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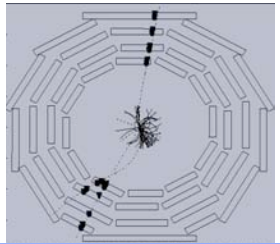


Barrel Muon Drift Chamber Performance from Cosmic Rays data with *autotrigger*

Cosmic rays have been triggered with the autotrigger signal generated by the Local Trigger of a MB3 chamber and the standalone trigger capability of a muon barrel chamber verified.

From the recorded drift times, the track reconstruction efficiency has been measured to be better than 99% without cuts when correlated triggers are required.

I report on

-Comparison of the performance of the Local DT Trigger from Test Beam and the 'bunched' cosmic rays data.

-Results from cosmic rays data with the standalone Trigger of the chamber

-**Best phase assignment at Test Beam on**

> **software autotrigger on scintillator data**
>
> **real autotrigger with HH and HL**

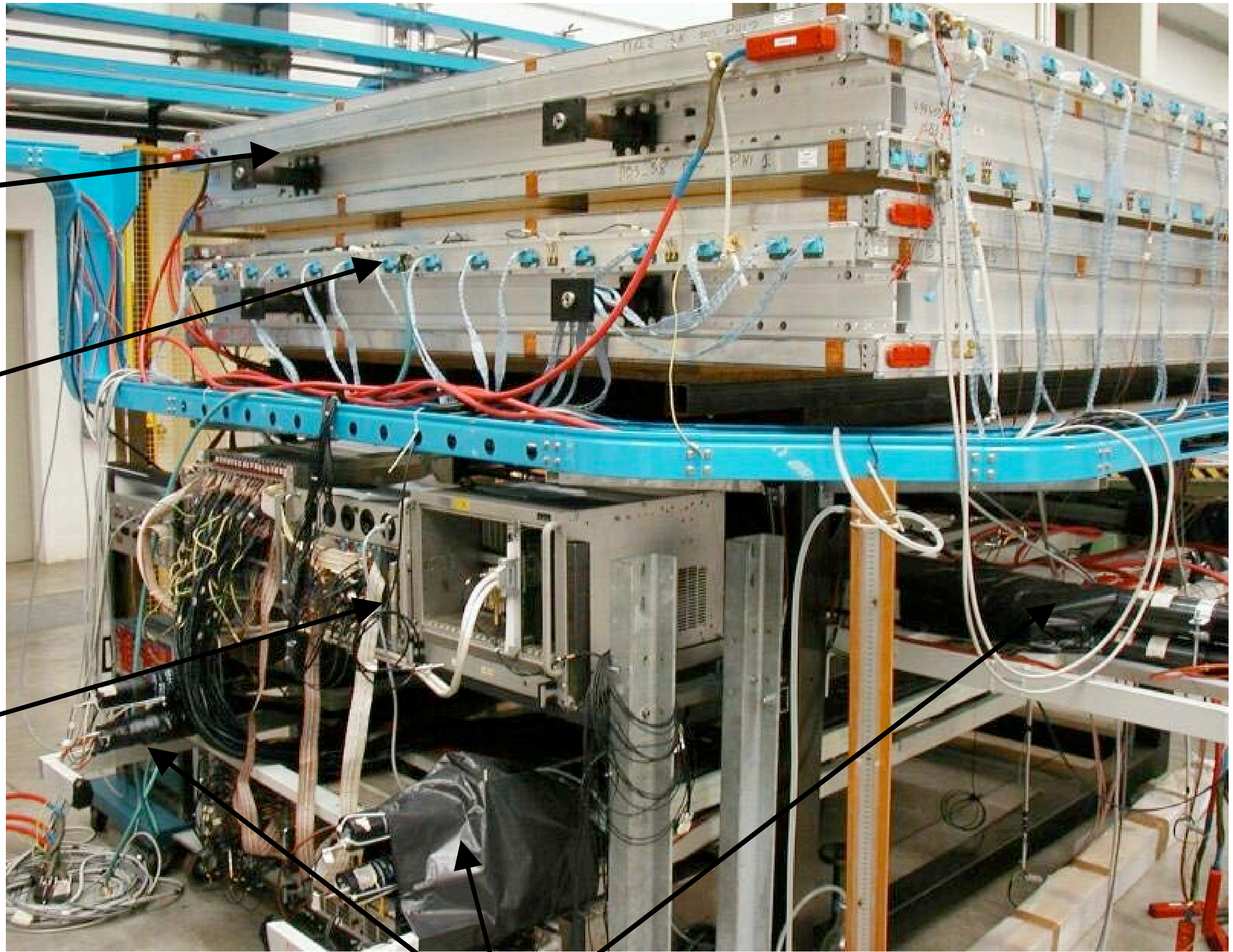
Chambers and Trigger set up at LNL

Chamber under test

Chamber under trigger test

Local Trigger CCB

(mai 2003 photo)



Cosmic Rays : trigger set-up

Runs

At TB2003 **bunched muons** ▯ **scintillators**

▯**L1A Mini Crate** ▯**stop TDC & start PU**

normal runs-------> study of the information of the Local Trigger which, at CMS, will be sent directly to the track finder.

Data were taken triggering with external scintillators: the chamber hits were recorded in the Read Out Unit (ROB), that uses the TDC (used in stop mode) located in the Mini Crate and the information of the Track and Trigger Board (TRB) were recorded in a Pattern Unit (PU), used in start mode. The hardware setup description of the Mini Crate (and the results of these test beam have been presented already.

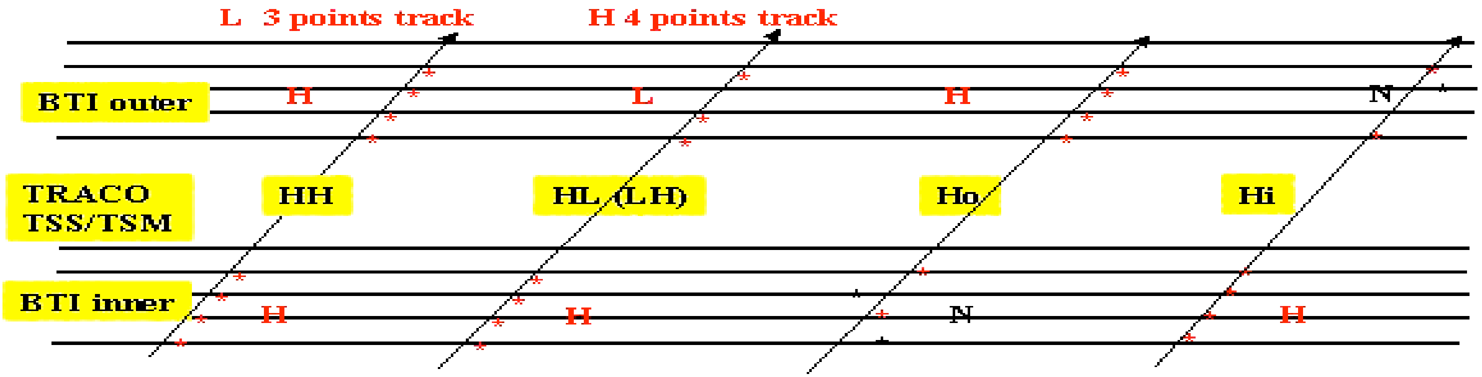
At LNL **cosmic rays (2KHz rate)** ▯**scintillators**

▯**'bunched' cosmic rays** ▯**L1A MINI CRATE**▯ ▯**stop TDC & start PU**

Normal runs. Bunched Data were taken triggering with the signals of external scintillators within a fixed window (about 6ns) w.r.t. the 40 MHz clock. The chamber hits and the information of the TRB were recorded as at Test beam. The signals of the scintillators and of the autotrigger were recorded in TDC channels so the phase of the track respect the clock was recorded.

autotrigger

The signal called *autotrigger* is generated on a predefined selection based on the quality of the track segments found by the local Trigger Board (from the signals which were - in *normal runs* at TB and at LNL- recorded in the PU).



Each MiniCrate generates locally the autotrigger in coincidence with the 40 MHz clock of the trigger system. In normal data taking, at CMS, it will be sent to the Track Finder with the track segments information at the 40 MHz frequency.

If required, the L1A of a Mini Crate can be generated by this signal. The data collected with this trigger will be used, at LHC, for finding the best timing setting of the Local Trigger parameters for the best bunch crossing assignment and track definition in each chambers independently.

At TB2003 a few runs were supposed to be triggered by *autotrigger* HH, HL,Ho,Hi

Software autotrigger

From the information recorded in the PU a SOFTWARE AUTOTRIGGER is assigned at the event at the slot where the first trigger with the selected quality is found (if found).

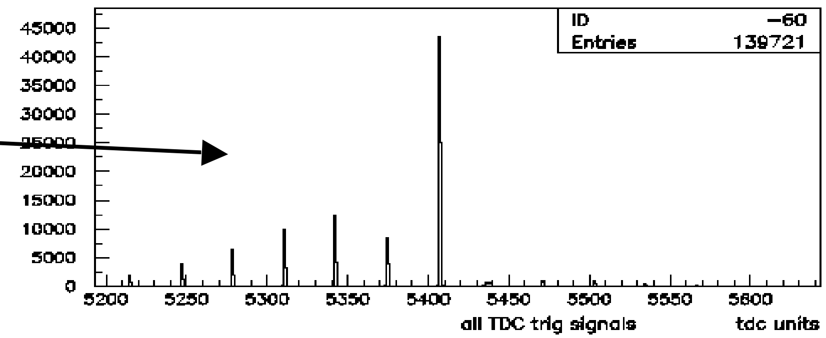
From the comparison of the ***software autotrigger*** with the ***real autotrigger*** signal recorded in the TDC in normal runs at LNL

-at TB2003 the autotrigger was not selecting the wanted HH,HL,Hi,Ho and in such runs no scintillator informations were available to be used to know the bunch crossing of the tracks recorded in the chamber.

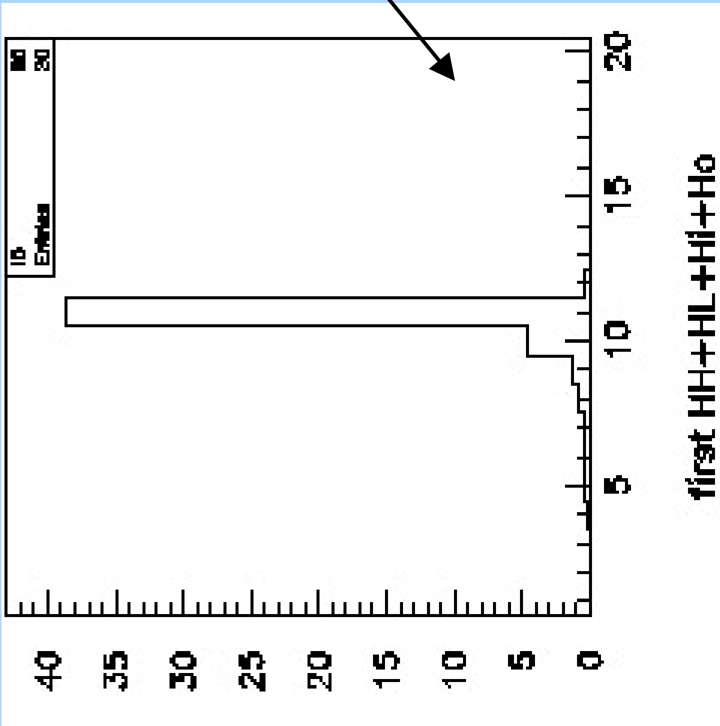
-Only the data taken with the autotrigger for syncronisation and with sync388 are ok (preliminary results of syncronisation and phase assignment …) .

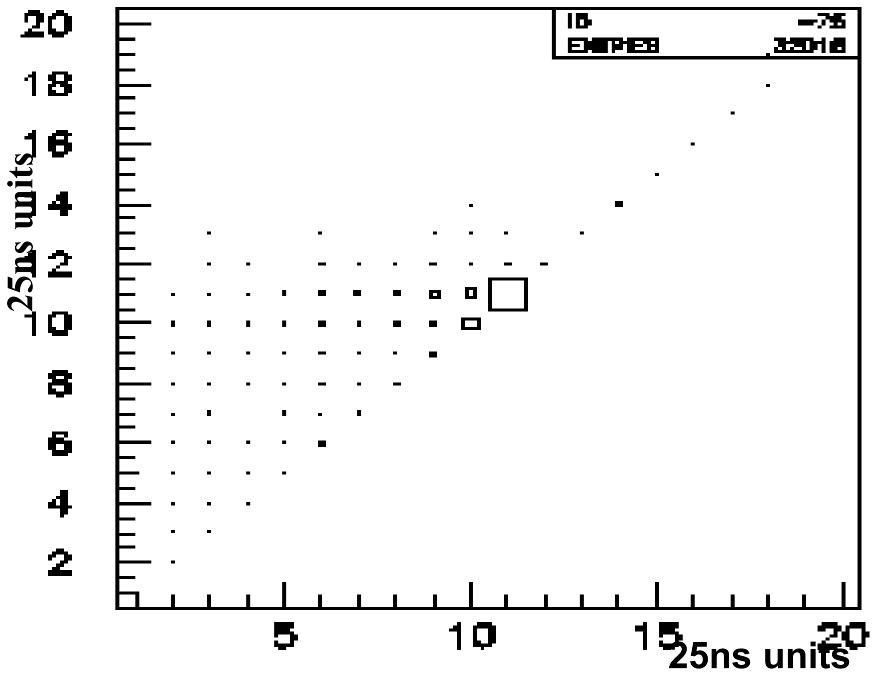
Wrong autotrigger setting at TB

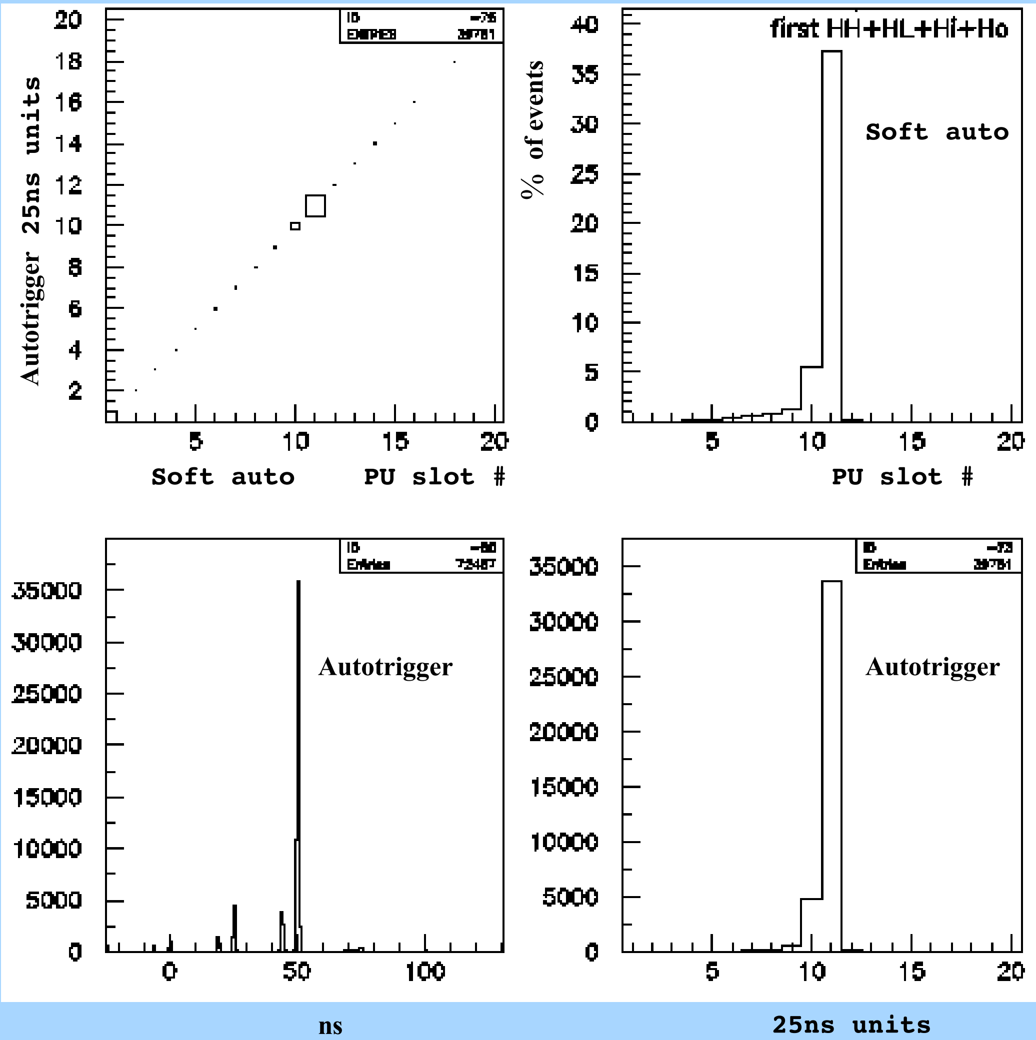
Wrong-Autotrigger recorded in TDC channel



Soft autotrigger
From PU data







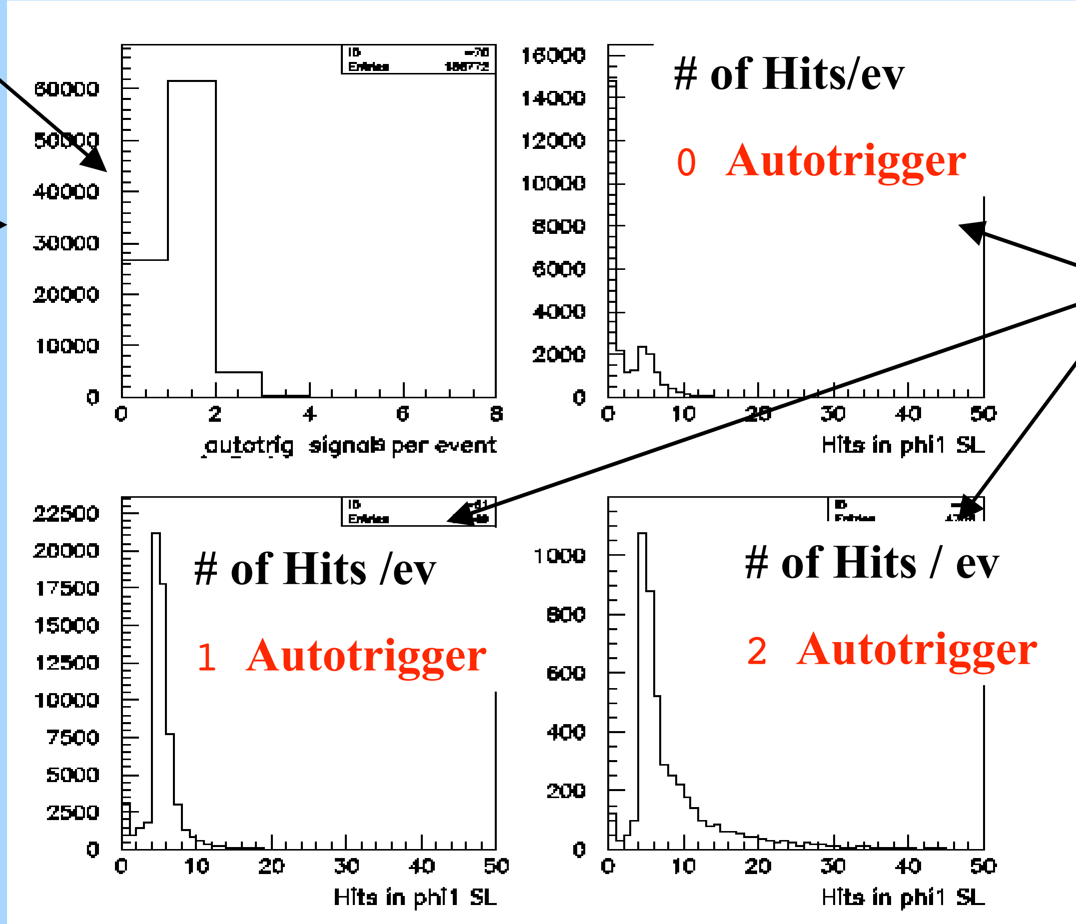
From PU data

Autotrigger recorded in TDC channel (arbitrary 0)

Checks of cosmic Data with scintillator trigger (bunched cosmics)

NB Only 2/3 of the PHI SL channels connected (the scintillator geometrical acceptance larger then chamber acceptance)

# of Autotrigger signals/ev recorded on the TDC



TDC data

(no cuts)

PHI 1 SL

Autotrigger runs on Cosmic Rays

AUTOTRIGGER set up at LNL

MB3 chamber # 36

MB1 MINI crate full equipped

BTI and TRACO □ set quiet configuration, the so called sync388 set-up i.e. only very high quality trigger in the TRACO: HH, HL or a H certified by a H_trigger in the theta view.

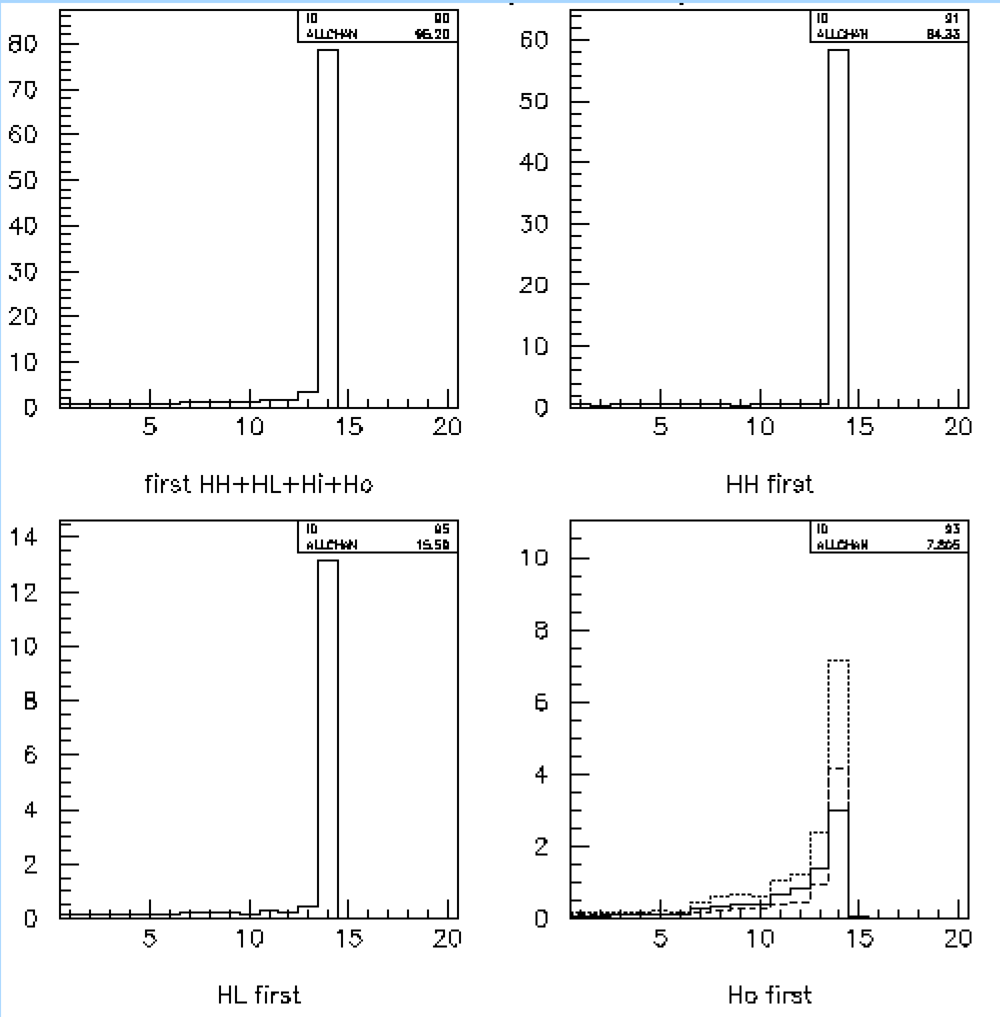
Autotrigger SELECTION□ only H

***Trigger : autotrigger* □ L1A of the Mini Crate**

***Autotrigger and* scintillators** signals recorded in TDC channels

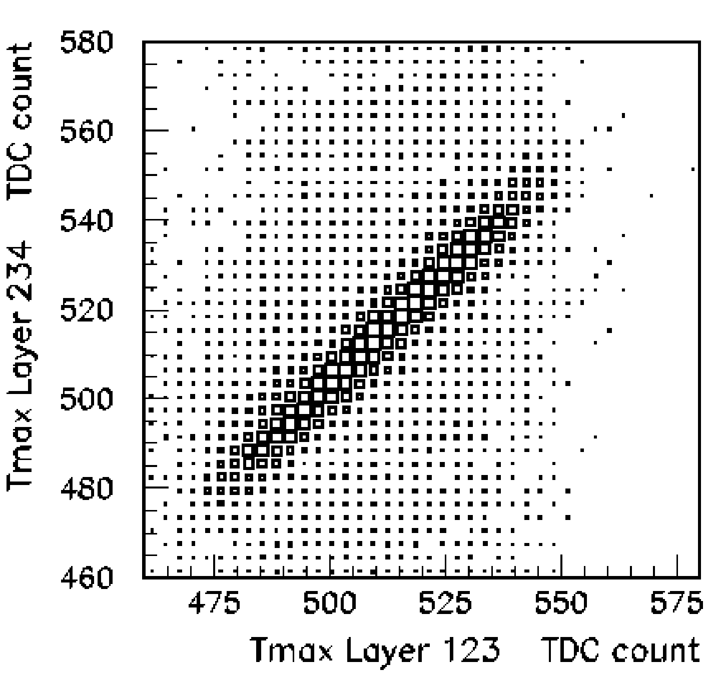
Test Beam soft autotrigger HH HL H efficiency (no cuts)

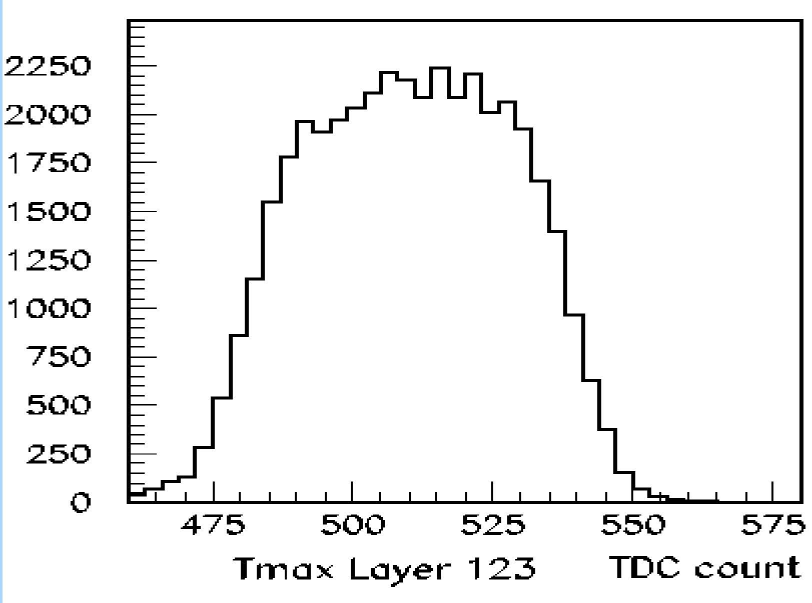
The expected bunch crossing assignment should be very good (when in phase ...see below). More then 90% of the events are triggered with the correct Bunch crossing by the autotrigger.

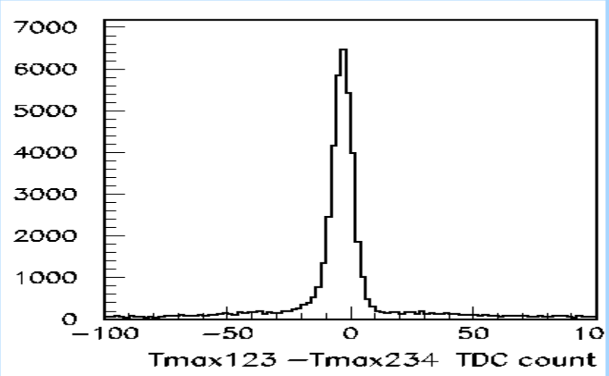


Tmax correlation in cosmic rays due to autotrigger

Cosmic rays have flat distribution in time but L1A stops the TDC always in phase with the edge of the clock : any event has an error do to the clock of about 25ns/(sqrt 12). The offset can be seen on the Mean Time plot



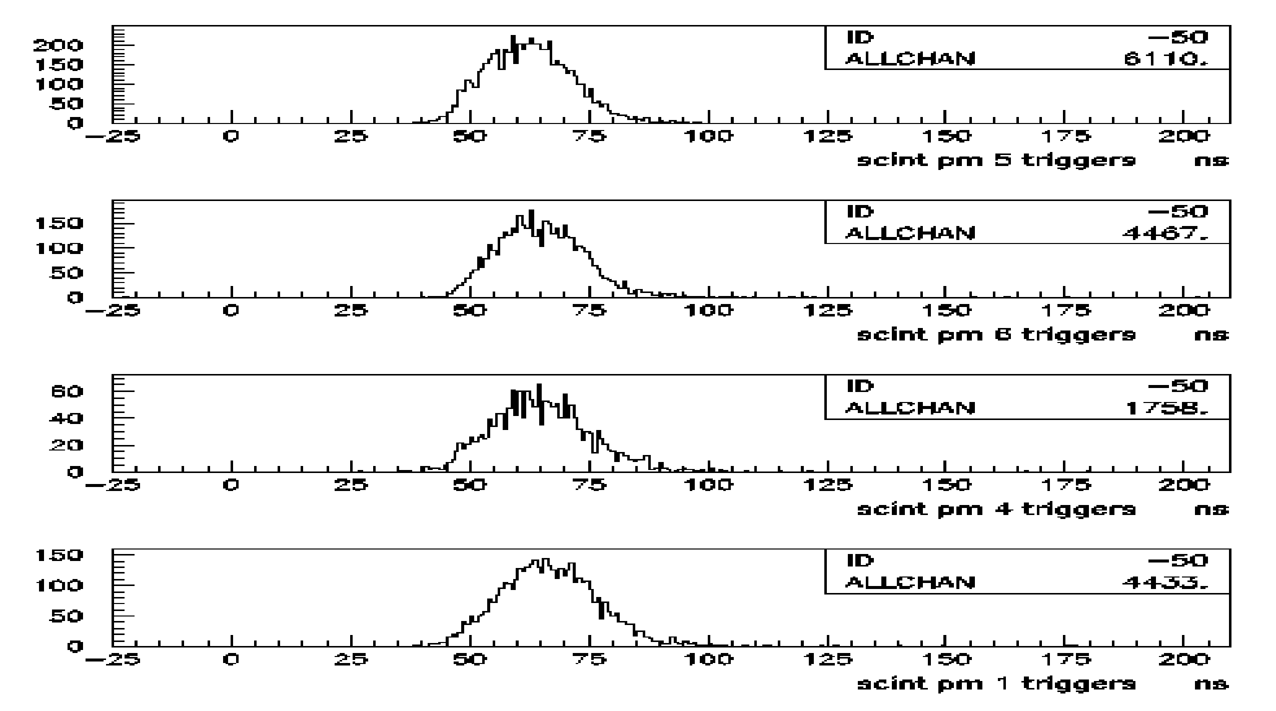




1 TDC count =0.78 ns

Scintillators time

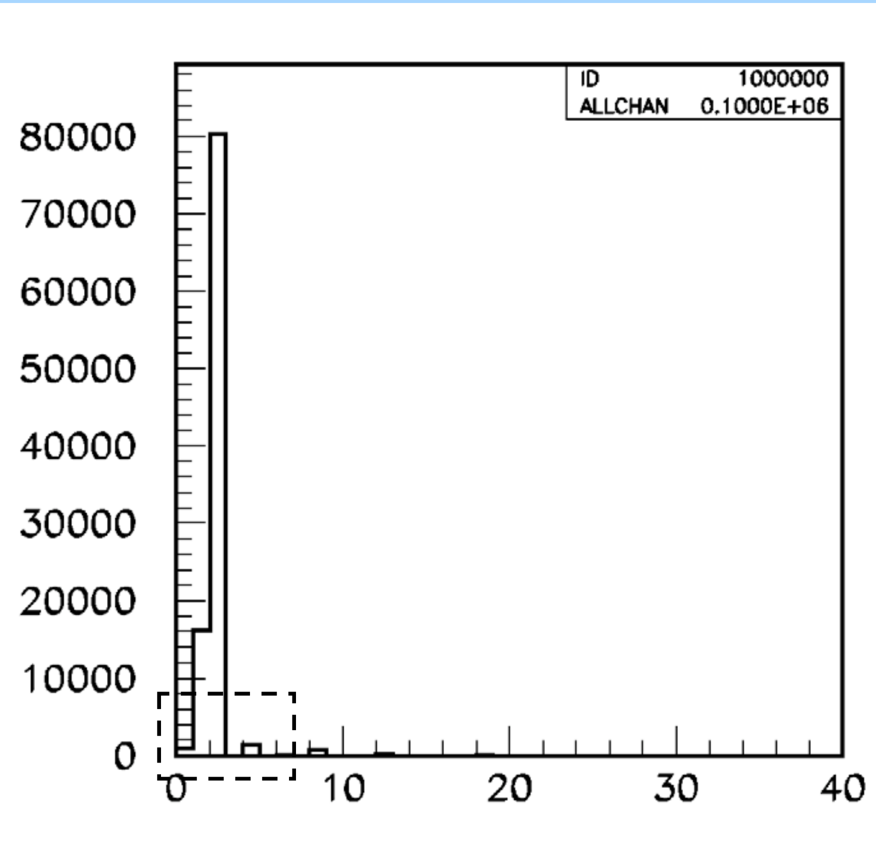
Distribution in ns (with an arbitrary 0) of the four different scintillators of the cosmic ray set up. Their intrinsic resolution was measured to be not better then 4-5 ns. With autotrigger runs their distribution is dominated by time fluctuation of the muon track with respect to the clock .

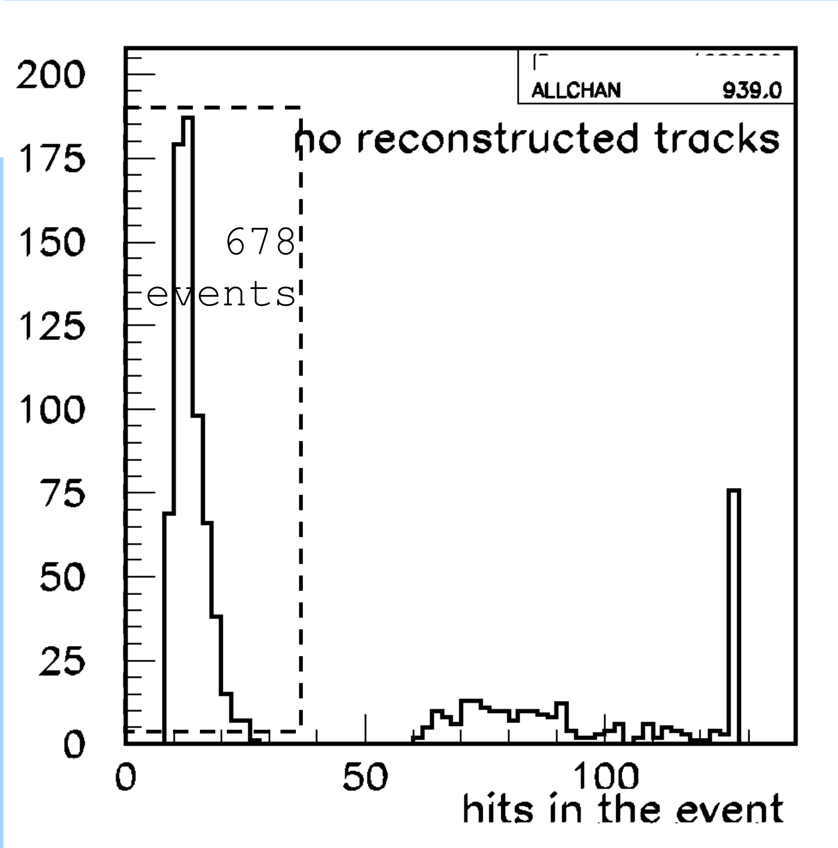


Autotrigger data :Track reconstruction efficiency

Standard fit

Number of tracks reconstructed in the event in the two projections (fit performed in with 3 or 4 layers and in with at least 3 and up to 8 layers).





hits in the event when there are not tracks reconstructed.

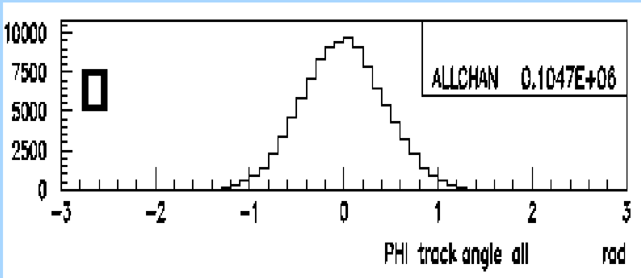
Autotrigger data :angle of the tracks and residuals

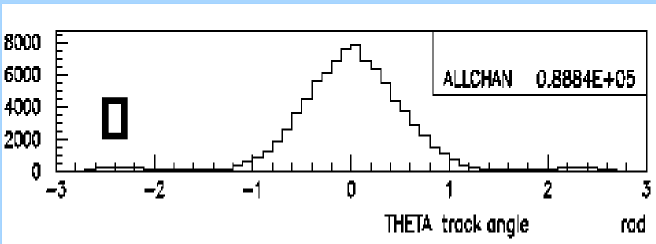
MB3 #36 no alignments corrections

fit performed : - in □ with 3 or 4 layers

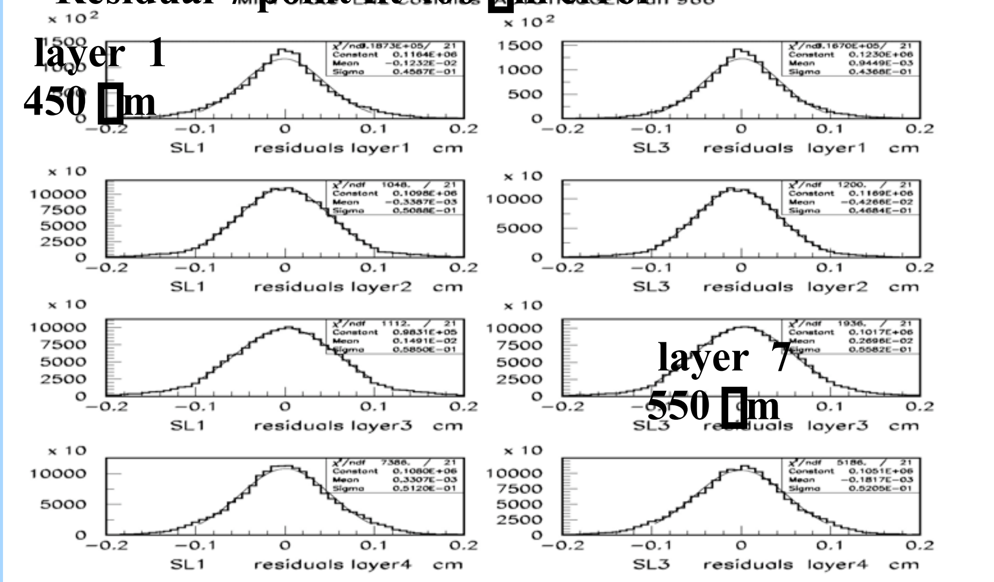
-in □ with at least 3 and up to 8 layers

angle distribution of the tracks reconstructed in the event



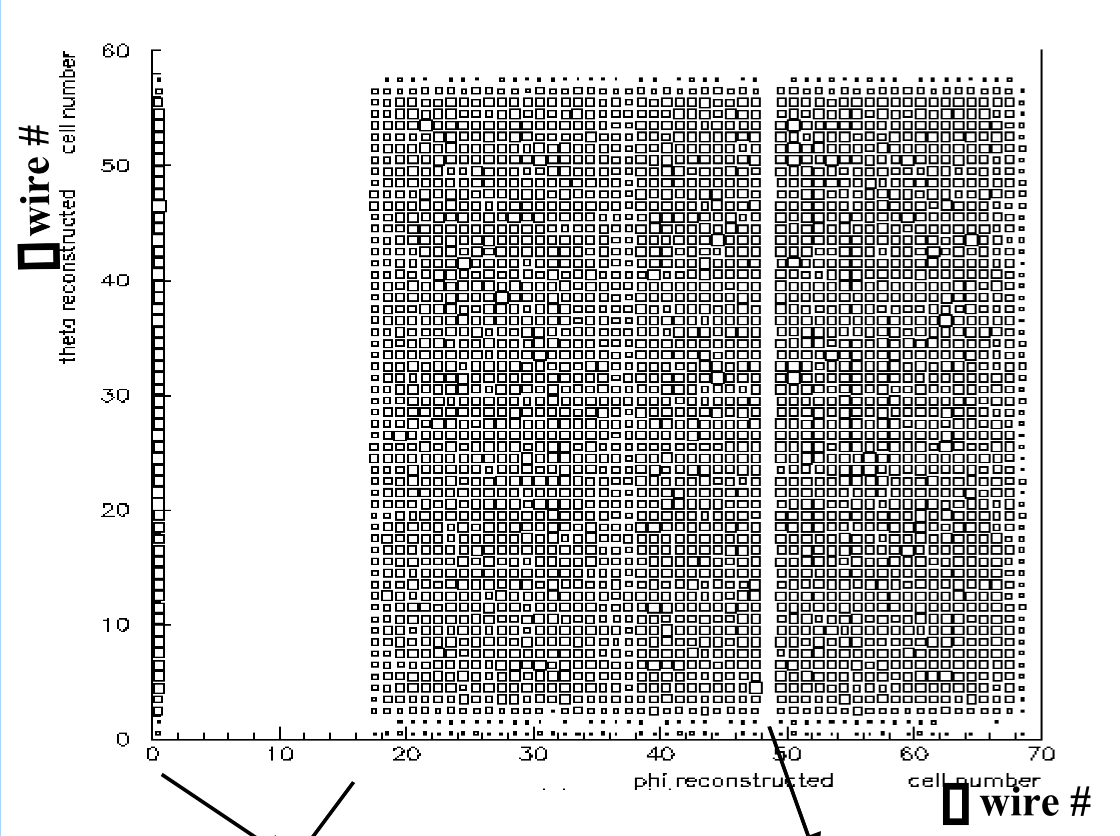


Residual 7 point fit 400 □m error



distribution in the Chamber: complitely illuminated

wire number hit in the first plane by the track reconstructed with respect to the wire hit in the first plane of SLPHI2. Wire 48 of SLPHI2 is not read out



Wires in the first SL not read out (MB1 Mini Crate)

Wire 48 of SLPHI2 is not read out (ROB channel problem)

Standalone MB chamber trigger on cosmic rays

The drift times recorded in *autotrigger* runs with cosmic rays have
-an error due to the phase of the track with respect to the clock edge (flat distribution 25 ns ie 450 □m)
-an error due to the position along the wire of the track (propagation along the wire flat +-5 ns). This can be corrected from the position along the wire if the □ wire is correctly associated in the event.

The accuracy of the track hits in the chambers with the cosmic *autotrigger* □ can not reach the real final chamber accuracy computed at test beam.

-Nevertheless the purity of such trigger is very high (at any trigger there is a track reconstructed in each projection with 99 % efficiency) .
-When there are more tracks hitting different cells they can be individually identified at least if separated in time by more than 20 ns which is the shaping time of the present *autotrigger* signal used in Legnaro (if the autotrigger signal could be recorded in one TDC channel).

Conclusions : cosmic rays data and autotrigger

The test performed in Legnaro with the *autotrigger* signal as L1A, shows that with cosmic rays the Mini Crate can work and data give plain information

-on the chamber performance as far as uniformity is concerned

-on the trigger since cosmic rays illuminate uniformly

The cosmic rays results show an excellent possibility to fully check one or more chambers, as far as uniformity of wires behavior (efficiency, drift velocity) and trigger performance are concerned, without any external trigger.

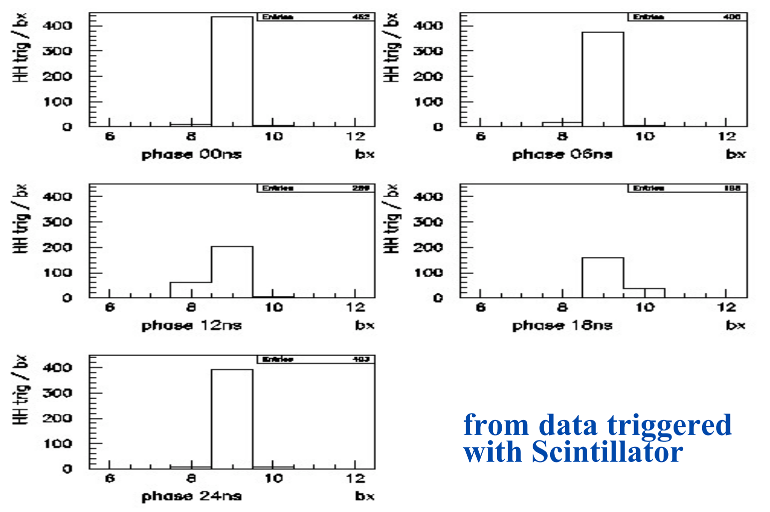
NOT yet done but promising :Multi tracks performance of the trigger device can be checked from cosmic shower events.

Syncronisation

SYNCRONISATION

The BTI samples the drift times signals sent by the FE at twice the 40 MHz Clock and , when it finds alignments,it sends results to the TRACO at 40 MHz. The efficiency of the BTI, of the TRACO and of the Local Trigger - for the different quality type - depends on the time of the muon track on the chamber with respect to the clock. A delay – *called phase* – must be adjusted in order to maximise the Local Trigger efficiency *. In the test performed using the external scintillators trigger where trigger data are collected in the PU, the best phase is found checking in a fixed number of triggers the number of HH quality triggers and their time distribution*

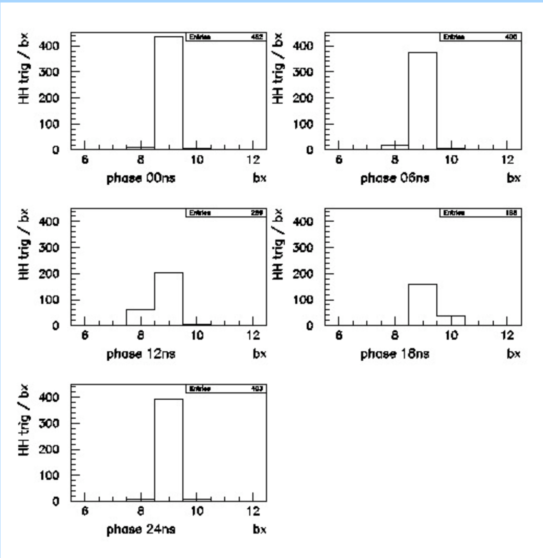
At CMS the clock will be sent by the machine and will reach each chamber with a specific but fixed phase with respect to the pp interactions. A syncronisation must be performed with autotrigger data in order to find the best phase in any chamber.

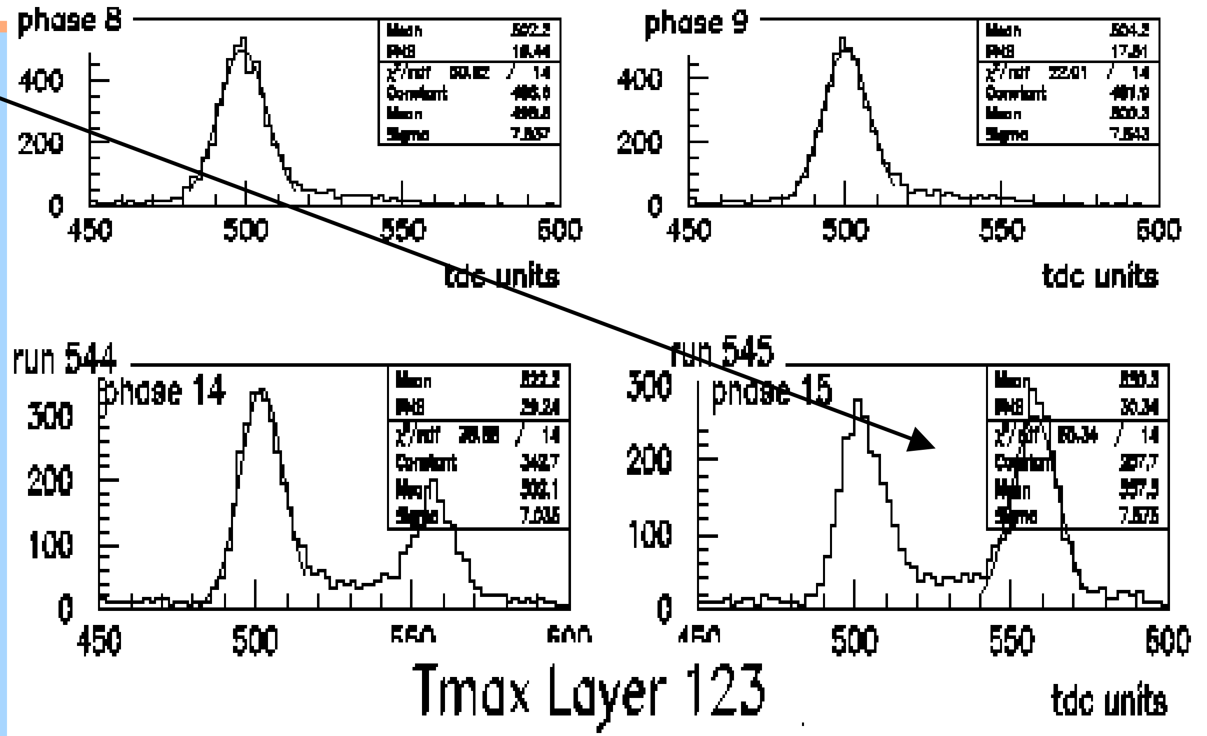


from data triggered with Scintillator

Synchronisation method

The Mean Time of the drift times in correlated cells can yield the Tmax but the value found depends on the T0. Defined a T0 respect the TDC stop, the Mean Time computed depends on the trigger capability to identify the bunch crossing. If the bunch crossing is 1bx earlier, the drifts times recorded are 25 ns longer so the Tmax is 50 ns later. Analysing data from autotrigger runs taken with different phases, Tmax distributions can yield information on the best phase.When the phase is worst the MT distribution present double peaks.





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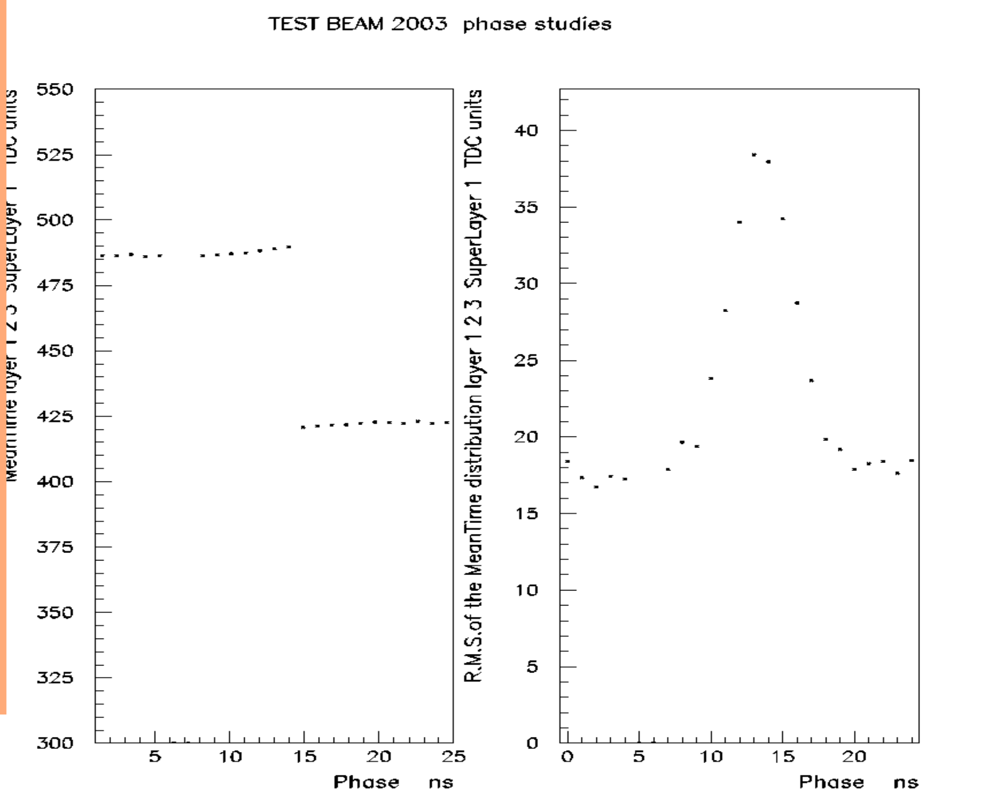
Sync from Test Beam data triggered with the Scintillator

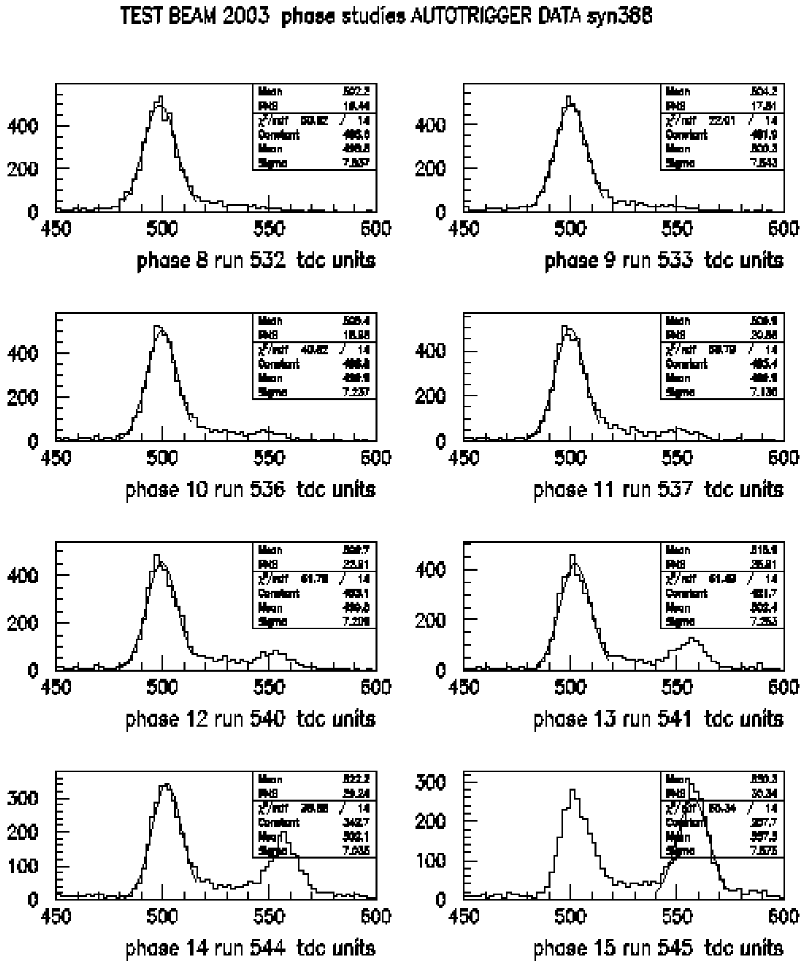
At CMS the clock will be sent by the machine at any chamber with a fixed phase with respect to the pp interactions. A syncronisation will be performed with autotrigger data in order to find the best phase in any chamber.

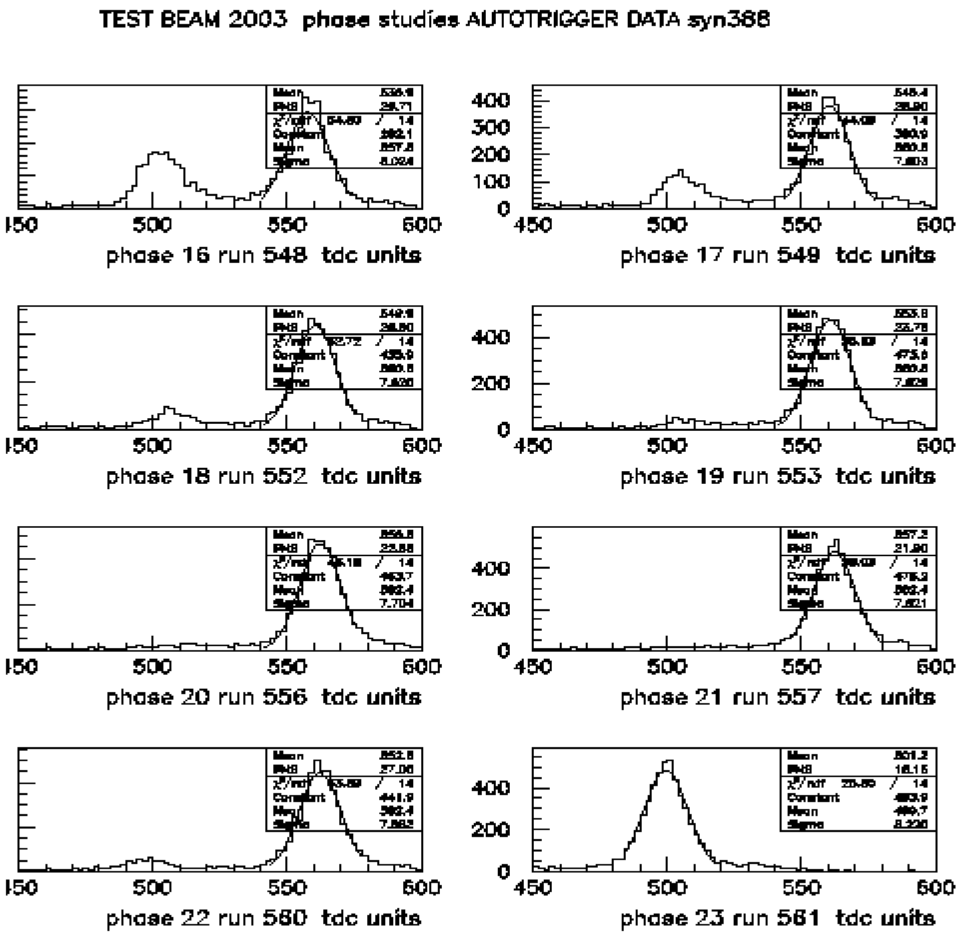
The TDC data in normal runs are displaced in time of the slot difference between the 'correct slot' and the slot of the first soft autotrigger found. In the plots the most probable MT and the RMS of a predefined MT range are plotted as a function of the phase.



The TDC data of normal runs are displaced in time of the slot difference between the 'correct slot' and the slot of the first soft autotrigger found. In the plots the most probable MT and the RMS of the MT distribution within a predefined MT range are plotted as a function of the phase.

Tmax: T beam auto runs phase





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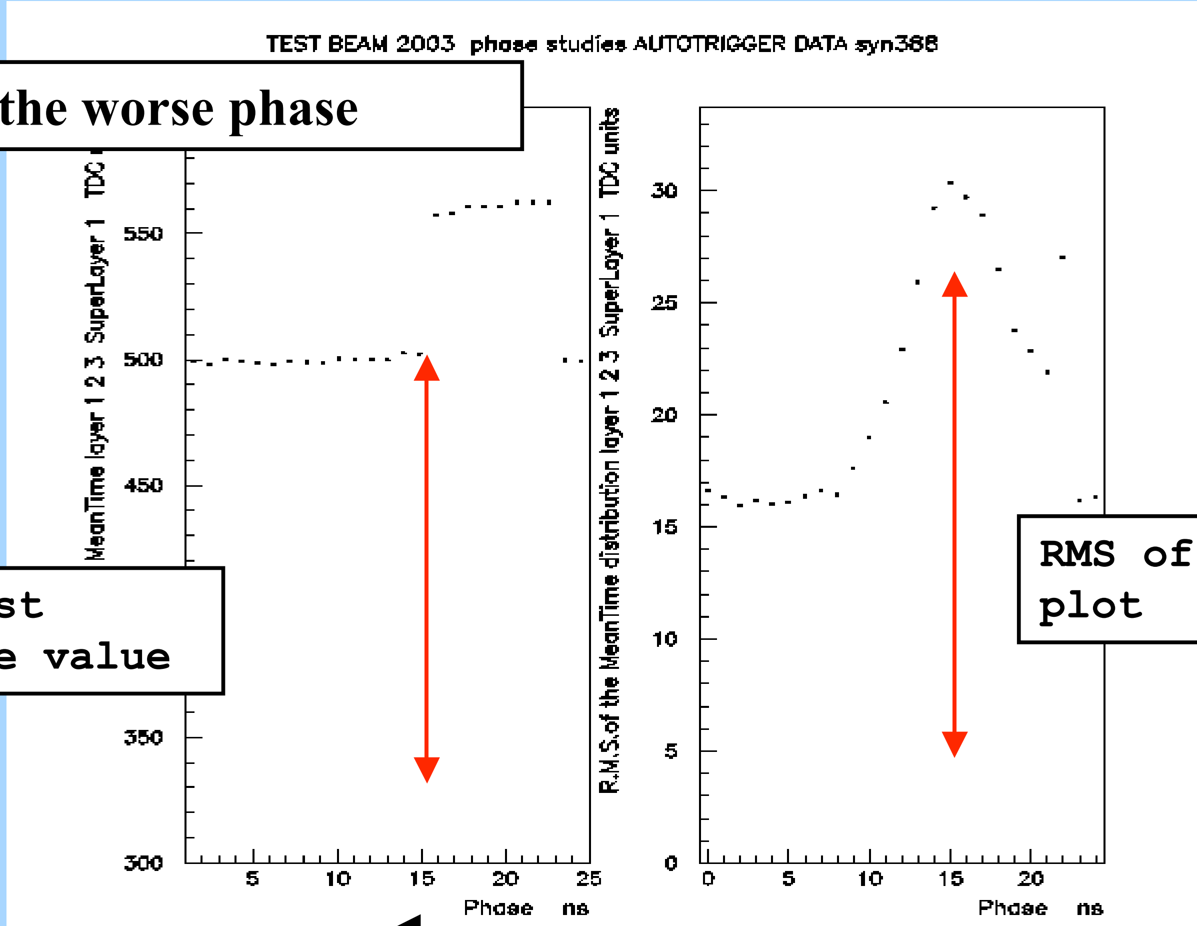
Best phase:from Tmax and RMS of Tmax distribution

It is easier to find the worse phase



Tmax most probable value

RMS of Tmax plot

In these data the worse phase is 15ns, so the best phase is 2 ns

Syncronisation : conclusions

autotrigger data can be used to develop a SYNCRONISATION strategy ***but***

-They are taken at only one incident angle

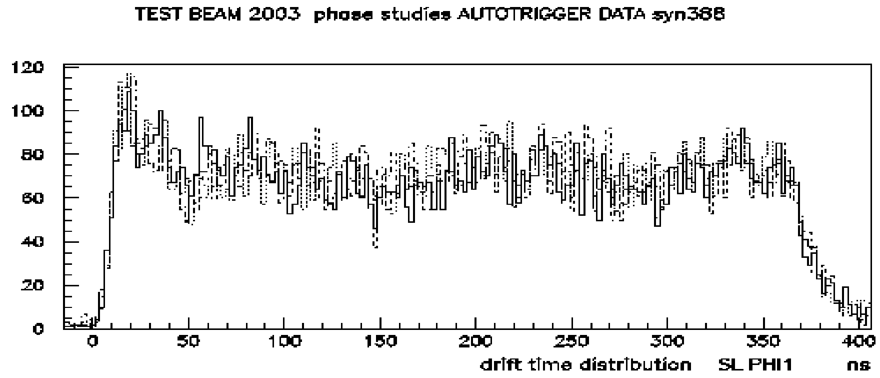
-They are taken with just one set up

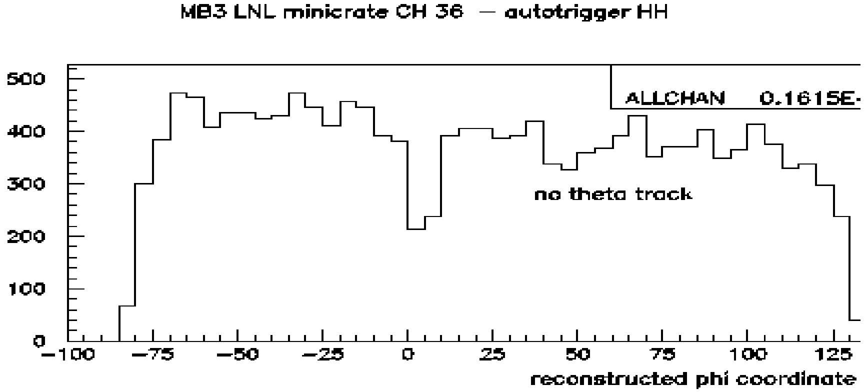
It must point out that >

Data taken with scintillator trigger allow also the development and comparison of a strategy in order to set up an algorythm for syncronisation in the offline code.

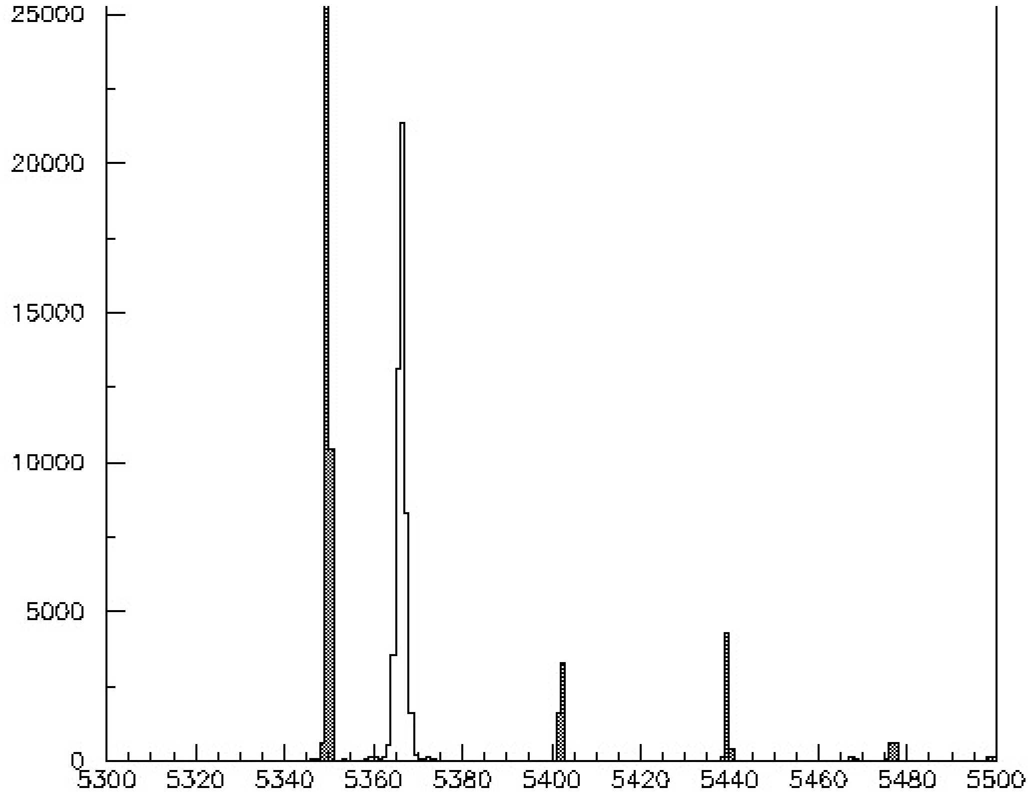
end

END

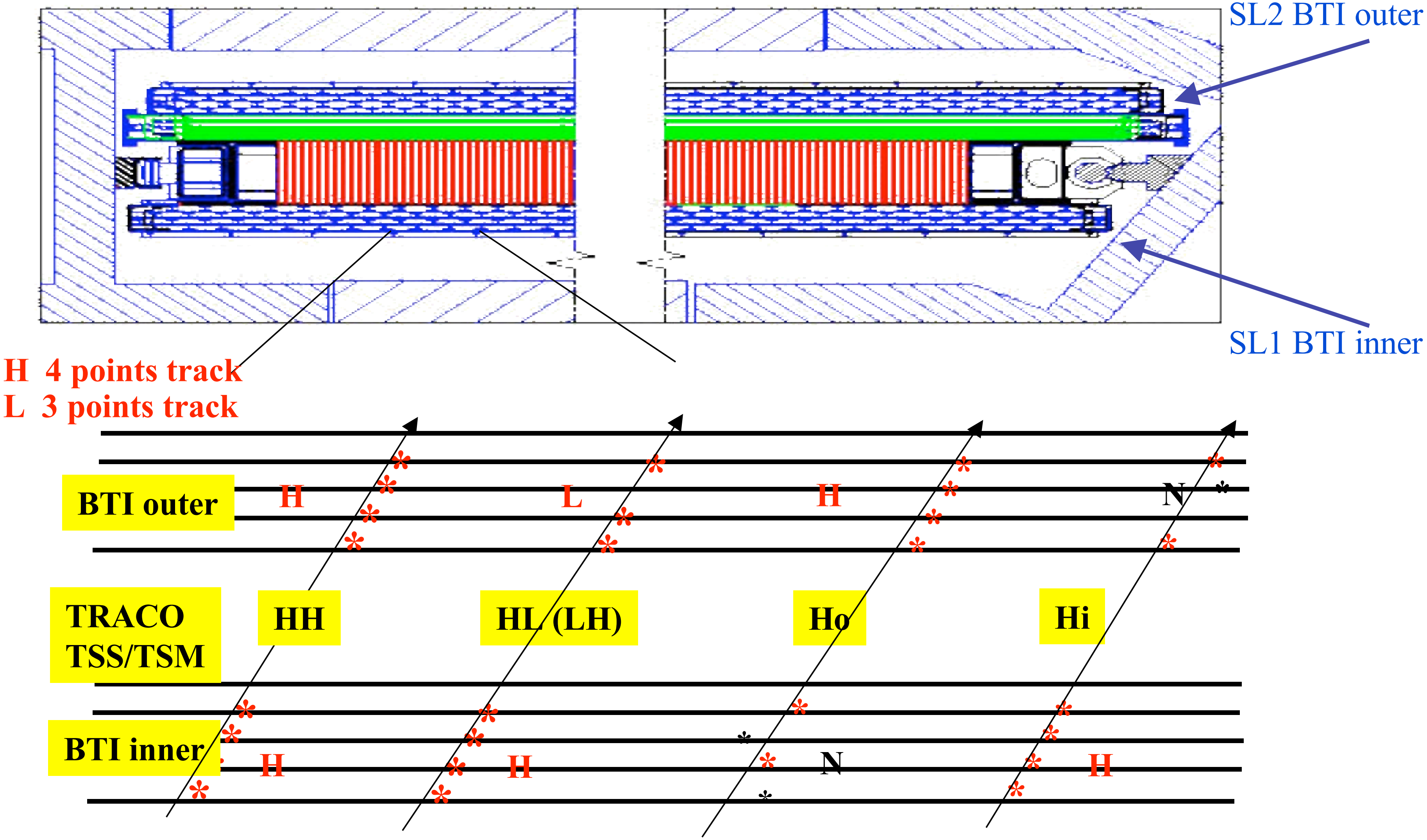

TEST BEAM 2003 phase studies AUTOTRIGGER DATA syn388
120
100
80
60
40
20
0
0
50
100
150
200
250
300
350
400
drift time distribution SL PHI1 ns


MB3 LNL minicrate CH 36 — autotrigger HH
500
400
300
200
100
0
ALLCHAN 0.1615E-
no theta track
−100
−75
−50
−25
0
25
50
75
100
125
reconstructed phi coordinate


Empty
theta reconstructed and no phi track
x

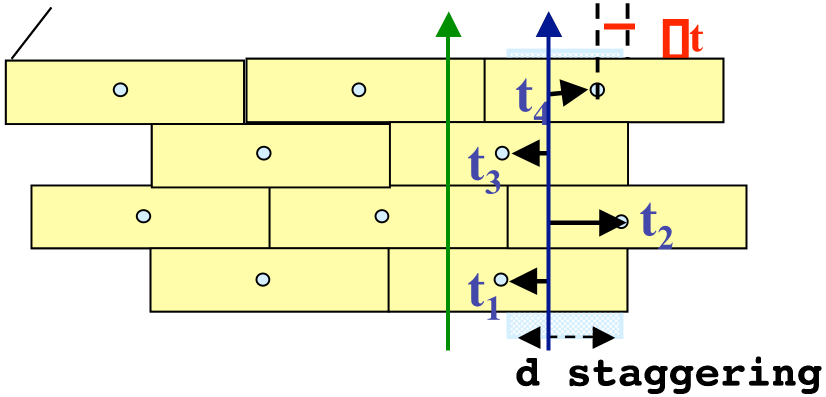

25000
20000
15000
10000
5000
0
5300
5320
5340
5360
5380
5400
5420
5440
5460
5480
5500

MB DT Chambers: 1st Level Trigger



MT: Layer displacement

Example: layer 4 displaced of dx



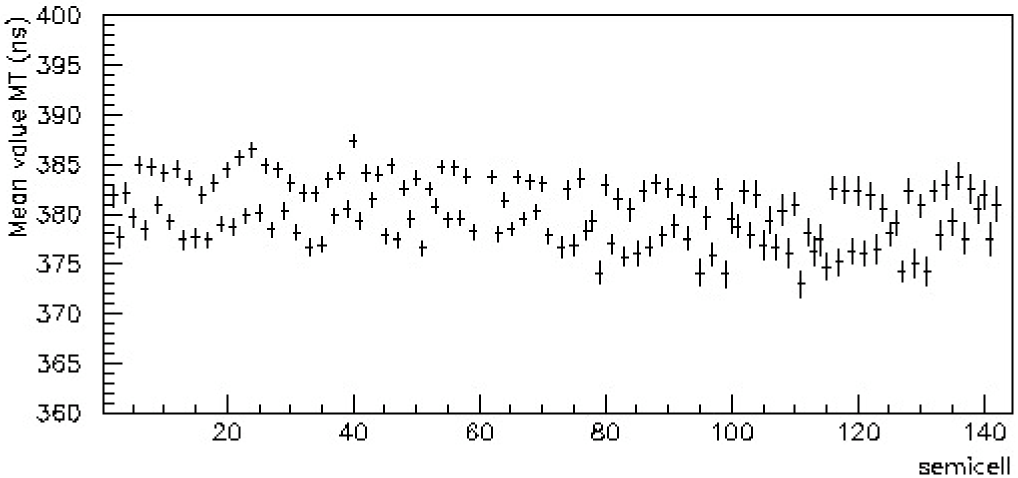
$$MT_{234L} = \frac{t_2 + t_4}{2} + t_3 < T_{max}$$

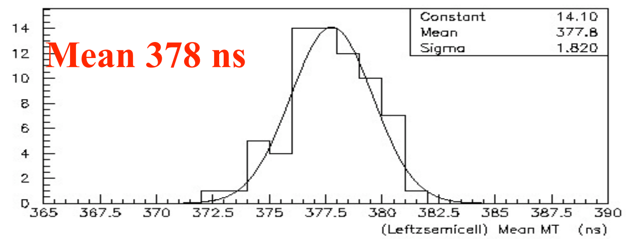
$$MT_{234R} = \frac{t_2 + t_4}{2} + t_3 > T_{max}$$

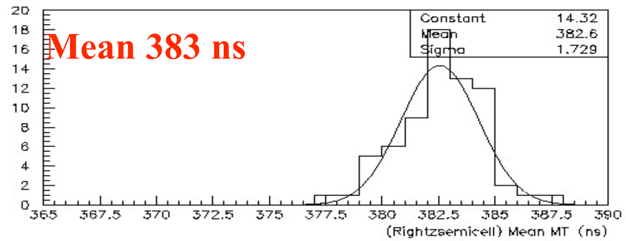
Δt = (MT_{234R} - MT_{234L}) using the mean value of all MT_{234} ->good accuracy

Layer 4 displacement -> Δx =Δt * vdrift

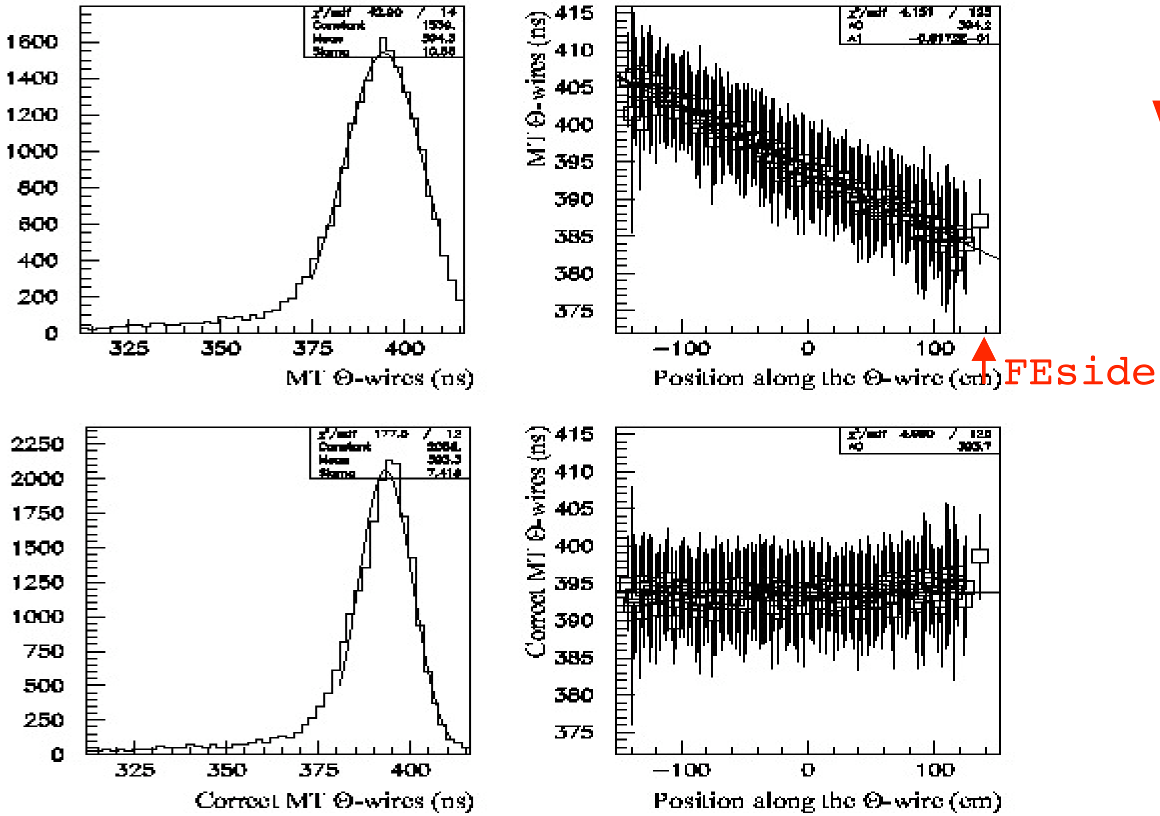
$$MT_{123L} = MT_{123R} = \frac{t_1 + t_3}{2} + t_2 = T_{max}$$







Measurement of the signal propagation along the wire

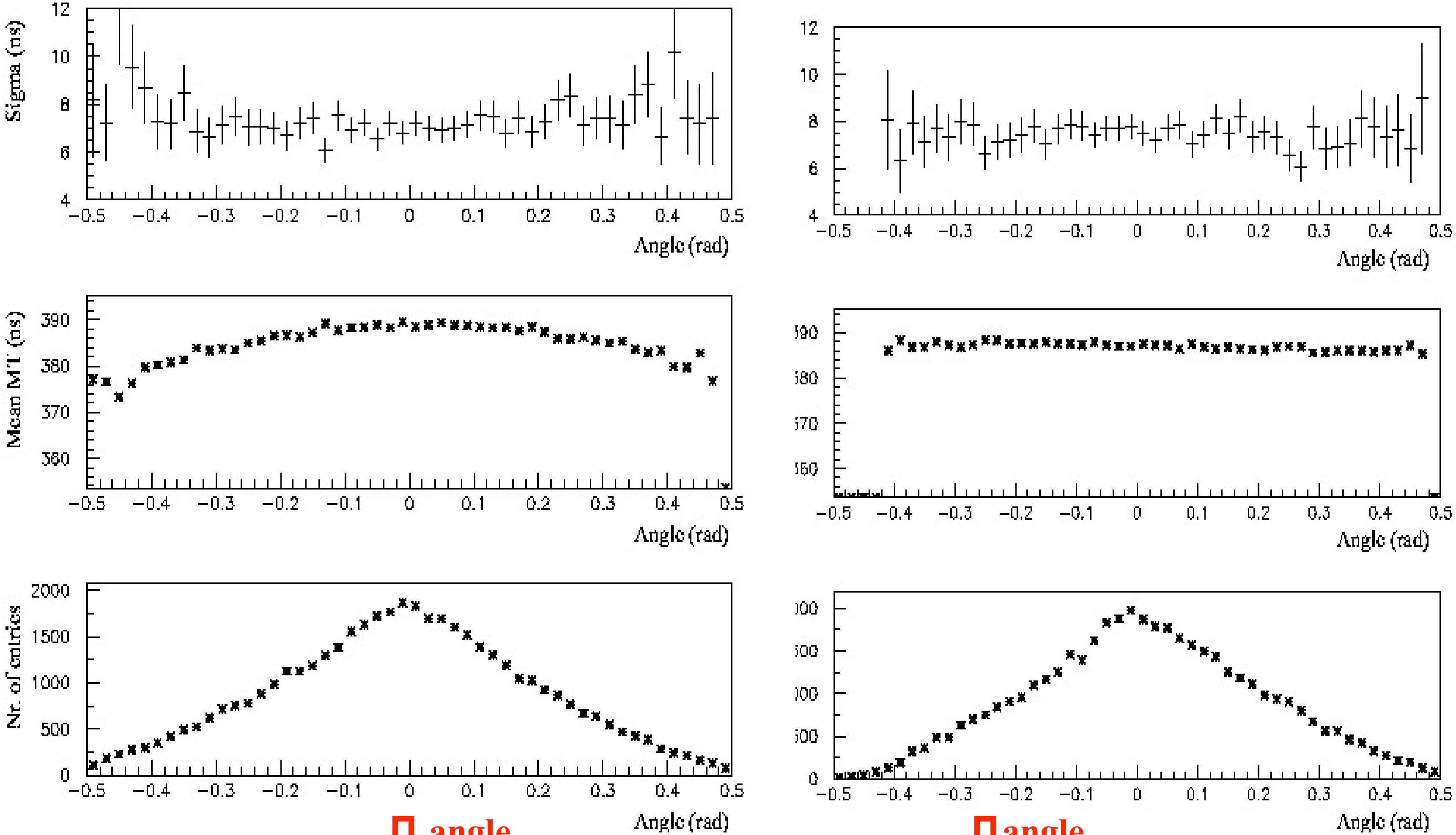


v_{signal}=0.244 m/ns

v_{drift}=21/378=0.55□m/ns

MT vs angle

The apparent drift velocity grows with □ angle;it is constant for □



□ angle □angle