

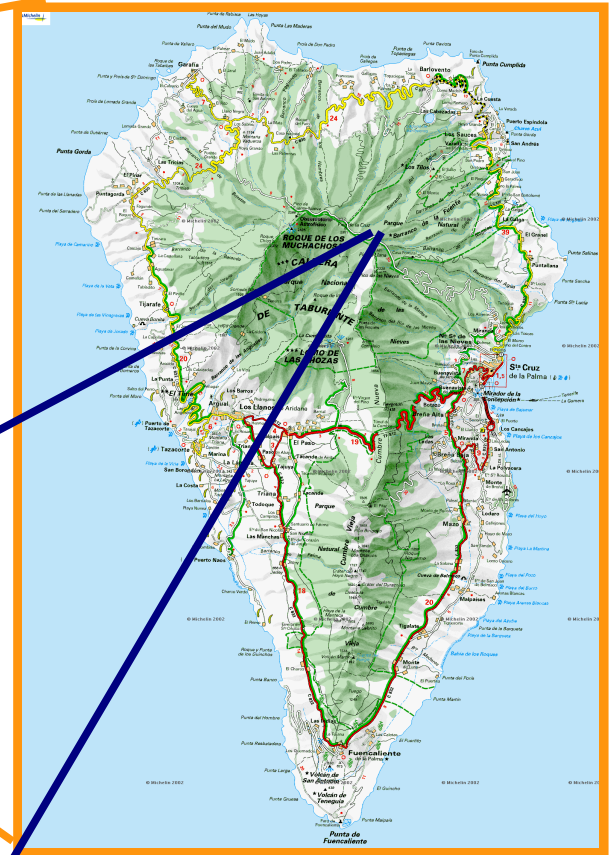
# MAGIC LATEST RESULTS

Oscar Blanch Bigas (IFAE)  
for the MAGIC collaboration



# The MAGIC Telescopes

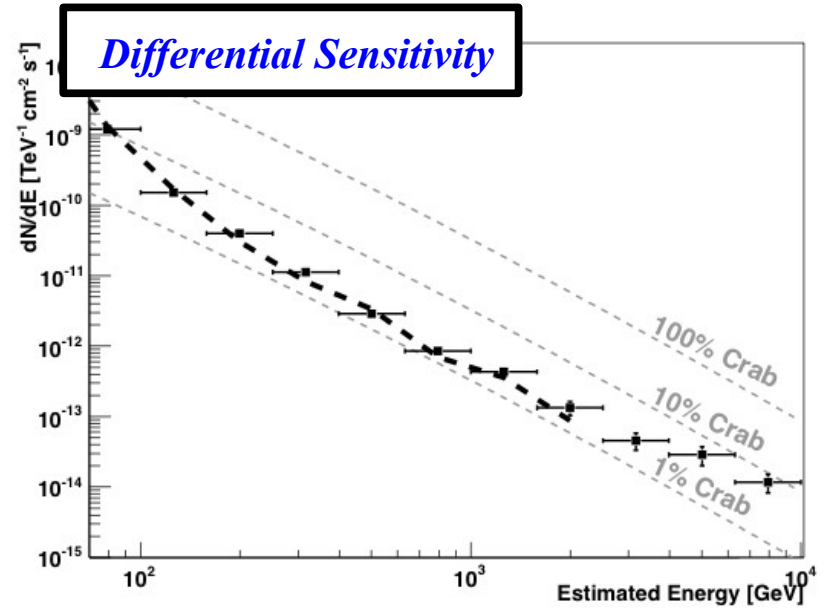
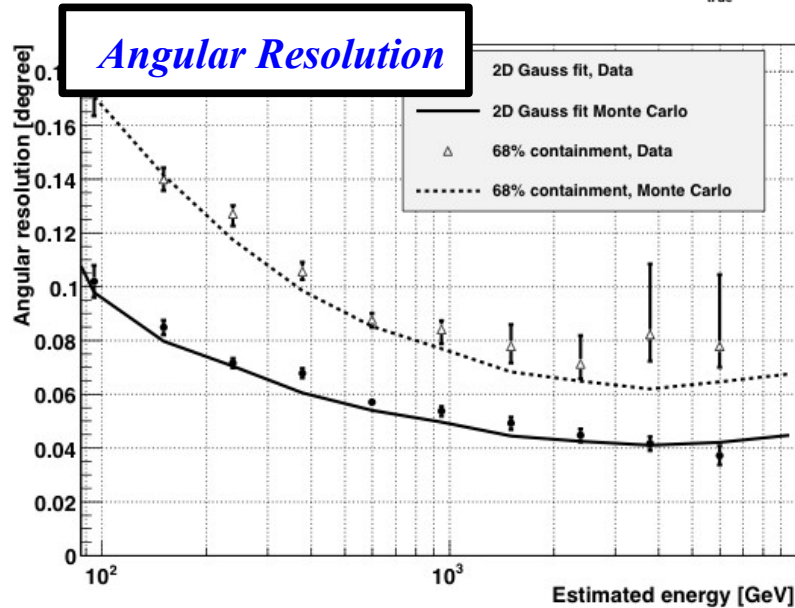
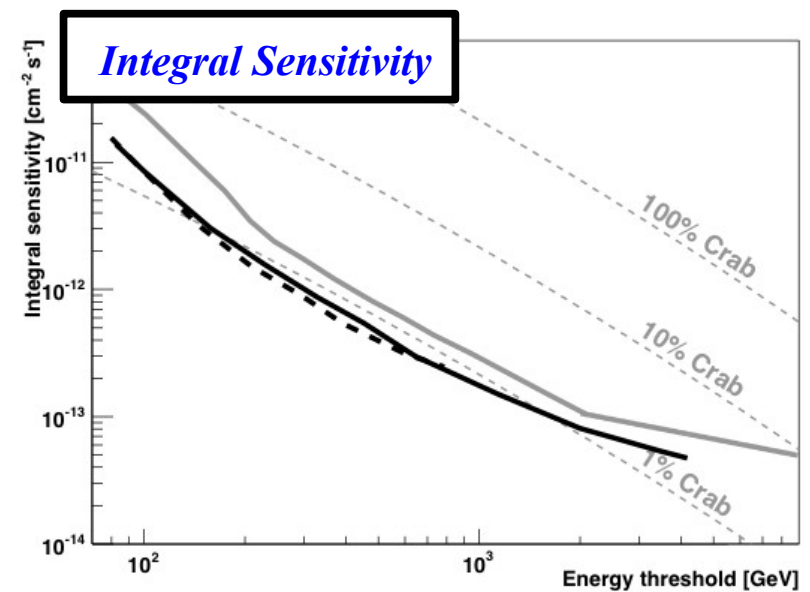
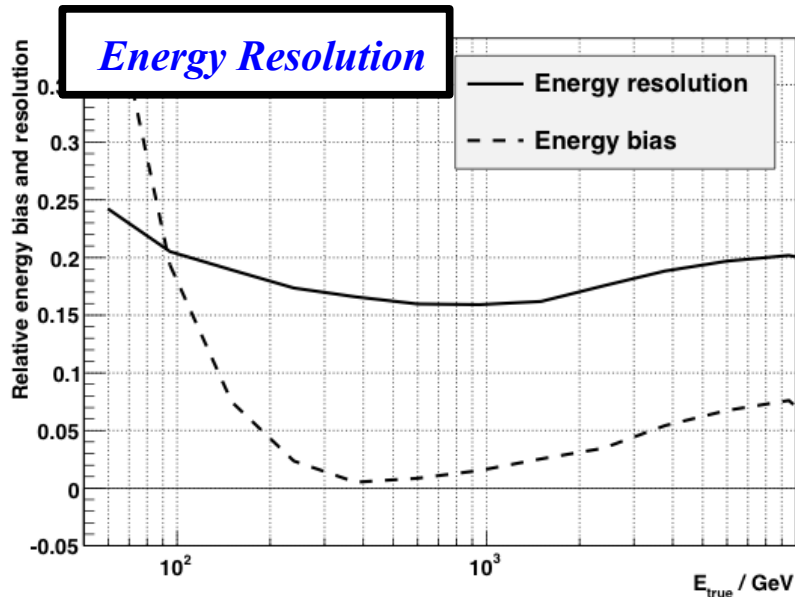
MAGIC is an Imaging Atmospheric Cherenkov Telescope system consisting of two 17m diameter telescopes, located on Canary island La Palma



# The MAGIC Telescopes

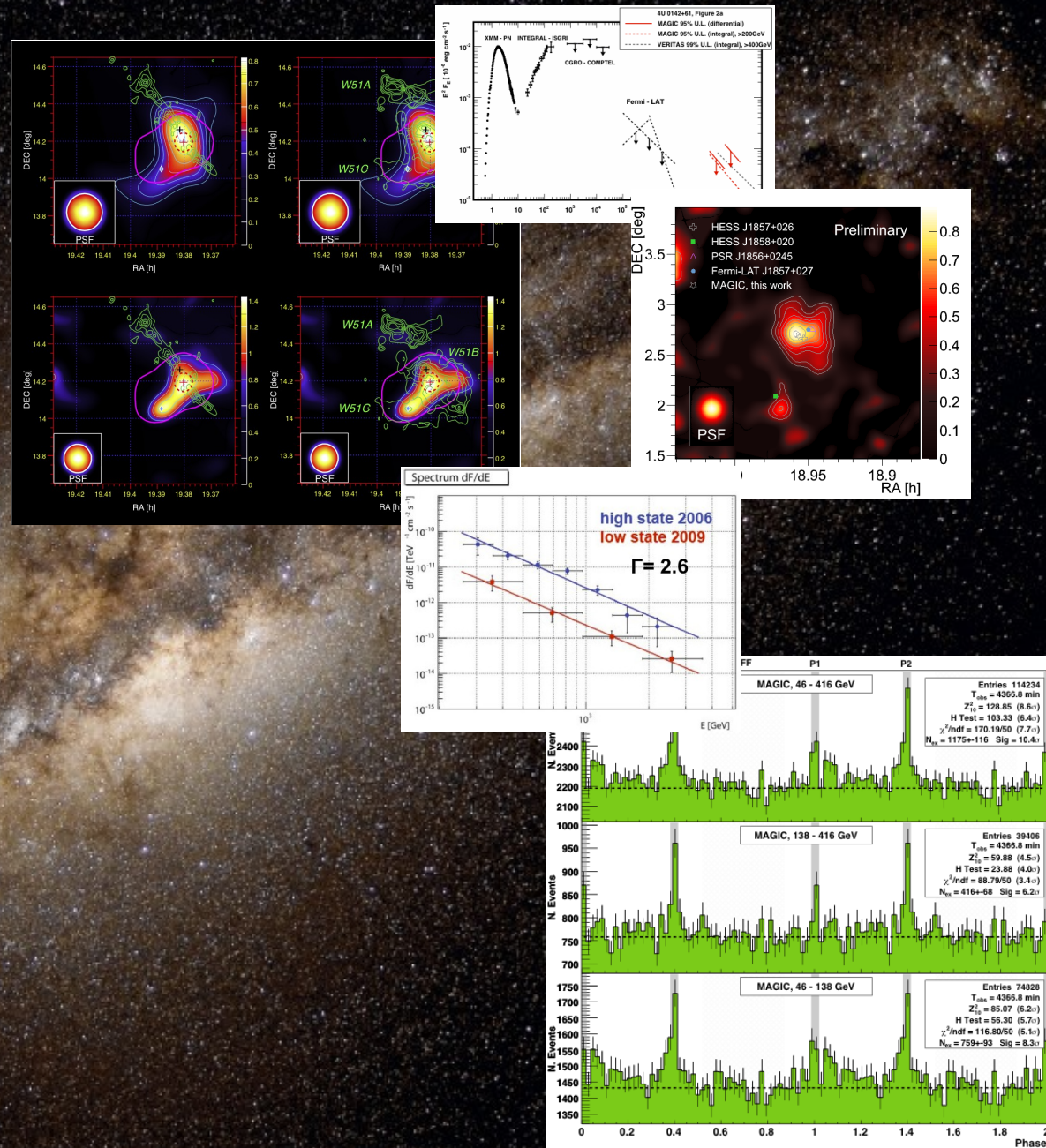
MAGIC is an Imaging Atmospheric Cherenkov Telescope system consisting of two 17m diameter telescopes, located on Canary island La Palma

Aleksic et al. (MAGIC) APh 35, 2012



# Galactic Science

- W51
- HESS 1857+026
- Magnetars
- Binaries
- Crab Nebula
- Crab Pulsar

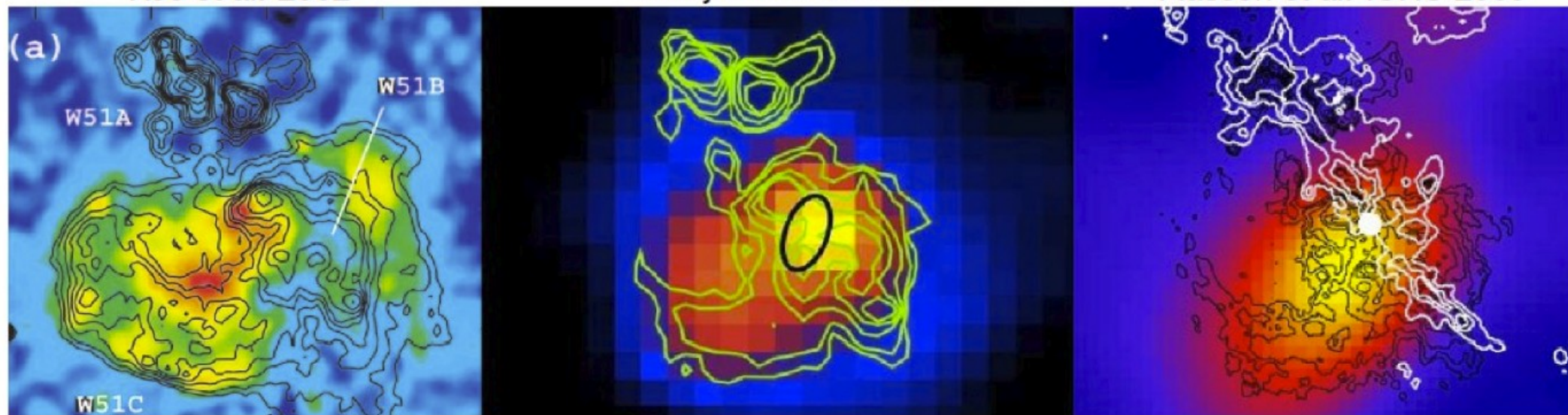


# The W 51 Complex

ROSAT 0.7-2.5 keV  
Koo et al. 2002

Fermi / LAT 2-10 GeV  
Uchiyama et al. 2011

H.E.S.S.  $>1$  TeV  
Fiascon et al. ICRC 2009



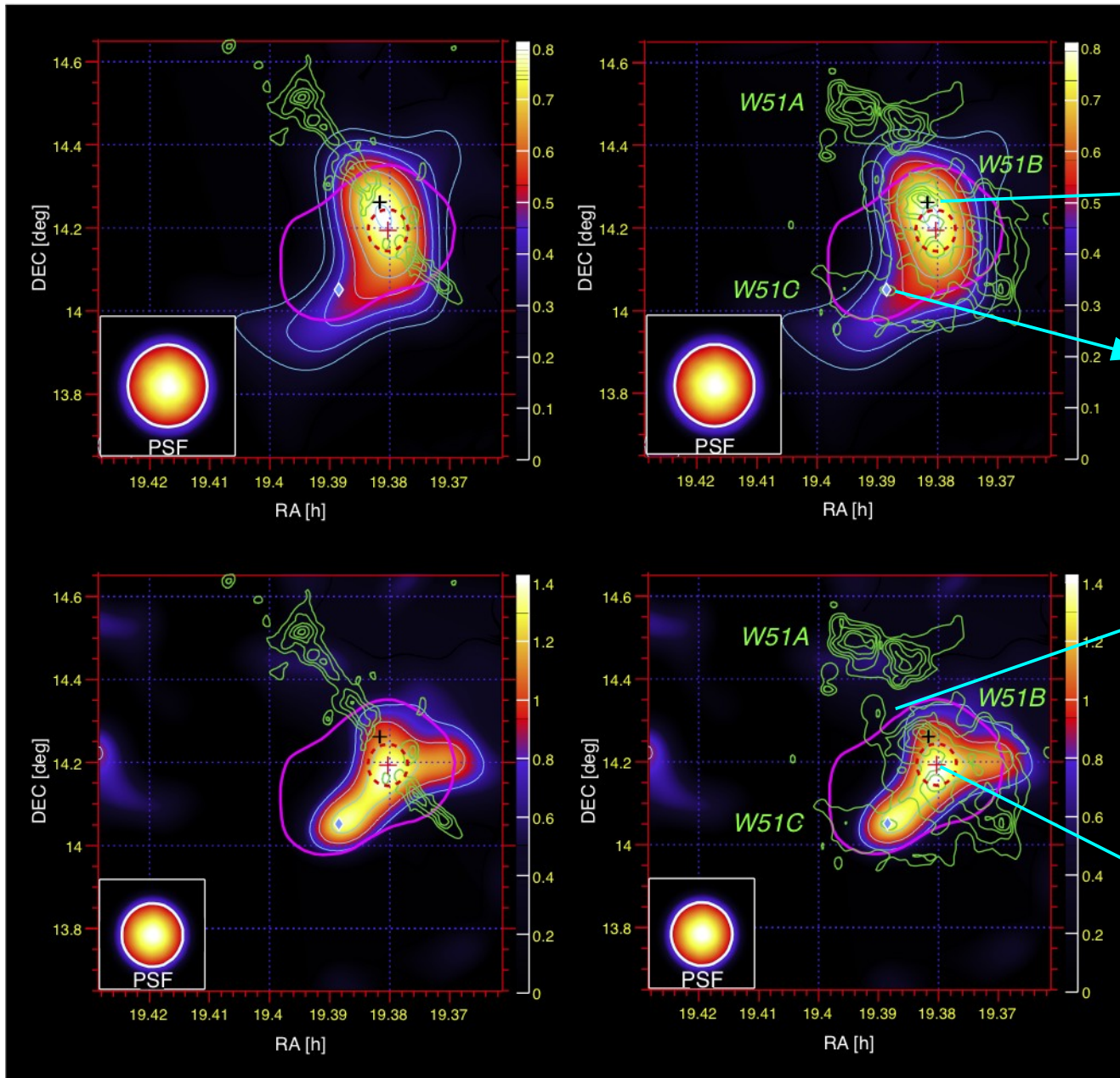
- **W51A & W51B** are star forming regions, **W51C** is a medium-age ( $\sim 30$ kyr) SNR at  $d \sim 5.5$  Kpc
- Possible PWN **CXO J192318.5+1403035** maybe associated with **W51C** (*Koo et al 2005 ApJ 633*)
- The SNR interacts with **W51B** (*Koo et al. 1997 ApJ 475&485, Green et al. 1997*)
- High Cosmic Ray ionization,  $\sim 100 \times$ ISM value (*Ceccarelli et al. 2011 ApJ 740*)

**MAGIC stereo data taken in 2010 and 2011 (53h),  $11 \sigma$  signal**

# The W 51 Complex

$^{13}\text{CO}(J=1-0)$  63-72 km/s

21 cm continuum



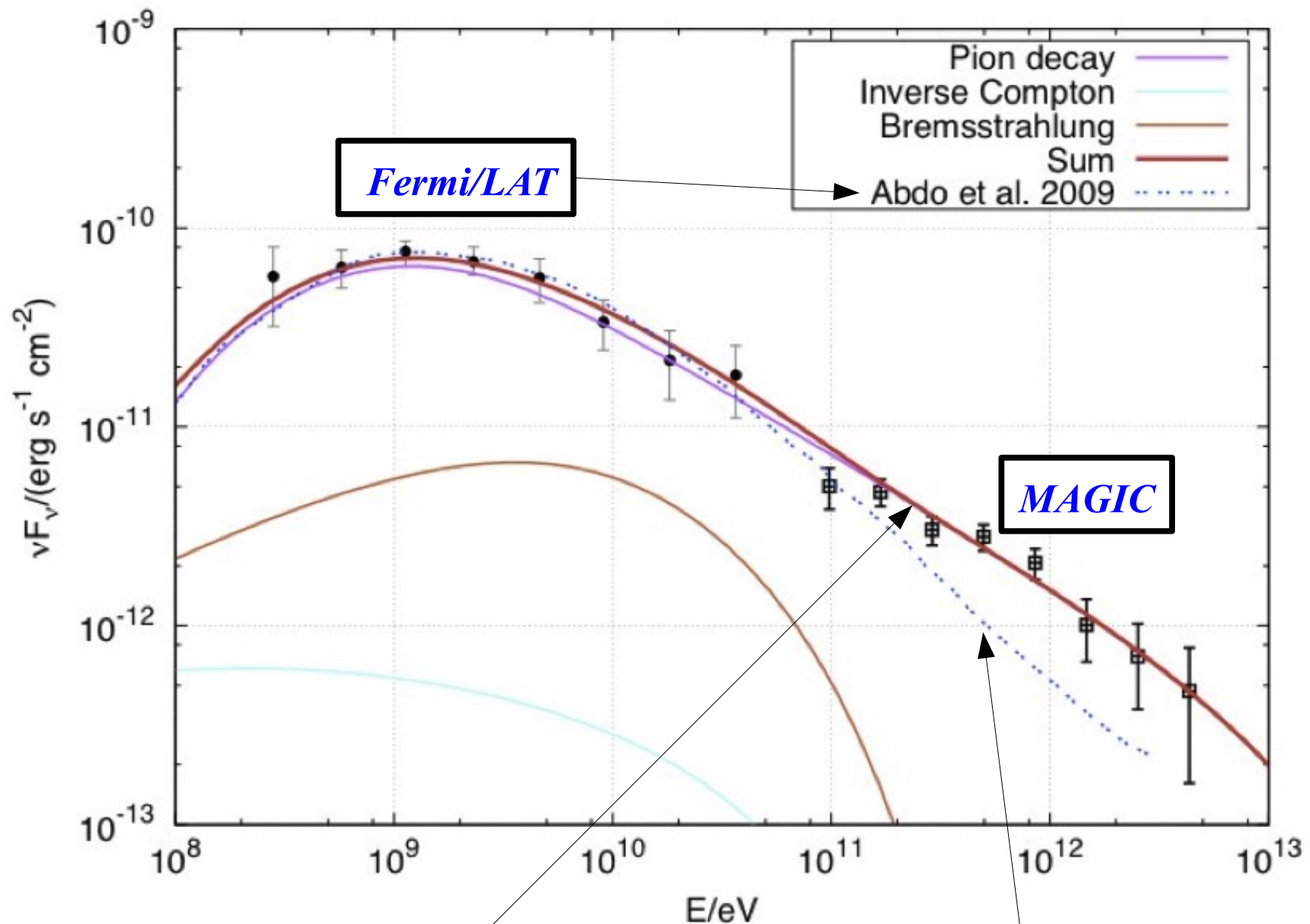
OH Maser emission

CXO J192318.5+140305

3 counts contour  
FERMI/LAT, > 1 GeV

Region of shocked  
Atomic & molecular gas

# The W 51 Complex

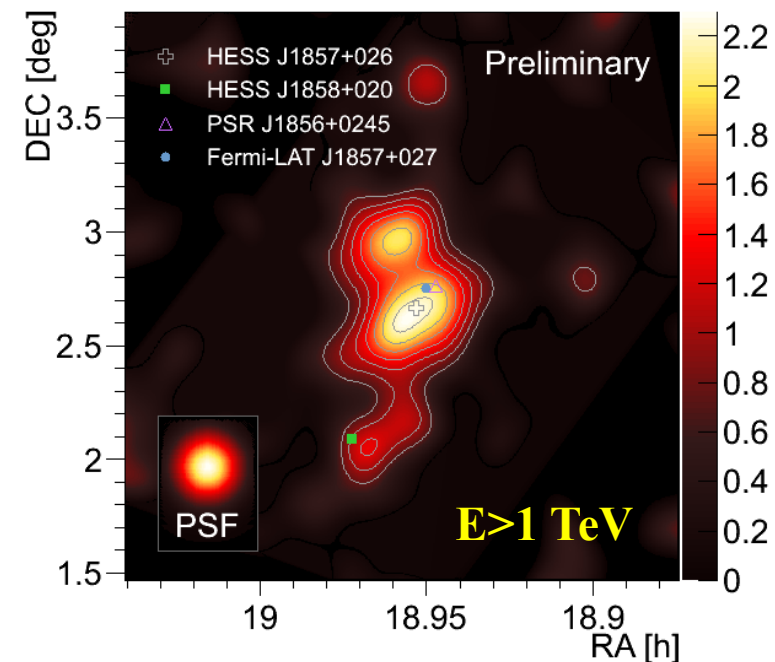
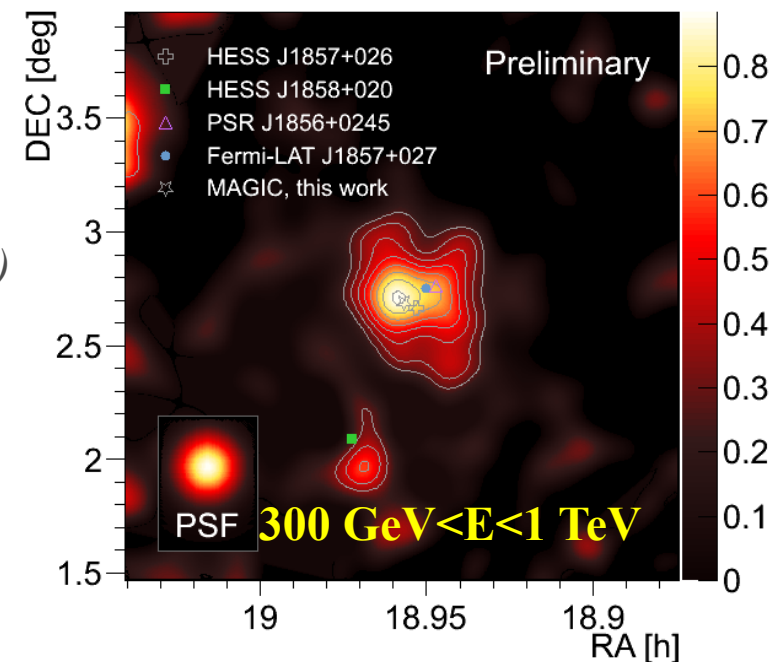
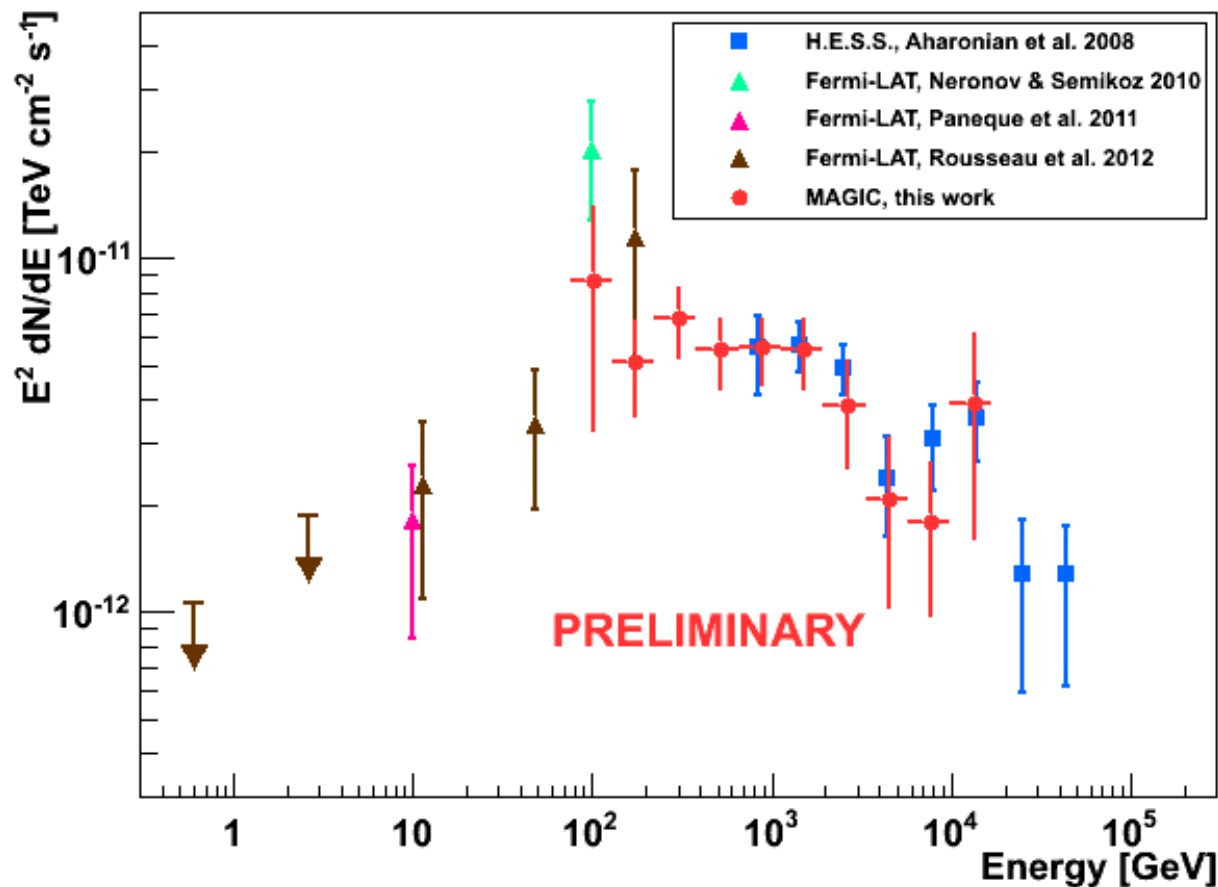


Emission probably hadronic (at least 1-zone Leptonic model fails)

# HESS 1857+026

Unidentified HESS source (*Aharonian et al. 2008 A&A 477*)  
Young energetic pulsar PSR J1858+0245 later discovered  
(*Hessels et al. 2008 ApJ 662*)  
Point-like source by Fermi-LAT (*Rousseau et al 2012 A&A 544*)

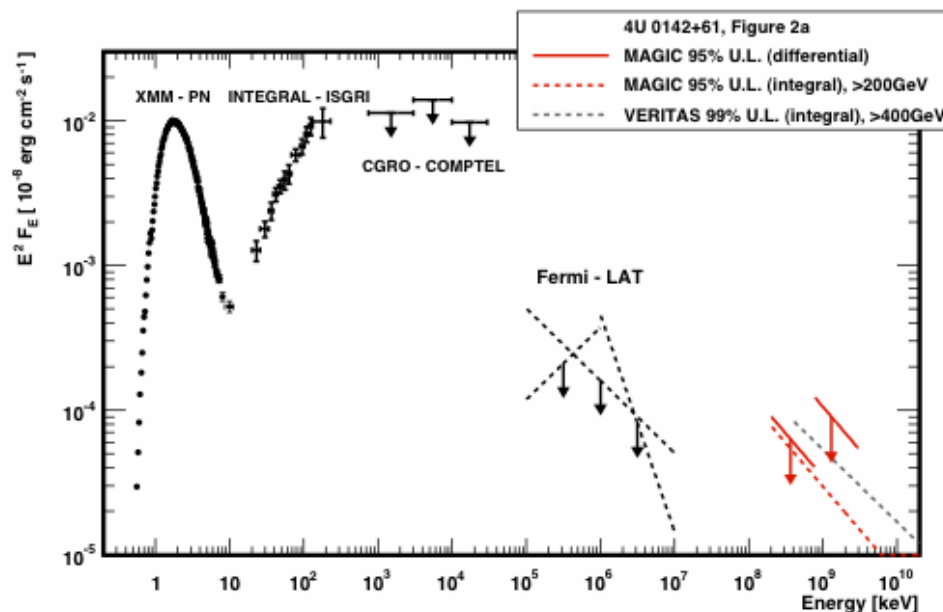
**Morphology and spectrum → Hint for PWN**



# Upper limits on Magnetars

**4U 0142+61**

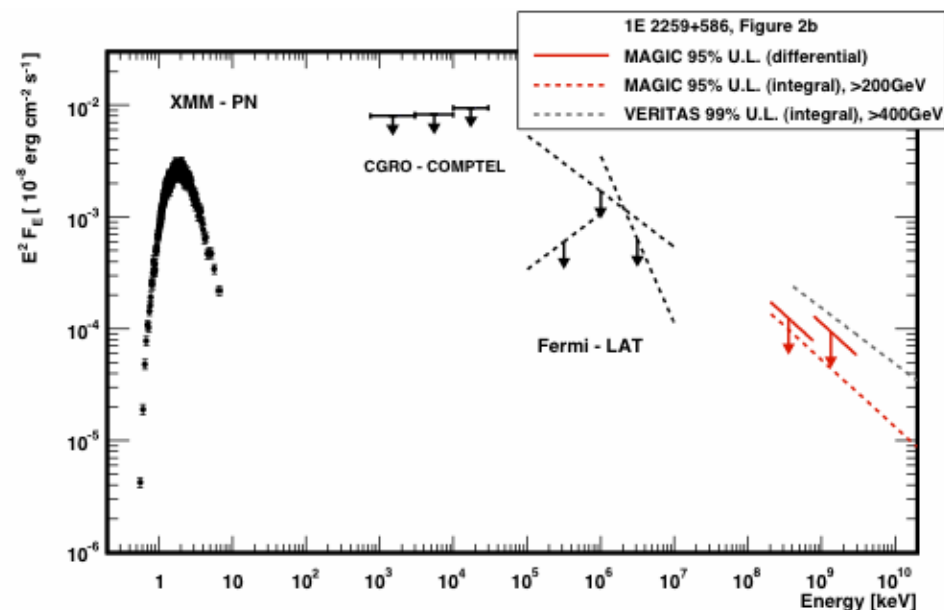
- $L_x \sim 10^{35} \text{ erg s}^{-1}$  (among the brightest)
- B on surface:  $1.3 \cdot 10^{14} \text{ G}$
- Distance:  $3.5 \pm 0.4 \text{ kpc}$
- MAGIC: 17h in 2008, mono data
- 95% upper limit at  $E > 200 \text{ GeV}$ :  
 $\sim 0.5\% \text{ C.U.}$



**1E 2259+586**

- $L_x \sim 0.3 \cdot 10^{35} \text{ erg s}^{-1}$
- B on surface:  $0.59 \cdot 10^{14} \text{ G}$
- Distance:  $4.0 \pm 0.8 \text{ kpc}$
- MAGIC: 8h in 2010, stereo data
- 95% upper limit at  $E > 200 \text{ GeV}$ :  
 $\sim 0.6\% \text{ C.U.}$

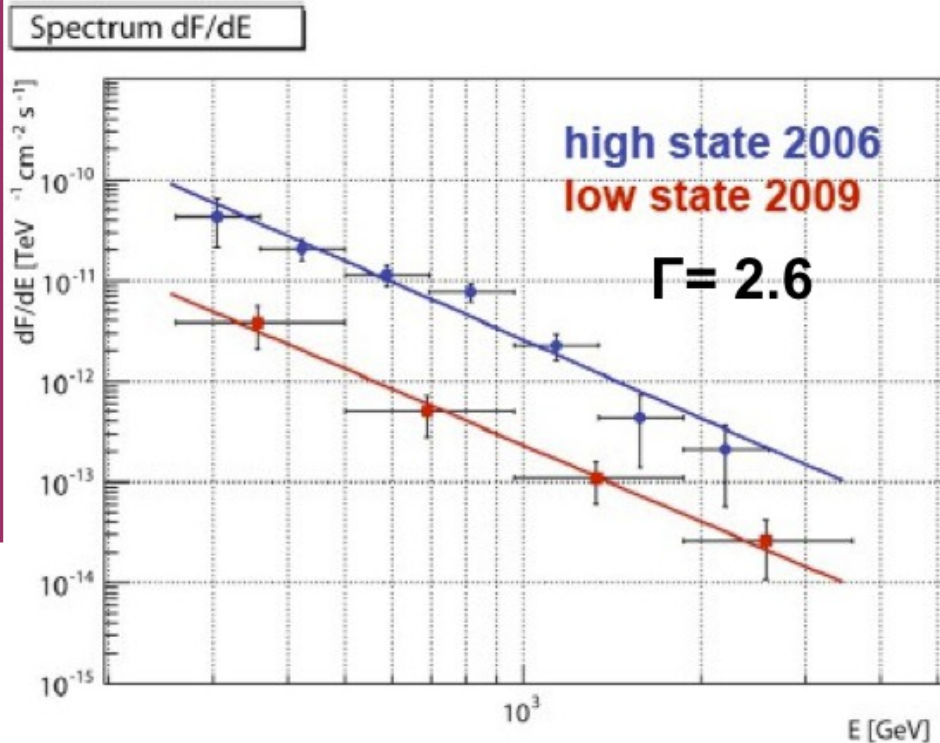
*Similar UL with half of the time*



# Binary Systems

*LS I +61 303*

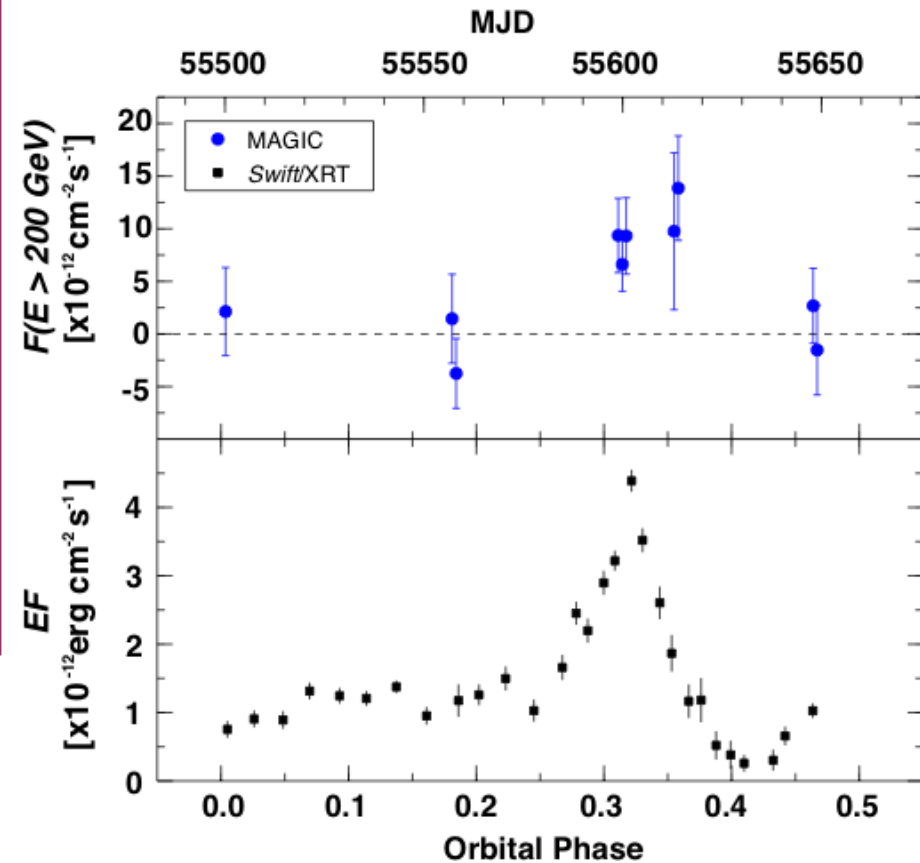
- Observed with MAGIC since 2005
- No spectral variability detected
- Low flux state detected in 2009
- Back to high state in 2011



Aleksic et al. (MAGIC) ApJ 754, 2012

*HESS J0632+057*

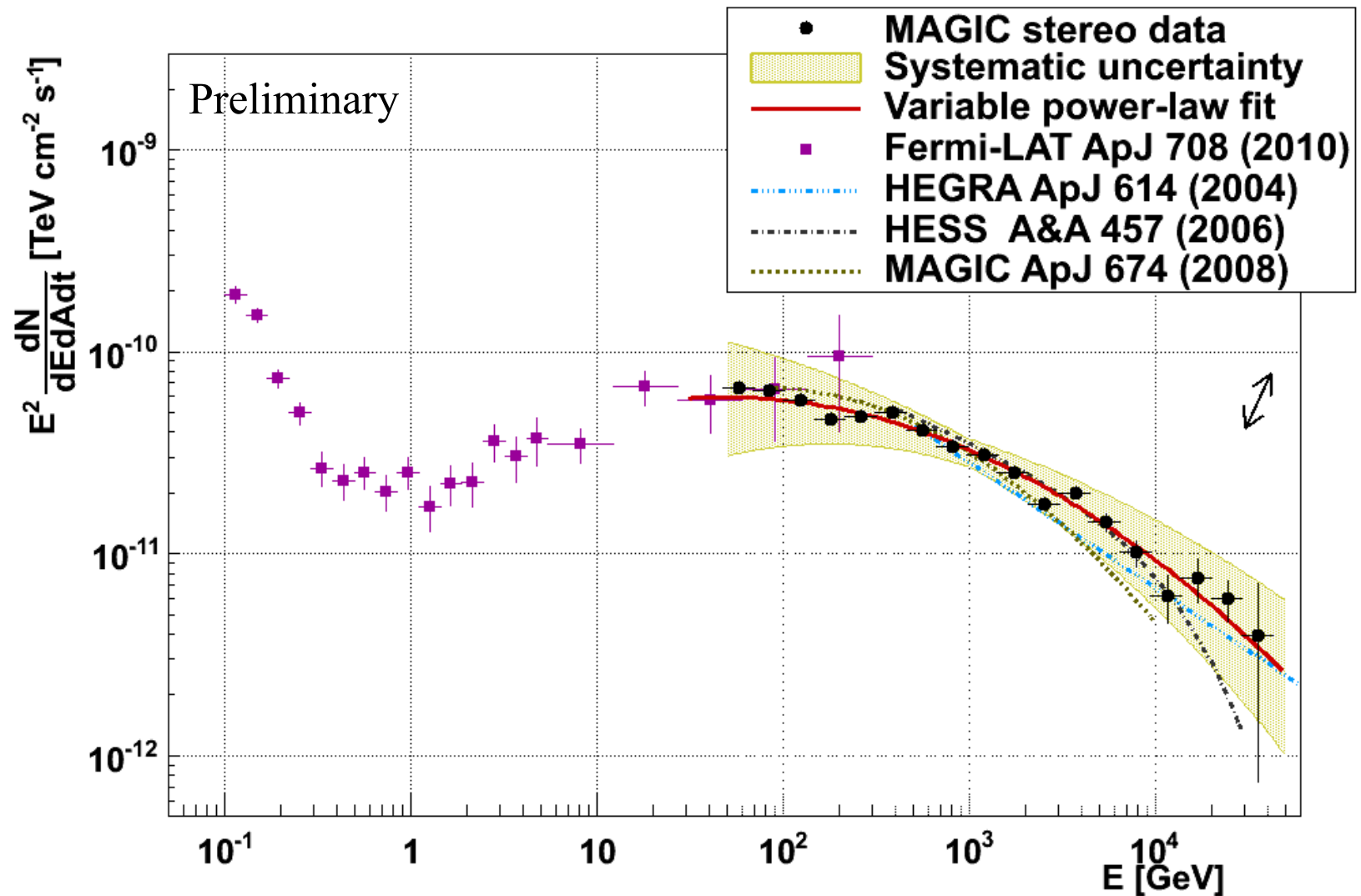
- Monitored with MAGIC since 2010
- February 2011  $\rightarrow 6\sigma$  in 5.6 hours  
 $\sim 4\%$  C.U.



# Crab Nebula

- MAGIC spectrum for 50 GeV to 45 TeV
  - About 50 hours in stereo mode, already dominated by systematics
  - Very good overlap with Fermi/LAT data → IC peak

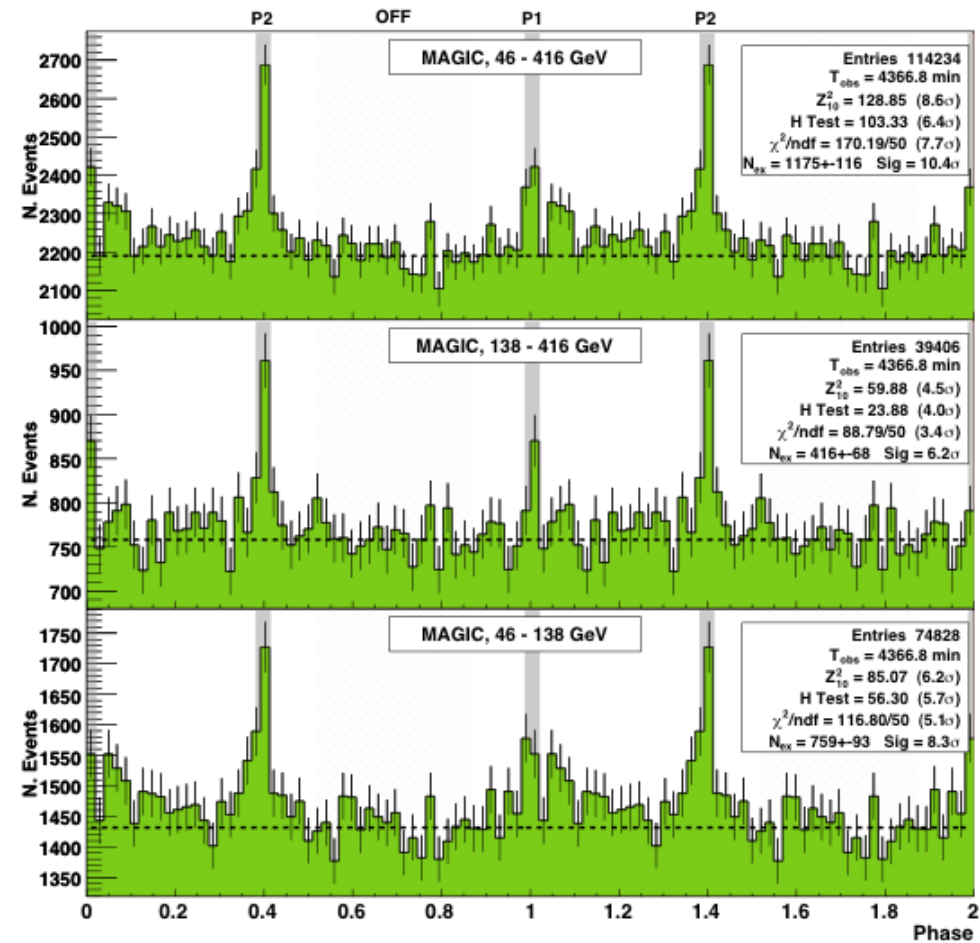
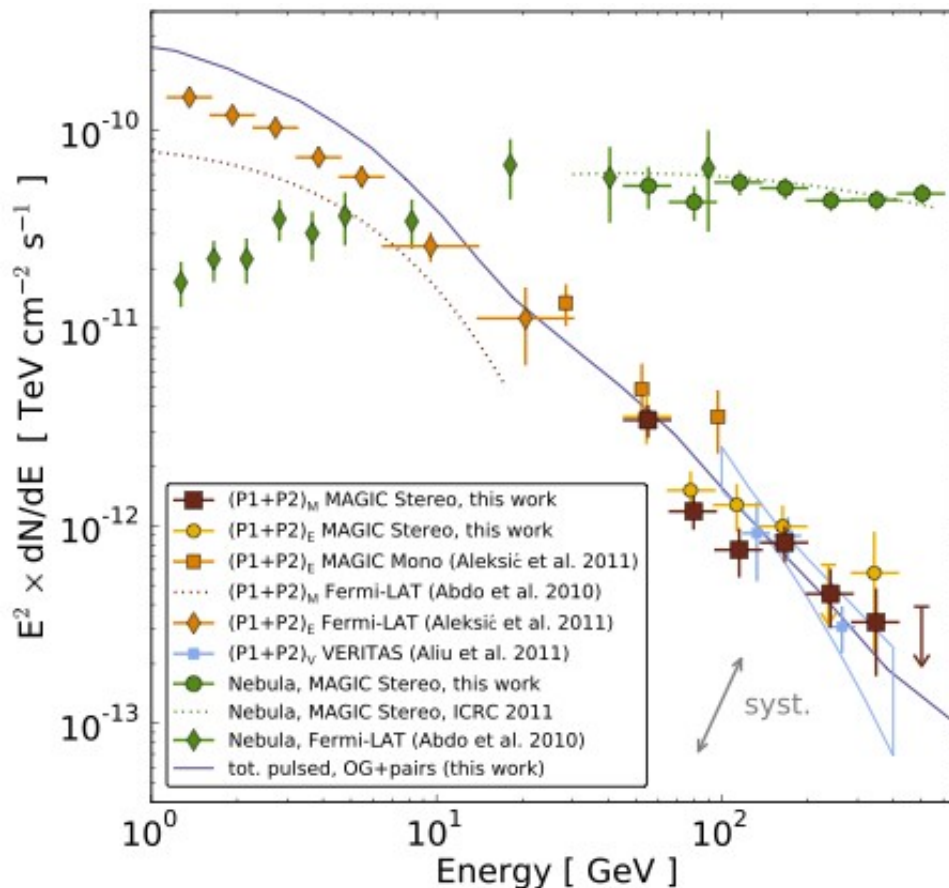
No flux enhancement observed during Crab Flares (ATel #2967)



# Crab Pulsar

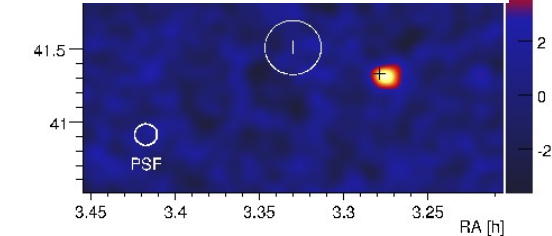
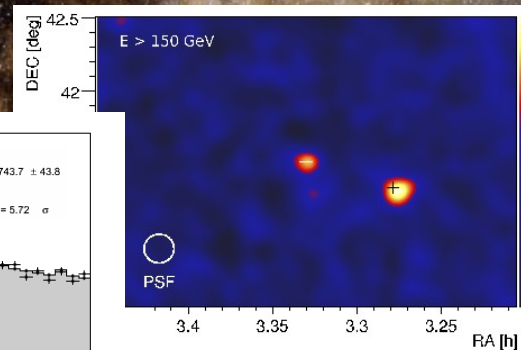
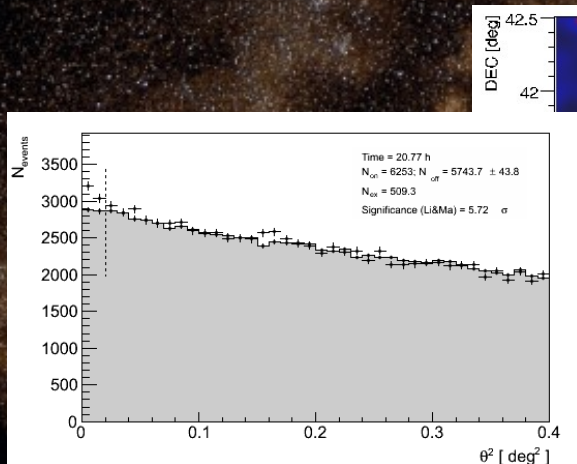
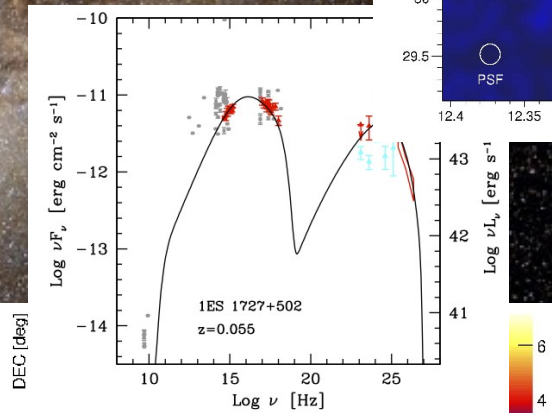
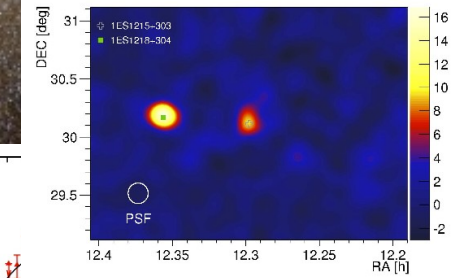
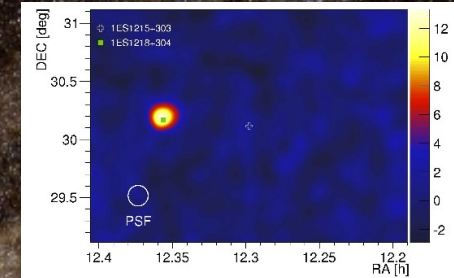
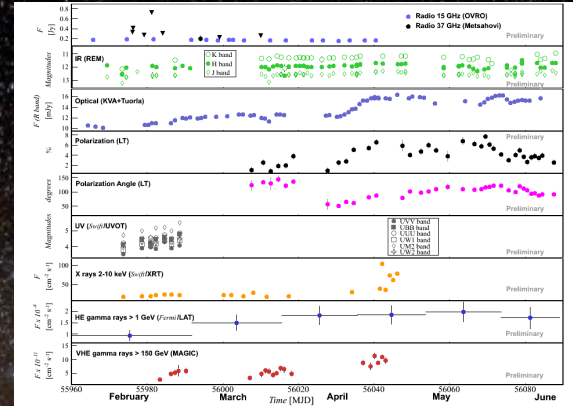
- MAGIC mono and stereo data establish a spectrum from 25 to 400 GeV (P1+P2, P1, P2)
- Together with VERITAS data challenged existent models → New set of models

*Hiroani 2006 Mod.Phys.Lett.A 21, Aharonian 2012 Nature 482, Chkheidze et al. 2011 ApJ 730, Bednarek 2012 MNRAS 424, Du et al 2012 ApJ 748, ...*



# Extragalactic Science

- New MAGIC sources
- 1ES 1215 +303
- Flare of PG 1553+113
- Markarian 421
- Flat Spectrum Radio Quasars
- Perseus cluster, flare IC 310



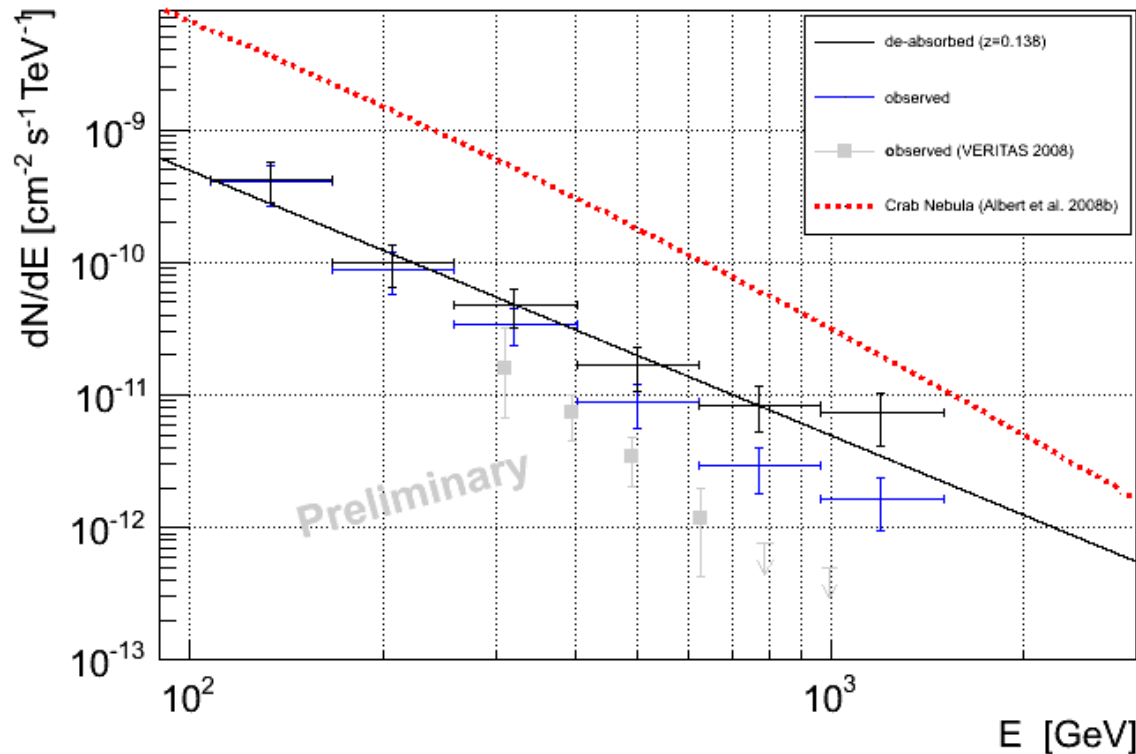
# New MAGIC sources

**1ES 0806+524**

HBL discovered by VERITAS

Observation triggered high optic state (KVA)

16 hours in Feb'11



**Daily variability /  $\Gamma=2.0\pm0.3$**

**MS1221.8+2452**

High Synchrotron peaked BL Lac

4 hours 1<sup>st</sup> of May

4% C.U. Above 200 GeV

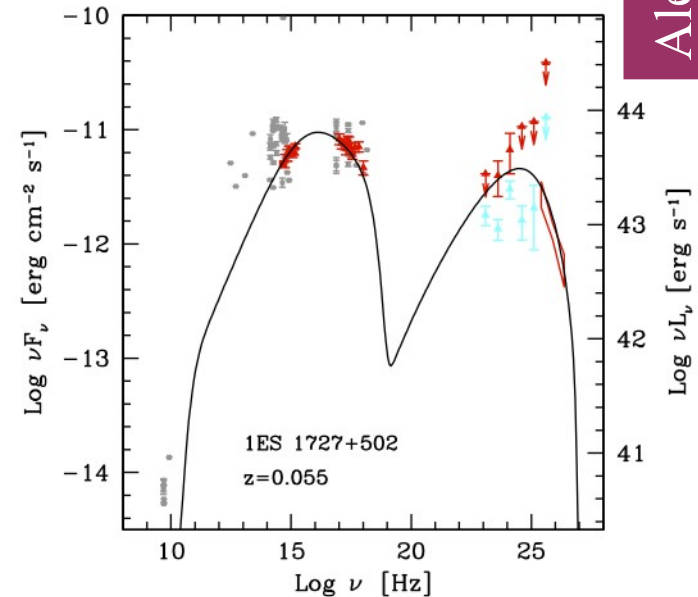
**1ES 1727+502**

HBL at  $z=0.055$

13 hours 2011  $\rightarrow 5.5\sigma$

No variability

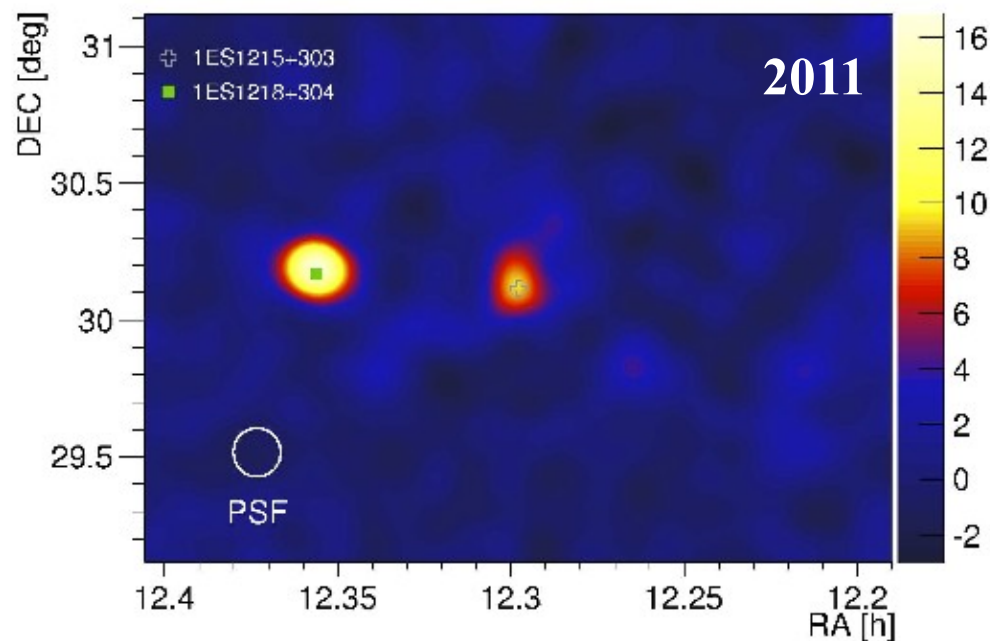
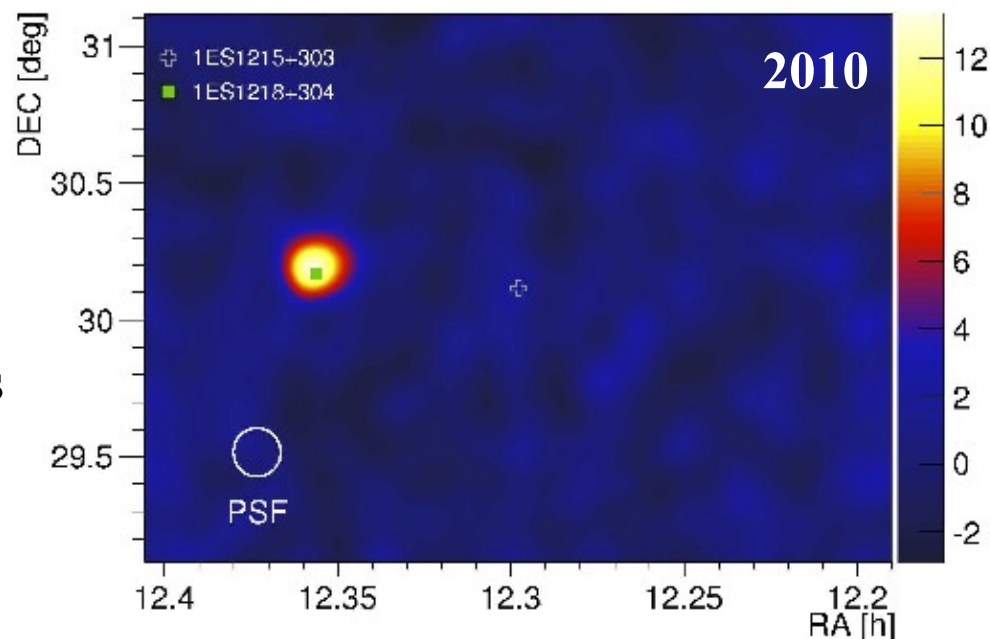
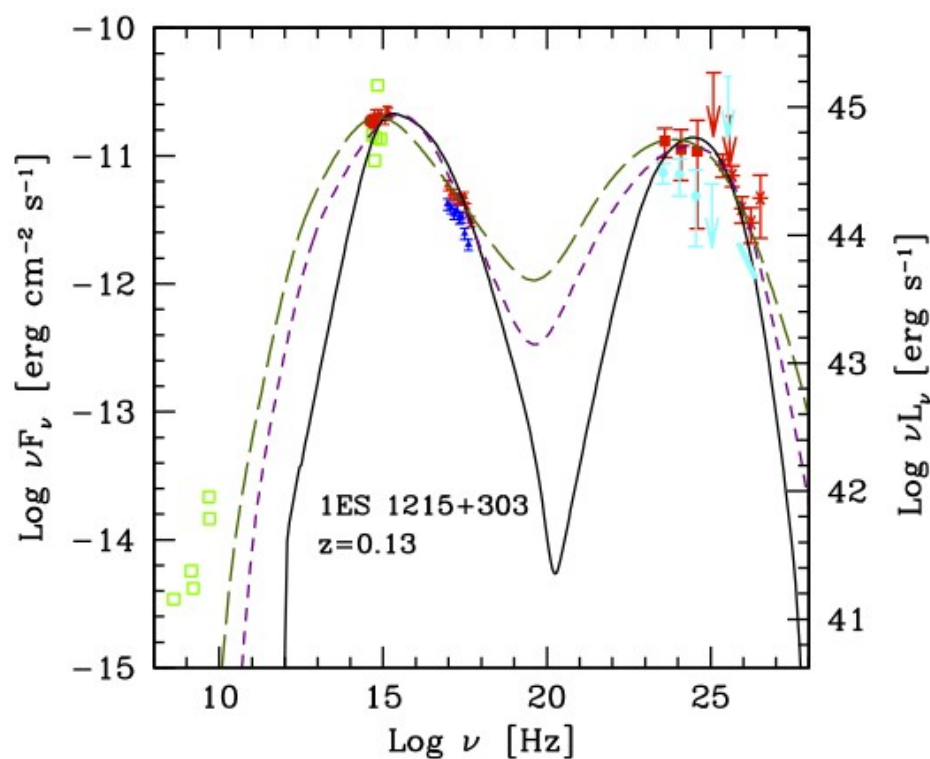
$\Gamma = 3.2 \pm 0.4$



Aleksic et al. Submitted to A&A

# 1ES 1215 +303

- First detection – 2011 January/February  
2010 observations lower flux
- Simultaneous MWL  $\rightarrow$  High state also in optic and X-Ray
- Simple 1 zone SSC model  $\rightarrow$  extreme values (doppler factor/ $e^-$  energy distributions)



# Flare of PG 1553 +113

- BL Lac object with unknown redshift

*Estimated  $\sim 0.4$*

*(Prandini et al 2011, Danforth et al. 2010)*

- First detected in 2005

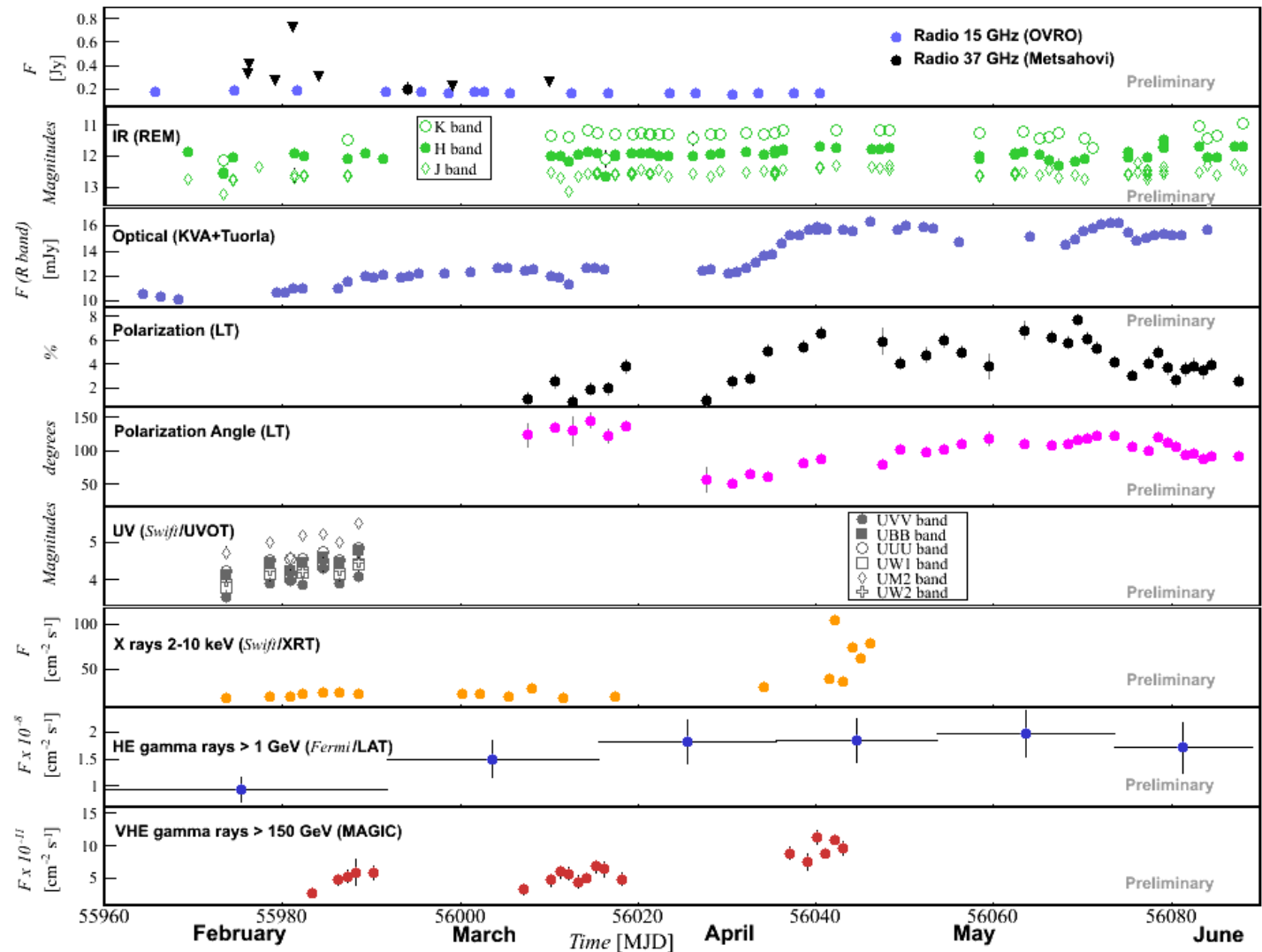
*(HESS/MAGIC)*

- February-May 2012:

- About  $50 \sigma$  in 17 hours
- Strong flare  $\sim 1$  C.U. at 100 GeV
- Complete MWL picture

| year             | Flux ( $E > 150$ GeV) [ $\text{cm}^{-2} \text{s}^{-1}$ ] |
|------------------|----------------------------------------------------------|
| 2007             | $(1.40 \pm 0.38) \times 10^{-11}$ [2]                    |
| 2008             | $(3.70 \pm 0.47) \times 10^{-11}$ [2]                    |
| 2009             | $(1.63 \pm 0.45) \times 10^{-11}$ [2]                    |
| 2012 (pre-flare) | $(5.03 \pm 0.25) \times 10^{-11}$                        |
| 2012 (flare)     | <b><math>(9.63 \pm 0.37) \times 10^{-11}</math></b>      |

*Preliminary*



# Markarian 421

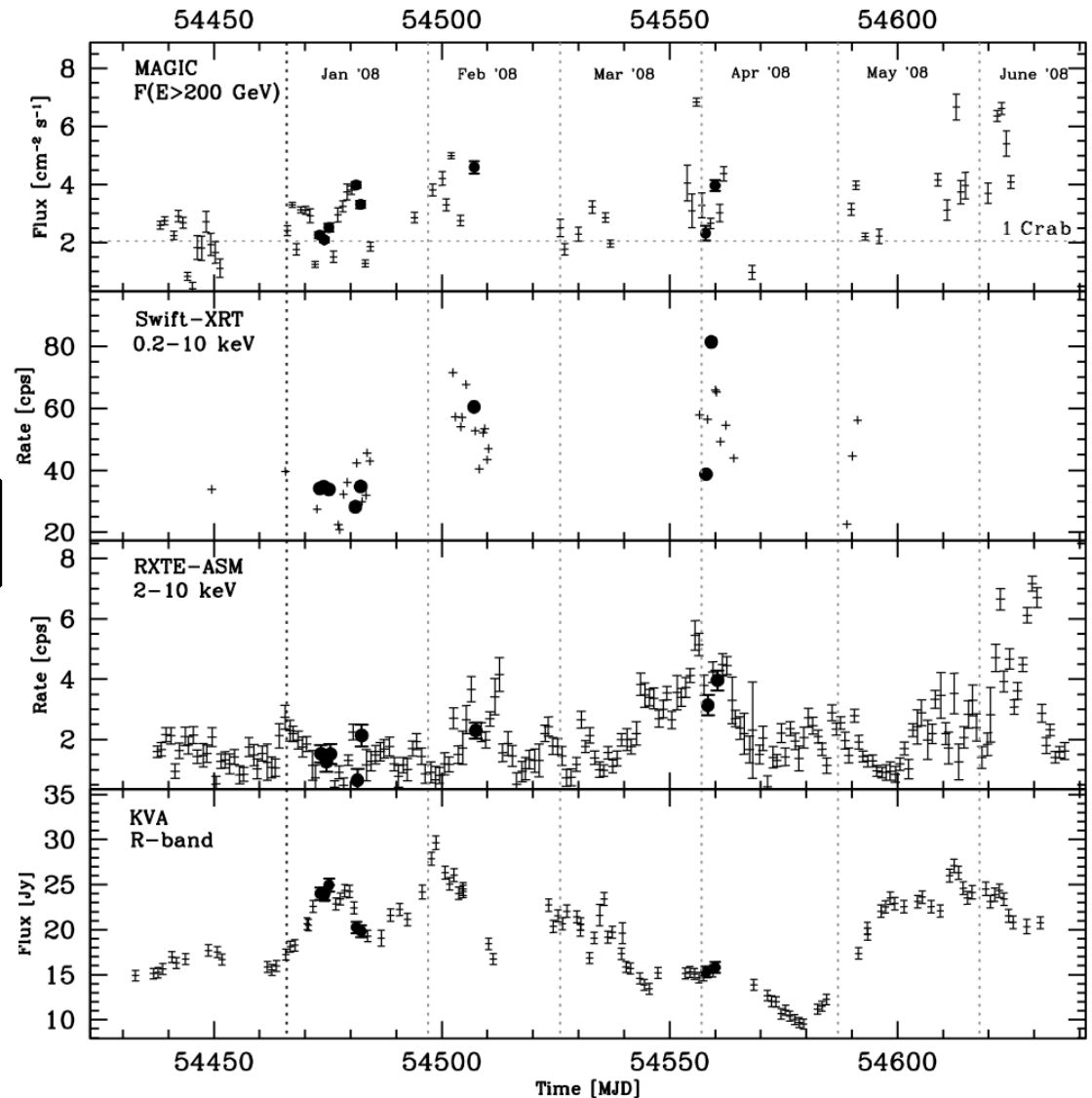
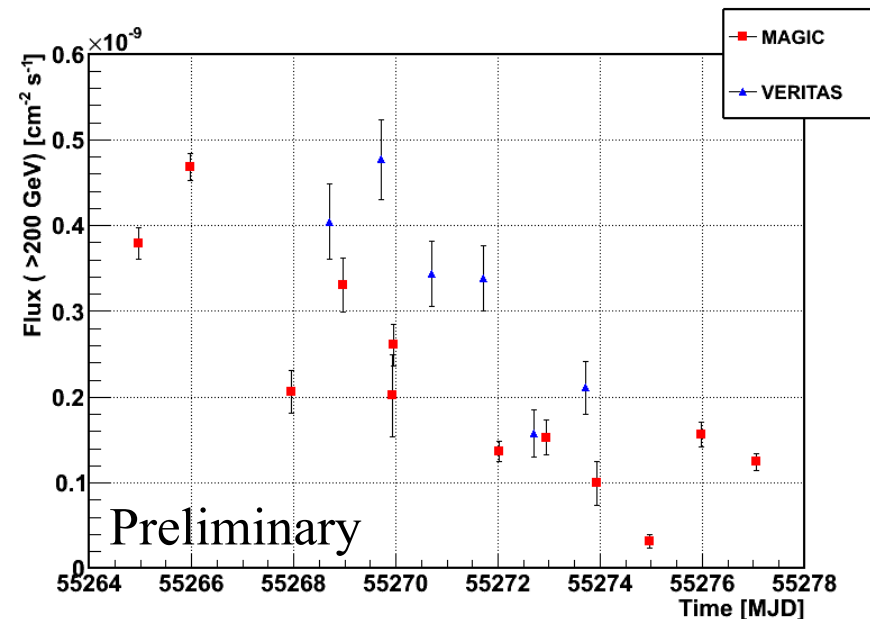
## Multi-year / MWL campaign on-going

→ Unprecedented amount of data to understand the system

- Several flaring episodes:
  - 2008 published
  - 2010 analysis ongoing
  - 2013 → highest level in VHE

MAGIC, ATel#4976

- Also low state (steady) emission

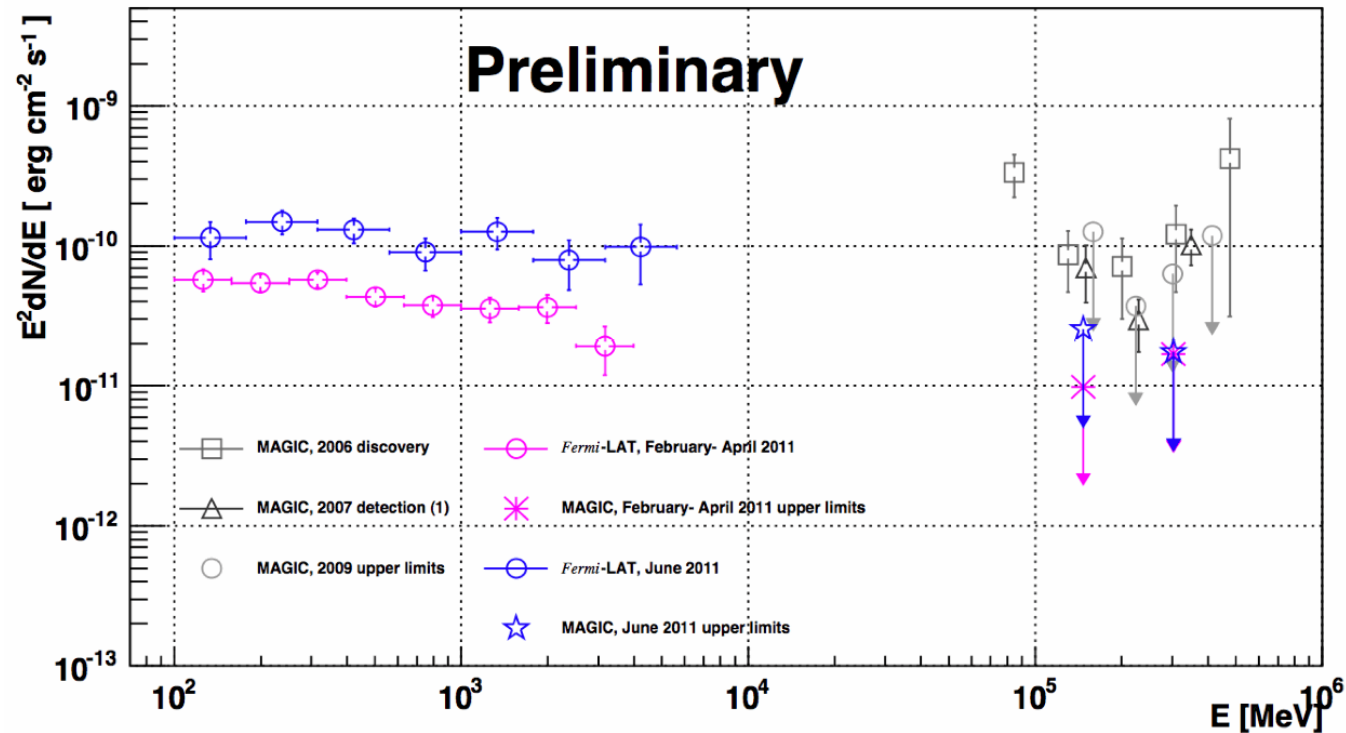


# FSRQs

**3c 279**

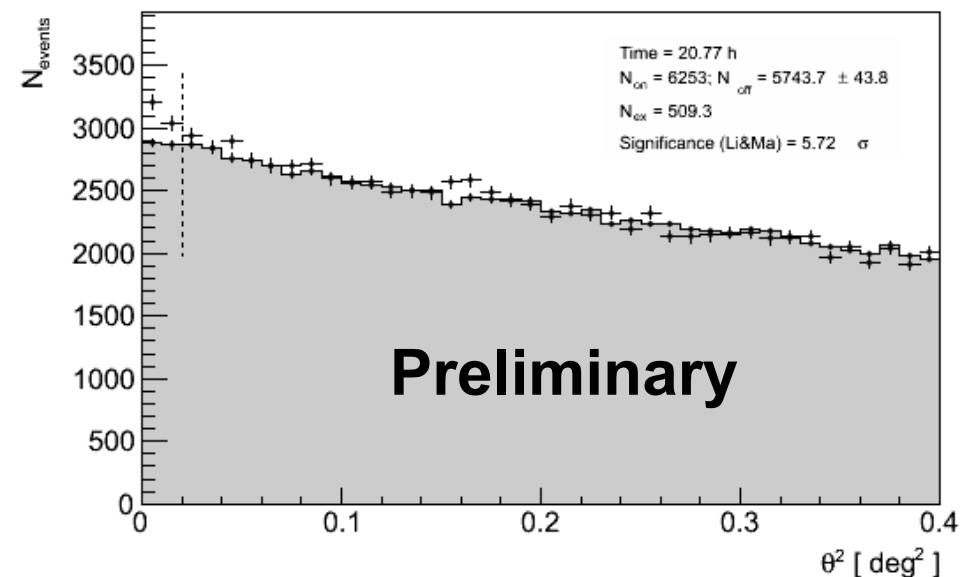
- Discovered in VHE by MAGIC in 2006
- Seen again in 2007
- Monitoring and ToO in 2011

Upper limits below previous detections



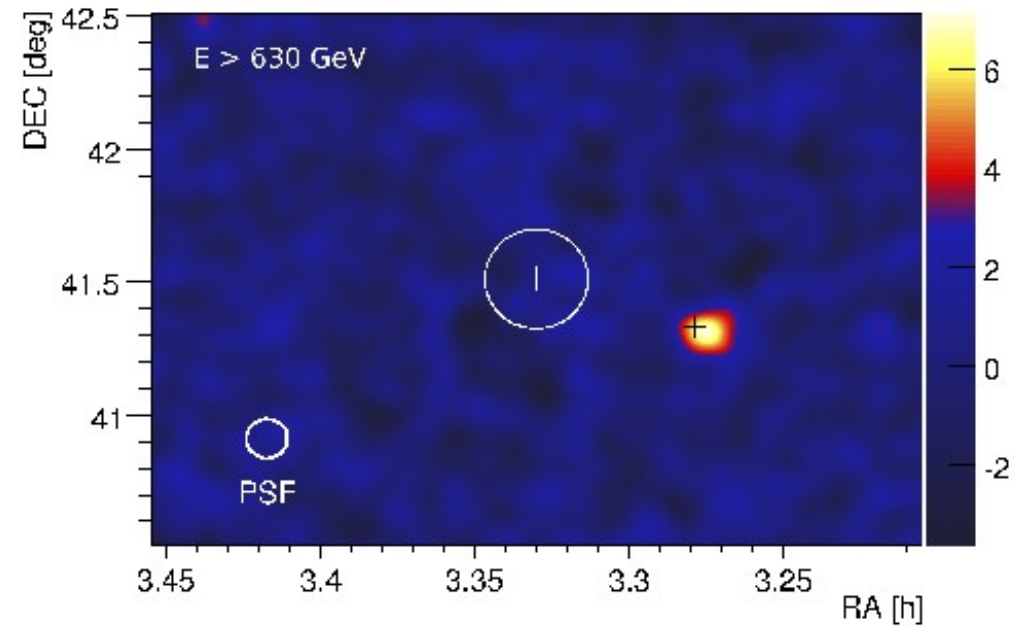
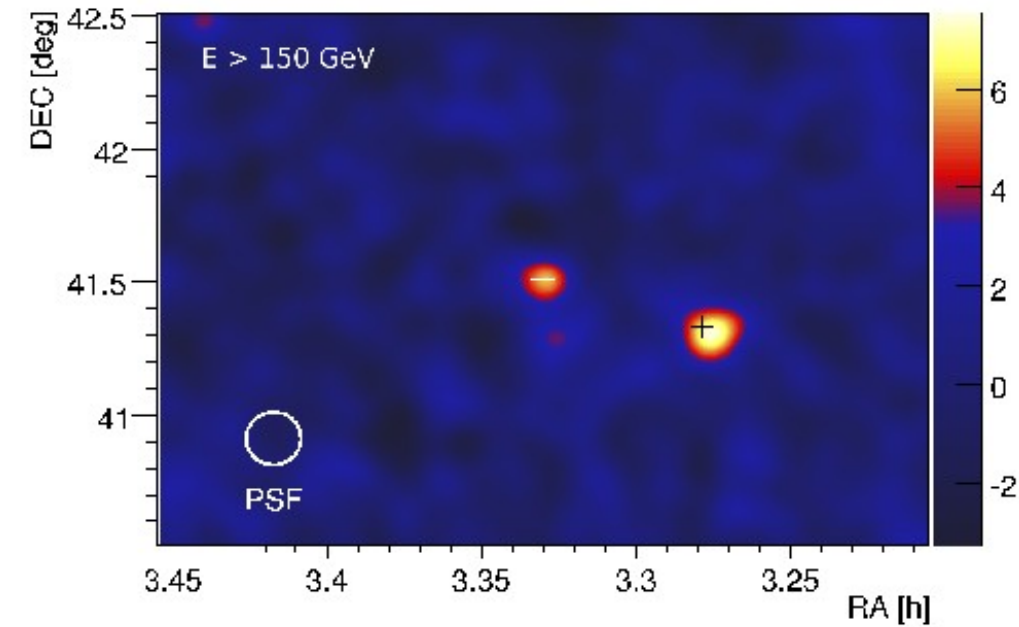
**PKS 1510 -089**

- Discovered in VHE by HESS in 2009
- MAGIC observations (Feb-Apr'12) triggered by Fermi/LAT
- 21 hours  $\rightarrow 5.7 \sigma$



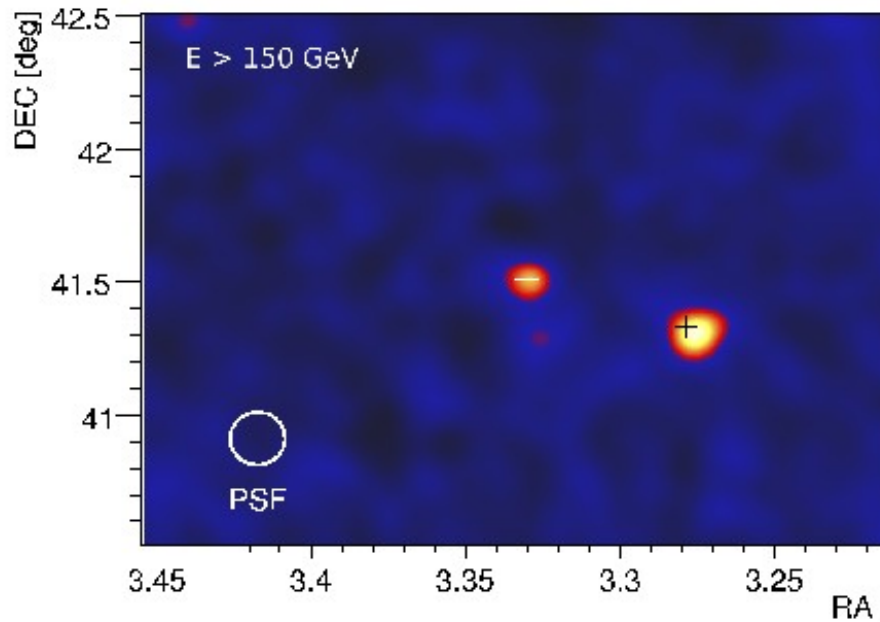
# Perseus cluster

Perseus is the brightest cluster of galaxies in X-rays



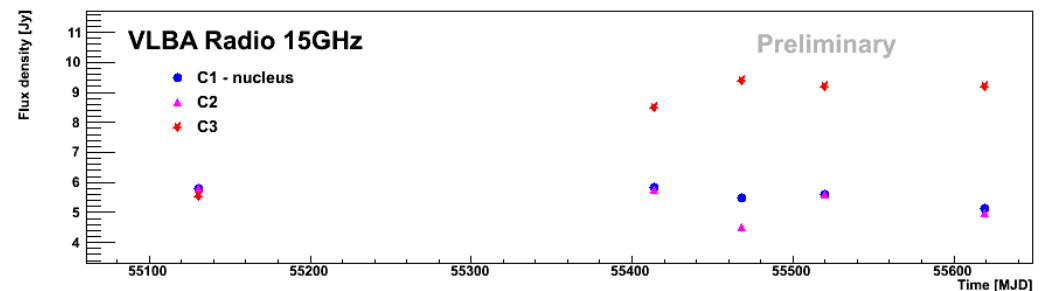
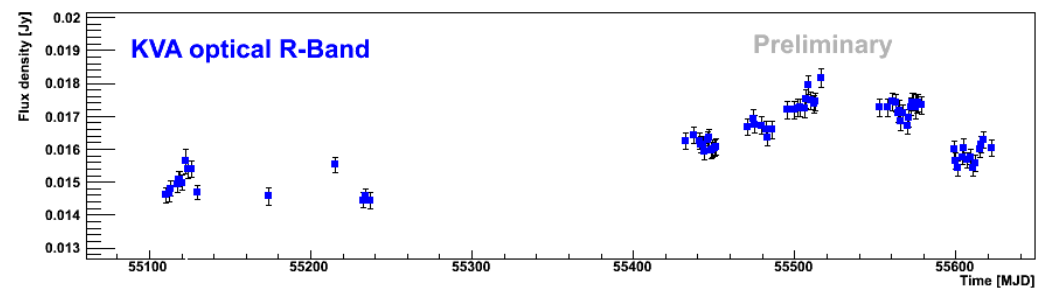
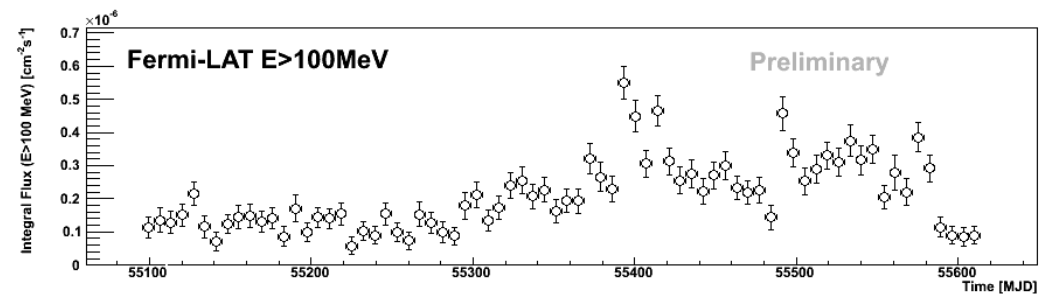
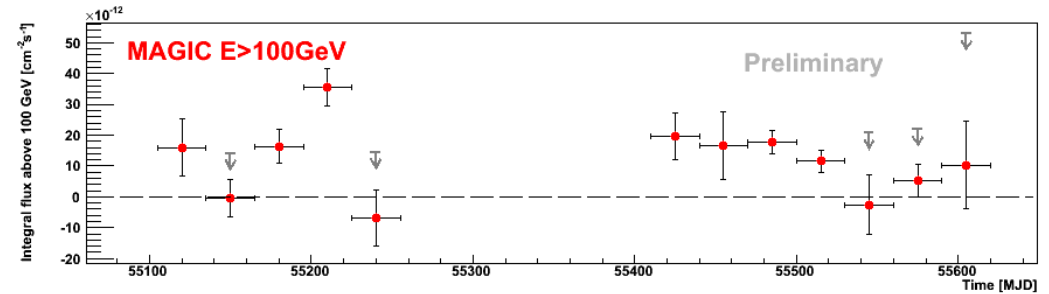
# Perseus cluster

Perseus is the brightest cluster of galaxies in X-rays



**NGC1275**

- Dominant central galaxy of Perseus
- Spectrum with MAGIC
$$\Gamma = 4.1 \pm 0.7$$
- MAGIC light curve, with MWL



# Perseus cluster

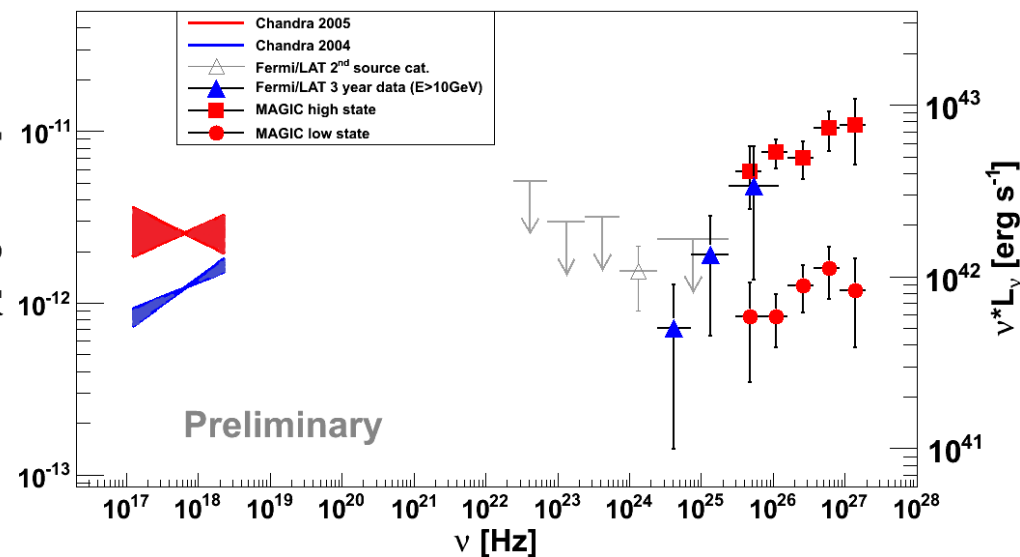
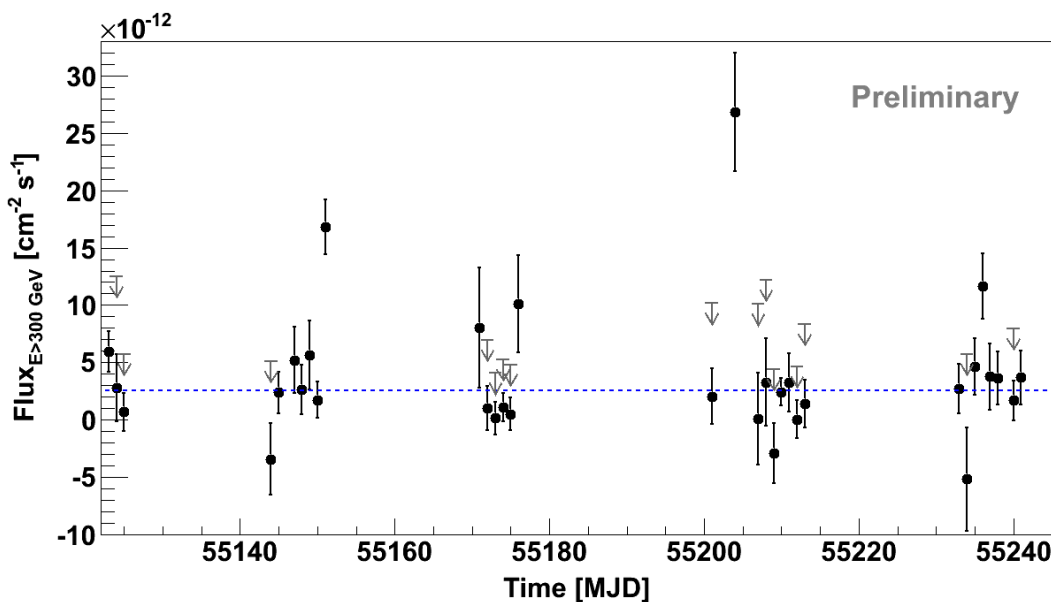
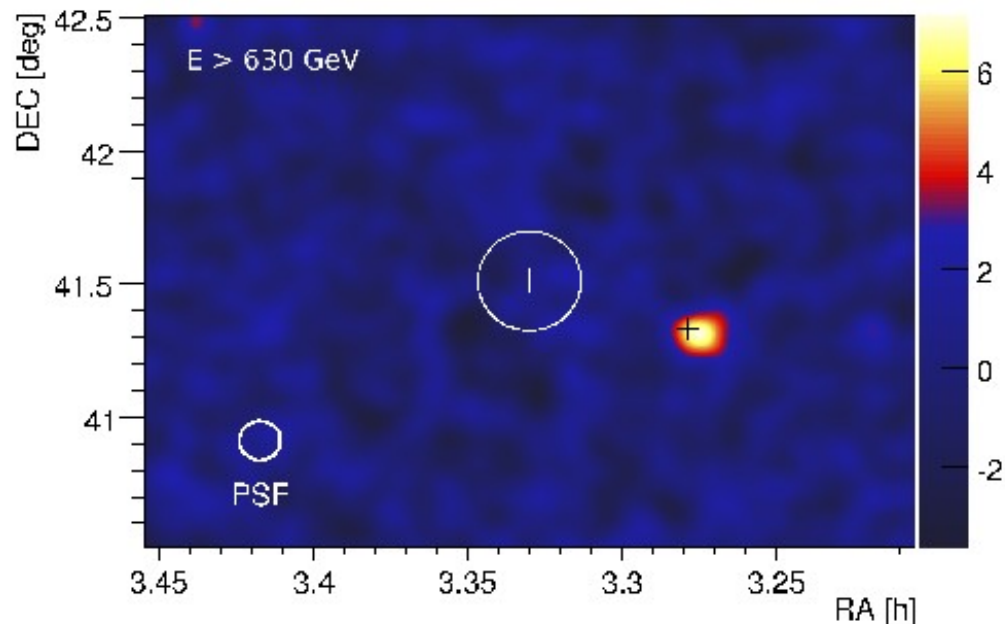
Perseus is the brightest cluster of galaxies in X-rays

**IC 310**

- Originally classified as “head - tail”
- VHE spectrum very hard  
 $\Gamma = 1.8 \pm 0.1$
- Day scale variability, new flare in Nov'12

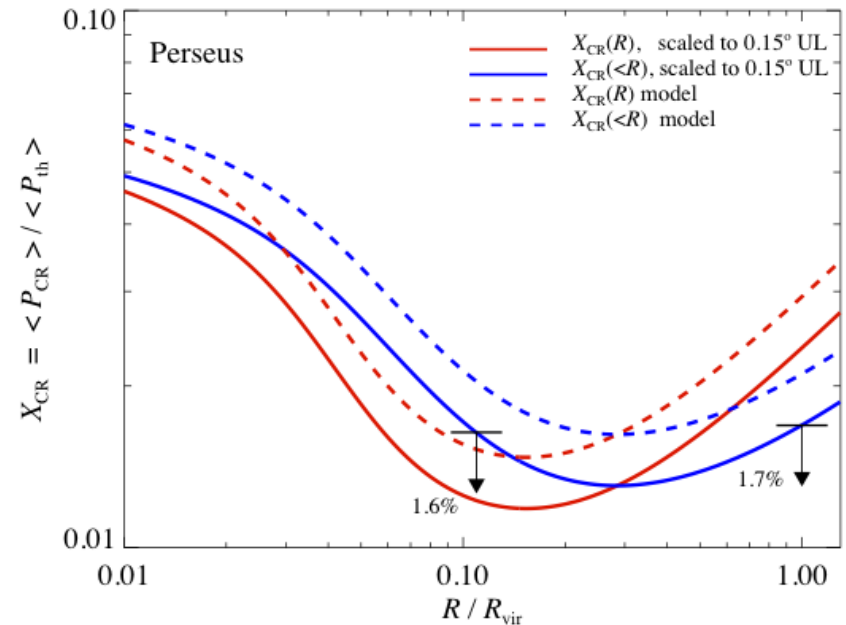
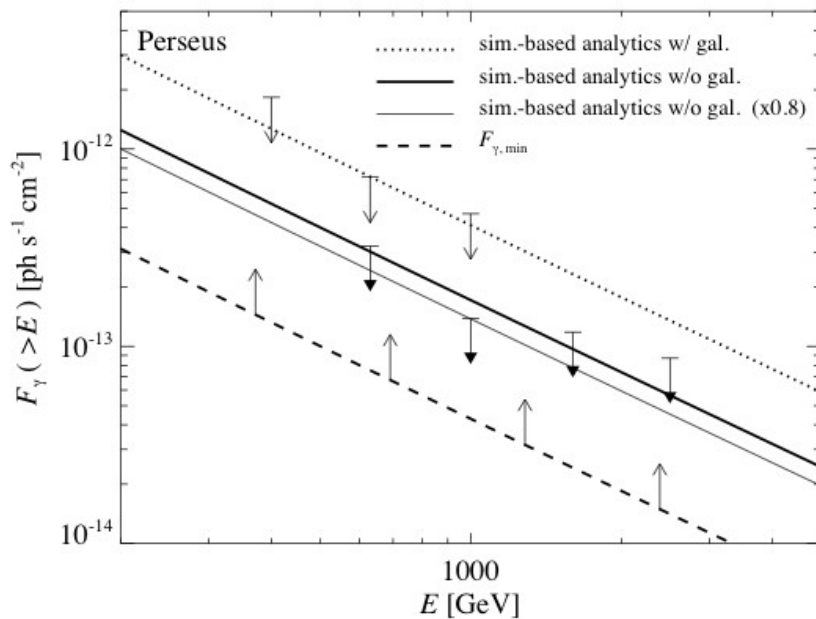
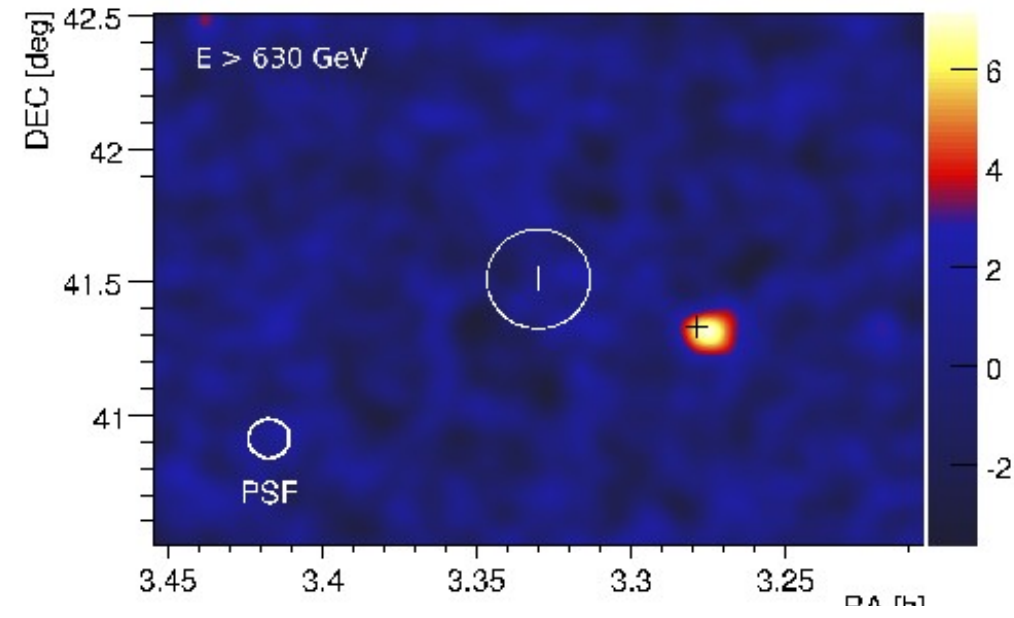
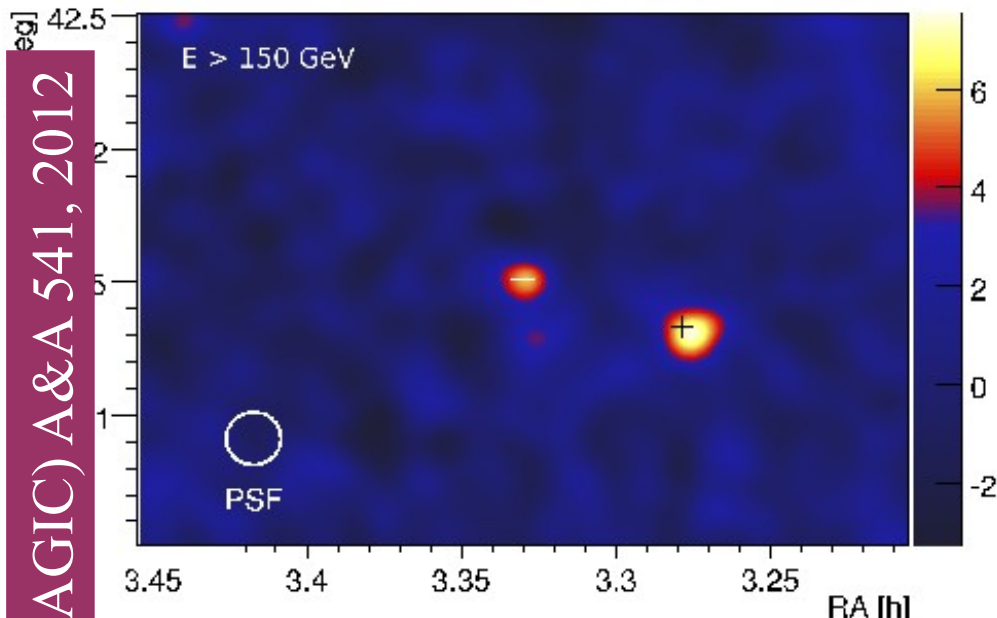
MAGIC, ATel#4976

MAGIC data supports blazar-like



# Perseus cluster → Cosmic Rays

Perseus is the brightest cluster of galaxies in X-rays



# Summary

- Improved imaging capabilities for **extended sources**:  
W51, HESS 1857+026
- Thanks to low energy threshold,
  - The best **pulsar detector above 25 GeV**: Crab Pulsar
  - Unique instrument for energy **overlap with Fermi/LAT** data: Crab Nebula
- MAGIC is a superb instrument to discovery and study **distant and close-by AGNs** at VHE gamma-ray
- Very relevant information on **Fundamental physics**
  - Deep Perseus observations
  - Dark matter searches
  - Lorentz Invariance and EBL
- After the major upgrade, a highly performance instrument with stable operation for the **next 5-10 year**

**The end**