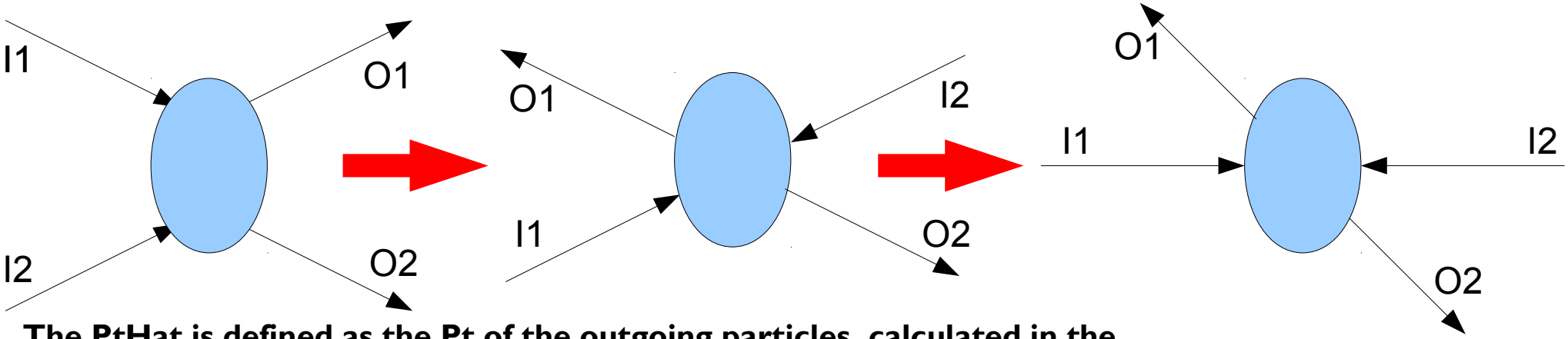
First look at PtHat

Mario Galanti

Overview

- Aim of the study:
  - Determine whether we can apply a cut on the PtHat for the generation of the ppMu[Mu]X sample, in order to gain efficiency
- How the analysis is done:
  - PtHat is reconstructed a posteriori, looking at the momenta of the partons taking part to the 2->2 hard interaction
- Sample analyzed:
  - PpMuMuX currently in the Padova cluster
    - 2 same-sign muons with pT>2.5GeV and |eta|<2.5 required at the generator level
  - Does the SS requirement affect the kinematics?
    - I guess **no**, but I have no data to justify this claim

PtHat a posteriori calculation (Fotis)

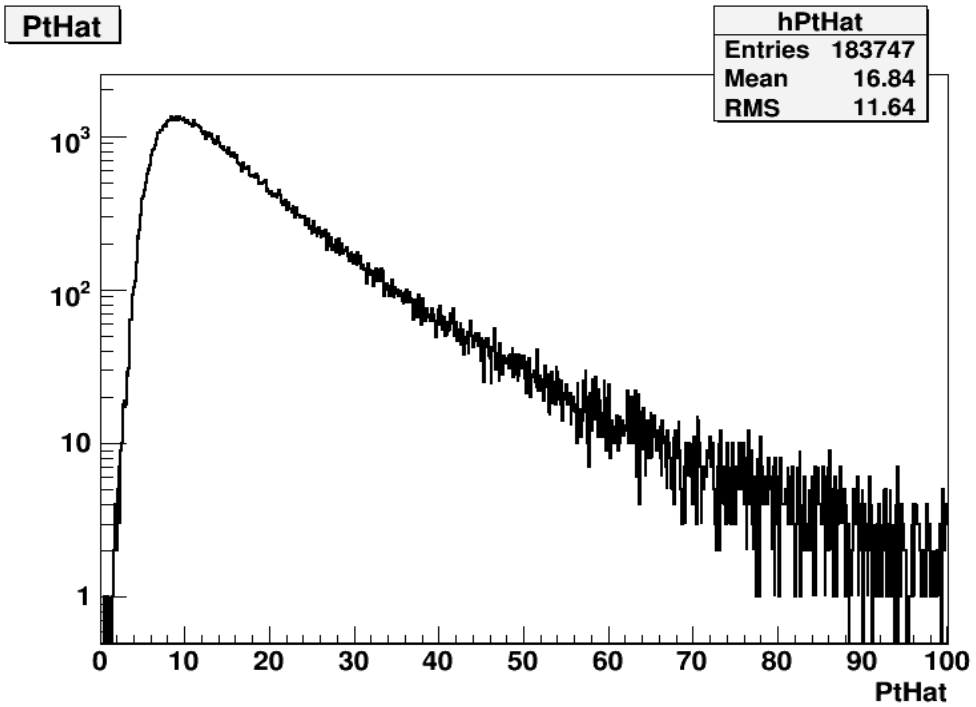


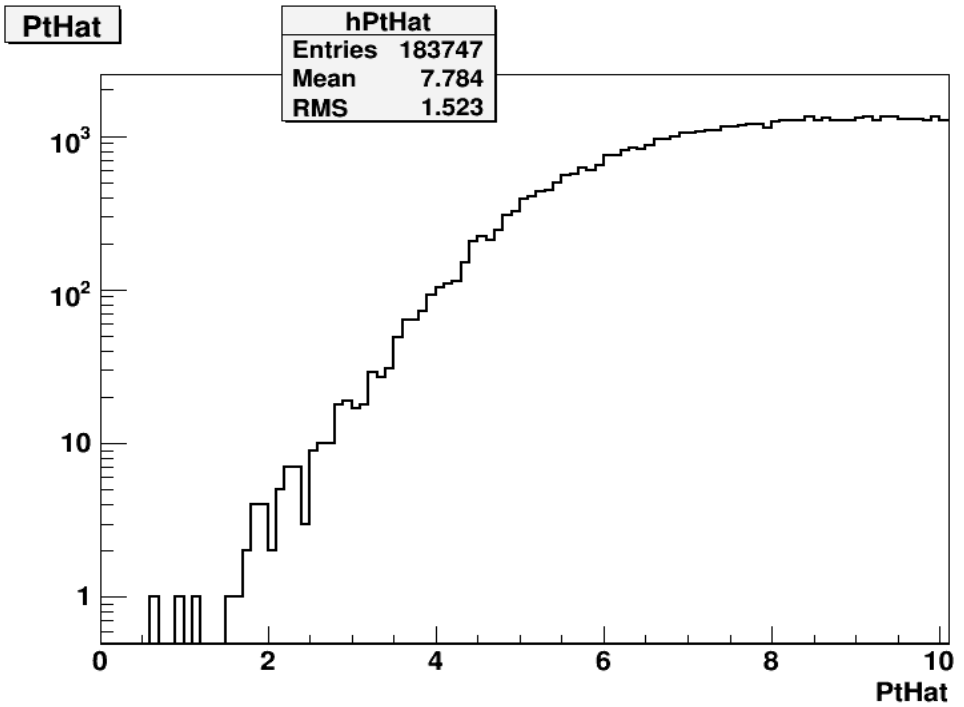
The PtHat is defined as the Pt of the outgoing particles, calculated in the reference frame of the hard interaction.

1) Incoming and outgoing partons are respectively #5,6 and #7,8 in the Pythia event record (started counting from 1)
2) Consider the Reference Frame in which the center of mass of the system formed by the 2 incoming particles is at rest
3) Boost the incoming and outgoing 4-momenta to this RF
4) This is not enough, because **the incoming 3-momenta are not yet oriented along the z-axis (so the Pt is still calculated WRT a wrong plane)!**
5) Perform a rotation along Z, and then another rotation along Y, to put the incoming 4-momenta along the Z axis
6) **The Pt of each outgoing particle in the boosted and rotated RF is the PtHat**

PtHat distribution

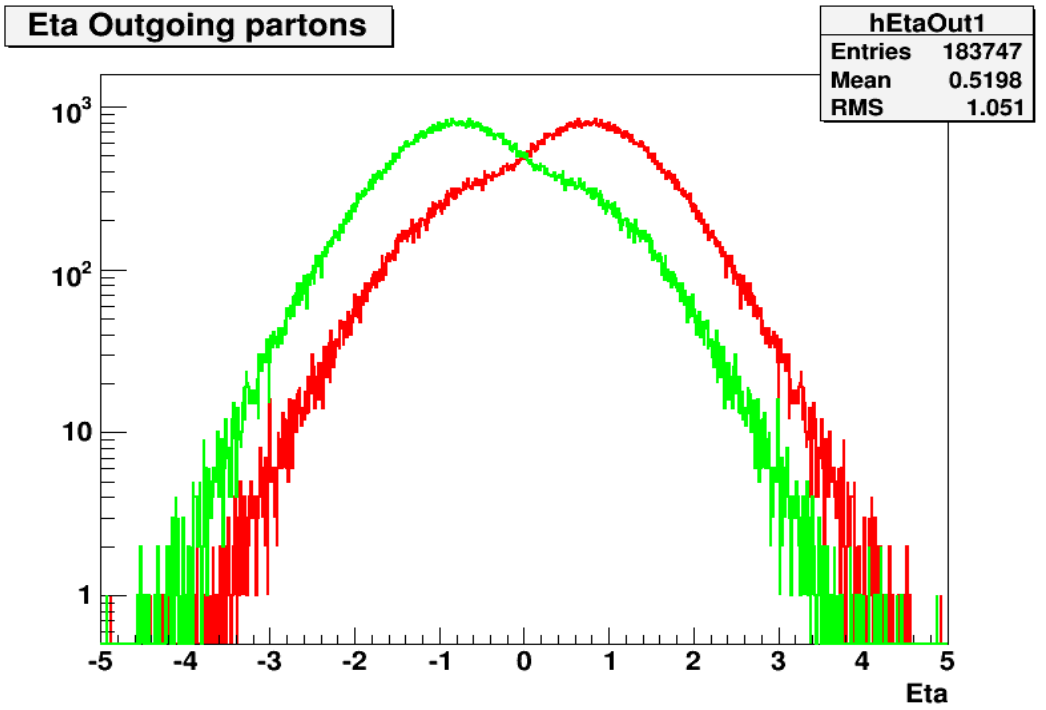
- PtHat distribution of ppMuMuX events shows no cut for low values
  - Right plot is a zoomed view of the left one
  - The distribution is anyway very low for small PtHat values, so there is room to apply a cut without affecting too much the sample composition

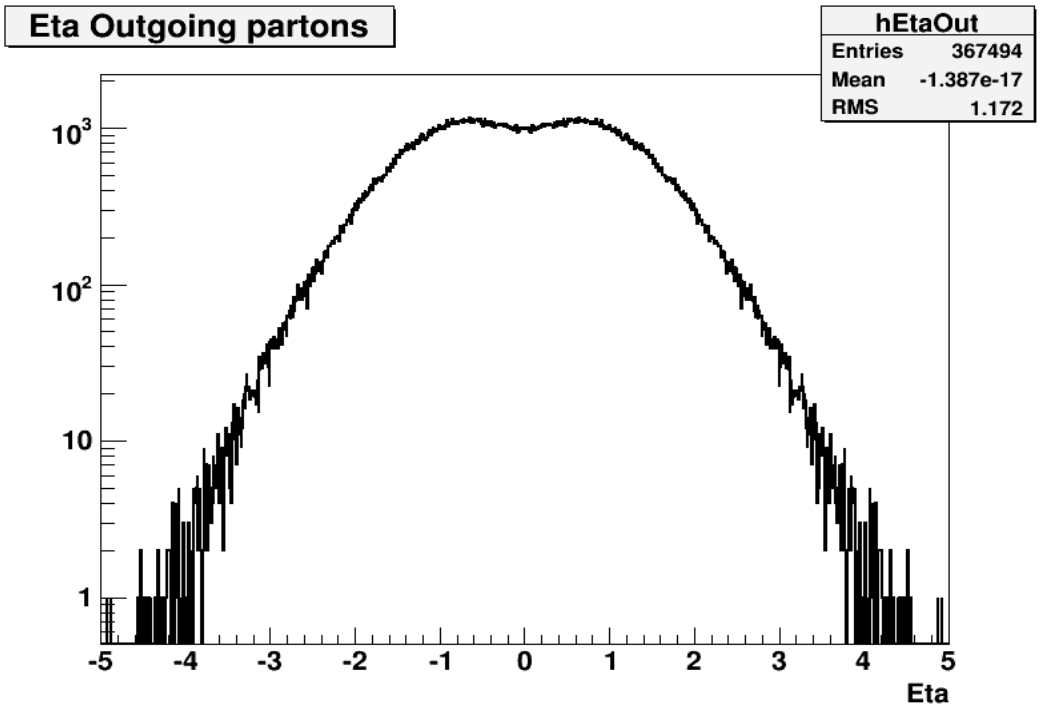




Outgoing eta distribution

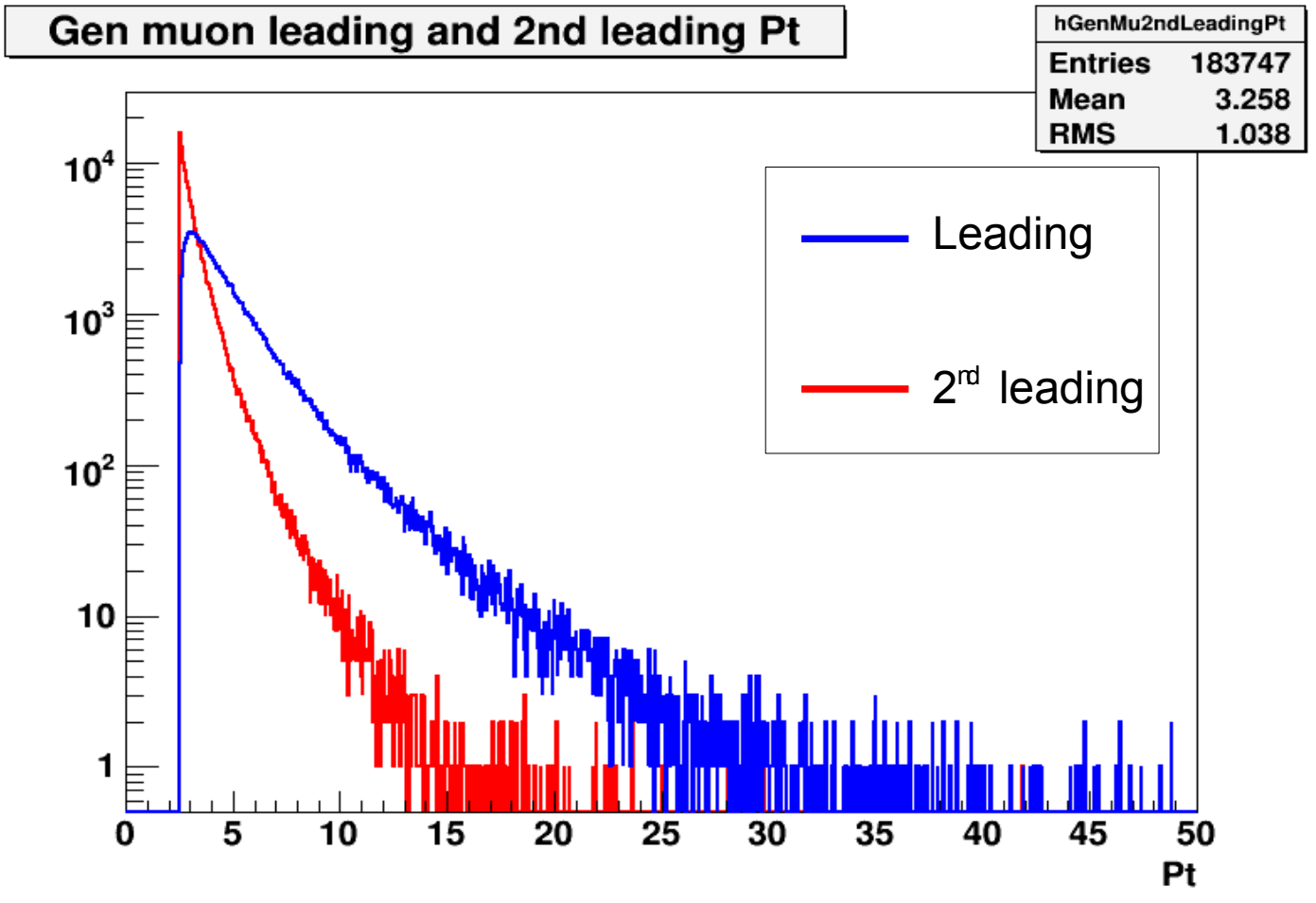
- Eta distribution of outgoing partons
  - Calculated in the boosted and rotated frame (proper RF of the scattering)
  - Right plot is the sum of the distributions in the left one
  - There is perhaps room for a cut at high eta values, but not much





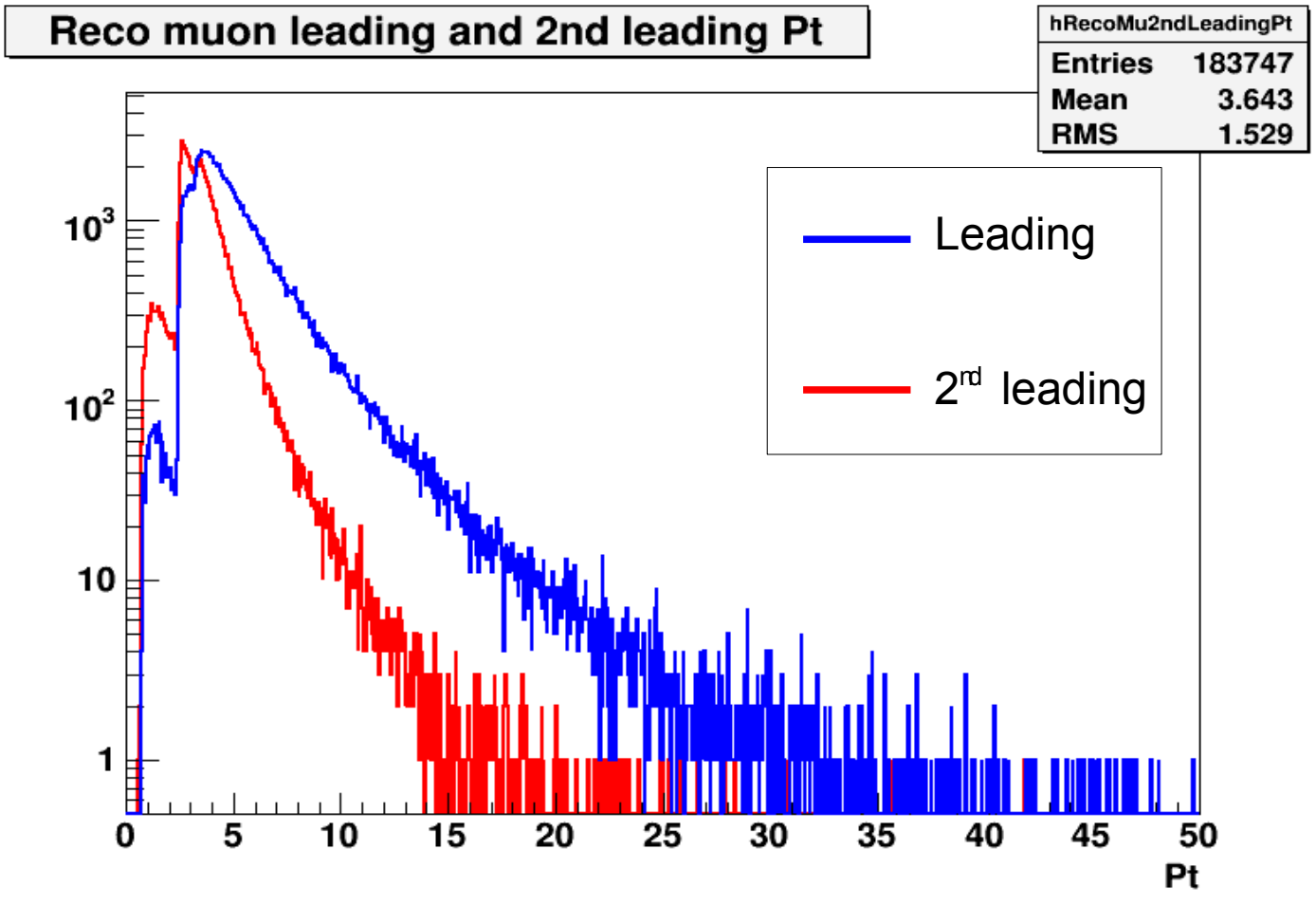
Generated muons Pt

- Leading (blue) and second leading Pt generated muons



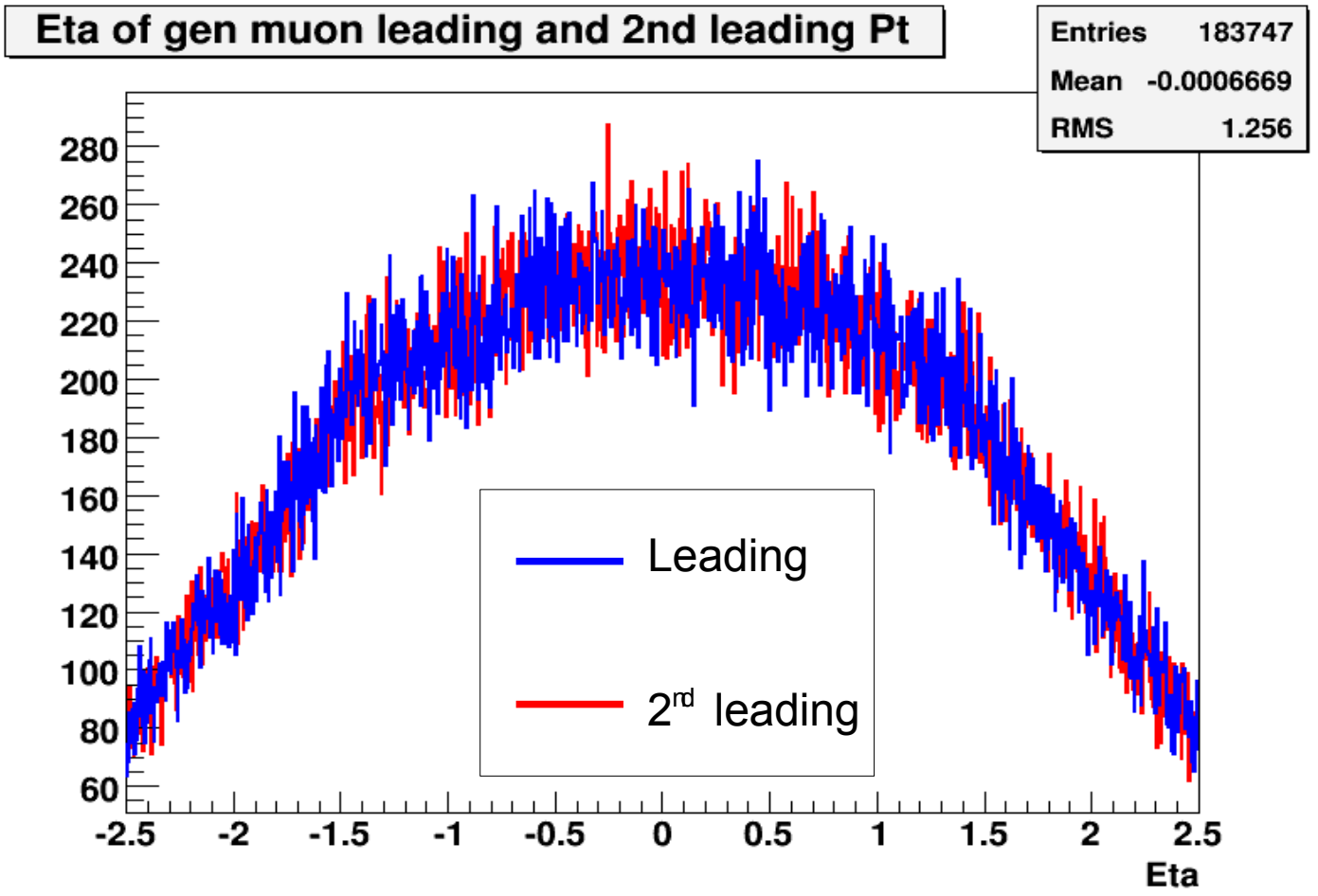
Reconstructed muons Pt

- No association or quality cuts applied to Reco Muons, only innerTrack required



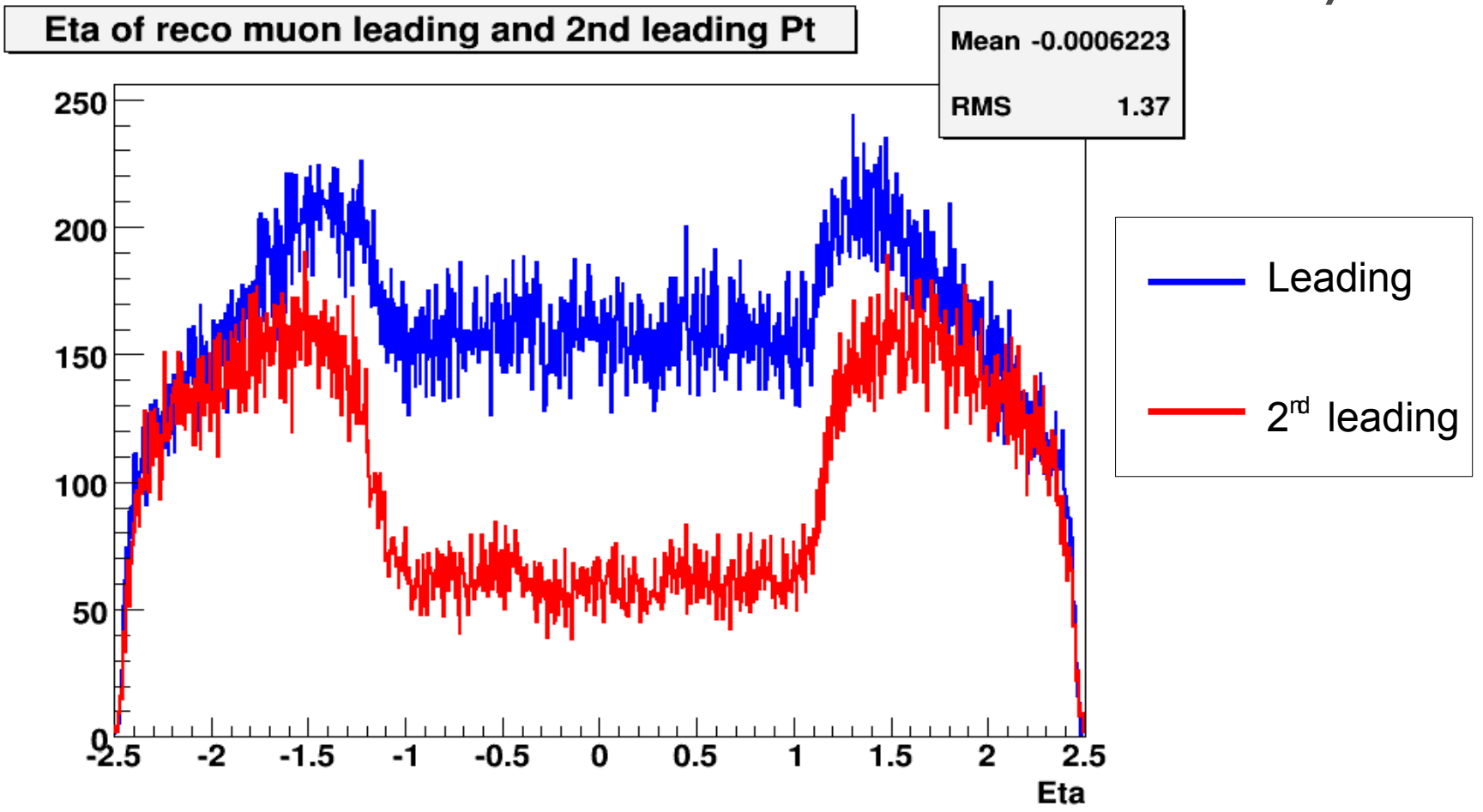
Generated muons Eta

- Leading (blue) and second leading Pt generated muons
  - No difference is visible in distributions



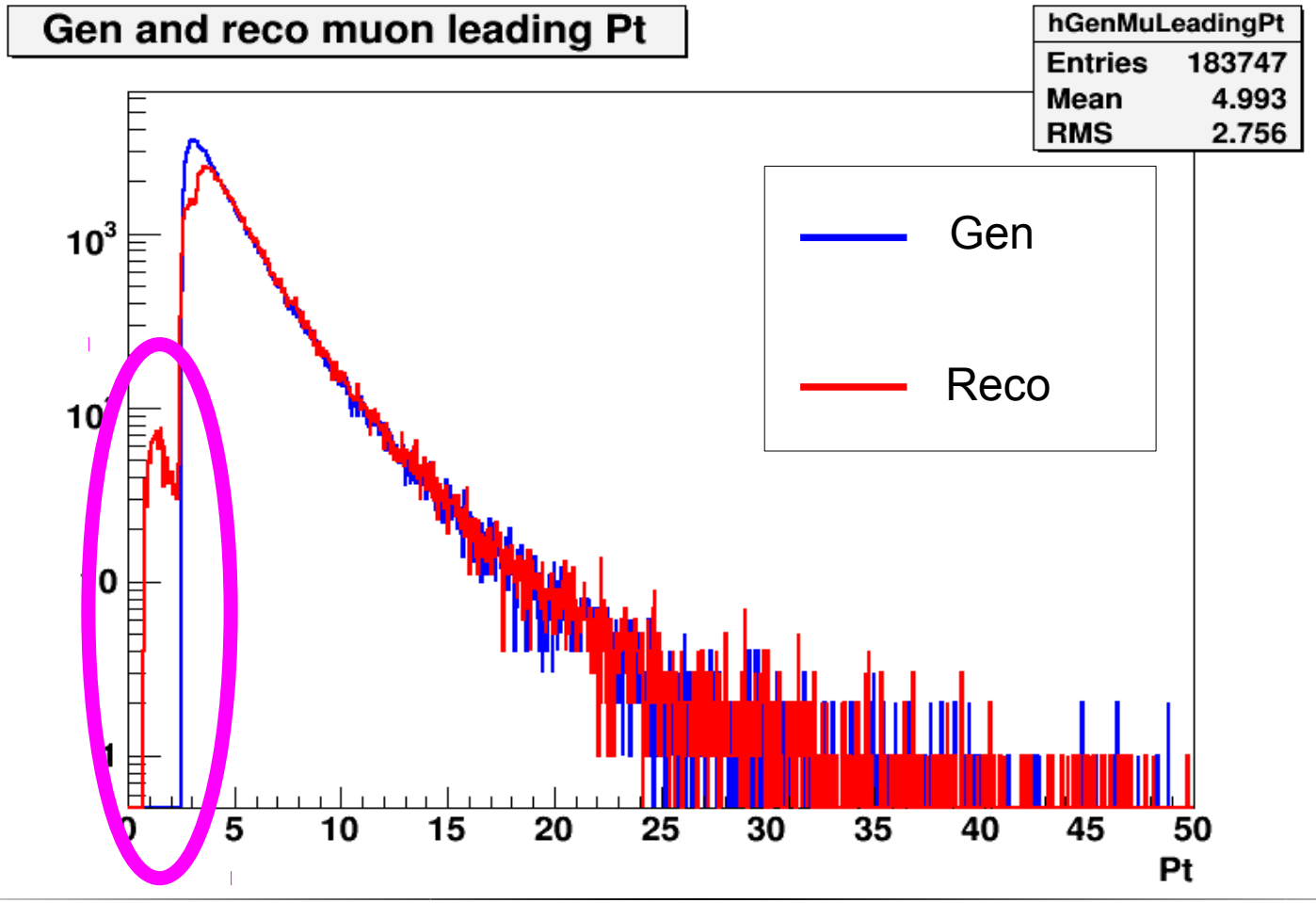
Reconstructed muons Eta

- Leading (blue) and second leading Pt reconstructed muons
  - Difference is due to the different reconstruction efficiency



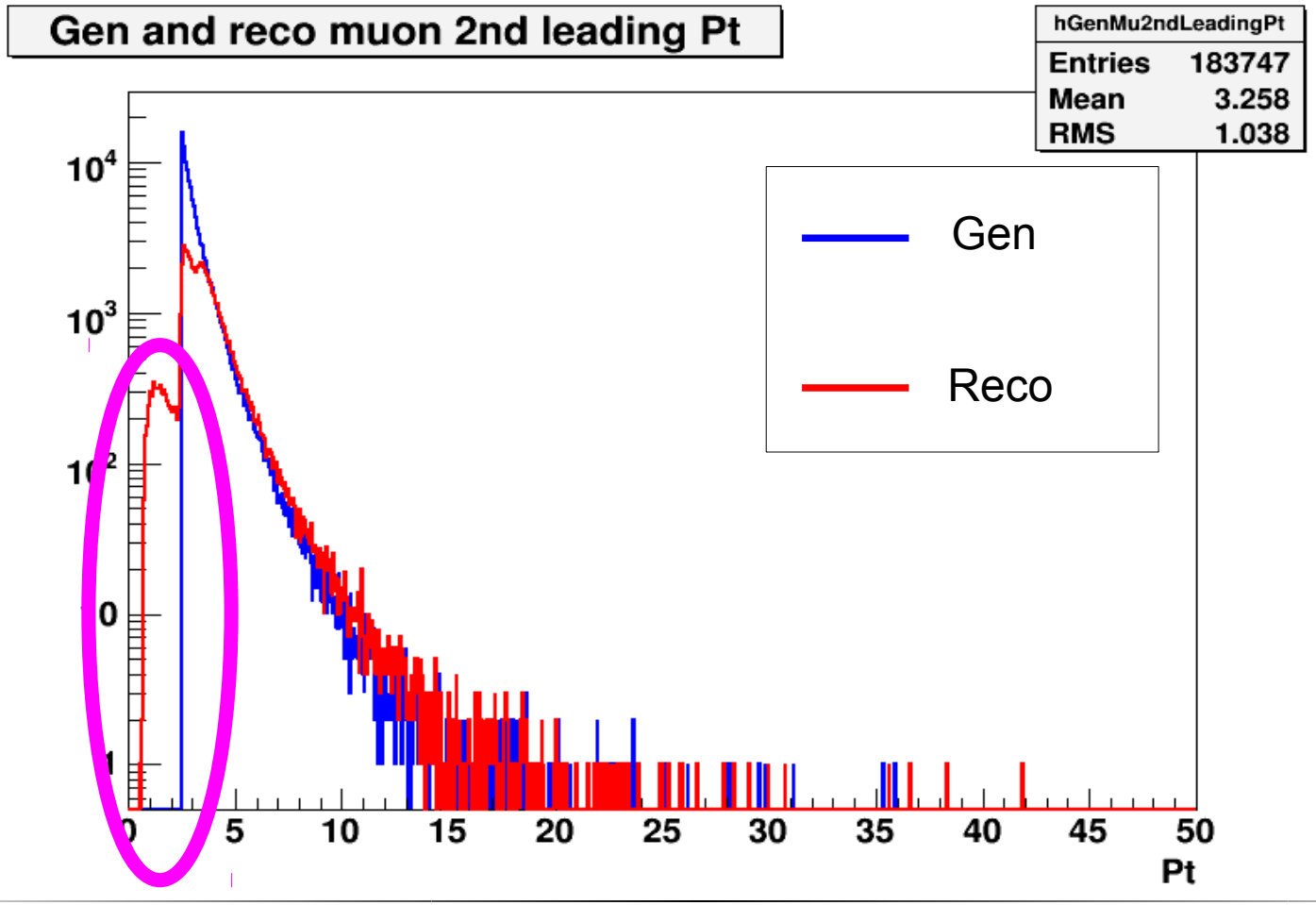
Gen-reco comparison - leading Pt

- More reco than gen muons for Pt higher than ~5 (??)
  A non negligible number of muons is reconstructed at very low Pt
  - Fakes, or real low-Pt muons in events in which the first two are not reconstructed?



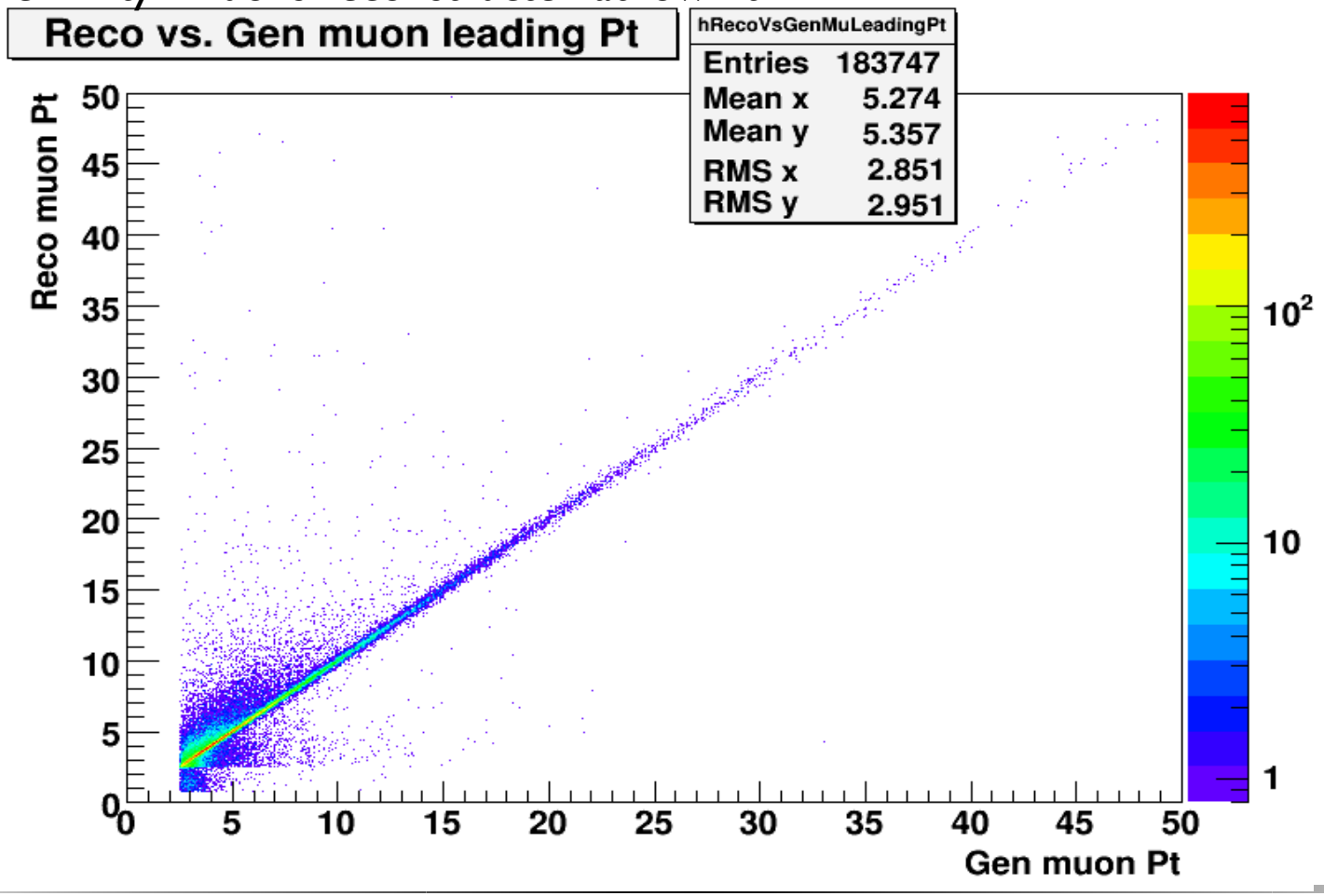
Gen-reco comparison - 2nd leading Pt

- Same effects of previous slide, amplified



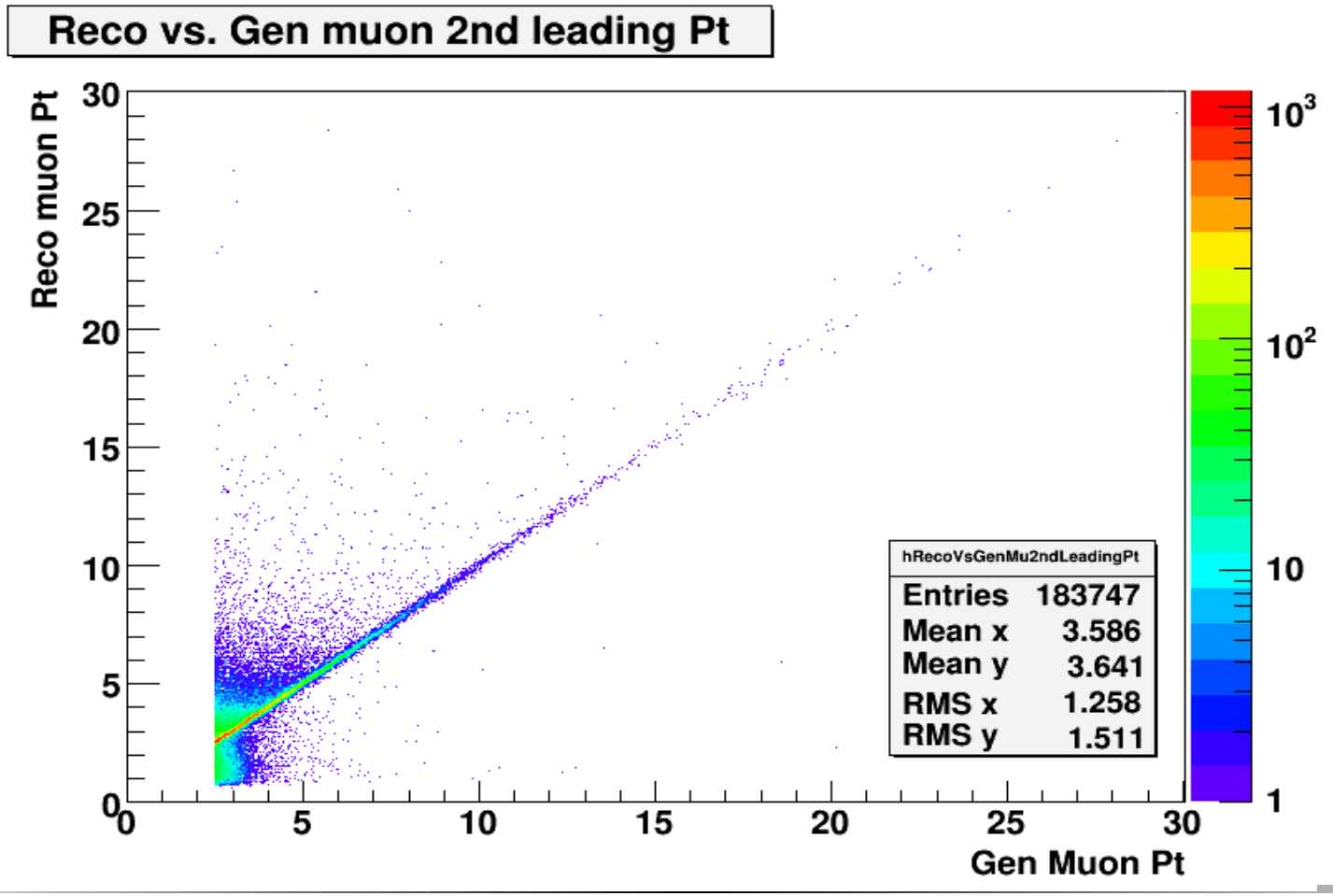
Reco vs. gen Pt - leading Pt muons

- Now the reconstructed muons Pt is well correlated to gen muons also in the lower region
  - Uncorrelation seen in previous version was due to a bug in the code
- Still, some "dirty" muons reconstructed at low Pt



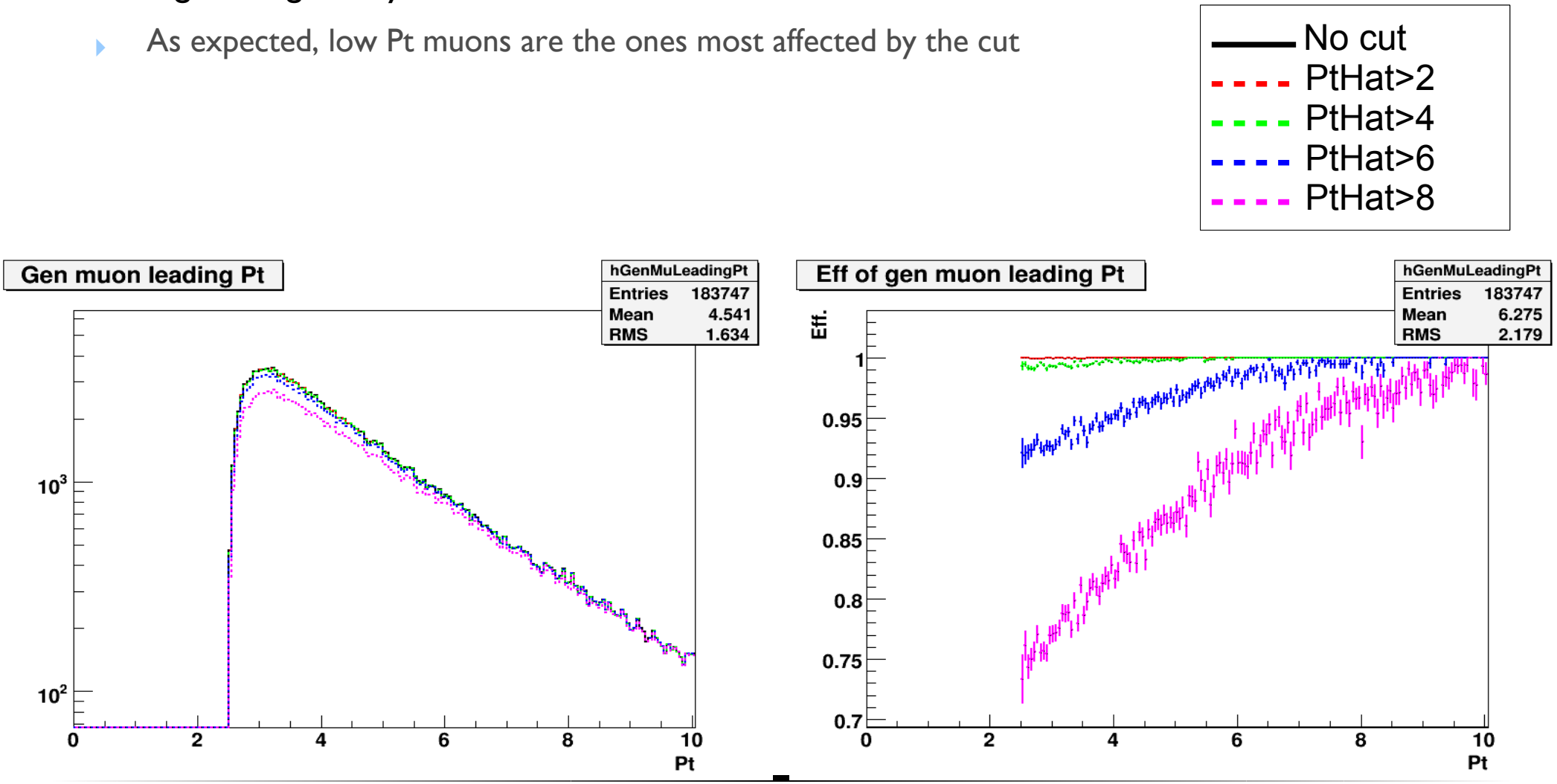
Reco vs. gen Pt - 2nd leading Pt muons

- Also for the 2nd leading Pt muons (gen and reco), the same effect is visible, but amplified



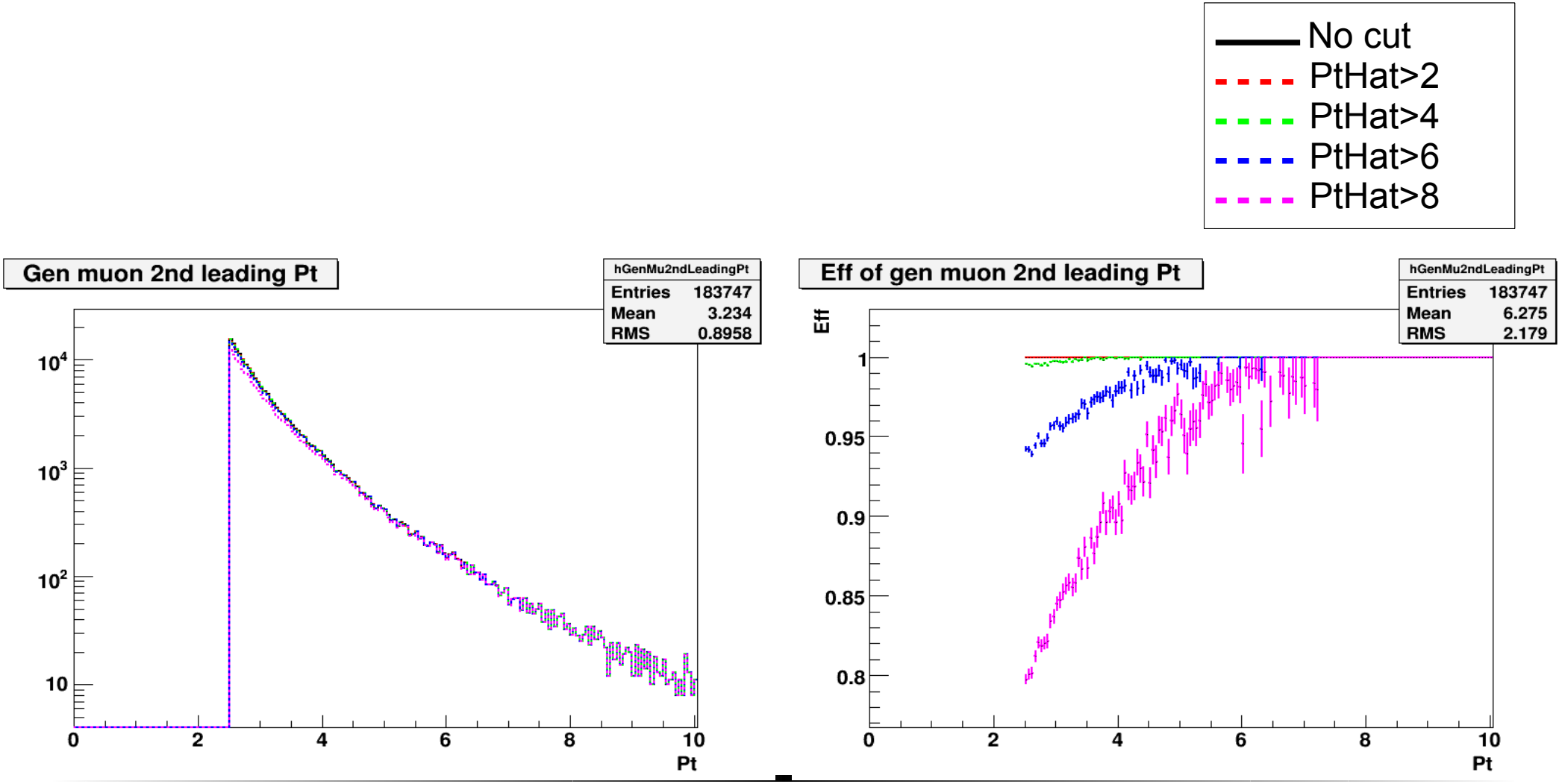
Effect of PtHat cut on lead. genMu

- PtHat>2,4 give almost no effect (mainly because of very few events in that region), while visible changes are given by cuts at 6 and 8
  - As expected, low Pt muons are the ones most affected by the cut



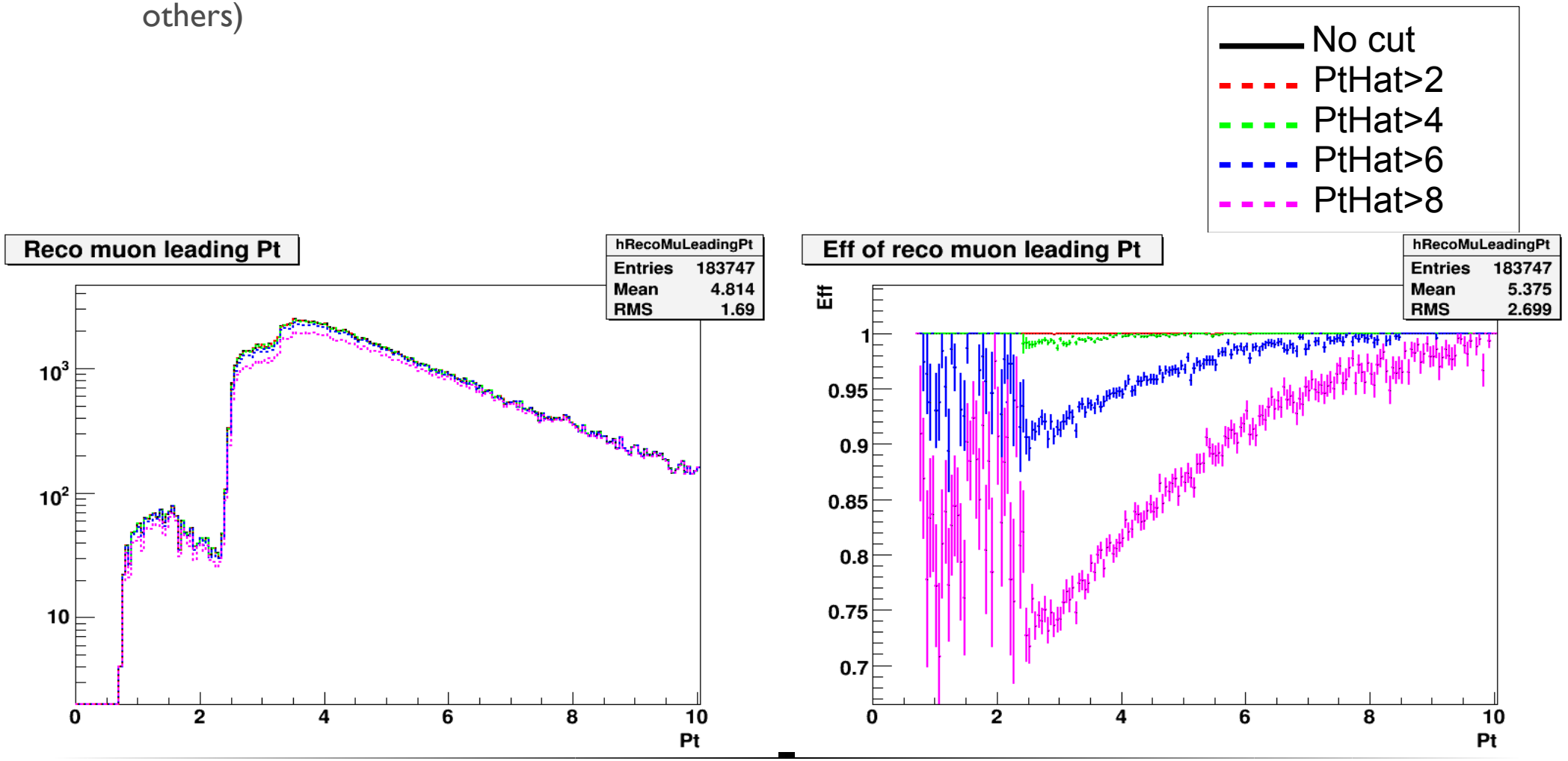
Effect of PtHat cut on 2nd lead. genMu

- Results are similar to the leading generated muon case



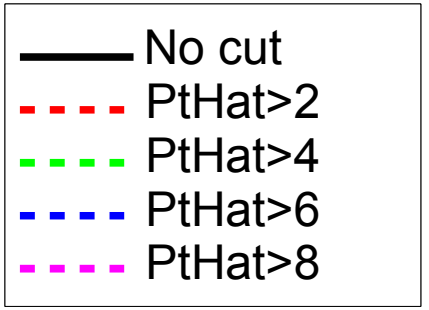
Effect of PtHat cut on lead. recoMu

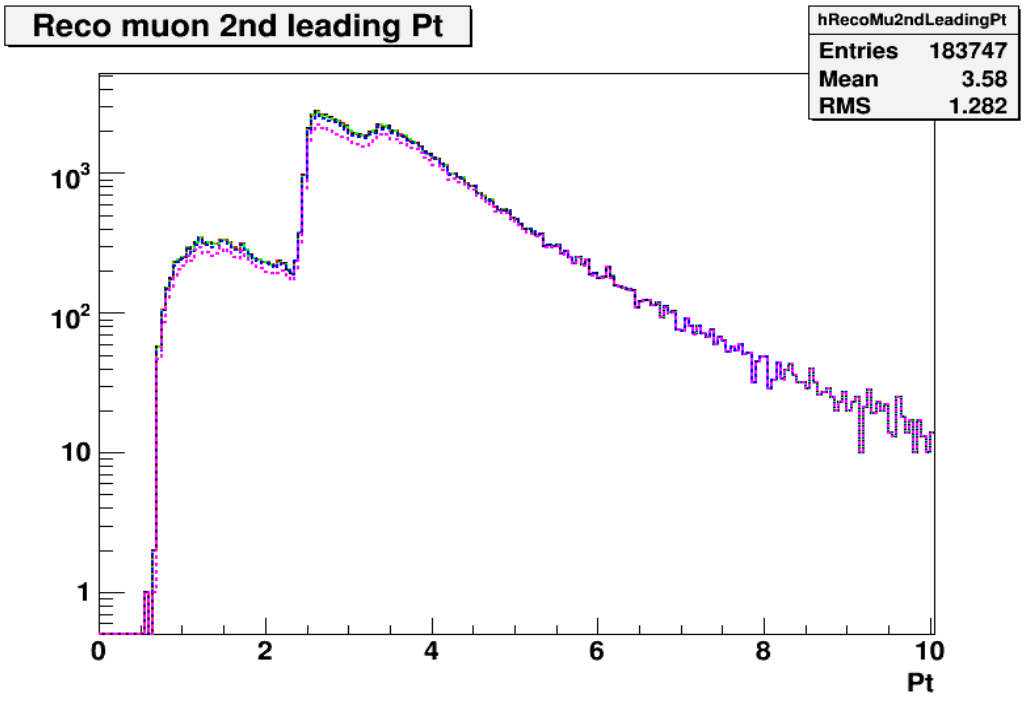
- Again similar results
  - Also the mis-reconstructed low-Pt muons are affected by the cut (perhaps a bit less than the others)

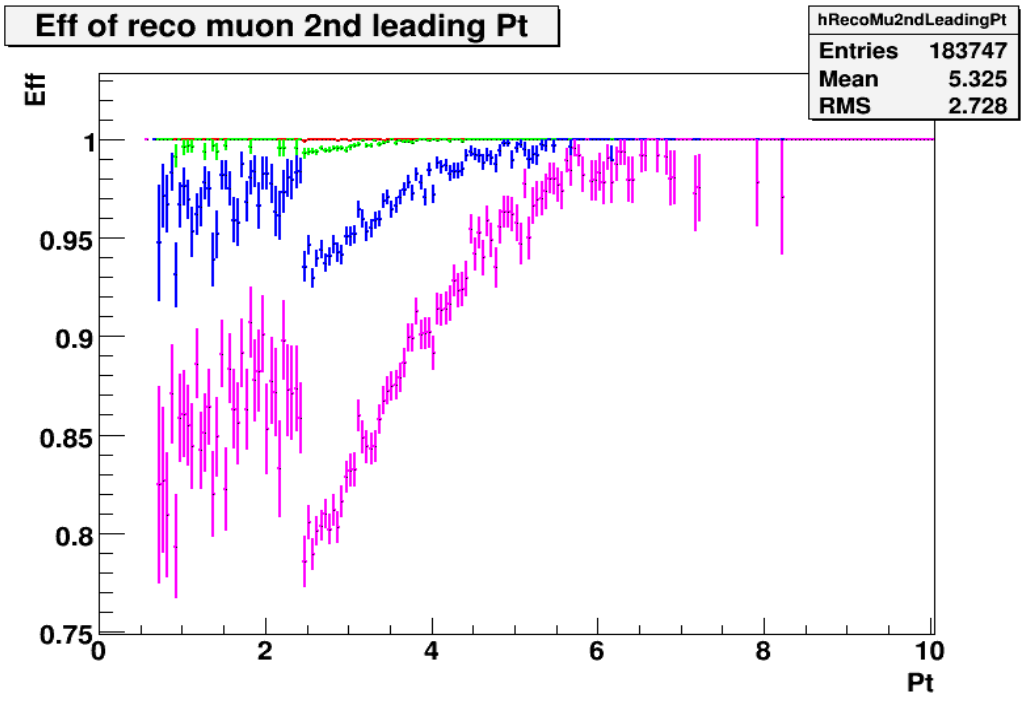


Effect of PtHat cut on 2nd lead. recoMu

- Again similar results
  - And again, also the mis-reconstructed low-Pt muons are affected by the cut

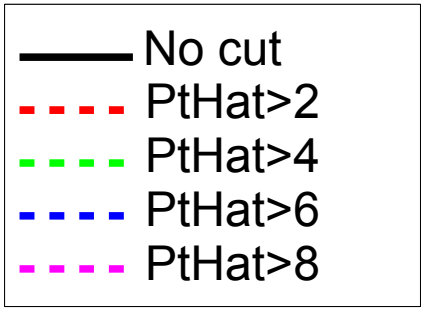


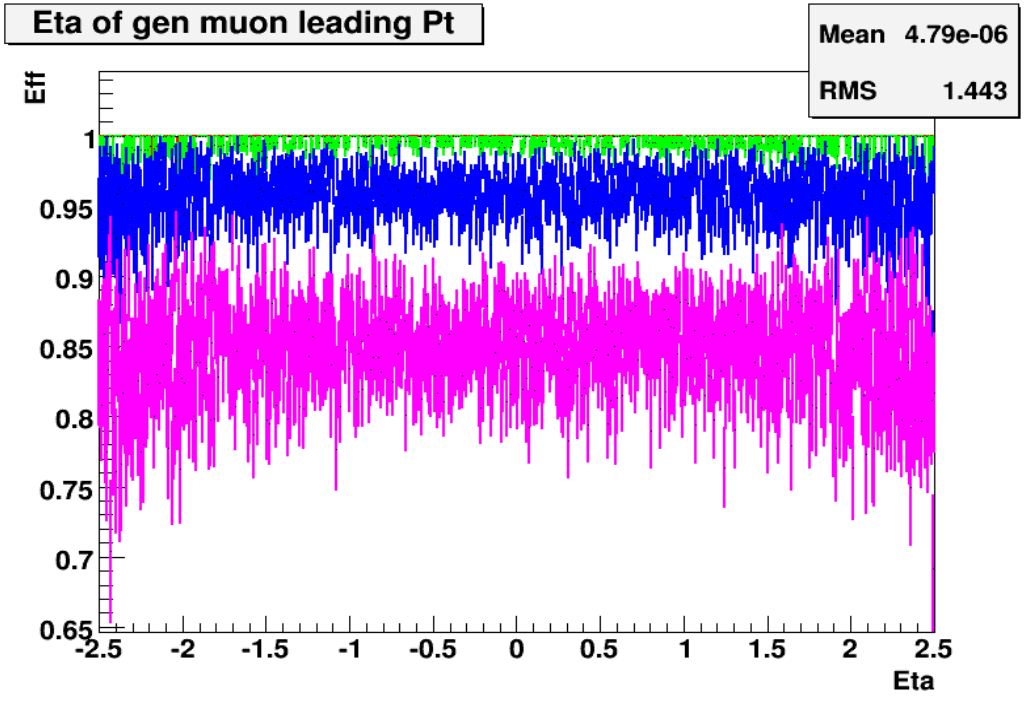


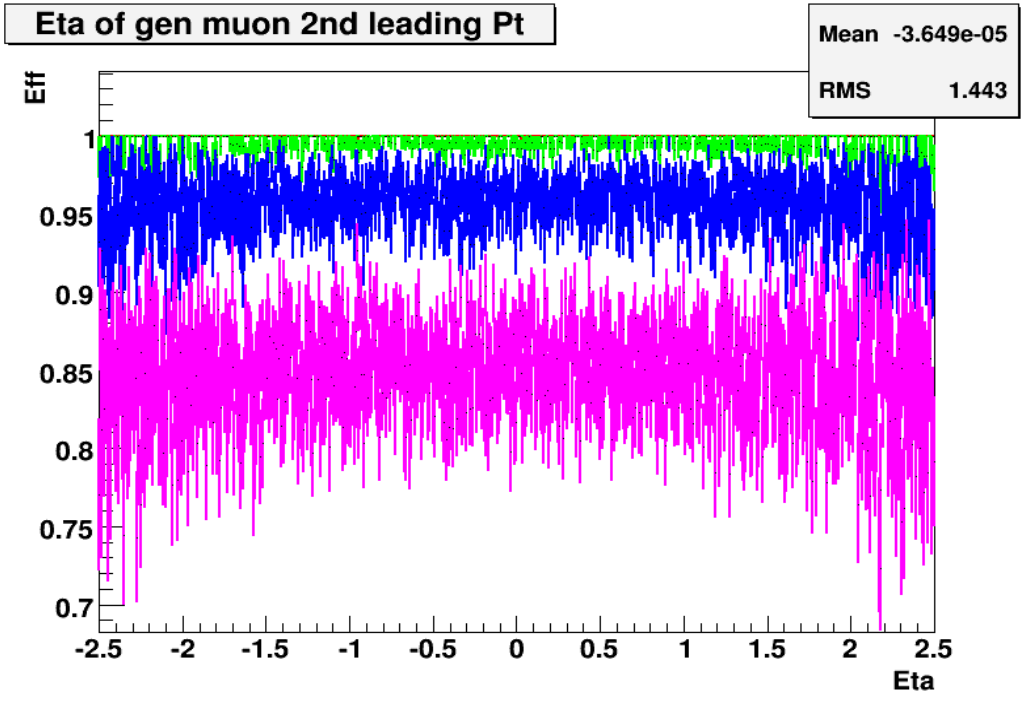


Efficiency eta profile for genMu

- Profiles are fairly flat
- No visible difference between leading and 2nd leading

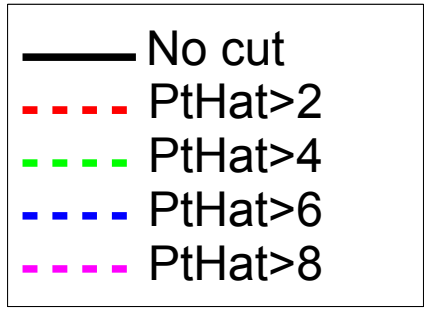


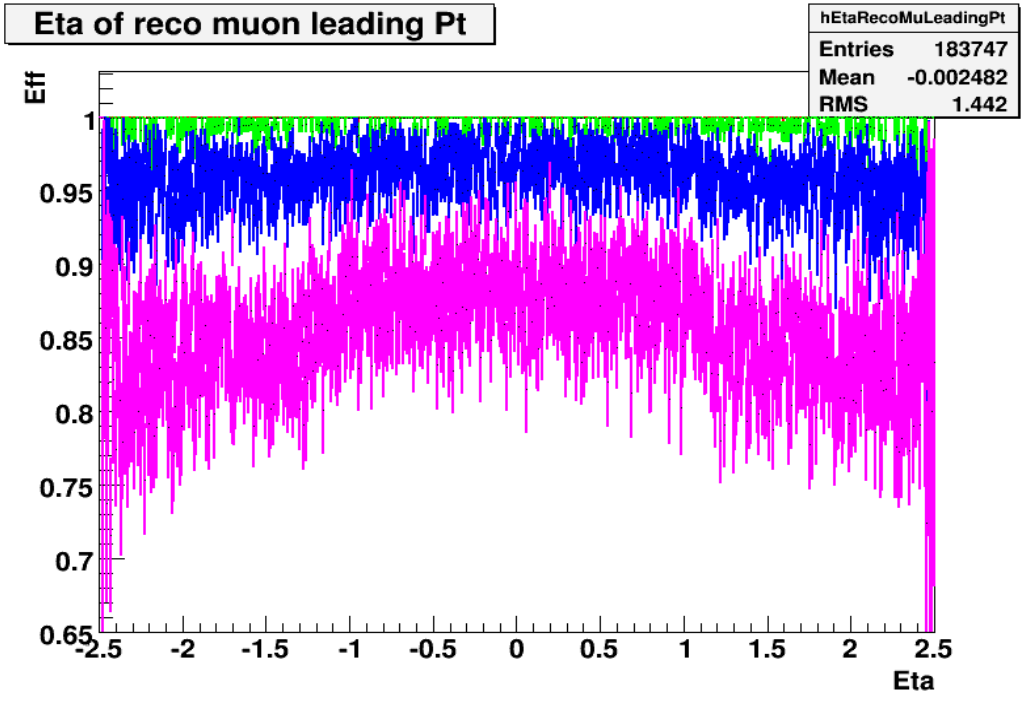


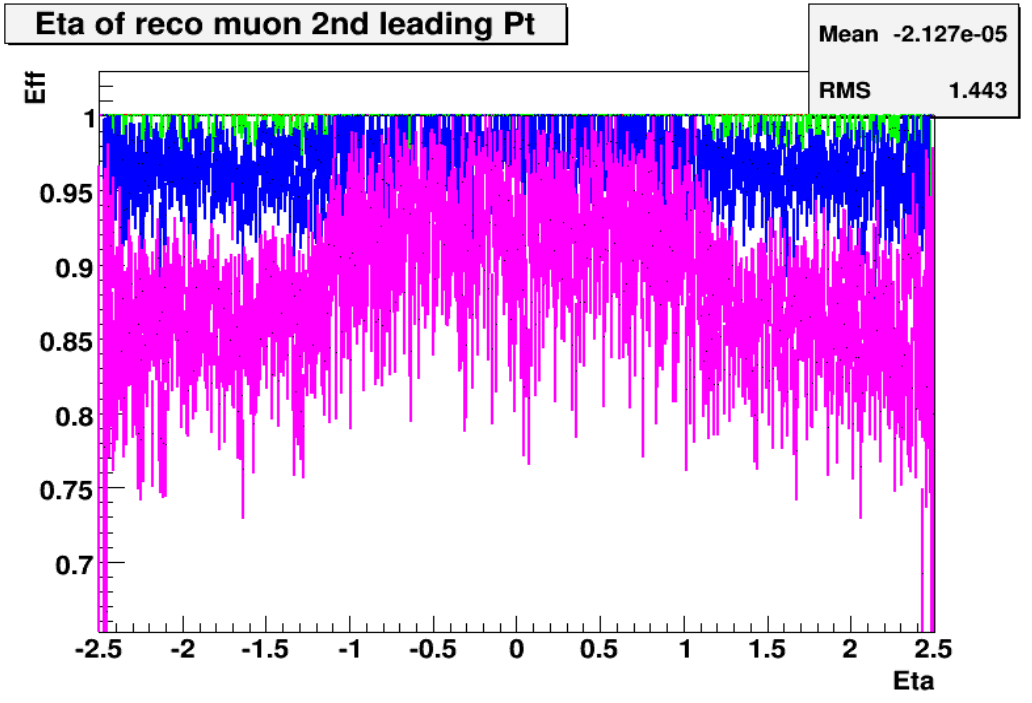


Efficiency eta profile for recoMu

- Small dependance of efficiency from eta
  - Due to the fact that barrel muons have higher Pt, so are in the region less affected by the cut
- Also, visible difference between lead. and 2nd lead
  - Probably due to the same reason as above: the region not affected by the cut is different for lead and 2nd lead

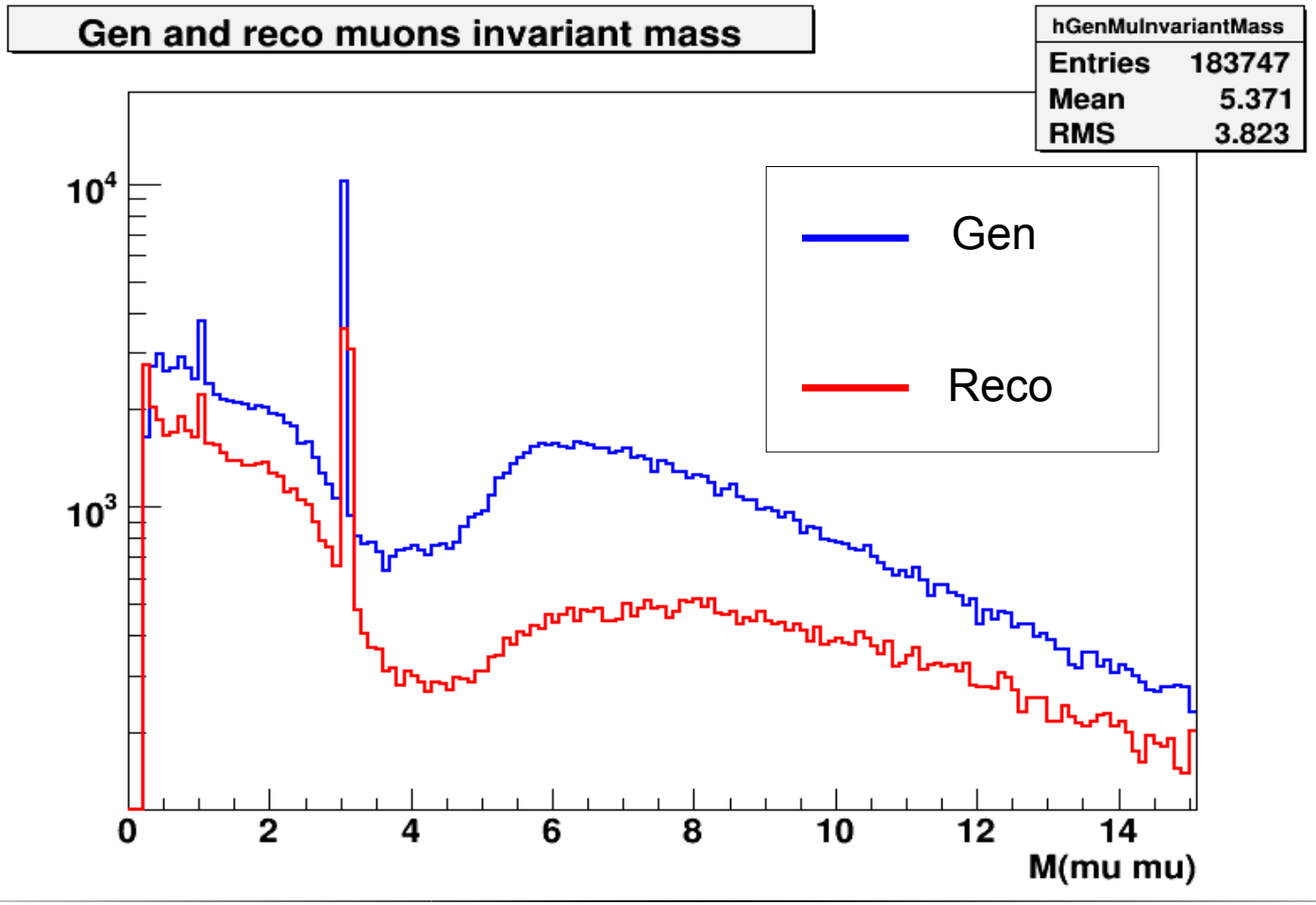






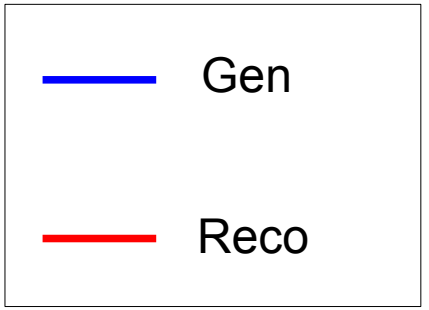
Gen and reco muons invariant mass

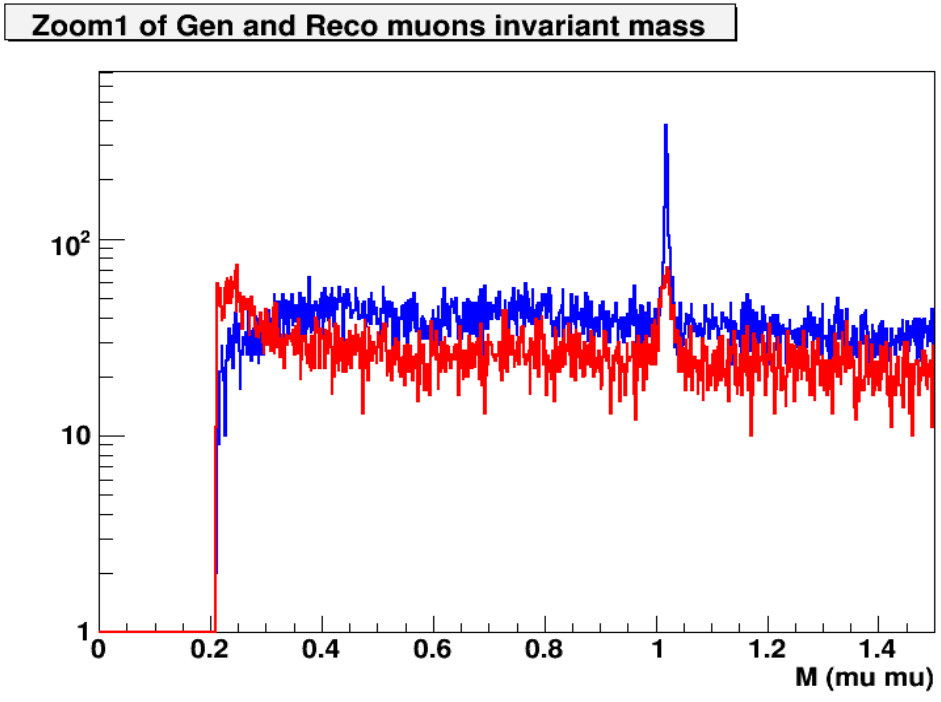
- Invariant masses of the mu-mu system at gen and reco level

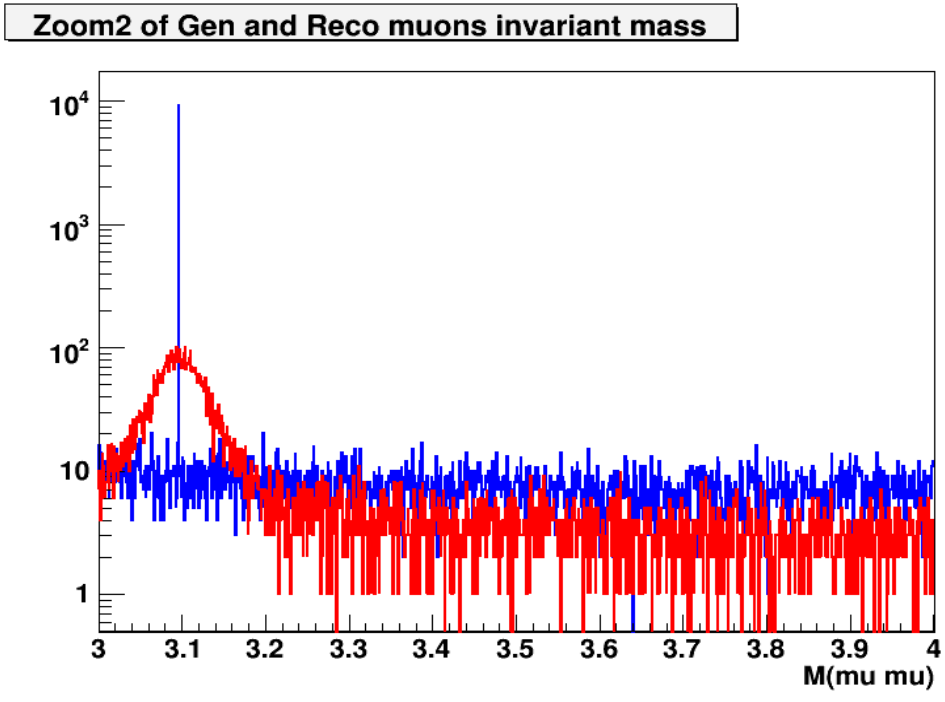


Zoom of invariant mass regions

- Phi and J/Psi peaks are well visible
- I don't see any hint of other resonances
  - Too low S/N for our statistics,
    or the particles aren't even generated?







Conclusions

- PtHat>2 (or >4) cuts give almost no effect to the gen and reco distributions
- **Applying a high-pass cut to PtHat seems a viable alternative...**
  - In any case, I'd like to start some preliminary study to see **if** (and **how much**) we gain (in terms of speed) with this cut
- **...but!**
  - The lack of effects due to the PtHat cut is mainly due to the very small phase space at low PtHat
  - The smallness of that region of phase space is probably due to the requirement of 2 generated muons with Pt>2.5GeV
  - Comparison between reco and gen muons gives some (unconfirmed!) evidence that this cut should be relaxed
    - There are muons reconstructed with very low Pt that match no generated muons
  - Relaxing the Pt cut on muons will likely enlarge the low-PtHat phase space
  - **So, effects of the PtHat cut could become significant!**

Conclusions (2)

- This means that, in order to increase the generation efficiency we could, either
  - Introduce a PtHat cut
- or
  - Relax the muon Pt cut
- or
  - A combination of the above two
- More data are needed to understand which is better...
- **Ideas??? :-)**