MAGIC Major Atmospheric Gamma Imaging Cerenkov Telescope

ETH Institute for Particle Physics

Results from the observation of extragalactic objects with the MAGIC telescope

D. Kranich [1] on behalf of the MAGIC collaboration

[1] ETH Zurich, CH-8093 Switzerland

Abstract

Given its low energy trigger threshold (50 GeV) and fast repositioning time (less than 30s) the Magic air Cherenkov telescope is well suited for the observation of fast transient objects. Here we present selected highlights from recent MAGIC observations of extragalactic objects.

The MAGIC telescope

The MAGIC Cherenkov telescope is located on the Canary Island La Palma. The telescope are a large parabolic Mirror of $234\mathrm{m}^2$, a $3.5°$ FoV camera with 577 enhanced QE PMTs and a 2 GS/s FADC system. Its design was optimized for a low 50 GeV trigger threshold and a fast repositioning time of 300° in 30 s. MAGIC has an $\sim$ 30% enhanced duty cycle as observations are also carried out during twilight or the presence of moonlight. The second telescope, MAGIC-II, is about to be fully commissioned (see dedicated poster from A. Moralejo).

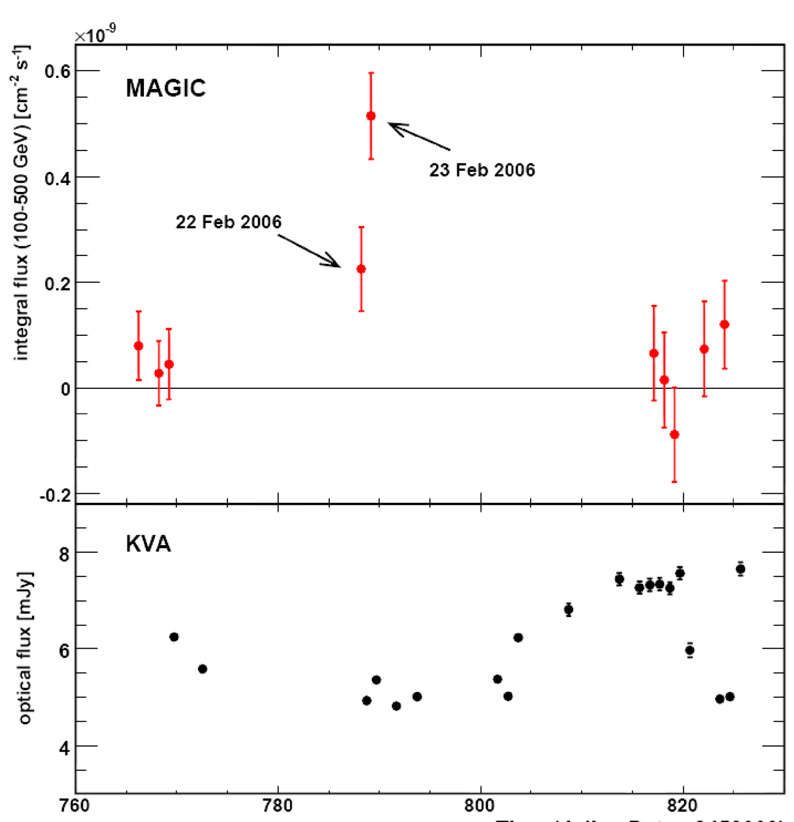
Gamma Ray Bursts

MAGIC started to follow-up GCN alerts in the beginning of 2005 and has observed more than 50 GRBs since then. Out of 23 GRBs observed during the last two years, 7 GRBs with accurate pointing position and weather condition were thoroughly analyzed. No detection, but upper limits for different energy regions could be made (results for different energy bins are given in units of $10^{-10}\,\mathrm{erg}\cdot\mathrm{cm}^{-2}\cdot\mathrm{s}^{-1}$. Follow up observations on accessible GRBs started in between 1 and 3 minutes after burst onset.

observation time [s]	Energy bin [GeV]			
	80-125	125-175	175-300	300-1000
GRB080315				
$T_0+160 \to T_0+1716$	–	0.16	0.18	0.05
$T_0+1761 \to T_0+5061$	–	–	0.05	0.05
GRB080319A				
$T_0+259 \to T_0+1736$	–	0.57	0.11	0.06
GRB080330				
$T_0+91 \to T_0+974$	–	–	0.76	0.49
$T_0+974 \to T_0+1754$	–	–	–	0.33
GRB080430				
$T_0+4753 \to T_0+11011$	0.55	0.77	0.30	0.05
$T_0+16912 \to T_0+17968$	7.76	6.59	2.45	0.92
GRB080603B				
$T_0+5578 \to T_0+7317$	–	0.16	0.06	0.01
$T_0+7497 \to T_0+12357$	–	0.05	0.12	0.03
GRB090102				
$T_0+1161 \to T_0+5181$	2.30	1.61	0.34	0.04
$T_0+5181 \to T_0+9381$	1.12	0.50	0.20	0.07
$T_0+9861 \to T_0+11241$	–	1.02	0.30	0.20
$T_0+11241 \to T_0+12621$	–	2.40	0.49	0.25
$T_0+12621 \to T_0+14841$	–	–	0.40	0.11
GRB090113				
$T_0+4603 \to T_0+10063$	0.54	0.99	0.10	0.08
$T_0+10183 \to T_0+13363$	–	0.93	0.2 3	0.08

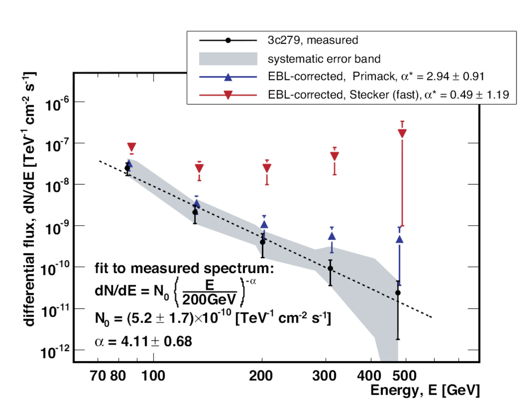
3C 279

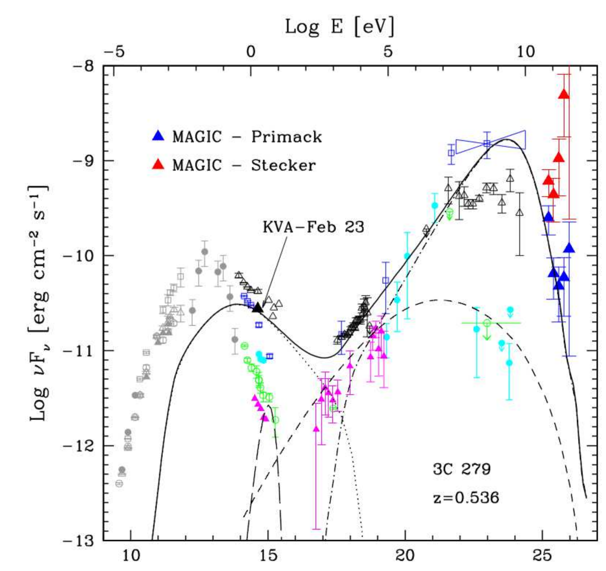
This is a famous FSRQ at $z = 0.536$ and the most distant VHE γ-ray emitter detected so far. Due to its large redshift it is an important object to study the EBL photon field. Magic detected 3C 279 during an optical outburst in spring 2006 [2]. A clear $5.8\,\sigma$ signal was found based on the high flux level at February 23rd.



The energy spectrum is well described by a pure power law with photon Index $\Gamma = 4.11 \pm 0.68$. The low level EBL corrected spectrum can be fitted by a one-zone SSC+EC model [5]. Taking into account quasi-simultaneous optical and X-ray data, however, suggests a multi-zone emission region. Hadronic models also seem to describe the data well [4].

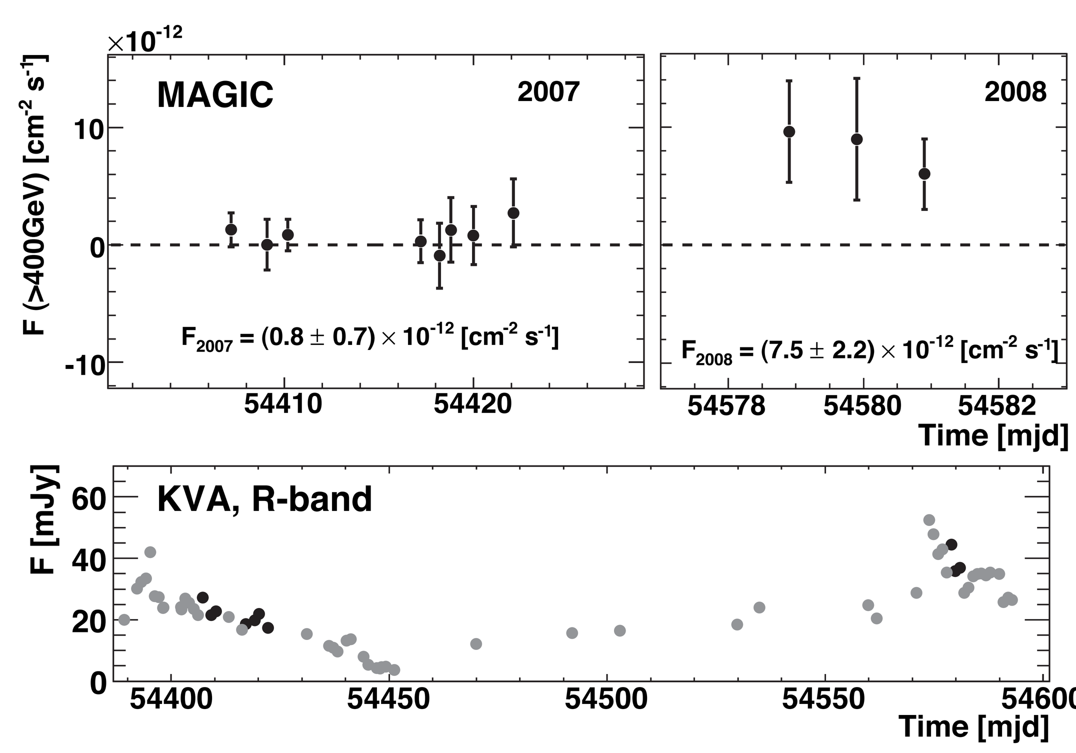
New observations after another optical outburst in January 2007 led to another clear detection at $5.2\,\sigma$.



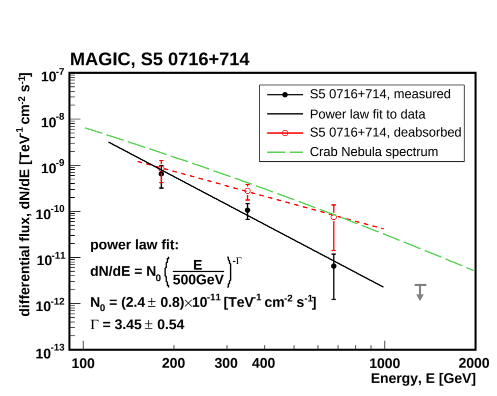


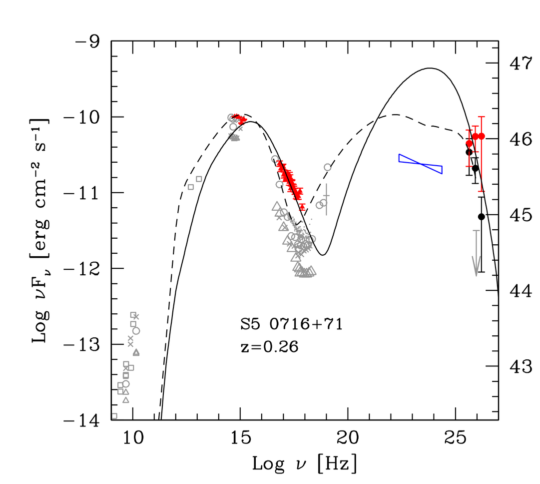
S5 0716+714

The low peaked BL Lac S5 0716+714 was observed for 13h between 2007 and 2008. The observations in April 2008 started after an optical trigger from KVA and led to a $5.8\,\sigma$ detection [3]. The integral flux above 400 GeV was $F = 7.5 \pm 2.2\,10^{-12}\,\mathrm{ph/cm^2/s}$ which corresponds to about 25% of the Crab Nebula flux. The reported X-ray flux (Swift) was also $\sim$ 50% larger compared to 2007.



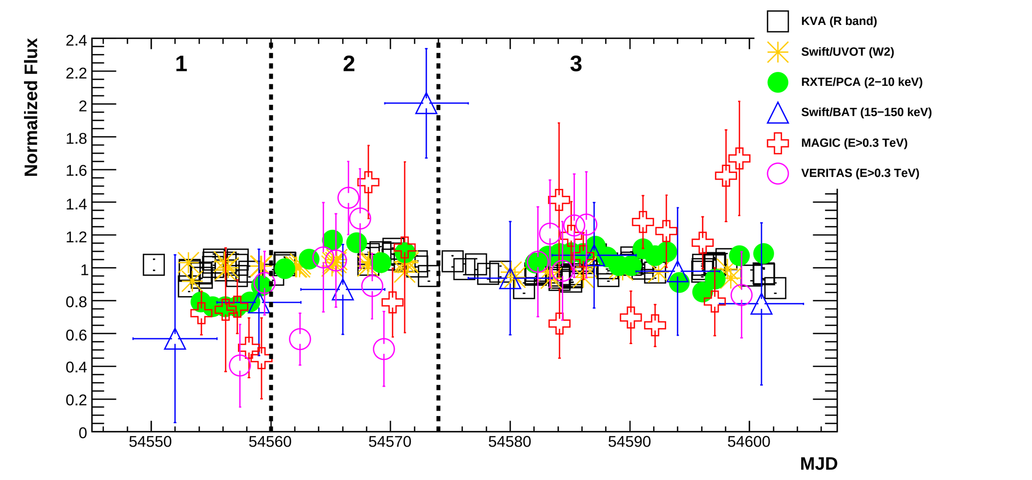
S5 0716+714 is the third low peaked VHE Blazar after BL Lac (MAGIC) and W Comae (Veritas). The redshift was determined from the host galaxy as $z = 0.31 \pm 0.08$ [6]. This is the 2nd farthest VHE object detected so far.
Due to the large redshift, the energy spectrum is rather steep with a photon index $\Gamma = 3.45 \pm 0.54$. A simple one-zone SSC model (solid line) well describes the broad band SED, but would predict a huge GeV flux.



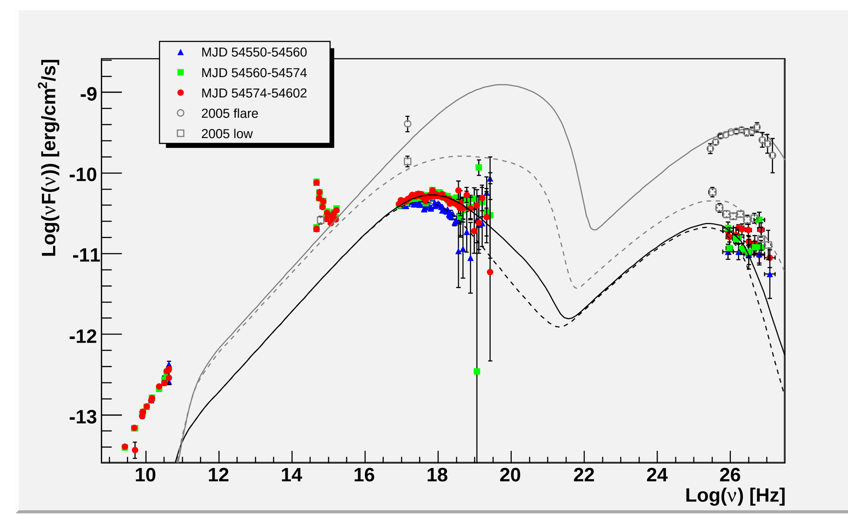


Multi-Wavelength campaign on Mrk 501

MAGIC took part in an extended MWL campaign (together with KVA, Swift, RXTE, Veritas and others), on the well know TeV Blazar Mrk 501. Mrk 501 was rather weak at 20% Crab but showed some significant flux variations, in particular at X-ray energies.



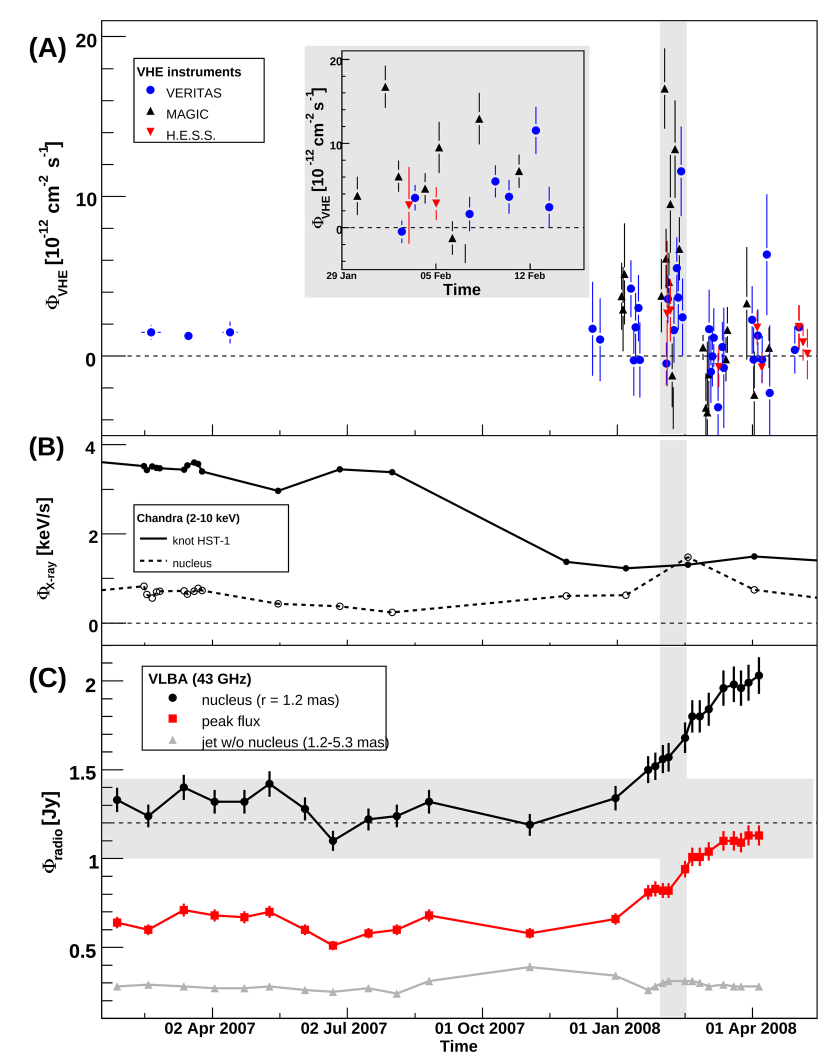
The broad band SED is well described by a one-zone SSC model [7]. The model parameter values for the different states are given in the table.



SSC model parameters	2008 high	2008 low	2005 high	2005 low
break energy γ_{break}	$2.6\cdot10^5$	$2.2\cdot10^5$	$1.0\cdot10^6$	$1.0\cdot10^5$
e^- slope n_1	2.0	2.0	2.0	2.0
e^- slope n_2	3.9	4.2	3.9	3.2
magnetic field B [G]	0.19	0.19	0.23	0.31
density K [cm^{-3}]	$1.8\cdot10^4$	$1.8\cdot10^4$	$7.5\cdot10^4$	$4.3\cdot10^4$
Radius R [cm]	$3\cdot10^{15}$	$3\cdot10^{15}$	$1\cdot10^{15}$	$1\cdot10^{15}$
Doppler factor δ	12	12	25	25

M 87

The Radio Galaxy M 87 was regularly monitored between January and June 2008, partially during moon. On January 1st, MAGIC detected a strongly increased emission from M 87 and triggered MWL observations with radio, X-ray and VHE coverage [1]. The data show evidence for a correlated radio and VHE γ-ray emission. There is a dedicated presentation (R. Wagner) on this campaign.



References

[1] V.A. Acciari, *et al.* 2009, Science 325, 444

[2] J. Aliu, *et al.* 2008, Science 320, 1752

[3] H. Anderhub, *et al.* 2009, ApJ 704, L129

[4] M. Boettcher, *et al.* 2008, arXiv:0810.4864

[5] L. Maraschi and F. Tavecchio 2003, ApJ 593, 667

[6] K. Nilsson, *et al.* 2008, A&A 487, L29

[7] F. Tavecchio, *et al.* 2001, ApJ 554, 725