

# The Cosmic Ray: Flux and Absorption

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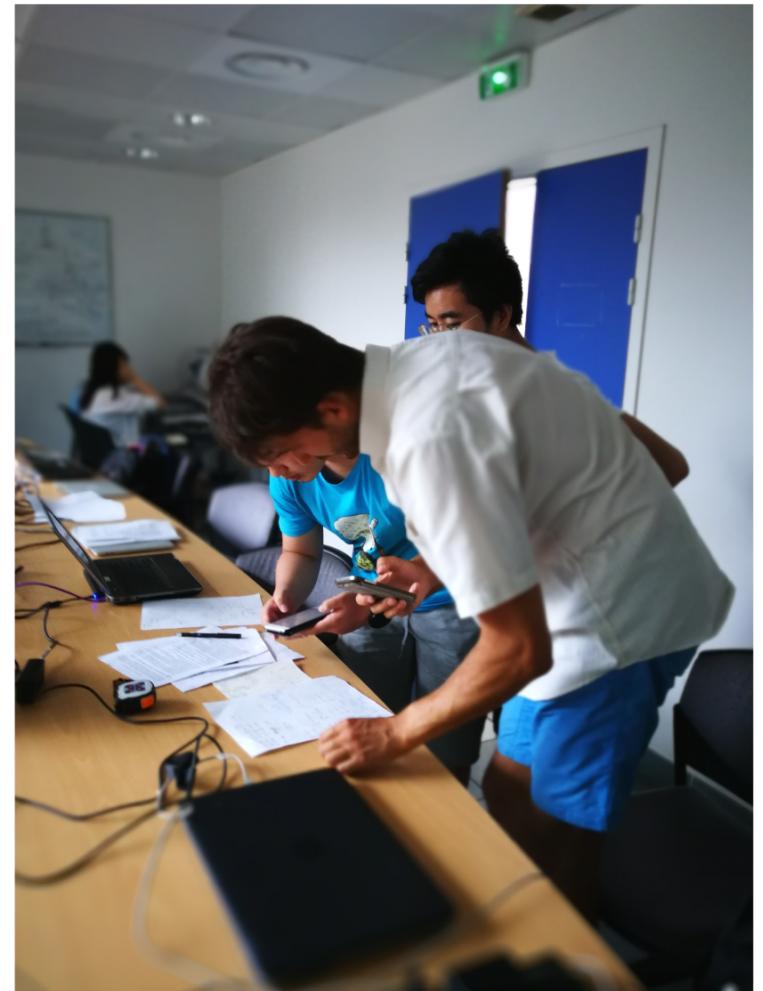
# Outline

- Principle & Purpose
- Detectors
- Results & Data Analysis

# Moments ~ ~ "



Moments

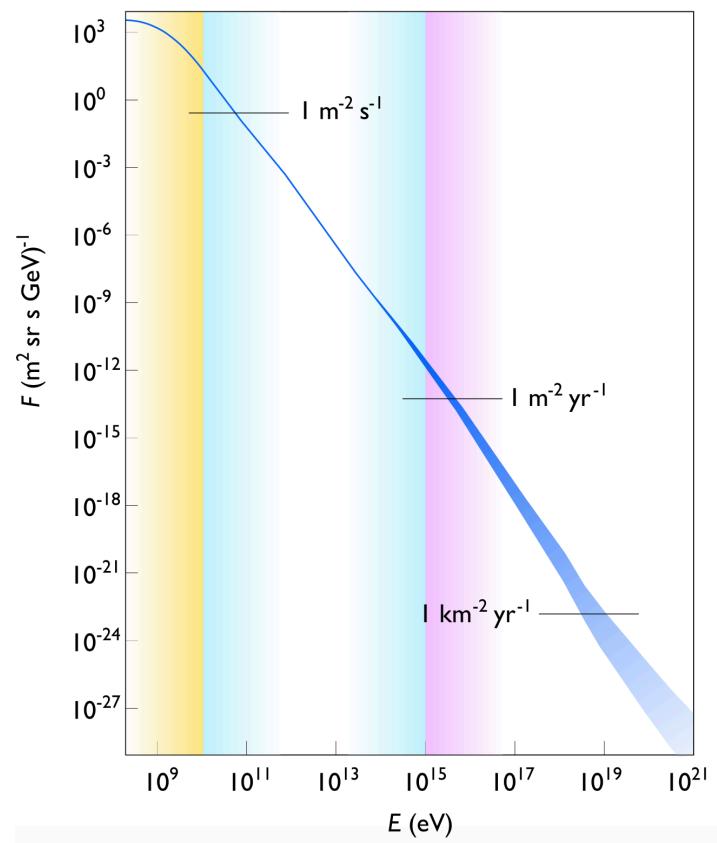
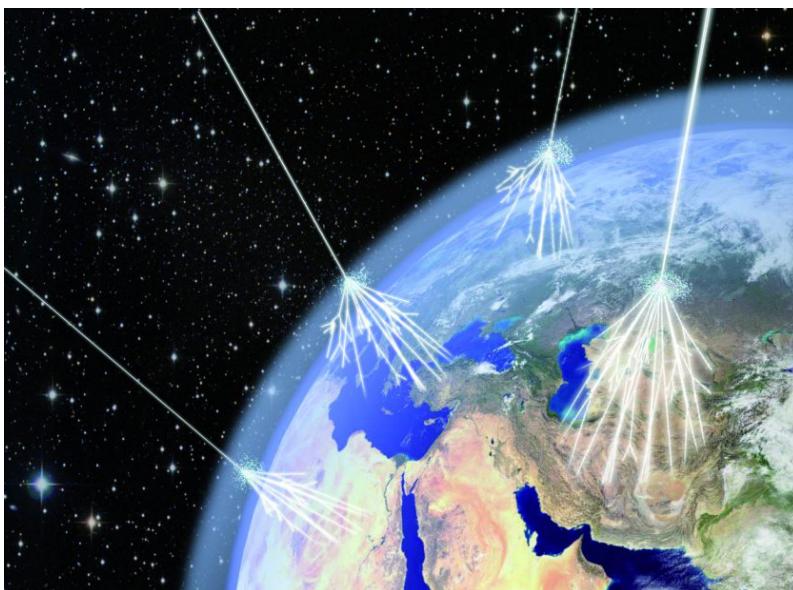


Cosmic Ray Muon Flux

# Principle & Purpose

- Cosmic ray

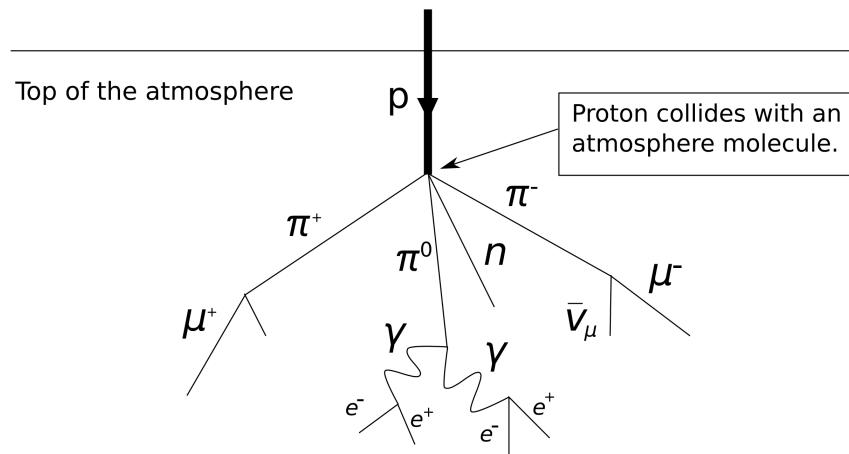
- Proton (heavier nuclei) 98%
- Electron 2%



# Principle & Purpose

- Muon

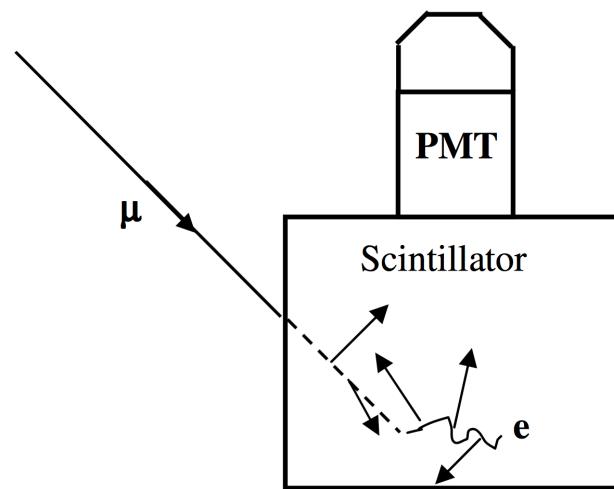
$$\pi^+ \rightarrow \mu^+ \bar{\nu}_\mu$$
$$\pi^- \rightarrow \mu^- \nu_\mu$$



- Detection

Muon Flux

Muon Absorption

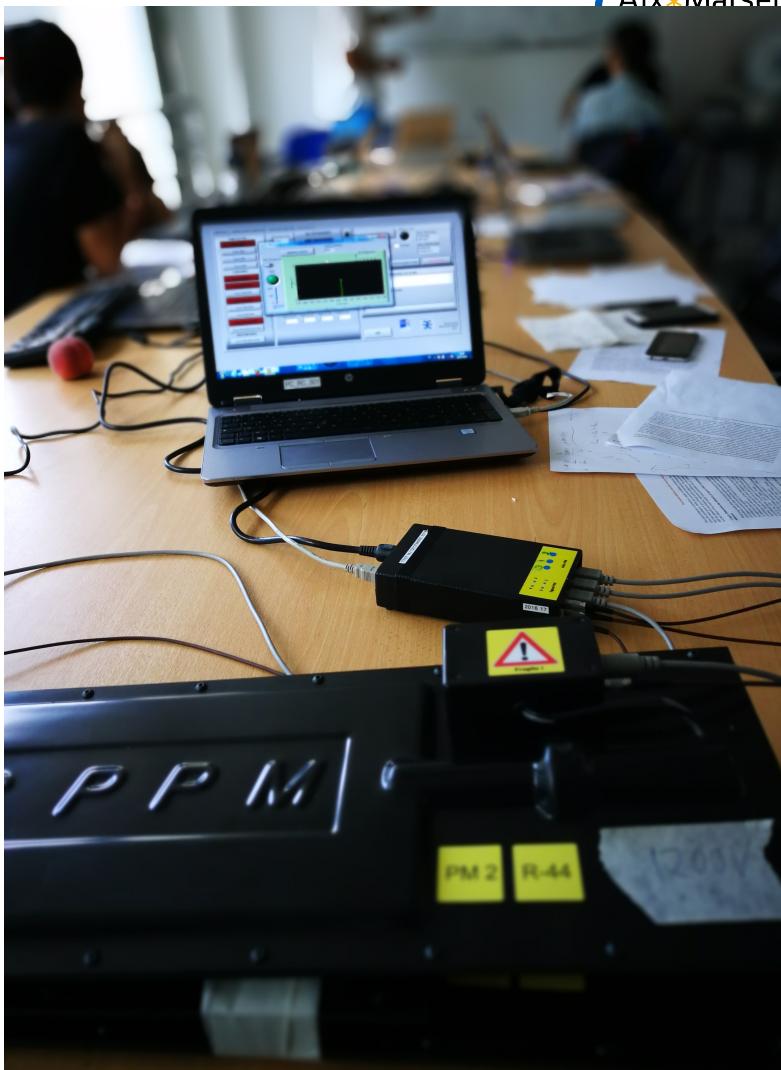
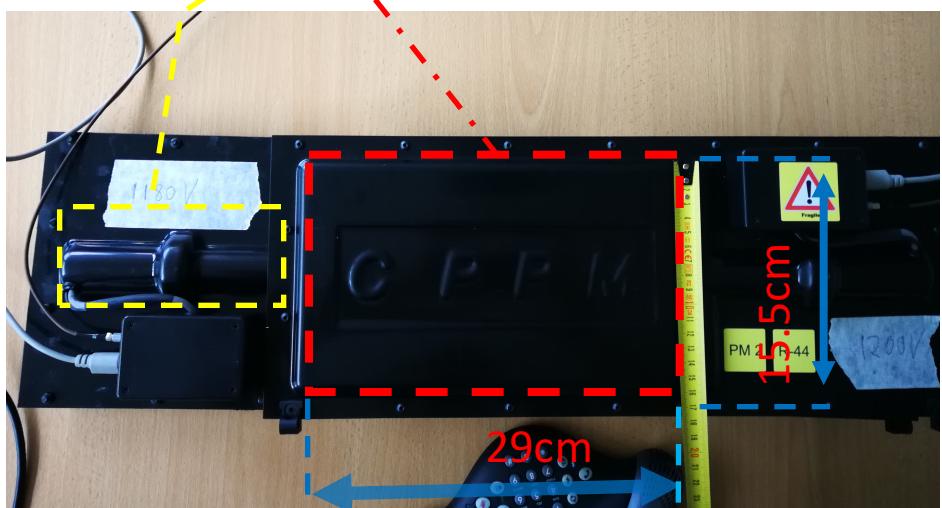
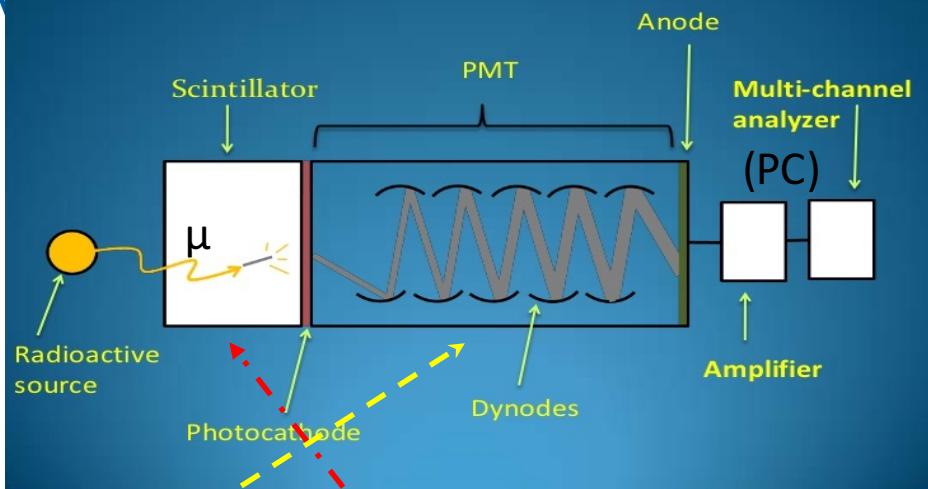


# Scintillation Detectors

The scintillation detector is undoubtedly one of the most widely used particle detection devices in nuclear physics and particle physics today.

- Plastic scintillator
- Photomultiplier Tube(PMT)
- Data acquisition board(DAQ)

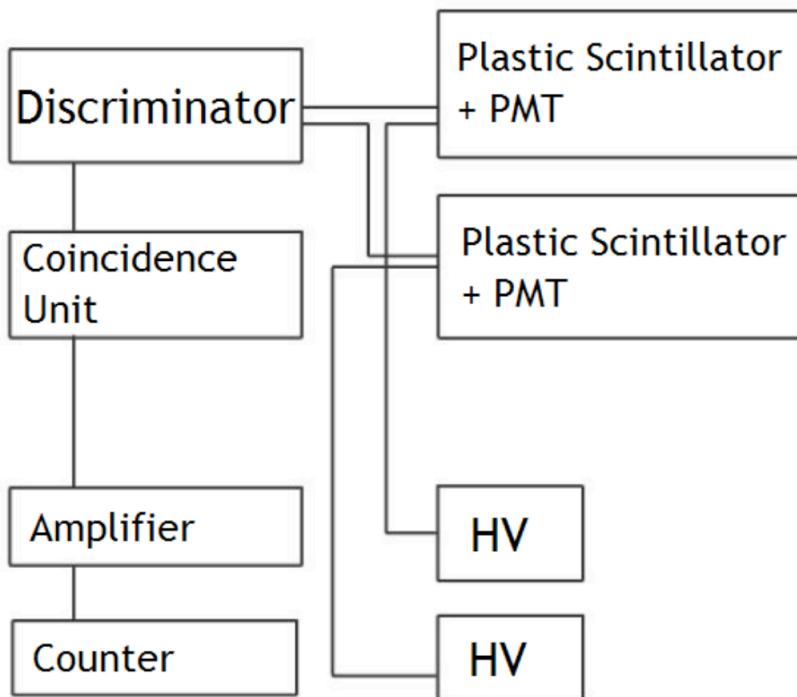
## Parts of scintillation detector



The active area of the detector is a plastic scintillator in the shape of a rectangle of 29cm length and 15.5cm width placed inside a black box.

Figure. Schematic view on a charged particle detector in experiment.

# Set-up



$$\tau = 100\text{ns}$$

$$R_{12}^{\text{random}} = 2R_1 R_2 \tau$$

$$R_{ij}^{\text{random}} \sim 0.5/\text{s}$$

i , j=1,2,3;

$$R_{ij}^{\text{ture}} \sim 10^{-6}/\text{s}$$

Random counting is negligible !

Figure. Schematic outline of the set-up. HV refers to a high voltage supply.

# Results & Data Analysis

- Efficiency and absolute muon rate

Measure place: the lab (**2<sup>nd</sup> floor**)

Measure time T=30 minute

Event of coincidence	$C_{123}$	$C_{12}$	$C_{13}$	$C_{23}$
number	3602	4862	5611	4736

$$C_{123} = R\text{-mu} * \text{eff1} * \text{eff2} * \text{eff3}$$

$$C_{12} = R\text{-mu} * \text{eff1} * \text{eff2}$$

$$C_{13} = R\text{-mu} * \text{eff1} * \text{eff3}$$

$$C_{23} = R\text{-mu} * \text{eff2} * \text{eff3}$$



$$\varepsilon_3 = \frac{C_{123}}{C_{12}} = 74.08 \pm 1.63\%$$

$$\varepsilon_2 = \frac{C_{123}}{C_{13}} = 64.20 \pm 1.37\%$$

$$\varepsilon_1 = \frac{C_{123}}{C_{23}} = 76.06 \pm 1.68\%$$

$$\begin{aligned} R\text{-mu} &= \frac{C_{123}}{\varepsilon_1 \varepsilon_2 \varepsilon_3 T} \\ &= 332 / \text{min} \end{aligned}$$

$$\begin{aligned} \text{Flux1} &= \frac{R\text{-mu}}{\text{area}} = \frac{332}{15.5 \times 29} \\ &= 0.74 / \text{min/cm}^2 \end{aligned}$$

# Results & Data Analysis

- Efficiency and absolute muon rate

Measurement at the main lecture hall(**RC**)

Measure time : $T=30$  min

Event of coincidence	$C_{13}$
number	4637

$$R\text{-mu} = \frac{C_{13}}{\varepsilon_1 \varepsilon_3 T} = 274 \text{ /min}$$

$$\text{Flux2} = \frac{R\text{-mu}}{\text{area}} = \frac{274}{15.5 \times 29} = 0.61/\text{min/cm}^2$$

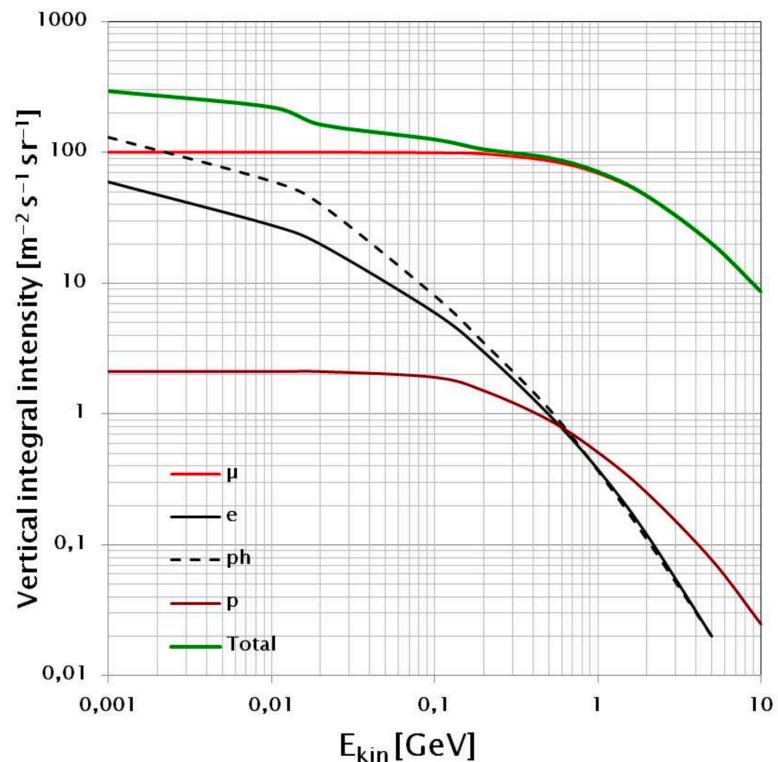
# The Absorption of CPPM floors

- Flux1  $\rightarrow 51.8 \text{ m}^{-2} \text{s}^{-1} \text{sr}^{-1}$
- Flux2  $\rightarrow 42.7 \text{ m}^{-2} \text{s}^{-1} \text{sr}^{-1}$

The energy loss : 2Mev/g/cm<sup>2</sup>

The E2=1.9 GeV, E1=2.2 GeV

The thickness of concrete =  $\frac{E_1 - E_2}{S\rho} = \frac{300}{2 \times 2.5} = 60 \text{ cm}$



# Thanks

Cosmic Ray Muon Flux