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

Zhiyong You

For LHAASO collaboration

The Institute of High Energy Physics of CAS

36th ICRC
Madison, WI, USA
26 July 2019
Outline

• Introduction of LHAASO

• Data analysis and preliminary results

• Conclusion
LHAASO

**WCDA:** Water Cherenkov Detector Array

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

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

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: $32 \times 32$ SiPMs array
- Pixel size: $0.5^\circ$
- FOV: $16^\circ \times 16^\circ$
- 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

Point at the zenith angle of 0°
A coincident event observed by WCDA and WFCTA

Shower Detector Plane (SDP)

Shower Core

NPEs of WCDA big PMTs
NPEs of WCDA++ small PMTs

WCDA big PMTs, size:NPE, color:time(ns)

WFCTA image, 20190530_evt371995

Cherenkov image

8'' PMT (-80,-60) 1.5'' PMT
Composition discrimination variables

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

$$P_c = \left( \frac{\text{Length}}{\text{Width}} \right)_{\text{normalized}}$$
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: $|X| < 6^\circ; |Y| < 6^\circ$

- After data selection: **101,940** events are left

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

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

Energy Threshold: 7TeV
(Triggered neighboring tubes $> 2$)

Energy Threshold: 10TeV
(Triggered neighboring tubes $> 5$)
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