Updated BeamCal Driver for Mokka

André Sailer

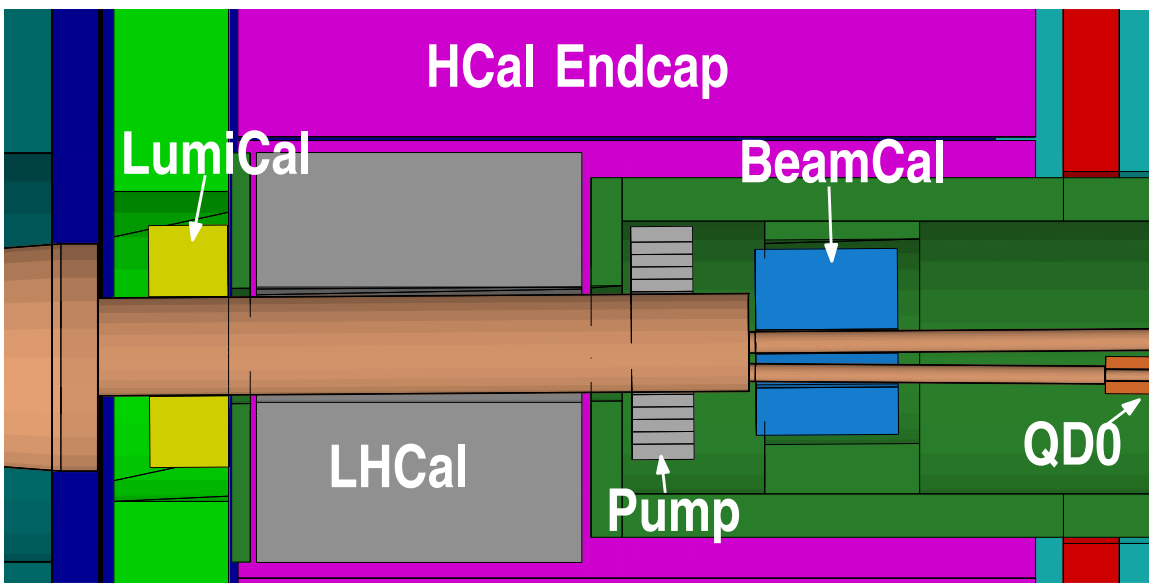
CERN-PH-LCD

ILD Software Workshop
DESY, Hamburg
July 7, 2010

Contents

BeamCal I

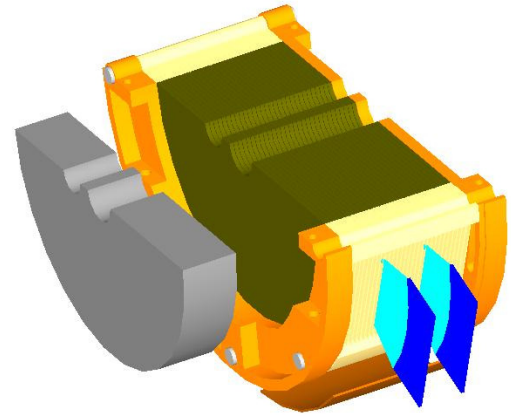
- Positioned 3.48 m downstream of the IP
- Centered around outgoing beam pipe
- Main absorber of e^+e^- pairs from beam-beam interaction
- Tungsten sandwich calorimeter with radiation hard sensors
- Used for beam diagnostics and high energy electron tagging



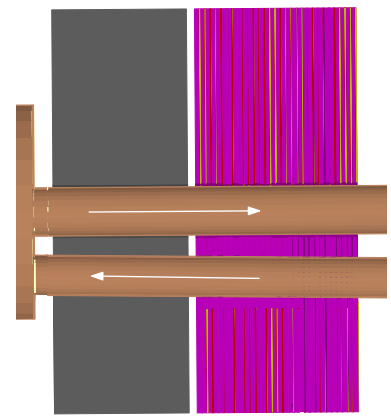
Close up on the forward region of the MOKKA model ILD_00fw

BeamCal II

- BeamCal consists of:
  - PairMonitor
  - 10 cm graphite absorber
  - The actual BeamCal: 30 layers of 3.5 mm tungsten and sensors
  - Two holes for the incoming and outgoing beam pipes
- In the new BeamCal Driver:
  - PairMonitor and Graphite are contained in one volume and placed at $\pm$Z
  - The W absorber plates are individually created and placed
  - One sensor layer is constructed and placed 30 times
  - BeamCal Volume placed at $\pm$Z



Sketch of BeamCal

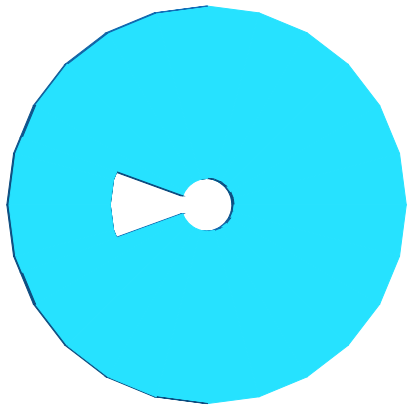


Cut through BeamCal

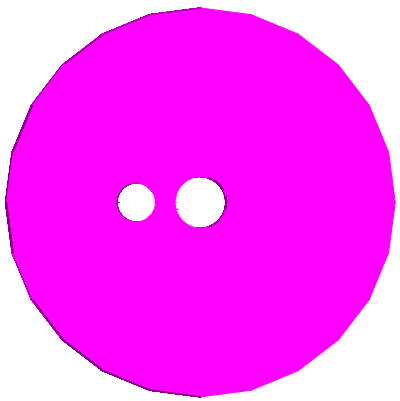
Updated Geometry

- Old driver had single transverse geometry
- Keyhole shaped cut-out for the incoming beam pipe
- No absorber material between the beam pipes
- e^+e^- pairs can hit last quadrupole
- New Driver: Maximal absorber coverage
- Only passage through the two beam pipes
- All absorber plates are slightly different

Old W and Graphite Absorber



New Absorber

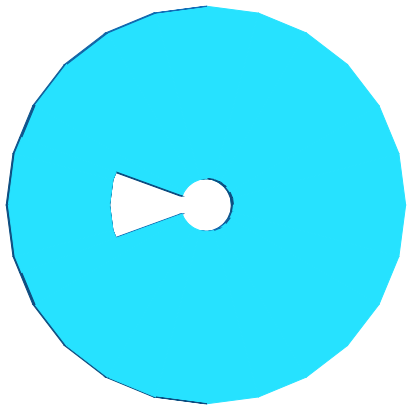


Sensor Structure ILD

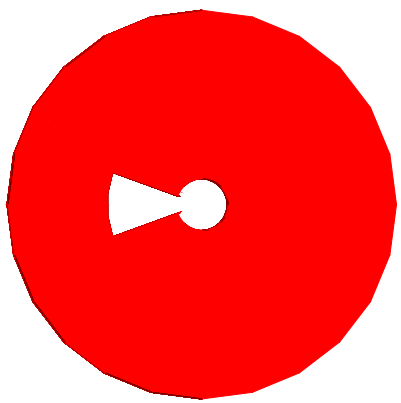
- Sensor shape was not changed
- GEANT4 implementation modified
- `SensitiveDetector` implementation modified where necessary
- Layers of the sensors unchanged:

Diamond sensor	0.3004 mm
Gold metalization	0.0004 mm
PCB	0.15 mm
Air gap	0.05 mm

Old Sensors



New Sensors



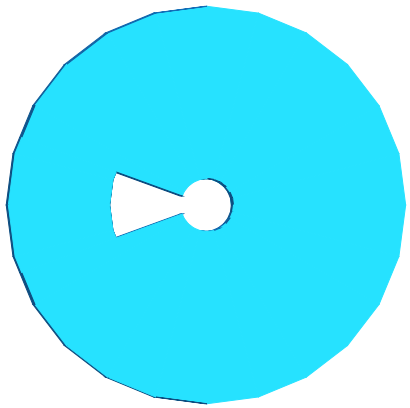
Sensor Structure CLIC

The same as for ILD, except

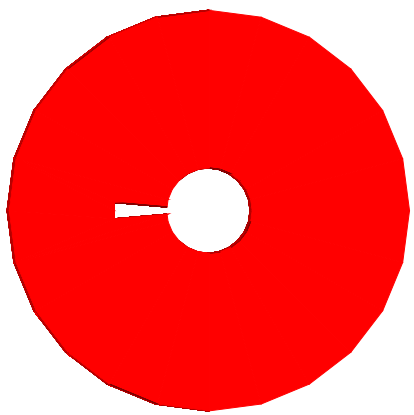
- Larger outgoing beam pipe radius
- Smaller incoming beam pipe radius
- The sensor structure is maximized for the given incoming beam pipe

Not yet decided about final sensor layout for CLIC, use maximal coverage

Old Sensors



New Sensors



Geometry checks

All GEANT4 overlap warnings have checked out and were fixed:

Checking overlaps for volume PairMonitorLayerPlaced ... OK!
Checking overlaps for volume GrVolumePlaced ... OK!
Checking overlaps for volume PairMonitorVolumeForw ... OK!
Checking overlaps for volume PairMonitorVolumeBack ... OK!
Checking overlaps for volume SensorLayerPlaced ... OK!
Checking overlaps for volume ElectrodeLayerPlaced ... OK!
Checking overlaps for volume PCBLayerPlaced ... OK!
Checking overlaps for volume AbsorberLayerPlaced1 ... OK!
Checking overlaps for volume BeamCalLayerPlaced1 ... OK!

⋮

Checking overlaps for volume CaloVolumeForw ... OK!
Checking overlaps for volume CaloVolumeBack ... OK!

BeamCal Parameter Database

- Old Driver
  - One database (DB) for each BeamCal containing all parameters
- New Driver
  - Almost all parameters changed to `globalModelParameter`
  - Only information about the sensor thickness in DB
  - BeamCal can be easily changed via run-time parameters
  - Some of the old parameters were (made) redundant

Run-time Parameters

- `BCal_rInner`: Inner radius of BeamCal (around outgoing beam pipe) in mm
- `BCal_rOuter`: Outer radius of BeamCal in mm
- `BCal_TubeIncomingRadius`: Radius of the incoming beam pipe in mm
- `BCal_nLayers`: Number of layers
- `BCal_dAbsorber`: Thickness of the tungsten absorber plates in mm
- `BCal_PairMonitor`: Turn PairMonitor On(1) or Off(0)
- `BCal_dGraphite`: Thickness of the graphite in front of BeamCal in mm

Run-time Parameters contd.

- `BCal_SpanningPhi`: Spanning angle of the instrumented region, without the dead area for the incoming beam pipe in degrees
- `BCal_rSegmentation`: Size of the radial segmentation in mm, this also has an impact on the segmentation in ϕ
- `BCal_nWafers`: The number of wafers the instrumented region is made from
- `LHcal_BCal_clearance`: Distance between `LHcal_zend` and the BeamCal Calorimeter in mm, the graphite shield will end 6 mm upstream

Run-time Parameter Default Values

Parameter	ILD	CLIC	Unit
BCal_TubeIncomingRadius	15	3.7	mm
BCal_rInner	20	32	mm
BCal_rOuter	150	150	mm
LHcal_BCal_clearance	390	390	mm
BCal_dAbsorber	3.5	3.5	mm
BCal_dGraphite	100	100	mm
BCal_SpanningPhi	320	350	degrees
BCal_nLayers	30	40	
BCal_PairMonitor	1	1	
BCal_rSegmentation	8	8	mm
BCal_nWafers	8	8	

Shared Parameters

Two other parameters affect the BeamCal driver:

- `ILC_Main_Crossing_Angle`: Crossing angle for beam pipe geometry.
- `LHcal_zend`: End of the LHCal, also used when LHCal is removed to determine BeamCal position. This parameter is also used to determine the placement of the beam pipes and the masking, it should not be changed to place BeamCal, use `LHcal_BCal_clearance` instead.

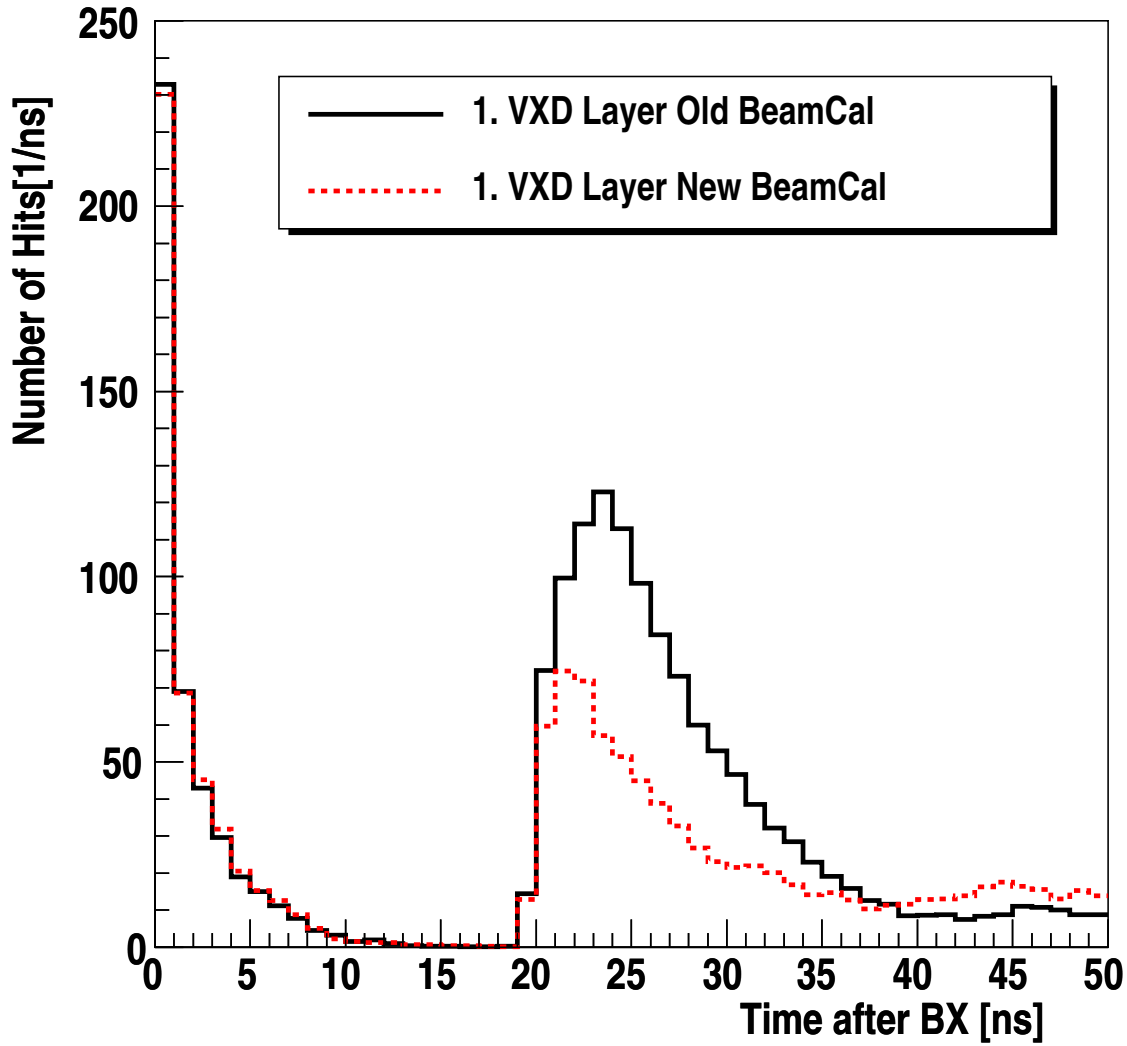
Output to the GEAR File

Two changes for the GEAR output were done as well:

- BeamCal `inner_z` is now set to the start of PairMonitor
  - Maybe this should be the start of the actual calorimeter?
- `cylinder_starting_phi` is now spelled correctly

First Result: Less Back-Scattering

- For CLIC detector model and CLIC background
- Significant decrease of hits in the first layer from 5.4 down to 4.1 Hits/mm^2/Train
- Changed BeamCal geometry reduces Background



Summary

- The BeamCal driver was updated to modify the W absorber plates and graphite layer in accordance with the present plan for construction
- The sensor layout remains the same
- `globalModelParameter` were added for greater flexibility
- A bug and a typo in the GEAR output were fixed
- New geometry improves background in the CLIC case