Drift Time Analysis in ATLAS Muon Spectrometer Under Varying Gas Conditions

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Purpose

- What we are trying to understand if we can distinguish between two different scenarios for an observed change in the maximum drift time: a change in CO_2 or perhaps a small diffusion of water vapor into the system.

Muons and Muon Tracking

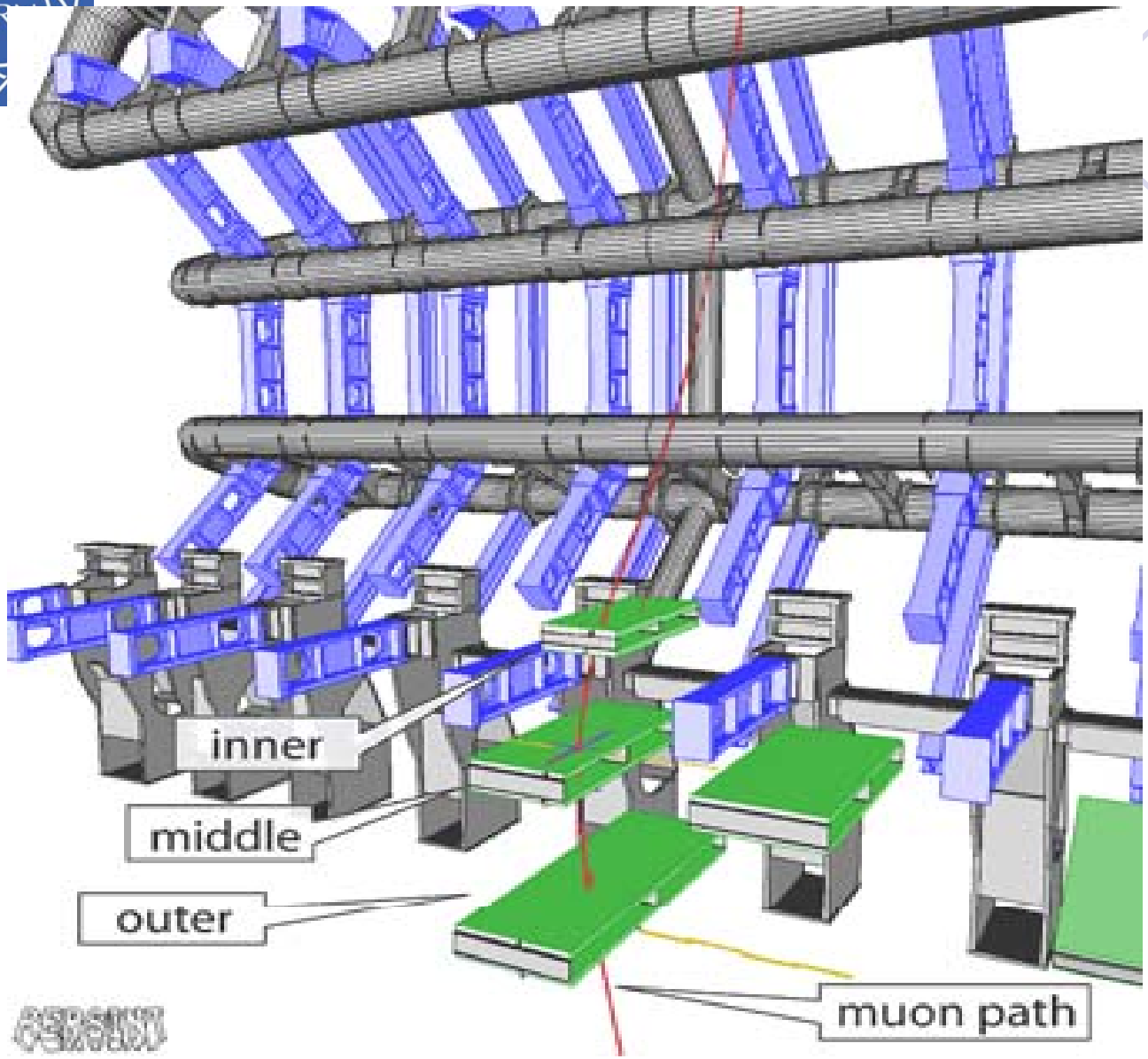
- An elementary particle which can have either a positive or negative electric charge; spin of 1/2.
- It is the decay product of many particles, one of these being the Higgs:

$$H \rightarrow Z\,Z^{*} \rightarrow \mu^{-}\mu^{+}\mu^{-}\mu^{+}$$

- We can reconstruct events by identifying the muon's tracks and measuring its momentum

Muon Spectrometer

- The muon spectrometer is used in the ATLAS experiment to identify and measure the muon momentum
- One of its major components: Monitored Drift Tube Chambers
- Drift Tubes help to provide precise co-ordinate measurements of the muon track



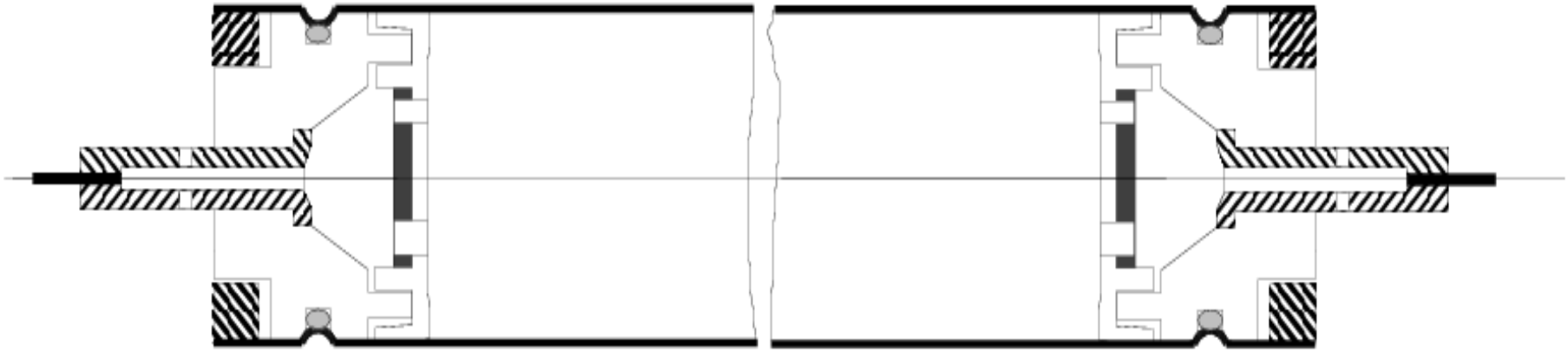
A 3-D event display of a cosmic muon event, showing the path of a muon traveling through three layers of the barrel muon spectrometer. Three of the eight coils of the barrel toroid magnet can be seen in the top half of the drawing.

MDT Chambers

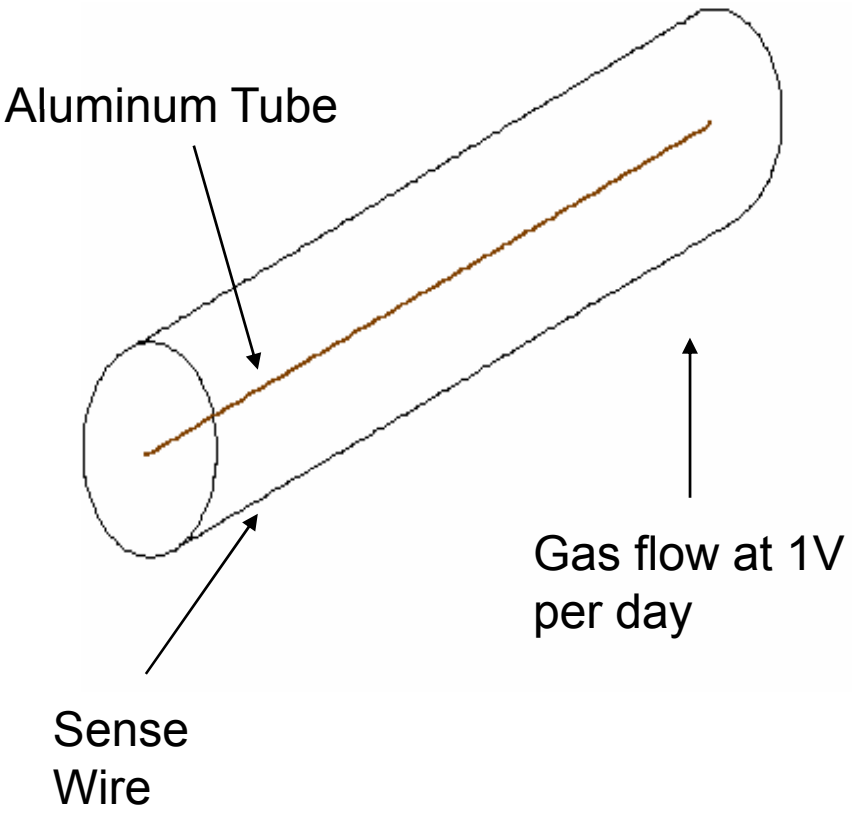
BARREL DRIFT TUBE CHAMBER

Schematic view of MDT

- Aluminum tubes: diameter= 30mm
- Central tungsten wire: diameter= 50μm
- Tube length:1m-6m
- ~ 1200 of these chambers in the ATLAS experiment



MDTs



Sense Wire:

- Gold-plated Tungsten wire
- r = 25μm
- V= 3080 V
- Stretched by 350g of tension

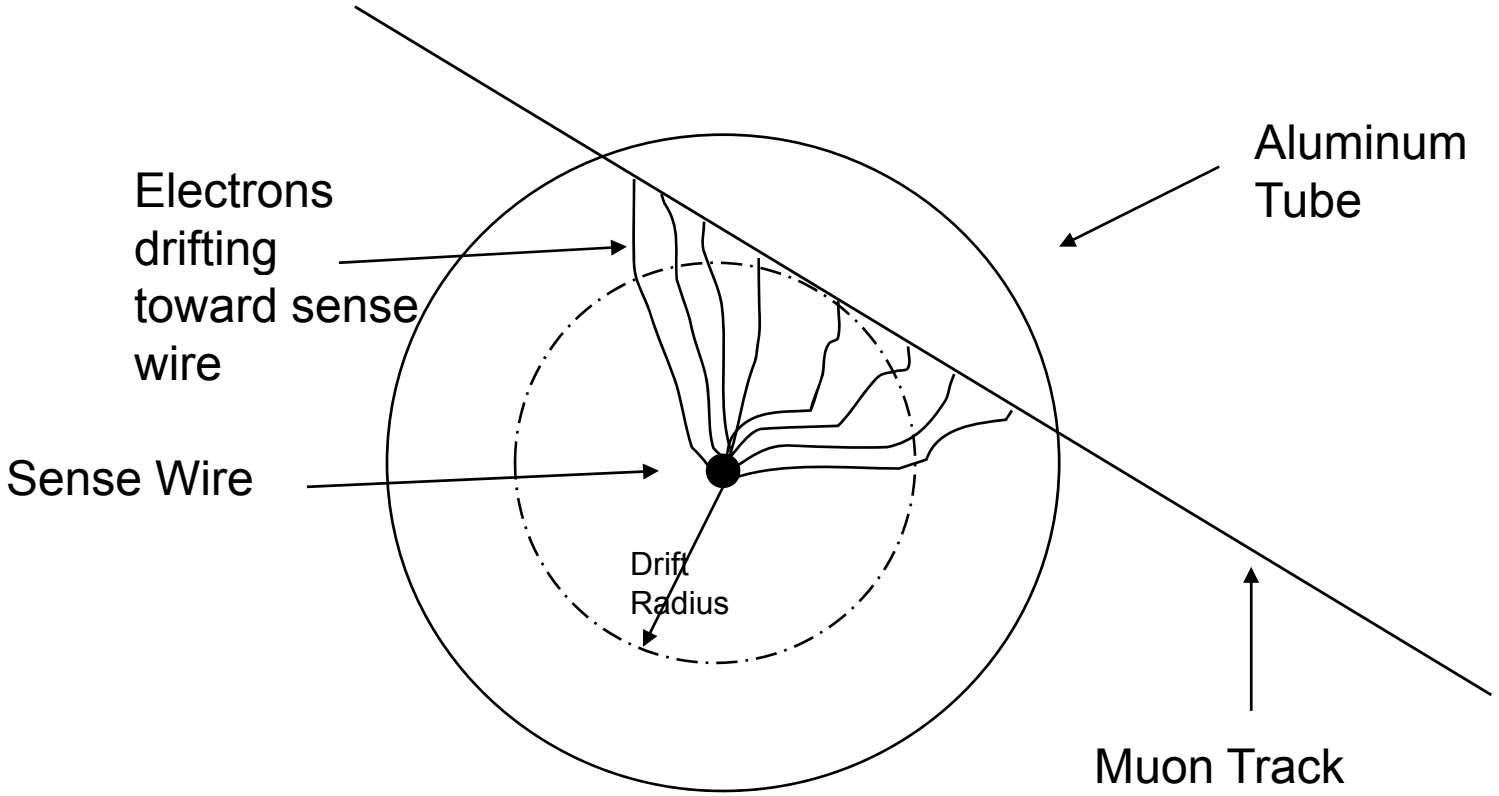
Aluminum Tube:

- radius inner= 1.46 cm
- radius outer =1.5 cm

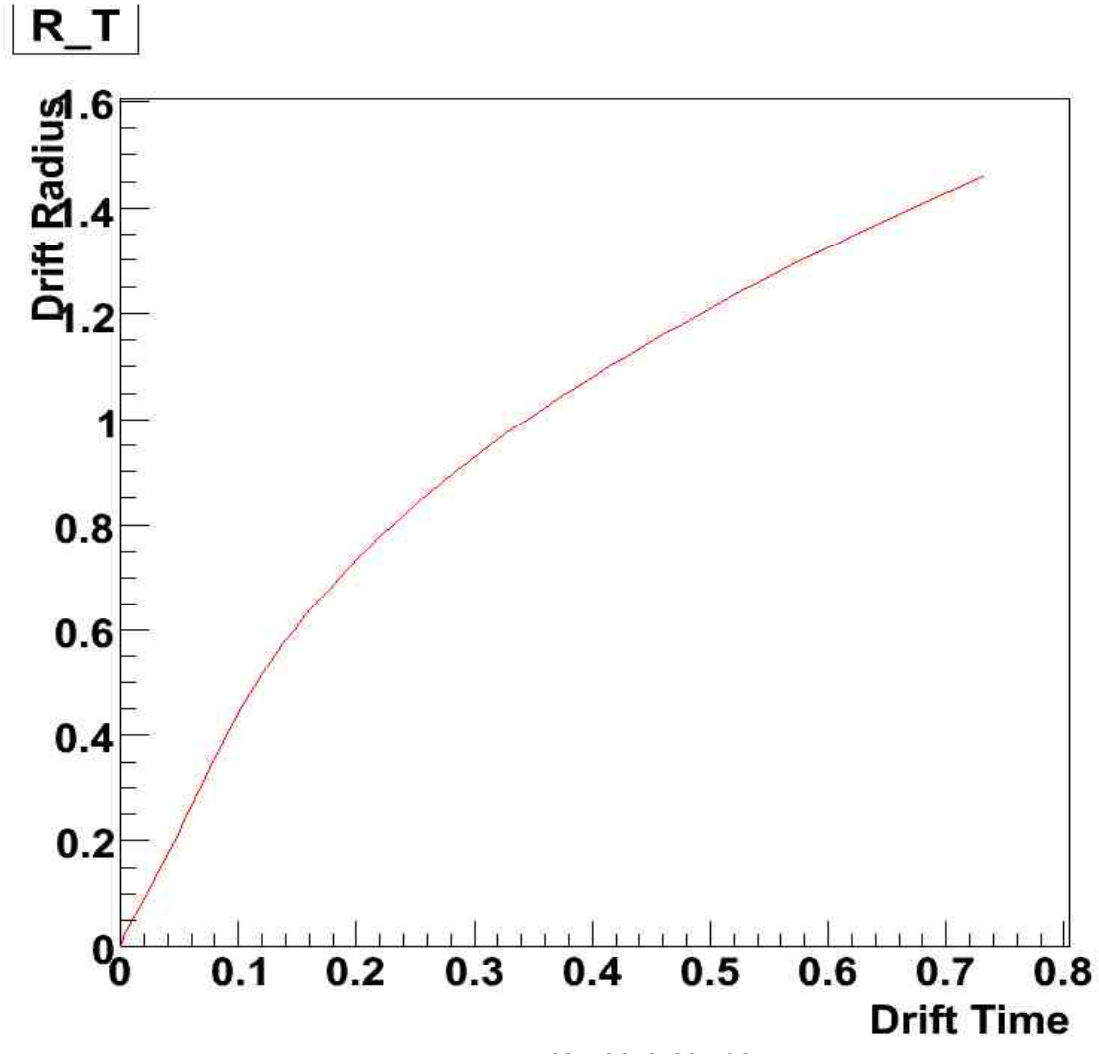
Gas :

- Mixture 93.0% Ar, 7.0% CO_2
- Pressure: 3 bar
- Temperature: ~293K

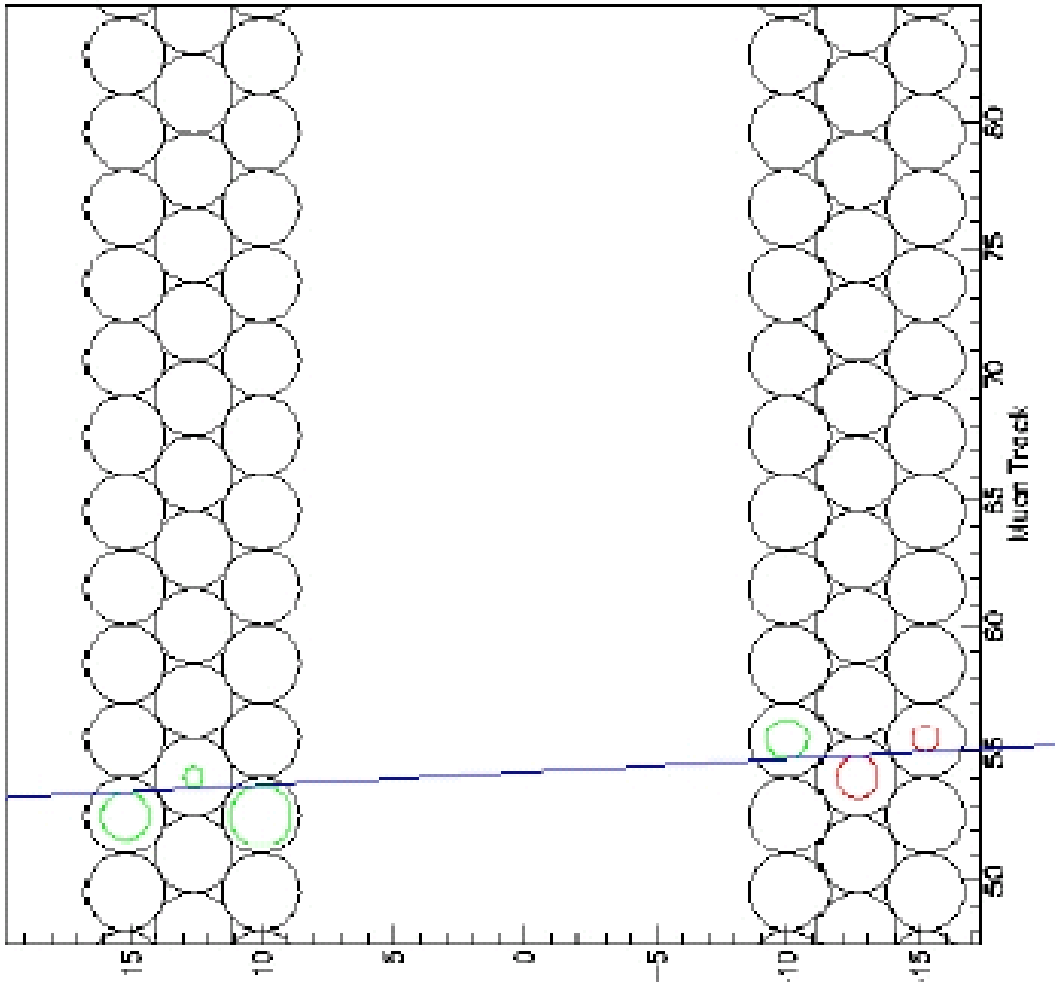
Tracking muons



Drift Radius vs Drift Time (RT) Function

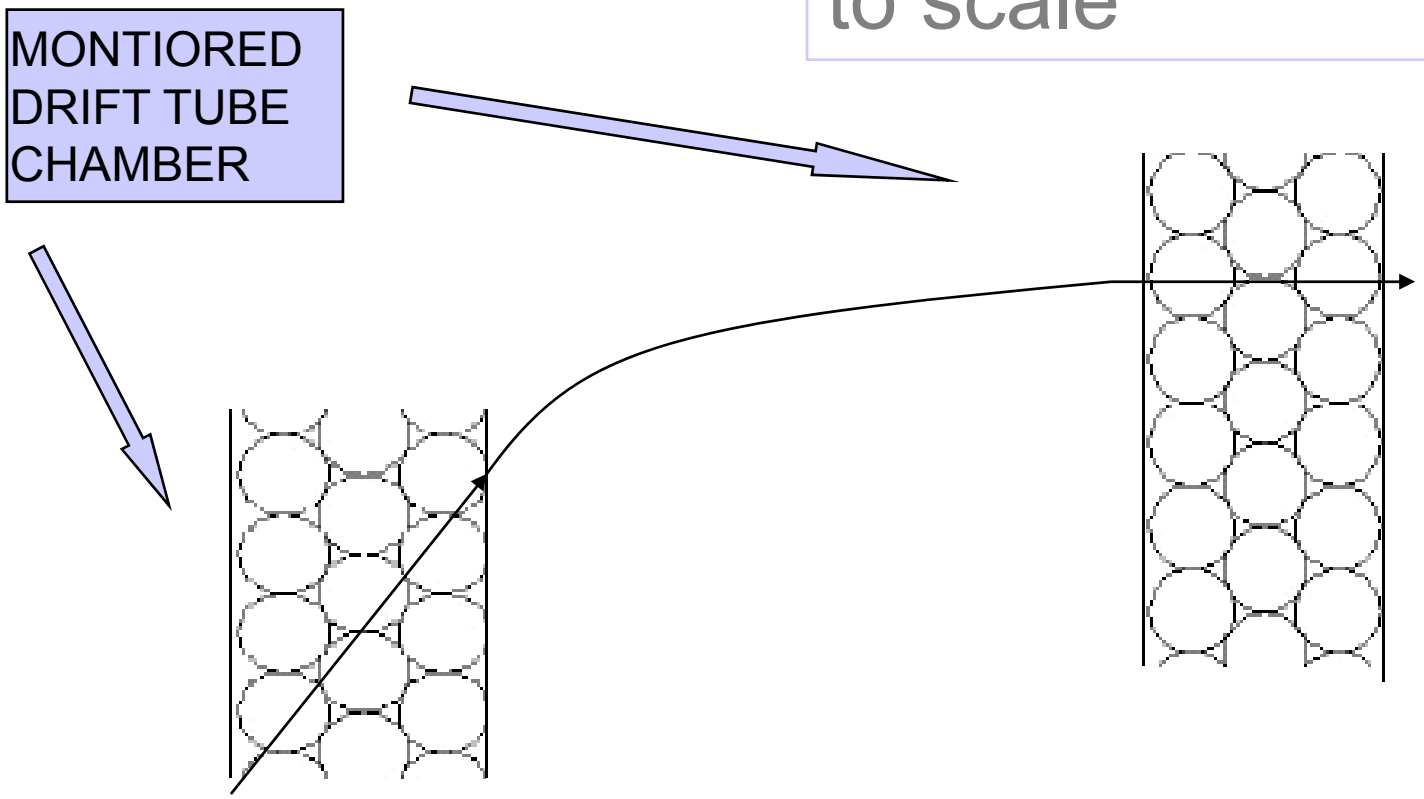


Tracking muons

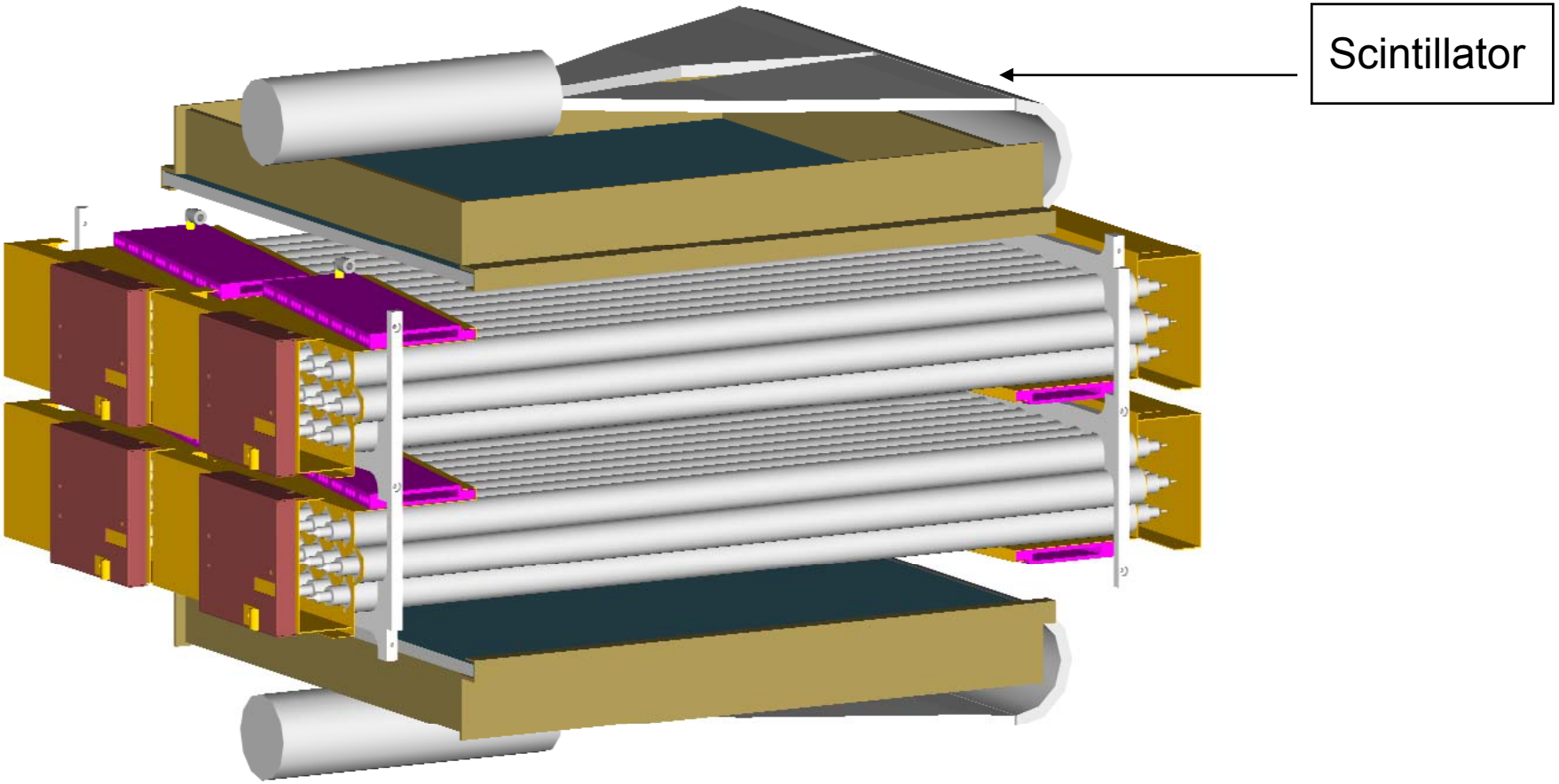


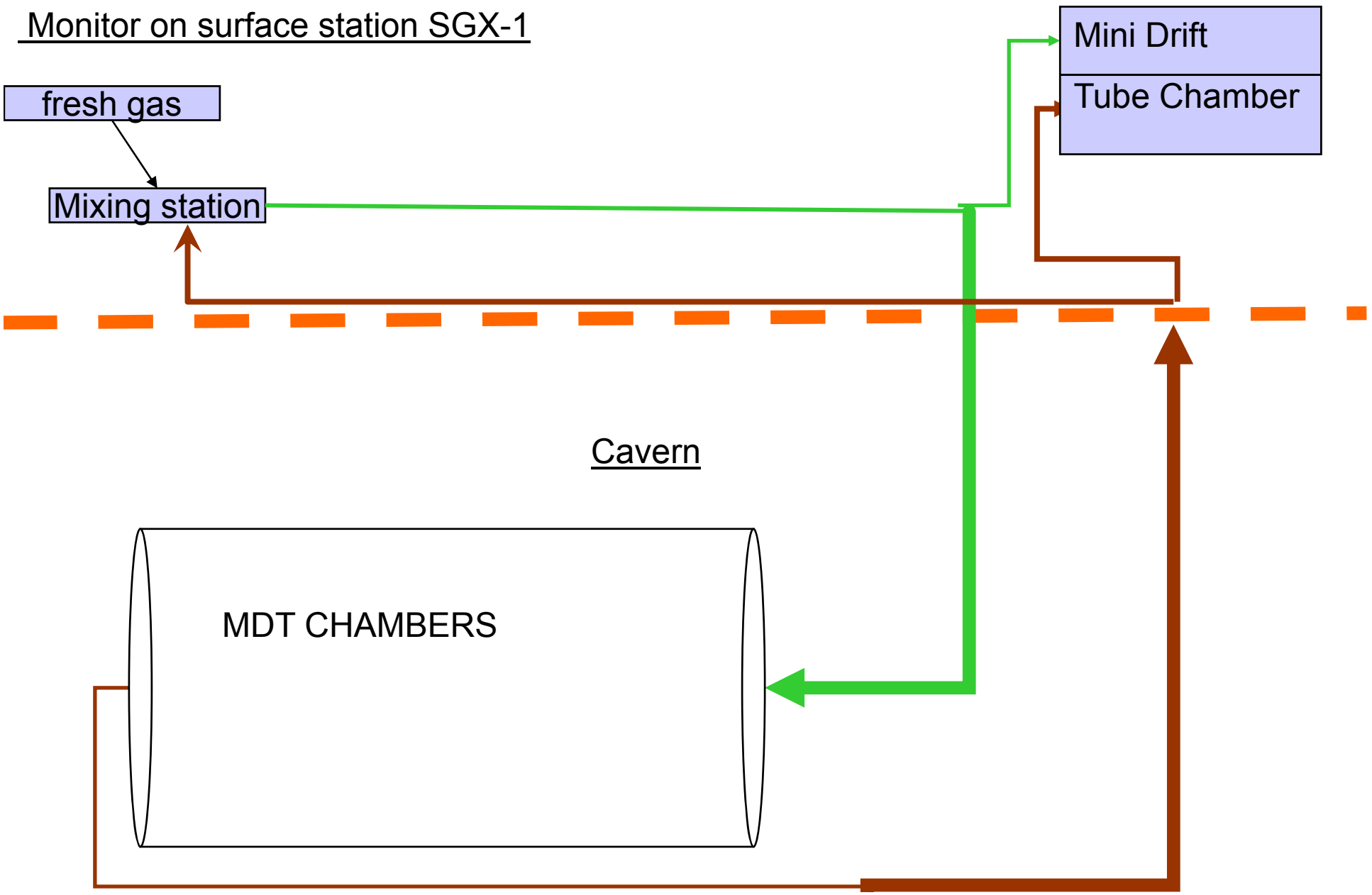
Muon Paths

Drift Tubes NOT drawn to scale



Mini MDT Chamber

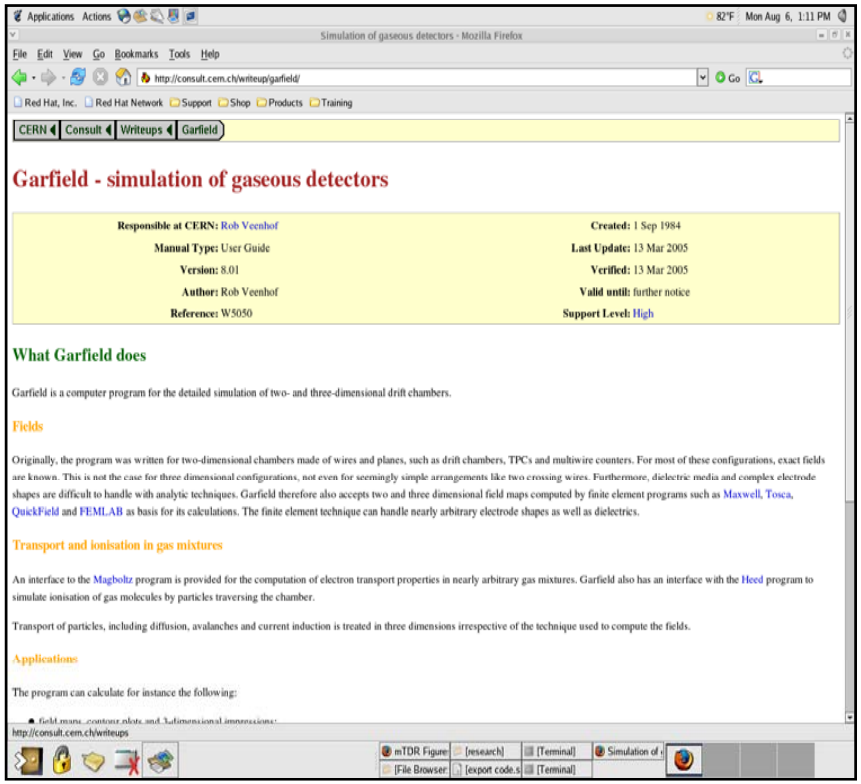



Monitor on surface station SGX-1
fresh gas
Mixing station
Mini Drift
Tube Chamber
Cavern
MDT CHAMBERS

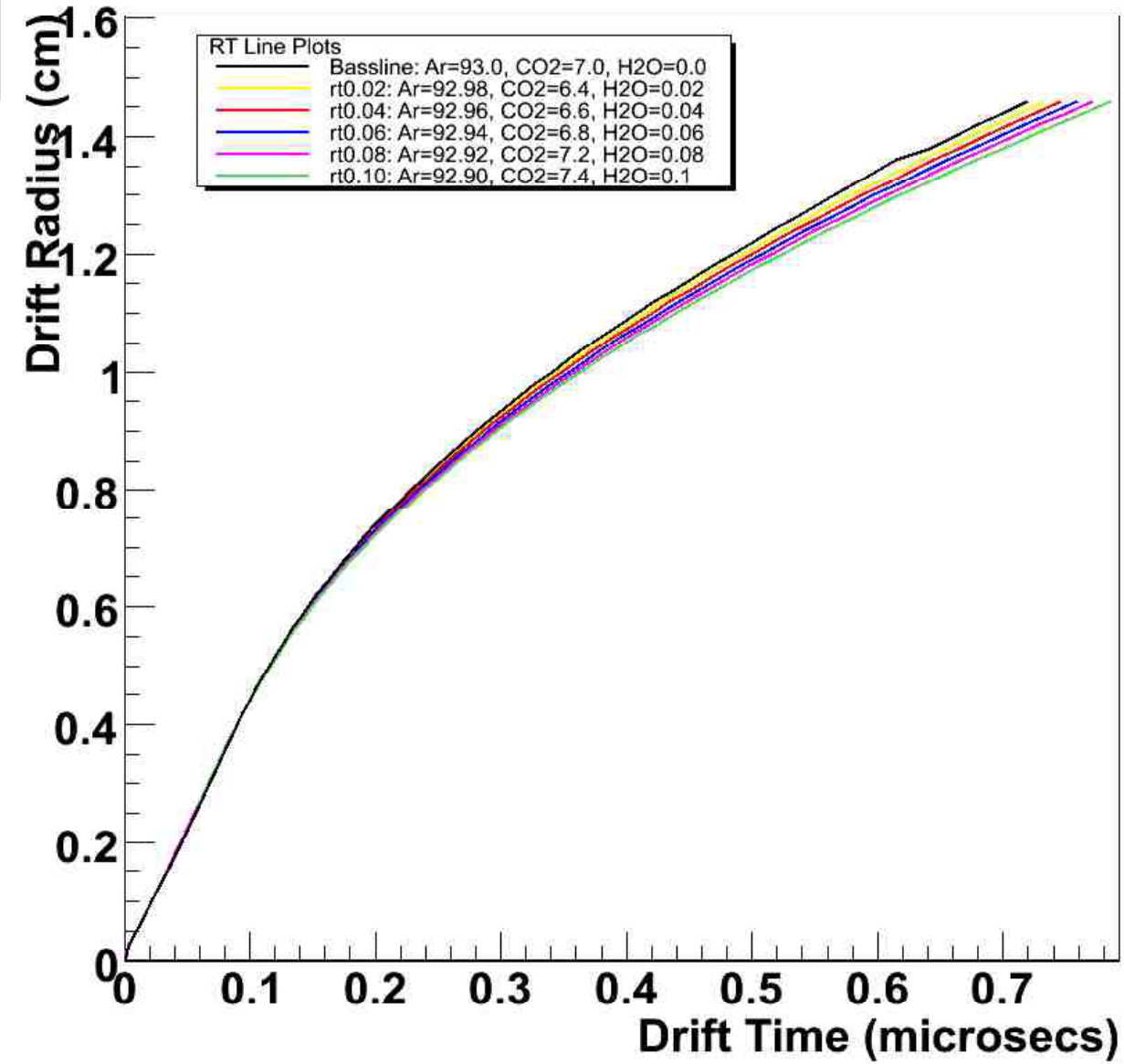
Garfield Simulations and Results

- Garfield: software package created by Rob Veenhof
- Used to

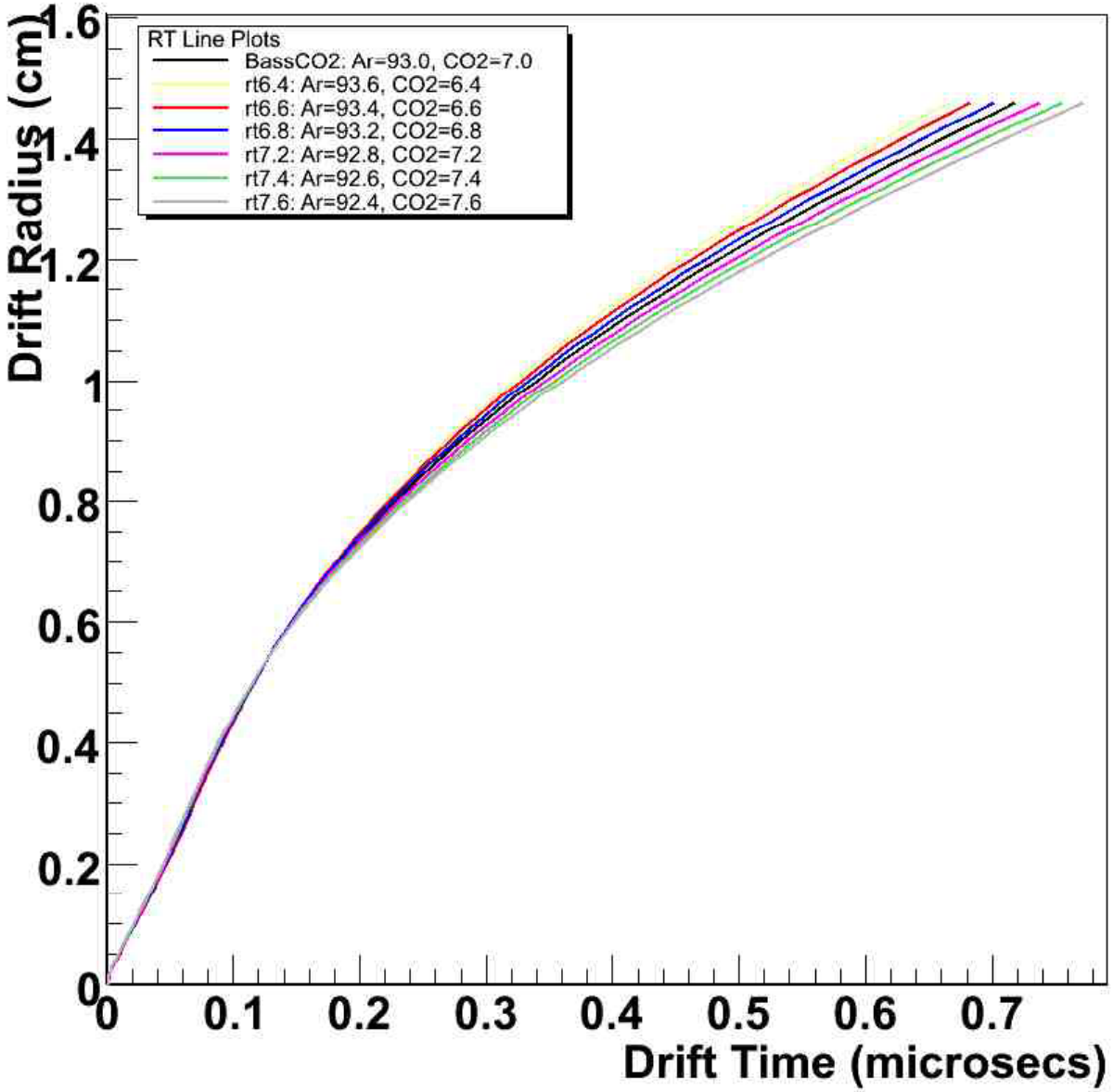
1) model the MDT tube geometry
2) model the gas mixture
3) model the electric field
4) model the gas properties: temperature and pressure



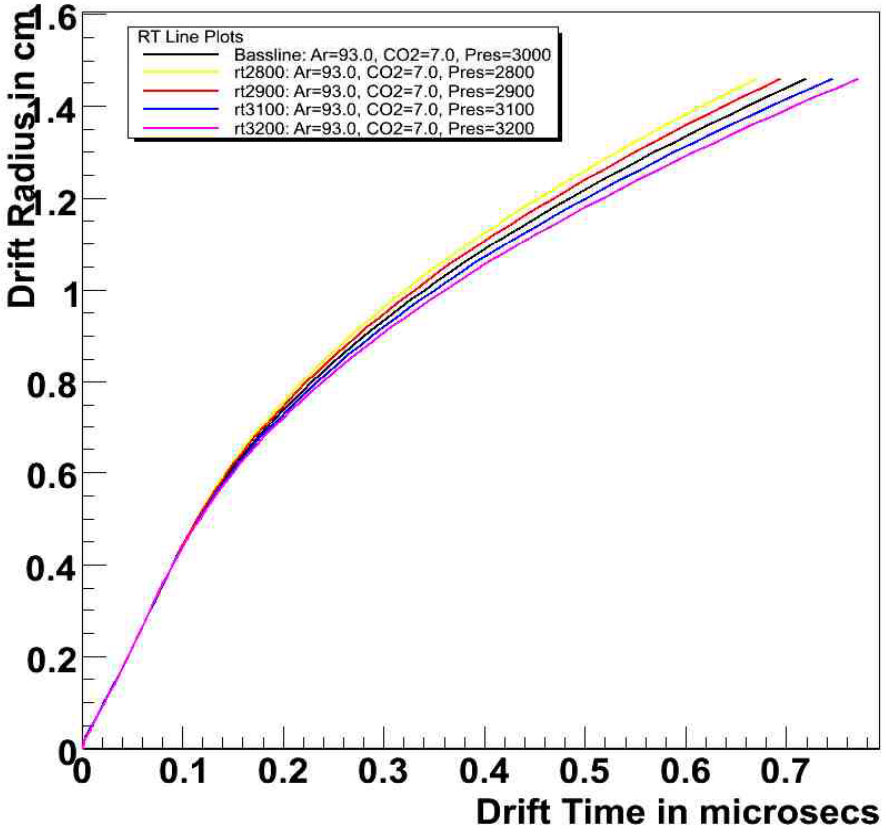
DR vs DT: Water



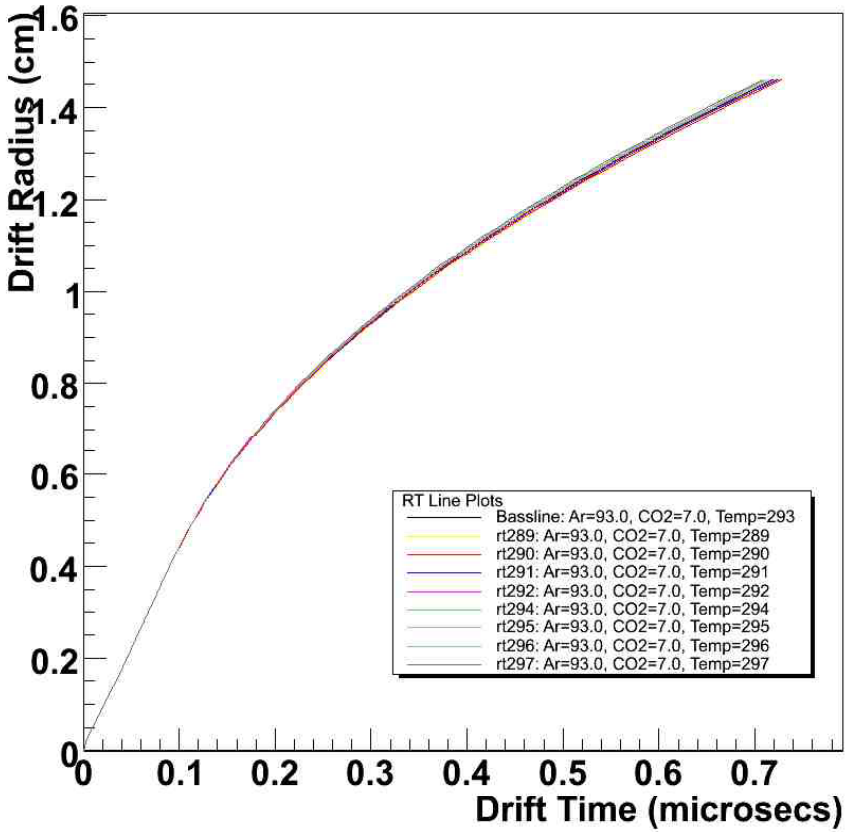
DR vs DT: CO_2

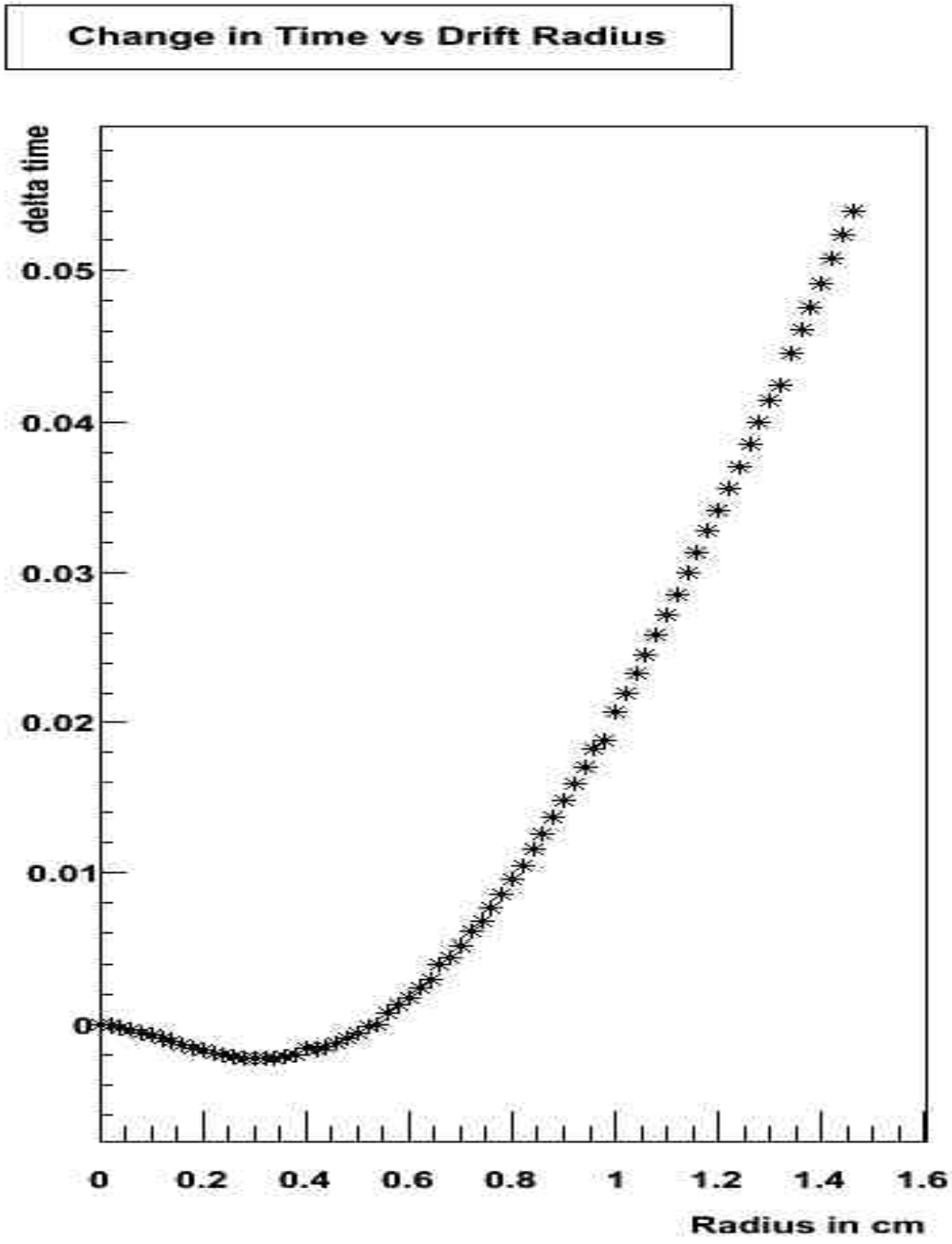

RT Line Plots
BassCO2: Ar=93.0, CO2=7.0
rt6.4: Ar=93.6, CO2=6.4
rt6.6: Ar=93.4, CO2=6.6
rt6.8: Ar=93.2, CO2=6.8
rt7.2: Ar=92.8, CO2=7.2
rt7.4: Ar=92.6, CO2=7.4
rt7.6: Ar=92.4, CO2=7.6
Drift Radius (cm)
Drift Time (microsecs)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
0.1
0.3
0.5
0.7

DR vs DT: Pressure



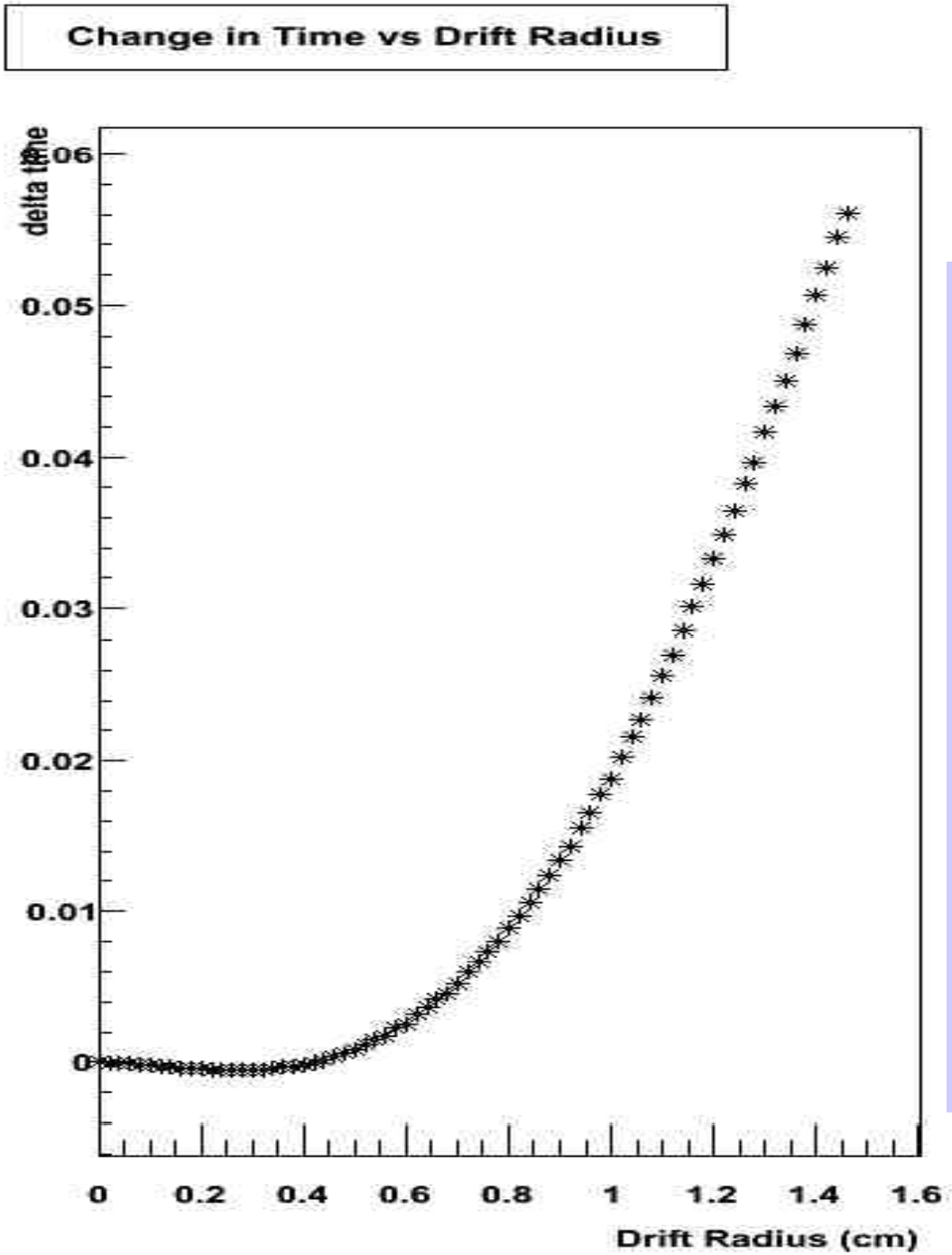
DR vs DT: Temperature





The graph shows the change in drift time vs drift radius when the mixture is at Ar: 92.4%, CO_2: 7.6%.

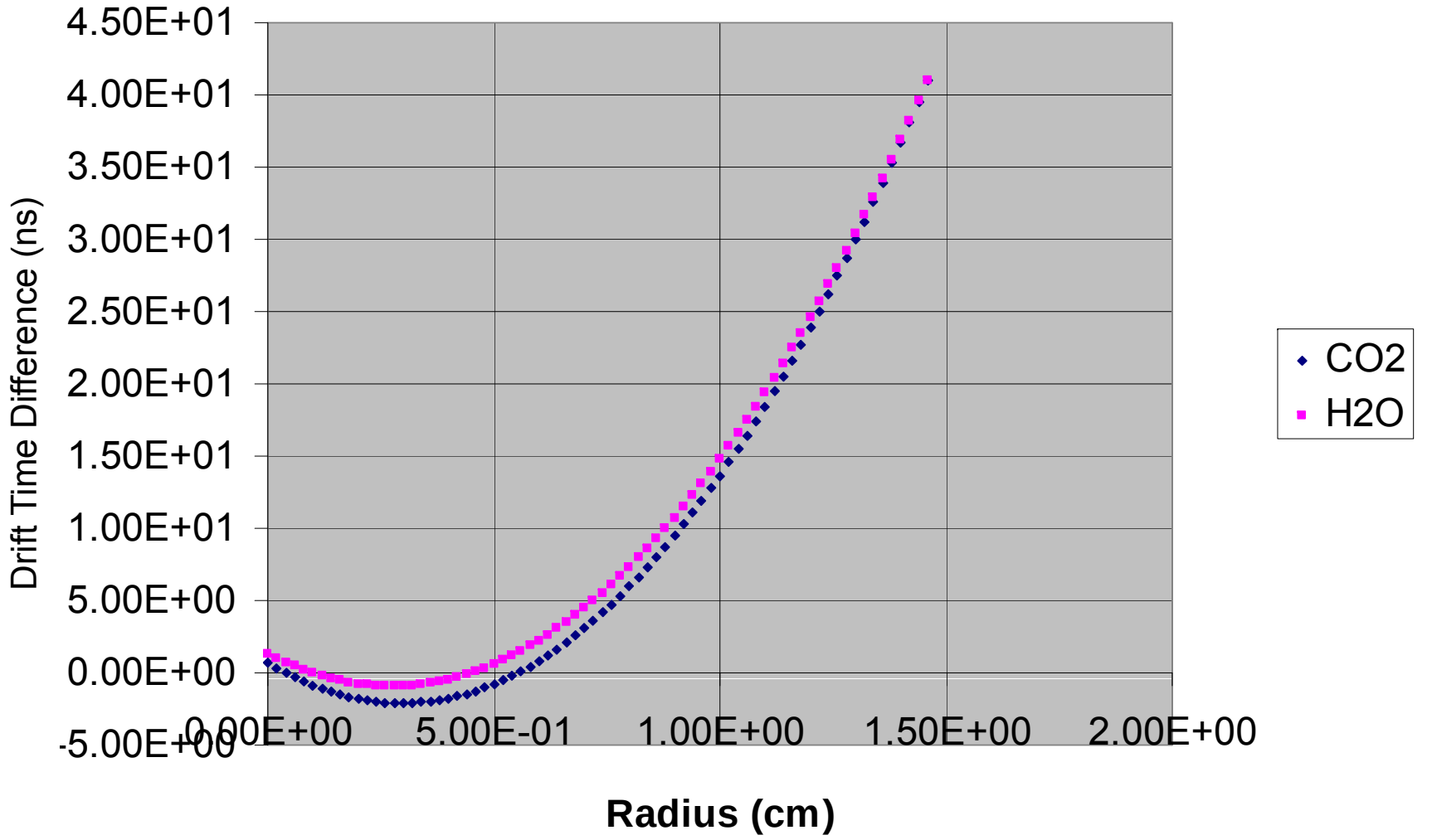
Barely any difference can be seen by the electrons within the first 4 mm from the sense wire. However, after this, there is a steady increase leading to an overall increase of about 0.7 µs for the electrons coming -from the electron wall- to make it to the sense wire.



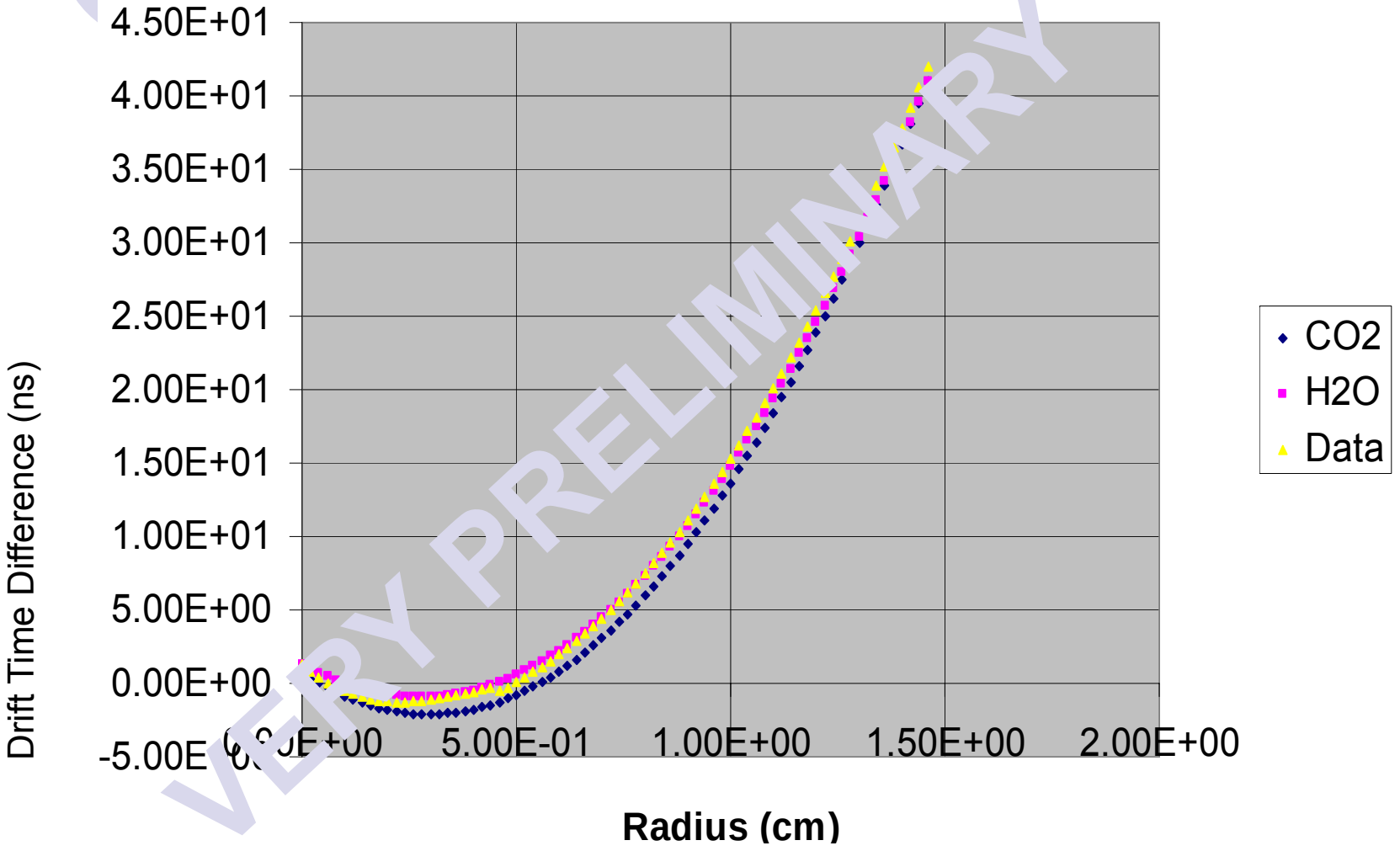
The graph shows the change in time against the radius when the mixture is at Ar: 92.0%, CO_2: 7.0%, H_2O: 0.1%.

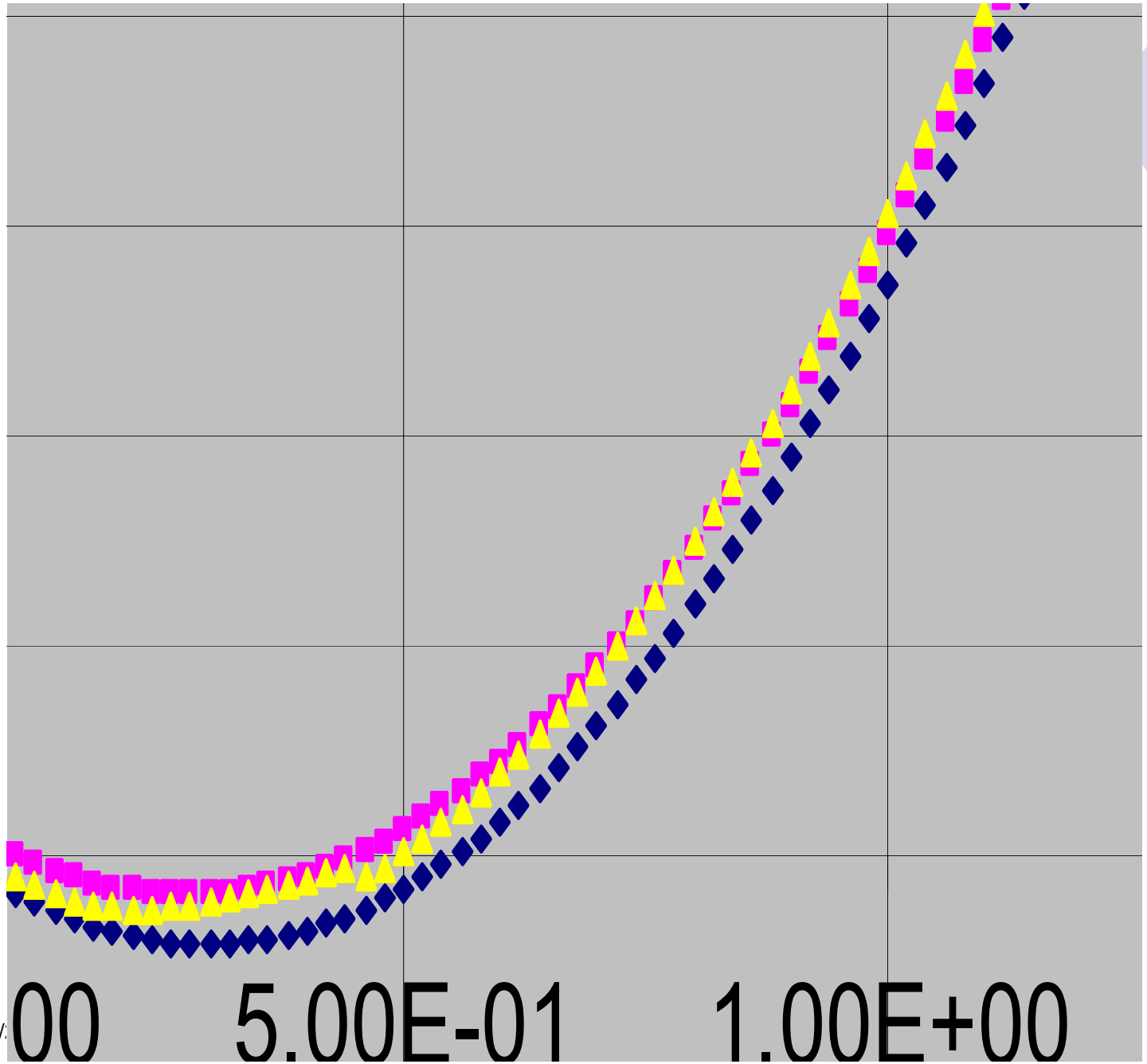
This graph seems to show almost no change in the time taken for electrons to reach the sense wire for the first 0.4 cm.
The difference comes after this as a steady rise is seen which makes a maximum time increase of a little less than 0.06 μs.

Predicted Drift Times



Predicted Drift Times




00
5.00E-01
1.00E+00

Conclusions

- With a lot more work still to be done, it may be possible to determine, with the use of Garfield, whether variation in DR-DT functions are caused by CO2, or by water contamination.

Acknowledgements

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