



AGILE **Scientific Highlights**

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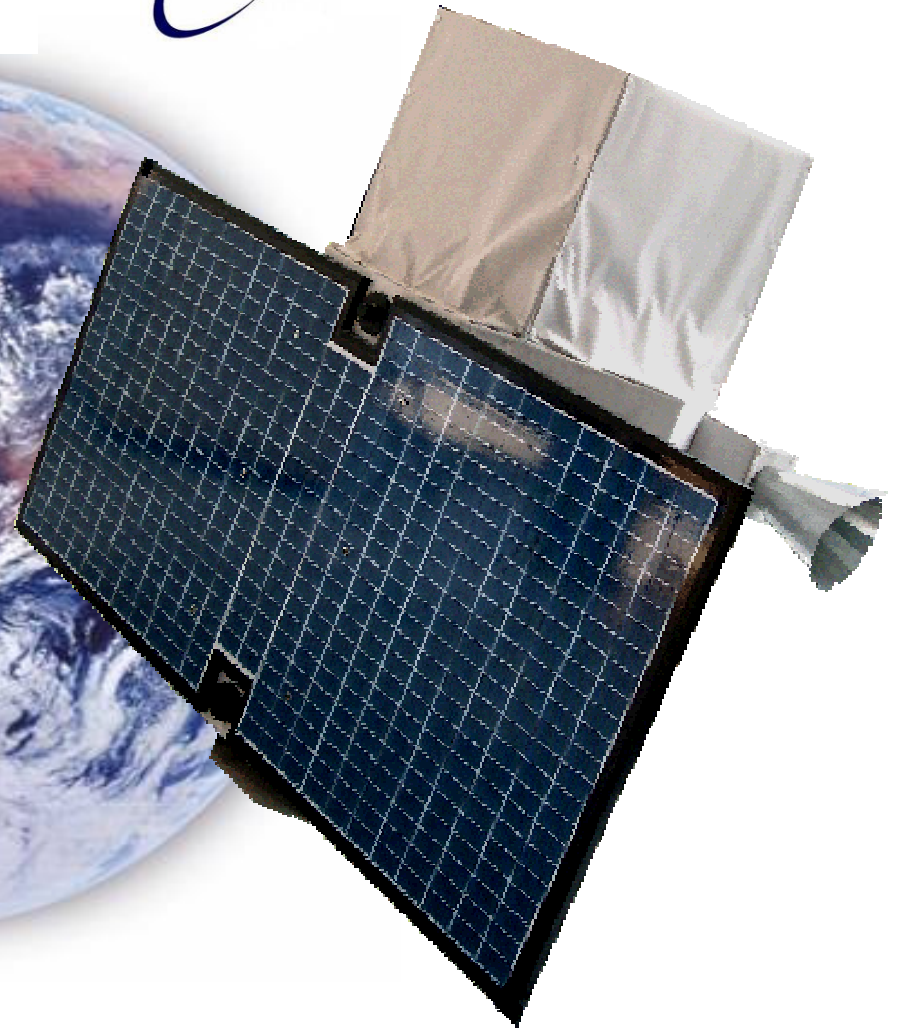
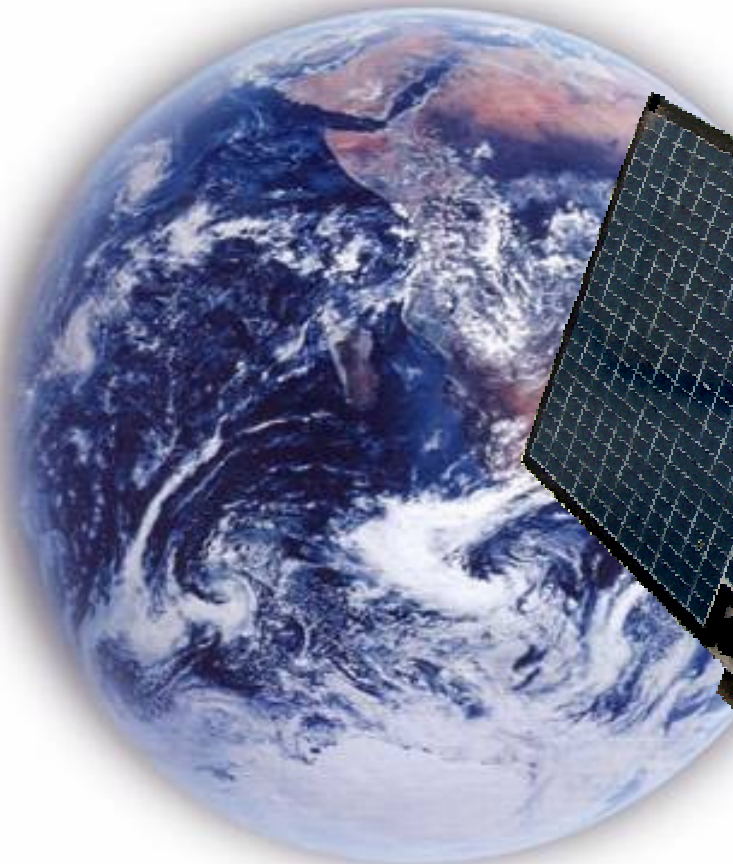
AGILE: an Italian Mission



INAF



ENEA



AGILE: a very innovative instrument

- AGILE combination of co-aligned gamma-ray (50 MeV – 5 GeV) and hard X-ray (20-60 keV) imagers
- AGILE-GRID is optimized near 100 MeV
 - good PSF ($\sim 3^\circ$ at 100 MeV)
 - typical daily exposure of $\sim 10^7 \text{ cm}^2 \text{ sec}$

AGILE

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

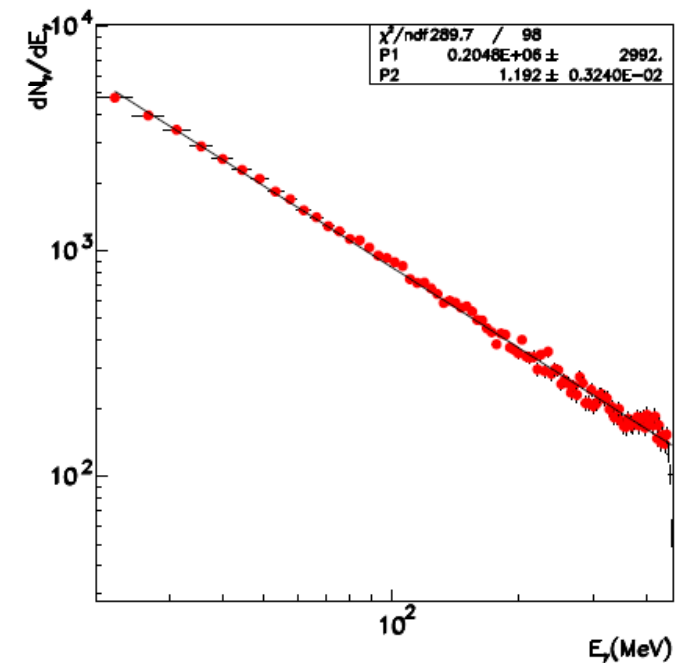
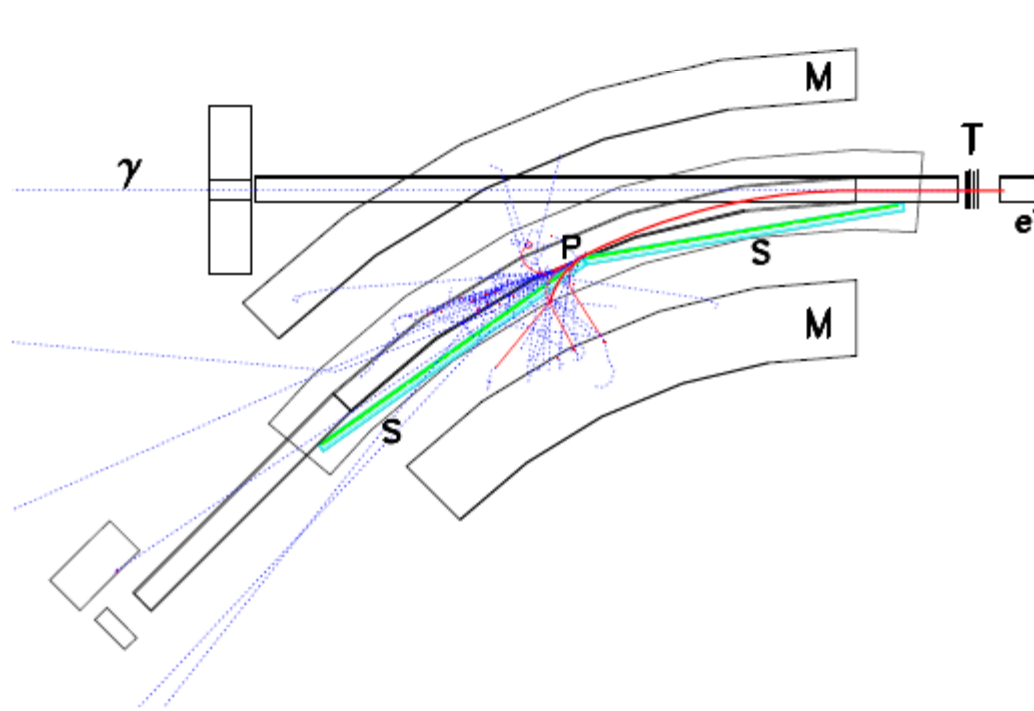
**GAMMA-RAY IMAGER
SILICON TRACKER**

(MINI) CALORIMETER



AGILE calibrations

- Characterization of a tagged γ -ray beam line at the DAΦNE Beam Test Facility



AGILE two lives

	pointing- AGILE	spinning- AGILE
time period	Jul.07 – Oct.09	Nov. 2010 -
attitude	fixed	variable (spinning, 1°/sec)
sky coverage	1/5	~ 70%
source livetime fraction	~ 0.5	~ 0.2
1-day exposure (30 degree off-axis, 100 MeV)	~ 2 10⁷ (cm² sec)	(0.5-1) 10⁷ (cm² sec)

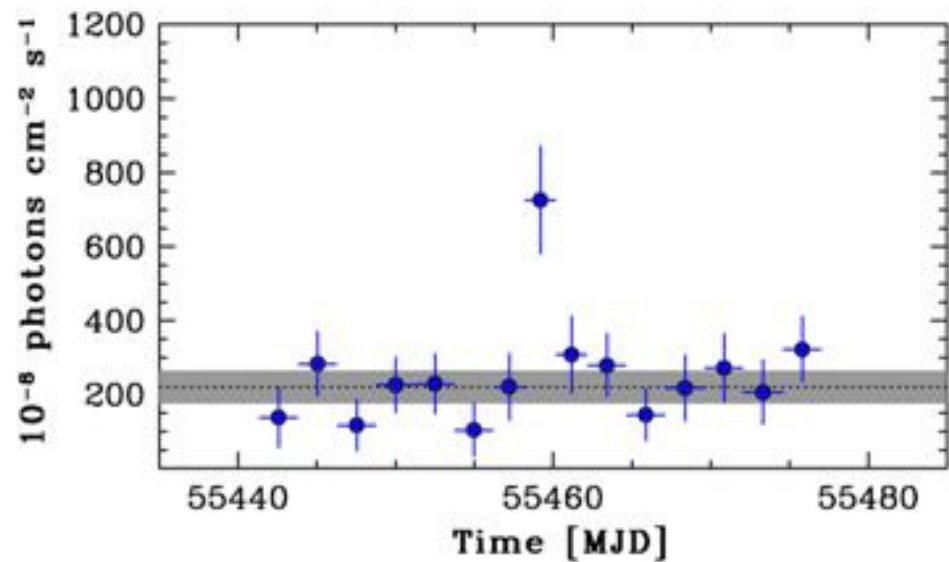
AGILE crucial contributions to testing particle acceleration theories, plasma instabilities in the Universe and on the Earth !

- **big surprise: discovery of gamma-ray flares from the Crab Nebula: 2012 Bruno Rossi Prize**
- **Origin of cosmic rays, SNR W44, first direct evidence of neutral pion emission**
- **Relativistic jets in microquasars and blazars**
- **Gamma-ray emission up to 100 MeV from Terrestrial Gamma-Ray Flashes**

The variable Crab Nebula

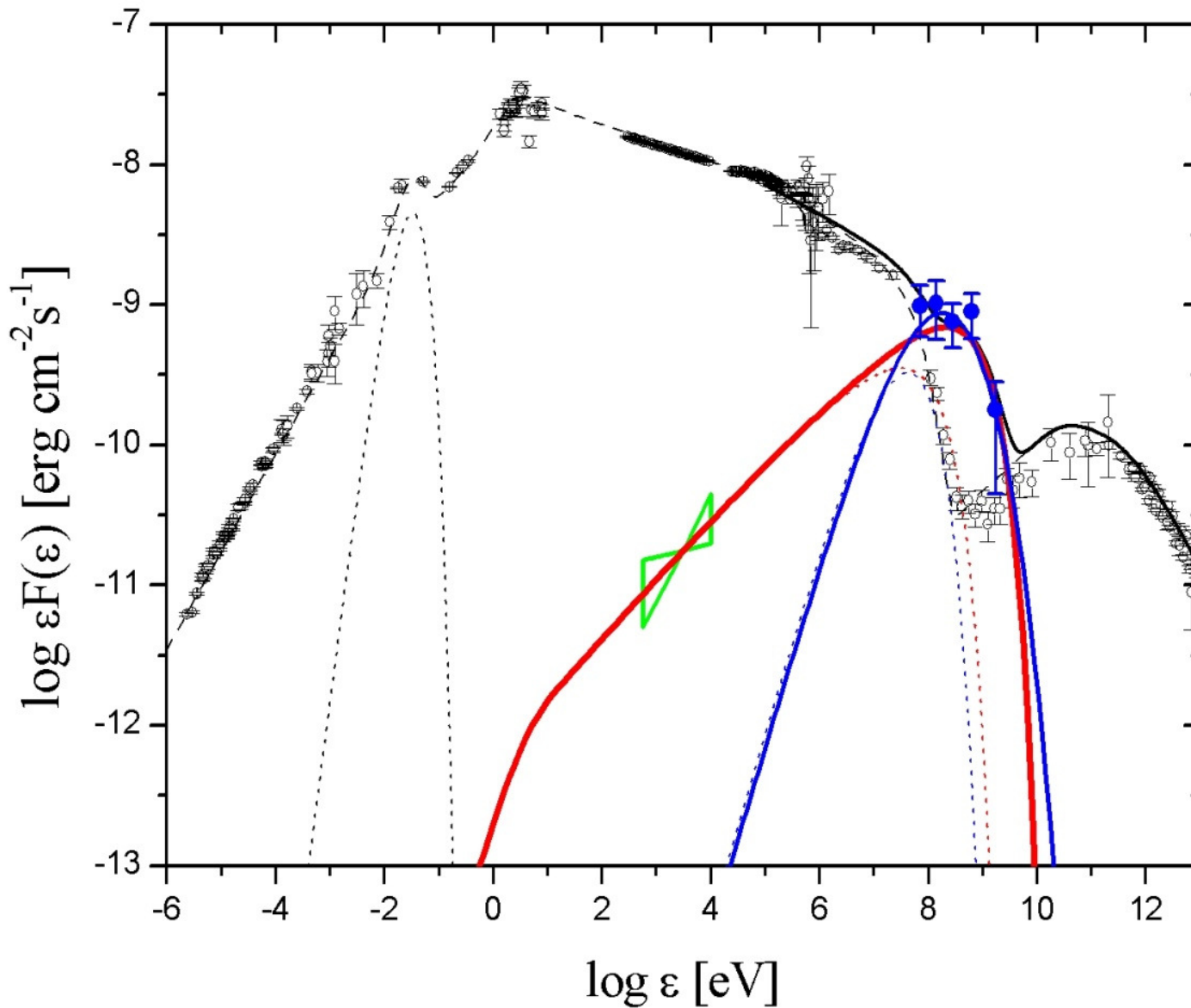
The Crab Nebula: a standard candle...

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



Science Express (6 January 2011)

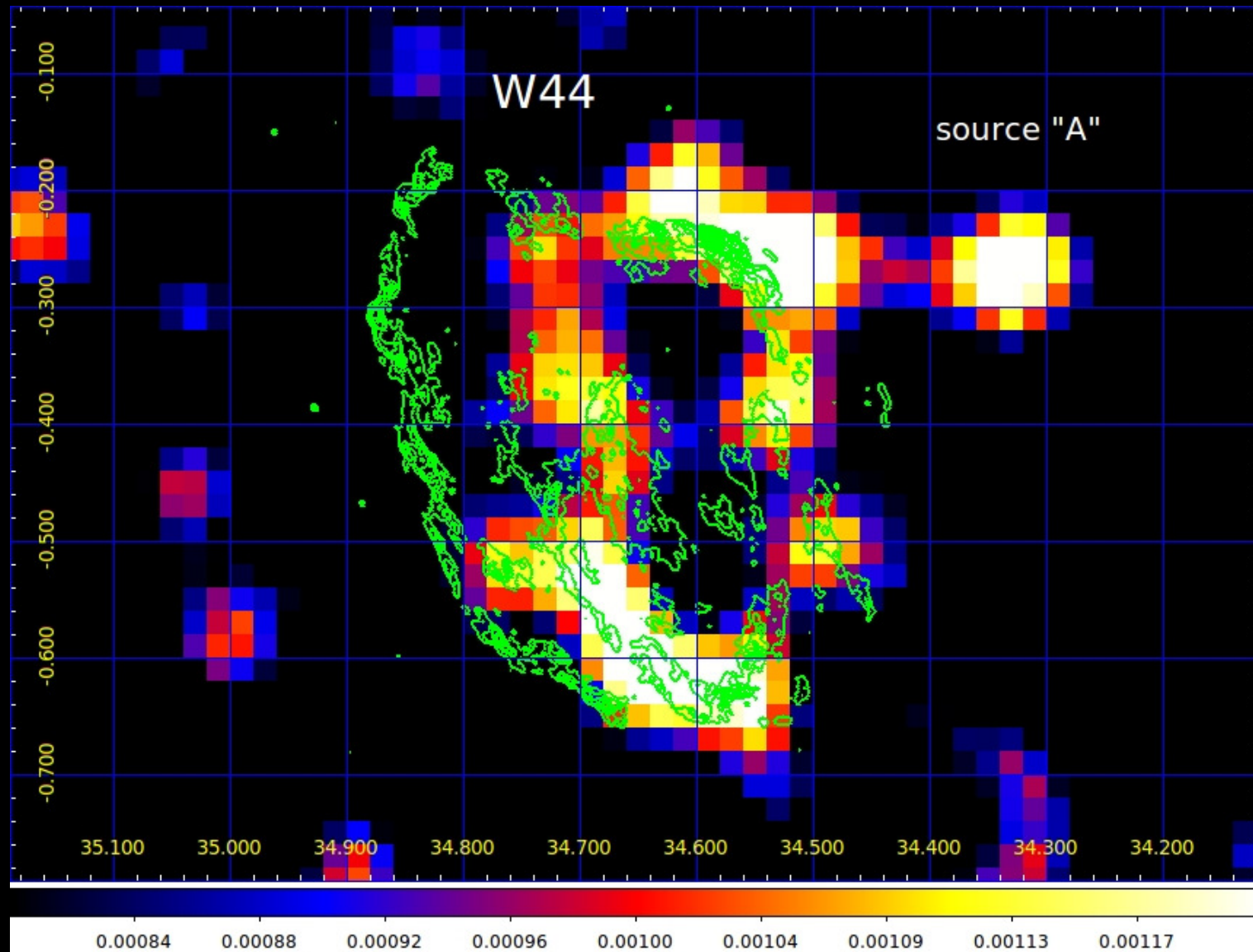
AGILE spectrum at the peak (2 days, Sept. 2010) (Science 2011)



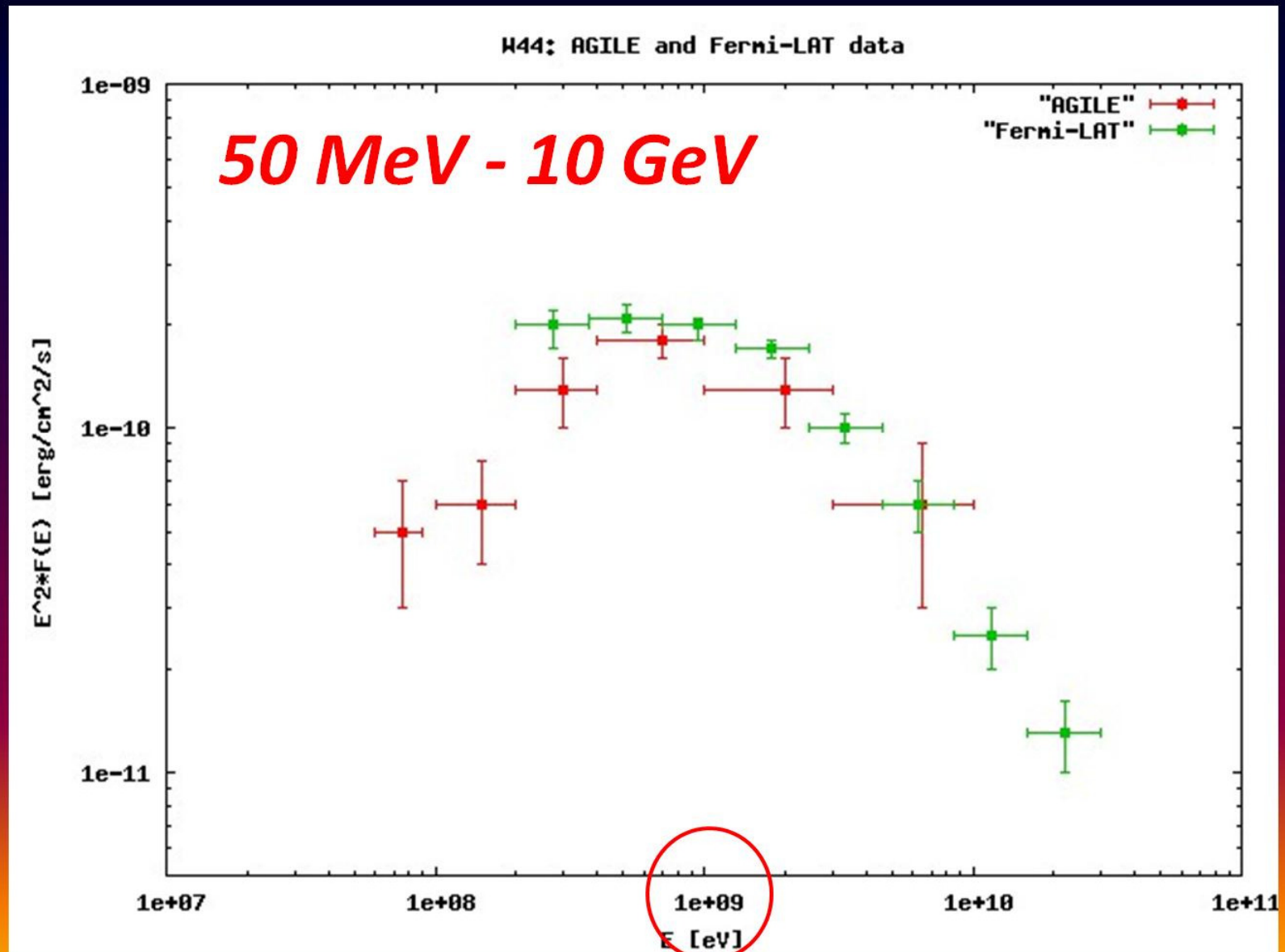
AGILE contribution to the study of cosmic rays

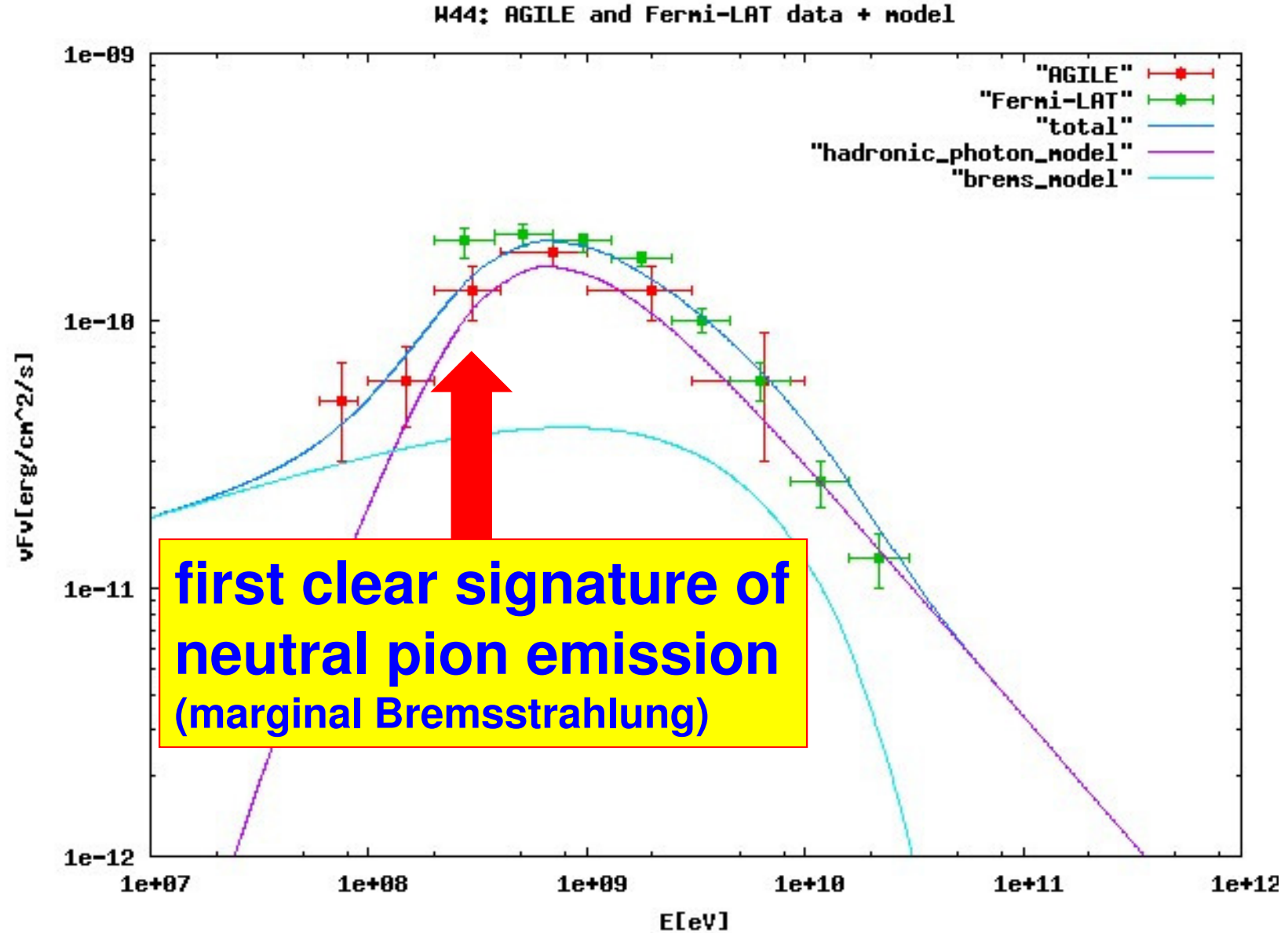
- **several SNRs well detected by AGILE**
- **fundamental contributions for “middle-aged” SNRs**
 - **IC 443**
 - **W28**
 - **W44**

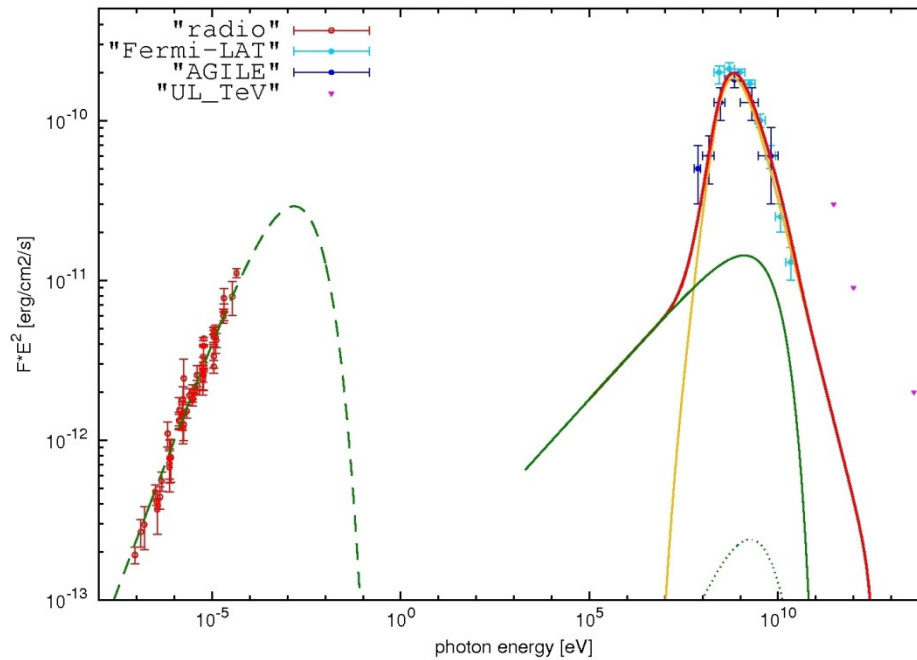
W44: AGILE gamma-ray emission and radio (green)



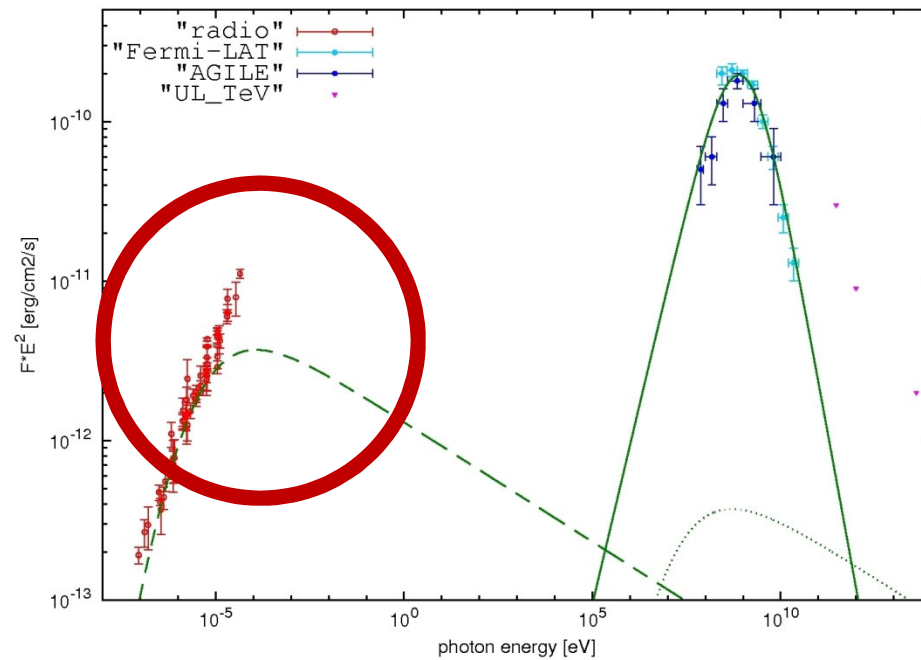
The SNRW44: AGILE







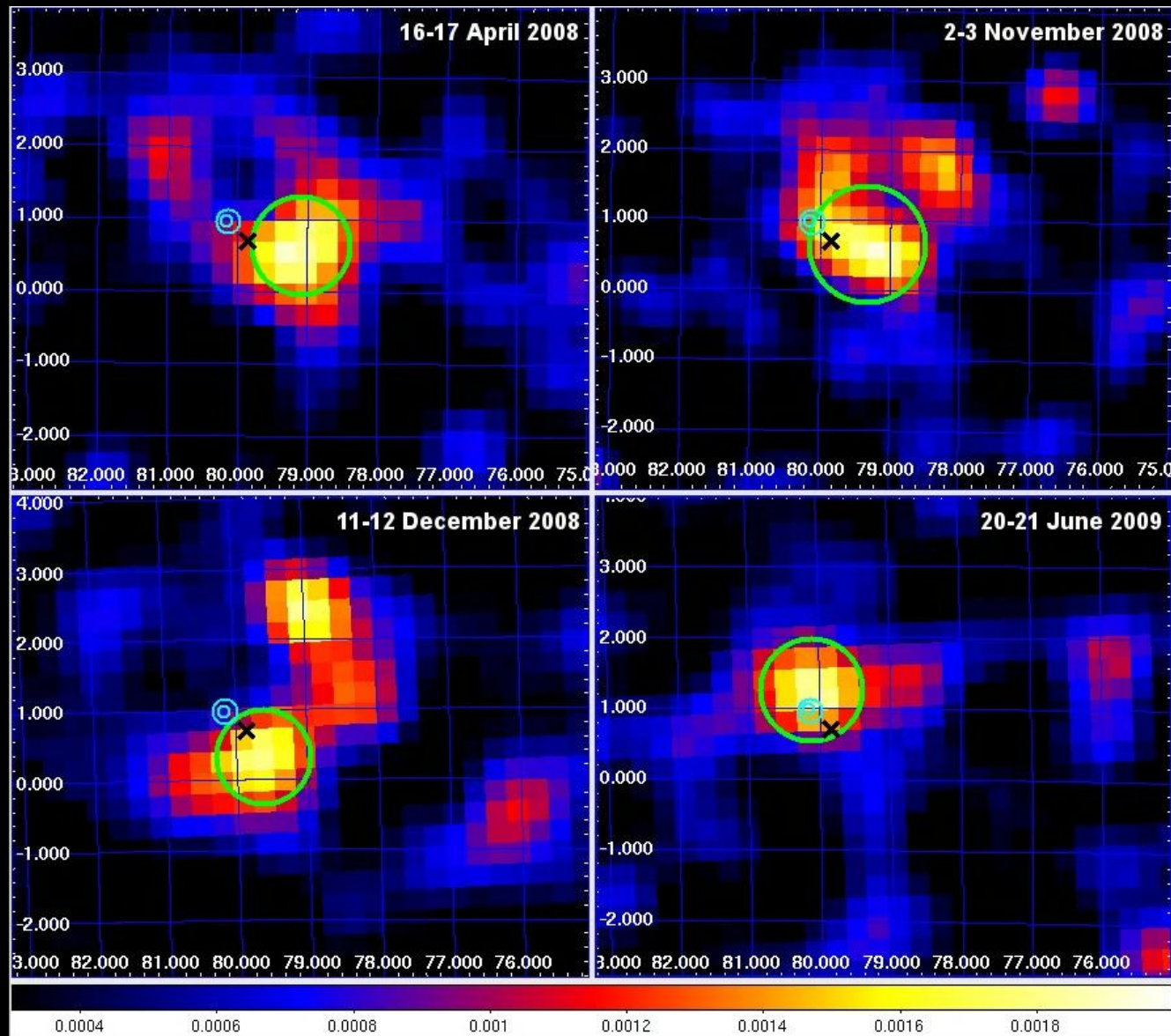
**hadronic
model,
 $B = 20 \mu\text{G}$,
 $n = 100 \text{ cm}^{-3}$**



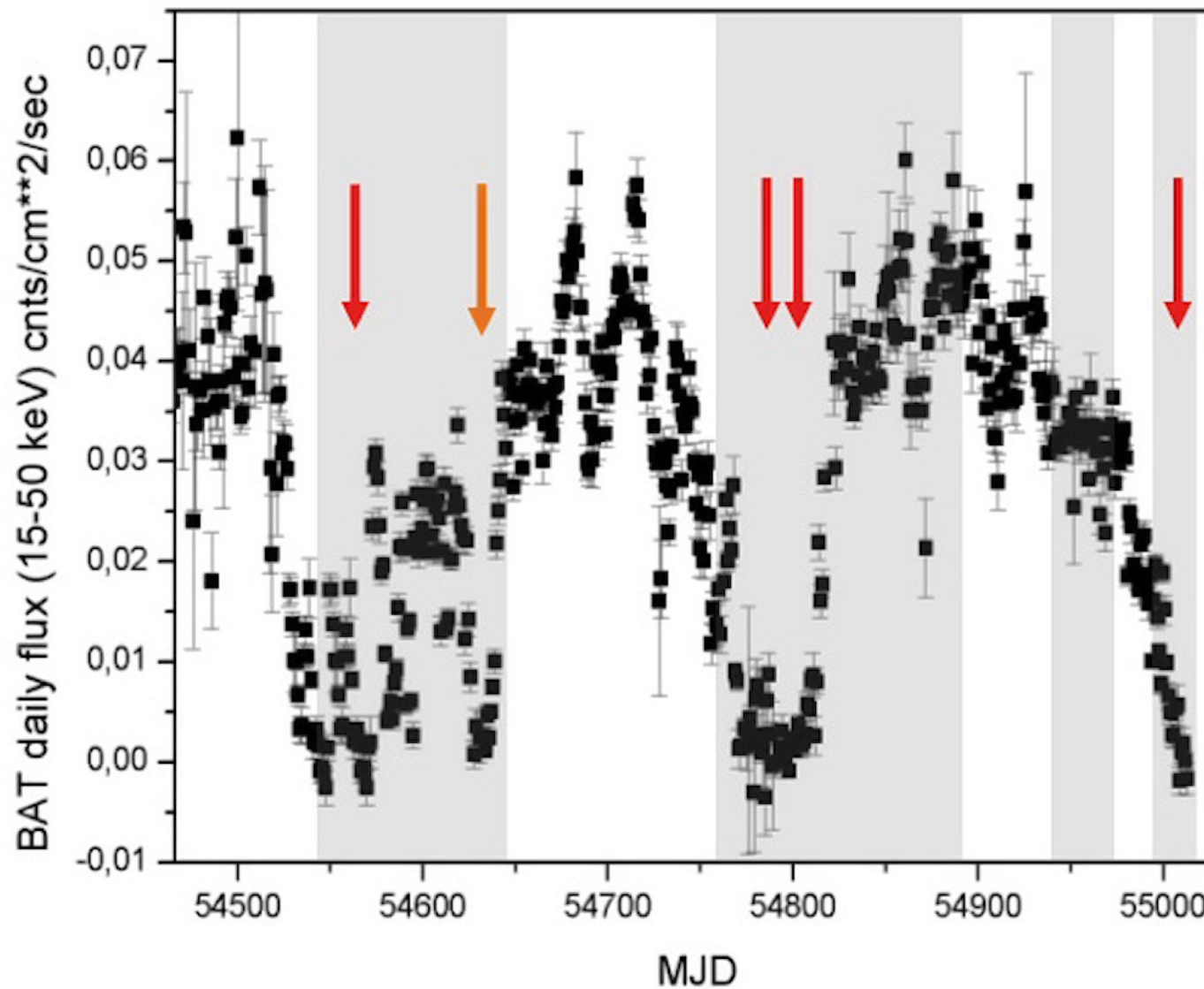
**“ad hoc” e-
Brems. model,
 $B = 20 \mu\text{G}$,
 $n = 300 \text{ cm}^{-3}$**

Microquasars

AGILE discovery of transient gamma-ray emission from Cygnus X-3 (*Nature*, 462, 620, 2009)



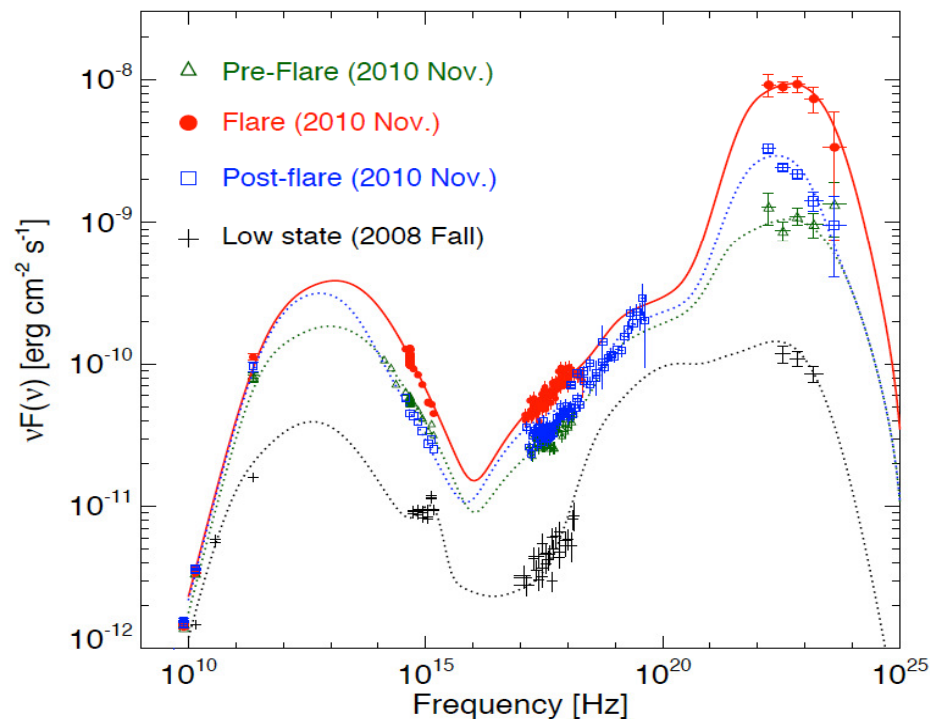
Cyg X-3 gamma-ray flares anticorrelated with hard X-rays



Active Galactic Nuclei

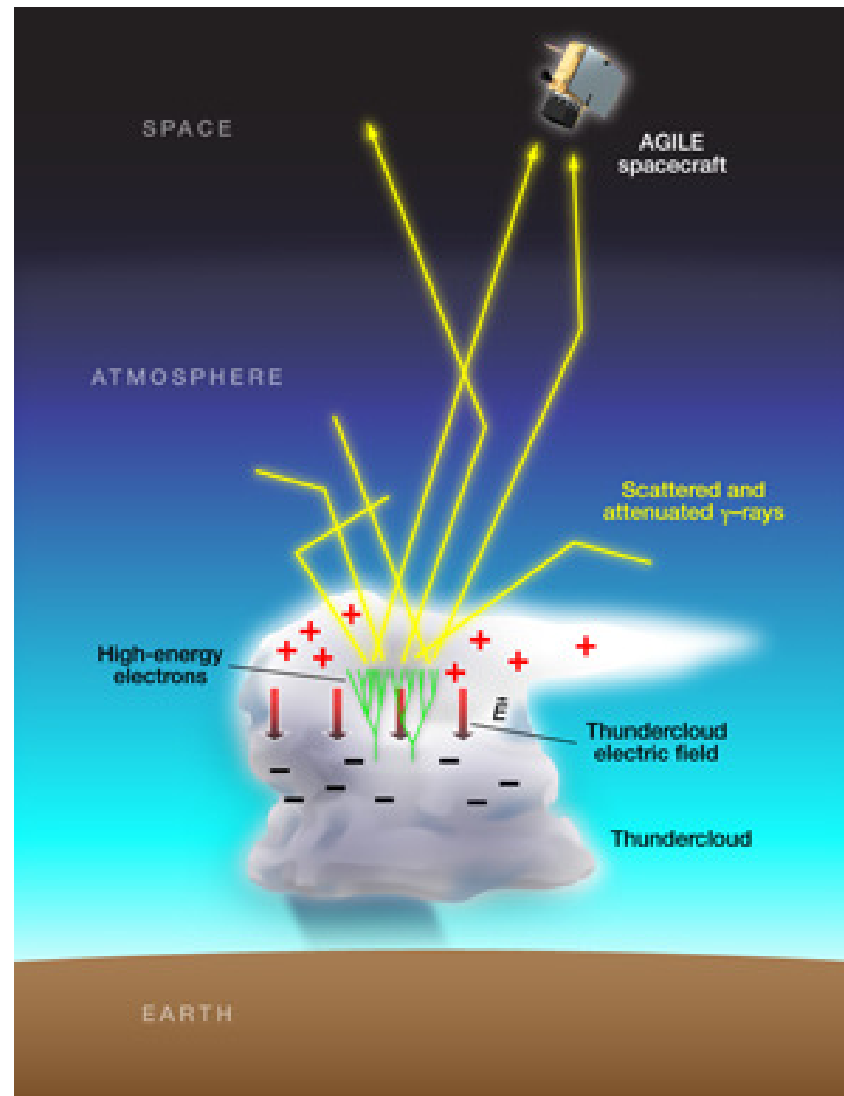
The Blazar 3C 454.3 “Crazy Diamond”

Detailed studies of the γ -ray and X-ray properties of the blazar 3C 454.3 suggest that extreme γ -ray flares can be modeled by an external Compton component driven by a substantial local enhancement of soft seed photons



3C 454.3 spectral energy distribution (SED) accumulated during the 2010 November super-flare (in colors) compared with a SED accumulated during a particularly low γ -ray state in Fall 2008

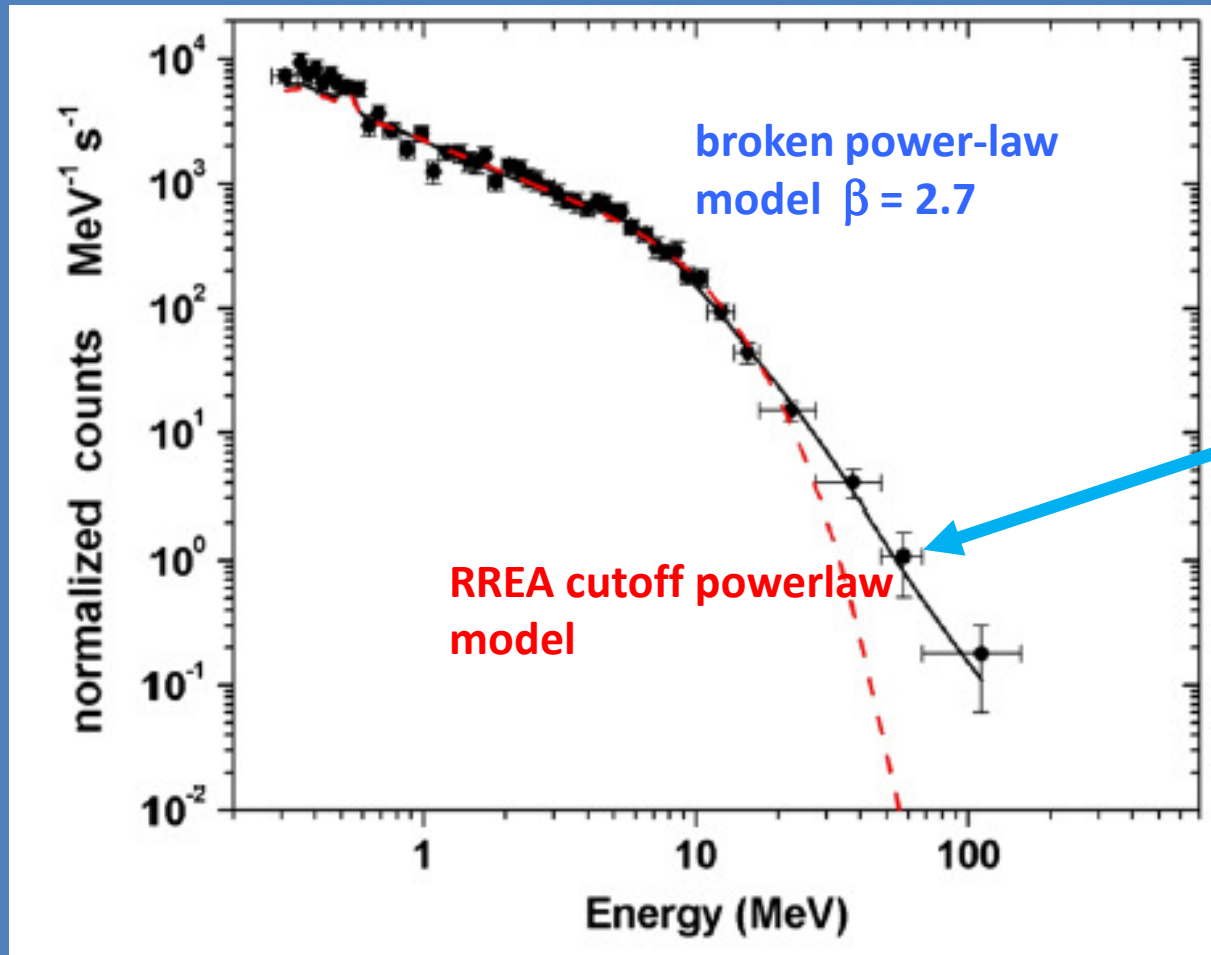
Terrestrial Gamma-ray Flashes



TFG cumulative spectrum

110 TGFs

26 events $E_{\text{max}} > 20$ MeV



significant detection of γ -rays with $E > 40$ MeV unexplained by standard RREA models: a challenge for emission models

Gamma Ray Bursts

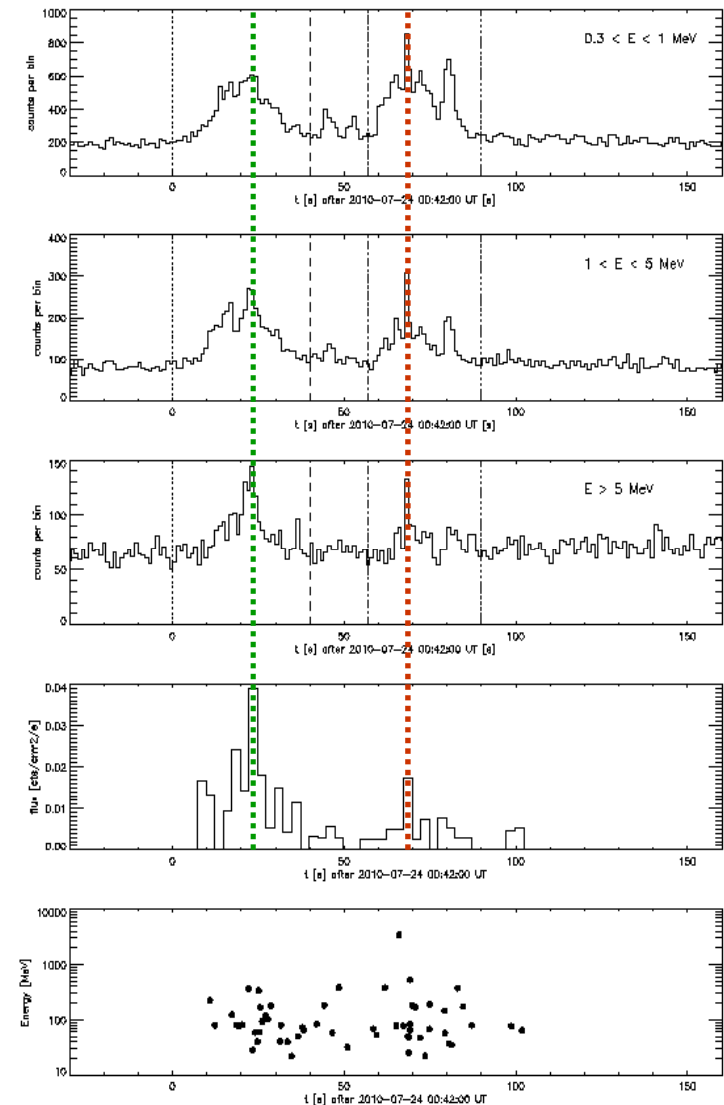
GRB 100724B: simultaneous GeV and MeV

No time lag is found between the MeV and GeV emission. The two main bumps in the lightcurve show a remarkably similar shape at MeV and GeV.

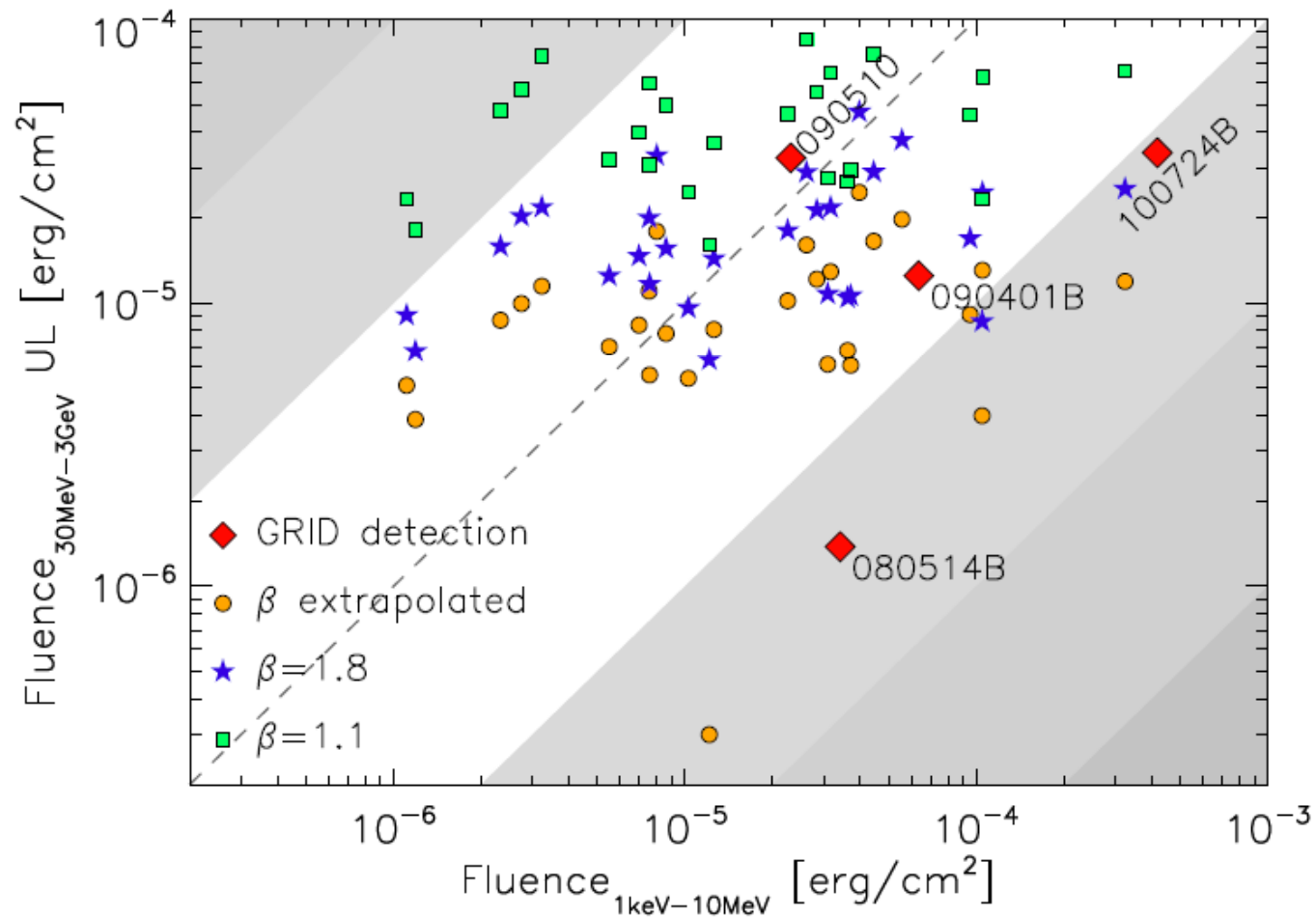
Due to the spinning operative mode, GRB 100724B remained within the AGILE/GRID FoV between $t_0 + 6$ s and $t_0 + 125$ s.

The GRB is not detected during the next “transit” in the FoV ($t_0 + 410$ s , $t_0 + 529$ s).

SuperAGILE was not collecting data for telemetry sharing reasons.



Upper limits in GRB



INFN activities

- INFN Trieste: GRB, TGF, TeV sources, Calibrations
- INFN Roma2: Galactic Transients
- INFN Pavia: TeV sources, Calibrations
- Richieste
 - 1.5 Missioni Interne
 - 2 Missioni Estere
 - 1 Pubblicazioni

AGILE Scientific Papers 2011-2012

Upper limits on GRB observed by AGILE-GRID	A&A	In press			2010	25/08/12	
The AGILE monitoring of Cygnus X-3: the gamma-ray flaring behavior and spectral constraints	A&A	in press			01/03/12	26/07/12	arXiv:1207.6288v1
The characterization of the distant blazar PKS 1239+0443 from flaring and low activity periods	MNRAS	in press			10/11/11	18/06/12	
Characterization of a tagged gamma-ray beam line at the DAΦNE Beam Test Facility	NIMA	in press			29/11/11	19/01/12	arXiv:1111.6147v2
Evaluating the Maximum Likelihood Method for detecting short-term variability of AGILE gamma-ray sources	A&A	540	A79	2012	30/11/11	07/01/12	arXiv:1201.2602v1
Agile detection of Cygnus X-3 gamma-ray active states during the period mid-2009/mid-2010	A&A	538	A63	2012	11/11/10	26/10/11	arXiv:1111.4960
Neutral pion emission from accelerated protons in the Supernova Remnant W44	ApJL	742	L30	2011	04/08/11	20/10/11	arXiv:1111.4868
The Crab Nebula super-flare in April 2011: extremely fast particle acceleration and gamma-ray emission	ApJL	741	L5	2011	24/05/11	20/09/11	arXiv:1105.5028v2

The AGILE observation of the hard and bright GRB 100724B	A&A	535	A120	2011	08/04/11	08/09/11	arXiv:1109.3018
The brightest gamma-ray flaring blazar in the sky: AGILE and multi-wavelength observations of 3C 454.3 during November 2010	ApJL	736	L38	2011	11/04/11	22/06/11	arXiv:1106.5162v1
The remarkable gamma-ray activity in the gravitationally lensed blazar PKS 1830-211	ApJL	736	L30	2011	11/03/11	20/06/11	arXiv:1106.4224v1
High spatial resolution correlation of AGILE TGFs and global lightning activity above the equatorial belt	GRL	38	L14806	2011	21/04/11	09/06/11	
Flaring Patterns in Blazars	ApJ	736	128	2011	17/11/10	14/05/11	arXiv:1105.2887v1
Spectral evolution of the September 2010 gamma-ray flare from the Crab Nebula	ApJL	732	L22	2011	16/03/11	30/03/11	arXiv:1104.0115v1
AGILE detection of extreme gamma-ray activity from the blazar PKS 1510-089 during March 2009. Multifrequency analysis	A&A	529	A145	2011	11/11/10	15/03/11	arXiv:1103.3647v1

Gamma-ray blazars: the view from AGILE	Advances in Space Research	48	76	2011	23/11/10	20/02/11	arXiv:1102.4428v1
Preliminary results on TeV sources search with AGILE	NIM A	630	202	2011			
The flaring blazars of the first 1.5 years of the AGILE Mission	NIM A	630	198	2011			
Discovery of powerful gamma-ray flares from the Crab Nebula	Science	331	736	2011	20/10/10	13/12/10	arXiv:1101.2311v1
First results about on-ground calibration of the silicon tracker for the AGILE satellite	NIM A	630	251	2011			
Terrestrial Gamma-Ray Flashes as powerful particle accelerators	PRL	106	018501	2011	16/09/10	01/11/10	
Study of the gamma-ray source 1AGL J2022+4032 in the Cygnus Region	A&A	525	A33	2011	24/06/10	20/09/10	arXiv:1009.5539v1
The AGILE Mission: the first 2 years	NIM A	630	7	2011	11/12/09	21/07/10	
Galactic Sources Science With Agile: The Case Of The Carina Region	NIM A	630	193	2011	03/09/09		
The observation of Gamma Ray Bursts and Terrestrial Gamma-ray Flashes with AGILE	NIM A	630	155	2011	27/07/09		

Conclusions

- **AGILE continues its scientific activity with success**
- **currently funded by ASI for the period mid-2012/mid-2013: possible extension**
- **more surprises to come...**