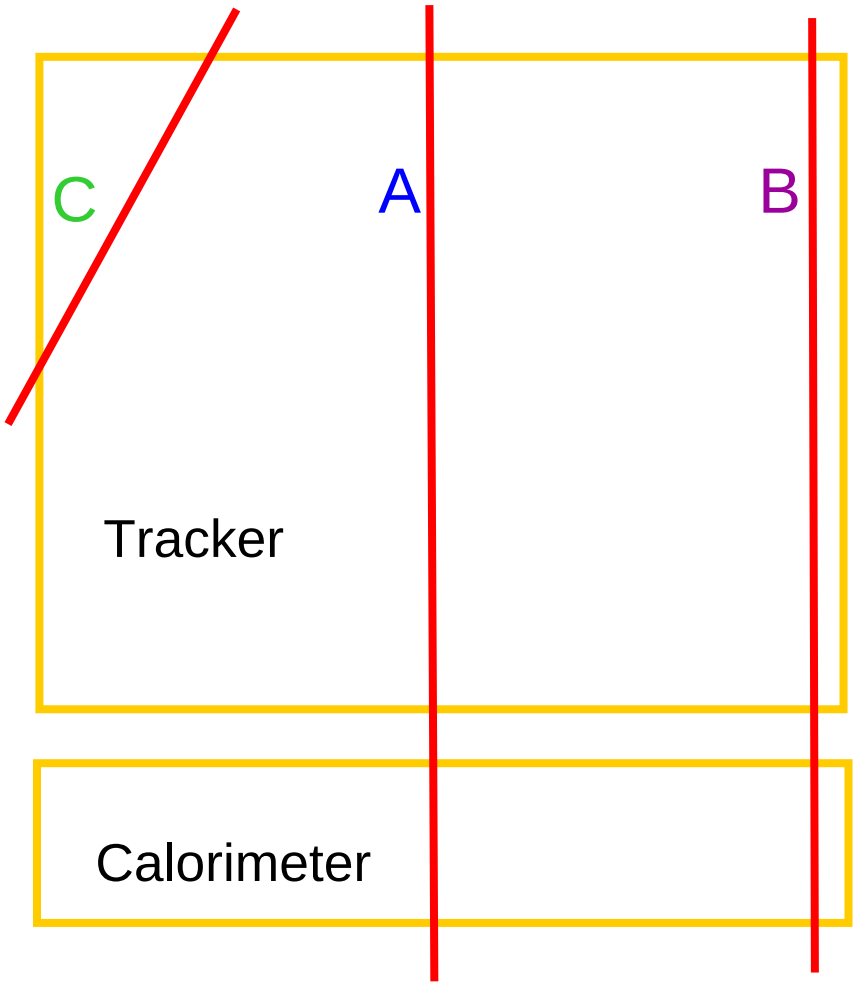


Preliminary Studies on the dependence of Arrival Time distributions in the LAT using CAL Low Energy Trigger Signals with flight configuration

Student: Jane Dai

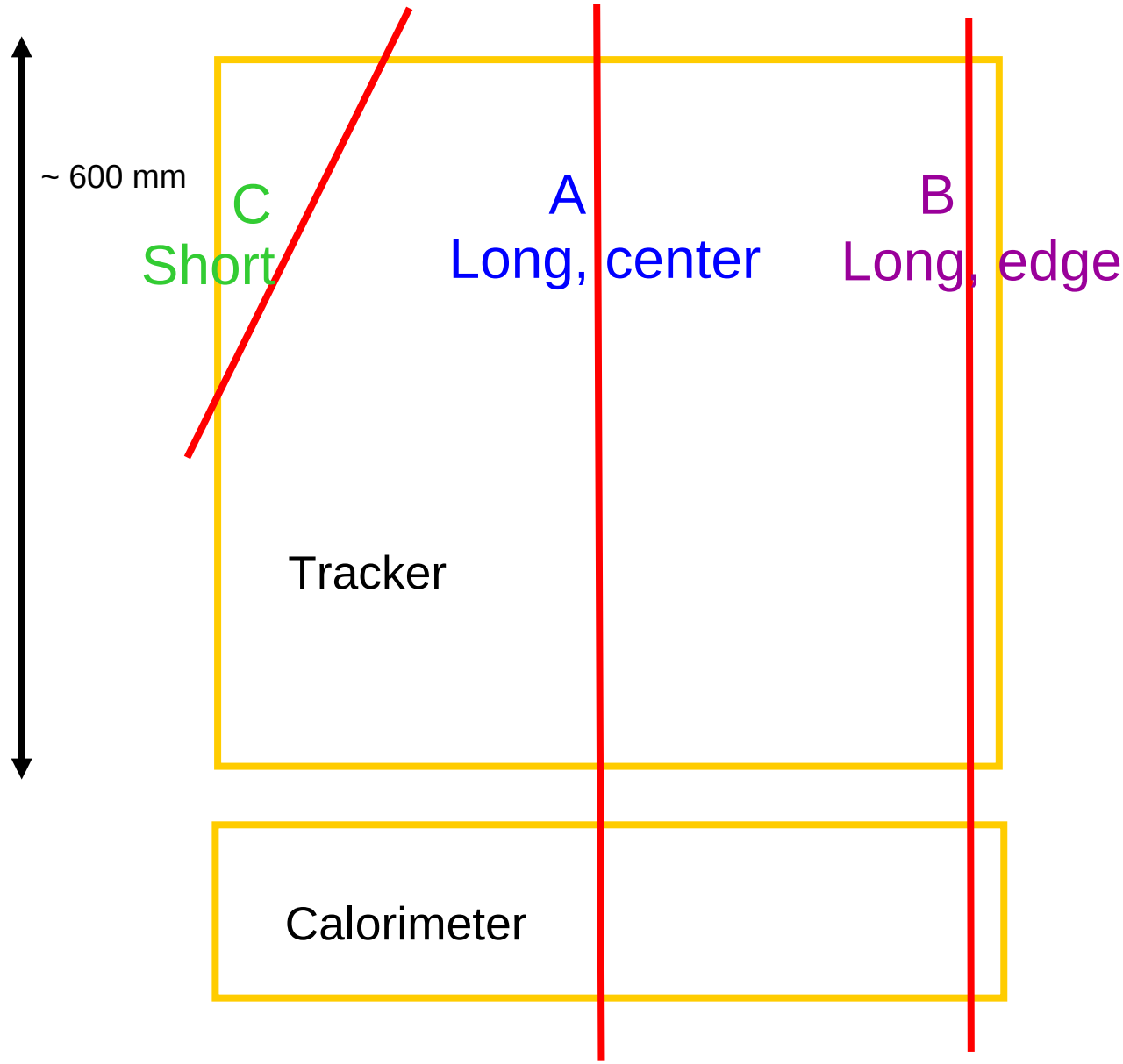
Supervisor: Eduardo

Outline

- Motivation
- Event Selection
- Results
- New questions
- Summary

- Data Used
  - 135005347
  - ~ 470,000 triggers

Motivation

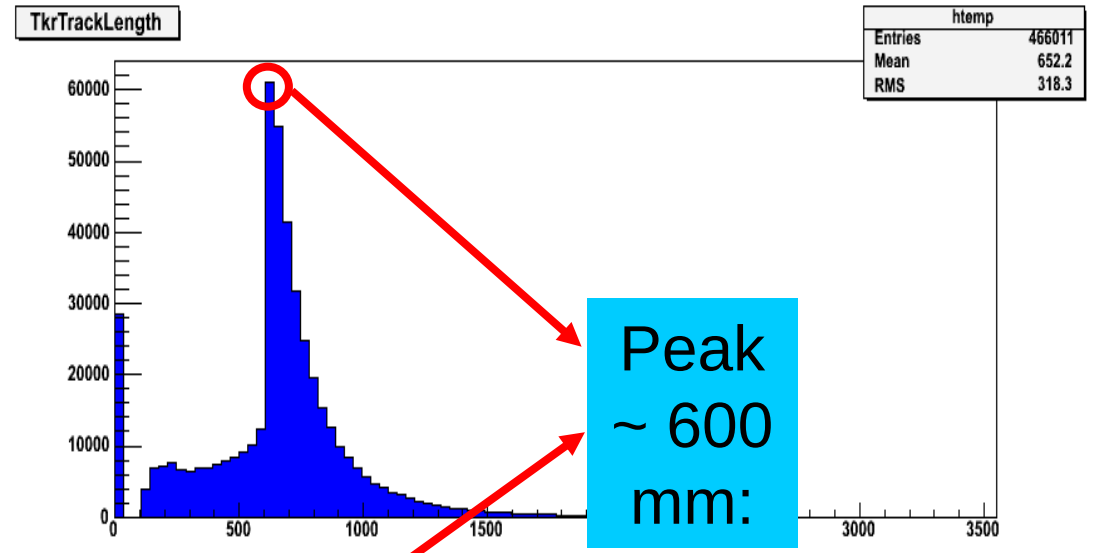


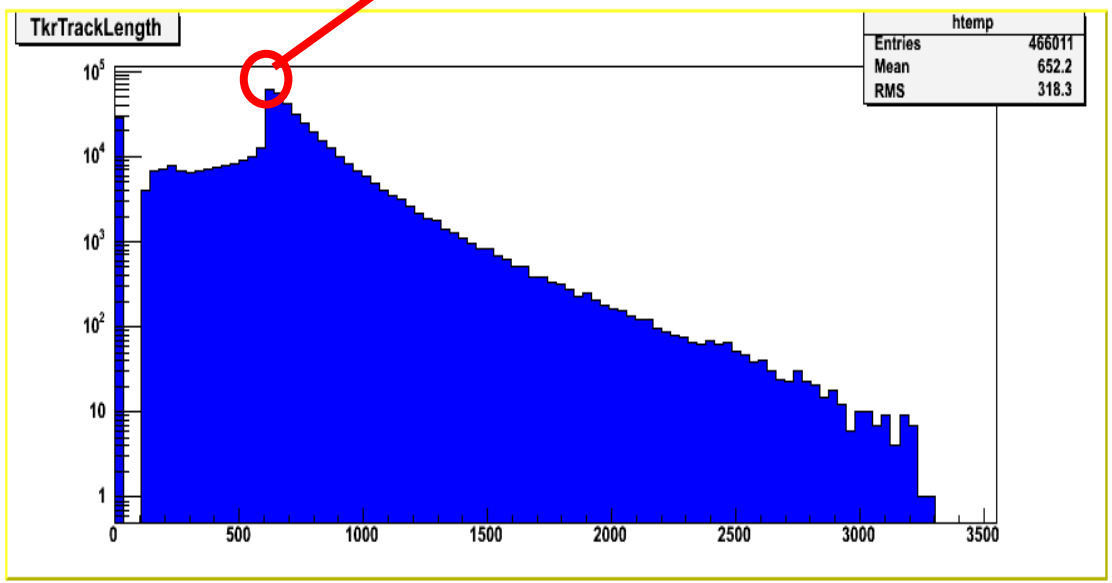
3 identical particles arriving at different incident angles and positions:

Is there any difference in the arrival time of the TKR trigger?

Criteria: Length of Tracks

Method to distinguish A/B and C --- Length of tracks





Define 2 samples

sample 1

length>=600mm: long

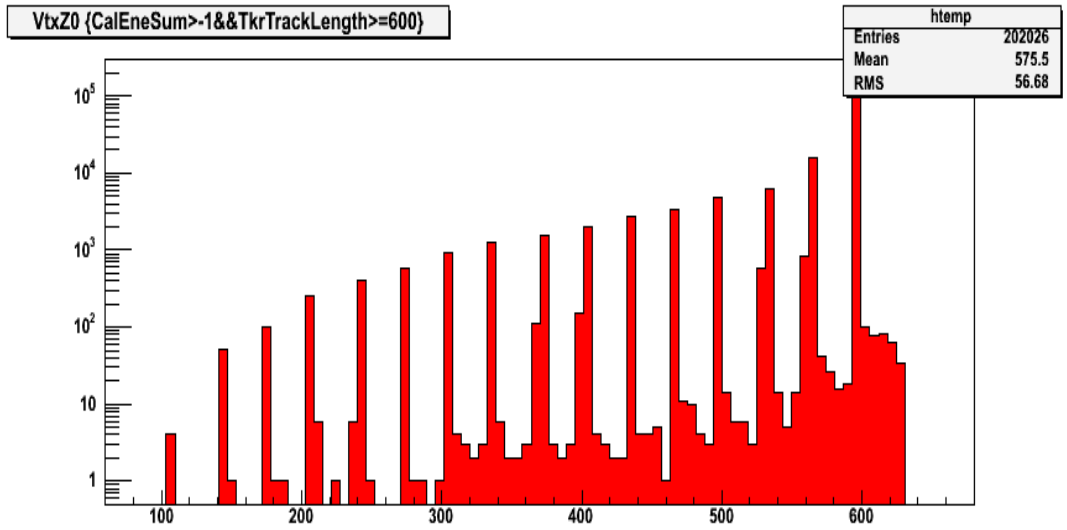
sample 2:

length < 600mm: short

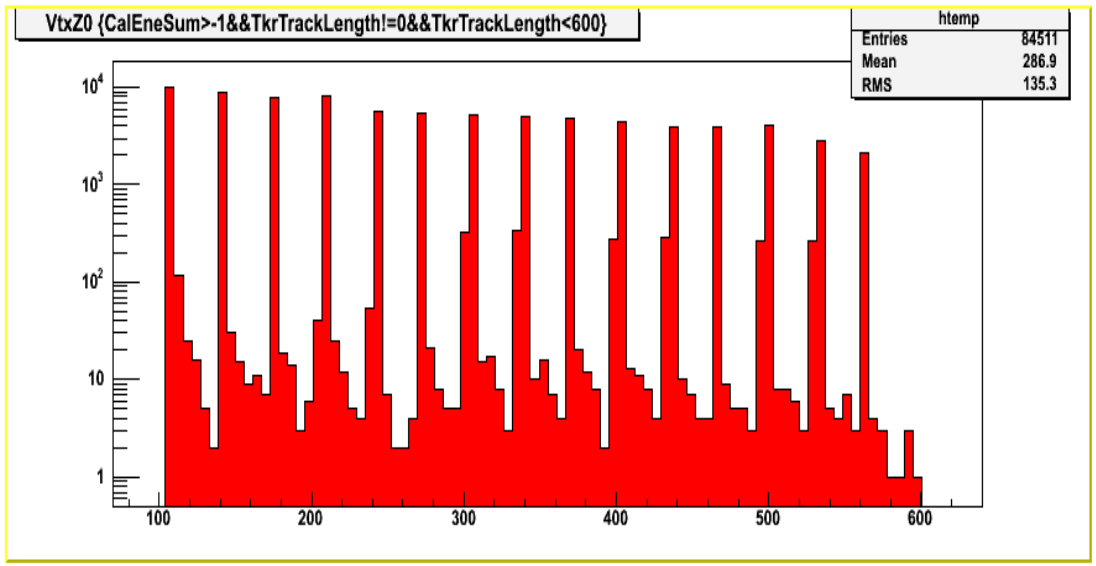
Test of the method1 : Z Location of "Vertex"

Long: peak around 600

Short: relatively uniform



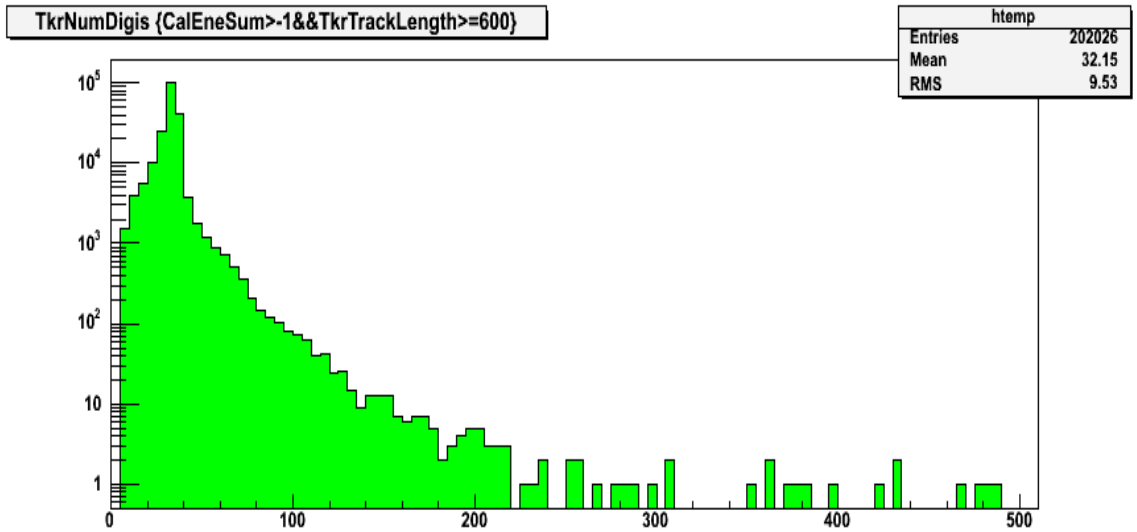
Additional Cut: Energy Sum of CAL Crystals >=0



Test of the Method 2: Number of TKR Planes Hit

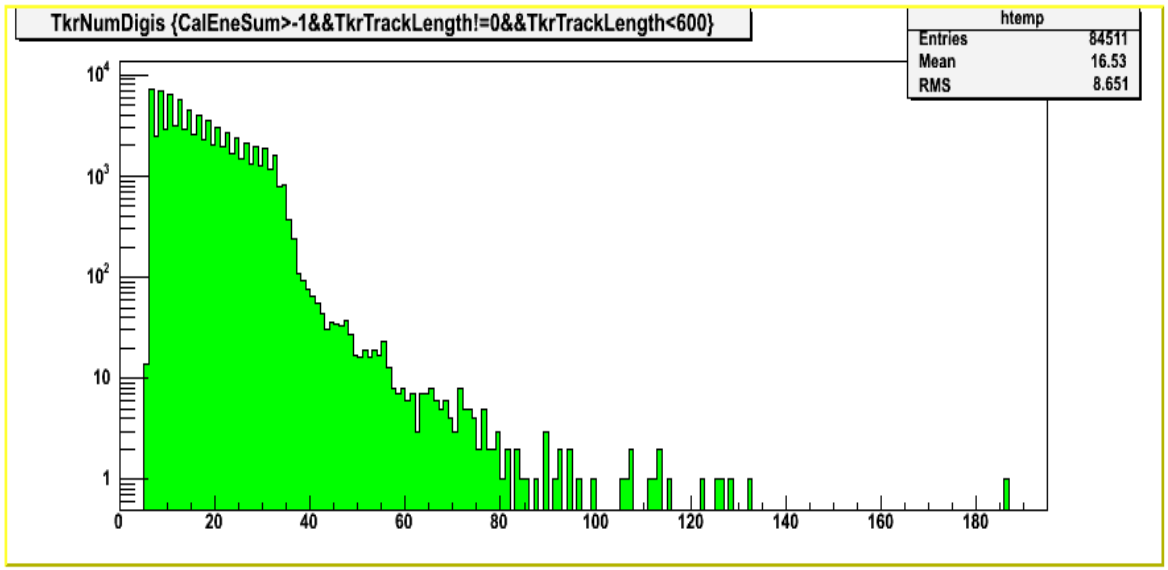
Long:

peak around 36 (# of planes in a tower), maximum ~ all planes of the 16 towers



Short:

mostly < 36 planes

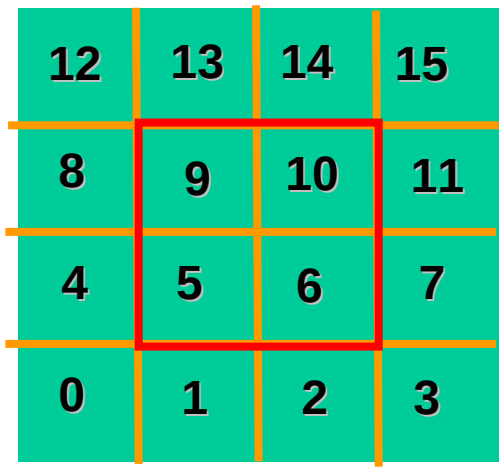


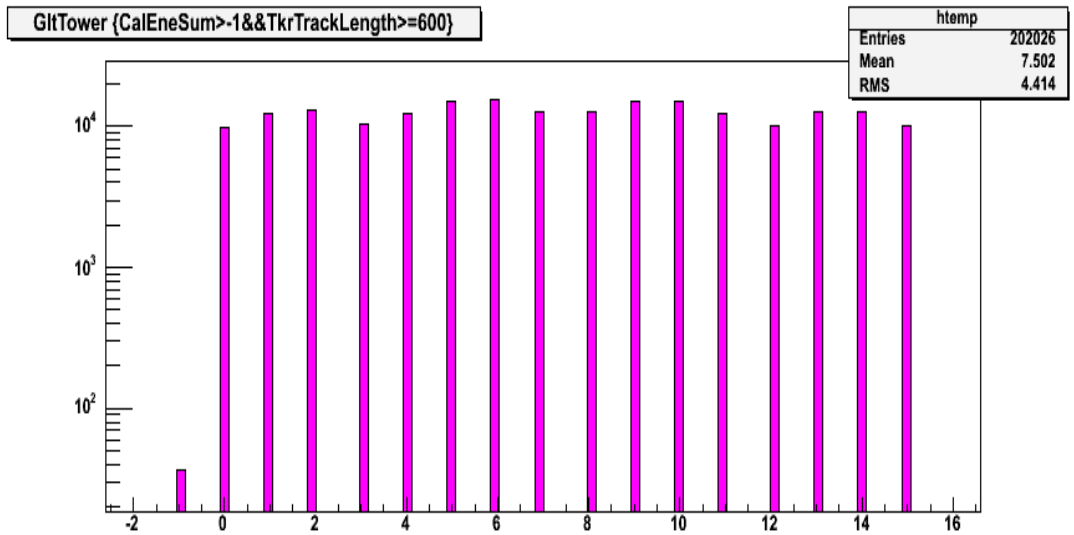
Test of the Method 3: # of Towers with TKR "triggered"

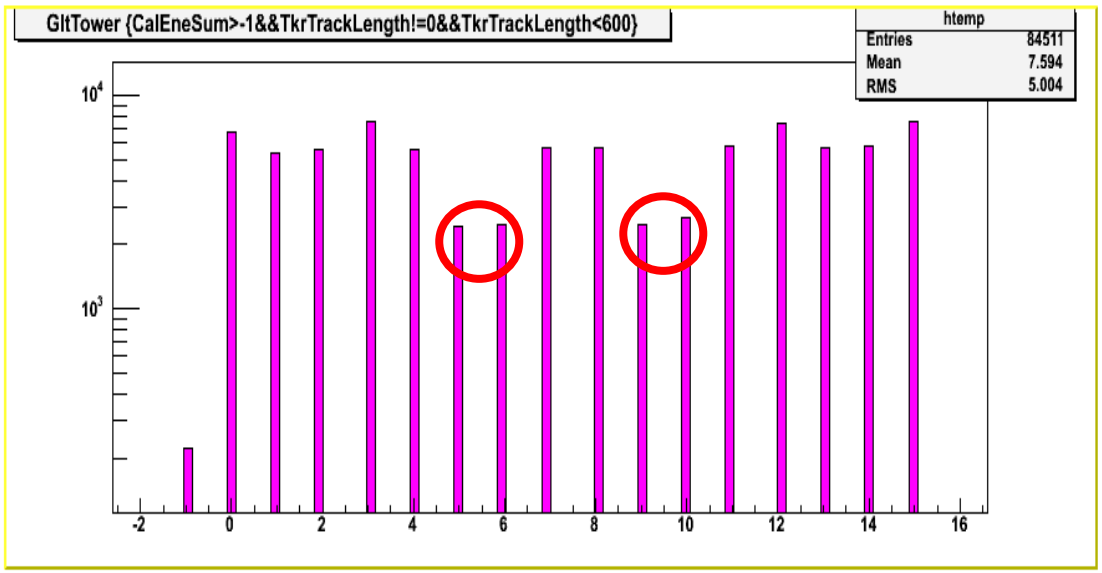
GLT Tower: "trigger" is created from hits in the TKR (not by the GEM!)

Short: easier to occur around the edge/corners

Top View





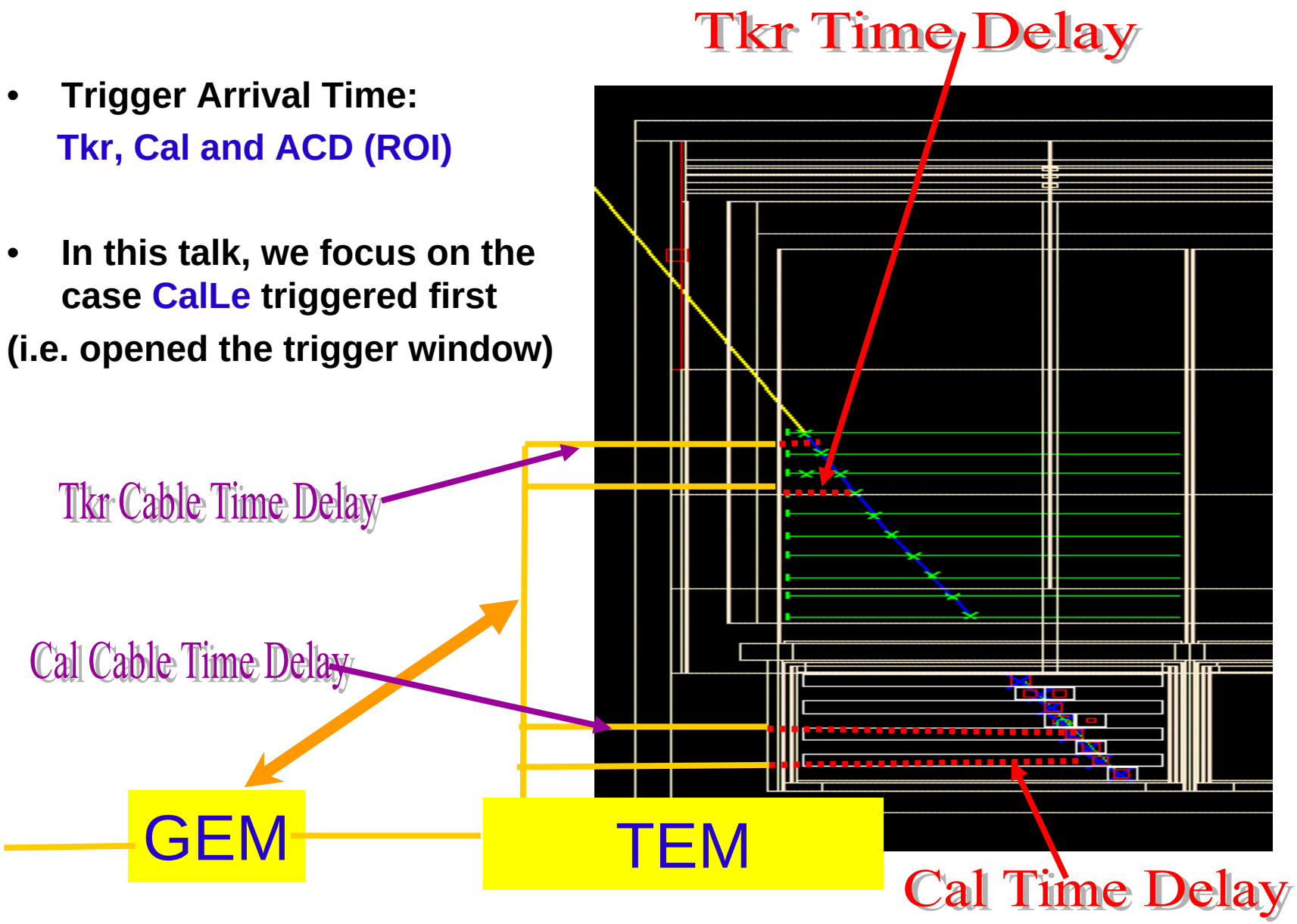


Time Delay of the Trigger Signal

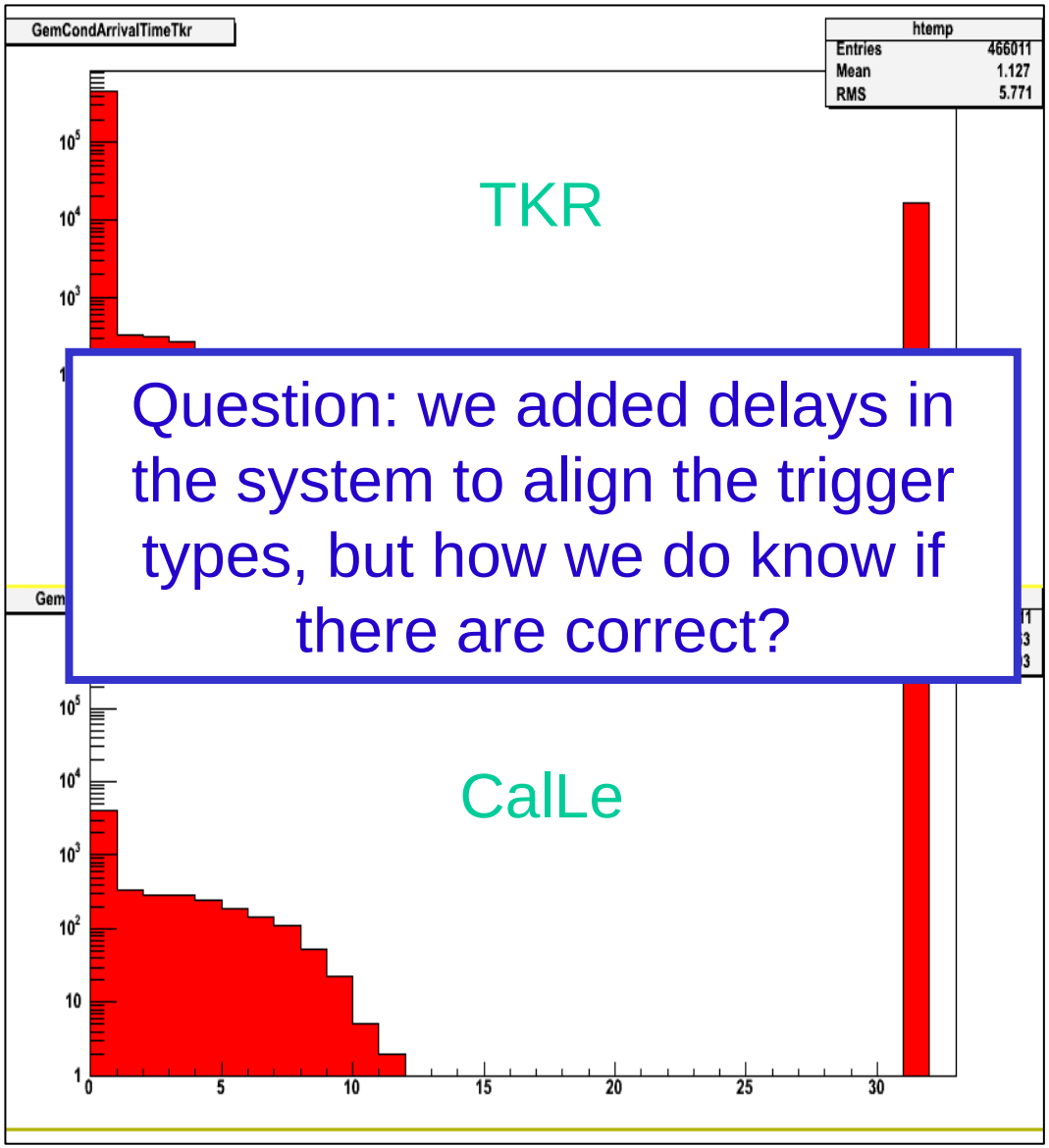
- **Trigger Arrival Time:**
  Tkr, Cal and ACD (ROI)

- **In this talk, we focus on the case CalLe triggered first**

(i.e. opened the trigger window)



Arrival Time of Trigger



TKR/CAL Arrival Time: the time **TKR/CAL** triggered with respect to the opening of the trigger window **(recorded by the GEM)**

0: it opened the trigger window

31: no participation or already high when trigger occured

Cal Trigger→

Low energy (>100MeV)

High energy (>1 GeV)

Results: TKR Trigger Arrival Time

Want to study 3 Cases:

1. CalLe =0, Tkr>0
2. Tkr =0, CalLe>0
3. Both=0

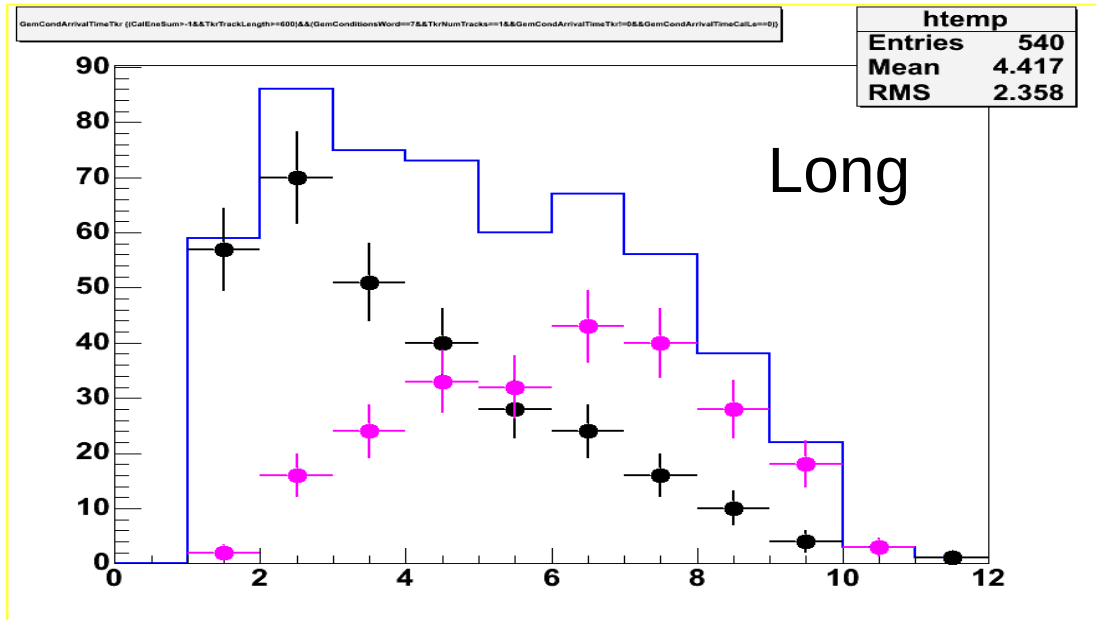
Only had time to study Case1

Selection cuts used:

GemConditionsWord ==7
TkrNumTracks==1
GemCondArrivalTimeTkr!=0
GemCondArrivalTimeCalLe==0

Pink: CalEne<100MeV
Black: CalEne>=100MeV

Overall:
no big difference between short and long tracks



Analysis of the plots

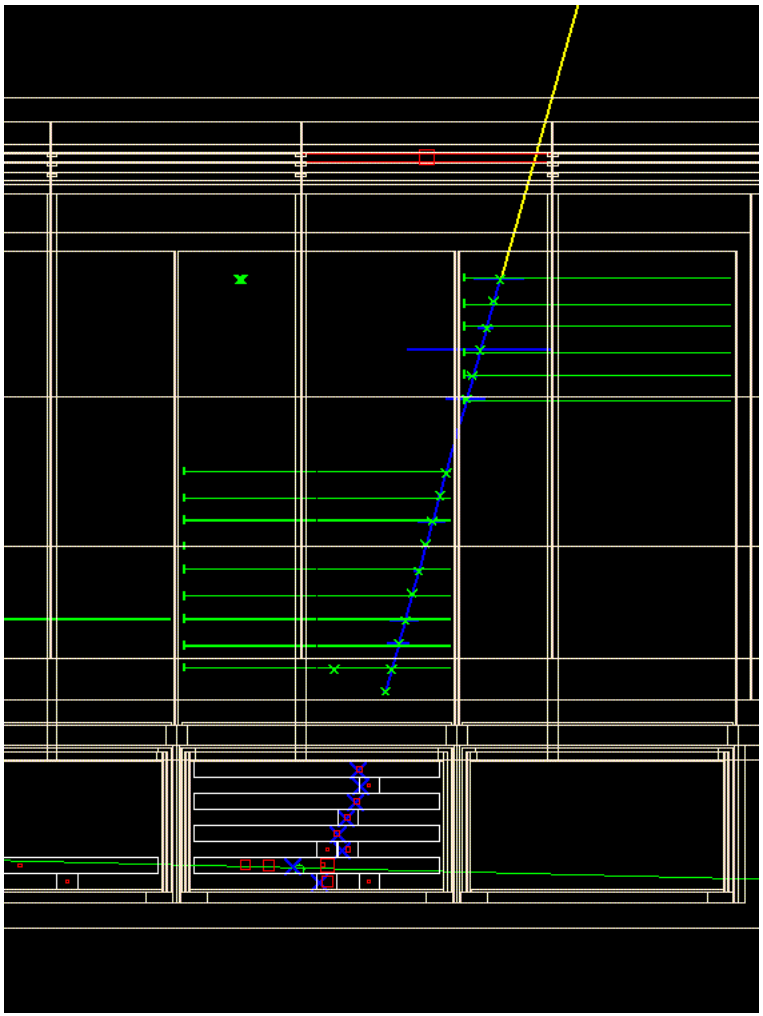
It seems that there are no big difference in the TKR Arrival Time distribution between long and short tracks.

→ This analysis sees no noticeable difference for the timing properties of the LAT (for event topologies A/B and C explained in the first slide)

But it also generates new questions:

1. Why does the CalLe fire when E is < 100 MeV?
2. Why does it have different distribution compared to E>=100MeV?
3. Why could CAL trigger first when most of the particles come from above?

Example: Energy Sum in the CAL >=100MeV



A typical trajectory of the particle which triggered the CalLe first and Tkr later.

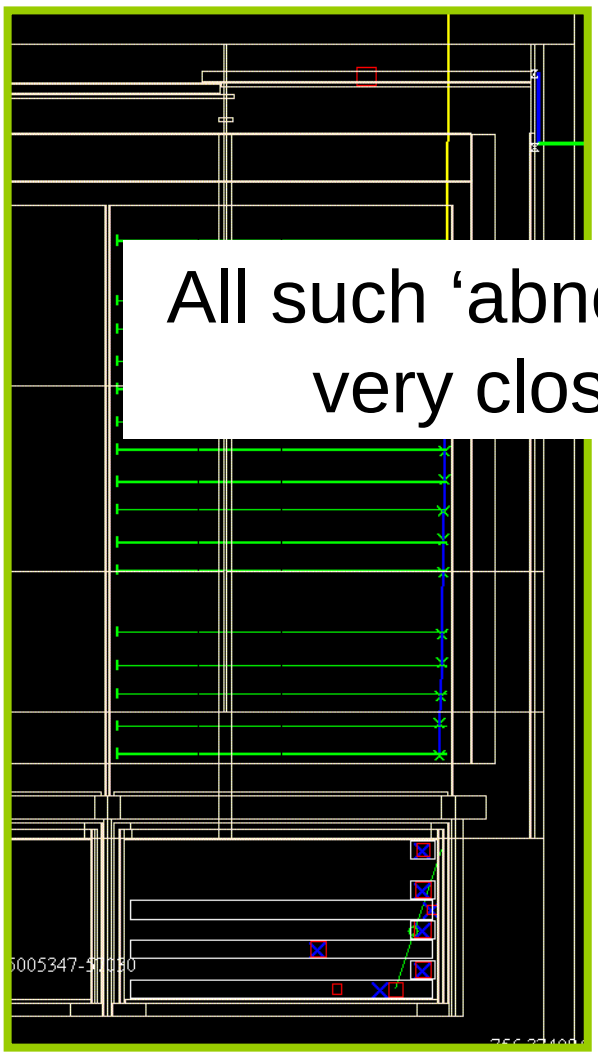
It has energy >100MeV, as it should be.

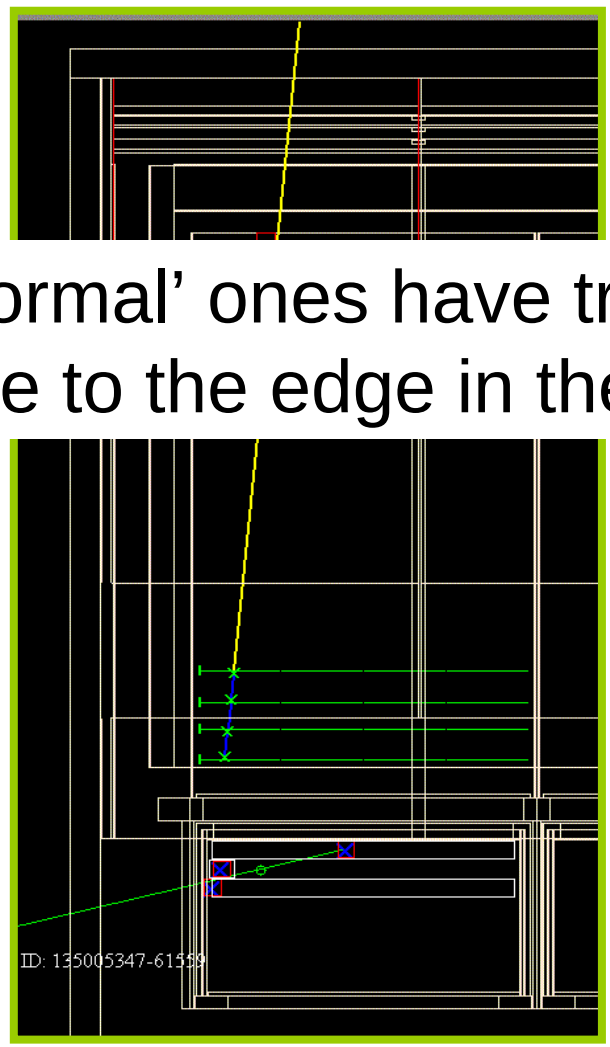
Examples: Energy Sum in the CAL < 100MeV

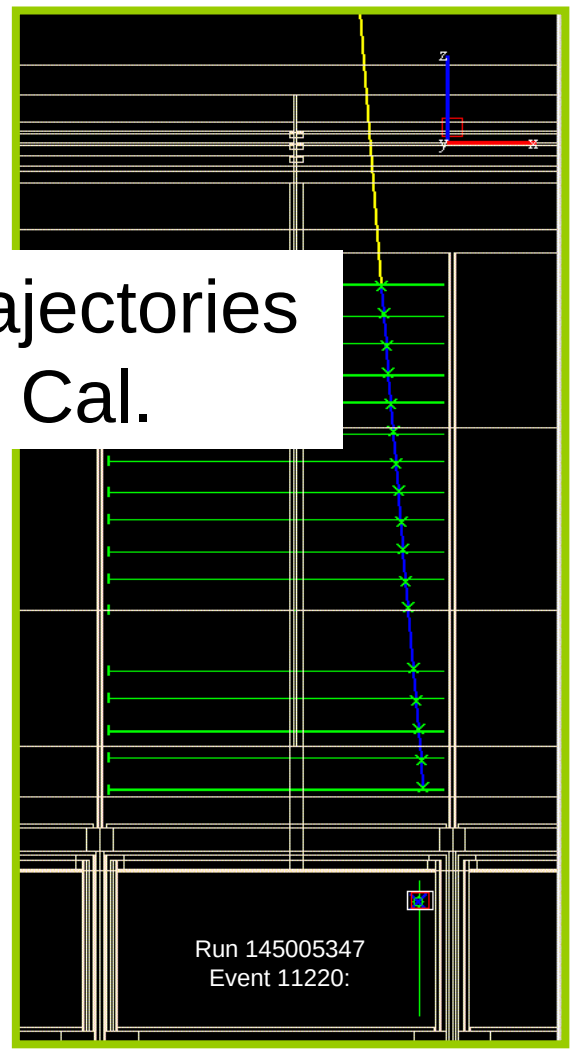
Long track

Short track

Long track: Only one hit on Cal, <3MeV

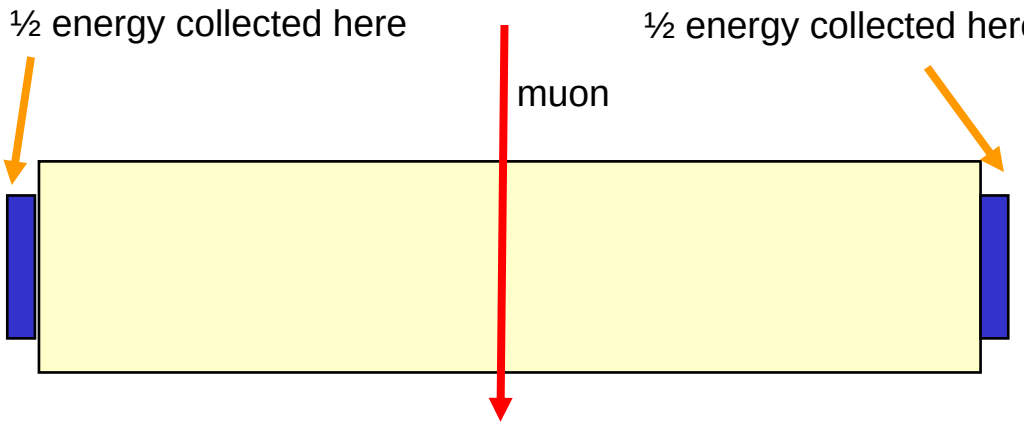




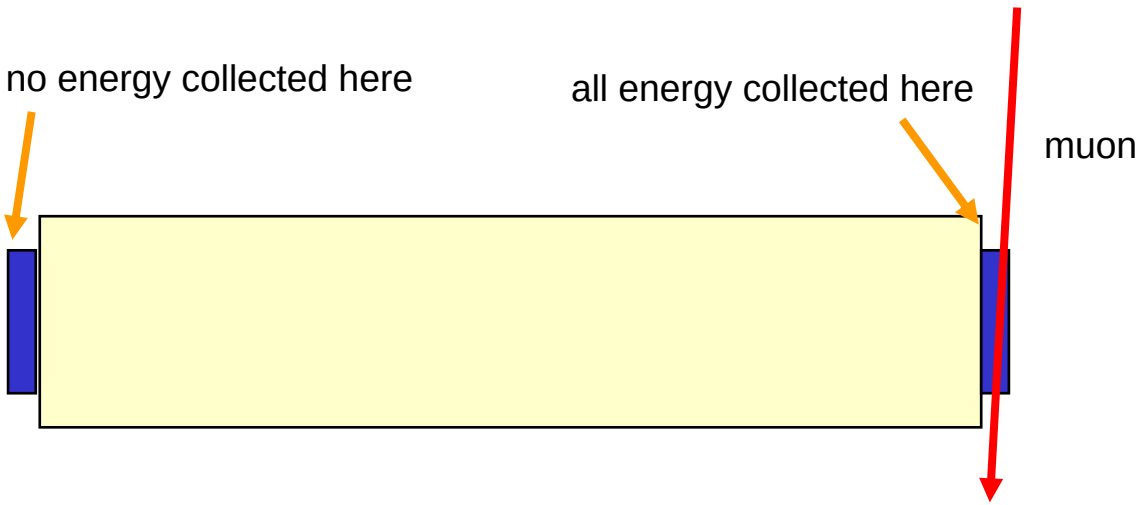


All such ‘abnormal’ ones have trajectories very close to the edge in the Cal.

Investigation of CAL LE triggering < 100 MeV



- **if the particle hits the diode it must have**
  - **one side of the crystal with lots of energy**
  - **one side of the crystal with no energy**



We looked at the CALNtuple to check this assumption and the answer is correct.

Explanation (…partially)

Questions:

1. **Why does the CalLe trigger fire when E is < 100 MeV?**

Ans: **The hits in CalLe were close to the edge/diodes, or even on the diodes. They deposit all the energy in the diode which has different material (Si instead of CsI) . This energy is high enough to trigger the CalLe.**

Work to do: Check that the number of occurrences is consistent with expectations

2. Why does the arrival time in the TKR has a different distribution compared to E>=100MeV?

Ans: **Particles going through the diodes deposit a lot of energy and the CAL trigger arrive first. CAL is the slowest signal and since they arrive before than "normal", the TKR signal arrives even later. (See Eduardo's talk for more details)**

3. Why could CAL trigger arrive first when most of the particles come from above? **We need a timing diagram to understand that (maybe Eduardo will have it in his talk)**

Conclusion

- We expected that the electronics could have different time delay for particles through center/edge, since they have different information propagation length.
- We will conclude that qualitatively, there seems to be no big difference for arrival times in the TKR when the CalLe opens the trigger window
  - when comparing long and short track samples: mean values of 4.6 vs 4.7 consistent with expectations
  - maybe there is a difference, but we need a timing diagram and more statistics
- We do not know for sure quantitatively, but the difference in TKR arrival time distribution for the energy>100MeV and energy<100MeV in the case studied is a hint that A (center) and B (edge) are shifted inappropriately.
- Recommendation: make a simulation to calculate all the time delay factors and compare with experimental results, then add the correct time delays to our data base
- Future work: Case 2 (TKR triggered first) and Case 3 (both)

Acknowledgement

Special Thanks to:

Eduardo

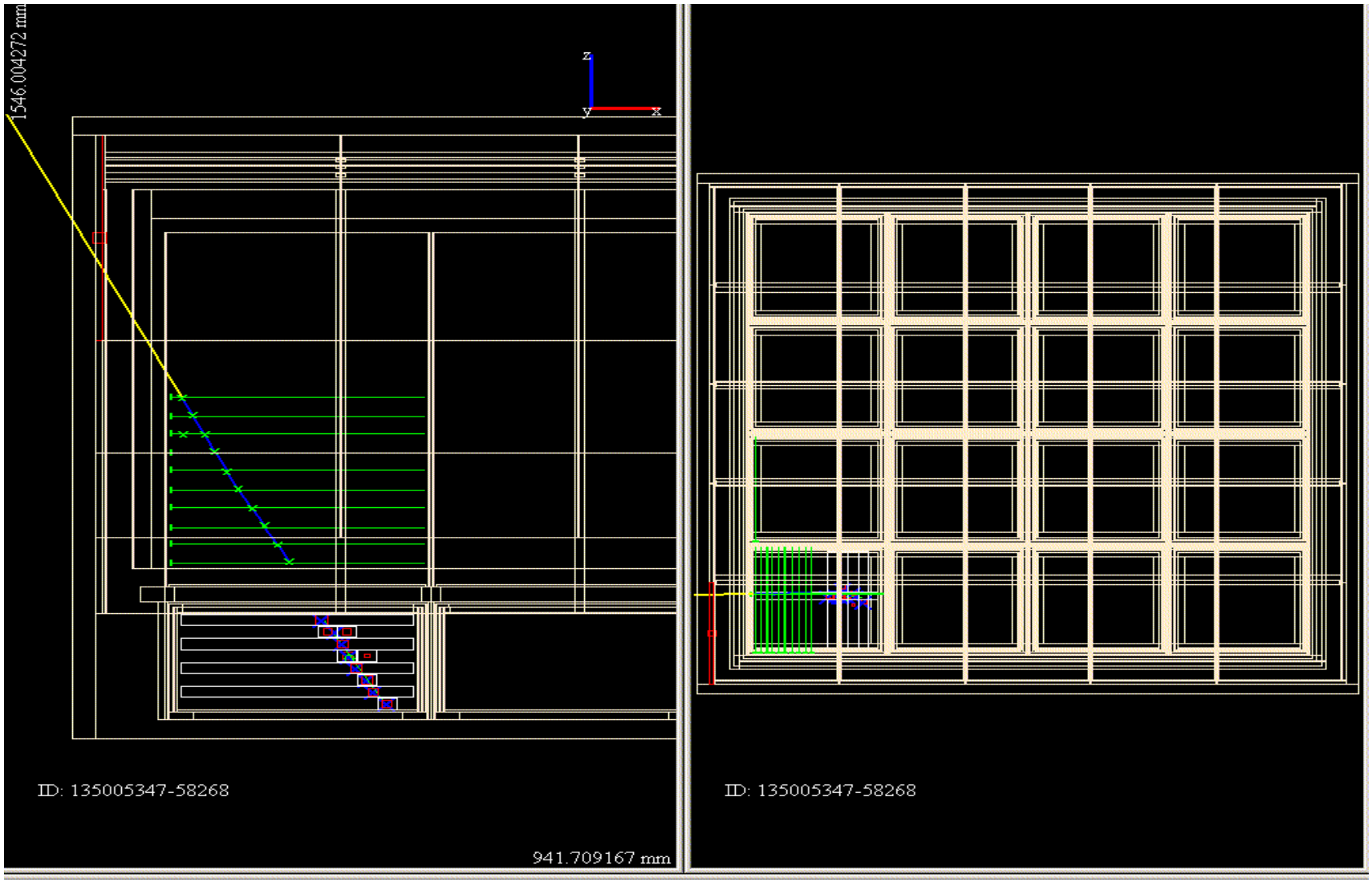
Paul

Anders

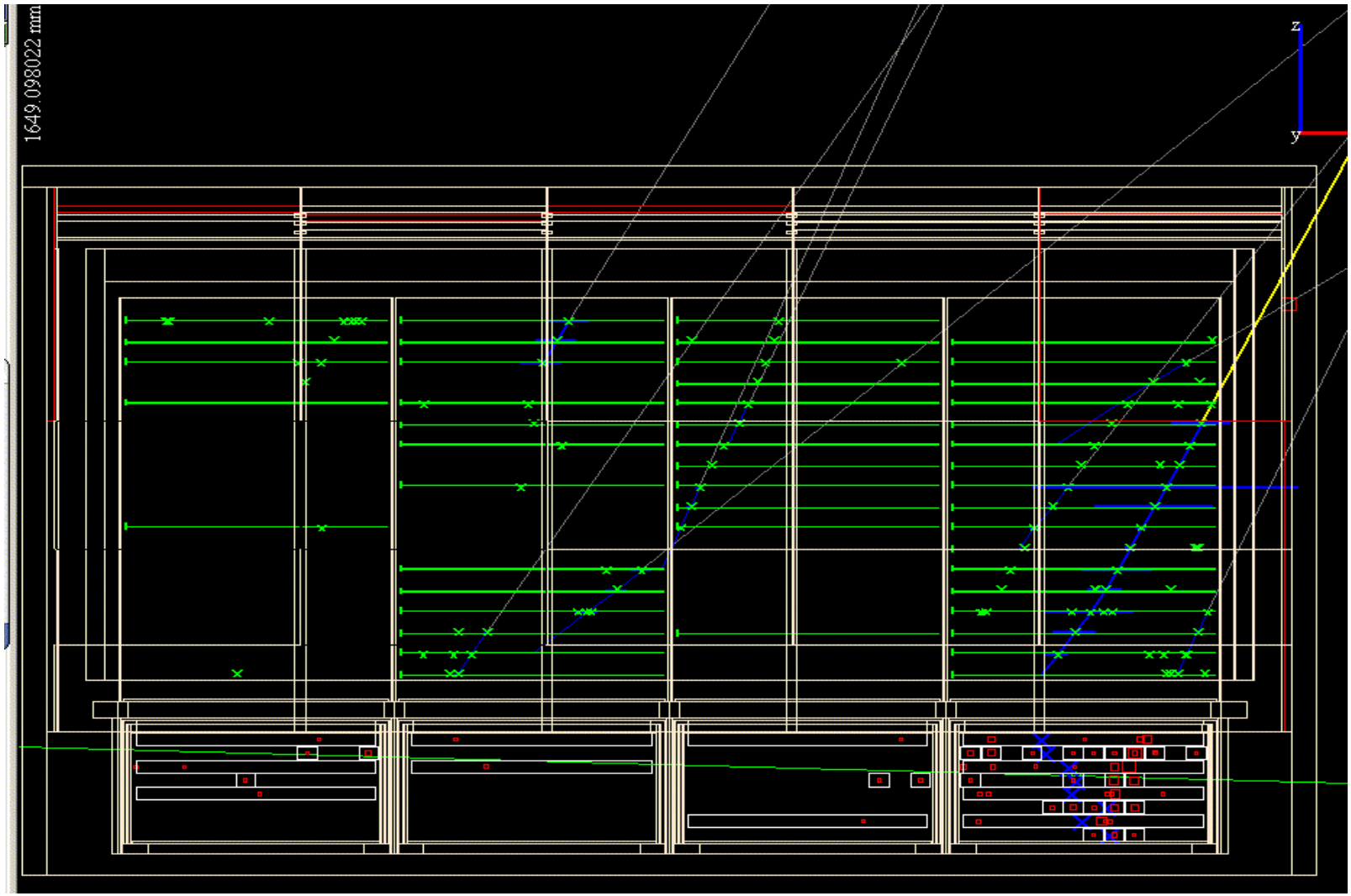
For their kind help!

Back up slides

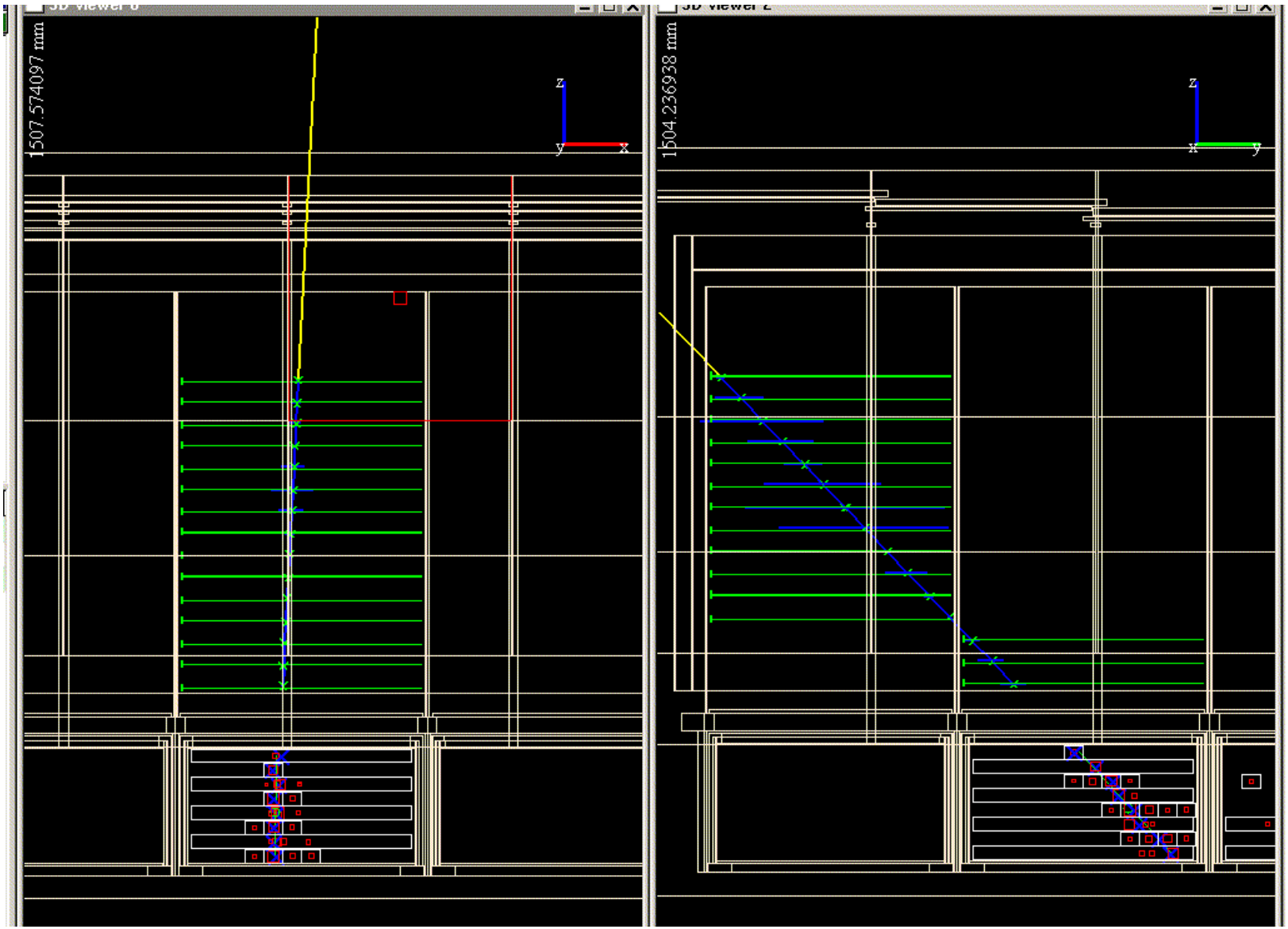
Example: Tkr trigger first



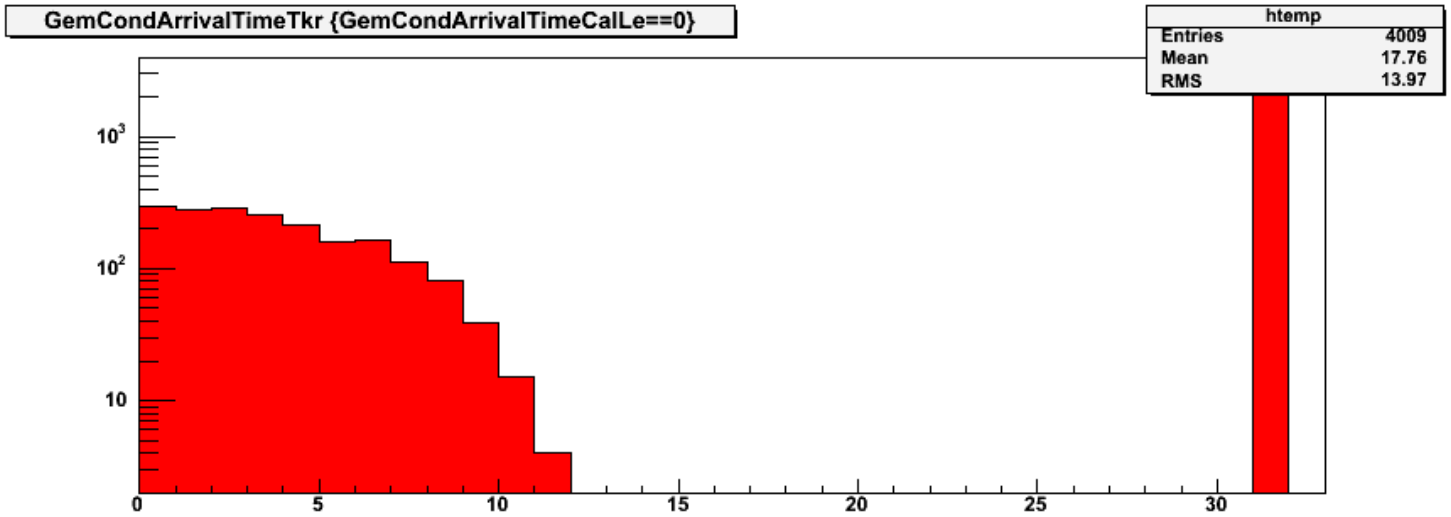
Example: Both 1 –cosmic shower

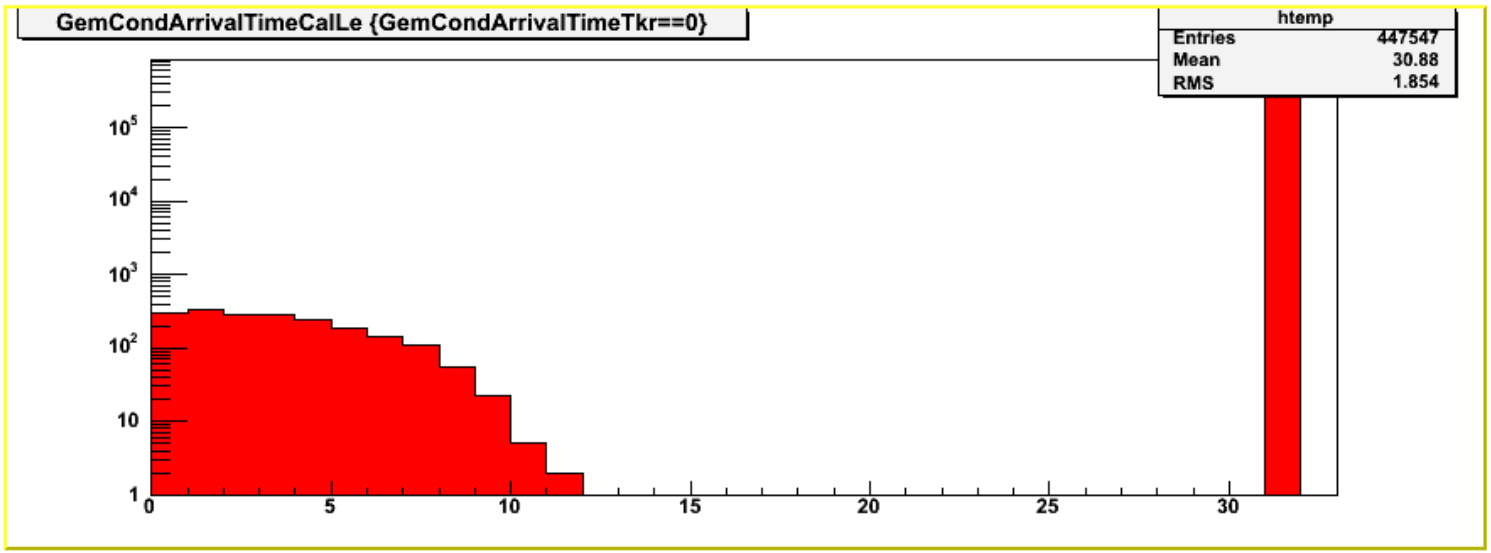


Example: Both 2 (normal)



Both case: tkr=0 && calle==0





CAL Crystal and Cluster Energy

- Run 145005347, Event 11220:
  - Numbers do not match in several places
    - SVAC, Merit and CAL Ntuples and Event Display !

- Explanation from Anders… (thanks!)
  - Only one crystal hit according to CAL Reconstruction :
    - For completeness:
      - » Other crystals were removed in CalRecon presumably because they fall below the zero suppression threshold cut
      - » Can be seen in the CalTuple
  - One crystal hit and one CAL cluster:
    - What are their energies?
      - » Crystal energy: 2.736 MeV
      - » Cluster energy: 2.936 MeV
    - This differences are seen in Merit, SVAC ntuples and Fred.
    - In both cases the energy is supposed to be 'uncorrected' energy.
- From the CalTuple:
  - We have for the two faces of the crystal:
    - ~2.65 MeV
    - ~2.82 MeV
  - And note: sqrt(2.65)xsqrt(2.82) ~ 2.736
- Additional correction applied to Cal cluster only?
  - Non-linearity correction?