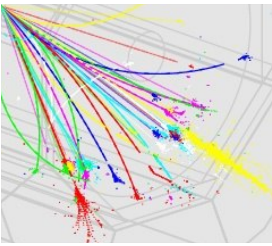
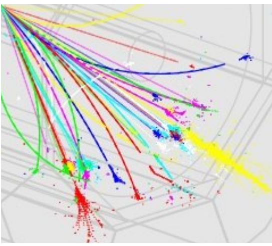


CALICE Meeting

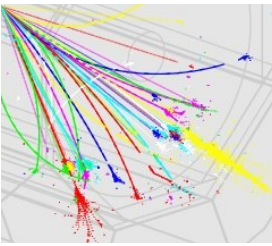
RAL 19.01.2007

M. Stanitzki



Overview

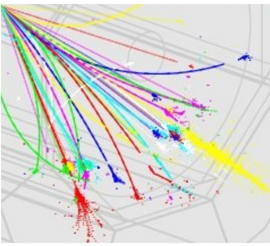
- ECAL Energy Scale
- Another look at the GEANT Simulations
- Occupancy studies
- Dead Area
- Resolution
- Different Pixel Sizes
- Noise Occupancy
- C.A.T.



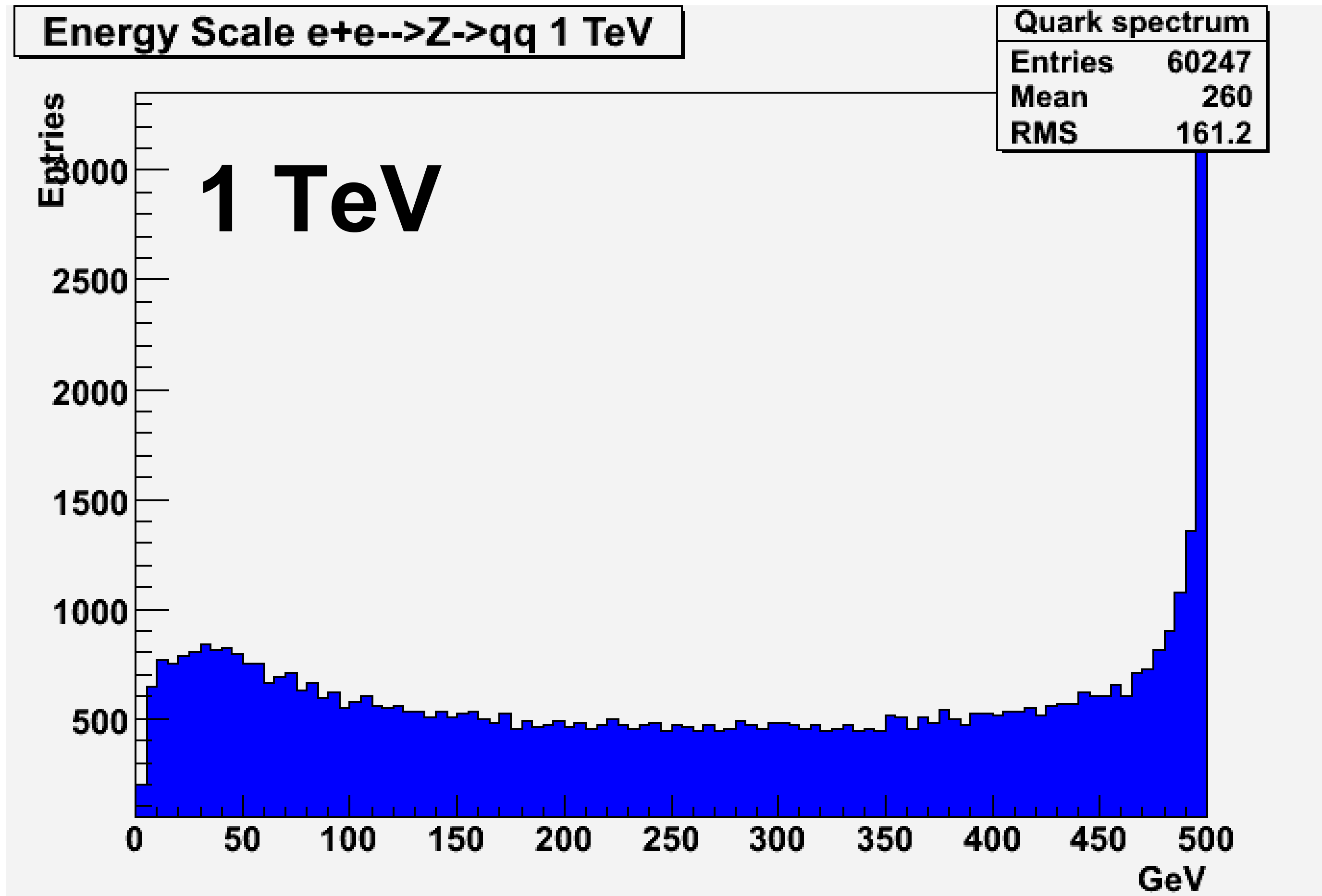
ECAL Energy Scale

To answer Anne-Marie's question : ***Why 500 GeV electrons ?***

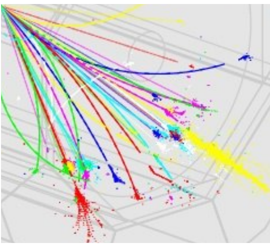
- Energy of ILC 0.5-1 TeV
- Chose 2 processes
  - $e^+e^- \rightarrow Z \rightarrow f\bar{f}$
  - $e^+e^- \rightarrow ZZ \rightarrow f\bar{f}f\bar{f}$
- Two energies
  - 500 GeV (baseline)
  - 1 TeV (upgrade)
- All processes simulated with Pythia 6.4



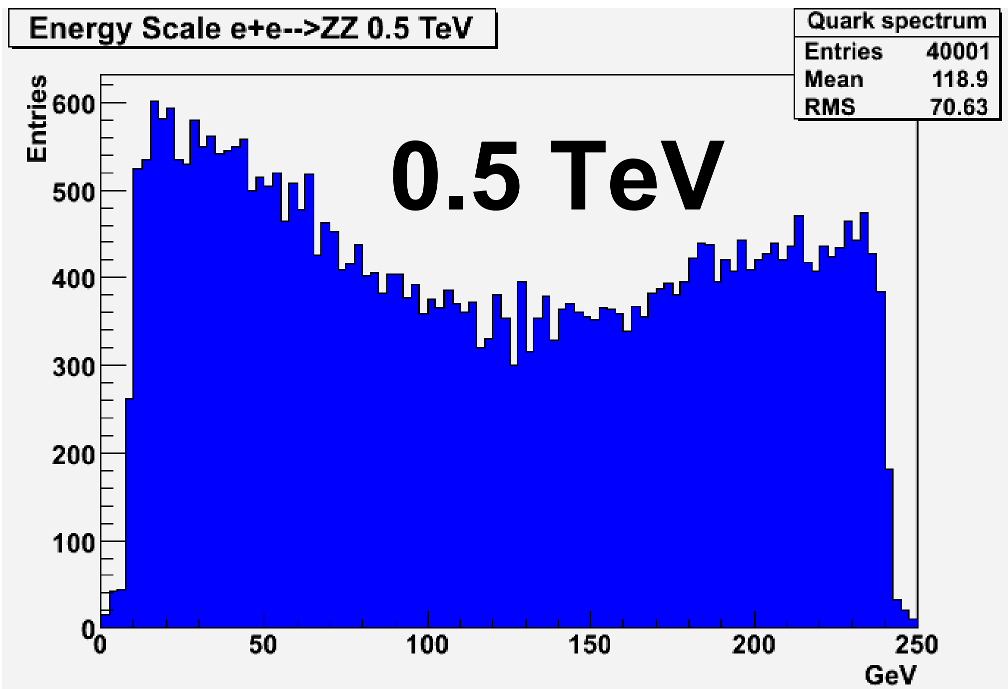
Results (I)

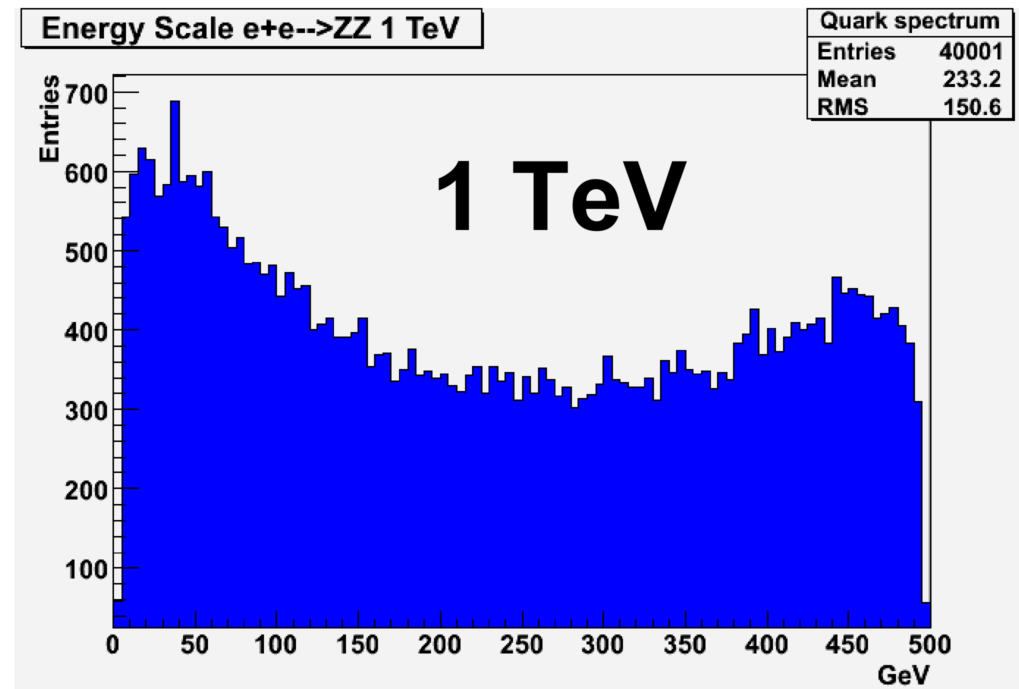


$$e^+e^- \rightarrow Z \rightarrow f\,\bar{f}$$

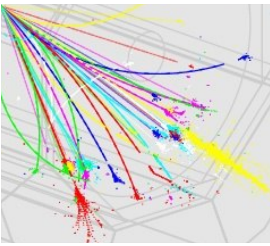


Results(II)



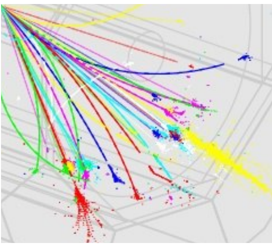


$$e^+e^- \to ZZ \to f\,\bar{f}\,f\,\bar{f}$$

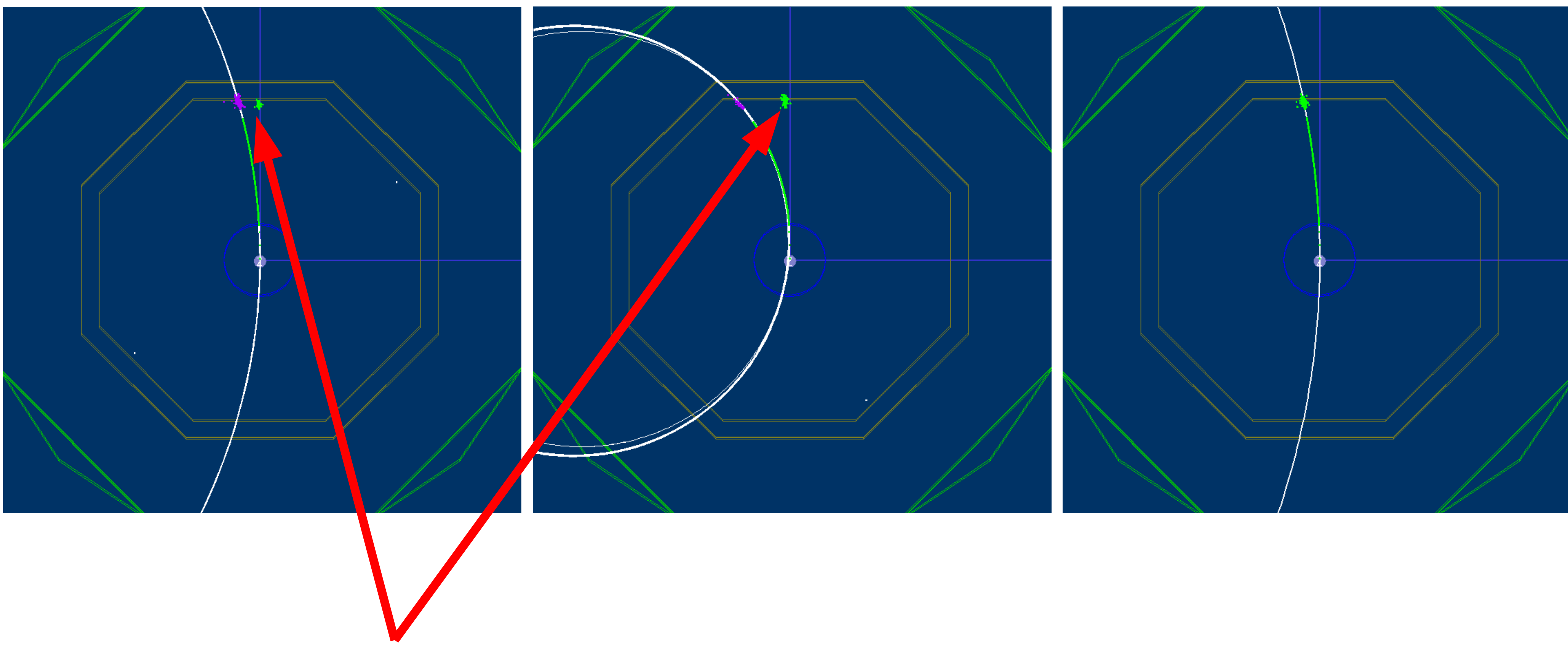


More Simulations

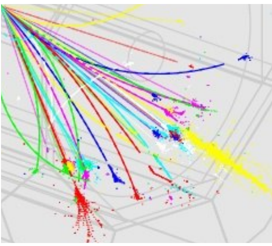
- Use Nigel's and Yoshi's GEANT version
- 50 μ Pixel Size
- Simulate Electrons (and muons, pions)
- Check basic distributions
- Use this to check
  - Occupancies per pixel
  - Dead area studies
  - Resolution



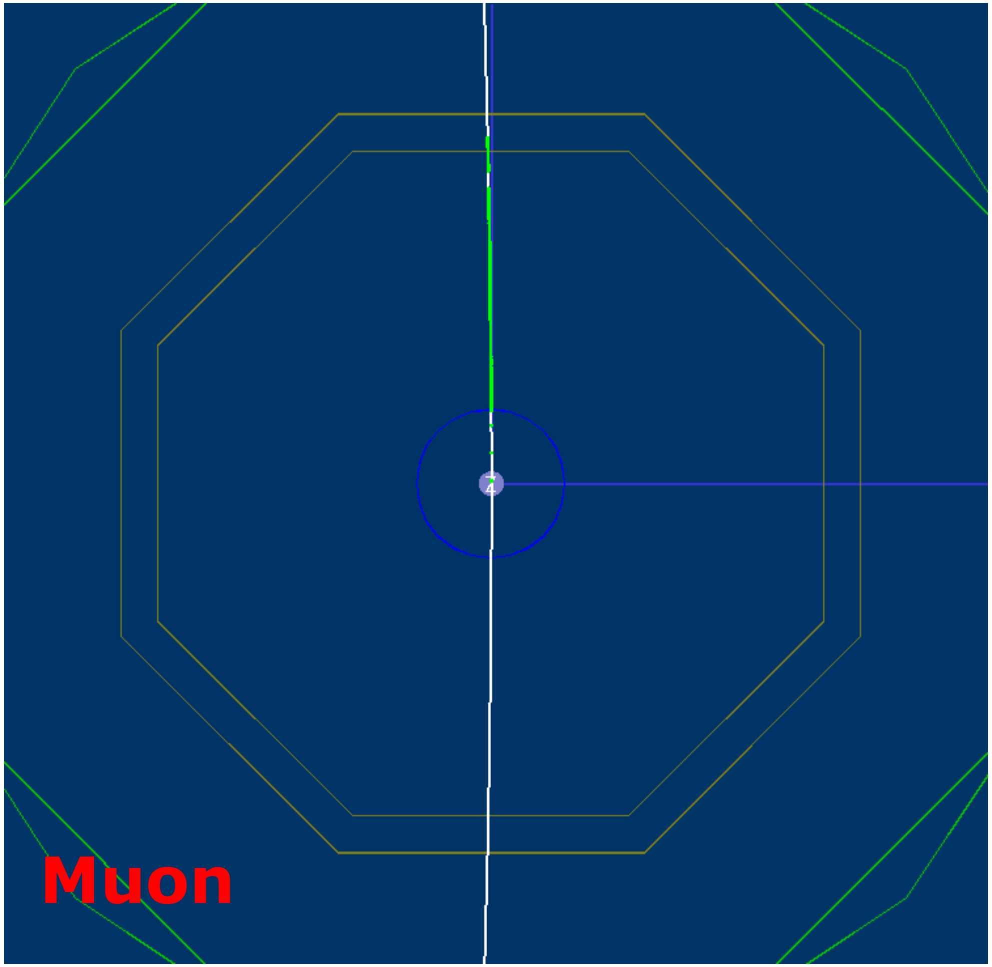
Electron Gallery

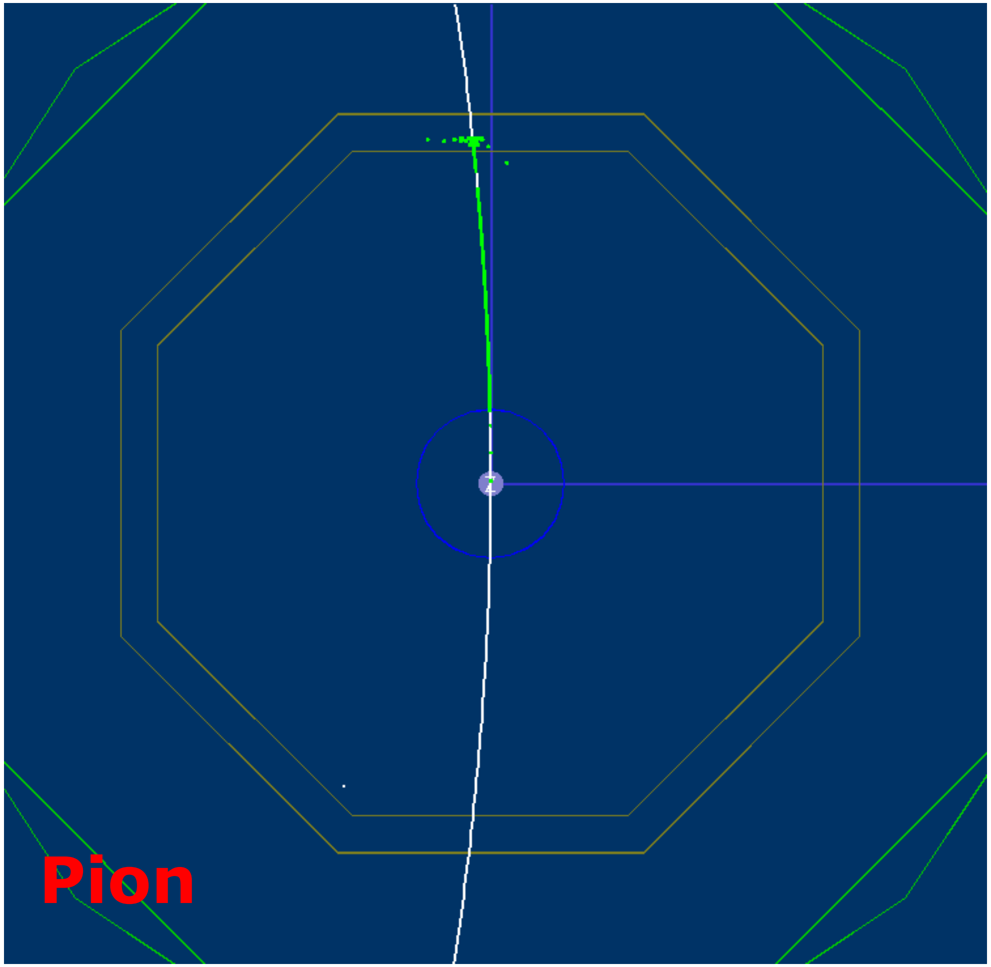


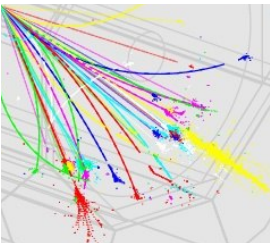
Photons !



Other particles

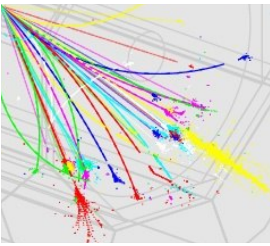




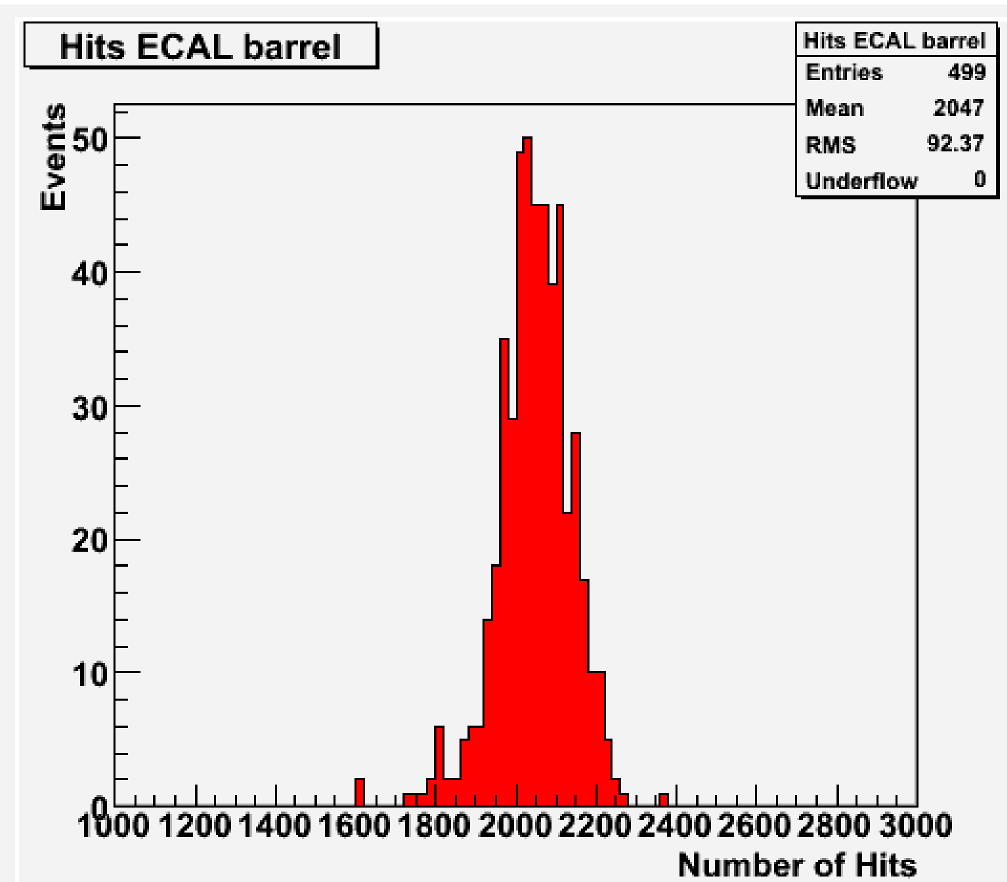


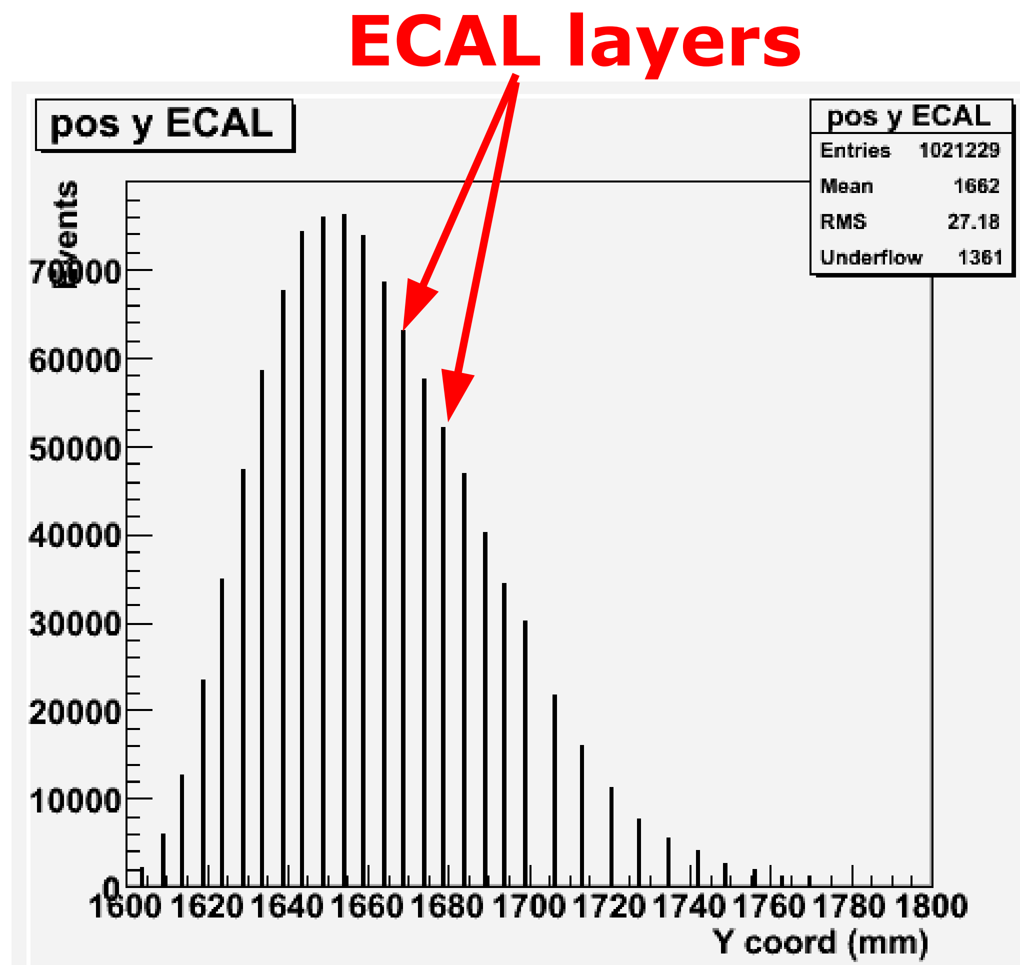
Studies with 20 GeV Electrons

- Use GEANT particle Gun
  - Fire at 0/1/0
- First check basic quantities
  - Shower shapes
  - Number of hits
- Study Occupancies
- Study Resolution
- Modify dead areas
- Modify pixel sizes

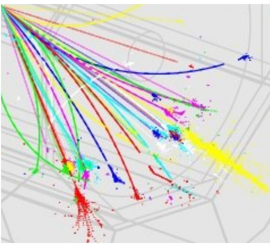


Basic checks

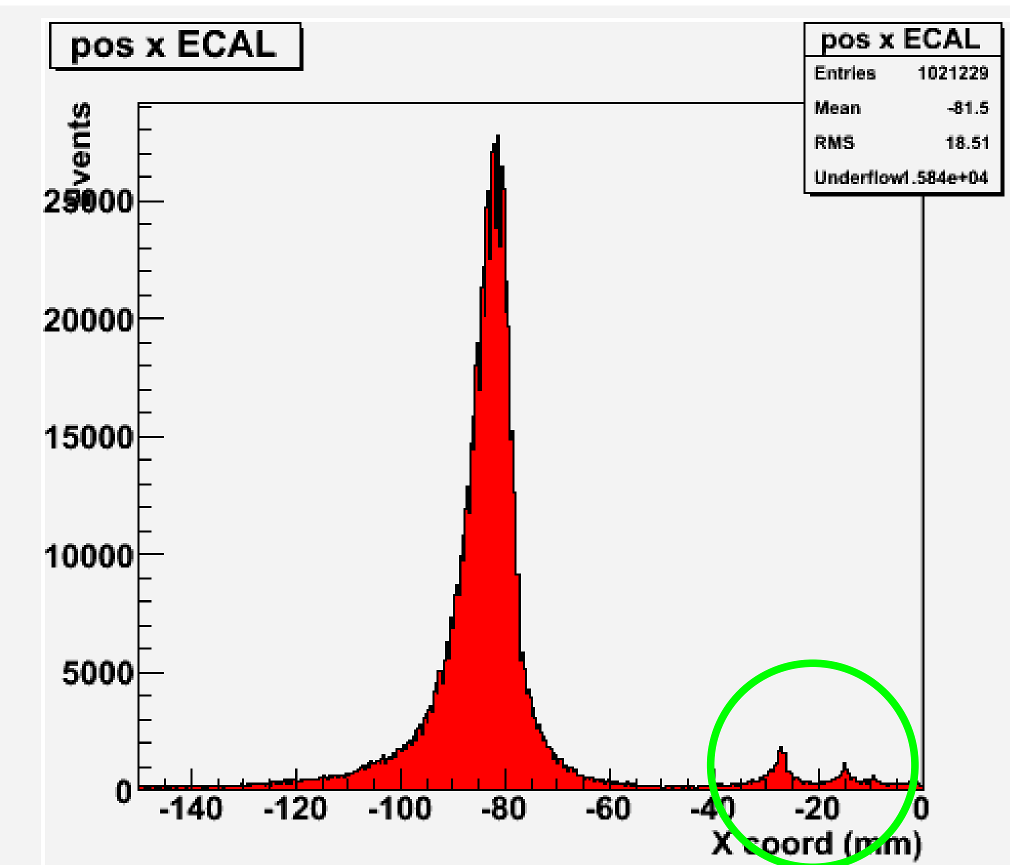


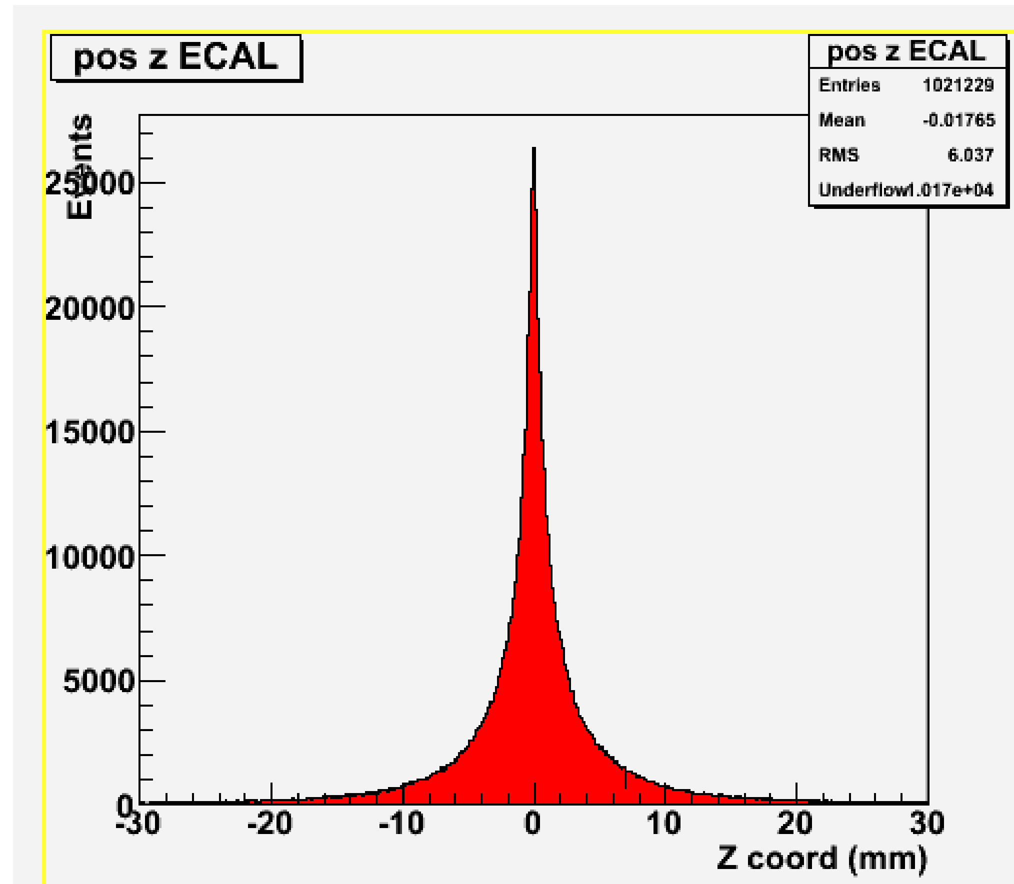


Numbers consistent
with Yoshi's

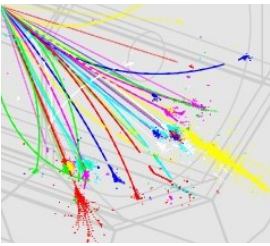


Basic Checks (II)

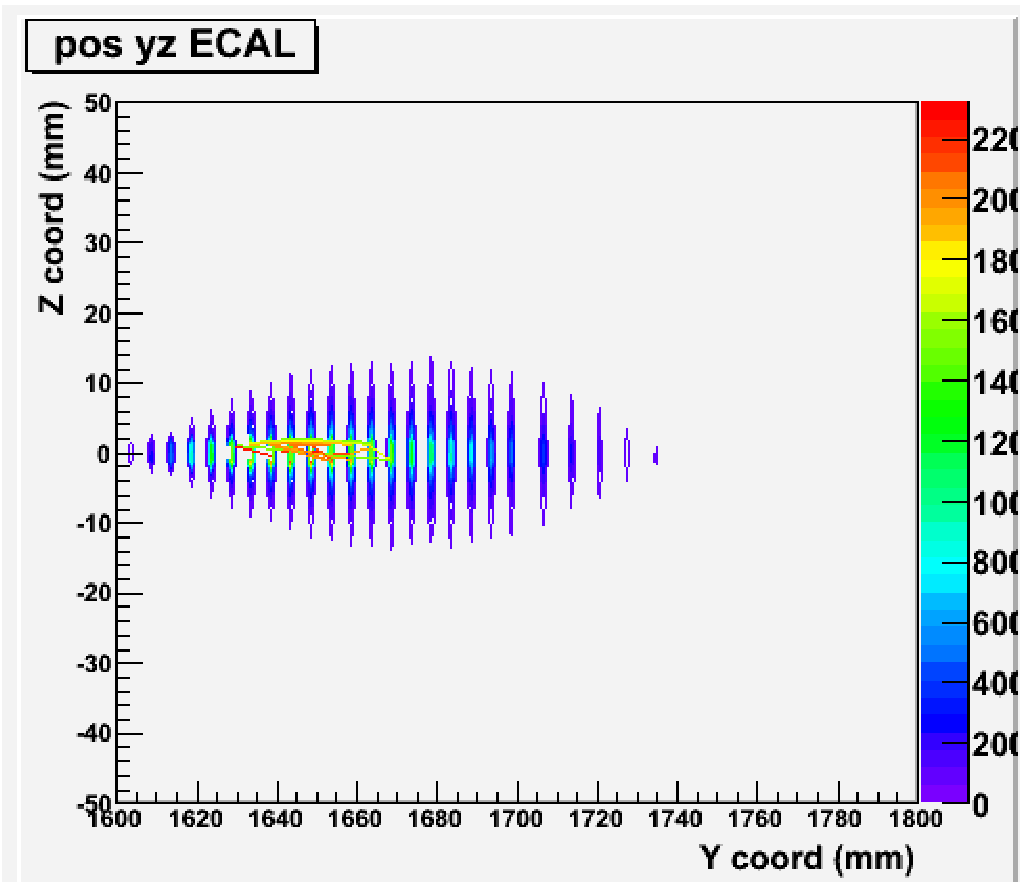


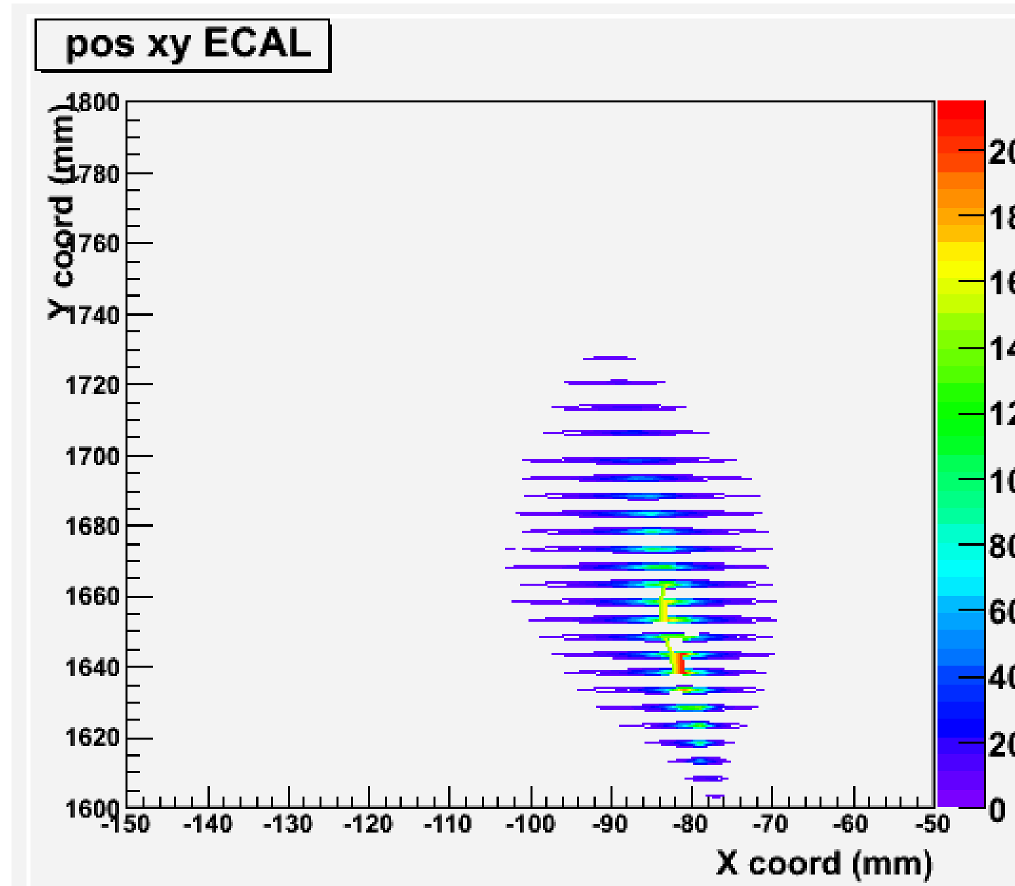


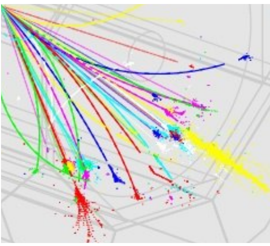
Conversion Photons
(Which material ?)



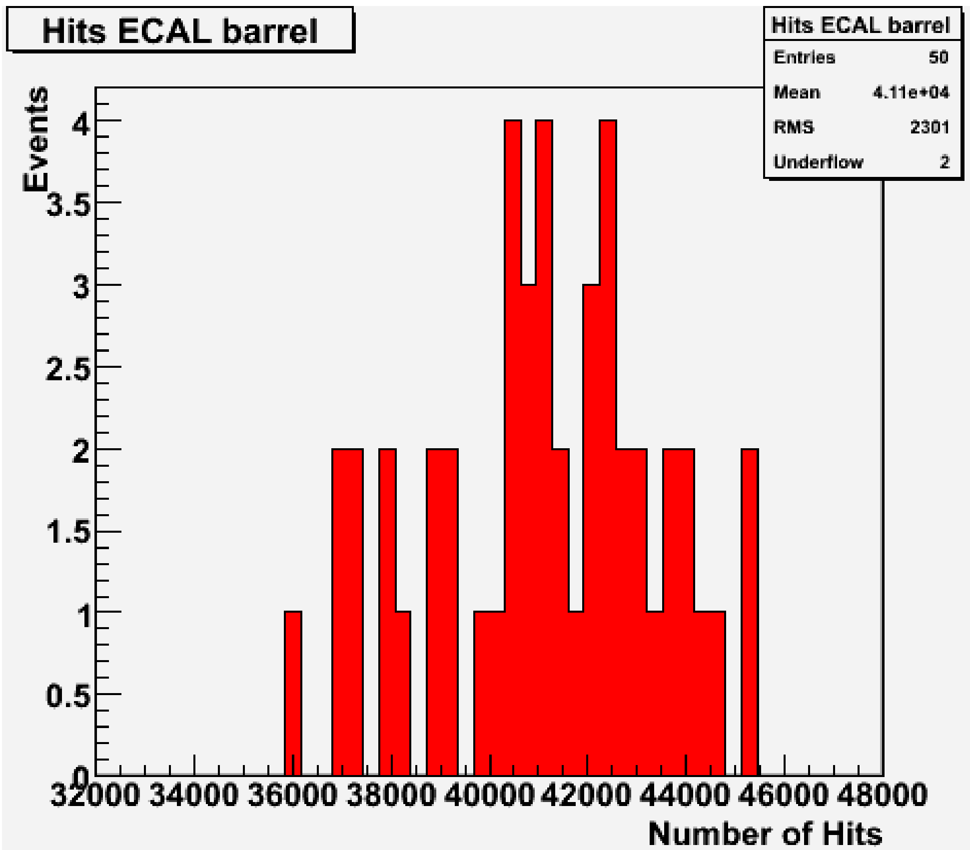
Basic Check (III)

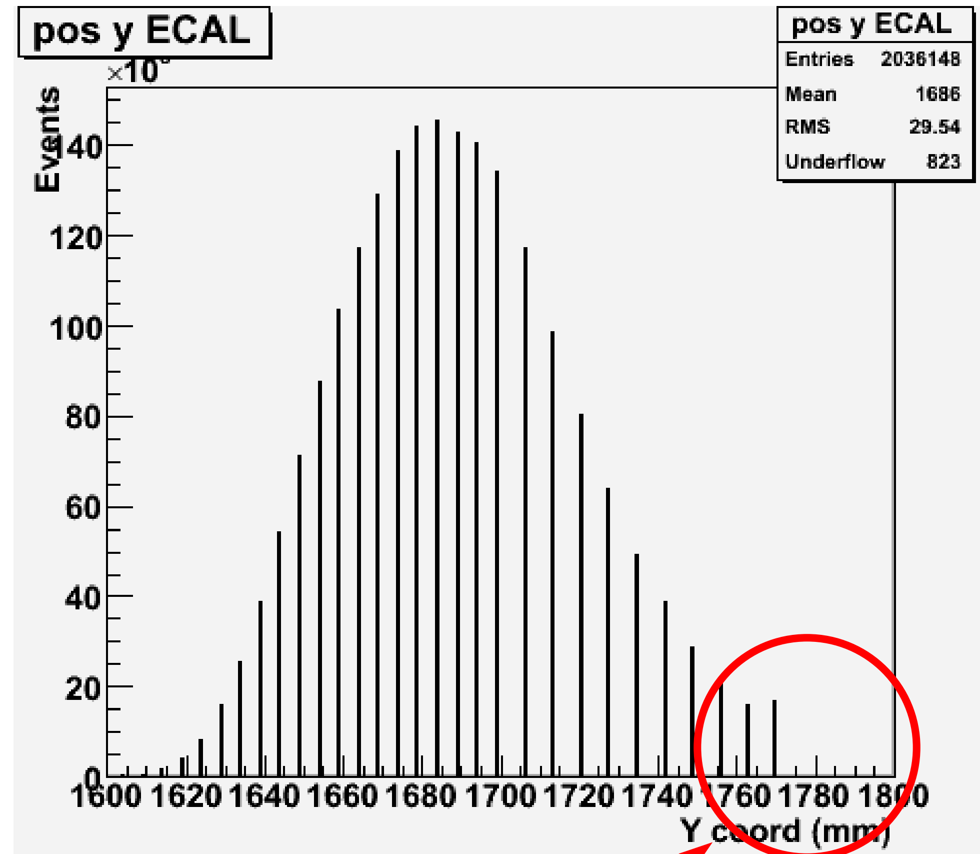






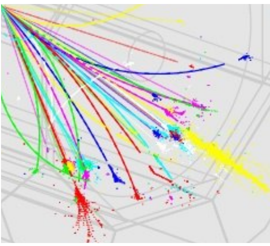
Compare with 500 GeV electrons



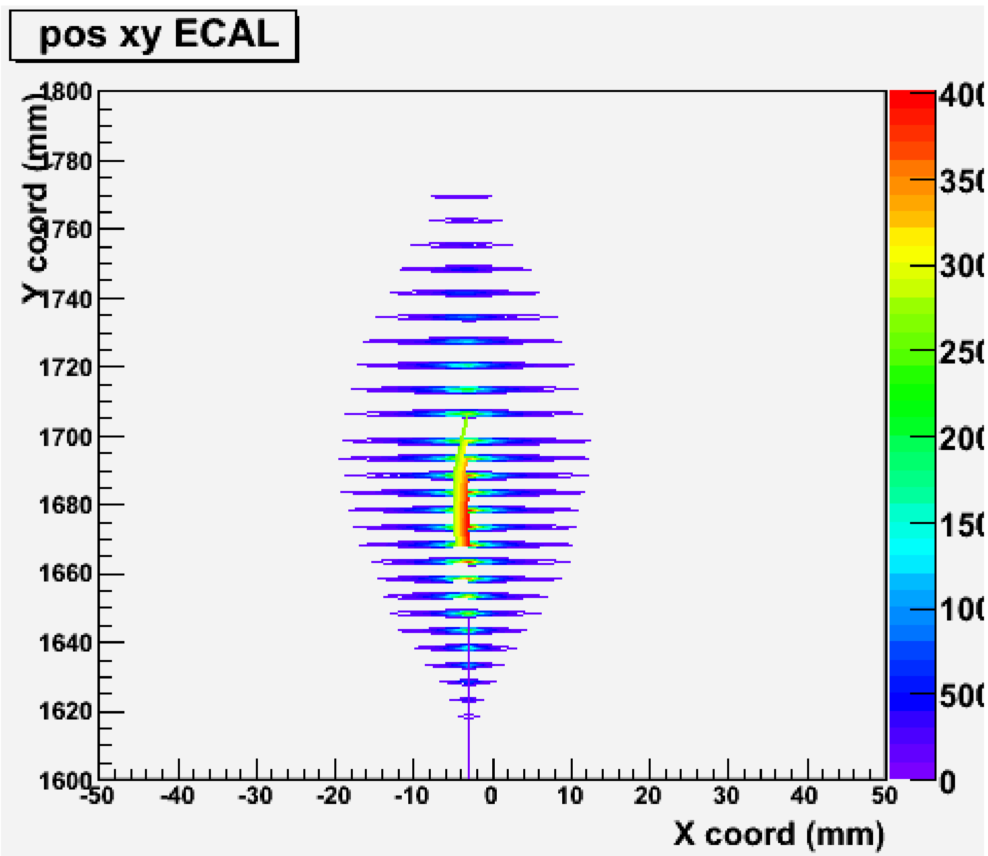


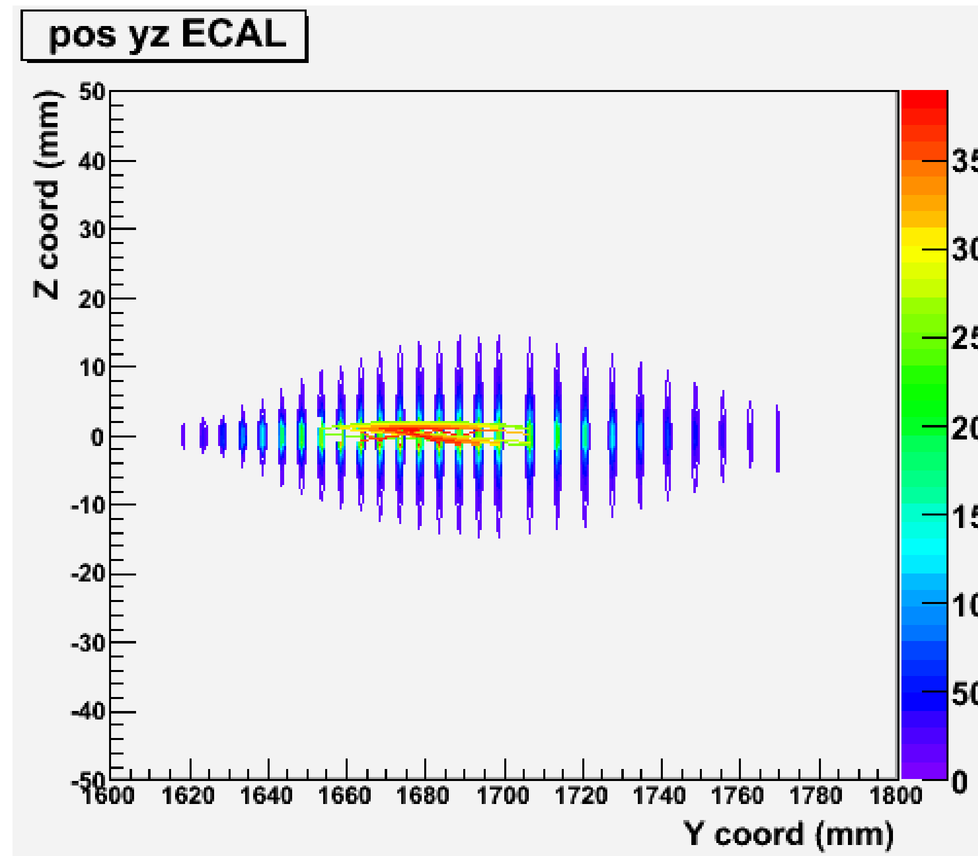
Only 50 events !

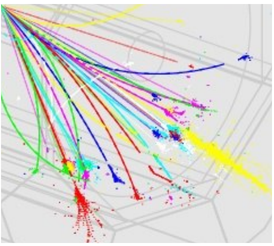
ECAL starts leaking into HCAL



500 GeV electrons (II)



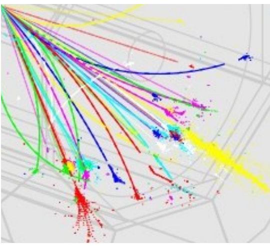




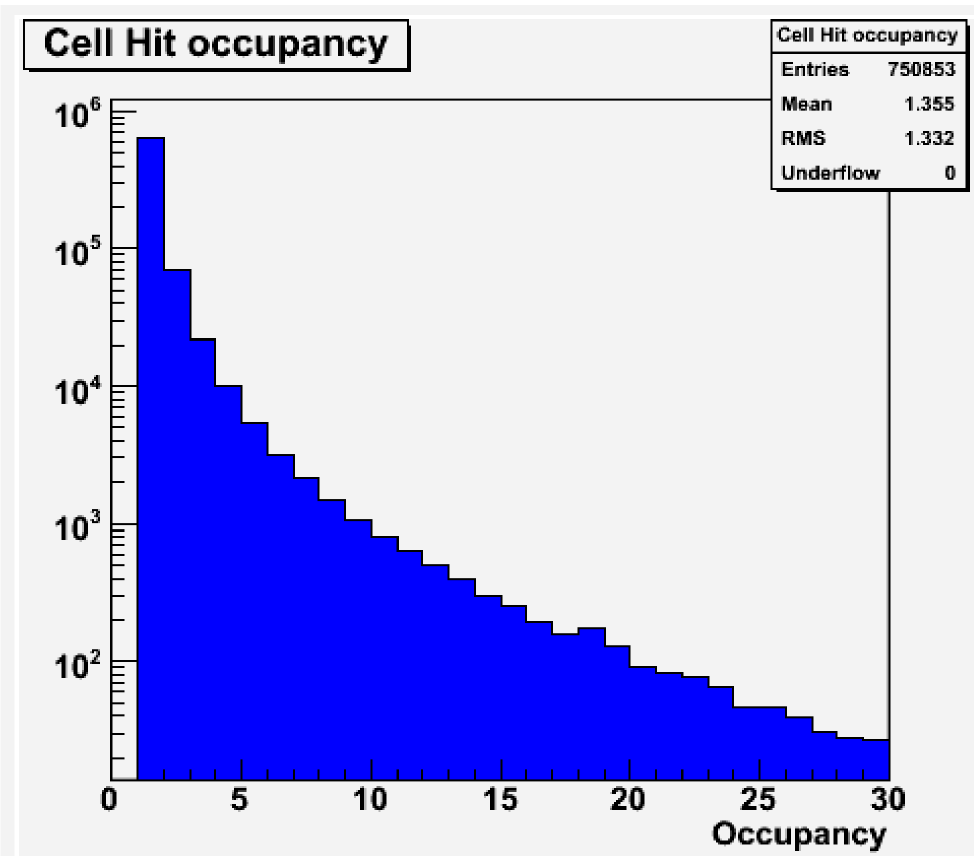
Detector Occupancy

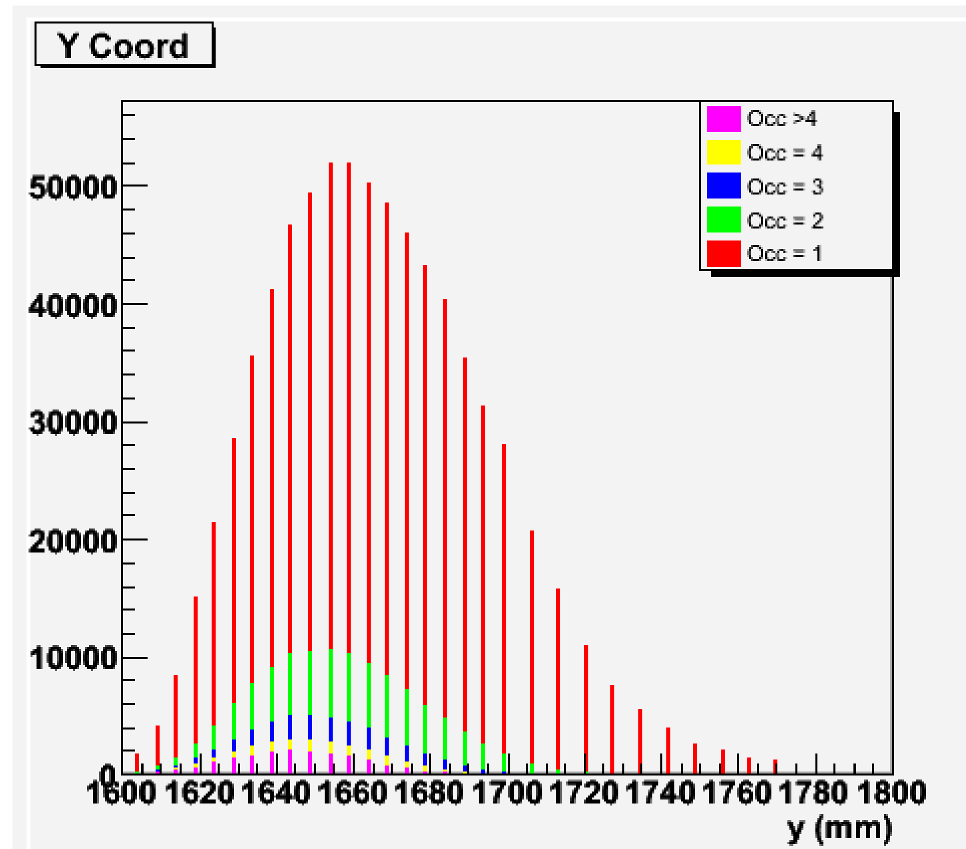
Question from Jamie and Renato:
How often is a pixel hit twice ?

- Test “worst” case
- 500 20 GeV electrons hitting the same area
- Physics will look very different
- But this will give us a good estimate



Occupancy

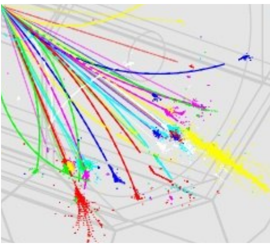




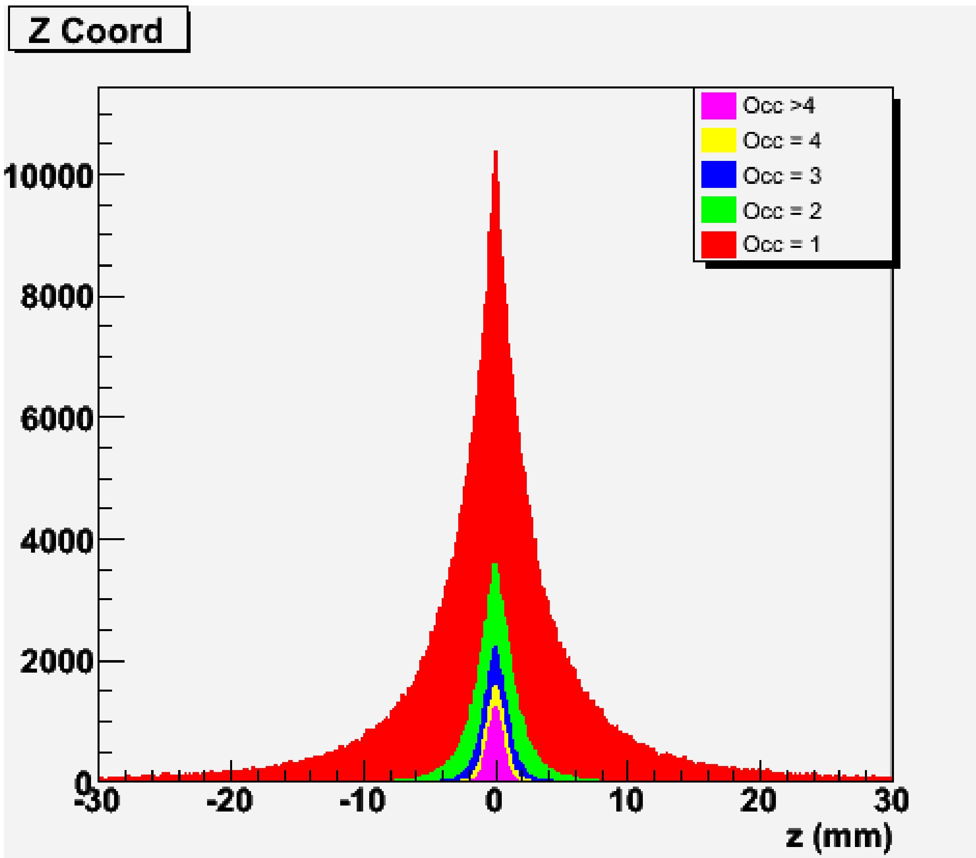
For 500 events !

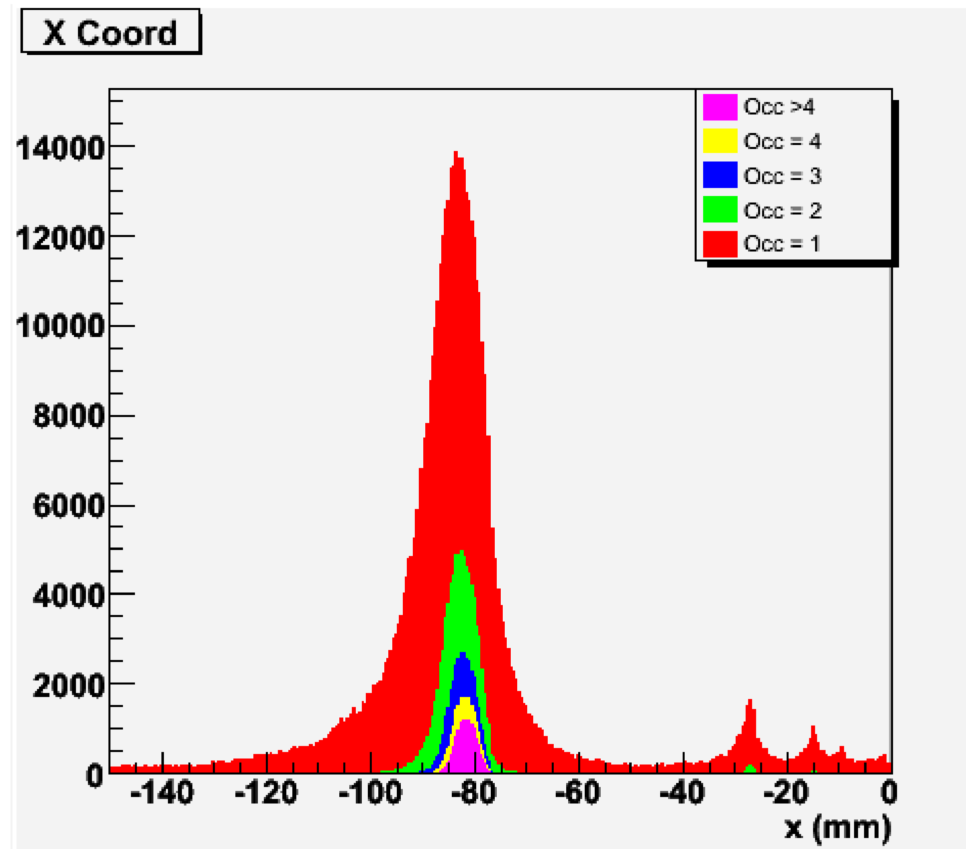
For 500 events !

No multiple pixel hits in a single event !

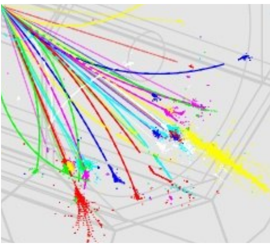


Occupancy (II)



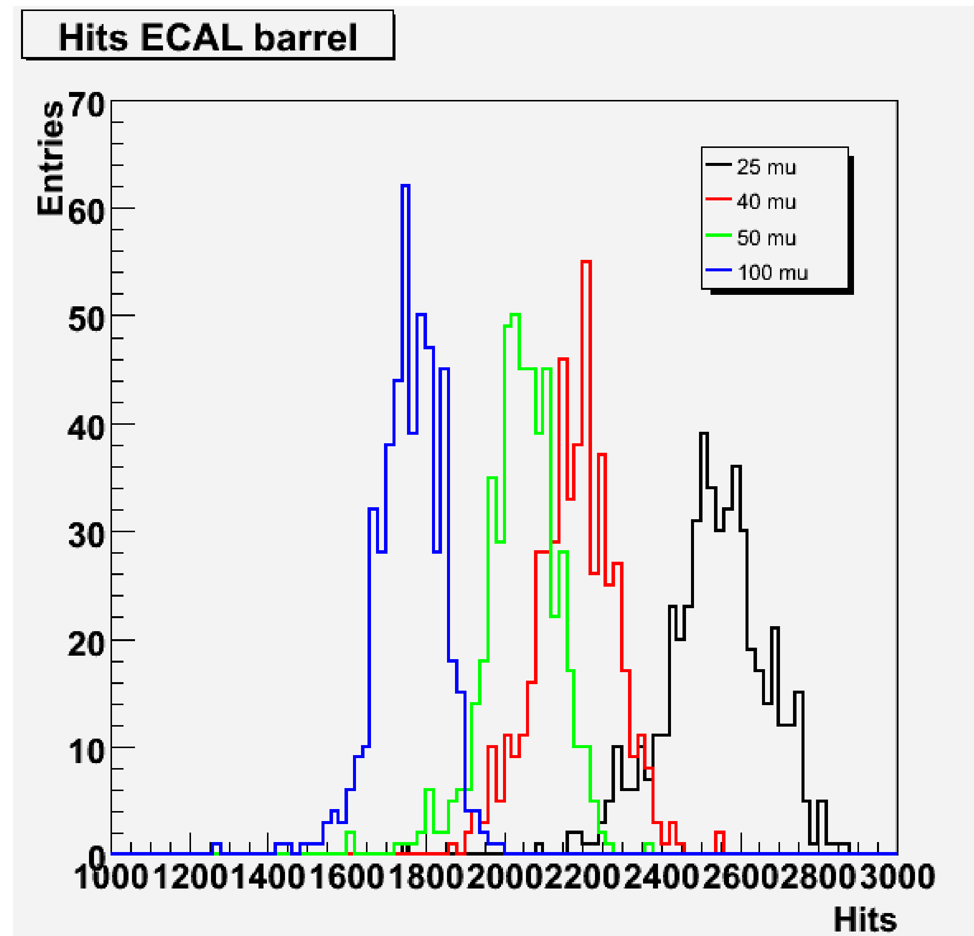


Multiple hits only in the shower core !

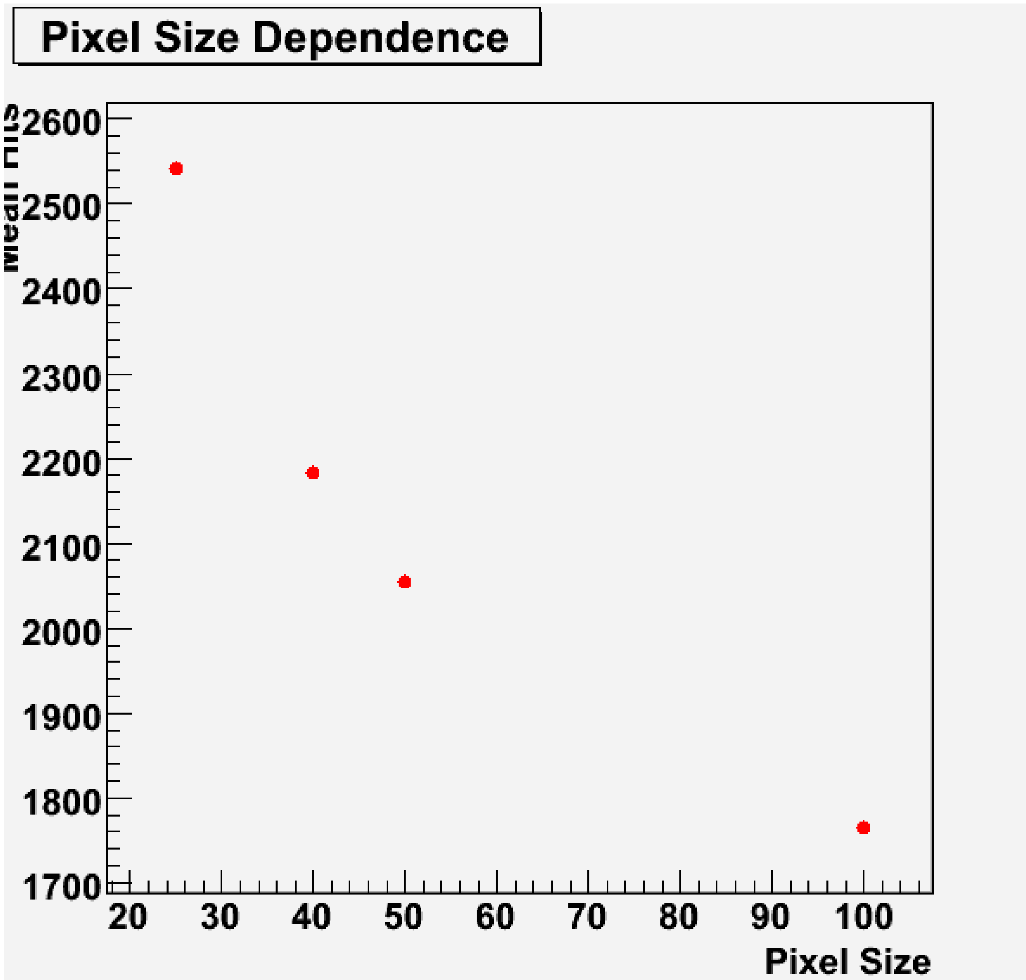


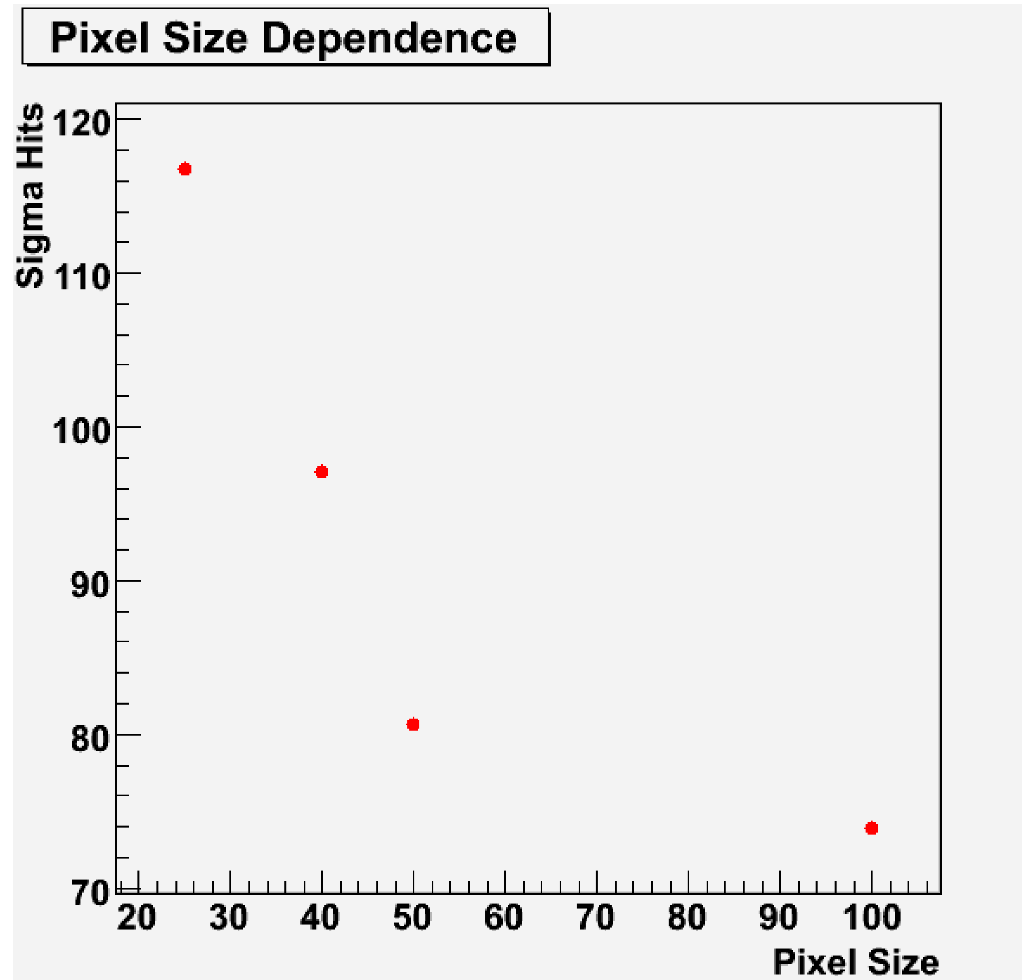
Dependency on Pixel size

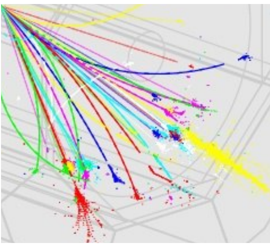
- Three additional pixel sizes
  - 100 μ (large)
  - 75 μ
  - 40 μ
  - 25 μ (too small)
- Use same Electron energy (20 GeV)



Pixel Size(II)

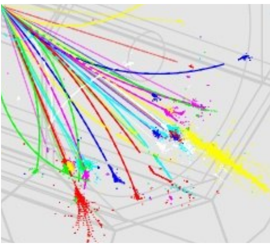






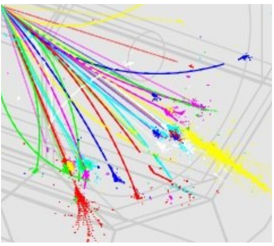
And the Noise ?

- Noise for 2880 bunches
- Vary noise probability
- With Noise=$O(10^{-6})$
  - P=0.3 % for 1 hit per pixel
  - P=0.0004 % for 2 hit per pixel
- But $O(10^{-12})$ pixels !
  - ~3 10^{9} single hits
  - ~4 10^{6} double hits
  - ~0 triple hits



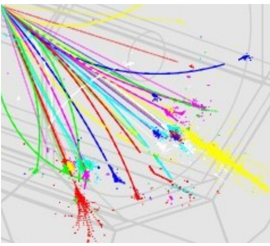
Occupancy summary

- Even in worst case scenario
  - Number of multiple hits is small for 500 events
  - concentrated in shower core
  - No multiple Hits in a single event
- We have to keep the Noise down
- This seems to drive the data volume !

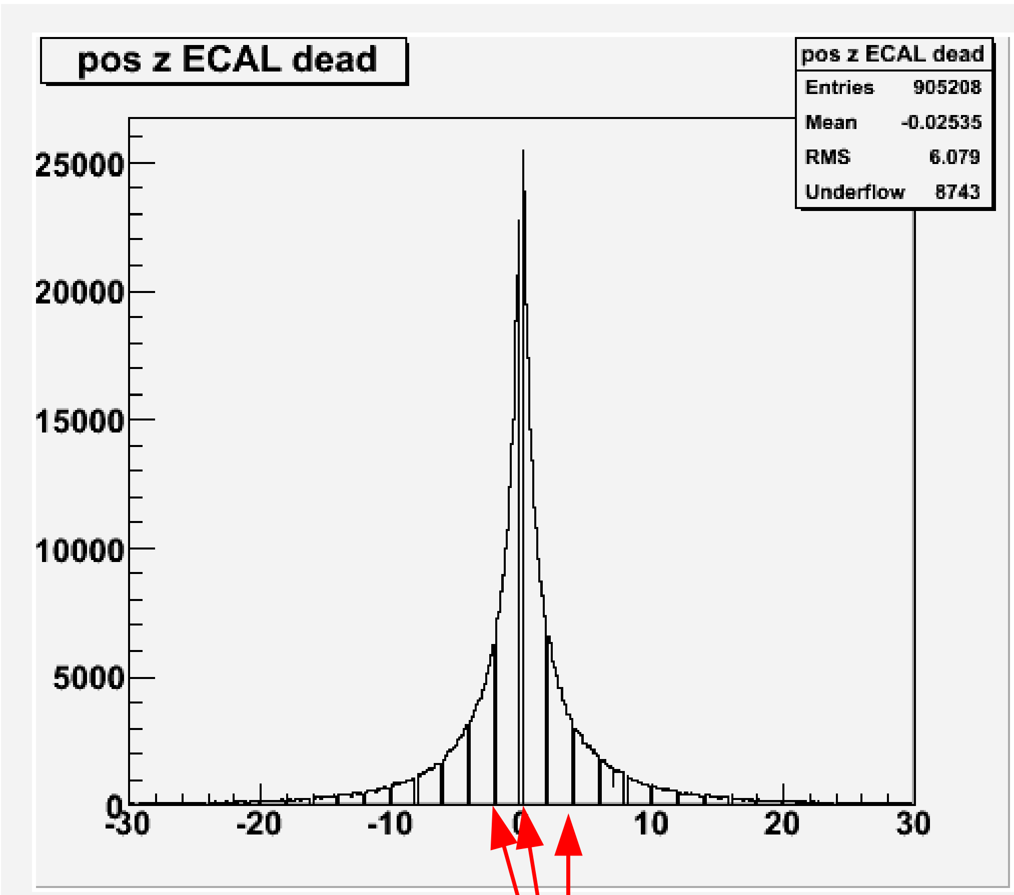


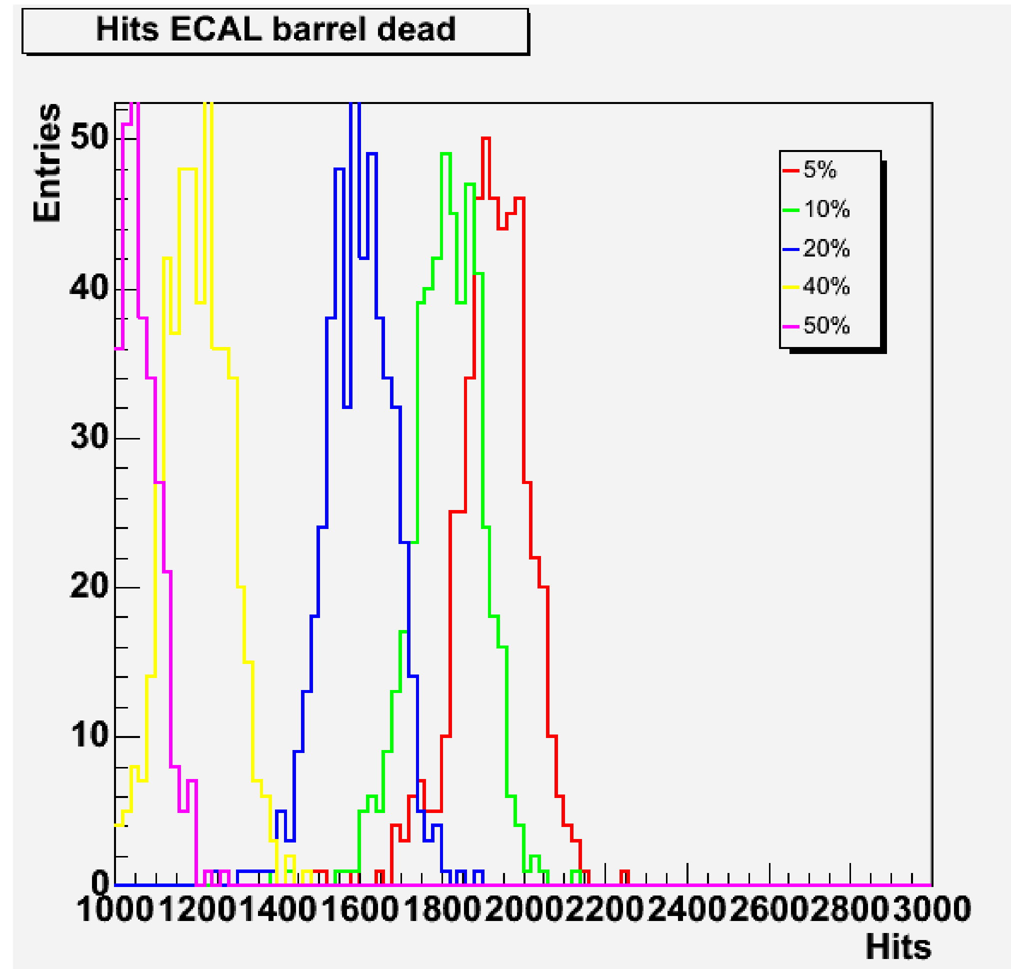
Simulation of Dead area

- Very simple approach
- dead area are strips along z
- for standard 10 % dead area
  - 36 active pixels
  - 4 dead pixels
- Medium worst case scenario
  - Gaps are on top of each other !
  - Gaps are mostly not pointing towards beamspot
- Use 20 GeV electrons, vary dead area

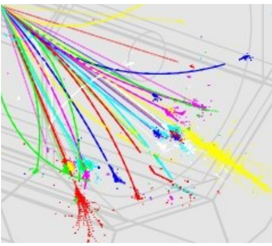


Dead Area and Hits

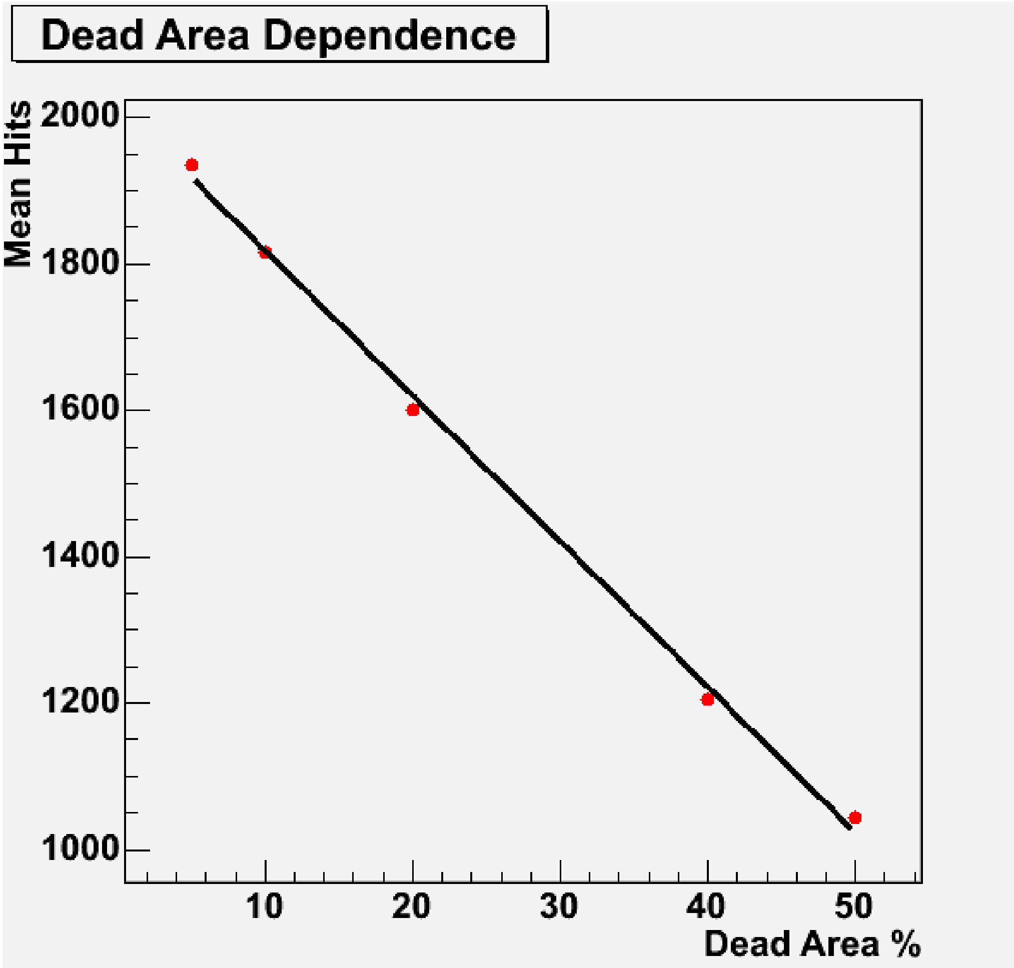


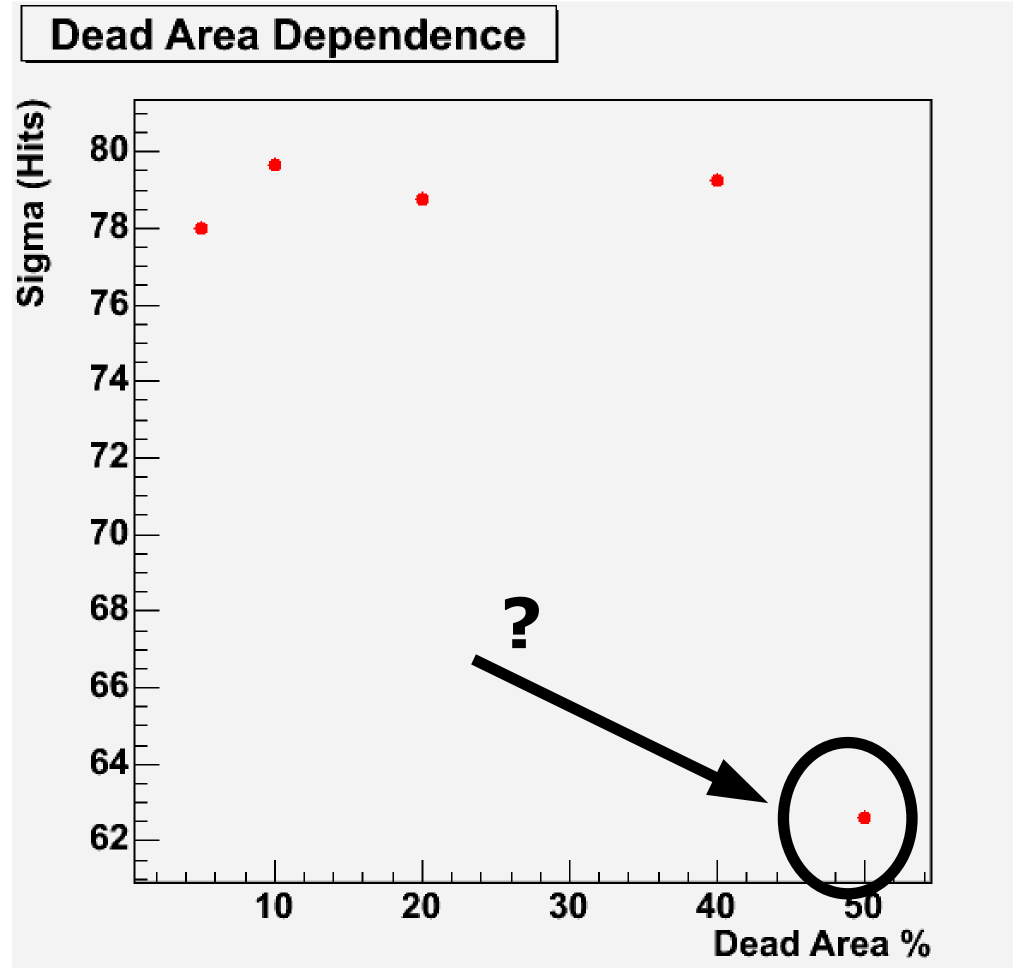


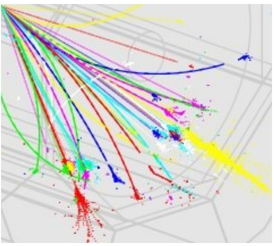
Dead area



Dead Area (II)

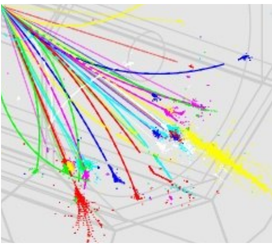

Dead Area Dependence
Mean Hits
2000
1800
1600
1400
1200
1000
10
20
30
40
50
Dead Area %


Dead Area Dependence
Sigma (Hits)
80
78
76
74
72
70
68
66
64
62
10
20
30
40
50
Dead Area %
?



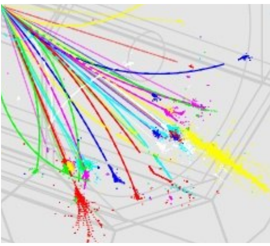
Dead Area (III)

- Sampling Calorimeter ->Dead Area decreases sampling area
- Linearity between Mean Hits and Dead Area
- Does not seem to impact Hit mean and sigma too much ...
- What about Resolution ?
- Tool is in place now !
- More studies needed

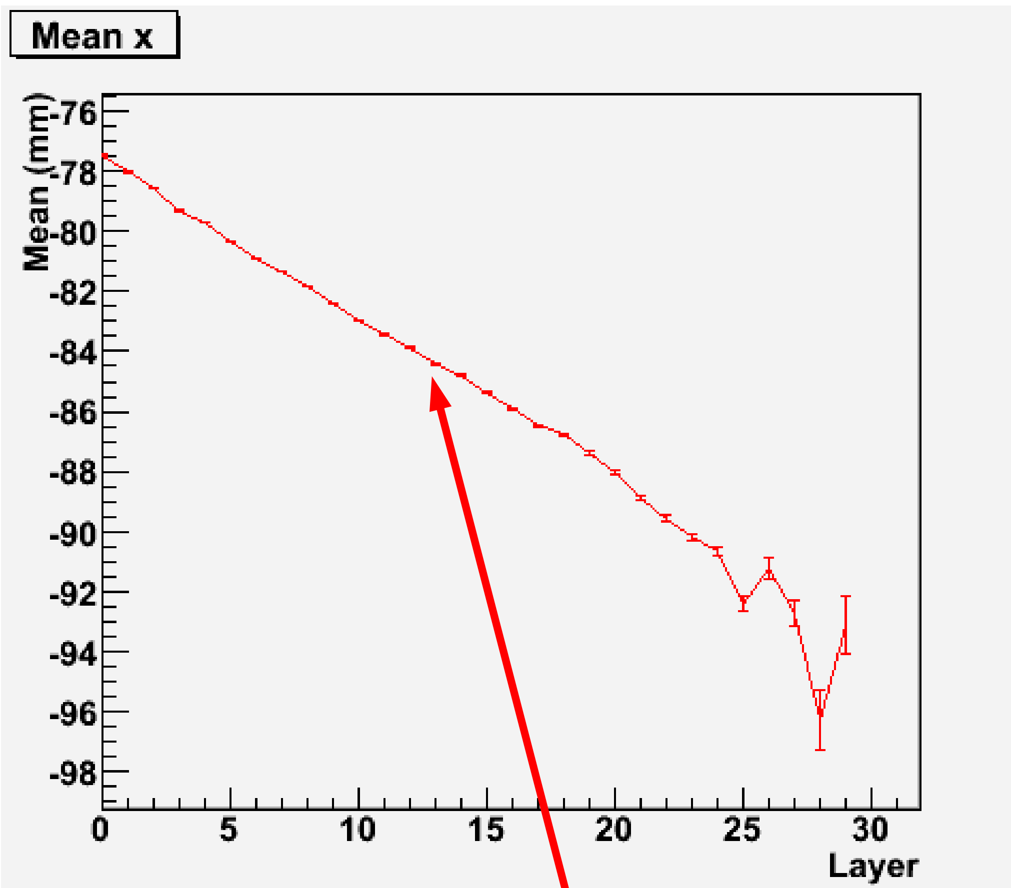


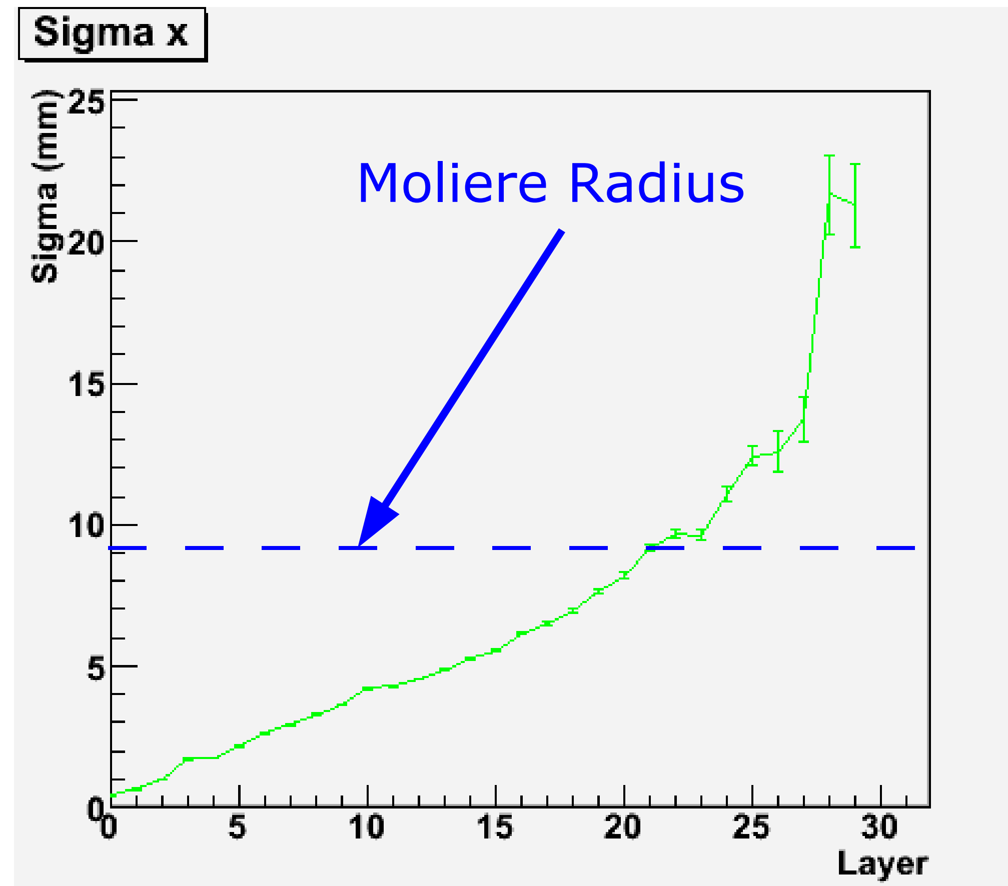
Shower resolution

- Try to get reasonable point resolution
  - Fit Gaussians per layer in x and z
  - Take this as mean and sigma
  - Not Optimal ...
- Again with our favourite 20 GeV electrons

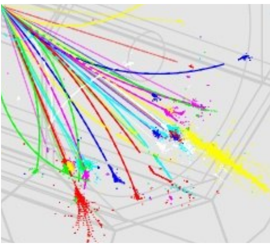


Resolution in x

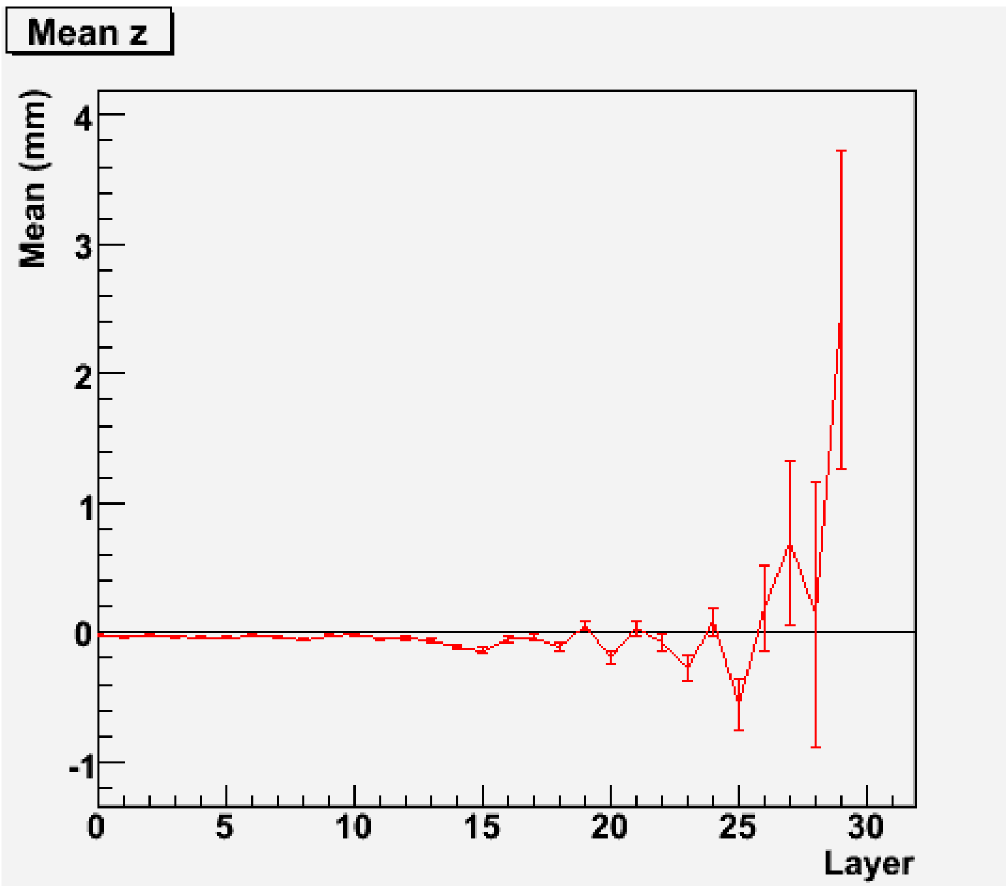


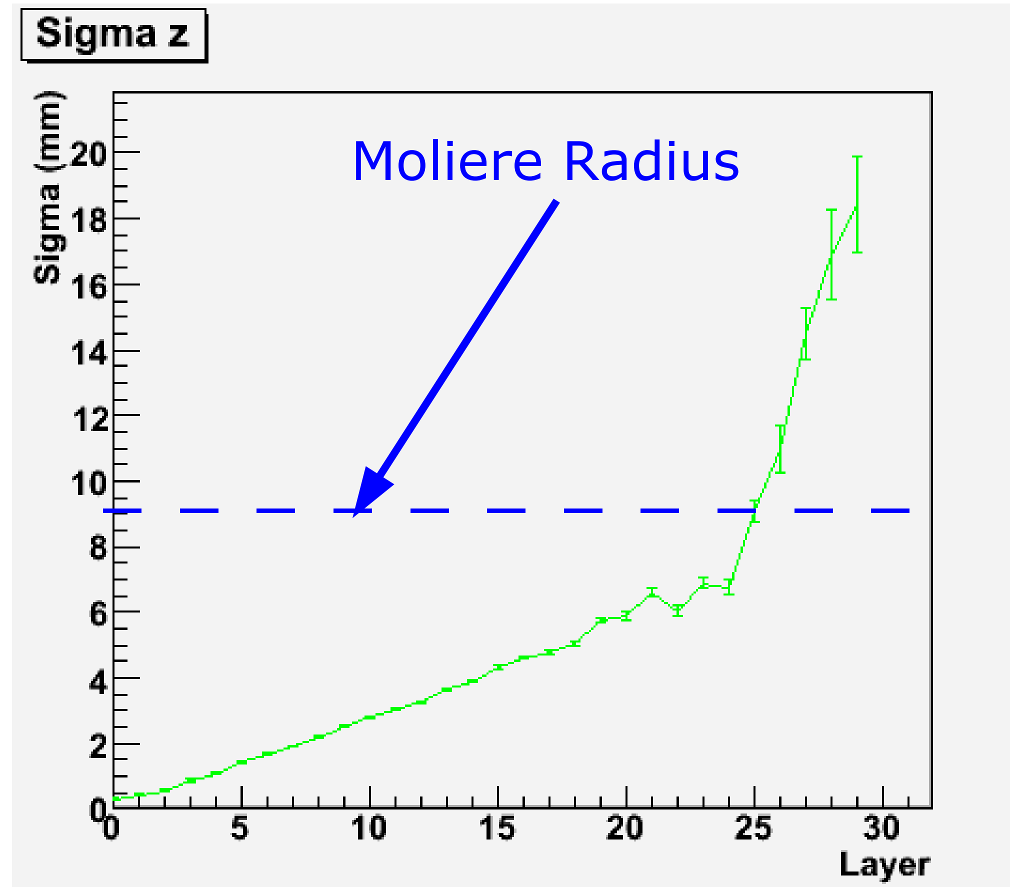


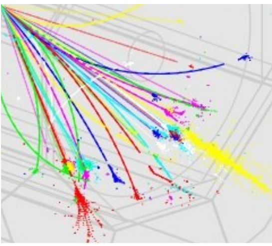
Shower bends in B field



Resolution in z



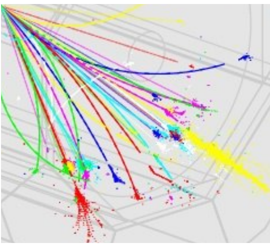




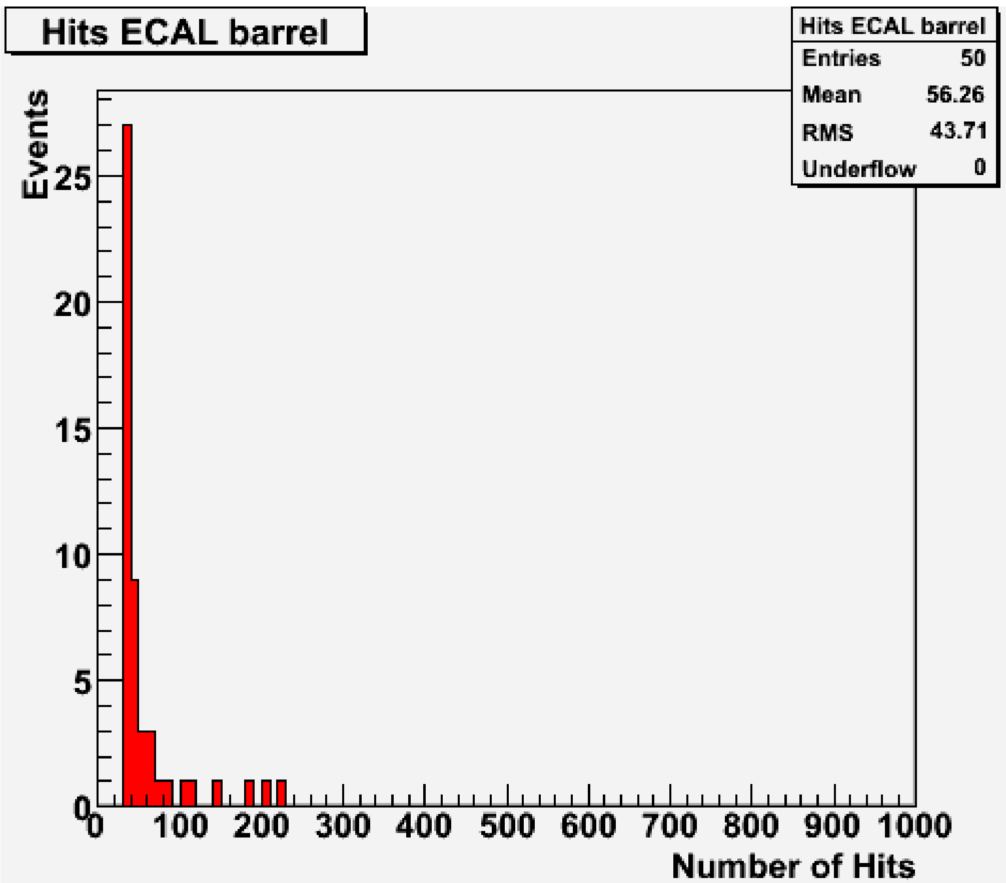
C.A.T.

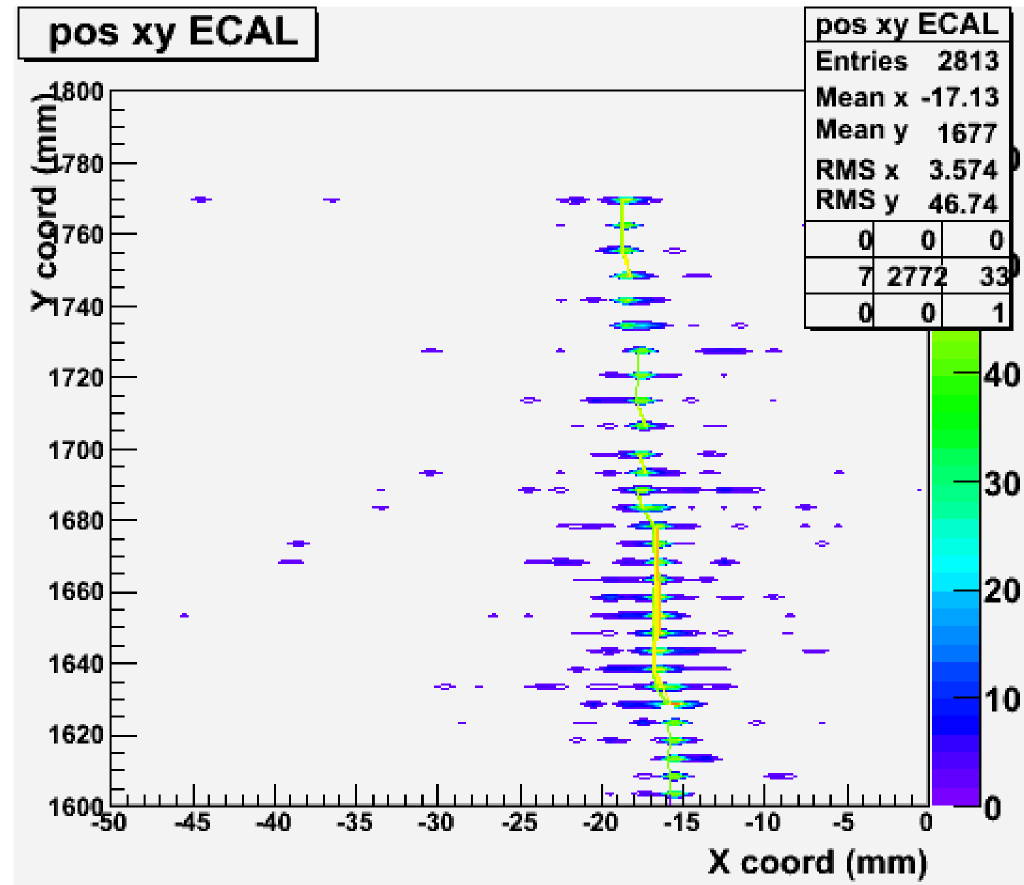
C.A.T. = **C**alorimeter **A**ided **T**racking

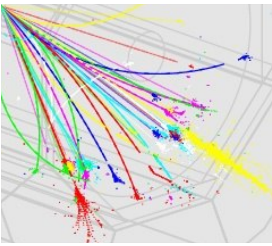
- Triggered by John Womersley
  - *Can you track muons in the ECAL and could you get rid of a dedicated muon system ?*
- Similar things have been done before
  - e.g. CDF Phoenix Forward Tracks (ECAL+ISL+SVX)
- Could take it to a new level (Who else has this kind of resolution)
- SiD needs seed tracks for their reconstruction



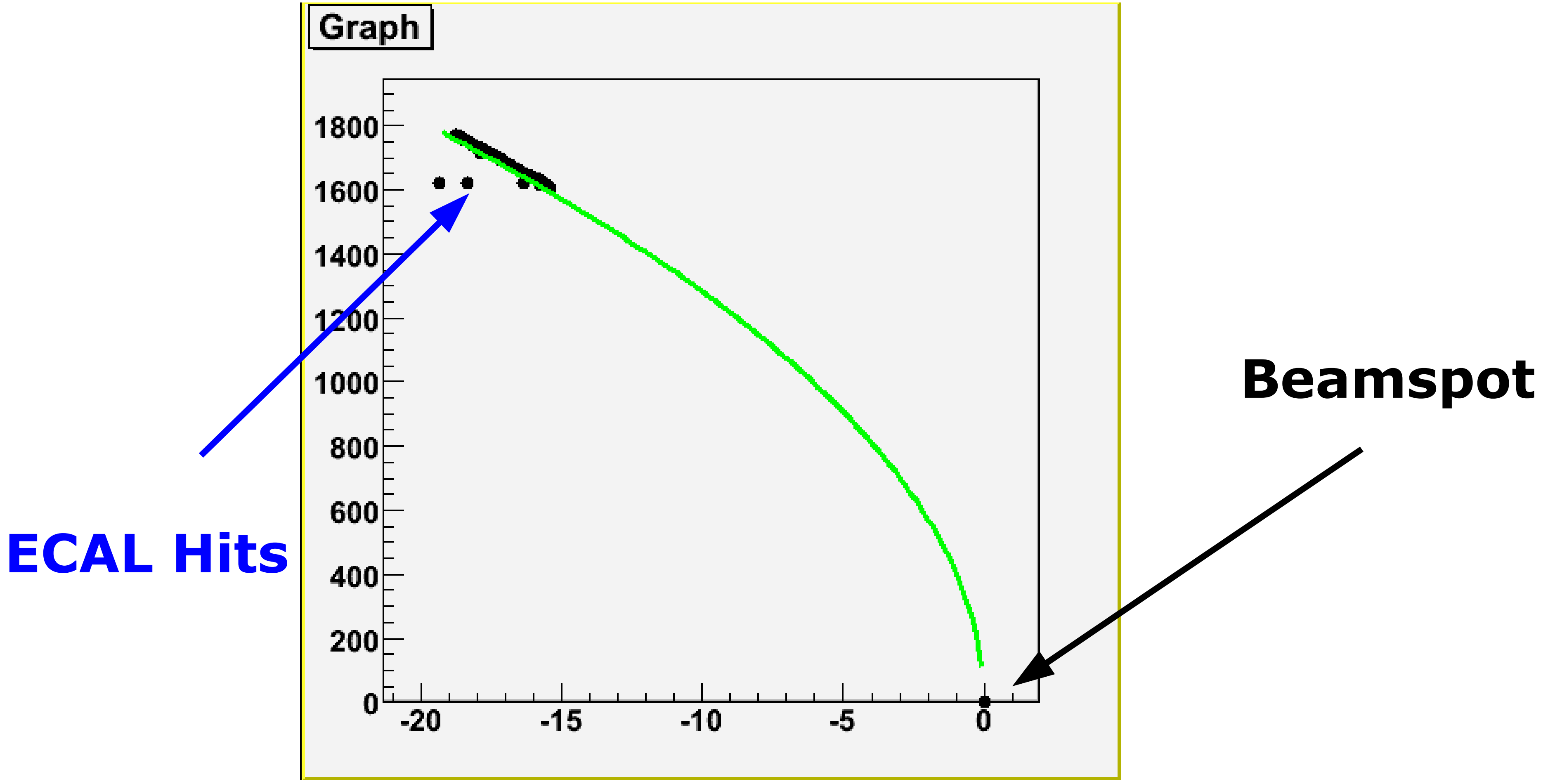
15 GeV Muons in ECAL



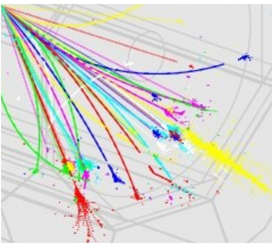




Proof of Principle



Quick and Dirty Tracking



Summary

- RAL GEANT setup is working
- 500 GeV per particle is a good upper limit
- Physics Occupancies are low, Multiple Hits per pixel are rare
- 50 μ seems again to be a reasonable size
- Noise is an issue !
- Dead area needs more studying
- Tracking with the ECAL is possible