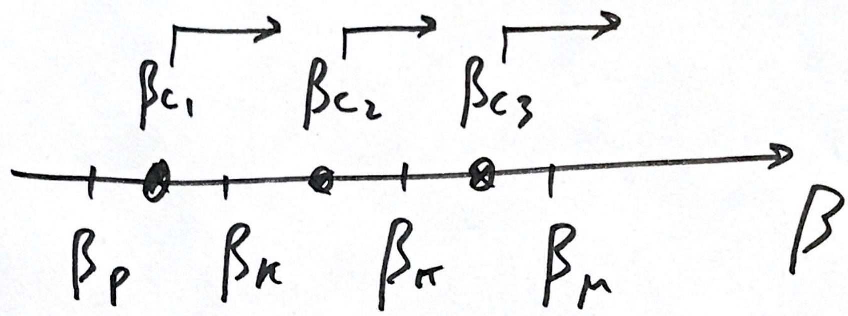
EX PER CASA

$p = 1\ GeV$ $\qquad$ μ^+, π^+, K^+, p

$$N_{min} = 3$$

$$m_\mu < m_\pi < m_K < m_p$$

$$\Rightarrow \beta_\mu > \beta_\pi > \beta_K > \beta_p$$



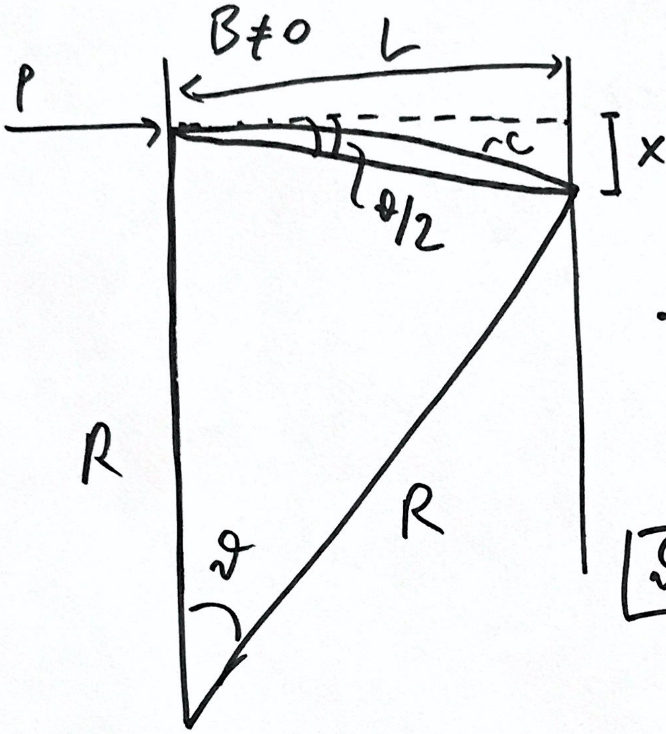
	$\check{C}_1(\beta_1)$	$\check{C}_2(\beta_2)$	$\check{C}_3(\beta_3)$
p:	NO	NO	NO
K^+:	SI	NO	NO
π^+:	SI	SI	NO
μ^+:	SI	SI	SI

$\boxed{EX}$ $p = 2.9$ GeV

spettrometro $B = 1T$

$L = 40$ cm

(a) distanza x dalla linea di volo all'uscita del magnete



$$\begin{cases} \tan\frac{\vartheta}{2} = \frac{x}{L} \\ \frac{c}{R} = \vartheta \end{cases}$$

$\boxed{\vartheta \ll 1}$

$c \sim L \rightarrow \frac{L}{R} \sim \vartheta$

$$\frac{\vartheta}{2} \sim \frac{x}{L}$$

$$\rightarrow \frac{L}{2R} = \frac{x}{L}$$

$$x = \frac{L^2}{2R}$$

$$p[GeV] = 0.3 \cdot B[T] \cdot R[m]$$

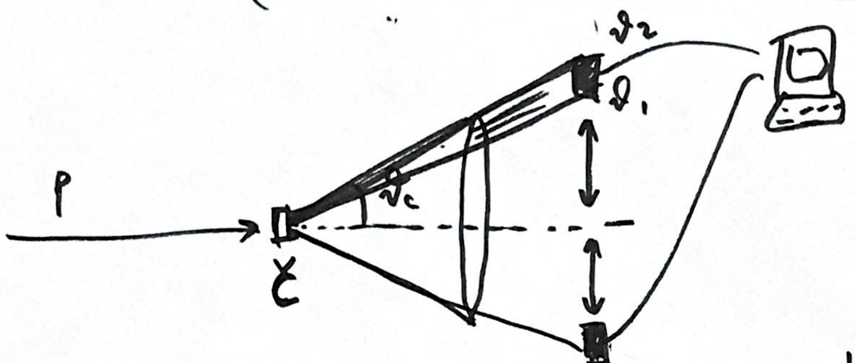
$$\Rightarrow R = \frac{p}{0.3 \cdot B}$$

$$x = \frac{0.3 \cdot BL^2}{2p} = \frac{0.3 \cdot 1 \cdot 0.4^2}{2 \cdot 2.9} =$$ ← in metri!

$$= 0.0083\ m = 0.83\ cm$$

(b) $\check{C}$ $n = 1.2$

sol $(\vartheta_1 = 28°) < \vartheta < (\vartheta_2 = 30°)$



$\left(\beta > \frac{1}{n}\right)$ ϑ_c : $\cos\vartheta_c = \frac{1}{\beta n}$

che particella era?

$$\beta_{soglia} = \frac{1}{n} = \frac{1}{1.2} = 0.83$$

$$\vartheta_1 \longrightarrow \beta_1 = \frac{1}{n\cos\vartheta_1} = 0.944$$

$$\vartheta_2 \longrightarrow \beta_2 = \frac{1}{n\cos\vartheta_2} = 0.962$$

$(p = 2.9\ GeV)$

$$\frac{dE}{dx} = (1.5 \text{ MeV } g^{-1} cm^{2}) \cdot (7.96 \text{ g } cm^{-3})$$

$$= 11.94 \text{ MeV/cm}$$

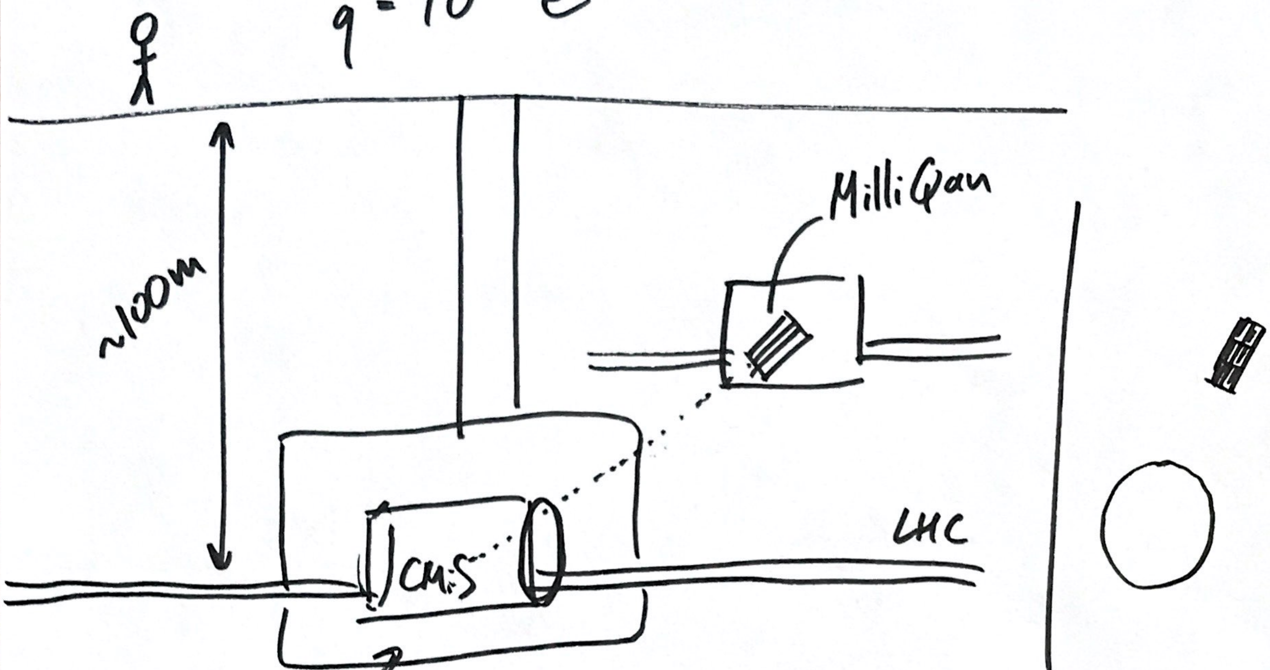
$p = 2.9$ GeV $\quad E \sim 3$ GeV

$$\Rightarrow K = E - m_p = 3 - 0.938 = 2.06 \text{ GeV}$$

$$R = \frac{K}{dE/dx} = \frac{2.06}{0.01194} = 173 \text{ cm} = 1.73 \text{ m}$$

$\boxed{EX}$ MilliQan

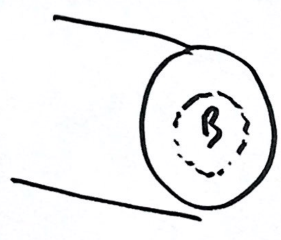
$q = 10^{-3} e$



$B = 3.8T$

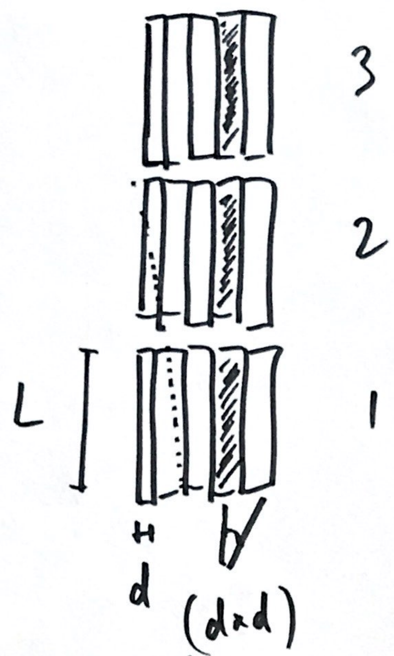
① $F = qvB$

$p = qRB$



② non riusciamo a tracciarle

$$\frac{dE}{dx} = C\rho \frac{Z}{A} \frac{z^2}{\beta^2} \cdot \left[\ln \ldots \right.$$

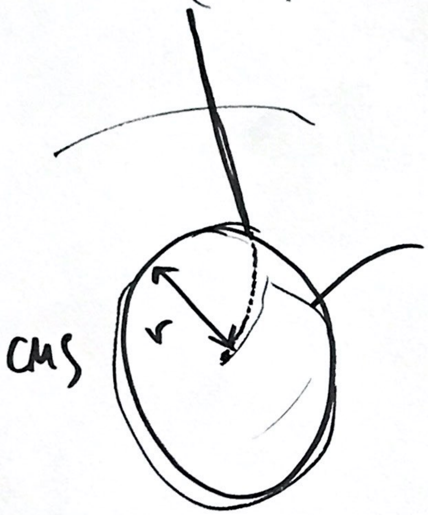


$L = 80$ cm

$d \times d = 5 \times 5$ cm^2

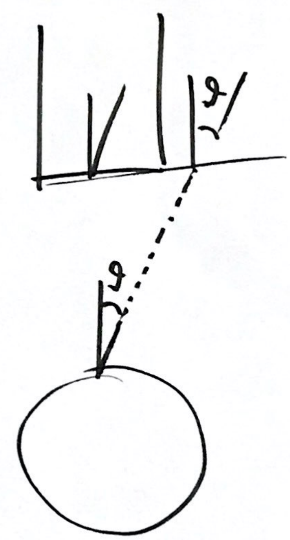
$q = 10^{-3} e$

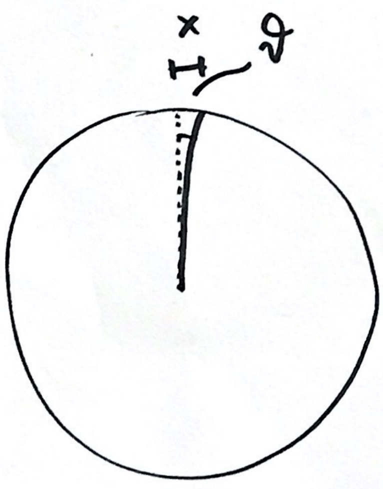
μ



$B = 3.8$ T

$r \leq 3$ m





$\rightarrow \tan\vartheta < \dfrac{d}{3L}$

$$\vartheta_{MAX} = \tan^{-1}\frac{d}{3L} = 21 \text{ mrad}$$

$$\frac{\text{"}L\text{"}}{R} \sim \vartheta \;\rightarrow\; \frac{r}{R} \sim \vartheta \Rightarrow R = \frac{r}{\vartheta}$$

$$p[\text{GeV}] = q\, R[\text{m}] \cdot B[\text{T}]$$

$$p = q\,\frac{r}{\vartheta} \cdot B$$

$p = 2.9$ GeV $\qquad (\beta = p/E)$

$$\beta_1 \rightarrow E_1 = \frac{p}{\beta_1} = 3.072 \text{ GeV}$$

$$\beta_2 \rightarrow E_2 = \frac{p}{\beta_2} = 3.014 \text{ GeV}$$

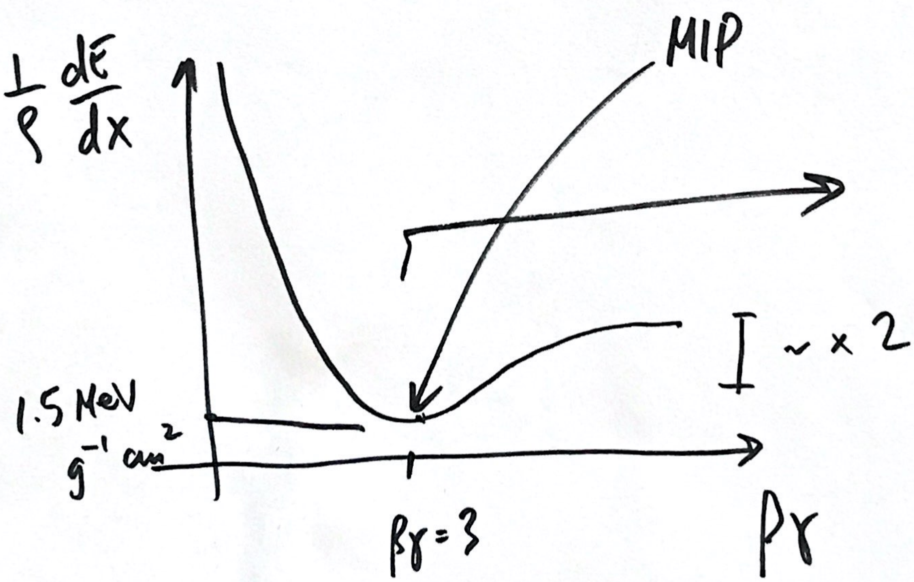
$$m_1 = \sqrt{E_1^2 - p^2} = 1.014 \text{ GeV}$$

$$m_2 = \sqrt{E_2^2 - p^2} = 0.821 \text{ GeV}$$

$\Rightarrow$ e' un protone $\qquad m_p = 0.938$ GeV

(c) Ferro $\rho = 7.96 \text{ g/cm}^3$

RANGE = ?



$$p \geq q \frac{r}{\vartheta_{MAX}} \cdot B$$

$$q = 0.3 \cdot 10^{-3}$$

$$p \geq 0.3 \cdot 10^{-3} \frac{3}{0.021} 3.8 = 0.16 \text{ GeV}$$
$$= 160 \text{ MeV}$$

$$\sqrt{s}_{LHC} = 13\text{-}14 \text{ TeV}$$

$$p_{min}^{mill:} = 160 \text{ MeV}$$

$$p_{min}^{\mu} = 160 \text{ GeV}$$

(5) CMS → MilliQan

17 m ROCCIA : $\rho = 3 \, g/cm^3$ $\frac{Z}{A} = 0.5$ $I = 100 eV$

1 m FERRO : $\rho = 8 \, g/cm^3$ $\frac{Z}{A} = 0.5$ $I = 260 eV$

E min persa da

un muone prodotto in CMS

$(q = 10^{-3} e)$

$$\frac{dE}{dx} = C \rho \left(\frac{Z}{A}\right) \frac{z^2}{\beta^2} \left[\ln\left(\frac{2 m_e \beta\gamma}{\langle I \rangle}\right) - \beta^2 \right]$$

$$\frac{dE}{dx}\frac{1}{\rho} \sim 1.5 \text{ MeV g}^{-1}\text{ cm}^2$$

$$\rightarrow \beta\underline{\gamma = 3} \qquad \beta \underline{\simeq} 1$$

$$\Delta E_\mu = \left(\frac{dE}{dx}\right)_{roccia} \cdot d_{roccia} + \left(\frac{dE}{dx}\right)_{Ferro} \cdot d_{Ferro} =$$

$$\beta\gamma = 3 \qquad 17\text{M}$$

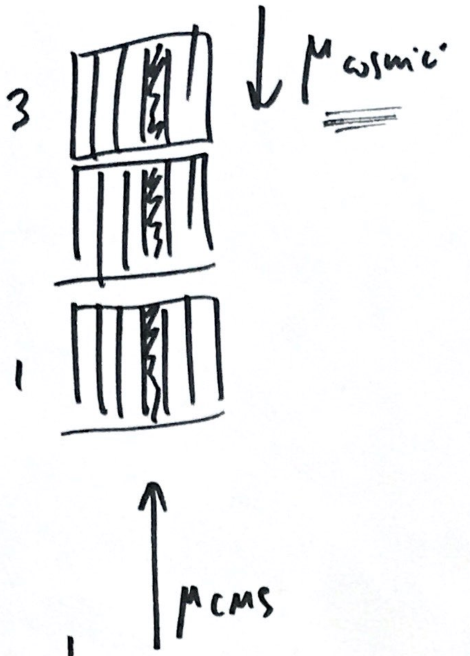
$$= 0.307 \cdot 3 \cdot 0.5 \cdot 1 \left[\ln\left(\frac{2 \cdot 0.511 \cdot 10^6 \cdot 3^2}{100}\right) - 1 \right] \cdot 1700$$

$$+ 0.307 \cdot 8 \cdot 0.5 \cdot 1 \left[\ln\left(\frac{2 \cdot 0.511 \cdot 10^6 \cdot 3^2}{260}\right) - 1 \right] \cdot 100$$

$$= 8.16 \text{ GeV} + 1.16 \text{ GeV} = 9.32 \text{ GeV}$$

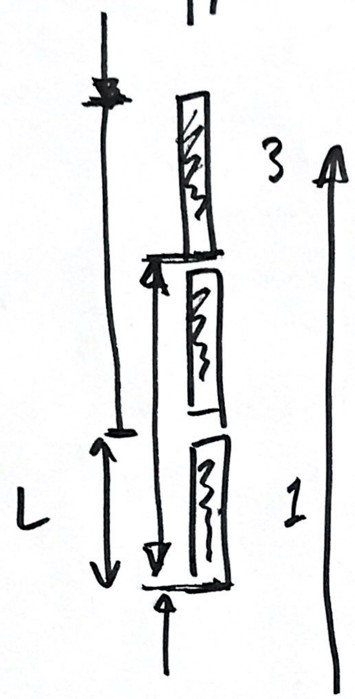
$$\Delta E_{milli} = 10^{-6} \cdot \Delta E_\mu = 9.32 \text{ keV}$$

(c)



$\sigma_t = ?$ $\sim 3\sigma$

$\beta = 1$



$L = 80$ cm

2L

$$\Delta t = \frac{2L}{c} = \frac{1.6}{3 \cdot 10^8} = 5.3\ \text{ns}$$

$+5.3$ ns

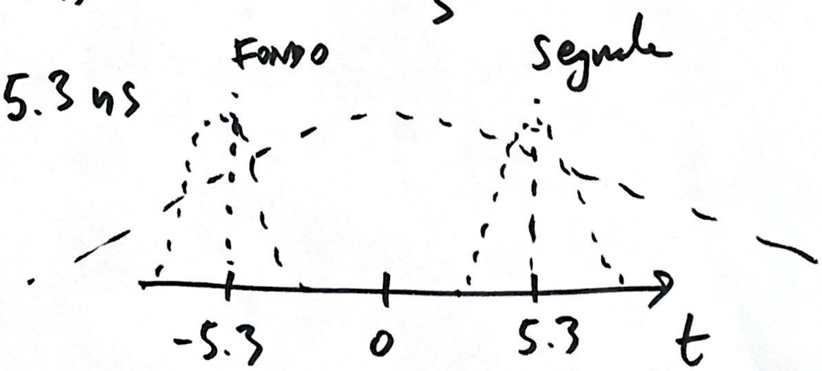
-5.3 ns

$$\delta t = 2\Delta t = 10.6\ \text{ns} \equiv 3\sigma$$

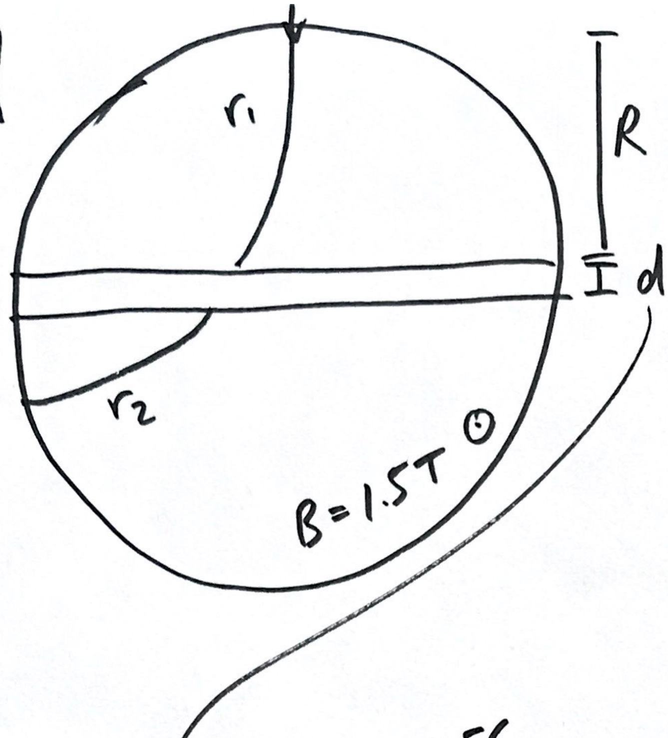
$$\sigma \sim \frac{10.6\ \text{ns}}{3} \sim 3\ \text{ns}$$

↑ $t_3 - t_1 = +5.3$ ns

↓ $t_3 - t_1 = -5.3$ ns



EX



$d = 1 X_0 = 0.56$ cm

$R = 25$ cm

Piombo

$\rho = 11.35\ g/cm^3$

$X_0 = 0.56$ cm

$\langle I \rangle = 823$ eV

$Z = 82$

$A = 207$

$r_1 = 67$ cm

$r_2 = 65$ cm

(a) con che angolo incide sulla lastra?

(b) Sapendo r_1 e r_2 e' un muone o un elettrone?