5. Tracking Detectors

5.1 Momentum reconstruction in a magnetic field

5.2 Magnetic spectrometers

5.3 Multi-wire proportional chambers

5.4 Drift chambers

5.5 Time projection chambers

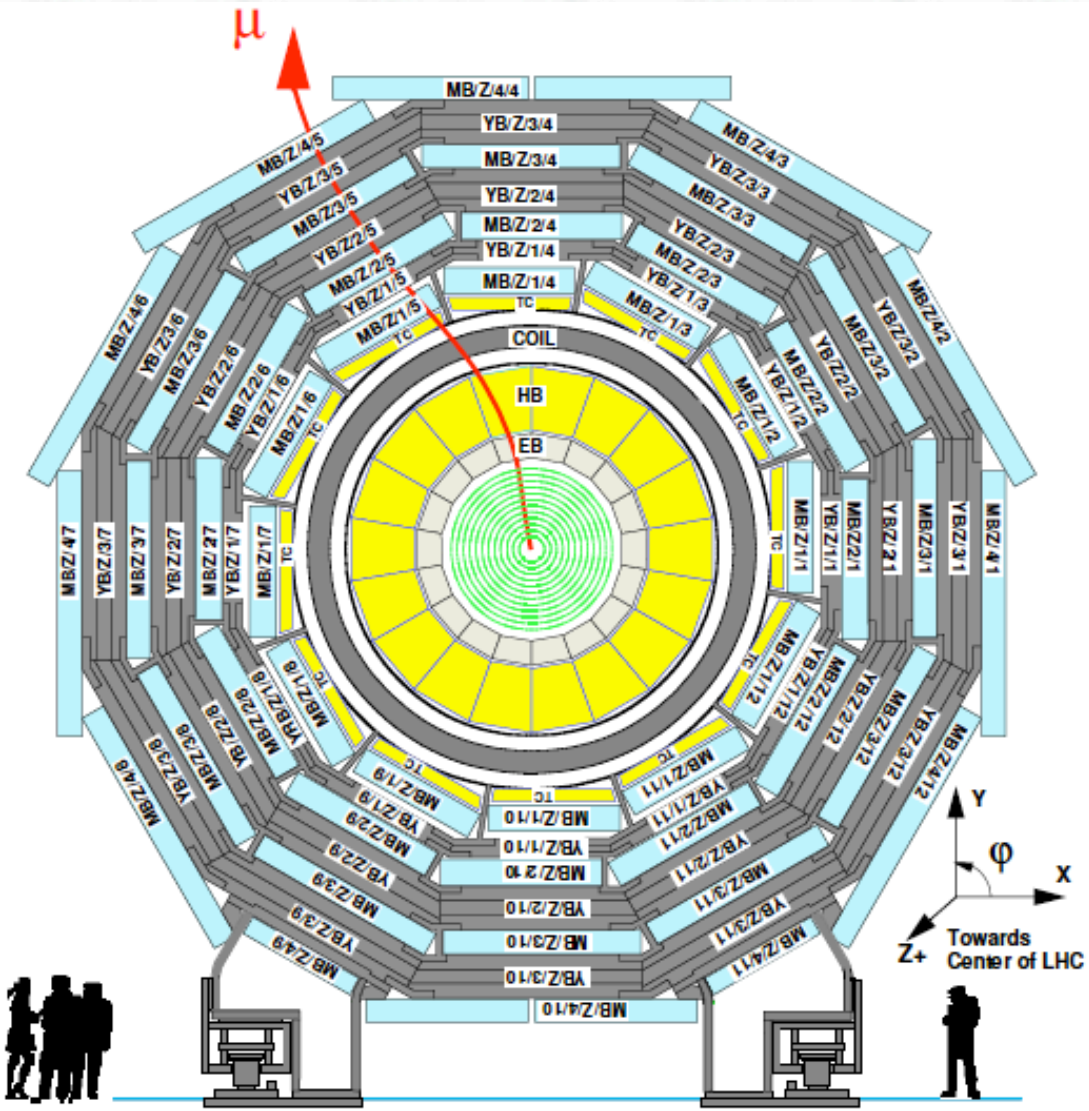
5.6 Microstrip gas chambers

5.7 Ageing of gas detectors

5.8 Large scale gaseous muon detectors

Silicon-based tracking detectors are discussed in Chapter 6
(together with impact parameter resolutions)

5.8 Large scale gaseous muon detectors



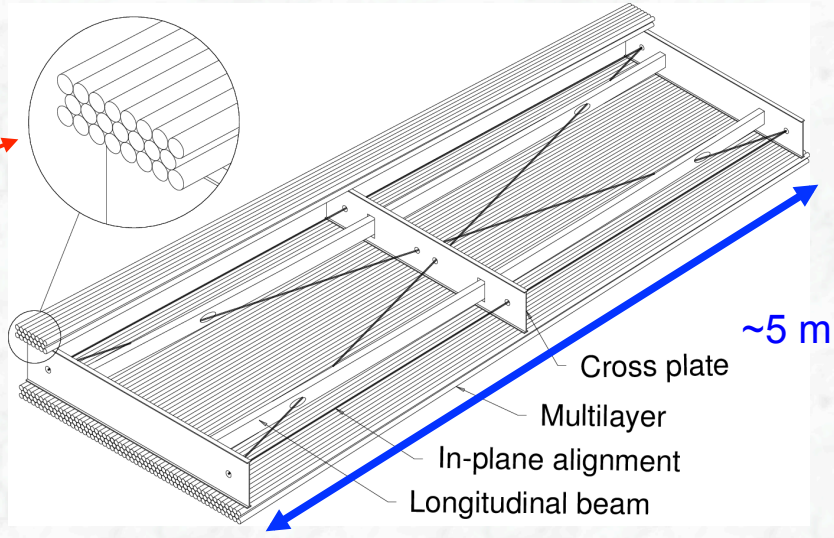
Muon Detectors

- Muon detectors are tracking detectors (e.g. wire chambers)
  - they form the outer shell of the (LHC) detectors
  - they are not only sensitive to muons (but to all charged particles)!
  - just by “definition”: if a particle has reached the muon detector, it's considered to be a muon (all other particles should have been absorbed in the calorimeters)

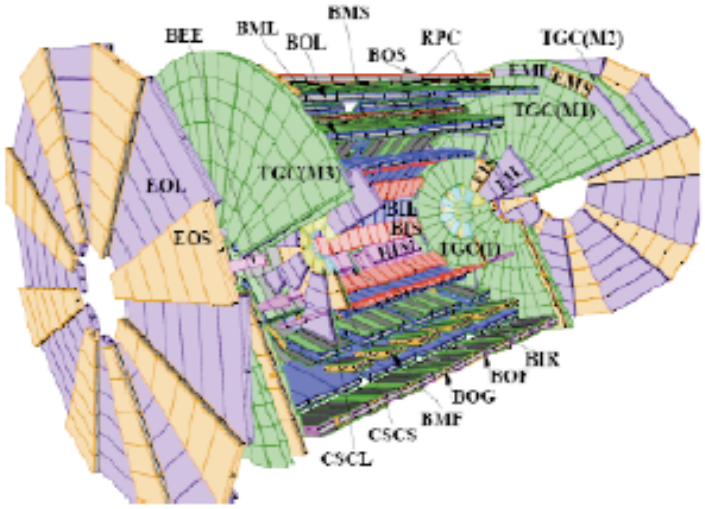
- Challenge for muon detectors
  - large surface to cover (outer shell)
  - keep mechanical positioning over time

- ATLAS
  - 1200 chambers with 5500 m^2
  - also good knowledge of (inhomogeneous) magnetic field needed

ATLAS Muon Detector Elements



ATLAS muon system



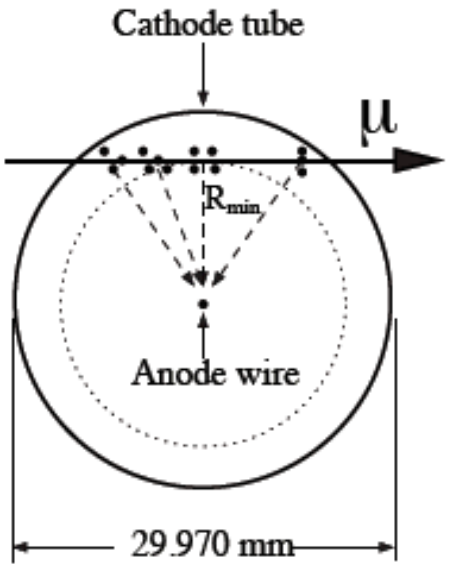
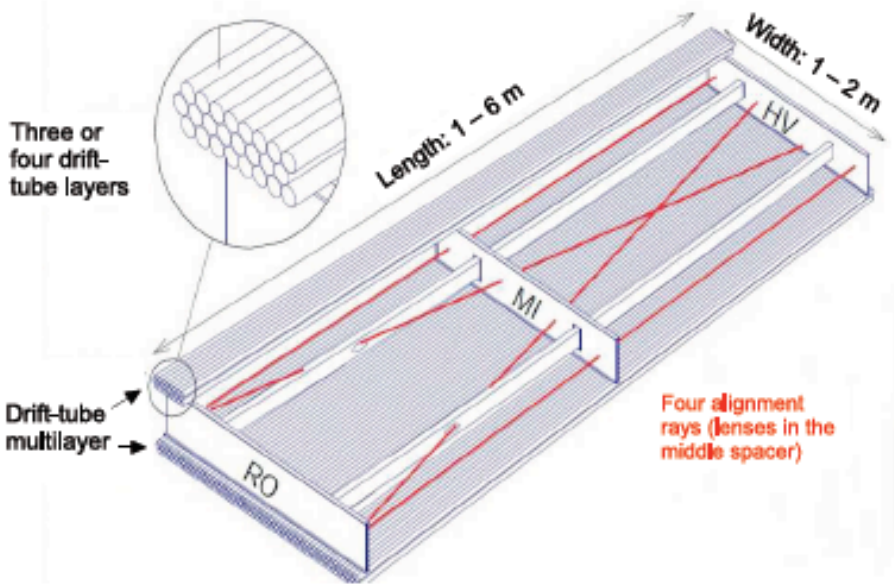


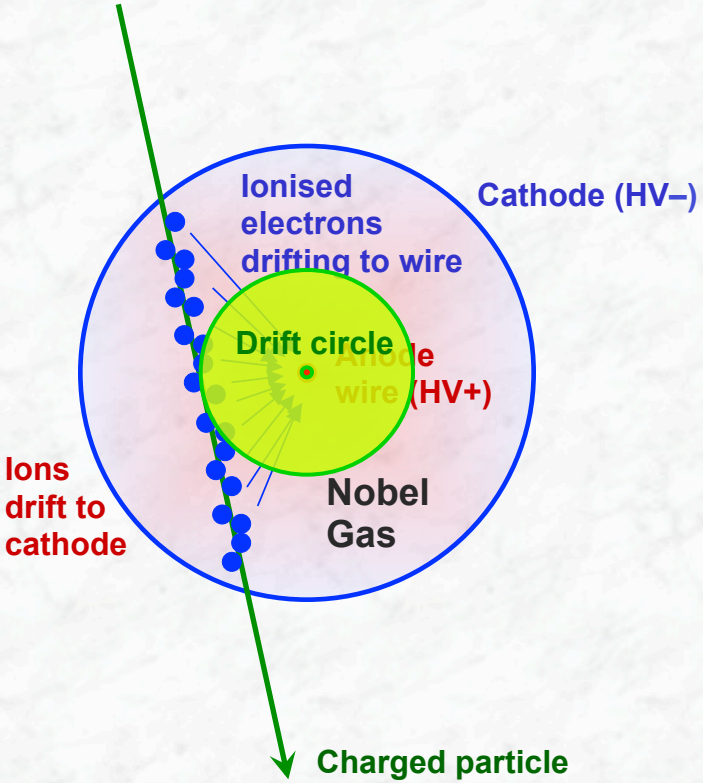
Table 6.2: Main MDT chamber parameters.

Parameter	Design value
Tube material	Al
Outer tube diameter	29.970 mm
Tube wall thickness	0.4 mm
Wire material	gold-plated W/Re (97/3)
Wire diameter	50 μm
Gas mixture	$Ar/CO_2/H_2O$ (93/7/$\leq$ 1000 ppm)
Gas pressure	3 bar (absolute)
Gas gain	2 x 10^4
Wire potential	3080 V
Maximum drift time	$\sim$ 700 ns
Average resolution per tube	$\sim$ 80 μm

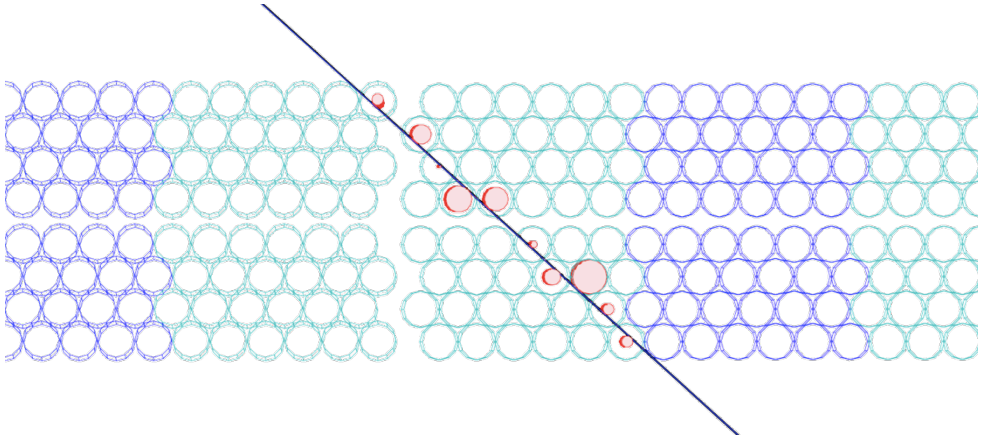


Drift Tubes (DT) in ATLAS: inner detector and muon spectrometer

- Classical detection technique for charged particles based on gas ionisation and drift time measurement



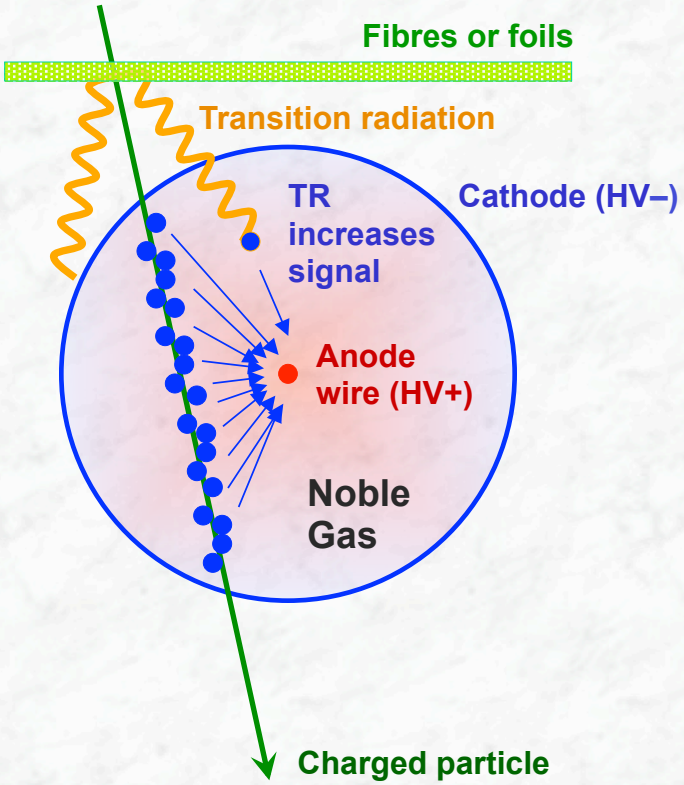
Example: muon in MDTs **(aligned !)**



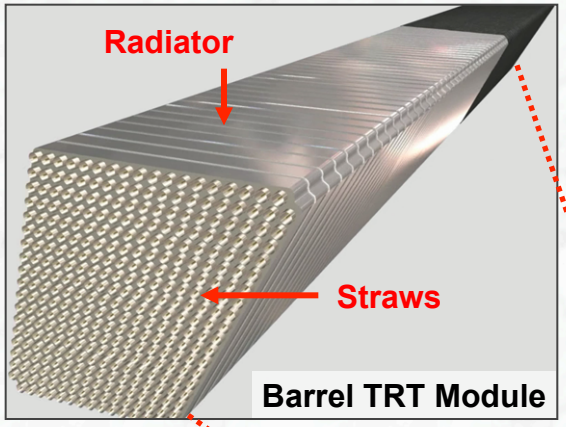
TRT: Kapton tubes, ∅ = 4 mm
Muon chambers: Aluminium tubes, ∅ = 30 mm

Combining Tracking with particle ID: ATLAS TRT

- e/π separation via transition radiation: polymer (PP) fibres/foils interleaved with DTs



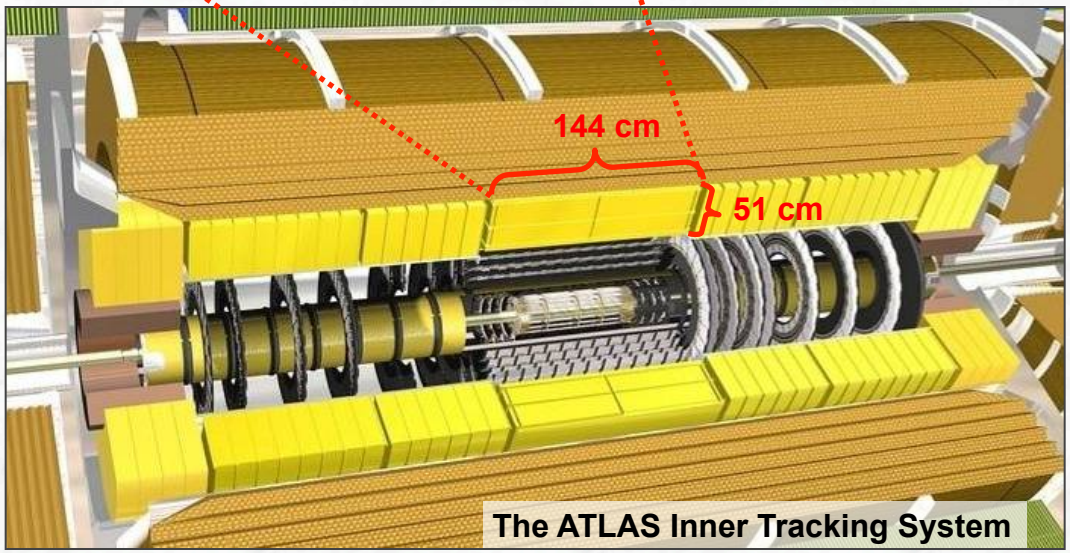
Electrons radiate → higher signal
Particle Identification by counting the number of high-threshold hits



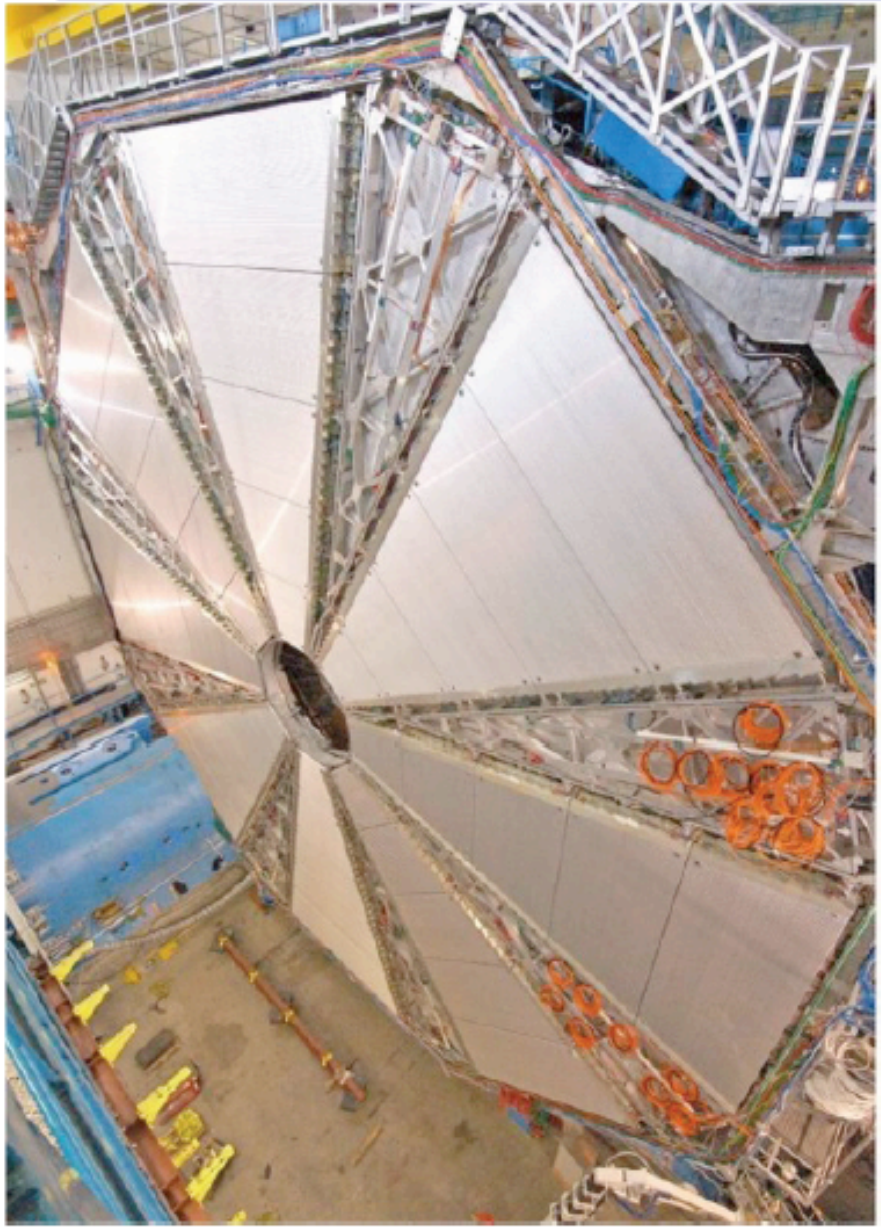
Total: 370000 straws

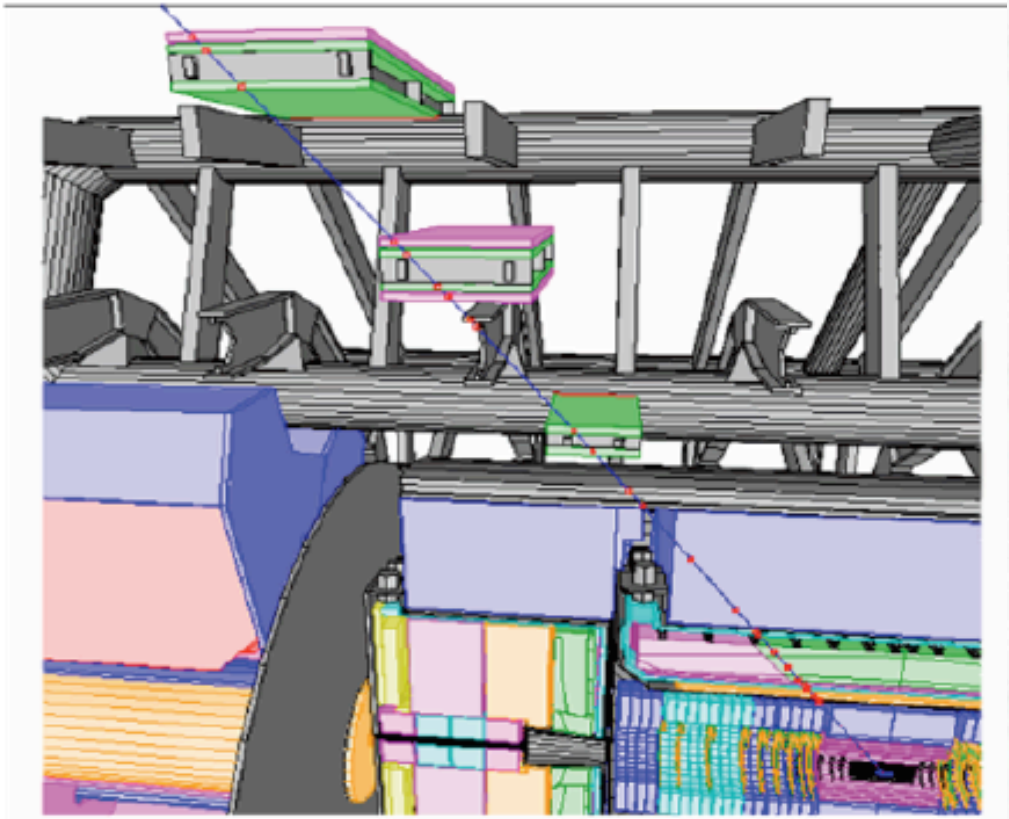
Barrel ($|\eta| < 0.7$): 36 r-ϕ measurements / track
Resolution ~130 μm / straw

18 end-cap wheels ($|\eta| < 2.5$): 40 or less z-ϕ points

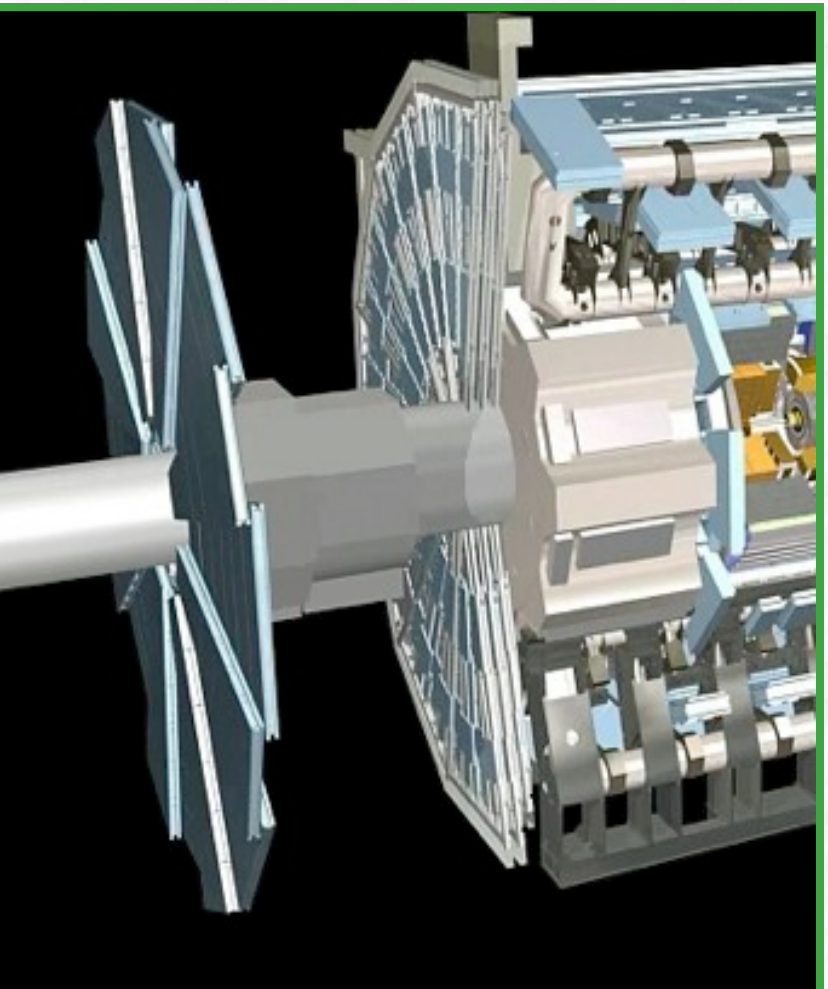


ATLAS muon system

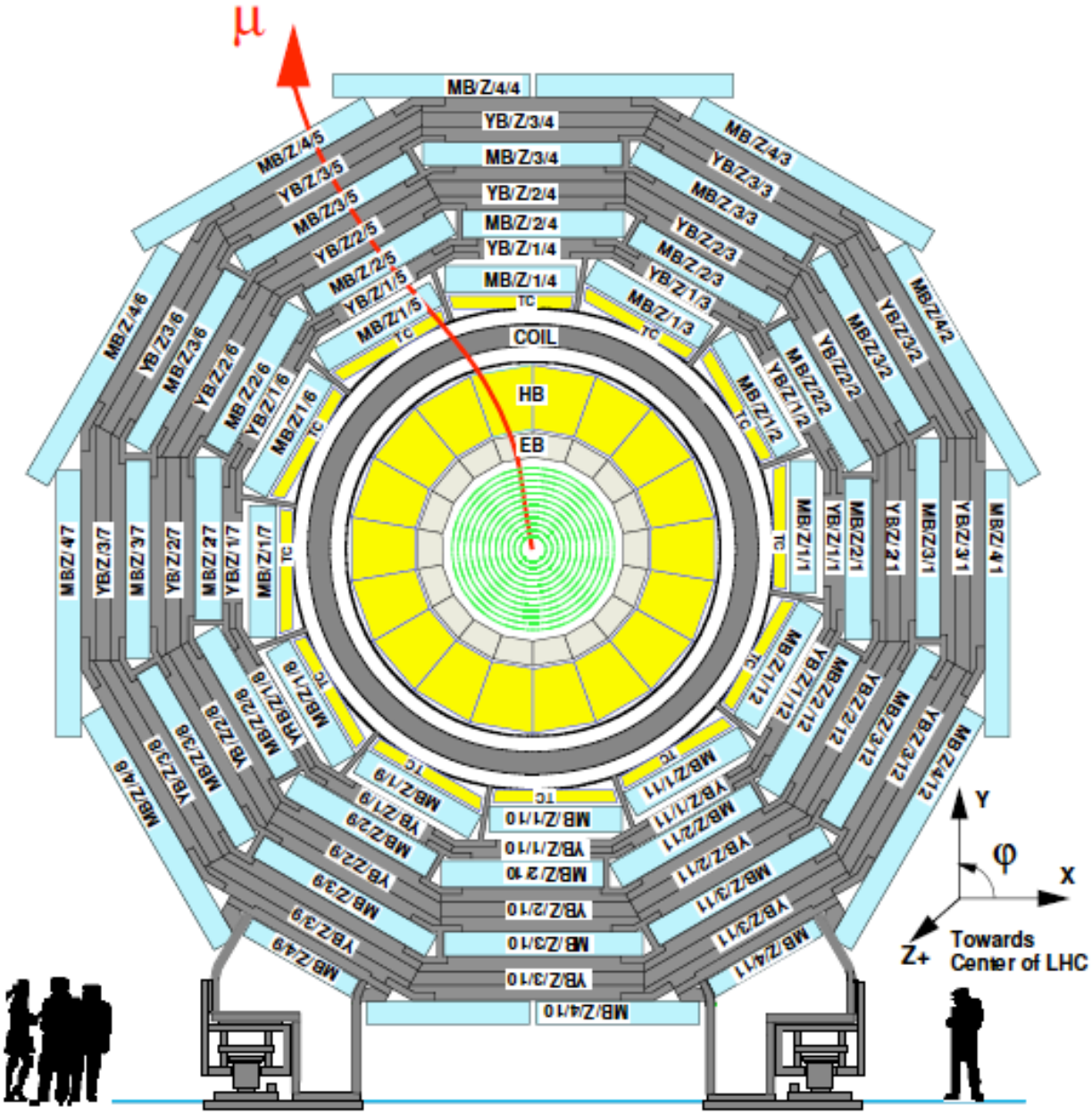




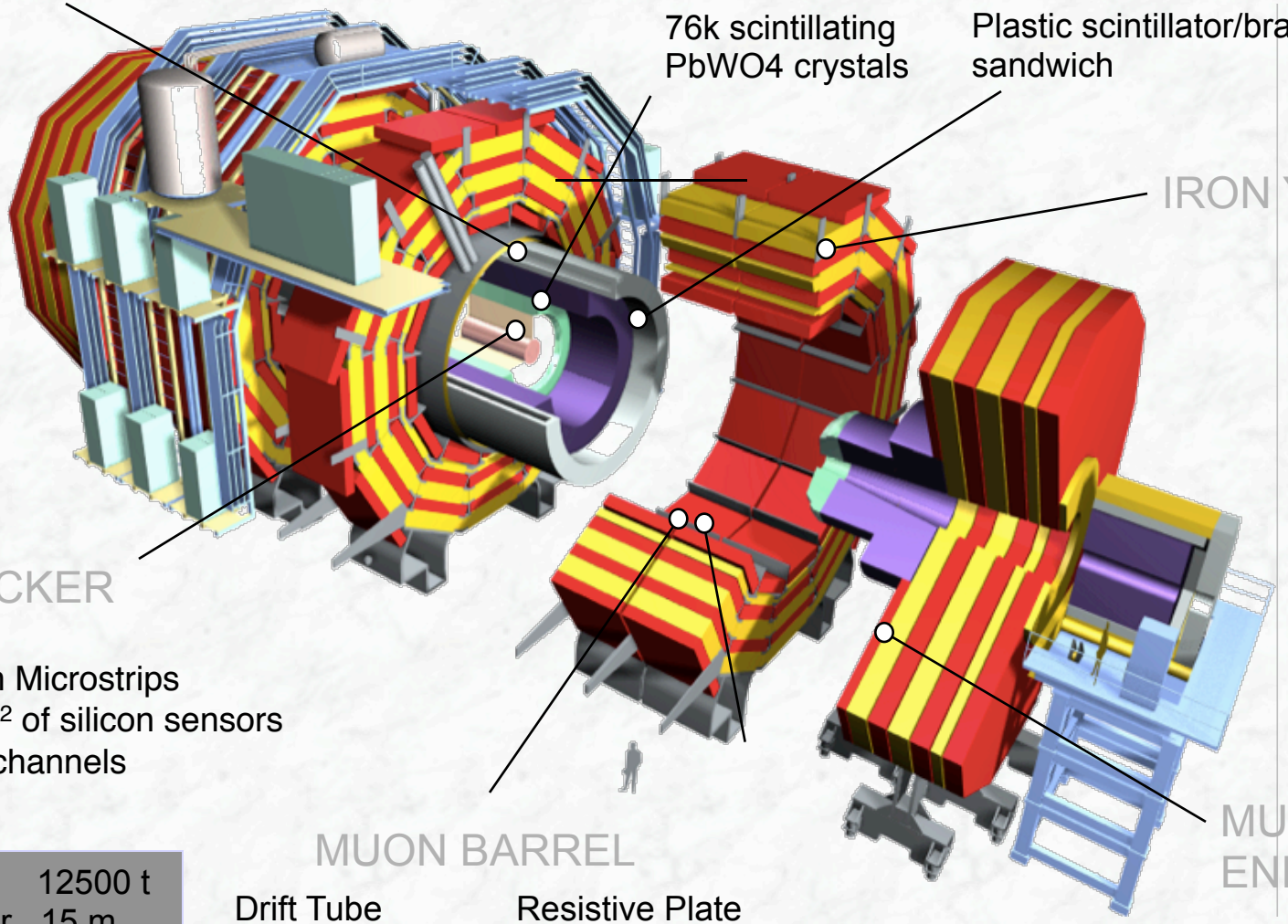
Muon detector system
In the forward region



CMS Muon system



CMS



Total weight	12500 t
Overall diameter	15 m
Overall length	21.6 m