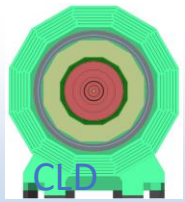
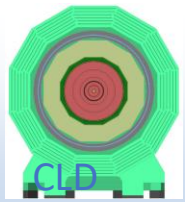


The CLD detector concept

Jeremy Andrea,
IPHC, CNRS, CERN
On behalf of CLD



Introduction

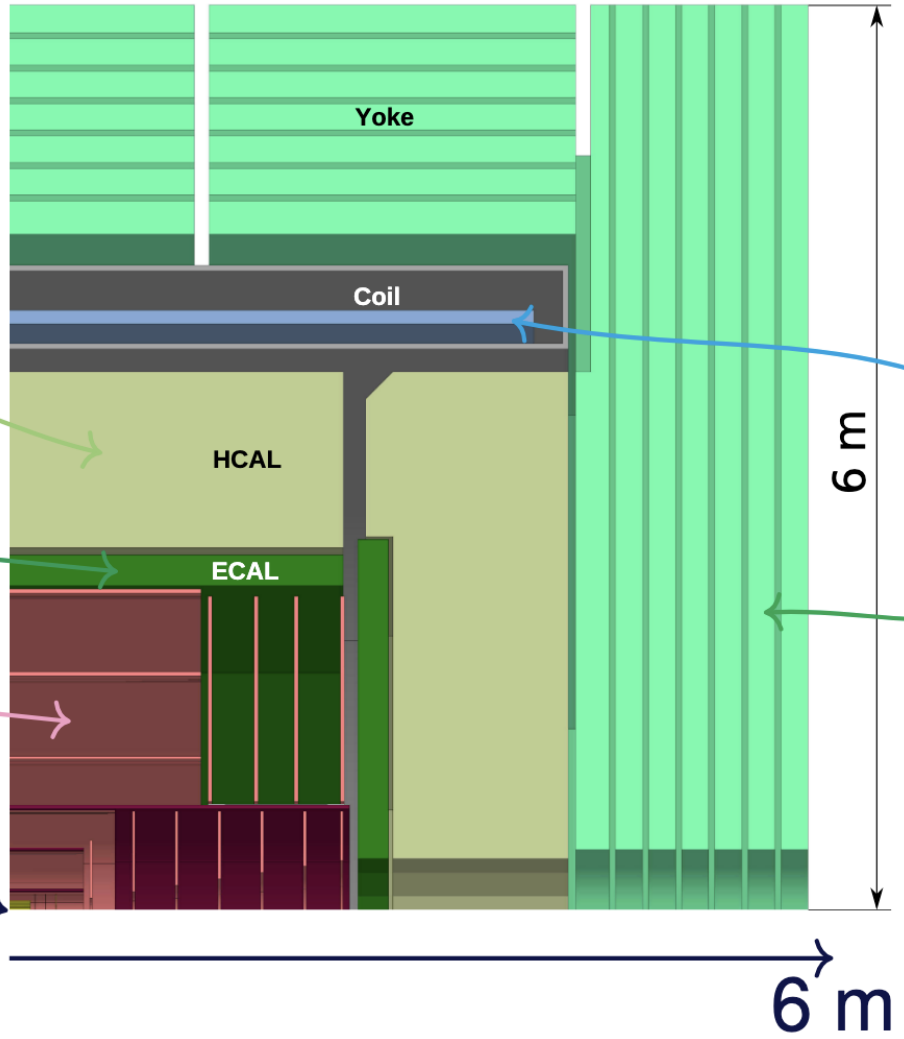
- CLD is a detector concept derived from CLIC detector model. Main features are :
  - Silicon based Vertex detector and tracker,
  - High granularity calorimeters with a silicon-tungsten ECAL and a scintillator-steel HCAL,
  - A superconducting solenoid providing a 2T magnetic field,
  - Steel Yoke and with RPCs for muon identification.
  - Options to have a dedicated particle ID sub-detector is under study.
- Detector concept very well suited for Particle Flow algorithms.
- detector concept existing with a complete full simulation, since a long time.

Slides inspired from A.Sailer (link)

CLD Detector Layout

General purpose detector for Particle Flow reconstruction Link

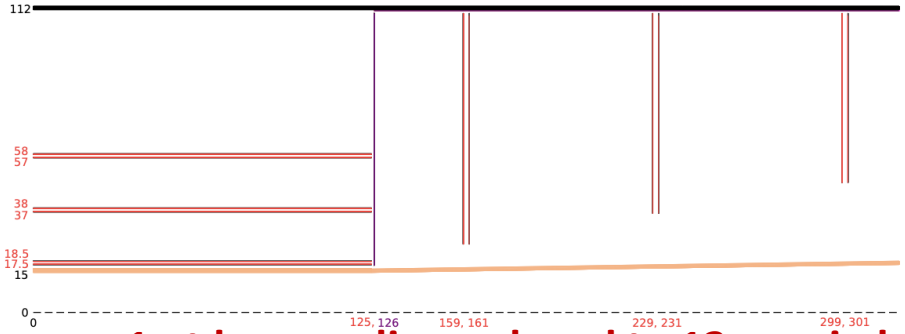
- Steel–Scintillator HCal with 3 cm cell-size
- Silicon–Tungsten ECal with 5 mm cell-size
- Silicon Tracker, mostly 50 μm pitch strips
- Vertex Detector with 25 μm pixels

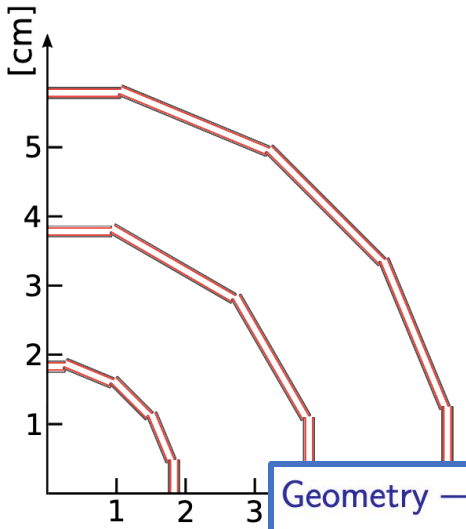


- Superconducting Solenoid of 2 T
- Iron Yoke with RPCs for Muon ID

Vertex detector

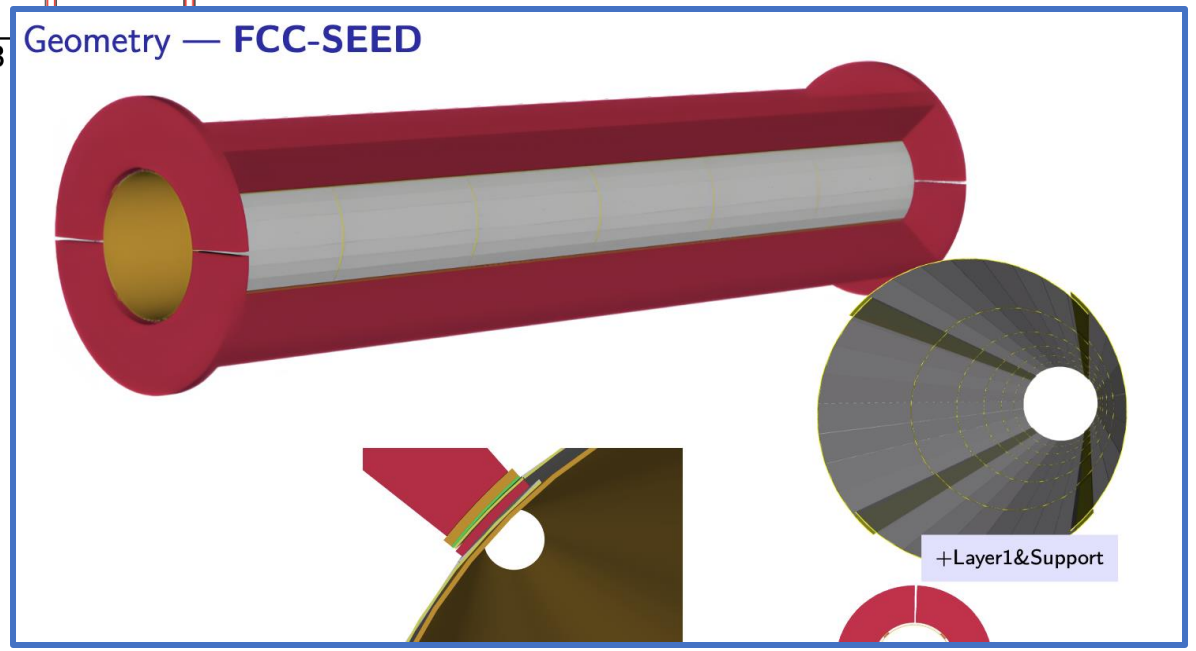
- Silicon vertex detector: precise vertex reconstruction
- $25 \times 25\ \mu m^2$ pixels, 3 μm single point resolution
- 50 μm silicon thickness
- Double layers (0.3%X_0 per detection layer)
- $R_{in} = 17.5$ mm





- Existing vertex historical CLD concept

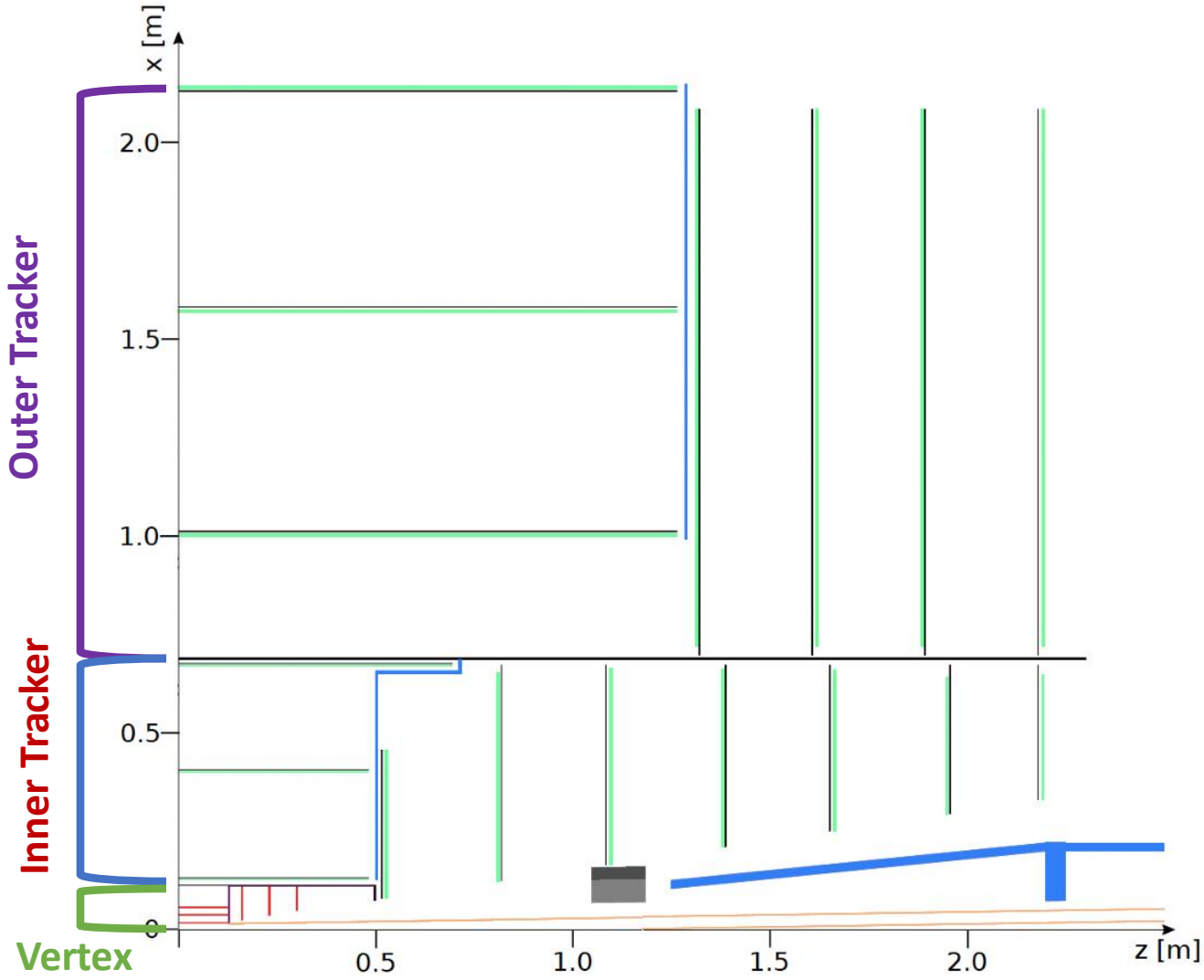
1srt layer radius reduced to 13 mm in latest design



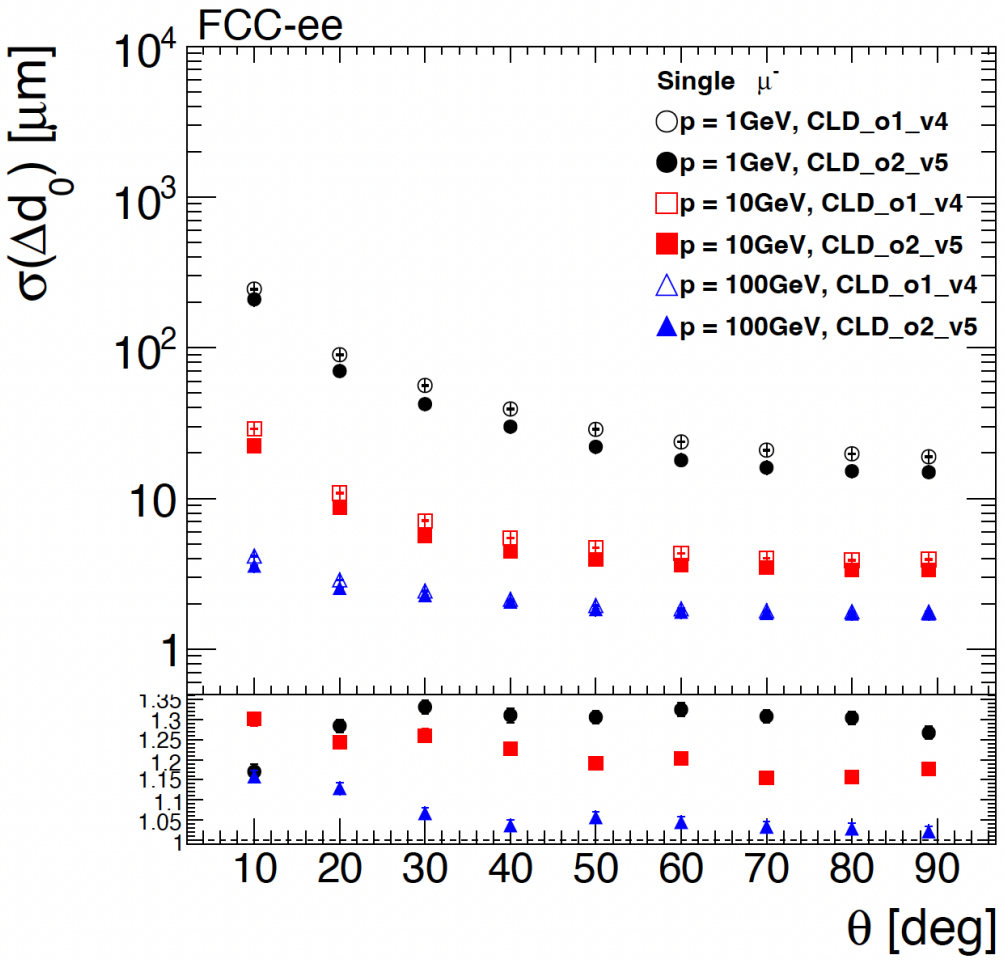
- Potentially replaced with FCC-SEED (see talk earlier today, link)
- Very competitive performances achieved.

Main tracker

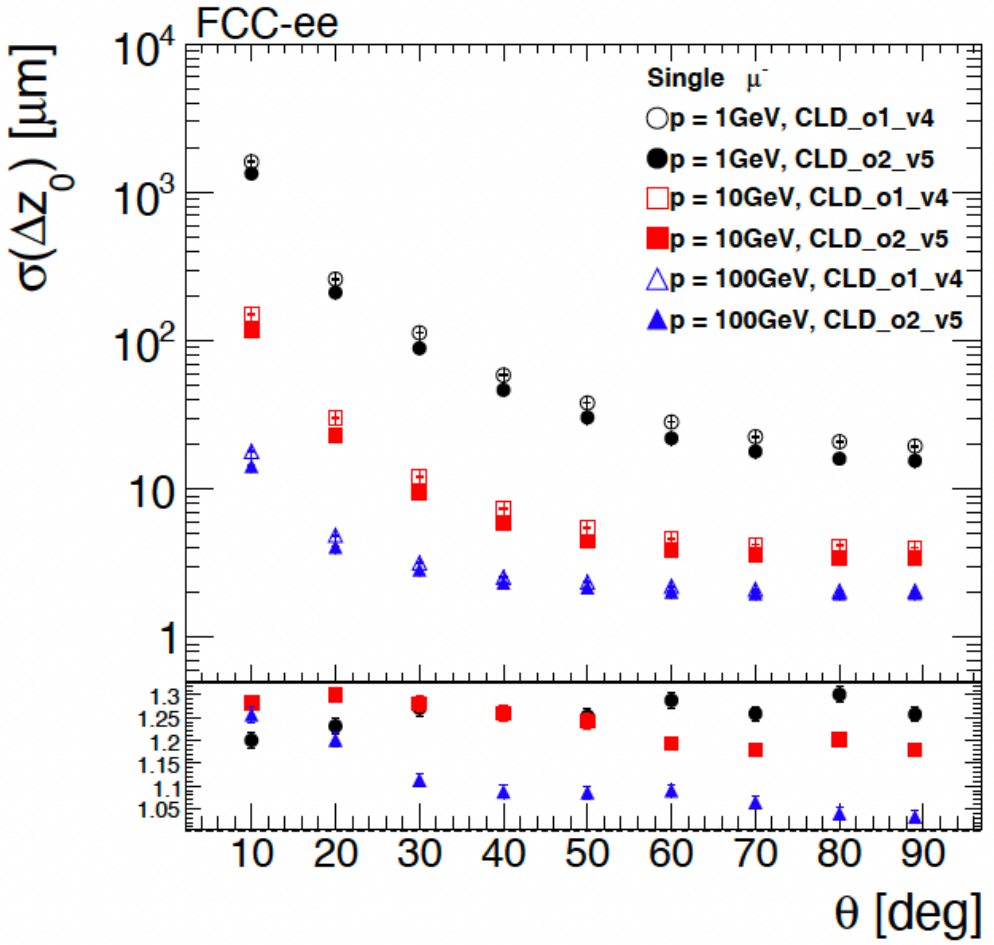
- Full silicon tracker.
  - Inner Tracker : 3 short layers and 7 inner disks,
  - Outer tracker : 3 long layers and 4 outer disks.
- 200 µm Silicon thickness,
  - 50 µm x 0.3 mm cell size,
  - 7 µm x 90 µm single point resolution (except first inner tracker disk, 5x5 µm2).
- At least 8 hits for θ > 8.5°
- Material budget: 1.1 % – 2.2 % X^0 per layer (including overlaps)



Tracking Performances



Vertex Barrel [mm]	R_1	R_2	R_3	L
O1_v4 CLD baseline geometry	17.5	37	57	125
O2_v5 CLD with new beam pipe	**13.0**	**35**	**57**	**109**

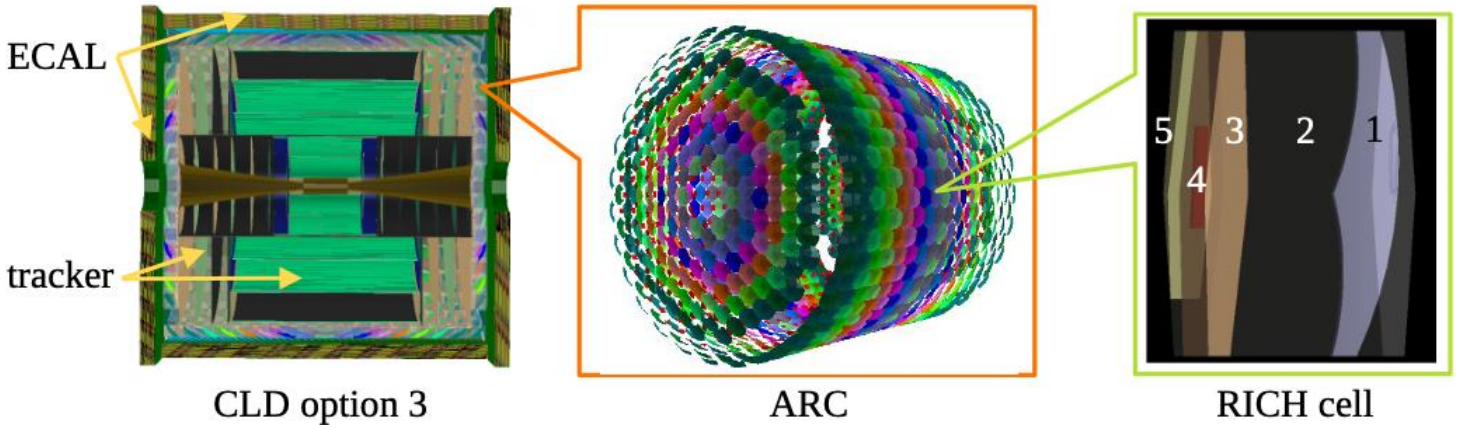


Redo the resolution estimations with the new digitizer !

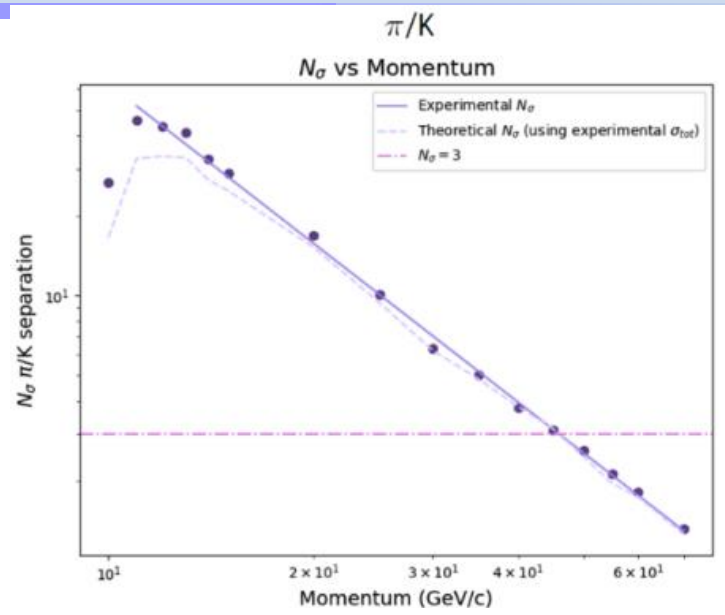
Options for ARC

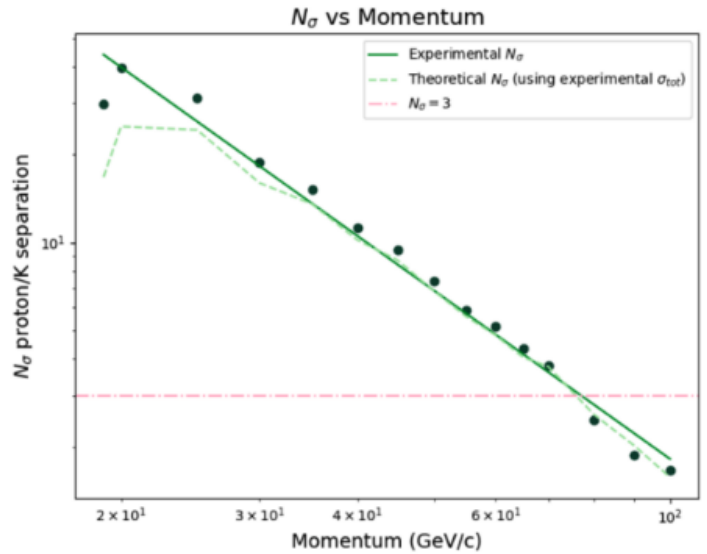
A.Tolosa Delgado (link).

- Studies to add a particle ID detector : Array of RICH Cell (ARC).
- Surrounds the tracker, occupying 10% of the initial tracker volume.
- Separation above 3σ up to 45 GeV(80 GeV) for $\pi - K$ $(p - K)$.
- Impact the tracker geometry (shorter track level arm and cracks at θ~50°).



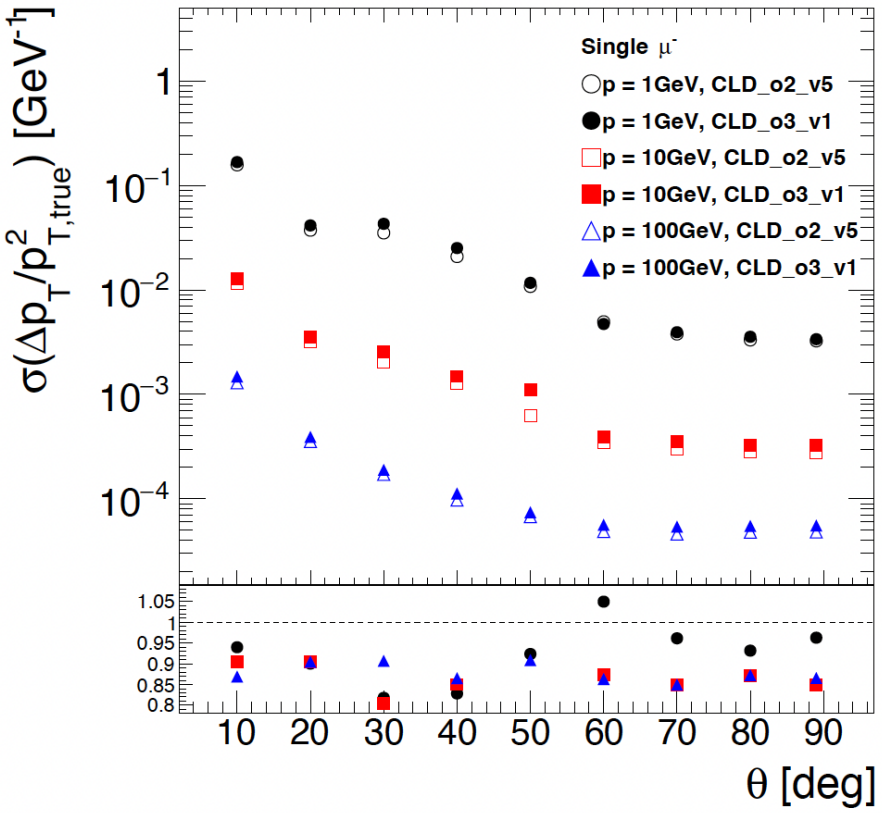
CLD option 3 ARC RICH cell



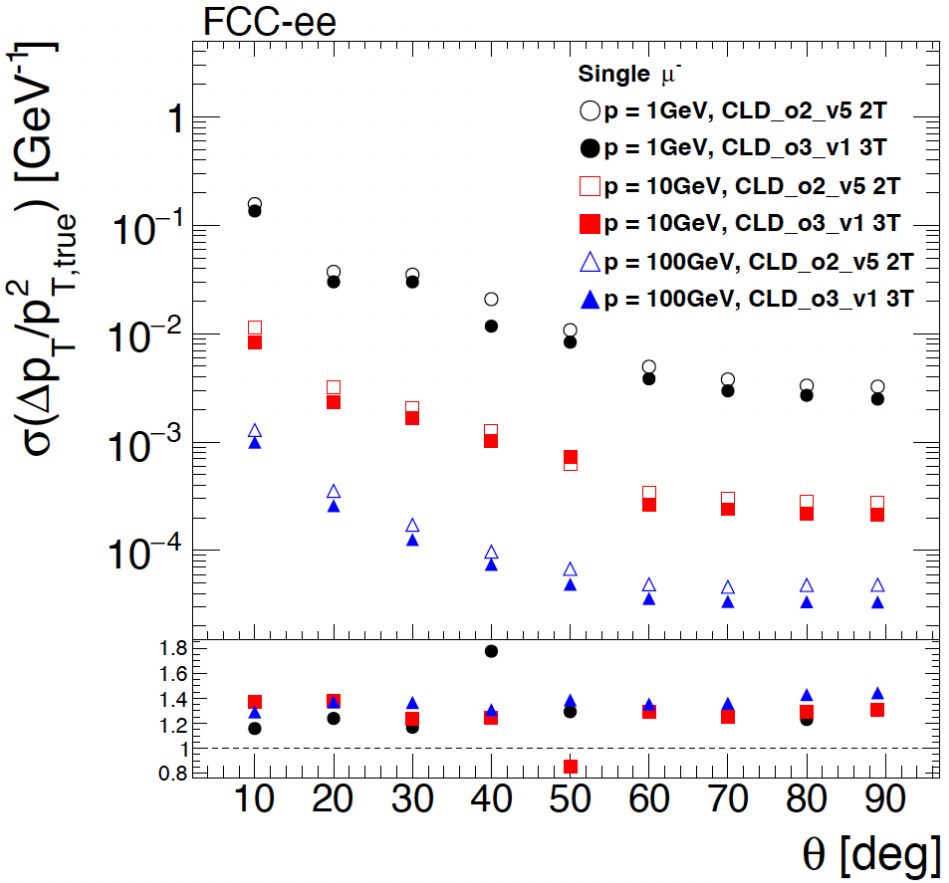


Tracker Performance and particle ID

baseline
reduced tracker volume



baseline (2T)
reduced tracker volume (3T).



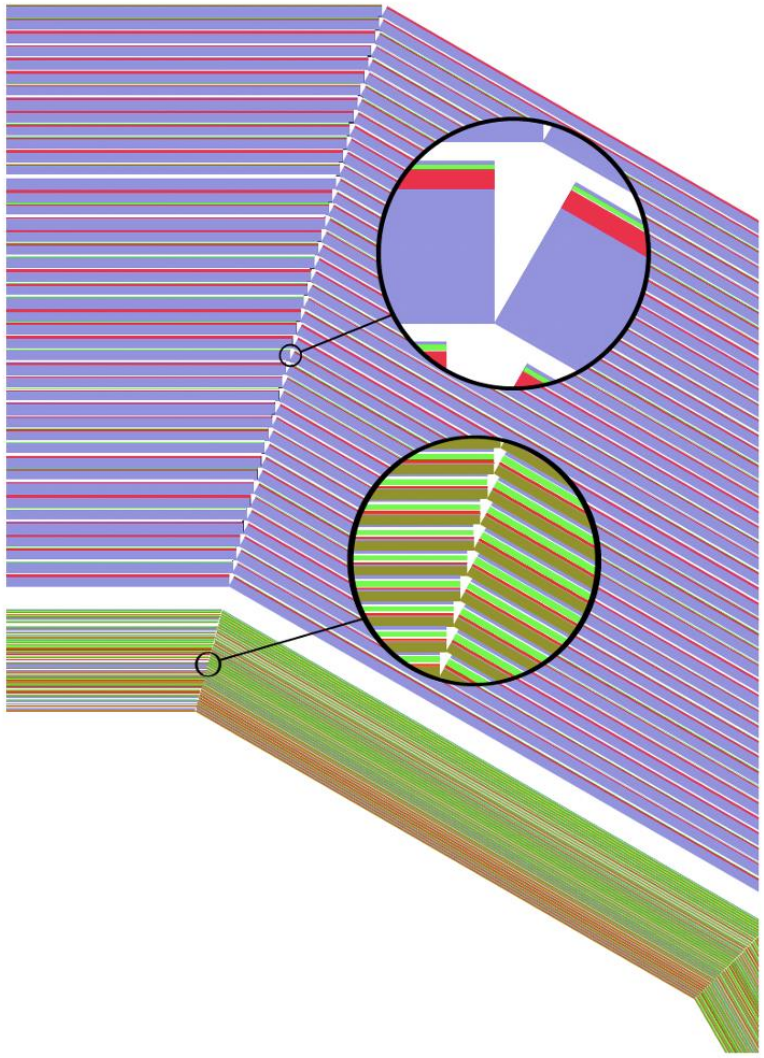
- p_T resolution inversely proportional to level arm.
  - Inclusion of the ARC impact negatively the p_T resolution.
- p_T resolution inversely proportional to magnetic field.
  - Increase of magnetic filed increases significantly the p_T resolution

Calorimeters

- High granularity calorimeters, optimized for particle flow.
  - Target percent level jet energy resolution,
  - Excellent hit time resolution possible.

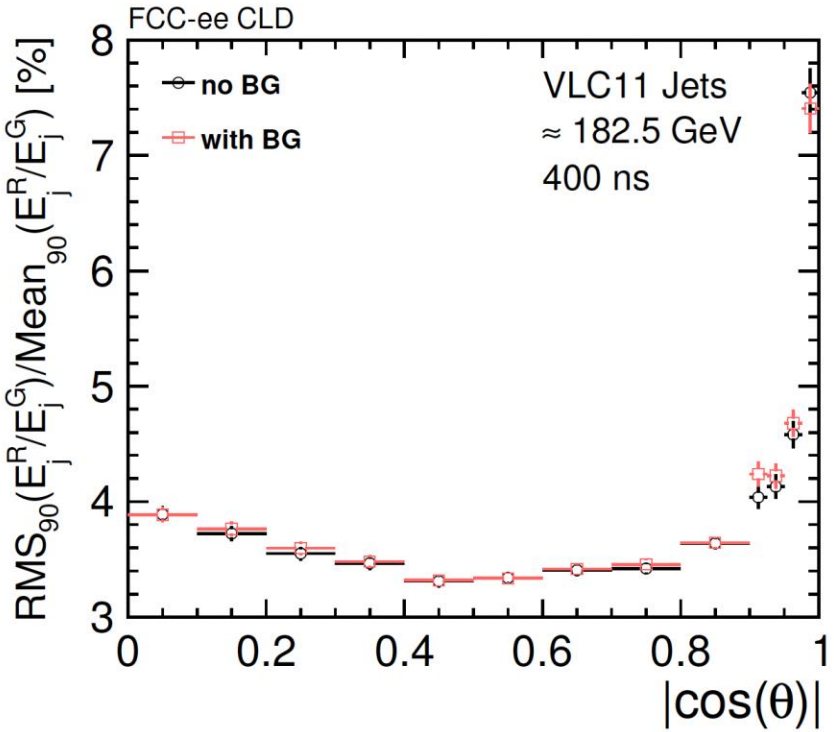
- Ecal
  - 40 layers, 1.9mm tungsten absorber, 22 X_0,
  - 0.5 mm thick silicon sensors (5x5 mm^2),

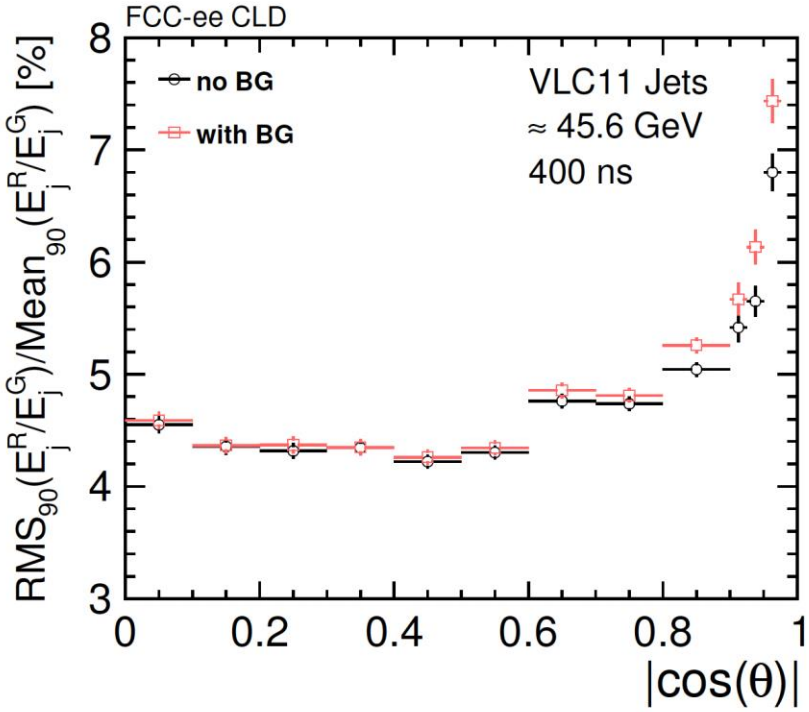
- Hcal
  - 44 layers, 19 mm steel absorber,
  - 3 mm thick scintillator tiles with 3x3 cm^2 granularity.



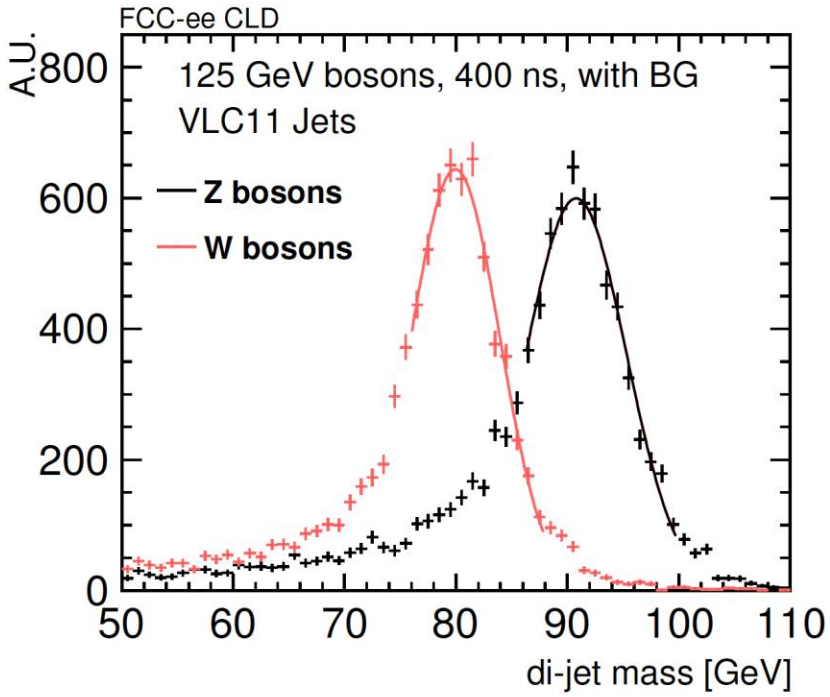
Jet performances

Jet energy resolution including incoherent pair backgrounds





W and Z boson separation power



Muon and Muon System

- 2 Tesla Solenoid Field.

- Return yokes contains Muon system
  - 1 Tesla magnetic field
  - Slots to hosts RPCs with cells of 30x30 mm^2.
  - 6 equidistant layers.
  - one additional layer after the solenoid to serve as a hadronic shower tail-catcher

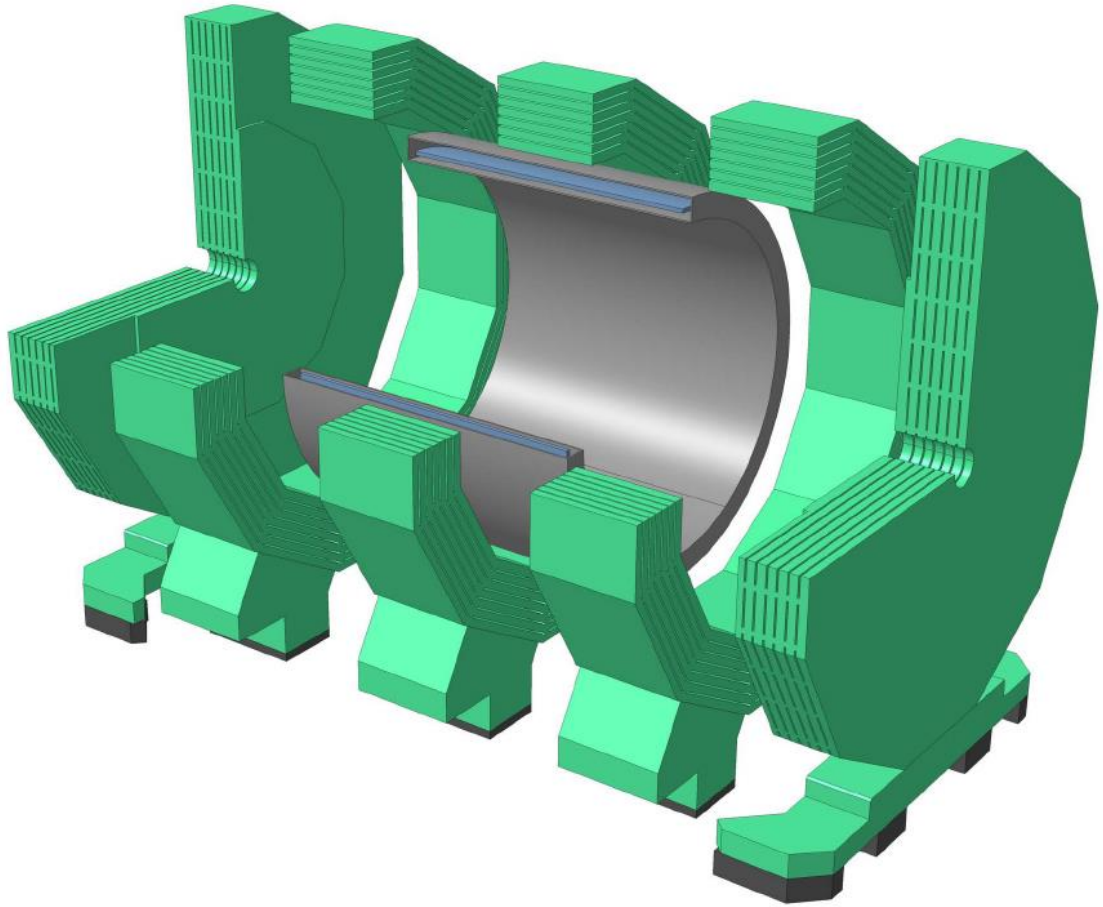
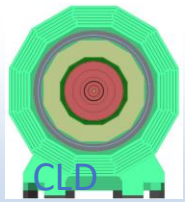


Figure 26: Segmentation of the iron return yoke of CLD into endcaps and three barrel rings.



Status and plans

- The CLD detector concept inherits from the studies done for CLiC => detailed design with full simulation available.

- Major update are foreseen, and require significant efforts, in particular for the tracking system.
  - The tracker is based fully on silicon detectors (MAPS), mastered and robust technology, that can sustain high particle rates and radiation levels,
  - But suffers from larger material budget, and does not allow for precise PID.
  - Silicon sensors R&D is happening in DRD3,

- Aspects to be covered
  - Inclusion of the new digitizer,
  - Design of a high resolution and light vertex detector, with new geometries based on curved MAPS sensors,
  - Optimisation of the Outer Tracker and Inner Tracker geometries (update sensor thicknesses ?),
  - Optimisation potentially to be performed in relation with the inclusion of a PID (ARC).

- Rooms for collaborations !