HEP NTUA
Weekly Report

27/1/2021

George Bakas

Summary

<u>TTbar analysis:</u>

- BLUE method
  - Implemented the method to check how the software works
- Created pipeline to switch to UL files
  - Production, several problems
  - 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

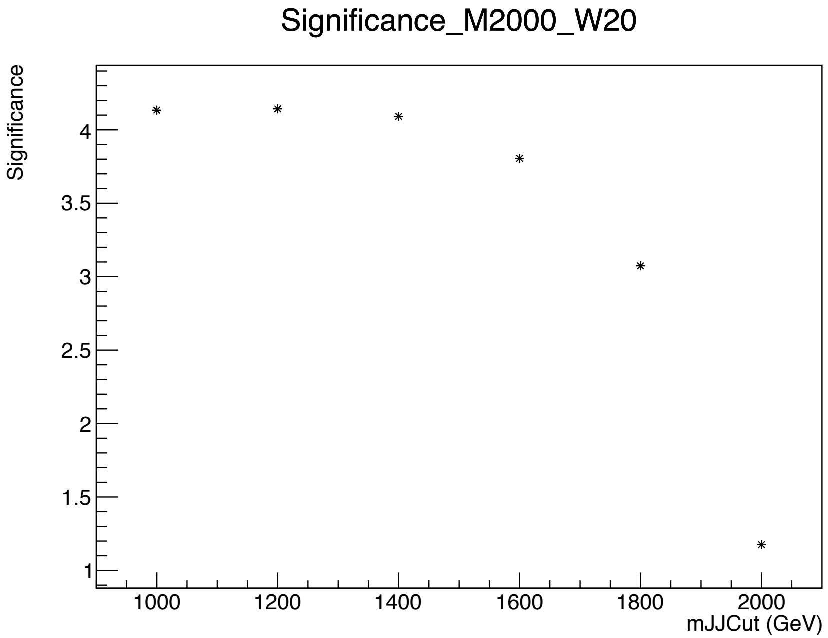
Angular Distributions, Z’ analysis:

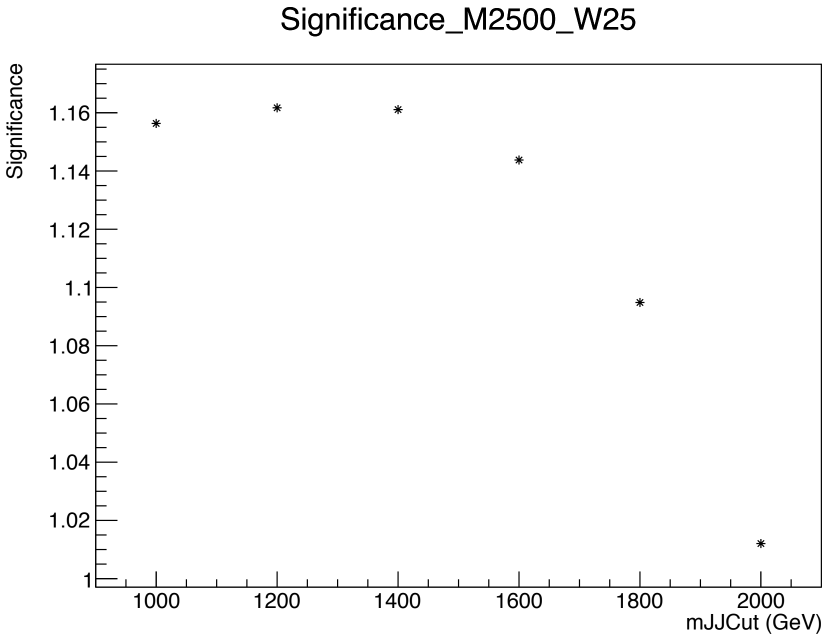
- Significance plots:
  - 1TeV – 2TeV mJJ Cut every 250GeV
  - Significance vs mJJ Cut for every Zprime mass, width pair
  - Full Run II (2016, 2017, 2018)
  - Search for the maximum significance for every mJJ Cut

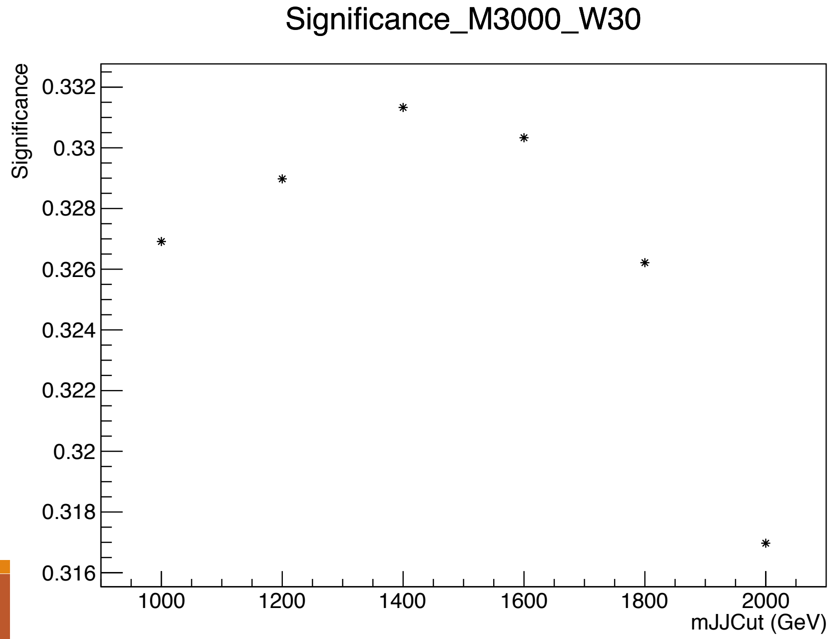
- $Significance = \frac{Signal}{\sqrt{Signal+Background}}$, where signal is the Zprime events and bkg → ttbar, qcd, subdominant

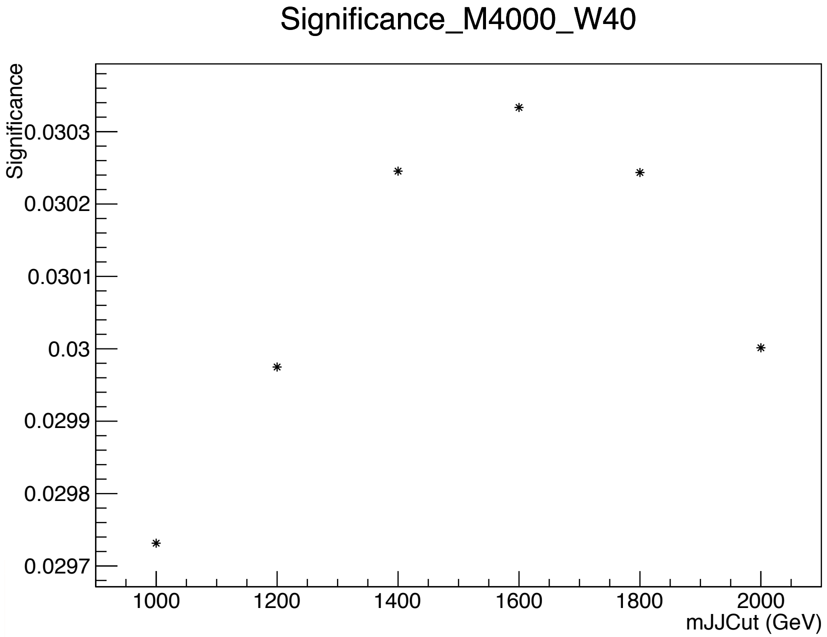
- In the regard of Expected limits for 2016 in this presentation you have:
  - Significance for 2000, 2500, 3000 and 4000 GeV Z’ masses (1% widths) → slide 3
  - Chi distribution asymptotic (Expected) limits vs mJJCuts [1000-1800]GeV → slide 4
  - Stacked chi (χ) distributions for 2016 Z’ 1% widths for 1600 GeV mJJCut → slide 5
  - Sensitivity plots (shape comparison of stacks vs Z’) for chi dist for 1600 GeV mJJCut → slide 7

Significance Plots 2016, width 1%

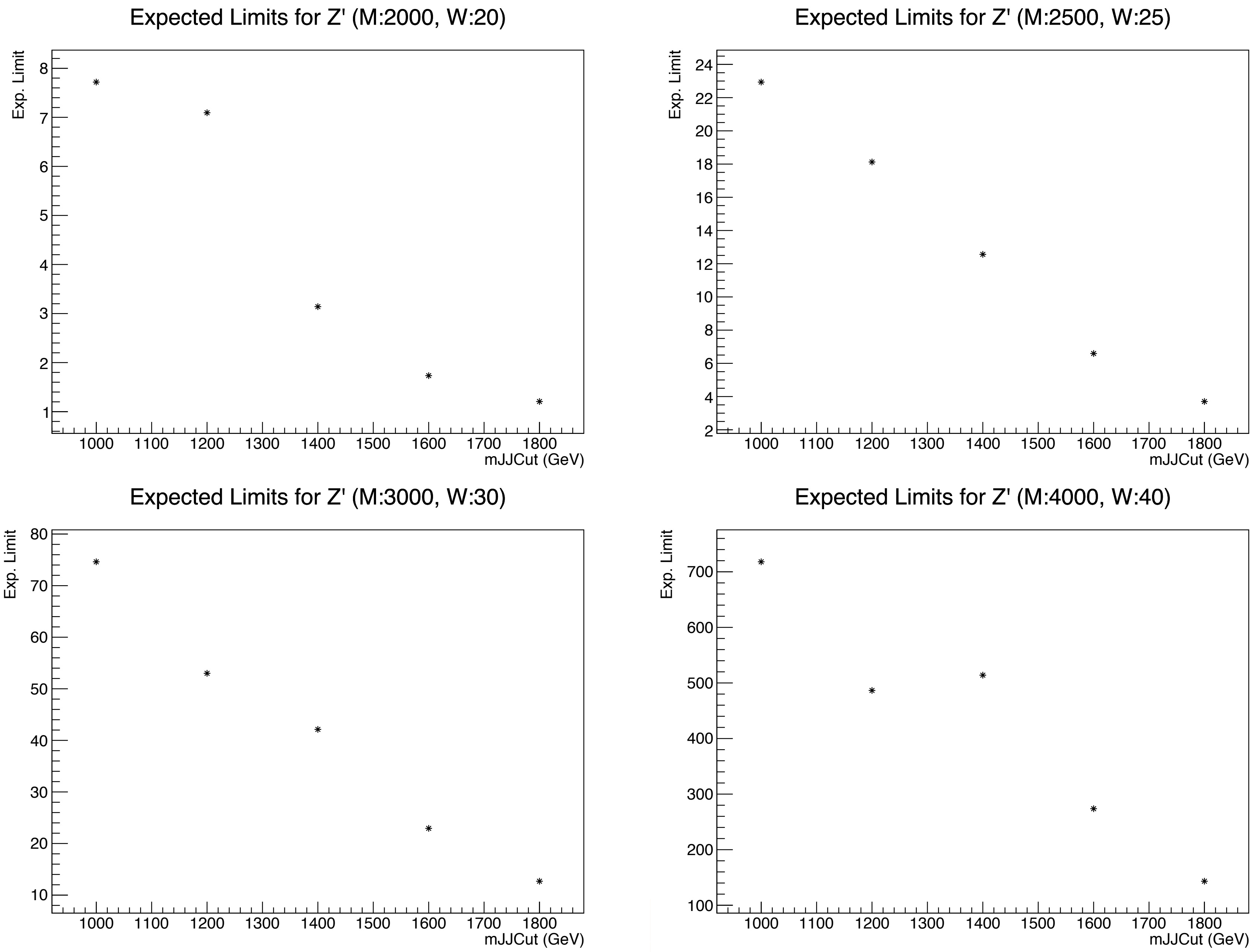






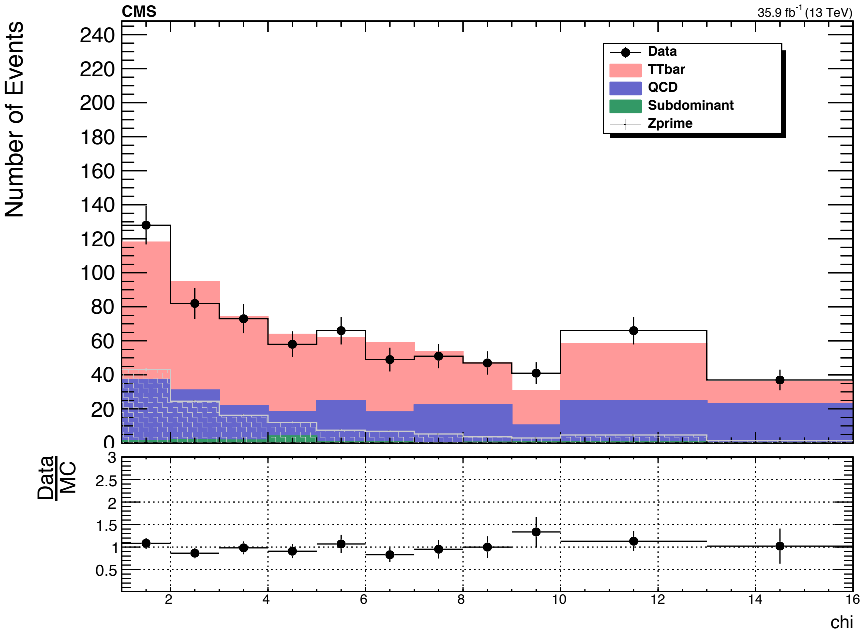


Expected Limit Plots 2016, width 1%

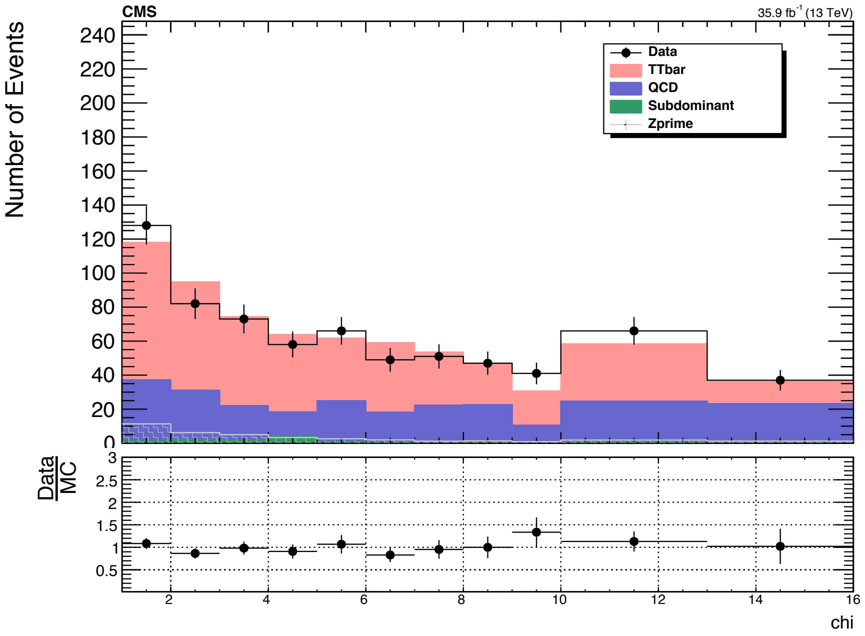


Stack Plots 2016, width 1%

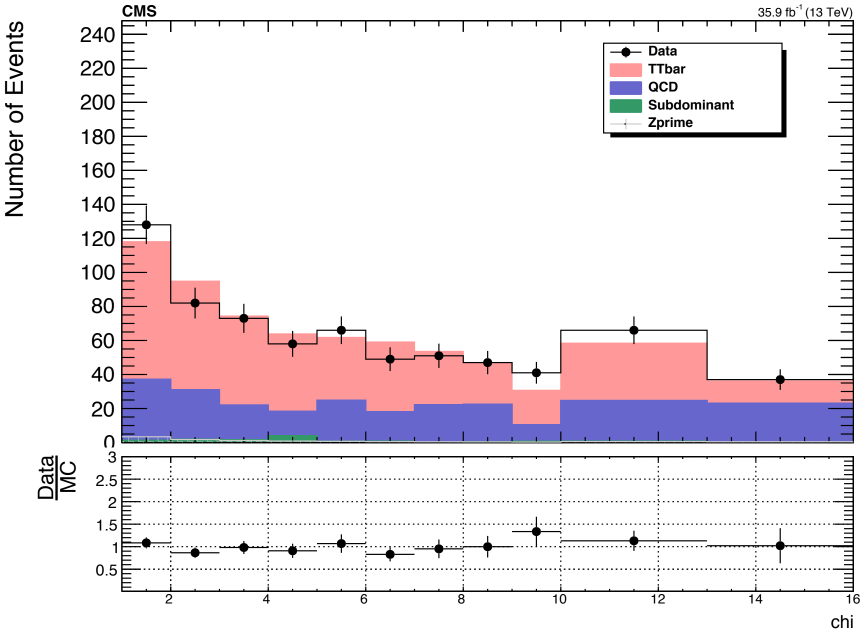
M: 2TeV



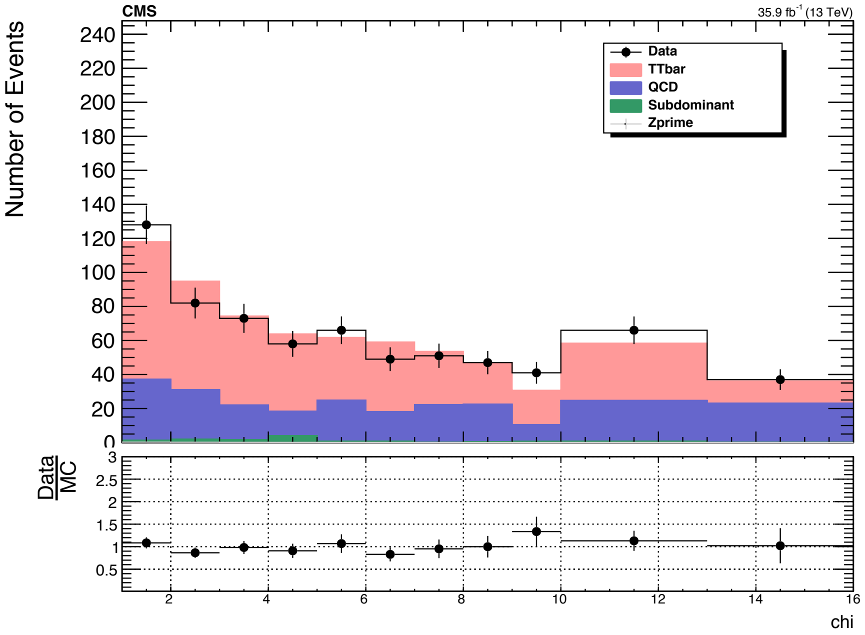
M: 2.5TeV



M: 3TeV

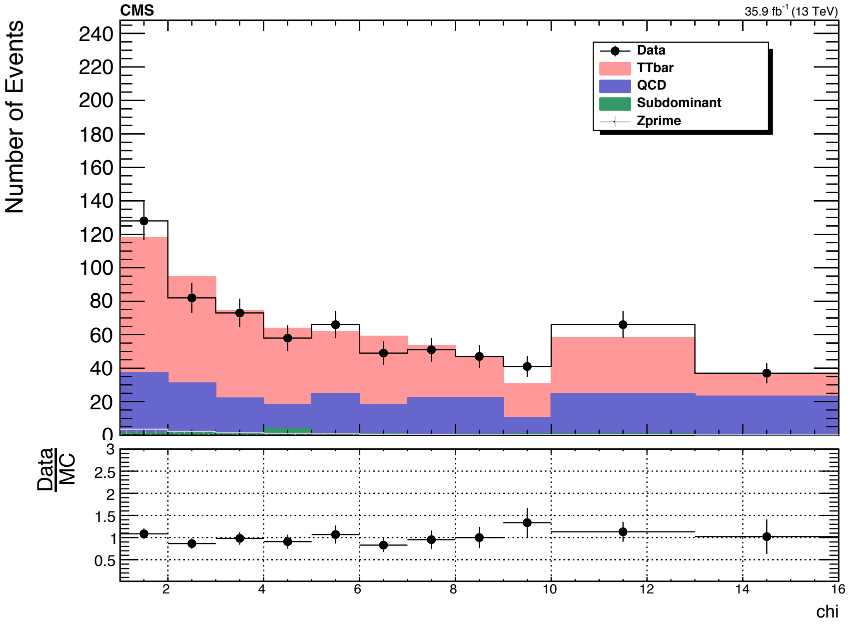


M: 4TeV

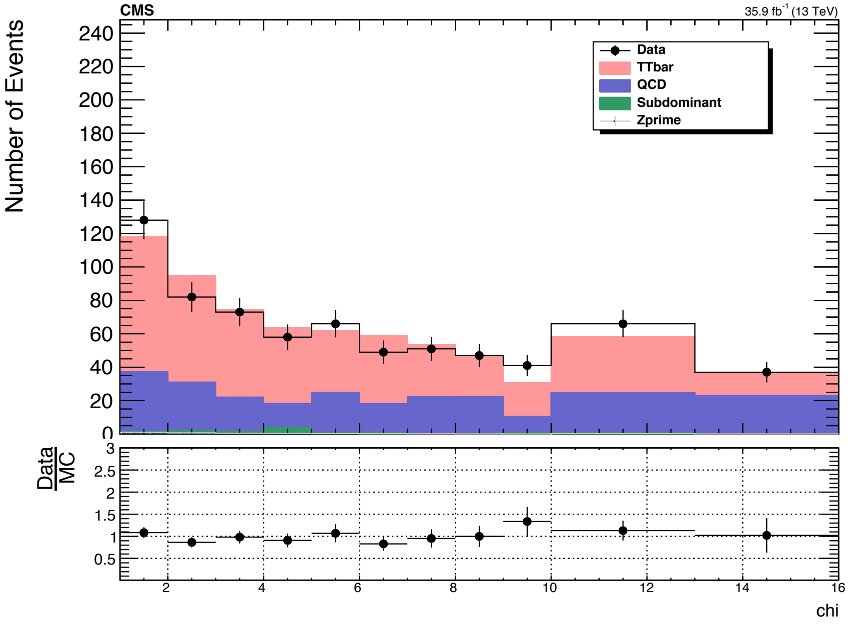


Stack Plots 2016, width 10%

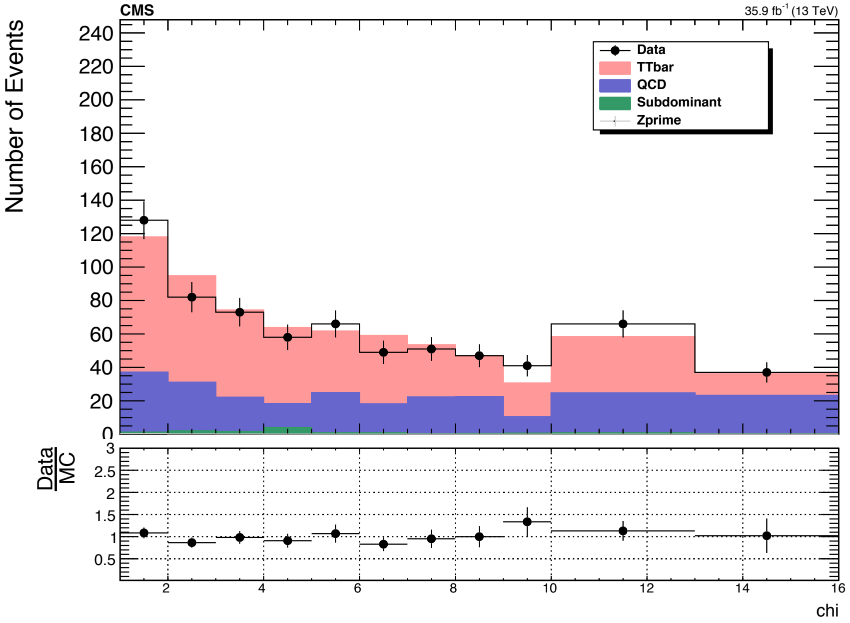
M: 2TeV



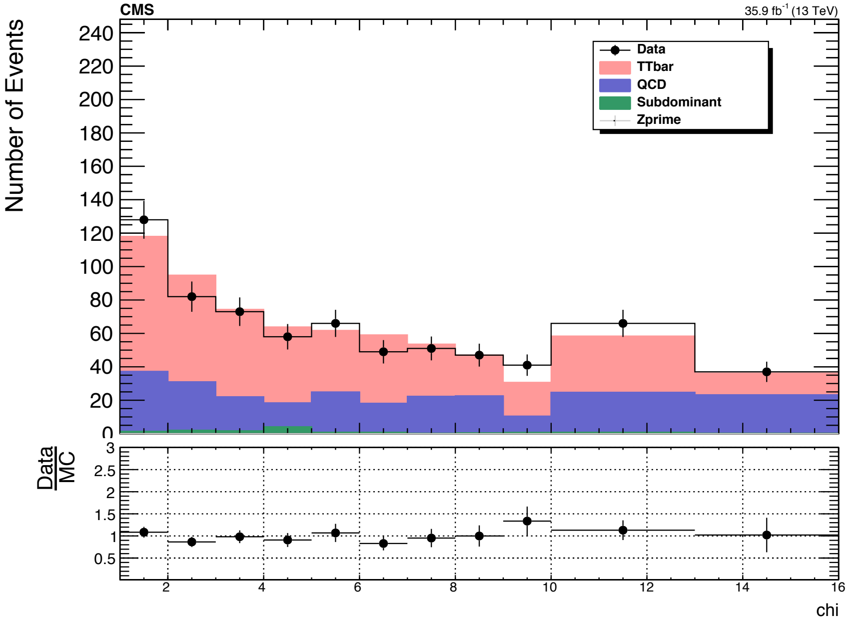
M: 2.5TeV



M: 3TeV

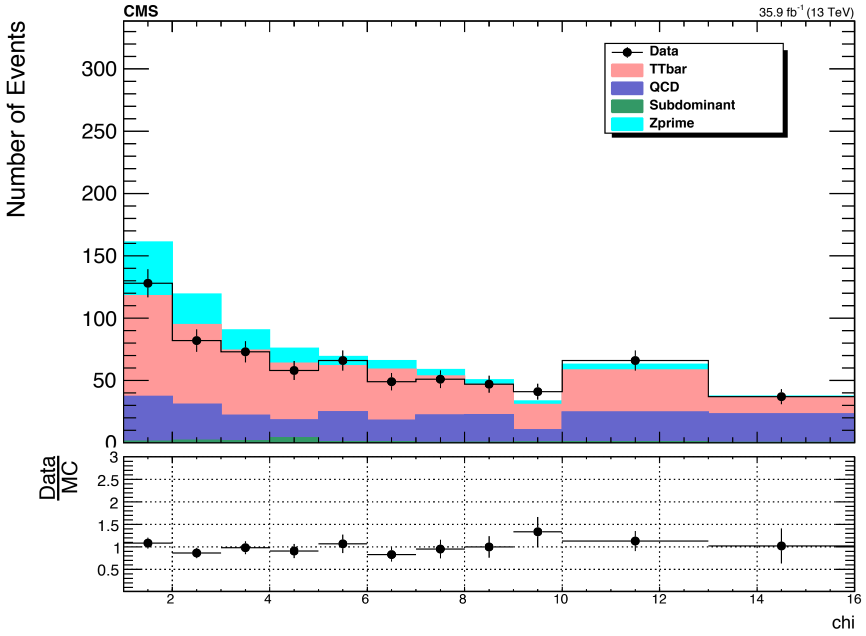


M: 4TeV

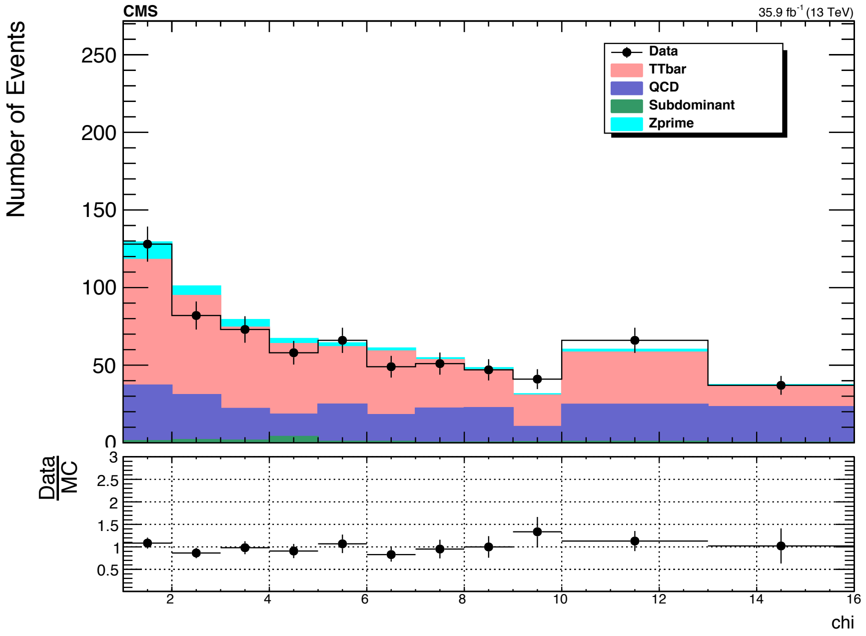


Stack Plots 2016, width 1% (Z’ hist incorporated in Stack)

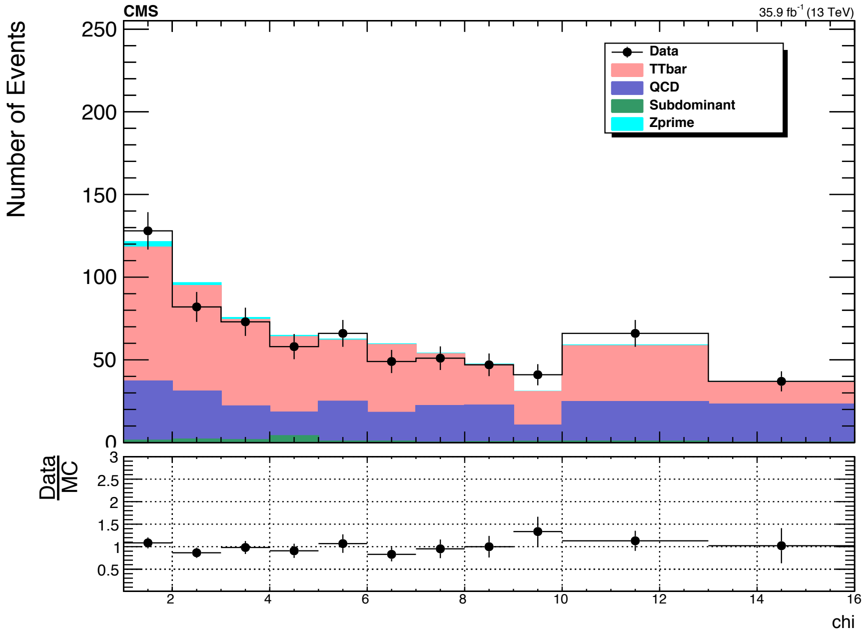
M: 2TeV



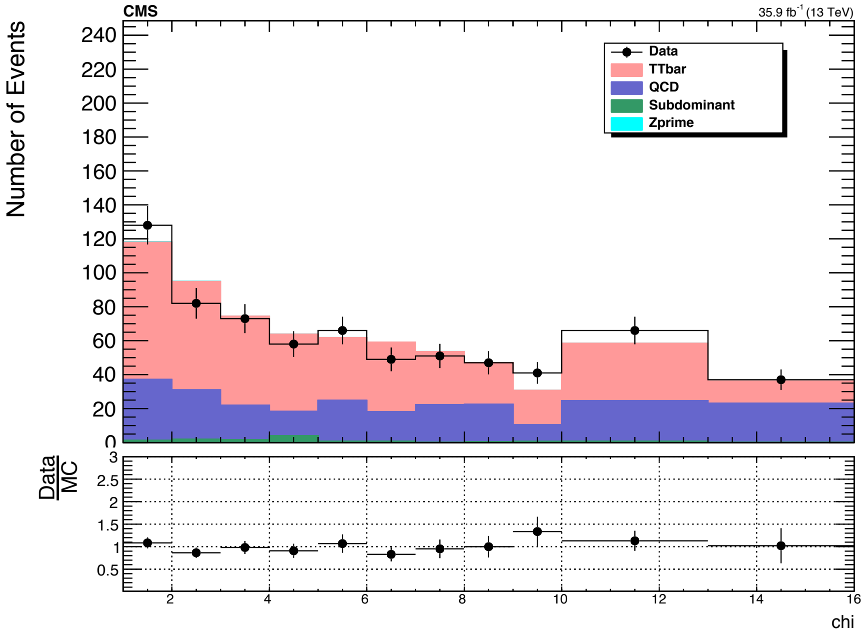
M: 2.5TeV



M: 3TeV

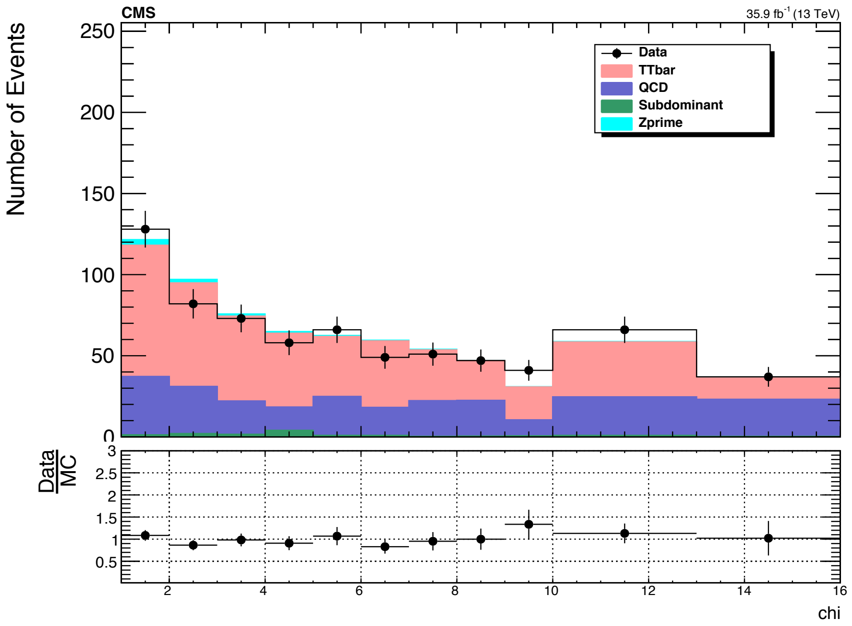


M: 4TeV

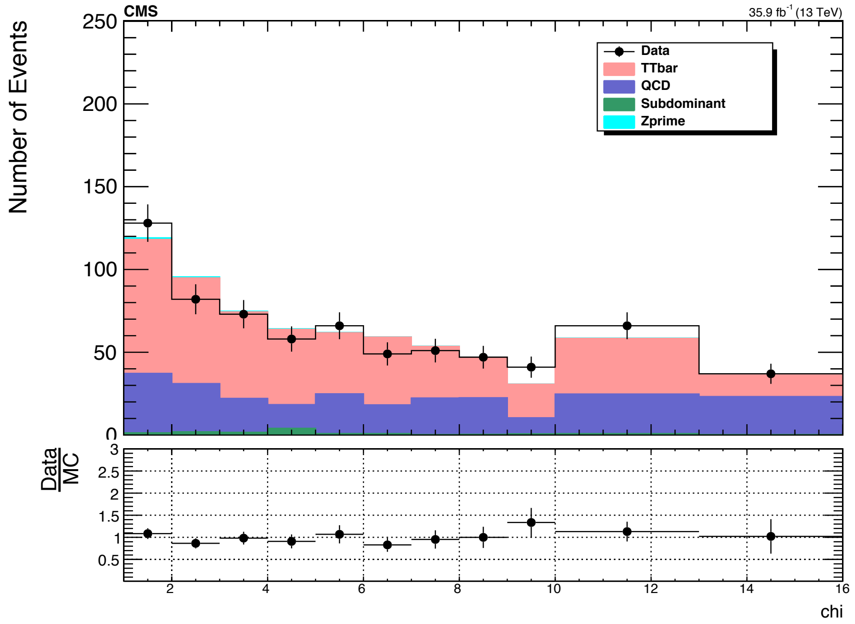


Stack Plots 2016, width 10% (Z' hist incorporated in Stack)

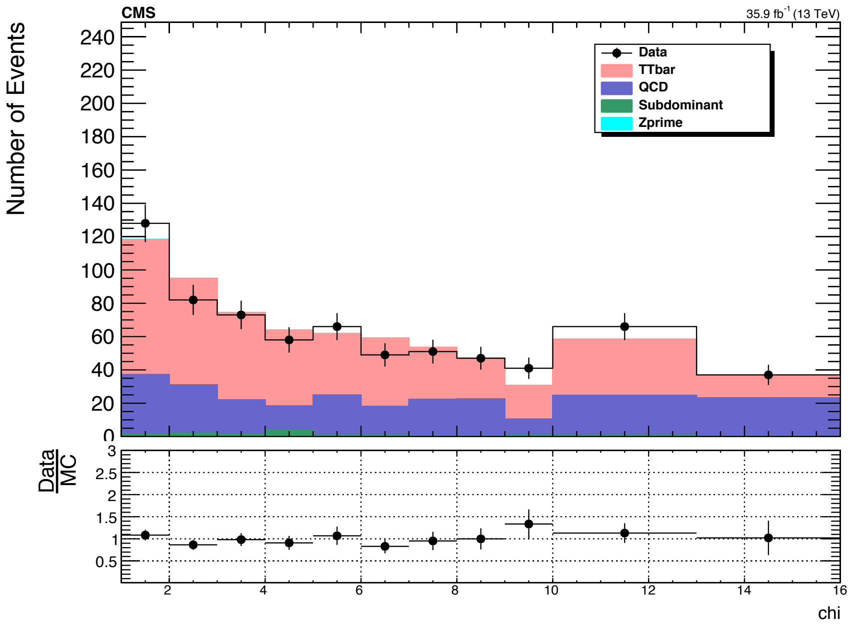
M: 2TeV



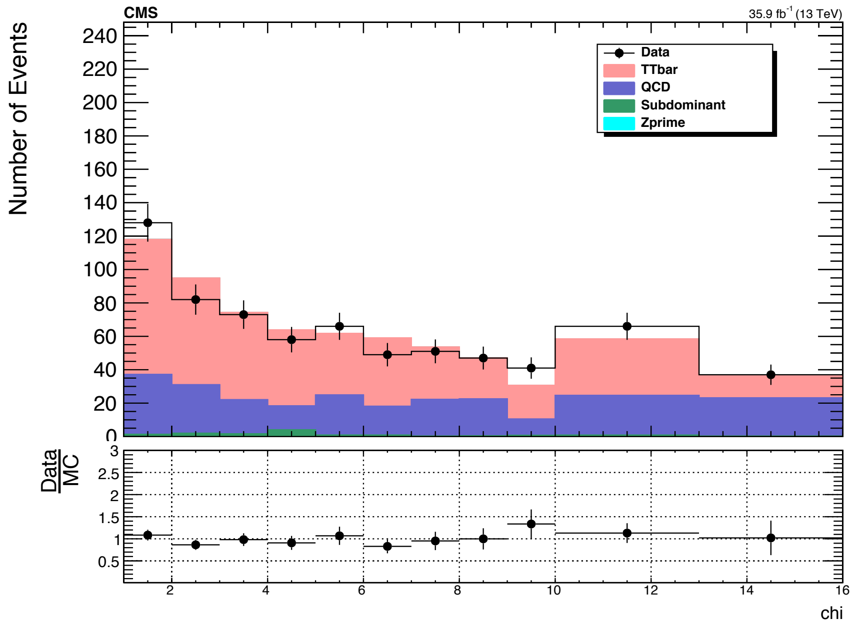
M: 2.5TeV



M: 3TeV

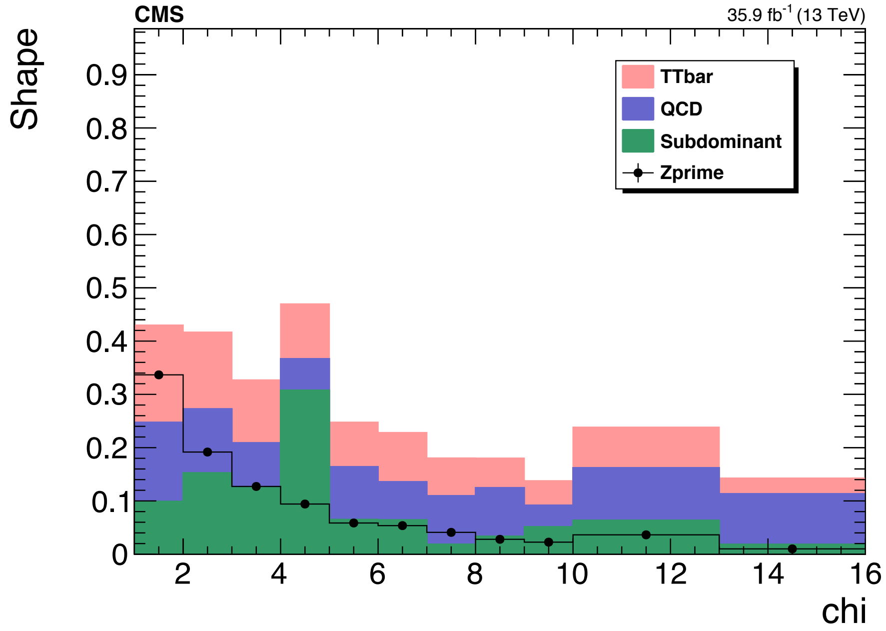


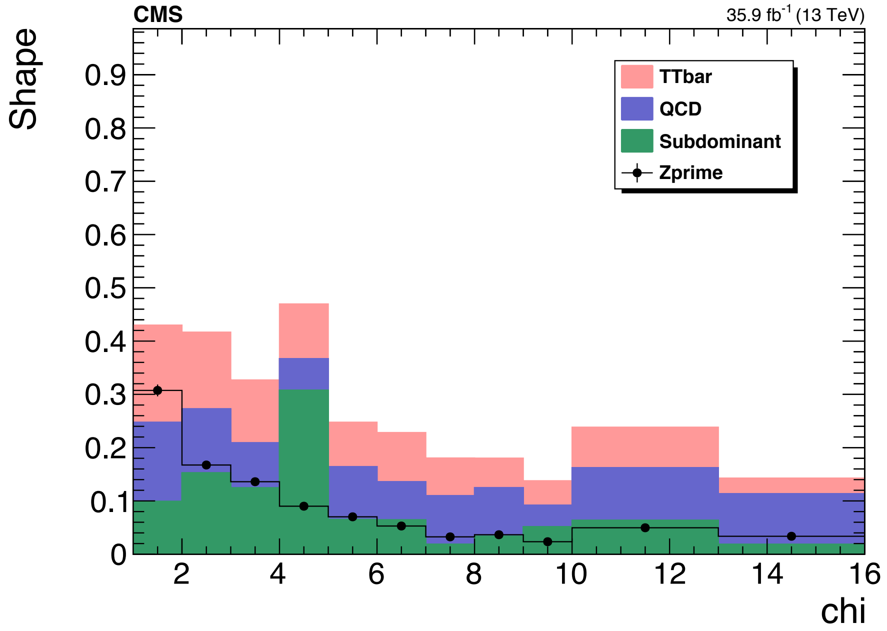
M: 4TeV



Sensitivity Plots 2016, width 1%

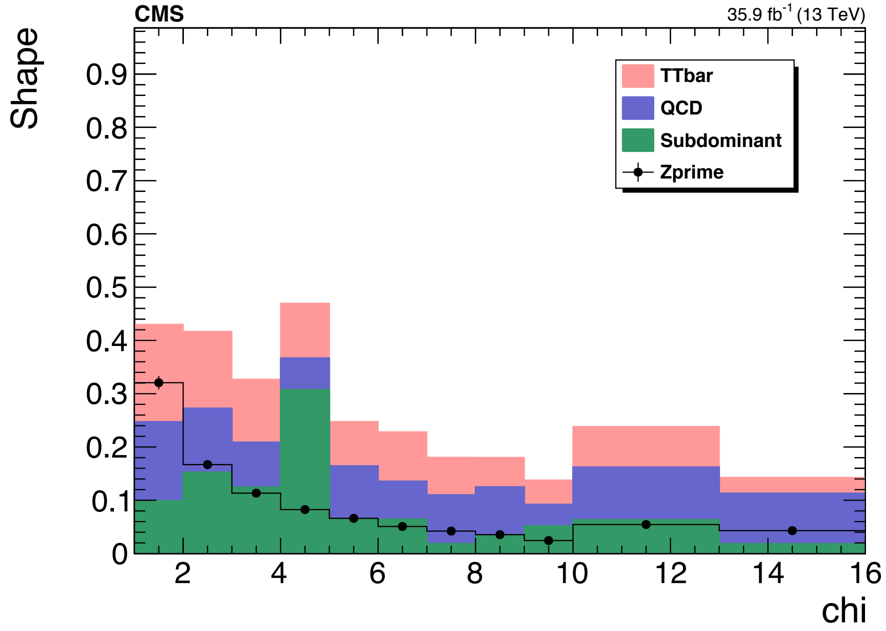
M: 2TeV

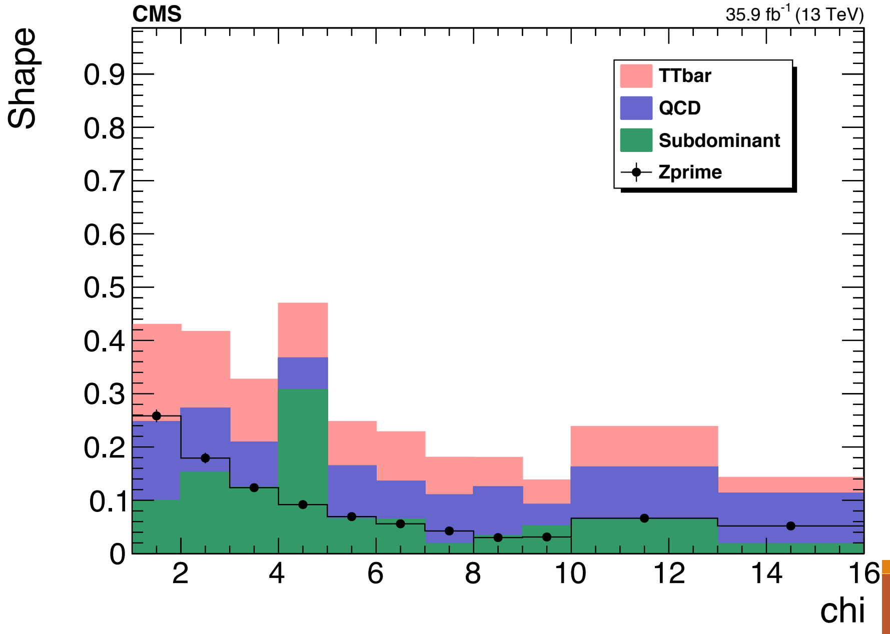




M: 2.5TeV

M: 3TeV

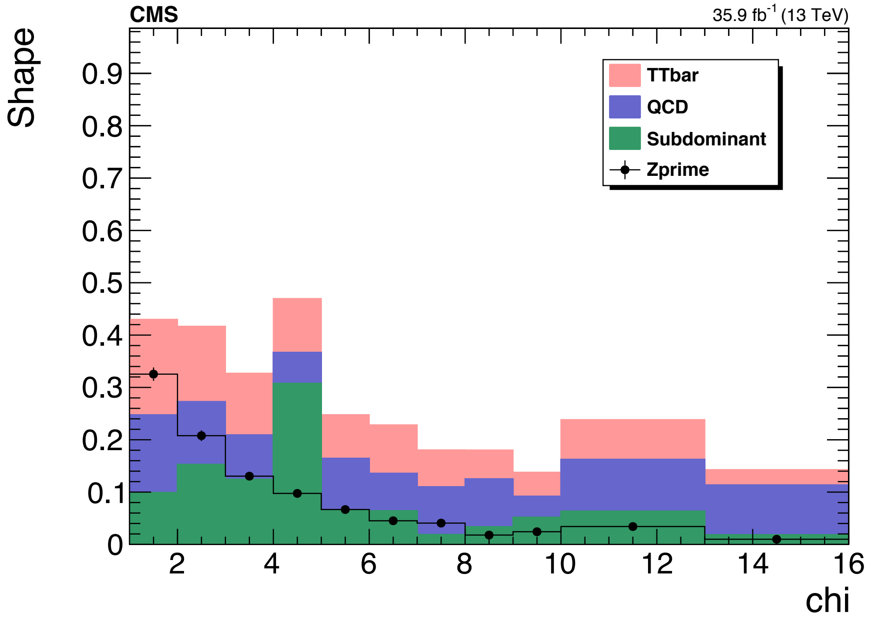




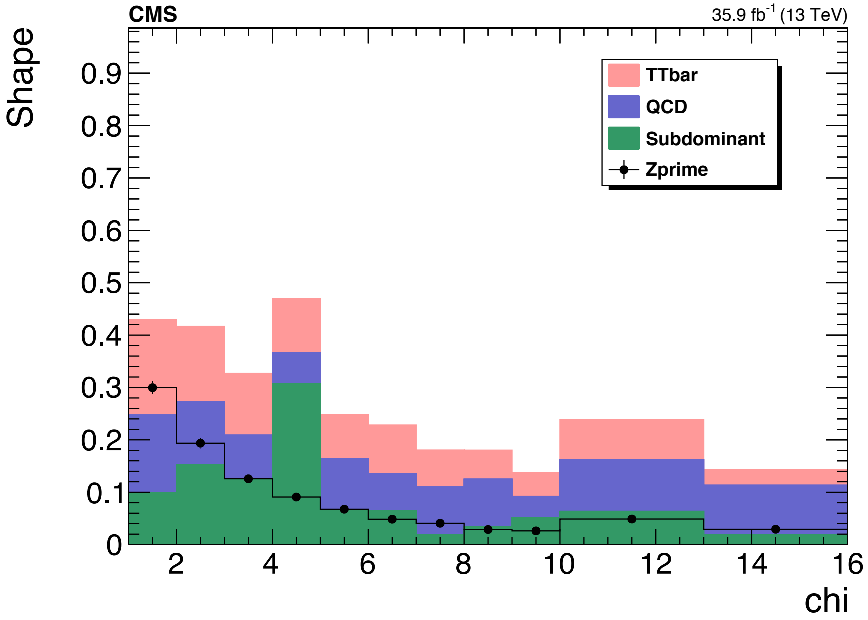
M: 4TeV

Sensitivity Plots 2016, width 10%

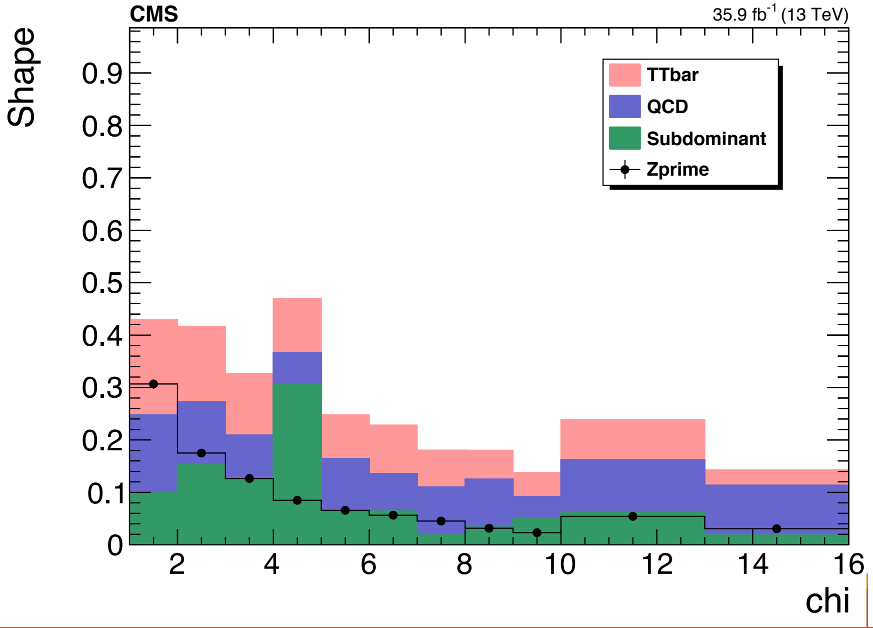
M: 2TeV



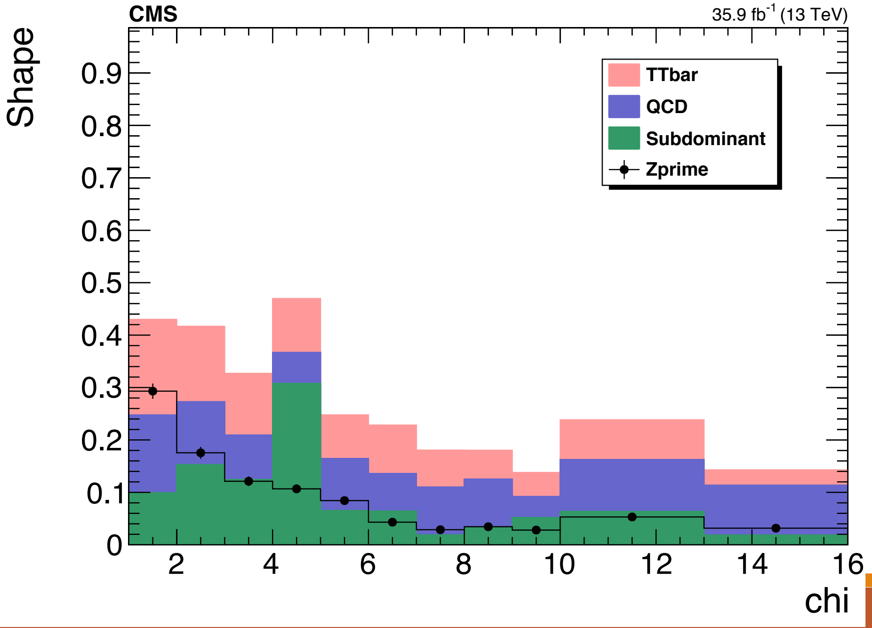
M: 2.5TeV



M: 3TeV

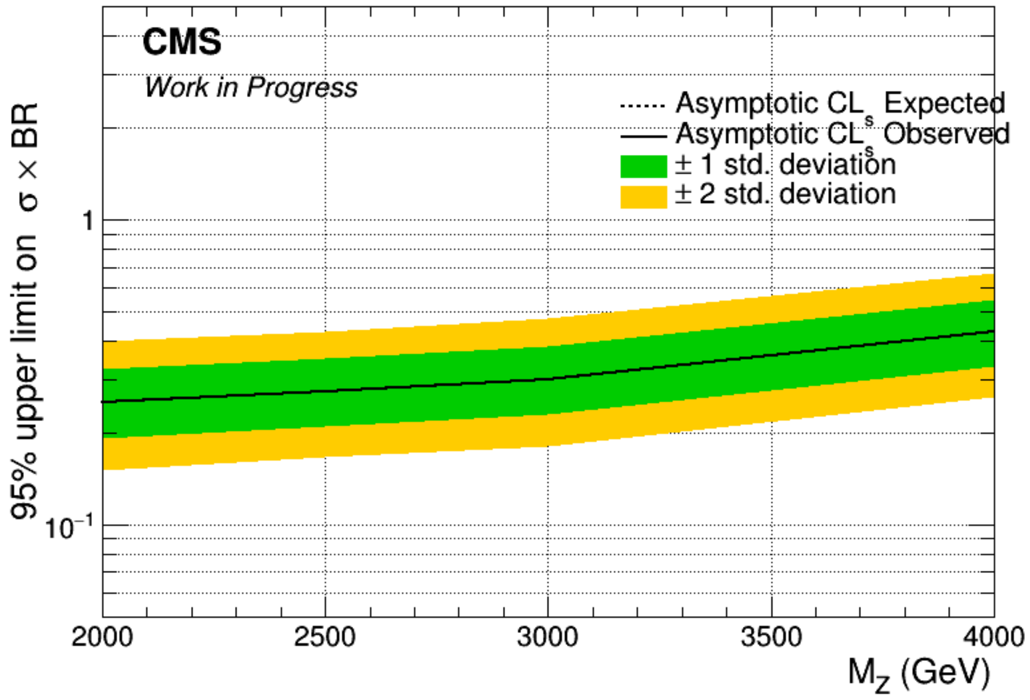


M: 4TeV

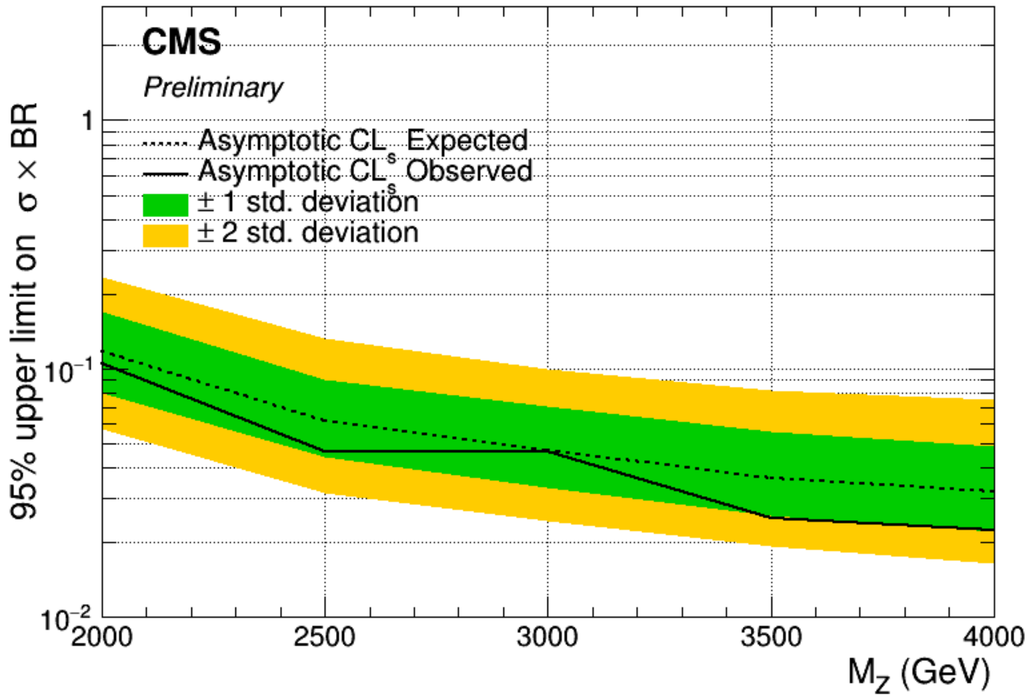


Brazilian Plots 2016, width 1%

2016 using
chi dist

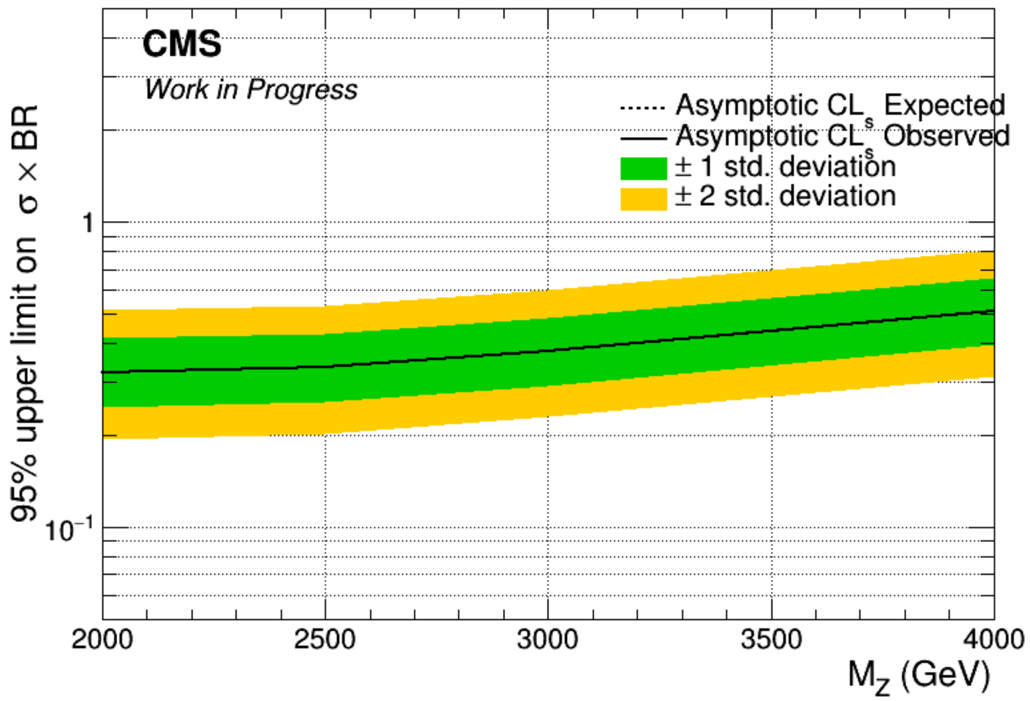


B2G-16-015
using mJJ

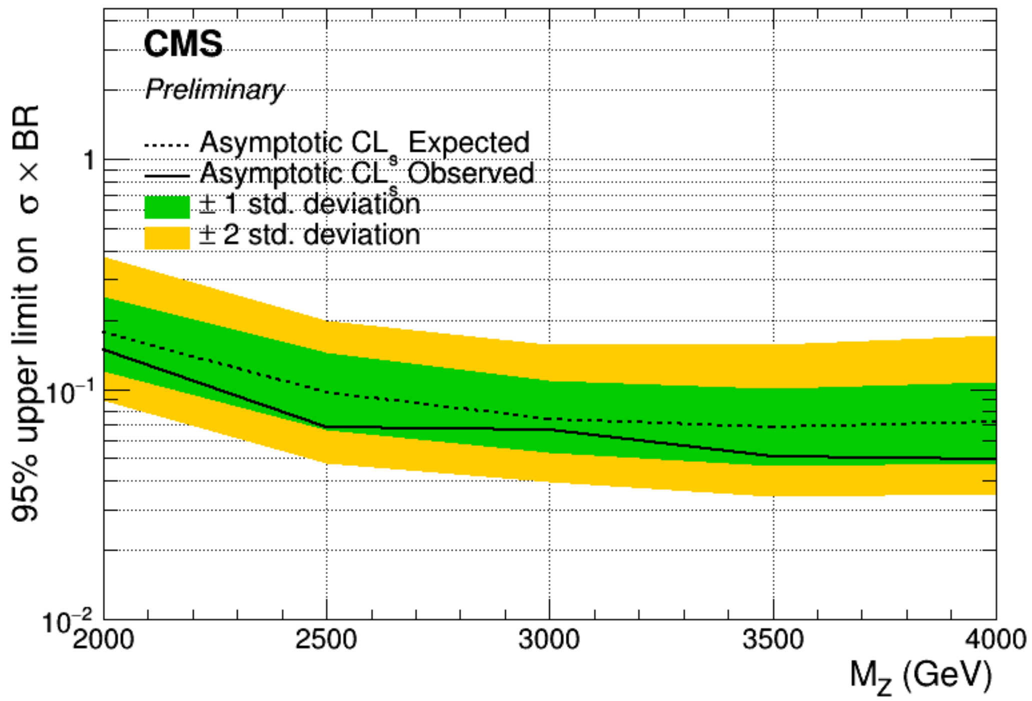


Brazilian Plots 2016, width 10%

2016 using
chi dist



B2G-16-015
using mJJ



Brazilian Plots 2016, width 1%, 10%

Width: 1%

Width: 10%

BACKUP

Summary

Angular Distributions, Z' analysis:

- New Signal Region:
  - SR_C = SR + mJJ > 1.5TeV

- 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 mJJ variable (only for 2016 and Zprime 1% width)
  - Tried to increase mass cut from 1.5 TeV to 2 TeV to improve sensititvity → not enough events coming from signal extraction
  - If I use ttbar 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 mJJ 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

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

Where $QCD_{1.5TeV}(x_{reco}) = D^{0-btag}_{1.5TeV,shape}(x_{reco})\,\boldsymbol{x}\,N_{SR(1.5TeV)}\,\boldsymbol{x}\,C^{shape\ SF}_{closure}$

and $N_{SR(1.5TeV)} = R^{1TeV\rightarrow 1.5TeV}_{yield}\,\boldsymbol{x}\,N^{QCD}_{SR(1TeV)} = R^{1TeV\rightarrow 1.5TeV}_{yield}\,\boldsymbol{x}\,R^{SR_A\rightarrow SR}_{yield}\,\boldsymbol{x}\,N^{QCD}_{SR_A}$

- The variable of interest here: x_{reco} → χ
- 1.5 TeV refers to the mJJ cut

- We deploy a fit in the Signal Region (2btag) to extract the N^{fit}_{QCD} in SRA (mJJ > 1TeV)

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

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 x

- 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:

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

X 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

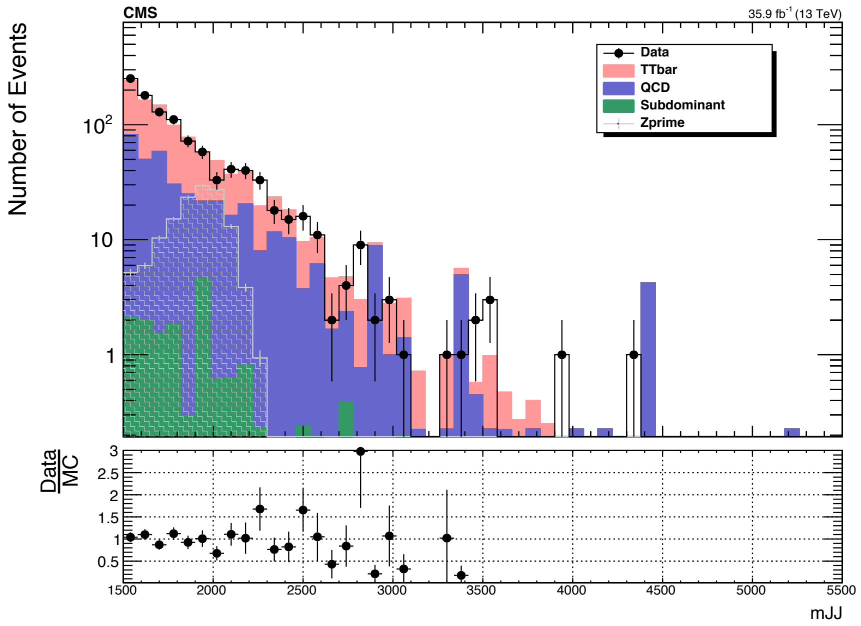
2. By measuring the scattering angle θ* (angle between top quark and z-axis in the Zero Momentum Frame)

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

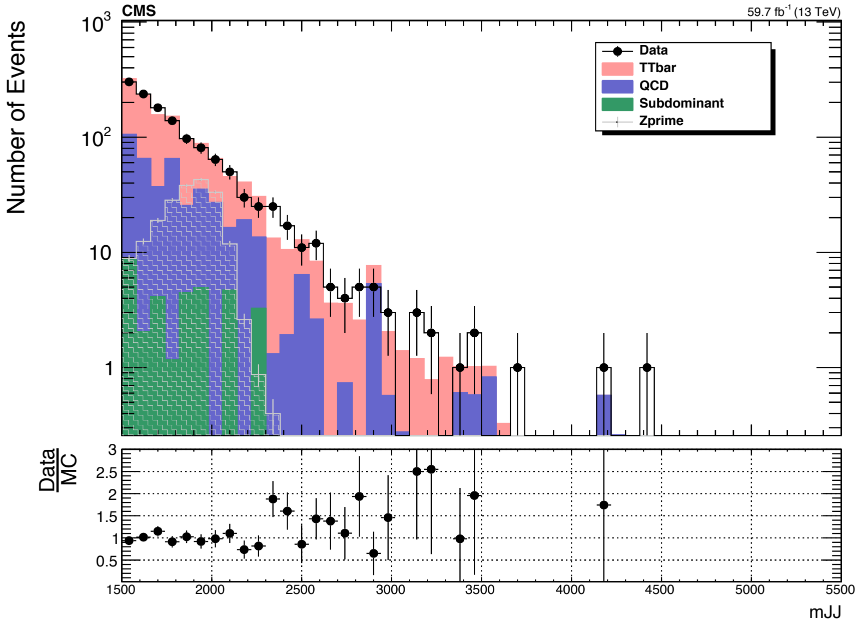
$$\chi = \frac{1 + |cos\theta^*|}{1 - |cos\theta^*|}$$

Stack Distributions vs B2G-16-015 Mz=2TeV, w 1%

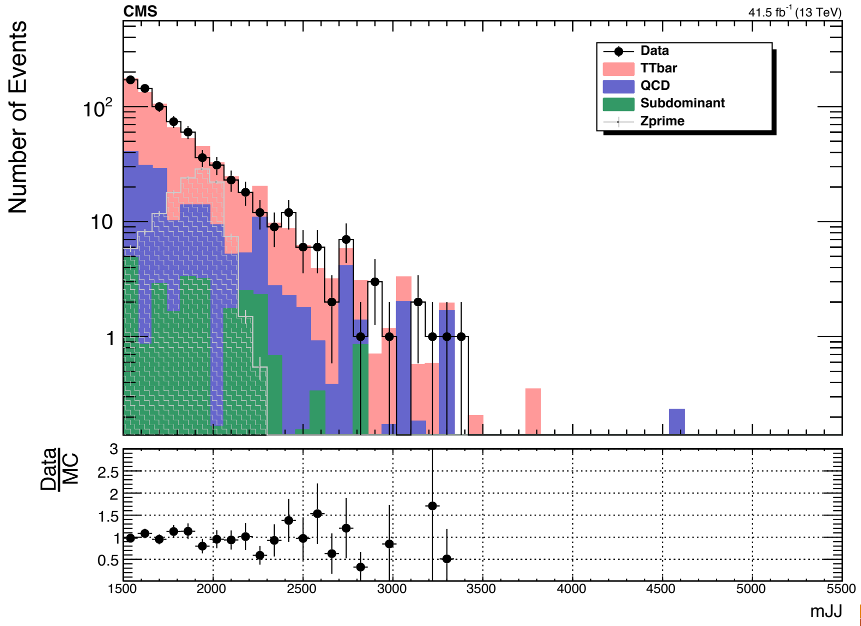
2016

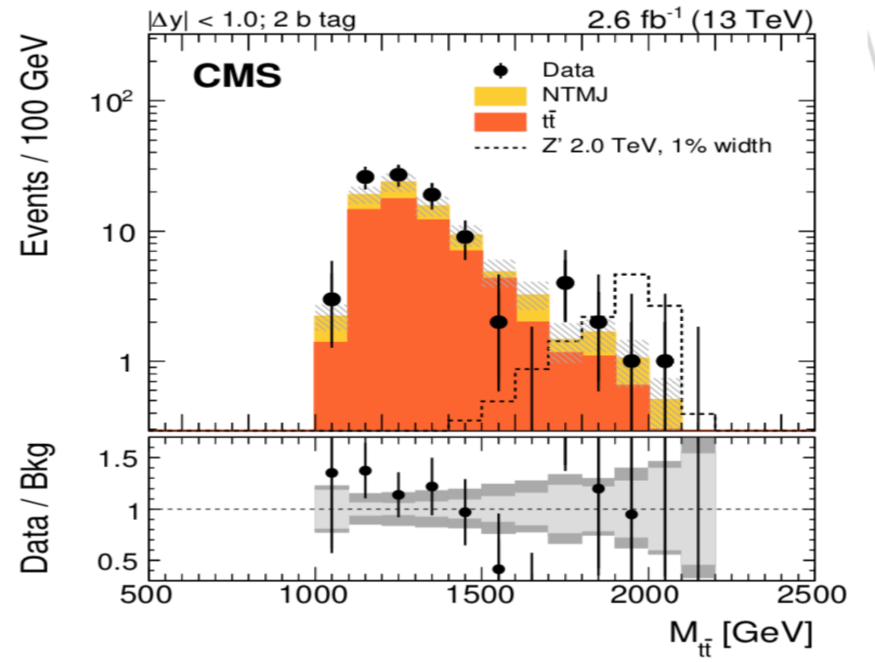


2018



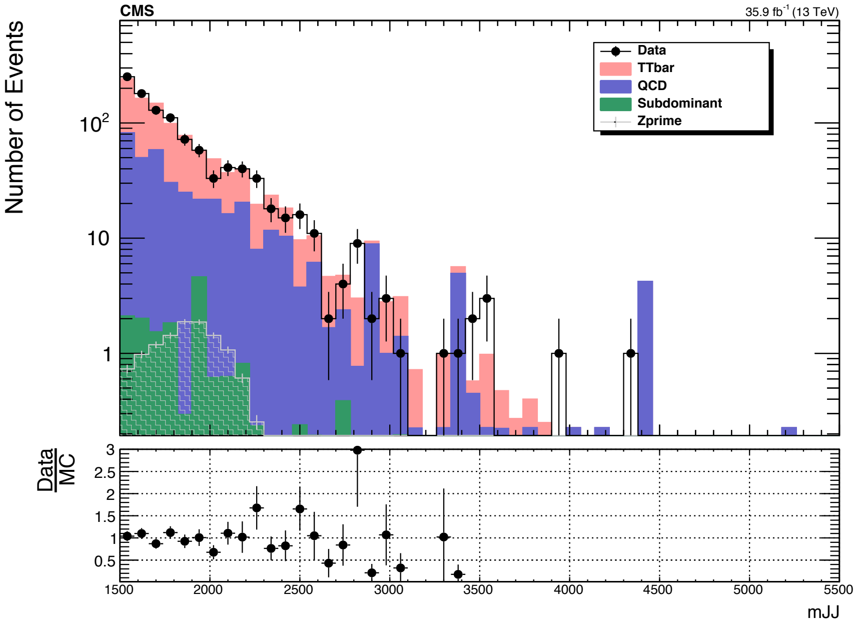
2017



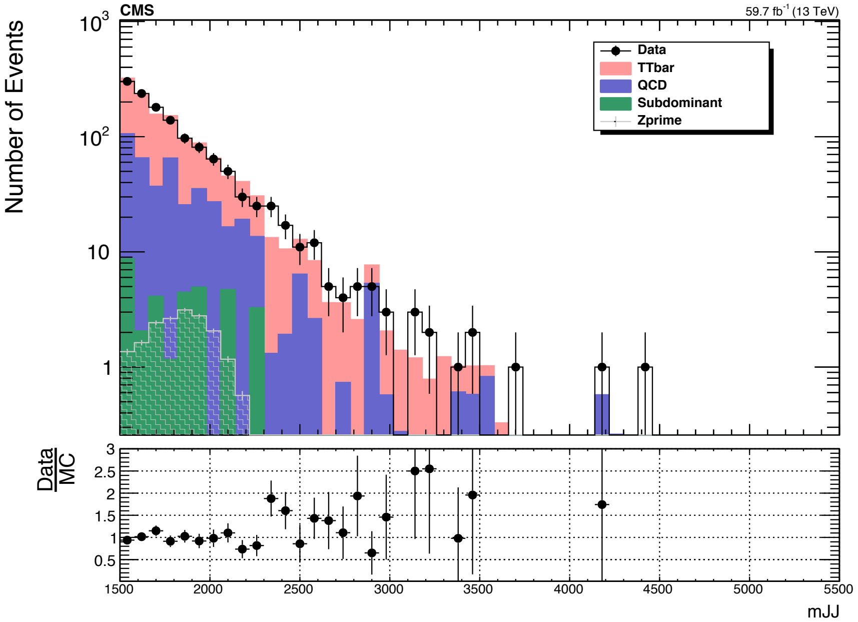


Stack Distributions vs B2G-16-015 Mz=2TeV, w 10%

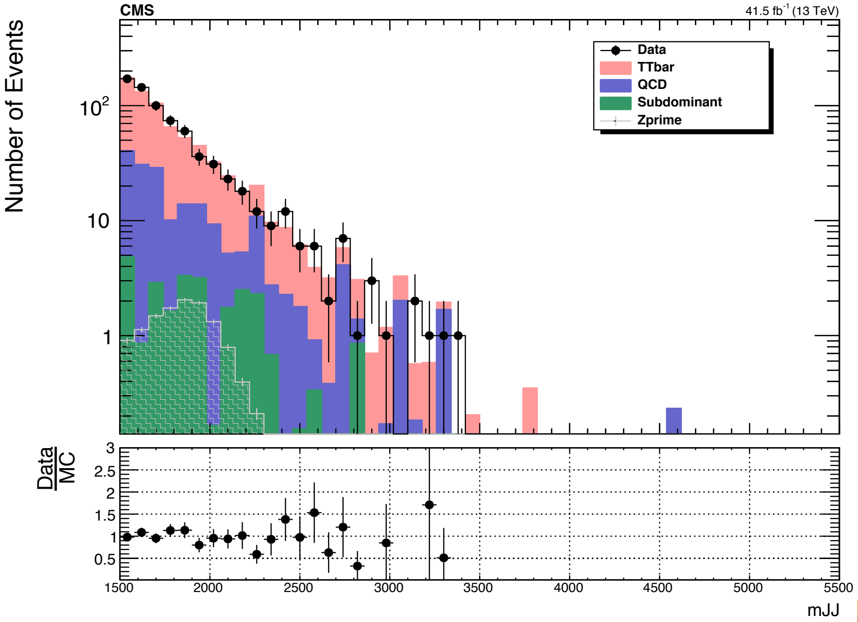
2016



2018

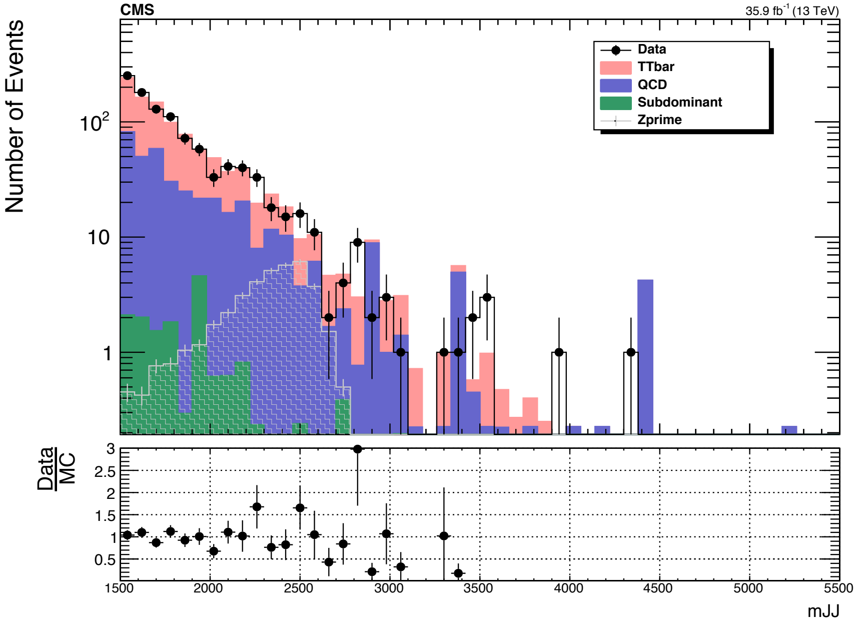


2017

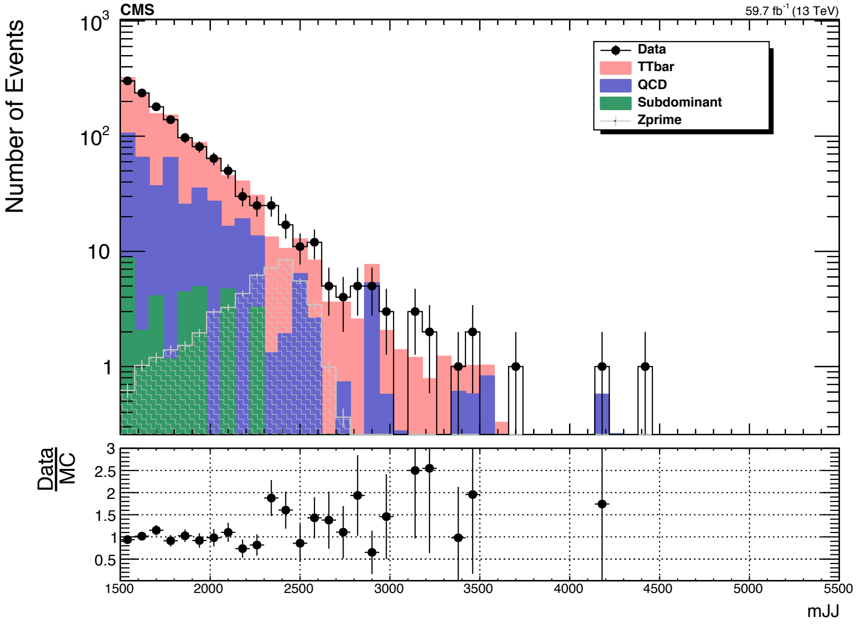


Stack Distributions Mz = 2.5TeV, w 1%

2016



2018



2017