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Top Mass Measurement in the Lepton+Jets Channel Using Soft Muon Tagging.

Version 12 Results and Migration to v13.

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Outline

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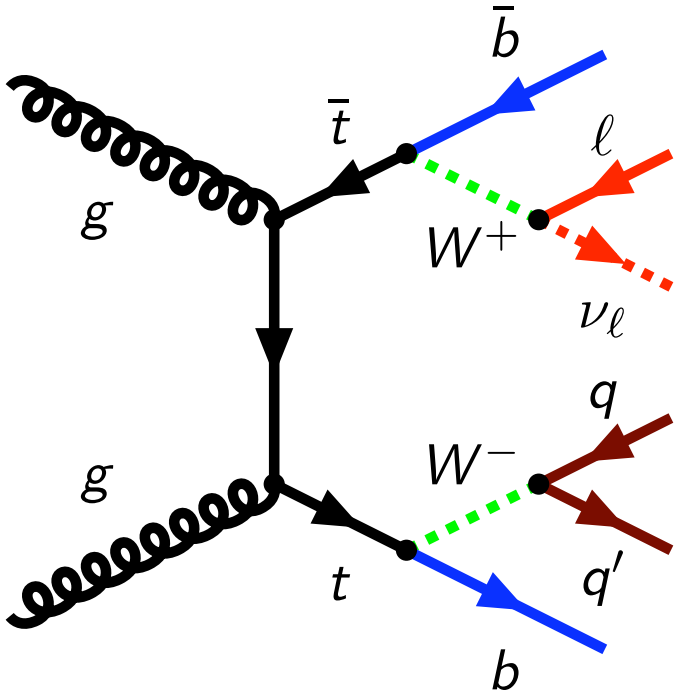
- Analysis overview.
- v12 Results.
- Comparison of v13 to v12.
- AtlfastII.

Event Selection



- 1 isolated lepton e > 25 *GeV*, μ > *20 GeV*
- Veto on events with 2 high pT leptons
- 3 or more jets with pT > 40 *GeV*
- MET > 20 *GeV*
- Scalar HT > 200 *GeV*
- One or more b-jet with a Soft Lepton Tag (SLT)
- Pass EF e25i and mu20i triggers

Event Selection
Definitions

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good electron

- e-gamma (author !=2)
- 'medium' (0x3FF)
- pT > 25 *GeV*
- |eta| < 2.5
- exclude 1.37 < |eta| < 1.52
- No Isolation (v12)

good muon

- STACO muid
- algo == 1
- pT > 20 *GeV*
- |eta| < 2.5
- eT cone20 < 6 *GeV*

good jet

- cone 0.4 (tower)
- pT > 25 *GeV*
- |eta| < 2.5
- no e in delta R < 0.4

triggers

- e25i (EM25i)
- mu20i (MU20 || MU40)

https://twiki.cern.ch/twiki/bin/view/Atlas/TopGroupCSCObjectSelection

MC Samples

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Fullsim

ttbar:

5200: semi-leptonic, dileptonic, M_{top} = 175 GeV/c^2 & v13

6203,4: semi-leptonic, dileptonic, M_{top} = 160, 190 GeV/c^2

W + Jets:

8440-8443: AlpgenJimmyWenu, Np = 2,3,4,5

8444-8447: AlpgenJimmyWmunu, Np = 2,3,4,5

AtlfastII (currently in sim/reco stage)

ttbar:

5200: semi-leptonic, dileptonic, M_{top} = 175 GeV/c^2 v14 only

Event Selection
electron channel

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$$\int \mathcal{L}\, dt \approx 100\ pb^{-1}$$

Signal

Cut	Total	Acceptance
Initial	48000	100%
Passed EFe25i	11099	23%
"Good" Electron	1979	4.1%
Nelectron==1	1782	3.7%
MeT > 20 GeV	1644	3.4%
HT > 200 GeV	1223	2.5%
1 or more SLT Jet	934	1.9%
SLT Ratio > 0.7	482	1.0%
Njets ≥ 3	324	0.68%

Background

Initial	81250	100%
W+jets	23	0.03%

Event Selection
muon channel

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$$\int \mathcal{L}\, dt \approx 100\ pb^{-1}$$

Signal

Cut	Total	Acceptance
Initial	48000	100%
Passed EFmu20i	13316	28%
"Good" Muon	11043	23%
Nmuon==1	10716	22%
MeT > 20 GeV	9809	20%
HT > 200 GeV	6364	13%
1 or more SLT Jet	3254	7.0%
SLT Ratio > 0.7	618	1.3%
Njets ≥ 3	468	0.98%

Background

Initial	81250	100%
W+jets	25	0.03%

SLT Likelihood Ratio

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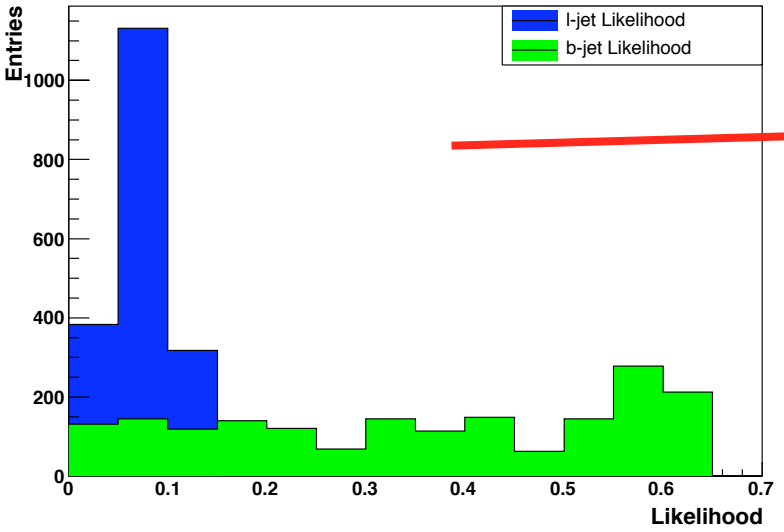
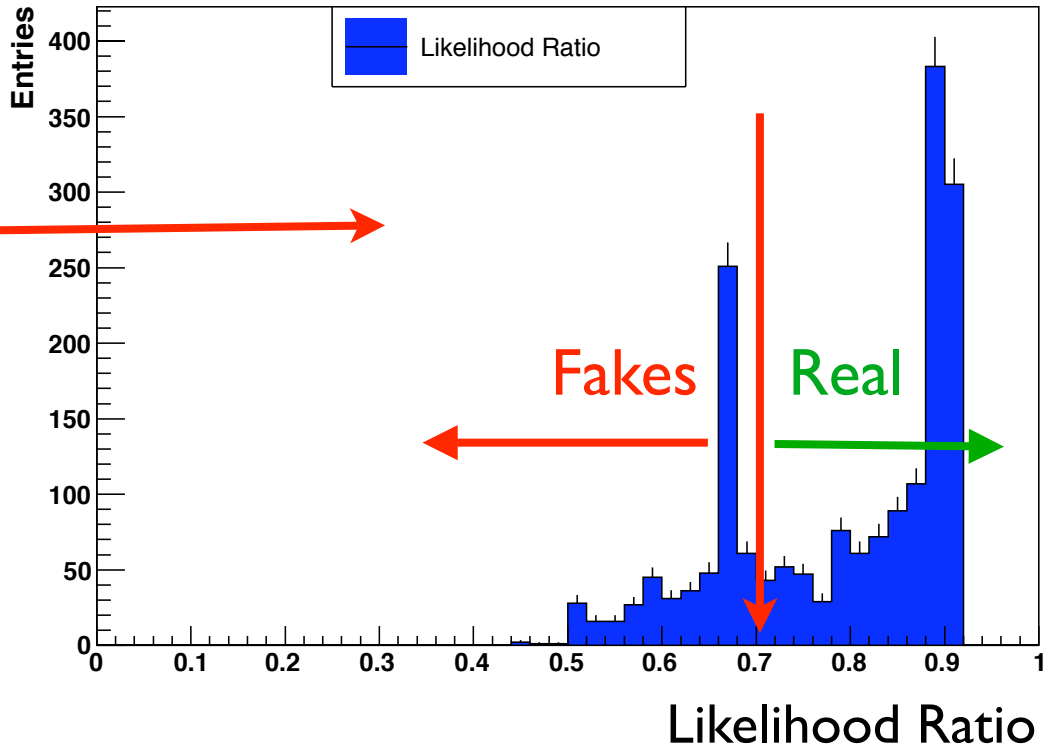
Muon Likelihood



$$\frac{b}{b+l}$$

SLT Ratio



Currently using the above formula to get a likelihood ratio of the muon likelihood with that of the light quark jet to help distinguish between them.

Measuring the Top Mass

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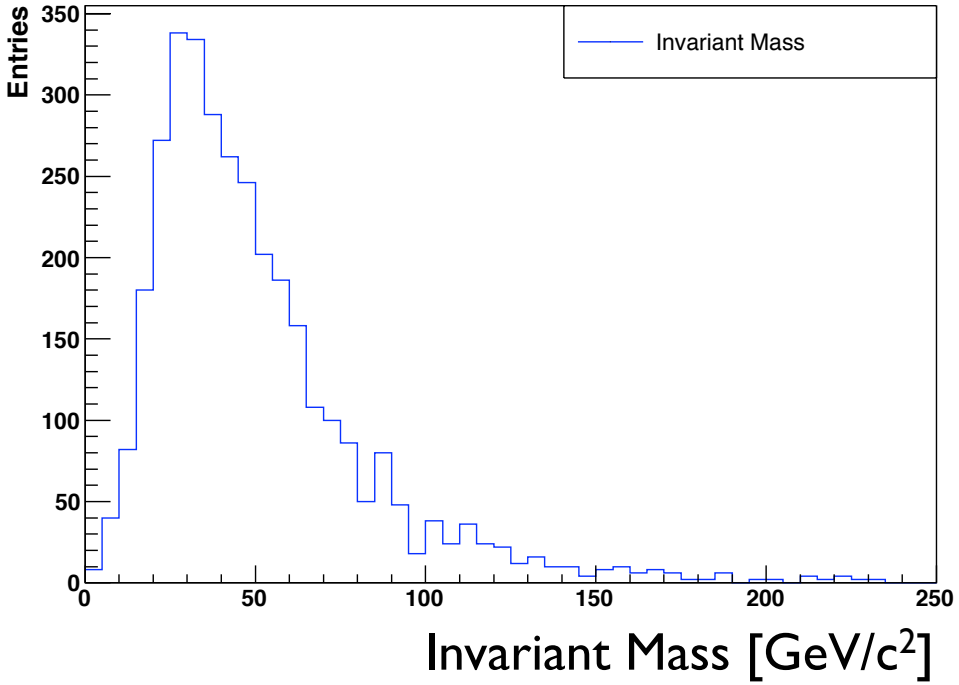
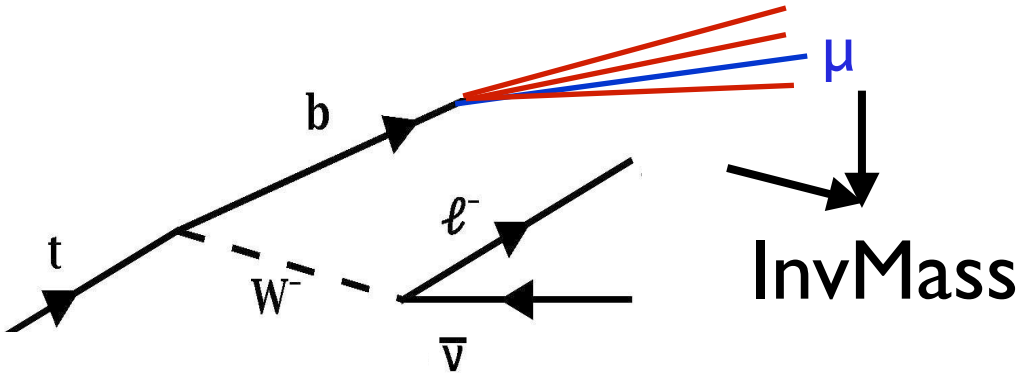
Invariant Mass of the lepton from W decay and the soft muon within the b-jet.

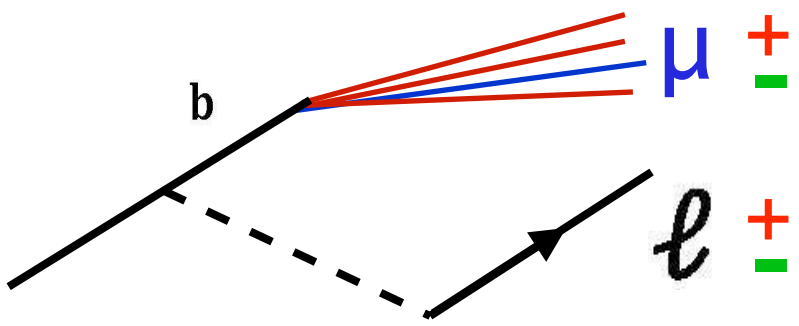




There is a correlation between the mass of the top quark and the invariant mass of its decay products. It's not possible to get a handle on the neutrino but the hard lepton from W decay and the soft muon are accessible.

These decay products will carry a significant fraction of the original Top mass with them and from this it is possible to get a handle on the Top mass.

Invariant Mass
Different Measurement Methods



Using different combinations of the hard lepton from W decay and the soft muon that are dependent on the sign of each yields differing accuracy on the invariant mass.

$$b \rightarrow \mu \qquad b \rightarrow c \rightarrow \mu$$

Method	Sign	Constituents
SS TL-SLT	++ or --	soft muon and tight lepton
OS TL-SLT	+-	soft muon and tight lepton
TL pT	+ or -	tight lepton only
All TL-SLT	++ +- --	soft muon and tight lepton

Invariant Mass
With W+Jet Backgrounds

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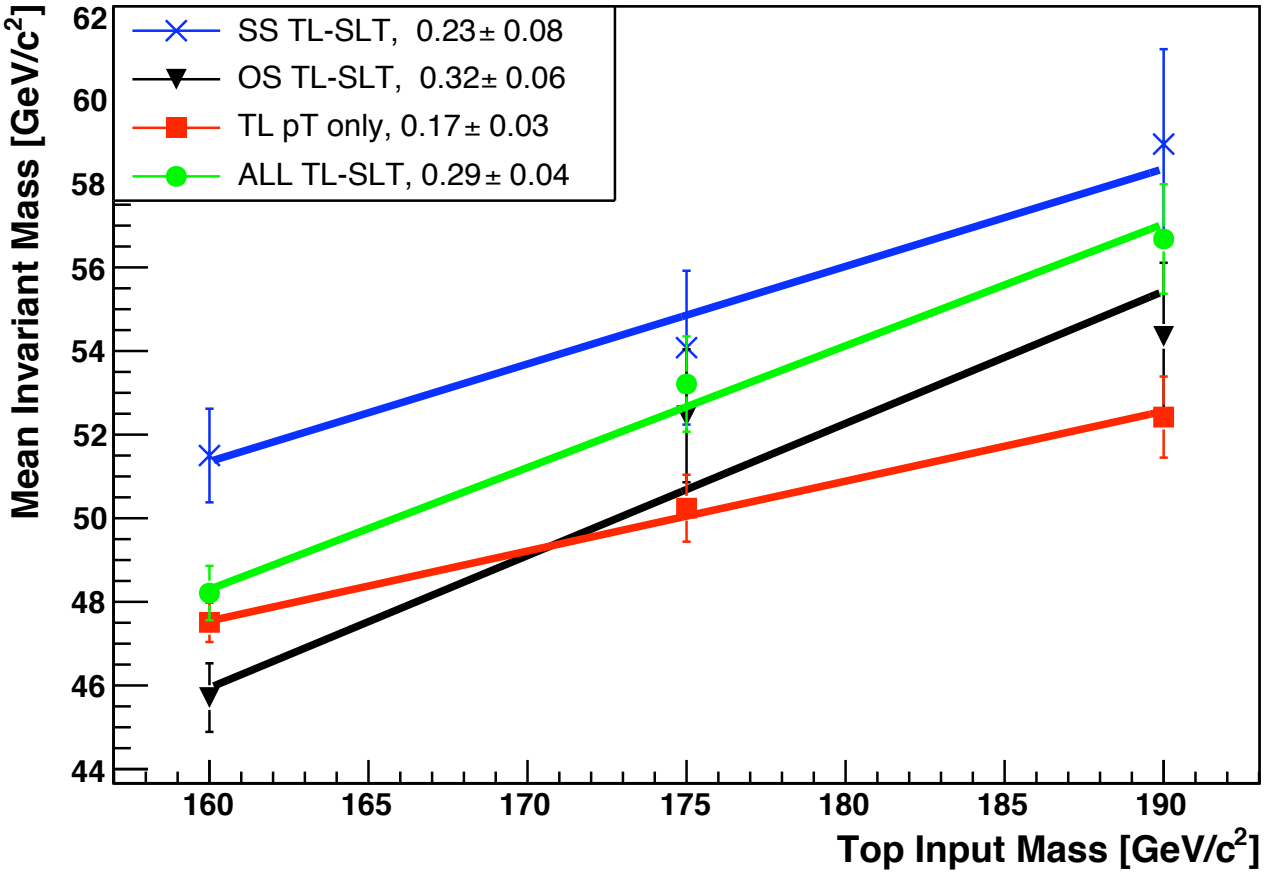
Variation of the mean invariant mass with different top input masses.



Small change in slopes with the addition of background with a slight increase in errors.

Precision on Top Mass

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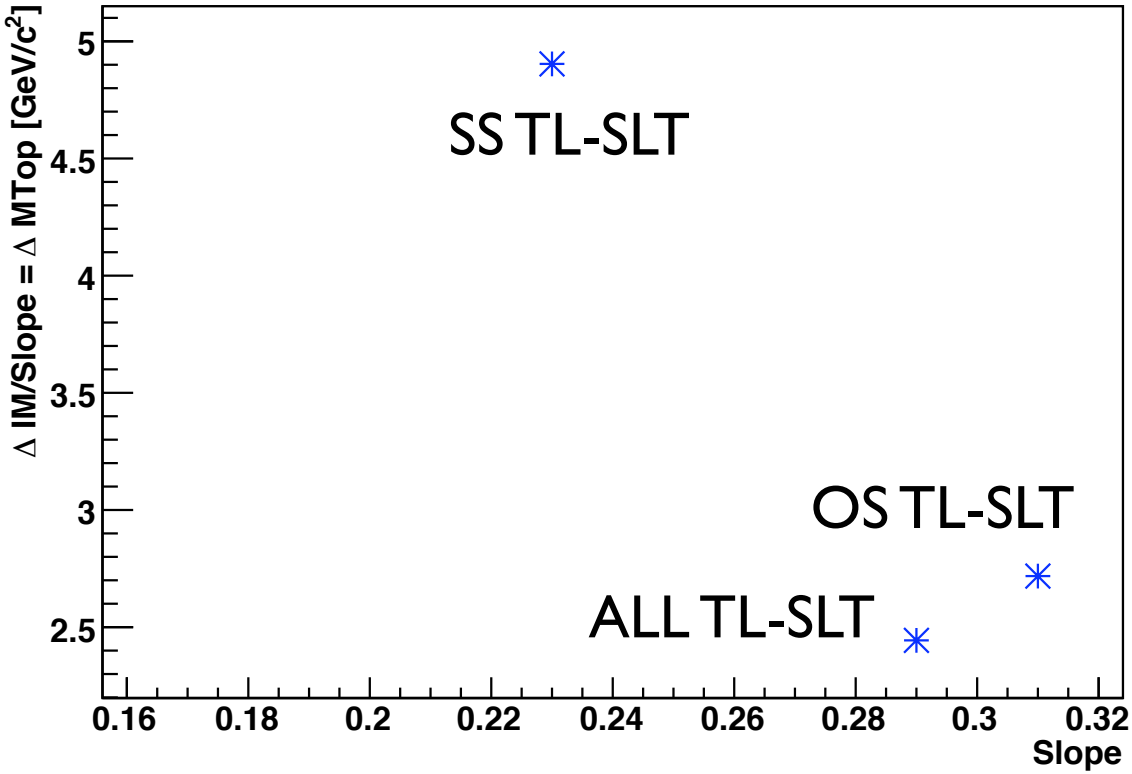

Running the different methods over ≈ 160 pb^{-1} of ttbar events.

Opposite sign method offers the best precision but with reduced number of statistics. All TL-SLT looks to be a good combination.

Precision on Top Mass

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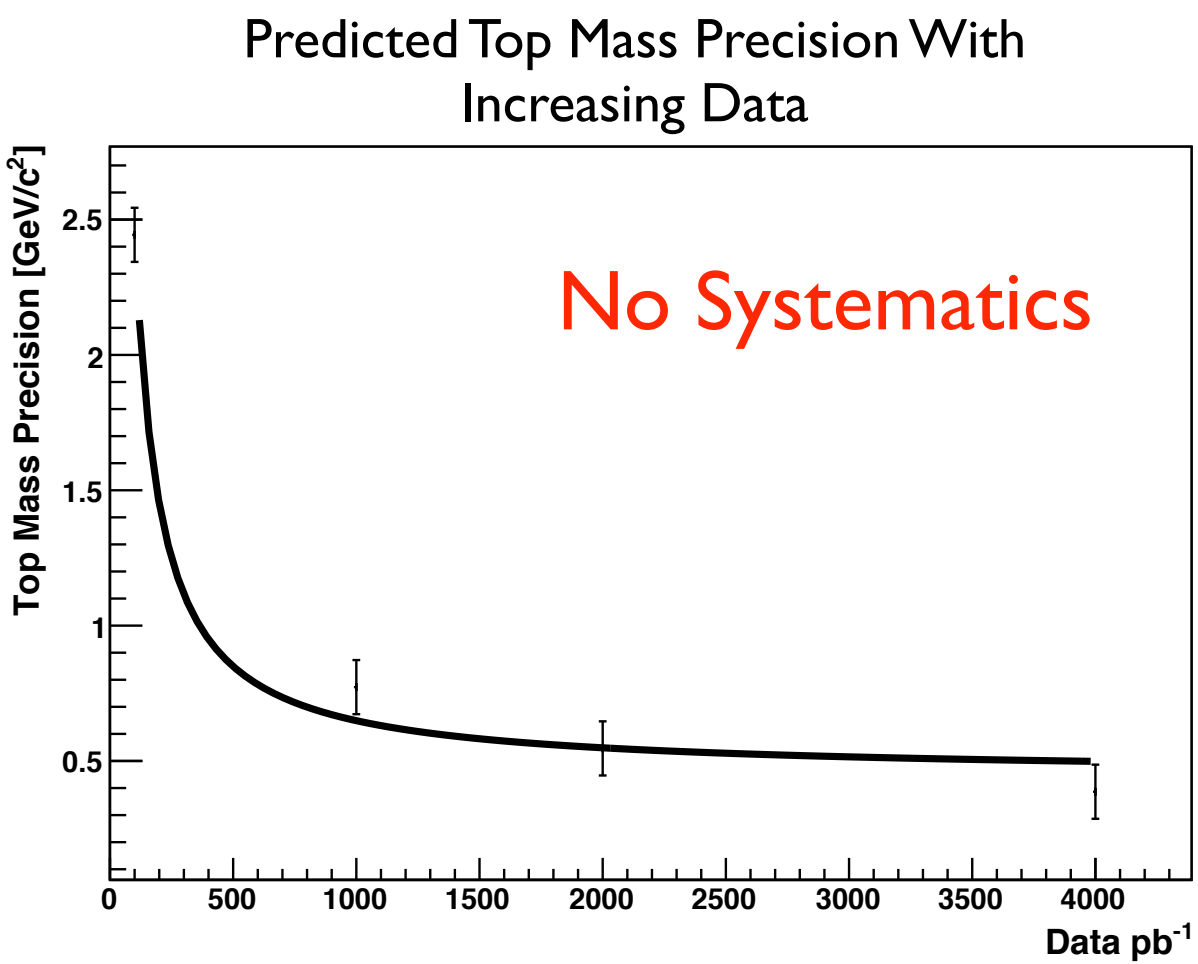

Using the ALL TL-SLT method the expected precision on the top mass measurement looks promising.

Moving from v12 to v13

Event Selection
electron channel

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NJets:	Total	0	1	2	3	4	5	6	>=7
Initial:	15000	76	536	1935	3907	4221	2758	1080	487
Passed eTrigger:	3439	20	123	448	873	994	616	262	103
Electron Pt>25 GeV/c^2:	3326	19	122	437	836	963	594	255	100
Good Electron:	590	3	24	82	168	145	106	44	18
No. Electron==1:	556	3	23	76	160	135	100	41	18
MEt>20GeV:	505	2	20	67	146	123	91	38	18
Njets $\geq$ 3:	416	0	0	0	146	123	91	38	18
HT>200GeV :	298	0	0	0	101	95	61	28	13
$\geq$1 SLT jets:	44	0	0	0	12	16	9	4	3
SLT Ratio $\geq$0.7:	14	0	0	0	4	2	3	3	2

Version 12

NJets:	Total	0	1	2	3	4	5	6	>=7
Initial:	15000	57	536	1967	3837	4246	2734	1140	483
Passed eTrigger:	3828	18	148	493	996	1070	677	293	133
Electron Pt>25 GeV/c^2:	3756	18	147	479	983	1054	663	284	128
Good Electron:	1160	6	50	161	293	337	195	84	34
No. Electron ==1:	1062	5	46	149	265	308	180	80	29
MEt>20GeV:	973	5	42	139	244	278	164	73	28
Njets $\geq$ 3:	787	0	0	0	244	278	164	73	28
HT>200GeV :	592	0	0	0	190	217	111	52	22
$\geq$1 SLT jets:	118	0	0	0	53	33	22	7	3
SLT Ratio $\geq$0.7:	26	0	0	0	13	5	6	2	0

Version 13

Event Selection
muon channel

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NJets:	Total	0	1	2	3	4	5	6	>=7
Initial:	15000	76	536	1935	3907	4221	2758	1080	487
Passed muTrigger:	4013	20	141	532	1064	1117	710	291	138
Muon Pt>20 GeV/c^2:	4003	20	141	530	1063	1113	710	288	138
Good muon:	3380	20	123	464	875	935	610	243	110
No. Muon==1:	3349	20	122	458	867	928	604	240	110
MEt>20GeV:	3079	18	112	412	796	857	556	225	103
Njets $\geq$ 3:	2537	0	0	0	796	857	556	225	103
HT>200GeV :	1988	0	0	0	619	674	438	176	81
$\geq$1 SLT jets:	312	0	0	0	113	103	52	28	16
SLT Ratio $\geq$0.7:	73	0	0	0	31	25	7	8	2

Version 12

NJets:	Total	0	1	2	3	4	5	6	>=7
Initial:	15000	57	536	1967	3837	4246	2734	1140	483
Passed muTrigger:	4151	13	145	528	1094	1154	773	317	127
Muon Pt>20 GeV/c^2:	4076	13	144	523	1067	1130	757	315	127
Good muon:	3514	13	127	446	930	968	649	271	110
No. Muon==1:	3255	12	114	407	868	896	602	259	97
MEt>20GeV:	2972	11	105	375	796	816	548	231	90
Njets $\geq$ 3:	2481	0	0	0	796	816	548	231	90
HT>200GeV :	1928	0	0	0	612	646	416	185	69
$\geq$1 SLT jets:	407	0	0	0	136	131	87	37	16
SLT Ratio $\geq$0.7:	96	0	0	0	31	29	20	13	3

Version 13

Njets
Update on differences

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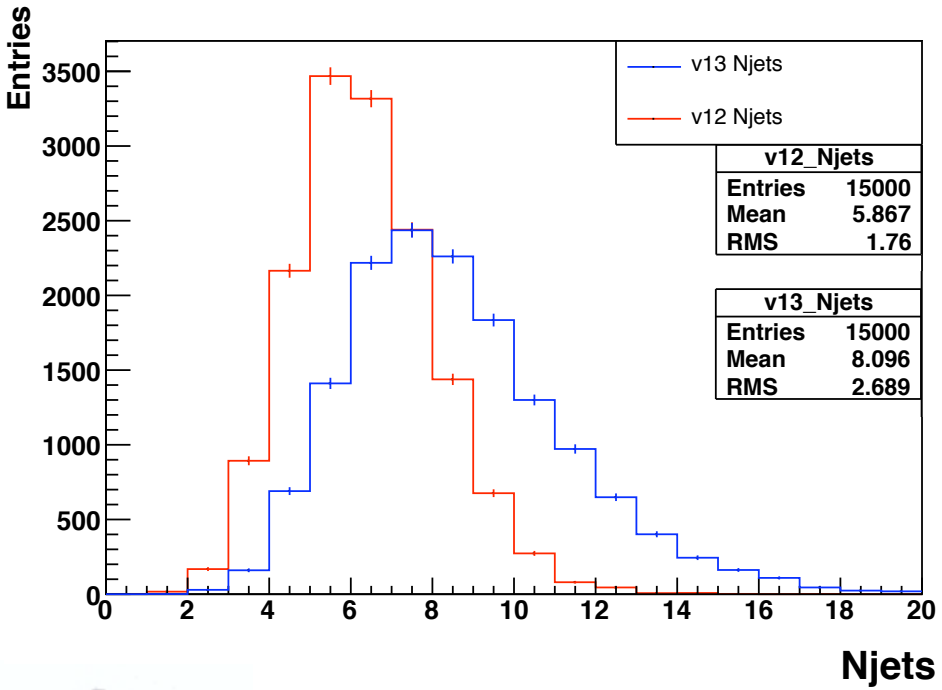
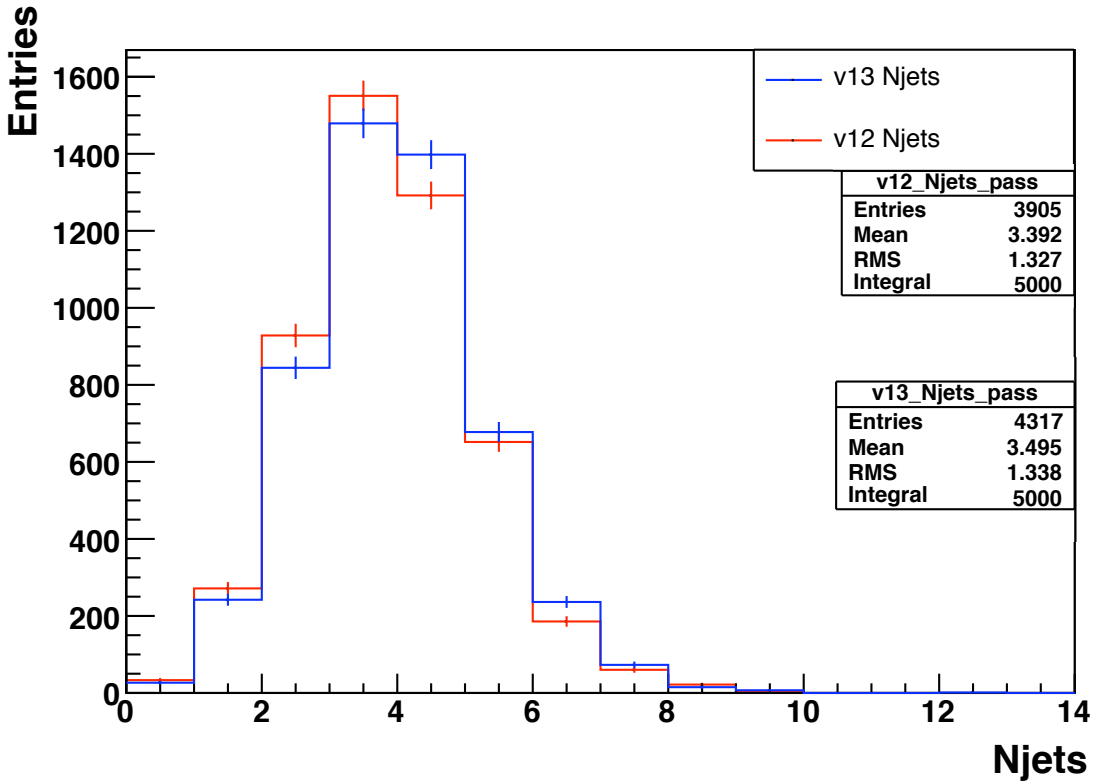
The differences seen in the njet count between v12 and v13 appear to be mostly due to light jets. Applying default pt and eta cuts, the differences between releases are reduced.





Njets for events == 1 good lepton

Electron and Muon Eta
v12 and v13

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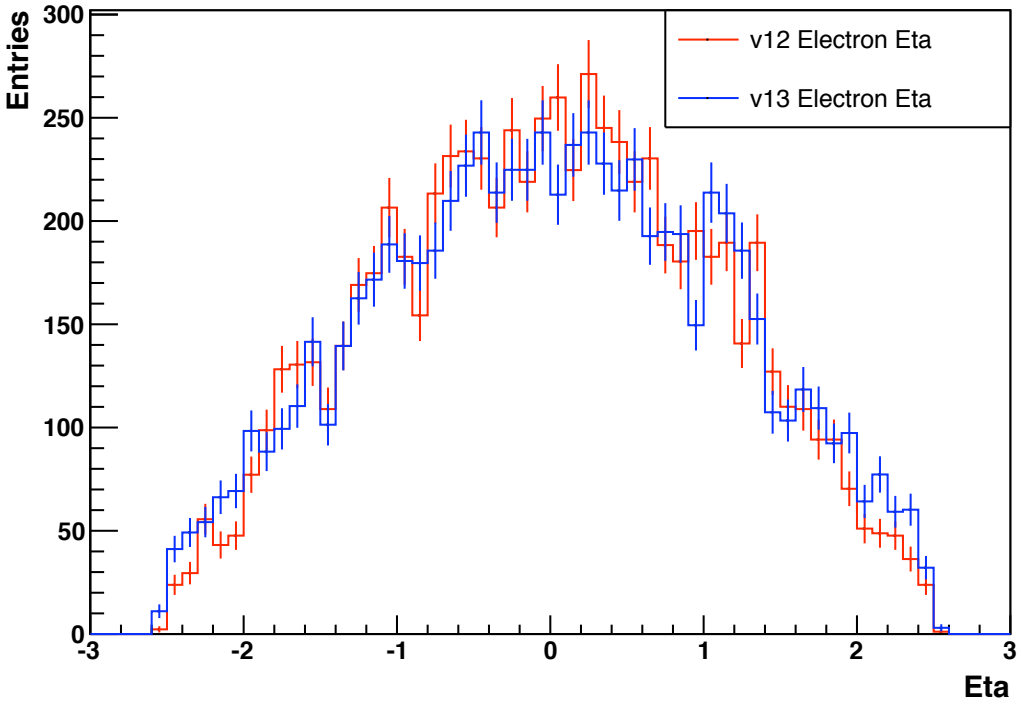

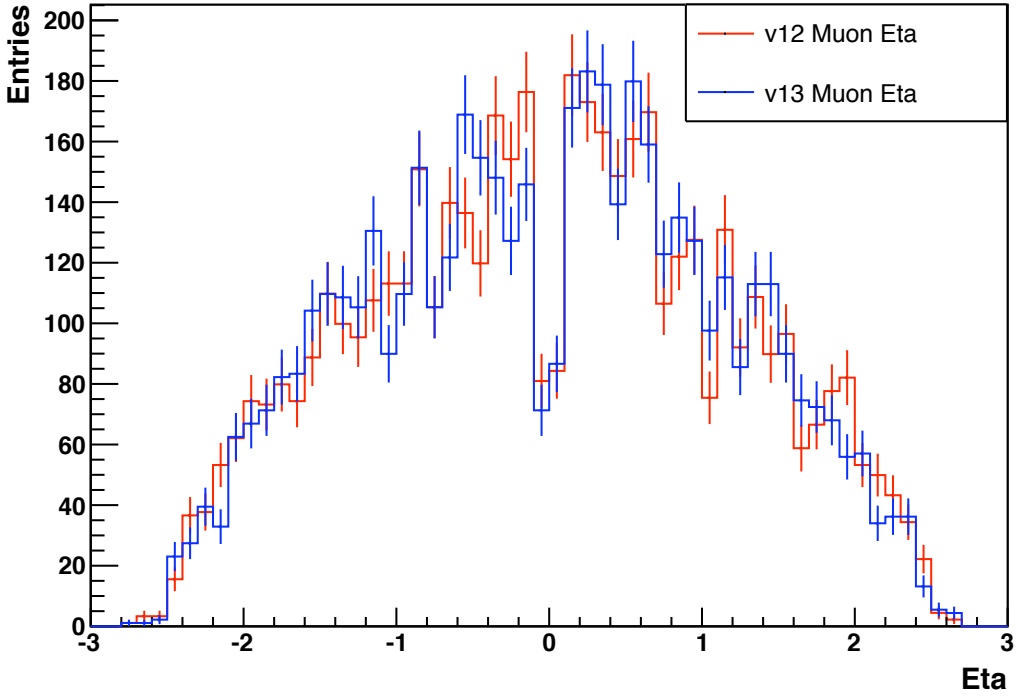

Eta of electron and muons that have passed trigger and pt cut

ElectronPt
v12 and v13

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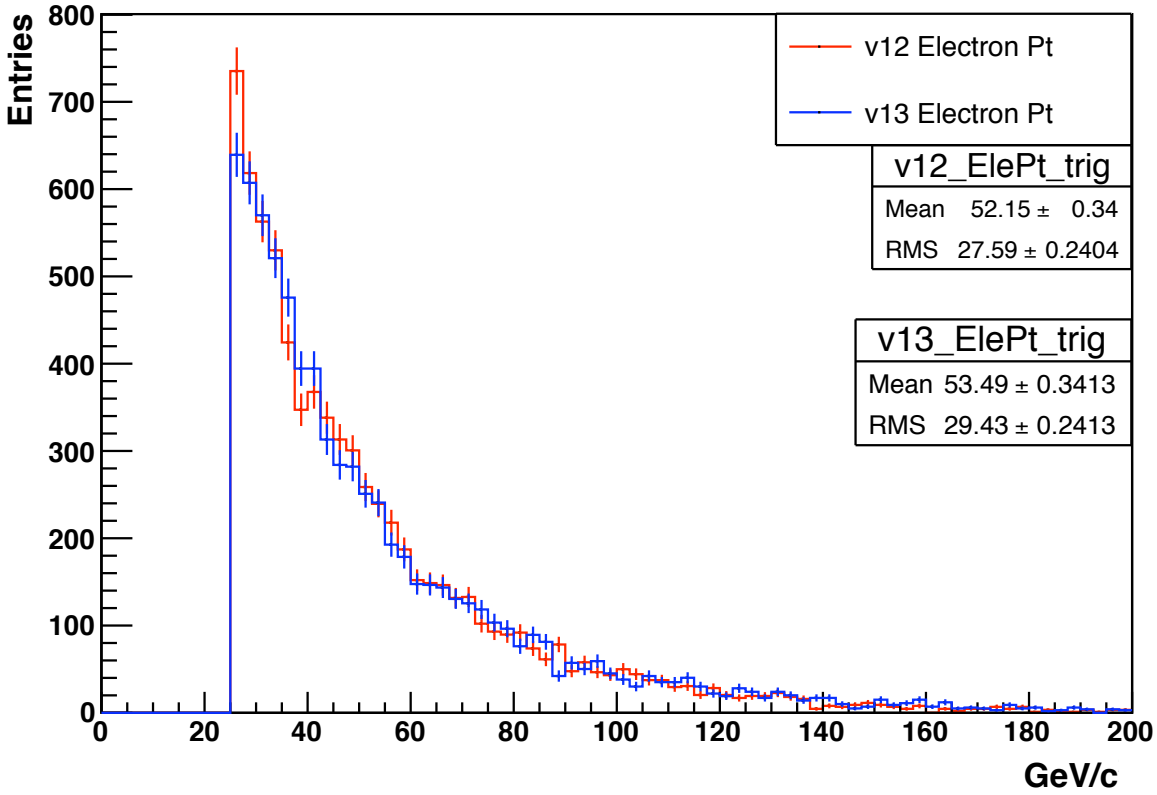

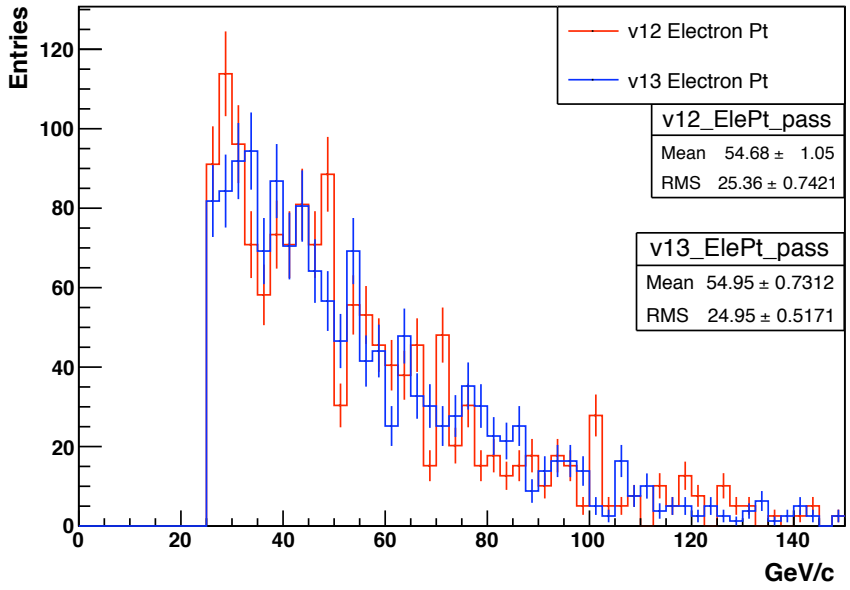

Electron pt in events that have passed EF25i trigger
and basic 25 GeV electron cut (left), "Primary" electron pt (right)

MuonPt
v12 and v13

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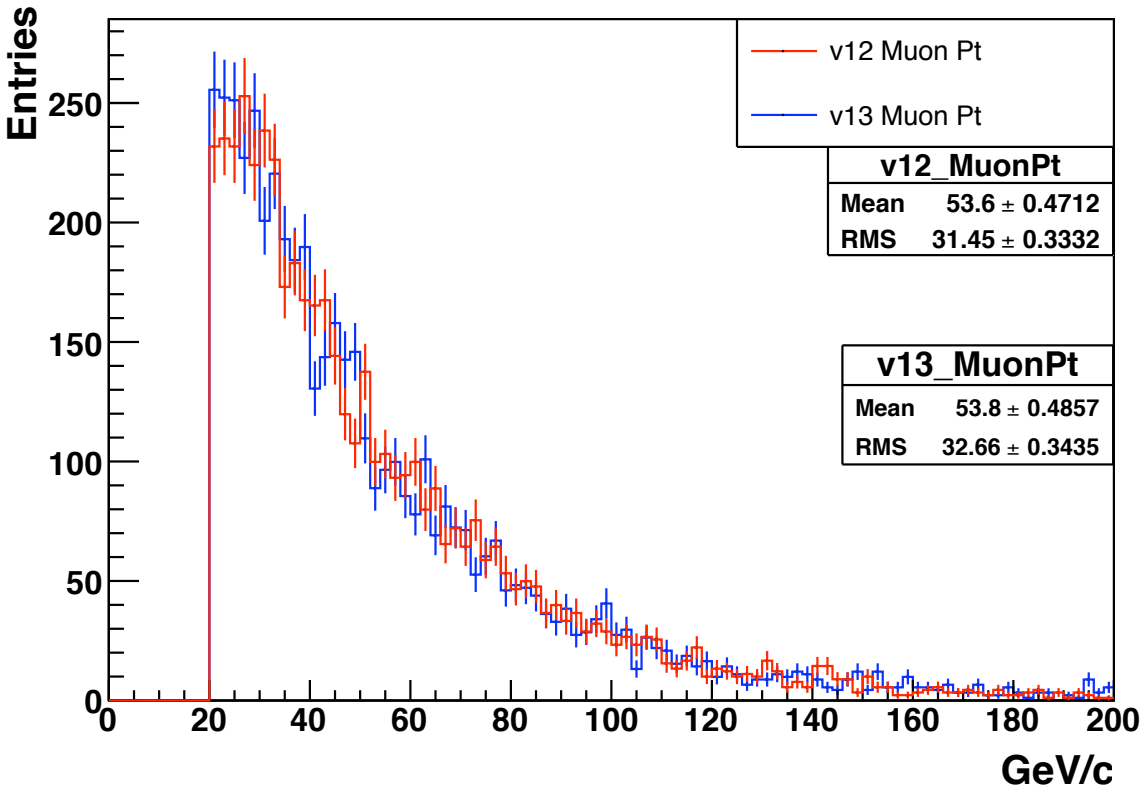

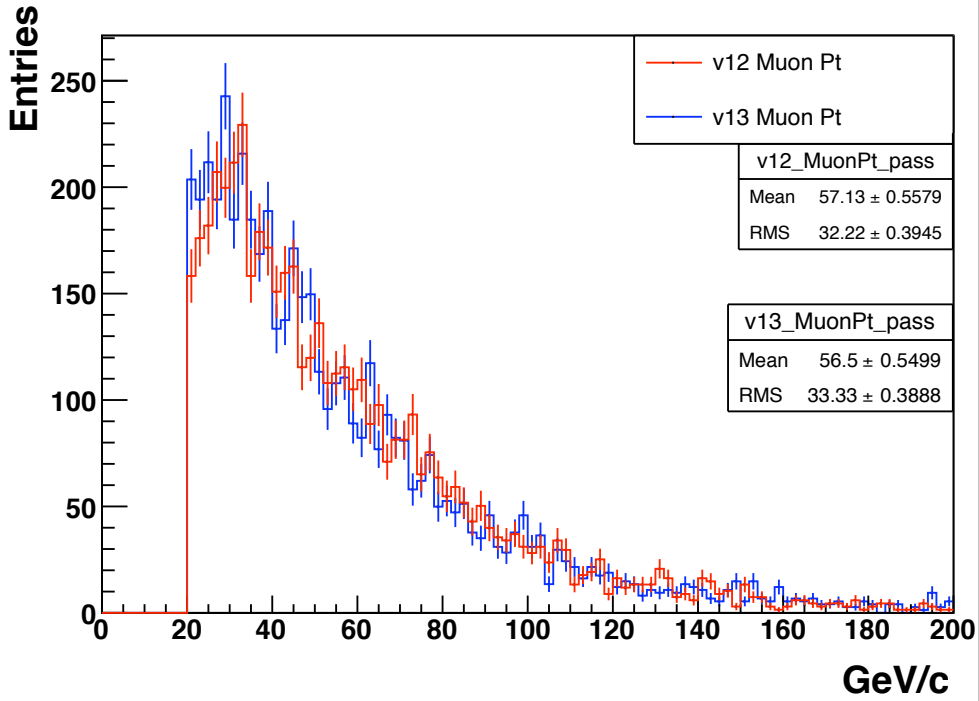

Muon pt in events that have passed MU20i trigger
and basic 20 GeV muon cut (left), "Primary" muon pt (right)

Muon Isolation Energy
v12 and v13

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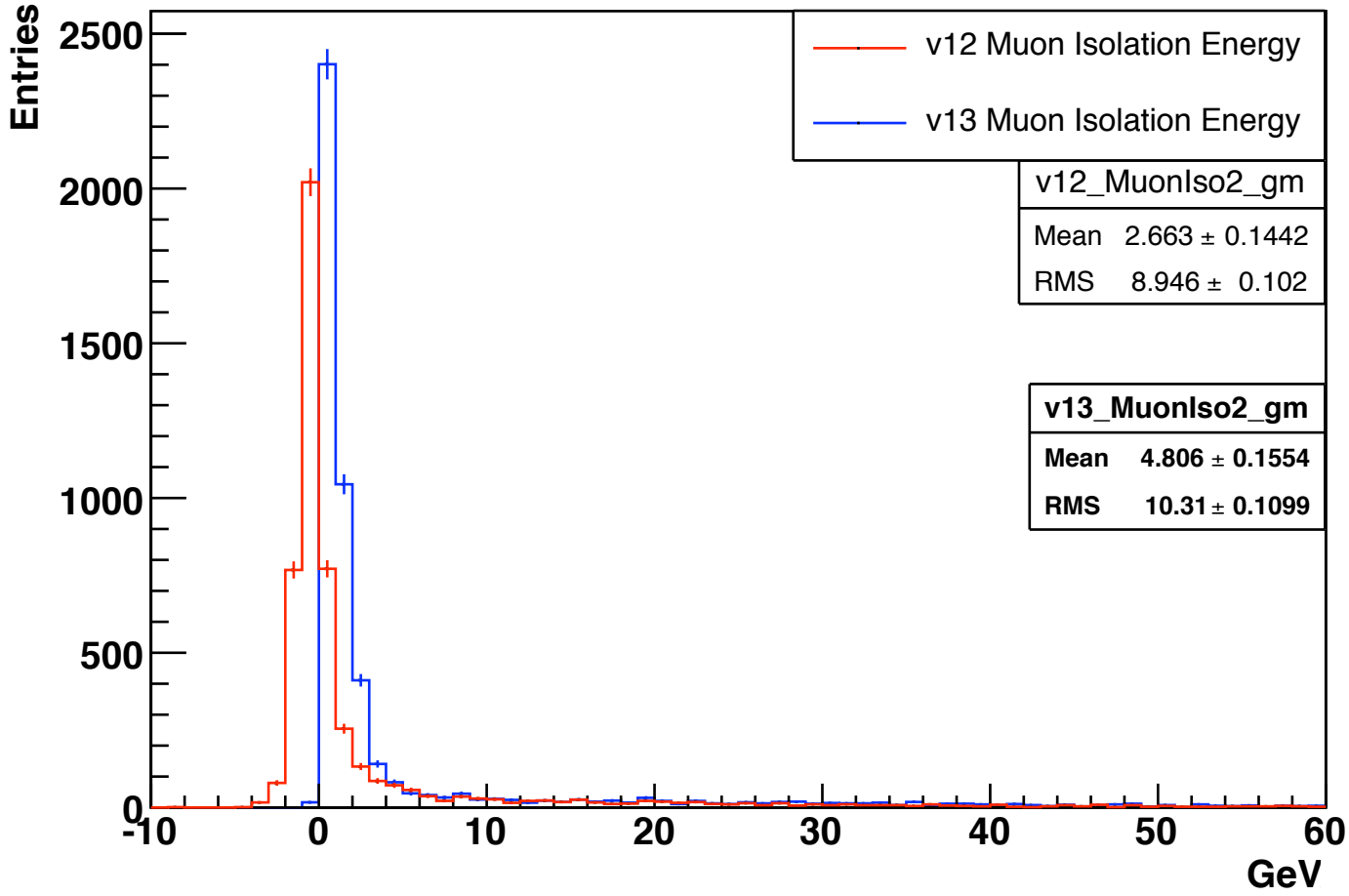

Isolation energy in cone 0.20 for muons that have passed MU20i trigger and basic 20 GeV/c muon cuts.

Scalar HT
v12 and v13

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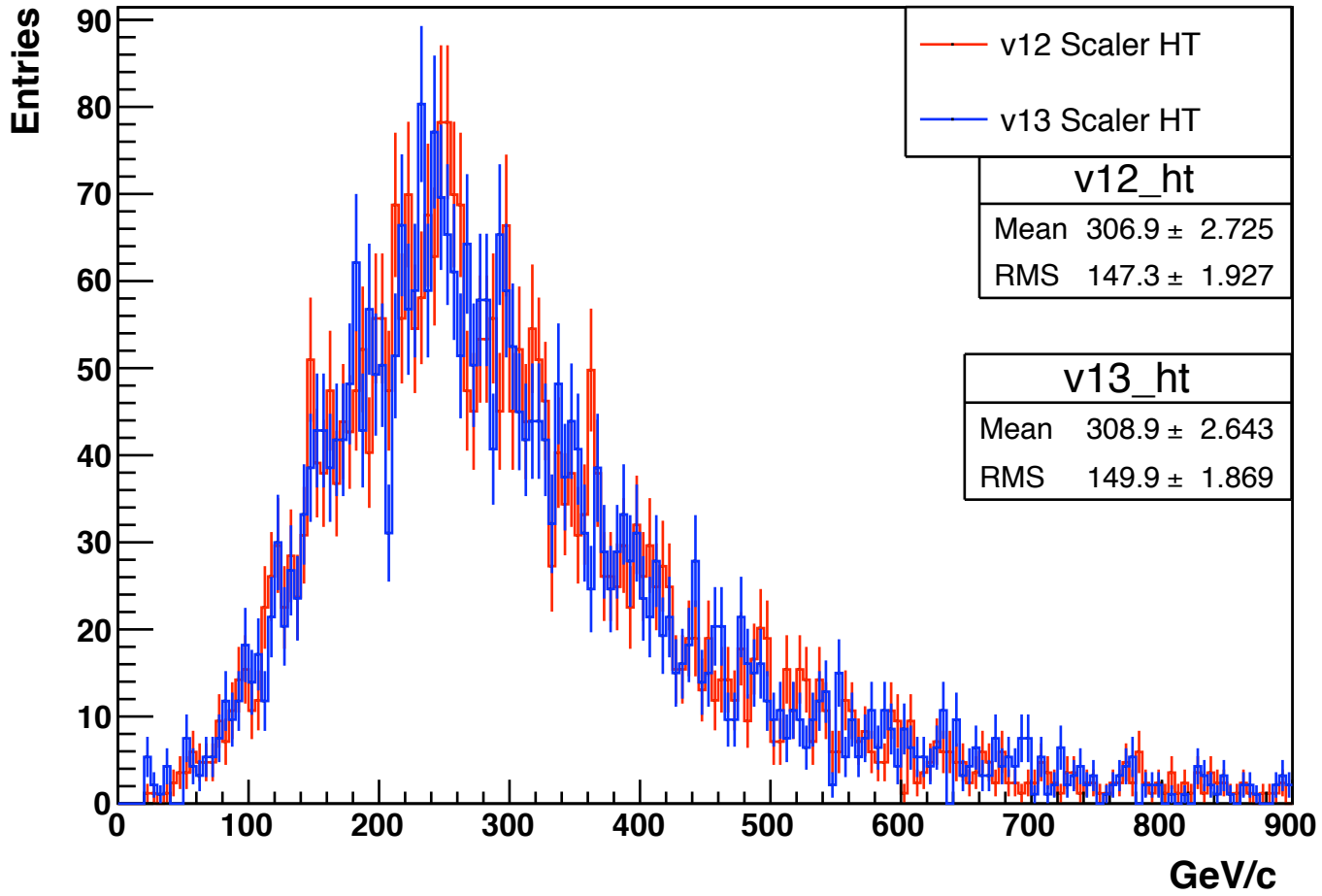

Scalar HT in events that have one isolated lepton and njets >= 3

What's Next?

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AtlfastII

- Currently generating ttbar using the latest version of AtlfastII

Run options (for Athena 13.0.40.5, 14.0.0.1 and 14.1.0 and newer)

- Atlfast II is still not fully validated, for details check the agenda pages of the Atlfast validation group
- The default Atlfast II run mode contains the following simulation steps:
  - Inner Detector full simulation
  - Only for muons: Calorimeter and Muon System full simulation
  - Digitization without calorimeter noise
  - Calorimeter simulation with FastCaloSim during the reconstruction step
- The ATLAS standard job transforms are used to run Atlfast II. The Atlfast II specific part is controlled by jobconfig files :
  - jobConfig.FastIDKiller.py : modifies full simulation to kill all particles except muons at the exit of the ID
  - FastCaloSimAddCellsRecConfig.py : If a calorimeter is already filled with some energies, this transform adds the particle simulation with FastCaloSim on top of the existing calorimeter entries.
  - FastCaloSimRecConfig.py : Simulated the calorimeter only with FastCaloSim. Any existing calorimeter in the RDO is discarded.

First batch run I did last week has to be re-run due to a bug in the inner detector simulation. Currently only trigger is L1 and it is untested, event filter trigger to be added at a later date...