Sensitivity estimation of LHAASO-WCDA for observing GLE events

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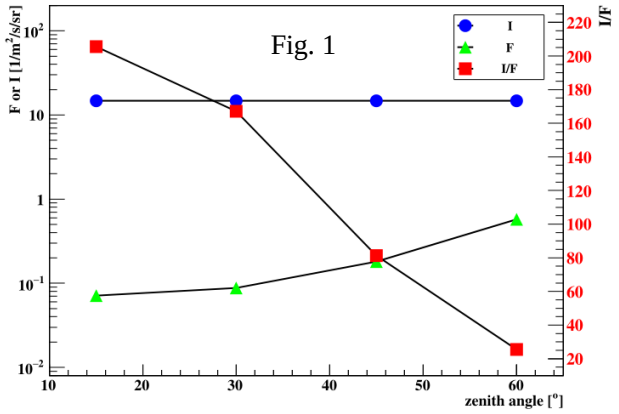
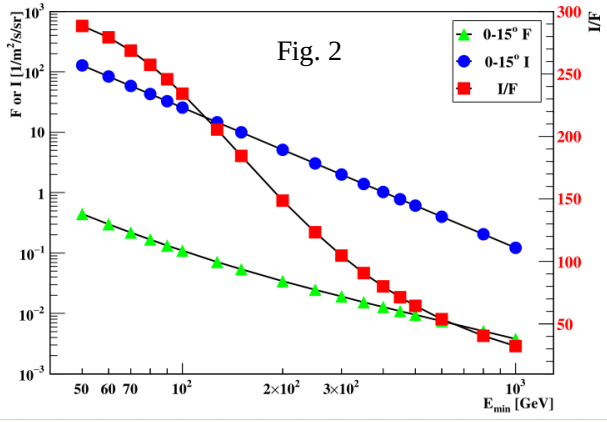
1. Introduction

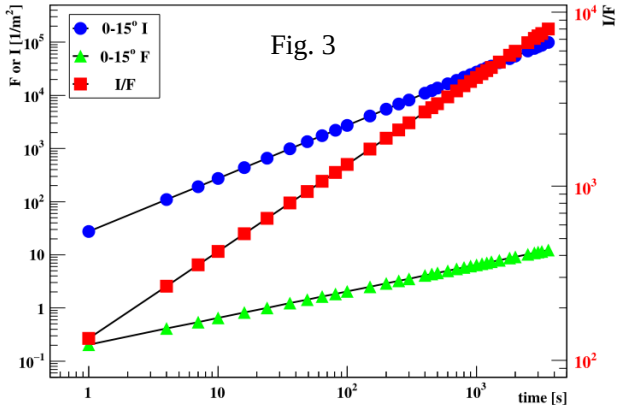
Ground Level Enhancement (GLE) [1] events of solar cosmic ray refer to the sudden, sharp and short-lived enhancement of ground level energetic particles generated from solar flare and coronal mass ejection (CME). The observation of GLE events is one of the scientific aim in the Large High Altitude Air Shower Observatory (LHAASO) [2]. In this work, we estimate the sensitivity of the LHAASO-WCDA experiment to observe GLE events under different zenith angles, observation energies and GLE time durations.

2. Calculation process

1. Calculate background(GCR) count N_{GCR} of LHAASO-WCDA experiment.
2. Calculate the minimum count N_{GLE} required for 5σ observation of GLE events.
3. Calculate the normalization constant coefficient K.
4. Calculate the sensitivity F.







3. Calculation results and discussion

Fig. 1 shows the sensitivity F of LHAASO-WCDA to observe GLE events (green triangle) and the flux I of solar energetic particles (blue dot) were calculated over different zenith angle ranges when the lower limit of WCDA observation energy is 127GeV. Also, the I/F (red square) with different zenith angles is plotted. These results show that the sensitivity of LHAASO-WCDA to observe GLE events becomes terrible and I/F decreases with increasing zenith angle. When the zenith angle is up to $45-60^{\circ}$, however, the I/F is still greater than 1. So LHAASO-WCDA can also detect GLE events over larger zenith angle ranges.

Fig. 2 shows F, I and I/F as a function of the observed energy when the zenith angle is $0-15^{\circ}$. It can be seen when the observed energy is more than 1TeV, I is 30 times than F, or even higher. This means that LHAASO-WCDA has a very strong ability to observe GLE particles with energy higher than TeV.

Dependence of F , I and I/F on the time duration are shown in Fig. 3 when the zenith angle is $0-15^{\circ}$ and minimum observed energy is 50 GeV. It can be seen that the possibility of LHAASO-WCDA to observe GLE events become larger with time duration.

4. Conclusion

By using LHAASO-WCDA sensitivity calculation method for Observing GLE Events and combined with the observation results of 13 GLE events in solar cycle 22, the ability of LHAASO-WCDA to observe GLE events for different zenith angles, observed energies and GLE time duration were analyzed in this paper. The results show that LHAASO-WCDA can observe GLE events with energy higher than 1 TeV at zenith angle of $0\text{-}15^{0}$. It is worth noting that our results are obtained by extrapolation of the energy spectrum of GLE events, this means that the energy spectrum of the solar energetic particles remains unchanged at higher energies.

Acknowledgments

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References

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