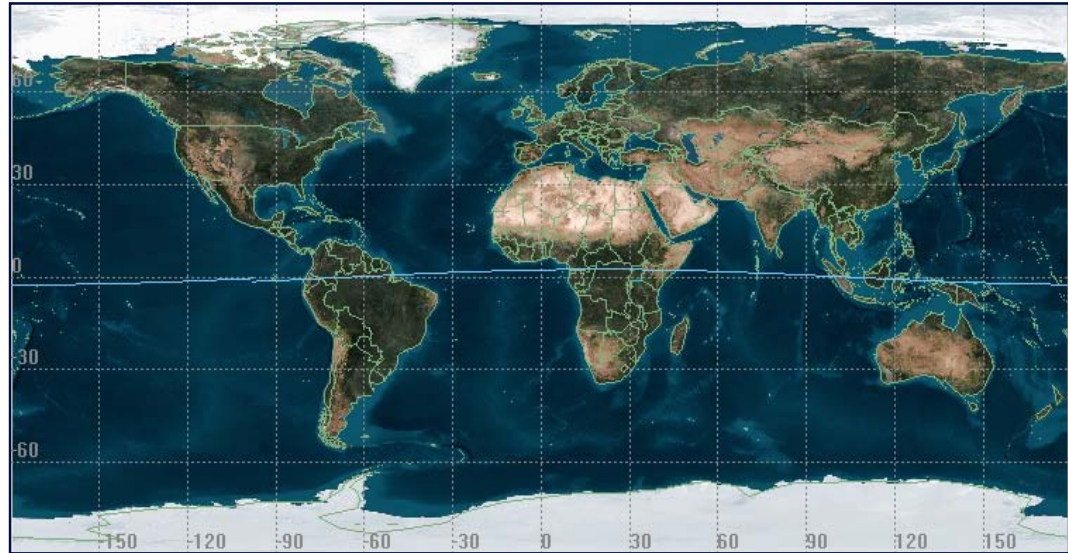
Requirement: 6928.0 ± 10 km

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

Requirement: $< 3^\circ$

Eccentricity: 0.002 (± 0.0015)

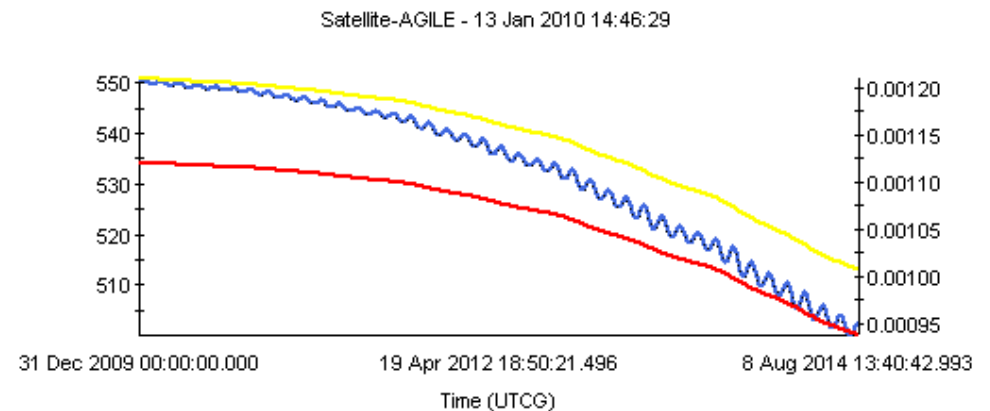
Requirement: $< 0.1^\circ$

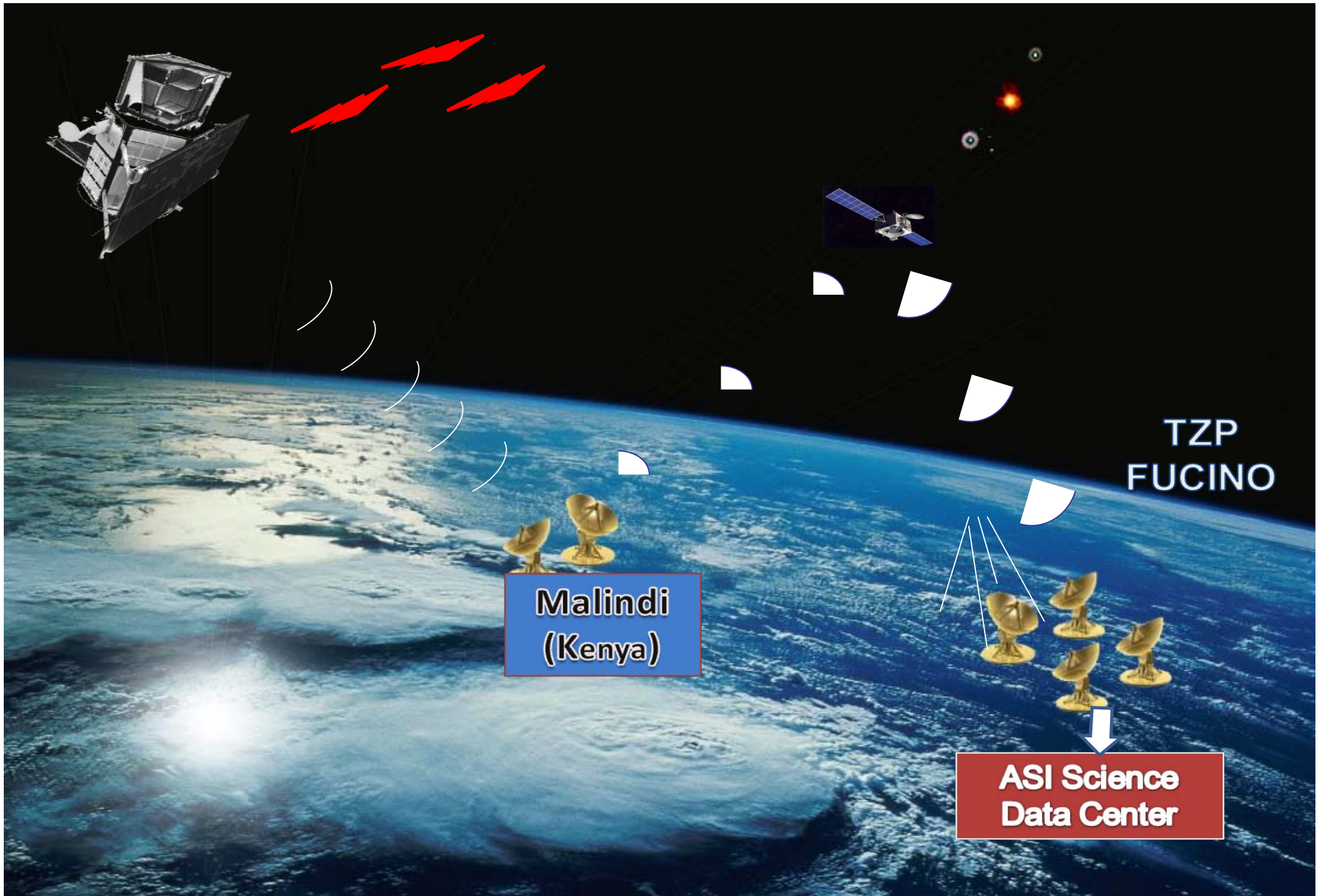


TPZ orbital decay estimate:

Height < 500 Km **08 Agosto 2014**

(Jan 13, 2010 estimate, using solar flux
“Schatten” forecasts + 2σ)

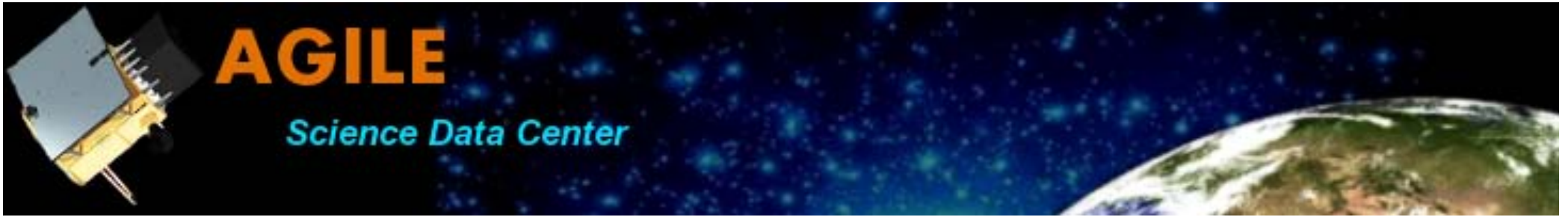




**Malindi
(Kenya)**

**TZP
FUCINO**

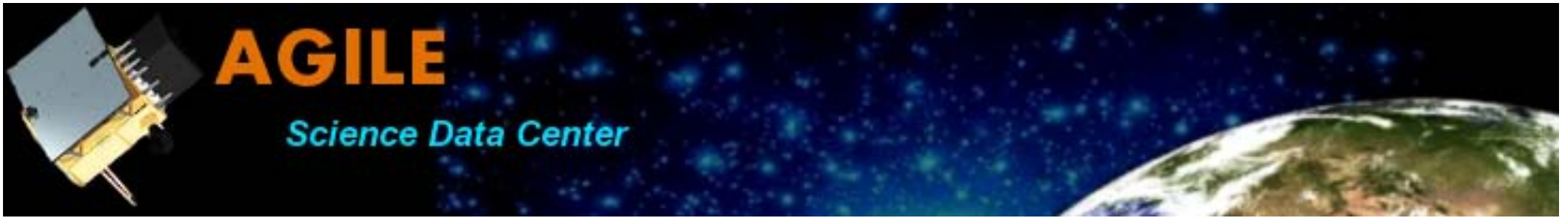
**ASI Science
Data Center**



AGILE Telemetry raw data (Level-0) are down-linked every ~ 100 min to the ASI Malindi ground station in Kenya and transmitted first to the Telespazio Mission Control Center at Fucino, and then to the AGILE Data Center (ADC). Raw data are routinely received at ADC **within ~ 5 min after the end of each contact.**

ADC main tasks are:

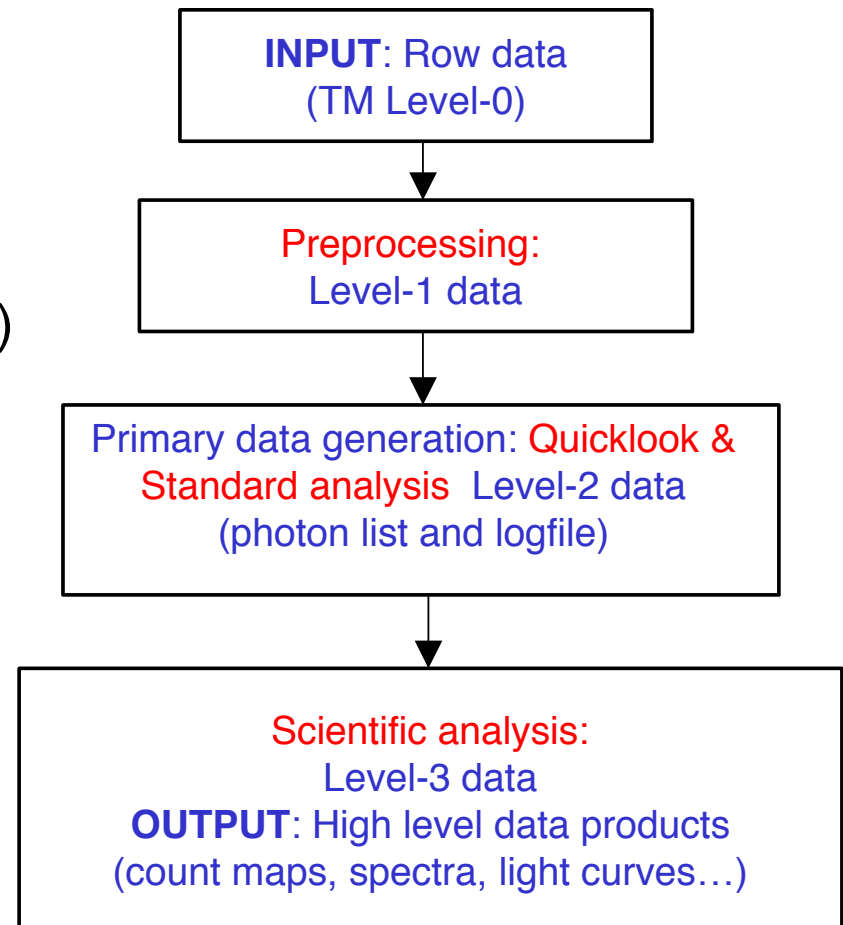
- data processing (real-time and reprocessing) and production of the data archives (from raw data to scientific level data through calibration level data),
- **preliminary data analysis (Quick Look Analysis),**
- management of the Guest Observer Program and of the AOs
- management of the Mission Planning (Long Term Plan preparation and emission),
- data and software distribution to the scientific community



- The ADC, based at ASDC-ESRIN, is in charge of **all the scientific oriented activities related to the analysis and archiving** of AGILE data:

From scientific telemetry (TM) Level-0:

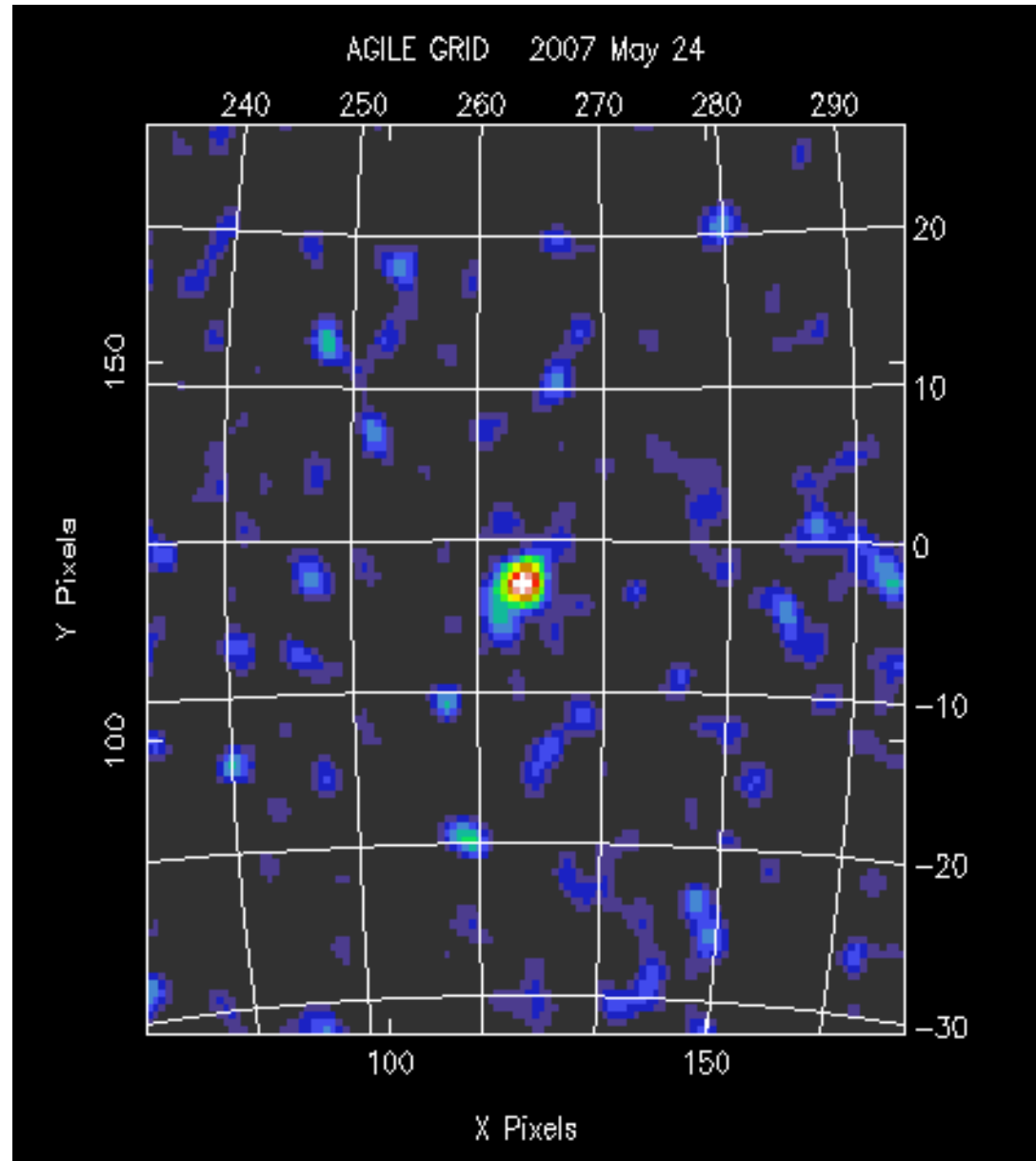
- ✓ Preprocessing → Level-1 data
- ✓ Quick-Look Analysis (transient detection)
- ✓ Standard analysis → Level-2 data (photon list)
- ✓ Scientific analysis (source detection, diffuse gamma-ray background)
- ✓ Archiving and distributing **all scientific AGILE data**



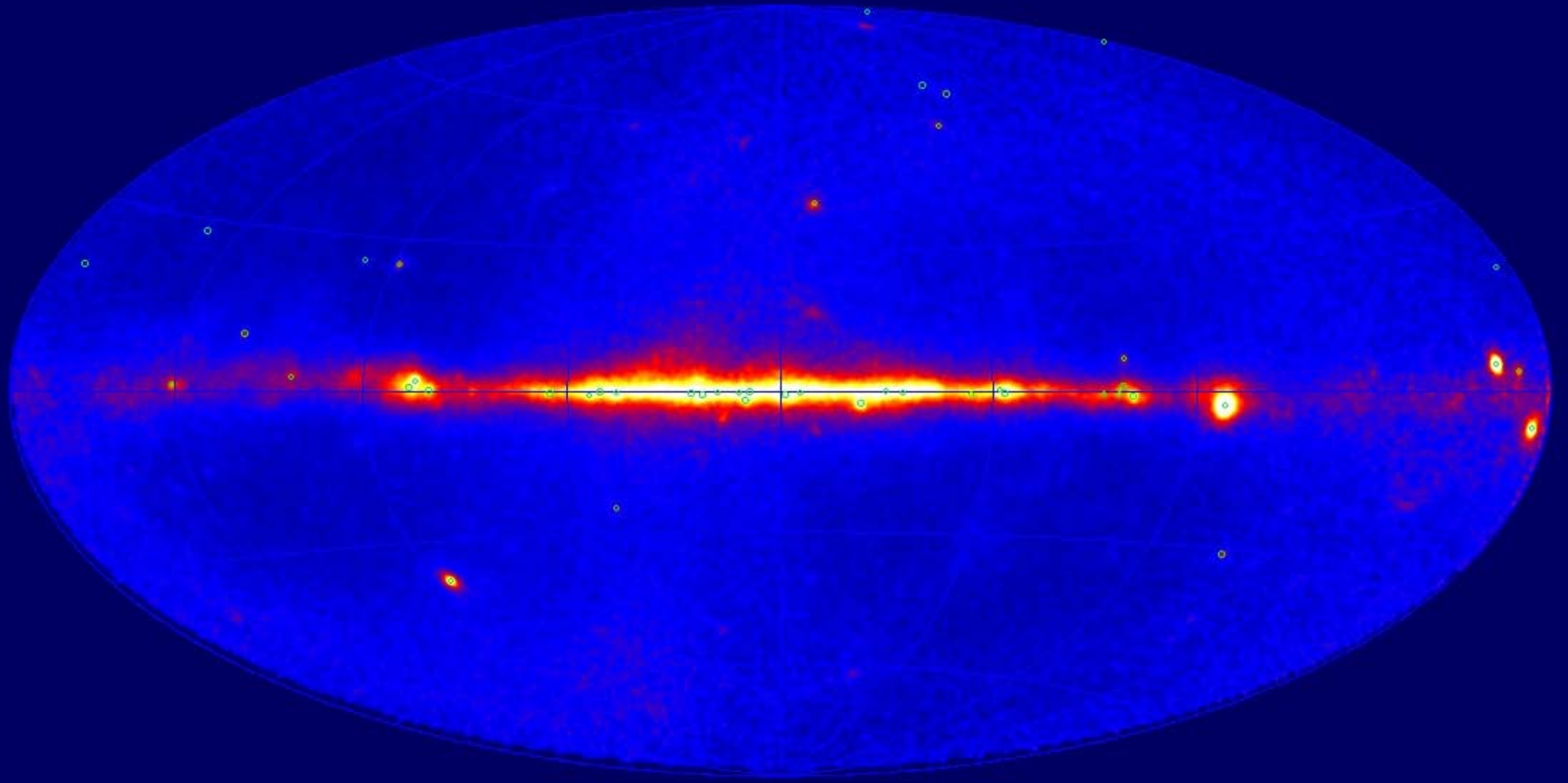
**First AGILE GRID light
ADC 24/5/2007**

**Commissioning Phase:
AGILE Vela PSR Count Map**

(~ 20000 s)



AGILE Total Intensity Map ($E > 100$ MeV):
Pointing + Spinning (up to July 30, 2011)



“The First AGILE-GRID Catalog of High Confidence Gamma-Ray Sources”
C. Pittori et al., A&A 506, 2009 (green circles, first year of operations)

The First AGILE GRID Catalogue of γ -ray Sources

Period July 2007 -- June 2008

Pulsars

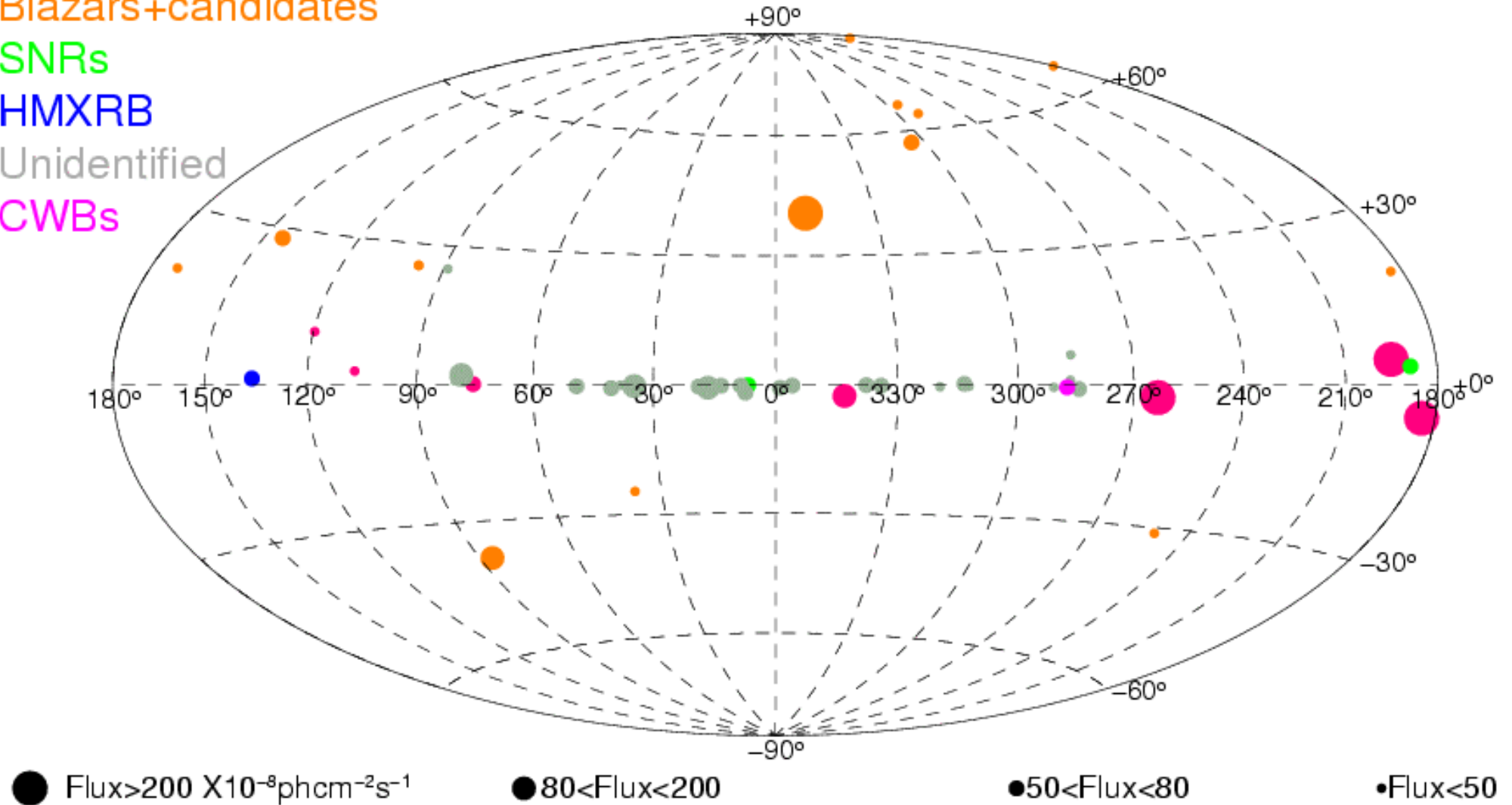
Blazars+candidates

SNRs

HMXRB

Unidentified

CWBs



- C. Pittori et al., A&A 506, 2009 - arXiv:0902.2959

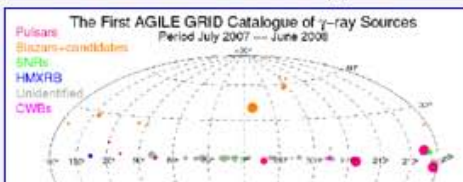
The First AGILE-GRID Catalog of High Confidence Gamma-Ray Sources

C. Pittori, F. Verrecchia, A. Chen, A. Bulgarelli, A. Pellizzoni, A. Giuliani, S. Vercellone, F. Longo, M. Tavani, P. Giommi et al.
A&A 506, 1563-1574 (2009)

Revised version - July 30, 2009.

The First AGILE Catalog includes sources detected by using AGILE-GRID data from July 9, 2007, end of the Satellite Commissioning phase, to June 30, 2008. Users can also download the First AGILE Catalog in FITS format here.
Refined analysis of complex regions of the Galactic plane yielded a new list of 47 high-confidence sources, compared to the 40 sources of the first version. Previous preliminary versions were published on this webpage to allow AGILE A02 guest observers to benefit of the Catalog in the preparation of their proposals.

If the AGILE Catalog data are used in publications, please acknowledge the AGILE Collaboration efforts by the following sentence:
"We acknowledge the use of The First AGILE Catalog of High Confidence Gamma-ray Sources, C. Pittori et al. 2009, A&A 506, 1563-1574 (2009), and on-line version available from the ADC web pages at ASDC."



asdc
ASI Science Data Center

VD mode: off (turn on) Help

Cone Search
Source Name:
Resolve name:
RA, Dec L.B.
radius: 60 arcmin
Search
Reset filter

Help
Show/hide columns
Advanced Filtering
Print current view of table
Print complete table
Reset all filters

asdc
ASI Science Data Center

Entry 1AGL J0634+1748 --- GEMINGA
R.A.(J2000) = 06 34 15.9 (98.5662 deg) l=195.14
Dec (J2000) = +17 48 27.8 (17.8077 deg) b=4.36
Galactic nH = 3.50E+21 (cm⁻²)

Error circle EXPLORER Source Details

TUTORIAL HELP

Default catalogs (always selected)
Selectable catalogs:
Default selection [i]
Radio [select]
Infrared [select]
Optical [select]
X-Ray [select]
Gamma [select]
Source Catalogs [select]
[Selected catalog List >>]

size (arcmin) 60

Position selected for the analysis: R.A.=06 34 15.9 (98.5662 deg) l=195.14
Dec=+17 48 27.8 (17.8077 deg) b=4.36
Galactic nH= 3.50E+21 (cm⁻²)

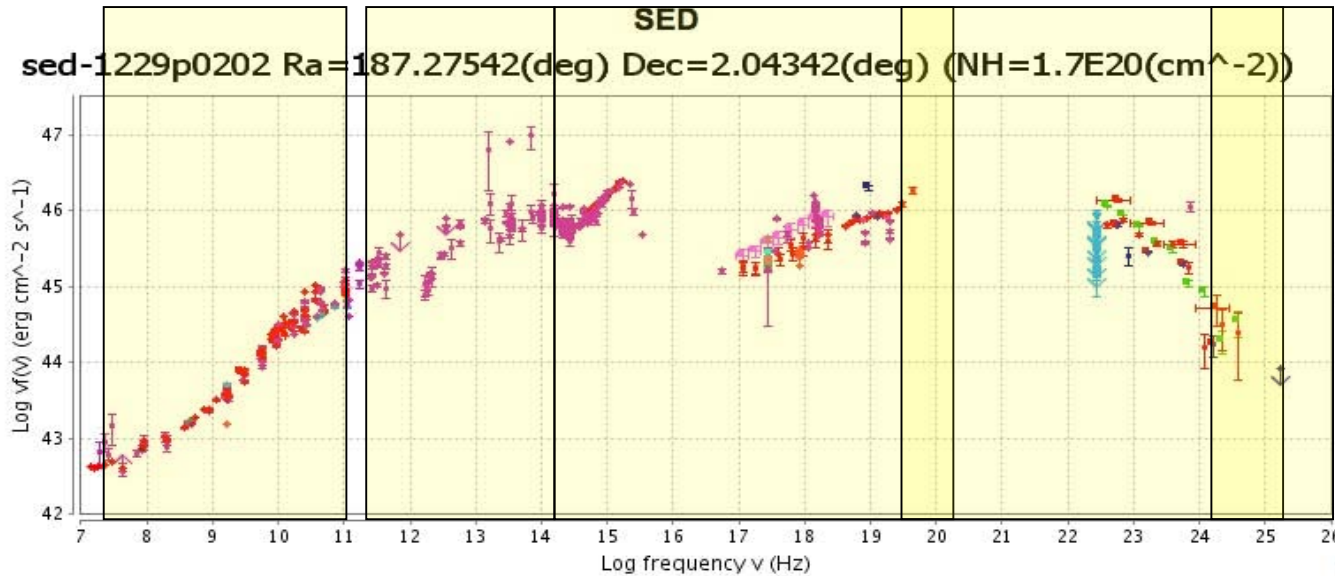
Source Name	RA (J2000)	Dec (J2000)	Galactic nH (cm ⁻²)
Pulsar CTA1	---	---	---
RB LSI+61303	---	---	---
Crab	---	---	---
3LLac PKS0537-441	BZBJ0538-4405	---	---
IC443	---	---	---
GEMINGA	---	---	---
---	BZUJ0654+4514	---	---
---	BZUJ0719+3307	---	---
3LLac S50716+714	BZBJ0721+7120	---	---
VelaPSR	---	---	---
Unidentified	---	---	---
B	---	---	---

ASDC interactive catalogs webpages

The ASDC SED Builder

Radiotelescopio, Planck, Swift

AGILE and Fermi/CTA



Redshift:
 Frequencies:

Y Axis:

Local Catalogs

	Type
<input checked="" type="checkbox"/>	Radio
<input checked="" type="checkbox"/>	X Ray
<input checked="" type="checkbox"/>	Gamma
<input checked="" type="checkbox"/>	Infrared

- KUEHR ▪ PKSCAT90 ▪ DIXON ▪ GB6 ▪ NVSS ▪ FIRST ▪ VLSS ▪ CRATES ▪ PMN ▪ NORTH20CM (flux 20 cm)
- NORTH20CM (flux 6 cm) ▪ NORTH20CM (flux 80 cm) ▪ Ned ▪ WMAP3 (Freq. 23e9) ▪ WMAP3 (Freq. 33e9)
- WMAP3 (Freq. 41e9) ▪ WMAP3 (Freq. 61e9) ▪ WMAP3 (Freq. 94e9) ▪ WMAP5 (Freq. 23e9) ▪ WMAP5 (Freq. 33e9)
- WMAP5 (Freq. 41e9) ▪ WMAP5 (Freq. 61e9) ▪ WMAP5 (Freq. 94e9) ▪ IPCSLEW ▪ IPC ▪ RASS ▪ WGACAT2 ▪ WFCCAT
- XRTSRC ▪ EGRET3 ▪ BAT39MCAT (15-30keV) ▪ BAT39MCAT (14-150keV) ▪ Fermi1FGL (200 Mev) ▪ Fermi1FGL (600 Mev)
- Fermi1FGL (2Gev) ▪ Fermi1FGL (6Gev) ▪ Fermi1FGL (60Gev) ▪ IBISSG4CAT (20-40 keV) ▪ IBISSG4CAT (40-100 keV)
- 3C273_simultaneous ▪ 3C273_BATAjello ▪ 3C273_AGILE ▪ 3C273_simul2 ▪ 3C273_GASP ▪ 3C273_SAGILE ▪ GTLIKE_P6v3
- RATAN ▪ OVRO_MAX_MIN ▪ 3C273_Claudia_Unfolding_18M ▪ swift_obs00035017300 ▪ Fermi_1yr

External Catalogs

<input checked="" type="checkbox"/>	Name	Search	Options
<input type="checkbox"/>	2Mass		U
<input type="checkbox"/>	USNO B1		U
<input type="checkbox"/>	SDSS7		U
<input checked="" type="checkbox"/>	Ned	<input type="text" value="3c273"/>	V S U
<input type="checkbox"/>	USNO A2.0		U

User Catalogs

<input checked="" type="checkbox"/>	Name	Options

Virtual Observatory Standards (*in progress*) and Tool for Operations on Catalogues And Tables (**Topcat**)

The image displays the Topcat software interface, which is used for operations on catalogues and tables. The interface is divided into several panels:

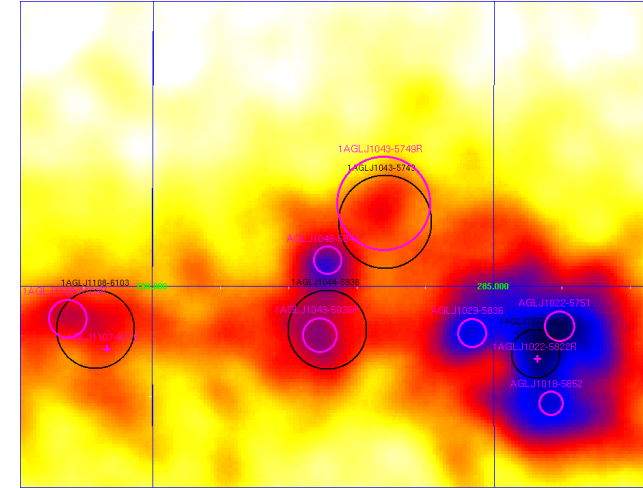
- Table List:** Shows a list of tables, with '1: aglgrd1cat' selected.
- Current Table Properties:** Displays details for the selected table, including Location (WebSampConnector:aglgrd1cat), Name (aglgrd1cat), Rows (47), Columns (11), Sort Order (up arrow), Row Subset (All), and Activation Action (no action).
- Spherical Plot:** A 3D plot showing a sphere with red dots representing data points. The plot is titled 'Spherical Plot' and has a toolbar with various navigation and manipulation tools.
- Main Panel:** Contains a 'Data' section with a 'Table' dropdown set to '1: aglgrd1cat', and 'Longitude Axis' (ra) and 'Latitude Axis' (dec) dropdowns. A 'Row Subsets' section shows 'All' selected. At the bottom, it displays 'Potential: 47 Included: 47 Visible: 47'.
- Status Panel (Right):** A yellow panel with the 'asdc ASI Science Data Center VO Tools' logo. It features a 'VO mode: on (turn off)' button circled in red, a 'Broadcast catalog' link, and status indicators for 'Aladin: stopped (start)' and 'Topcat: started'.
- Search Panel (Bottom Right):** A 'Cone Search' panel with a 'Source Name' input field, a 'Resolve name' button, radio buttons for 'RA, Dec' and 'L, B', a 'Clean' button, a radius input field set to '60 arcmin', and a 'Search' button.
- Help Panel (Left):** A vertical list of buttons including 'Help', 'Show/hide columns', 'Advanced filtering', 'Print current view of table', 'Print complete table', and 'Reset all filters'.

WORK IN PROGRESS:

- **The AGILE Pointed Variability Catalog (F. Verrecchia et al.)**

Variability study of an improved 1AGL source list (55 sources) on the timescale of the AGILE pointed observations (Observation Blocks)

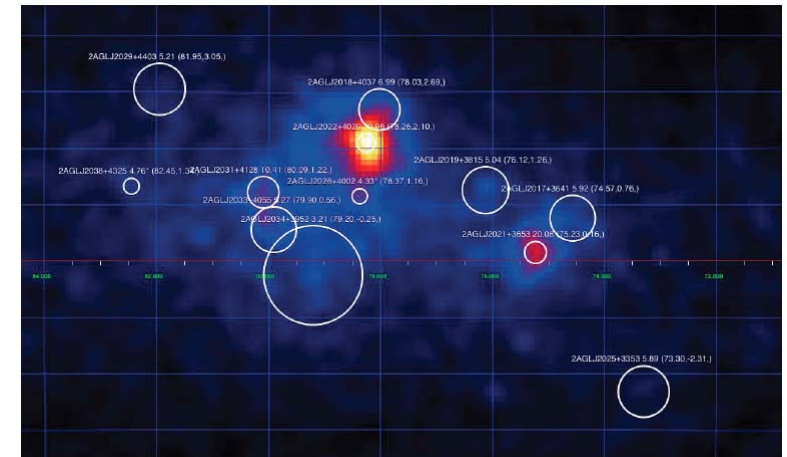
Refined positioning of some 1AGL sources: the Carina region →



- **The second AGILE Catalog (A. Bulgarelli et al.)**

New AGILE-GRID source catalog over the whole period of AGILE pointed observations (2.3 years), with improved event filter and updated calibrations.

More than 180 sources on the galactic plane only: the Cygnus region →

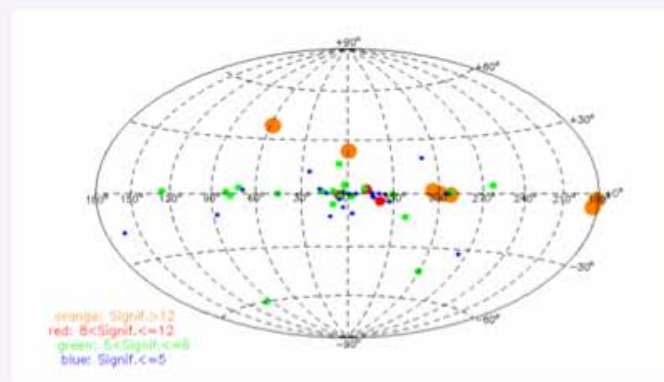


The X-ray imager SuperAGILE: public source list from interactive pages at ADC:

SuperAGILE Source Catalog: POINTING + SPINNING

NOTICE: This page contains the light curves of a set of X-ray sources as measured by the SuperAGILE detector on-board the AGILE satellite both in "pointing observing mode" from July 2007 to October 2009, and in "spinning observing mode" from January 4, 2010 onward. In nominal pointing conditions, the fluxes were estimated with an exposure of about 3 ks while, in spinning mode, longer integration times are required to obtain equivalent exposures. The light-curve time binning is of one satellite orbit (~ 100 minutes) in pointing mode and of one week in spinning mode, from MJD=55200.

- Help
- Show/hide columns
- Advanced filtering
- Print current view of table
- Print complete table
- Reset all filters





Cone Search

Source Name

Resolve name

RA, Dec L.B.

Ex: p. 00 22 34.6, -53 01 10.2 or 0.64417, -53 01 06)

radius: arcmin

SuperAGILE in the SPINNING OPERATIVE MODE: E. Del Monte et al., SPIE 7732 (2010), section 4.
 Monitoring the hard X-ray sky with SuperAGILE M. Feroci et al., 2010, A&A 510,A9, arXiv:0910.4895

NOTE for the proper user of the pointing data contained on this Webpage

Export Current view of Table in:

◀ Previous Page Next Page ▶ Page Size (# of lines) 50 Refresh page Reset all filters Show all entries

Entry number	Light Curve	Target Name	RA (J2000) hh mm ss.d	Dec (J2000) dd mm ss.d	Latest Observation Time	Flux (cts cm ⁻² s ⁻¹)	Flux error (cts cm ⁻² s ⁻¹)	Detection Significance	Exposure (sec)	Orbit number
1	<input type="button" value="ASDC data Explorer"/> <input type="button" value="Show"/>	Sco X-1	16 19 55.2	-15 38 34.8	2011-09-18T10:00:03	0.155	0.0139	24.19	12872	022711
2	<input type="button" value="ASDC data Explorer"/> <input type="button" value="Show"/>	Crab	05 34 30.9	+22 01 04.8	2011-09-18T10:00:03	0.102	0.0088	29.67	16111	022711

50 X-ray (18-60 keV) validated sources, up to September 2011



AO1: Dec 1, 2007 - Nov 30, 2008

Status AGILE AO1: **completed/public**

Submitted proposals: 29

Approved/P. Approved: 24

Requested Targets: 122

Approved Targets: **100**

Pulsars: 39

AGN: 31

3EG sources: 30

AO2: Dec 1, 2008 - Nov 30, 2009

Status AGILE AO2: **completed/public**

Submitted/Approved proposals: 15

14 PI, 74 co-PI

Requested/Approved Targets: **93**

Pulsars: 21

AGN: 62

3EG sources: 10

AO3: Dec 1, 2009 - Nov 30, 2010

Status AGILE AO3: **completed/public**

Submitted/Approved proposals: 11

11 Proposals,

10 PI, 78 co-PI

Requested/Approved Targets: **67**

Pulsars: 13

AGN: 37

3EG sources: 7

1FGL Sources: 10

AO4: Dec 1, 2010 - Nov 30, 2011

Status AGILE AO4: **completed/proprietary**

Submitted/Approved proposals: 18

16 PI, 69 co-I

Requested/Approved Targets: **123**

Pulsars: 43

AGN: 50

3EG sources: 5

1FGL Sources: 24

1AGL Sources: 1

AGILE Public Data Distribution from the ASDC MMIA

- **First Cycle-1 public delivery (17 OBs): Jun 10, 2009** (*data_release_note_v1*)
- **Second Cycle-1 public delivery (3 OBs): July 17, 2009**
- **Publication of a reprocessed Cycle-1 (20 OB) dataset: Oct 6, 2009**
(*data_release_note_v2*)
- **Complete Cycle-1 public data release (29 OB): Dec 22, 2009**
(*data_release_note_v3*)
- **Cycle-2 public delivery (22 OB) and reprocessed Cycle-1 dataset: Oct 6, 2010** (*data_release_note_v4*)
- **Complete Cycle-1 and Cycle-2 reprocessed data release: Dec 21, 2010**
(*data_release_note_v5*)
- **Cycle-3 (spinning) public delivery (22 OB): Nov 9, 2011**
(*data_release_note_v6*)

New
developed

Available parameters

- OB Number OB Name RA_PNT ERR_RAP DEC_PNT ERR_DECP RA_SUN (degrees) ERR_RAS DEC_SUN (degrees) ERR_DECS GRID Data Retrieval GRID Interactive Archive OB start date OB end date Processing version Mean OB Exposure (cm² s) Related SuperAGILE Entries Notes

GO

Entry number		OB Number	OB Name
Selection mode:		<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>
<input type="checkbox"/> Inclusive			
1 <input type="checkbox"/>		4900	Cygnus Field 1
2 <input type="checkbox"/>		4910	Cygnus Field 1 b<0
3 <input type="checkbox"/>		4920	Cygnus Field 1 Extended

AGILE Imaging Tool @ ASDC

Image parameters: ?

Source Name ?

RA Dec ?

LII BII ?

Image radius (deg) ?

Emin ?

Emax ?

Catalog Overlay ?

Radio Infrared X-Ray Gamma

NVSS SUMSS FIRST GB6

Ximage smoothing parameters: ?

Smoothing filter ?

sigma ?

back ?

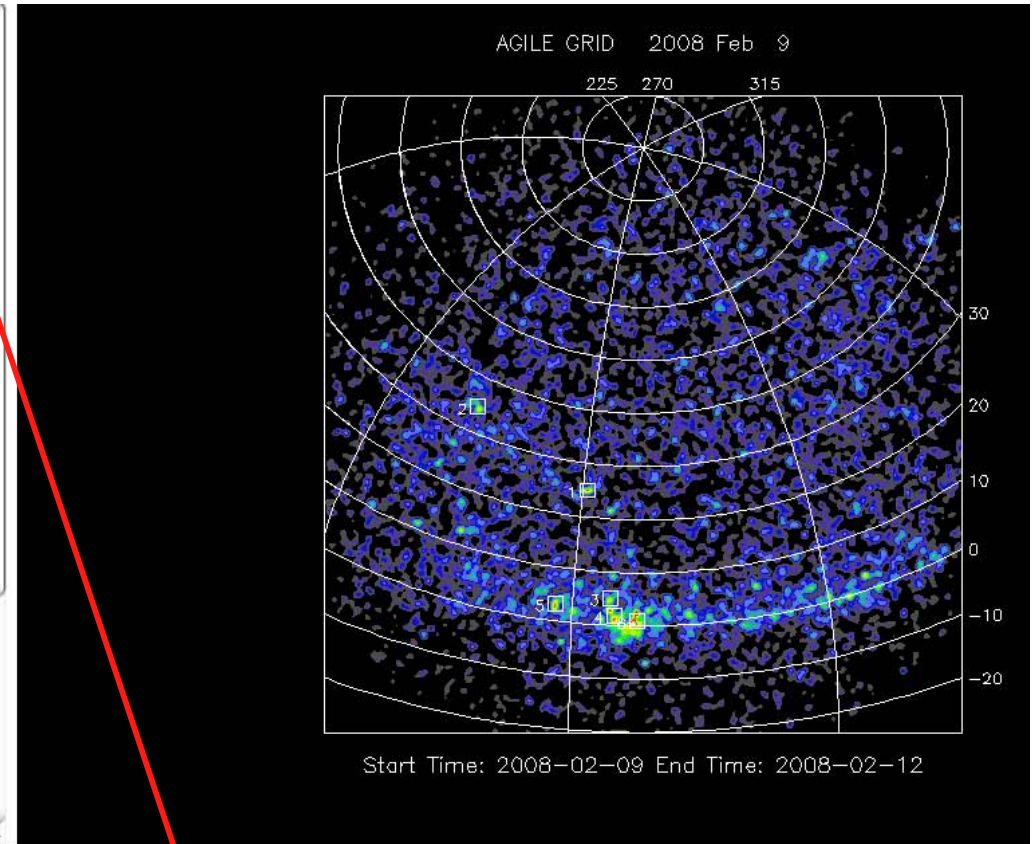
Ximage display parameters: ?

Color scaling ?

Minimum level displayed ?

Ximage detect parameters: ?

Probability threshold ?



Entry number		OB Number	OB Name	RA	DEC	Access	Analysis	Start	End	Count	Notes
1		4900	Cygnus Field 1								
2		4910	Cygnus Field 1 b<0	21 54 00.0	+38 00 00.0	Public access	On-line Analysis	2007-12-05 09:00:00	2007-12-15 12:00:00	18604859	Partial Repointing
3		4920	Cygnus Field 1 Extended	22 16 00.0	+37 54 00.0	Public access	On-line Analysis	2007-12-15 12:00:00	2007-12-16 12:00:00	1741245	ToO

Ximage sw package adapted to gamma-rays

Allows web users to have a **preview** of the AGILE public data fields and perform an interactive **preliminary analysis** around a chosen sky position.

Baseline
Baseline
Baseline
ToO
Baseline

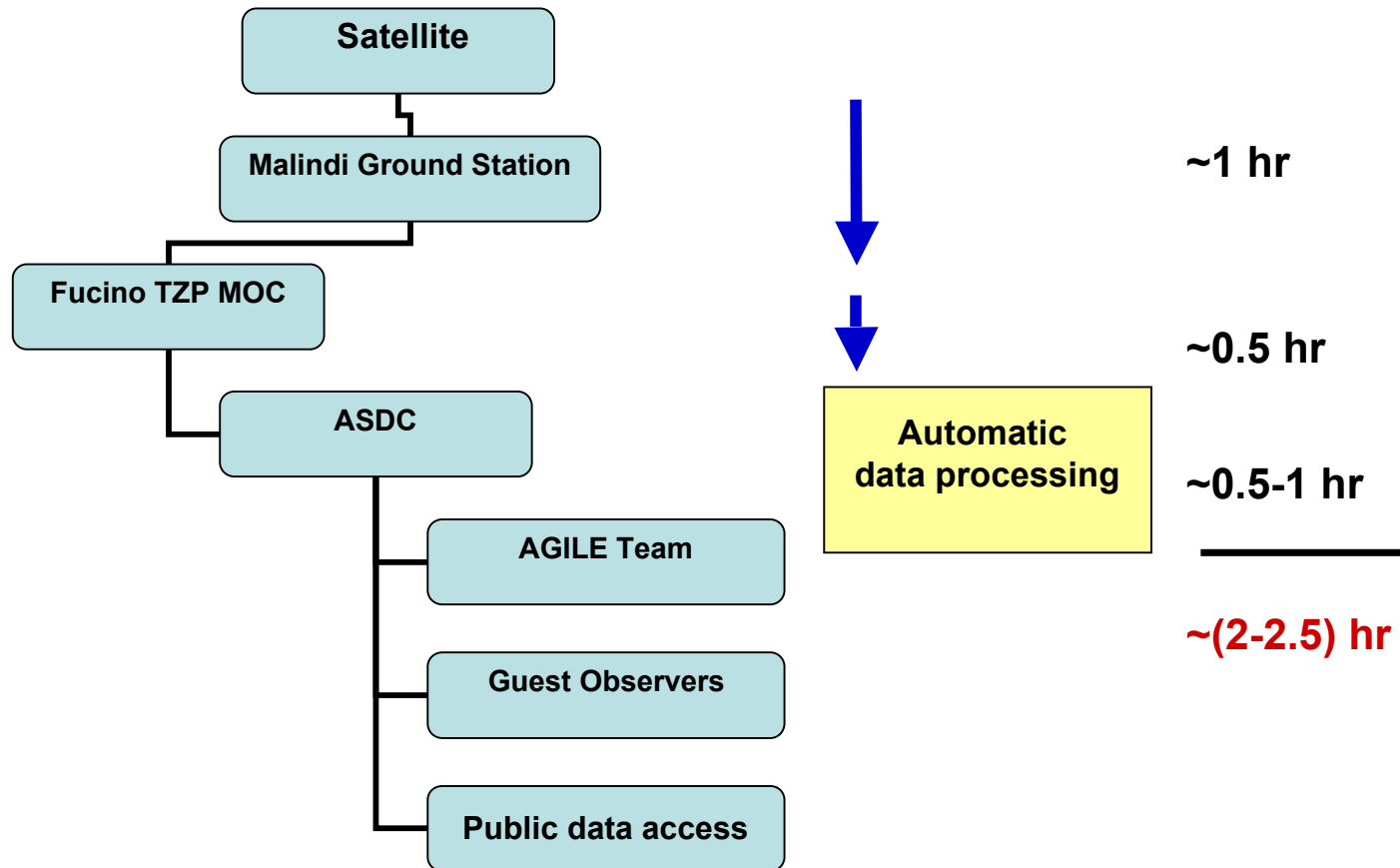
Warning: use imaging tool only as a preview of the AGILE γ -ray field. To perform your own scientific analysis, please **download data and use the official public AGILE software** available at: <http://agile.asdc.asi.it/public/> following the AGILE Software User Manual

Index of /public/AGILE_SW_5.0_SourceCode

Icon	<u>Name</u>	<u>Last modified</u>	<u>Size</u>	<u>Description</u>
[DIR]	Parent Directory		-	
[]	AGILE-IFC-OP-009 Build-21.pdf	22-Nov-2011 18:24	928K	
[]	BUILD GRID 5.0.tgz	22-Nov-2011 16:56	121M	
[TXT]	SoftwareReleaseNote 5.0.txt	25-Nov-2011 16:01	16K	
[TXT]	readme 5.0.txt	22-Nov-2011 16:57	5.2K	
[]	test dataset 5.0.tgz	22-Nov-2011 16:57	346M	

Apache Server at agile.asdc.asi.it Port 80

AGILE: “very fast” Ground Segment (with contained costs)

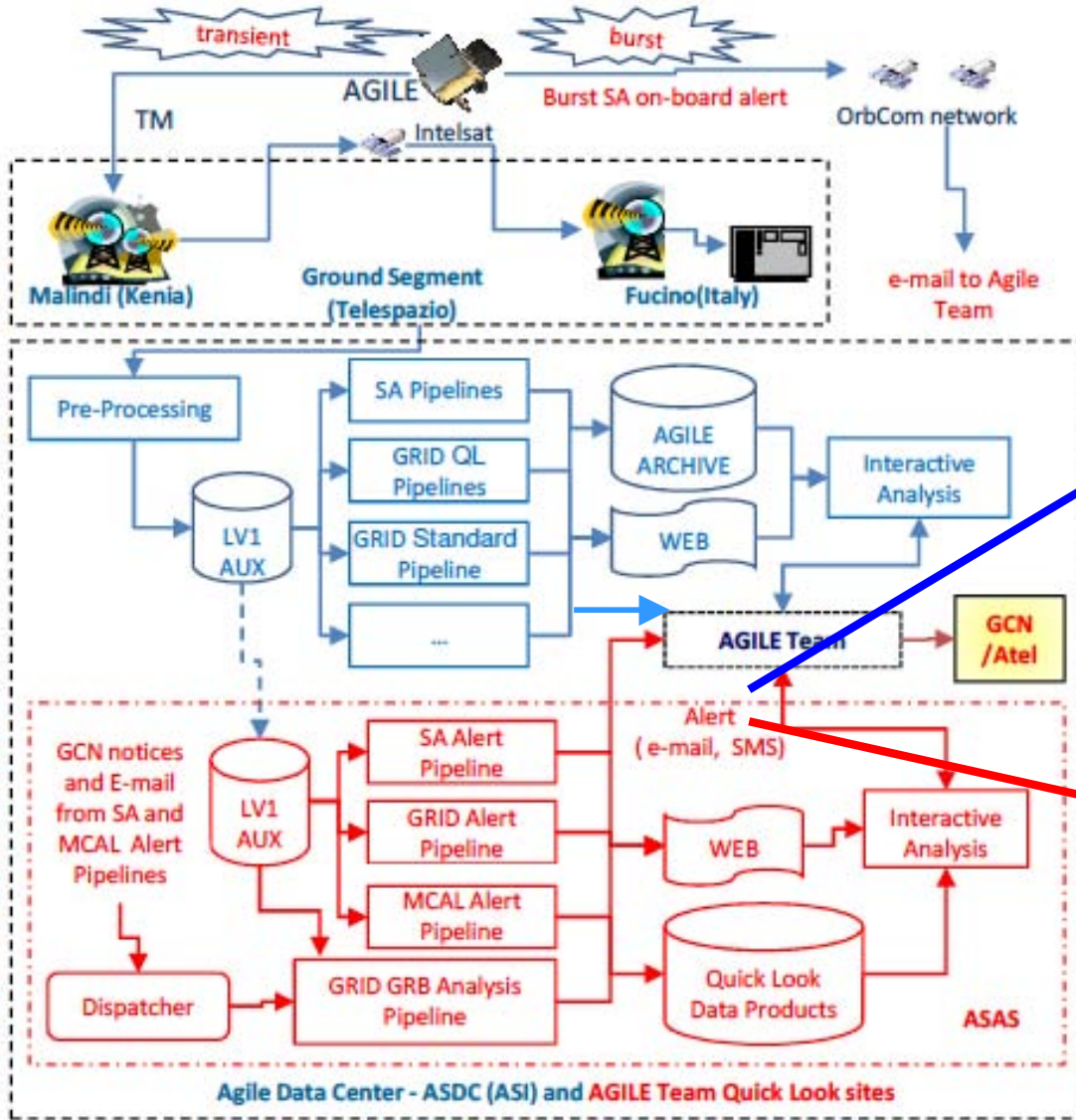


Record for a gamma-ray mission!

AGILE Science Alert System

- The system is distributed among the ADC @ ASDC and the AGILE Team Institutes (Trifoglio, Bulgarelli, Gianotti et al.)
- Automatic Alerts to the AGILE Team are generated within $T_0 + 45 \text{ min (SA)}$ and $T_0 + 100 \text{ min (GRID)}$
- GRID Alerts are sent via email (and sms) both on a contact-by-contact basis and on a daily timescale
- Refined manual analysis on most interesting alerts performed every day (daily monitoring)
- **98 ATel** (42 in pointing + 56 in spinning) and **37 GCN** published up to March, 2012

Selected **alerts** sent via email, sms



(Figure adapted from M. Trifoglio et al.)

label:agile-daily-report

The label "AGILE Daily Report" has been removed from the conversation. [Learn more](#) [Undo](#)

From	Subject	Date	Time
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report 11/12/2011 (ok) - AGILE Daily Report 11/12/2011 (MJD:55906) ### FM Filter ...	10:12 am
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 11/12/2011 (ok) - AGILE Daily Report Global Proc. 11/12/2011 (MJD:559	9:49 am
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 10/12/2011 noon (ok) - AGILE Daily Report Multi2 Results 10/12/2011 (Dec 10
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 10/12/2011 noon (ok) - AGILE Daily Report Global Proc. 10/12/2011 noo	Dec 10
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 10/12/2011 (ok) - AGILE Daily Report Multi2 Results 10/12/2011 (MJD:	Dec 10
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 10/12/2011 (ok) - AGILE Daily Report Global Proc. 10/12/2011 noo	Dec 10
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 09/12/2011 (ok) - AGILE Daily Report Multi2 Results 09/12/2011 (MJD:	Dec 9
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 09/12/2011 (ok) - AGILE Daily Report Global Proc. 09/12/2011 noo	Dec 9
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 09/12/2011 (ok) - AGILE Daily Report Multi2 Results 09/12/2011 (MJD:	Dec 9
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 09/12/2011 (ok) - AGILE Daily Report Global Proc. 09/12/2011 (MJD:	Dec 9
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 08/12/2011 noon (ok) - AGILE Daily Report Multi2 Results 08/12/2011 (MJD:	Dec 8
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 08/12/2011 (ok) - AGILE Daily Report Global Proc. 08/12/2011 noon	Dec 8
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 08/12/2011 (ok) - AGILE Daily Report Multi2 Results 08/12/2011 (MJD:	Dec 8
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 08/12/2011 (ok) - AGILE Daily Report Global Proc. 08/12/2011 (MJD:	Dec 8
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 07/12/2011 (ok) - AGILE Daily Report Multi2 Results 07/12/2011 (MJD:	Dec 7
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 07/12/2011 (ok) - AGILE Daily Report Global Proc. 07/12/2011 noon	Dec 7
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 07/12/2011 (ok) - AGILE Daily Report Multi2 Results 07/12/2011 (MJD:	Dec 7
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 07/12/2011 (ok) - AGILE Daily Report Global Proc. 07/12/2011 (MJD:	Dec 7
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 06/12/2011 noon (ok) - AGILE Daily Report Multi2 Results 06/12/2011 (MJD:	Dec 6
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Global Proc. 06/12/2011 noon (ok) - AGILE Daily Report Global Proc. 06/12/2011 noon	Dec 6
no_reply	AGILE Daily Report	[gridaler] AGILE Daily Report Multi2 Results 06/12/2011 (ok) - AGILE Daily Report Multi2 Results 06/12/2011 (MJD:	Dec 6

Daily time scale (twice a day)

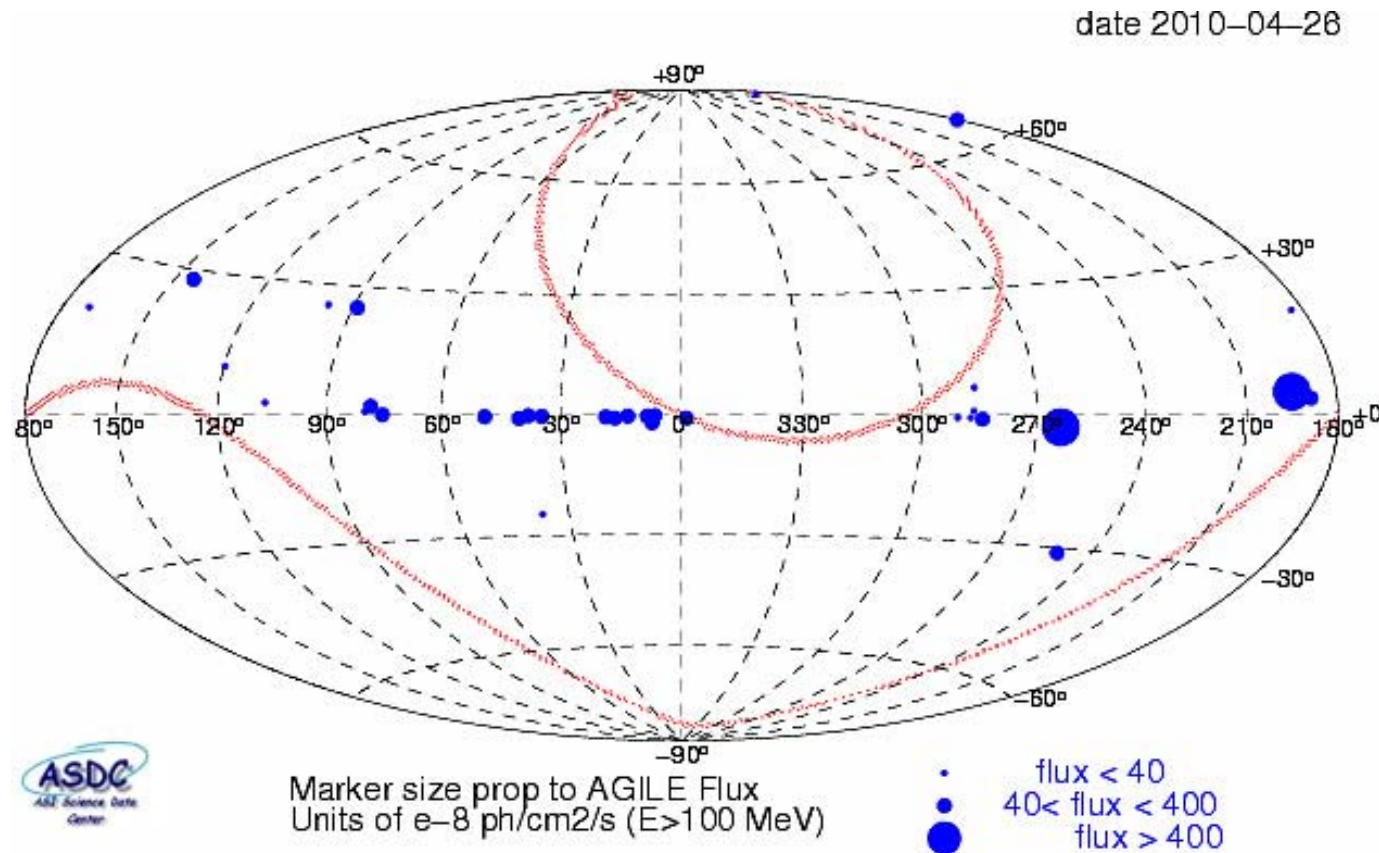
Contact-by-contact time scale (~100 min)

label:grid-alert

Gmail's getting a new look soon. [Learn more](#) [Dismiss](#)

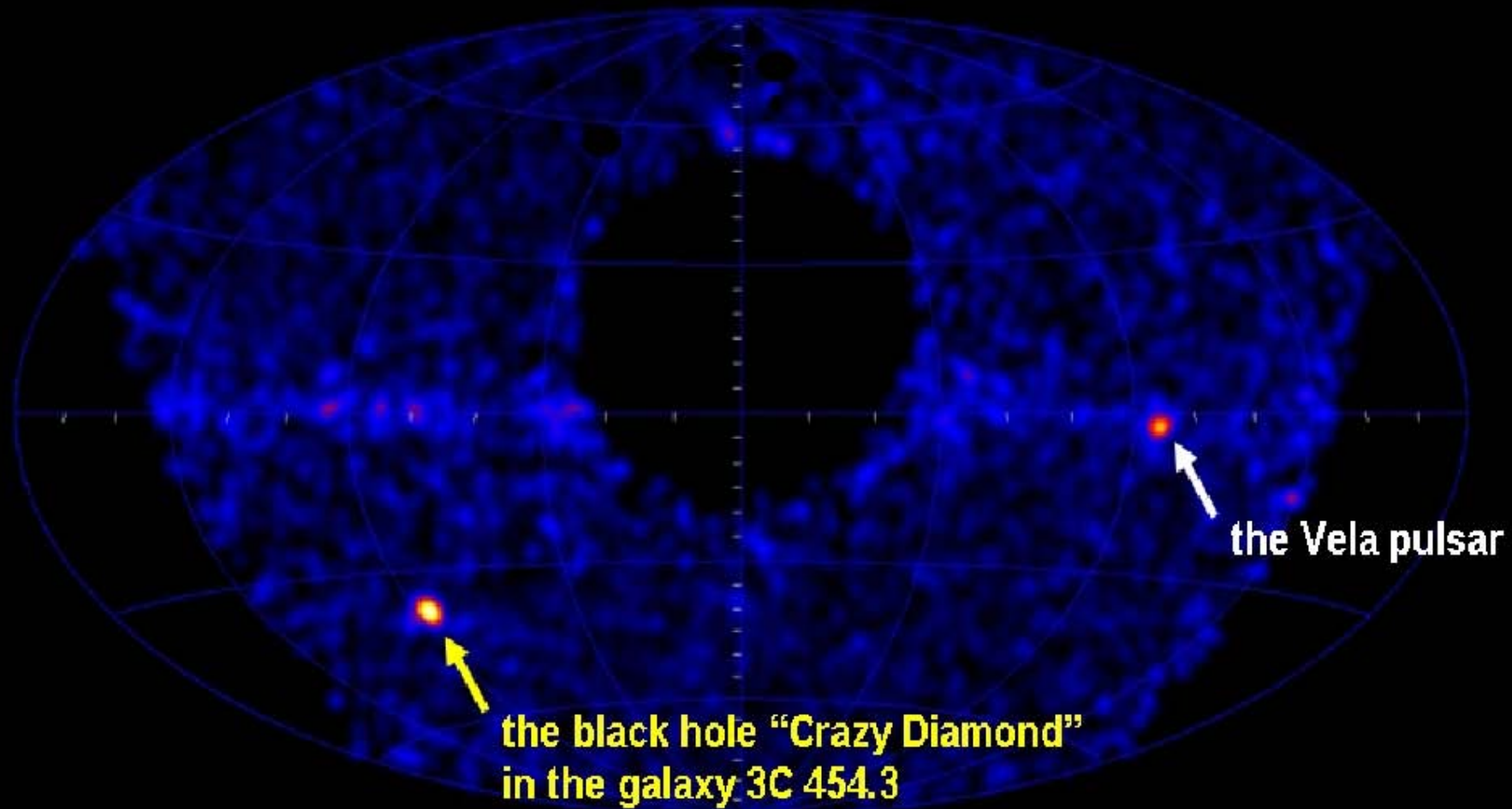
From	Subject	Date	Time
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.08 165.7+-79.5 (297.5, 19.9, 165) - 12 - FM3.119_2_SPOTS_100... - 4.08 297.517 19.9021 off axis	2:28 am
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.09 493.7+-202.9 (151.7, -48.9, 60) - 34 - FM3.119_2_SPOTS_10... - 4.09 151.732 -48.9168 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.53 193.9+-75.0 (71.2, 26.3, 178) - BZQJ1801+4404 - FM3.119_2... - 4.53 71.1847 26.2573 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.08 177.3+-76.0 (223.7, -67.4, 150) - BZBJ0235-2938 - FM3.119... - 4.08 223.689 -67.3961 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.02 325.4+-128.4 (124.7, -5.2, 124) - 29 - FM3.119_2_SPOTS_10... - 4.02 124.685 -5.21243 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.59 652.9+-229.0 (137.9, -33.9, 63) - JB144.5+2709 - FM3.119... - 4.59 137.945 -33.8679 off axis 3	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.33 549.0+-214.9 (151.7, -48.9, 59) - 34 - FM3.119_2_SPOTS_10... - 4.33 151.732 -48.9168 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.13 122.3+-53.0 (79.0, 1.6, 230) - 1AGL_J2022+4032 - FM3.119... - 4.13 79.0172 1.57494 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.44 619.0+-231.5 (151.8, -48.9, 59) - 33 - FM3.119_2_SPOTS_10... - 4.44 151.753 -48.9368 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.75 715.0+-250.2 (137.8, -33.3, 61) - BZQJ0151+2744 - FM3.119... - 4.75 137.777 -33.3228 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.42 195.7+-76.6 (71.2, 26.3, 175) - BZQJ1801+4404 - FM3.119_2... - 4.42 71.1797 26.2511 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.17 200.1+-83.5 (223.6, -67.4, 149) - BZBJ0235-2938 - FM3.119... - 4.17 223.641 -67.4126 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.07 184.9+-76.6 (71.4, 25.9, 490) - BZBJ1811+4416 - FM3.119_2... - 4.07 71.4071 25.8768 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.7 662.7+-230.0 (137.8, -33.3, 67) - J0144.5+2709 - FM3.119_2... - 4.70 137.771 -33.3317 off axis 3	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.38 558.6+-211.5 (151.8, -48.9, 64) - 33 - FM3.119_2_SPOTS_10... - 4.38 151.753 -48.9368 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.34 183.6+-72.9 (71.2, 26.2, 188) - BZQJ1801+4404 - FM3.119_2... - 4.34 71.1877 26.1827 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.04 180.2+-76.5 (223.6, -67.4, 164) - BZBJ0235-2938 - FM3.119... - 4.04 223.648 -67.4144 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.10 190.5+-75.2 (71.5, 25.8, 549) - BZBJ1811+4416 - FM3.119_2... - 4.10 71.4615 25.7513 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.0 175.5+-72.7 (71.3, 26.0, 527) - BZBJ1811+4416 - FM3.119_2... - 4.00 71.2924 25.9978 off axis ;	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.25 527.4+-205.8 (151.7, -48.9, 64) - 32 - FM3.119_2_SPOTS_10... - 4.25 151.745 -48.9242 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.01 180.2+-76.9 (223.6, -67.4, 163) - BZBJ0235-2938 - FM3.119... - 4.01 223.649 -67.4149 off axis	Dec 10
Uteme GRID1 BUILD17	GRID ALERT	[gridaler] ALERT LEVEL 4.14 502.0+-200.2 (151.8, -48.9, 63) - 32 - FM3.119_2_SPOTS_10... - 4.14 151.751 -48.9267 off axis	Dec 10

Since November 4, 2009, AGILE is operating in a **spinning observing mode** and it is now surveying a large fraction of the sky every day. **AGILE spinning sky view on a particular day:**



All ADC functionalities and data processing promptly adapted to the new spinning configuration at no extra costs!

On December 3-4, 2009 the AGILE satellite detected the strongest γ -ray flare ever observed ($E > 100$ MeV). The flaring γ -ray source is in the active galaxy 3C454.3 ($z=0.859$, $F_\gamma > 2 \times 10^{-5}$ ph cm $^{-2}$ s $^{-1}$, $L_{\text{iso}} = 6 \times 10^{49}$ erg s $^{-1}$)



AGILE: 5th year in orbit

- AGILE demonstrates for the first time the covering of $\sim 1/5$ of the entire gamma-ray sky (FoV ~ 2.5 sr) with excellent angular resolution and competitive sensitivity.
- AGILE shows for the first time an optimal performance of its gamma-ray and hard X-ray imagers.
- **> 26300 orbits, May 28, 2012**
- **Pointing observation** mode up to October 18, 2009 and **spinning observation mode** since October 2009.
- **Very good scientific performance, especially at ~ 100 MeV**
- **Guest Observer Program open to the scientific community:**
 - Cycle-1: completed, Dec. 1, 2007 – Nov 30, 2008**
 - Cycle-2: completed, Dec. 1, 2008 – Nov 30, 2009**
 - Cycle-3: completed, Dec. 1, 2009 – Nov 30, 2010**
 - Cycle-4: completed, Dec. 1, 2010 – Nov 30, 2011**
 - Cycle-5: on-going data taking**

**AGILE: Gamma-Rays
MAIN DISCOVERIES
AND SURPRISES!**

- **Carina region:** γ -ray detection of the colliding wind massive binary system η -Car with AGILE

Tavani et al., **ApJ**, 698, L142, 2009 (arXiv:0904.2736)

- **Cygnus region microquasars:**
 - AGILE observations of Cygnus X-1 gamma-ray flares

Sabatini et al., **ApJ** 2010, Del Monte et al., **A&A** 2010

- AGILE detects several gamma-ray flares from Cygnus X-3, and also weak persistent emission above 100 MeV

Tavani et al., **Nature** 462, 620, 2009 (arXiv:0910.5344)

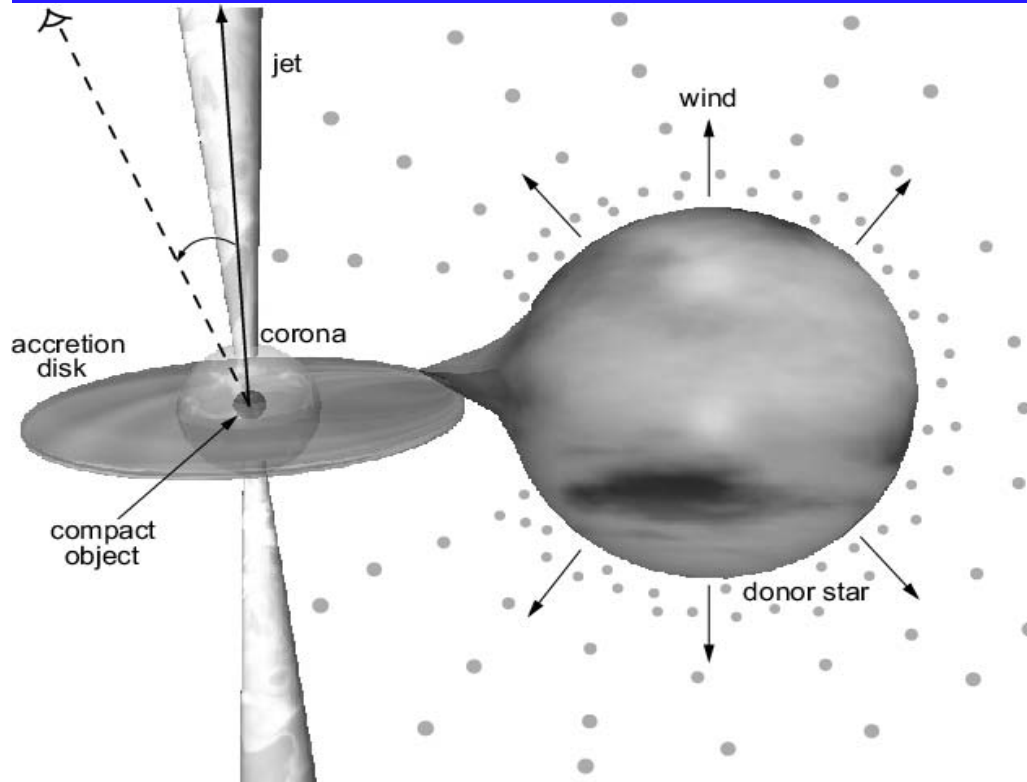
- Detection of Gamma-Ray Emission from the **Vela Pulsar Wind Nebula** with AGILE

Pellizzoni et al., **Science** 327, 2010

- Neutral pion emission from accelerated **protons** in the **SNR W44** See Giuliani talk

Giuliani et al., **ApJ**, 742, 2011

Microquasars



Open questions (pre-AGILE):

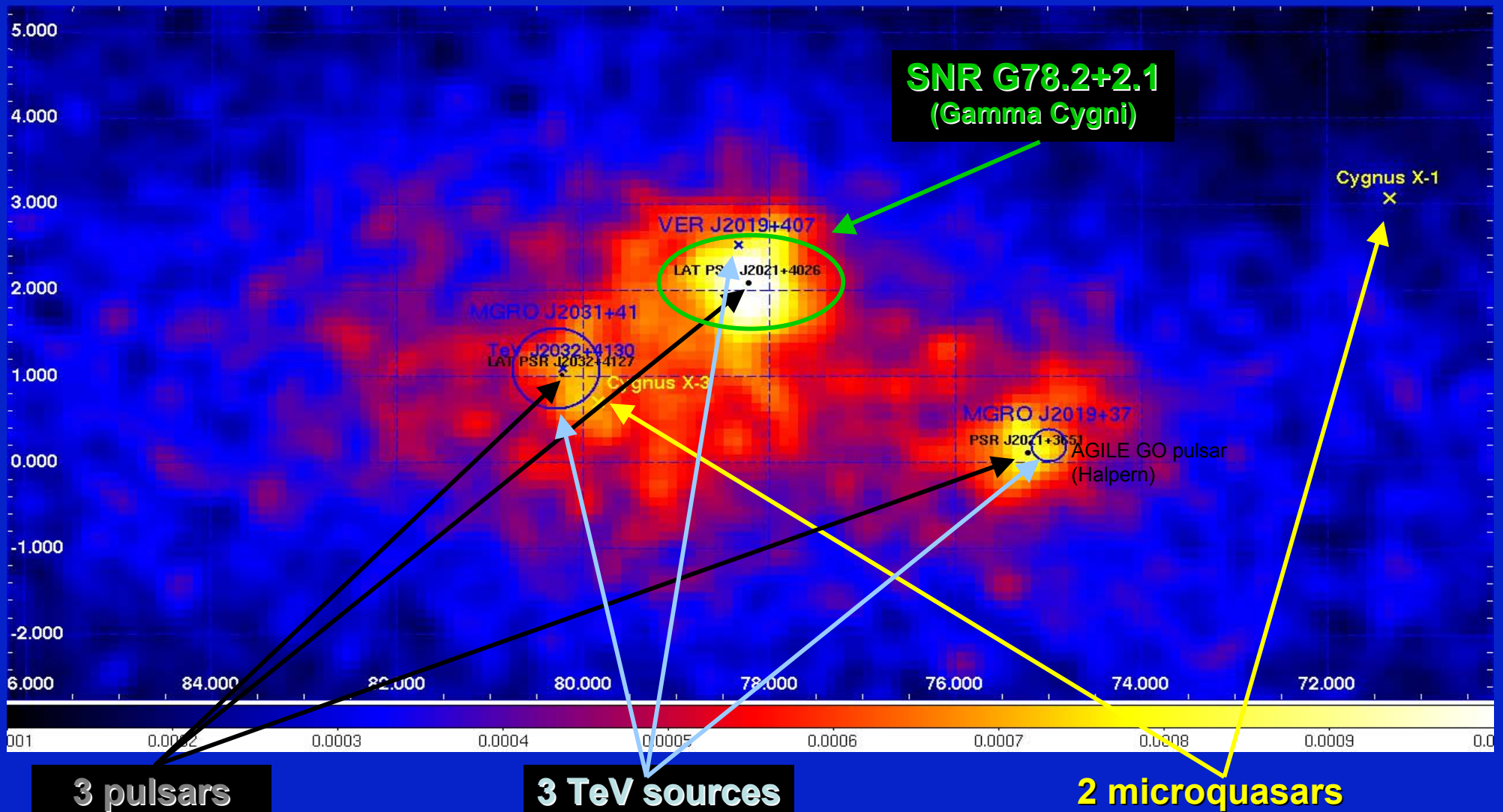
- Can jet formation accelerate relativistic particles?
- Can the jet emit γ -rays above 100 MeV?

The discovery of the γ -ray activity from Cygnus X-3 is the proof of extreme particle acceleration in microquasars.

The Cygnus region in γ -rays:

AGILE Intensity Map (100 MeV-10 GeV)

Pointing Mode: Nov. 2007 – Oct. 2009, ~ 13 Ms net exposure time



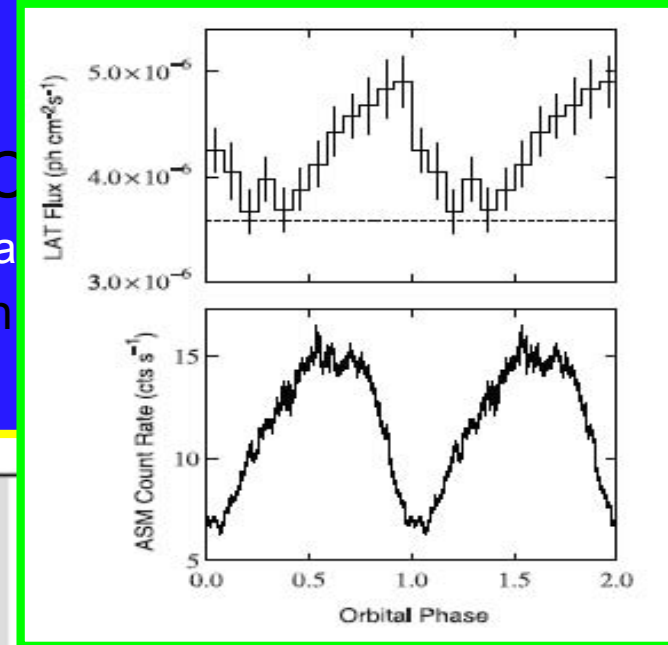
Slide adapted from G. Piano, 9th AGILE WS, April 2012

The γ -ray detection of Cygnus X-3: brief story of a discovery

- December 2, 2009:

The AGILE-GRID detects 4 γ -ray flares from Cygnus X-3
(“Extreme particle acceleration in the microquasar Cygnus X-3”, Tavares et al. 2010)

- γ -ray flaring-fluxes greater than 1 order of magnitude with respect to the quiescent level
- coincident with **prominent minima** of the hard X-ray flux
- a few days before major radio flares



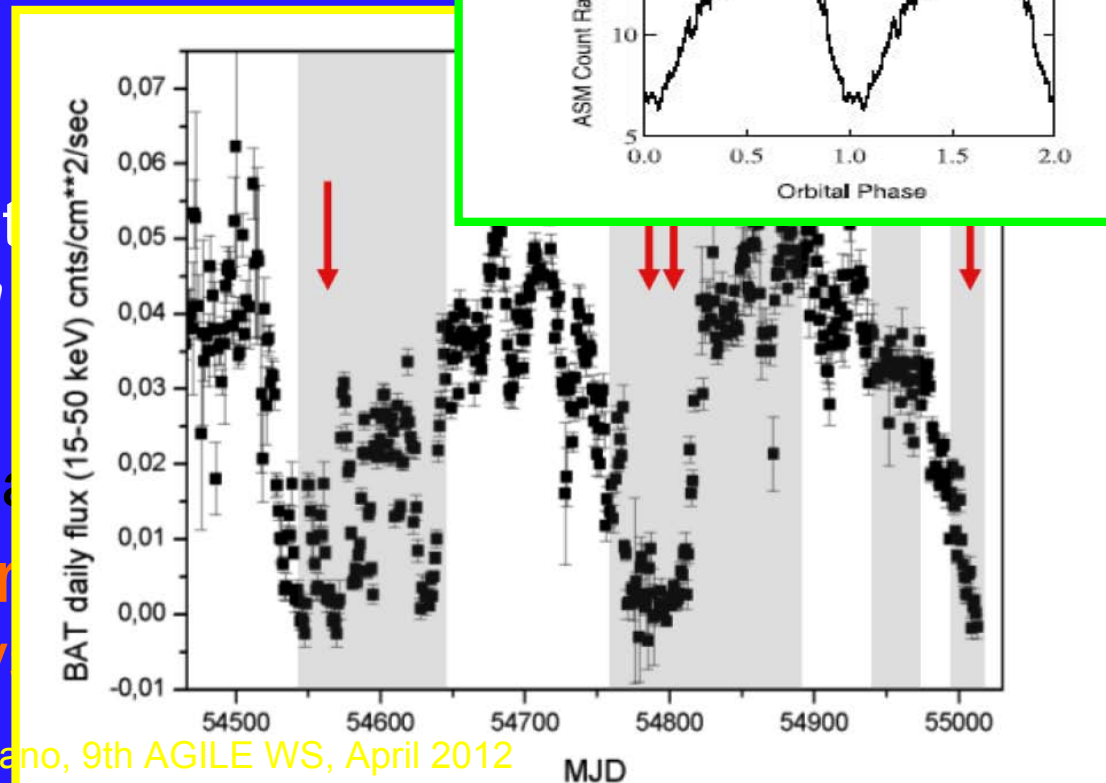
- December 11, 2009:

Fermi-LAT confirms AGILE detection of γ -ray emission from Cygnus X-3
(“Modulated High-Energy Gamma-Ray Emission from Cygnus X-3”, Tavares et al. 2010)

- γ -ray detection of the **orbital period** of the microquasar

In 9 days a long-lasting mystery has been solved

Cygnus X-3 is able to accelerate particles to ultra-relativistic energies and to emit γ -ray emission



Major gamma-ray flares in special transitional states in preparation of radio flares!

- Gamma-ray flares tend to occur in the **rare** low-flux/pre-flare radio states.
- For all gamma-ray flaring episodes, the radio and hard-X-ray fluxes are low or very low, while the soft X-ray flux is large

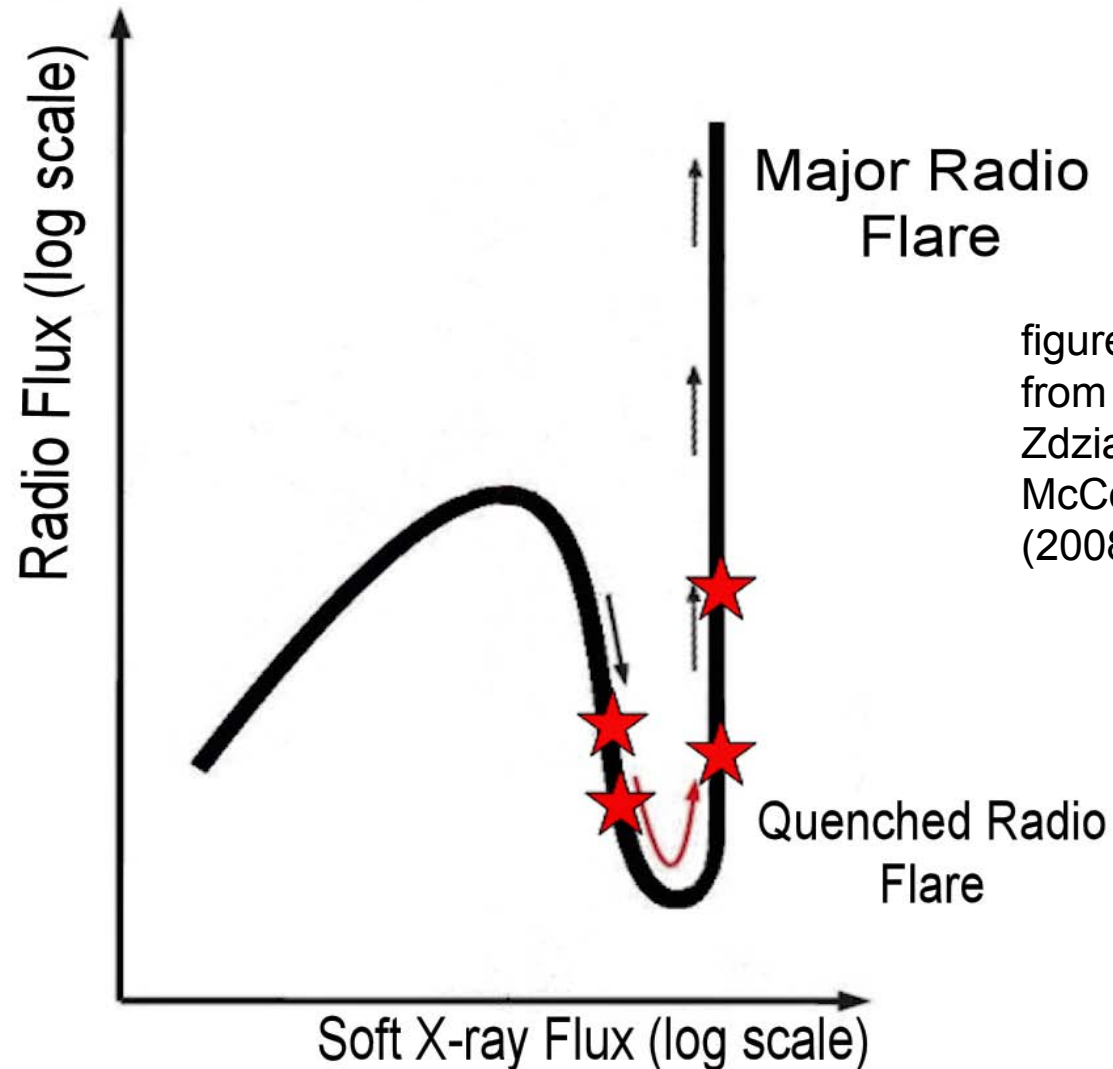


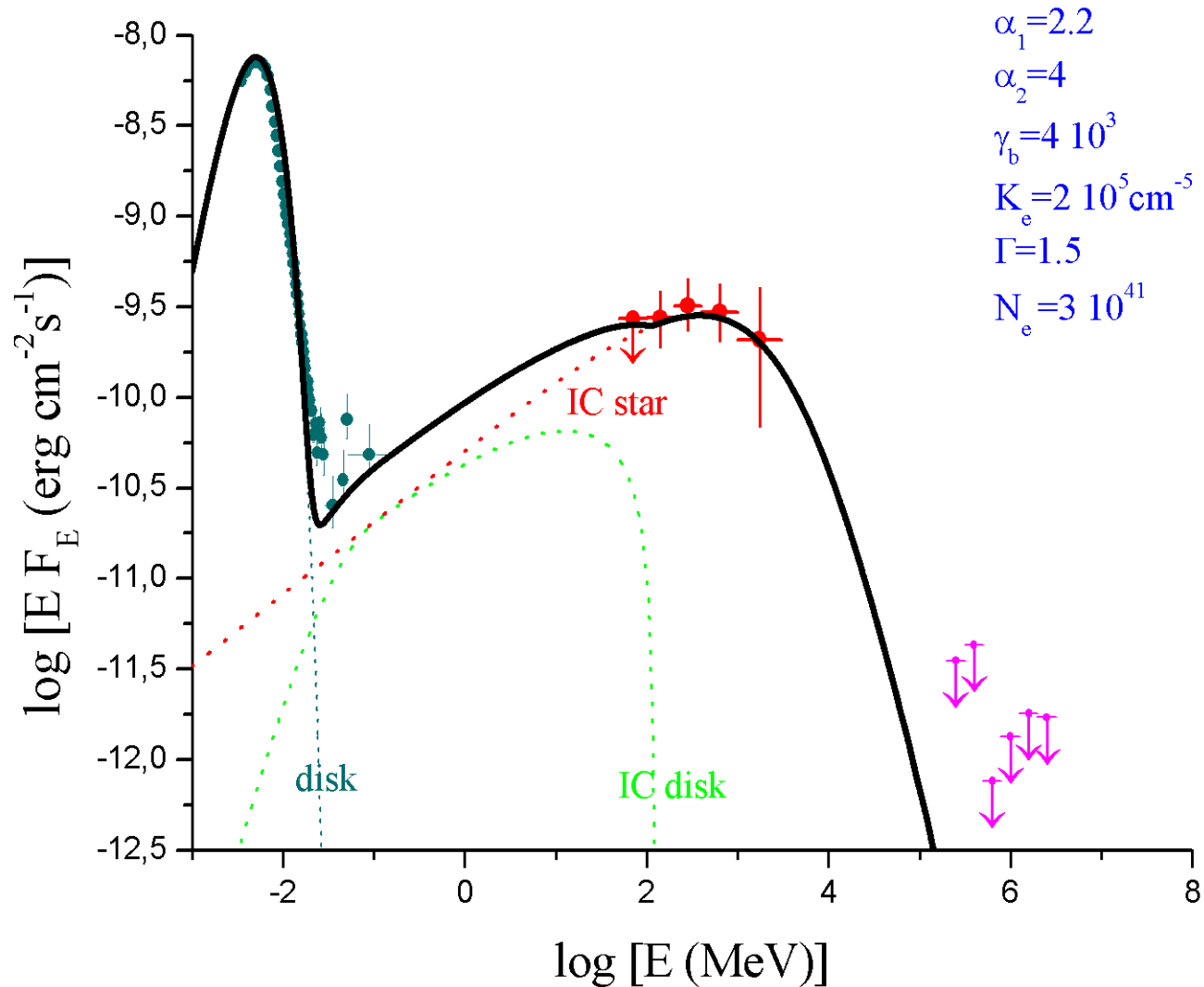
figure adapted from Szostek Zdziarski & McCollough (2008)

Cygnus X-3 lessons:

- **Direct evidence that extreme particle acceleration (above 100 MeV) and non-thermalized emission can occur in microquasars with a repetitive pattern**
- **Emission must be produced not too far away from the central object (4,8 hours orbital modulation revealed by Fermi!)**
- **Cyg X-3 is capable of accelerating particles by a very efficient mechanism leading to photon emission at energies thousands of times larger than the maximum energy previously detected ($E \sim 300$ keV)**
- **Comptonization models (thermal and non-thermal) that reproduce the spectral states up to 300 keV must take into account the new data above 100 MeV**

Cyg X-3 AGILE gamma-ray flaring spectrum

Leptonic model favored but hadronic model not excluded (very high jet kinetic power required). **Piano et al., 2012, Submitted to A&A**



Evidence of proton acceleration in the Supernova Remnant W44

A. Giuliani et al., ApJ 742, 2011

SNR W44

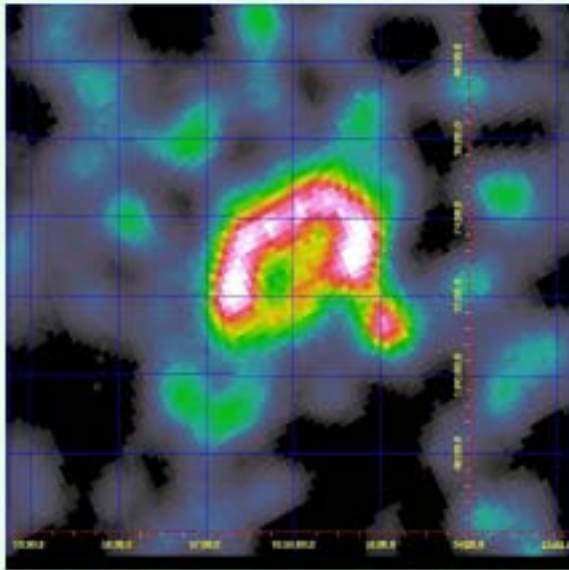


Fig 1 : SNR W44 as seen by AGILE for energies greater than 400 MeV

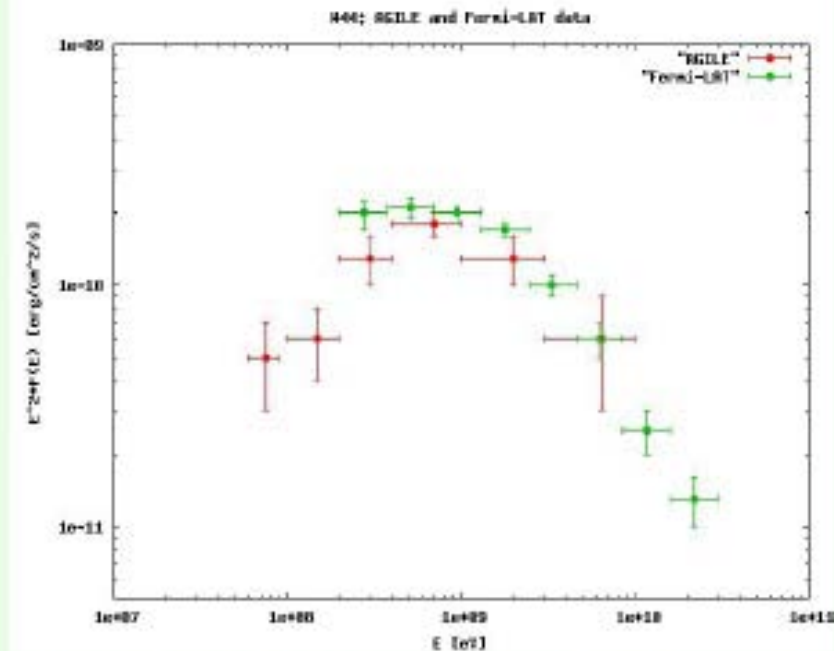


Fig 3 : combined AGILE (red) and Fermi/LAT (green) spectra energy distribution (SED) for SNR W44. AGILE points are in the range 50 MeV- 10 GeV divided in six energy intervals. Fermi/LAT data span the energy range 0,2-30GeV (from Abdo et al, 2010)

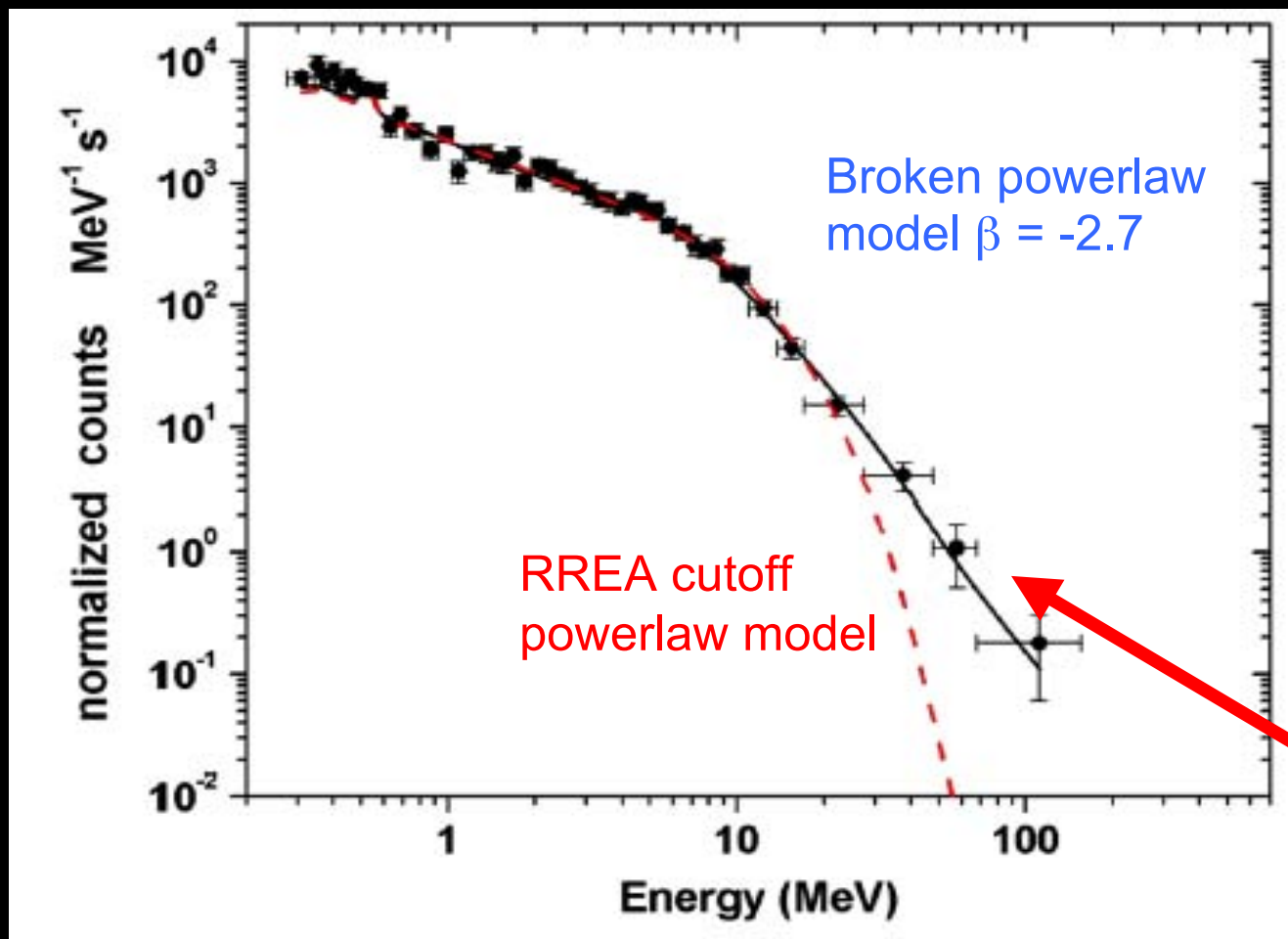
(See A. Giuliani talk, 21 June, 12:15)

Impulsive events: GRBs and TGFs

- **SuperAGILE** has detected several GRBs in its energy band (18-60 keV) at a rate of about **1 per month** while the AGILE **Minicalorimeter** (MCAL) observes about **1 GRB per week** in the energy range 0.7-1.4 MeV on several time scales (Marisaldi et al.). **GRID energies: only three confirmed GRBs up to now with HE component $E > 50$ MeV. Delayed HE emission.**
- **GRB 111211A: a new Gamma-ray Burst associated to a Supernova discovered by SuperAGILE**
- The AGILE Minicalorimeter also detects **Terrestrial gamma-ray flashes up to 100 MeV on timescales < 5 ms** (Marisaldi et al., JGR 115, A00E13, 2010, available online from ADC webpage, and Marisaldi et al., Phys. Rev. Lett. 105, 2010)

TGF Cumulative spectrum

110 TGFs 1806 photons 142 γ $E > 10$ MeV 26 γ $E > 20$ MeV

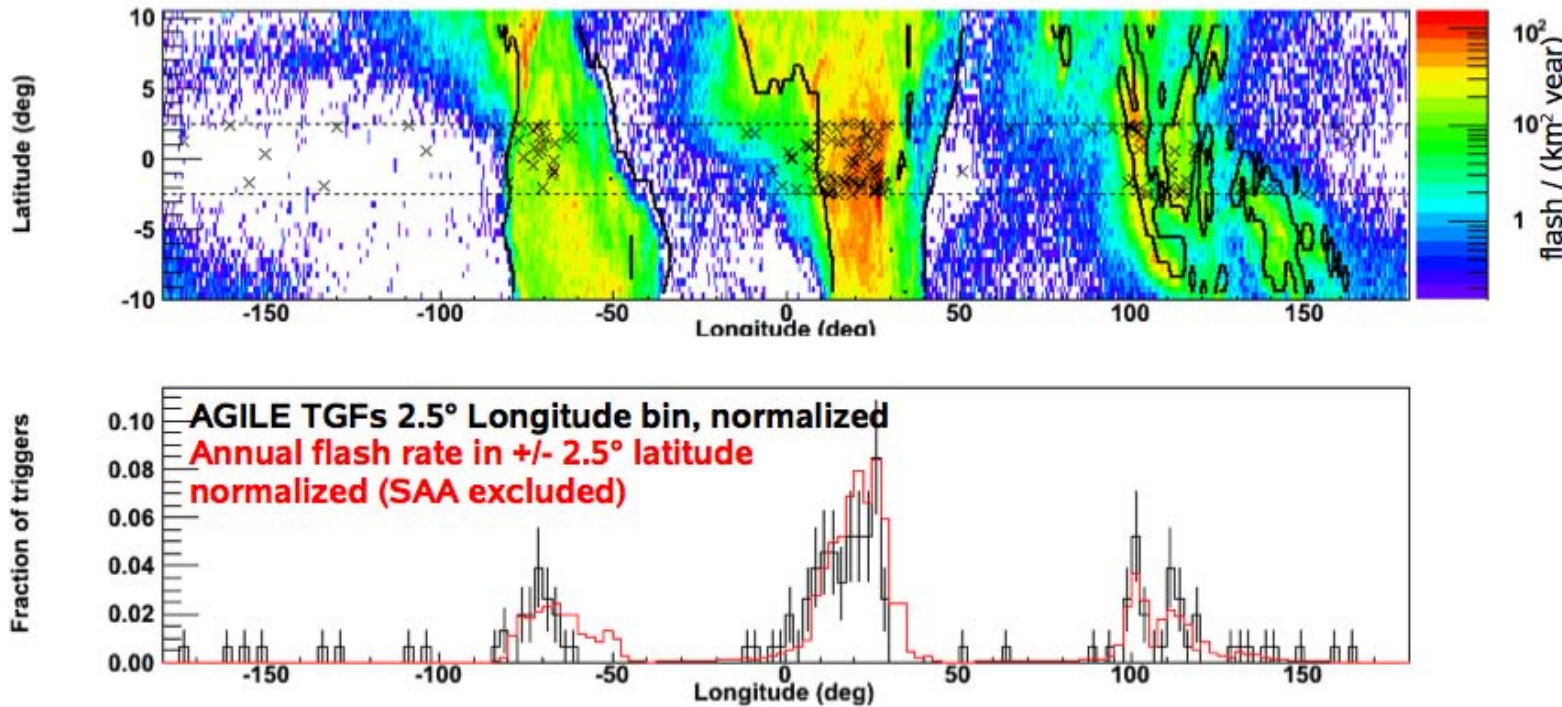


Significant
detection of γ
>40 MeV!!
Unexplained by
standard RREA
model: challenge
for emission
models

**AGILE-MCAL
crucial spectral
contribution up
to 100 MeV!!**

Tavani et al., Phys. Rev. Letters 106, 018501 (2011)

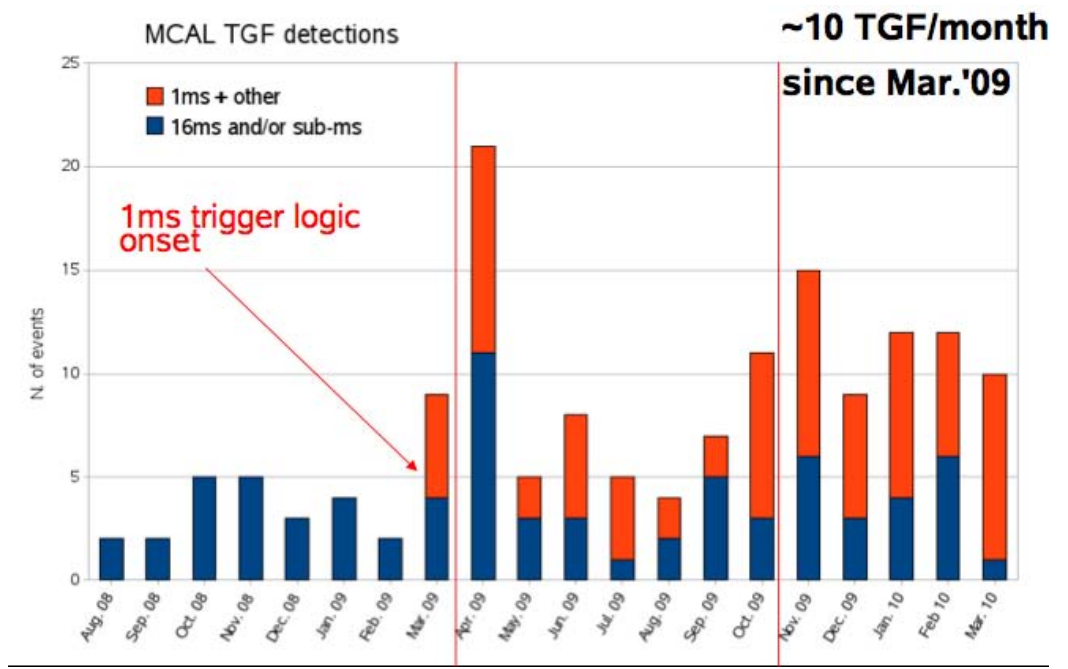
Slide adapted from M. Marisaldi, 10th AGILE WS



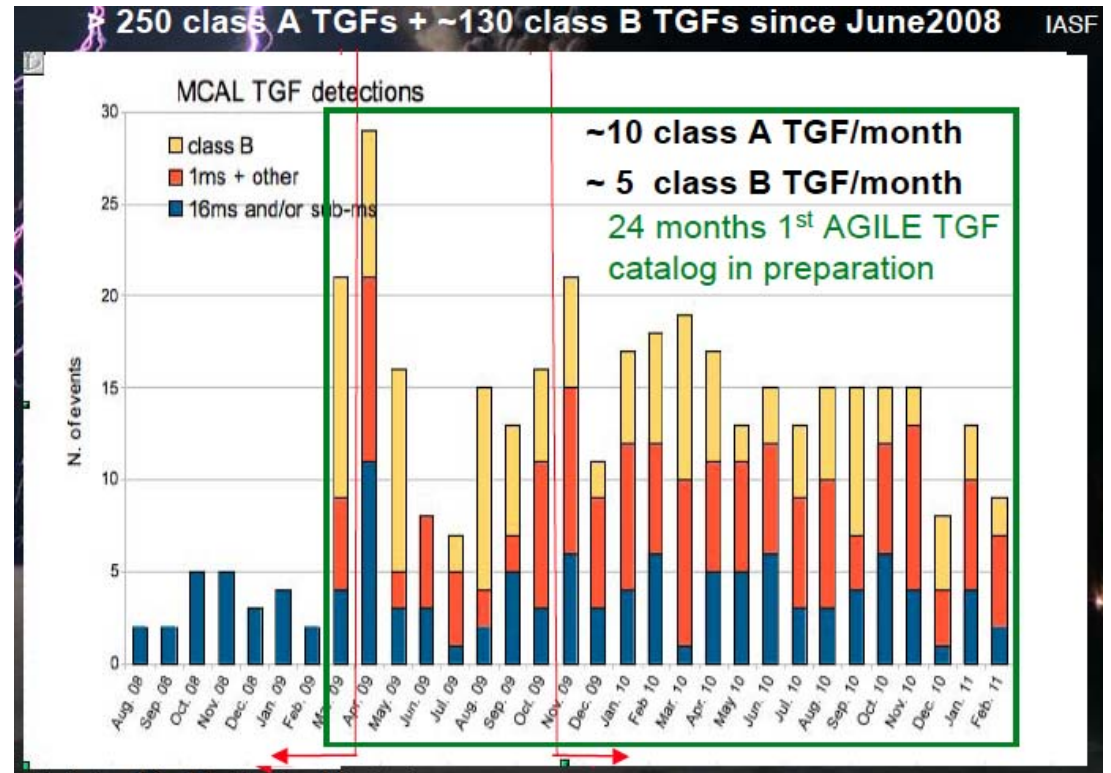
Good match between AGILE TGF pattern and lightning map

34 TGFs Published in M. Marisaldi et al., J. Geoph. Res., 115, A00E13, 2010

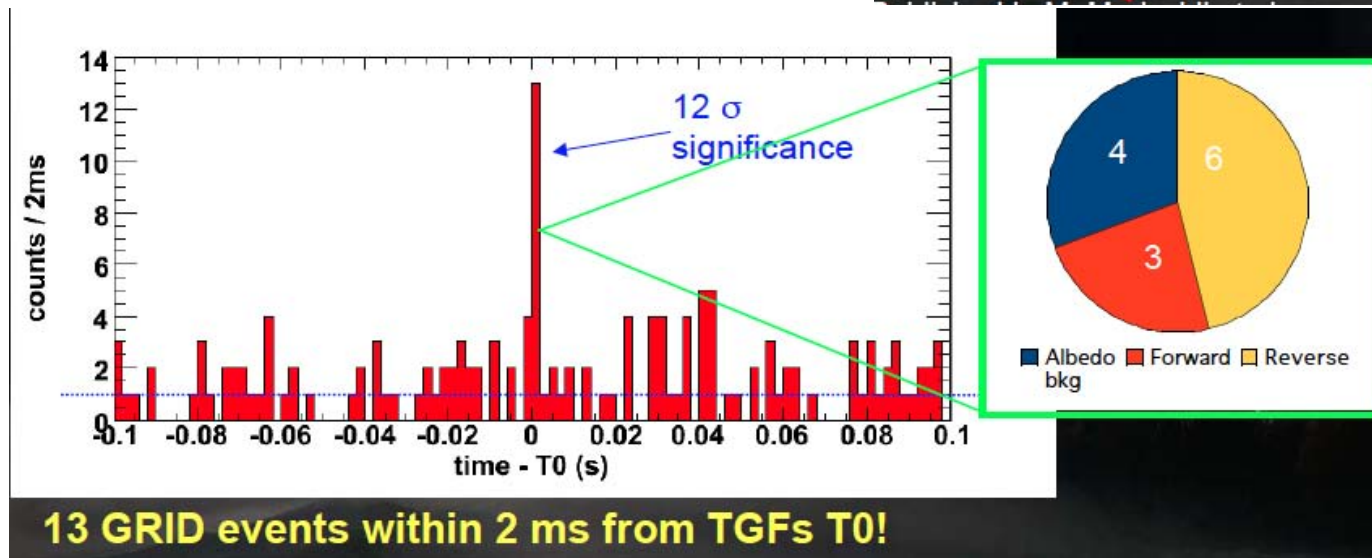
153 good candidates between June '08 and Mar. '10



AGILE TGF 2010 updates:



13 AGILE-GRID events:

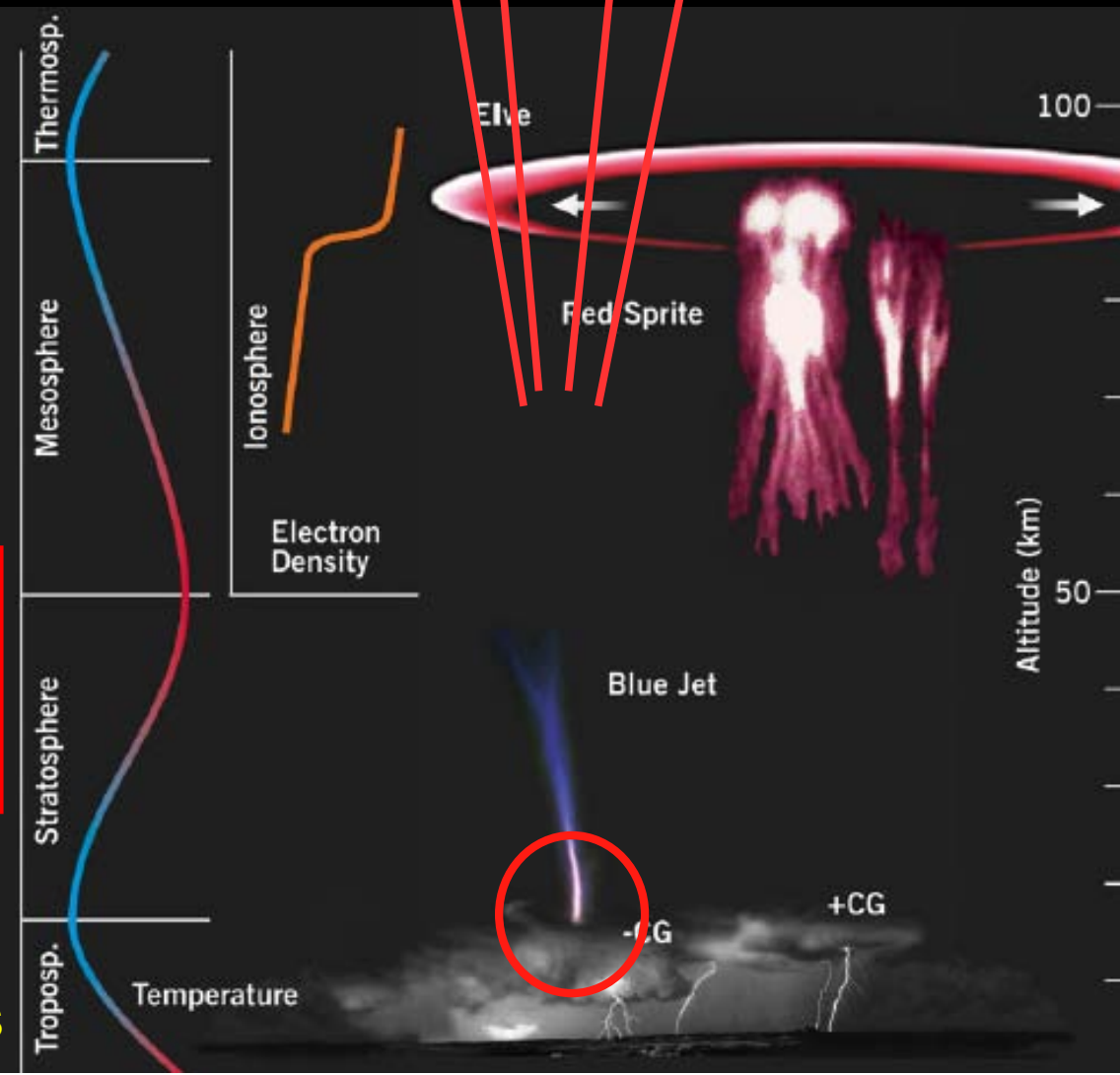


Marisaldi et al., Phys. Rev. Letters 105 (2010)

Not easy to propagate up to 550 km

TGFs originate at ~ 10-20 km

Slide adapted from Tavani, 10th AGILE WS



550 km

50-100 km

10-20 km

- Normal lightnings involve a potential difference ~ 500 kVolts
- **Terrestrial Gamma-Ray Flashes (TGF) involve DV > 100 MVolts !**
- Models??: **Relativistic Runaway Electron Avalanche (RREA)** with relativistic feedback (Dwyer 2008). Bremsstrahlung + Compton scattering. *Much theoretical work in progress*
- RHESSI cumulative spectrum compatible with a production altitude of 15-21 km (just above tropical thunderstorms)

AGILE MCAL: an optimal detector for TGF

- MCAL energy range is extended **up to 100 MeV**
- Efficient trigger at **ms and sub-ms time scale** (the TGF time scale)
- AGILE **equatorial orbit** at 2.5° inclination is optimal for mapping the equatorial region, where most of the events take place
- A real-time monitoring and alert system can be implemented for correlation with other meteo resources (work in progress)

LATEST UNEXPECTED NEWS FROM THE γ -RAY SKY:

**AGILE DISCOVERY OF THE CRAB
NEBULA VARIABILITY IN γ -RAYS**

Tavani et al., Science, 331, 736 (2011)

Fermi confirmation:

Abdo et al., Science, 331, 739 (2011)

The Crab Nebula: a spectacular cosmic accelerator

THE STANDARD
REFERENCE SOURCE
IN ASTROPHYSICS

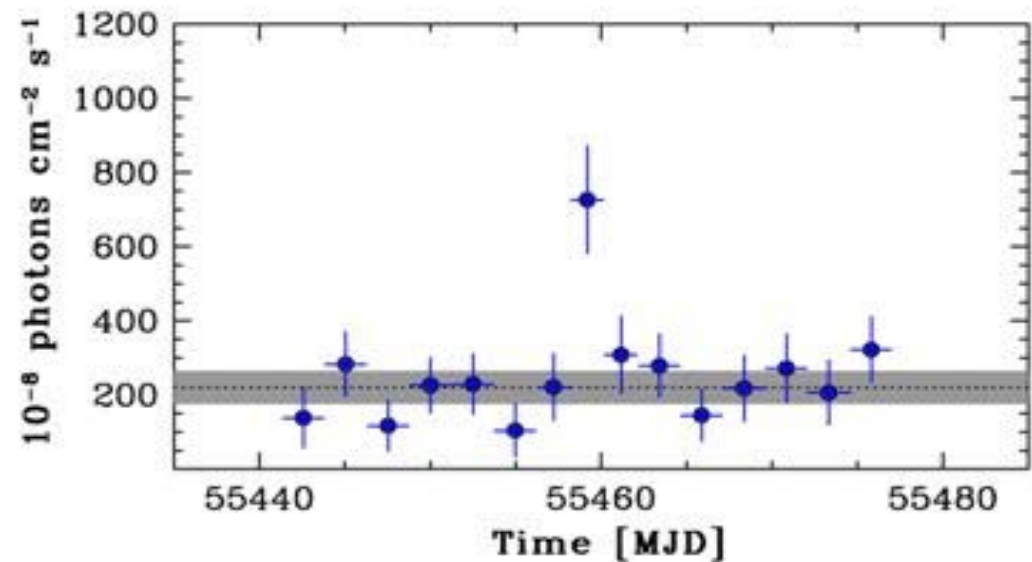
POWERFUL PULSAR
(Neutron Star
rotating 30 times a sec)

NEBULA SHOCKED
BY THE PULSAR
WIND

Crab Nebula: a remnant of a supernova that exploded in AD 1054 (Chinese astronomers). X-ray data from Chandra (light blue), visible light data from Hubble (dark blue and green) and infrared data from Spitzer (red), 31/1/2001

The variable Crab Nebula!

FIRST PUBLIC ANNOUNCEMENT
Sept. 22, 2010: AGILE issues the
Astronomer's Telegram n. 2855



***Science Express* (6 January 2011)**

First AGILE catalog of high-confidence gamma-ray sources

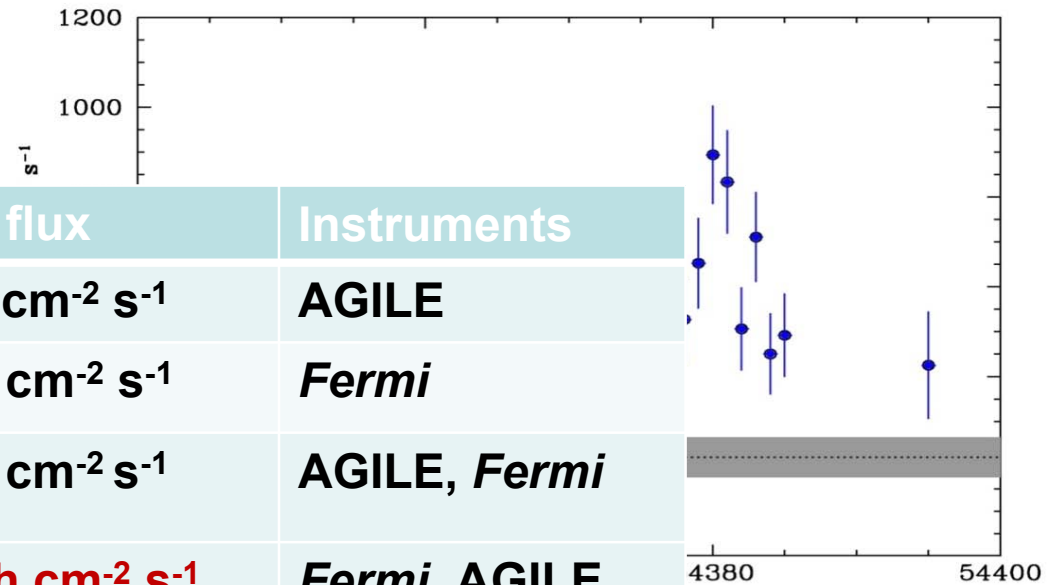
C. Pittori¹, F. Verrecchia¹, A. W. Chen^{2,3}, A. Bulgarelli⁴, A. Pellizzoni⁵, A. Giuliani^{2,3}, S. Vercellone⁶, F. Longo^{7,8}, M. Tavani^{9,10,11}, P. Giommi¹², G. Barbiellini^{7,8,3}, M. Trifoglio³, F. Gianotti¹, A. Argan⁹, A. Antonelli¹³, F. Boffelli¹⁴, P. Caraveo², P. W. Cattaneo¹⁴, V. Cocco¹⁵, S. Colafrancesco^{14,2}, T. Contessini², E. Costa⁹, S. Cutini¹, F. D’Ammando^{9,10}, E. Del Monte⁹, G. De Paris⁹, G. Di Cocco⁹, G. Di Persio⁹, I. Donnarumma⁹, V. Evangelista⁹, G. Fanari¹, M. Feroci⁹, A. Ferrari¹⁵, M. Fiorini², F. Fornari², F. Fuschino¹, T. Froysland^{8,11}, M. Frutti⁹, M. Galli¹⁶, D. Gasparini¹, C. Labanti⁴, I. Lapshov^{9,17}, F. Lazzarotto⁹, F. Liello⁹, P. Lipari^{18,19}, E. Mattaini², M. Marisaldi⁴, M. Mastropietro^{9,21}, A. Mauri⁴, F. Mauri¹⁴, S. Mereghetti², E. Morelli⁴, E. Moretti^{7,8}, A. Morselli¹¹, L. Pacciani⁹, F. Perotti², G. Piano^{9,10,11}, P. Picozza^{10,11}, M. Pilia^{22,23}, C. Pontoni^{3,8}, G. Porrovecchio⁹, B. Preger¹, M. Presti^{8,22}, R. Primavera¹, G. Pucella⁹, M. Rapisarda²⁰, A. Rappoldi¹⁴, E. Rossi⁴, A. Rubini⁹, S. Sabatini¹⁰, P. Santolamazza¹, E. Scalise⁹, P. Soffitta⁹, S. Stellato¹, E. Striani¹⁰, F. Tamburelli¹, A. Traci¹, A. Trois⁹, E. Vallazza⁹, V. Vittorini^{9,2}, A. Zambra^{2,3}, D. Zanello^{18,19}, and L. Salotti¹²

AGILE first detection of a strong gamma-ray flare in Oct. 2007 reported in the First AGILE source catalog as possible short unexpected flux increase

Sect. 6.1
 Notes on individual sources:

1AGL J0535+2205 and 1AGL J0634+1748 (Crab and Geminga). These two well known strong γ -ray pulsars, together with the Vela pulsar, were used for in-flight AGILE calibrations. We report the flux values obtained during calibration subperiods. These values agree with pulsed flux values reported in (Pellizzoni et al. 2009). We note, however, that we observed higher flux values, over 1σ from the reported mean flux, for both sources when merging all the data, including shorter (1 day) integration periods during 2007. This point is under investigation.

1AGL J0617+2236. This AGILE detection provides an im-

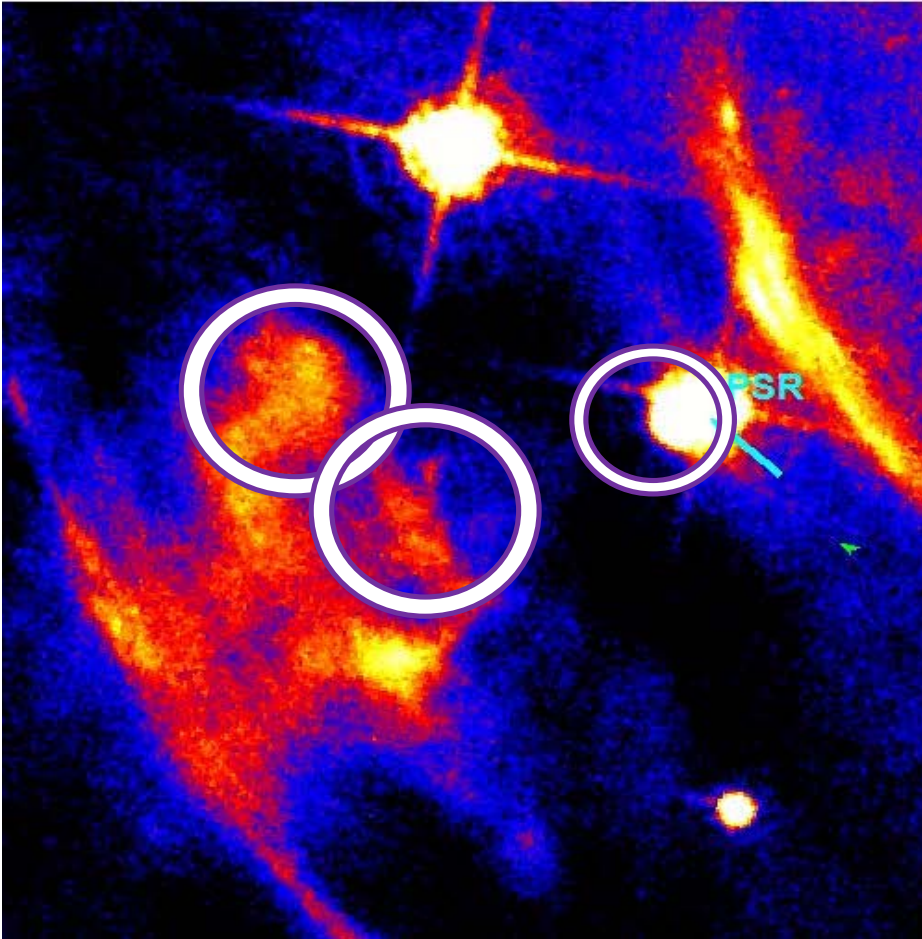


Flare date	Duration	Peak γ -ray flux	Instruments
October 2007	~ 15 days	~ $6 \cdot 10^{-6}$ ph cm ⁻² s ⁻¹	AGILE
February 2009	~ 15 days	~ $4 \cdot 10^{-6}$ ph cm ⁻² s ⁻¹	Fermi
September 2010	~ 4 days	~ $5 \cdot 10^{-6}$ ph cm ⁻² s ⁻¹	AGILE, Fermi
April 2011	~ 2 days	~ $30 \cdot 10^{-6}$ ph cm ⁻² s ⁻¹	Fermi, AGILE

- a big theoretical challenge: **the Crab Nebula is not a standard candle in gamma-rays!**



Hubble (optical) Oct. 2, 2010



PUZZLING ACCELERATION:

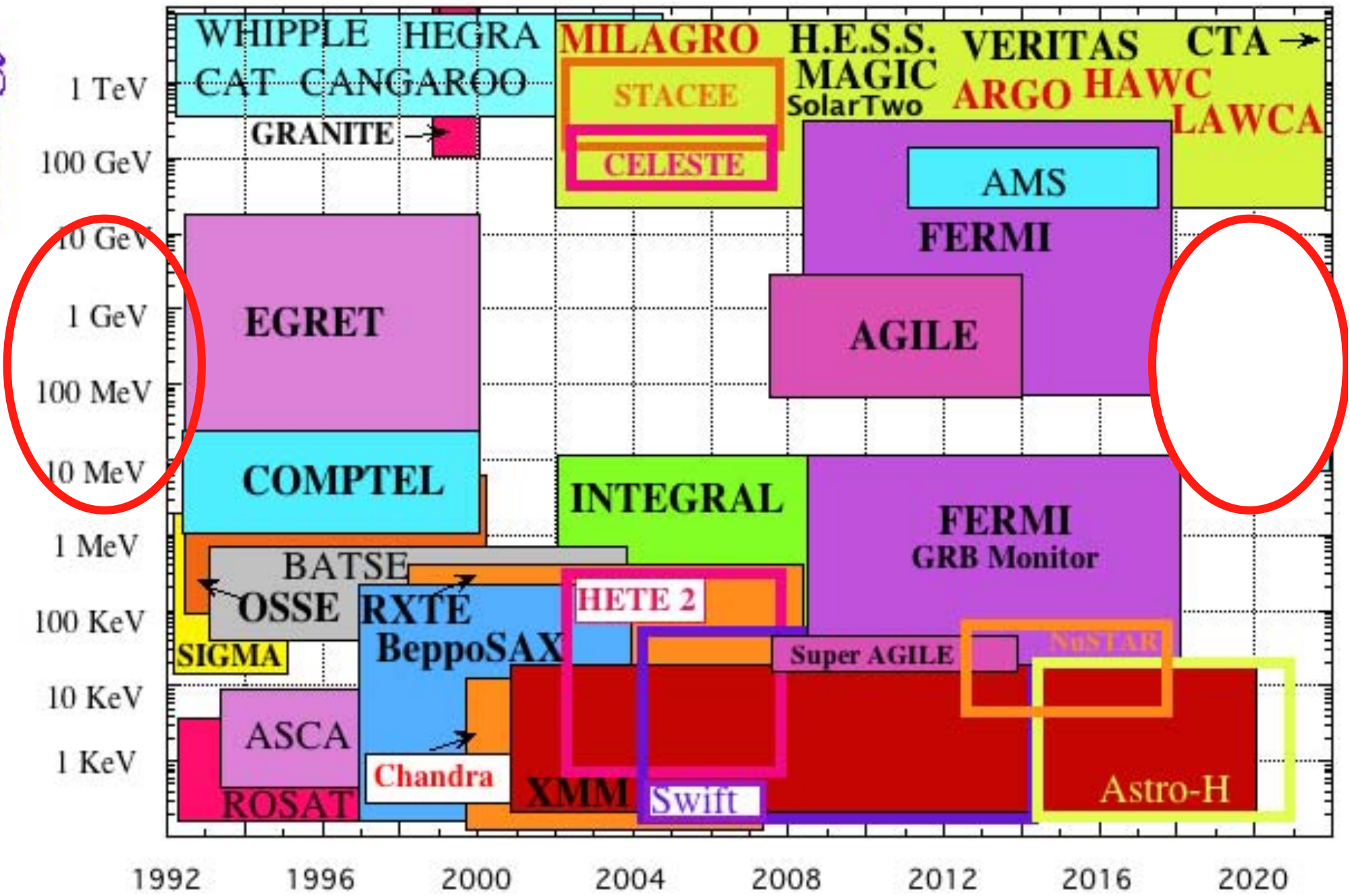
- fast flares imply VERY EFFICIENT particle acceleration at shocks, and “small” emission sites

- ***FAST ACCELERATION inconsistent with “slow” diffusion processes, a challenge to shock acceleration theory !***

- acceleration up to 10^{15} eV, 1000 times larger than Tevatron or LHC

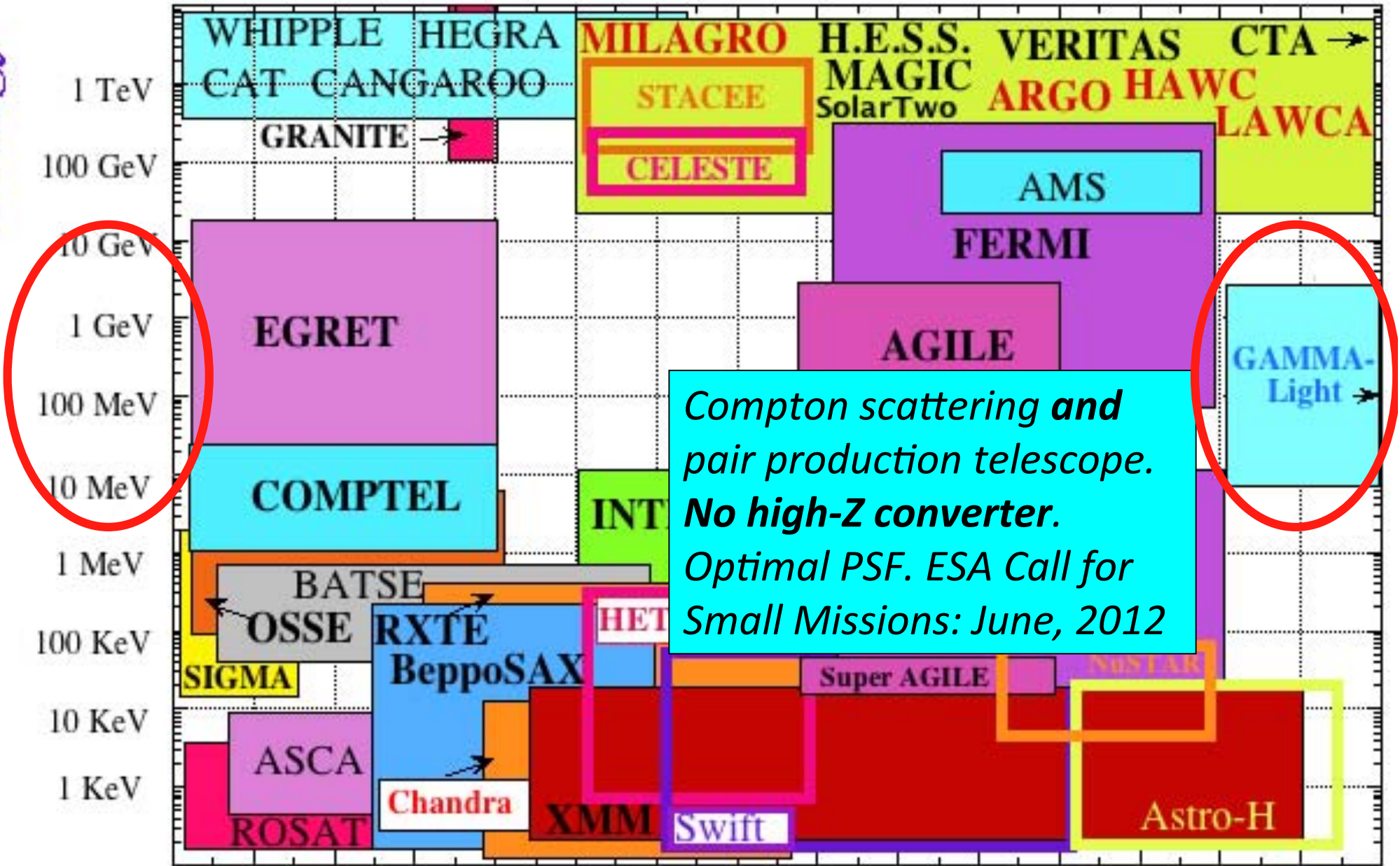
- shock structures might be the sites of transient gamma-rays, HST and Chandra candidates

Energy



Year

Energy



Compton scattering and pair production telescope.
No high-Z converter.
Optimal PSF. ESA Call for Small Missions: June, 2012

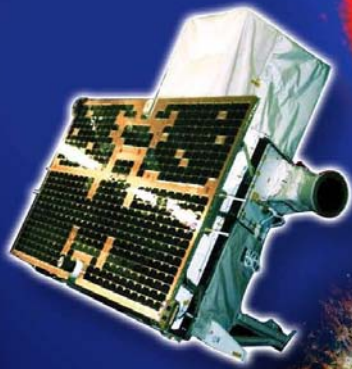
Year

9th and 10th AGILE Workshops, ASDC April 16-18, 2012

On-line presentations available at <http://agile.asdc.asi.it>

9th **AGILE** Science Workshop
 ESA-ESRIN (Frascati), April 16-17, 2012

**ASTROPHYSICS
 WITH AGILE:
 FIVE YEARS OF
 SURPRISES**



Scientific Organizing
 Committee (SOC)

A. Antonelli, G. Barbiellini,
 P. Caraveo, E. Costa, M.R. D'Antonio,
 E. Del Monte, G. Di Cocco, M. Feroci,
 A. Ferrari, P. Giommi, A. Giuliani,
 F. Longo, M. Marisaldi, A. Pellizzoni,
 P. Picozza, C. Pittori, S. Sabatini,
 M. Tavani (chair), S. Vercellone.



10th **AGILE** Science Workshop
 ESA-ESRIN (Frascati), April 18, 2012

**Lightning, Terrestrial
 Gamma-Ray Flashes,
 and Meteorology**



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 M. Tavani (INAF and Univ. Tor Vergata, co-chair)



Bruno Rossi Prize 2012
Marco Tavani and the AGILE team