Study on QCD background for $W \longrightarrow \mu\nu$ analysis

Feed through of low p_t muons & MET algos comparison

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Outline

Reminder of cut applied for $W \rightarrow \mu\nu$ analysis

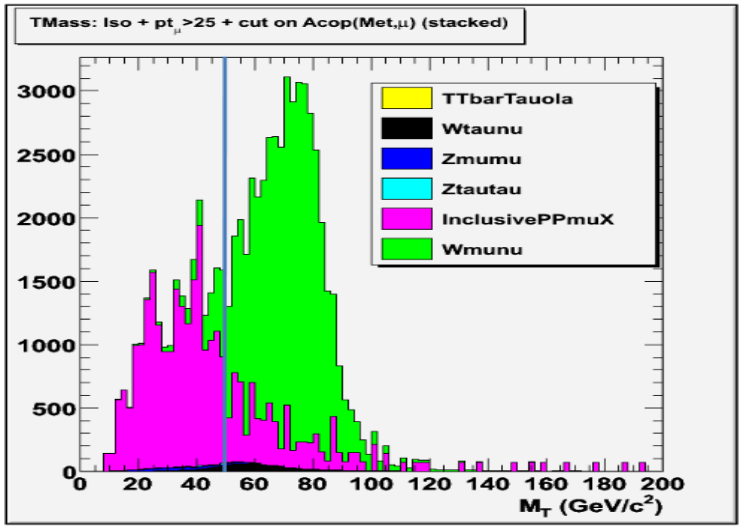
Muon cut

- GlobalMuon;
- Muon $p_t > 25\ GeV$;
- Muon $|\eta| < 2$;
- Muon isolation $\sum p_t / p_t^{\mu} < 0.09$;

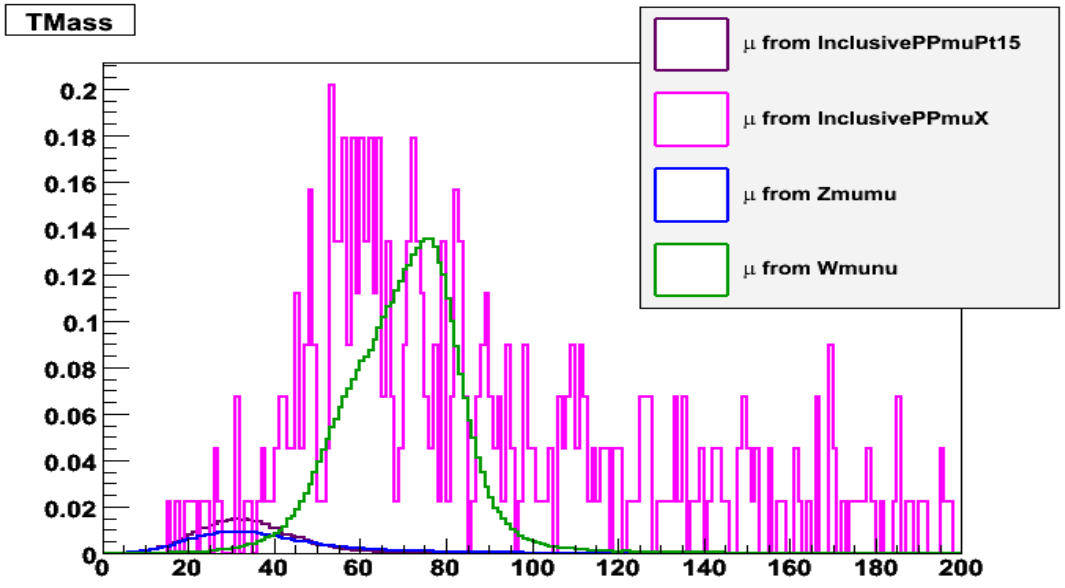
Event cut

- Acoplanarity $|acop| < 1\ rad$ $(acop \in [-\pi, \pi])$;
- Cut on Z $(2\ \mu\ p_t > 20\ GeV)$ **not used**;
- Reject top **not used**;
- MET cut **not used**;

TMass (using PfMet) after all cuts including `InclusivePPmuX`



MET with Particle Flow



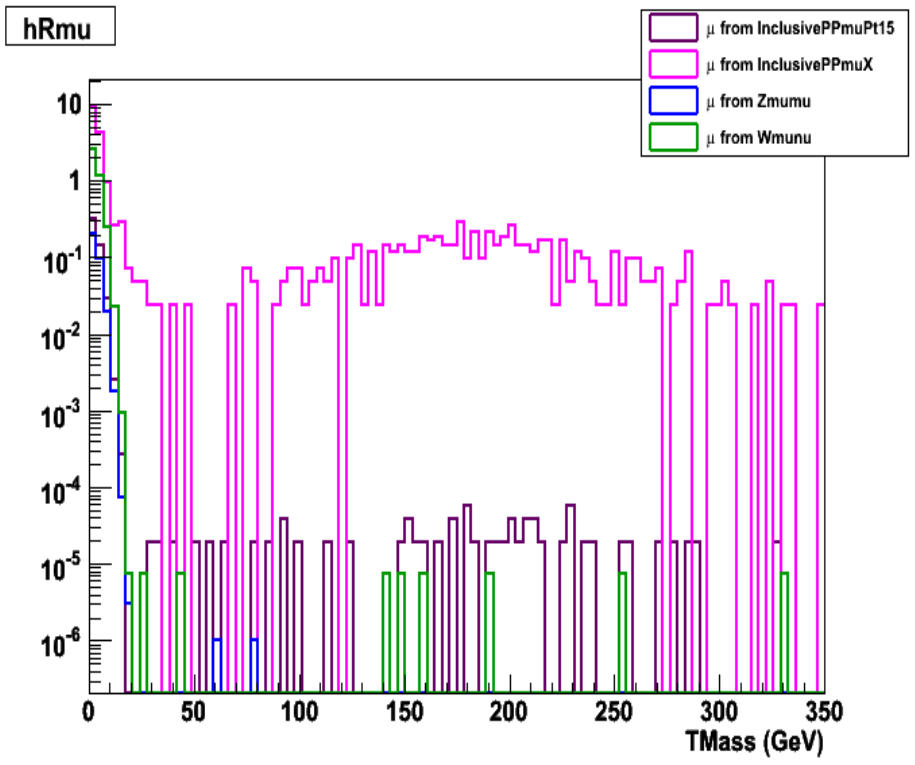
Left: *26/2/09 talk* CMSSW 223, stacked. Right: CMSSW 225 *redigi* samples, superimposed.

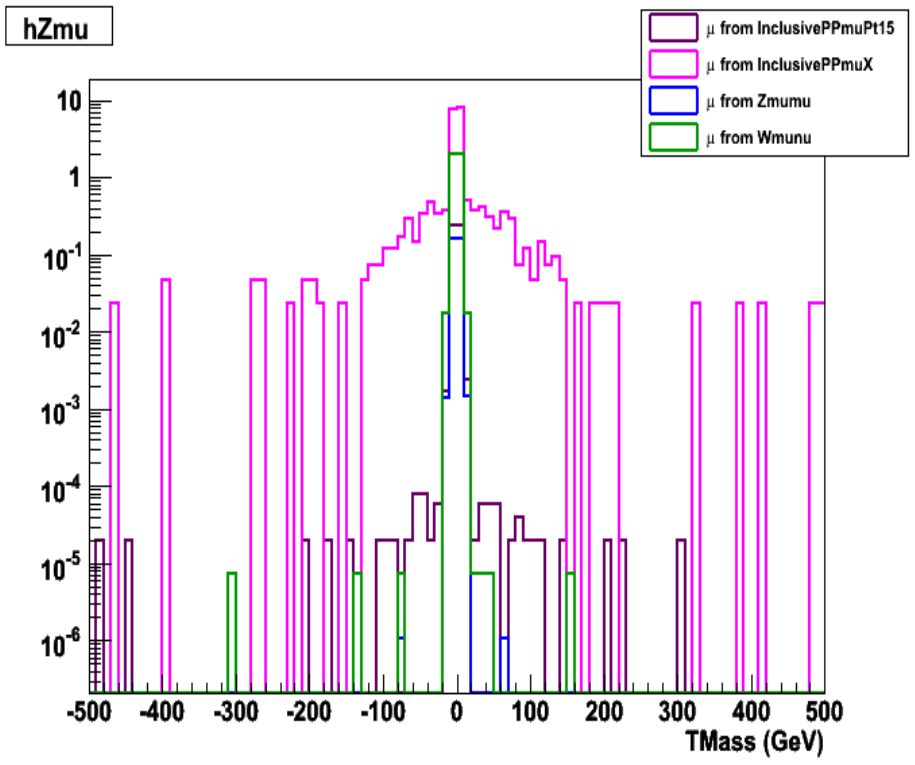
Feed-through of low pt muon *dominates* the signal

Not 100% sure normalization is correct in past plot, but anyway the problem is there.

$\sigma = 51.56\ mb$, $\epsilon_{filter} = 0.002305$, $\#events \approx 5.3\ M$

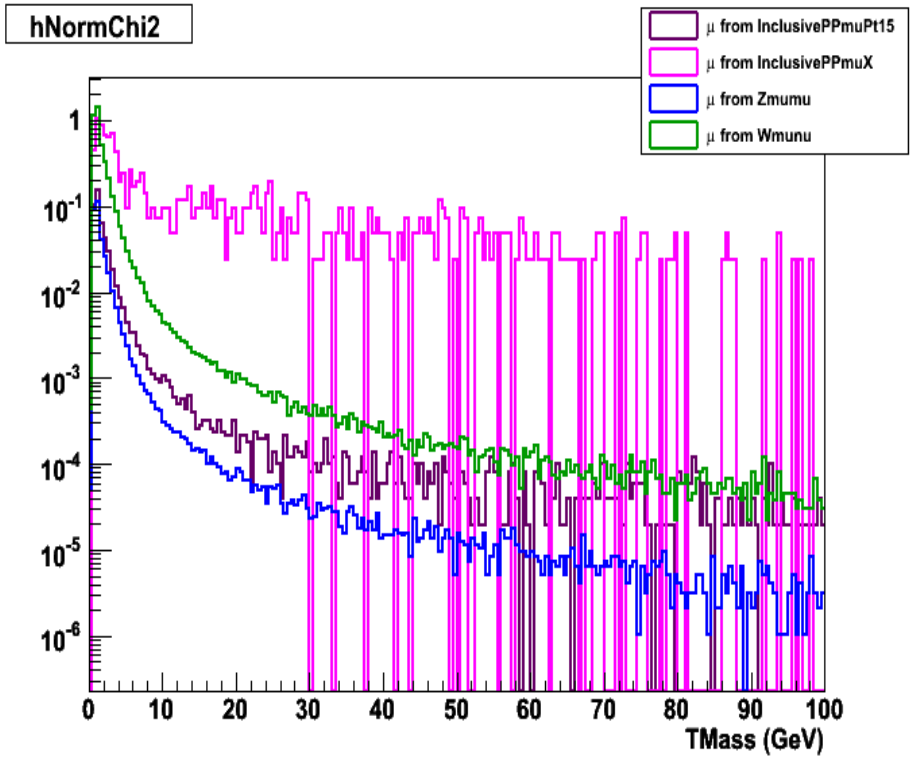
Muon vertex R and Z for muons passing all cuts

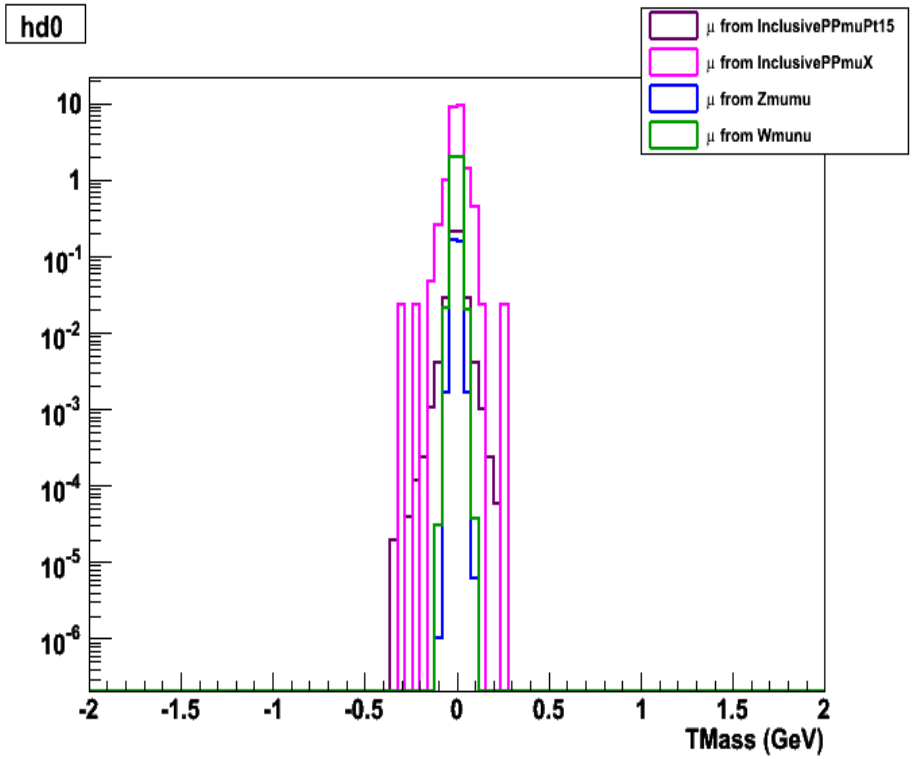




Muons vertex very far from IP

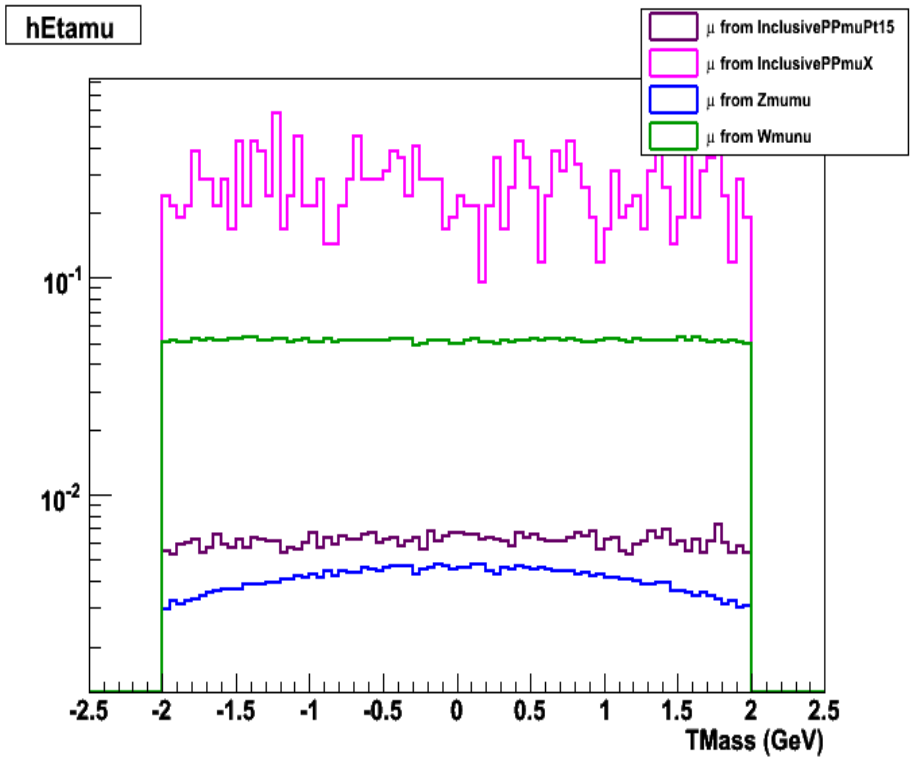
$\chi^2/NDoF$ and d0 for muons passing all cuts

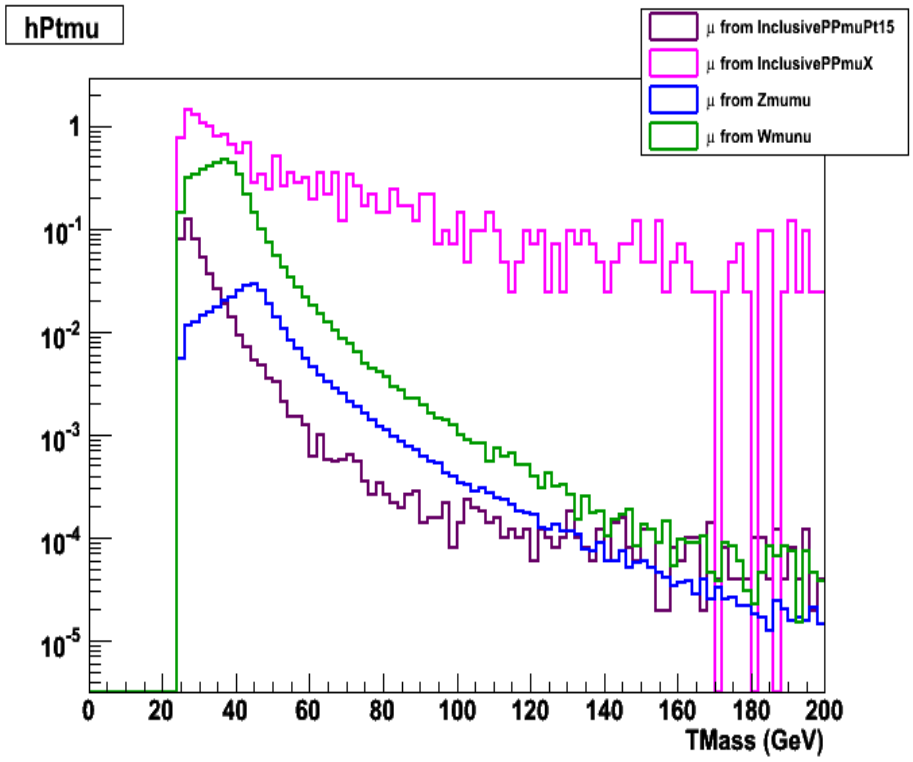




- χ^2 not so good, but not so bad either.
- Impact parameter (d0) larger but not terrible (note log scale)
- NB. no explicit cut on d0!

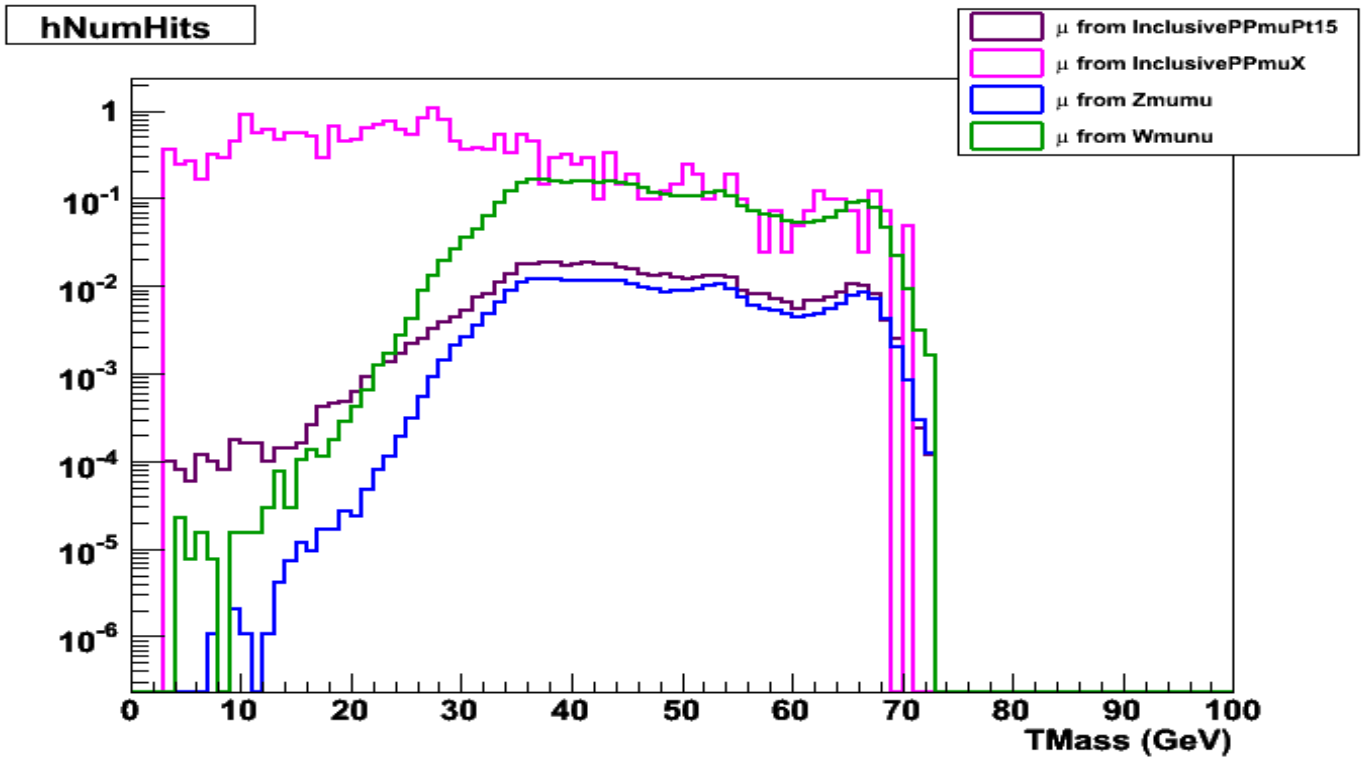
η, p_t for muons passing all cuts





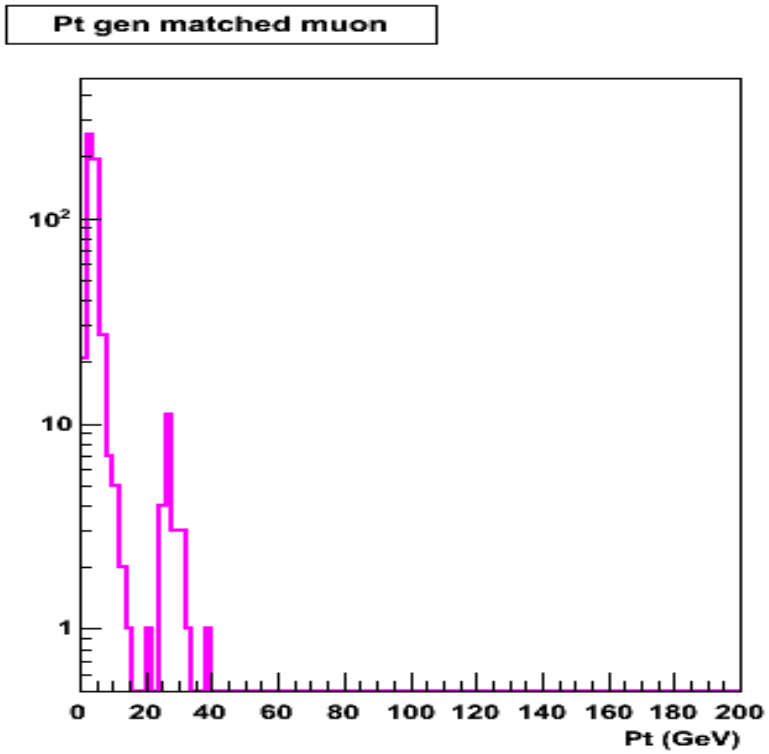
Flat eta muons

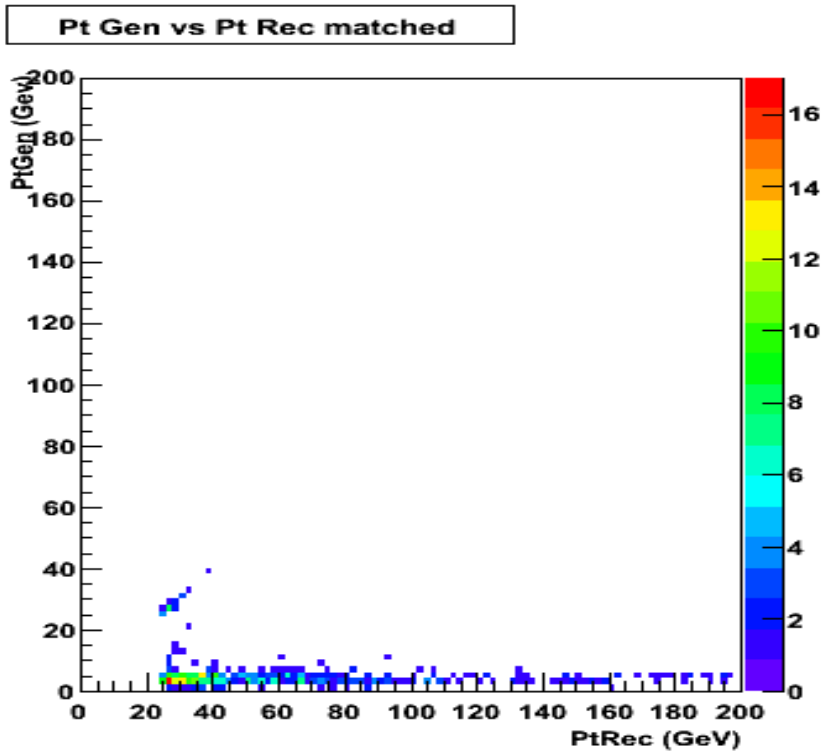
#*hits* for muons passing all cuts



- Clear excess at low # hits;
- but sizeable fraction of the muons from low QCD has $\#_{hits} > 30$;
- Should look at tracker and muon system hits separately;

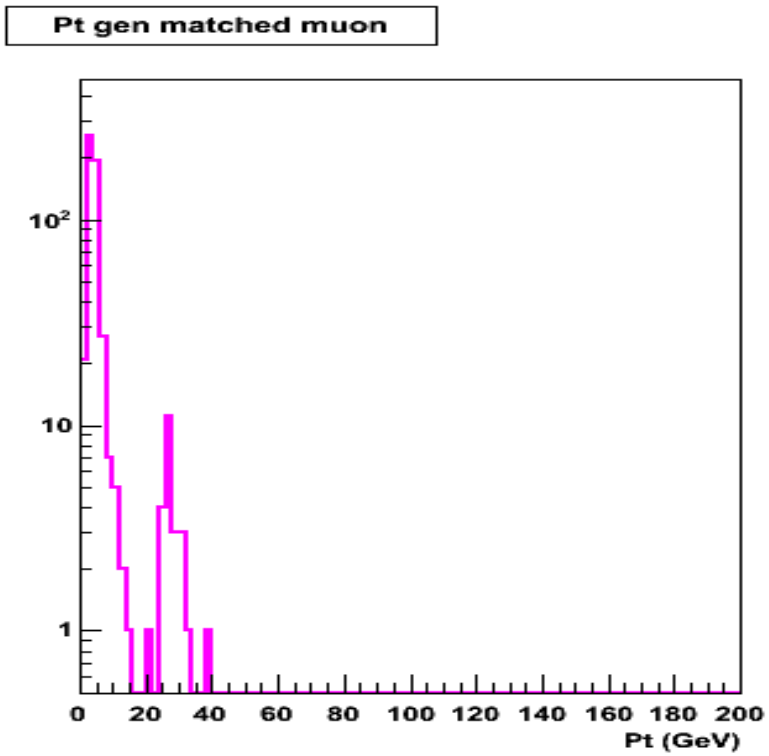
Look at Generated quantities for matched muon (if any)

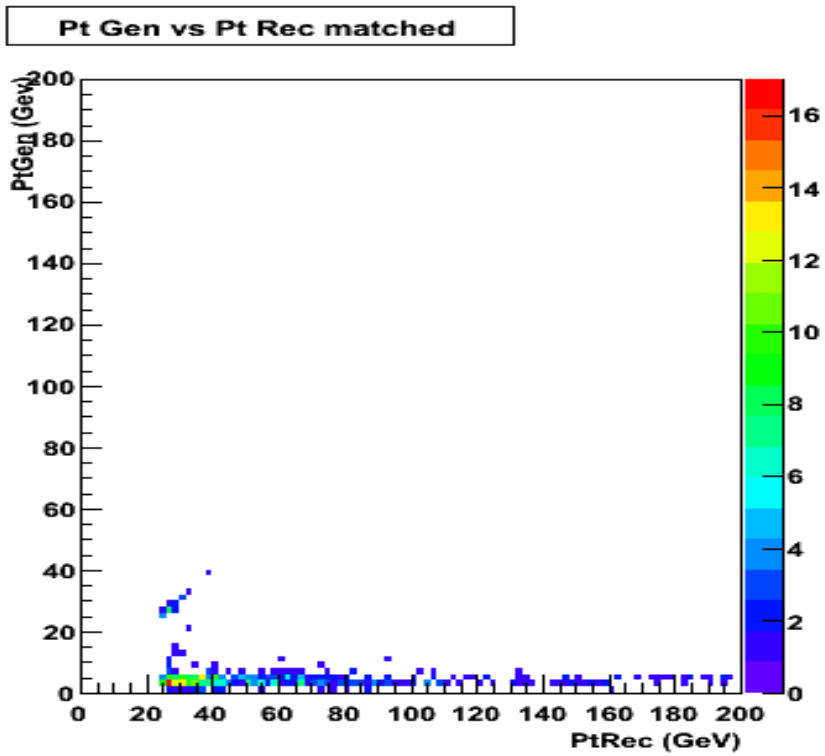




- Reminder $p_t^{rec} > 25\ GeV$ applied!
- NB. only 534/782 rec muons match a generated one within $\Delta R < .3$

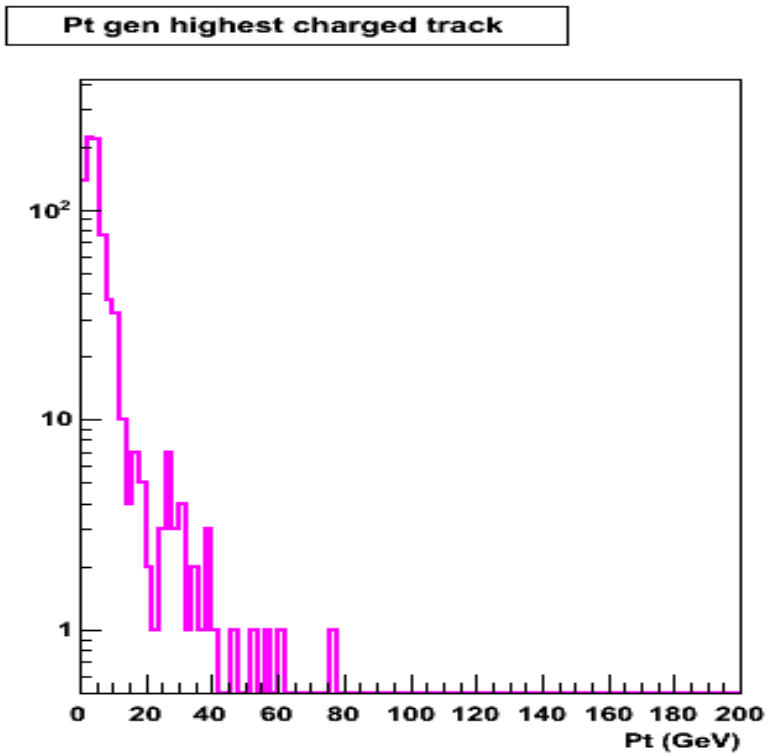
Decay in flight? Or punch through?
Look at Generated quantities for matched charged track

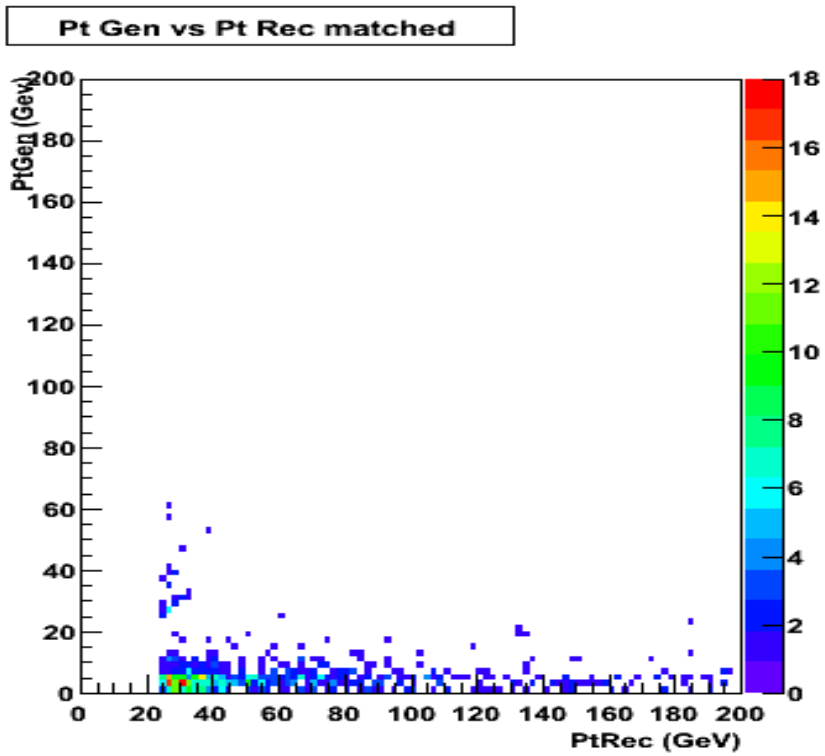




Same as before: rec muon p_t has little to do with that of the matched gen charged track

Look at Pt of highest charged track $\Delta R < .3$



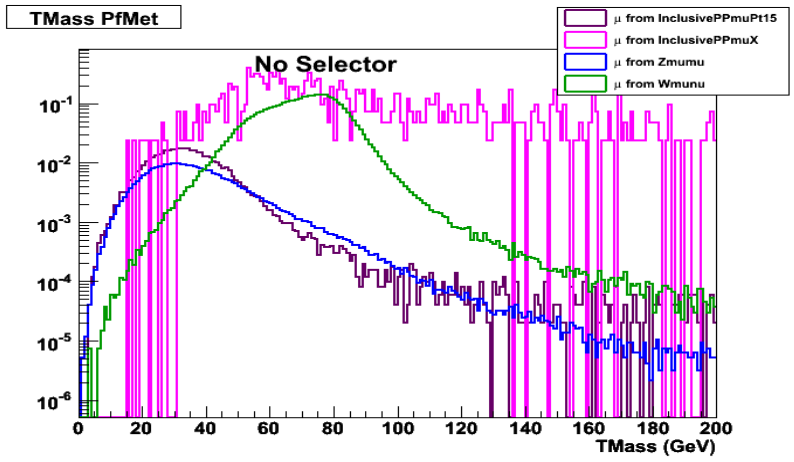


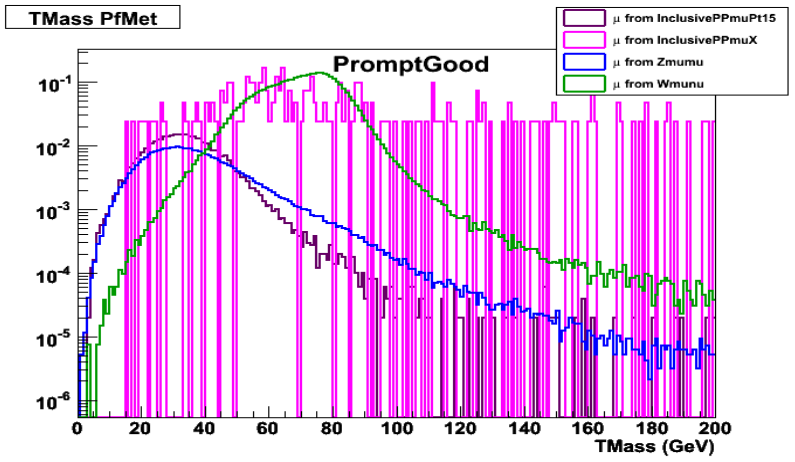
Mostly, no high p_t track close to reconstructed muons

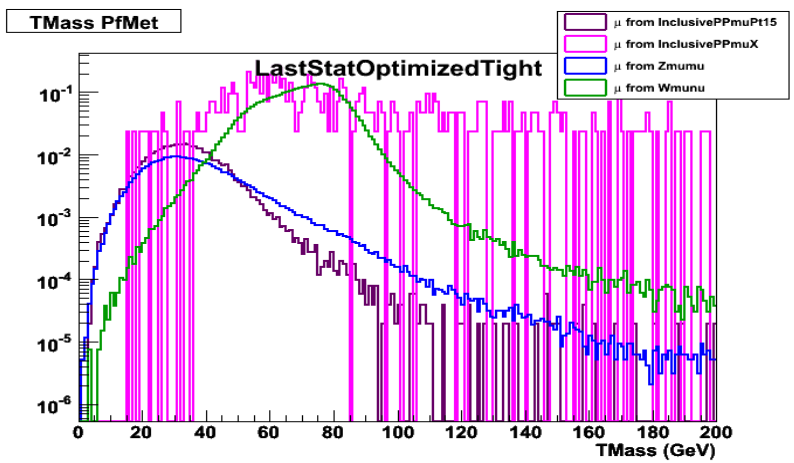
Tightening the muon selection

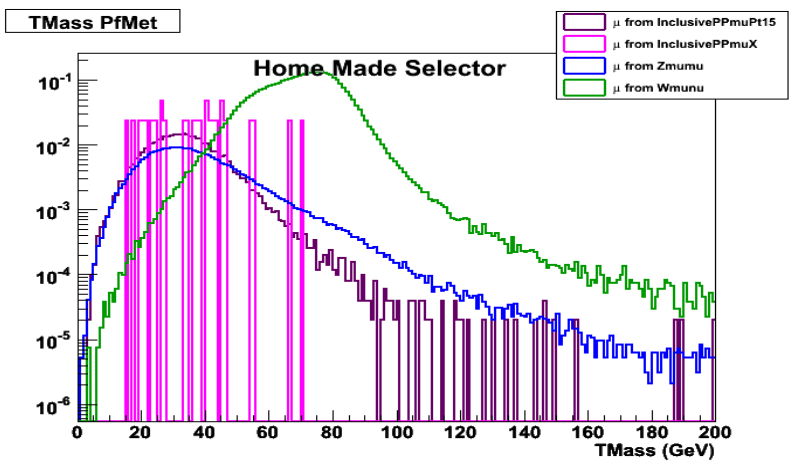
- Note: we just consider GlobalMuon!
- Tried different `MuonSelector`
- Selector `GlobalMuonPromptTight` (Global $+\chi^2/NDoF < 10$);
- Better, but not enough
- Selector `TMLastStationOptimizedLowPtTight` :
  - one well matched segment
  - Penetration depth tight selector (most external chamber crossed by the track should have segment)
- Basically NO effect
- Try `home-made` selector
  - `TMLastStationOptimizedLowPtTight`
  - $\chi^2/NDoF < 10$
  - $vtx_\mu.R < 20\ cm$, $|vtx_\mu.Z| < 20\ cm$
  - $d0_\mu < 2\ mm$
- Looks like selectors works more on outer tracker than on inner one...

TMass all cuts, Tight, GoodPrompt, Personal







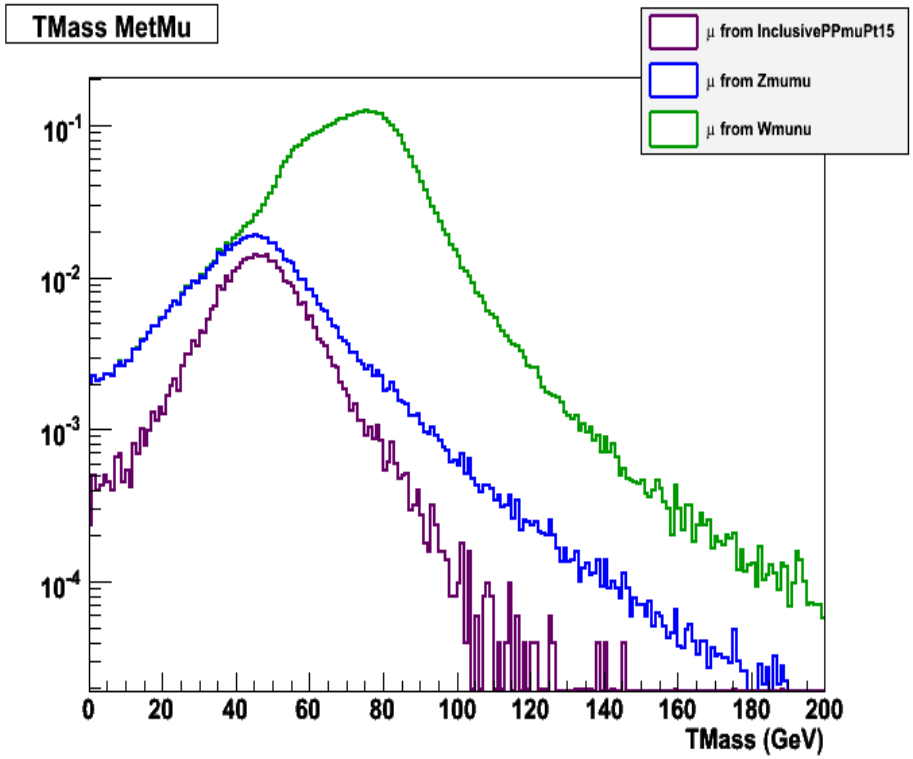


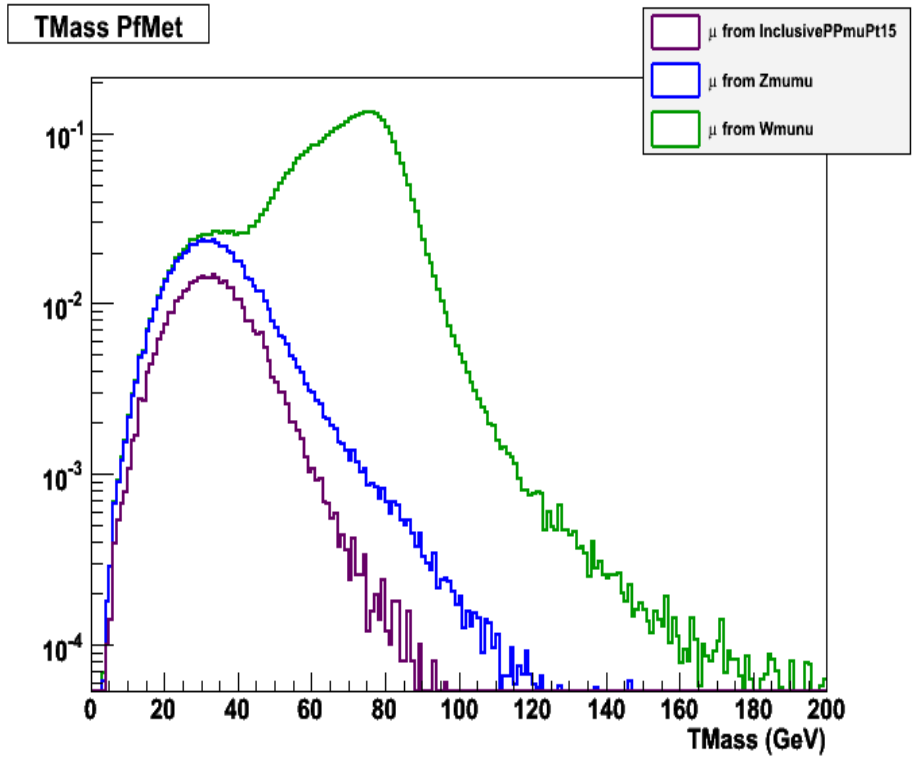
Note: with good selector, given the very low stats, PPmuX is distributed like PPmuPt15

Outline

Why PfMet and CaloMet gives different results for TMass?

TMass after all cuts: only W, Z and QCD shown

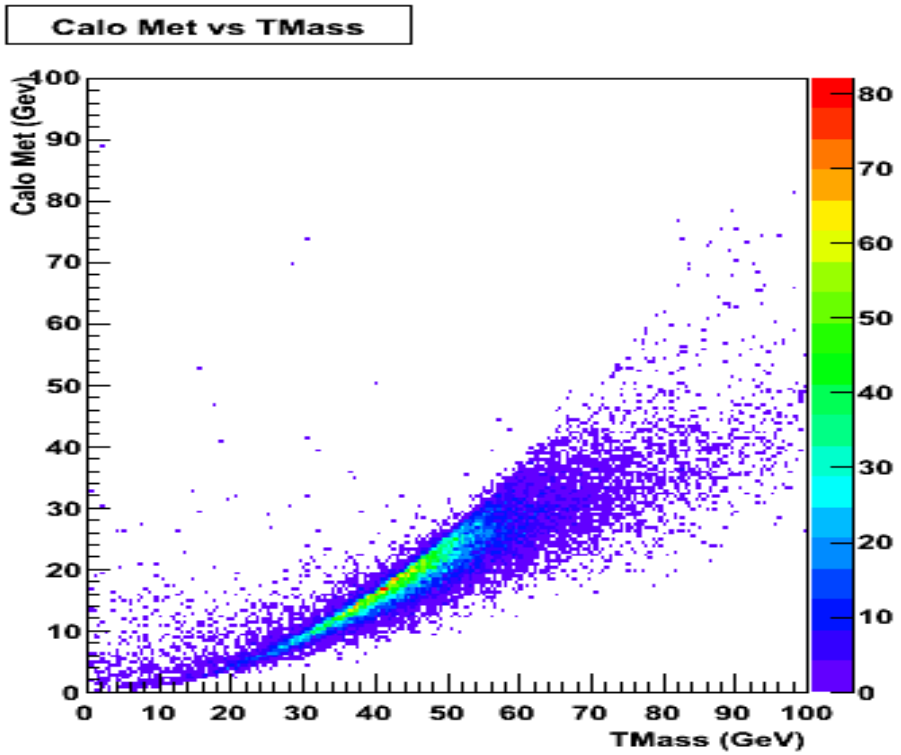


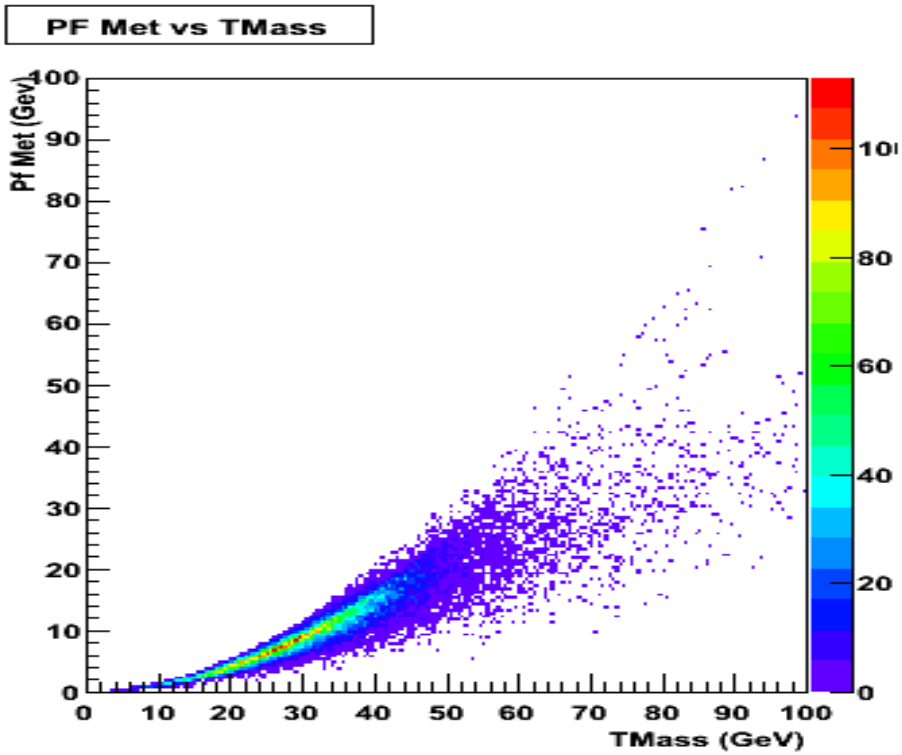


Calo MET (left) with μ and Jet correction applied PFMEt (right)

For QCD events, low TMass is equivalent to low MET

MET vs TMass for QCD (pt15) events



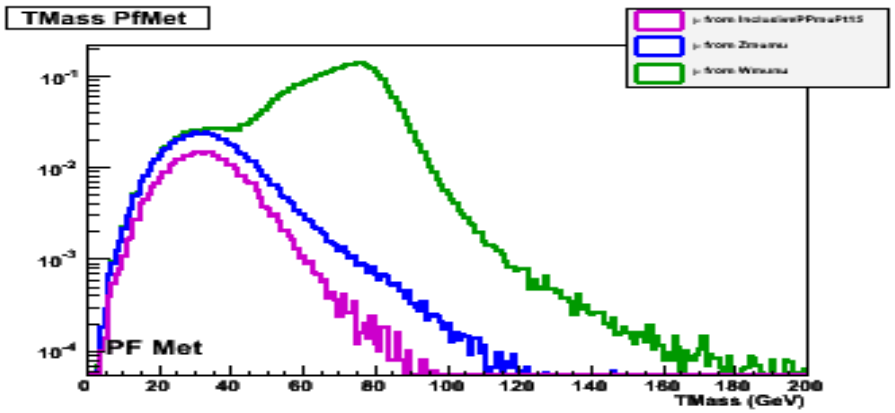


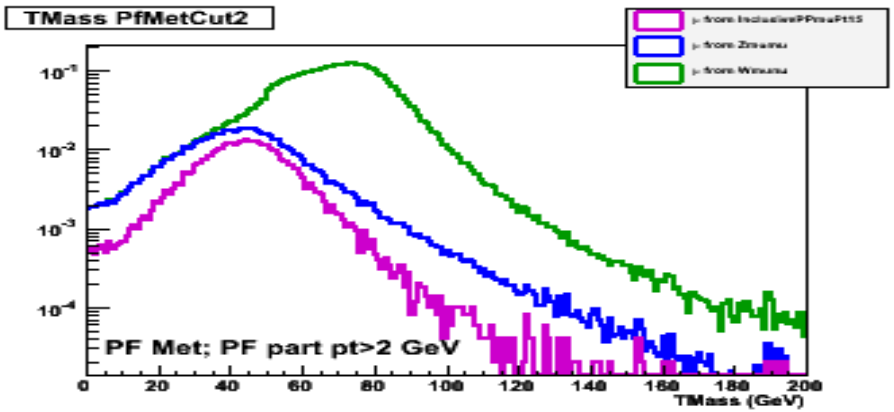
Lower MET means lower TMass

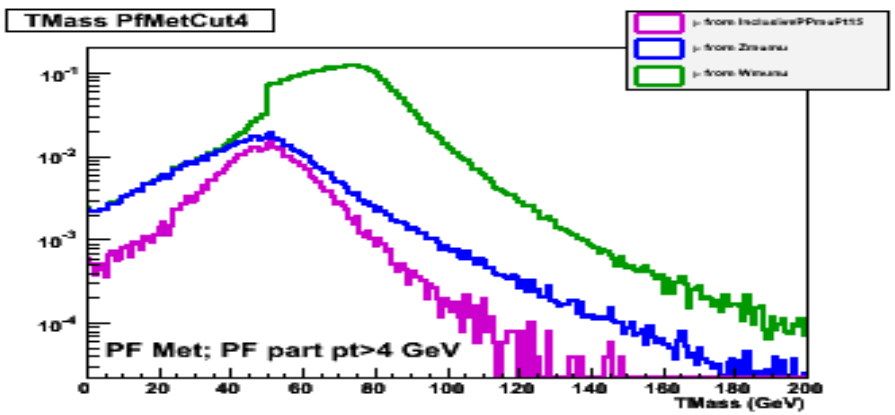
MET *à la carte*

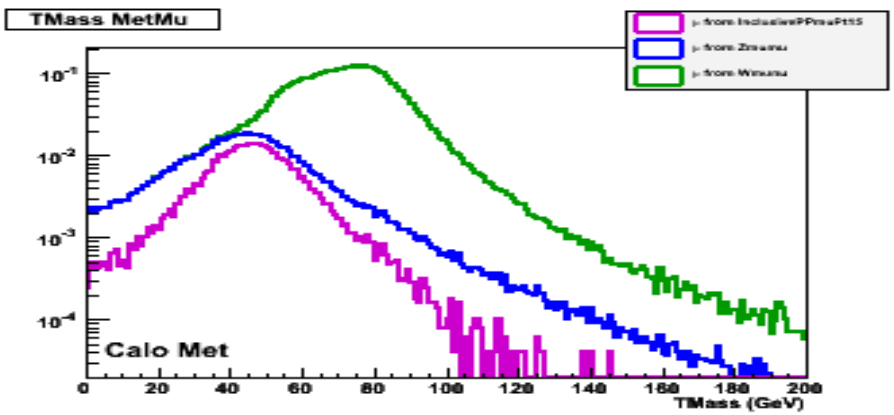
- Could it be a threshold effect? PF, using tracker, sees particles with lower pt than Calo
- Build PFMet with a threshold on all PF candidates p_t
- Build PFMet with a threshold on charged PF candidates p_t
- Build PFMet with a threshold on neutral PF candidates p_t
- Look also at `TcMET`: if a Calo cluster is matched by a track, use the latter, and remove the expected track deposit in the calo.
- Use TMass as benchmark, concentrate on No-MET sample (QCD and $Z \to \mu\mu$) and signal $W \to \mu\nu$.

TMass using PFMet with different cut on PF particles



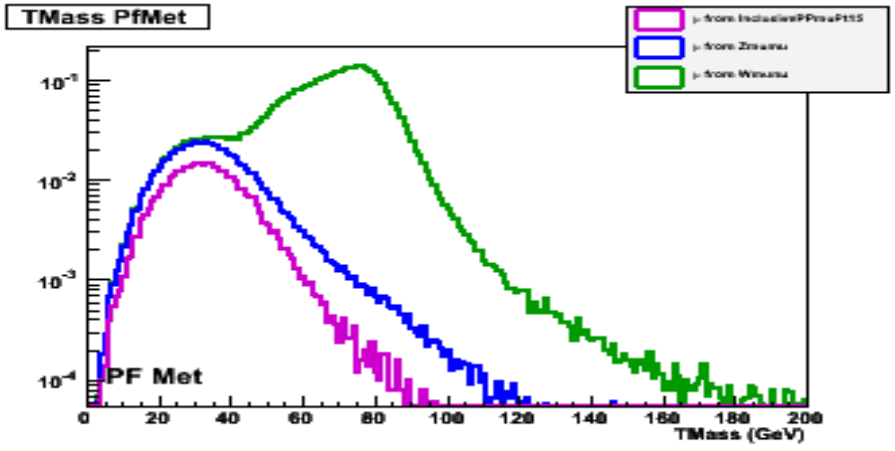


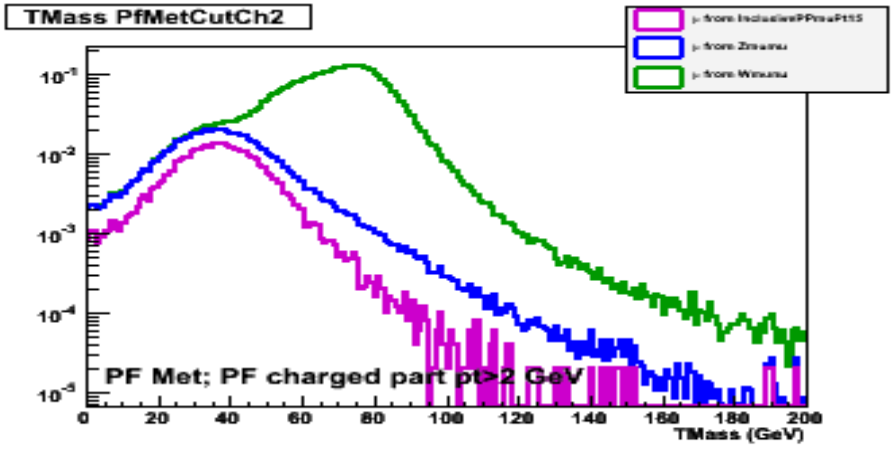


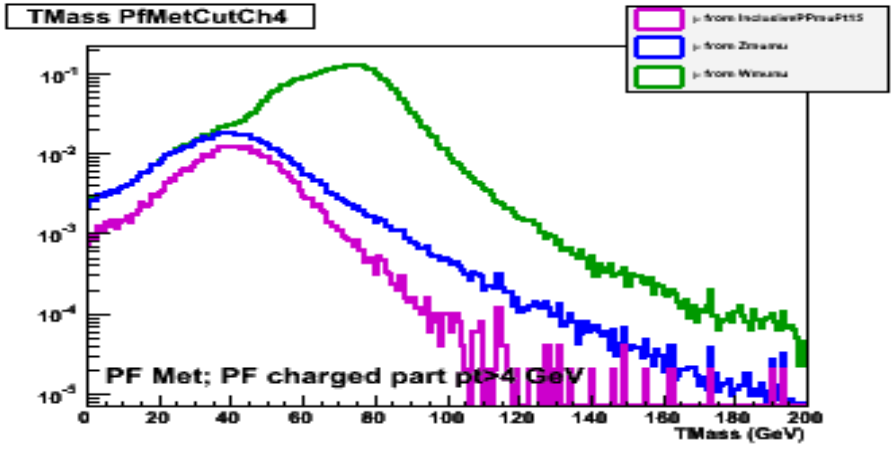


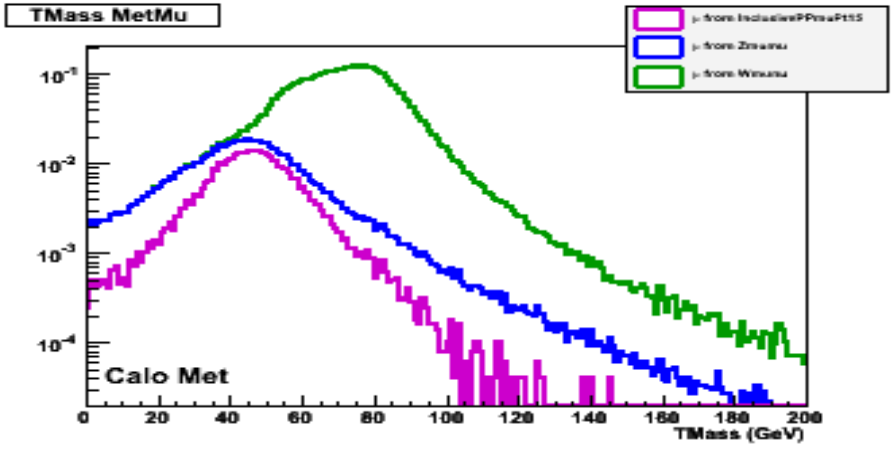
- the higher the threshold, the higher the PF MET
- with threshold 2 *GeV*, $< MET_{PF} > \approx < MET_{Calo} >$
- step at 50 *Gev*, when MET is build just from μ.

TMass using PFMet with cut on PF charged particles



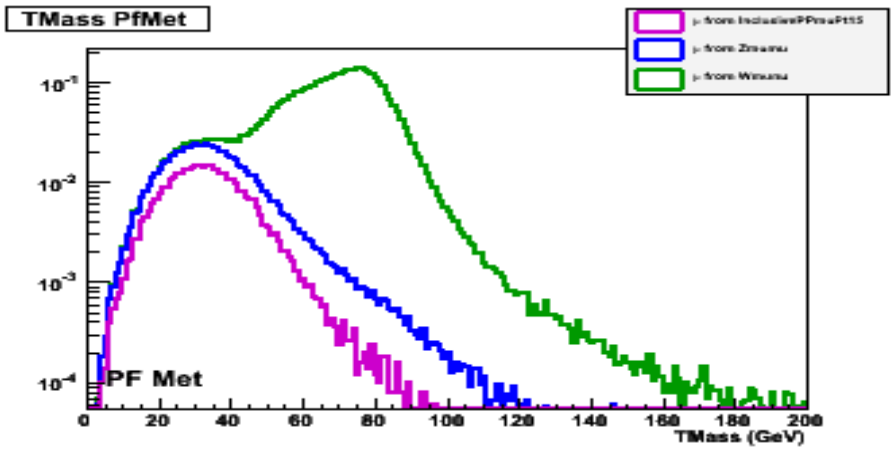


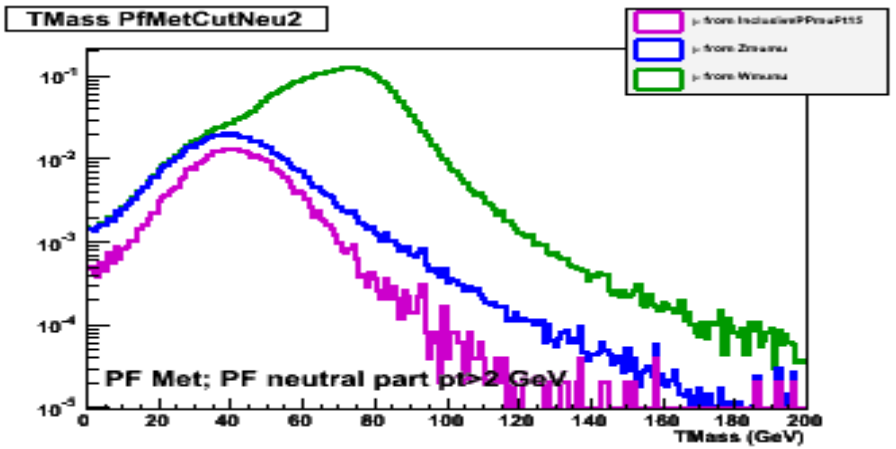


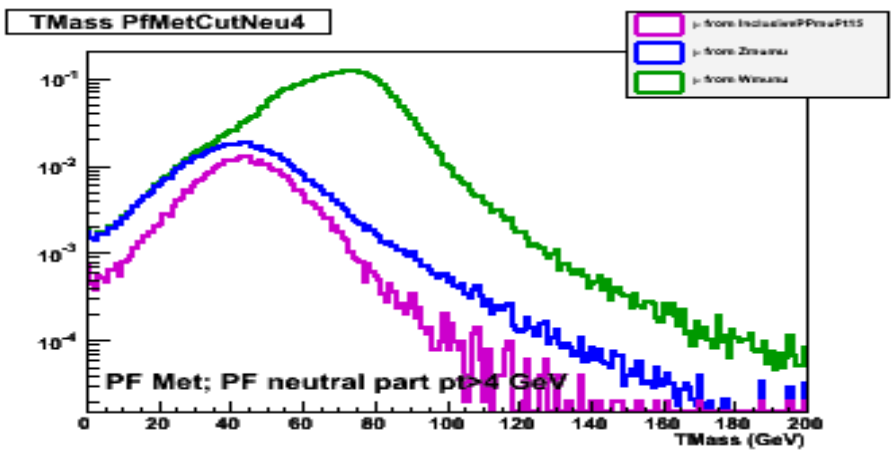


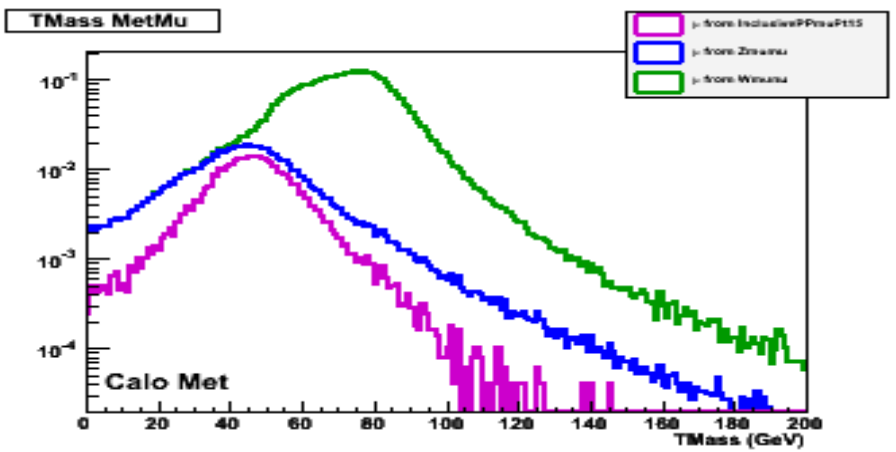
- If cut only on charged particle, need an higher threshold to reproduce CALO met

TMass using PFMet with cut on PF neutral particles



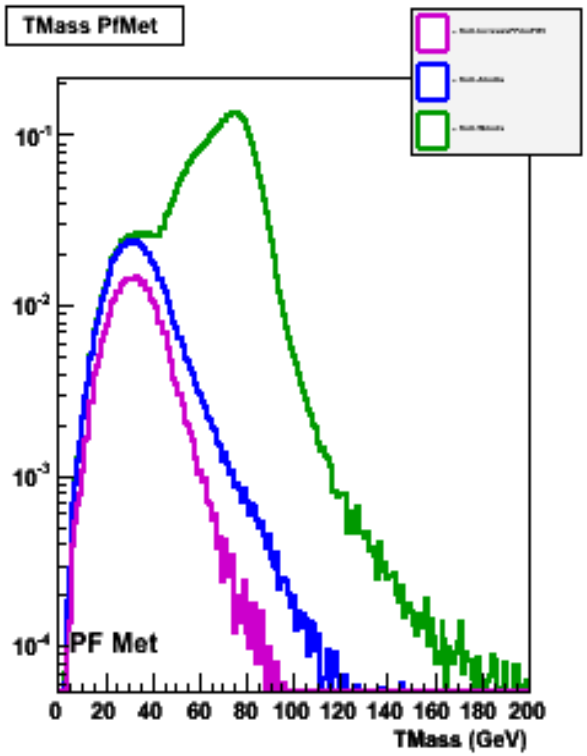


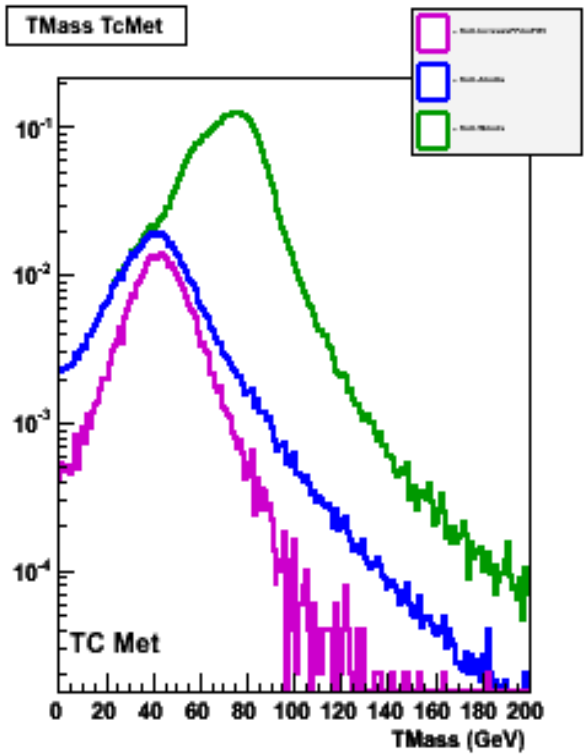


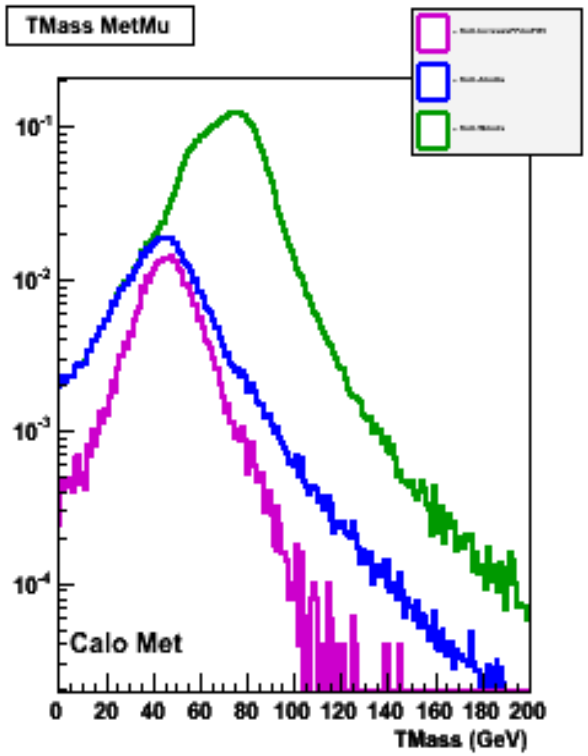


- Need lower cut on neutral to reproduce CaloMet

TMass using PFMet, TcMet and CaloMet

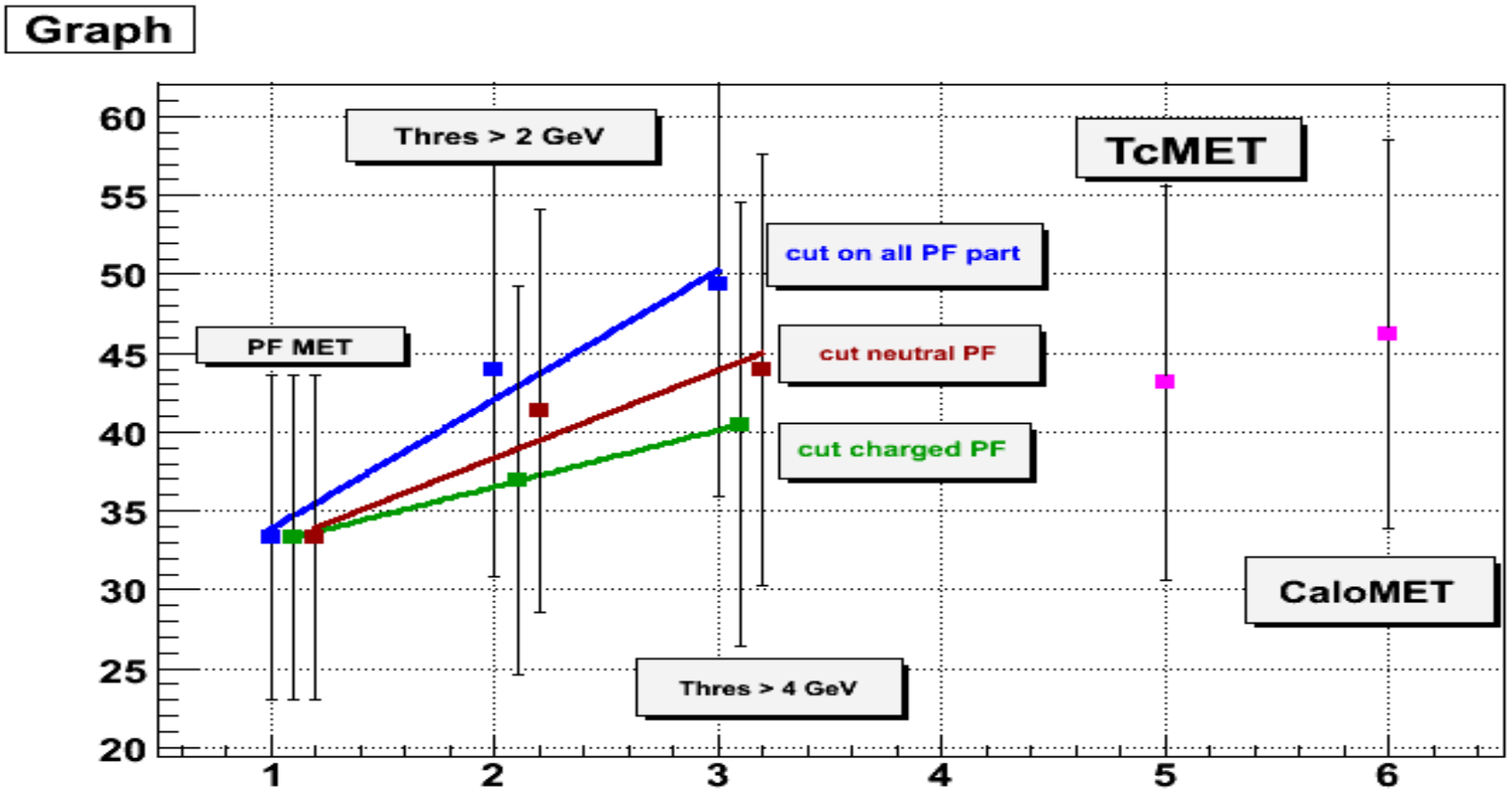






- TcMet improves a little wrt CalMet, but not much

<TMass> (& σ) for PFMet(s), TcMet and CaloMet for QCD



- Similar results for $Z \rightarrow \mu\mu$ sample (backup slides)

Outline

Conclusions

Low p_t muons feed-trough

- Mandatory to apply quality cut on muons: Prompt is NOT enough, Tight neither!
- If done, PPmuX resamble PPmuPt15 so we can use just the latter.
- If not, must use PPmuX as well!

MET algo comparision

- PfMet gives lower mean for QCD events than CaloMet, due to lower intrinsic threshold.
- If at *day 0* Calo need to work with high threshold, due to noise or anything, likely we can work with PfMet with results comparable to the CaloMET in ideal condition. Could be enough in any case.

Backup

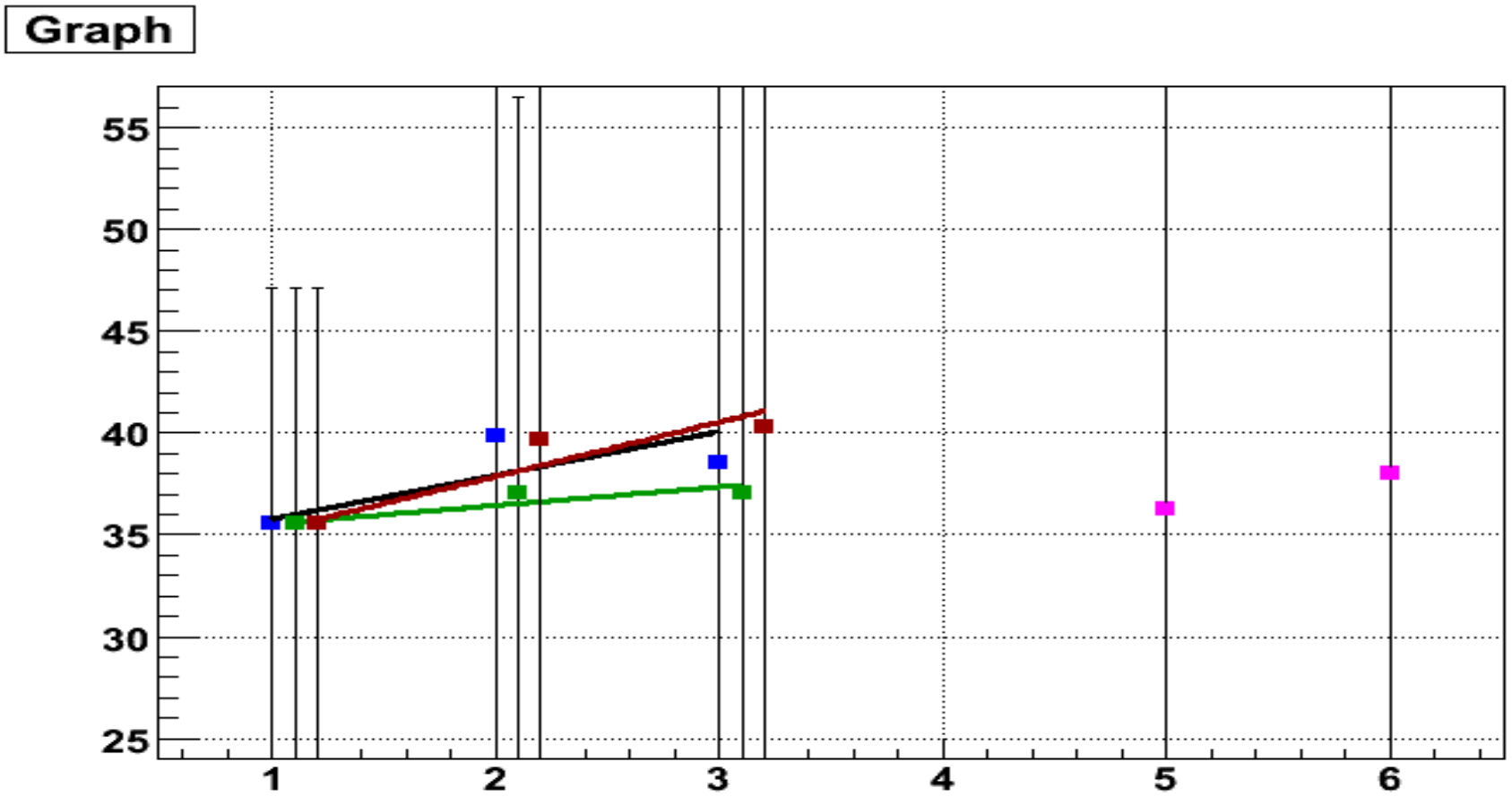
...

Dataset used

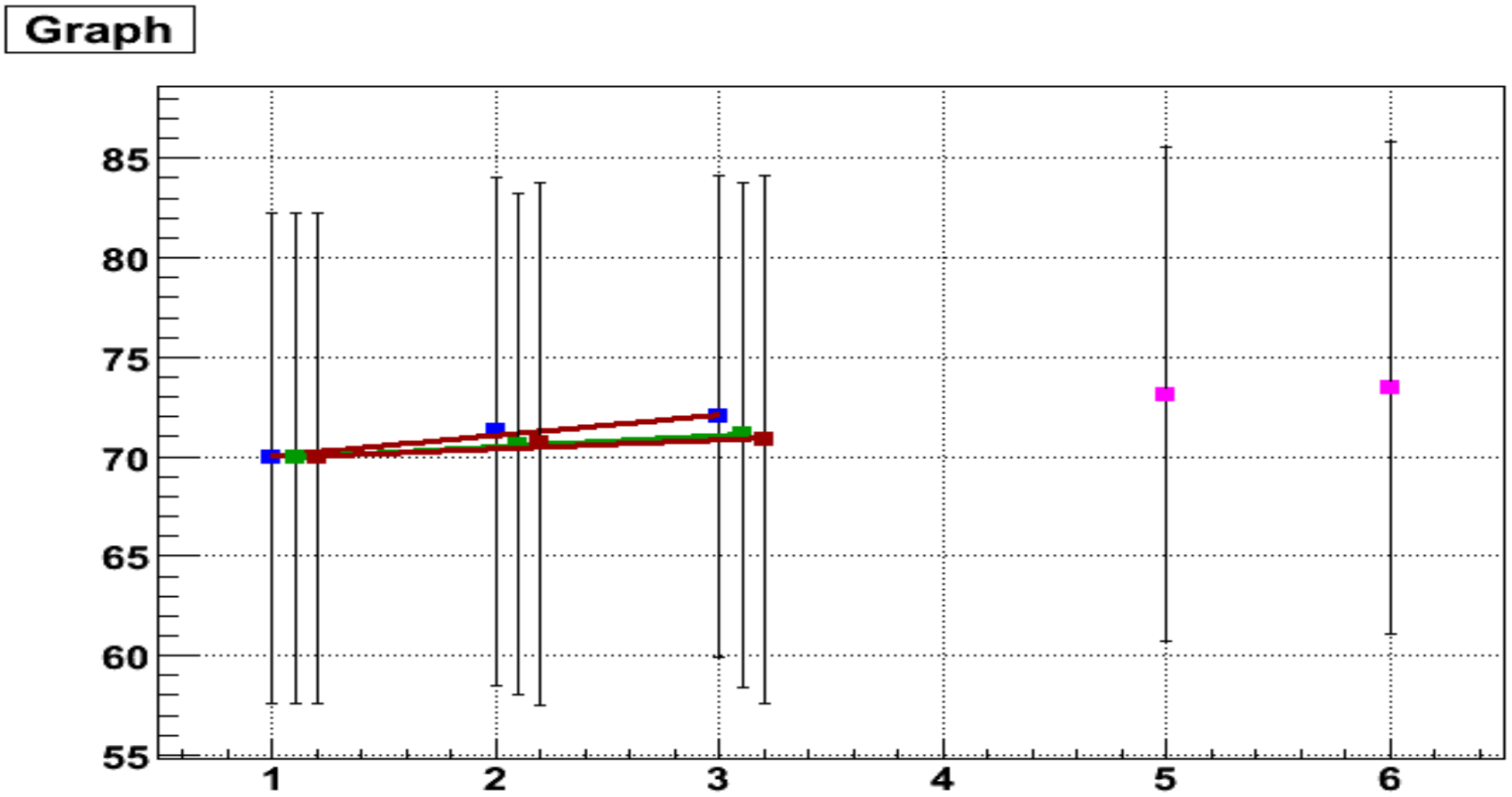
DatasetPath	ev. analyzed	σ (nb)	ϵ_{filter}	$\int \mathcal{L}\ pb^{-1}$
/InclusiveMuPt15/Summer08_IDEAL_V11_redigi_v1	6162805	509100	0.000239	50.6
/InclusivePPmuX/Summer08_IDEAL_V11_redigi_v1	5309035	51560000	0.002305	0.0447
/TTJets-madgraph/Fall08_IDEAL_V11_redigi_v10	446644	317	0.33	4.27e+03
/TauolaTTbar/Summer08_IDEAL_V11_redigi_v1	18400	241.7	1.0	76.3
/Wtaunu/Summer08_IDEAL_V11_redigi_v2	1098500	11.84	1.0	92.8
/Zmumu/Summer08_IDEAL_V11_redigi_v1	601025	1.233	0.509	958
/Ztautau/Summer08_IDEAL_V11_redigi_v2	1245500	1.086	1	1.15e+03
/Wmunu/Summer08_IDEAL_V11_redigi_v2	1096434	11.85	0.691	134

all `/GEN-SIM-RECO`

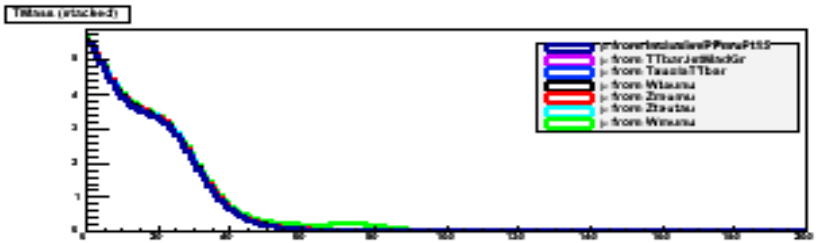
<TMass> (and σ) for PFMet(s), TcMet and CaloMet for $Z \rightarrow \mu\mu$

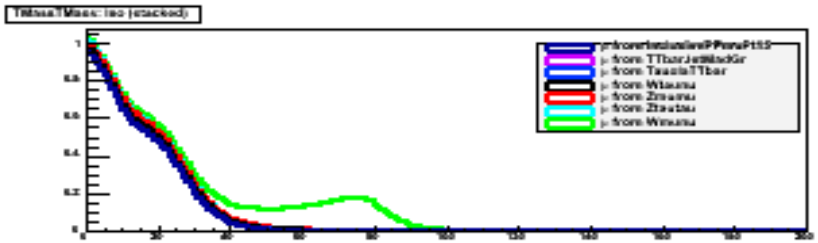


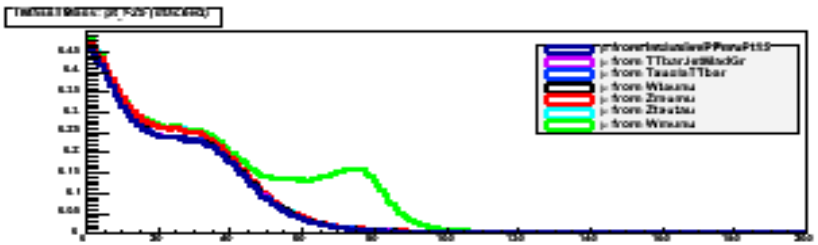
<TMass> (and σ) for PFMet(s), TcMet and CaloMet for $W \rightarrow \mu\nu$

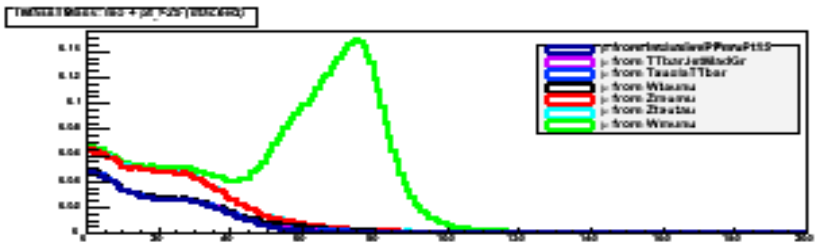


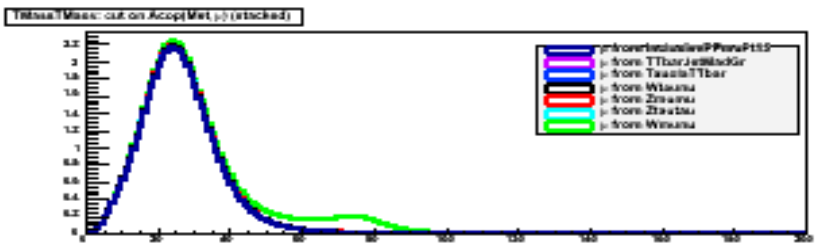
TMass PFMet All cuts (stacked)

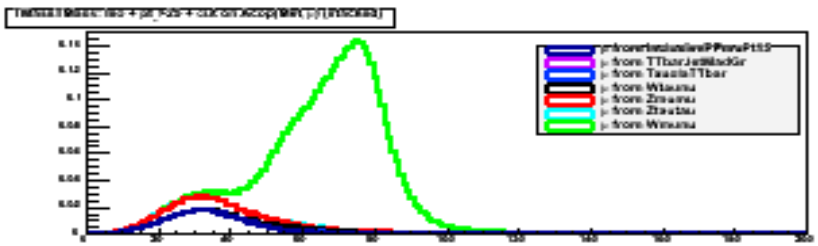


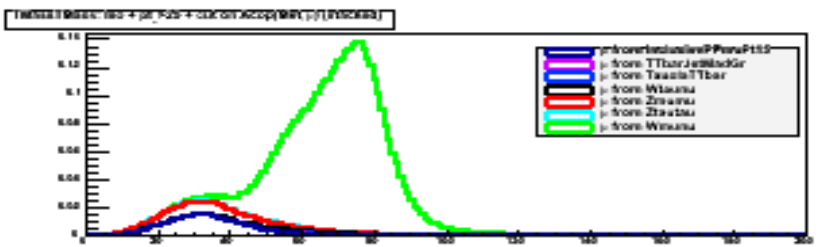


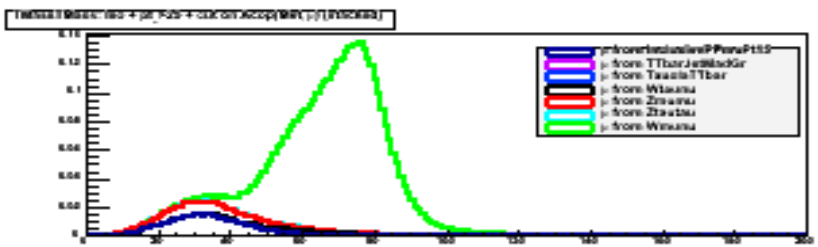




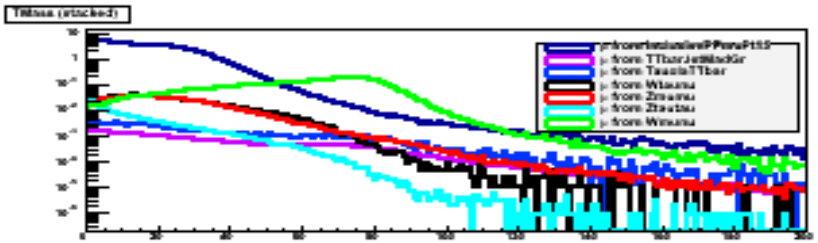
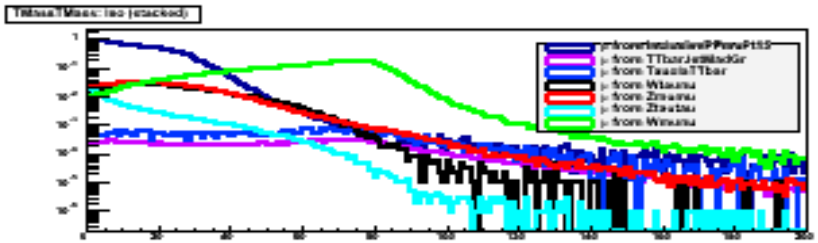
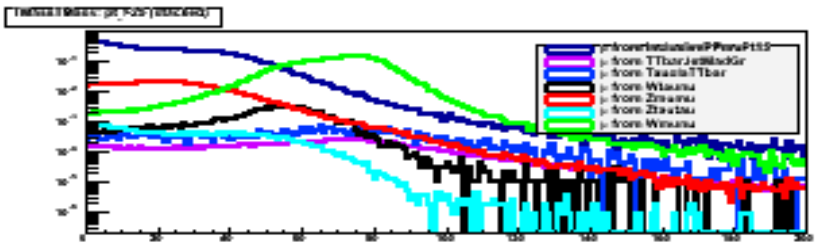
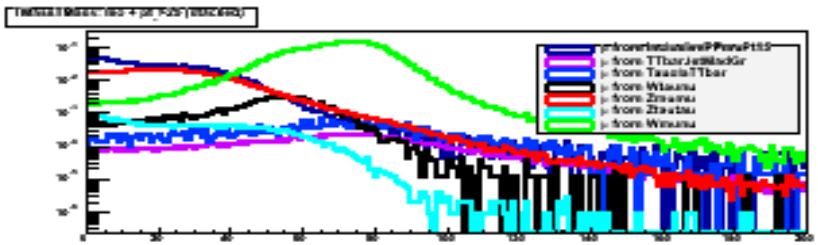
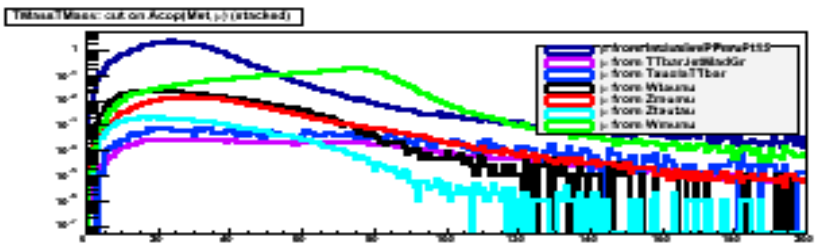
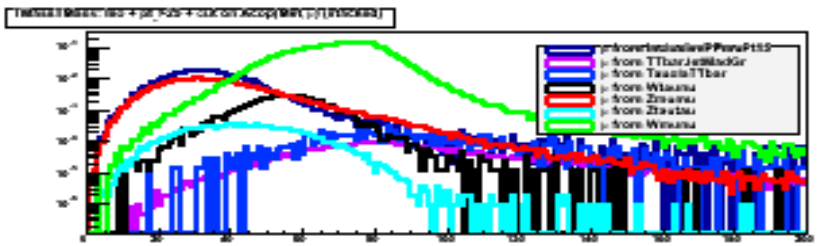
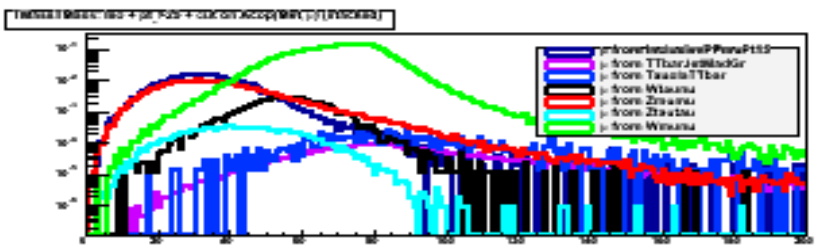
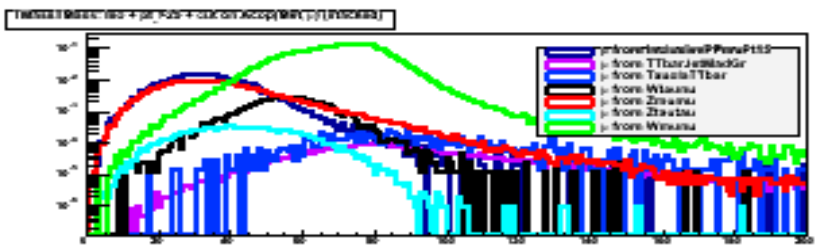




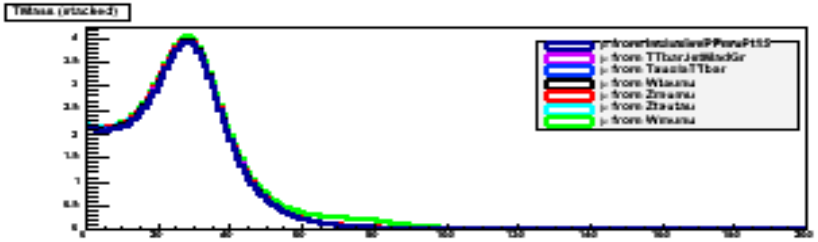


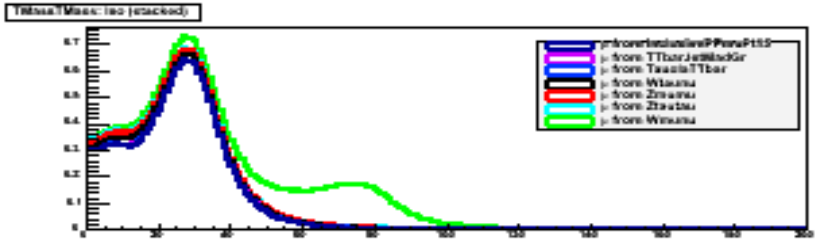


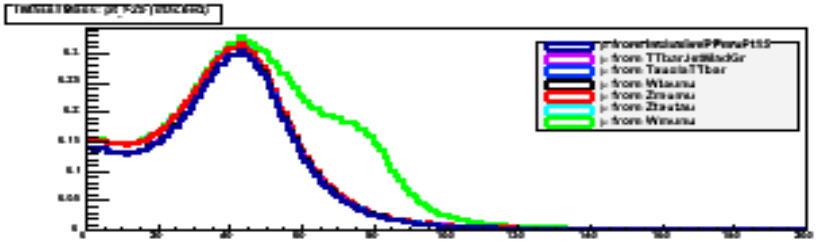
TMass PFMet All cuts (not stacked)

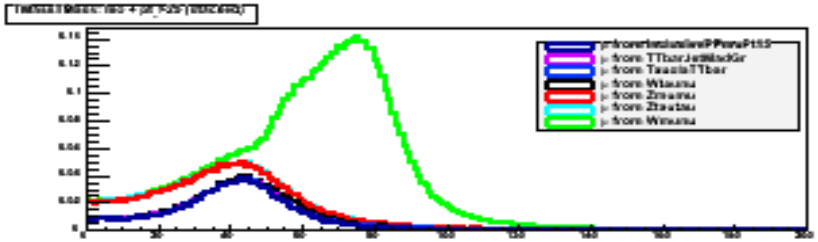









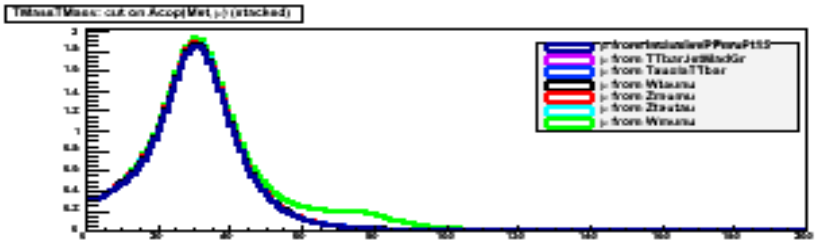
TMass CaloMet All cuts (stacked)

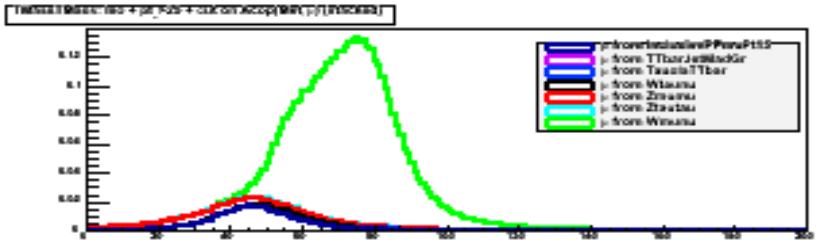


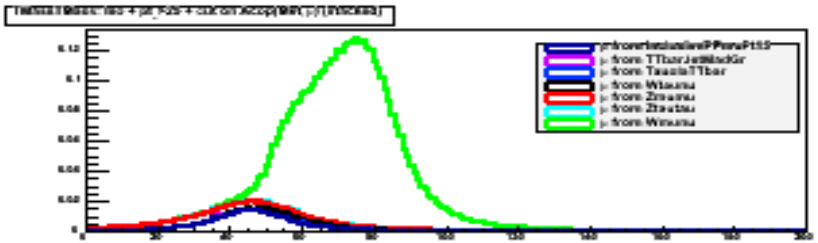


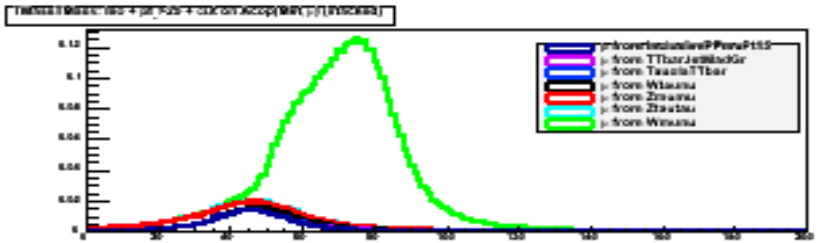




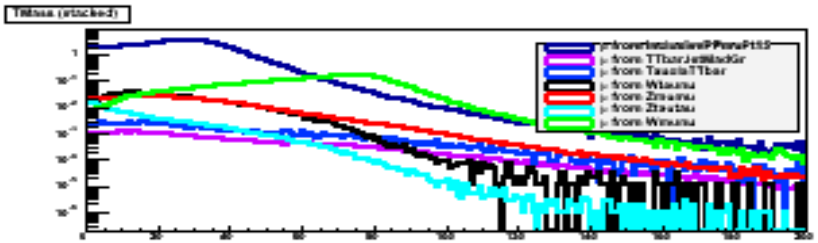


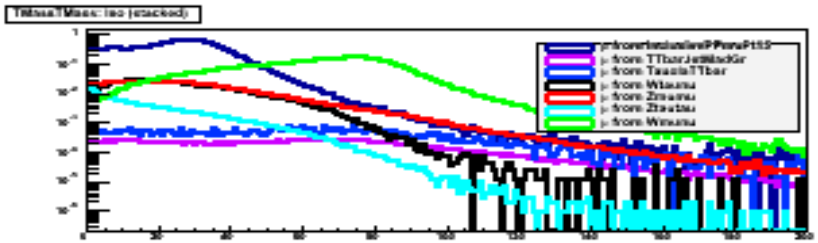


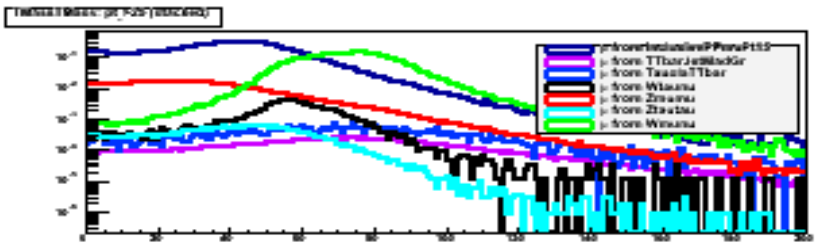


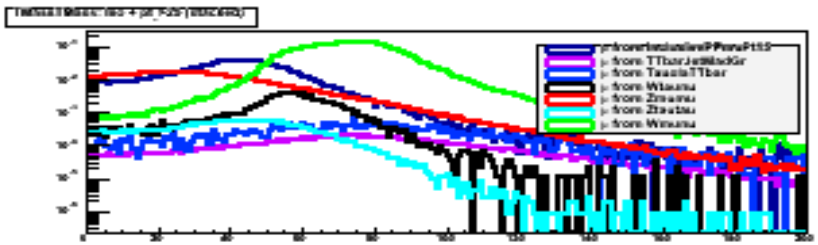


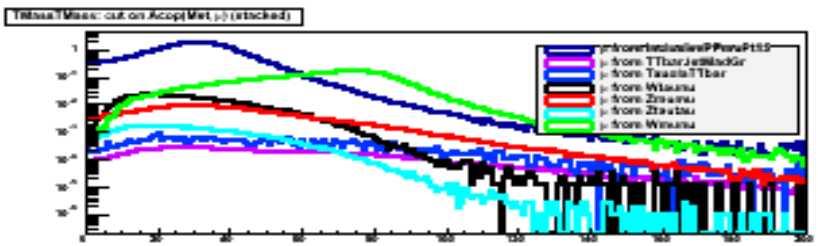
TMass PFMet All cuts (not stacked)

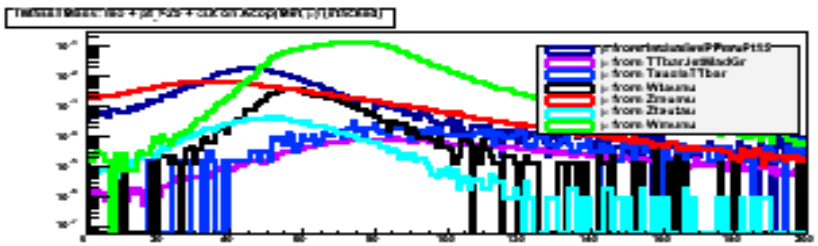


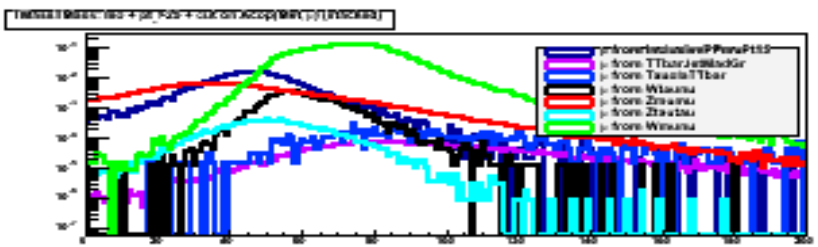


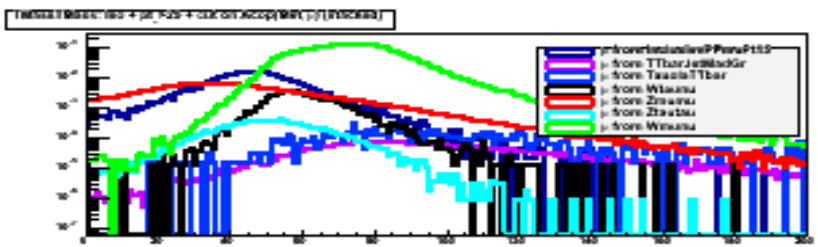




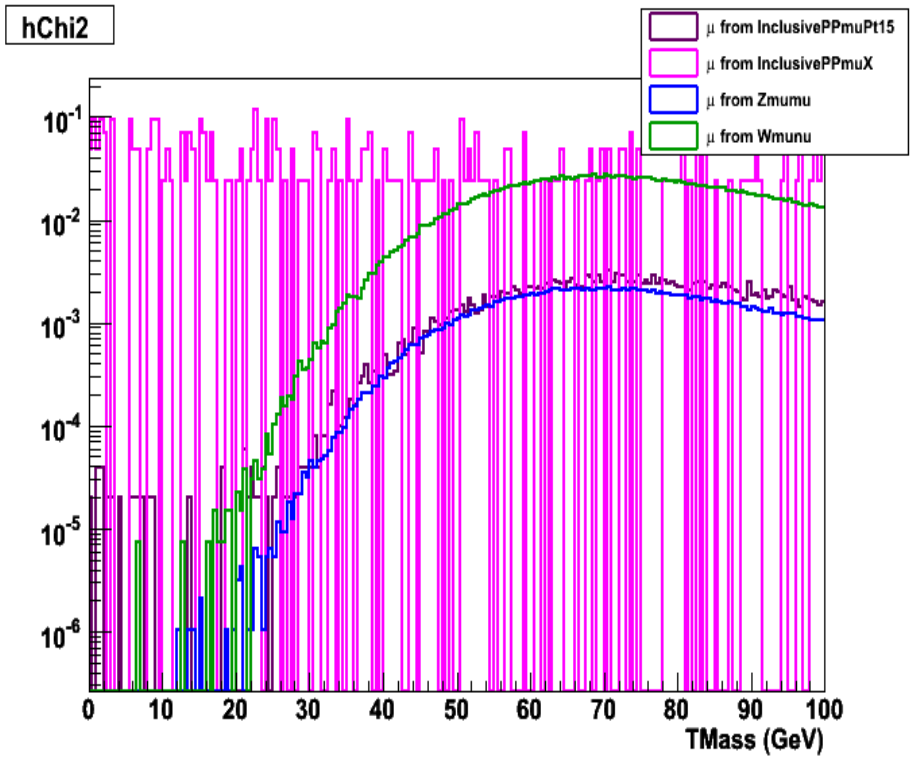


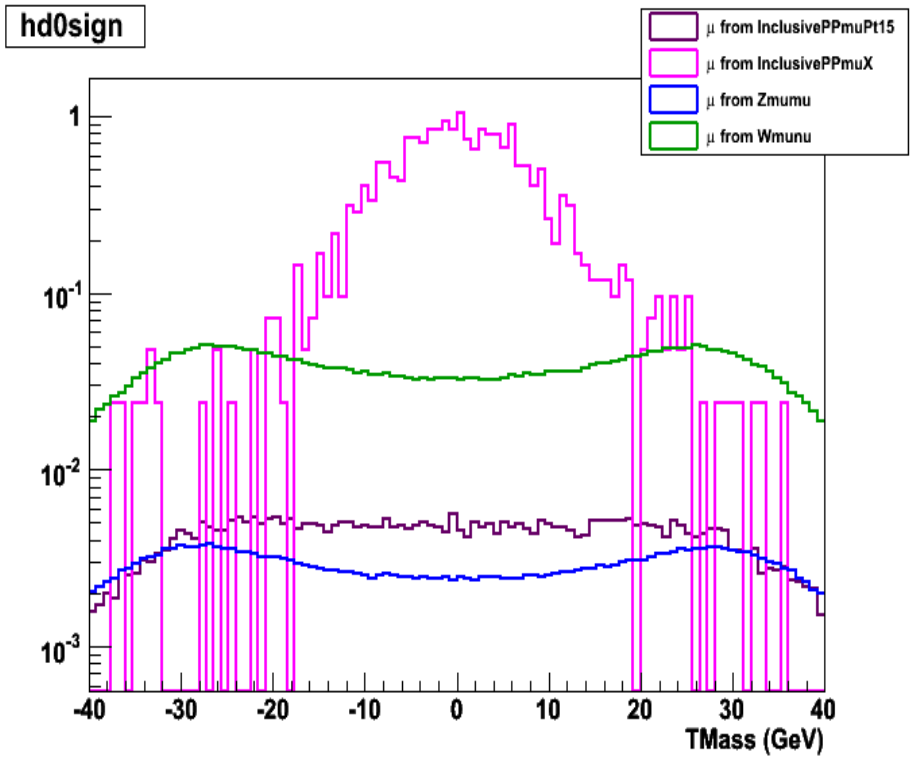






χ^2 and $d0/\sigma d0$ for muons passing all cuts





- $d0/\sigma d0$ broad peaks at ~ 25 for W and Z: why??