PRS timing

1. Overview of the timing settings.

2. Analysis of June TED events:

   - ✓ Channel time.
   - ✓ 64-channels board time.
   - ✓ Relative alignment.

3. Next TED run and first data:

1. Overview of the timing settings:

Croc:

- fine delay [0 : 25] ns [+ coarse delay (+ N cycles)]:
  → currently set at 12 ns.

VFE:

- t^0_{VFE} tunable phase [0 : 25] ns defining the integration start → accounts for both clear and WLS fibre lengths differences. One per board.

- t^0_{Reset} tunable phase [0 : 25] ns to sample the VFE reset signal (start at each LHC orbit on the same alternance)
  → tuned empirically to match the t^0_{VFE}.

1. Overview of the timing settings:

ADC:

- t^{VFE}_{ADC} tunable phase [0 : 25] ns to sample the analogical signal. 4 phasers for one board (one phaser deals w/ two ADC) $\rightarrow$ tuned such that the difference (t^0_{VFE}- t^0_{ADC}) is constant

FE_PGA:

- t^{ADC}_{FE} tunable phase [0 : 25] ns to sample the digitized data in the FE-PGA $\rightarrow$ tuned to the same value on the whole detector.

- t^{SPD}_{FE} tunable phase [0 : 25] ns to sample the digitized SPD data in the FE-PGA $\rightarrow$ tuned by Carlos to account for clock cables and fibre lengths differences.

1. Overview of the timing settings:

TRIG_PGA:

- t^{ECAL}_{FE} 2 tunable phases to sample ECAL addresses signal. Tricky point (cf APA story). Minimal authorized range = +/-3 ns around the current value, i.e if one moves ECAL by more than 3 ns w/ respect to PRS, we're loosing electron and photon triggers.

- + some other phasers for neighbours, irrelevant here, except transmissions from crate to crate. Cosmics and TED data told us that we don't need to move PRS crates.

2. TED events analysis - June 2009

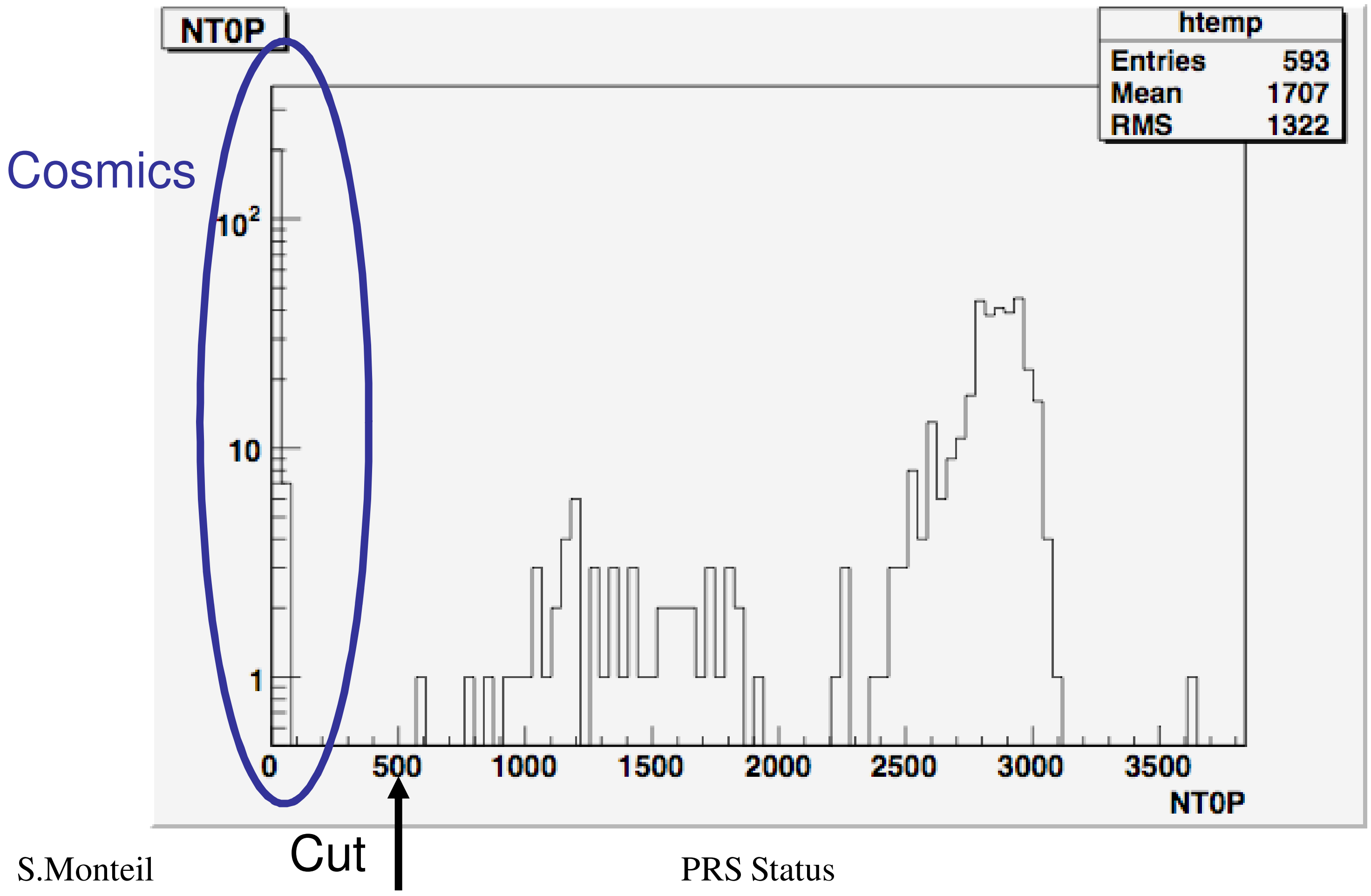
The analyzed runs:
Take the runs tagged as LHC/SPS clocks are synchronous.

- Run #50425: 30 shots.
- Run #50427: 37 shots.
- Run #50428: 70 shots.
- Run #50430: 45 shots.
- Run #50432: 89 shots.
- Run #50433: 90 shots.
- Run #50435: 14 shots.

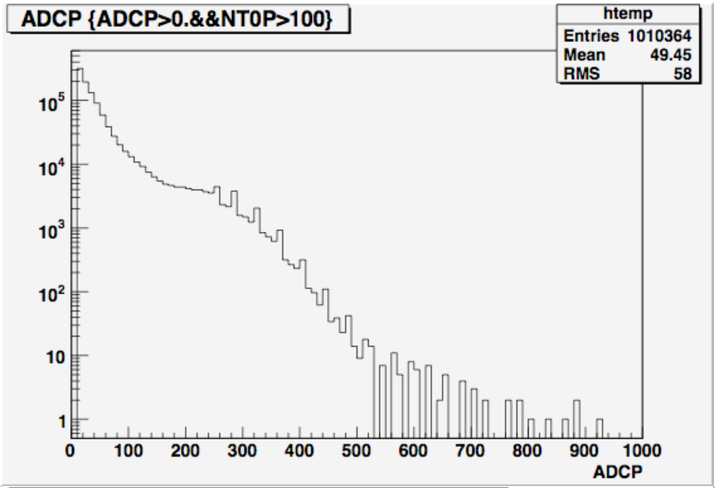
Particle fluency varied among these shots (to match the tracker requirements)

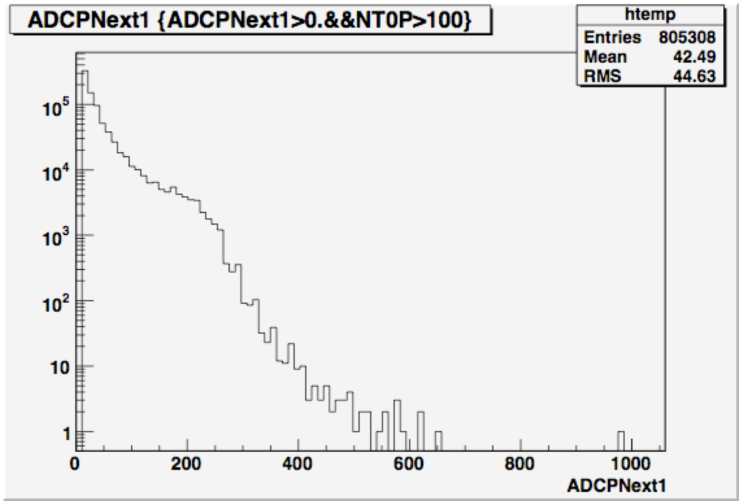
2. TED events analysis - June 2009

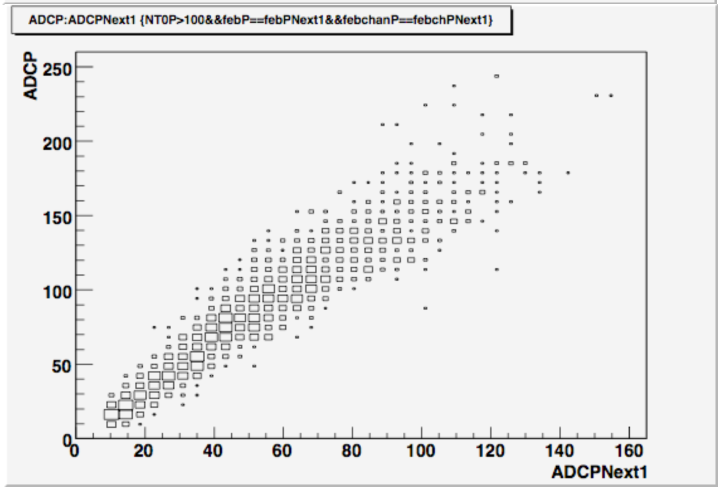
Particle fluency distribution



ADC distributions in T0 and Next BC:







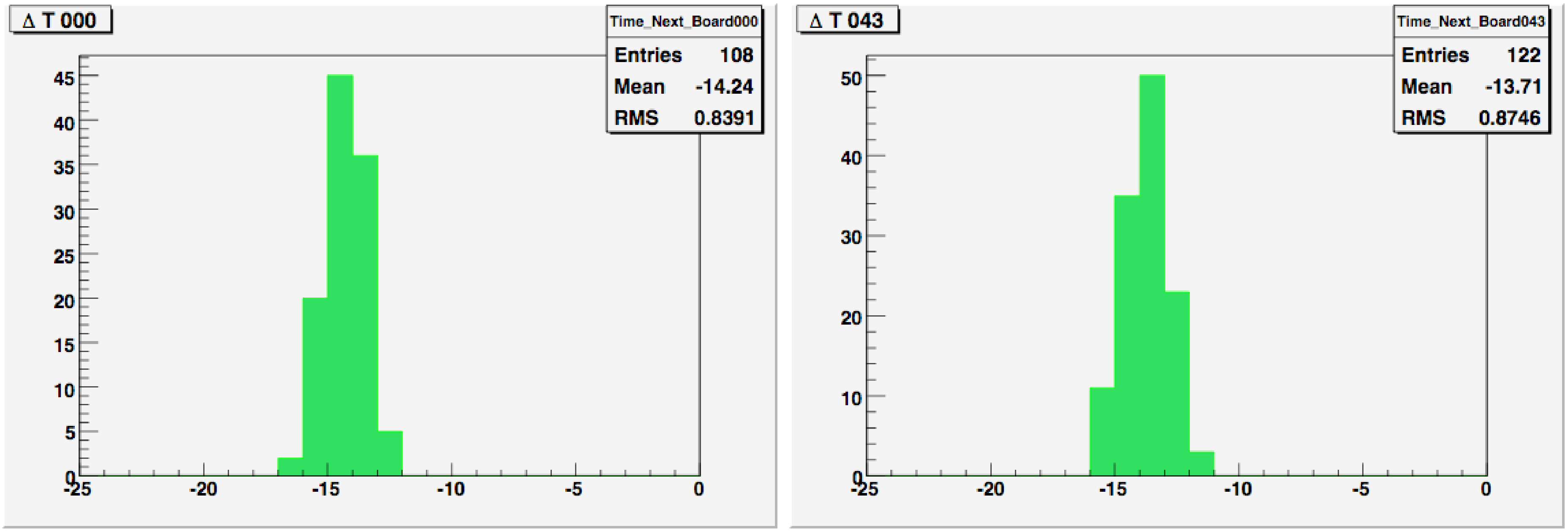
We can compute the asymmetry:

$A = (S_{T0}-S_{Next1})/ (S_{T0}+S_{Next1})$.

Model: $t^{PRS} = (A-1.7)/0.11$ [ns].

2. TED events analysis - June 2009

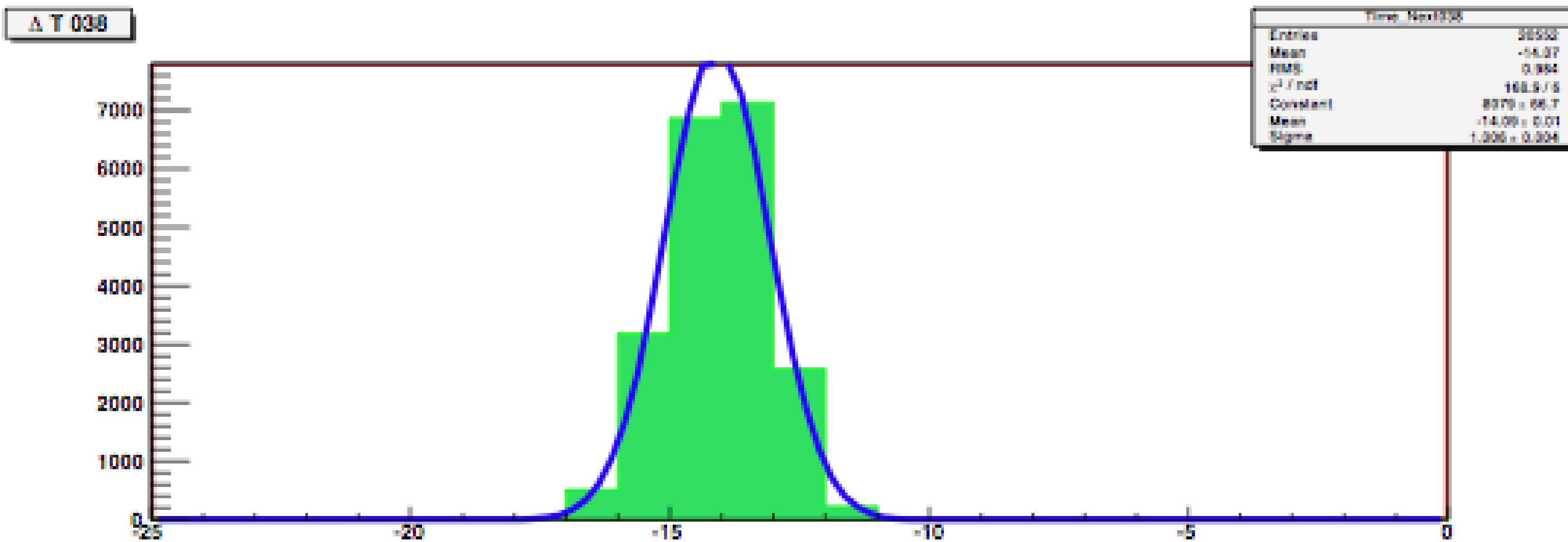
Typical response for one channel:



The typical r.m.s of a channel is better than 1 ns.

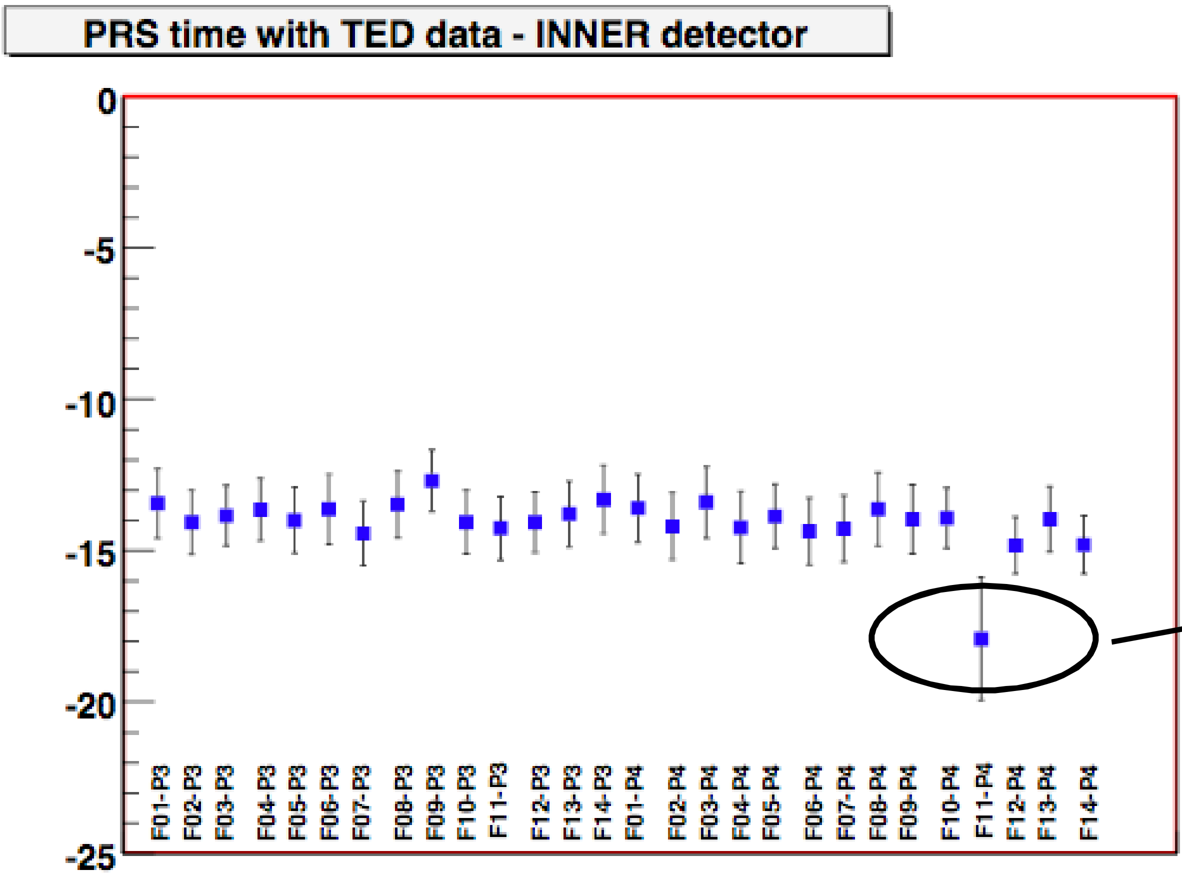
The PRS integrates 14 ns earlier than the arrival of LHC particles in wrong direction.

Typical response for one board:



The typical r.m.s of a channel is roughly the nanosecond.

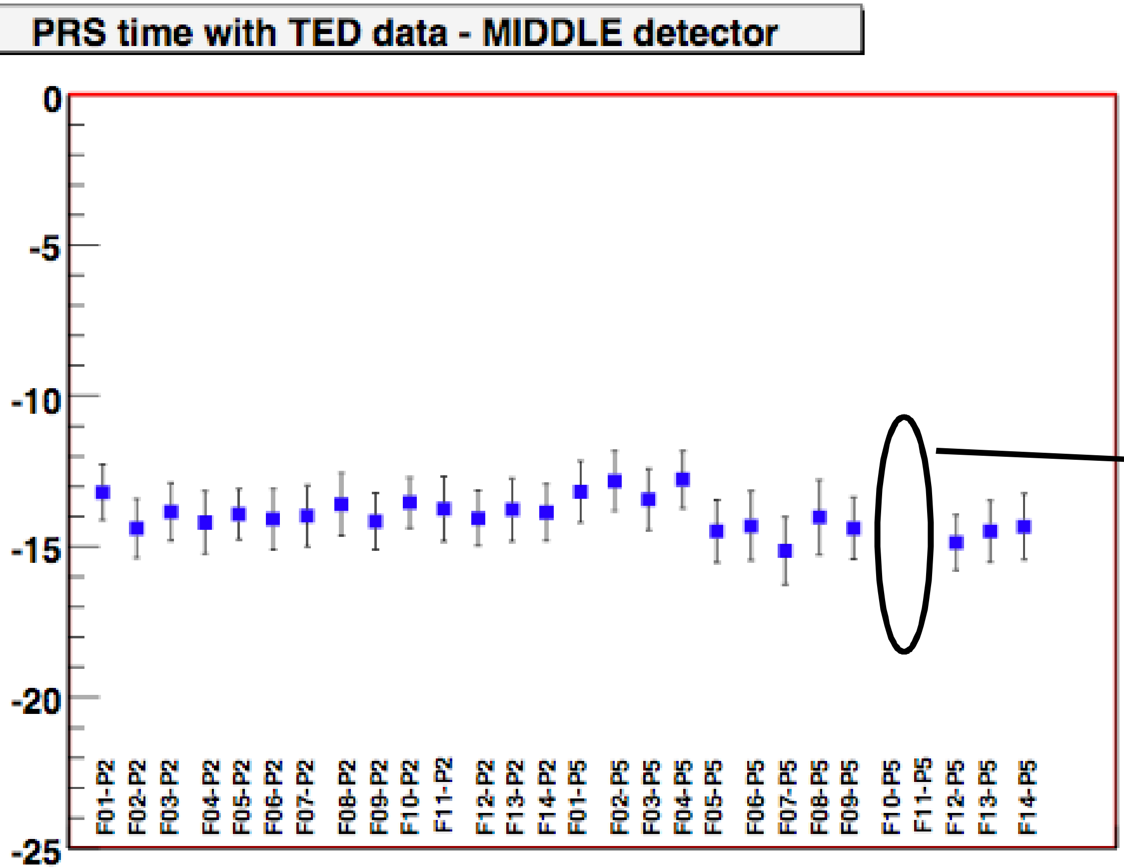
2. TED events analysis - June 2009 INNER DETECTOR



Bad fit due to too low statistics : mean value is -14.8 ns.

Caution: the error bar displays the one sigma value of the fit, not the uncertainty on the mean value.

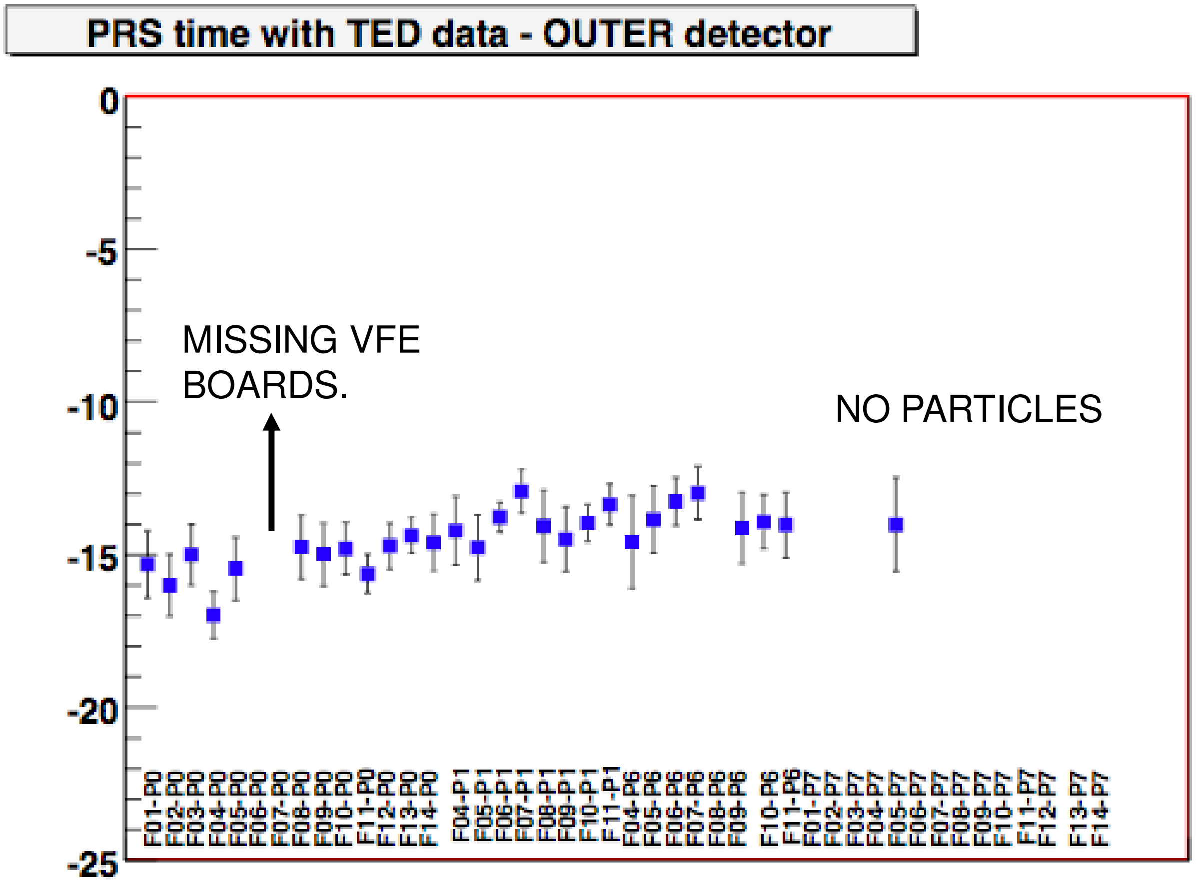
2. TED events analysis - June 2009 MIDDLE DETECTOR



Too low statistics : mean values are -14.9 and -13.7 ns, resp.

Caution: the error bar displays the one sigma value of the fit, not the uncertainty on the mean value.

2. TED events analysis - June 2009 OUTER DETECTOR



Caution: the error bar displays the one sigma value of the fit, not the uncertainty on the mean value.

2. TED events analysis - June 2009

A conclusion:

- Overall picture for the PRS channels/boards/crates timing interalignment is satisfactory.

- TED data are very useful.

- There are here and there misalignments at the level at most of 3 ns for some boards. To be scrutinized further.

- The nasty point is that when we compare w/ ECAL and HCAL times relative to LHC particles, we have a very mild agreement:
HCAL asymmetry = 0.4 => t_PRS=13 ns.
ECAL asymmetry = 0.2 => t_PRS=8.9 ns.

3. Next TED and future data.

TED data have proven to be very useful for the time intercalibration of the channels. There are several MIPs in a single cell (low fluctuations). PRS signal does not care about the particle direction.

- TED data already available are enough for an inter-alignment of the boards at the level of the ns.

- What is to be tested for the next run ?

Absolute alignment w/ LHC particles. Get the experimental dependency of the time as a function of the asymmetry.
Constraints since SPD multiplicity gives the trigger.
Scan around the zero asymmetry value shall be safe even without triggering on one side or one crate.
Sort out XCAL/PRS inconsistencies.

3. Next TED and future data.

Physics data:

✓Modest requirements.

✓Apply the asymmetry method.

✓Get the slope of the asymmetry with a scan around t = -15ns (or take TED data) and scan Prev/ Current around 0 to get the offset.

✓Check/get the time of flight correction.

✓Accurate job (~ 1ns) with few hundreds of events.