Report from the Software and Analysis Working Group

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FCAL Workshop
CERN, March 6, 2017

Overview

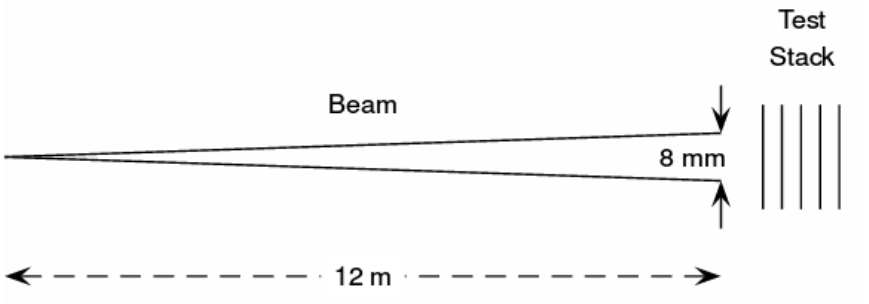
- There were 4 meetings since the last FCAL workshop;
- 9 talks;
- Discussion overview:
  - TB2014 data analysis and simulation;
  - TB2016/15 data analysis and simulation;
  - Update on BeamCal study;
  - FCAL integration with ILCSoft.
- Summary

TB 2014 Data

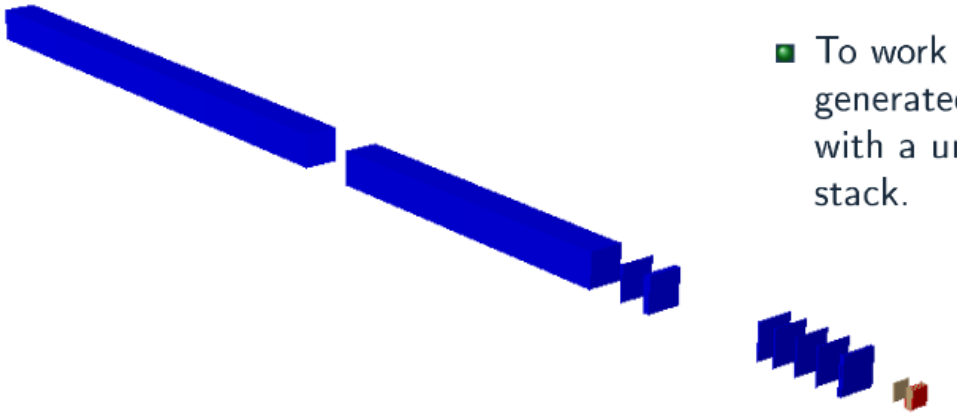
- The data collected during the beamtest of 2014 have been analyzed and most of the results were presented in the paper draft:
  - raw signal processing;
  - calibration and signal to noise ratio;
  - longitudinal shower development, there is reasonable agreement between results of Geant4 applications and DD4Hep;
- The paper draft was discussed both at S&A and Hardware WG meetings.
- Ongoing study of the shower development in transverse plane:
  - recent study was focused on the uncertainty evaluation using the approach presented in the paper draft;
  - Template fit method was developed and applied to calculate Moliere radius.

Correction of Small Inaccuracies in Simulation

1. The 18th pad
2. Veto counter
3. Cherenkov counter CO_2 pressure

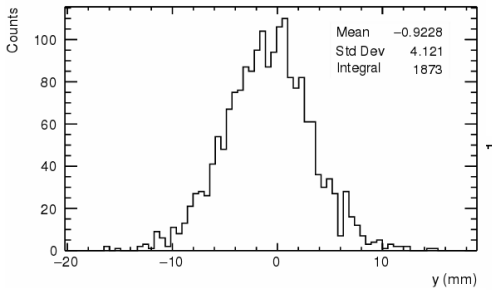


Sketch of the beam generation scheme (not to scale).

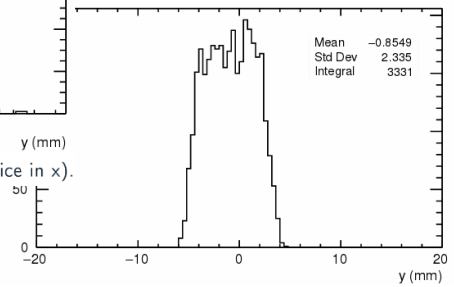


Test beam setup including upstream materials.

- To work around a bug in the old version of DD2hep, the beam is generated from a point source 12 m upstream from the test stack, with a uniform angular distribution to cover the spot size at the stack.



Beam profile along the y-coordinate (2 mm slice in x).



Beam profile along the y-coordinate (2 mm slice in x).

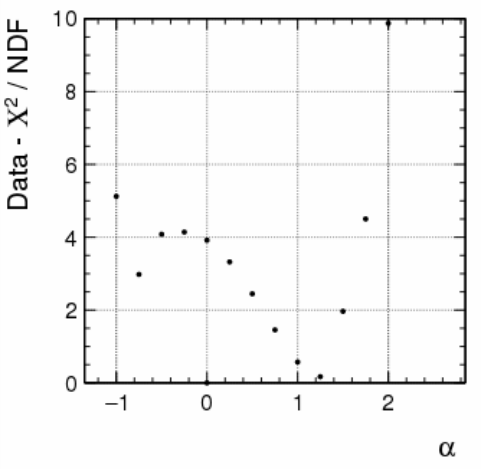
- When the upstream material is included, beam gets additional spread due to multiple scattering

Workaround: Generate a wider beam and emulate the veto counter!

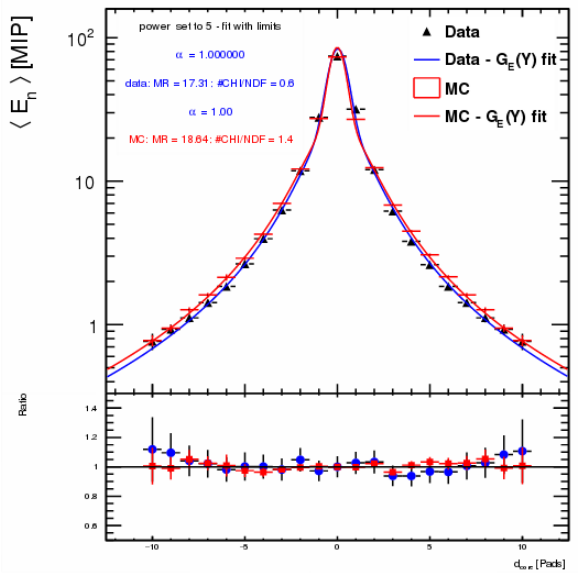
Longitudinal shower profile in simulation shifts upward – closer to data.

Transverse Shower Parameterization

In order to test the effect the tails have on the $R_{\mathcal{M}}$ calculation we introduce a parametrisation for the power of r in the tail part. Then $\alpha = 0$ correspond to tail behavior like G.P. parametrisation,
and $\alpha = 1$ correspond to tail behavior as we used.

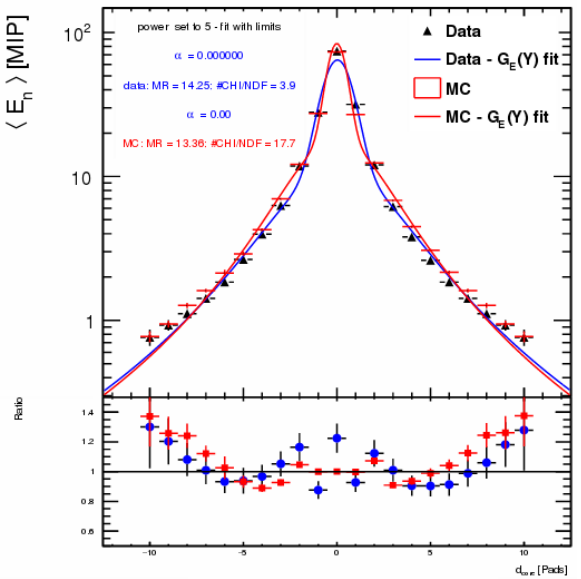


$$F(r) = (A_C)e^{-(\frac{r}{R_C})^2} + (A_T)\frac{2r^{\alpha}R_T^2}{(r^2 + R_T^2)^2} \qquad (11)$$



α = 1

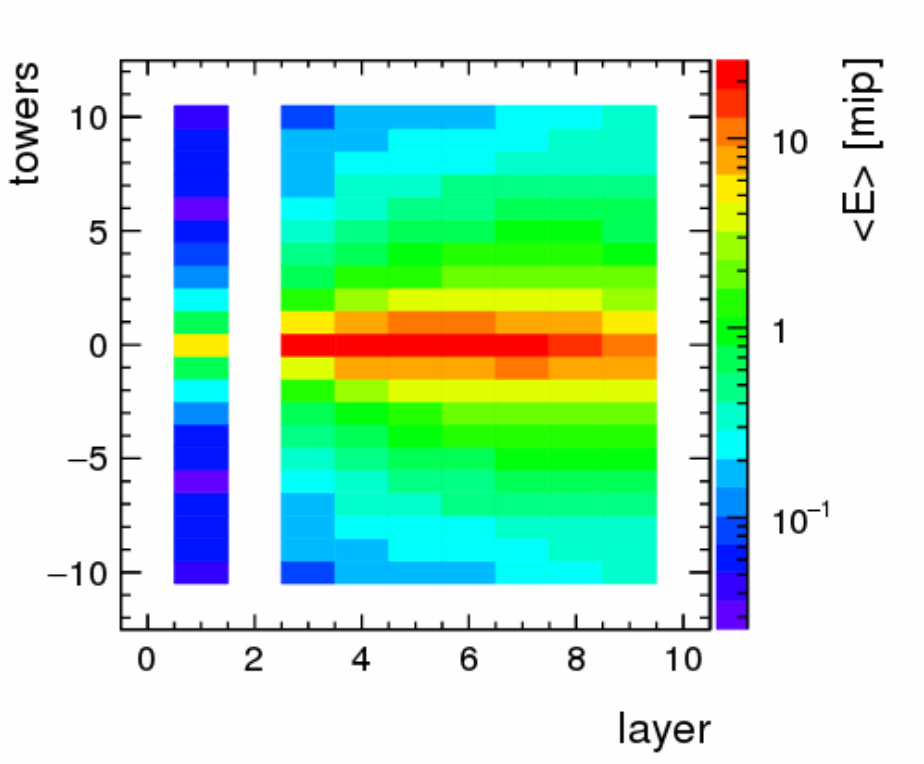
α = 0

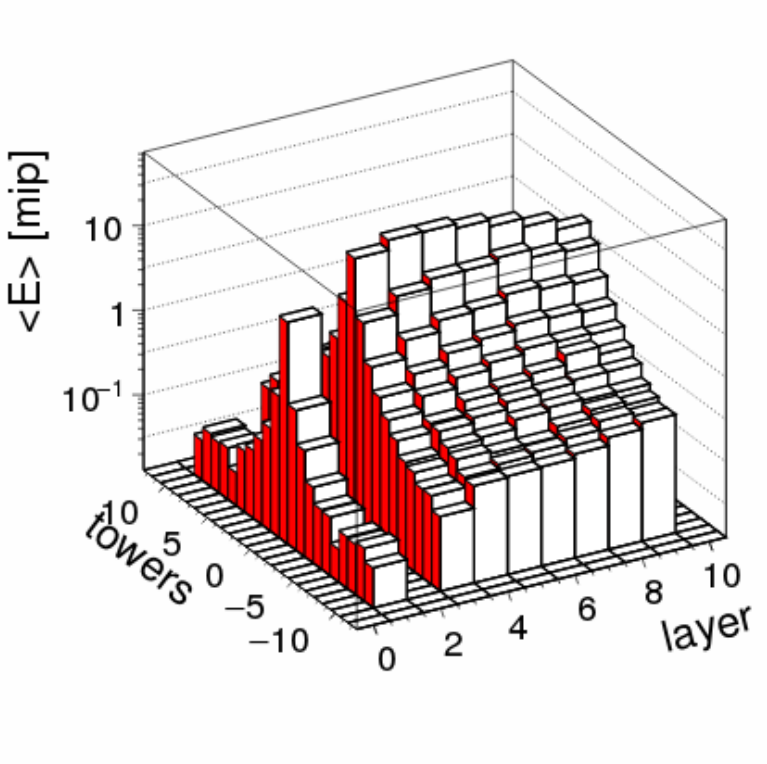


Transverse Shower Layer by Layer

All layers

Since we have all layers we can have look on all :

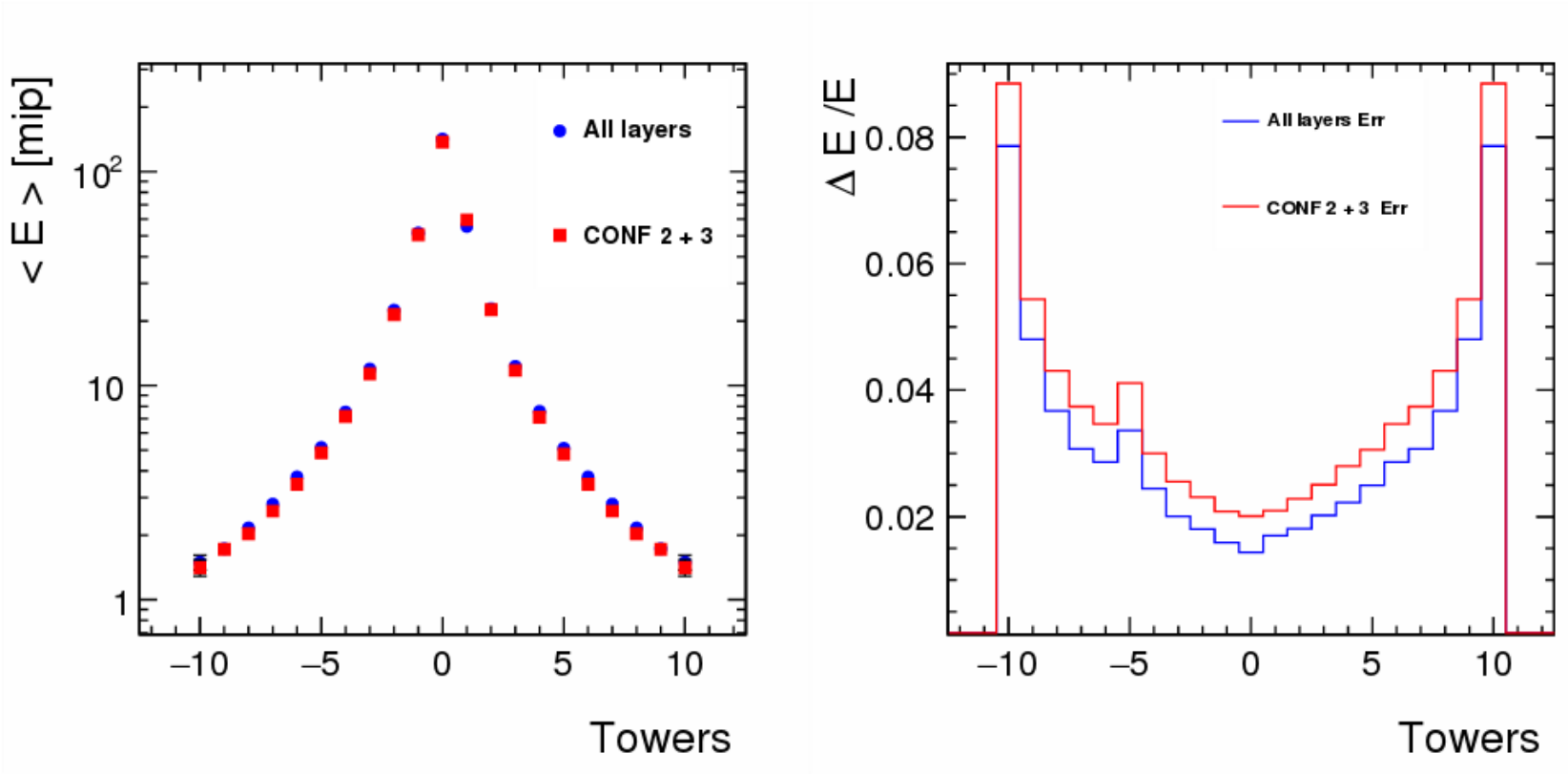




Uncertainty Evaluation

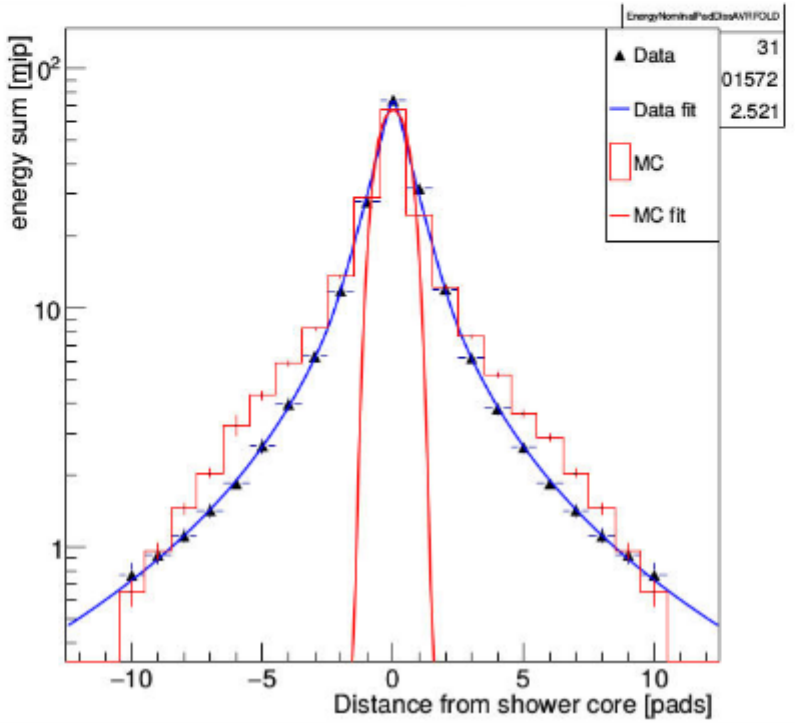
All layers together

Since we have all layers we can add them together to get single profile :



Data and LuCaS vs DD4Hep

- A determination of the Molière radius of the Lumical prototype is presented in the TB2014 paper draft.
- Vertical shower profiles are fitted with the planar projection of a linear combination of a Gaussian and a term inspired by the parametrisation by Grindhammer and Peters (arXiv:hep-ex/0001020)
- Disagreements between DD4hep simulation results and Lucas simulations and data analyses have been reported.

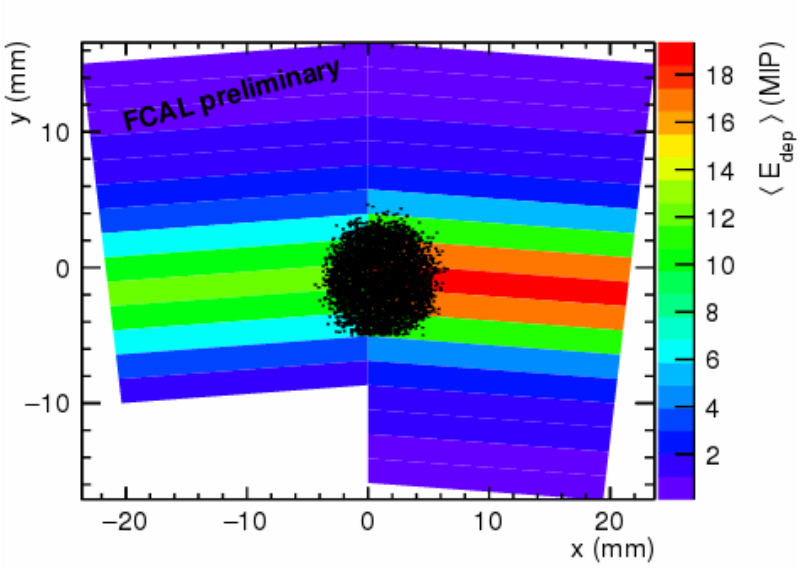


- New ILCSoft release v01-19-01 in January 2017;
- Ongoing work on v01-19-02;
- Would it be good idea to make simulation with new ILCSoft?

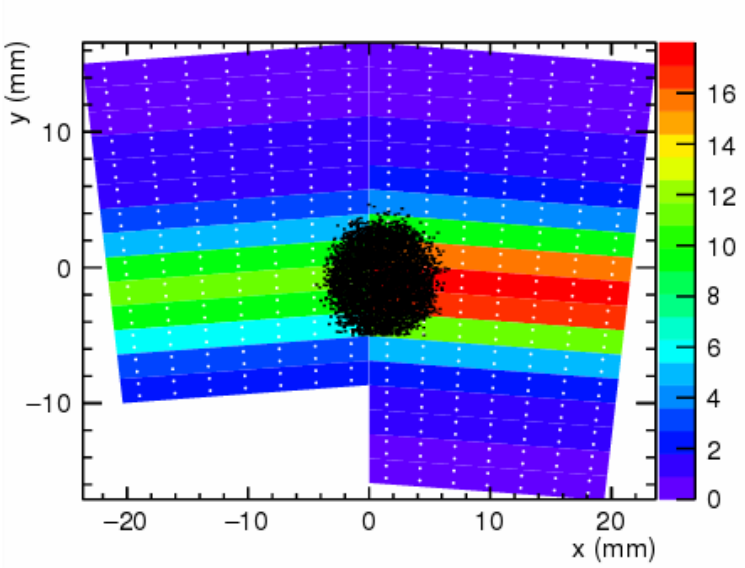
Template Fit. 2D, 3D Fit to Extract Moliere Radius and Other Parameters of the Shower

Template fit

- Fit the data with the discrete distribution of deposits in pads generated from the Grindhammer-Peters (GP) parametrization
- Edge effects, incomplete integration and slope of the pads are all automatically taken account of
- All pads are used – no information is thrown away + n_{df} is higher
- Subdivide the beam spot vertically to exploit the dependence on y_{core}



Average deposits – DD4hep sim (color)
Shower core cordinates (dots)

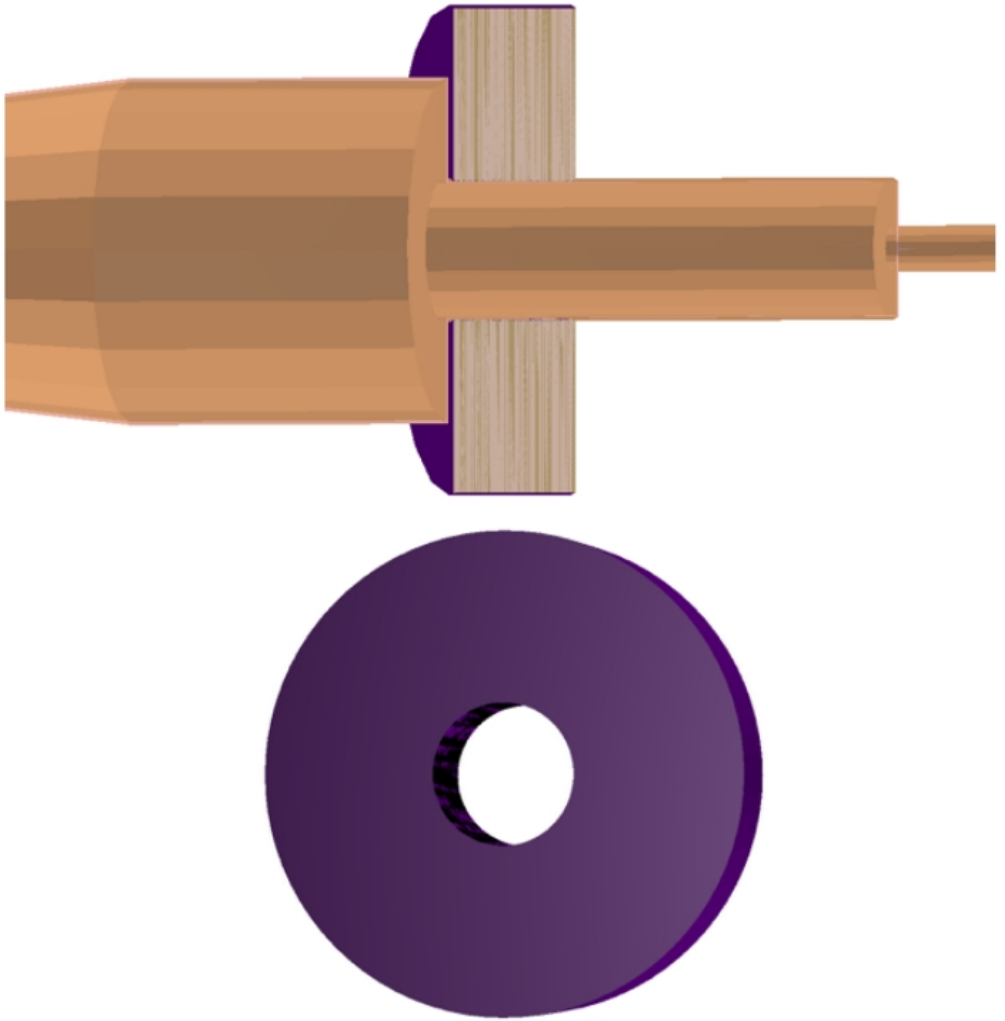


GP model, numerical integration with parameters from the 1D fit (color)
Shower core cordinates (black dots)
Grid points (white dots)

LumiCal Geometry in DD4Hep

Simple geometry

- **Staggered disks**
  - 3.5mm tungsten
  - 0.1mm Air
  - 0.32mm Silicon
  - 0.4mm Copper
- no rotations
- no gaps
- no sectors



FCAL Reconstruction

FCalClusterer Moved to Github

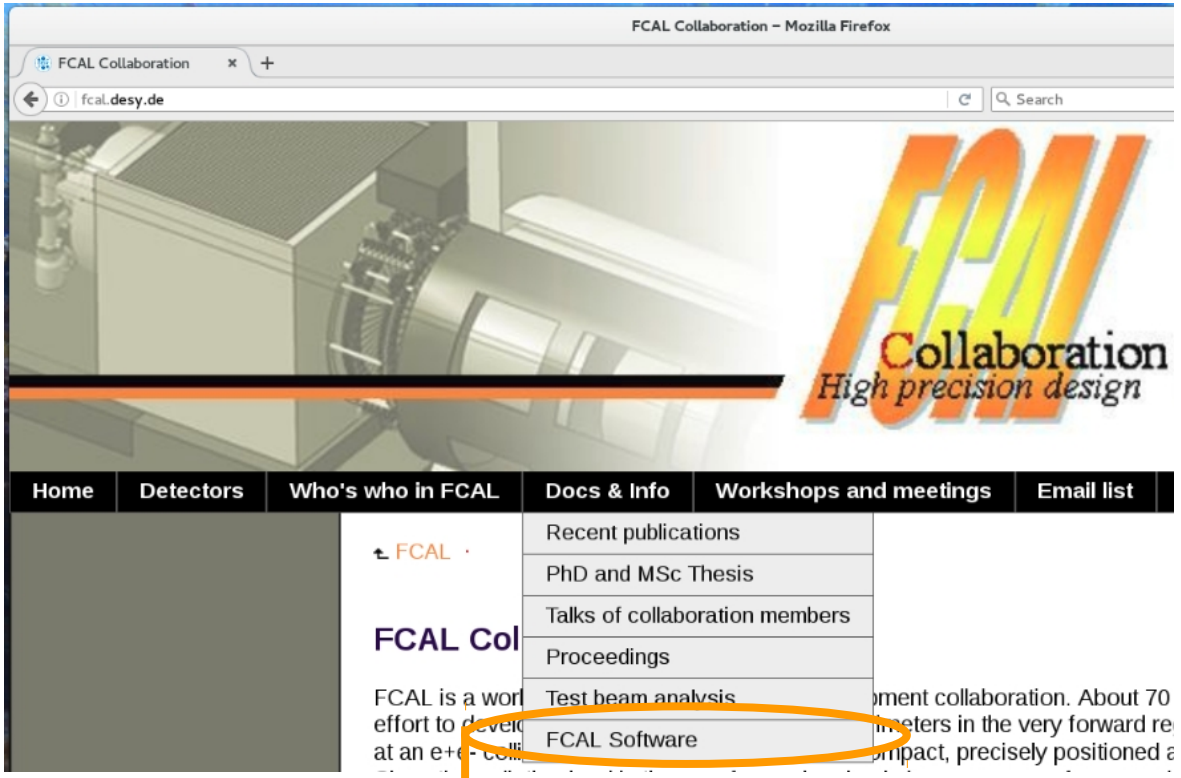
- https://github.com/FCALSW/FCalClusterer
- Compile code for every pull request (PR)
- Discuss changes before they are applied

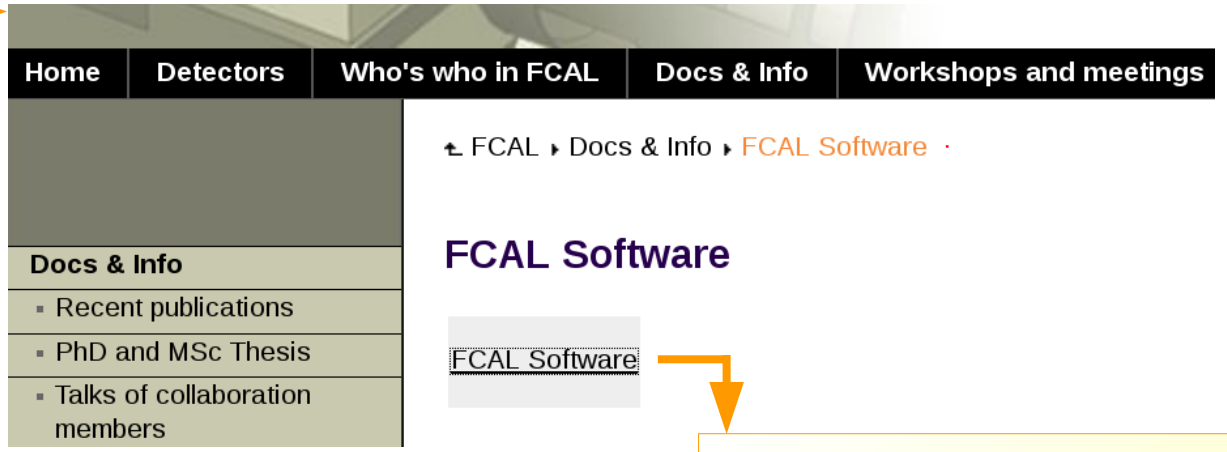
LumiCalClusterer and DD4hep

- Implemented option to obtain geometry information from DD4hep
- Some cleanup of functions and small bugfixes
- Changed internal coordinate systems used in reconstruction to be more natural
  - Work in the centre-of-mass frame, i.e., positions only rotated towards $+/-$ Z axis, not all hits rotated to
  - Easier comparison with expected position, `MCParticle` momentum, reconstructed objects
  - Checked DD4hep and Mokka that reconstructed objects are in the right place
- PR pending sign off from Bogdan: PR#5

Note on BeamCal reconstruction finished: CLICdp-Note-2016-005
https://cds.cern.ch/record/2227265?ln=en

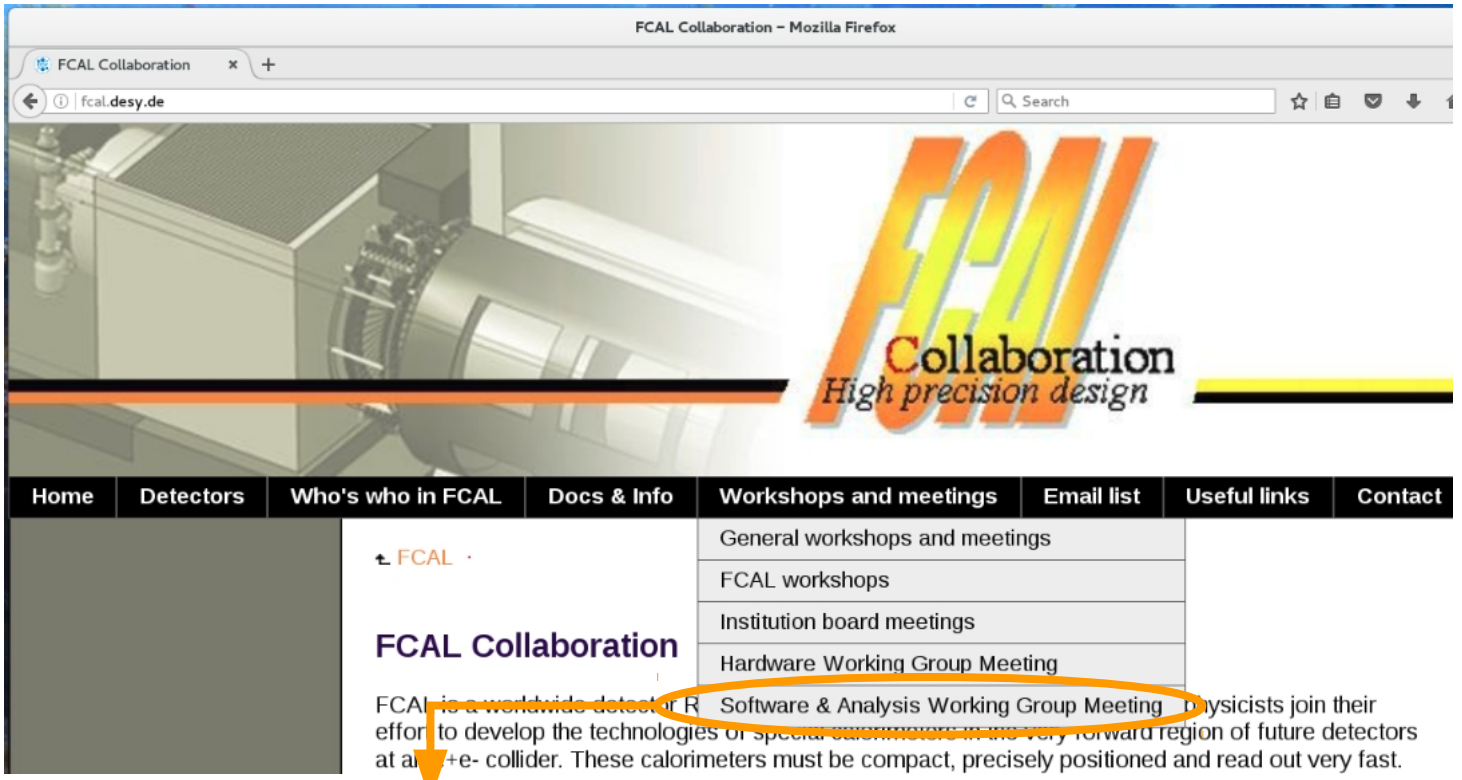
FCAL web page updates

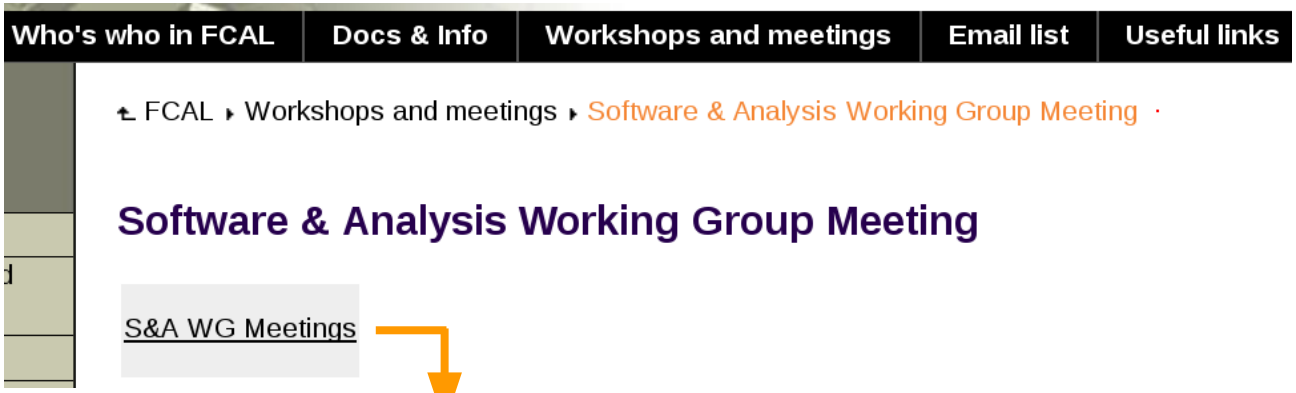




https://github.com/FCALSW

FCAL web page updates





https://agenda.linearcollider.org/category/217/

FCAL in ILD

Validation of ILD simulation models

- FCal (B.Pawlik)
- checked mainly LCal
- compatible w/ (old) anti-DID field map
  - need to re-check w/ new anti-DID
- BCal needs to be moved closer to IP (~40cm) => **to be done...**
- BP will compare models w/ CAD drawings, shown by A.Levy in Morioka

Simulation of pair-bg (w/ anti-DID)

- need to simulate effect of pair-bg w/ and w/o anti-DID in ILD
  - beamCal
  - backscatter into inner tracker (VXD)
- created field maps from simulation (U.Schneekloth)
- implemented GuinePigReader in **DDSim**
- implmentation of B-field code ongoing
  - A.Perez Perez (IPHC)

Agenda for Upcoming Software Meetings

- address open issues in iLCSoft and iLCDirac:
  - finalize the transition to Github
  - restructure some of the iLCSoft packages
  - work on iLCDirac
  - implement new features
  - ...

sub-detector status report

- expect sub-detector software contacts to report on status
- ideally already final validation ?

Summary

- LumiCal:
  - TB 2014 data analysis and simulation, namely an estimation of the transverse shower size is in progress;
  - A lot of additional tests and checks were done to evaluate uncertainties of Moliere radius measurement;
  - Transverse shower development of TB 2014 simulation obtained using DD4Hep framework and LuCaS are not in good agreement, though significant amount of time was spent to investigate it;
  - Ongoing study of luminosity measurements in simulation with recent models of ILD and CLIC detectors.
- LHCal:
  - Last results on LHCal simulation study using DD4Hep framework were presented in FCAL workshop in Tel Aviv in September 2016. Nothing has been done since that time.
  - LHCal geometry was not integrated with ILD software. It is need to be done.
- BeamCal:
  - Bogdan asked about exact position of BeamCal in ILD;
  - Note on BeamCal reconstruction has been published:

https://cds.cern.ch/record/2227265?ln=en

Thank you for your attention