



Results from CSC Track-Finder Simulation

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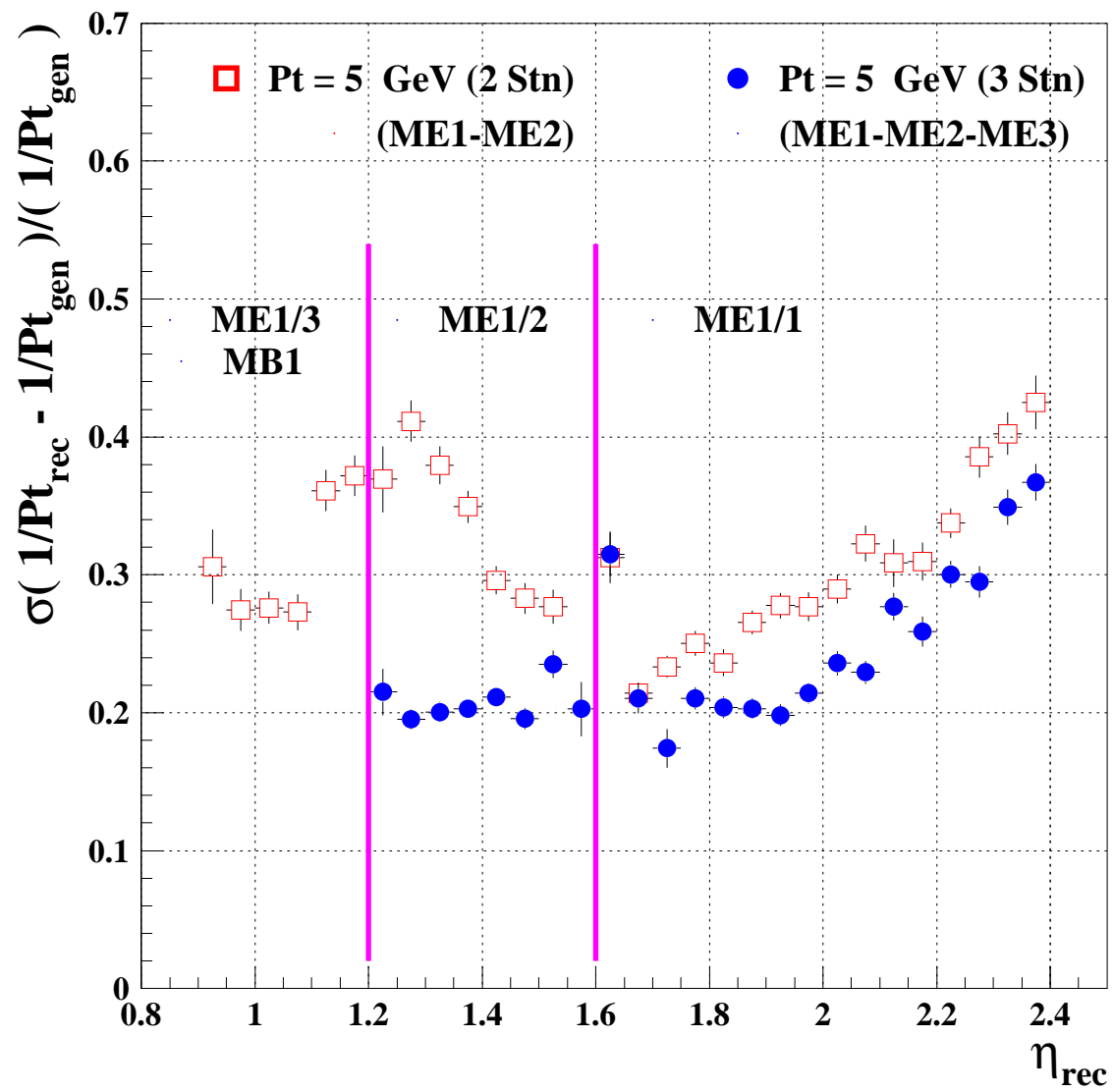
EMU Meeting
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Outline :

- Re-visit Single Track Finding Efficiency
 - using LCT efficiency at 95%, 90%
 - No ME4, or ME4/1 only, or ME4/2 only
 - effect on Single Muon Rate
- Ghostbusting in CSC Track Finder

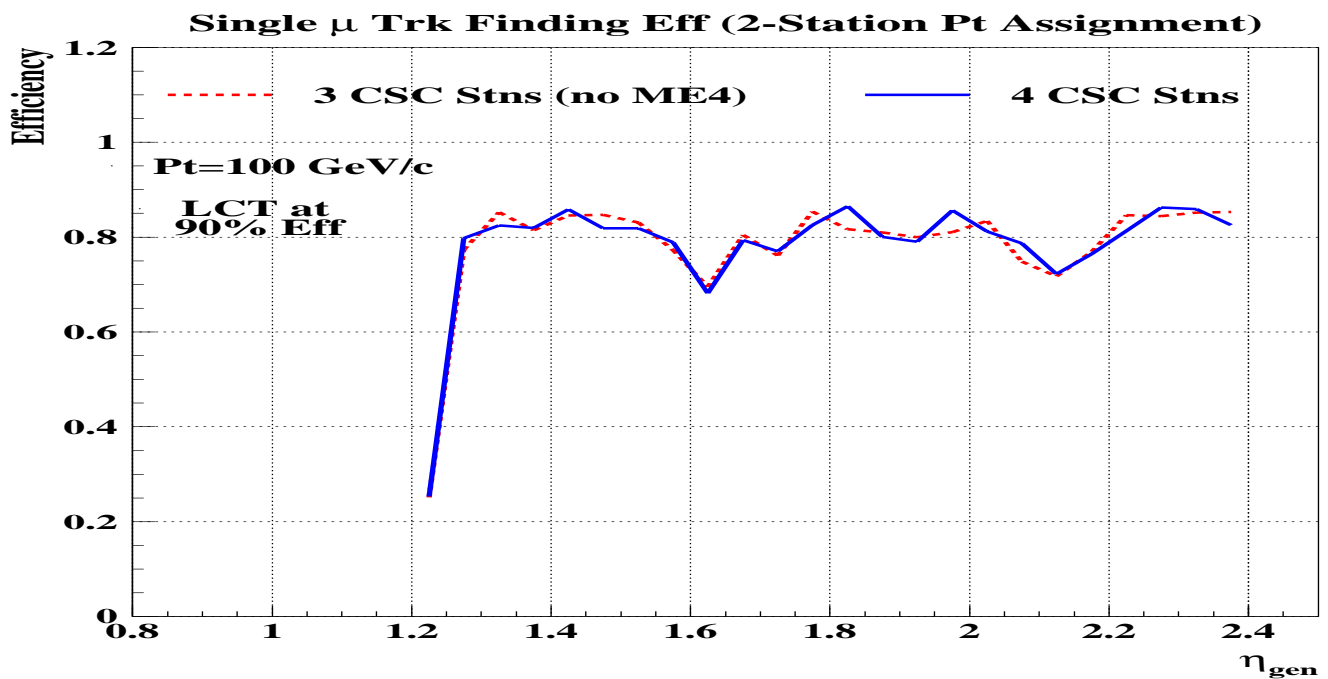
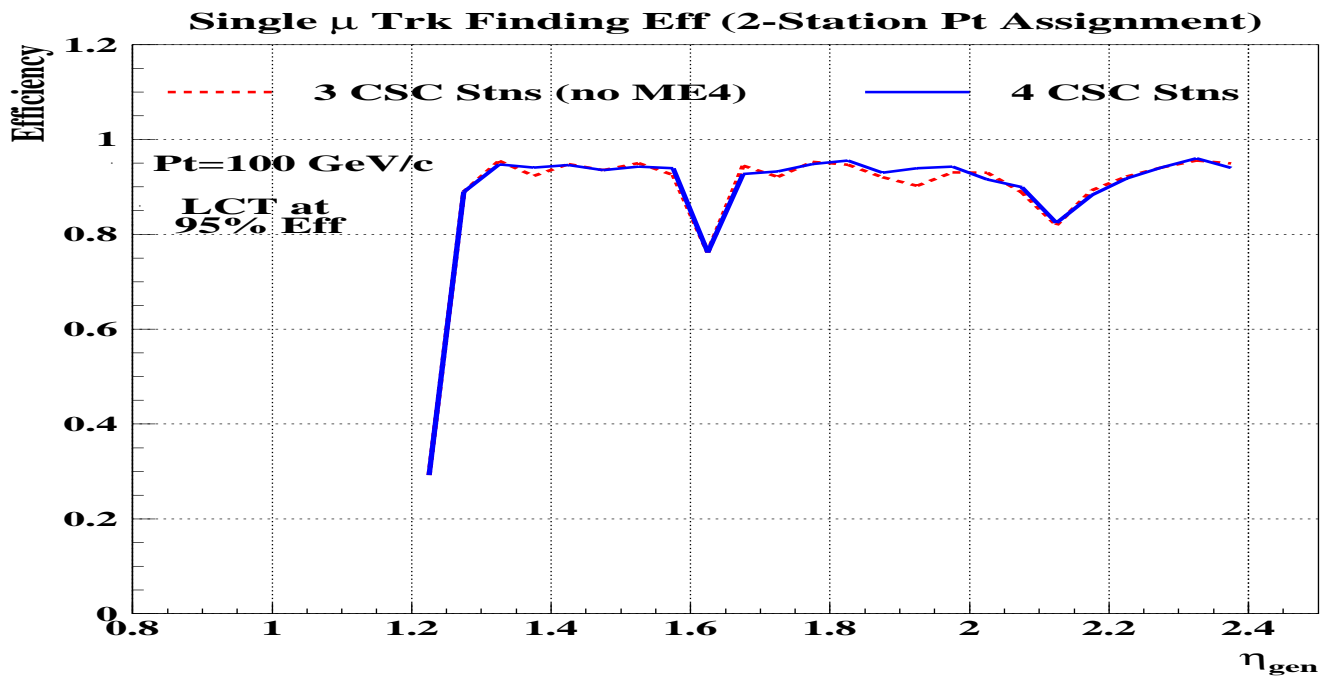
Single Muon Trigger Efficiency

- Track-Finder performs Pt assignment based on either 2-station or 3-station sagitta measurements
- Require one LCT measured in ME1 for good Pt resolution
- Motivation for using 3-station sagitta measurement \Rightarrow to improve the resolution of Pt measurement for low Pt tracks
- **2-Stn Pt measurement Track Types**
ME1-ME2-X-X
ME1-ME3-X (when there is no LCT in ME2)
 \Rightarrow does not matter if no ME4
- **3-Stn Pt measurement Track Types**
ME1-ME2-ME3-X
ME1-ME2-ME4 (when there is no LCT in ME3)
ME1-ME3-ME4 (when there is no LCT in ME2)
 \Rightarrow only restrict to type ME1-ME2-ME3 if no ME4
- Use old LCT simulation in CMSIM (Acosta, Rowe) to simulate trigger primitives
- Standalone Fortran code was used to simulate CSC Track Finder
- Exist a C++ version of Track Finder

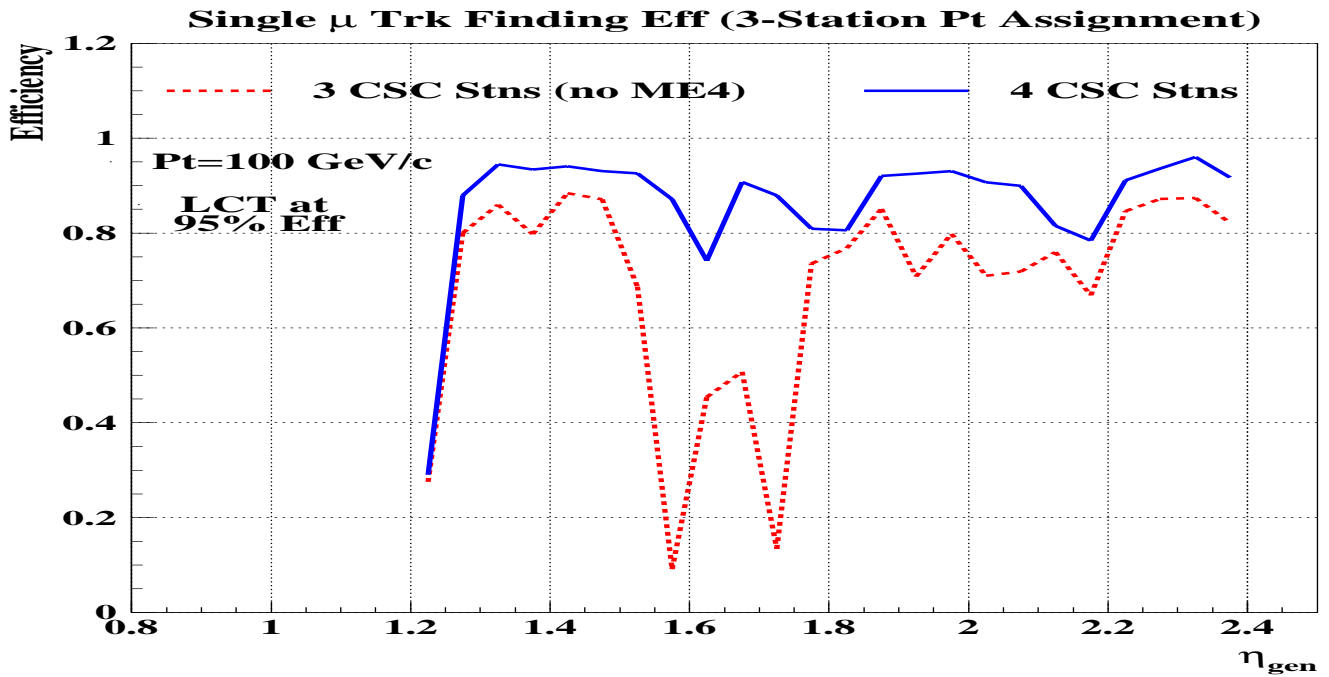


Track Finding Eff vs η (2-Stn Pt Measurement)

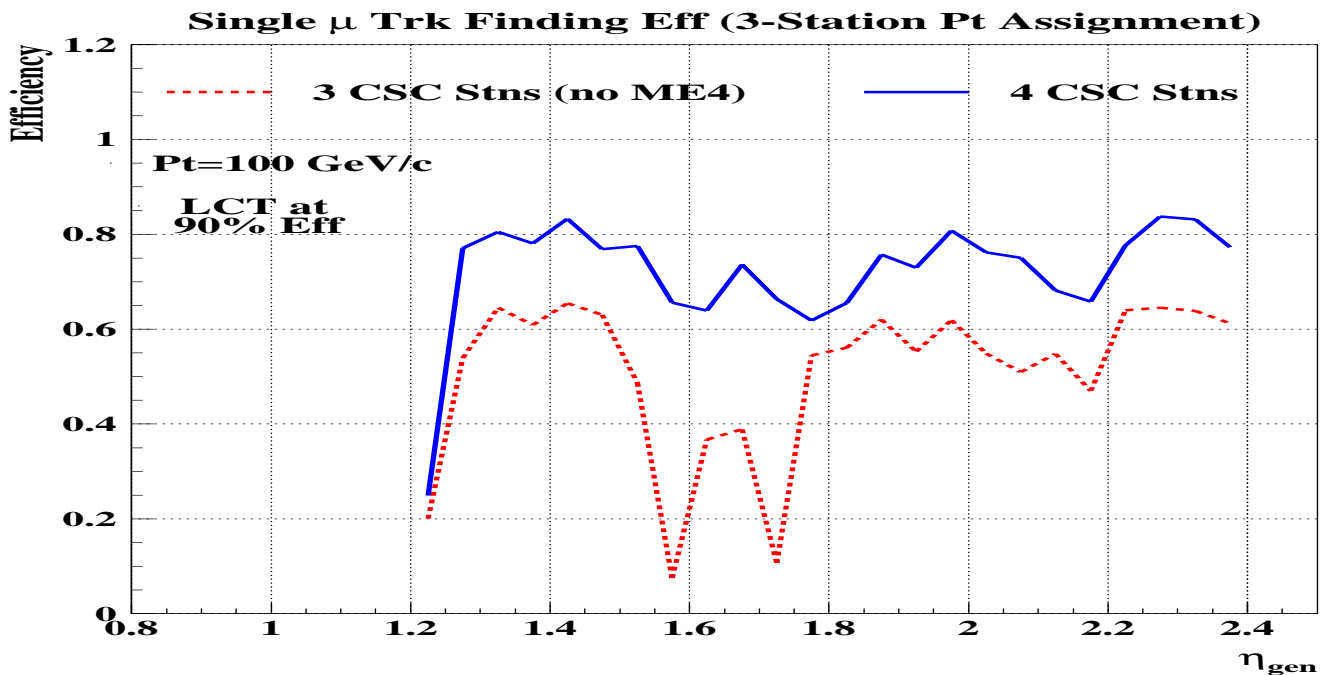
- LCT efficiency in CMSIM (old LCT simulation) is $\approx 97\%$
- Use statistical treatment to lower the efficiency to 95% and 90%



Track Finding Eff vs η (3-Stn Pt Measurement)

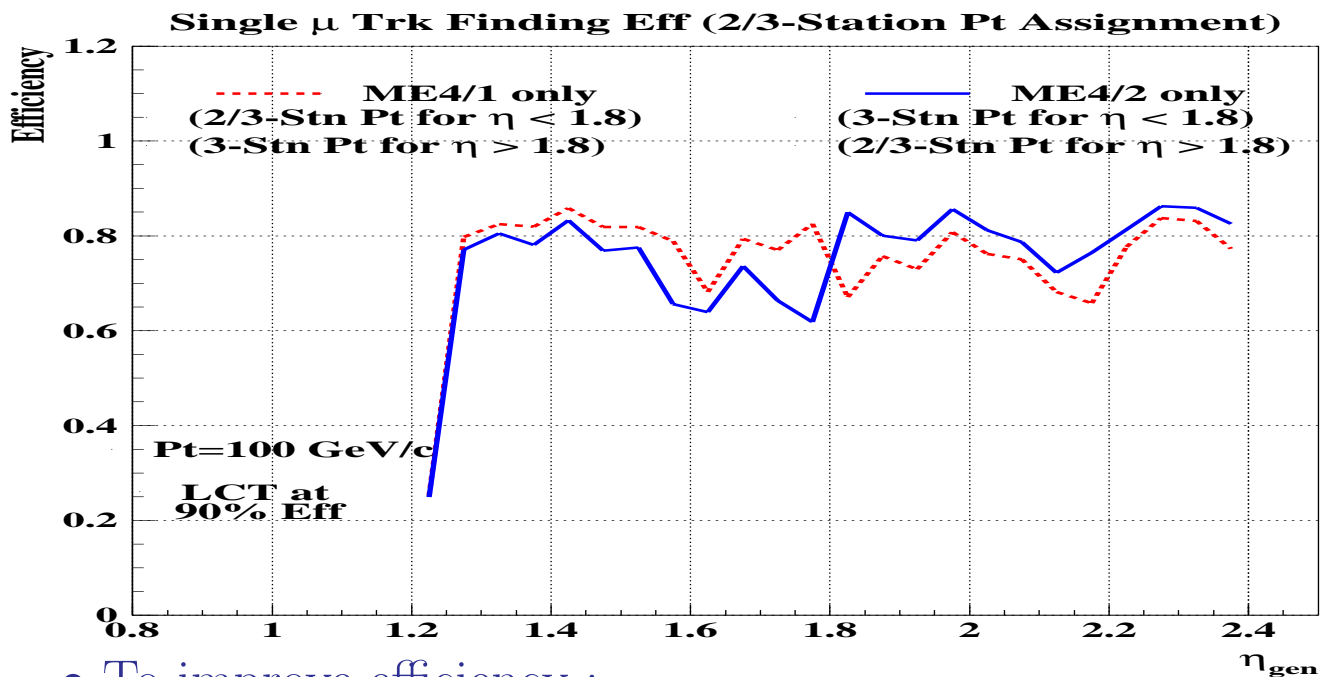
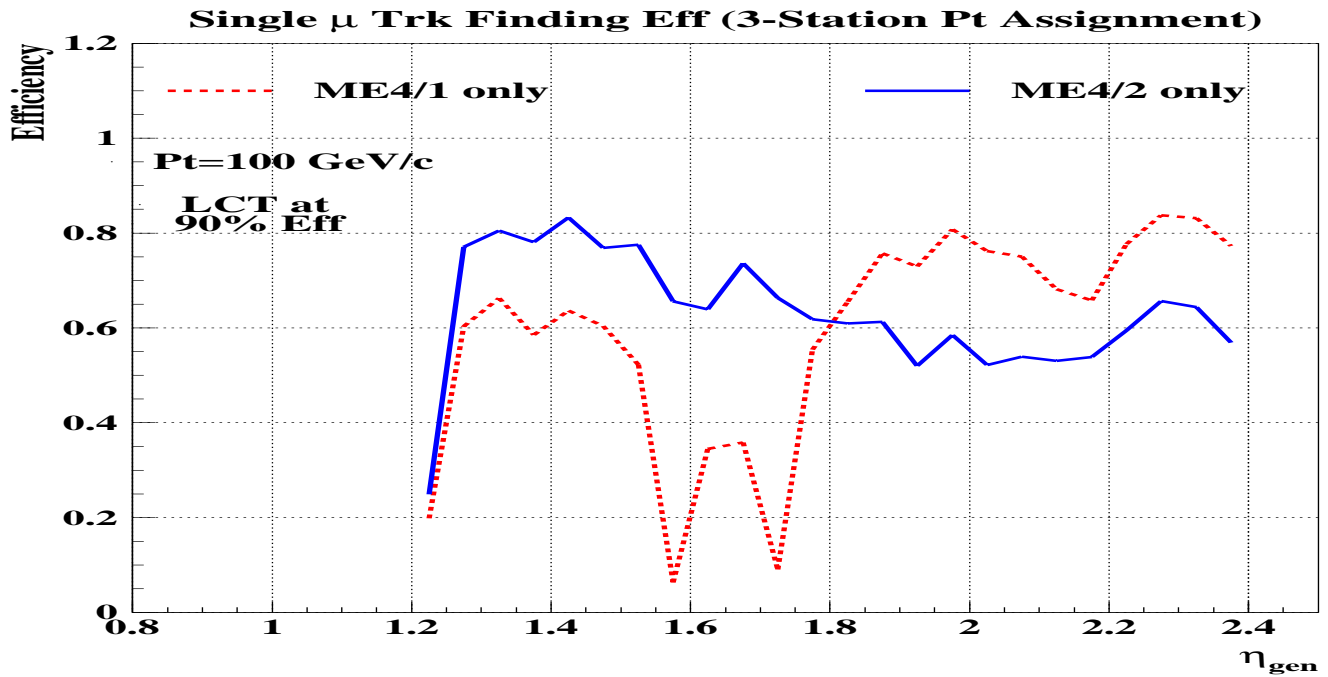


- If trigger to $|\eta| \lesssim 2.1$, \Rightarrow higher efficiency with ME4/2

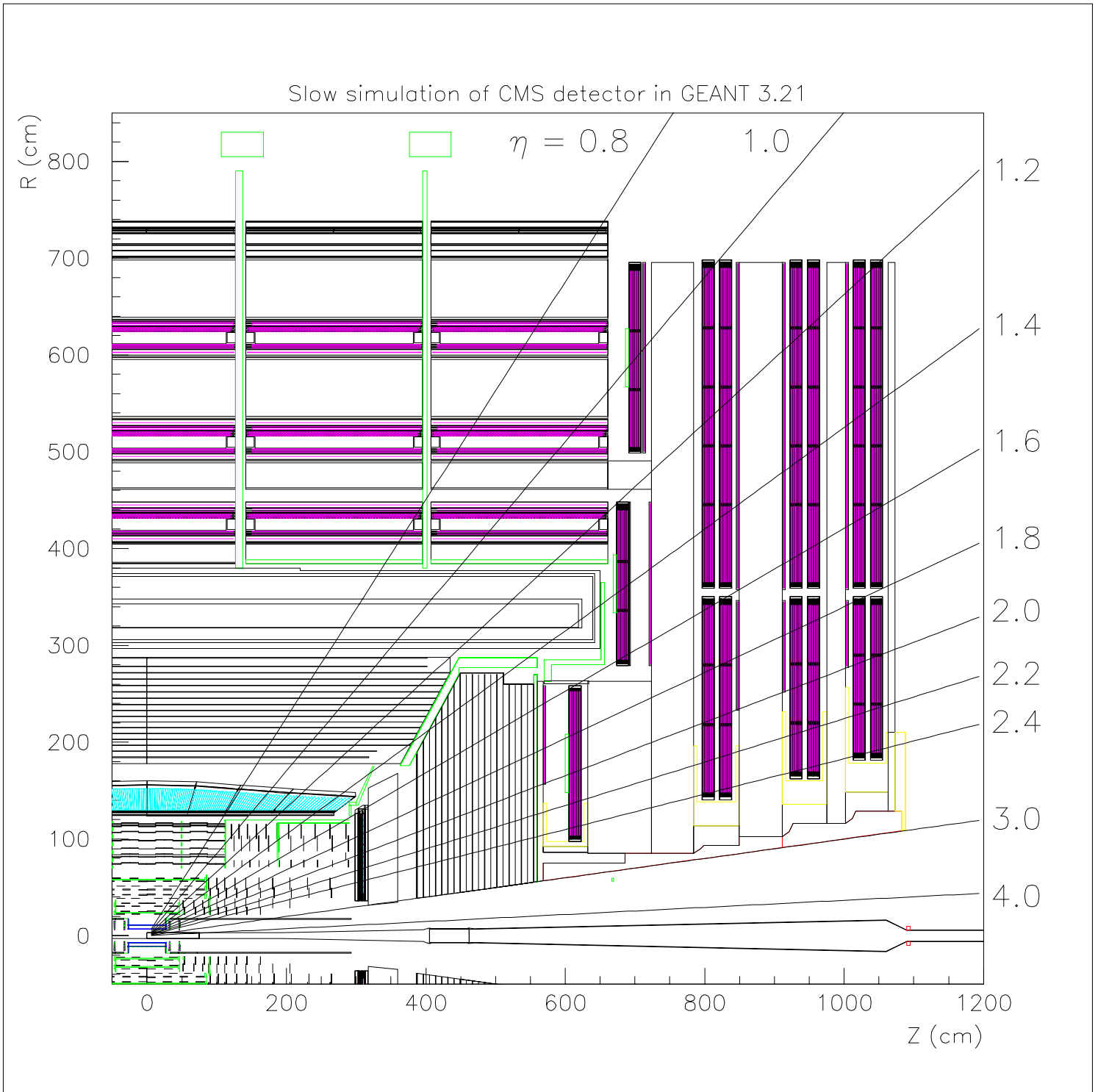


- Dips at $\eta \sim 1.6, 1.7$ are due to gaps in ME2 and ME3

Track Finding Eff vs η (ME4/1 only, or ME4/2 only)



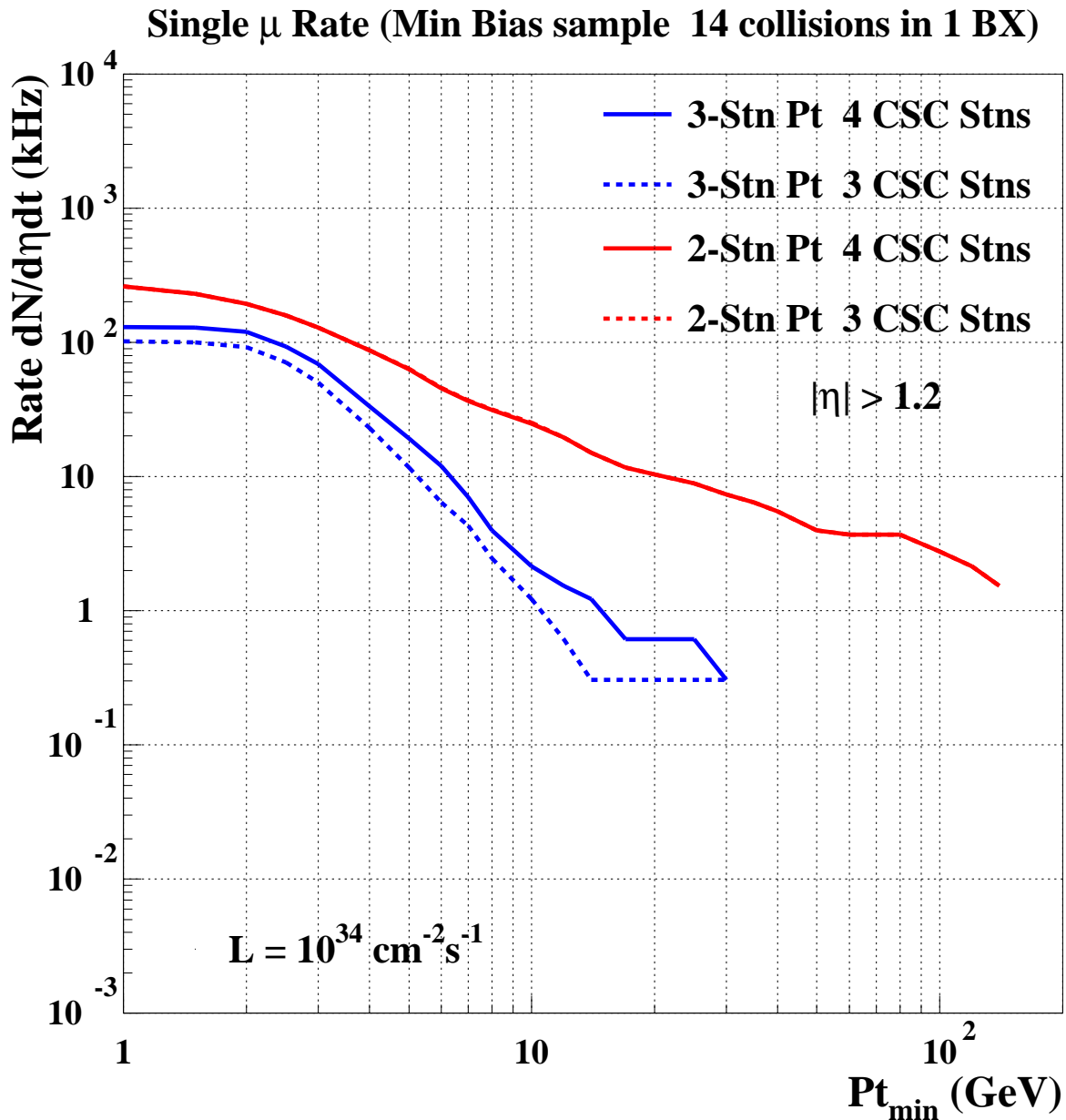
- To improve efficiency :
 - Use 2-Stn or 3-Stn Pt measurements in η region with no ME4
 - Use 3-Stn Pt measurement in η region with ME4



- ME4/1 and ME4/2 are separated at $\eta \approx 1.8$

L1 CSC Single μ Trigger Rate (per unit rapidity)

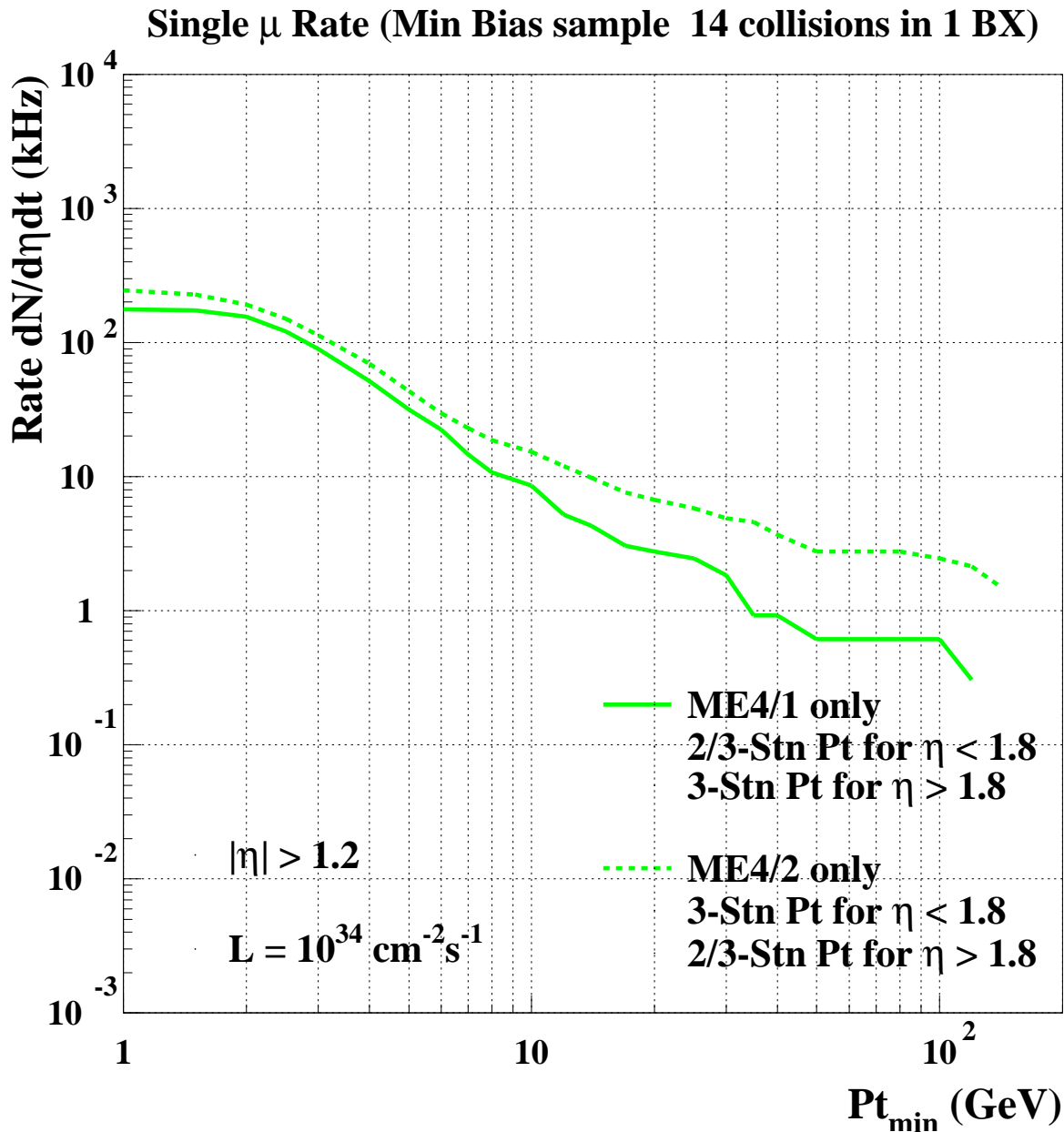
- Rates for cases with 4, or 3 CSC (no ME4) stations
- Rates for using 2-Stn, or 3-Stn Pt Measurements
- Consider trigger rate in the range $1.2 < \eta < 2.4$



- NOTE: LCT efficiency is $\approx 97\%$ (from CMSIM), did not perform additional statistical treatment to lower the efficiency.

L1 CSC Single μ Trigger Rate (per unit rapidity)

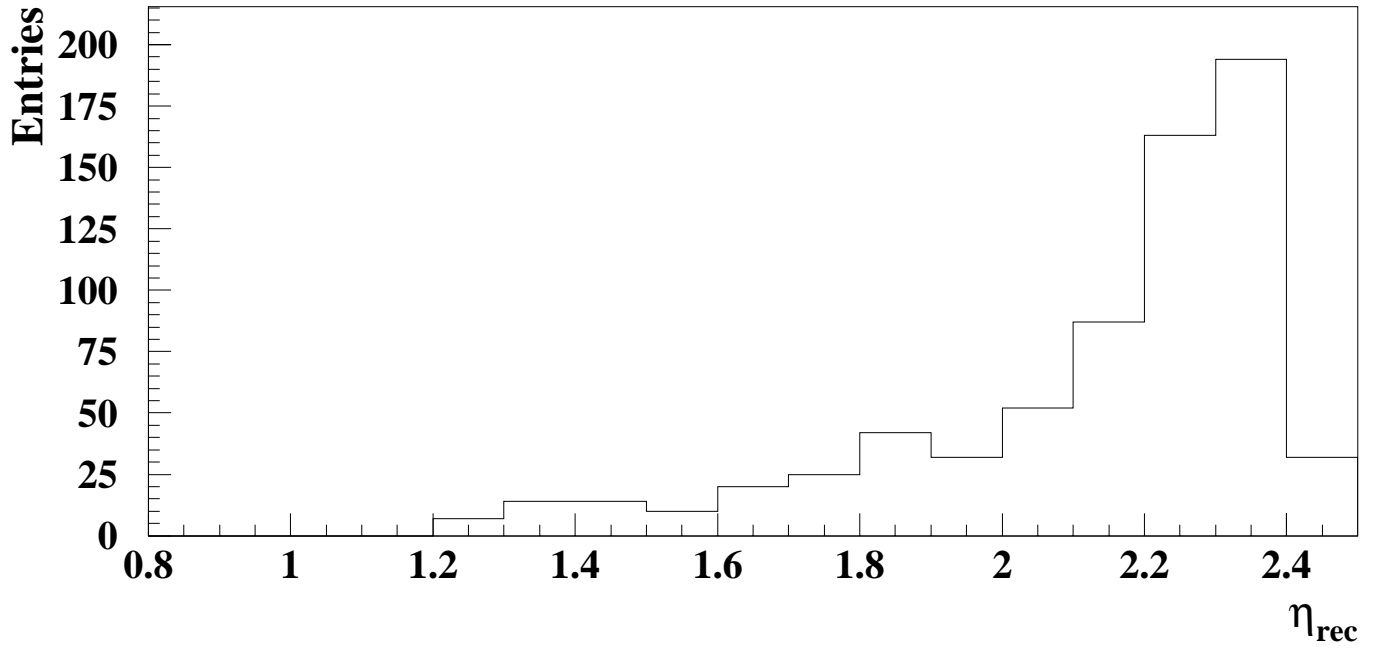
- Rates for cases with 3 full CSC stations + ME4/1 or ME4/2
- Consider trigger rate in the range $1.2 < \eta < 2.4$



- Rate from “ME4/1 only” is lower than “ME4/2 only” because most of the soft muons (Min. Bias) are at high η

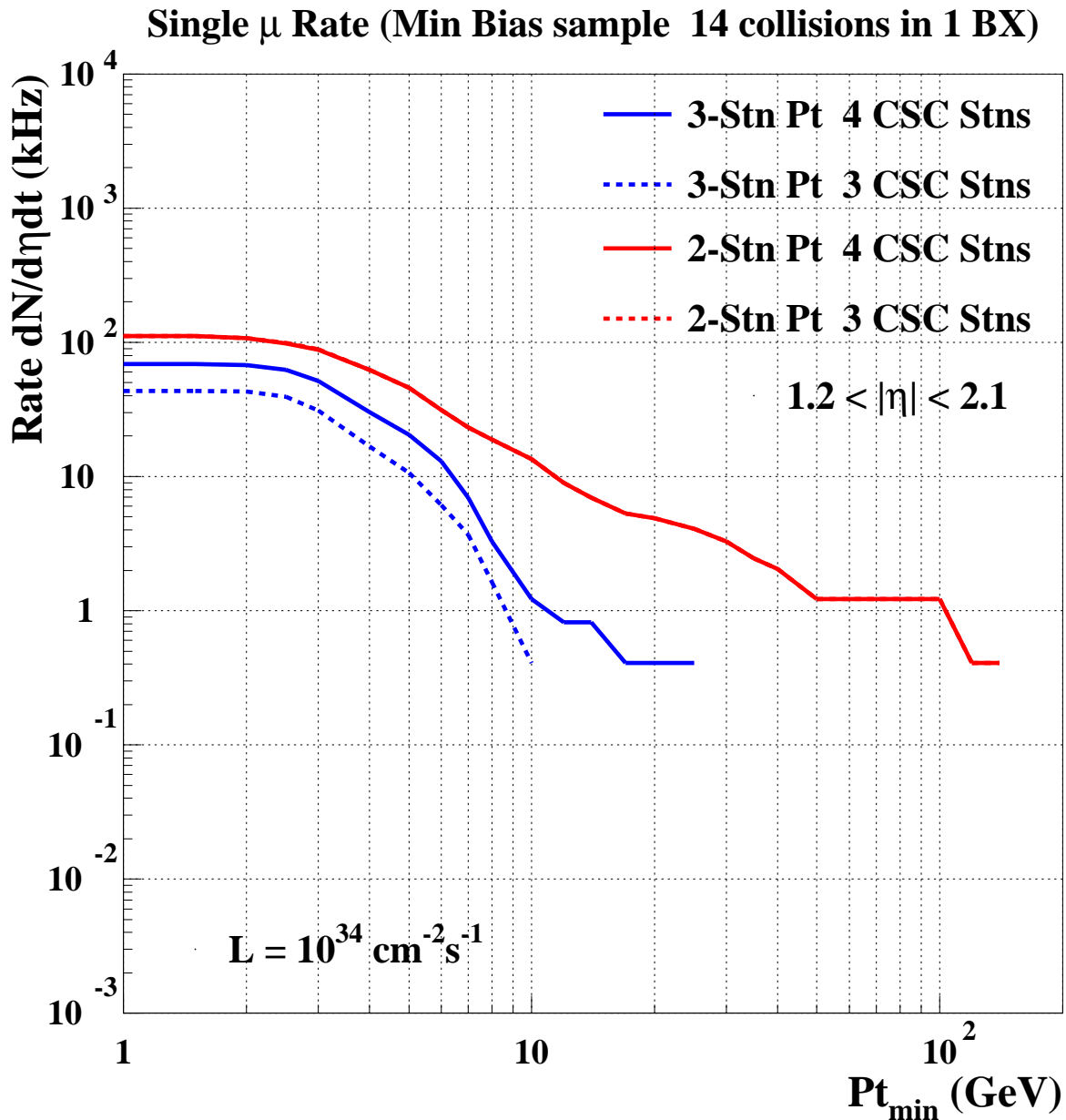
- At high lumi ($L \sim 10^{34} \text{cm}^{-2} \text{s}^{-1}$), need to apply a threshold at $\sim 35 \text{ GeV}/c$ for the case “ME4/1 only” (to stay at 1 kHz rate). **May not be low enough due to many uncertainties in the single muon rate**
 - At low lumi ($L \sim 10^{33} \text{cm}^{-2} \text{s}^{-1}$), need to apply threshold at :
 - $\sim 20 \text{ GeV}/c$ for using 2-Stn Pt measurement only
 - $\sim 15 \text{ GeV}/c$ for the case “ME4/2 only”
 - $\sim 10 \text{ GeV}/c$ for the case “ME4/1 only”
- \Rightarrow B physics at low lumi !
- $\sim 25\%$ of muons from b quarks enter the region $1.8 < |\eta| < 2.4$ (Acosta)

η Distribution of Tracks Found in CSC



L1 CSC Single μ Trigger Rate (per unit rapidity)

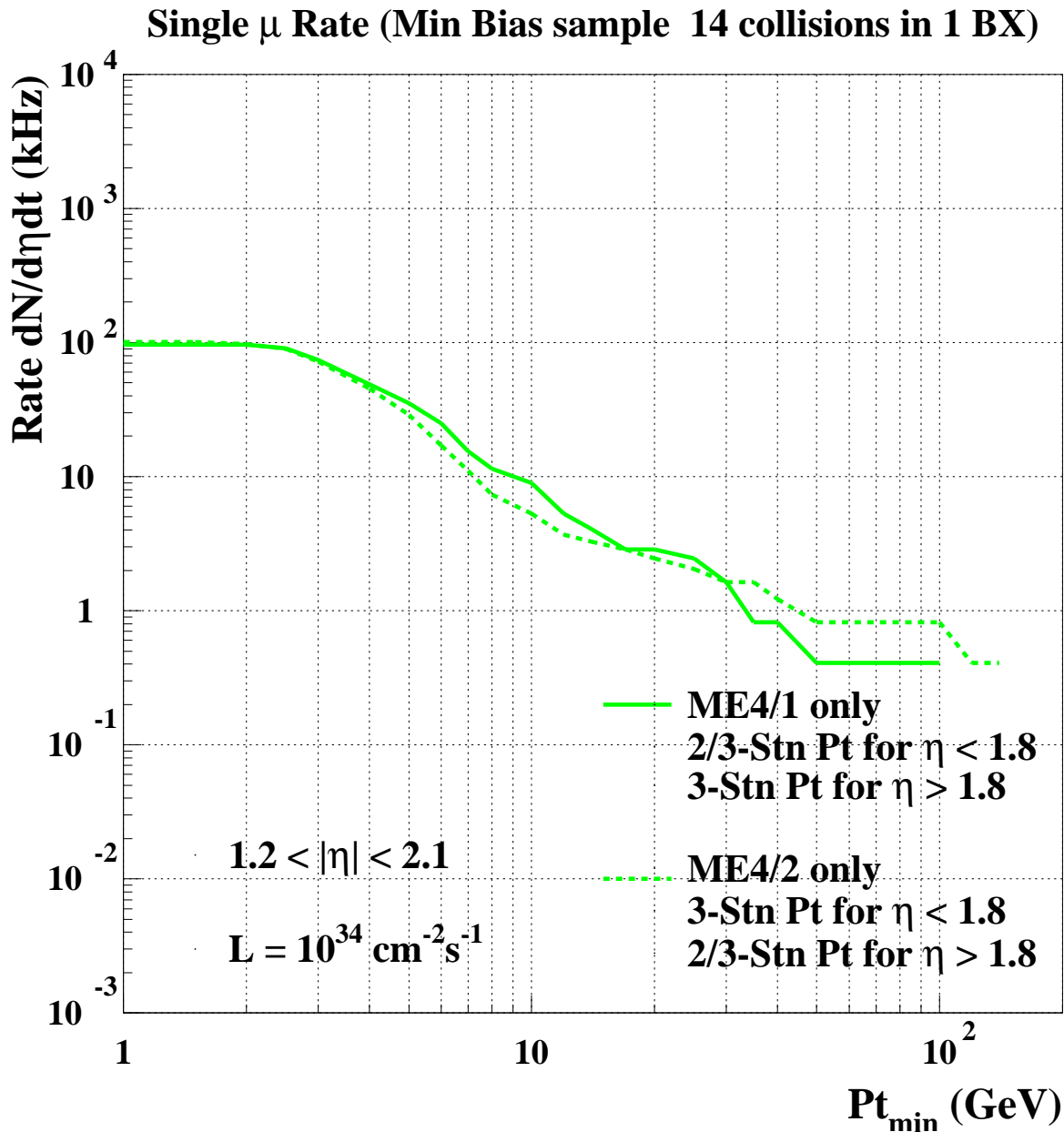
- Rates for cases with 4, or 3 CSC (no ME4) stations
- Rates for using 2-Stn, or 3-Stn Pt Measurements
- Consider trigger rate in the range $1.2 < \eta < 2.1$



- Reduction in rate by excluding high η region
- Can apply lower threshold

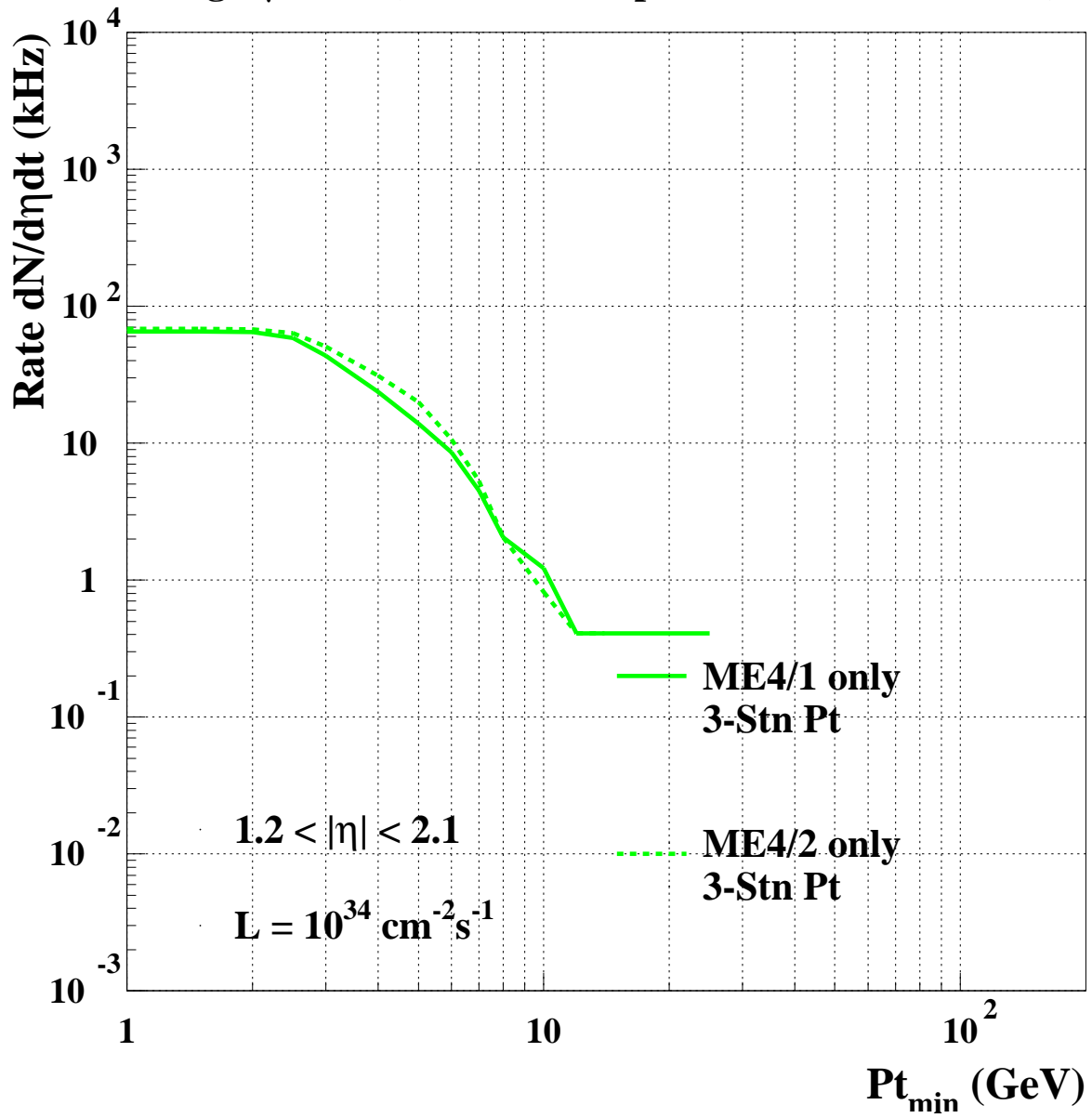
L1 CSC Single μ Trigger Rate (per unit rapidity)

- Rates for cases with 3 full CSC stations + ME4/1 or ME4/2
- Consider trigger rate in the range $1.2 < \eta < 2.1$



- Rate from “ME4/1 only” is similar to “ME4/2 only” because most of the soft muons (Min. Bias) are at high η ($\eta > 2.1$)
- Still need to apply high Pt threshold (at high lumi)

Single μ Rate (Min Bias sample 14 collisions in 1 BX)



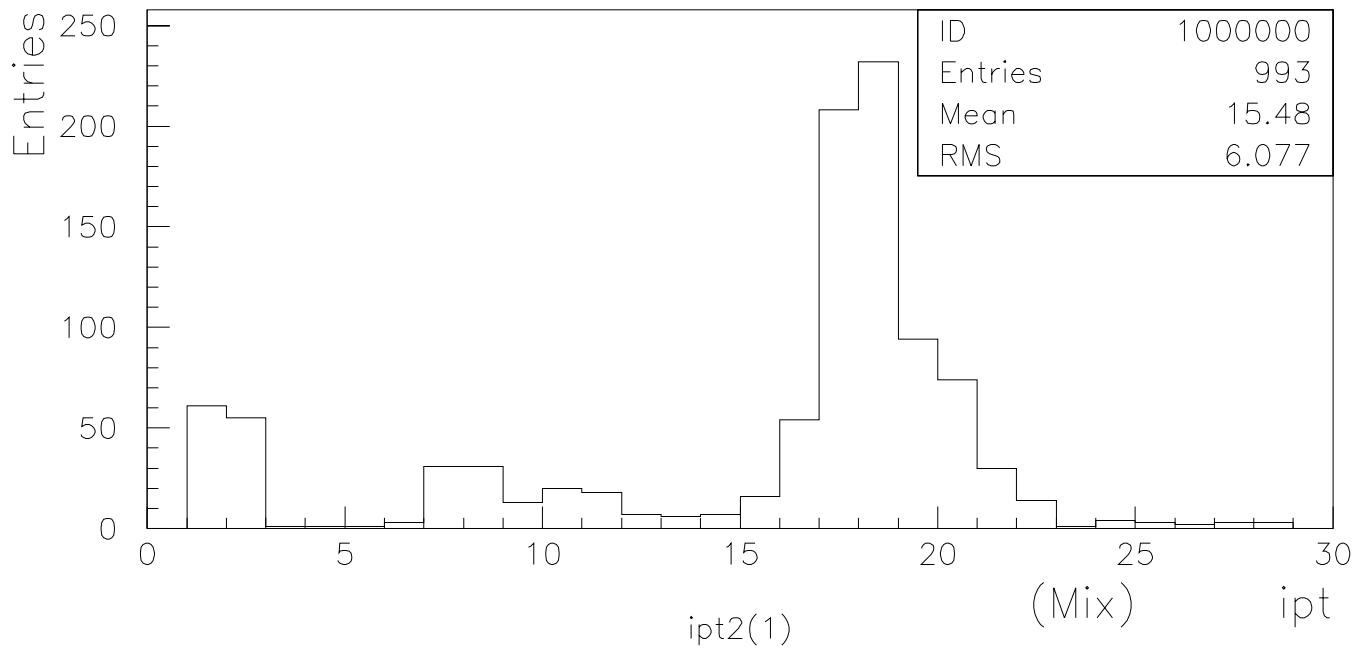
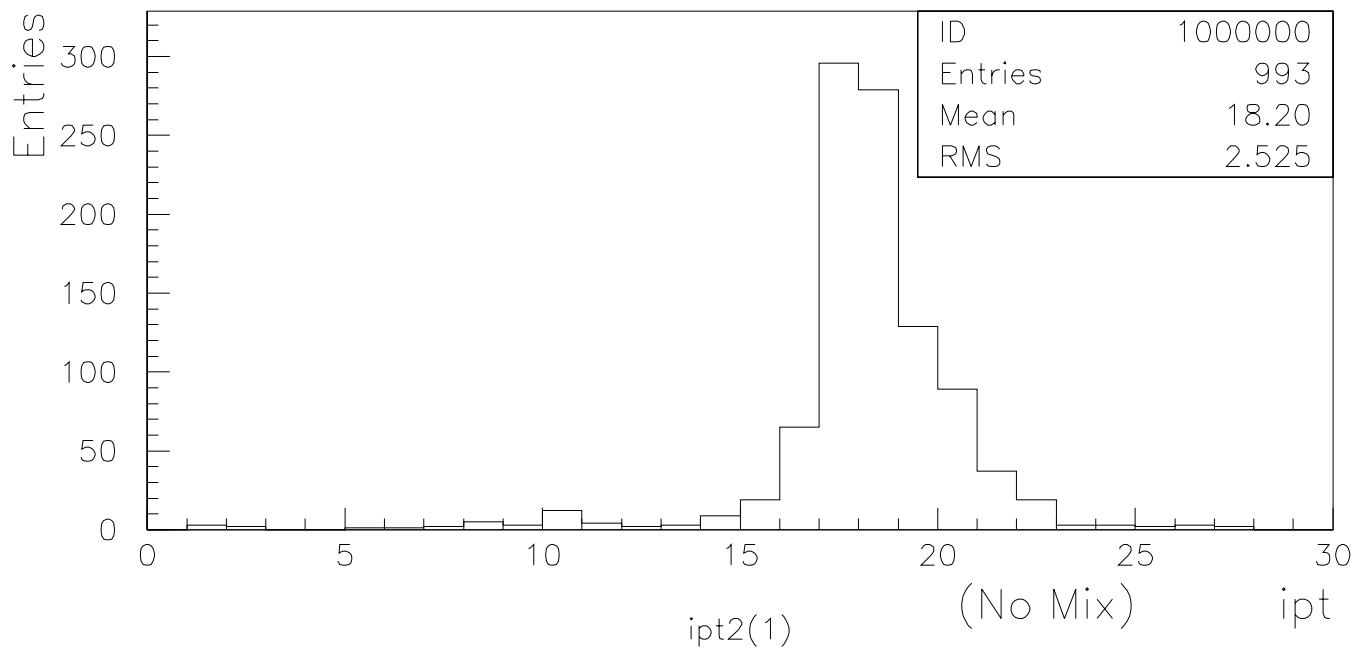
Ghostbusting in CSC Track Finder

- In the original Track Finder design (w/o ghostbusting) the fake hits may lead to fail extrapolations, or wrong Pt assignment.
- A possible way to resolve ghost hits in ME1. (Acosta)
 - Has minimum impact on Sector Processor
 - Require minor modification to Sector Receiver and back plane (to send info on whether the hits are from the same chamber)
- Details on the implementation \Rightarrow refer to Acosta's talk

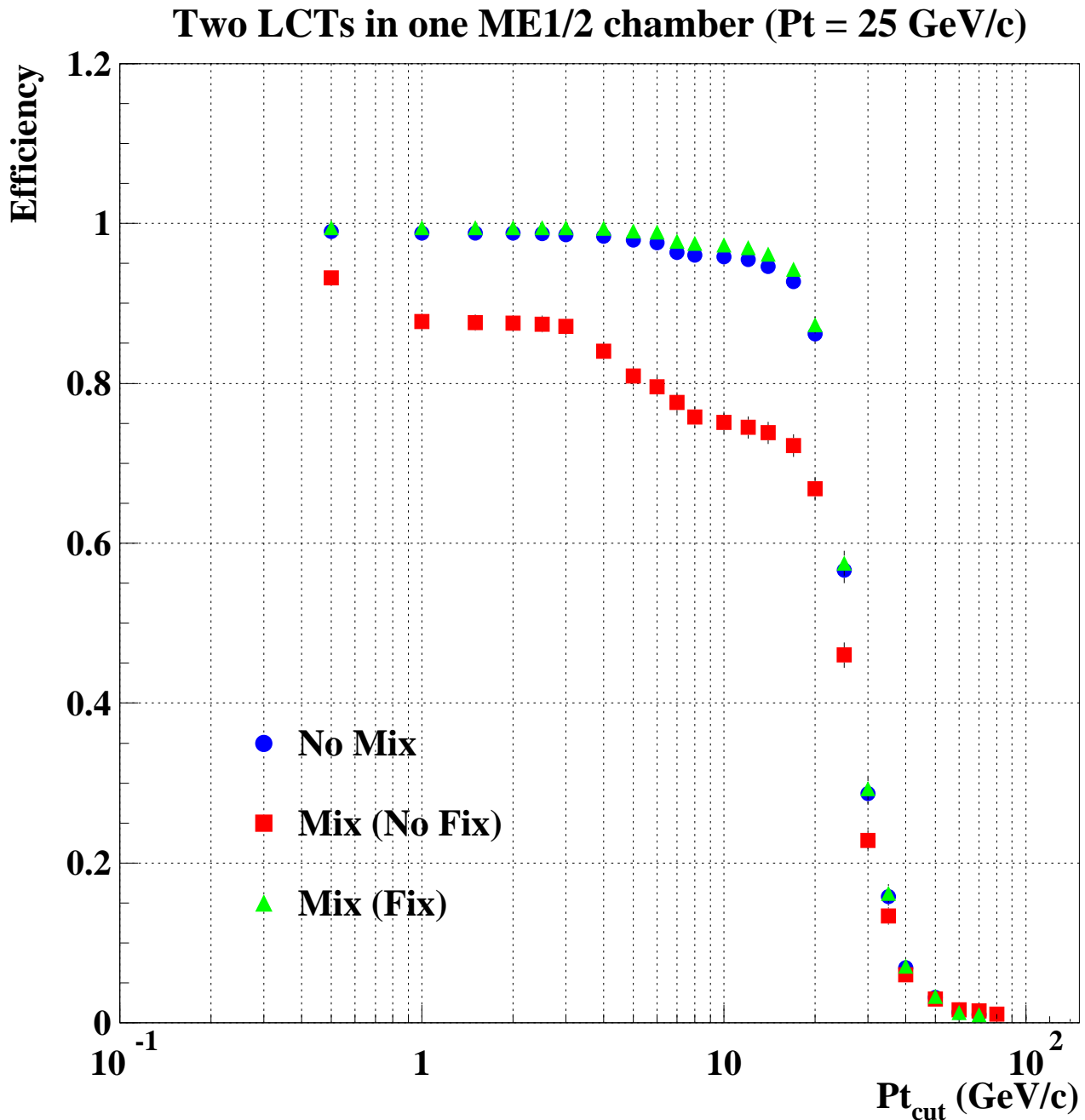
Test Ghostbusting

- Generate two muons ($P_t=25 \text{ GeV}/c$) that enter into 1 ME1/2 chamber ($1.2 < \eta < 1.6$)
- Keep only one hit in each ME2,3,4 chambers
- For “No Mix” sample :
The ALCT/CLCT pairs in ME1/2 chamber are not mixed \Rightarrow the ALCTs and CLCTs are correctly associated
- For “Mix” sample :
Half of the events with ALCTs and CLCTs wrongly associated

- Run TF (C++) over these two samples



Track Finding Eff vs Pt Threshold cut



- The “Mix” sample after treated by Ghostbusting gives a slightly higher track finding efficiency. This is because the TF tends to select from the extrapolation combinations the one that gives a higher Pt measurement.

Summary

- It is important to have high LCT efficiency
- If there will be either ME4/1 or ME4/2 only:
 - At Low Lumi ($L \sim 10^{33}\text{cm}^{-2}\text{s}^{-1}$)
 - * ME4/1 may be more preferable than ME4/2 (if we want to trigger to $|\eta| \lesssim 2.4$, using 2-Stn and 3-Stn Pt measurement)
 - At High Lumi ($L \sim 10^{34}\text{cm}^{-2}\text{s}^{-1}$) and trigger to $|\eta| \lesssim 2.1$
 - * ME4/2 may be more preferable than ME4/1 (using 3-Stn Pt measurement)
- The method to resolve ghost hits in ME1 has been successfully tested. Need to study how would the ghostbusting affect single muon rate.
- Trigger Primitive simulation from ORCA is now in good state. Eager to use it in TF simulation and compare results with the ones from using CMSIM