Some Work on ZH -> mumubb

Lepton ID !!!!!!!!!!

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Isolation

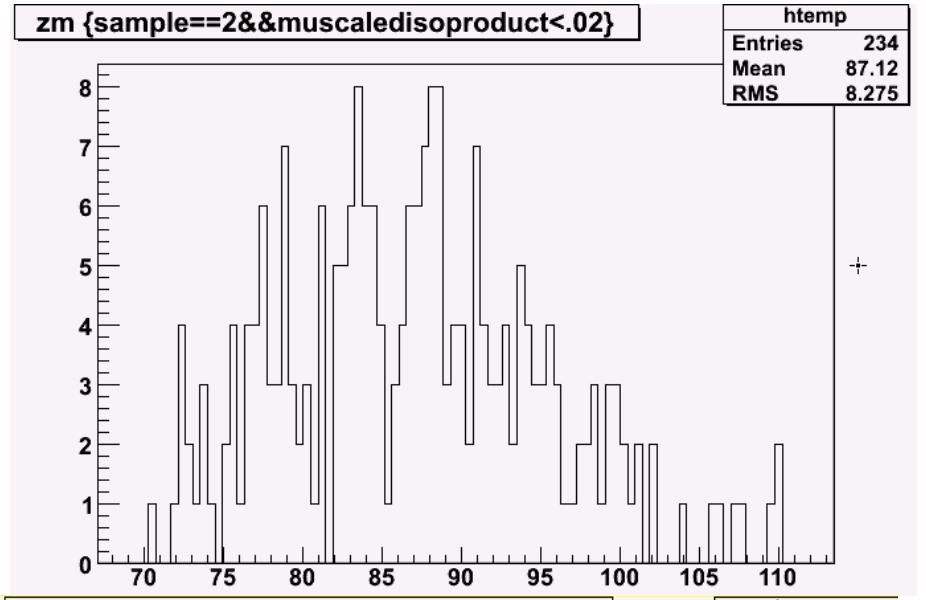
Using *product* scaled (track+cal) iso <0.01

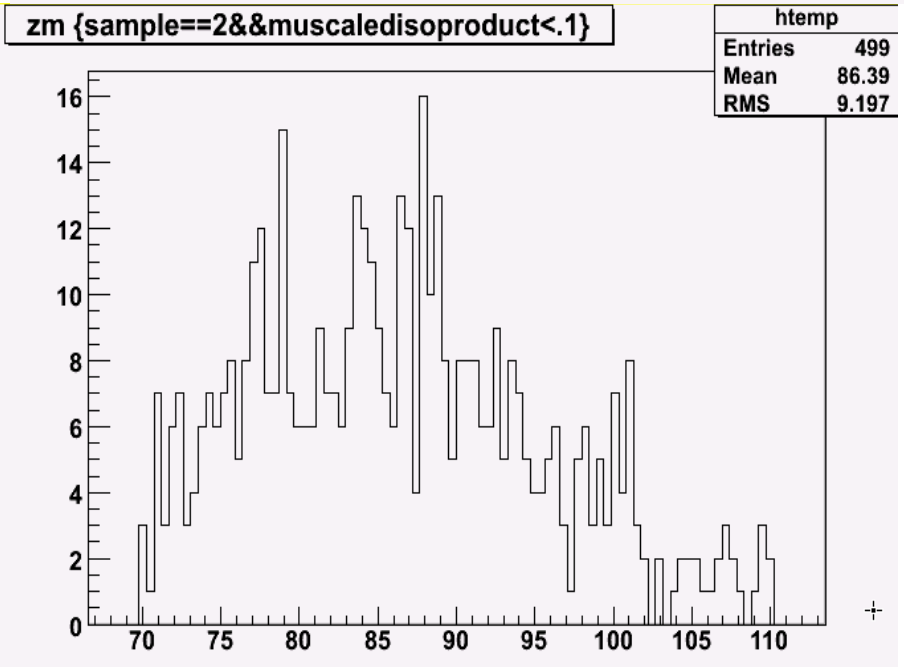
QCD turned out to be a small background

- Should probably loosen isolation

Look at mumu mass in “QCD” sample

- There are Z's in there...





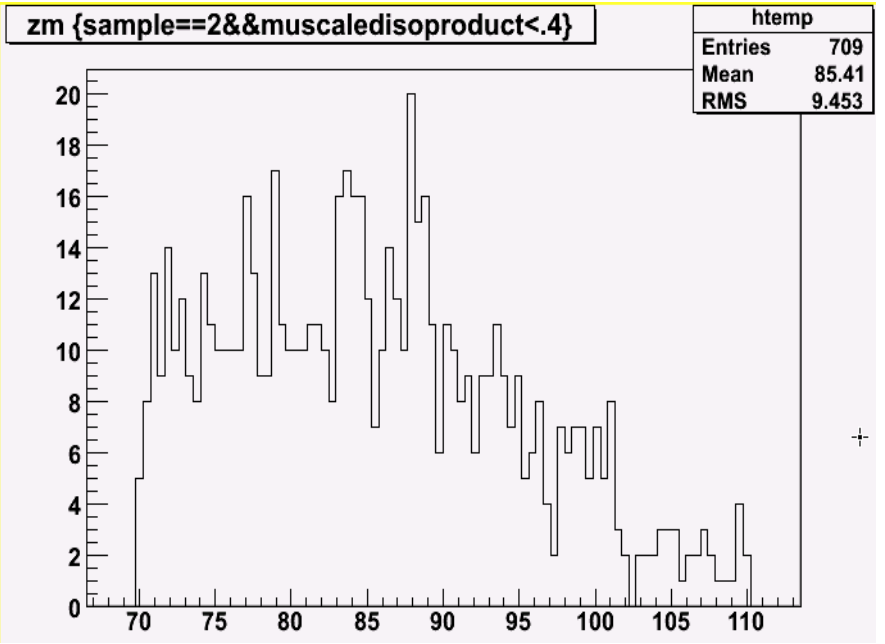
Isolation

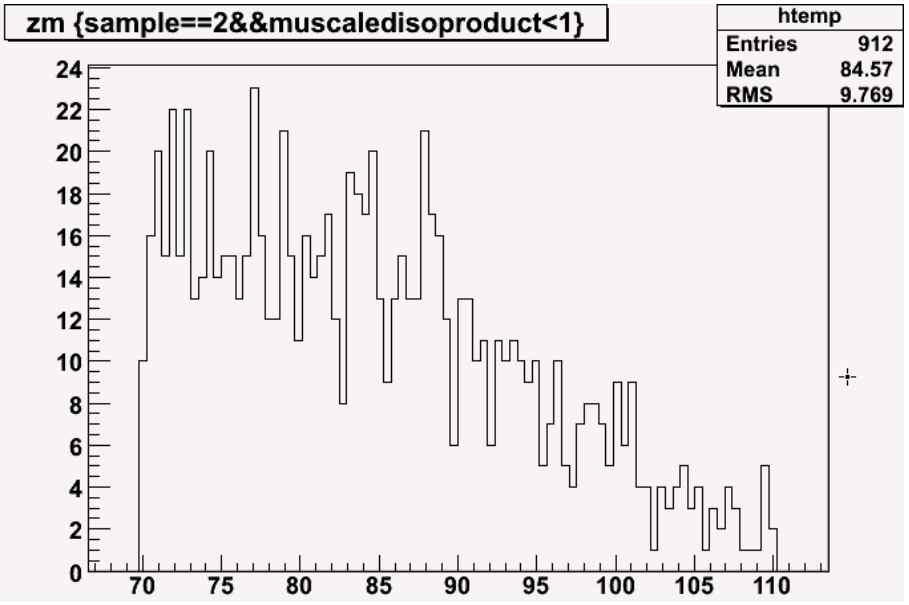
I like a cut of 0.1 (instead of 0.01)

I think 0.4 is getting dangerous, and any higher than that is useless...

Using 0.1 isolation instead of 0.01, we get 77 events failing after isolation cut, vs. 119 events

Increase eff. by 4.2%





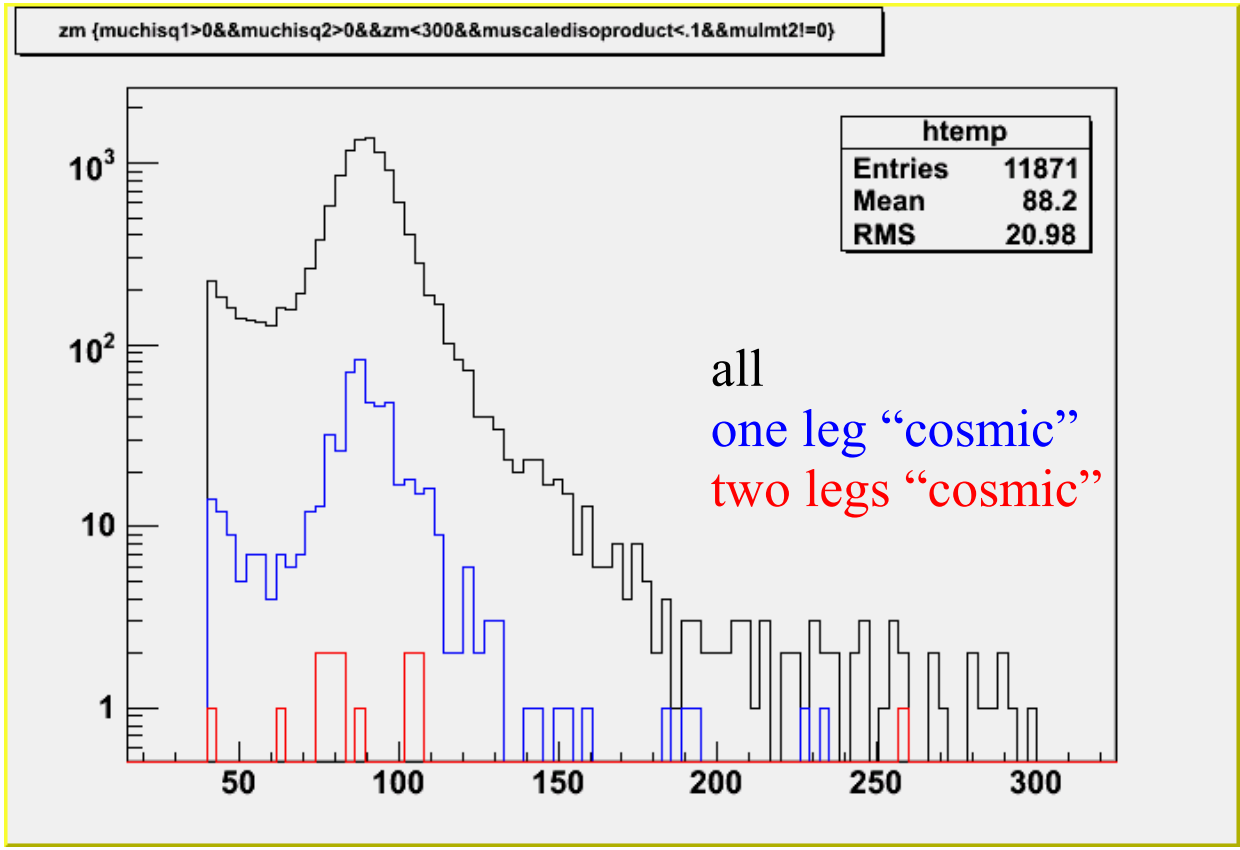
Cosmic Veto

HZ->mumubb (115):

Without cosmic veto, go from
624
to
648
events accepted.

Increase eff. by 2.4%

No sign in data that this increases the background...



DCA cuts

HZ->mumubb (115):

Standard:
0.02 cm w/ SMT
0.2cm w/ no SMT

Remove the cuts:
648
to
653
events accepted.

Increase eff. by 0.5%

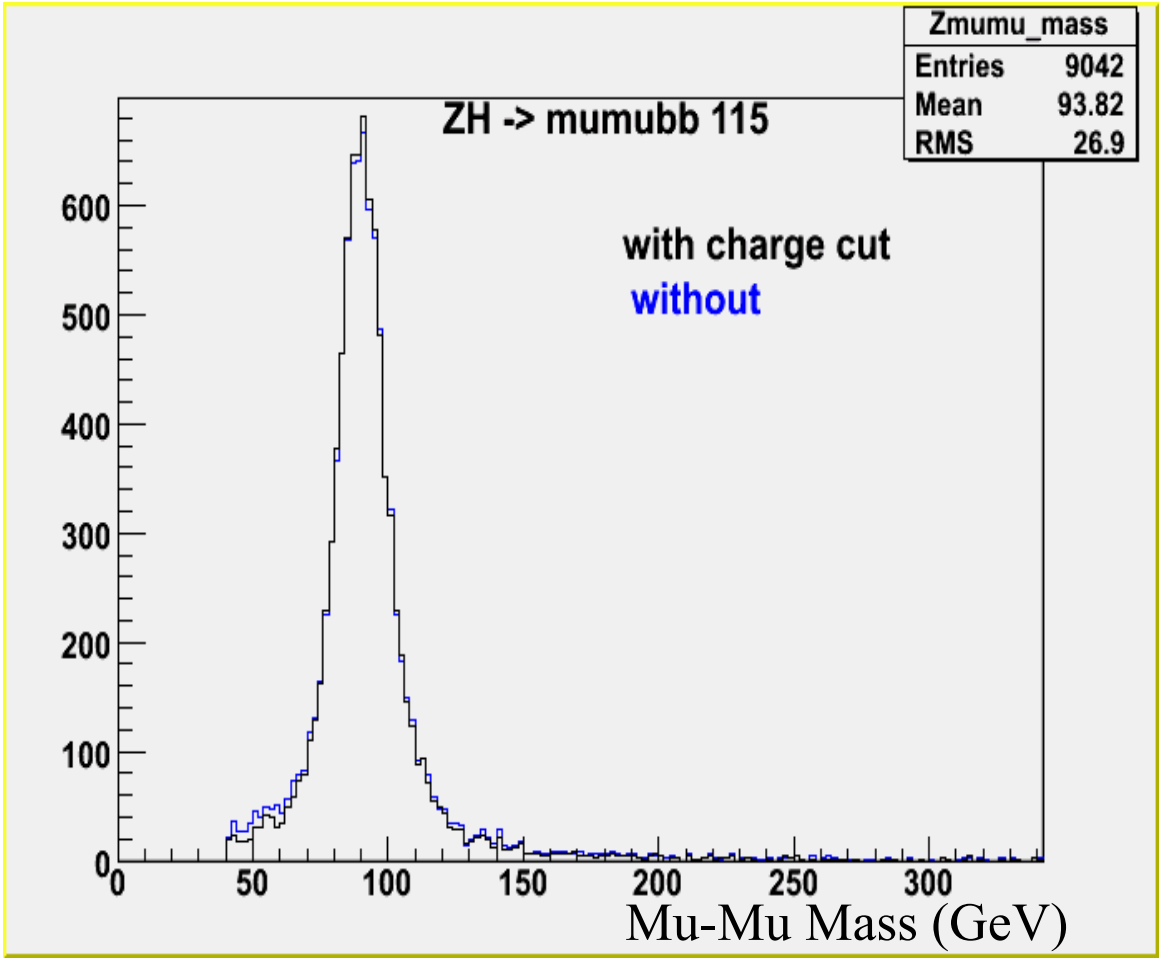
These are pretty loose... will keep the cuts for now.

Charge Cut

Could remove the requirement of opposite charge tracks

Actually *lose* efficiency in ZH->mumubb because you can pick up the muon from the b-decay more often

Will keep this cut for now.



No Track Match

HZ->mumubb (115):

Remove requirement of central track match... had to hack Zmumu.cpp
(remove dz cut, etc.)

653
to
683

Increase eff. by 3%!!!

In ALPGEN Z->mumu 0lp:

477
to
511

Increase of 3.4%
Consistent with ZH->mumubb.

No Track Match in Data

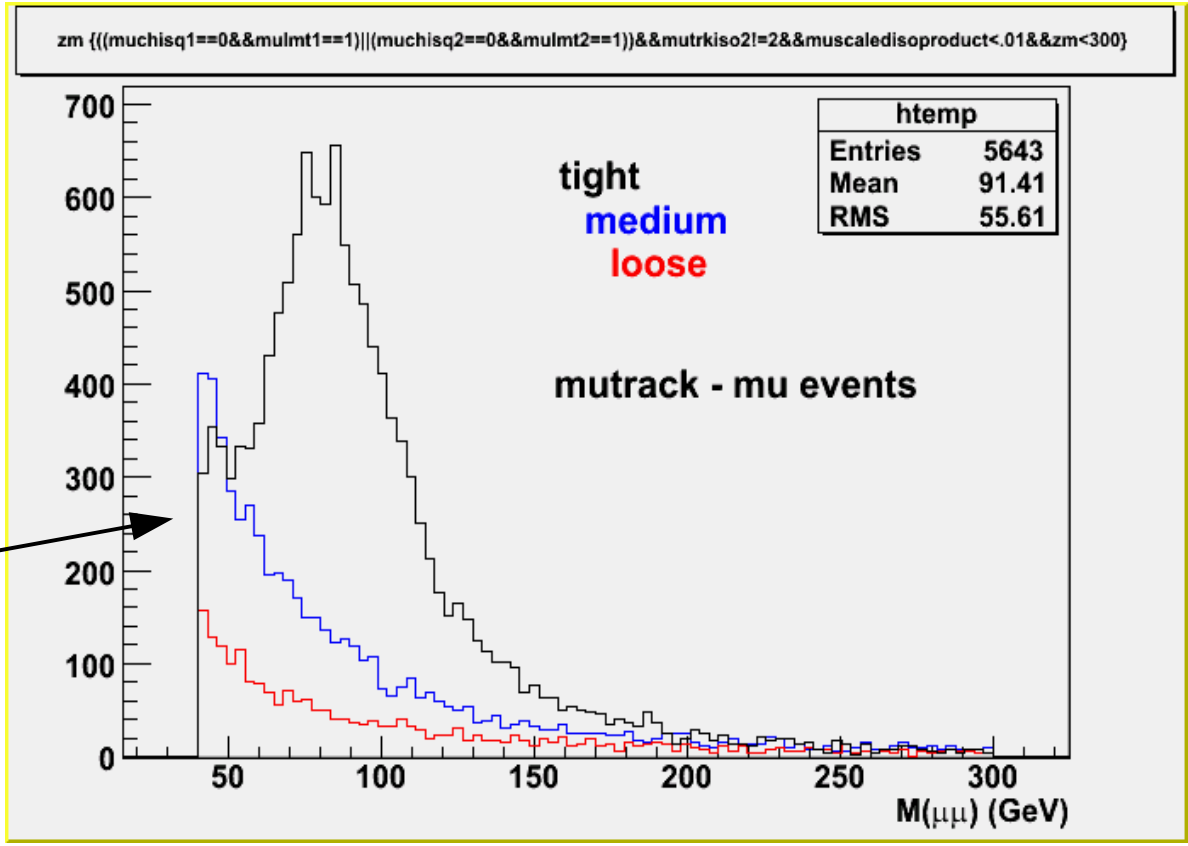
Definitely Z's in there!

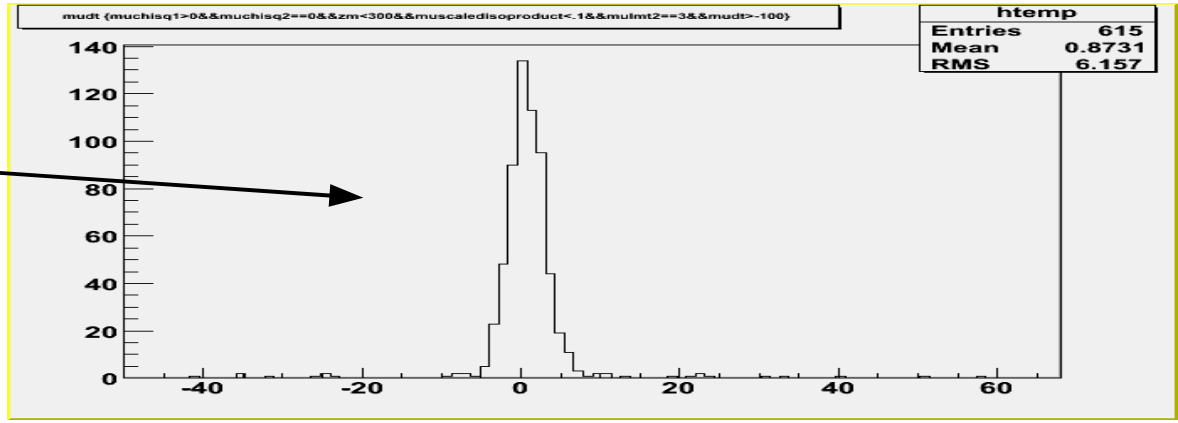
All of them have nseg==-3
(Loose but no track-match.)

Tight muon requirement keeps nearly all signal and greatly reduces the background.

Note that the peak is not at the Z mass...

Muon timing is good, not much background from cosmics.





Z Efficiency

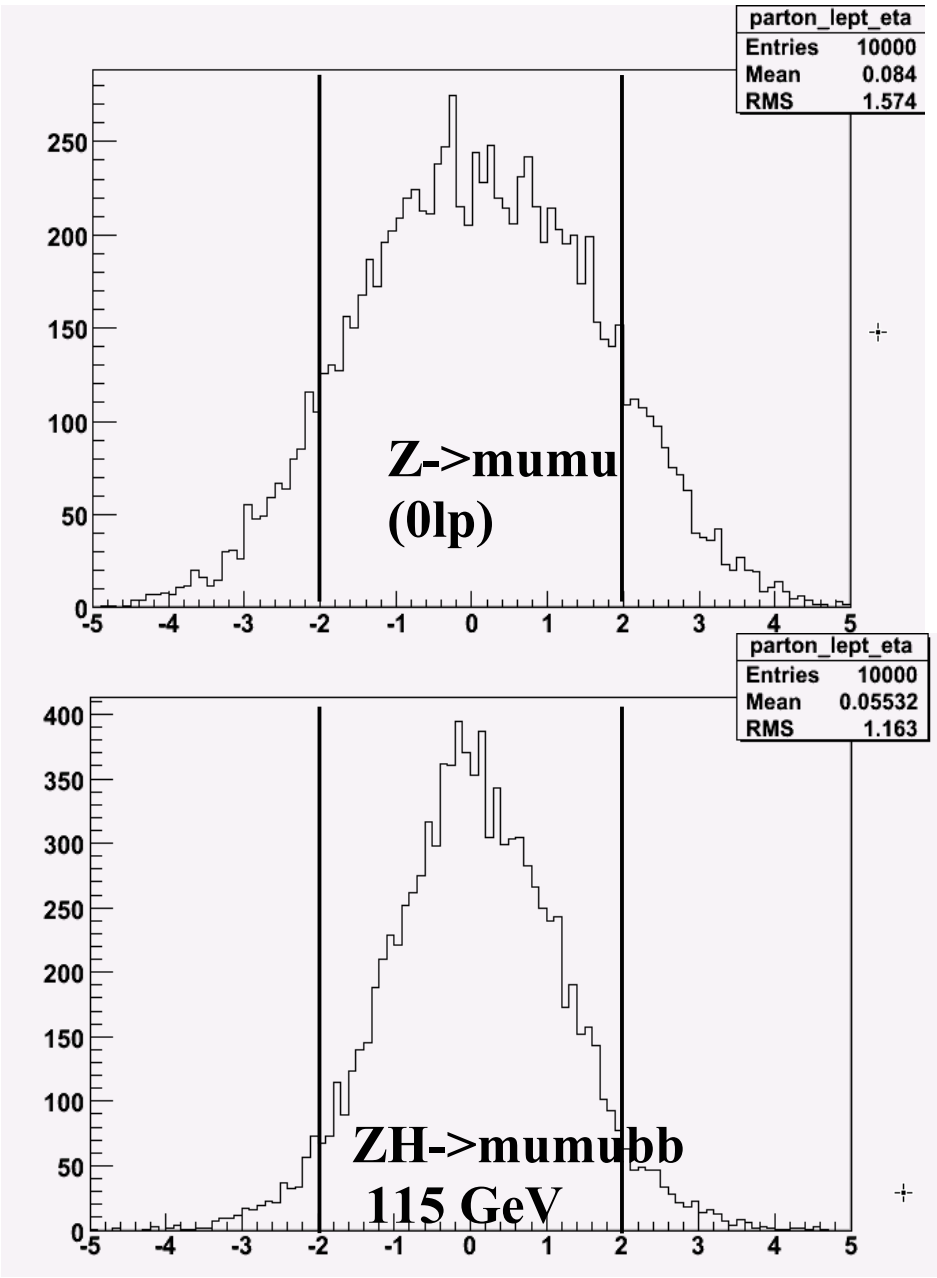
Still have only 511/1000 Z->mumu (0lp) events reconstructed?!

The loose muon efficiency should be ~90% at least, so would have >810/1000 reconstructed?

Look at parton info, to see if the parton muons are there...

Only 80% of *each* lepton in |eta|<2 for Z->mumu 0lp (64% of Z)

92% of each lepton in |eta|<2 for ZH->mumubb 115 (82% of ZH)



Isolated Tracks

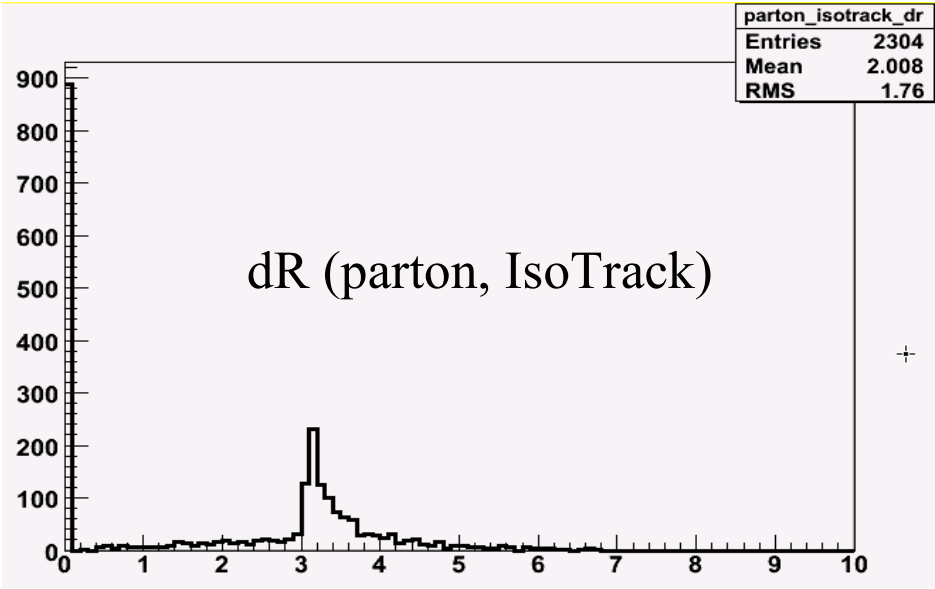
But could still find the track!

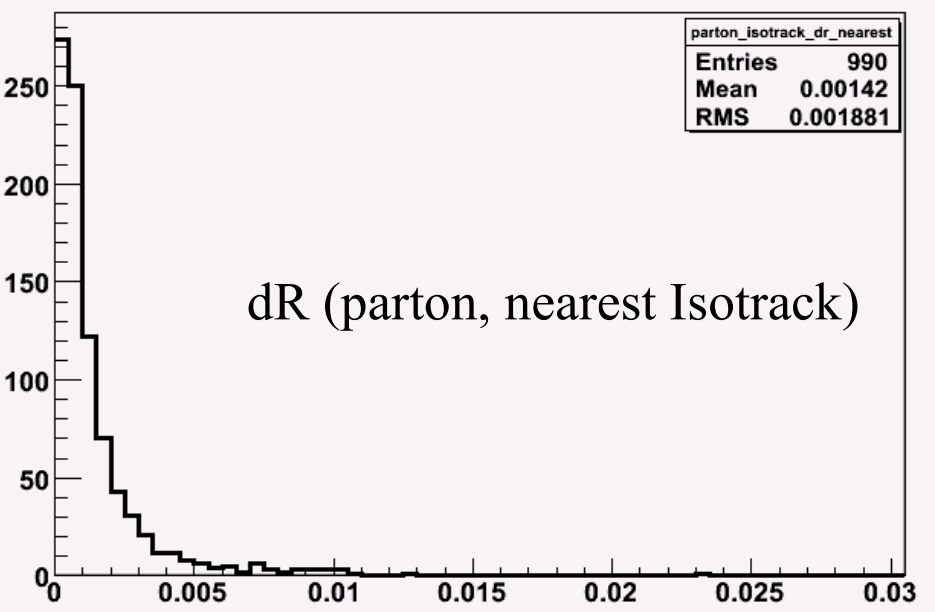
Since we lose 18% of Z's in ZH 115 due to muons in |eta|>2, *we can gain a lot by requiring only a track*

Look at IsoTrack branch for a match to the parton-level lepton...

For now, study Z->mumu only...

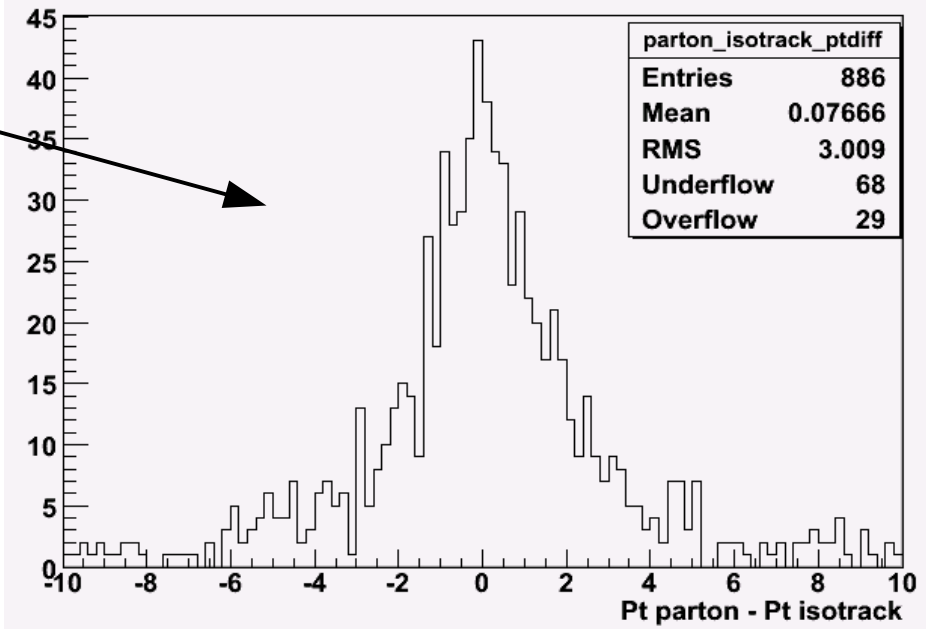
When there is a match, the match is very good





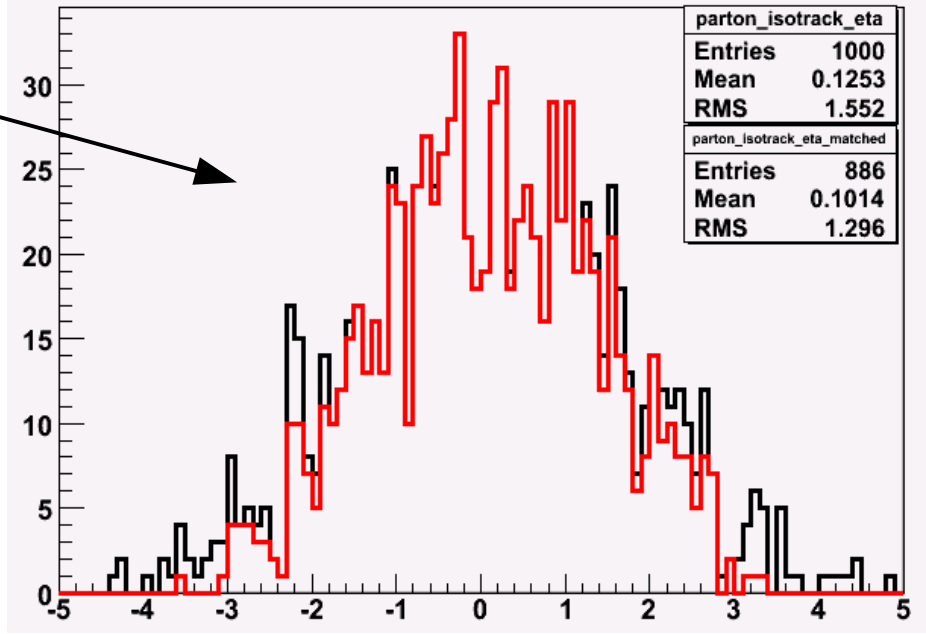
Isolated Tracks

The pt resolution is OK...



The overall efficiency is ~90%

Better in the central region, but still not bad up to eta ~3.0!



Efficiency ~75% @ 2<|eta|<3... where there's ~15% of ZH events, so *should* get:

an efficiency increase of ~11%!

In total can get Z eff. in ZH of ~80% instead of ~60%!

Isolated Tracks in Data

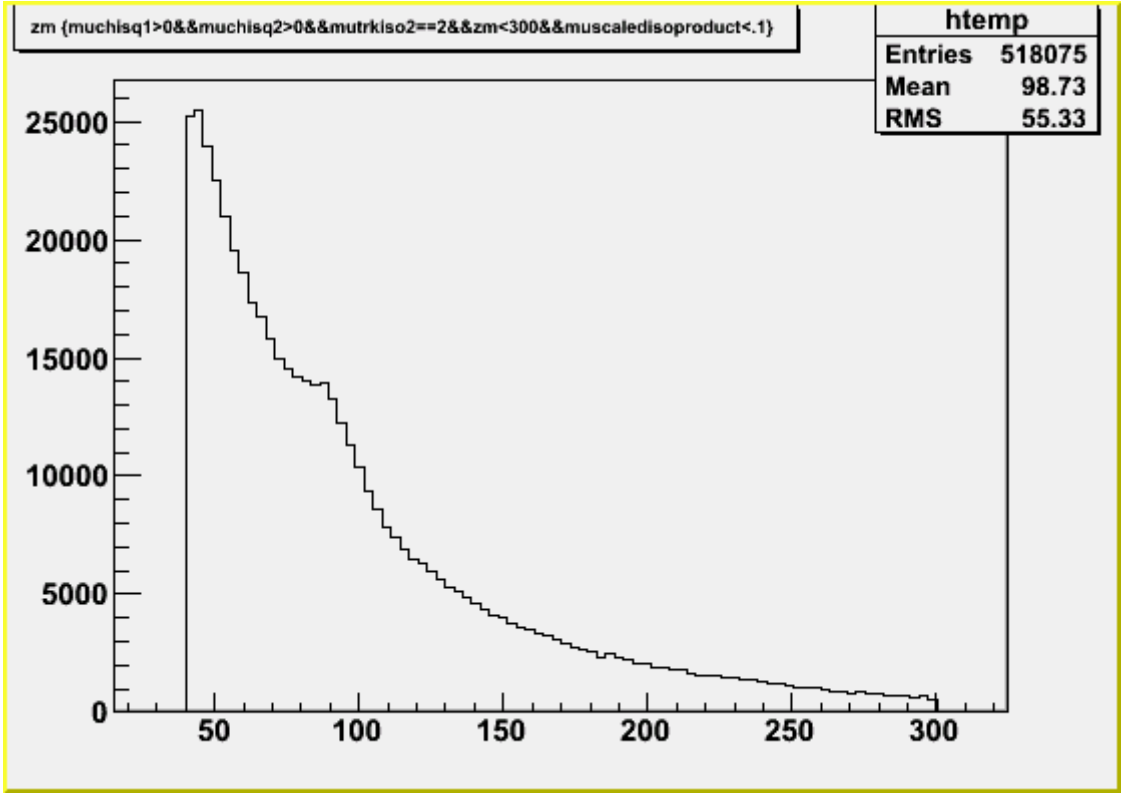
Modified wz_cafreco ZMumuSelector to combine muons and tracks into Z's...

After finding ***no*** isolated Z passing cuts using normal pairs of track-matched muons, look for one leg with a “track-only muon”

Reject tracks which match a JCCB jet with (uncorrected) pt>15 GeV within dR<0.5

Still a lot of background, but there are Z's!

Now we must clean up the Z sample...

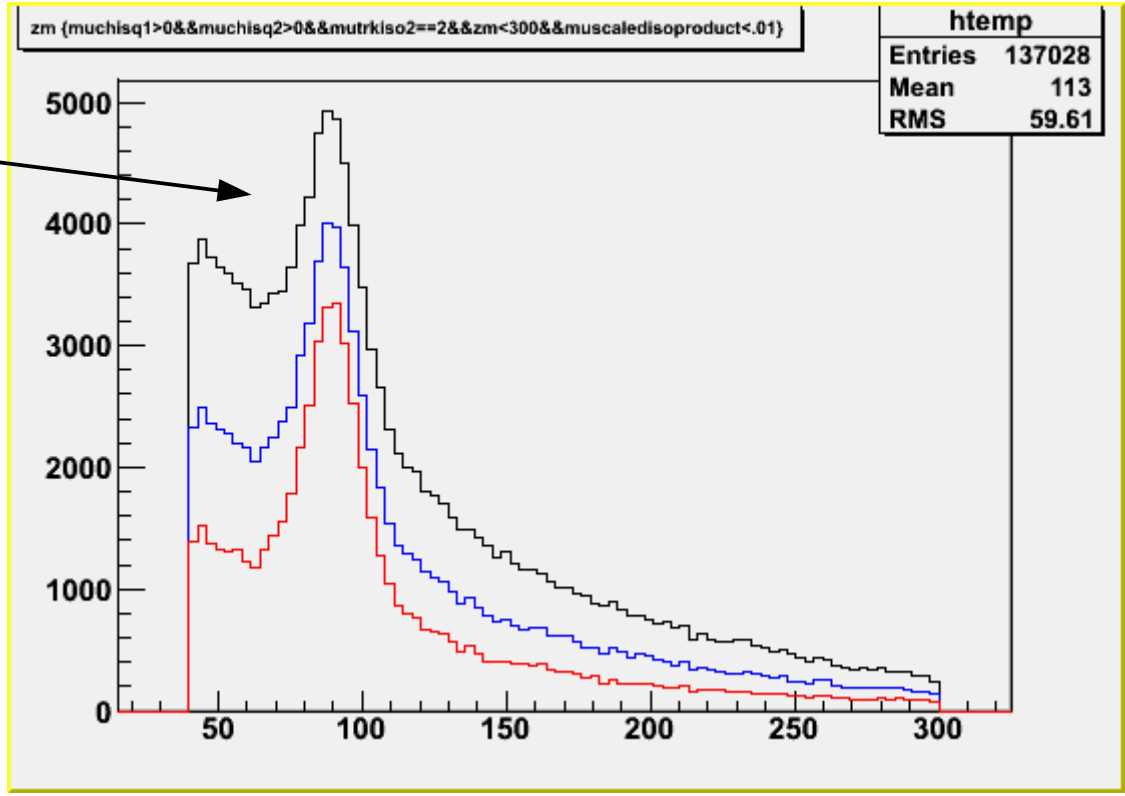


Isolated Tracks in Data

First, increase the isolation to 0.01 (from 0.1)

DCA <.02
(corrected for beam-spot)

Track chisq <= 5

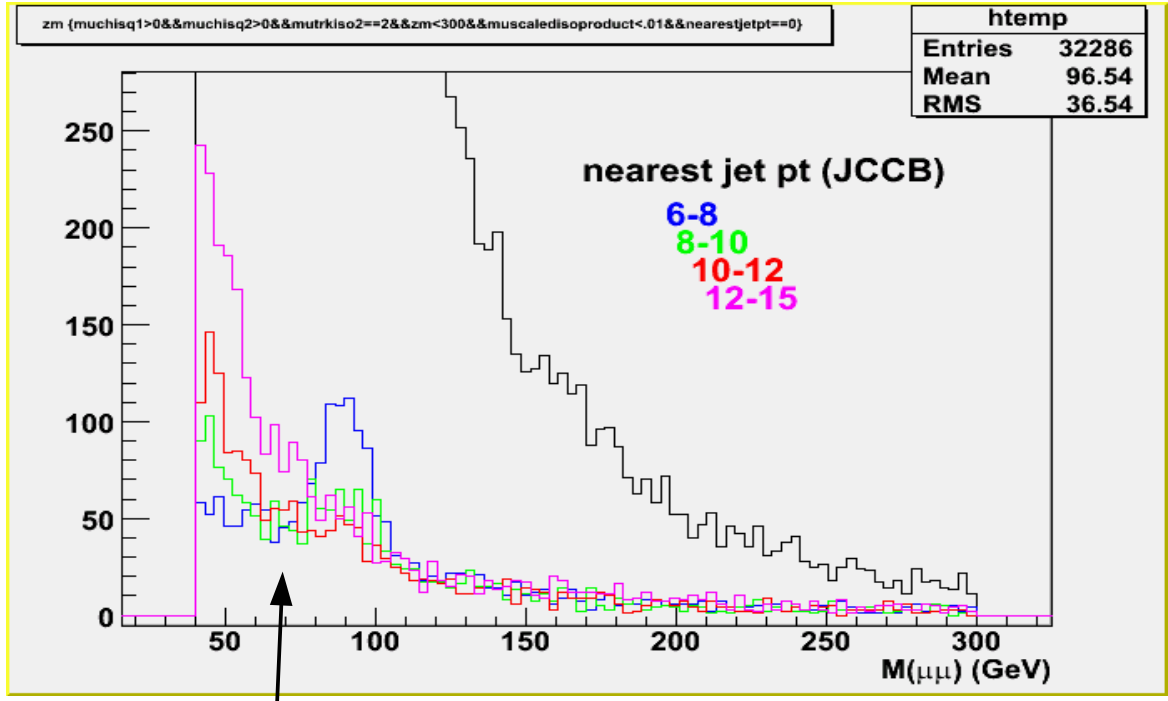


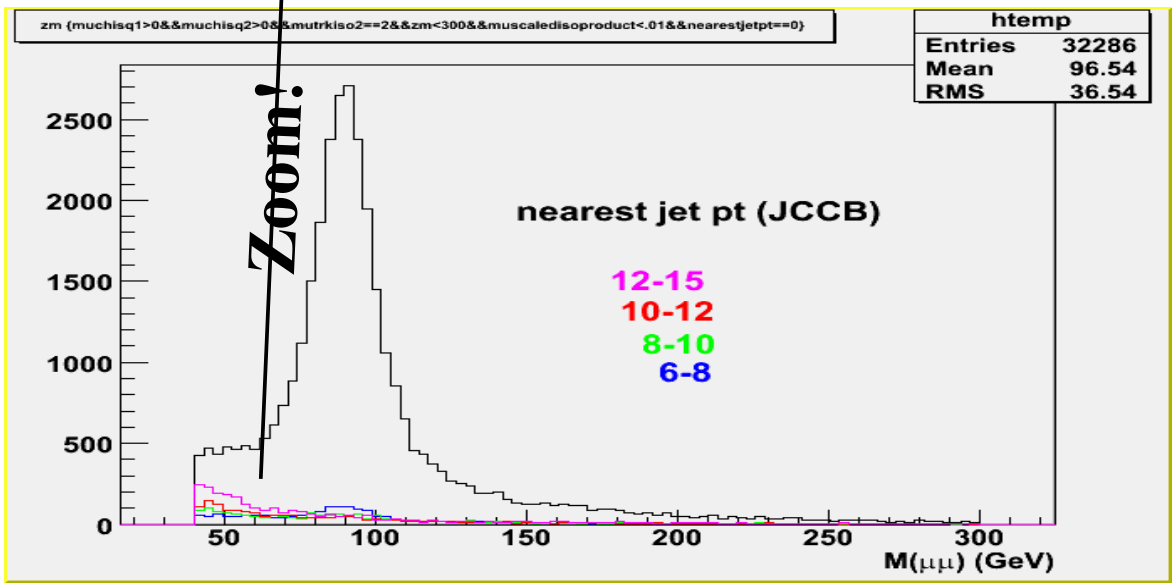
Isolated Tracks in Data

Finally, we can tune the pt cut on the jet used to reject matching tracks

A cut of ~9 GeV on JCCB seems optimal for keeping Z's and killing background

Sample is now pretty clean (comparable to track-matched sample)





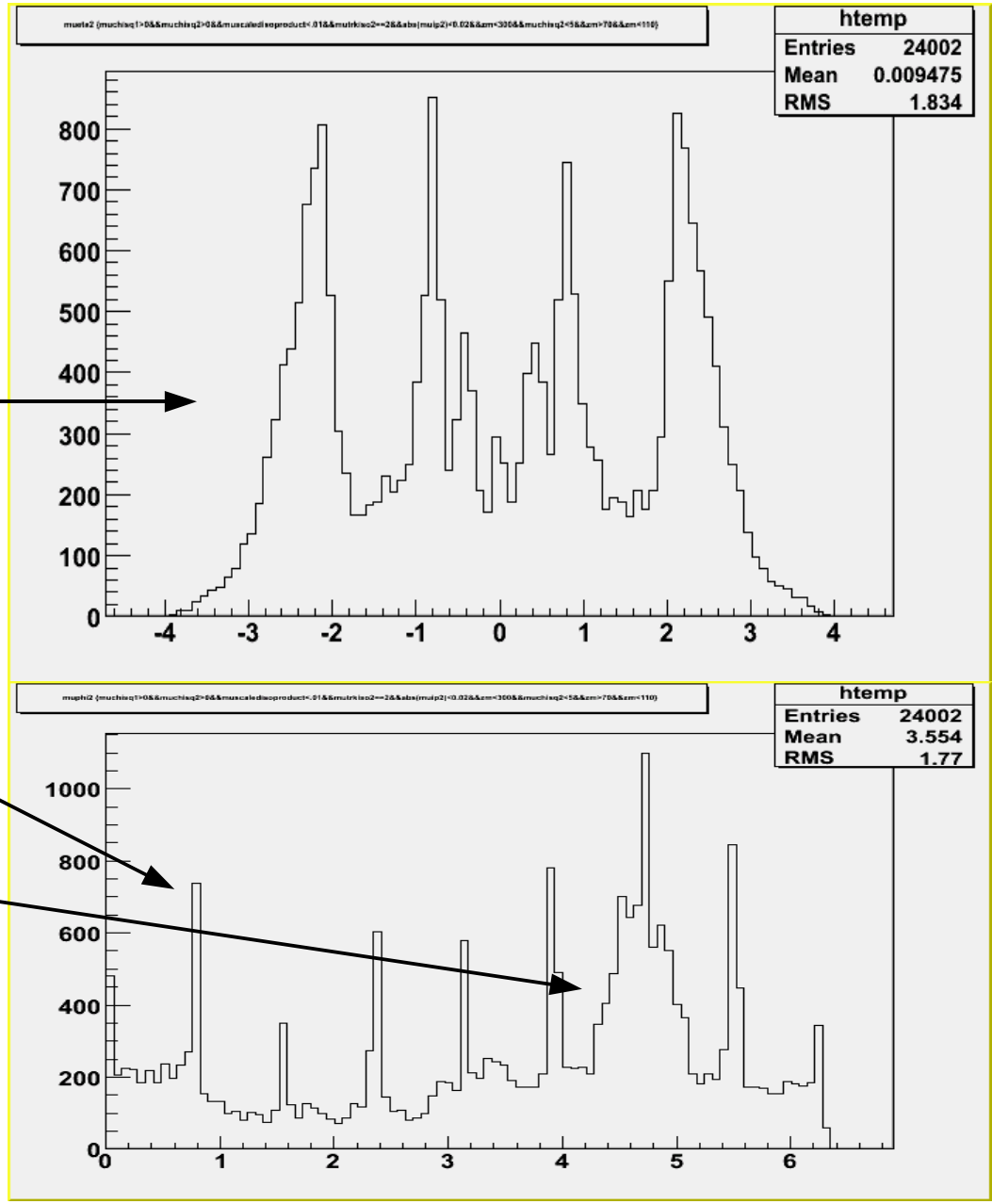
Isolated Tracks in Data

Interesting to see where the non-track-matched muons are in eta/phi...

We are definitely picking up muons in |eta|>2, where there is no muon coverage!

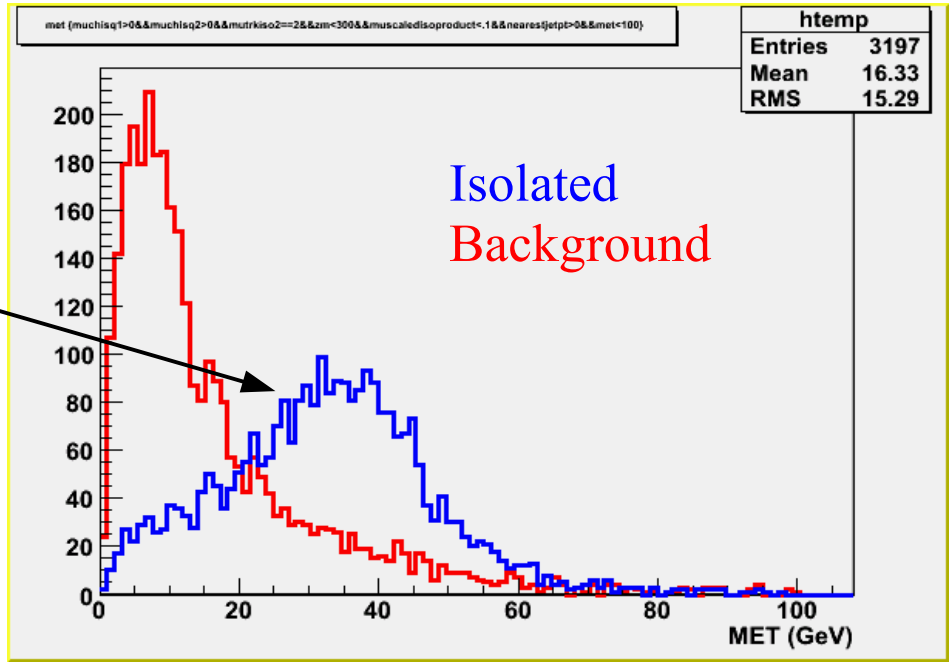
And we're also picking up muons in gaps between octants!

And in the bottom hole!

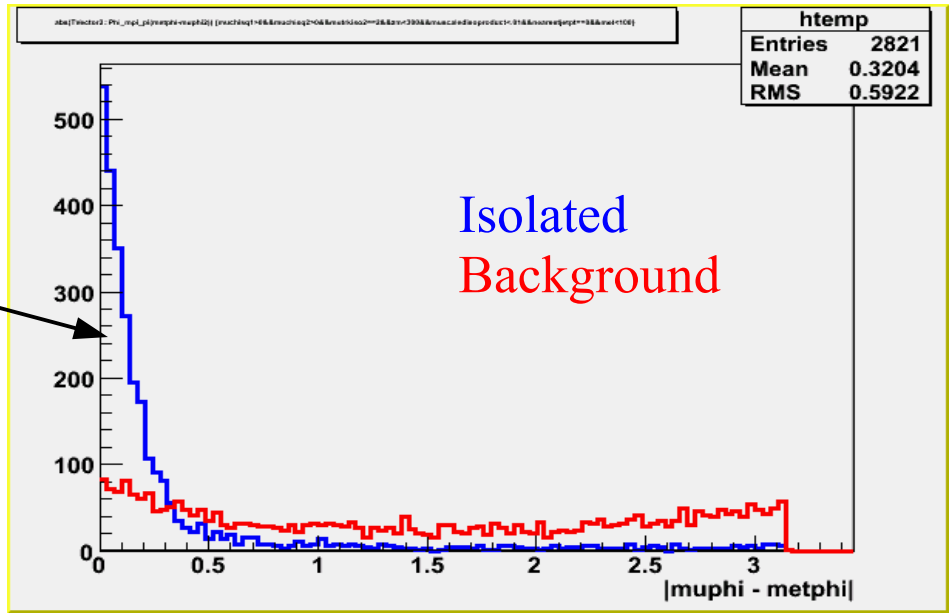


Isolated Tracks in Data

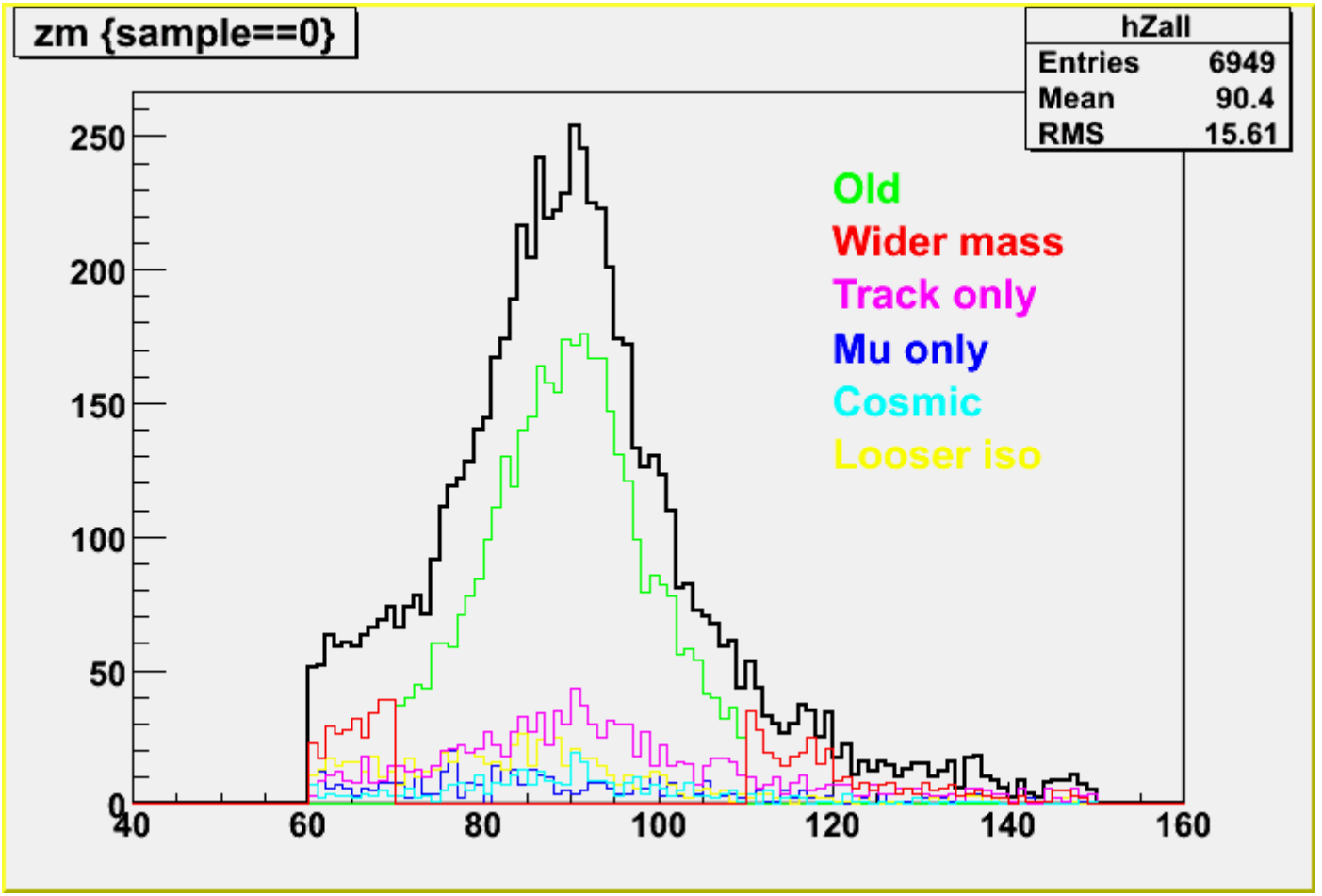
We can see the missing muon pT in the MET!



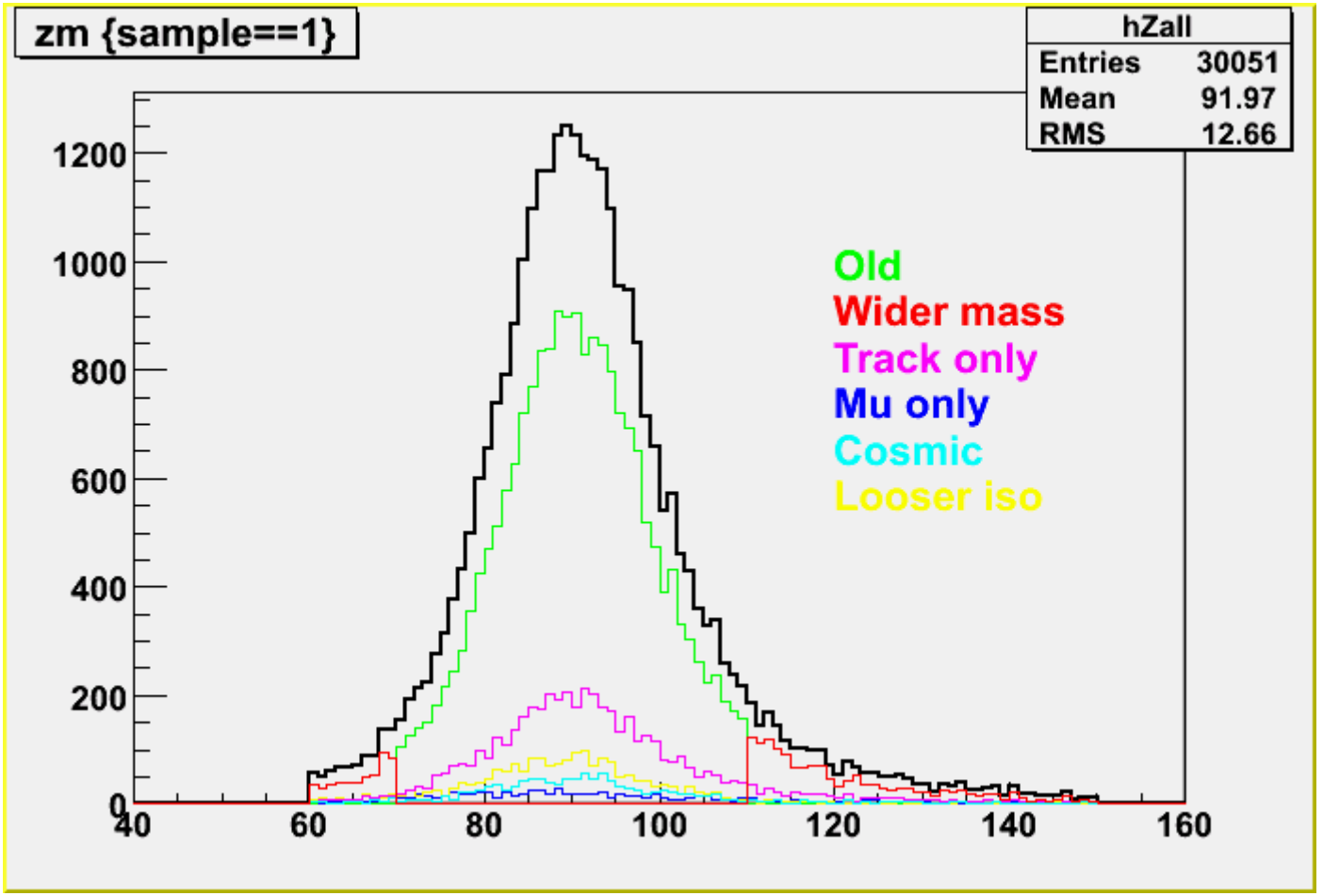
And it's pointing in the direction of the (recovered) non-track-matched muon!



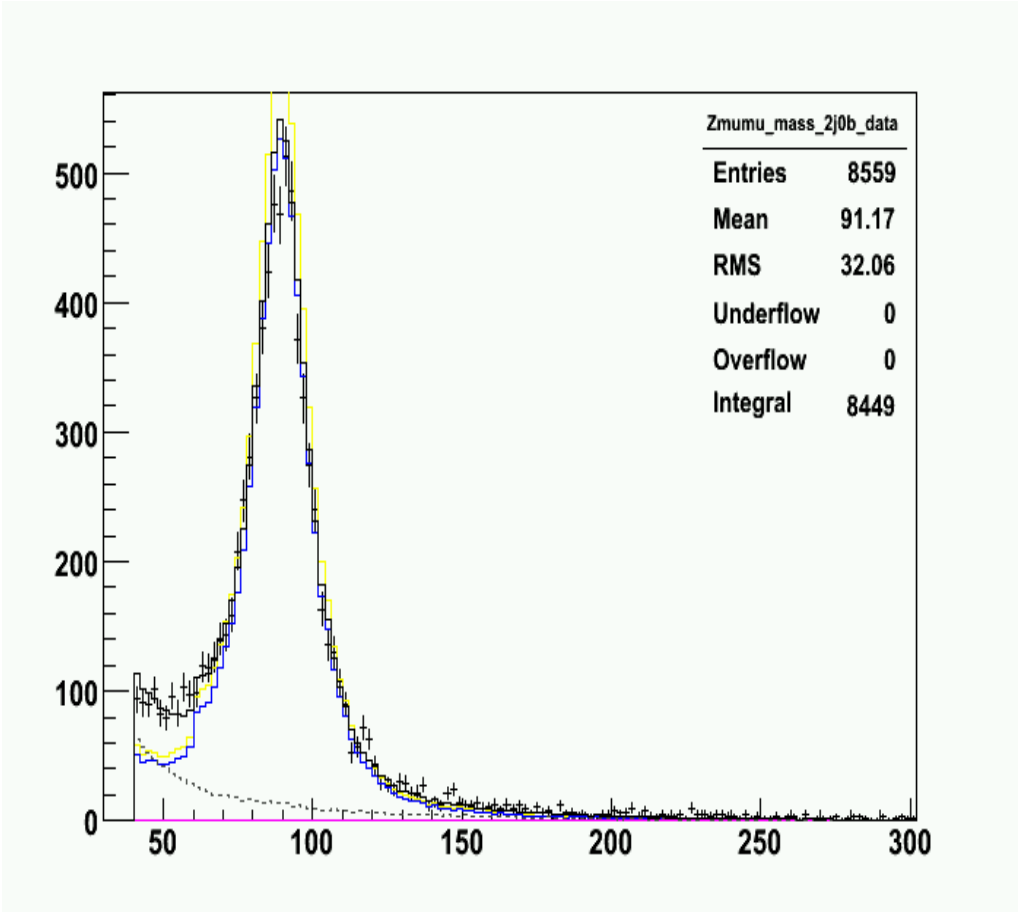
Efficiency Gains (DATA)

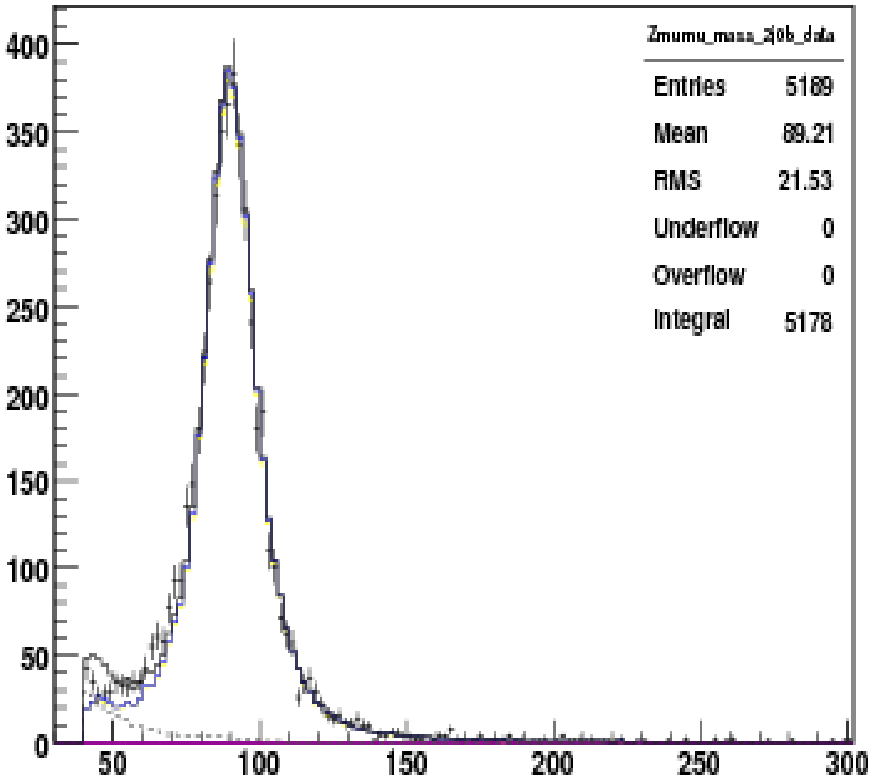


Efficiency Gains (SIGNAL)

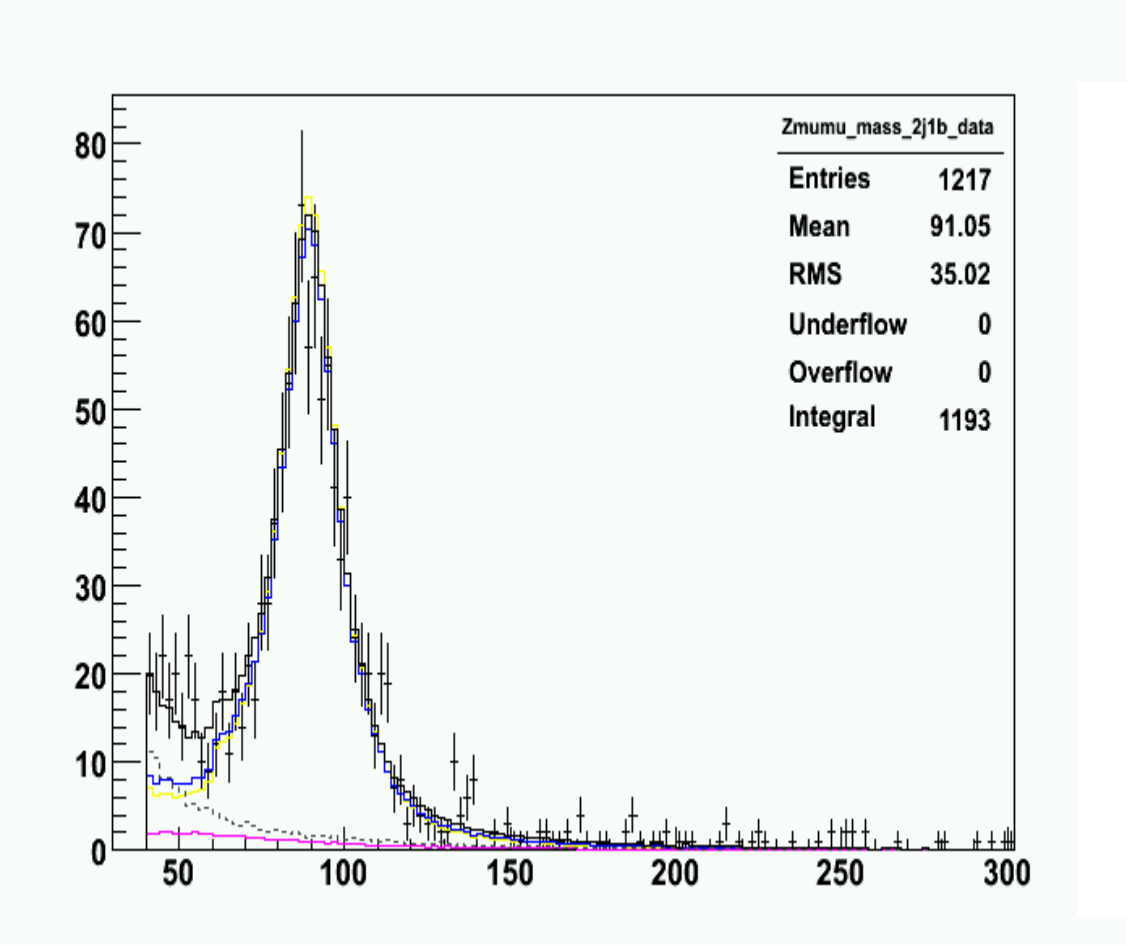


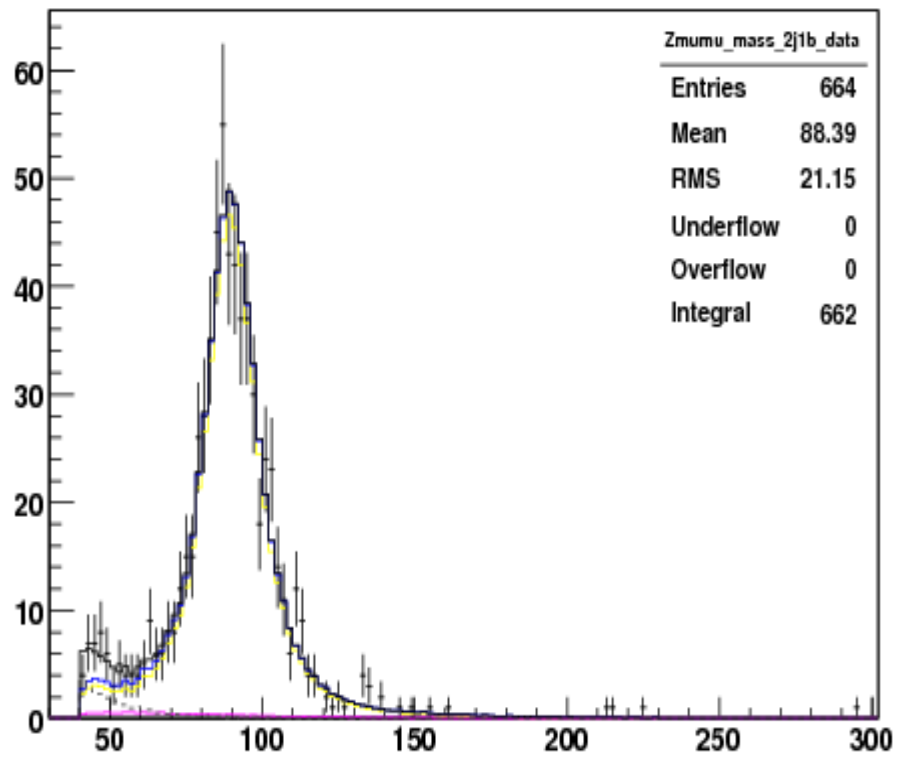
New / Old Z Selection (2j, 0b)



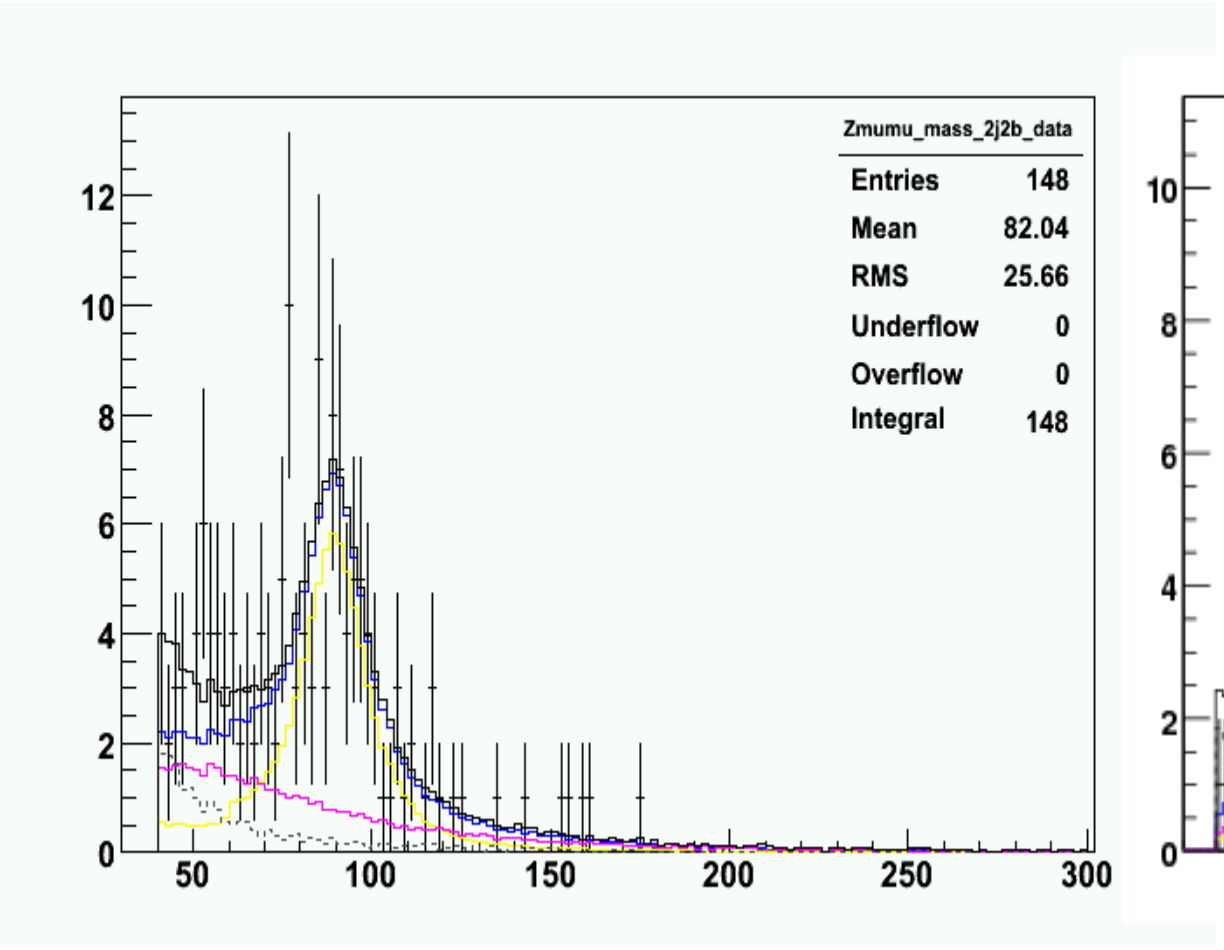


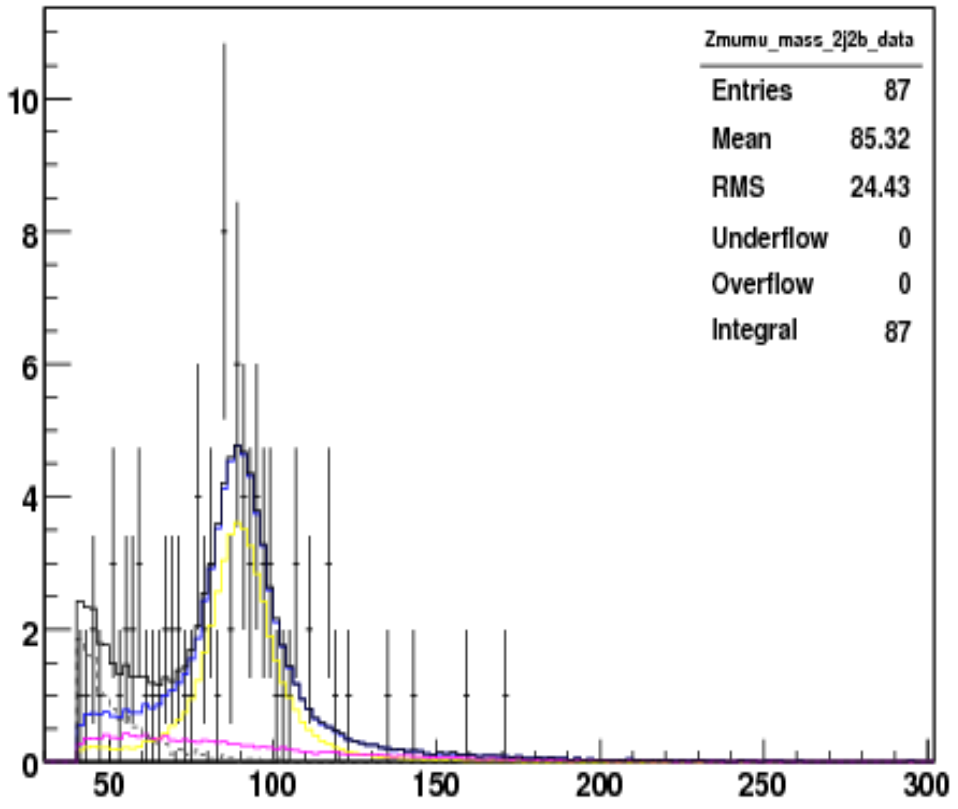
New / Old Z Selection (2j, 1b)





New / Old Z Selection (2j, 2b)





Event Counts in 70<Mjj<110

New Z selection:

Data & 1597 & 258 & 27 (+107%)
Total Bgnd. & 1603.512 & 228.151 & 23.844 (+92%)
QCD & 87.381 & 10.814 & 0.910 (+500%)
ZH(115) & 0.192 & 0.395 & 0.283 (+57%)
ZZ & 16.070 & 4.490 & 1.467 (+63%)
WZ & 16.377 & 3.428 & 0.197 (+79%)
\ttbar\ & 3.270 & 6.487 & 4.718 (+193%)
Z+(light) & 1445.339 & 168.196 & 8.078 (+67%)
Z+2b & 35.076 & 34.736 & 8.474 (+78%)

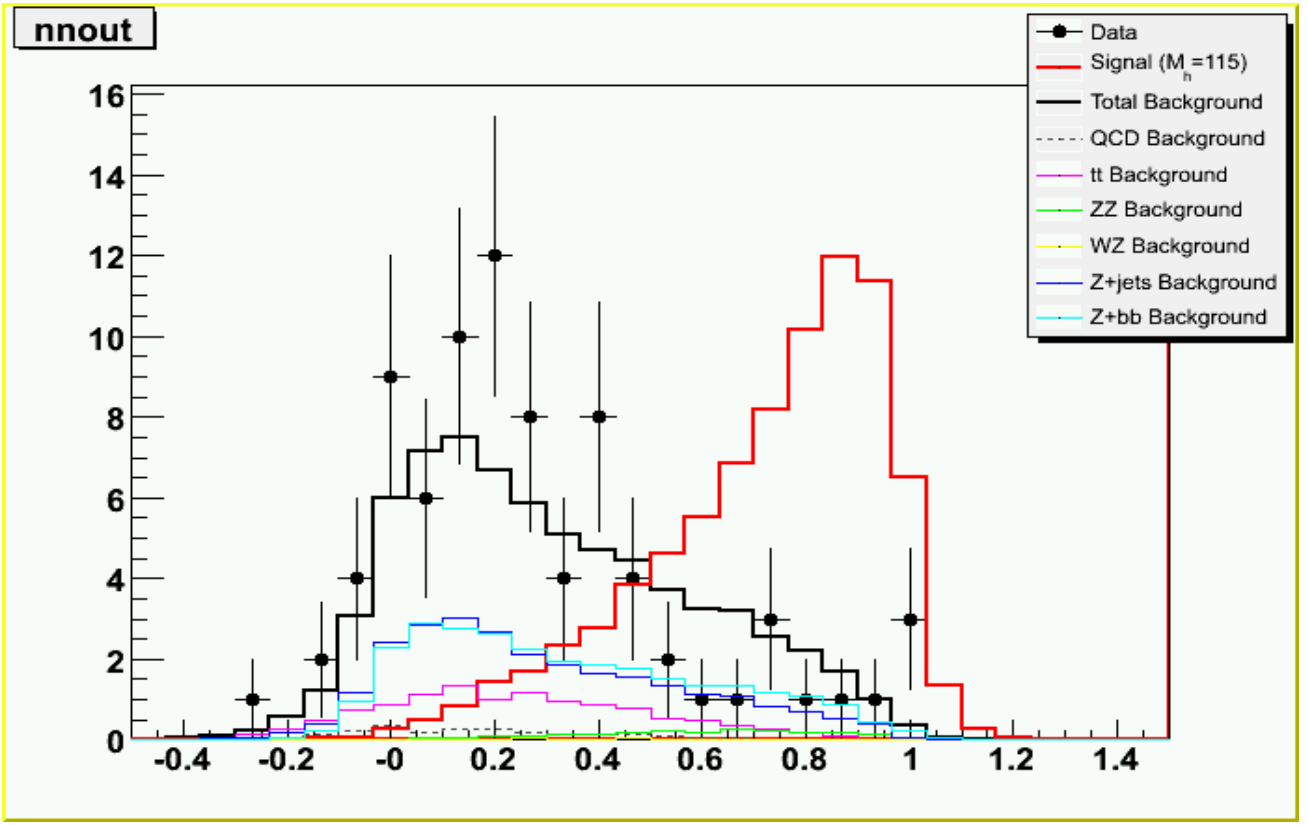
Sample	0 tag	>=1 tag	>=2 tag
Data	915	139	13
Total background	873.023	124.188	12.403
QCD	9.284	0.633	0.178
ZH(115)	0.122	0.256	0.180
ZZ	9.449	2.688	0.900
WZ	9.540	2.019	0.110
$t\bar{t}$	1.139	2.303	1.610
Z+(light)	824.653	97.910	4.845
Z+2b	18.959	18.634	4.761

Limits (Mjj window counting)

ZZ & 37 & 1.47 & 35.26 & 1.95 & 0.13 & 14.414 (10.13) & 15.613 \\
105 & 44 & 1.48 & 37.64 & 0.54 & 13.08 & 4.363 (37.93) & 5.665 \\
115 & 43 & 1.45 & 37.50 & 0.40 & 14.17 & 4.041 (51.21) & 5.063 \\
125 & 43 & 1.43 & 37.65 & 0.27 & 15.32 & 3.728 (75.13) & 4.665 \\
135 & 48 & 1.33 & 35.32 & 0.16 & 16.01 & 3.444 (126.89) & 5.596 \\
145 & 48 & 1.28 & 34.26 & 0.07 & 16.77 & 3.225 (262.17) & 5.472 \\
155 & 47 & 1.18 & 31.92 & 0.02 & 17.32 & 2.881 (733.07) & 5.407 \\

m_H (GeV)	Data	QCD	Total Bgnd.	Sig.	Eff(%).	Exp.(pb) (Exp./SM)	Obs.(pb)
ZZ	22	0.28	19.66	1.21	0.08	15.100 (10.61)	18.213
105	21	0.27	19.04	0.34	8.20	4.497 (39.09)	5.106
115	20	0.29	19.25	0.25	9.03	4.056 (51.39)	4.323
125	16	0.30	18.85	0.17	9.51	3.653 (73.61)	3.194
135	19	0.31	17.73	0.10	10.01	3.363 (123.90)	3.853
145	18	0.30	16.32	0.04	9.88	3.334 (271.02)	3.844
155	17	0.31	15.58	0.01	10.21	3.075 (782.53)	3.566

NN (2L)



Best cut = 0.81, signal significance = 0.0707235
cutting on mjj alone +-1.5sigma, signal significance = 0.0448506
no cut, signal significance = 0.0372886
significance improved over mjj cut by 1.57687

+15% sens.
+30% lum.

m_H (GeV)	$\frac{S}{\sqrt{B}}$, no cut	$\frac{S}{\sqrt{B}}$, $M_{jj} \pm 1.5\sigma$ cut	$\frac{S}{\sqrt{B}}$, NN cut	$\frac{S}{\sqrt{B}}$ improvement
115	0.0343848	0.0424987	0.0580564	1.36607

Conclusions

Large gains in signal efficiency when using “optimized” lepton ID

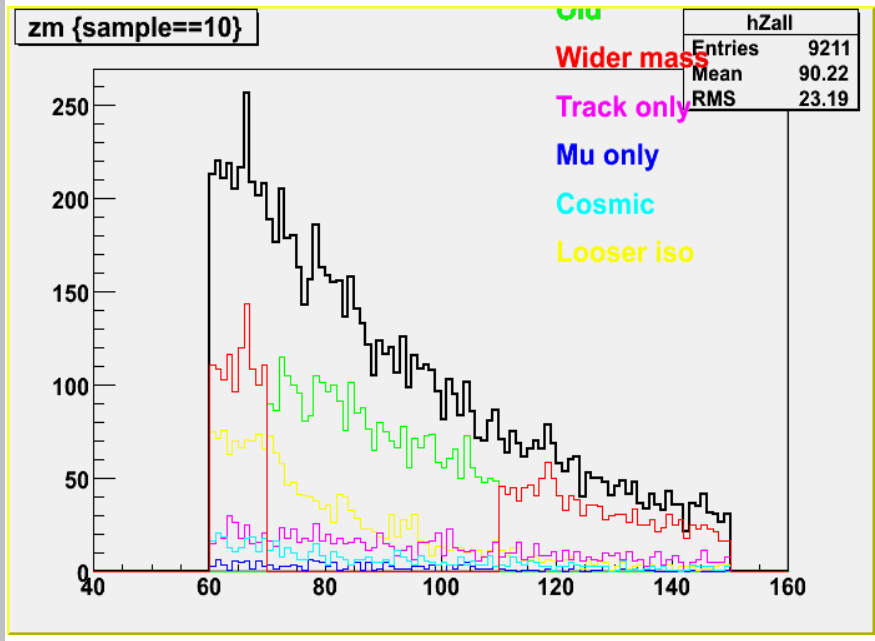
+60% signal !!!

+90% background.

Further studying the various “Z-types”

- Correct MET for track-only events

May gain more sensitivity by having separate NN's for some of the different Z-types



tt background