Cluster efficiency study in the di-muon data

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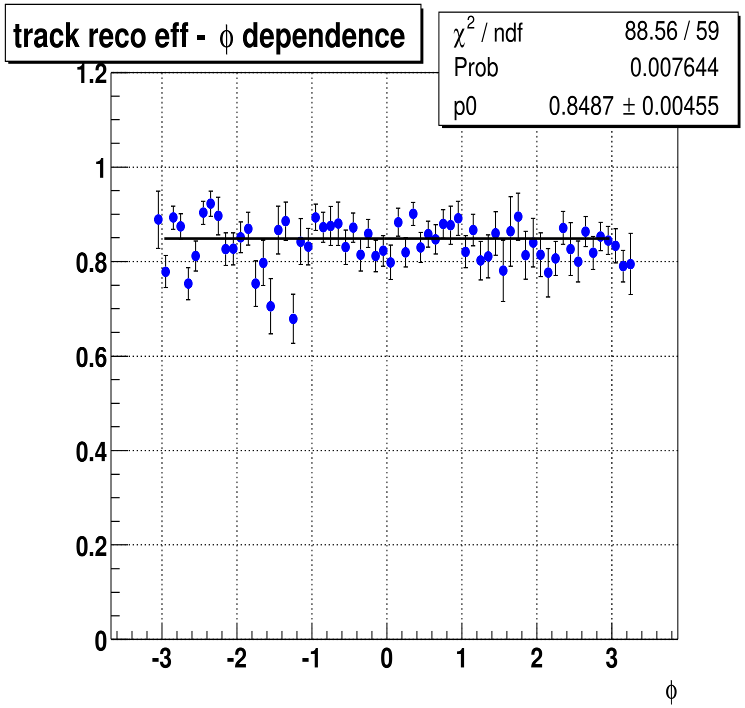
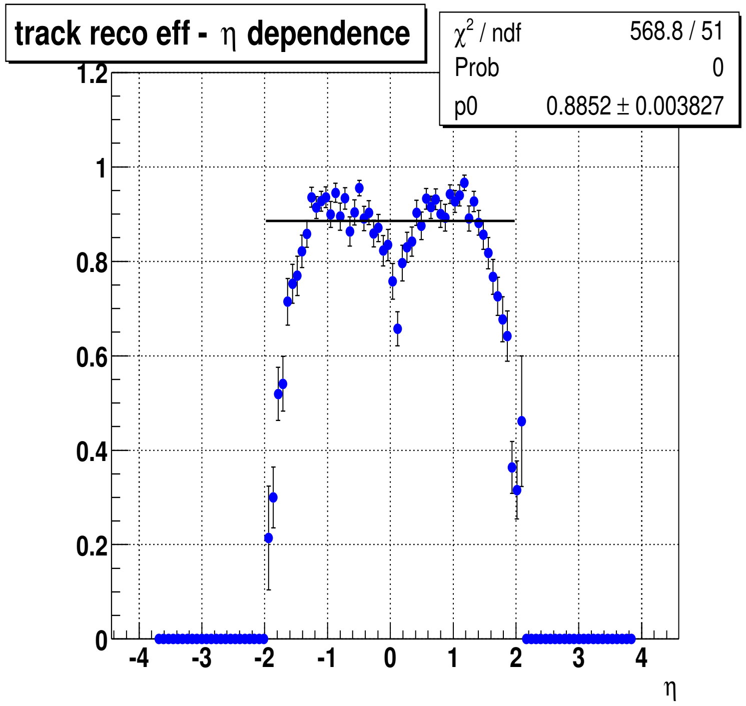
- Di-muon sample - raw data
- Cluster efficiency vs. window size (no. of resolution σ)
- 20 ADC cut applied
- 20 ADC cut removed
- Conclusions

Motivation





Why there is such a dip in η ?

Cluster efficiency is in high 90's and we allow at least 2 misses in p13.

Could we do something about it ?

Dimuon sample

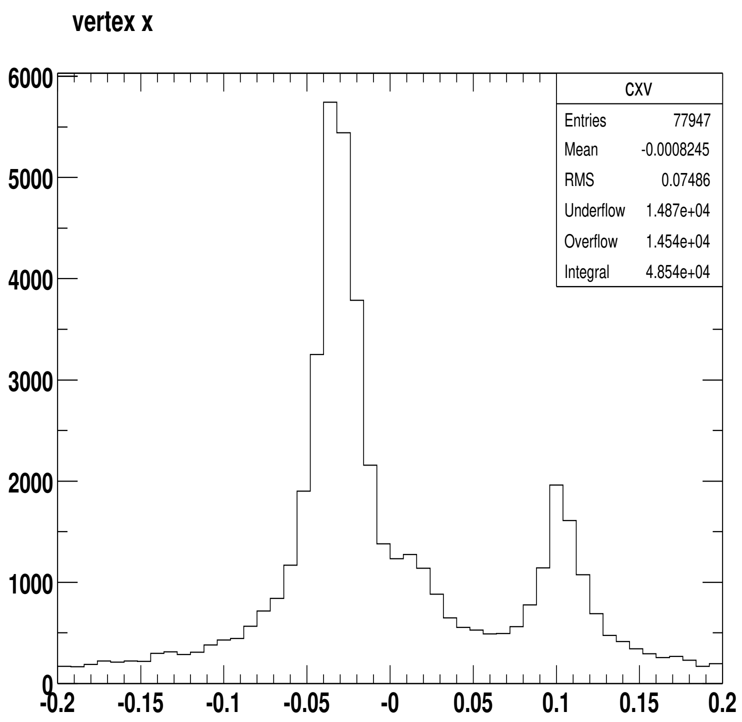
EVENT SELECTION :

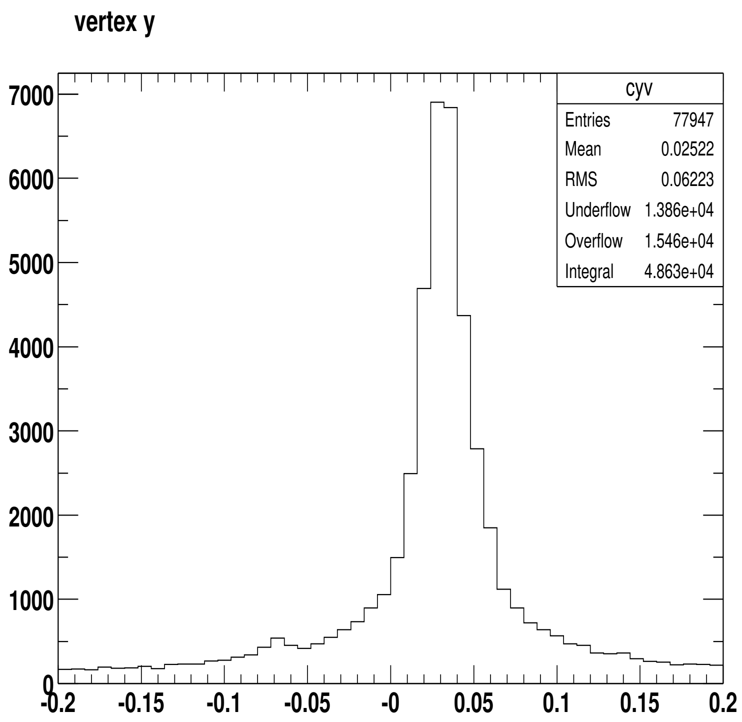
- 2 loose central muons
- $p_T > 15$ GeV, global (stereo) tracks (no. of CFT hits > 8 and more than 2 SMT hits)
- isolation cut - standard cut on p_t of tracks around muon and CAL E_t in a hollow cone around muon, highest p_T muon must be isolated
- unlike-sign muons
- sample corresponds to 104 pb^{-1} of data (August 2002 - June 2003)

Cluster efficiency study :

- always skip one layer at the time
- good track selection : DCA < 300 μm (uncorrected), $p_T > 15$ GeV, CFT stereo tracks (> 8 CFT hits), road method (11 track sigma isolation)
- efficiency definition : a cluster either is (or it is not) found inside the 6 resolution sigma window around the track on a given surface/layer.

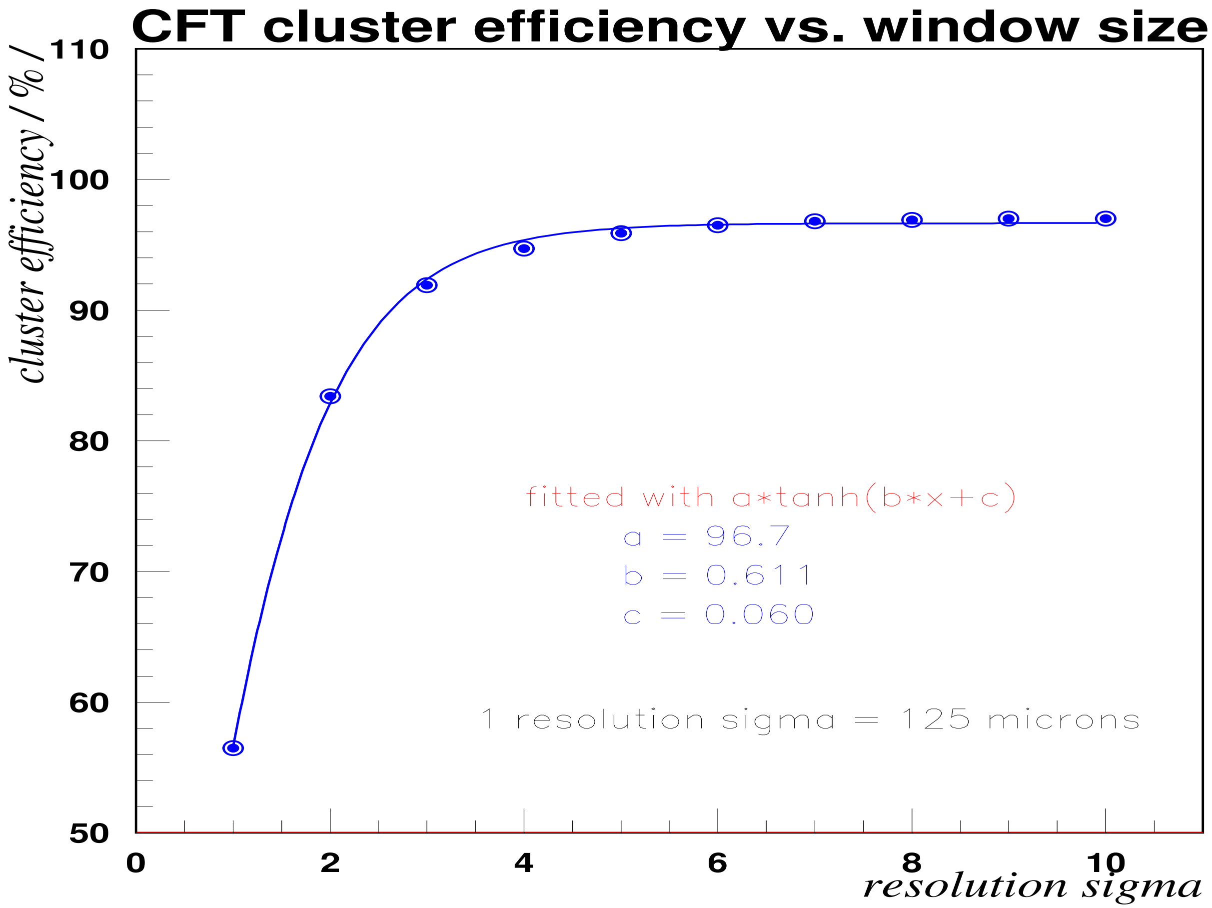
Vertex position in the di-muon sample





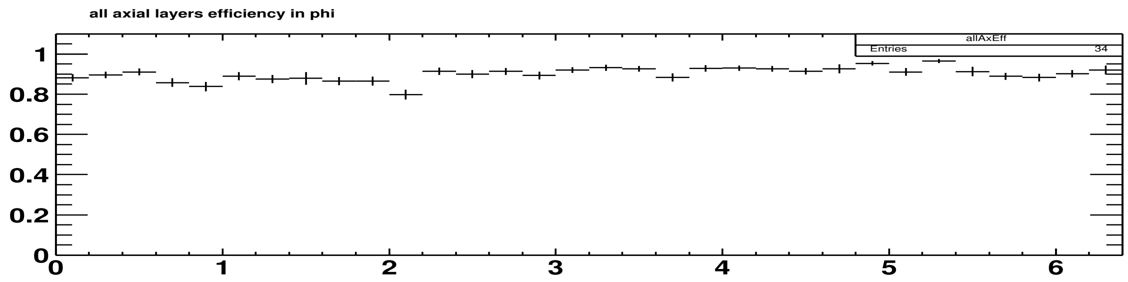
vtx position : $x_1 = -324\ \mu m, x_2 = 103\ \mu m$ and $y = 322\ \mu m$

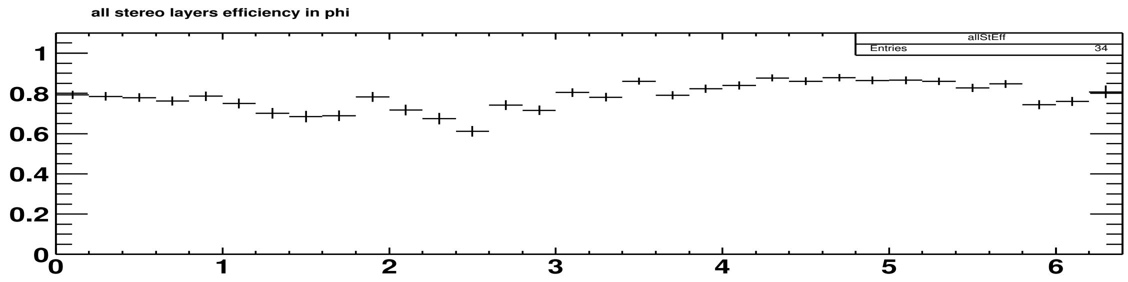
CFT cluster efficiency vs. size of the window

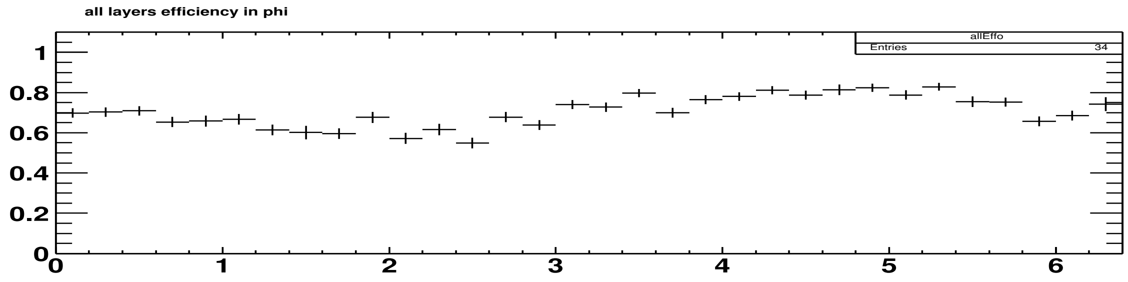


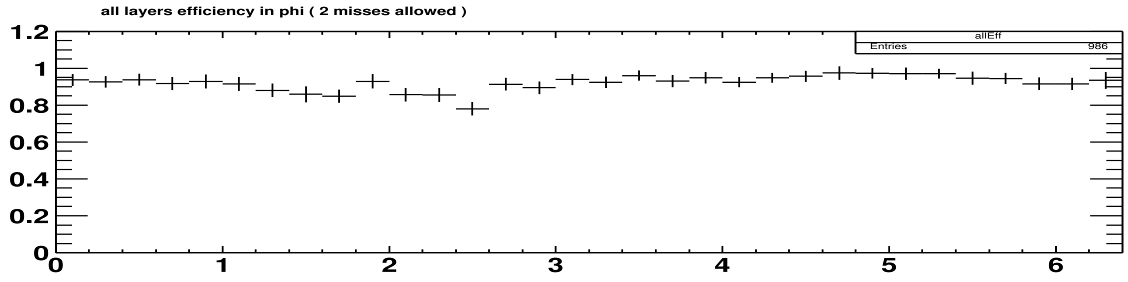
Layer 10 (cylinder 5, stereo layer) only. Other layers are available too.
6 resolution sigma has been chosen as a definition of the cluster efficiency window.

20 ADC cut applied - ϕ

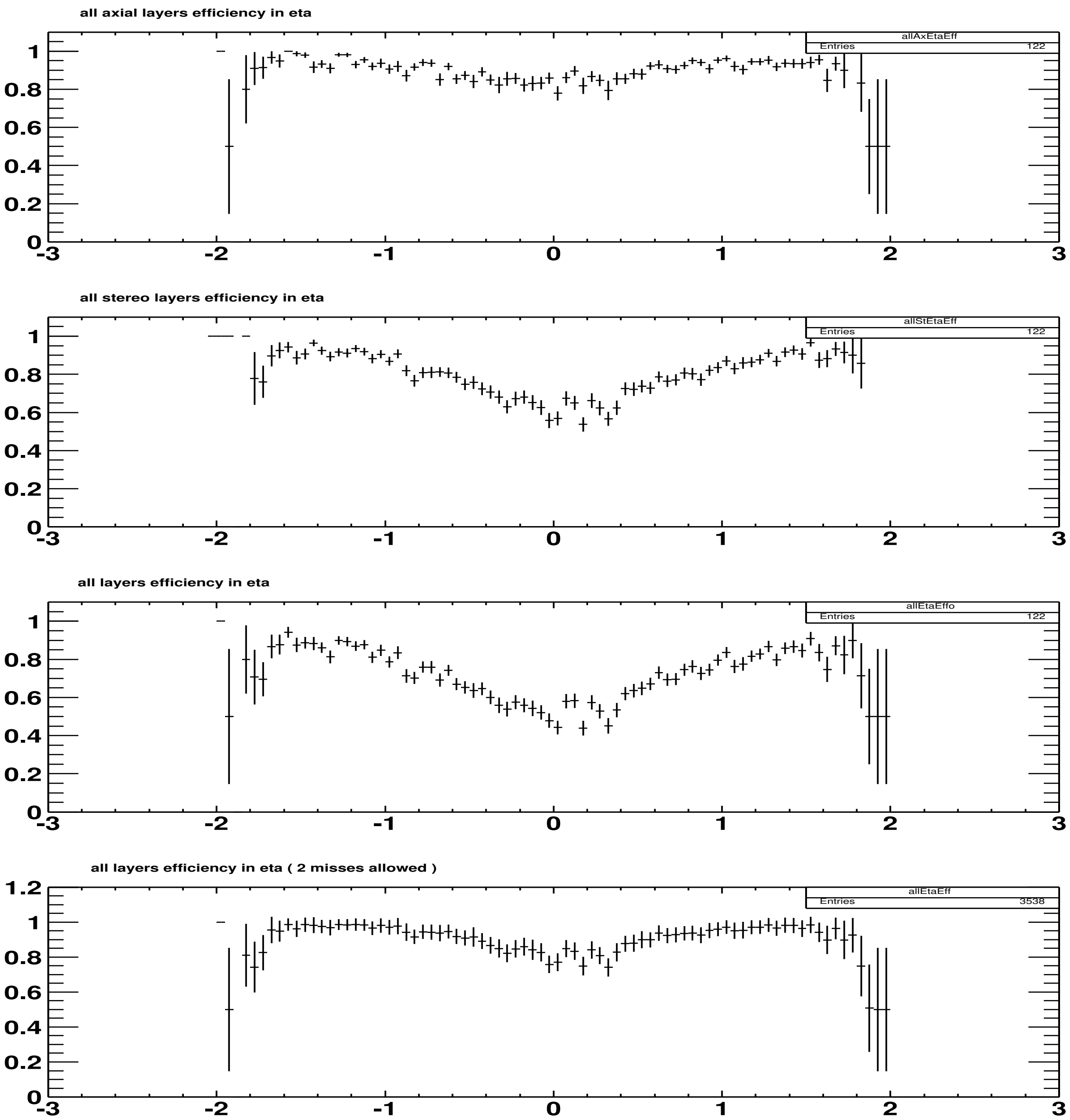




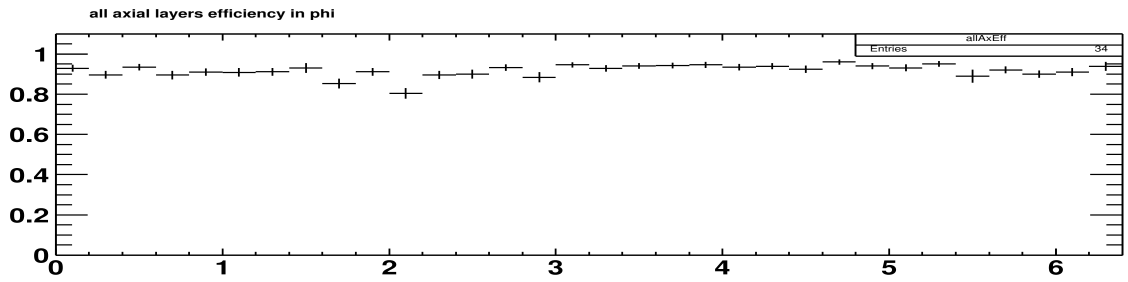


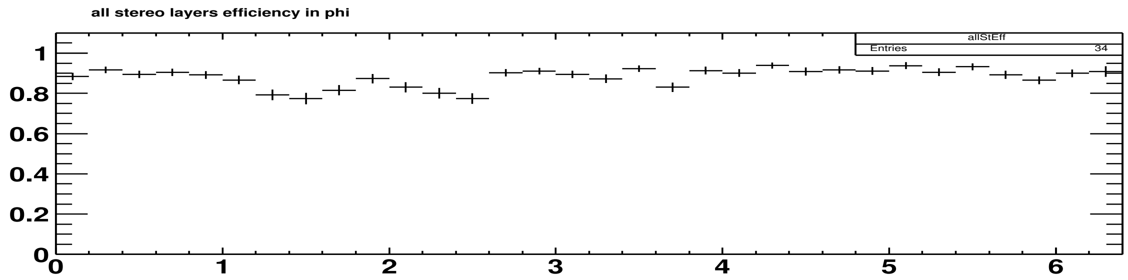


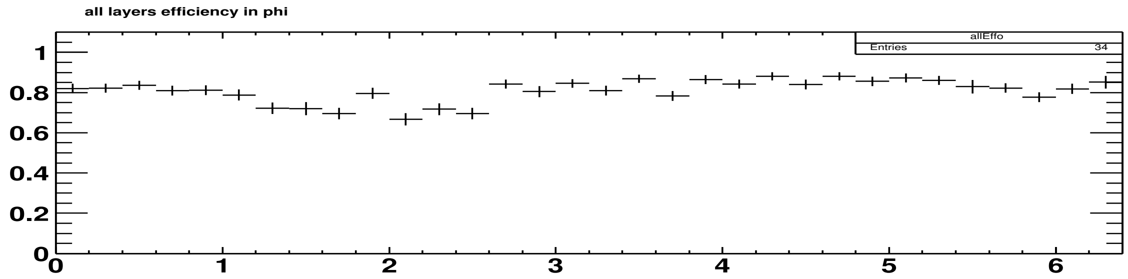
20 ADC cut applied - η

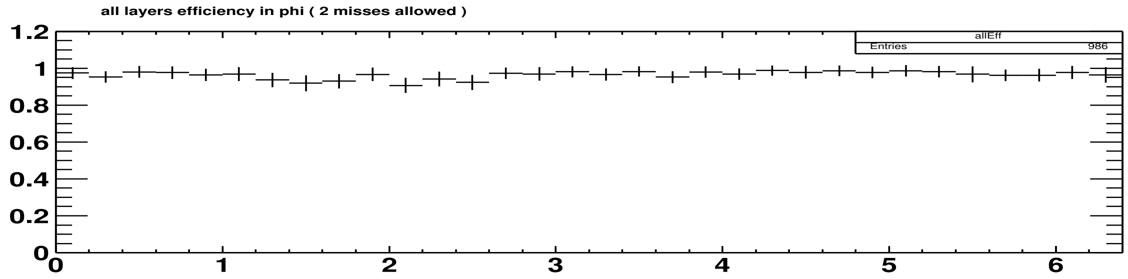


20 ADC cut removed - ϕ

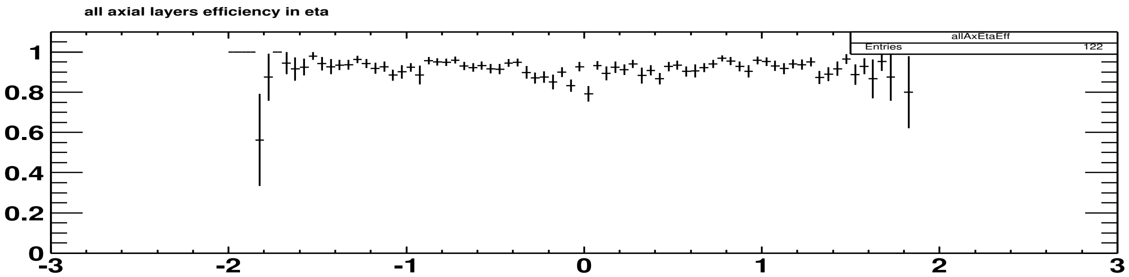


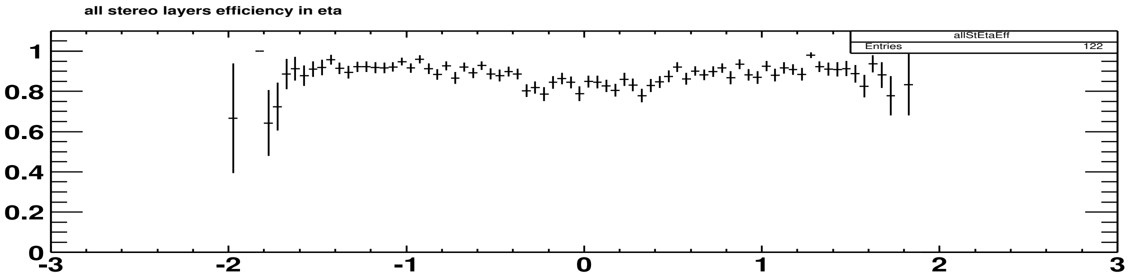


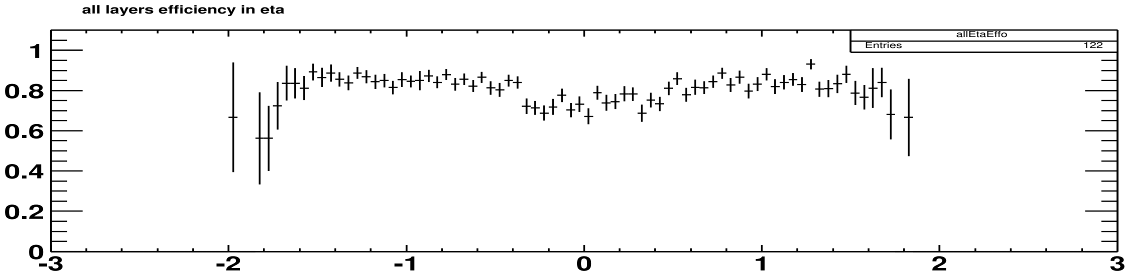


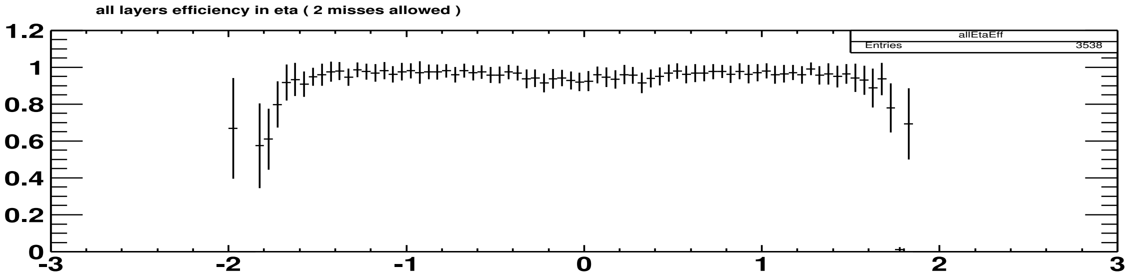


20 ADC cut removed - η









Efficiency in axial/stereo layers

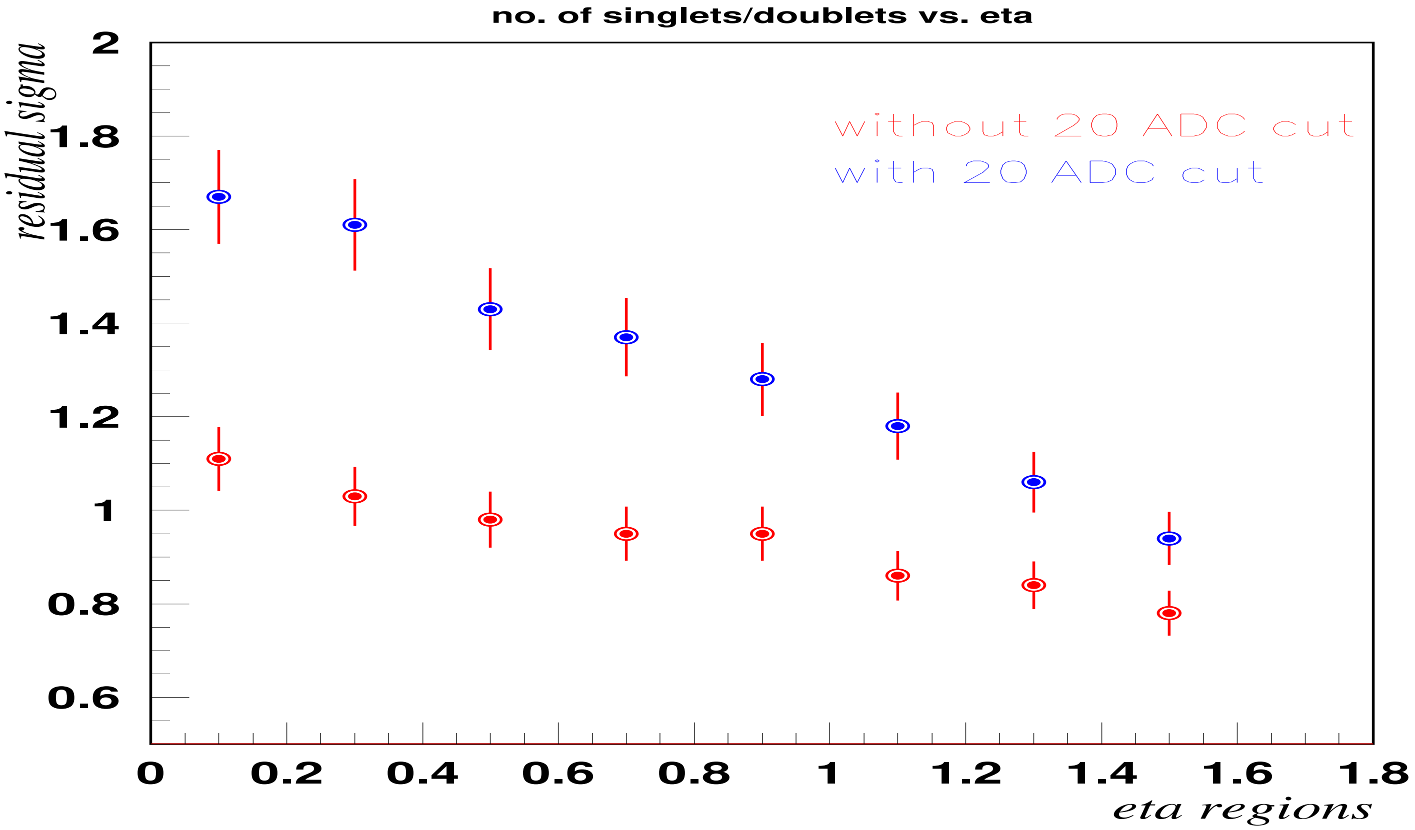
- AXIAL layers : efficiencies in all axial layers multiplied (7 layers)
- STEREO layers : efficiencies in all stereo layers multiplied (7 layers)
- ALL layers : efficiencies in all layers multiplied. This is an equivalent to saying that we require hits in all layers (only 14 layers). Efficiencies for the last cylinder are not measured due to the nature of the GTR algorithm (p13). GTR starts to find tracks from the outer-most cylinder. It would not be impossible to do, results would be really hard to interpret however.
- ALL layers with 2 misses allowed :

$$\epsilon = \prod_{i=1}^{14} \epsilon_i + \sum_{i=1}^{14} (1-\epsilon_i) \prod_{j \neq i} \epsilon_j + \sum_{i=1}^{14} \sum_{j \neq i} (1-\epsilon_i)(1-\epsilon_j) \prod_{k \neq i \neq j} \epsilon_k \qquad (1)$$

The cluster efficiency should be in high 90's thanks to the track finding algorithm that allows several misses in different layers.

Is this consistent with other measurements we can do ?

no. of singlets / no. of doublets vs η



Ratio of no. of singlets and doublets vs. η in MC is flat. It is equal to 0.78. Efficiency obtained from this plot is about 85 % at $\eta = 0$. (20 ADC cut applied)

CFT cluster efficiencies - 20 ADC cut

layer	efficiency [%]	occupancy [clus/cm]	fake rate [%]
1	98.2(2)	1.76	0.24
2	95.8(2)	1.66	0.56
3	98.5(2)	1.38	0.16
4	97.1(2)	1.25	0.27
5	98.3(2)	1.51	0.19
6	96.9(2)	1.38	0.35
7	98.8(2)	1.25	0.11
8	96.8(2)	1.17	0.28
9	98.4(2)	1.05	0.13
10	96.5(2)	0.99	0.26
11	98.6(2)	0.91	0.10
12	96.5(2)	0.83	0.21
13	98.9(2)	0.71	0.06
14	96.5(2)	0.71	0.18

CFT cluster efficiencies - no 20 ADC cut

layer	efficiency [%]	occupancy [clus/cm]	fake rate [%]
1	98.6(2)	2.0	0.21
2	97.5(2)	1.9	0.39
3	98.5(2)	1.6	0.19
4	98.3(2)	1.5	0.20
5	98.5(2)	1.7	0.20
6	98.3(2)	1.6	0.25
7	99.0(2)	1.5	0.12
8	98.5(2)	1.4	0.16
9	98.6(2)	1.3	0.14
10	98.3(2)	1.3	0.17
11	98.8(2)	1.2	0.12
12	98.3(2)	1.1	0.15
13	99.2(2)	1.0	0.06
14	98.3(2)	1.0	0.13

Conclusions

- There is a good agreement between various methods that show the source of cluster inefficiency for lower dip angles due to the ADC cut applied on the cluster level in the offline reconstruction code.
- The cluster efficiency is significantly lower in the stereo layers as compared to axial layers.
- The explanation is the following :
  - lower light yield for smaller dip angles is due to the shorter particle path (geometrical fact only). This is why less light is collected and read out. Any ADC cut will affect lower physics eta tracks first.
  - stereo layers are using worse electronics. Worse in terms of electronics quality, gain, noise etc. This why stereo layers will be more sensitive to any ADC cuts.
- It has been shown that allowing at least 2 misses significantly improves the situation. When the 20 ADC cut is not applied (only electronics/hardware cuts are in place), the total cluster efficiency is almost flat in η.

Conclusions (cont'd)

- It is going to be hard to fight hardware cuts. Impossible is probably a more apropriate word for this kind of situation...
- It will be hard to fight the 20 ADC cut on cluster ADC information as well... The reason is the current situation with looong events (long in terms of CPU time reconstruction)...they are mainly caused by the high occupancy events that occur in trackers (CFT mainly). These events are mainly due to the interactions of beam hallo with the residual gas in the beam pipe.
- Possible solution and a way to optimize this ADC cut (obviously it cannot be removed completely) is by determining the occupancy in all CFT layers in a regular physics run and trying to adjust ADC cuts offline so that they occupancy seen by the offline reconstruction code is about the same for all layers per unit φ-angle.
- the goal is to push this ADC cut as low as possible...