



Results from MAGIC and the (near?) future

Adrian Biland, ETHZ
MAGIC-Collaboration

CHIPP 2007

PSI, Oct. 16.



Major Atmospheric Gamma-ray Imaging Cherenkov Telescope

Roque de los Muchachos, Canary Islands, 2200m a.s.l.

~150 Physicists, **22** Institutes, 9 Countries

IFAE Barcelona, UAB Barcelona, U Barcelona,
Humboldt U Berlin, IAC Canarias, UC Davis,
U Dortmund, U Lodz, UCM Madrid,
MPI Physik München, U/INFN Padua,
U Siena/INFN Pisa, INR Sofia,
Tuorla Observatory,
U Udine/INFN Trieste,
U Würzburg,
Yerevan Phys.Inst.
ETH Zürich

ICREA Barcelona, IAA Granada,
INAF Italy, DESY Zeuthen

Start of construction: 2001

Inauguration: October 2003

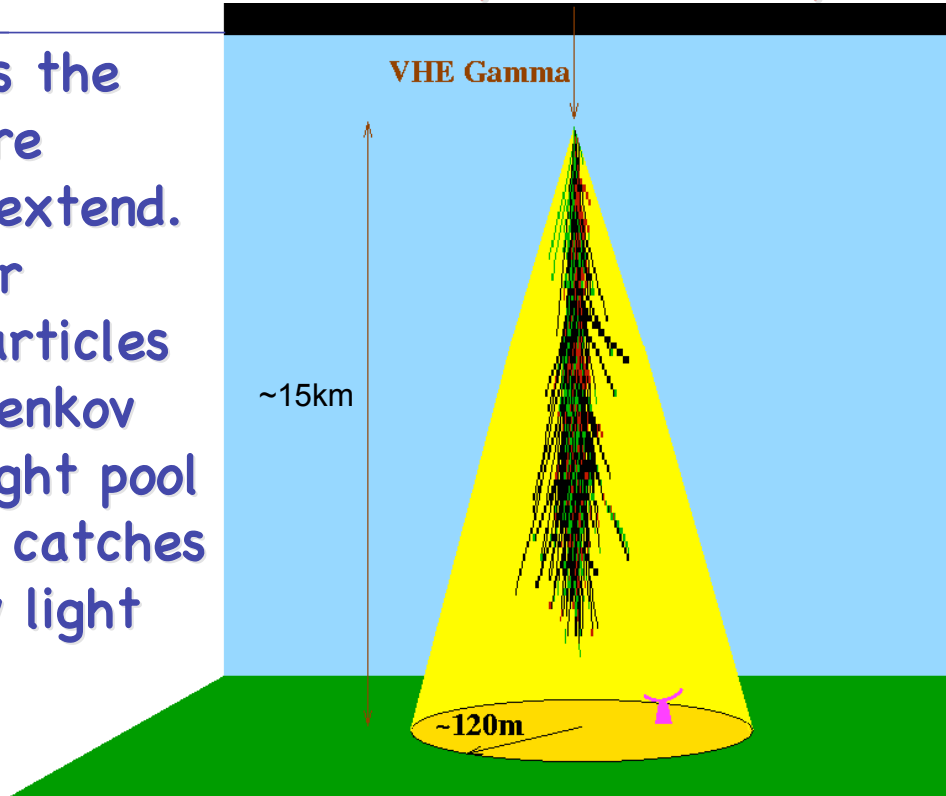
Start regular data taking: Sept. 2004





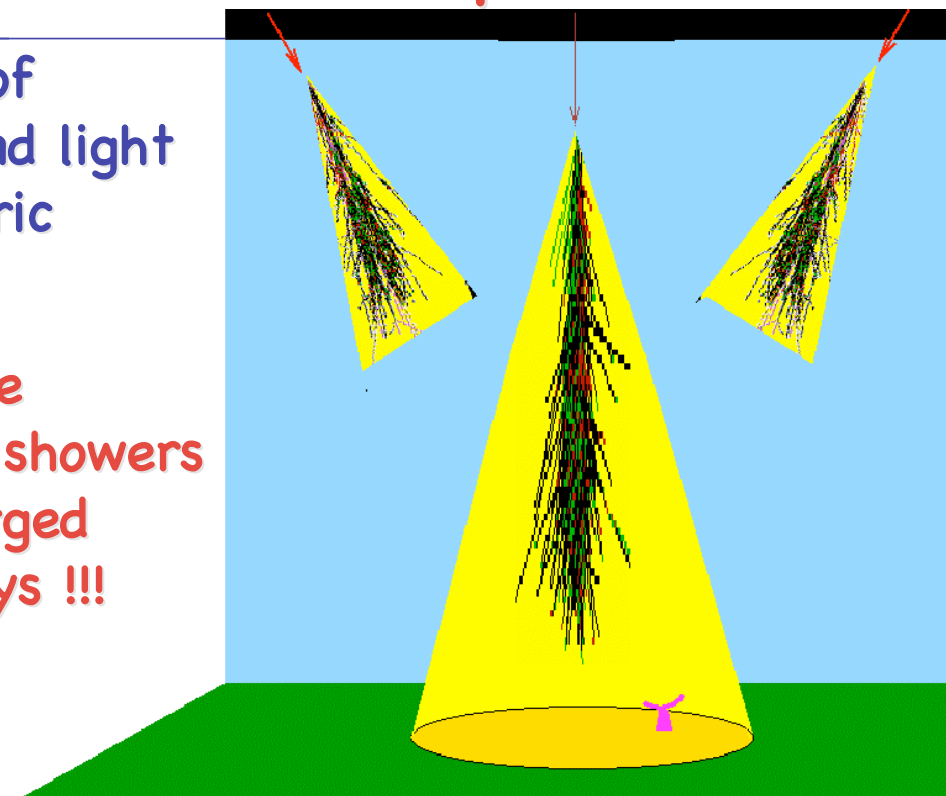
Cherenkov Telescope Principle

- VHE γ hits the atmosphere
- produces extend. air-shower
- shower particles emit cherenkov light \Rightarrow light pool
- telescope catches cherenkov light



Cherenkov Telescope Problems

- all kinds of background light
- atmospheric conditions
- much more abundant showers from charged cosmic rays !!!





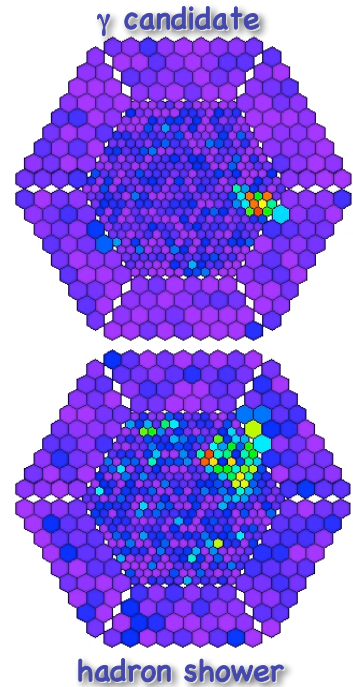
Imaging Technique

electromagnetic and hadronic showers have different shapes

====>

using a high resolution Camera allows to distinguish (statistically) between γ - and hadron-showers

Works excellent > 100 GeV
but very difficult < 100 GeV



MAGIC Telescope

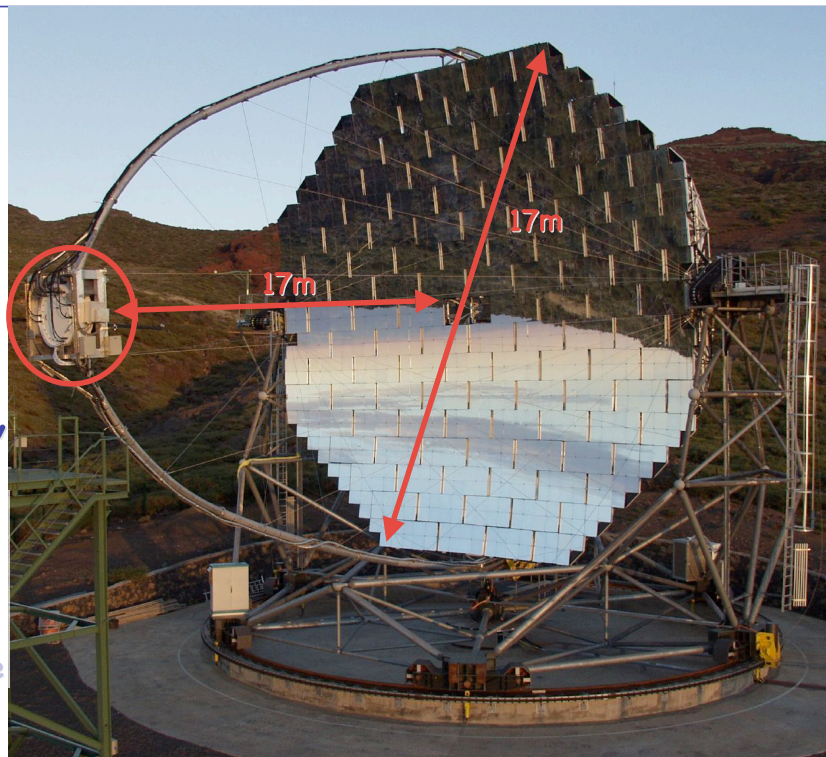
Mirror:

17m (234m²), f/d=1
parabolic shape
formed from 964 0.5x0.5m²
spherical Al-mirrors

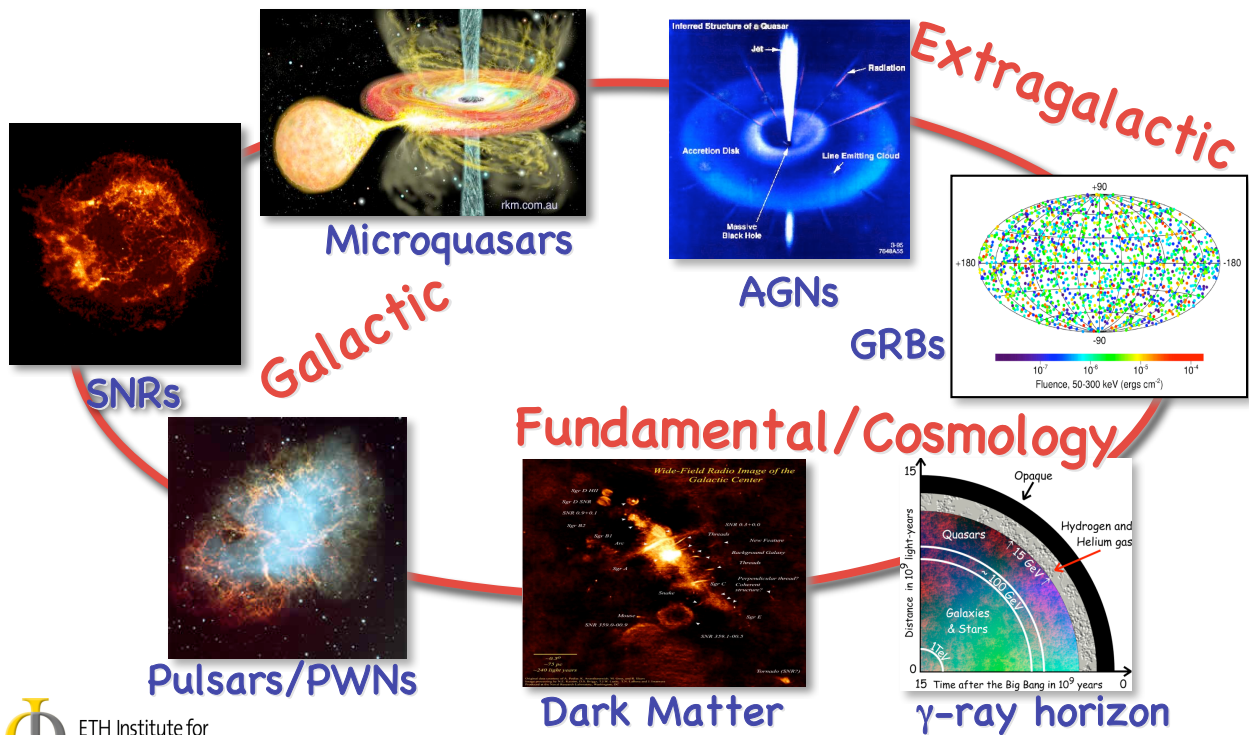
Camera:

576 high QE PMTs,
FoV = 3.5°,

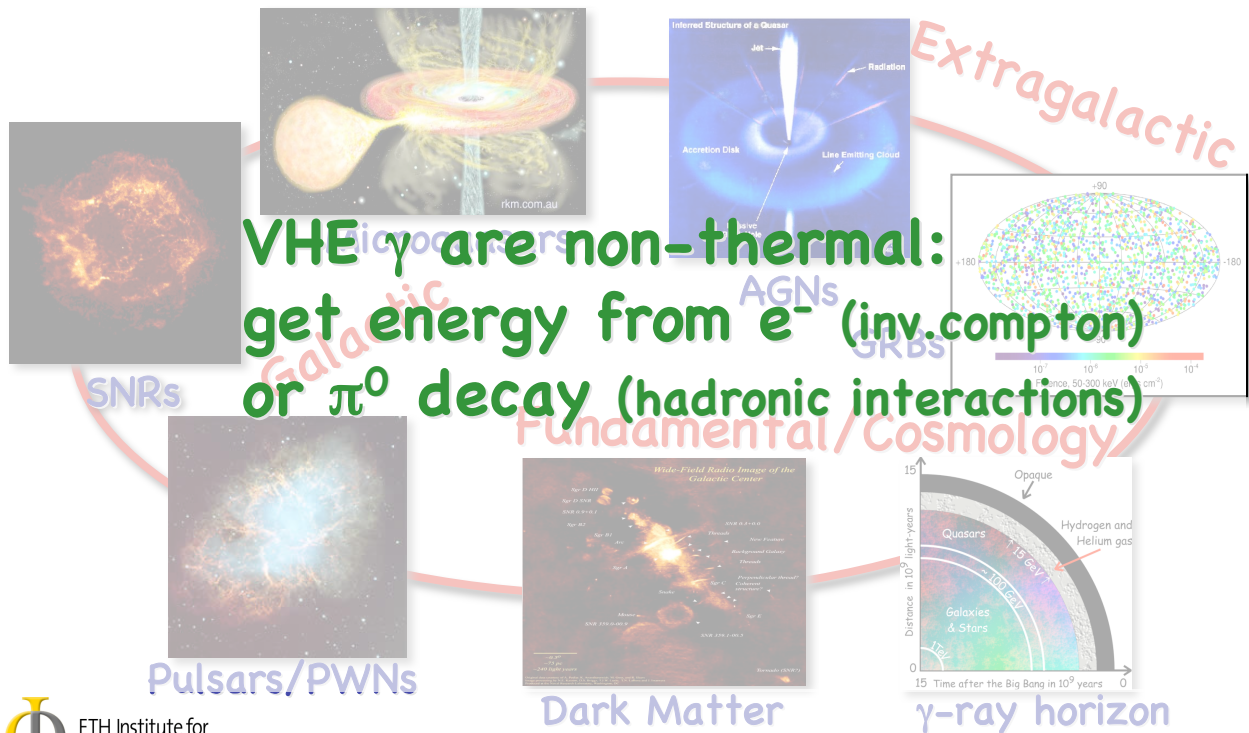
2 GHz FADC
analog fibre readout ;
+50% sensitivity
(better γ/h separation)



Some Physics Objectives



Some Physics Objectives

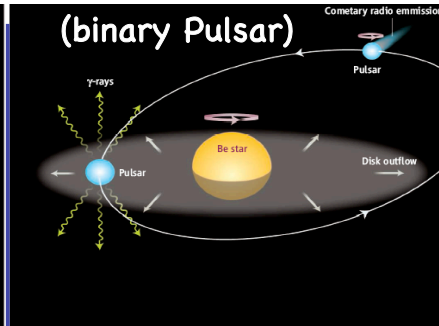
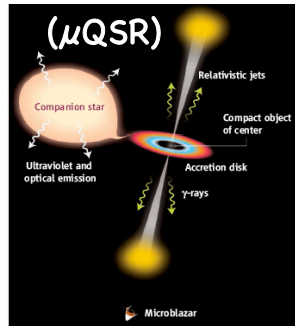




Galactic: Binary Systems

Several VHE-sources known; all have $m \sim 1.3 M_{\text{sun}}$
 \implies don't know if Neutron-Star or Black Hole
 \implies VHE emission Quasar-like or Plerion-like ?

e.g: LS I +61 303
Science 312:1771-1773
60 citations in SPIRES



Acceleration in the relativistic jet ?

Interaction between Pulsar-wind and stellar atmosphere ?



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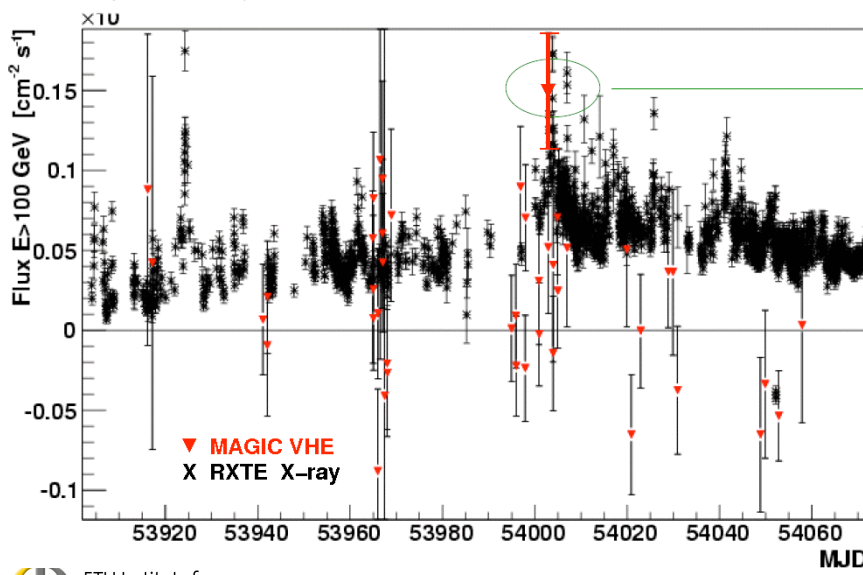
Galactic: Binary Systems

Cygnus-X1:

arXiv:0706.1505

Dense partner sure to be a BH: $m \sim 10M_{\text{sun}}$

Lightcurve of Cyg X1, measured by RXTE and MAGIC



MAGIC: 4.7σ

(4.1σ after trials)
in coincidence with X-ray flare \implies

first indication for VHE from 100% stellar BH (μ -Quasar)



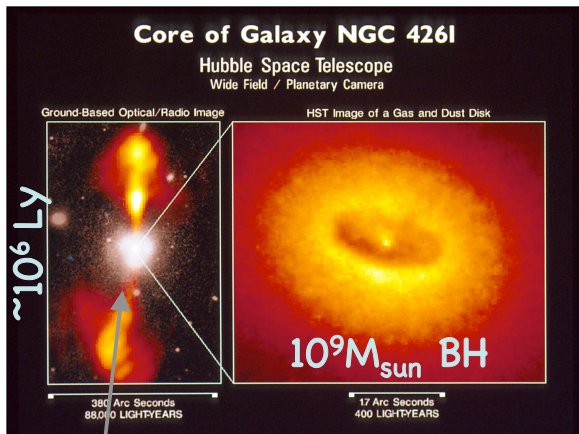
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Extragalactic: BL Lacertae



'BL-Lac': subclass of AGN with line of sight directly along the jet axis

So far, all BL-Lac type AGNs found in VHE (all extragalactic sources but M87) belong to the so called 'HBL'-subclass

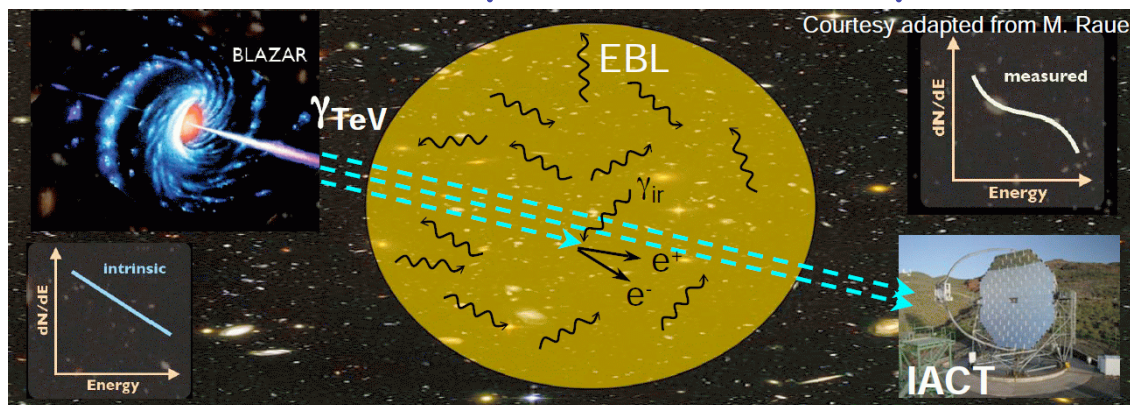
BL Lacertae (BL-Lac name-giving) belongs to the far more abundant 'LBL'-subclass
5.1 σ MAGIC detection (flux change >factor 2 in 2005/06)
=>exist far more extragalactic VHE candidates

astro-ph/0702077



Extragalactic: High Redshift

Universe not transparent for VHE photons:



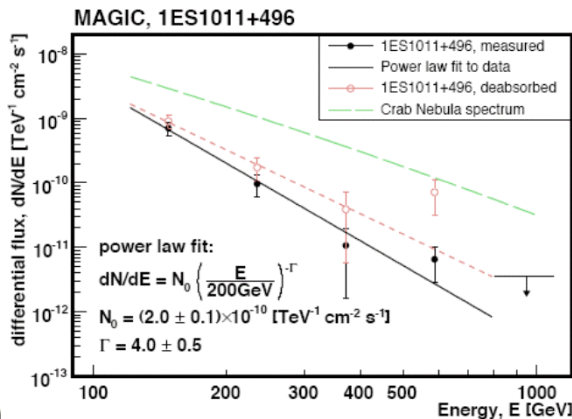
100 GeV ... 100 TeV: pair production with IR (extragalactic IR: difficult to measure; lower limit from galaxy count; unknown contribution from 1st pre-galactic stars)





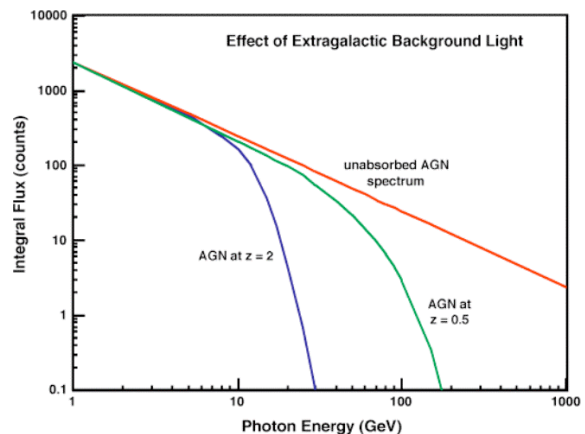
Extragalactic: High Redshift

Extracting IR-density from high-z VHE sources important input to cosmology



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MAGIC detection:
VHE from 1ES1011,
 $z=0.21$ arXiv:0706.4435
 (world record was $z=0.186$)

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Extragalactic: High Redshift

Results from HESS and MAGIC indicate that total amount of extragalactic IR rather close to lower limit from galaxy count

==> protogalaxies first, stars later ?

(or pre-galactic stars completely different emission spectra:
 e.g. because DM dominated)



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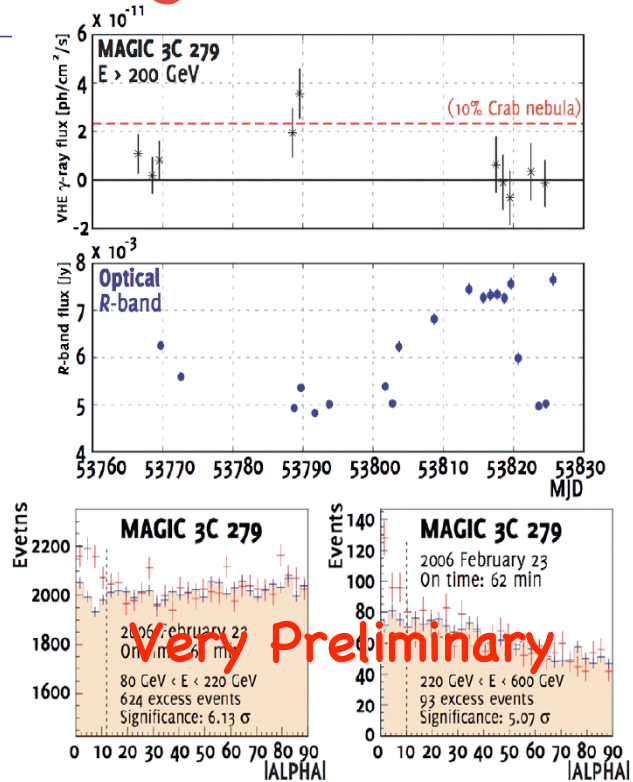
Extragalactic: High Redshift

Very Preliminary:
Indication for VHE
flare seen from AGN
3C279 ($z=0.536$!)

close to VHE-horizon

If VHE > 500GeV seen:
major problem

- less IR than lower limit from galaxy count ?
- Lorentz Violation ?



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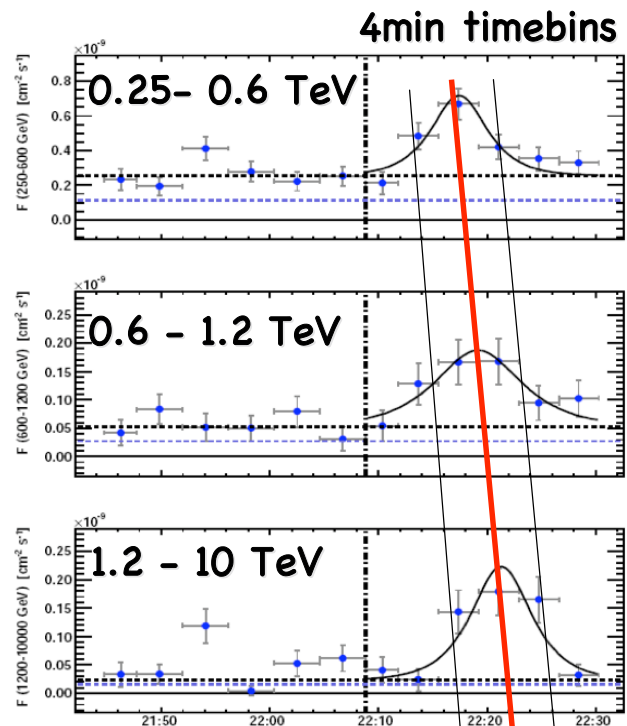
Extragalactic: Low Redshift

Mkn-501: very short
flare seen by MAGIC
(shortest variability of all
AGNs in all wavelengths !!!)
⇒ tiny emission region

astro-ph/0702008

Indication for energy
dependent arrival time

- acceleration ?
- emission ?
- transport ?



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Extragalactic: Low Redshifts

Assuming energy-independent emission time,
dispersion because of Quantum-Gravity effects

$$\Delta c/c = -E/M_{QG1} \quad \text{or} \quad \Delta c/c = -(E/M_{QG2})^2$$

$$M_{QG1} = (0.47^{+0.31-0.13}) 10^{18} \text{ GeV}$$

$$M_{QG2} = (0.61^{+0.49-0.14}) 10^{11} \text{ GeV} \quad \text{arXiv:0706.4453}$$

[but be careful with statistics of '1']

or 95% lower limits:

$$M_{QG1} > 0.26 10^{18} \text{ GeV} ; \quad M_{QG2} > 0.27 10^{11} \text{ GeV}$$

much better than any other measurement

(assuming the observed time-shift to be source
intrinsic, the lower limits would get higher)



VHE Status

General remark:

doing *observations*, not *experiment*

interesting results from transient sources:

inpredictable occurrence; no (reliable) trigger

==> serendipity detections;

increasing observation-time does not
automatically improve result

Must increase sensitivity !!!!





Near Future

- MAGIC data-taking and analysis going on
- construction of 2nd telescope started

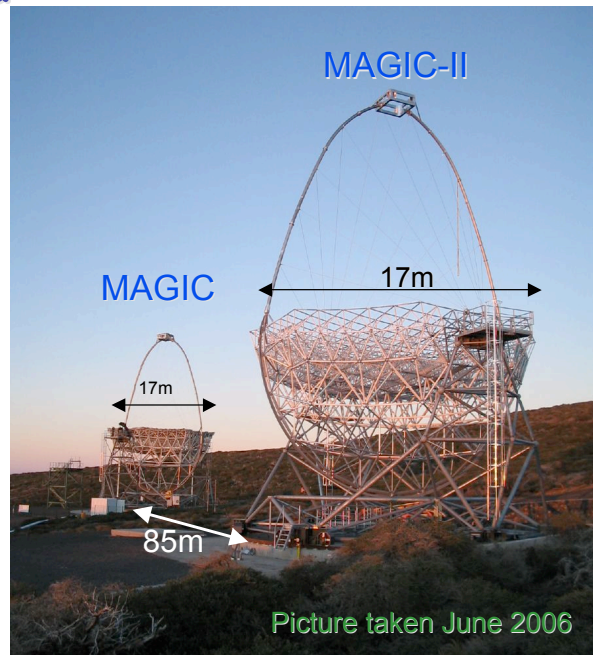
ETH responsible for [improved] AMC
 DAQ based on DOMINO-Chip from PSI

==> stereo observations

==> sensitivity +100%

(goal: Inauguration Sept.2008)

- also: HESS (HESS-II), CANGAROO, VERITAS... GLAST



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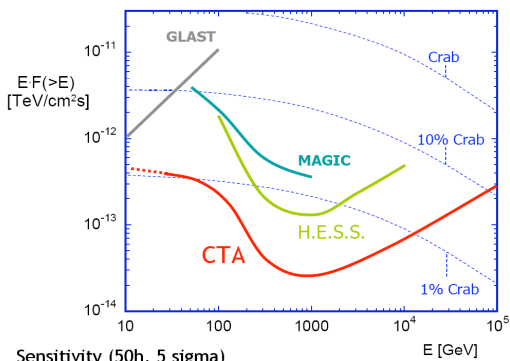
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Not too far future

CTA: pan-european initiative to increase sensitivity and energy coverage



Sensitivity (50h, 5 sigma)

O(100) telescopes



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Adrian Biland: Results from

ID	Short Name	1 MNG	2 PHYS	3 MC	4 SITE	5 MIR	6 TEL	7 FPI	8 ELEC	9 ATAC	10 OBS	11 DATA	12 QA	Total person month
1	MPG	108	54	90	21	33	147	96	129	24	0	6	24	732
2	CNRS	0	93	173	12	0	32	71	177	26	0	36	78	698
3	INFN	0	27	0	12	55	0	54	92	0	0	21	6	267
4	IFAE	0	6	12	0	0	0	0	0	90	0	6	6	120
5	IEEC	0	25	0	0	0	0	0	0	6	0	0	0	31
6	UErlangen	0	18	0	0	0	0	0	0	0	0	42	3	63
7	ULeeds	0	9	33	0	0	0	0	8	0	0	0	3	53
8	UTurku	0	0	0	0	0	0	0	0	0	36	0	0	36
9	CEA	0	0	18	0	0	0	0	54	0	0	0	0	72
10	OBSPARIS	0	24	15	15	0	0	45	0	0	0	20	0	119
11	DIAS	0	54	0	0	0	0	0	0	0	0	24	0	78
12	INAF	0	54	0	0	117	0	37	0	14	45	9	0	276
13	DESY	0	0	29	0	0	0	0	0	0	0	18	0	47
14	UBer	0	0	6	0	0	0	0	0	0	0	6	0	12
15	UHH	0	7	6	0	7	0	0	0	0	0	0	0	20
16	LSW	0	20	0	9	6	0	0	0	0	6	0	0	41
17	IAAT	0	9	0	0	54	27	0	0	0	0	0	0	90
18	UDurham	0	12	6	0	6	0	0	0	18	0	0	0	42
19	ETH Zurich	0	0	9	3	21	0	42	0	0	0	48	0	123
20	UNIGE	0	18	0	0	0	0	0	0	0	0	48	0	66
21	ON	0	0	0	0	0	0	0	0	15	0	0	0	15
22	UCM	0	6	6	0	0	0	26	0	6	0	0	0	44
23	UAB	0	12	0	0	12	0	0	0	8	0	0	0	32
24	UB	0	12	0	0	0	0	11	8	0	0	0	0	31
25	IPNP	0	0	0	0	6	0	0	0	0	0	0	0	6
26	NCAC	0	18	0	0	0	0	0	0	0	0	0	0	18
27	SRC	0	0	0	0	0	18	18	0	0	0	0	0	36
28	YerPhl	0	0	9	0	12	0	0	0	0	0	0	0	21
29	UvA	0	8	0	0	0	0	0	0	0	0	6	0	14
30	UU	0	6	0	0	0	0	0	0	0	0	0	0	6
31	NWU	0	18	0	0	6	0	0	0	0	0	0	0	24
32	WashU	0	0	6	0	9	0	0	0	0	0	0	0	15
33	StanU	0	11	6	0	0	0	0	0	0	0	0	0	17
34	UOXF.DL	0	0	6	0	0	0	0	0	0	0	0	0	6
Total		108	521	430	72	344	224	400	468	207	87	290	120	3271



Conclusion

very interesting time for VHE-Astronomy ...

stay tuned !!!

... or join the party



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