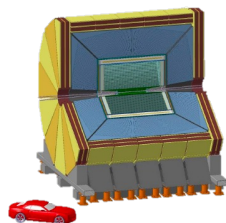# Particle identification with the cluster counting technique for the IDEA drift chamber
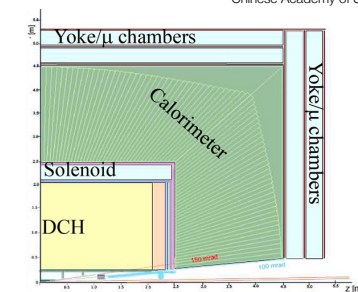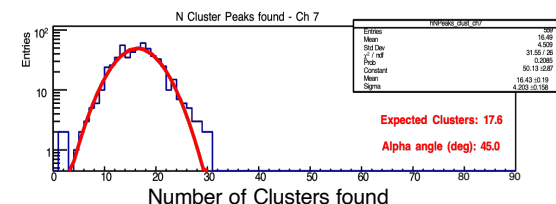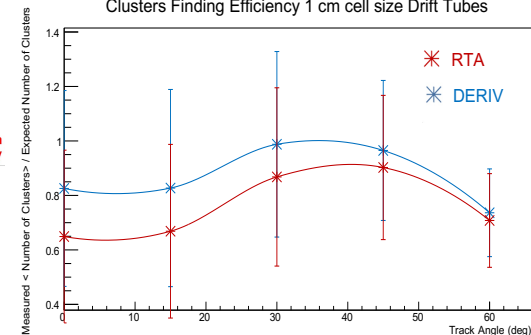
Université Catholique de Louvain, Belgium
Istituto Nazionale di Fisica Nucleare, Pisa, Italy
Istituto Nazionale di Fisica Nucleare, Lecce, Italy
Università del Salento, Italy
Università degli Studi di Bari »Aldo Moro«, Italy
Istituto Nazionale di Fisica Nucleare, Bari, Italy
Politecnico di Bari
Florida State University
Chinese Academy of Sciences

The IDEA (Innovative Detector for an Electron-positron Accelerator) drift chamber is supposed to provide an excellent particle identification (PID) by exploiting the application of the electron cluster counting (CC) technique. The effectiveness of the CC algorithms' usage for PID has been demostrated by theoretical results.
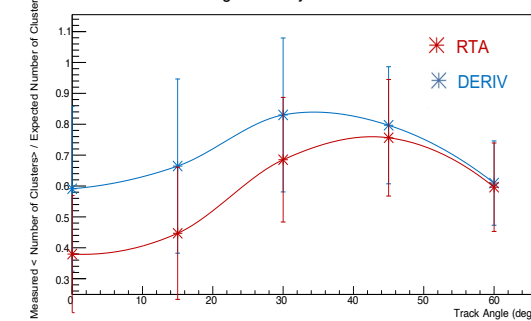
- A simulation of the ionization clusters generation has been done by developing an algorithm which can use the energy deposit information provided by Geant4 toolkit to reproduce the clusters number distribution (Poissonian) and the cluster size distribution predicted by Garfield++. The analytical and full simulation results agree reasonably and confirm that the cluster counting technique dN/dx allows to reach a resolution 2 times better than the traditional dE/dx method which has not seen progress since 40 years.
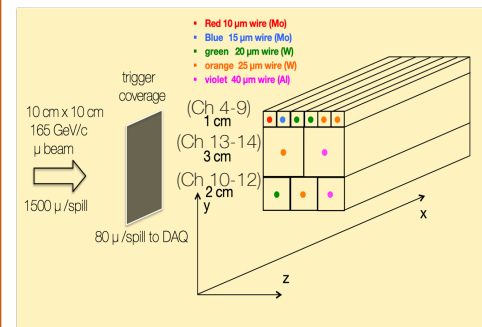
- A beam test has been performed at H8 CERN:
  - to select the most efficient cluster counting algorithms, the Running Template Algorithm (RTA) and the Derivative Algorithm (DERIV), many others have been discarded
  - to define the limiting effects for a fully efficient cluster counting (space charge effect + attachment + recombination)
  - to demonstrate the ability to count the number of electron clusters released by an ionizing track at a fixed $\beta\gamma$ as a function of the operative parameters (track angle, HV, gas mixtures)
  - to define a set of parameters optimizing the cluster counting efficiency, to undergo a new test with the same setup in a muon beam of momenta in the relativistic rise range, in order to define the PID capabilities of the cluster counting approach over the full range of interest for all future lepton machines.

Particle Separation (dE/dx vs dN/dx)

dN/dx
dE/dx
e/μ
μ/π
K/π
K/p

4.3% dE/dx resolution
80% cluster counting efficiency

#σ K/π separation with TOF over 2 m
3σ
GeV

Clusters Finding Efficiency 1 cm cell size Drift Tubes
RTA
DERIV

N Cluster Peaks found - Ch 7
Expected Clusters: 17.6
Alpha angle (deg): 45.0

Clusters Finding Efficiency 2 cm cell size Drift Tubes
RTA
DERIV

Red 10 μm wire (Mo)
Blue 15 μm wire (Mo)
green 20 μm wire (W)
orange 25 μm wire (W)
violet 40 μm wire (Al)

trigger coverage
10 cm x 10 cm
165 GeV/c
μ beam
1500 μ /spill
80 μ /spill to DAQ
(Ch 4-9) 1 cm
(Ch 13-14) 3 cm
(Ch 10-12) 2 cm

2 cm drift tube Track angle 45°
Clusters
Electrons