



# Activity Seven: Picturing Particles

Whether they are called *atom smashers*, *accelerators* or *colliders*, the massive devices used for research by particle physicists all produce new particles by colliding two high-energy particles with one another.

For this activity, imagine that an electron and positron are traveling at nearly the speed of light. They collide head-on, carrying equal and opposite momenta and produce many particles that spread out in all directions.

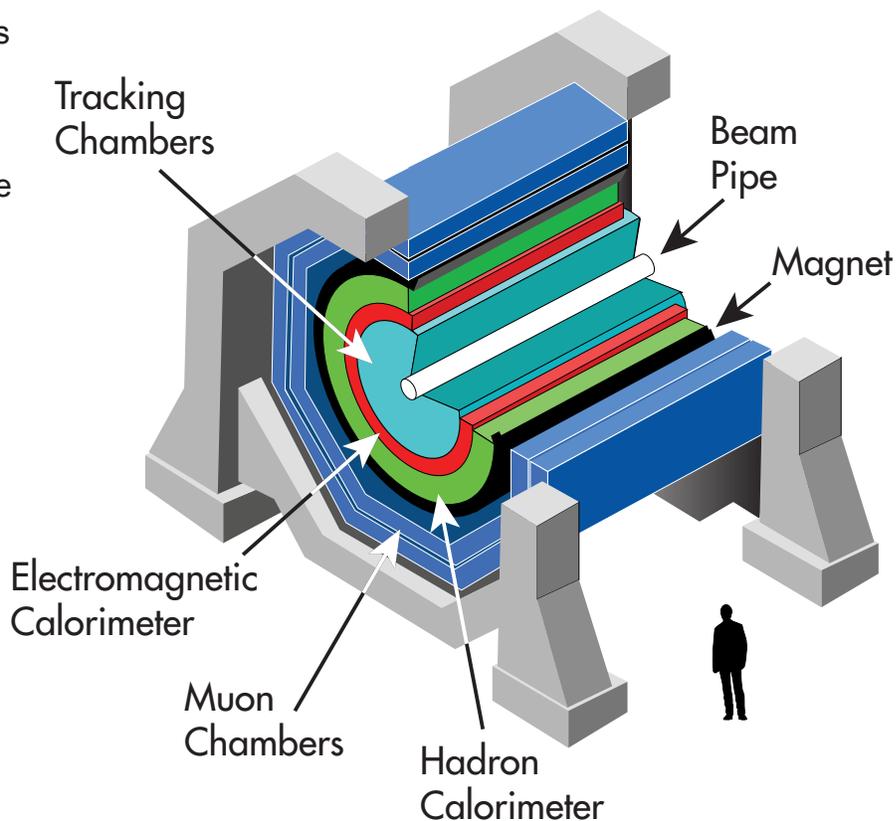
Surrounding the collision point of these particles in the accelerator is a multi-layered *particle detector*,

shown here in a cutaway view. Detectors are the sensors used by particle physicists to gather information about the particles produced by an event. Each layer of the detector senses a different property of the particles. The tracking chamber shows the paths of charged particles. In the calorimeter layers, only the total energy deposited is measured; the actual tracks cannot be reconstructed. The electromagnetic calorimeter collects energy from photons, electrons and positrons. Hadrons deposit their energy in the hadron calorimeter.

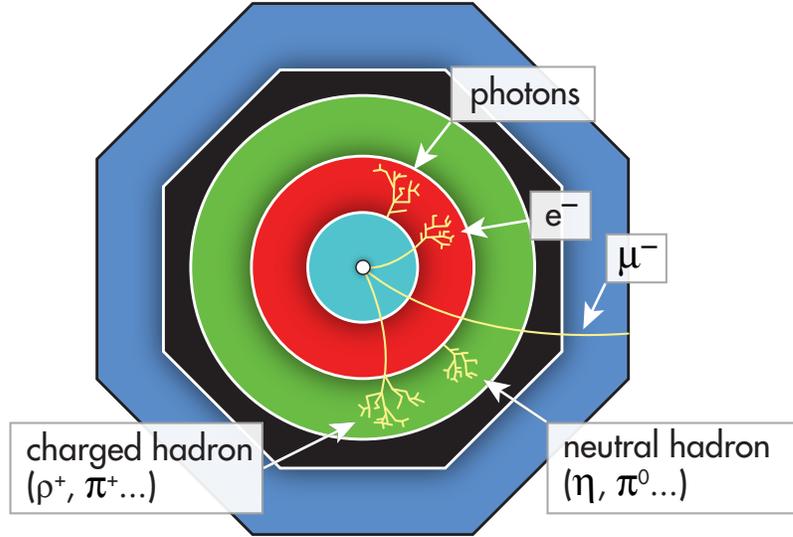
Notice the large magnet in the detector. The magnetic field inside the magnet (parallel to the beam pipe) causes the paths of charged particles moving out from the collision point to curve. The paths of positive and negative particles curve in opposite directions.

Now imagine that you are a physicist trying to analyze the tracks shown in the four cross-section "event" illustrations at bottom left, which are taken from actual experiments. Use the labeled cross section of a detector, showing sample tracks of various particles, as a reference (along with the given "rules" of conservation).

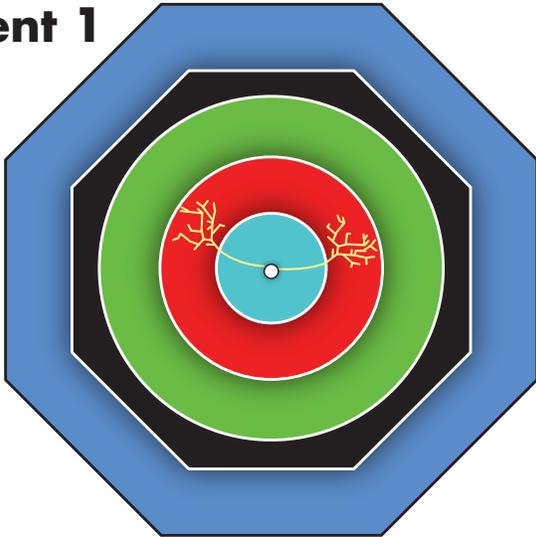
## CUTAWAY VIEW OF A DETECTOR



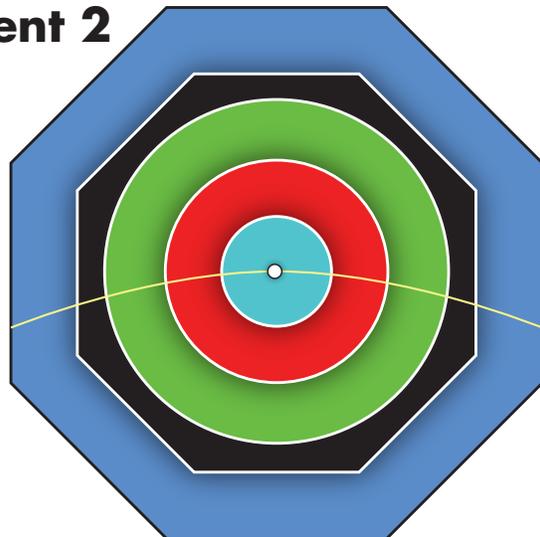
Sample Tracks  
(not a possible event)



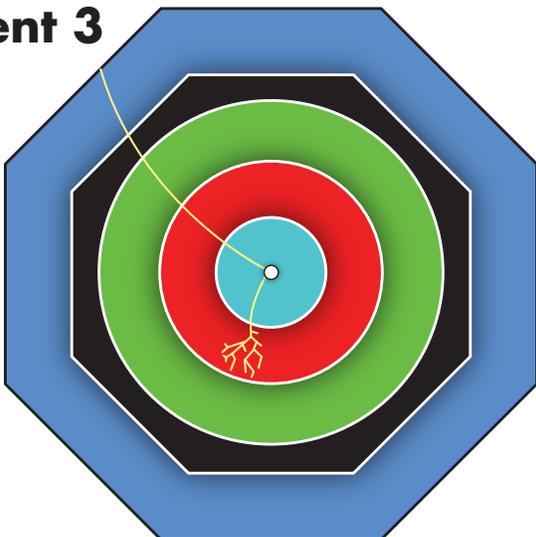
Event 1



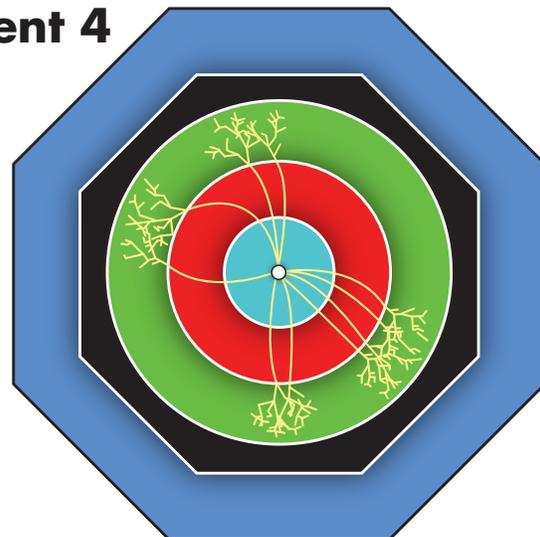
Event 2



Event 3



Event 4



**Rules of the Game:**

**1) Charge is conserved. (The event started with a negative electron and a positive proton, so the total charge is always zero.)**

**2) Momentum is conserved. (The original particles had equal and opposite momenta, so the total momentum is always zero.)**

After analyzing these event pictures, complete the following chart. Check off each column representing a detector layer where the track appears. Compare your findings with the particle tracks shown in the "Sample Tracks" cross section at left. Then answer the questions for each event below the chart.

Track	Tracking Chamber	Electromagnetic Calorimeter	Hadron Calorimeter	Muon Chamber
Event 1				
Event 2				
Event 3				
Event 4				

1. Events 1-4:

From your chart, what could the particles be?

Event 1 \_\_\_\_\_

Event 2 \_\_\_\_\_

Event 3 \_\_\_\_\_

Event 4 \_\_\_\_\_

2. In events 1 & 2, are the particles of the same or of opposite charges?

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3. In event 3, the two tracks are not back to back. What does this tell you?

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