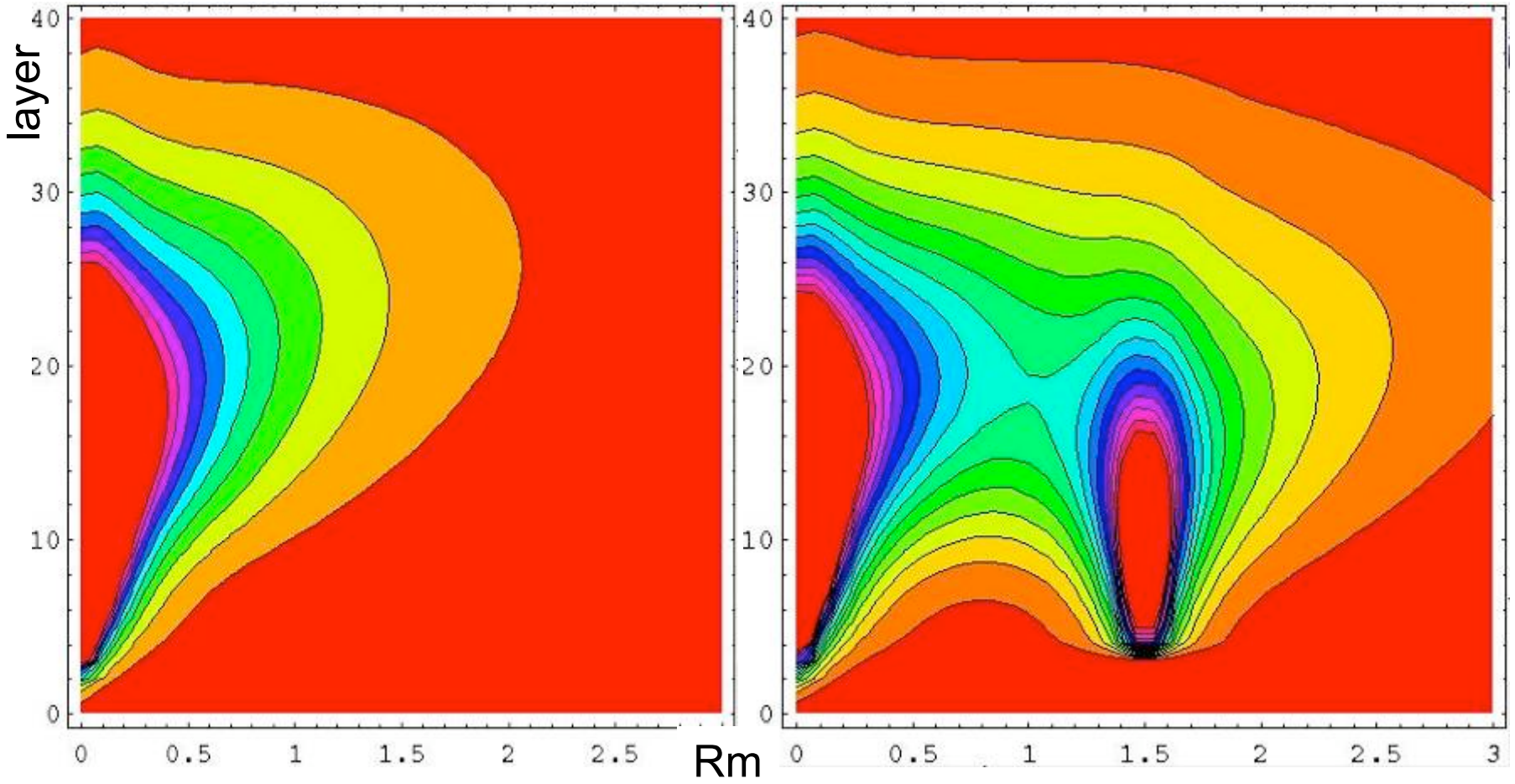
Photon (Re)Construction Kit

3D photon shower profile



Integral over the ring with dr=cell size (10mm) for photon shower profile , left single 10GeV photon, right 10GeV and 4GeV photon

• Idea – have same procedure for reconstruction of photons in single and multiple photon cases

• Based on 3D shower model and imaging calorimeter

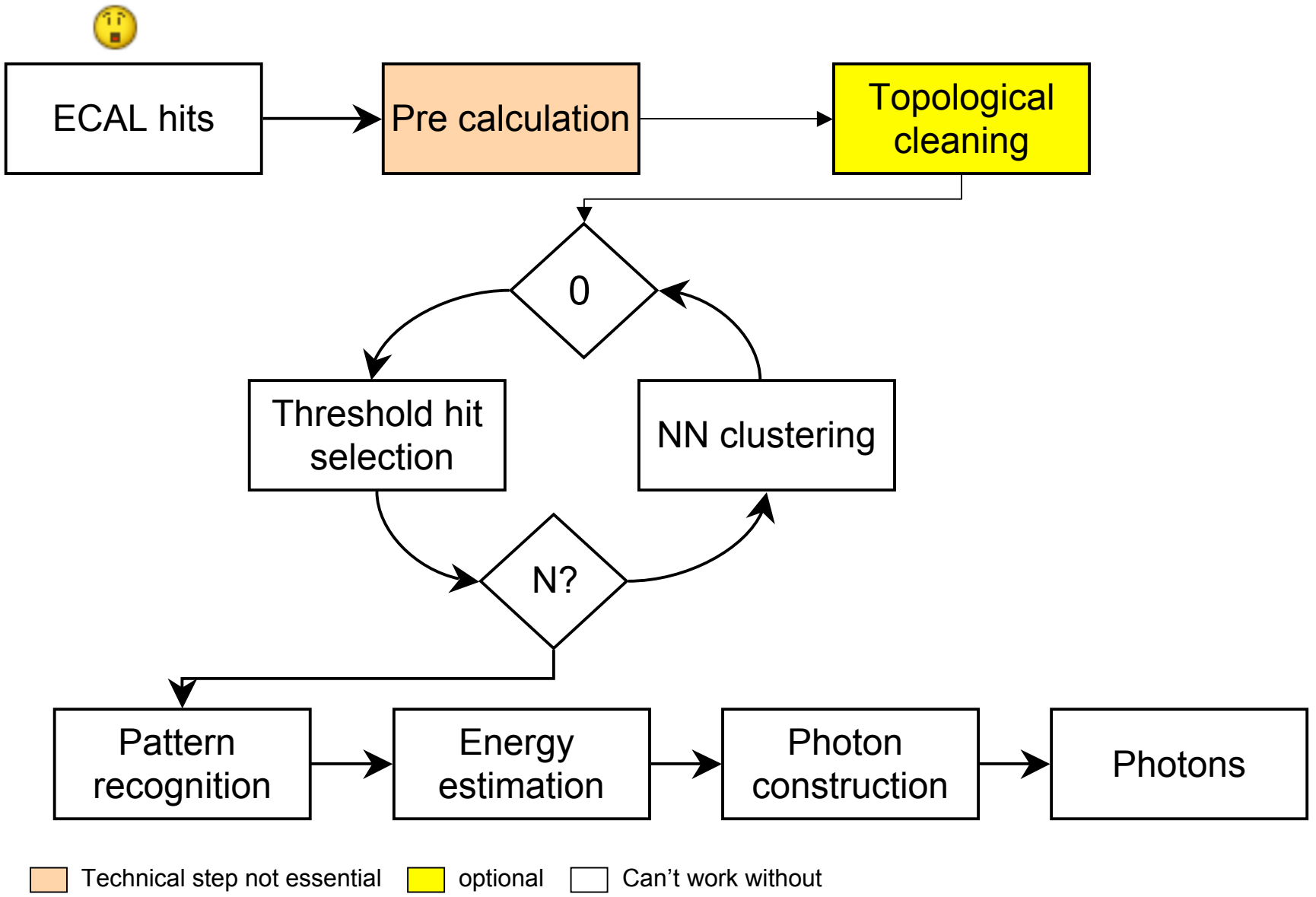
• Inverse engineering – from pattern extract parameters to construct a “photon” model

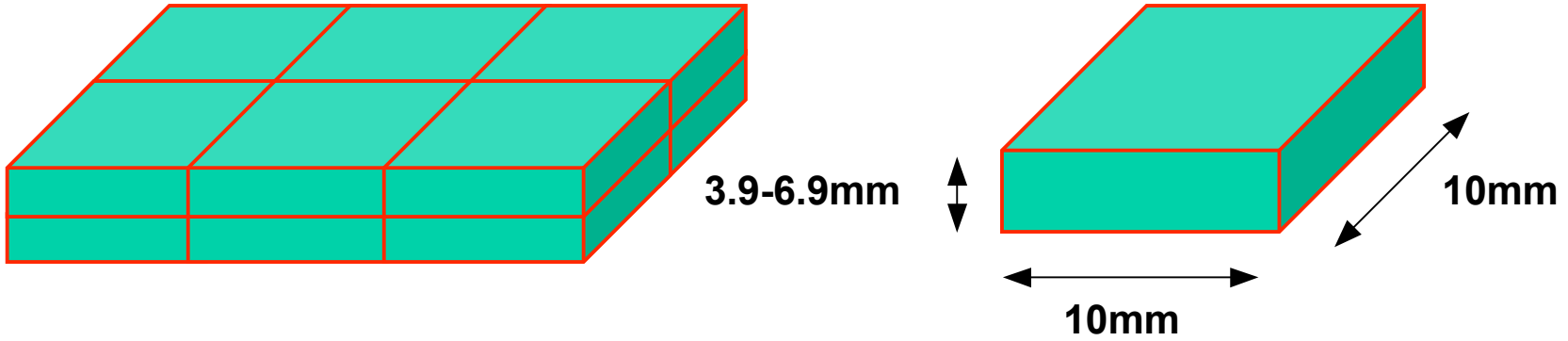
• Fly through the algorithm

• Some results - a bit for anyone taste

• How to use and where to find

• CCC (conclusion , congratulations and complains)

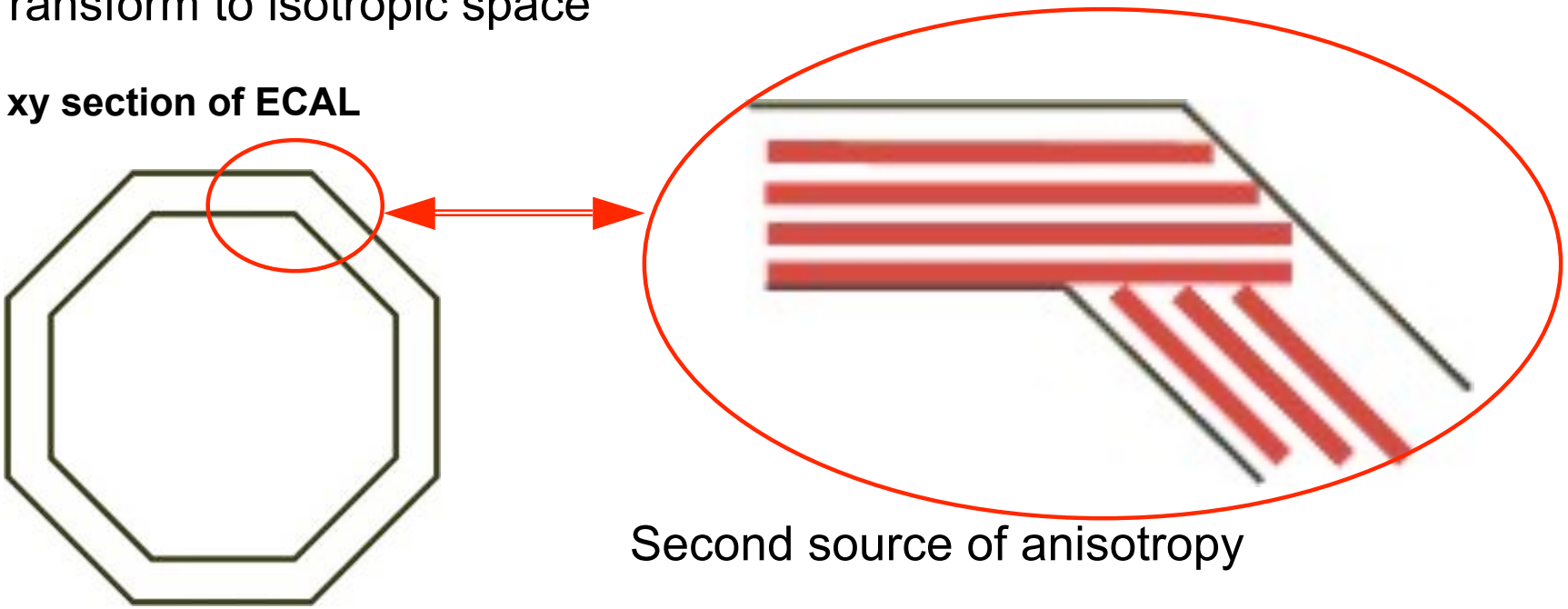

ECAL hits
Pre calculation
Topological cleaning
0
Threshold hit selection
NN clustering
N?
Pattern recognition
Energy estimation
Photon construction
Photons
Technical step not essential
optional
Can't work without



Isotropic in ijk non isotropic xyz

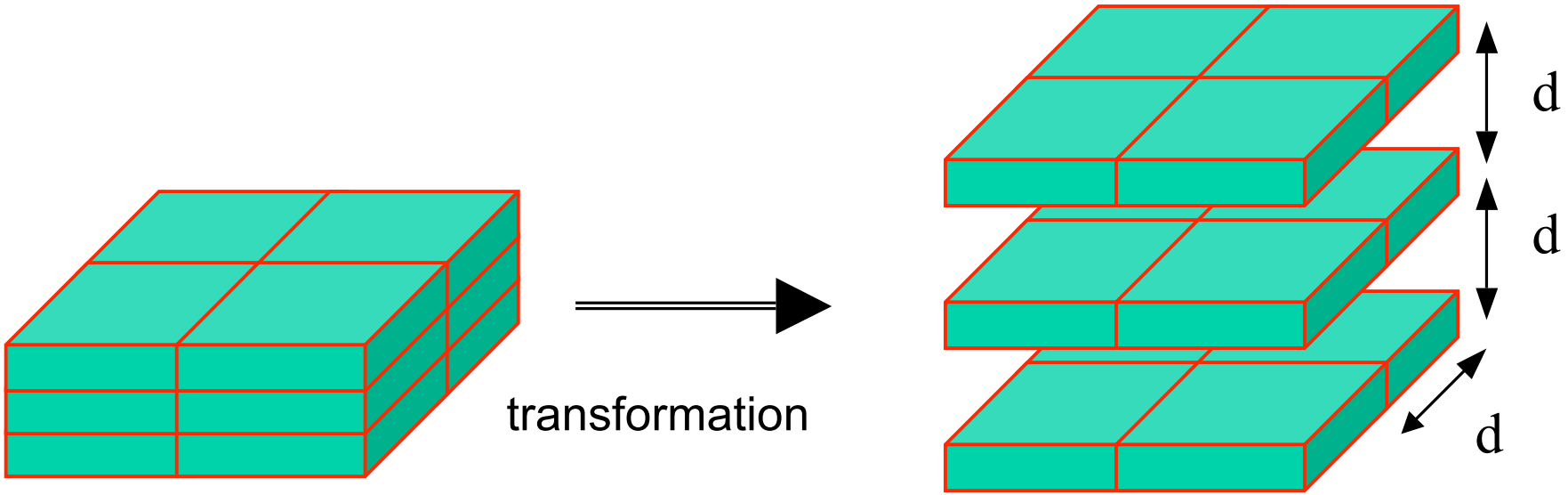
Since there is no geometry package to have a Nearest Neighbor (NN) in ijk we Transform to isotropic space

xy section of ECAL



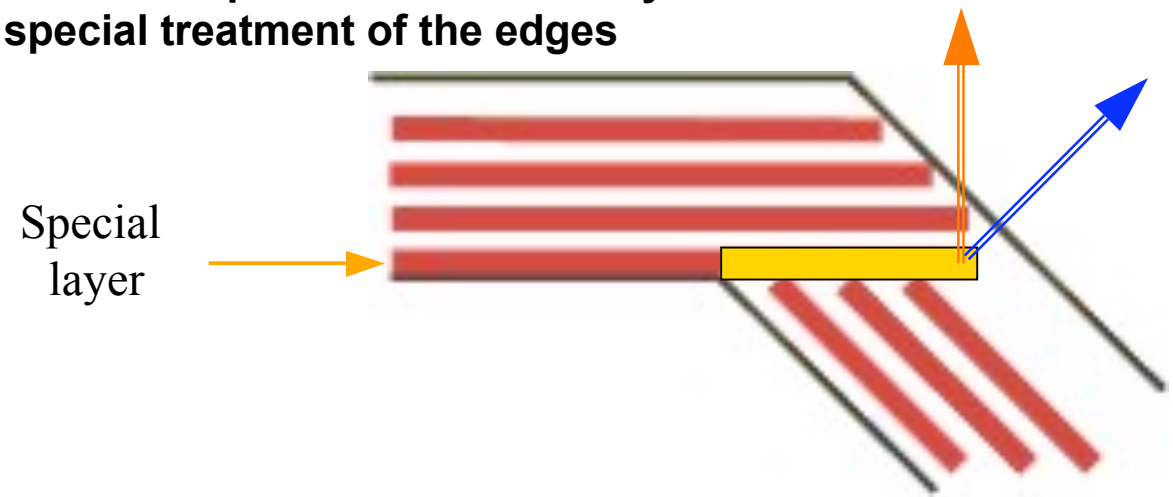
Second source of anisotropy

Cell size distance between layers

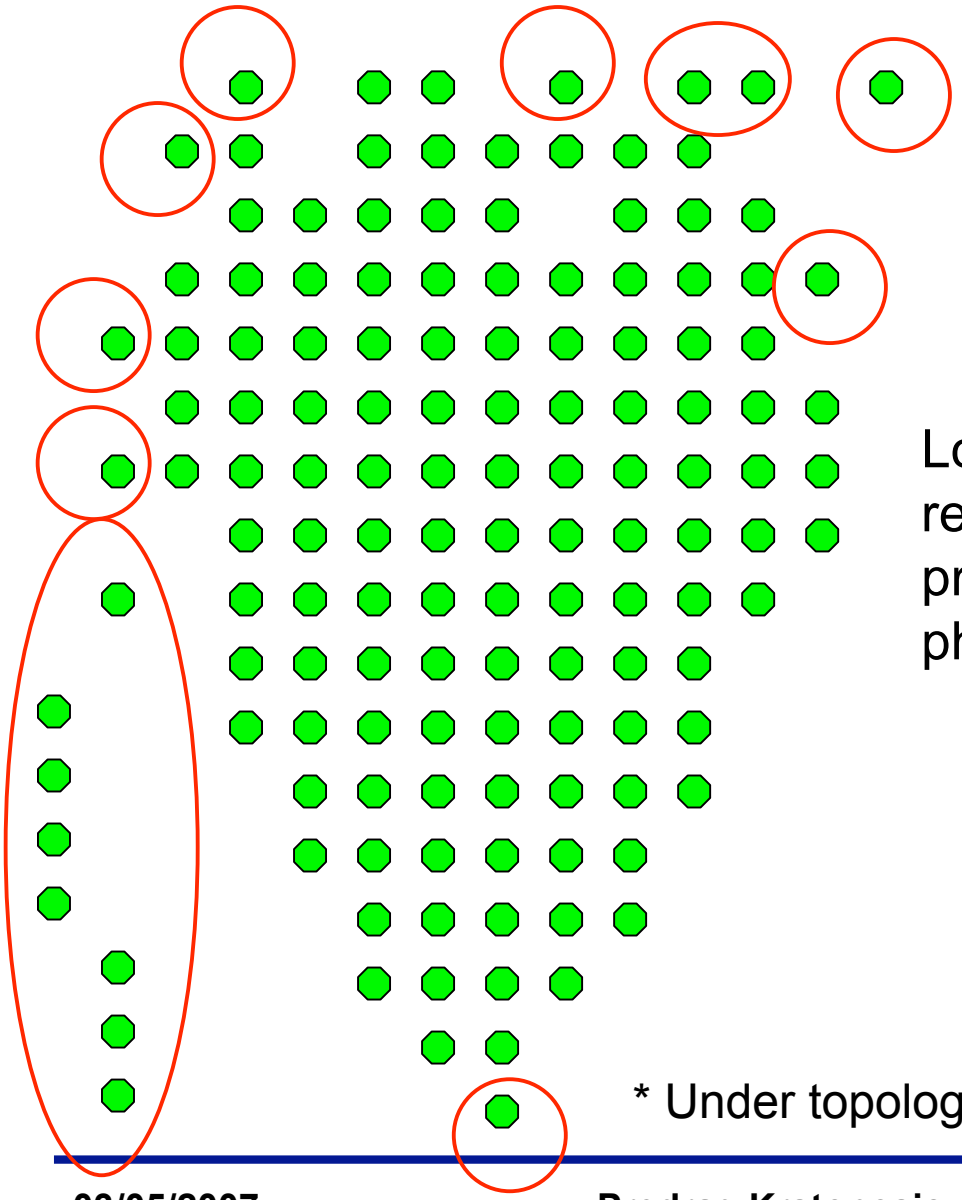


transformation

In order to preserve connectivity special treatment of the edges



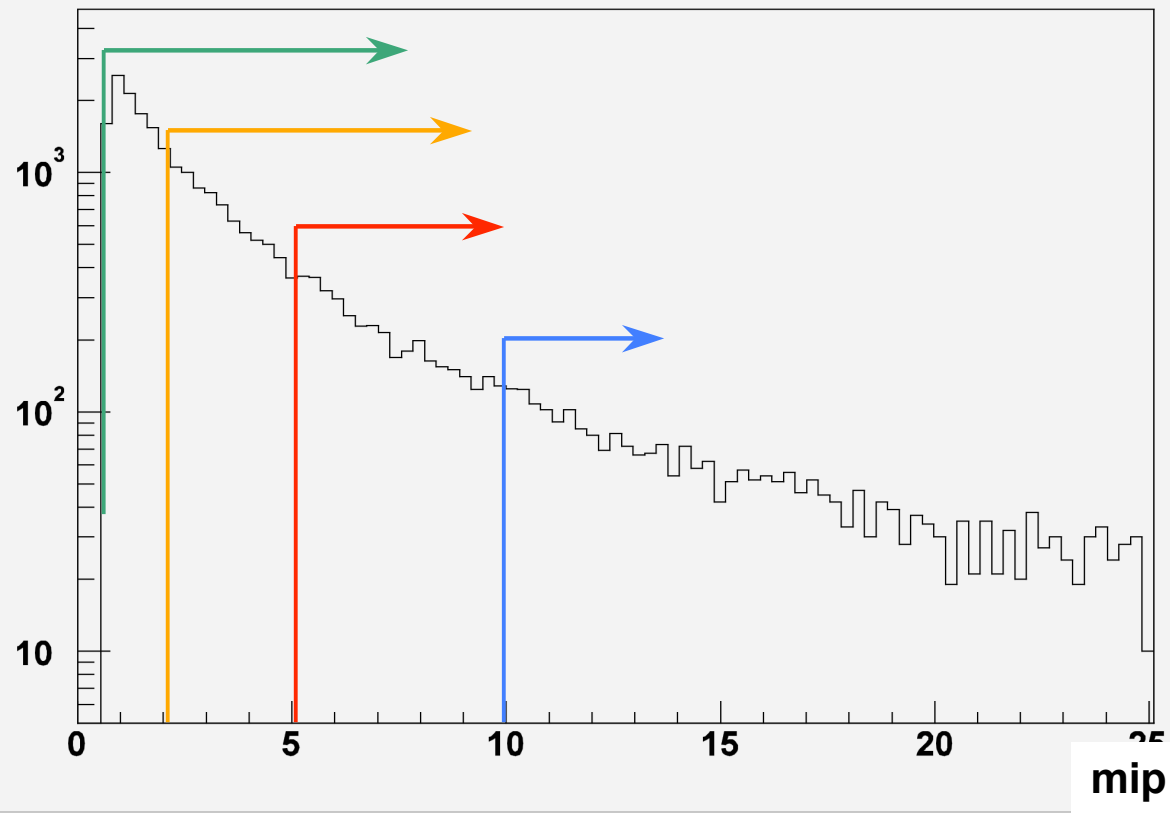
At the end we have a collection of hits in Isotropic space



Hits are divided
Into two classes
$N_{neighbors} <= X$
and $N_{neighbors} > X$
(at the moment X=4)

Low topology* hits are then removed from further steps of procedure till the final one photon construction

* Under topology one means number of neighbors

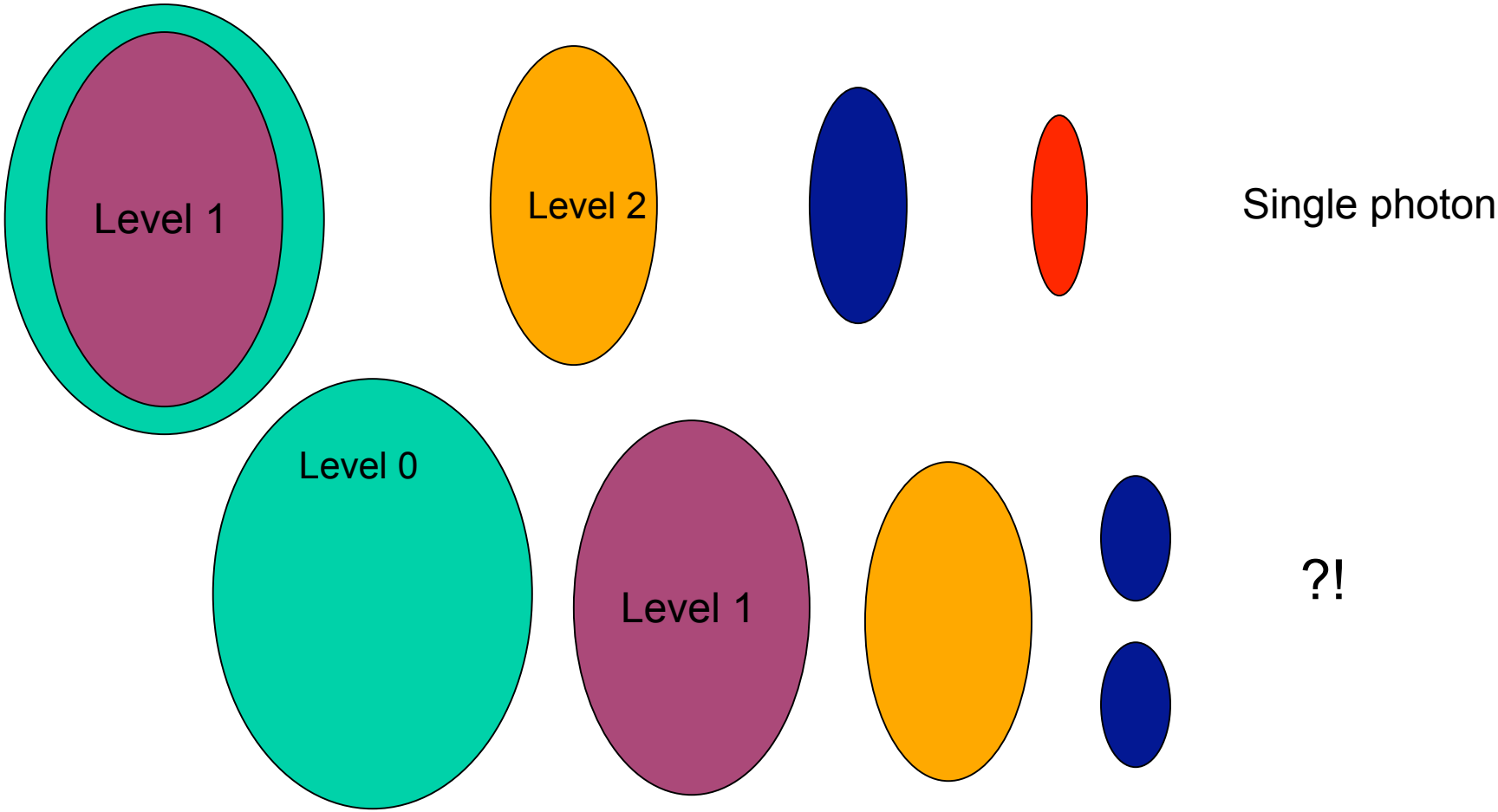


Choose
N thresholds
(N=10 at the moment)
and get N sets of hits

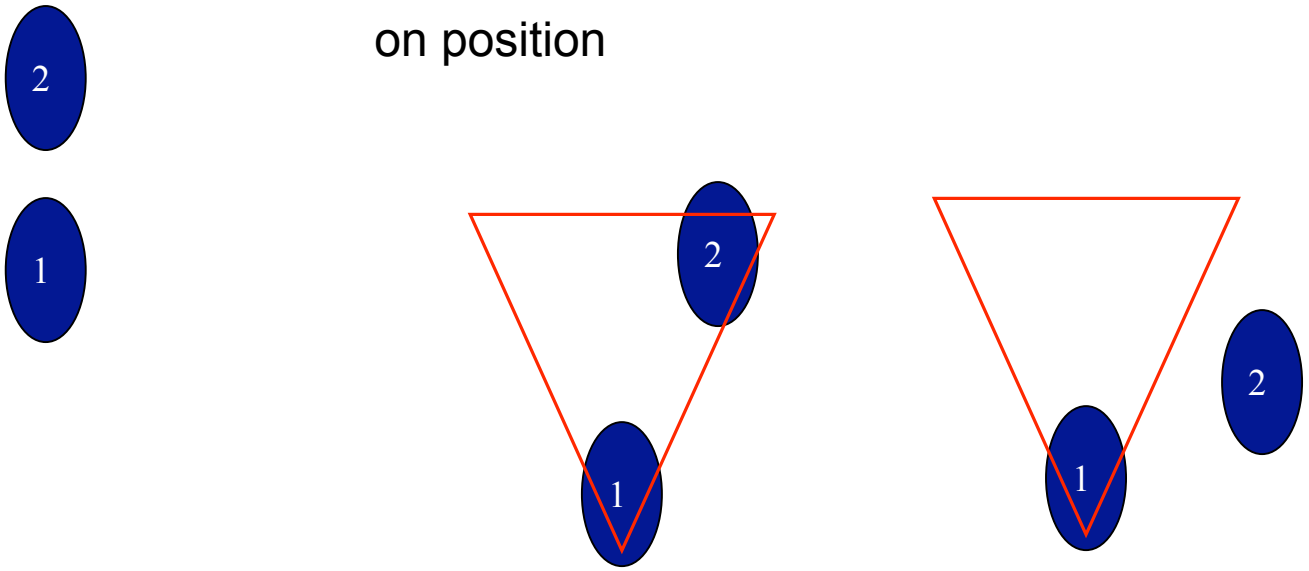
For each set do a
NN clustering
Only in particular
set!!

- Exponential distribution of the energy in hits
- don't' forget that full energy range of the photons is from detection threshold till CMS Energy/2.0

At this stage you have set of NN clusters for different thresholds
What would one expect in case of no fluctuation



Decision when to split
on size
on position

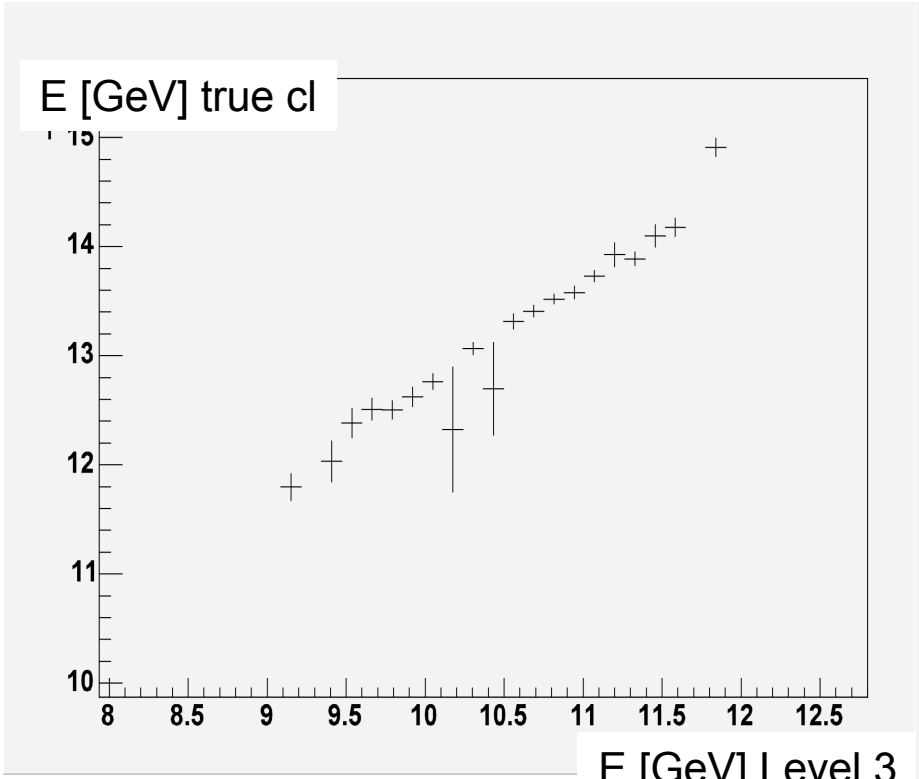


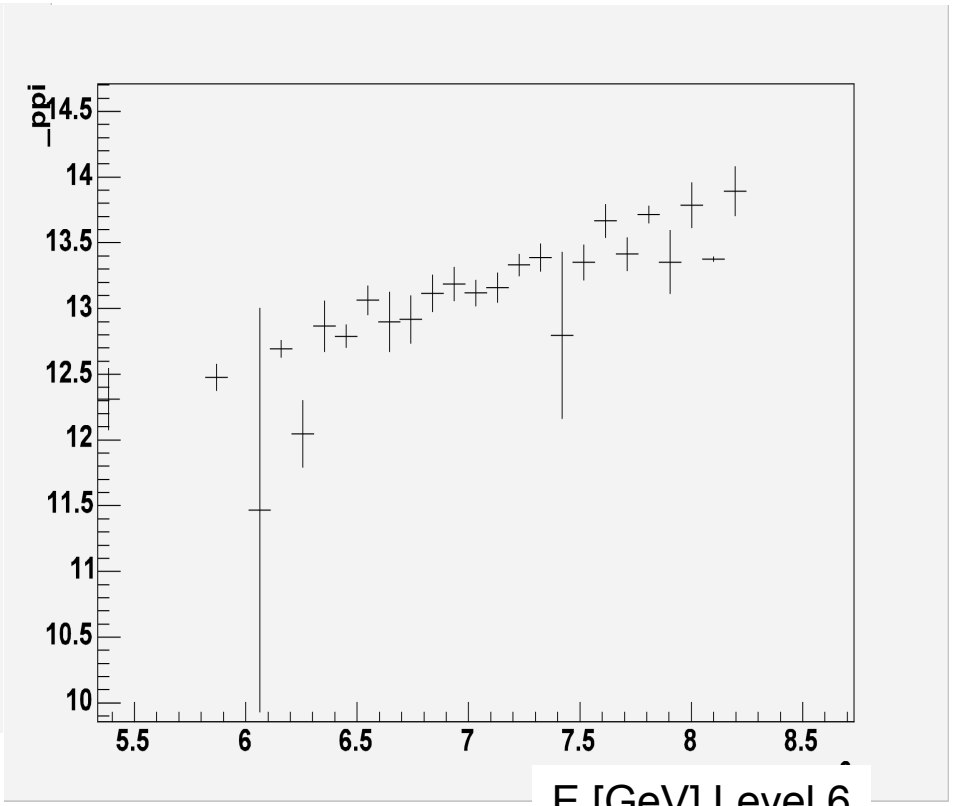
No split Split

“Split” means that each of the clusters is now considered as a photon core

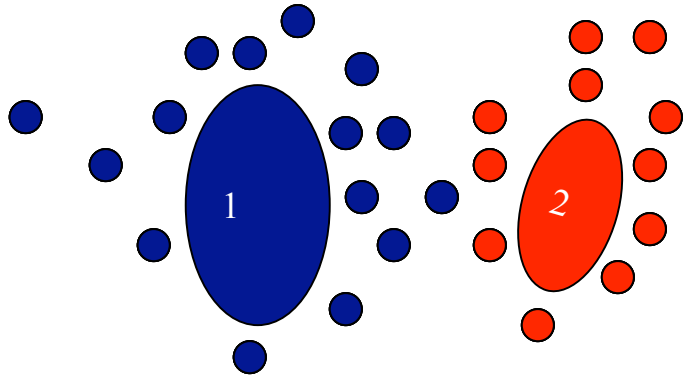
At the end of procedure we have a set of clusters with their level that are considered core candidates

• Energy estimation in terms of algorithm means procedure to get an estimate of incoming photon energy based on the core energy and the cluster level
•linear parameterization was chosen as appropriate





• At this stage you have a set of Energies, directions and starting points
• now it's possible to apply full 3D model for the photon
• now the we take into account all the hits !! (irrespective of number of neighbors)
• material parameters for the model must be provided from geometry package



• spread the probabilities for first

• spread the probabilities for second

• if more then one contribution in hit pick the larger one

• now assign

Event generation and selection

Model - LDC00_02ScP – same as one from the central database if you exchange vtx to cylindrical one.

Generation - single photons - particle gun - uniform smearing over theta phi

List - QGSP

Event selection – to suppress events with conversion in any part of detector before calorimeter only events with photon ending in ECAL are considered

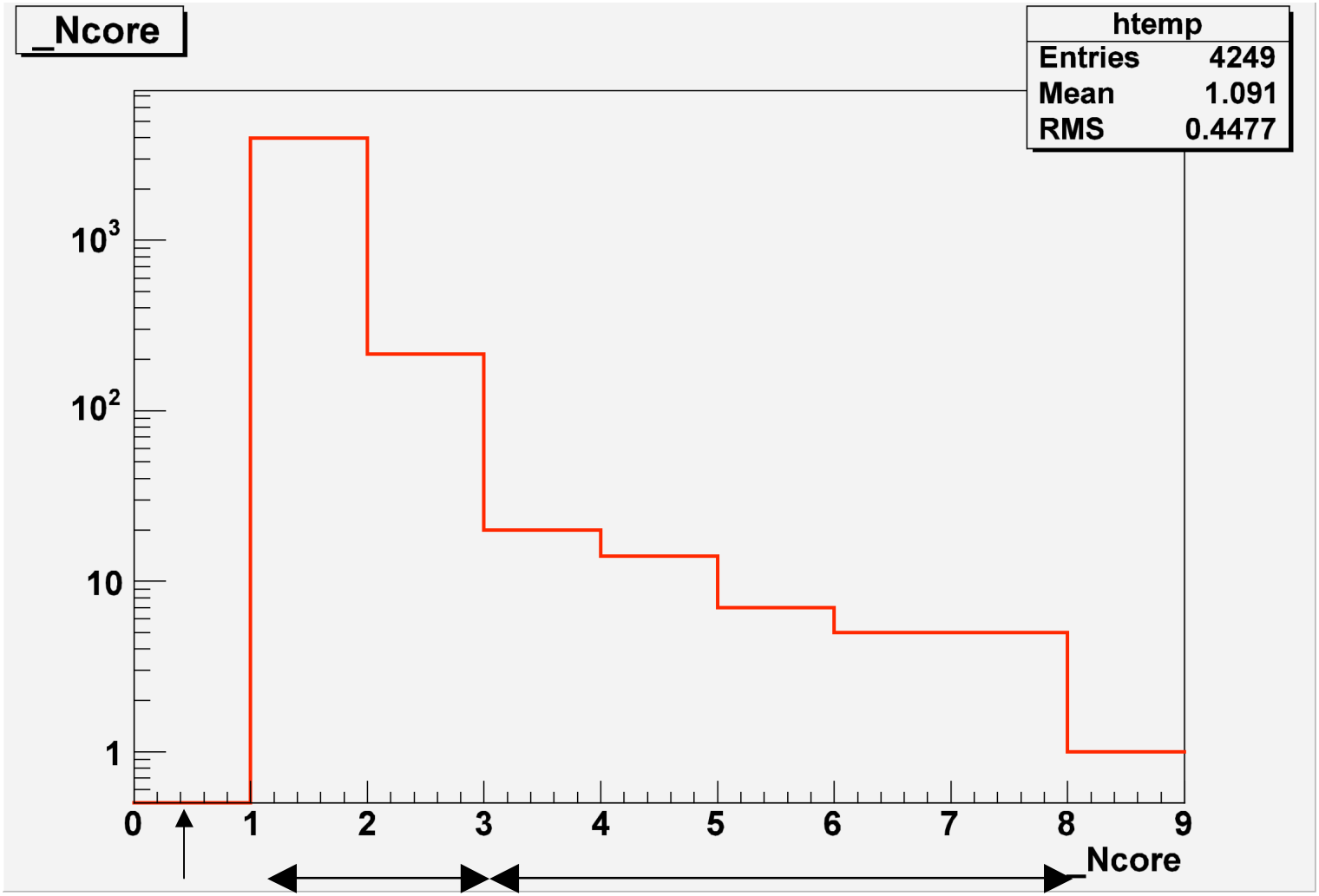
5000 events at 1,3,5,9 and 16GeV = 4200 left !!! Please no more material !*

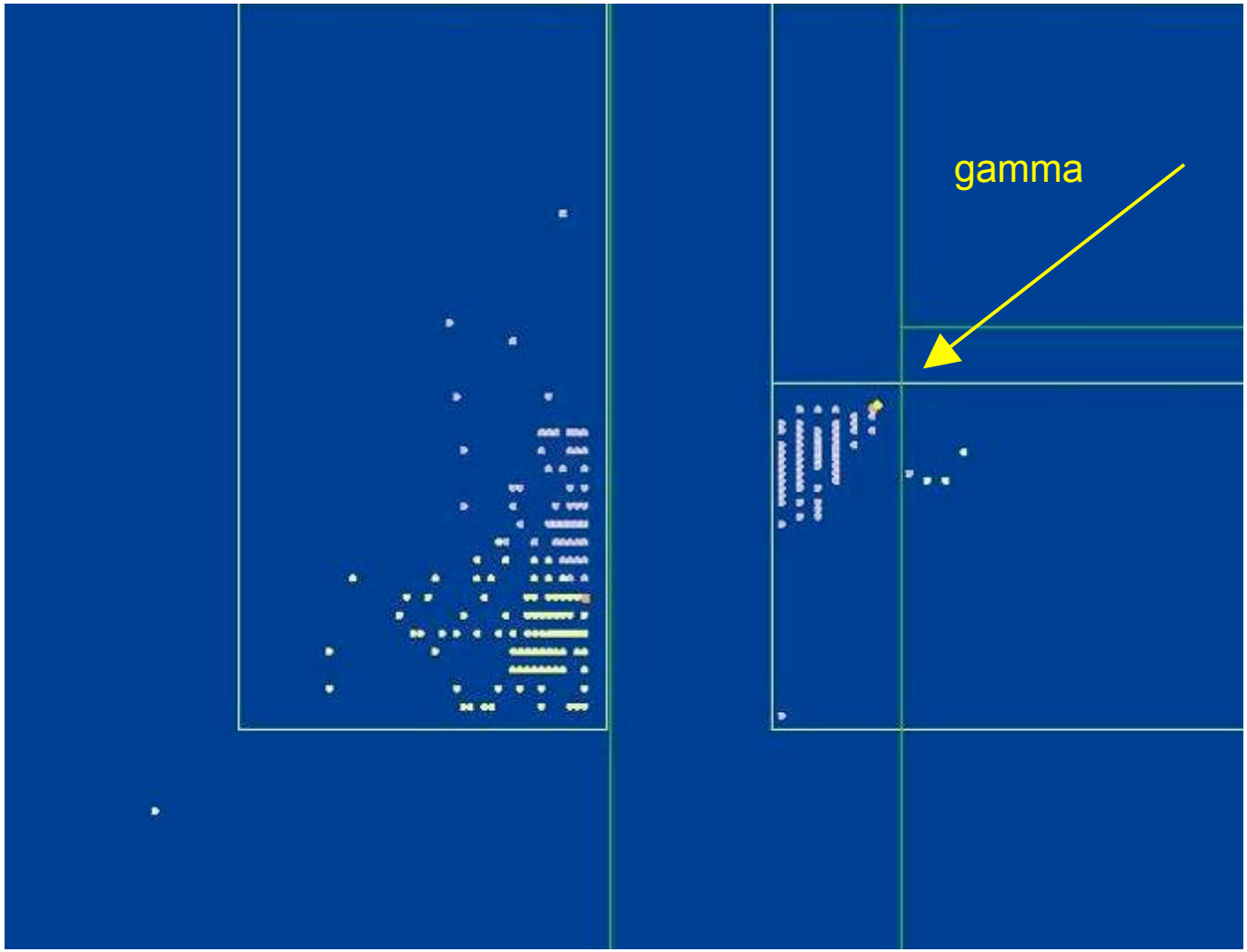
3 step procedure

find cores =>	Ncore	=>	x	=> photons	=>	x
	Ncore	=>	fake suppression	=> photons	=>	x
	Ncore	=>	fake suppression	=> photons	=>	quality check

* For SILC only ☺

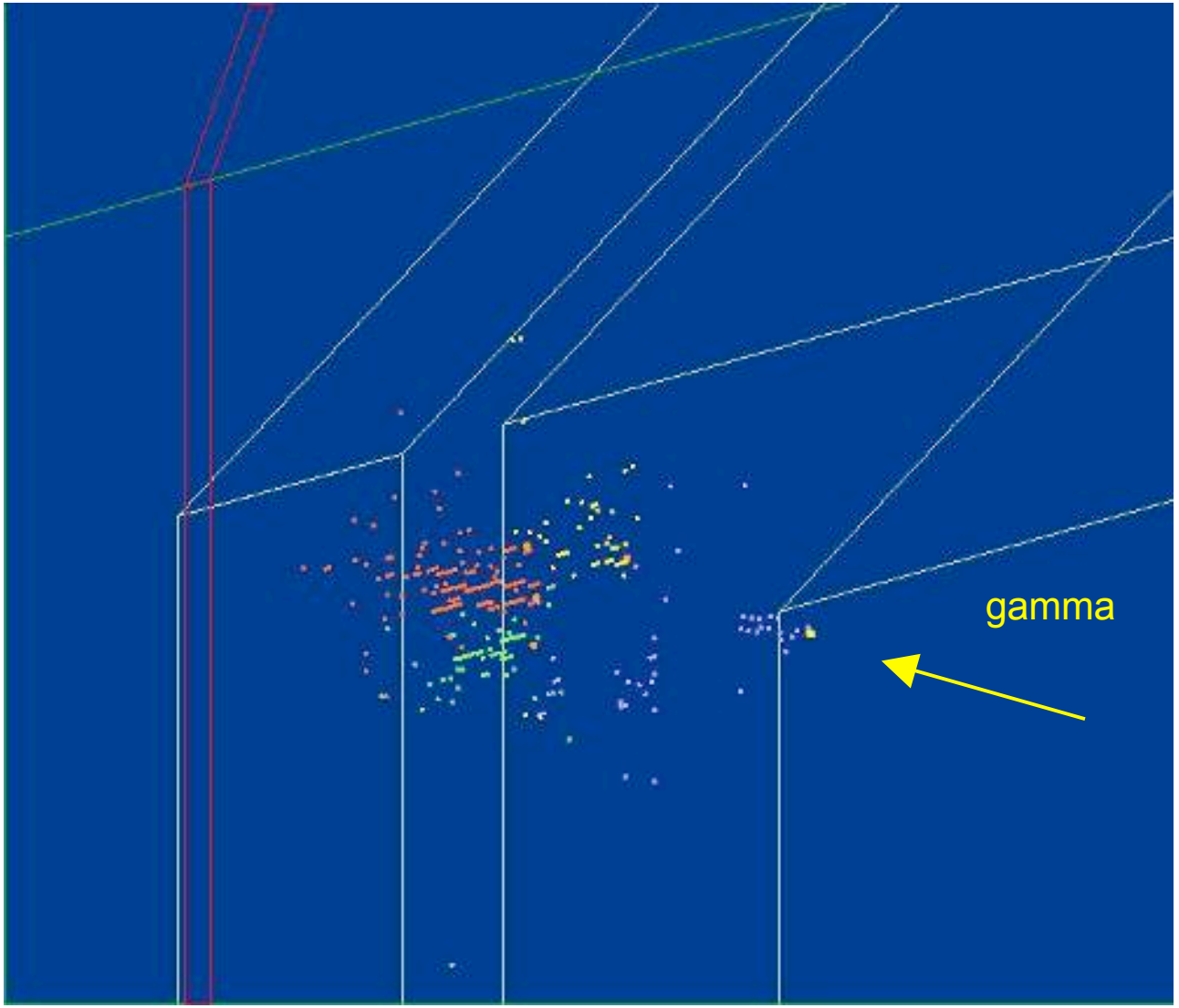
User task!


_Ncore
htemp
Entries 4249
Mean 1.091
RMS 0.4477
10^3
10^2
10
1
0 1 2 3 4 5 6 7 8 9
Ncore
Pure inefficiency
normal
corner



Corner 1

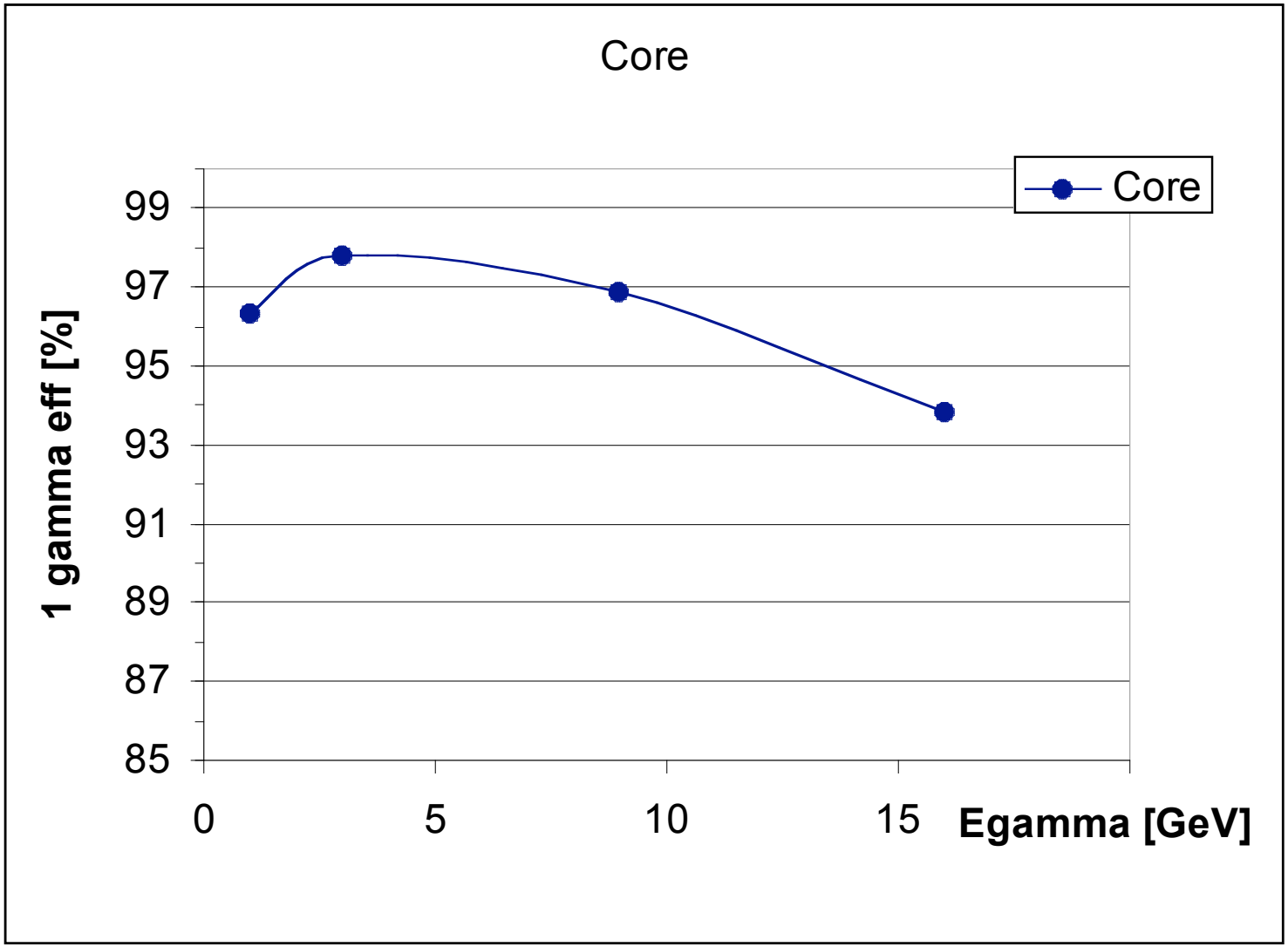
1 to 2



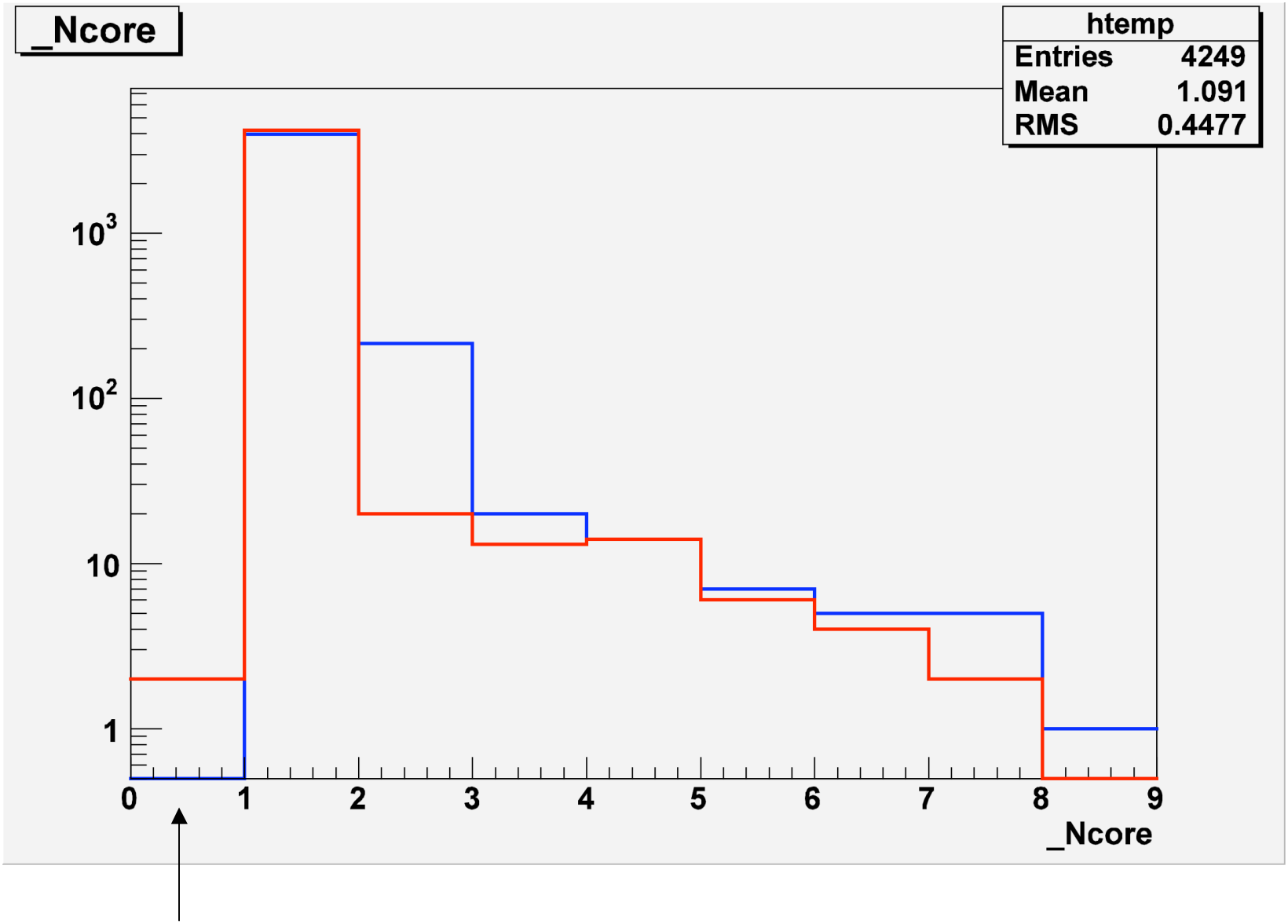
Corner 2

1 to 4

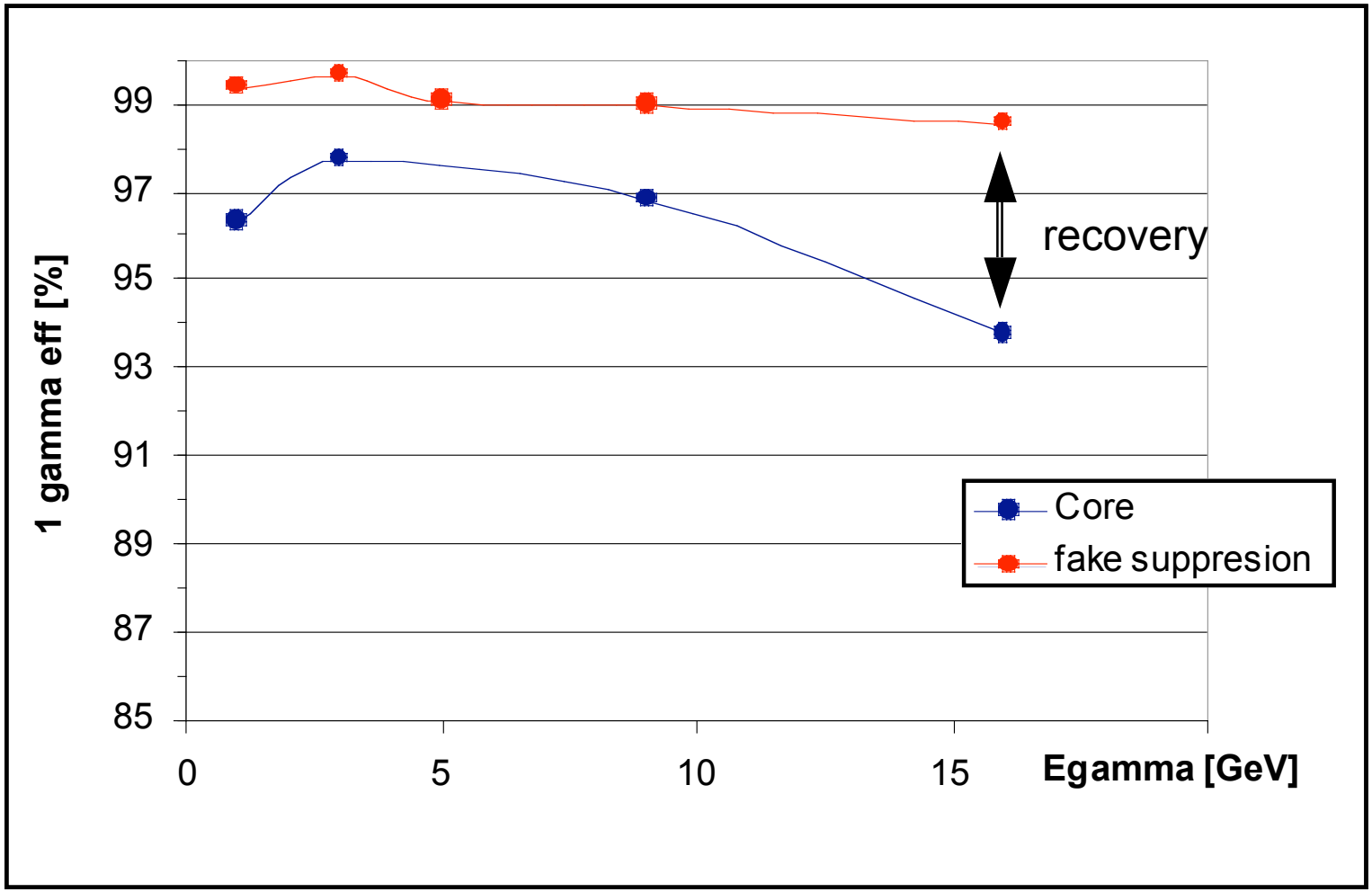
You need a special procedure for corner !!



Efficiency to get 1 back if you “shoot” one in

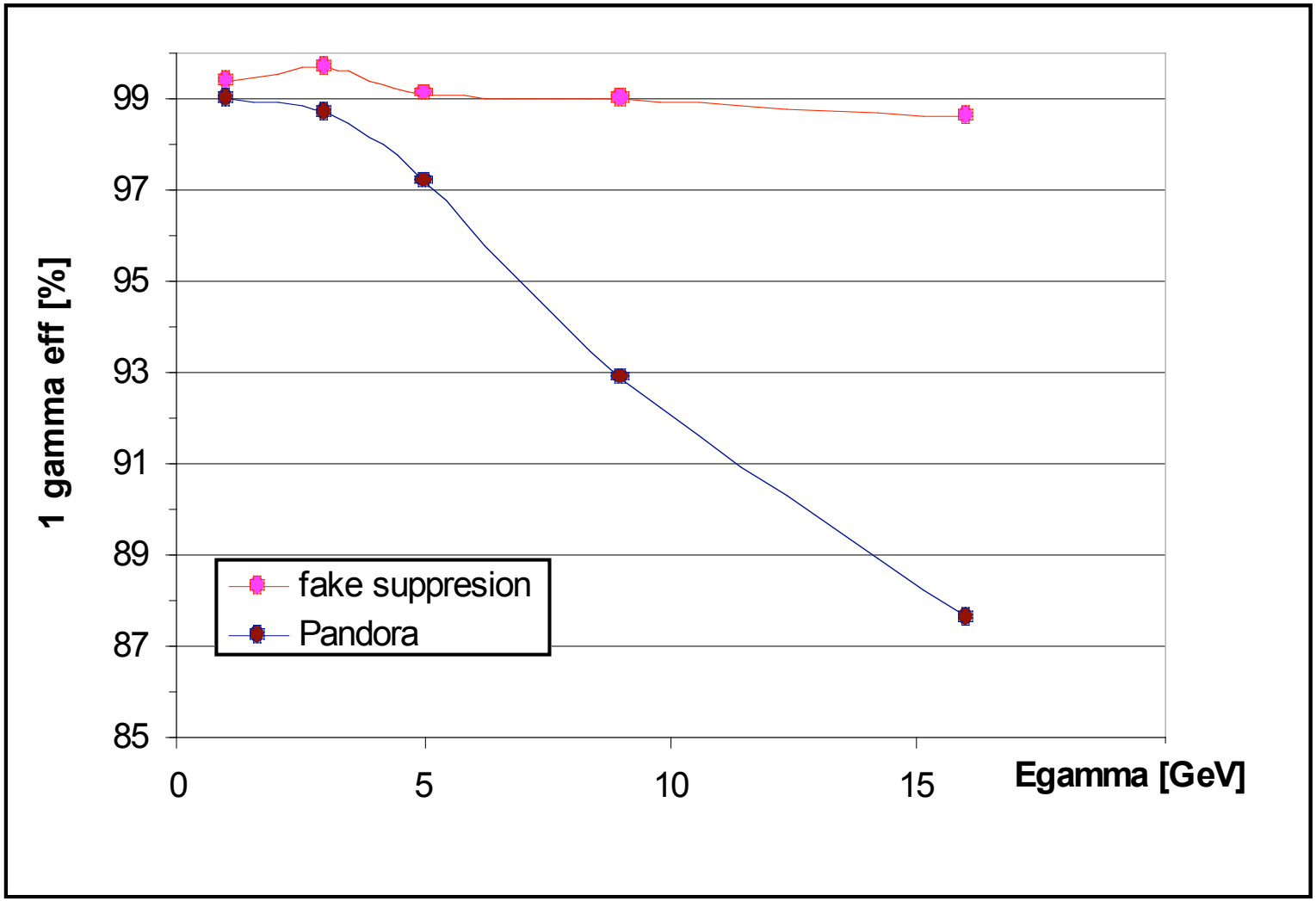


* Problem with calibration function => returned 0 This is a bug not a feature !

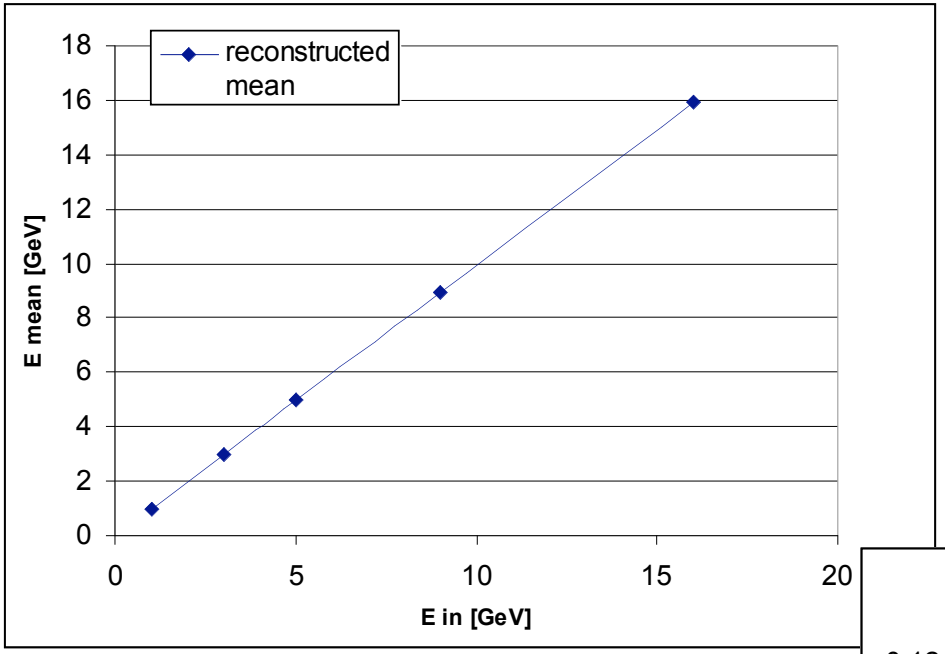


First guess fake suppression recovers most of the fakes

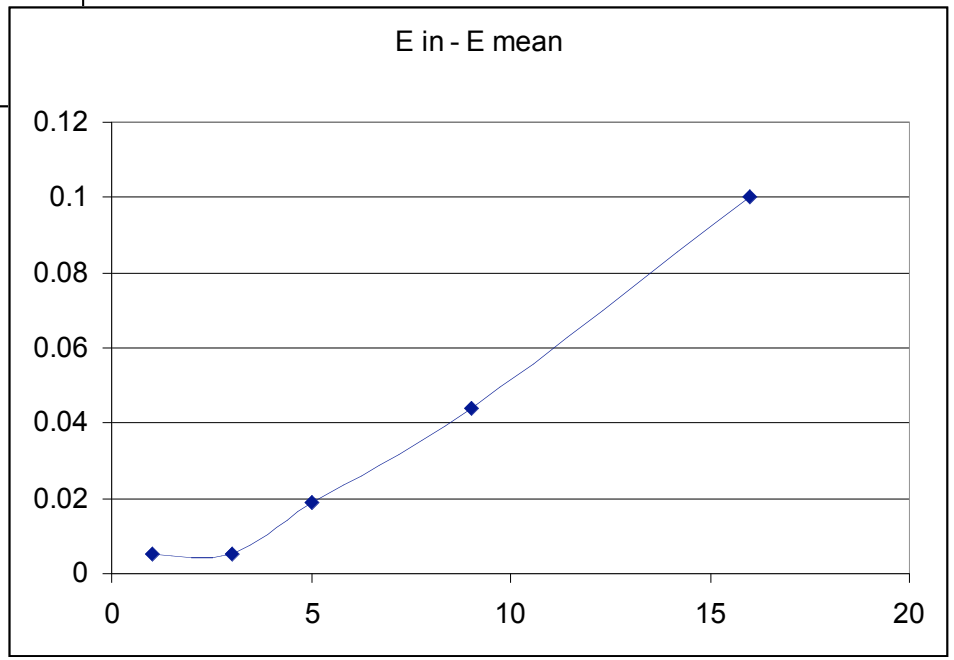
* 5GeV point on the core curve is missing due to the fingers faster then the brain i.e. file was deleted by mistake

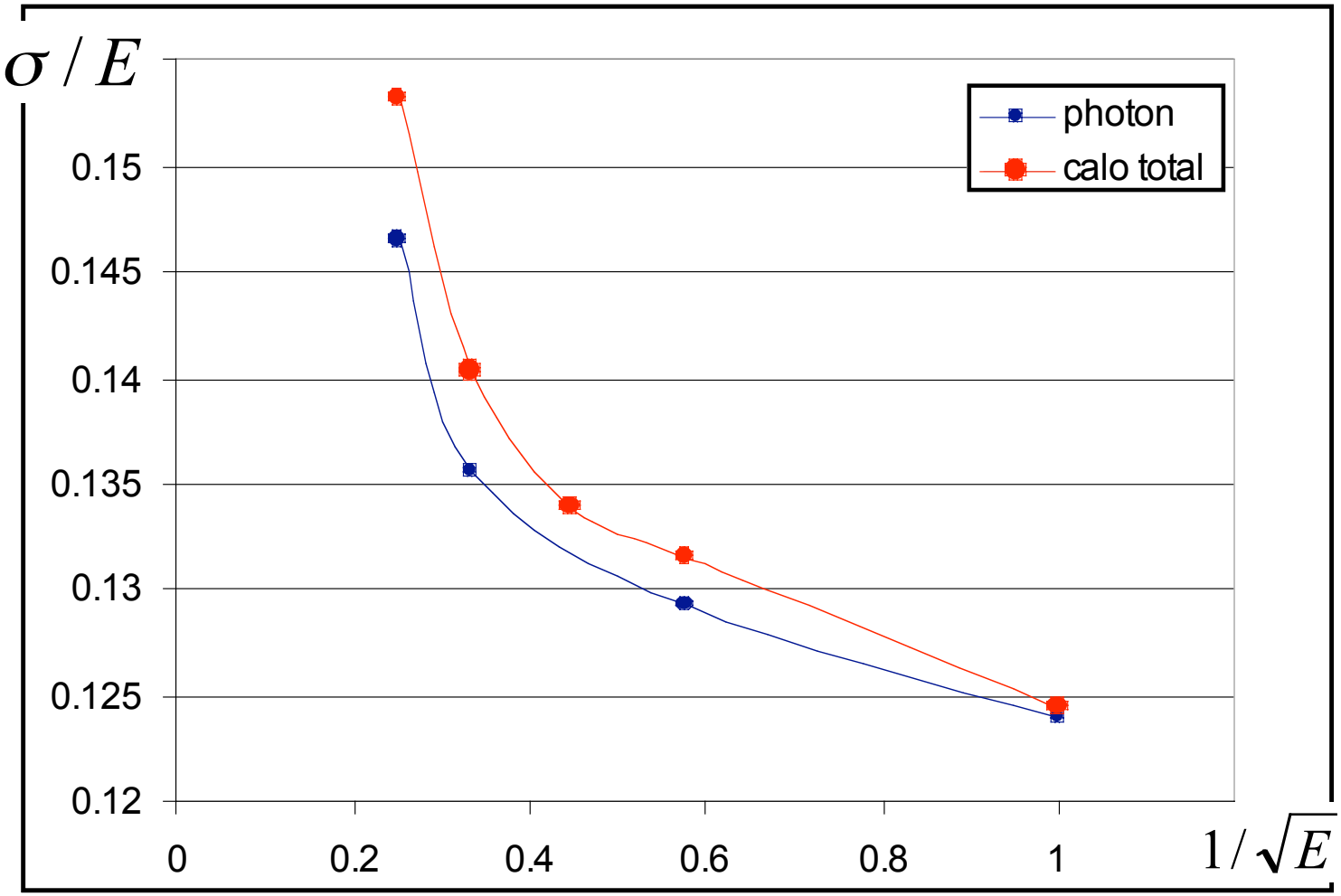


Comparison with Pandora

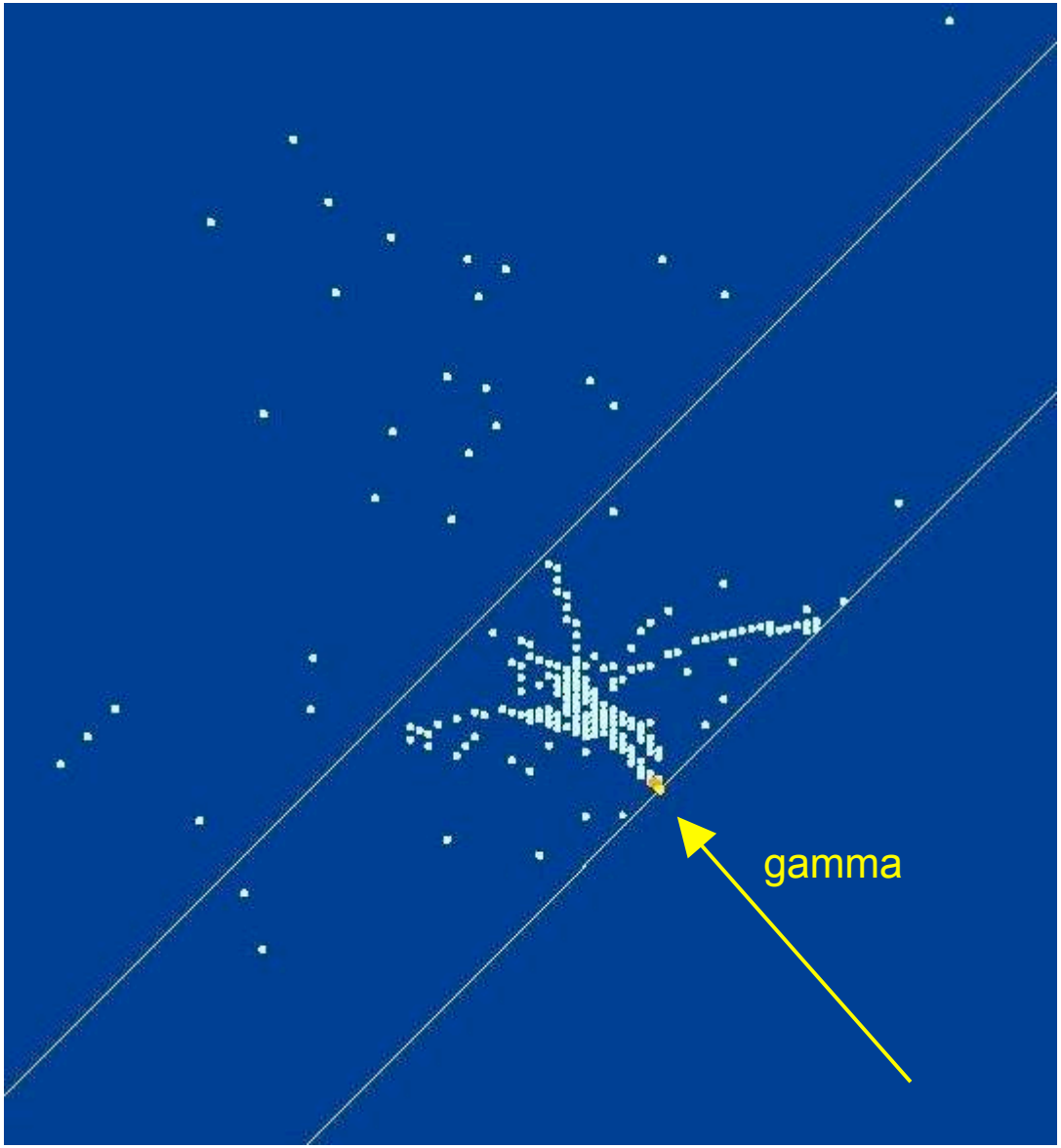


Linearity – good





Yes there is longitudinal leak to the HCAL since this part was not treated !

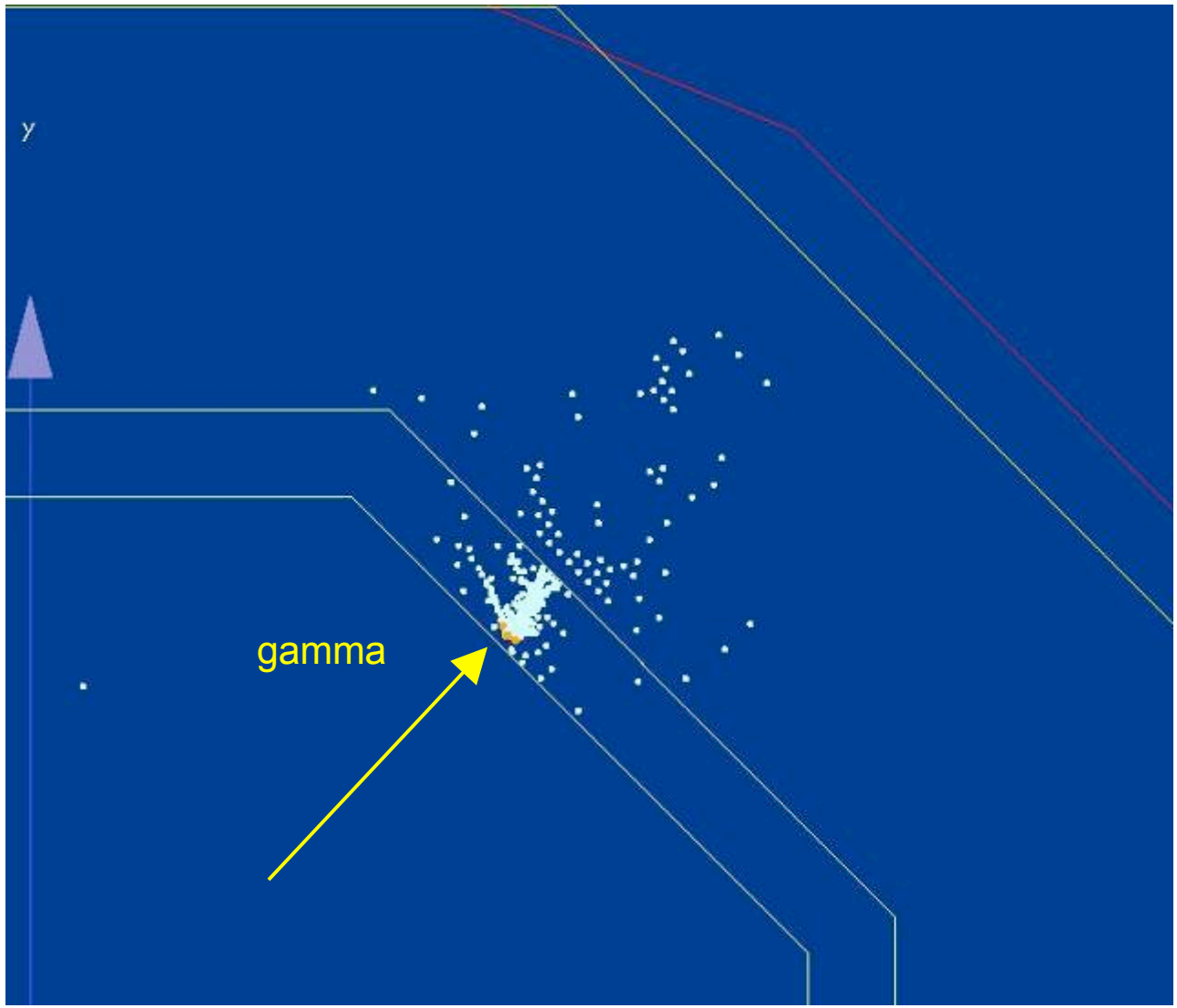


Strange “hadron”
Events

Not seen only in 1GeV
Sample !!!

What is the “physics” that produces this ???

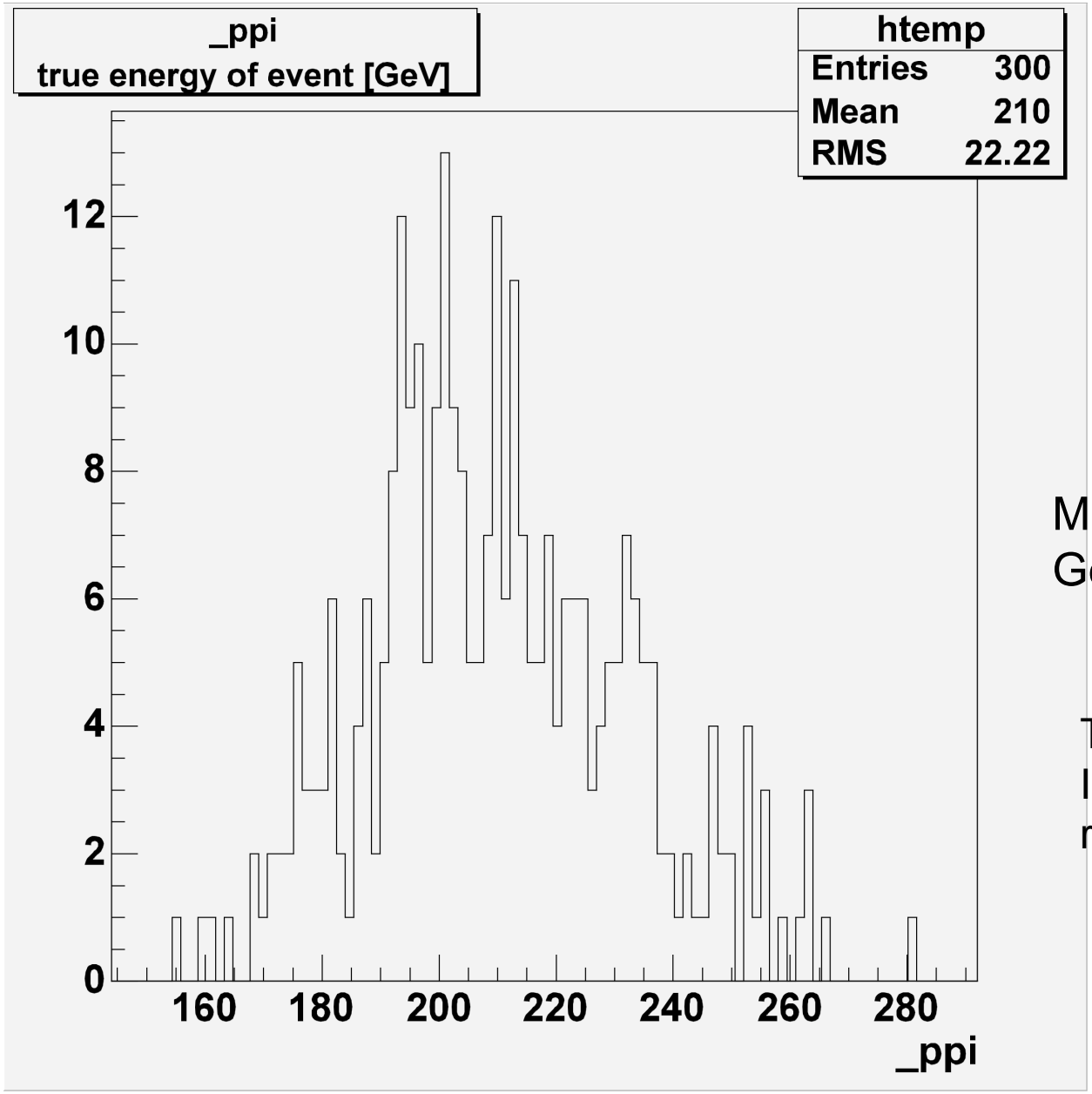
Strange “hadron” events



CCC

Complains	Congratulation	Conclusion
• Yes the user still needs to DO something and to UNDERSTAND what is doing on • Final decision on quality check is on users shoulders • Documentation at the moment only in the code i.e. enough for experts more detailed to come	• It can be incorporated in more complex procedures • It will work with different cell sizes !!! (as long as layer thickness < cell_size out of box)	• Code is available from cvs with an example processor • It works • you can play with parameters for E range of your interest (not recommended for below 0.5GeV)

Appendix beyond this page

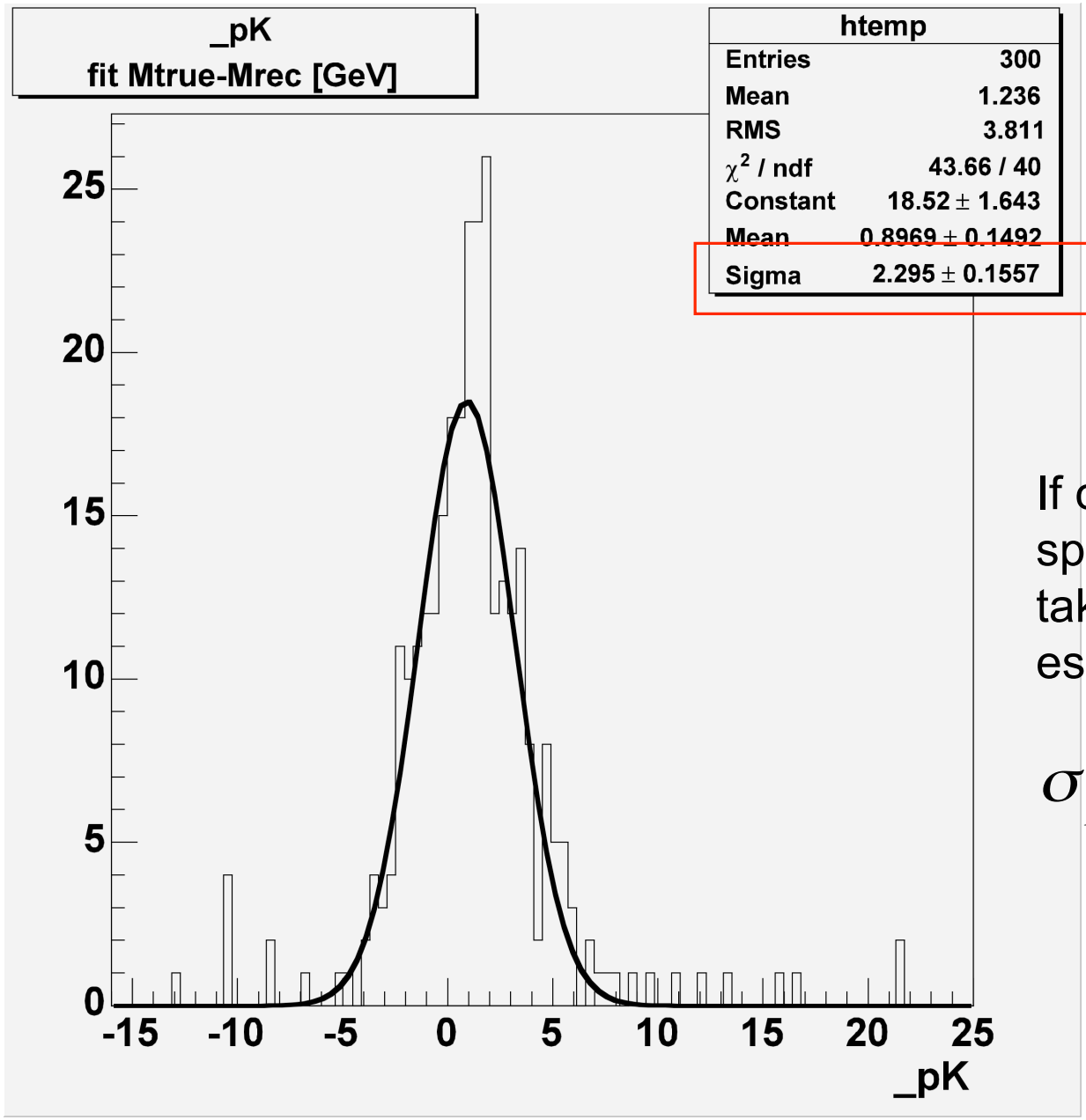


20 photons over the Detector

Egamma 1-20GeV

Mass distribution of the Generated events

Tracking and V0 search Included plus electron reconstruction



$$\sigma = 2.3 \pm 0.16$$

If one neglects the spread of the events and takes mean as an estimator

$$\sigma_{perfect} = 0.135\sqrt{210}$$

$$= 1.96$$

Tabular results for considered energies 1 gamma per event is input

1 GeV

N per event	Nevt	Ncore	%	Nrec	%	Npan	%
0	4267	2	0.046871	3	0.070307	0	0
1	4267	4110	96.3206	4242	99.41411	4224	98.99227
2	4267	152	3.562222	21	0.492149	40	0.937427
3	4267	3	0.070307	1	0.023436	3	0.070307

3 GeV

N per event	Nevt	Ncore	%	Nrec	%	Npan	%
0	4245	0	0	3	0.070671	0	0
1	4245	4150	97.76207	4233	99.71731	4190	98.70436
2	4245	81	1.908127	5	0.117786	53	1.248528
3	4245	11	0.259128	2	0.047114	2	0.047114
4	4245	3	0.070671	2	0.047114	0	0

5 GeV

	Nevt	Ncore	%	Nrec	%	Npan	%
0	4245	0	0	3	0.070671	0	0
1	4245	0	0	4207	99.10483	4125	97.17314
2	4245	0	0	17	0.400471	110	2.591284
3	4245	0	0	12	0.282686	10	0.235571
4	4245	0	0	6	0.141343	0	0

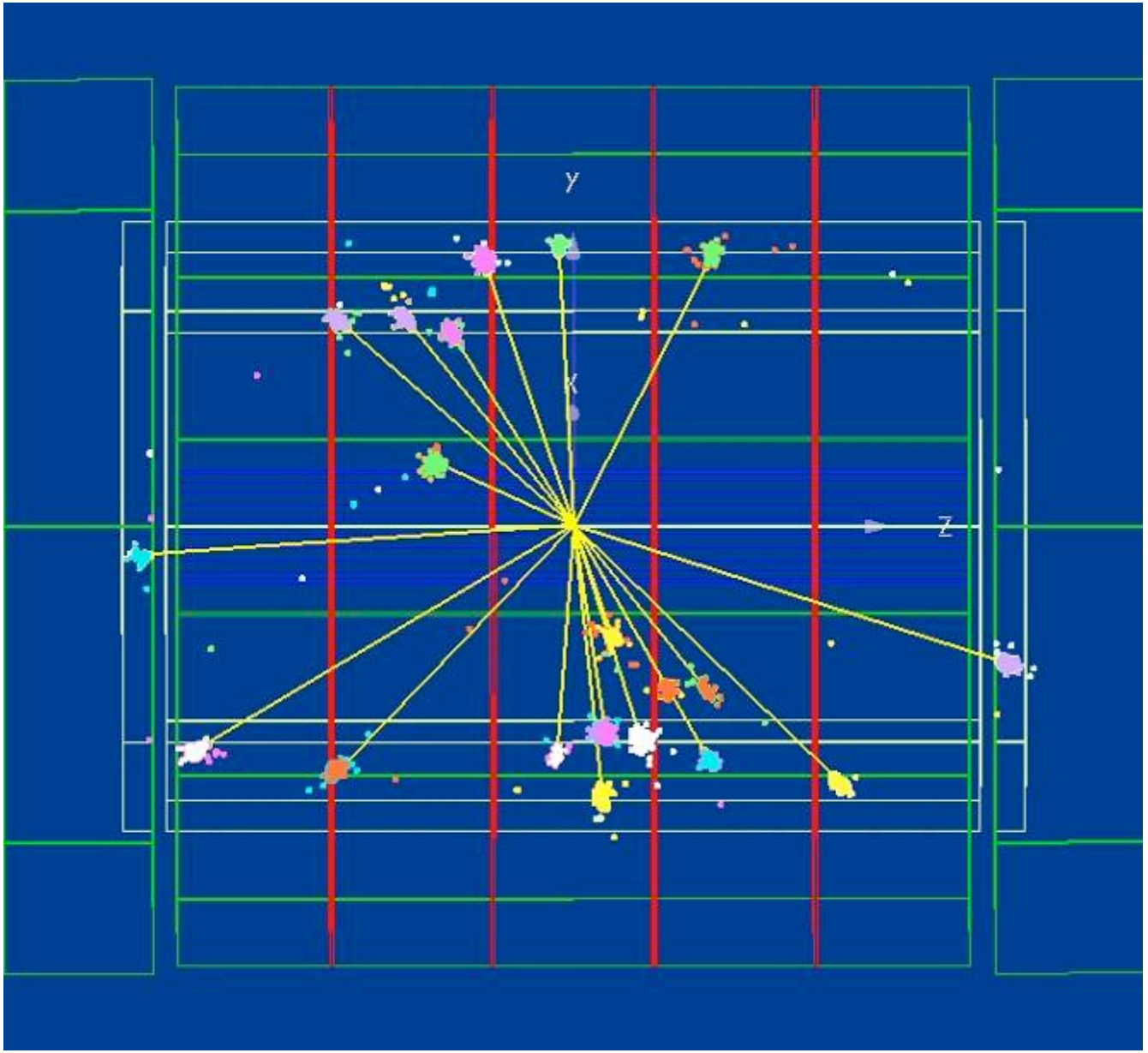
Inefficiency only at 1GeV for the rest bug in calibrator function

9 GeV

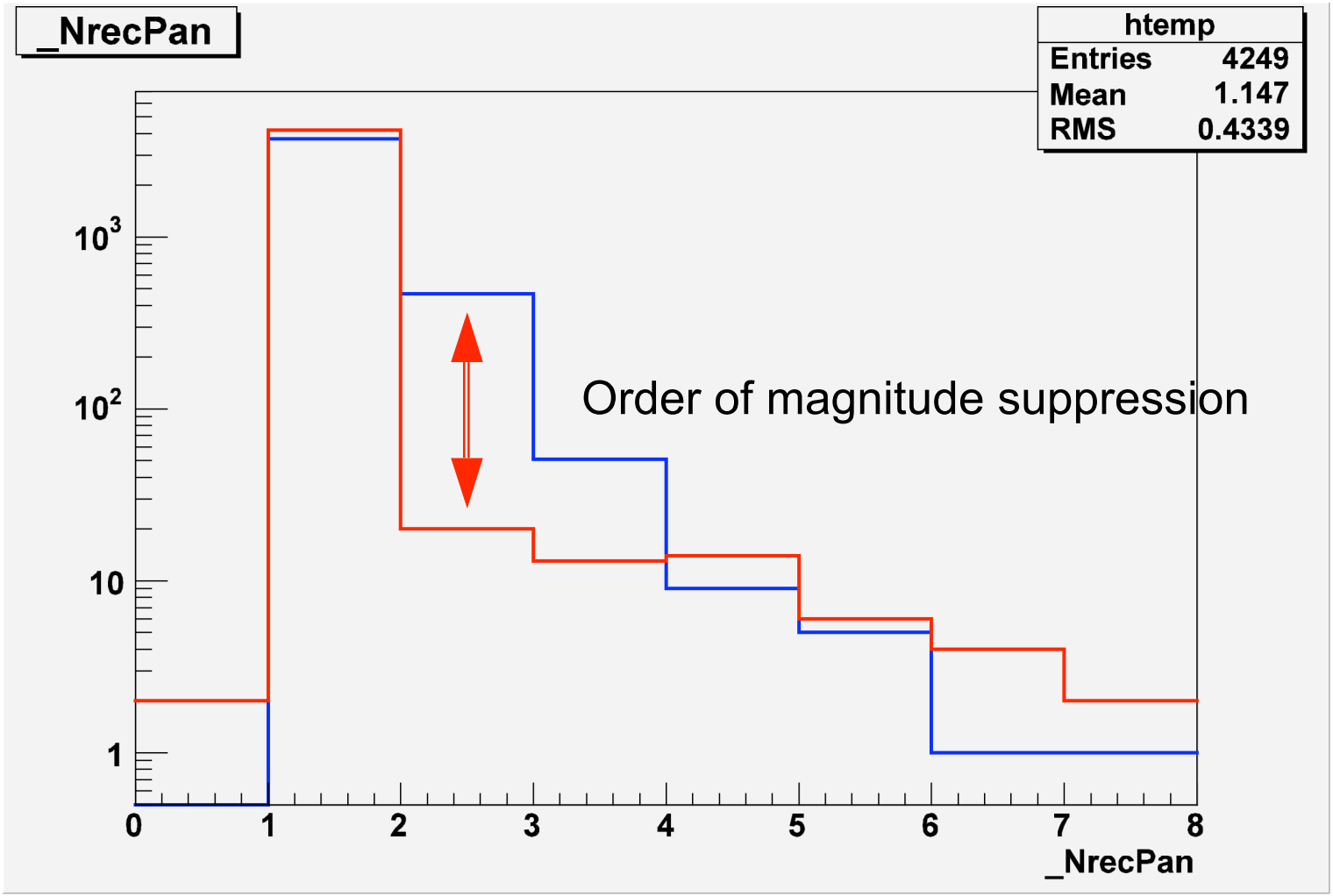
	Nevt	Ncore	%	Nrec	%	Npan	%
0	4271	0	0	0	0	0	0
1	4271	4137	96.86256	4228	98.99321	3967	92.88223
2	4271	98	2.294545	13	0.304378	279	6.532428
3	4271	18	0.421447	17	0.398033	16	0.37462
4	4271	9	0.210723	10	0.234137	7	0.163896
5	4271	5	0.117069	1	0.023414	2	0.046827
6	4271	2	0.046827	1	0.023414	0	0
7	4271	2	0.046827	1	0.023414	0	0

16 GeV

	Nevt	Ncore	%	Nrec	%	Npan	%
0	4289	0	0	2	0.046631	0	0
1	4289	4023	93.79809	4227	98.55444	3756	87.57286
2	4289	215	5.012824	20	0.466309	466	10.865
3	4289	20	0.466309	13	0.303101	51	1.189088
4	4289	14	0.326416	14	0.326416	9	0.209839
5	4289	7	0.163208	6	0.139893	5	0.116577
6	4289	5	0.116577	4	0.093262	1	0.023315
7	4289	5	0.116577	3	0.069946	1	0.023315



Event example

20 photons
Over the detector

16 GeV Algorithm output after fake suppression in red , Pandora output in blue