On TileCal-Pulses for Level-1

June09, ph

Recent developments require a recapitulation of our knowledge on characteristics of analog signals from the TileCal. The one and only occasion, where a direct communication took place, was ages ago in the year 2000. The engineer S. Berglund from Stockholm presented TileCal front-end electronics along with signal-properties on transparency-foils. Unfortunately, those three(or four) important pages were not scanned-in for the ‚minutes-archive' (see below).

ATLAS Level-1 Calorimeter Trigger Joint Meeting

at Heidelberg_2–4 November 2000

AGENDA

THURSDAY, 2 NOVEMBER, AFTERNOON SESSION

- ...
- Calorimeter signals and cables
- Trigger cable issues after the PRR - Paul Hanke (html and ps)
- **TileCal receiver tests and status** - Svante Berglund (slides not available)
- Preprocessor
- PPr-ASIC status - Cornelius Schumacher (html and ps)
- PPr-MCM status and preparations for testing - Ullrich Pfeiffer (html and ps)
- ...

CALORIMETER SIGNALS AND CABLES_(minutes by Oliver Stelzer)

Trigger cable issues after the PRR - Paul Hanke ...

TileCal receiver tests and status - Svante Berglund

The slides are not available.

Svante's presentation started with the question of whether we can use the LAr transformer coupling also for analogue signals from the Tile Calorimeter. This is related to the unipolar shape of the TileCal signal, which results in two complications: it produces a little „bump“ on the tail of the signal, and the pedestal level is rate dependent. The later is less of a problem as a plot from Martine Bosman showed, where high-energy depositions are very rare and the bulk of signals are low-energy signals which do not change the pedestal much. Signals have been examined using „soft“ and „hard“ differentiation, where the relaxation time has been found to be 5 and 0.5 microsec respectively.

Test-beam results were presented showing the influence of the tower-builder electronics. A discussion started on understanding the width of the distribution. There seems to be confusion on the costs and availability of cables. An attempt to obtain a single twisted-pair cable resulted in no response, therefore a „Tensolite“ cable with similar properties but much higher cost was used in these tests.

Discussion:

It is not clear anymore that the TileCal group have understood that we want the triggers as 9 towers in the barrel and 6 in the extended barrel, as already agreed, rather than 10 and 7. This must be checked.

PREPROCESSOR_(minutes by Oliver Stelzer)

Slides for all of the Preprocessor talks can be accessed from this Web page.

PPr-ASIC status - Cornelius Schumacher ... ... (and much more ... = cut out)

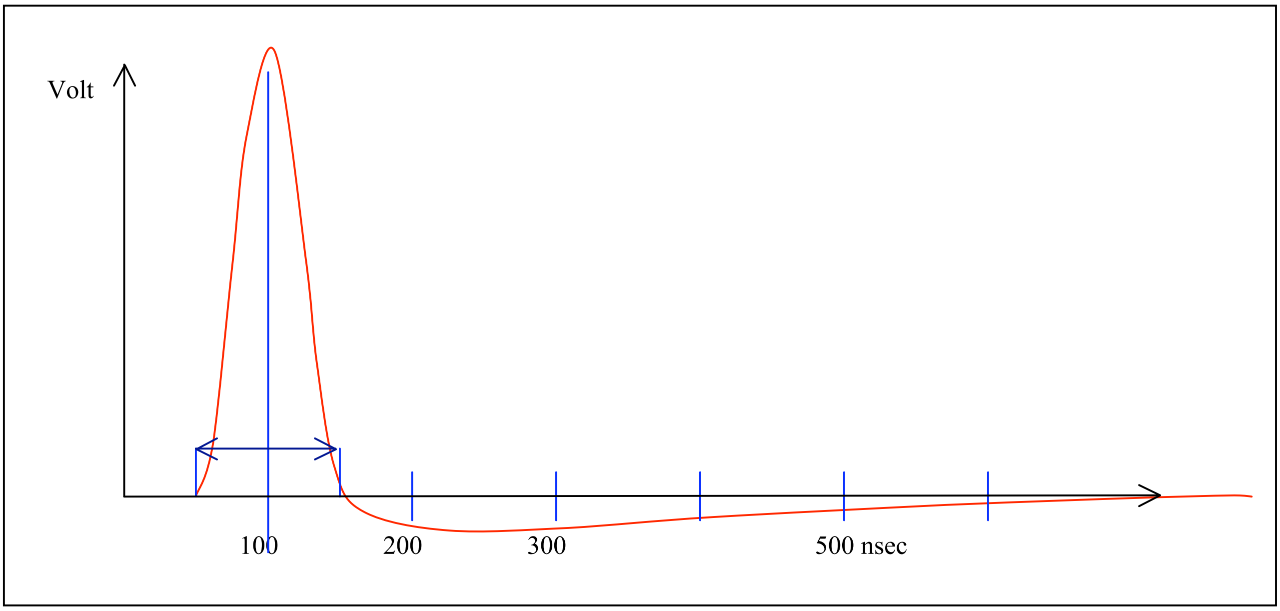
The status, as i remember it:

From my memory on Svante Berglund's talk, i draw a typical pulse from the TileCal for Et ranging from 0 to 250 GeV linearily (see sketch below). The pulse rises from onset to peak in appr. 50 nsec (like a LAr pulse). It decays in a similar time giving a span of 100 nsec at the base (i.e. 4 to 5 bunch-crossings). This is the ‚fast' part relevant for the Level-1 trigger.

Since the TileCal is viewed by a ‚kind of photomultilplier' (= phototriodes - if i remember correctly - to stay insensitive to the strong magnetic field), the pulse should just decay to ‚zero'. After all, there is only an avalanche of electrons coming down the amplifier (dynode)-chain leading to a uni-polar current-pulse at the anode.

The question arose then, how the current is balanced, after it is dumped into some sink. Clearly, a balancing takes place through ‚the system' leading to ‚some' undershoot following the pulse. Berglund showed, that this undershoot is small in amplitude (‚few percent') and stretches over a ‚few hundred' nanoseconds. However, if the rate in that particular PM-tube is high, the undershoot grows (negative pile-up).

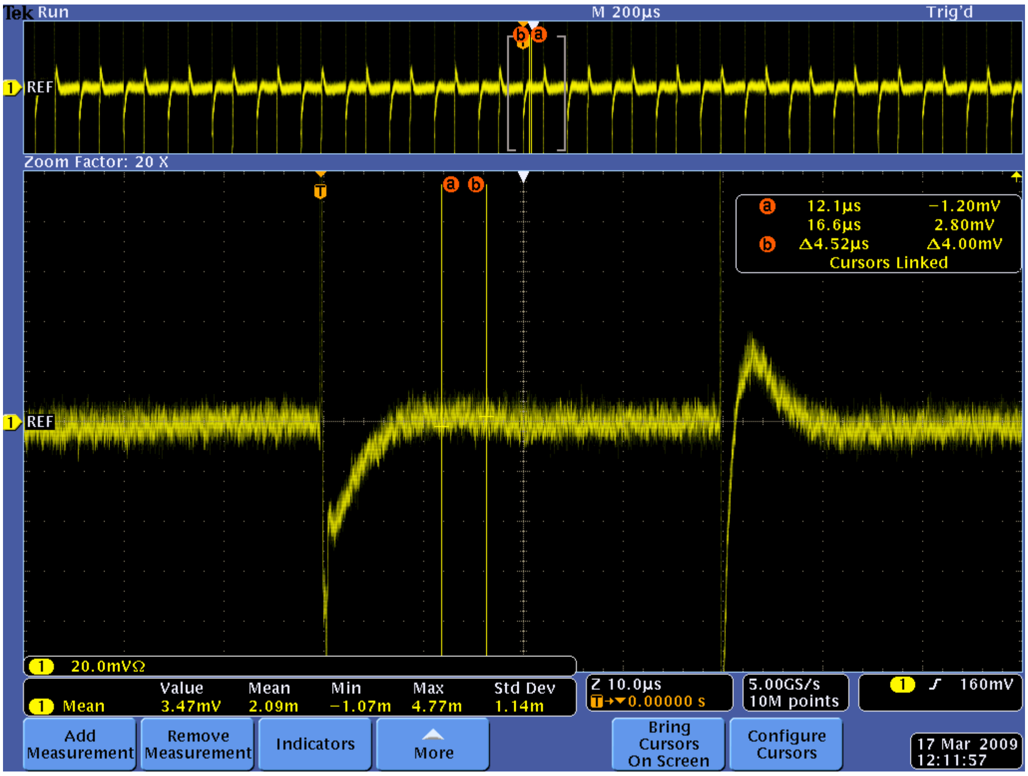
Reminder: The LAr pulse is shaped similarly for the positive part (trigger usage). It has, however, a well defined undershoot of 20% stretching over 400 nsec due to electron-drift in liquid Argon. The integrals of polarities balance exactly.



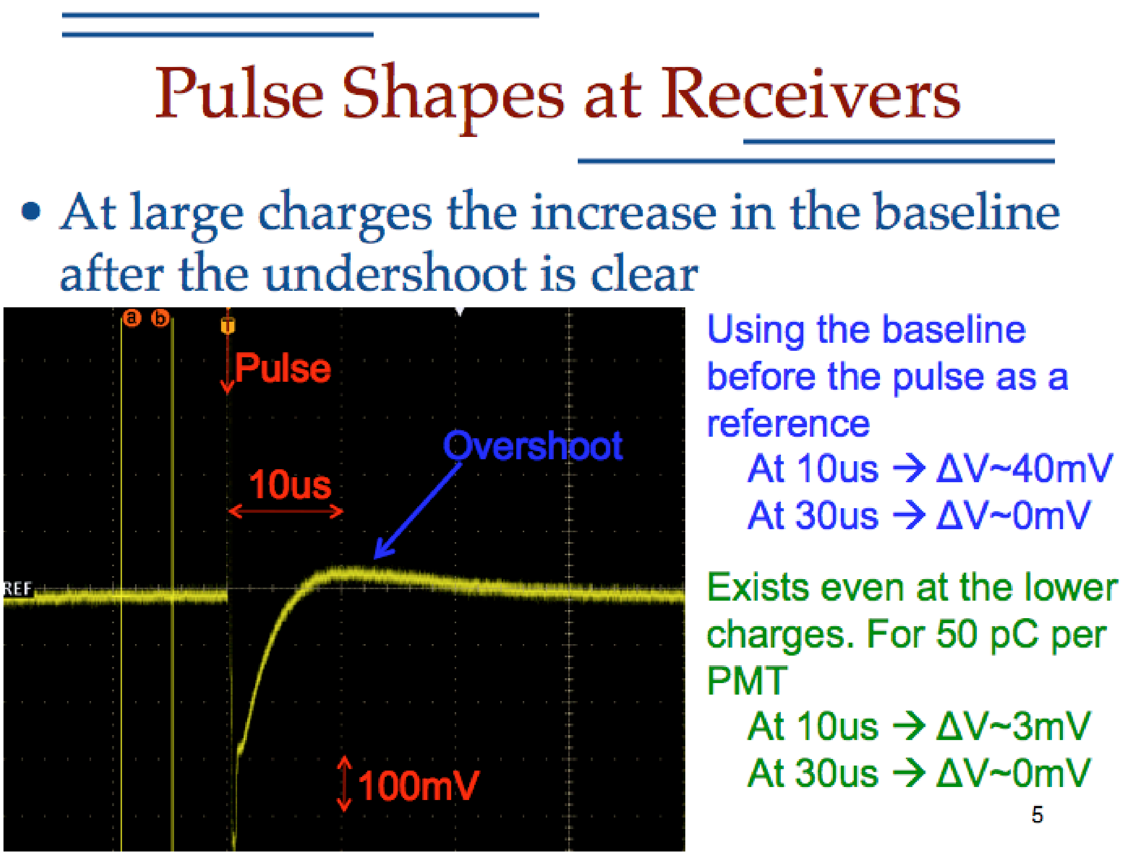
All observations in testbeams later on were in good agreement with these TileCal specifications, where obvously ‚hard differentiation' was built-in. High rates could not be observed in testbeams.

It was not made clear then, what ‚soft' / ‚hard' differentiation meant in technical terms. This concerns values of R and/or C and their placement in the chain of analog Tile electronics. Neither did we ever learn unfortunately, what was actually used in the real detector as installed now. The word ‚Differentiation' leads to a capacitive coupling (AC) for the pulse output. One can expect this, if the photomultiplier anode is at high-voltage. These questions could - at least- now be answered by TileCal.

If a capacitor decouples the EHT, the anode-pulse must be differentiated.



Is the differention by AC a fact ? Is it, what we see on the screen-shot from a scope. The analysis by Tile-people shows the behaviour in more and commented detail (copied from M.Dunford’s talk in May09):



1. Undershoot.

From this, one can conclude, that the ‚differentiation’ implemented is of the ‚soft’ kind, which gives a 5 microsec time-range (see Berglund-minutes above). This range spans at least **200** bunch-crossings at LHC, where the trigger does not ‚see’ a following small signal (100 mV correspond to 10 GeV)! For this length of time, any physics-threshold is unusable due to linear superposition of negative -- positive analog signals.

Reminder: The span must be compared to the well-defined 16 BCs (400 nsec) undershoot in the LAr Calorimeters.

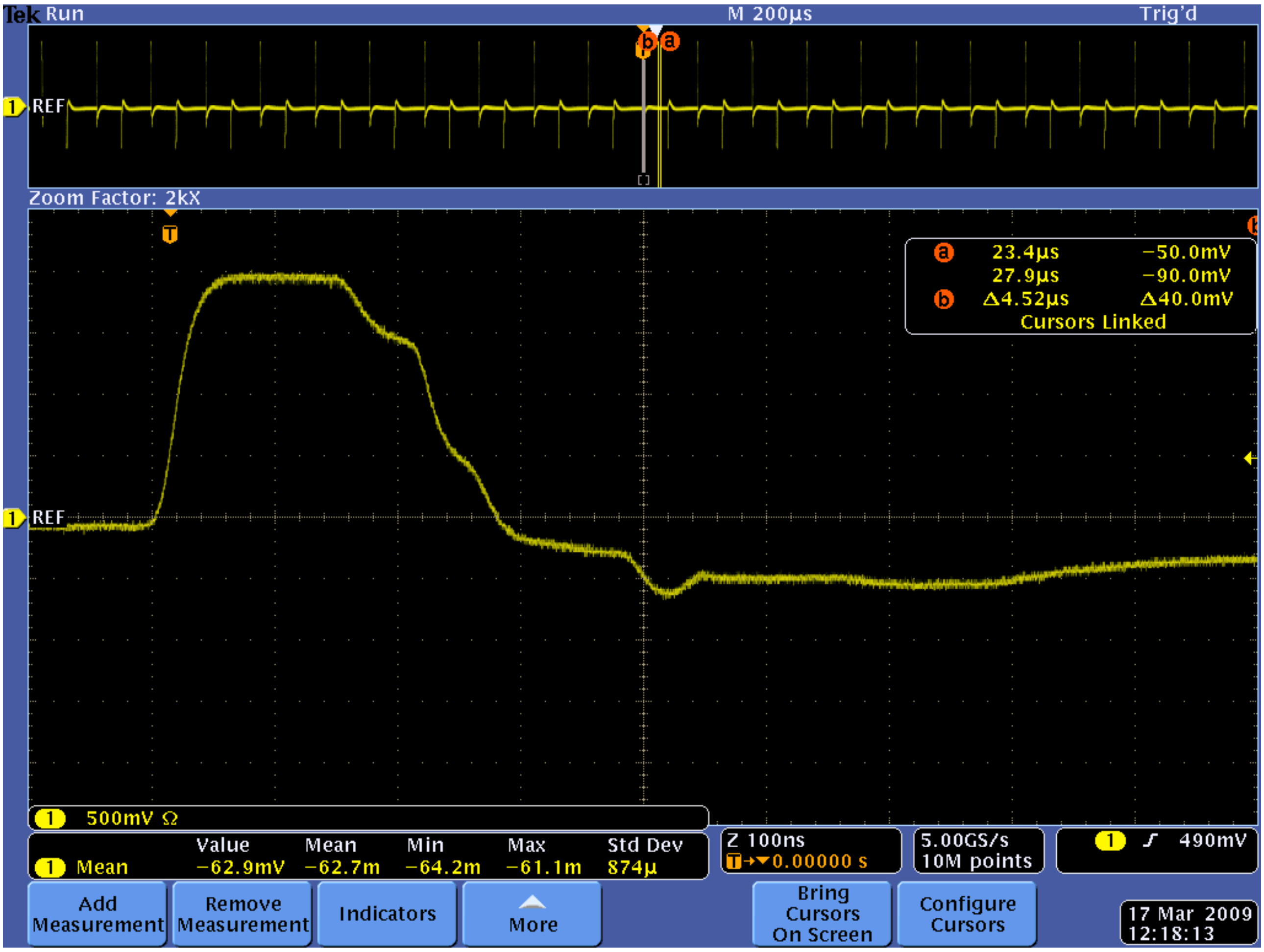
2. Overshoot.

The subsequent ‚overshoot’ is not taken into account yet. Here, for another **400** BCs the superposition is positive -- positive in case of signal occurrence in the same tower. The influence on effective thresholds is less dramatic, but still in the range of few GeV Et added onto the nominal threshold (see the summary).

3. Saturation from shower-signals.

A further important fact, namely a pulse in saturation, had never been seen in testbeams either (as far as i can remember).

For illustration another new information is added into here (copied from M.Dunford’s talk in May09):



A pulse saturating the analog TileCal electronics is well-behaved in its first part as the trigger does expect it since the days of the ‚Tech. Design Report’ of 1998. The ‚falling edge’ is not as expected.

Reminder: The LAr calorimteres made big efforts to keep a saturated pulse within the envelope, i.e. ‚rising edge’ at max. speed, saturation clipped to ‚flat-top’ and the ‚falling edge’ following the shaper charactistic.

The ‚falling edge' in TileCal looks as if it is plagued with latching circuitry. This is not so dramatic, because the trigger electronics ignores it as long as there are no secondary maxima produced. These would fool the FIR-filter and its Peak-finder, faking a new events.

More worrisome, is the duration of the ‚undershoot'. All the scope-shot says: it is bigger than 600 nsec. Most likely, it follows on the time-scale the behaviour of a non-saturated signal, i.e. a relaxation up to 5 µsec.

Summary a) for now,

- What is the relaxation-time after a pulse (0.5 µsec / 5.0 µsec corresponding to 20 / 200 bunch-crossings)? Is this acceptable for physics? My prel. answer: Only, if trigger-tower occupation is small, i.e. Luminosity is low. How low?

- What is the source of the ‚positive overshoot', which becomes really significant after occurrence of a BIG pulse (see M.Dunfords talk) ? It shifts the trigger's baseline for that paticular hadronic tower upwards by 5 GeV Et (20 FADC counts acc. to M.Wessels). The upwards shift lasts for an additional 20 µsec (800 BCs).

- TileCal should avoid ‚artifical induction' of problems. A huge coherent laser-shot for ‚calibration' in the large (120 BC) bunch-gap after a complete LHC turn ought to be avoided. Remember, a LHC-turn is appr. 3564 BCs including the ‚empty buckets'. Out of these, only 2808 buckets contain protons for physics collisions.

- TileCal should make a statement on ‚saturated pulses' and their undershoot. Are they also followed by an overshoot like the coherent calibration pulses? These pulses will occur (rate ?) even at reduced energy running (e.g. 4 Tev).

Summary b) for the long term.

- Which of the facts seen now is acceptable for physics? ‚Trigger acceptance' becomes highly complicated, if there are threshold dependencies on pre-history (previous pulses).

- What can be done and when to improve the trigger situation (luminosity may rise ‚quickly' to the design-value of 10**34, if LHC performs well as a machine)?

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