

Supplemental Material to the article

“Carpet–2 search for gamma rays above 100 TeV in coincidence with HAWC and IceCube alerts”

This Supplemental Material presents results of the search for $E > 100$ TeV photons associated with individual alerts. Table 1 gives the list of alerts, Tables 2 and 3 present the numbers of expected and observed (in 24-hour and 30-day time windows) photon-candidate events and upper limits on fluxes and fluences for $E > 100$ TeV and $E > 300$ TeV, respectively. Table 4 presents the same quantities for 1000-second time windows for two alerts whose arrival direction was in the Carpet–2 field of view at the event arrival time.

Table 1. List of alerts used in the present analysis. HAWC alerts are published at https://gcn.gsfc.nasa.gov/amon_hawc_events.html, HESE IceCube alerts were published at https://gcn.gsfc.nasa.gov/amon_hese_events.html, EHE IceCube alerts were published at https://gcn.gsfc.nasa.gov/amon_ehe_events.html, GOLD and BRONZE IceCube alerts are published at https://gcn.gsfc.nasa.gov/amon_icecube_gold_bronze_events.html. We add “H” for HAWC or “T” for IceCube to the official alert ID for clarity. MJD gives the event time as a Modified Julian Day, R.A. and DEC are equatorial coordinates in degrees

Type	ID	MJD	RA, °	DEC, °
HAWC	H190806A	58701.556	78.4	6.6
HAWC	H190917A	58743.052	321.8	40.0
HAWC	H190927A	58753.954	248.7	21.2
HAWC	H191019A	58775.841	217.5	25.8
HAWC	H191208A	58825.557	228.9	40.2
HAWC	H200314A	58922.446	255.7	48.1
HAWC	H200814A	59075.901	177.8	19.9
HAWC	H200815A	59076.264	11.2	11.5
HAWC	H201019A	59141.905	203.1	29.7
HESE	I190331A	58573.289	355.6	71.1
EHE	I190503A	58606.724	120.3	6.4
GOLD	I190619A	58653.552	343.3	10.7
GOLD	I190730A	58694.869	225.8	10.5
GOLD	I191001A	58757.840	314.1	12.9
GOLD	I200109A	58857.987	164.5	11.9
GOLD	I200530A	58999.330	254.4	27.5
BRONZE	I190704A	58668.784	161.8	27.1
BRONZE	I190712A	58676.052	76.5	13.1
BRONZE	I191215A	58832.465	285.9	58.9
BRONZE	I191231A	58848.458	46.4	20.4
BRONZE	I200117A	58865.464	116.2	29.1
BRONZE	I200410A	58949.972	241.3	11.6
BRONZE	I200425A	58964.977	100.1	53.6
BRONZE	I200512A	58981.314	295.2	15.8
BRONZE	I200614A	59014.529	33.8	31.6
BRONZE	I200620A	59020.127	162.1	11.9
BRONZE	I200911A	59103.597	51.1	38.1
BRONZE	I200916A	59108.861	109.8	14.4
BRONZE	I200921A	59113.797	195.3	26.2
BRONZE	I201014A	59136.093	221.2	14.4
BRONZE	I201021A	59143.276	260.8	14.6

Table 2. Results of the search of $E > 100$ TeV photons. Alert IDs are defined in Table 1. For a given time period, 24 h or 30 days centered at the alert, n_{expected} and n_{observed} are the expected and observed numbers of photon-like events from the alert direction, respectively ($n_{\text{observed}} = 0$ for all cases for 24 h); F_{95} and $\mathcal{F}_{95}$ are the 95 % CL upper limits on the flux and fluence of the putative burst associate with the alert

ID	$E > 100$ TeV limits						
	24 hours			30 days			
	n_{expected}	F_{95} $10^{-11}\text{cm}^{-2}\text{s}^{-1}$	$\mathcal{F}_{95}$ GeV/cm^2	n_{observed}	n_{expected}	F_{95} $10^{-11}\text{cm}^{-2}\text{s}^{-1}$	$\mathcal{F}_{95}$ GeV/cm^2
H190806A	0.0009	1790	154	0	0.0262	59	153
H190917A	0.0170	49.9	4.31	1	0.5093	2.37	6.13
H190927A	0.0060	172	14.9	2	0.1809	11.7	30.4
H191019A	0.0092	109	9.44	0	0.2747	3.32	8.6
H191208A	0.0167	49.7	4.3	0	0.5013	1.39	3.6
H200314A	0.0179	47.9	4.14	0	0.5360	1.32	3.42
H200814A	0.0052	199	17.2	0	0.1556	6.31	16.4
H200815A	0.0021	650	56.2	0	0.0636	21.2	55
H201019A	0.0113	80.4	6.95	1	0.3396	3.96	10.3
HAWC stacked	0.0862	10.2	0.88	4	2.5871	0.77	1.99
I190331A	0.0054	201	17.4	0	0.1618	6.35	16.5
I190503A	0.0007	1890	163	0	0.0222	62.4	162
I190619A	0.0019	747	64.6	1	0.0582	39	101
I190730A	0.0017	774	66.9	0	0.0516	25.4	65.8
I191001A	0.0024	517	44.7	0	0.0720	16.8	43.7
I200109A	0.0021	609	52.6	1	0.0618	31.7	82.3
I200530A	0.0106	94.8	8.19	0	0.3182	2.83	7.34
I190704A	0.0104	97.9	8.46	0	0.3111	2.93	7.61
I190712A	0.0024	501	43.3	0	0.0733	16.3	42.3
I191215A	0.0134	70.8	6.12	0	0.4013	2.05	5.32
I191231A	0.0057	188	16.2	1	0.1702	9.59	24.8
I200117A	0.0109	83.9	7.25	2	0.3262	5.59	14.5
I200410A	0.0019	639	55.2	0	0.0556	20.9	54.2
I200425A	0.0167	54.9	4.74	0	0.5018	1.53	3.97
I200512A	0.0037	336	29	0	0.1116	10.8	28.
I200614A	0.0136	71	6.14	0	0.4080	2.05	5.32
I200620A	0.0022	609	52.6	0	0.0667	19.9	51.5
I200911A	0.0168	52.6	4.54	3	0.5027	4.27	11.1
I200916A	0.0029	410	35.5	0	0.0862	13.3	34.5
I200921A	0.0100	106	9.12	0	0.2996	3.18	8.23
I201014A	0.0029	410	35.5	0	0.0880	13.3	34.5
I201021A	0.0034	399	34.4	0	0.1022	12.8	33.3
IceCube stacked	0.1417	6.82	0.59	8	4.2502	0.81	2.10

Table 3. Results of the search of $E > 300$ TeV photons. See Table 2 for notations

$E > 300$ TeV limits							
ID	24 hours			30 days			
	n_{expected}	$F_{95},$ $10^{-11}\text{cm}^{-2}\text{s}^{-1}$	$\mathcal{F}_{95},$ GeV/cm^2	n_{observed}	n_{expected}	$F_{95},$ $10^{-11}\text{cm}^{-2}\text{s}^{-1}$	$\mathcal{F}_{95},$ GeV/cm^2
H190806A	0.0006	1350	351	0	0.0182	44.9	349
H190917A	0.0102	38	9.84	1	0.3053	1.88	14.6
H190927A	0.0033	131	33.9	2	0.0982	9.02	70.1
H191019A	0.0049	83	21.5	0	0.1480	2.64	20.5
H191208A	0.0102	37.8	9.8	0	0.3058	1.14	8.83
H200314A	0.0119	36.4	9.44	0	0.3564	1.07	8.35
H200814A	0.0031	151	39.2	0	0.0929	4.89	38
H200815A	0.0014	493	128	0	0.0427	16.2	126
H201019A	0.0065	61.1	15.8	0	0.1964	1.91	14.8
HAWC stacked	0.0521	7.84	2.03	3	1.5640	0.55	4.27
I190331A	0.0030	153	39.5	0	0.0889	4.94	38.4
I190503A	0.0005	1430	371	0	0.0160	47.5	369
I190619A	0.0014	567	147	1	0.0413	29.7	231
I190730A	0.0010	588	152	0	0.0311	19.4	151
I191001A	0.0015	393	102	0	0.0440	12.9	100
I200109A	0.0014	462	120	0	0.0427	15.2	118
I200530A	0.0055	72	18.7	0	0.1640	2.27	17.7
I190704A	0.0054	74.4	19.3	0	0.1631	2.35	18.3
I190712A	0.0013	380	98.6	0	0.0387	12.5	97.4
I191215A	0.0083	53.8	14	0	0.2480	1.65	12.8
I191231A	0.0034	143	37	1	0.1009	7.38	57.4
I200117A	0.0059	63.8	16.5	0	0.1778	2	15.6
I200410A	0.0012	485	126	0	0.0347	16	124
I200425A	0.0104	41.7	10.8	0	0.3111	1.25	9.73
I200512A	0.0019	255	66.2	0	0.0582	8.35	64.9
I200614A	0.0070	54	14	0	0.2111	1.68	13
I200620A	0.0012	462	120	0	0.0364	15.2	118
I200911A	0.0095	40	10.4	1	0.2836	1.99	15.5
I200916A	0.0019	312	80.8	0	0.0564	10.2	79.3
I200921A	0.0054	80.2	20.8	0	0.1609	2.53	19.7
I201014A	0.0016	312	80.8	0	0.0476	10.2	79.5
I201021A	0.0020	303	78.4	0	0.0587	9.89	76.9
IceCube stacked	0.0805	5.28	1.37	3	2.4151	0.32	2.51

Table 4. Results for alerts in the field of view (1000 s time window). See Table 2 for notations

1000-second limits				
ID	$E > 100$ TeV		$E > 300$ TeV	
	$F_{95},$ $10^{-11}\text{cm}^{-2}\text{s}^{-1}$	$\mathcal{F}_{95},$ GeV/cm^2	$F_{95},$ $10^{-11}\text{cm}^{-2}\text{s}^{-1}$	$\mathcal{F}_{95},$ GeV/cm^2
I190331A	7124	7.12	5405	16.2
I191215A	1065	1.07	808	2.43

