The MAGIC Telescope Project: MAGIC-I

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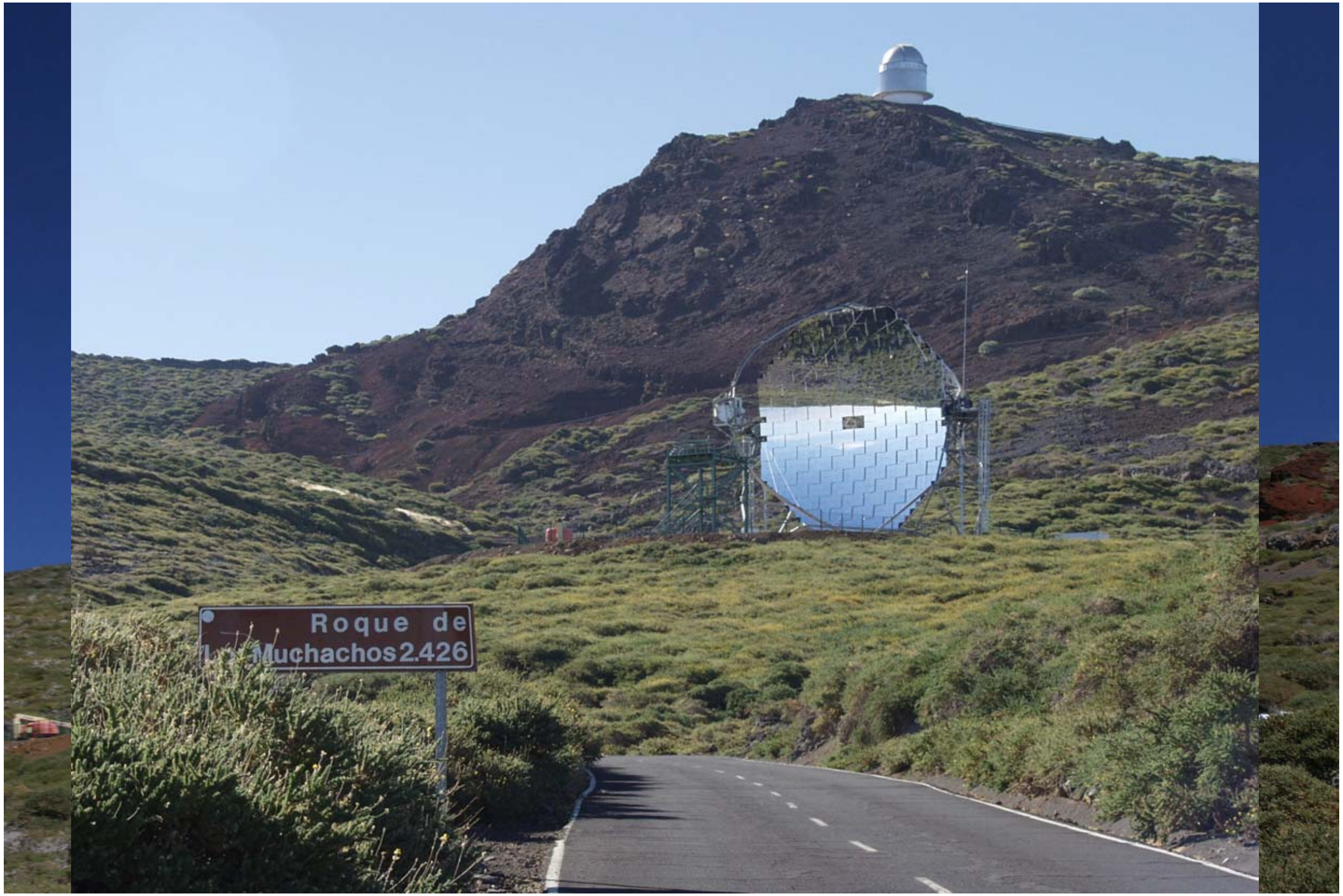
MAGIC-I: regular observations since fall 2004

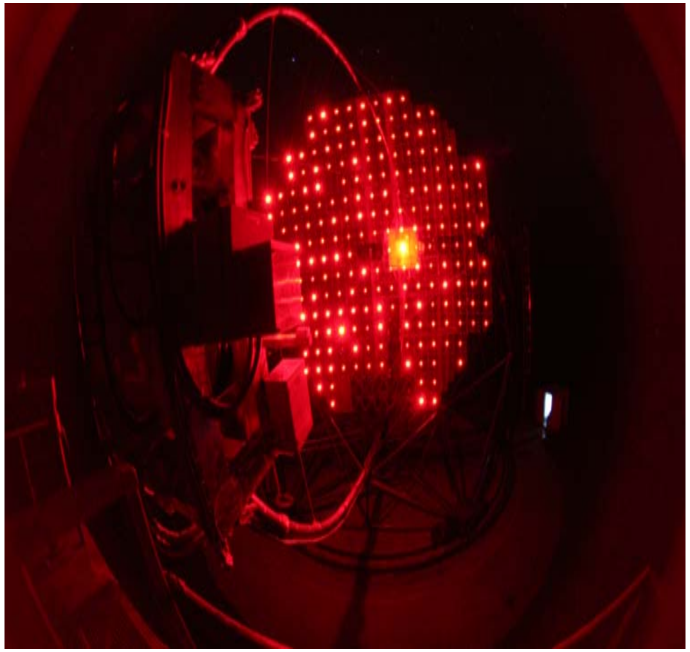


The MAGIC Collaboration

Major Atmospheric Gamma-Ray Imaging Cherenkov Telescope

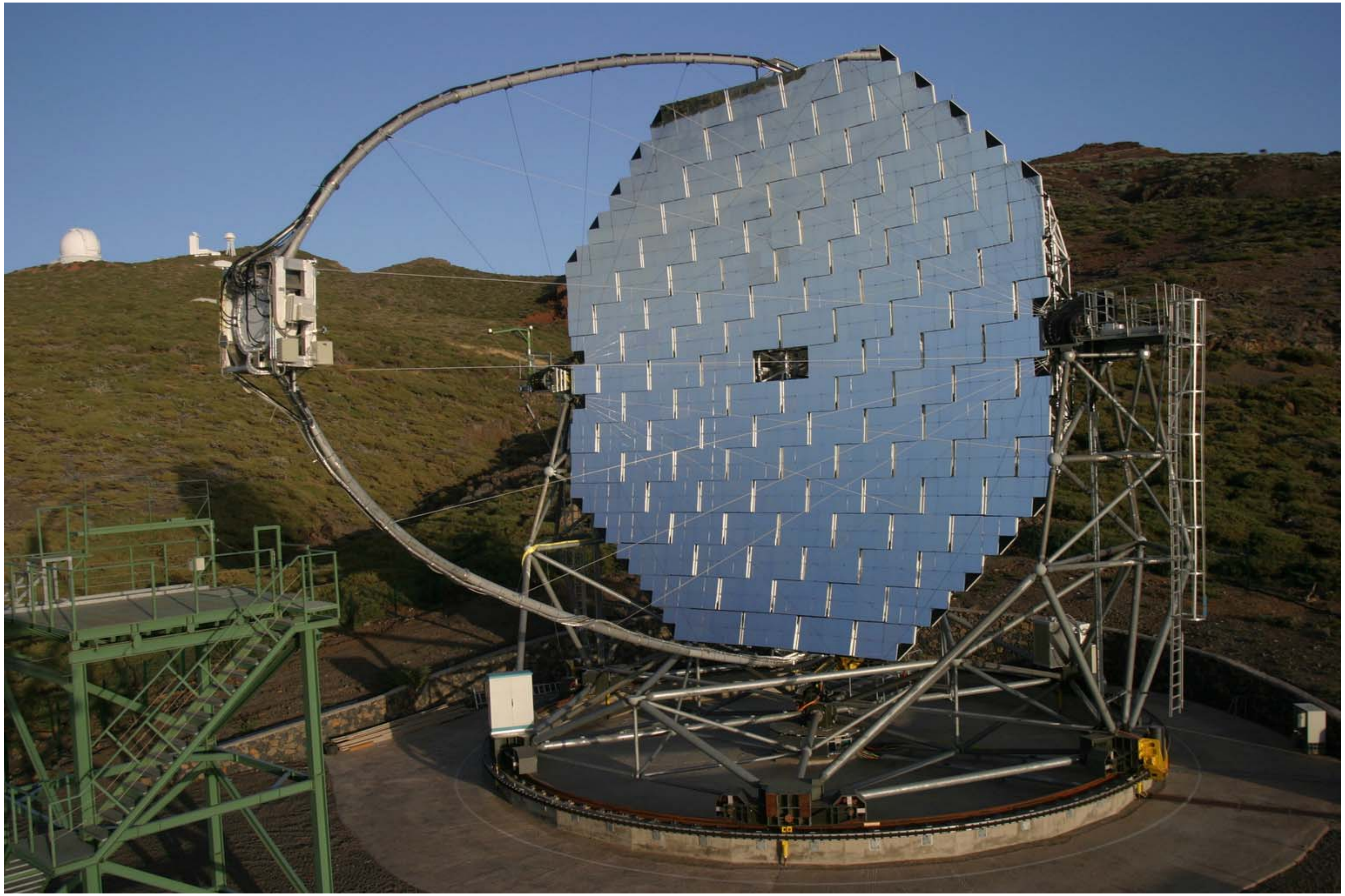
Barcelona IFAE, Barcelona UAB, Crimean Observatory, **U.C. Davis, U. Lodz, UCM Madrid, MPI Munich, INFN/ U. Padua, INFN/ U. Siena U. Humbold Berlin,** Tuorla Observatory, Yerevan Phys. Institute, **INFN/U. Udine, U. Würzburg, ETH Zürich, INR Sofia, Univ. Dortmund ?**

- MAGIC is an international collaboration of ~ 150 physicists operating a 17 m Cherenkov Telescope for observation of HE cosmic γ–rays.
- Main aim: to detect γ–ray sources in the unexplored energy range: 30 *(10)->* 250 GeV
- MAGIC is a challenging design to lower the energy threshold, by 1) increased **mirror size** 2) using of improved **optics, light sensors and electronics 3) using of advanced trigger, 4) ultra-fast readout**



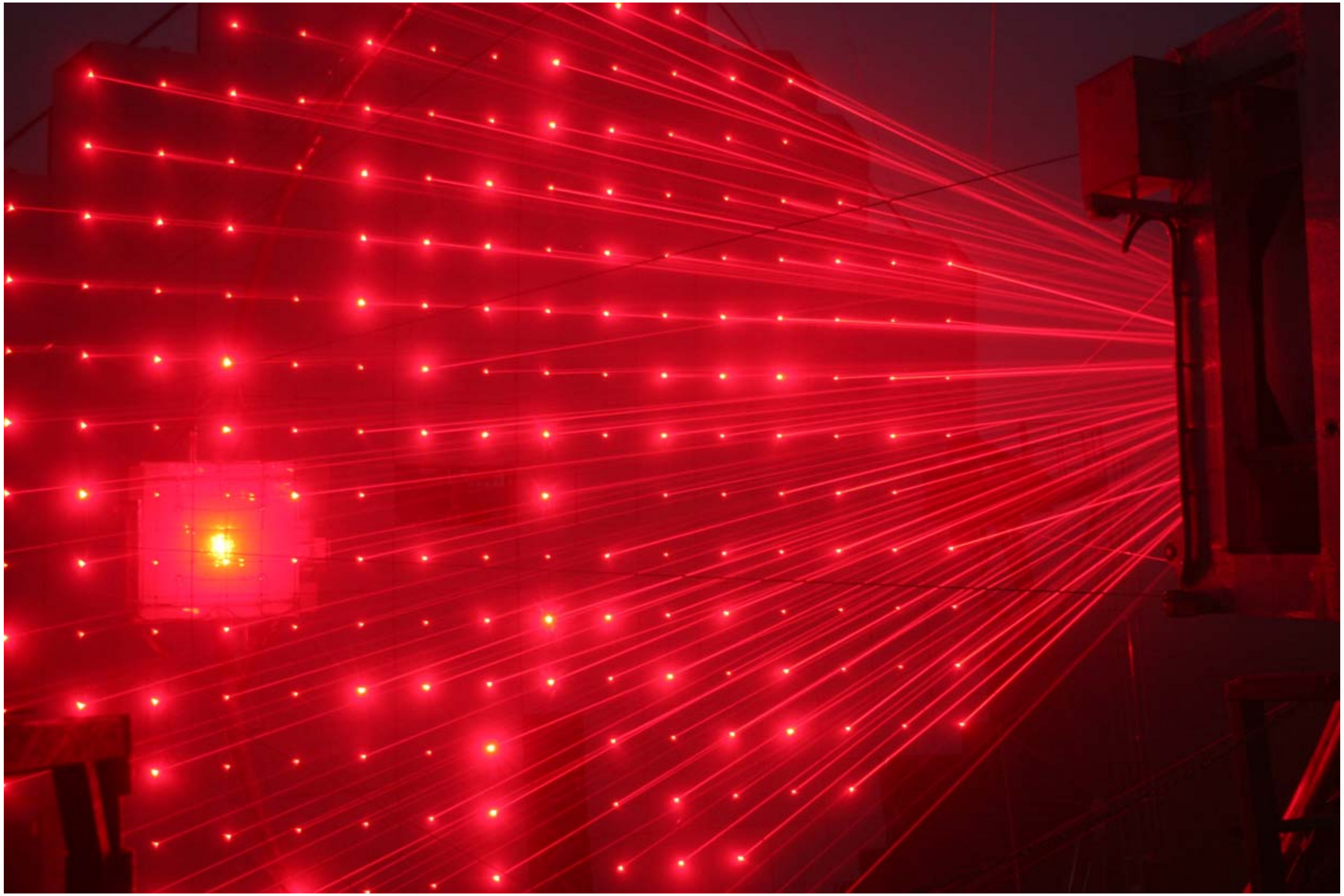
MAGIC aims for the lowest possible threshold for a Cherenkov telescope !

After upgrade of the optics in July 2004 the telescope is in its final shape



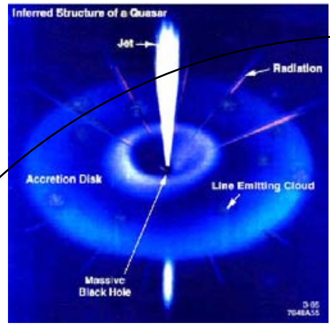
Because of the used mode of the active mirror control system and because of too optimised space left between the neighbour mirrors many of them were „touching“ each-other when moving

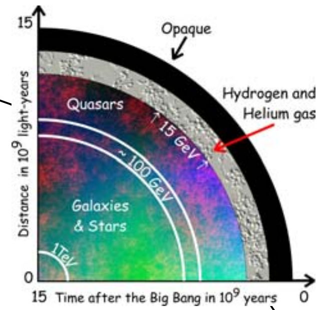
Dense fog (or a cloud) helps to visualize the Active Mirror Control laser pointer beams

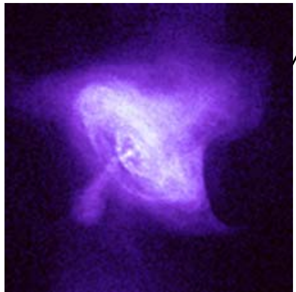


Photograph of the 576-pixel imaging camera of MAGIC-I. In the central part one can see the 396 high resolution pixels of 0.10° size. Those are surrounded by 180 pixels of 0.20°.

The MAGIC PHYSICS Goals

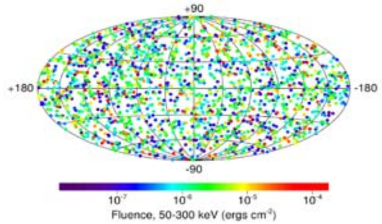


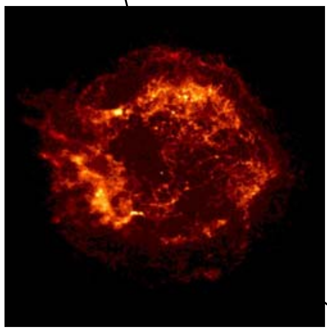


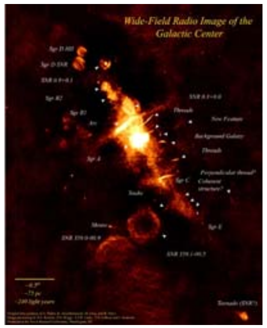


- AGNs
- Cosmological γ ray horizon
- Pulsars

Origin of Cosmic Rays



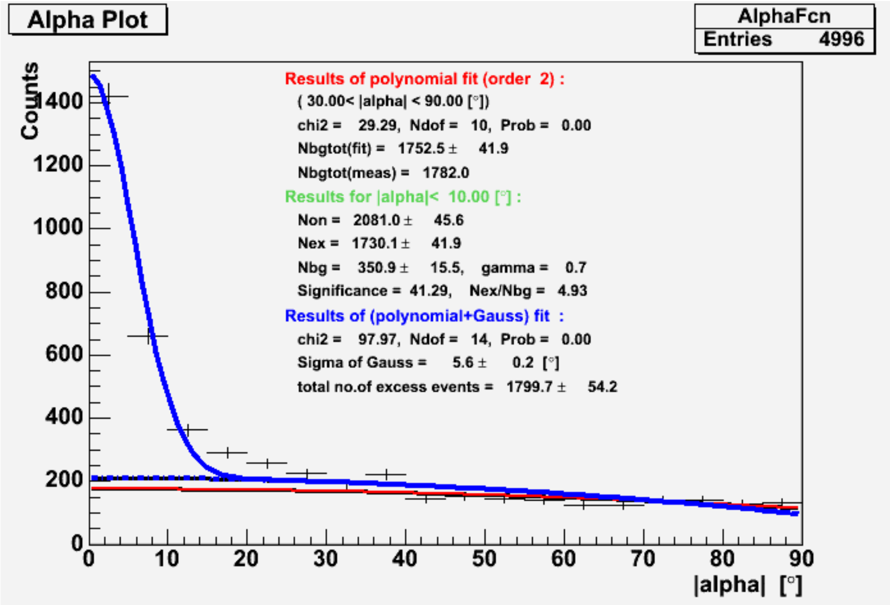




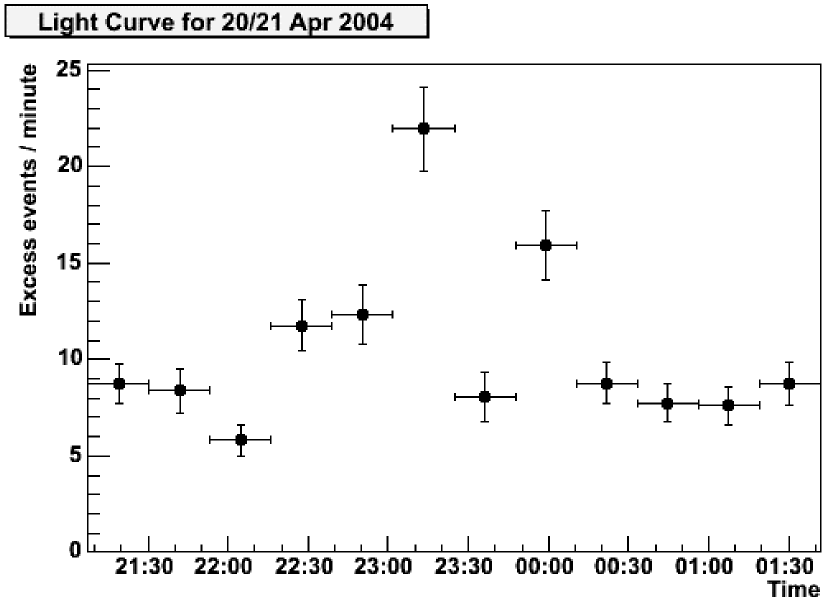
- GRBs
- Tests on Quantum Gravity effects
- Cold Dark Matter
- SNRs

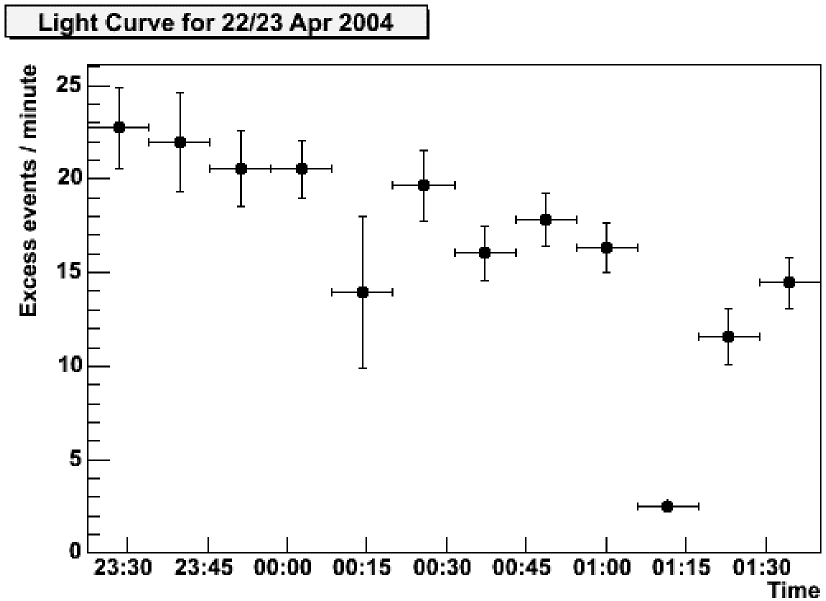
Sources observed in February-June 2004

Source	Hours	Events	Runs
1ES1426+128	1.51	994282	38
1ES1959+650	11.46	6399695	326
3EG1605+15	1.13	681680	39
3EG1727+04	4.21	2606361	115
3EG2033+41	10.50	6800354	339
3c279	17.67	9414296	511
Crab Nebula	10.25	6897274	1653
GRS1915	11.51	7137904	647
M87	0.23	97542	13
Mrk421	36.88	23752394	2455
Mrk501	7.47	4268800	201
PSRB1957+20	6.03	4296547	178
Offdata	70.12	39946768	3869

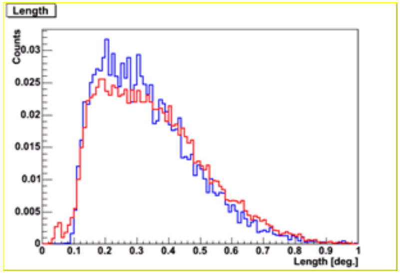


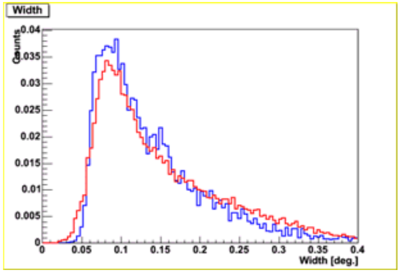
Observations of Mkn-421 outburst in spring 2004: very strong signals allowed us to measure the light curves. Signal doubling times as short as 10-15 minutes were measured.

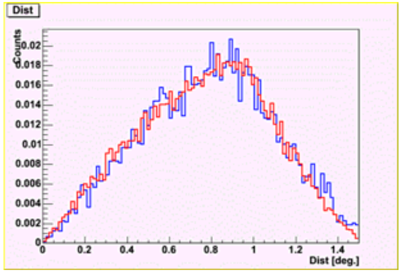


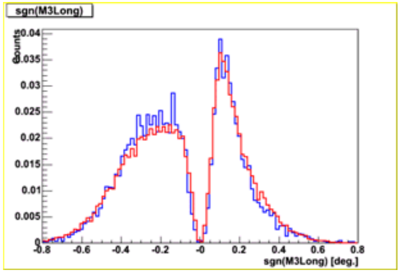


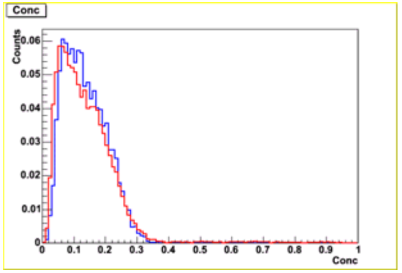
Comparison between the image parameter distributions from the Monte Carlo simulations and from the OFF-data for SIZE > 1300 photons.

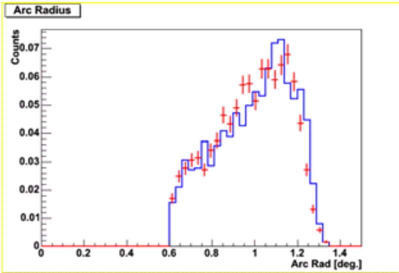


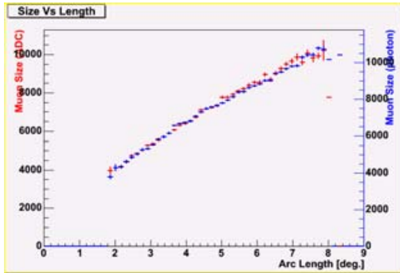


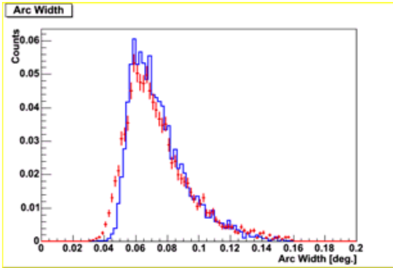


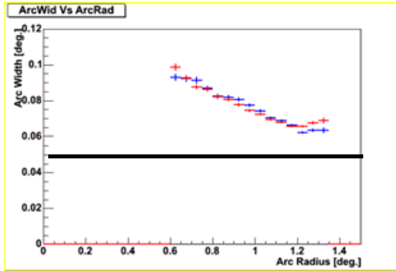










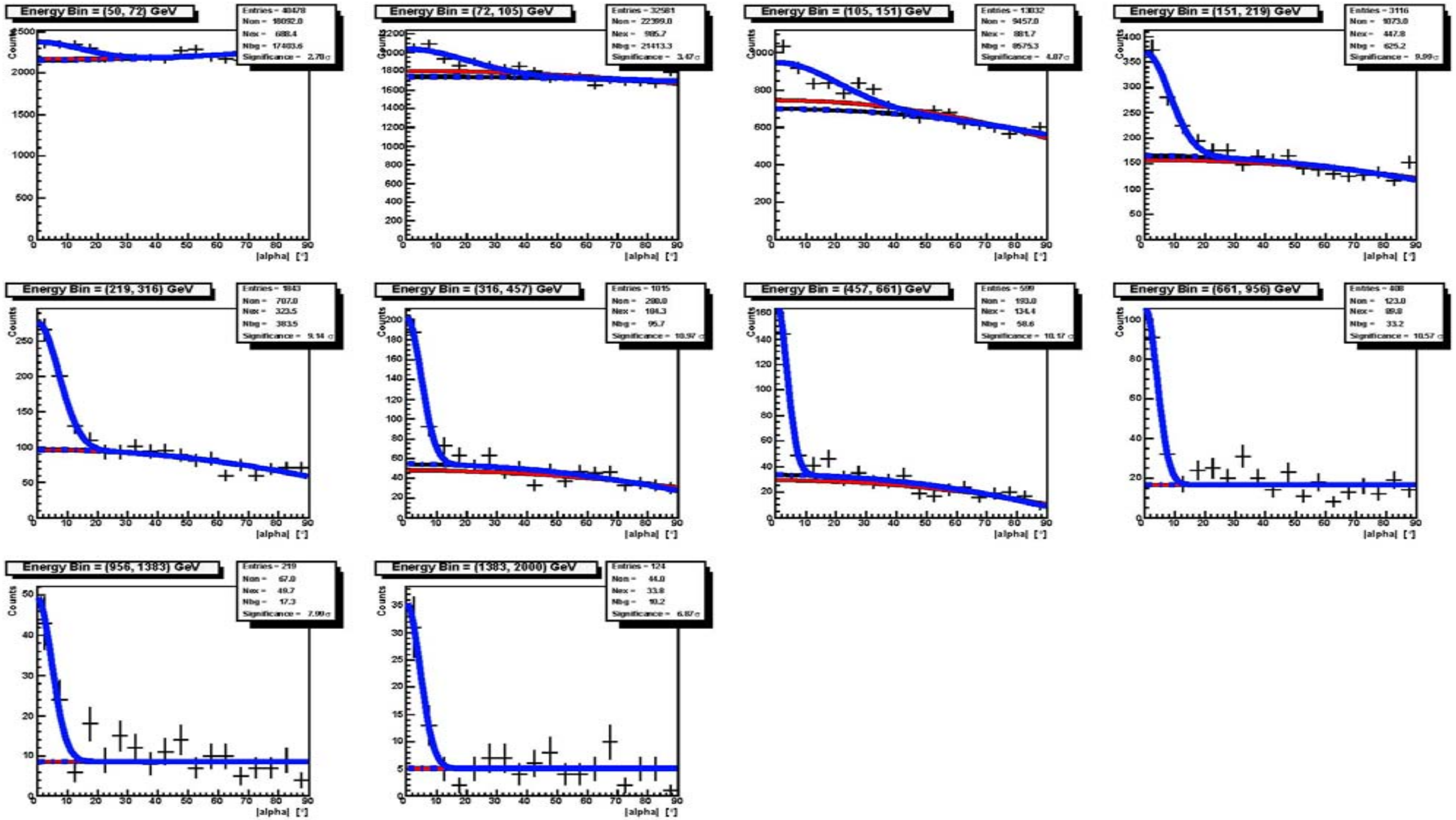


Distribution of number of μ- events on the arc radius (upper left) and dependence of SIZE on the arc length (upper right). Also are shown distribution of number of events on the arc width (lower left) and arc width versus its radius (lower right). Blue is Monte Carlo and red is data.

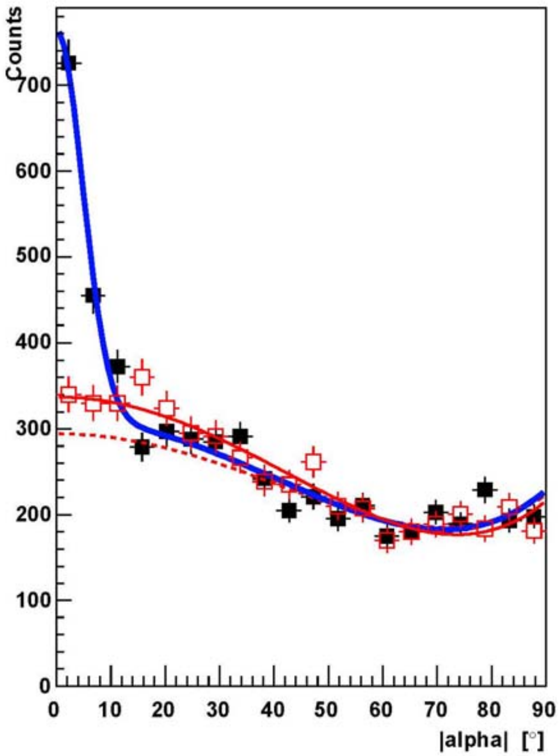
List of the observed sources after the July upgrade

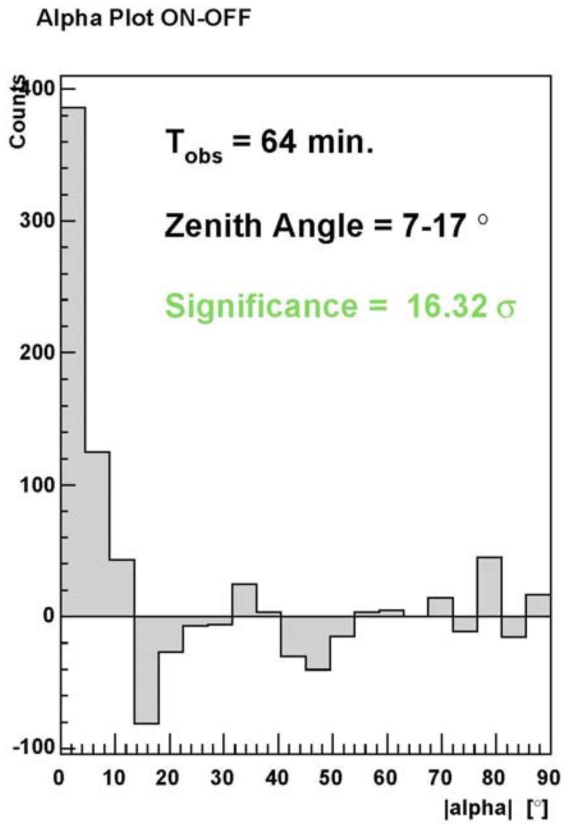
	August		September		October		Total
	Schedule[d]	Observed	Schedule[d]	Observed	Schedule[d]	Observed	Obs. Only
CRAB	7	4.2	35	14.3	33	5.4	23.9
PSRB1951	14	6.6	13	4.1	0		10.7
PSRB1957	0	0	0	0	28	7.1	7.1
SGR A*	0	0	3	2.4	0		2.4
1ES1426	2	0.3	0	0	0		0.3
1ES1959	0	0	4	2.6	14	4.2	6.8
3C66A	23	8.9	21	7.9	20	4.6	21.4
3EG1727	14	3.6	0	0	0		3.6
3EG2033	14	6.6	22	7	0		13.6
4C15.05	0	0	8	1.8	20	6.8	8.6
Mkn501	2	0.4	0	0	0		0.4
Offdata	50	17	28	7.6	27	8.1	32.7
Sub Total	126	47.6	134	47.7	142	36.2	131.5
Bad Weather		16		40		62	118
Tech Probs		26		25			51
Total	126	89.6	134	112.7	142	98.2	300.5

Signal from the Crab Nebula in different energy ranges

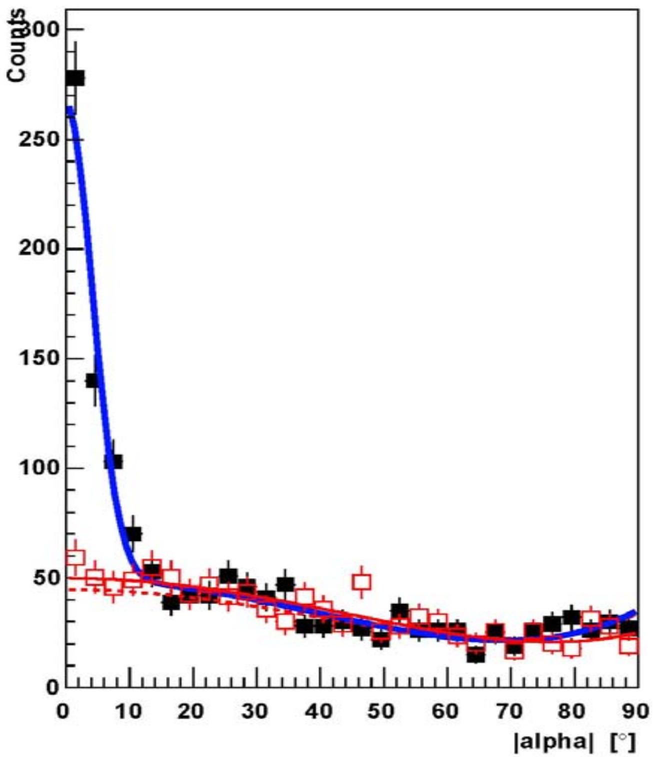


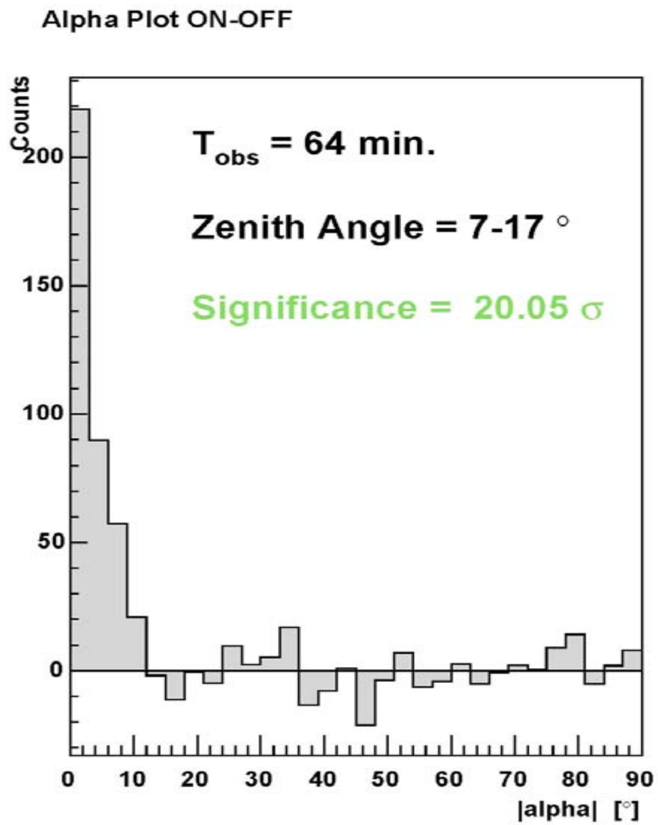
Crab signal for the size > 1500 photons (~ 130 GeV)



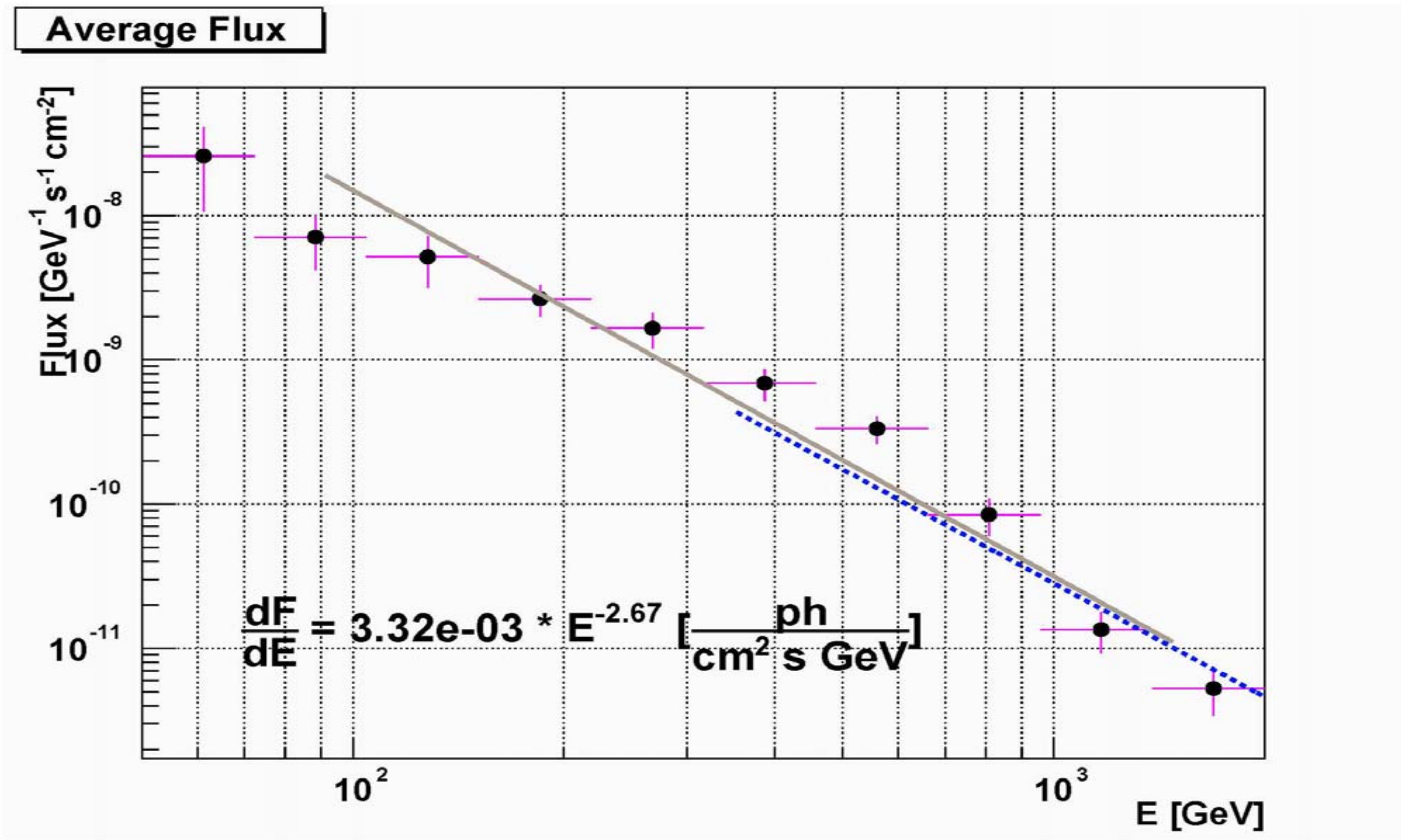


Crab signal for the size > 2000 photons (~ 180 GeV)

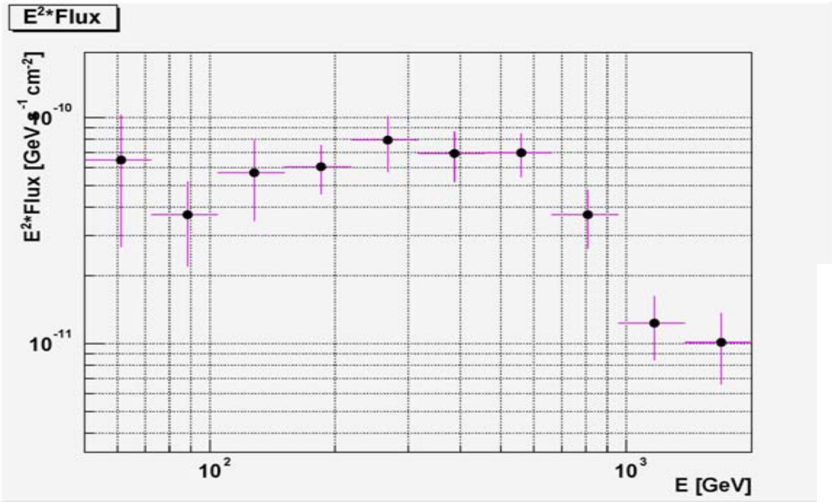


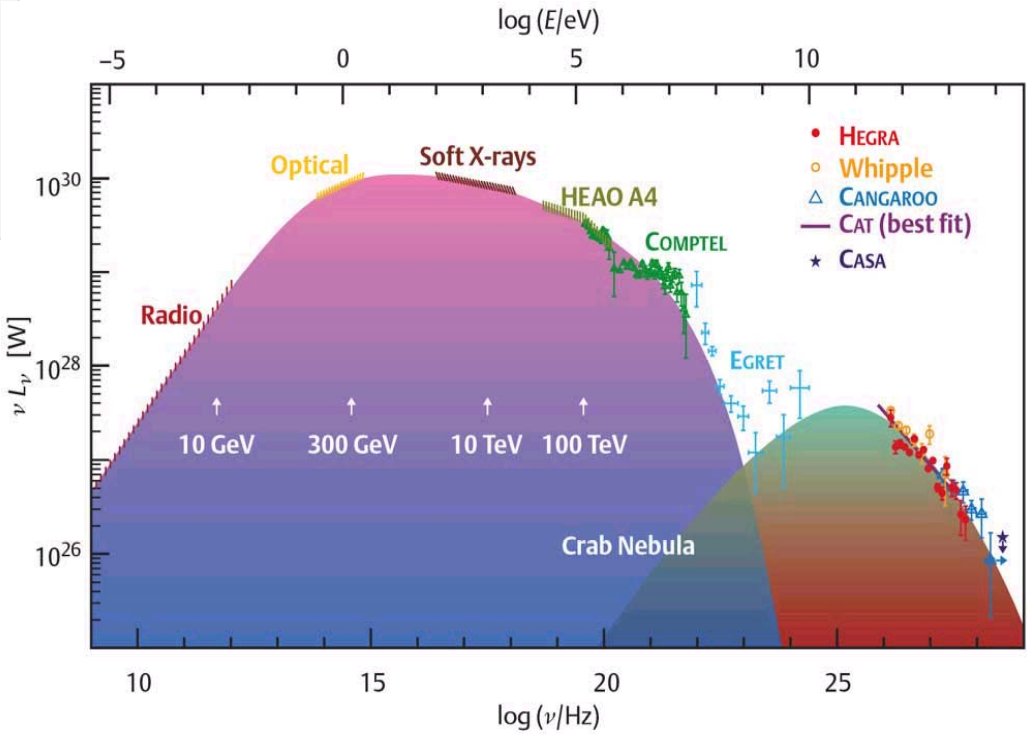


Calculated flux from the Crab Nebula (preliminary)



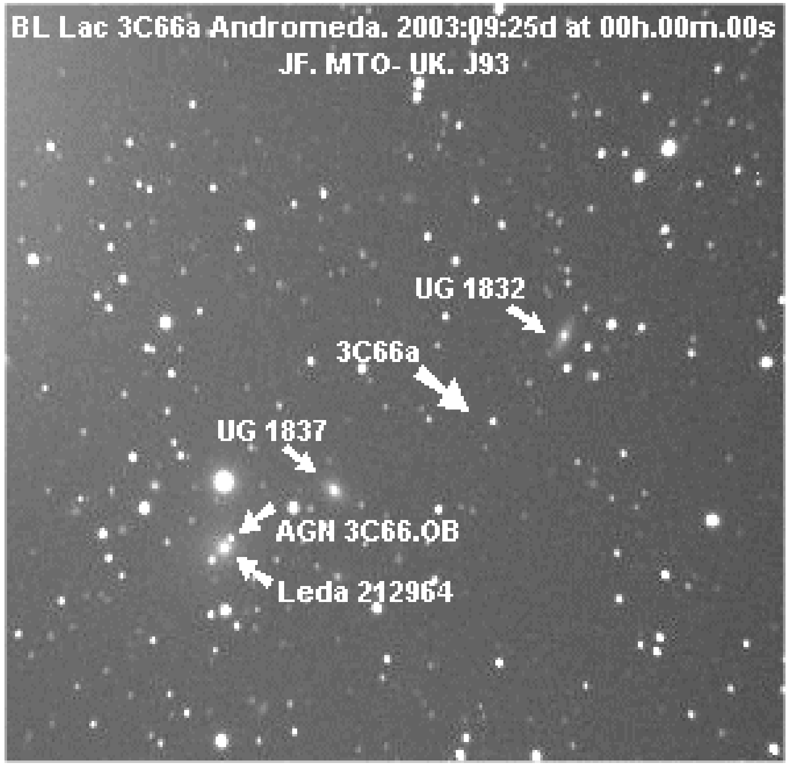
Measured energy emission from the Crab Nebula (preliminary)

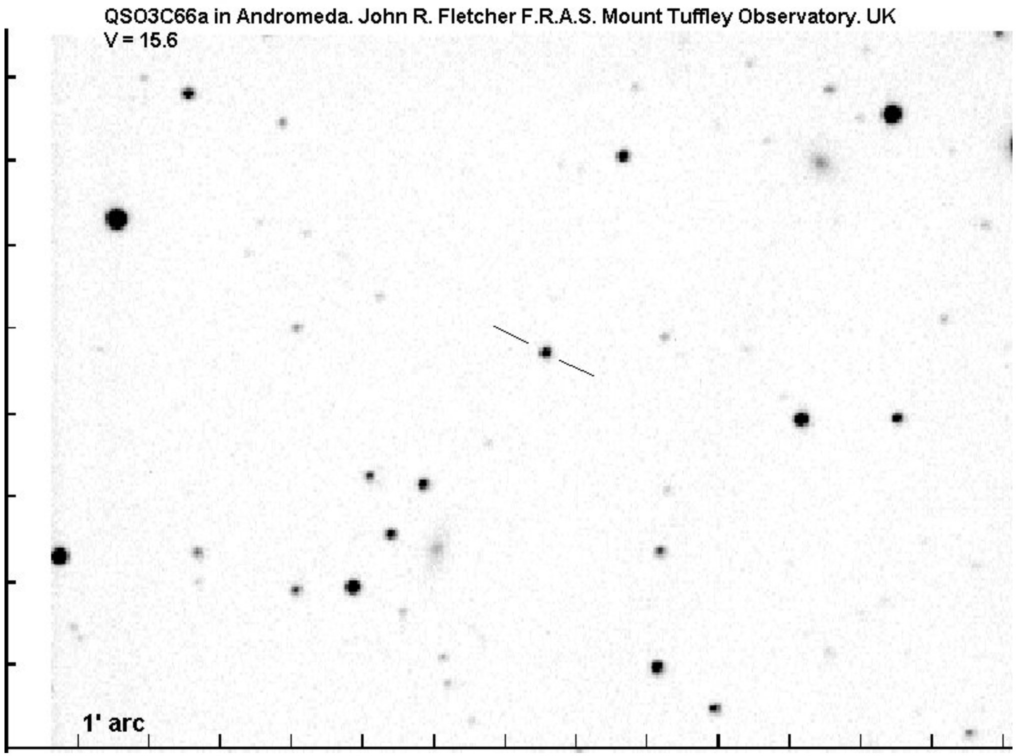




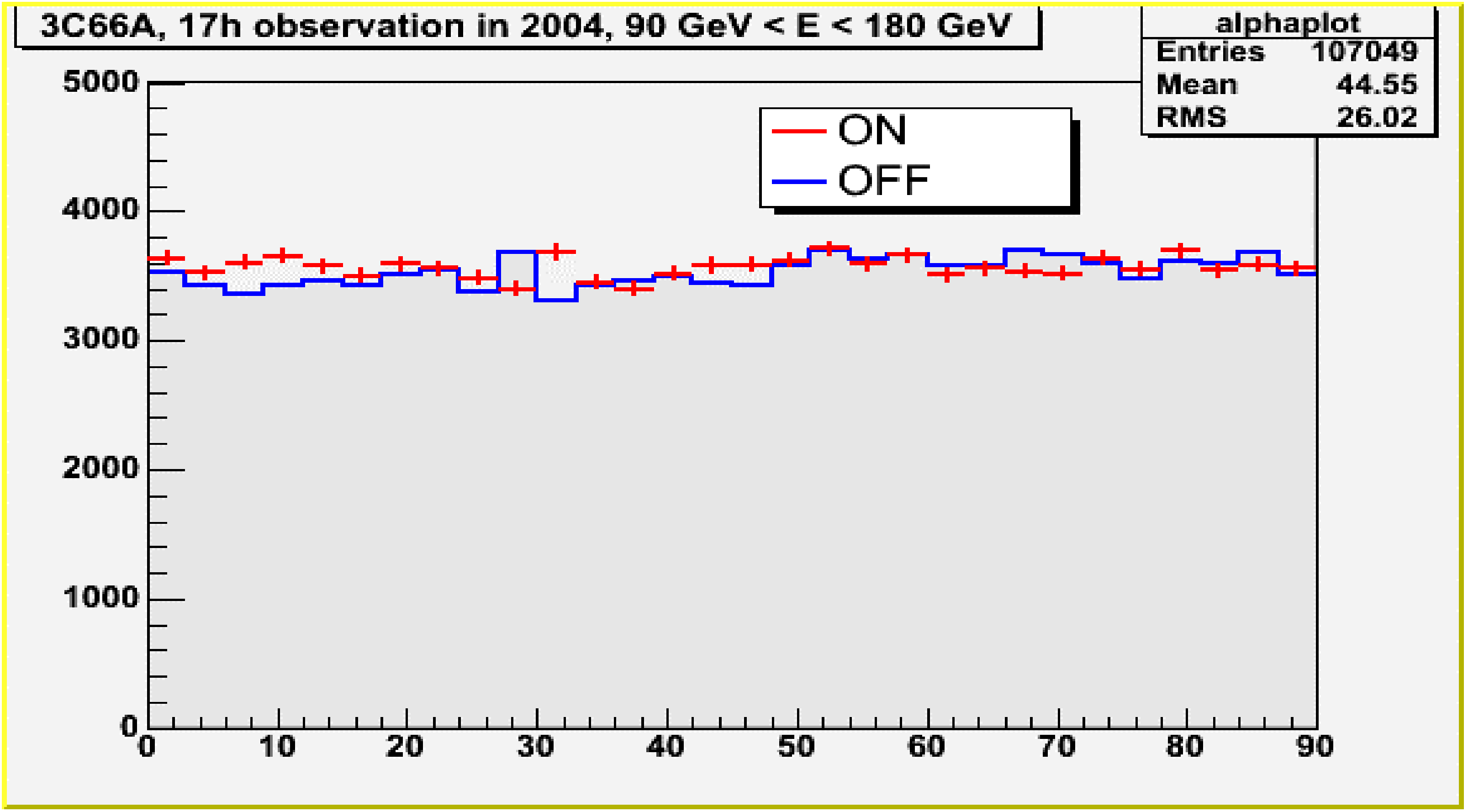
If this results is correct, then in the first time we can show experimentally that the SSC model is working for Crab

Recent observations of the 3C66A: radio selected BL Lac at $z = 0.444$; usually strong variability in optical and X-ray bands. Because of the high z one expects strong attenuation by the EBL, therefore the excess should be expected at lower energies. Historically there is a marginal positive measurement from the Crimean group for E > 1 TeV (Neshpor, et al., 1998).

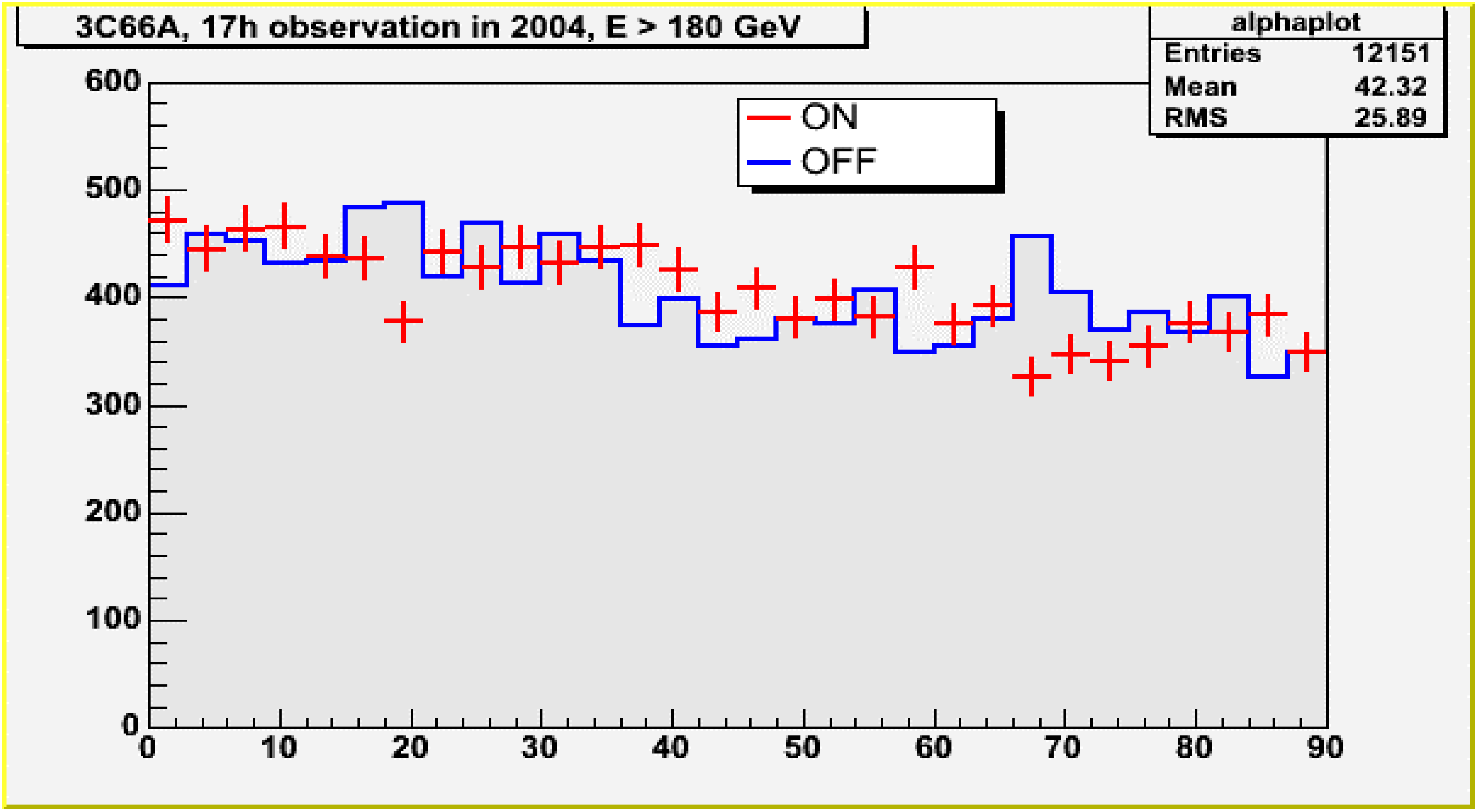




Observations of the 3C66A: red shift z = 0.444; 17 hours ON
Energy range ~ 90 – 180 GeV

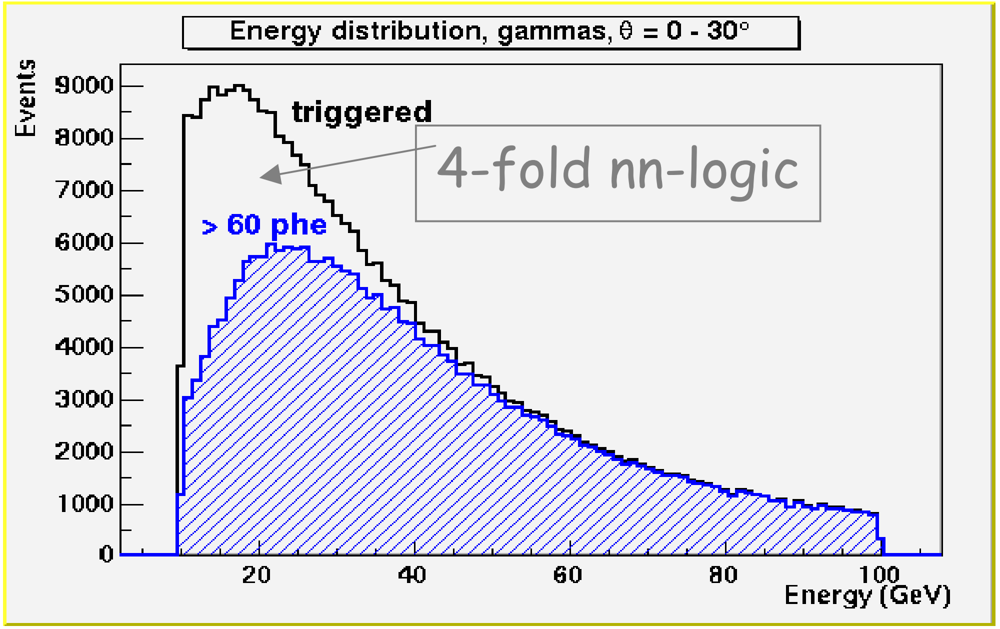


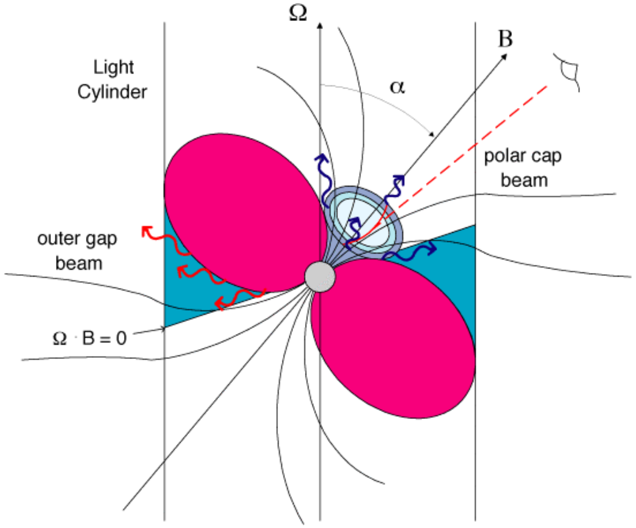
Observations of the 3C66A: red shift Z = 0.444; 17 hours ON
Energy range > 180 GeV
The source emission is < 18 mCrab



Pulsars

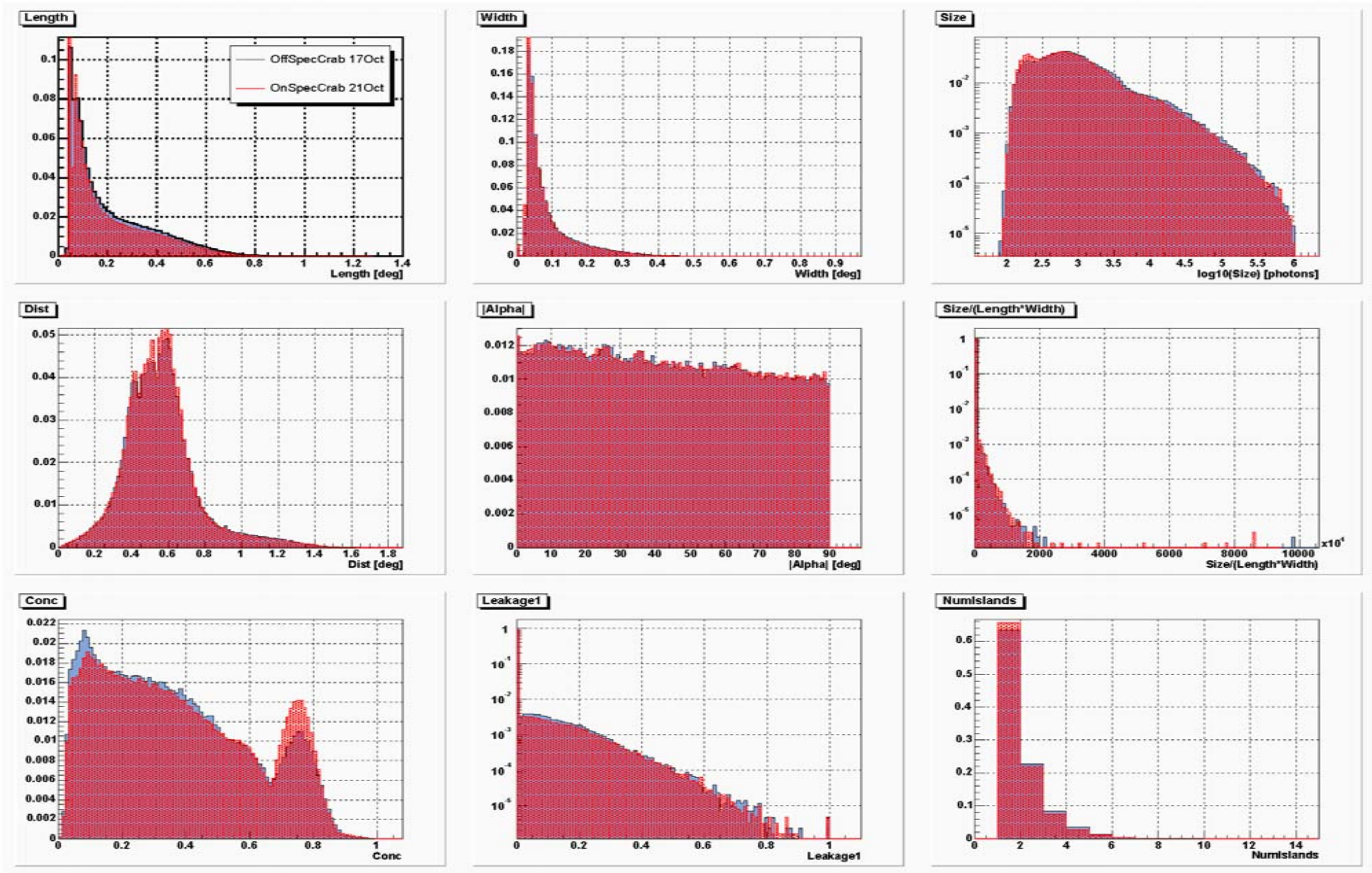
- 7 γ-ray pulsars seen by EGRET. Only upper limits from present IACTs (spectral cut-off)





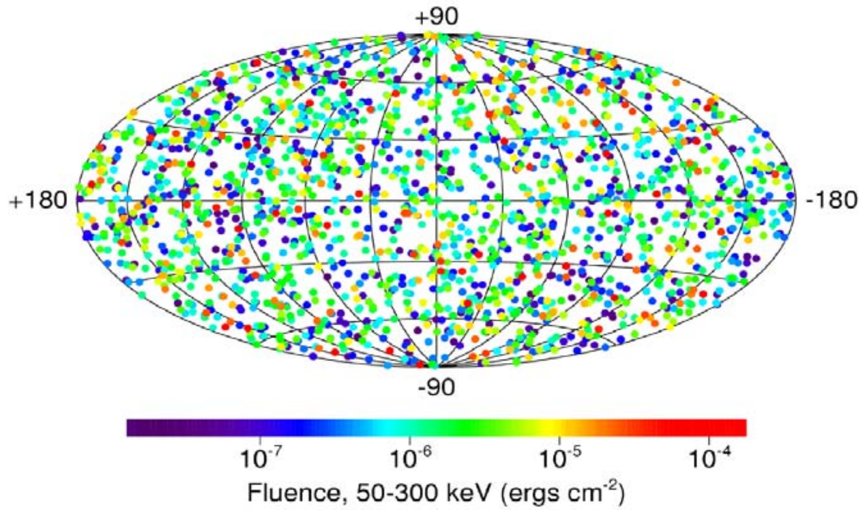
- Where do γ-rays come from? Outer gap or polar cap?
- Many of the ~170 EGRET unidentified sources may be pulsars.

Data (October 04) taken on the Crab pulsar under special trigger conditions, 3NN. The gamma threshold is lower by ~ 20-25 %

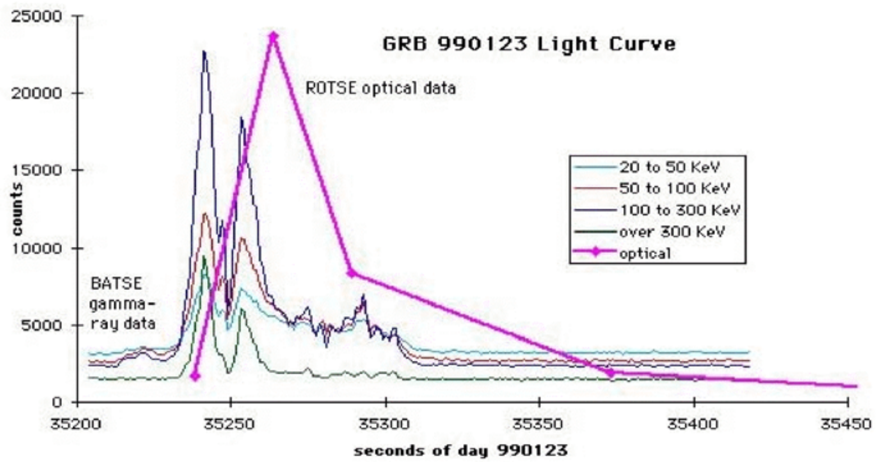


Gamma Ray Bursts

- Mechanism not yet fully resolved.
- MAGIC can take advantage of:
  - Huge collection area
  - Fast repositioning.
- Low energy threshold



Under the assumption that it is possible to extrapolate the GRB energy spectrum in the GeV region, **MAGIC can observe 2-3 GRB/year**

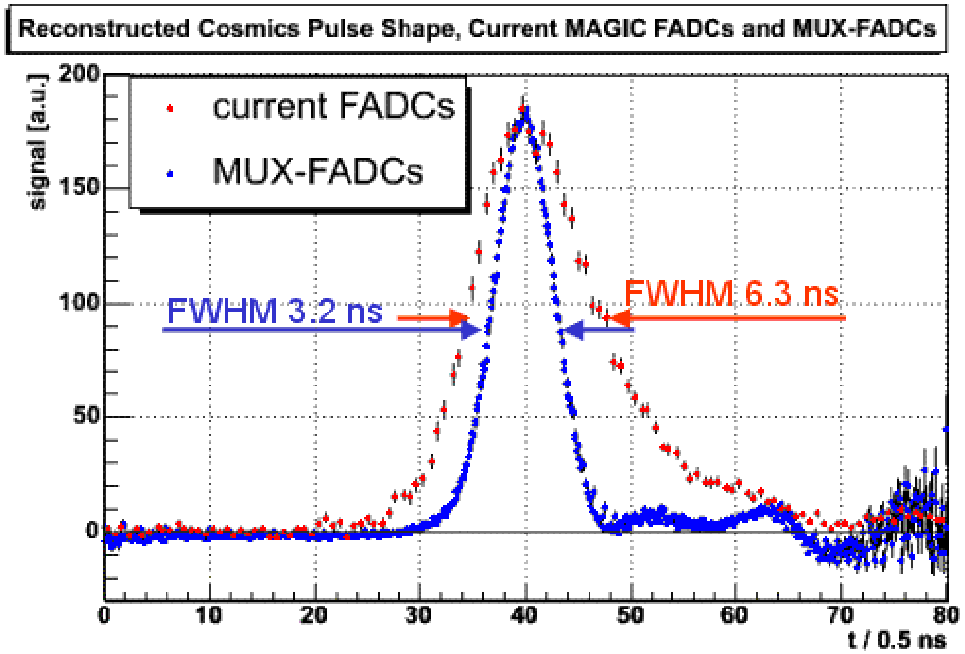


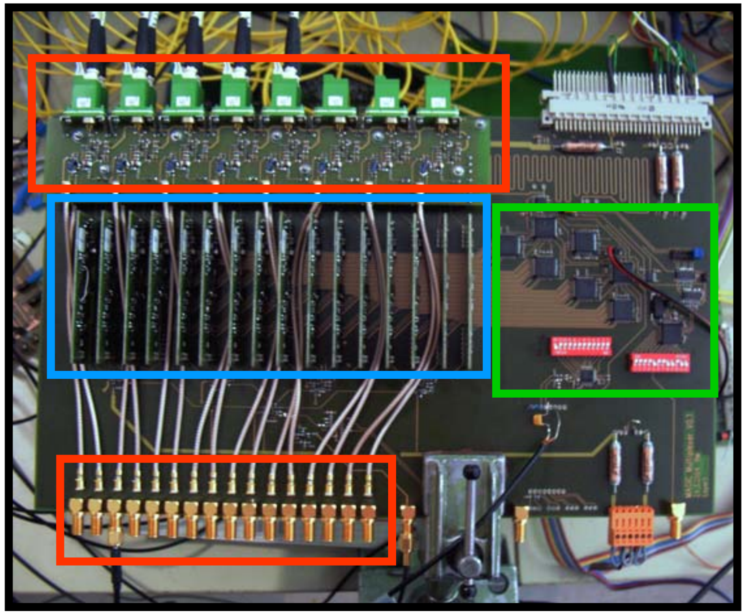
Tests are underway to implement the GRB observation mode

Production of 2 GygaSample/s optical fibre based multiplexed FADC for MAGIC-I

- Such FADC will improve the sensitivity and can lower the threshold setting of the telescop (less μ and other backgrounds contamination).
- Development completed in the MPI electronic's workshop.
- First 2 prototypes of 16 → 1 multiplexed FADC successfully tested in La Palma under real conditions.
- Financial support by the „Grossgeräte" application to MPG
- Production has already started
- Mid 2005: implementation of the ultra-fast system in La Palma

Photo of the 2 GigaSample/sec FADC fibre-optic multiplexer (lower right). The measured average pulse width from cosmic rays shrinks from 6.3 ns down to 3.2 ns; this means much less contamination of noise from LONS





Near Future Plans: MAGIC-I

- Regular observations
- Implement 2 GigaSample/sec ultra-fast fibre-optic based readout in 2005 (is under preparation)
- Step-by-step lowering of the threshold setting towards ~30 GeV

Near Future Plans: MAGIC-II

(see the following presentation by Florian Goebel)

The frame with understructure shall be ready in La Palma in mid 2005, the 2nd Telescope to be completed till the beginning 2007.

The 2^{nd} telescope will essentially be the clone of the 1^{st} telescope, only a few improvements will be implemented.

Conclusions

- **MAGIC-I is essentially understood and recently has been calibrated (still some stability problems in the C++ analysis code)**
- **Strong signals have been measured from Mkn-421 and Crab Nebula. We are in the process of understanding of the energy- dependent sensitivty in the sub-100 GeV domain**
- **A significant signal from the Crab- like sources can be reliably measured in ~ 200 seconds !**
- **The gamma trigger rate from Crab Nebula is ~ 1 Hz !!!**
- **Since a few months MAGIC-I has started the regular data collection**
- **Construction of the 2nd telescope has already been started.**