Simulation of the DHCAL Response

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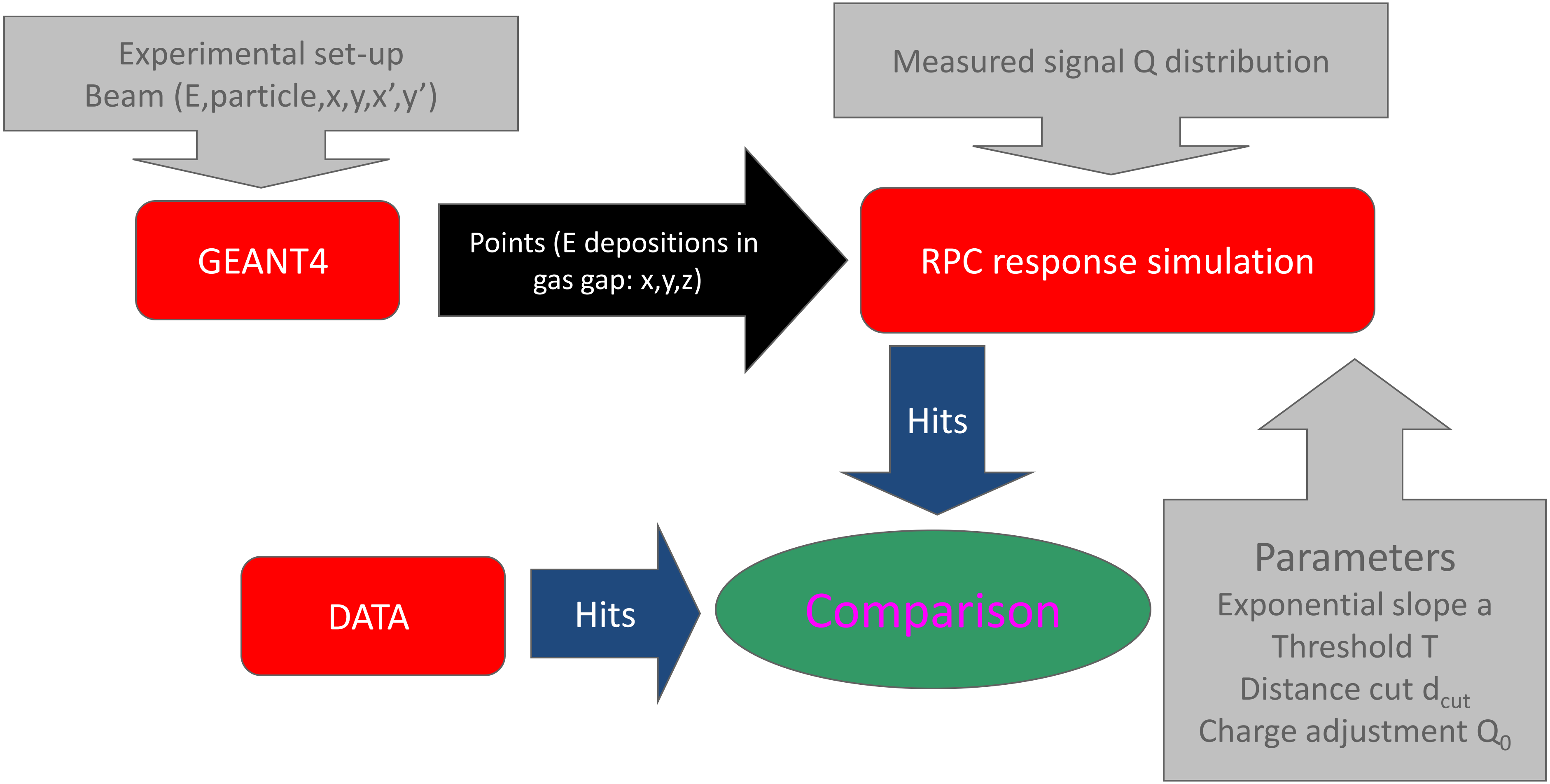
Simulation Strategy



With muons – tune a, T, (d_{cut}), and Q_0
With positrons – tune d_{cut}
Pions – no additional tuning

RPCSIM Parameters

Distance d_{cut}

Distance under which there can be only one avalanche
(one point of a pair of points randomly discarded if closer than d_{cut})

Charge Q_0

Shift applied to charge distribution to accommodate possible differences in the operating point of RPCs

Slope a

Slope of exponential decrease of charge induced in the readout plane

Threshold T

Threshold applied to the charge on a given pad to register a hit

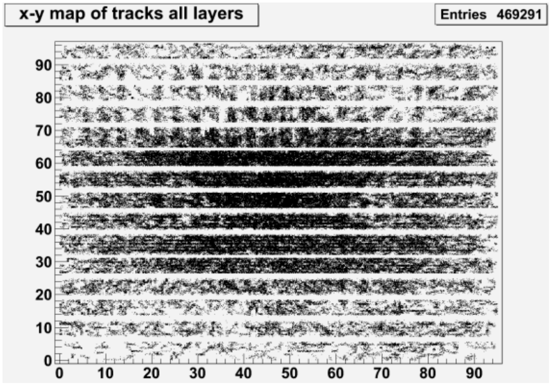
Muon analysis

Muons in test beam

Use +32 GeV/c momentum selection + 3 m Iron beam blocker
→ Broadband muon beam with at the moment unknown momentum distribution

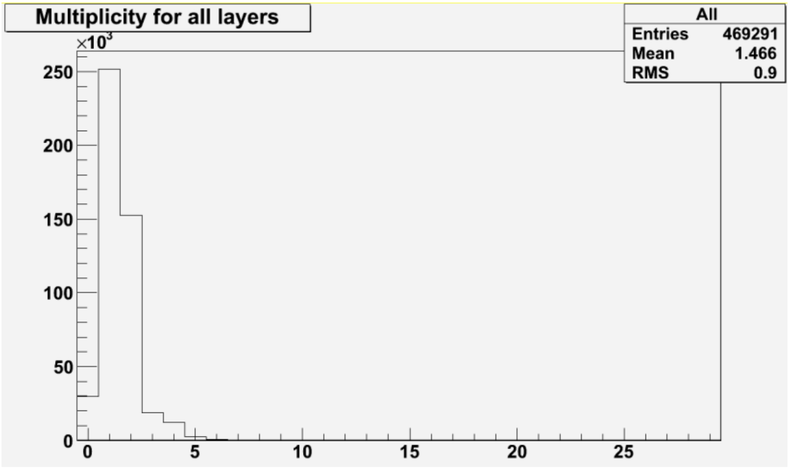
Track muons

Use any, but the layer i for reconstructing a muon track
→ apply quality cuts on tracks



Select 'clean' regions away from

Dead ASICs (cut out 8 x 8 cm^2 + a rim of 1 cm)
Edges in x (2 rims of 0.5 cm)
Edges in y (6 rims of 0.5 cm)
Fishing lines (12 rectangles of ±1 cm)
Layer 27 (with exceptionally high multiplicity)

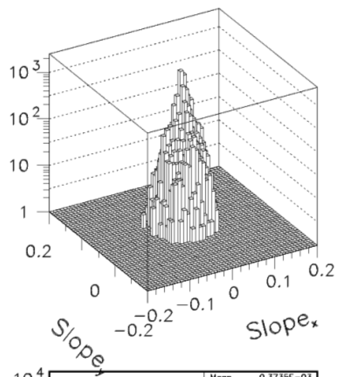


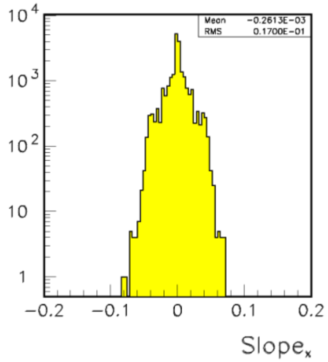
Measure average response

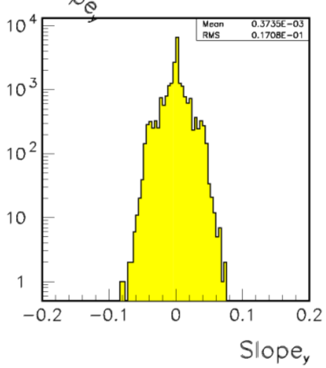
Simulate Muons I

Adjust

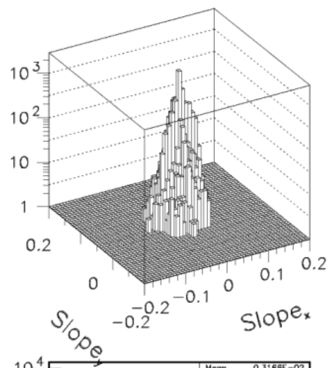
x/y distribution
x/y slopes

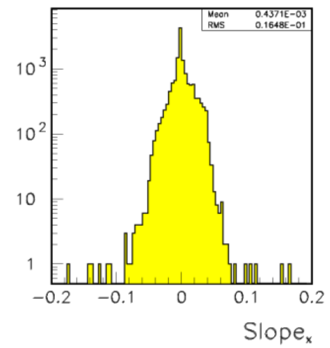


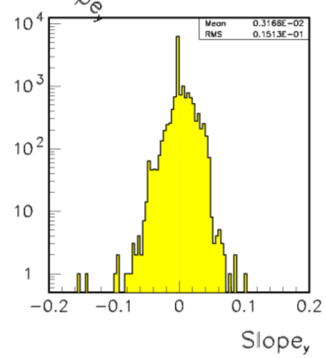




Simulation



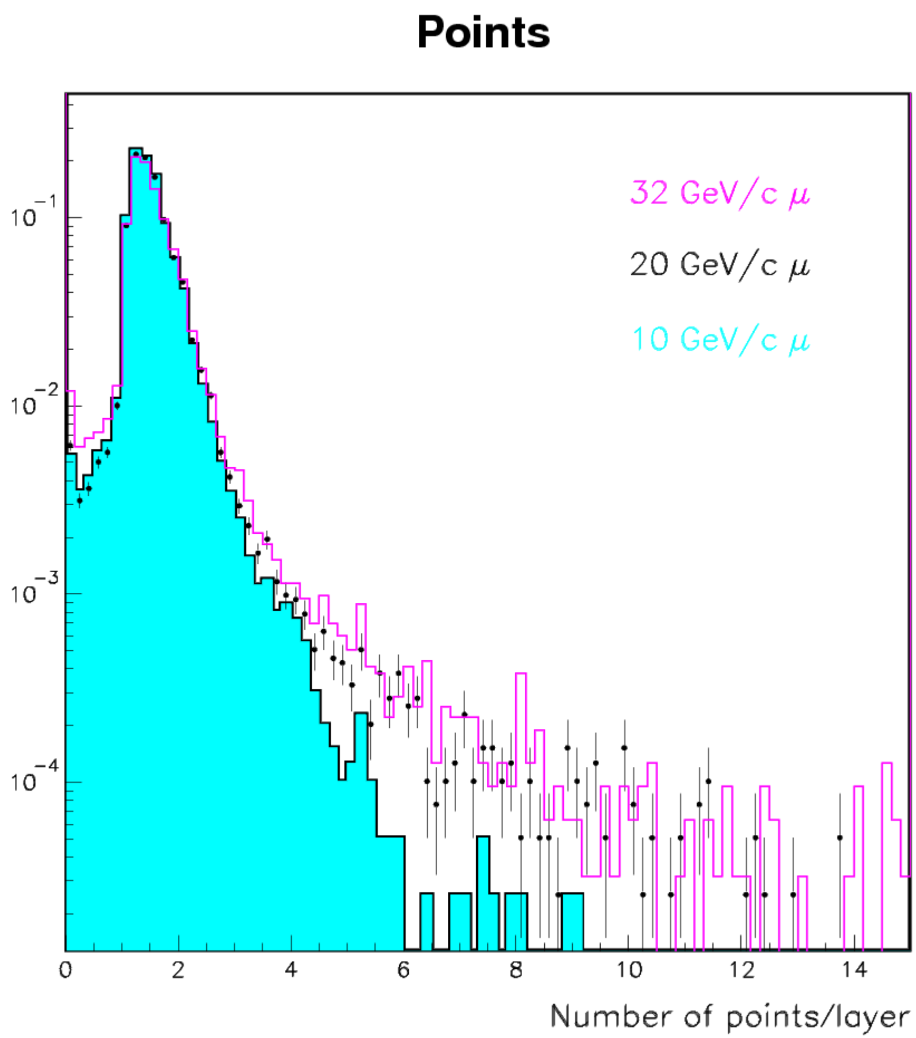


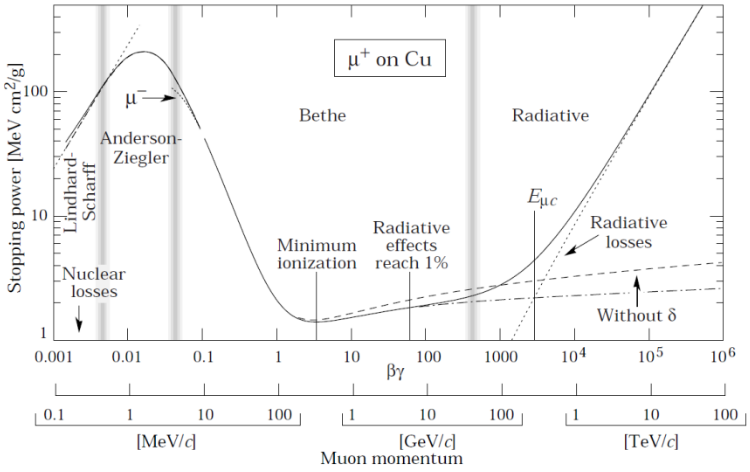


Data

Simulate Muons II

Choose momentum



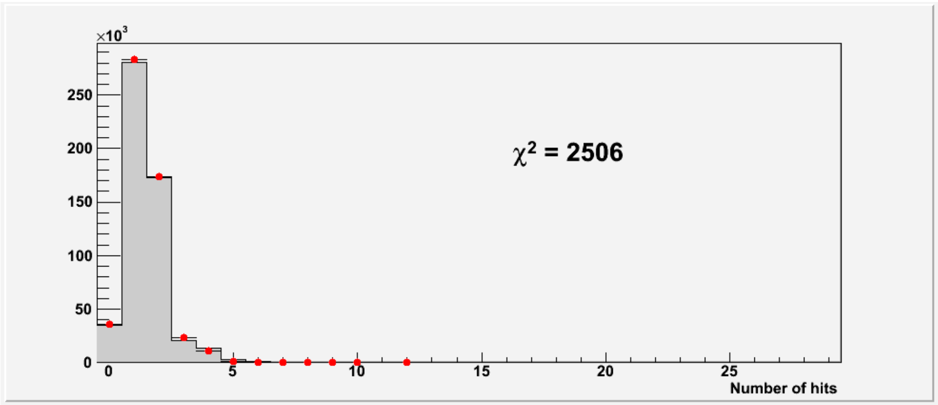


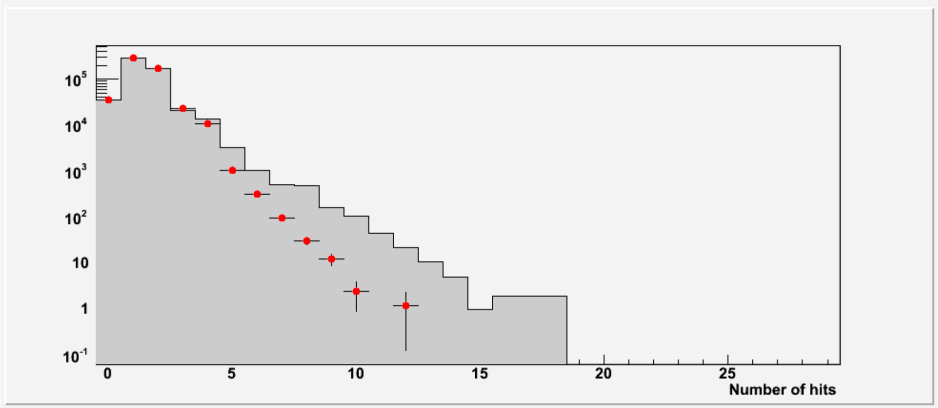
For the following chose

20 GeV/c

→ Systematic study to follow

Comparison with Measurement





Linear plot

Reasonable agreement

Logarithmic plot

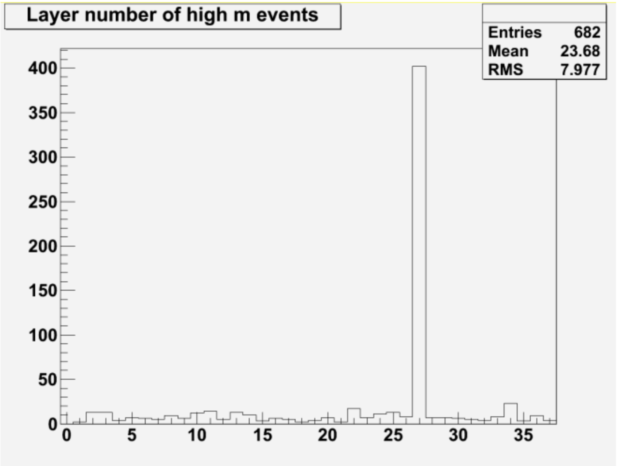
Tail towards large multiplicities not reproduced

→ What are these high multiplicity events?

High Multiplicity Events

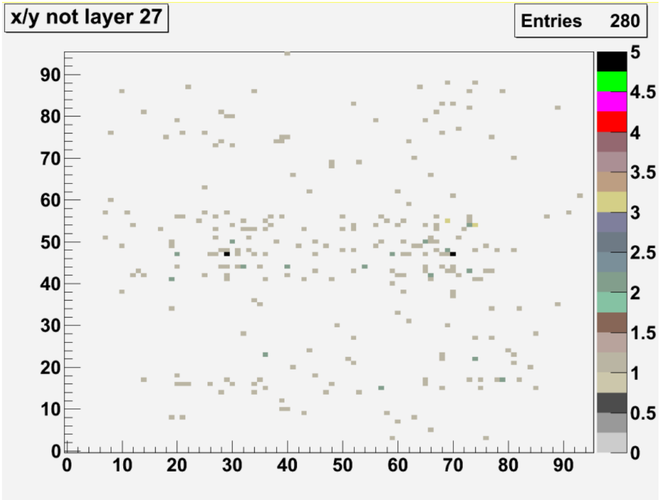
Clusters with > 6 Hits

Layer 27 is problematic
(later replaced RPC)
Other layers nothing
spectacular

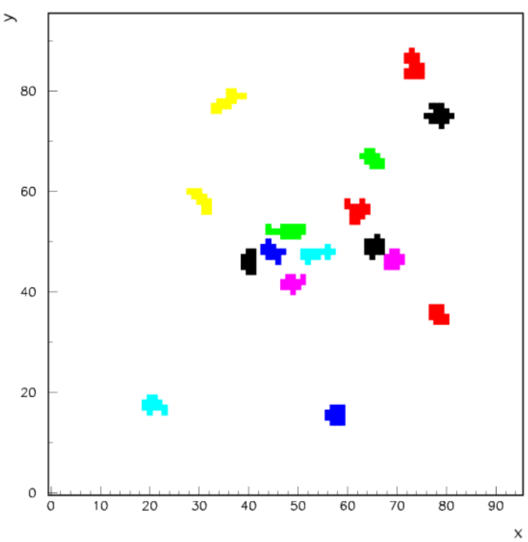


Clusters with > 6 Hits

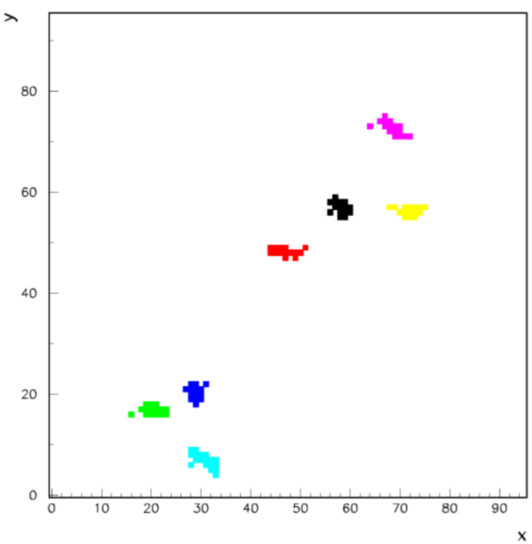
Layer 27 excluded
Nothing spectacular



1 cluster



2 clusters



Print out clusters with

More than 12 hits

Look perfectly normal

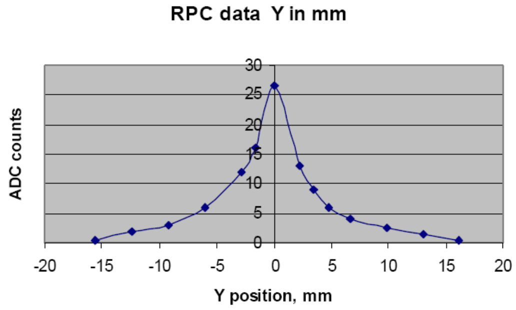
→ Need to be simulated!

Simulation of High Multiplicity Events

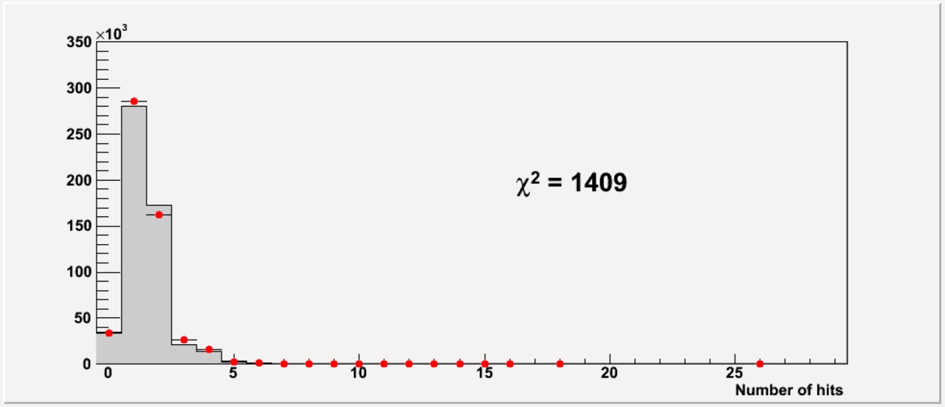
Distribution of Q on pad plane

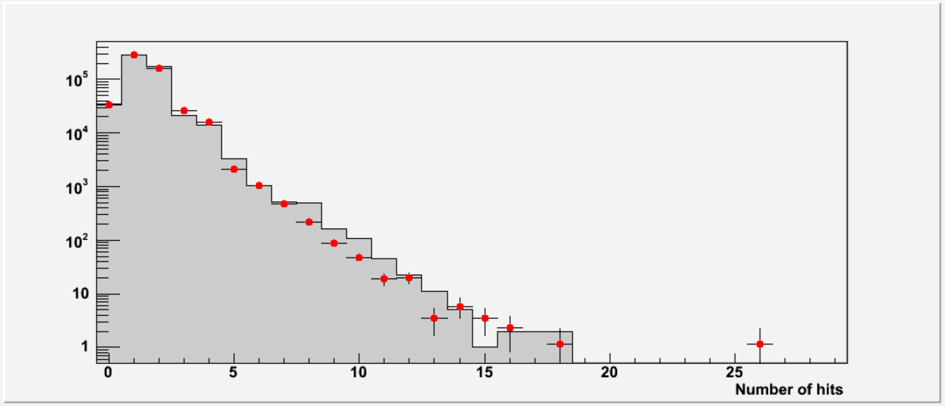
Previously assumed exponential decrease with distance

Introduced 2nd exponential



D.Underwood et al.





Able to reproduce tail

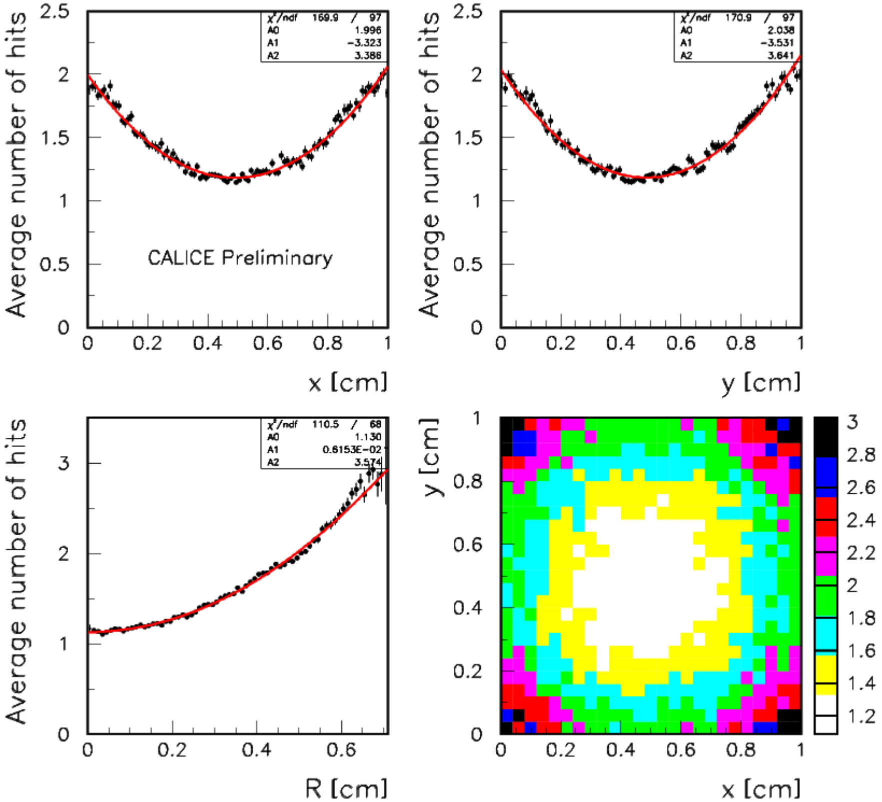
Tuning still ongoing

Scan Across Pads

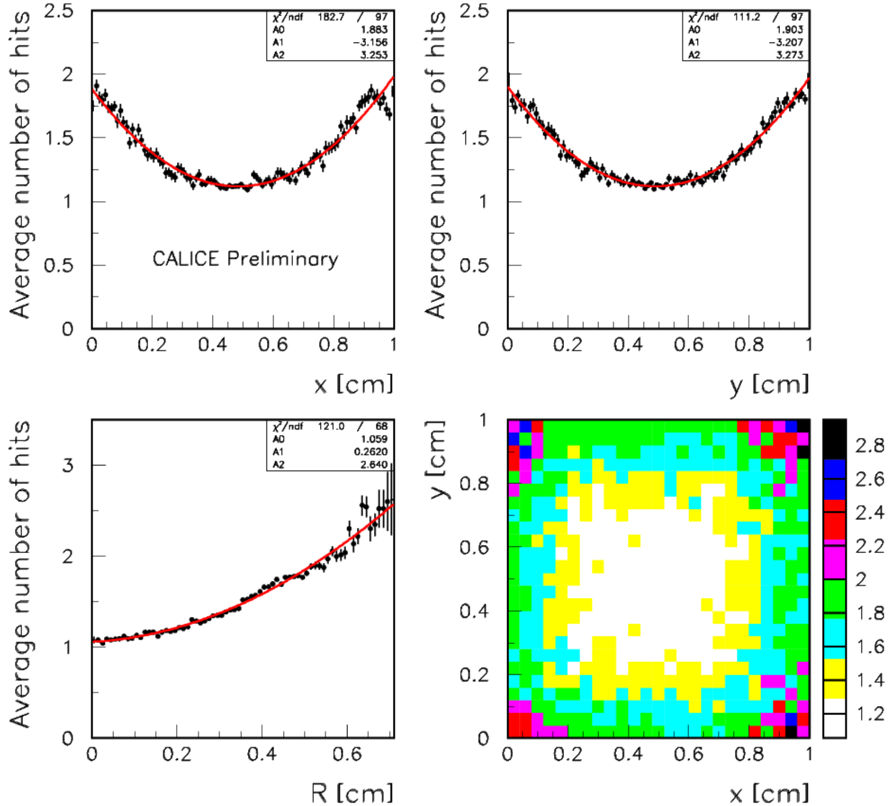
$x = \mathrm{Mod}(x_{track} + 0.5, 1.)$ for $0.25 < y < 0.75$
$y = \mathrm{Mod}(y_{track} - 0.03, 1.)$ for $0.25 < x < 0.75$

Caveat: not latest tuning parameters

Data 630011



Simulation



Note

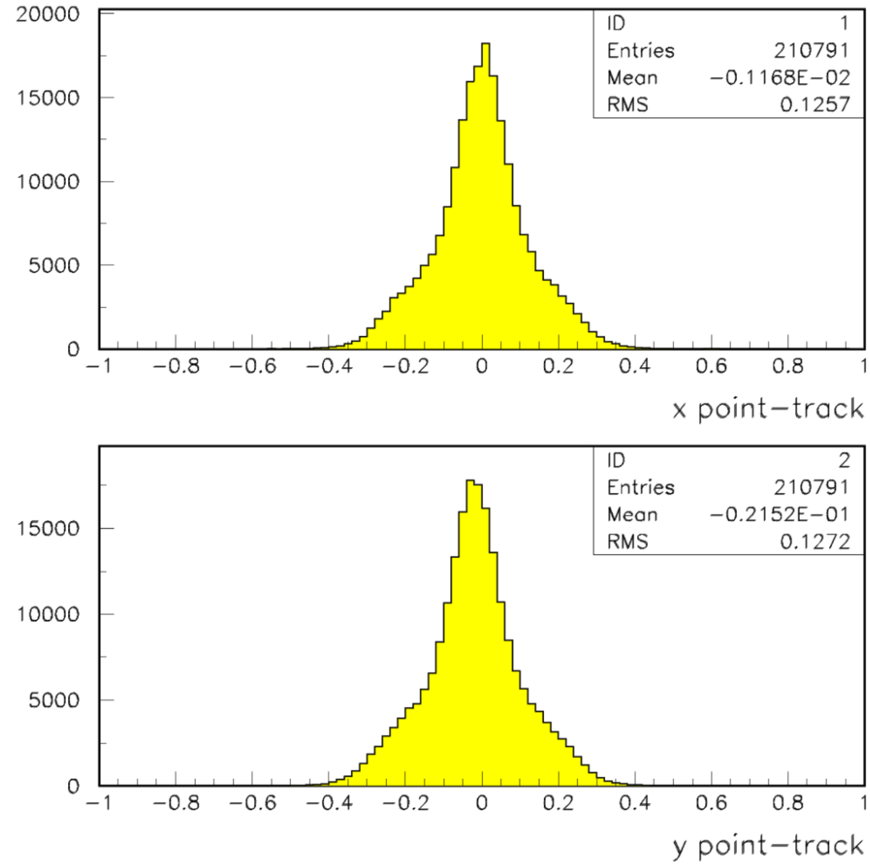
These features **not** implemented explicitly into simulation
Simulation distributes charge onto plane of pads…
→ Tracking resolution?

Tracking Resolution

Monte Carlo study

Comparison of track x/y with x/y of point

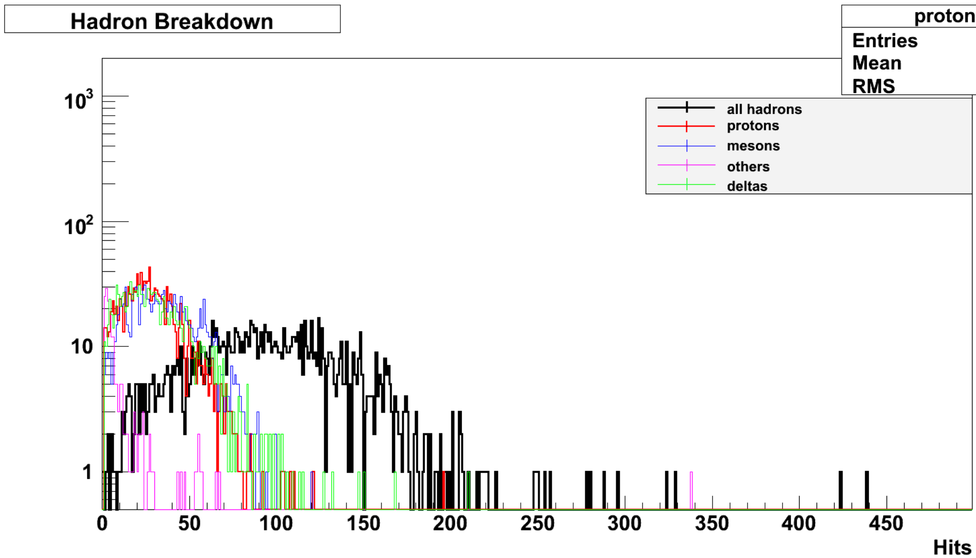
Resolution ~ 1.3 mm

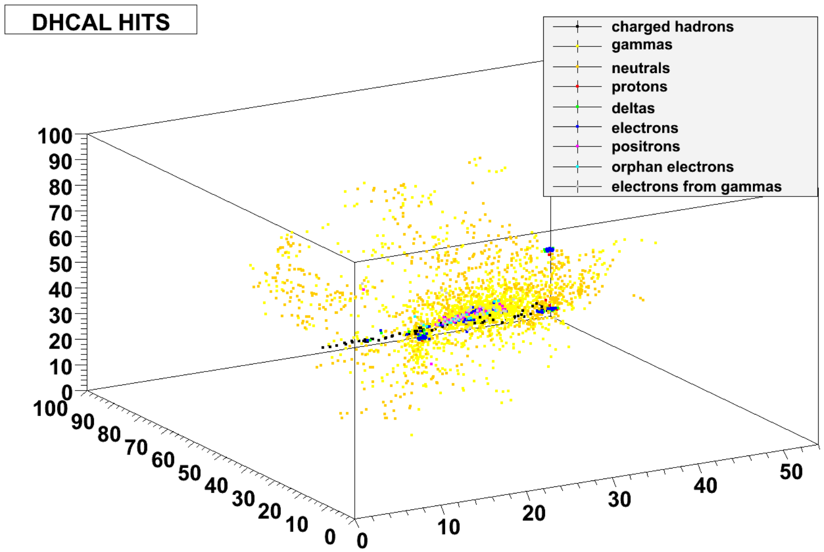


Monte Carlo – Particle ID

Development of particle association for DHCAL hits (Kurt Francis)

Requires understanding history of energy depositions in GEANT4
Developed event display
Work in progress





Summary

Strategy for RPC simulation

Emulate induction of charge on readout plane
Tune RPC response to muons, positrons
Absolute prediction for pions

Muon response

Already quite good, but still more tuning needed
2^{nd} exponential needed to reproduce tail with large number of hits

Response across pad

Reasonably reproduced
Not explicitly implemented
Tracking resolution ~1.3 mm

Particle ID w/in GEANT4

First results, still more understanding needed