Observation of large-scale anisotropy in the arrival directions of cosmic rays with LHAASO-KM2A

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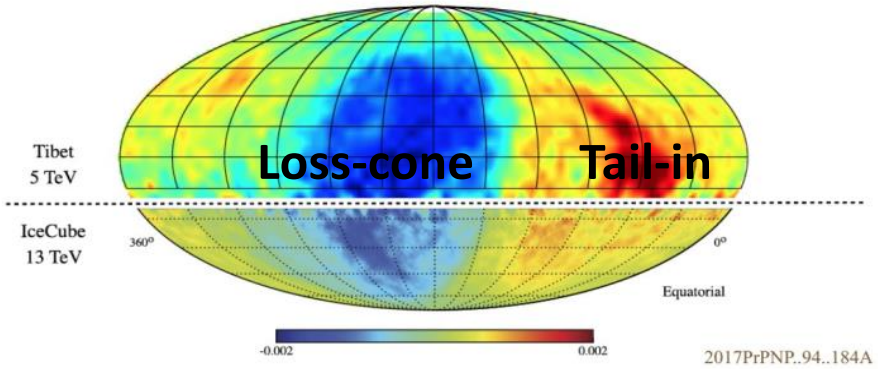
Introduction

- **Anisotropy :**

  - a probe to study the origin and propagation of cosmic rays.

  - the structure and intensity of anisotropy are obviously energy dependent.



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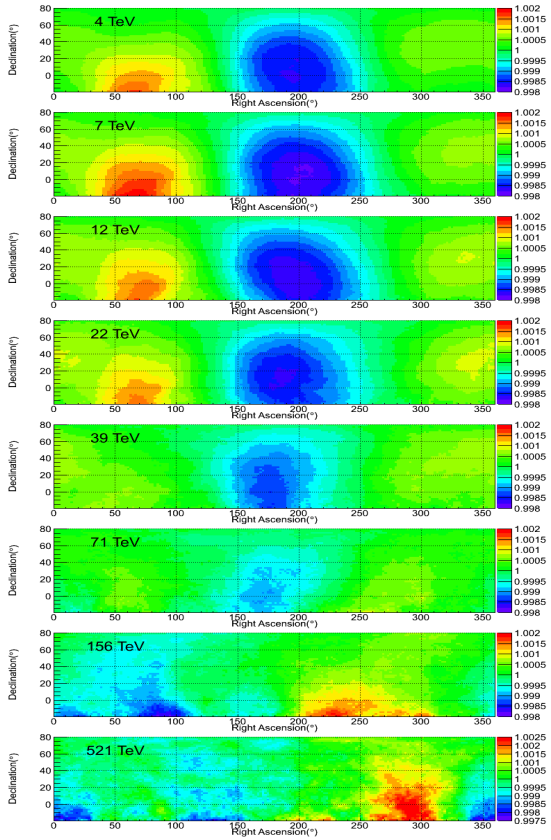
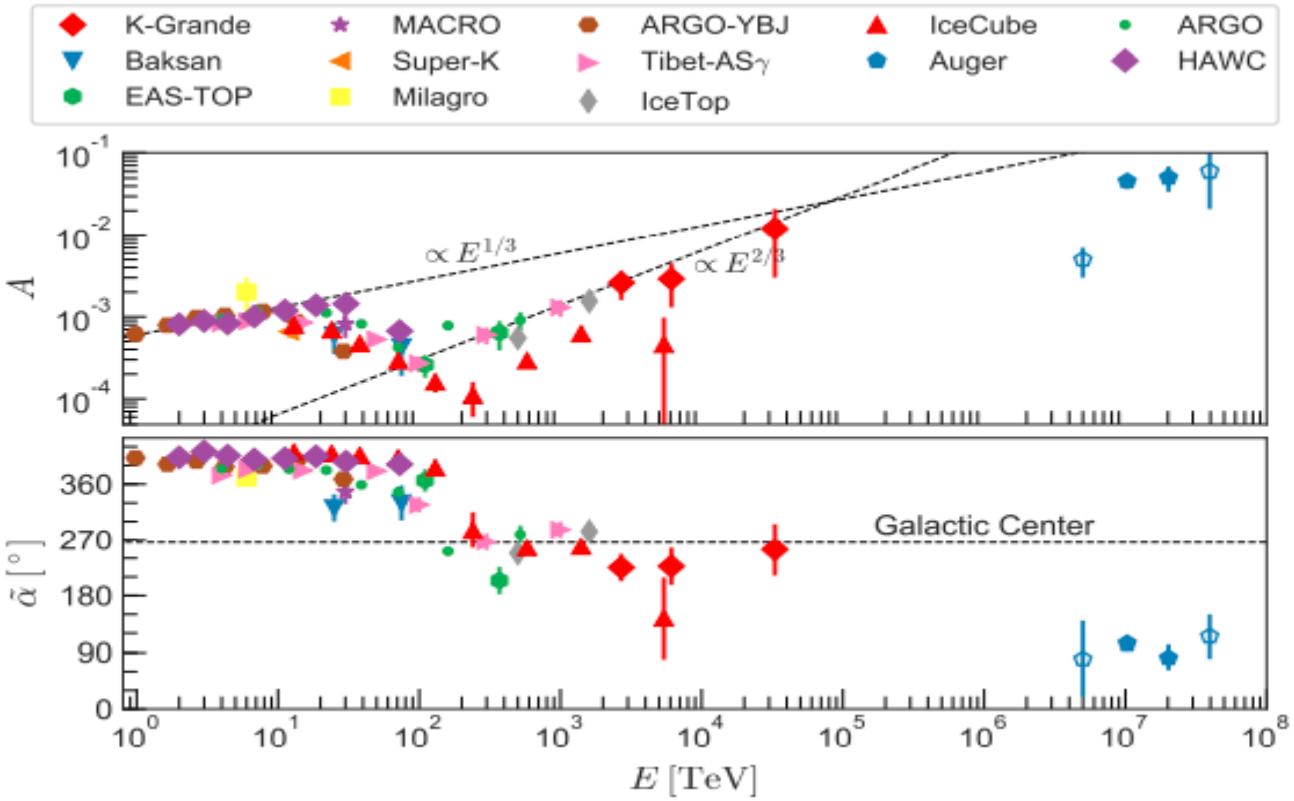


Bartoli et al. 2018

- **Puzzles** :

The irregularity of energy dependence of amplitude and phase —Why ?

JuliaBecker Tjus et al., Physics Reports, 872

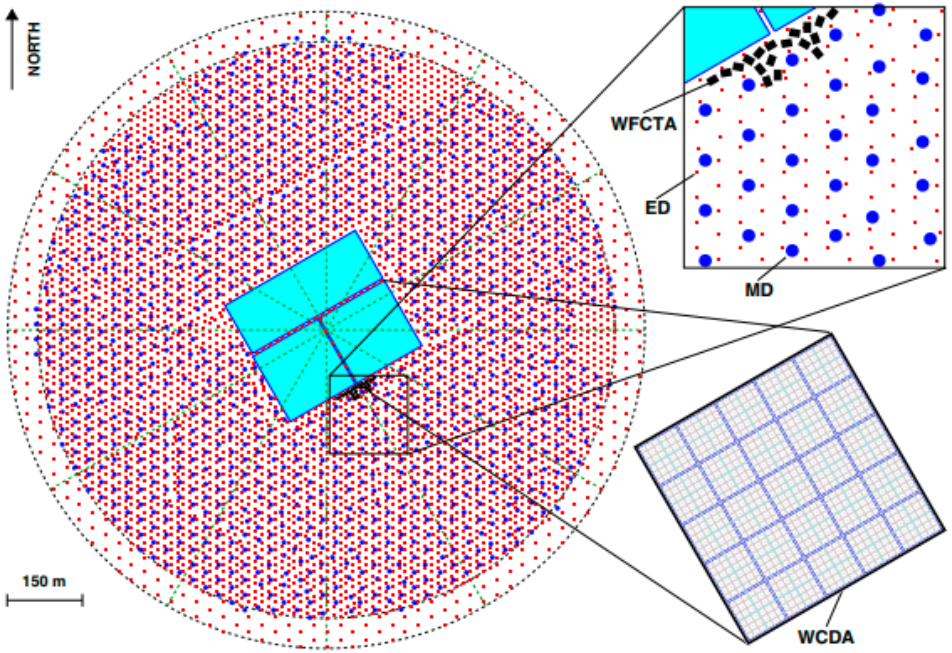


Energy range of LHAASO

LHAASO

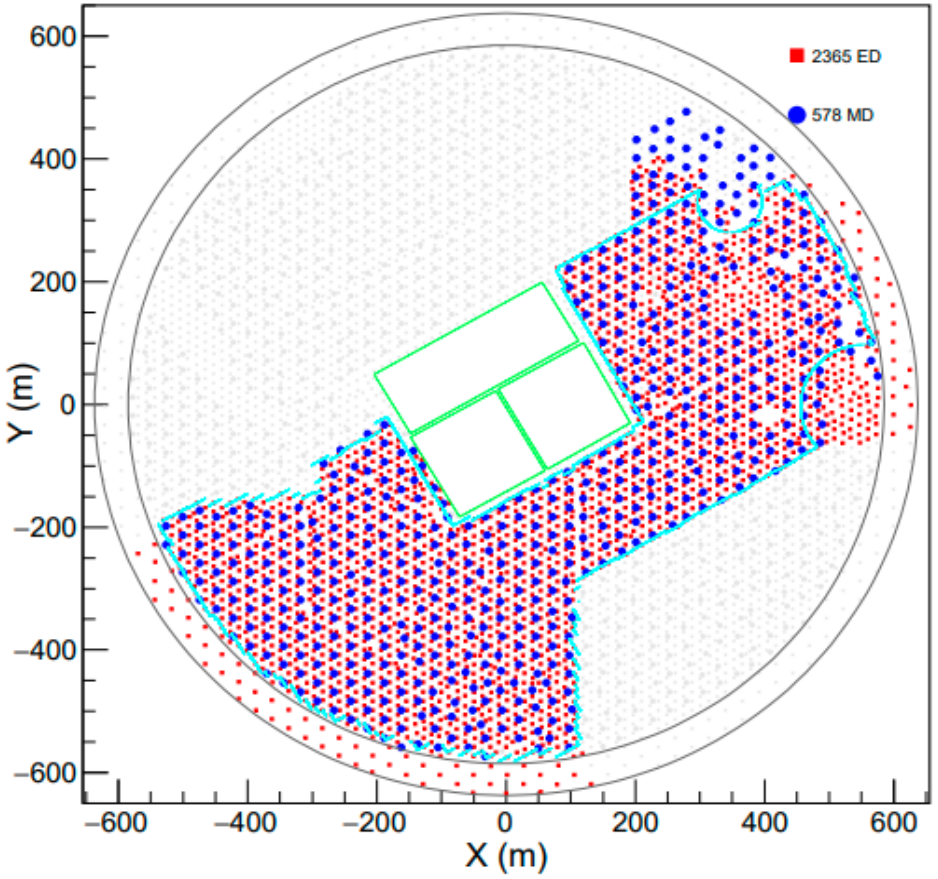
- Large High Altitude Air Shower Observatory (LHAASO), 4410 m a.s.l.@Daocheng, Sichuan, China

Kilometer Array (KM2A):
5195 Electromagnetic particle Detectors (EDs)
1188 Muon Detectors (MDs)
1.3 km^2 area
Water Cherenkov Detector Array (WCDA):
3 water ponds
3120 detectors
78,000 m^2 area
Wide Field Cherenkov Telescope Array (WFCTA):
18 wide-field-of-view Cherenkov/fluorescence telescopes



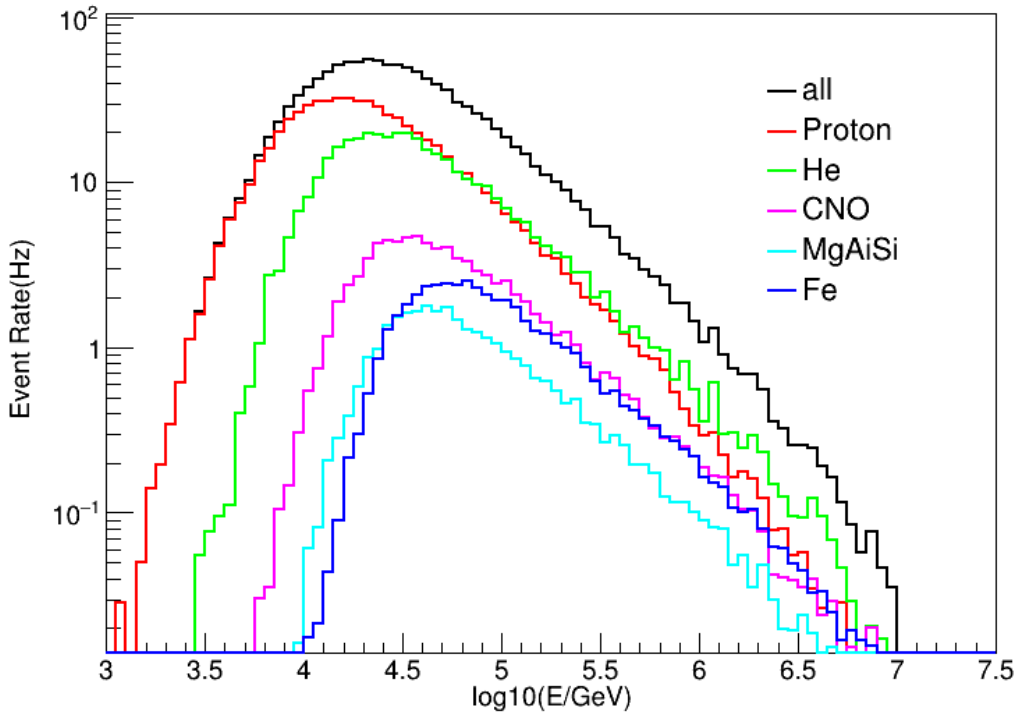
Data selection

- Half array of KM2A
- more than 20 EDs trigged
- Zenith < 50 degree
- Core within the array
- 2020001-2020366



Simulation

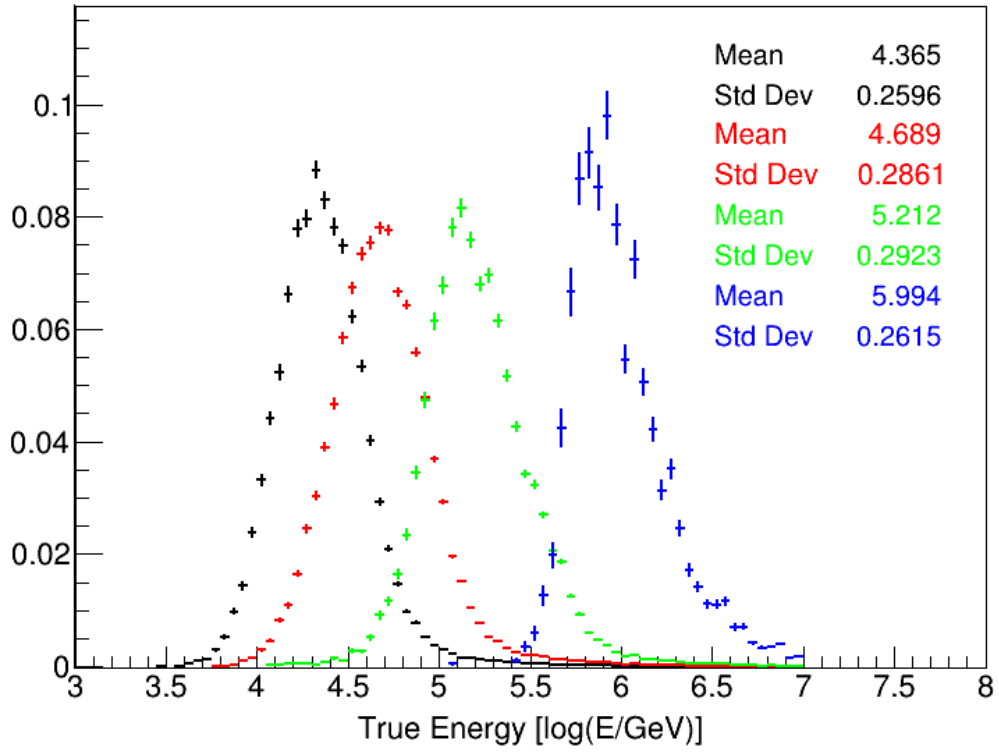
- QGSJETII-04_Gheisha
- 1TeV-10PeV
- Zenith angle 0-70°
- $\sim 7.8 \times 10^7$ events
- Gaisser model
- G4KM2A for half array



Energy estimation

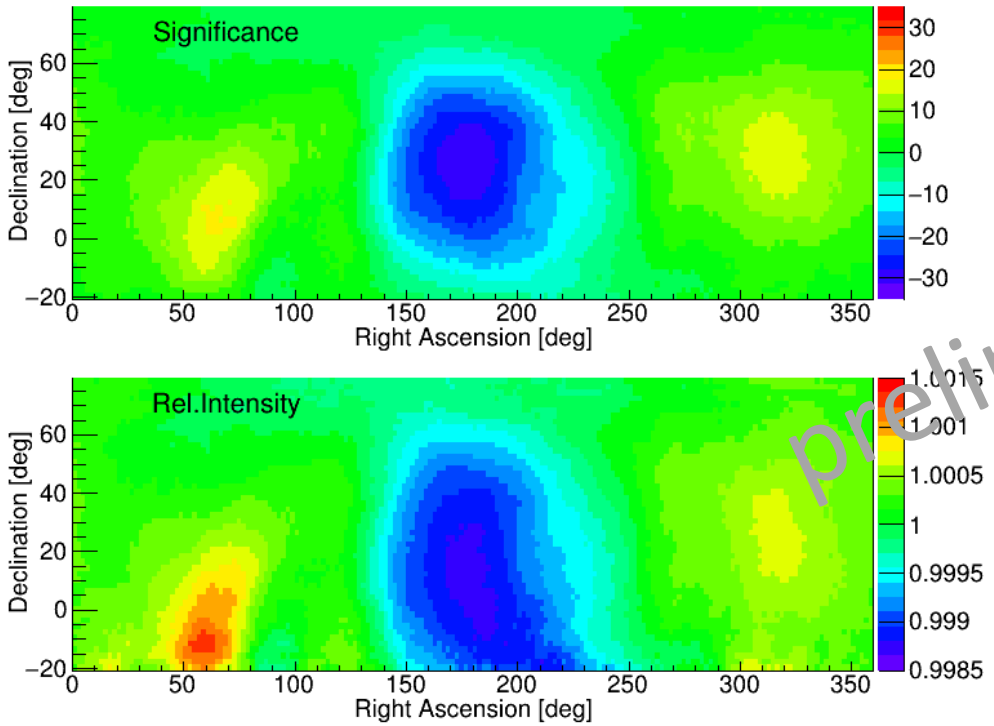
- $logE = f(log\sqrt{NpE * NuM})$

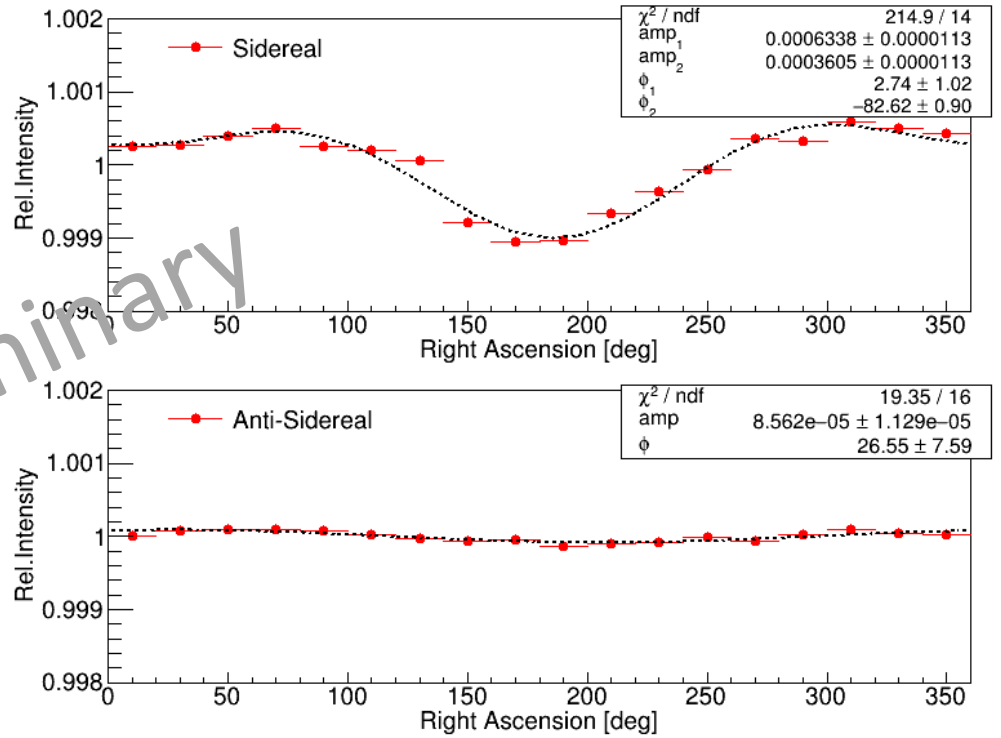
Bin	log(Erec)	Energy (TeV)	Number (10^8)
1	3.50~4.5	23	64.67
2	4.5~5.00	49	73.99
3	5.00~5.75	163	16.65
4	>=5.75	985	0.86



Anisotropy with LHAASO-KM2A

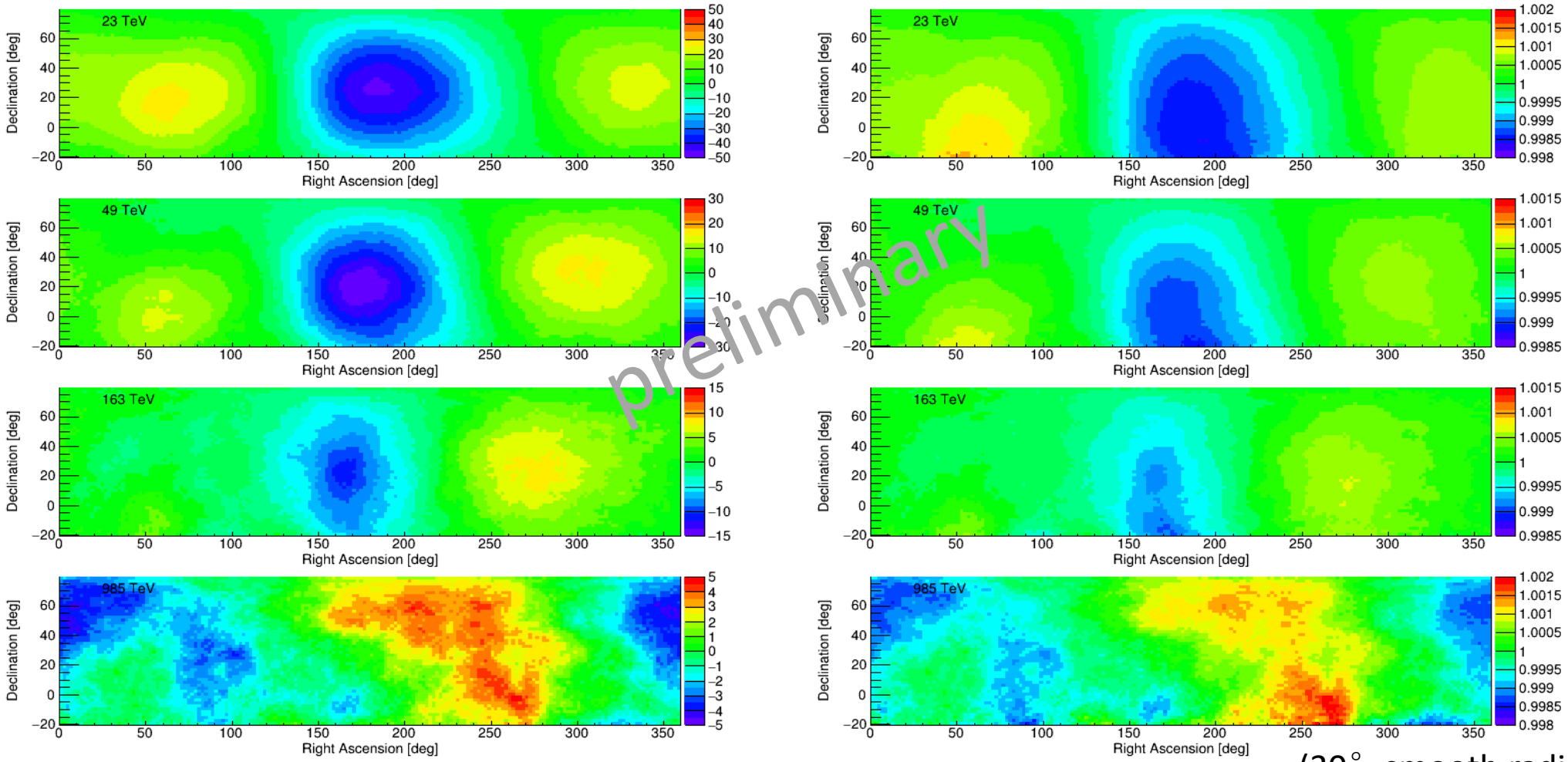
- ~42TeV, 1.56×10^{10} events
- A spurious frame (anti-sidereal) is used to estimate the systematic error





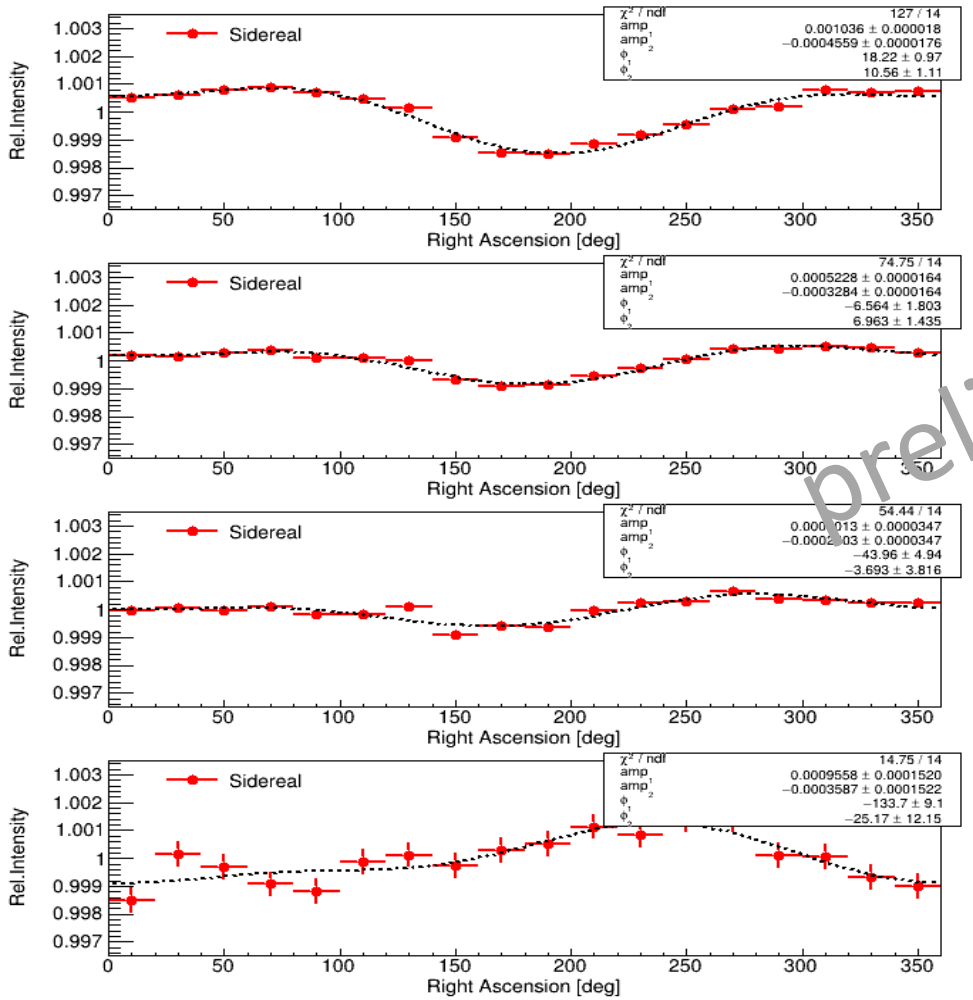
preliminary

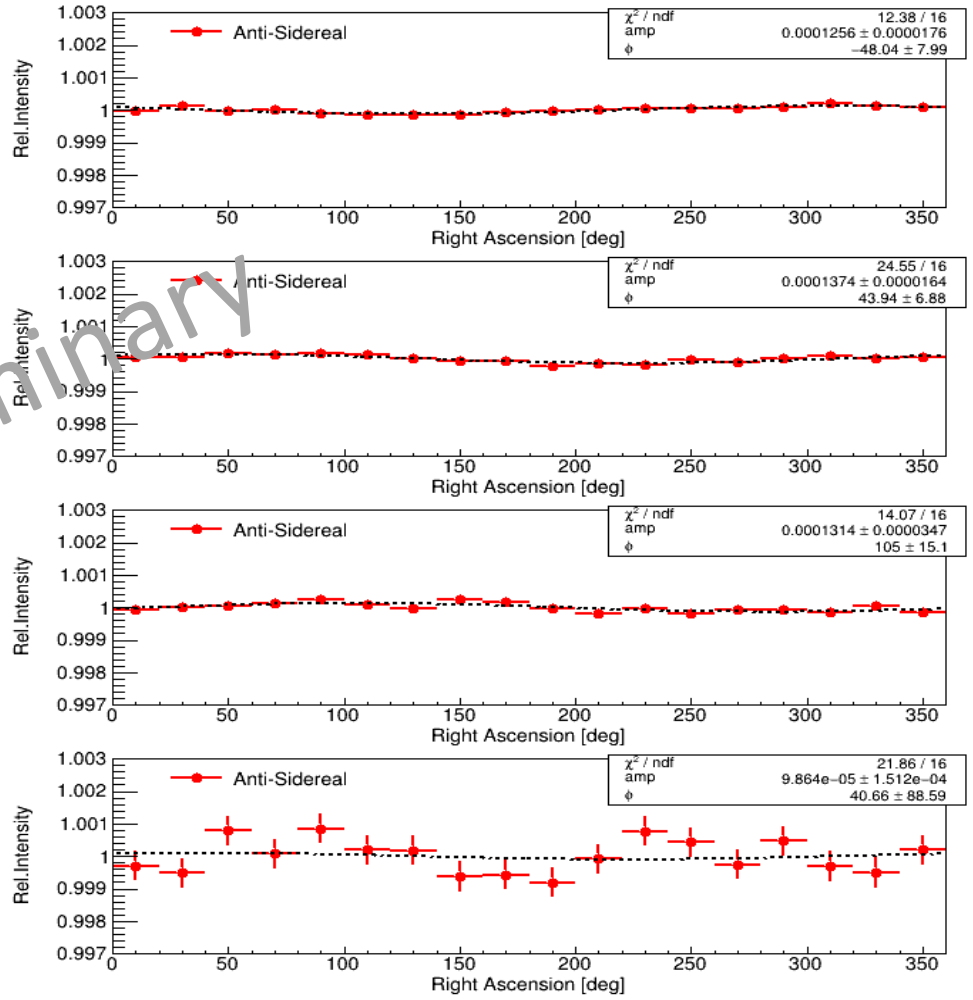
Energy dependence



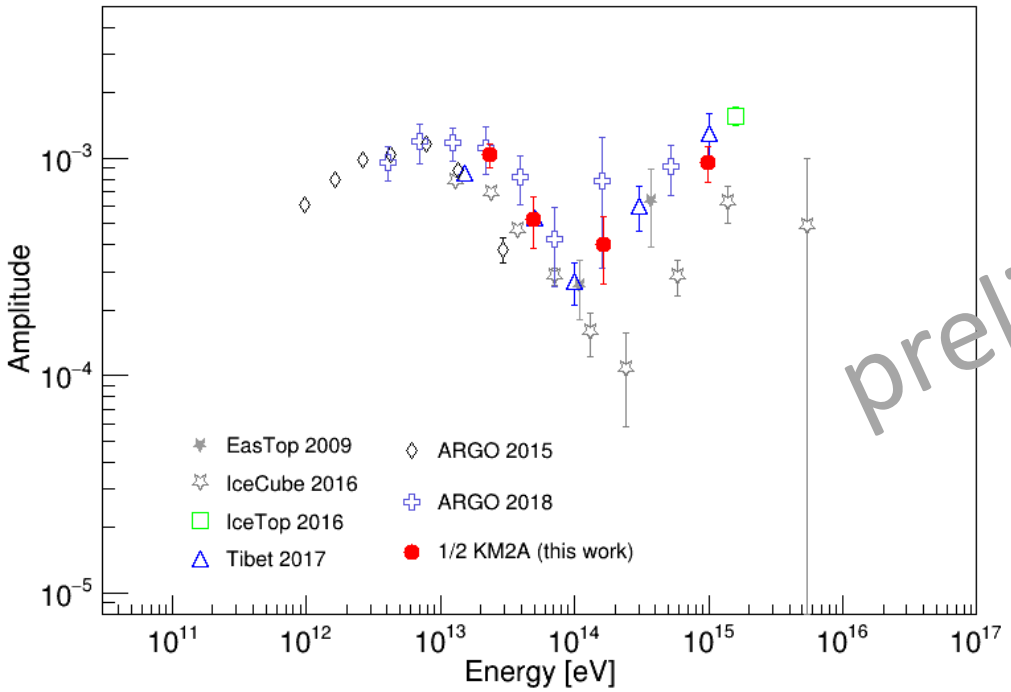
(30° smooth radius)

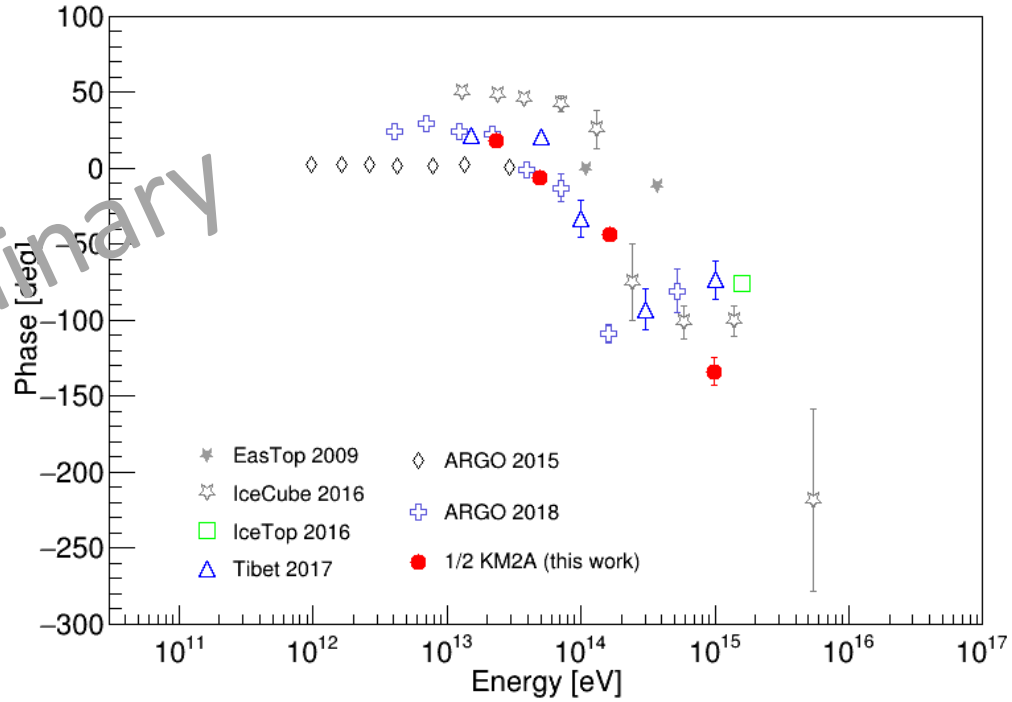
Energy dependence





Compared with others





Conclusion

- The half array of LHAASO-KM2A observed the large-scale anisotropy from 23 TeV up to 985 TeV.
- An inverse anisotropy is observed with a significance of 5σ at 985 TeV.
- The evolution of large-scale anisotropy observed by KM2A is consistent with other experiments.