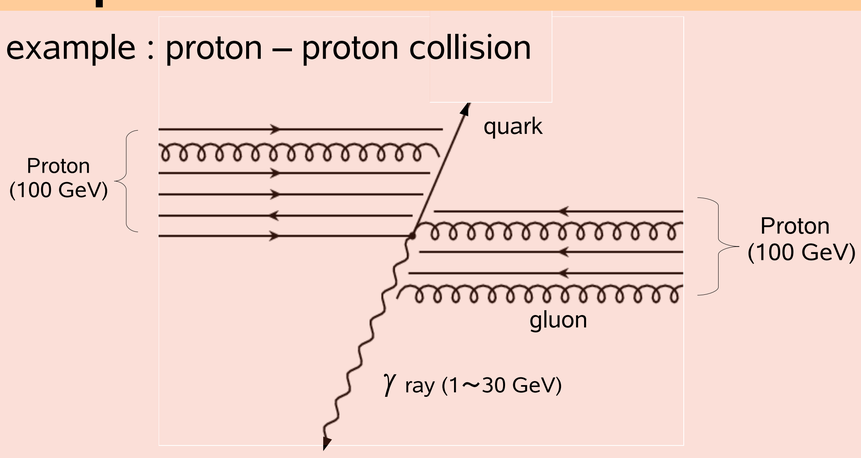
2008/5/23 基礎物理学コロキウム　　柴田研究室　08M01205　水頭 慎一

“Performance test of a lead glass Cherenkov detector with cosmic ray muons”

（鉛ガラスチェレンコフ検出器の宇宙線ミューオンを用いた性能測定）

1. High energy γ rays in particle physics experiments

example : proton – proton collision



・High energy γ ray is emitted in high energy particle experiments

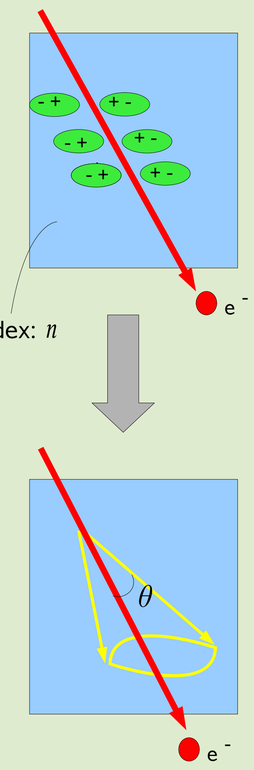
・Electromagnetic calorimeter measures the γ ray energy

2. Cherenkov radiation

・The principle of the Cherenkov radiation

conditions : $v > \frac{c}{n}$ （ v : velocity of charged particle, n : refractive index ）

Cherenkov light is emitted in the shape of a cone.



The Cherenkov radiation angle θ :

$$\cos\theta = \frac{1}{n\beta} \qquad \left(\beta = \frac{v}{c} \right)$$

The number of photons N :

$$\frac{dN}{dx} = 2\pi\alpha z^2 \sin^2\theta \int \frac{d\lambda}{\lambda^2}$$

（ α : fine structure constant, z : charge of particle, x : path length ）

3. Electromagnetic calorimeter

・Electrons and positrons emit Cherenkov photons.

・Energy of the particle is determined by the total number of the Cherenkov photons in electromagnetic shower.

・A detector longer than Radiation length is required for measurement.

Lead glass Cherenkov detector is one of the electromagnetic calorimeters

(E = 1～30 GeV)

Electromagnetic shower takes place when

A photon enters lead glass

↓ electron-positron pair creation (電子-陽電子対生成)

An electron and a positron are created

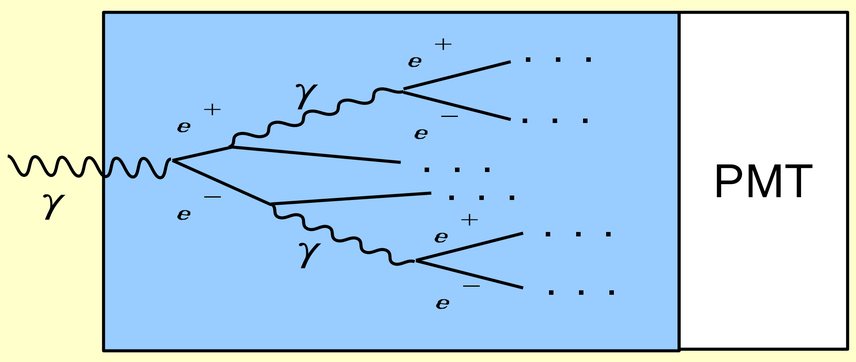
↓ bremsstrahlung (制動輻射)
cherenkov radiation (チェレンコフ輻射)

Photons are emitted

↓ electron-positron pair creation(電子-陽電子対生成)

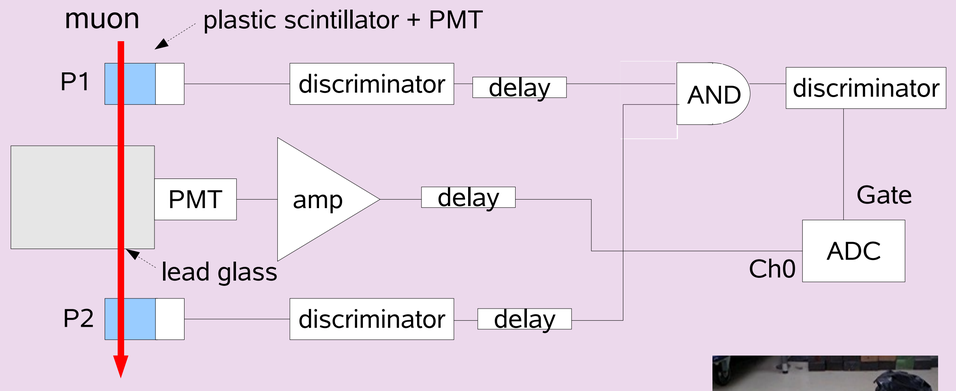
⋮

Electromagnetic shower is created



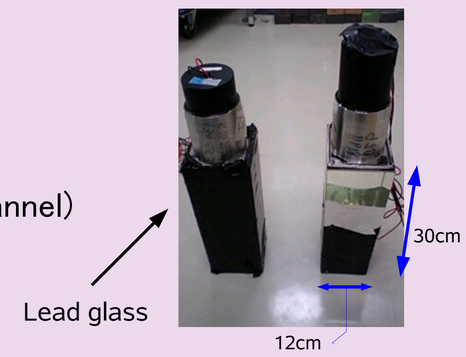
4. Experiment

・Experimental Setup

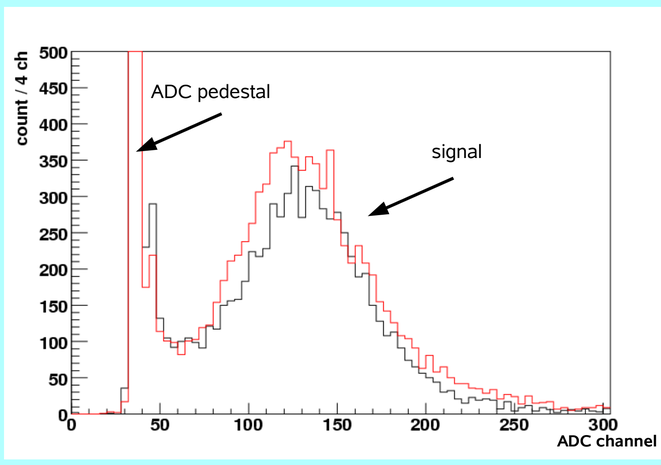


ADC (LeCroy,2249W)

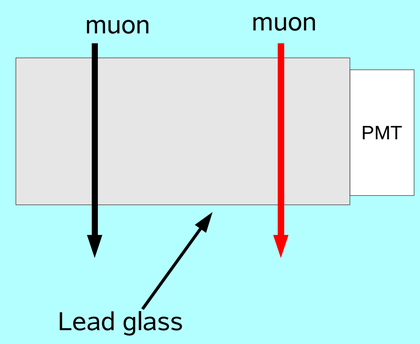
Full Scale Range	0～512pC
Number of Bits	11bit (1024channel)
High Sensitivity	0.25pC
Resistance	50Ω



5. Results

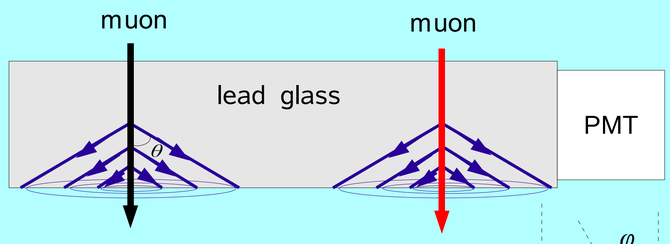


・the peak positions are the same in both cases.



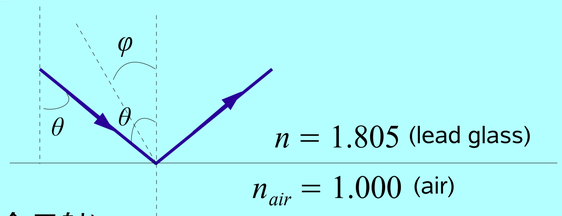
: histogram at the top side of lead glass

: histogram at the bottom side of lead glass



Cherenkov angle θ :

$$\theta = \cos^{-1}\left(\frac{1}{n\beta}\right) \simeq 56° \quad (\beta \simeq 1)$$



Critical angle of total internal reflection (全反射) φ :

$$\varphi = \sin^{-1}\left(\frac{n_{air}}{n}\right) = 34° \Rightarrow \theta > \varphi$$

6. Summary

・High energy gamma ray is often measured in high energy particle physics experiment.

・Lead glass is used as Electromagnetic calorimeter.

・Cherenkov radiation takes place when $v > \frac{c}{n}$.

・I measured muons at two different positions at the lead glass detector.

・The peak positions are the same in the ADC histograms.

・This was against my expectation, so I investigated it and found the reason.

・Outlook

・I will measure muons with lead glass in vertical direction:

For that purpose, I will construct a mechanical support structure because lead glass is heavy

・Detailed simulation of photon propagation is also in preparation