Search for diffuse γ-ray emission from galactic plane with YBJ-HA

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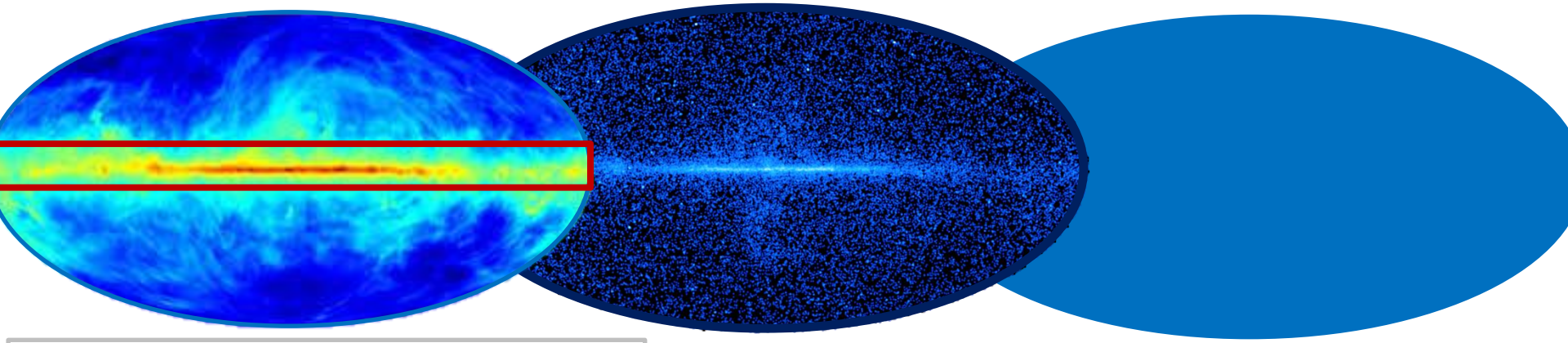
UNIVERSITY OF WISCONSIN-MADISON

MADISON, WISCONSIN, USA

outline

- Diffuse gamma-ray emission
- YBJ-HA (YangBaJing Hybrid Array)
- Data analysis
- Estimation of signal and background
- Result and summary

Diffuse gamma rays

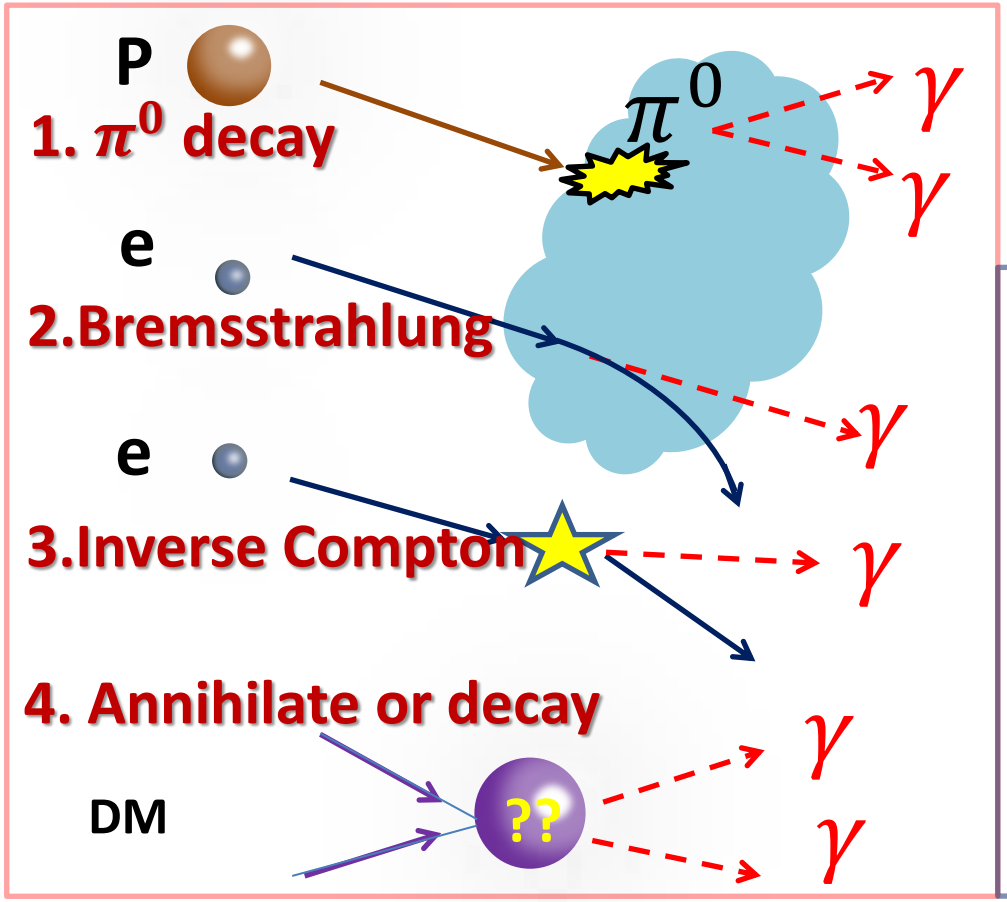


Diffuse galactic gamma-ray

Undetected faint point sources

Extragalactic background

Galactic interstellar γ-rays



For the sduty of :

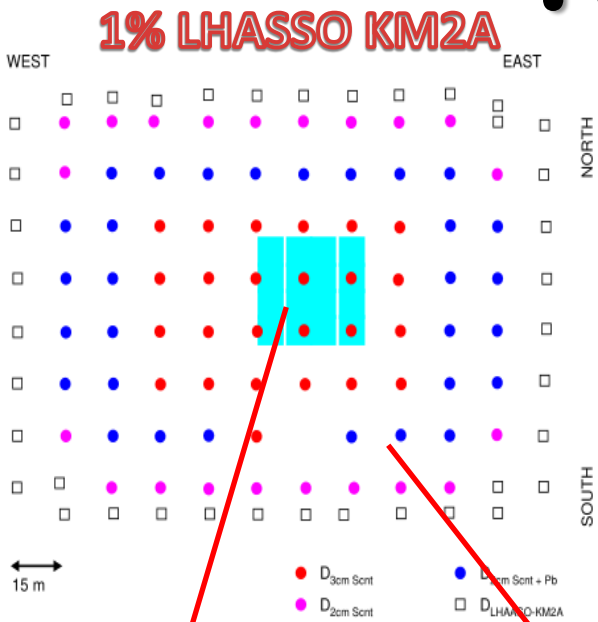
1).Galactic CRs

2). ISM

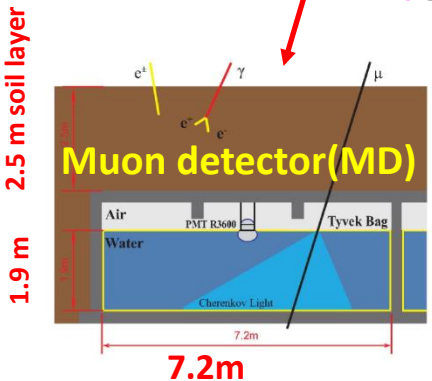
3). ISRF

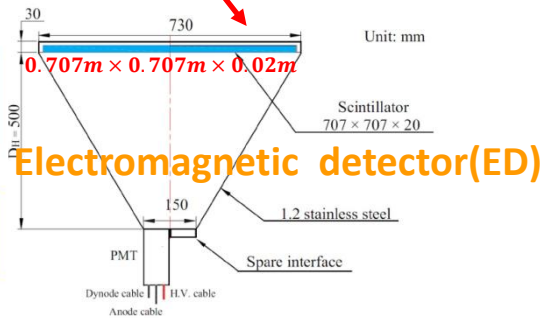
4). DM

YBJ-HA



- **115 EDs :** plastic scintillator
- **16 MDs :** water Cherenkov
- **Energy range :** TeV to hundred TeV
- **Location:** 4300m a.s.l. Tibet/China





DataSet

Experiment data：

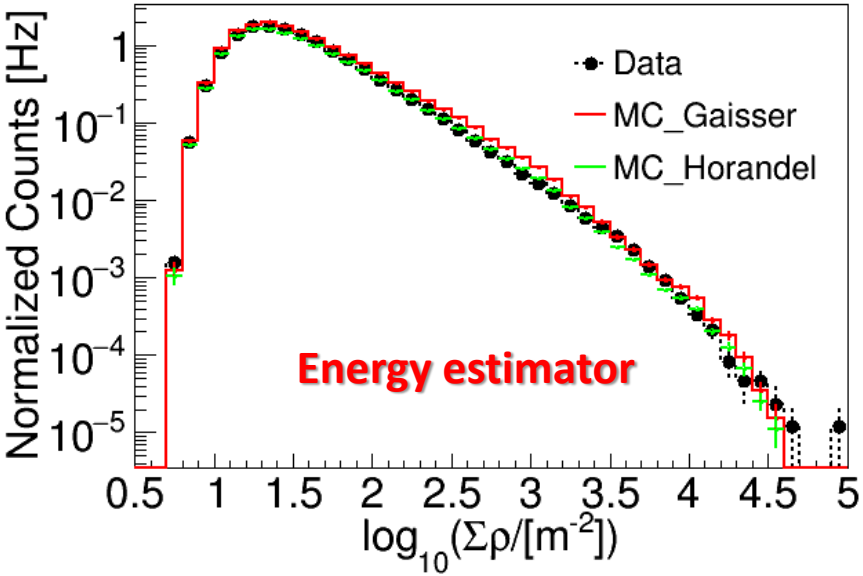
- Duration：01/2017-06/2018(~160 days)
- Number of events: $\sim 7.6 \times 10^8$

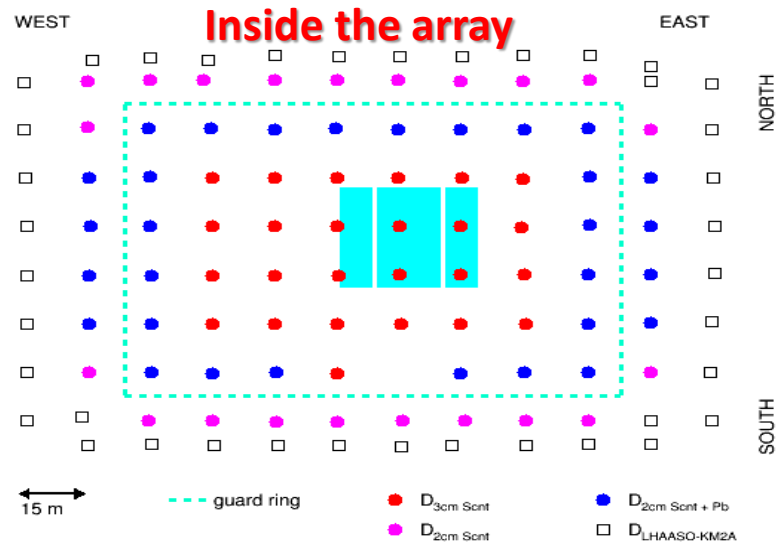
Reconstruction：

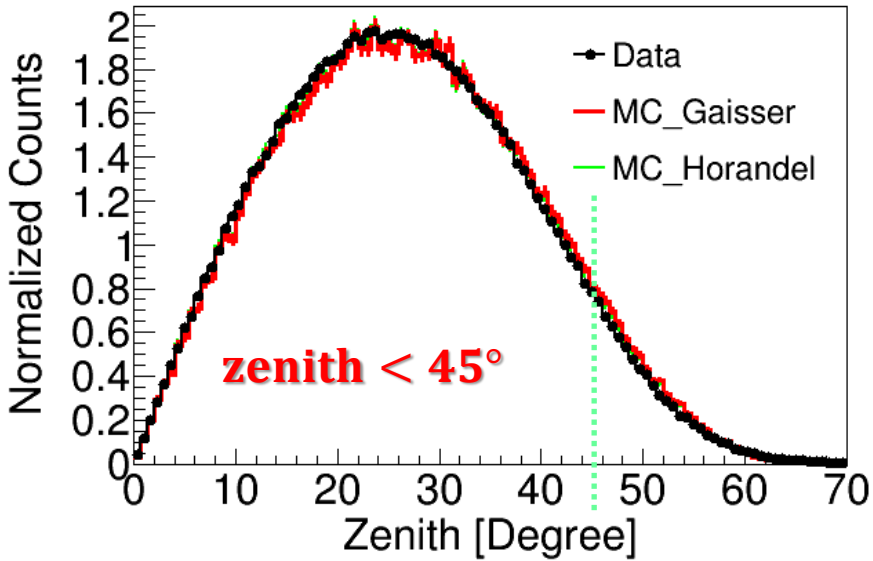
- Arrival time→Direction
- Detected charge→ Energy proxy
- The same procedure are used for both data and monte carlo samples

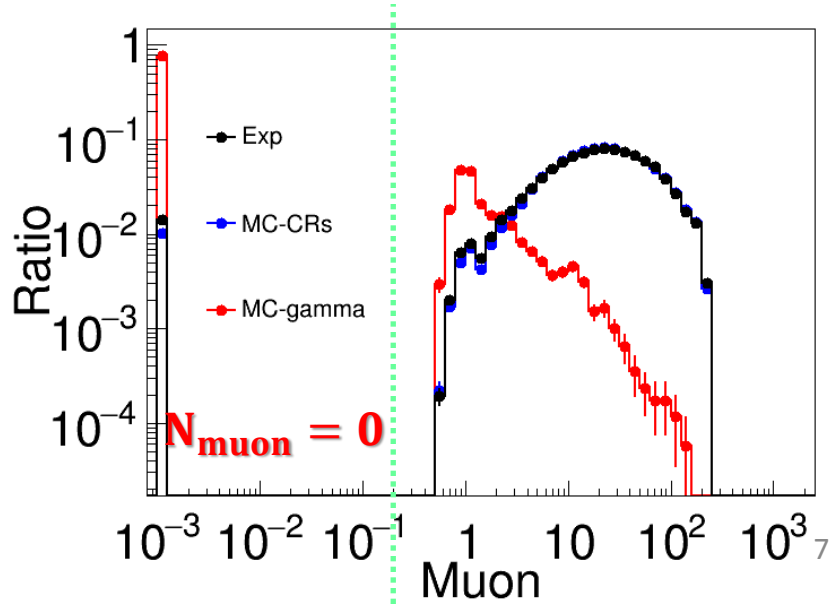
Monte Carlo samples:

- Corsika_v74005：
  - CRs:
    - Hadronic model:QGSJET2+GHEISHA
    - Energy range:1TeV-10PeV
    - Zenith range: $0° - 60°$
    - Location：YBJ (4300m)
    - Component：p He Fe CNO MgAlSi
    - Scale model：Giasser/Horandel Model
    - Number of CRs samples： ~3.5×10^8
  - Gamma-rays:
    - Spectrum index: -2.59
    - Number of γ-ray samples： ~1.5×10^7
- Geant4_v4.09.03

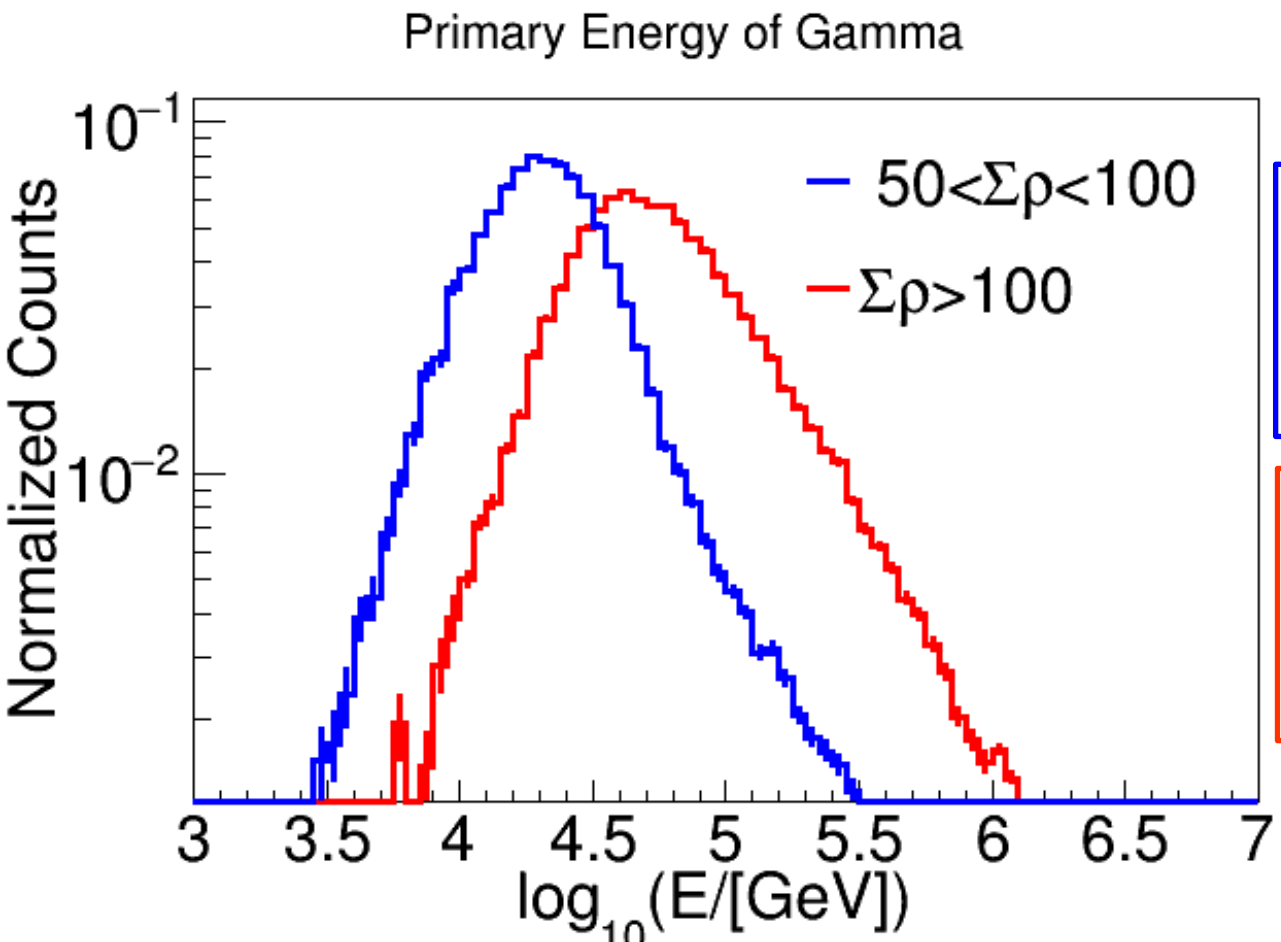

Normalized Counts [Hz]
Data
MC_Gaisser
MC_Horandel
Energy estimator
$\log_{10}(\Sigma\rho/[m^{-2}])$


Inside the array
WEST
EAST
NORTH
SOUTH
15 m
guard ring
$D_{3cm\ Scnt}$
$D_{2cm\ Scnt}$
$D_{2cm\ Scnt + Pb}$
$D_{LHAASO-KM2A}$


Normalized Counts
Data
MC_Gaisser
MC_Horandel
zenith < 45°
Zenith [Degree]


Ratio
Exp
MC-CRs
MC-gamma
$N_{muon} = 0$
Muon

Energy estimation



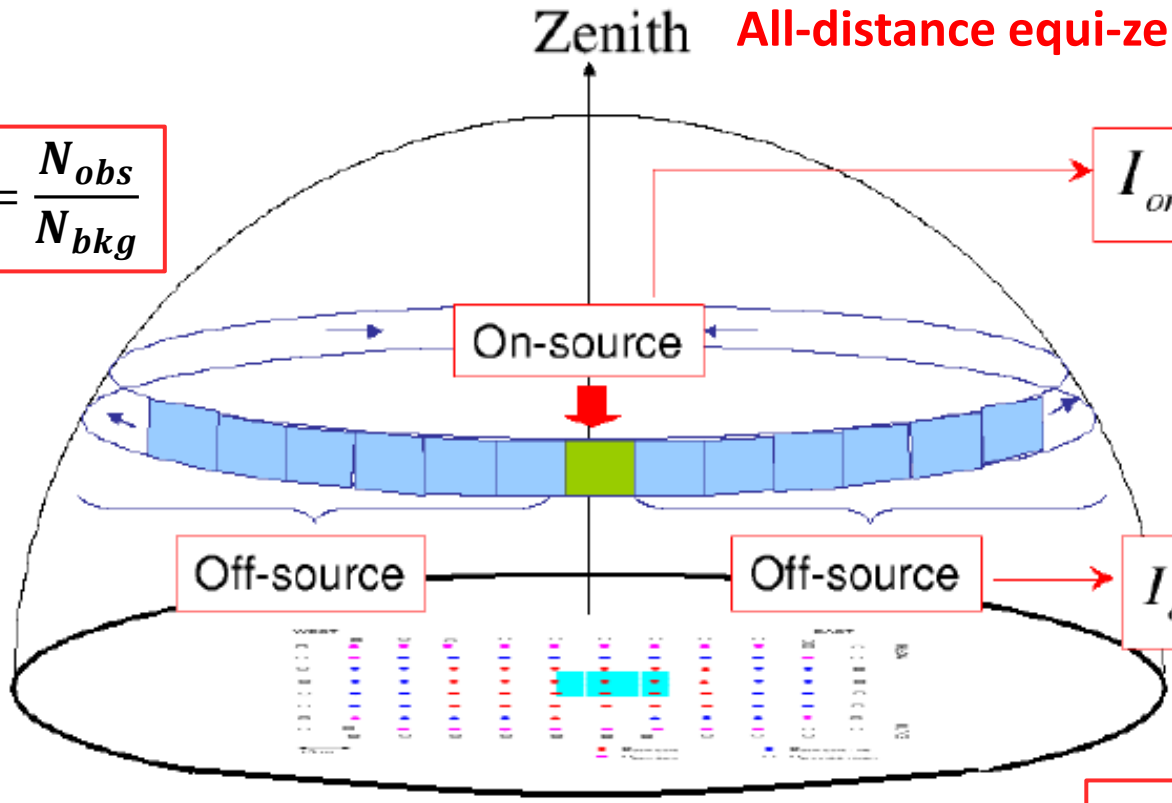
- median Energy: ~20TeV
- Number of selected data samples: ~1.3× 10^6

- median Energy: ~50TeV
- Number of selected data samples : ~3.0× 10^5

Estimation of signal and background

All-distance equi-zenith angle method

$$I = \frac{N_{obs}}{N_{bkg}}$$



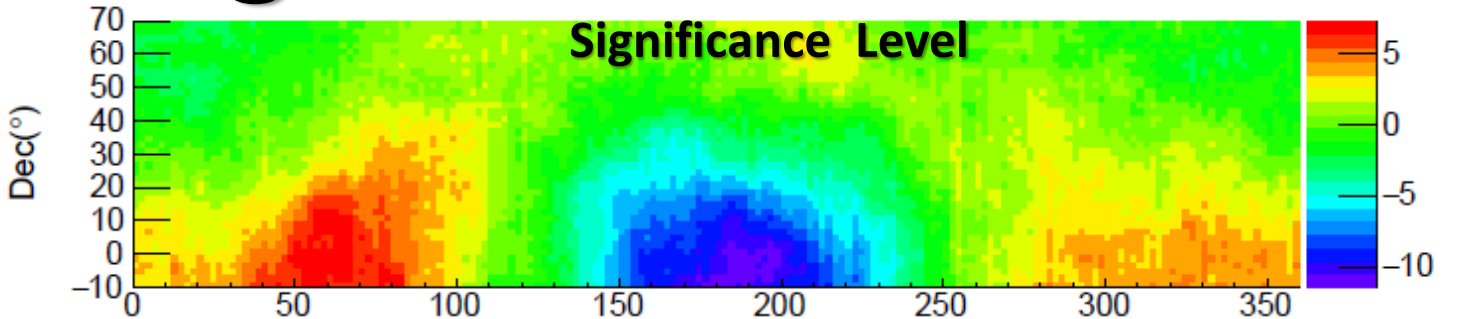
$$I_{on}, N_{on} \rightarrow \frac{I_{on}}{N_{on}}$$

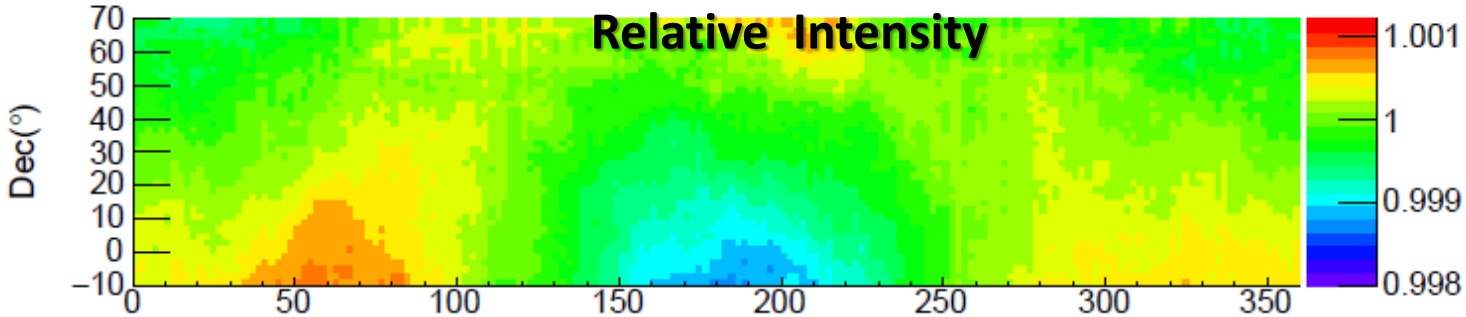
$$I_{off}, N_{off} \rightarrow \frac{I_{off}}{N_{off}}$$

$$Signi_{ij} = \frac{I_{ij} - 1}{\Delta I_{ij}}$$

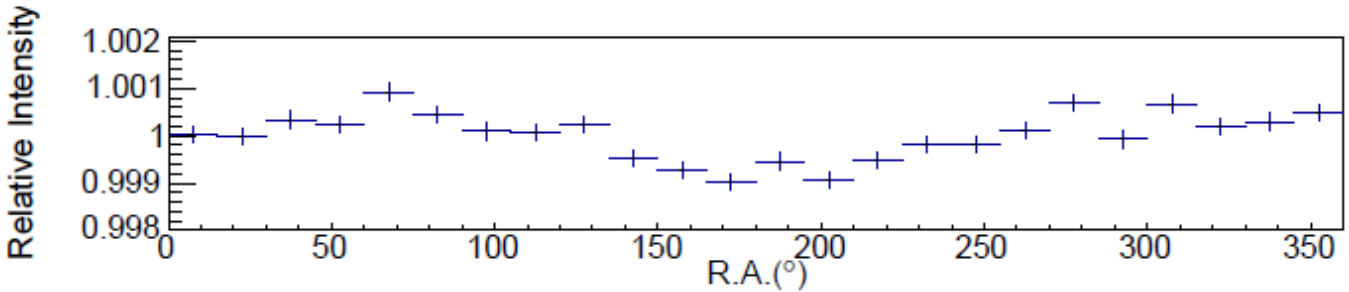
M Amenomori, *APJ*, 633(2):1005–1012, 2005.

Large-scale CRs anisotropy





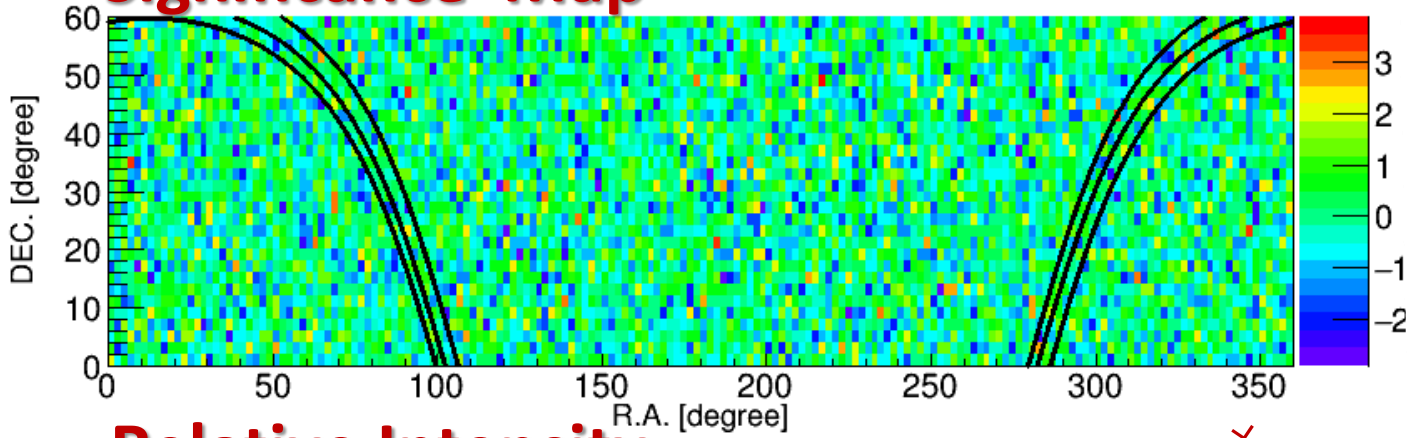
~15 TeV

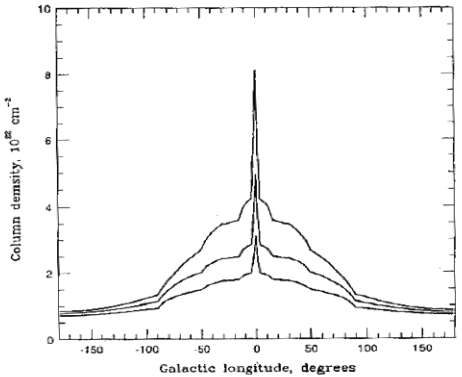


Adopted from the talk of Yingying Guo

Diffuse gamma-ray

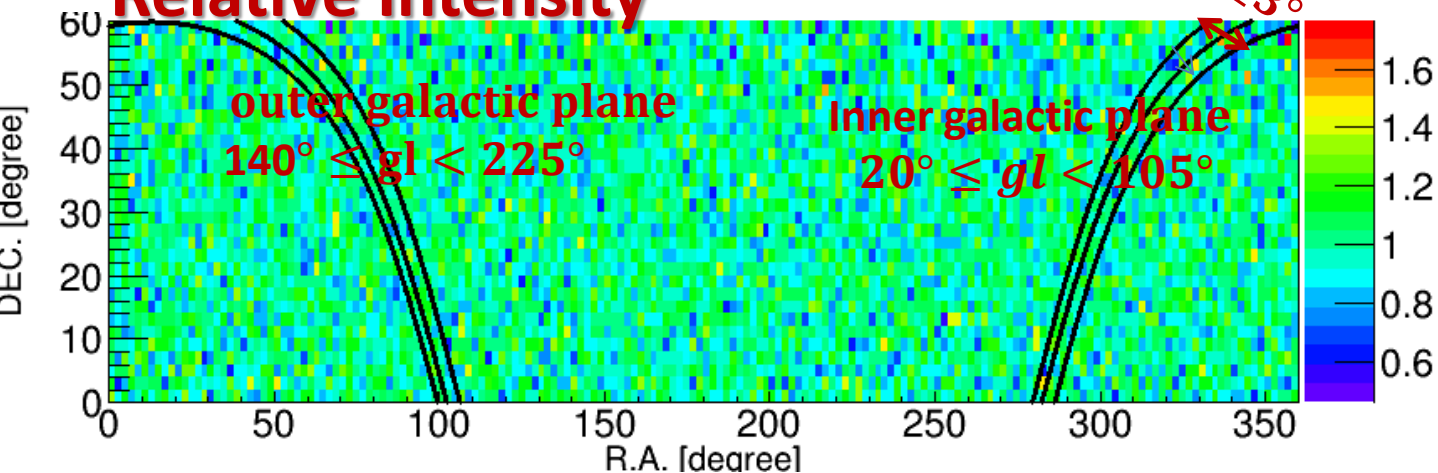
Significance Map

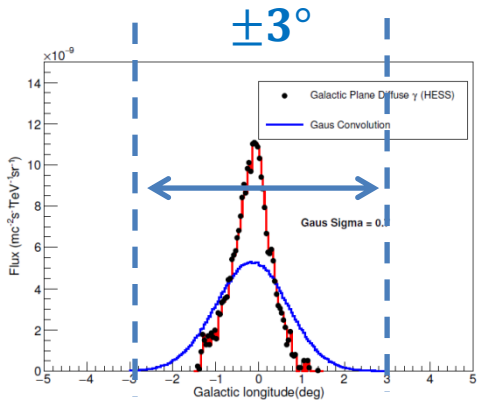




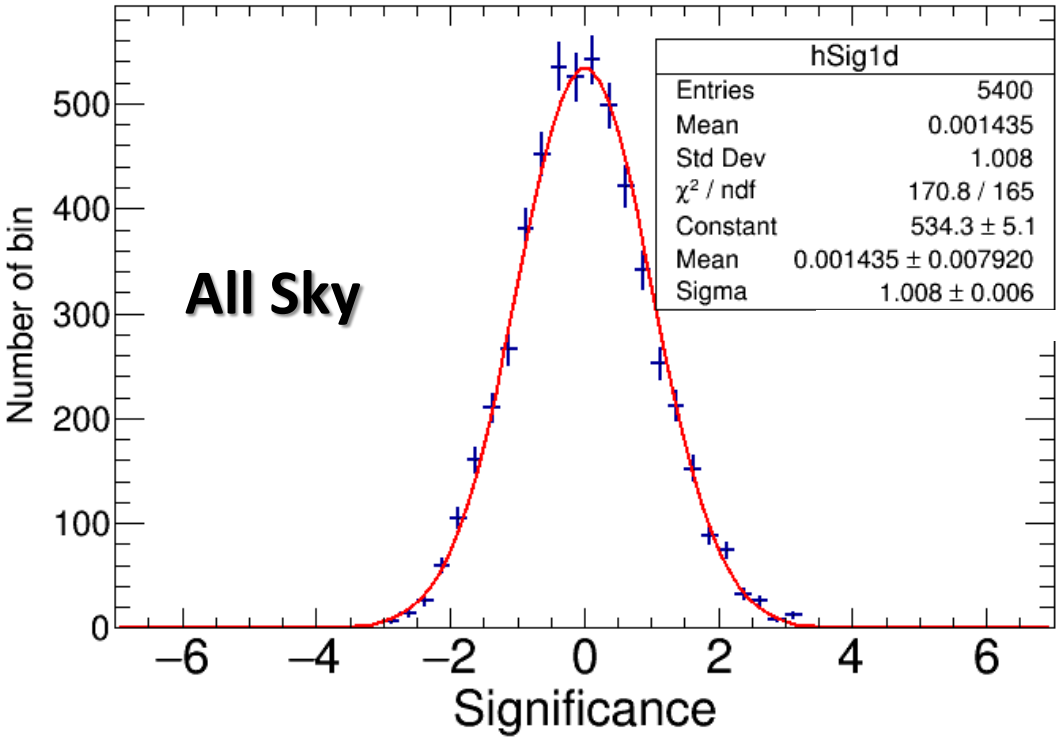
Galactic longitude [degree]

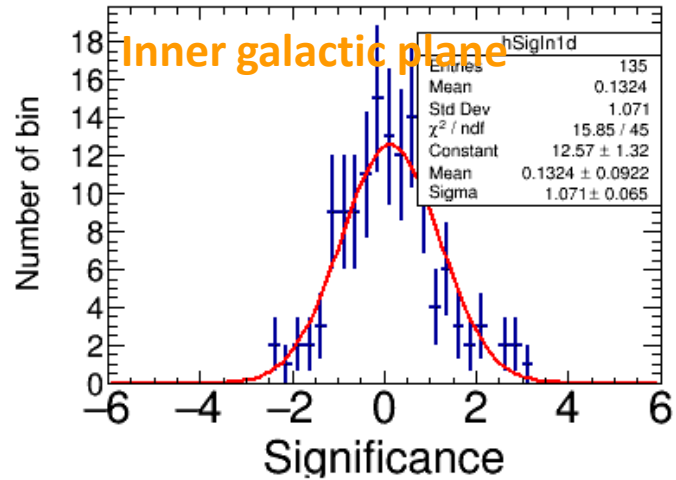
Relative Intensity

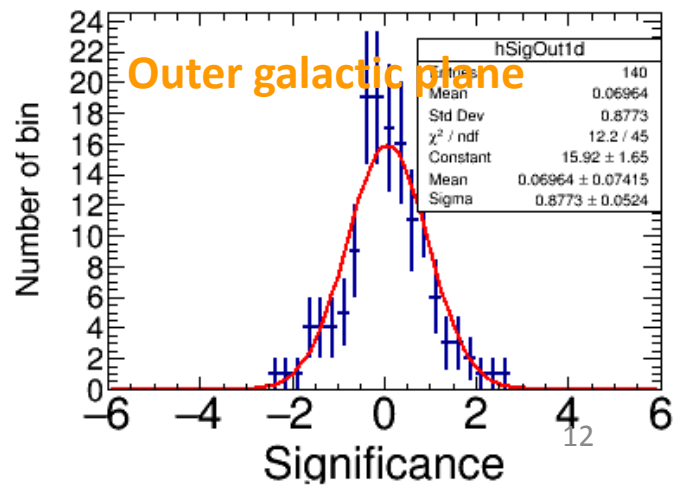




Significance Distribution





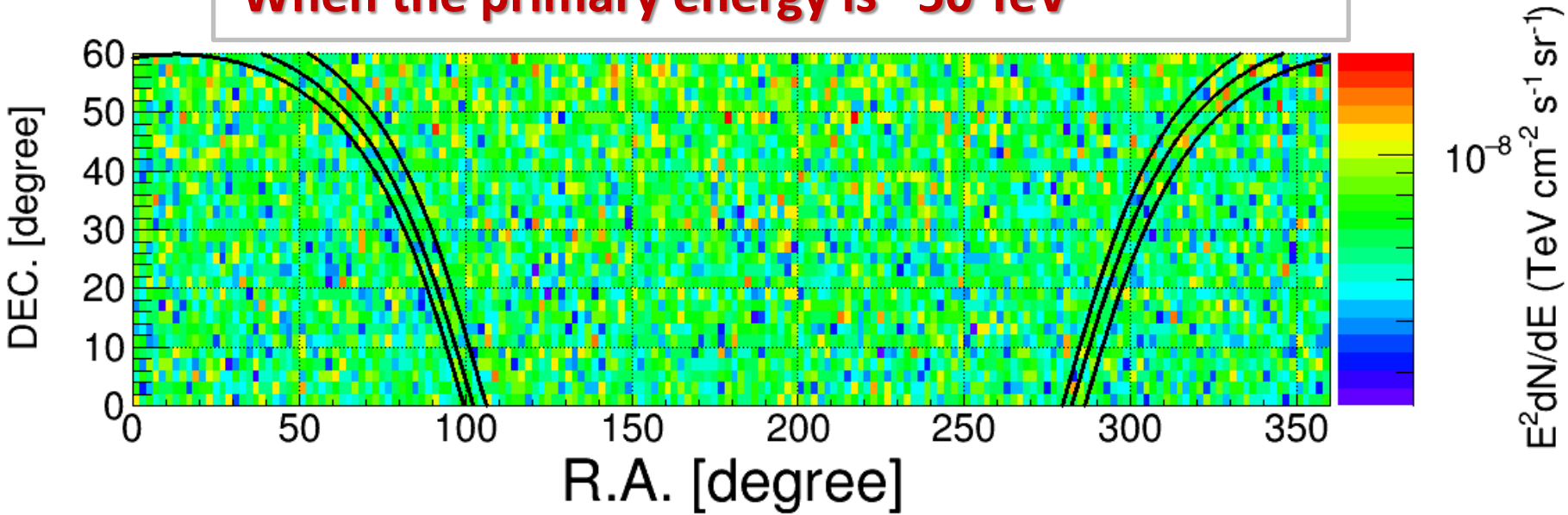


Consistent with Gaussian function→

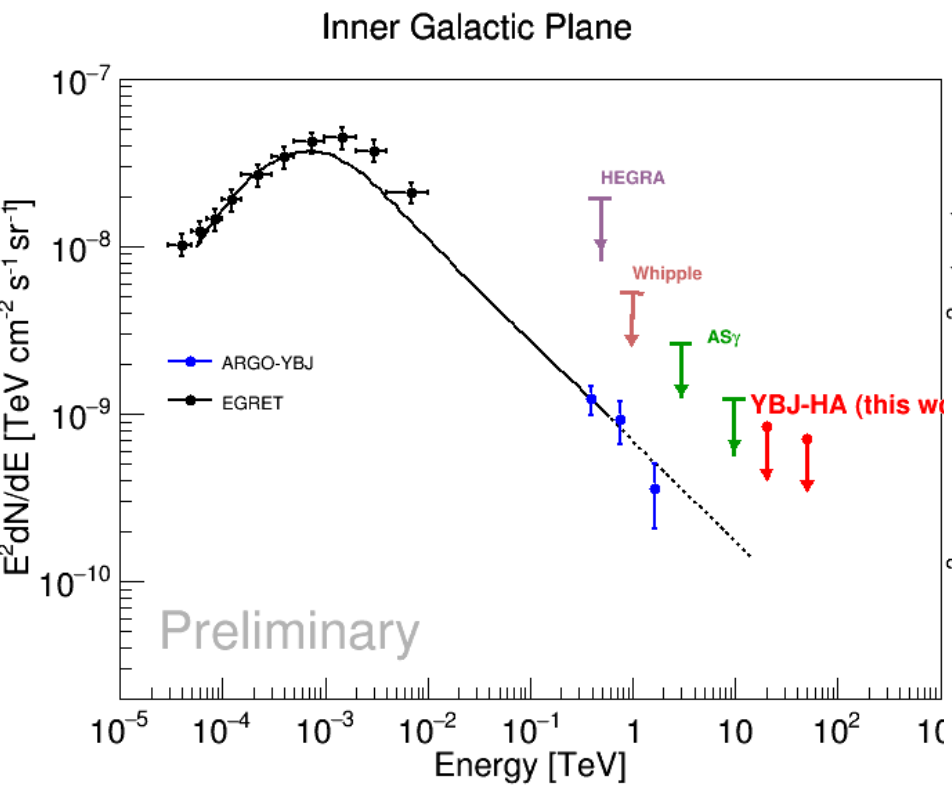
No significant gamma-ray excess

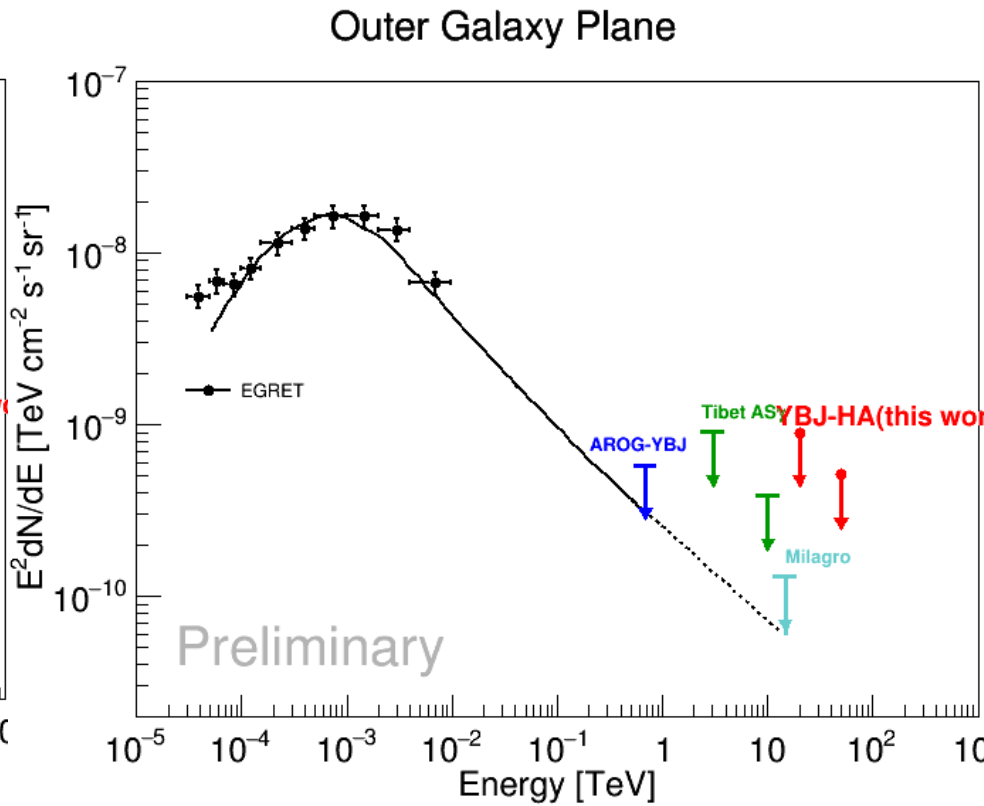
90% CL upper limit on flux

When the primary energy is ~50 TeV

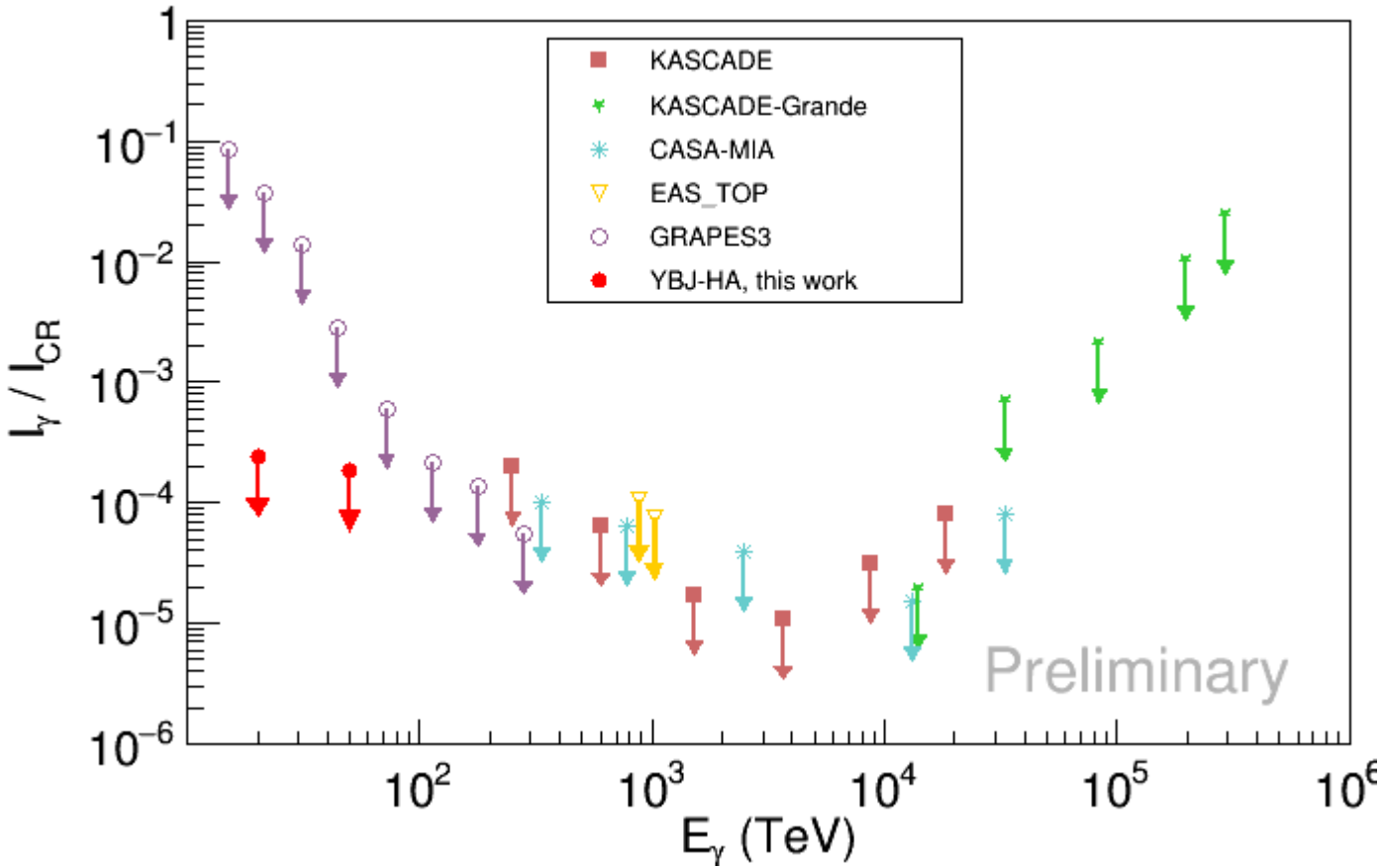


Helene, O.NIM. A300 (1991) 132-136


Inner Galactic Plane
HEGRA
Whipple
ASγ
YBJ-HA (this w
ARGO-YBJ
EGRET
Preliminary
E²dN/dE [TeV cm⁻² s⁻¹ sr⁻¹]
Energy [TeV]


Outer Galaxy Plane
EGRET
AROG-YBJ
Tibet ASγ
YBJ-HA(this wor
Milagro
Preliminary
E²dN/dE [TeV cm⁻² s⁻¹ sr⁻¹]
Energy [TeV]

90% CL upper limit

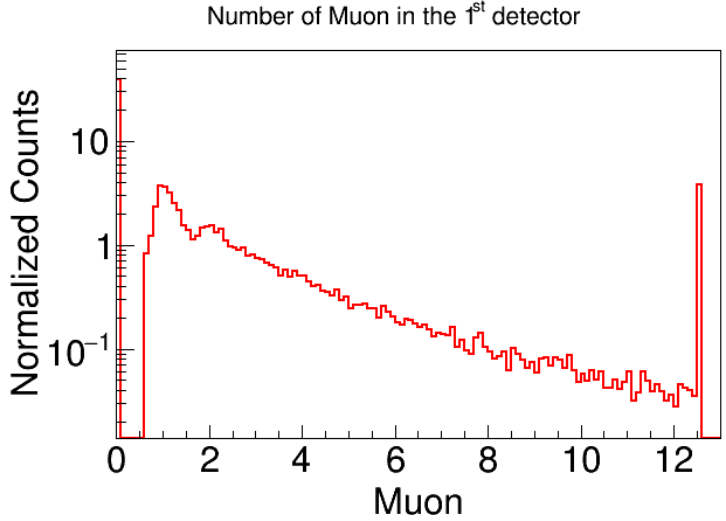


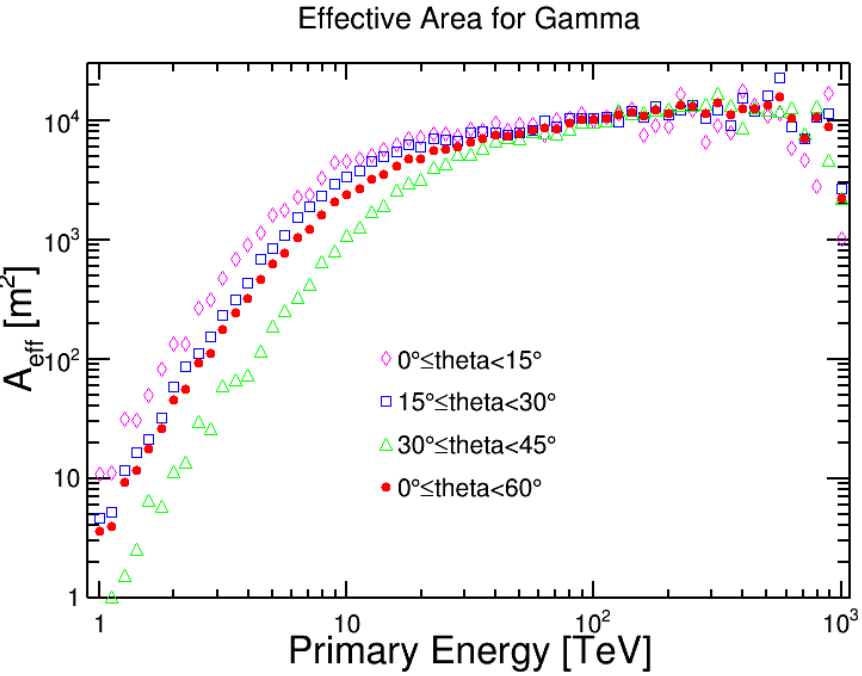
summary

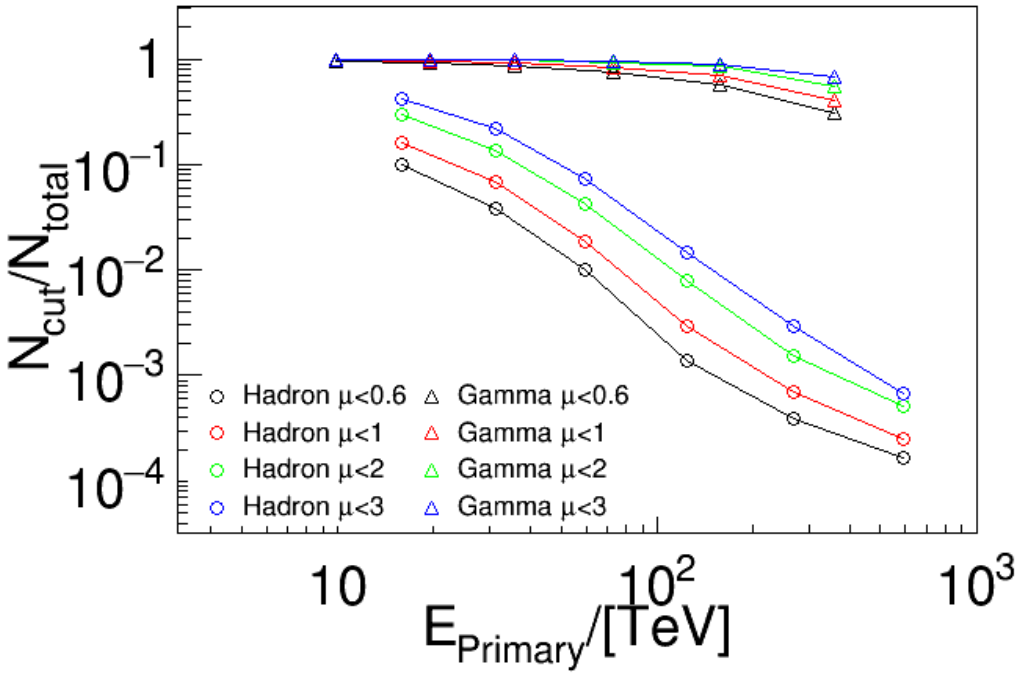
- No significant diffuse γ-ray excess in the galactic plane is observed by YBJ-HA in energy range of several dozens of TeV in the first 160 days.
- 90% CL upper limits on flux are obtained.
- More data are being collected by the YBJ-HA, and LHAASO-KM2A are under-construction.

Thank you for your attention!

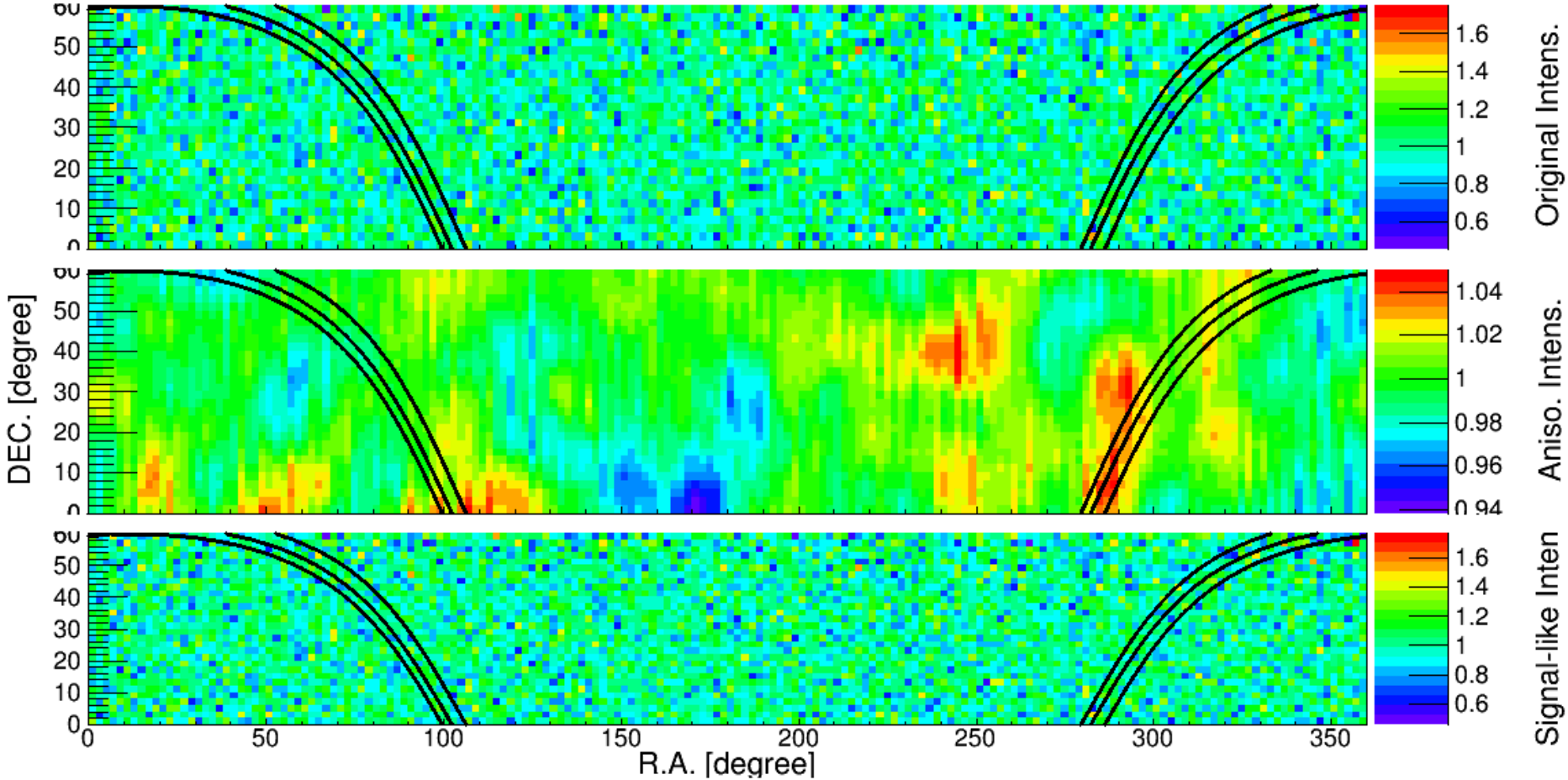
backups


Number of Muon in the 1st detector
Normalized Counts
Muon

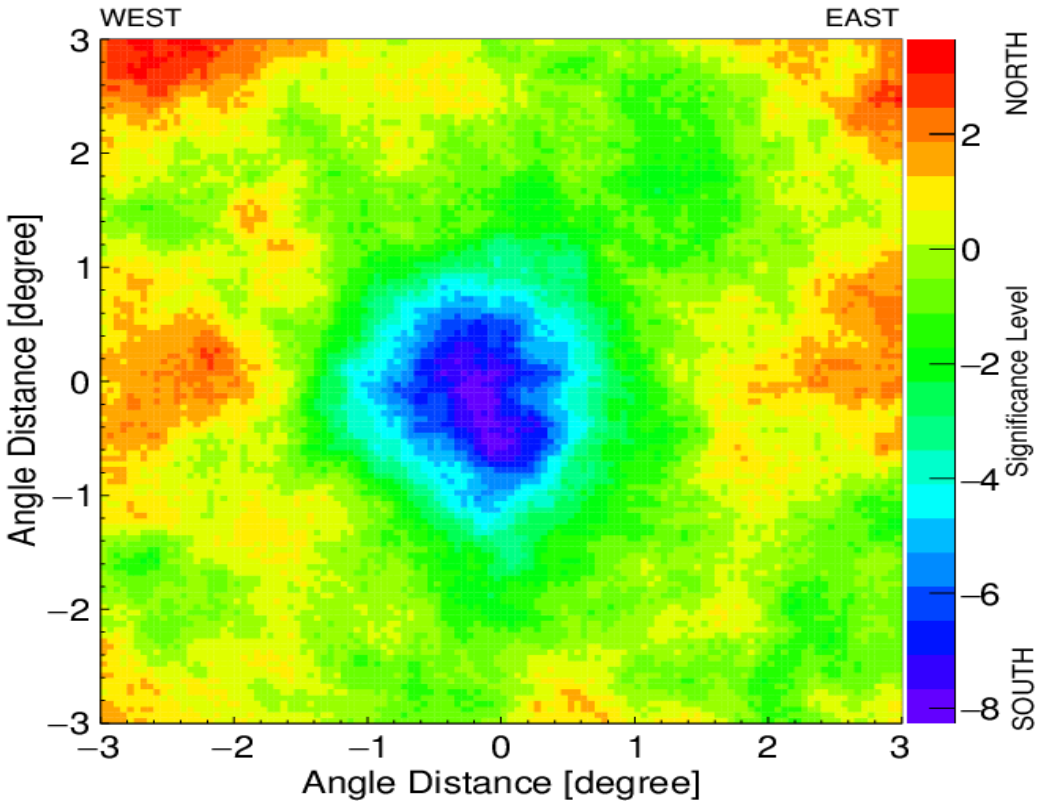

Effective Area for Gamma
A_{eff} [m^2]
Primary Energy [TeV]
0°≤theta<15°
15°≤theta<30°
30°≤theta<45°
0°≤theta<60°

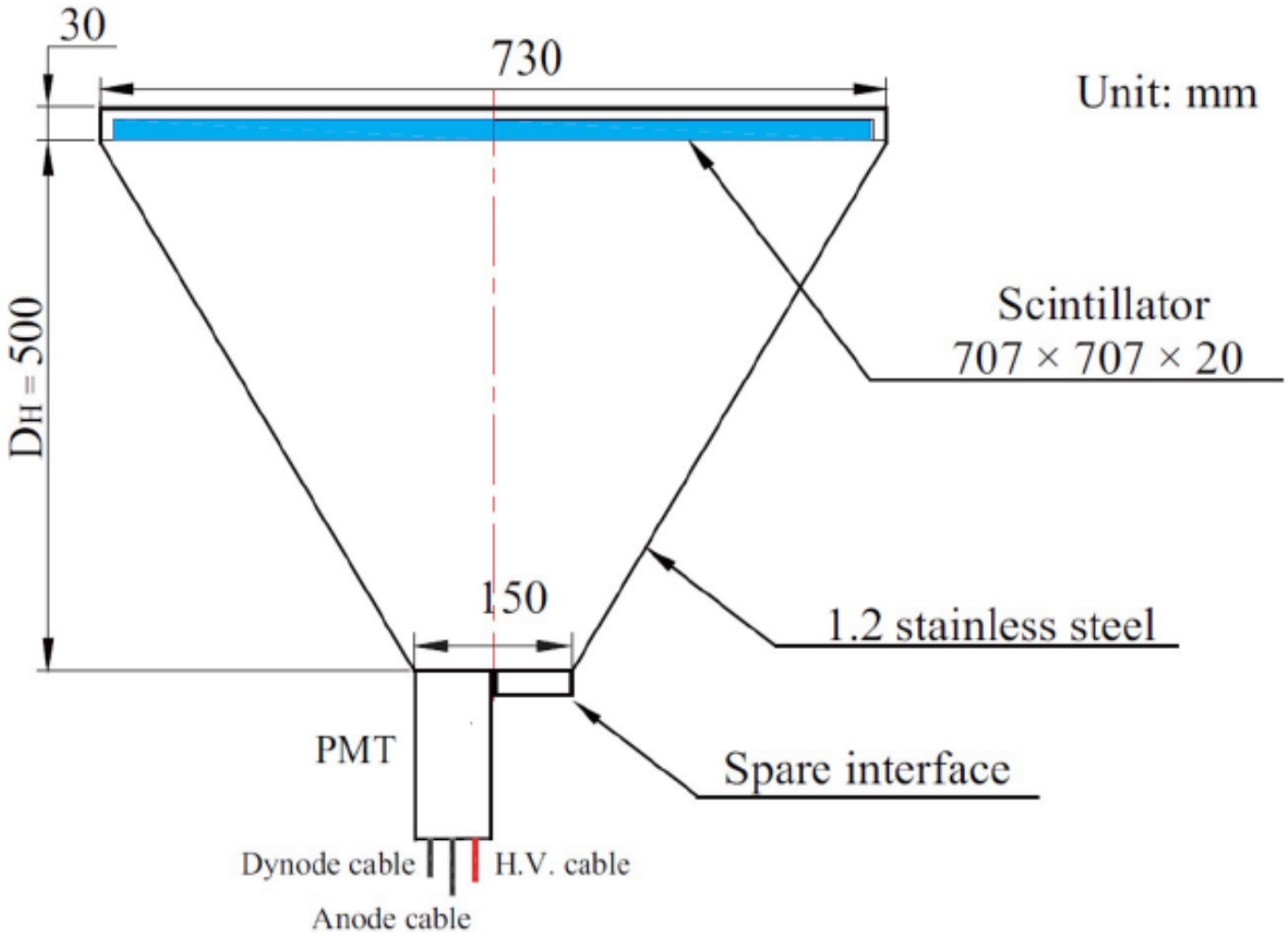

N_{cut}/N_{total}
$E_{Primary}$/[TeV]
Hadron μ<0.6
Hadron μ<1
Hadron μ<2
Hadron μ<3
Gamma μ<0.6
Gamma μ<1
Gamma μ<2
Gamma μ<3

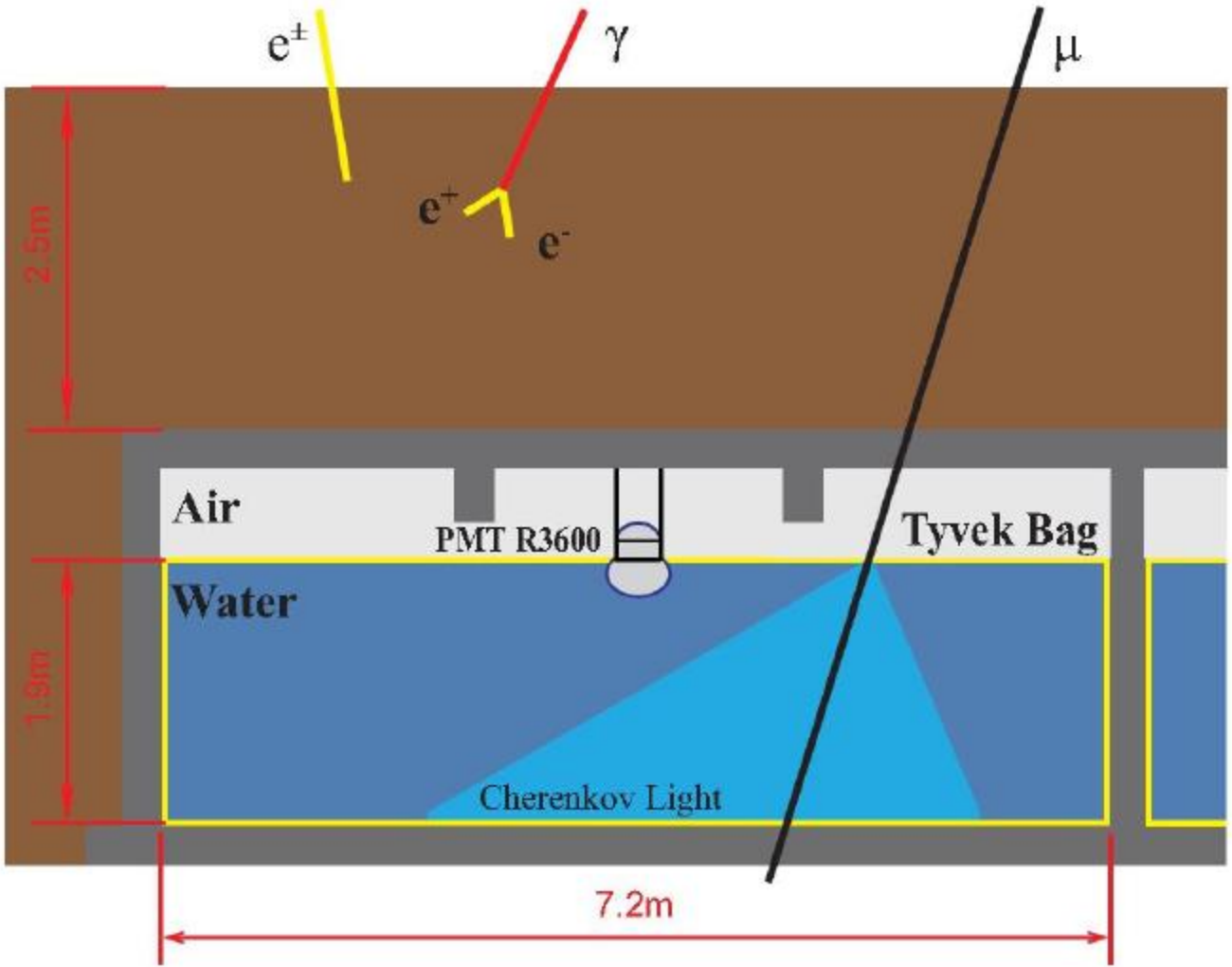
Subtraction of anisotropy



Group shot of moon and sun




30
730
Unit: mm
Scintillator
707 × 707 × 20
DH = 500
150
1.2 stainless steel
PMT
Spare interface
Dynode cable
H.V. cable
Anode cable


e±
γ
μ
e+
e-
2.5m
Air
PMT R3600
Tyvek Bag
Water
1.9m
Cherenkov Light
7.2m