Study on the direction construction for low energy γ-rays with lhaaso-wcda experiment

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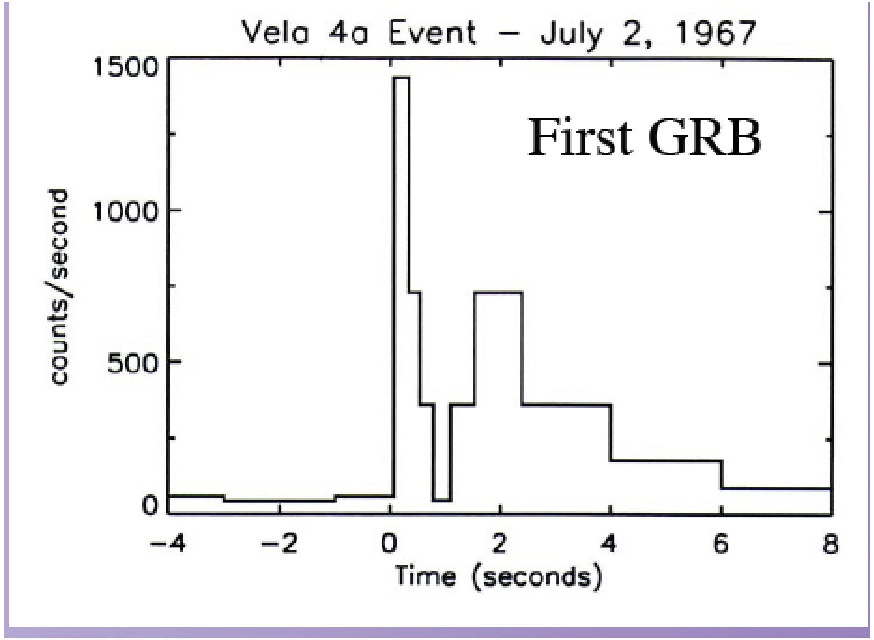
- 2.Method
- 3.Result
- 4.Conclusion & Future Work

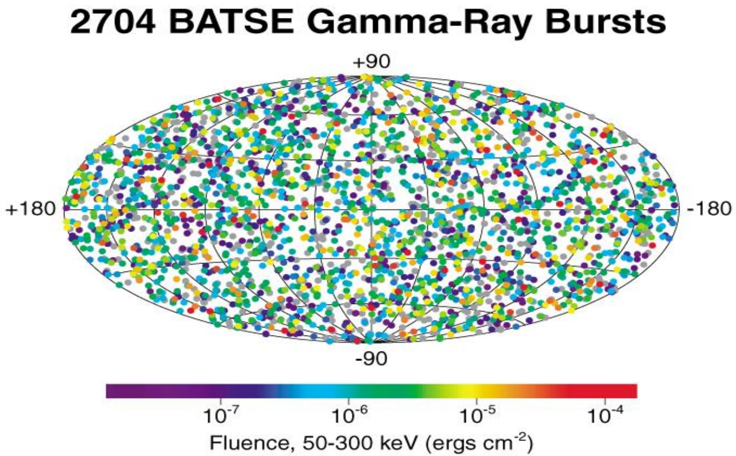
The discovery of GRBs

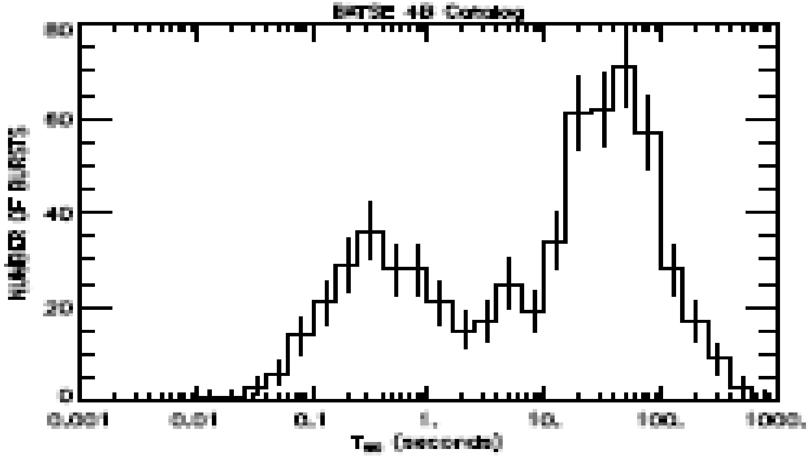
Sketch of one of the Vela satellites to search for violations of the nuclear test ban treaty.

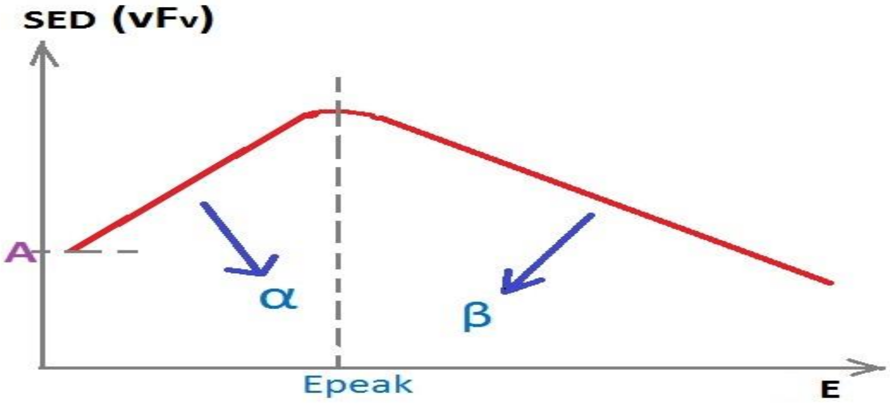


1967, Vela satellites detected extremely bright flares from the sky, with durations of a few seconds;(Klebesadel et al.,1973)

Characteristics of GRBs







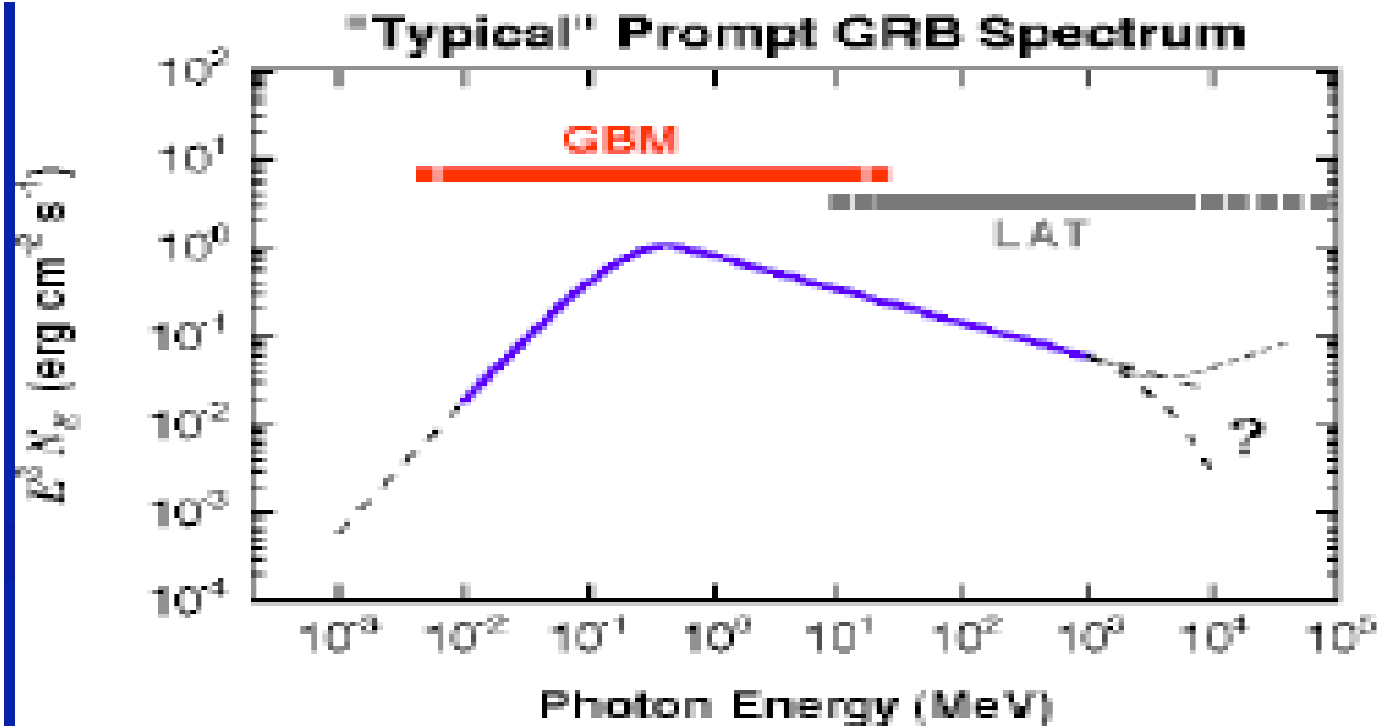
During the burst, GRBs are the brightest gamma-ray objects in the sky, brighter than the Sun!

Locations： Cosmological distance

Light curve： ms—1000s

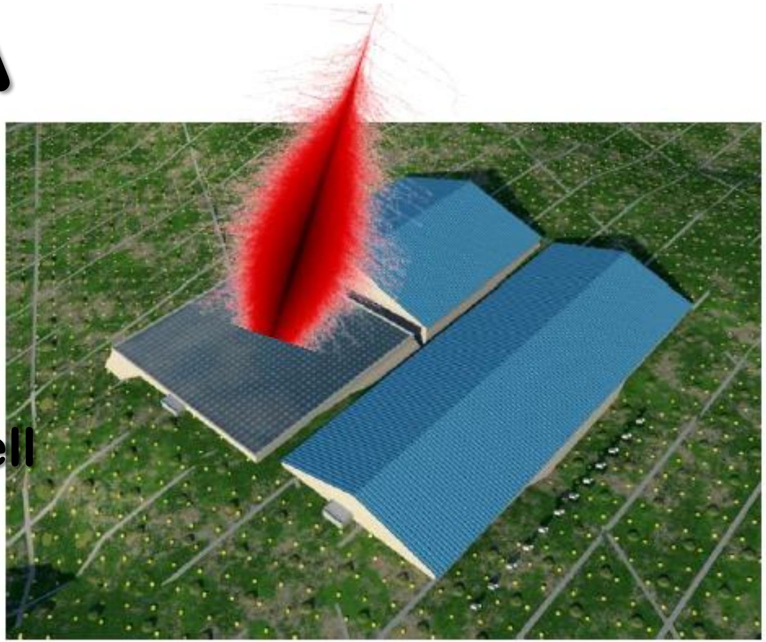
Spectrum ： Bimodality (Band model)

high enregy GRBs radiation



~100 GeV region gap

WCDA

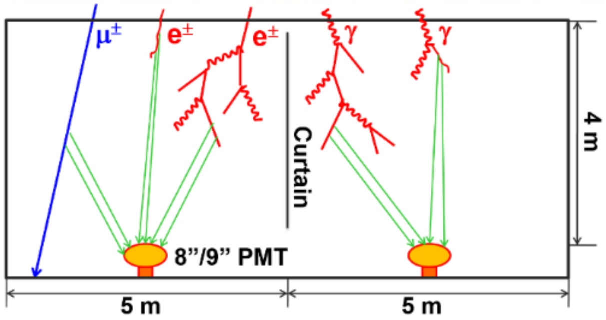


3 water ponds:

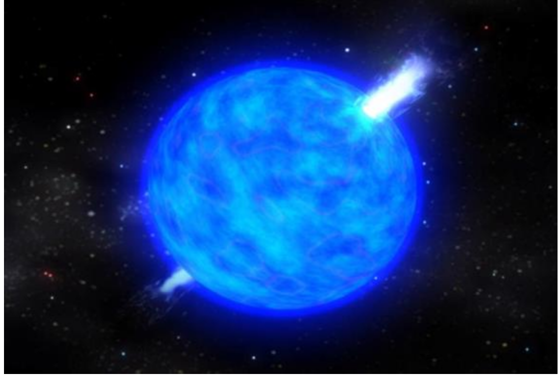
- 78,000 m2in total;
- 3,120 cells, with an 8"PMT in each cell

Detect shower secondary particles:

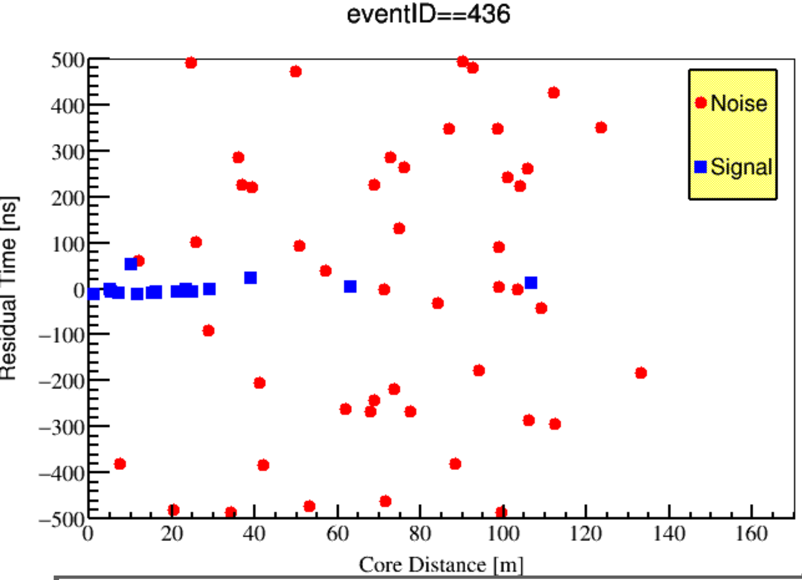
- Electrons/positrons;
- Muons;
- Gammas.

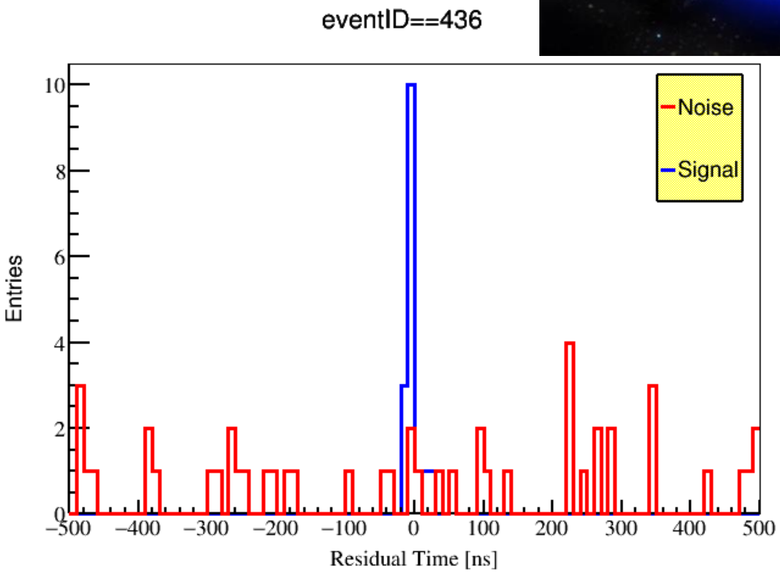


Method



A MC γ-ray event





The narrower the time window, the less background

True direction → the narrow time window(tens of ns)

Monte Carlo Sample

Corsika+g4wcda+hitsreader_recon3

/eos/wcda/g4wcda/full_sky/Gamma/1.e10_1.e11

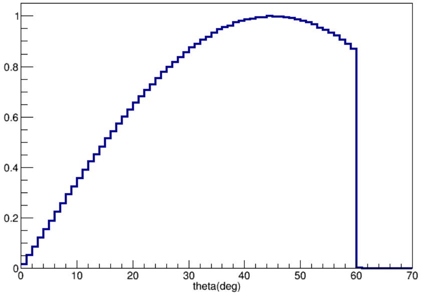
Gamma-ray : 10-100 [GeV]

Zenith ： 0-60 [degree]

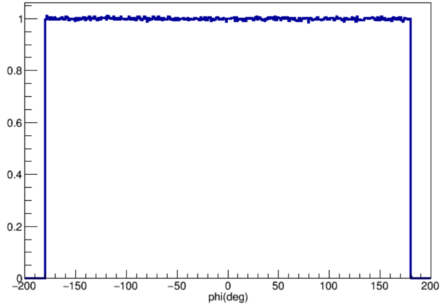
Azimuth： 0-360 [degree]

Total sample ： 4e7 [events]

Area: 150m×150m(one pool)



Distribution of true zenith



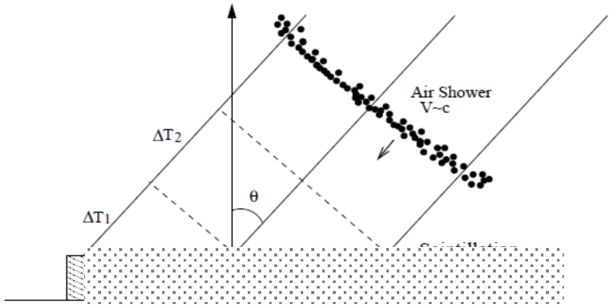
Distribution of true azimuth

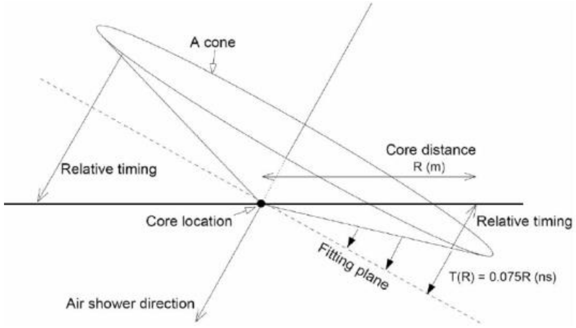
Direction construction

the true direction of the event

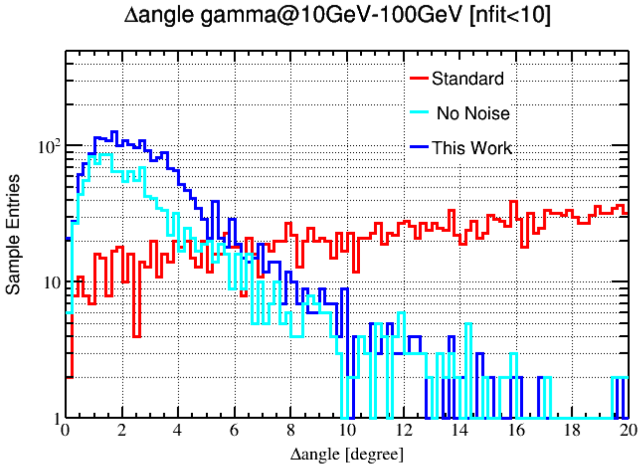
MC→Corsika, Experiment→ Other Experiments:Fermi……

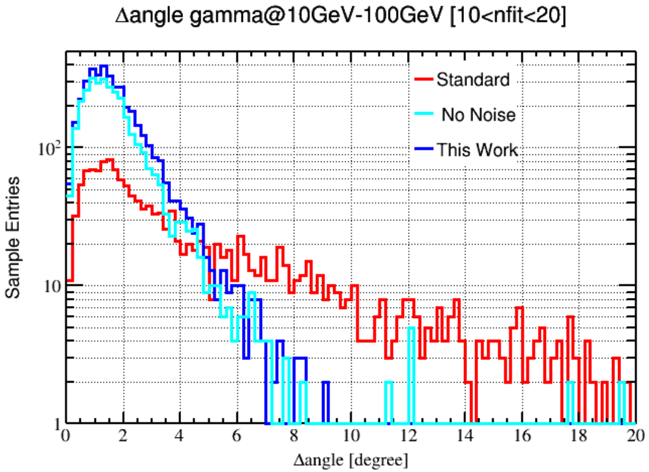
$abs(t_{hit} - t_{expected}) < 15ns$ √

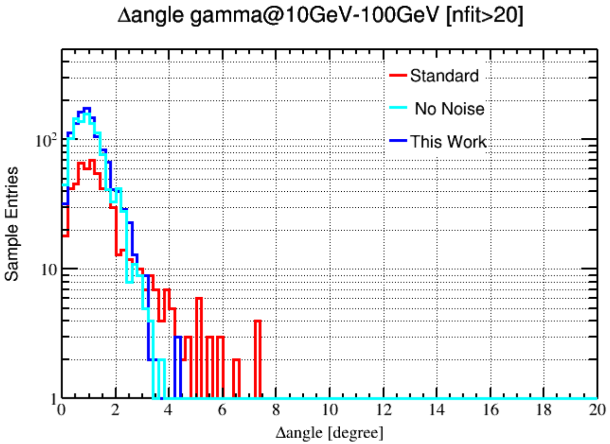




The schematic diagram of the direction reconstruction

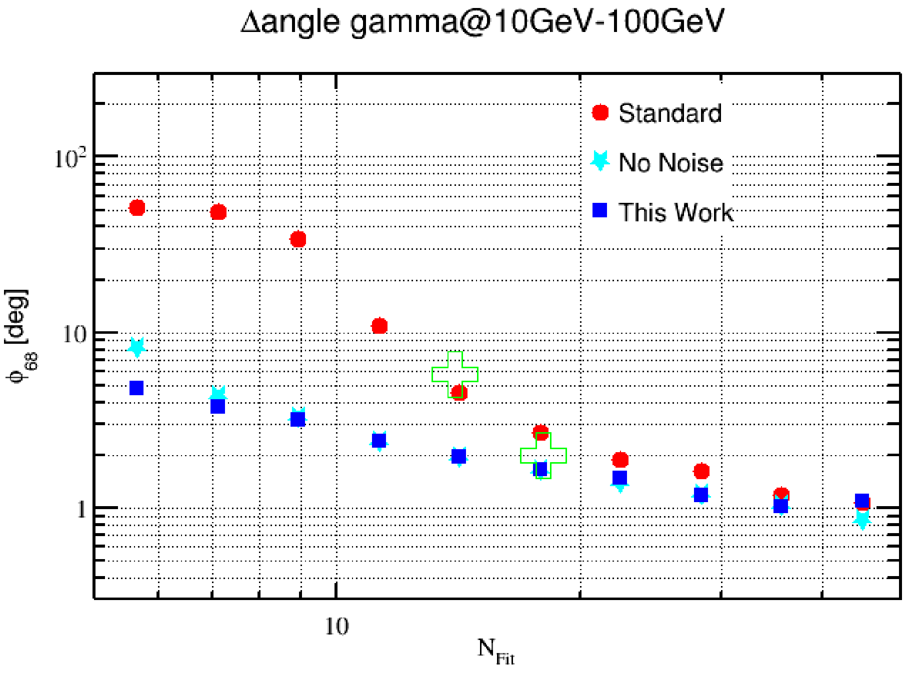


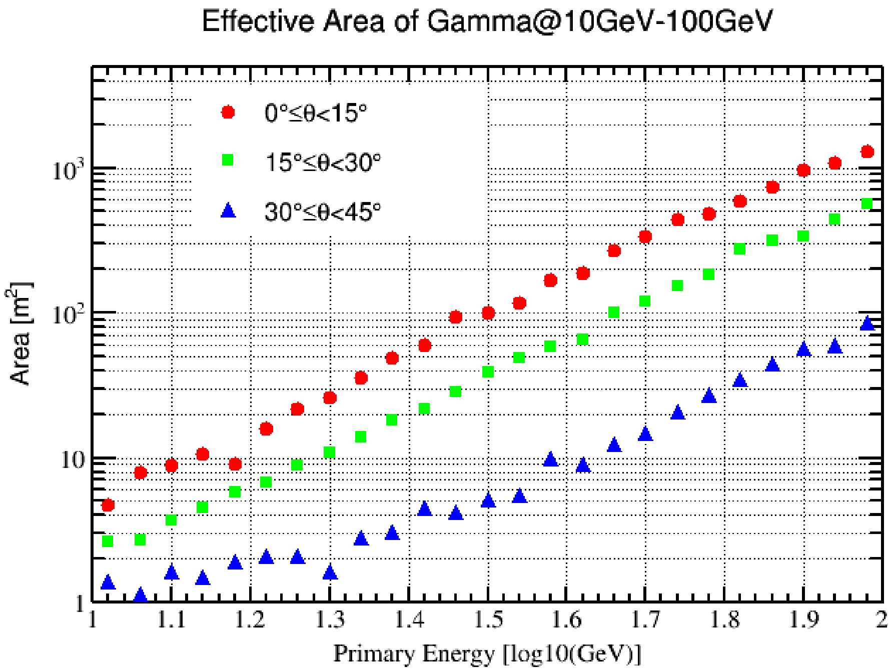




1.The angular difference distribution between the true angle and the reconstructed one
2.The angular resolution is becoming better with the increase of nfit
3. Our method does works!

Angular Resolution & Effective Area





Sensitivity to GRBs

- 1. Construct GRB samples
- 2. Be identical with the observation by Fermi
- 3. Expect the observation of GRBs with lhaaso-wcda

Generator of GRBs

Band 谱， α, β → α, β

额外成分： R_{extr}, β_{extr} → R_{extr}, β_{extr}

根据红移分布 $R(z)$, 光度函数 $\varphi(L_p)$ 得到 Z, L_p → Z, L_p

$$(E_{\rm iso}/T'_{90})/L_p = 0.31 \pm 0.2.$$

根据 E_{peak}-L_p 经验关系得到 E_{peak} → E_{peak}

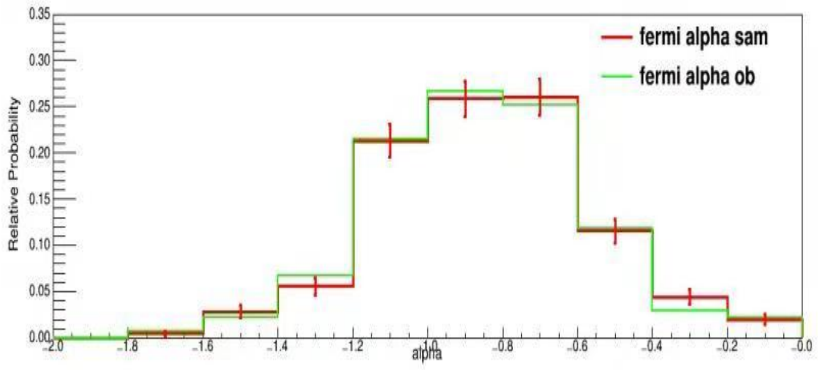
$$L_{\rm ave} = 0.31 L_p$$ → A

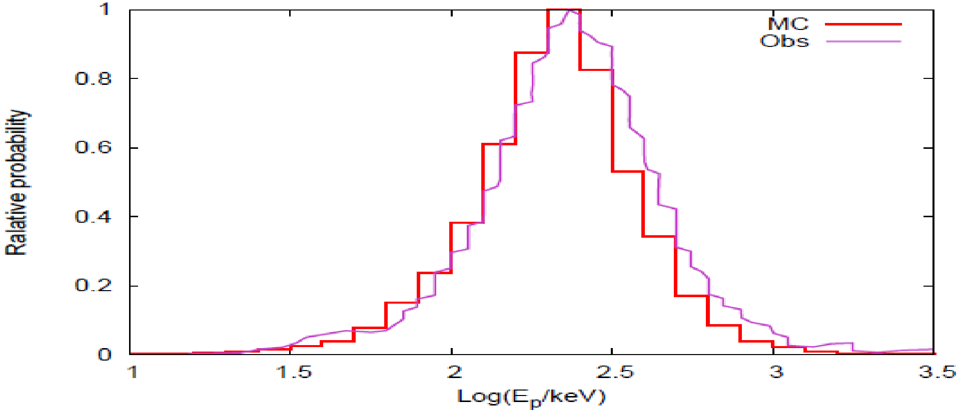
$$\log E_{iso,52} = 0.9 \log L_{p,52} + 0.6$$

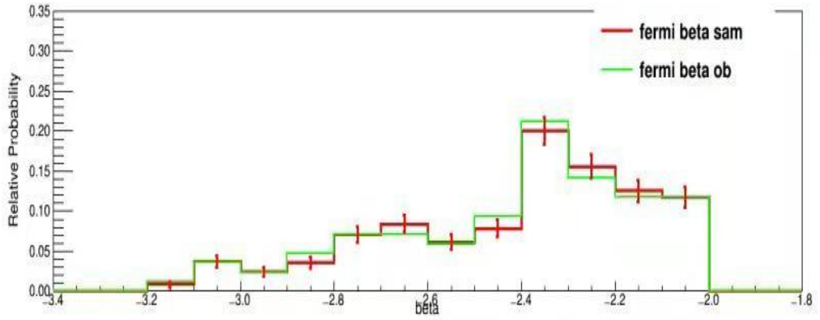
$$T'_{90} = E_{\rm iso}/L_{\rm ave}$$

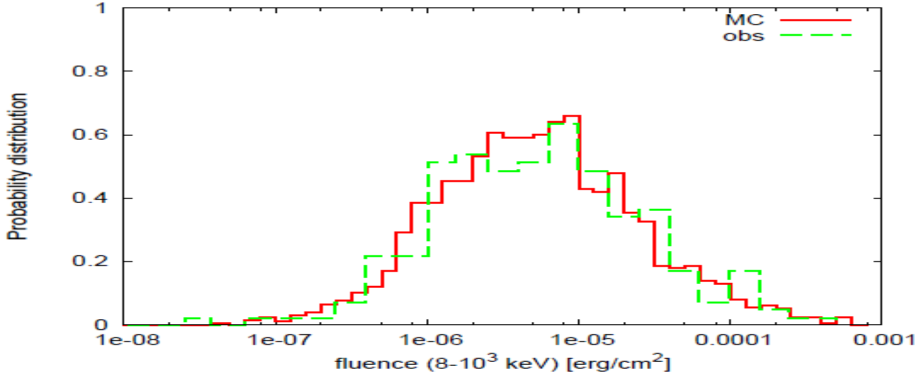
$$T_{90} = (1+z) T'_{90}.$$ → T_{90}

“Band” & Fermi’s observation

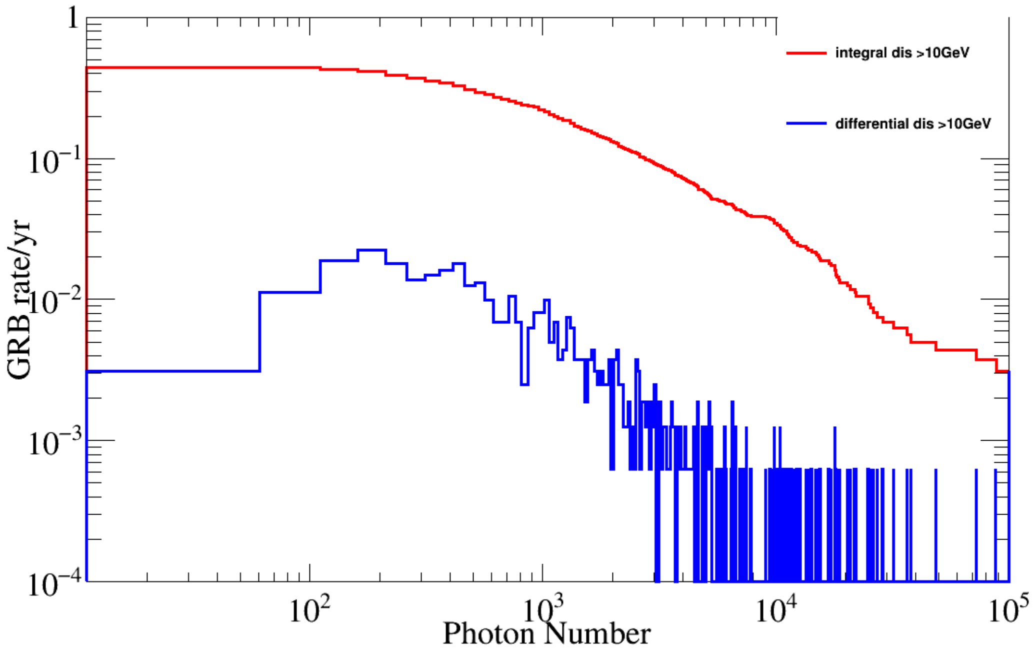




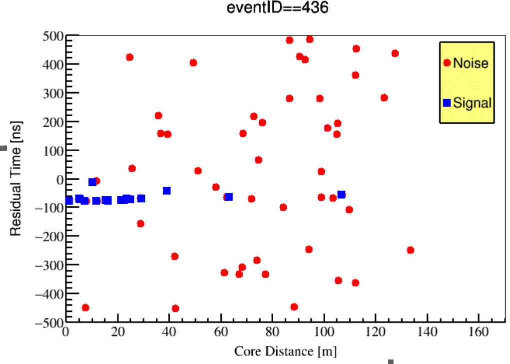




Annual detection rate of GRBs



Based on the samples that have been tested, the expected annual detection rate of GRBs with ¼ lhhaso-wcda is ~0.5



Conclution :

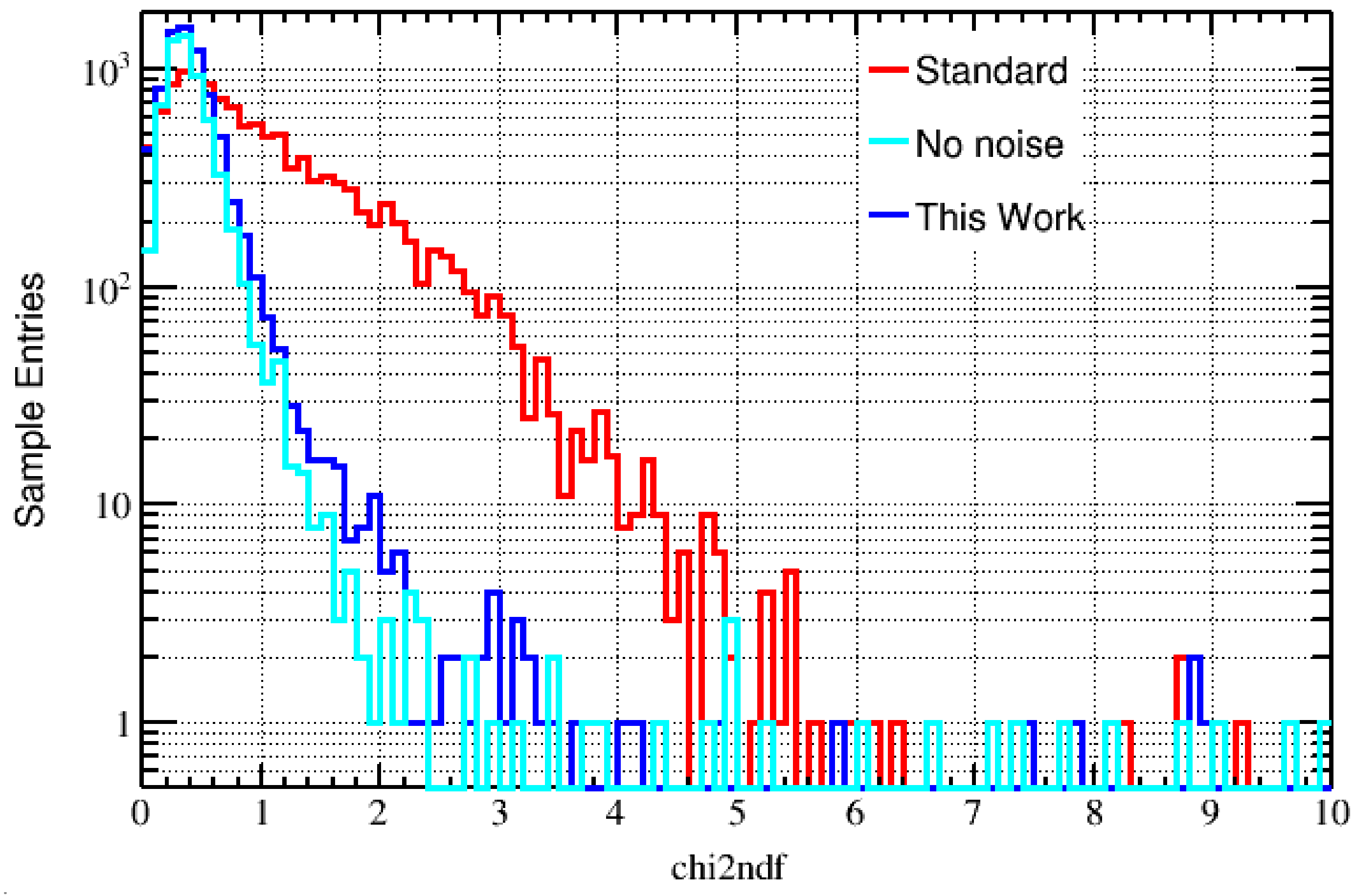
1.A narrower TIME window → the less noise → a better angular resolution in the low energy region
2.Angular resolution + effective area → sensitivity of GRBs

Future Work:

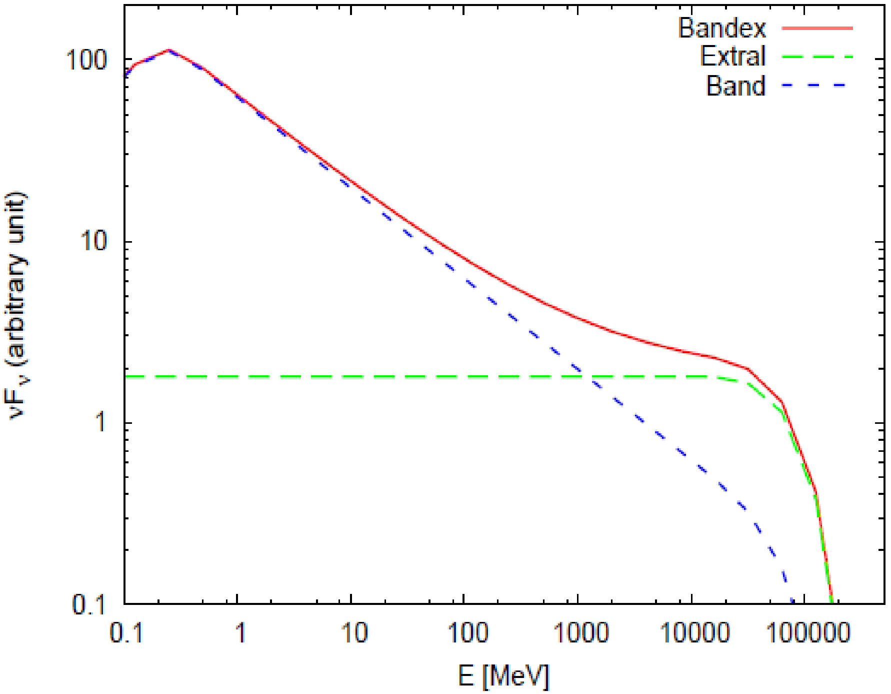
1.A narrower POSITION window → exclude more noise → a much better angular resolution
2. Robust reconstruction method

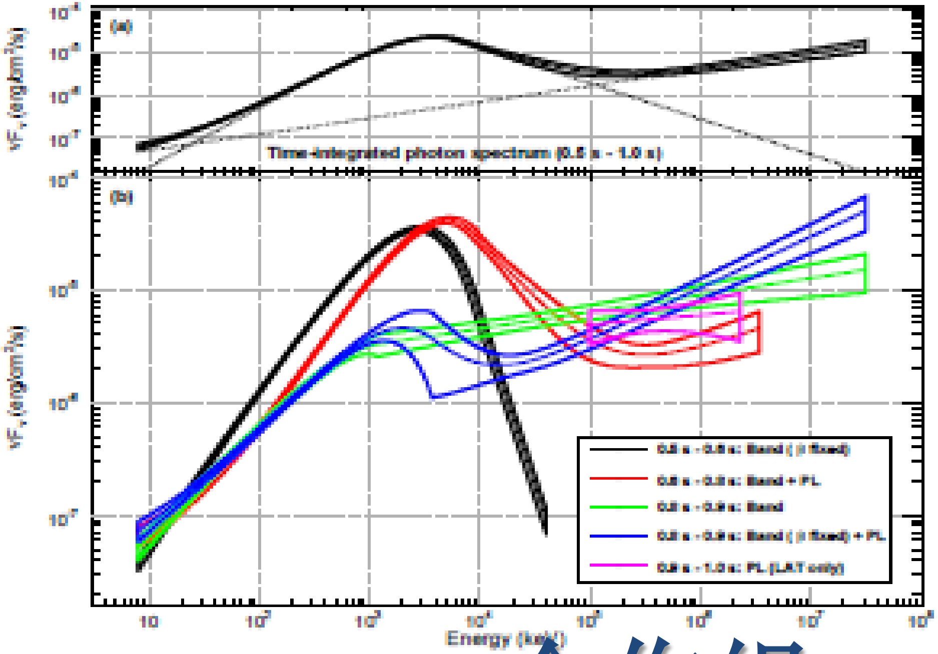
Thank you !

chi2ndfc gamma@10GeV-100GeV



高能额外成分观测





对高能贡献关键

Ferm-LAT 合作组

2010,ApJ,716,1178