Study of Z1b control region for $A \to Zh \to \ell\ell b\bar{b}$ analysis.

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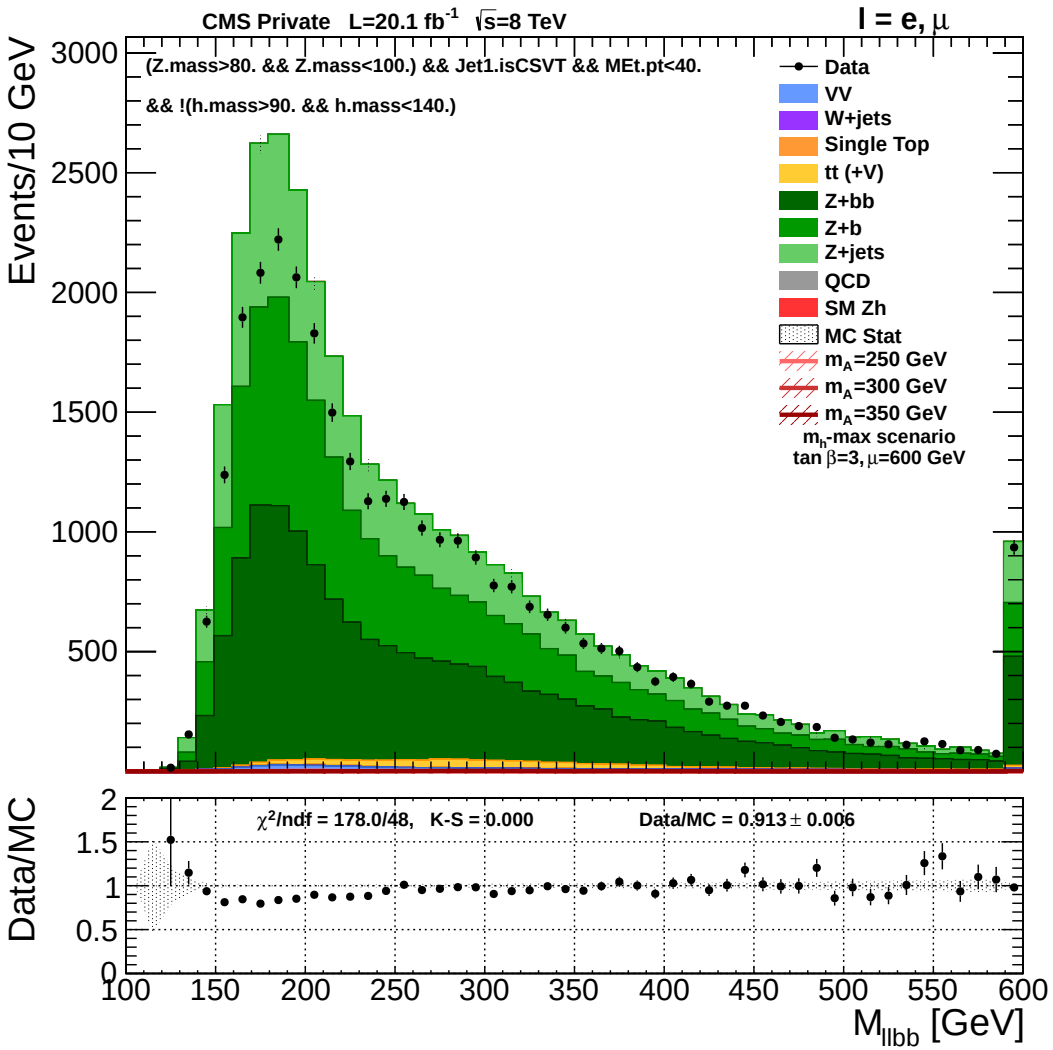
CERN, 26 August 2013

Issue with Z1b control region

- The control region for Zbb and TTbar are fine for shape and normalization
- The Z1b control region is not that good, in particular the shape does not agree for Data/MC comparison.
- Why is that?
- Try to show more kinematical distribution for the Z1b control region

Zb control region

$m_A = m_{\ell\ell bb}$



Zb CR cuts

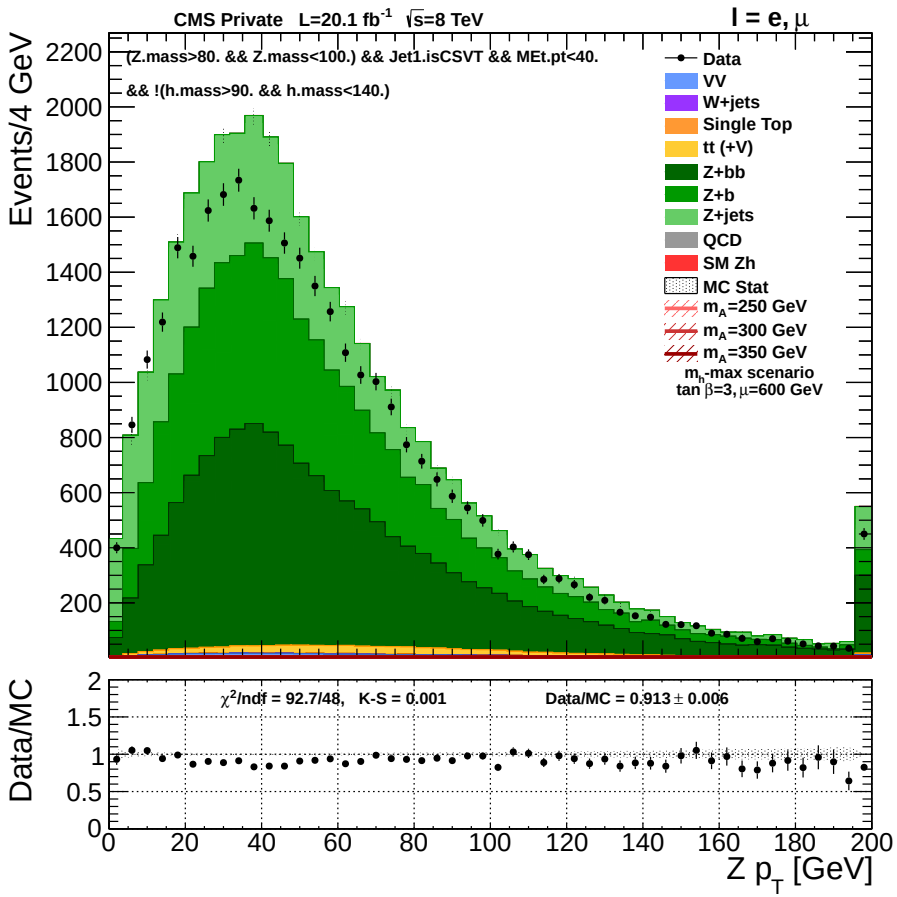
- Preselection
- Z selection: $80 < m_{\ell\ell} < 100\ GeV$;
- h veto: $m_h < 80$ or $m_h > 140\ GeV$
- B-tag: Jet_1 CSVT
- top veto: $MET < 40\ GeV$
- Data/Bkg= 0.913 ± 0.006

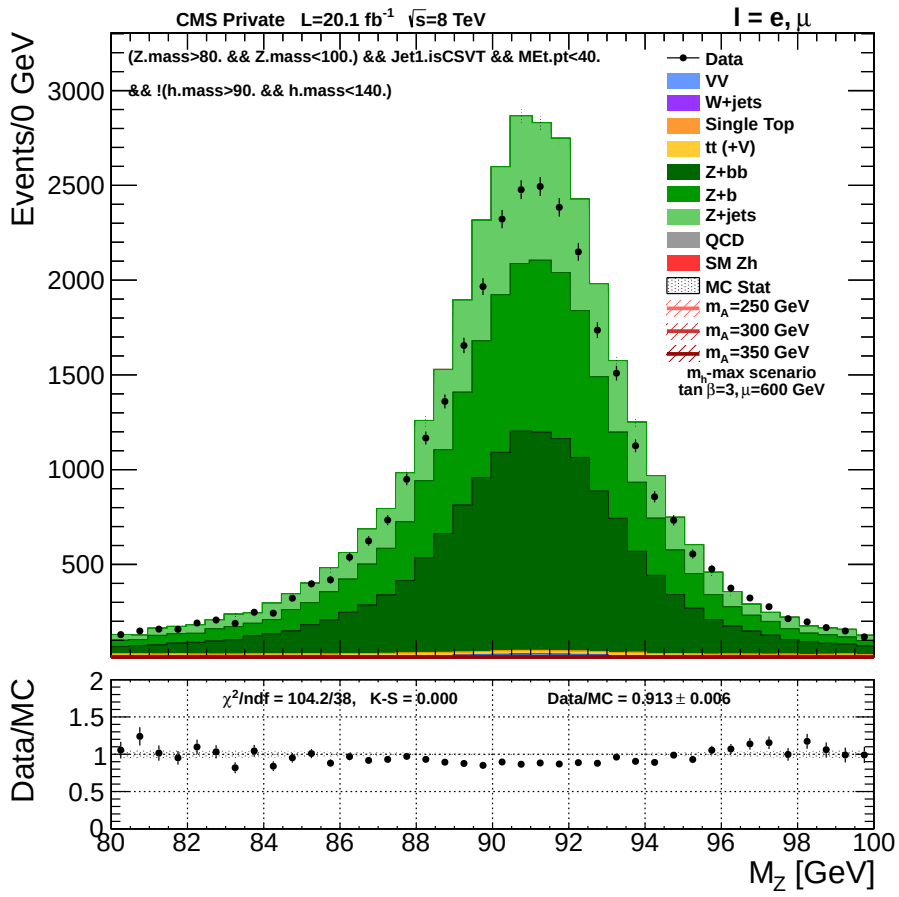
Same as Zbb but just 1 b-tag.

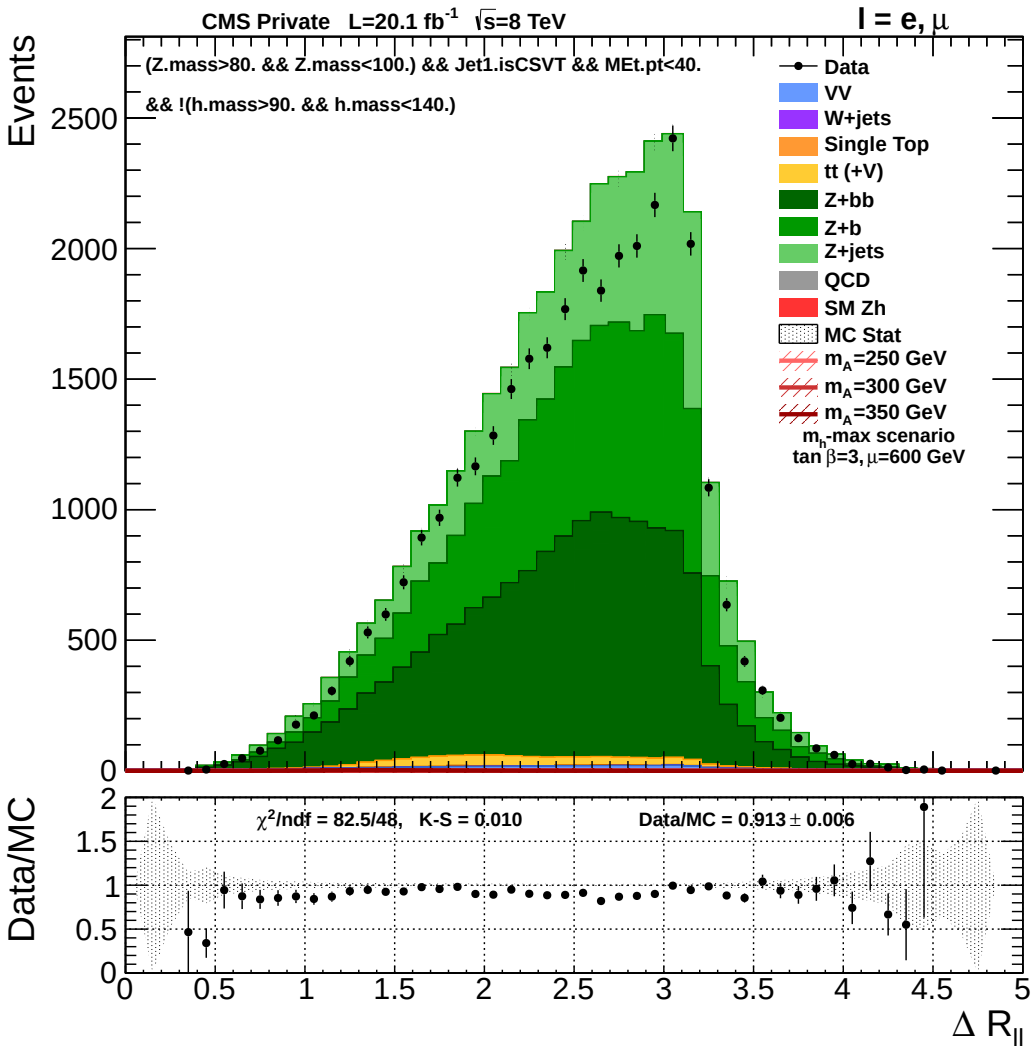
No SF applied (yet)

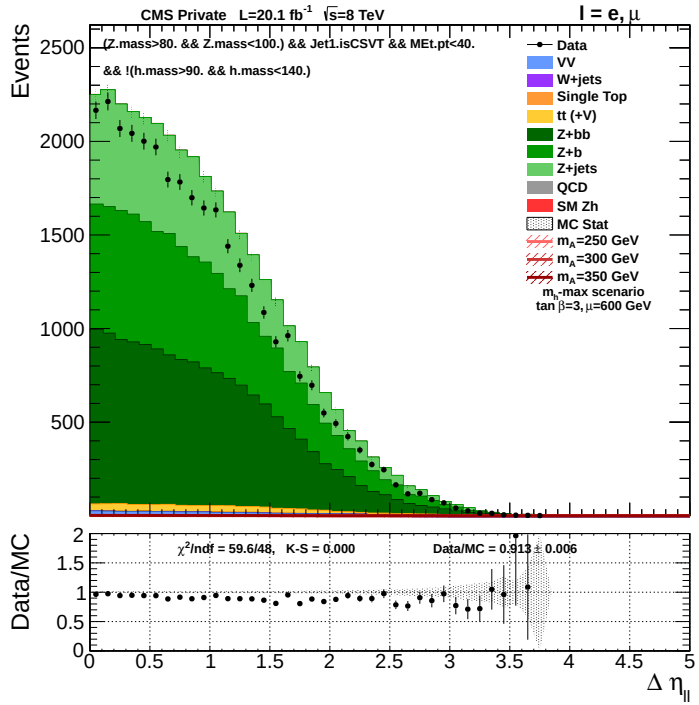
Statistical correlation with Zbb sample!

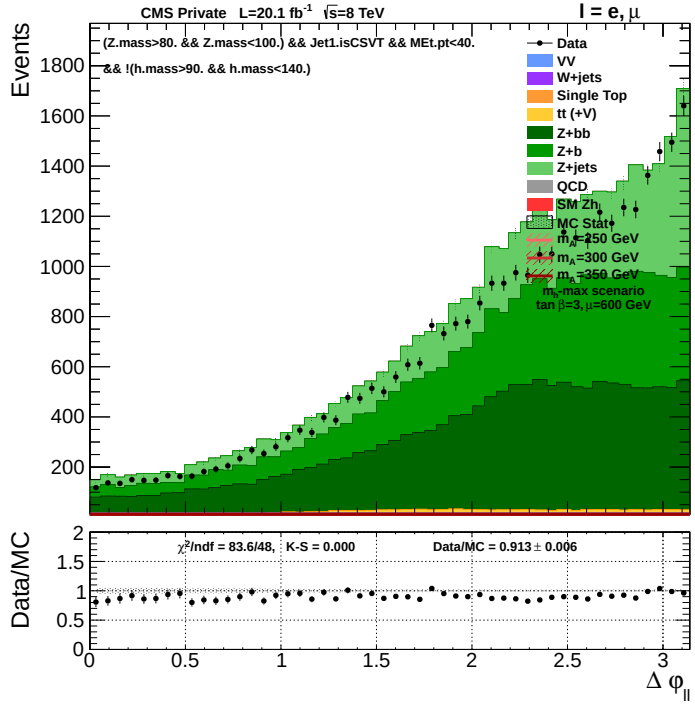
Will try anti b-tag on jet_2.

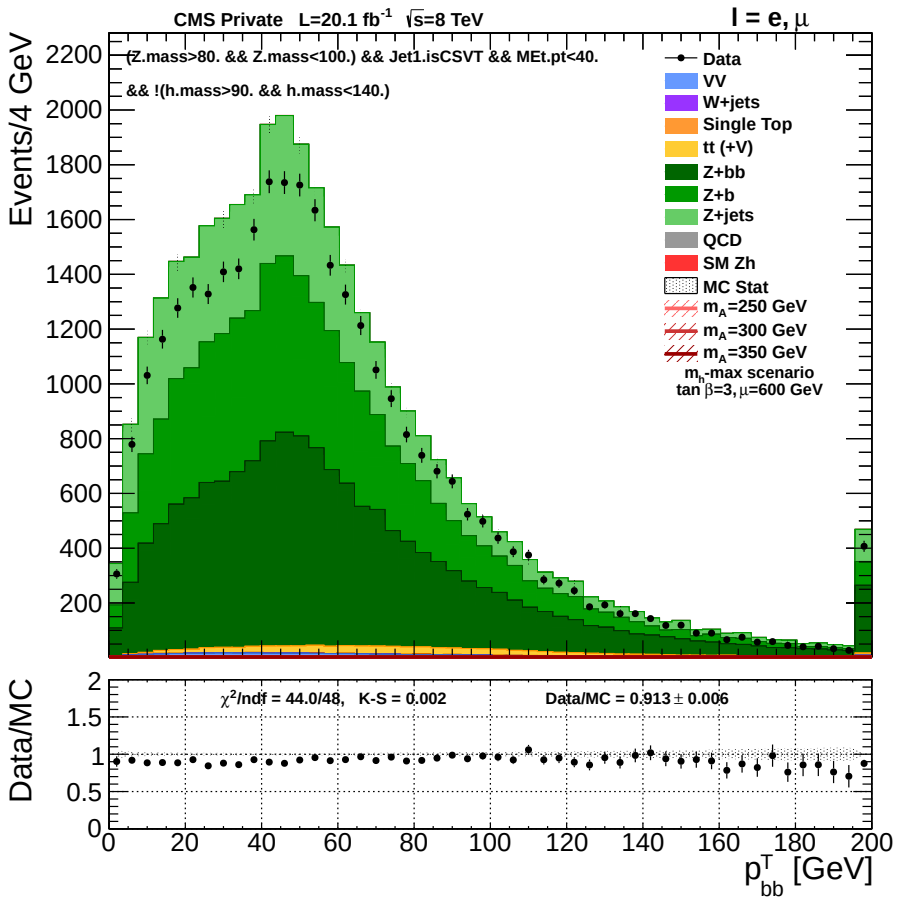

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m_A=250 GeV
m_A=300 GeV
m_A=350 GeV
m_h-max scenario
tan β=3, μ=600 GeV
Events/4 GeV
Data/MC
χ^2/ndf = 92.7/48, K-S = 0.001
Data/MC = 0.913 ± 0.006
Z p_T [GeV]

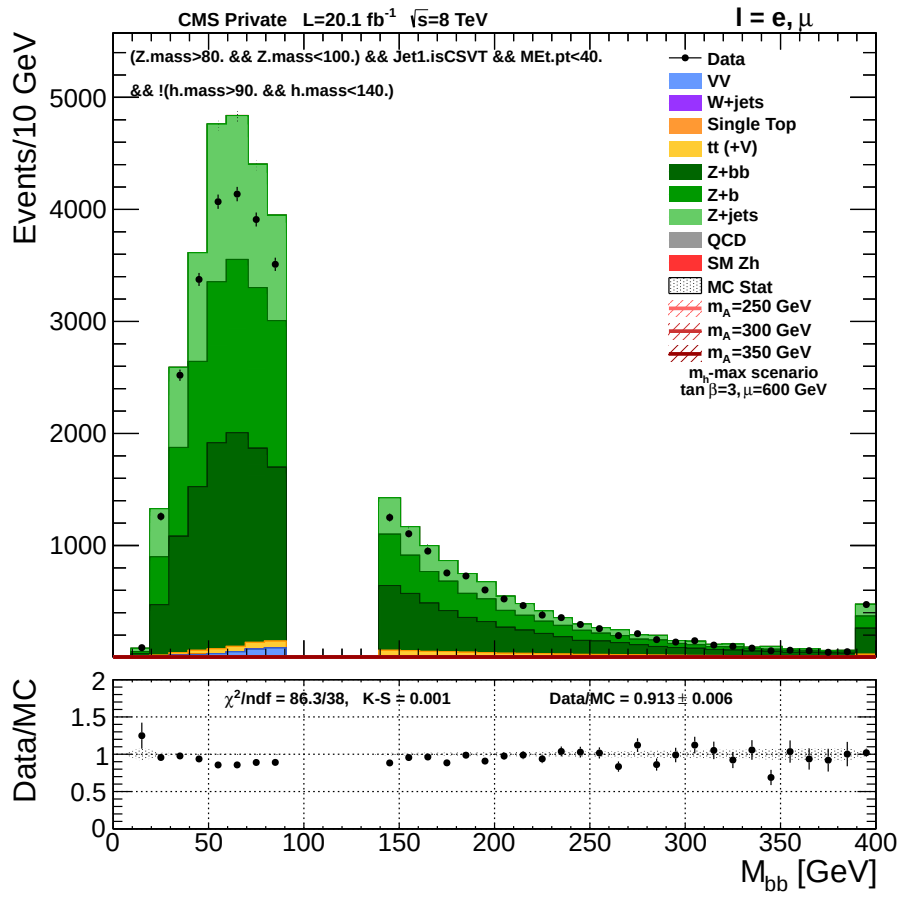

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m_A=250 GeV
m_A=300 GeV
m_A=350 GeV
m_h-max scenario
tan β=3, μ=600 GeV
Events/0 GeV
Data/MC
χ^2/ndf = 104.2/38, K-S = 0.000
Data/MC = 0.913 ± 0.006
M_Z [GeV]

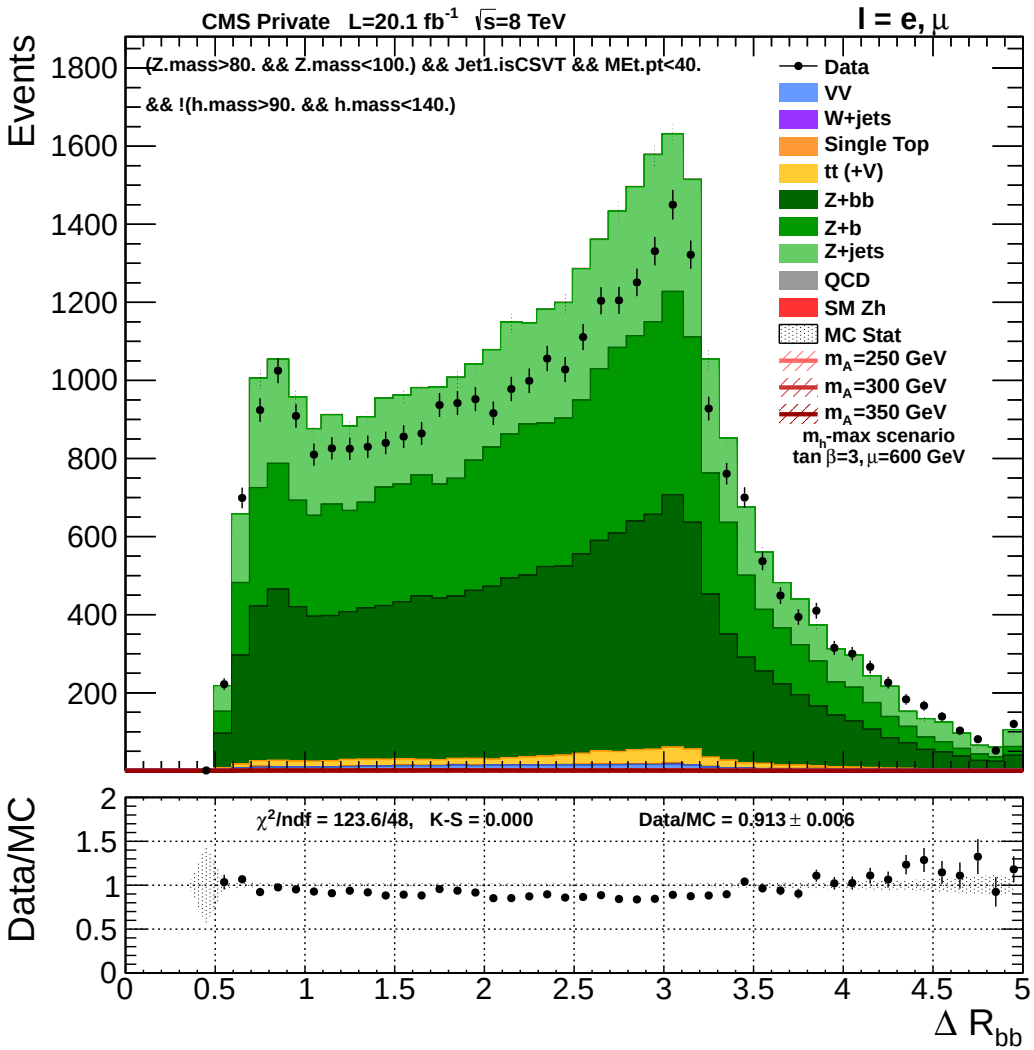

CMS Private L=20.1 fb-1 √s=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
mA=250 GeV
mA=300 GeV
mA=350 GeV
mh-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ2/ndf = 82.5/48, K-S = 0.010
Data/MC = 0.913 ± 0.006
Δ RII

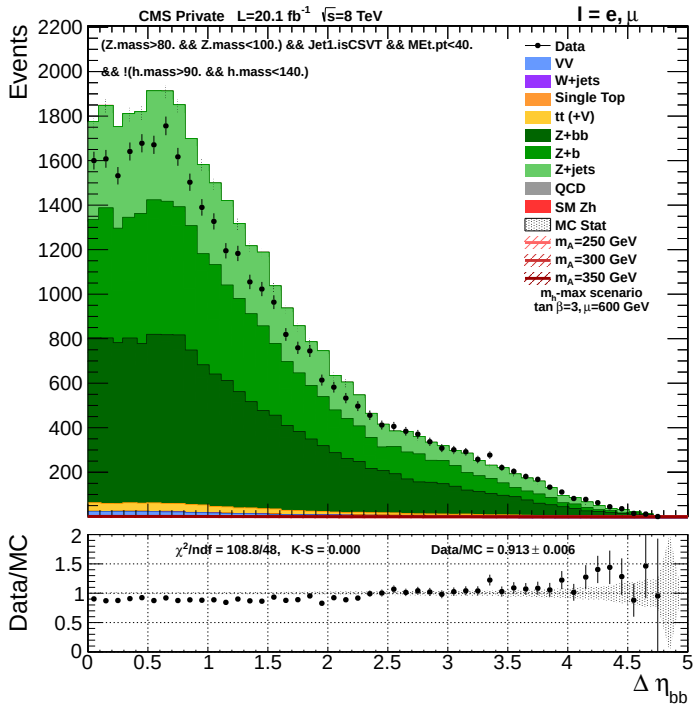

CMS Private L=20.1 fb-1 √s=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
mA=250 GeV
mA=300 GeV
mA=350 GeV
mh-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ2/ndf = 59.6/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ ηII

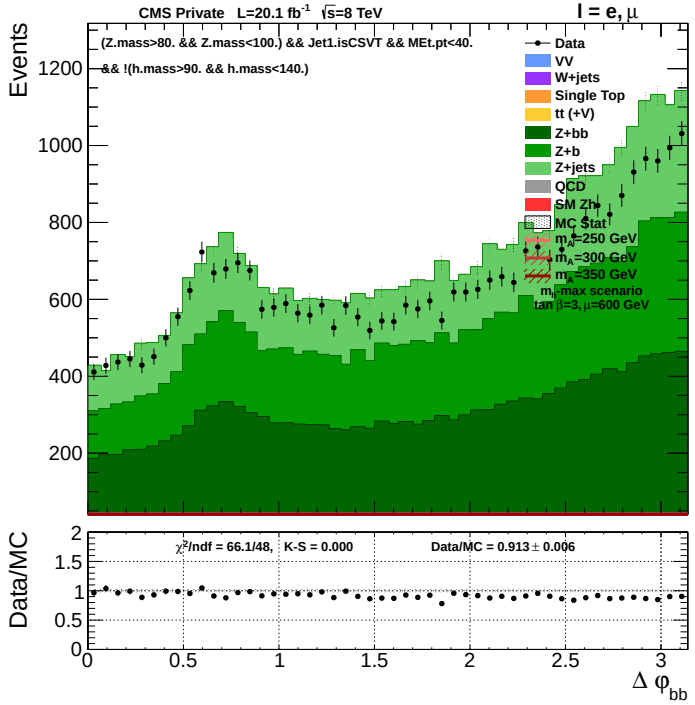

CMS Private L=20.1 fb-1 √s=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
mA=250 GeV
mA=300 GeV
mA=350 GeV
mh-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ2/ndf = 83.6/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ φII

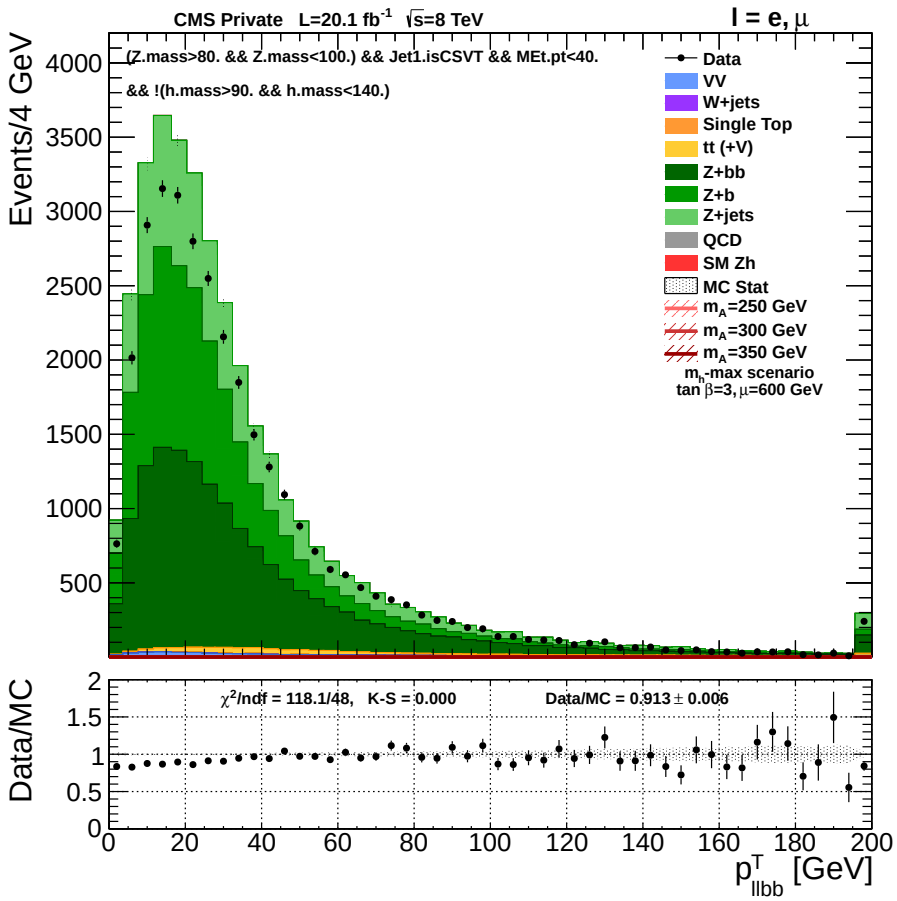

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m_A=250 GeV
m_A=300 GeV
m_A=350 GeV
m_h-max scenario
tan β=3, μ=600 GeV
Events/4 GeV
Data/MC
χ^2/ndf = 44.0/48, K-S = 0.002
Data/MC = 0.913 ± 0.006
p^T_{bb} [GeV]

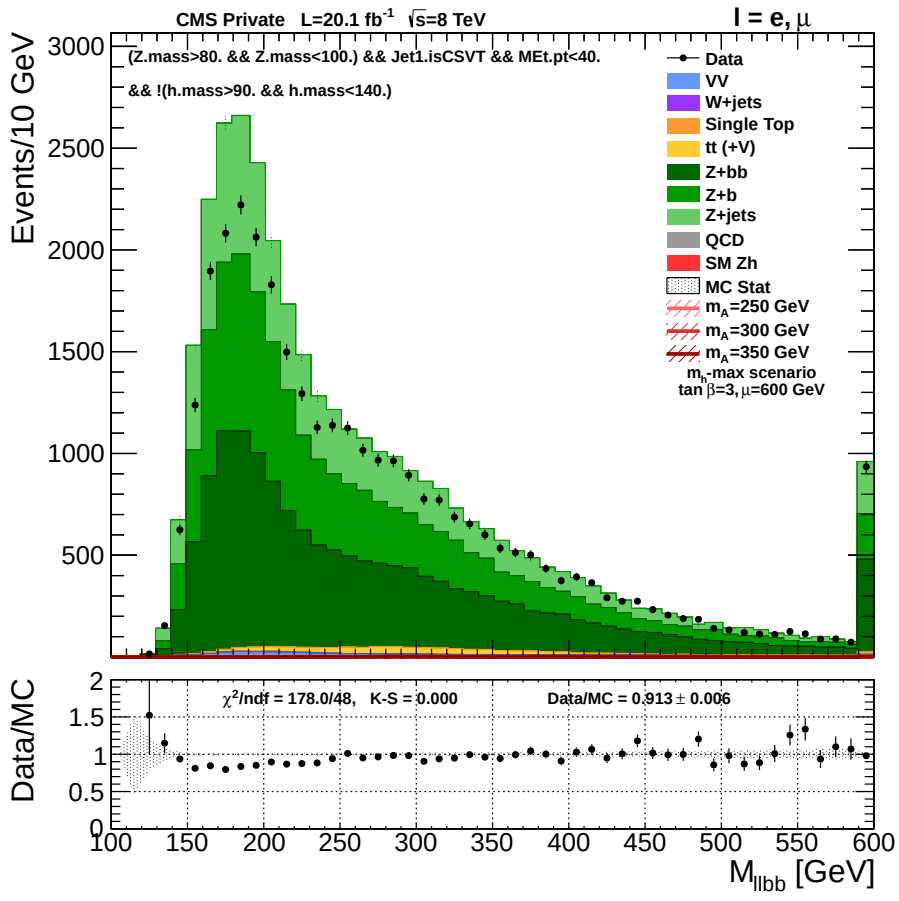

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m_A=250 GeV
m_A=300 GeV
m_A=350 GeV
m_h-max scenario
tan β=3, μ=600 GeV
Events/10 GeV
Data/MC
χ^2/ndf = 86.3/38, K-S = 0.001
Data/MC = 0.913 ± 0.006
M_{bb} [GeV]

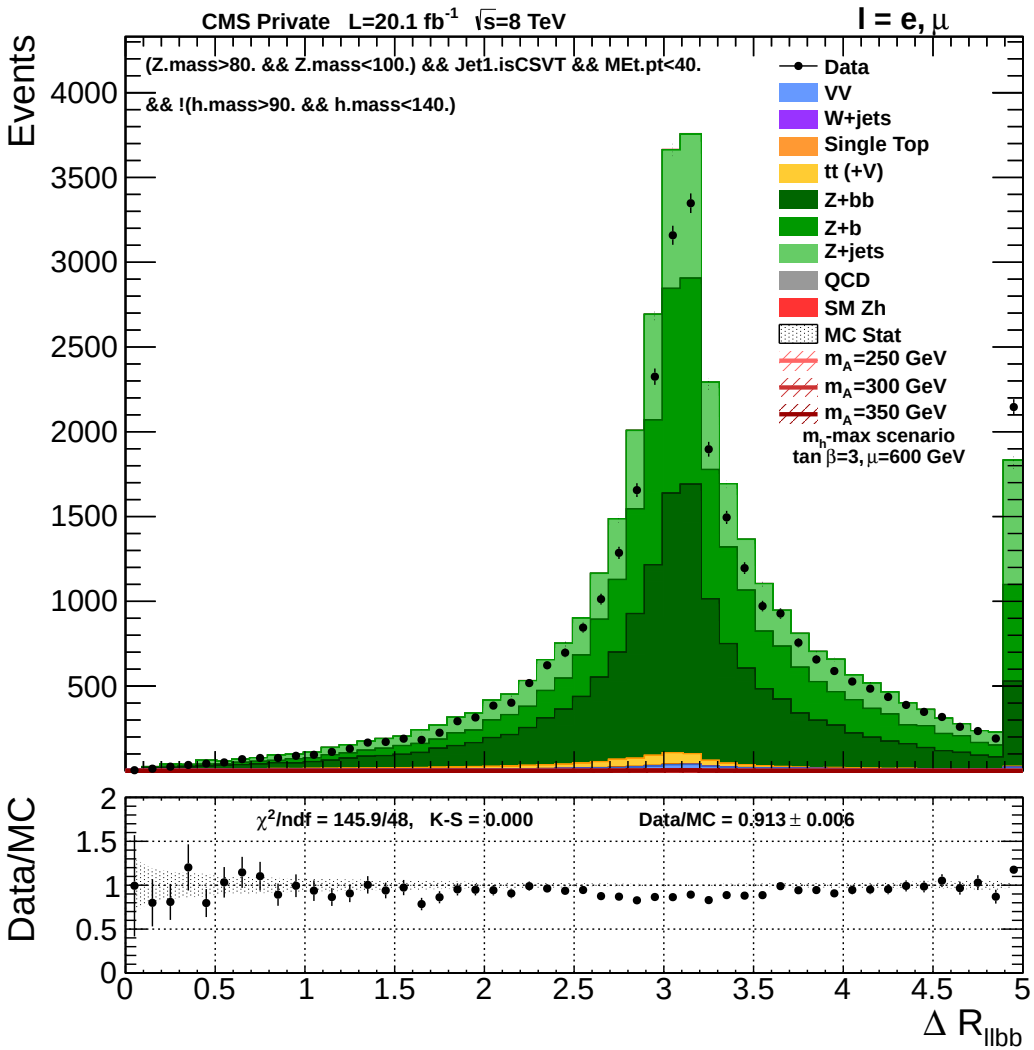

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ^2/ndf = 123.6/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ R$_{bb}$

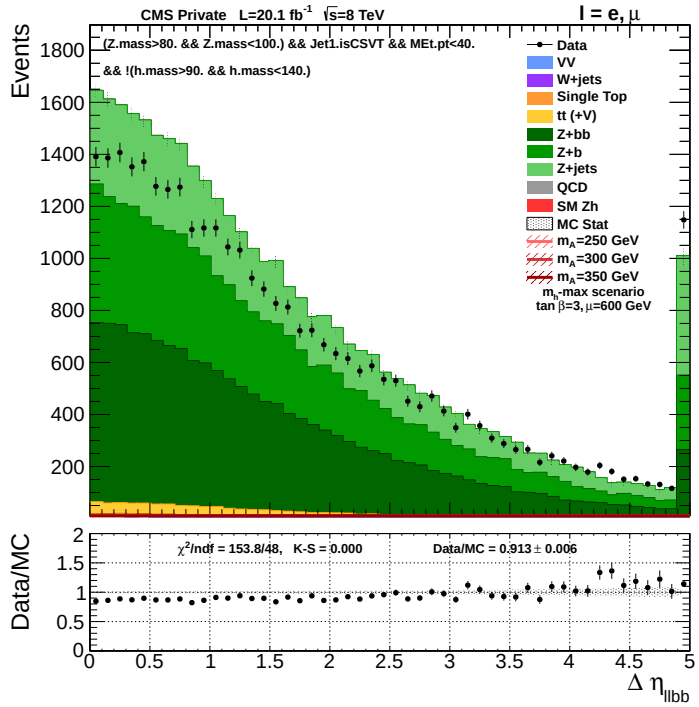

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ^2/ndf = 108.8/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ η$_{bb}$

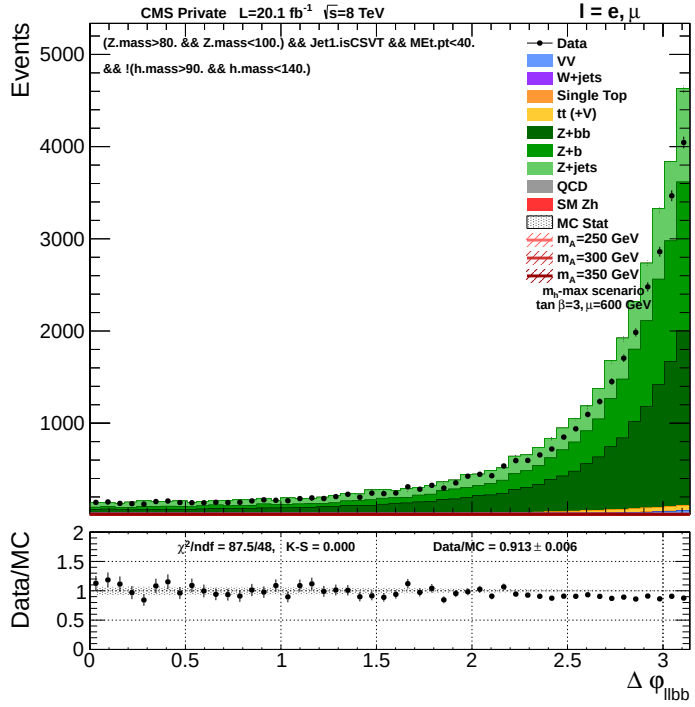

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ^2/ndf = 66.1/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ φ$_{bb}$

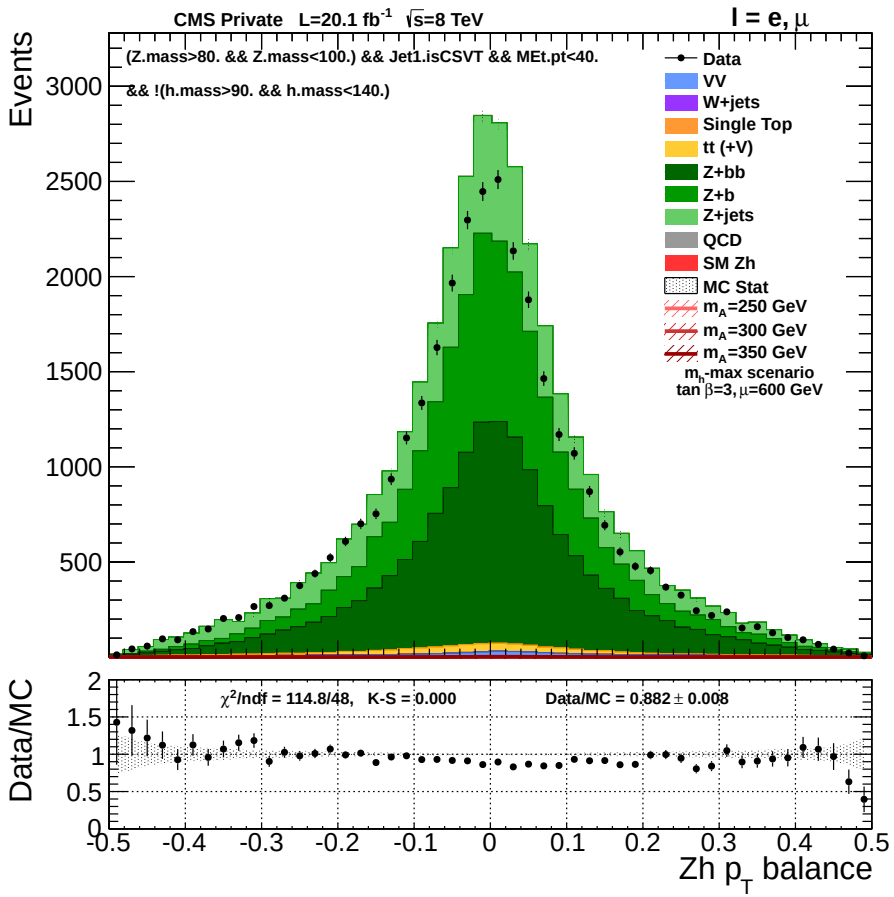

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m_A=250 GeV
m_A=300 GeV
m_A=350 GeV
m_h-max scenario
tan β=3, μ=600 GeV
Events/4 GeV
Data/MC
χ^2/ndf = 118.1/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
p^T_{llbb} [GeV]

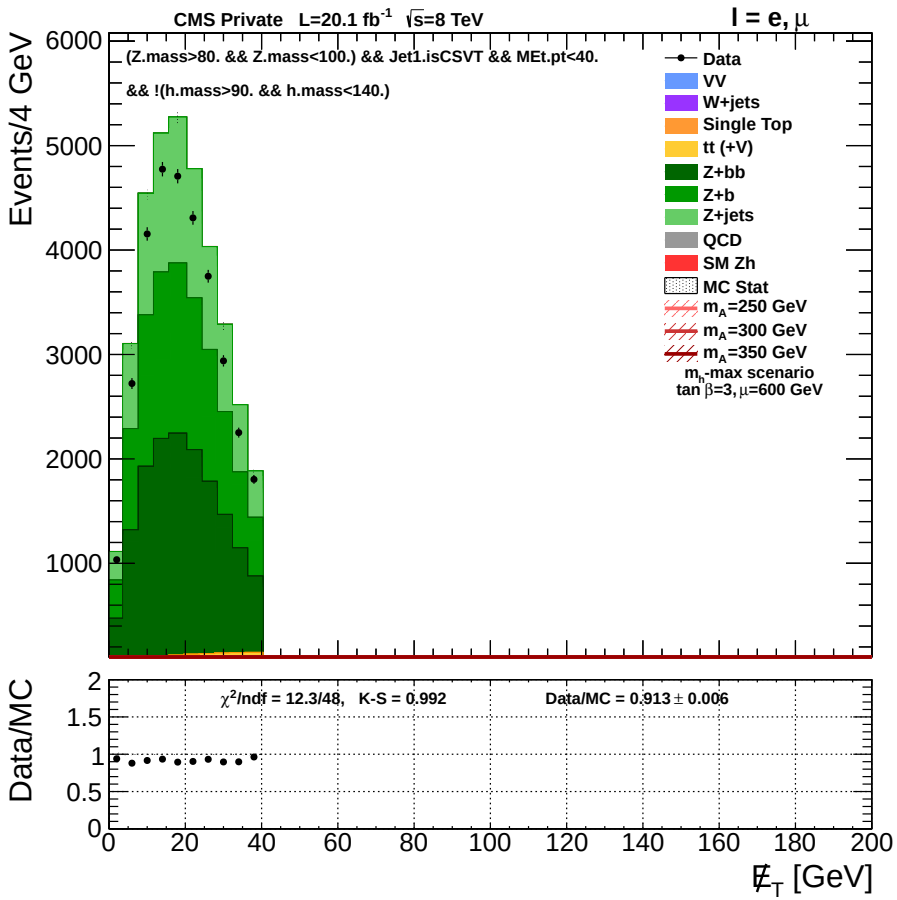

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m_A=250 GeV
m_A=300 GeV
m_A=350 GeV
m_h-max scenario
tan β=3, μ=600 GeV
Events/10 GeV
Data/MC
χ^2/ndf = 178.0/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
M_{llbb} [GeV]

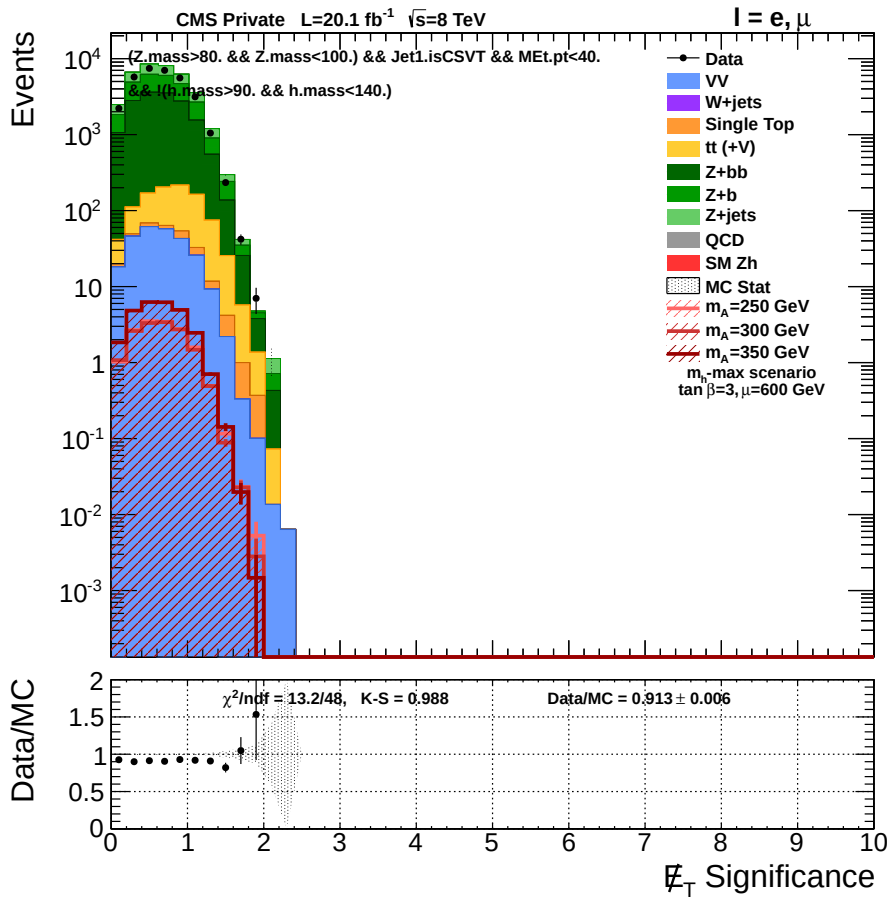

CMS Private L=20.1 fb-1 √s=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
mA=250 GeV
mA=300 GeV
mA=350 GeV
mh-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ2/ndf = 145.9/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ Rllbb

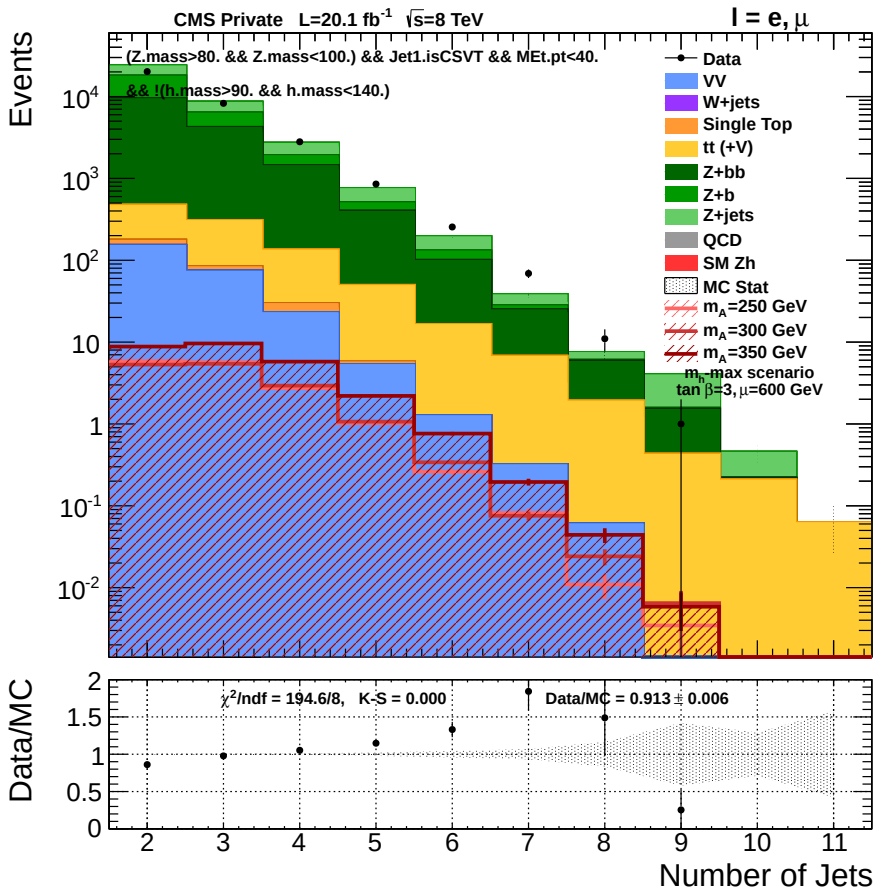

CMS Private L=20.1 fb-1 √s=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
mA=250 GeV
mA=300 GeV
mA=350 GeV
mh-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ2/ndf = 153.8/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ ηllbb

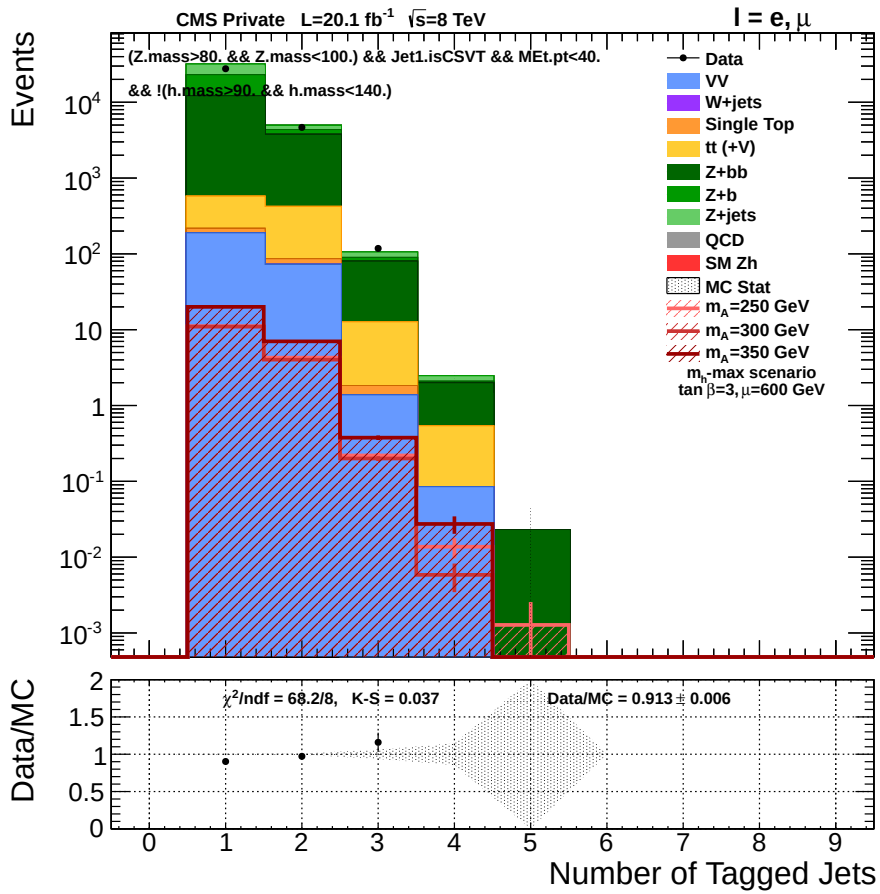

CMS Private L=20.1 fb-1 √s=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
mA=250 GeV
mA=300 GeV
mA=350 GeV
mh-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ2/ndf = 87.5/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
Δ φllbb

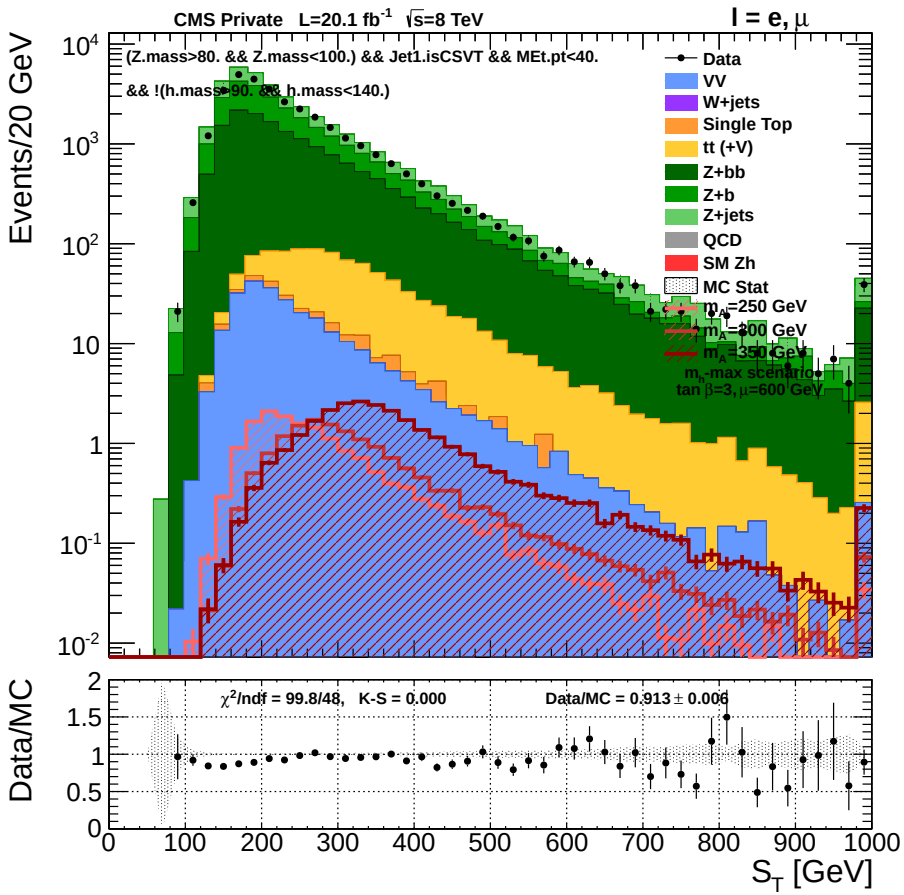

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ^2/ndf = 114.8/48, K-S = 0.000
Data/MC = 0.882 ± 0.008
Zh p$_T$ balance

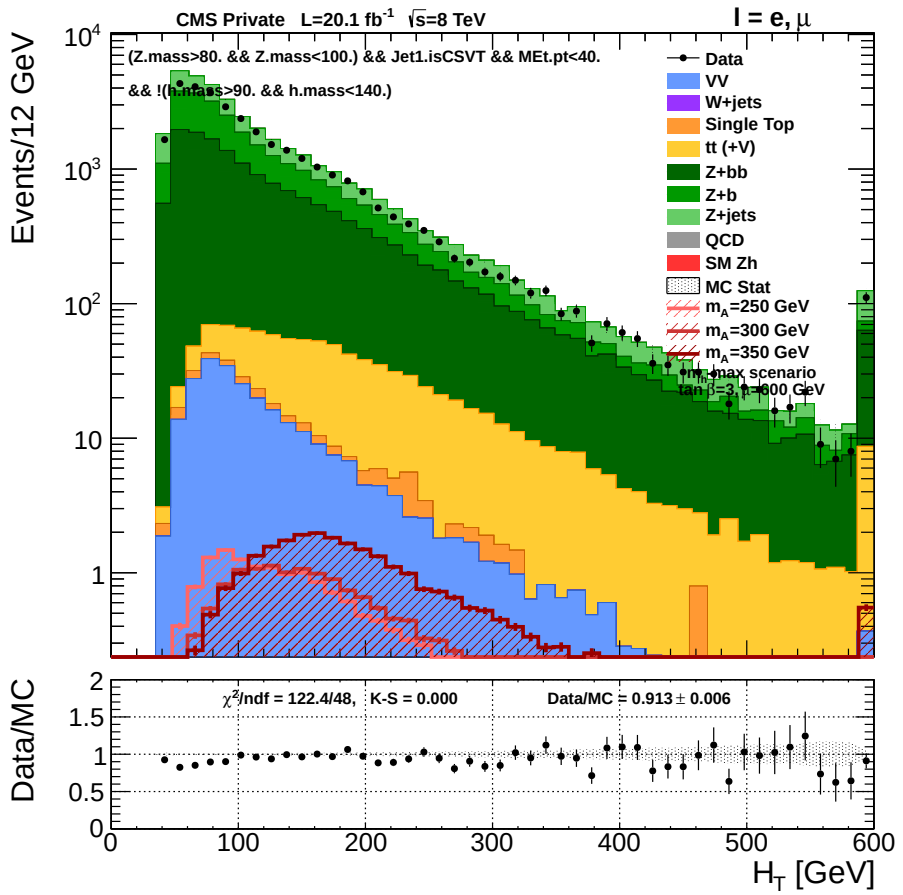

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events/4 GeV
Data/MC
χ^2/ndf = 12.3/48, K-S = 0.992
Data/MC = 0.913 ± 0.006
$\not{E}_T$ [GeV]


CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MEt.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ^2/ndf = 13.2/48, K-S = 0.988
Data/MC = 0.913 ± 0.006
$\not{E}_T$ Significance

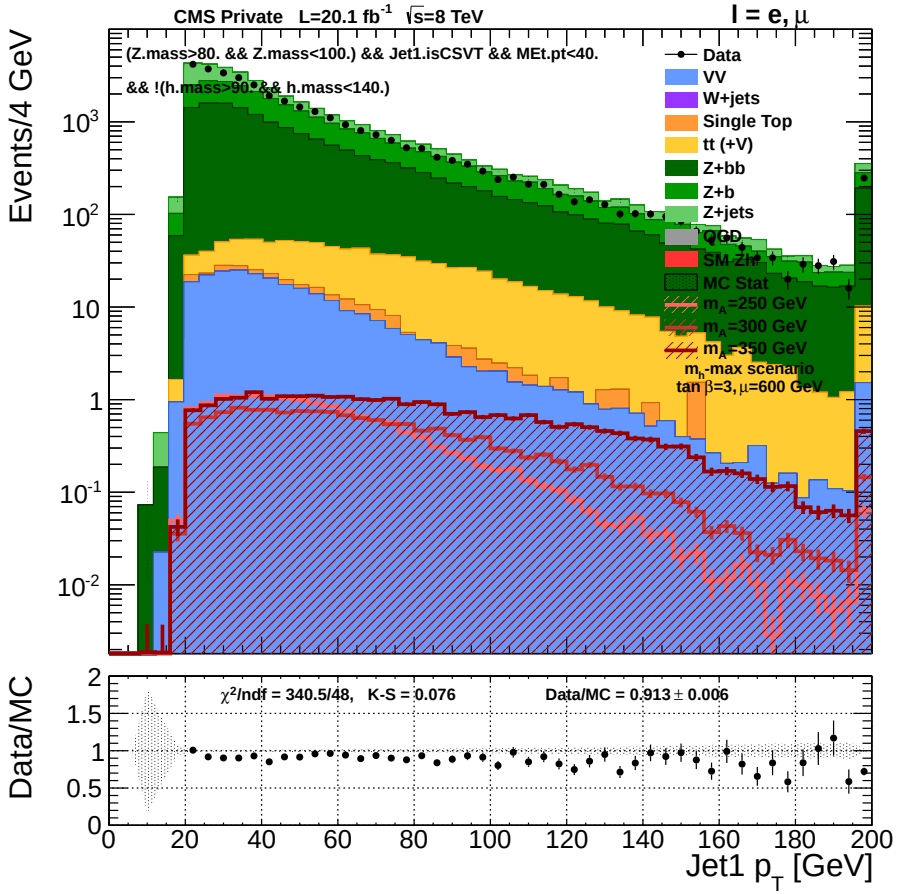

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ^2/ndf = 194.6/8, K-S = 0.000
Data/MC = 0.913 ± 0.006
Number of Jets

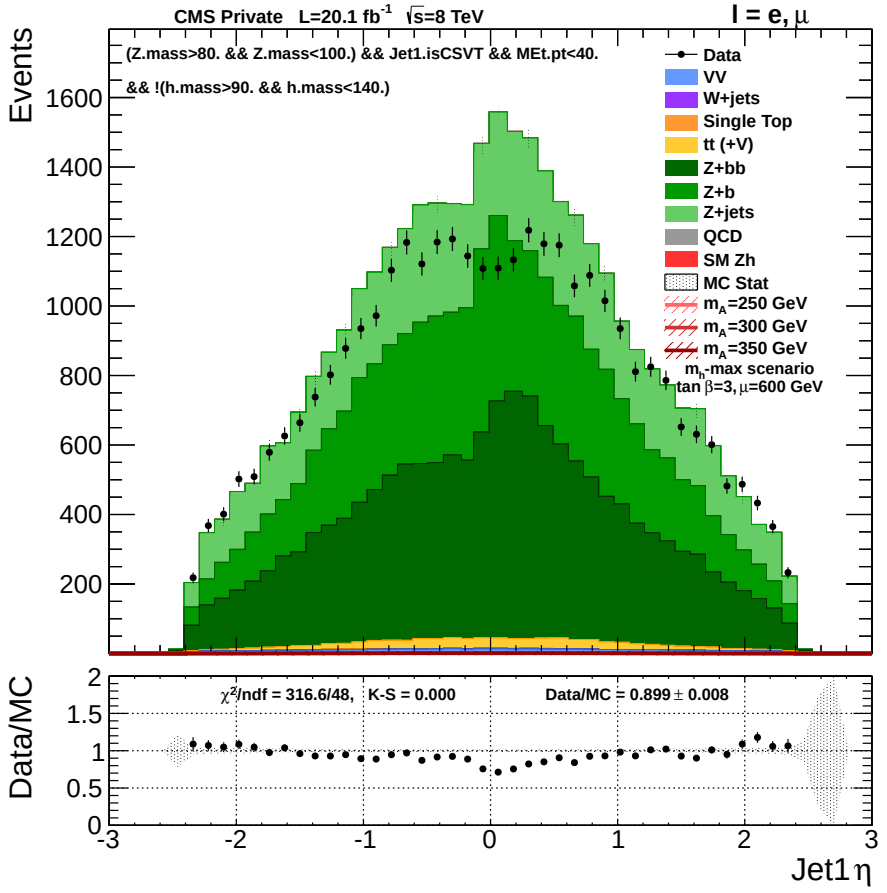

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events
Data/MC
χ^2/ndf = 68.2/8, K-S = 0.037
Data/MC = 0.913 ± 0.006
Number of Tagged Jets


CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events/20 GeV
Data/MC
χ^2/ndf = 99.8/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
S$_T$ [GeV]

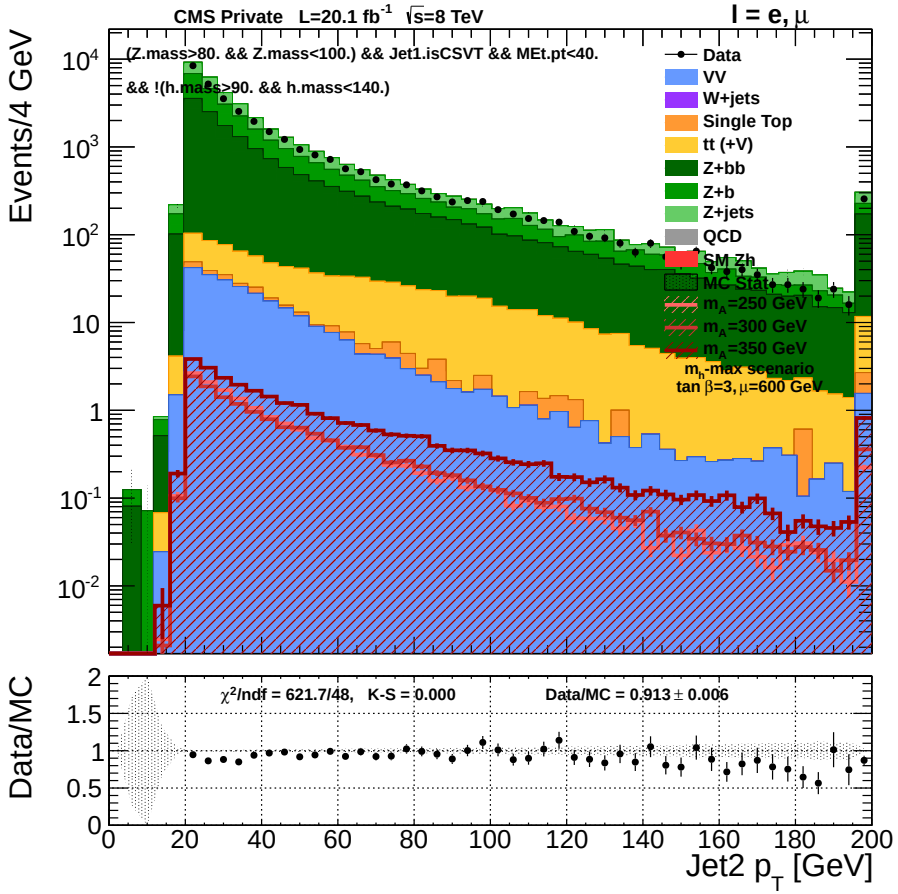

CMS Private L=20.1 fb^{-1} $\sqrt{s}$=8 TeV
l = e, μ
(Z.mass>80. && Z.mass<100.) && Jet1.isCSVT && MET.pt<40.
&& !(h.mass>90. && h.mass<140.)
Data
VV
W+jets
Single Top
tt (+V)
Z+bb
Z+b
Z+jets
QCD
SM Zh
MC Stat
m$_A$=250 GeV
m$_A$=300 GeV
m$_A$=350 GeV
m$_h$-max scenario
tan β=3, μ=600 GeV
Events/12 GeV
Data/MC
χ^2/ndf = 122.4/48, K-S = 0.000
Data/MC = 0.913 ± 0.006
H$_T$ [GeV]

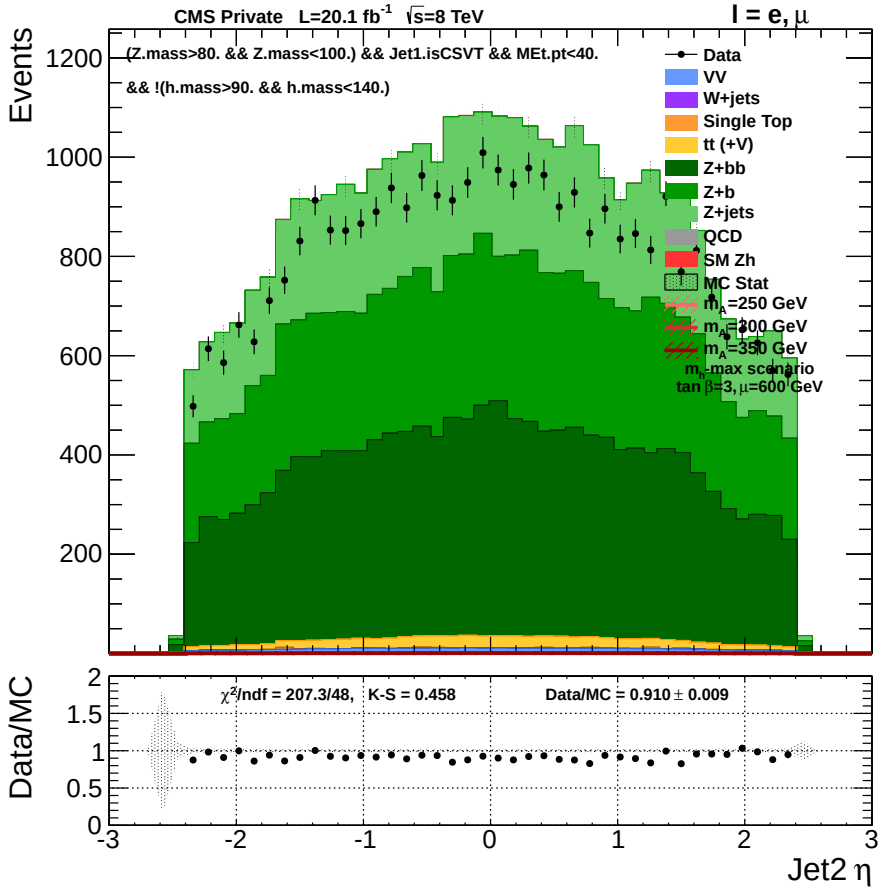
Highest CSV Jet





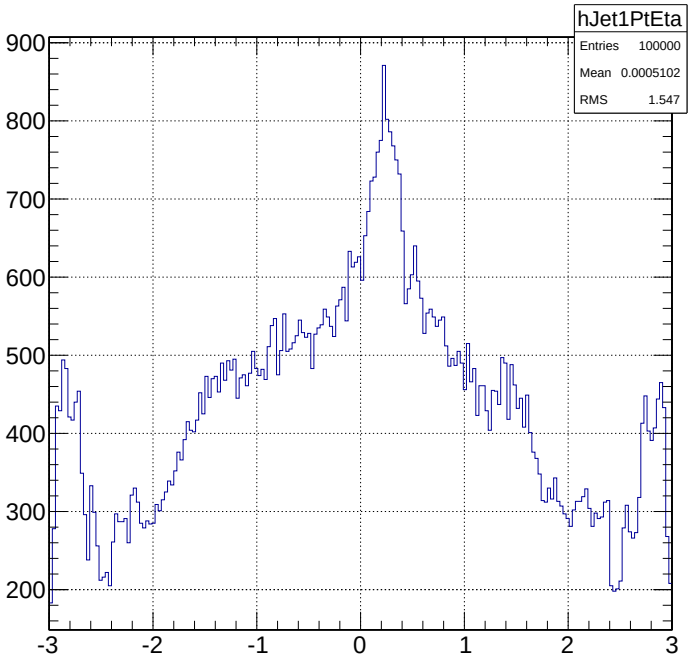
Second highest CSV Jet



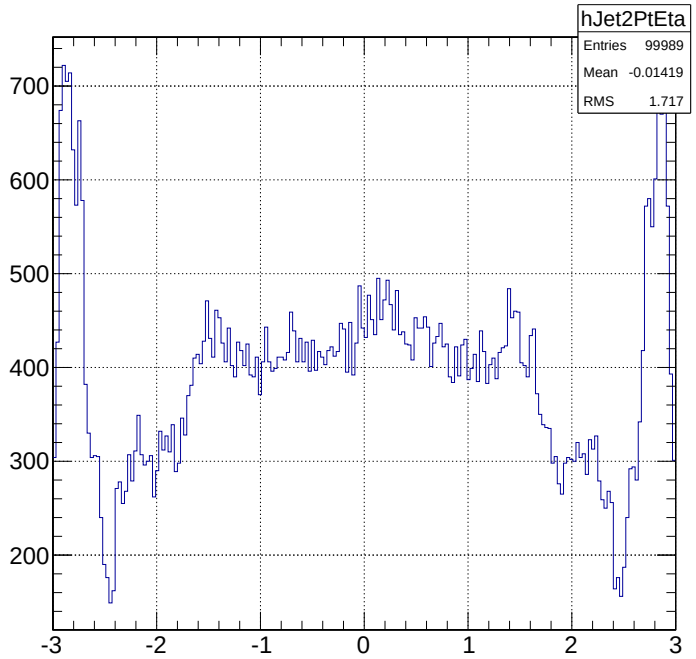


Leading and sub-leading (in Pt) jets for Zbb dataset

Leading Jet η

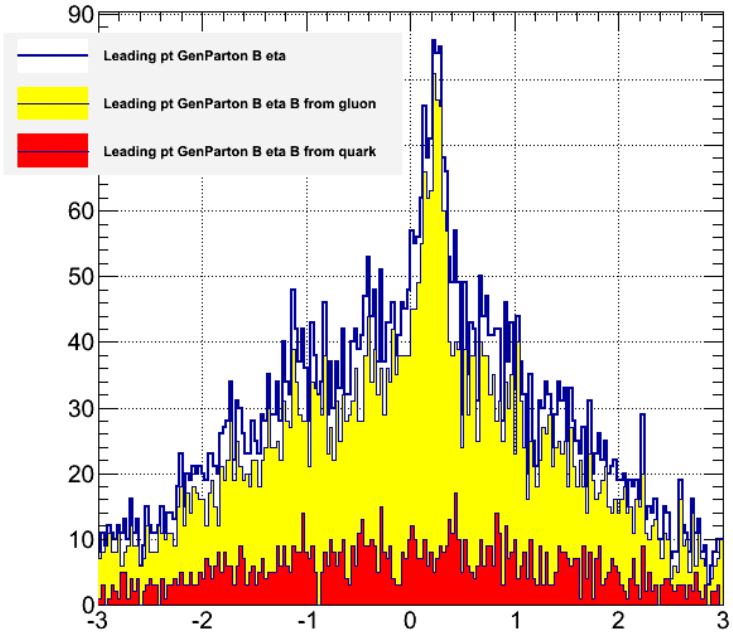


SubLeading Jet η

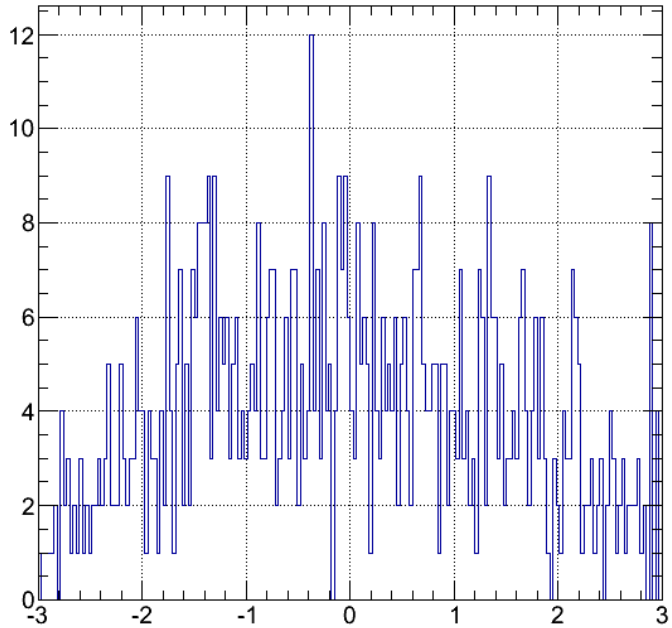


GenParticle B from Zbb dataset

Leading B parton η



Sub-Leading B parton η



Shown separately for $gg \rightarrow Zbb$ and $qq \rightarrow Zbb$

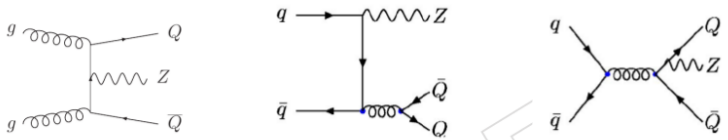
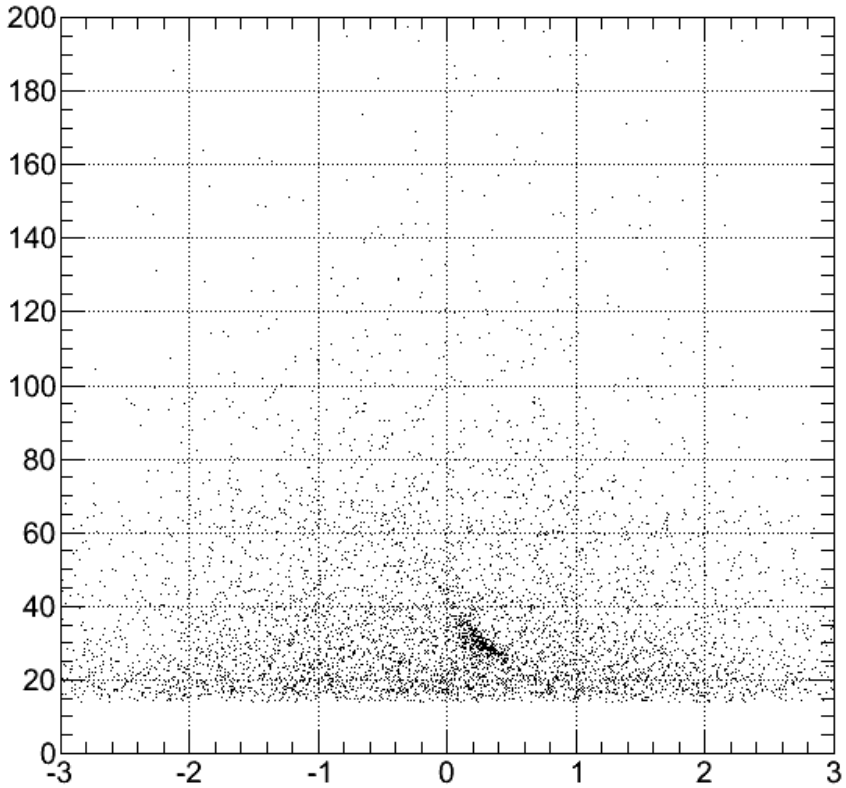
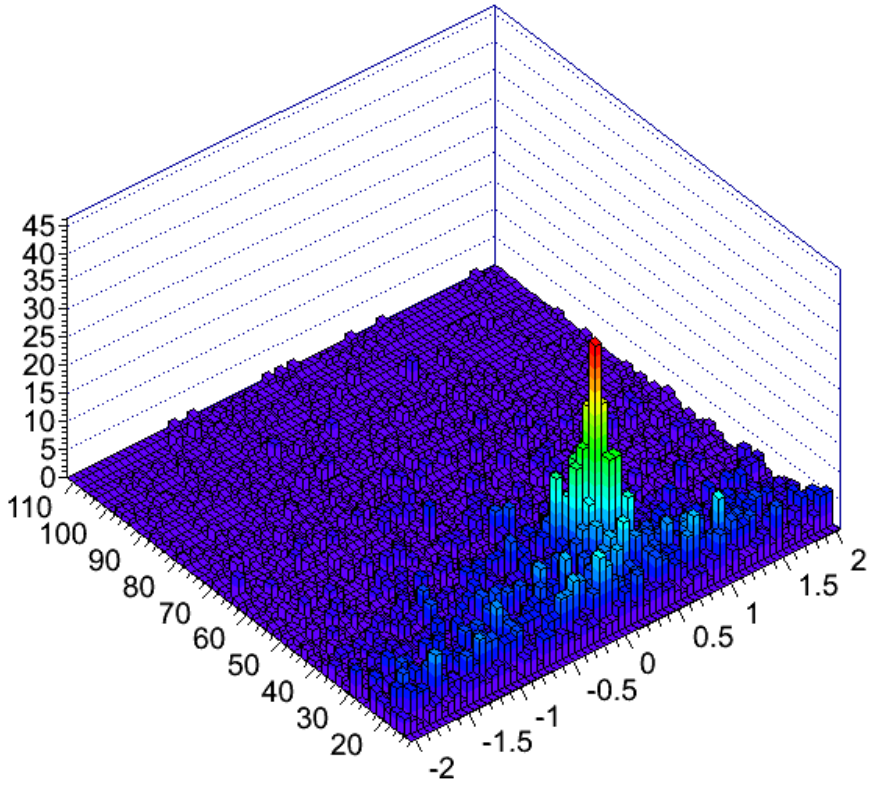


Figure 1: $q\bar{q} \rightarrow ZQQ$ and $gg \rightarrow ZQQ$ processes.

GenParticle B from Zbb dataset

Pt vs Eta





Summary and TODO

Summary

Backup

Backup

Guess what?

Yes!

Backup slides.