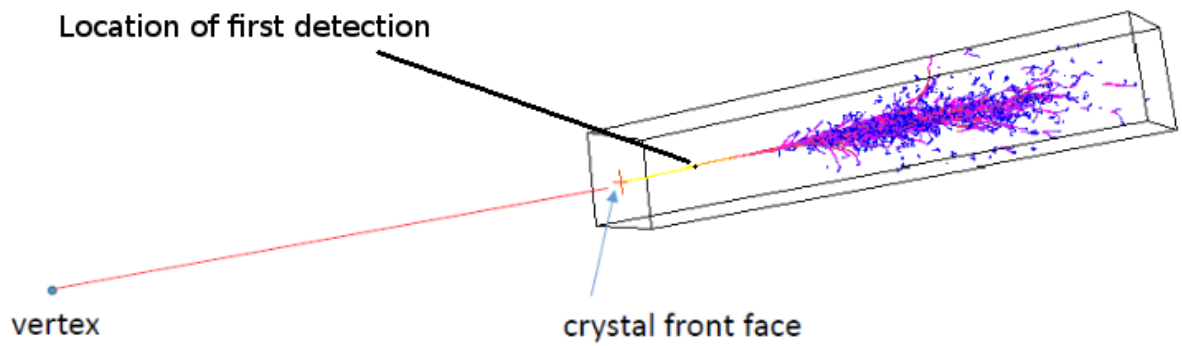
Four Dimensional Shower Profiling

Caltech Group Meeting, 9/July/2013

Cedric Flamant

True Time Goal

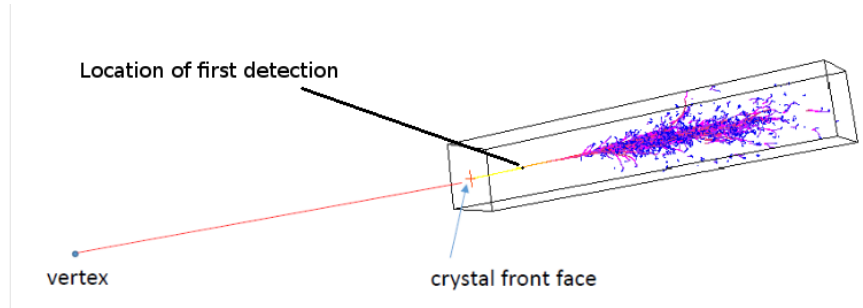
- One issue with time-based vertexing (tVertexing) is defining arrival time.
- The first detection location might be quite deep in the crystal, which would correspond to a longer flight time.
- If we could know the position and time of the first detection, we could potentially correct the time.



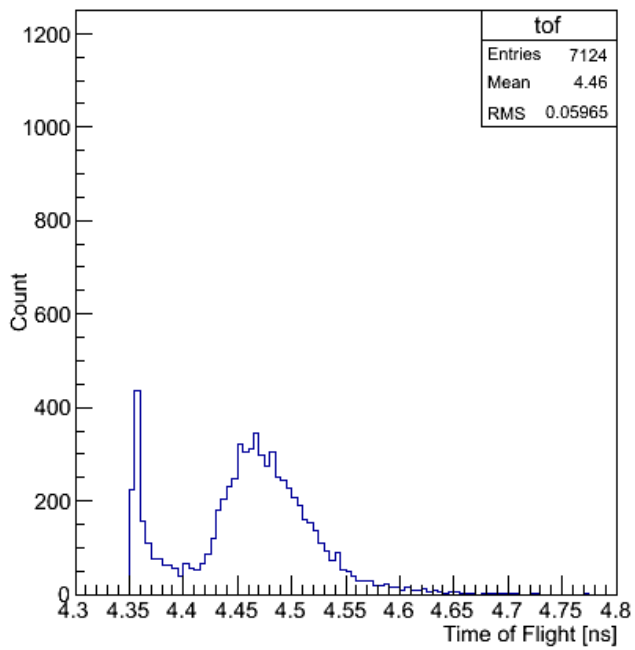
- We would also have to understand the structure of detection patterns and how it relates to detection time.
- Energy deposited in the first detection may be helpful in weighing the accuracy of the reported detection time.

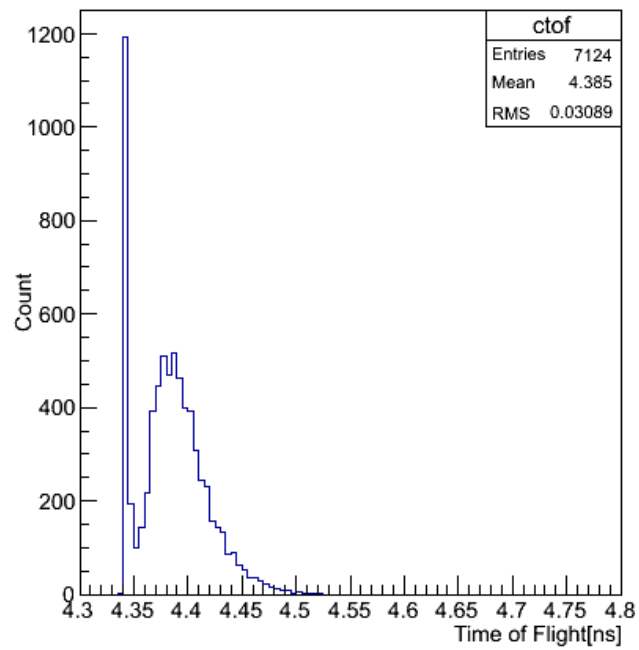
Simple Time of Flight Correction

- Take the hit location within the crystal.
- Find the distance to the nearest crystal face in the direction of the true vertex.
- Convert this distance to a time using the speed of light
- Subtract the time from the recorded detection time.



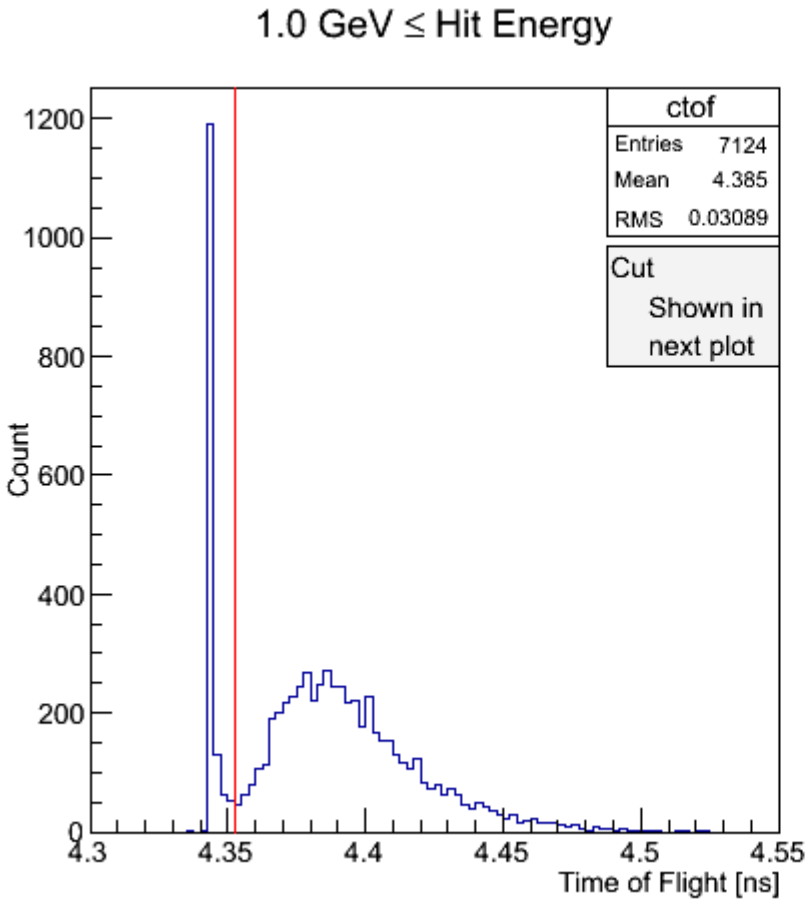
Raw Time of Flight — Correction → Corrected Time of Flight

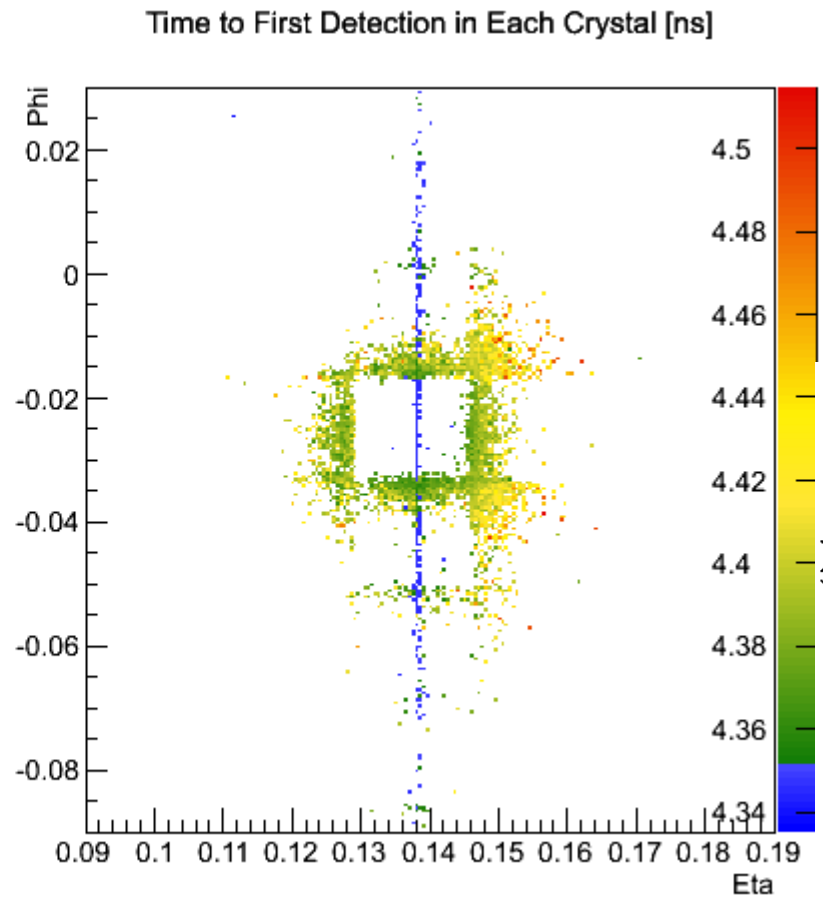




Photon 100 GeV

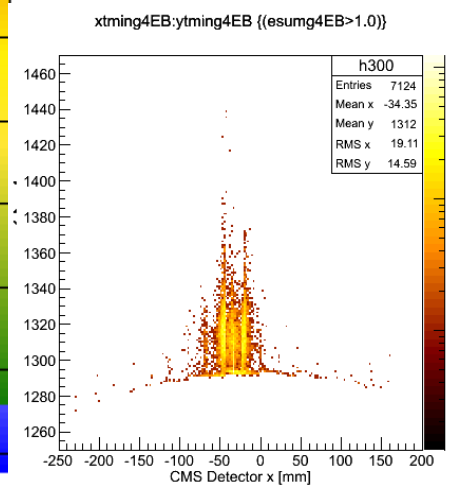
- Notice the cut (also shown in color) separates the true “first arrivals” from the first Hit in each crystal





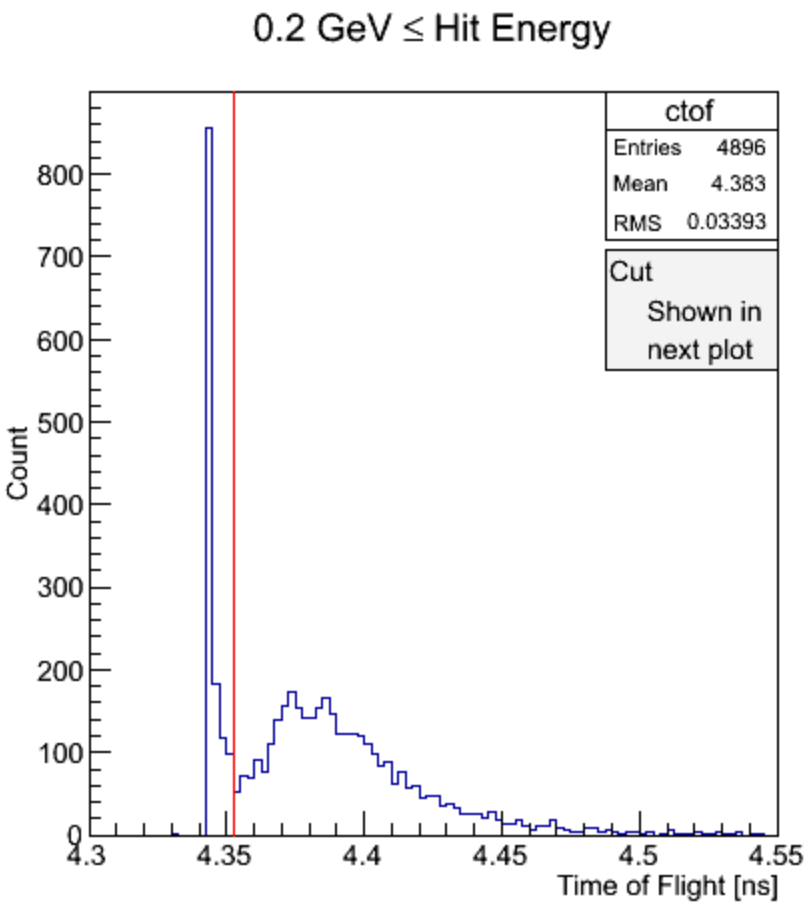
Spread of blue line Is thought to be due To photon->e+e- Conversion. B-field Spreads them in phi

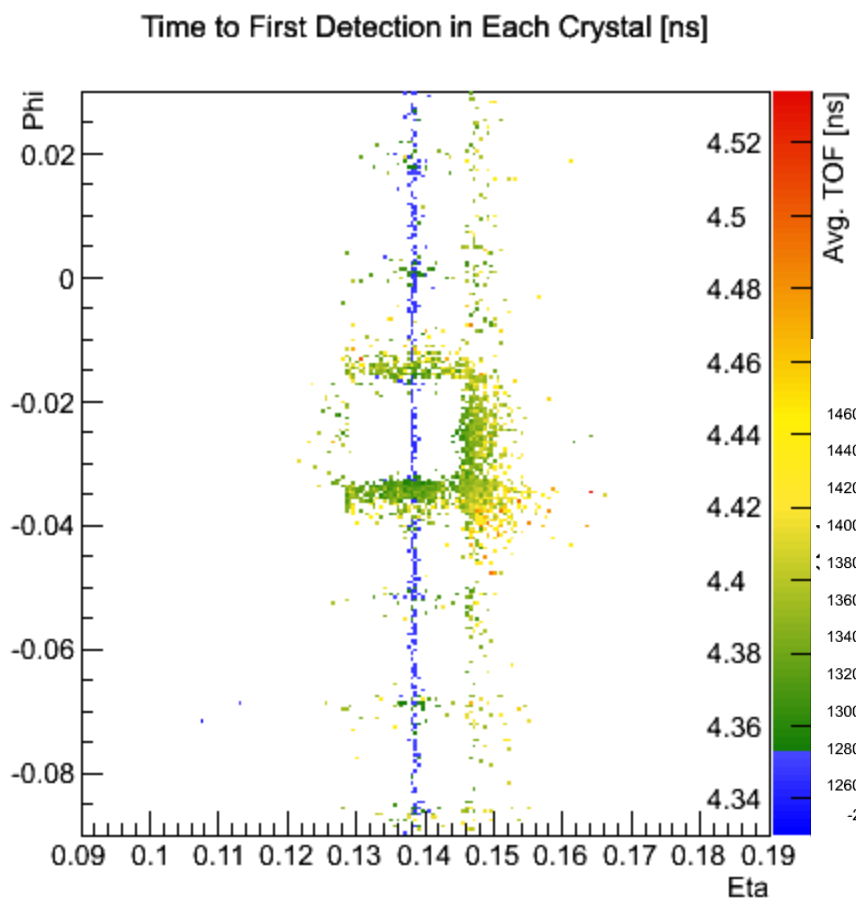
Last week's plot



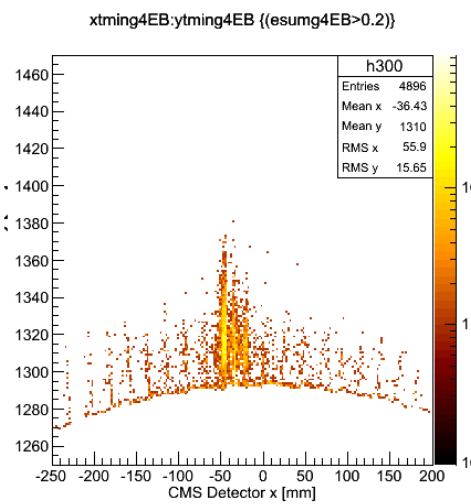
Photon 10 GeV

- cTOF plot (right) looks similar to that of the 100 GeV photon



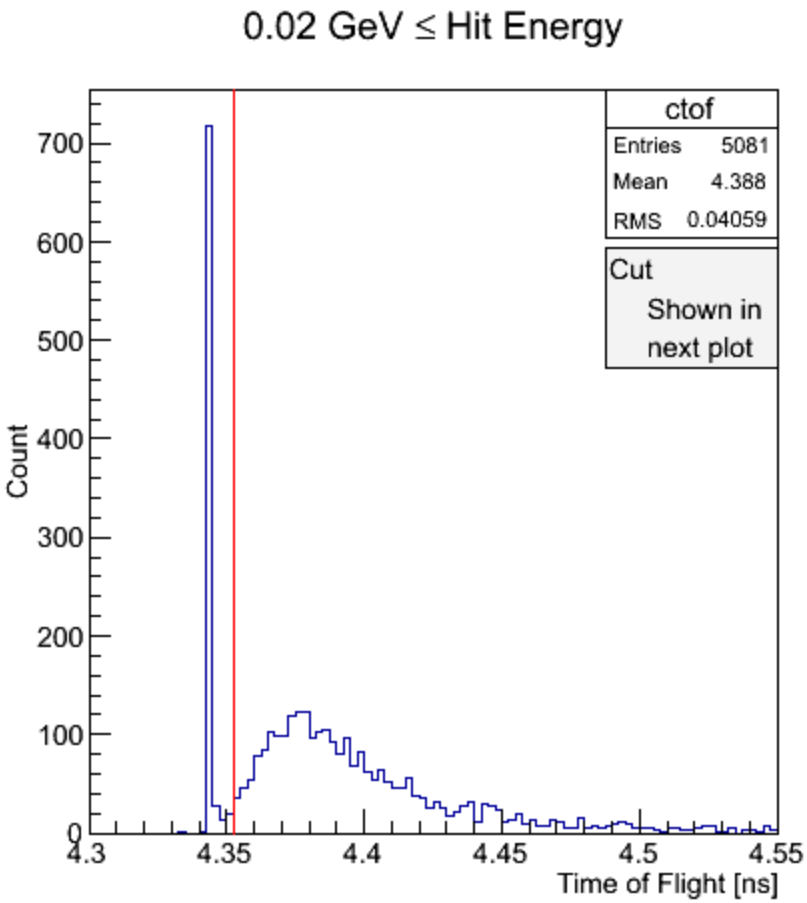


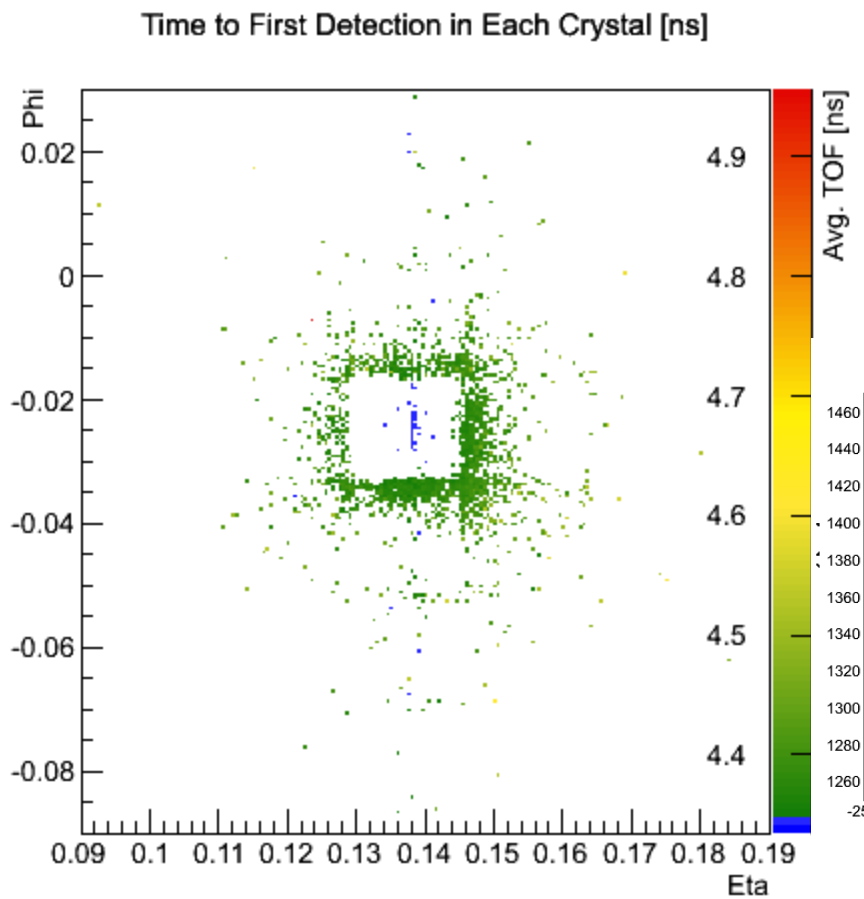
Last week's xy plot



Photon 1 GeV

- cTOF plot (right) looks similar to both that of 100, and 10 GeV photons





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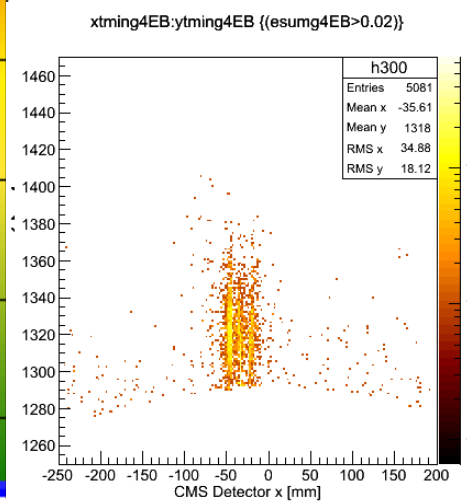
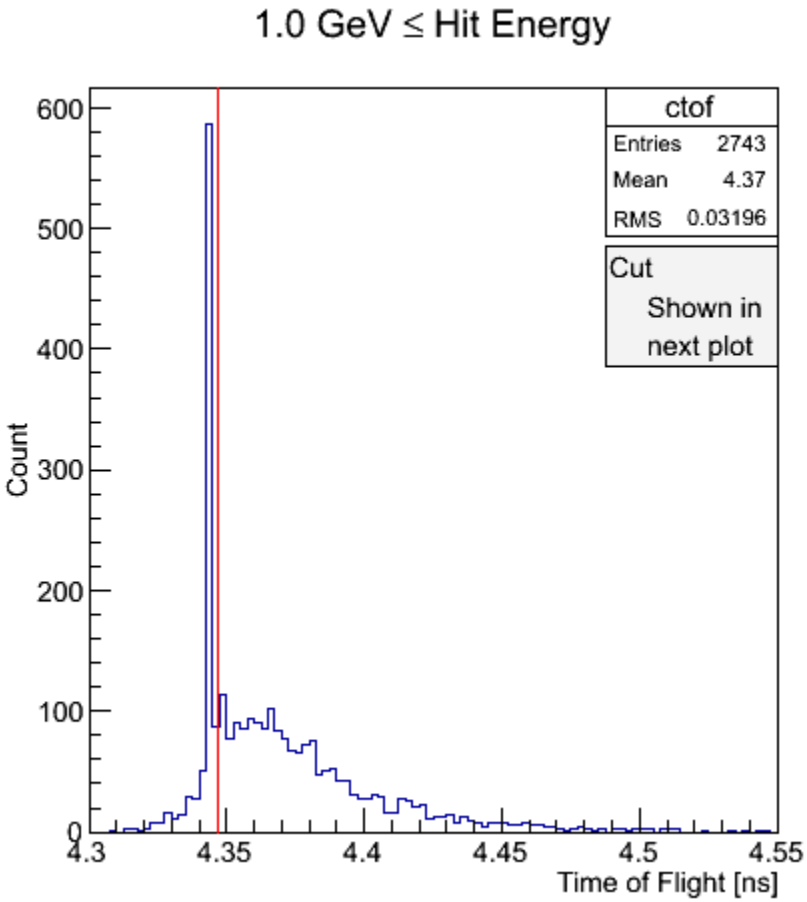
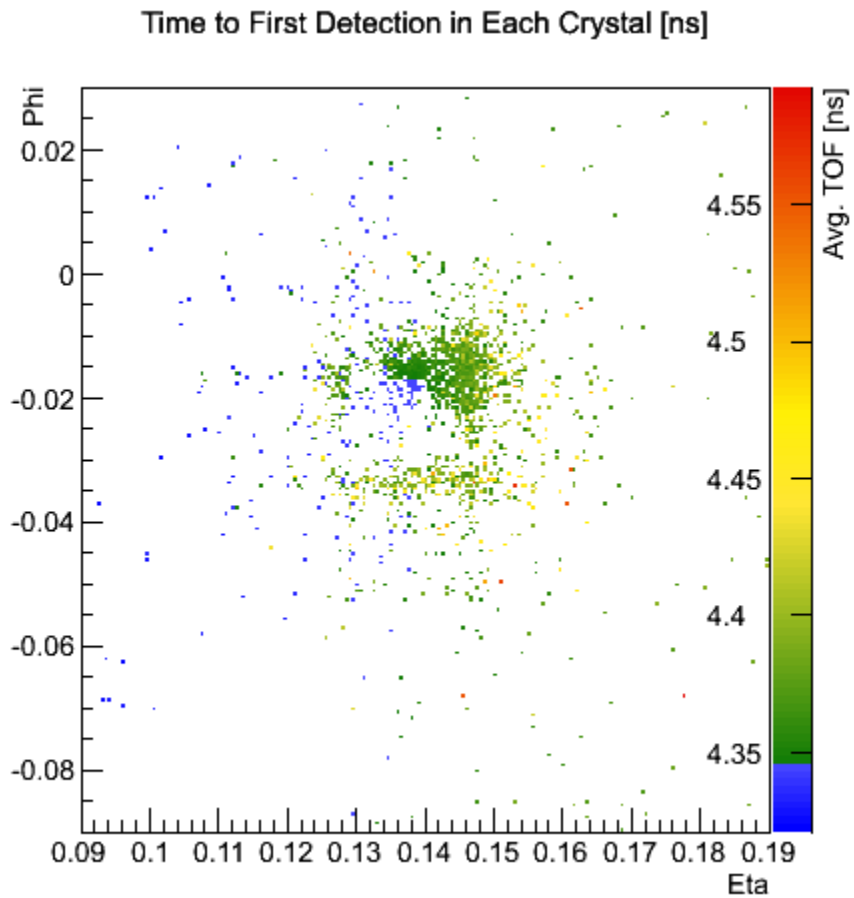


Pi Minus 100 GeV

- cTOF plot is different; some particles arrive earlier than the 100 GeV photons (due to taking a shorter path).





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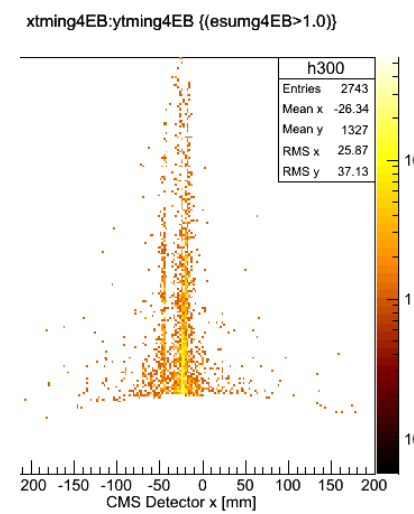
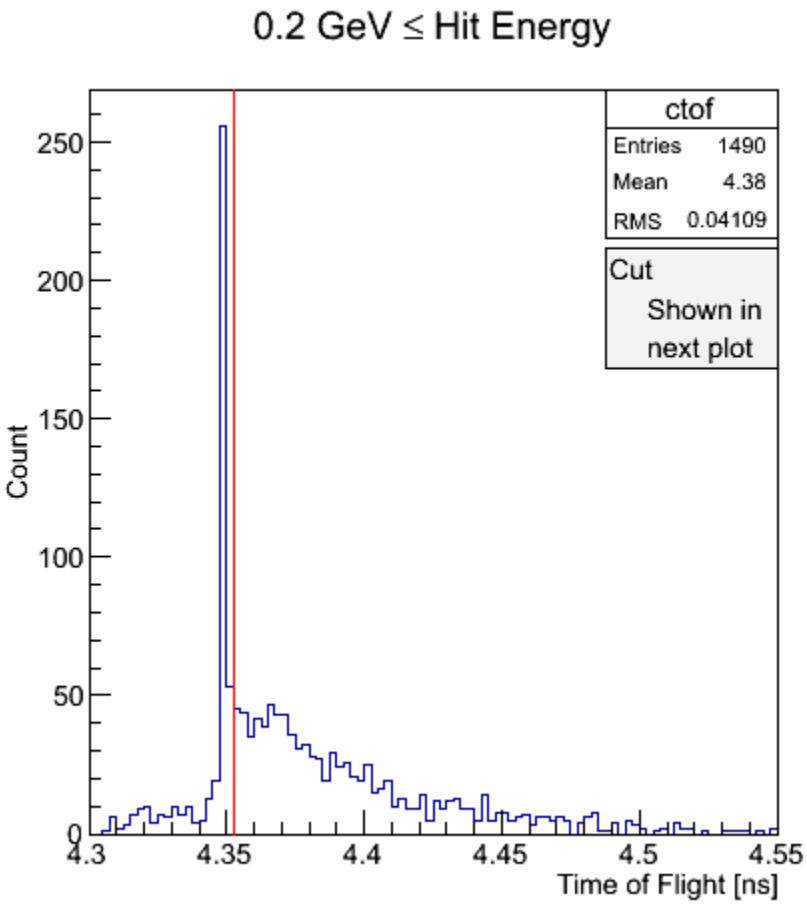
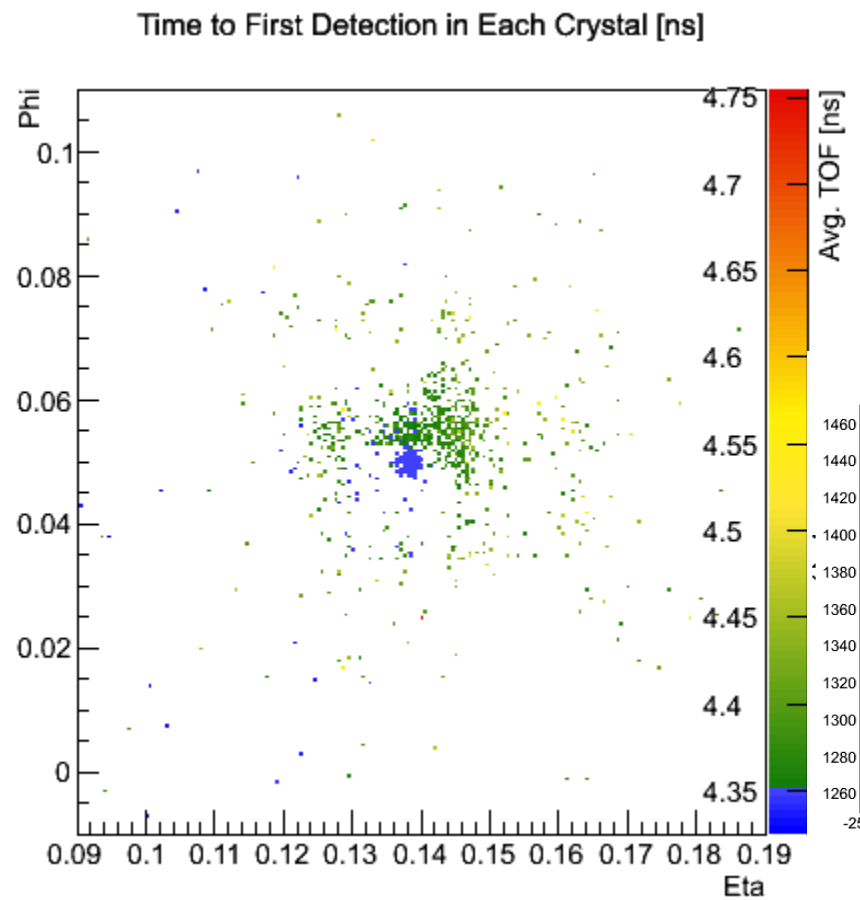


Pi Minus 10 GeV

- Beam is deflected, but still quite collimated





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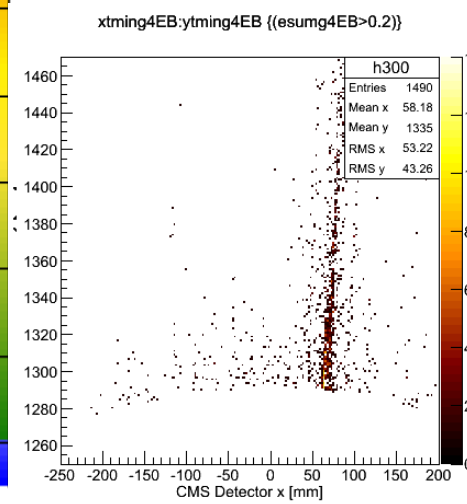

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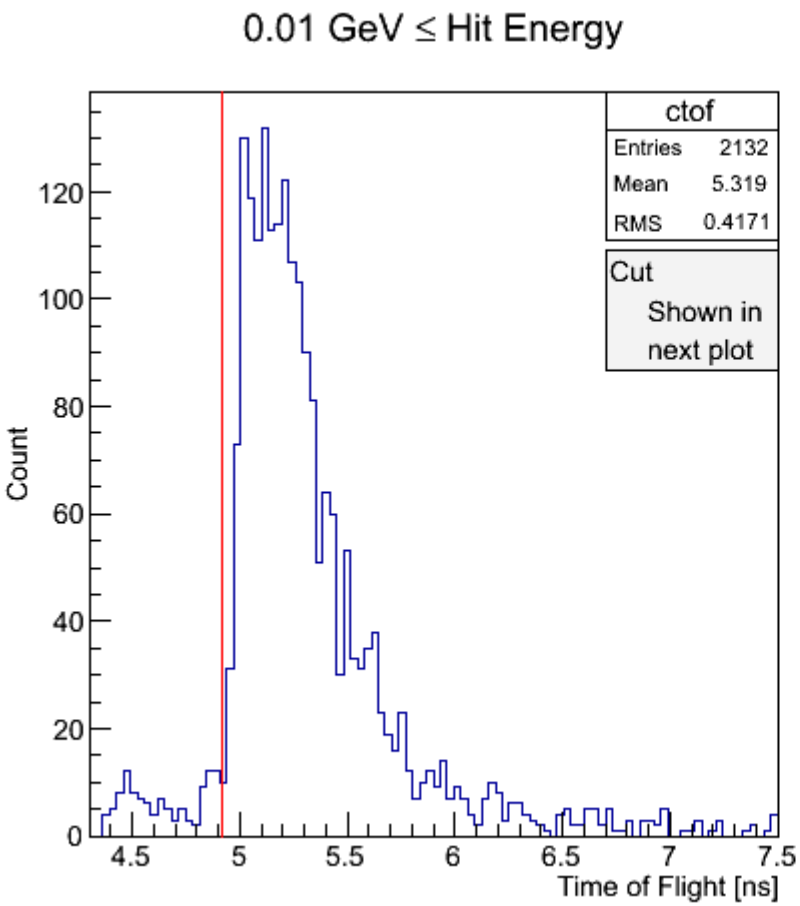
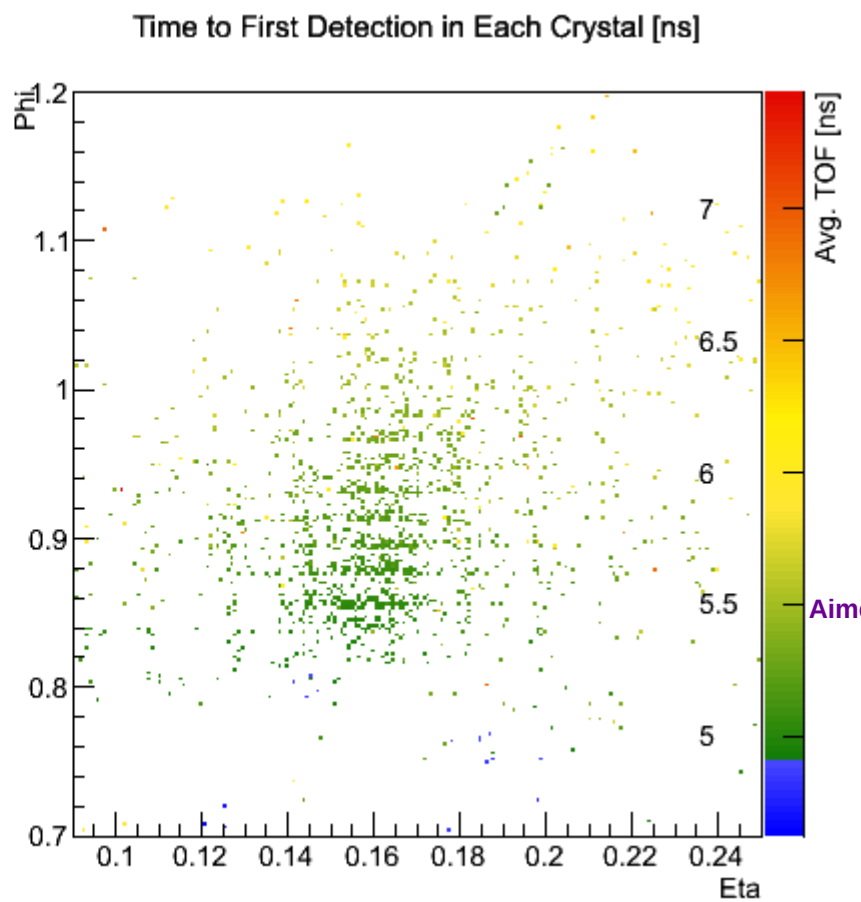
Pi Minus 1 GeV

- Highly deflected, detections spread over many crystals in phi, messy arrival time.





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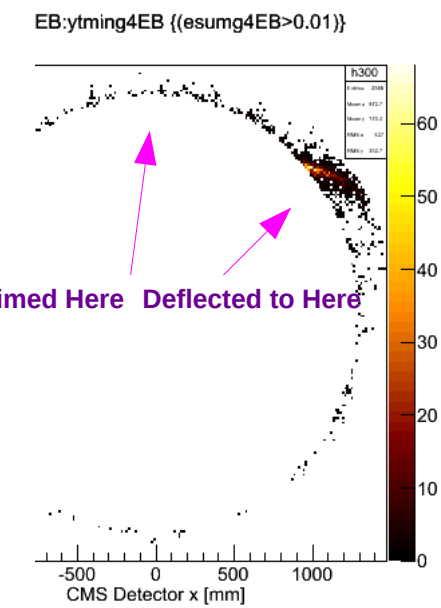
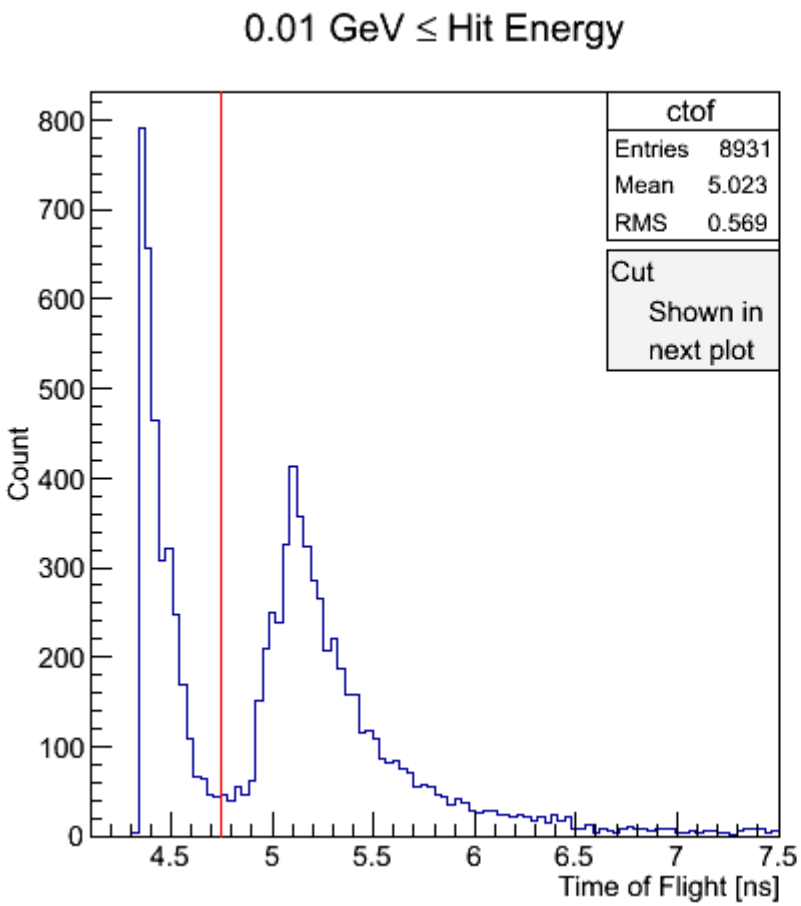


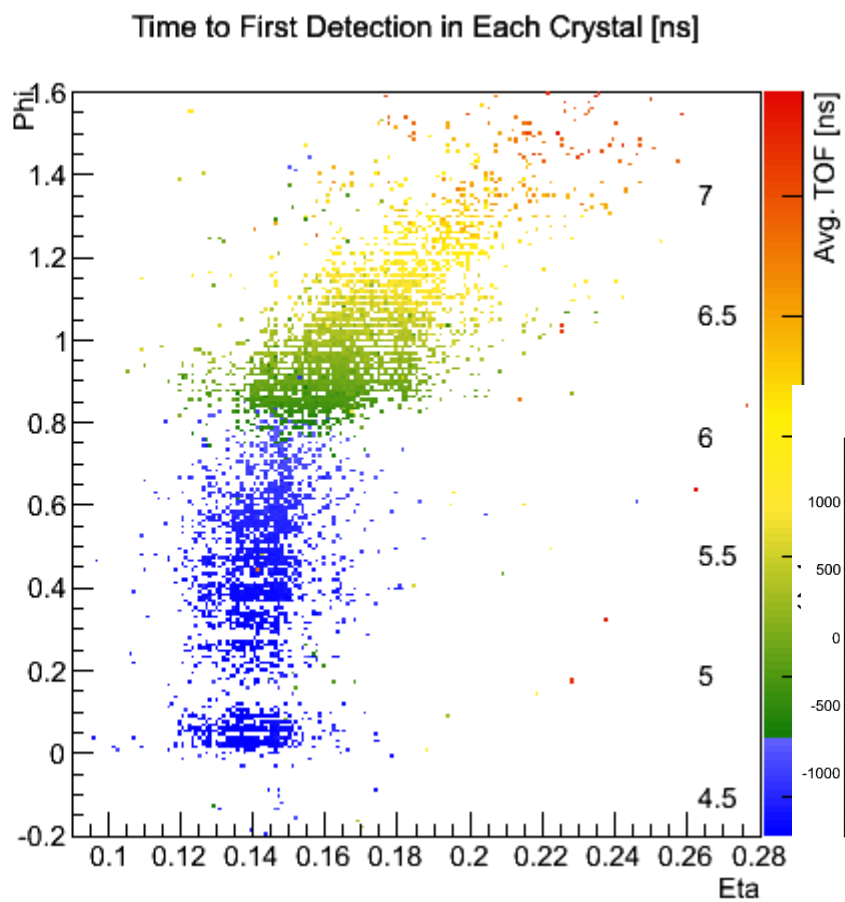
Electron 1 GeV

- cTOF plot shows two arrival clumps

- "boost" in eta

(caution, effect highly amplified by x-scale)





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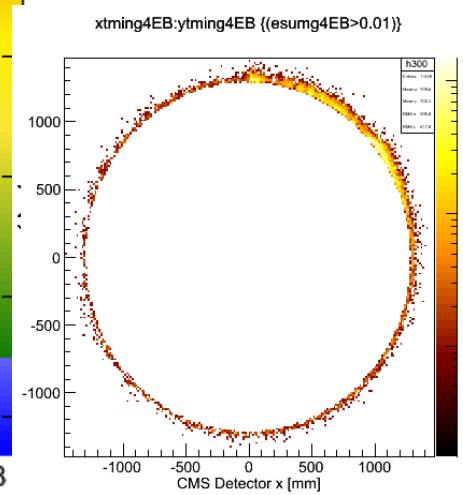
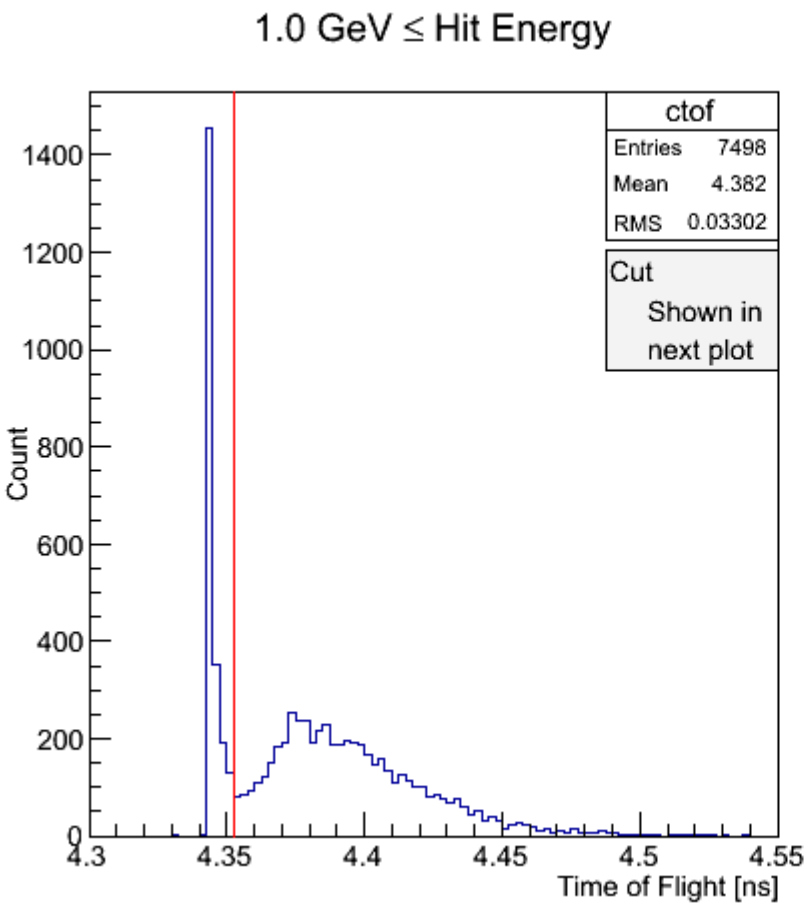
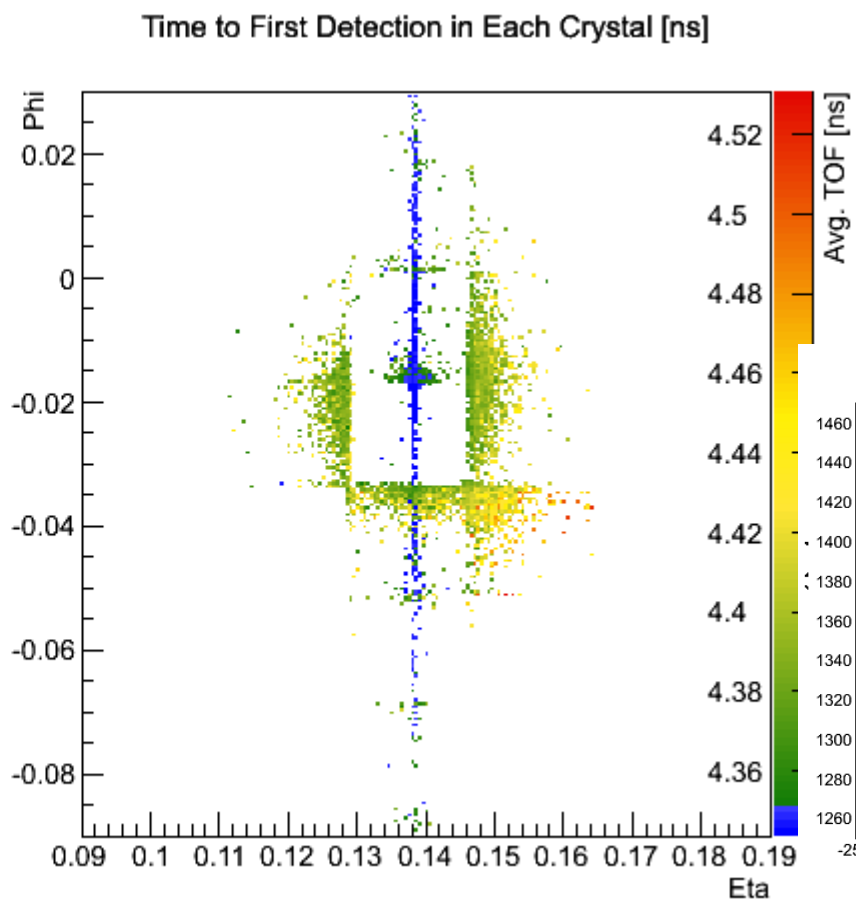


Electron 100 GeV

- Has a similar cTOF to the 100 GeV Photon





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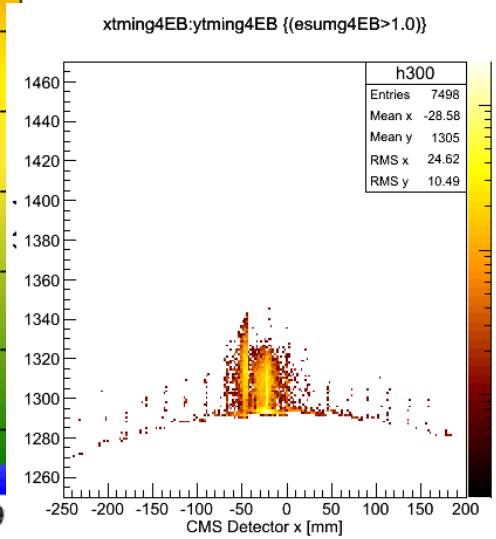
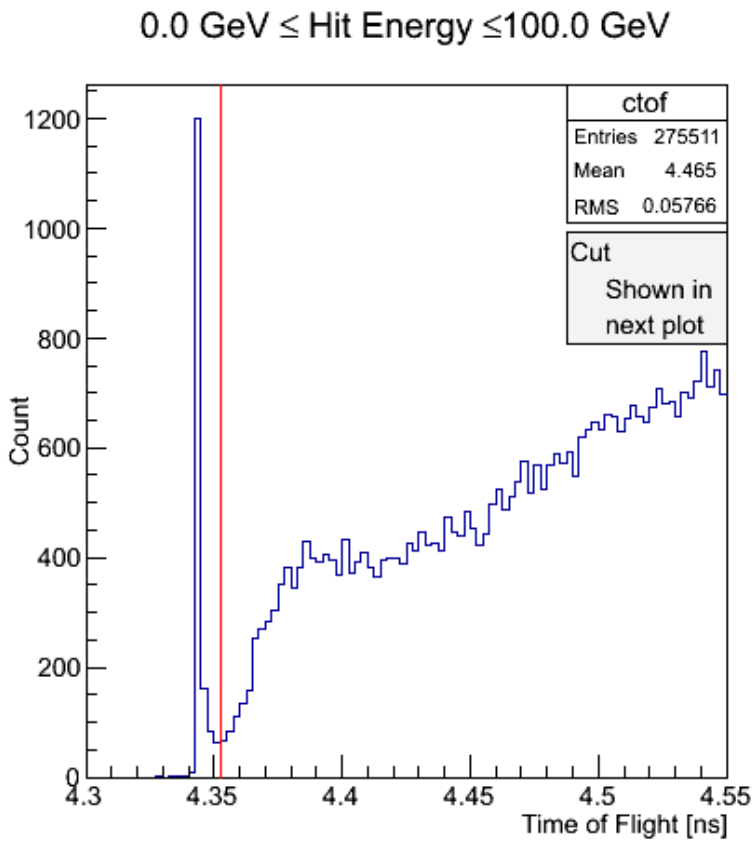
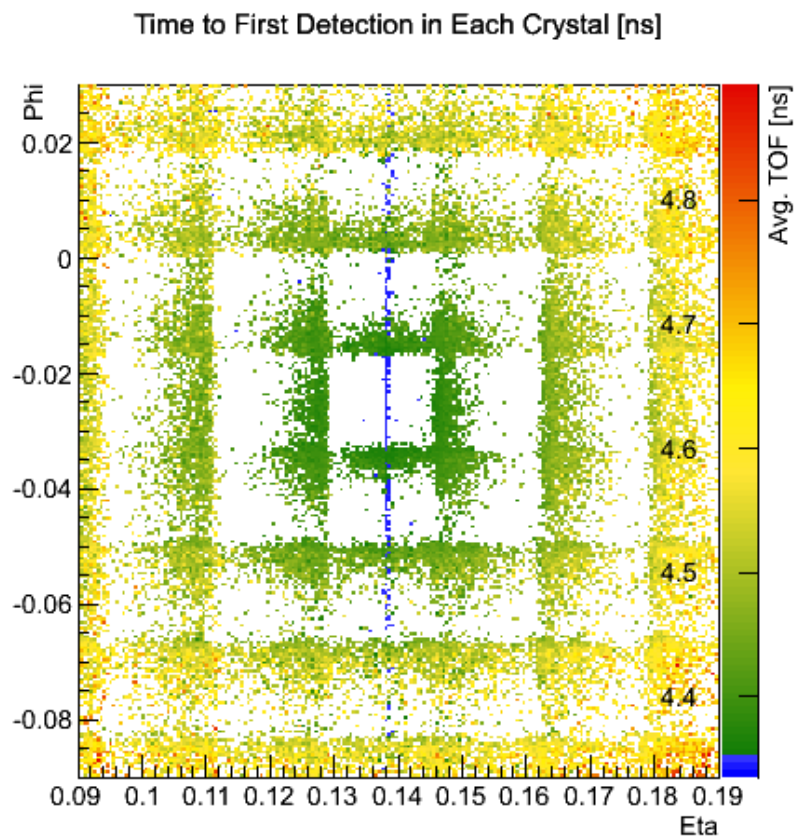


Photon 100 GeV All Energy First Hits

- Interesting pattern due to the crystals





From Here

- Add Z-vertex smearing
- Profile more in the Hit energy dimension
- Produce an area scan (various distributions of targets) in Geant4
- Attempt to apply a “measuring stick” to patterns to be able to characterize them.