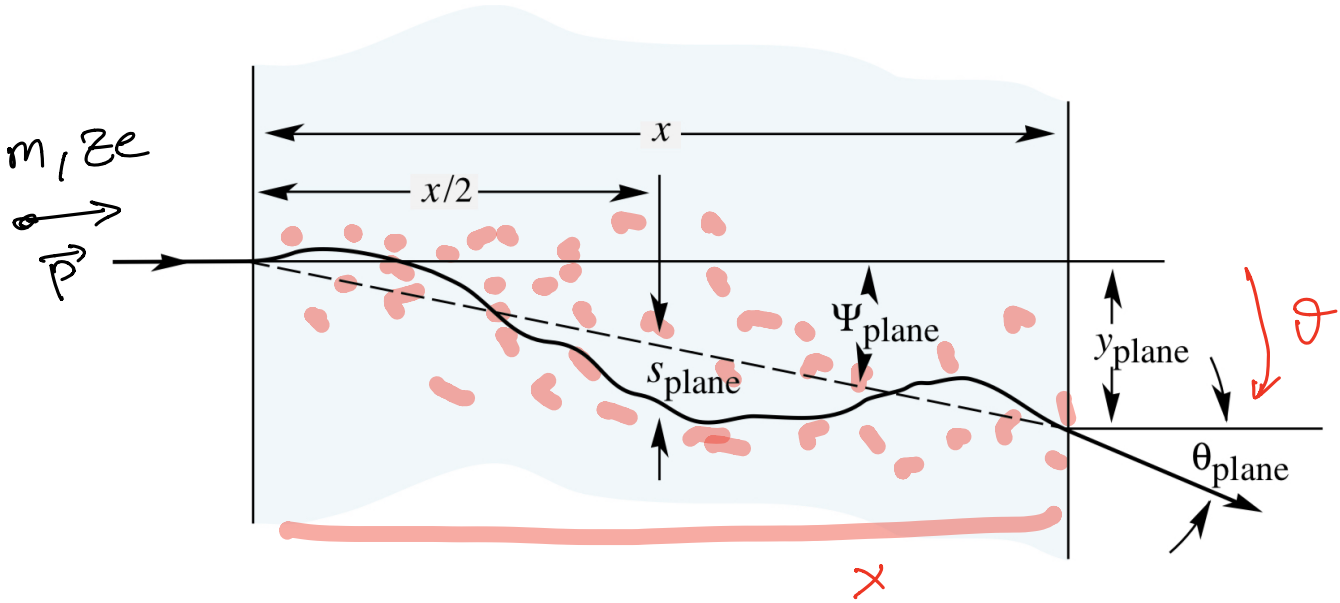
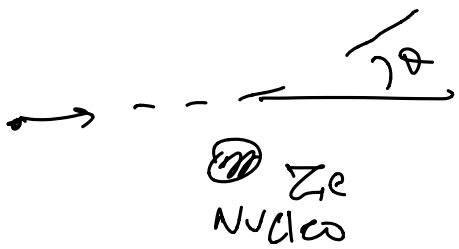


$f(\theta \mid \vec{p}, m, z)$



$\frac{d\sigma}{d\Omega}$ sezione d'urto diff. di Rutherford.

$d\Omega = \sin\theta d\theta d\varphi = 2\pi \sin\theta d\theta$

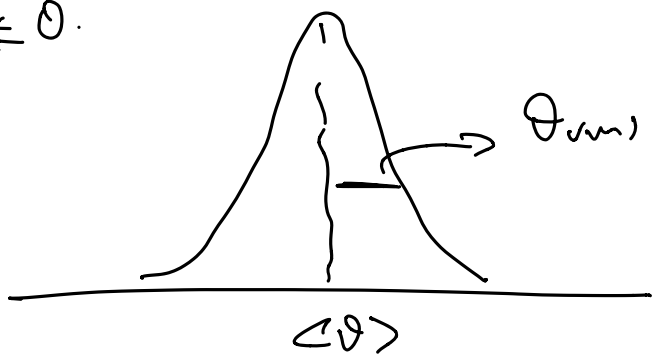
$\frac{d\sigma}{d\Omega} \propto \frac{1}{\sin^4\frac{\theta}{2}}$

$$\langle \theta^n \rangle = \frac{\int \theta^n \frac{d\sigma}{d\Omega} d\Omega}{\int \frac{d\sigma}{d\Omega} d\Omega} \propto \frac{\int \theta^n \frac{1}{\sin^4\frac{\theta}{2}} \sin\theta d\theta}{\int \frac{1}{\sin^4\frac{\theta}{2}} \sin\theta d\theta}$$

$\langle \theta \rangle = 0$

$\langle \theta^2 \rangle \neq 0$

$\Rightarrow f(\theta \mid --) \propto \frac{1}{\sqrt{2\pi}\,\theta_{rms}} e^{-\frac{\theta^2}{2\theta_{rms}^2}}$

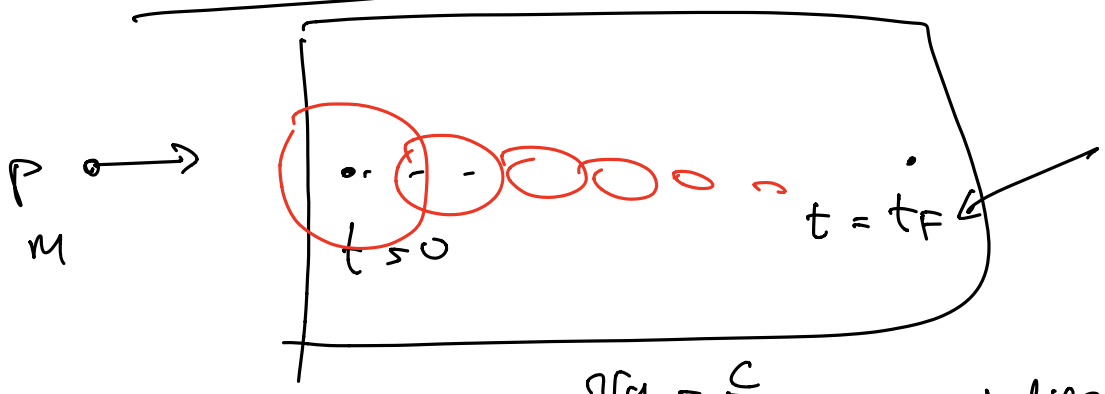


$\sqrt{\langle \theta^2 \rangle} = 21 MeV \frac{z_{proiett.}}{\beta p} \sqrt{\frac{x}{X_0}}$ x: spessore attrav. nel materiale.

$X_0 \propto \rho \frac{N_A}{A} Z^2 \ln(183 Z^{-1/3})$ X_0: lunghezza di radiazione Caratt. del mezzo non del proiettile.

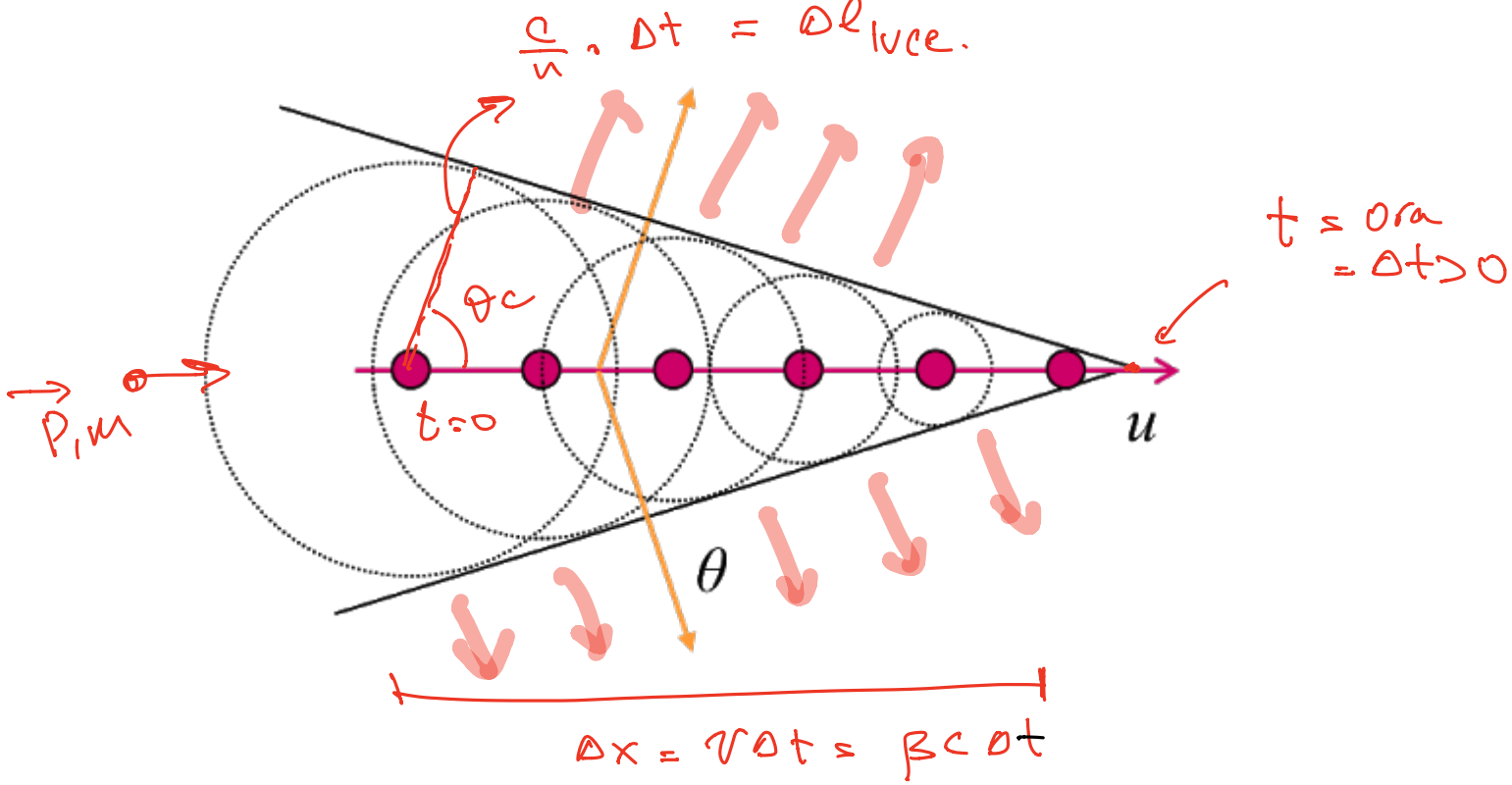
Interazione particelle cariche nel mezzo.

Effetto Cerenkov 1934



$v_g = \frac{c}{n}$ n: indice di rifrazione.

$\beta = \frac{p}{E} = \frac{p}{\sqrt{p^2 + m^2}}$



$$\frac{c}{n}\Delta t = \beta c \Delta t \cdot \cos\theta_c .$$

$$\cos\theta_c = \frac{1}{\beta n}$$ angolo di Cerenkov θ_c

$$\cos\theta_c \leq 1 \Rightarrow \frac{1}{\beta n} \leq 1 \Rightarrow \beta \geq \frac{1}{n} = \beta_{th}.$$

Effetto a soglia.

info. $\Rightarrow$ sulla massa.

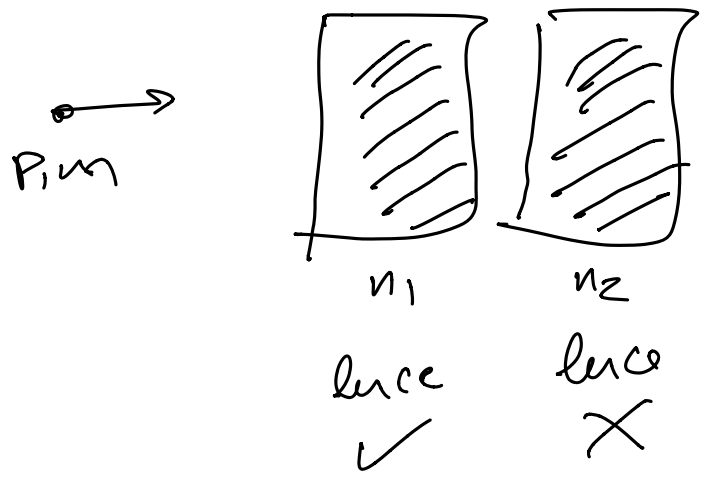
$$\beta \geq \frac{1}{n} = \beta_{th} = \frac{p_{th}}{E_{th}} = \frac{p_{th}}{\sqrt{p_{th}^2 + m^2}}$$

$$\beta = \frac{p}{E} = \frac{p}{\sqrt{p^2 + m^2}} \geq \frac{1}{n}.$$

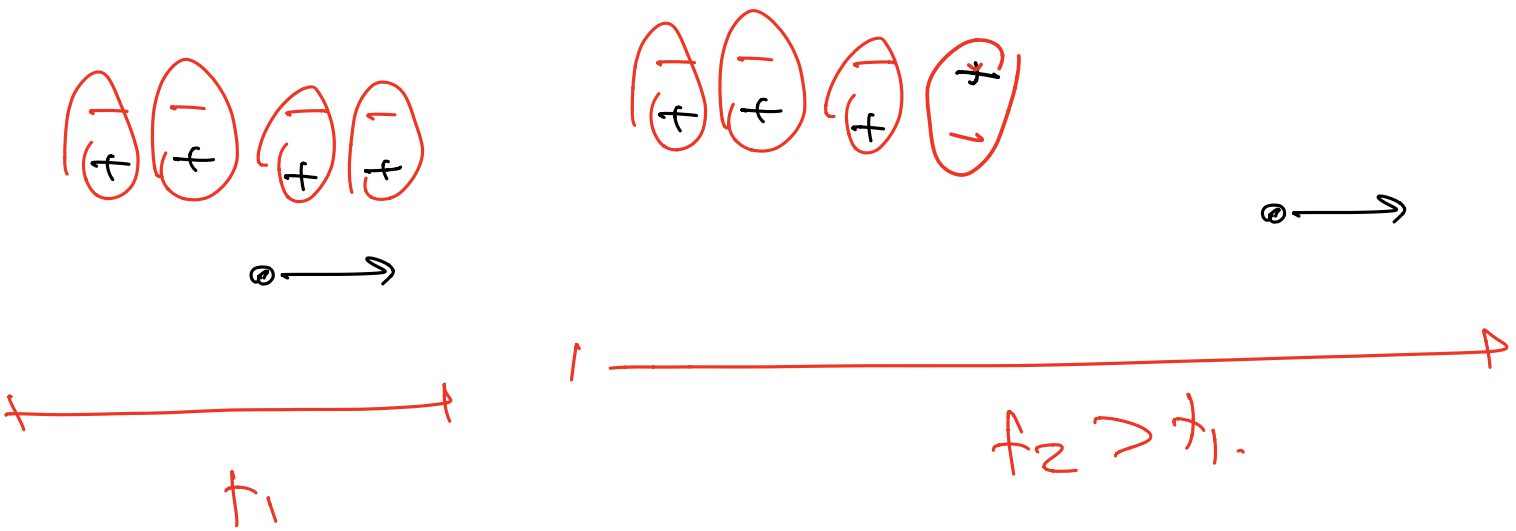
$$n^2 = \frac{p_{th}^2 + m^2}{p_{th}^2} = 1 + \frac{m^2}{(p_{th})^2}.$$

$$n^2 - 1 = \frac{m^2}{p_{th}^2} \Rightarrow p_{th} = \frac{m}{\sqrt{n^2-1}}$$

$$p > \frac{m}{\sqrt{n^2-1}}$$ emissione luce Cerenkov.



$\beta > \frac{1}{n_1}$ && $\beta < \frac{1}{n_2}$. $\Rightarrow$ $\frac{1}{n_1} < \beta < \frac{1}{n_2}$.

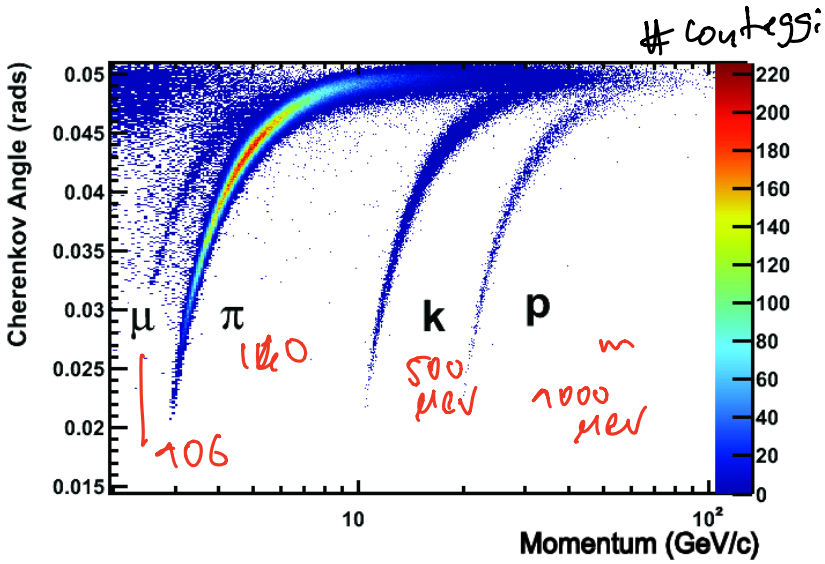


$\cos\theta_c = \frac{1}{\beta n}$

$= \frac{1}{n}\frac{E}{p} = \frac{1}{n}\sqrt{1+\left(\frac{m}{p}\right)^2}$

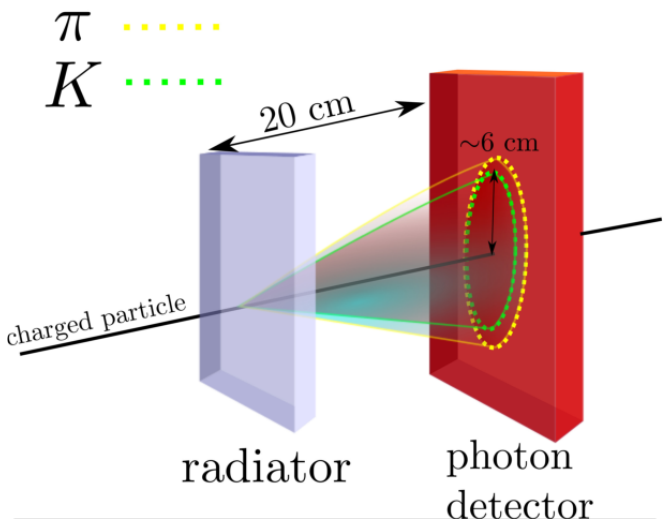
$\theta_c = \arccos\left[\frac{1}{n}\sqrt{1+\left(\frac{m}{p}\right)^2}\right]$.

$p > p_{th} = \frac{m}{\sqrt{n^2-1}}$



misuro p con spettrometro.

Se misuro (p, θ_c) $\Rightarrow$ stima massa.
$\Rightarrow$ identificazione particella.



quante emessi emesse con luce Cerenkov ?
Z: proiettile.

$$\frac{d^2N}{dx\,dE} = \frac{\alpha Z^2}{\hbar c}\sin^2\theta_C$$

dall'EM.

di fotoni emessi per unità di spessore
unità di energia.

luce blu: 400 nm. $= 4\times10^{-2}\times10^{6}$ fm

luce rosso: 700 nm. $= 7\times10^{-2}\times10^{6}$ fm

$$E = h\nu = h\frac{c}{\lambda} = 2\pi\frac{\hbar c}{\lambda} = 2\pi\frac{200\ \text{MeV}\times\text{fm}}{\lambda}$$

Blu: $E = 2\pi\times\frac{200\ \text{MeV fm}}{4\times10^{8}\ \text{fm}} = 3\times\frac{10^{8}}{10^{8}}$ eV..

$= 3$ eV.

rosso: $E = 1.7$ eV

$$E = 2\pi \frac{\hbar c}{\lambda} \qquad dE = 2\pi\hbar c \frac{1}{\lambda^2} d\lambda$$

$$\frac{d^2N}{dx\,d\lambda} = \frac{d^2N}{dx\,dE}\frac{dE}{d\lambda} \propto \frac{\alpha z^2}{\hbar c}\frac{1}{\lambda^2}\sin^2\vartheta_c .$$

λ_{max} evoluto.

$$\frac{dN}{dx} \propto \int_{\lambda_{min}=blu} \frac{1}{\lambda^2} d\lambda$$

$$\frac{dN}{dx} \simeq 450\, z^2 \sin^2\theta_c \quad \text{fotoni/cm.}$$

$$\sin^2\vartheta \simeq 1. \qquad z^2 \simeq 1.$$

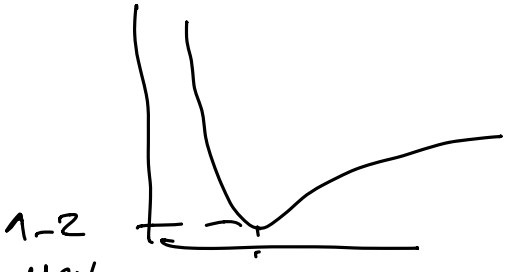
$\Rightarrow$ circa 450 fotoni/cm.

$$\langle E \rangle \simeq 2\,eV.$$

$\Rightarrow$ $\frac{dE}{dx} \simeq 900$ eV/cm.

energia emessa per Cerenkov.

$$\frac{1}{\rho}\frac{dE}{dx}\Big|_{min.} \simeq 1\text{-}2 \frac{MeV}{cm}$$



Nell'acqua:

$$\frac{dE}{dx}\Big|_{cerenkov} \simeq 1 \frac{KeV}{cm}.$$

$$\frac{dE}{dx}\Big|_{ion.} \simeq 1 \frac{MeV}{cm}. \Rightarrow$$

Perdita per cerenkov trascurabile