Synchronization procedure of barrel Drift Tubes Trigger

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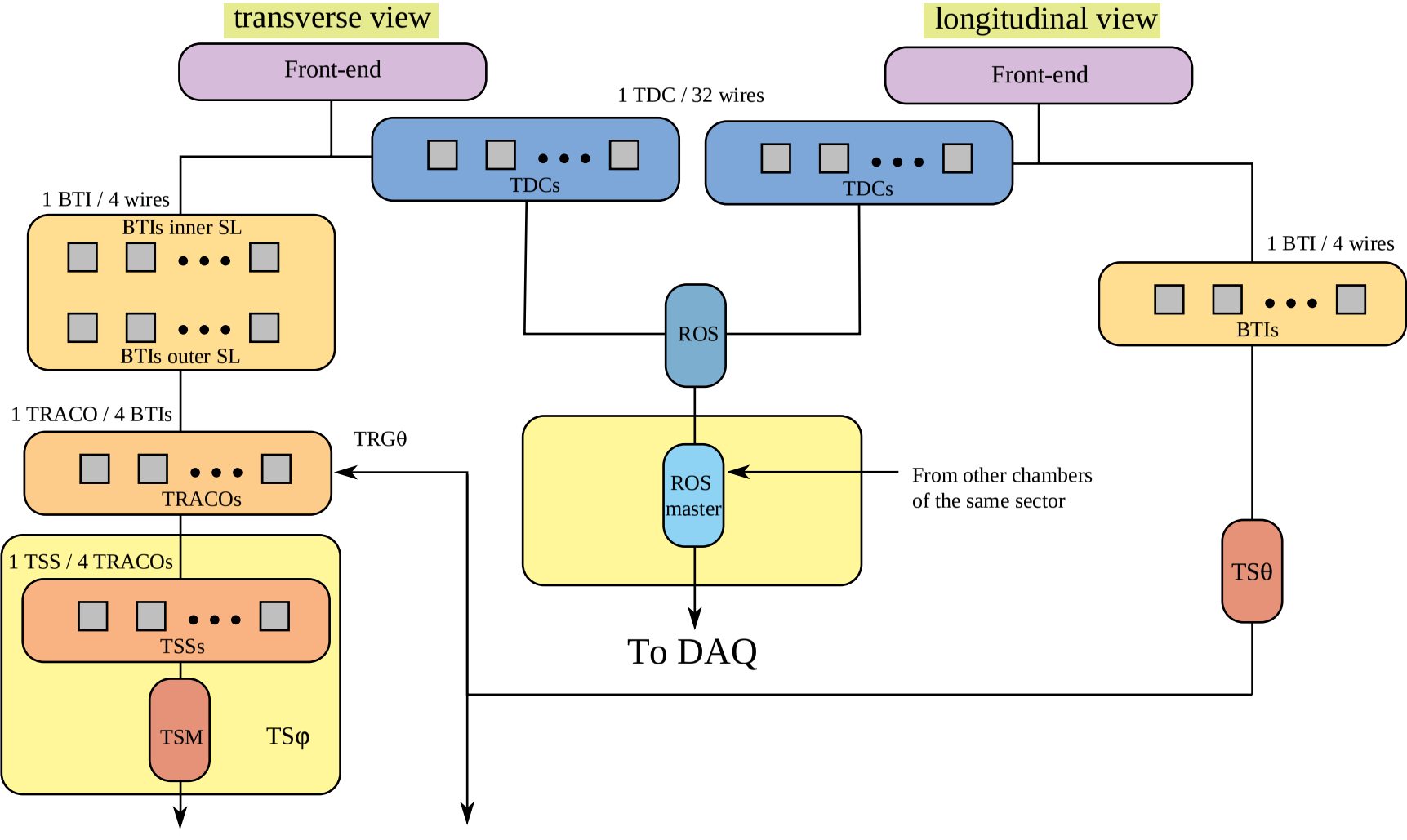
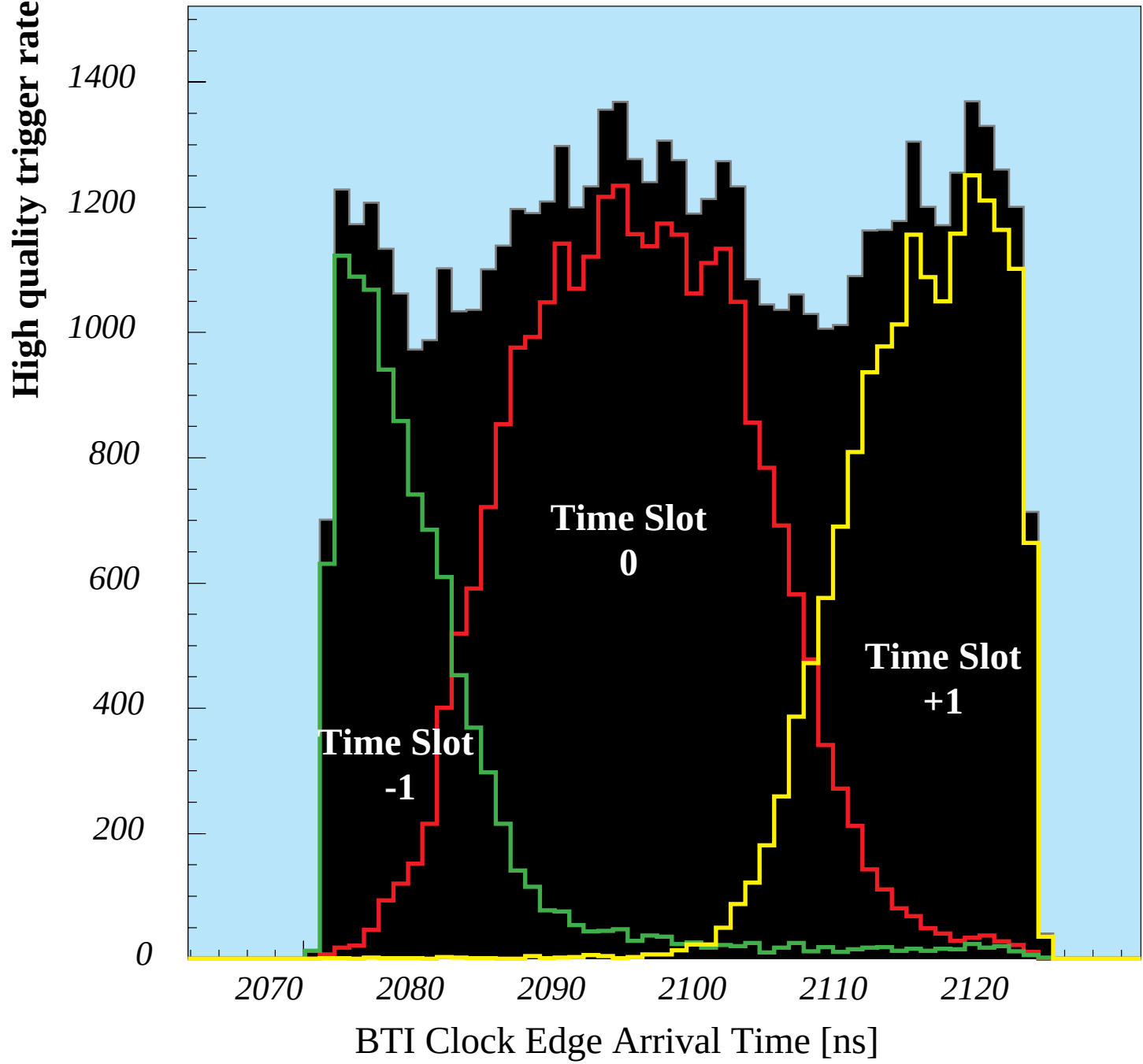
Overview of the electronics layout of a chamber



To Muon Regional Trigger

Trigger ASICS		
	BTI	50000
	TRACO	4400
	TSS	1100
	TSM	240



Syncronization quality

DRIFT TUBES CHAMBER SYNCHRONIZATION: procedure description

A - sampling clock phase adjustment

For each chamber High Quality Trigger the FIFO is read out and the mean timers of the hits are calculated and histogrammed.
The mean timer depends on trigger latency and its rms is minimized when the clock phase is correct.
The TTCrx fine phase adjustment is changed step by step in order to reach the minimum mean timer rms.
This procedure is dependent nor on trigger rate neither on beam pattern.

B - TTCrx synchronization

Every time a local High Quality Trigger is detected by the Control Unit its arrival time wrt BCO is histogrammed.
Once filled, each histogram is cross-correlated with the expected LHC beam pattern to align the TTCrx all over the detector.
This procedure depends on beam pattern.

C -Trigger Links synchronization

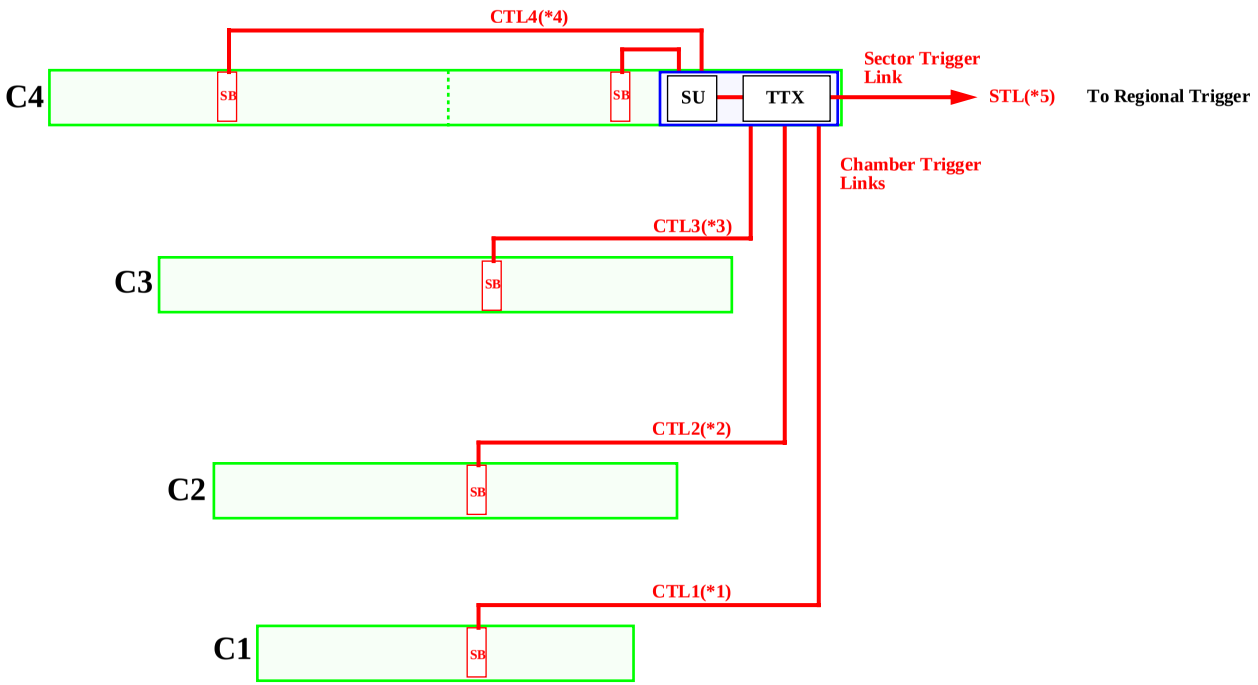
Trigger Link transmission clock phase is fixed by hardware in order to be synchronous with the chamber trigger links.

Once TTCrx are aligned the Test Pulse system is used to synchronize the Trigger Links:
a command is broadcasted and the corresponding data is expected to arrive at the same time at the Regional Trigger. Synchronizing FIFOs of the receiver are used to equalize the delay.

CHAMBER TRIGGER LINKS: system interconnections

CTL1v11: Padova, 28 oct 1998

SB: Server Board
SU: Sorting Unit
TTX: Trigger Transmitter



(*1) Station 1 Trigger Link
Φ1(0:11) Radial of first track
Φb1(0:9) Bending of first track
Q1(0:2) Quality of first track
Φ2(0:11) same for second track
Φb2(0:9)
Q2(0:2)
Θ(0:31) Theta SL hits
QΘ Quality of theta SL trigger

3x20 wires twisted flat cable

(*2) Station 2 Trigger Link
Φ1(0:11) Radial of first track
Φb1(0:9) Bending of first track
Q1(0:2) Quality of first track
Φ2(0:11) same for second track
Φb2(0:9)
Q2(0:2)
Θ(0:31) Theta SL hits
QΘ Quality of theta SL trigger

3x20 wires twisted flat cable

(*3) Station 3 Trigger Link
Φ1(0:11) Radial of first track
Q1(0:1) Quality of first track
Φ2(0:11) same for second track
Q2(0:1)
Θ(0:15) Theta SL hits
QΘ Quality of theta SL trigger

2x20 wires twisted flat cable

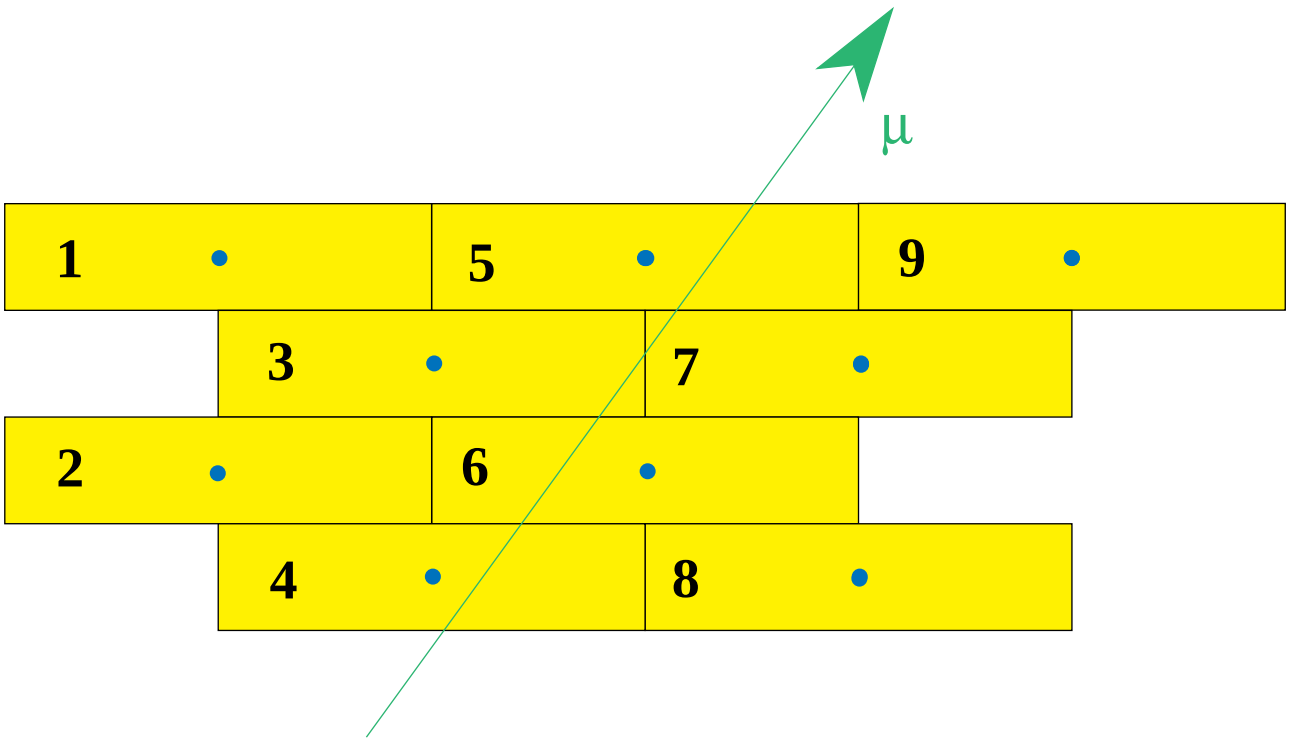
(*4) Station 4 Trigger Link
Φ1(0:11) Radial of first track
Q1(0:1) Quality of first track
Φ2(0:11) same for second track
Q2(0:1)

20 wires twisted flat cable

(*5) Sector Trigger Link

2x12 fibers ribbon cable

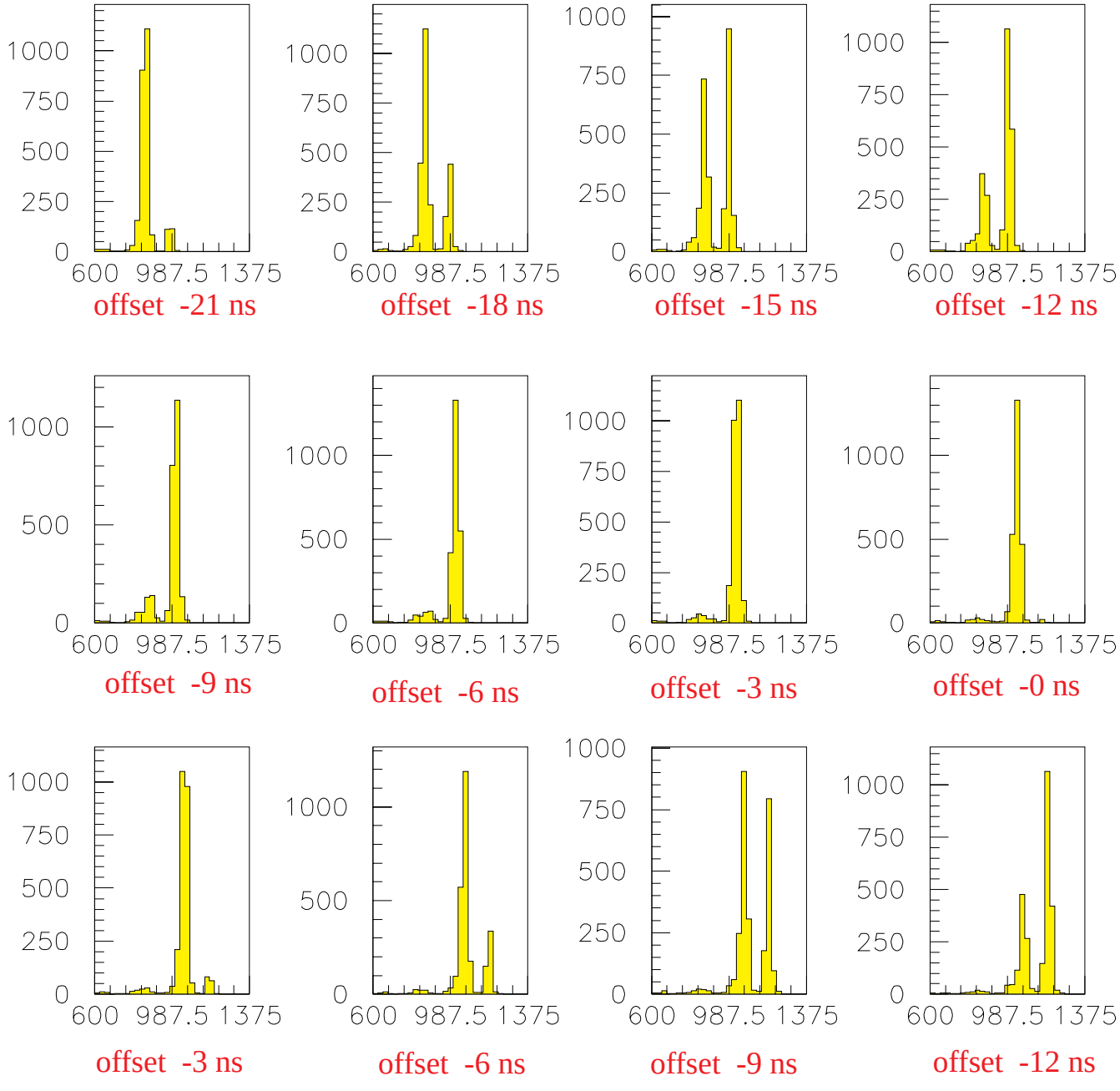
Description of implemented algorithm



1 BTI trigger must be High Quality
2 Triggering BTI is identified
3 Corresponding readout channels are read out
4 Only four cells should have a hits
5 Calculation of

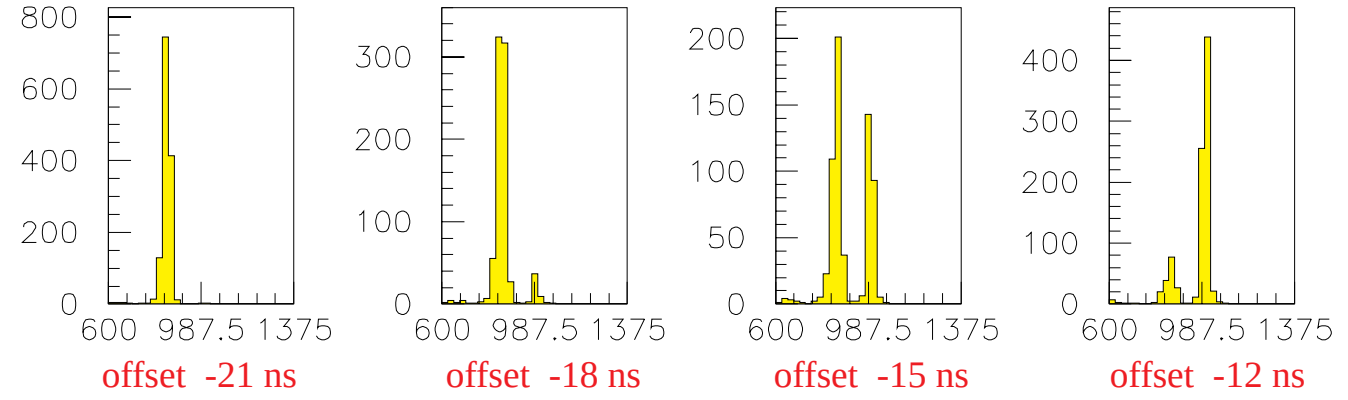
$$T_1 + 2\,T_2 + T_3 \text{ and } T_2 + 2\,T_3 + T_4$$

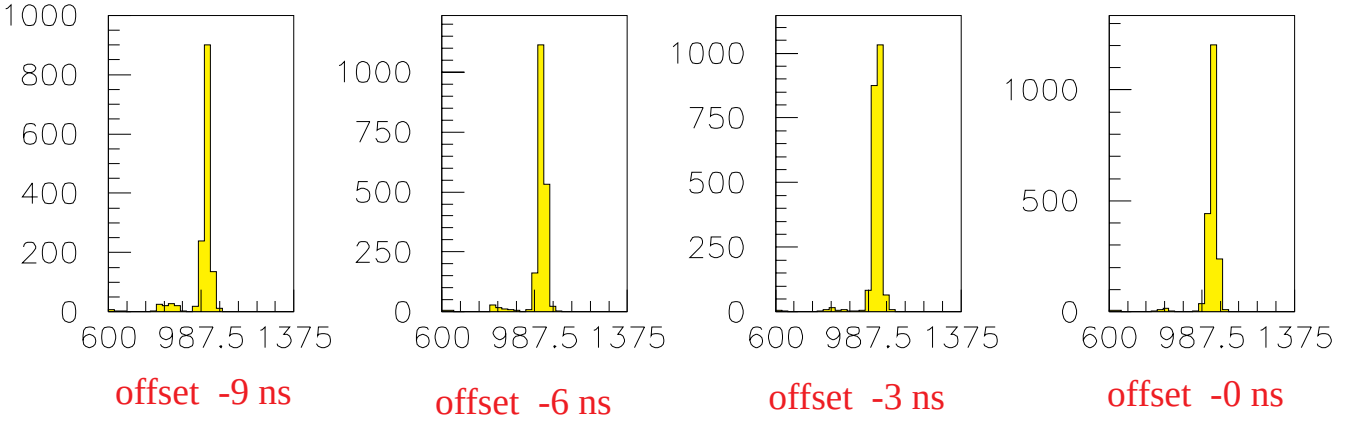
where labels refer to chamber layers
6 One of the two quantities is histogrammed

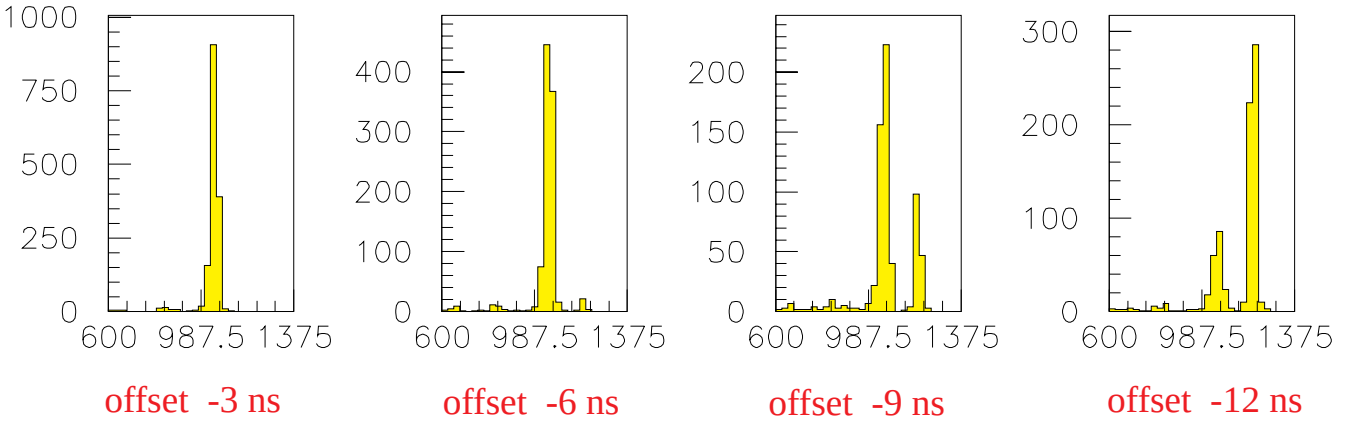


Standard acceptance

Accumulated histograms for about 5000 events per chamber

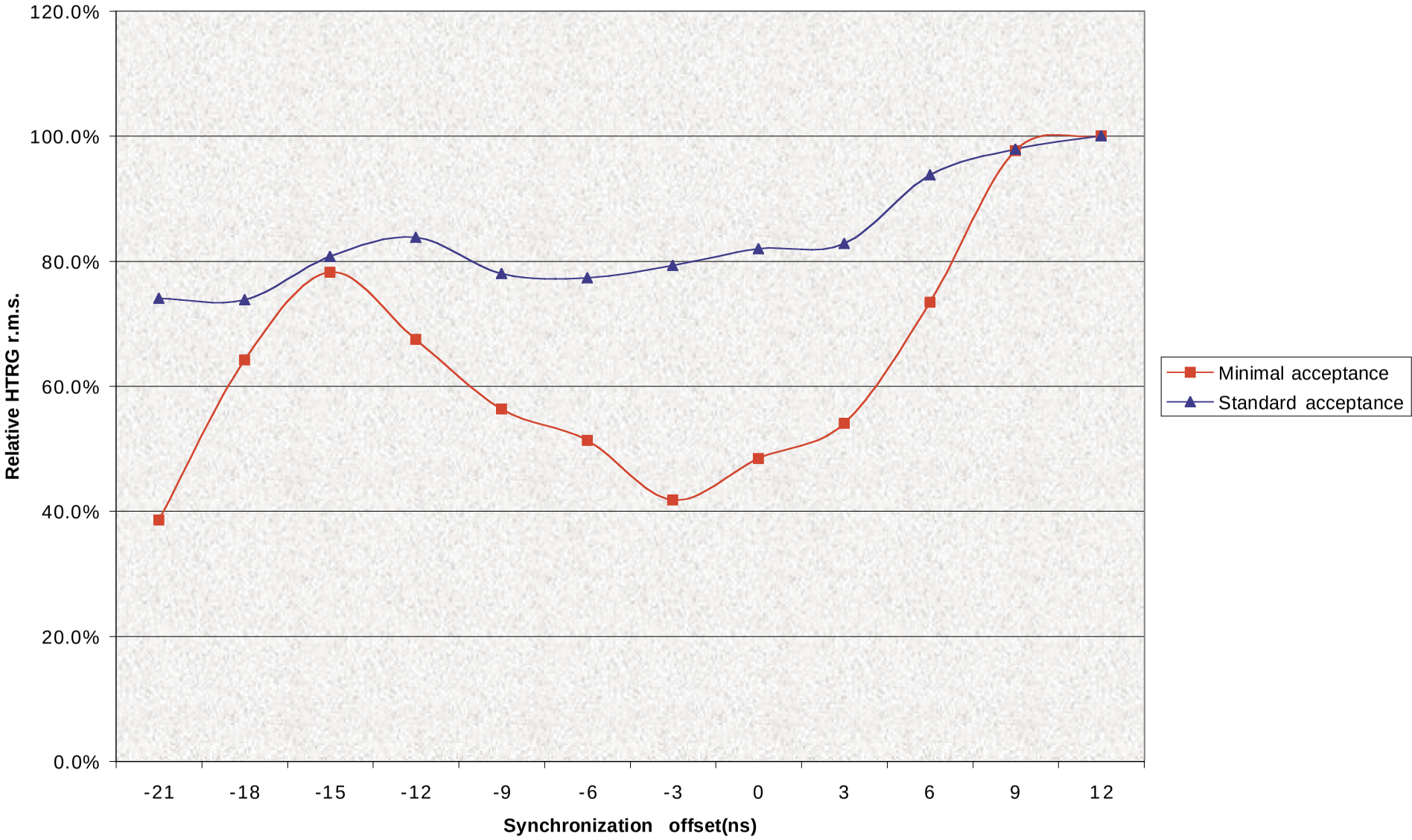


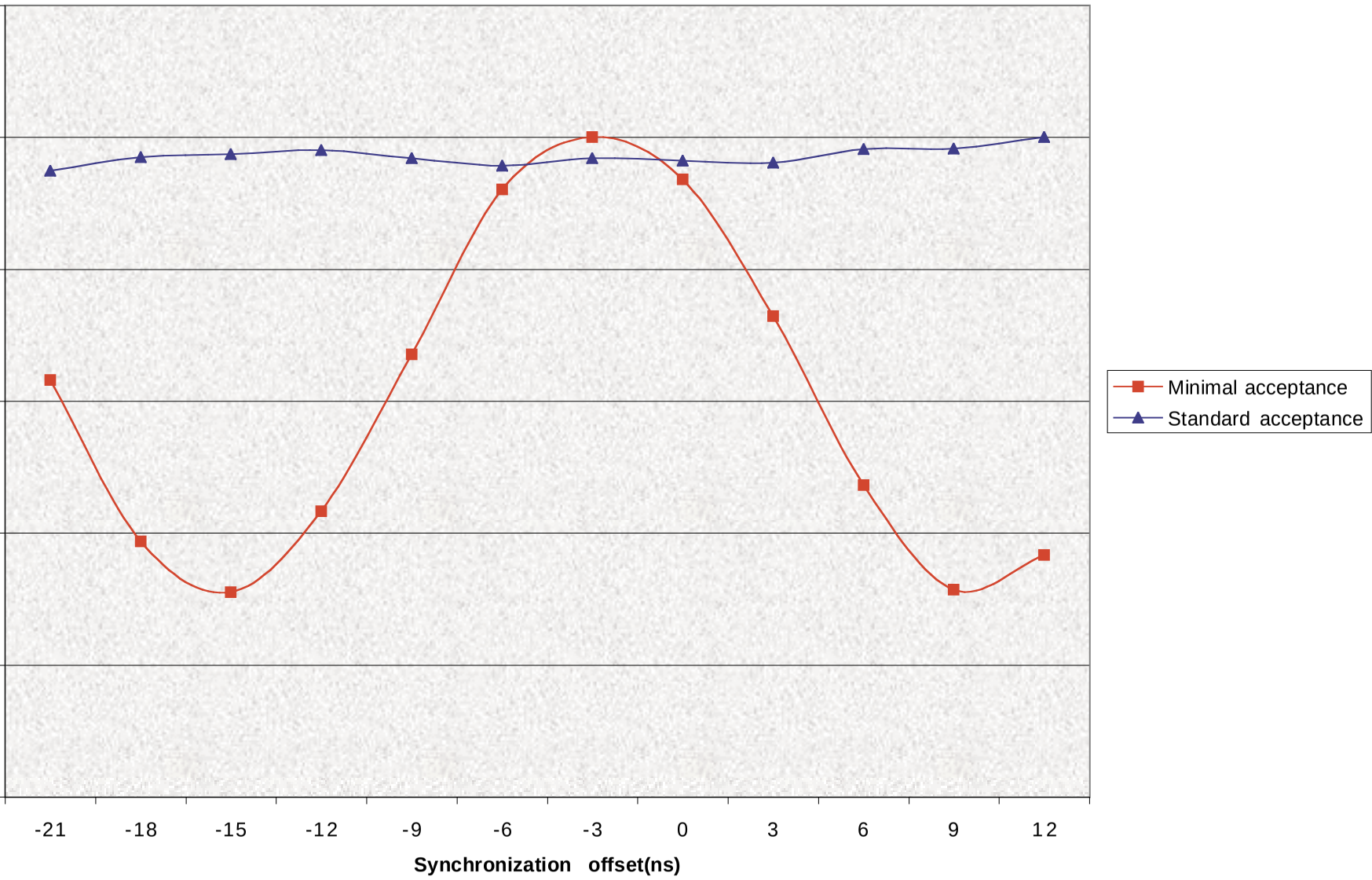




Minimal acceptance

Accumulated histograms for about 5000 events per chamber


120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Relative HTRG r.m.s.
-21
-18
-15
-12
-9
-6
-3
0
3
6
9
12
Synchronization offset(ns)
Minimal acceptance
Standard acceptance


Minimal acceptance
Standard acceptance
-21
-18
-15
-12
-9
-6
-3
0
3
6
9
12
Synchronization offset(ns)

DRIFT TUBES CHAMBER SYNCHRONIZATION: monitoring

Either Sampling Clock Phase or TTCrx Synchronization procedures can be run continuously just to monitor long term drifts.

During the LHC abort gap is possible to monitor the full Drift Tubes Detector synchronization using the Test Pulse system.

A Test Reset command must be broadcasted in order to initialize the local sequencers.

At every LHC abort gap a Test Pulse command is sent all over the detector; each chamber Control Unit injects charge in four wires per superlayer simulating a track crossing vertically the relative drift cell.

All drift cells are tested, one per LHC abort gap, if a Sequence Advance command is sent right after the gap.

If a loss of synchronization is detected on the test pulse patterns received by Regional Trigger, the trigger link FIFOs can be automatically adjusted to compensate for.

A Test Preset command has to be broadcasted to the front-end amplifiers at least 100ns before the Test Pulse command in order to turn them into Test Mode.