Report from the Software and Analysis Working Group

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FCAL Workshop
Tel Aviv, September 18, 2016

Overview

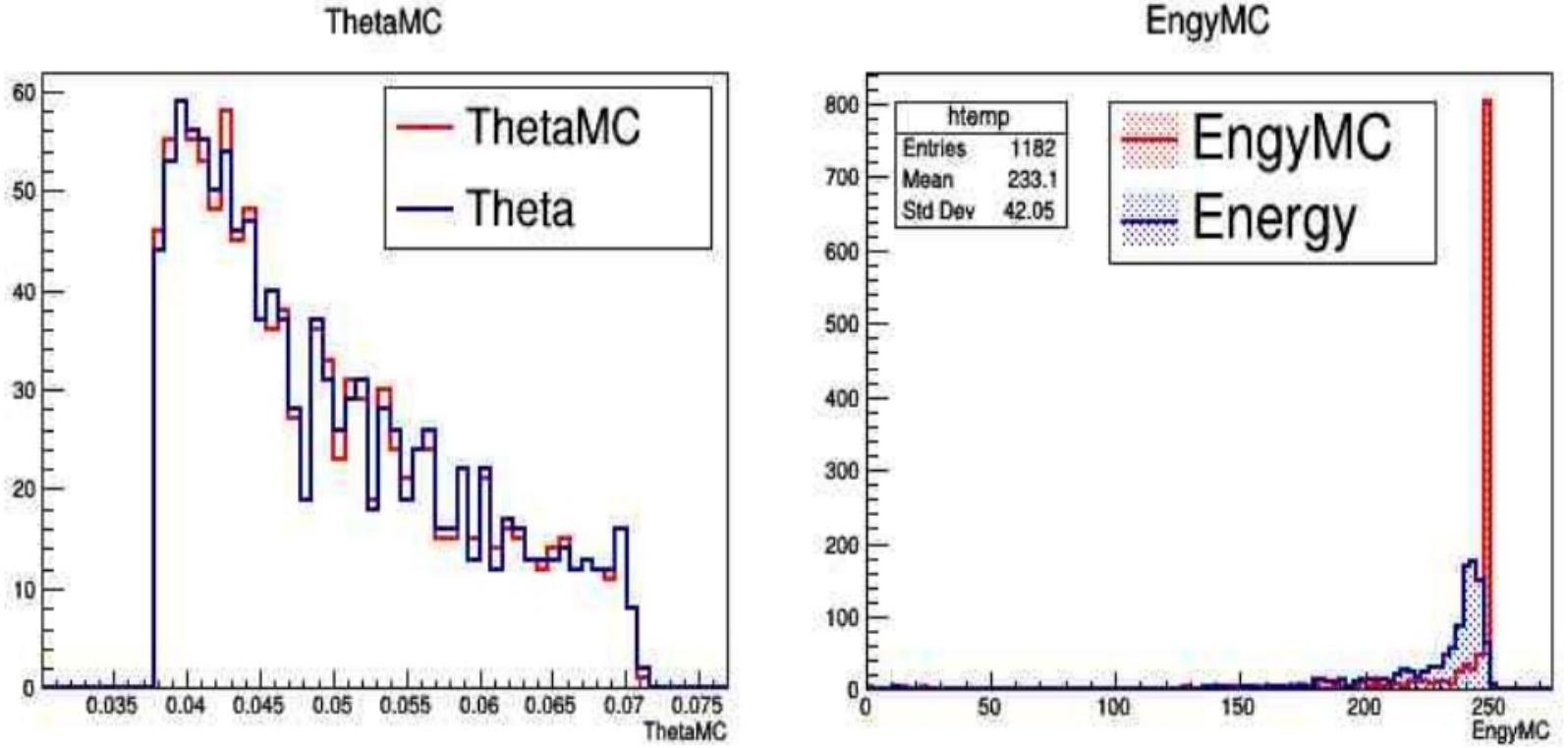
- There were 5 meetings since the last FCAL workshop;
- 8 talks;
- Discussion overview:
  - LumiCal software update;
  - LHCal study;
  - Update on BeamCal study;
  - Beam test data analysis and simulations
- Future plans

LumiCalClusterer

- LumiCalClusterer processor usable within Marlin environment – need still few fixes and tune-up
- LuCaS fully compatible, may be used with Marlin LumiCalCluterer

Required DD4Hep geometry import interface implementation

LumiCalClusterer (results example)

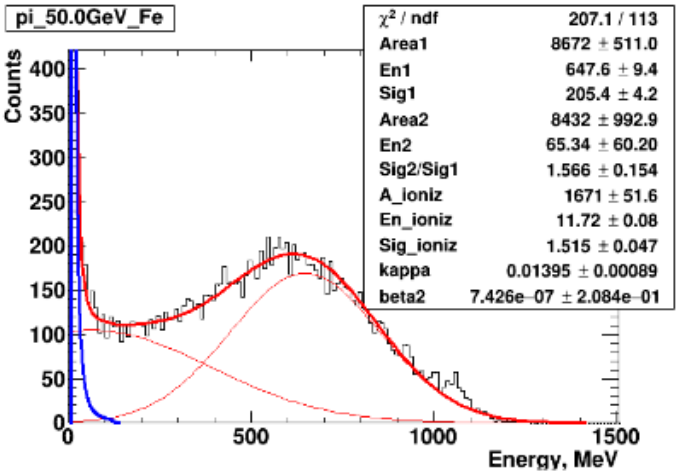


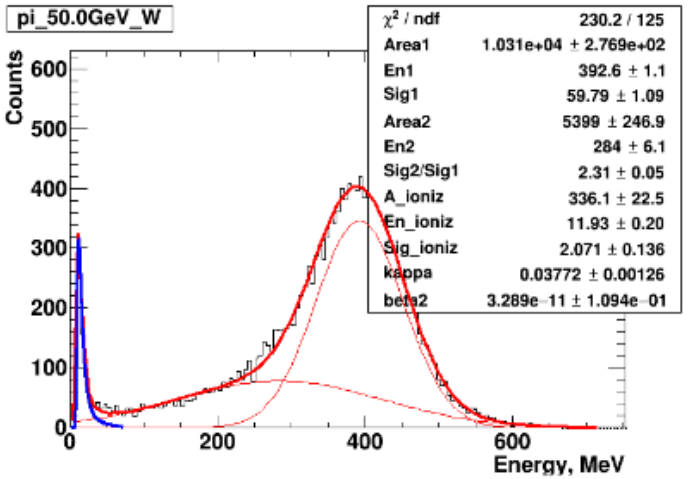
LHCal Study in Simulations

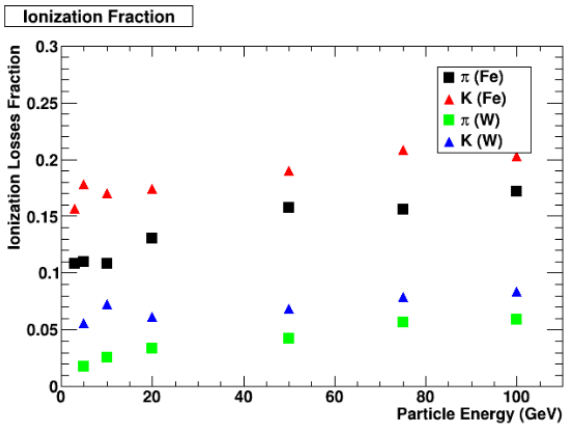
- LHCal has been intensively studied by Maryna and Vlad – students from Kiev group;
- They have successfully graduated with master degree this year;
- The work continues by new students Sasha and Dima under the supervision of Yuriy Onishchuk.

- Hadrons as nuclearly and ionisationally interacted particles have the most complicated response function:

$$R_H = A_1 \cdot G(E, E_{01}, \sigma_1) + A_2 \cdot G(E, E_{02}, \sigma_2) + A_V \cdot V(\lambda_V, \kappa, \beta^2), \quad \sigma_2 > \sigma_1$$



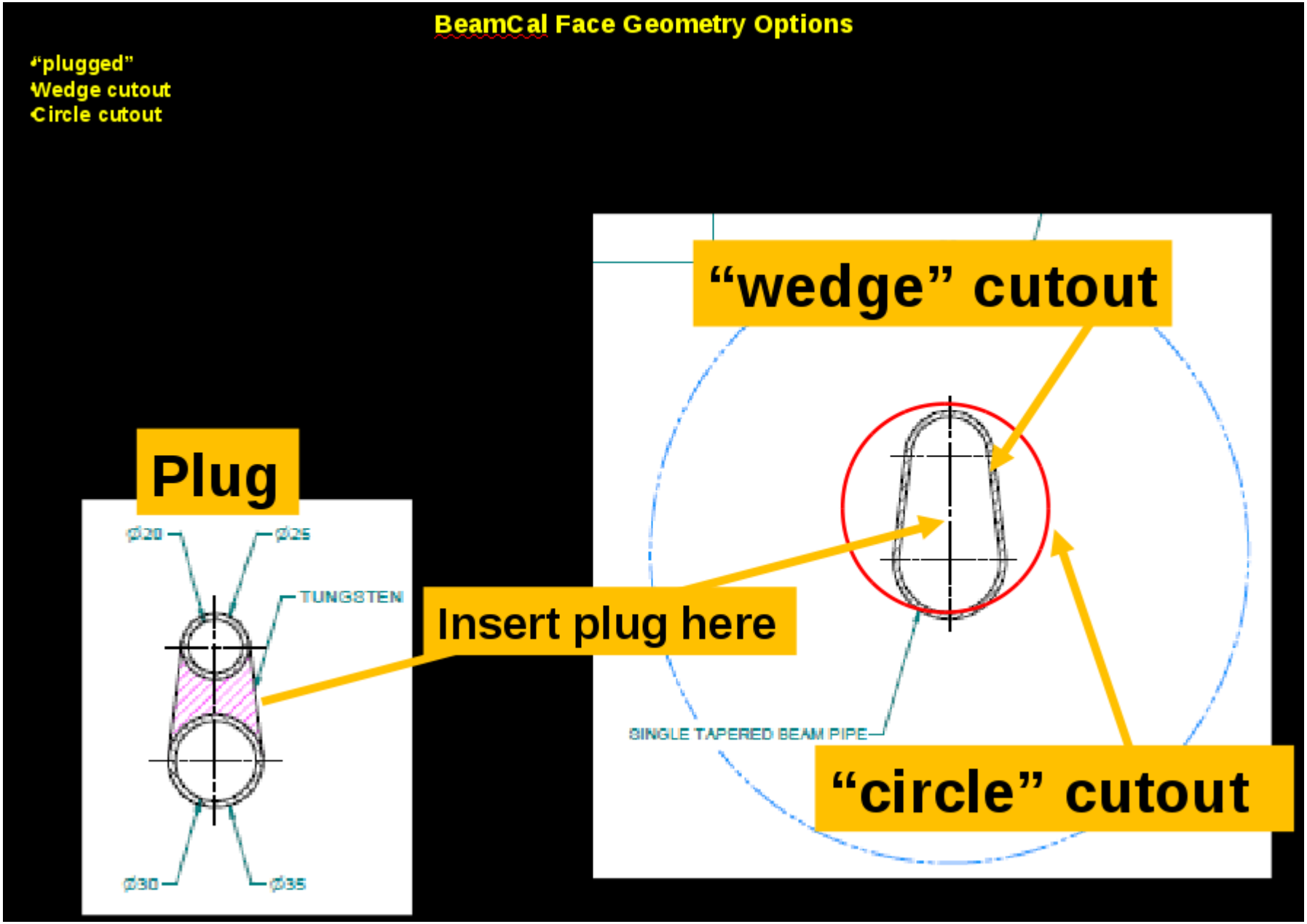




- Fraction of ionisation events is of 0.05 – 0.2 for Fe and W absorbers
- Fe absorber gives 3-4 times larger values
- Kaons have a bit bigger values in comparison with pions

We probably have to start thinking about integration of LHCal with ILD and CLIC

BeamCal Studies at UCSC



BeamCal Studies at UCSC

Configurations Explored

Nominal: L^* = 4.1m; no antiDiD; plug in place

Then, relative to Nominal:

Small L*: L* = 3.5m

AntiDID: Include antiDiD field

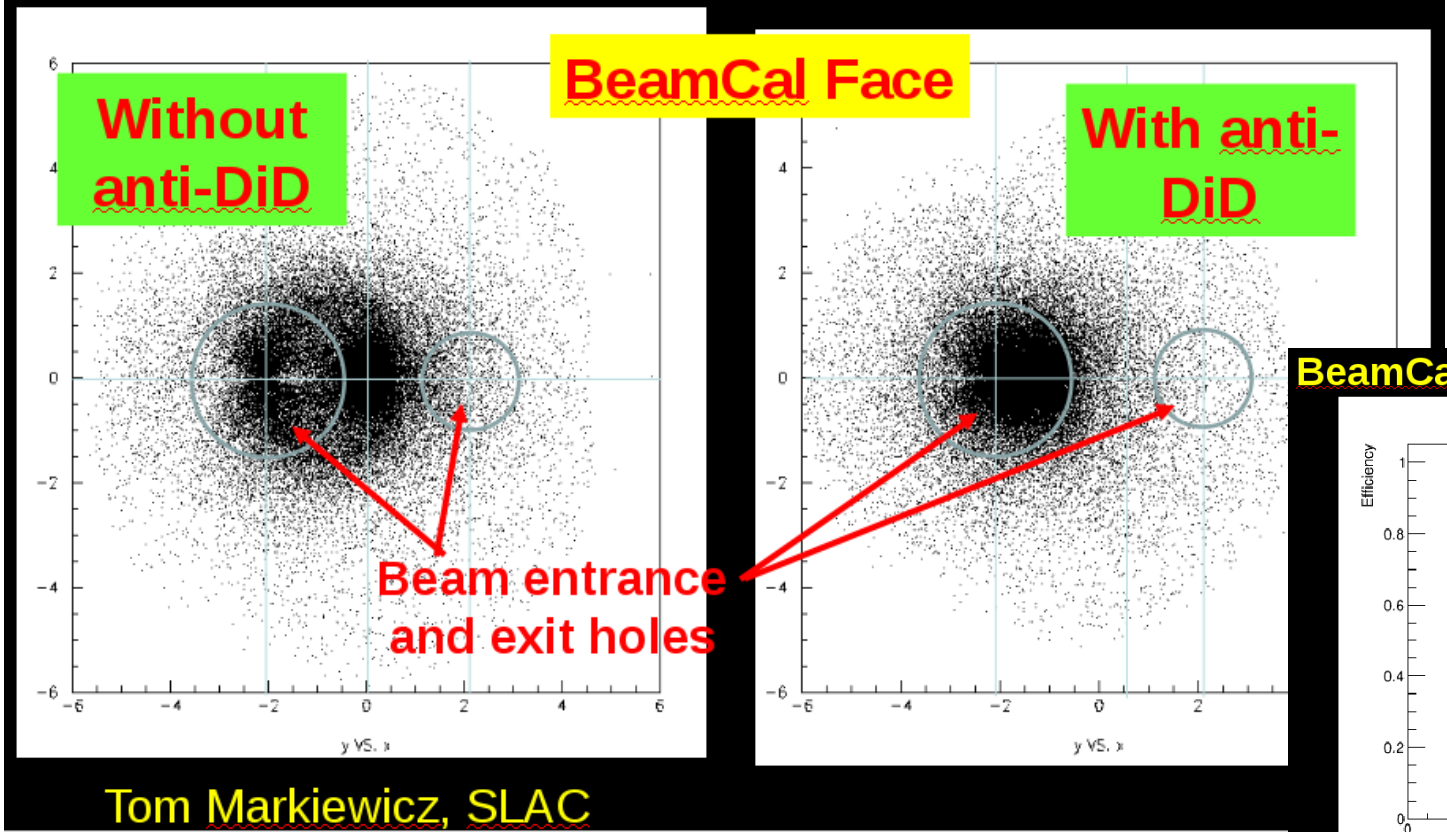
Small L* AntiDID: L^* = 3.5m with antiDiD field

Wedge: Remove BeamCal plug

Circle: Remove additional BeamCal coverage as shown in prior slide.

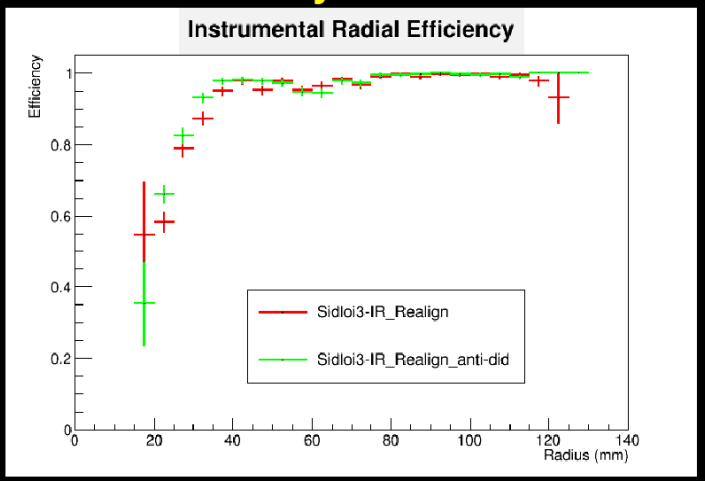
BeamCal Studies at UCSC

Incidence of pair backgrounds on BeamCal with and without "anti-DiD" field



Tom Markiewicz, SLAC

BeamCal Efficiency and the Anti-DiD Field



Appreciable decrease in inefficiency for 30 < R < 50 mm
➔ Physics studies to see if important…

- **BeamCal reconstruction shows only small improvement with anti-DiD field.**

Beam Parameters Reconstruction in BeamCal

Energy depositions in BeamCal from e^+ e^- pairs, produced by beamstrahlung photons, can be used for fast beam parameter reconstruction and instant luminosity measurements.

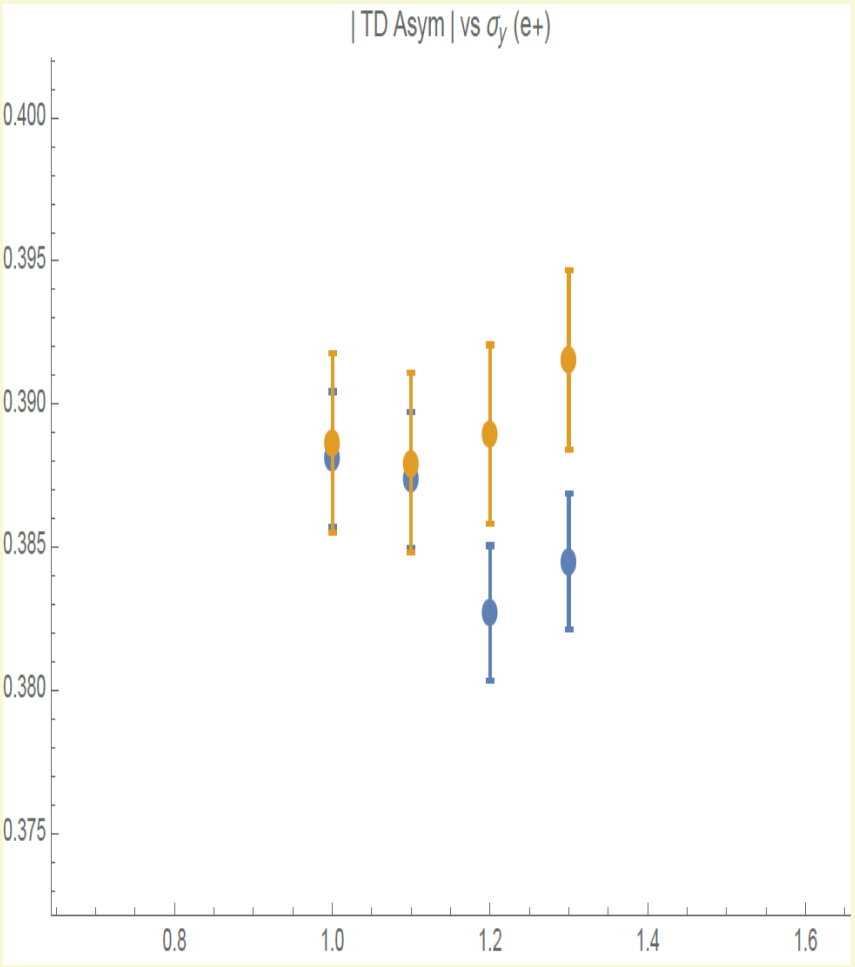
- Use GuneaPig to simulate the beam with modified parameters:
  - Increase beam envelope at origin;
  - Move waist of electron and positron beam;
  - Change targeting angle of electron and positron beam.
- Study parameters (observables) of 3D energy deposition distribution in BeamCal:
  - Deposited energy,
  - mean depth of shower,
  - L/R and up/down asymmetries,
  - thrust (relative to barycenter) value.
- find the dependence between BeamCal observables and beam parameters.

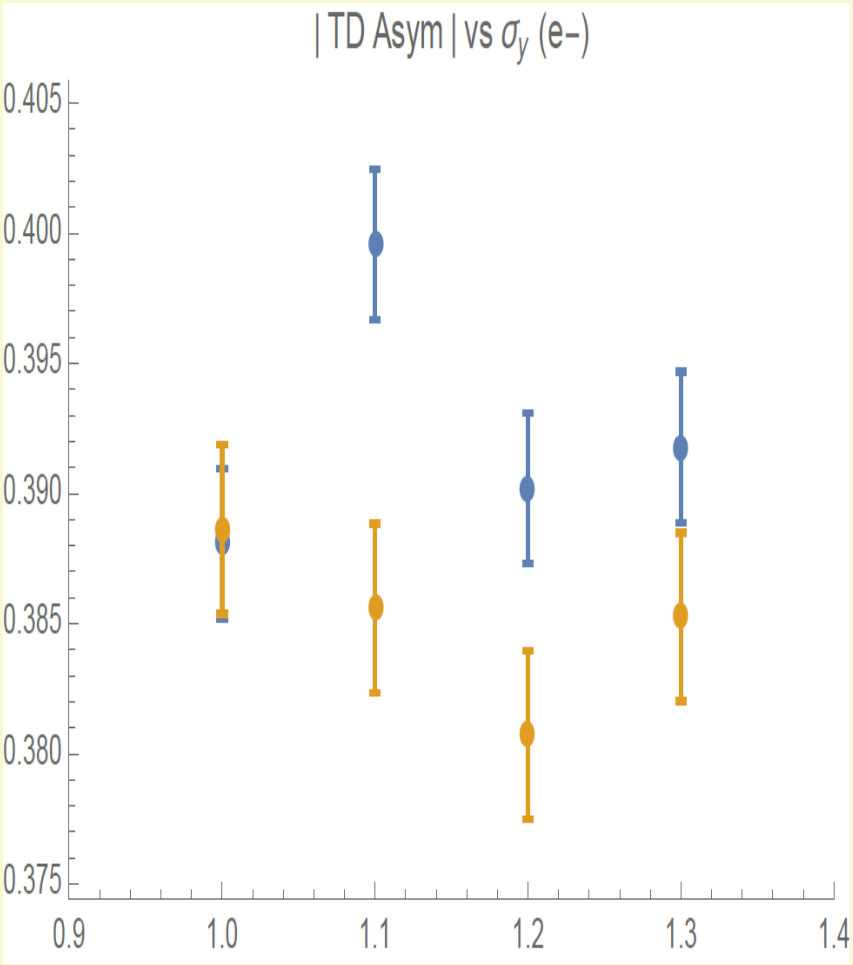
Previous study assumed linear dependence between BeamCal observables and beam parameters and used Moore-Penrose inverse of the Taylor matrix to calculate the parameters of the beam.

BeamCal Studies at UCSC

Beam Parameters Reconstruction in BeamCal

Up-Down Asymmetry





e^+ and e^- beam envelope scan

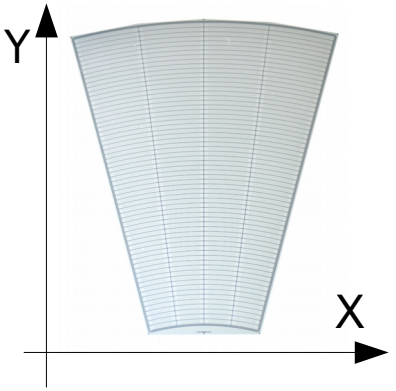
Study in progress, it could affect IP and BeamCal design

TB 2014 Data

- The data collected during the beamtest of 2014 have been analyzed and most of the results were presented in the paper draft:
  - raw signal processing;
  - calibration and signal to noise ratio;
  - longitudinal shower development;
- The paper draft was discussed both at S&A and Hardware WG meetings.
- Ongoing study of the shower development in transverse plane:
  - position reconstruction;
  - the procedure has been developed for Moliere radius calculation;
  - both are included in the paper draft, but some tests of the final results were needed.

TB 2014 Shower Position Reconstruction

$$Y_s = \frac{\sum_n n w_n}{\sum_n w_n},$$

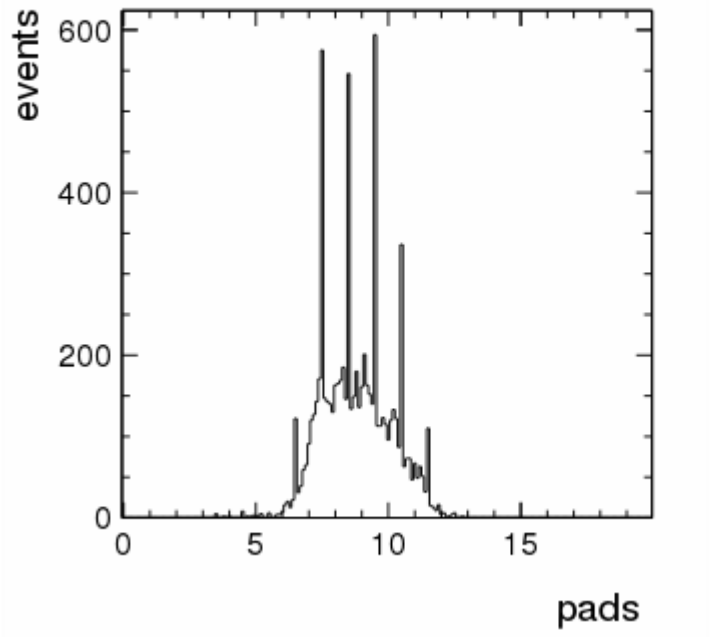


Shower position in LumiCal sensor radial direction, corresponds to θ in LC experiment

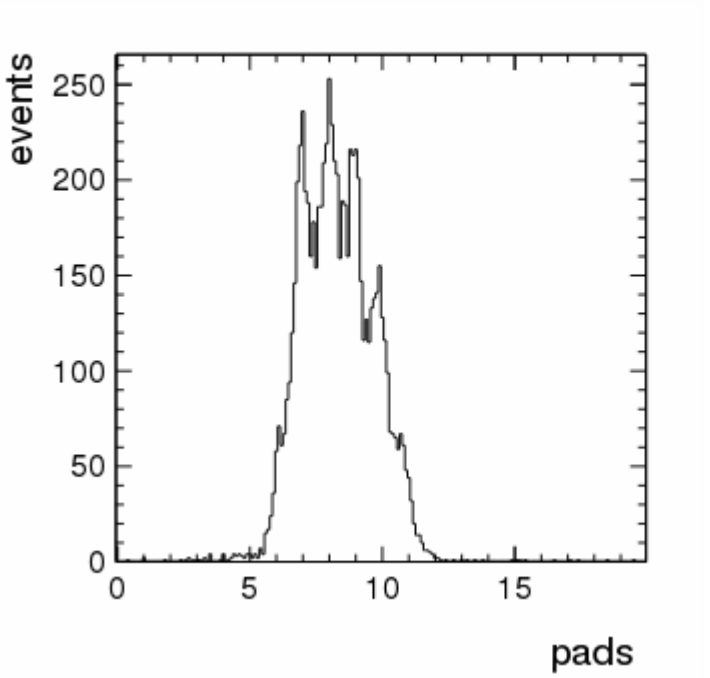
$$w_n = max\left\{0; W_0 + \ln\frac{E_n}{\sum_n E_n}\right\}$$

Gaussian fit to the transverse shower profile

position reconstruction using $W_0 = 1.8$

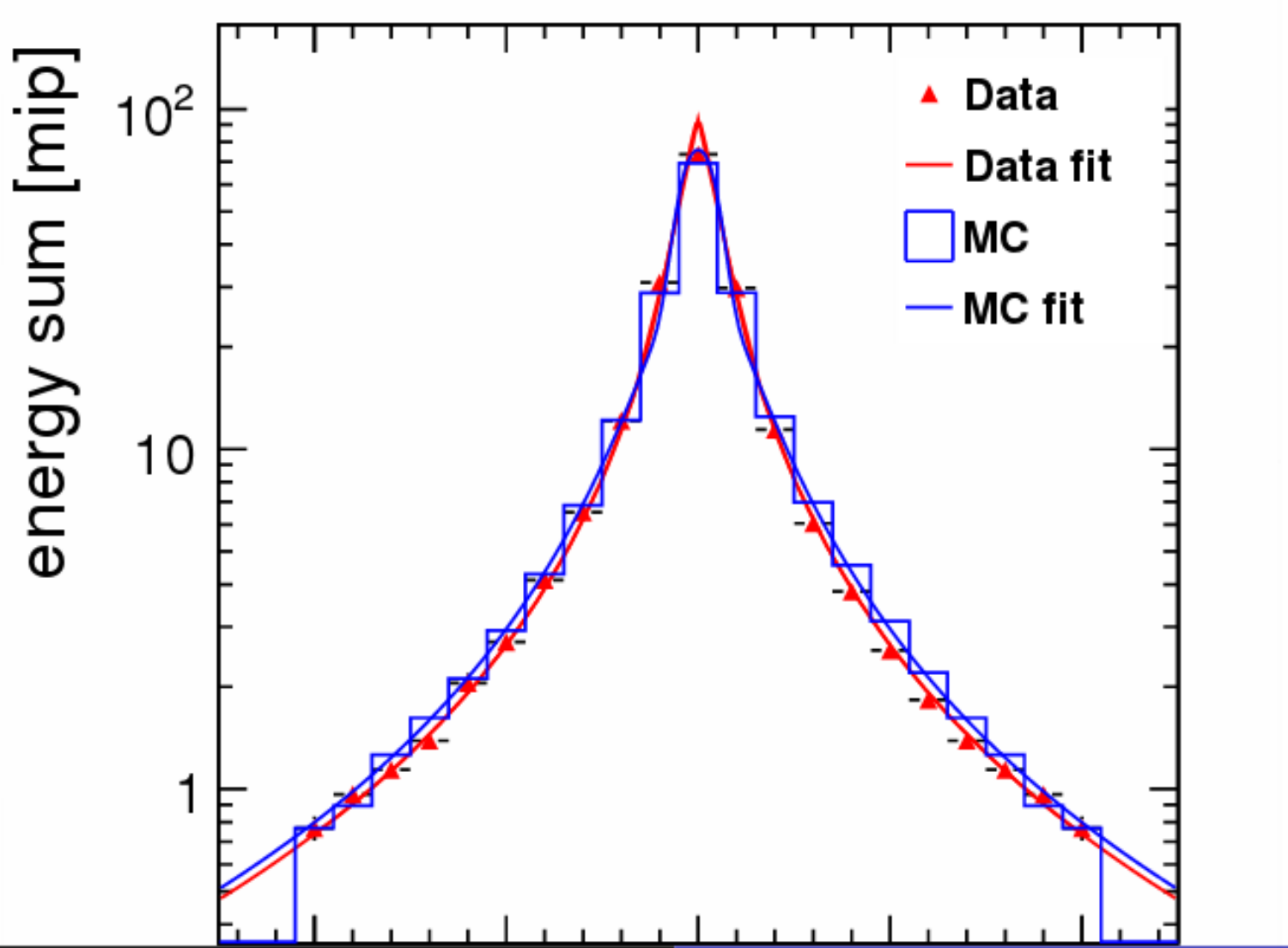


position reconstruction using fit results



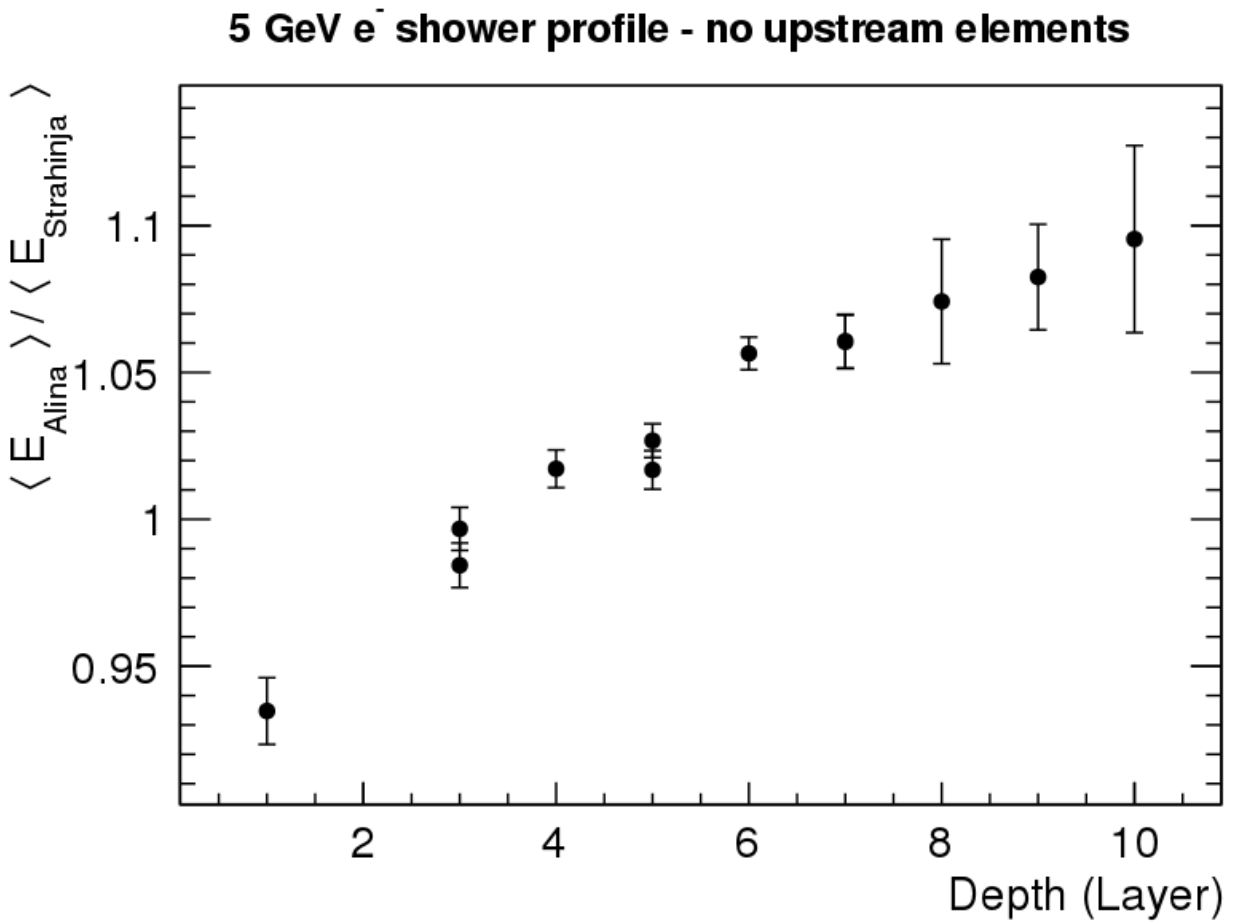
- Both supposed to be the beam profile in transverse plane
- Study is in progress

TB 2014 Projected Average Transverse Shower Profile.

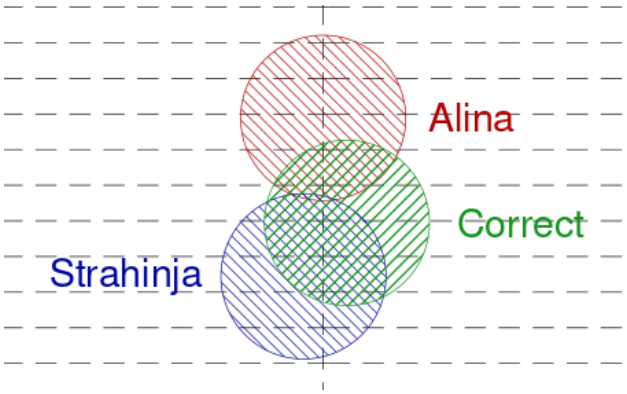


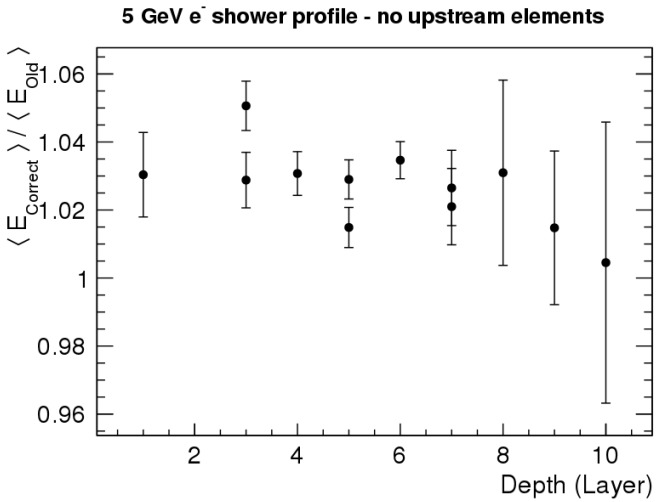
Resolving the differences in the simulations of TB 2014 - geometry

Comparison without upstream elements



Location of the beam spot





Final conclusion was not made and no recent progress reports...

Beam-test 2016 Simulation

ideas

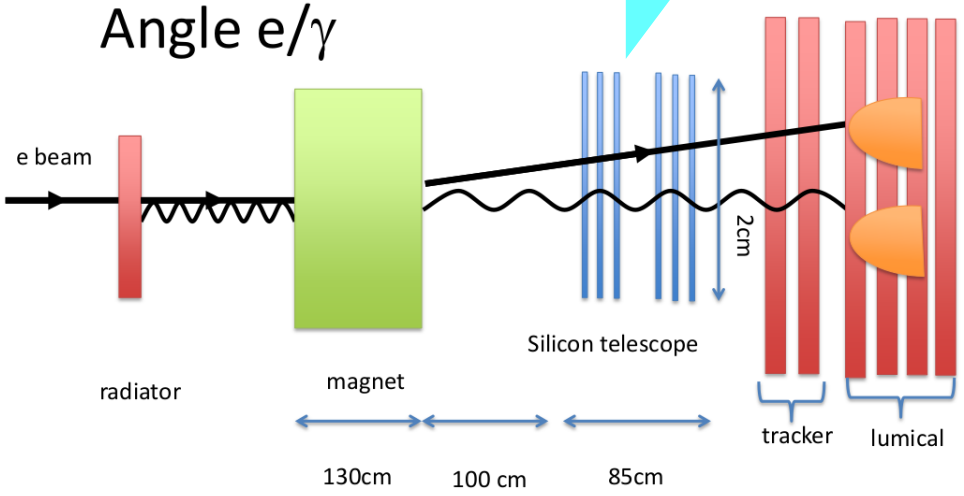
1. Verify the tab bonding (or other candidates is ready)
2. Add more W layers
3. Use of a tracker in front of lumical to identify electron/photon

This was presented by Yan and discussed at the last FCAL workshop.

Identification e/γ

- Need to create e/γ
- Need to curve the e trajectory
- Need to have both of them in the silicon telescope
- Need to have a silicon tracker in front of the lumical detector and both e and γ inside

Angle e/γ



If we want both photon and e inside the telescope :

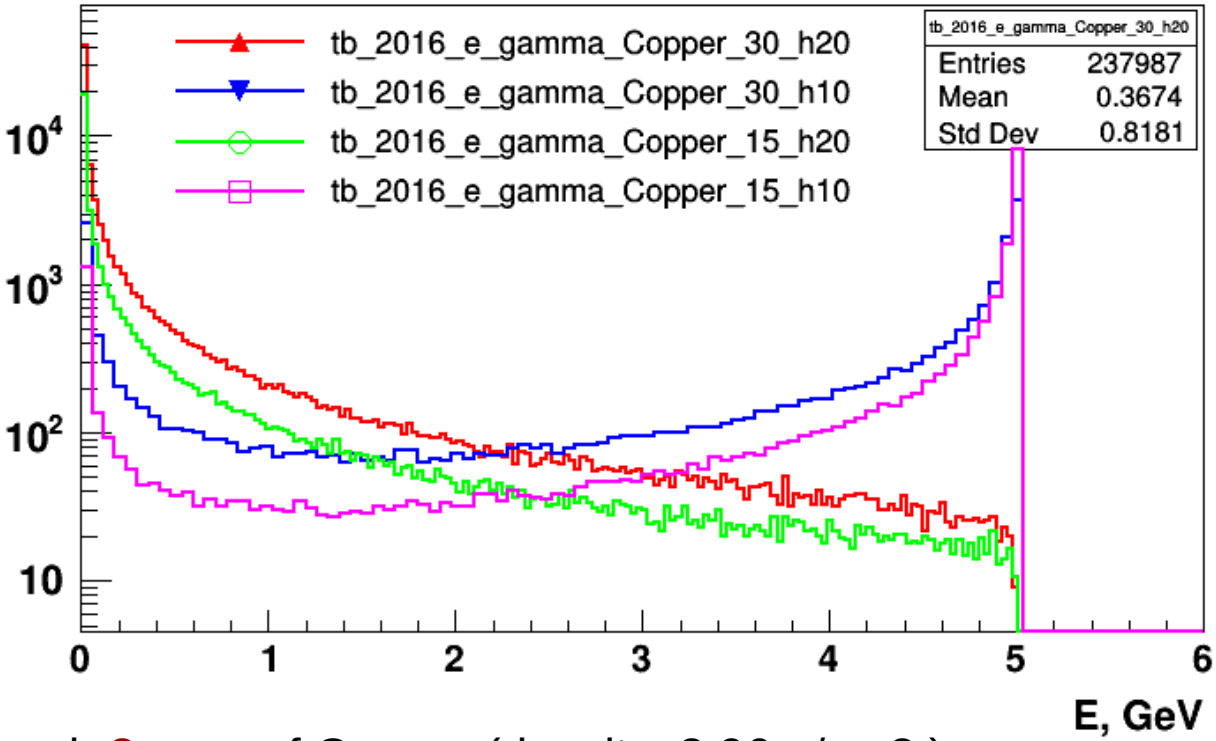
tan θ =2/(130+100+85)= 6 mrad = 0.4 degrees

Beam-test 2016 Simulation

Copper Absorber of 1.5 and 3.0 mm Thickness

The run was 100000 e- of 5 GeV through **1.5 mm** of Copper (density: 8.96 g/cm3)
Number of secondaries per event :

- Gammas = 1.28;
- electrons = 0.5193;
- positrons = 0.02402

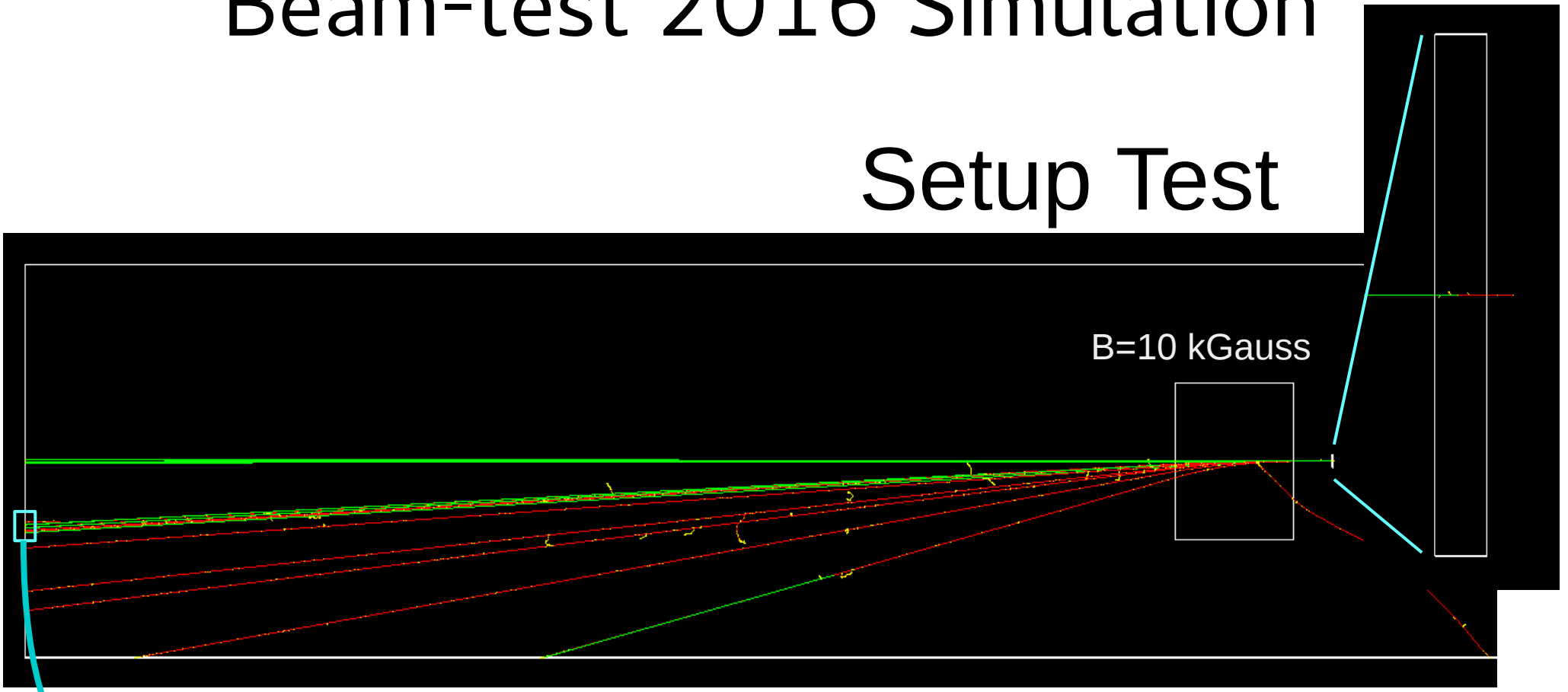


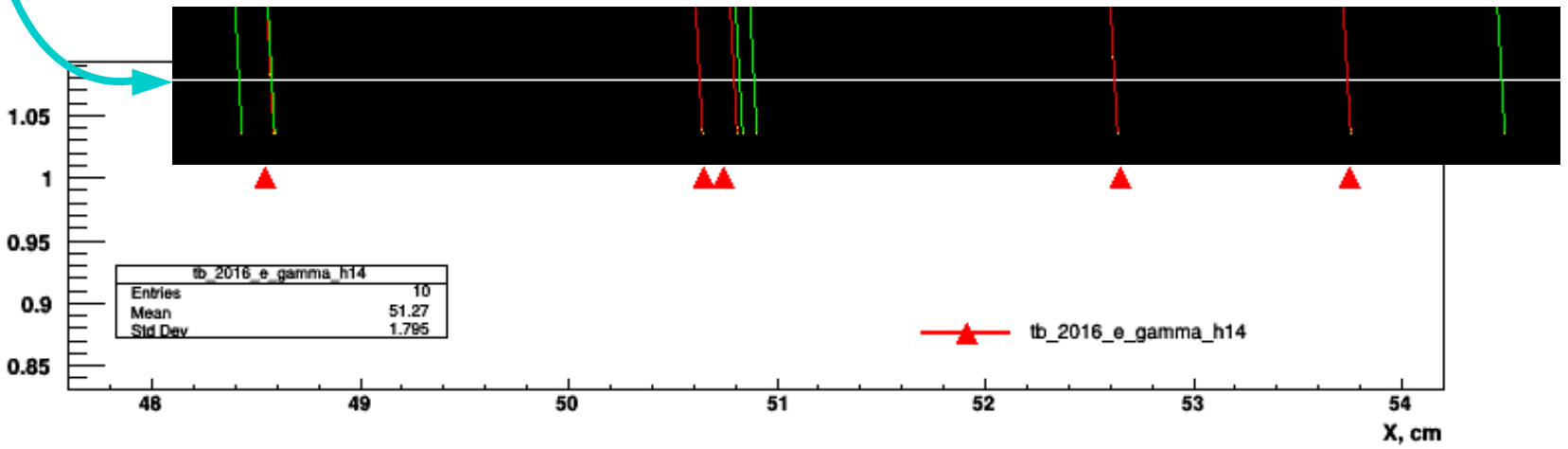
The run was 100000 e- of 5 GeV through **3 mm** of Copper (density: 8.96 g/cm3)
Number of secondaries per event :

- Gammas = 2.758;
- electrons = 1.274;
- positrons = 0.09292

Beam-test 2016 Simulation

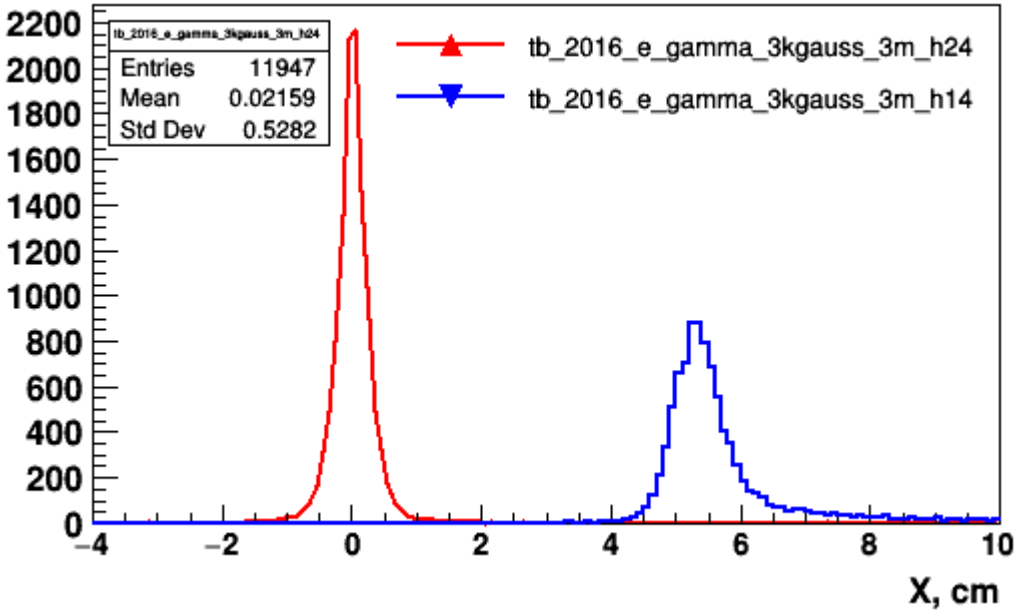
Setup Test

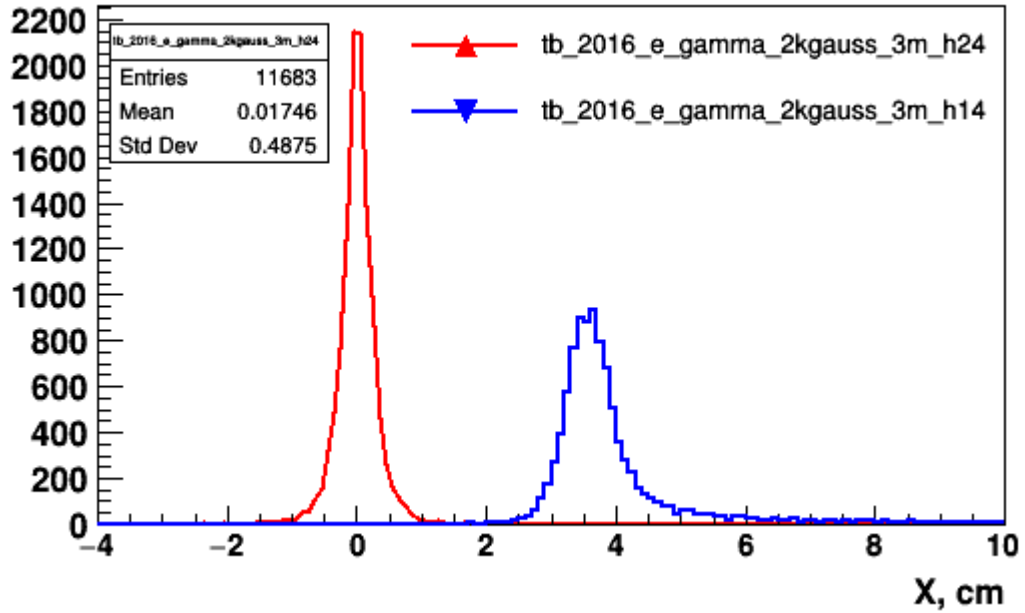




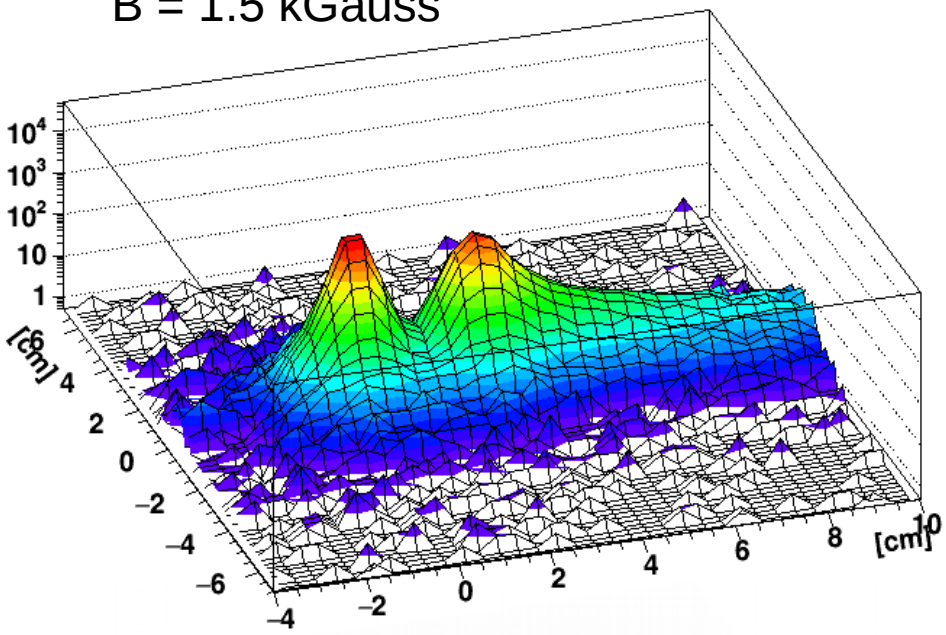
Beam-test 2016 Simulation

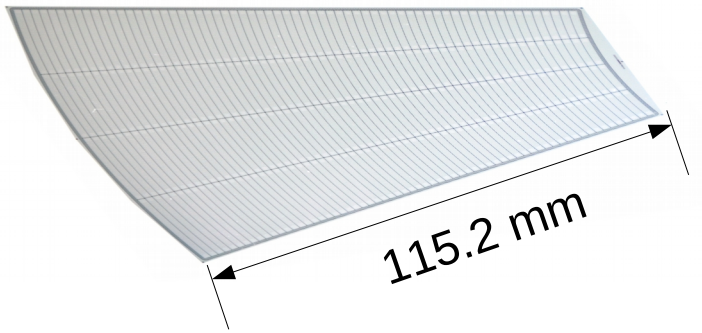
Electron and Photon Beam Position





B = 1.5 kGauss





- e-γ angle ~ 4/400 = 10 mrad;
- For both beams to be in telescope it must be within 6 mrad.
- Need to play with distance and **B**.

ILD Plans

Materials presented in ILD Analysis/Software Meeting (September 14)
Report from Software coordinator - Frank Gaede.

Main Goal for next months

- prepare the software and computing tools for large scale Monte Carlo production for further ILD detector optimization in preparation of the update document to the TDR
  - using the newly developed software chain with:
    - DBD-like ILD model and
    - new small ILD model
      → talk by Ties in last ILD Phone Meeting
  - large SM and BSM data samples for ongoing and future physics analyses

Detailed Baseline Design:
ILD_o1_v05, ILD_o3_v05 (SciEcal in DD4hep)
ILD_s1_v01 (small)

- started by gathering information on status and open issues of software and computing tools
  - validation of new DD4hep based software chain
  - finalization and validation of new reconstruction chain for old (DBD) and new sim.

iLCSoft release v01-17-10

- released iLCSoft v01-17-10 in 1. week of August
  - progress in tracking, PFA and HLR for DBD re-reconstruction
  - starting point for validation of the new ILD simulation models
- started to prepare patch release v01-17-10.p01

future iLCSoft releases

- started to move into the new world:
  - using **C++11** in the code
  - requires gcc4.8 and higher only
  - ROOT6 (requires C++11)
  - (partly) move the iLCSoft packages to **github**
    - started with DD4hep this week
  - phase out old (Mokka based) code and packages
  - create the software chain for the ILD MC mass production
    - cannot expect all code to be backward compatible

ILD Plans

ILD sub-detector contacts

group	name	detectors/systems
Calo	Daniel Jeans	Ecal, Hcal
Si-Tracker	Marcel Vos	SIT, SET, FTD
VFS	Bogdan Pawlik	beamCal, LCal, LHCal
Yoke	Nicola d'Ascenzo	Muon, Coil
MDI	Karsten Buesser	beam pipe, cables, services

- they will play an important role in
  - validating the simulation models
    - geometry parameters and materials
  - validating the digitization (and reconstruction)
    - realism of the digitizers
    - expected resolutions/performance

CLIC Simulation

Introduction

- Future linear collider software chain based on two pillars
  - LCIO Event Data Model
  - DD4hep Geometry Source
- Recent developments
  - DD4hep core/DDG4/ddsim mostly finished
  - Finalising the detector model
  - Track reconstruction with full silicon tracking in MARLIN
  - Providing DD4hep based geometry information and tracks to PandoraPFA
  - Improvements in Pandora and LCIO, and other packages

CLIC Simulation Models

- Have two options of the detector model: Main difference is the tracker layout
- Different versions for both options when wrong parameters are fixed, or changes requested
- Models currently in work: CLIC_o[23]_v06

Reconstruction: Very Forward Calorimeters

Reconstruction of electromagnetic showers in LumiCal and BeamCal

BeamCal:

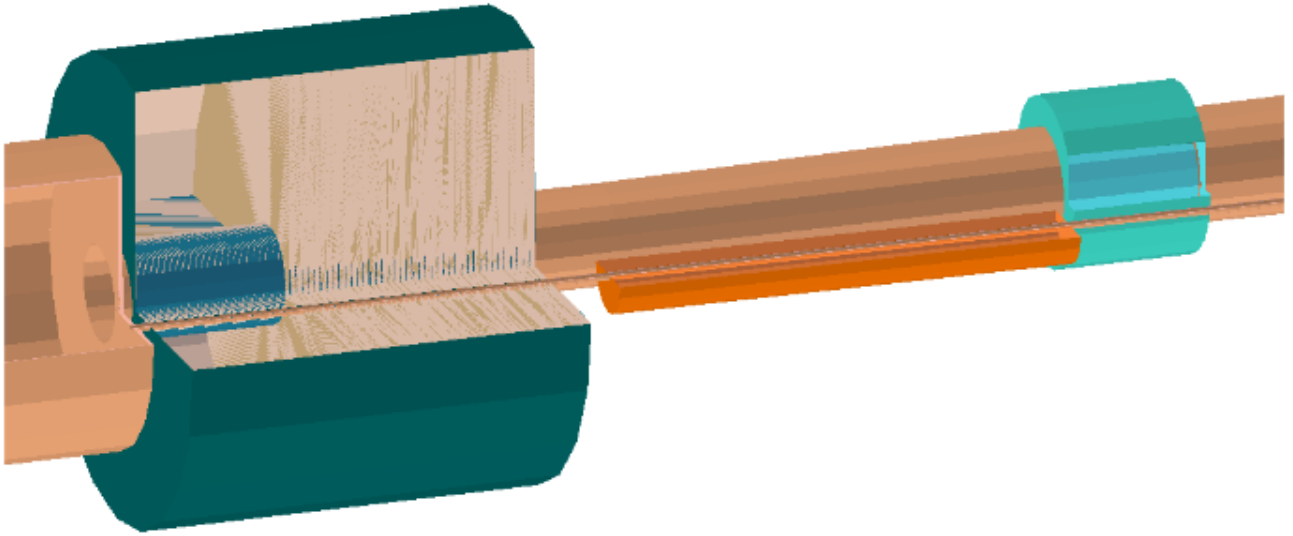
- Reconstruction usable with dd4hep pending final validation

LumiCal:

- Not yet able to handle dd4hep geometry or input files

Forward Region in CLIC

Very Forward Region, Beam Pipe



Request to increase incoming beam pipe radius behind ITF BPM

- Found discrepancy between BeamCal position in simulation model and engineering drawing
- Waiting for updated numbers for beam pipe
- Need to shrink beam pipe radius before QD0, but that is not part of the simulation model at the moment

Summary

- LumiCal:
  - Cluster reconstruction class (LumiCalClusterer) and stand alone simulation program LuCaS have been updated;
  - Ongoing work to test it with DD4Hep;
  - Finalizing TB 2014 data analysis, namely an estimation of the transverse shower size;
  - Arrive to conclusion in understand the discrepancy between TB 2014 simulation results obtained using DD4Hep framework and Geant4 application directly;
  - Redo the study of luminosity measurements in simulation with recent models of ILD, CLIC detectors and consider the improvement its accuracy for CLIC.
- LHCal:
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- BeamCal:
  - Recent studies made only by UCSC aimed on the design optimization of BeamCal for fast beam parameters measurements and enhancing its contribution in physics analysis.

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Thank you for your attention