

HEP NTUA Weekly Report

3/2/2021

George Bakas



Summary

TTbar analysis:

- Created pipeline to switch to UL files
 - **Ongoing Production (2016 is finished, ongoing 2017 and 2018)**
 - 2016 is divided into preVFP and post VFP
 - All years have *UL 19* and *UL 20* files: which should we use? Some files only with UL19 some only with UL20 and some on both!
 - After production → training
 - Re-do the whole pipeline of the analysis
 - Efficiency, Acceptance, Responses
 - Mass Fit, Ryield, Contamination, Closure Tests
 - Signal Extraction
 - Unfolding
- Systematics
- Combination



Summary

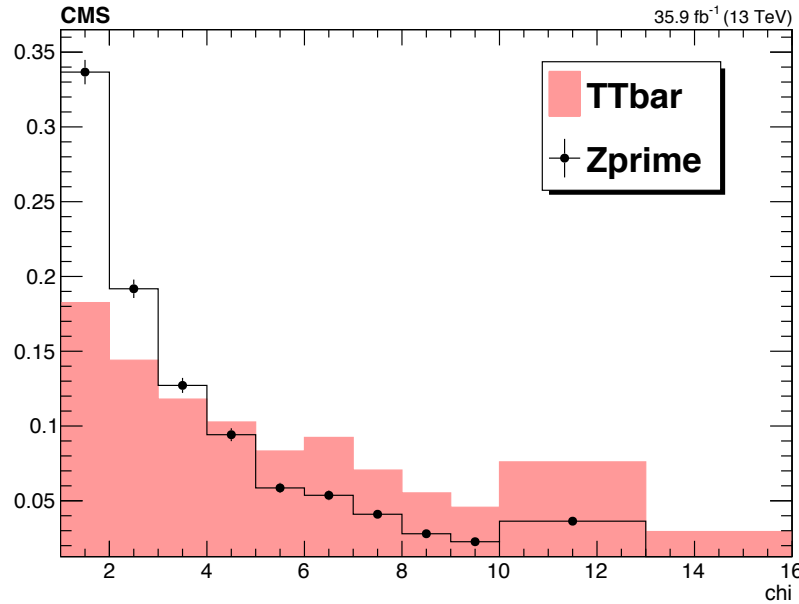
Angular Distributions, Z' analysis:

- Significance plots:
 - 1TeV – 2TeV mJJ Cut every 250GeV
 - Significance vs mJJ Cut for every Zprime mass, width pair
 - Full Run II (2016, 2017, 2018)
 - Search for the maximum significance for every mJJ Cut
- $Significance = \frac{Signal}{\sqrt{Signal+Background}}$, where signal is the Zprime events and bkg \rightarrow ttbar, qcd, subdominant
- In this presentation you have:
 - Sensitivity plots (shape comparison of Z' vs ttbar) for chi dist for 1600 GeV mJJCut \rightarrow slides 3, 4
 - **In BACKUP**
 - Significance for 2000, 2500, 3000 and 4000 GeV Z' masses (1% widths) \rightarrow slide 3
 - Chi distribution asymptotic (Expected) limits vs mJJ Cuts [1000-1800]GeV \rightarrow slide 4
 - Stacked chi (χ) distributions for 2016 Z' 1% widths for 1600 GeV mJJCut \rightarrow slide 5
 - Sensitivity plots (shape comparison of stacks vs Z') for chi dist for 1600 GeV mJJCut \rightarrow slide 7

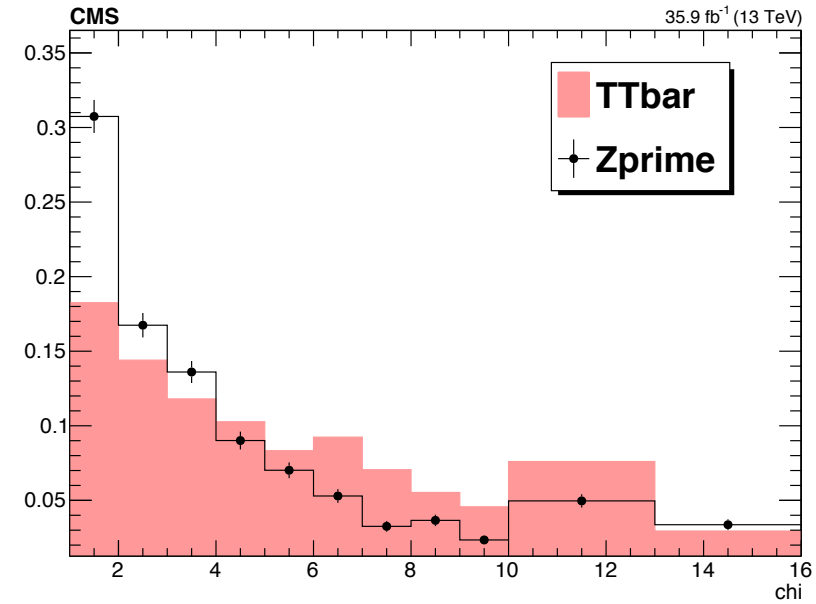


Sensitivity Plots 2016 (Zprime vs ttbar) width 1%

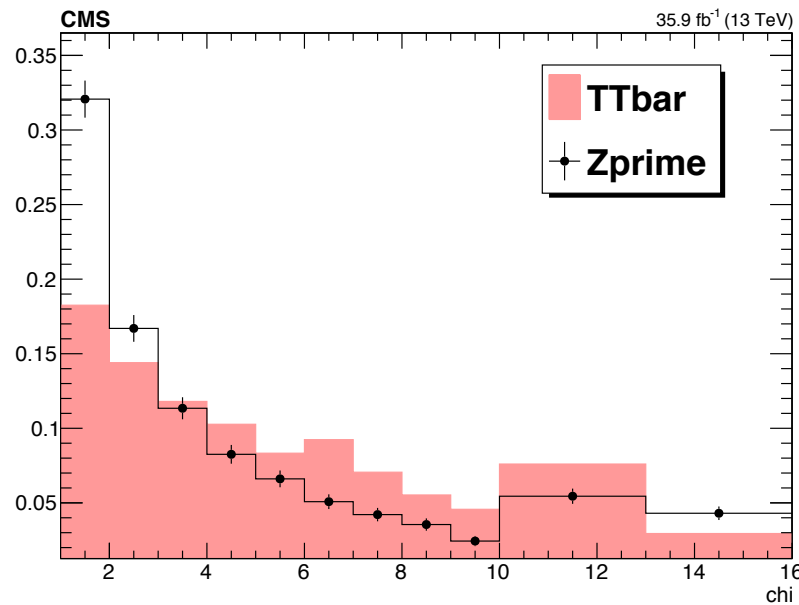
M: 2TeV



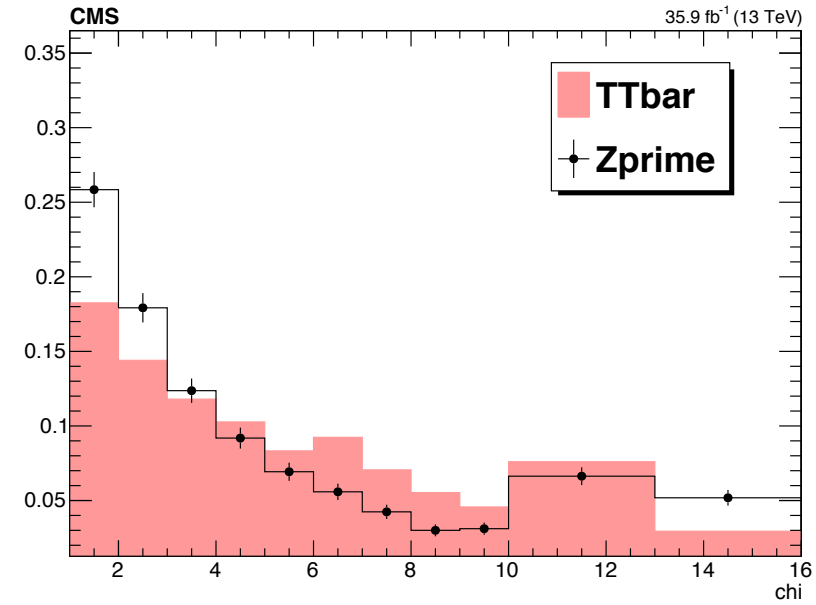
M: 2.5TeV



M: 3TeV

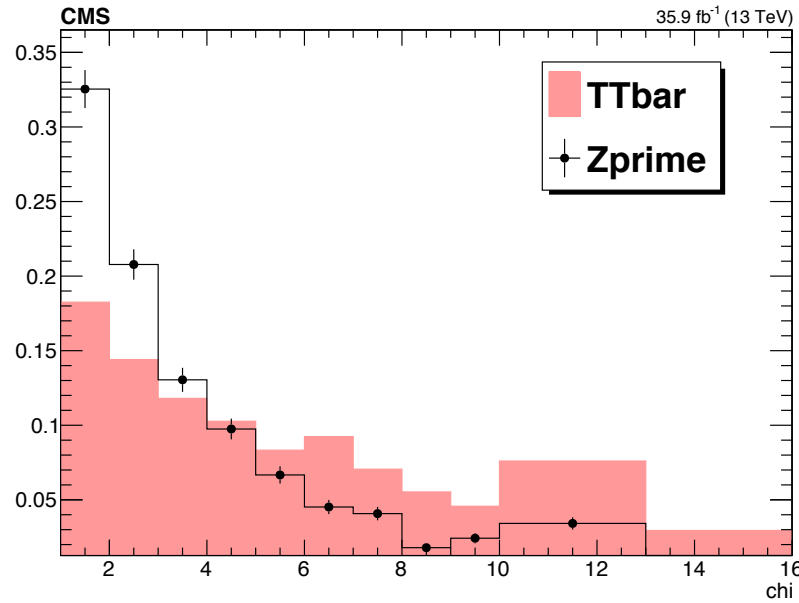


M: 4TeV

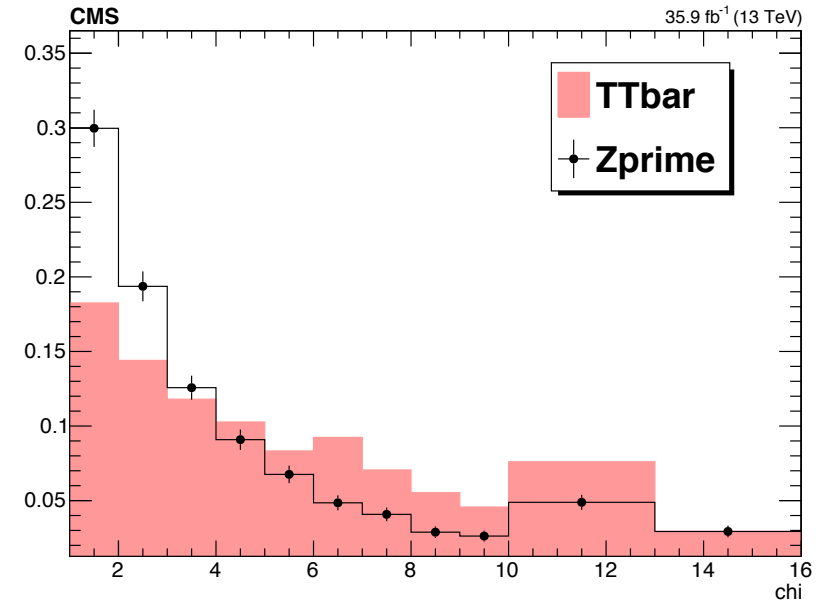


Sensitivity Plots 2016 (Zprime vs ttbar) width 10%

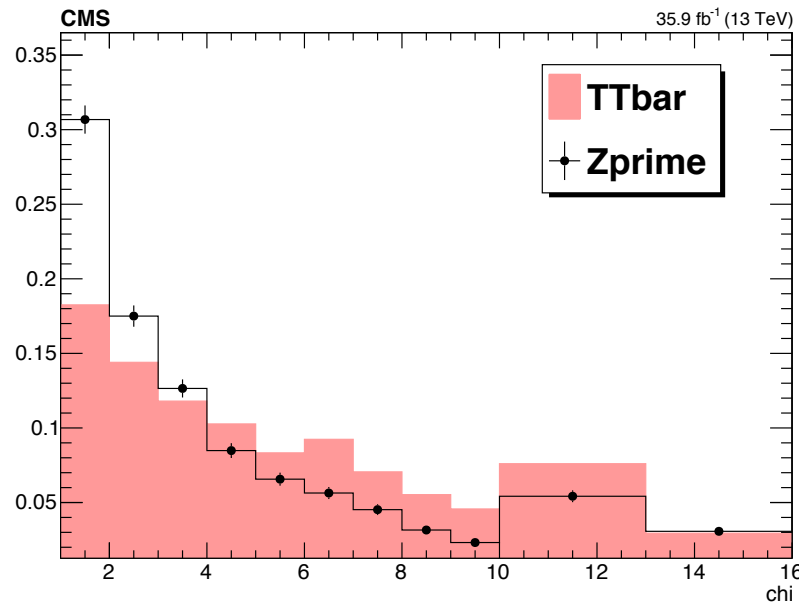
M: 2TeV



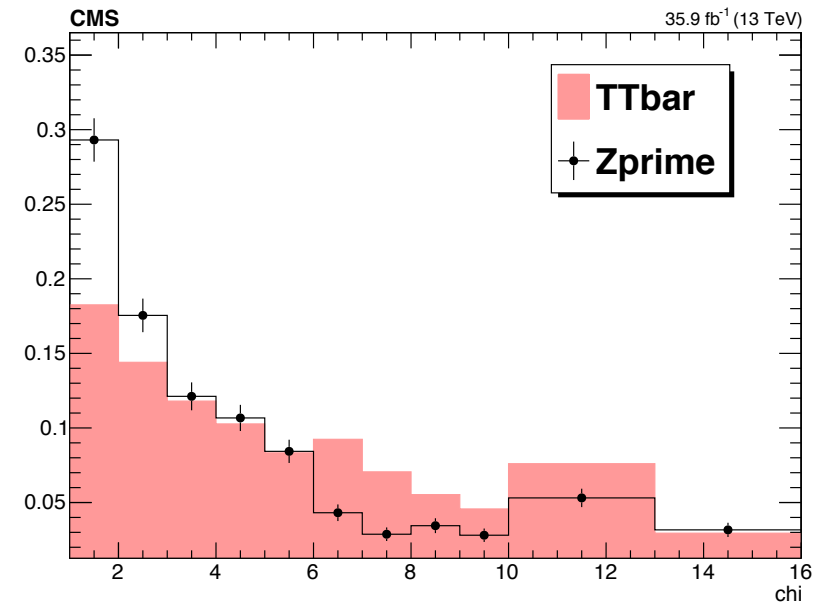
M: 2.5TeV



M: 3TeV



M: 4TeV



BACKUP



Summary

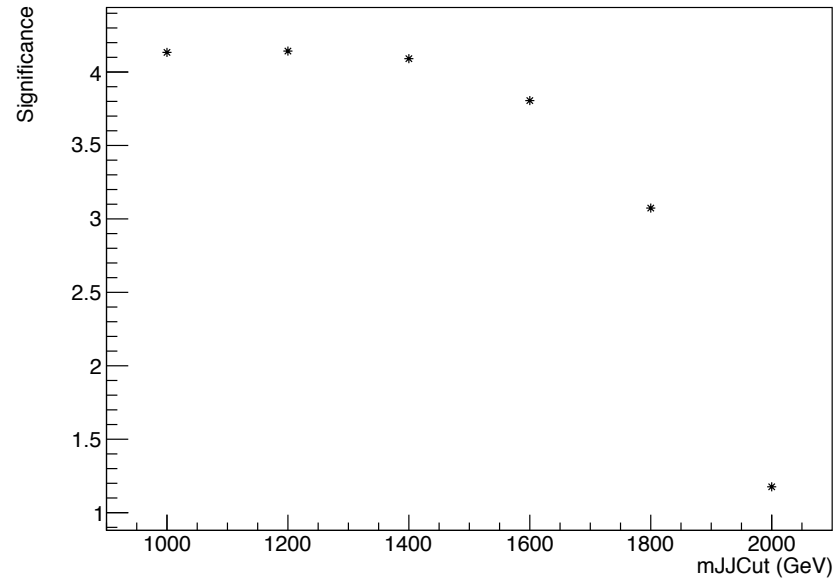
Angular Distributions, Z' analysis:

- Significance plots:
 - 1TeV – 2TeV mJJ Cut every 250GeV
 - Significance vs mJJ Cut for every Zprime mass, width pair
 - Full Run II (2016, 2017, 2018)
 - Search for the maximum significance for every mJJ Cut
- $Significance = \frac{Signal}{\sqrt{Signal+Background}}$, where signal is the Zprime events and bkg \rightarrow ttbar, qcd, subdominant
- In the regard of Expected limits for 2016 in this presentation you have:
 - Significance for 2000, 2500, 3000 and 4000 GeV Z' masses (1% widths) \rightarrow slide 3
 - Chi distribution asymptotic (Expected) limits vs mJJ Cuts [1000-1800]GeV \rightarrow slide 4
 - Stacked chi (χ) distributions for 2016 Z' 1% widths for **1600 GeV** mJJCut \rightarrow slide 5
 - Sensitivity plots (shape comparison of stacks vs Z') for chi dist for **1600 GeV** mJJCut \rightarrow slide 7
 - Sensitivity plots (shape comparison of Z' vs ttbar) for chi dist for 1600 GeV mJJCut \rightarrow slides 3, 4

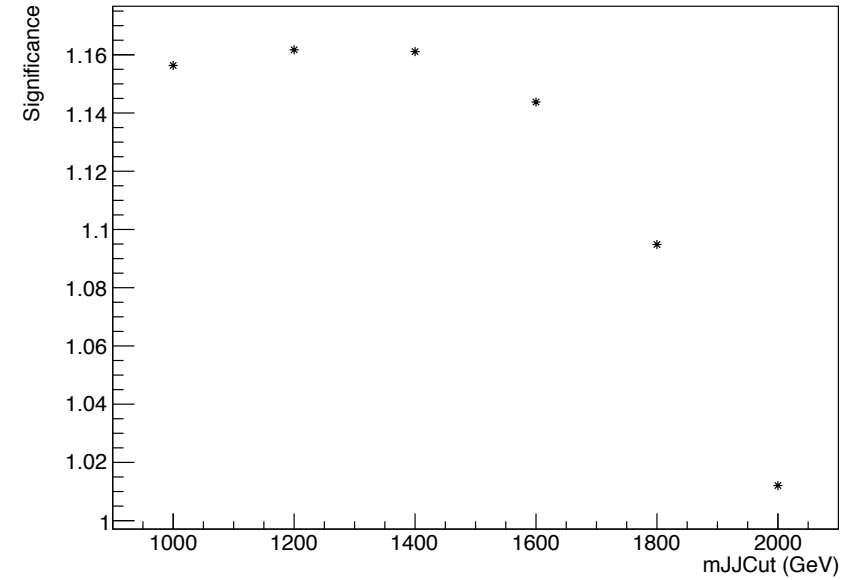


Significance Plots 2016, width 1%

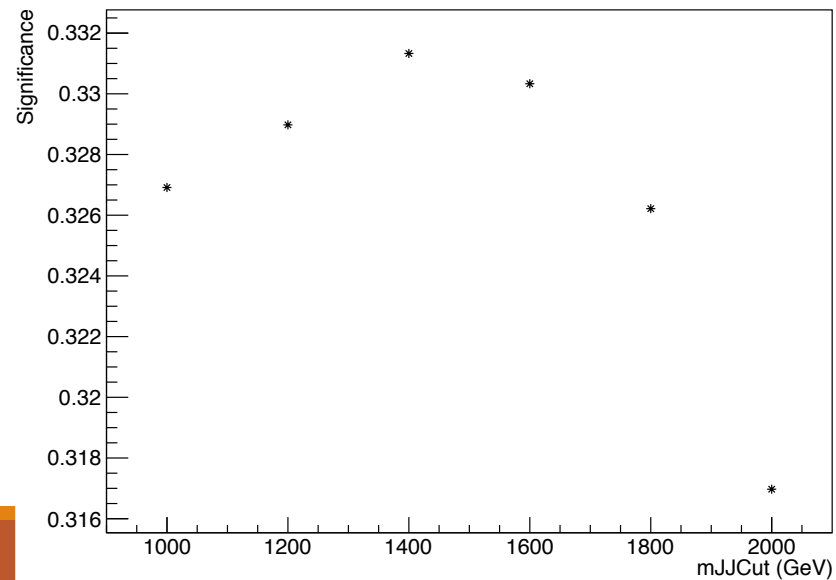
Significance_M2000_W20



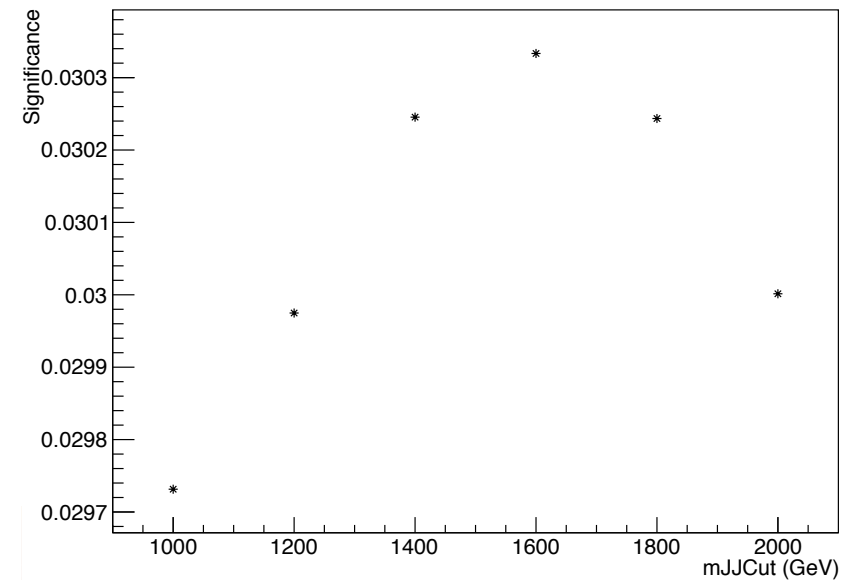
Significance_M2500_W25



Significance_M3000_W30

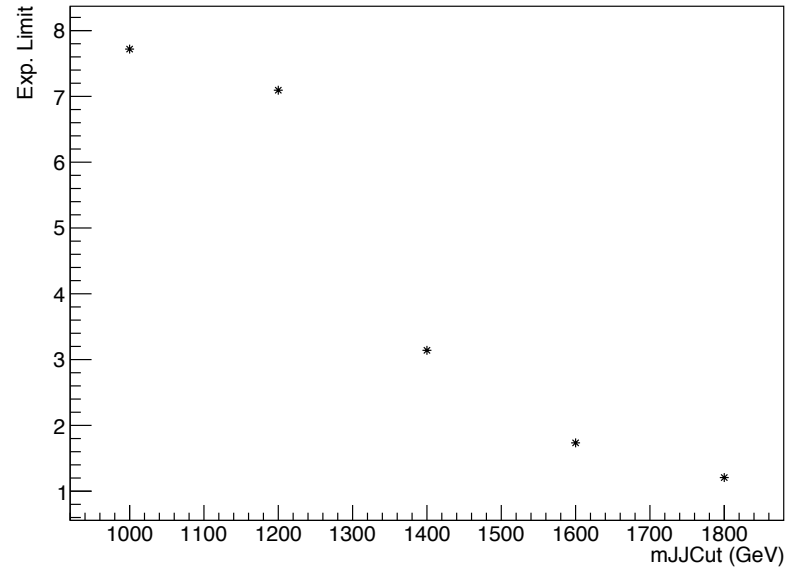


Significance_M4000_W40

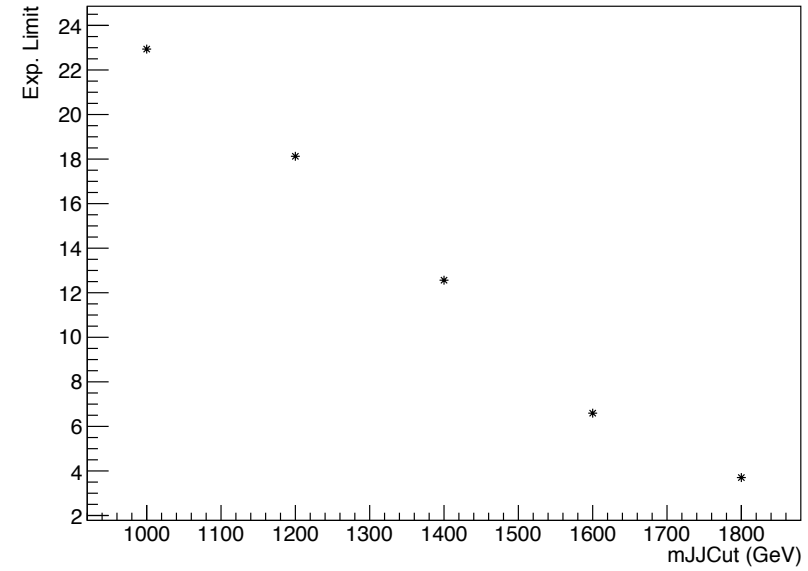


Expected Limit Plots 2016, width 1%

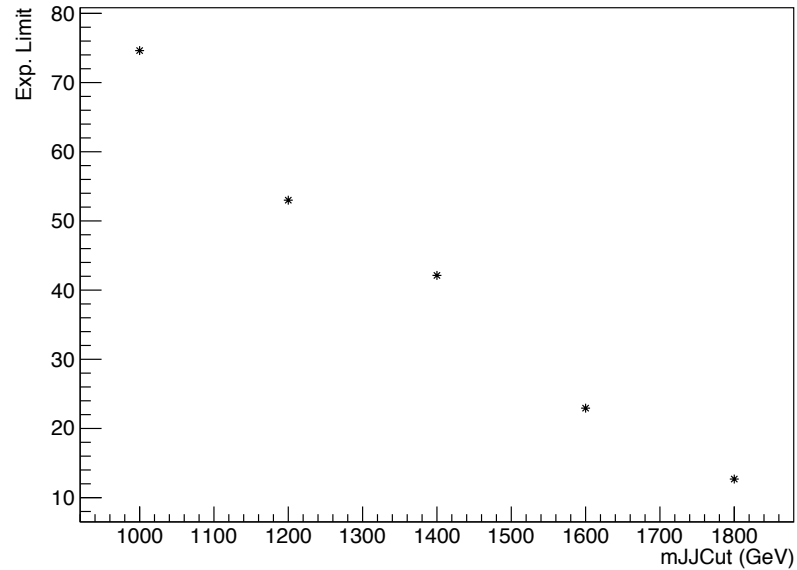
Expected Limits for Z' (M:2000, W:20)



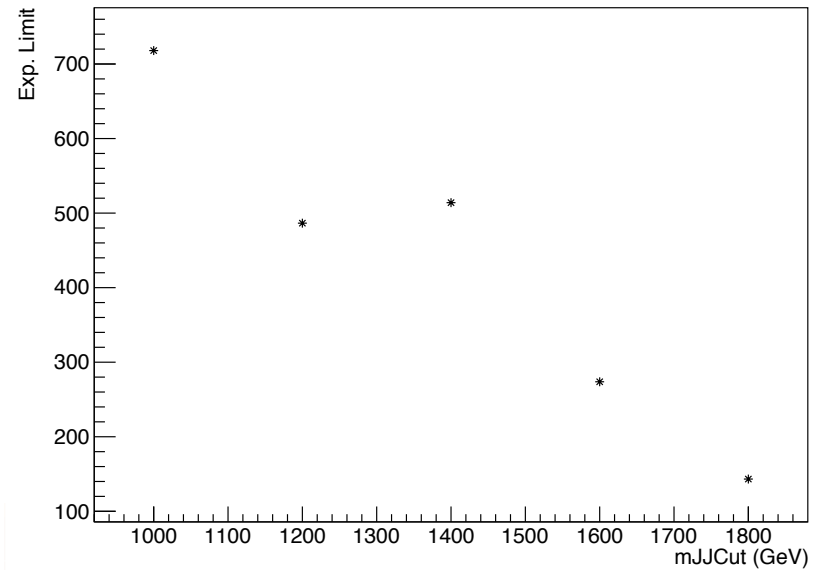
Expected Limits for Z' (M:2500, W:25)



Expected Limits for Z' (M:3000, W:30)

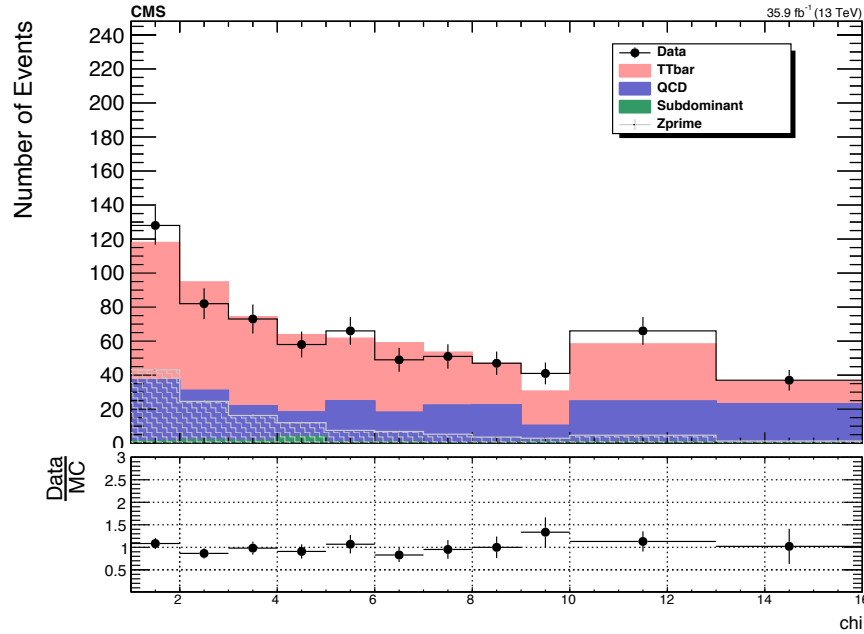


Expected Limits for Z' (M:4000, W:40)

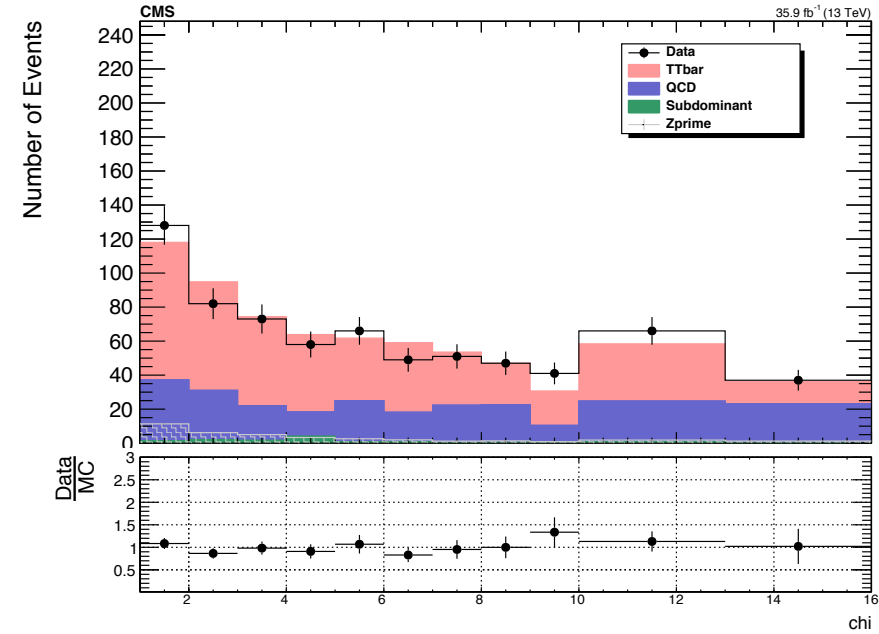


Stack Plots 2016, width 1%

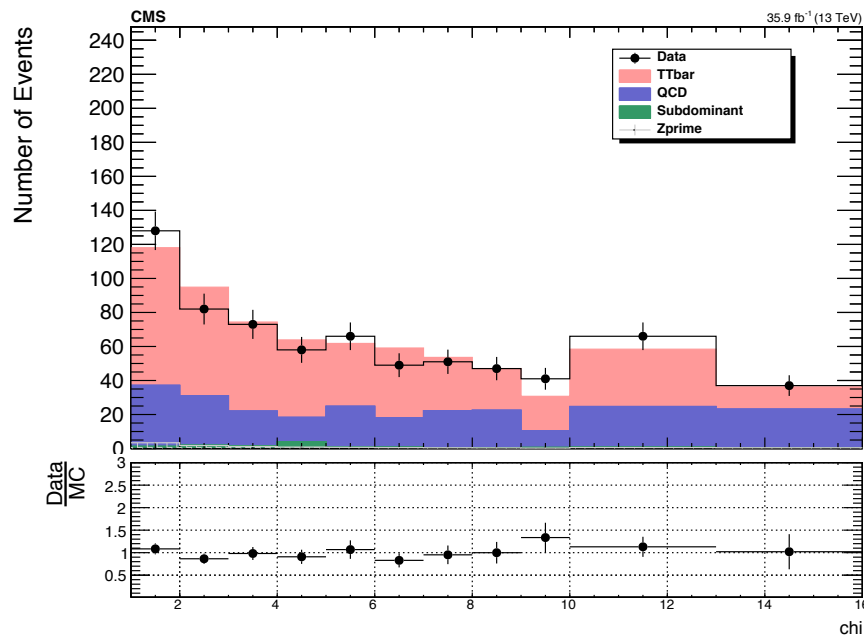
M: 2TeV



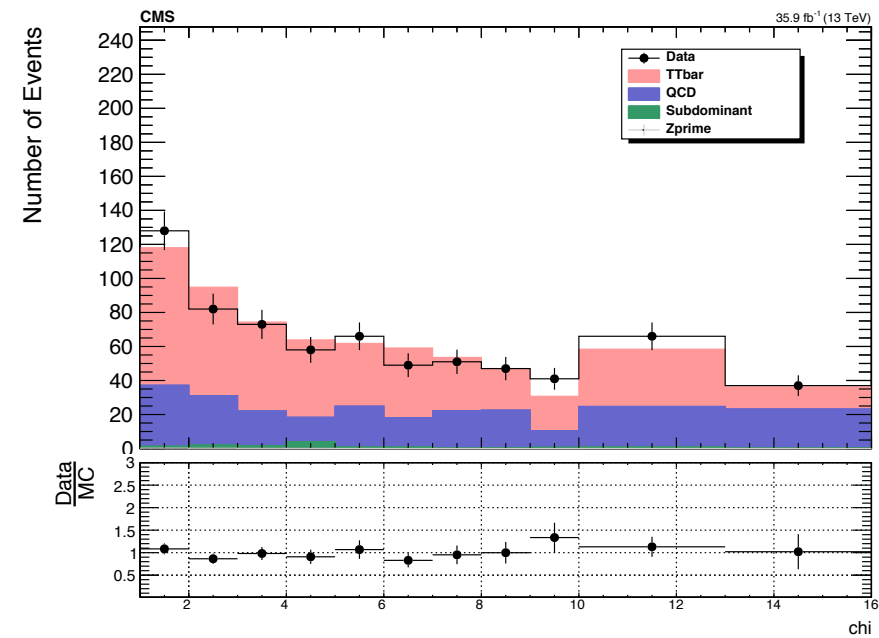
M: 2.5TeV



M: 3TeV

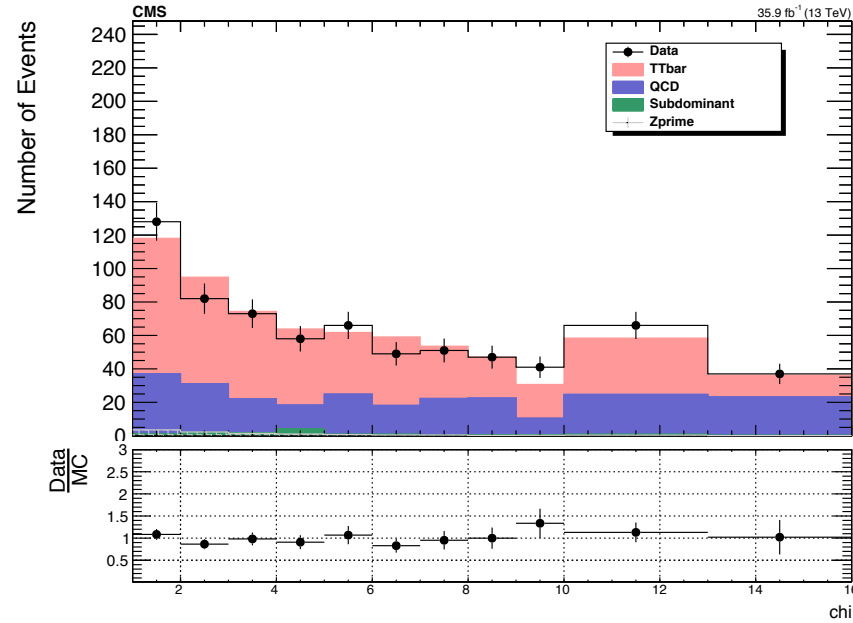


M: 4TeV

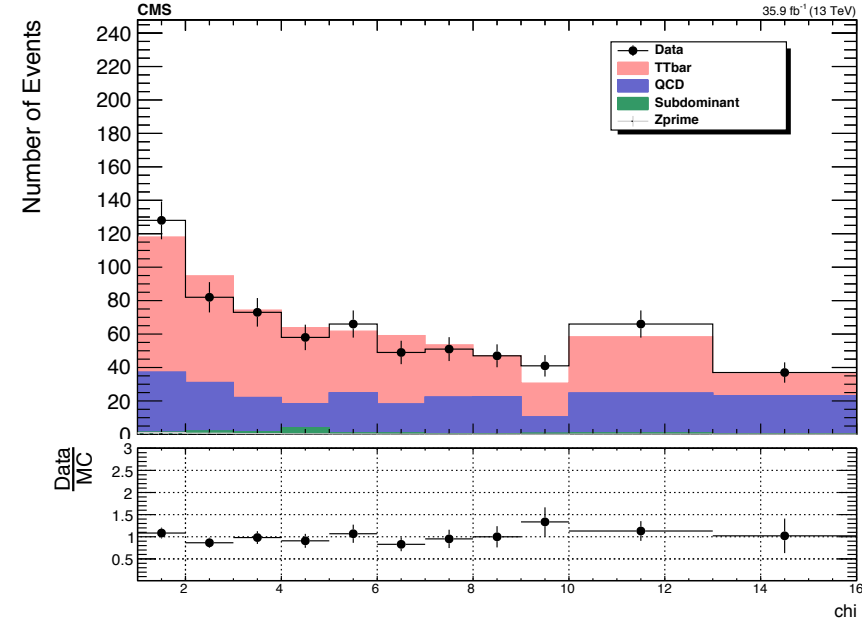


Stack Plots 2016, width 10%

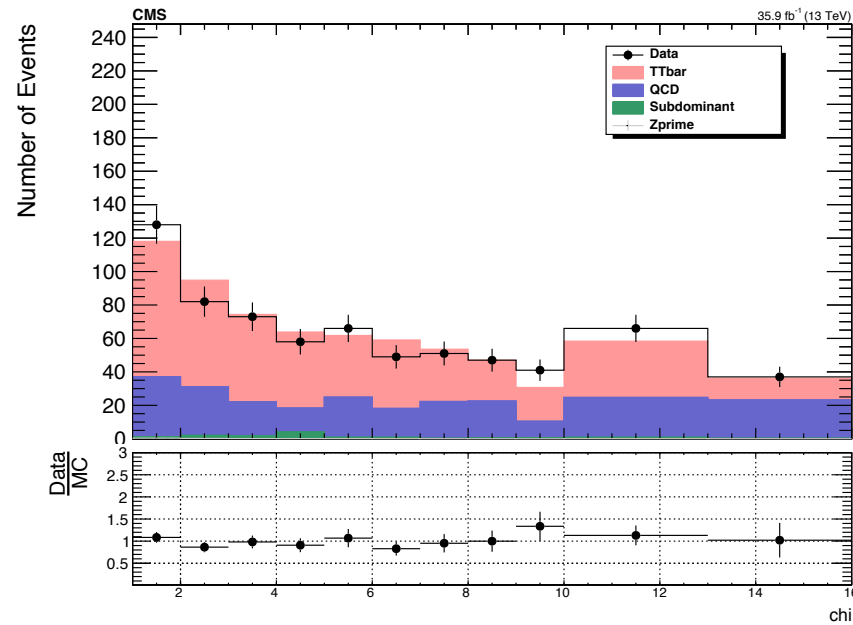
M: 2TeV



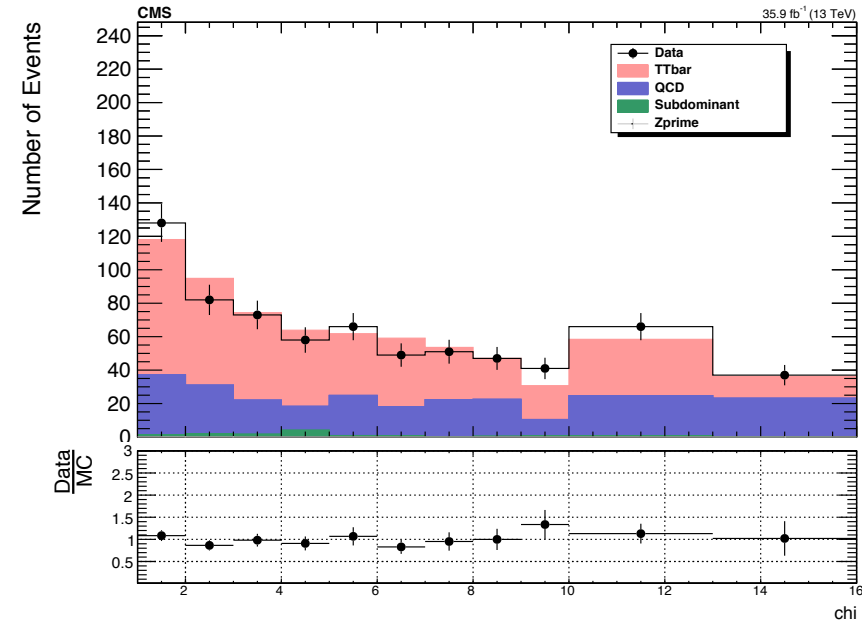
M: 2.5TeV



M: 3TeV

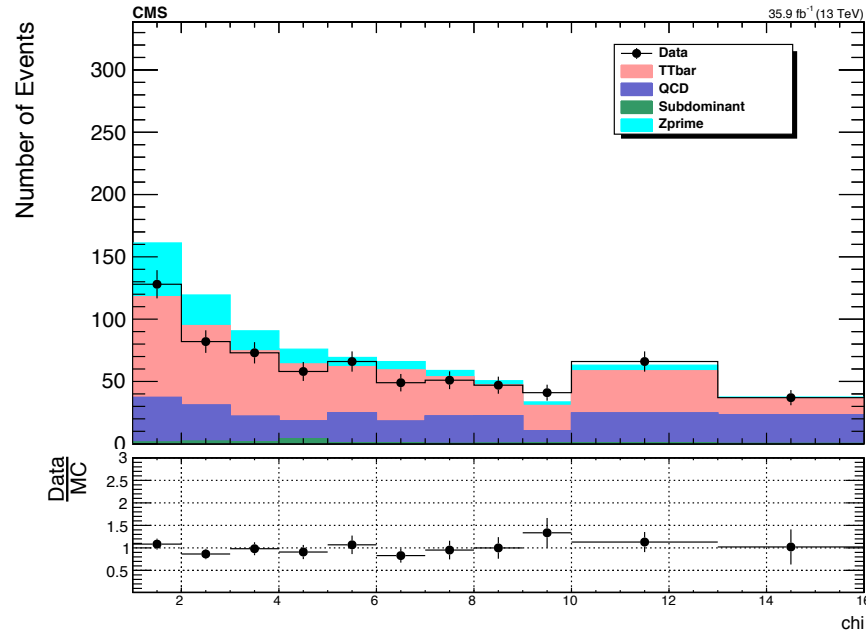


M: 4TeV

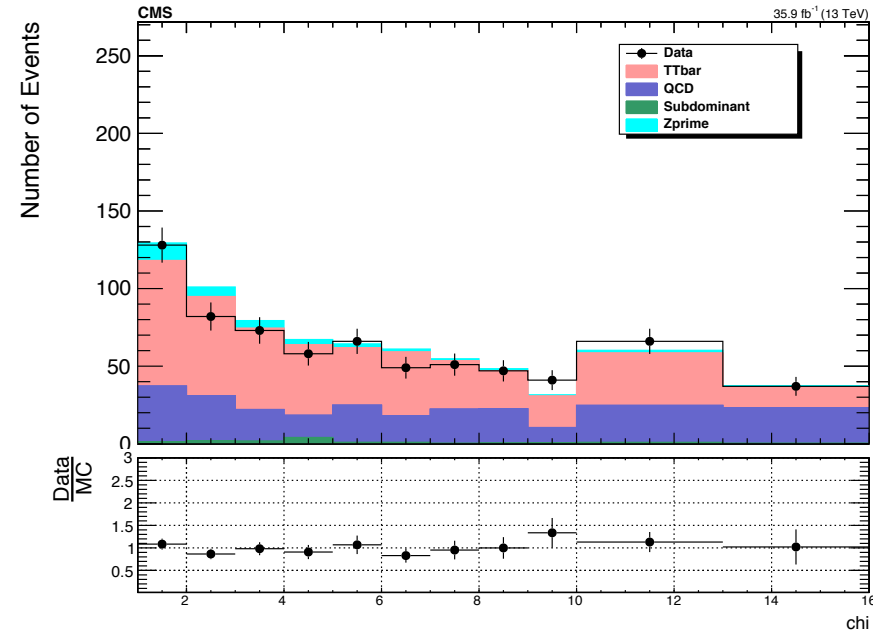


Stack Plots 2016, width 1% (Z' hist incorporated in Stack)

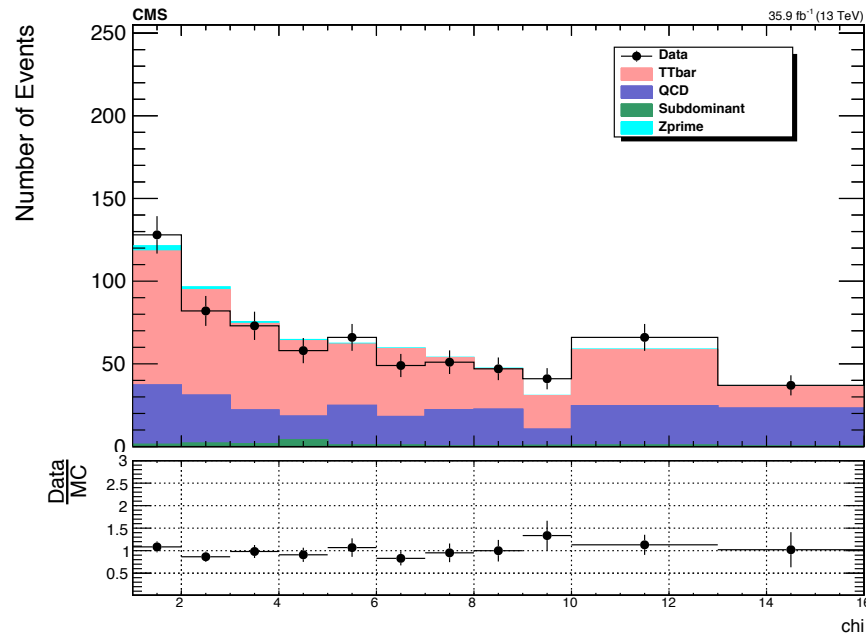
M: 2TeV



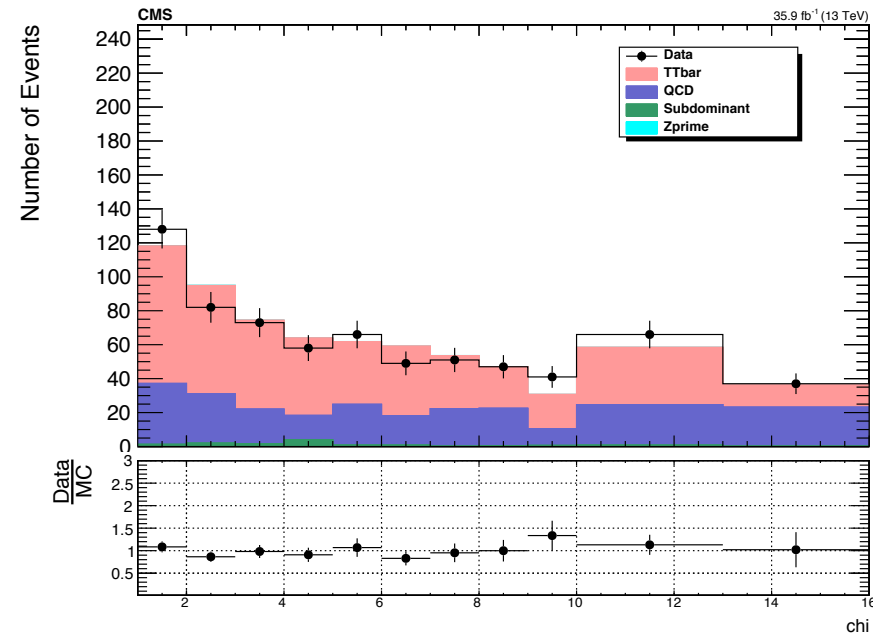
M: 2.5TeV



M: 3TeV

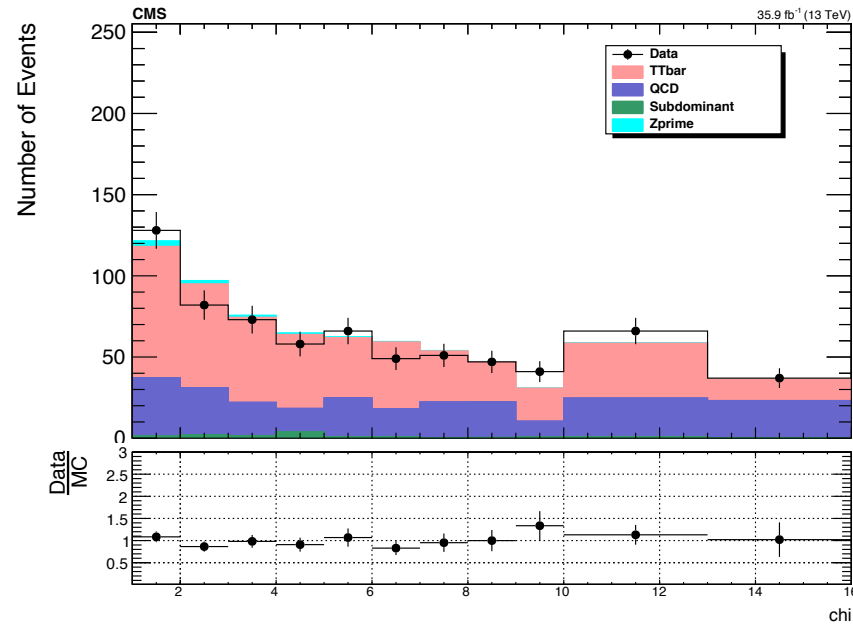


M: 4TeV

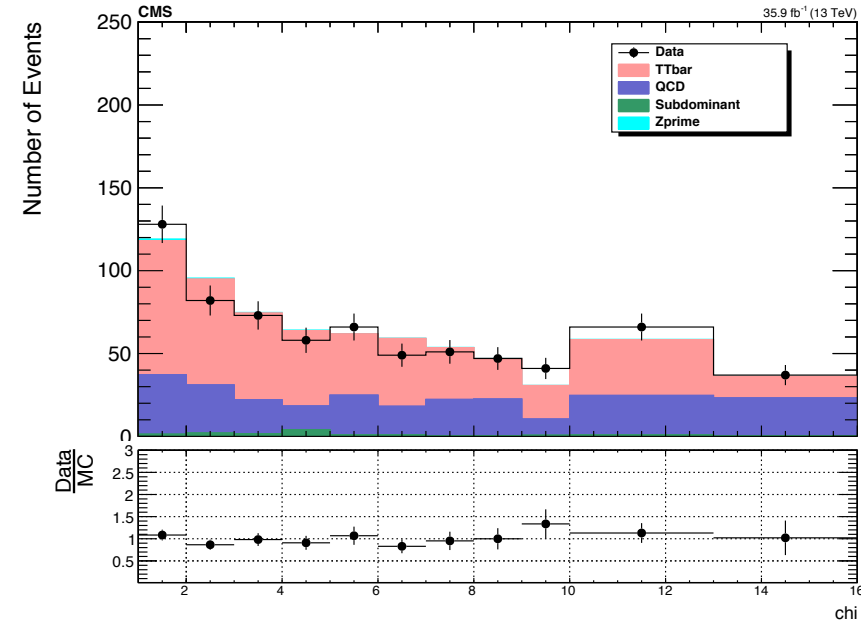


Stack Plots 2016, width 10% (Z' hist incorporated in Stack)

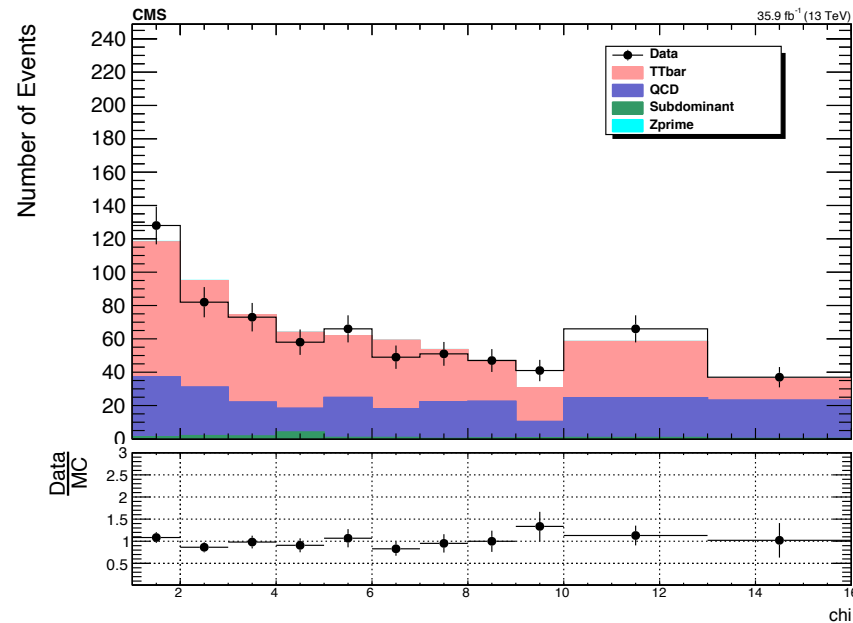
M: 2TeV



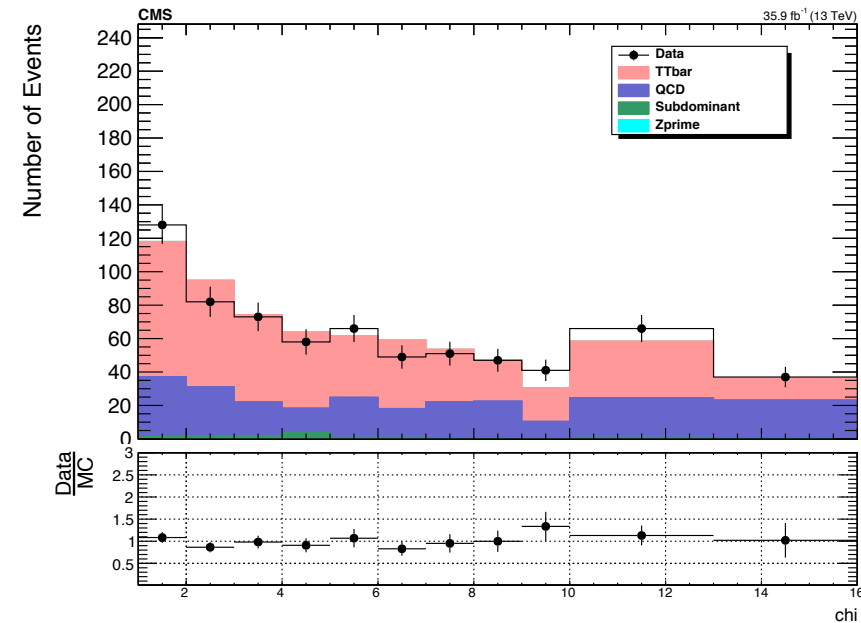
M: 2.5TeV



M: 3TeV

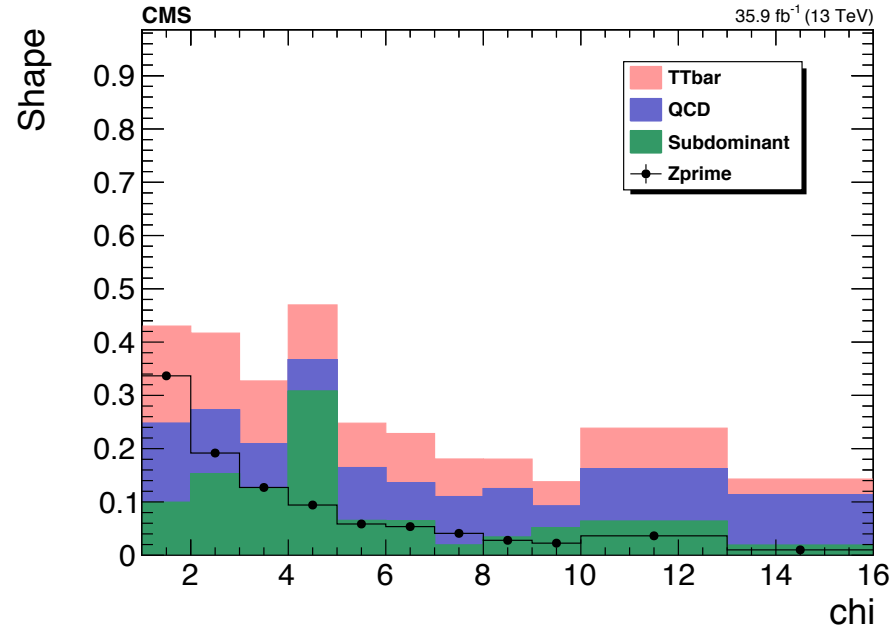


M: 4TeV

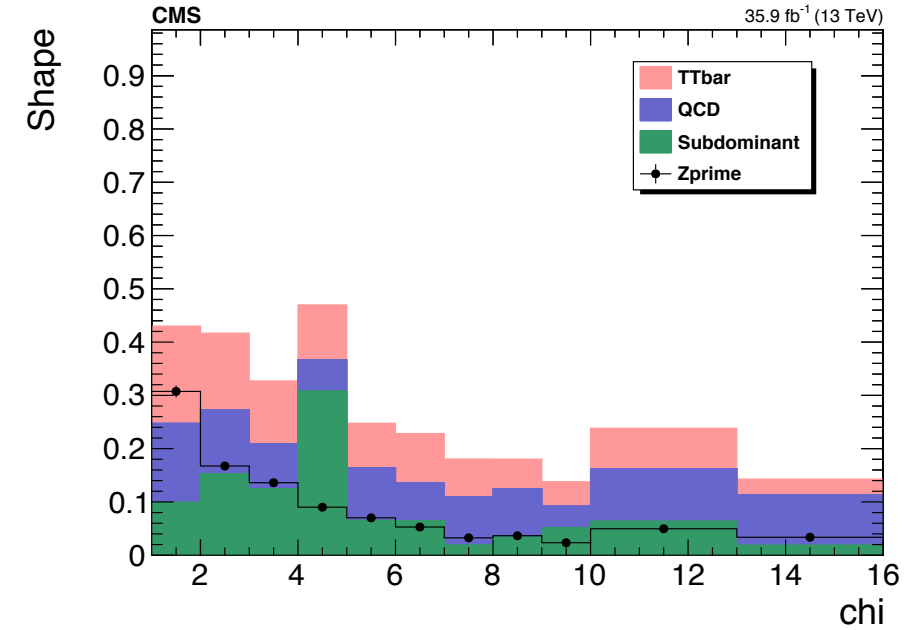


Sensitivity Plots 2016, width 1%

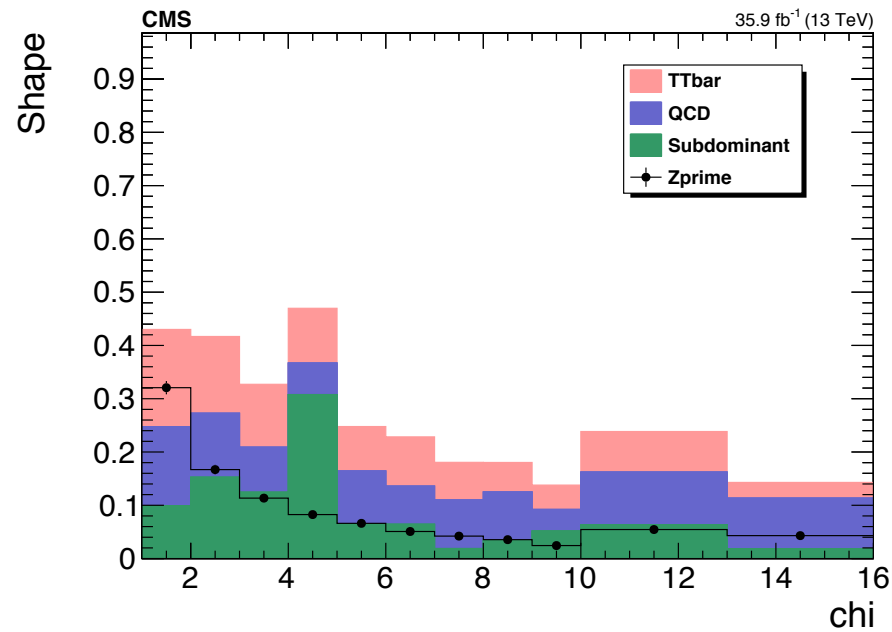
M: 2TeV



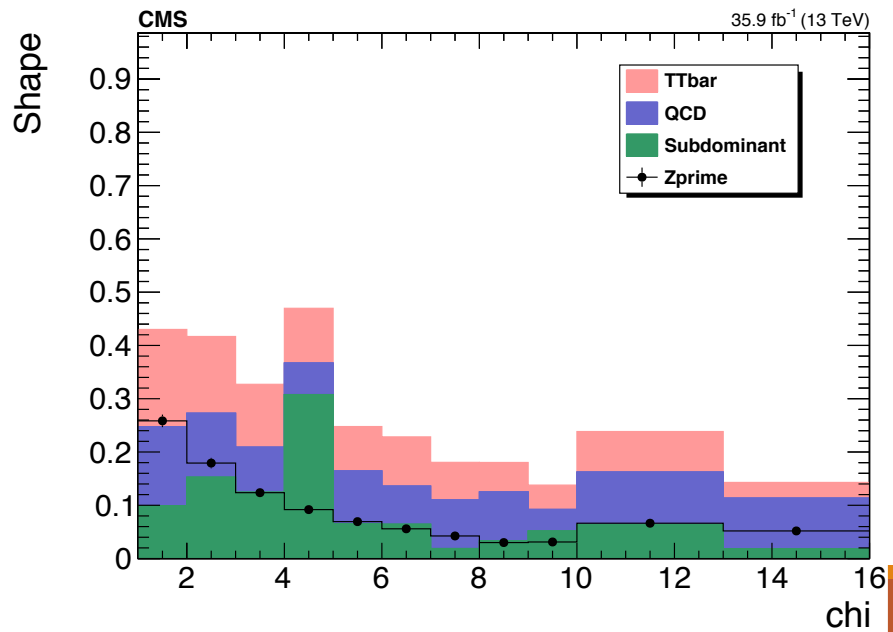
M: 2.5TeV



M: 3TeV

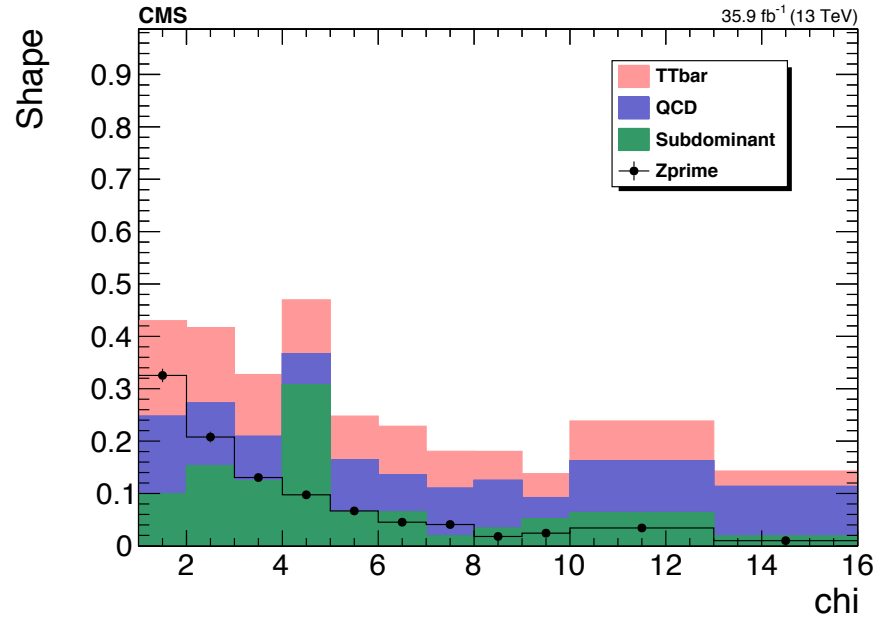


M: 4TeV

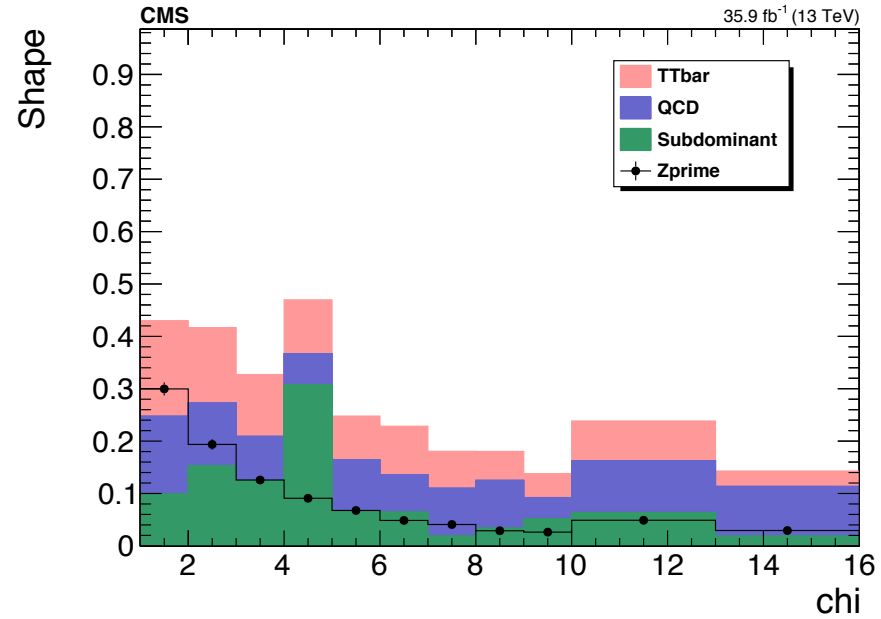


Sensitivity Plots 2016, width 10%

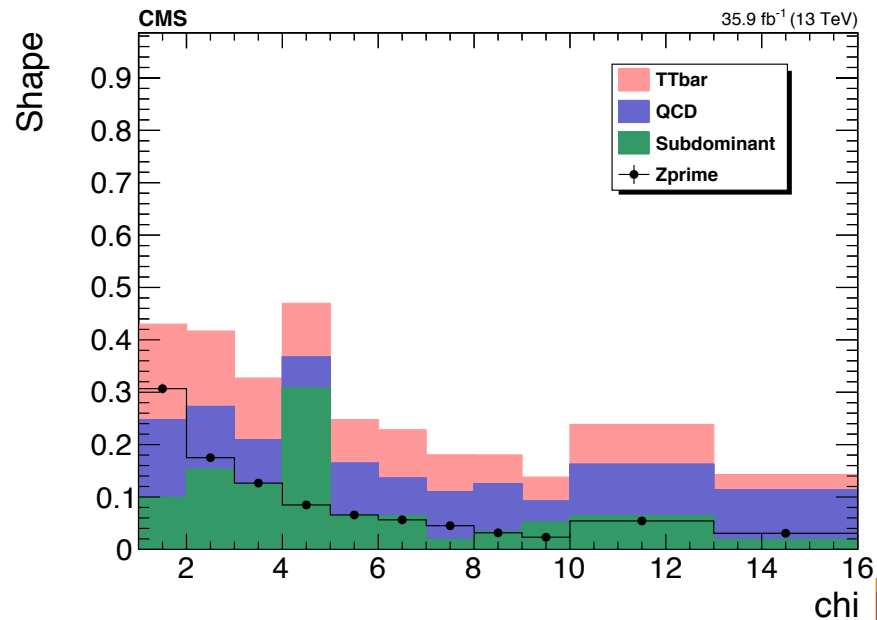
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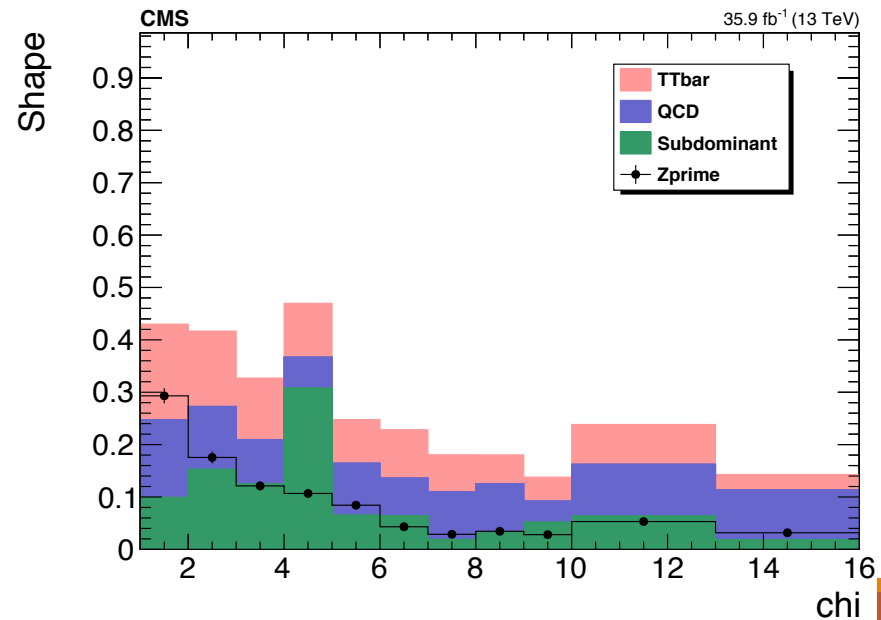
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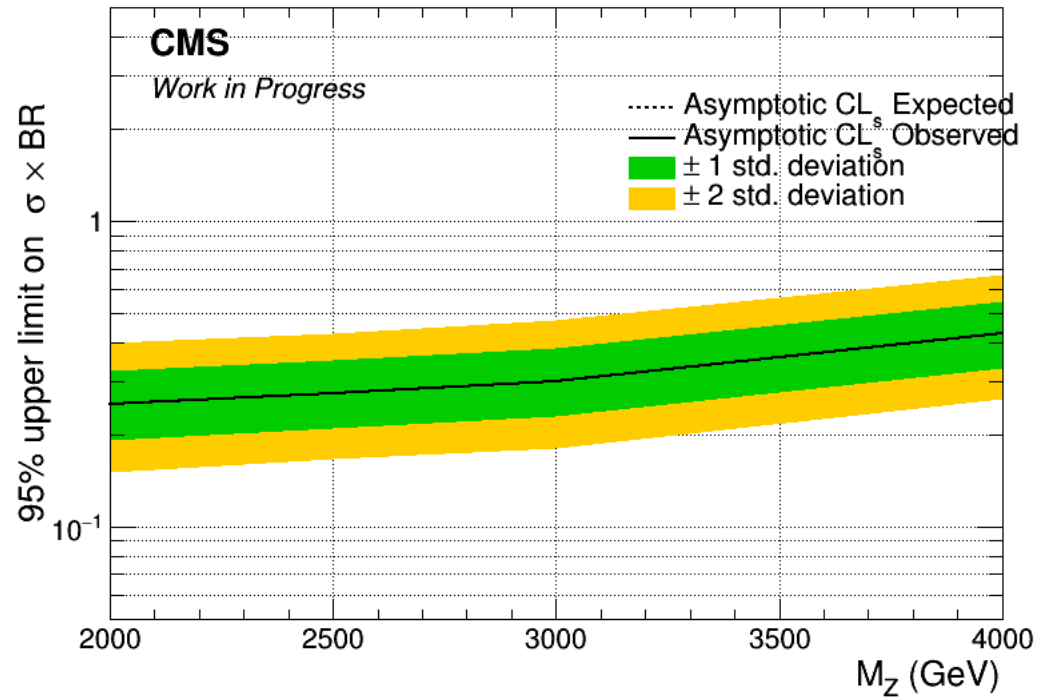


M: 4TeV

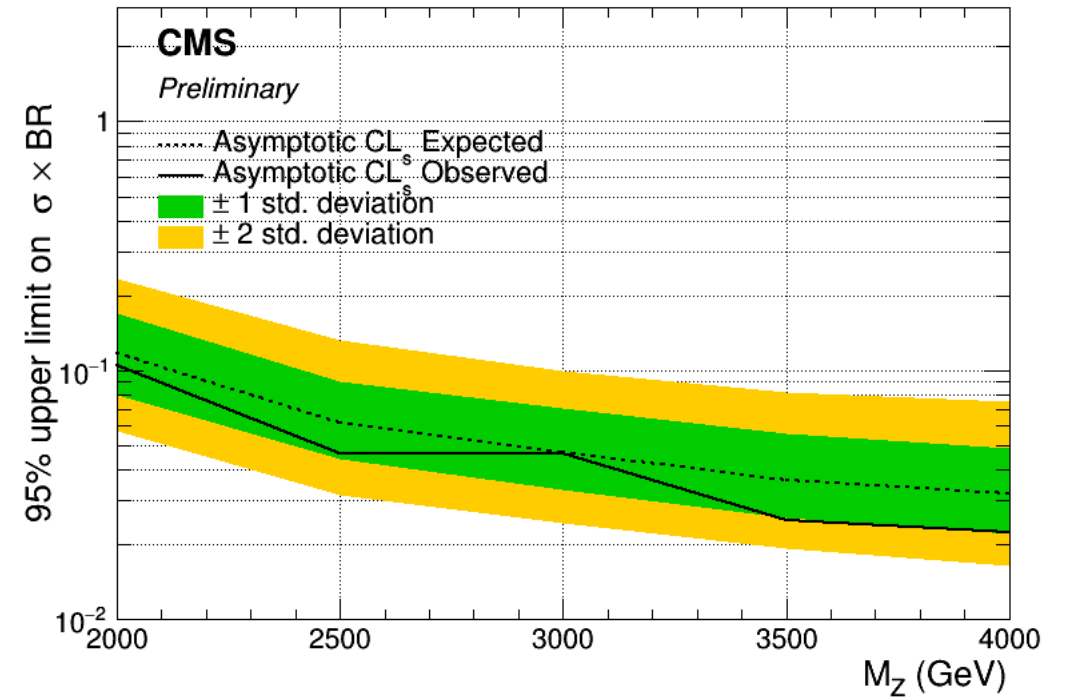


Brazilian Plots 2016, width 1%

2016 using
chi dist

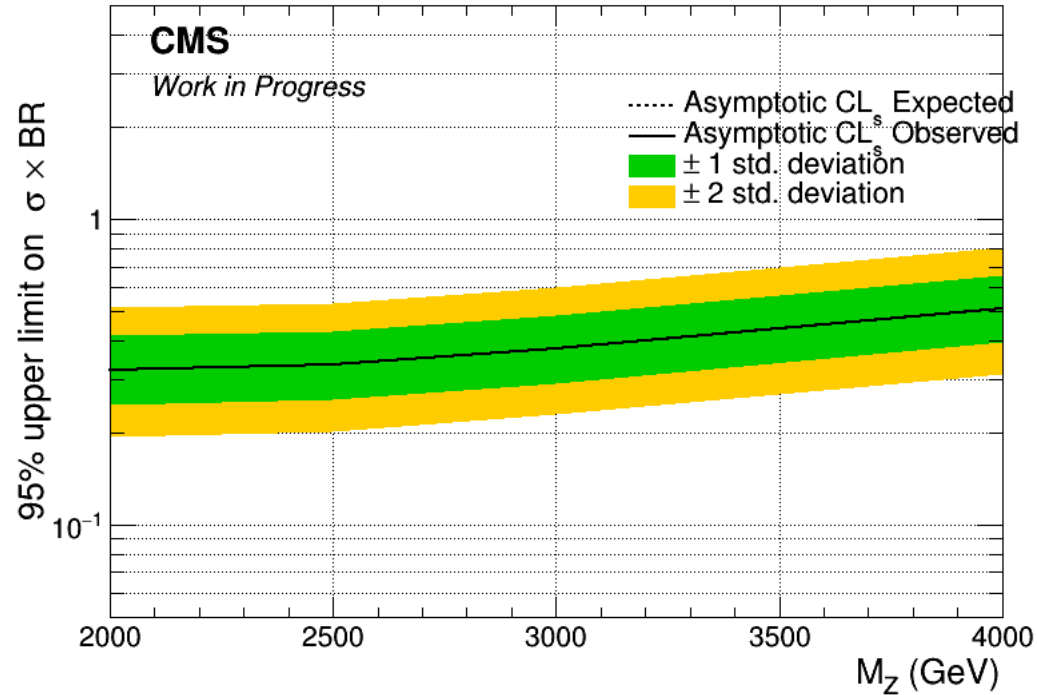


B2G-16-015
using mJJ

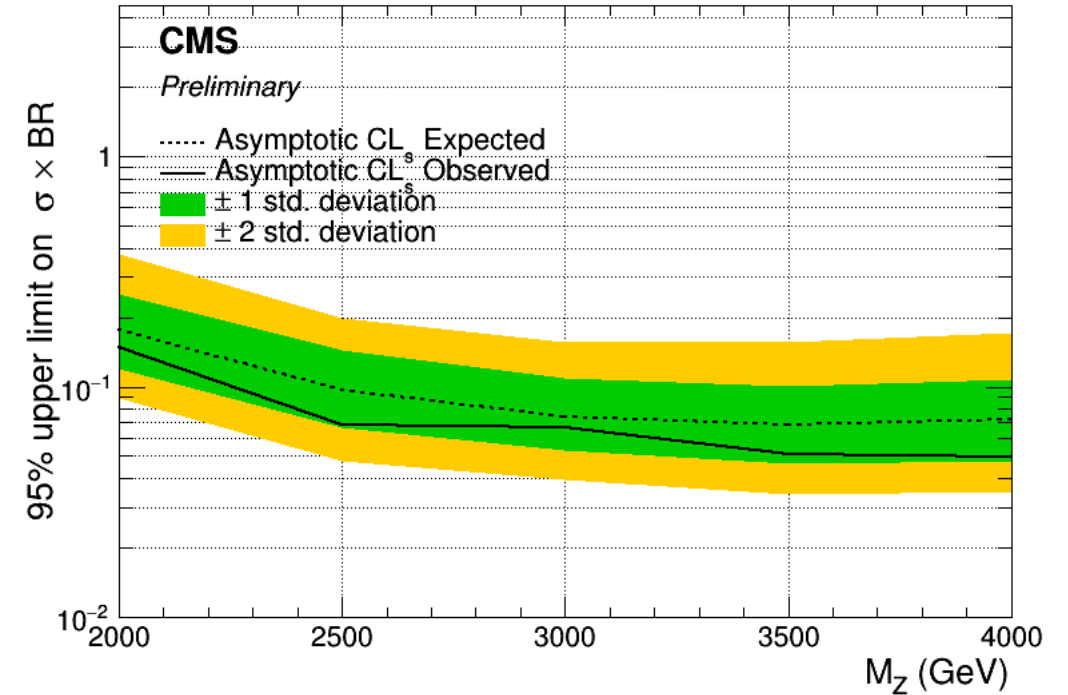


Brazilian Plots 2016, width 10%

2016 using
chi dist



B2G-16-015
using mJJ



Summary

Angular Distributions, Z' analysis:

- New Signal Region:
 - $SR_C = SR + m_{JJ} > 1.5\text{TeV}$
- Stack histograms for SR_C
- Asymptotic Limits (Brazilian plots) for 2016, 2017, 2018
 - Total Cross section x BR
 - Total Cross section = $\sum_{i=1}^N S_i$, where S_i is the signal yield in the reconstructed level
- X distributions show a different slope than the B2G-16-015
 - Recreated Brazilian plot using m_{JJ} variable (only for 2016 and Zprime 1% width)
 - Tried to increase mass cut from 1.5 TeV to 2 TeV to improve sensitivity → not enough events coming from signal extraction
 - If I use $t\bar{t}$ MC (χ dists) as input, the shape is the same as with the 1.5 TeV cut
 - Maybe sliding mass cuts? For each Z' use a different m_{JJ} cut

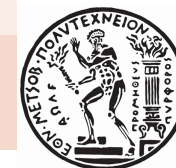


Signal Selection

Variables	Selected Cut
pT (both leading jets)	> 400 GeV
Njets	> 1
N leptons	= 0
eta (both leading jets)	< 2.4
mJJ	> 1000 GeV
jetMassSoftDrop (only for fit)	(50,300) GeV
Top Tagger	> 0.2, 0, 0.1
B tagging (2 btagged jets)	> Medium WP
Signal Trigger	

Control Region Selection

Variables	Selected Cut
pT (both leading jets)	> 400 GeV
Njets	> 1
N leptons	= 0
eta (both leading jets)	< 2.4
mJJ	> 1000 GeV
jetMassSoftDrop (only for fit)	(50,300) GeV
Top Tagger	> 0.2, 0, 0.1
B tagging (0 btagged jets)	< Medium WP
Control Trigger	



Signal Extraction

$$S_{1.5TeV}(x_{reco}) = D_{1.5TeV}(x_{reco}) - QCD_{1.5TeV}(x_{reco}) - Sub_{1.5TeV}(x_{reco}) \rightarrow$$

$$\text{Where } QCD_{1.5TeV}(x_{reco}) = D_{1.5TeV,shape}^{0-btag}(x_{reco}) \times N_{SR(1.5TeV)} \times C_{closure}^{shape SF}$$

$$\text{and } N_{SR(1.5TeV)} = R_{yield}^{1TeV \rightarrow 1.5TeV} \times N_{SR(1TeV)}^{QCD} = R_{yield}^{1TeV \rightarrow 1.5TeV} \times R_{yield}^{SRA \rightarrow SR} \times N_{SRA}^{QCD}$$

- The variable of interest here: $x_{reco} \rightarrow \chi$
- 1.5 TeV refers to the mJJ cut
- We deploy a fit in the Signal Region (2btag) to extract the N_{QCD}^{fit} in SRA (mJJ > 1TeV)

$$D(m^t)^{(i)} = N_{tt}^{(i)} T^{(i)}(m^t, k_{MassScale}, k_{MassResolution}) + N_{bkg}^{(i)} B(m^t)(1 + k_1 x) + N_{sub}^{(i)} O^{(i)}(m^t)$$



Top Angular Distributions

- We employ the dijet angular variable χ from the rapidities of the two leading jets
- Why χ ?
 - The distributions associated with the final states produced via QCD interactions are relatively flat in comparison with the distributions of the BSM models or new particles, which typically peak at low values of χ
- We can measure the variable χ in two ways

1. By measuring the difference of the rapidities of the two leading jets such as the corresponding rapidity in the ZMF is:

$$y^* = \frac{1}{2}(y_1 - y_2)$$

χ is defined as $\chi = e^{|y^*|} = e^{|y_1 - y_2|}$ (1) and can be measured by creating the TLorentzVector, boost it to the ZMF and find the rapidity difference of the two leading jets

2. By measuring the scattering angle θ^* (angle between top quark and z-axis in the Zero Momentum Frame)

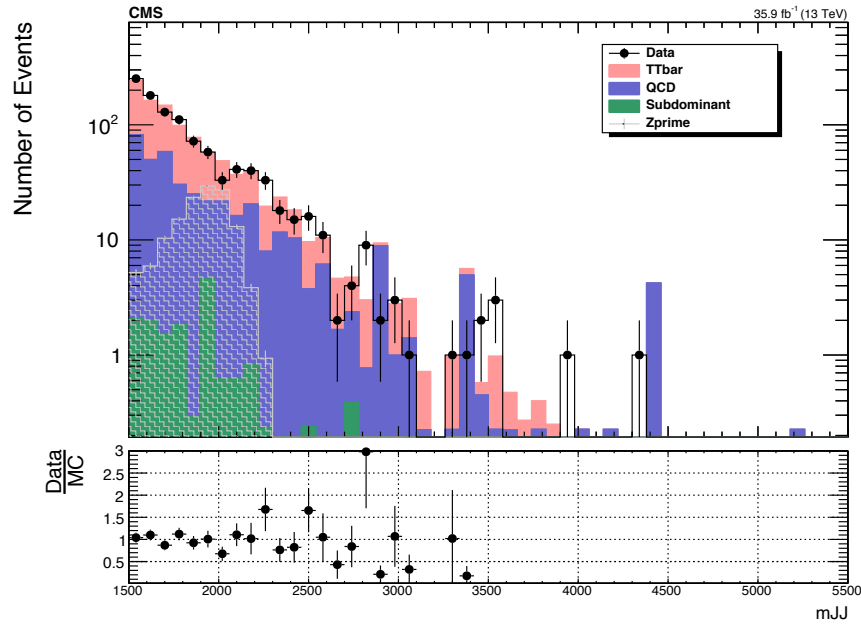
We define as $y^* = \frac{1}{2} \ln\left(\frac{1+|\cos\theta^*|}{1-|\cos\theta^*|}\right)$ and from (1) we can find that:

$$\chi = \frac{1 + |\cos\theta^*|}{1 - |\cos\theta^*|}$$

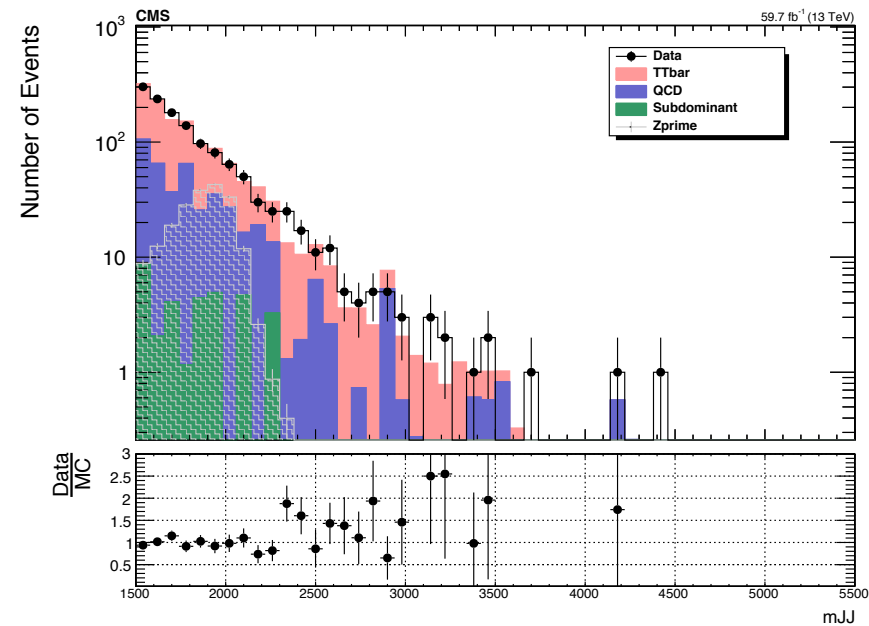


Stack Distributions vs B2G-16-015 $M_{Z'}=2\text{TeV}$, w 1%

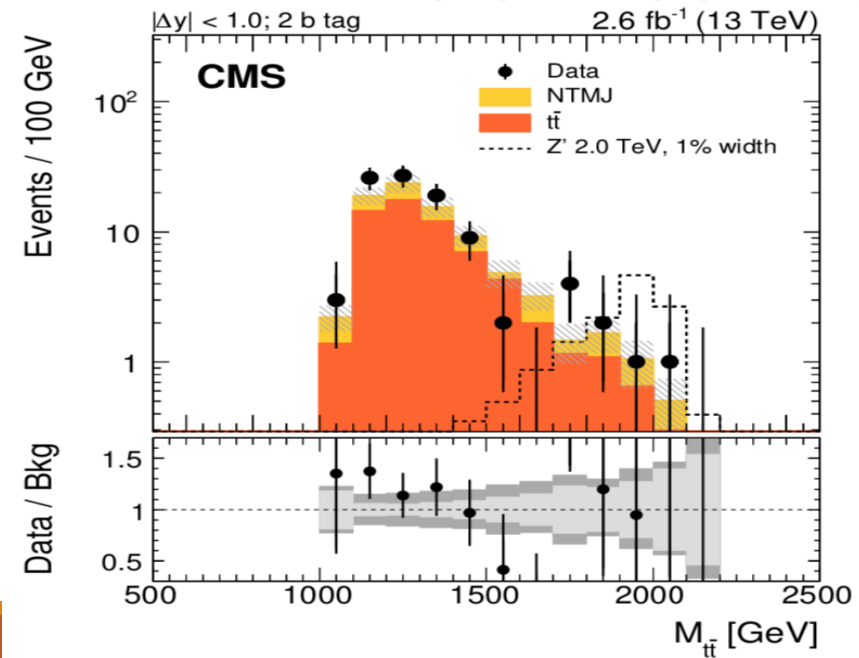
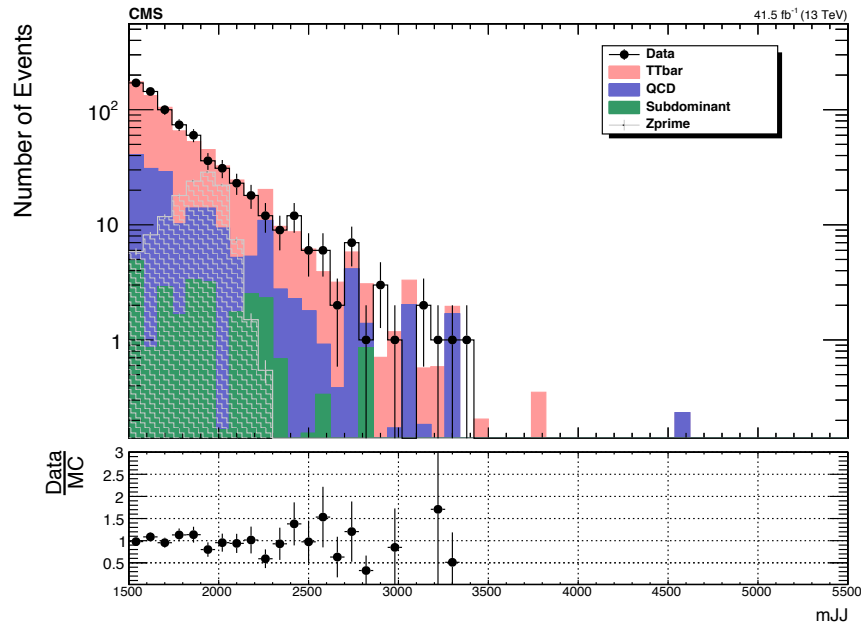
2016



2018

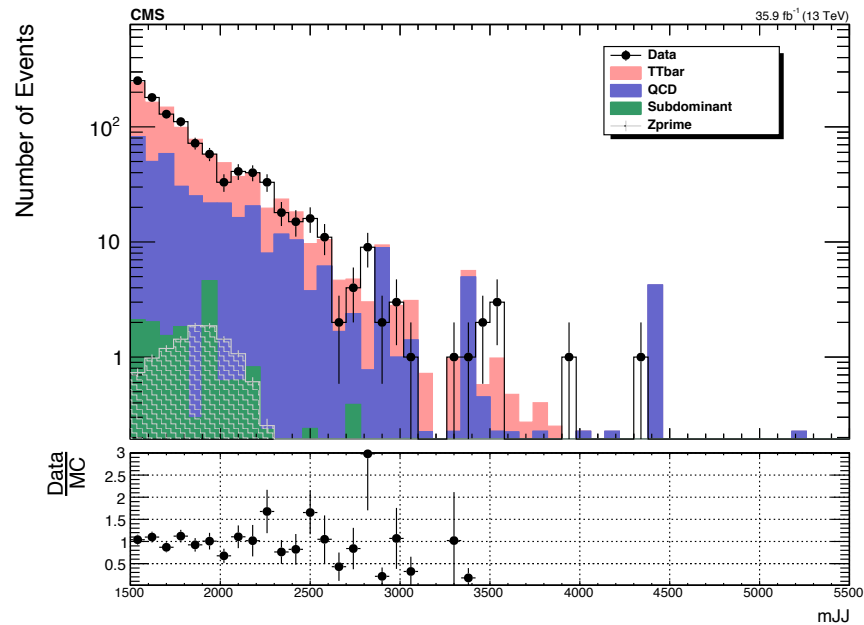


2017

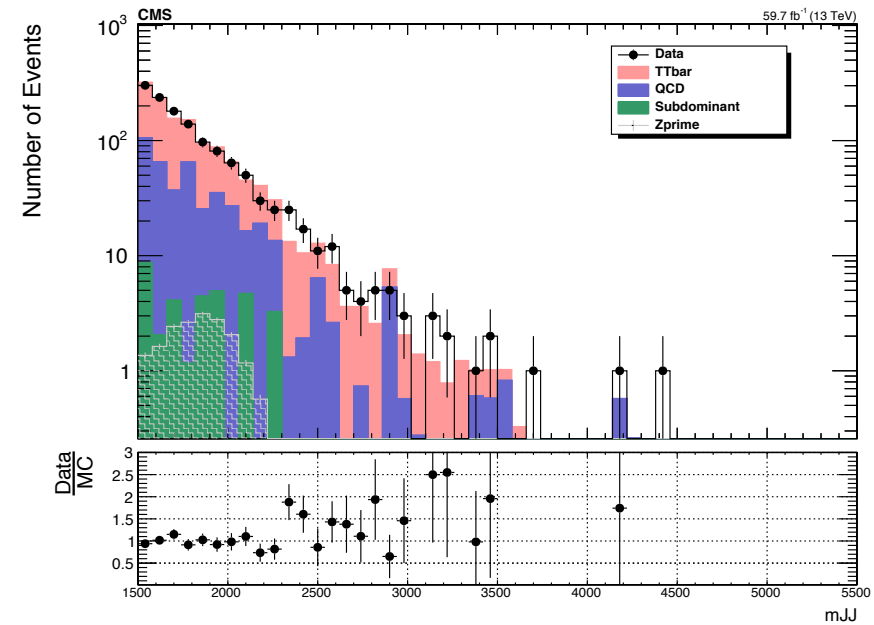


Stack Distributions vs B2G-16-015 $M_{Z}=2\text{TeV}$, w 10%

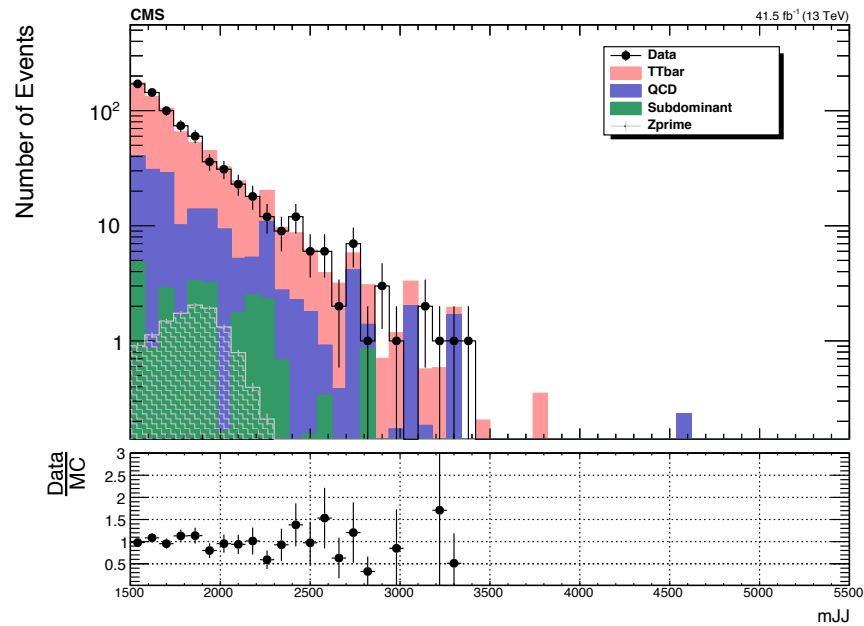
2016



2018

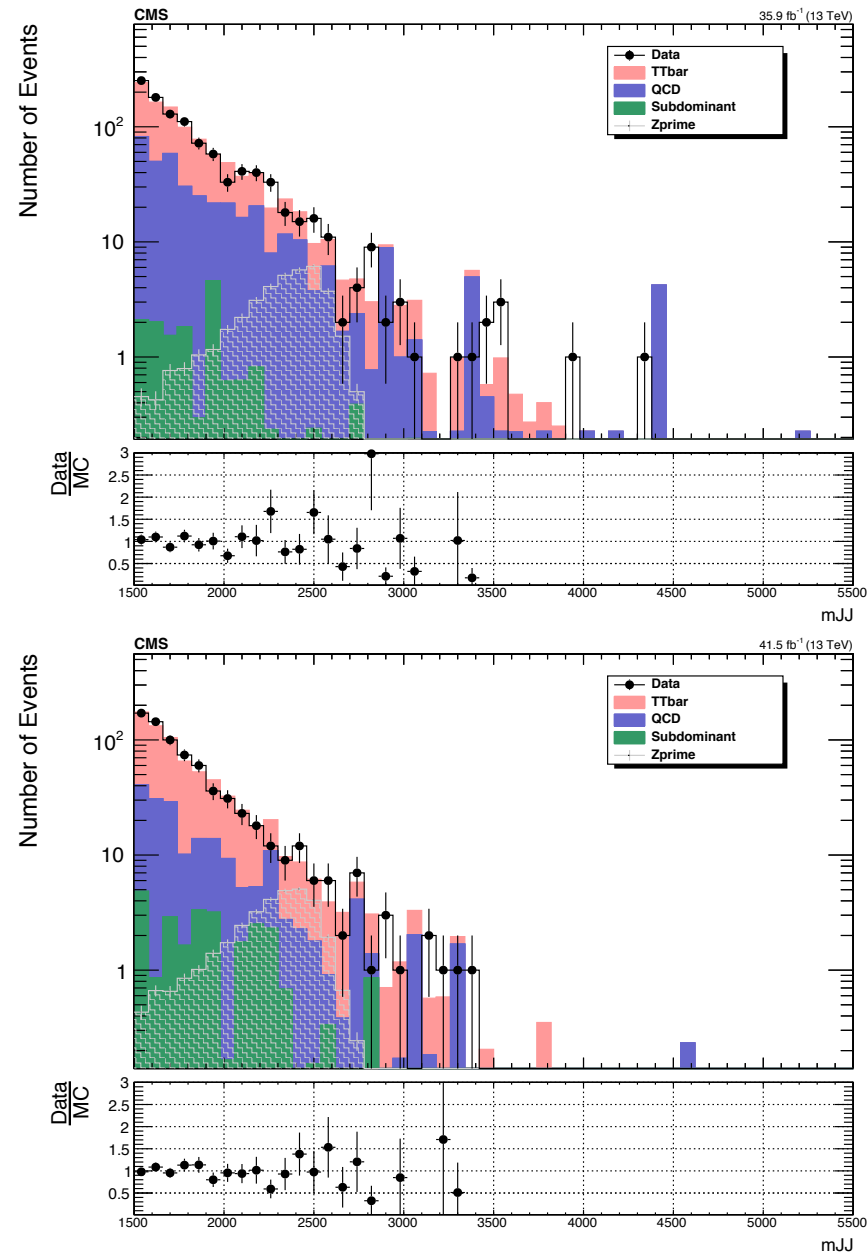


2017

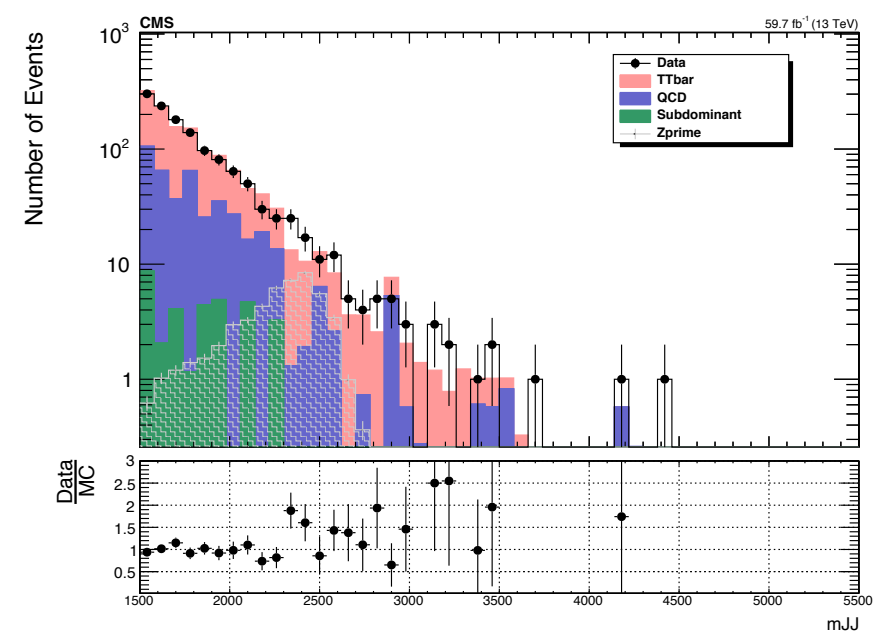


Stack Distributions $M_Z = 2.5\text{TeV}$, w 1%

2016



2017



2018

