HEP NTUA
Weekly Report

11/3/2021

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Summary

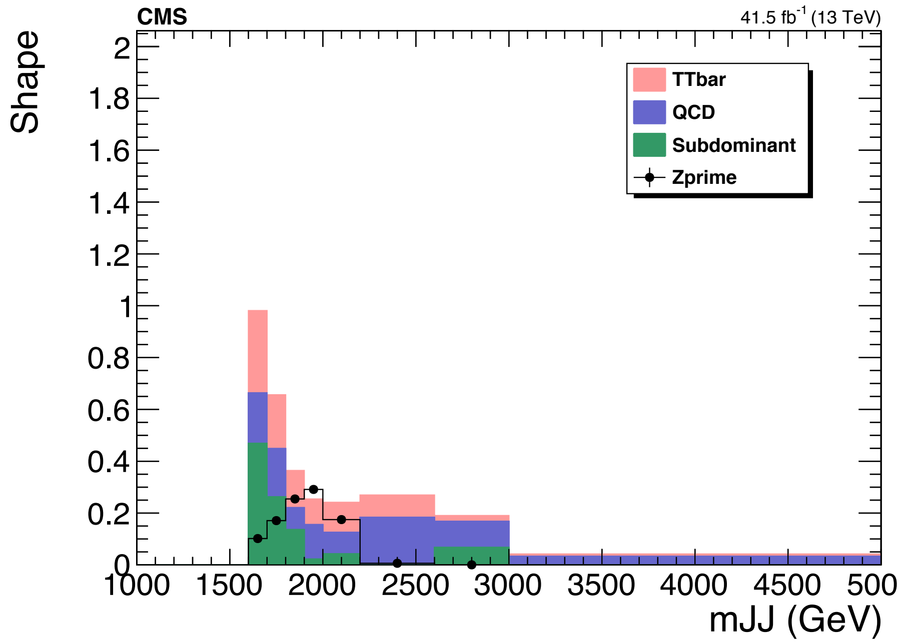
ttX analysis:

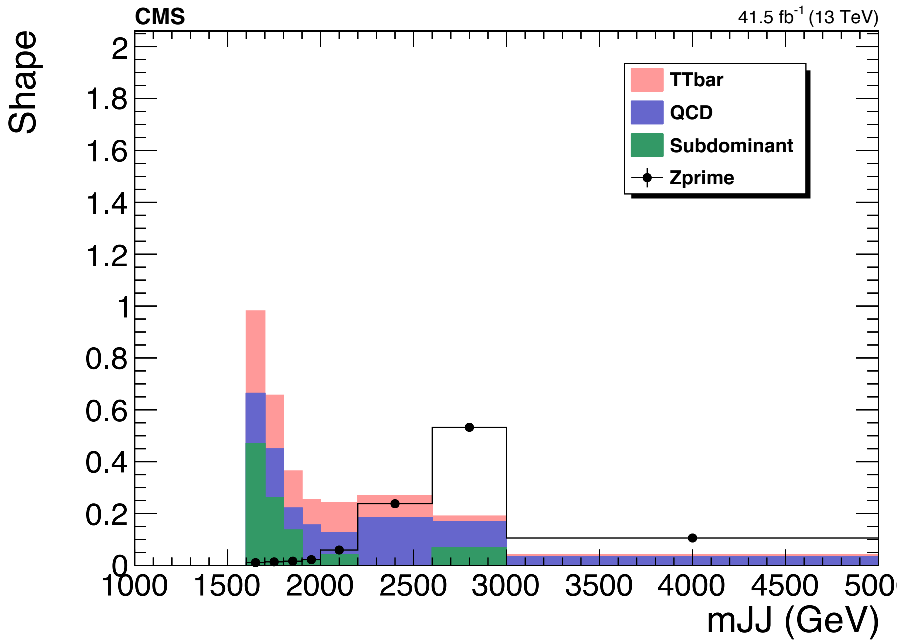
- Production of UL files
  - 2016 (both pre and postVFP) is missing bTagging WP's and scale factors
- Acceptance Problem:
  - We tried several approaches
  - Discussion --> we applied geometrical matching on our jets
  - Removed matching from all our code
  - Doesn't seem to fix the problem (Giannis)

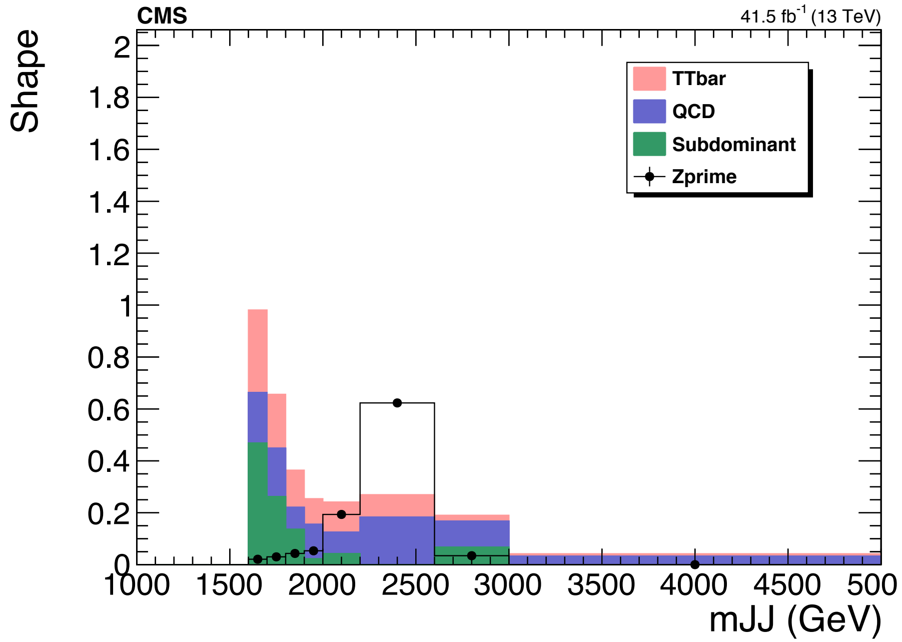
Z' analysis

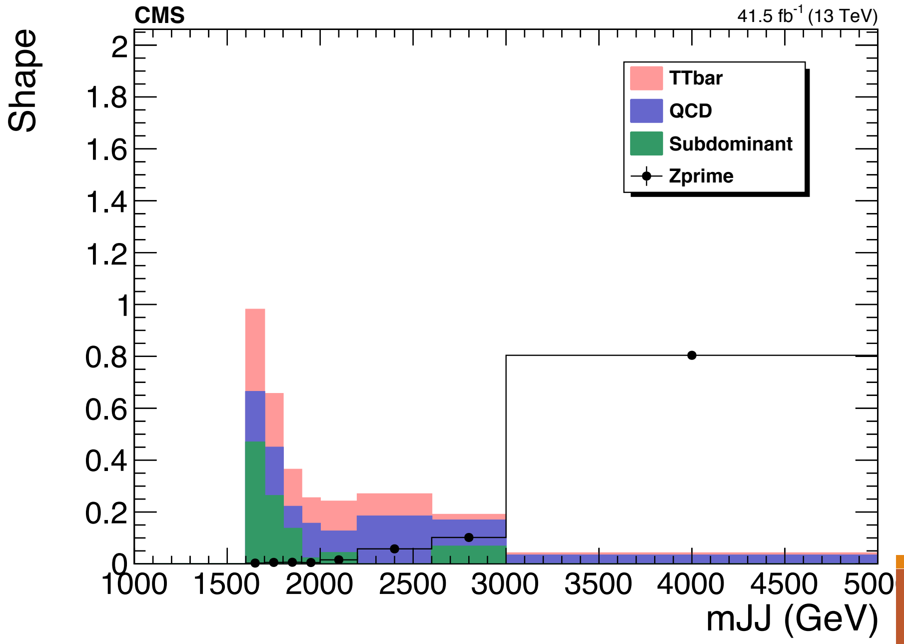
- Switch to UL files for Z' (missing: 2016_postVFP (all widths) and 2016_preVFP, 2017, 2018 10% and 30% width files)
  - Email to MC generation group
- Trying to switch to more sensitive variables
  - Chi (dijet) is not suitable for this type of analysis → Asymptotic limits
  - Most analyses use the mJJ variable
    - All distributions are for 2017
    - mJJ sensitivity (both stack and only with ttbar) with mJJ > 1600 GeV
    - Implementation of $|\Delta y| < 1$ cut
  - Chi distributions over different mJJ ranges (next week)

Sensitivity Plots

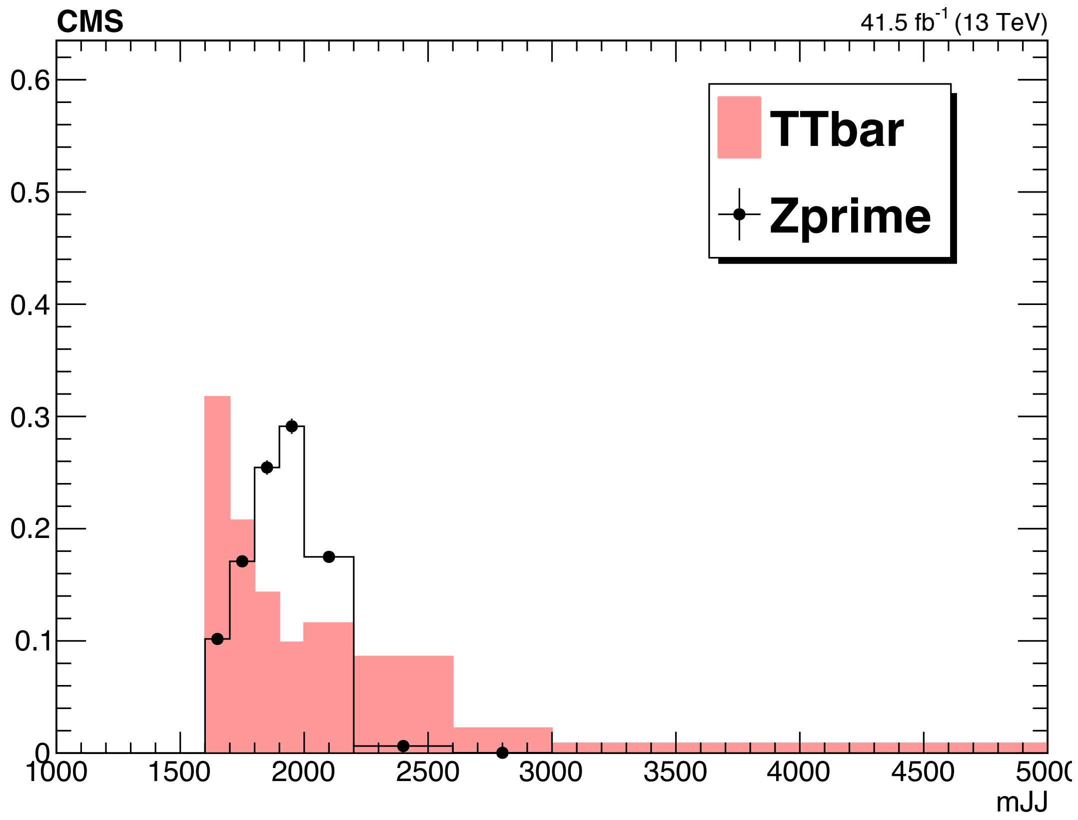


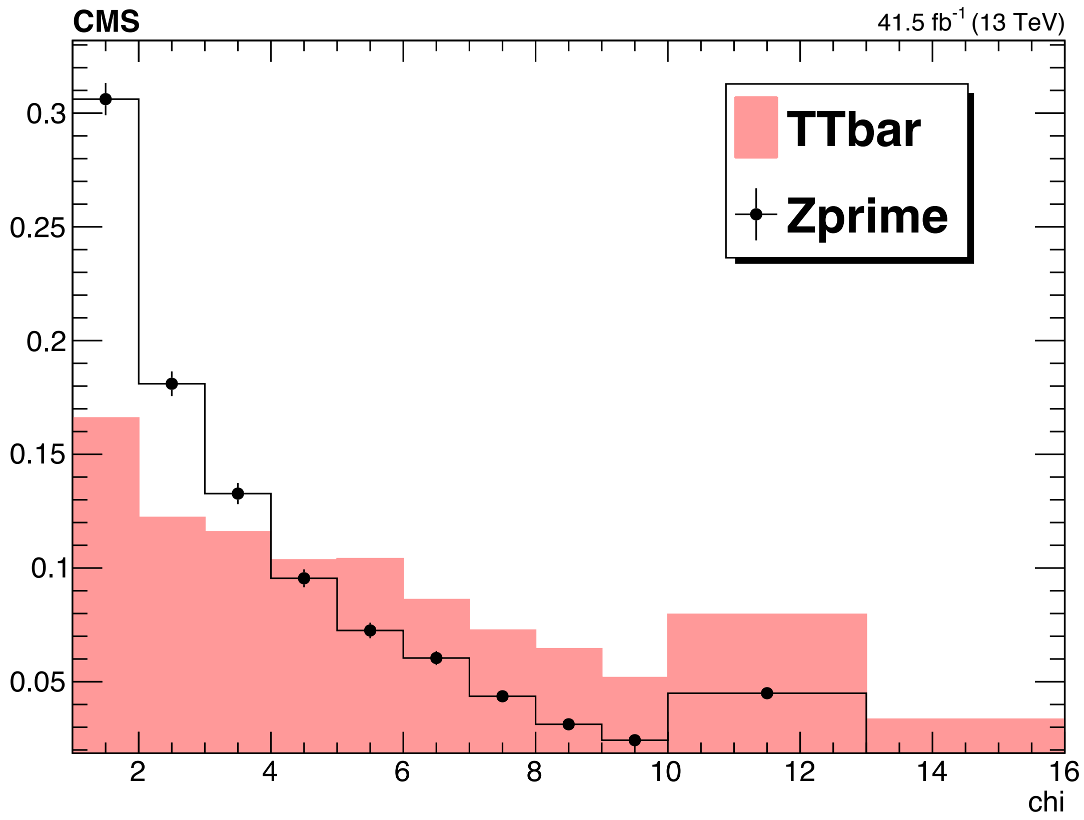




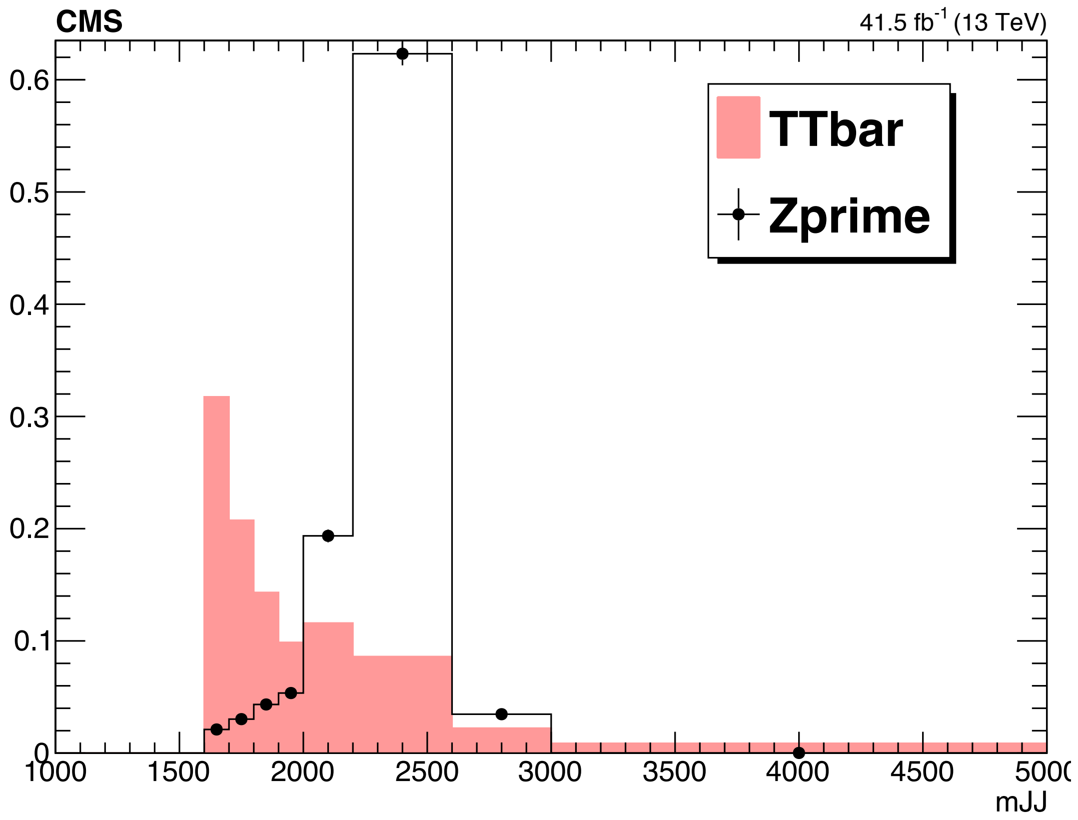


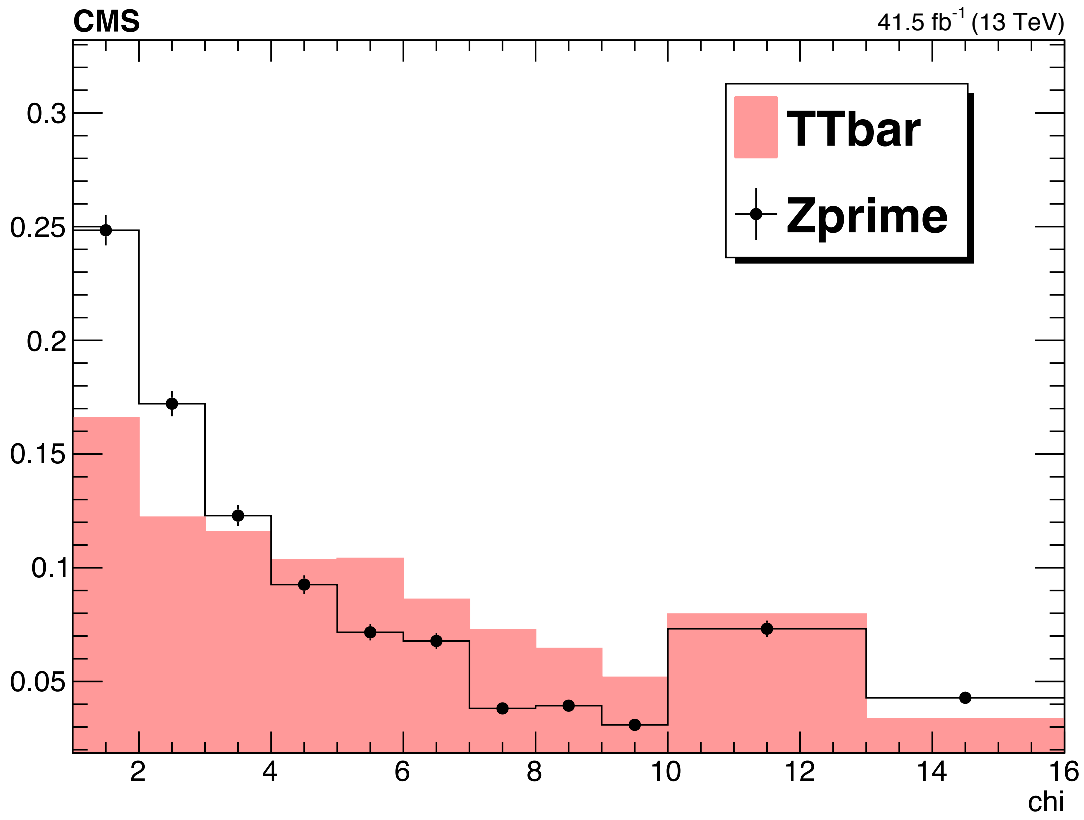
Sensitivity Plots (ttbar vs Z') mJJ vs chi, mZ' = 2TeV, w = 1%



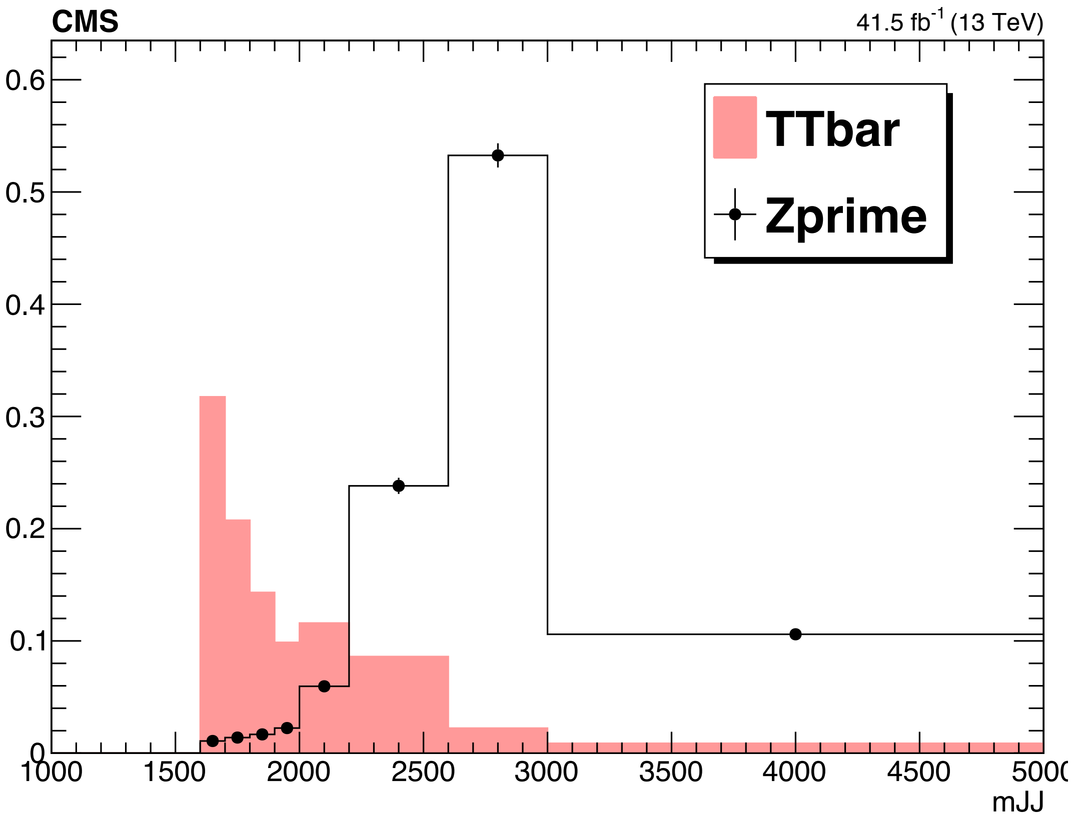


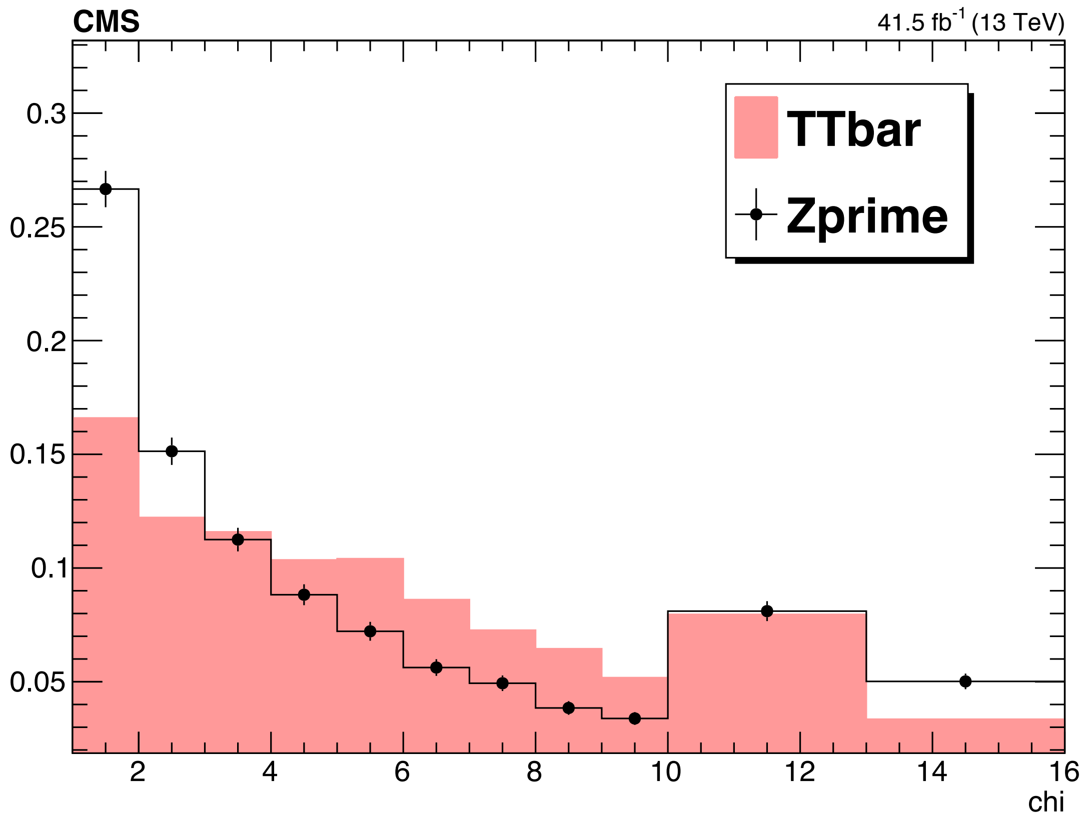
Sensitivity Plots (ttbar vs Z’) mJJ vs chi, mZ’ = 2.5TeV, w = 1%





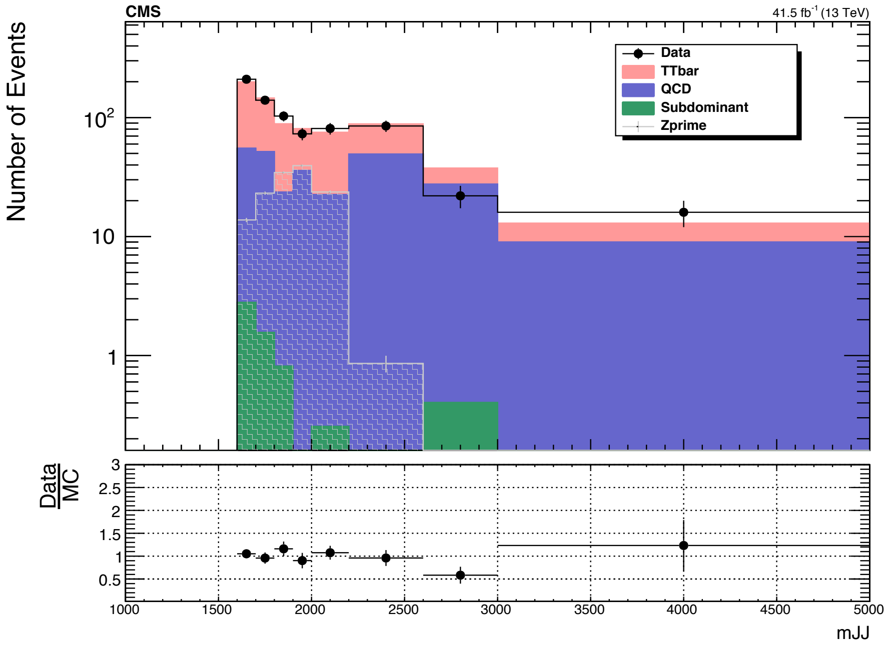
Sensitivity Plots (ttbar vs Z’) mJJ vs chi, mZ’ =3TeV, w = 1%



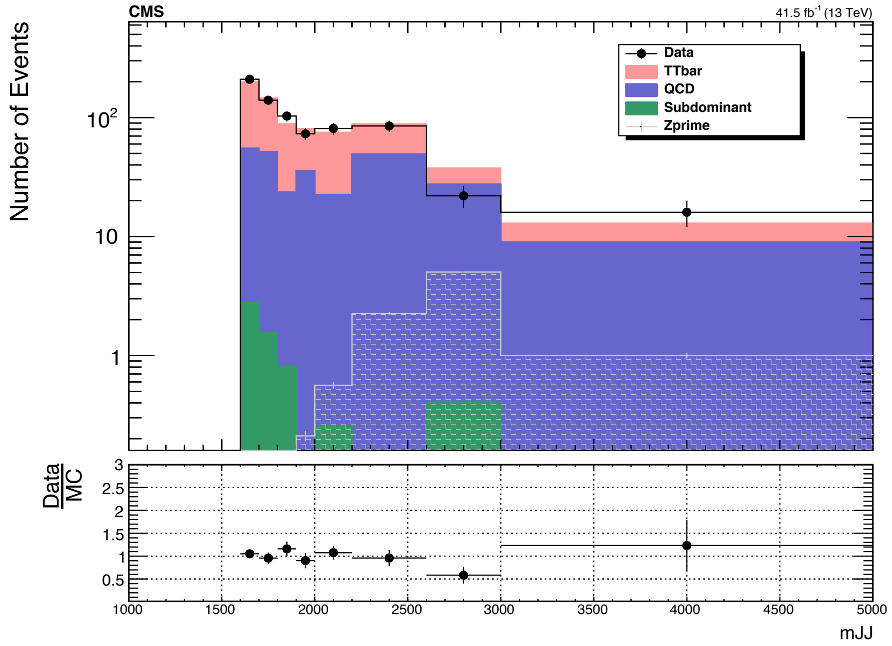


mJJ Stack Plots without Implementation of |Δy| < 1

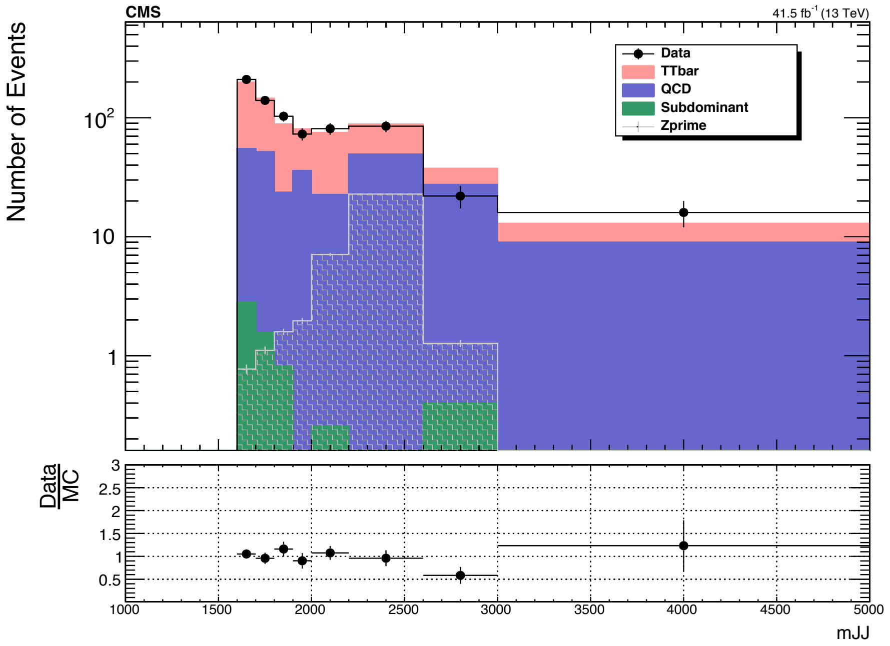
M:2TeV,
W=1%



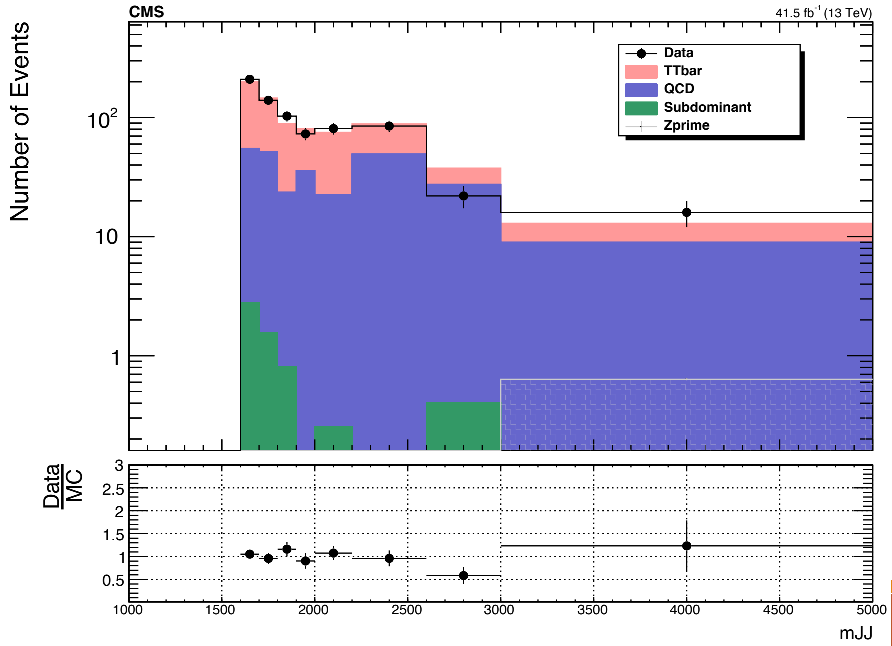
M:3TeV,
W=1%



M:2.5TeV,
W=1%

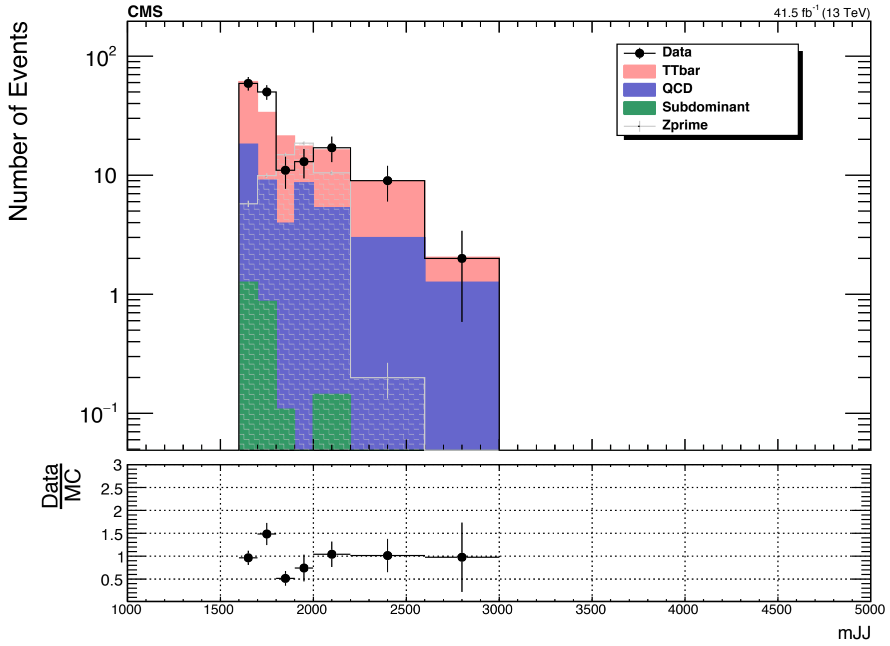


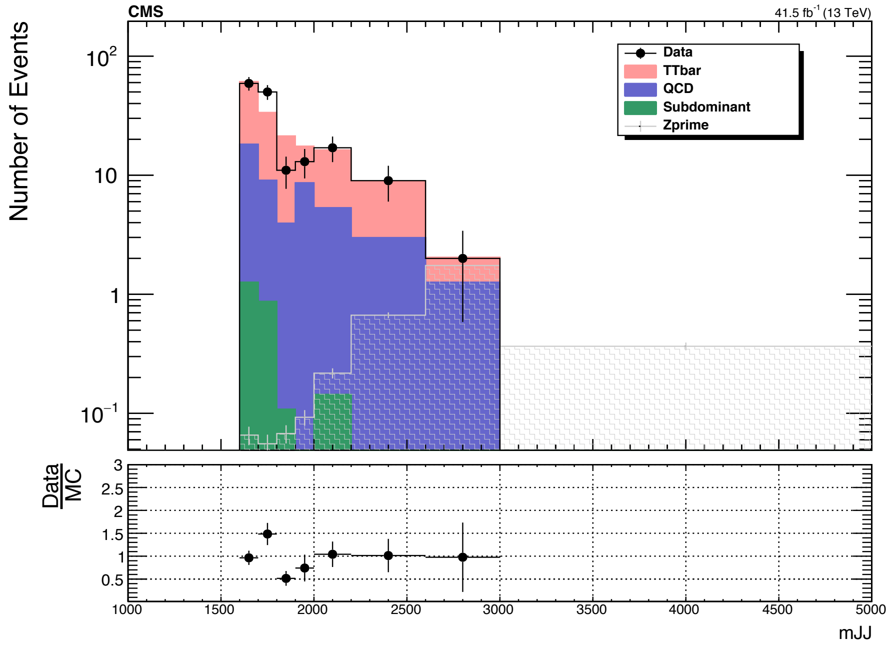
M:4TeV,
W=1%



mJJ Stack Plots with Implementation of |Δy| < 1

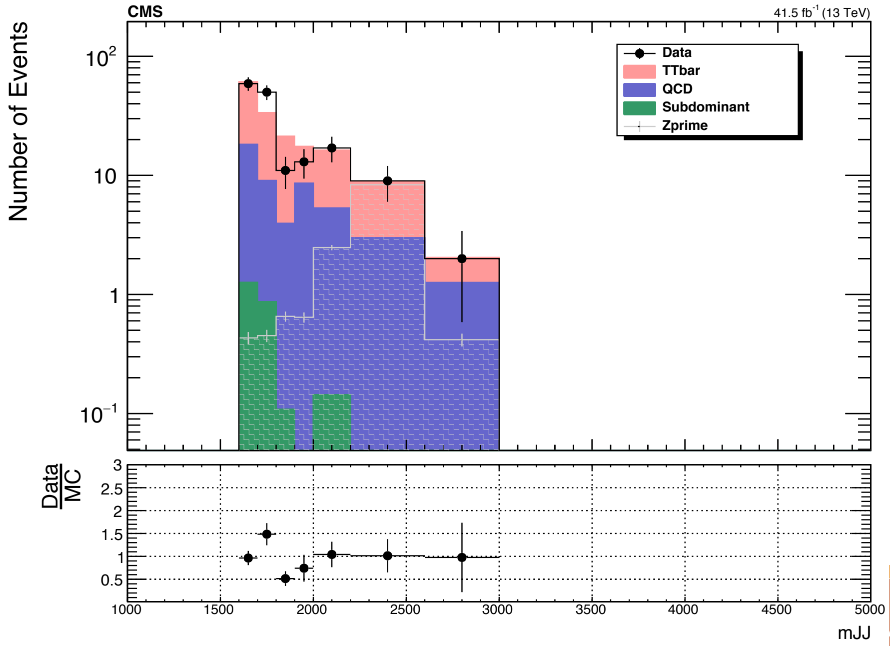
M:2TeV,
W=1%

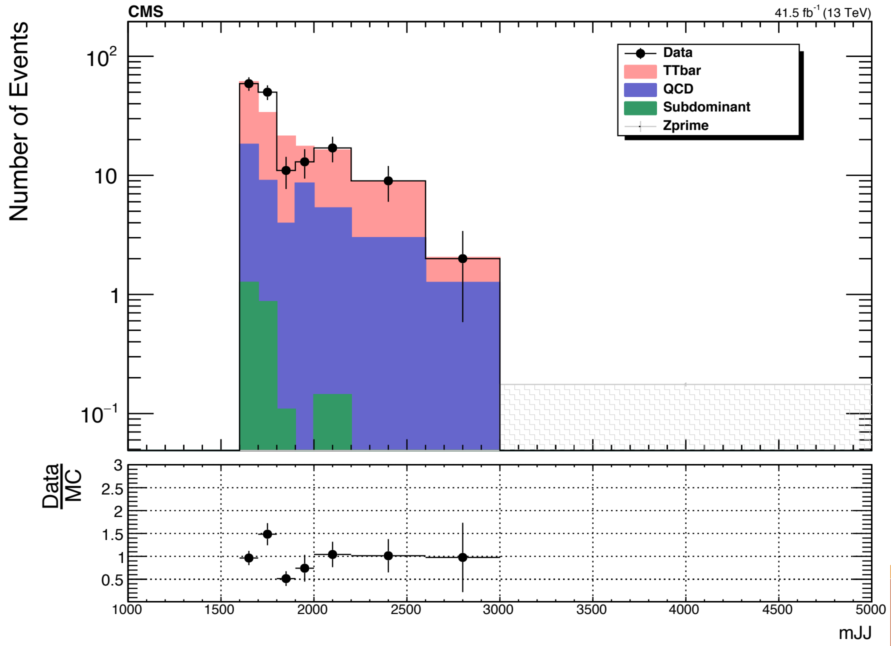




M:3TeV,
W=1%

M:2.5TeV,
W=1%





M:4TeV,
W=1%

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:

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