

ILD @ FCCee

ILD Ana/Soft
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HELMHOLTZ



CLUSTER OF EXCELLENCE
QUANTUM UNIVERSE



Who Am I?



❖ 03/2024 - present: **Doctoral Researcher at DESY & University of Hamburg, Germany**

- ❖ Topic: *Design of the Interaction Region for the ILD Detector Concept at the FCCee*
- ❖ Group: *FTX-SLB led by Jenny List*



❖ 10/2021 - 11/2023: **M. Sc. Physics, RWTH Aachen University, Germany**

- ❖ Thesis title: *Deep Learning Driven Measurement of Single Top Quark and Top Quark Pair Associated Higgs Boson Production at the CMS Experiment*



❖ 08/2021 - 06/2022: **ERASMUS+ year abroad, Chalmers University of Technology, Gothenburg, Sweden**

CHALMERS
UNIVERSITY OF TECHNOLOGY



❖ 10/2017 - 10/2021: **B. Sc. Physics, RWTH Aachen University, Germany**

- ❖ Thesis title: *Data Augmentation Strategies for Deep Learning based Di-Higgs Classification at the CMS Experiment*



My PhD Project in a Nutshell

- ❖ Modified ILD model...
 - ❖ ... compatible with FCC requirements
 - ❖ ... that mitigates backgrounds and other machine-related effects
 - ❖ ... that can be assembled and maintained
- ❖ Carry out a physics study with this detector model
 - ❖ Sensitive to differences in machine-detector-interface (MDI)
 - ❖ e.g. strongly forward-boosted

ILC vs FCCee

- ❖ Different machine interface
- ❖ Different backgrounds
 - ❖ ILC: mainly beamstrahlung
 - ❖ FCC: synchrotron radiation, scattering and beam-gas interaction more relevant

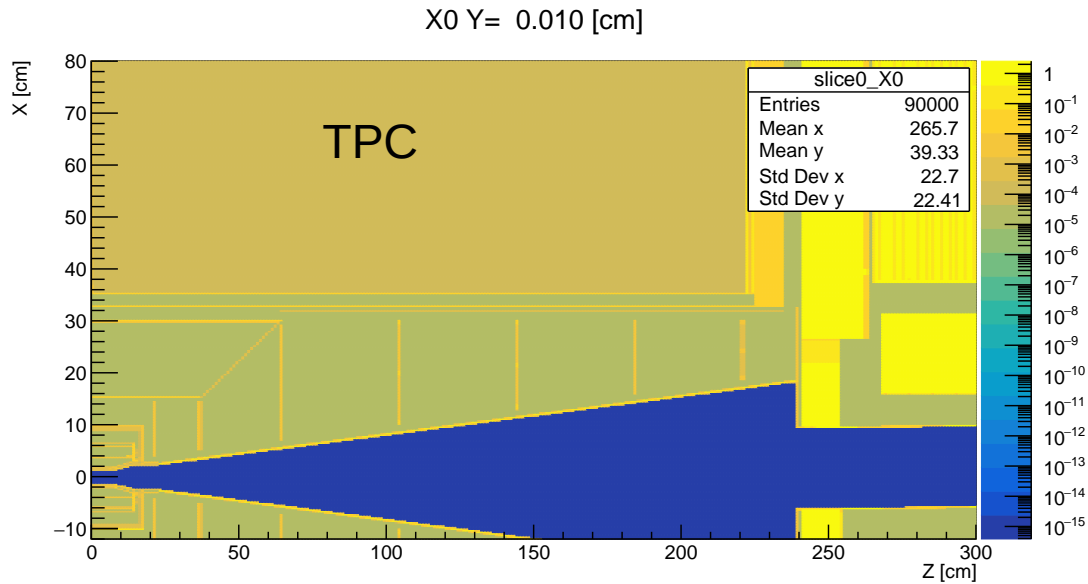
	ILC	FCCee
crossing angle	14 mrad	30 mrad
L^* [distance from IP to last accel focusing quadupole magnet]	4.1 m	2.0 m
detector solenoid	3.5 T	2.0 T
additional B-fields	anti-DID (?)	- compensating - screening

From Daniel Jeans

Starting Point

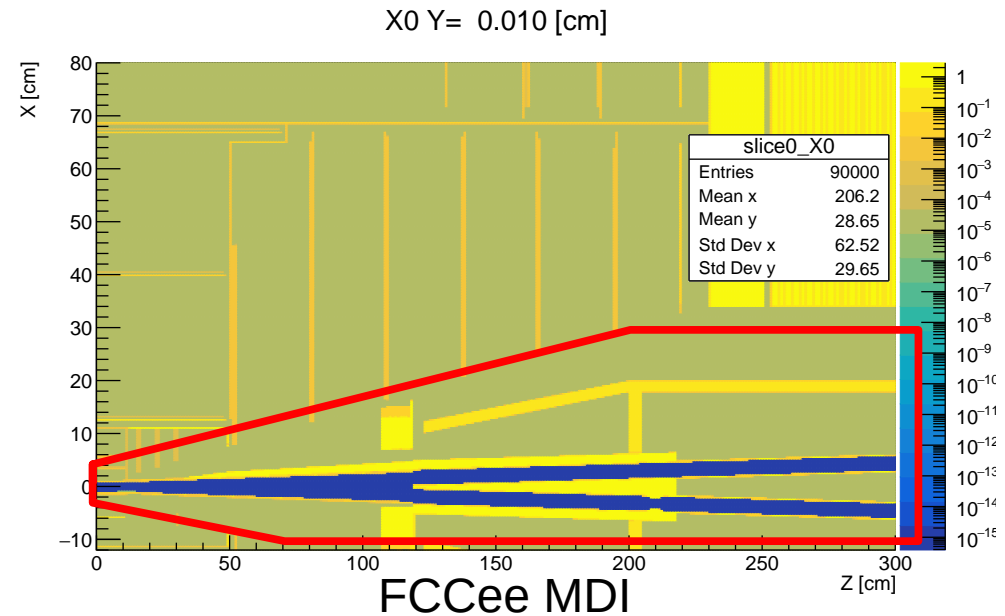
ILD (for ILC)

- ❖ ILC MDI
- ❖ Hybrid tracking layout



CLD (CLIC-like Detector)

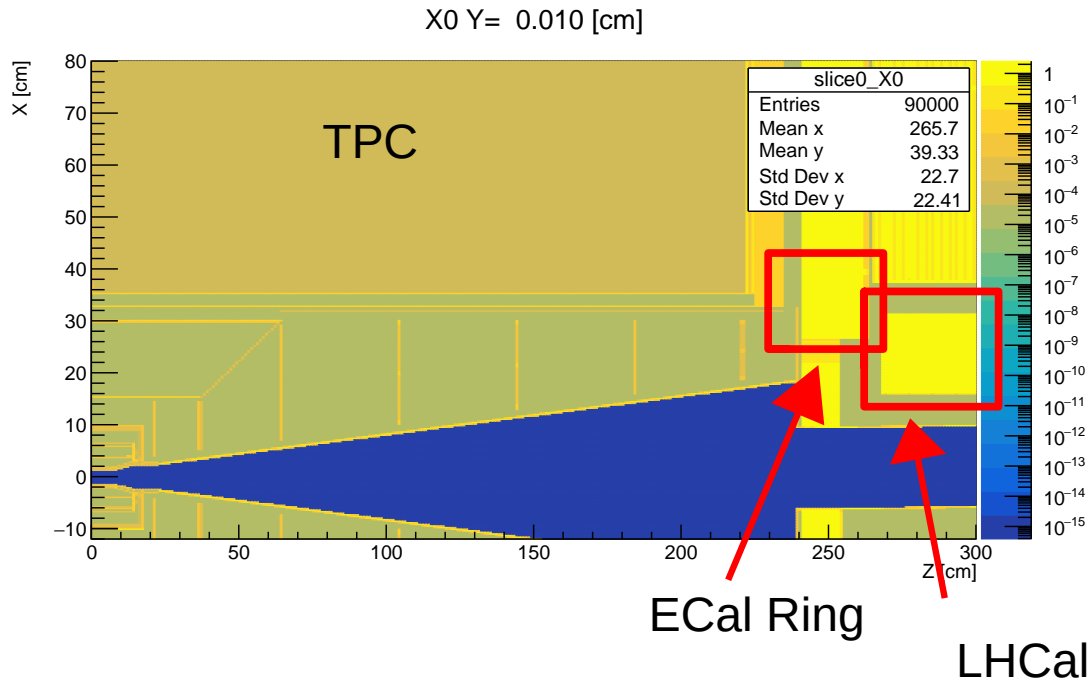
- ❖ FCCee MDI
- ❖ All-silicon tracking



Starting Point

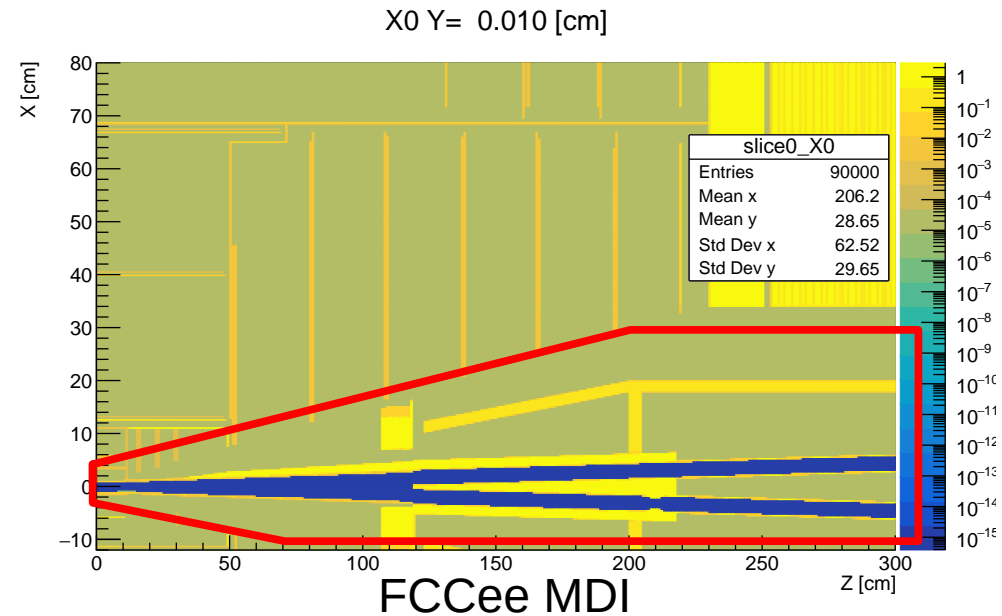
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CLD (CLIC-like Detector)

- ❖ FCCee MDI
- ❖ All-silicon tracking



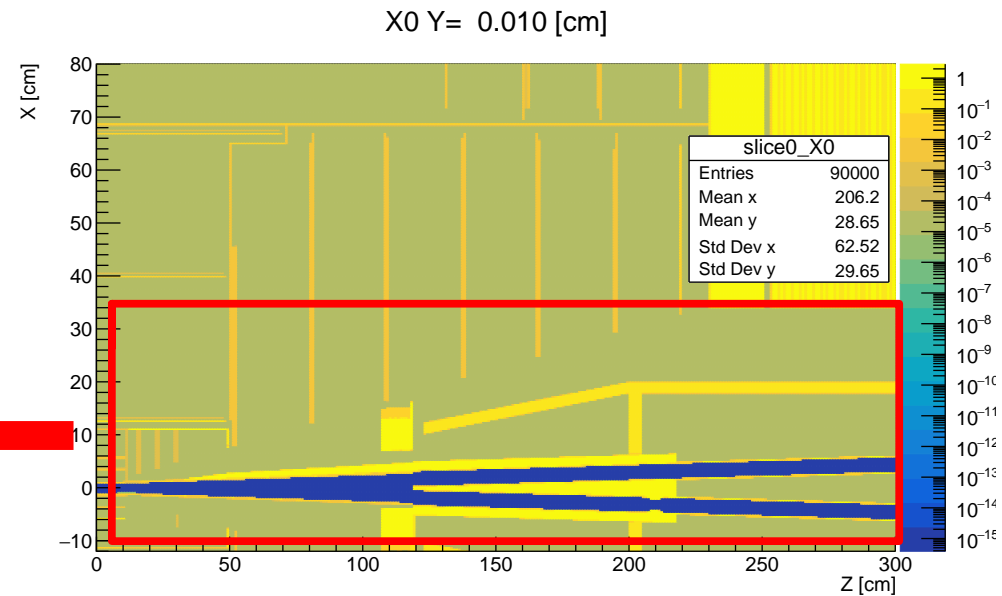
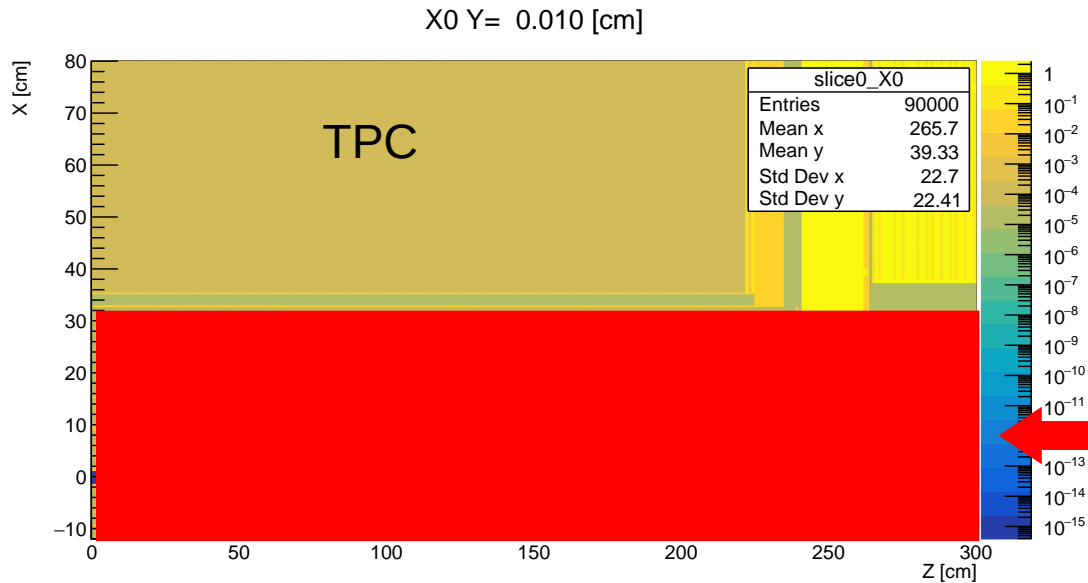
Ansatz

ILD (for ILC)

- ❖ ILC MDI
- ❖ Hybrid tracking layout

CLD (CLIC-like Detector)

- ❖ FCCee MDI
- ❖ All-silicon tracking



Ansatz:

- 1) Remove everything inside of the TPC from ILD
- 2) Replace with CLD subdetectors

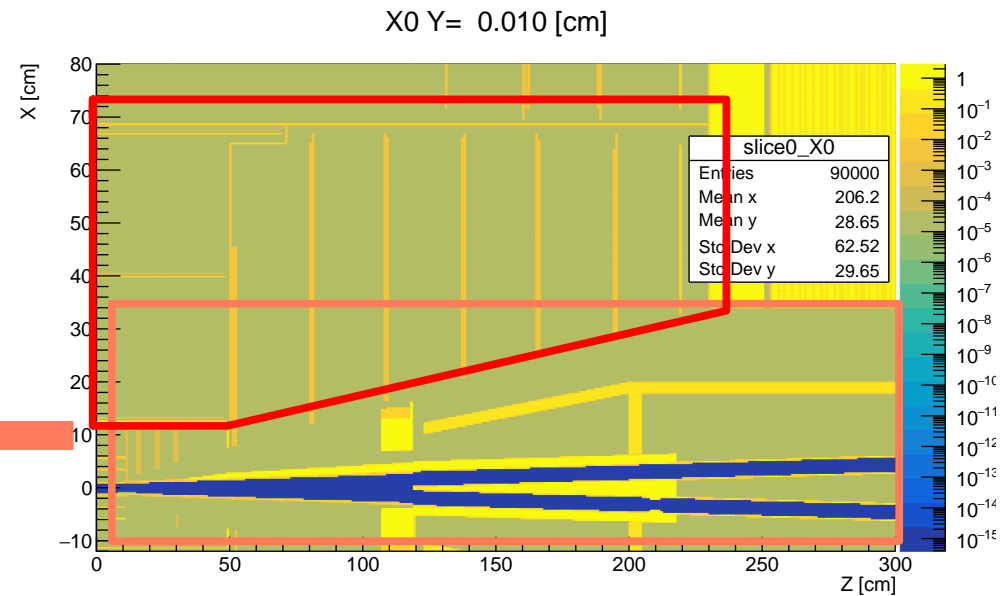
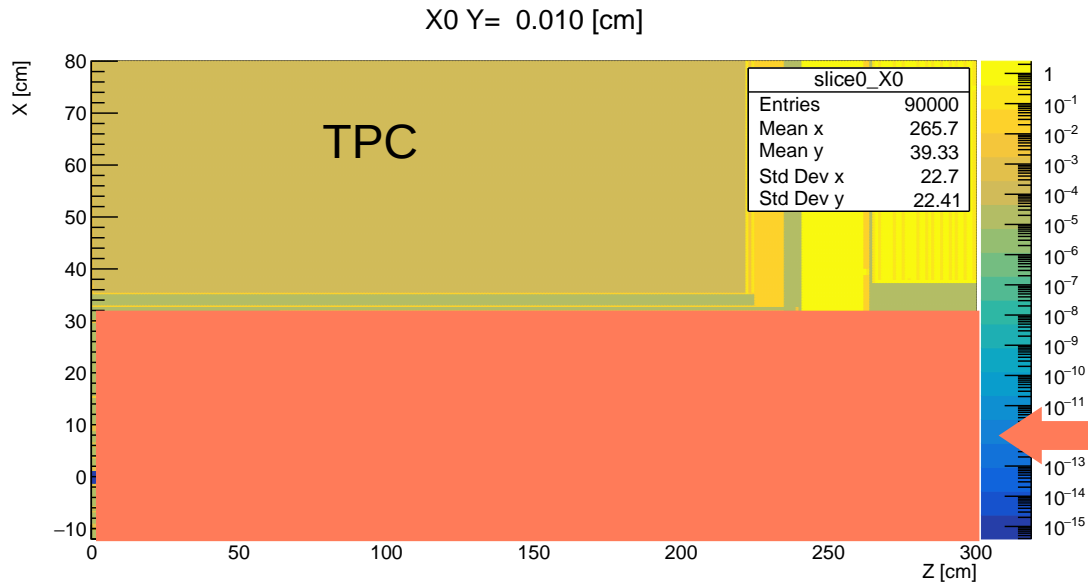
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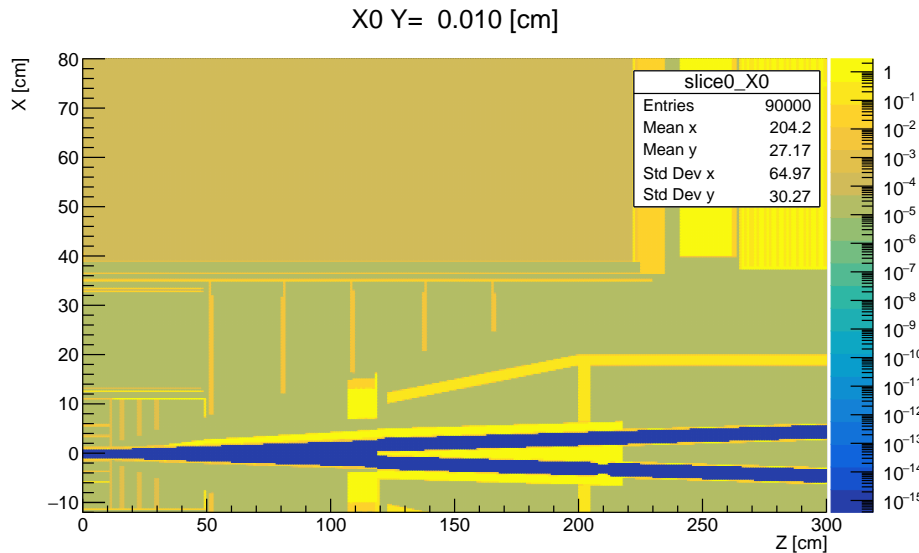
New Models or 2 Merging Strategies

ILD for FCCee **v01** – large TPC:

- ❖ Leave TPC as large as possible
- ❖ Squeeze Inner Tracker in between TPC and Vertex Detector

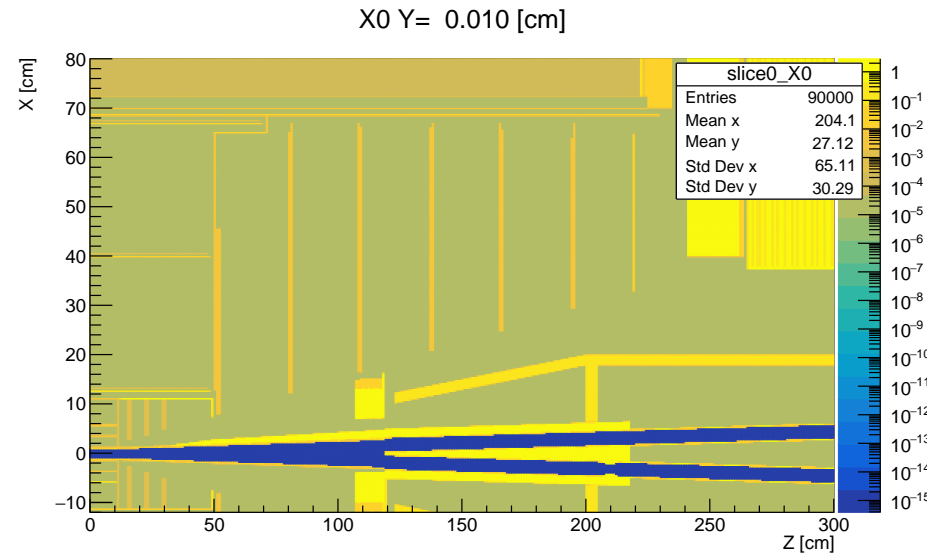
ILD for FCCee **v02** – small TPC:

- ❖ Copy Inner Tracker from CLD
- ❖ Shrink TPC to accommodate the IT



*Common MDI_o1_v00

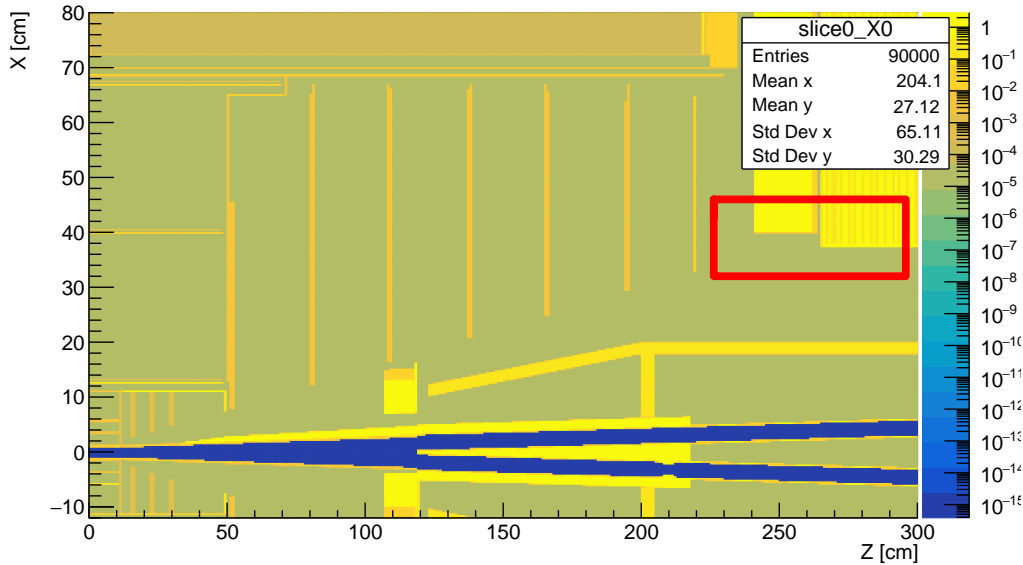
*Calorimeter and solenoid volumes were left unchanged, except for removed ECal Ring and LHCAL



Next Steps

ILD for FCCee v02 – small TPC

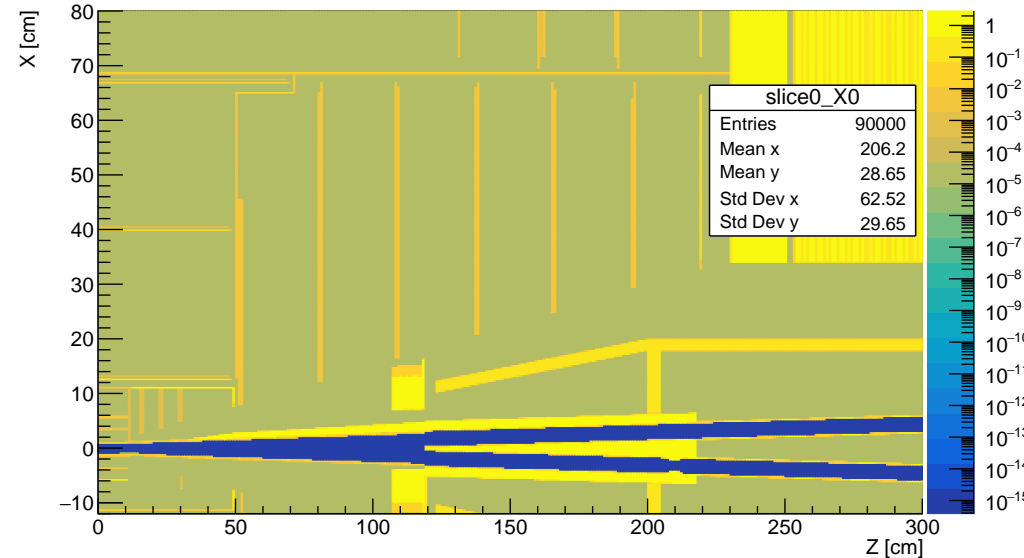
X0 Y= 0.010 [cm]



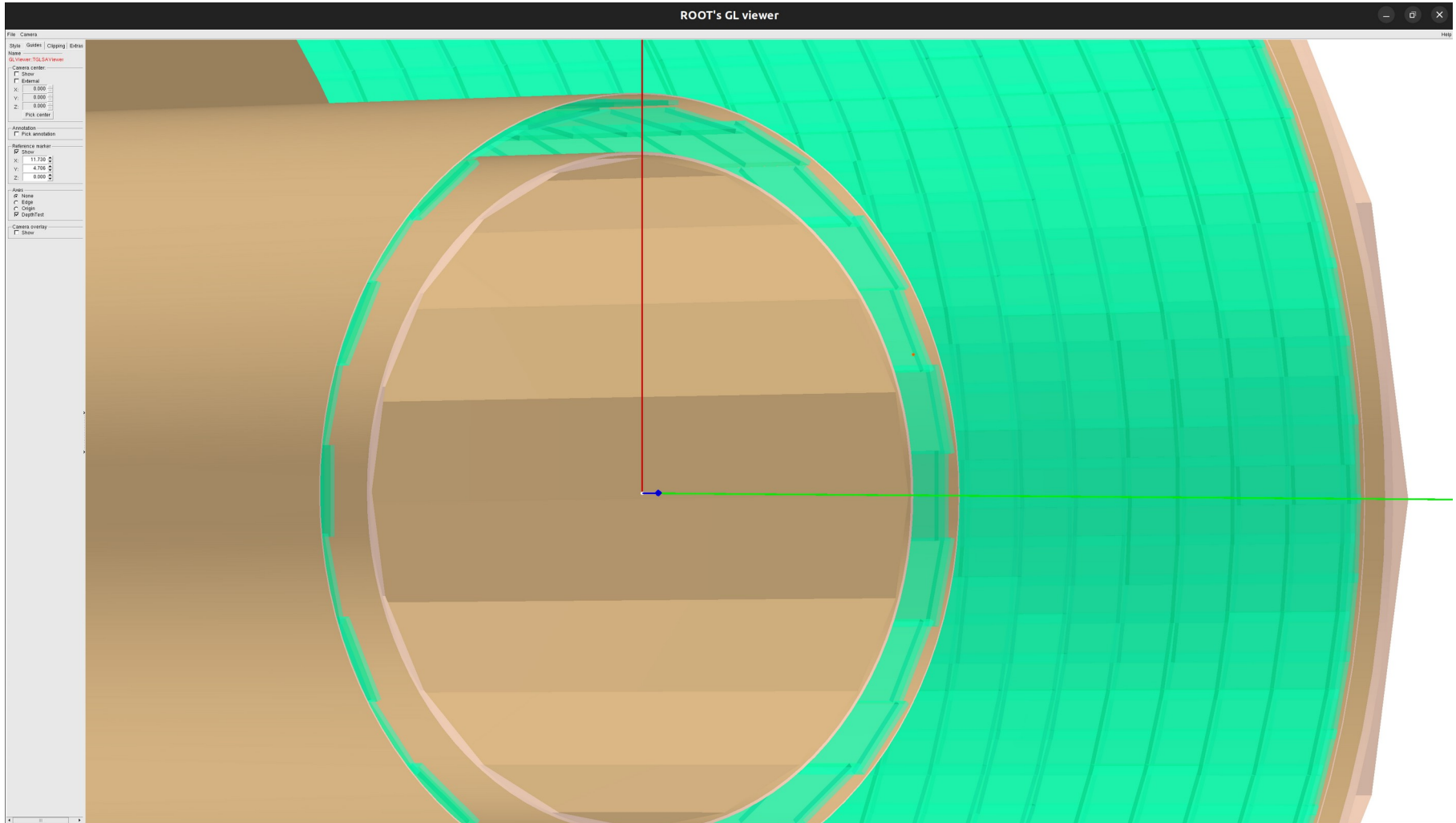
- ❖ ILD_l5_v11 is retired
- ❖ Check calorimeter coverage
- ❖ Generalized track merging for hybrid tracking models
- ❖ Investigate tracking performance (k4DetPerformance)

CLD

X0 Y= 0.010 [cm]



Fixing overlaps and other things...

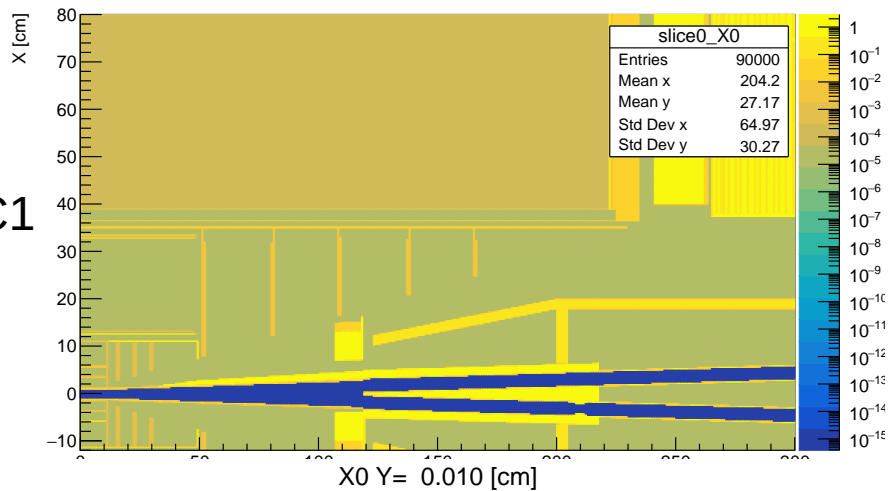


Back-Up

Overview of FCCee Models

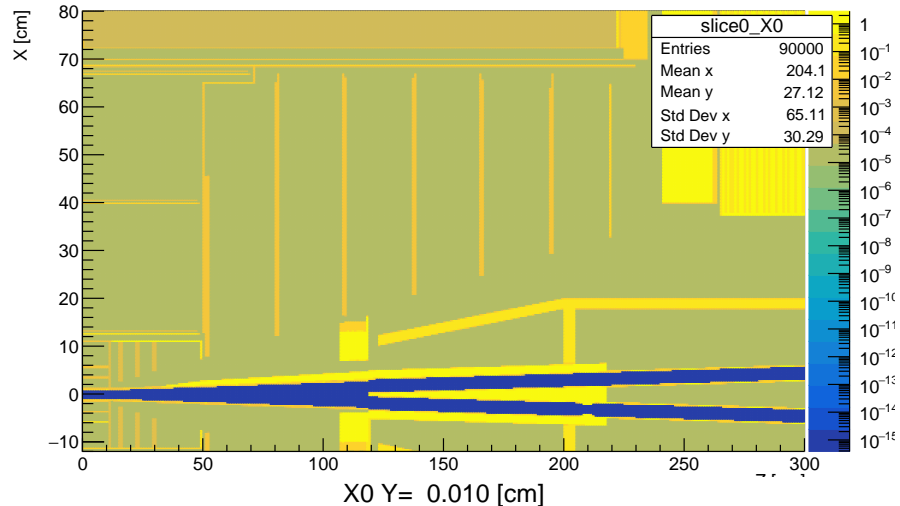
X0 Y= 0.010 [cm]

FCC1



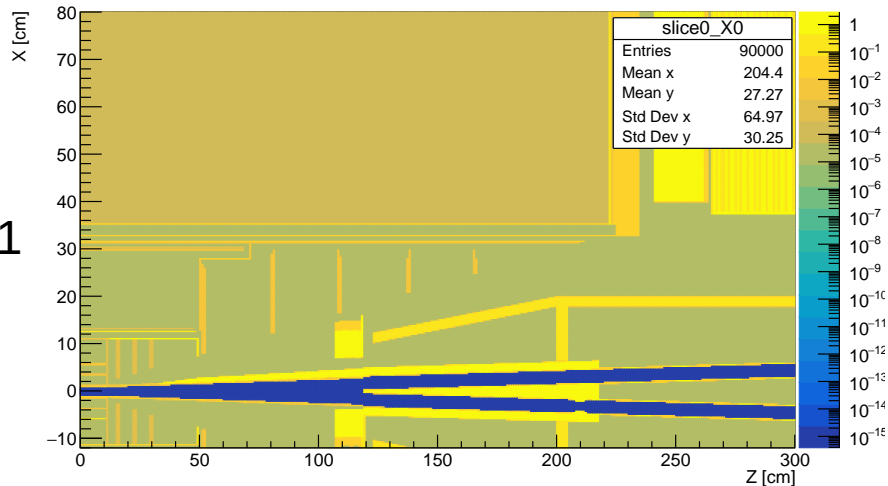
X0 Y= 0.010 [cm]

FCC2



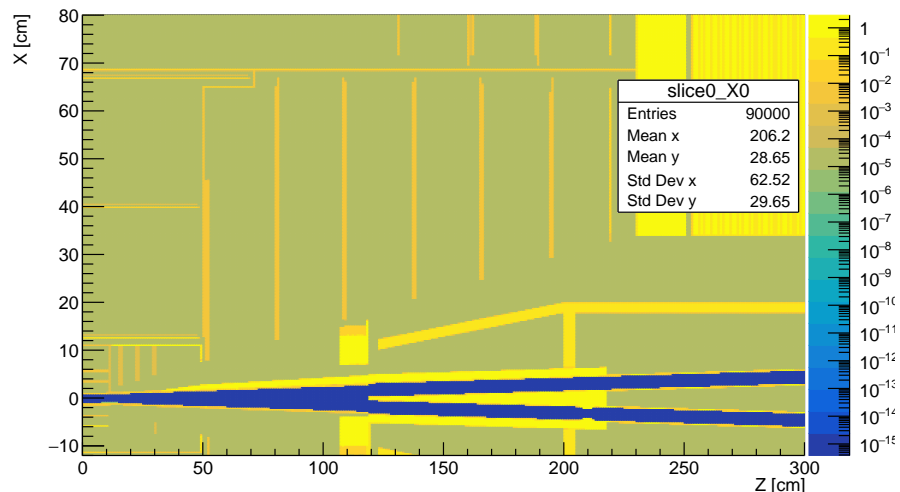
X0 Y= 0.010 [cm]

v11



X0 Y= 0.010 [cm]

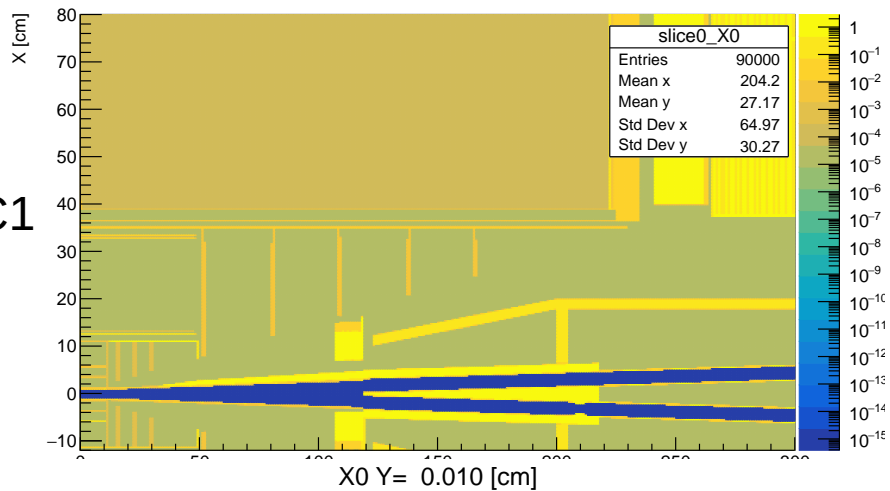
CLD



Overview of ILD Models

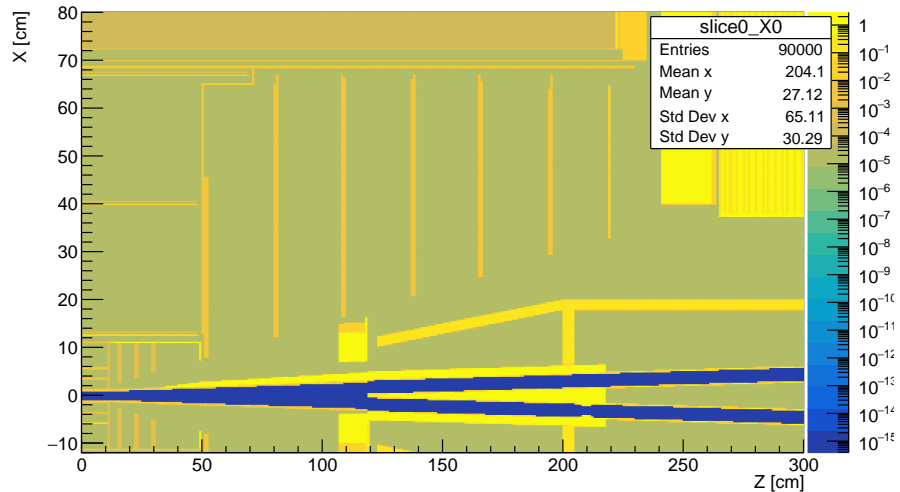
X0 Y= 0.010 [cm]

FCC1



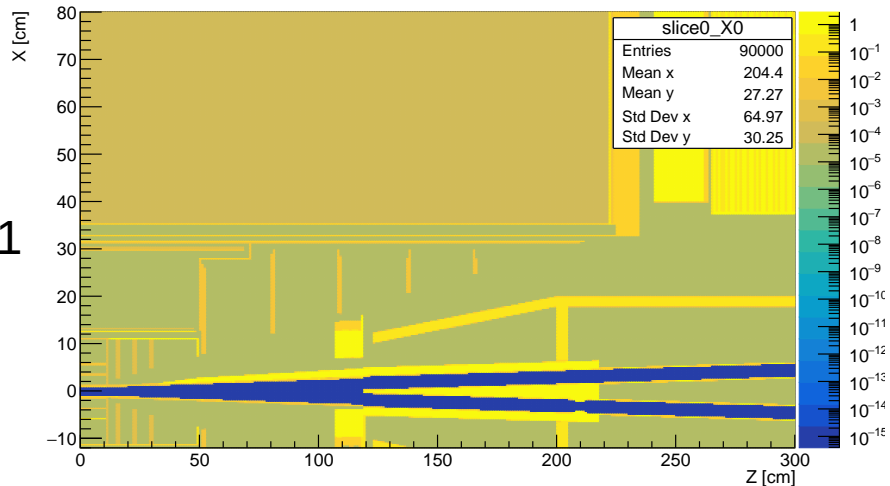
X0 Y= 0.010 [cm]

FCC2



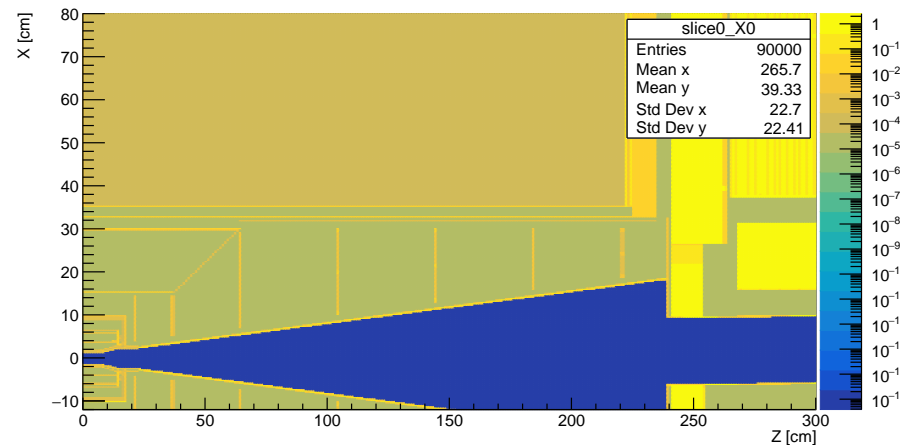
X0 Y= 0.010 [cm]

v11



X0 Y= 0.010 [cm]

v02



Tracking Subdetector Systems ILD vs CLD

ILD

- ❖ Hybrid tracking layout

ILD barrel trackers:

- ❖ VerTeX detector (VTX)
- ❖ Silicon Internal Tracker (SIT)
 - ❖ Two layers
- ❖ Time Projection Chamber (TPC)
- ❖ Silicon External Tracker (SET)
 - ❖ One layer

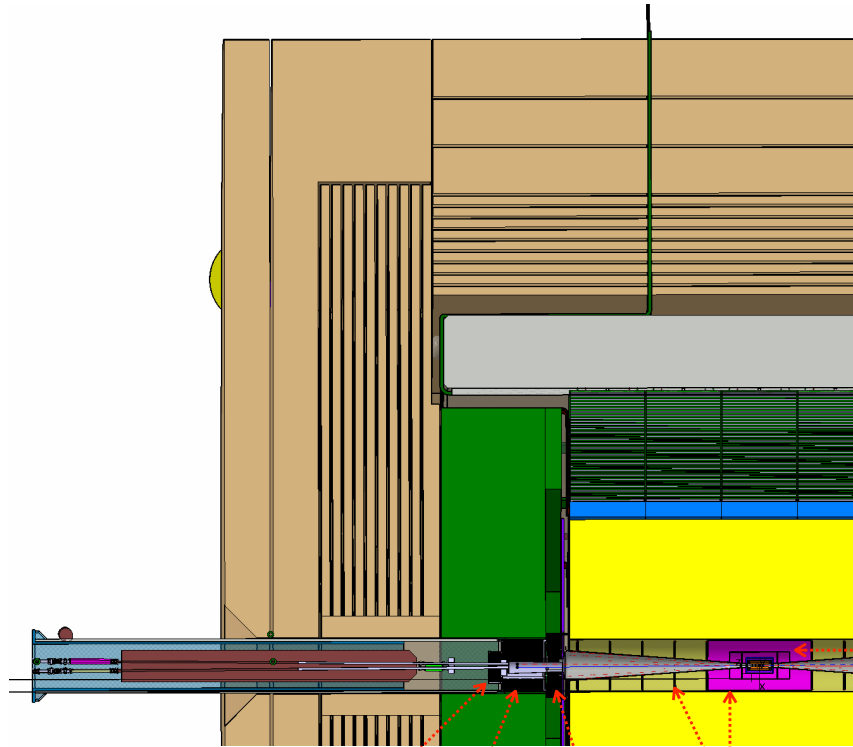
ILD disc/endcap tracker:

- ❖ Forward Tracking Detector (FTD)
 - ❖ 2 + 5 discs
 - ❖ Endcap for VTX and SIT

CLD

- ❖ All-silicon tracker
- ❖ All subdetectors: barrel + discs/endcaps
- ❖ **Vertex Detector:**
 - ❖ Three double layers + three double-discs on both sides
- ❖ **Inner Tracker:**
 - ❖ Three barrel layers + seven discs
- ❖ **Outer Tracker:**
 - ❖ Three barrel layers + four discs (enclosing the Inner Tracker discs)

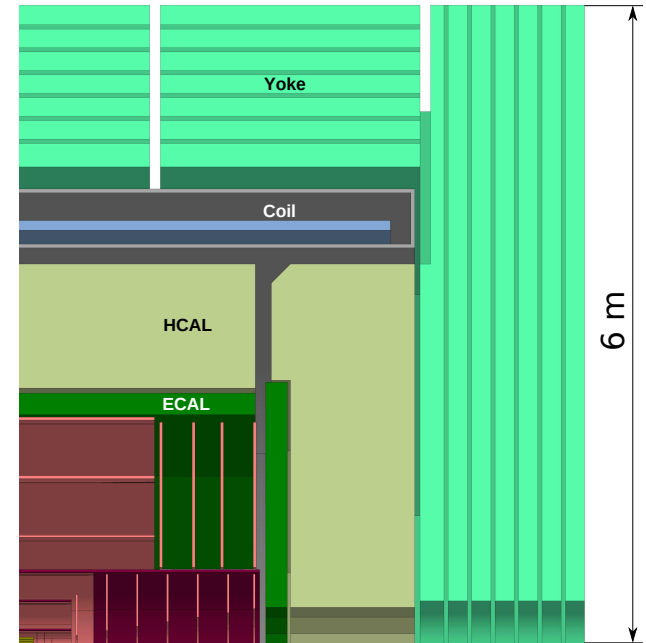
ILD vs CLD



BeamCAL LHCAL LumiCAL FTD/SIT

← Yoke/Muon
← Coil
← HCAL
← ECAL
← TPC
← Vertex

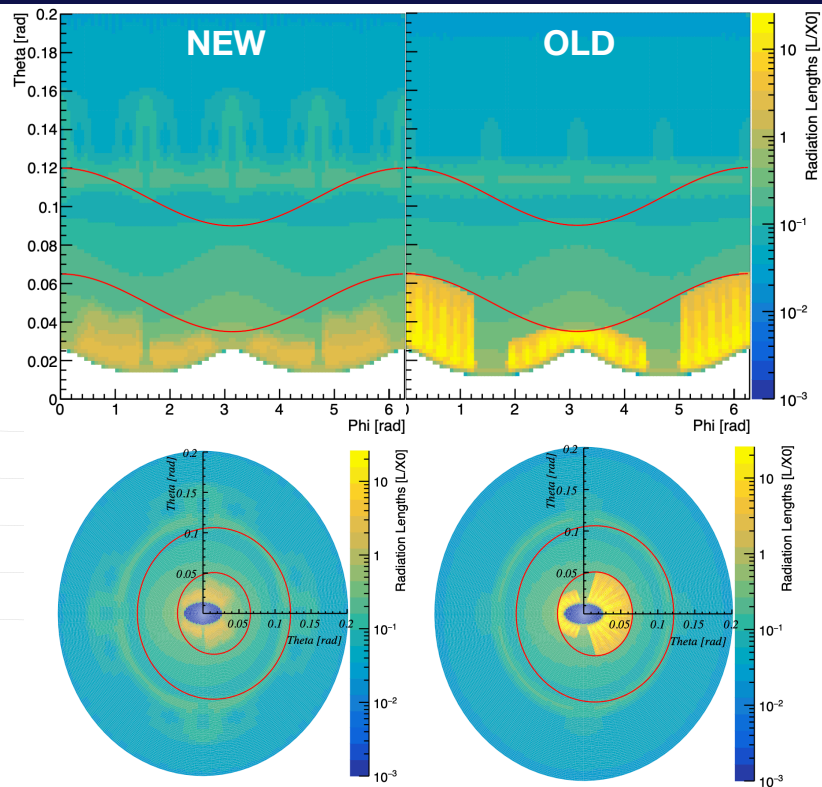
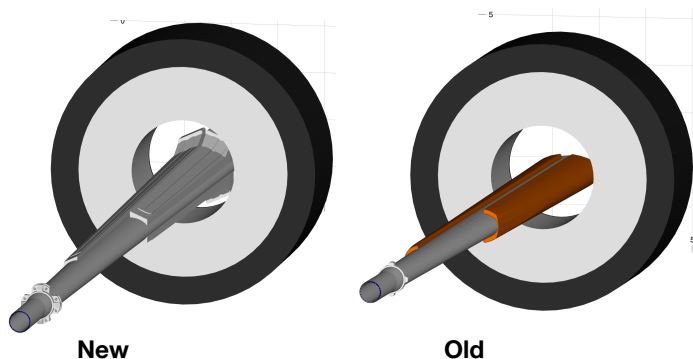
ILD



CLD

New beam pipe and cooling

After this feedback, a new solution for the trapezoidal chamber cooling was found. Cooling manifolds are now **all in AlBeMet162** and are placed at **safety margin from the LumiCal acceptance**.



k4DetPerformance

- ❖ Framework designed to study tracking performance within full simulation environments
 - ❖ Requires complete simulation and reconstruction setup
 - ❖ Matches reconstructed tracks to simulated particles
 - ❖ Various plotting options: superimpose plots and ratios for comparative analyses
- ❖ Initially developed for CLD at FCCee by Gaelle Sadowski
- ❖ Now integrated into Key4HEP
- ❖ Leonhard Reichenbach, Gaelle and me are looking into extending its applicability to other detectors

<https://github.com/key4hep/k4DetPerformance>

Track Example in v02

