Silicon Parametric Charge Deposition Model

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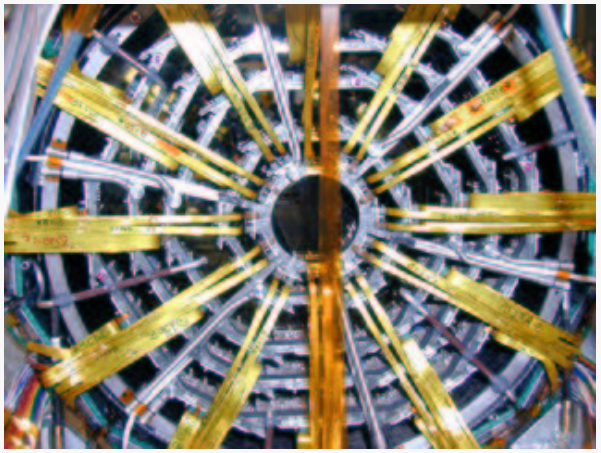


The Model (a minimal explanation)

-Primary charge deposition is calculated from the basic Bethe-Block formula
-Parameterized Geant distributions are inputed for the Delta Rays contribution. Magnetic Effects are built into distributions
-Capacitive Sharing is included.
-Realistic Noise from database is added
-*Use of Parameterized distributions as Input to the Code, are supposed to save Much time, as opposed to calculating every contribution from first principles*

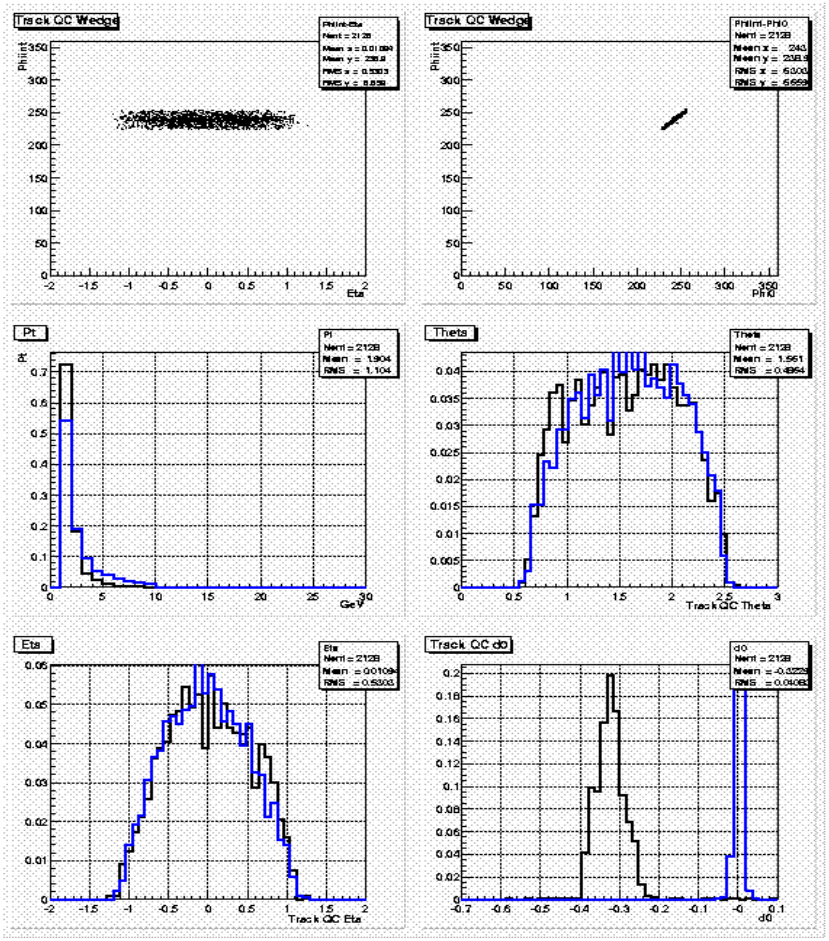
Tunable Parameters

-Crosstalk (amount of capacitive sharing)
-Gain (2 parameters)
-Amount of Noise

Creation of Study Samples

-After code changes create library from SvxSim package
-Compile new version of cdfSim using new library, created single muons with Fake Event builder
-From created Sample, Ntupled using SiStrip ntuple separately for each layer excluding the layer from patern recognition
-Ntuples are filtered using Silicon Quality cuts provided by Doug Glenziski, at macro level.
-All samples created are 10K events big
-Data is processed through the same ntuple and cuts, also removing layer from patern recognition of track.

Layer 2 Original Sample (blue-Model, black-Data)



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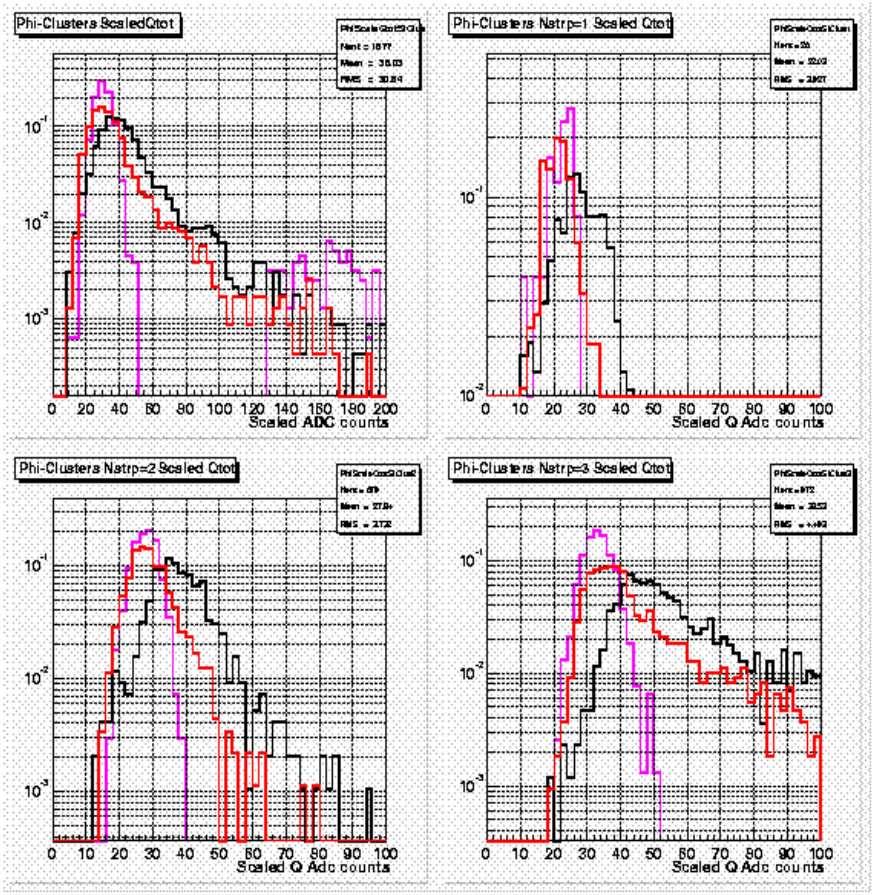
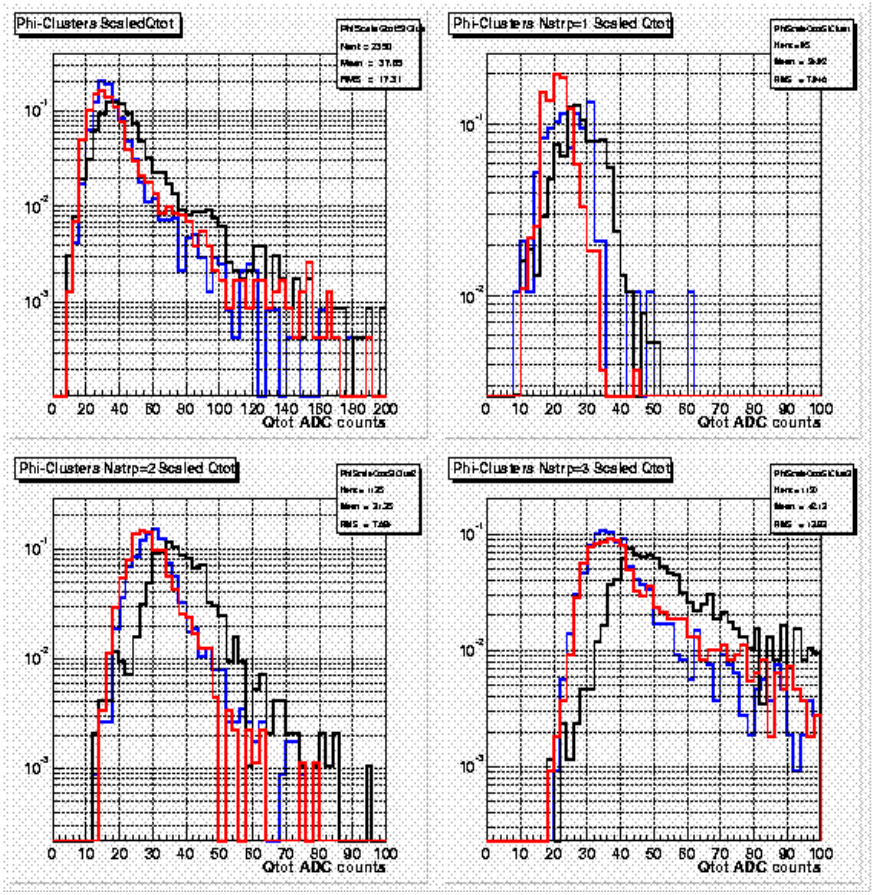
Cluster Charge Distributions, Layer 2 (data, old parametric, fixed parametric, physical)

Original Distributions



After Delta Ray Bug Fix



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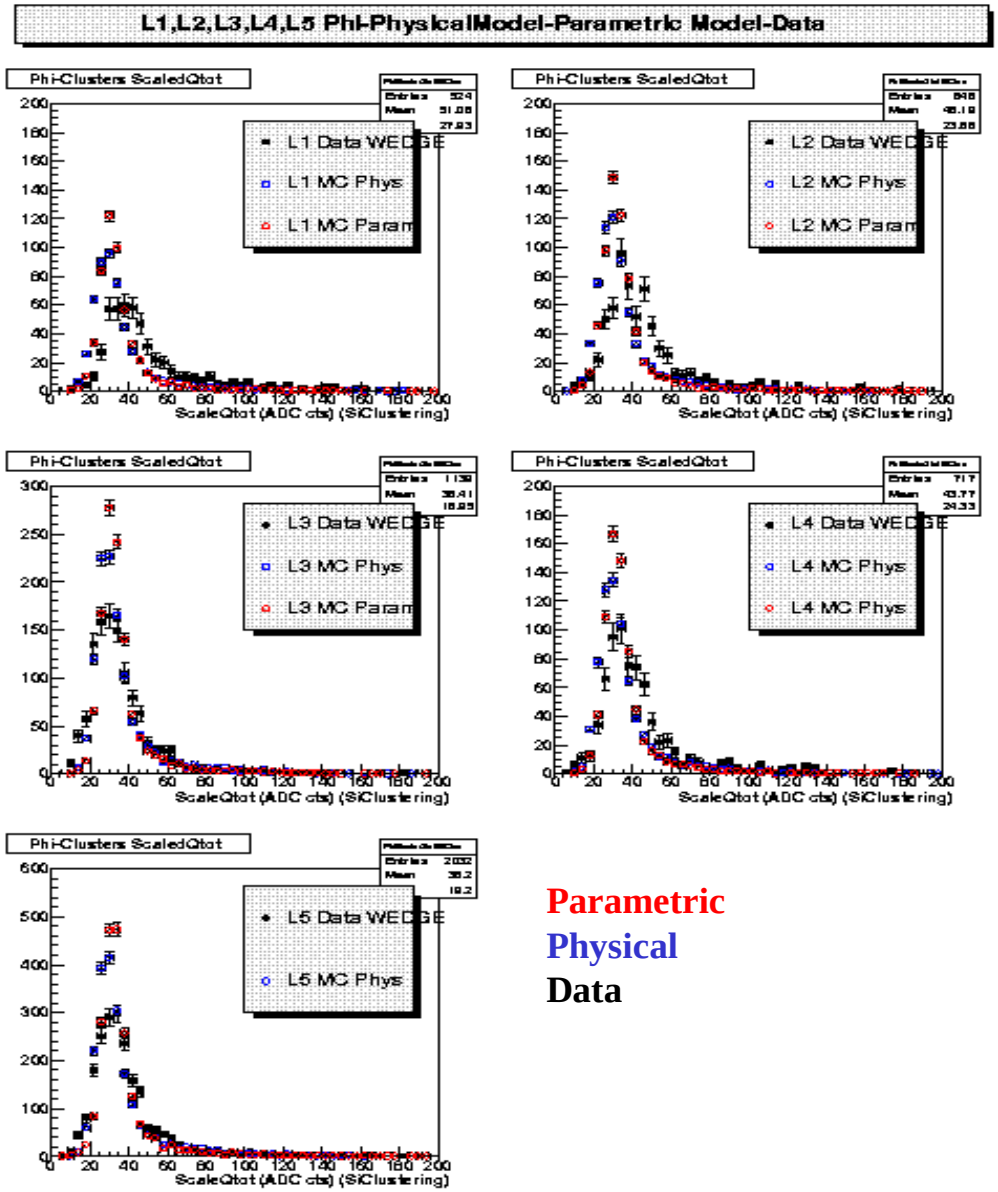

Parametric
Physical
Data

Without Logarithmic scale we can see that Both Montecarlos have charge distributions That are narrower than data in layers 1 To 5 (Not including L0 and ISL in this study)

At this point realistic noise was not being added.

Did code modifications to include realistic Noise. Amount of noise added can be tuned using the value of a cutoff in the noise gaussian.

Also option can be chosen in tcl so that noise is only added to strips that had hits (option hits) or randomically to all strips (option all)

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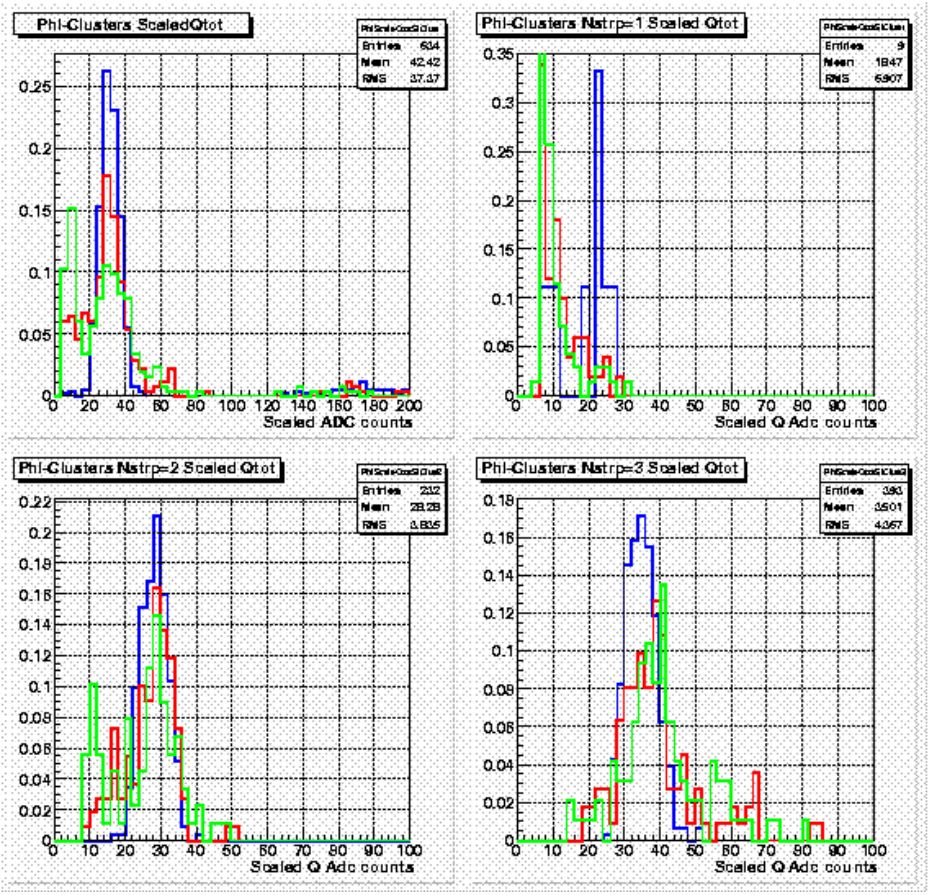
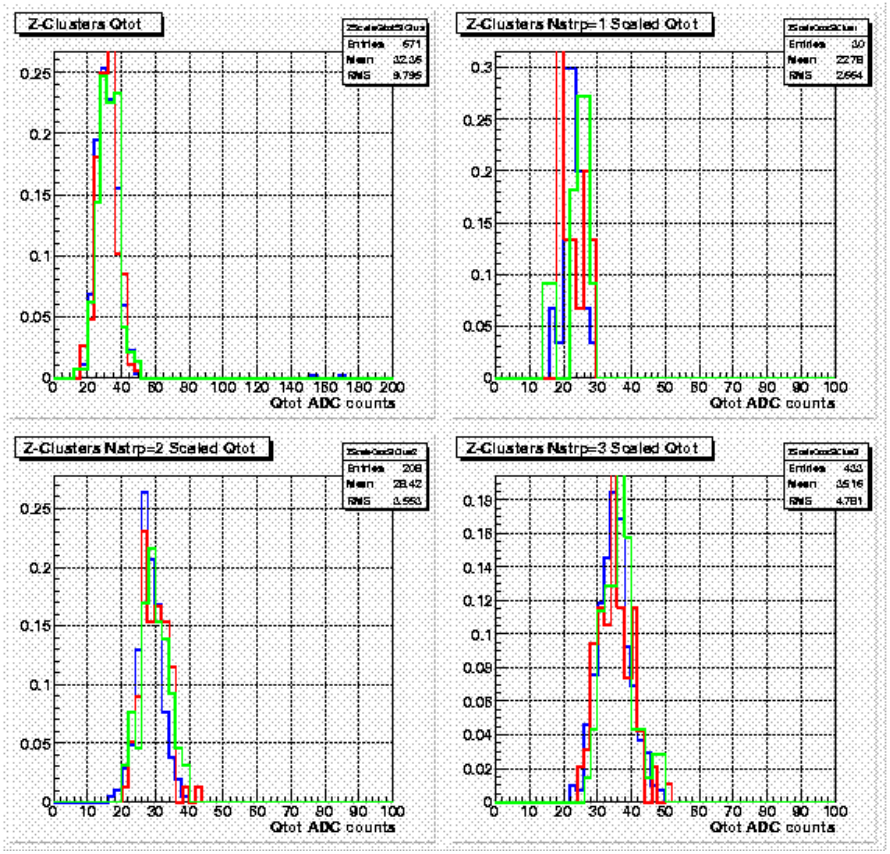


Charge Distributions Phi side, option All

Charge Distributions, Z side option Hits

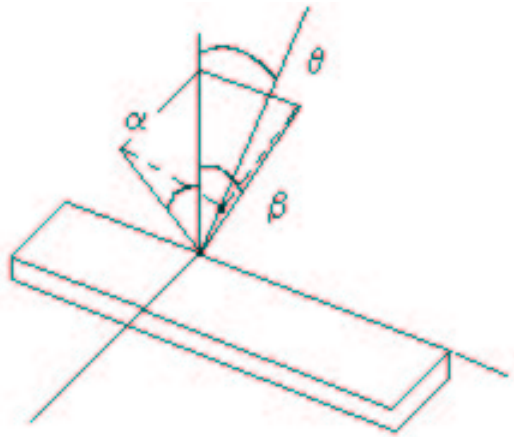


cutoff 2.0
cutoff 1.0
cutoff 0.5

The options all adds too many more hits per event (for cutoff of 0.5, 30k), which makes the code much slower. Since it seems an ineffective way to broaden the distributions, the option Hits was selected with cutoff of 0.5 using noise from database.

Scaling of Charge

All charge distributions considered are scaled to Compensate for the different pathlenths.



The charge was corrected according to the expression: (used by silicon experts)

$$Q_S = Q/\cos\theta \qquad \cos\theta \approx \cos\alpha \cdot \cos\beta$$

Which if written in terms of tangent gives:

$$\cos\alpha \cdot \cos\beta = 1 \Big/ \sqrt{1+\tan^2\alpha+\tan^2\beta+\tan^2\alpha\cdot\tan^2\beta}$$

But the correct expression is below:

$$\cos\theta = 1 \Big/ \sqrt{1+\tan^2\alpha+\tan^2\beta}$$

Therefore the error was more manifest in the tails

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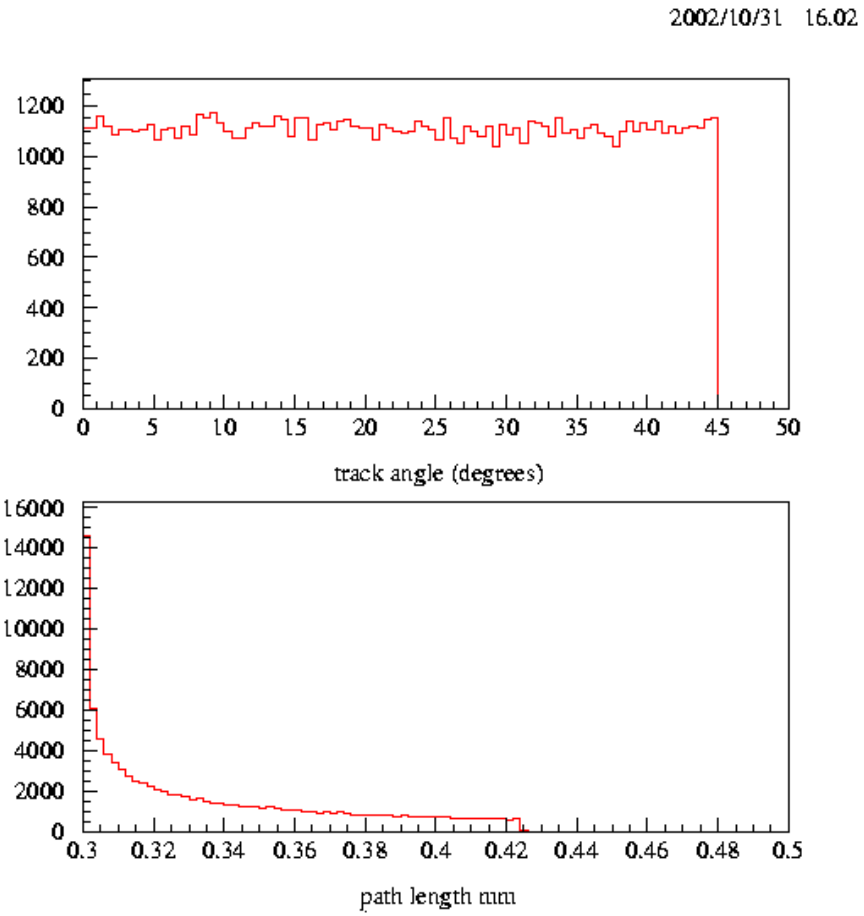
It was noted that the Data and MC behaved Slightly differently under the application Of the charge scaling

Problems in Montecarlo then must be angle dependent

The Montecarlo track angle distribution looks flat, then problem must not be in track angles generated.



Delta Rays Multiplicity

At this point the delta rays in the model did not have a different multiplicity according to incidence angle to the silicon wafer.

We implemented code changes to include Different multiplicities of Delta Rays

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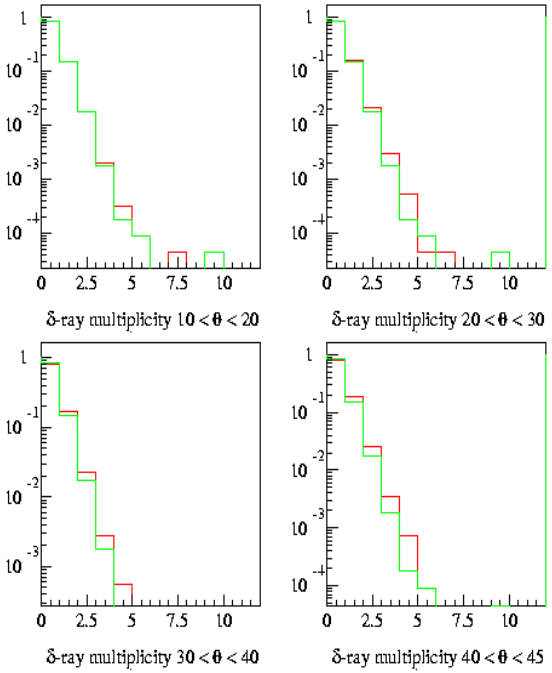
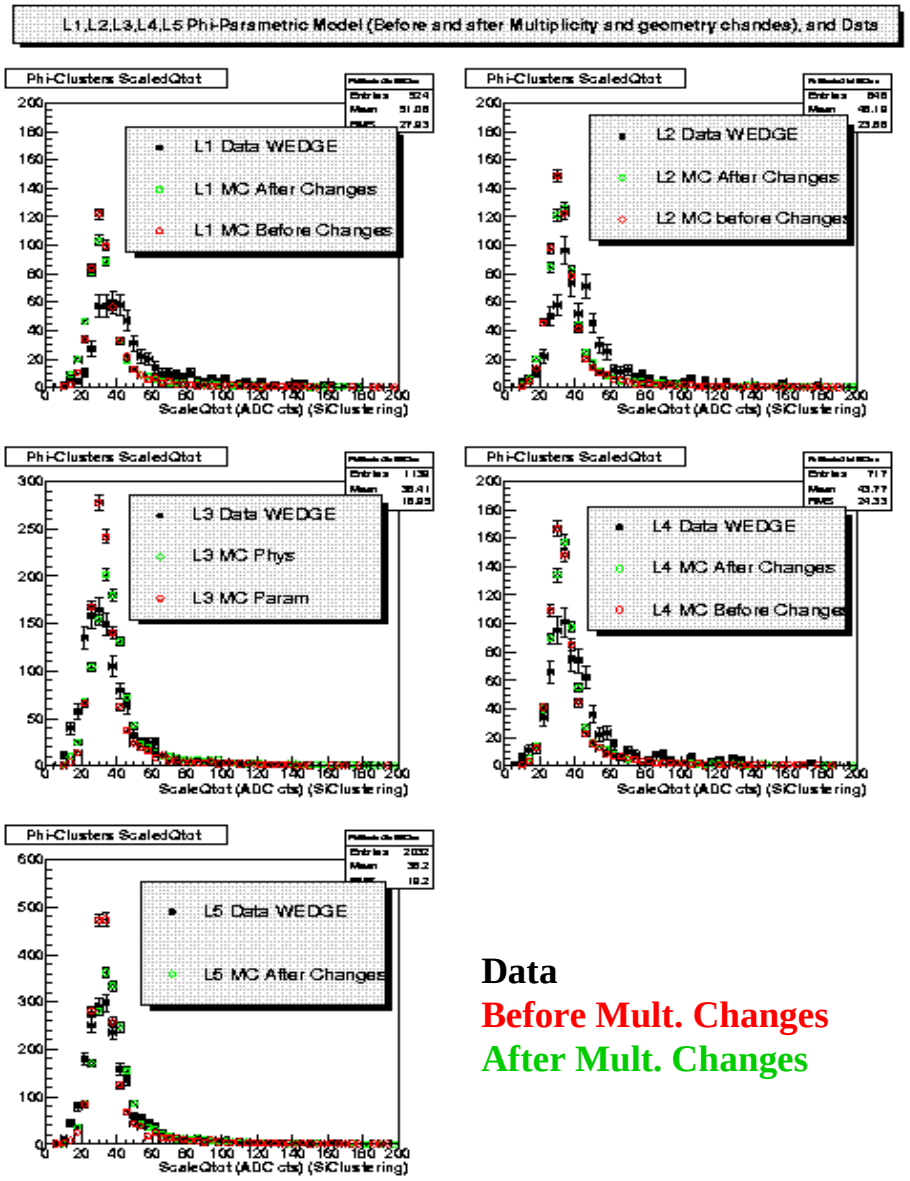
Multiplicity distributions by
Angle bins, as implemented in code from
Geant reparametrization 2002/10/31 16.02



Charge distributions after the changes,
We can see that the was some improvement,
But more is needed to reach good agreement



Data
Before Mult. Changes
After Mult. Changes

Tuning the Model

After fixing bugs and improving code, what remains is to tune Model. The two most Important distributions are the Cluster Charge and the Cluster Width distributions

To fix Cluster Charge distribution the only parameter that remains is the Gain (Conversion between charge and ADC counts), We found **necessary to use a linear function for the gain instead of a number, with a multiplicative factor and an offset.** The factor makes the distribution wider or thiner, and the offset sifts it left or right.

To tune cluster width distributions, we found that changes in the Crosstalk were Quite effective. It was necessary to implement code to allow for different Crosstalks For different layers and sides.

Although both types of distributions were not completely independent to changes to tune the other one, they were nearly so.

It was necessary to create more than 20 10k event samples to reach the current Gain and Crosstalk numbers.

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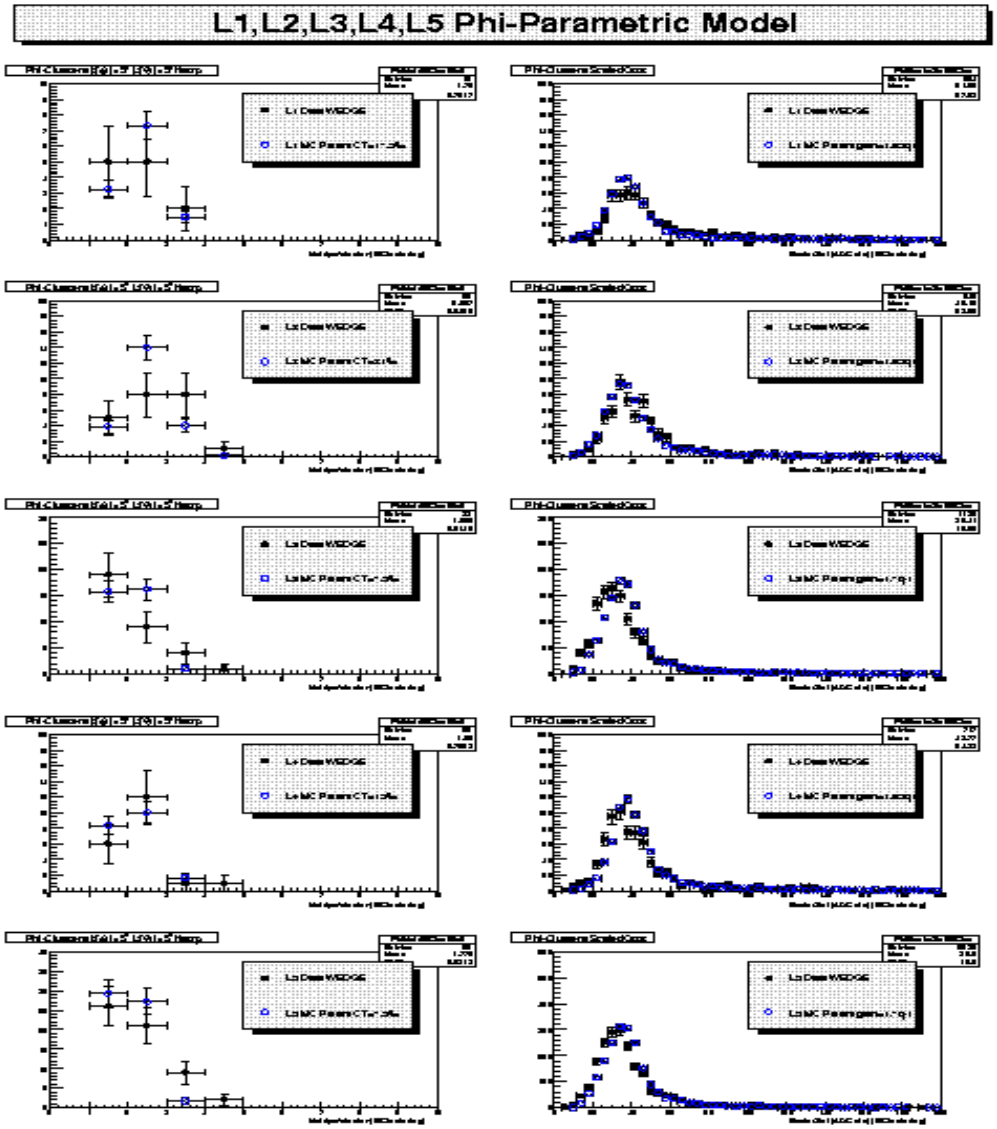


Parametric Model and New Data Phi side

Layers 1, 2 and 4 are the same Brand, and layers 3 and 5 are the same brand.

The same value for gain both Slope and offset was maintained For same brand layers.

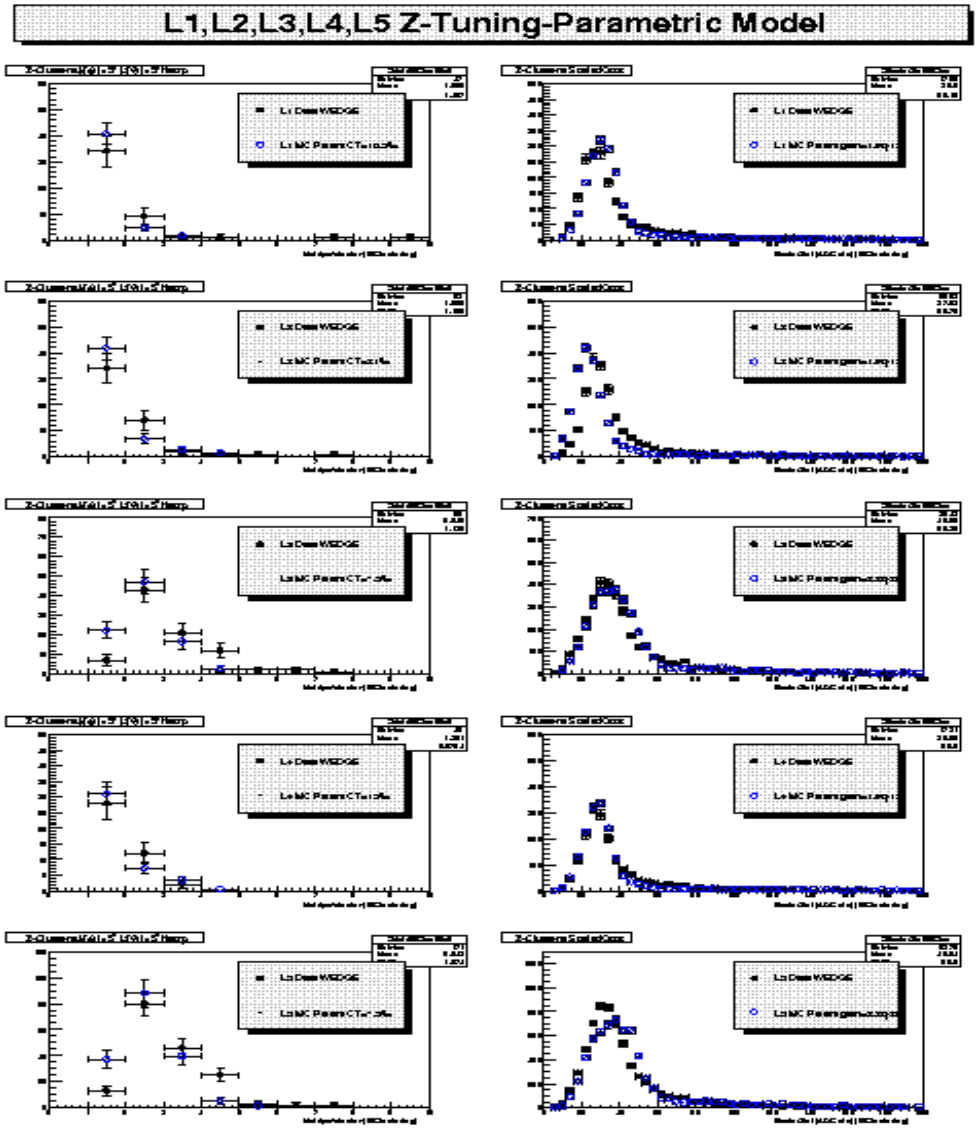
As close values of Crosstalk as possible Were kept for same brand layers

We see that agreement is pretty good!!!, vastly improved from original default values

Data

Parametric Model

Silicon Parametric Charge Deposition Model



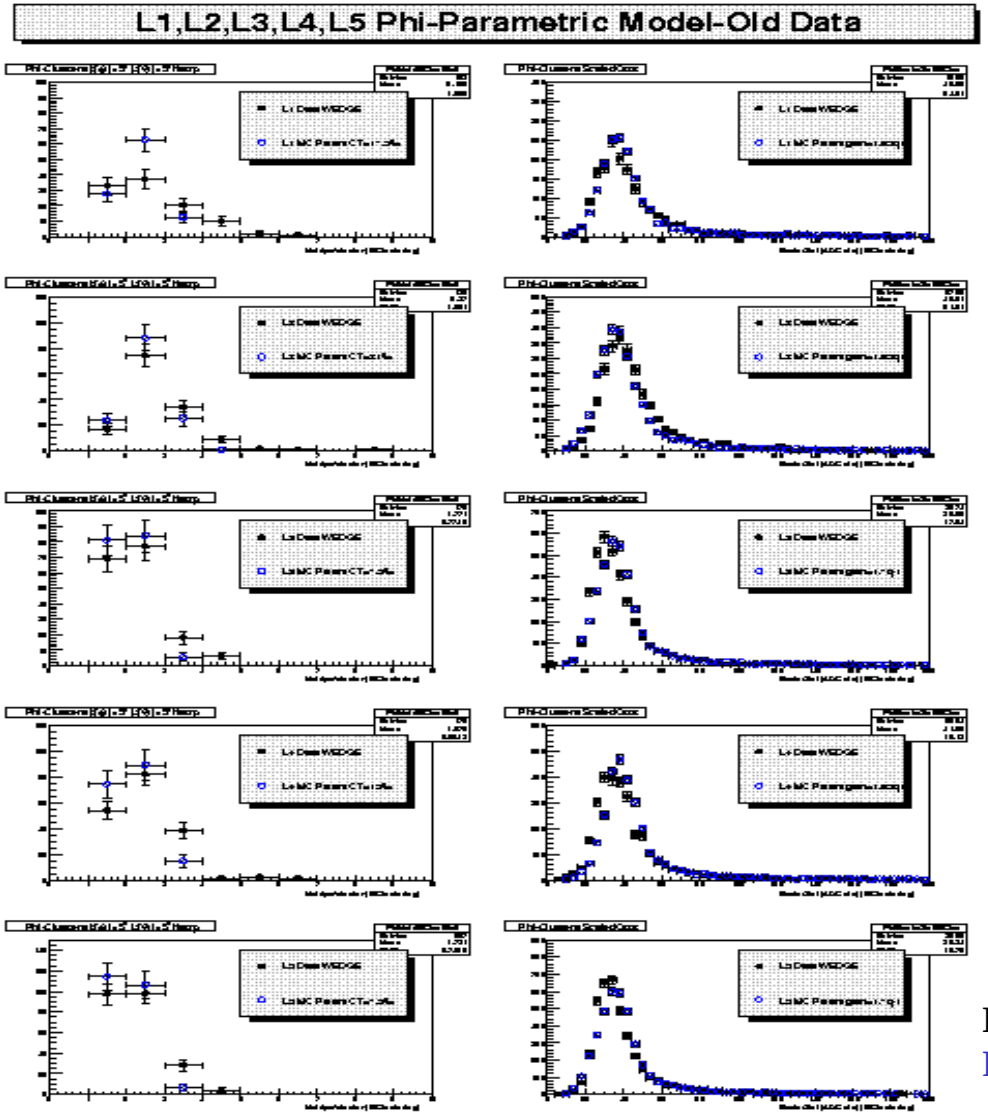
Parametric Model and
New Data Z side

The cluster charge distribution
For Layer 2 does not agree as
Well. However the requirement
For same gain values for the same
Brand can be lifted for layer 2
Because this layer has a different
Pitch.

If this is done, agreement can be reached easily

Data
Parametric Model

Silicon Parametric Charge Deposition Model



Data
Parametric Model

Parametric Model and Old Data Phi side

The older data is considered less reliable and can be thought as an independent check for the Tunning.

The tuning was performed on the New data

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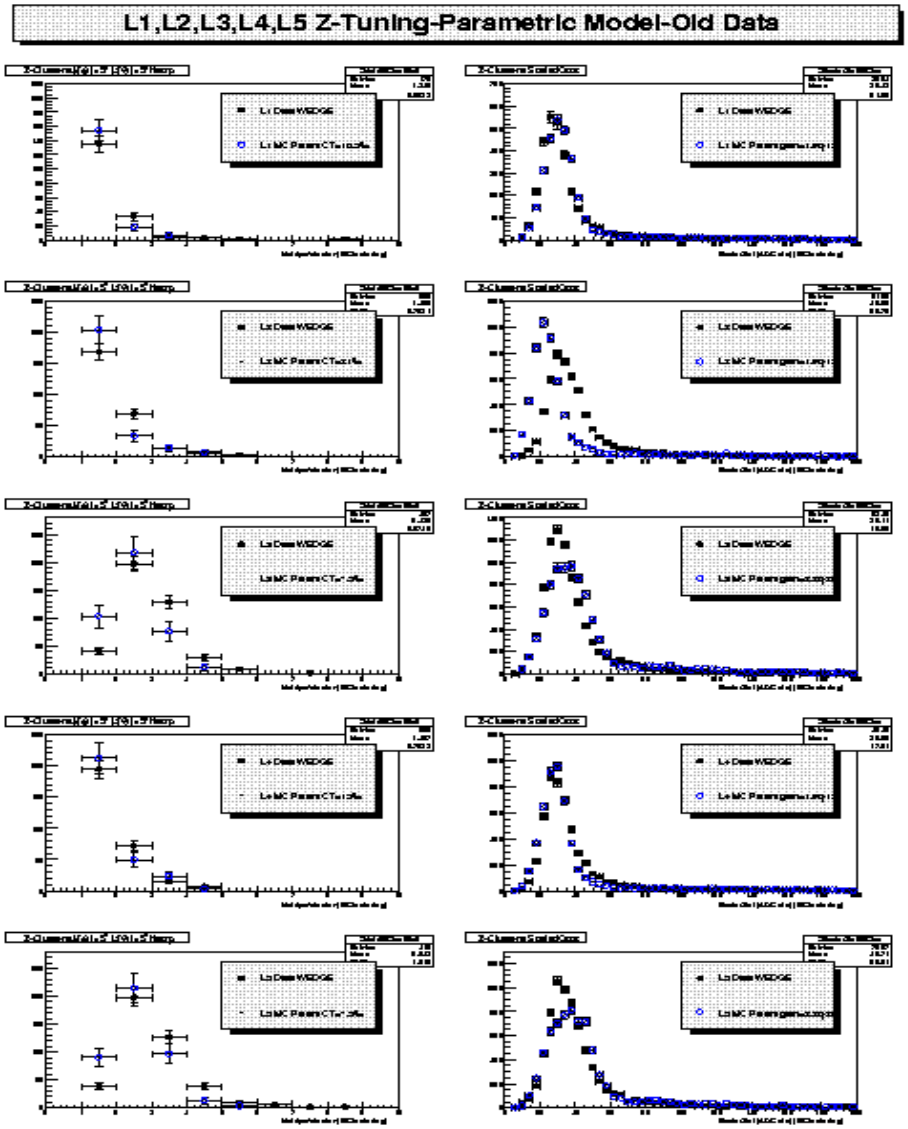

Parametric Model and Old Data Z side

The disagrement for Layer 2
In cluster charge is a bit worse
Than with New Data.

But this can be solved by changing the gain parameters for Layer 2

Data
Parametric Model

Conclusions and to do list

Agreement reached is pretty good between Montecarlo and Data.

Agreement of Parametric model with data now is better than Physical model (Physical Model was not tuned for gain values)

Currently Parametric Model close to a factor of 2 faster

Big improvement can be made in speed, and work for optimizing speed has begun

CDF note is being written with all details of study

Validation of Model remains to be done, M. Paulini has agreed to generate t tbar using the model. We have already the macros to compare residuals, etc for validation