C.1.8 Zenith Dependence of Muons Flux

SG6215D

Dedicated kit	
Description	pp.
SP5620CH Cosmic Hunter	182

Requirements

SP5609 – Telescope Mechanics or a similar structure

Difficulty	Execution Time	Data Analysis	Radioactive Sources
		YES	NO

Equipment

SP5620CH - Cosmic Hunter

Model	SP5621	SP5622 (x2)
Description	Coincidence Module	Detection System
		
	p. 182	p. 187

See the Application

Purpose of the experiment

Measurement of the zenith dependence of the cosmic ray flux as a function of altitude. The goal of the experiment is to analyse zenith dependence by performing a series of measurements at different zenith angle values.

Fundamentals

Most muons are produced in the upper atmosphere, typically 15km above the surface of the earth. Muons typically lose about 2GeV to ionization before reaching the ground. The average energy of muons on the ground is around 4GeV. When their decay ($E_\mu > 100 / \cos\theta$ GeV) and the curvature of the Earth (for $\theta > 70°$) can be disregarded the flux of cosmic muons can be expressed as follows:

$$\frac{dN_\mu}{dS dt d E_\mu d\Omega} = 0.14 E_\mu^{-2.7} \left\{ \frac{1}{1 + \frac{1.1 E_\mu \cos\theta}{115 GeV}} + \frac{0.054}{1 + \frac{1.1 E_\mu \cos\theta}{850 GeV}} \right\} [cm^2 \, s \, GeV \, sr]^{-1}$$

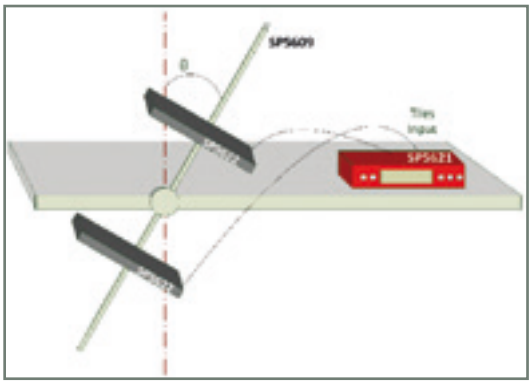
Where θ is the zenith angle, and the two terms in the brackets indicate the contribution of the charged pions and kaons. For E_μ ~ 3GeV, the angular distribution of muons is proportional to cos2θ at sea level. The intensity of cosmic muons is only determined by the angular dependence of the zenith on their energy spectrum and their energy. As first approximation, the dependence of the muon flow from ϕ is considered negligible, which is in fact less than 10% (*).

(*) A. A. Ivanov et al., JETP letters, V69 N4(1999)288

Carrying out the experiment

Connect the cable connectors of the two SP5622 to the tile inputs located on the rear panel of the SP5621 module. Power on the SP5621 module and start the acquisition via the front panel START button. When a charged particle crosses the black tile it's energy is converted into scintillation light. The photons which are produced are detected by the photosensor and converted into an electrical signal. The number of counts for each scintillator may be viewed via the SP5621 display. Select the scintillators coincidence via the related button on the front panel, then select the integration time of the measurement.

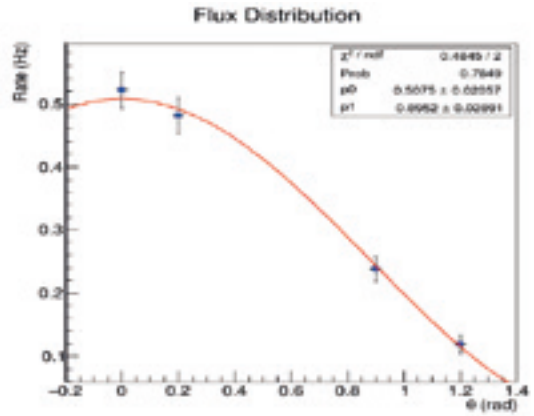
Before starting acquisition choose the system geometry. Be sure to keep this geometry constant for the duration of the experiment. Take and record more data to obtain statistical significance.



Experimental setup block diagram.

Results

The following plot shows the result obtained by positioning the two detectors at 20 cm distance. The count rate was measured at four values of the zenith angle, θ=[0, 10°, 50°, 70°], to verify the cos2(θ) theoretical trend of the muons flux.



Zenith angle dependence of the muons flux [Fit: $y = p0 * \cos^2(p1 * x)$]

This experiment is also possible with the following kits

A **SP5600D** Educational kits

see pp. 182, 179

B **SP5600AN** Educational kits ★ PREMIUM

see p. 179