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Status of the Cleanup procedure in the 'Road Method' pattern recognition in the Central Tracker

Gianluigi Boca

Universita' di Pavia and INFN, Italy

Universita' di Pavia Italy

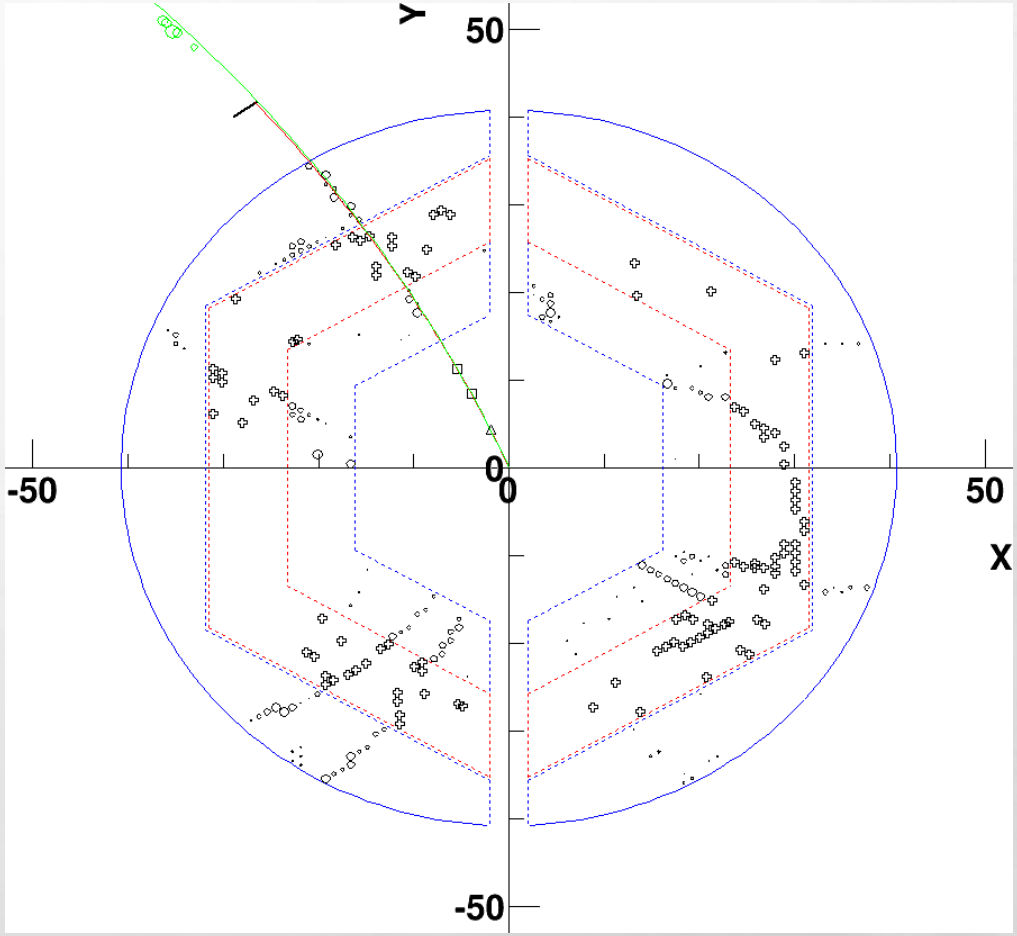
INFN Istituto Nazionale di Fisica Nucleare

The Cleanup procedure

This is a 1 GeV/c 1 muon track event embedded in a 20 MHz event rate environment

Many hits belonging to different events so many spurious tracks found by Pattern Recognition.

The Cleanup procedure is necessary to eliminate the spurious tracks.



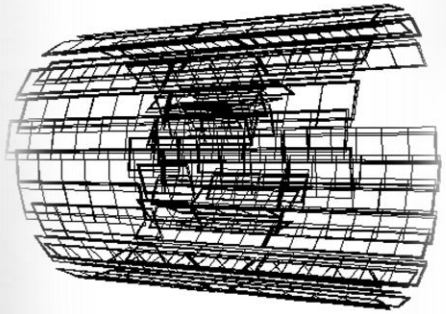
The Cleanup procedure

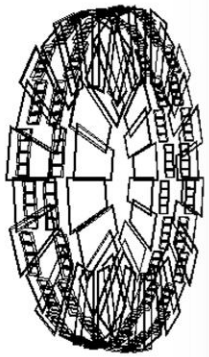
The Cleanup procedure is contained in the `class pandaroot/tracking/PndTrkCleanup.cxx`

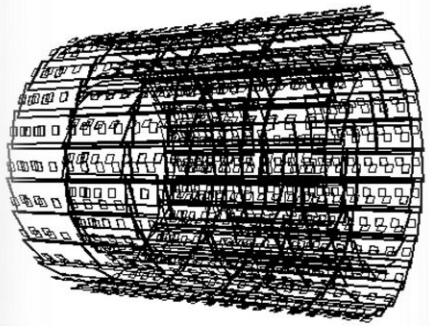
The cleanup is achieved with in two steps :

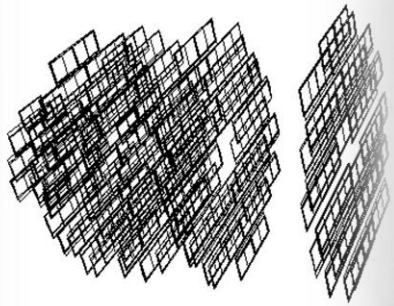
1) first all tracks a'cleaned' with the use of the Mvd hits. The track trajectory info is used to predict in detail how many Mvd hits there should be in the track and in which Mvd layers. The info from the Mvd geometry file is used with the detailed positions of the sensitive layers : `pandaroot/geometry/Mvd2.1_FullVersion.root` Only ONE Mvd hit is allowed to be missing (to take into account the probability that the track crossed a sensitive layer in a dead region).

Examples of Mvd geometry volumes as per `pandaroot/geometry/Mvd2.1_FullVersion.root` file









The Cleanup procedure

The Cleanup procedure is contained in the `class pandaroot/tracking/PndTrkCleanup.cxx`

The cleanup is achieved with in two steps :

2) then all tracks a'cleaned' with the use of the Stt hits. The track trajectory info is used to predict in detail how many Stt hits there should be in the track and where.
Except in some special cases, a maximum number of 1 axial Stt hit and 1 skew Stt hit are allowed to be missing (it takes care of imprecision of the track parameters and possible inefficiency in straw tubes).

The Cleanup procedure performance

I am showing :

1) performance on events without pileup : how many good tracksvare inadvertently rejected by the procedure;

2) performance on events with pileup : efficiency in keeping the good tracks, , rejection power of the fake tracks.

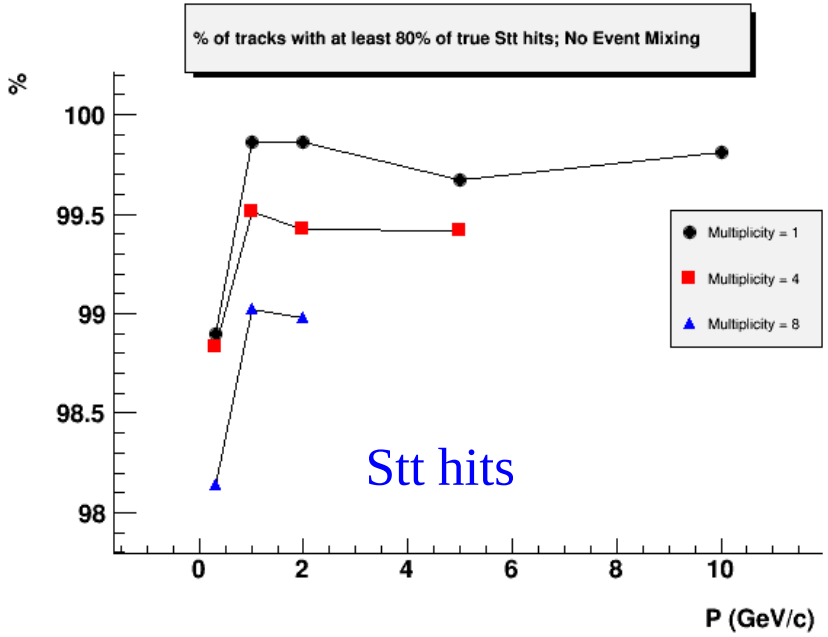
Results for Mvd+Stt Cleanup procedure ON and NO Pileup (just for reference)

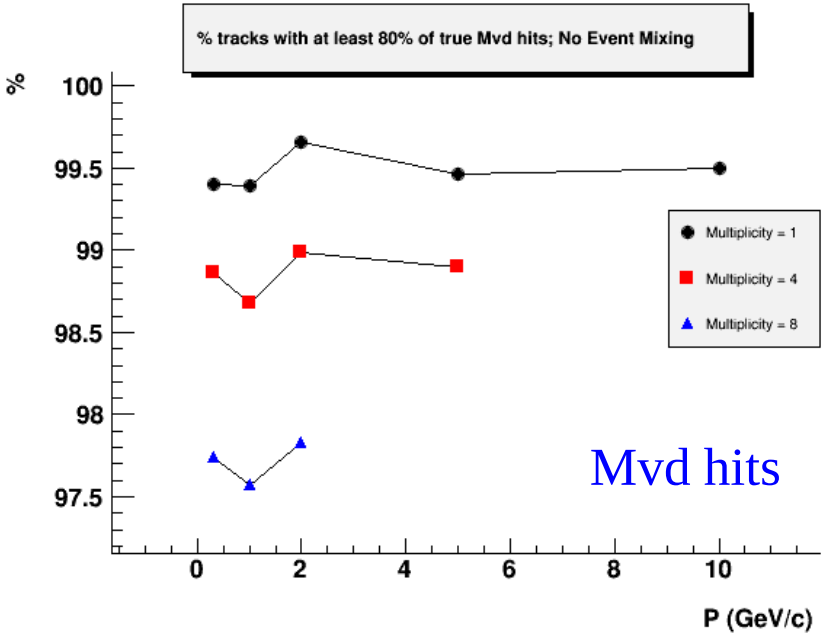
Mvd+Stt Cleanup procedure ON, NO Pileup

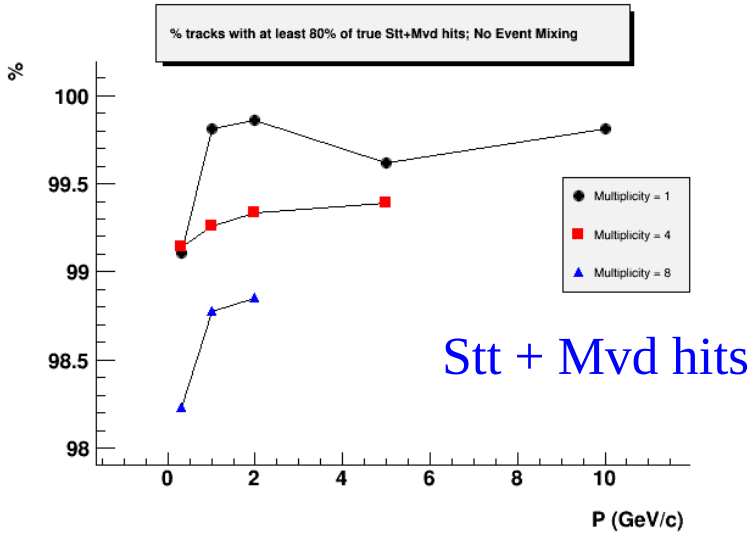
MC, Box generator, μ tracks

P (GeV/c)	Tracks per evt	Total tracks generated	% rec. tracks	# ghost tracks	# ghost/evt
0.3	1	3987	95.6	0	0.0
0.3	4	3982	90.3	4	0.0
0.3	8	3992	82.2	1	0.0
1.0	1	3883	95.9	0	0.0
1.0	4	3882	90.3	0	0.0
1.0	8	3869	84.3	1	0.0
2.0	1	3846	94.8	0	0.0
2.0	4	3860	89.5	0	0.0
2.0	8	3864	83.3	0	0.0
5.0	1	3860	94.5	0	0.0
5.0	4	3860	89.3	0	0.0
10.0	1	3864	94.6	0	0.0

Mvd+Stt Cleanup procedure ON, NO Pileup







Track Quality Check

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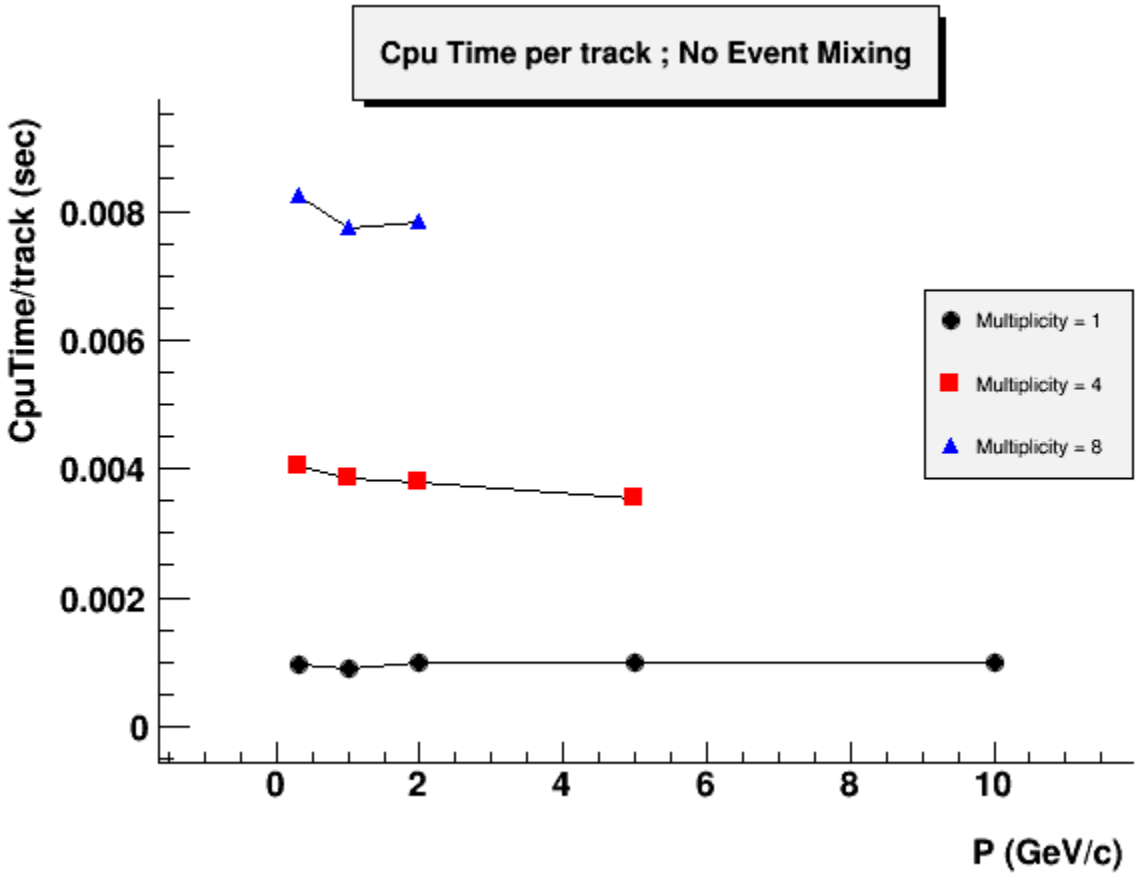
Mvd+Stt Cleanup procedure ON, NO Pileup

Cpu time consumption

Processor : Intel Core i7-2600K CPU @ 3.40 GHz



Partial conclusion :

Results for Mvd+Stt Cleanup procedure ON and NO Pileup satisfactory.

But obviously that was an ideal situation. Let's go down to the nitty-gritty and see what happens when the 20 MHz interaction rate is turned on …..

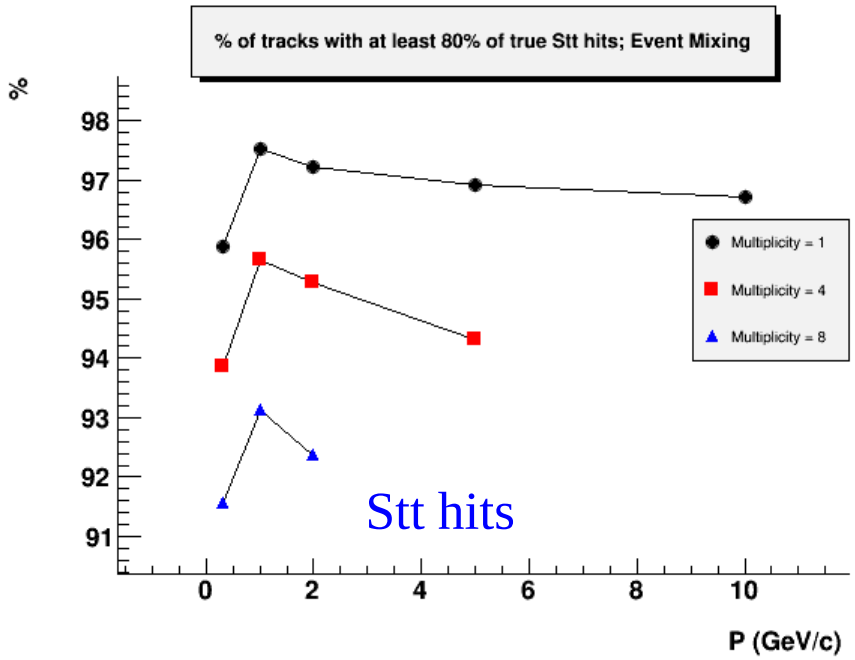
First the situation
when
the Pileup is ON
and
the Cleanup procedure is OFF

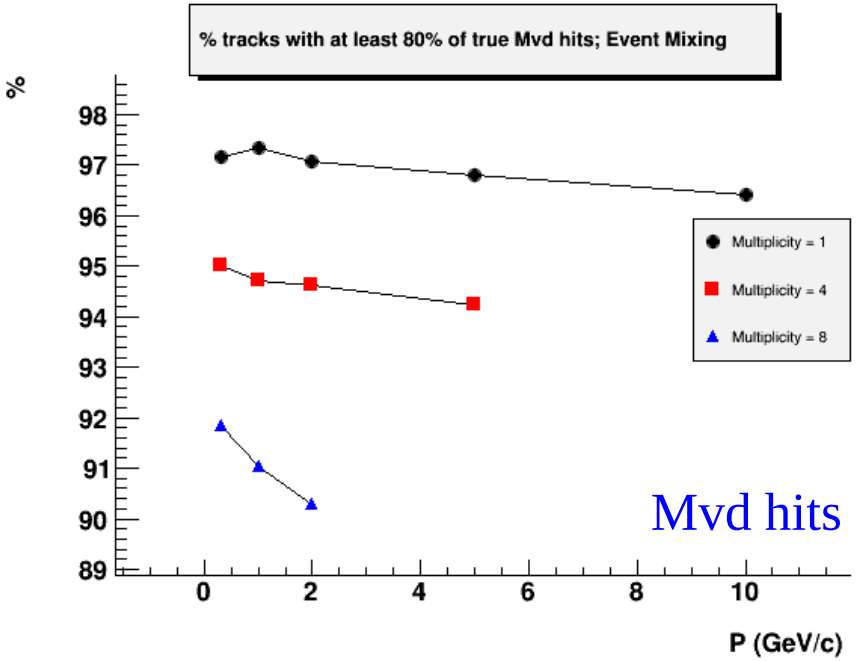
Cleanup procedure OFF, Pileup ON

MC, Box generator, μ tracks

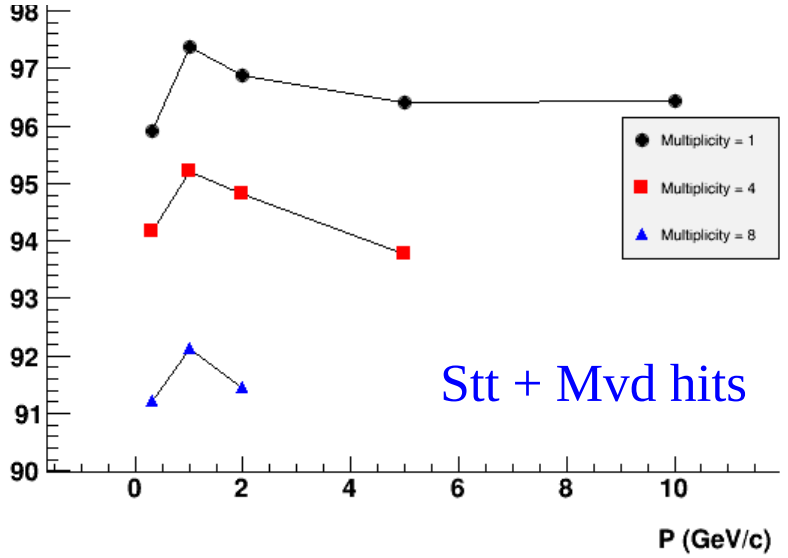
P (GeV/c)	Tracks per evt	Total tracks generated	% rec. tracks	# ghost tracks	# ghost/evt
0.3	1	3987	98.9	27640	6.9
0.3	4	3982	97.9	6613	6.6
0.3	8	3992	95.1	3098	6.2
1.0	1	3883	99.4	26775	6.9
1.0	4	3882	97.5	6688	6.7
1.0	8	3869	96.0	3204	6.4
2.0	1	3846	99.2	26726	6.9
2.0	4	3860	98.0	6704	6.7
2.0	8	3864	95.9	3109	6.2
5.0	1	3860	99.5	26726	6.9
5.0	4	3860	97.8	6703	6.7
10.0	1	3864	98.5	26825	6.9

Cleanup procedure OFF - Pileup ON





Track Quality Check



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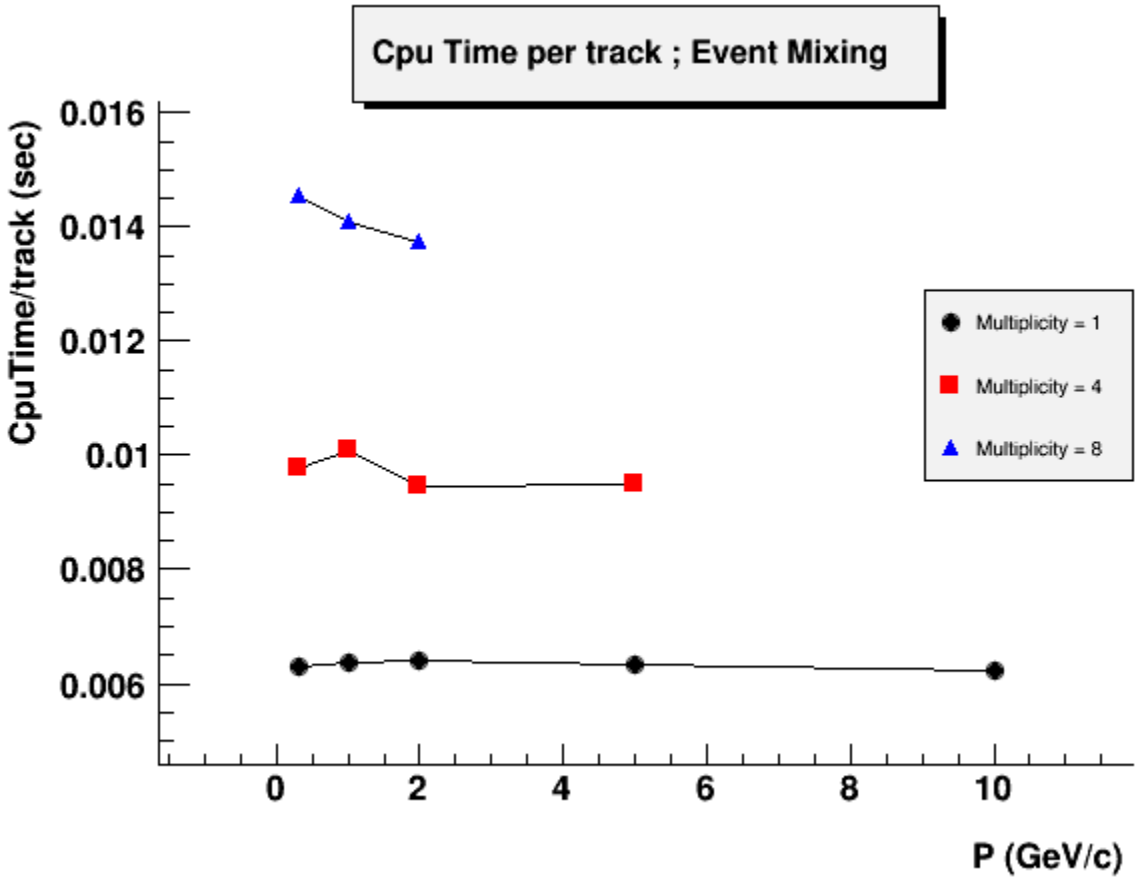
Cleanup procedure OFF - Pileup ON

Cpu time consumption

Processor : Intel Core i7-2600K CPU @ 3.40 GHz



Partial conclusion :

Track efficiency remains good (never less than 95 %) but there are on average about 6.7 ghost tracks PER EVENT caused by the hits belonging to a different event.

Well, that was expected …. the cleanup procedure is needed for this type of Pattern Recognition.

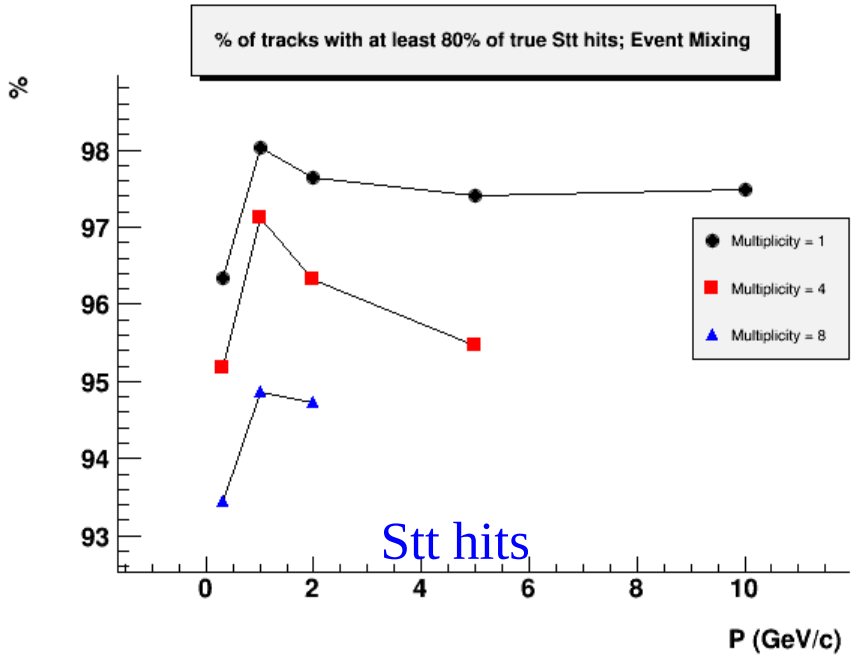
Situation when only Mvd Cleanup procedure is ON and Pileup ON

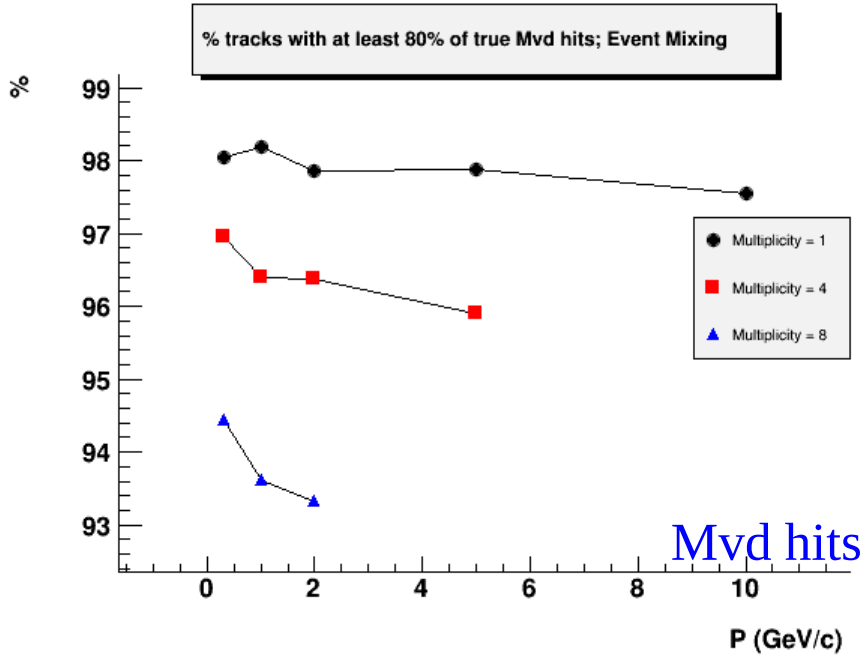
only Mvd Cleanup procedure ON, Pileup ON

MC, Box generator, μ tracks

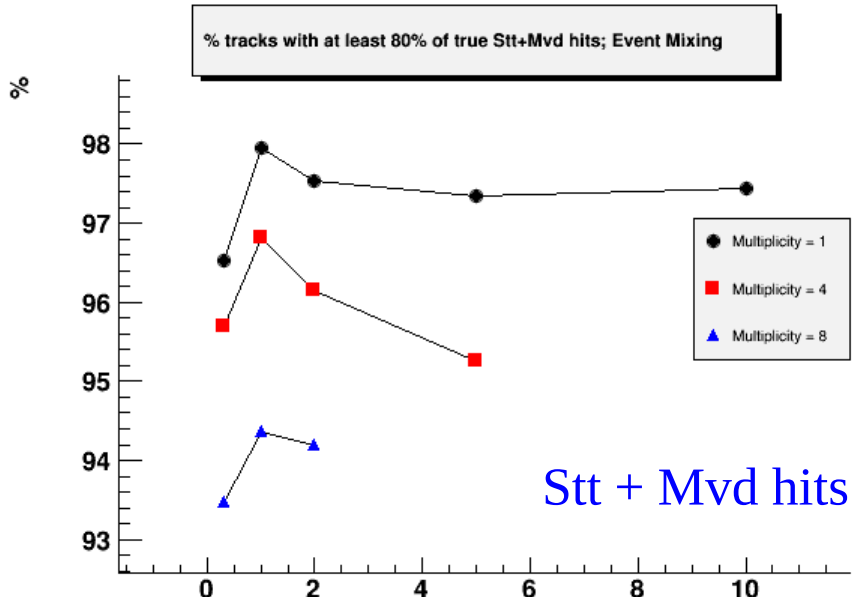
P (GeV/c)	Tracks per evt	Total tracks generated	% rec. tracks	# ghost tracks	# ghost/evt
0.3	1	3987	98.0	10932	2.7
0.3	4	3982	95.8	2712	2.7
0.3	8	3992	92.2	1376	2.8
1.0	1	3883	98.5	10638	2.7
1.0	4	3882	95.4	2748	2.7
1.0	8	3869	93.4	1354	2.7
2.0	1	3846	94.8	10659	2.8
2.0	4	3860	96.2	2751	2.8
2.0	8	3864	92.6	1327	2.7
5.0	1	3860	98.2	10607	2.7
5.0	4	3860	95.9	2761	2.8
10.0	1	3864	98.0	10674	2.8

only Mvd Cleanup procedure ON, Pileup ON





Track Quality Check



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Partial conclusion :

Track efficiency remains good (never less than 95 % except in the case of 2 GeV/c , 8 tracks per event where the efficiency goes down to 93 %).

The ghost tracks per event goes down to about 2.7

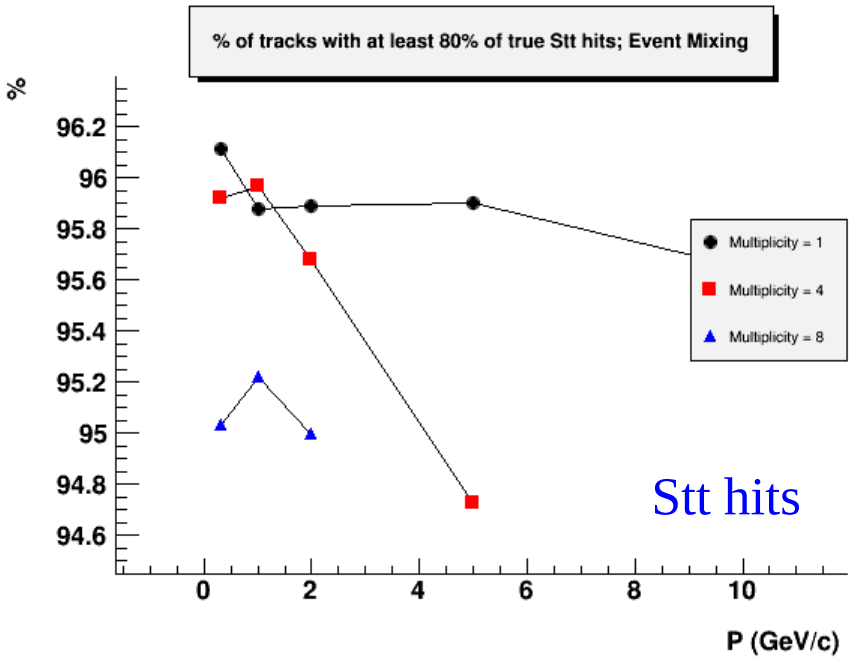
Situation when Mvd+Stt Cleanup procedure is ON and Pileup ON

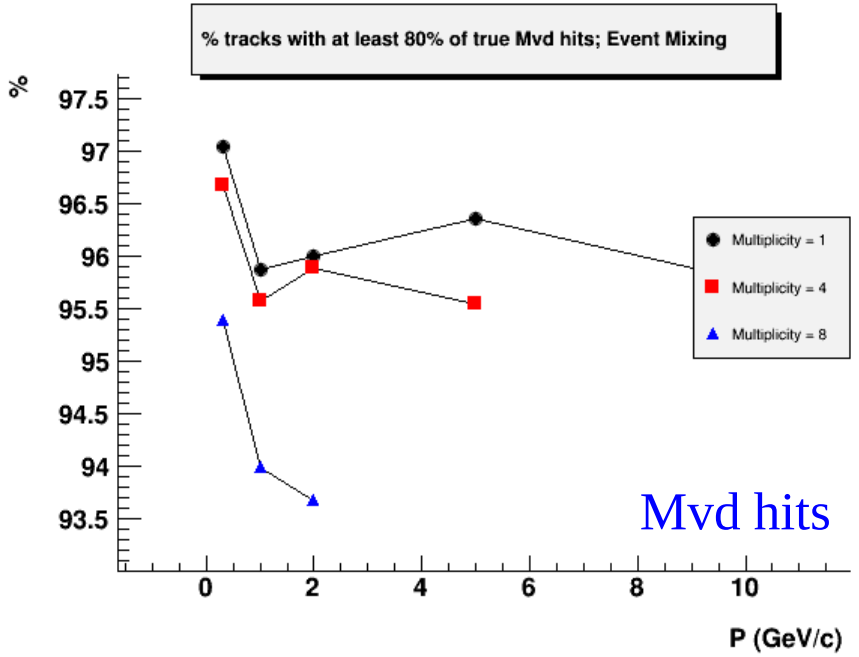
Mvd + Stt Cleanup procedure ON, Pileup ON

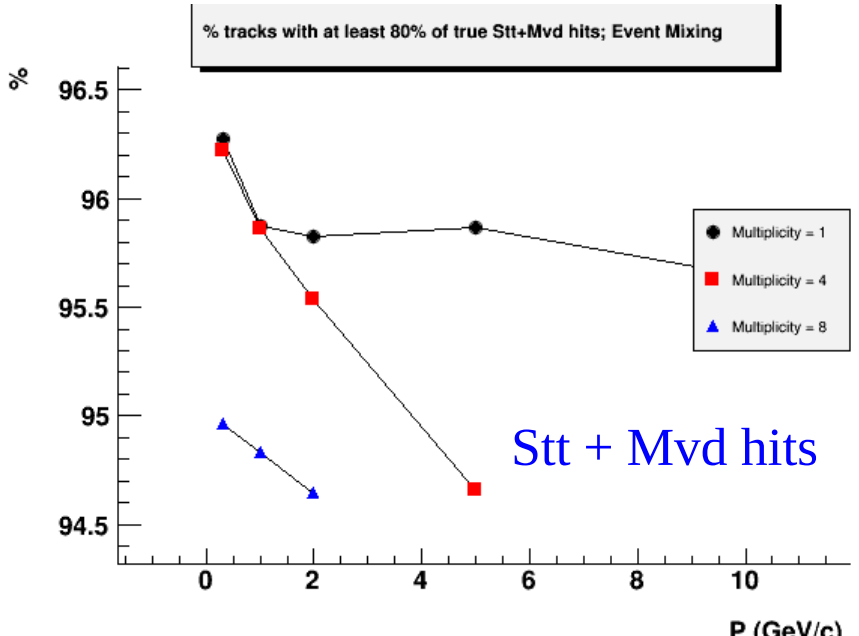
MC, Box generator, μ tracks

P (GeV/c)	Tracks per evt	Total tracks generated	% rec. tracks	# fake tracks
0.3	1	3987	77.5	0.9
0.3	4	3982	74.5	0.7
0.3	8	3992	67.1	0.7
1.0	1	3883	76.2	0.9
1.0	4	3882	72.2	0.8
1.0	8	3869	67.0	0.6
2.0	1	3846	75.3	0.9
2.0	4	3860	70.8	0.8
2.0	8	3864	66.7	0.6
5.0	1	3860	74.0	0.9
5.0	4	3860	70.8	0.8
10.0	1	3864	75.5	0.9

Mvd + Stt Cleanup procedure ON, Pileup ON







Track Quality Check

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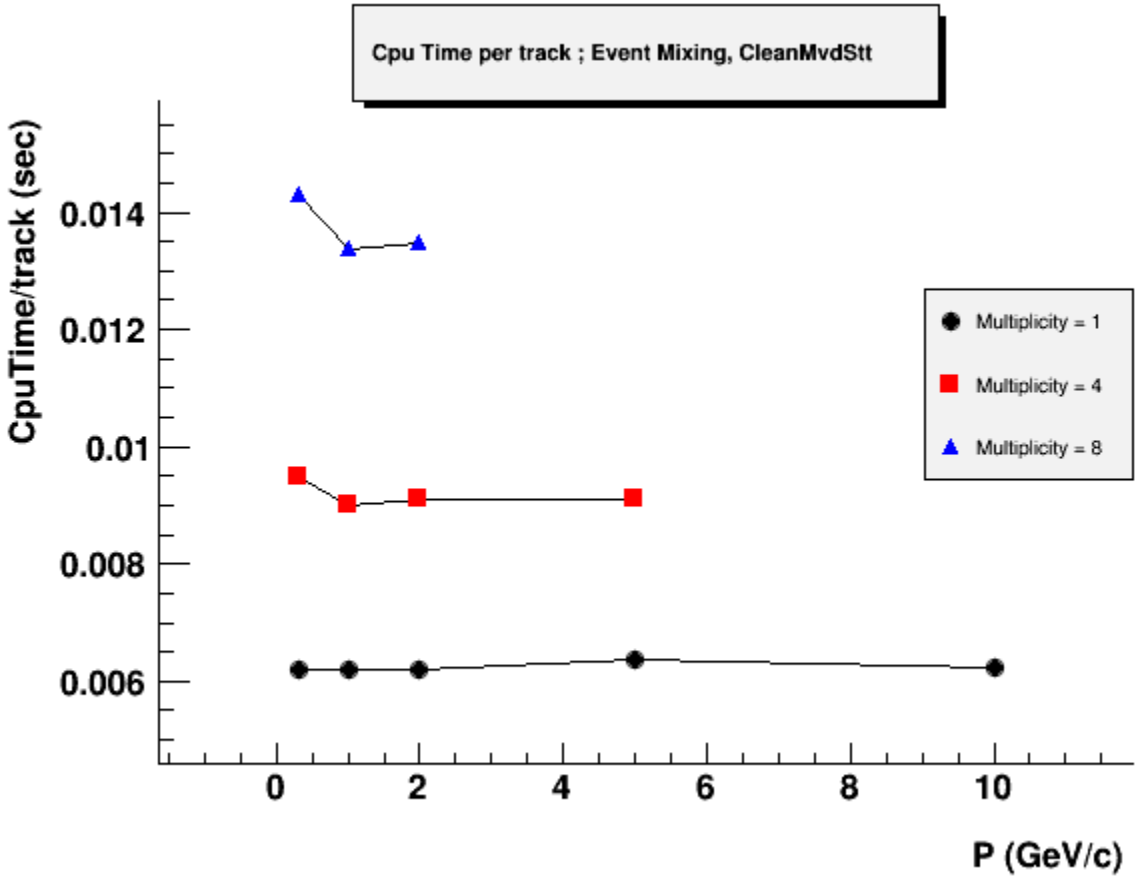
Mvd + Stt Cleanup procedure ON, Pileup ON

Cpu time consumption

Processor : Intel Core i7-2600K CPU @ 3.40 GHz



Partial conclusion :

Track efficiency goes down, in the range between 67 % and 78 % .
The ghost tracks per event goes down to about 0.8 per event.

Evidently the Stt part of the Cleanup procedure needs some more work and fine tuning.

Final conclusions

The Cleanup procedure is at a good stage of completion; the detailed geometry of the Mvd and Stt subdetectors is used.

The Mvd part of the algorithm doesn't spoil the true track reconstruction efficiency and cut essentially in half the ghost tracks per event.

The Stt part of the Cleanup procedure drastically cuts down the ghost tracks but lowers the true tracks reconstruction efficiency in the 70 % range

Some more work and fine tuning (but probably not too much) is needed.