# The Cosmic Ray Spectrum of Light Component above 10 TeV Measured by LHAASO Experiment

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**For LHAASO collaboration**

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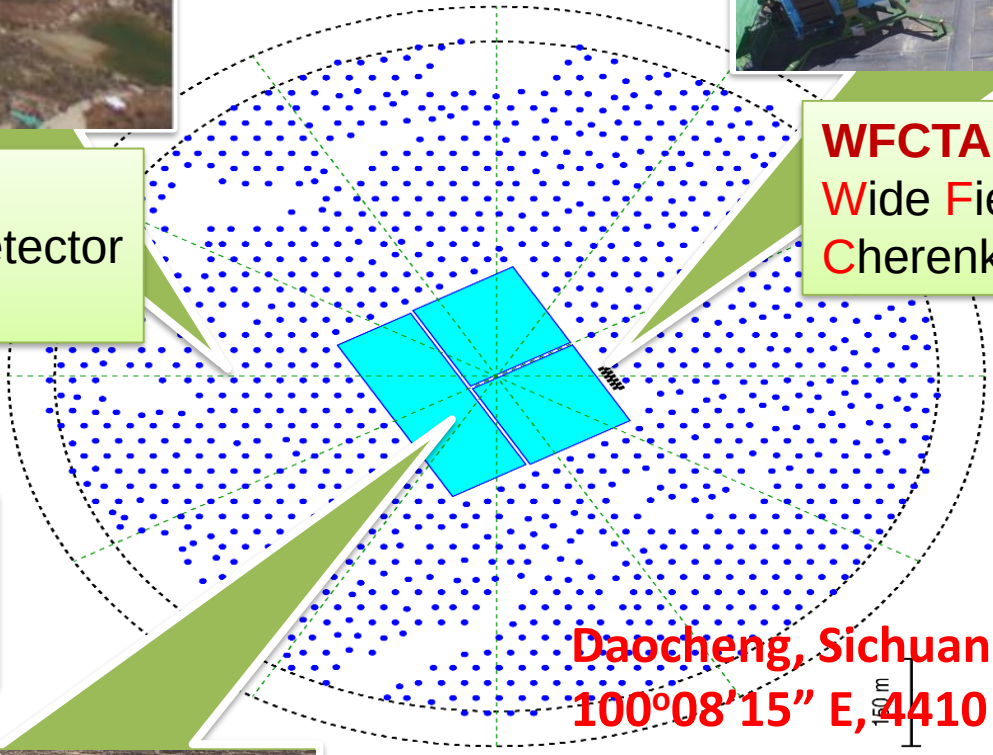
# Outline

- Introduction of LHAASO
- Data analysis and preliminary results
- Conclusion

# LHAASO

**KM2A: (ED, MD)**
Electromagnetic Detector
Muon Detector

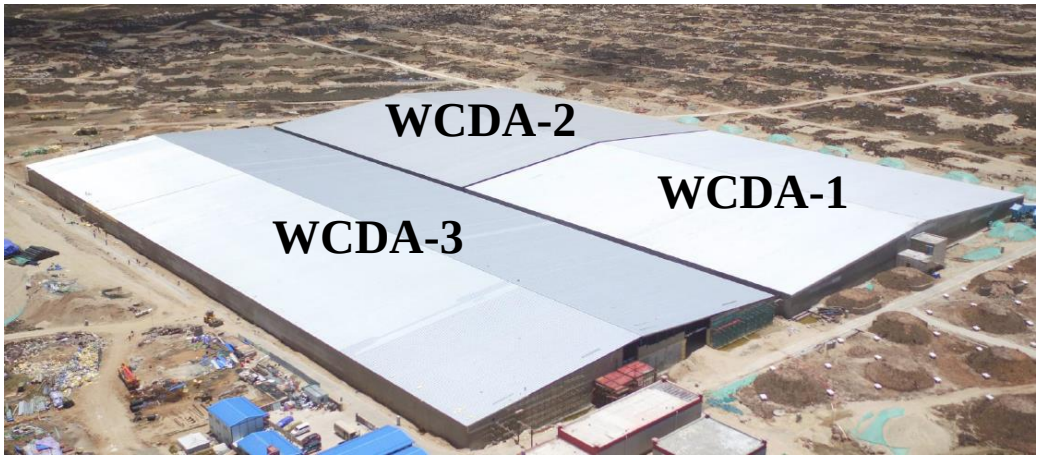
**WFCTA:**
Wide Field of view
Cherenkov Telescope Array

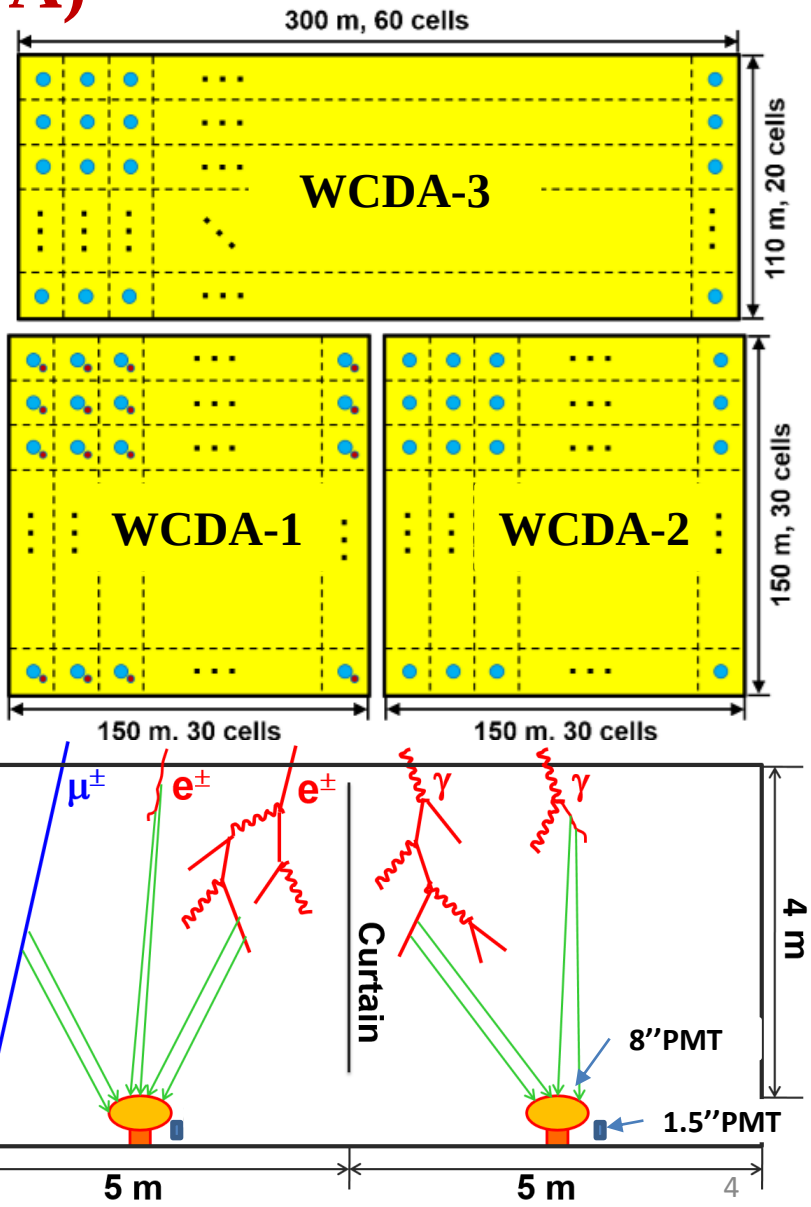


**WCDA:**
Water Cherenkov
Detector Array

**Daocheng, Sichuan (29°21’ 31” N, 100°08’15” E, 4410 m a.s.l., 600 g/cm)**

# Water Cherenkov Detector Array (WCDA)



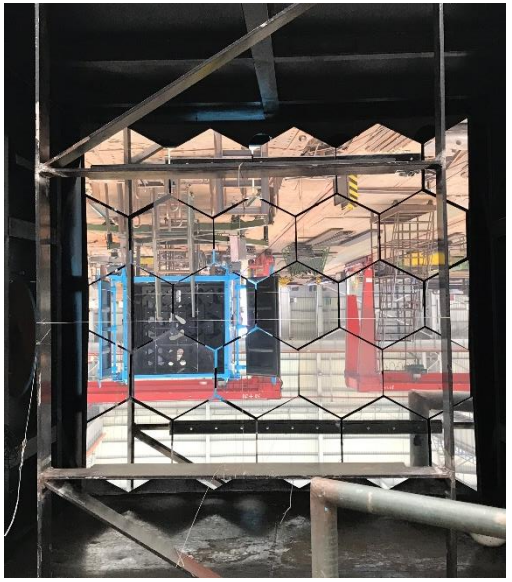



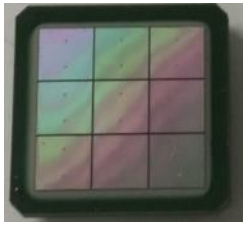

- Total area: $78,000m^2$
- Total units: 3,120
- Unit size: $5m \times 5m \times 4m$
- Two type of PMTs in first pool:
  - 8 inches
  - 1.5 inches

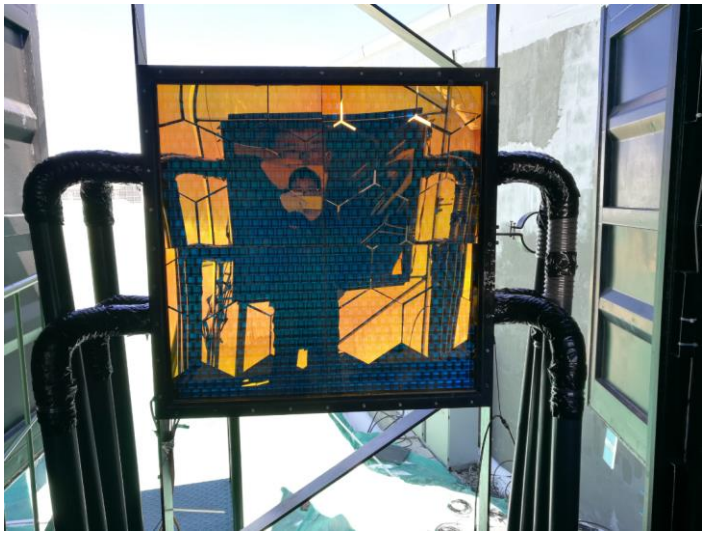
# Wide Field of View Cherenkov Telescope (WFCTA)

## 18 Telescopes

- 5m$^2$ spherical mirror
- Camera: 32×32 SiPMs array
- Pixel size: 0.5°
- FOV: 16° × 16°
- Portable design: easy to switch the array configurations



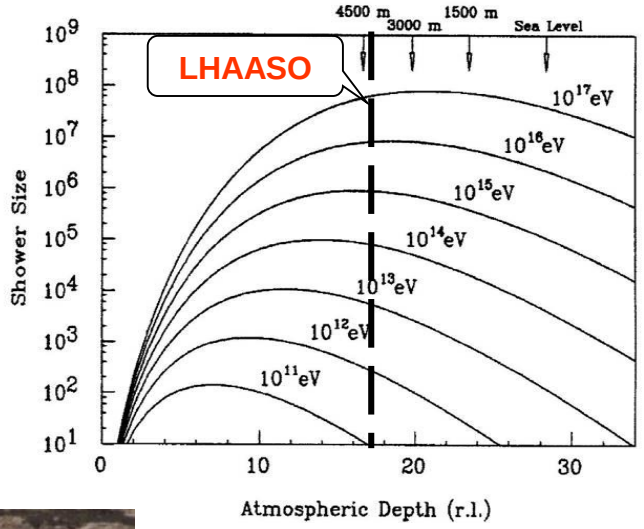


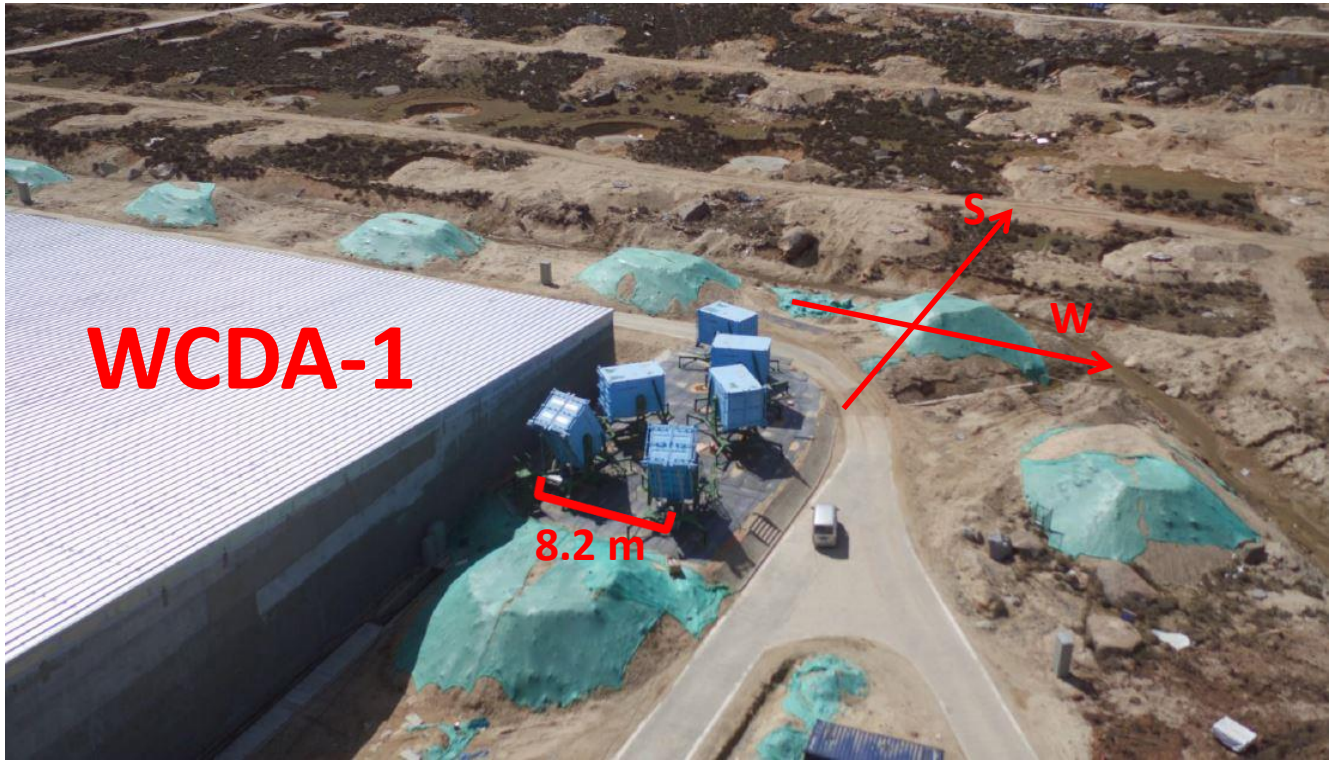


# Arrangement of WFCTA

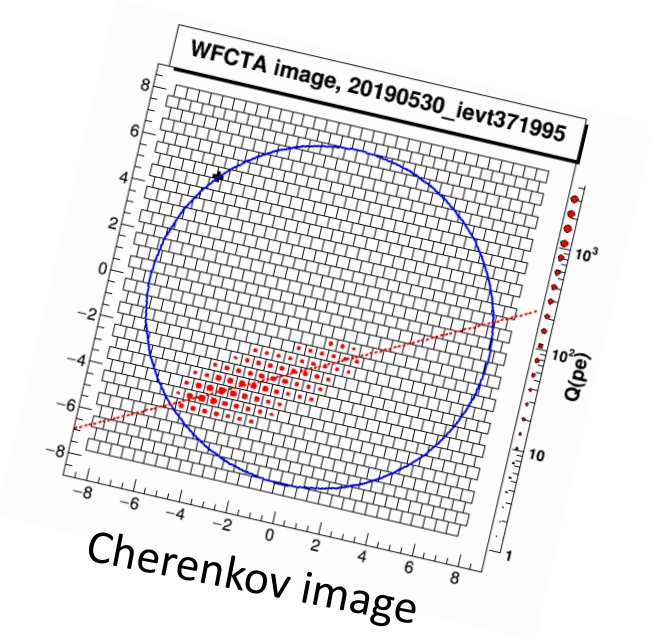
- The first telescope: January 2019
- The second one: May 2019

- The first pool of WCDA began operation in February 2019



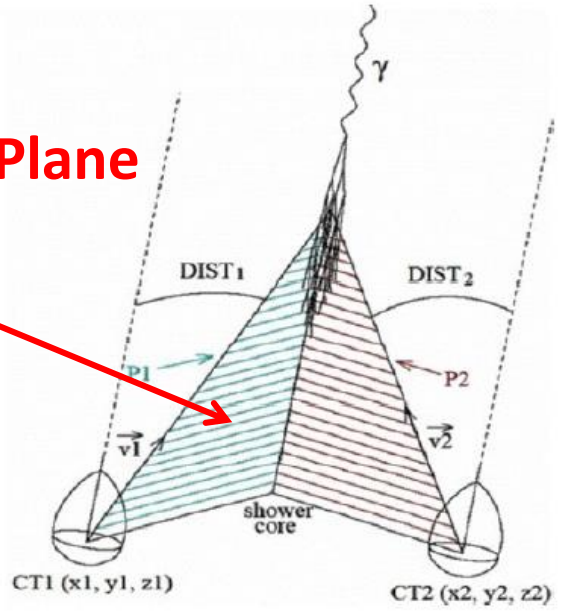



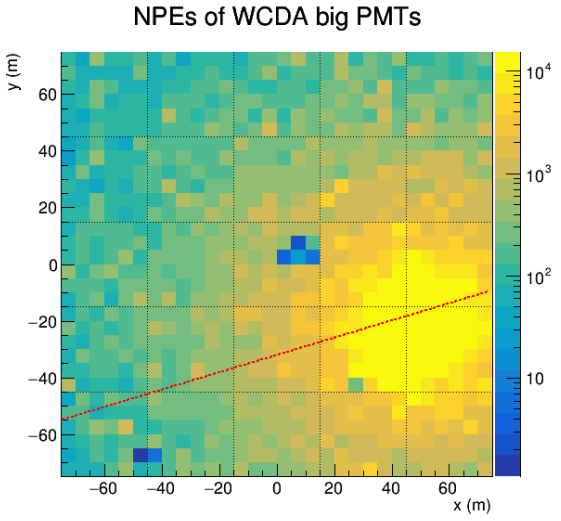

# A coincident event observed by WCDA and WFCTA



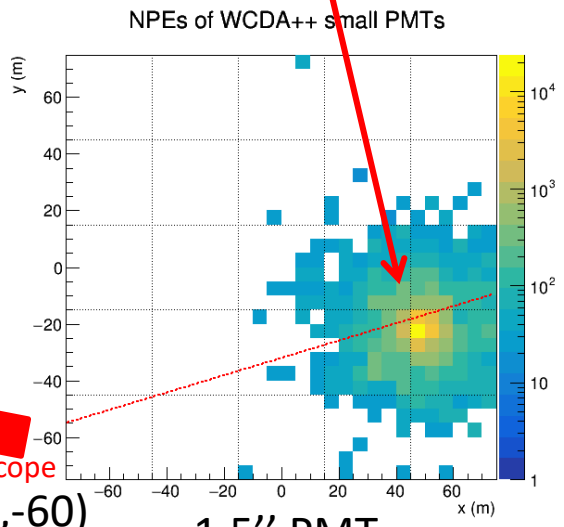

Shower Detector Plane (SDP)

Shower Core

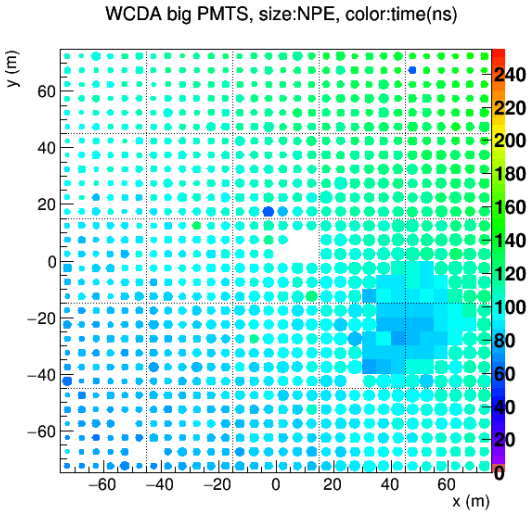


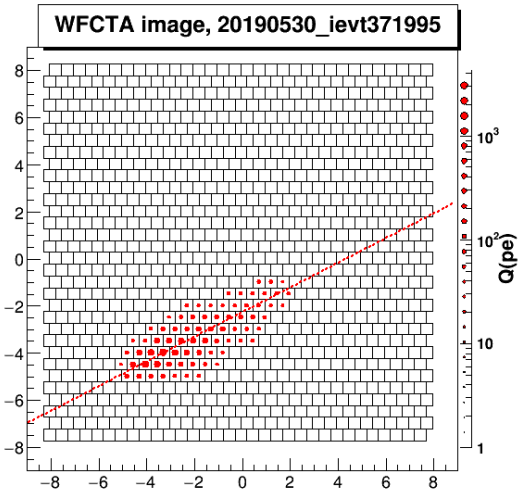

8'' PMT




1.5'' PMT



# Composition discrimination variables



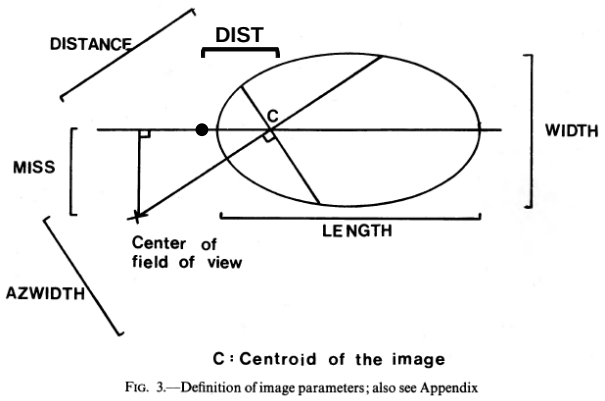
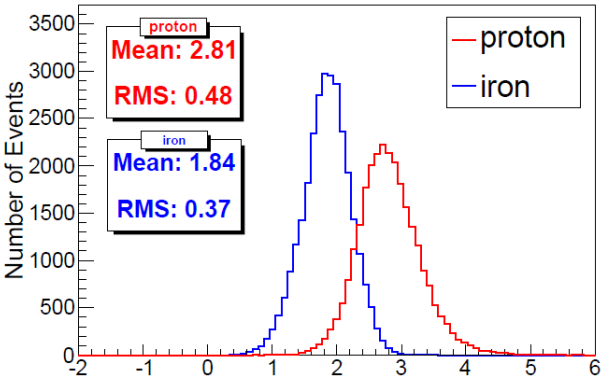
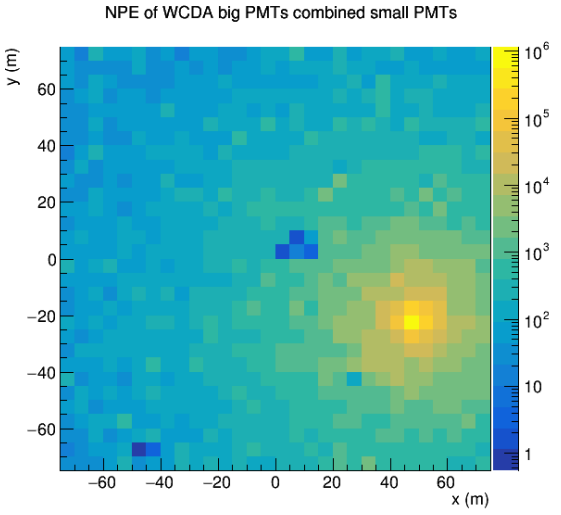



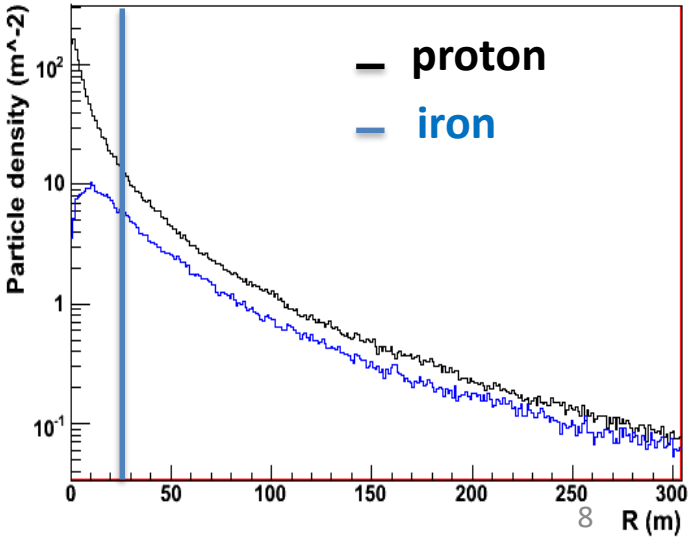
FIG. 3.—Definition of image parameters; also see Appendix




$$P_c = \left(\frac{Length}{Width}\right)\Big|_{normalized}$$

- **Length/Width**
- **Dist (related to $X_{max}$)**
- **Particle numbers near the shower core**
- **$\mu$-like information**



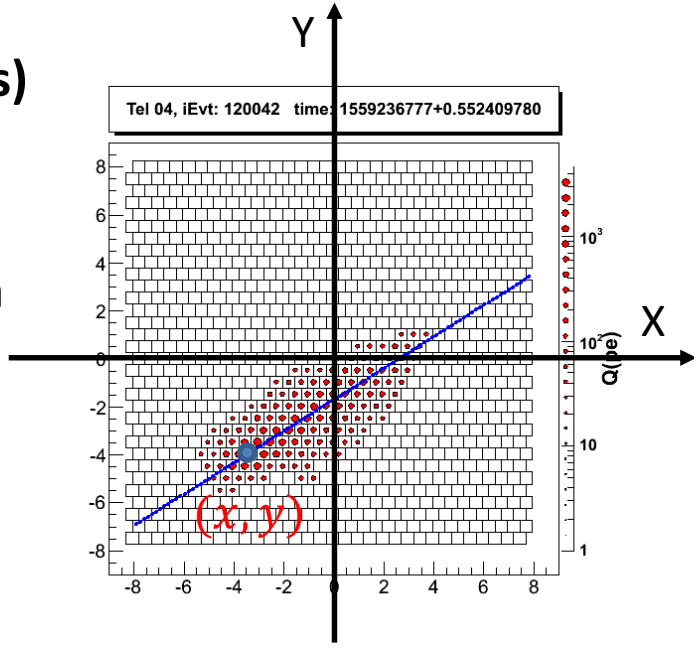



# Events observed by WCDA and WFCTA

- From 2019.04 ~ 2019.05
  - **Both WFCTA and WCDA were running (10 days)**
- Data selection:

  Good weather
  - **no cloud in FoV of telescope and no moon (4 days selected)**

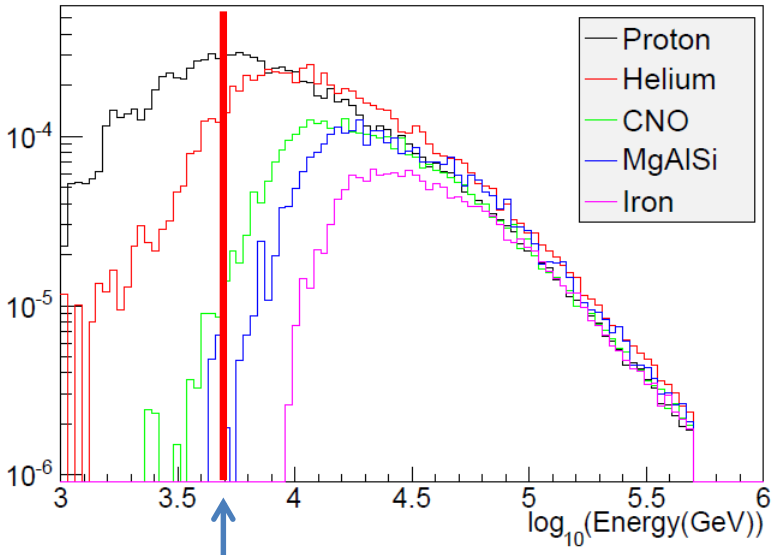
  Well observed
  - **Number of fired sipm > 5**
  - **Centroid of image:** $|X|<6^o$; $|Y|<6^o$
- After data selection: **101,940** events are left




| Date | Number of events | Number of events without clouds | Number of events of no cloud and well observed |
|---|---|---|---|
| 02/04 2019 | 3,853 | 3,853 | 2,370 |
| 28/05 2019 | 58,524 | 50,164 | 30,592 |
| 29/05 2019 | 49,870 | 49,025 | 29,456 |
| 30/05 2019 | 70,078 | 50,838 | 39,522 |
| Sum | 182,325 | 153,880 | 101,940 |

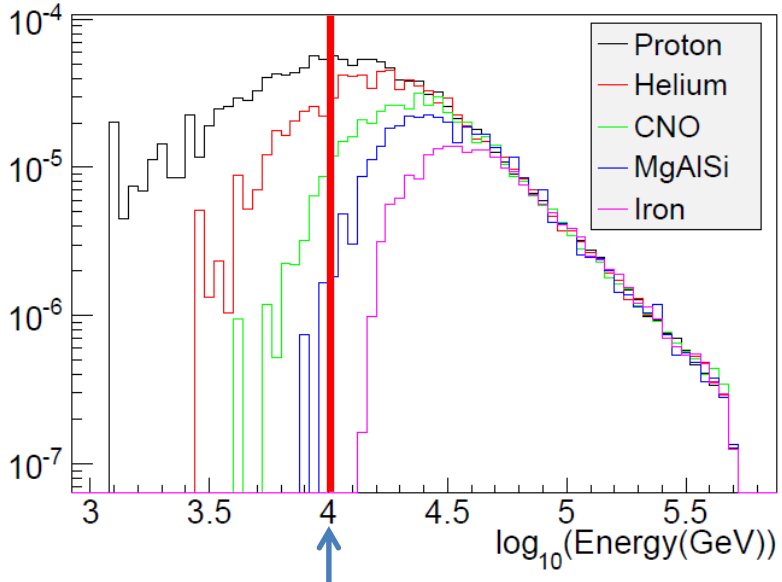
# Simulation

- Tool: CORSIKA -74005 + QJSJET-II04 + FLUKA
- Energy range: 1 TeV – 500 TeV
- Primary particles: proton, helium, CNO, MgAlSi, iron
- Geometry: zenith: $0^o - 13^o$, azimuth: $0^o - 360^o$, core: $\pm 200\ m$




Energy Threshold: 7TeV

(Triggered neighboring tubes $> 2$)

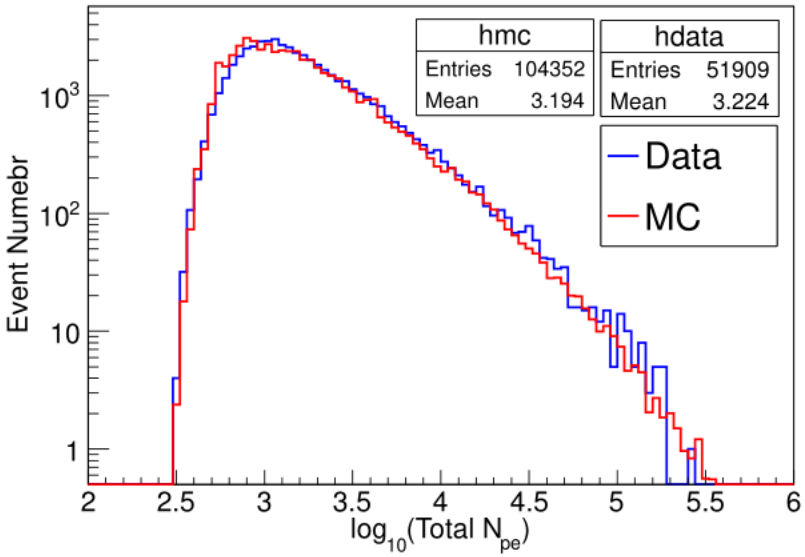


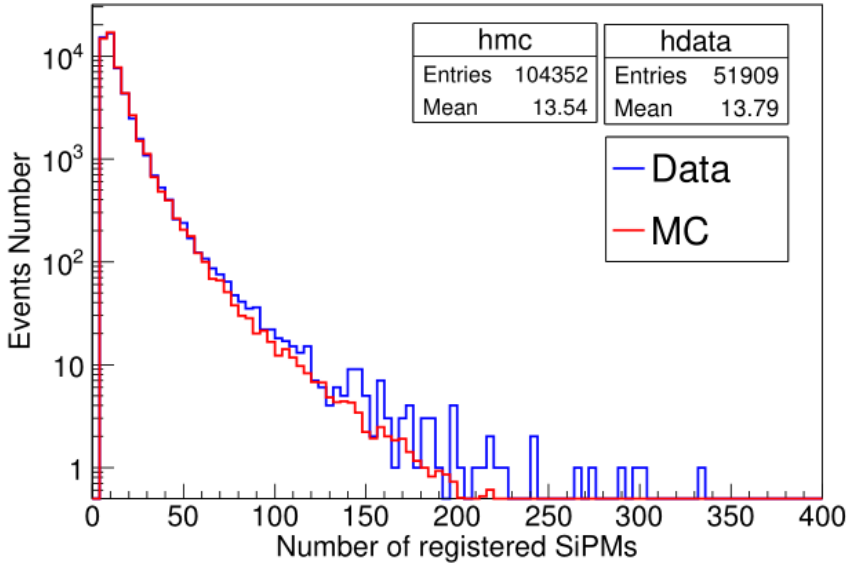

Energy Threshold: 10TeV

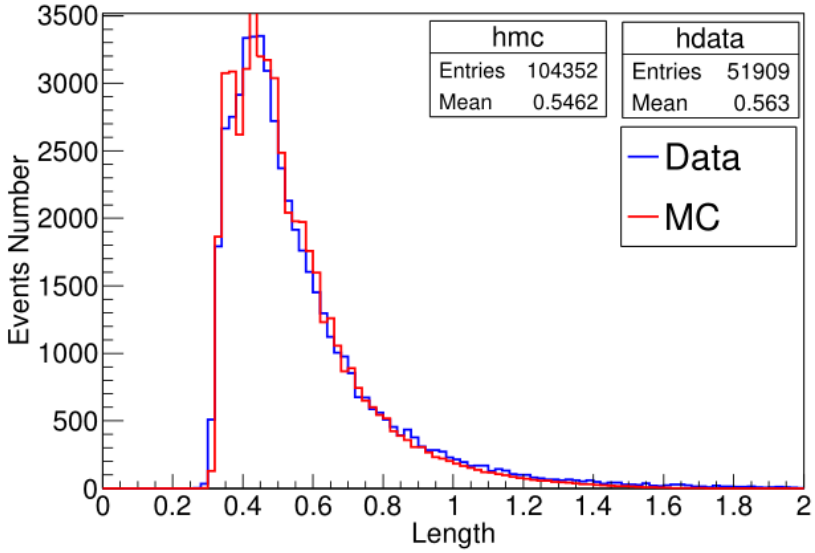
(Triggered neighboring tubes $>_{10} 5$)

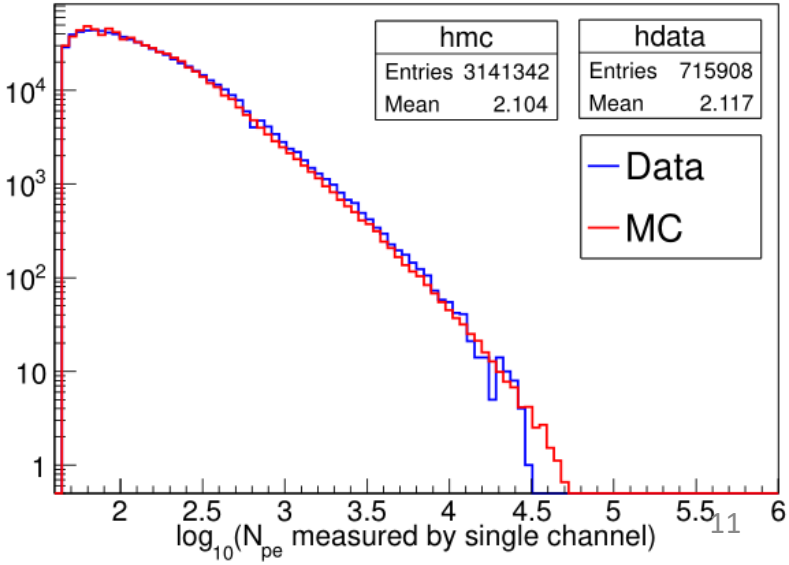
# Comparison of data and simulation of WFCTA

## Simulation and data is consistent in 10%



# Conclusion and future works

1. **The energy threshold of telescope is 10 TeV or lower**

2. **The simulation is agree with data of WFCTA in 10%**

3. **In September , a quarter of LHAASO will start running: six telescopes + one WCDA pool + a quarter of KM2A**

***Thanks***