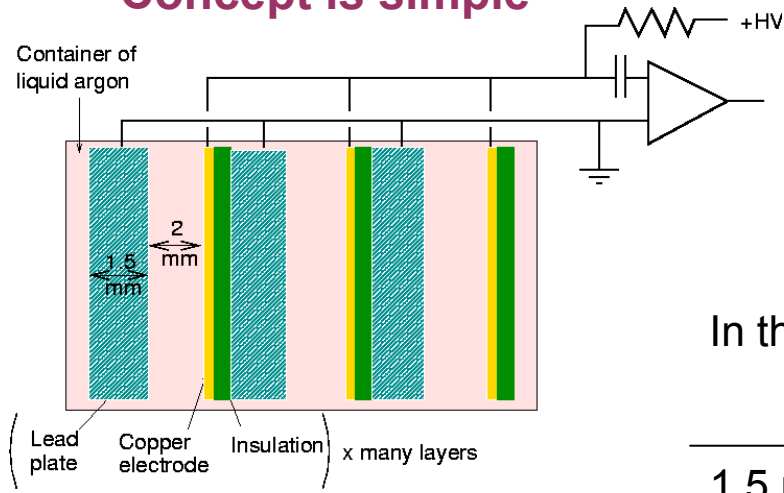


Concept is simple



ATLAS Liquid Argon Calorimeter

$$\sigma_E/E = 10\% \sqrt{E} \oplus 0.7\%$$

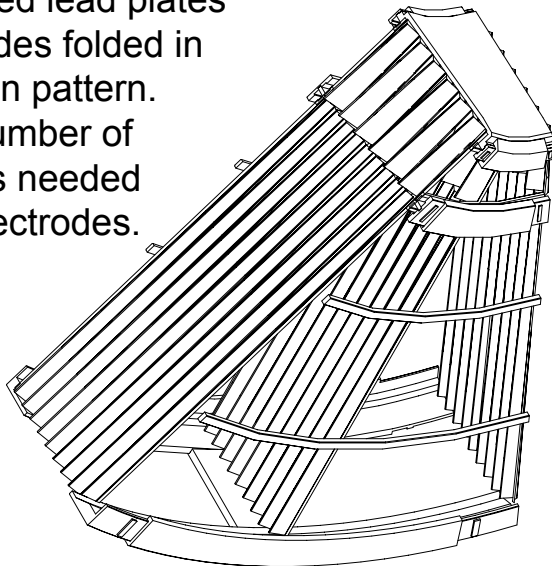
(expected for EM showers)

In this example the sampling fraction is

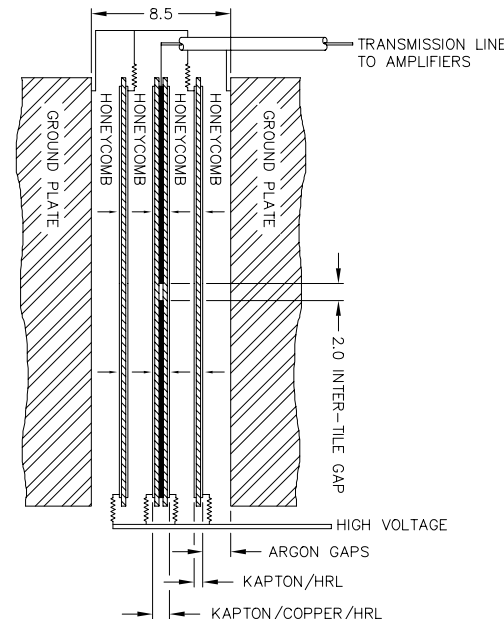
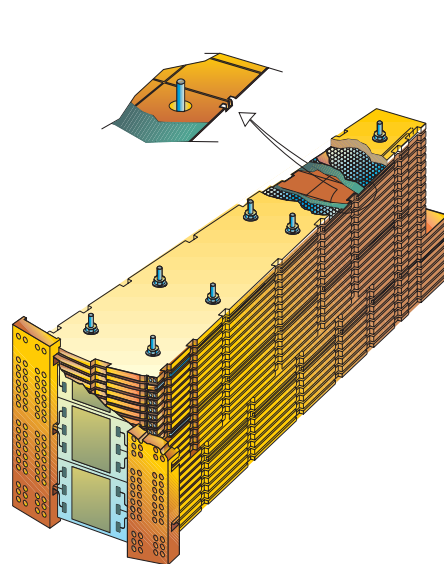
$$\frac{2 \text{ mm } / X_0(\text{Ar})}{1.5 \text{ mm } / X_0(\text{Pb}) + 2 \text{ mm } / X_0(\text{Ar})} = 5\%$$

Implementation is more complex

EM part used lead plates and electrodes folded in an accordion pattern. Reduces number of connections needed between electrodes.



Hadronic part used 25 mm copper absorber (0.17λ). Argon gap divided into 4 parts with signal collection on middle plane. Keeps drift time down and signal level up.



CMS lead tungstate EM Calorimeter

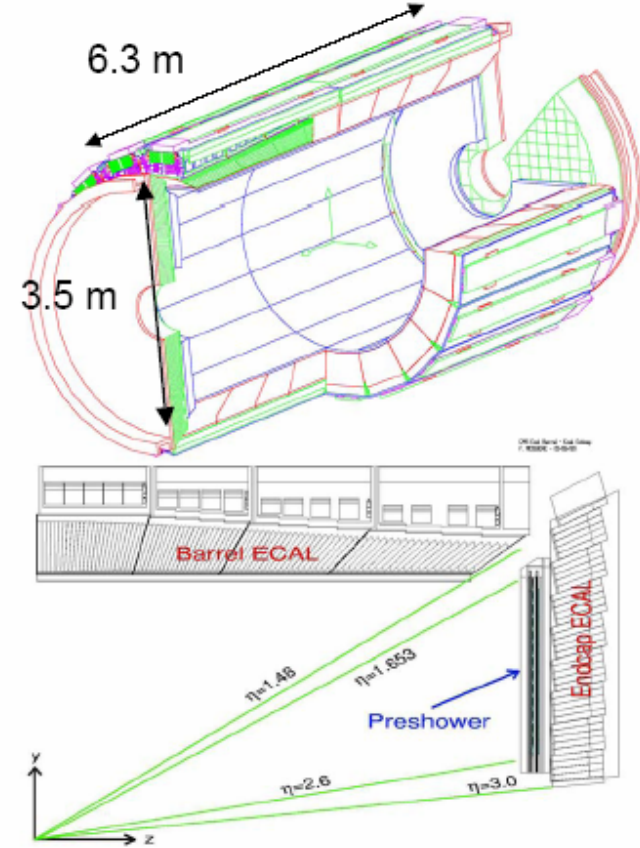
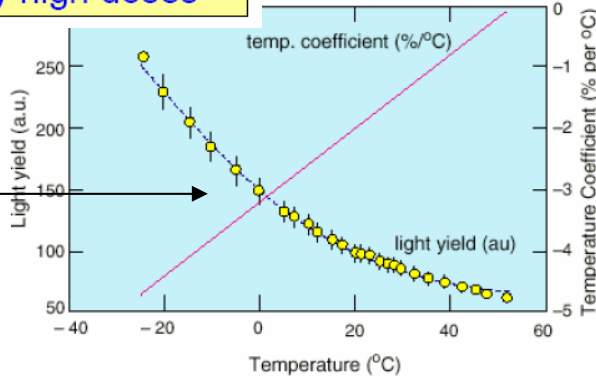
$$\sigma E/E \sim 5\% / \sqrt{E}$$

Good features of PbWO

- Fast light emission: $\sim 80\%$ in 25 ns
- Peak emission ~ 425 nm (visible region)
- Short radiation length: $X_0 = 0.89$ cm
- Small Molière radius: $R_M = 2.10$ cm
- Radiation resistant to very high doses

BUT PbWO has low light output and strong temperature coefficient

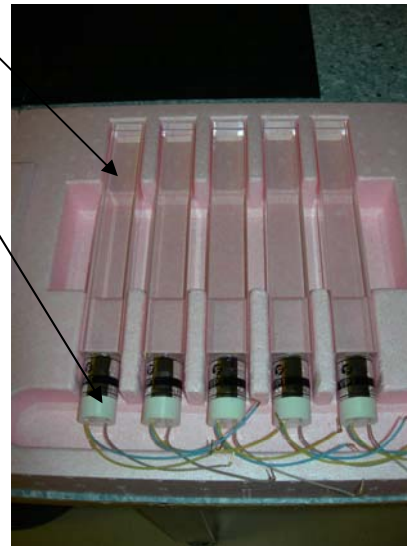
Temperature must be stabilised to < 0.1 C



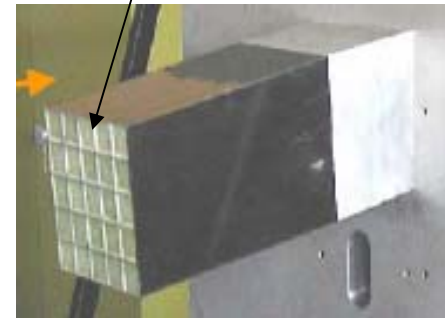
Grow crystals



Cut to shape and attach light sensors, in this case vacuum photo-triodes



Stack into "supercrystals"



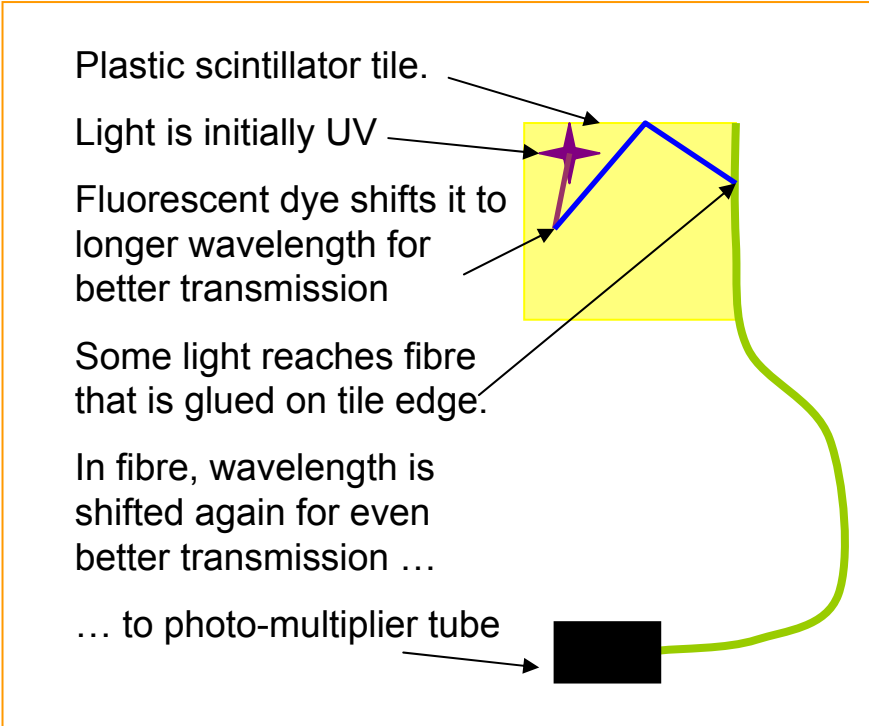
ATLAS Tile Calorimeter



Gluing a stack of steel plates, leaving slots for tiles.



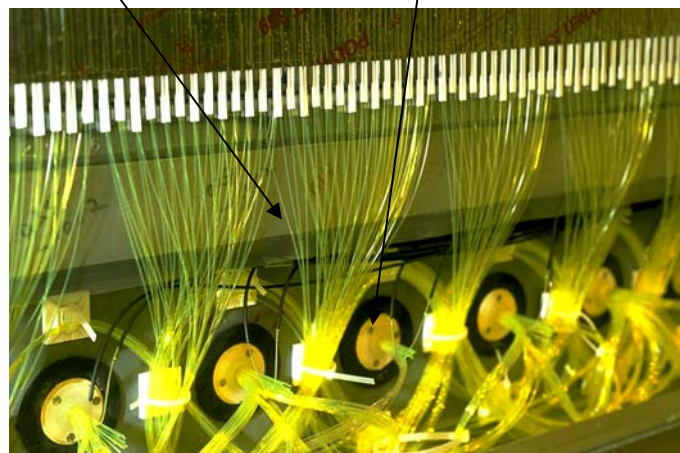
Raw material for 460000 plastic scintillator tiles.



One slice of the finished calorimeter

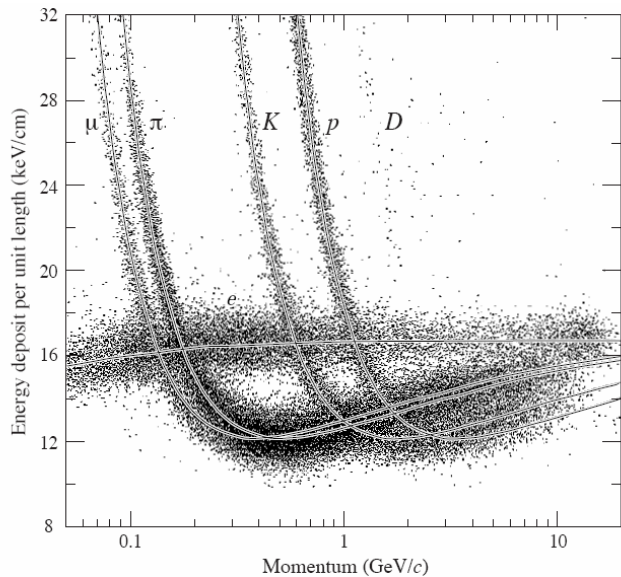


WLS fibres coupling to PM tubes



dE/dx

Can be highly effective for particle ID up to ~ 10 GeV/c

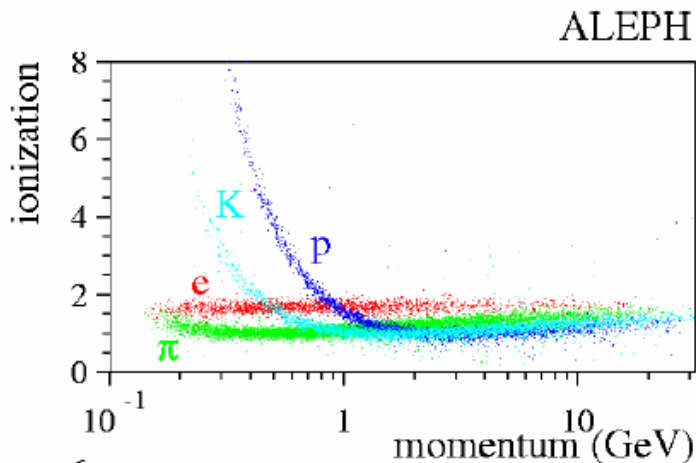


PEP4 TPC.

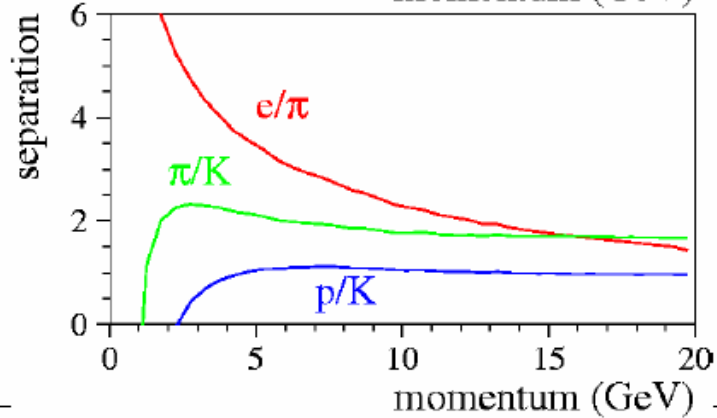
185 samples at 8.5 atm.

Good dE/dx resolution requires

- Large number of samples/track
- Good calibration, low noise
- Truncated (lowest 60%) mean of samples.

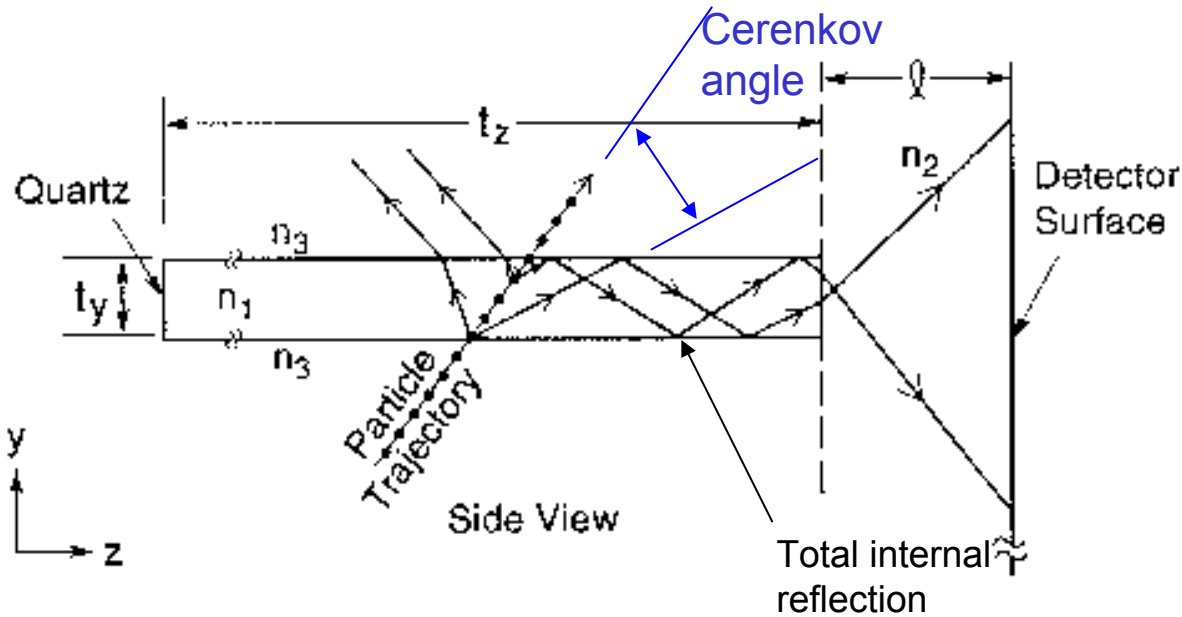


ALEPH TPC got 4.5% resolution with ~ 300 samples at 1 atm.



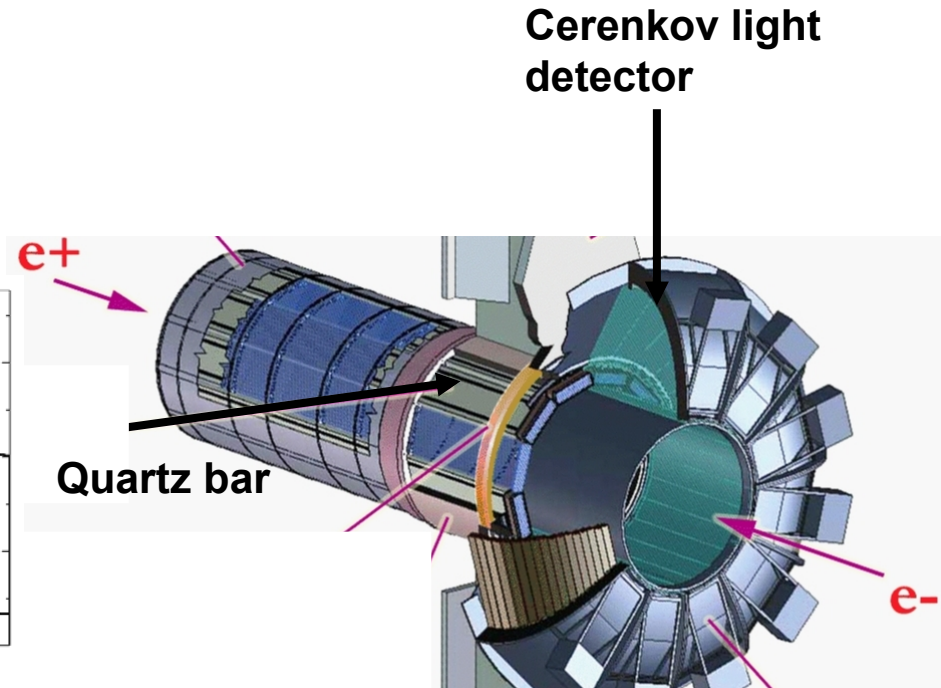
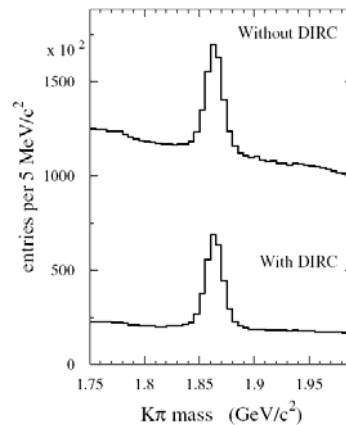
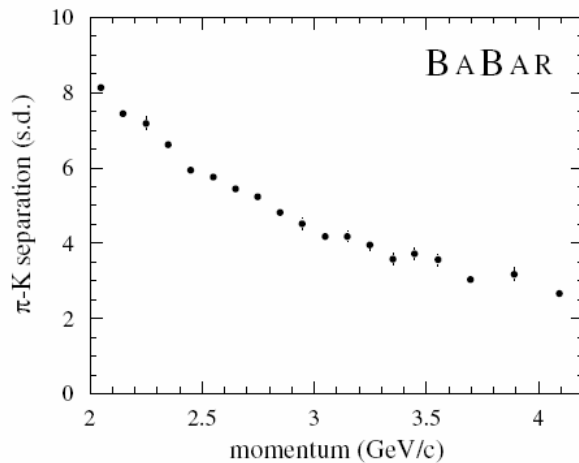
Separation depends on particle types and momentum.

Babar DIRC

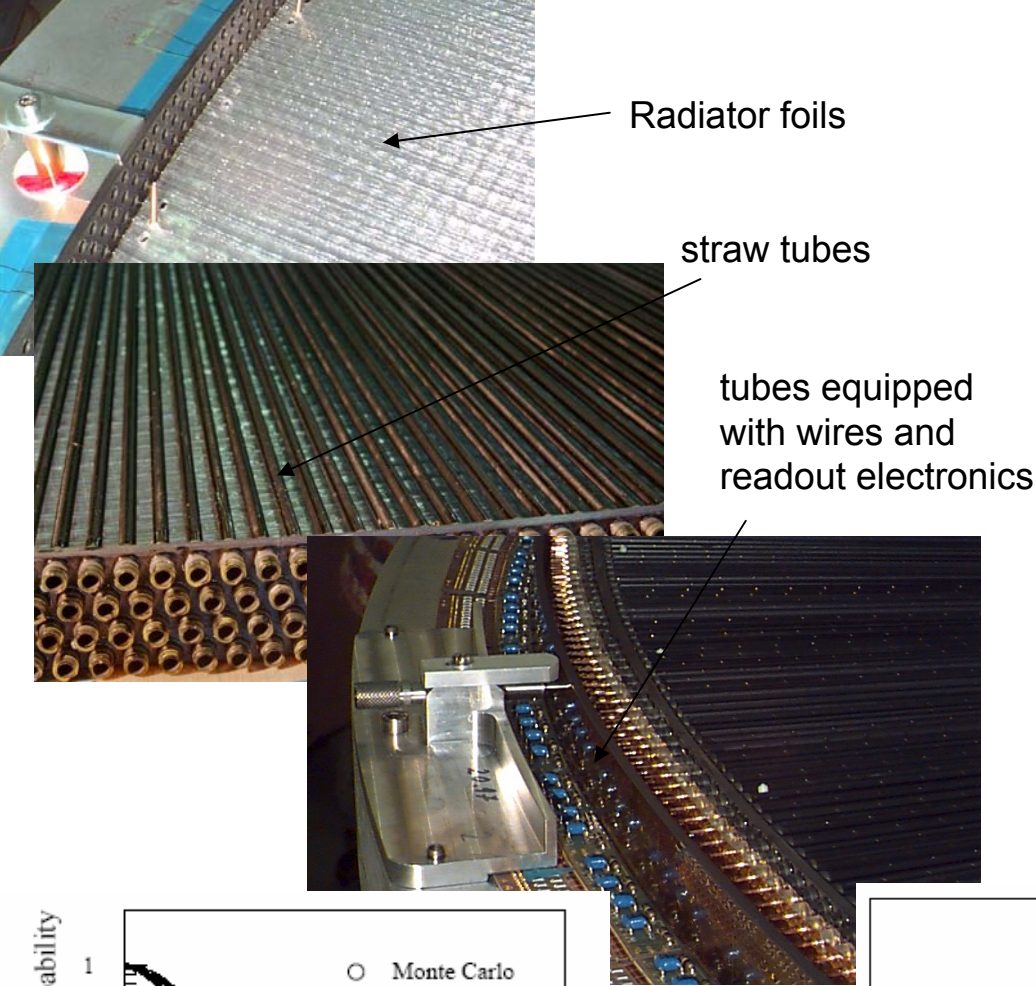


With small t_y , large ℓ ; position of light on detector surface depends on Cerenkov angle.

π/K separation of > 2 s.d.
up to 4 GeV/c.



Atlas transition radiation tracker TRT

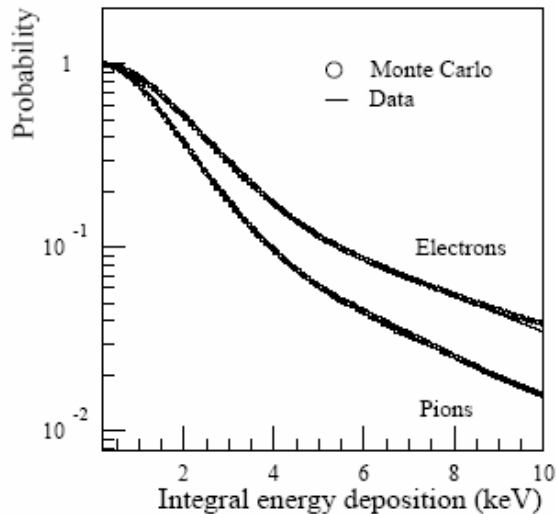


For most tracks it acts as a conventional drift chamber. Each cell is a carbon-fibre tube the size of a drinking straw with a wire down the centre.

Layers of radiator between cells produce TR photons if the track is an electron.

Xenon in cells absorbs X-ray TR photons and produce extra-large pulses.

Tracks with a large proportion of large pulses are probably electrons.



Simulated event

