

Simulations for Silicon Tungsten ECALs

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ECFA Higgs Factories: 1st Topical Meeting on Simulation

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Outline

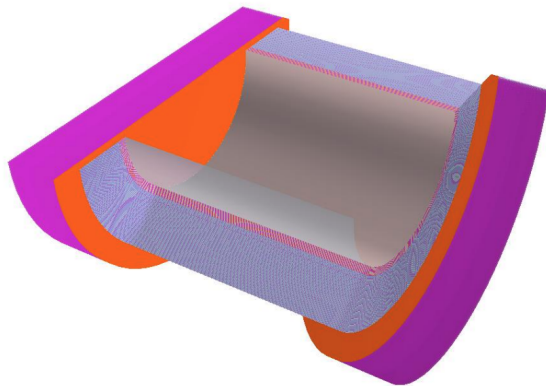
- SiW ECAL Simulation tools in current LC detector concepts
- ILD SiW ECAL prototype simulation

CEPC Calorimeter simulation

- CEPC software is based in Mokka.
 - GEANT4 wrapper @ LLR for TESLA and early ILD
- Available in cepcsoft.ihep.ac.cn
- No geometry defects
- Totally homogeneous
- Simple, easily modifiable:

```
/Mokka/init/globalModelParameter world_box_hx 100000  
/Mokka/init/globalModelParameter world_box_hy 100000  
/Mokka/init/globalModelParameter world_box_hz 250000  
/Mokka/init/globalModelParameter SiCalLayerStructure (W:3,Si:0.25,PCB:  
/Mokka/init/globalModelParameter SiCalZeroThickReset 0
```

```
/Mokka/init/globalModelParameter SiCalInnerRadius 1845  
/Mokka/init/globalModelParameter SiCalBarrelHalfZ 2245  
/Mokka/init/globalModelParameter SiCalEndcapEta1 10000  
/Mokka/init/globalModelParameter SiCalEndcapEta2 10000  
/Mokka/init/globalModelParameter SiCalBuildBarrel 1  
/Mokka/init/globalModelParameter SiCalEndcapOuterR 2500  
/Mokka/init/globalModelParameter SiCalXCellSize 5  
/Mokka/init/globalModelParameter SiCalYCellSize 5
```

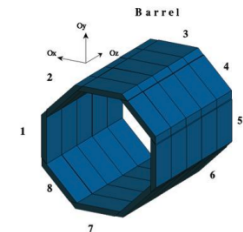
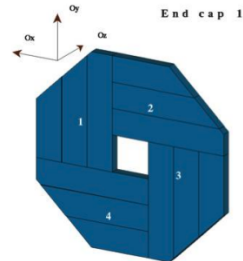
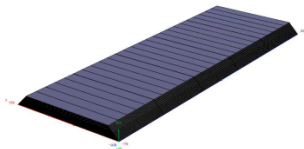
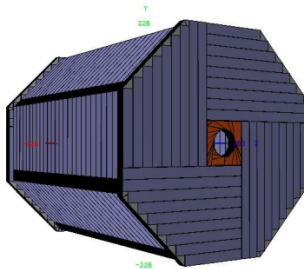


(Taken from [Hang Zhao's talk.](#))

CEPC Calorimeter

Similar to ILD ECAL (below)

- $10 \times 10 \text{ mm}^2$ cells in optimized version
- 30 layers, 2.8mm W + 0.5mm Si in each layer
- Thickness: 84 (90) mm

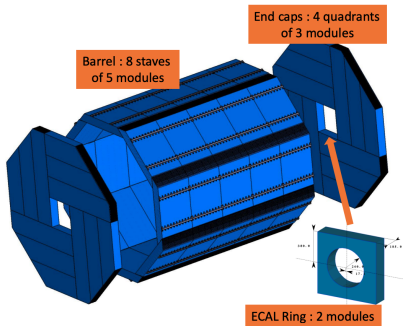


LCGEO repository

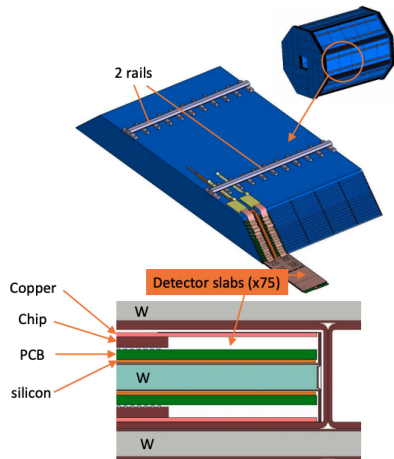
LCGEO: common repo for detector geometry descriptions, based on DD4HEP

- SiW ECALs for ILD SiD and CLICdp, FCCee + many other models for LC detectors
- CEPC using LCGEO in:
github.com/cepc/CEPCSW/tree/master/Detector/DetCEPCv4/compact
- XML geometry description files for DD4hep (the successor of Mokka)
 - dd4hep → Icio files (SimCalorimeterHits)
 - (See e.g. [Daniel Jeans' talk earlier.](#))
- Available at github.com/iLCSoft/lcgeo

The ILD SiW-ECAL



- $5 \times 5 \text{ mm}^2$ cells, 0.525 mm thick
- W: 20 (2.1mm) + 10 (4.2mm)
- Thickness $\sim 22 \text{ cm}$ ($\sim 24X_0$)



(Taken from J.-C. Brient's talk.)

- Even/odd layers

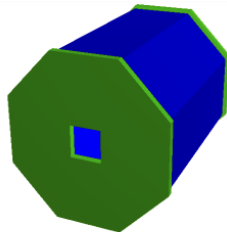
ILD SiW ECAL - Simulation (1)

Assumptions for simulation

- Barrel: trapezoidal modules
- Endcaps: octagonal shapes, identical quarters
- Same layer structure in barrel and endcaps

→ Parameters defined at runtime

- Define barrel/endcap modules
- Detection elements: "slabs"
- Mechanical structure, gaps



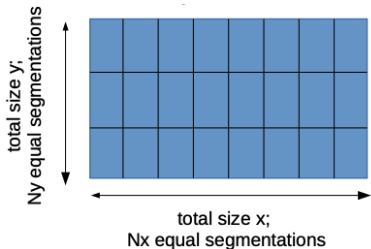
one Barrel module: split into towers



(Taken from [Daniel Jeans' talk.](#))

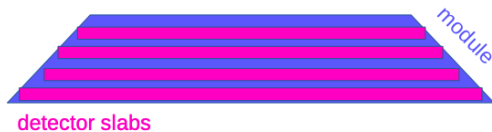
ILD SiW ECAL - Simulation (2)

Megatile: rectangular surface segmented into $N_x * N_y$ tiles

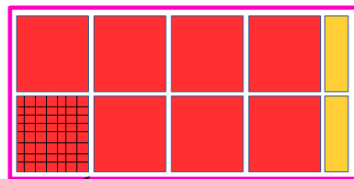


Megatiles usually same size ($x*y$) but layer-specific (N_x, N_y)

Sensitive layer segmentation



one detector slab

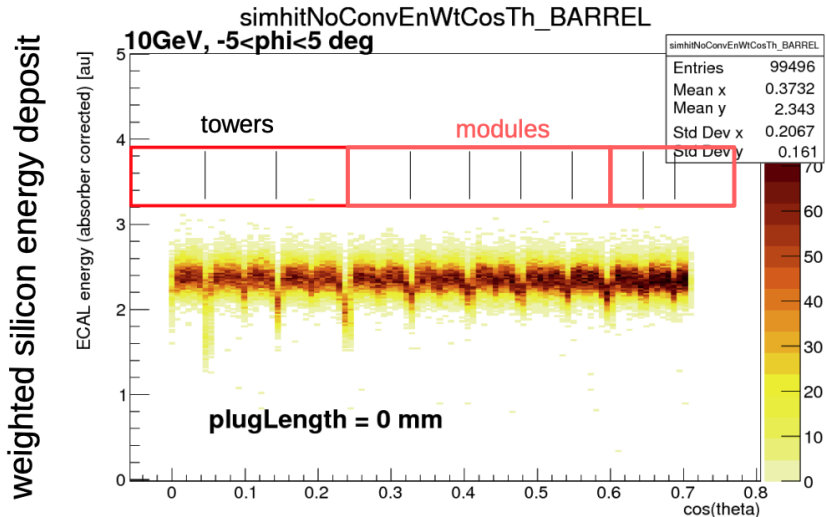


possibly dead space between megatiles

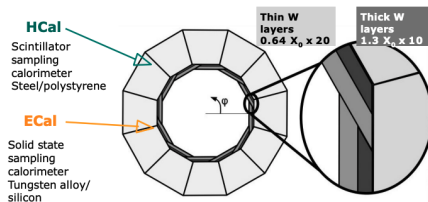
(Figures taken from [Daniel Jeans' talk.](#))

Energy response of photons

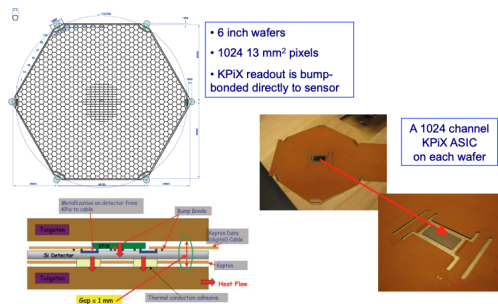
10 GeV photons from IP into barrel (Taken from Daniel Jeans' talk.)



The SiD ECAL



- Similar geometry to ILD ECAL
- Hexagonal wafers
- 12 module barrel \rightarrow Special regions to be described



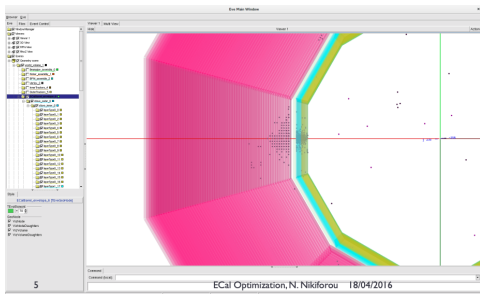
(Figures taken from [J. Brau's talk.](#))

- Tested prototype ($6 X_0$).

CLICdp, FCCee ECALs

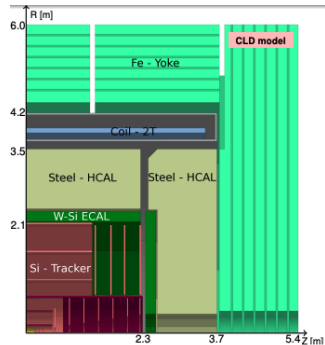
CLICdp

- 40 layers (each $0.54 X_0$) $\rightarrow 22.8 X_0$
- Cells $5 \times 5 \times 0.5 \text{ mm}^3$
- Total thickness = 156 mm



FCCee

- 40 layers



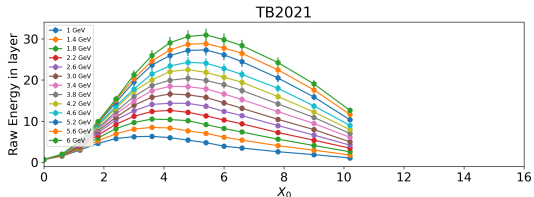
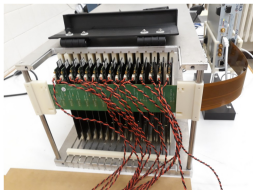
Both similar to ILD ECAL proposal

ILD ECAL prototype simulation

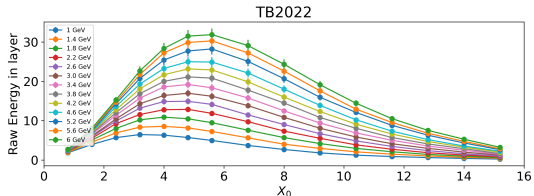
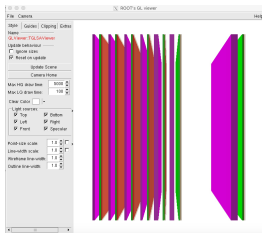
ILD SiW ECAL prototype simulation

- Simulation for detector design, R&D \Leftrightarrow prototypes in Test Beam
- ILD SiW ECAL technological prototype taken to DESY TB last November

15 layers; runs w/o and with W ($10 X_0$); 1 to 6 GeV e^-

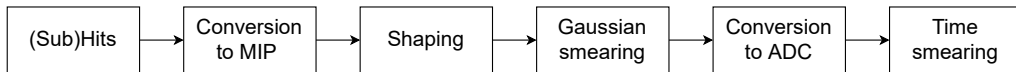


TB2022: go to $15 X_0$

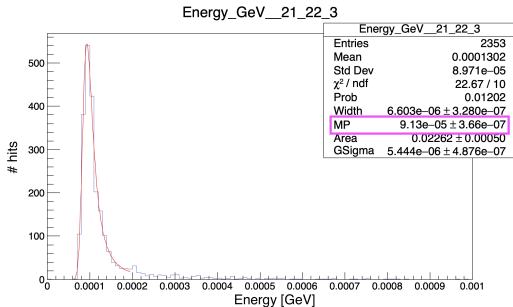


Digitization (raw sim. \rightarrow \sim detector output)

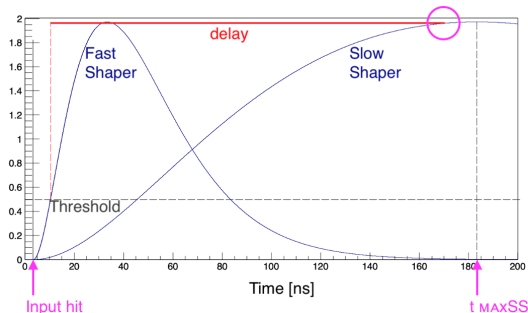
Digitization chain is written as pipeline of Marlin processors



Conversion:



Shaping:



Conclusion

- Common software tools for most of SiW ECAL concepts
- Powerful/flexible framework, allowing required level of design
- The importance of the Simulation \leftrightarrow R&D
- Generic digitization tools (in development)