J/A+A/587/A93 MeV-GeV counterparts of TeV sources (Rappoldi+, 2016)

Search of MeV-GeV counterparts of TeV sources with AGILE in pointing mode.
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Abstract:
Known TeV sources detected by major,Cerenkov telescopes are investigated to identify possible MeV-GeV γ-ray counterparts. A systematic study of the known sources in the web-based TeVCat catalog has been performed to search for possible γ-ray counterparts on the AGILE data collected during the first period of operations in observing pointing mode. For each TeV source, a search for a possible γ-ray counterpart that is based on a multi-source maximum likelihood algorithm is performed on the AGILE data taken with the GRID instrument from July 2007 to October 2009. In the case of high-significance detection, the average γ-ray flux is estimated. For cases of low-significance detection the 95% confidence level (CL) flux upper limit is given. 52TeV sources out of 152 (corresponding to ~34% of the analysed sample) show a significant excess in the AGILE data covering the pointing observation period. This analysis found 26 new AGILE sources with respect to the AGILE reference catalogs, 15 of which are galactic, 7 are extragalactic and 4 are unidentified. Detailed tables with all available information on the analysed sources are presented.

Description:
The analysis described in this paper has been applied to a reference sample of TeV sources extracted from the online TeVCat catalog (http://tevcat.uchicago.edu/ (Wakely S., and Horan D.). This online catalog is continuously updated with new sources detected by TeV experiments, and for each source it provides many parameters such as coordinates, source type, flux, and estimated distance (when available).
The analysis has been performed using the data collected by the main AGILE instrument, the Gamma-Ray Imaging Detector (GRID).

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
tablea1.dat	111	152	152 TeV sources considered in this analysis.
tablea2.dat	133	52	Results for all the sources detected with AGILE in this work, according to the criteria described in the text

See also:
J/A+A/506/1563 : First AGILE catalog of gamma-ray sources (Pittori+, 2009)
J/A+A/553/A33 : AGILE Mini-Calorimeter gamma-ray burst catalog (Galli+, 2013)
J/A+A/558/A137 : AGILE bright gamma-ray sources updated list (Verrecchia+ 2013)

Byte-by-byte Description of file: tablea1.dat

Bytes	Format	Units	Label	Explanations
1- 3	I3	---	ID	[1/152] Sequential number
4	A1	---	f_ID	[*] * indicates sources passing the detection criteria discussed in Sect. 5.2
6- 17	A12	---	TeVName	TeV source name (TeVJHHMM+DDd)
19- 20	I2	---	n_ID	? Note on ID (2)
22- 29	F8.4	deg	GLON	Galactic longitude
31- 38	F8.4	deg	GLAT	Galactic latitude
39	A1	---	n_pos	[*] Note on position (1)
41- 46	F6.4	deg	e_pos	?=- Error on position
48- 69	A22	---	Name	Canonical name
71- 86	A16	---	Type	TeV source classification type (3)
88- 91	F4.1	---	sqrt(TS4)	? Estimate of the γ-ray statistical significance at Step 4
93- 96	F4.1	---	sqrt(TS3)	? Estimate of the γ-ray statistical significance at Step 3
98-101	F4.1	10-7ph/cm2/s	Fgamma	? γ-ray flux (E>1000MeV) at Step 4
103-105	F3.1	10-7ph/cm2/s	e_Fgamma	? rms uncertainty on F(E>1000MeV)

107-109	F3.1	10-7ph/cm2/s	UL	? AGILE γ-ray flux upper limit at 95% confidence level at the input TeV source position from Step 4 at Step 4
111	A1	---	Ext	[X] X for TeV source extension

Note (1): *: best-fit position of the TeV excess is not available and the position of the optical/radio known counterpart has been used

Note (2): Individual notes as follows:

10 = The sources TeVJ0222+430 and TeVJ0223+430 are as close as 0.1° and therefore indistinguishable in this analysis. Their detection is counted as one.

11 = Results of a refined MLE analysis performed using the updated AGILE best-fit position of the Crab Nebula (one of the known γ-ray sources within 10 deg from the TeV J0521+211 position) obtained in this work.

12 = The TeV error region for the Vela X PWN does not overlap the AGILE Vela Pulsar position error, hence the Vela PSR average γ-ray flux value for a spectral index of -1.69 was subtracted in the MLE automatic analysis. However the result is affected by the very intense Vela Pulsar nearby. The Vela X accurate γ-ray flux estimate and source location by AGILE is discussed in the dedicated analysis in (Pellizzoni et al., 2010Sci...327..663P).

13 = Also in this case, the MLE automatic analysis is affected by the very intense Vela Pulsar nearby. A dedicated analysis will be performed.

14 = Detected by AGILE during a flaring episode (Verrecchia et al., 2008ATel.1582....1V).

15 = Detected by AGILE during several flaring episodes (Bulgarelli et al., 2010ATel.2641....1B; Striani et al., 2010ATel.2686....1S; Verrecchia et al., 2014ATel.6733....1V).

16 = The region of the MLE analysis is not yet well modelled since this source shows a point-like core and extended emission from the lobes, which are not yet included in the AGILE reference catalogs. A dedicated analysis will be performed.

17 = AGILE detection presented at the 32nd ICRC (Lucarelli et al. 2011, in 32nd International Cosmic Ray Conference, Bejing, China, 7, 236).

18 = Source located in a crowded region of the Galactic plane. The automatic MLE analysis is not reliable. A dedicated analysis will be performed.

19 = Source located in the region near the Galactic Center. The automatic MLE analysis is not reliable. A dedicated analysis is being performed with an improved AGILE diffuse background model in the Galactic center region (Fioretti et al., in prep.).

Note (3): TeV source classification types as follows:

PWN = Pulsar Wind Nebulae
BIN = Binary
SNR = SuperNova Remnant
Sbs = StarBursts
UNID = UNIDentified
FSRQ = Flat Spectrum Radio Quasar
HBL = High frequency peaked BL Lac object
IBL = Intermediate frequency peaked BL Lac object
LBL = Low frequency peaked BL Lac object
XRB = X-Rays Binary
WR = Wolf-Rayet star
FRI = Fanaroff-Riley type I
GC = Globular Cluster
MC = Molecular Cloud
PSR = Pulsar.

Note that the γ-ray emission detected in the search of counterparts to the TeV emission from PWN is in general due to the average (pulsar + nebula) γ-ray flux values. Timing analysis of pulsars was not performed in this paper.

Byte-by-byte Description of file: tablea2.dat

Bytes	Format	Units	Label	Explanations
1- 3	I3	---	ID	Identification number
5- 18	A14	---	TeVName	TeV source name (TeVJHHMM+DDd or TeVJHHMM+DDMM) (1)
20- 23	F4.1	---	sqrt(TS)	Estimate of the γ-ray statistical significance as result of the AGILE MLE analysis
25- 30	F6.2	deg	GLON	?=- Galactic longitude optimised peak position of the AGILE excess
33- 38	F6.2	deg	GLAT	?=- Galactic latitude optimised peak position of the AGILE excess
40- 43	F4.2	---	e_pos	?=- γ-ray source location error radius at 95% CL from Step 3 (statistical error only) (2)
47- 50	F4.1	10-7ph/cm2/s	Fgamma	Estimate of the γ-ray flux (E>100MeV) at the optimised peak position
52- 54	F3.1	10-7ph/cm2/s	e_Fgamma	?=- rms uncertainty on F(E>100MeV)
56- 58	F3.1	deg	Dist	?=- Distance of the γ-ray peak position from the input position of the TeV source
60- 82	A23	---	AGILE	AGILE association: already known AGILE

				source from the published 1AGL/1AGLR catalogs within the error radius in the 7th column
84-130	A47	---	Fermi	Fermi association(s): known Fermi-LAT source(s) associated to the TeV source, as described on 3FGL catalog
132-133	A2	---	Flag	Analysis flag (3)

Note (1): The upper part reports the results of the MLE analysis, Step 3, and the lower part the results of Step 4.
Note (2): The AGILE team recommends adding a systematic error of ±0.1° linearly.
Note (3): Analysis flag as follows:
IN = (Inside): the TeV source, including its extension (if any), is entirely within the AGILE contour (see an example in Fig. 4);
O = (Overlapping): the AGILE contour at the 95% CL overlaps with the error circle and/or the extension of the TeV source (see Fig. 5);
E = (External): the AGILE contour neither includes nor overlaps with the TeV source. Nevertheless, the AGILE peak position is within 0.6° from the TeV source position (see Fig. 6).

History:
From electronic version of the journal

(End) Patricia Vannier [CDS] 19-May-2016

*The document above follows the rules of the Standard Description for Astronomical Catalogues; from this documentation it is possible to generate **f77** program to load files into arrays or line by line*