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Update to the chain finder

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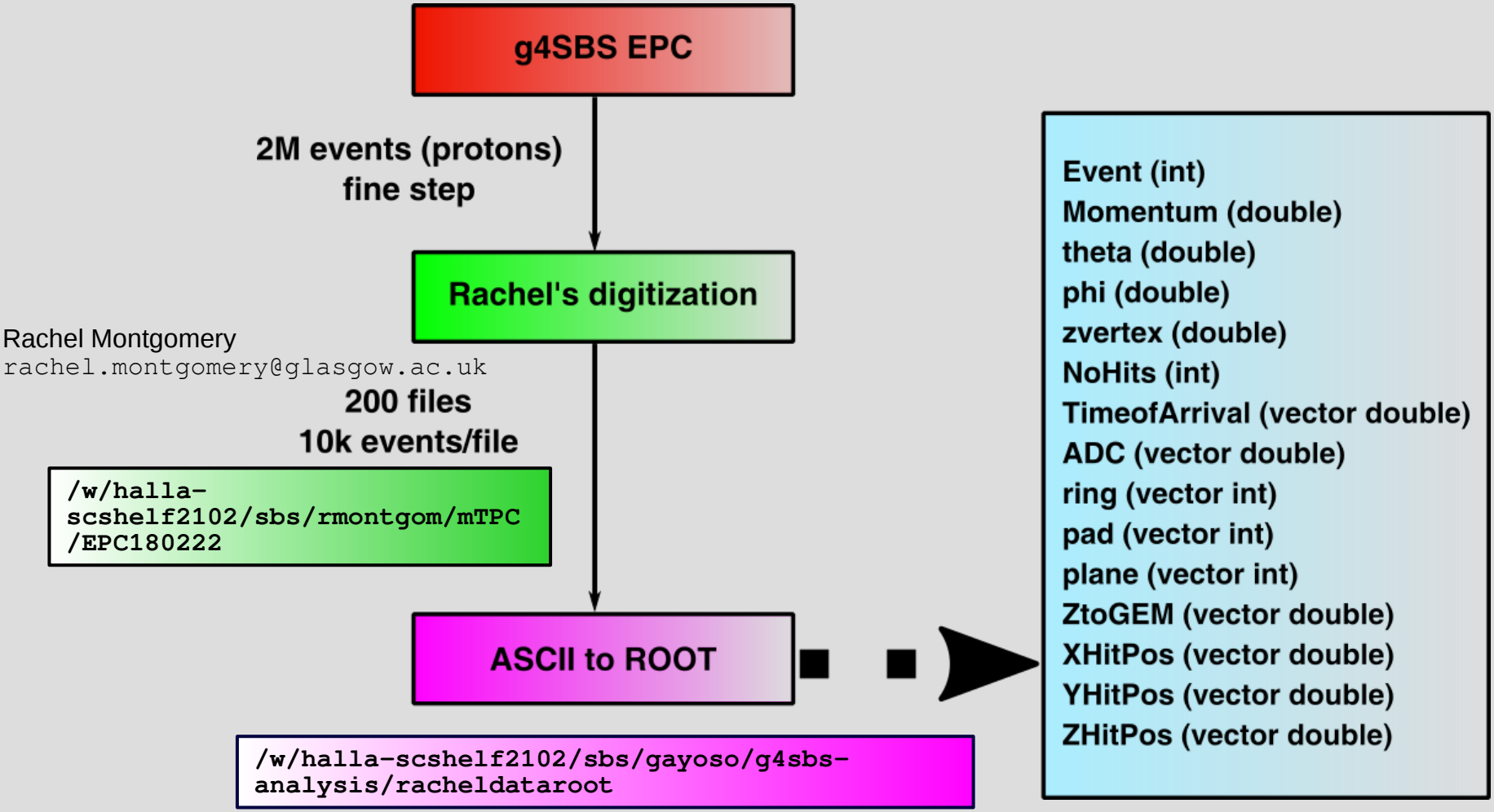

g4SBS EPC
2M events (protons)
fine step
Rachel's digitization
Rachel Montgomery
rachel.montgomery@glasgow.ac.uk
200 files
10k events/file
/w/halla-scshelf2102/sbs/rmontgom/mTPC/EPC180222
ASCII to ROOT
/w/halla-scshelf2102/sbs/gayoso/g4sbs-analysis/racheldataroot
Event (int)
Momentum (double)
theta (double)
phi (double)
zvertex (double)
NoHits (int)
TimeofArrival (vector double)
ADC (vector double)
ring (vector int)
pad (vector int)
plane (vector int)
ZtoGEM (vector double)
XHitPos (vector double)
YHitPos (vector double)
ZHitPos (vector double)

Rachel's data output structure

```
Event 0
        0.391797        56.63   -95.11  0.0532
        1128.22 5.12029e-07     0       91      6       0.0361991       0.000277426     -0.0500013      0.0861991
        1145.36 3.79636e-07     0       91      6       0.036749        0.000360927     -0.0508323      0.086749
        1162.5  2.13527e-07     0       91      6       0.037299        0.000446939     -0.0516631      0.087299
        1179.64 1.38157e-07     0       91      6       0.0378489       0.000535465     -0.0524936      0.0878489
        1196.78 1.3457e-07      0       91      6       0.0383989       0.000626495     -0.0533238      0.0883989
        1213.92 1.05379e-07     0       91      6       0.0389488       0.000720043     -0.0541538      0.0889488
        1231.06 1.0527e-07      1       90      6       0.0394988       0.000816089     -0.0549834      0.0894988
        1248.21 1.54814e-07     1       90      6       0.0400487       0.00091463      -0.0558128      0.0900487
        1265.35 1.70296e-08     1       90      6       0.0405987       0.00101567      -0.0566418      0.0905987
        1282.49 1.07147e-07     1       90      6       0.0411487       0.00111922      -0.0574705      0.0911487
        1299.63 3.50869e-07     1       90      6       0.0416987       0.00122528      -0.0582989      0.0916987
```

Sort the data pool

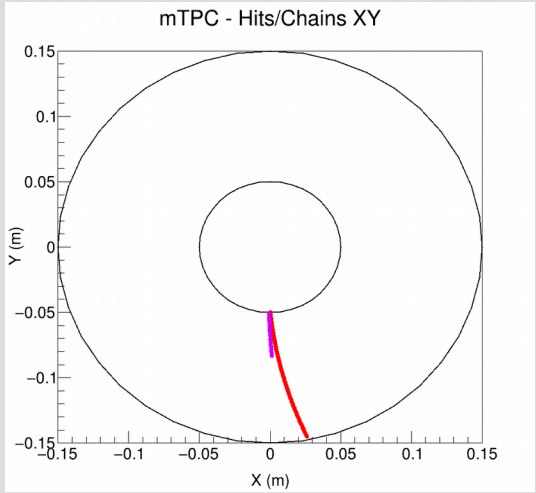
G4 data enter in the data pool as first produced, first event → inner to outer

https://userweb.jlab.org/~gayoso/file.gif

Sorting (making use of Tvector and Quick Sort algorithm
http://www.algolist.net/Algorithms/Sorting/Quicksort
→ outer to inner

https://userweb.jlab.org/~gayoso/file_01.gif

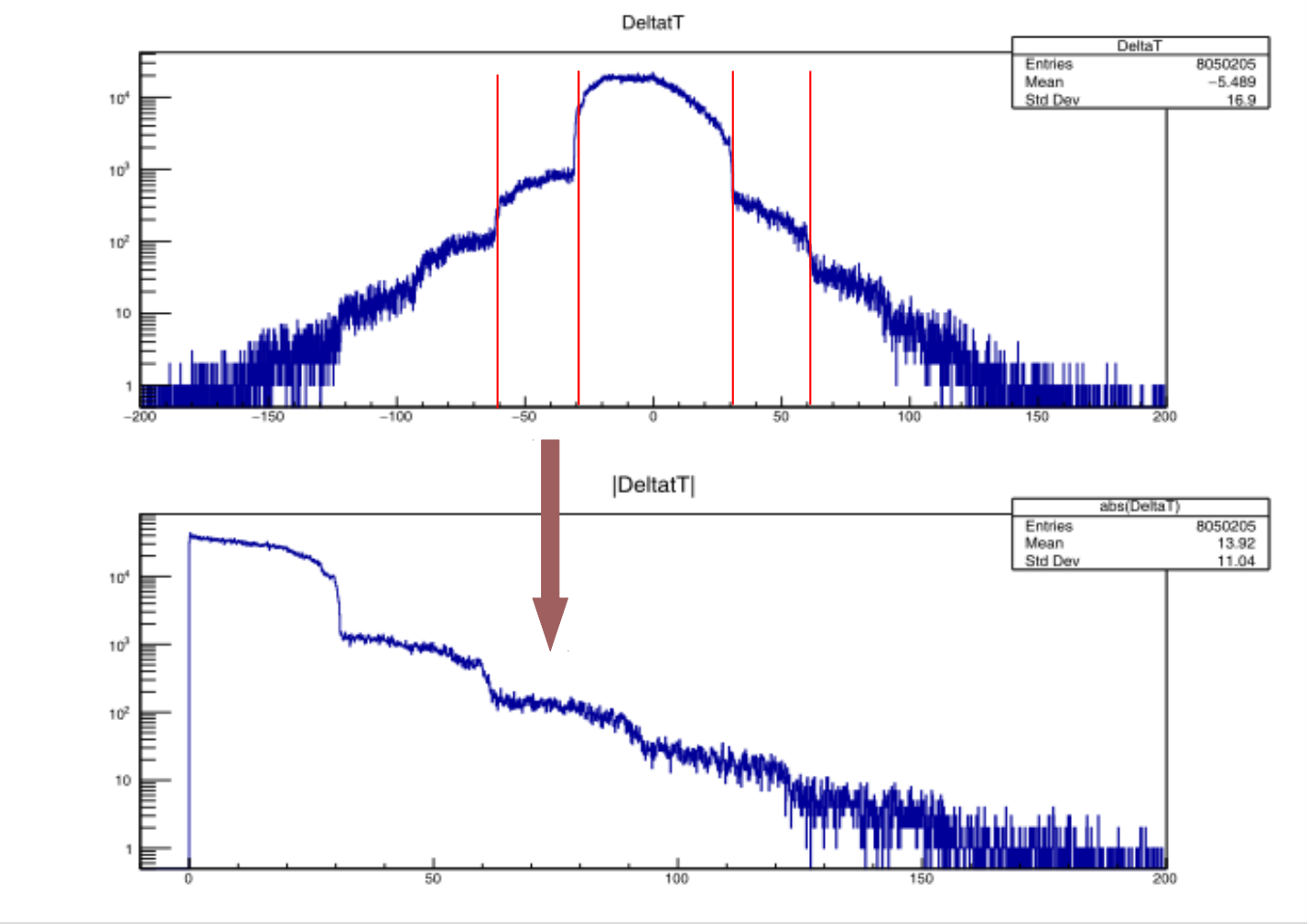
Gif animations of these two events showing the data pool sorted (before and after)



Use of time

- The chain finder makes use of the spatial coordinates (now directly the g4sbs output)
- Make use of time difference between hits could help to select hits
  - It is assumed that different tracks will have different TDC timing hits within the time slot.
- But first I need to understand the data

Time difference (Δt)

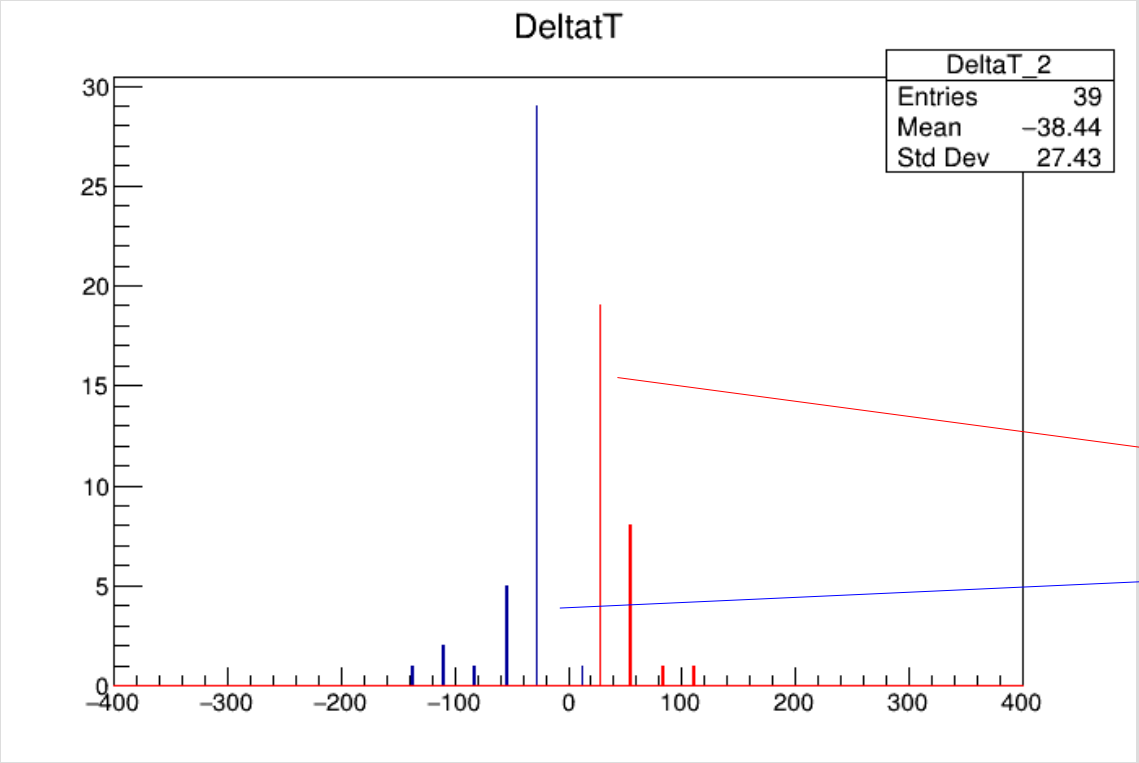


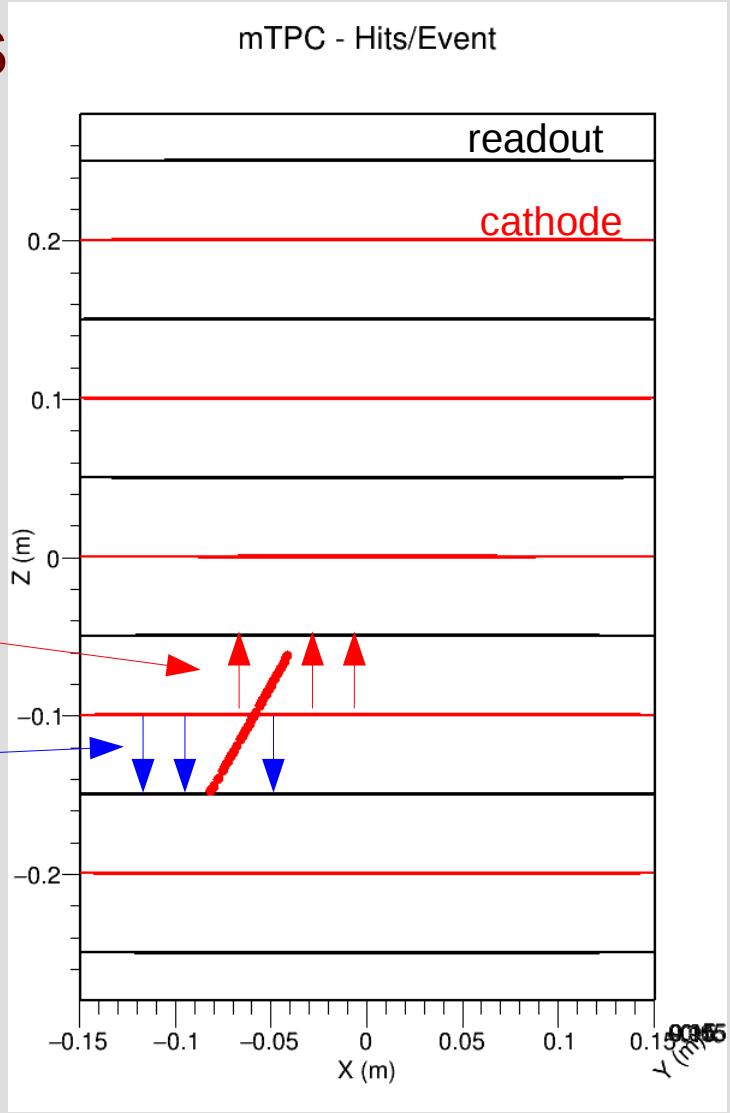
100k events

$\Delta t = t\_hit_i - t\_hit_{(i-1)}$

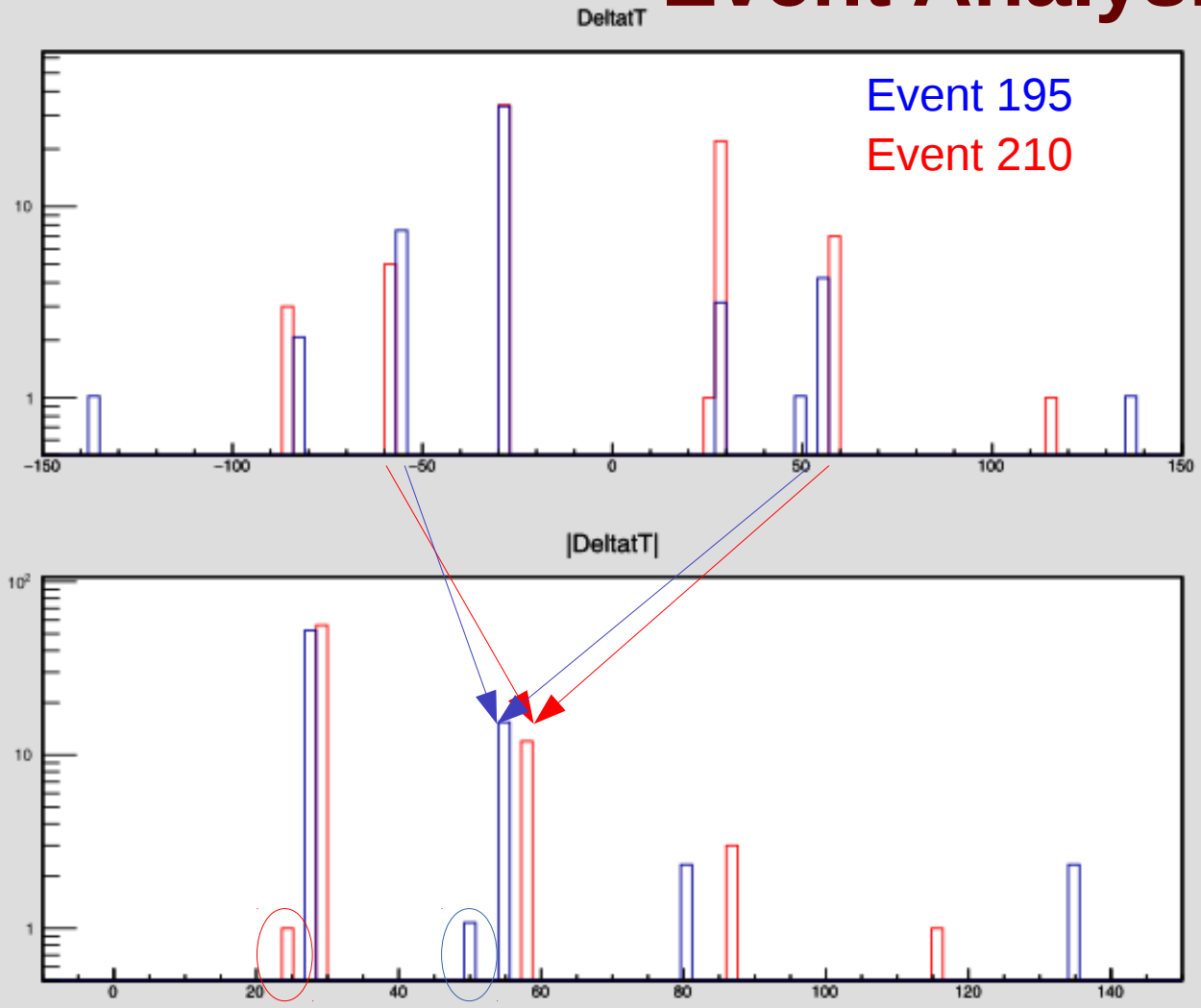
30 ns structure
(SAMPA sampling)

Event analysis





Event Analysis



Events at both sides of readout/cathode have ~|Δt|

- The hits time is close of a multiple of shorter Δt
- Some events present some challenging to understand:
  - Events (in circle) are effect of the Geant4 engine and not accomplish the previous rule

Geant4 ‘effect’

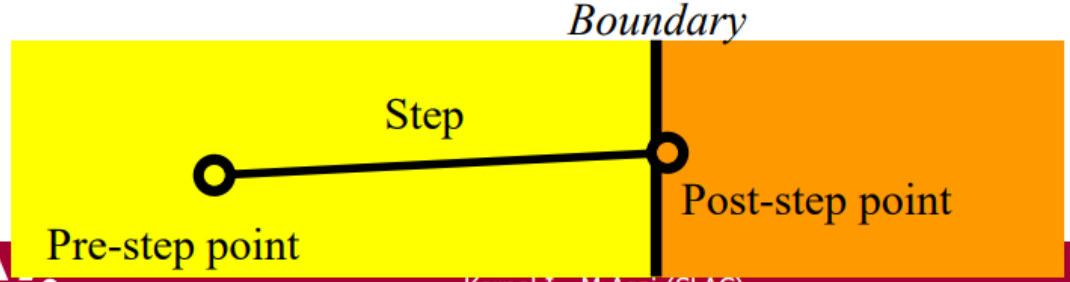
```
Plane (bef): 1
deltat: 54.12
Plane (aft): 1
Plane (bef): 1
deltat: 27.05
Plane (aft): 1
Plane (bef): 1
deltat: 54.12
Plane (aft): 1
Plane (bef): 1
deltat: 27.05
Plane (aft): 1
Plane (bef): 1
deltat: 49.9
Plane (aft): 0
Plane (bef): 0
deltat: -27.04
Plane (aft): 0
```

Step in Geant4

SLAC

- Step has two points and also “delta” information of a particle (energy loss on the step, time-of-flight spent by the step, etc.).
- Each point knows the volume (and material). In case a step is limited by a volume boundary, the end point physically stands on the boundary, and it logically belongs to the next volume.
  - Because one step knows materials of two volumes, boundary processes such as transition radiation or refraction could be simulated.
- G4SteppingManager class manages processing a step, a step is represented by G4Step class.
- G4UserSteppingAction is the optional user hook.

Steps always stop at volume boundary

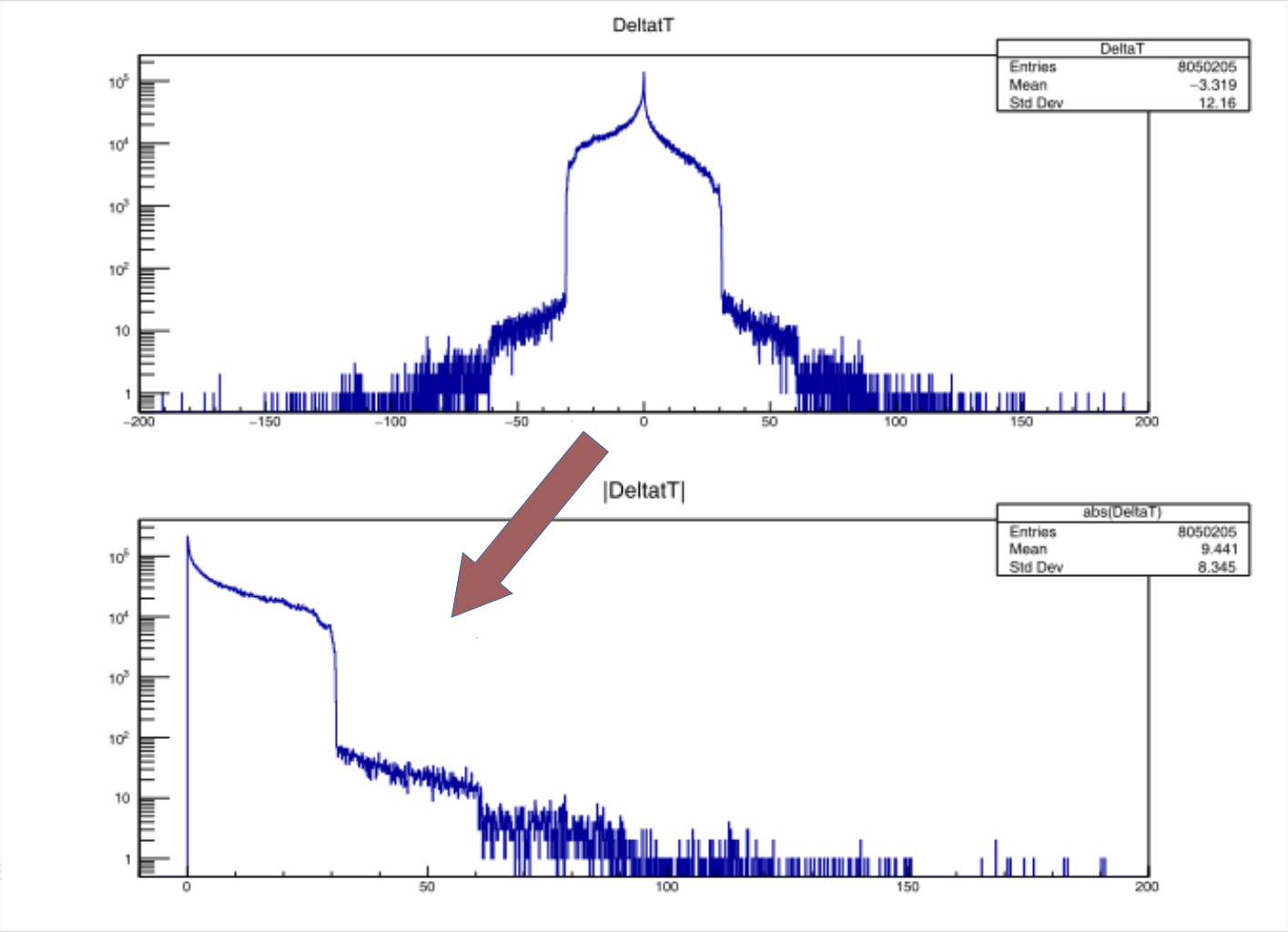


Using the time to select hits

1. From the first hit (1), search the nearby hit (2) and calculate the time difference $\Delta t_{12} = \text{RAW } t_2 - \text{RAW } t_1$
   - Keep that time difference ($\Delta t_{tmp} = \Delta t_{12}$)
2. Search the next nearby hit (3) and calculate the Δt_{23}
3. Calculate the ratio and round up → $int_t = round(\Delta t_{23} / \Delta t_{tmp})$
4. Then calculate the reduced time minus the previous one ($\Delta t_{23}/int_t - \Delta t_{tmp}$)
   - If such a difference is < tolerance → good hit to the chain
   - Keep the new time difference $\Delta t_{tmp} = \Delta t_{23}/int_t$

5. Repeat from 2.

Reduced time distribution

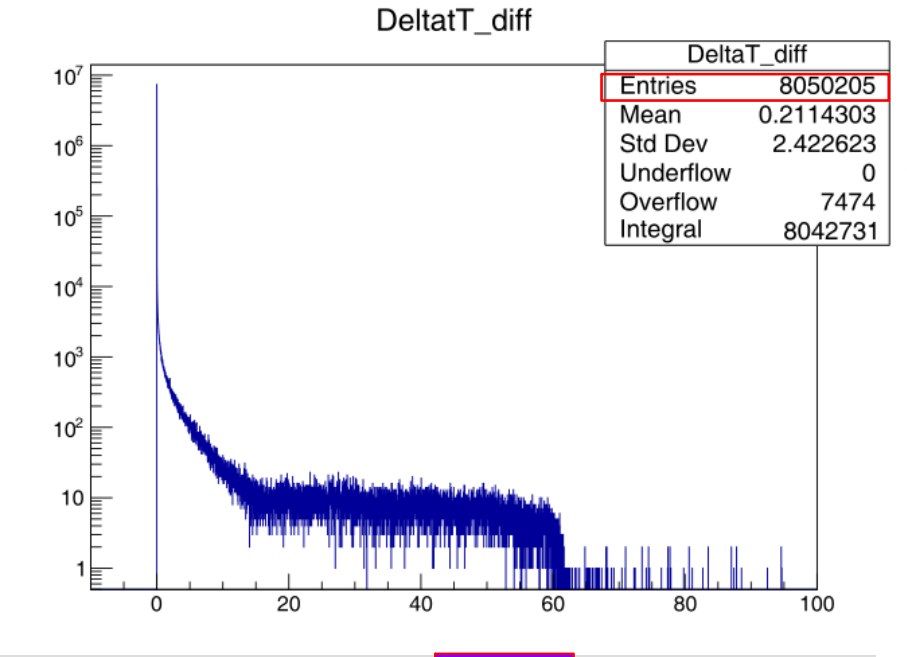


In principle, all the time differences should be comprised to the range <30 ns.

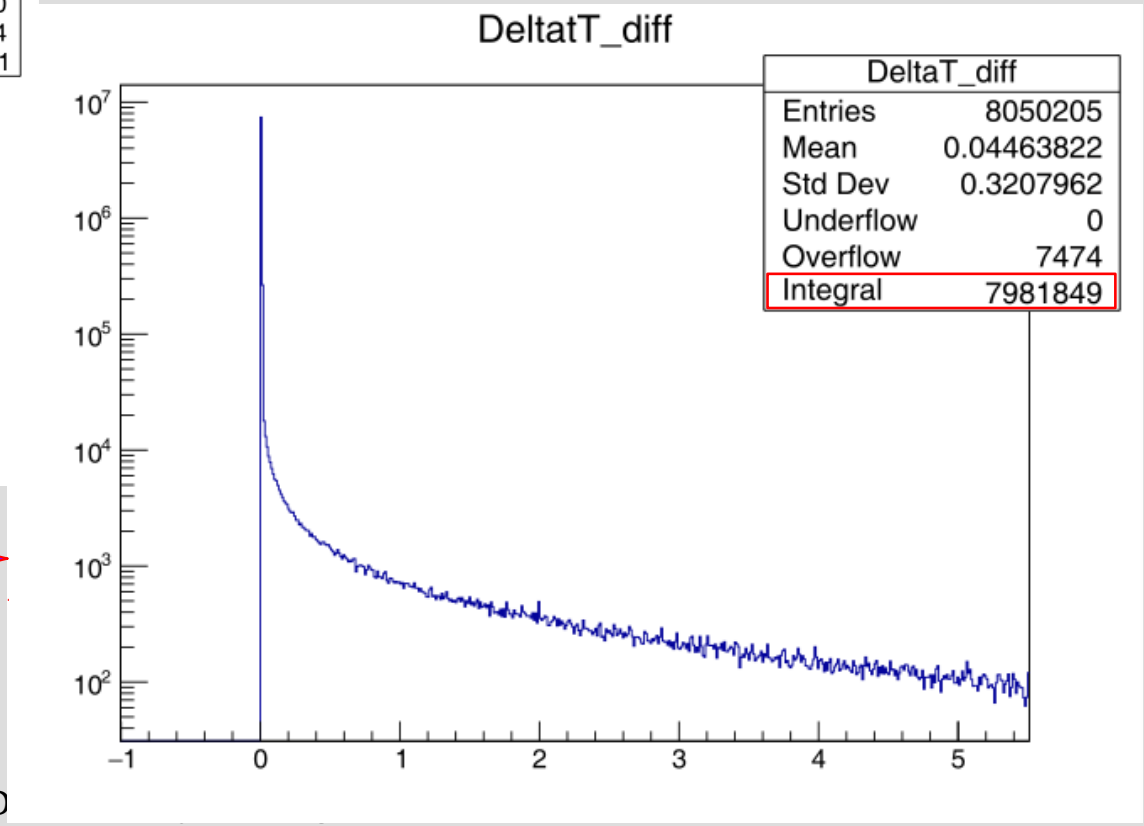
Δt > 30 ns:

- Initial hits which the first Δt is not the basic multiple of the track.
- G4 ‘effect’
- Those hits represent ~1% of the total data pool.

Time difference distribution



Cutting at t_{diff}<5.5 ns remove less than 1% of all the hits



This could be a good criteria to use time to select hits

Next steps

- Implement the time difference as a selection criteria in the chain finder algorithm
- Combine several events in one super-event
- Make efficiency studies
- ...