Zenith angle dependence of pressure effect in GRAPES-3 muon telescope

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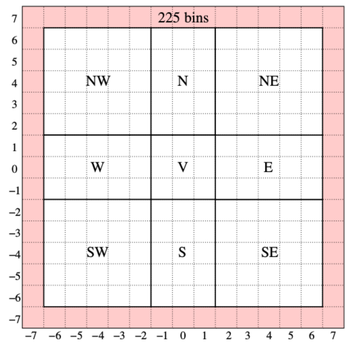
Motivation

- The modulation in the Earth's atmospheric condition can affect the muon intensities at ground level.
- The amount of secondaries absorption in the atmosphere depends on primary particle energies.
- The barometric coefficient (β_P) is expected to change with the geomagnetic cutoff rigidity (R_C), which quantifies the minimum energy required by a primary particle to reach that location.
- It is important to apply the rigidity dependent barometric corrections to study the tiny changes in the muon flux caused by solar origin phenomenon.

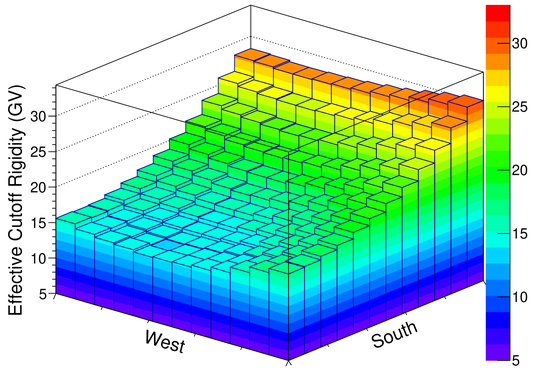
G3 Muon Telescope

- 16 modules × 4 layers × 58 PRCs = 3712
- Muon track reconstruction in 169 independent directions (Sky coverage = 2.3 sr).



R_C Calculation

- Field of view divided into 360°×60°grid. Anti-proton ($\overline{p}$) of increasing rigidity launched in each direction.
- The $\overline{p}$ escape rigidity from the geomagnetic field is equivalent to the R_C for incoming proton from that direction.



Conclusion

The barometric coefficient is found to decrease linearly with ln(R_C) up to ~26 GV beyond which a flattening in the curve is observed.

References

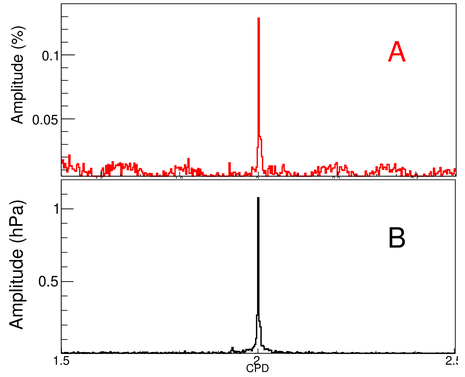
[1] P.K. Mohanty, et al., Astropart. Phys. 79, 23-30 (2016)

[2] D.F. Smart and M.A. Shea., Grant NAG5-8009

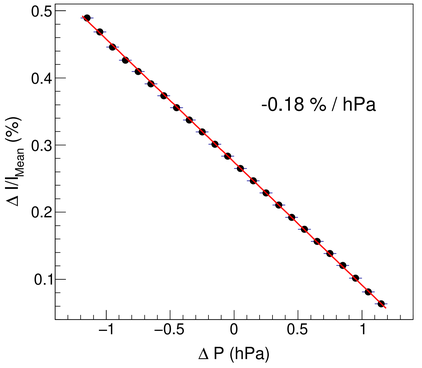
β_P Calculation

- Fast Fourier Transform is used to extract the 12 h periodicity from both muon and atmospheric pressure data (Year 2001 to 2006).
- β_P can be obtained as:

$$\frac{\Delta I}{\langle I \rangle}\,(\%) = \beta_P\,(P - \langle P \rangle)$$



Power Spectrum: (A) Muons, and (B) pressure



For Dir = 083 (CC = 0.99)

Results

- The barometric coefficients for 169 directions show a clear dependence on ln(R_C), which can be described by second order polynomial function (Spearman Rank correlation : 0.99).