GSPC19 October/November data: event reconstruction using ANTS v061

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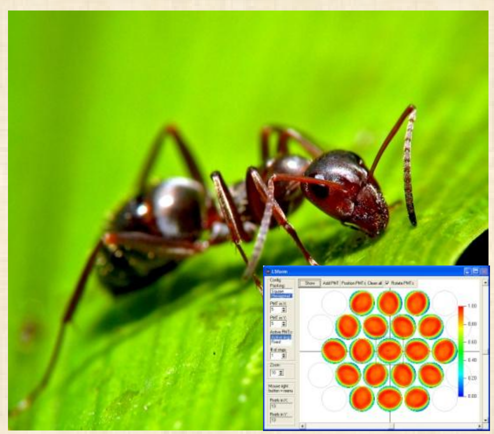
LIP-Coimbra



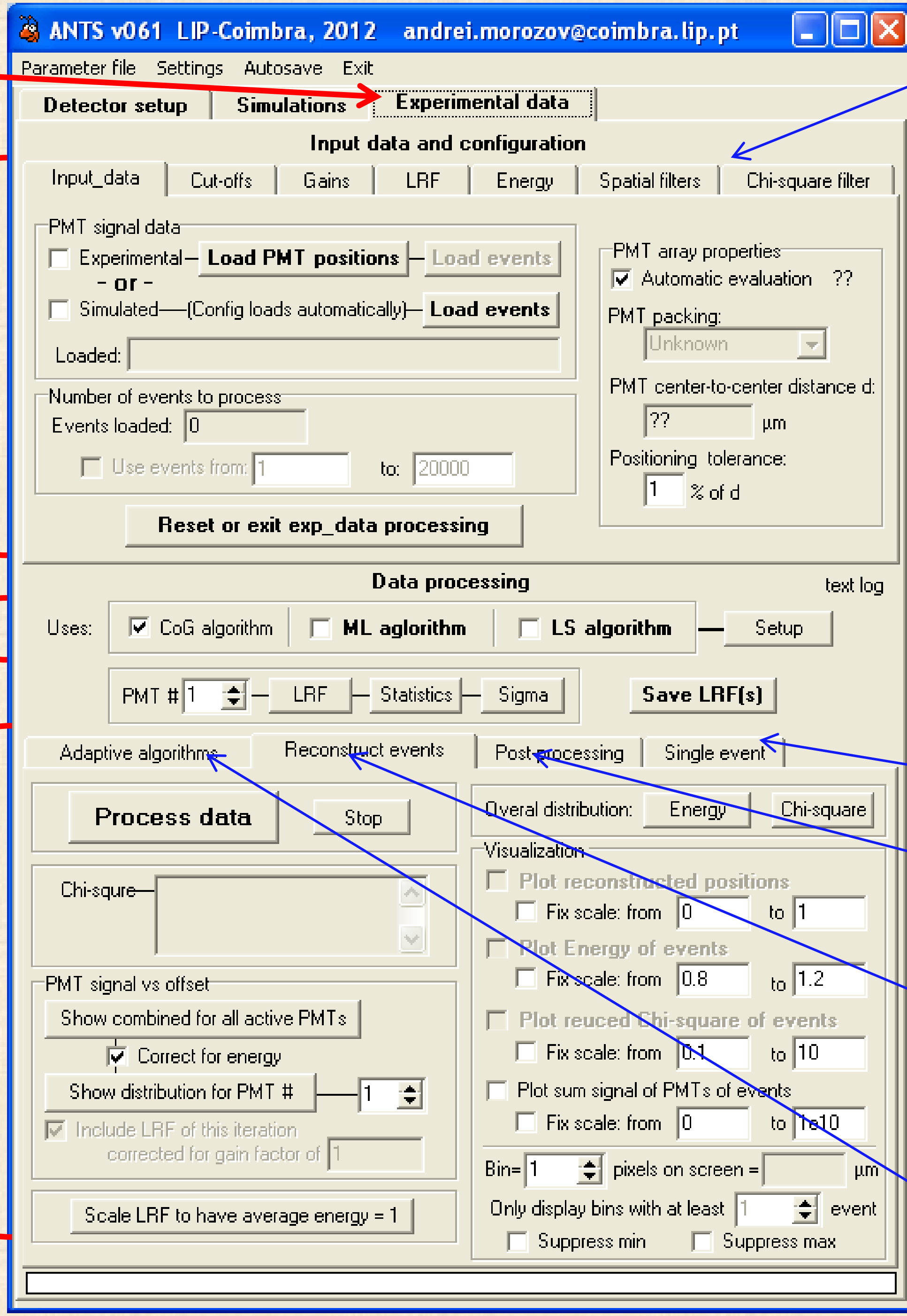
NMI3 meeting, Garching, Dec 2012

We are here

Input data, configuration, event filters

Reconstruction algorithm

Reconstruction and post-processing



Other tabs:

- PMT signal cut-offs (individual and sum)
- PMT gains (input/estimation)
- Light response function (model + first guess+ load)
- Event energy (scaling + filter)
- Two spatial filters
- Goodness of fit filter

Single event processing

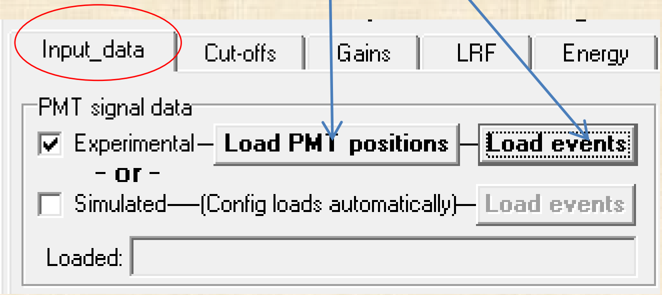
Analysis of reconstruction results

Reconstruction of positions and energies of the loaded events

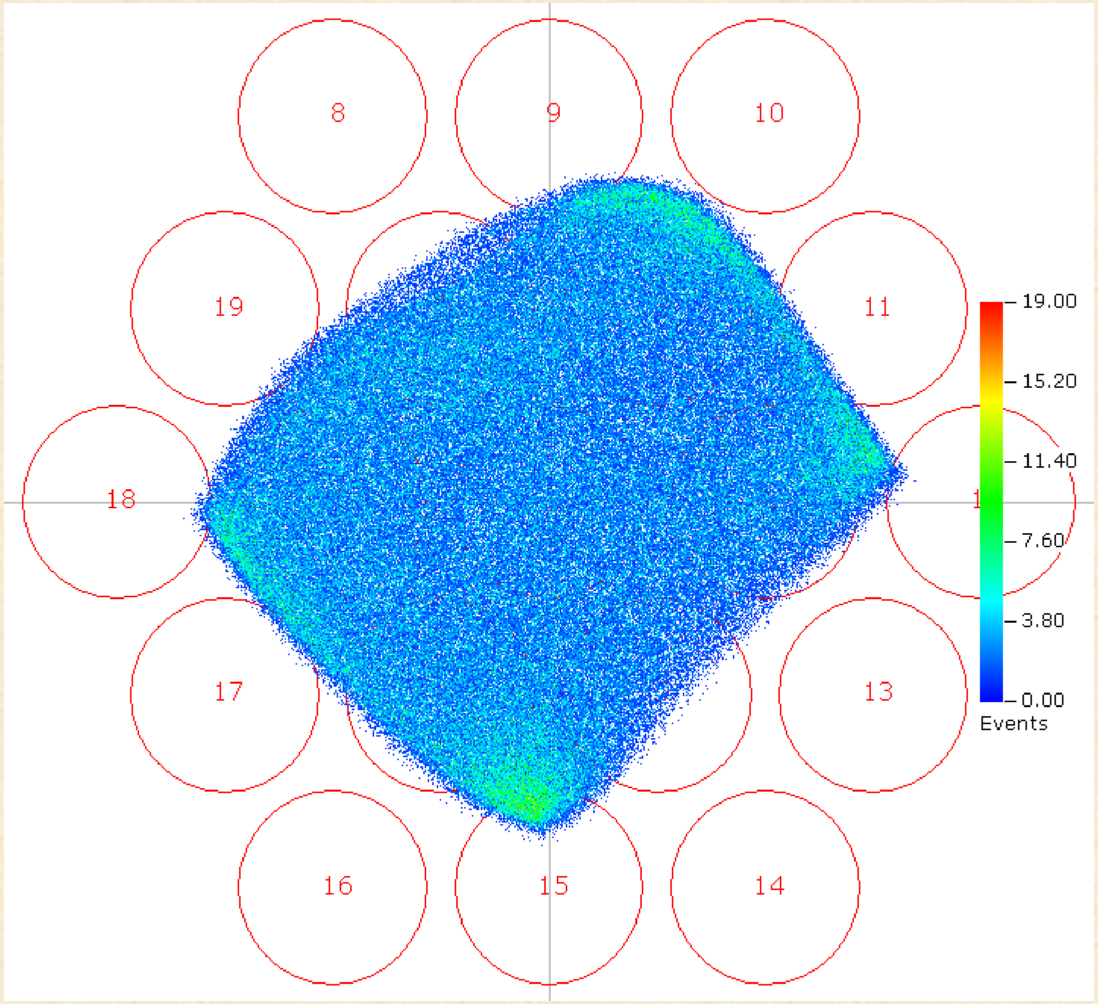
Iterative reconstruction of LRF / gains

Data input

1) Load the file with PMT positions
And then the file with flood field illumination

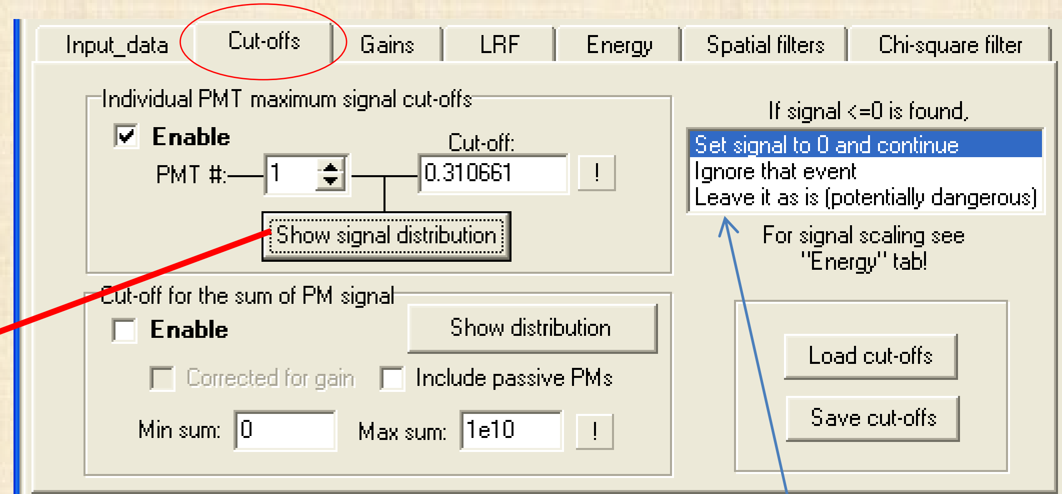


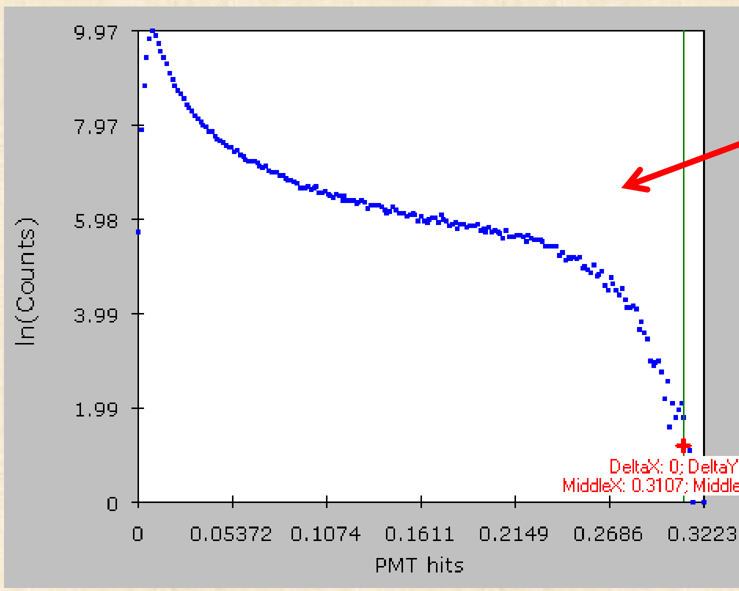
Automatically, the CoG reconstruction will be shown:



Individual cut-offs

2) Second step is to define the cut-off for the individual PMTs (Cut-offs tab):





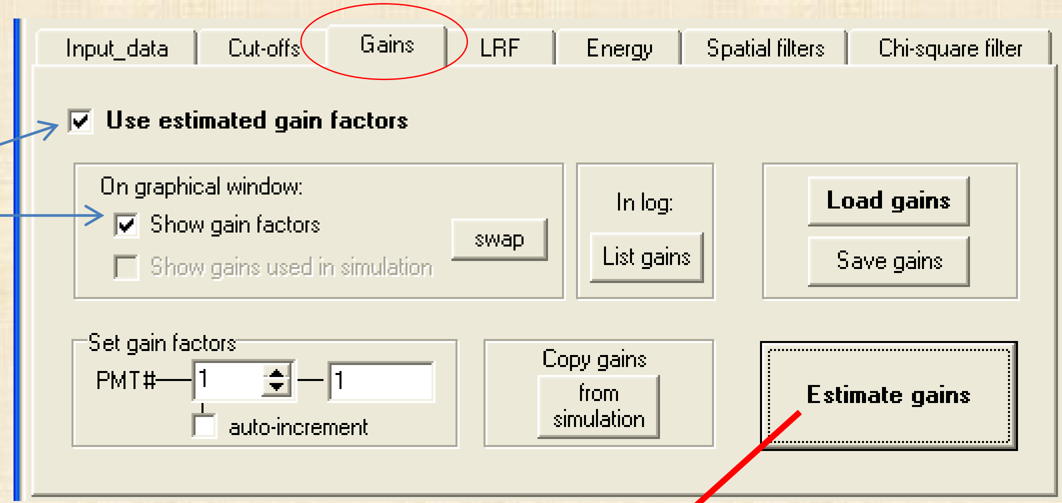
Use the mouse right-button menu to set cut-offs

Define how ANTS treat events with zero or negative PMT signals
It is assumed that the signals are already corrected for the offsets
(signals are proportional to the number of photoelectrons!)

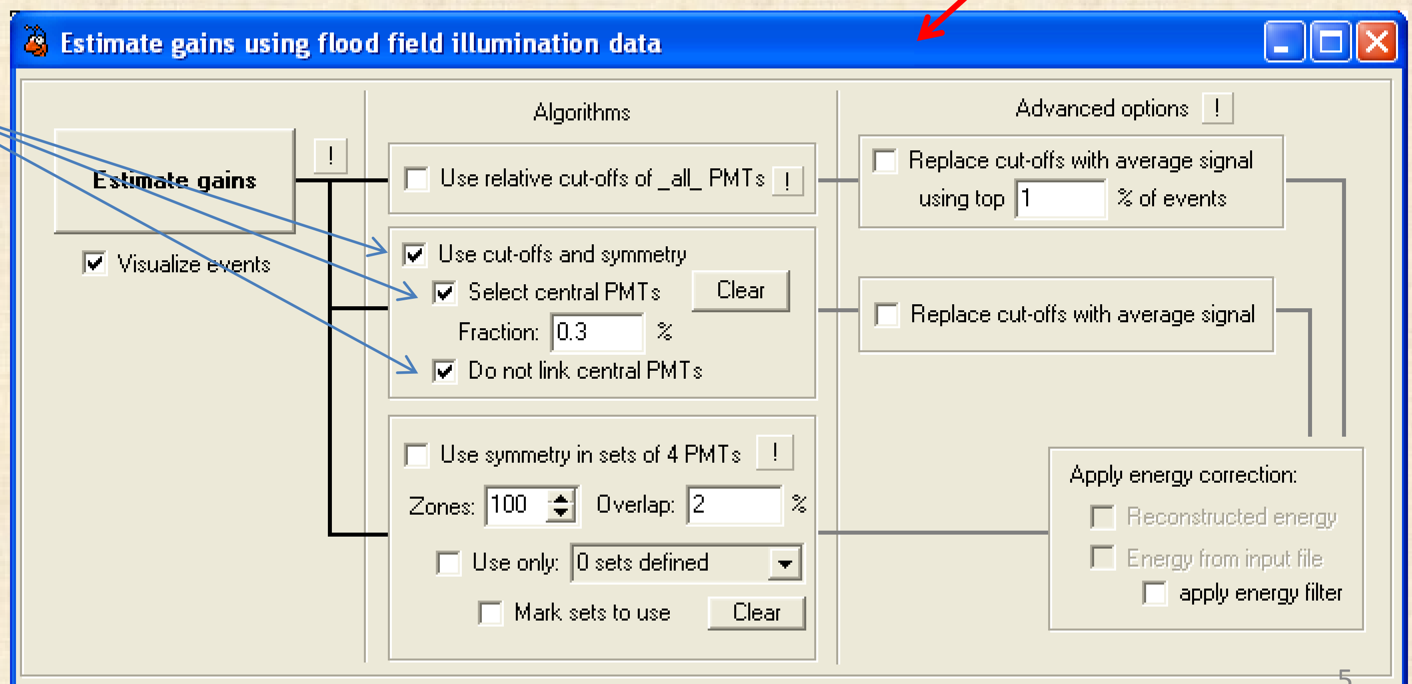
Gains

3) Now gains can be estimated:

Select these options



Select these options

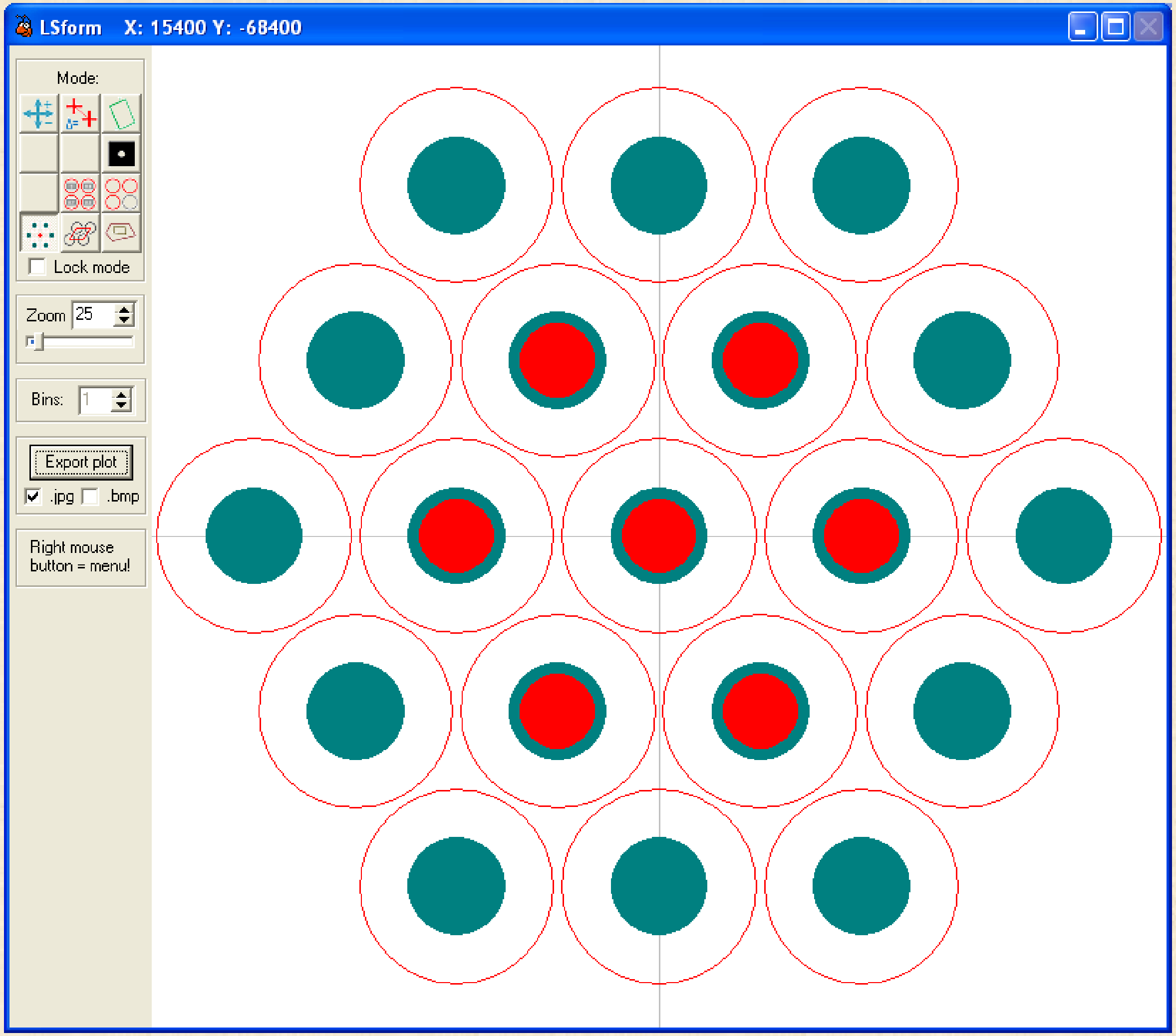


Gains

Then on the graphical window indicate (left click) those PMTs which definitely have events in front of their center.

In our case: 7 central PMTs.

The selected method will find events in front of the center of each “red” PMT and find relative gains for all neighboring PMTs (teal) from their average relative signals.



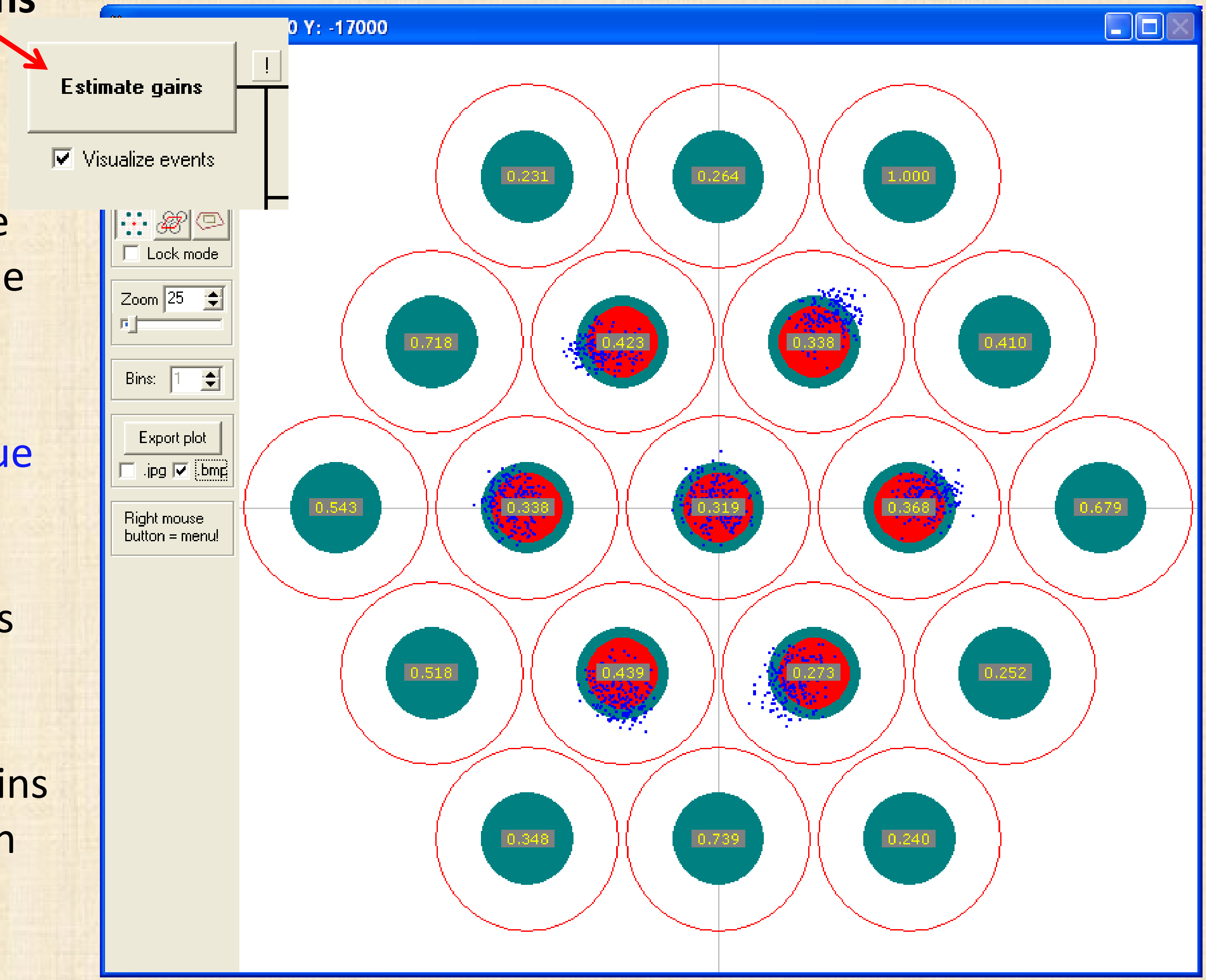
Gains

Press “**Estimate gains**”

The “**fraction**” parameter can be changed if there are two few events (blue dots) or two many.

Selected events (blue dots) should form compact groups
Offsets from centers are normal

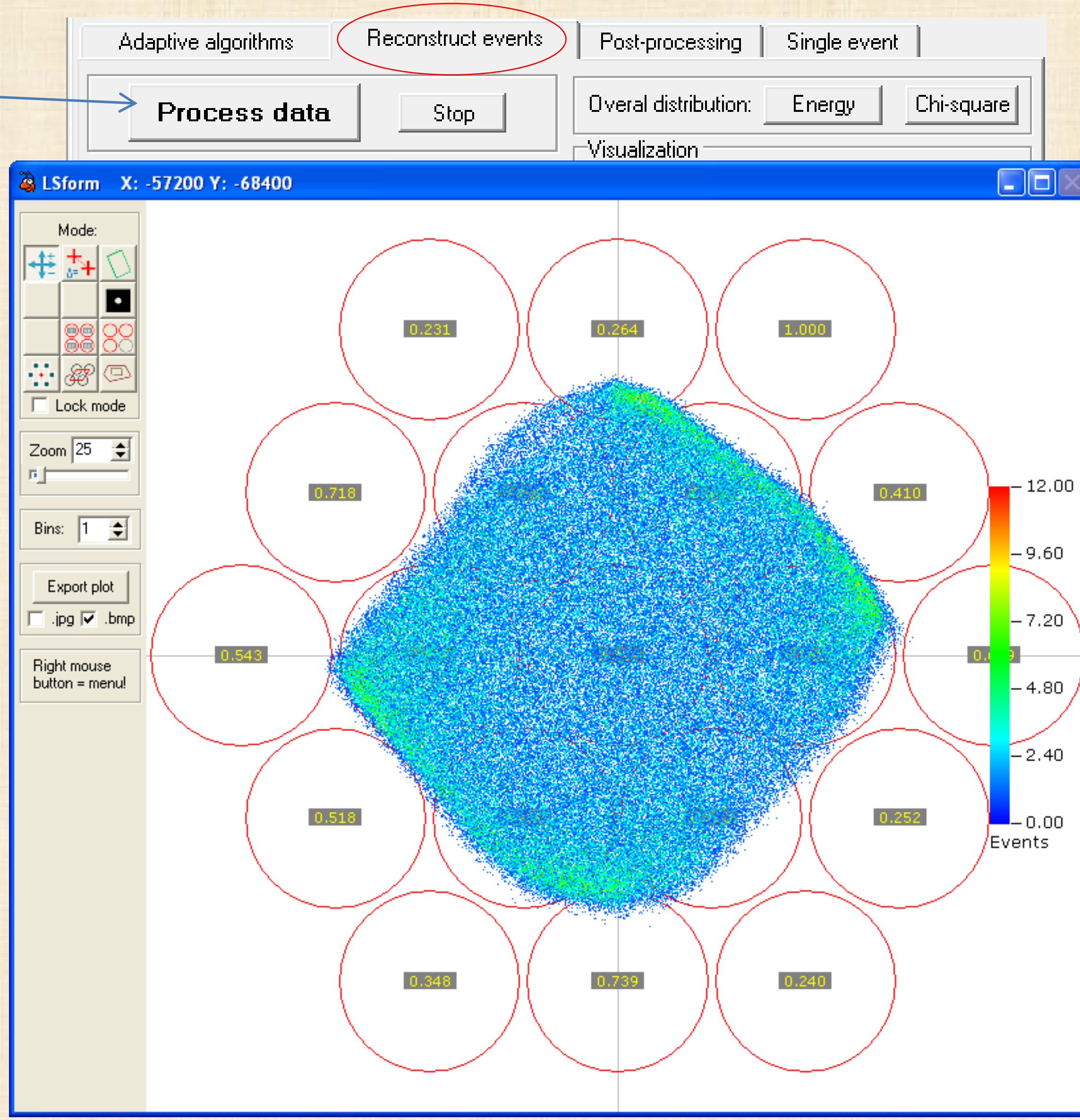
Ideally, obtained gains should not vary with small change of the **fraction** parameter.



Gains

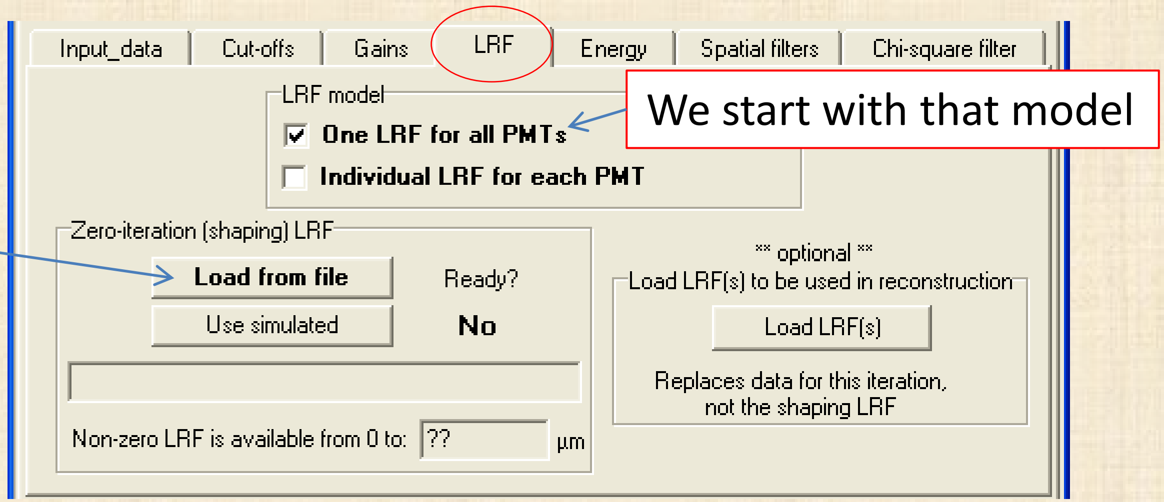
Press "**Process data**" (button in "**Reconstruct events**" tub in the lower tab control)

The CoG reconstruction of the flood field should cover a more symmetric area!

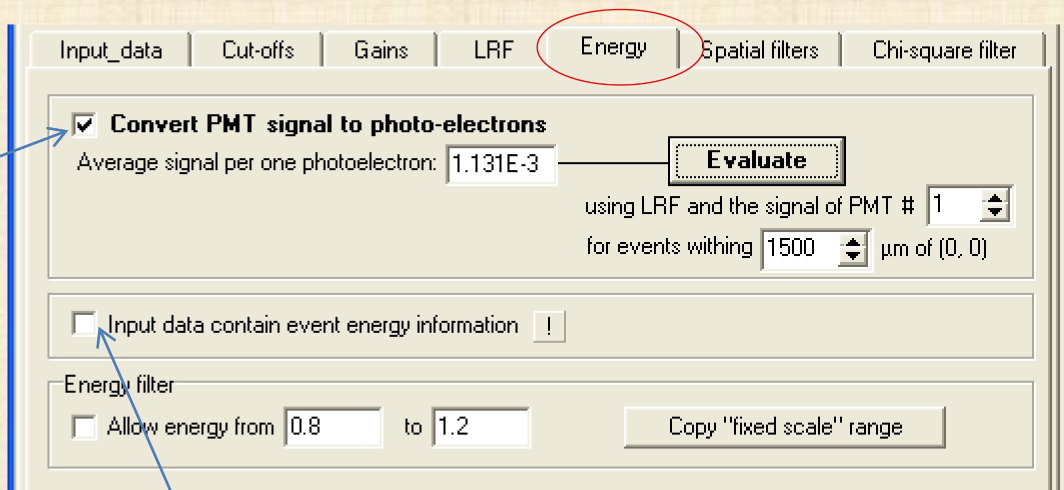


LRF / Energy tabs

4) Next step is to load shaping LRF – it is the first guess on the actual LRF. Also used by adaptive algorithms for shaping of reconstructed LRFs during iterations.



5) Since Poisson statistic is used, the signals of PMT has to be converted to integers (number of photoelectrons)



Select this and provide the value of "**Average signal per photoelectron**" or click the "**Evaluate**" button to estimate the value.

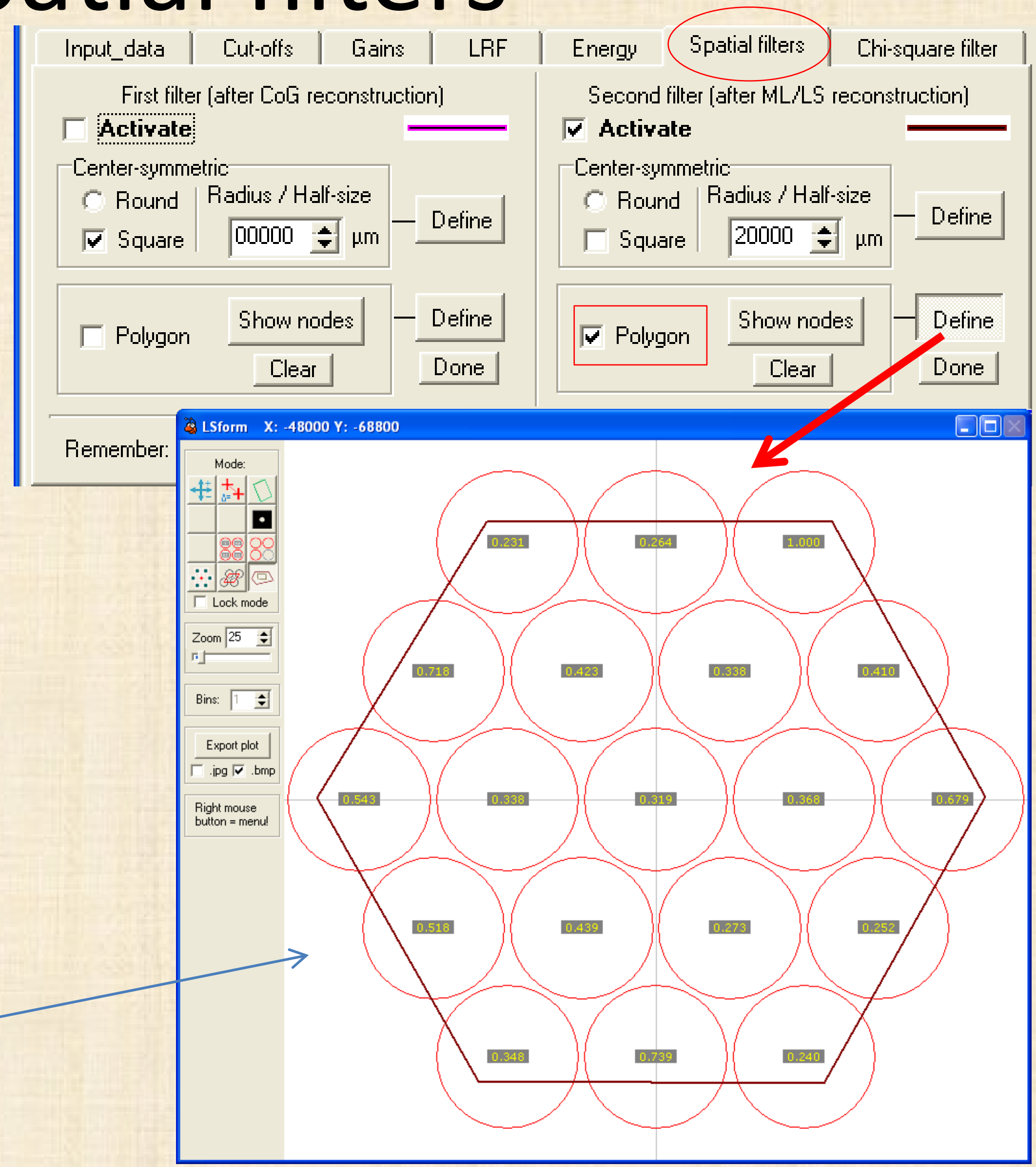
If experimental data contain charge information, this checkbox has to be activated.

Spatial filters

The first spatial filter is checked (if activated) after CoG reconstruction.

The second is checked after ML (or LS) reconstruction. It has to be activated if there are events in the regions where the ML/LS algorithms are known to produce significant errors – e.g. the area outside of the centers of the border PMTs

Select “**Polygon**”, “**Define**” and click at the positions where you want to have the polygon corners.



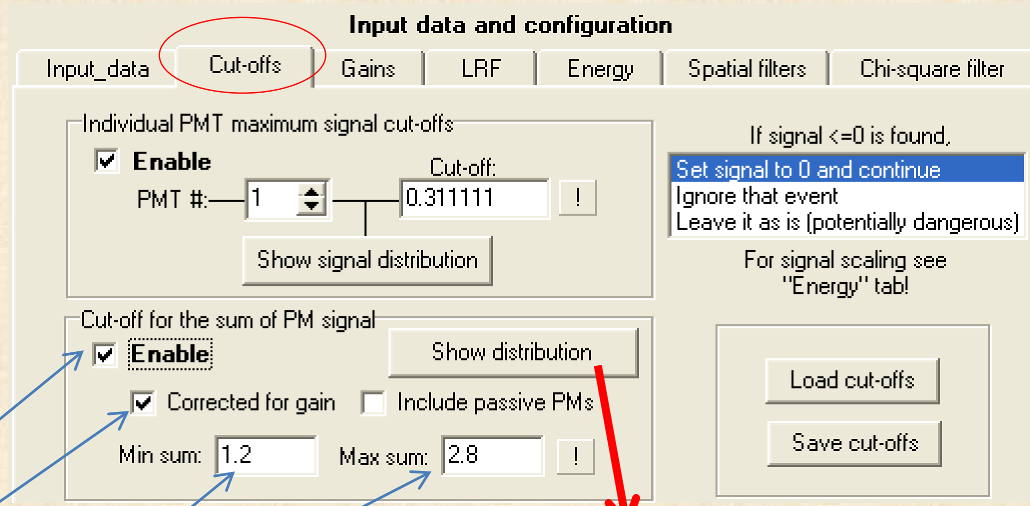
“Bad events” filtering

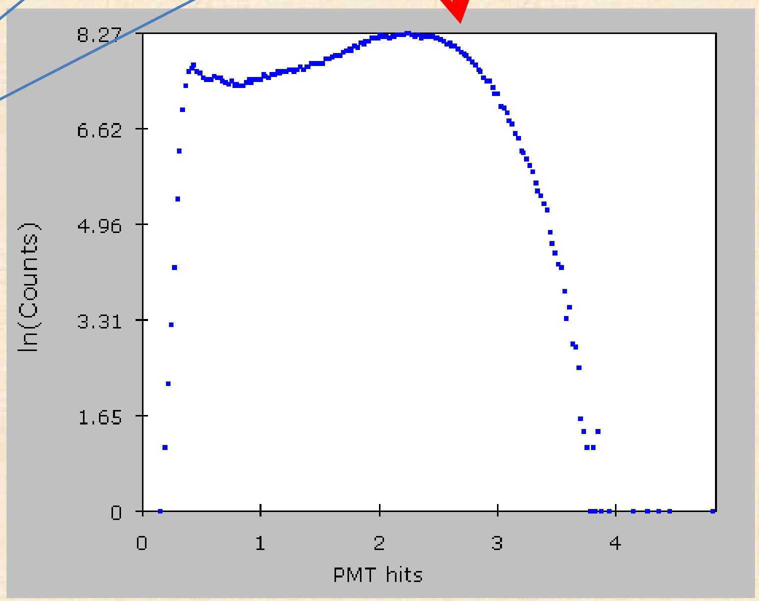
“Bad events” – Any event which is not a proper single neutron event.

These events “confuse” the adaptive algorithms – have to be removed.

We can use
“cut-off for the sum of PM signal”
With the option
“corrected for the PMT gains”

<u>How to select the proper range?</u>



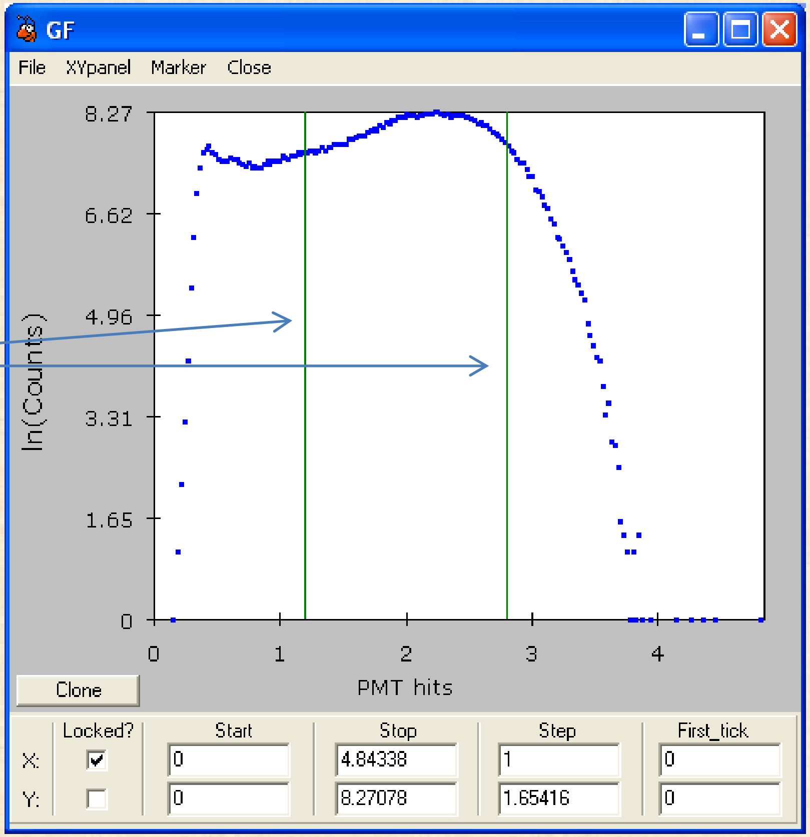


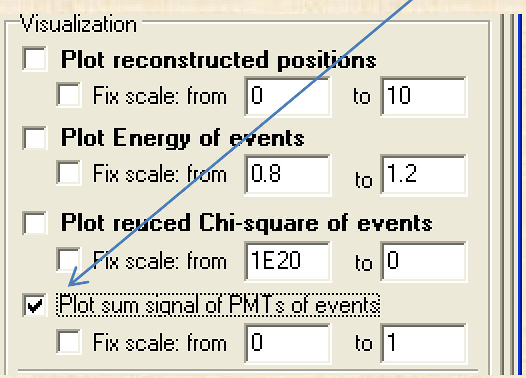
Sum cut-off filter

We would like to avoid
low and high energy events,
but we do not have yet
the energy information!
(It could happen we cut too much)

Make a guess on the cut-offs
(later we can correct)

Then perform reconstruction with the
Sum cut-off filter enabled.
Select this visualization option





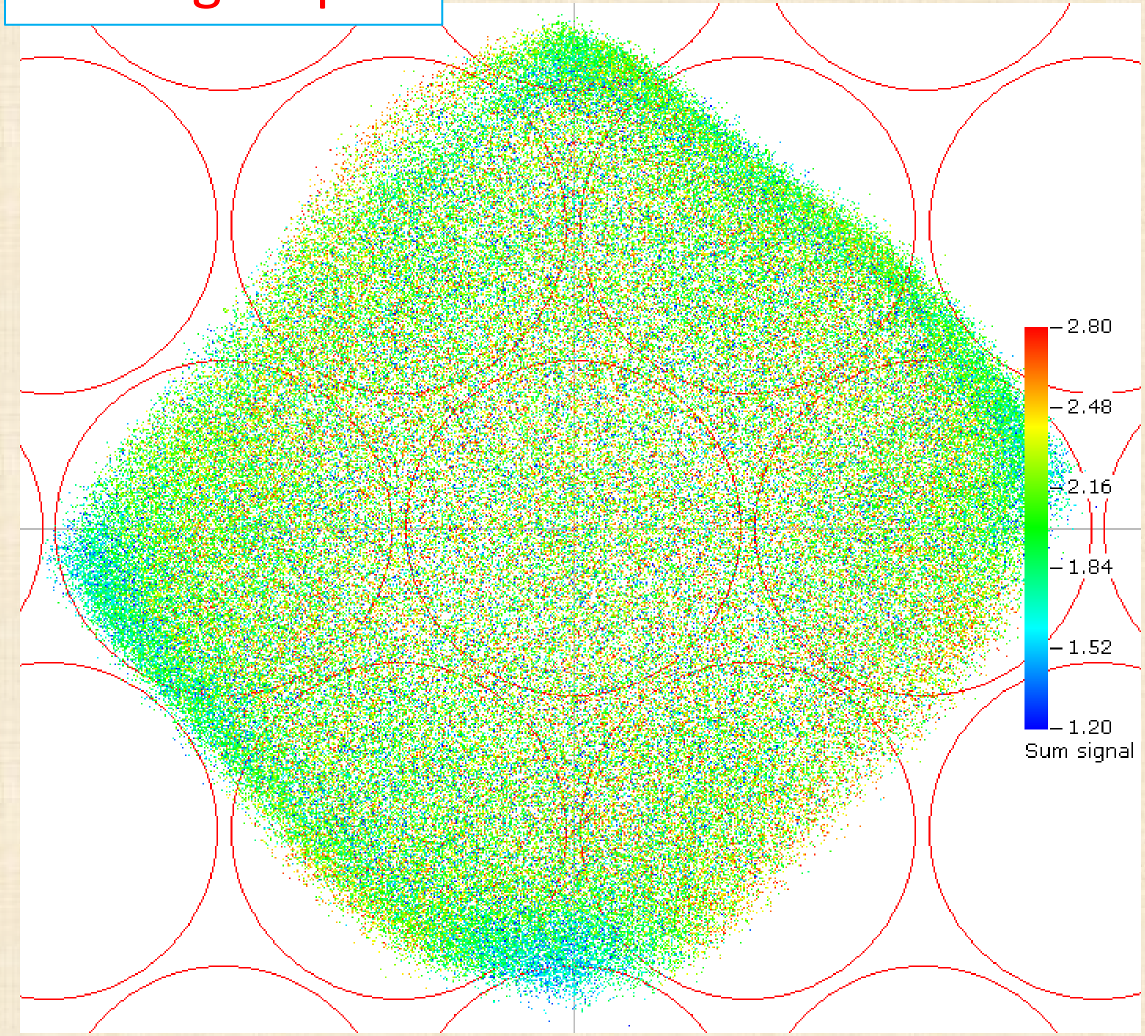
Sum cut-off filter

There should be no areas where events density is significantly reduced.

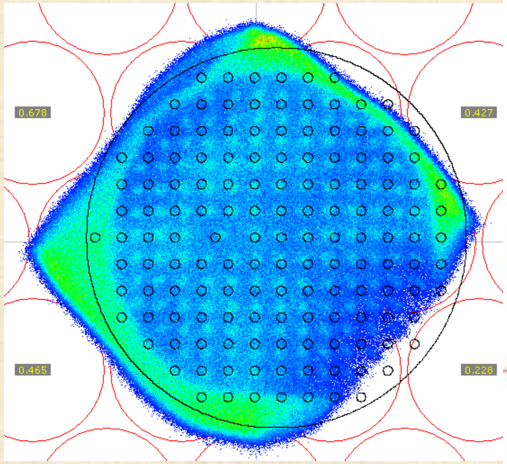
Any "ensembles" with a dominating contribution by events with too low (blue) or too high (red) sum signal are suspicious!

(Rim area?
Wrong gain estimation?
Defect?)

Sum signal plot

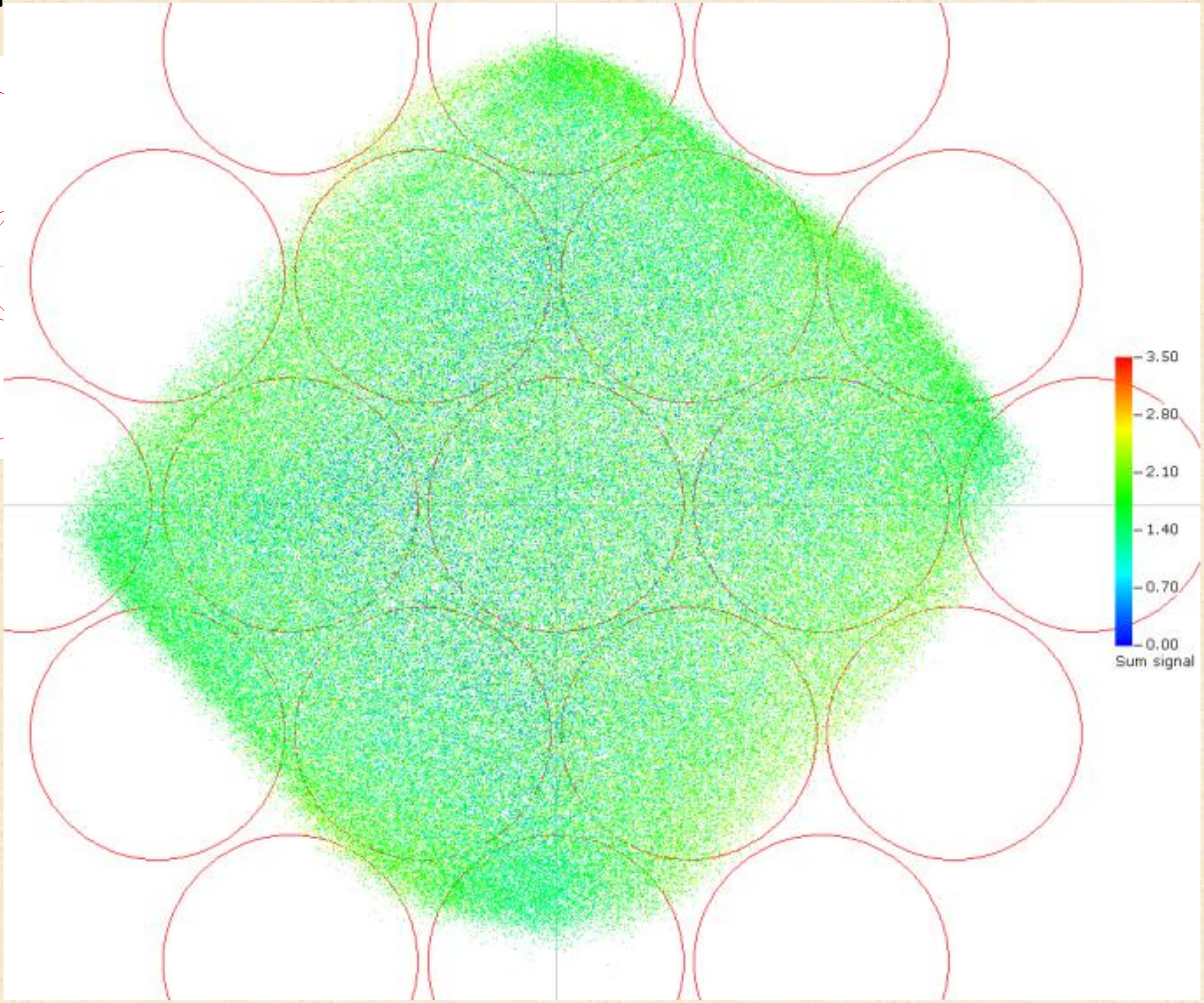


Example of a bad "ensemble"



A diffuse "halo" is visible in high statistics CoG reconstruction

In the "Sum signal" plot one can see blue points scattered over the halo area (sorry - need high resolution) .

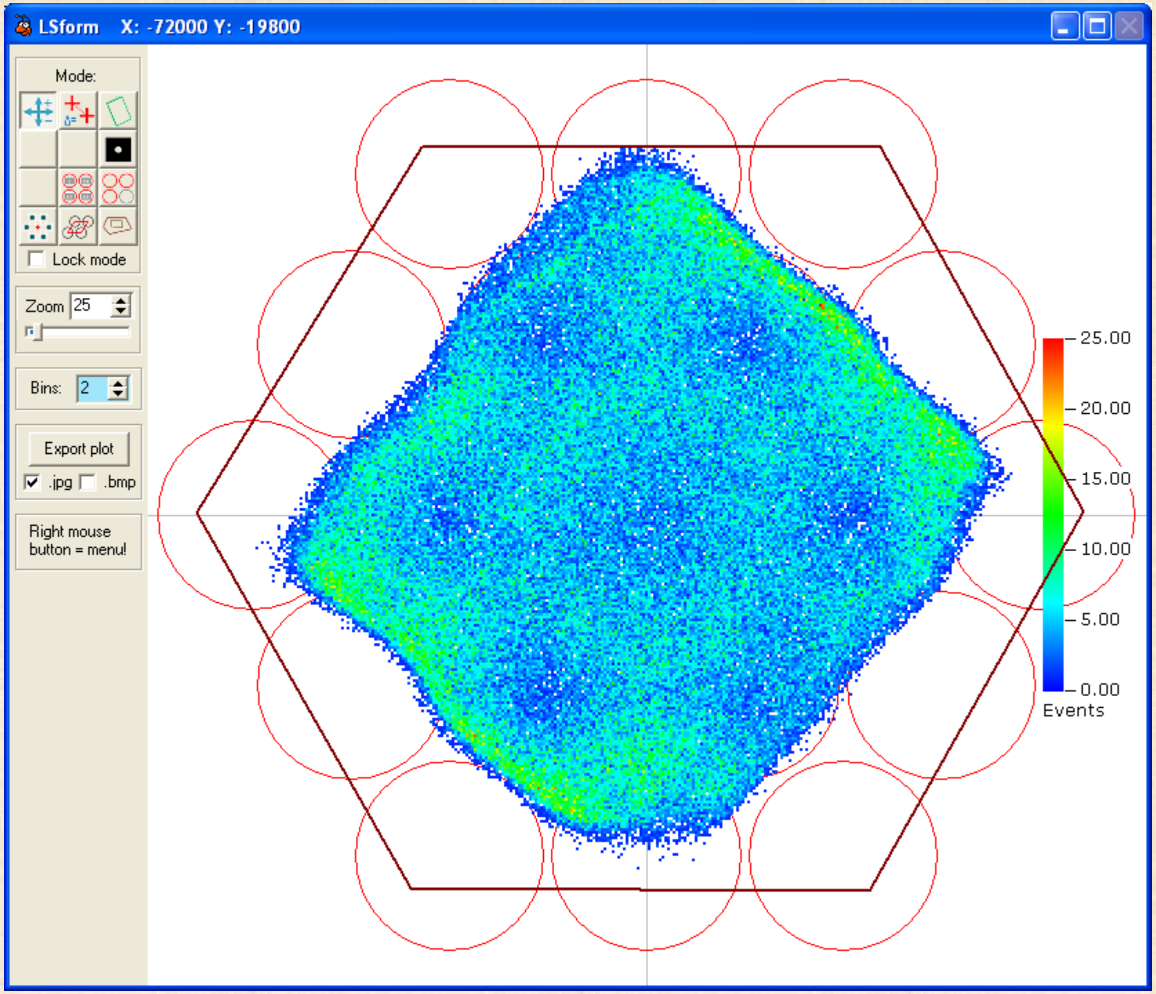


Now we are ready for the LRF reconstruction

LS reconstruction – first guess

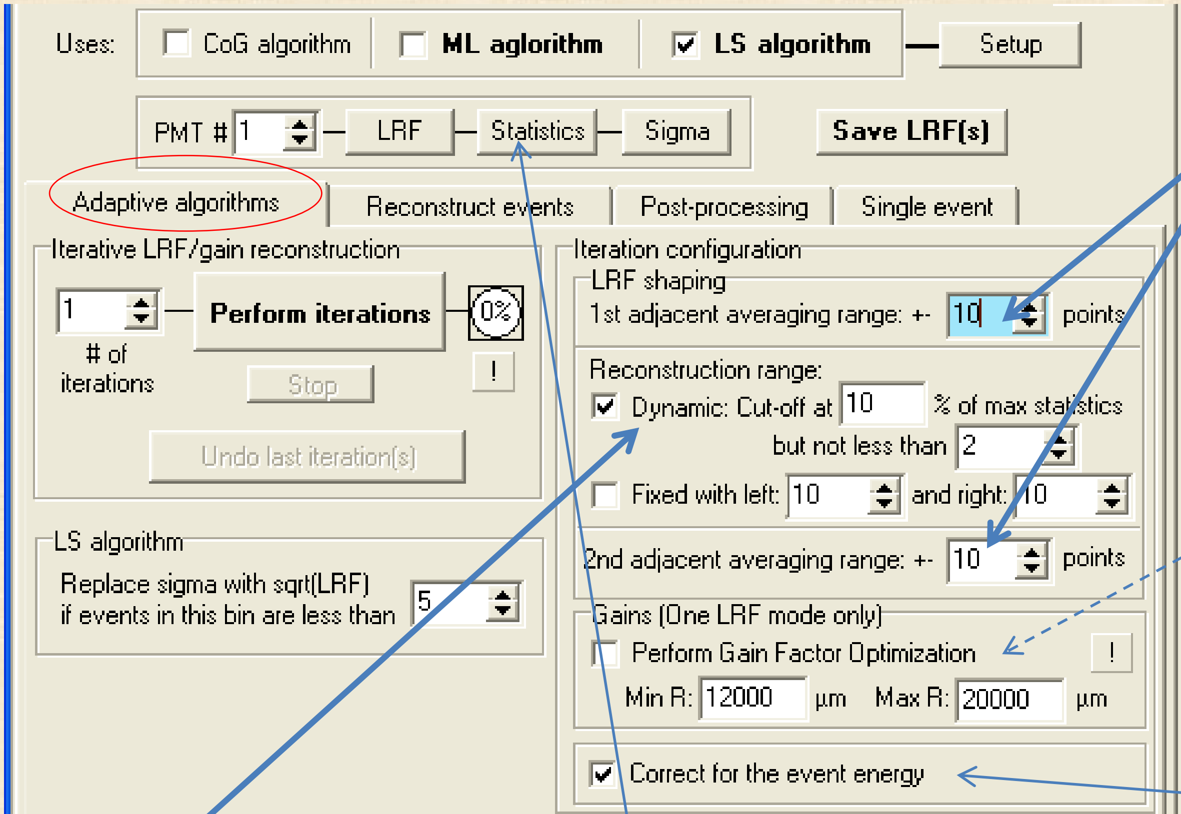
Switch to LS algorithm and use “**Process data**” again.

One can see that the first guess LRF is not adequate



Next step: adaptive reconstruction of LRFs

Configuration for iterations



1 point = 100 um

If range is too small, LRF will "wriggle"

If too large, LRF at short distances will go lower than it should

(will discuss later)

Used to do iterative gain reconstruction.

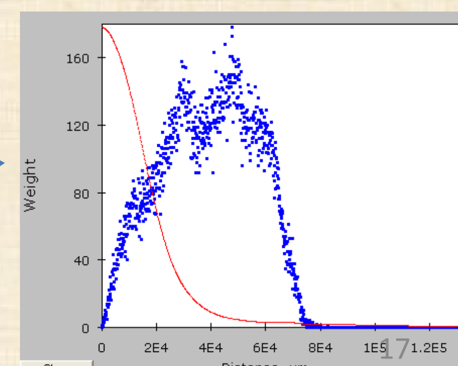
For GSPC19 data we do not have to do it.

Always keep it activated

Defines the limits where reconstructed data are used: outside them the shaping LRF takes over.

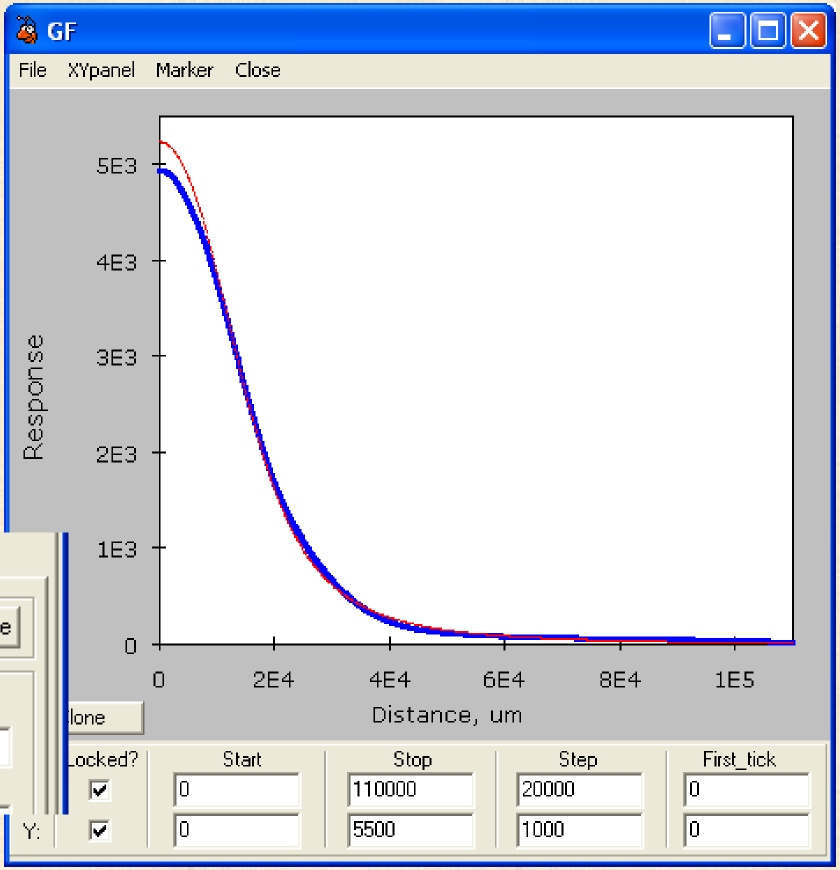
Statistics can be checked here (shows distribution)

After some iterations, 5% can be a better option.

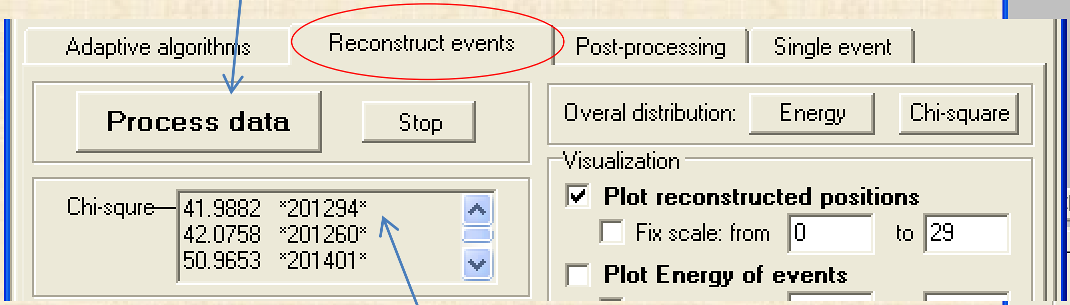


LRF reconstruction: single LRF model

Press “**Perform iteration**”.
When it is finished, a window will pop up which will show the new (blue) and old (red) LRFs.



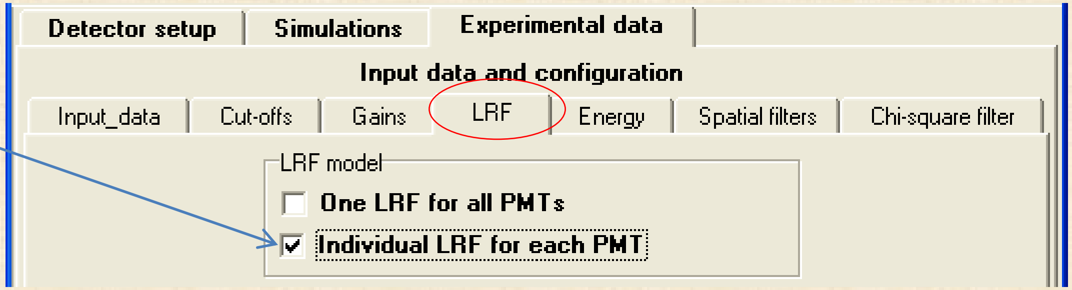
Change to “**Reconstruct events**” tab and press “**Process data**”.



Return back to “**Adaptive algorithms**” and repeat iteration→processing cycle 2 – 3 times. Watch the Chi-square after each processing. When it stopped to increase, it is time to change to another model.

LRF reconstruction: individual LRF model

Select "**Individual LRF for each PMT**" model



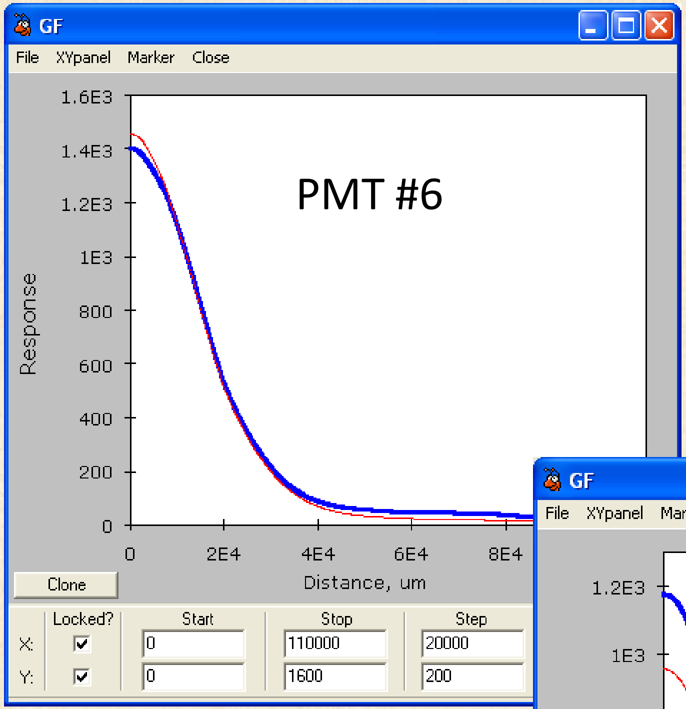
The processed (current) LRF will be attributed to each PMT taking the gain of the PMT as the scaling factor.

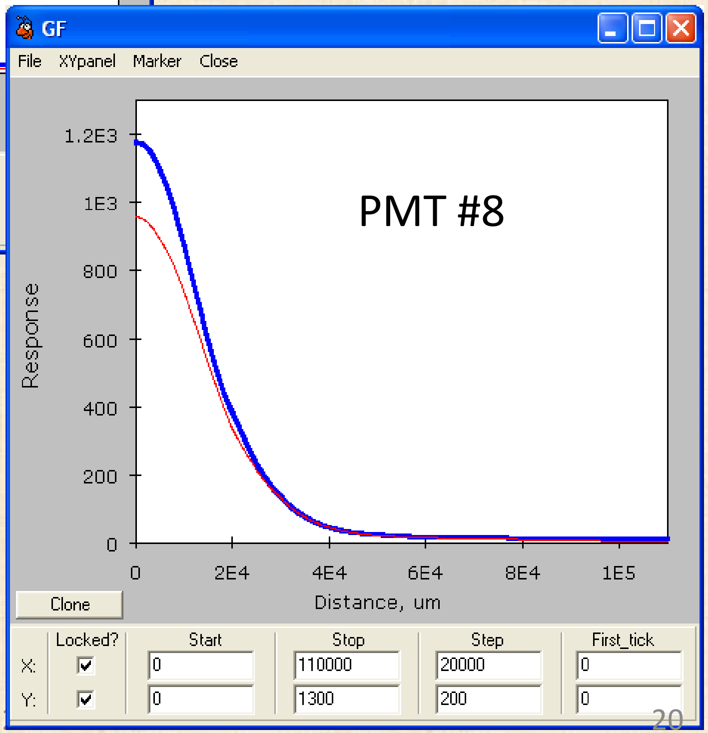
In "**Reconstruct events**" tab use "**Process data**". Reconstruction should be the same as before, but Chi-square factor will change due to scaling.

Change to "**Adaptive algorithms**"
and perform one iteration using the same settings.

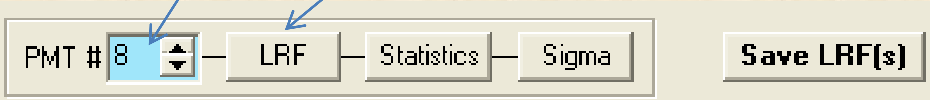
LRF reconstruction: individual LRF model

Now all PMTs will get different adjustment to their LRFs





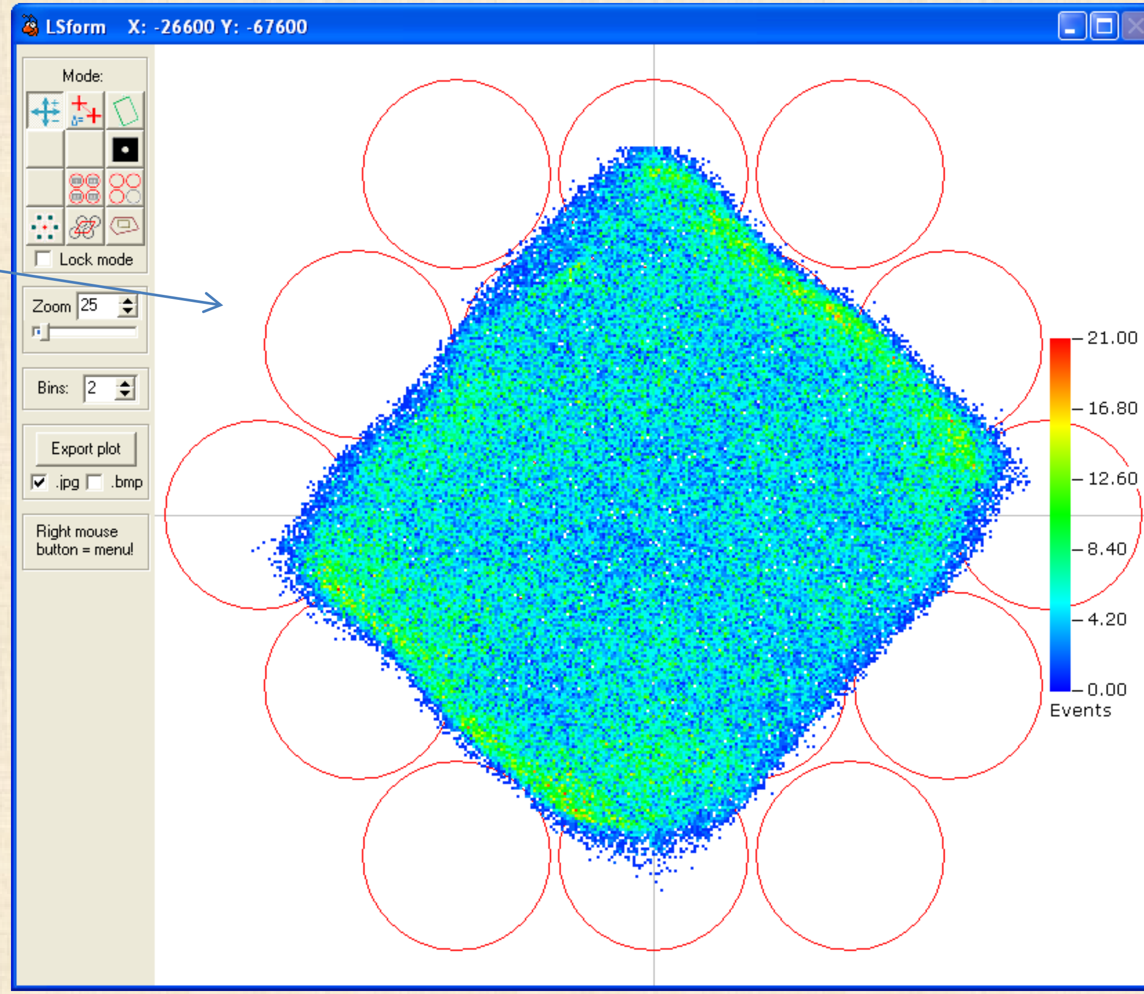
Select the PMT and press "LRF" to see info for different PMTs



LRF reconstruction: individual LRF model

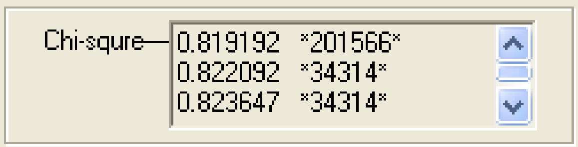
Now the reconstruction image should make more sense

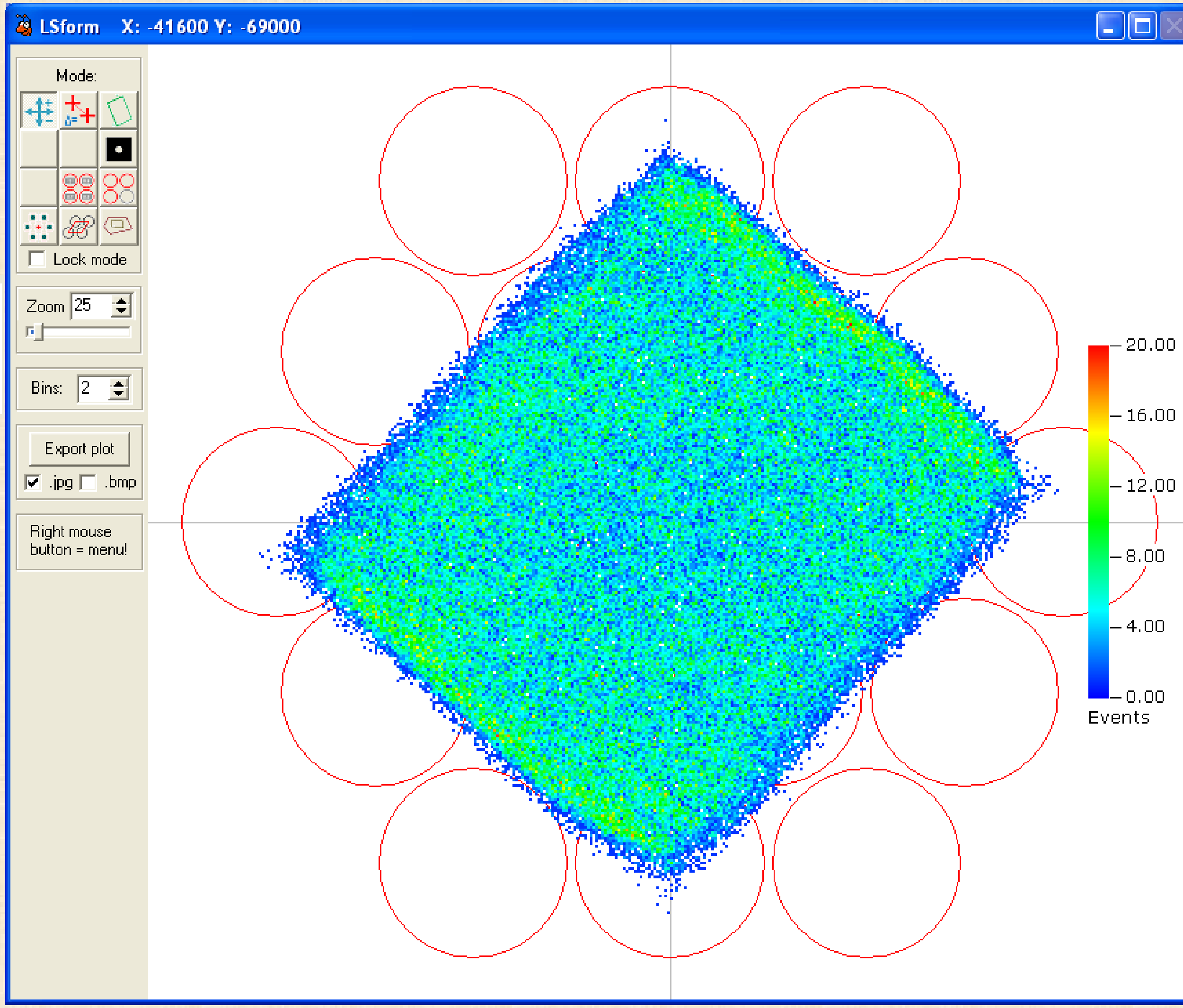
Chi-square also should reduce fast:



LRF reconstruction: individual LRF model

After several iterations:



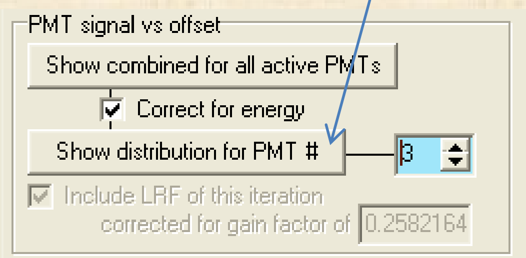


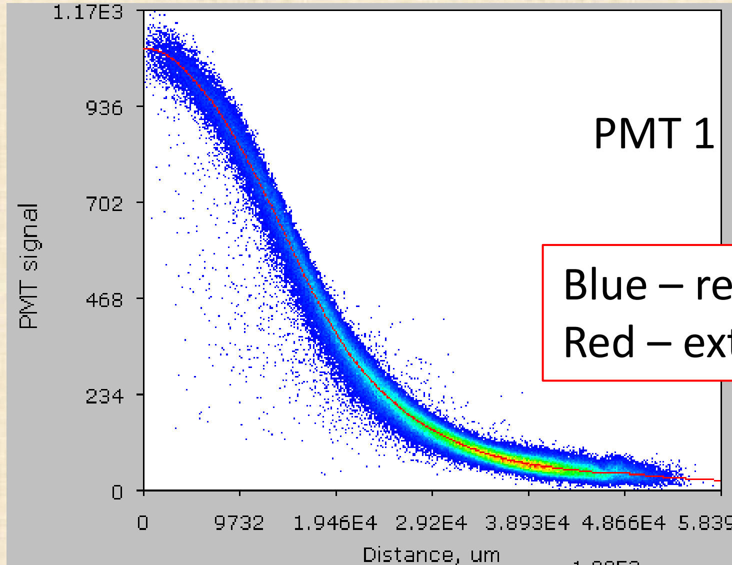
LRF reconstruction: individual LRF model

"Quality control"

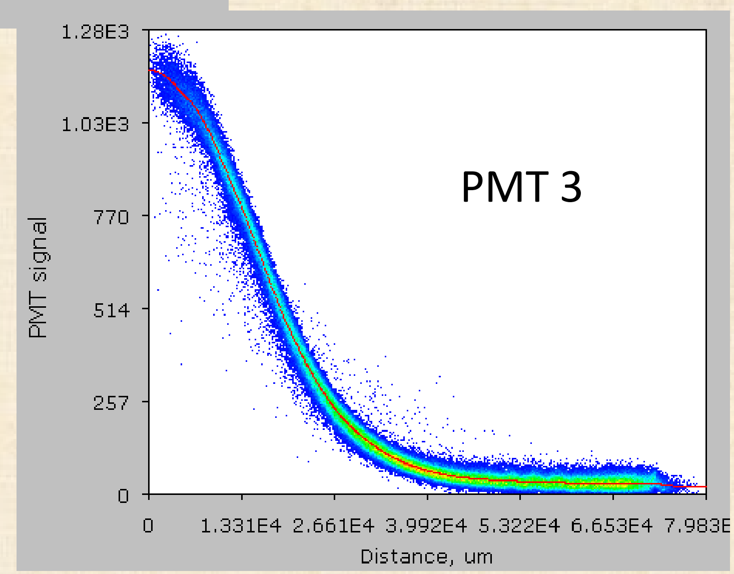
Is LRF adequately describe the data for each PMT?

To check, use this tool:





Blue – reconstructed data
Red – extracted LRF



If LRF appears too much below the center of the scattered data – too much averaging was used! Reduce the averaging range!

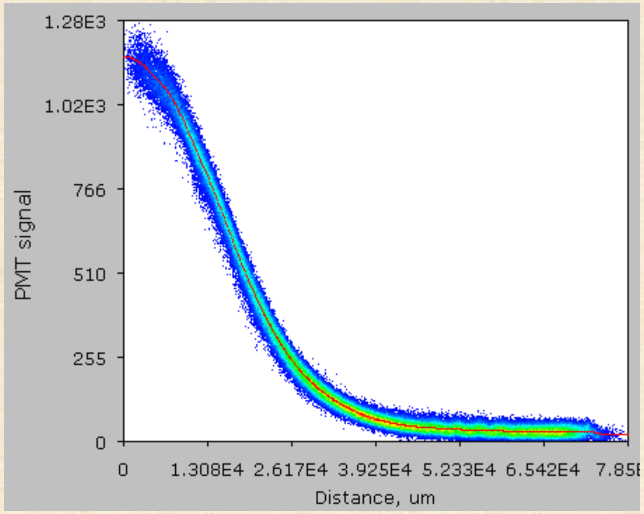
If there is too much "wriggling" in the reconstructed LRF – averaging was not adequate! Increase the range!

Watch for saturation signs: spread in the scattered points close to the peak is larger than square root of average and blurring downwards!

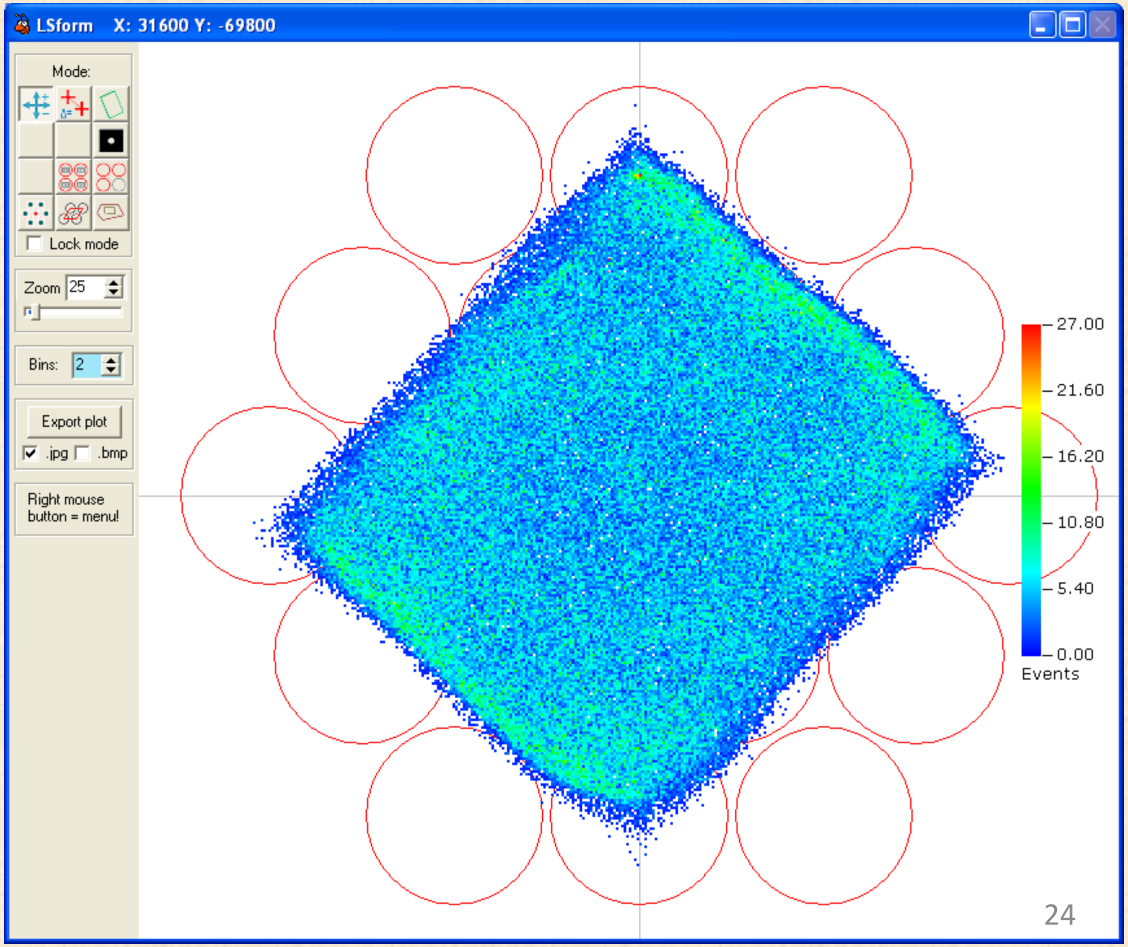
LRF reconstruction: individual LRF model

Next step – can introduce energy and chi-square filters.
Energy filter is typically not needed if strong sum cut-off filter is used.

Applying Chi-square filter with the a very relaxed range 0.1 – 10:



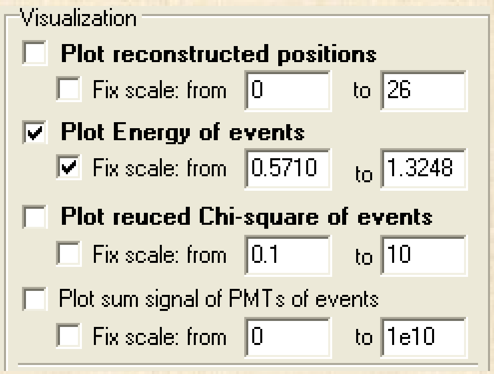
"Noise" is greatly reduced!

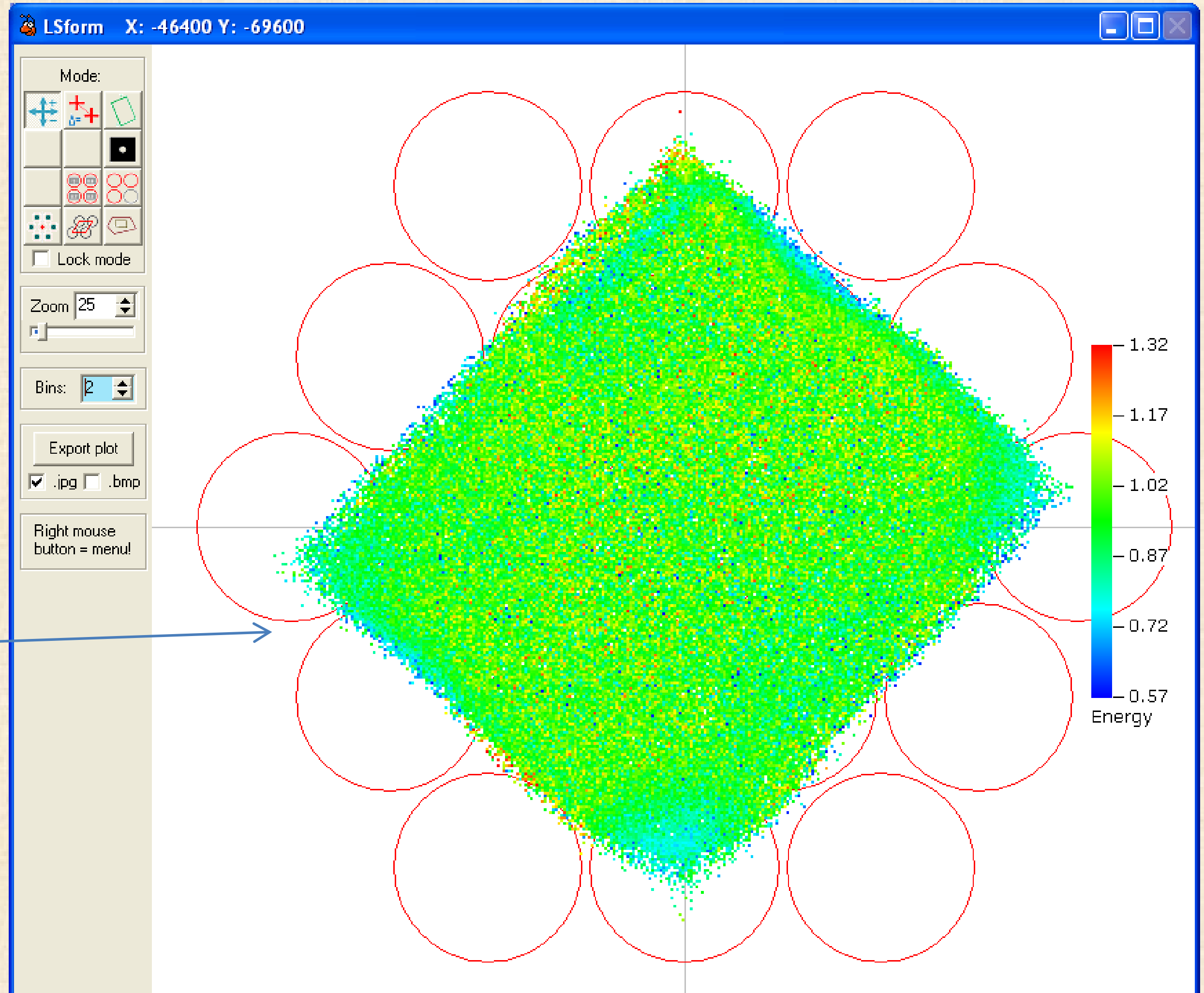


LRF reconstruction: individual LRF model

Now have to perform two quality-tests

1) Area distribution of energy – should be ~uniform



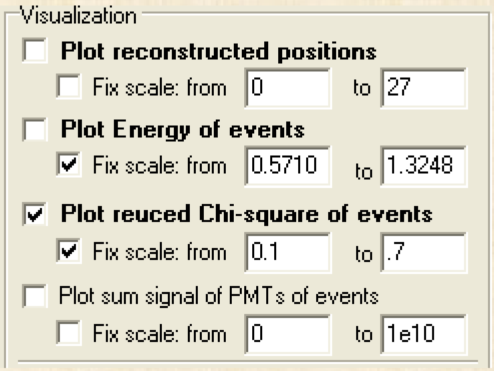


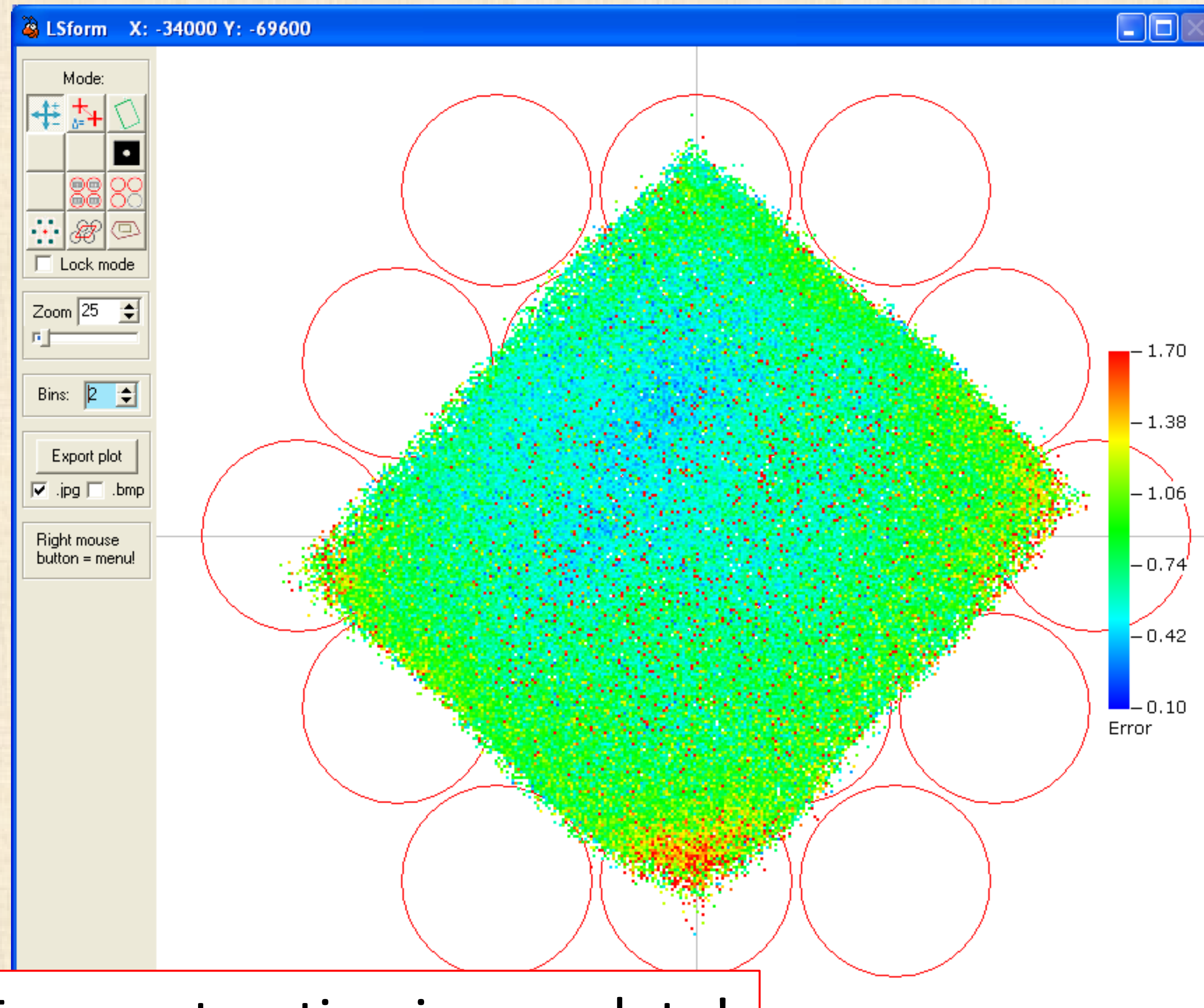
Essentially flat!

(only very small problems in corner areas – as expected)

LRF reconstruction: individual LRF model

2) Chi-square distribution:





It is expected to have <u>minimum in the center</u> and have <u>symmetric distribution</u>.

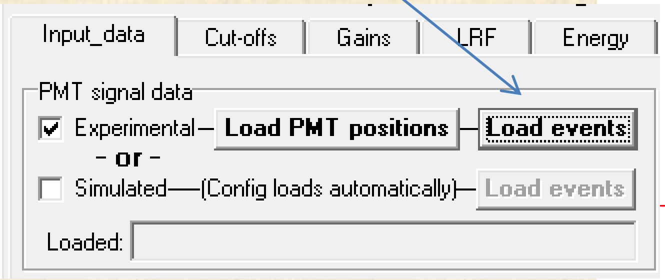
Small problem (again) with the lower corner (need more strict sum cut-off filter?)

LRF reconstruction is complete!

Checking how good was the LRF reconstruction

“Multihole” mask data

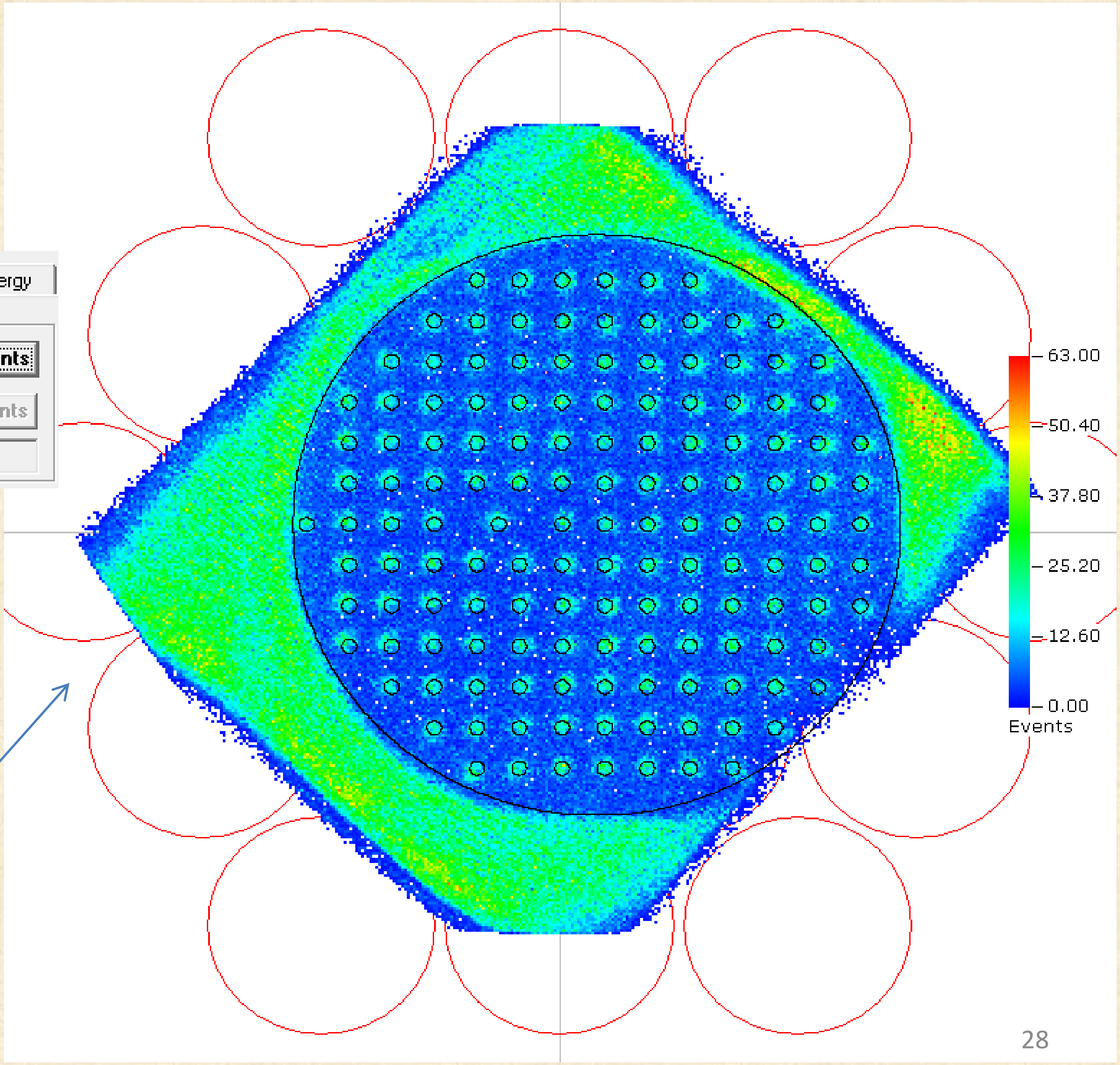
Loading data recorded with the ISIS “multihole” mask



All LRF/settings are conserved!

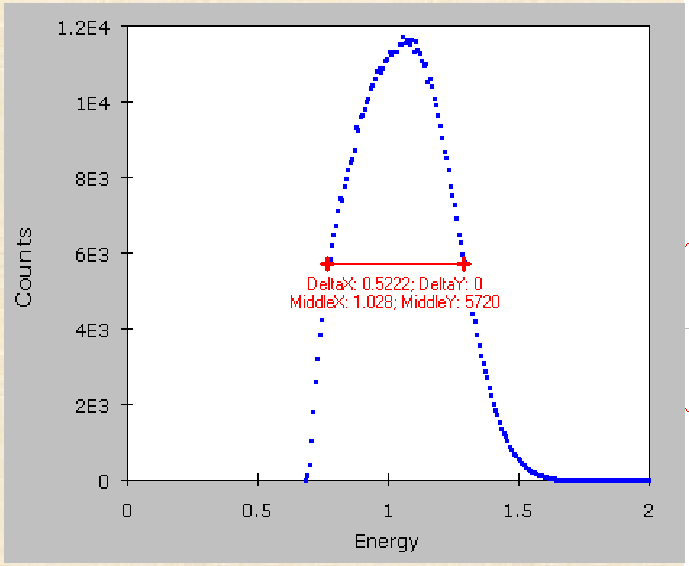
Running ML reconstruction gives:

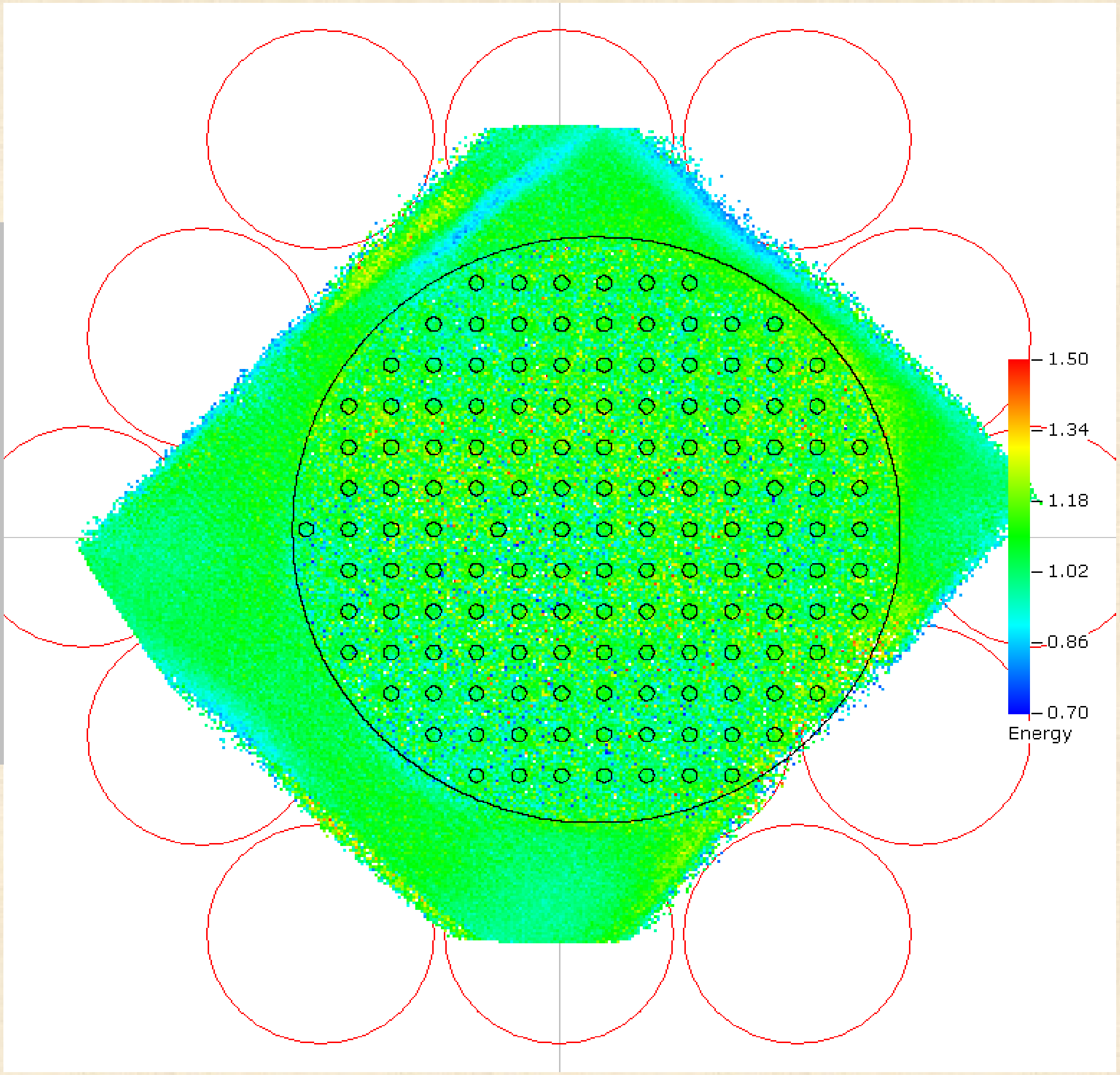
Good quality!



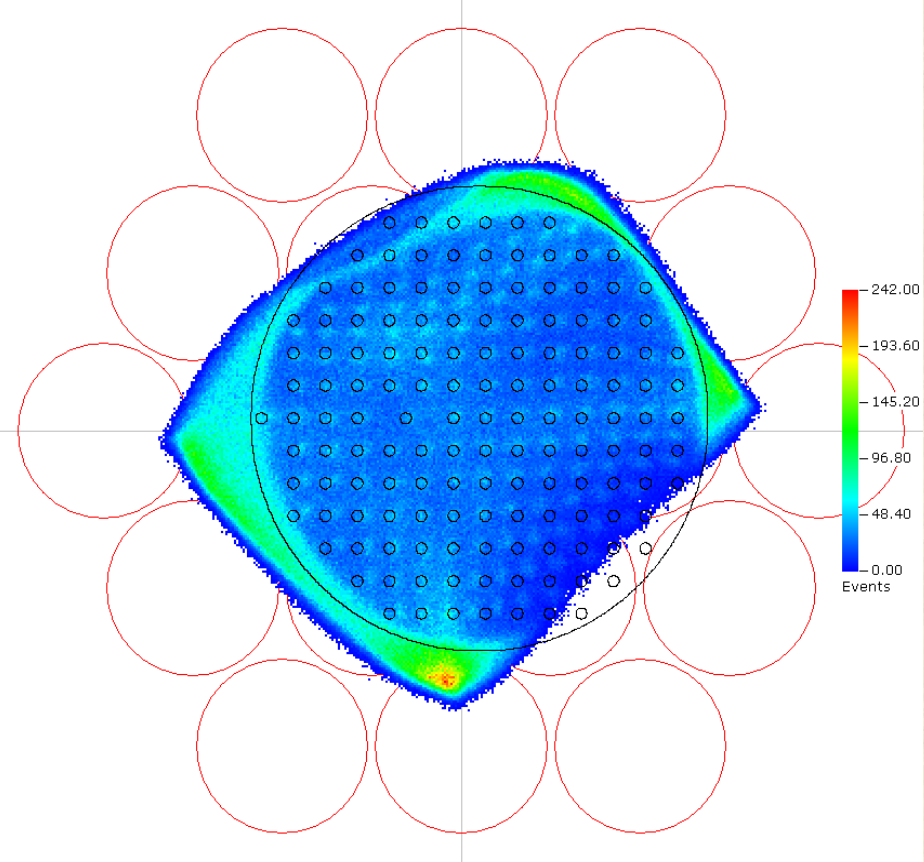
“Multihole” mask data

Checking energy distribution:

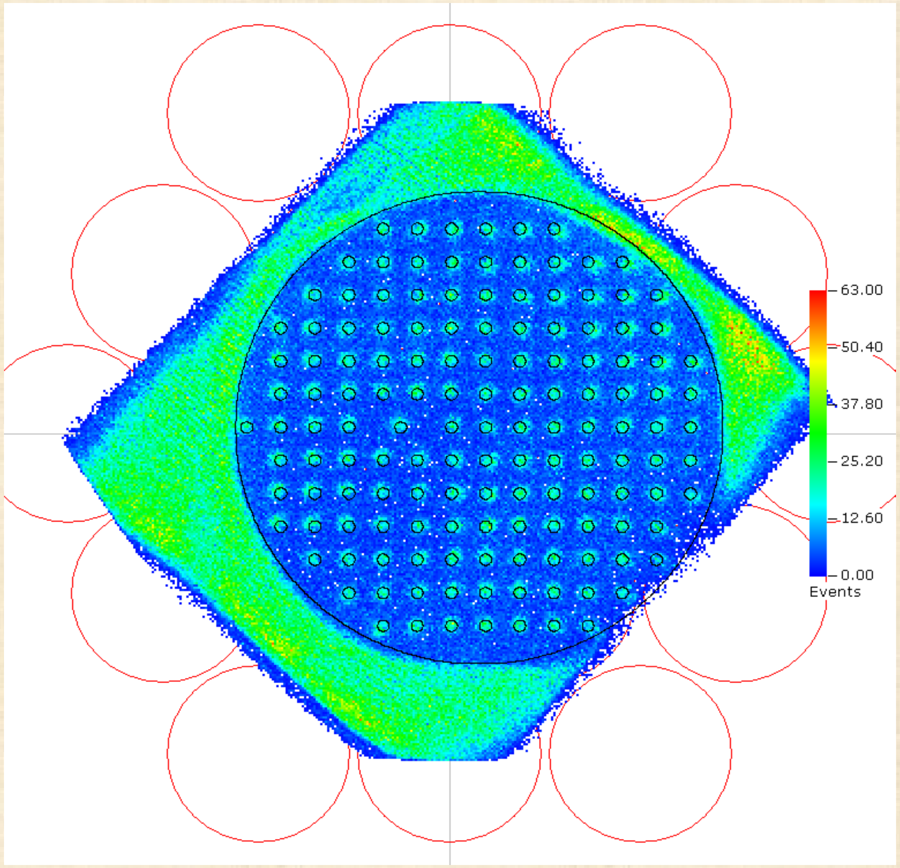




CoG vs ML reconstruction:



CoG, no gains



ML, individual LRFs

October run (another MSGC installed)

Two read-out systems:

Jülich and **Acqiris** data

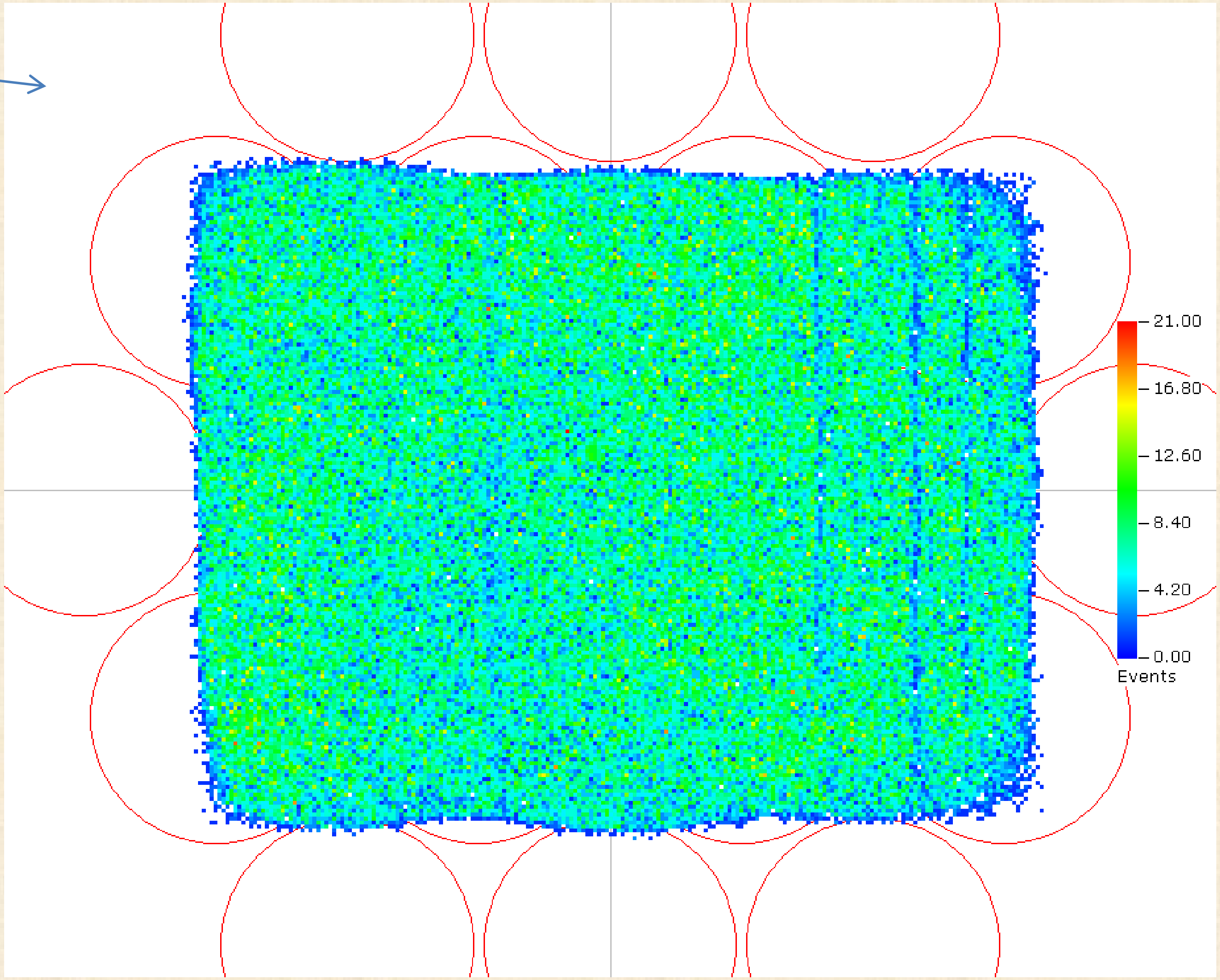
Jülich read-out data

Applying the same adaptive reconstruction technique, we get the following data:

Flood field

Broken anodes still show some bending

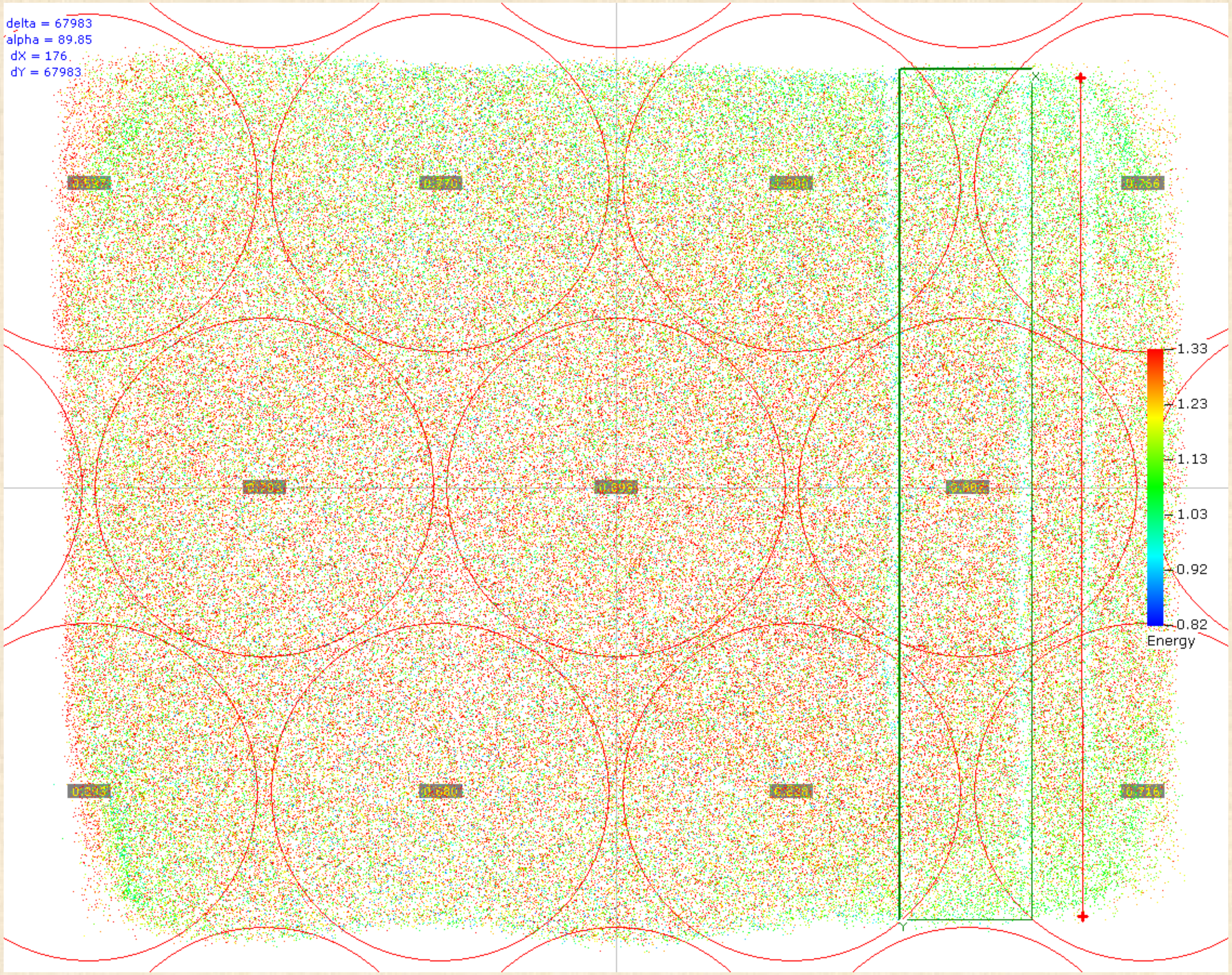
The MSGC rim shows strong "undulation"
Probable reason:
Scattered light on HV connectors and metalized border areas of the MSGC



Jülich read-out data

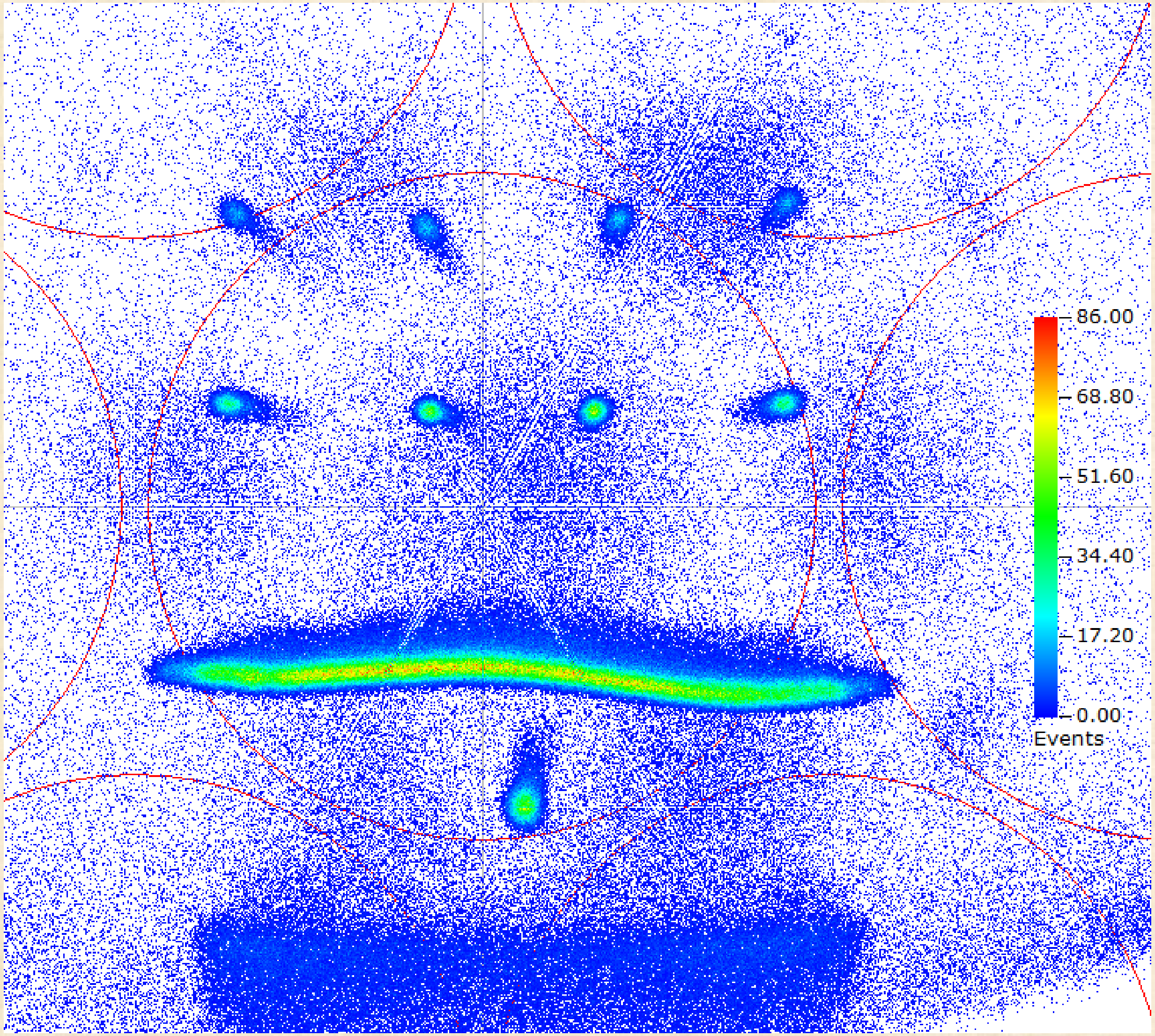
Another flood
Image (not final data!),
LS reconstruction,
plot of
energy distribution.

One can see that
that there are two
distinct ensembles
of events in the
corners!



Jülich read-out data: Slit mask

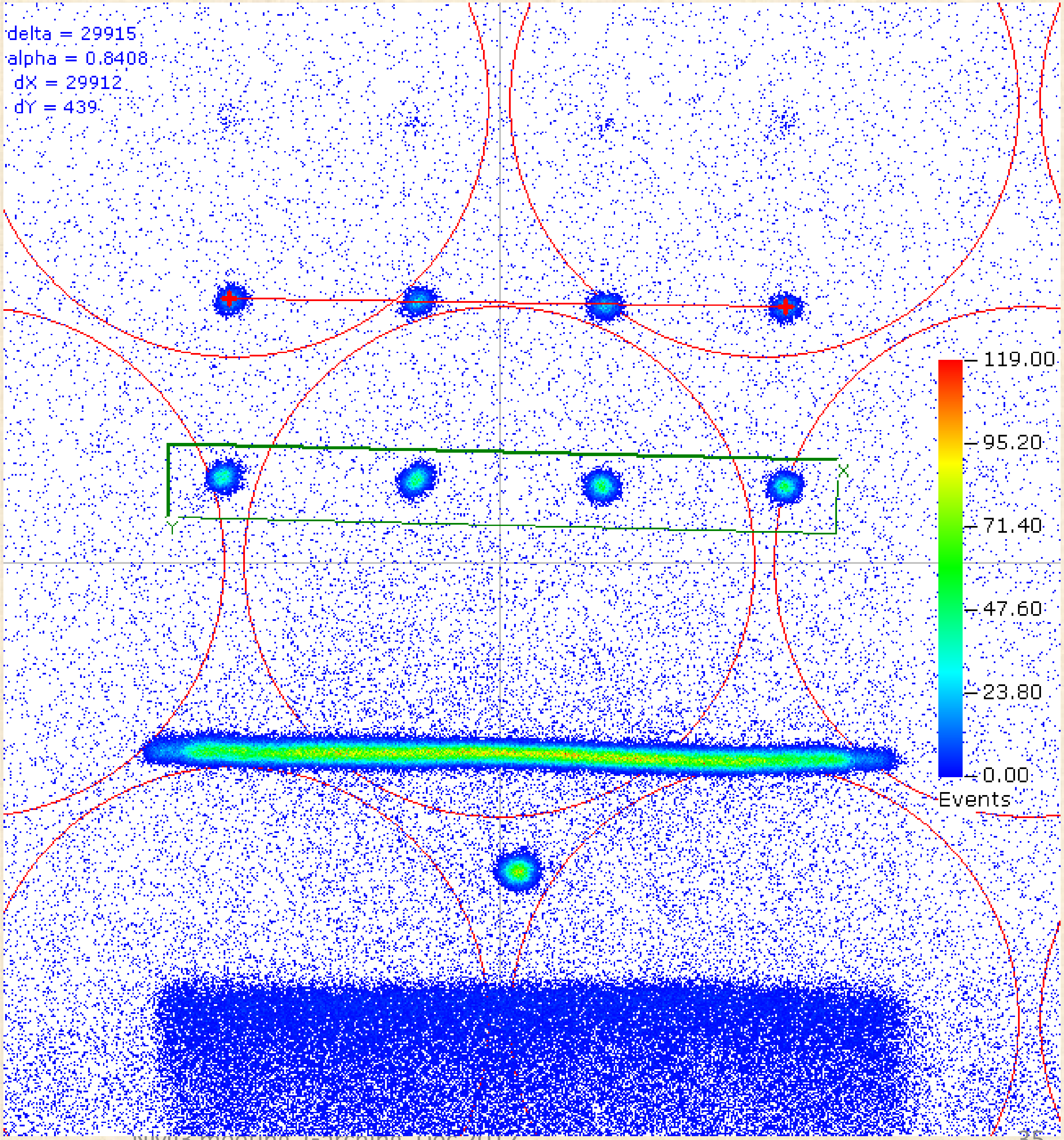
CoG reconstruction, no gains



ML reconstruction,

Individual LRFs

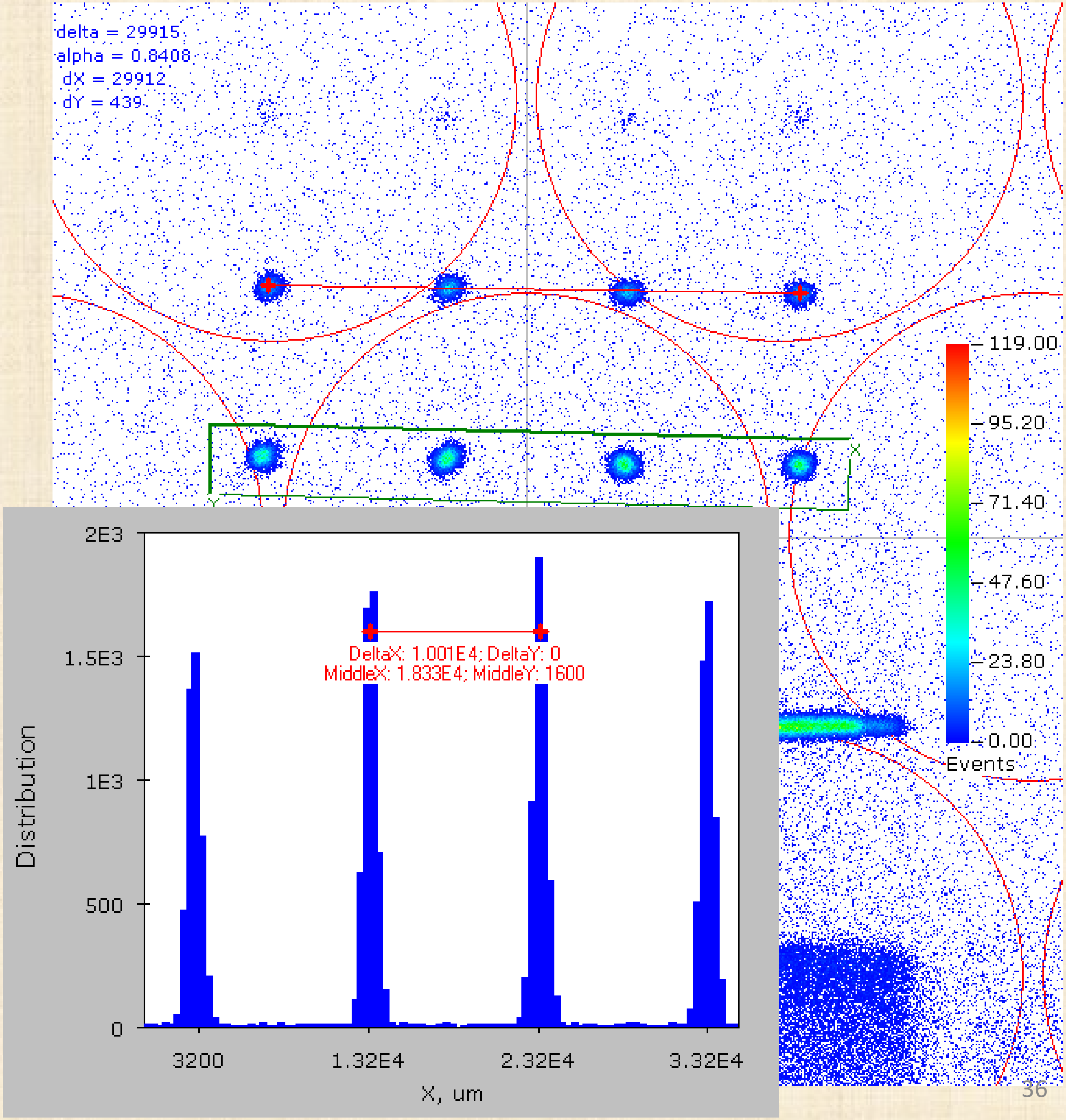
10 mm hole-to-hole distance



ML reconstruction,

Individual LRFs

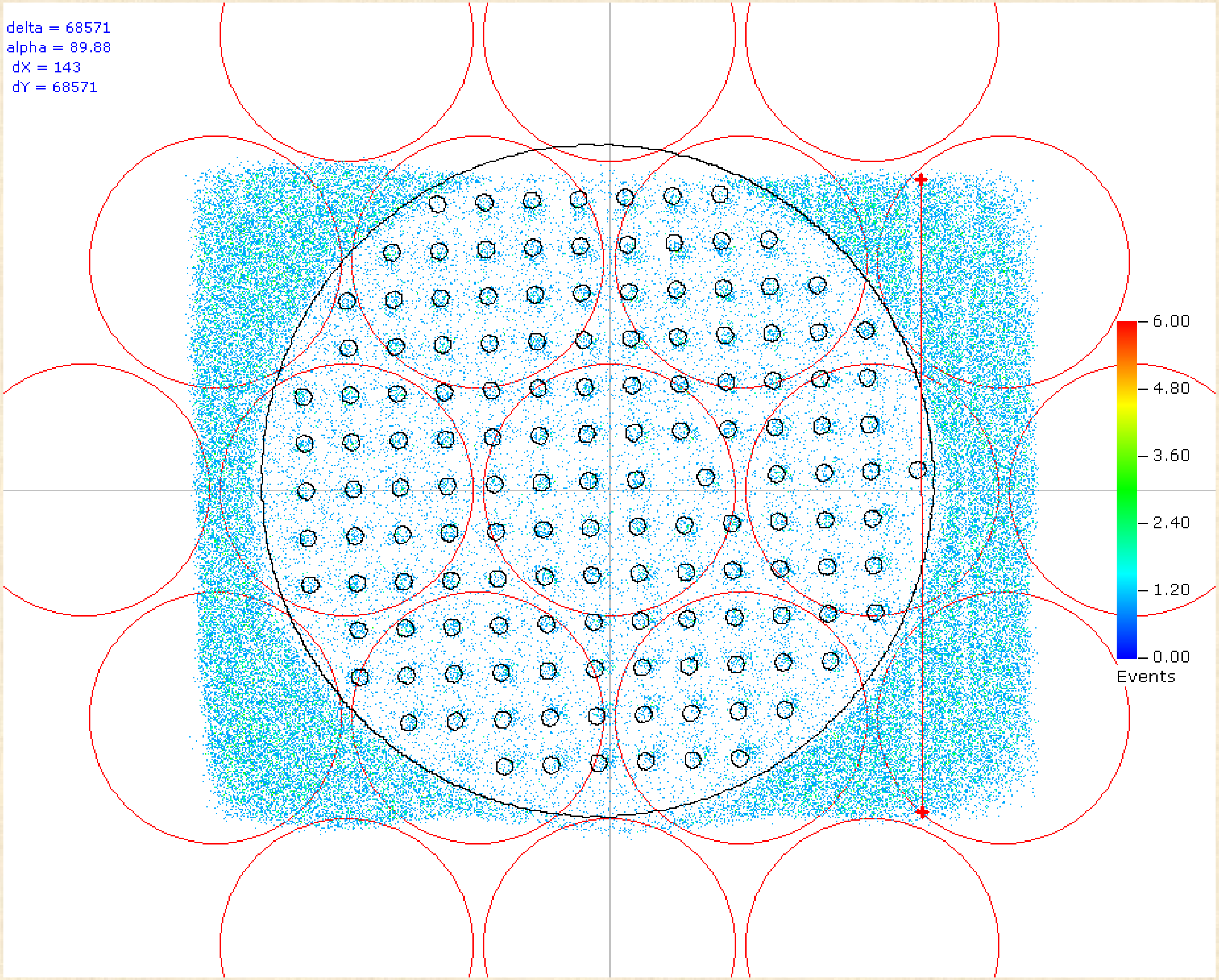
10 mm is well reproduced!



Jülich read-out data: Multihole mask

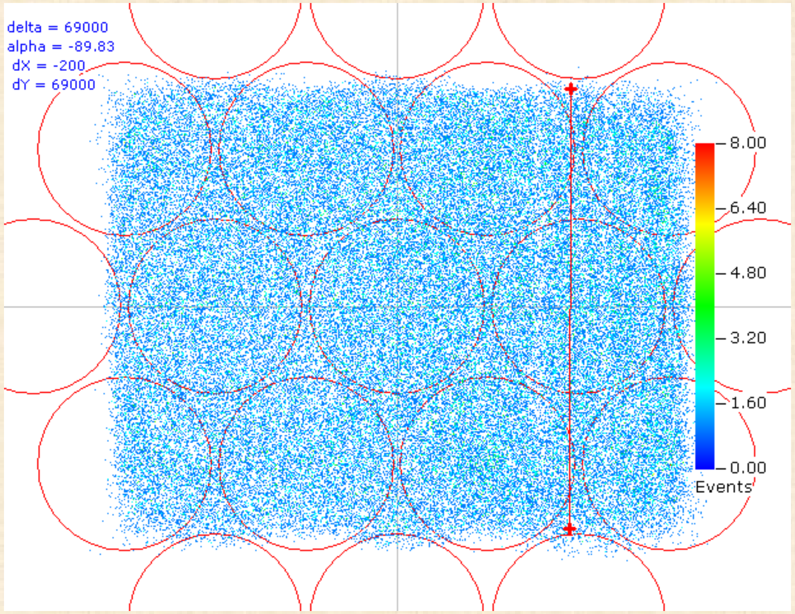
ML reconstruction,

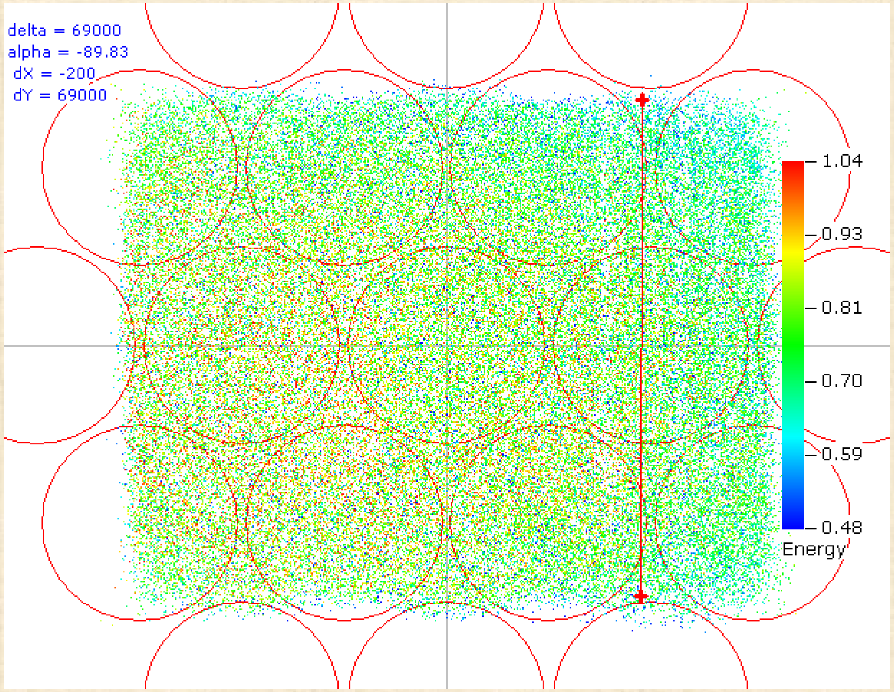
Individual LRFs



Acqiris read-out: Flood data

Problem – in the PMT signal data, the offsets were not corrected for, and some of them were negative!

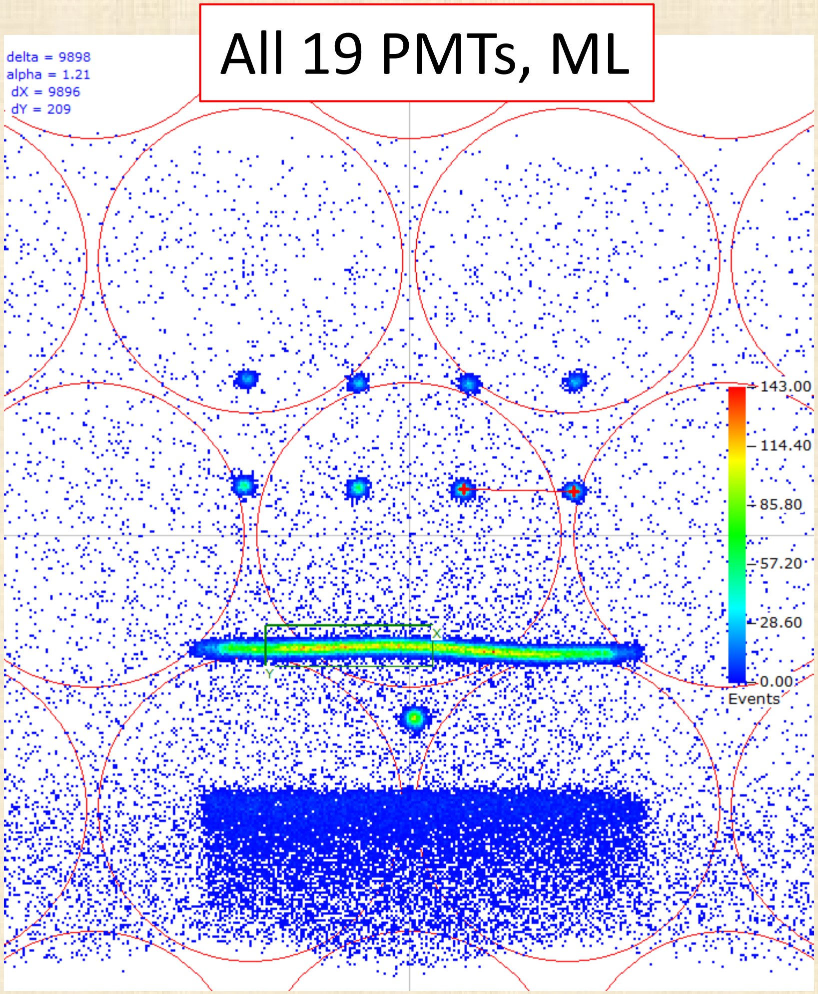


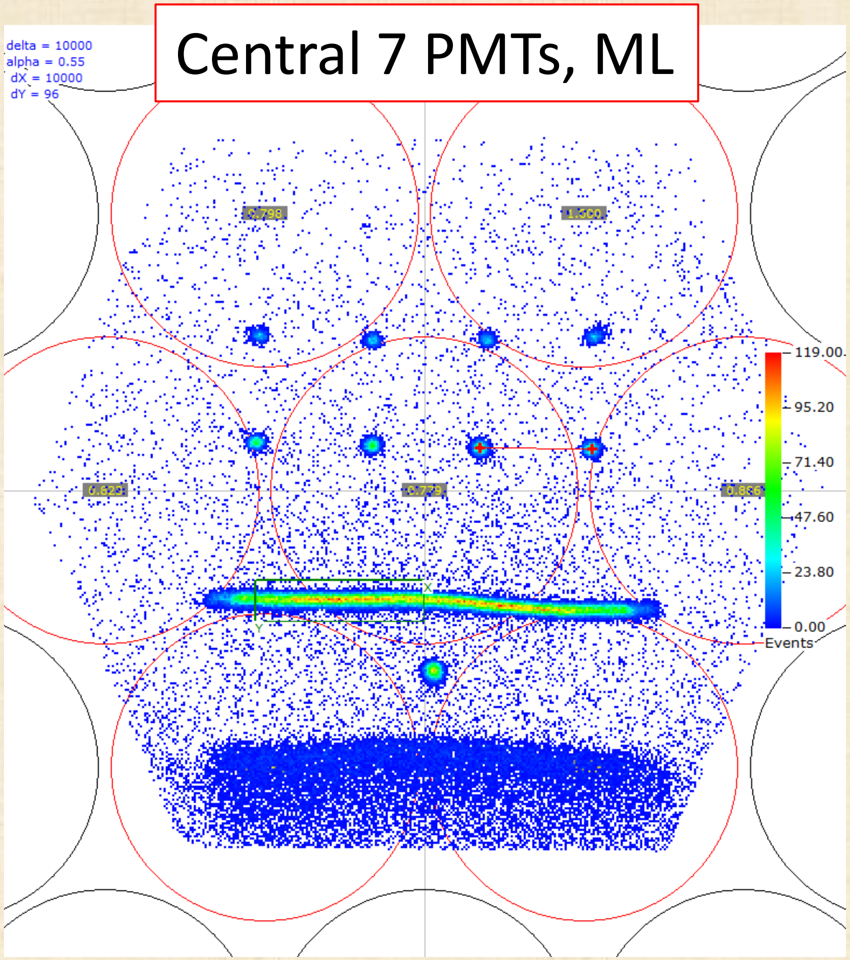


Positions, LS reconstruction, Individual LRFs

Energy, LS reconstruction, Individual LRFs

Acqiris read-out: Slit mask





ML perform significantly better than LS
7-PMT reconstruction is better than 19-PMT one!

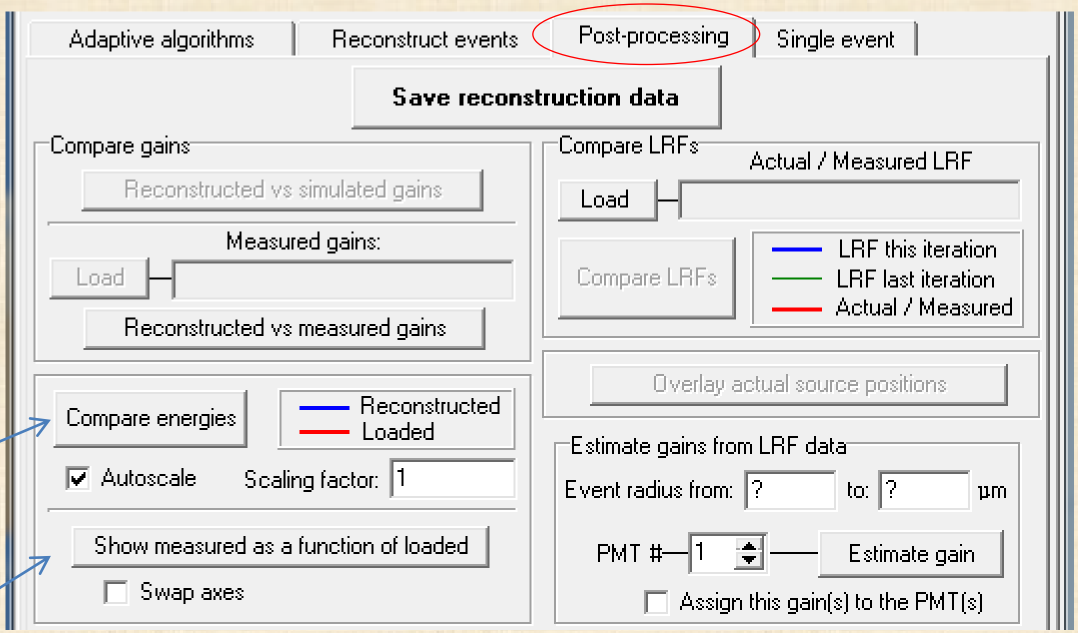
Post-processing in ANTS

Just a few features

Post-processing

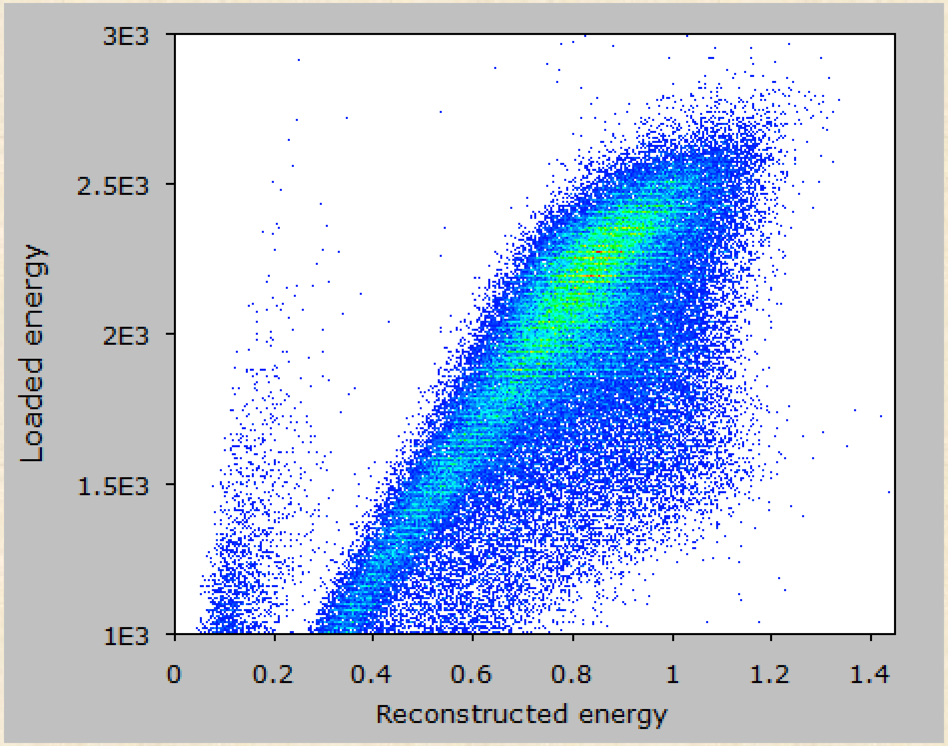
With Acqiris, the energy of events was recorded (anode signal).

This energy can be compared with the reconstructed energy.



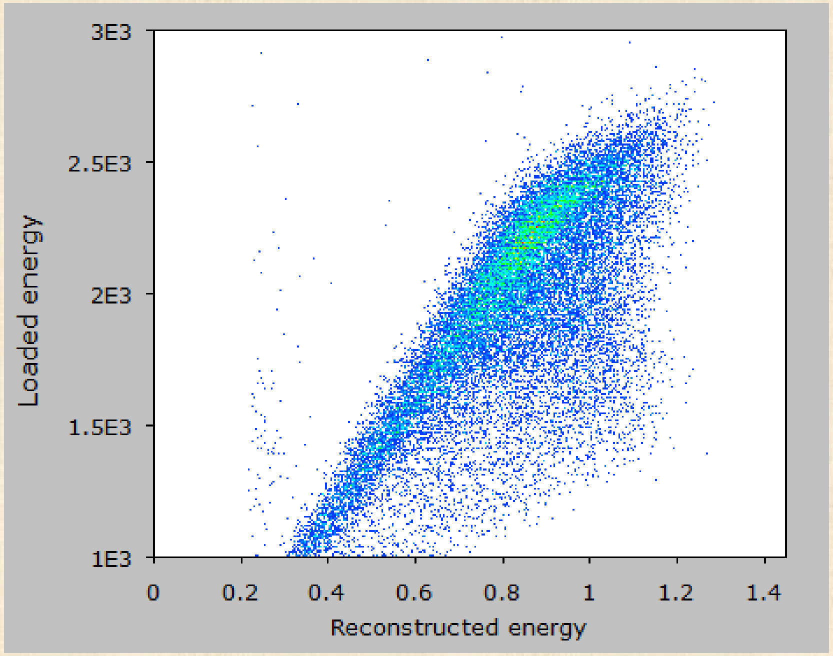
"**Compare energies**" shows both distributions,
and the "**Show measured as a unction of loaded**" plots one versus the other (over all events).

Compare energies



All event filters are respected!

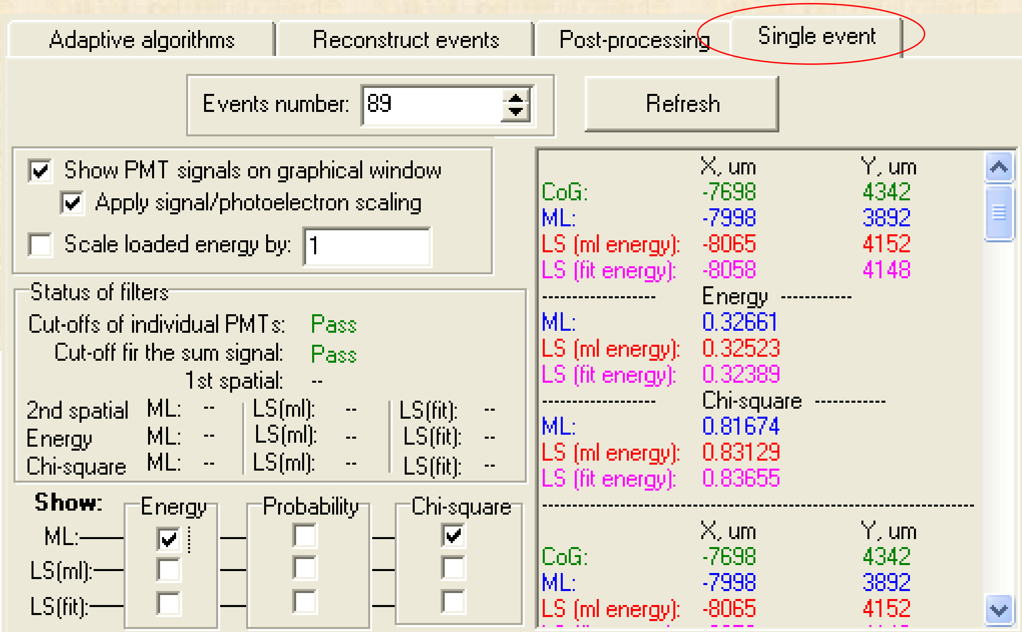
No cut-offs, all MSGC area

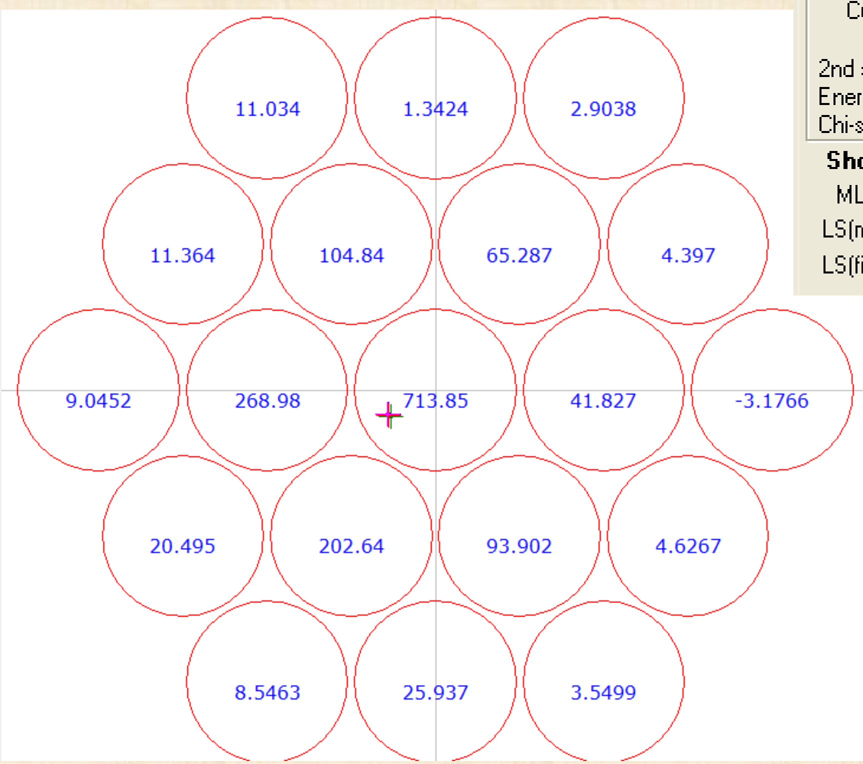


Sum cut-off on, 20 mm x 20 mm central area

Single event processing

Example of a "good" event

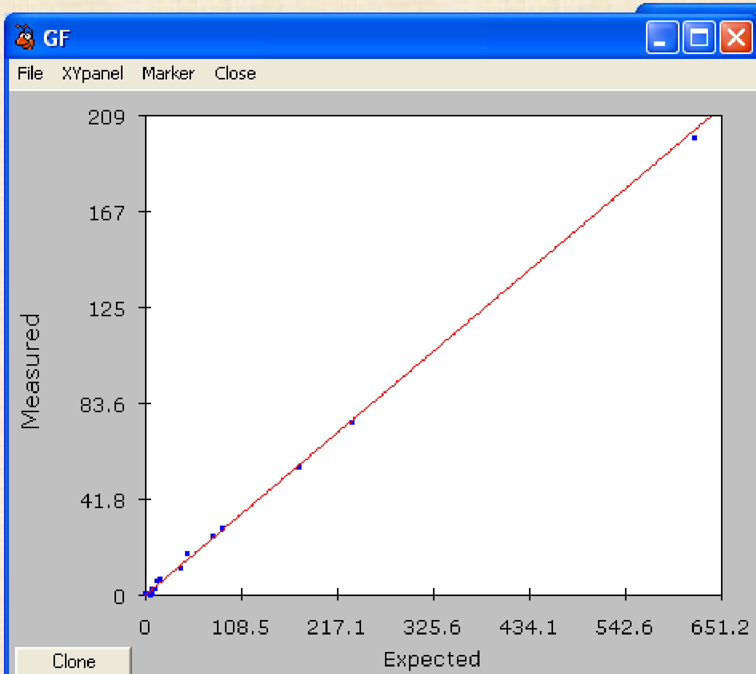




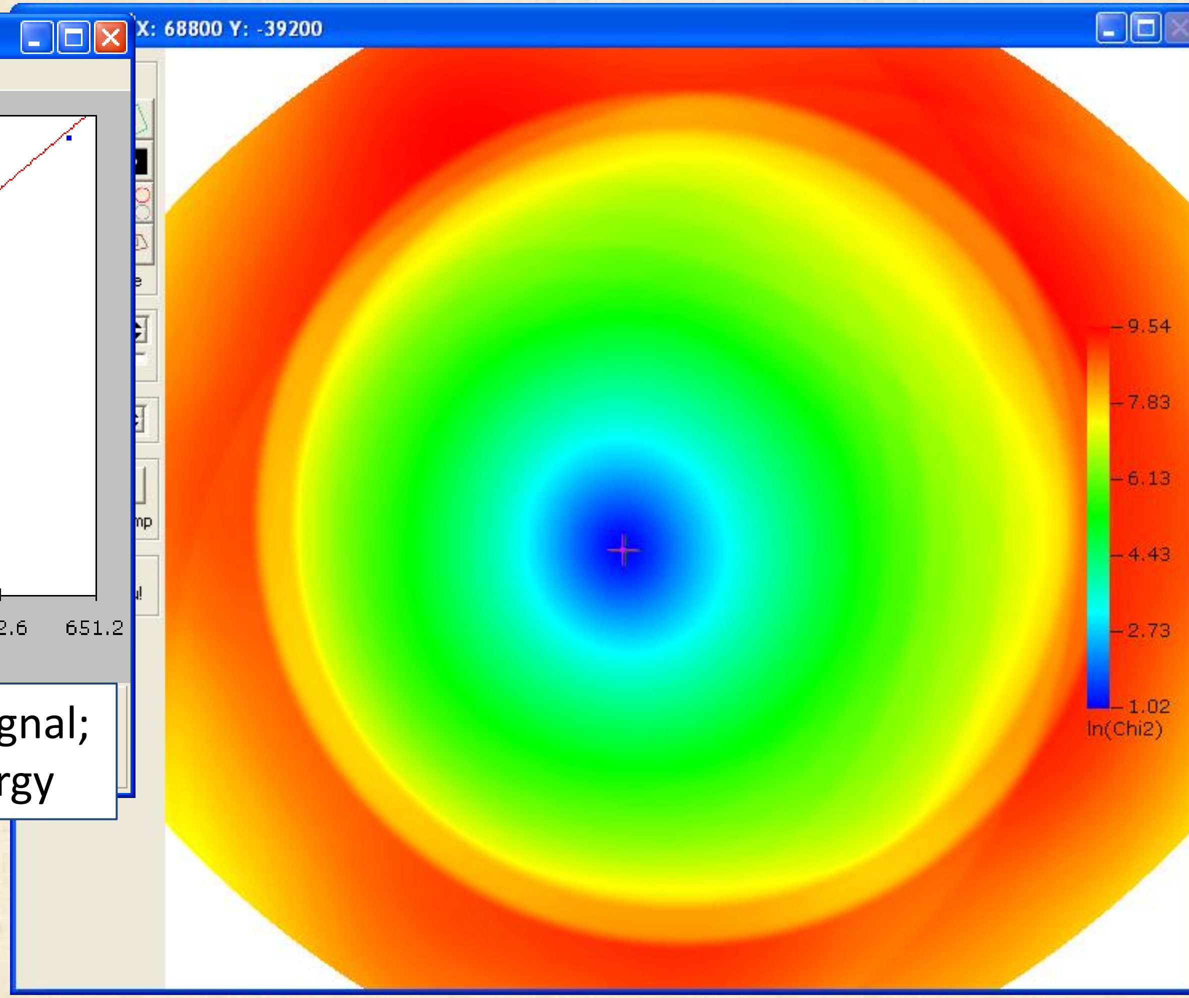
Information shown (ML and two LS algorithms):

- Reconstruction position, energy and chi-square;
- Status of all event filters;
- PMT signals;

Single event processing: good event

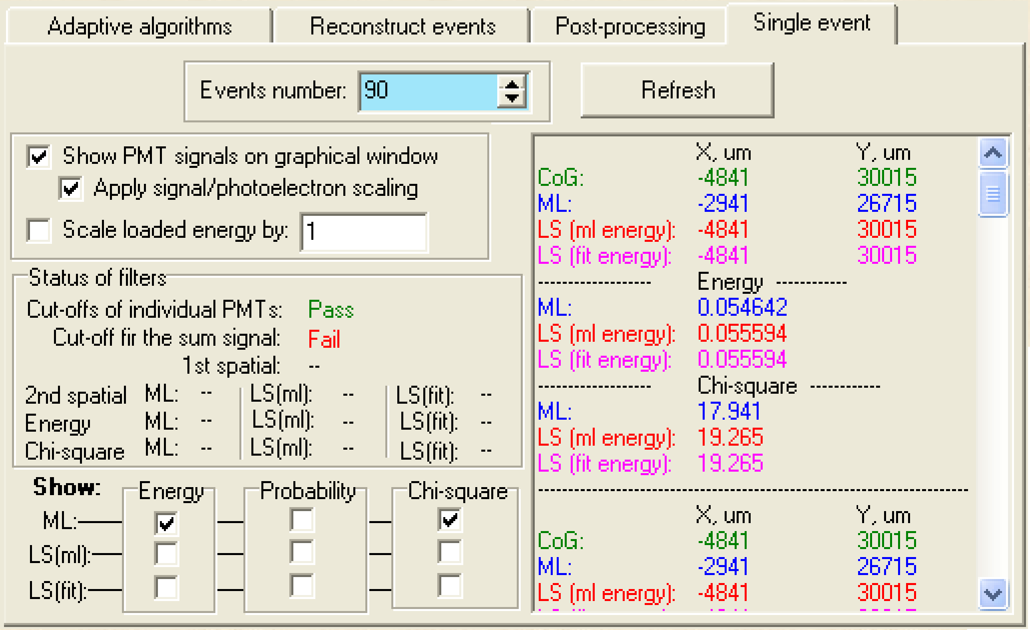


Measured vs Expected PMT signal;
The slope gives the event energy

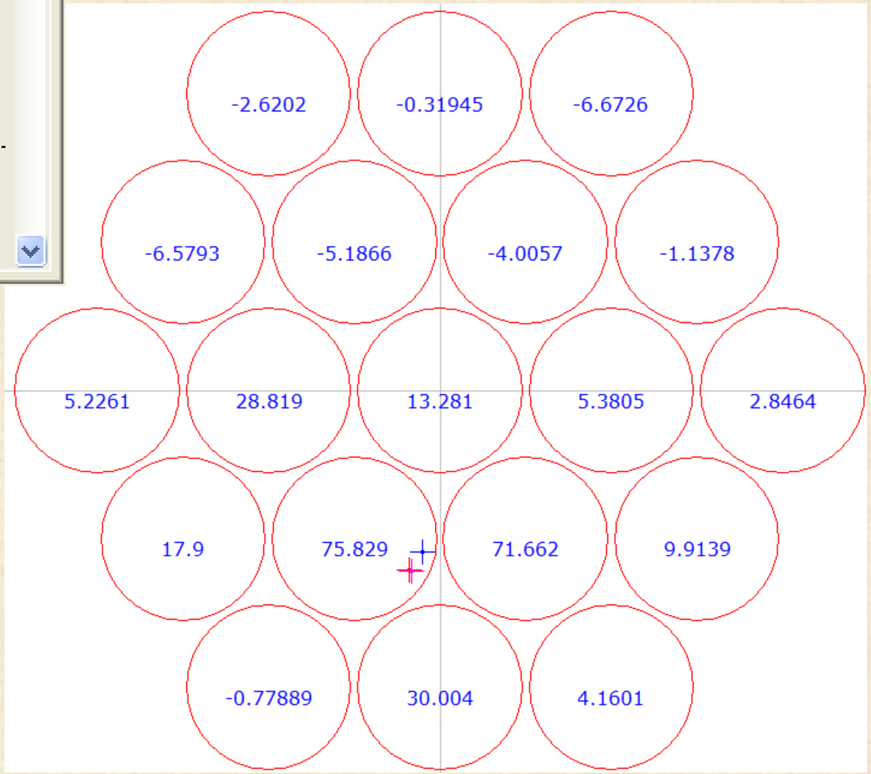


Chi-square vs position: Visible area is scanned (source position is assumed at each location) and the Chi-square is reported.

Single event processing: bad event



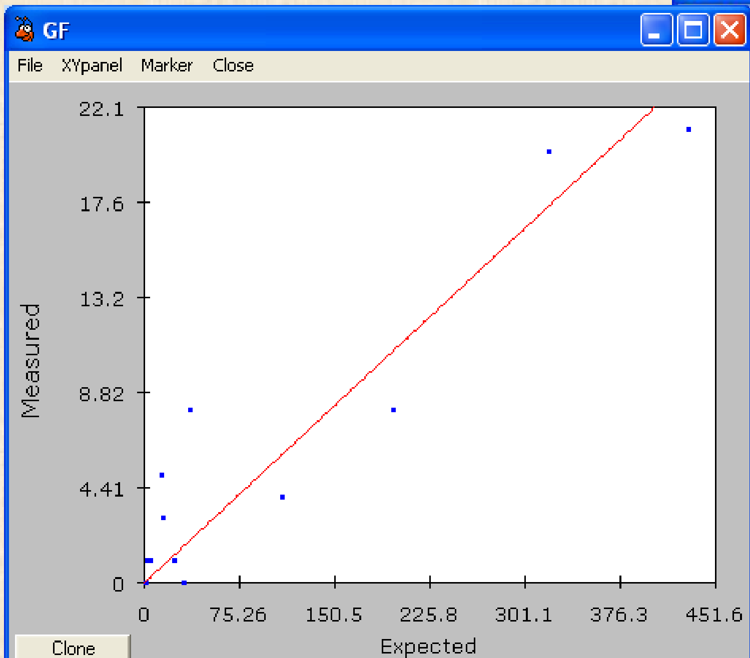
Example of a “bad” event



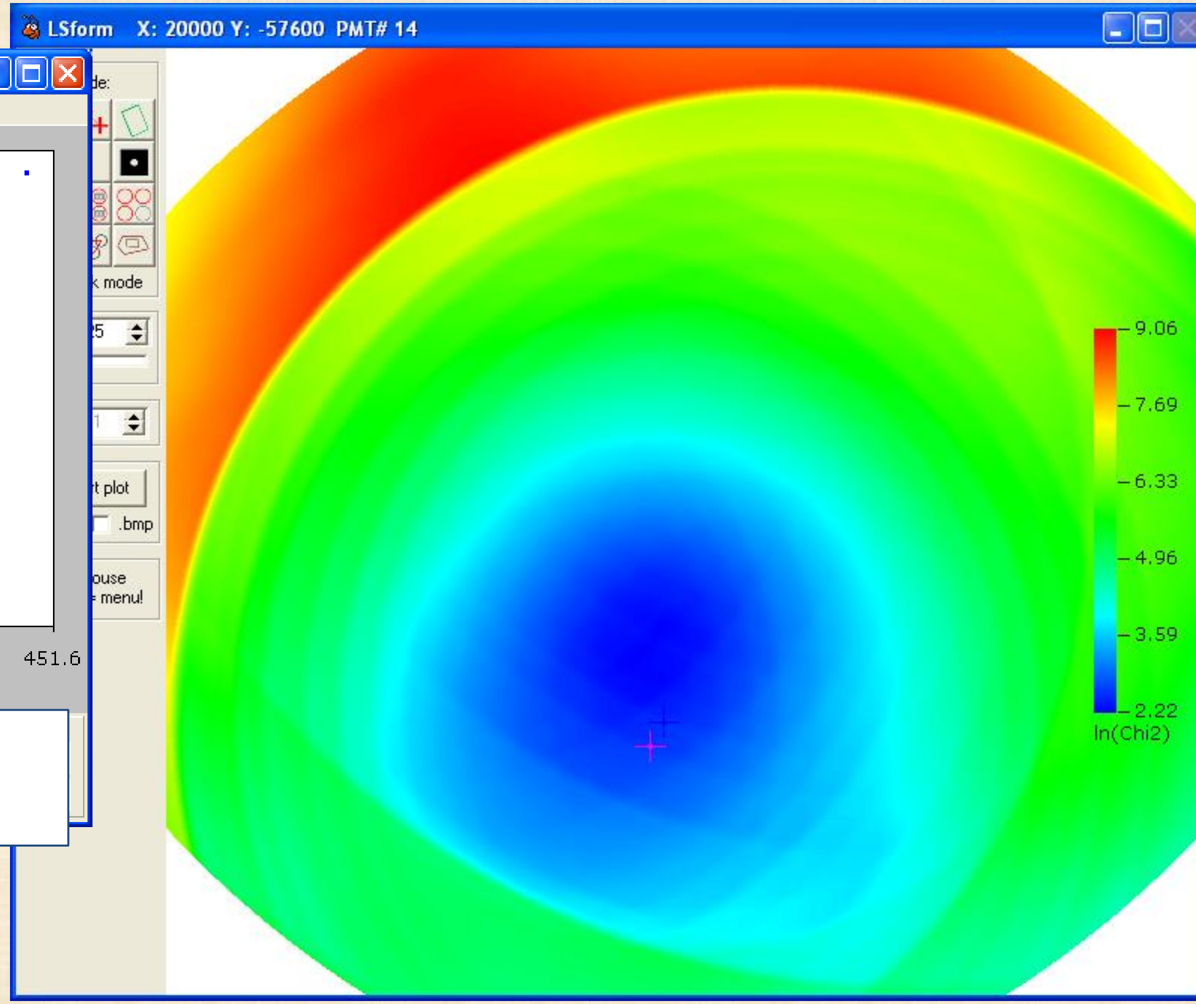
Too low energy,
Too large Chi-square;
LS position = CoG position.

Failed Sum cut-off filter.

Single event processing: bad event



Too far away from linear dependence!



Broad min area; Many local minima.

Can be used as an advanced event filter!

GSPC 19 contributing to the modern art ☺

Artifacts in the
CoG reconstruction
due to discreteness
of the PMT signals:
There are
“forbidden bands”
in space
(60 degrees symmetry)