The ILD simulation model

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Outline

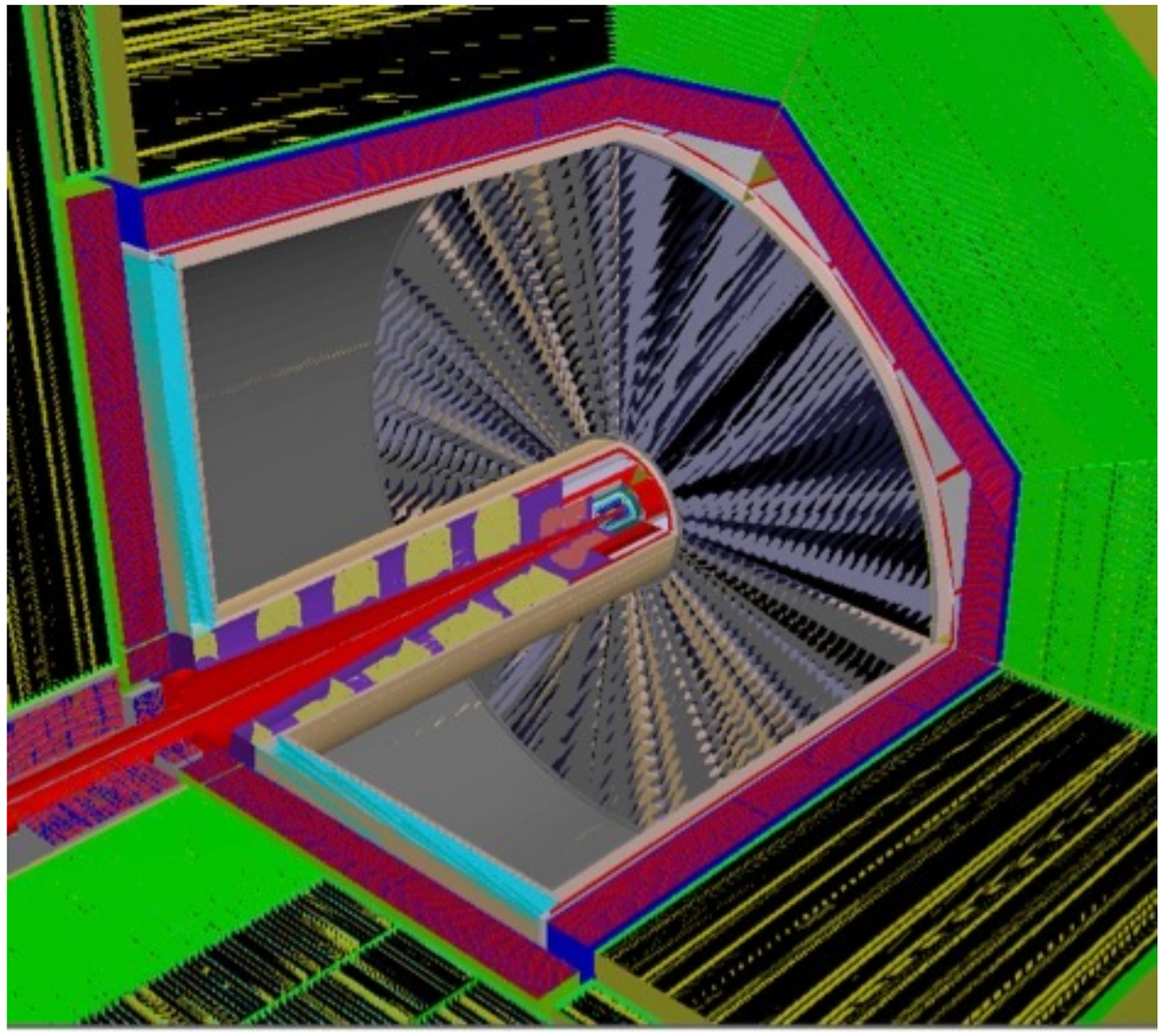
- Detector description toolkit—DD4hep
- The status of ILD_o1_v05 implementation in lcgeo
- The new introduced ‘mandatory’ envelops
- Overview of ILD simulation model
- The validation of geometry and sensitive layer segmentation
- The reconstruction validation (Ongoing)
- Summary

DD4hep and lcgeo

- DD4hep is a complete Detector Description toolkit
  - Includes geometry, materials, visualisation, readout, alignment, calibration, etc.
  - Support Full Experiment life cycle: Detector concept development, detector optimisation, construction, operation
  - Easy transition from one phase to the next
  - Consistent Description, Single source of information, used in simulation, reconstruction, analysis, etc.
- **lcgeo is a common LC detector description package based on DD4hep for ILD and CLICdp**

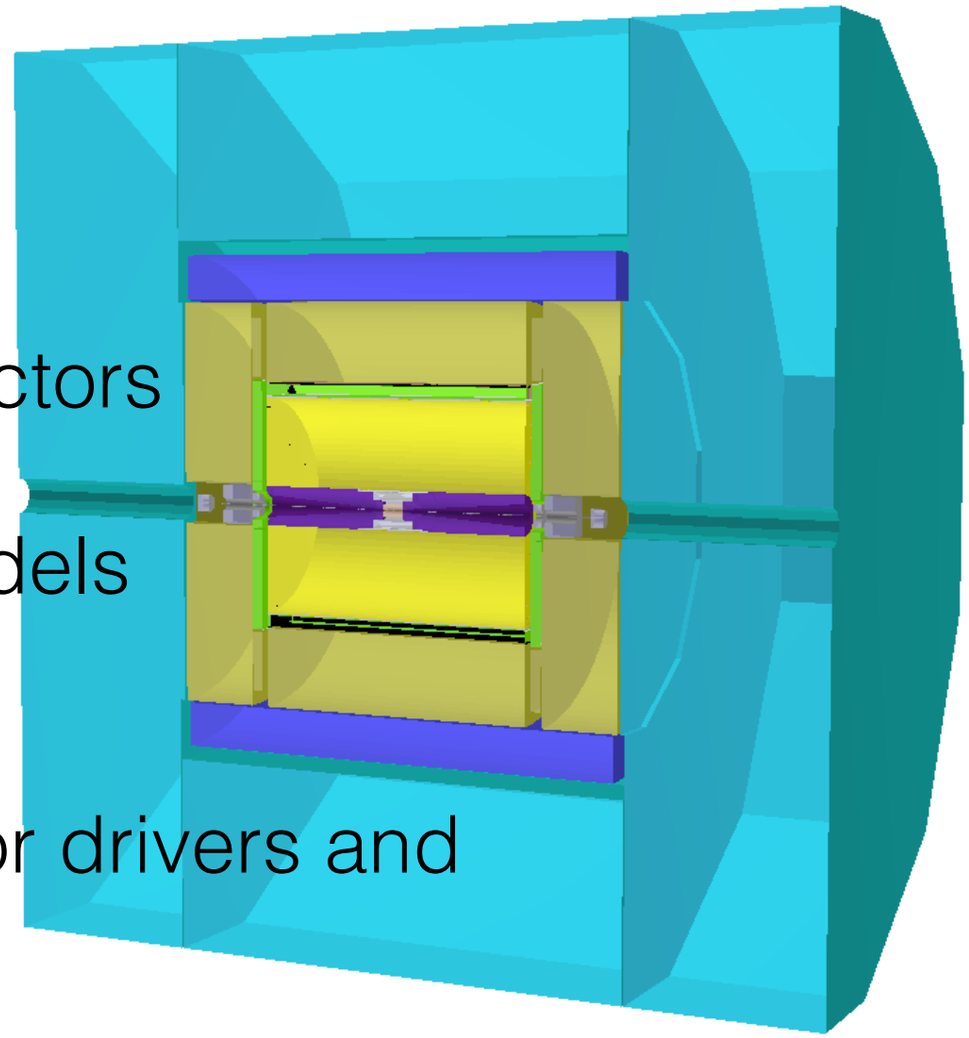
ILD_o1_v05 model in lcgeo

- ported current Mokka model ILD_o1_v05 to lcgeo/DD4hep
  - VXD, FTD, SIT, TPC, SET, beam pipe (F. Gaede)
  - Ecal, Hcal, Yoke (S.Lu)
  - Beamcal, Lcal, LHcal (A.Sailier, M.Petric)
- DDSegmentation used for sensitive layer digitisation in lcgeo/DD4hep
- modified, reimplemented and improved in DD4hep framework



Envelopes in ILD simulation model

- introduced ‘mandatory’ envelops into the ILD simulation model, in order to
  - speed up the simulation (navigation)
  - have well defined ‘real estate’ for detectors
  - synchronise more easily with CAD models (place holder volumes)
  - facilitates development of new detector drivers and models
  - eventually allow for some well defined scaling behaviour



Envelope in ILD_o1_v05

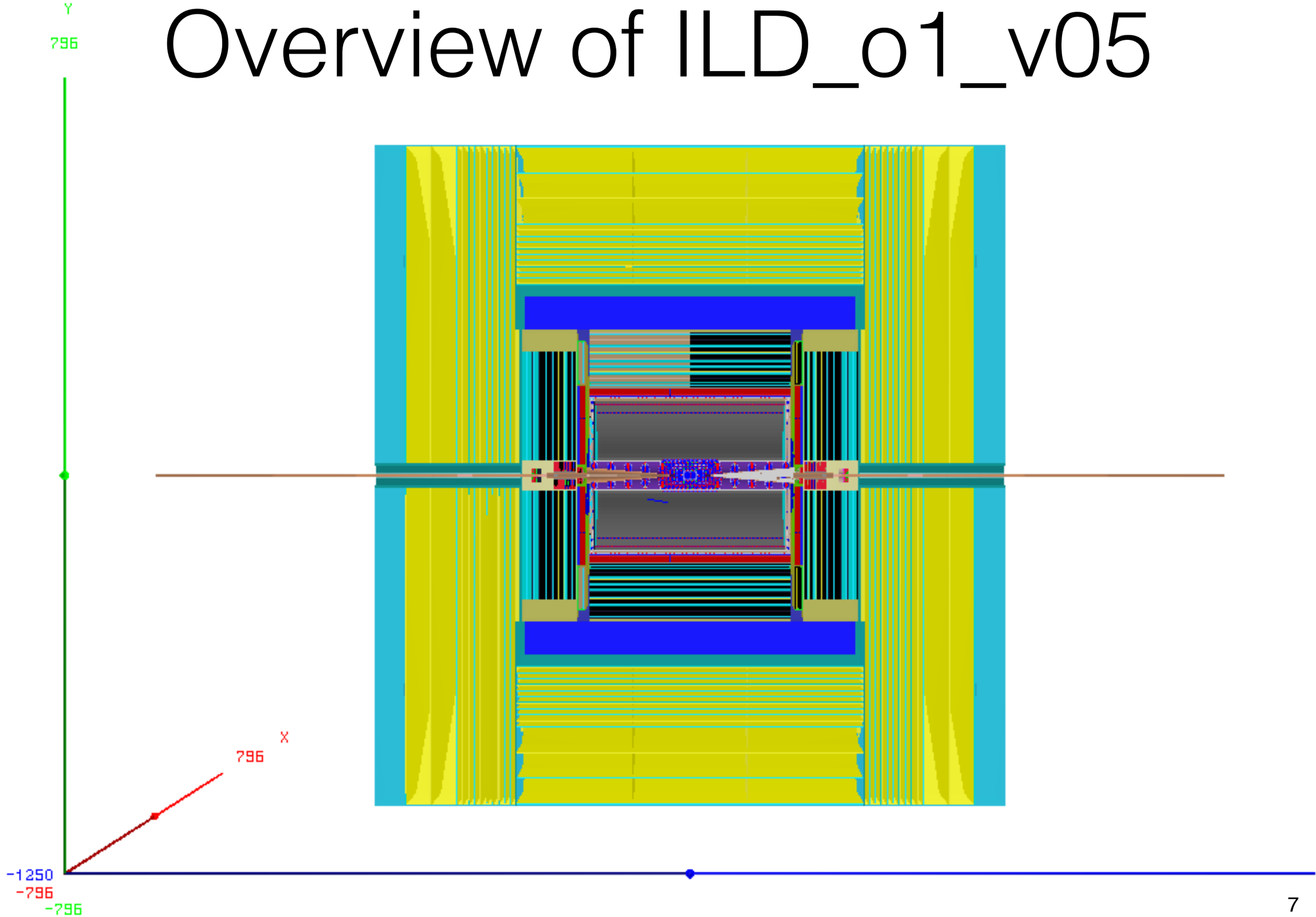
detector	inner radius	outer radius	half length min z, max z	additional parameters	

VXD	16.0	60.0	177.6	`VXD_cone_min_z`
				`VXD_cone_max_z`
				`VXD_inner_radius_1`
					80.0
					150.0
					24.1

FTD	25.1	328.9	2350.0	`FTD_outer_radius_1`
				`FTD_outer_radius_2`
				`FTD_min_z_0`
				`FTD_min_z_1`
				`FTD_min_z_2`
				`FTD_cone_min_z`
				`FTD_cone_radius`
					152.8
					299.7
					177.7
					368.2
					644.2
					230.0
					184.1

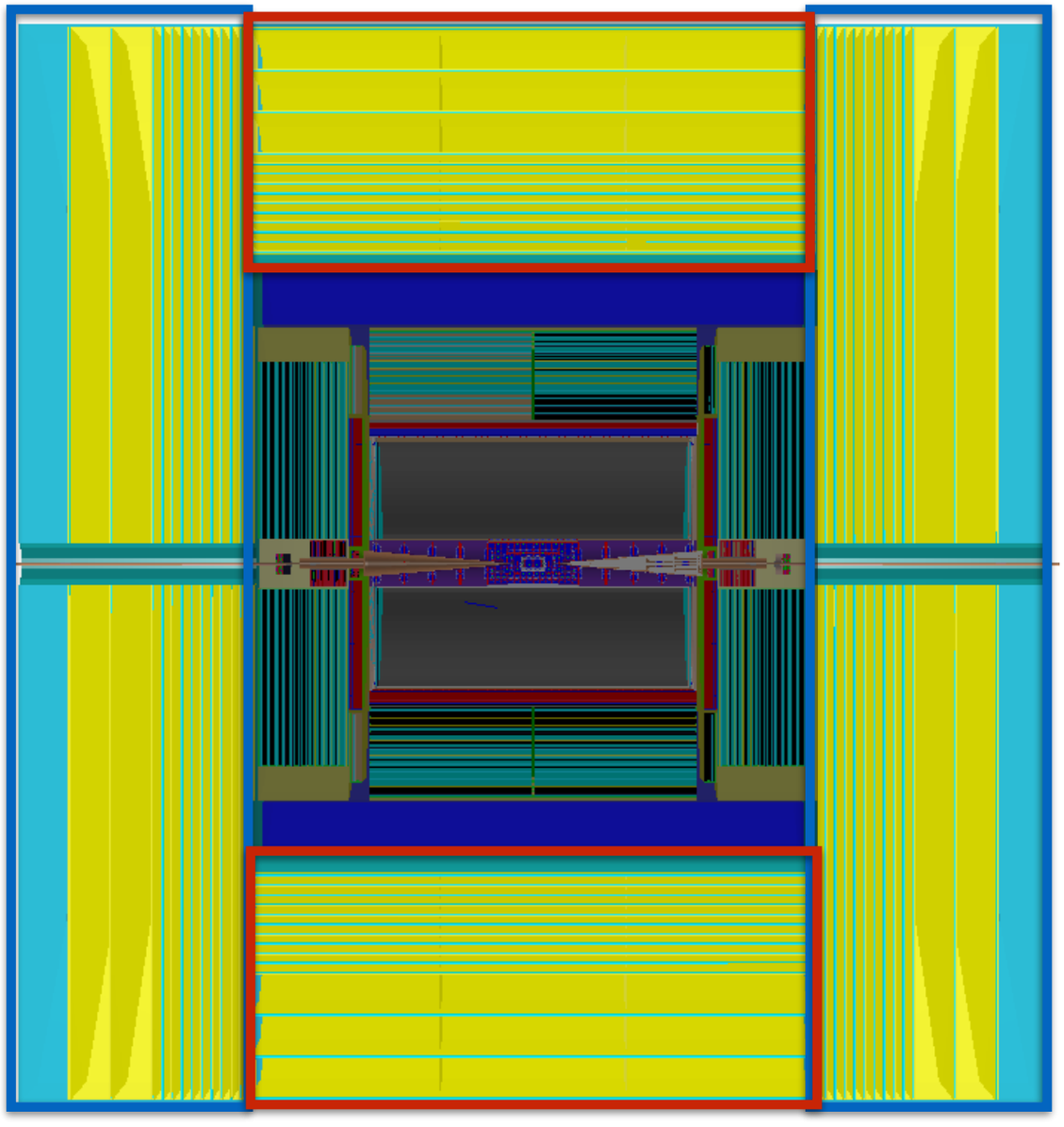
SIT	152.9	324.6	644.1	`SIT_outer_radius_1` `SIT_half_length_1`	299.8 368.1
TPC	329.0	1808.0	2350.0		
SET	1808.1	1827.9	2350.0		
Ecal	1843.0	2028.0	2350.0	`Ecal_Hcal_symmetry` `Ecal_symmetry`	8.0 8.0
EcalEndcap	400.0	2088.8	2450.0, 2635.0		
EcalEndcapRing	250.0	390.0	2450.0, 2635.0		
Hcal	2058.0	3395.5	2350.0	`Hcal_inner_symmetry`	8.0
HcalEndcap	350.0	3395.5	2670.7, 3957.7	`EcalEndcap_symmetry`	8.0
HcalEndcapRing	2138.8	3137.0	2450.0, 2635.0	`HcalEndcapRing_symmetry`	8.0
Coil	3425.0	4175.0	3872.0		
Yoke	4424.0	7725.0	4047.0	`Yoke_symmetry`	12.0
YokeEndcap	300.0	7725.0	4072.0, 7373.0	`YokeEndcap_symmetry`	12.0
YokeEndcapPlug	300.0	3395.5	3981.5, 4072.0	`YokeEndcapPlug_symmetry`	12.0
BeamCal	20.0	150.0	3475.0, 3695.0	`BeamCal_thickness` `BeamCal_tubeIncoming_radius`	220.0 15.0
LHCal	100.0	325.0	2680.0, 3200.0	`LHCal_thickness`	520.0
LumiCal	80.0	195.2	2500.0, 2630.7	`LumiCal_thickness`	130.7

Overview of ILD_o1_v05



Yoke in DD4hep/lcgeo

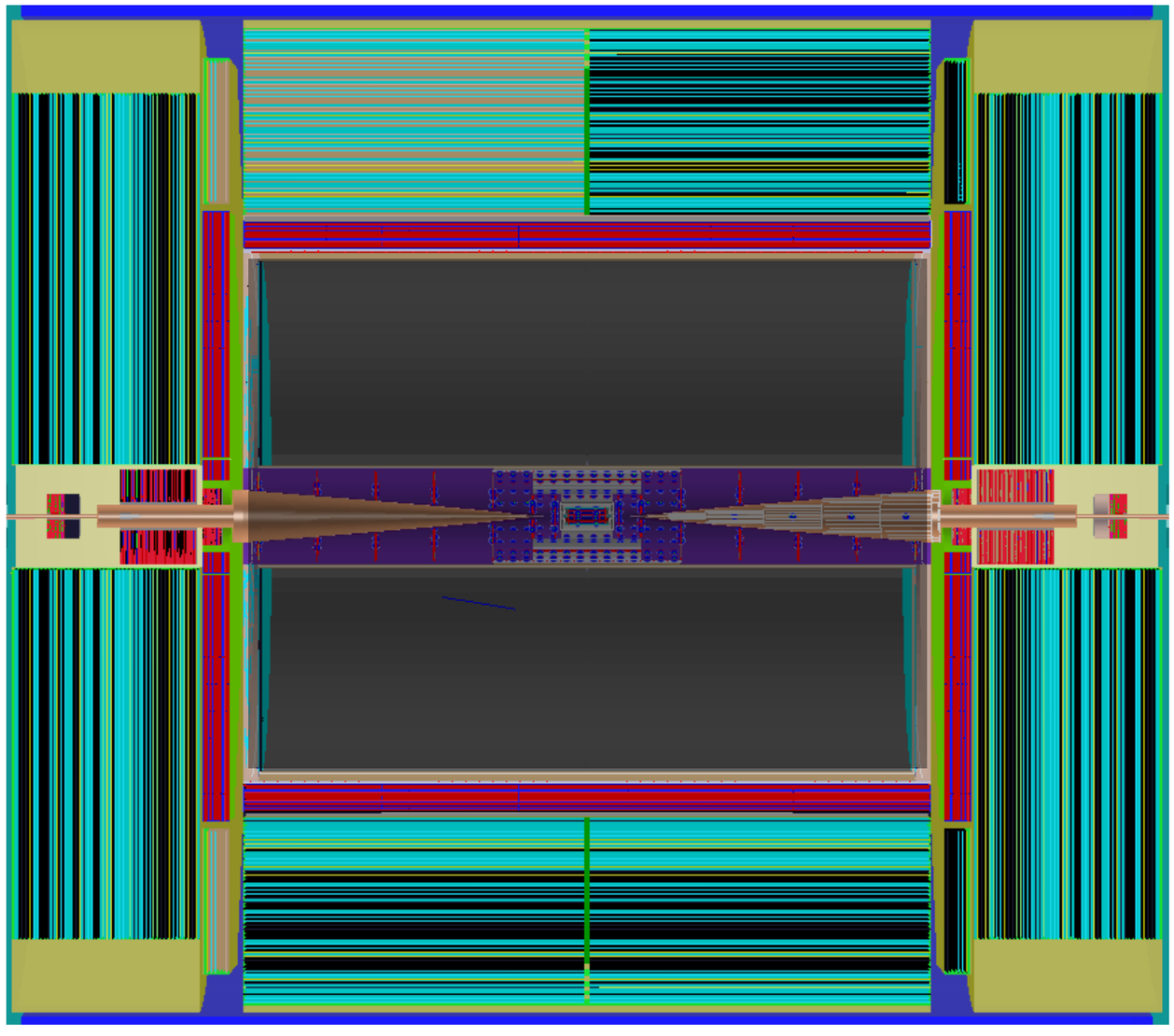
- ported from Mokka by S.Lu
  - line by line from Yoke05 geometry
  - comment out unused code lines for accessing database
  - adapted to the New DD4hep [code.cc/compact.xml] style
  - further cleanup needed fully adapt to DD4hep framework
  - validation and improvement needed
- **currently review by N.D`Asczenso**



The high light part is the Yoke barrel and endcaps

AHcal in DD4hep/lcgeo

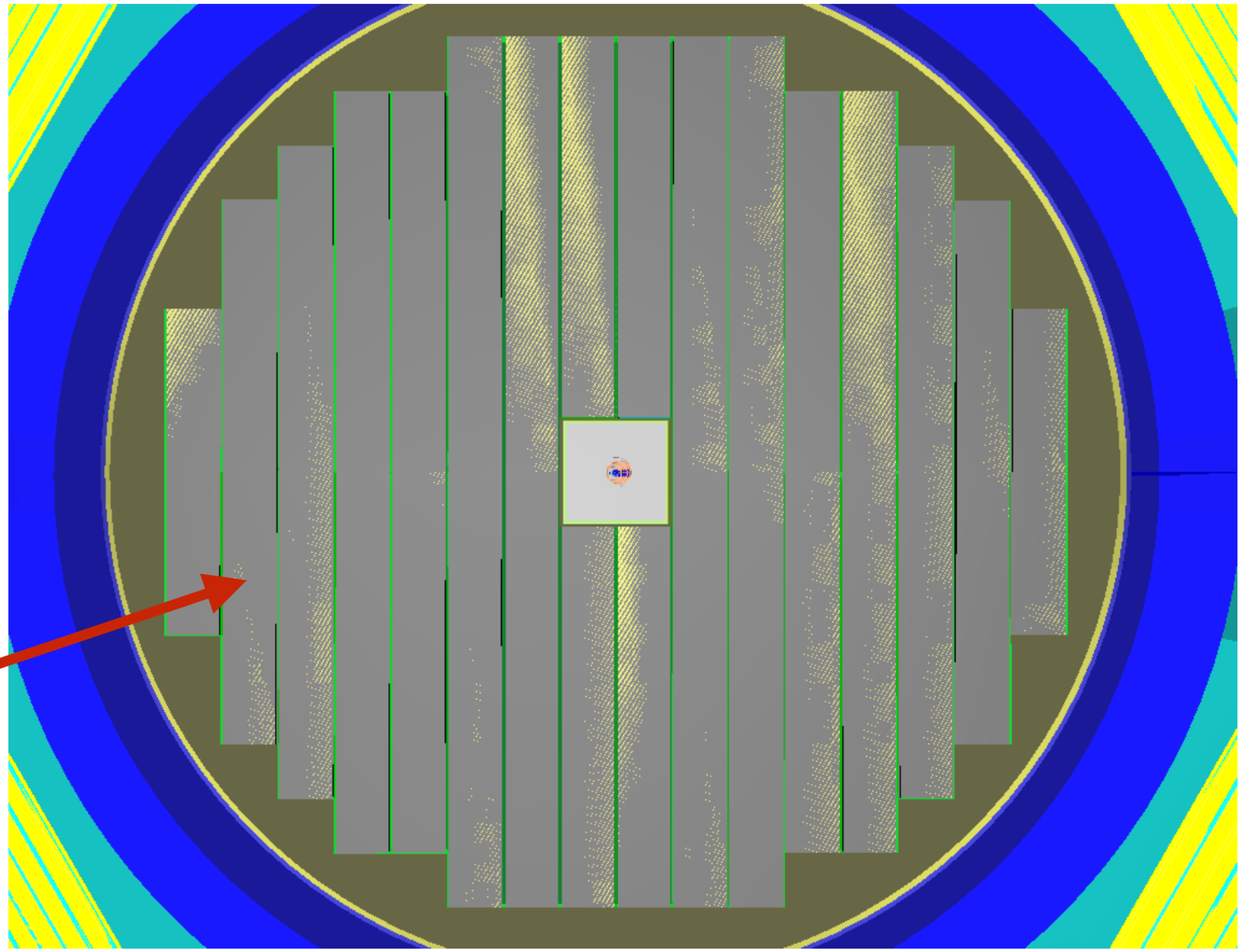
- AHcal ported/reimplemented by S.Lu
  - the latest engineering design
  - adapted to DD4hep framework
  - improved on scaling for next optimisation study
- custom segmentation code for AHcal Barrel scintillator tile has been implemented
  - layer edge fraction tile: same size in the same layer, each lager than half tile,
  - further improvement needed on fraction position



The high light part is the AHcal barrel and endcaps

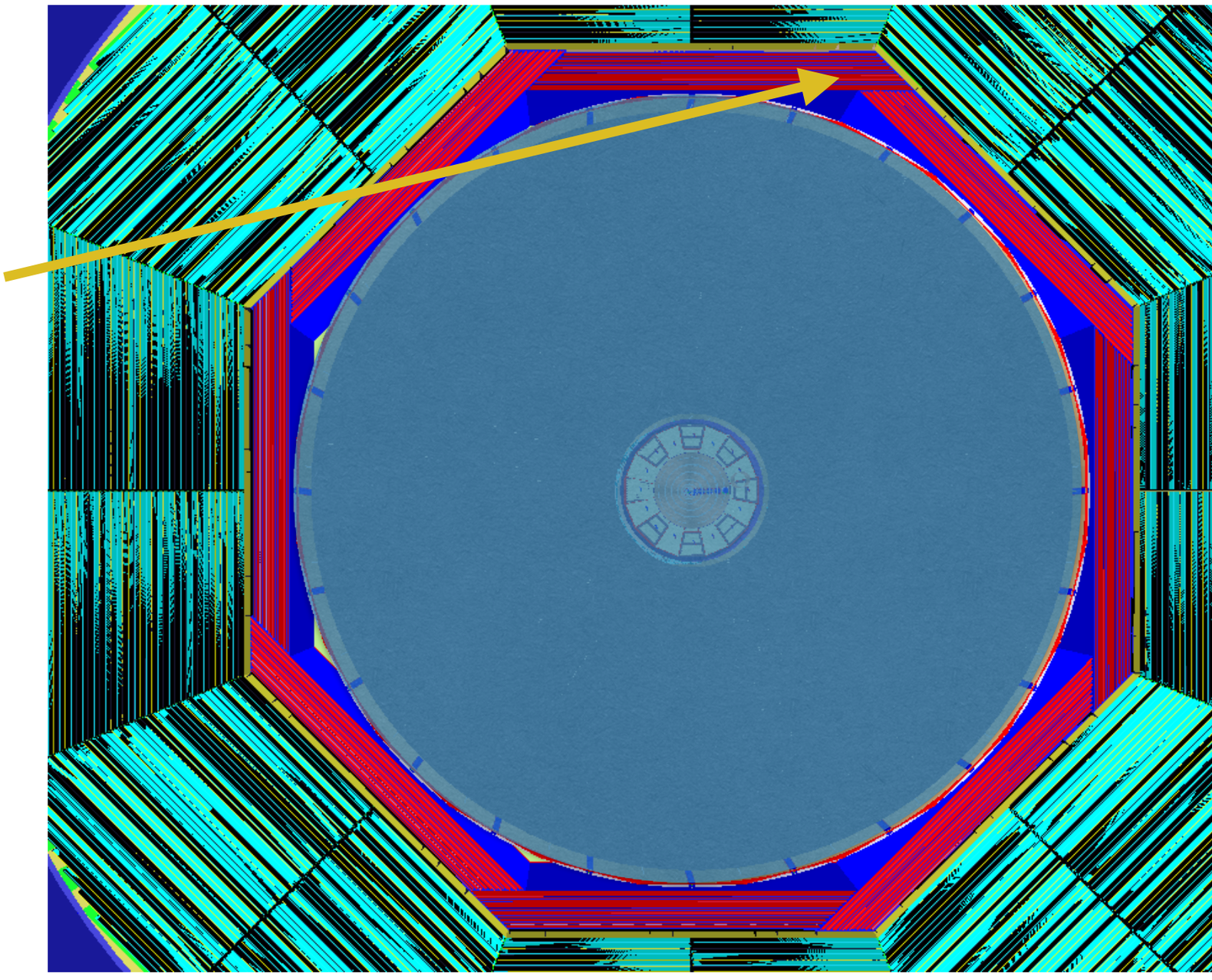
AHcal Endcaps in DD4hep

- the lastest HBU engineer design model has been implemented in the lcgeo.
- It include 16 towers, build base the HBU type size.
- DDSegmentation used for the tile digitisation



SiEcal Barrel in DD4hep/lcgeo

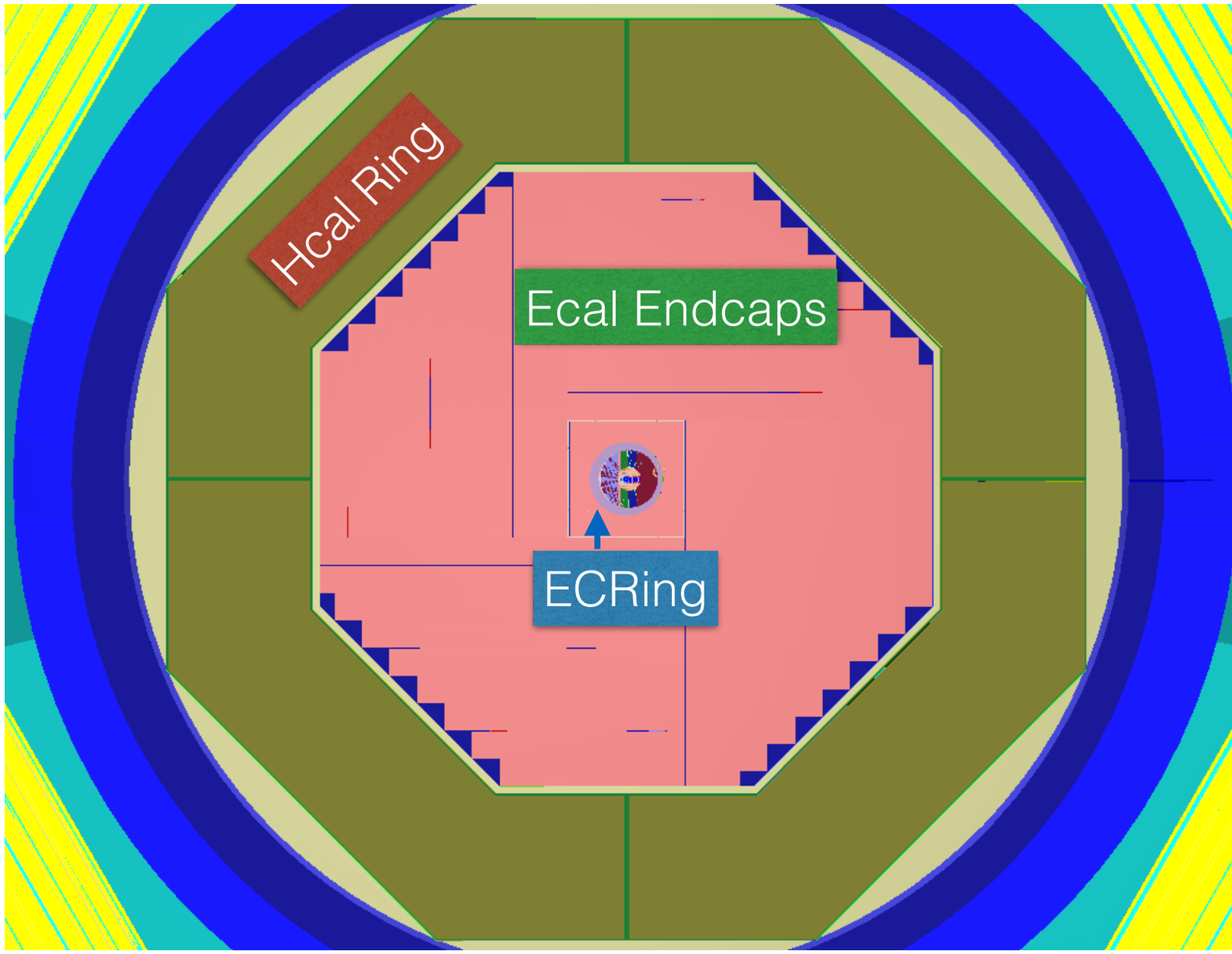
- ported from Mokka by S.Lu for **ILD_o1_v05**
  - SiW option only
  - adaptation of code flow
- new common ILD/CLIC Ecal driver exists:
  - after expert meeting at LLR
  - issue w/ endocarp symmetry (12 vs 8)
  - double layer structure ?
- **Need resolution and review by Ecal experts !**



Endcaps model in lcgeo

- Simple Hcal Ring, which ported from Mokka
  - less effort made here
- The EcalEndcap and EcalECRing, which ported from Mokka
  - SiW option only for ILD_o1_v05
  - new common ILD/CLIC Ecal driver exists after expert meeting at LLR

➡ same situation as barrel

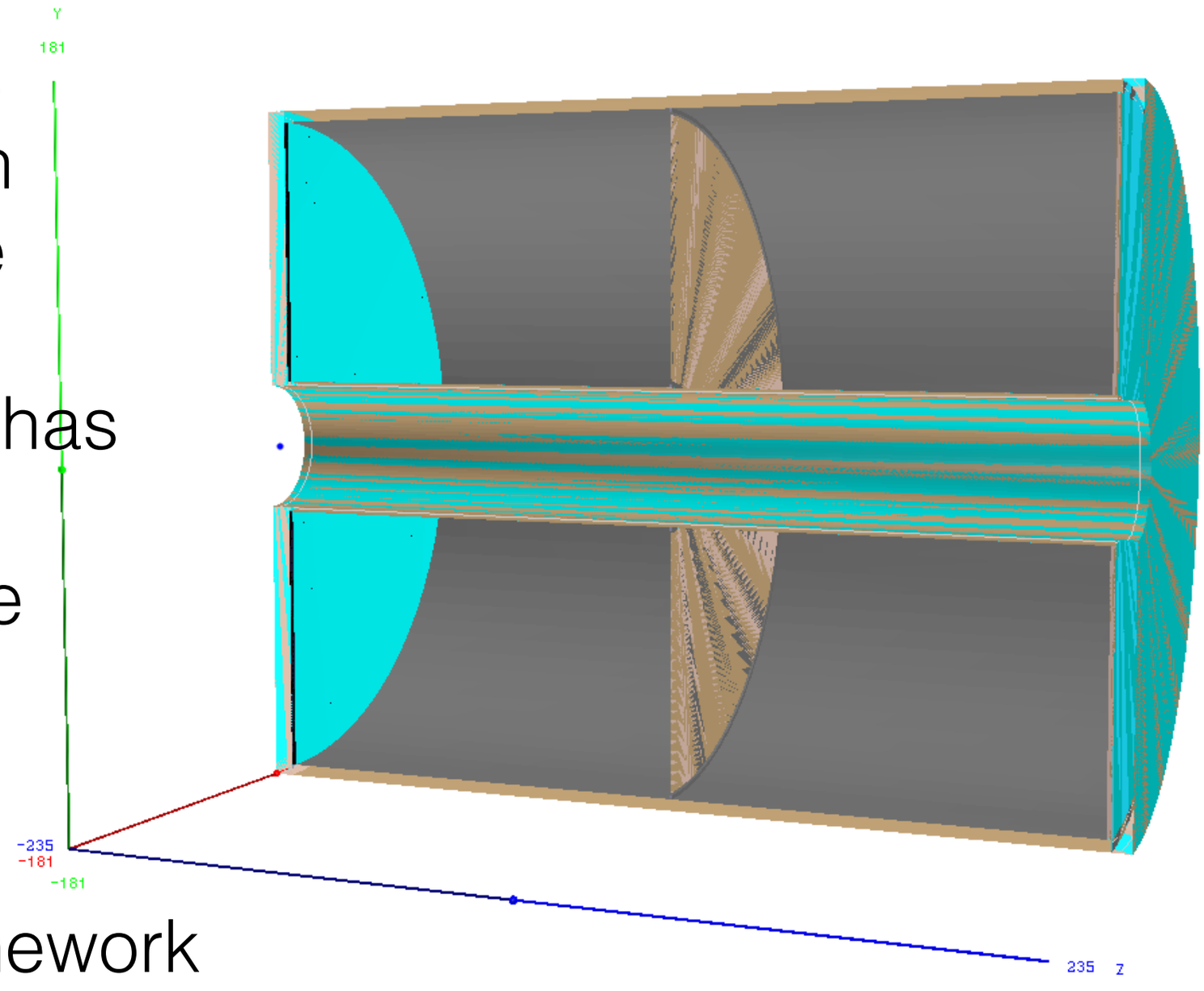


TPC in lcgeo

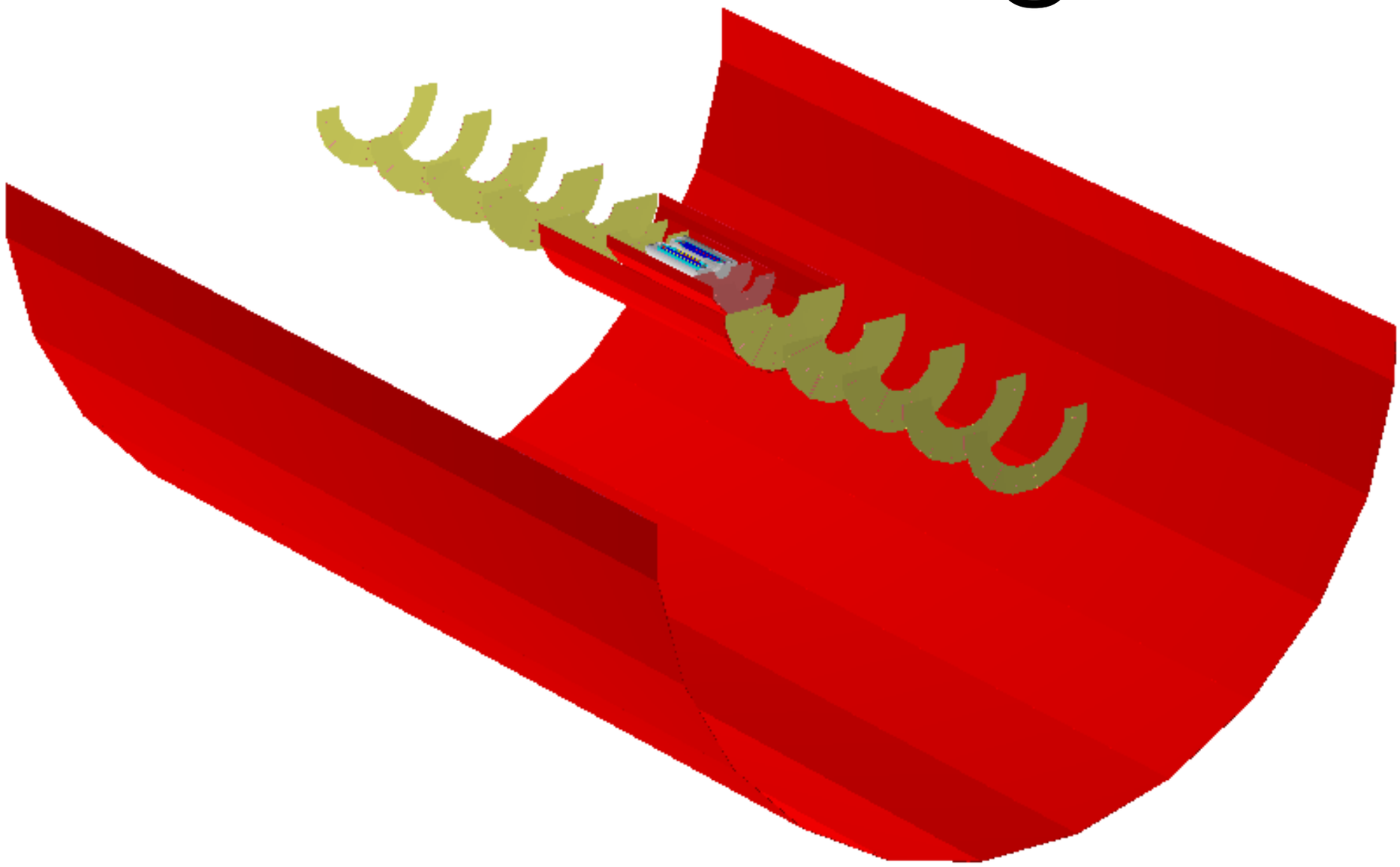
- TPC is the same as Mokka in simulation ported by F. Gaede

- The reconstruction has been adapted to DD4hep/DDSurface

- New DD4hep/ DDMarlinPandora reconstruction framework working with this update.

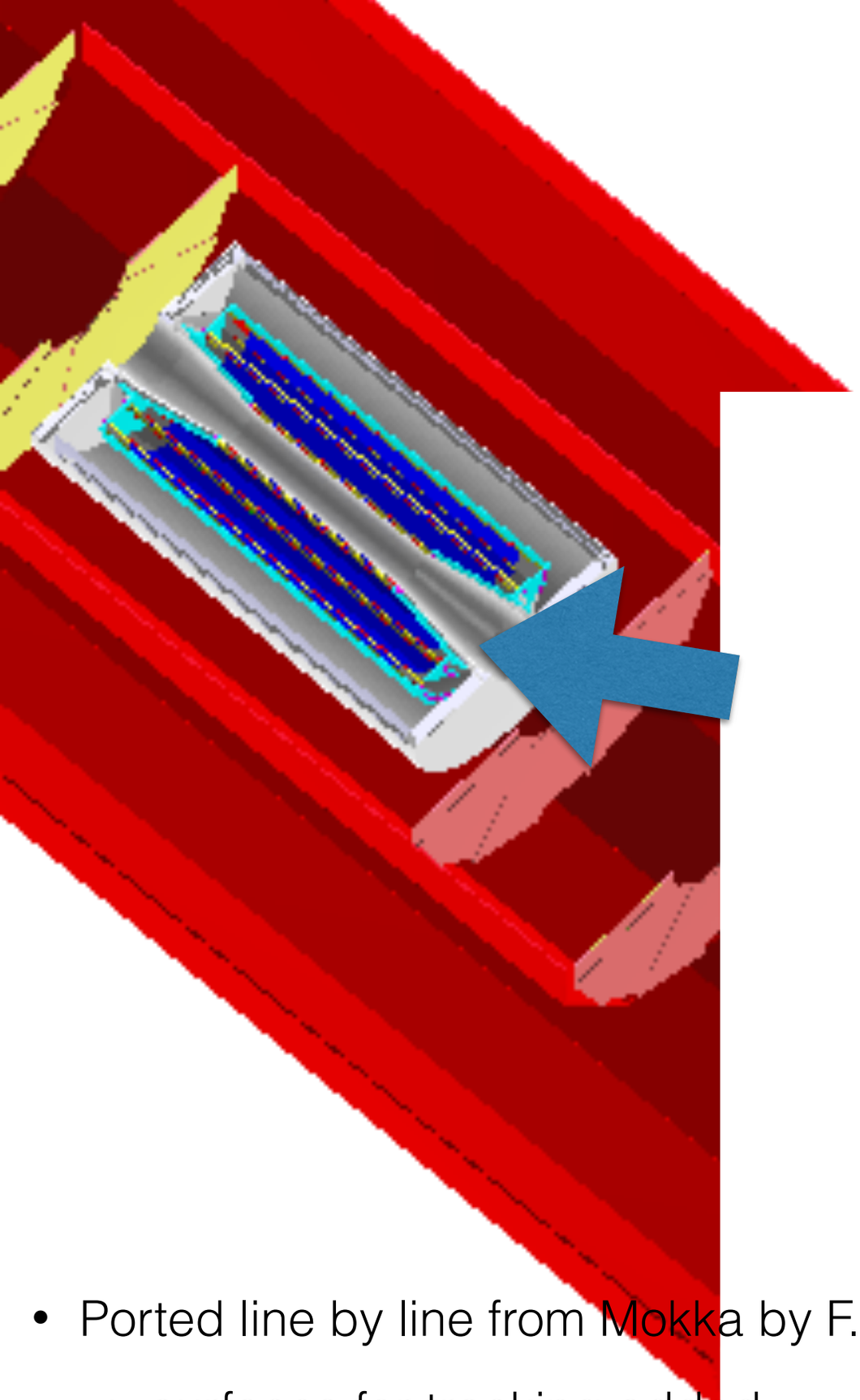


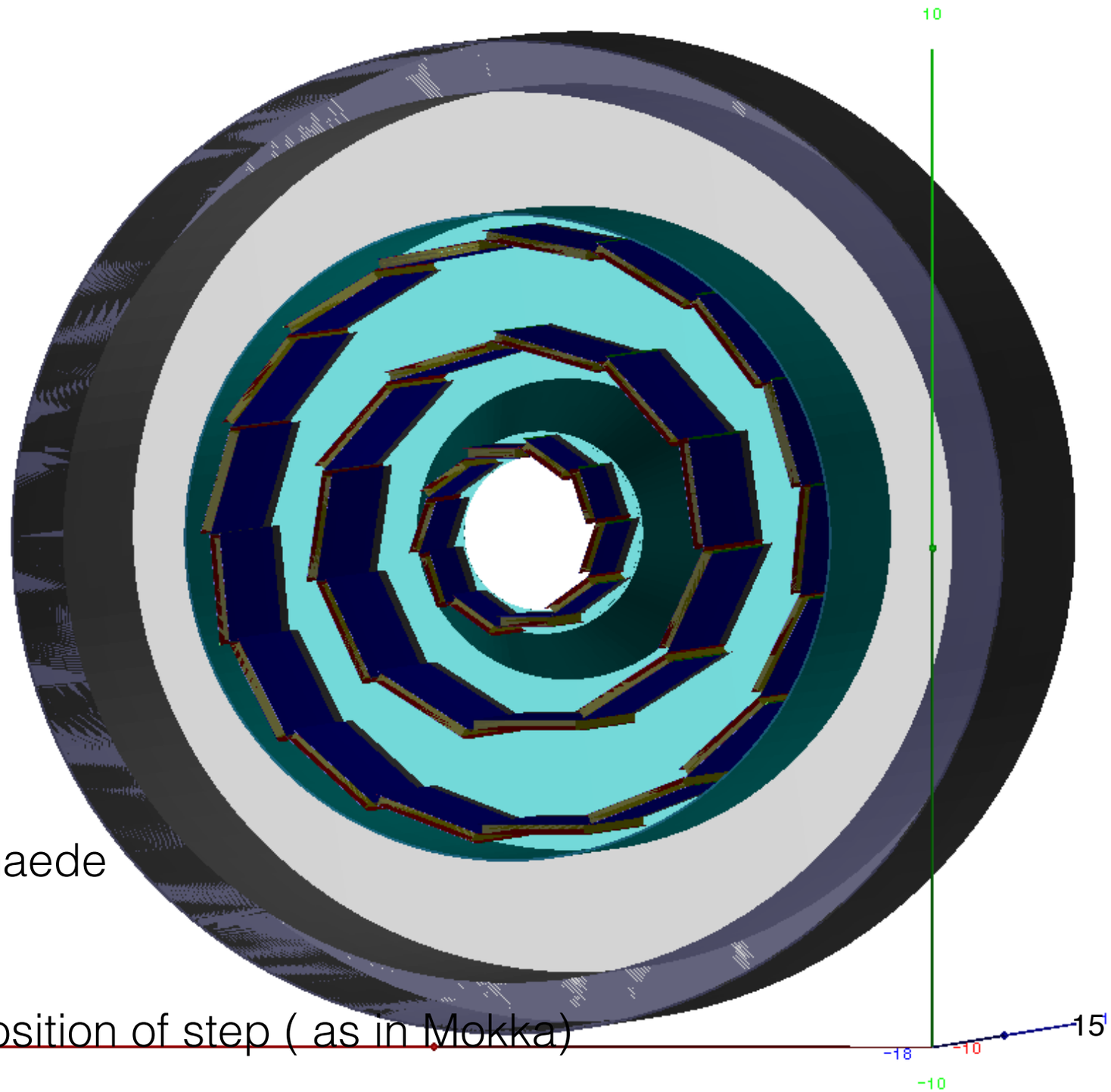
SET SIT in lcgeo



- Ported line by line from Mokka by F. Gaede
  - surfaces for tracking added
- sensitive detector computes mean position of step (as in Mokka)

VXD in lcgeo



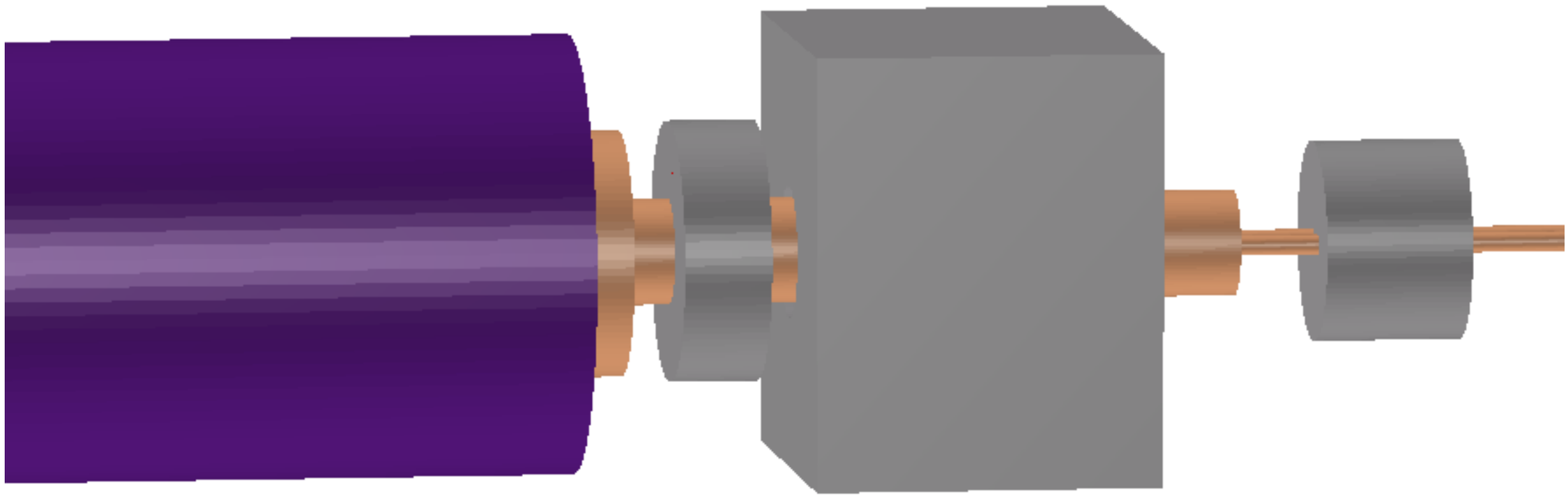


- Ported line by line from Mokka by F.Gaede
  - surfaces for tracking added
- sensitive detector computes mean position of step (as in Mokka)

FTD in lcgeo

- Ported line by line from Mokka by F.Gaede
  - surfaces for tracking added
- sensitive detector computes mean position of step (as in Mokka)

Forward Calo in lcgeo



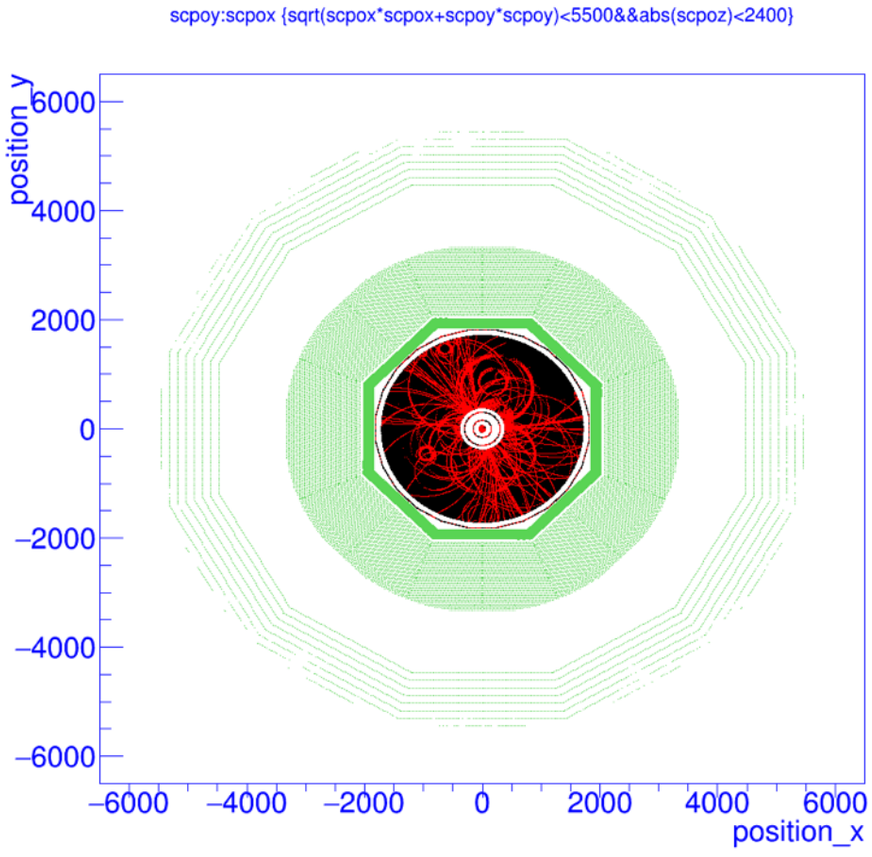
Lcal LHcal Beamcal

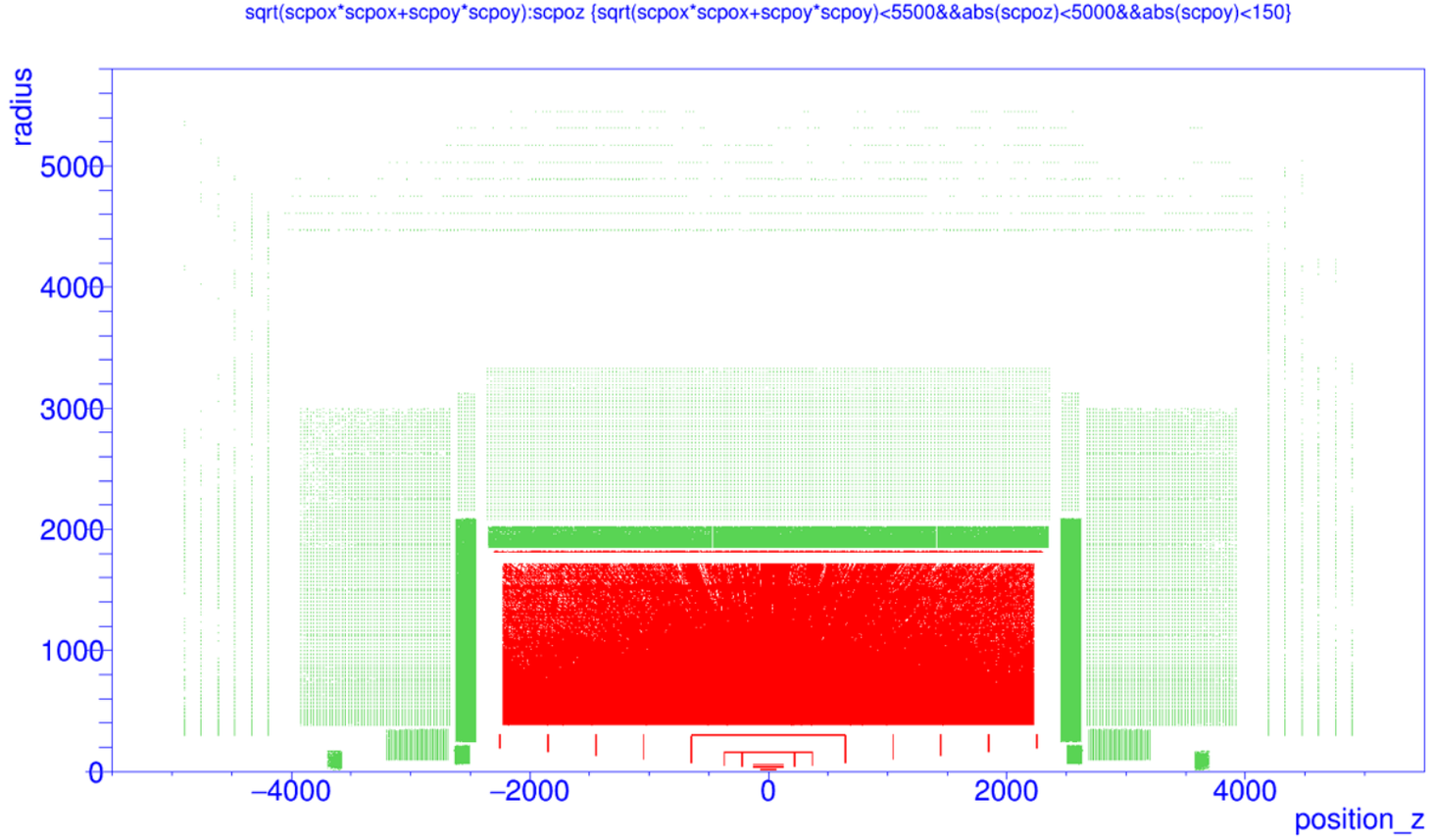
- written by A.Sailier, M.Petric
- shared drivers between ILD and CLICdp

beam pipe in lcgeo

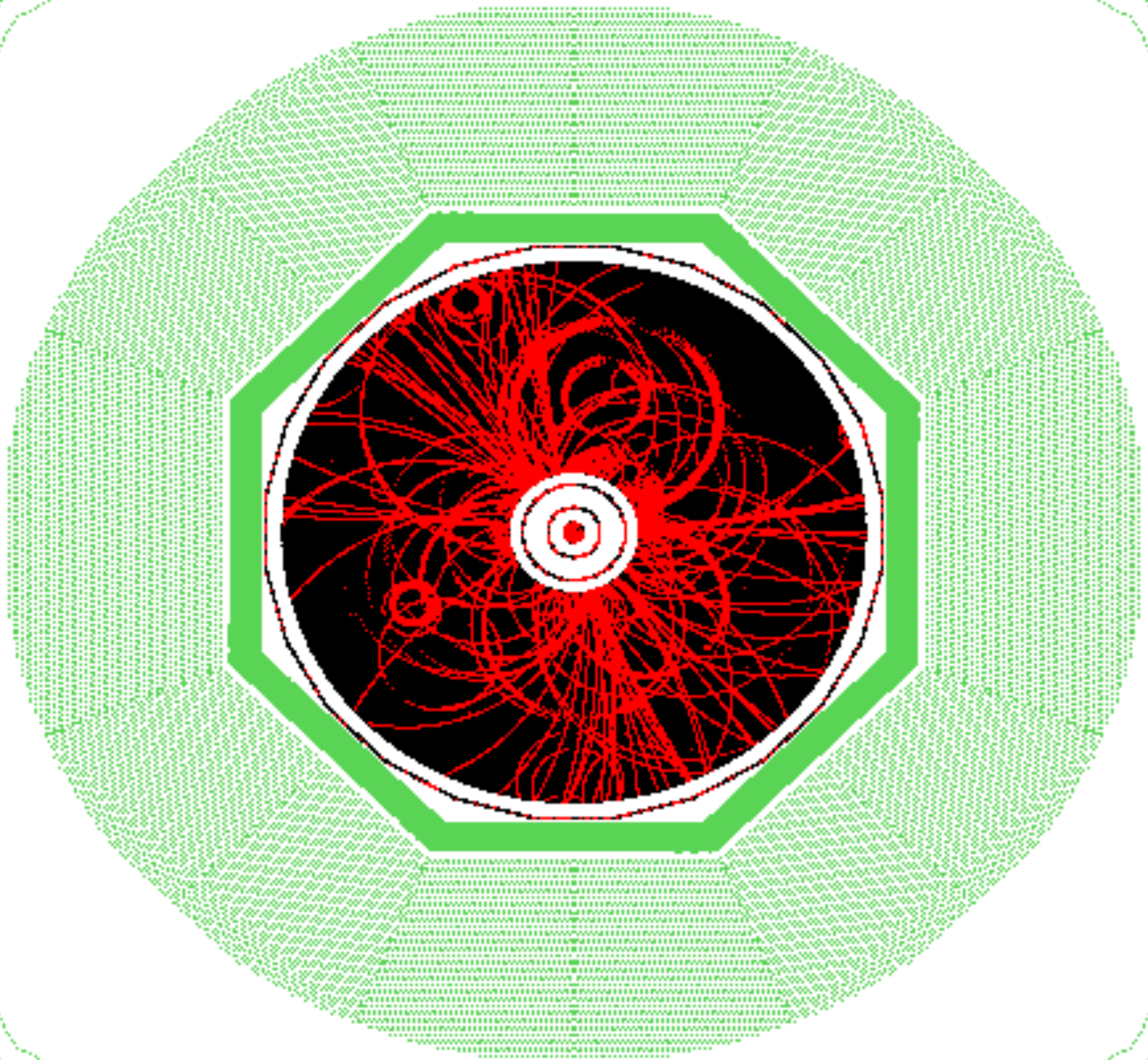
- rewritten by A.Sailer
  - compatible with Mokka

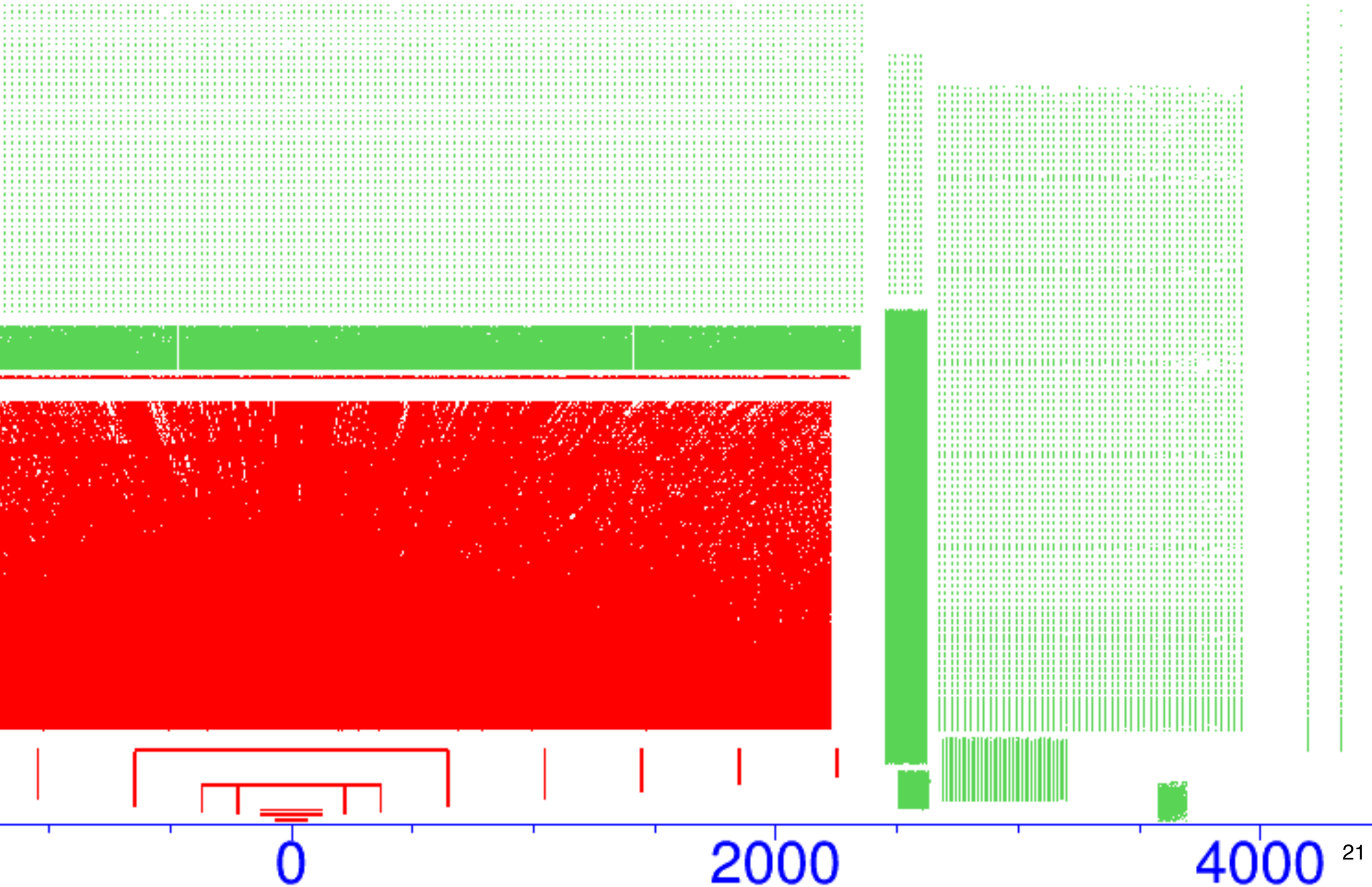
Hits map in ILD_o1_v05



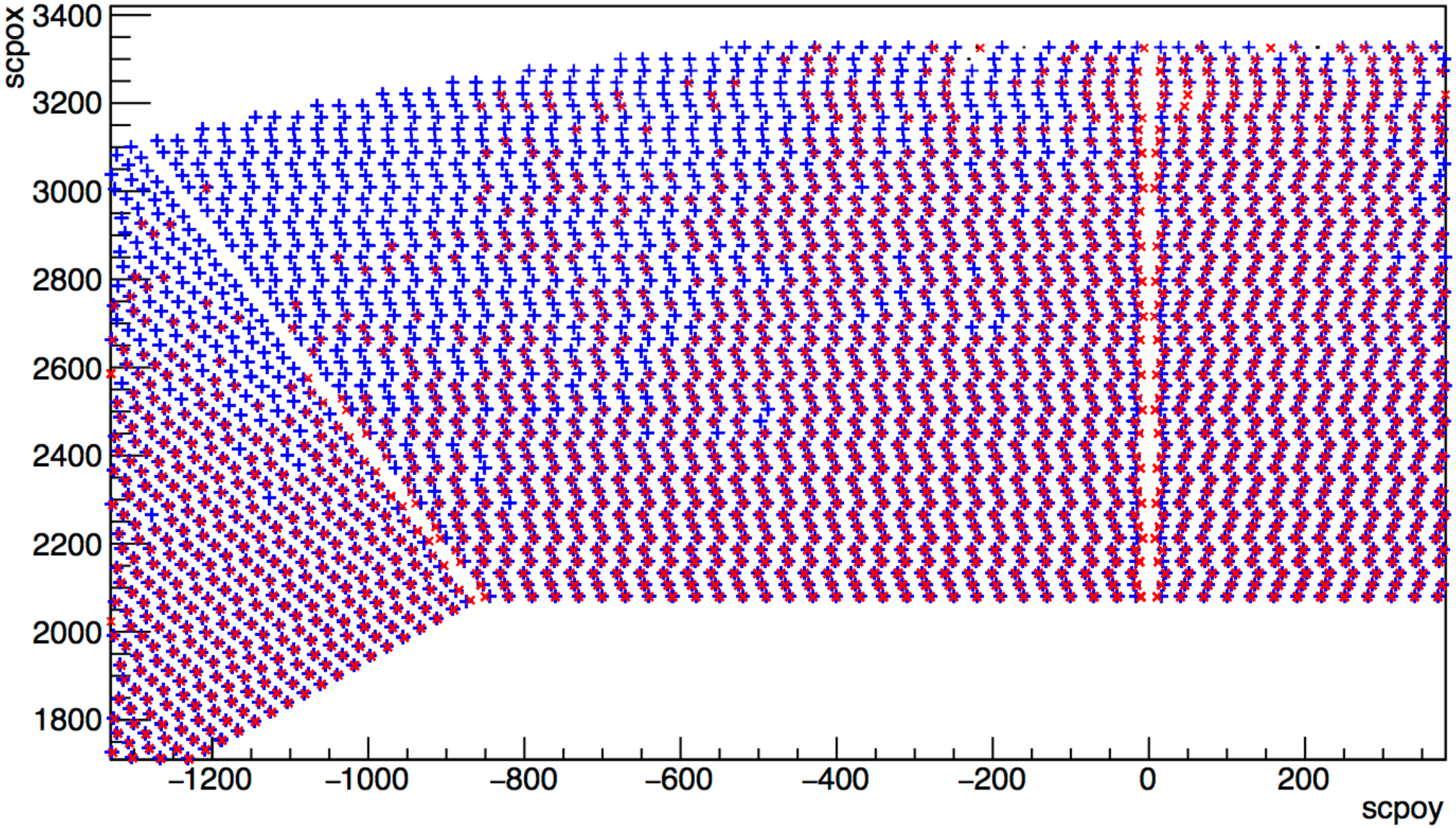


- can now fully simulate new DD4hep based ILD_o1_v05 model
- The green part are calorimeters, and the red part are trackers. The inner Si trackers are displayed clearly here in the hits map




0
2000
4000

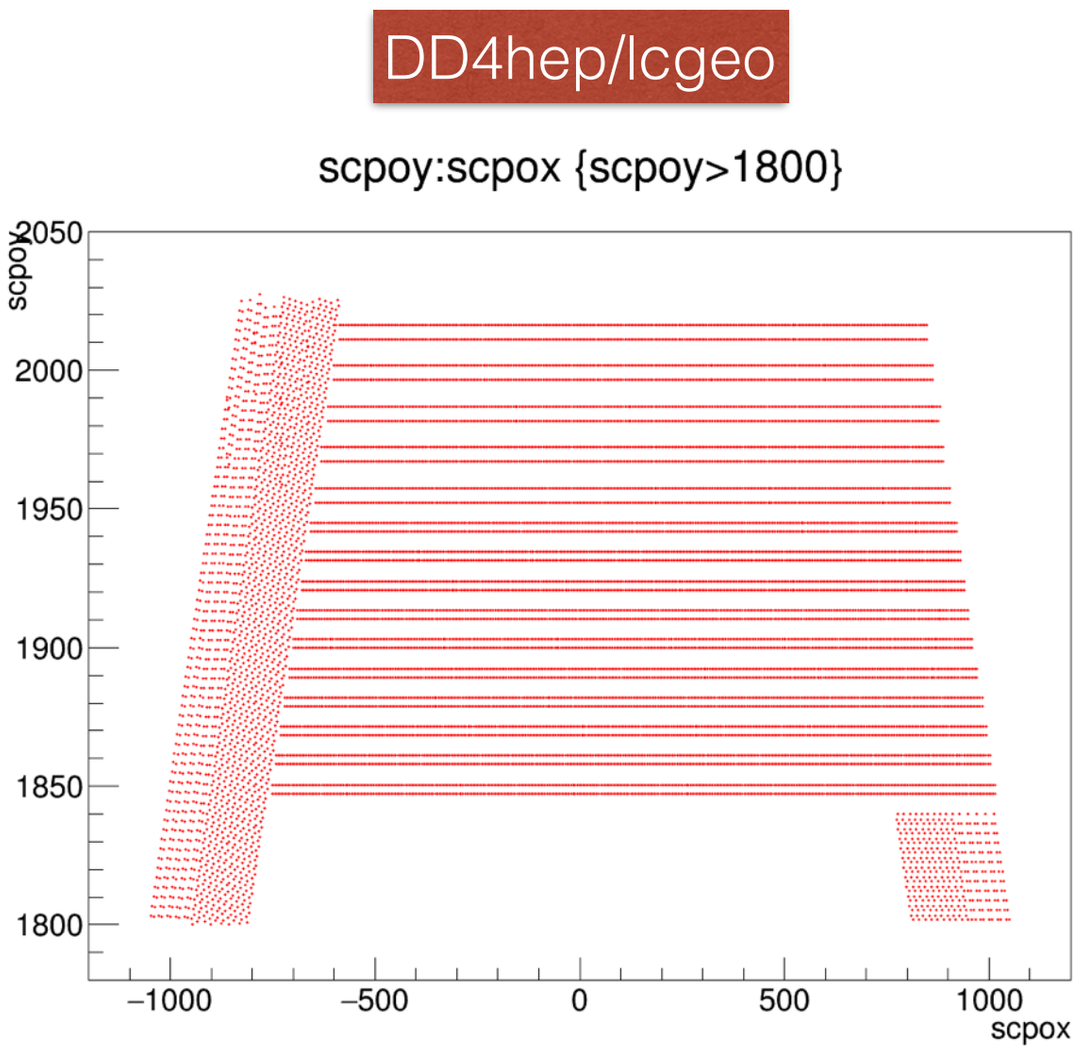
Validation of the AHcal SD



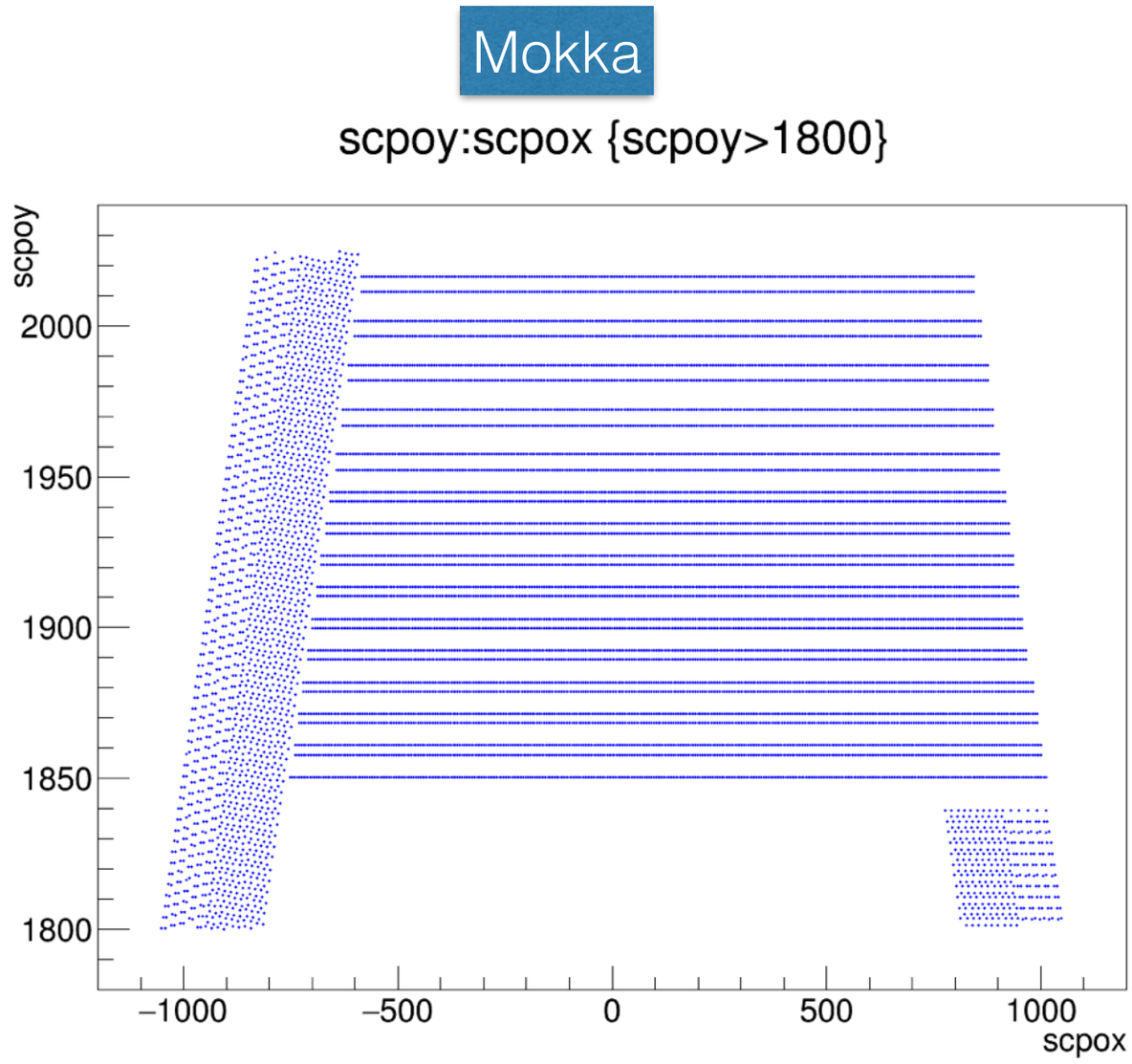
- The scintillator sensitive tile digitisation has been reimplemented in DD4hep/lcgeo.

Ecal Hits map in ILD_o1_v05

DD4hep/lcgeo



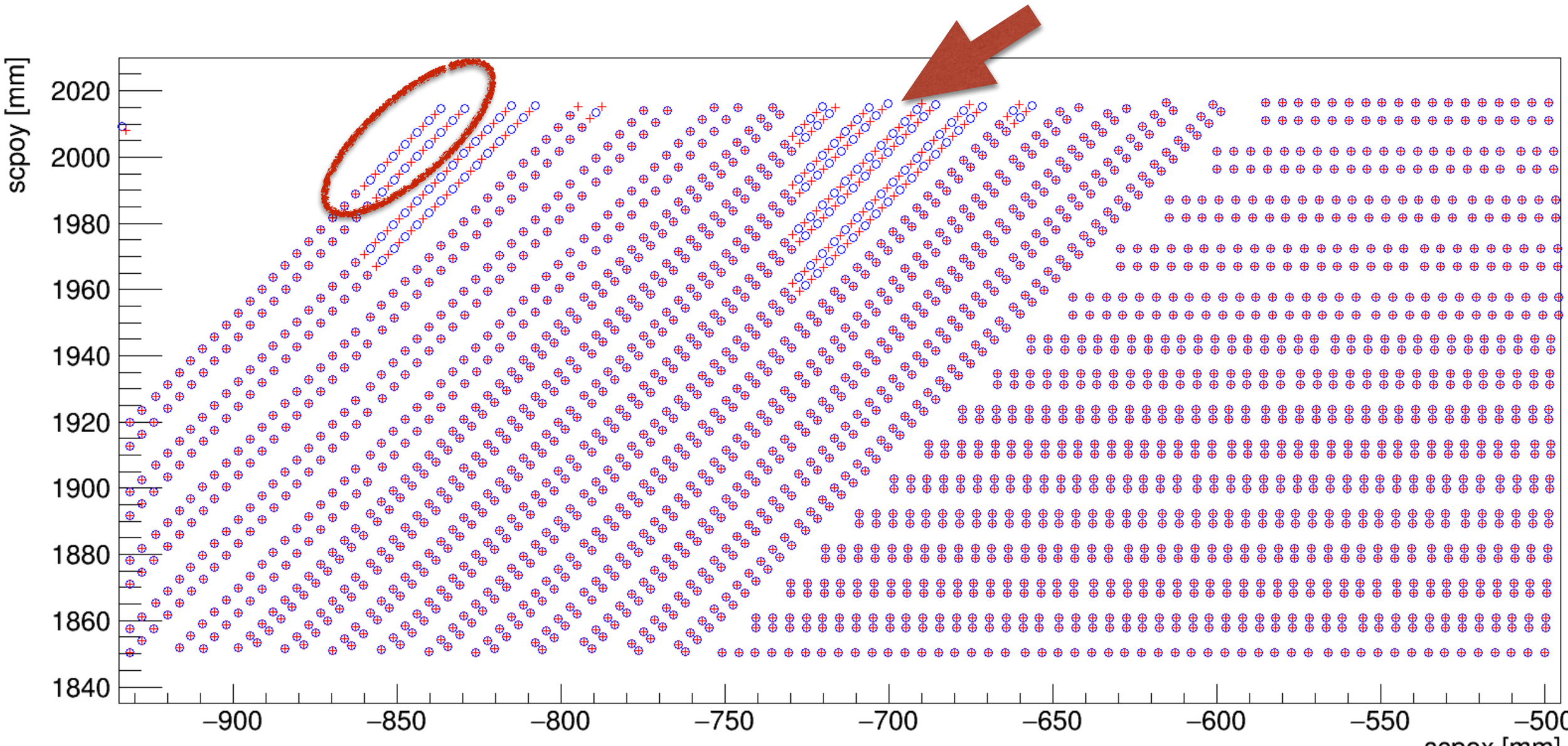
Mokka



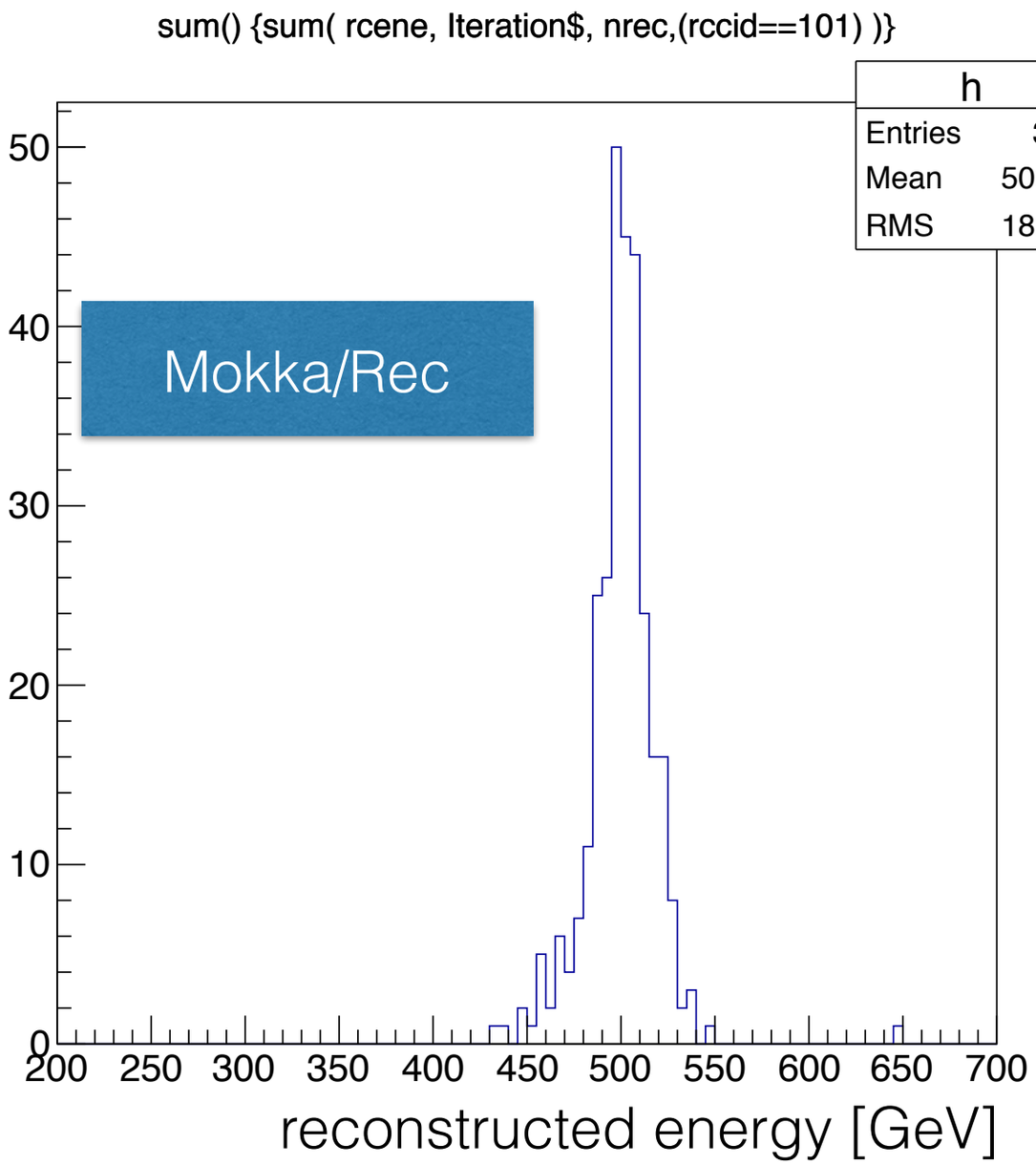
- during the validation, one issue found in the ported SiEcal driver in lcgeo.
  - ➡ Mokka has a separated collection, “PreShower”, for the most inner layer.
  - ➡ ported SiEcal driver in lcgeo as Mokka, has a separated collection “PreShower” too.
- the reality to be checked and confirmed by R&D group expert.

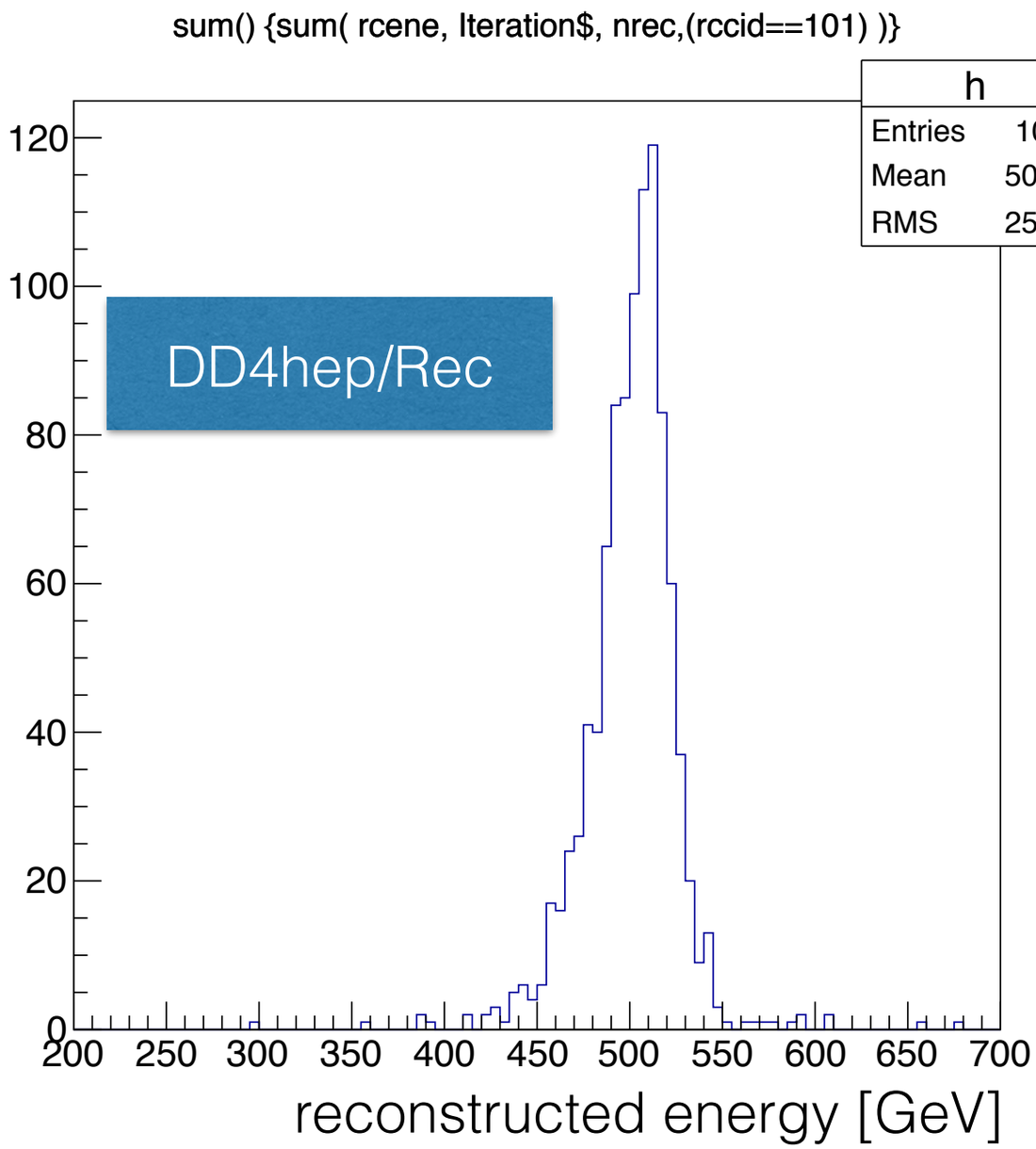
Validation of the Ecal SD

- a generic segmentation (with one offset value) used for cell digitisation
  - further improvement and implementation needed



Validating Reconstruction





- Mokka+REC (left), DD4hep+REC(right).
  - 500GeV uds sample
  - reconstructed with DD4hep/DDRec, DDCaloDigi and DDMarlinPandora
  - calibration constants from Mokka stdreco

Summary

- The **lcgeo** is a new DD4hep based detector geometry description and simulation package with **complete simulation model ILD_o1_v05**.

  ➡ Tracking detectors have been ported line by line from mokka into DD4hep/lcgeo.

  ➡ DDSegmentation used as sensitive layer digitisation with DD4hep.

    ➡The scintillator sensitive tile digitisation has a custom implemented segmentation driver in DD4hep/lcgeo.

  ➡ Silicon Ecal first layer has been written into preShower collection, too.

- Further improvement and validation, or any new design geometry driver will be done by **R&D group expert**.

- Please **nominate responsible person** to continue to validate and improve the geometry description and sensitive detector digitisation implementation for each sub-detector in parallel.