Validation of the ILD simulation models

Frank Gaede, DESY
Integration pre-meeting @ ILDMeeting
Fokuoka, Japan, May 21, 2012

new Mokka post-LOI ILD models:

- major rewrite of some sub detector drivers :
  - SIT, SET, ETD - FTD - Muon
  - increased level of detail and realism (incl. services)
- made existing drivers more realistic:

  - TPC, AHCal, Ecal, FCal,...
- new drivers (technology options):

  - SDHCal, SciEcal
- added overall services and cables

- new models for DBD:

**ILD_O1_v03** "ILD simulation reference Model for DBD using Analog HCal"
ILD_O2_v03 "ILD simulation reference Model for DBD using SD HCal"
ILD_O3_v03 "ILD simulation reference Model for DBD using SciW Ecal and Analog HCal"

- first part ILD_OX – read "ILD – Option X", refers to the choice of sub-detector technology options of the model

- second part _vXX refers to the software release version that describes this option for ILD

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increased realism in ILD_OX models

- added cabling and services for TPC, ECal & Hcal (C.Clerc, G.Musat)
- including inner detector services as defined by R&D groups

Mokka

cooling pipes

electronics
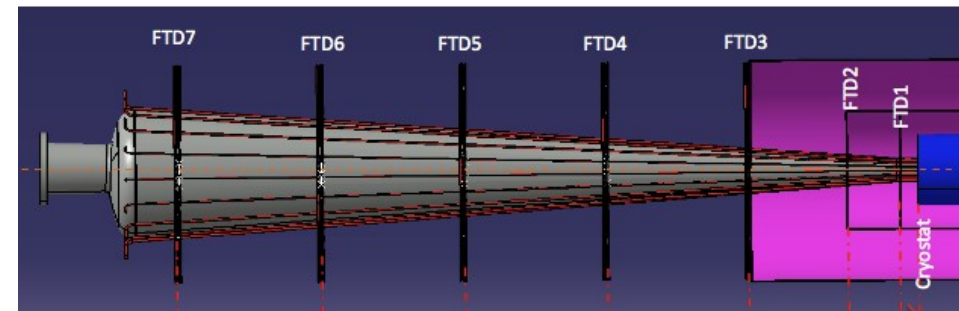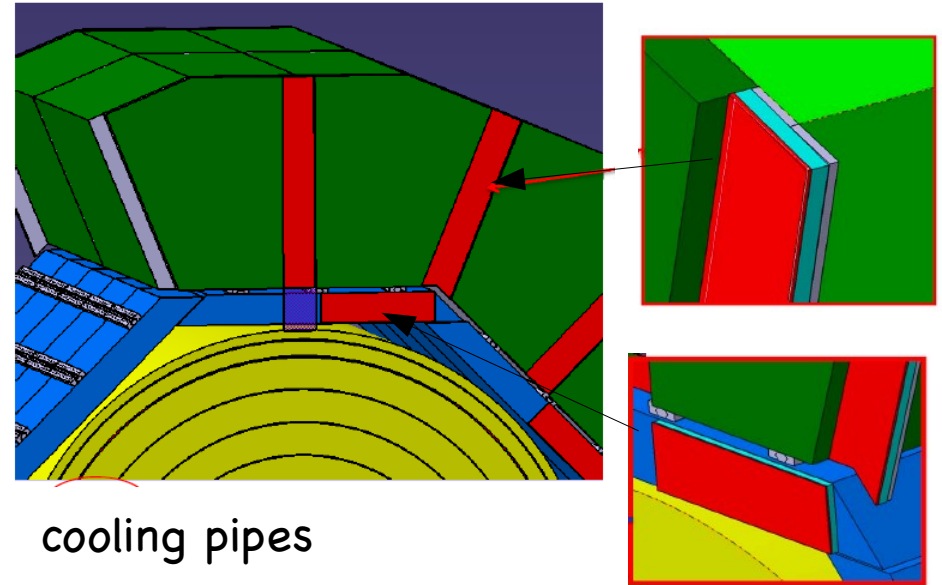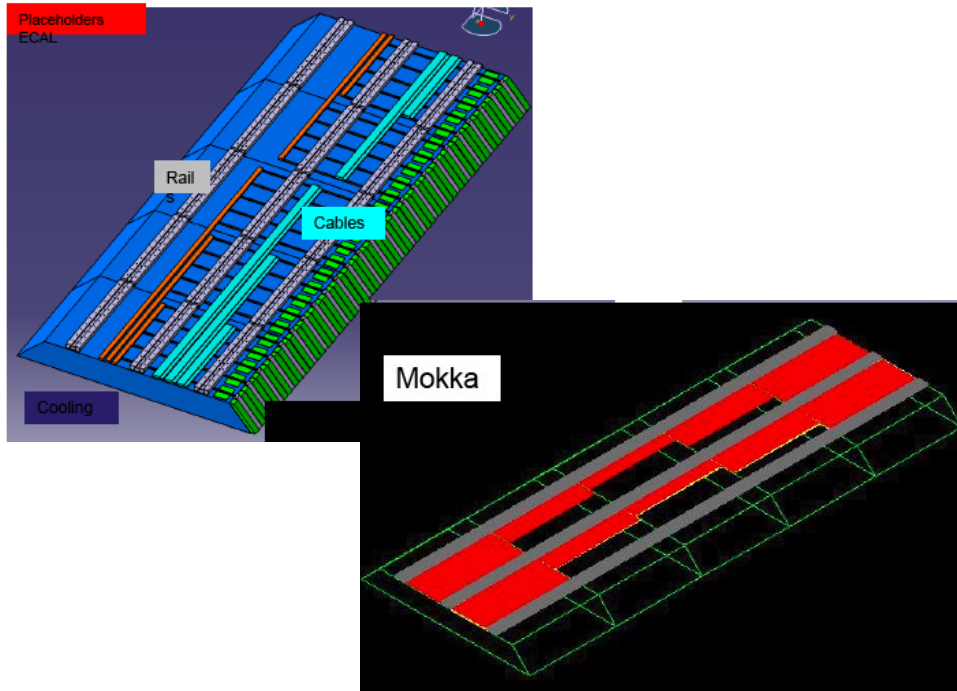
big step forward in increasing realism of ILD detector simulation !

power supply cables

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validation of Mokka ILD model(s)

- started validation process with volunteers nominated by the subdetector R&D groups, checking the Mokka drivers for:
 - overlaps, consistency w/ engineering model, hit production,..

detector	person
VXD	G.Voutsinas
SIT/SET	K.Androsov
FTD	J.Duarte
TPC	S.Aplin
ECal	D.Jeans
AHCal	Sh.Lu
SDHcal	G.Grenier
FCal	A.Rosca, B.Pawlik
Muon	A.Saveliev

start MC production, once all sub detectors are 'approved'

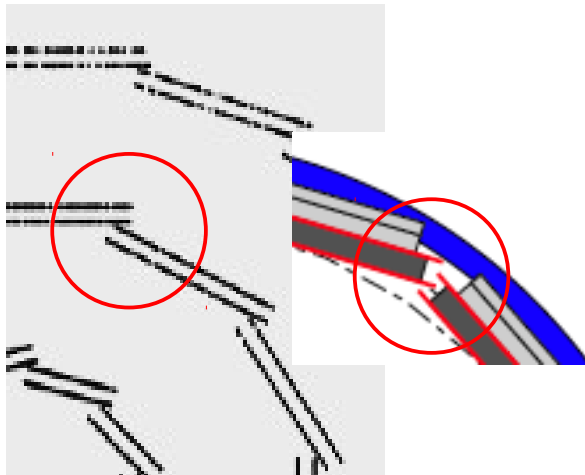overall overlap checking: Ch.Grefe

VXD validation

50 μm Si	
10 μm Al	
50 μm kapton	
1.88 mm SiC foam 6 % density	
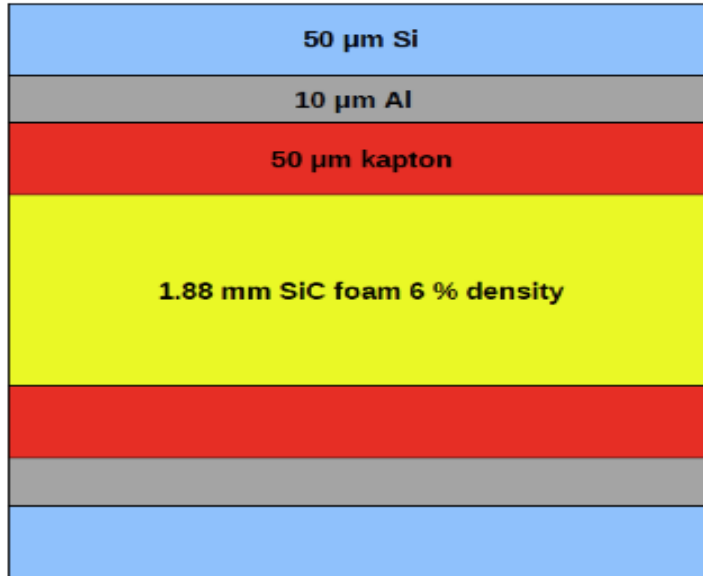
- 0.053 % x 2 +
- 0.011 % x 2 +
- 0.018 % x 2 +

- 0.130 % =

_____

- 0.294 % X_0 per double layer

simplified in GEAR:
0.2% X0 support
+ 0.1% X0 sensitive
= 0.3% X0 total

- inconsistency in geometry
  detected
- potential impact on track finding

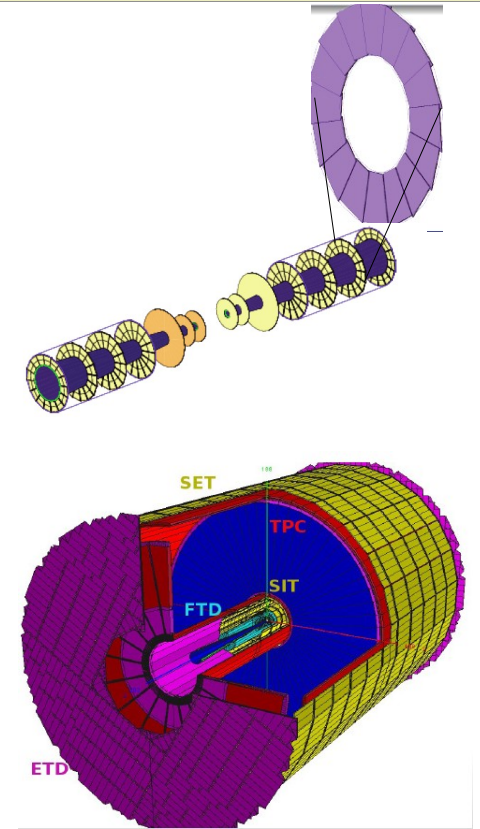=> fixed by Yorgos
=> VXD is validated

Frank Gaede, ILD Meeting, Kyushu U., May 21-25, 2012

- very detailed new simulation models had been developed for SIT/SET as well as for the FTD (ETD is not in simulation models)

- these models did not quite reach the level of maturity one would need for the DBD mass production

- slightly simplified have been developed in parallel in order to proceed with new C++ tracking code

- these models have planar wafers, ~realistic support material and work with new tracking

- have now been validated by R&D groups
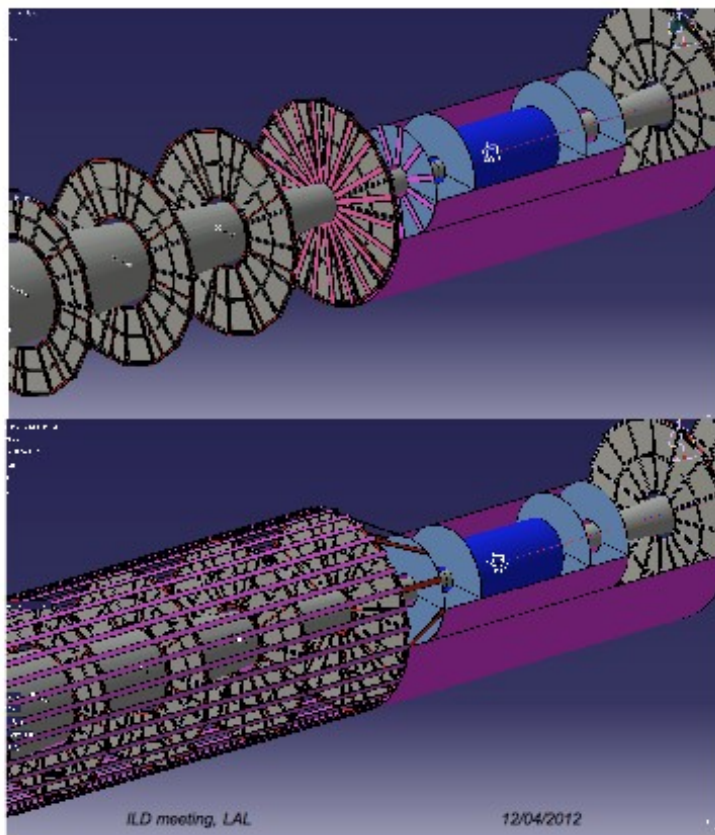
=>SIT/SET validated
=> FTD validated

SIT, two solutions

1. Along the beampipe : they have to run on backside of FTD2 and 3 , then :
   • huge amount of material around BP
   • Material in front of the other FTD

2. Run along the inner radius of TPC

erc   C.Clerc   ILD meeting, LAL   12/04/2012

- need to finalize the numbers as proposed by C.Clerc
- question of routing:
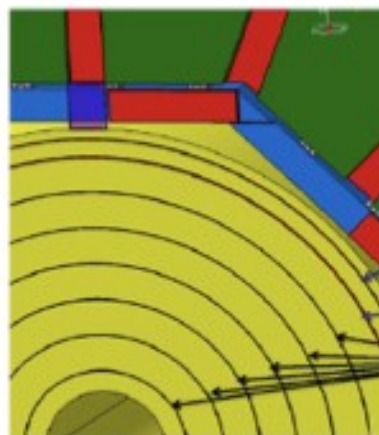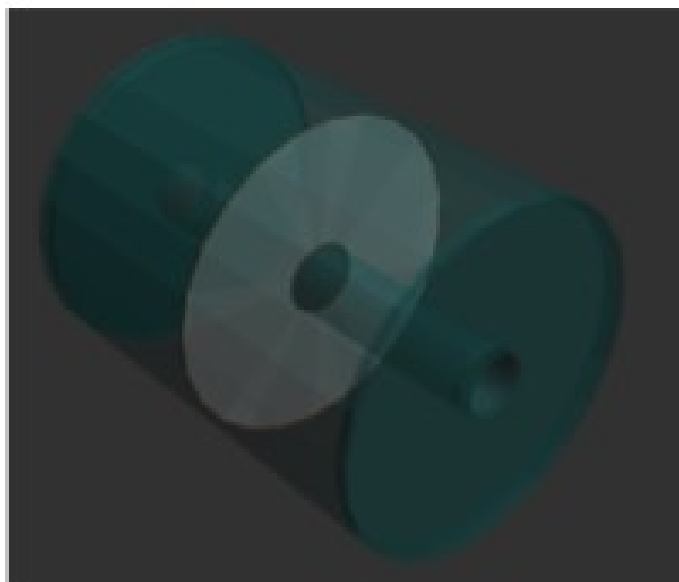 - along beam pipe !?
  - cables going out to SIT/SET missing ?

	Aluminum								
	position	FTD7	FTD6	FTD5	FTD4	FTD3	FTD 2	FTD 1	VTX
new values	eq Th of Al	0,85	0,99	1,22	1,54	2,18	2,76	2,00	0,67
	X0% FCPPD	0,95%	1,11%	1,37%	1,73%	2,45%	3,10%	2,25%	0,75%
old values	eq Th of Al	2,16	2,39	2,74	3,20	4,12	3,45	2,00	0,67
	X0% FCPPD	2,43%	2,68%	3,08%	3,60%	4,63%	3,87%	2,25%	0,75%

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TPC validation

S.Aplin

rings of equivalent thickness
in copper

Liquid supply ring 7x2.7 mm^2

Vapor return ring 10x2.8 mm^2

6 Cooling tubes 4x1.9 mm^2

End-Plate modeled as discs of material representing components of the readout: GEM structure, Readout, and Support frame.

Cathode constructed from two thin discs, insulator and conductor, held by membrane grip.

Cooling modeled using rings attached to the outside of the end-plate.

Parameterised digitisation well established in the main reconstruction chain.
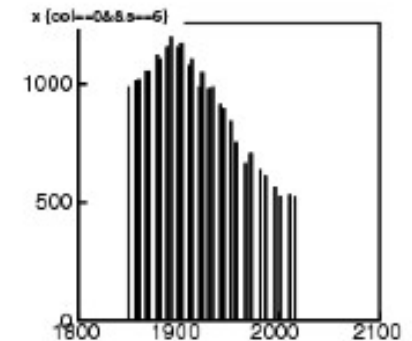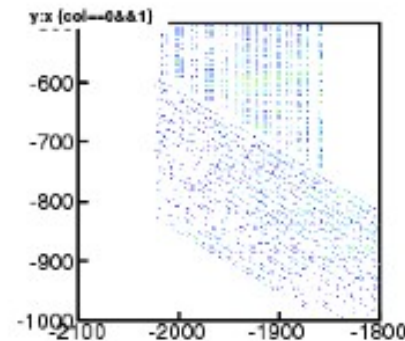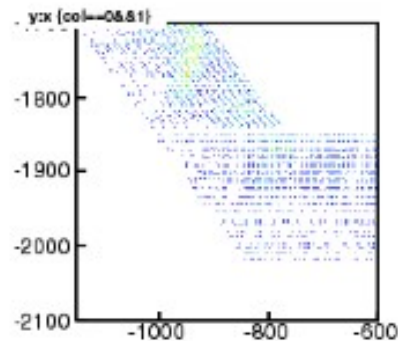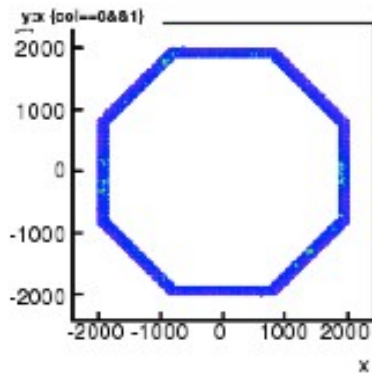
=> TPC is validated

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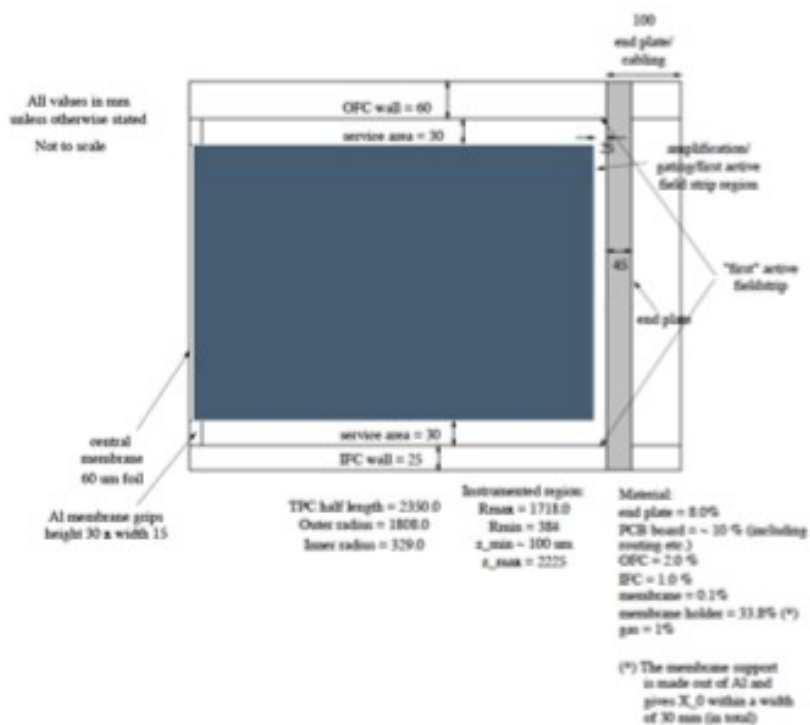
D.Jeans

Engineering design dimensions:
  Barrel: Rin=1843, Rout=2028, 1/2 length=2350
  Endcap: Rin = 400 (square), Rout=2090 (octogon), Zin=2450, Zout=2635

StepLeng		NextVolume
	0	WorldPhysical
	3	BarrelEcalModule
	2.45	FirstSlab
	0.25	PCBCuShield
pcb	1.3	FirstSlab
	0.1	WaferSi
si	0.5	Ground
	0.1	BarrelEcalModule
cf	0.15	RadiatorSlab
w	2.1	BarrelEcalModule
cf	0.15	Ground
	0.1	WaferSi
si	0.5	SecondSlab
	0.1	PCBCuShield
pcb	1.3	SecondSlab
	0.25	BarrelEcalModule
cf	0.75	RadiatorStruct
w	2.1	BarrelEcalModule
cf	0.75	FirstSlab
	0.25	PCBCuShield
pcb	1.3	FirstSlab
	0.1	WaferSi

Conclusions

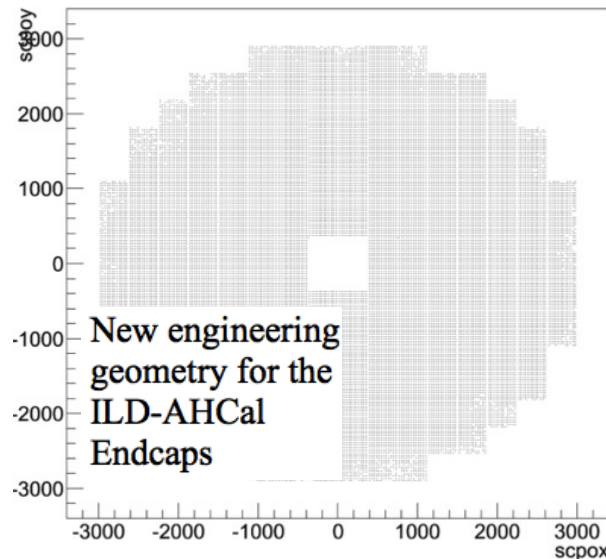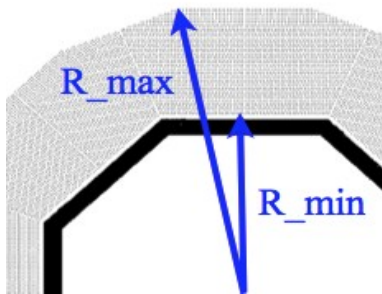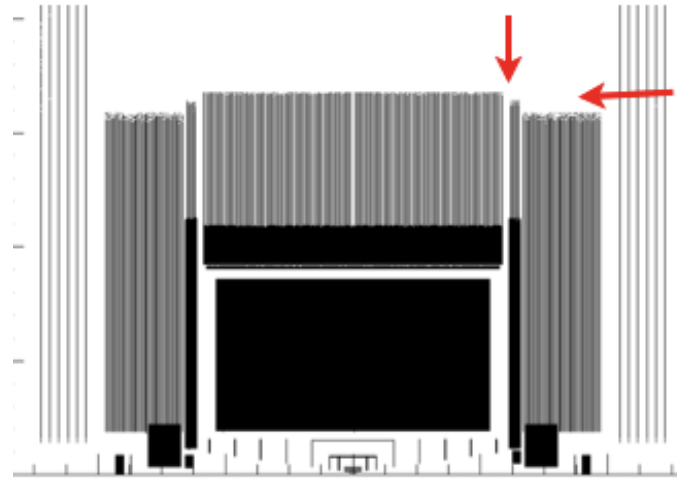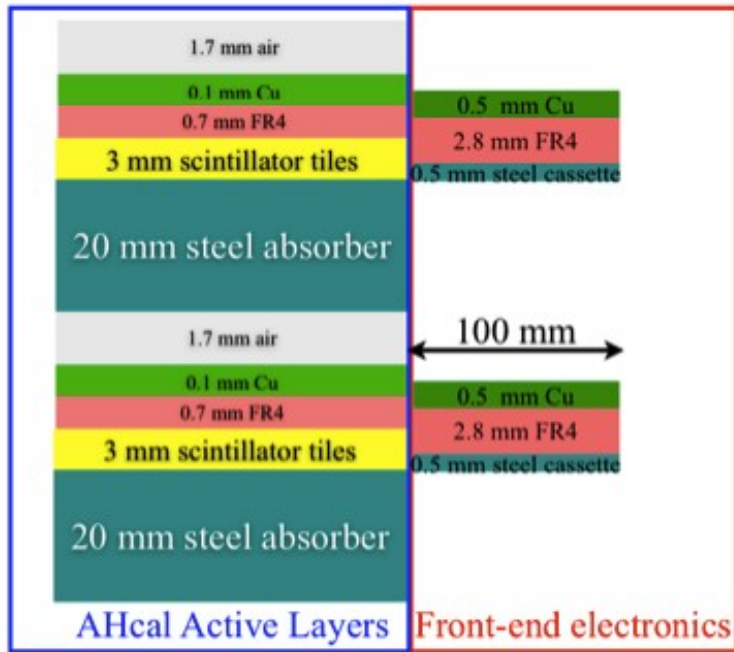Hit positions consistent with engineering design

Decoded CellID behave as expected

No problems detected in ECAL structure (geantino)

=> Ecal is validated !

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AHcal validation

1.7 mm air
0.1 mm Cu
0.7 mm FR4
3 mm scintillator tiles
0.5 mm Cu
2.8 mm FR4
0.5 mm steel cassette
20 mm steel absorber
100 mm
1.7 mm air
0.1 mm Cu
0.7 mm FR4
3 mm scintillator tiles
0.5 mm Cu
2.8 mm FR4
0.5 mm steel cassette
20 mm steel absorber
AHcal Active Layers Front-end electronics

R_max
R_min

New engineering geometry for the ILD-AHCal Endcaps
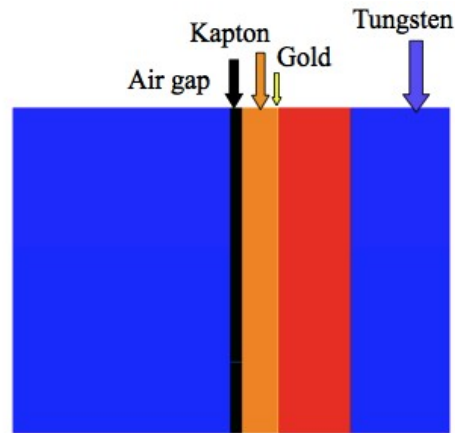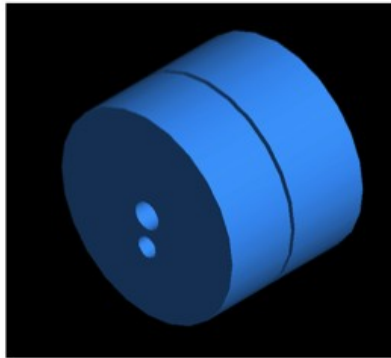
The Mokka drivers for the Barrel and the Endcap have been validated and synchronized with engineering design.

EndcapRing has been checked with engineering design too.

=> AHCal is validated

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Fcal validation

A.Rodca, B.Pawlik

Simulation

Air gap Kapton Gold Tungsten

Diamond

Geometry has been checked for overlaps
— No overlap found.

Hits XY plane

Hits YZ
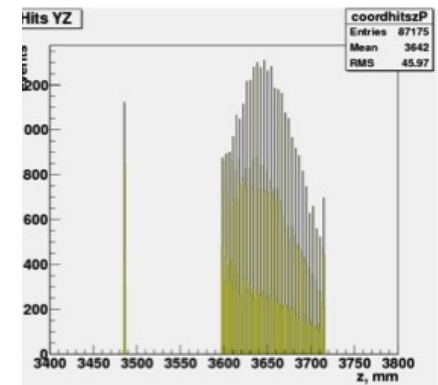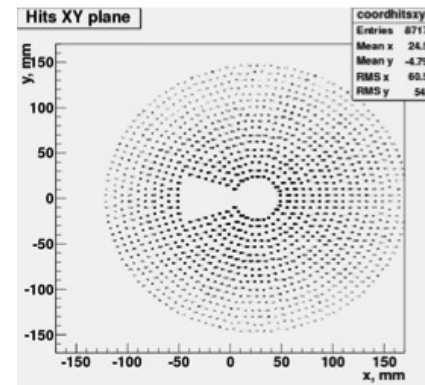
Z_{in} = 3450 mm in the engineering design and ~3600 mm in the simulation.

Implemented Geometry
(according to official RD)

PCB
cooling
FE Chip
sensor
absorber
fanout
Pad metalization
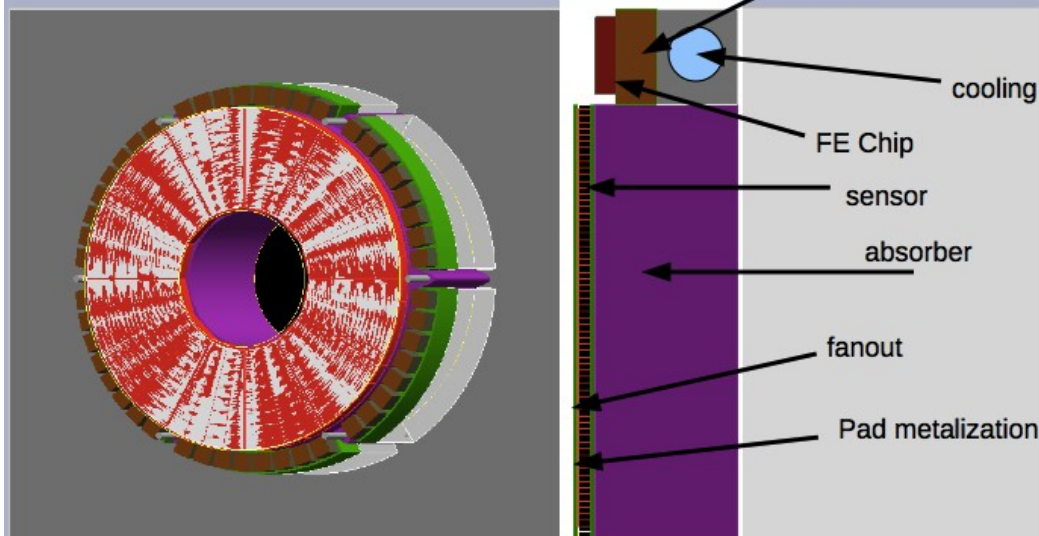
- different z-pos was just a proposal
-> decided to keep value in simulation eng. model

=> BCal validated
=> LCal validated

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Muon validation   V.Saveliev
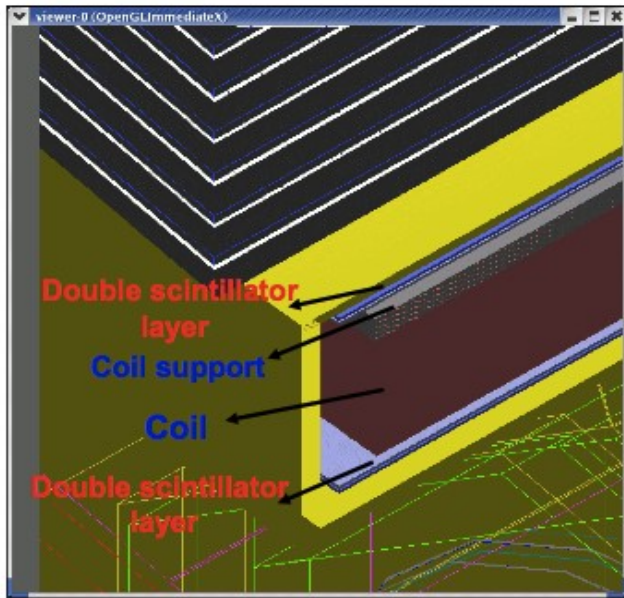
Cryostat: Detailed Geometry
- Instrumentation 2 Double Scintillator Layers -> no baseline
-> remove from sim. model

Coil: Detailed Geometry,
- Coil Segmentation

Yoke: Detailed Geometry based on Mechanical Design
- Barrel: 10x(100+40) +3x(560 +40) mm
- EndCup: 10x(100+40) +2x(560+40) mm

various readout options exist
- 3x3cm scint. tiles <- used in LOI & Pandora
- 3x3cm RPC <- implemented in ILD_O1
- 3xLcm scint. strip stereo <- proposed
  => need decision asap !!
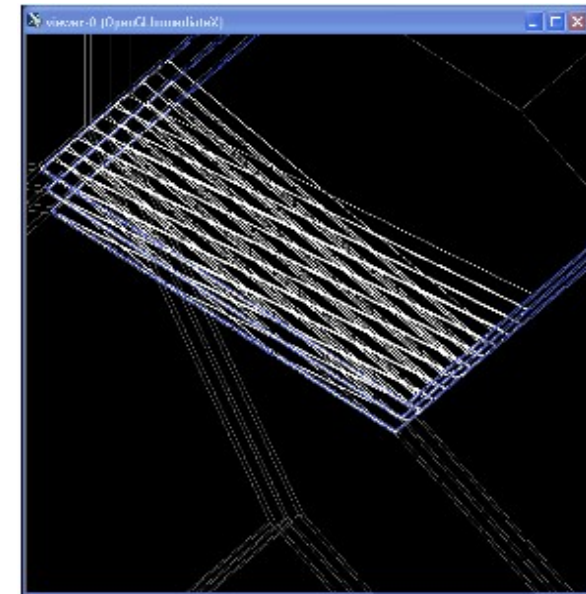
=> muon validation ongoing

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/geometry/test/recursive_test

Gives detailed printout with coordinates of overlaps:

```
GeomTest Error: Overlapping daughter volumes
   The volumes tube_IPOuterBulge[0] and tube_IPOuterBulge[0],
   both daughters of volume WorldPhysical[0],
   appear to overlap at the following point in global coordinates:
     length (cm)  ---------- start position (cm) ----------   ---------- end position (cm) -----------
       16.45        0        0       37.13          0        0       53.58
   Which in the mother coordinate system is:
     length (cm)  ---------- start position (cm) ----------   ---------- end position (cm) -----------
       16.45        0        0       37.13          0        0       53.58
   Which in the coordinate system of tube_IPOuterBulge[0] is:
     length (cm)  ---------- start position (cm) ----------   ---------- end position (cm) -----------
       16.45        0        0       -1.16          0        0       15.29
   Which in the coordinate system of tube_IPOuterBulge[0] is:
     length (cm)  ---------- start position (cm) ----------   ---------- end position (cm) -----------
       16.45        0        0       -21.91         0        0       -5.46
```

Careful: can be false positives / false negatives

Still the best starting point

- World volume to small – fixed
- SIT overlaps with FTD – fixed
- Overlapping sensors in SIT and SET – fixed
- Overlaps in FTD – fixed
- Insulators overlap in TPCCathode (fixed
- Overlaps in tube_IPinnerTube (fixed
- Overlaps in tube_IPOuterBulge   fixed
- YokeEndcap overlaps YokePlug – fixed
- Overlaps in HCalServices – fixed
- Chamber1 and Chamber2 overshoot YokeEndcap
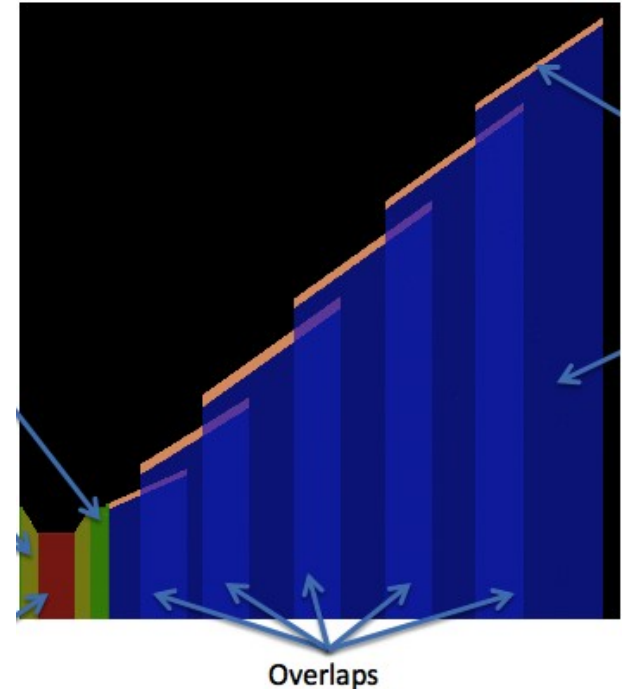
Overlaps

=> ILD_O1_v03 should be free of overlaps

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validation of Mokka ILD model(s)

- started validation process with volunteers nominated by the subdetector R&D groups, checking the Mokka drivers for:

  - overlaps, consistency w/ engineering model, hit production,..

detector	person	status
VXD	G.Voutsinas	done
SIT/SET	K.Androsov	done
FTD	J.Duarte	done
TPC	S.Aplin	done
ECal	D.Jeans	done
AHCal	Sh.Lu	done
SDHcal	G.Grenier	to be done
FCal	A.Rosca, B.Pawlik	done
Muon	A.Saveliev	ongoing

start MC production w/ ILD_O1_vxx a.s.a.p.
- finalize muon readout
- finalize SIT cabling
- ... ?

overall overlap checking: Ch.Grefe

Summary & Outlook

- ILD simulation models in Mokka have been made more realistic wrt. to the version that was used for the LOI:

  - added electronics, cabling and services

  - introduced wavers and support for Si-Tracking

- R&D groups have nominated people to validate the corresponding drivers -> almost complete now

- now known (major) discrepancy known between the simulation and the engineering models

- -> will start Monte Carlo production for DBD soon