ID: ICRC2019(647)

A Northern Sky Survey for 100 TeV γ-ray Source Using the Tibet Air Shower Array and Muon Detector Array

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GAI7b: JULY 29TH 16:45-17:00, Gamma Ray Indirect, Historical Society

The Tibet ASγ Collaboration

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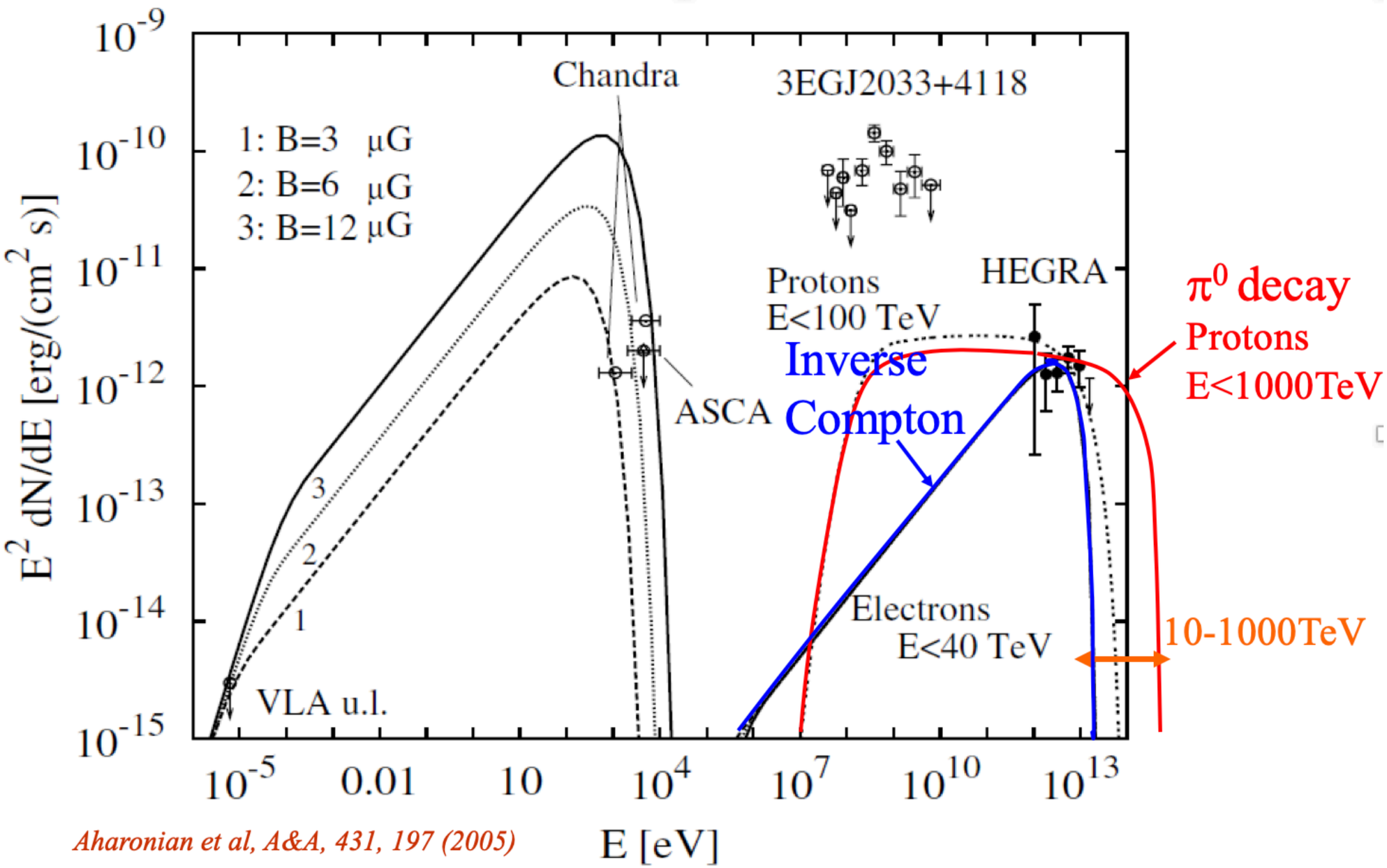
γ rays in the 100 TeV region

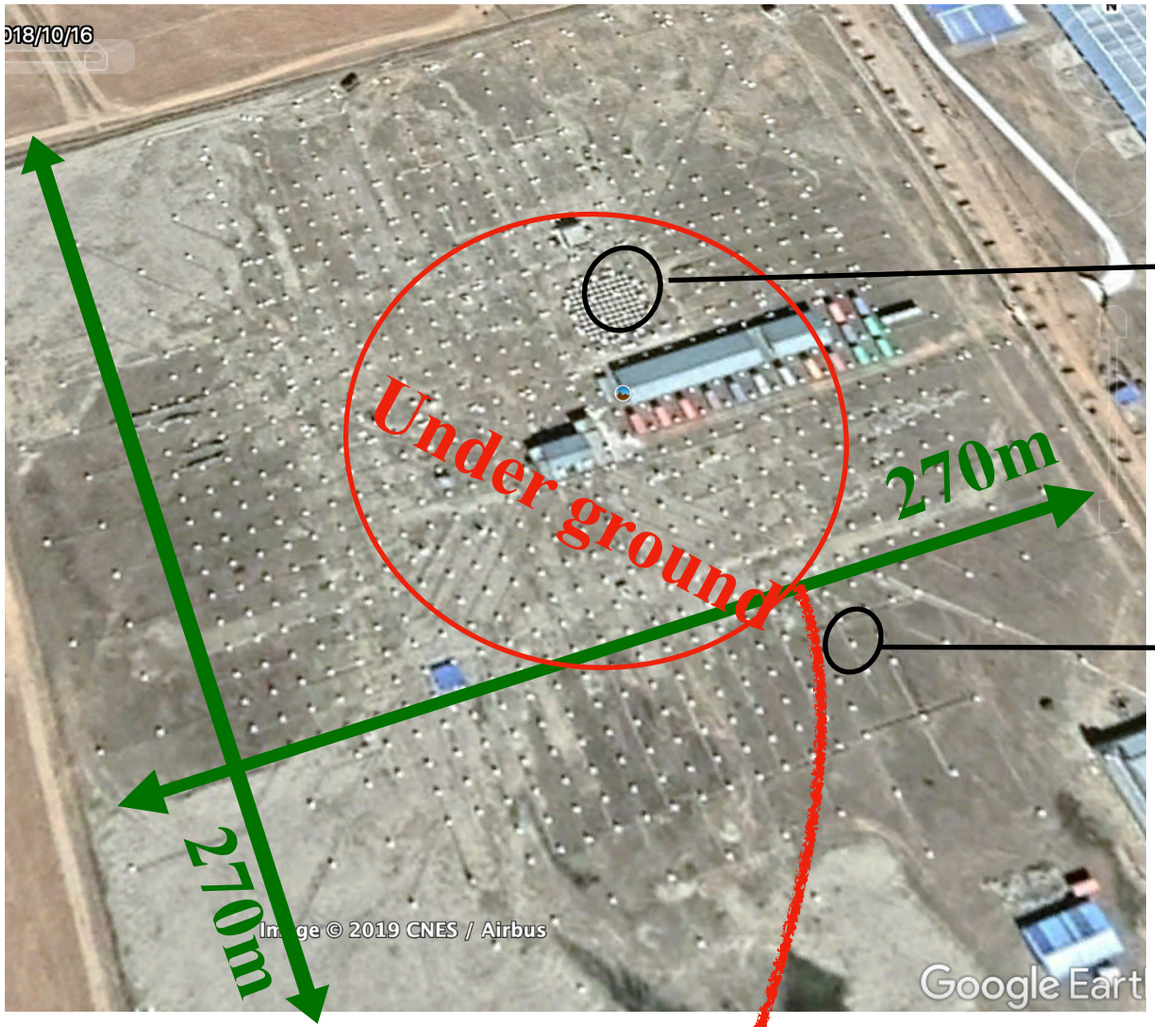
TeV J2032+4130 **Hard spectral index(-2.0) at TeV energies**

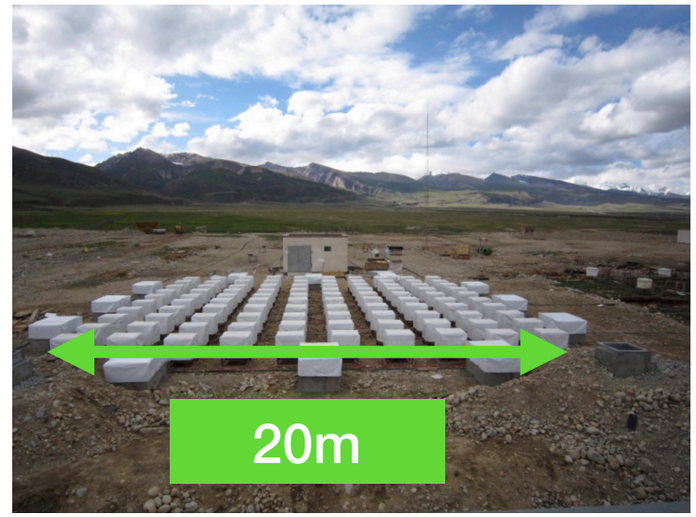


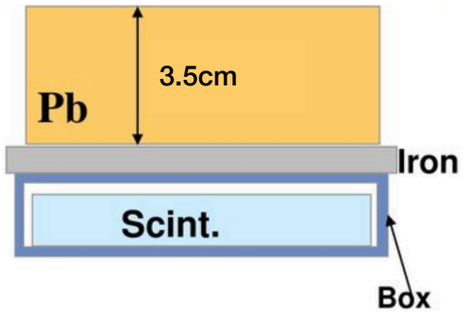
Aharonian et al, A&A, 431, 197 (2005)

The Tibet ASγ experiment

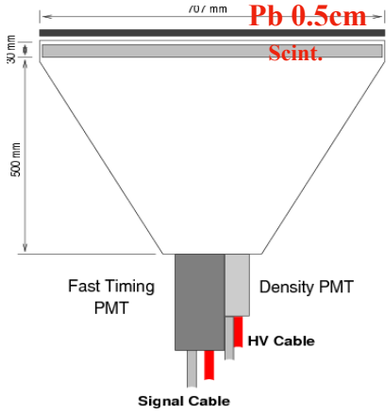
At Yangbajing, Tibet, China(90.522°E, 30.102°N, 4300m a.s.l)



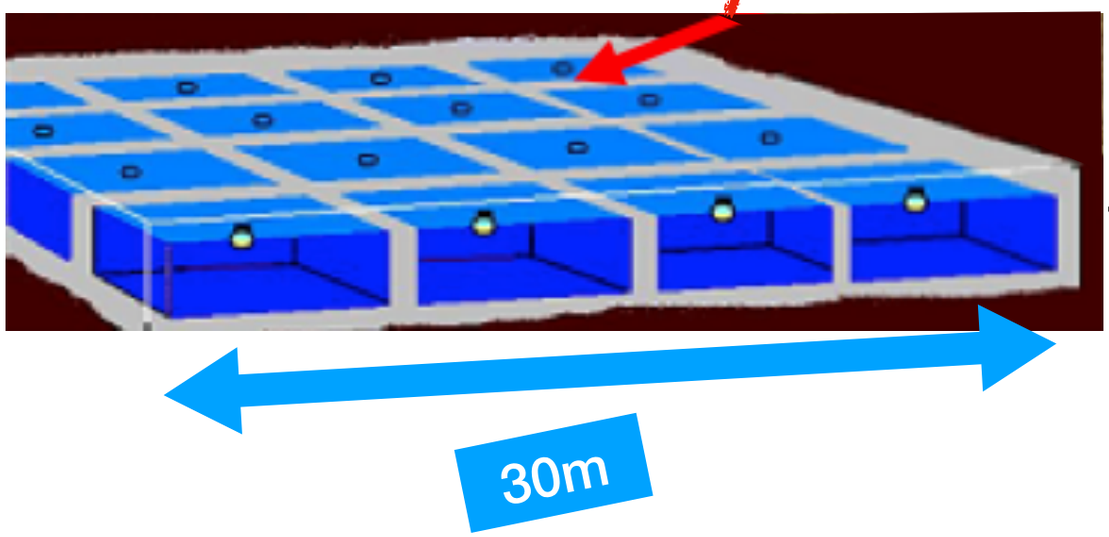




YAC-II

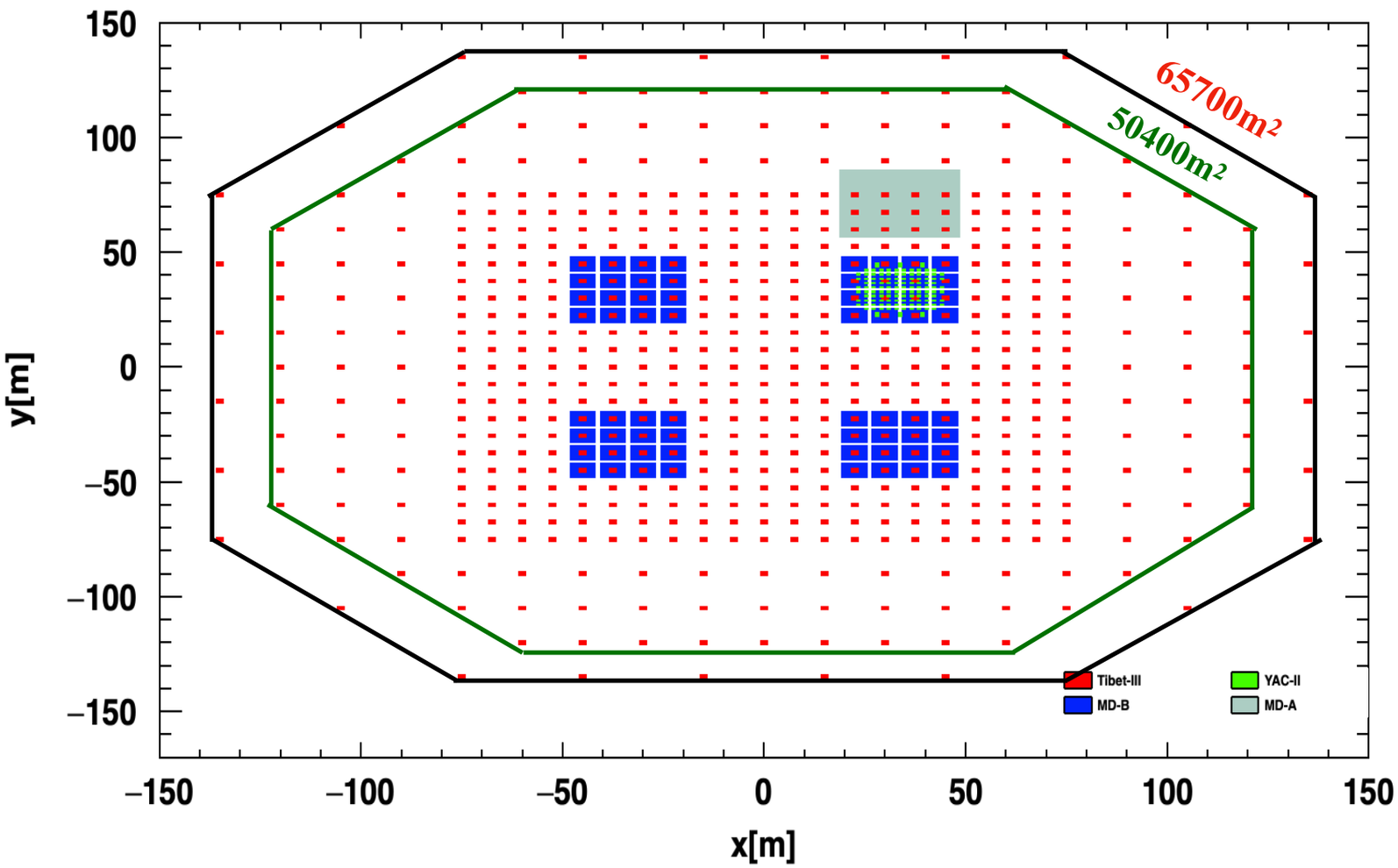


Tibet-III



MD

Tibet-III+MD



Tibet-III (Primary energy, Primary direction)

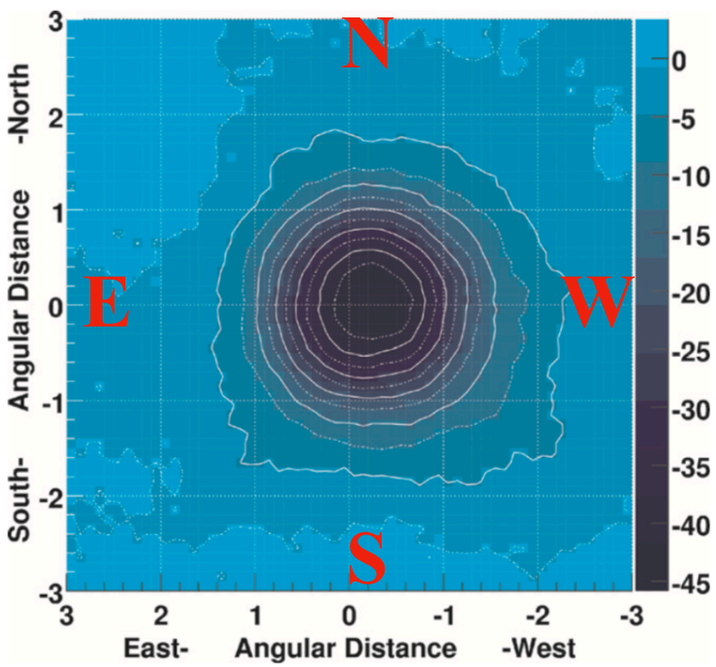
- Area: 65700 m²
- Each detector: 0.5 m²
- Energy: TeV-PeV
- Angular resolution:
  - 0.4°~10 TeV
  - 0.2°~100 TeV
- Field of View ~2Sr

MD(P/γ)

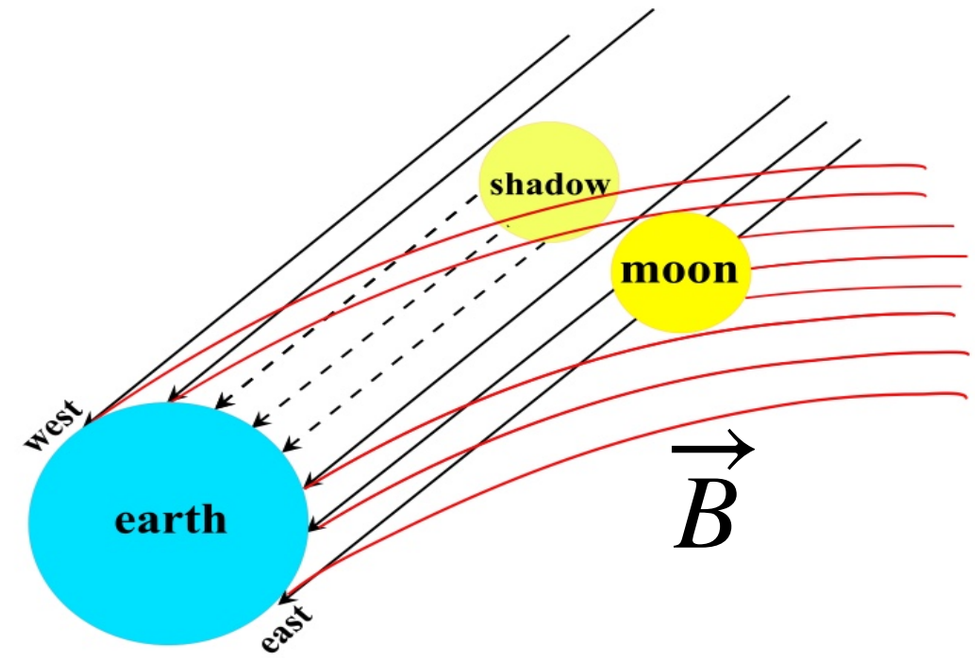
- Effective area: 3400 m²
- Each detector: 54 m²
- Underground ~19X_0

Pointing accuracy and Energy uncertainty

Moon shadow

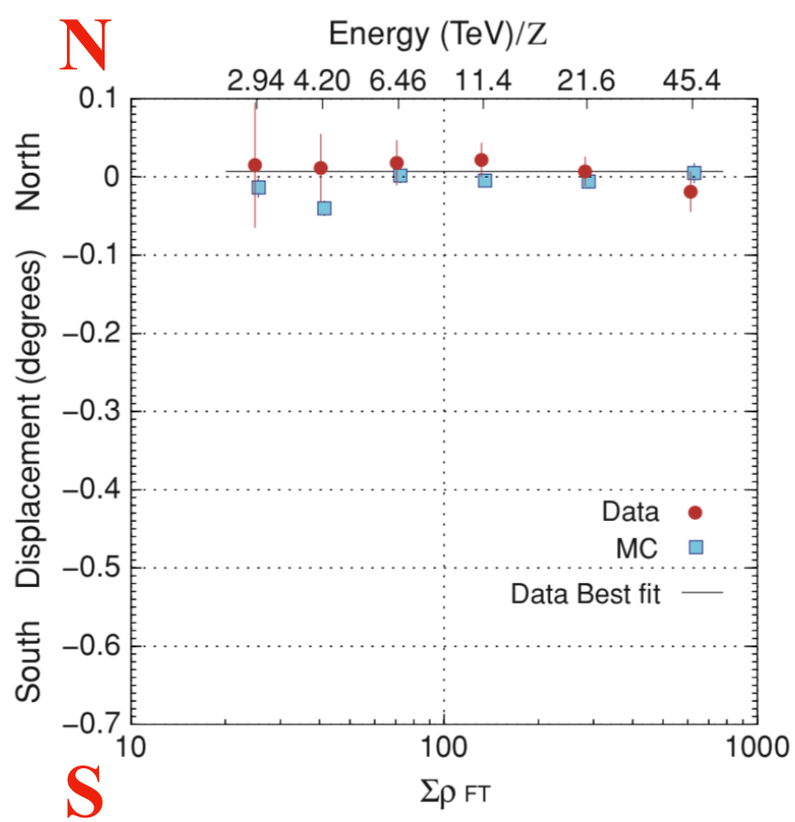


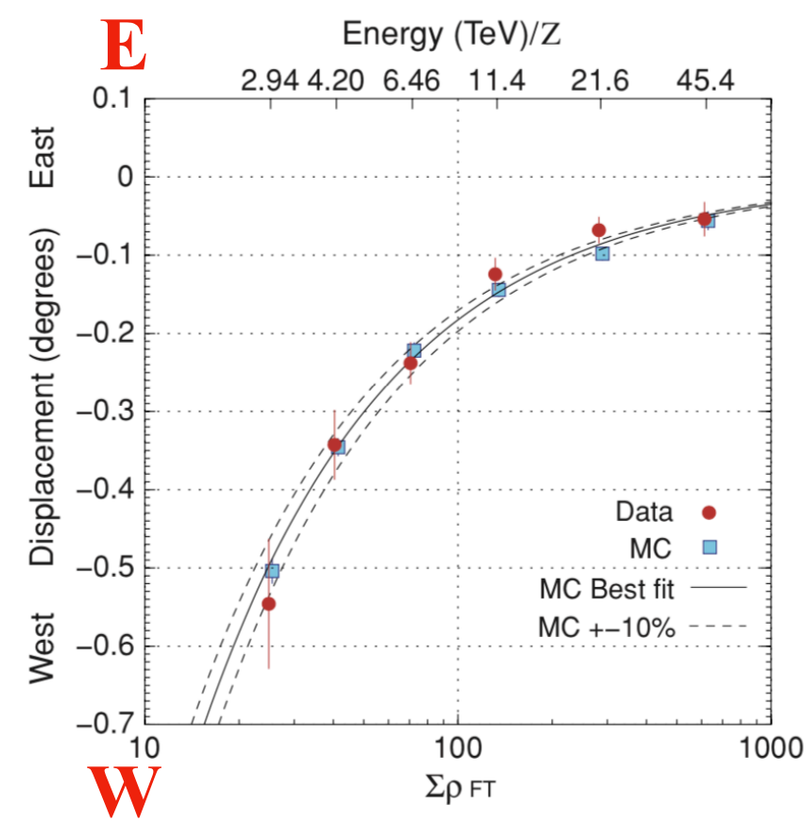
(M. Amenomori et al., APJ, 2009)



Proton

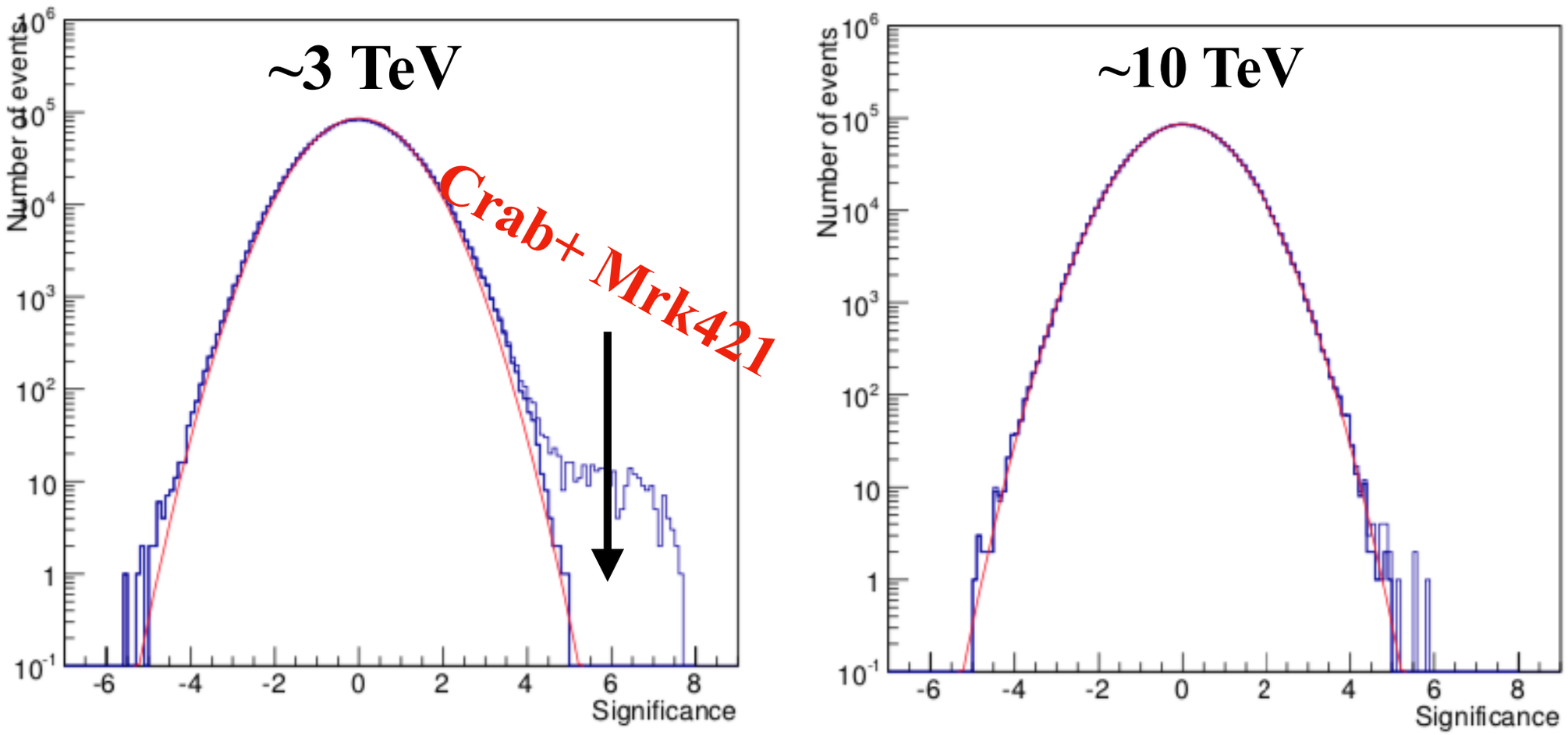
Tibet-III





pointing accuracy ~0.01° **energy uncertainty ~12%**

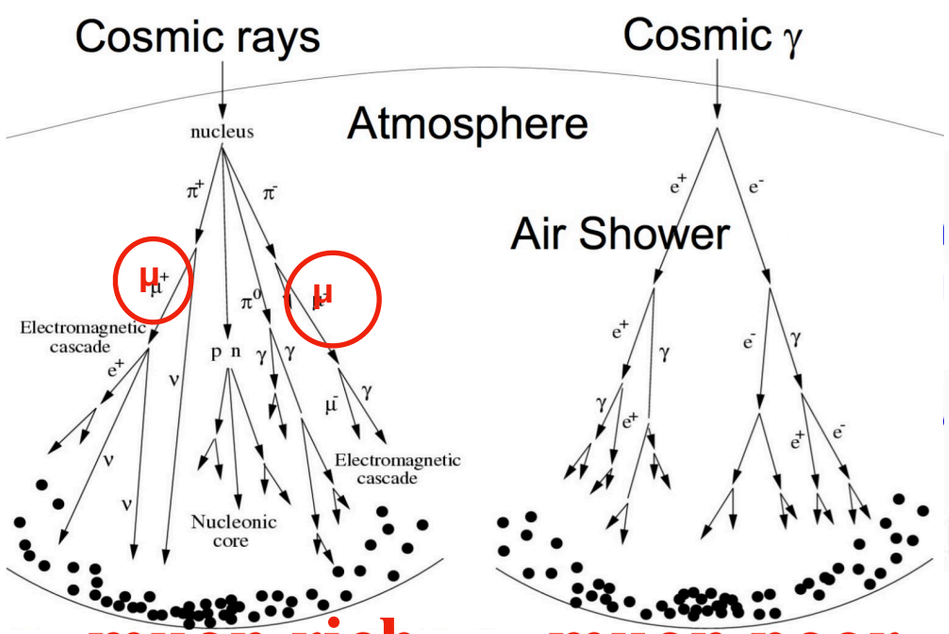
Tibet-III （1999-2010）



M. AMENOMORI, et. al. ICRC2013-0498

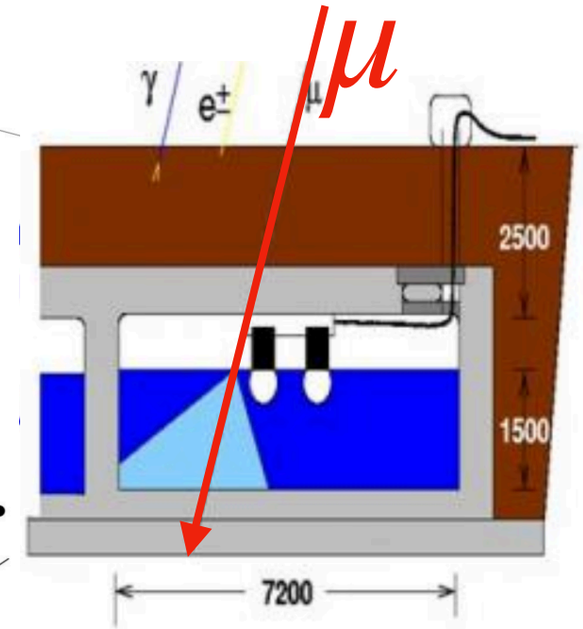
Only Tibet-III, not enough significance beyond 10 TeV.

Muon detector(MD)(P/γ)

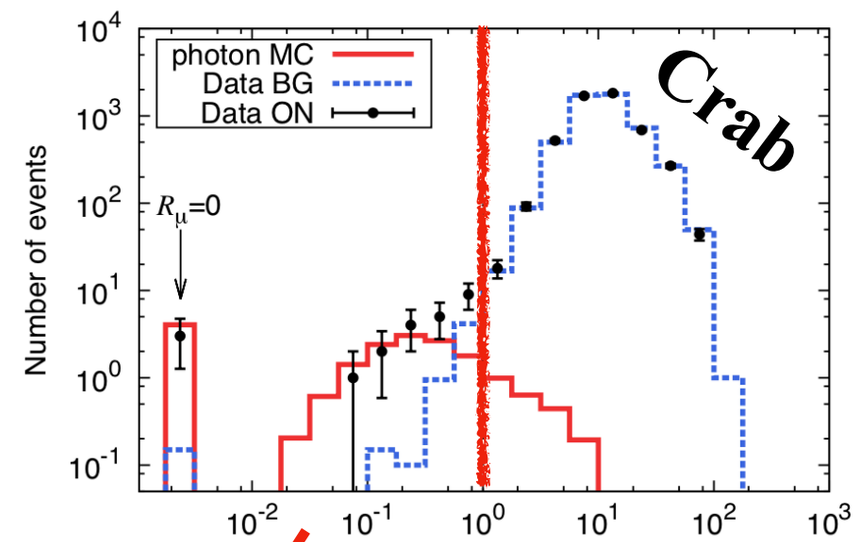


muon rich

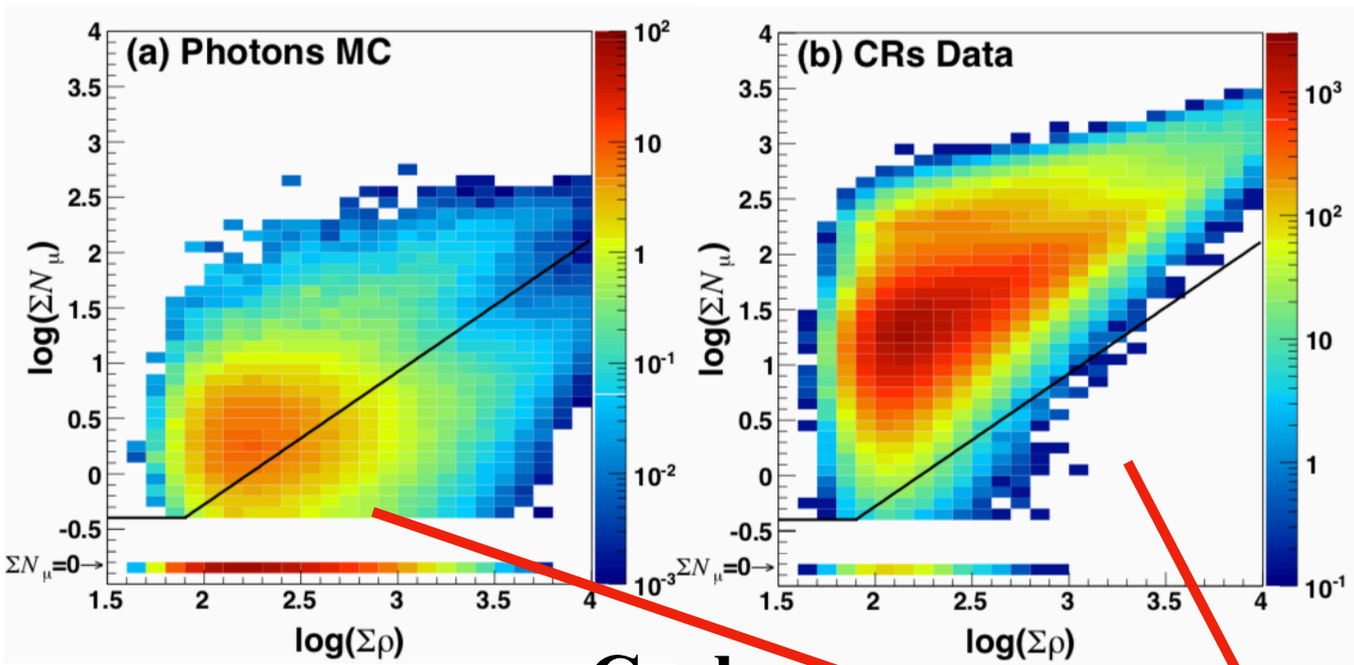
muon poor



E>100TeV



$N_\mu / N_{\mu,cut}$



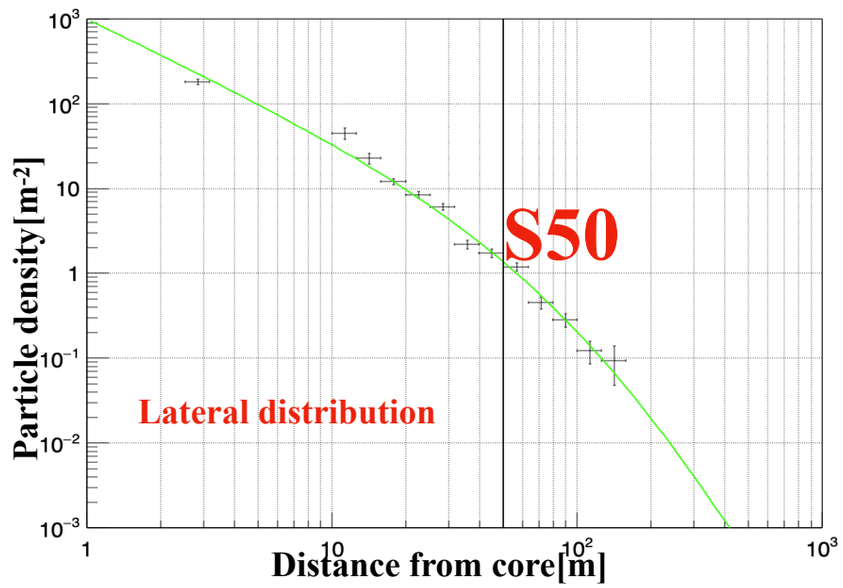
Crab

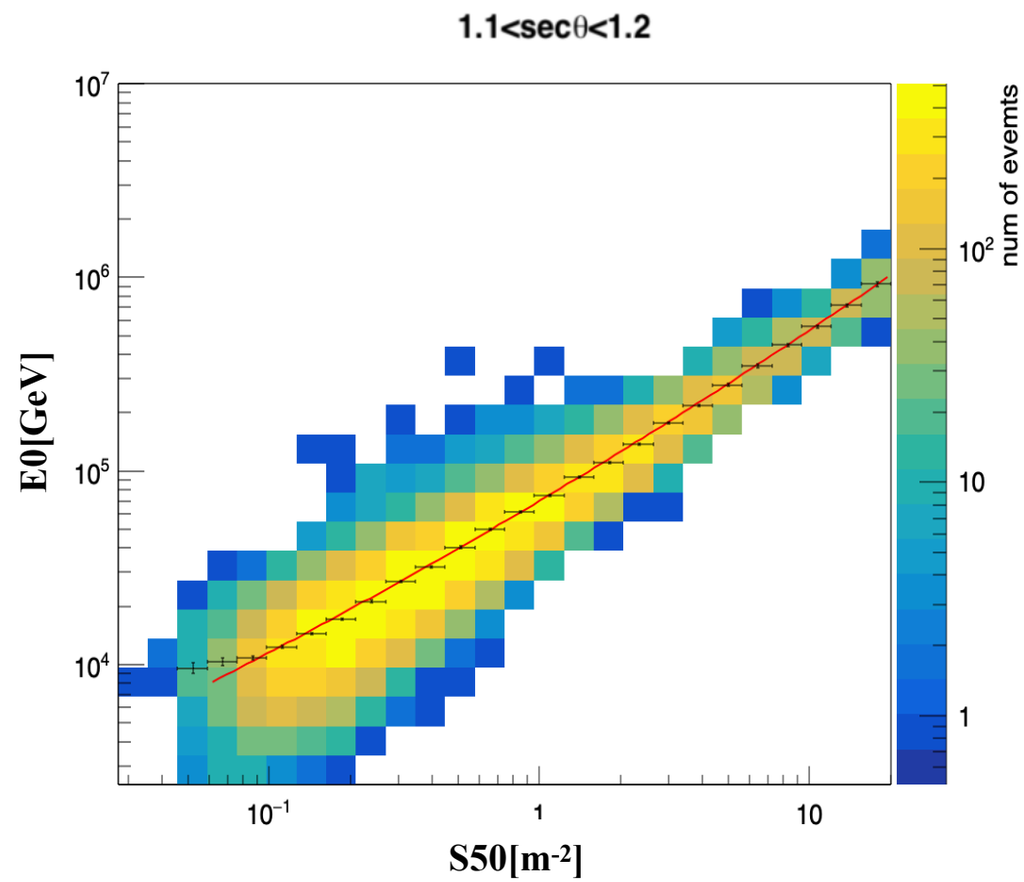
(M. Amenomori et al., PRL, in press, 2019)

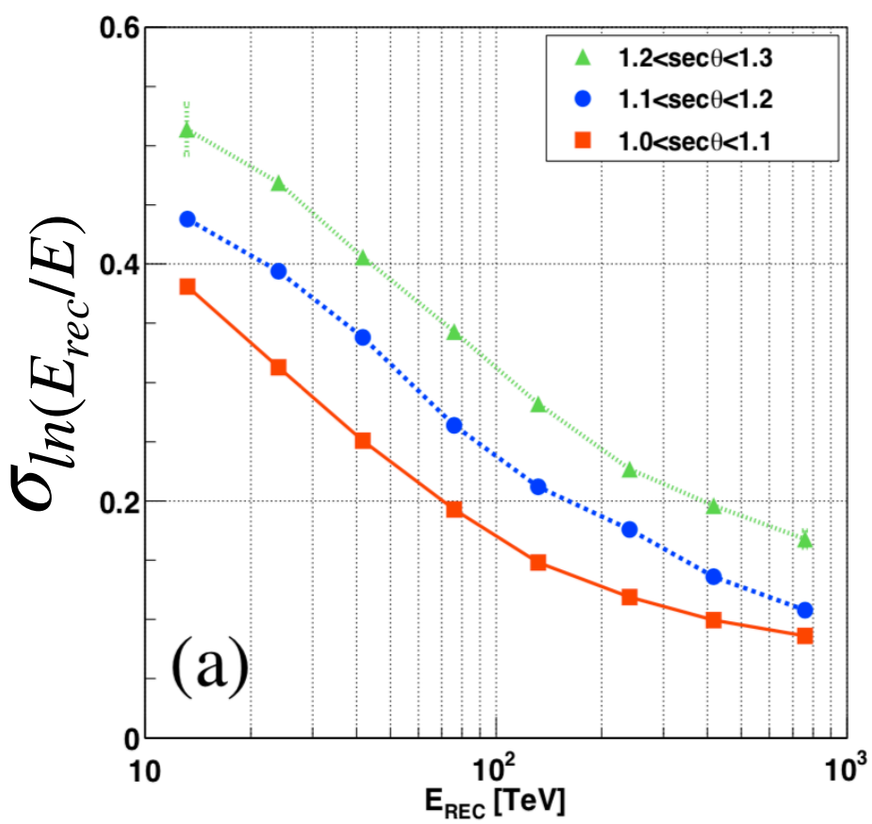
At Energy >100 TeV, The CRs background rejection is 99.92%, while 90% of the photons remaining.

muon poor events, γ-like

Energy determination





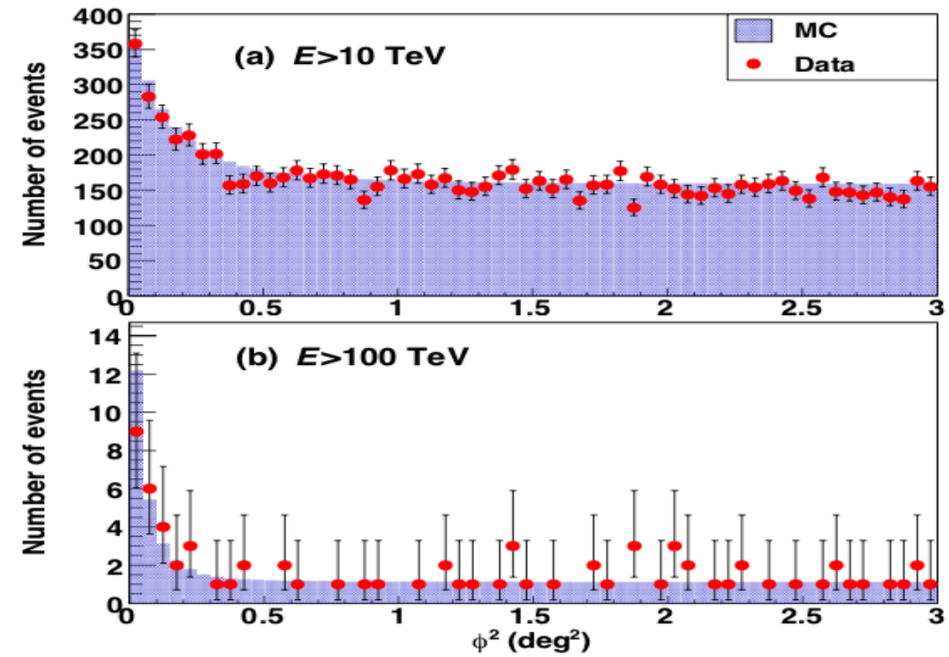


(K. Kawata et al., 2017)

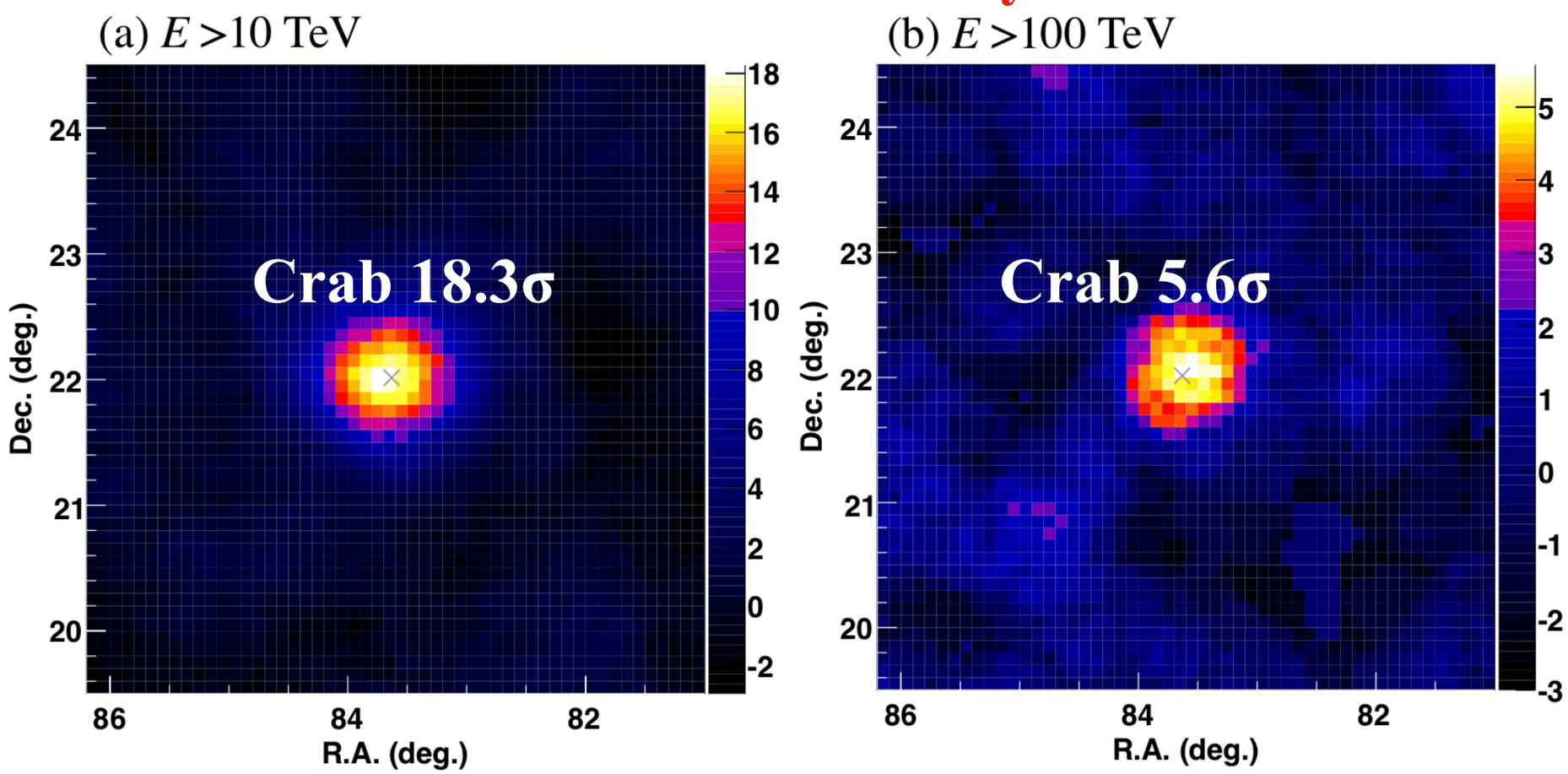
The average energy resolutions with S50 are estimated to be 40% at 10 TeV and 20% at 100 TeV.

Crab Nebula

E >100 TeV: 24 photon-like events against 5.5 background events. corresponds to 5.6σ statistical significance



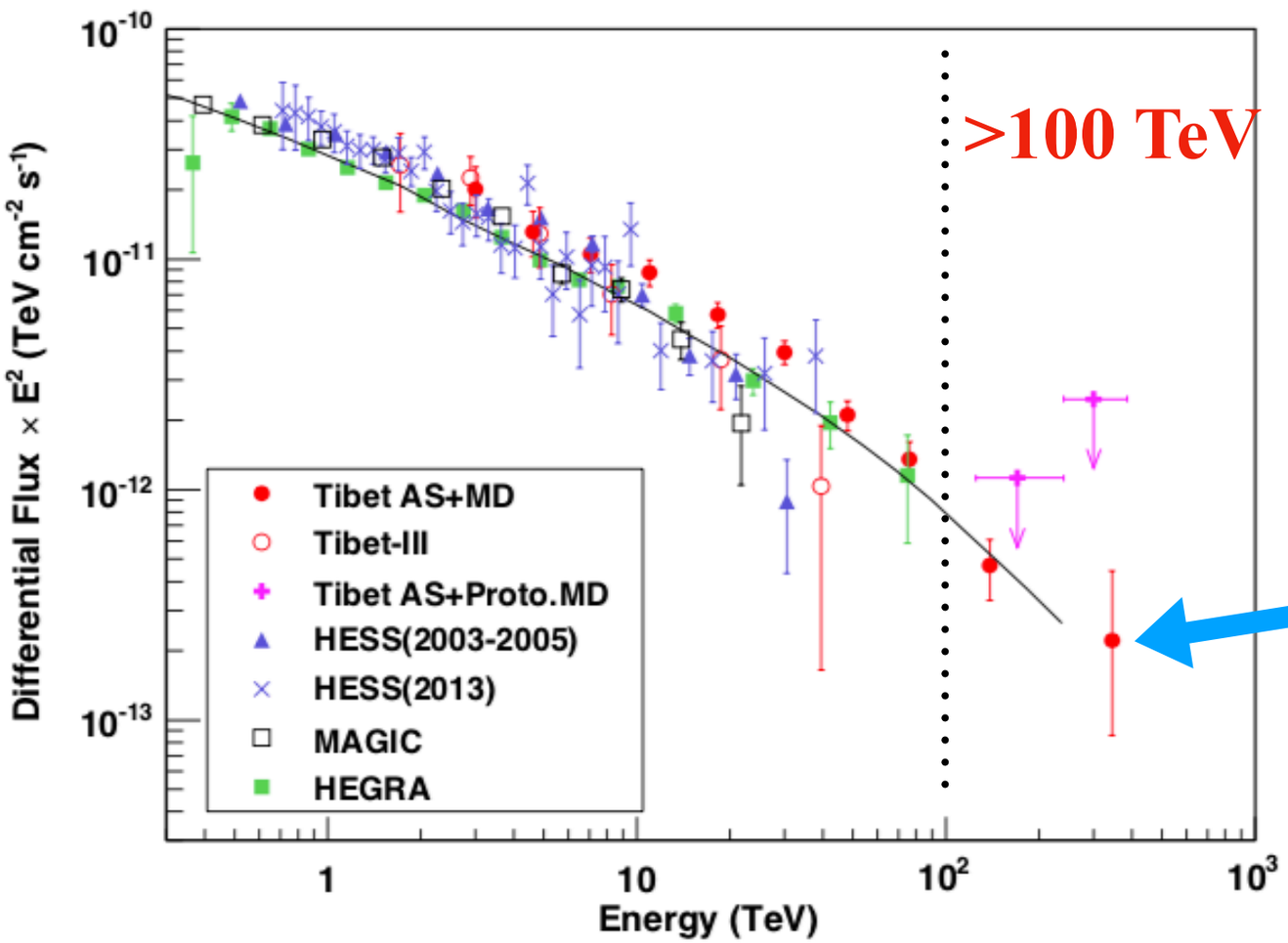
Live time: 719 days



(M. Amenomori et al., PRL, in press, 2019)

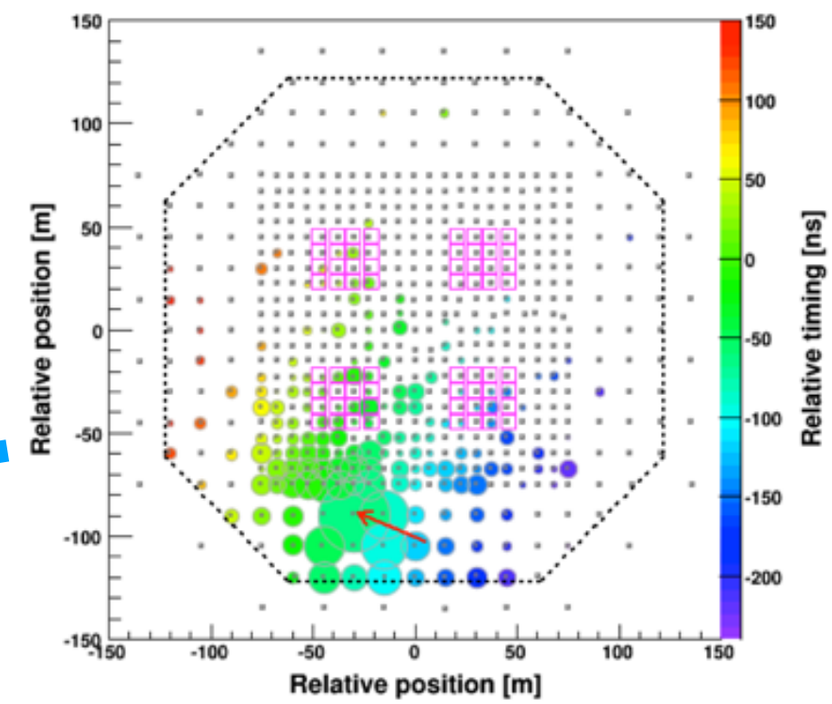
Crab Nebula beyond 100 TeV

Differential energy spectrum



(M. Amenomori et al., PRL, in press, 2019)

This is the first detection of photons beyond 100 TeV from an astrophysical source.



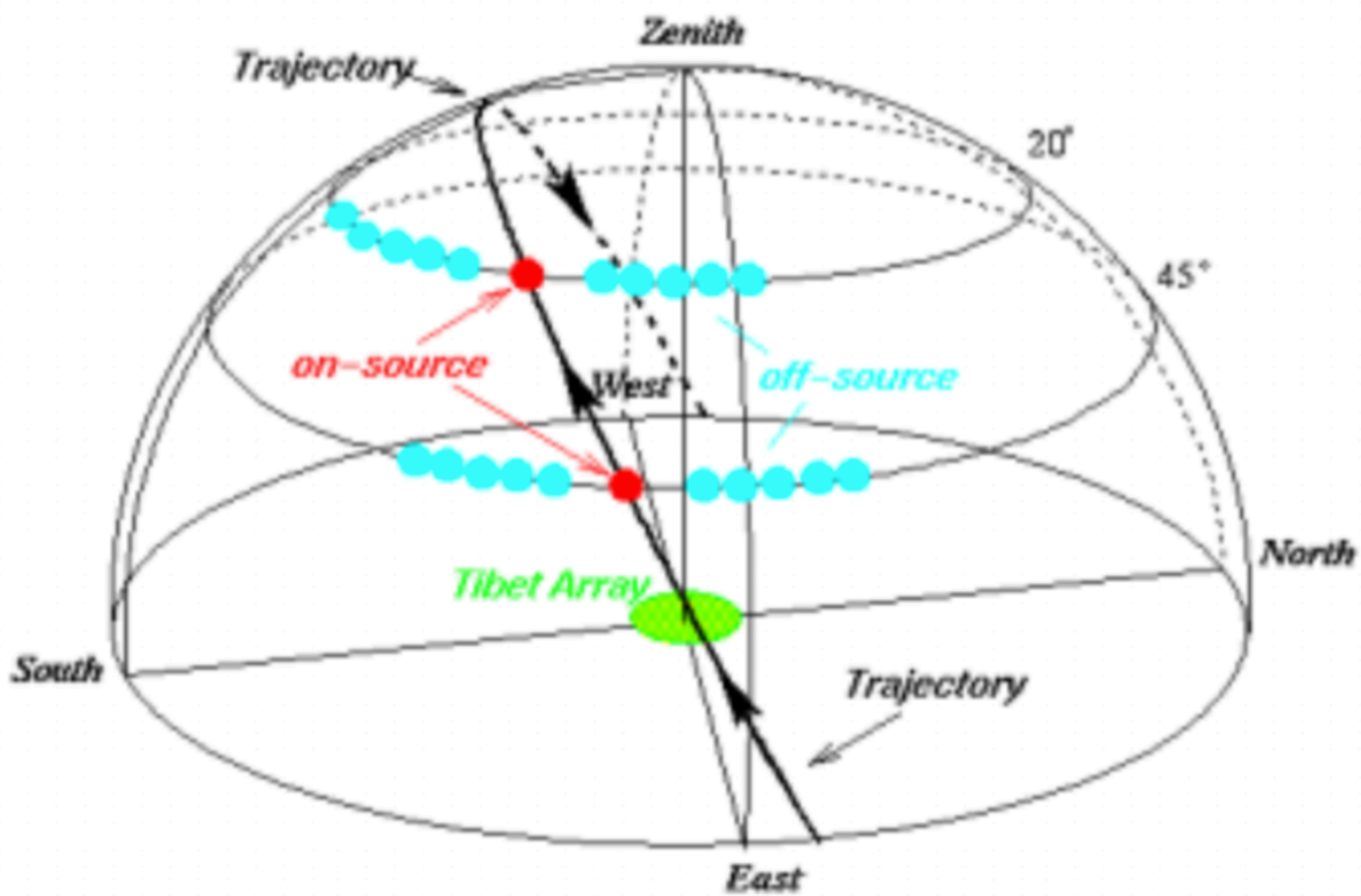
- **the highest photon-like event**
- **energy: ~450TeV**
- **Zenith: 35.4°**
- **Probability of misidentifying 0.029**

Summary

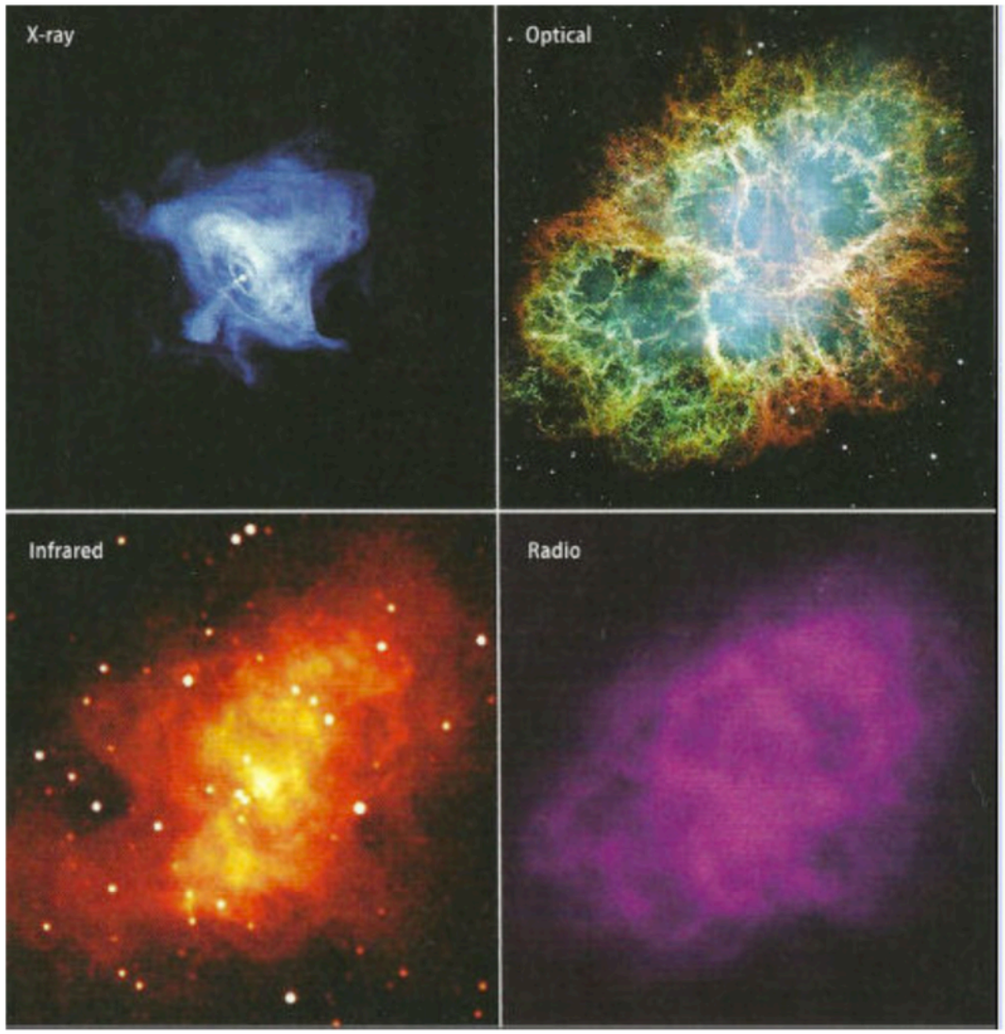
- **The Tibet ASγ experiment has a wide field of view and large effective area.**
- **The Tibet-MD array significantly improves its gamma-ray sensitivity in the 10-1000 TeV energy region.**
- **the northern sky survey shows that Crab has the most excess in the number of primary γ rays beyond 10 TeV. The significance of Crab beyond 10 TeV is 18.3σ, and significance of Crab beyond 100 TeV is 5.6σ.**
- **This is the first detection of the highest energy photons beyond 100 TeV from Crab Nebula.**
- **The results of northern sky survey for γ-ray are under analysis.**

Thanks!!

equa-zenith method



Crab Nebula



NASA, ESA, J. Hester and A. Loll