

Ring Imaging CHerenkov Detectors

The LHCb
Detector

RICH2

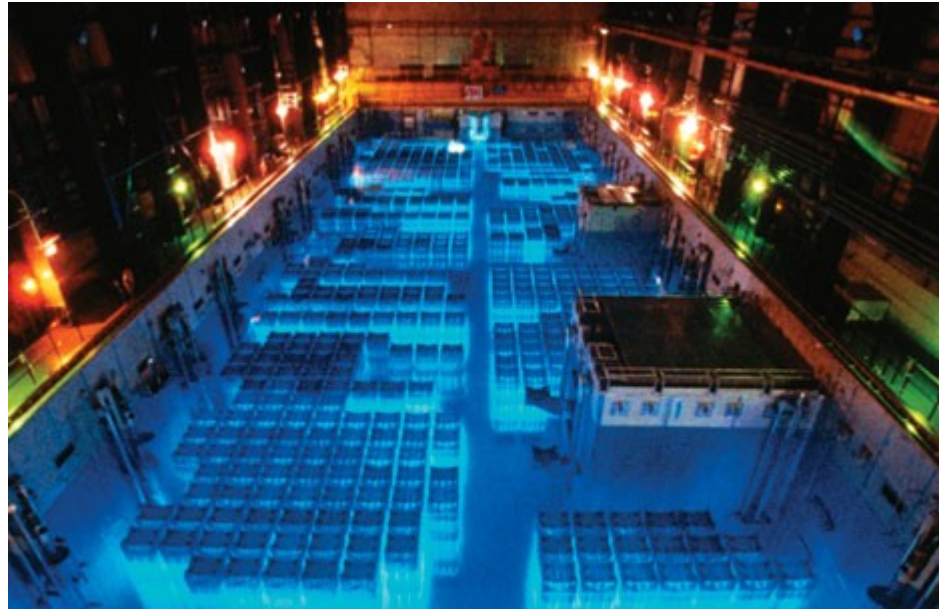
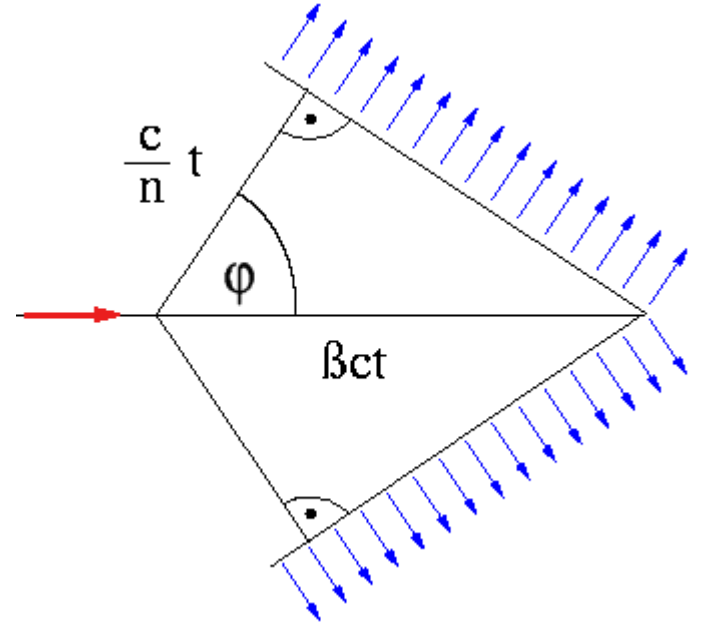
RICH1



The Cherenkov Effect



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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 **$\cos\theta = 1/n\beta$** .

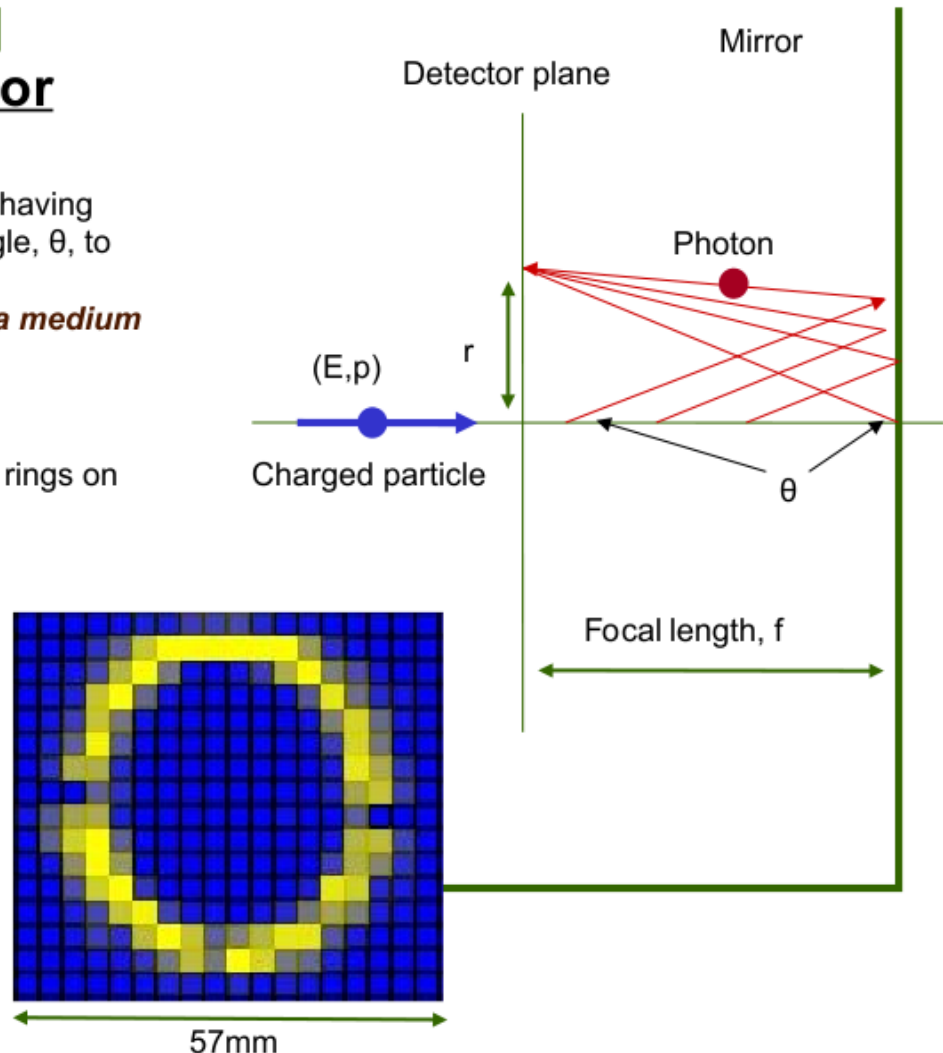
Calculate $\cos\theta$ for 10GeV electrons, pions and kaons using a medium of refractive index 1.0003. Comment on the values you get.

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 **$r = f \tan\theta$** .

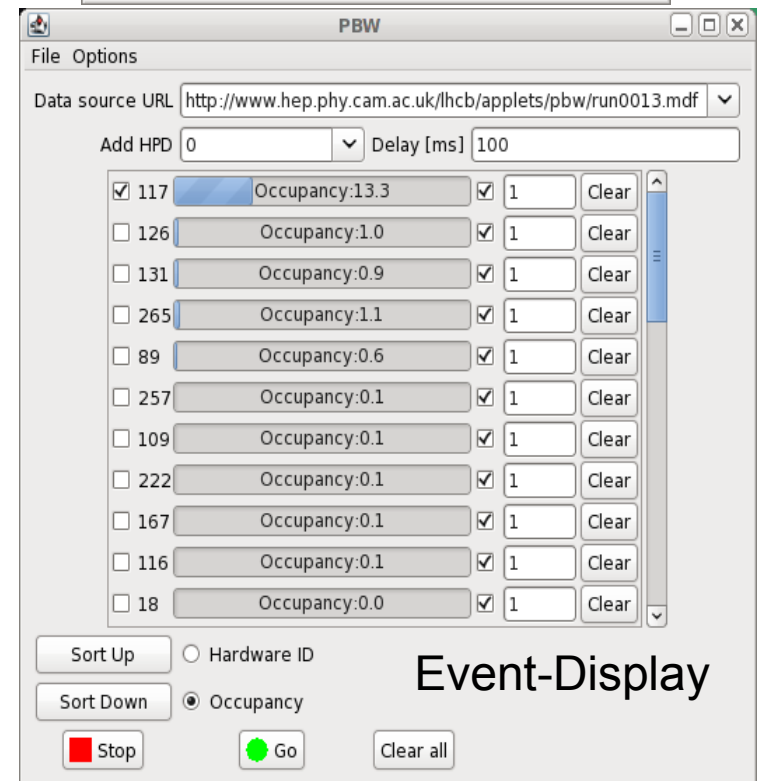
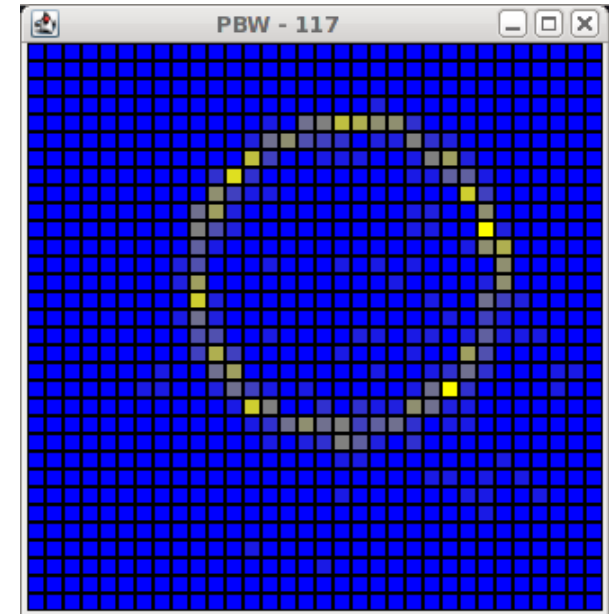
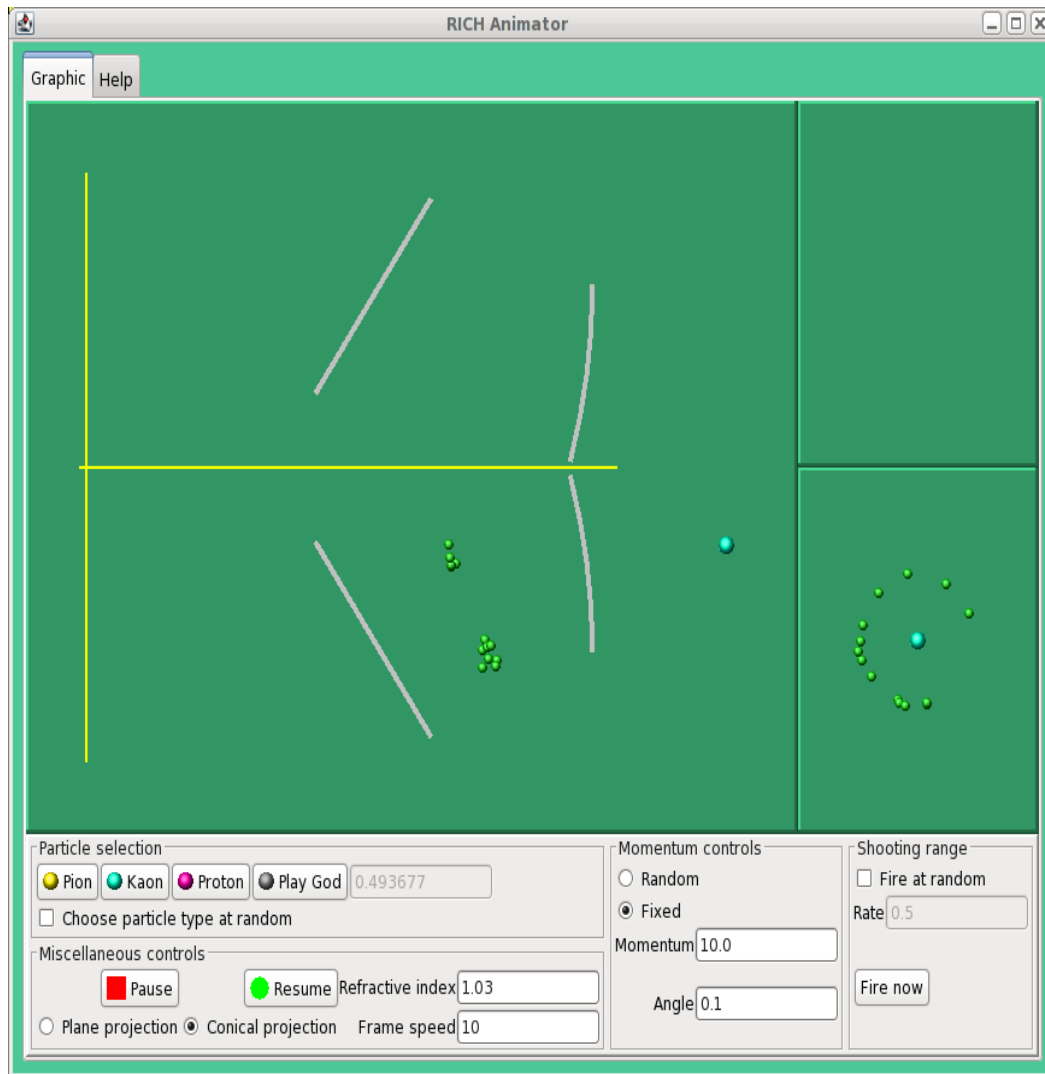
The Cherenkov ring below is due to 10GeV particles in a medium of refractive index 1.0003 imaged with a mirror of focal length $f=1143\text{mm}$.

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?



Applications available from the 'MasterClass' Folder on your desktop

RICH-Simulator



Event-Display

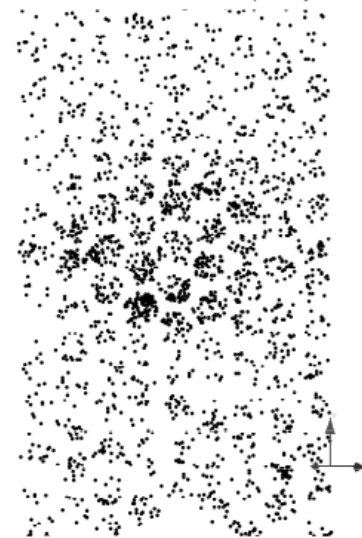
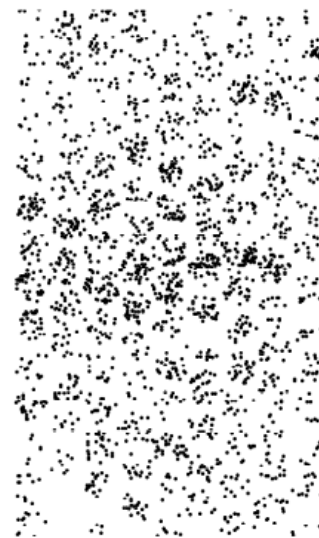
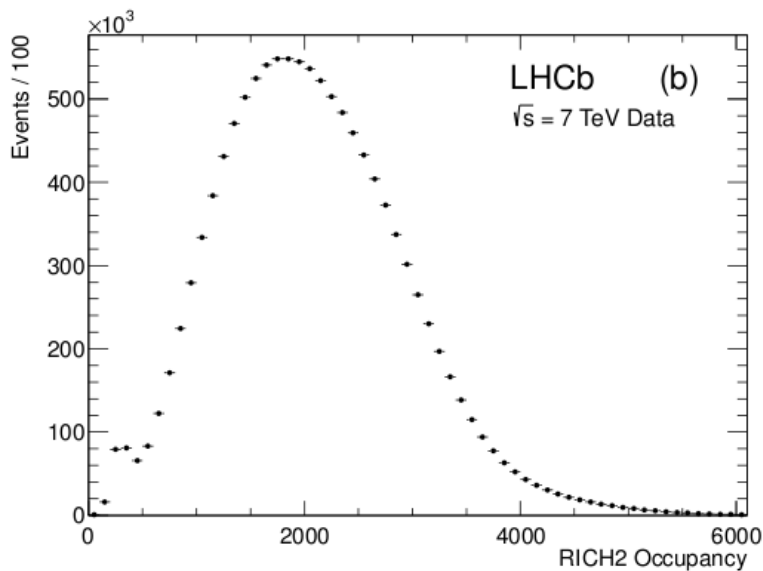
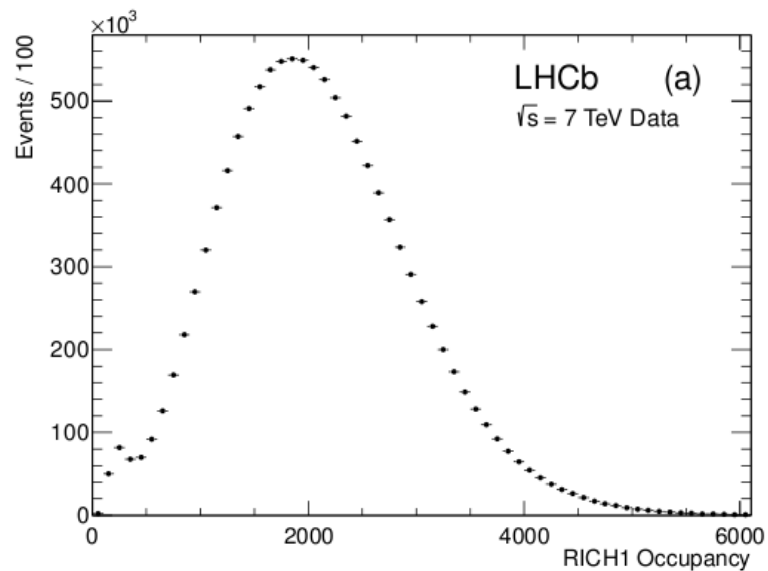


Figure 13: Distribution of the number of pixel hits per event in (a) RICH 1 and (b) RICH 2. An example of a typical LHCb event as seen by the RICH detectors, is shown below the distributions. The upper/lower HPD panels in RICH 1 and the left/right panels in RICH 2 are shown separately