Camera Control System and GRB observation in MAGIC telescope

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- We are also fighting against bad weather

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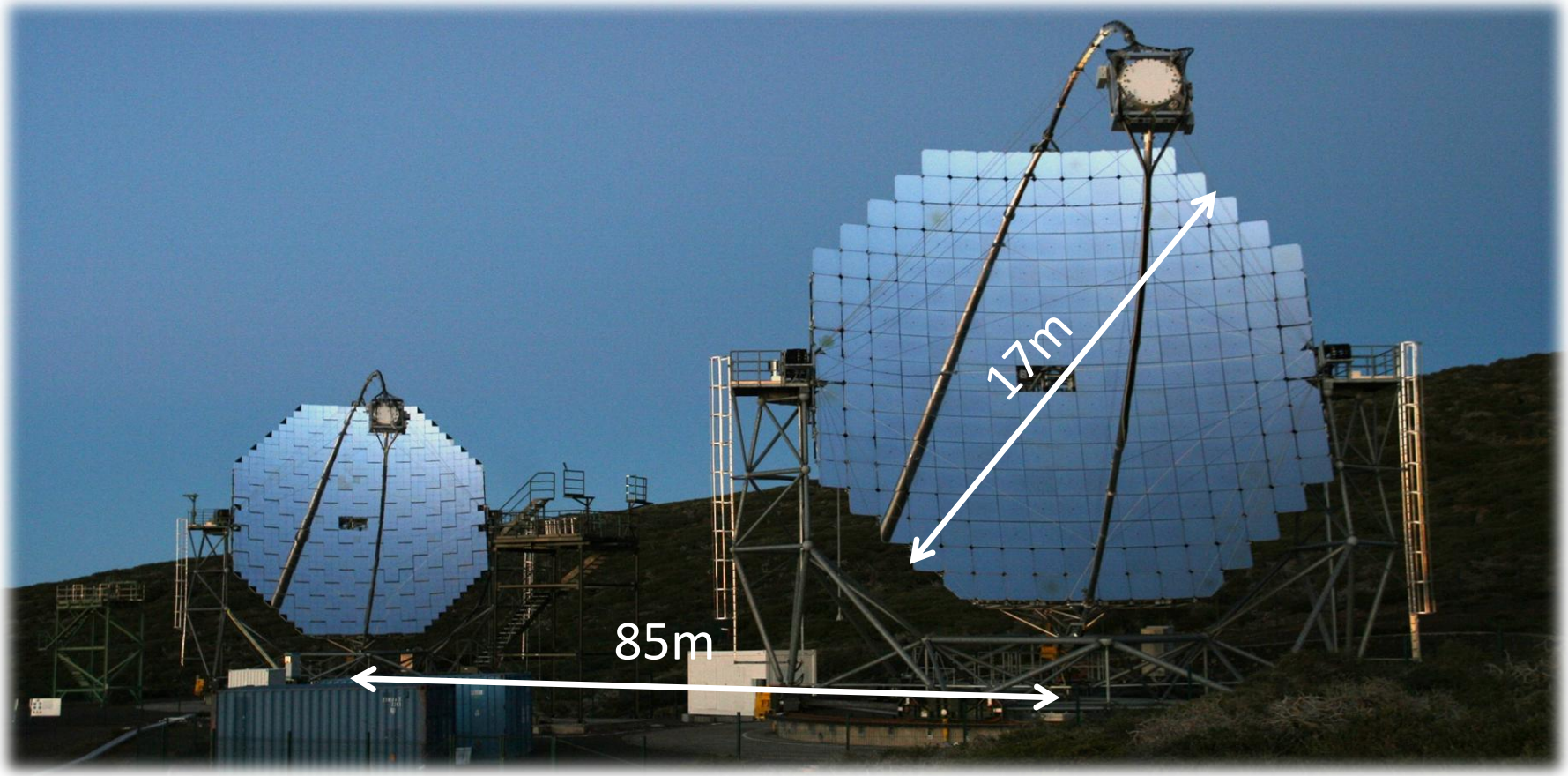
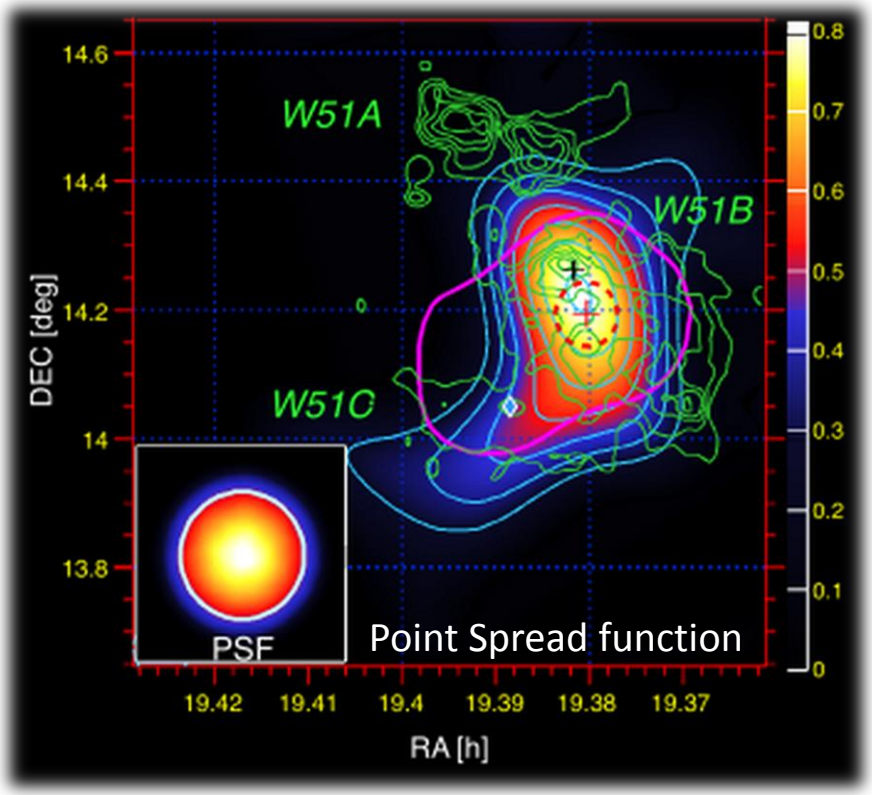
- Motivation for GRB Observation
- GRB Observation system by MAGIC telescope
- Future state

MAGIC telescope



Location	Canary Island La Palma
Energy range	50GeV - 50TeV
Angular resolution	~0.06° (@1TeV)
Sensitivity	~0.06%Crab (@500GeV with 50h observation)

MAGIC telescope



J. Aleksic et al (2012)

Typical sources in GeV-TeV gamma

	Flux [10^{-12} cm^{-2} s^{-1} TeV^{-1} at 1 TeV]
Crab nebula	22–37
Galactic Center	2.5
R1713.7-3946	17
Mkn 421	12–97
Mkn 501	0.5–100

Data from F. Aharonian et al (2008)

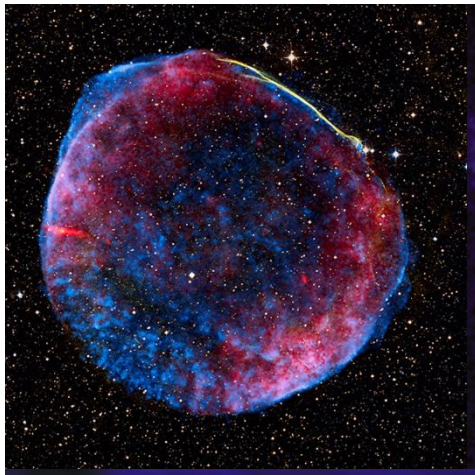
Location	Canary Island La Palma
Energy range	50GeV - 50TeV
Angular resolution	~0.06° (@1TeV)
Sensitivity	~0.06%Crab (at 500GeV with 50h observation)

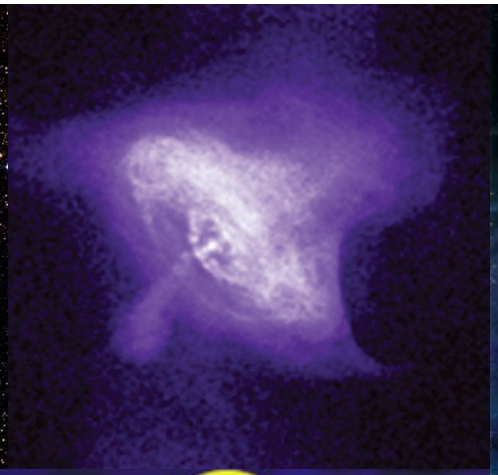
Science Target

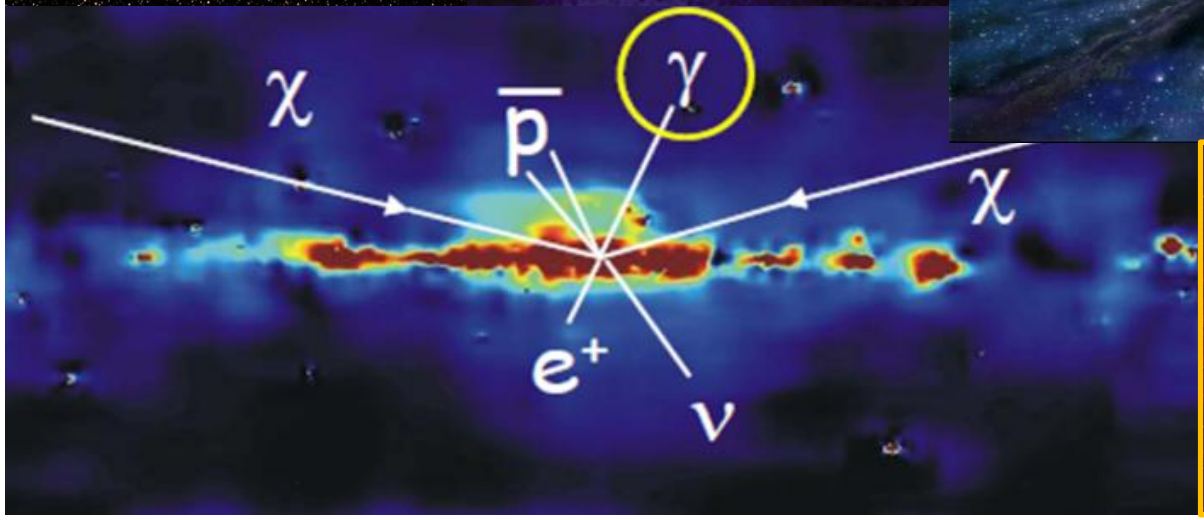
Super Nova Remnant

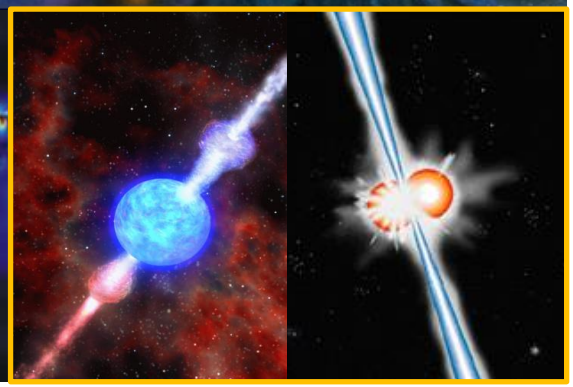
Pulser / Pulse Wind Nebula

Active Galactic Nuclei







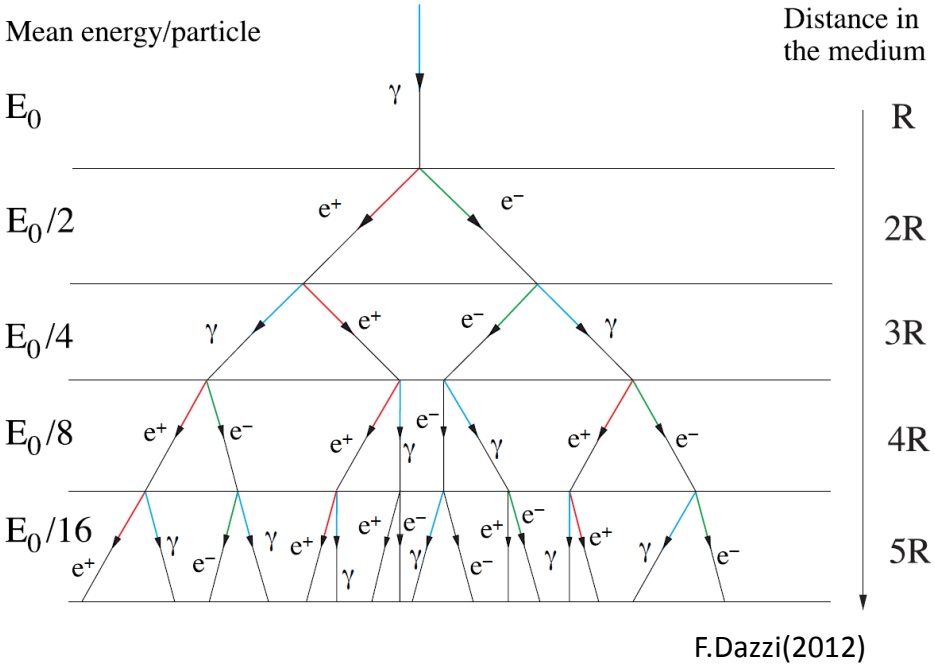


Indirect Dark Matter search

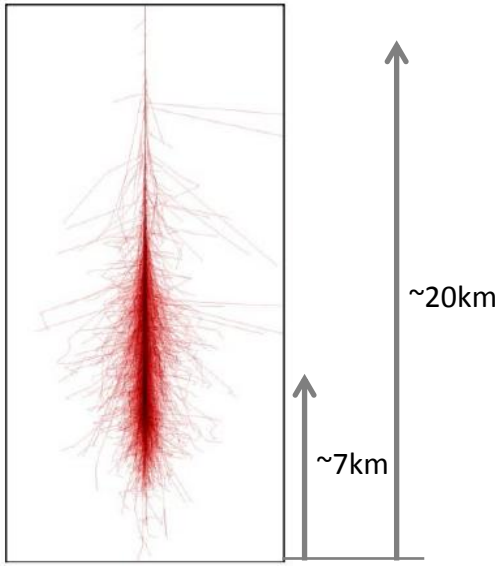
Gamma Ray Burst

Way to detect Gamma ray in MAGIC

When a gamma ray goes into atmosphere



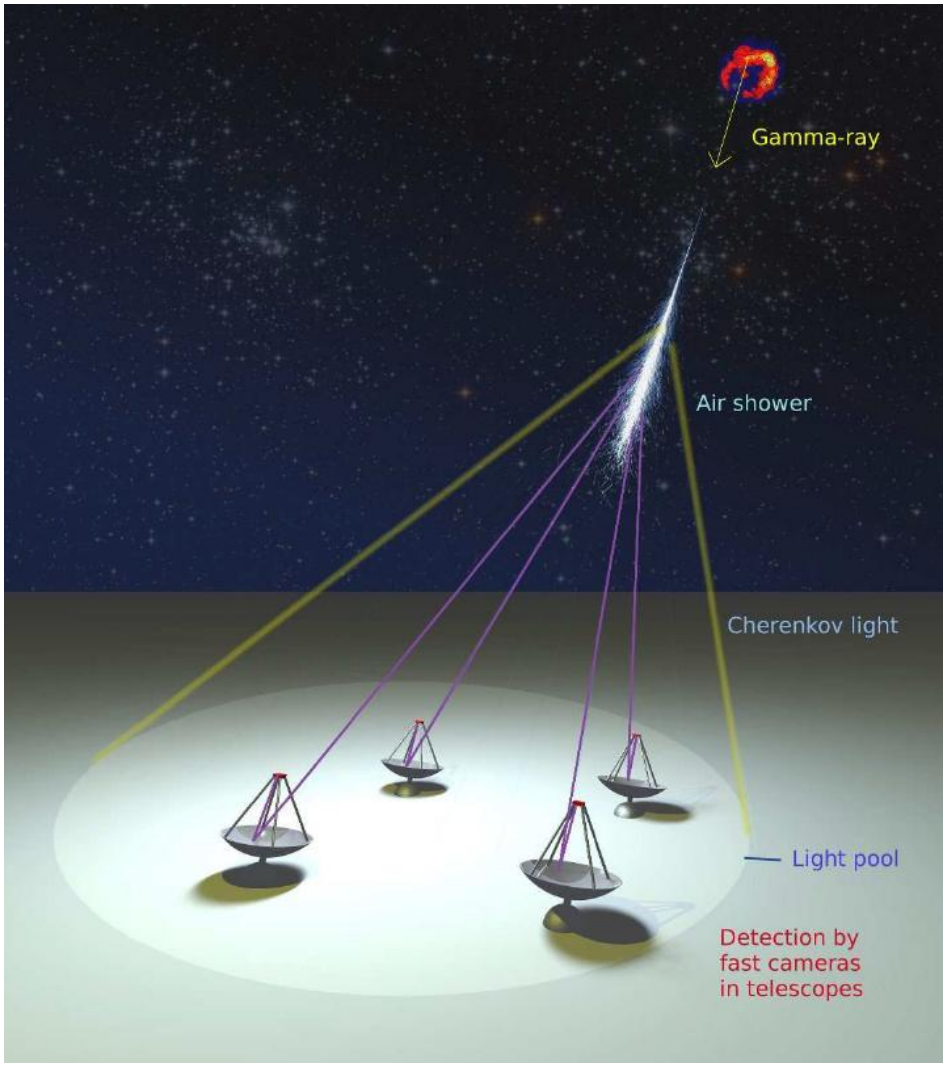
F.Dazzi(2012)

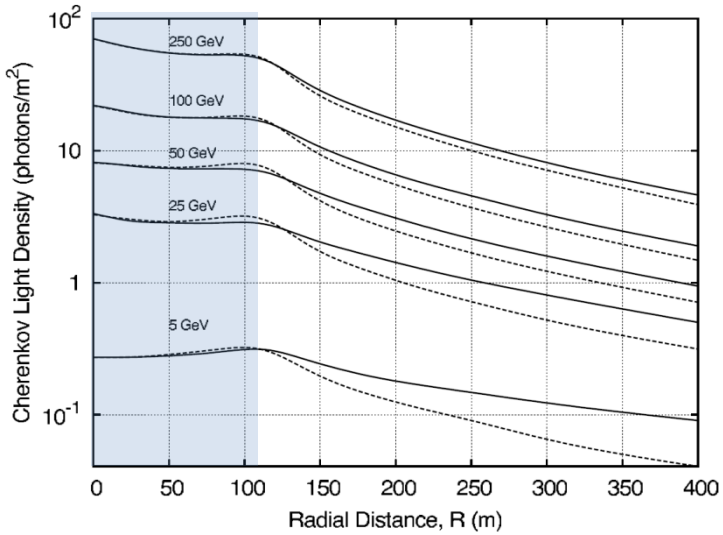


Air shower by gamma at 300GeV

E_0:Original energy of gamma
R:Radiation length

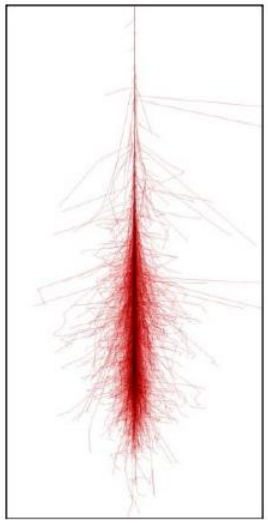
Way to detect Gamma ray in MAGIC



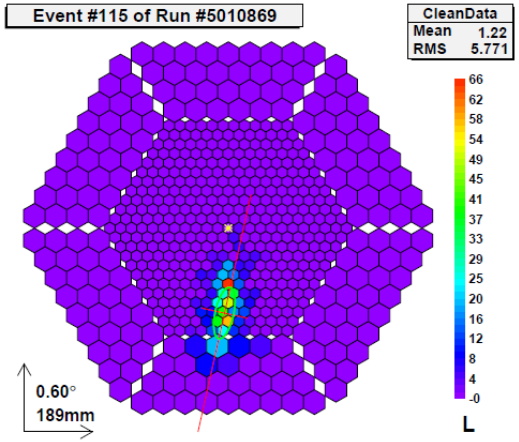


Signal is faint(10ph/m^2) at 50GeV
and short(a few nsec)

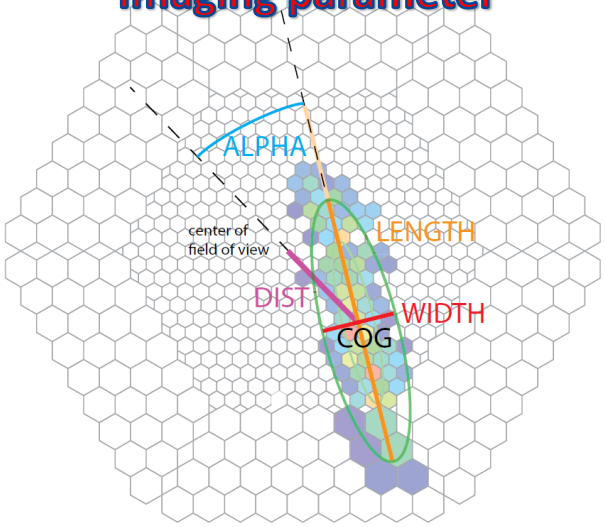
Way to detect Gamma ray in MAGIC

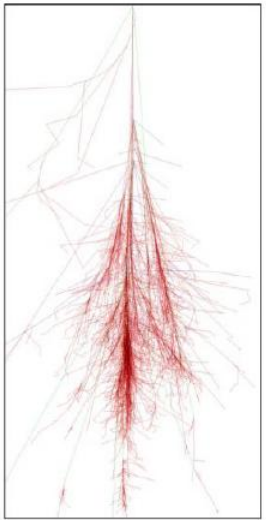


Air shower by gamma ray

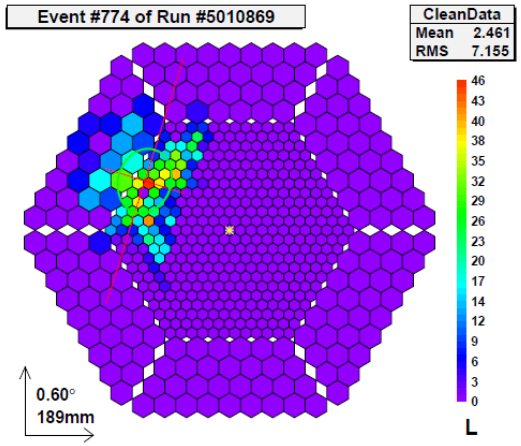


Imaging parameter



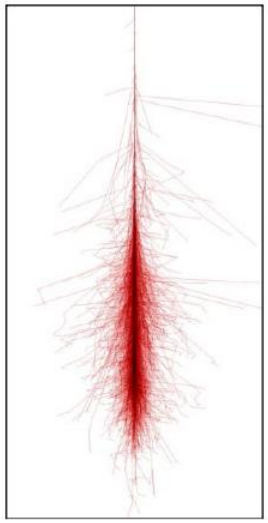


Air shower by hadron

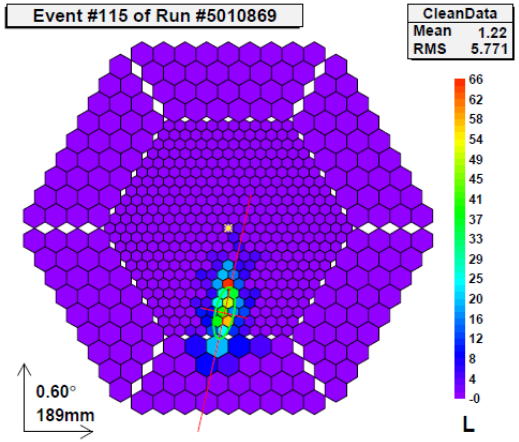


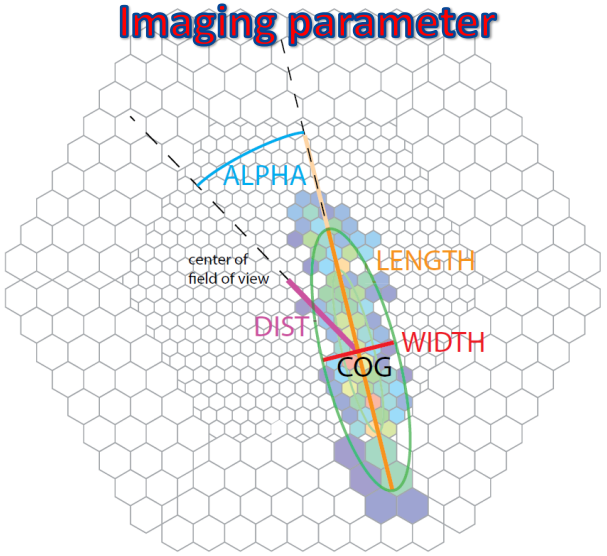
This parameter is used
to discriminate gamma from hadron
to measure direction and energy of signal

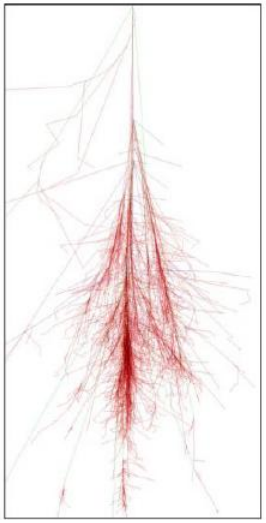
Way to detect Gamma ray in MAGIC



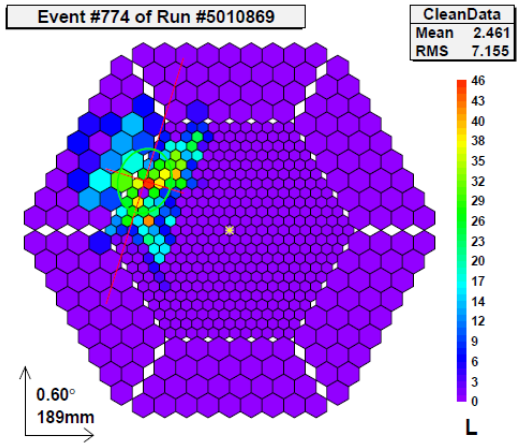
Air shower by gamma ray







Air shower by hadron

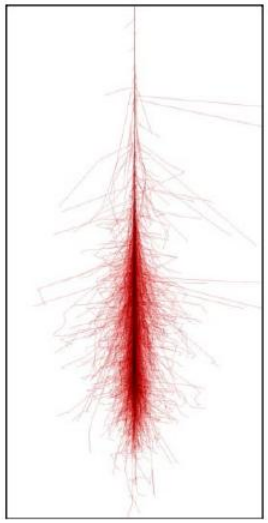


Gamma ray signal in many background!

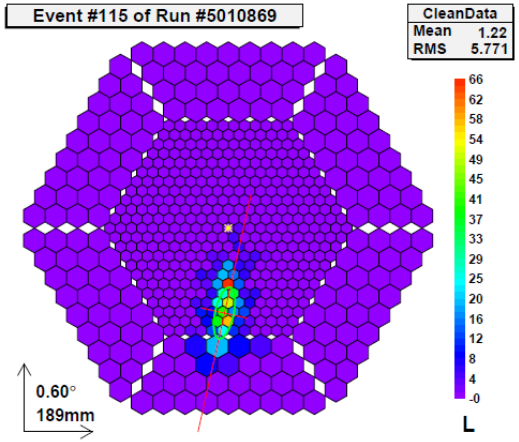
Gamma ray: Hadron ≒ 1 : 1000

(even observing strong source)

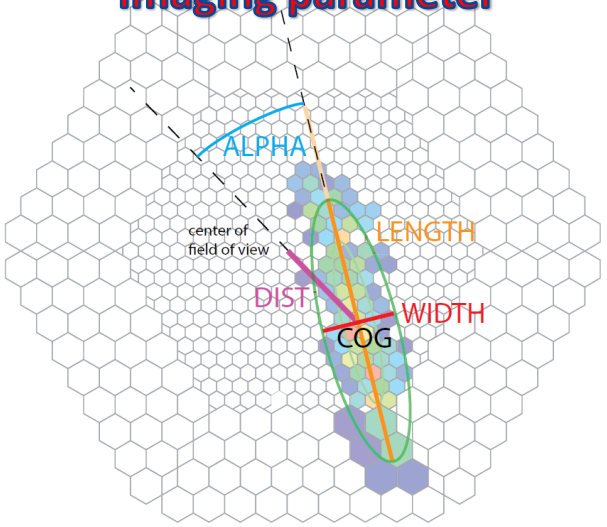
Way to detect Gamma ray in MAGIC

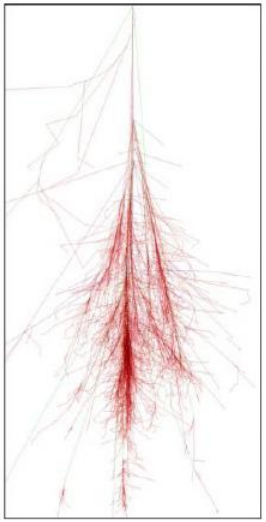


Air shower by gamma ray

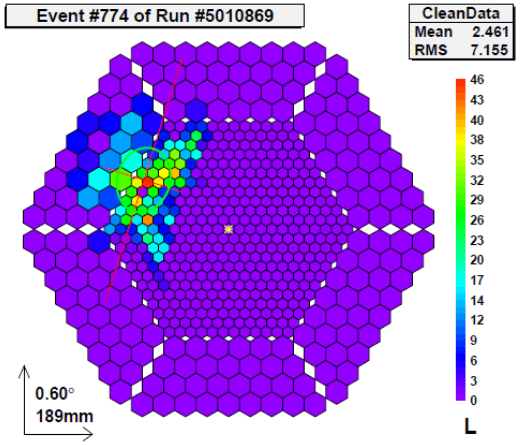


Imaging parameter



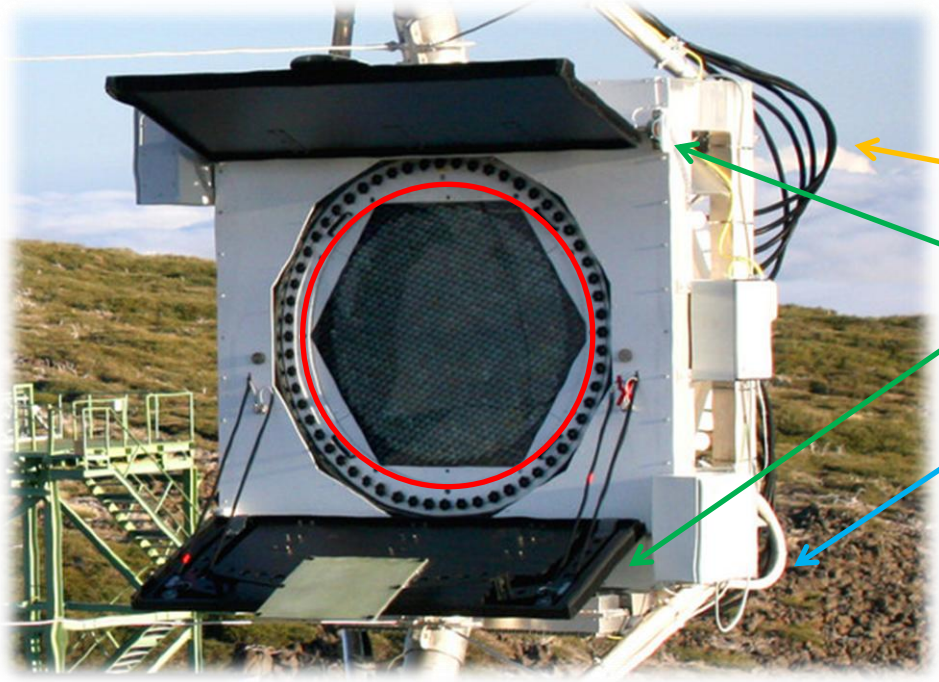


Air shower by hadron



Gamma ray signal in many background!

Camera of MAGIC telescope



Camera consist of 1039 PMTs
Why don`t we use CCD??

Cables for signal

Lid can be controlled by remote

Cable for cooling

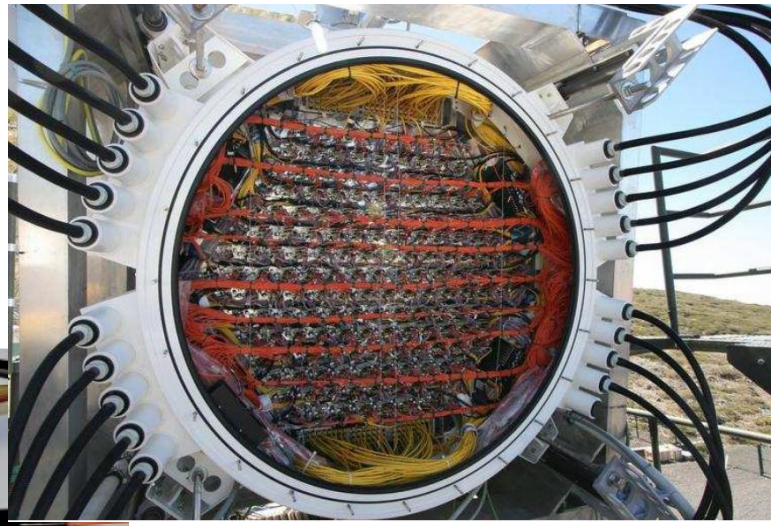
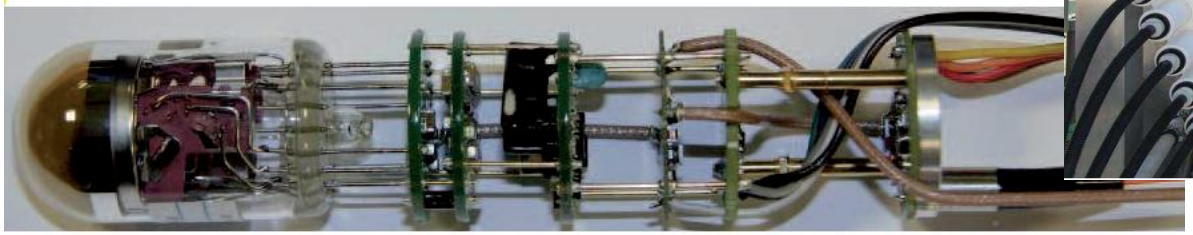


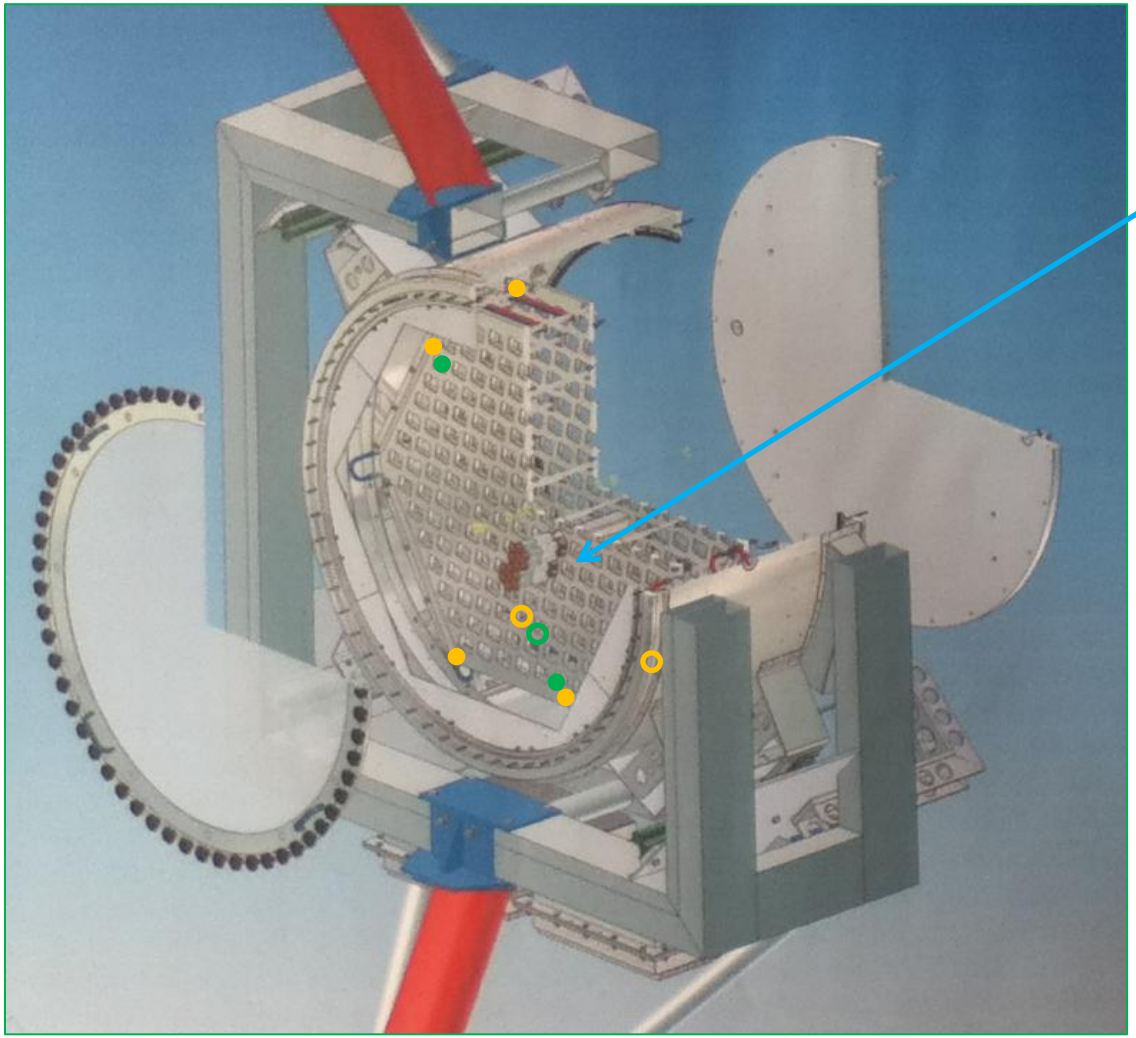
Photo Multiplier Tube (PMT)

Temperature sensor



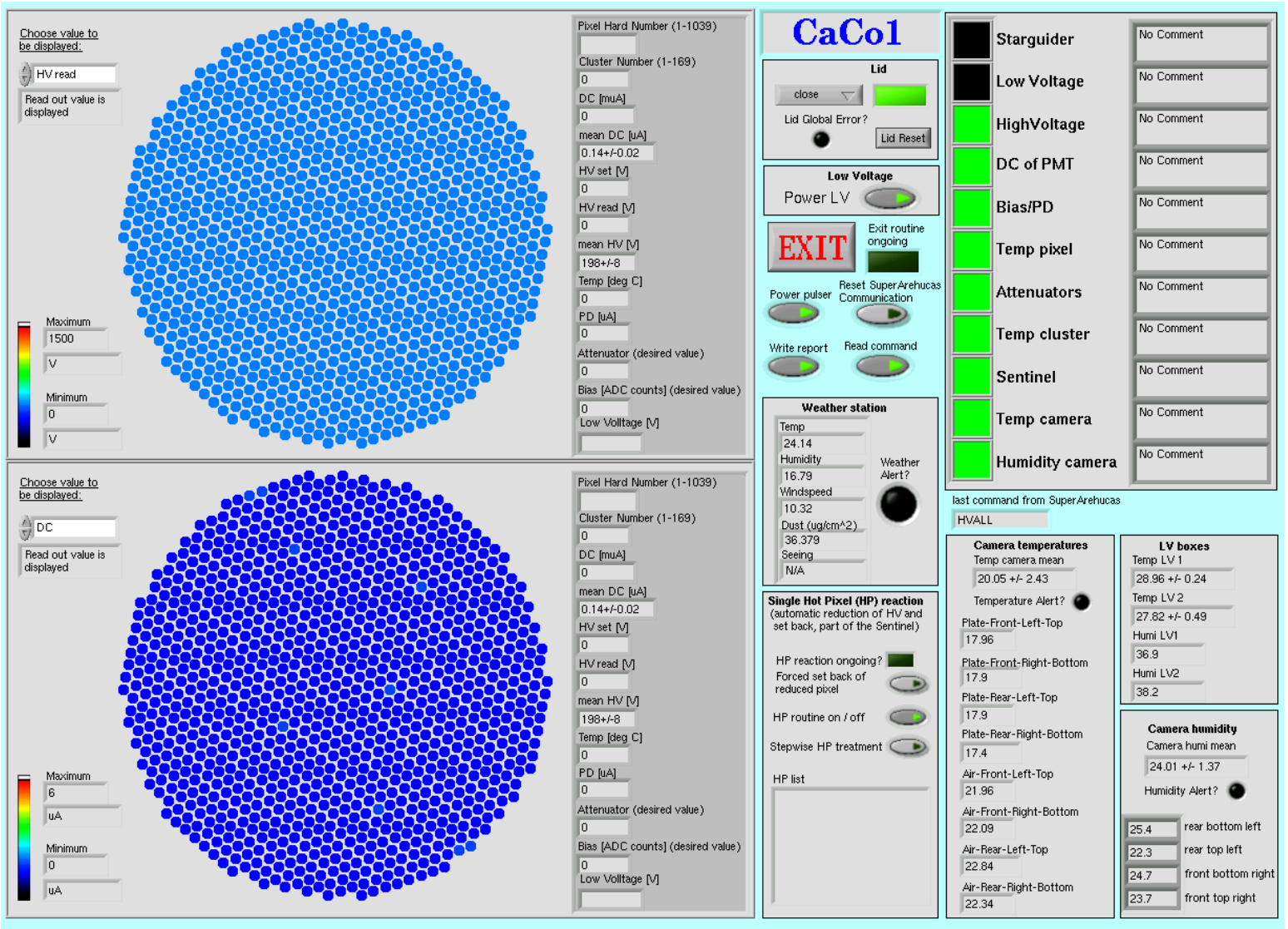
Cockcroft Walton Circuit to supply High voltage (HV)

Devices for safe operation



- Temperature sensors
- Humidity sensors
- Cooling Plate
- Device to measure wind speed

Camera Control Software System



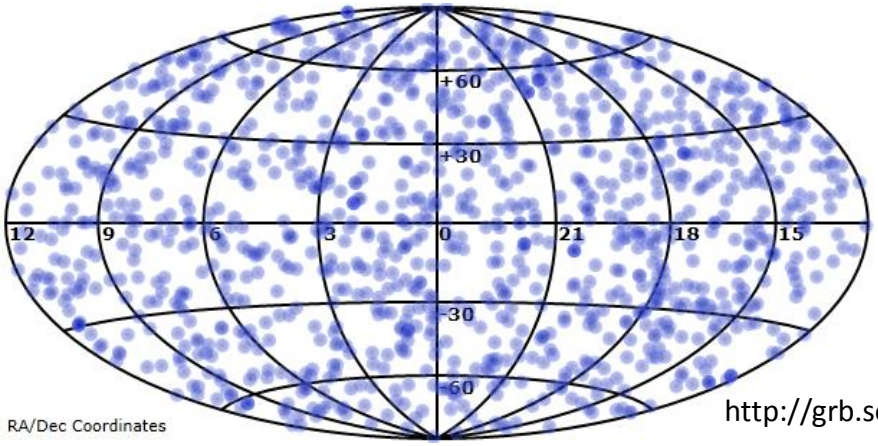
Security Routine for Camera

1. Direct current (from PMT) over 20uA?
   HV is reduced to protect PMT
2. Pixel Temperature over 40 degree?
   Power supply is OFF, Alert warring to check Cooling system
3. Humidity in Camera over 98%?
   HV is OFF, Wait for fine weather
4. Wind speed over 40km/h?
   Camera Lid is close to protect MAGIC CAMERA, Alert warring to stop tracking

We are monitoring and controlling HV DC.

We are also fighting against wind, humidity, temperature, strong light

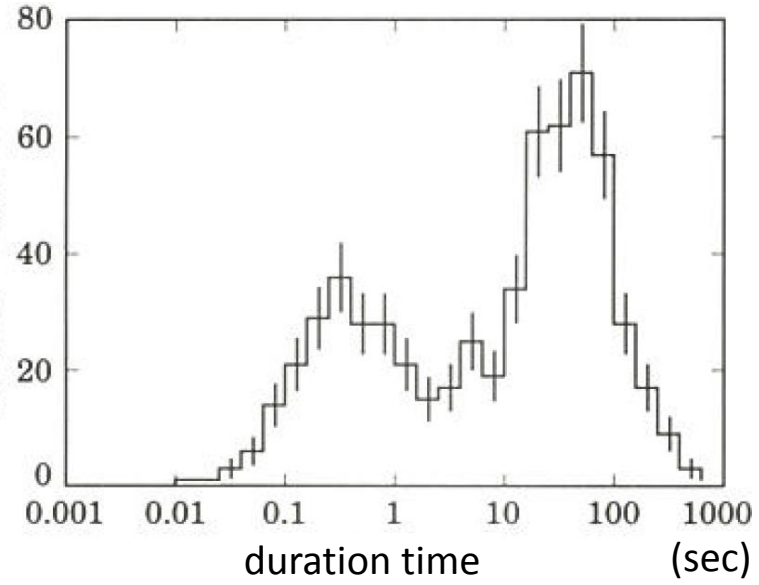
Gamma Ray Burst



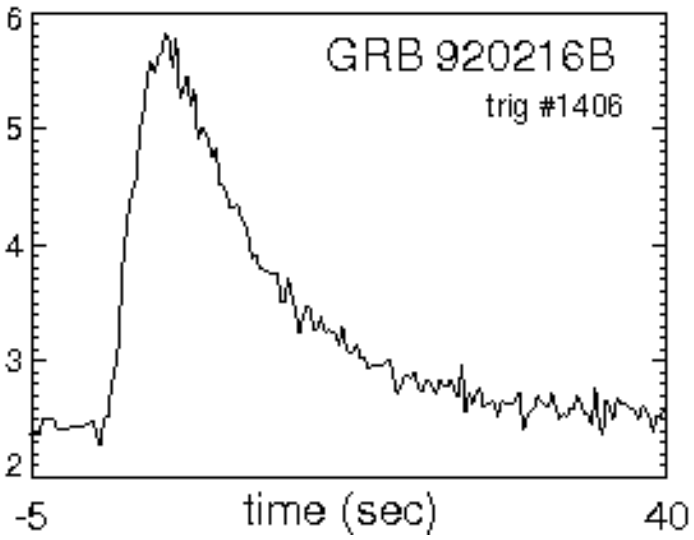
http://grb.sonoma.edu/

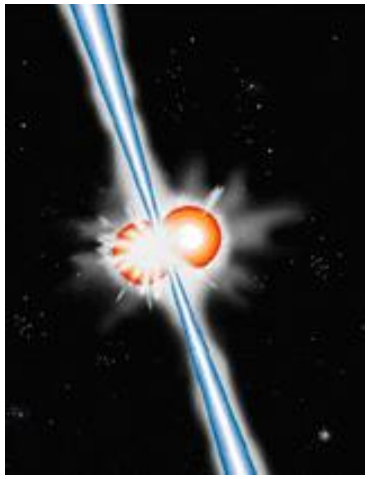
No anisotropy

Number of burst

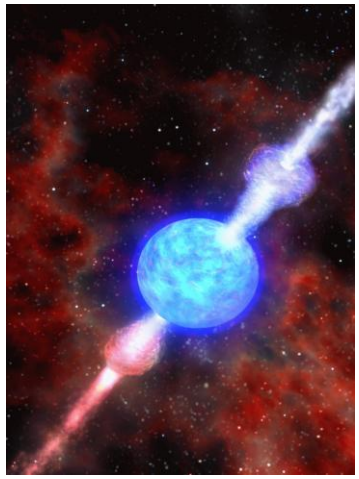


duration time (sec)



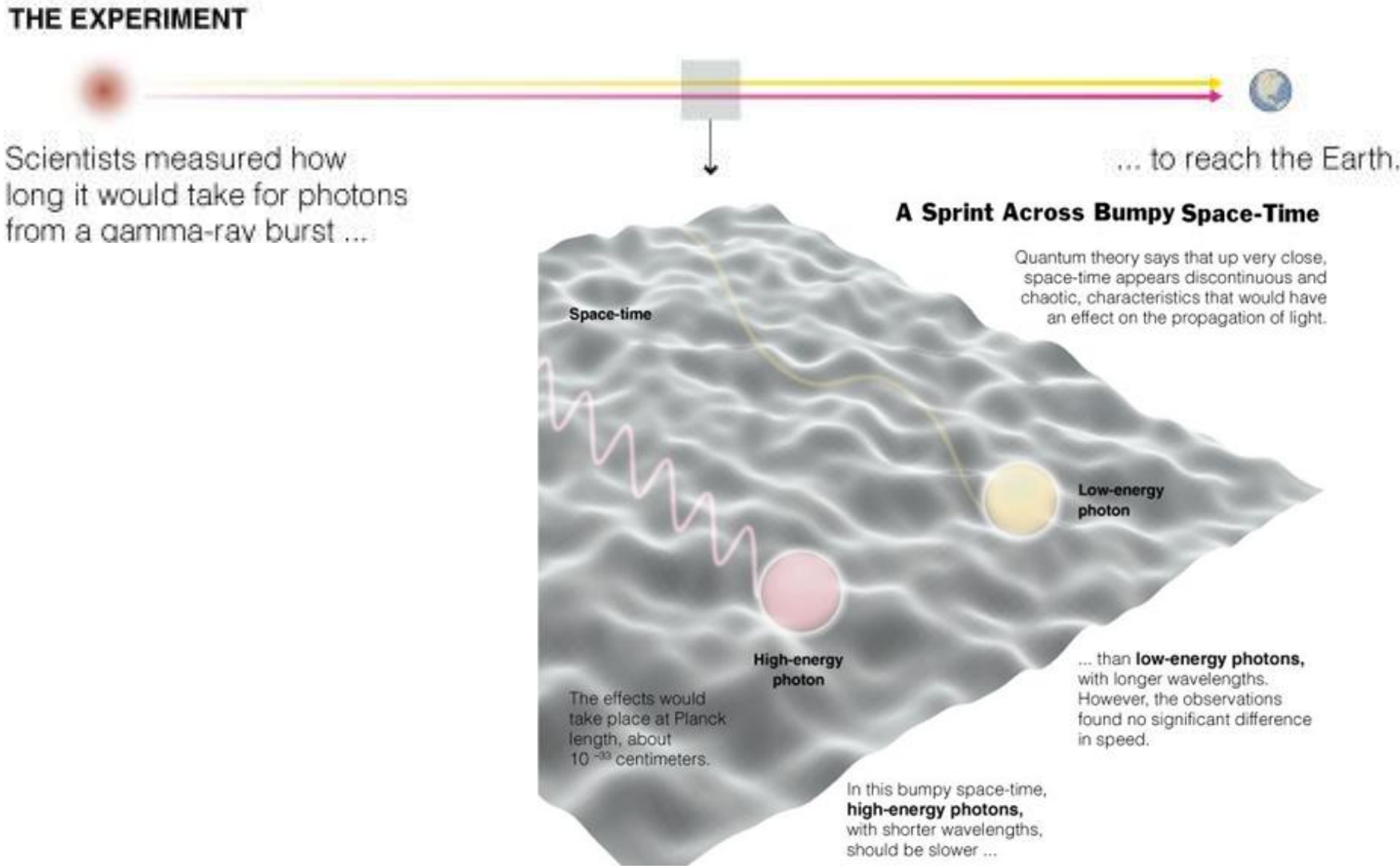


Short GRB

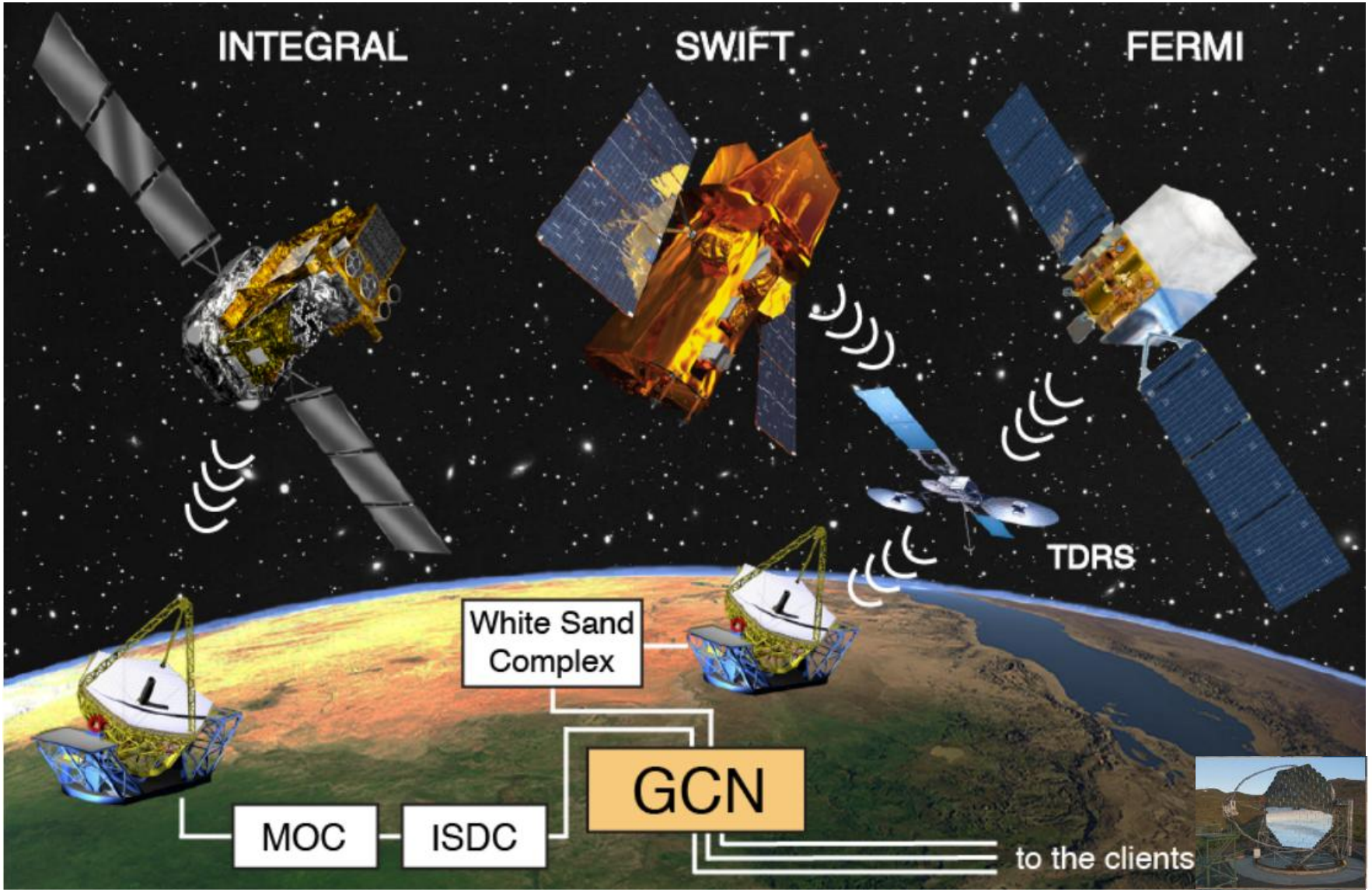


Long GRB

One of Motivations



GRB observation in MAGIC



GRB observation in MAGIC

Satellite/instrument	Energy range	Observed GRB rate (yr^{-1})	Typical localisation error (radius)	Typical delay time
Swift BAT	15–150 keV	95	few arcmin	20 s
Swift XRT	0.3–10 keV	90	<3″	~70 s
Fermi GBM	8 keV–40 MeV	250	10° / 1-3°	20-300 s / 20 min-2 hr
Fermi LAT	20 MeV–300 GeV	10	few deg / 10-60′	<1 min / 4-8 hr

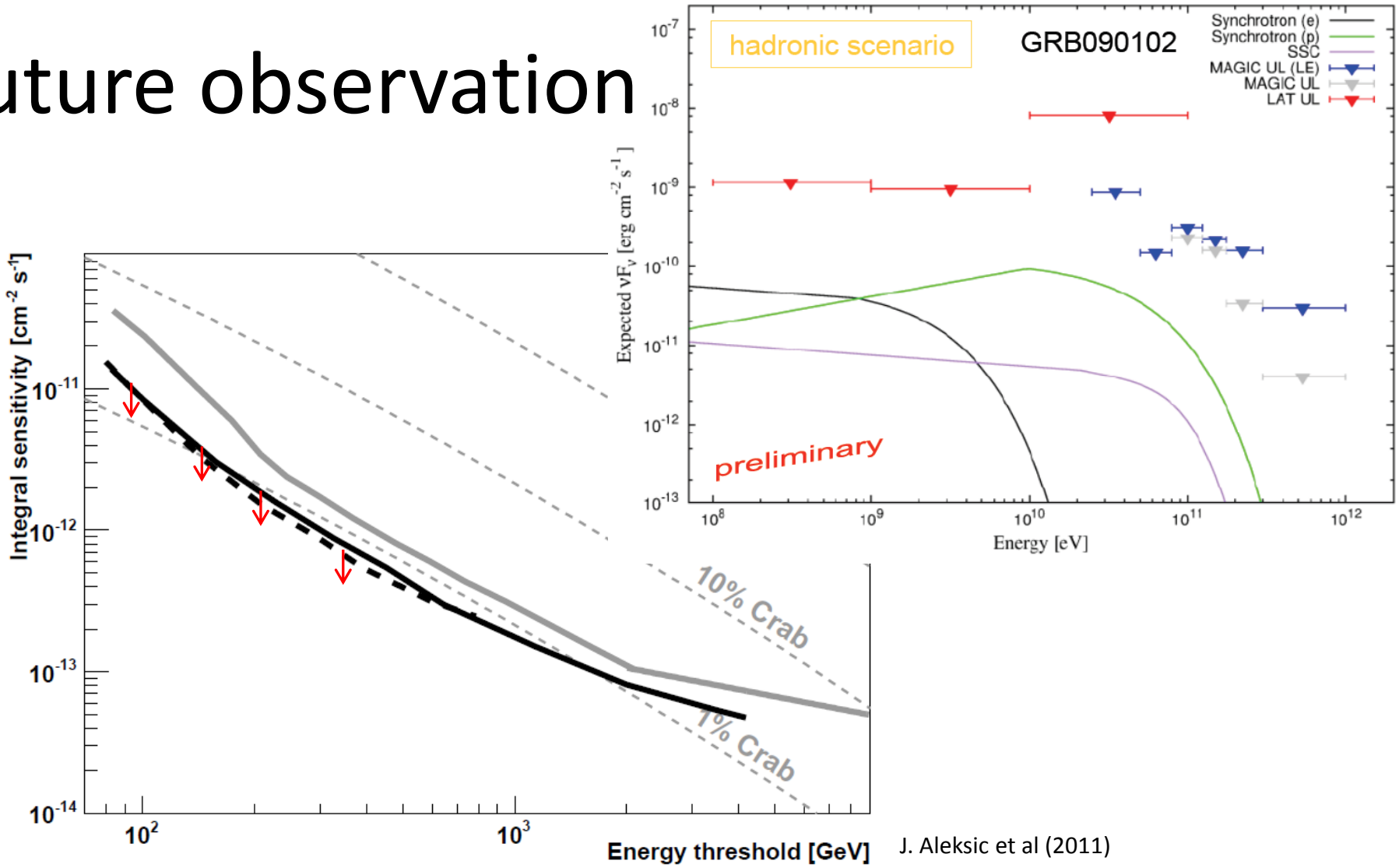
S. Inoue et al 2012

	GRB	z	T_{90} [s]	ΔAz [deg]	rep. time [s]	Zd [deg]	start obs. [s]	obs. time [min]
1.	050421	–	10.3	30	26	52	108	76
2.	050505	4.27	60.0	114	90	49	717	101
3.	050509a	–	11.6	128	108	58	131	119
4.	050509b	0.23	0.04	86	83	70	108	8
5.	050528	–	10.8	7	12	49	77	28
6.	050713a	–	70	50	17	49	40	37
7.	050904	6.29	225	55	54	24	145	147
8.	060203	–	60	268	84	44	268	43
9.	060206	4.05	7	44	35	13	59	49
10.	060522	5.11	69	64	58	60	2786	13
11.	060602b	–	9	102	191	60	4109	26
12.	060825		8.1	7	39	2	57	33
13.	060904a		8	1	20	6	23	1
14.	060912	0.94	5.0	127	40	60	24291	18
15.	060923	3.21	8.5	240	83	31	12923	23
16.	061021		0.5	51	2	30	169	100
17.	061110b	3.44	128	196	69	43	698	59
18.	061217	0.83	0.30	126	45	60	786	66
19.	070411	2.95	101	–	–	38	2652	128
20.	070412	–	34	26	9	23	701	124

We Should follow GRB as soon as possible in duration time

D. Bastieri et al 2012

Future observation

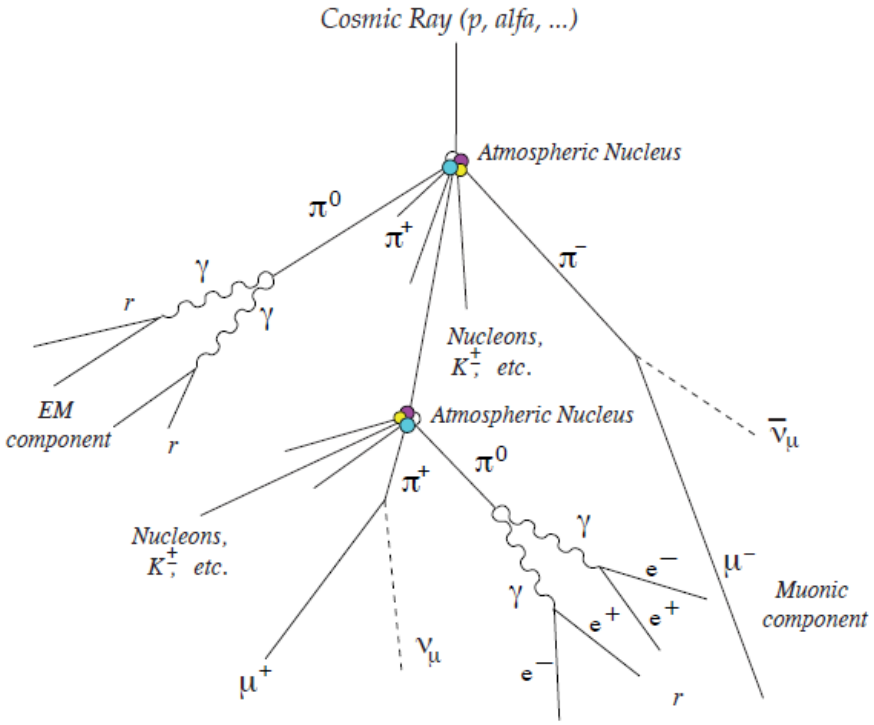


J. Aleksic et al (2011)

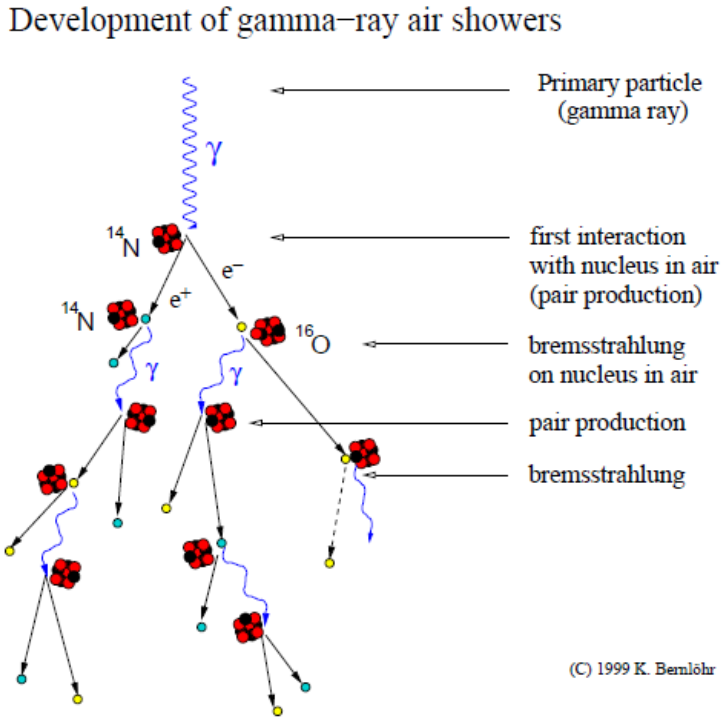
After upgrade we can get better sensitivity in low energy (<500GeV)
Moreover,
In this year, New trigger system will be installed to achieve lower threshold energy(~25GeV)

Summary

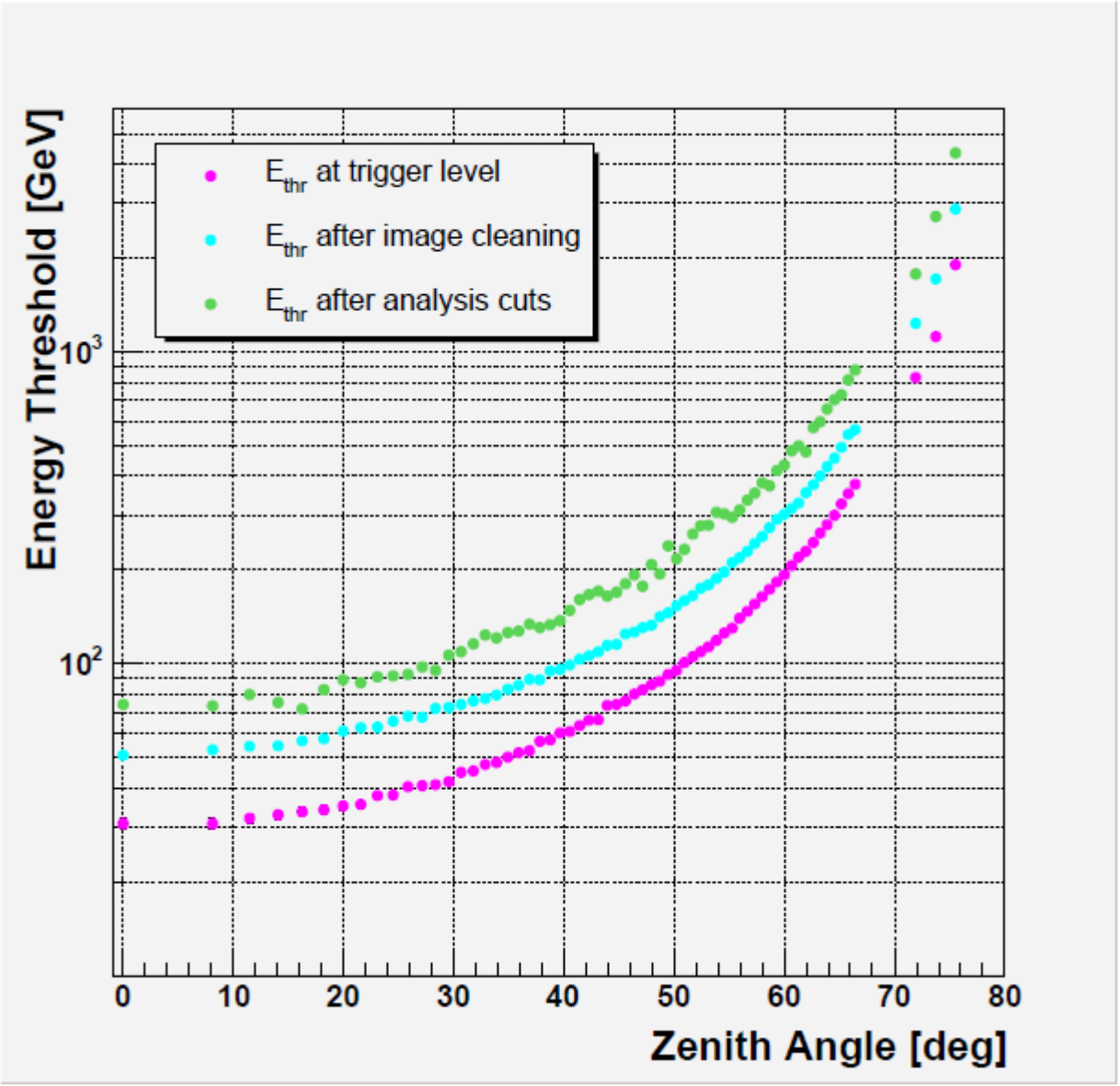
- Camera Control System is not only controlling HV and monitoring DC&HV, but also saving camera from bad weather, accident.
- To detect GRB by MAGIC, it is important to point quickly and certainly in duration time of burst.
- After upgrade of new trigger, we will achieve lower threshold energy (~25GeV). This helps GRB observation.



(a) Hadronic shower



(b) Electromagnetic shower


Energy Threshold [GeV]
10^3
10^2
E_{thr} at trigger level
E_{thr} after image cleaning
E_{thr} after analysis cuts
0
10
20
30
40
50
60
70
80
Zenith Angle [deg]