

# The first AGILE low-energy (<30 MeV) TGF catalog



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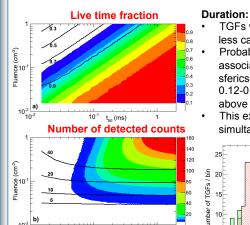
We present the first catalog of Terrestrial Gamma-ray Flashes (TGFs) detected by the Minicalorimeter (MCAL) instrument on-board the AGILE satellite: Marisaldi et al., JGR (2014), DOI: 10.1002/2013JA019301

- **308 TGFs**
- detected during the period March 2009 July 2012 in the +/- 2.5° latitude band
- maximum photon energy up to 30 MeV

The characteristics of the AGILE events are analysed and compared to the observational framework established by the two other currently active missions capable of detecting TGFs from space, RHESSI and Fermi.

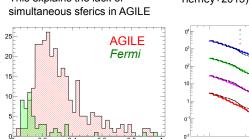
- A detailed model of the MCAL **dead time** is presented, which is fundamental to properly interpret our observations, particularly concerning duration, intensity and correlation with lightning sferics detected by the World Wide Lightning Location Network (WWLLN).
- The TGFs cumulative spectrum supports a low production altitude, in agreement with previous measurements.
- The AGILE TGF catalog below 30 MeV is publicly accessible online at the website of the ASI Science Data Center (ASDC) http://www.asdc.asi.it/mcaltgfcat/

## 1. Dead time and its effects on the TGF sample properties



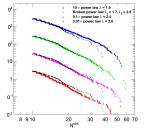
#### TGFs with duration ~100us or • less cannot be detected.

- Probability of simultaneous association with WWLLN sferics is 10% for T50 in 0.12-0.19 ms range, zero above (Connaughton+2013).
- This explains the lack of simultaneous sferics in AGILE



#### Intensity:

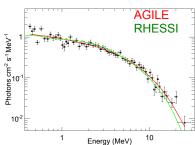
- Paralizablle detector: cannot correct each TGF, need a forward folding approach.
- Simulations yield a true fluence distribution ~E-2.4 in agreement with recent RHESSI and Fermi results (Østgaard+2012; Tierney+2013).



### 2. Cumulative spectrum

### The paper





Good fit with a cutoff power law model

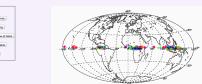
$$F(E) = KE^{-\alpha}e^{-\frac{E}{E_C}}$$

- $\alpha$  = 0.2 +/- 0.1 Ec = 5.5 +/- 0.6 MeV
- Unfolded model matches guite well simulations by Dwyer & Smith (2005) BUT a harder spectrum is observed
- This may be due to different energy ranges and selection cuts adopted (hardness ratio)

## 3. The online AGILE TGF catalog: http://www.asdc.asi.it/mcaltgfcat/

#### **Properties of Terrestrial Gamma-Ray Flashes** detected by AGILE MCAL below 30 MeV

TGF (E <30 MeV) observed from March 2009 to July 2012



Intry number			TGF ID	GeoLon	Goolat	Date (UTC)	Trigger Time TO (MET in s)	TO_mkro (µs)	(ms)	Raw Counts	HR	ML Counts+/-Err	Notes [*] &
	y All												
18	(min.)	THE LE	090302.71821	17.42	-1.64	2009-03-02717:14:14	163098854	254075	0.103	12	1.4	10.6+/-3.3	
2.9		10/16	090308.40378	110.96	-2.33	2009-03-08109:41:27	163590087	958609	0.48	17	1.4	19.9+/-4.8	
3 8	1000	19715	090308.61530	106.13	-1.45	2009-03-08T14:45:02	163608362	205006	0.154	10	2.3	10.7+/-3.3	
4 8	[Min]	TOTAL	090309.25894	136.66	-1.93	2009-03-09706:12:53	163663973	166586	0.282	11	0.6	11.7+/-3.5	
5 %	2002	TEFE	090309.37239	-6.65	1.89	2009-03-09708:56:15	163673775	205677	0.212	17	1.4	16.5+/-4.2	Multiple peaks within 10 ms
9.8	(223)	19615	090309.37239	-6.65	1.09	2009-03-09708:55:15	163673775	207135	0.251	11	1.2	10.4+/-3.5	Multiple peaks within 10 ms
7.8	2003	16/16	090315.2	-8.08	1.73	2009-03-15706:02:24	164181744	994547	0.156	18	0.8	18.7+/-4.4	
9.8	200	19716	090315.54239	20.66	-2.40	2009-03-15713:01:03	164206863	83205	0.256	12	1.4	12.3+/-3.6	
9.8	(200)	TOT LE	090318.11112	123.26	-2.15	2000-03-18702:40:01	164428801	655135	0.171	11	1.6	11.6+/-3.5	
10	1000	10/16	090320.97835	-65.7	1.17	2009-03-20123-25-50	164676530	559745	0.596	21	1.6	21.9+/-4.8	
11 8	1000	19715	090321.13434	7.40	0.89	2009-03-21703:13:27	164690001	624520	0.261	17	1.4	17.5+/-4.2	
12	1000	TETLE	090323.70296	100.89	2.16	2009-03-23716:52:16	164911936	749444	0.185	13	1.6	13.8+/-3.7	
13 9	1000	19716	090326.75312	121.95	-0.17	2009-03-26118:04:30	165175470	924223	0.436	- 11	0.8	9.6+/-3.5	
14 :	1000	THE LE	090333.00988	112.00	-2.23	2009-03-30700:14:14	165456854	92700	0.162	15	- 11	14.0+/-3.9	
15 5	1000	10/16	090403.32898	102.52	2.4	2009-04-03107:53:44	165830024	913604	0.56	10	1	34.24/-3.9	
16	100	19715	090423.47965	102.34	1.93	2009-04-03T11:17:45	165942265	218162	0.206	17	1.4	17.0+/-4.2	
17 :	1000	TOTAL	090403.54289	109.32	0.75	2009-04-03713:01:46	165848505	649177	0.287	10	1	10.8+/-3.5	
18 9	1000	75716	090423.86259	-75.86	2.46	2009-04-03720:39:15	165975955	460826	0.252	11	0.6	23.6+/-4.9	
19 8	1000	797.15	090404.46177	99.27	1.07	2009-04-04T11:04:57	165927997	969797	0.205	10	1.5	10.7+/-3.3	
20	1000	TEFAE	090414 644R1	5.89	10.61	2009-04-14715-28-32	166807712	294330	0.42	10		11.3+03.5	



The catalog

