Study of sMDT Chambers at the ATLAS Experiment

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The ATLAS Experiment

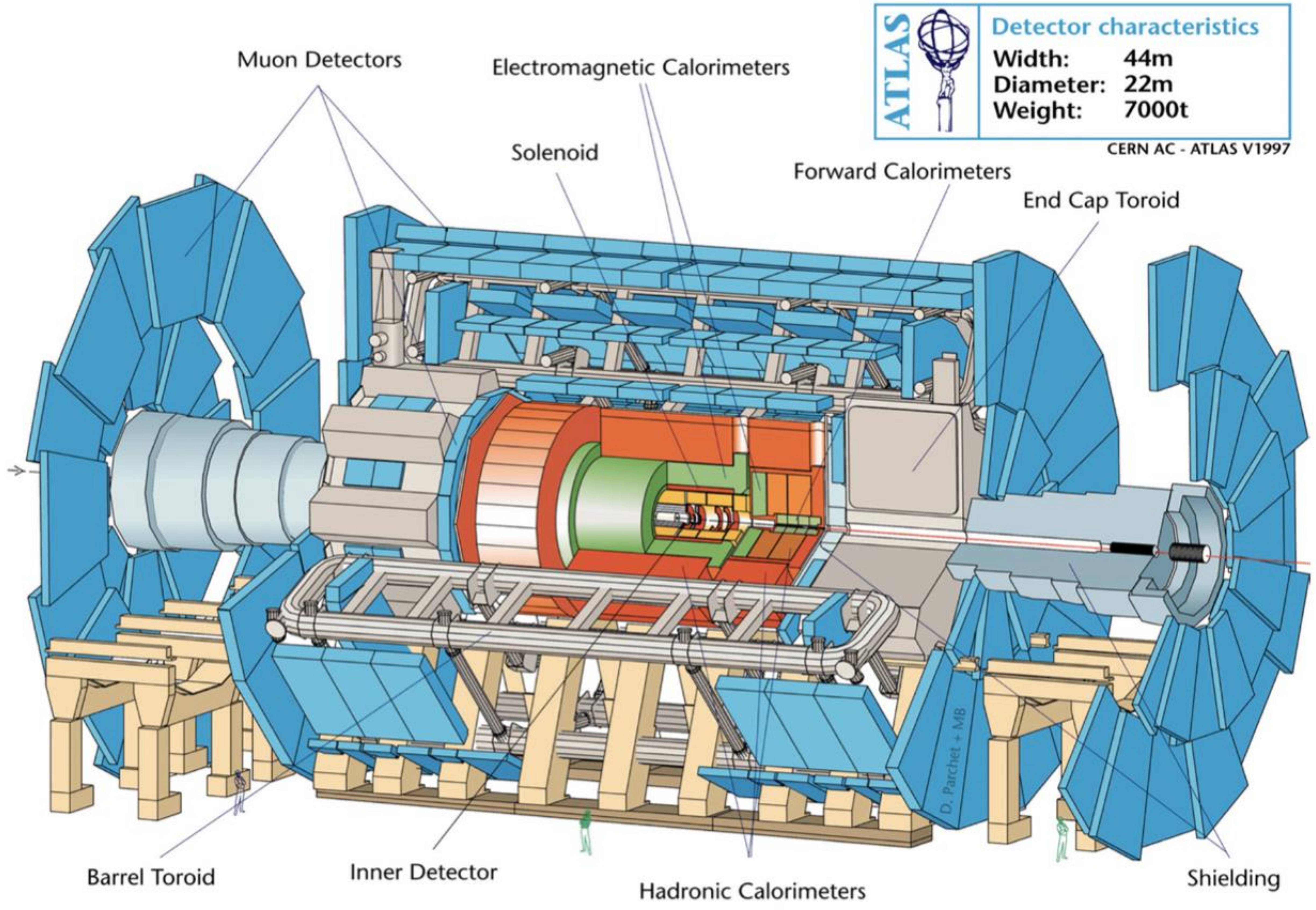


Figure 1-1

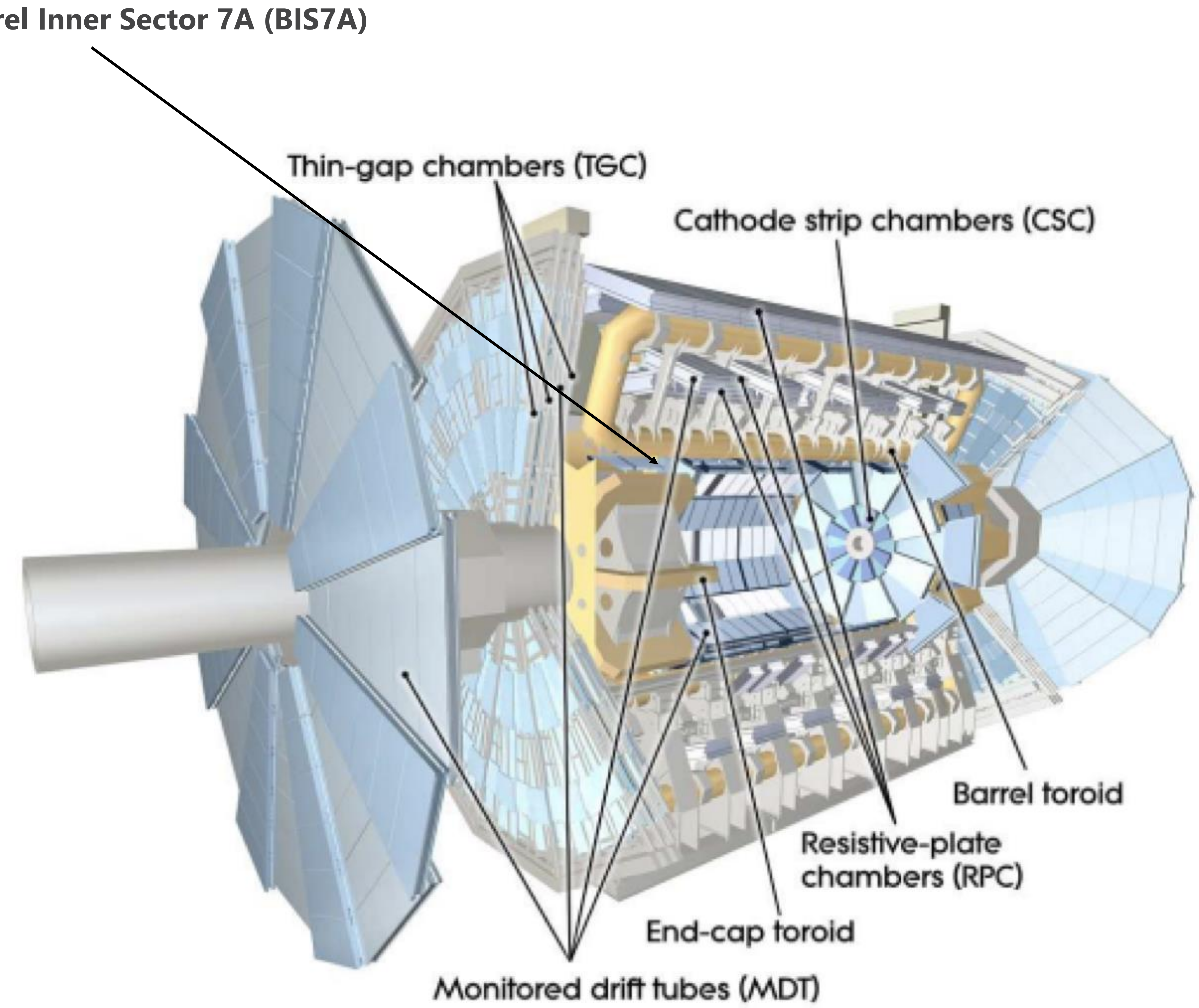
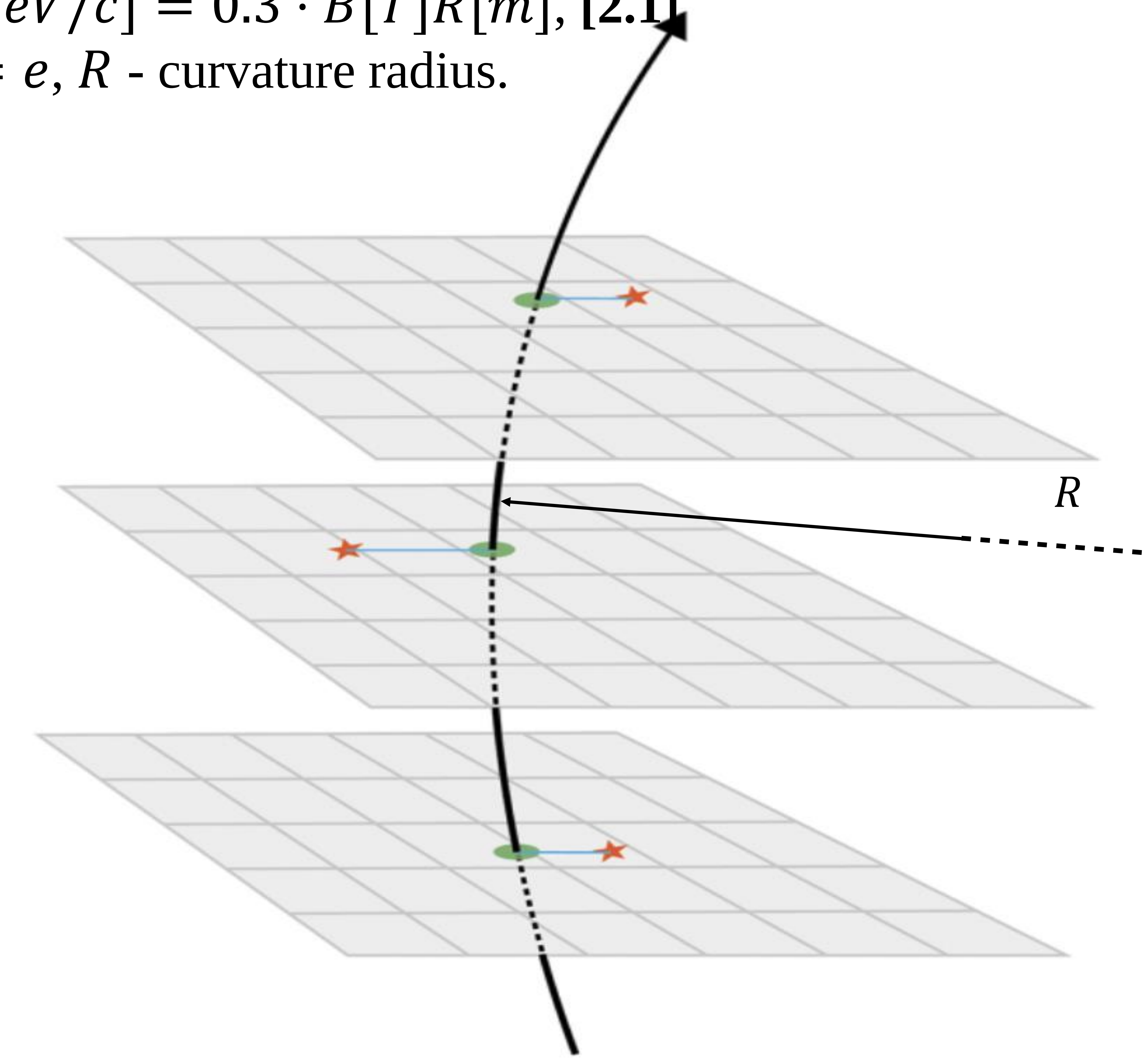


Figure 1-2

Monitored Drift Tube (MDT) Chambers

The muon momentum determination by ATLAS MDT chambers is based on the deflection of a charged particle in the magnetic field.

Muon momentum can be determined as:
$p[GeV/c] = 0.3 \cdot B[T]R[m]$, **[2.1]**
$q = e$, R - curvature radius.



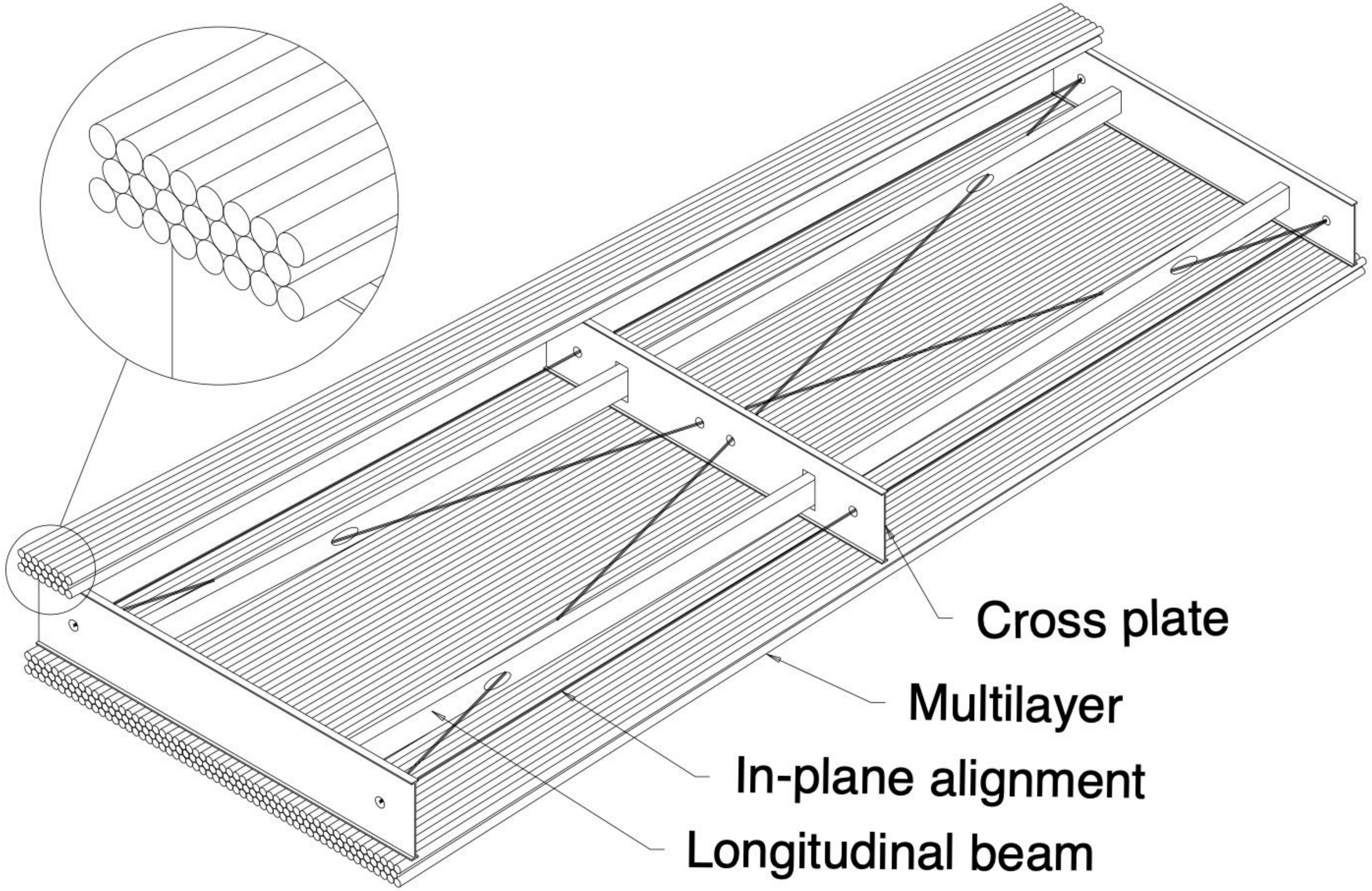


Figure 2-1

Functioning Principle of Cylindrical Drift Tubes

The basic detection element is a cylindrical aluminum drift tube with a diameter of 29.97 mm and filled with an Ar/CO2 mixture (93%/7%) at a pressure of 3 bars.

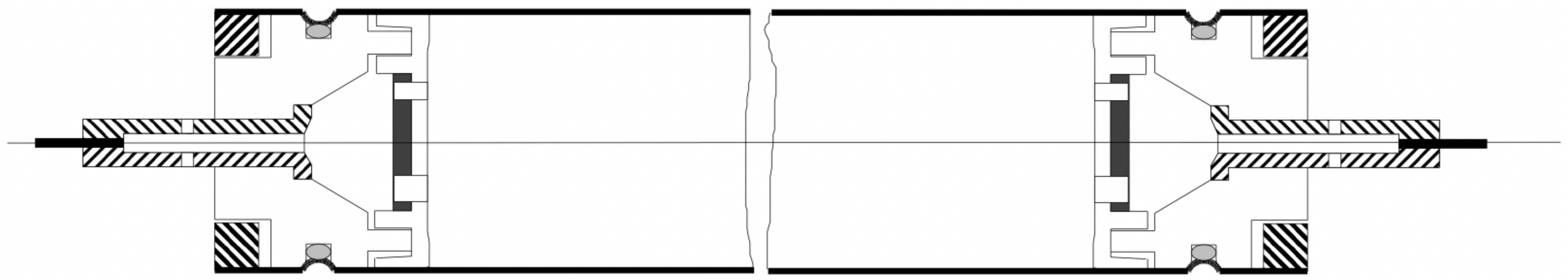


Figure 3-1: Schematic view of a monitored drift tube.

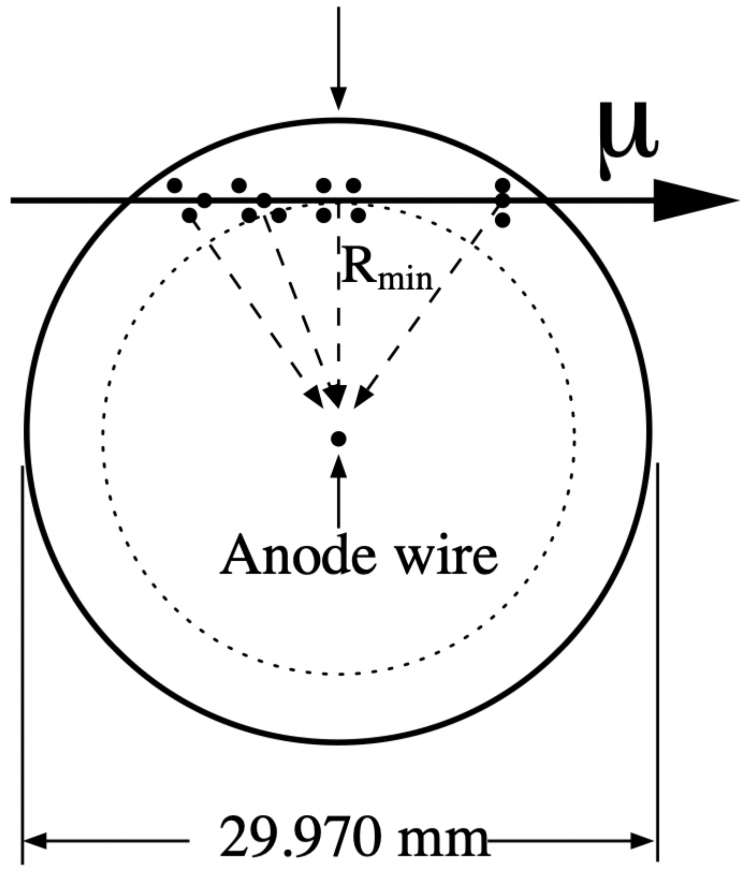


Figure 3-2: Drift tube operation in a magnetic field with a curved drift path.

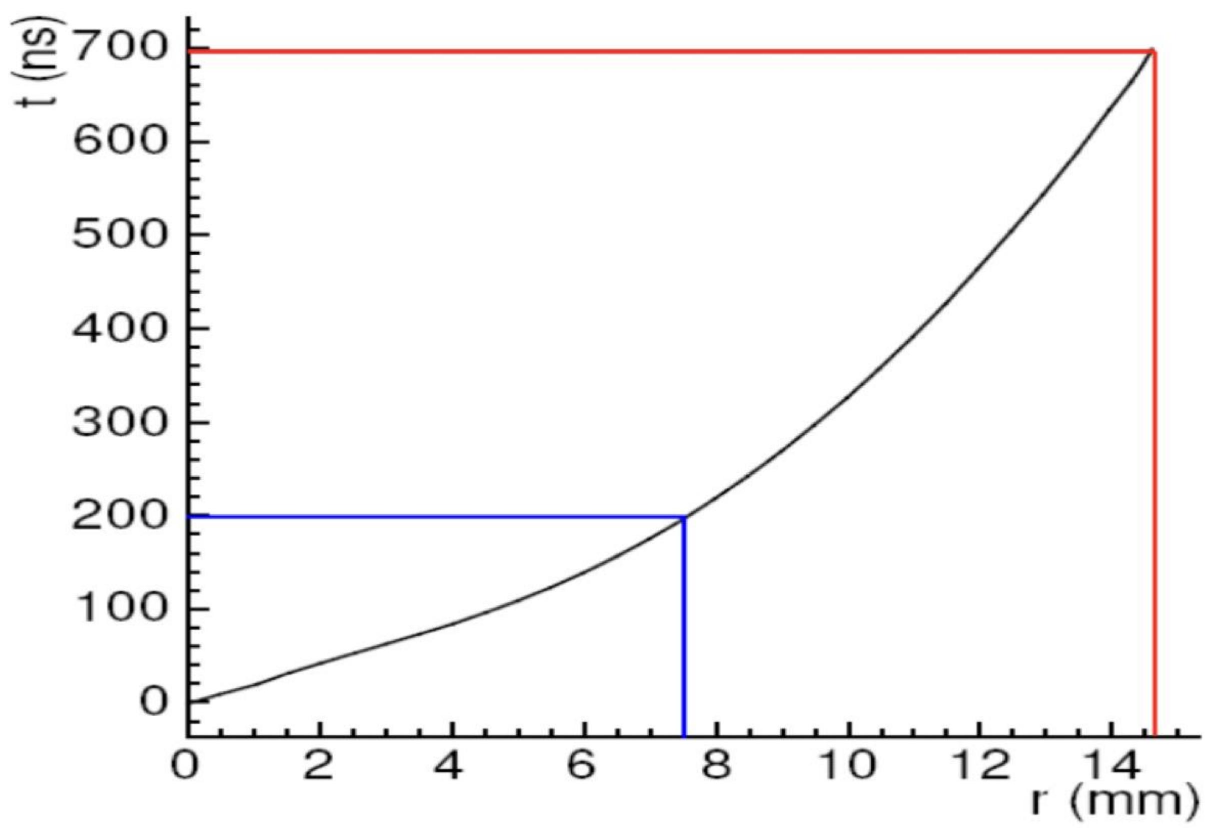


Figure 3-3: RT relation of the MDT chamber.

Drift velocity:

$\vec{v} = \mu\vec{E}$, **[3.1]**

μ - charge mobility.

The electric field in the tube:

$E(r) = \frac{V}{ln(\frac{R}{r_{min}})}\frac{1}{r}$, **[3.2]**

r_{min} - radius of the anode wire,

R - inner radius of the tube,

V - potential difference between anode wire and tube wall.

Tube Resolution and Efficiency

$Resolution$

$$\varepsilon = \frac{trackhits}{trackhits + holes}$$

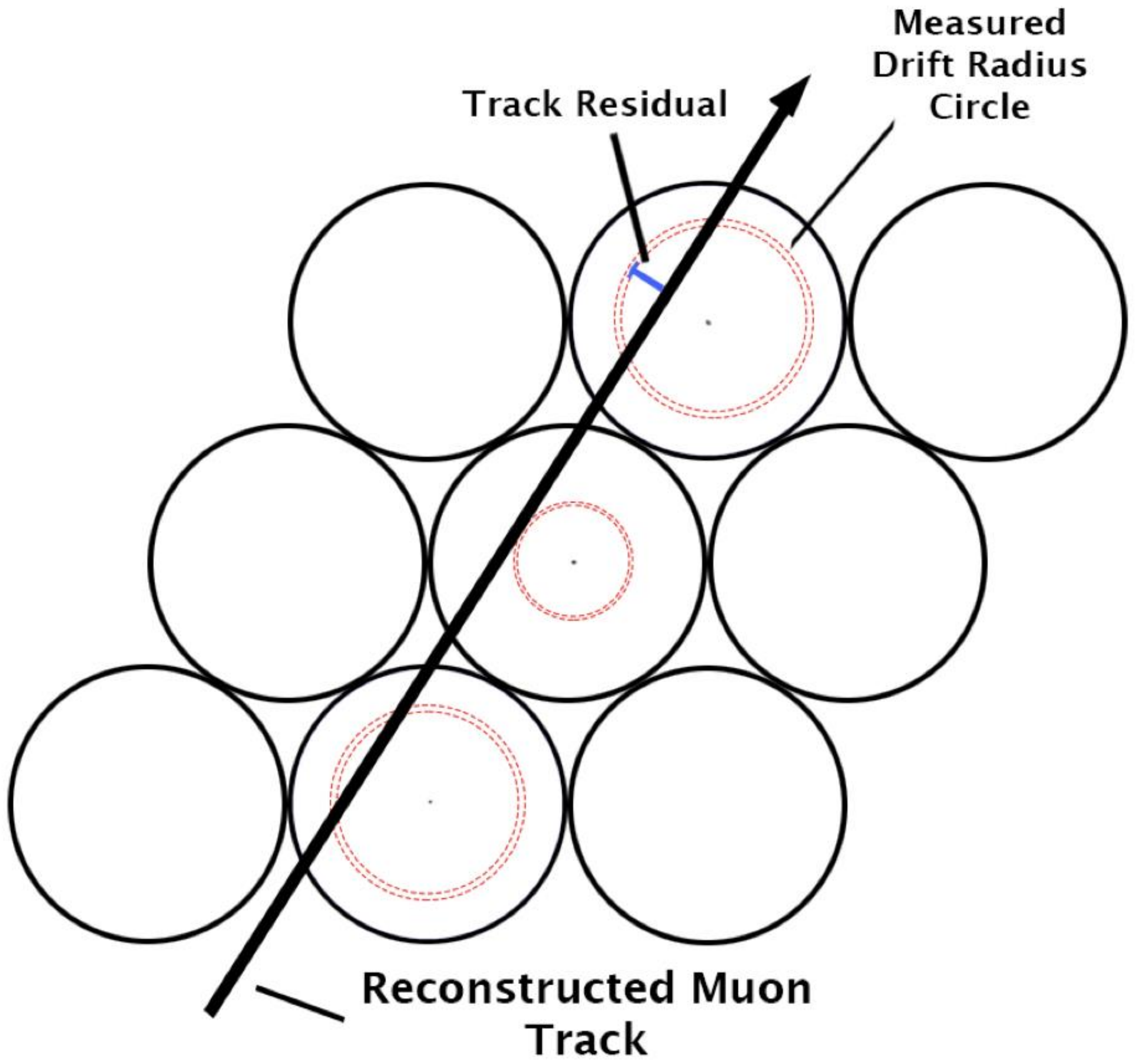


Figure 4-1: Visualization of the biased residuals for a track.

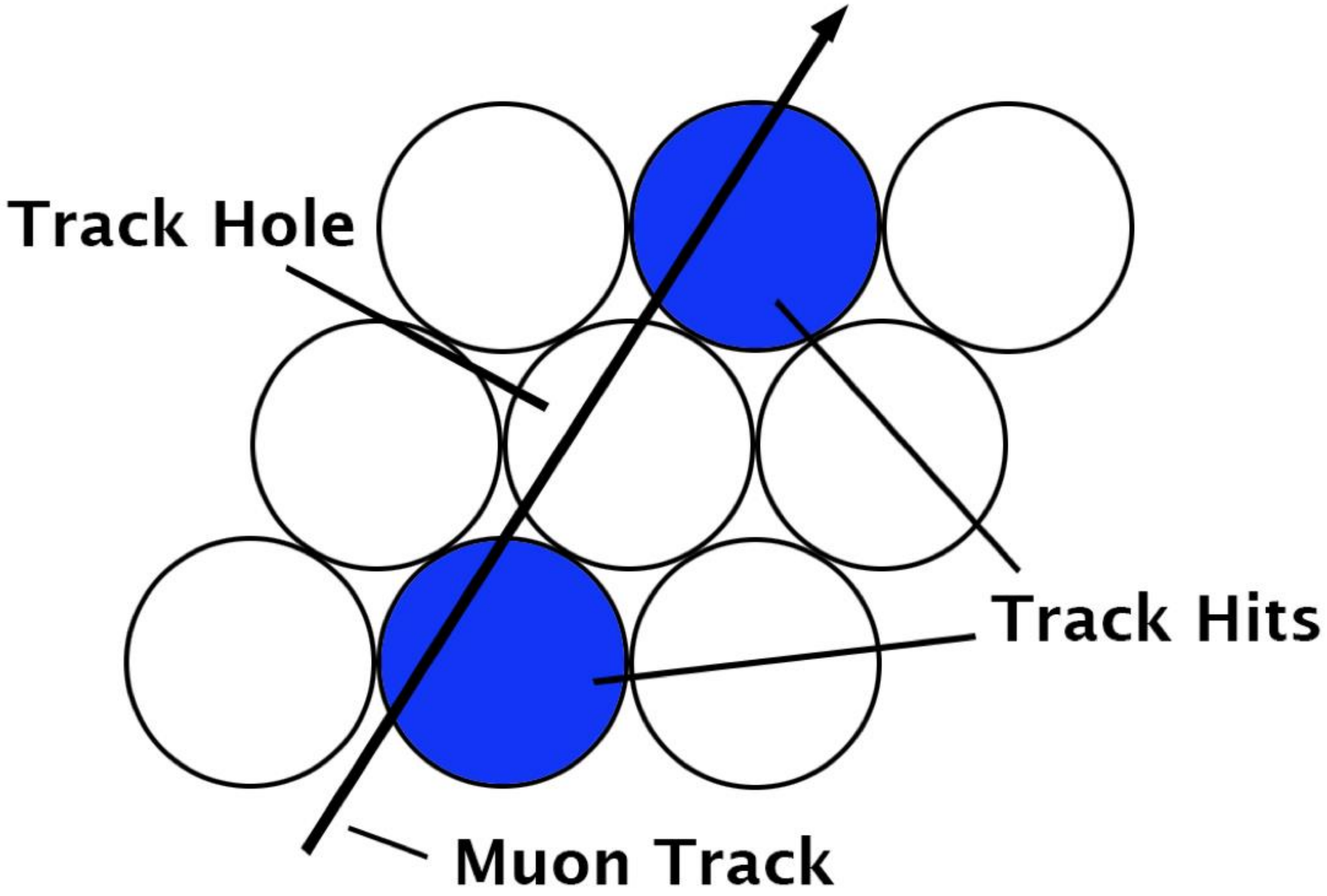


Figure 4-2: Visualization of a track hole.

small Monitored Drift Tube (sMDT) Chambers

Parameter	MDT	sMDT
Tube material	Aluminium	Aluminium
Outer tube diameter	29.970 mm	15.000 mm
Tube wall tickness	0.4 mm	0.4 mm
Wire material	gold-plated W/Re (97/3)	gold-plated W/Re (97/3)
Wire diameter	50 μm	50 μm
Gas mixture	Ar/CO_2 (93:7)	Ar/CO_2 (93:7)
Gas pressure	3 bar (absolute)	3 bar (absolute)
Gas gain	2×10^4	2×10^4
Wire potential	3080 V	2730 V
Maximum drift time	$\sim$ 700 ns	$\sim$ 190 ns
Average resolution per tube	83 μm	106 μm
Drift tube muon efficiency	95%	94%

Figure 5-1: Main MDT and sMDT chamber parameters.

Advantages of sMDT Chambers:

- Smaller radius (7.5 mm compared to 15 mm), which shortens the maximum drift time to 175 ns compared to 700 ns for MDTs, which means the electronic dead time is 4 times smaller for sMDTs, allowing for sMDT chambers to function 8 times higher rates than MDT chambers.
- The smaller size of sMDT chambers allows them to be installed in certain areas of the muon spectrometer that other chambers could previously not be mounted.

- However, sMDT chambers have significantly poorer resolution than MDT chambers.

small Monitored Drift Tube (sMDT) Chambers

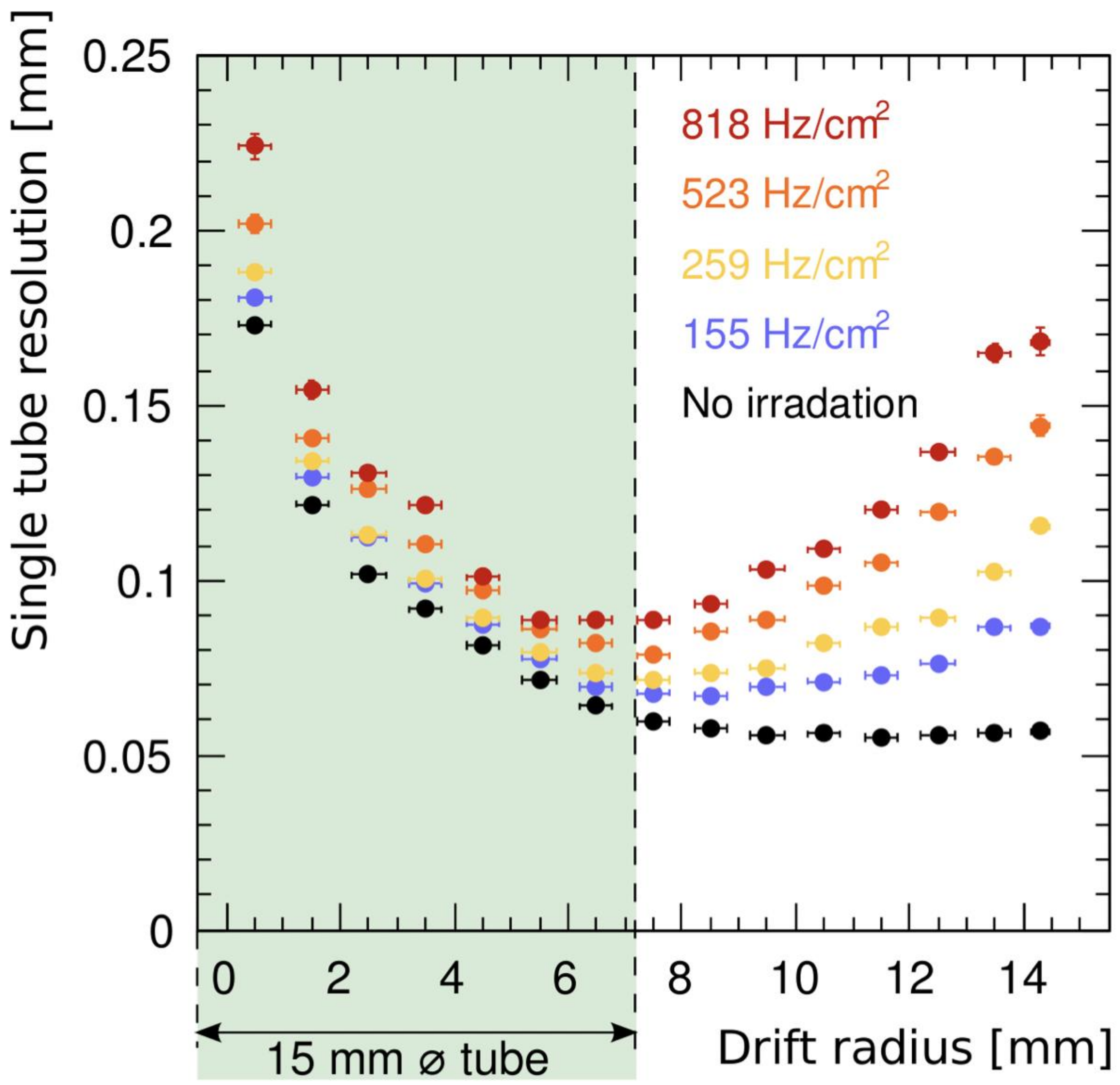


Figure 6-1: Measured spatial resolution of MDT chambers vs the drift radius at different rates of radiation.

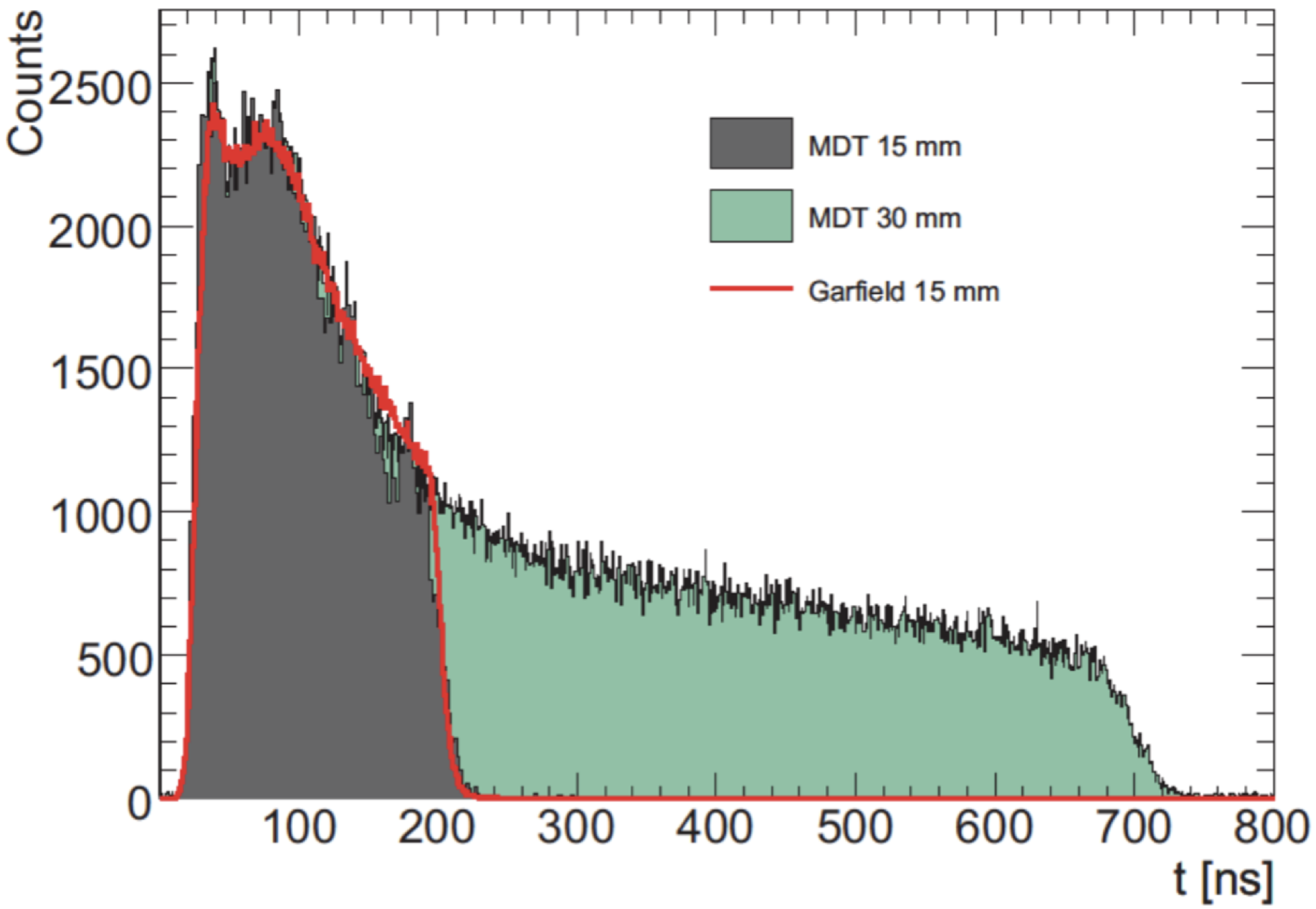


Figure 6-2: The plot of drift times for an sMDT chamber compared to that of a MDT chamber.

Thank you for your attention!