

# Drift Chambers in Current and Future Collider Experiments

**Magdy Louka**

Universita e INFN di Bari

[Magdy.louka@ba.infn.it](mailto:Magdy.louka@ba.infn.it)

# Outlines

- Gaseous Ionization Detectors
- Drift Chambers (DC)
- DC in current experiments
- DC for Future Collider Experiments
- Geant4 Simulation of multi-wire DC
- summary

# Gaseous Ionization Detectors

Basic concept: The passage of ionizing radiation inside the gas creates Electron-ion pairs causing a read out signal (current).

## Types:

### • *Ionization chambers*

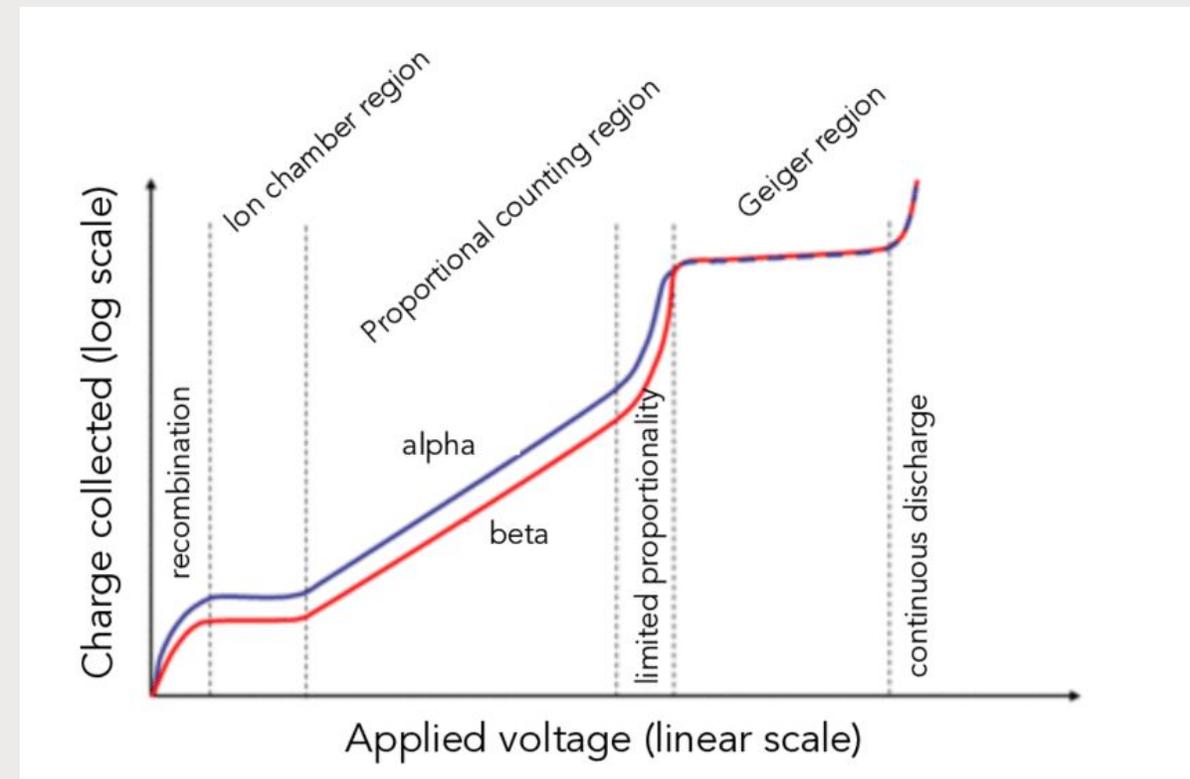
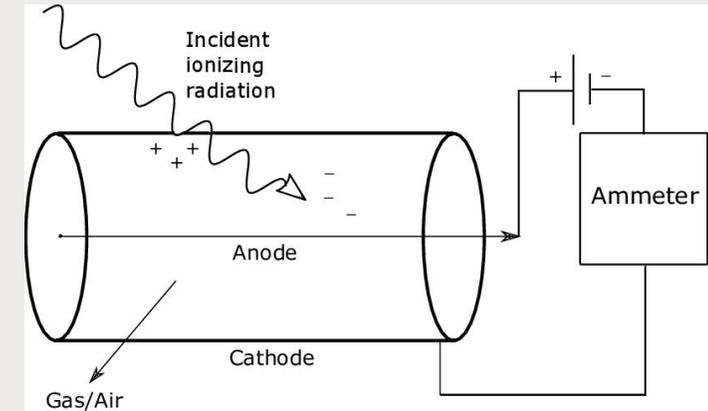
- Operates at a low electric fields
- No gas multiplication (gain).

### • *Proportional counters*

- Operates at a relatively higher voltages
- Each ion pair produces a single avalanche
- Output current is proportional to the energy deposited
- The **wire chamber** is a multi-electrode proportional counter.

### • *Geiger–Müller counters*

- Operates at higher voltages
- Each ion pair produces a single avalanche **plus** second avalanches due to UV emissions.



# Drift Chambers DC

A multi-wire drift chamber is a type of proportional counters that is capable to be used in **tracking** of the ionizing particles and **particle identification**.

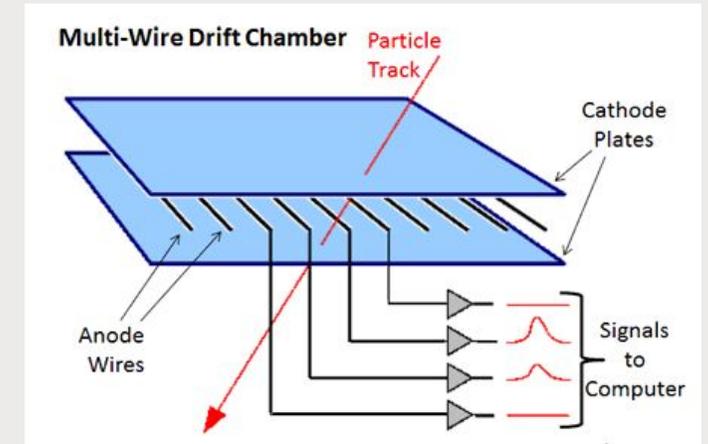
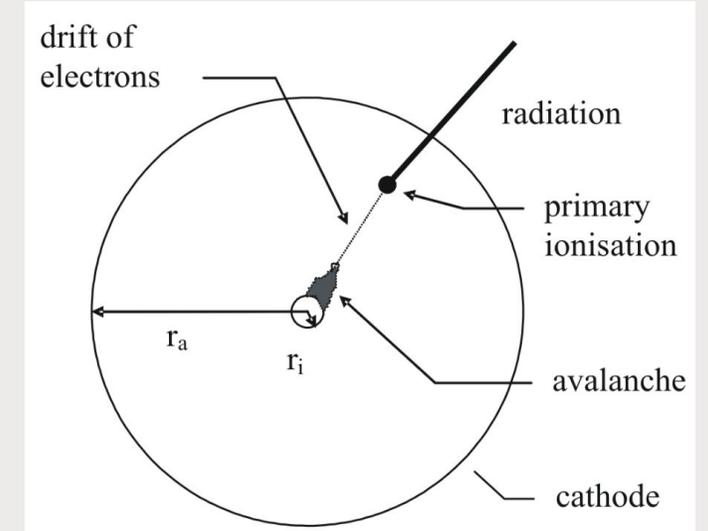
## Principles of operation:

1. Primary ionizations are created along the particle's track
2. The electrons are accelerated towards the anode
3. Secondary ionizations (**clusters**) are produced
4. Induction current (**signal**) is produced in the read out electrode (anode)
5. Discharge takes place

## Two operational modes:

- Constant drift field
- Variable drift field

$$t_{drift} = \int_{track}^{anode} \frac{ds}{v(\vec{x})}$$

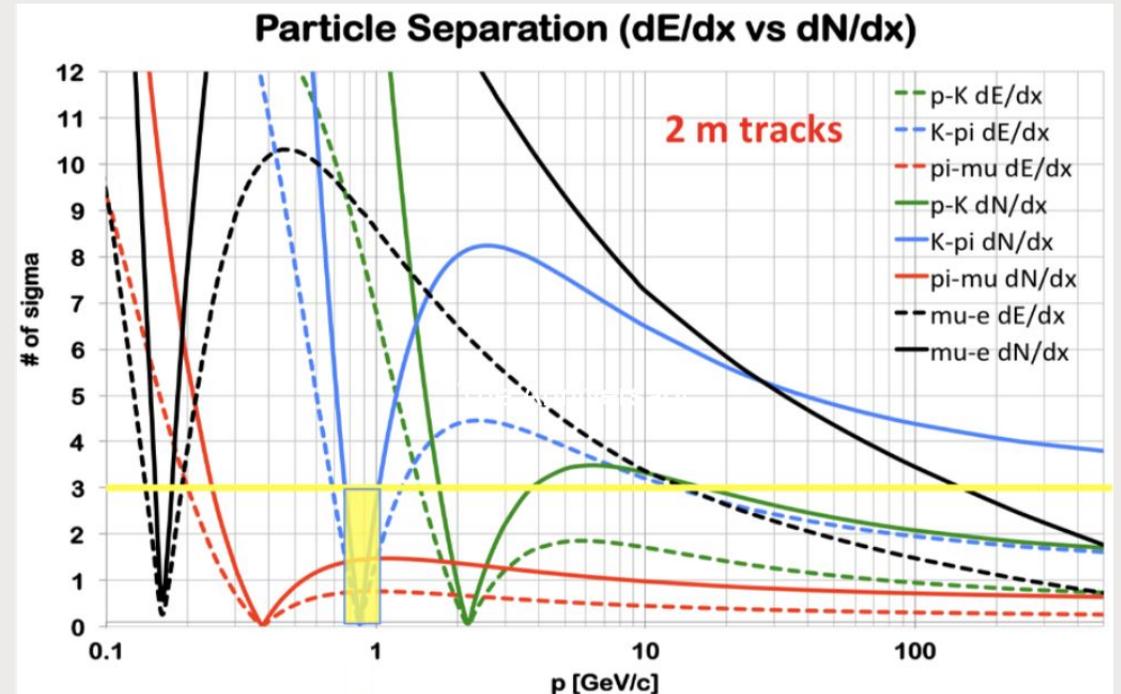
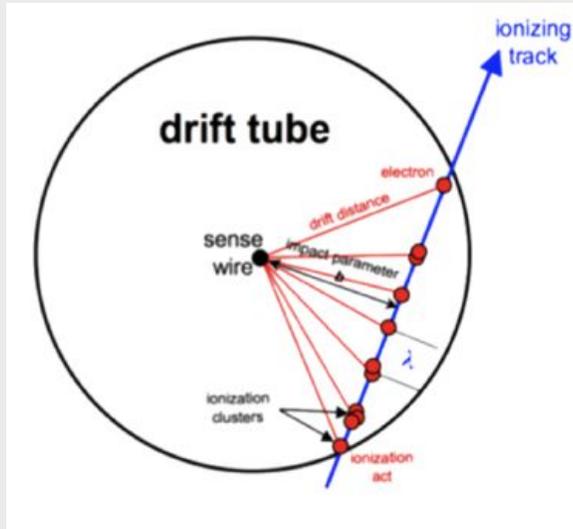


# Drift Chambers DC

A multi-wire drift chamber is a type of proportional counters that is capable to be used in **tracking** of the ionizing particles and **particle identification**.

## Particle identification:

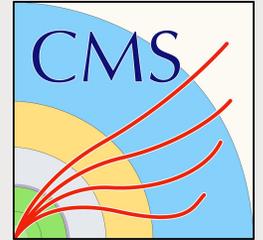
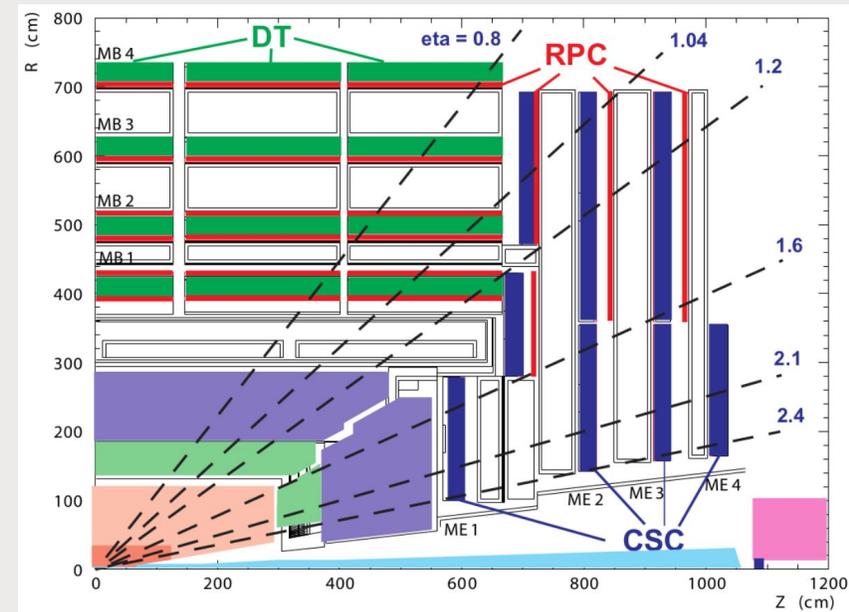
- One of the main tasks of particle detectors is the **particle identification**
- The traditional method of particle identification is by measuring the  $dE/dX$
- Cluster counting: measuring the ionization per unit length  $dN/dX$



# DC in current Experiments

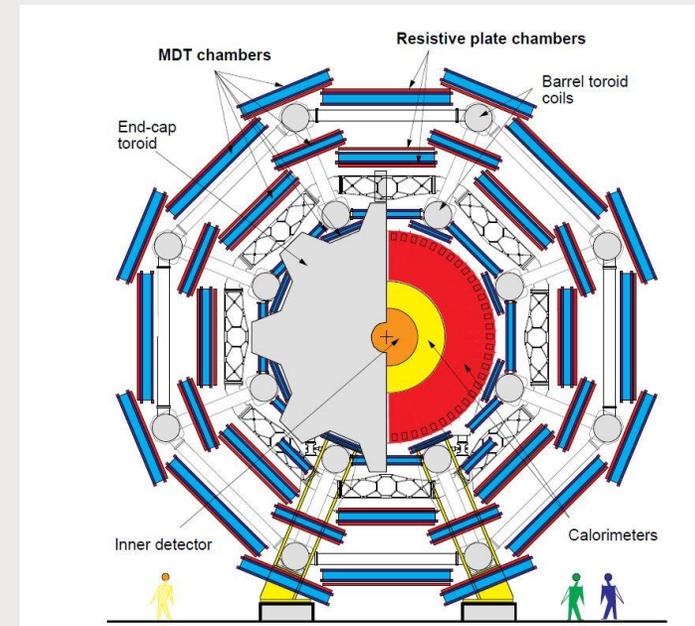
## CMS Muon drift tubes

- Are used in the barrel part of the muon system to identify muons and measure the energy
- 12 aluminum drift chambers are placed on each of MB1, MB2 & MB3
- 14 chambers are placed on MB4



## ATLAS Monitored Drift Chambers

ATLAS uses 1200 drift chambers in the muon detector to measure the Momentum of muons.



# DC for Future Collider Experiments

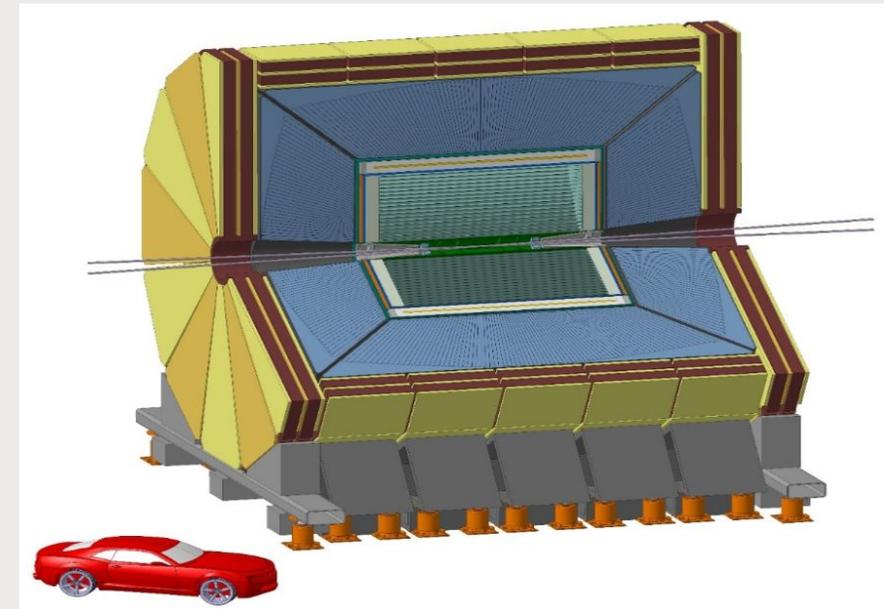
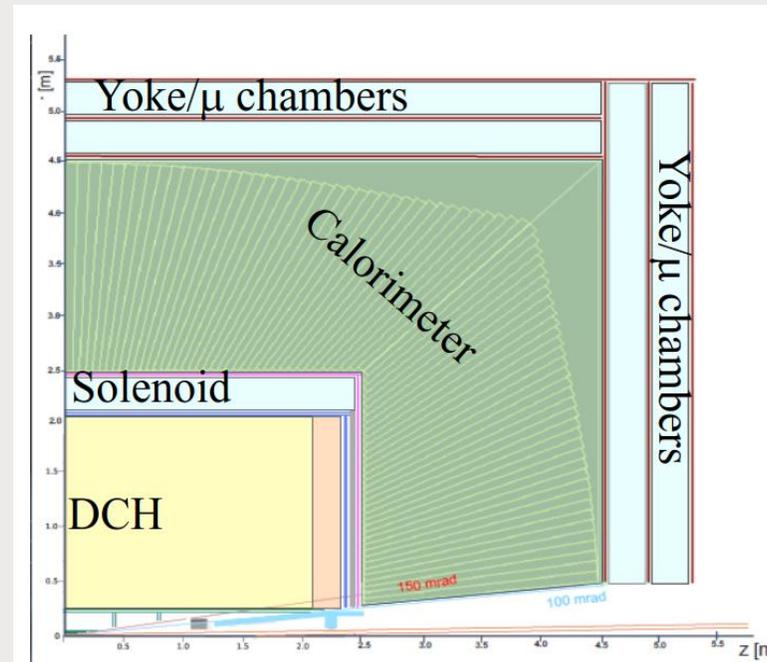
## Innovative Detector for e<sup>+</sup>e<sup>-</sup> Accelerator IDEA

- Silicon pixel vertex detector
- Large-volume extremely-light drift wire chamber (used as tracker & particle identification with cluster counting)
- superconducting solenoid coil
- Preshower detector
- Dual read-out calorimeter
- Muon chambers

FCC ee @ CERN



CEPC @ IHEP-China



# Genat4 Simulation of multi-wire DC

- Multiwire DC of aluminum filled with a mixture of Helium He & Isobutane  $C_4H_{10}$
- Golden sense wires with radius of 20 micro-m
- Radiated by high  $P_T$  muons beam 100 GeV

`class MyDetectorConstruction : public G4VUserDetectorConstruction`

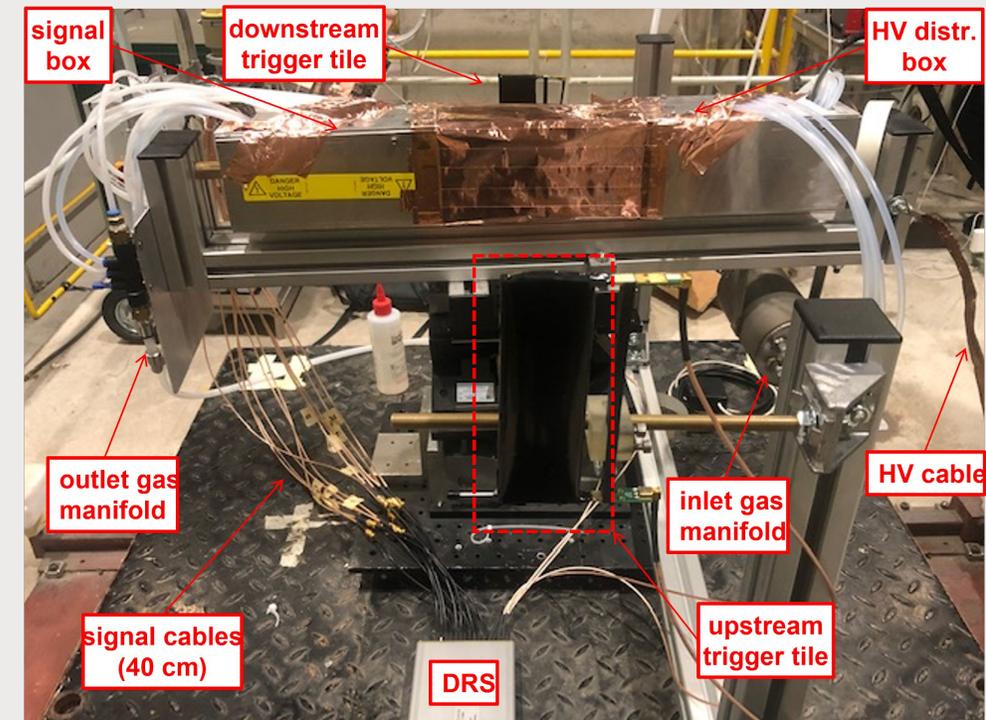
Take cares of: Detector Geometry, Material, Conditions (pressure, temp, ...),  
Electric and Magnetic fields, sensitive part

`class MyPhysicsList : public G4VModularPhysicsList`

Take cares of: particles and physics processes included in the simulation

`class MyGeneratorAction : public G4VUserPrimaryGeneratorAction`

Take cares of: the process of generation of particles (G4ParticleGun)



# Summery

- Gas Detectors in general and multi-wire DCs in particular are widely used in many detectors, and have been suggested for future detectors
- The cluster counting algorithm within the multi-wire DCs will improve the particle identification process at future collider experiments.

# Thanks

Are you Interested in

One of these

*Search for new resonances to HH*

*R&D of Drift Chambers for future collide*

*Search for Dark Matter (WIMPs) @ particle colliders*



You are welcome to contact me for discussions

[Magdy.louka@cern.ch](mailto:Magdy.louka@cern.ch) / [magdy.louka@ba.infn.it](mailto:magdy.louka@ba.infn.it)