A proposal of a He based Drift Chamber as central tracker for the IDEA detector concept for a future e^+e^- collider

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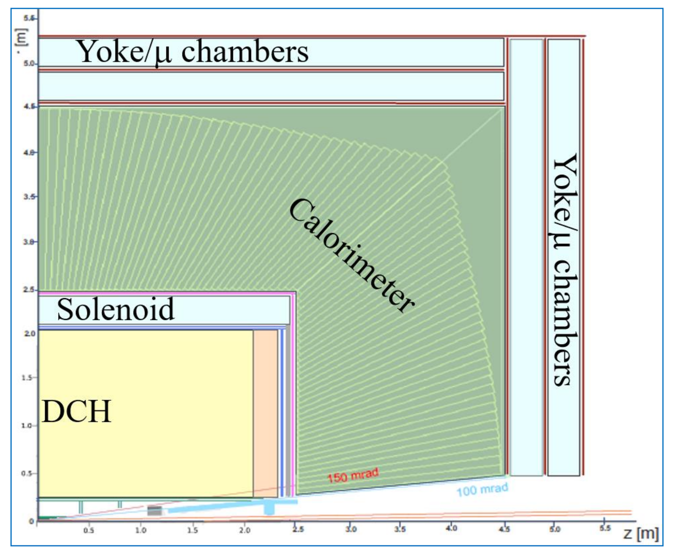
ABSTRACT

The IDEA detector concept for a future e^+e^- collider adopts an ultra-low mass drift chamber as *the central tracking system*. It is a He based, 4 m long and 4 m diameter, fully stereo drift chamber with a total material budget of ~ 0.016 X_0 in the barrel part and ~ 0.05 X_0 in the end-caps. It will be instrumented with readout electronics implementing the Cluster Counting/Timing techniques, allowing for a larger than 3 sigma π/K separation over most of the momentum range of interest.

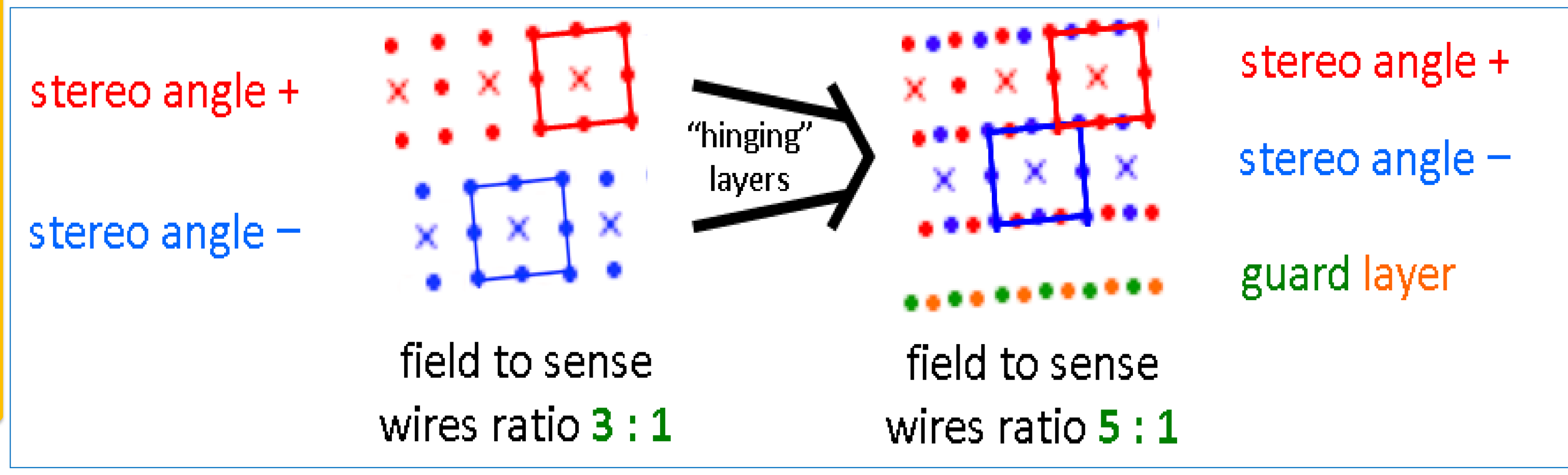
The IDEA detector

The IDEA detector is a general purpose detector which consists of a silicon pixel vertex detector, a large-volume extremely light drift chamber surrounded by a layer of silicon micro-strip detectors, a thin, low-mass superconducting solenoid coil, a µRwell pre-shower detector, a dual-readout calorimeter and a µRwell muon system inside the magnet return yoke [1].



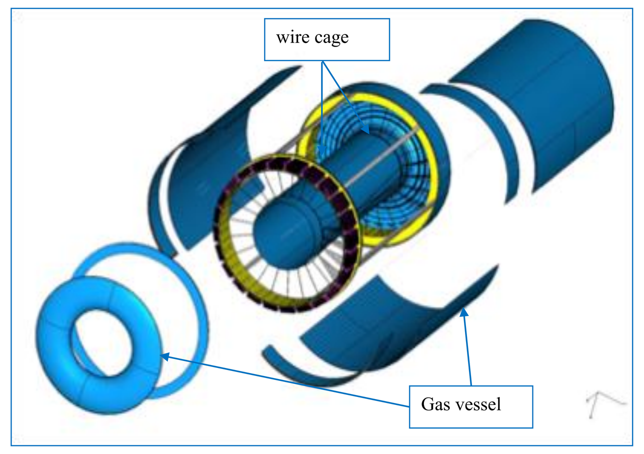
The drift chamber

- Unique-volume
- High granularity
- Fully stereo
- Low mass
- Co-axial with the 2 T solenoid field
- Rin = 0.30 m
- $Rout$ = 2 m
- L = 4 m
- 112 co-axial layers, at alternating-sign stereo angles, in 24 azimuthal sectors



The wire net created by the combination of + and – orientation generates a more uniform equipotential surface. The high wire number requires a new wiring procedure and a feed-through-less wiring system. A novel wiring procedure developed and used for the construction of the ultra-light MEG-II drift chamber can be used.

The novel approach for the construction technique of high granularity and high transparency drift chambers



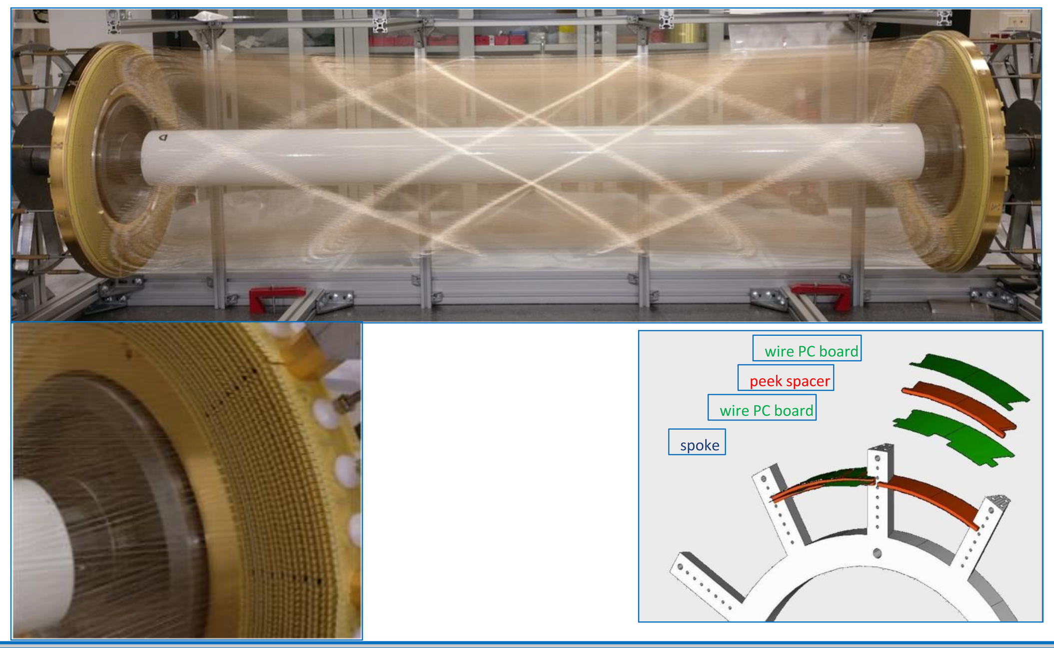
GOALS

- **Gas containment – wire support functions separation**

The wires are anchored to a self-sustained light structure (wire cage), which is surrounded by a thin skin of a suitable profile (gas vessel) to compensate for the gas differential pressure with respect to the outside.

- **Feed-through-less wiring**

This procedure allows to increase chamber granularity and field/sense wire ratio to reduce the multiple scattering and the total tension on the end plates due to wires by using thinner wires.



MEG-II

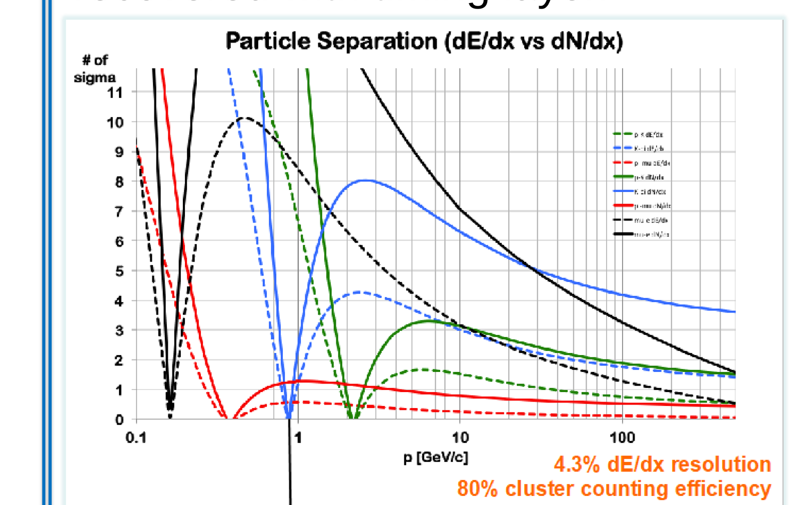
- End-plates numerically machined from **solid Aluminum** (mechanical support only);
- Field, sense and guard wires placed azimuthally by a Wiring Robot with **better than one wire diameter accuracy**;
- wire PC board layers (green) radially spaced by numerically machined peek spacers (red) (***accuracy < 20 µm***);
- wire tension defined by homogeneous winding and wire elongation (**accuracy on wire tension <0.5g**);
- drift chamber assembly done on a 3D digital measuring table;
- build up of layers continuously checked and corrected during assembly;
- end-plate gas sealing done with glue [3].

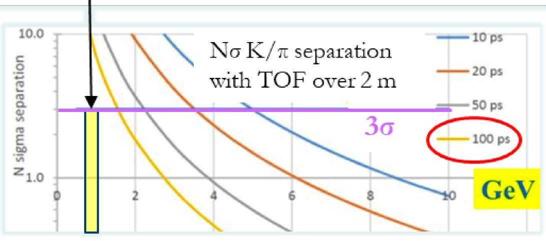
Cluster Counting/Timing and P.Id. expected performance

Counting the number of ionization acts per unit length (dN/dx) is possible to identify the particles (P.Id.) with a better resolution than dE/dx method.

Analytical calculations

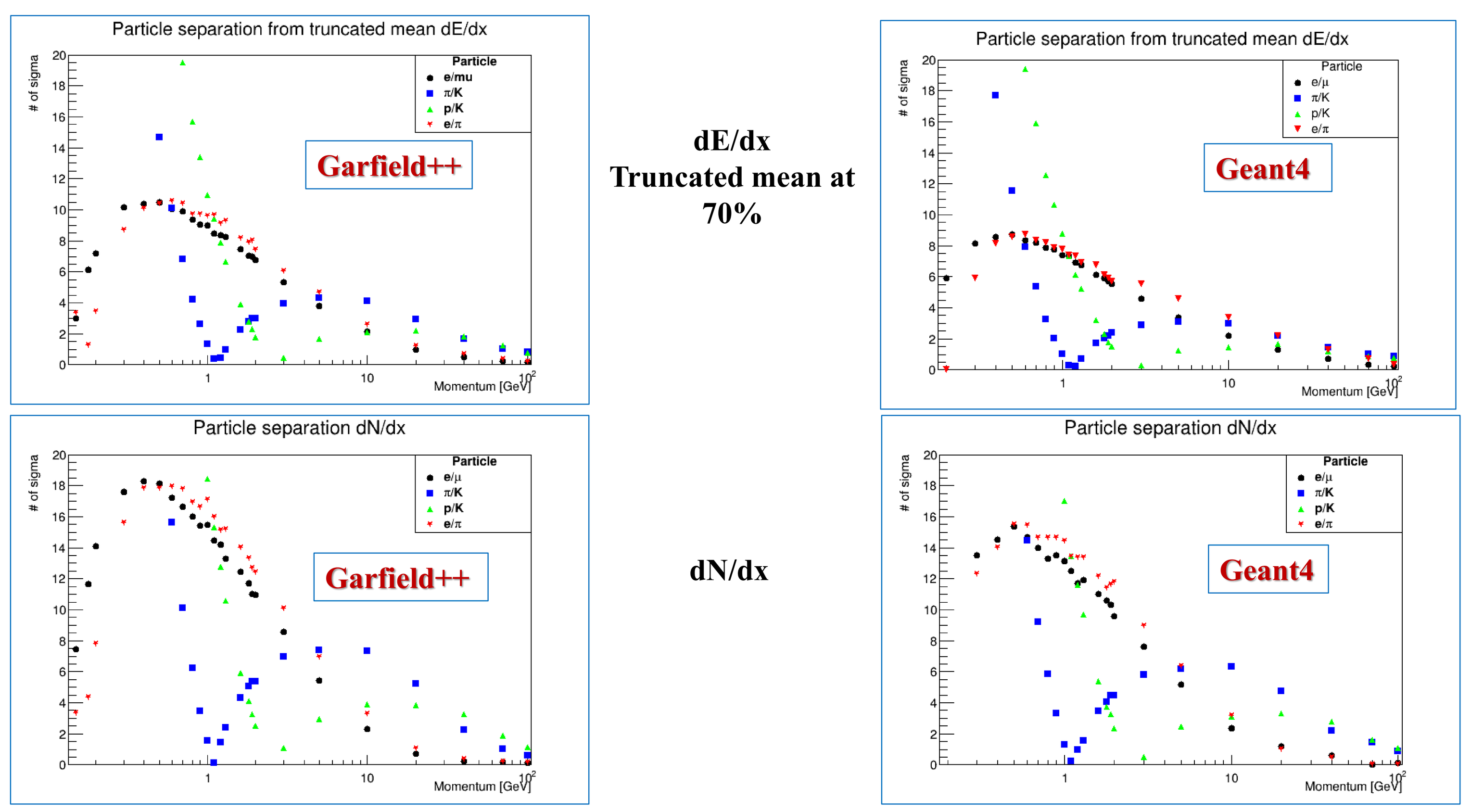
Expected excellent K/π separation over the entire range except 0.85<p<1.05 GeV (blue lines), which could be recovered with timing layer.



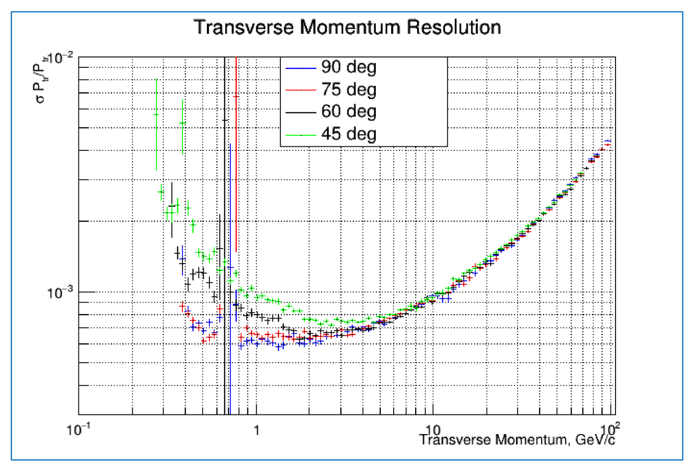


Simulation results

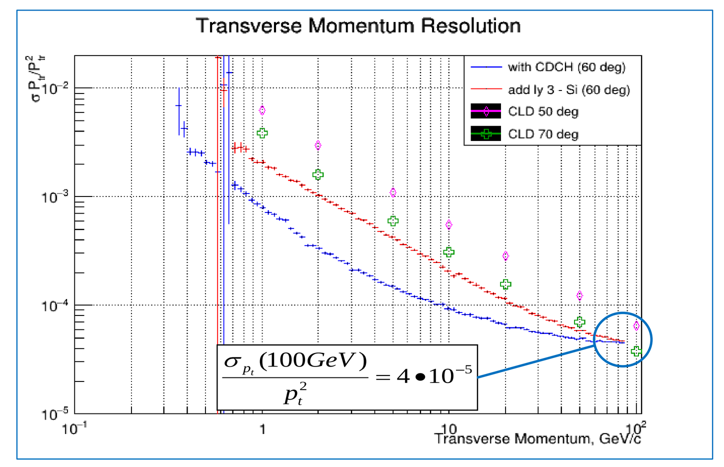
An algorithm which, using Garfield++ simulations, reproduces number of clusters and cluster size distribution in Geant4 was implemented [4]. **dN/dx improves particle separation capabilities of a factor of 2.**



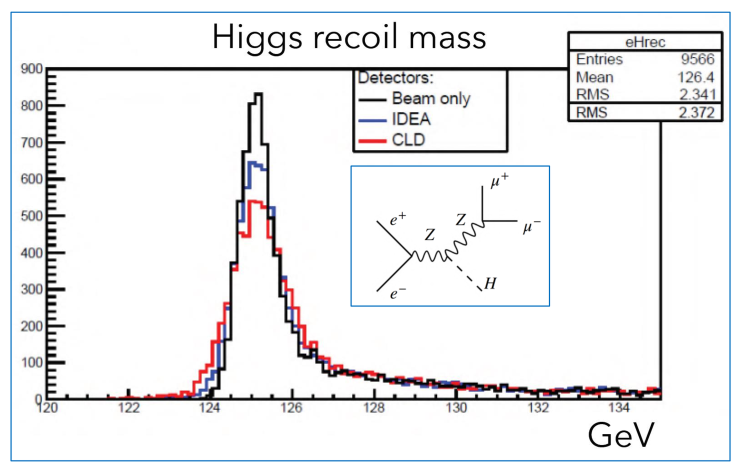
Tracking performance



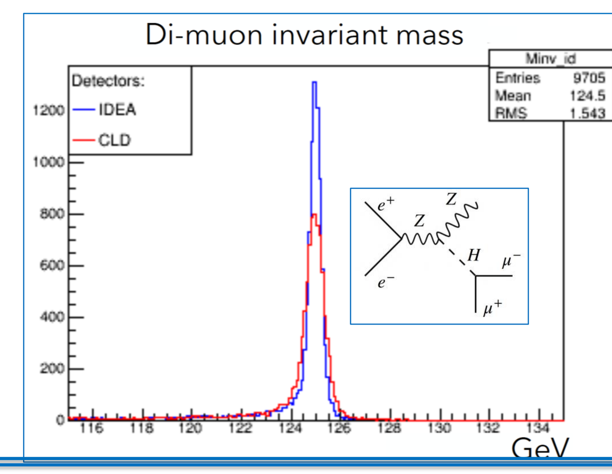
A Geant4 simulation has been performed to estimate the performance of the IDEA tracking system, assuming a single cell resolution of **100 µm** for the CDCH and conservative spatial resolution ($^{pitch}/_{\sqrt{12}}$) for Si detectors [2].



Fast simulation studies



The mass distribution expected with a perfect knowledge of the Z momentum compared to expectations with the IDEA and CLD tracking system, when the Z decays to two muons [5].



The tracker performance in measuring the Higgs invariant mass in its two muon decay mode [5]

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