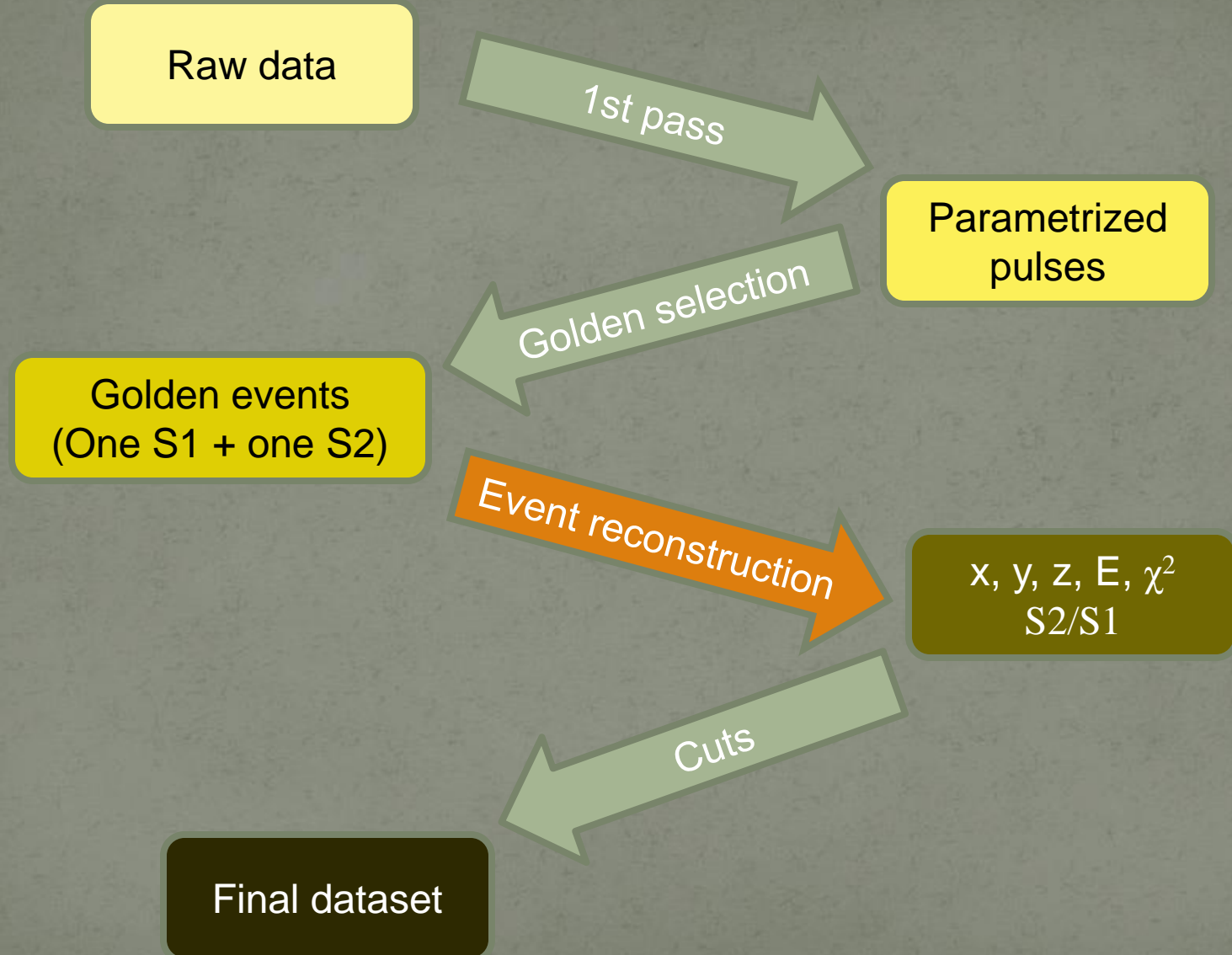


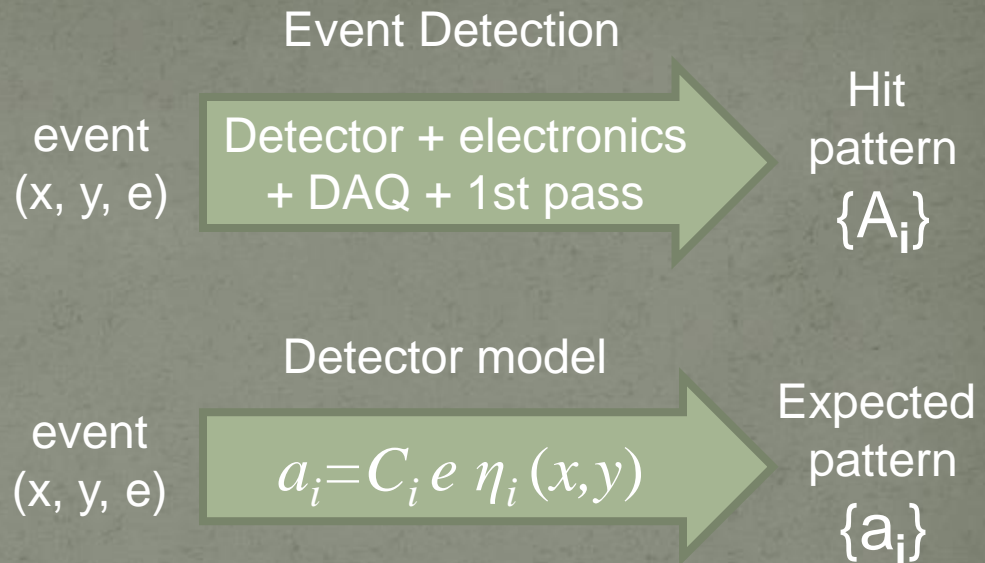
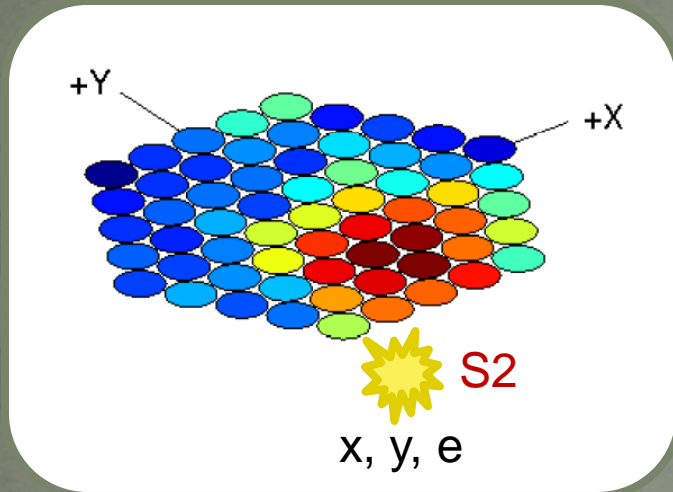
Reconstruction of events in LUX

Vladimir Solovov (LUX Collaboration)

Event analysis



Event reconstruction



To reconstruct an event from a hit pattern find \mathbf{x} , \mathbf{y} and \mathbf{e} for which the expected pattern $\{\mathbf{a}_i\}$ is in the best agreement with hit pattern $\{\mathbf{A}_i\}$.

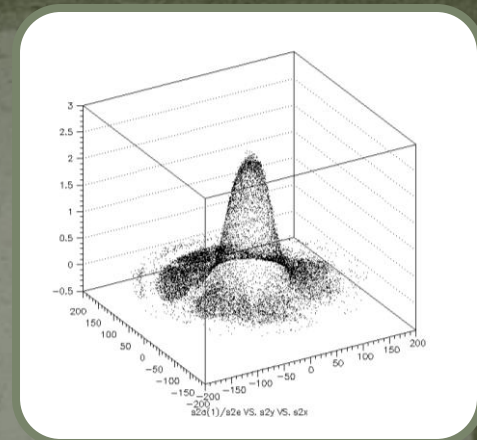
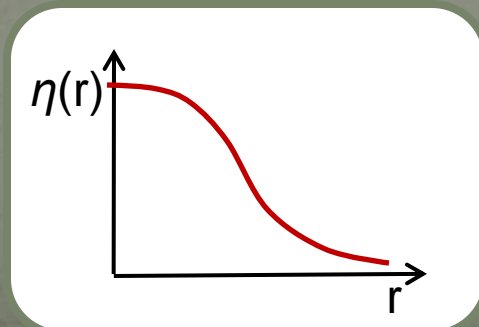
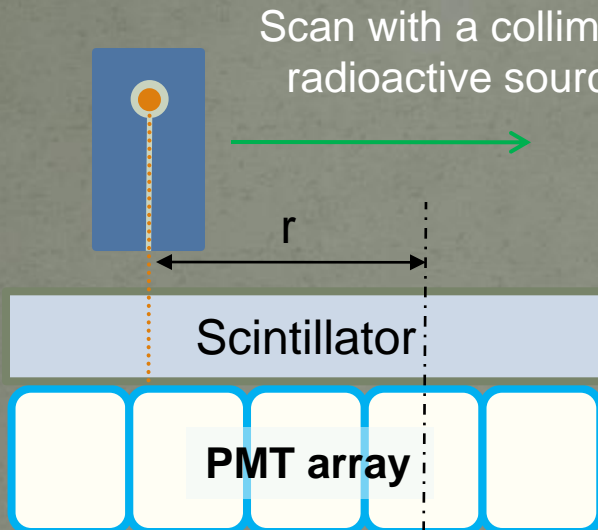
Weighted Least Squares (LS) method can be used if A_i are normally distributed (true for S2 in all practical cases). x , y and e are found by minimizing the following function:

$$\chi^2(x, y, e) = \sum_i w_i (A_i - C_i e \eta_i(x, y))^2$$

Light Response Functions

Light Response Function (LRF) $\eta_i(x,y)$ is the response of i -th PMT to an isotropic point source at the position (x,y) . In many cases it has axial symmetry and can be reduced to $\eta_i(r)$ where r is the distance from the PMT axis

How to find $\eta_i(r)$?

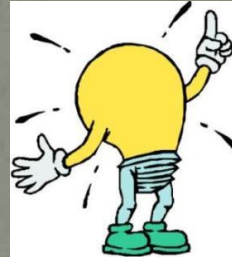
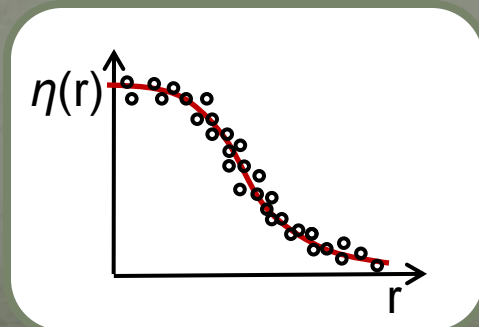
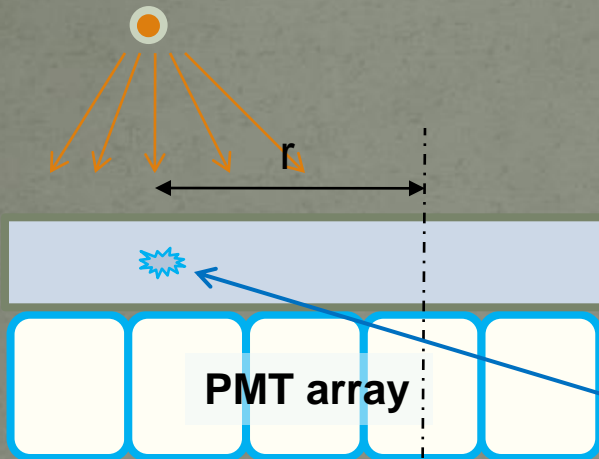


☹ Impossible for a liquid xenon detector

Light Response Functions

How to find $\eta_i(r)$?

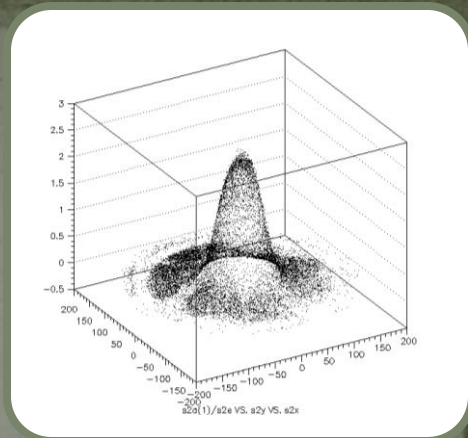
A crazy idea:



What if we remove the collimator altogether and do a “virtual” scan instead?

We can use the good old center of gravity (COG) method to get the approximate event position

Plot the PMT response vs approximate distance and fit it to estimate LRF

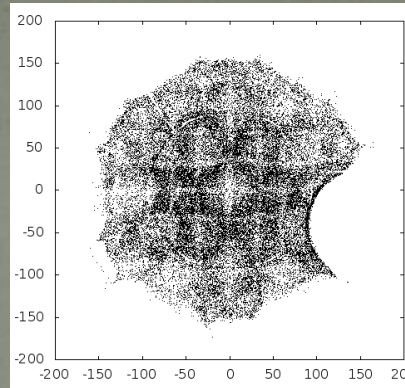


Iterative procedure

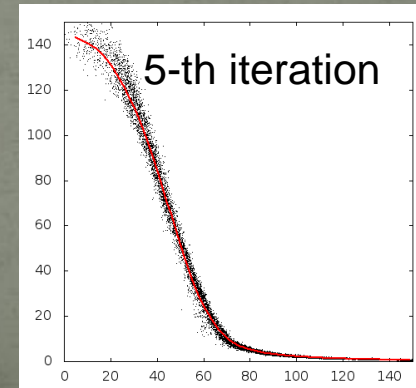
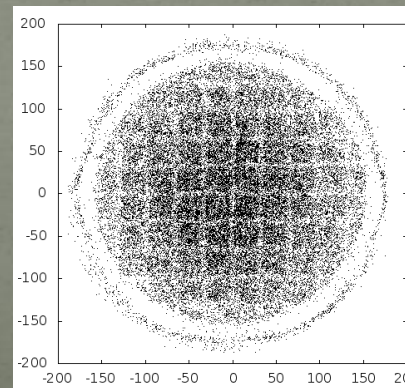
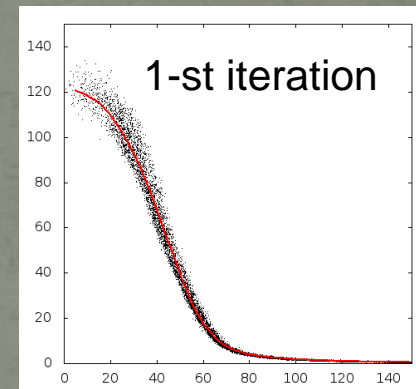
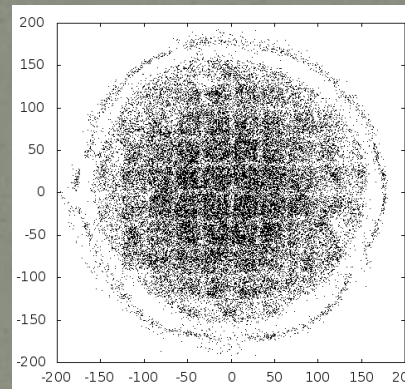
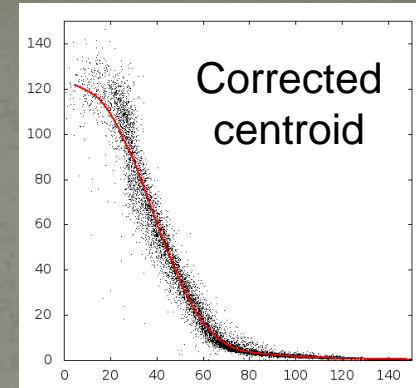
- 1) Reconstruct “virtual” scan data with COG algorithm
- 2) Plot S2 for a given PMT vs distance from its axis (r) for events in the central region
- 3) Convert it to profile histograms and fit to get the first approximation for the PMT response functions
- 4) Run the least squares reconstruction with the new set of response functions
- 5) Update S2 vs r plot
- 6) Find second approximation for response functions
- 7) Repeat (4)...(6) until response functions don't change

ZEPLIN-III example

y – x scatter

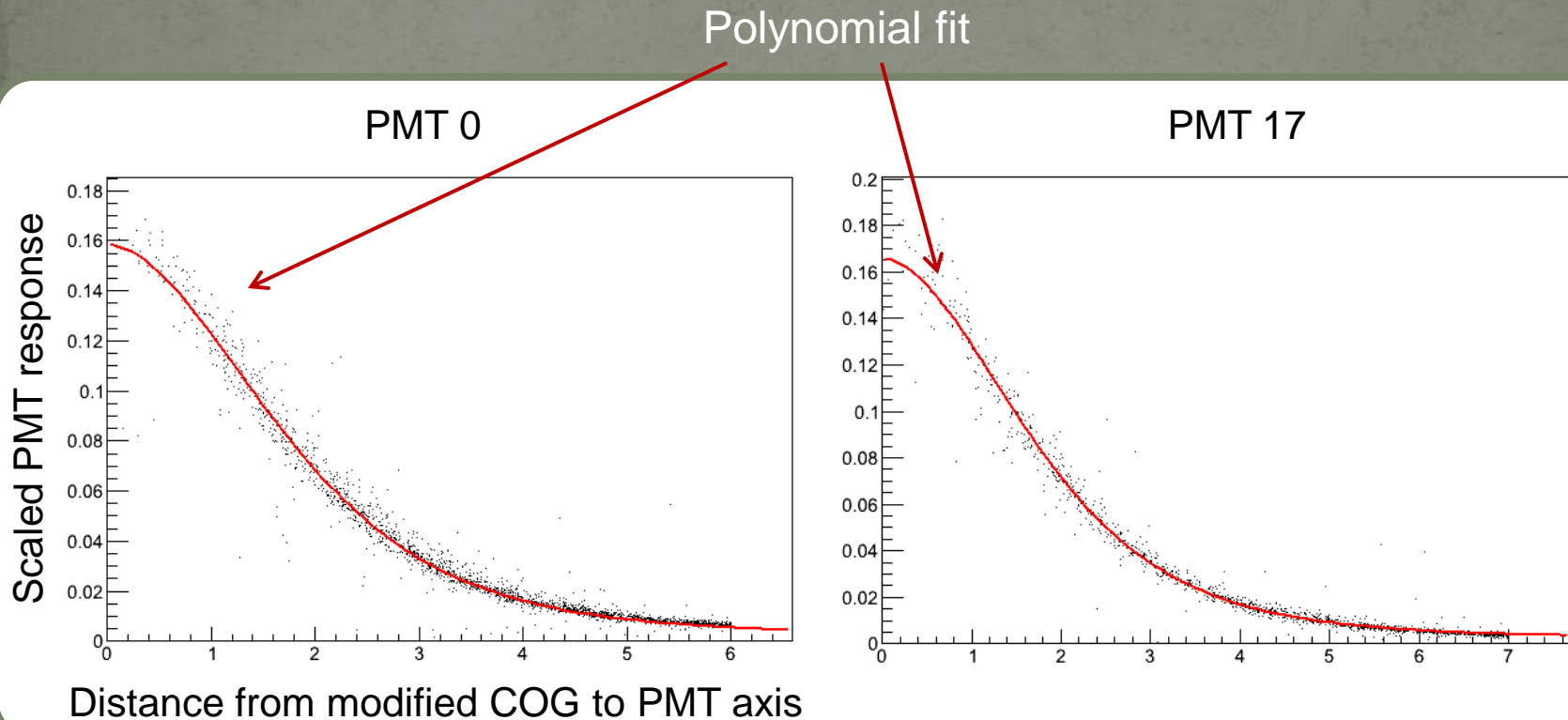


PMT response vs r
and the **LRF**



LUX case

- No uniformly distributed calibration data
- Better light collection => better total light estimate from the sum of PMT responses => can scale the PMT responses
- Let's try using background data for the same purpose

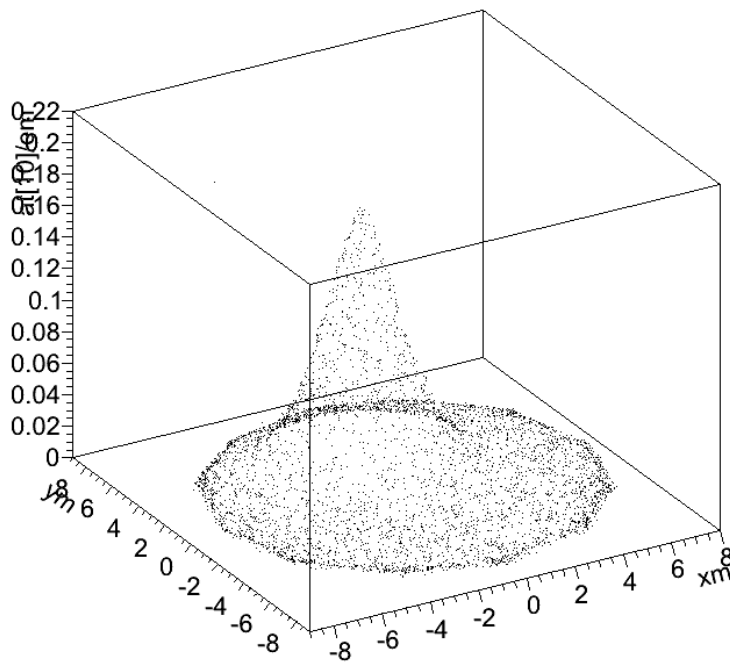


Second iteration

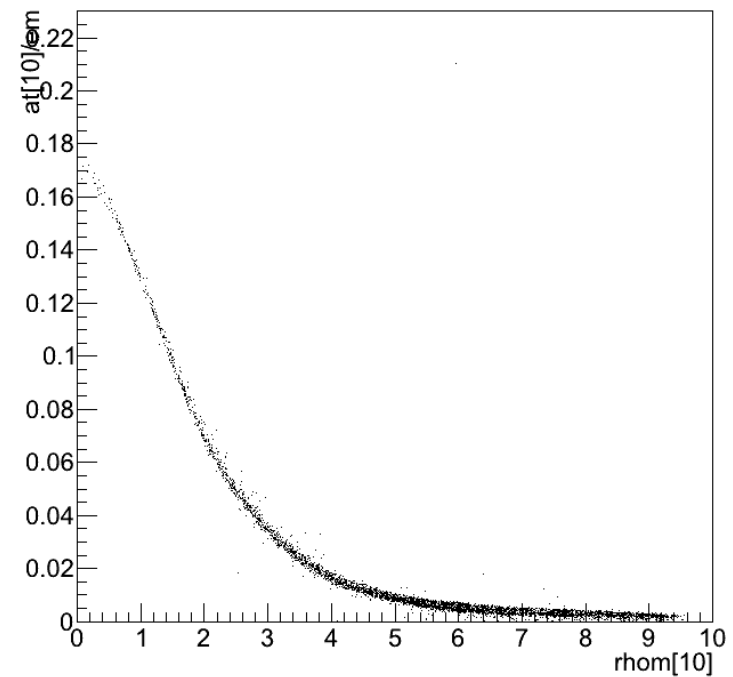
- The LUX PMT array is so amazingly good that LRFs converge on the second iteration!

Example: LRF for PMT10

at[10]/em:ym:xm {rhom[0]<8&&chim/em<100&&at[10]/em<0.3}

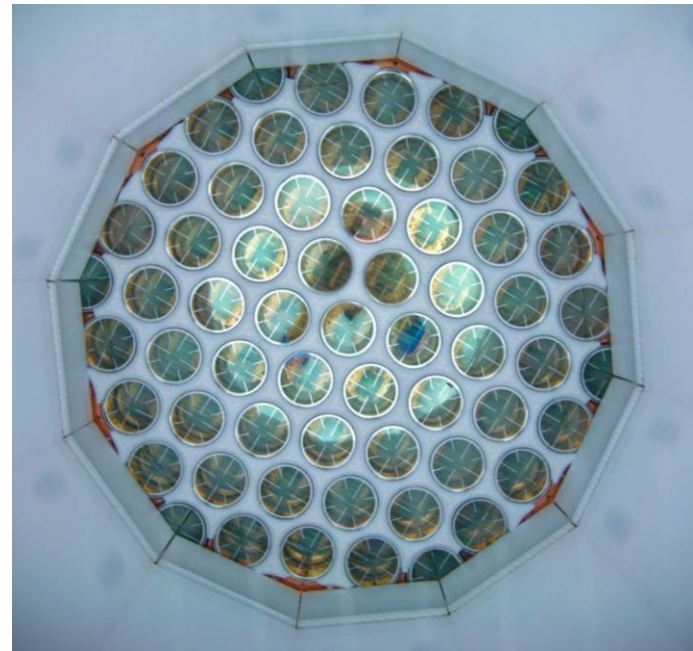
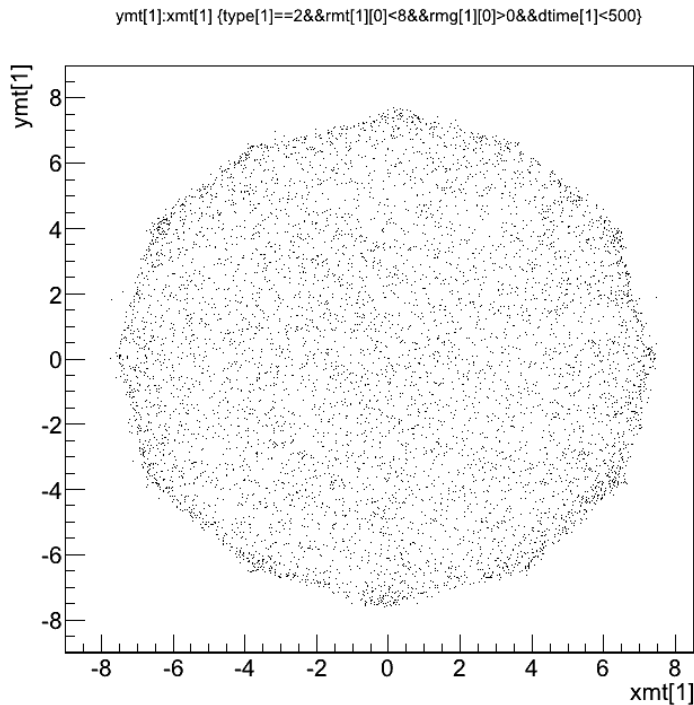


at[10]/em:rhom[10] {rhom[0]<8&&chim/em<100&&at[10]/em<0.3}



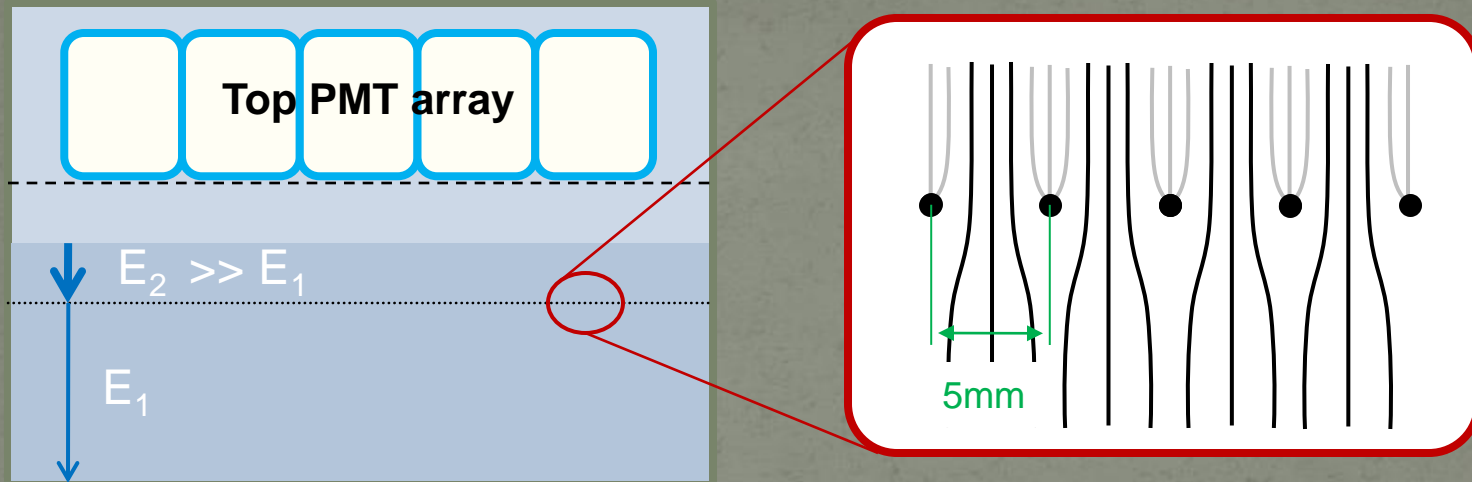
Background x-y distribution

- Background distribution is uniform and closely reproduces dodecagonal cross section of the detector field cage

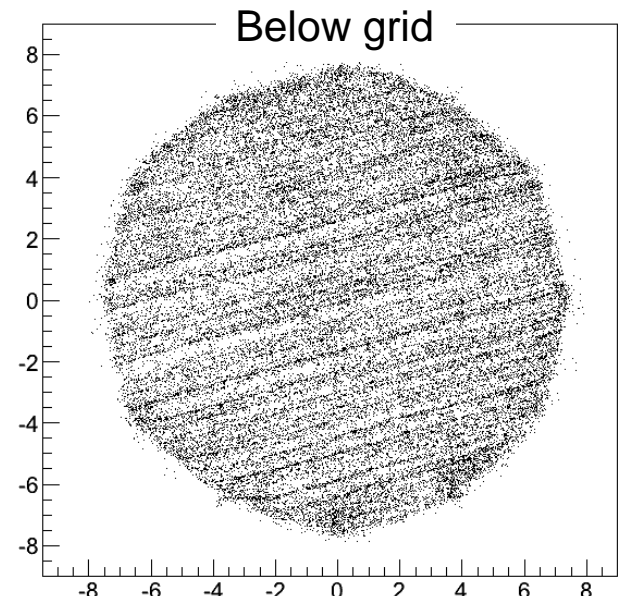
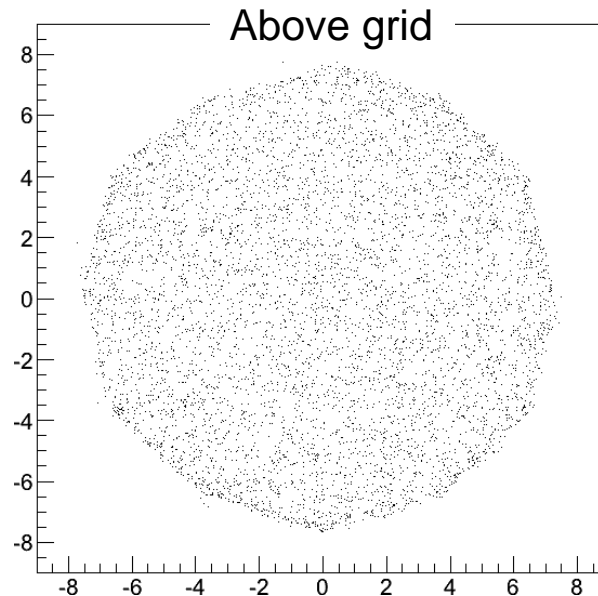


Imaging the wires

Focusing of the drifting electrons at the extraction grid

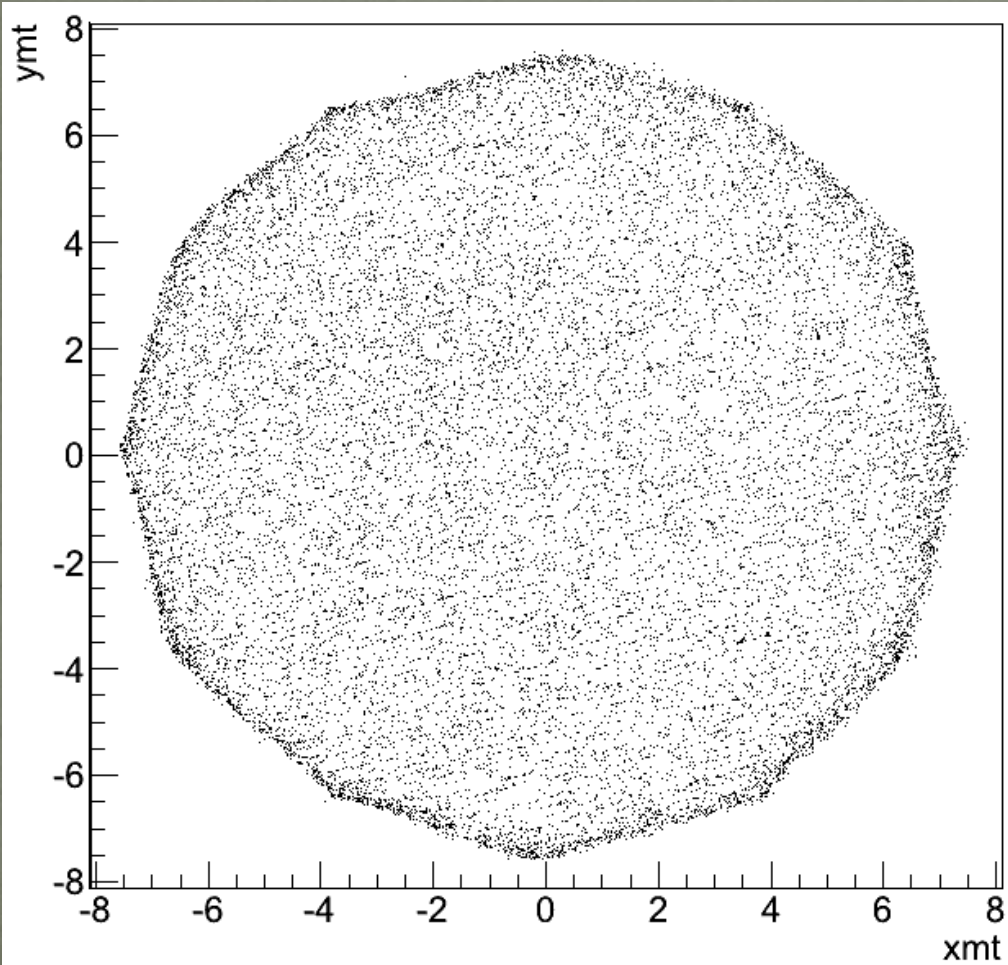


- We can select events from above the grid or below the grid by the drift time
- We got uniform distribution in the first case and striped pattern in the second

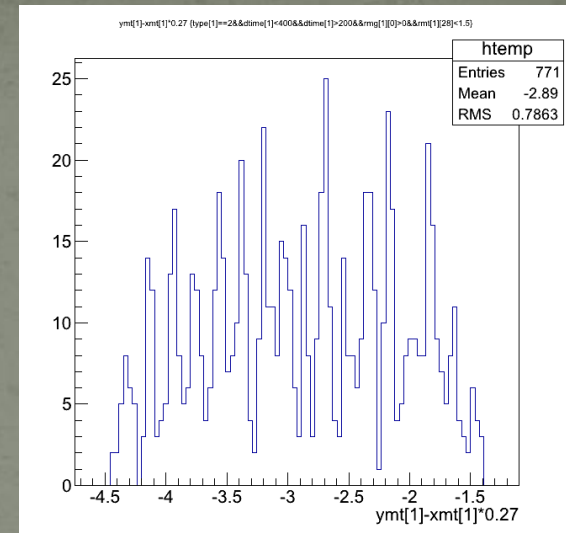


Imaging the wires

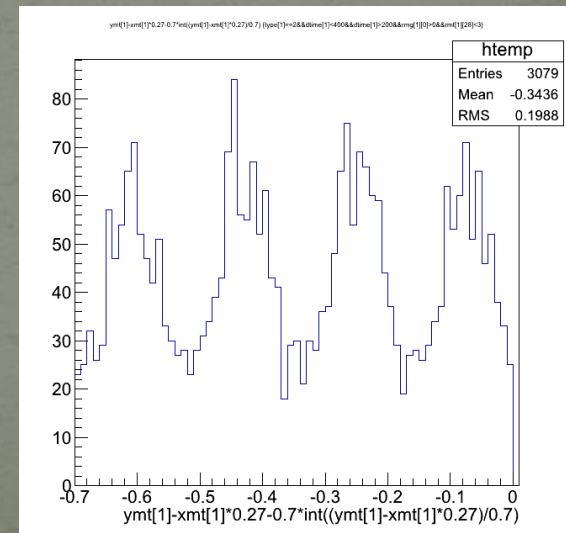
Events from the grid region



Projection



Overlapped projection



Conclusions

- The “virtual scan” technique developed by LIP-Coimbra team in the framework of ZEPLIN-III collaboration allows to infer the detector model from calibration (and sometimes from background) data
- This technique was adopted for event analysis for the LUX detector and is already showing promising results
- The LUX event analysis chain is under active development with LIP-Coimbra active participation