CSC Track Finder: Simulation Results

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EMU and CMS Week
Sept 1999

Results from the Simulation

- CMSIM 114 was used for the detector simulation, and the LCTs were simulated with an old version of the LCT simulation (Rowe,Acosta)
- A Fortran version of the CSC Track Finder simulation was used for the study of the track finder
- A C++ version of the CSC Track Finder simulation is completed. Preliminary comparions between the two versions show good agreement.

Extrapolation Efficiency for Single Muon Events

Endcap Region

		%	
Pt = 3 GeV		ME1-ME2	ME1-ME3
successful extrapolation	=	93.4	81.3
Low Pt	=	77.1	58.1
Medium Pt	=	14.5	19.5
High Pt	=	1.8	3.7
Pt = 5 GeV			
successful extrapolation	=	99.1	98.1
Low Pt	=	44.8	46.4
Medium Pt	=	53.2	46.8
High Pt	=	1.2	4.9
Pt = 50 GeV			
successful extrapolation	=	99.4	99.4
Low Pt	=	0.02	0.01
Medium Pt	=	0.9	1.1
High Pt	=	98.4	98.2

Overlap Region

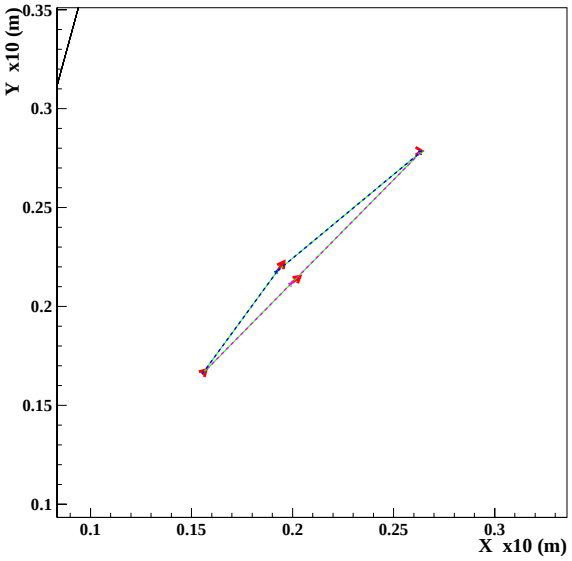
		%	
Pt = 5 GeV		MB1-ME2	MB2-ME2
successful extrapolation	=	100	100
Low Pt	=	48.9	70.9
Medium Pt	=	39.9	3.1
High Pt	=	11.2	26.0
Pt = 50 GeV			
successful extrapolation	=	99.8	100
Low Pt	=	0.3	1.8
Medium Pt	=	0.6	0.8
High Pt	=	98.9	97.5

(Note :The chamber efficiency was not taken into account)

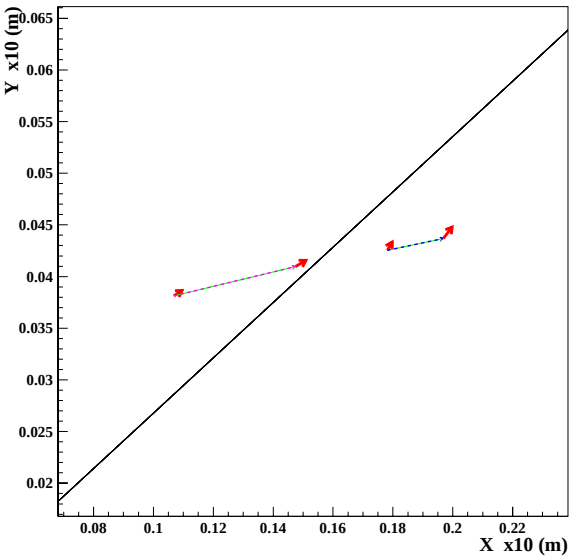
Final Selection Unit

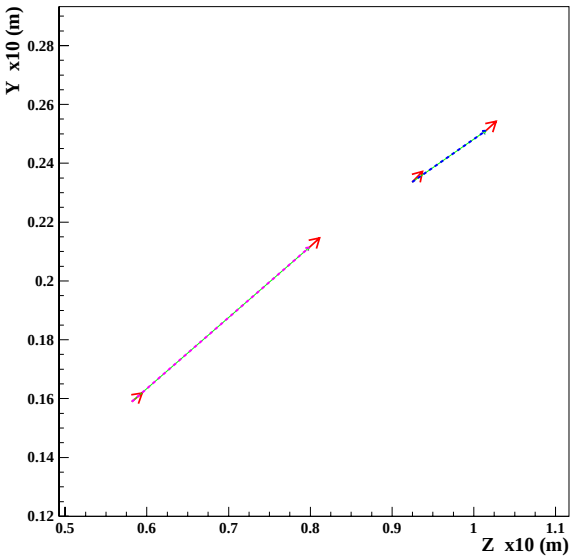
Efficiency of FSU on single muon events

- High efficiency for high Pt muons ($\sim 100\%$)
- $\sim 0.5\%$ of events FSU found > 1 track.
  - Extra LCTs due to bremsstrahlung, delta rays

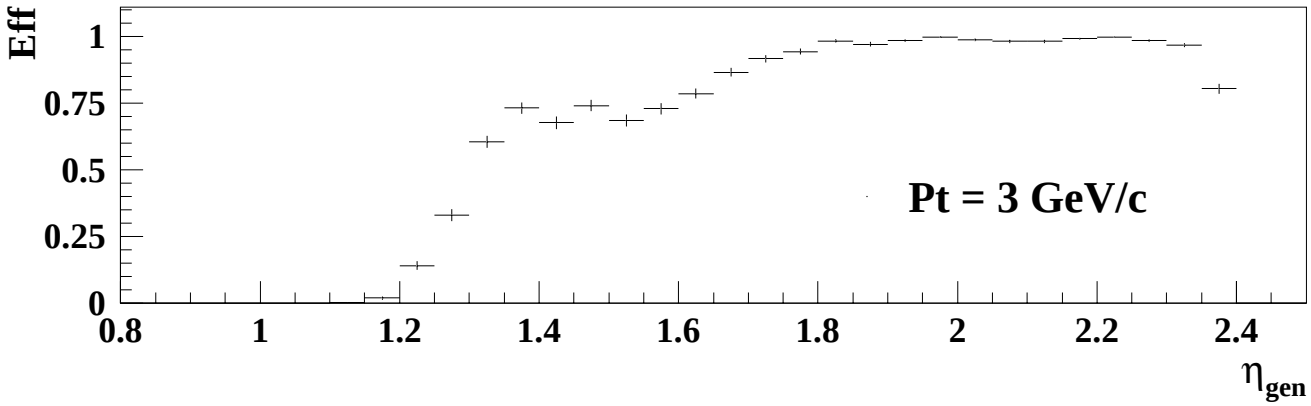


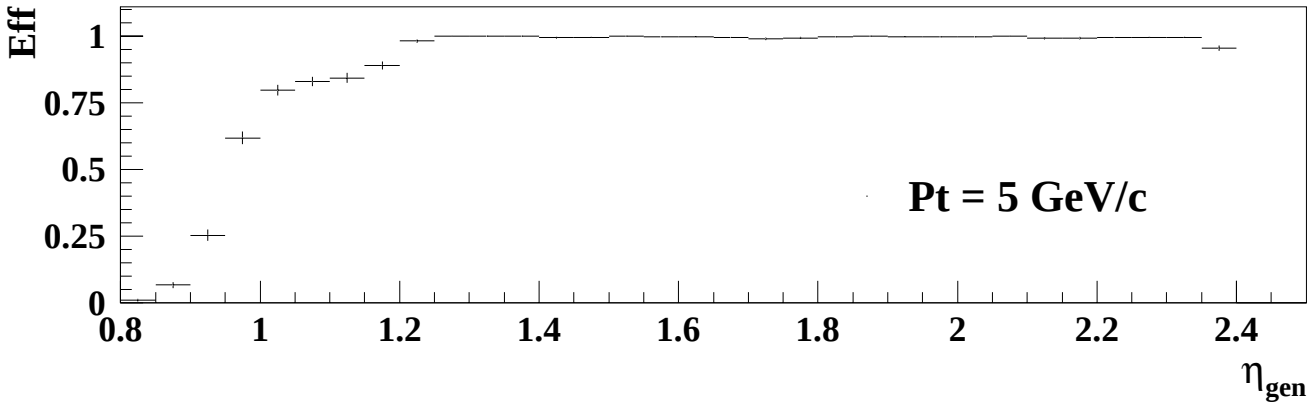
  - Broken track due to sector boundary, failed extrapolation

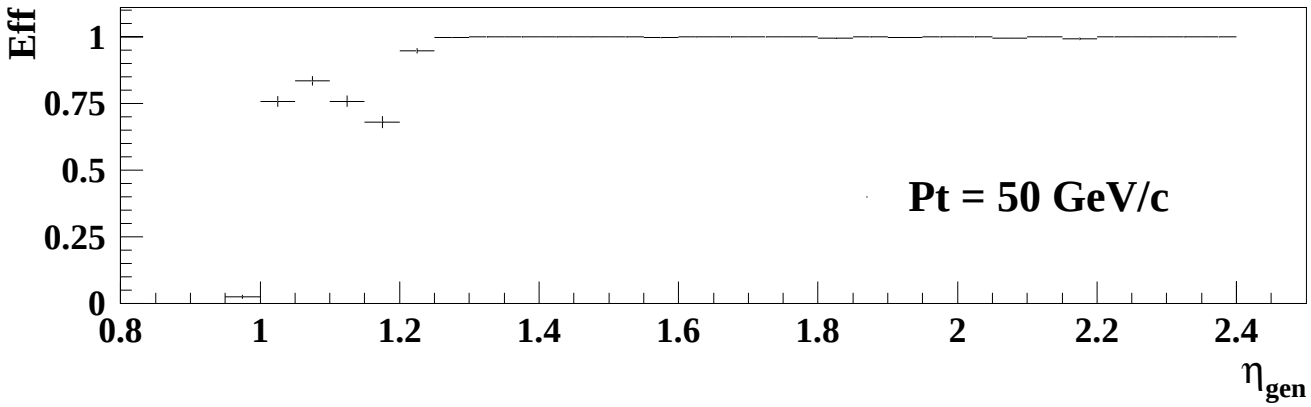


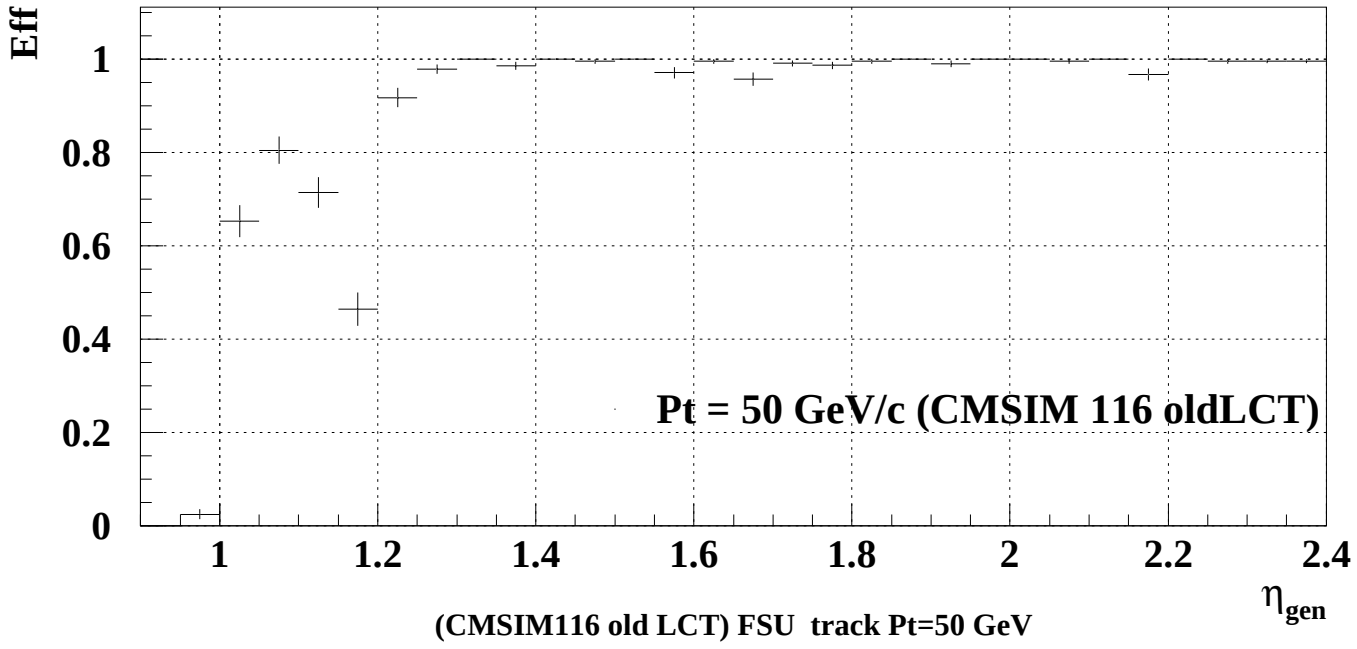


Single Muon Track Finding Efficiency (OL + EC)



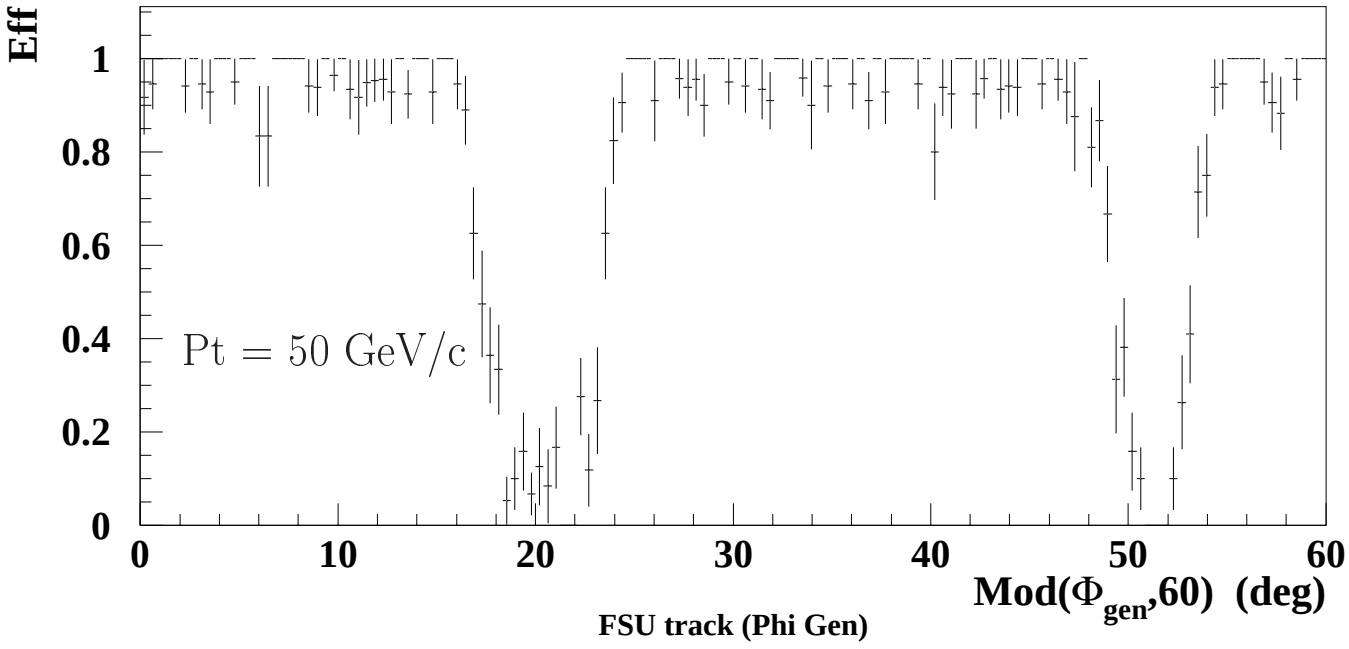




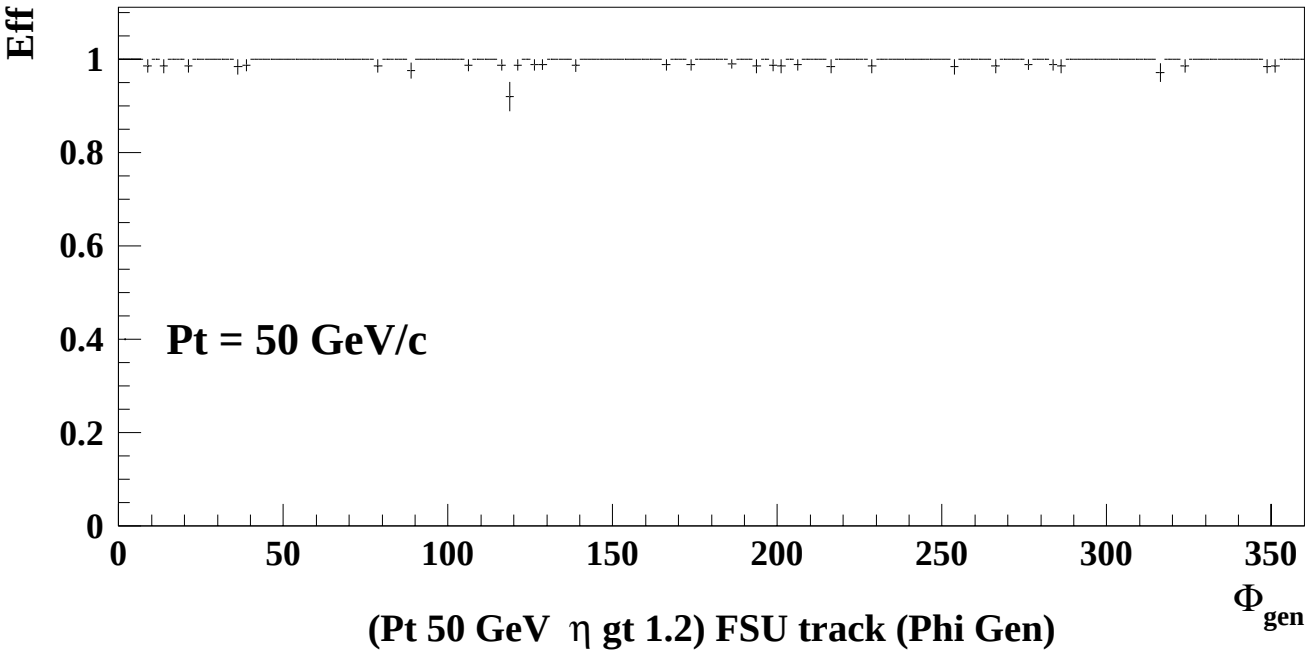


(CMSIM116 old LCT) FSU track Pt=50 GeV

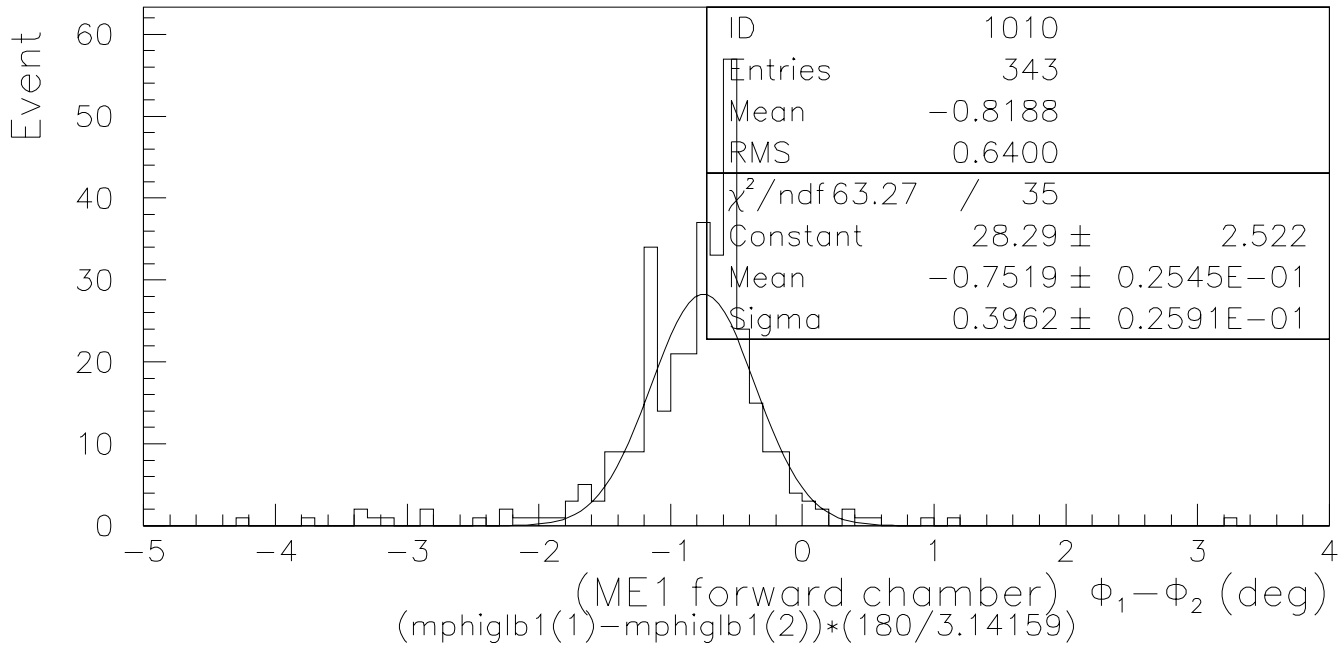
Efficiency vs ϕ $(1.05 < \eta < 1.15)$



Efficiency vs ϕ $(\eta > 1.2)$



- Broken track due to muon crossing sector boundary contributes $\sim 50\%$ of the events with > 1 found by FSU for low Pt muons
- Contribution to fake tracks due to bremsstrahlung or delta rays (dominant for high Pt muons) may be lesser than expected :
  Old LCT simulation allows > 1 LCT within 16 cathode strips or anode wires
- Look at the difference in ϕ of two LCTs in a single station
- For 10° chambers with 80 cathode strips,
  $\Rightarrow$ 16 strips $= 2^\circ$ in ϕ
  For 20° chambers with 80 cathode strips,
  $\Rightarrow$ 16 strips $= 4^\circ$ in ϕ
- Only a small fractions of single muon events have two LCTS that are separated by more than 16 cathode strips
- Preliminary studies using new LCT simulation (Benn) indicates only $\sim 0.04\%$ high Pt single muon events have > 1 reconstructed tracks in the FSU

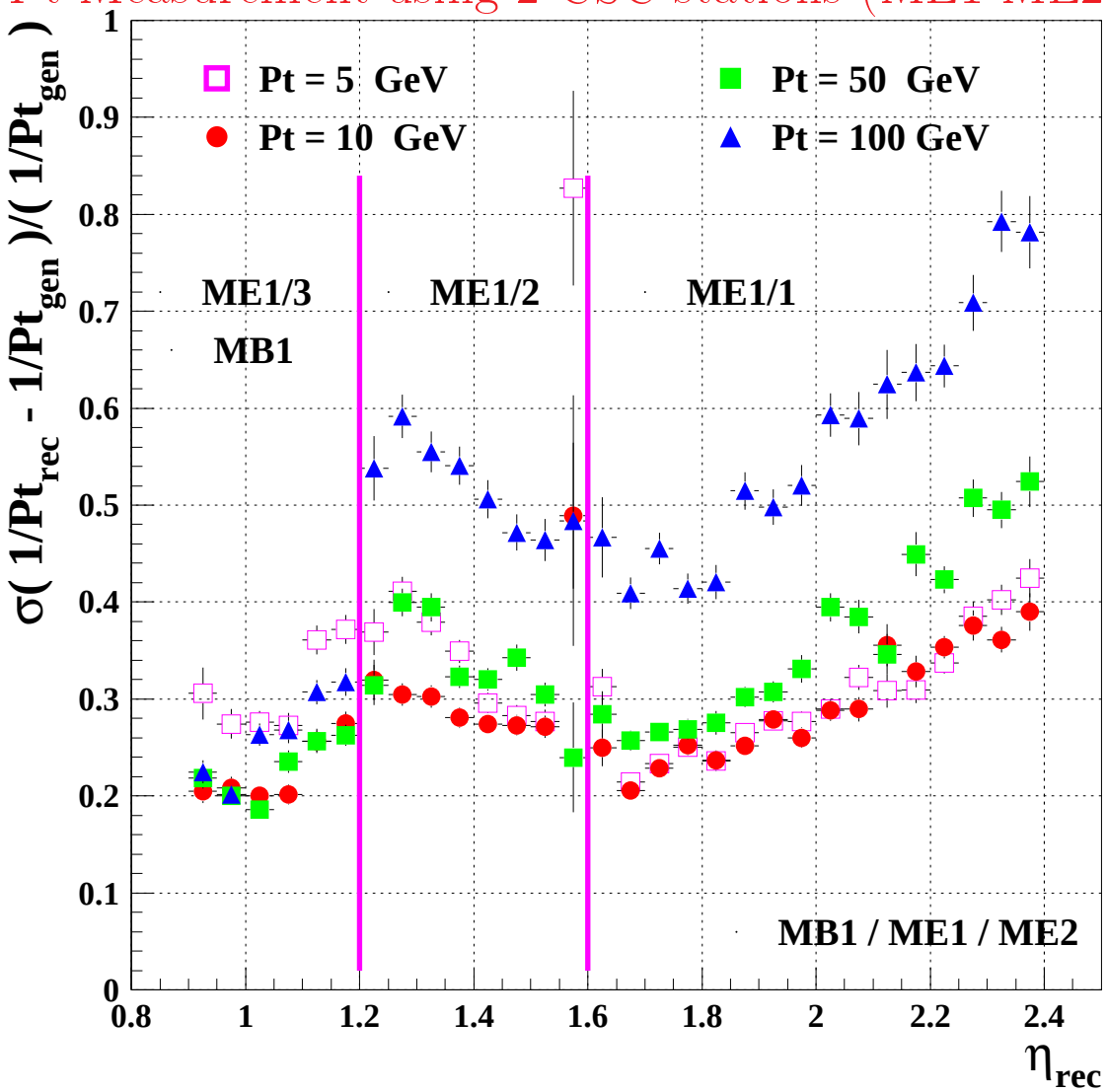

Event
60
50
40
30
20
10
0
−5
−4
−3
−2
−1
0
1
2
3
4
ID 1010
Entries 343
Mean −0.8188
RMS 0.6400
χ²/ndf 63.27 / 35
Constant 28.29 ± 2.522
Mean −0.7519 ± 0.2545E−01
Sigma 0.3962 ± 0.2591E−01
(ME1 forward chamber) Φ1−Φ2 (deg)
(mphiglb1(1)−mphiglb1(2))*(180/3.14159)

Pt Assignment (Endcap)

- Extract Pt using ϕ of LCTs measured in 2 or 3 CSC stations
- One of the ϕ of LCT must be measured in ME1

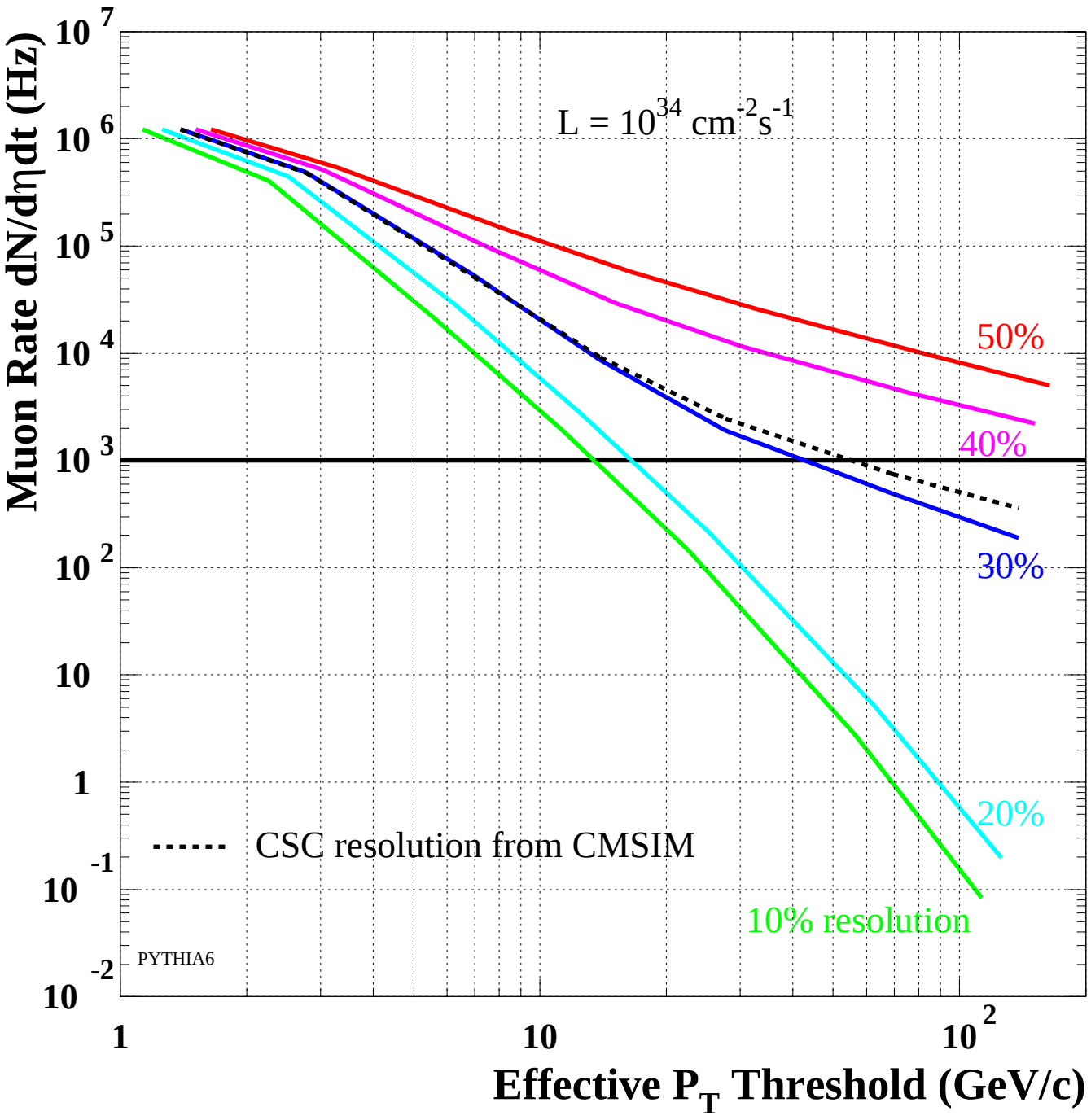
Why do we need 3 CSC stations for Pt measurement ?

Pt Measurement using 2 CSC stations (ME1-ME2)



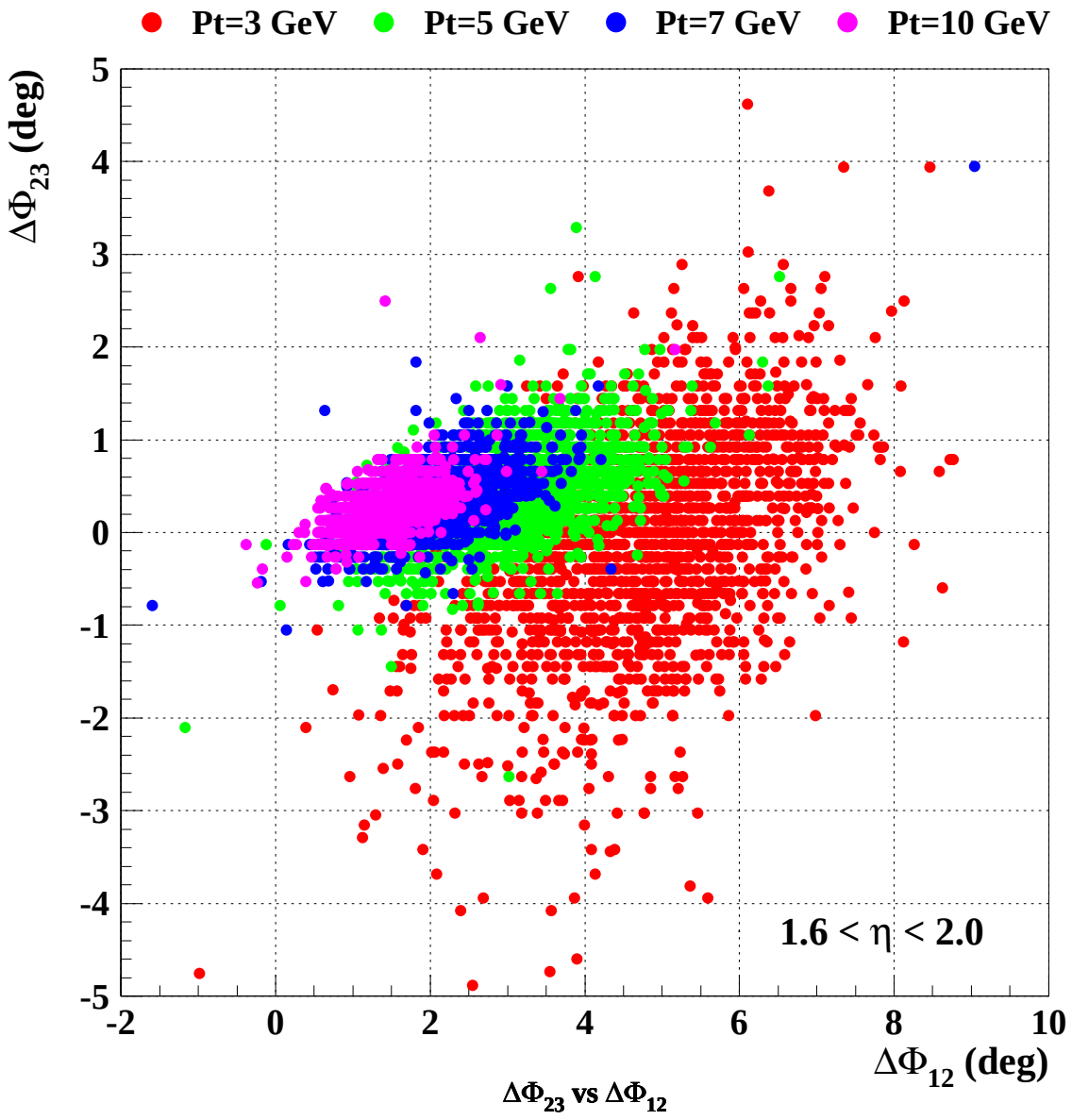
- Resolution of 1/Pt is $\sim$ 30% at low Pt

Single Muon Trigger Rate in CSC Endcap



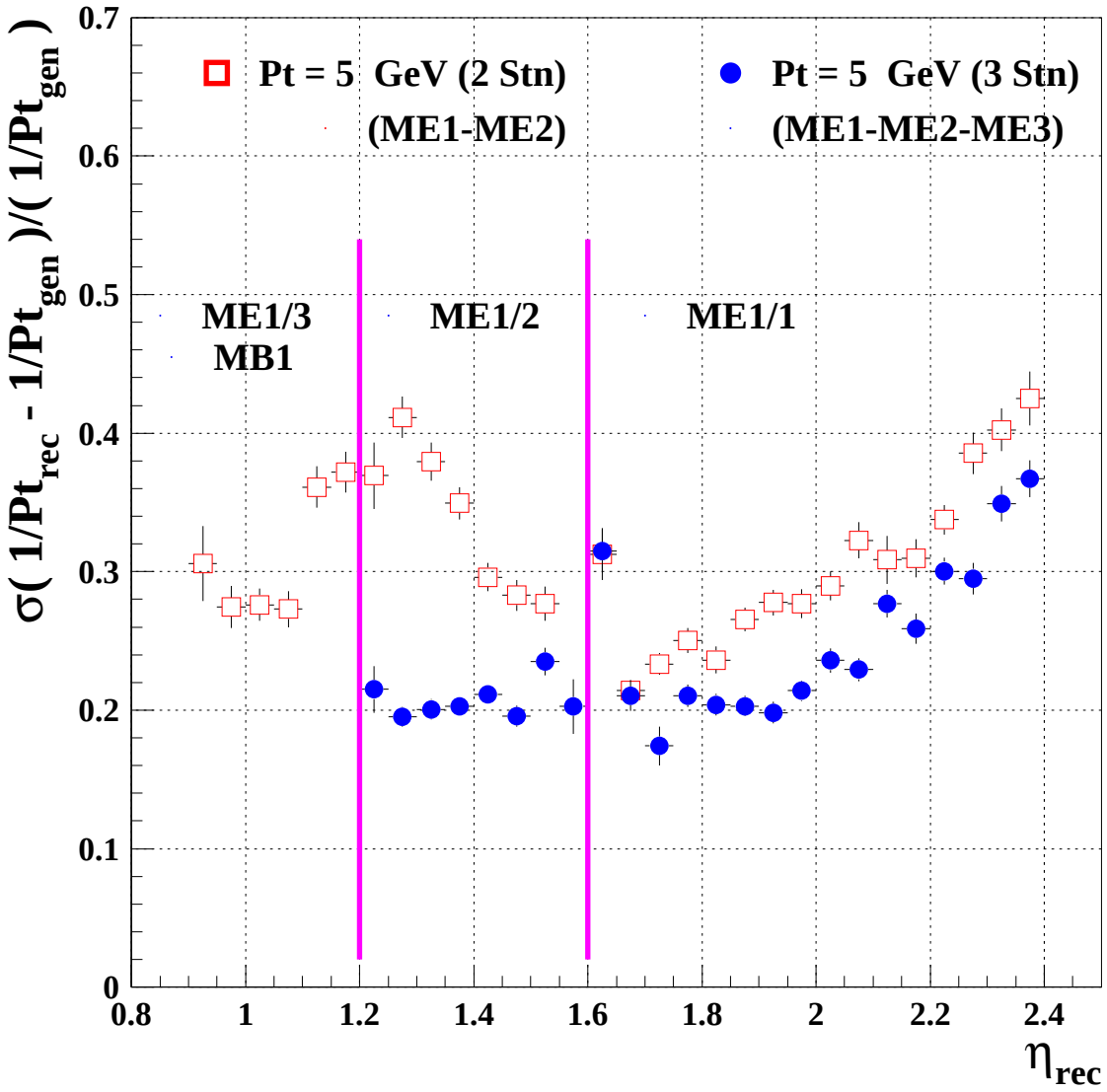
- Require that the 1/Pt resolution to be 30% or better for the the trigger rate to be below 1 kHz per unit rapidity

Using ϕ of LCTs measured in 3 CSC stations



- Contributions from low Pt muons can be well separated from the muons of higher Pt when ϕ of the LCTs are measured in 3 stations
  $\Rightarrow$ improves the 1/Pt resolution at low Pt

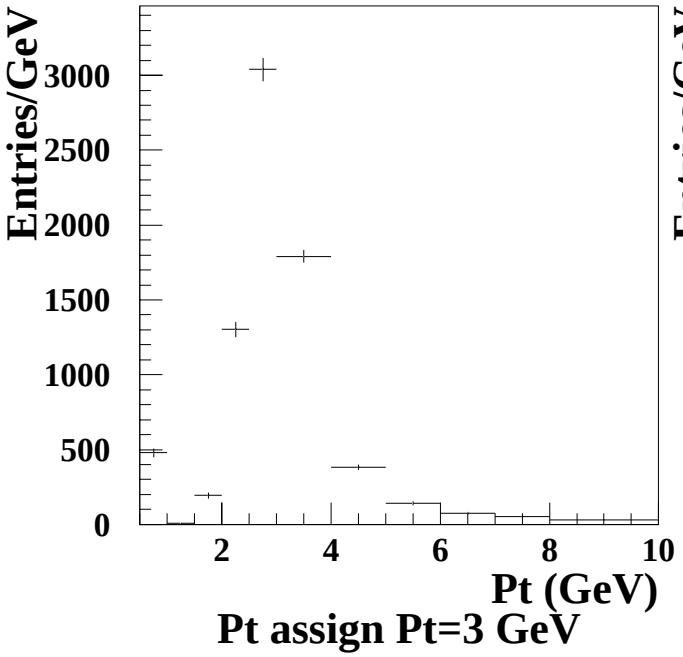
Pt Measurement using 2 VS 3 CSC stations

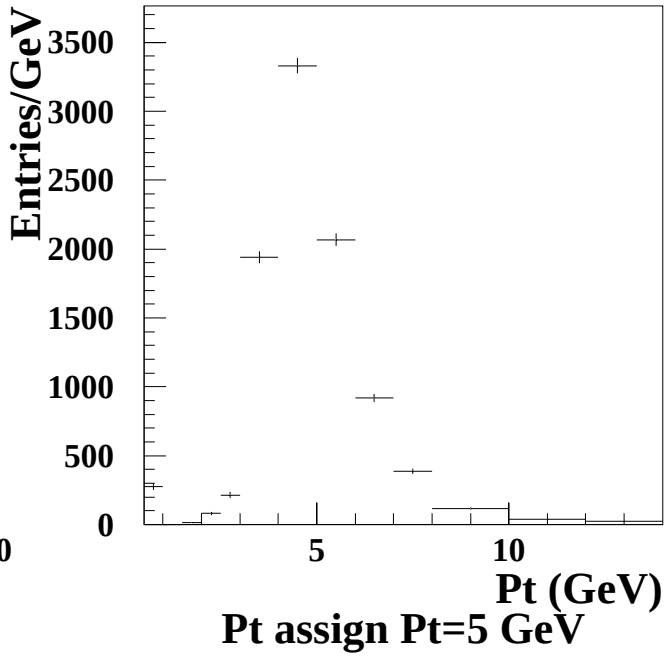


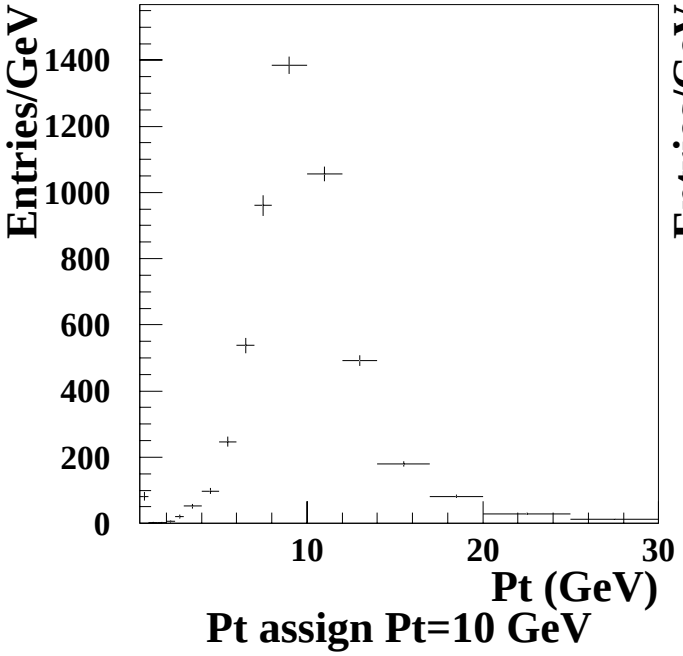
- Significant improvement in the 1/Pt resolution using 3 CSC stations

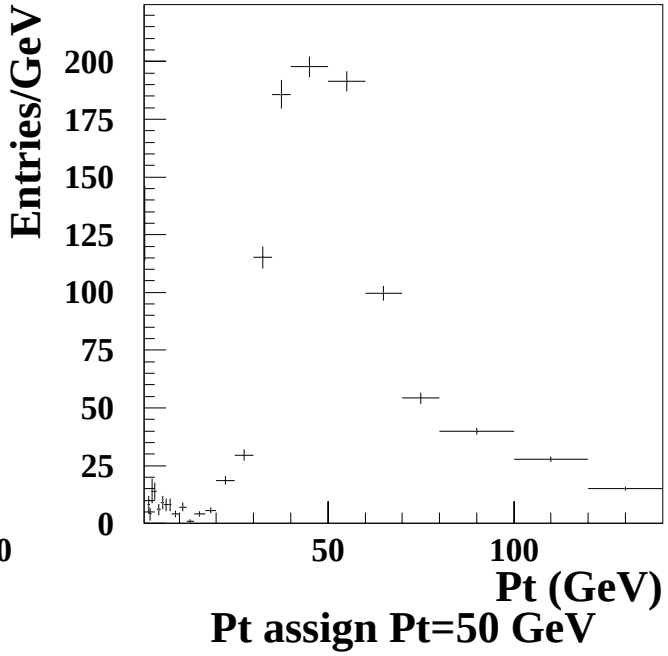
Pt Distributions from Pt Assignment Unit

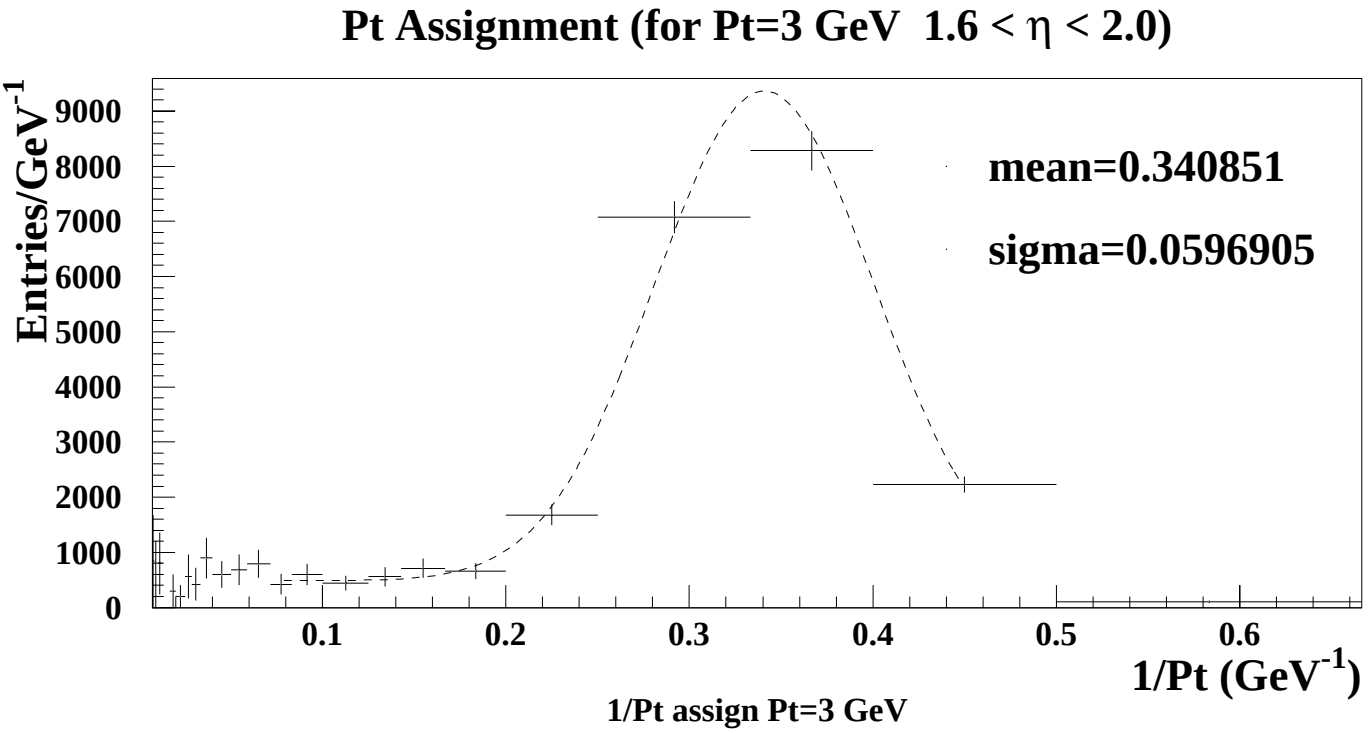
- Single muon events generated at fixed Pt

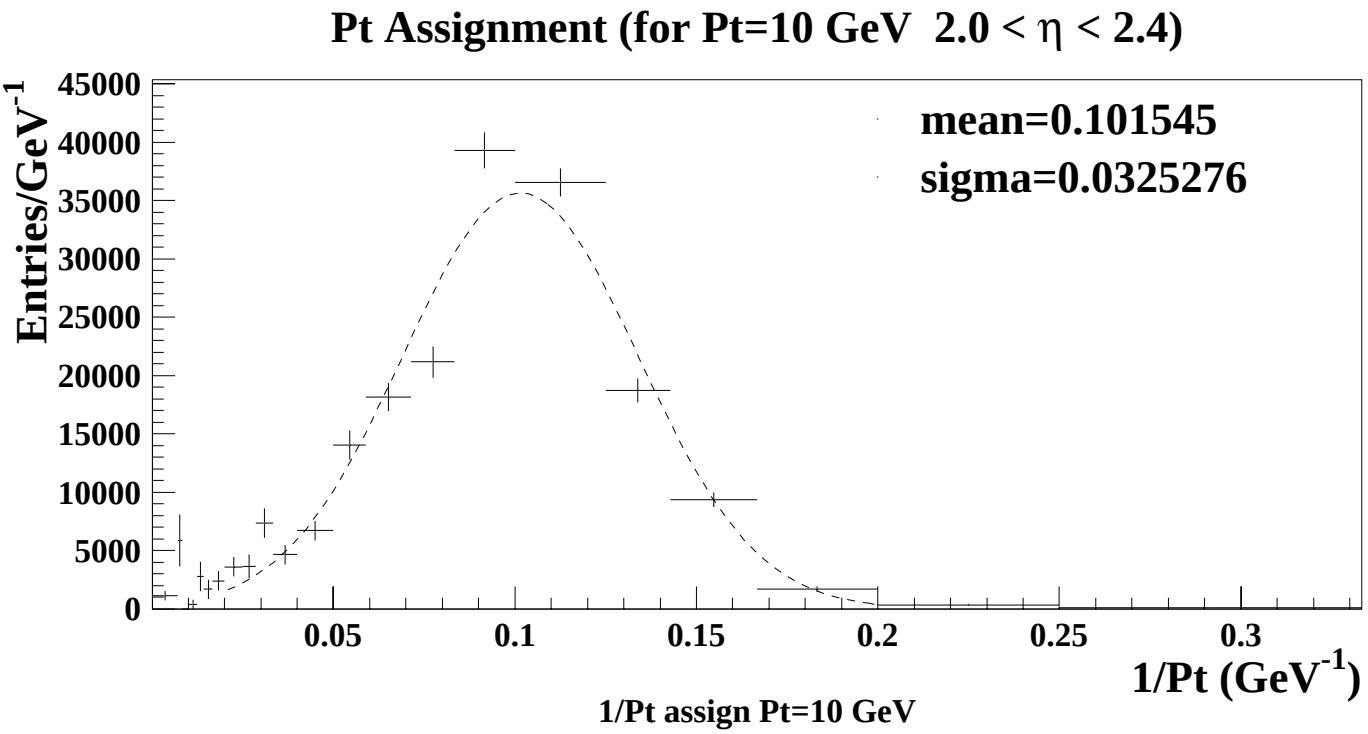








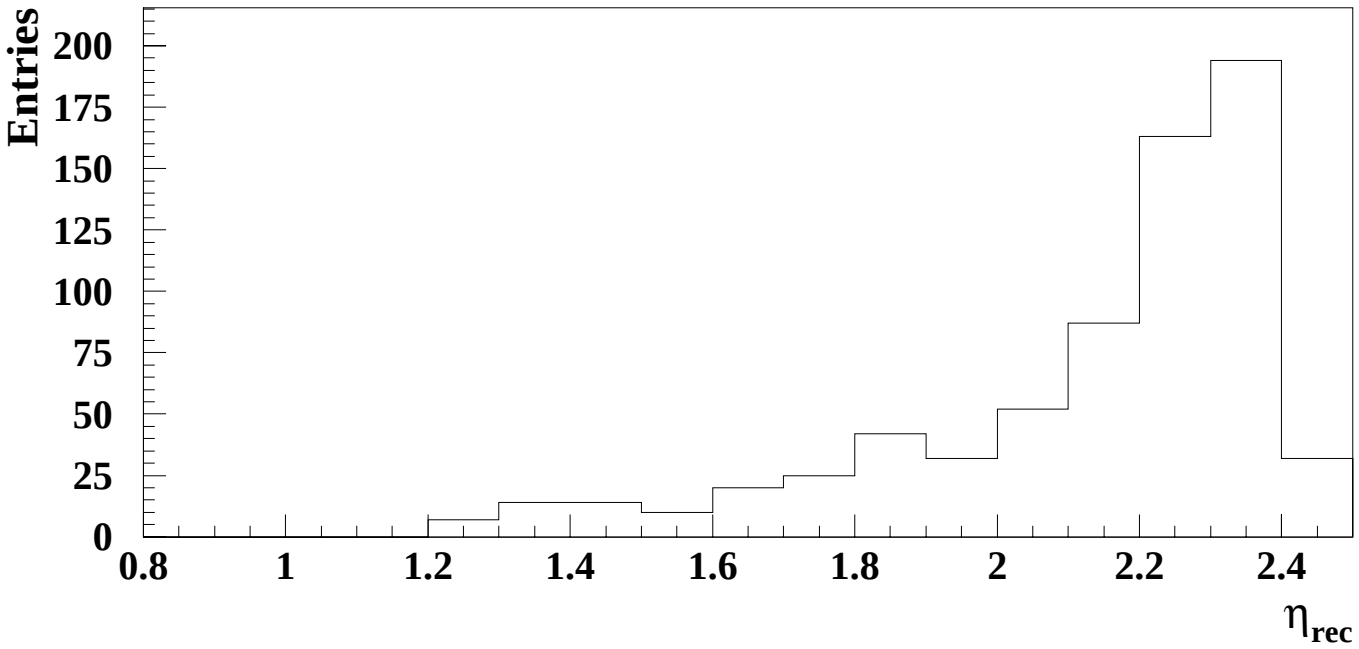

Pt Assignment (for Pt=3 GeV 1.6 < η < 2.0)
Entries/GeV-1
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0.1
0.2
0.3
0.4
0.5
0.6
1/Pt (GeV-1)
mean=0.340851
sigma=0.0596905
1/Pt assign Pt=3 GeV


Pt Assignment (for Pt=10 GeV 2.0 < η < 2.4)
Entries/GeV-1
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
0.05
0.1
0.15
0.2
0.25
0.3
1/Pt (GeV-1)
mean=0.101545
sigma=0.0325276
1/Pt assign Pt=10 GeV

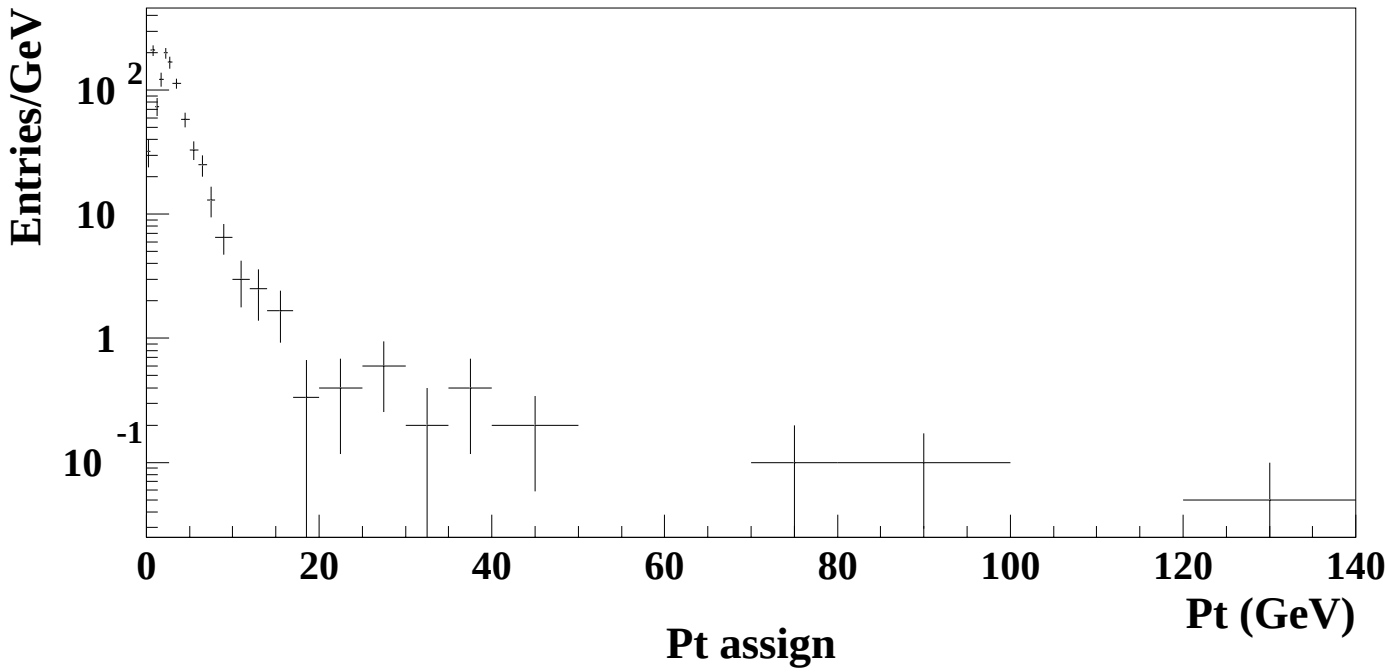
Trigger Studies on Minimum Bias Events

- Generated $\sim$ 500 k min. bias events with Pythia
- The events were sent through detector simulation (CMSIM 116)
- The Fortran version of the CSC Track Finder simulation was used to search for tracks in CSC
- Only trigger on tracks that contain a track stub in ME1
- Studies limit to the Endcap region only

η Distribution of Tracks Found in CSC



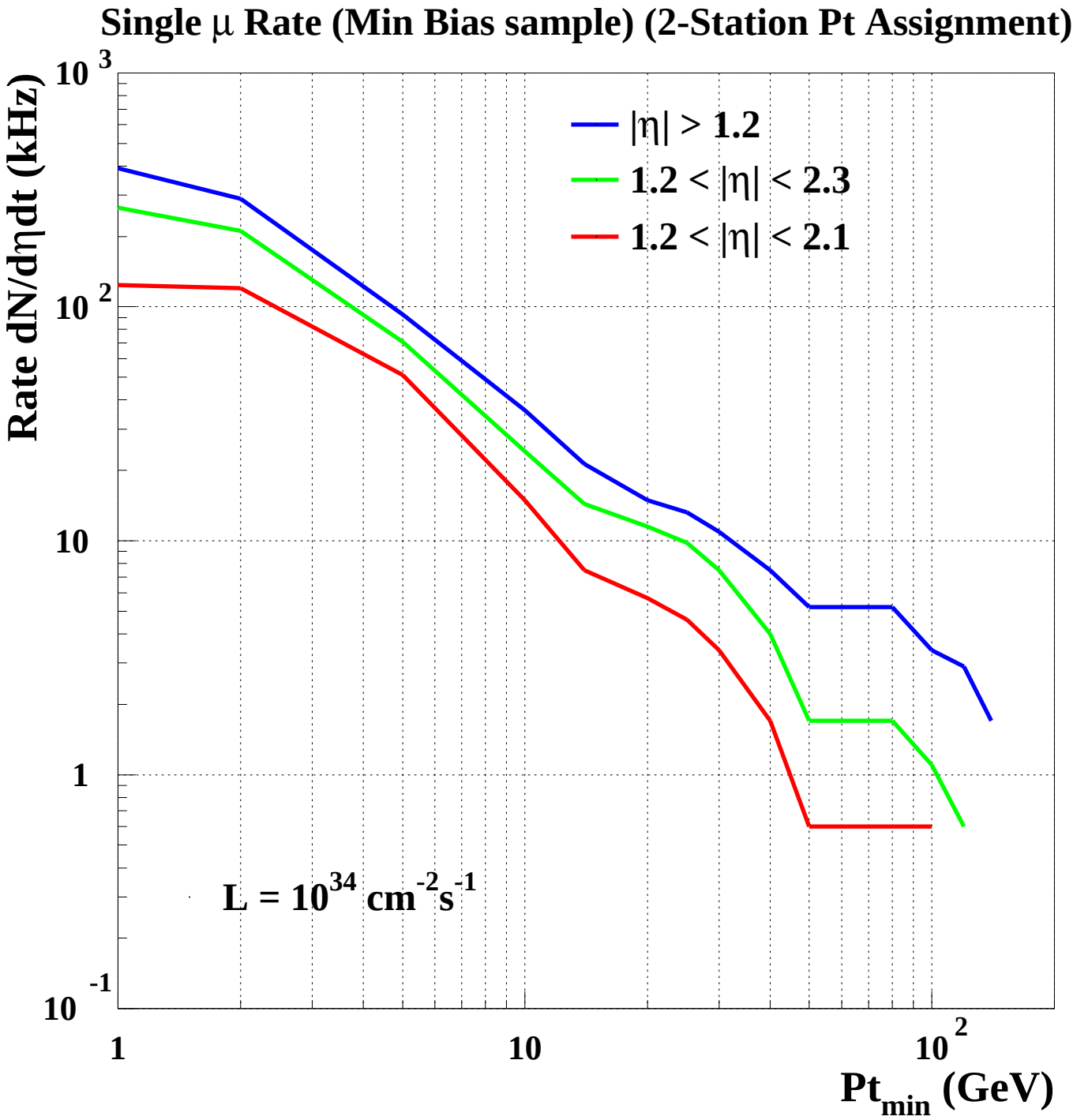
Pt Distribution of Tracks Found in CSC

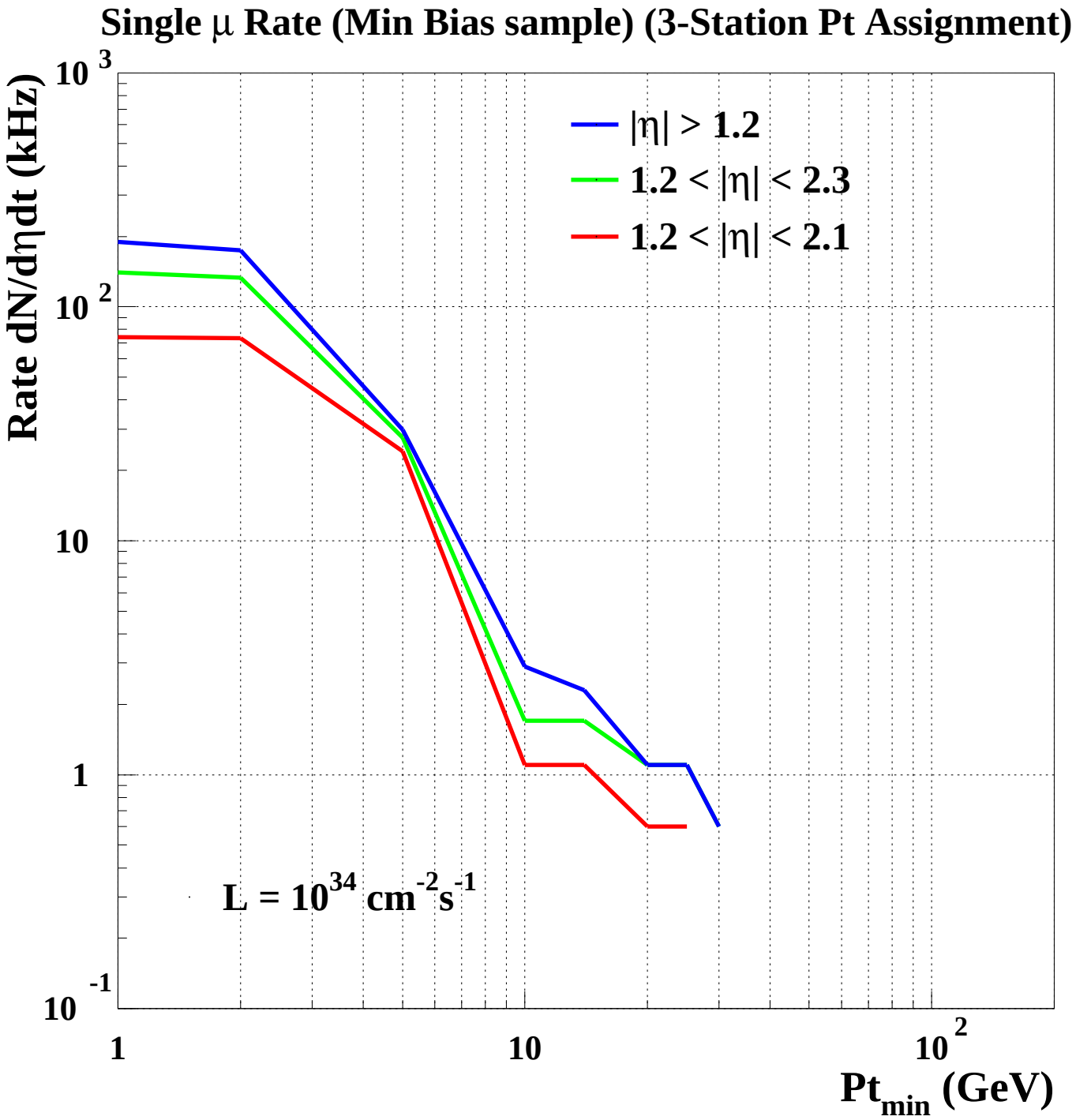


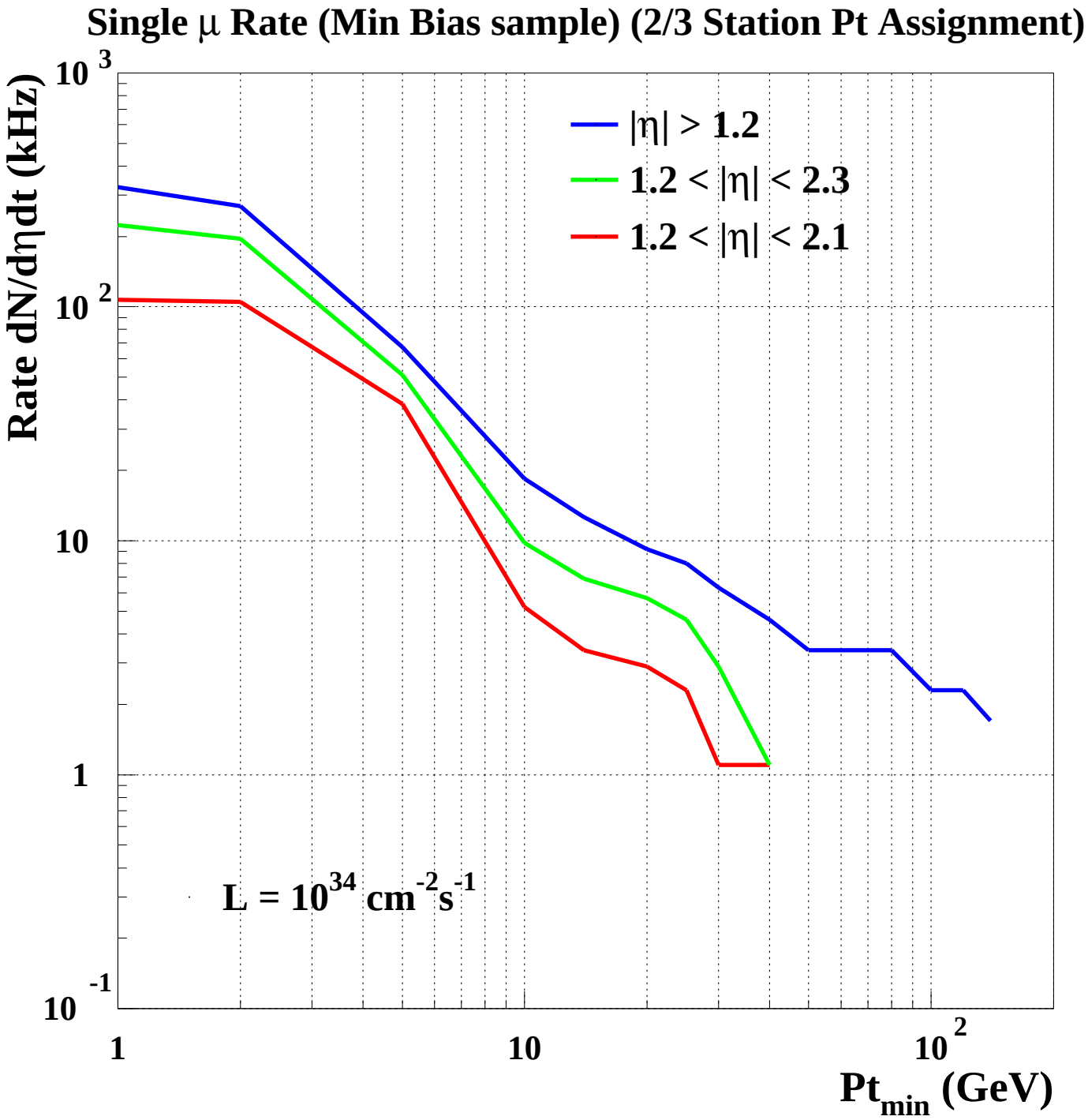
Preliminary Estimate of Single Muon Rate

Rates are estimated for :

- Pt reconstructed using 2-stns or 3-stns only, or 2/3-stns
- in different η ranges
  $1.2 <\mid \eta \mid < 2.1, \quad 1.2 <\mid \eta \mid < 2.3, \quad \mid \eta \mid > 1.2$


Single μ Rate (Min Bias sample) (2-Station Pt Assignment)
Rate dN/dηdt (kHz)
10 3
10 2
10
1
10 -1
1
10
10 2
Pt min (GeV)
|η| > 1.2
1.2 < |η| < 2.3
1.2 < |η| < 2.1
L = 10 34 cm -2 s -1


Single μ Rate (Min Bias sample) (3-Station Pt Assignment)
Rate dN/dηdt (kHz)
10 3
10 2
10
1
10 -1
1
10
10 2
Pt min (GeV)
|η| > 1.2
1.2 < |η| < 2.3
1.2 < |η| < 2.1
L = 10 34 cm -2 s -1


Single μ Rate (Min Bias sample) (2/3 Station Pt Assignment)
Rate dN/dηdt (kHz)
10 3
10 2
10
1
10 -1
1
10
10 2
Pt min (GeV)
|η| > 1.2
1.2 < |η| < 2.3
1.2 < |η| < 2.1
L = 10 34 cm -2 s -1

Preliminary results show that:

- Rates using 3-station Pt assignment is an order of magnitude lower than rates using 2-station Pt assignment (for $\mathrm{Pt}_{\mathrm{min}} > 10$ GeV)
- Trigger rates can also be greatly reduce if one limits to tracks in the region $\mid \eta \mid < 2.1$

Summary/Plans

- Now have Fortran and C++ versions of the CSC Track-Finder simulation
- Simulation shows high efficiency in finding high Pt tracks
- Pt resolution improves significantly when 3 CSC stations are used in the determination of Pt
- Perform simulation studies using C++ version of Track-Finder
- Include Pt Assignment for Overlap region
- Generate weighted M.B. events (to increase statistics at high Pt)
- Study di-muon rate