HEP NTUA
Top Angular Report

2/4/2021

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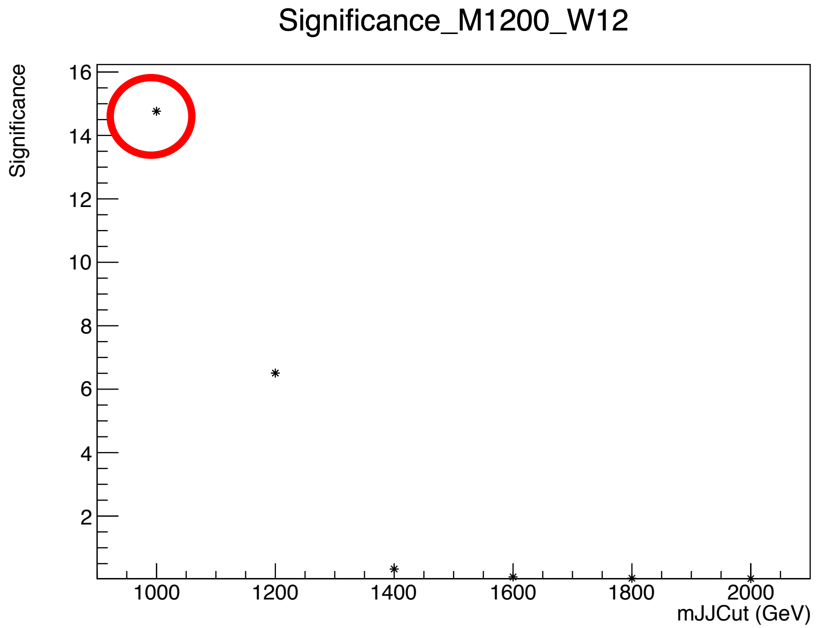
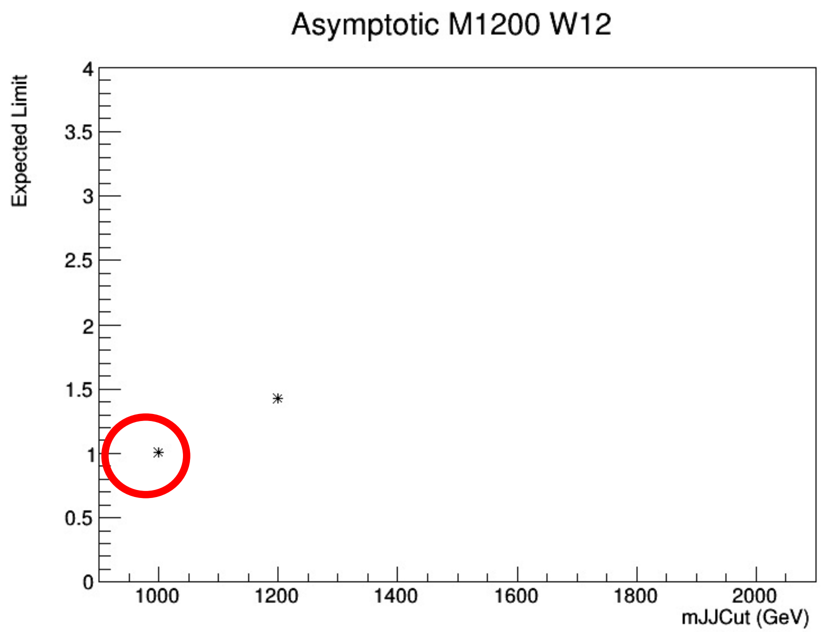
Summary Z' Analysis

- Switch to mJJ > 1000 GeV cut:
  - No sensitivity for higher Z' masses (> 2.5 TeV)
  - Calculate significance and Brazilian plots for different mJJ cuts
    - mJJ Cuts: [1000, 1200, 1400, 1600, 1800, 2000] GeV
    - $Significance = \frac{Signal}{\sqrt{Signal+Bkg}}$ where signal is the Z' distribution and $Bkg \coloneqq ttbar + QCD + Subdominant$
  - Calculate asymptotic limit to find optimal mJJ cut
    - Compare this to the significance for each mJJ cut
  - I was using ttbar as the extracted signal from data: Instead I use the ttbar MC distribution (scaled to the signal strength)
  - For QCD I use the QCD MC distribution which is scaled to data (using k-factor)
  - Both the Significance and Brazilian plots use these files as input → this is the reason that the Brazilian plots are different than what I showed on the HEP NTUA weekly on 24th of March
  - Sliding mJJ Cut

Significance (left) and Asymptotic (right) Graphs (2017)

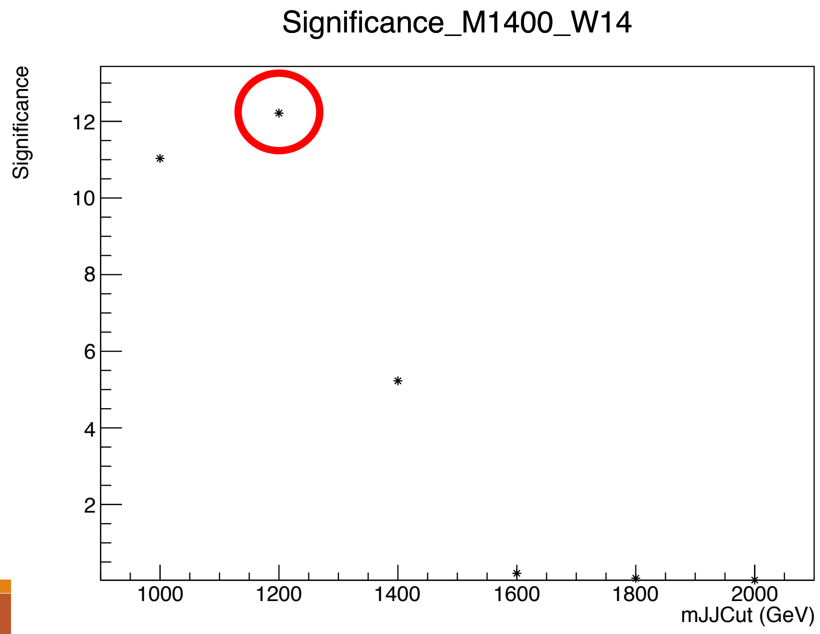
$M_{z'}$ =1200, w = 1%

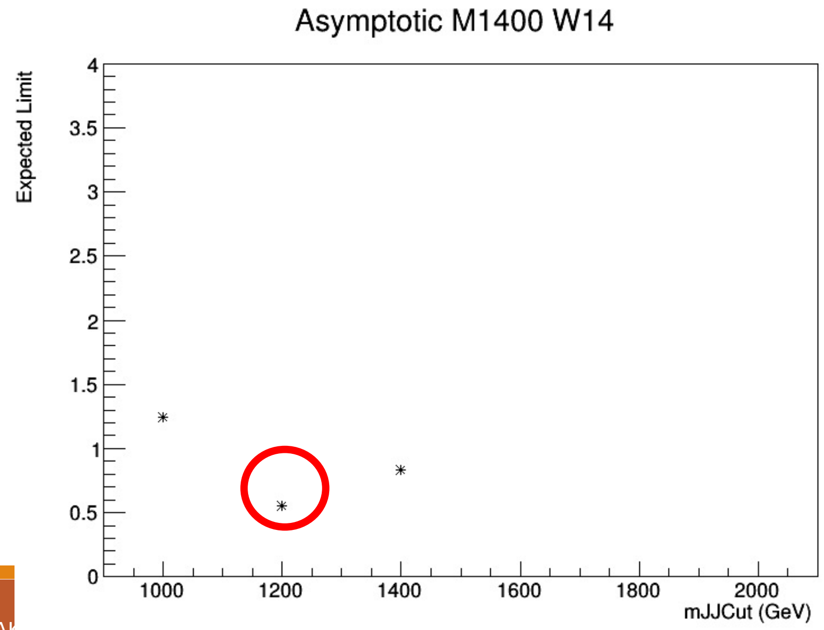




$M_{z'}$ = 1200, w = 1%

$M_{z'}$ =1400, w = 1%

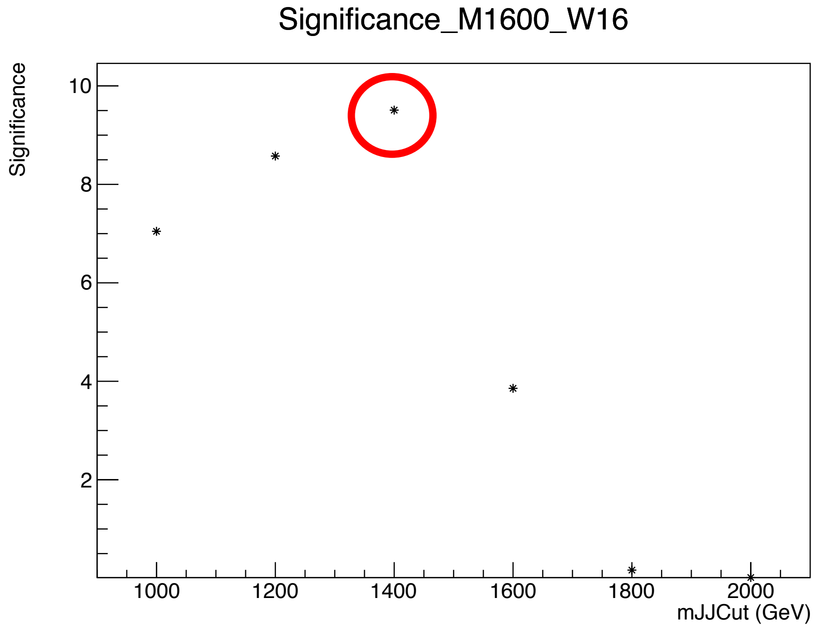


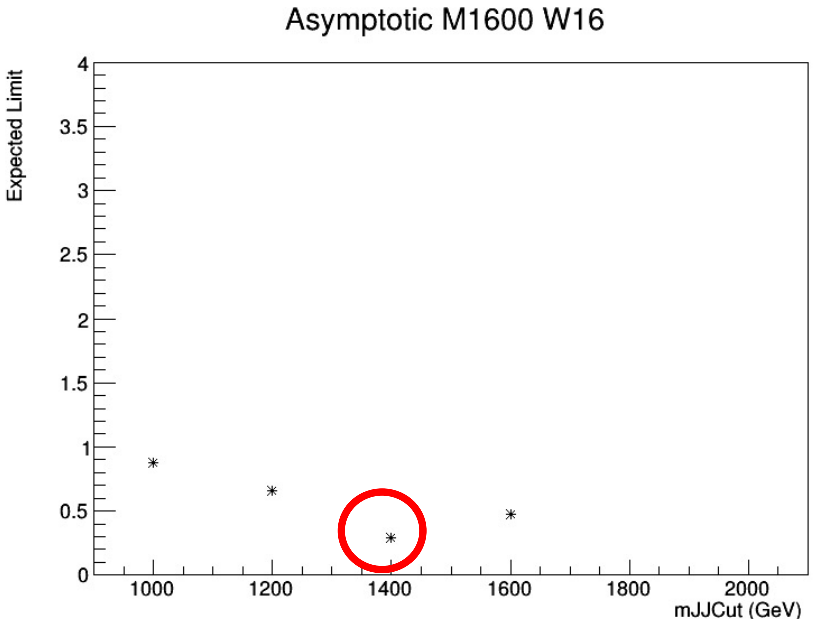


$M_{z'}$ =1400, w = 1%

Significance (left) and Asymptotic (right) Graphs (2017)

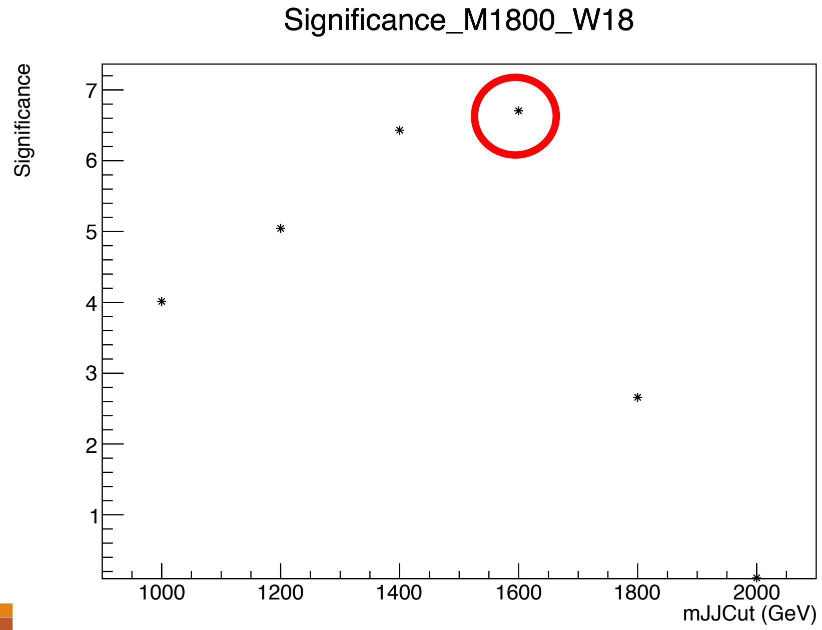
$M_{z'}$ =1600, w = 1%

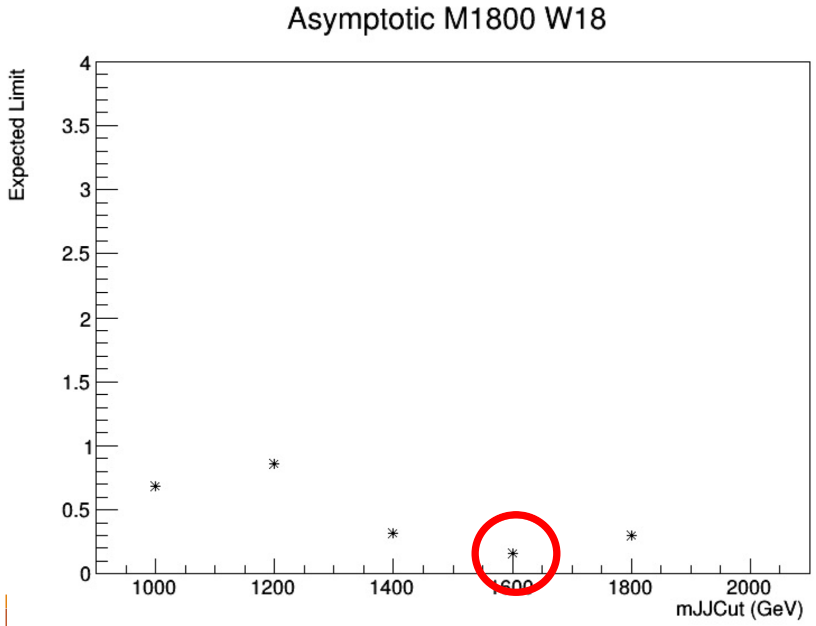




$M_{z'}$ =1600, w = 1%

$M_{z'}$ =1800, w = 1%

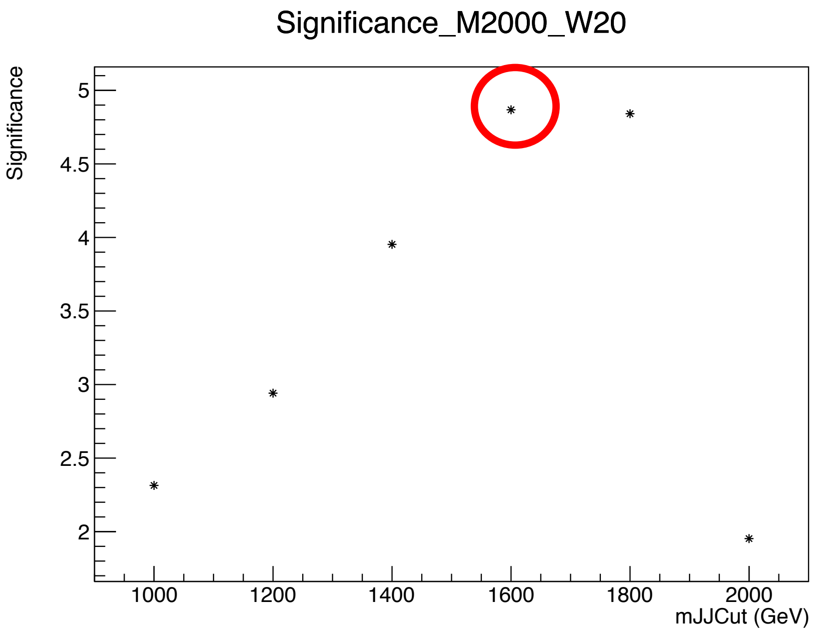


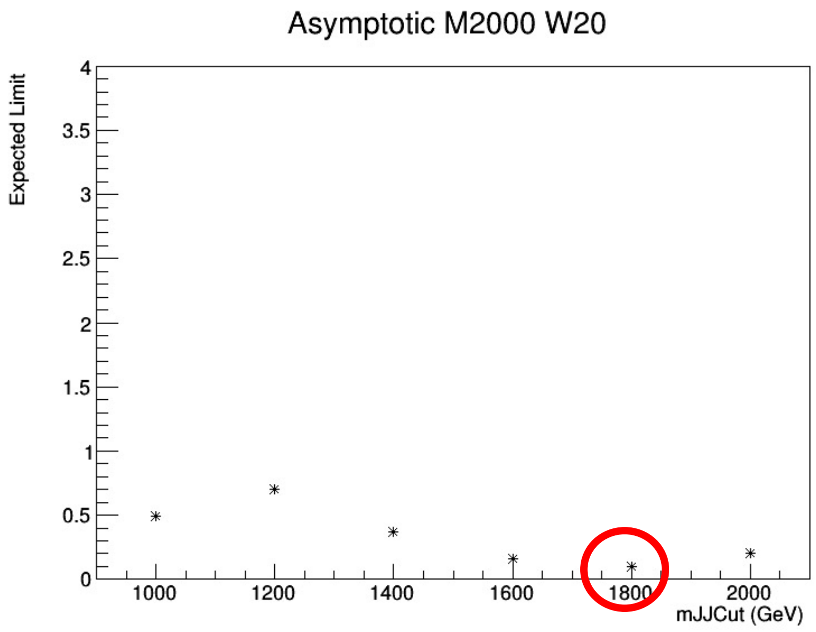


$M_{z'}$ =1800, w = 1%

Significance (left) and Asymptotic (right) Graphs (2017)

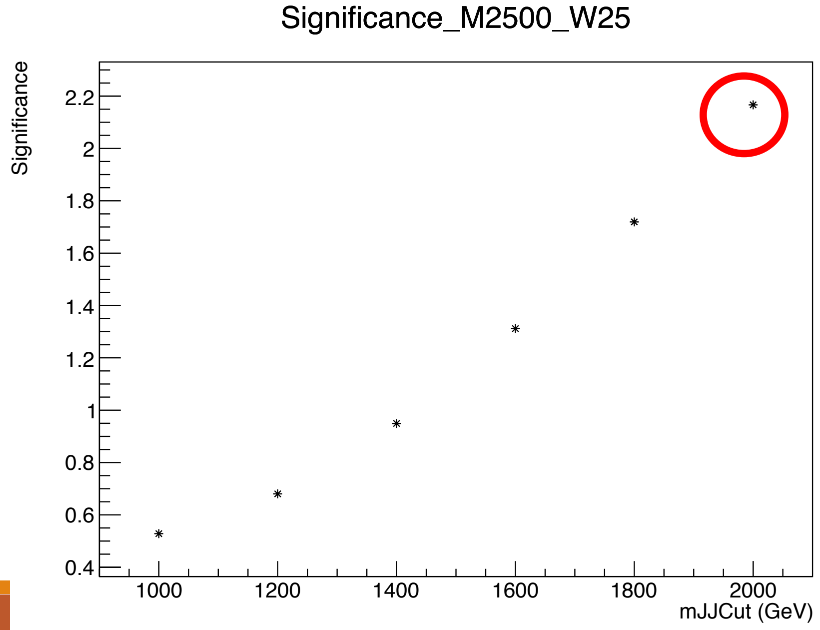
$M_{z'}$ =2000, w = 1%

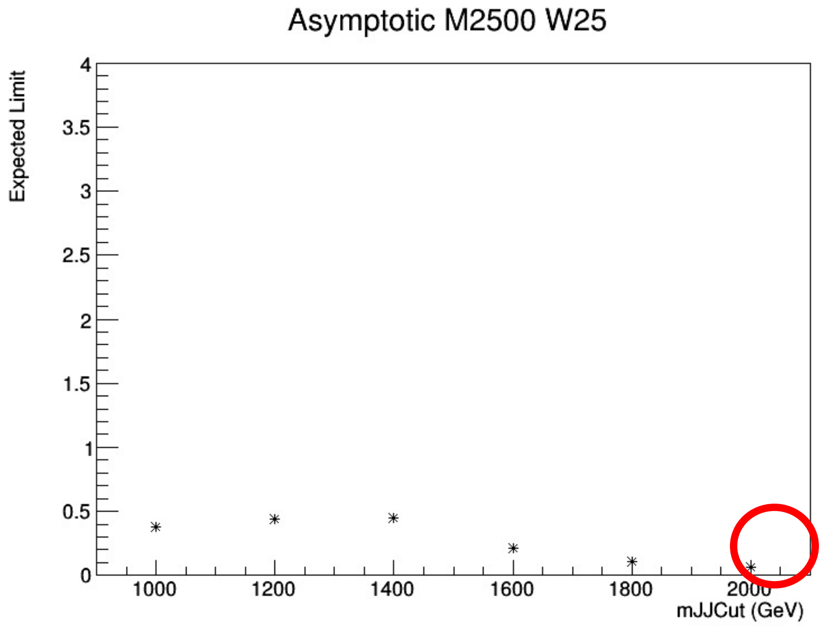




$M_{z'}$ =2000, w = 1%

$M_{z'}$ =2500, w = 1%

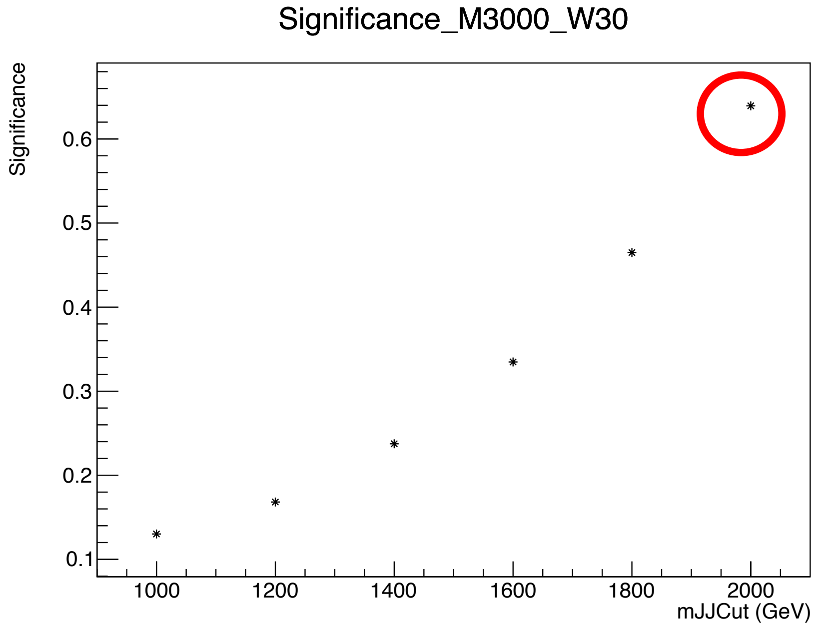


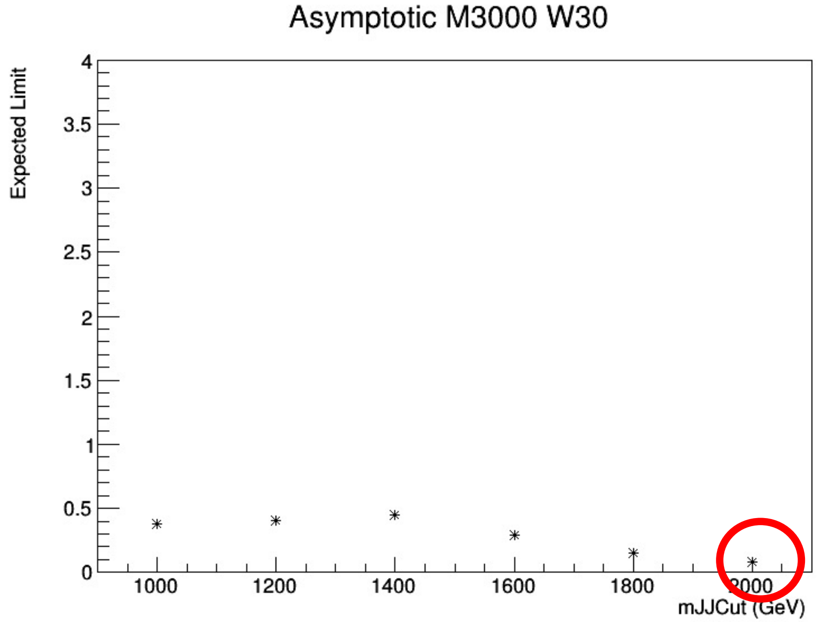


$M_{z'}$ =2500, w = 1%

Significance (left) and Asymptotic (right) Graphs (2017)

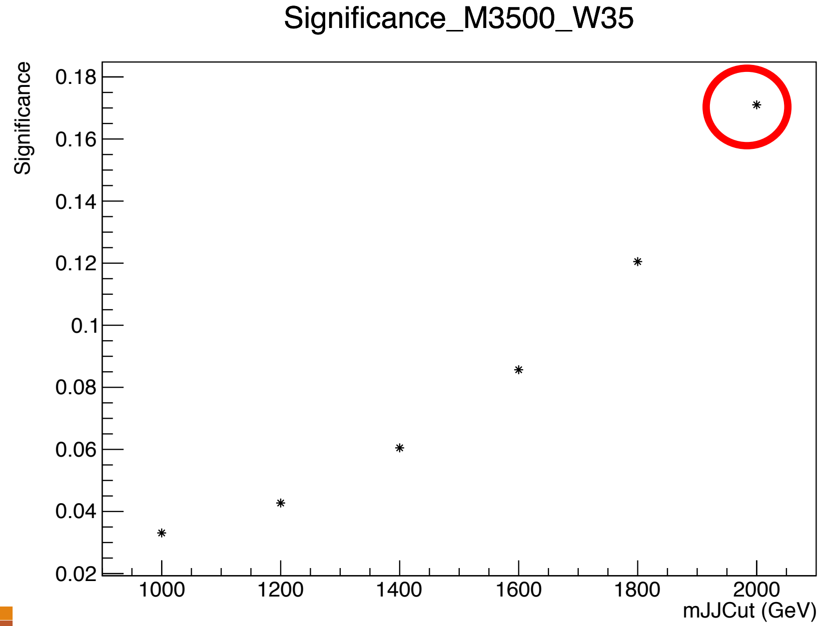
$M_{z'}$ =3000, w = 1%

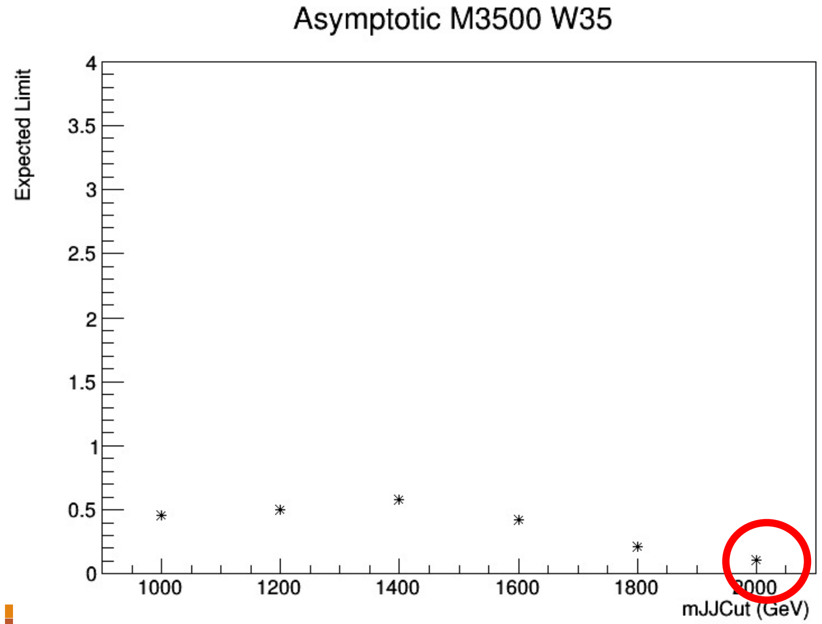




$M_{z'}$ =3000, w = 1%

$M_{z'}$ =3500, w = 1%

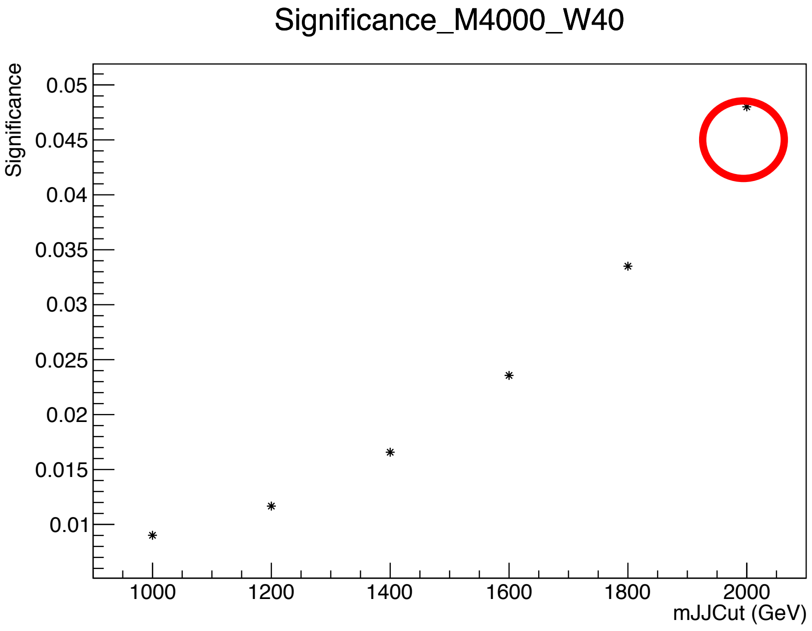


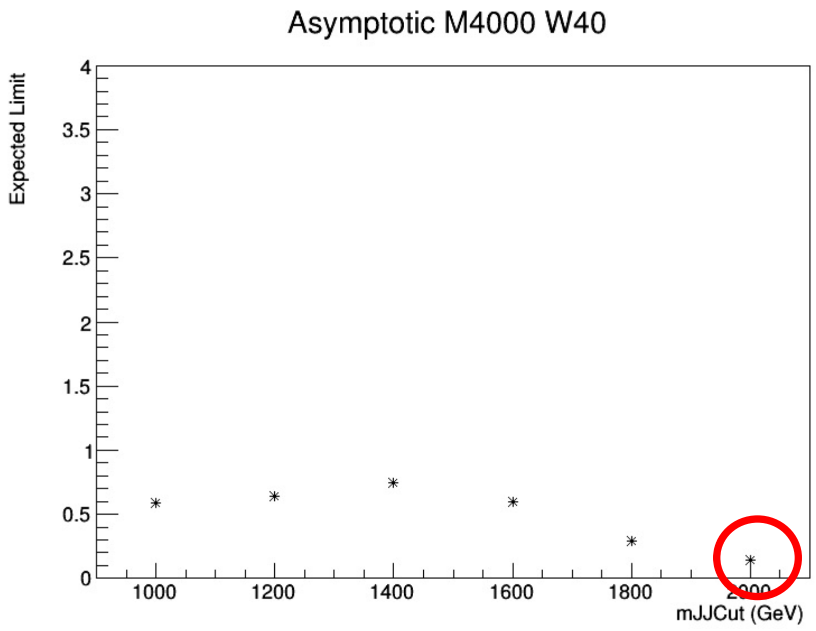


$M_{z'}$ =3500, w = 1%

Significance (left) and Asymptotic (right) Graphs (2017)

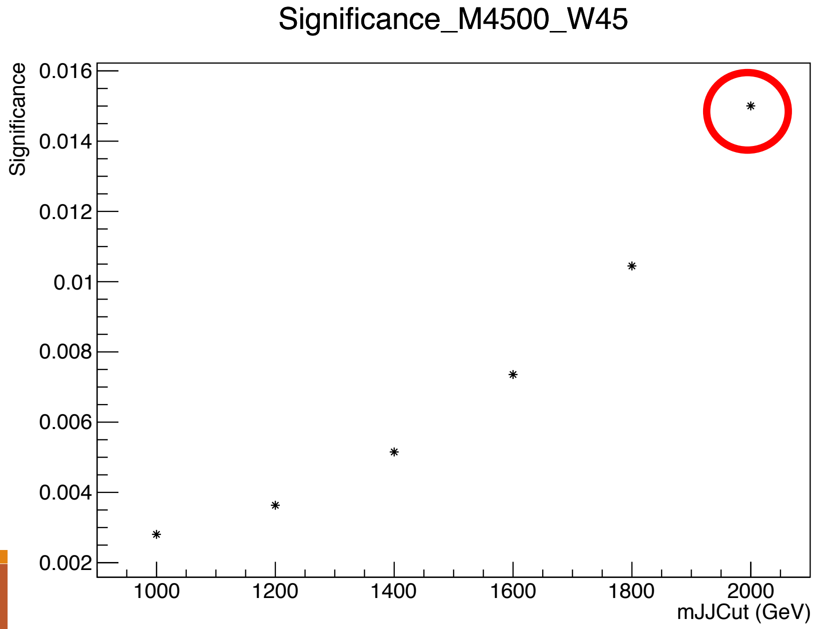
$M_{z'}$ =4000, w = 1%

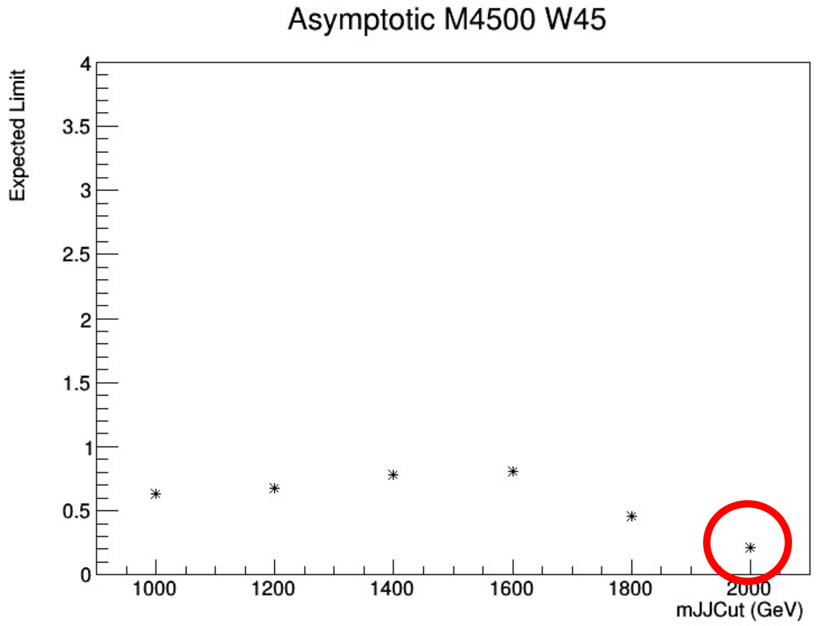




$M_{z'}$ =4000, w = 1%

$M_{z'}$ =4500, w = 1%

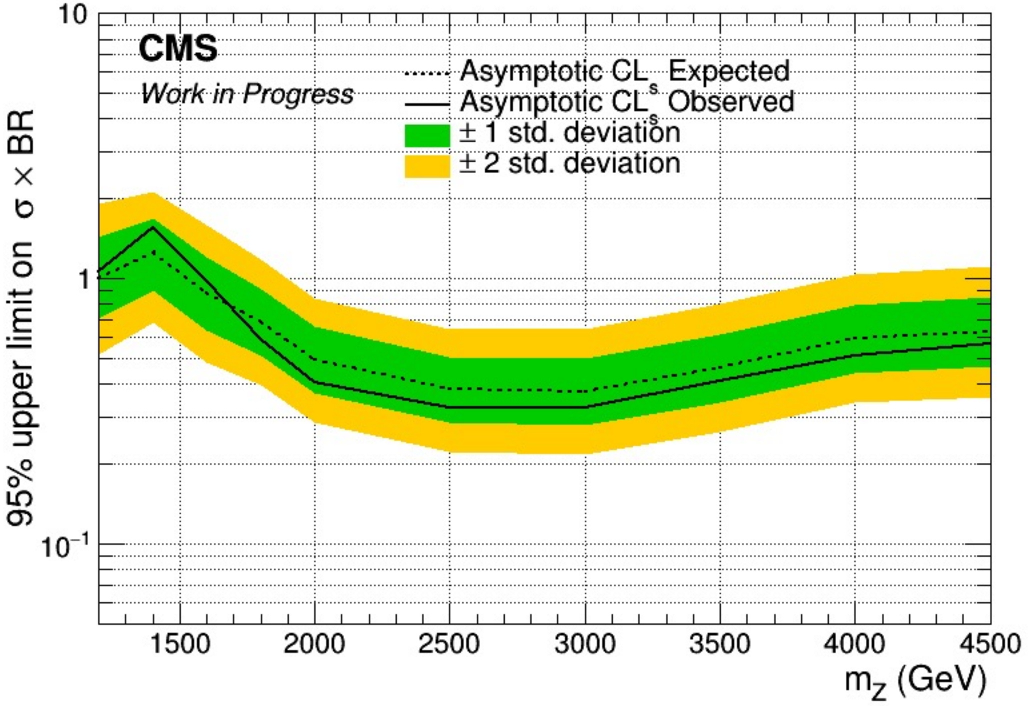




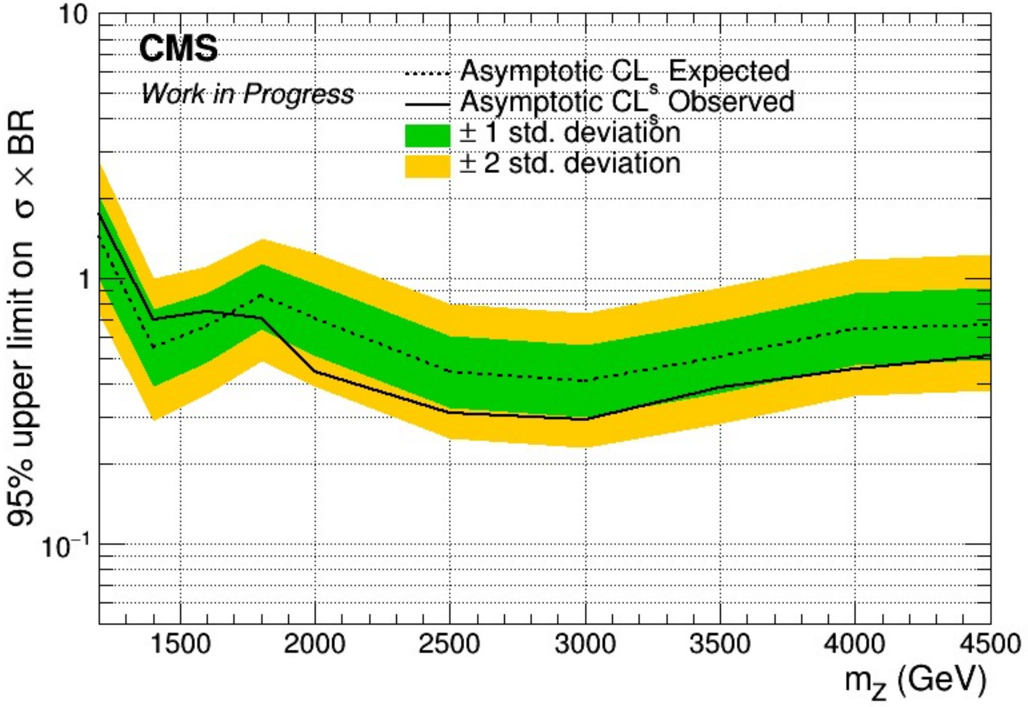
$M_{z'}$ =4500, w = 1%

Brazilian Plots (2017)

mJJ > 1000 GeV

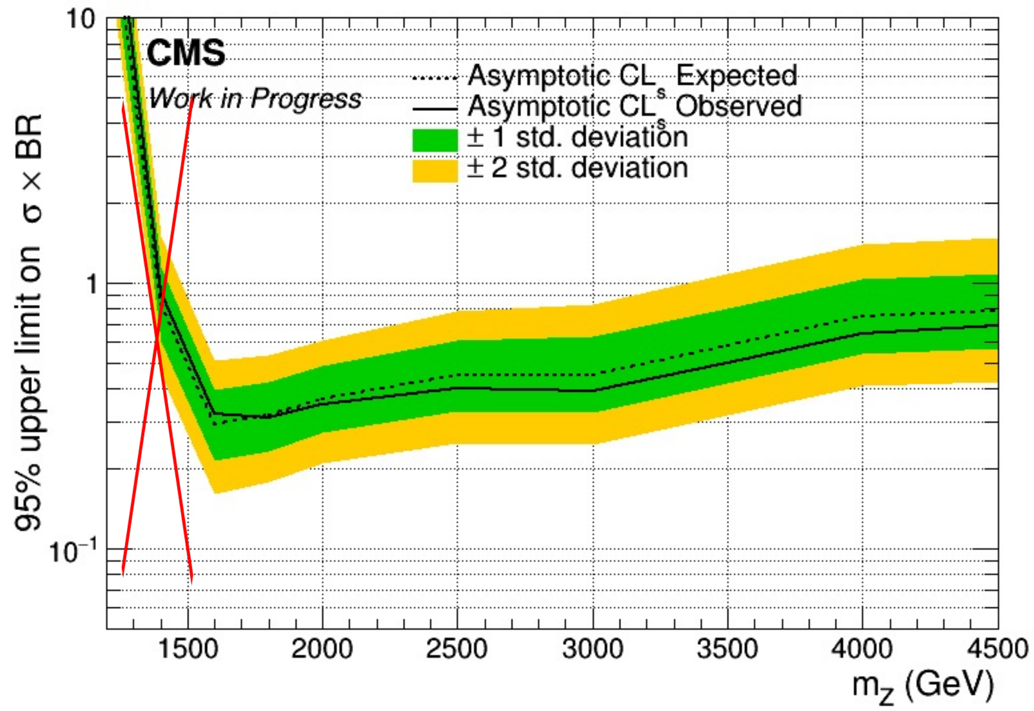


mJJ > 1200 GeV

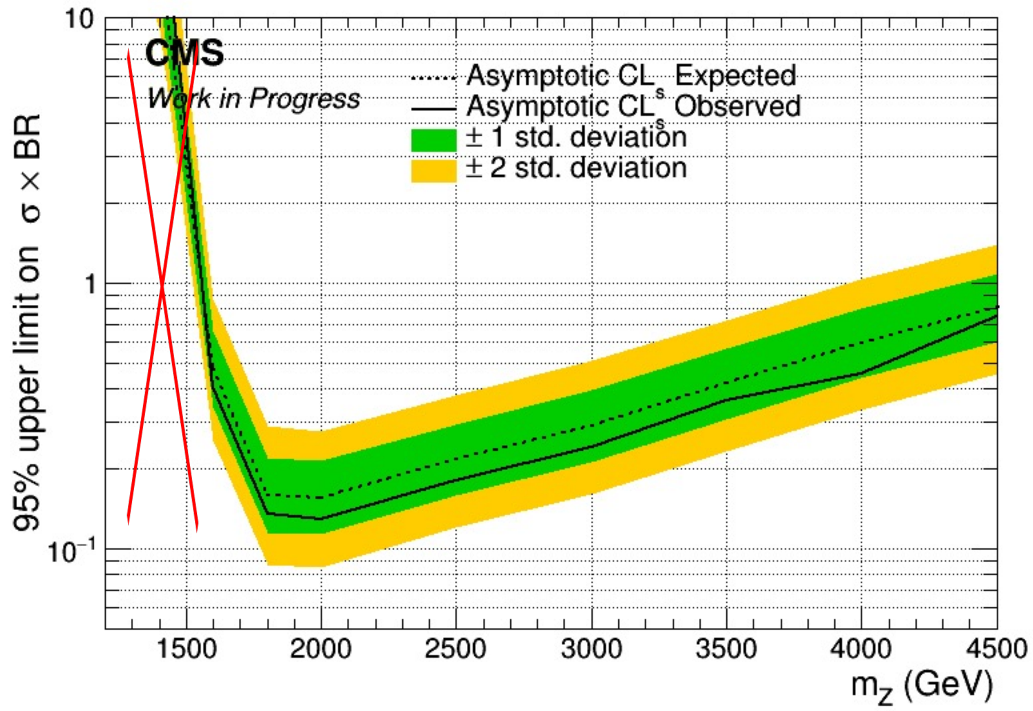


Asymptotic Limits - Brazilian Plots (2017)

mJJ > 1400 GeV

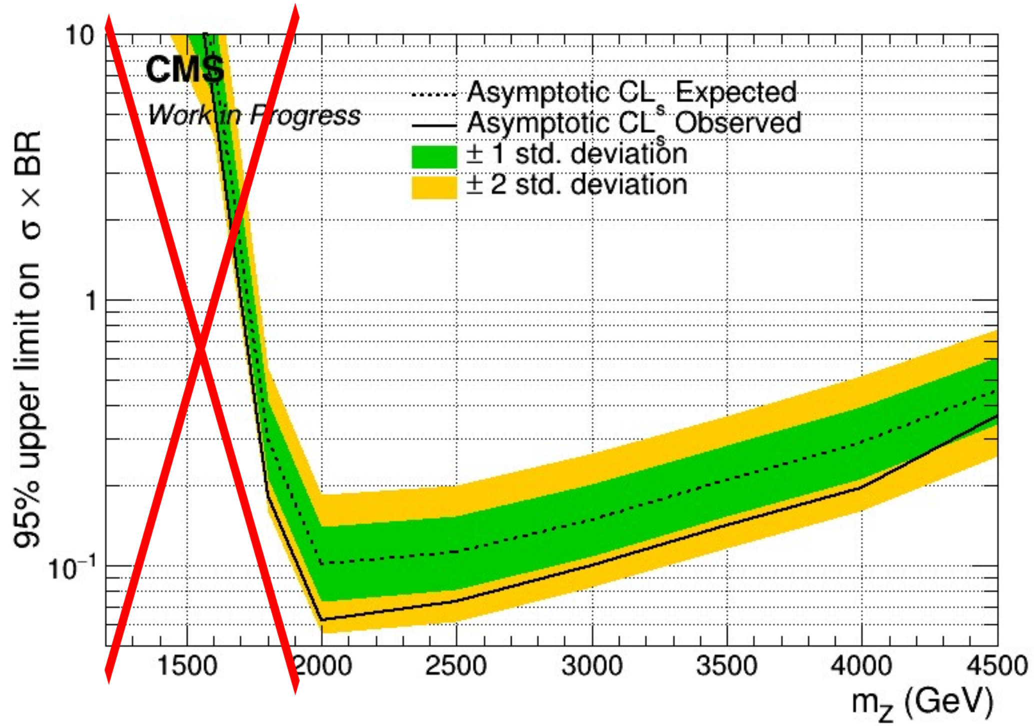


mJJ > 1600 GeV

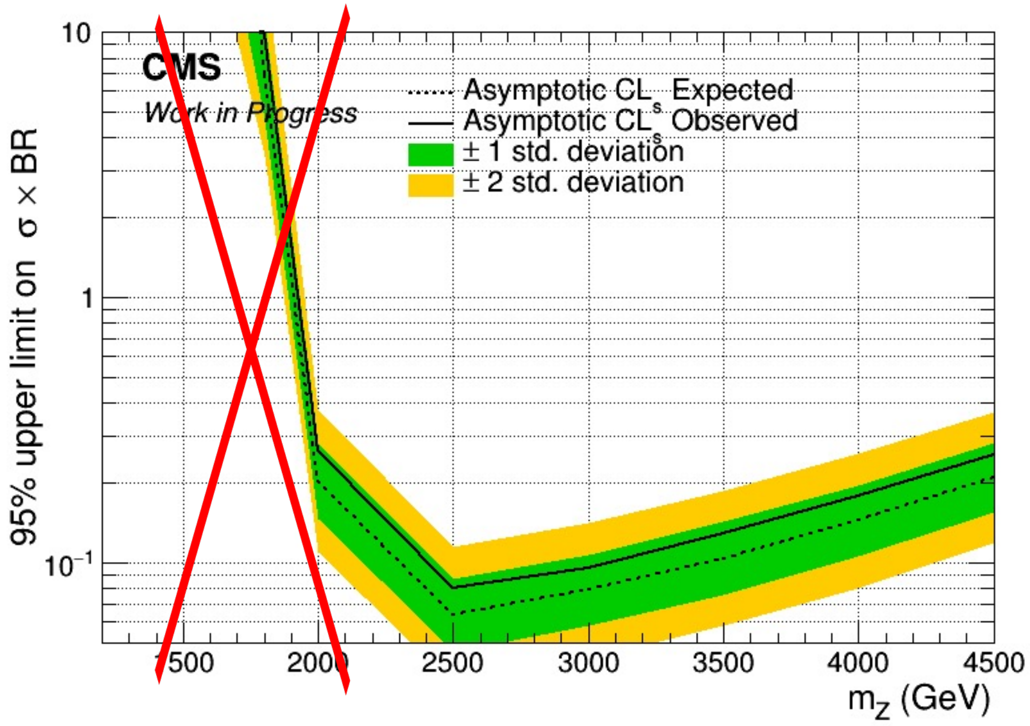


Brazilian Plots (2017)

mJJ > 1800 GeV



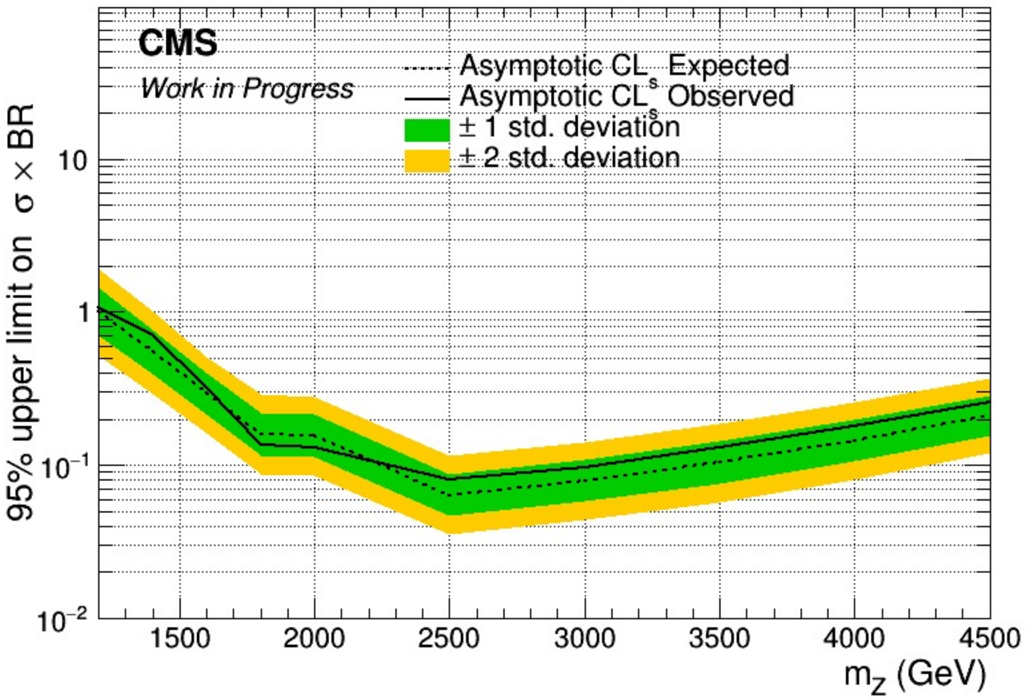
mJJ > 2000 GeV



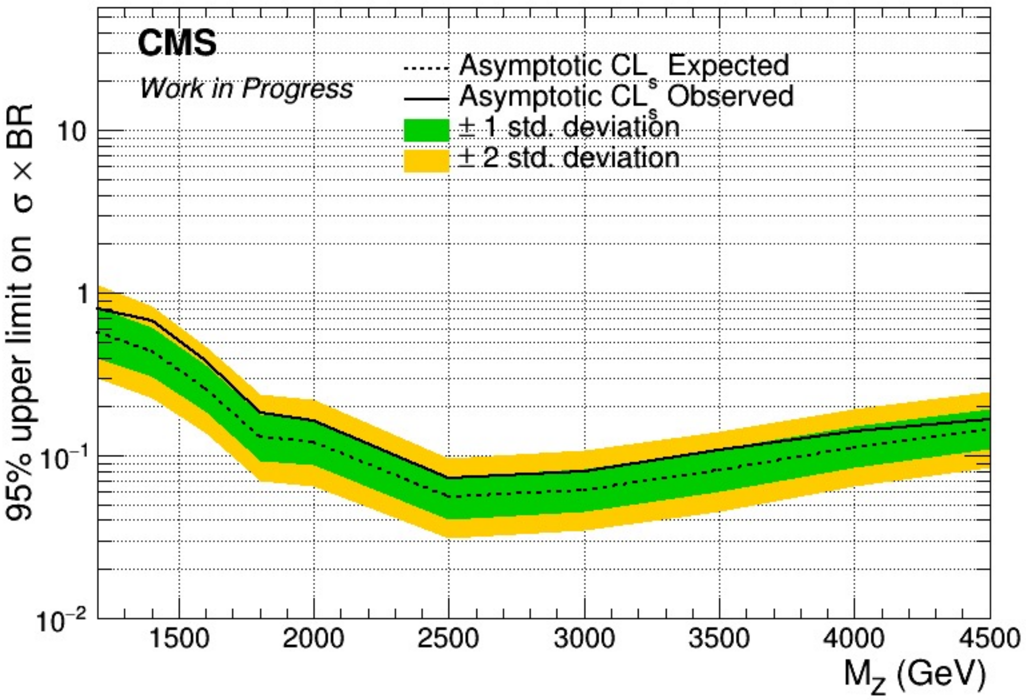
Brazilian Plots (2017 and 2018) with sliding mJJ Cut

Mass Cut Mapping
{"mZ_1200_12":1000, "mZ_1400_14":1200, "mZ_1600_16":1400, "mZ_1800_18":1600, "mZ_2000_20":1600,
"mZ_2500_25":2000, "mZ_3000_30":2000, "mZ_3500_35":2000, "mZ_4000_40":2000, "mZ_4500_45":2000}

2017



2018

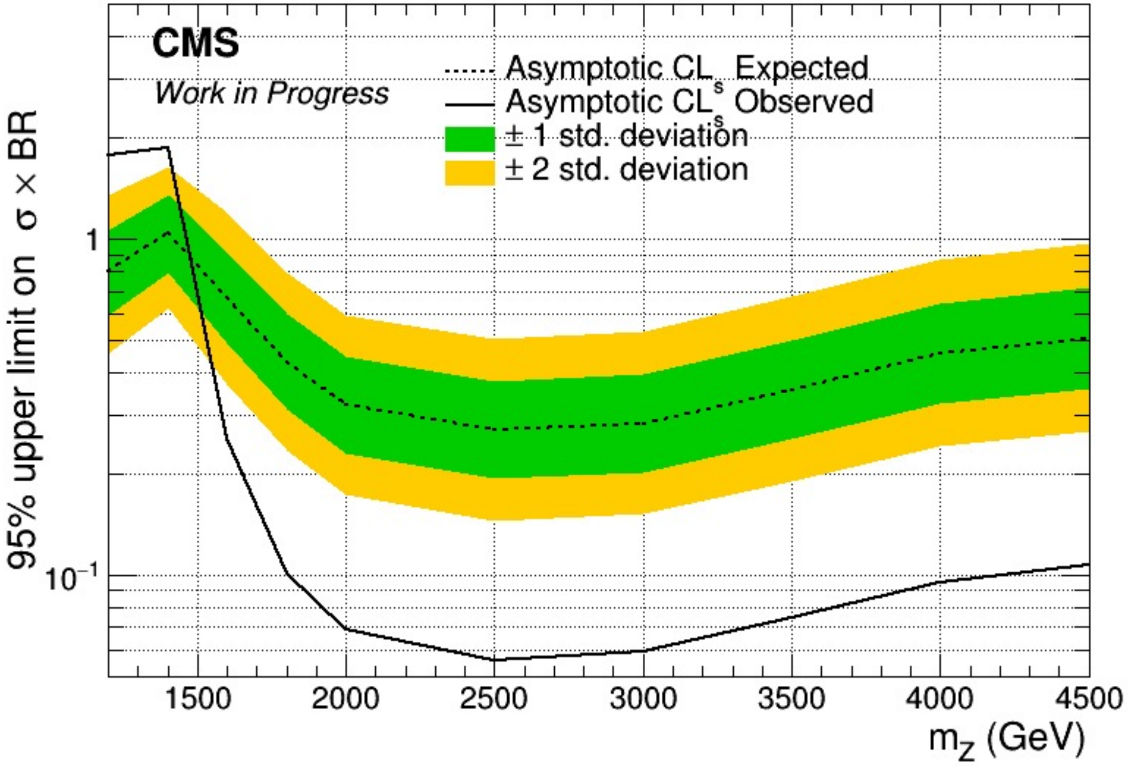


BACKUP

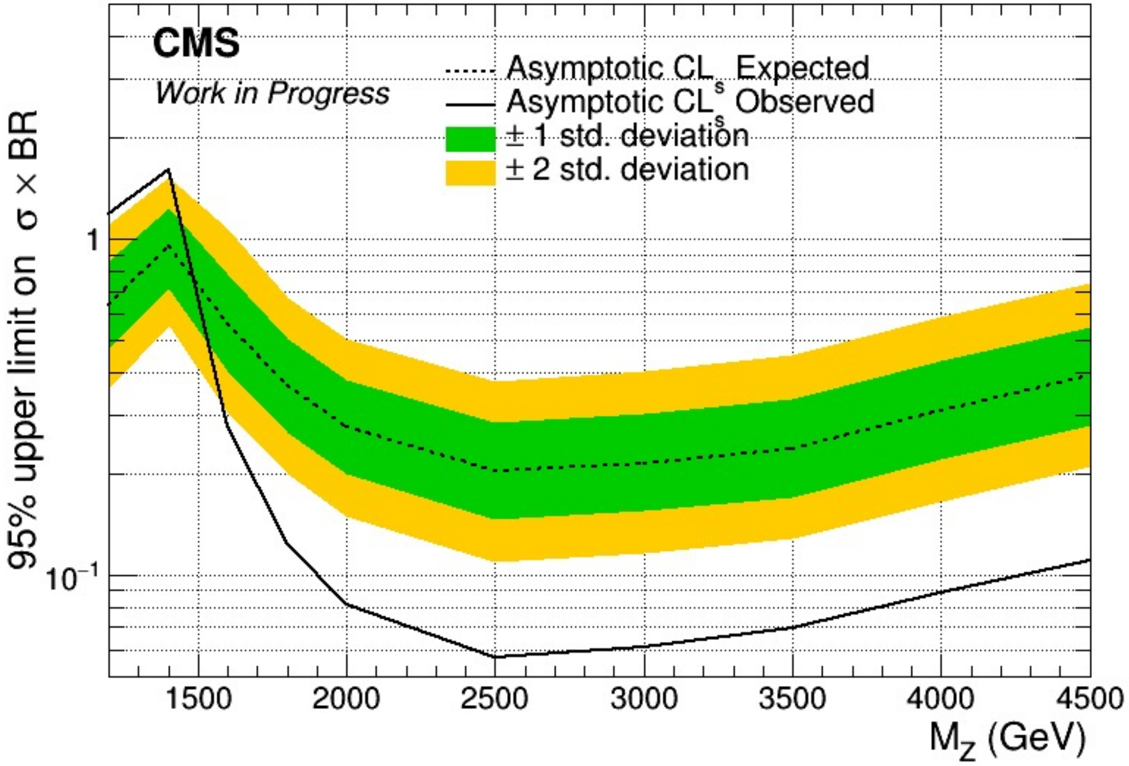
Angular Distributions (Brazilian Plot using data!!!!)

Assymptotic limits for M Z’: 1.2, 1.4, 1.6, 1.8, 2, 2.5, 3, 3.5, 4, 4.5 TeV
Width 1%

2017



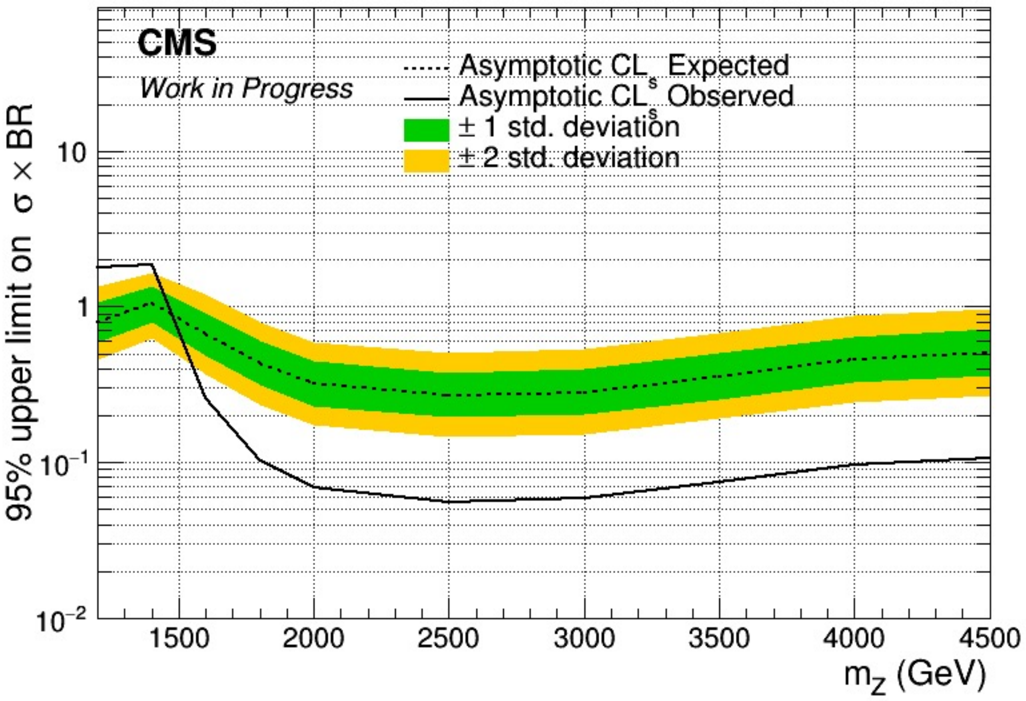
2018



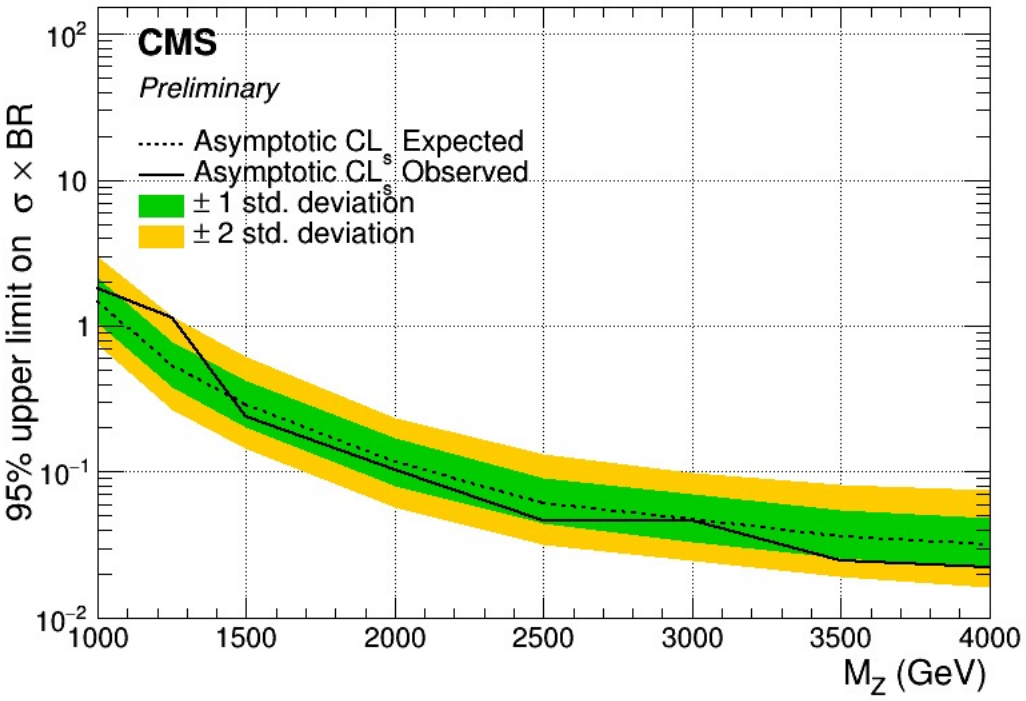
Angular Distributions (Brazilian Plot using extracted signal!!) vs B2G-16-015

Assymptotic limits for M Z': 1.2, 1.4, 1.6, 1.8, 2, 2.5, 3, 3.5, 4, 4.5 TeV
Width 1%

2017



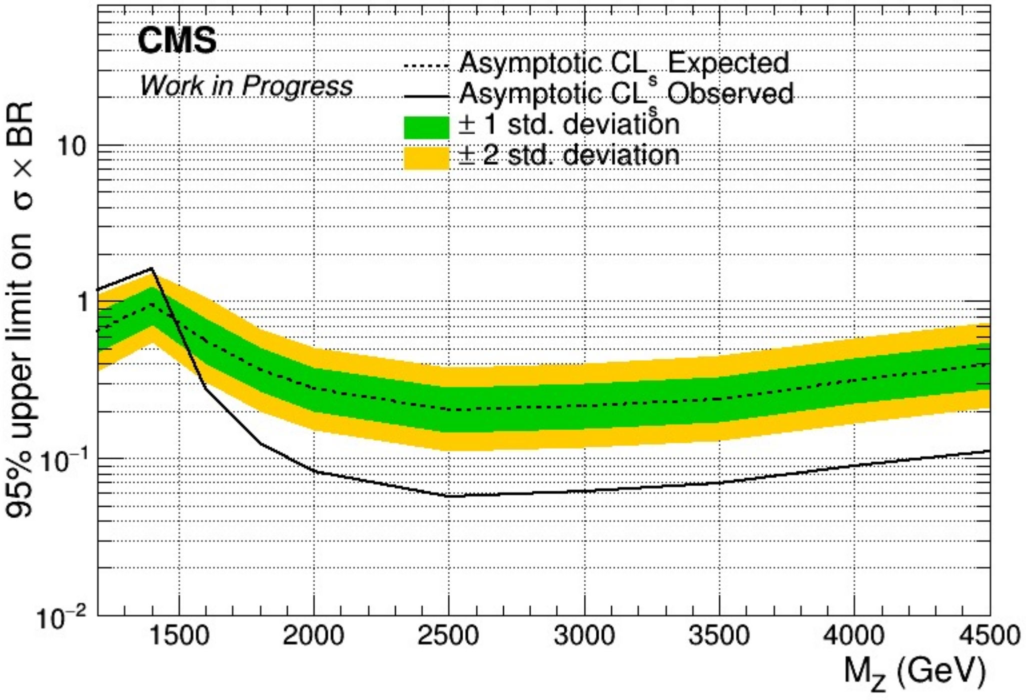
B2G-16-015



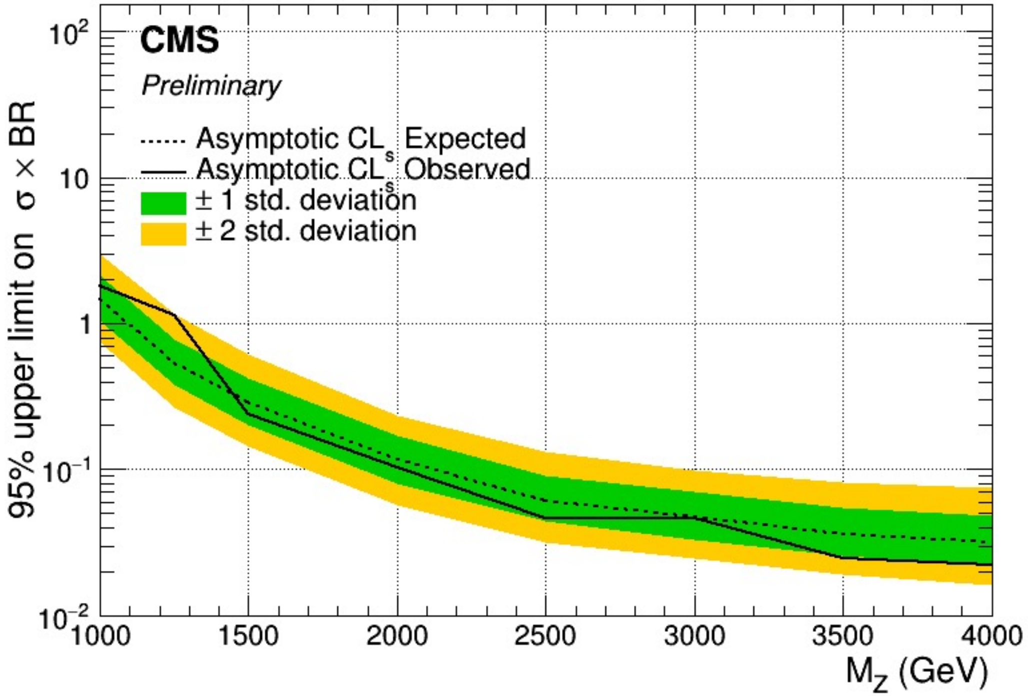
Angular Distributions (Brazilian Plot using extracted signal!!) vs B2G-16-015

Assymptotic limits for M Z’: 1.2, 1.4, 1.6, 1.8, 2, 2.5, 3, 3.5, 4, 4.5 TeV
Width 1%

2018



B2G-16-015



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	

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:

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