Particle detectors

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What they measure

- As a particle goes through matter, it releases energy
- Detectors collect the released energy and convert it to electric signals that get recorded by DAQ
- **Hit**: a single measurement in a particle detector, characterized by
  - position (x,y,z)
  - energy deposit ΔE
  - time t
- Raw event record: a collection of hits
  - real events incude "noisy" hits (e.g. due to electronics noise) and "shared" hits (due to more than one particle)

Hit components

- Position: can be precise (μm) or defined by the size of the detecting element, also can be precise in one direction and coarse in other
  - known w.r.t. detecting element, needs to be converted to the global reference frame
  - **alignment**: the procedure of figuring out the actual location of detector elements
- Energy deposit: may or may not be present (analog vs digital readout)
  - tracking detectors: try to make it small to minimally disturb the particle motion
  - calorimeteres: make it close to the total particle energy
  - the readout (if present) needs to be converted to the actual energy deposit ("calibration")
- Time: determined w.r.t. some reference (accelerator clock, trigger), can be precise (tens of ps) or just a time window

What we can learn about detected particles

- that they are there (the detectors that can just detect the particle presence are called "counters")
- their momentum (by combining individual hits into trajectories)
  - a charged particle of momentum $\vec{p}$ in magnetic field $\vec{B}$ follows a helix of radius $R = p_\perp / qB$
  - luckily, we can (almost) always assume $|q| = e$
- the particle type ($\Rightarrow$ mass):
  - from the way it looks in the detector (e.g. RICH)
  - from time of flight ($\Rightarrow$ velocity)
  - from energy deposit
- If a particle gives rise to a bunch of collinear particles, it makes sense to measure all of them together as a single object (e.g. jets due to quarks/gluons)