Branch Description for SuperFGD Data Files

The SuperFGD outputs its data using 19 Front End Boards (FEBs), 18 of which are connected to Multi-Pixel Photon Counters (MPPCs) to detect any scintillation inside the detector, and 1 FEB (FEB_12) which is connected to an external trigger system to provide information on the type of particle impinging on the detector and the time it triggers the system.

Note that FEB_12 is NOT connected to an MPPC and therefore does not provide information on what takes place inside the detector.

The following table shows the FEBs of the SuperFGD and their locations in each of the four minicrates (MCR) as well as the side of the detector they take their data from and the type of MPPC they are connected to.

FEB #	MCR	Slot	Detector Side	MPPC Type
0	0	0	Front	I
1	0	1	Right	I
2	0	2	Left	I
3	0	3	Top	II
4	0	4	Top	II
8	1	0	Top	III
9	1	1	Bottom	II
10	1	2	Bottom	II
11	1	3	Bottom	III
12	1	4		
16	2	0	Back	I
17	2	1	Left	I
18	2	2	Top	I
19	2	3	Top	I
20	2	4	Top	I
24	3	0	Right	I
25	3	1	Bottom	I
26	3	2	Bottom	I
27	3	3	Bottom	I

After performing the unpacking of the data from the .daq files, a root file is produced which combines the data from all FEBs. Below you can find details on the contents of the different branches in the _all.root file.

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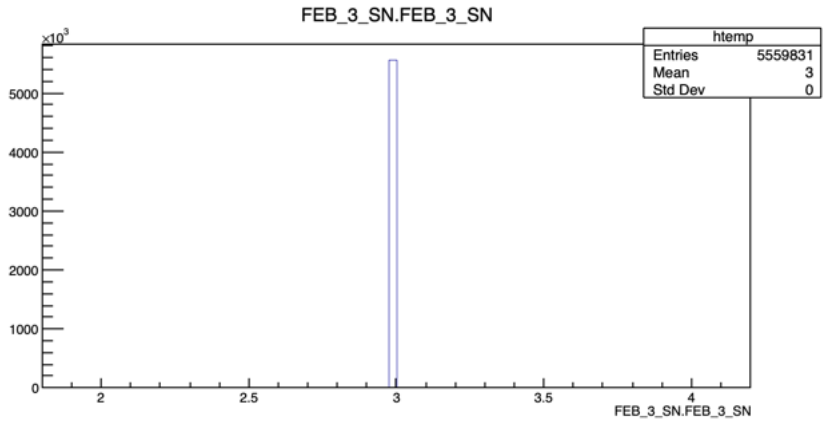
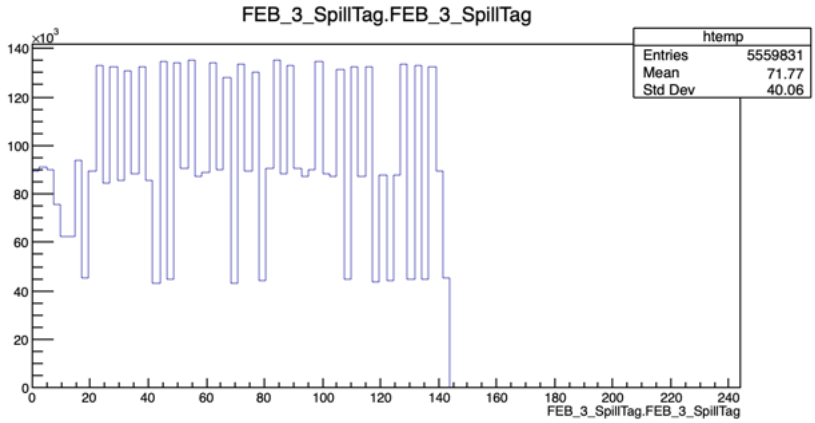
FEB_X_SN

This branch provides the serial number of the FEB for each hit. It gives information on the total number of hits recorded by the FEB.



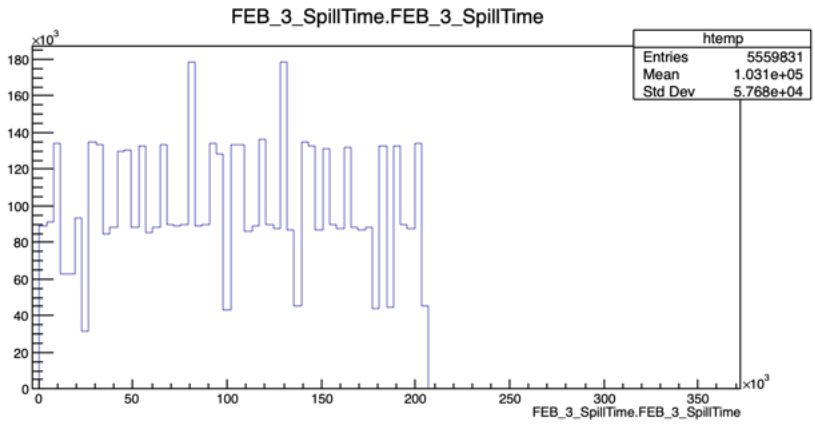
FEB_X_SpillTag

This branch provides the spill number for each hit. It gives information on the number of hits recorded for each spill, where a “spill” is the group of hits recorded in one acquisition window determined by the pulse generator.



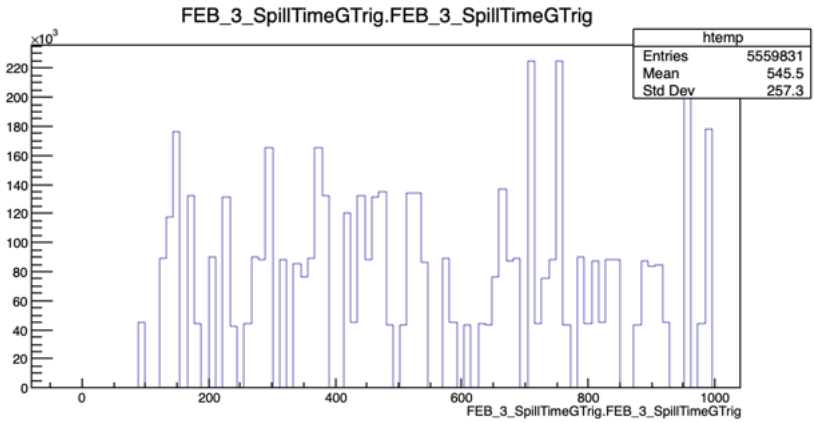
FEB_X_SpillTime

This branch records the time of the beginning of the spill. In units of [10 ms].



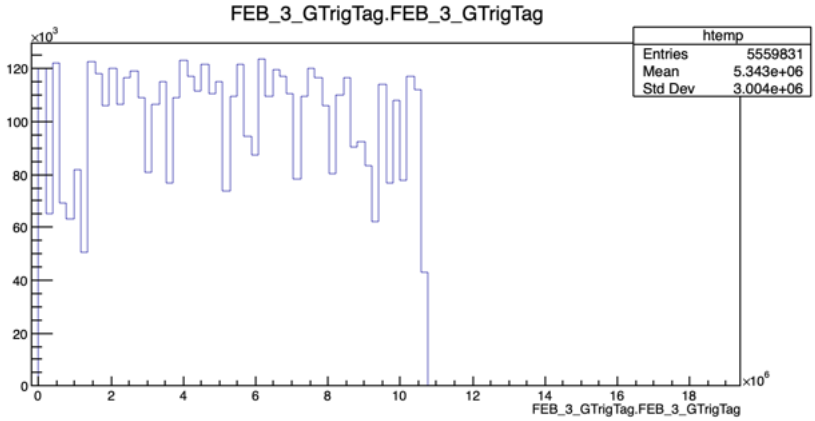
FEB_X_SpillTimeGTrig

This branch records the relative time measurement of the GTrig signal from the spill start for each hit, with a 10 µs resolution.



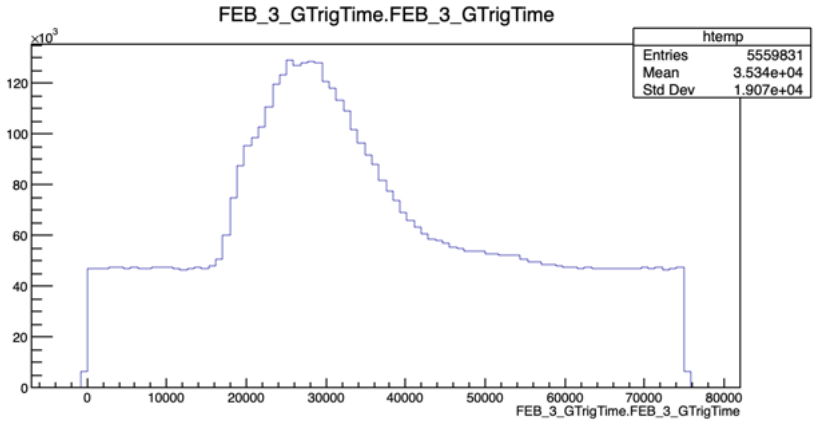
FEB_X_GTrigTag

This branch provides the tag assigned by the global trigger to the hit in units of [10 µs].



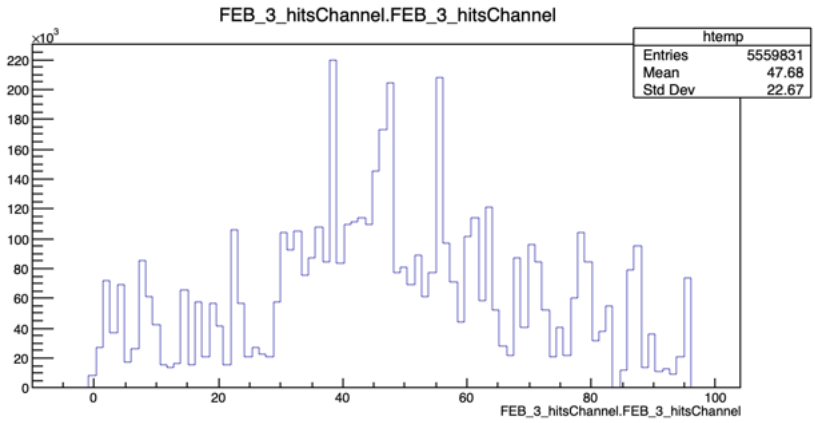
FEB_X_GTrigTime

This branch provides the tag assigned by the global trigger to the hit in units of [10 µs]. In this case the global trigger resets with each spill.



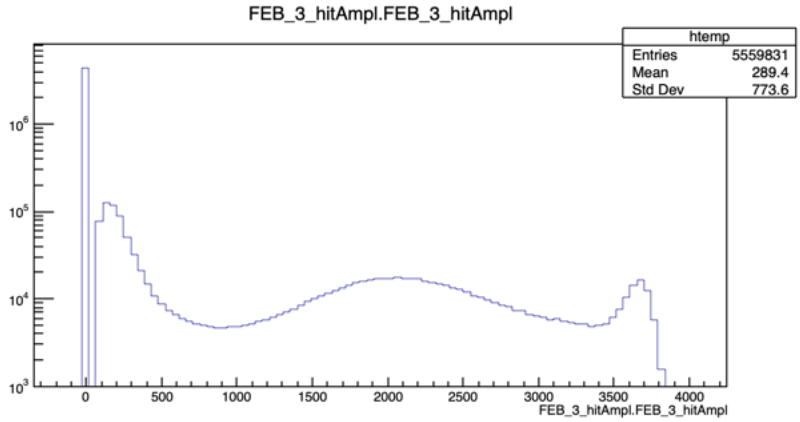
FEB_X_hitsChannel

This branch shows the number of hits recorded in each of the 96 channels in the FEB for the whole duration of data acquisition.



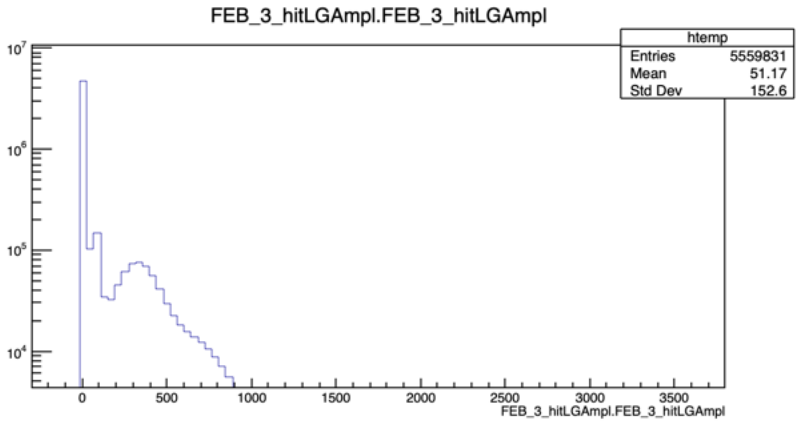
FEB_X_hitAmpl

This branch shows the high gain analogue amplitude in units of [ADC]. It is later used in the HG_reconstructed code to create the branches FEB_X_hitAmplRecon and FEB_X_hitHG_pe.



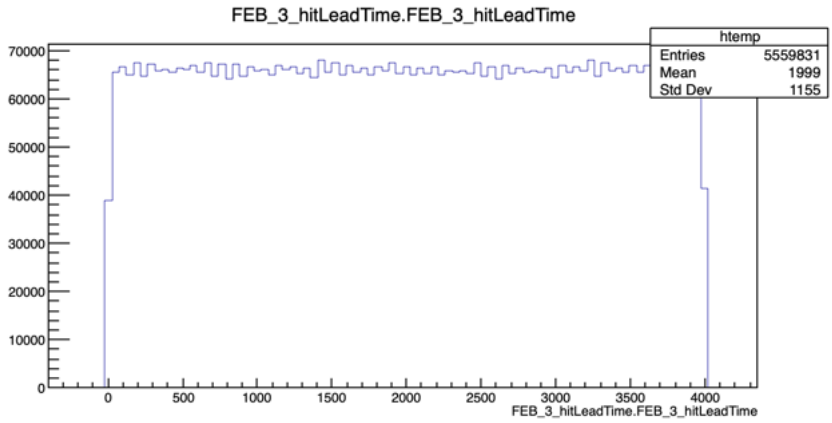
FEB_X_hitLGAmpl

This branch shows the low gain analogue amplitude in units of [ADC]. It is later used in the HG_reconstructed code to create the branch FEB_X_hitLG_pe.



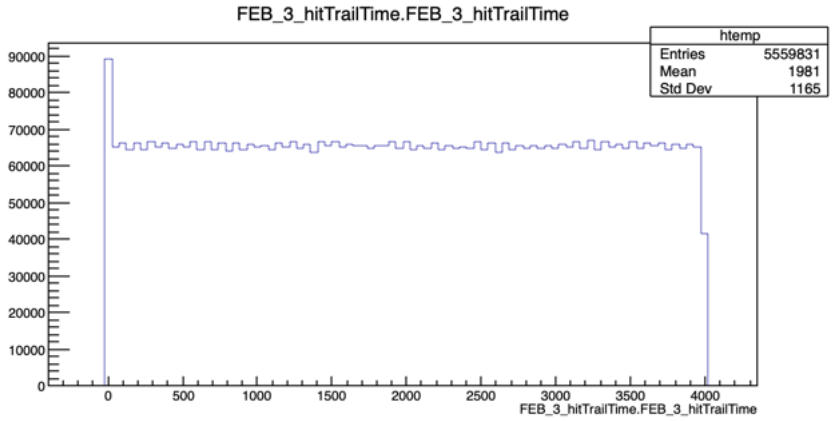
FEB_X_hitLeadTime

This branch shows the rising edge trigger sampling time in units of [2.5 ns].



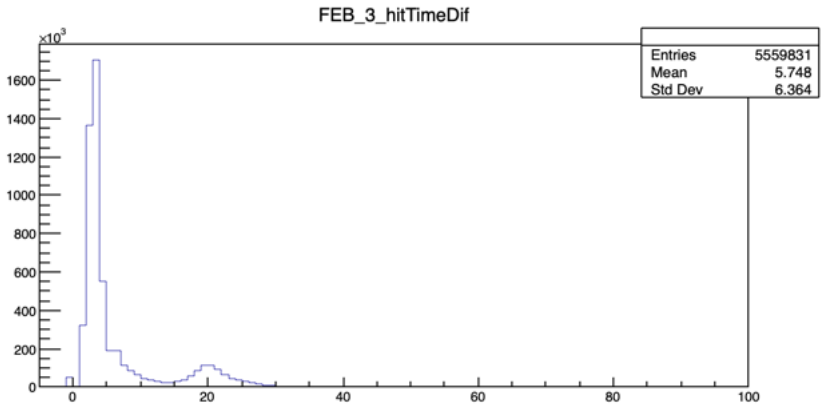
FEB_X_hitTrailTime

This branch shows the falling edge trigger sampling time in units of [2.5 ns].



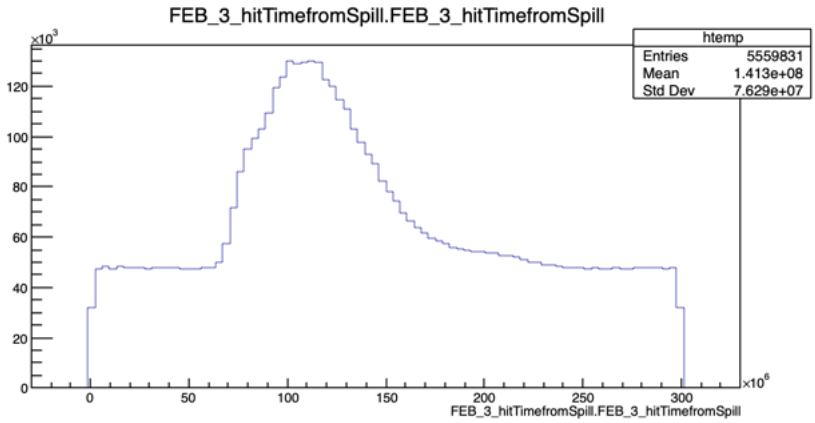
FEB_X_hitTimeDif

This branch shows the difference between the lead and trail times in units of [2.5 ns]. It is also referred to as the Time over Threshold (ToT). When the value of the trail time of a hit is missing, the hitTimeDif of that hit is recorded as -1. This branch is later used in the HG_reconstructed code in order to create the branch FEB_X_hitToT_pe.



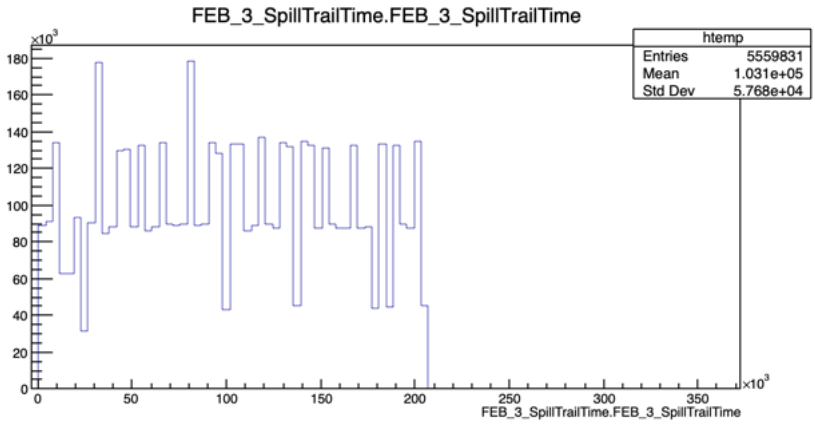
FEB_X_hitTimefromSpill

This branch records the time of the hit from the beginning of the spill in units of [2.5 ns].



FEB_X_SpillTrailTime

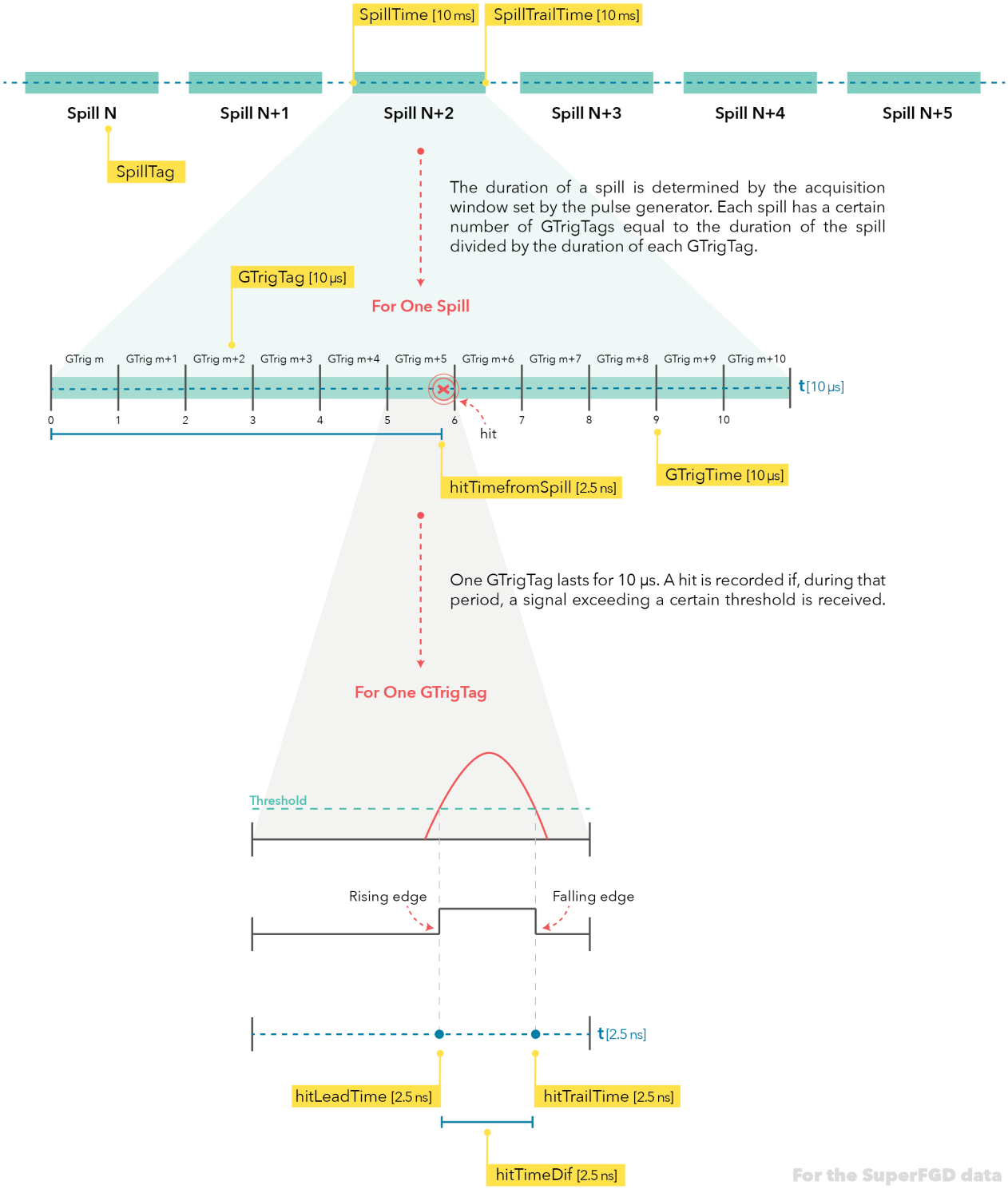
This branch records the time of the end of the spill in units of [10 ms].



The remaining following branches are not filled for the moment.

FEB_X_AsicTemperature
FEB_X_FPGATemperature
FEB_X_GlobalHV
FEB_X_BoardTemperature
FEB_X_BoardHumidity

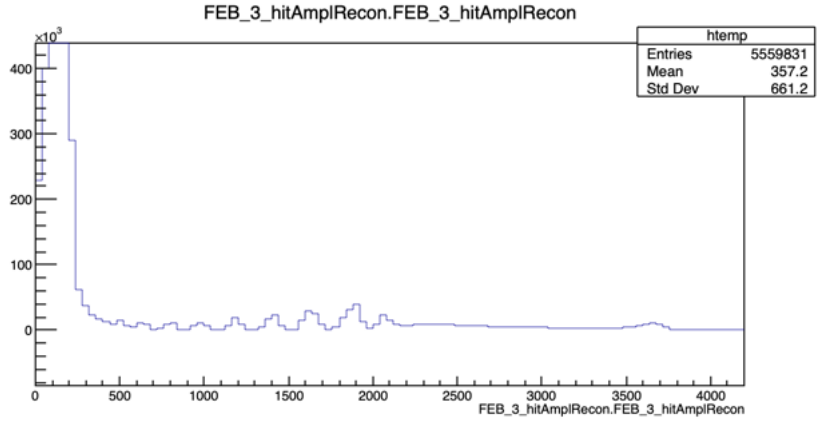
The infographic on the following page illustrates the timing aspects of a hit and how they are recorded in the different branches of the data files.



For the SuperFGD data

The HG_reconstructed code performs the calibration needed in order to obtain branches with the energy in units of photoelectrons. Below you find the description for the branches added after executing ./HG_reconstructed

FEB_X_hitAmplRecon



This branch is created using FEB_X_hitTimeDif (ToT) and converting it to units of [ADC] as follows:

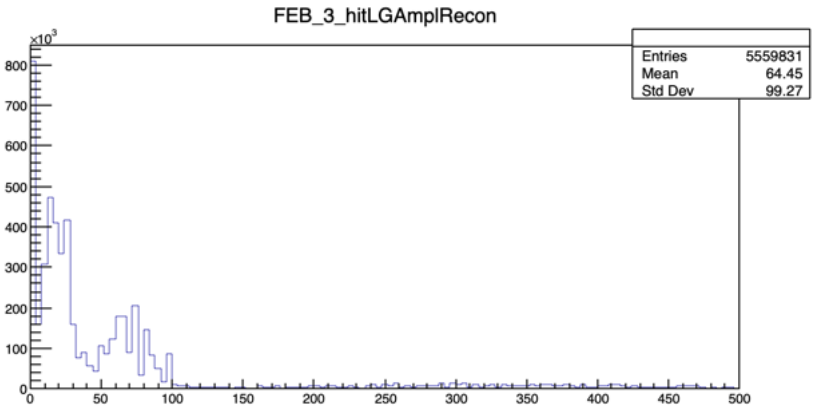
- If the hitTimeDif of the hit was below 20 [2.5ns], then hitAmplRecon is obtained using the calibration files “HG_ToT_calib” to convert ToT to high gain in [ADC].

- If the hitTimeDif was between 20 and 100 [2.5ns] then hitAmplRecon is obtained using first the calibration files “LG_ToT_calib” to convert ToT to low gain, and then using “HG_LG_calib” to convert low gain to high gain.

- If hitTimeDif was equal to -1 (in the case when trail time is missing) then hitAmplRecon takes the value of the high gain analogue amplitude, hitAmpl, of that hit.

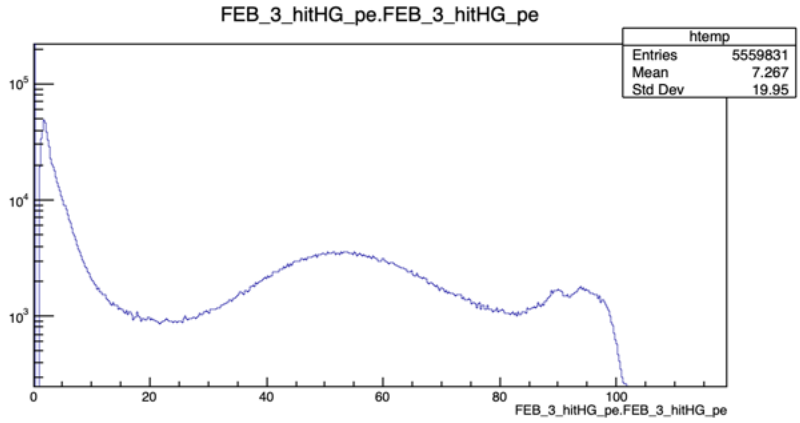
FEB_X_hitLGAmplRecon

This branch is created using FEB_X_hitTimeDif (ToT) and converting it to units of [ADC] using the calibration files “LG_ToT_calib” to convert ToT to low gain. If hitTimeDif was equal to -1 then hitLGAmplRecon takes the value of the low gain analogue amplitude, hitLGAmpl, of that hit.



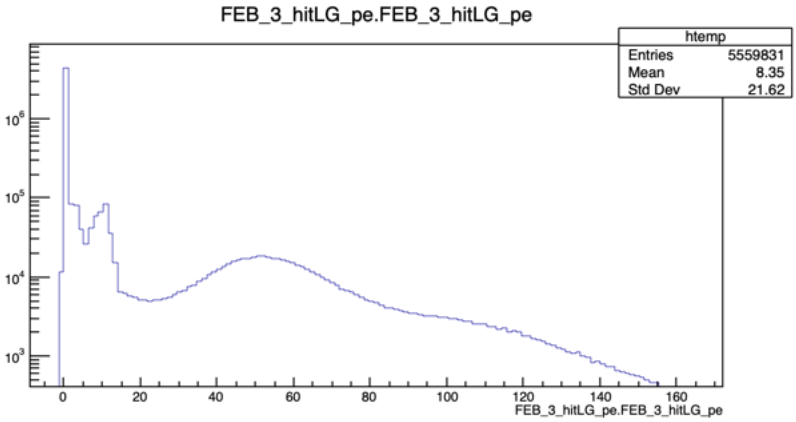
FEB_X_hitHG_pe

This branch shows the high gain amplitude in units of photoelectrons. It is created using the calibration files “PE_HG_calib” to convert the high gain analogue amplitude hitAmpl from units of [ADC] to [p.e].

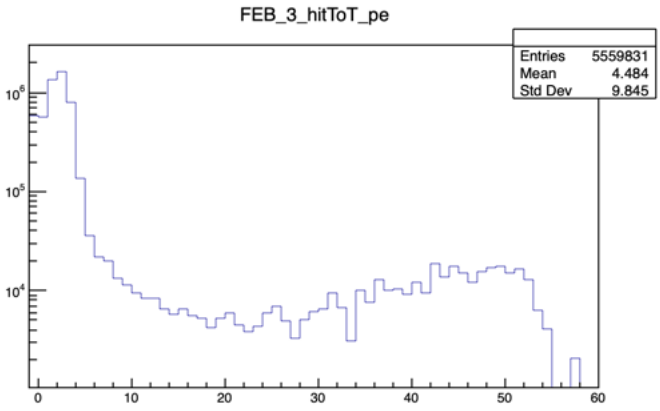


FEB_X_hitLG_pe

This branch shows the low gain amplitude in units of photoelectrons. It is created using first the calibration files “HG_LG_calib” to convert low gain to high gain, then the calibration files “PE_HG_calib” to convert the high gain amplitude from units of [ADC] to [p.e].



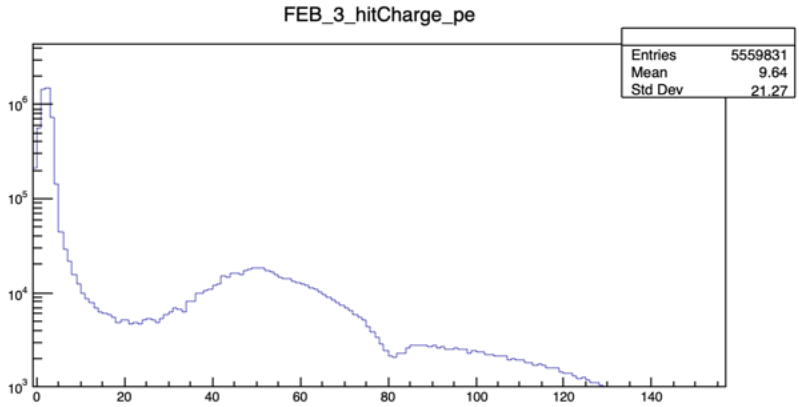
FEB_X_hitToT_pe



This branch shows the Time over Threshold in units of photoelectrons. It is created using the branch hitAmplRecon as follows:

- If hitAmplRecon > 0 then hitToT_pe takes the value of hitAmplRecon converted to photoelectrons using “PE_HG_calib”.
- Otherwise, hitToT_pe is recorded as -1.

FEB_X_hitCharge_pe



This branch takes a combination of the previous three branches as follows:

- For hitAmpl<3000 ADC, hitCharge_pe takes the value of the hitHG_pe.
- Otherwise, and for hitLGAmple<3000, hitCharge_pe takes the value of hitLG_pe.
- If the above two conditions fail or have values of zero, hitCharge_pe takes the value of hitToT_pe.

The following chart explains the process of creating the new branches in ./HG_reconstructed