Fit and OF amplitude reconstructions and timing issues

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Calibration Factors for ADC$\rightarrow$pC: review

Two methods are adopted for TileCal signal reconstruction: the Fit and the OF algorithms.

The ingredients are:

Fit : is a standard, iterative minimum-χ^2; it is supposed to be the reference method

OF-NI : the standard on-line method used during data-taking

reconstructed quantities :

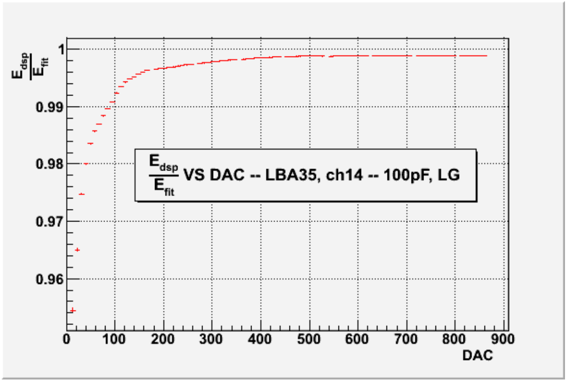
- amplitude A
- timing-shift τ
- pedestal p
- quality factor QF

Calibration Factor : ratio between the Fit reconstruction and the known CIS Q_{inj} in a reasonable clean region; one CF $\forall$ channel

The critical point is that the the Calibration Constants calculated with the Fit method are applied in the ROD to the OF reconstructed amplitudes.

E_{fit} and E_{OF-NI} using CIS

One of the most important point for Optimal Filtering validation is therefore to assure that the Fit and the OF methods behave exactly the same.



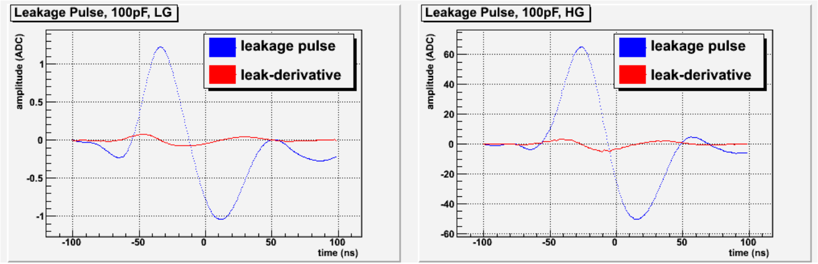
This is a typical example of non-out-of-time channel: for $Q_{inj} < 80$ pC the two methods differ more than 1%.

GOAL: make the two method behave exactly the same.

Leakage Pulse shapes

Our main assumption: differences reflect the different implementations of the two methods.

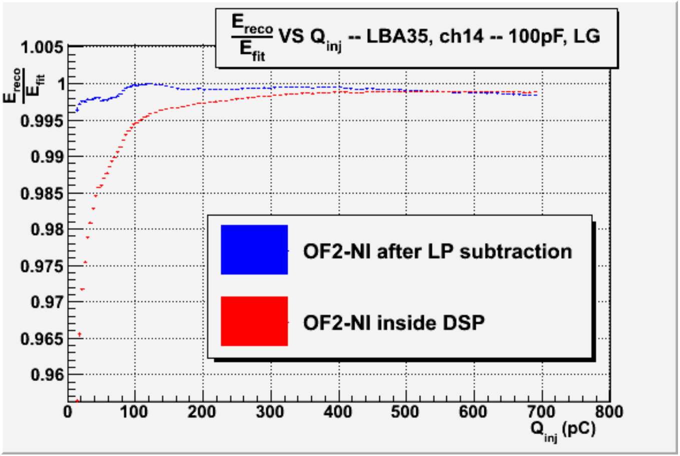
One of the more important differences is the way the two algorithms deal with the Leakage Pulse: the Fit method can treat the LP sample-by-sample.



Only the 100 pF capacitor will be used because of timing differences between the two CAP during charge injection.

Leakage Pulse subtraction for LG

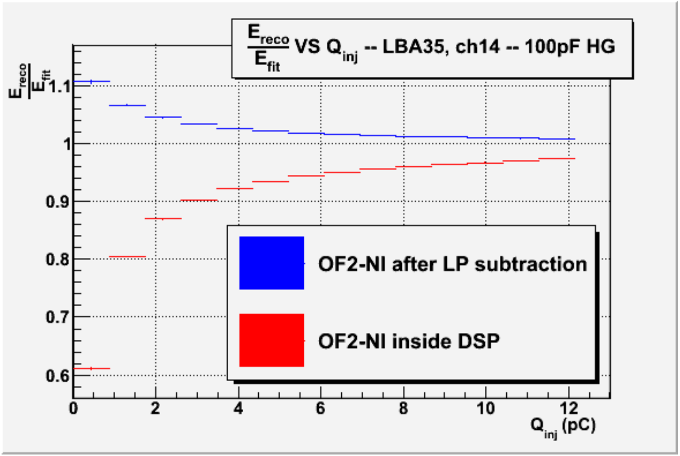
The leakage pulse can be subtracted for Low Gain:



The result seems very interesting: in the Low Gain region the two methods now are very similar within a few per mille.

Leakage Pulse subtraction for HG

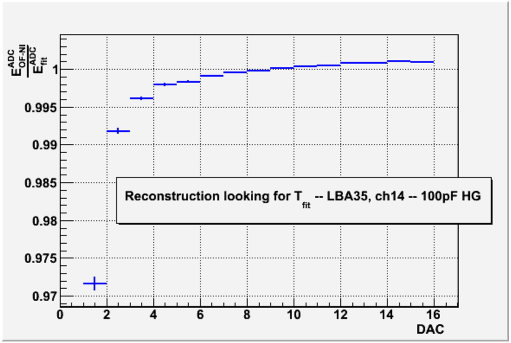
The same trick for the High Gain:



Again, some signal recovery is achieved, but the differences are still of the 10% at very low injected charge.

The High Gain branch correction

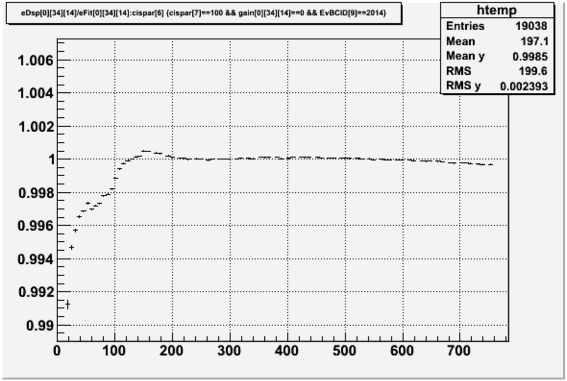
In the HG region the LP is more important due to the amplification factor of 64 and maybe to the signal distortion at low injected charge. The idea is then to use the T_{fit} information as a prior for the LP, thus an improved LP is subtracted from the signal.



$DAC = 3$ with 100 pF corresponds at about $Q_{inj} = 2.4$ pC, thus if the released energy is above 2.4 GeV the calibration constants in this region are correct within 0.5%.

Verify the assumption in the reverse order

The assumption can be verified in the reverse order: we asked the Fit not to perform the LP subtraction. Then the standard OF2-NI and Fit amplitude reconstructions are compared.



The fake-Fit trick makes the Fit behave like the OF-NI in the LG region within a 0.6% for charges above 16 pC.

Importance of correct timing assumption

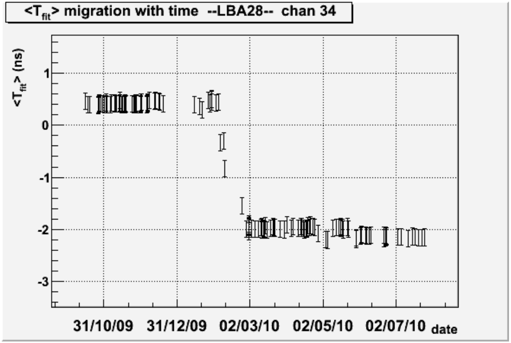
These results show the importance of a more than optimal choise of the timing prior needed by the OF method: the two algorithms behave the same within a few per mille if the same assumptions are made.

In particular, the timing is critical.

This leads almost naturally to the Timing Monitor.

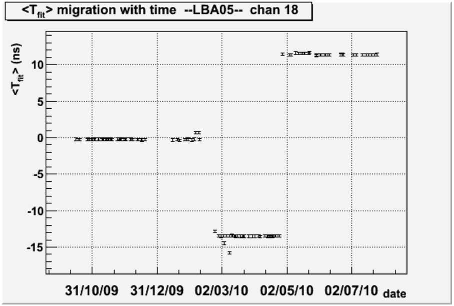
Timing Monitor: a good channel

- Timing Monitor has been updated
- only standard MonoCis runs have been used: LG, 100pF, DAC==120
- cuts:
  - BCID
  - at least 1000 entries in each channel
  - $RMS_{ch} < 4\ ns$



Timing Monitor: a bad channel

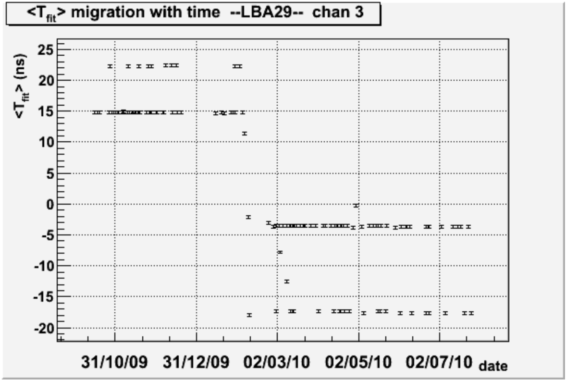
- on some channels was performed another Dskew2 update
- these channels have currently a wrong time stored in COOL
- two possible solutions:
  1- a T_{COOL} update for each channel
  2- a MB update followed by a T_{COOL} update



Solution 2 will shift the injection time for the whole MB, and a consequent T_{COOL} update will follow.

Timing Monitor: a strange channel

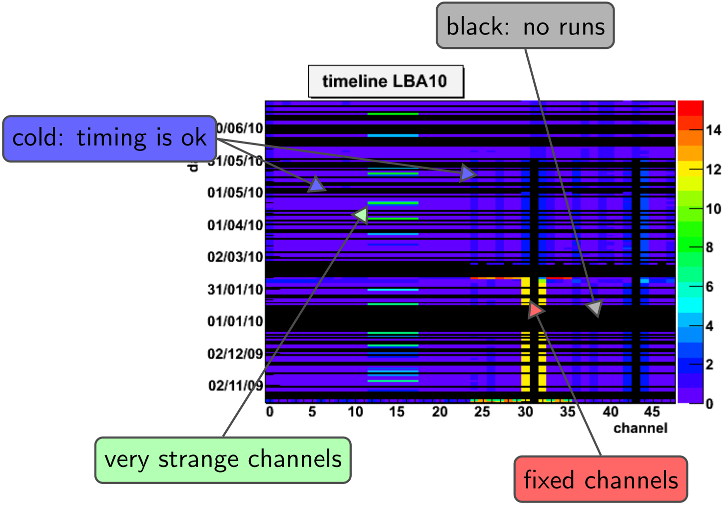
Some channels (in the same Digitizer) show a very strange behaviour, which affects noticeably the timing stability:



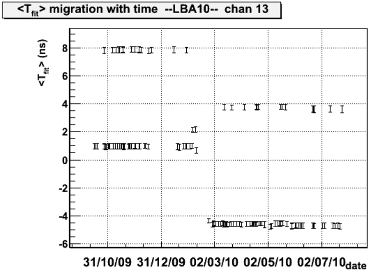
- for some runs the T_{fit} is completely shifted
- soon after, the previous setting is re-established

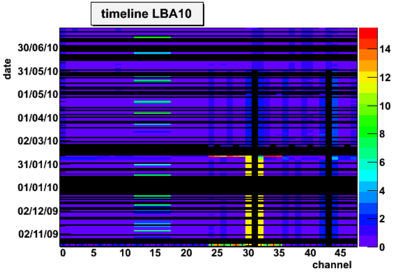
A timeline stability watcher (I)

A useful tool for monitoring purposes may be a timeline plot of $|<T_{fit}> - T_{COOL}|$ for each channel (based on IOV):



A timeline stability watcher (II)





- the shift is coherent inside the same Digitizer (Digi6)
- the shift amount is always the same
- the shift is always in the same direction
- which one is the correct value for T_{COOL}?

Giulio suggested that, due to some TTC error, a default value is chosen for that Digitizer for some runs (still to be verified).

Conclusions

- the LP is responsible for difference between the Fit and the OF-NI reconstruction
- after a proper subtraction the similarity is recovered
- the assumption has been verified changing the Fit reconstruction, only LG
- next steps:
  - complete the analysis with the HG fake-Fit reconstruction
  - what happens in the low charge region with fake-Fit for LG?
  - should understand the low-charge region both for LG and HG
  - apply the same methods to the timing reconstruction
- Timing Monitoring:
  - update of channels with understood shifts
  - look for transmission errors for strange channels
  - how should we calculate MB timings when dealing with such channels?