ECAL optimisation studies at the University of Tokyo

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At Tokyo, we have started activities on the ECAL only in October,
so this talk will be “light”

We plan to work on hardware and simulation studies of the ECAL,
in this talk I discuss only the simulation side

- some recent developments (and preliminary results)

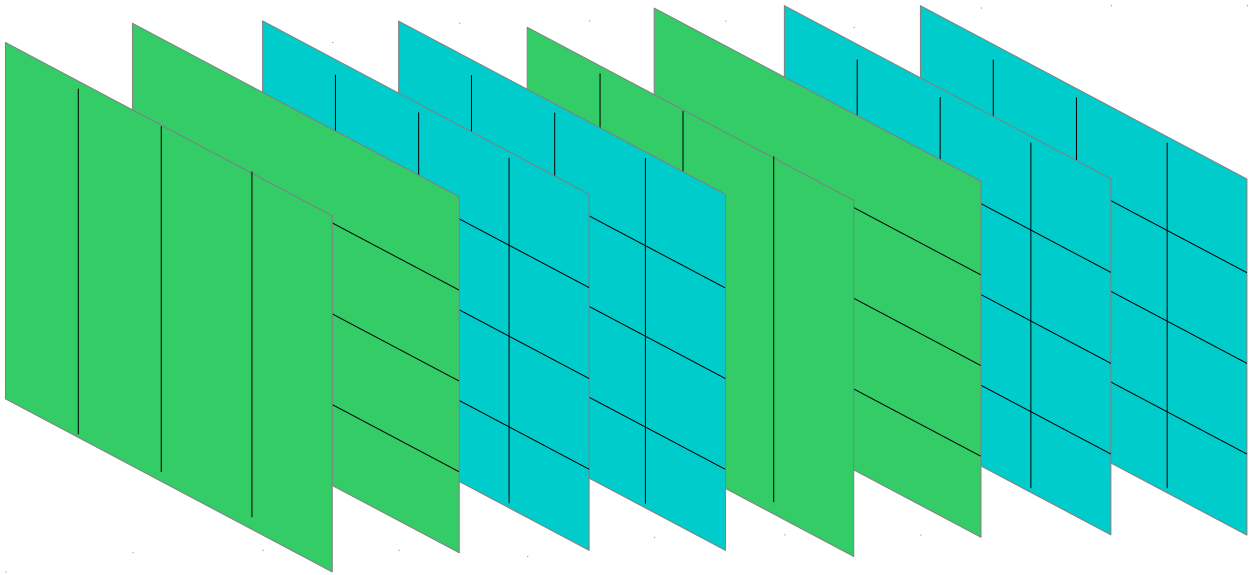
  Hybrid ECAL simulation, calibration and performance

- ideas for future studies

Hybrid ECAL simulation, calibration and performance

Made some updates to the Mokka driver used to simulate ECAL

- allow layer-by-layer configuration



Scintillator / silicon layer pairs

Hybrid ECAL simulation, calibration and performance

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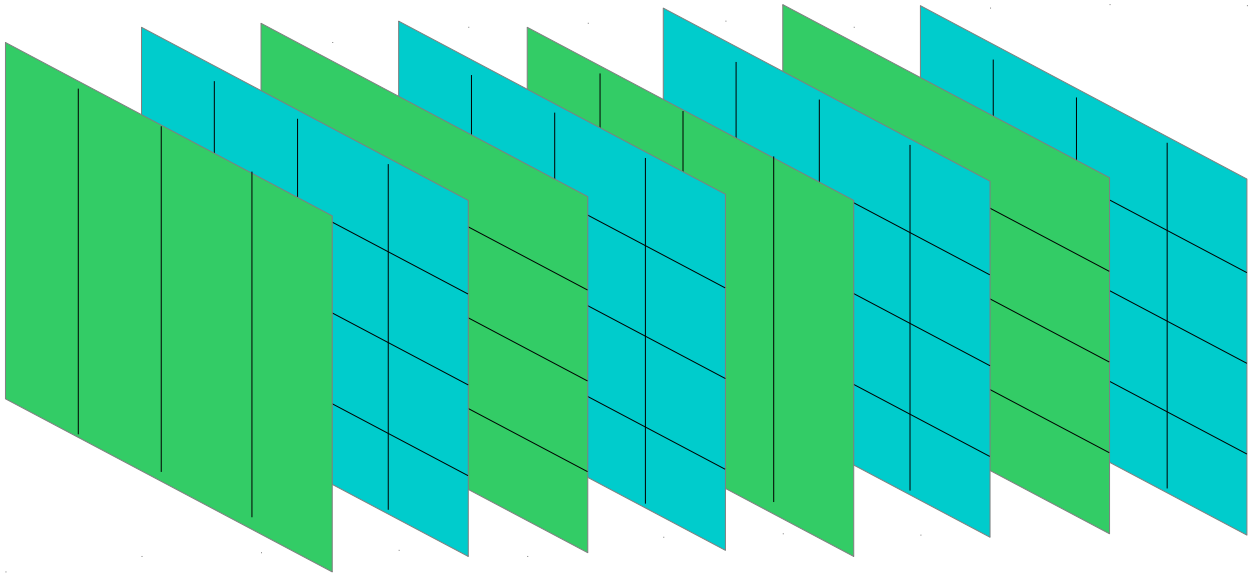


Scintillator / silicon individual layers

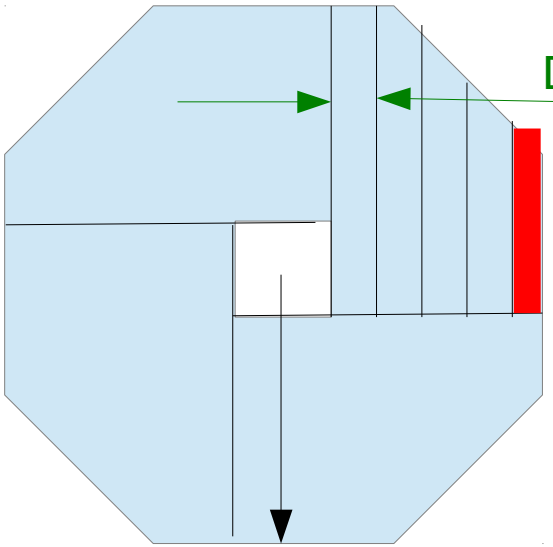
Should allow better use of hybrid structure
e.g. more robust performance of Strip Splitting Algorithm

Hybrid ECAL simulation, calibration and performance

Made some updates to the Mokka driver used to simulate ECAL

- allow layer-by-layer configuration

- avoid strange geometrical behaviour in endcap



Endcap radius
determined by barrel
radius

Hybrid ECAL simulation, calibration and performance

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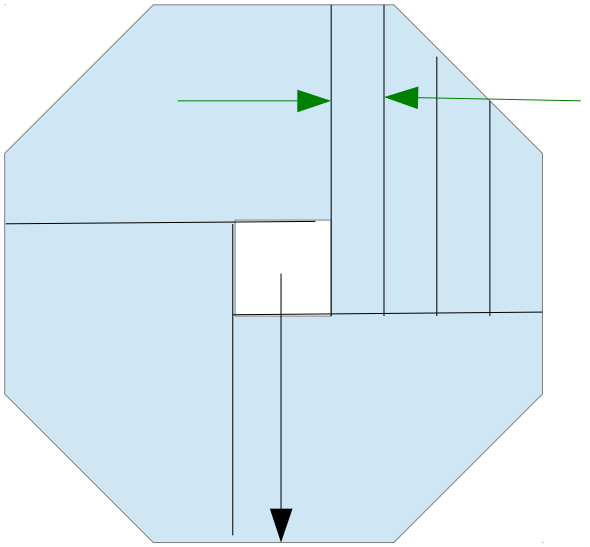


Redefine according to endcap radius to ensure no uninstrumented region

Endcap radius determined by barrel radius

Hybrid ECAL simulation, calibration and performance

To test this change in simulation,
and reconstruction chain (e.g. strip splitting algorithm in hybrid ECAL),
we measure it's performance in jet events (using ilcsoft v01-16-01)

Whenever we want to test a new ECAL geometry,
must recalibrate ECAL to ensure correct energy scale

Use single particles

photons @ 10 GeV	electromagnetic scale of ECAL
kaon0L @ 10 GeV	hadronic scale of ECAL
mu- @ 10 GeV	MIP scale

Follow standard calibration procesure. 2 steps:

At hit digitisation (NewLDCCaloDigi processor)
to obtain correct average ECAL energy
for EM showers

Clustering level (MarlinPandora processor)
taking into account EM or HAD shower shape
Correct effects of
clustering (unclustered hits)
different EM and HAD response: e/h != 1

Hybrid ECAL simulation, calibration and performance

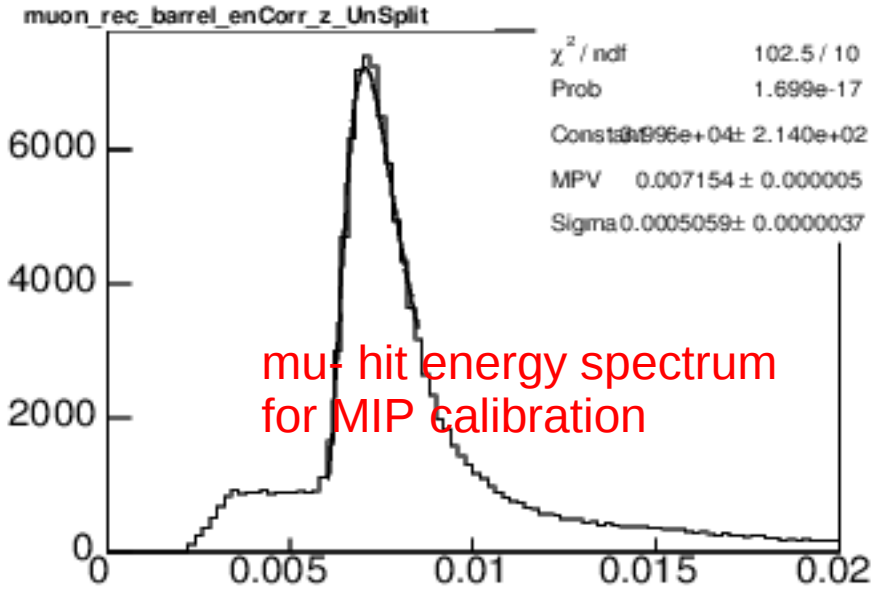
1. Test calibration procedure on standard ECAL model (ILD_o1_v03)
   Silicon only, 30 layers, 2.1/4.2 mm absorber, 0.5mm silicon

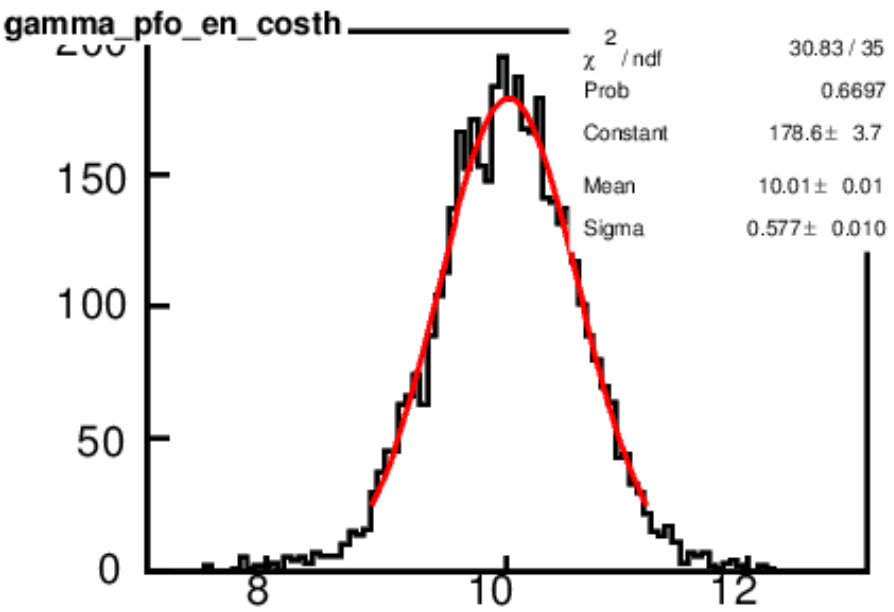
   Cross-check with “official” results
   -> gain confidence

2. swap silicon layers for scintillator (2mm)
   no other change
   calibrate and test

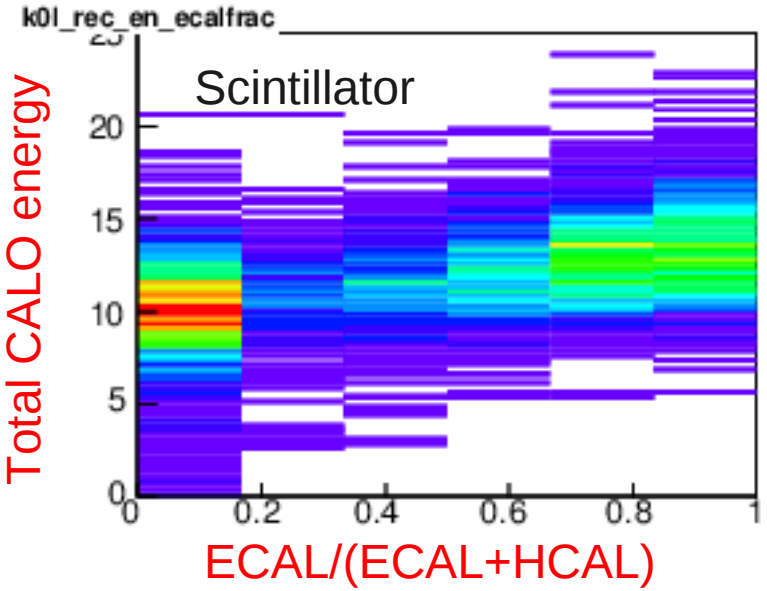
3. swap every 2nd layer back to silicon
   no other change
   calibrate and test

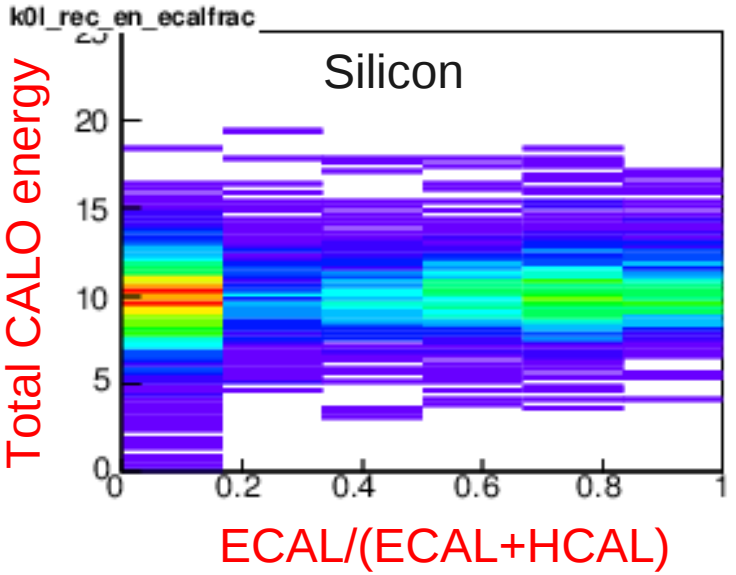
PFO energy for 10 GeV photons



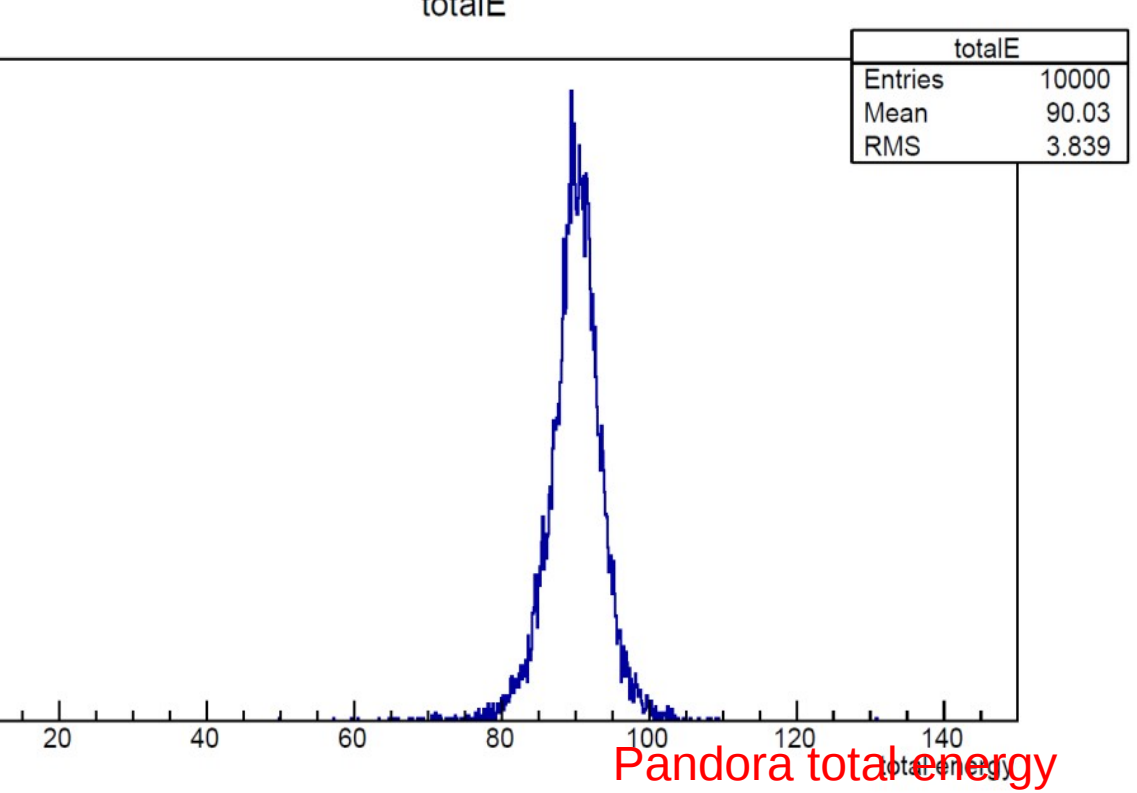


10 GeV kaon_0L





ECAL e/h very different for Si and Scint, corrected within Pandora

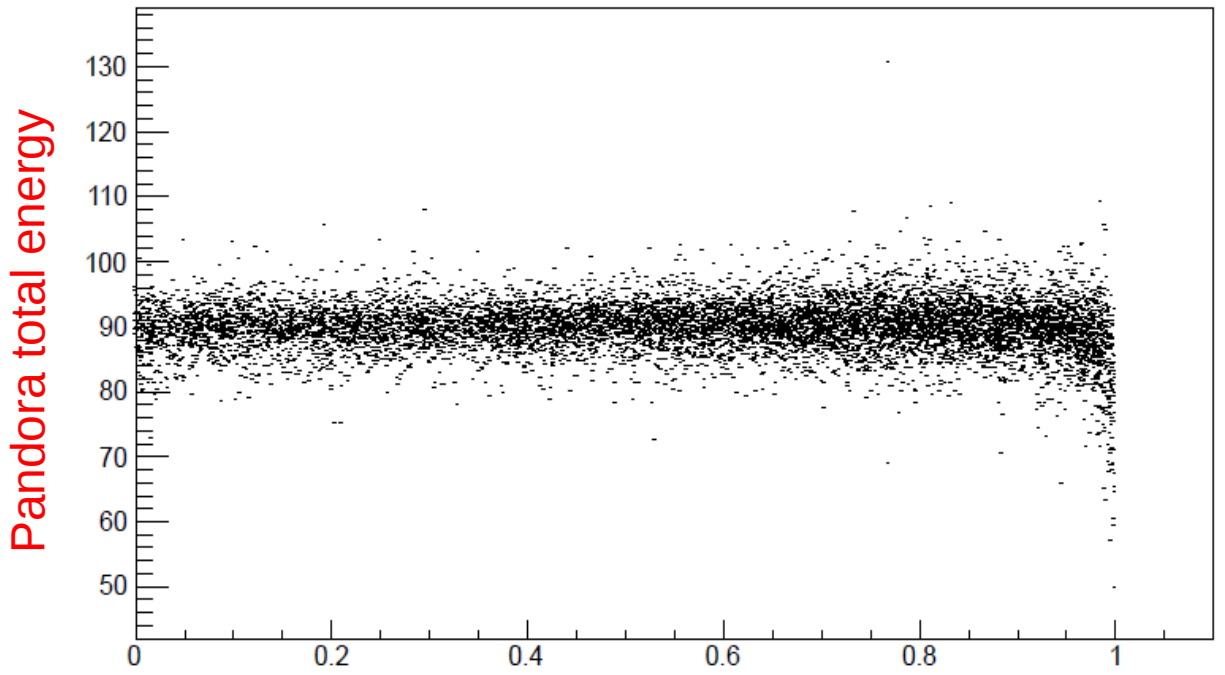


Pandora total energy

Example for

e+e- -> qq (uds) at 91 GeV

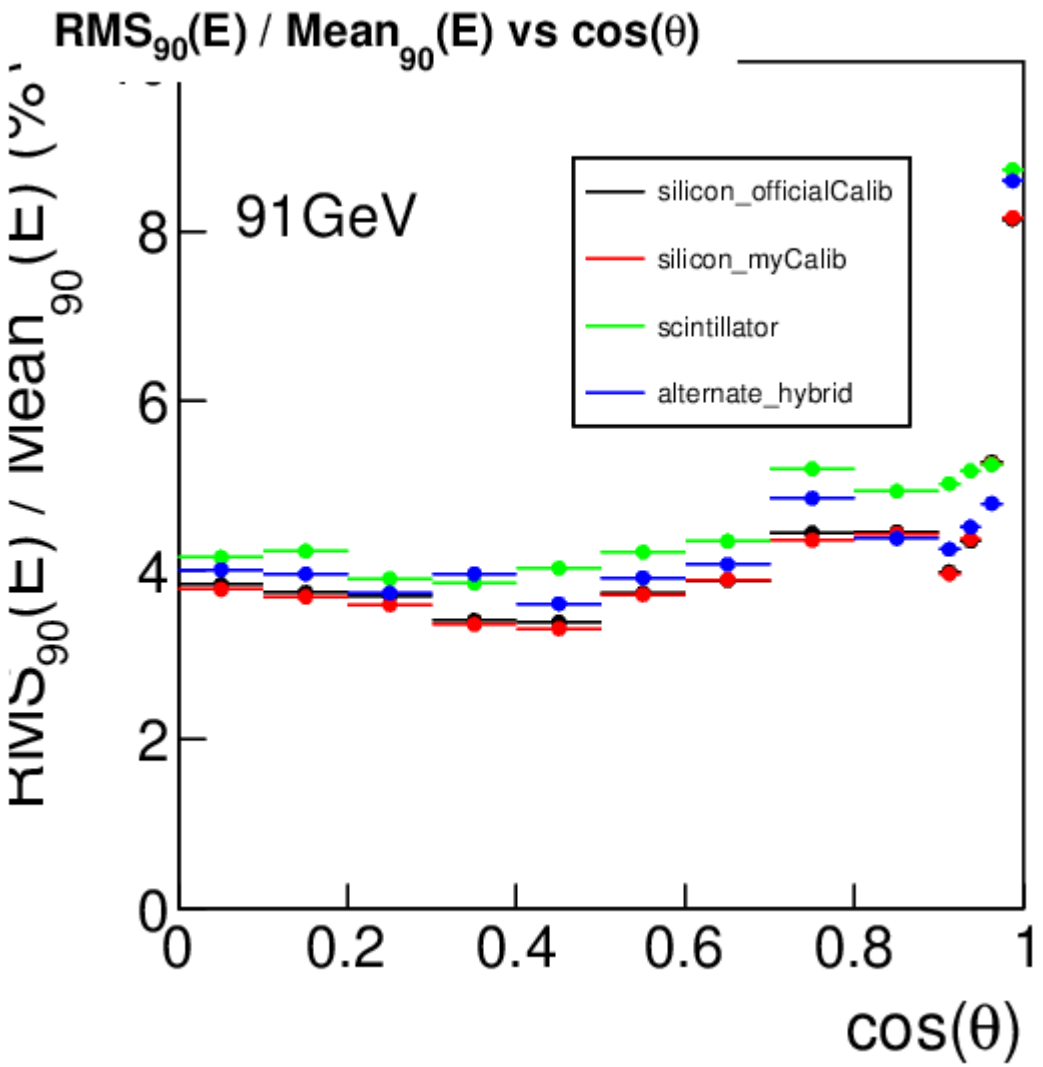
in default si-only ECAL

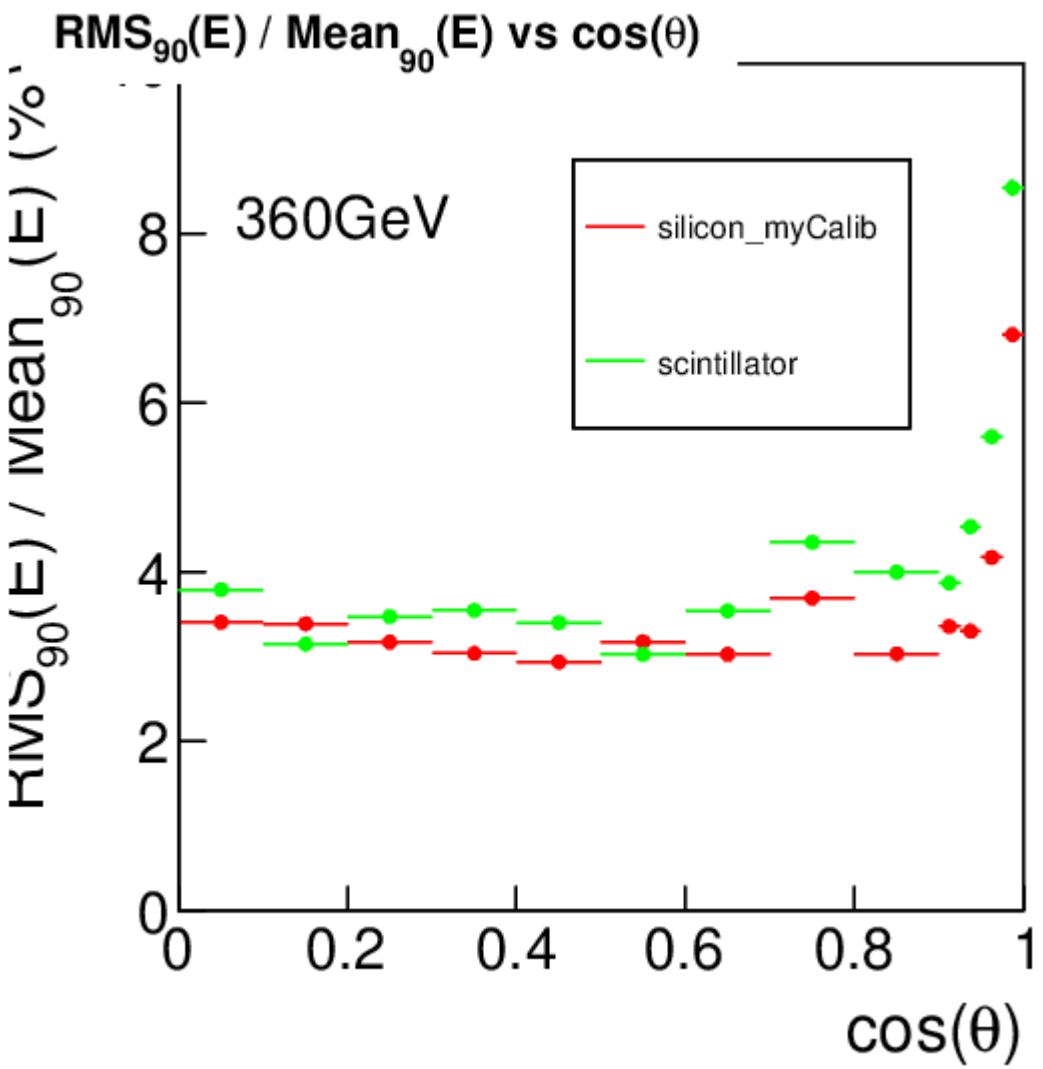


| cos (theta) | of quark pair

Very preliminary results of jet energy resolution

Same number and thickness of absorber layers
Silicon only, scintillator only, si-sc-si-sc....





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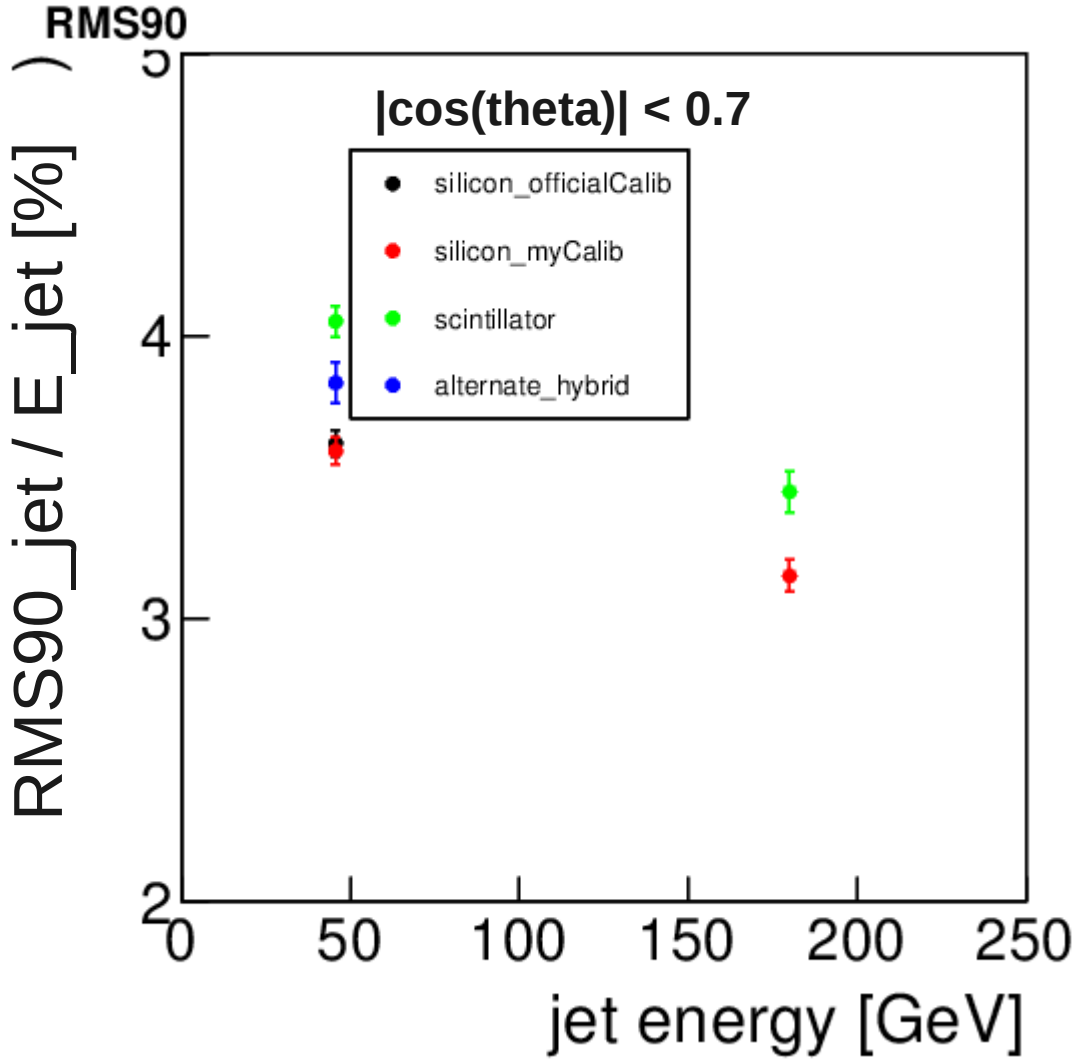

Results for standard ECALs in reasonable agreement with others' results

Simulation, calibration and reconstruction of hybrid seem to be OK (at least at 91 GeV)

Further checks are still required

Plans/ideas for future simulation studies

ECAL (cost, performance) optimisation

ECAL represents dominant contribution to ILD cost
sensors represent large fraction of ECAL cost

- impact of non-perfect silicon sensors on performance
  - increase industrial yield of sensors
    - and therefore reduce cost

  Impact of
  - fraction of random “bad” pixels
  - dead zones (e.g. at edge)

  in different ECAL regions

- total ECAL thickness (now ~24X0); inner radius

- conservative technological implementation
  - less compact design, thicker PCB, packaged ASICs...