

Drift Chambers in Current and Future Collider Experiments

Magdy Louka

Universita e INFN di Bari

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*

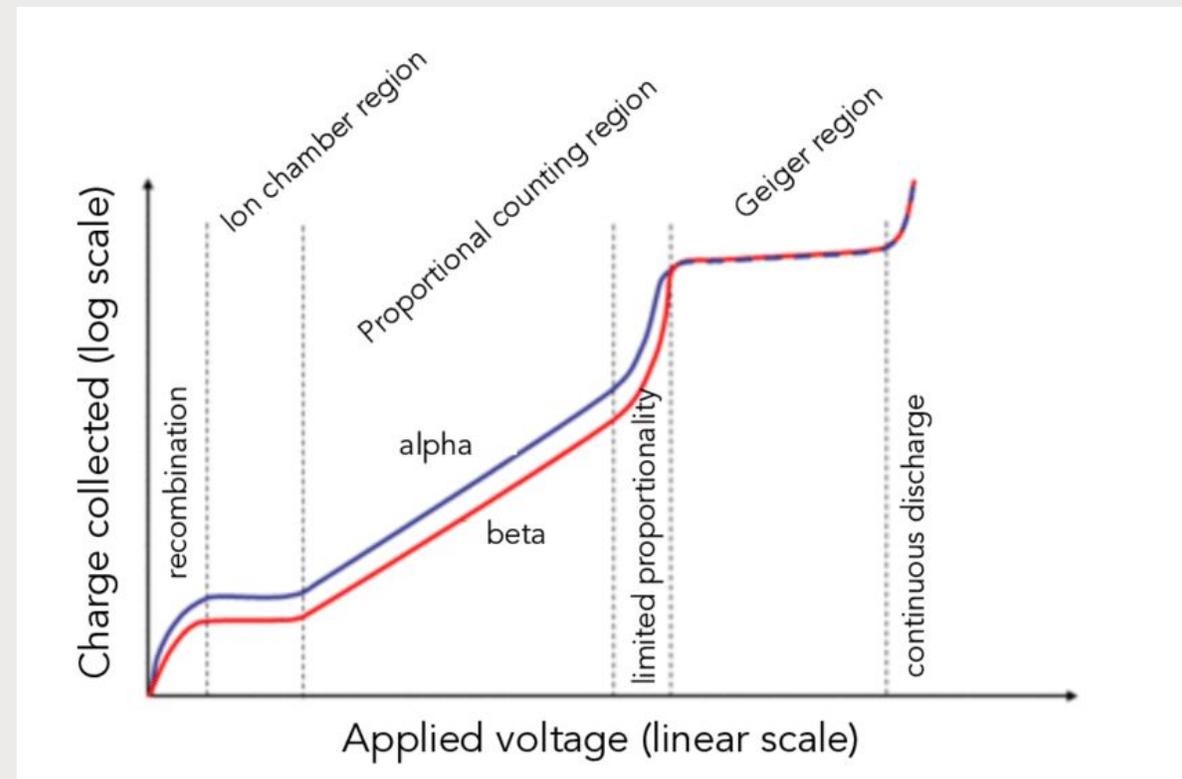
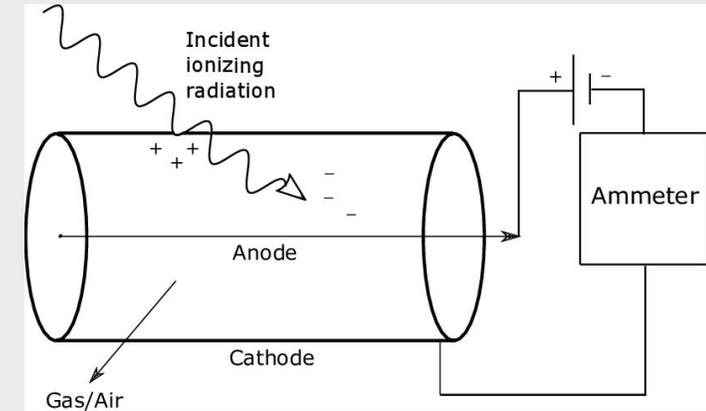
- Operates at a low electric fields
- No gas multiplication (gain).

• *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 counter that is capable to be used in **tracking** of the ionizing particles and **particle identification**.

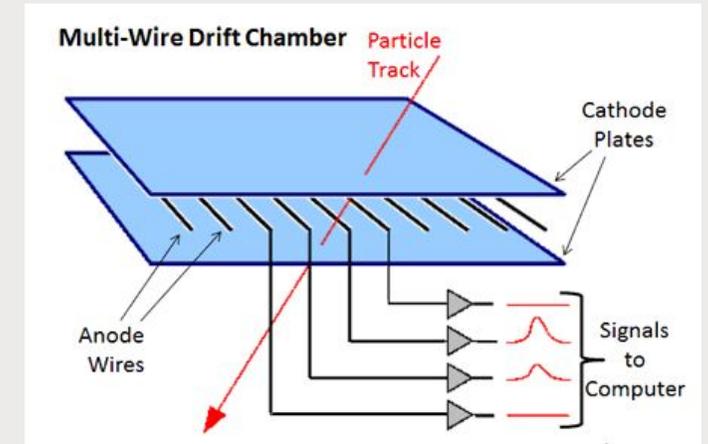
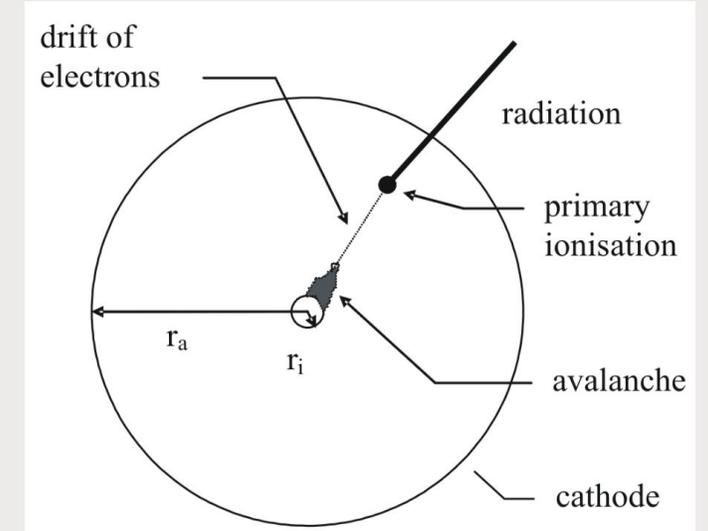
Principles of operation:

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

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

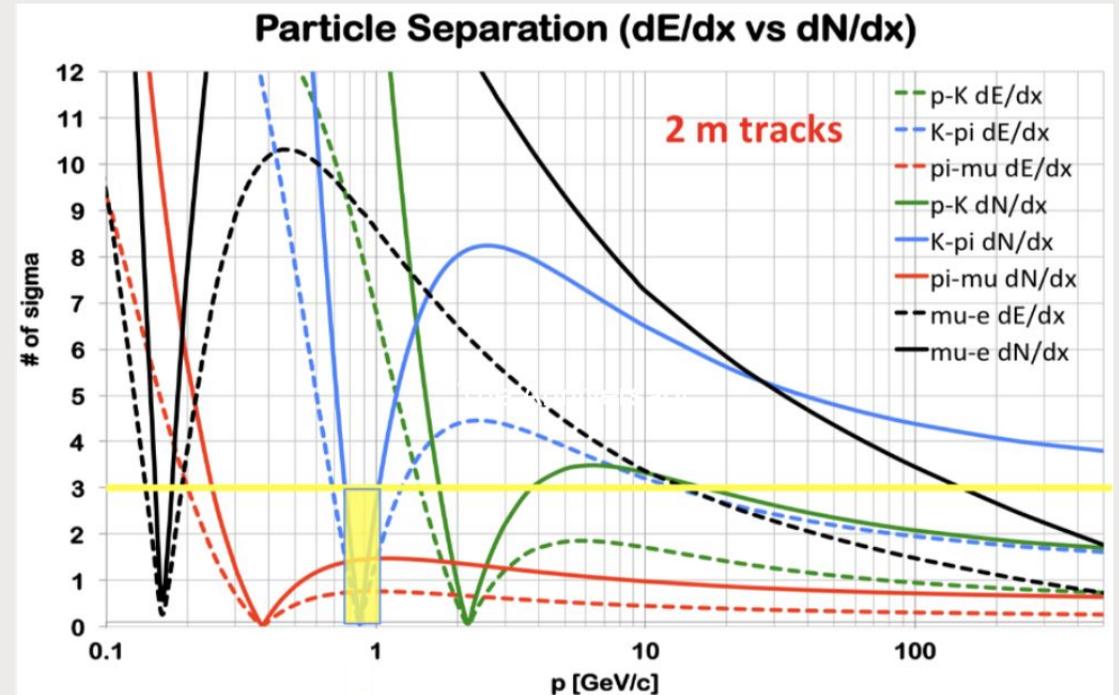
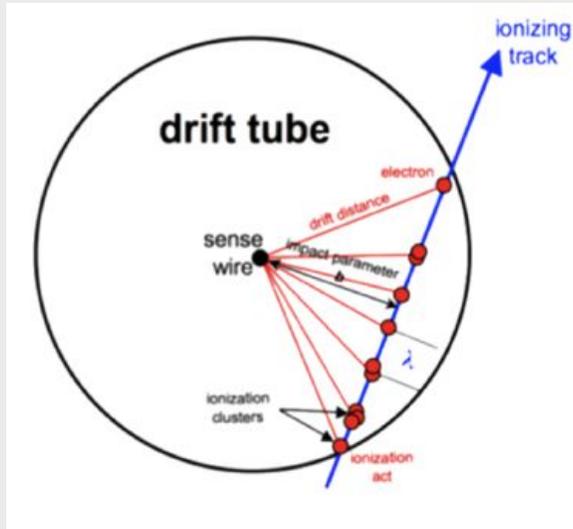


Drift Chambers DC

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:

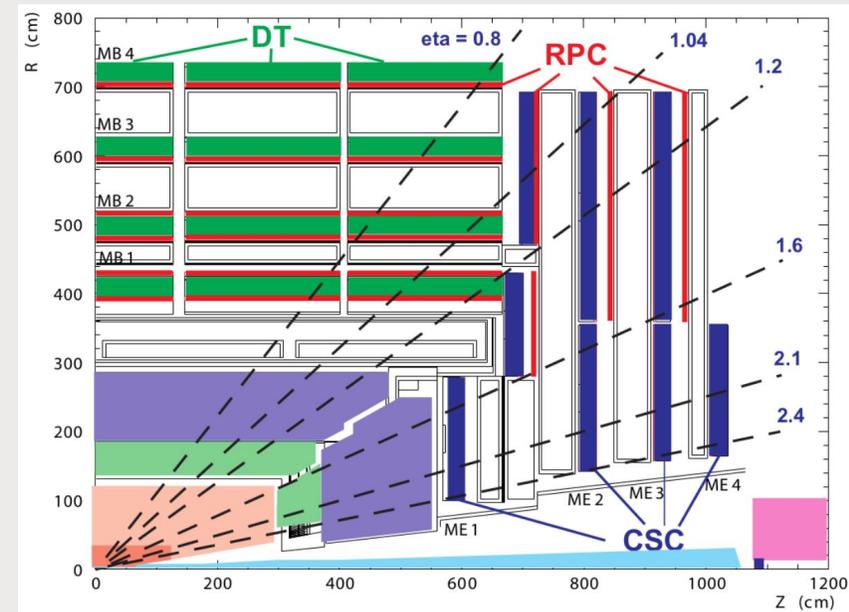
- One of the main tasks of particle detectors is the **particle identification**
- The traditional method of particle identification is by measuring the dE/dX
- Cluster counting: measuring the ionization per unit length dN/dX



DC in current Experiments

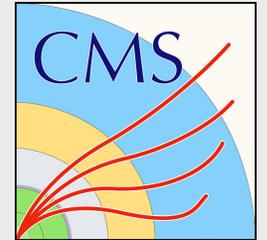
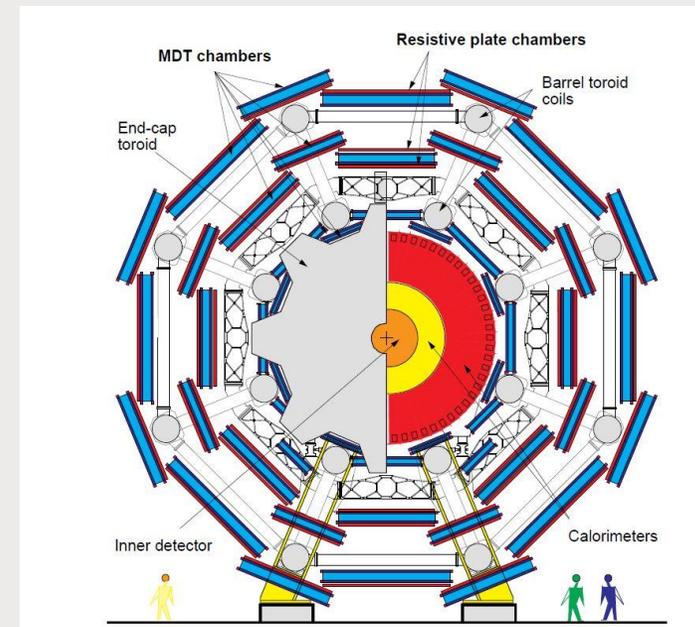
CMS Muon drift tubes

- 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

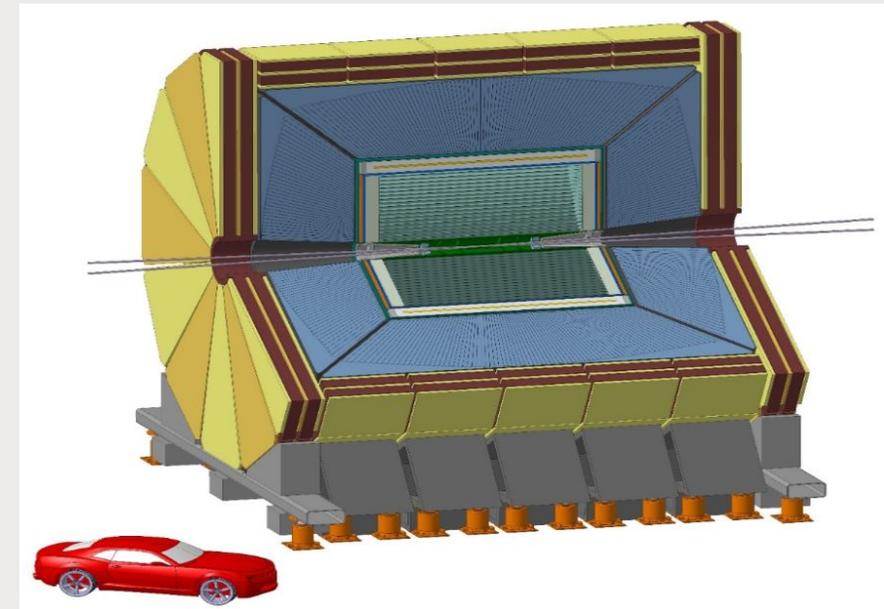
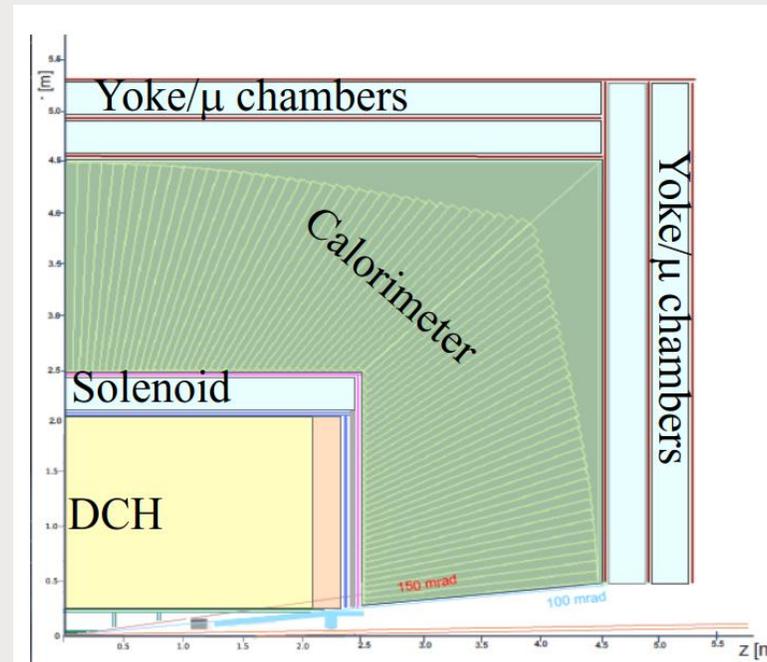
Innovative Detector for e⁺e⁻ Accelerator IDEA

- 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`

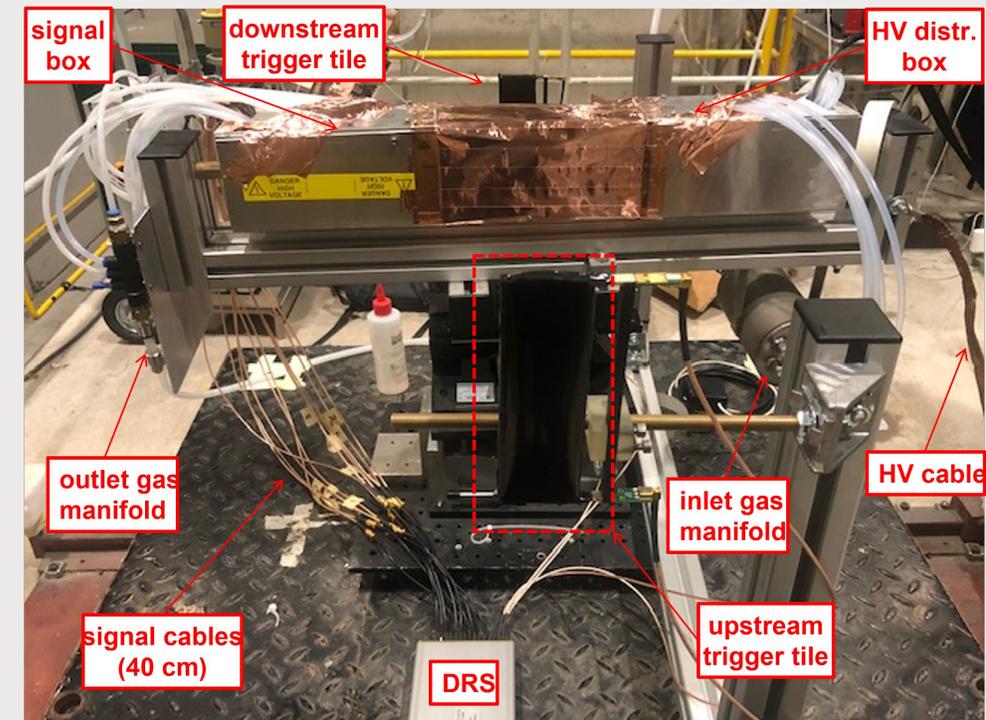
Take cares of: Detector Geometry, Material, Conditions (pressure, temp, ...),
Electric and Magnetic fields, sensitive part

`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 / magdy.louka@ba.infn.it