The Election MIP Finder and the "No Harm" Physics Study

MAPS Group Meeting, RAL

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Outline

A new MIP Finder

Objective

Devise a method for iterating over raw MAPS hits (after charge spread etc.) and determine the number of MIPs to be associated with each group of hits.

- Number of MIPS: Charge sharing creates popular shapes $\Rightarrow$ we must not over or under count! Can this be done reliably?
- Group of hits: Number of hits in MAPS ECAL is huge: can we economise?

Motivations

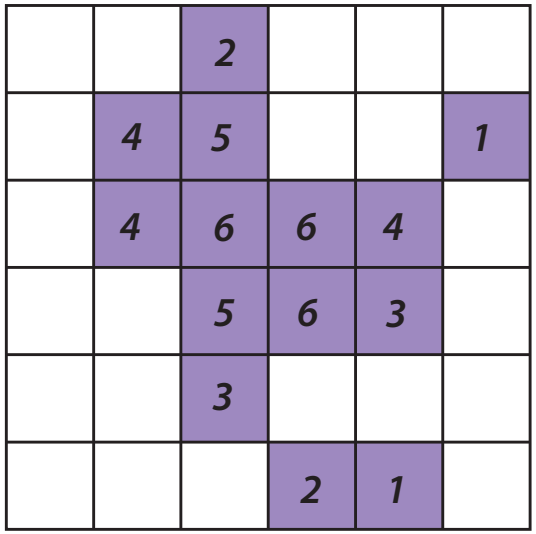
- Helps us understand the impact of charge sharing
- Faster processing of events
- Forms a basis for clustering algorithms (PFAs etc)

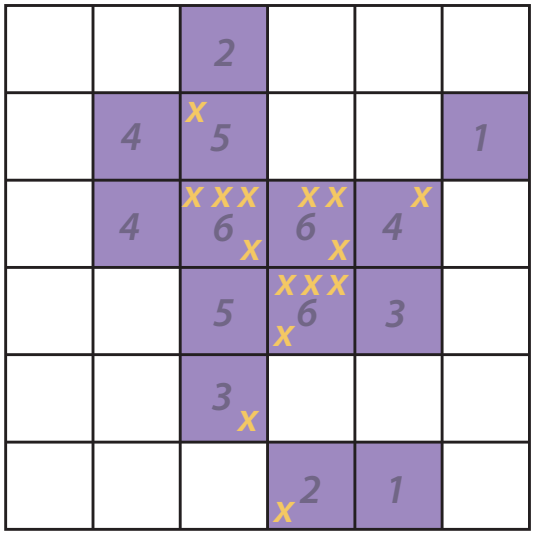
CALICE Calorimeter for ILC

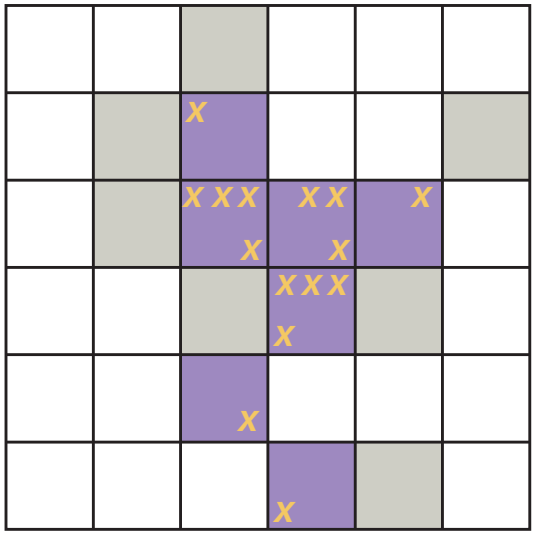
The Election Scheme

Overview Aims to account for charge sharing's special cases, do elementary clustering and reduce the number of raw hits.

1. For each hit, write down how many neighbours it has (0–8).
2. Each hit then votes for the neighbour with the largest number of neighbours.
3. Cells without votes are discarded.



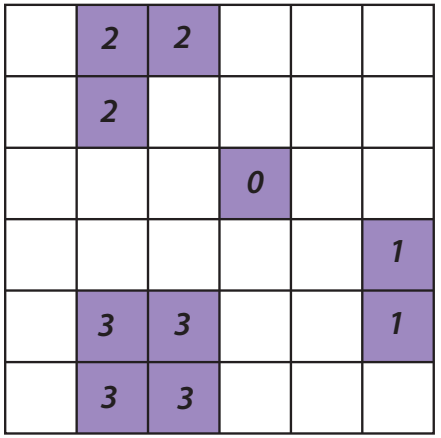


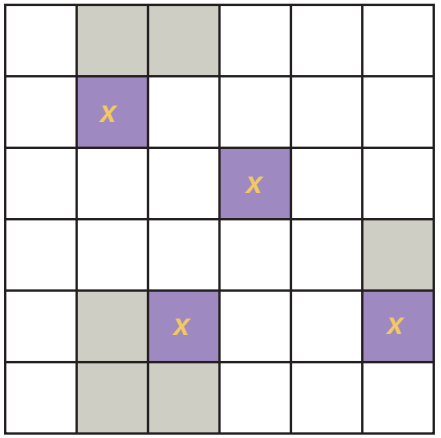


The Election Scheme

Special rules and cases

- Special cases: These *whole* shapes are all given a weight of 2, and 1 vote regardless:
- Special rule 1: If the voting pixel has more votes than all its neighbours, it abstains.
- Special rule 2: output number of hits = number of votes (Pseudo Analogue, or PA Scheme) or $>$ 0 votes $\Rightarrow$ one hit (Digital, D Scheme).

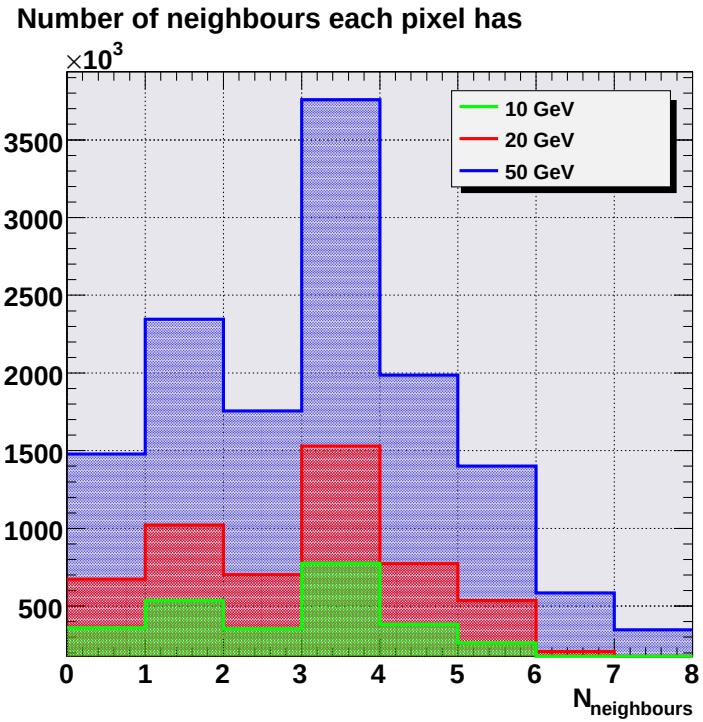




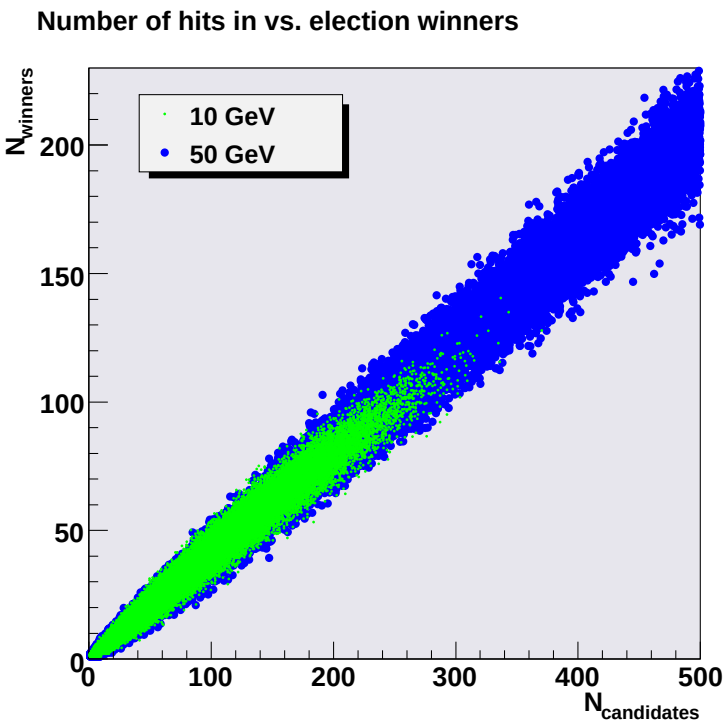
CALICE Calorimeter for ILC

The Election Scheme
Results

Testing with photons (D Scheme)



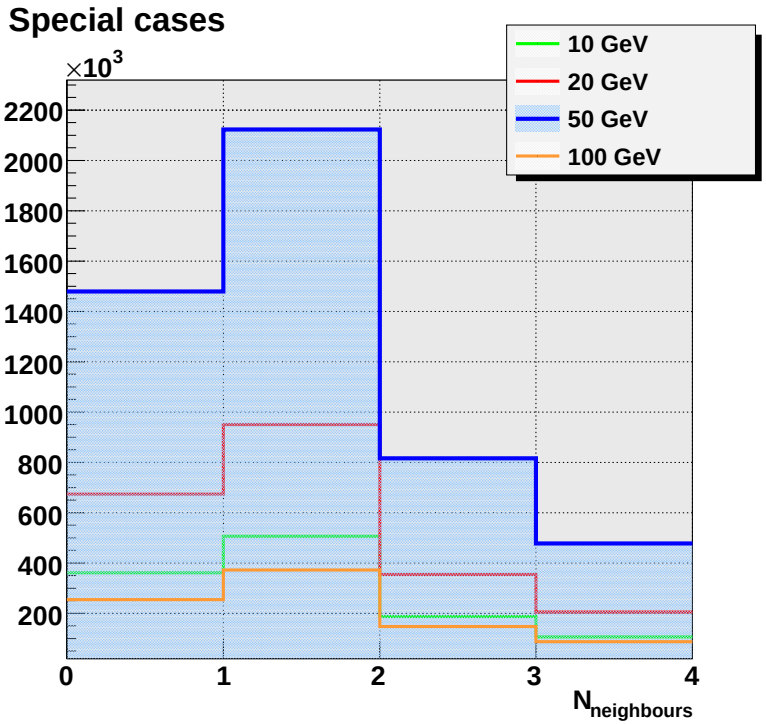
The ratio $\frac{N_m}{N_{0,1}}$ (for N_m being m neighbours) increases with energy.



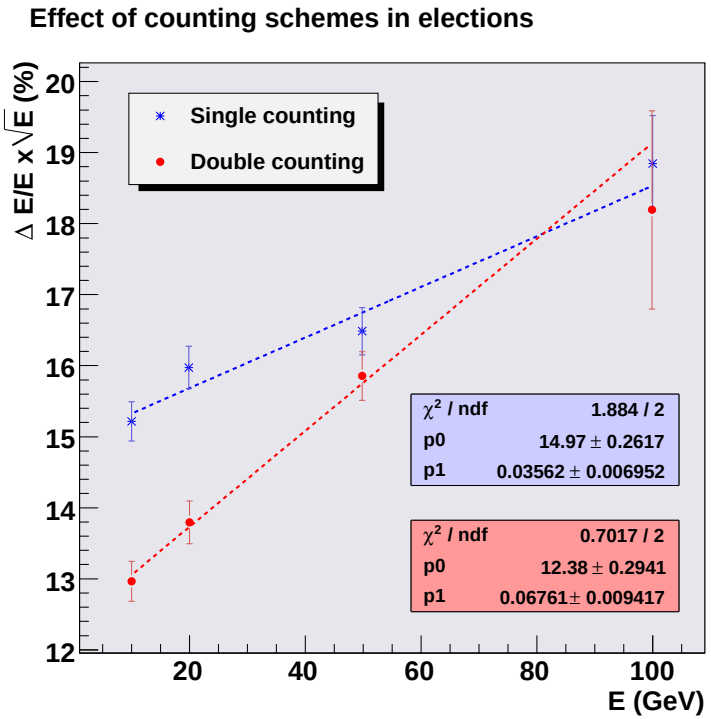
Reduces number of hits by factor of $\sim 2\frac{1}{2}$.

The Election Scheme
Results

Testing with photons



(1) There are lots of lonely hits, and discarding them gives awful energy resolution. (2) Lots of hits with one neighbour.

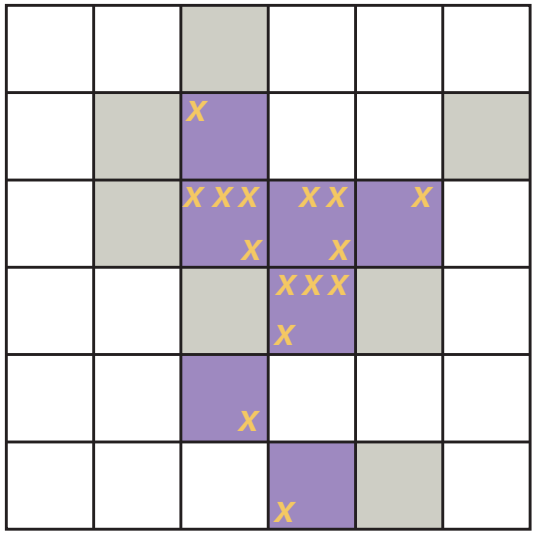


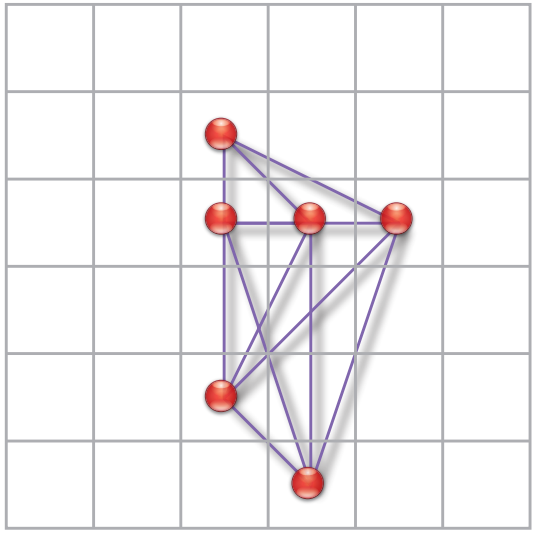
i.e. what weight do we attach to the special cases ⇒ weight of 2 is appropriate. (For reference, '3' gave poorer results than '1'.)

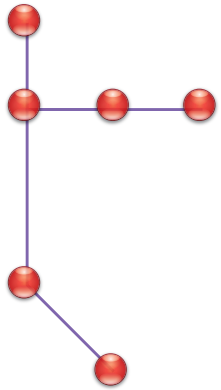
The Election Scheme

Next time...

- PA Scheme gave bad results (not presented here), but why?
- What needs to be linear?
- Start looking towards MSTs!
- Turn dead area back on: set `ActivePixelWidth = 42, GuardWidth = 6` rather than `47, 0`.







The Election Scheme

Summary

- Parameters governing elections are not critically energy dependent.
- Standard ECAL photon energy resolution ($\sigma/E \times \sqrt{E}$) at 10 GeV: 15.8% and 20 GeV: 16.3%
- Election–based MAPS ECAL: 10 GeV: 13.0% and 20 GeV: 13.8%. We're doing well!
- Constant gradient for $N_{\text{hits in}}/N_{\text{hits out}}$ bodes well for linearity and NoHarm study (needs quantification).

Now available in CVS

The Election Scheme

Parameters to be specified in `MIPFinder` steering file
Defaults are in red

- `DoMIPFinder` Specify 2 for Elections, 1 for old MIP Finder, 0 to just count hits regardless
- `PseudoAnalogue` Specify 0 for D-Scheme, 1 for PA-Scheme
- `SelfSetsThreshold` Specify 1 to enable Special Rule 1, else threshold neighbour count = 0
- `SpecialCasesWeighting` Special cases contribute this many hits/energies more than other voted for pixels. 2 is the default.

Comments are included in the 118 lines of the `MIPFinder::Election()` method.

Factors of 2

Question: Should the factor of two required for the last 10 layers of the ECAL be included in the output of the digitisation?

The “No Harm” idea

Just count hits in virtual 1 cm^2 cells

- check we do no harm by applying MAPS: sum hits in virtual 1 cm^2 cells, and apply a factor to convert from the number of hits to MIPs or GeV
- takes output from Election MIPFinder and digitisation
- turn off noise, no dead area for now

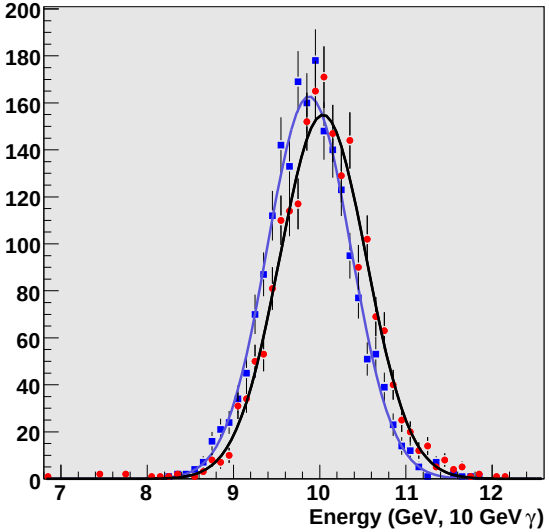
Update Since our last meeting, I’ve removed some bugs :-) (Also using Election MIP Finder now)

CALICE Calorimeter for ILC

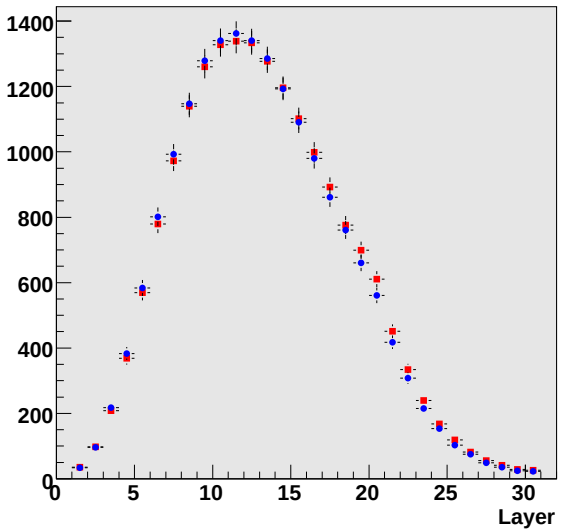
10 GeV and 20 GeV γ

NoHarm compared with Standard concept

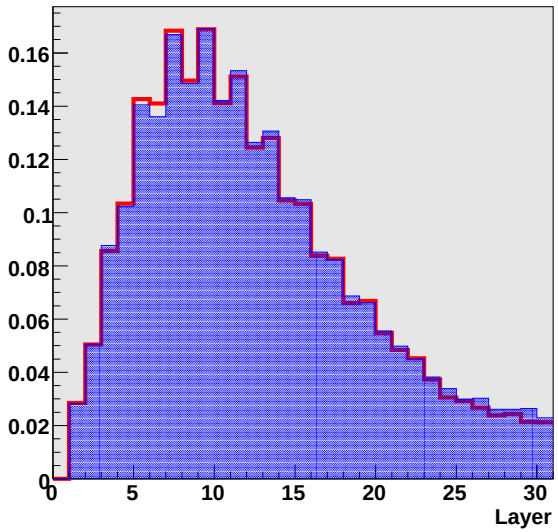
Summed calorimeter hit energies



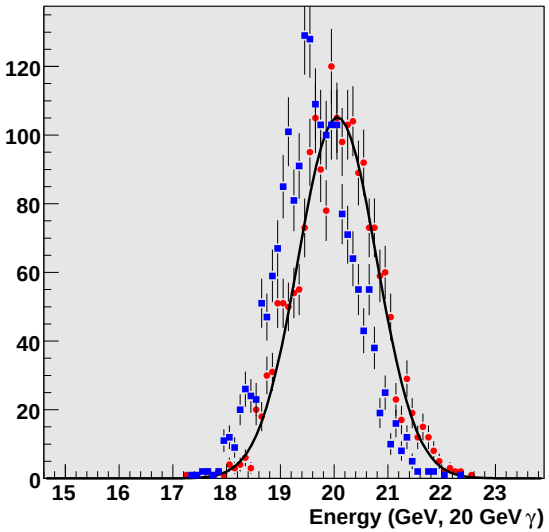
Energy by layer, 2000 events, 10 GeV γ



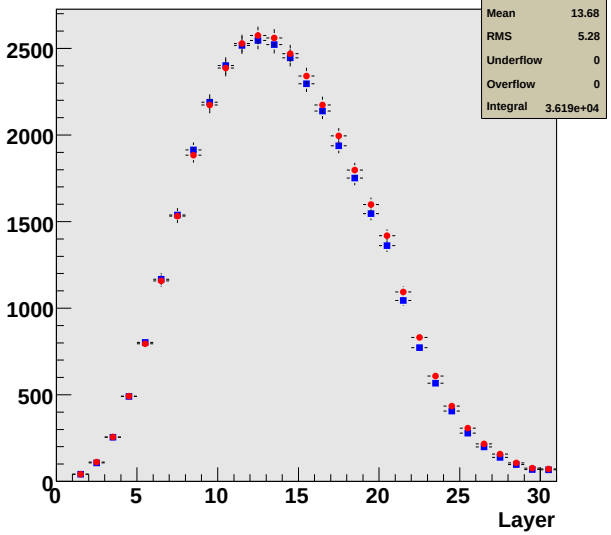
RMS of energy by layer, 2000 events, 10 GeV γ



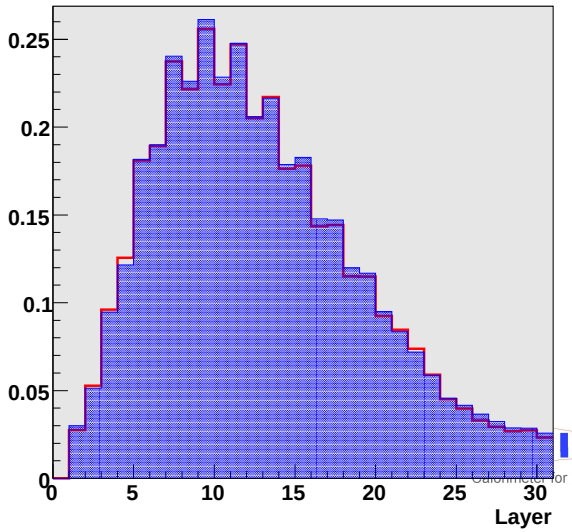
Sum of digitised energies



Energy by layer, 2000 events, 20 GeV γ

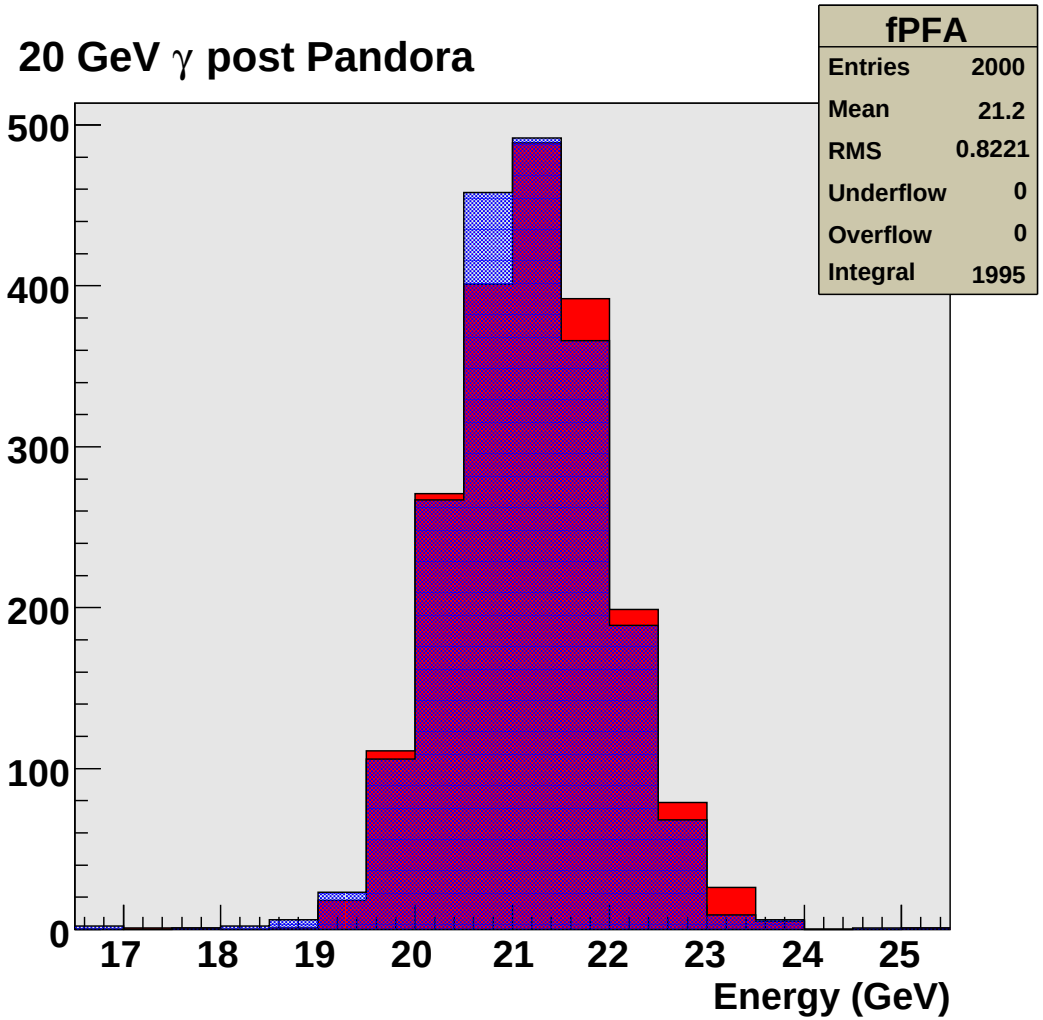


RMS of energy by layer, 2000 events, 20 GeV γ



Photons in Pandora

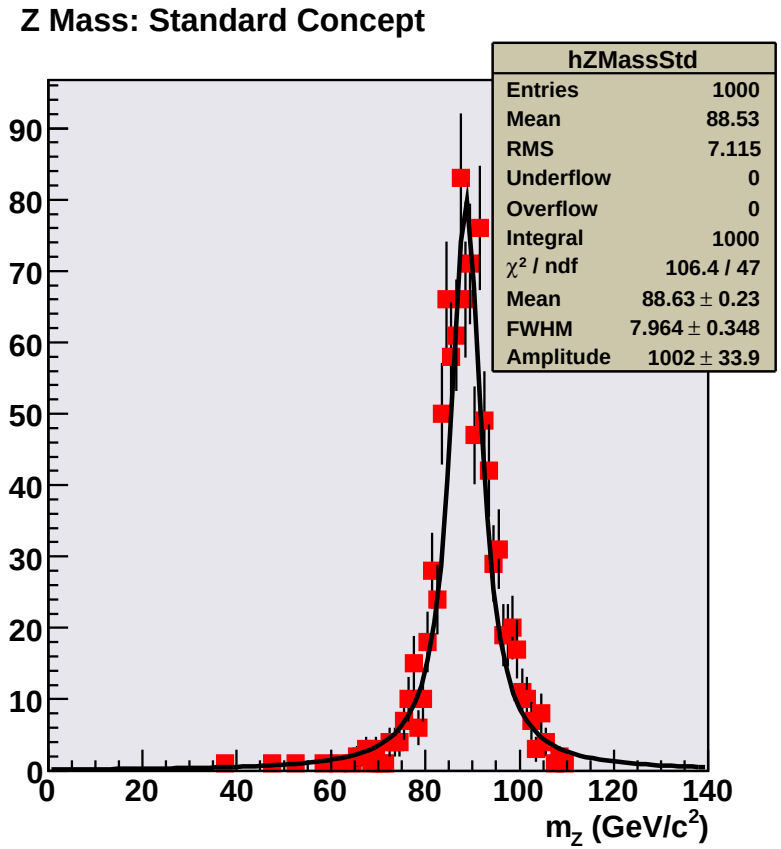
Unlike last time, Standard and No Harm case agree:

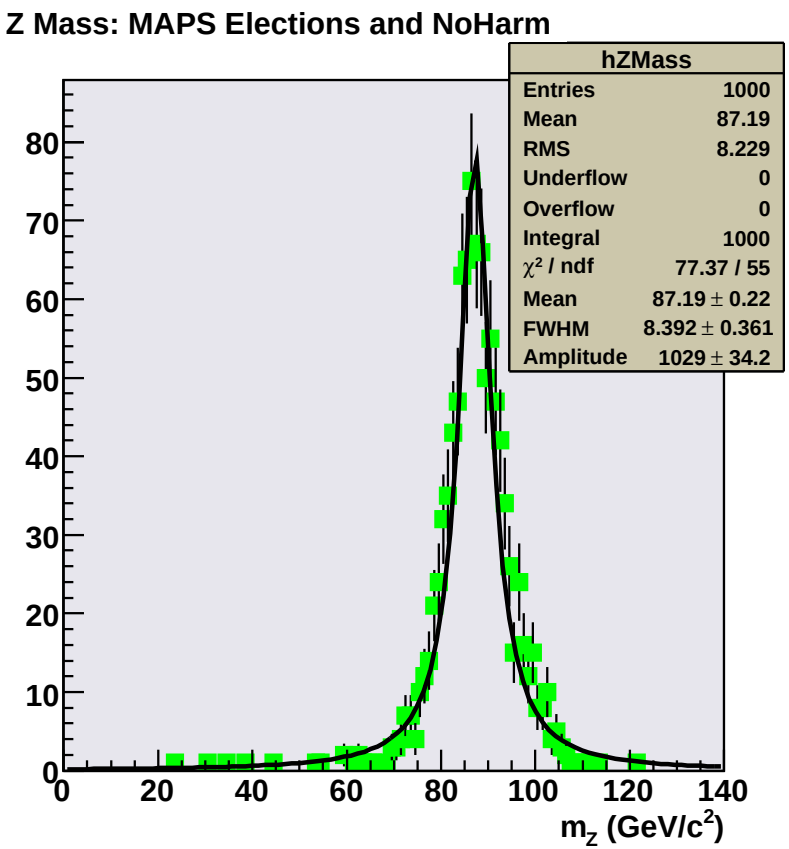


Also happy for 10 and 50 GeV photons.

Z Pole in Pandora

$Z \rightarrow uds$; same calibrations for both ECALs





Compatible! Next step: more statistics. . .