

Status of the Geant4 MC simulation for the FDIRC prototype in the SLAC CRT

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People involved in the analysis

- Douglas Roberts has coded the Geant4 MC and still maintains it
- Jerry Va'Vra is responsible of the CRT test and is also analysing first data with an upgrade of the code that he used to get the results for the first prototype (published by NIM)
- Biplab, me and Nicolas have been working with the simulation to produce photon dictionaries and evaluate performance

Geant4 MC is a critical tool to test the prototype

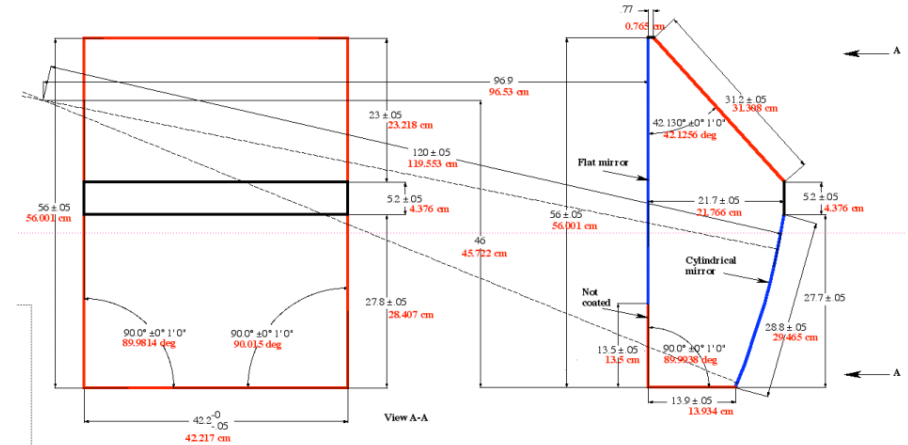
- Production of a “*Photon Dictionary*” to infer Cherenkov angle from real photon hits
- Evaluating the expected *performance* with the present setup
- Development of *analysis tools* to cope with ambiguities and get the best out of data

Updated geometry in Geant4 with “as built” numbers

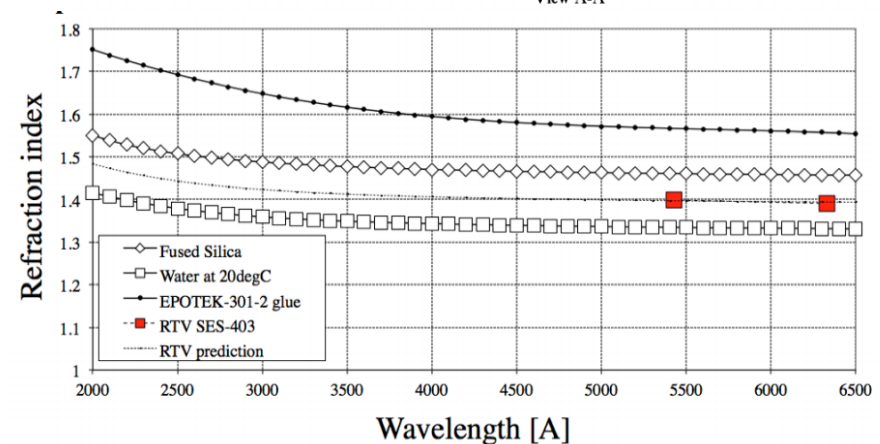
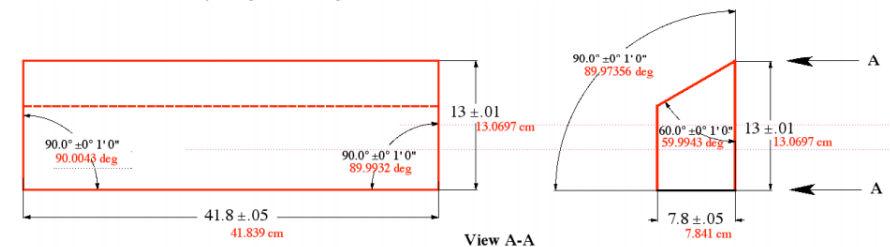
From Jerry's “Critical dimensions” document

- FBlock dimensions (higher mirror)
- New wedge dimensions
- Bars and old-wedge widths as average values
- RTV glue thickness
- RTV glue properties: refr. index and transparency

Numbers relative to my original design (in red are measured numbers):



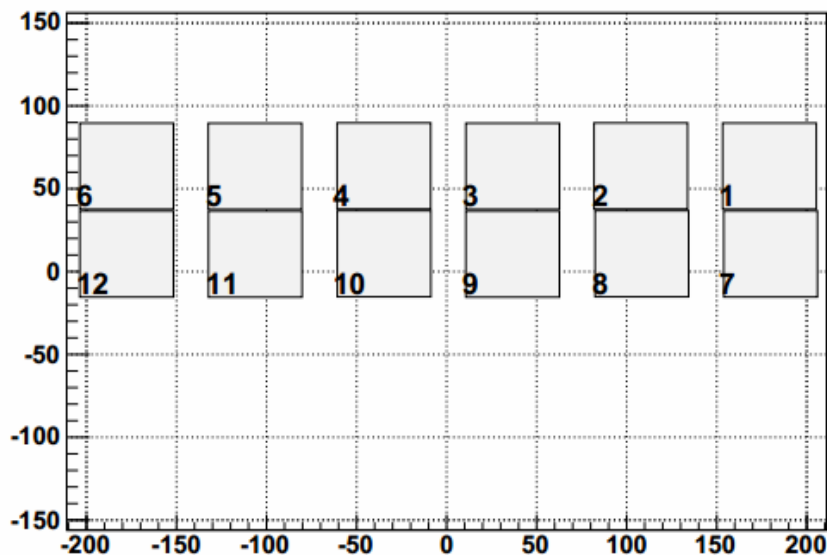
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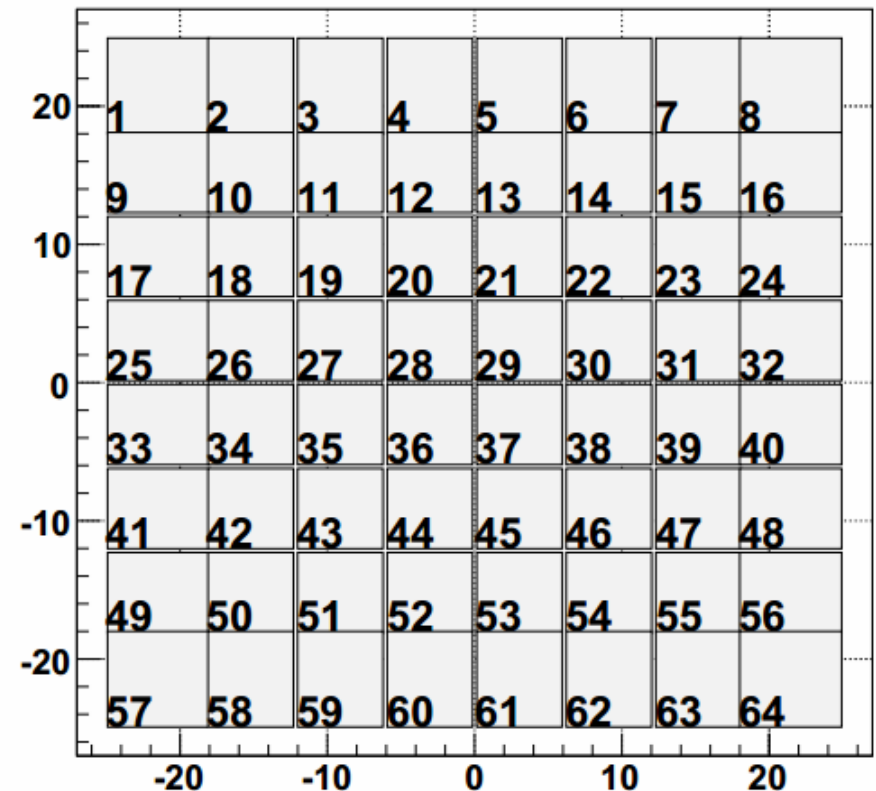
PMT configuration for first prototype has been plugged into Geant4

- 12-slot G10 holder
- H8500 pixel geometry
- All 64 pixel read-out (no ganging)

G10 holder, looking from photon side



H8500, looking from photon side



Production of constants with Geant4 (photon dictionary)

- 5M photons fired in all directions from the middle of each bar
- k_x, k_y are “measured” at bar exit and stored
- Δt between bar exit and pixel hit is stored

(then TOP inside the bar is easily calculated for each track when z_{track} and k_z are given)

Clusterization of solutions with Doug's algorithm

CLUSTERING ALGORITHM

- RUN A SIMPLE "NEAREST NEIGHBOR" CLUSTERING ALGORITHM ON ALL OF THE RAW DATA FROM THE PREVIOUS PAGE TO REDUCE THE DICTIONARY TO A SET OF CLUSTERS
- "NEAREST" IS DEFINED BY A DISTANCE IN (K_X , K_Y , TIME) SPACE:

$$d_{i,j}^2 = \frac{(k_{x,i} - k_{x,j})^2}{\sigma_{k_x}^2} + \frac{(k_{y,i} - k_{y,j})^2}{\sigma_{k_y}^2} + \frac{(t_i - t_j)^2}{\sigma_t^2}$$

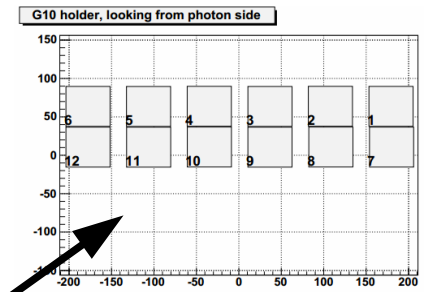
- THE CLOSEST PAIR WITHIN A PIXEL IS MERGED INTO A SINGLE CLUSTER
 - STORE AVERAGE (K_X , K_Y , TIME)
 - ALSO STORE RMS OF (K_X , K_Y , TIME) AND NUMBER OF PHOTONS USED IN THE CLUSTER

Doug proposed two clustering options: *Signed* and *Absolute*

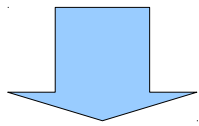
DIFFERENT CLUSTERING

- LOOKING AT THE REFLECTION SYMMETRY IN THE k_y VS. k_x PLOTS, AND GIVEN THAT WE ARE ACCOUNTING FOR THE 8-FOLD AMBIGUITY EXPLICITLY, IT MIGHT MAKE SENSE TO CLUSTER IN $|k_x|$, $|k_y|$ INSTEAD
- THE SYMMETRY ISN'T PERFECT
 - TRADE OFF BETWEEN HAVING TOO MANY SOLUTIONS VS. FEWER BUT MAYBE NOT AS ACCURATE
 - BUT WE ARE PROBABLY DOUBLE COUNTING AT SOME LEVEL

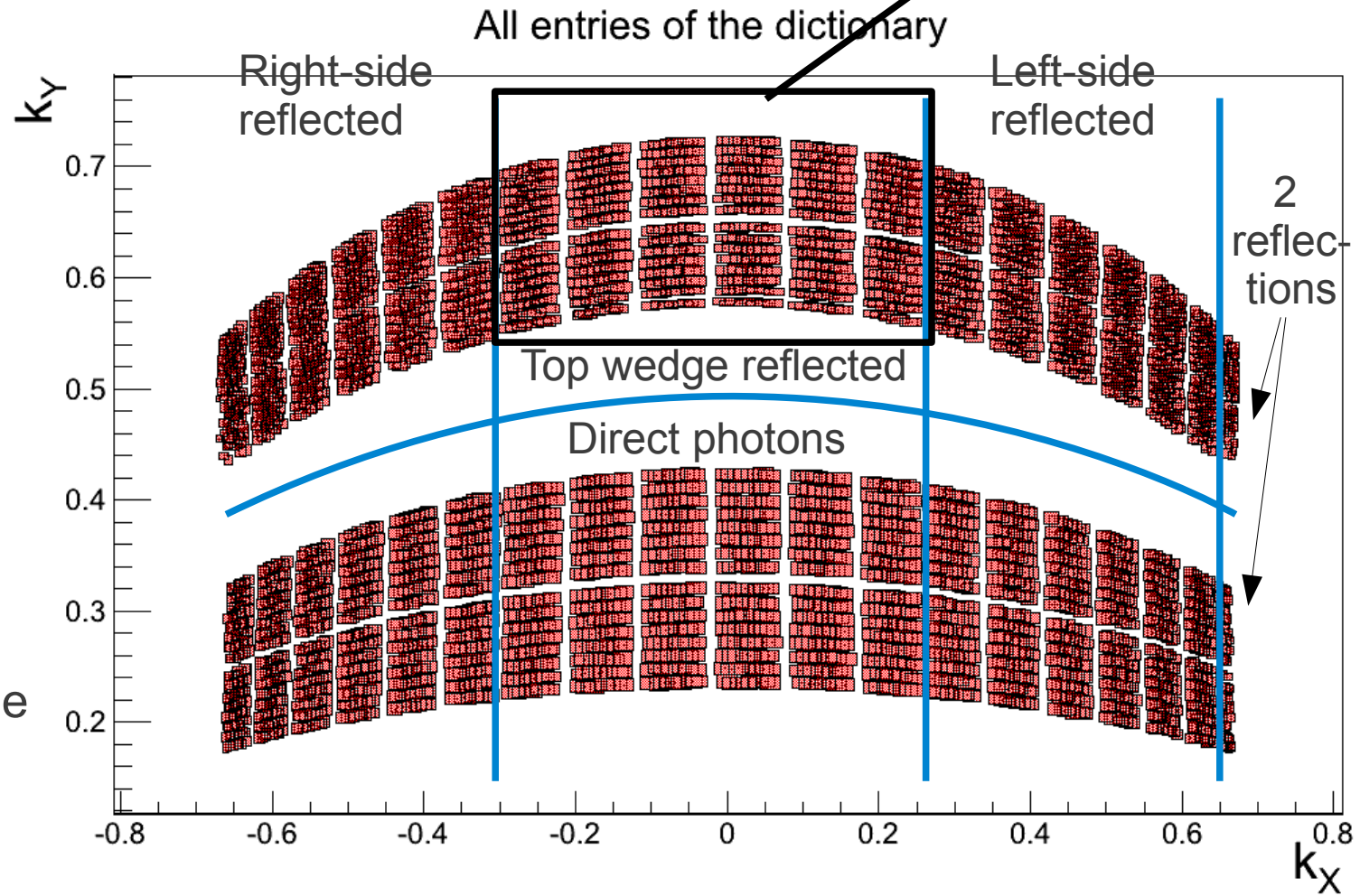
One can think an option inbetween the two



- Absolute k_y at bar-exit
- Signed k_x at OldWedge-exit



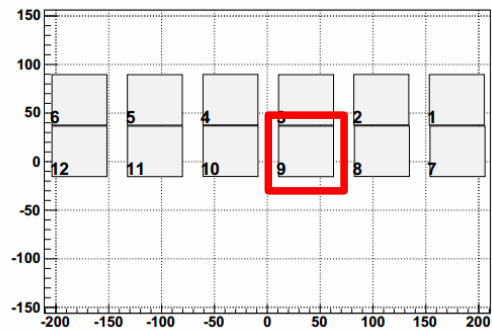
- You can recognize the PMT plane pattern
- The pattern is mirrored ~6 times because of reflections on sides



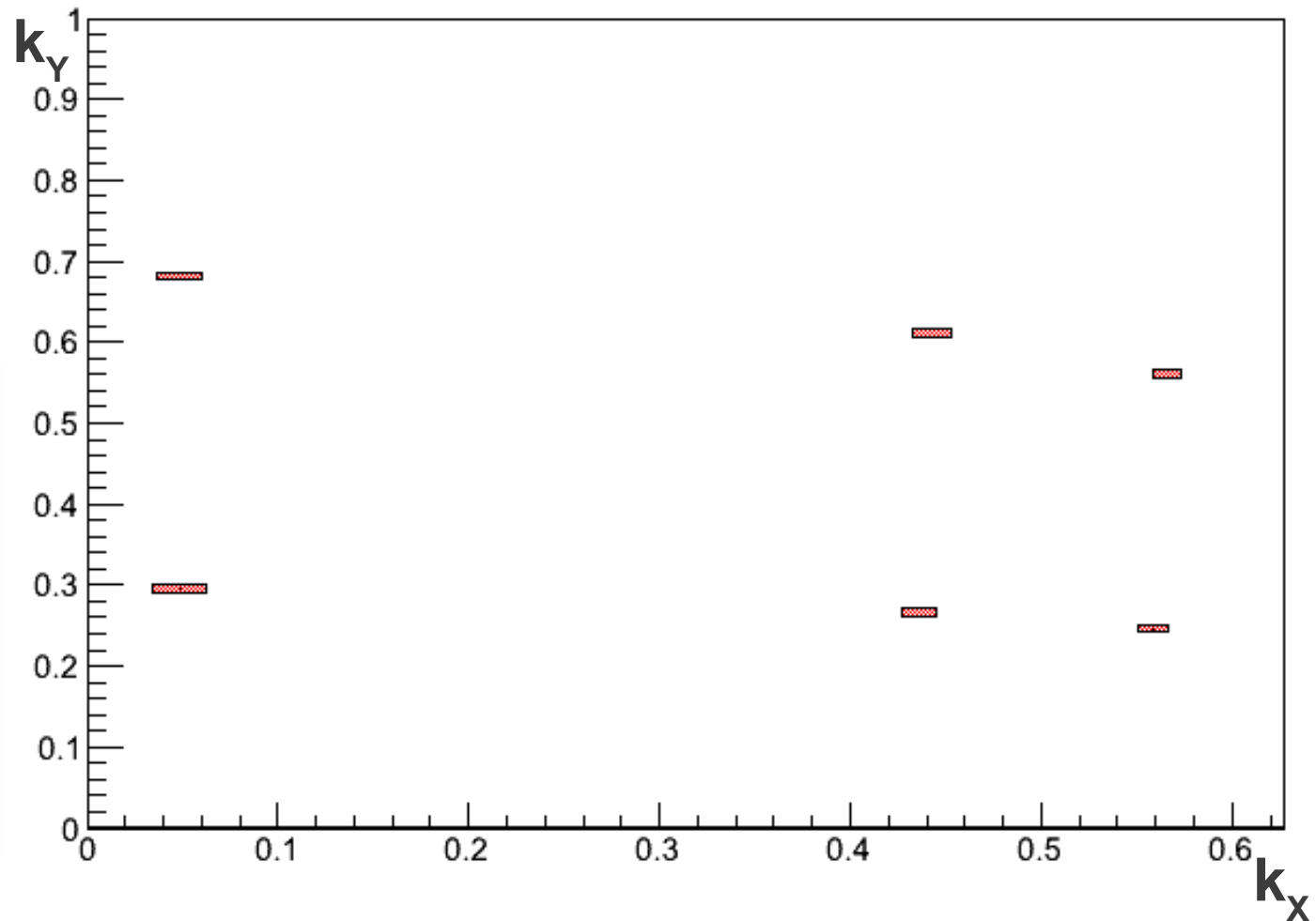
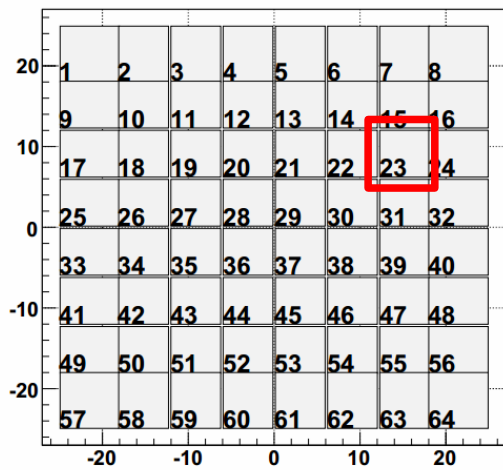
Example of dictionary entry: Constants for Bar 6, PMT 9, pixel 23

(older option: absolute clustered dictionary)

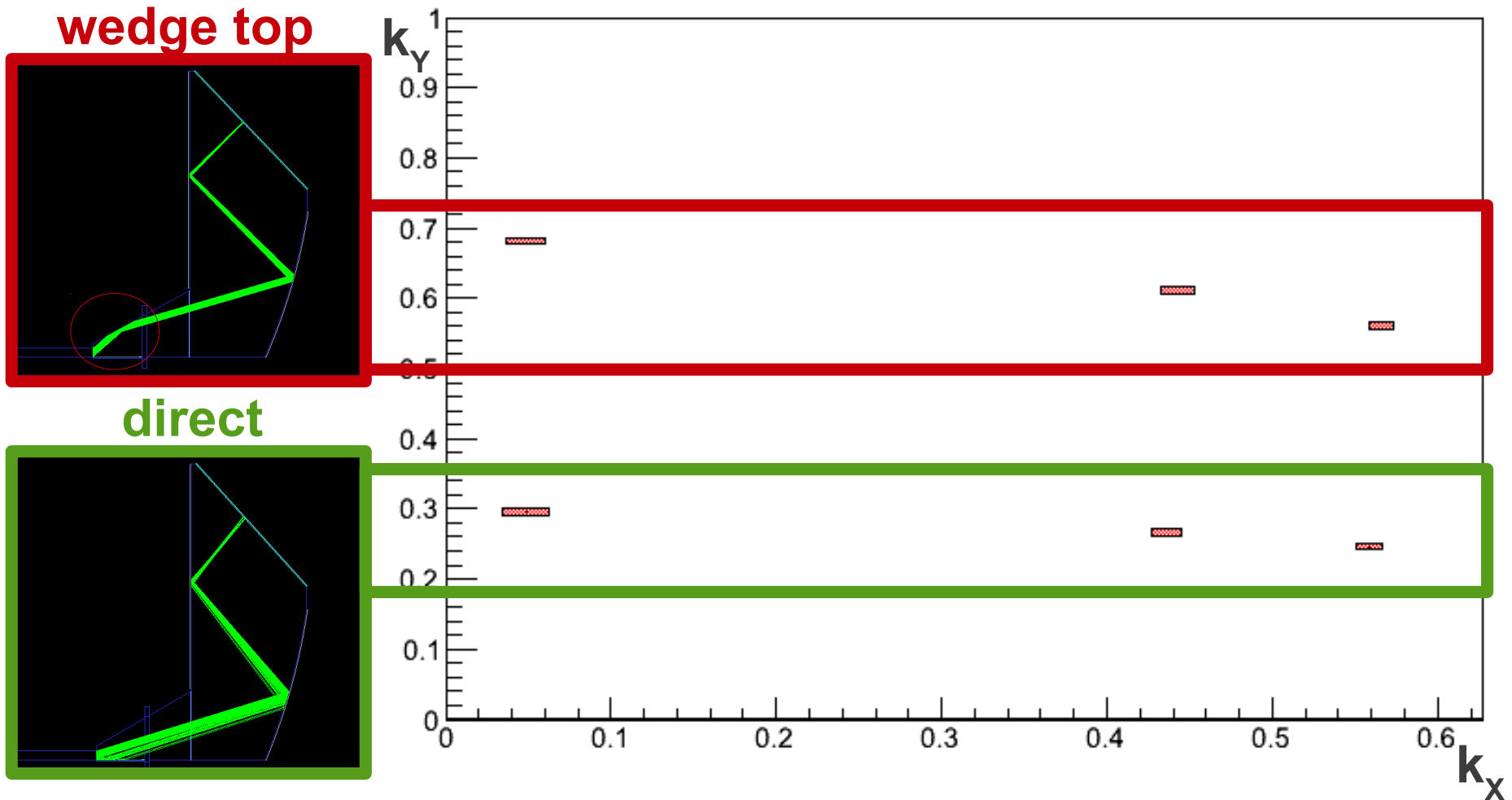
G10 holder, looking from photon side



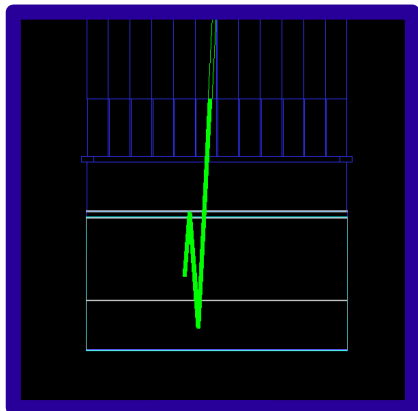
H8500, looking from photon side



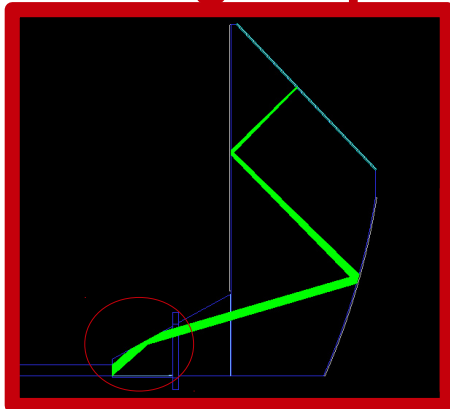
Example of dictionary entry: Constants for Bar 6, PMT 9, pixel 23



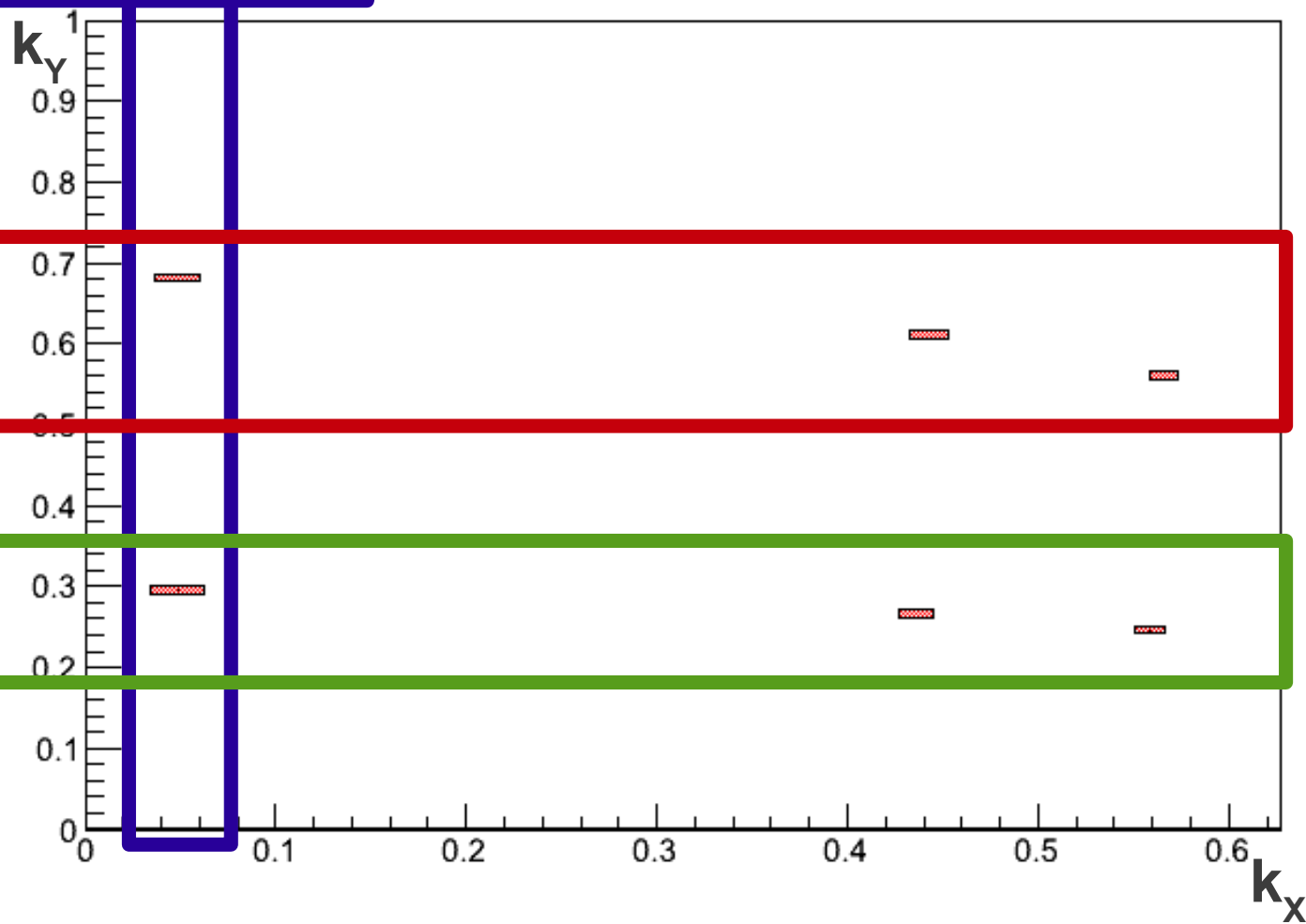
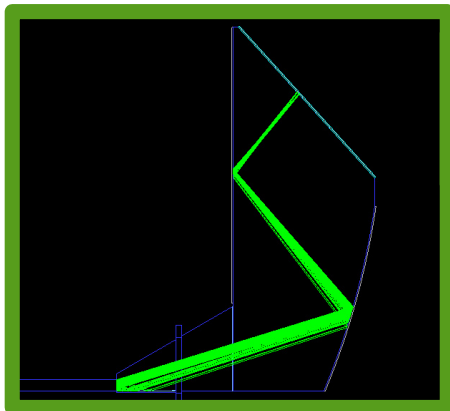
direct



wedge top



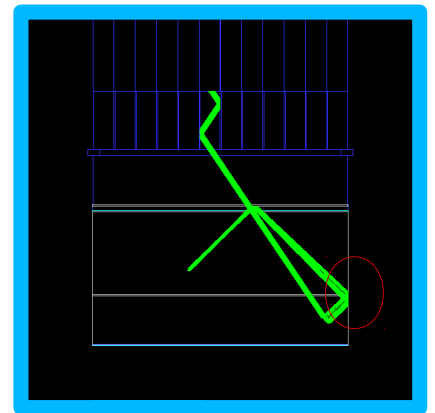
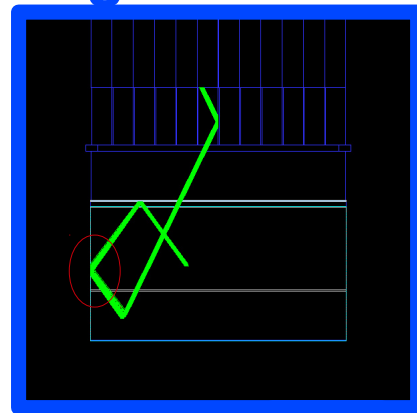
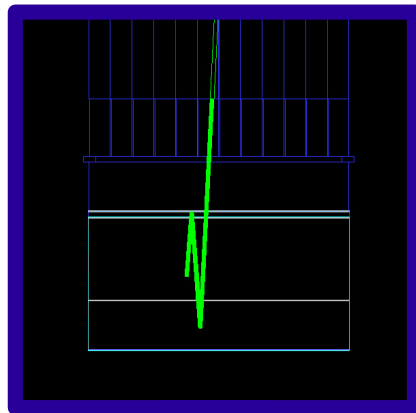
direct



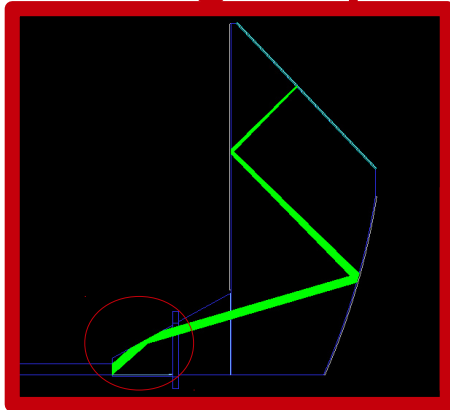
direct

right side

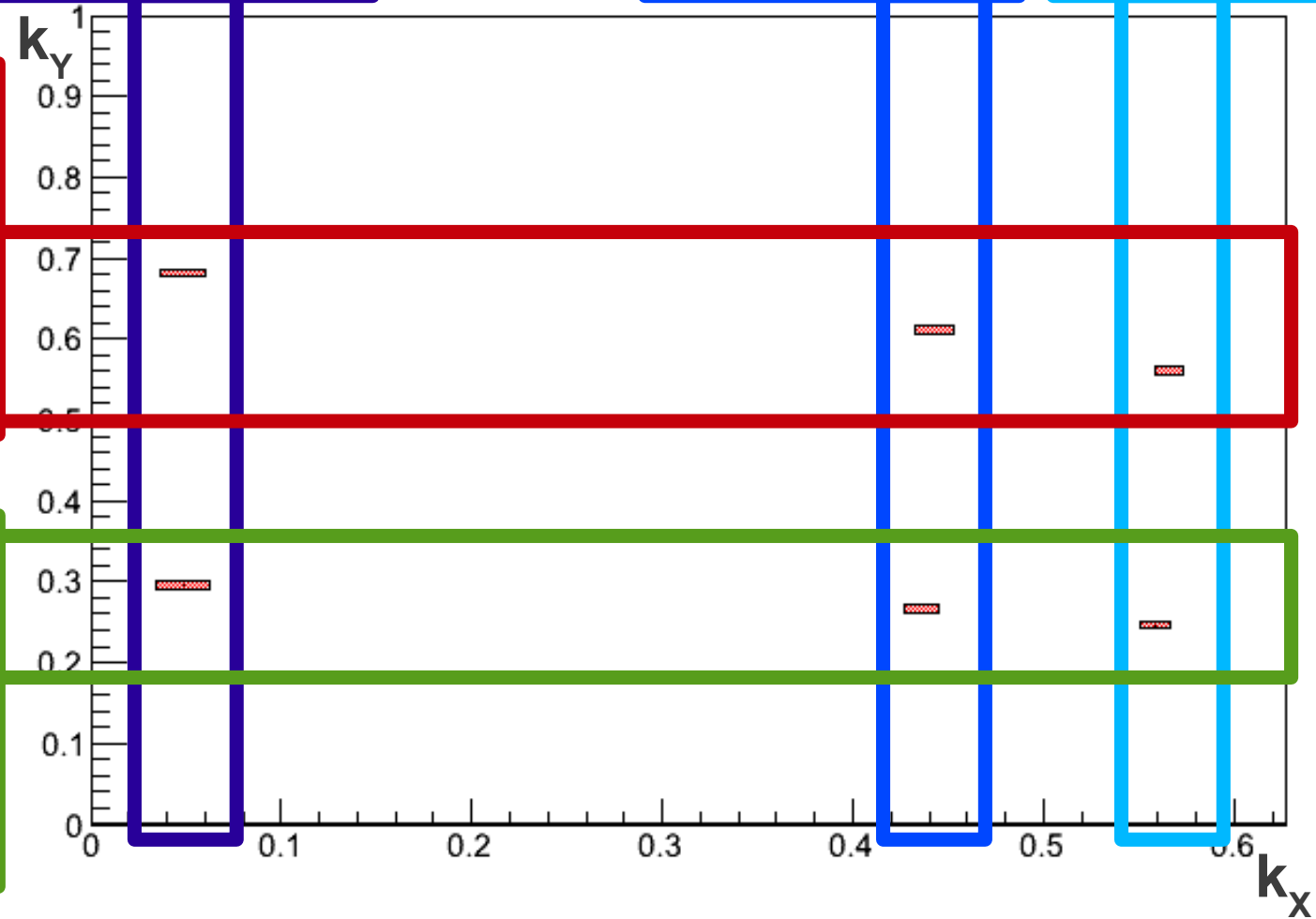
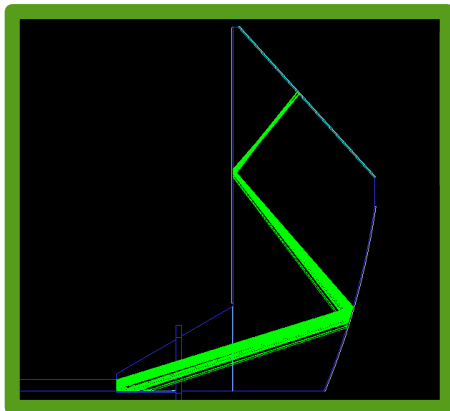
left side



wedge top



direct

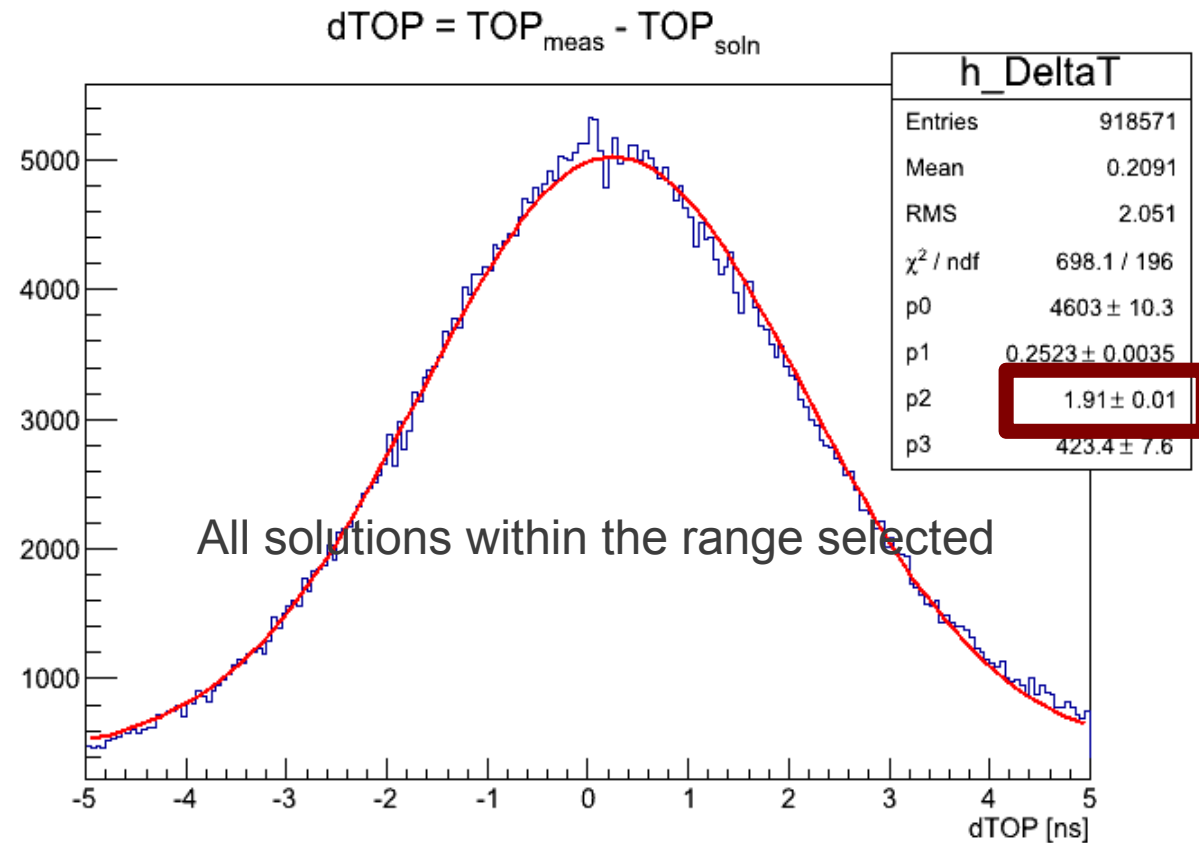


Analysis of CRT real data

- Final goal is to have a common format for the CRT real data and the simulation output in order to analyse both with the same program (C++)
- Decoding of the dst file is in progress
- Analysis framework independent from Jerry's fortran code: will allow cross-checks
- Work in progress...
- First look at MC results in the next slides

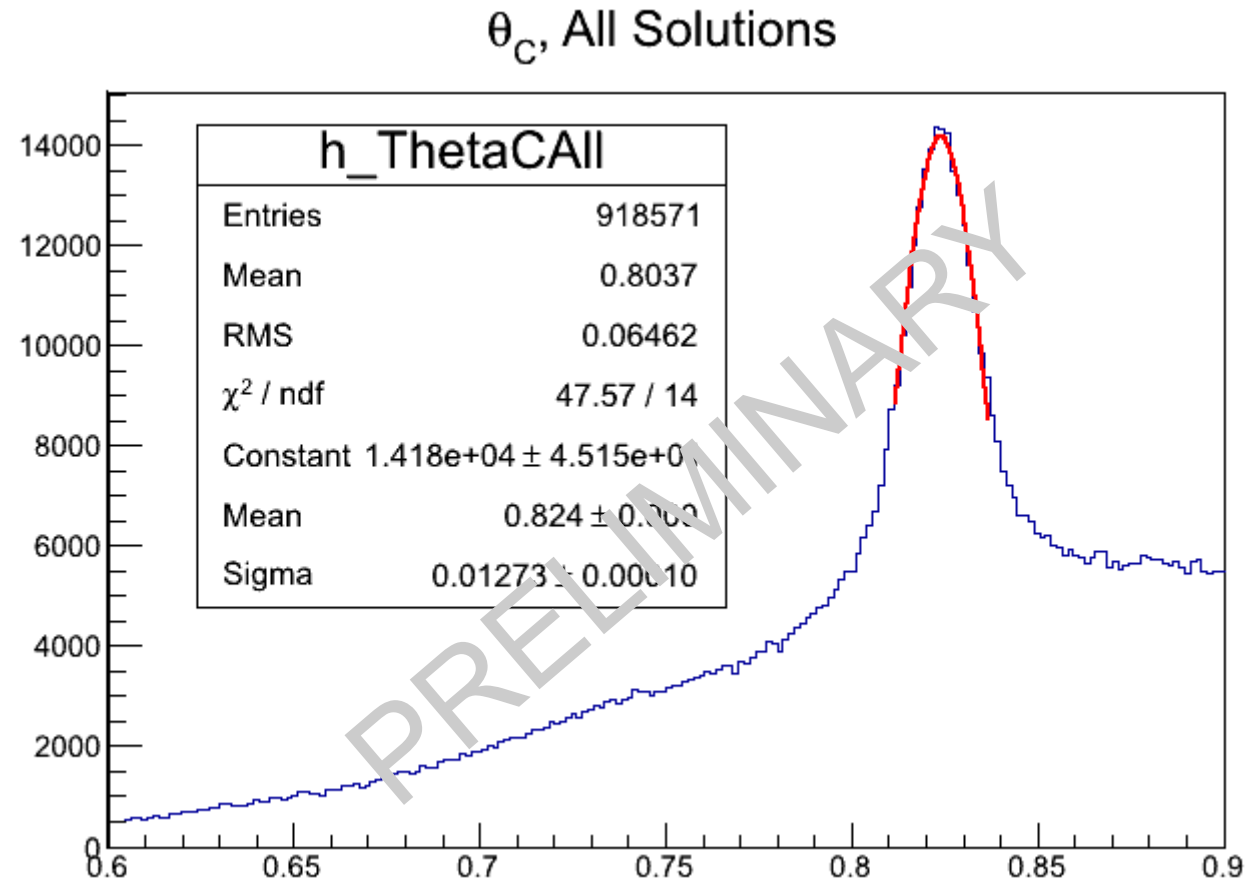
MC simulated CRT data

- CRT acceptance
- Cosmics distribution
- Time resolution 1.5 ns (as with present setup)
- x_{track} resolution 1.5 cm (affects bar selection)
- $E_{\mu} > 1.5 \text{ GeV}$
- 12 PMTs (we still have 8)



ThetaC resolution result

- Already a clear peak at the expected value comes out
- ThetaC resolution would not be the best yet (~ 13 mrad), but there is room to improve it
- This at least is telling us that we should see something on present CRT data



Next steps

- Data are being collected and analysis are in progress
- Improvements are foreseen in the electronics timing and the last 4 PMTs will be instrumented
- Permanent interplay foreseen between MC and data analysis

Another approach to data analysis

- A completely different approach using PDFs of the expected hits from each track is being considered.
- The power of such an approach as well as its feasibility are still to be evaluated
- This possibility will be investigated later on, after results will be obtained with the present well understood setup

