Dependence of the trigger efficiency with the muon energy on TB04 Some Ideas

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Motivation

Studies of the trigger efficiency as a function of the muon energy had been already shown during the last CMS week (see test beam talks from Enrico and Stefano).

It was found that the trigger efficiency decreases with the energy. This is very suprising because there are not reasons for that.

In order to understand this behaviour, a detailed study of these data was performed looking for reasons of this inefficiency.

It was found that there are differences in between the runs that are not coming from the energy of the muon.

Therefore, it might be that the differences on the efficiency were not associated to the energy of the muon itself but to the "conditions" of the runs.

The results obtained for different runs with the same energy (100GeV) also show some differences on the trigger efficiency from run to run. Again the "conditions" of the runs seem to be slightly different.

Event Selection

Each chamber (MB1, MB3) was analyzed independently

For each chamber two different event samples have been used:

A) Events with one track (3 or 4 hits) on AT LEAST one of PHI SLs
B) Events with one track (3 or 4 hits) on BOTH PHI SLs.

In both cases we select events with NO SECOND muon.

Efficiency vs Energy

We call Eff_A : efficiency for sample A (red)
Eff_B: efficiency for sample B (blue)

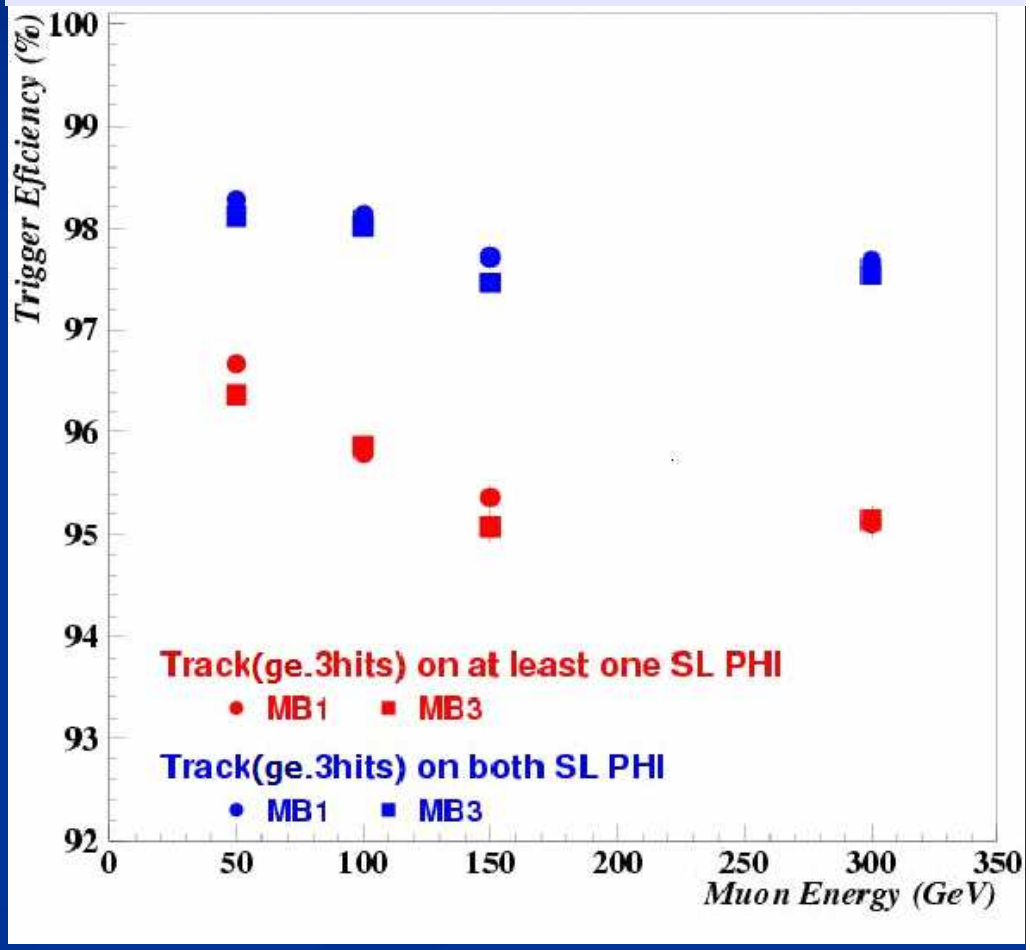
The same behaviour is observed in both chambers.

In both samples the efficiency decreases with the energy.

BUT

the effect is bigger on the sample A

~ 1.39% vs ~0.58%



Let's first look for the reasons of the differences between both samples

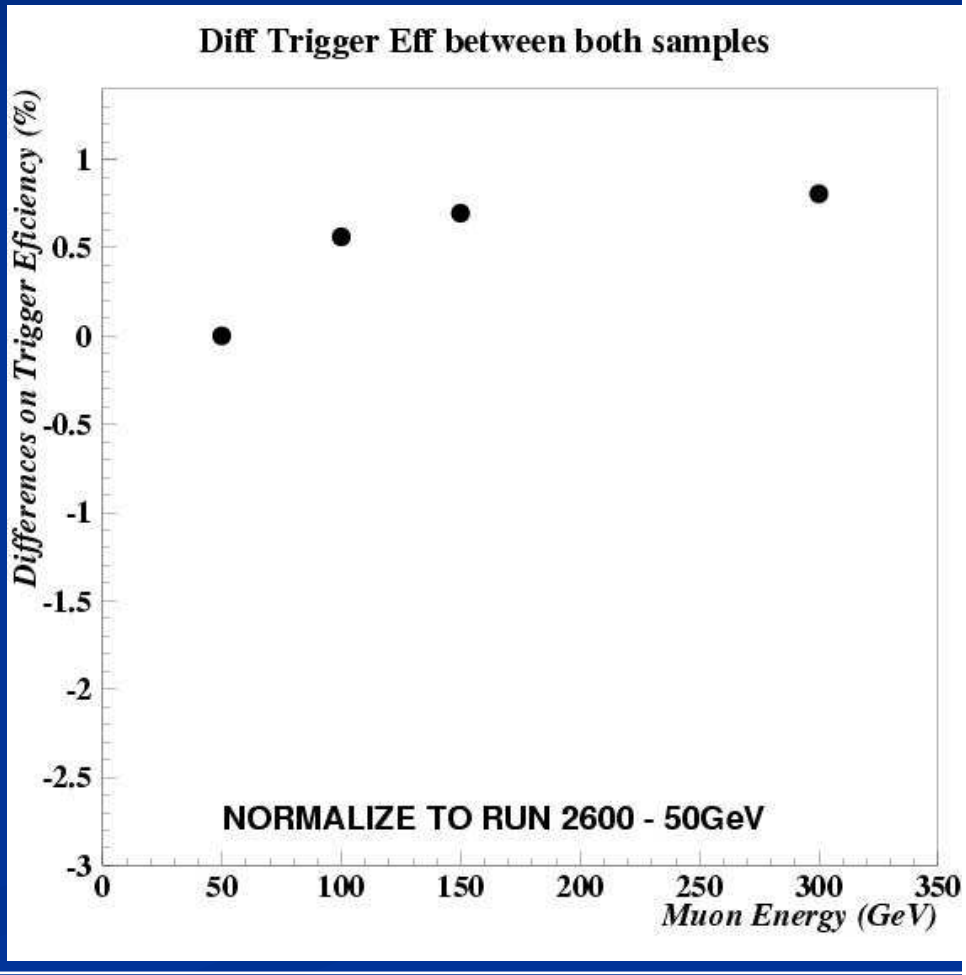
Differences between both samples (I)

By computing the differences on efficiency between both samples

Diff_Eff = Eff_B - Eff_A

The difference increases with the energy

(Values are normalized to Diff_eff(50GeV))



Differences between both samples (II)

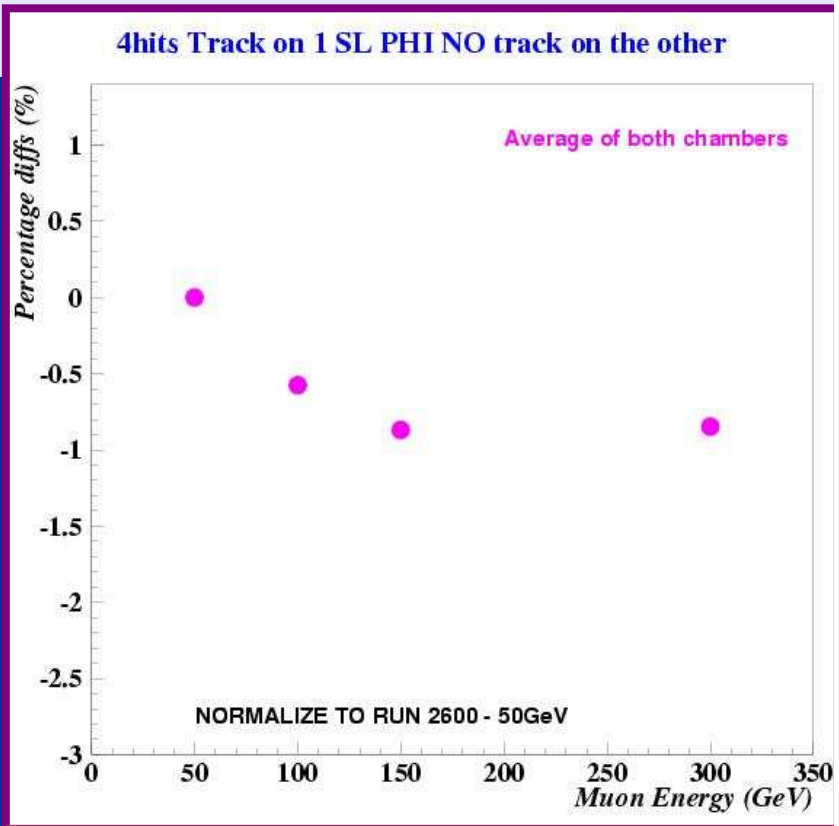
In order to understand the differences we look to the data going on Sample A that are not present on Sample B:

Tracks with 1 track on ONLY 1 of the PHI SLs

(They represent about the 3% of events)

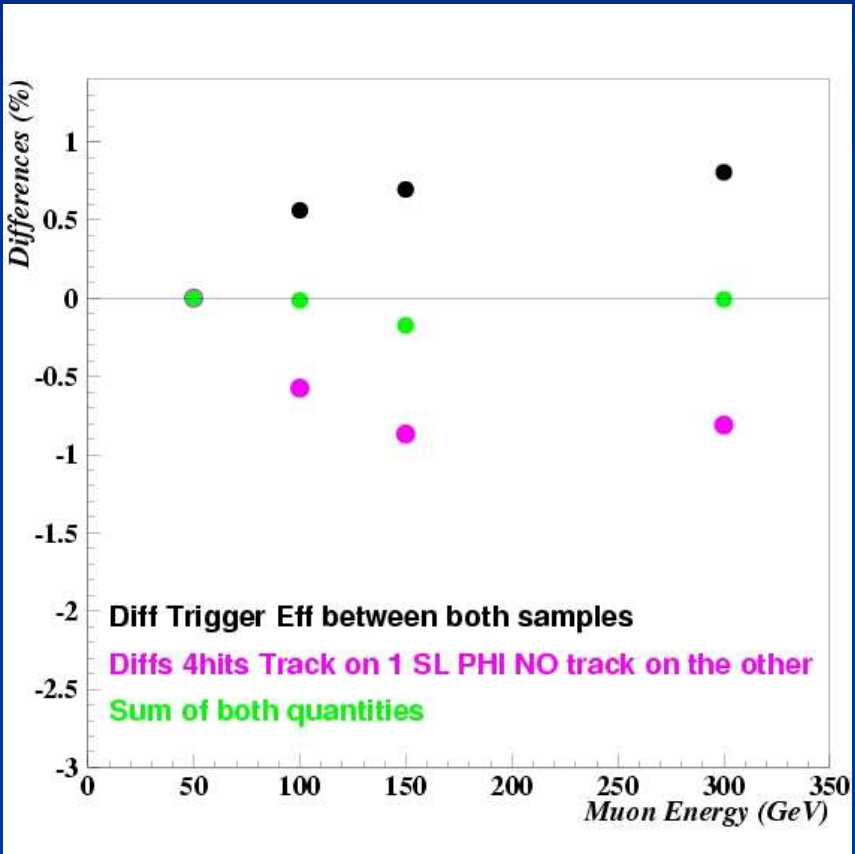
Looking to the quality of these events the percentage of 4hits track is

Run	Energy		PHI2	PHI1
2600	50GeV	MB1	83.88%	84.76%
		MB3	80.72%	76.27%
2555	100GeV	MB1	68.29%	68.13%
		MB3	69.66%	73.57%
2597	150GeV	MB1	66.11%	69.81%
		MB3	62.79%	57.19%
2551	300GeV	MB1	61.93%	60.80%
		MB3	66.33%	66.12%



Percentages respect to the TOTAL number of events and normalized to the 50GeV run

Differences between both samples (III)



The differences on the trigger efficiencies are "compensated" by the deficits on the 4hits tracks

BUT

Which is the reason of this deficit on 4hits tracks?

How it can be related to the muon energy ?

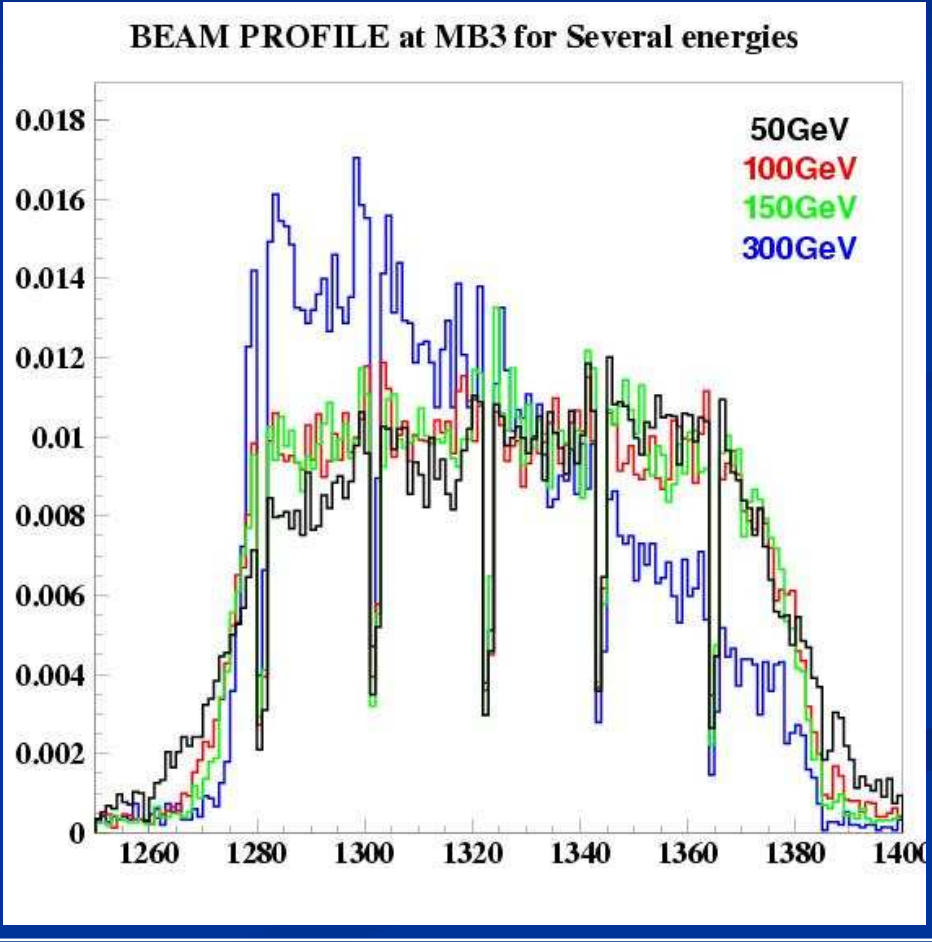
Reasons for the differences between both samples (I)

There are not reasons for a dependence of "missing" 4hit tracks with the energy:

Could be found the reasons on the beam "itself"?

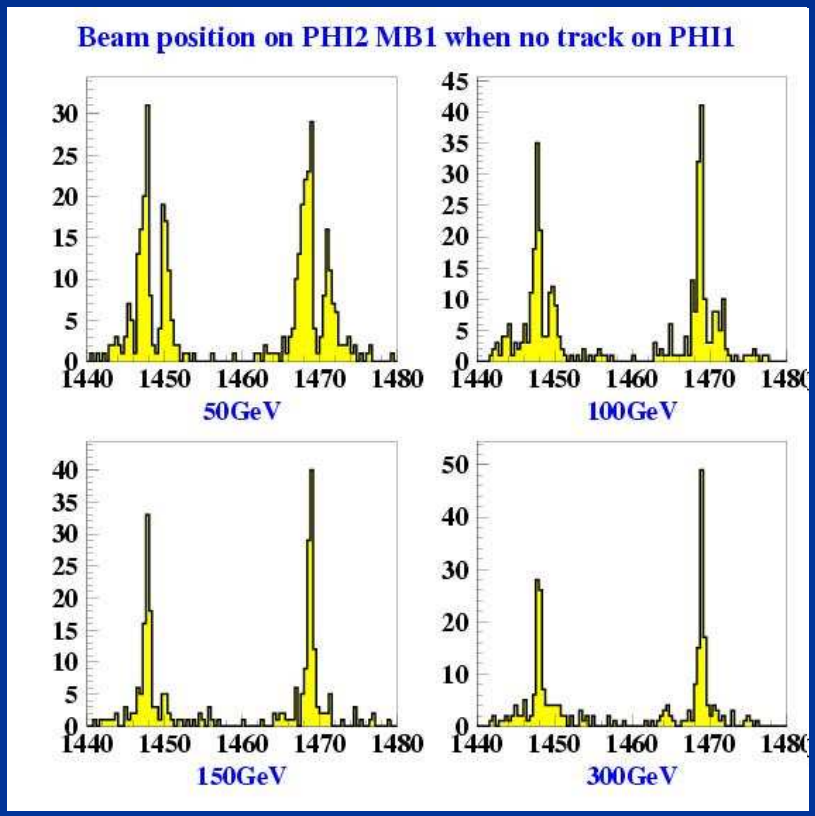
In fact, the profile is different for different energies.

Which other differences can be found by looking to the chamber results ?

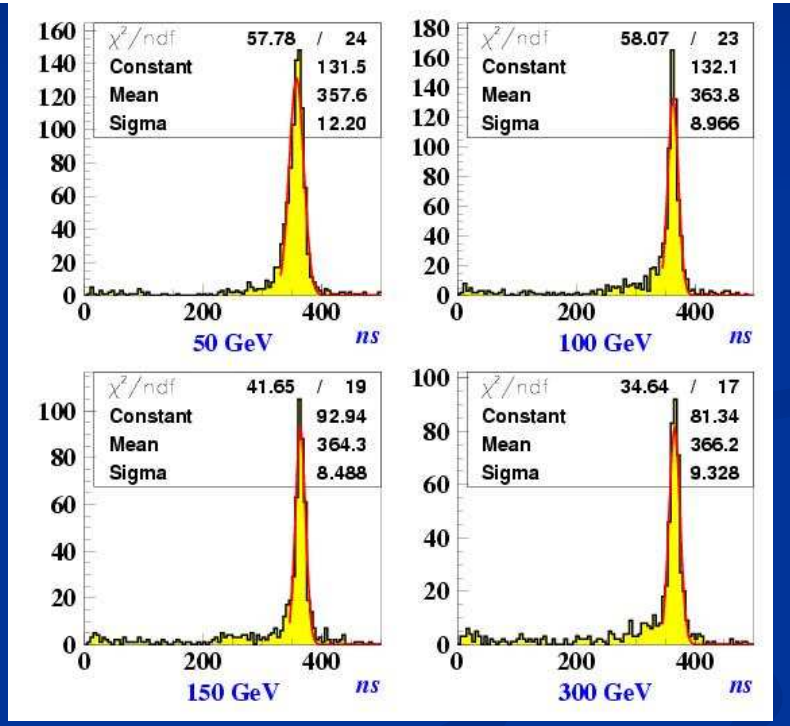


Reasons for the differences between both samples (II)

Looking to the beam position on SL PHI2 when no track in PHI1 was found.
(Most of events are near the I-beam region)



For each of these events we plot maximum time out of the 3-4 hits on the track



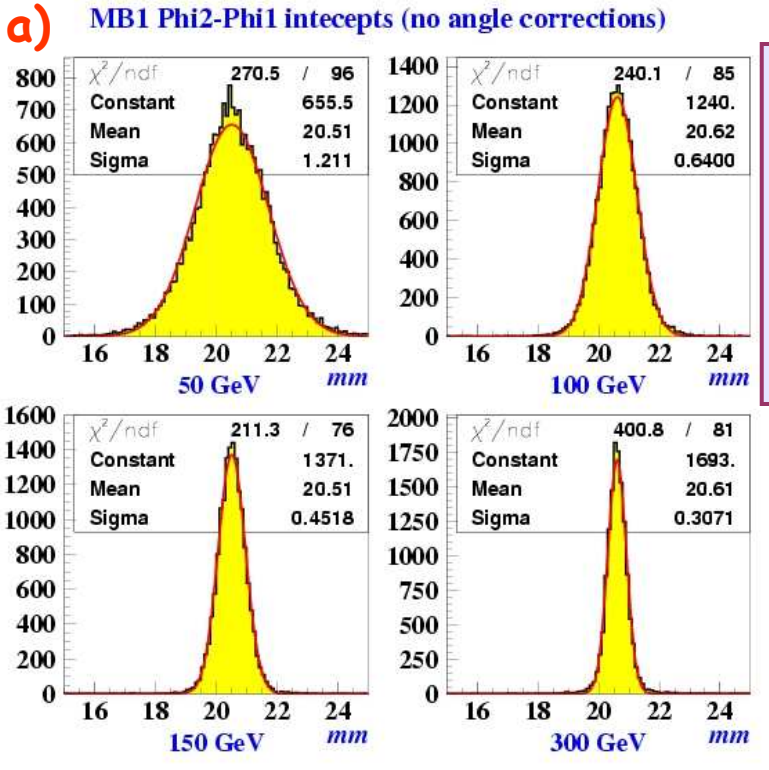
At 50 GeV the value is lower than for 300 GeV
➔ the distance to the Ibeam is bigger.
Then the probability of having 4hits must be also bigger for 50 GeV

Reasons for the differences between both samples (III)

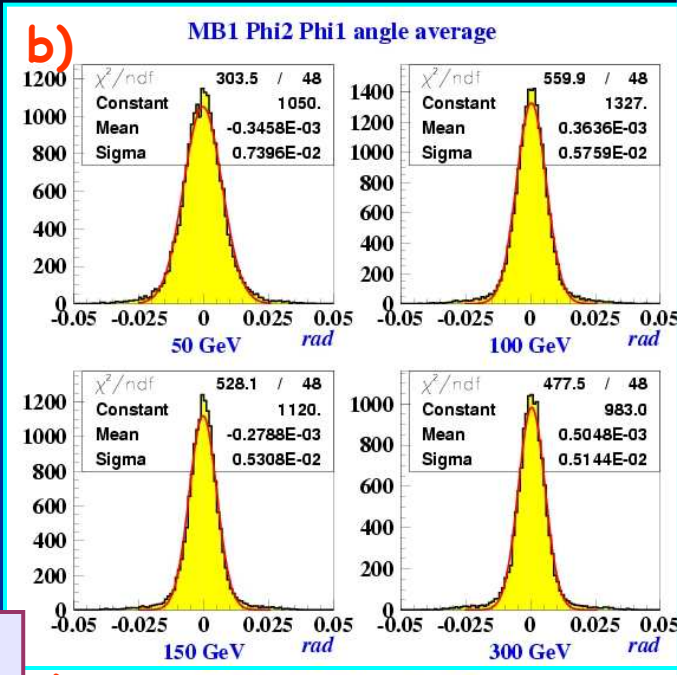
By fitting tracks independently on each SL we plot:

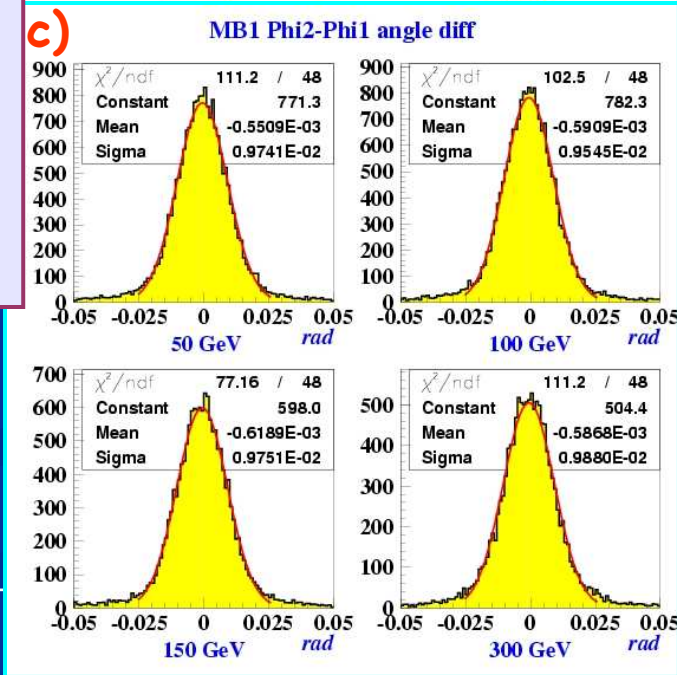
a) Intercept on PHI2 – Intercept on PHI1
b) Angle Average= 0.5*(Angle PHI2 + Angle PHI1)
c) Angle Diff = Angle PHI2-Angle PHI1

Sigma values of a) & b) decrease when energy increases

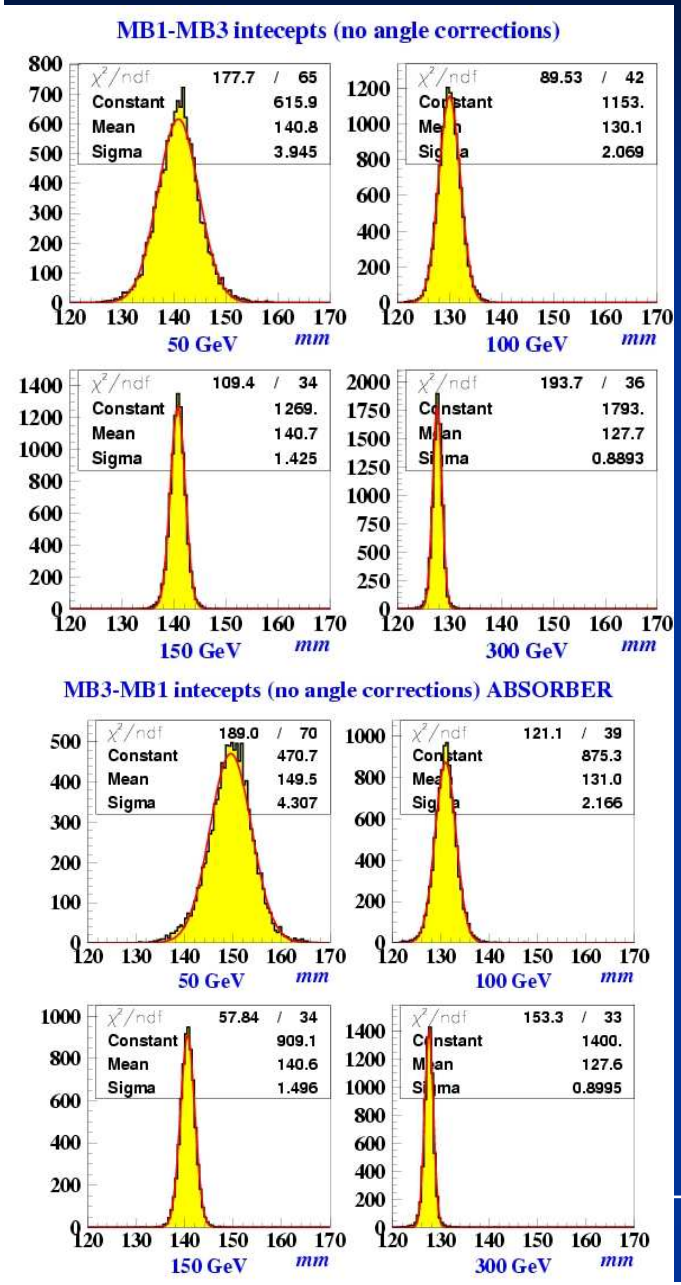


The angular dispersion of the beam seems bigger for low energies

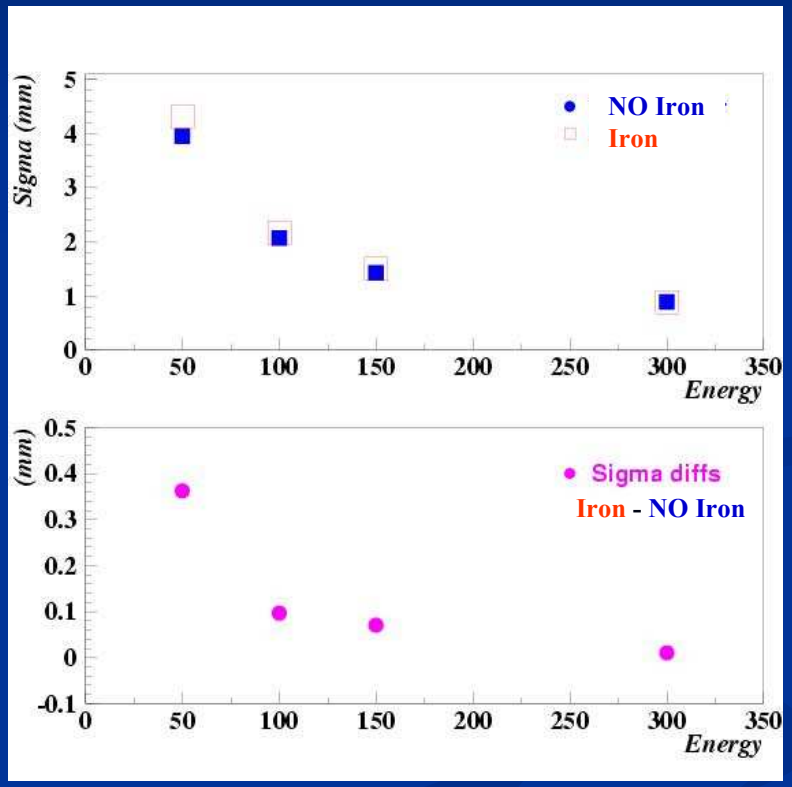




Reasons for the differences between both samples (IV)



Let's compare results without/with iron
Comparing the intercepts on both chambers.



The dispersion increases with iron but the effect is small.
The differences must come from the beam itself

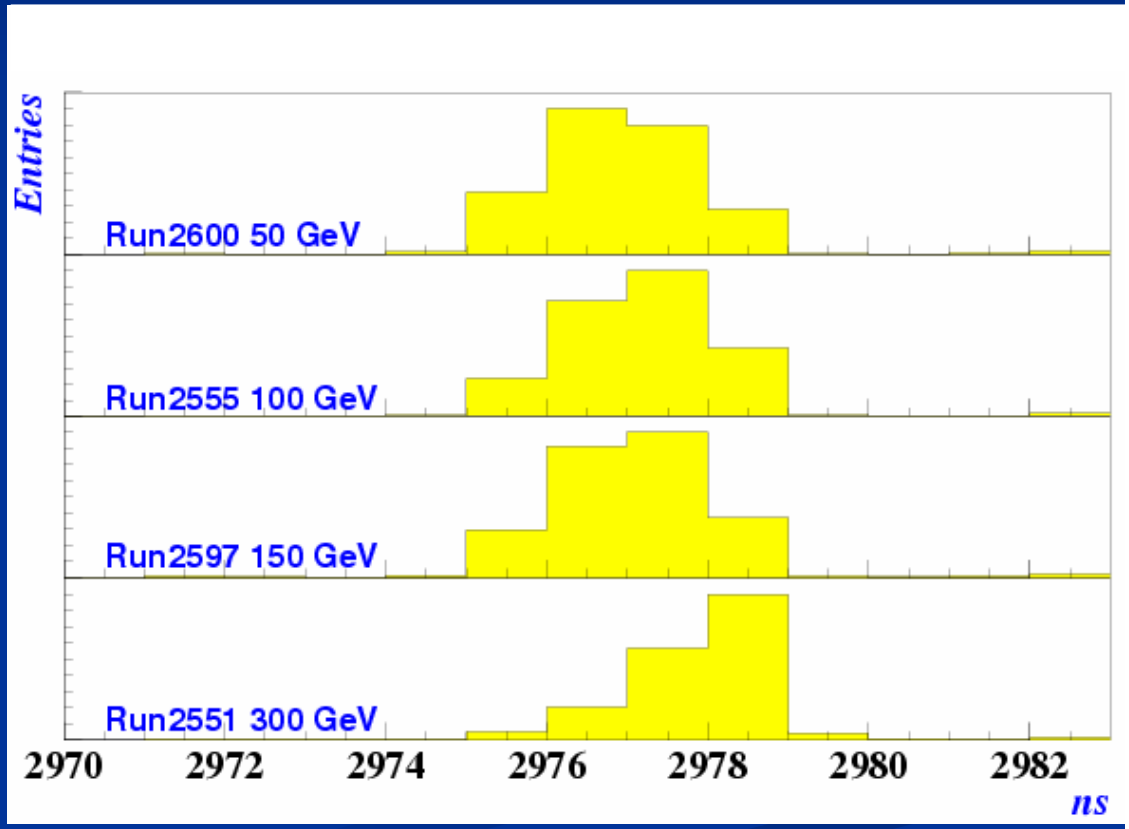
There are "beam differences" that perhaps can explain part of the trigger inefficiency

BUT

Nevertheless there is still a difference between 50 and 300 GeV of about 0.58%

Times registered for external trigger

By looking to the time of the external trigger (scintillators) registered on the ROB, variations of some ns were found.



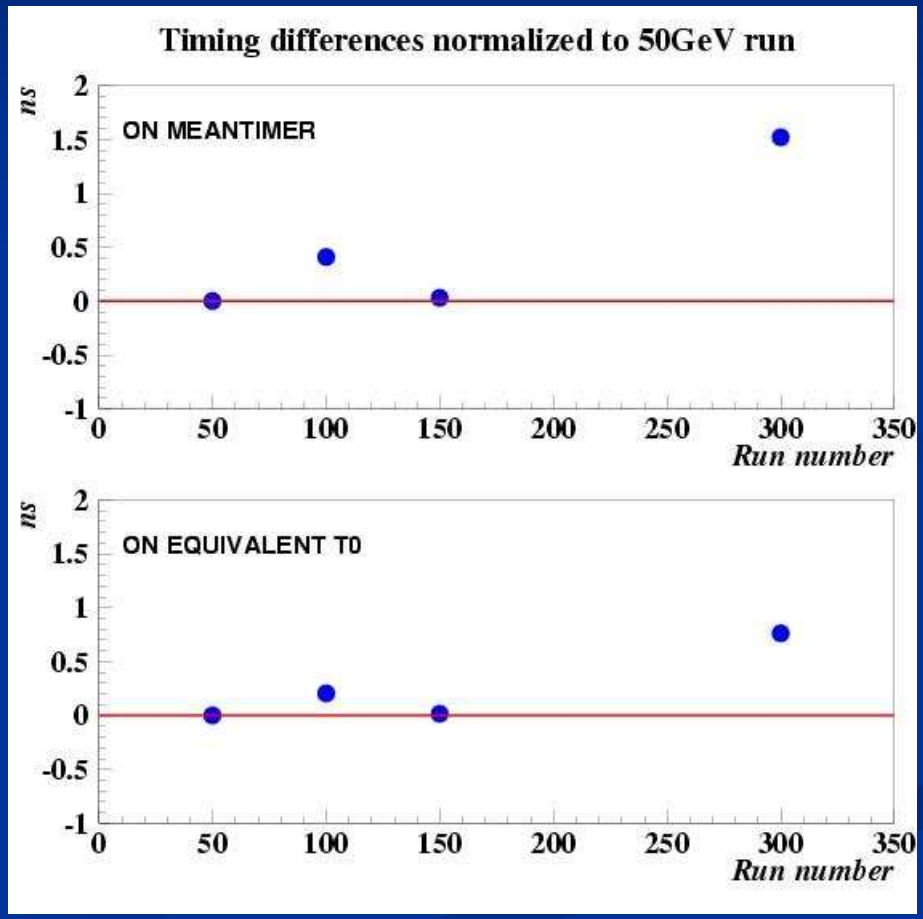
Timing Differences

If we compute meantimers for the different runs using the same T0s and without correct the data with the scintillator trigger time a difference of 1.8 ns for run at 300GeV is obtained.

This correspond to a T0 variation of 0.9 ns

This effect is equivalent to a change on the synchronization of the trigger.

This can introduce differences on the trigger efficiency



To understand the differences on efficiency due to the synchronization let´s take a look to the phase scan runs (beam type).

Data corresponding to R2612-2638 will be used.

(In this case MB3 was rotated an angle of 19.5 degrees.)

Timing and Phase runs (MB1)

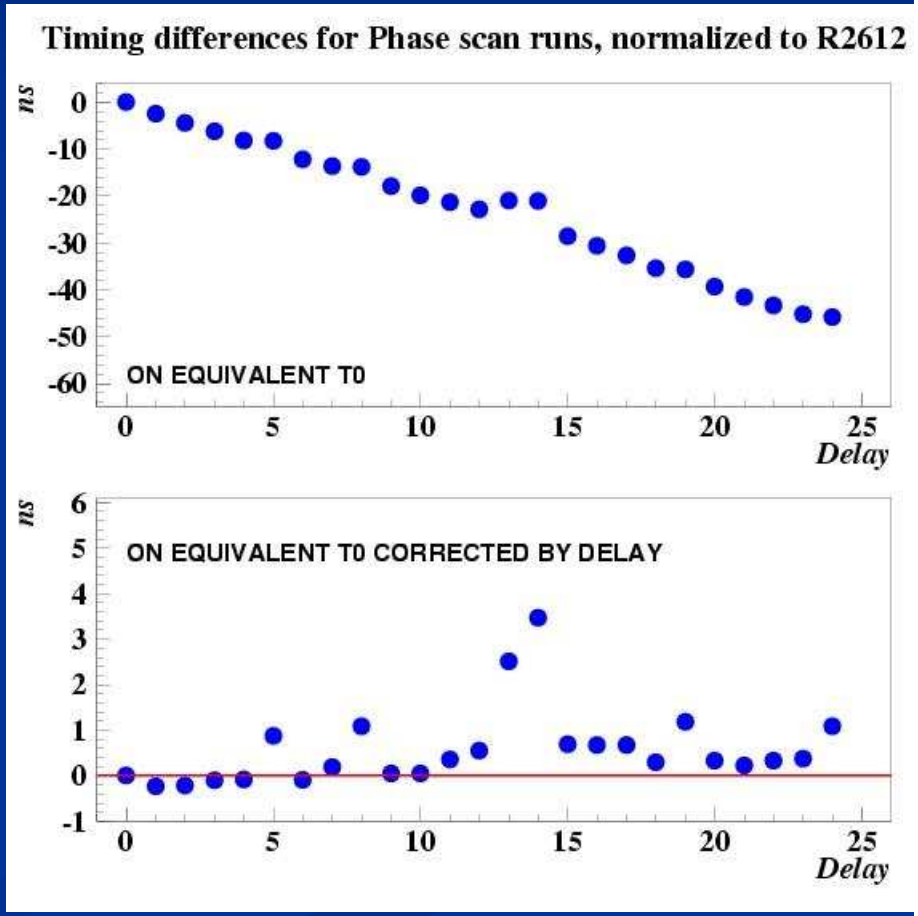
By using the same T0 for all the runs, we can calculate the T0 variations extrapolating from the meantimers value.

Upper plot shows the T0 differences normalized to the first run (delay = 0) for Chamber MB1

It was found (as expected) differences of about 1 ns between 2 consecutive runs

There are some deviations, as can be showed on the figure on the bottom, where we plot

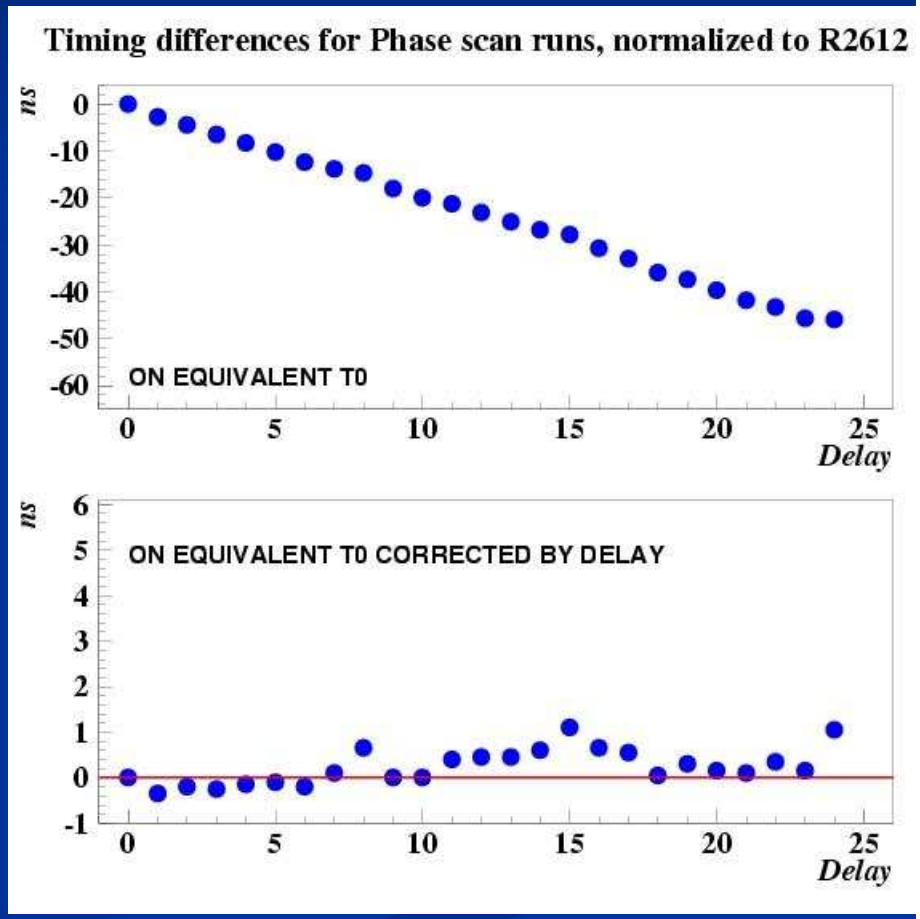
T0 diff - delay



Timing and Phase runs

BUT, If we make the same for Chamber MB3

The "big" deviations of ~3-4ns found on MB1 for delays 13 & 14 are not presented for MB3!!!!



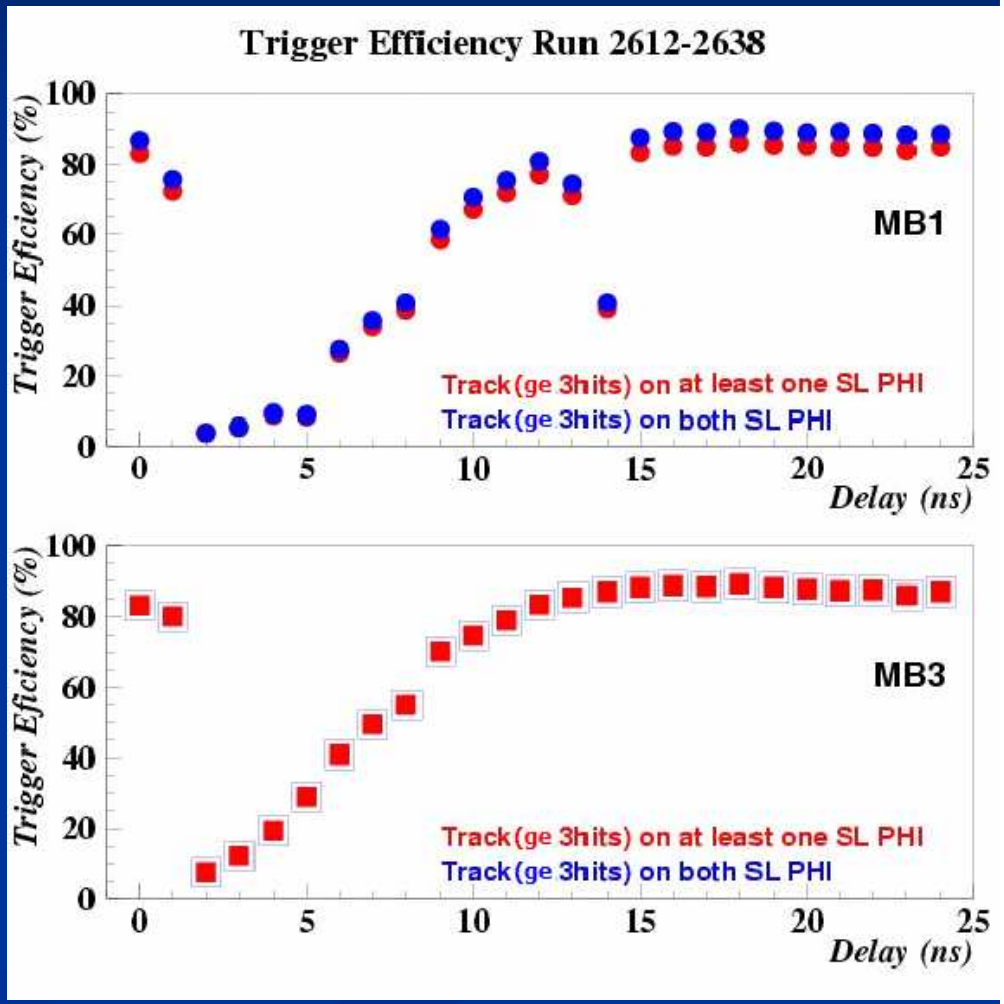
Trigger efficiencies for phase runs

There is, as expected, a variation of efficiency with the delay.

Since MB3 is rotated the effect of I-Beams disappears. Therefore both samples are equivalents.
(ALL muon registered (3-4 hits) on 1 PHI SL is also observed on the other one.)

The "extra" inefficiency for delays 14 & 15 seems to be correlated with "bad" timing found previously
(also some small effects can be seen for delays 5 & 7)

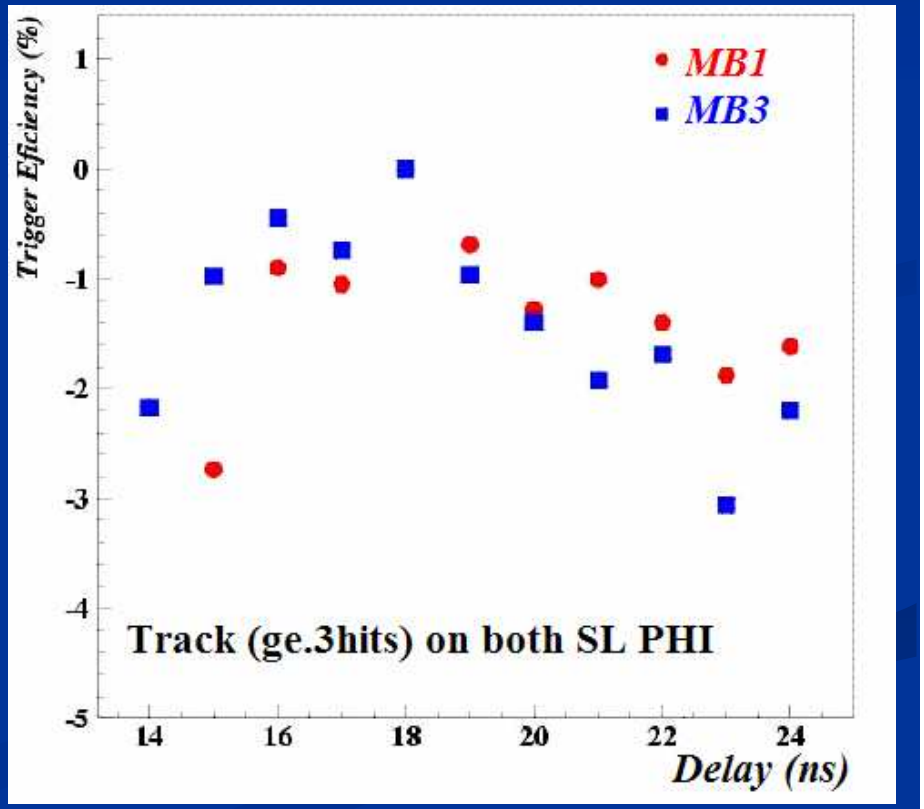
This does not happen to MB3 where no timing variations were found



Trigger efficiencies for phase runs (II)

By making a zoom on the efficiency "plateau zone" and normalizing to delay 18ns (where maximum value of efficiency was found) we see that differences on efficiency of the order of ~0.5-1% are observed by moving 1 ns.

The timing differences observed on energy scan runs can also affect to the efficiency values of those runs.



Trigger efficiency 'fluctuations' for the runs at 100 GeV

Several runs were taken at 100 GeV.

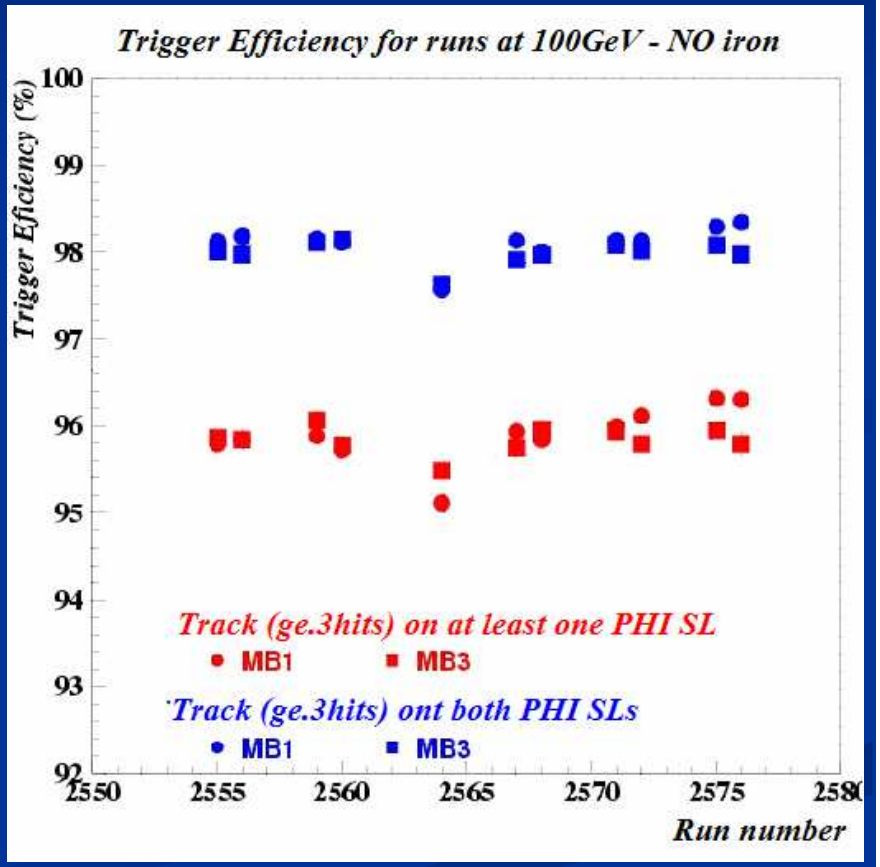
The chamber MB1 was moved but chamber MB3 stays on the same position.

We don't expect, at least for chamber MB3 differences on the efficiency from run tu run

BUT

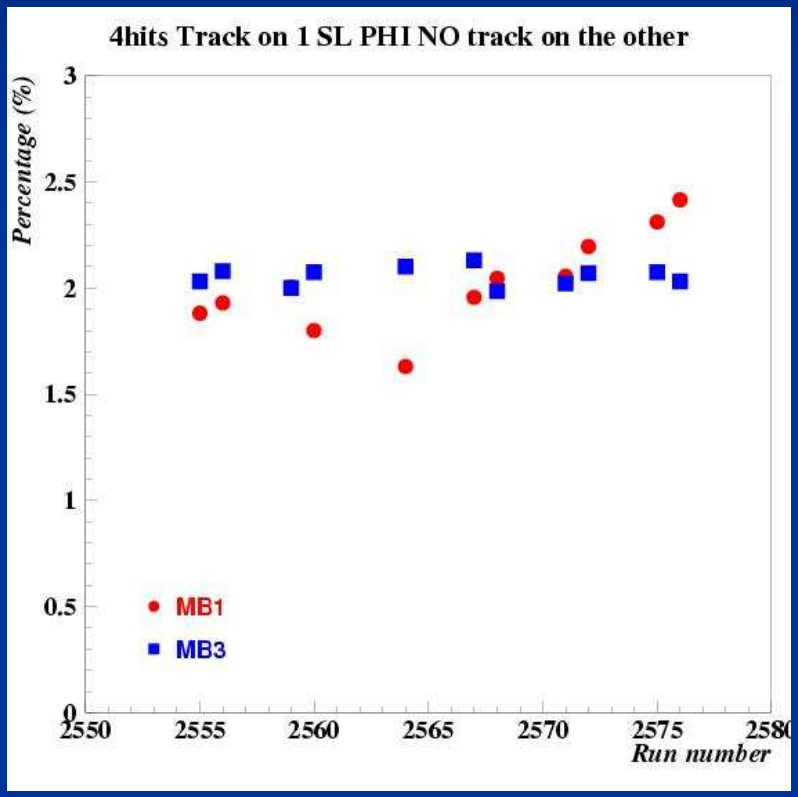
Differences on the efficiency were found

MAX-MIN ~ 1.0 %
MAX-MIN ~ 0.5 %



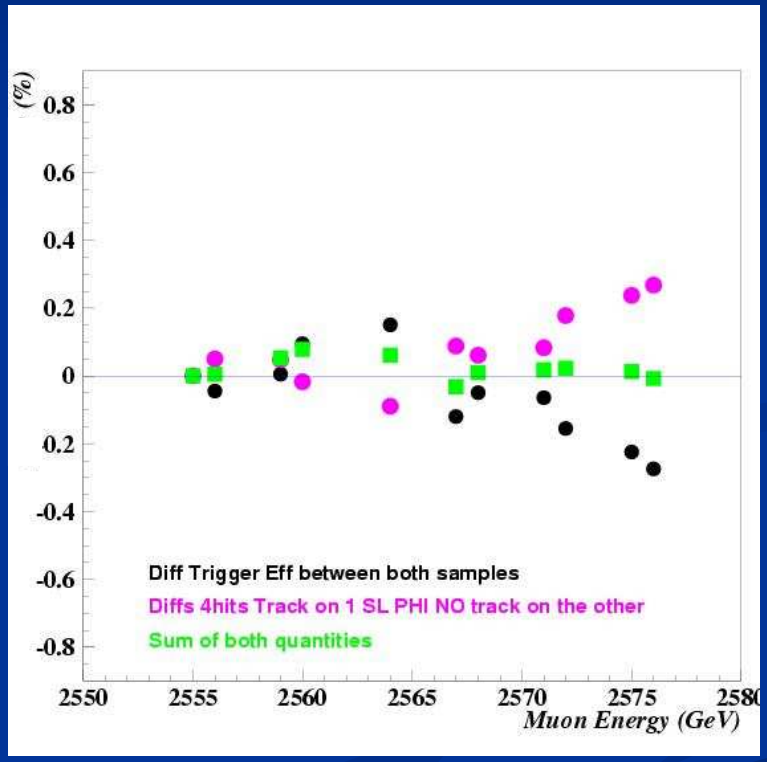
Beam effects on the efficiency for runs at 100 GeV

Looking first to the differences between booth samples



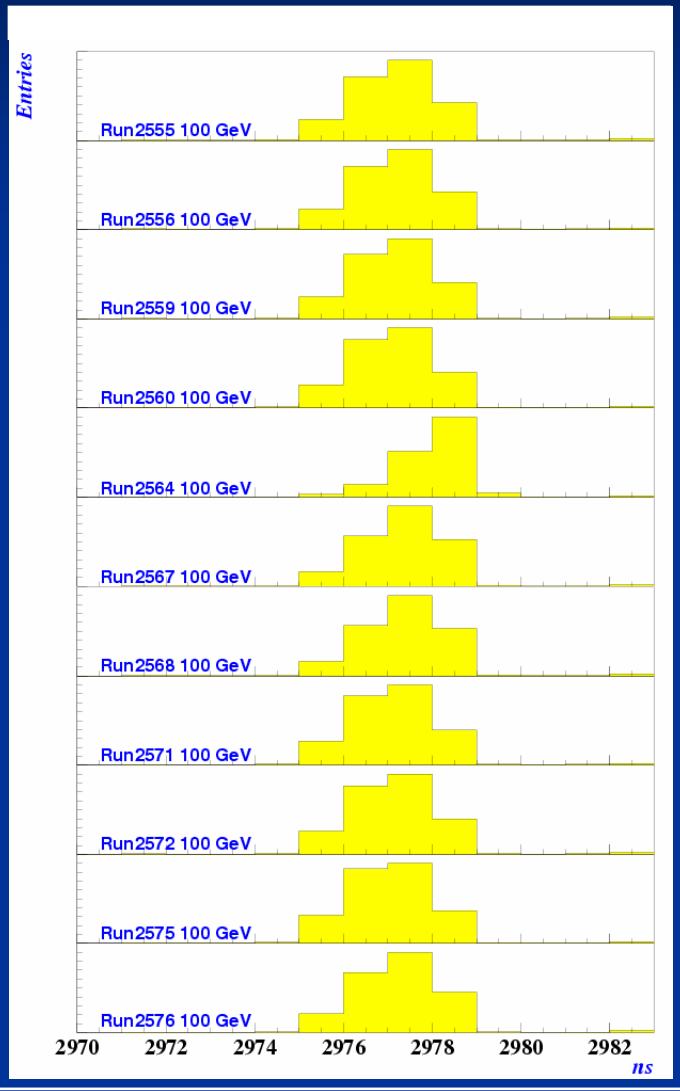
Since MB3 was not moved there are not representative differences but this effect could be observed on MB1.

Comparing with the deficit of 4hits tracks

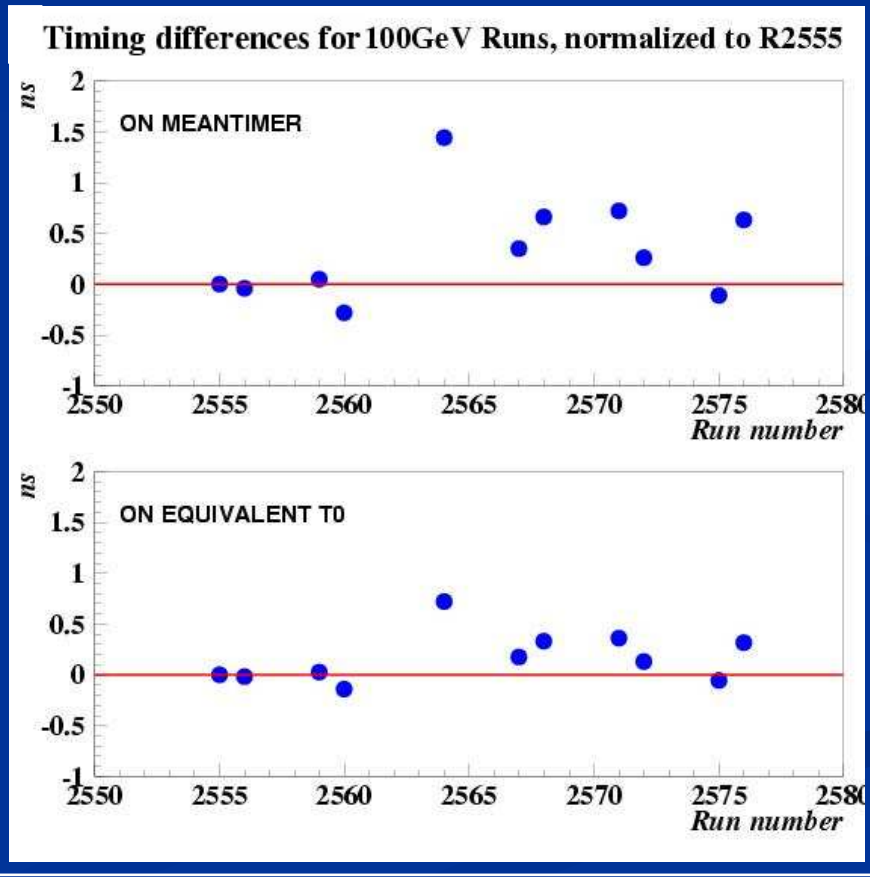


As for the energy scan, the differences on the trigger efficiencies are "compensated" by the deficits on the 4hits tracks

Timing effects on the efficiencies of runs at 100 GeV



Timing differences are found.
For run 2564 a difference of ~ 0.8ns could be the responsible of the lower efficienncy found for this run.



Summary

It was observed that the trigger efficiency decreases with the muon energy but there are no reasons a priori for that.

Looking in detail the data it was observed two types of effects that have influence on the results:

1. The beam seems different for the different energy runs.
2. There are differences on the trigger timing.

Similar effects were found for the 100 GeV runs and the efficiency for 100GeV was different from run to run.

The dependence of the trigger efficiency with energy might be asociated to the "conditions" of the runs and not to the muon energy

Some "timing" problems were observed on different data runs