MUON COLLIDER

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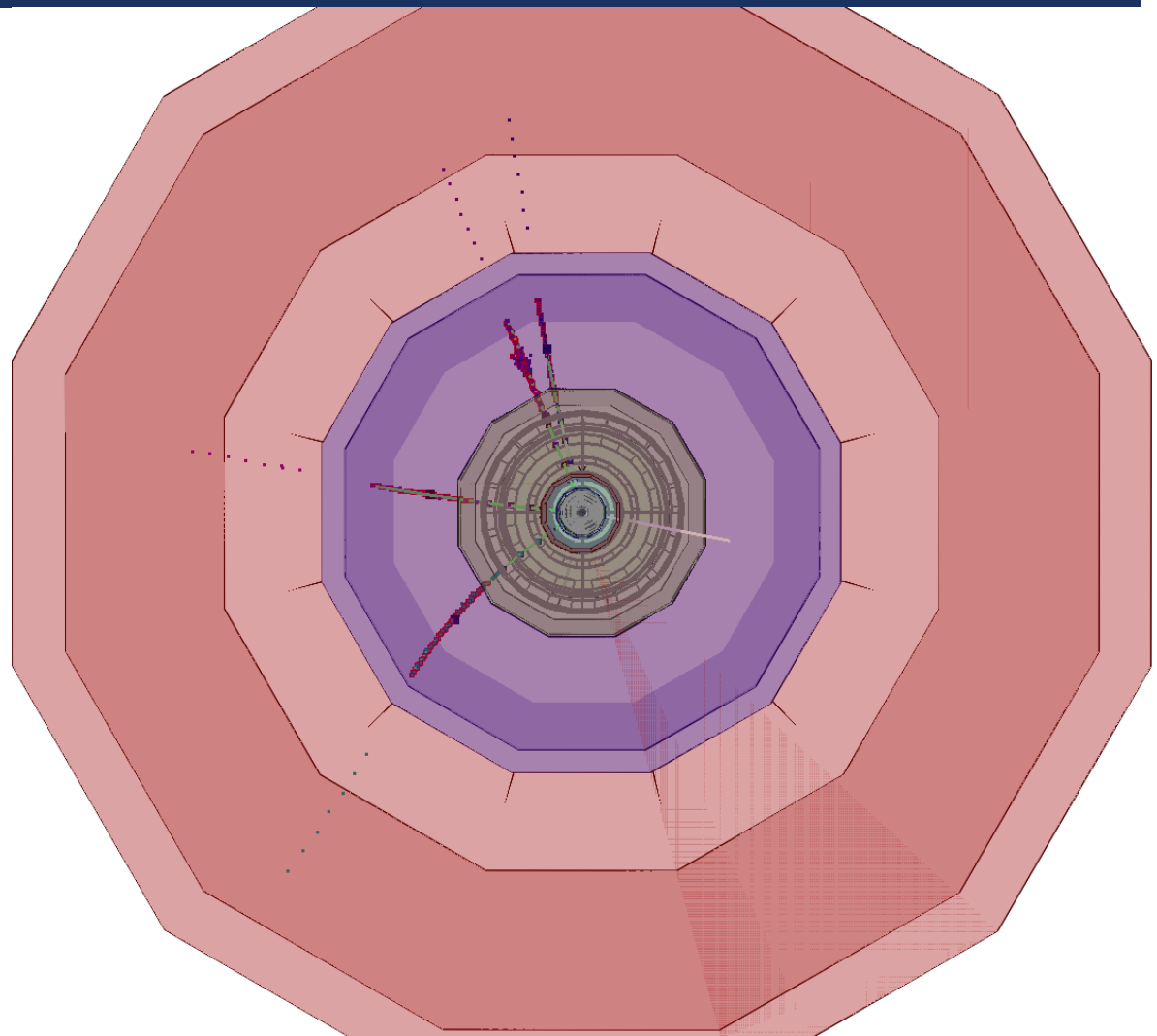

Update on muon reconstruction performances

$$\mu^+\mu^- \rightarrow \mathrm{H} \rightarrow \mathrm{Z}Z^* \rightarrow 4\mu$$

$\sqrt{s}$ = 1.5 TeV and 3 TeV studies

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Muon reconstruction performance

Goal: validate the results of the study on muon reconstruction performance, conducted on signal samples, by making a comparison with the results of track reconstruction performance, shown by Massimo and Alessandro, evaluated on muon gun samples.

Signal samples (muon reconstruction with PFA): $H \rightarrow ZZ^* \rightarrow 4\mu$	
$\sqrt{s}$	# events
1.5 TeV	50k
3 TeV	50k

Muon gun (track reconstruction)	
Sample characteristics	#events
$\theta \in U[10°, 170°]$ p = 1, 10, 100 GeV	100k
$p_T \in U[0.1,100]\ GeV$ $\theta = 13°, 30°, 89°$	100k

Samples provided by Massimo.

Reconstruction efficiency

Muon reconstruction efficiency: $\frac{histo_{num}}{histo_{den}}$

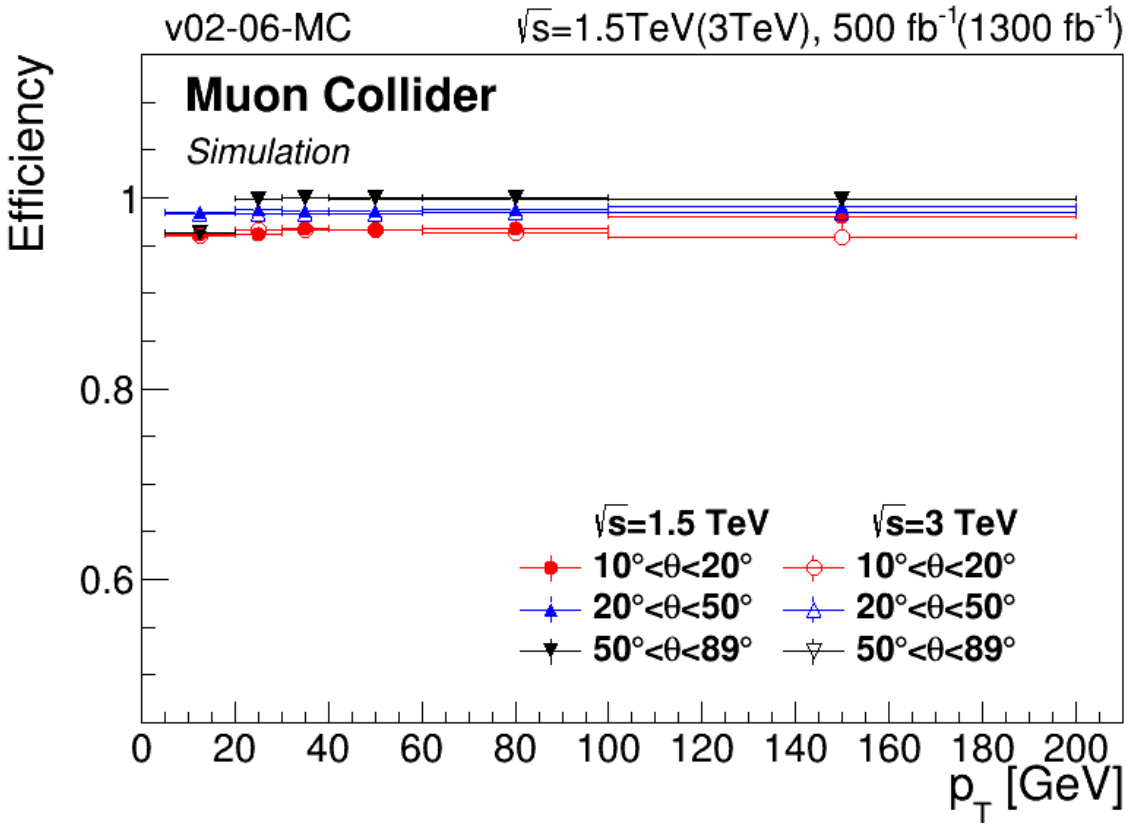
- $histo_{num}$: filled with p_T (θ) of generated muons associated to good quality reconstructed muons. For the reco-gen match, the link between reconstructed and associated particles returned by the reconstruction software is used.
  good quality muons: $p_T > 5GeV,\ \eta < 2.5,\ D_0 < 0.2\ cm,\ Z_0 < 1\ cm.$
- $histo_{den}$: filled with p_T (θ) of generated muons.

Track reconstruction efficiency: $\frac{histo_{num}}{histo_{den}}$

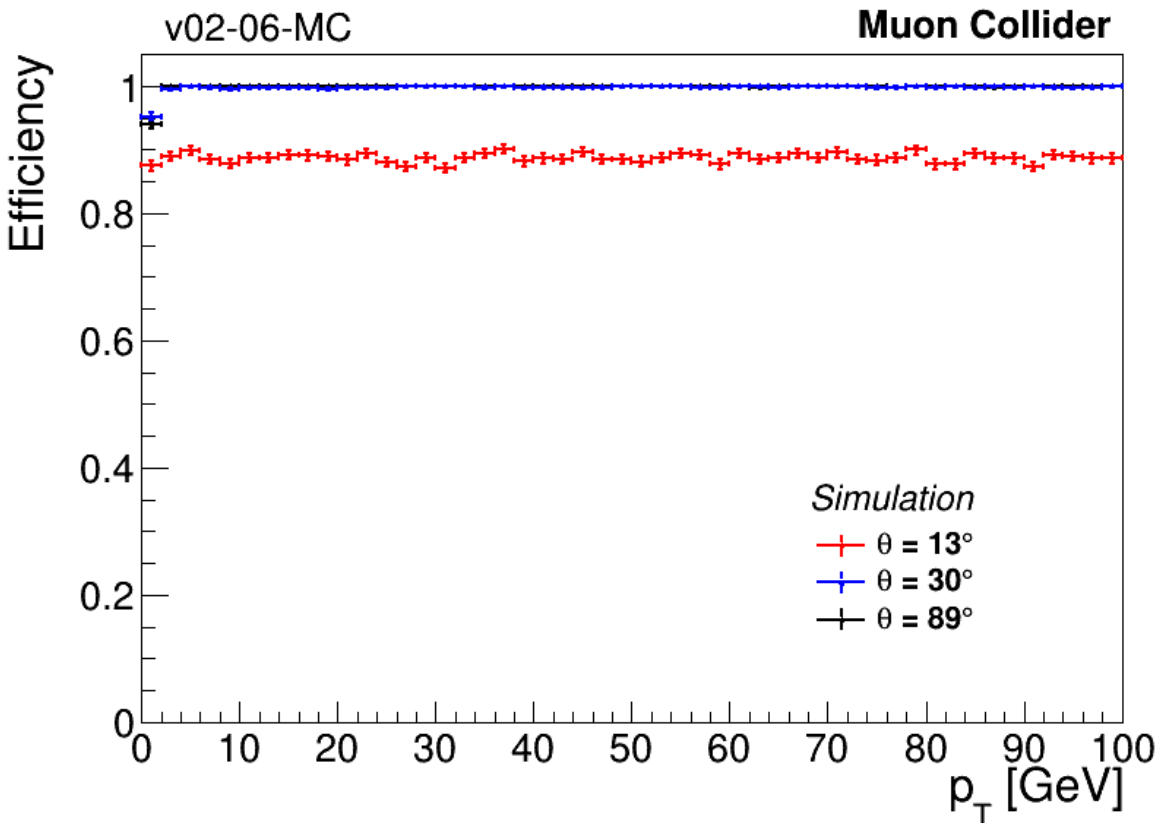
- $histo_{num}$: filled with p_T (θ) of generated muons associated to good quality tracks. For the reco-gen match, the link between reconstructed and simulated hits returned by the reconstruction software is used. In particular, a track is considered as matched with a gen muon if : purity > 0.75.
  purity: ratio between the number of superlayers with at least one reco hit matched with a sim hit and the number of superlayers with at least one hit
  good quality tracks: at least 5 superlayers with at least one hit.
- $histo_{den}$: filled with p_T (θ) of generated muons.

Reconstruction efficiency vs p_T

Muon reconstruction, signal samples



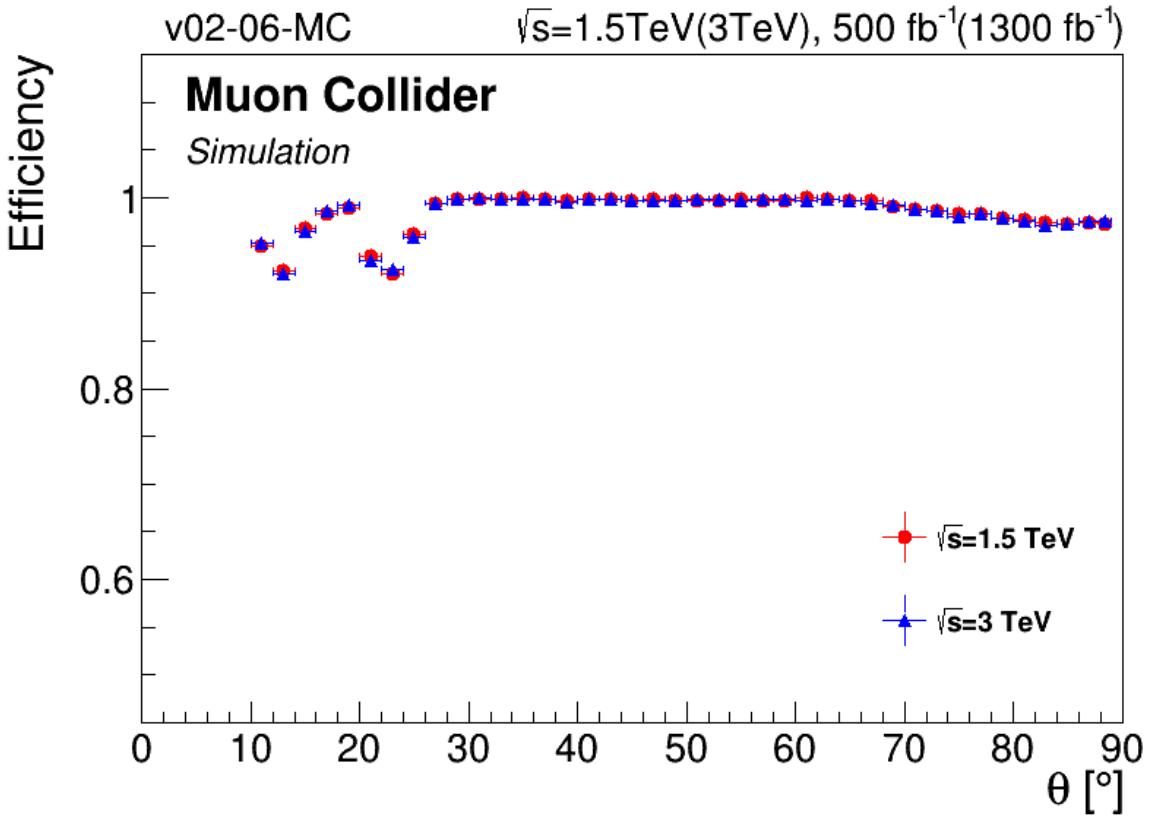
Track reconstruction, muon gun



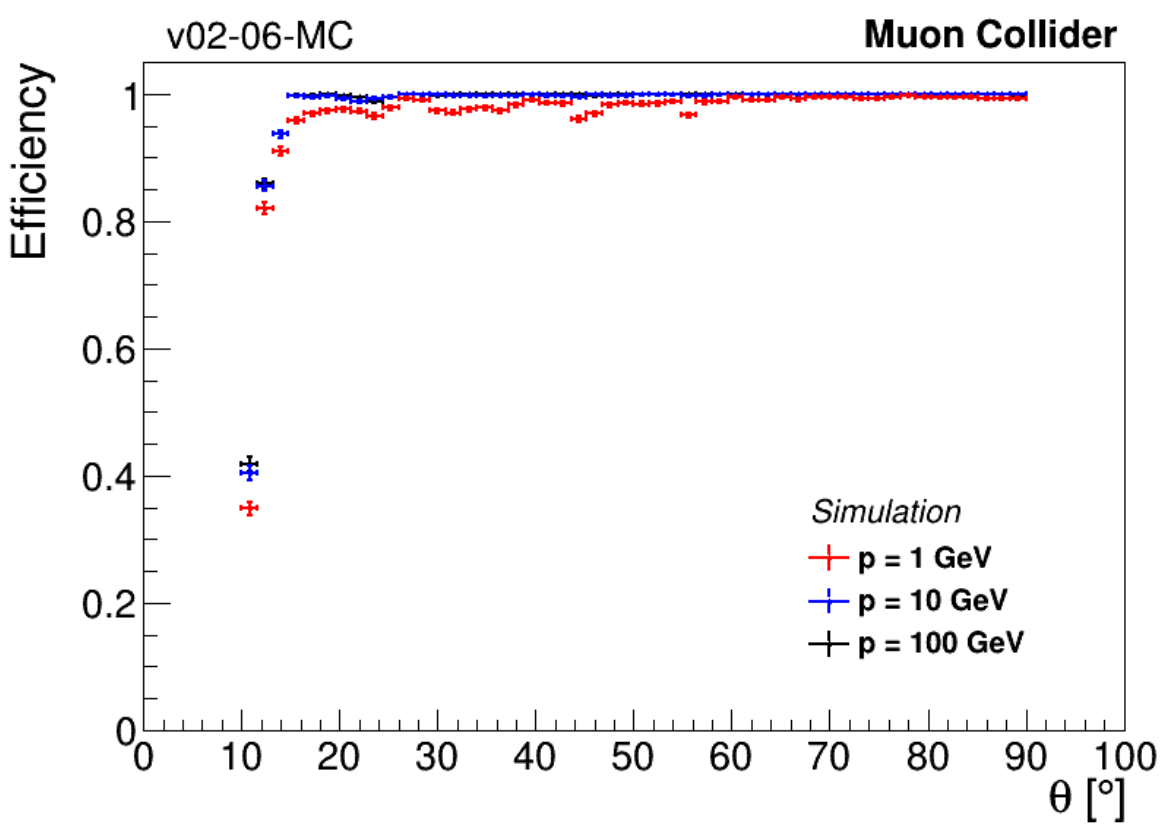
At 90° the reconstruction efficiency shows a drop related to the presence of a hole in the tracking system at the borders of the sensors → https://agenda.infn.it/event/25026/contributions/126873/attachments/77754/100382/tracker_studies_2.pdf

Reconstruction efficiency vs θ

Muon reconstruction, signal samples



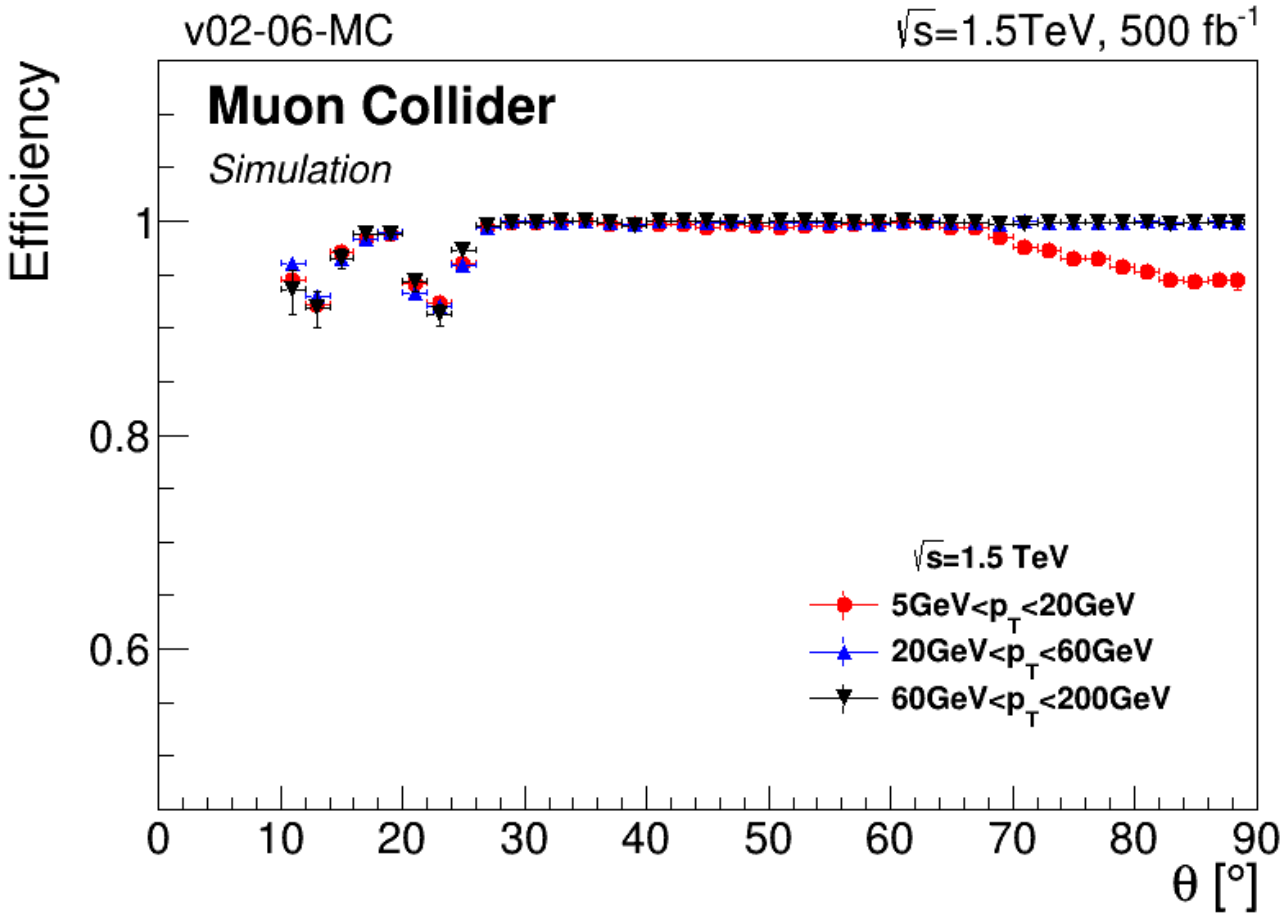
Track reconstruction, muon gun



The muon reconstruction efficiency shows a drop at $\theta \sim 25°$ and a decrease for high values of θ, which is not dependent on the applied cuts.

Reconstruction efficiency vs θ

Muon reconstruction, signal samples



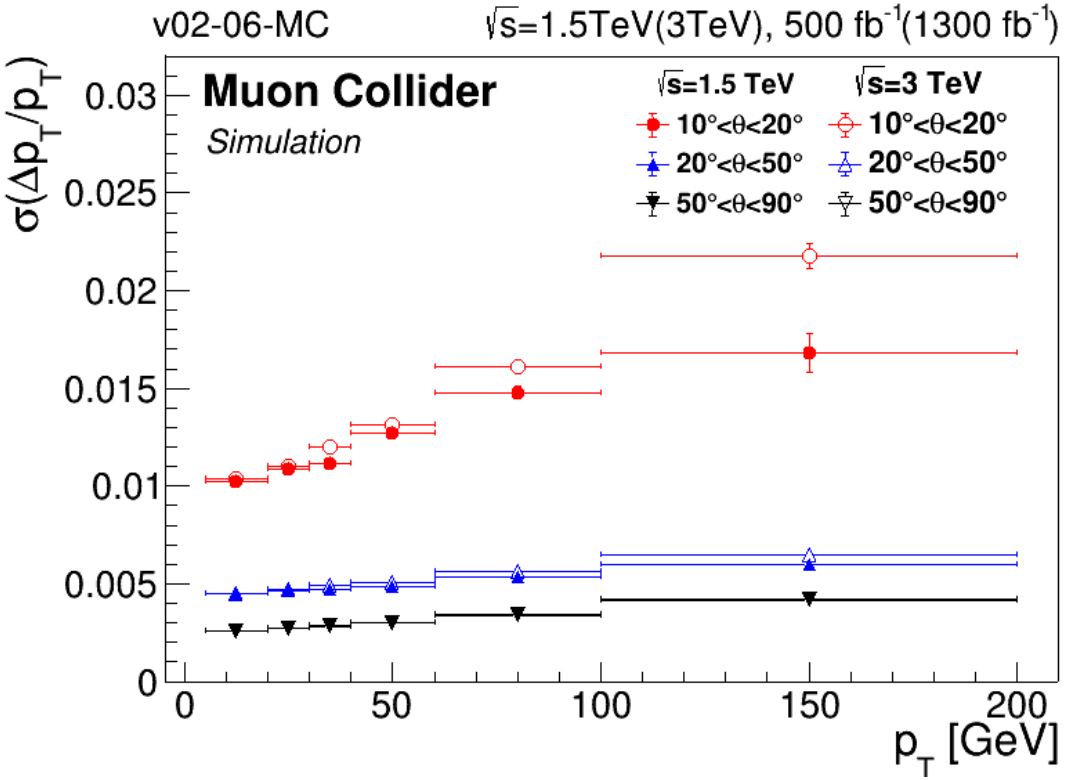
In the range of θ 70° - 90°, there is a reduction of the reconstruction efficiency for low p_T muons.

Possible causes of the efficiency reduction?

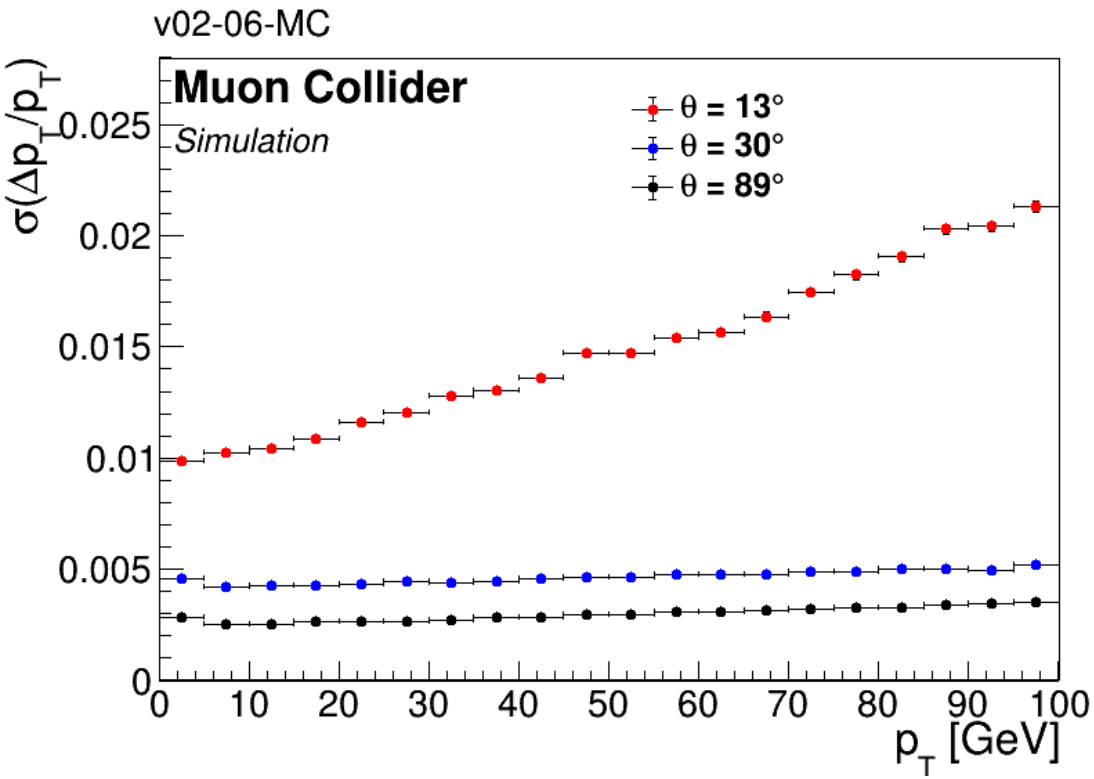
- These muons are also low energy muons ($p \sim p_T$), for this reason subject to multiple scattering $\left(\Delta\theta \sim \frac{1}{p}\right)$.
  Problems in the reco-gen matching?
- Problems in the object reconstruction?

p_T Resolution vs p_T

Muon reconstruction, signal samples



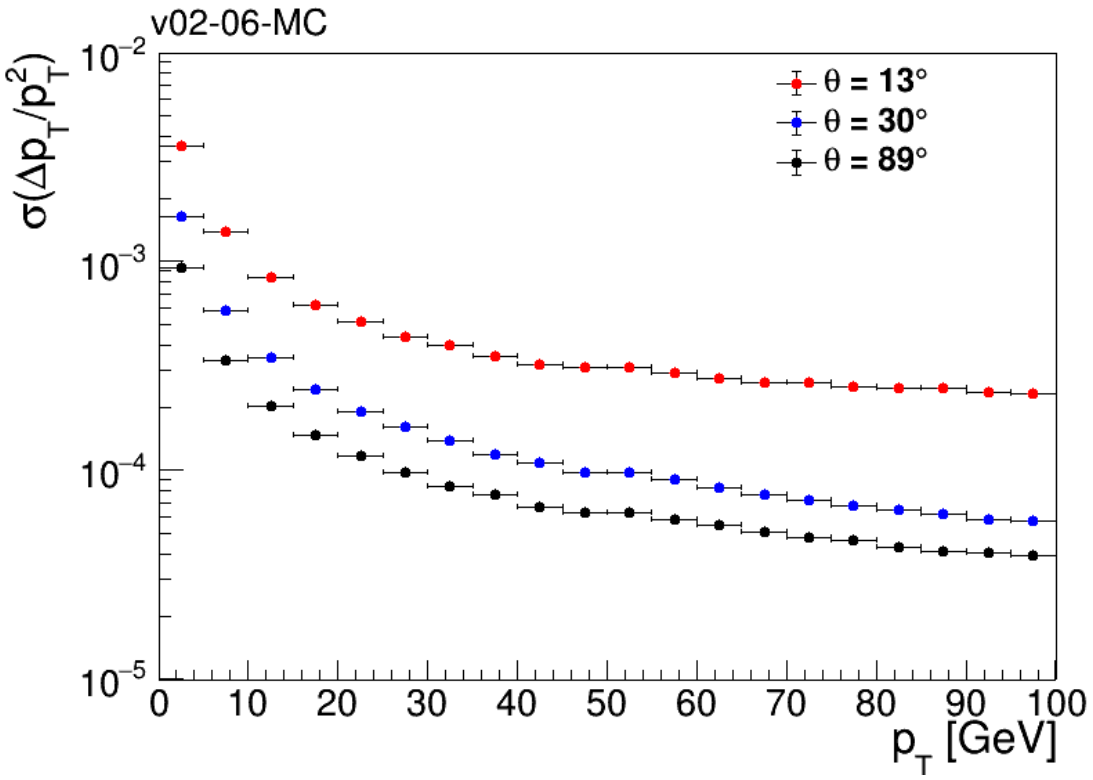
Track reconstruction, muon gun

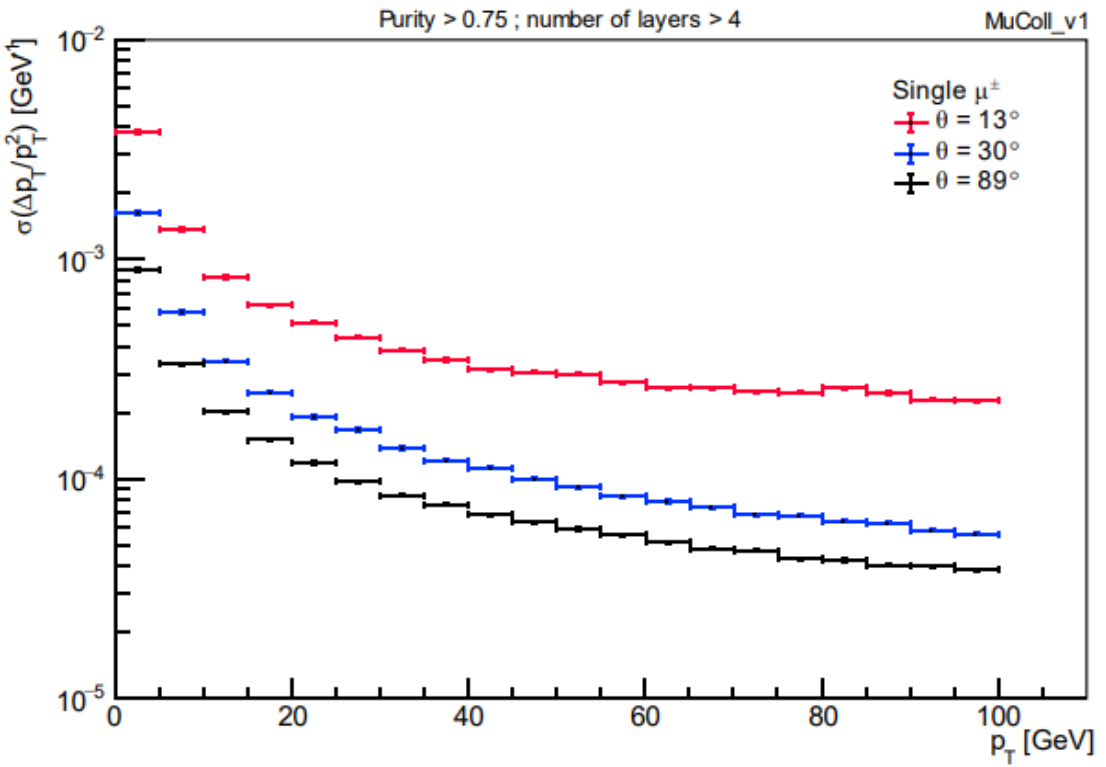


Muon reconstruction: The p_T resolution worsens, in the region close to the nozzles, as the center of mass energy increases. This effect is related to the fact that, at 3 TeV, muons are emitted more forward than at 1.5 TeV. The distributions of $\frac{\Delta p_T}{p_T}$ corresponding to small values of θ, have more populated tails at 3 TeV, thus resulting in higher resolutions.

p_T Resolution vs p_T

Track reconstruction, muon gun

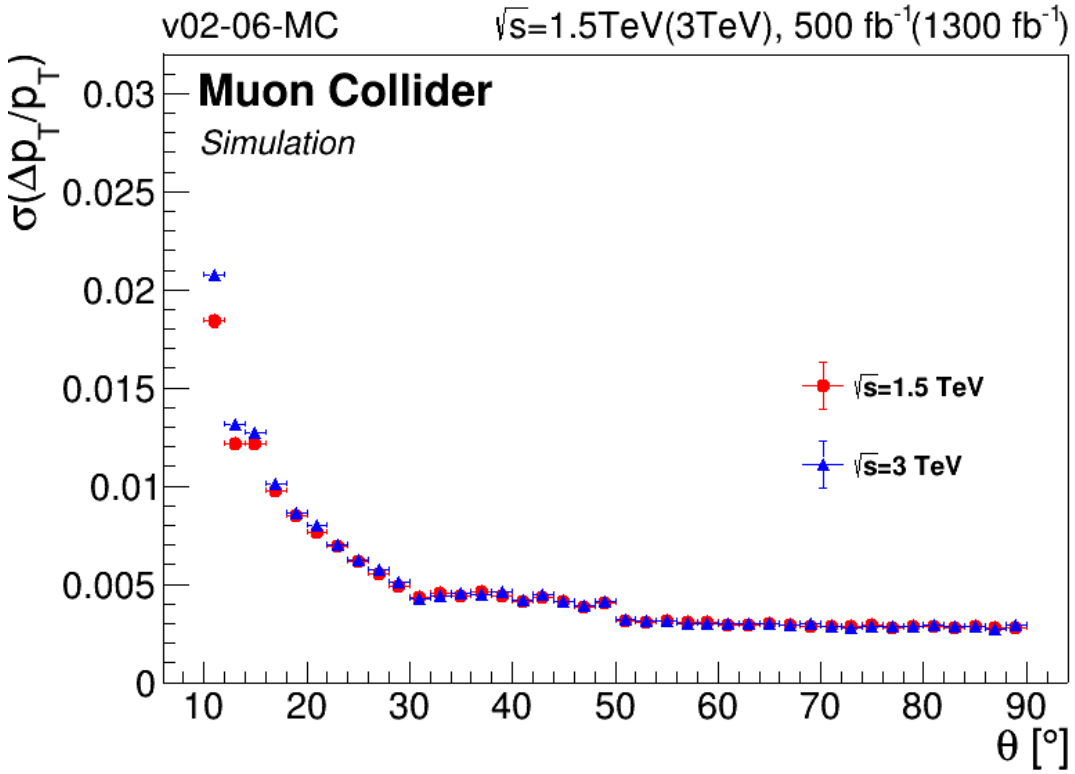




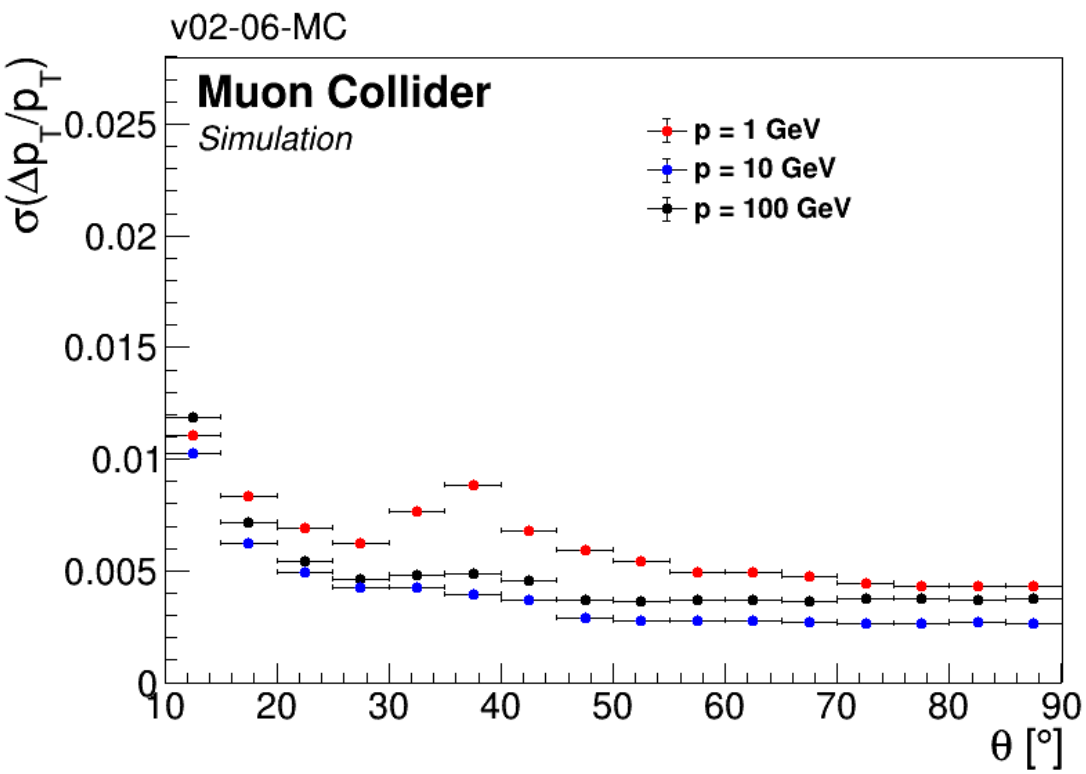
Taken from Alessandro presentation:
https://indico.cern.ch/event/997659/contributions/4191544/attachments/2174149/3670942/tracker_studies_montella_3.pdf

p_T Resolution vs θ

Muon reconstruction, signal samples

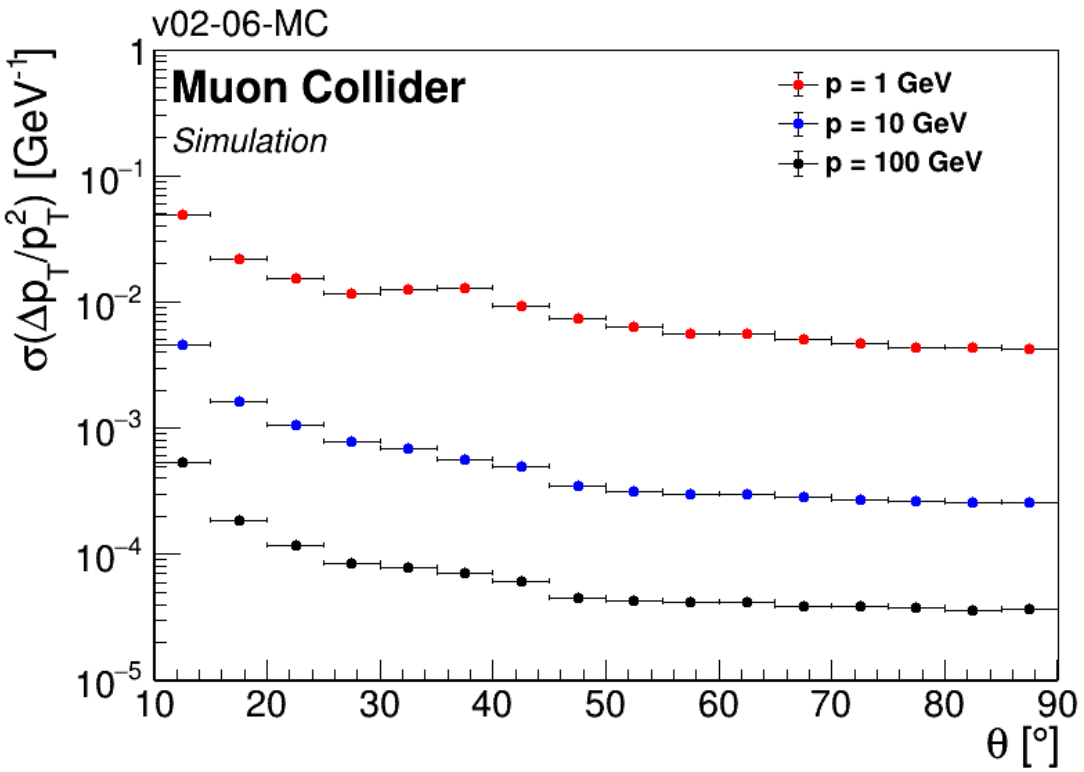


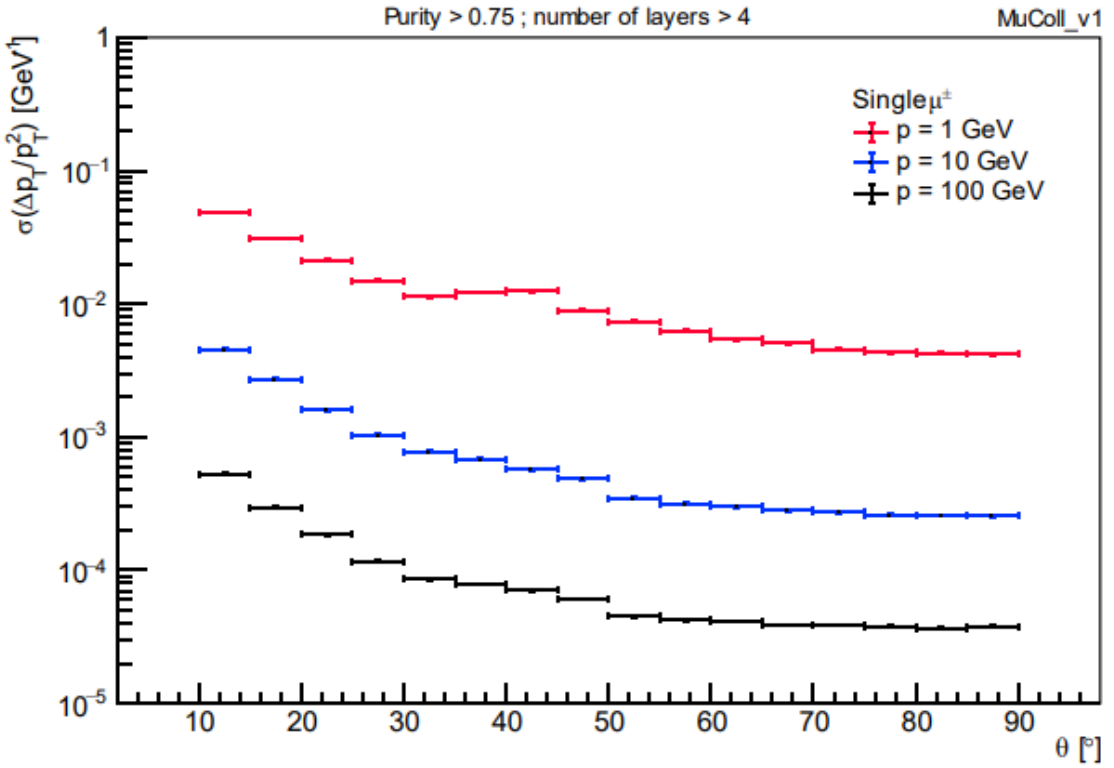
Track reconstruction, muon gun



p_T Resolution vs θ

Track reconstruction, muon gun





Taken from Alessandro presentation:
https://indico.cern.ch/event/997659/contributions/4191544/attachments/2174149/3670942/tracker_studies_montella_3.pdf

Update on track reconstruction performance with BIB

conformal tracking: 3 steps $\sqrt{s}$=1.5 TeV	
sample	# events
Only signal	2500
Signal + BIB	2500

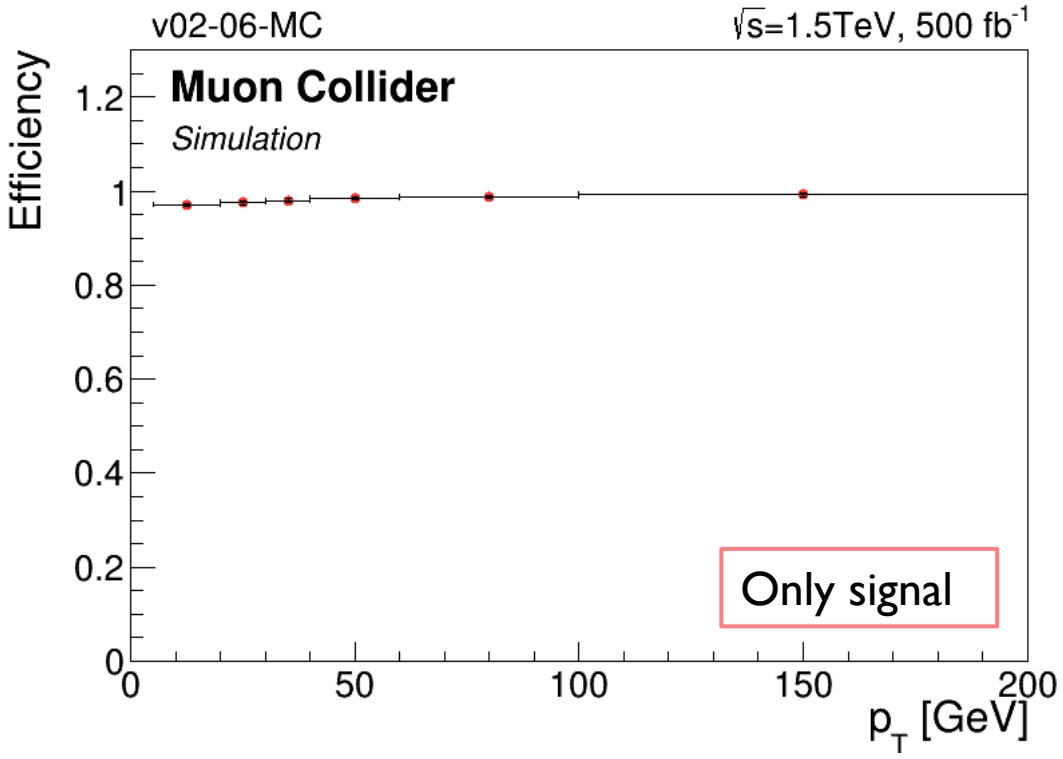
Track reconstruction efficiency: $\frac{histo_{num}}{histo_{den}}$

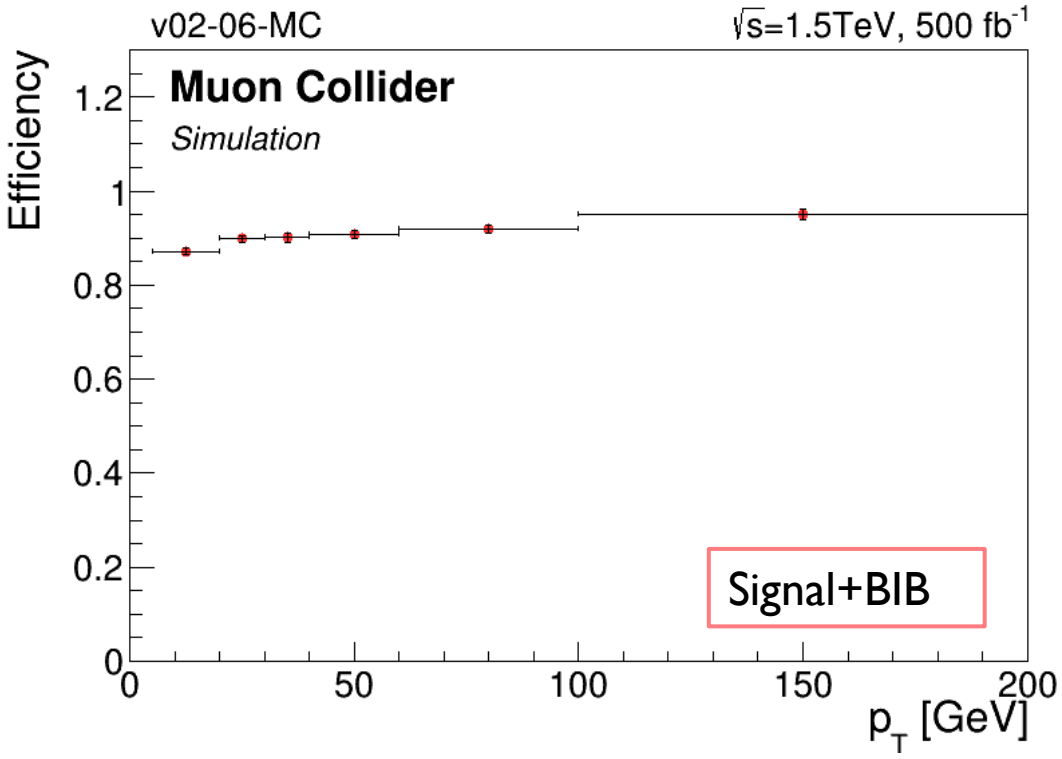
- $histo_{num}$: filled with p_T (θ) of generated muons associated to selected reconstructed tracks. For the association, I have implemented a geometrical match based on the minimization of ΔR.

  selected tracks: $p_T > 5GeV,\ 10° < \theta < 170°,\ n_{hits} > 4, \frac{\chi^2}{ndf} < 10$

- $histo_{den}$: filled with p_T (θ) of generated muons.

Track reconstruction: signal+BIB



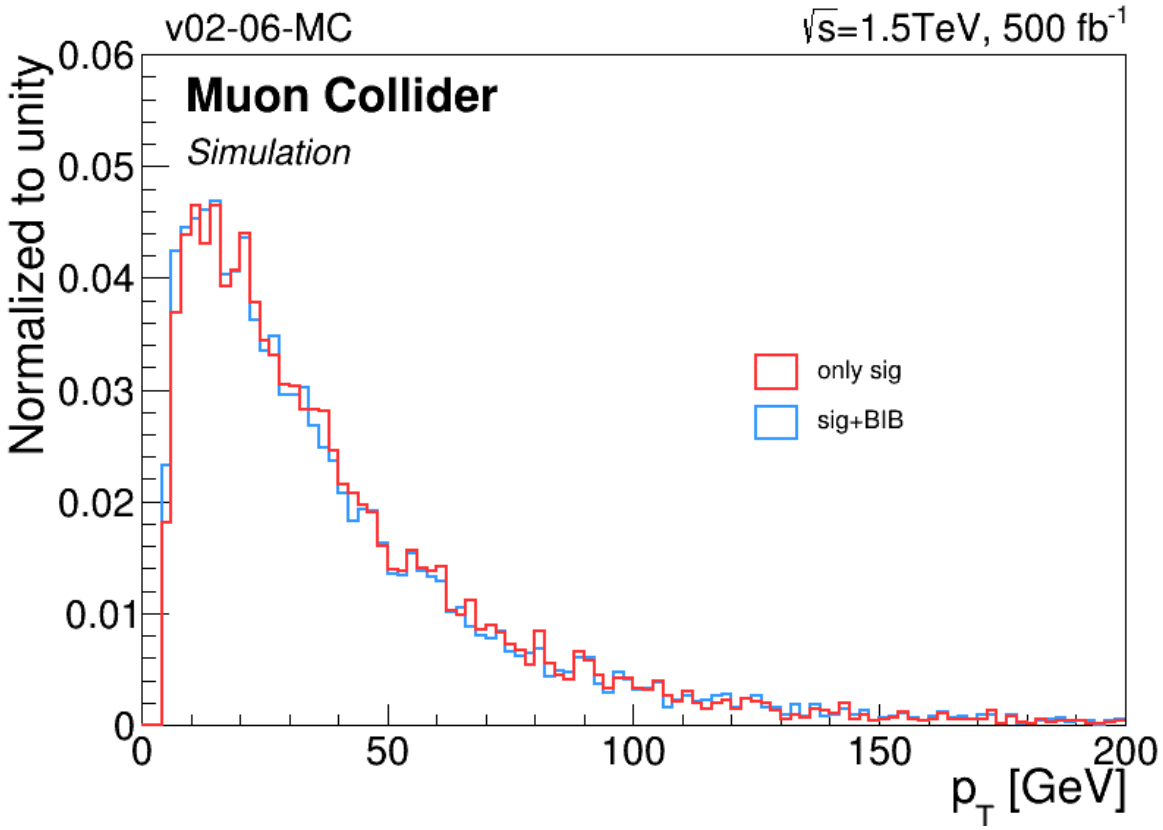


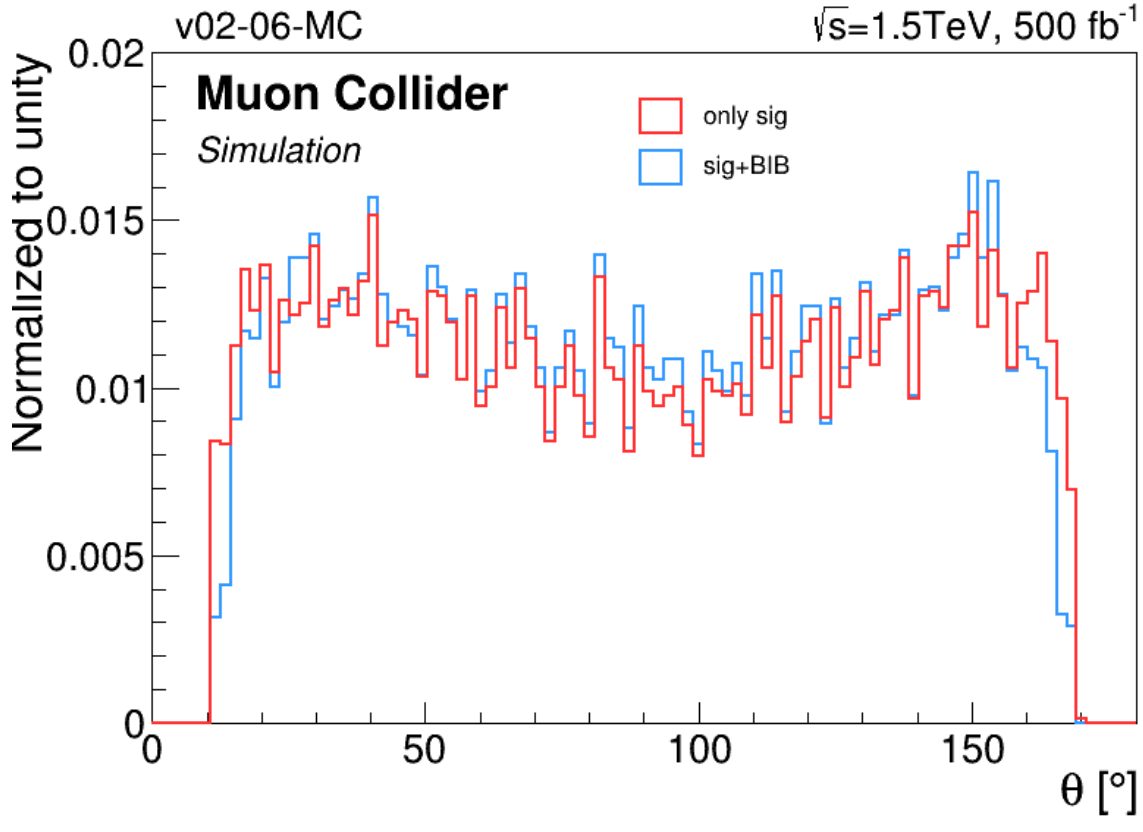
In order to take into account the effect of the BIB in the analysis, we intend to scale , according to the p_T, the number of muons reconstructed without BIB to the track reconstruction efficiency estimated in the scenario with BIB overlay.

Track reconstruction: signal+BIB

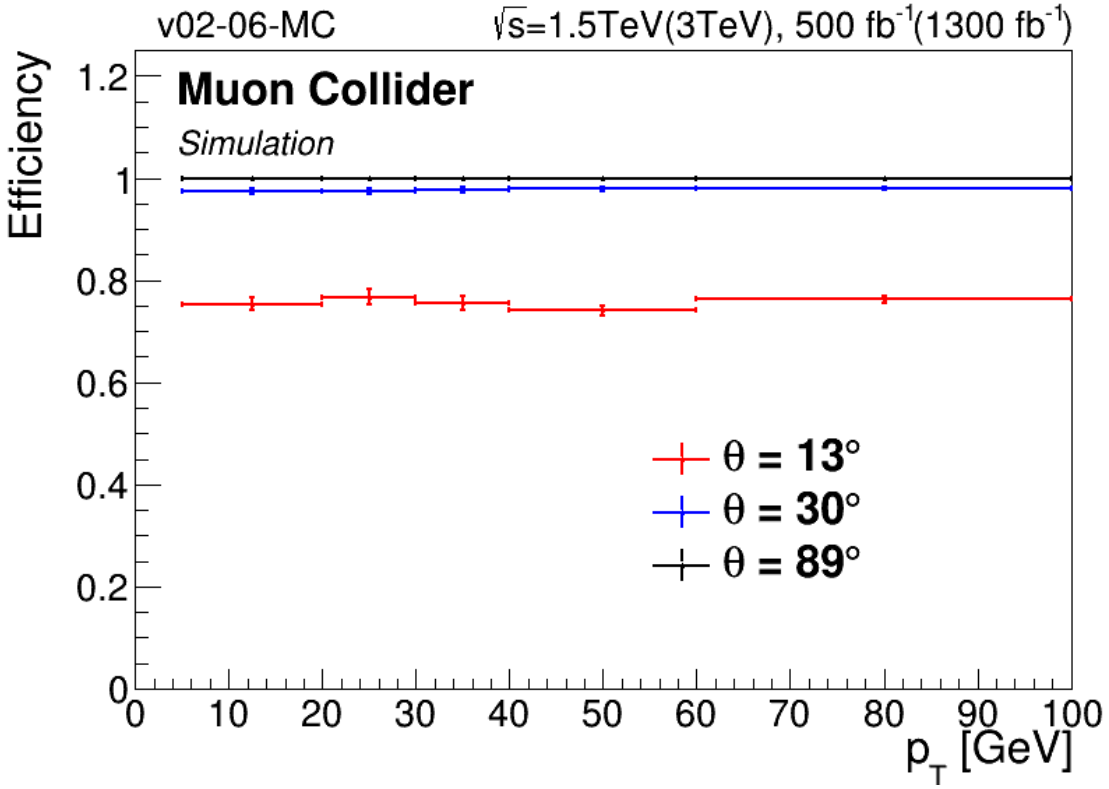
Cuts: $p_T > 5GeV,\ 10° < \theta < 170°,\ n_{hits} > 4,\ \chi^2/ndf < 10$

Tracks reconstructed with the 3-steps configuration

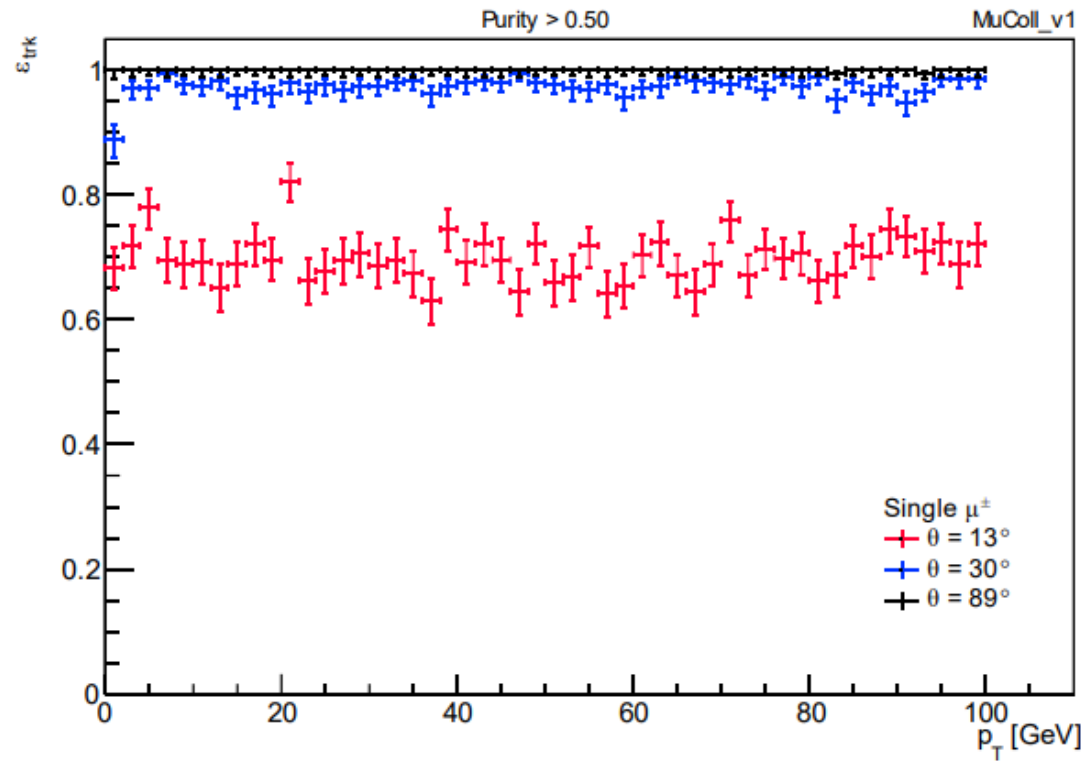




Validation of the reconstruction efficiency results with BIB overlay



I have used the geometrical match to evaluate the track reconstruction efficiency on the samples provided by Massimo. In this case, the DL filter is used with the 3-steps conformal tracking configuration. No selection is applied on the reconstructed tracks.



Taken from Alessandro presentation:
https://agenda.infn.it/event/26568/contributions/134429/attachments/80570/105278/tracker_studies_4.pdf

Conclusions

- Validation: good agreement between the muon reconstruction performance evaluated on signal samples and the track reconstruction performance evaluated on muon gun samples.
- Limits of this study: the muon reconstruction performance with BIB overlay has not been evaluated.
- Questions: causes of the reduction of muon reconstruction efficiency vs θ?
  considerations about the proposed strategy for taking into account the BIB impact on the analysis?

THANK YOU!

BACK UP

Track reconstruction : sig+BIB

Cuts: $p_T > 5GeV,\ 10° < \theta < 170°,\ n_{superlayers} > 4,\ \chi^2/ndf < 10$