Report from the Clustering Working Group

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FCAL Meeting, CERN
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History and Numbers

- There were 9 meetings since the last FCAL workshop;
- 12 talks and many useful discussions:
  - Test beam: Telescope - Lumical synchronization;
  - LumiCal geometry implementation in DD4HEP;
  - LumiCal simulation and reconstruction;
  - High-energy particles in the FCAL detectors;
  - Change of L* and BeamCal background;

Software for Telescope Data Reconstruction

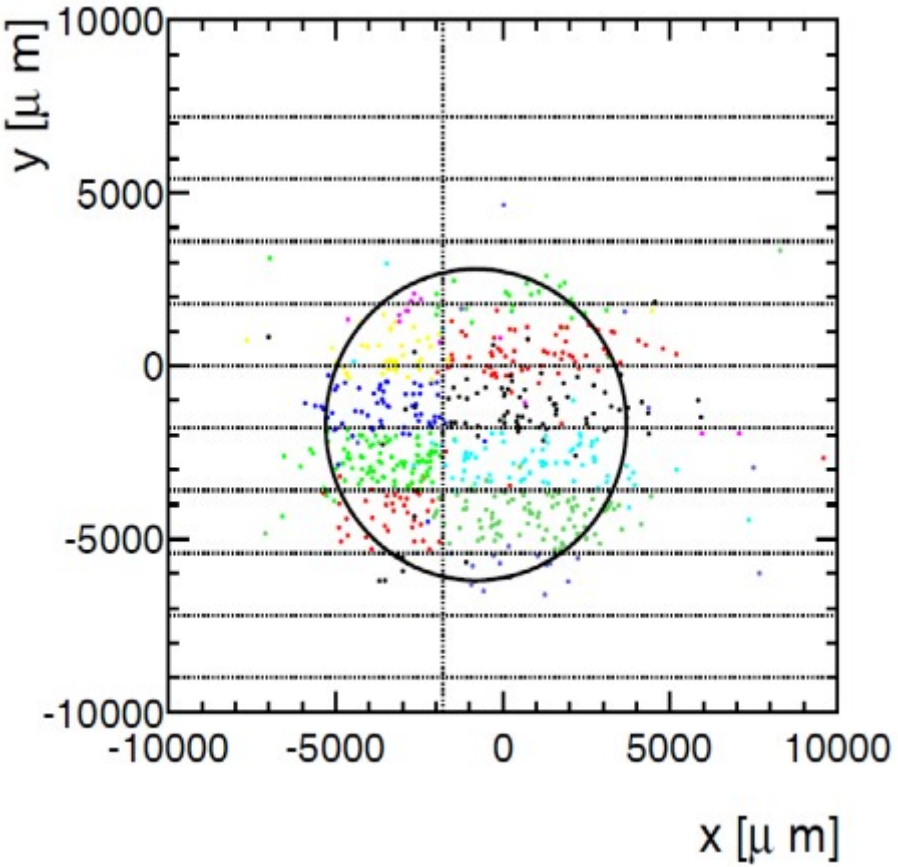
- TAF (TAPI Analysis Framework) is used for reading raw data files from Mimosa sensors and producing hits;
  - developed in IPHC (Strasbourg) using MIMOSA Analysis Framework (MAF).
  - http://www.iphc.cnrs.fr/Public-documentation.html;
  - requires root and configuration file for data analysis.
- Aarhus telescope reconstruction software:
  - alignment;
  - tracks reconstruction;
  - requires: root, armadillo c++ linear algebra library (depends on LAPACK).

- TAF has been modified to save the hardware frame number in output tree. (gTAF->DSFProcudtion(...) output)
  - Modified version: http://alzt.tau.ac.il/~aborysov/mi_telescope/taf_dev_v_tele.tar.gz;
- Aarhus telescope reconstruction software has been modified:
  - to produce tree with tracks and particles position in first sensor of LumiCal.
  - to copy frame number from TAF to output tree;
  - Small changes in track finding procedure.
  - Last version: http://alzt.tau.ac.il/~aborysov/mi_telescope/fcal_tracking.tar.gz.

Test of LumiCal -Telescope Synchronization

Final synchronization algorithm was developed by Itamar

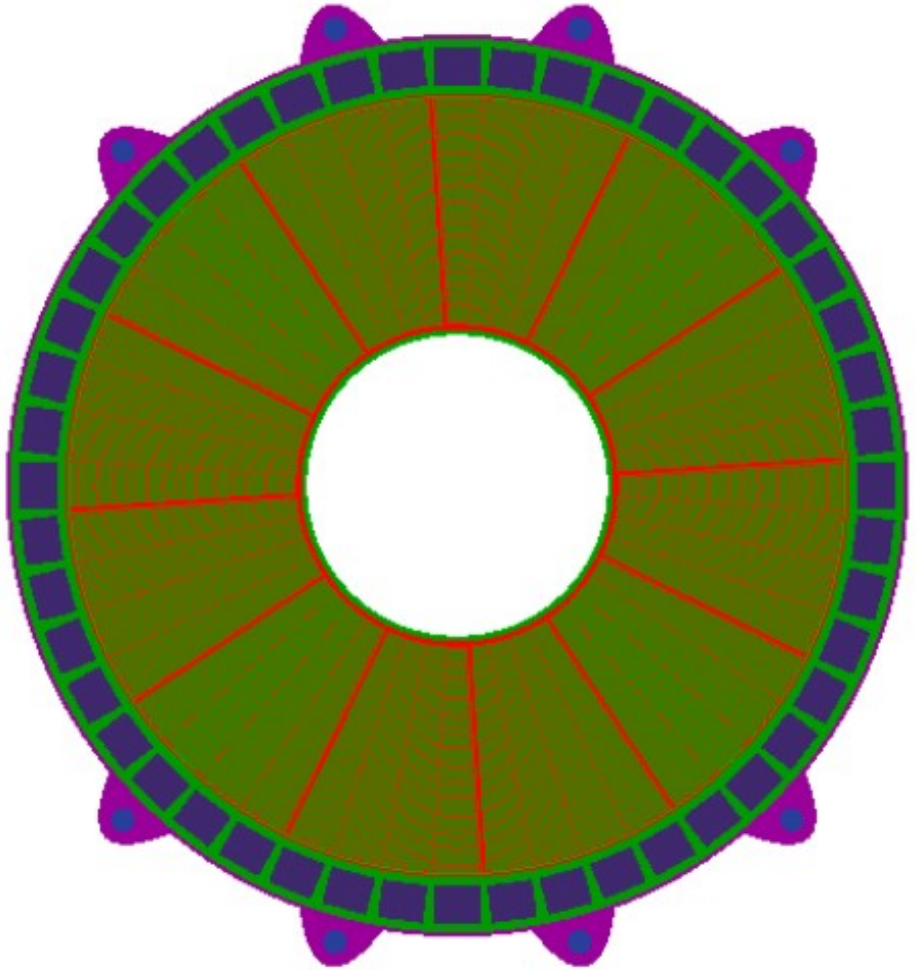
- Extrapolation of the tracks seen by the beam telescope to the first layer of LumiCal reproduces the round shape o the trigger scintillators.
- Position of the point is defined by the reconstruction of telescope data;
- Color of the point is defined by the channel which has a signal in LumiCal;
- The fact that this type of plot reproduce the pad structure of LumiCal sensor means that synchronization works successfully.



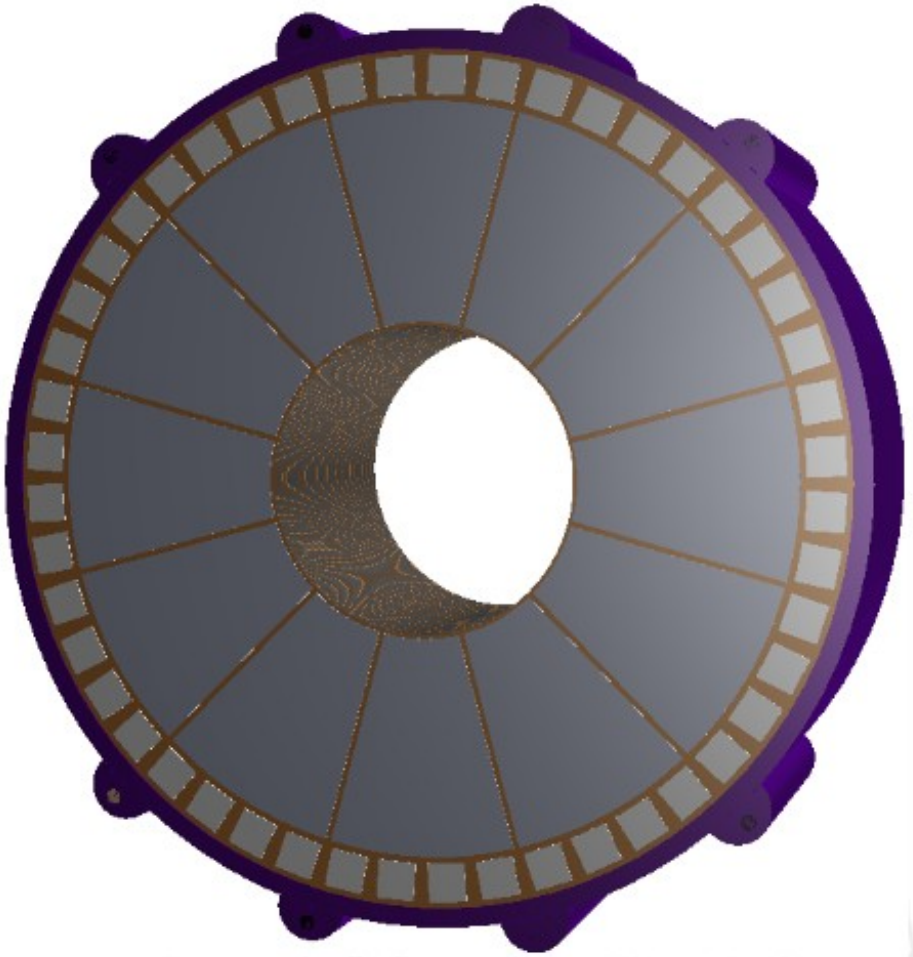
LumiCal in DD4hep V. 2.0

- First detailed version ready

Mokka

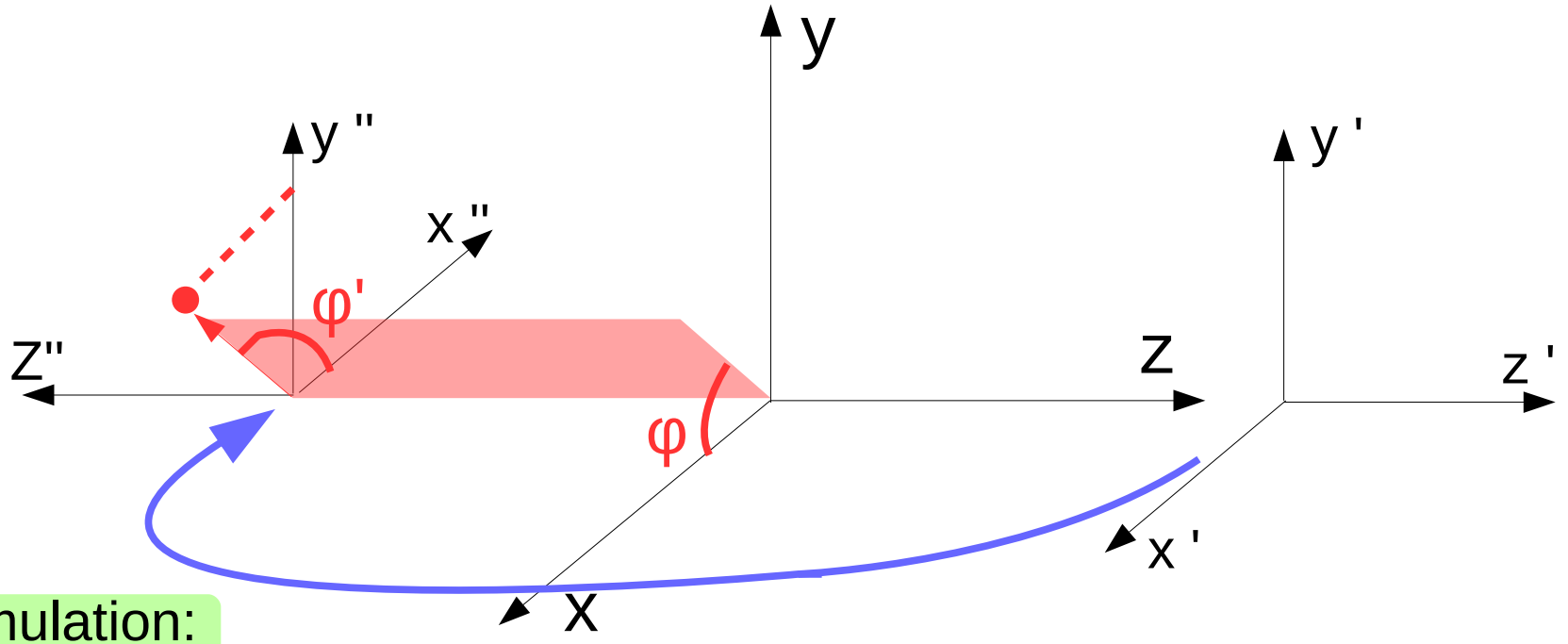


DD4hep



- Not yet submitted to SVN, some testing needed and fitting to the whole detector
- Need real input for "guessed" values (e.g chip size etc.)

LuCaS – Reconstruction Coordinates Mismatch



Simulation:

Global hit coordinate → local coordinate in LumiCal arm → R', φ' → Cell radial ID, Cell azimuthal ID

Reconstruction

Global hit coordinate ← R, φ ← Cell radial ID, Cell azimuthal ID

Cause the problem for Z<0

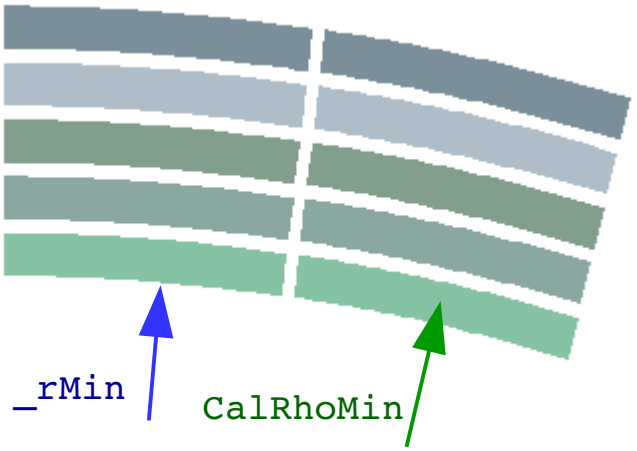
Radial Cell Position

```
Setup::Lcal_CellPitch  = (   Setup::Lcal_SensRadMax
                           -    Setup::Lcal_SensRadMin
 - 2.*Setup::Lcal_sector_dead_gap )/G4double(Setup::Lcal_n_rings); // result: ~1.762

.......
void LCDetectorConstruction::InitDetectorParameters()
CellPitch  = Setup::Lcal_CellPitch;

    SensDet = new LCSensitiveDetector("LumiCalSD",  // name
                                      .......
                                     CellPitch,    // radial cell size
                                      .......
                         VirtualCell); // cell type real/virtual =  false/true
.........................
          SetRhoCellDim(cellDimRho);
.........................
    cell_num   = (G4int)floor(( rho - (CalRhoMin-cellDimRho/2.) ) / cellDimRho );
```

```
ClusterFinder:
_rCellLength = (_rMax - _rMin) / _cellRMax; // result: 1.8
........
rHit = (rCell+0.5)   * _rCellLength + _rMin;
```



Luminosity measurement – 500 GeV ILC

Process	cross-section (nb)	Rel. syst. unc. (uncorrected)
Signal	1.39	–
4f – lumi signature total	0.0063	4.5×10^{-3} (new)
4f – lumi signature hadrons	4.7×10^{-5}	3.3×10^{-5}
Coinc. Bhabha evts / one side	2.05	5.3×10^{-3}
4f total	0.087	2.4×10^{-4}
4f hadronic	0.0019	5.2×10^{-6}

- Lumi cut (one particle): E $>$ 200 GeV, 41 mrad $< \theta <$ 67 mrad
- Lumi signature: Lumi cut + E_{CM} cut + 2-sides coincidence

Change Request No 2: Common L*<= 4m

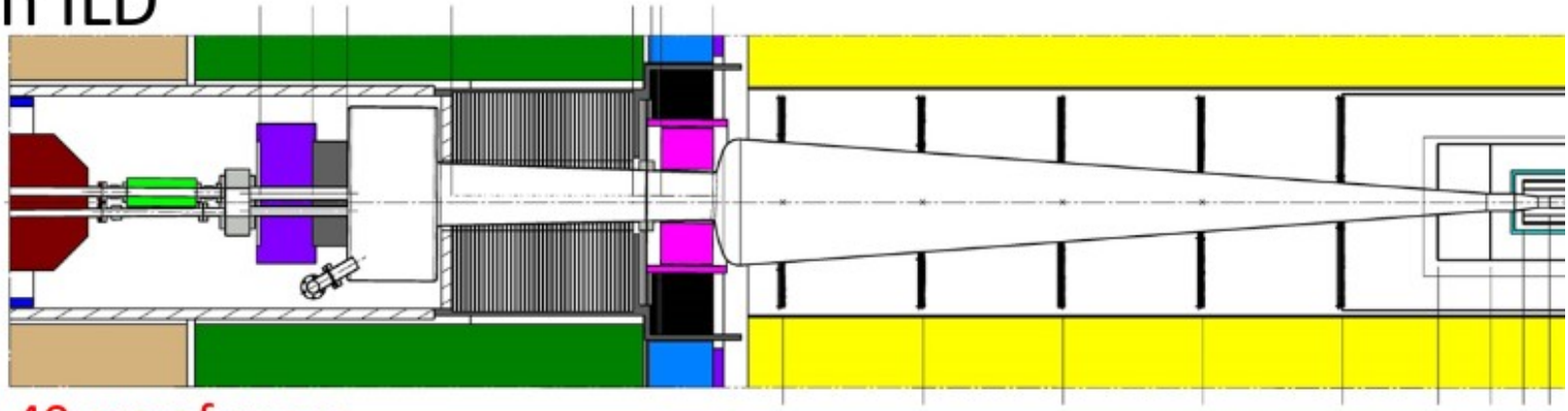
CHANGE REQUEST NO. ILC-CR-0002	EDMS No: **D*01082495**	Created: **02-09-2014**
		Last modified: **09-09-2014**

BASELINE OPTICS TO PROVIDE FOR A SINGLE FFS L* (QD0 EXIT – IP DISTANCE) OPTICS CONFIGURATION

The final focus system (FFS) and beam dump extraction system (EXT) baseline design is to provide a standard optics with fixed L* (yet to be determined, but provisionally assumed to be ≤4m). This optics solution is to be common to both detectors.

- Submitted by Glen White (BDS WG leader) in September 2014
- Change Management Board has formed a Change Review Panel for this request:
  - T. Markiewicz (SiD), N. Terunuma, N. Walker, G. White, KB (MDI, ILD)
  - CRP has agreed to come to a suggestion at the time scale of the next ILC workshop (April 2015, Tokyo)
  - CMB will decide eventually

Changing L* in ILD



need to find about 40 cm of space …

“in principle” there are two basic ways to do this:

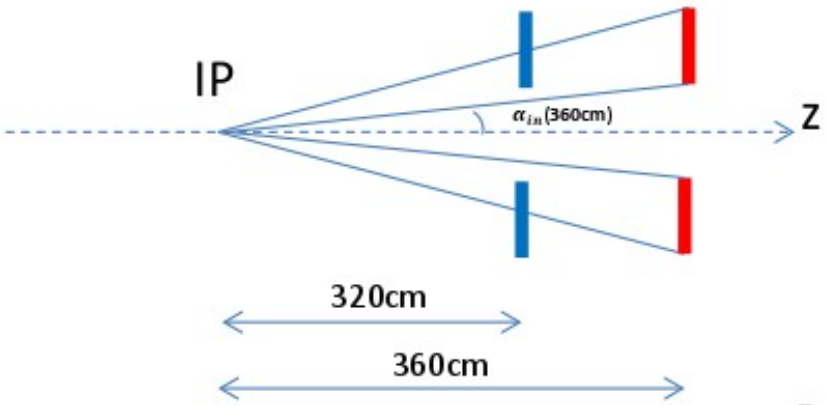
a) change everything starting with the length of the tracker
(could seem natural if the tracker radius is changed -> ILD Detector Optimisation)

b) change as little as possible … remove some elements (vacuum pump ?)
and shorten others (LHCAL ?) to gain the 40 cm of space needed

IF a) -> huge amount of work / all systems are concerned

IF b) -> some work for vacuum experts;
re-design of LHCAL (or the whole forward region ? shielding ??)
BeamCal will be closer to the IP
-> more backscattering into the vertex region ? to be studied

BG energy vs Radius of BeamCal on 320 and 360cm from IP
Rad – in rings

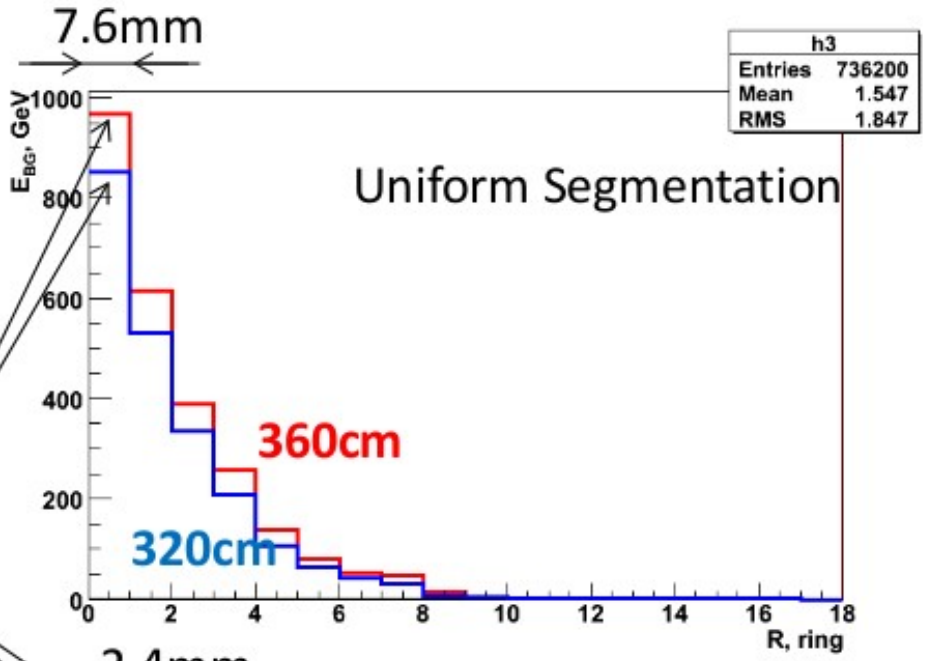


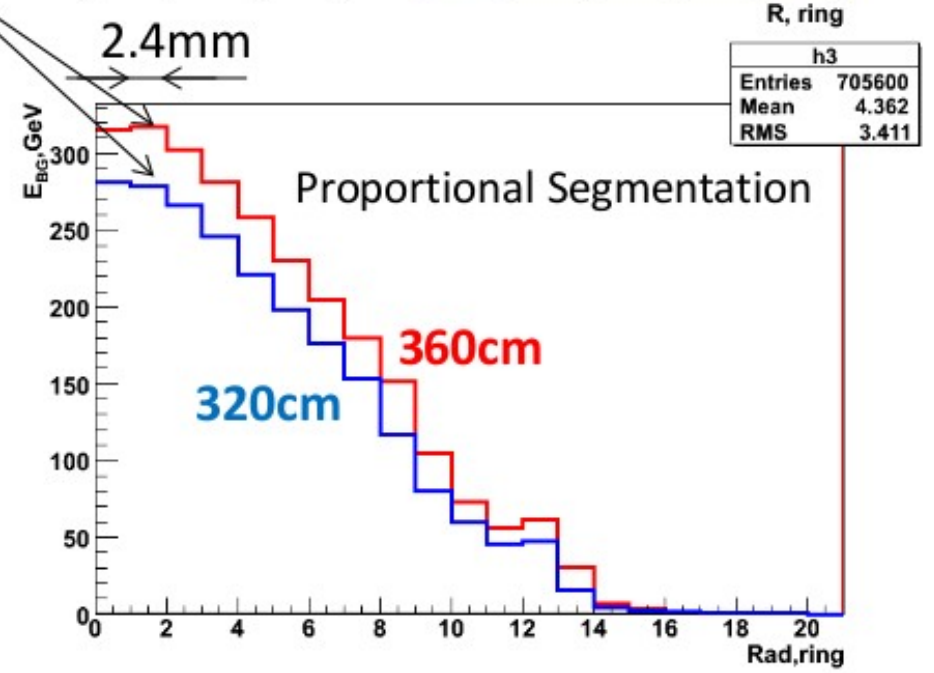
$$\frac{\alpha_{in}(360\text{cm})}{\alpha_{in}(320\text{cm})} = \frac{6.2\ mrad}{5.5\ mrad} \sim 1.13$$

$\Rightarrow$ To cover same α_{in}
as on 360cm, Rin should be
1.78cm instead 2cm

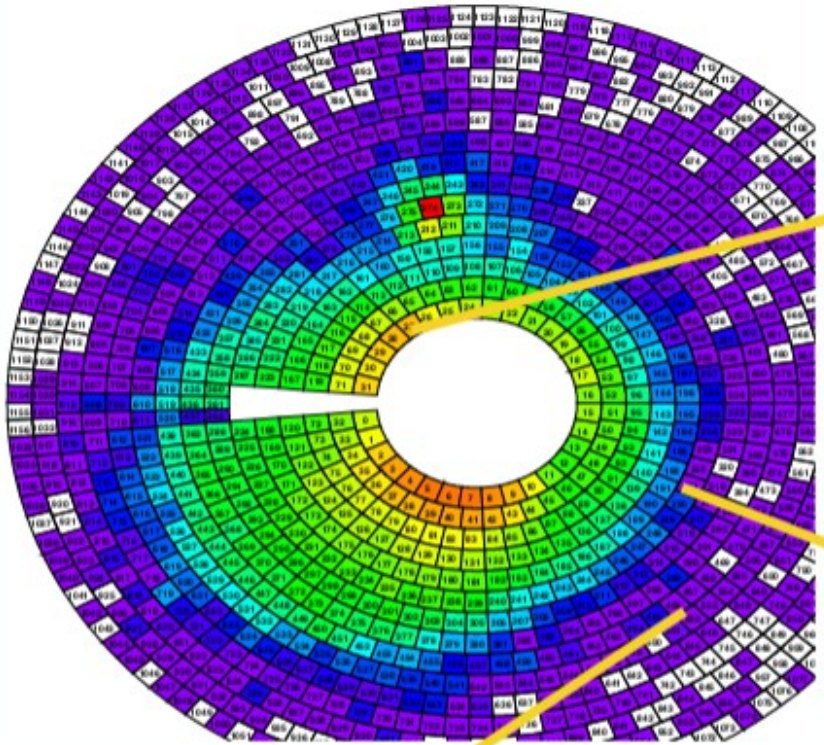
Studied recently by Lucia

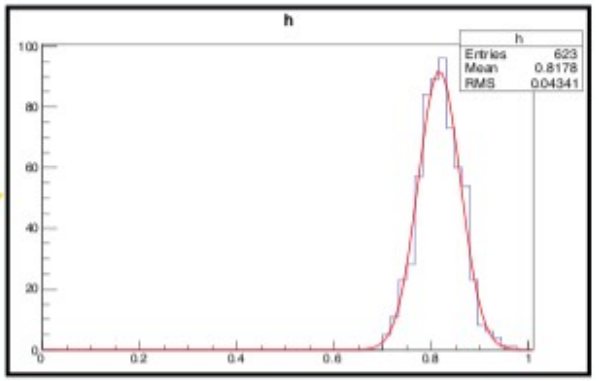
Ratio ~ 1.14

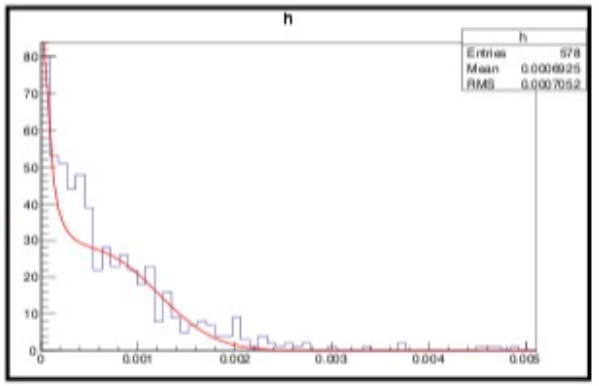


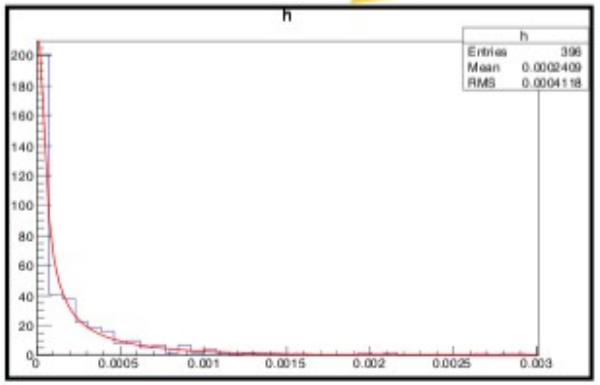


Background parametrisation: fits









General formula:

$$f(x) = \frac{[1]}{x} \exp\left[-\left(\frac{x-[2]}{[3]}\right)^2\right]$$

Ongoing study by Andrey

Summary

- LumiCal:
  - Software infrastructure for test-beam data decoding and synchronization is ready;
  - DD4hep geometry is developing, physical parameters for some components have to be clarified;
  - Work in progress to achieve a consistent performance of LuCaS simulation and reconstruction. Updated versions to be disposed in svn repository;
  - Updated results of the accuracy of luminosity measurements.
- BeamCal:
  - Some results on the performance with new L*=4 m are available;
  - Ongoing study of background parameterization;
  - UCSC group works on the comparison of existing BeamCal clustering algorithms.

- Continue once in two weeks?
- Day and time for the meetings?