Essential relativity

Moving massive particles have total energy, E, made up of motion-energy and mass-energy. The quantity $E^2 - p^2 = m^2$ relates the total energy to the particle momentum and mass.

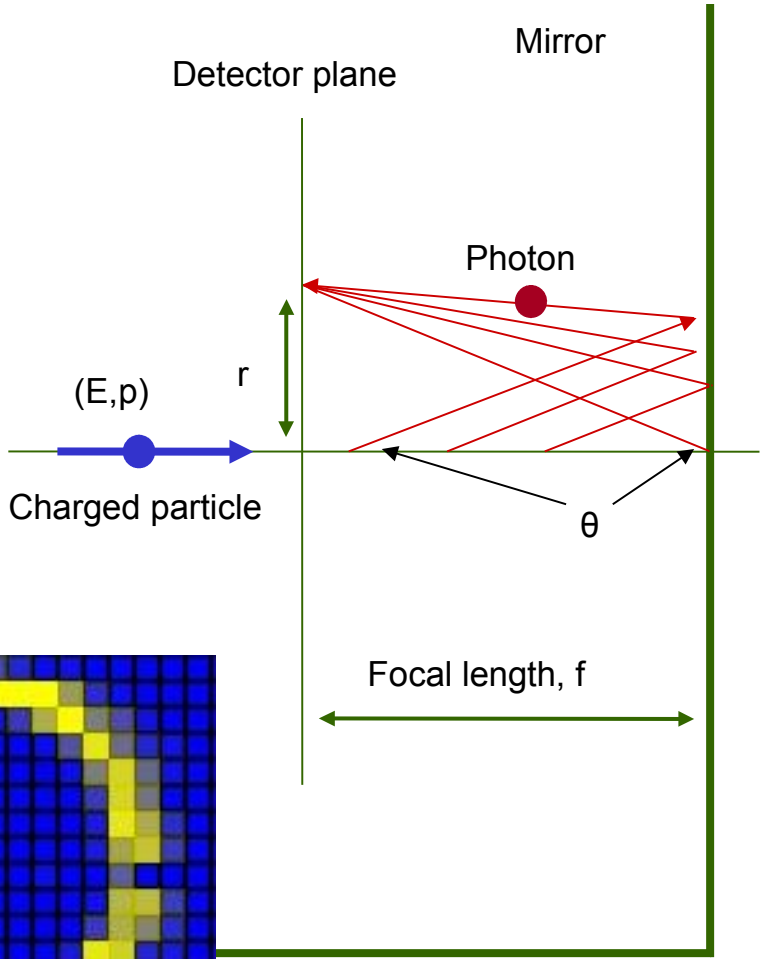
The speed of a particle (as a fraction of the speed of light), β, can be found from $\beta^2 = (E^2 - m^2)/E^2$, or rearranged **$\beta^2 = 1 - (m/E)^2$**

Calculate β for an electron (mass 0.000511GeV), pion (mass 0.1396GeV) and kaon (mass 0.4937GeV) if each has 10GeV total energy.

The Ring Imaging Cherenkov detector

Charged particles moving in a medium of refractive index, n, and having speed greater than the local speed of light emit photons at an angle, θ, to the direction of motion where **$\cos\theta = 1/n\beta$**.

Calculate cosθ for 10GeV electrons, pions and kaons using a medium of refractive index 1.0003. Comment on the values you get.



These parallel rays can be focussed by a spherical mirror to form rings on an image plane.

The radius of the ring image is given by **$r = f \tan\theta$**.

The Cherenkov ring below is due to 10GeV particles in a medium of refractive index 1.0003 imaged with a mirror of focal length f=1143mm.

Predict the Cherenkov ring radii for electrons, pions and kaons and compare your radii with the image below. Was the image formed by electrons, pions or kaons?