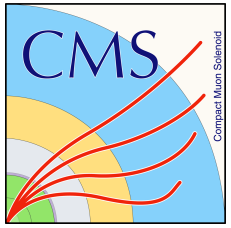
# HEP NTUA
# Weekly Report

# 21/4/2021

George Bakas




# Summary Z' Analysis

- Switch to mJJ > 1000 GeV cut:
  - No sensitivity for higher Z' masses (> 2.5 TeV)
  - Calculate significance and Asymptotic 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 $Bkg := ttbar + QCD + Subdominant$

  - 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)

  - Sliding mJJ Cut
    - Asymptotic limits using Limit value as guide and not significance
    - Use Systematic variations within my datacard (talked with Lisa and Anna about this)
      - shapeN (not lnN or shape)
    - Not yet JES (production)

# Datacard Summary (example for mJJ > 1600 GeV)

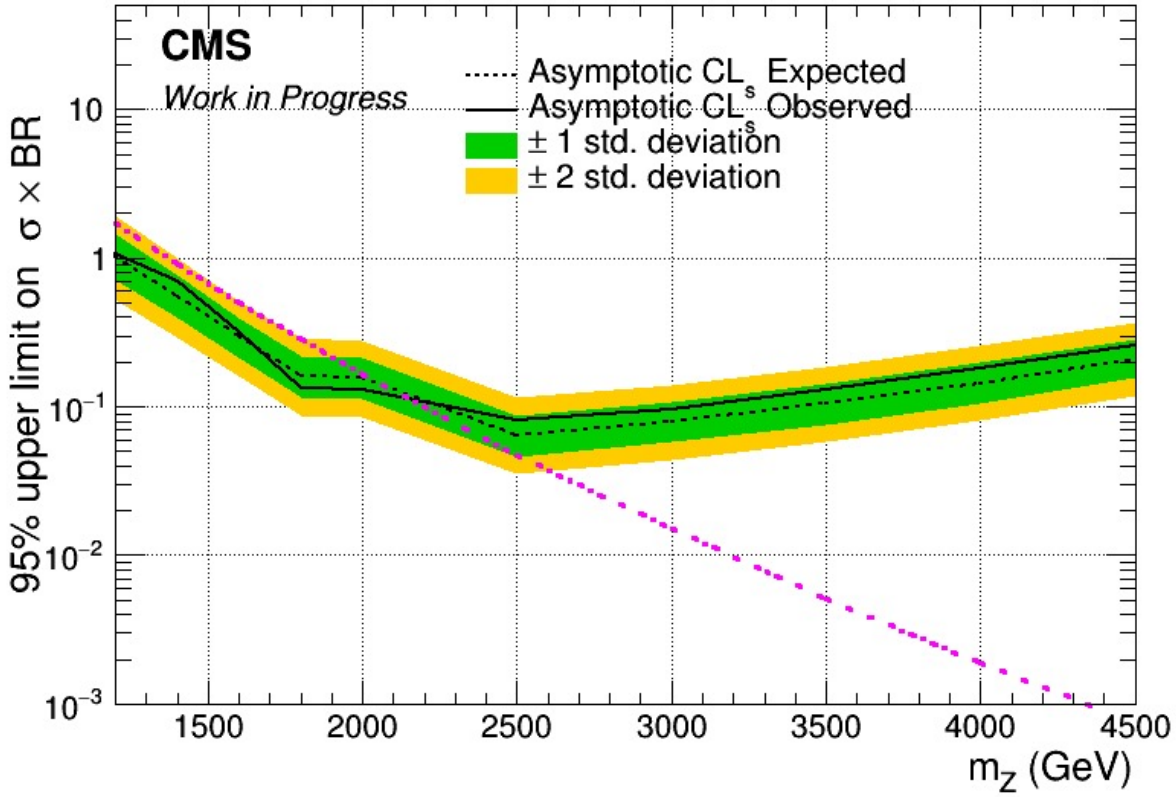
```
imax * number of bins
jmax * number of processes minus 1
kmax * number of nuisance parameters
---------------------------------------------------------------------------
shapes *        SR_C      ProcessesFile_1600.root h_chi_$PROCESS h_chi_$PROCESS_$SYSTEMATIC
shapes Zprime    SR_C              ZprimeFile_2000_20_massCut1600.root h_chi_$PROCESS
shapes data_obs  SR_C      DataFile_1600.root h_Data
---------------------------------------------------------------------------
bin         SR_C
observation  -1.0
---------------------------------------------------------------------------
bin                        SR_C      SR_C      SR_C       SR_C
process                     Zprime     qcd       Subdominant  ttbar
process                     0         1         2          3
rate                       -1.0      -1.0      -1.0       -1.0
---------------------------------------------------------------------------
yield_ttbar          lnN       -         -         -          1.5
yield_qcd            lnN       -         1.5       -          -
yield_Subdominant    lnN       -         -         1.5        -
lumi_13TeV           lnN       -         1.025     1.025      1.025
scale                shapeN    -         -         -          1.0
pdf                  shapeN    -         -         -          1.0
fsr                  shapeN    -         -         -          1.0
isr                  shapeN    -         -         -          1.0
btag                 shapeN    -         -         -          1.0
*  autoMCStats  10  1
```

# Brazilian Plots (2017 and 2018) with sliding mJJ Cut

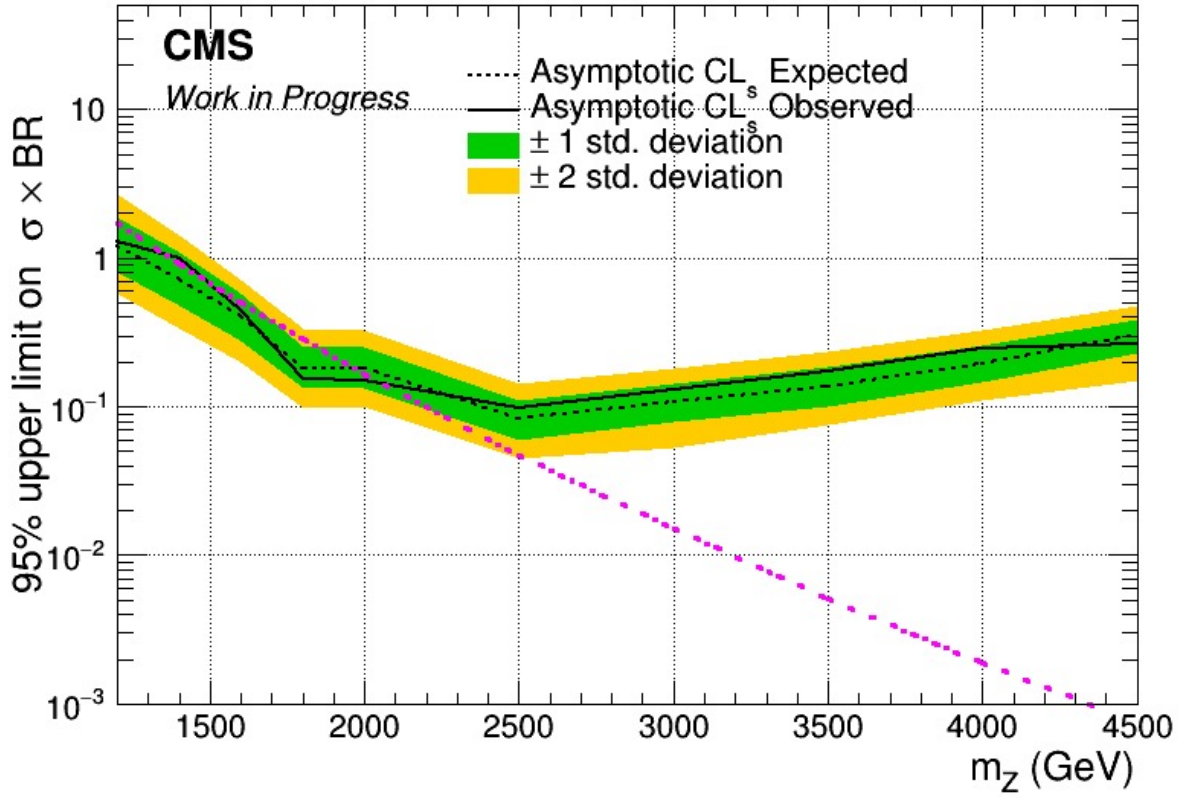
Mass Cut Mapping

{"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




2017 with systematics

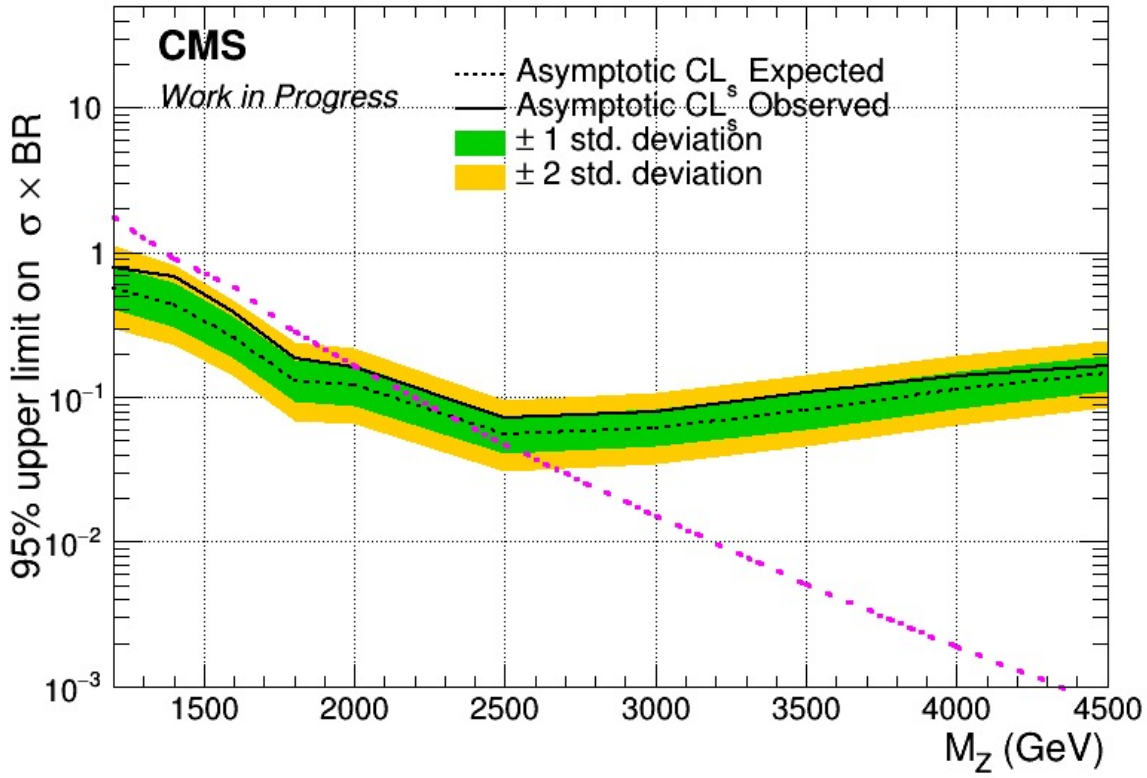


# Brazilian Plots (2017 and 2018) with sliding mJJ Cut

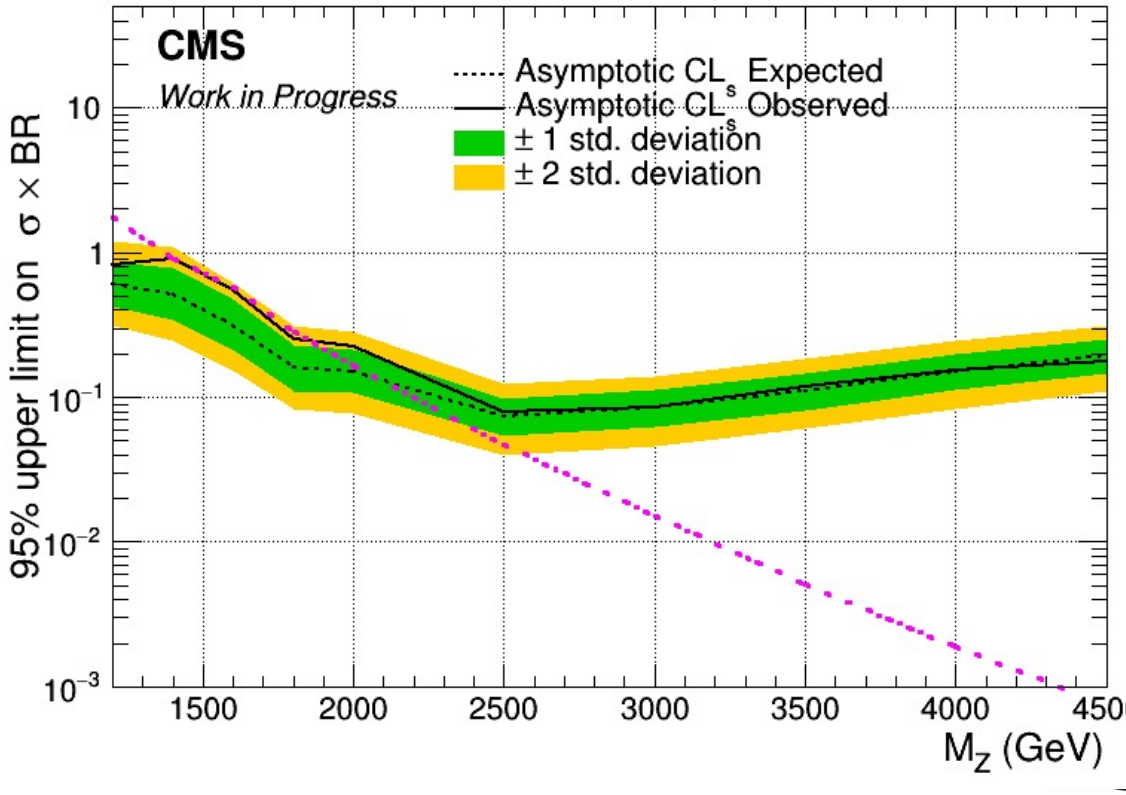
Mass Cut Mapping

{"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}

2018




2018 with systematics

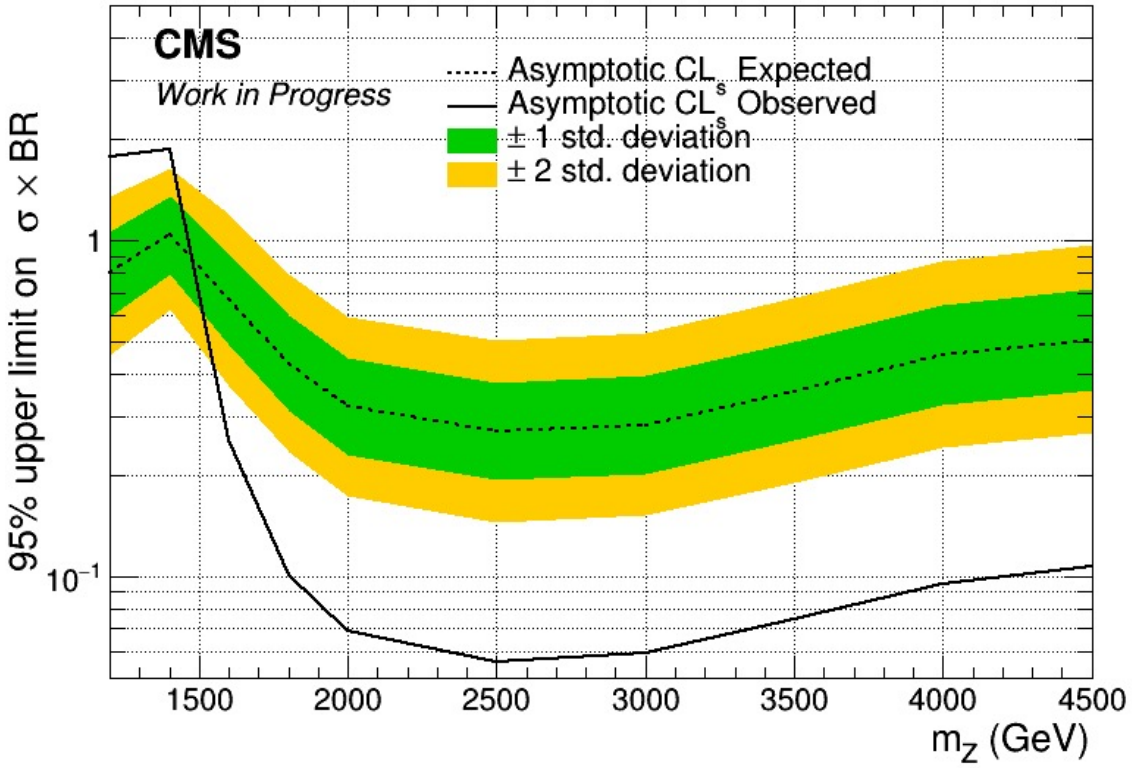


# BACKUP

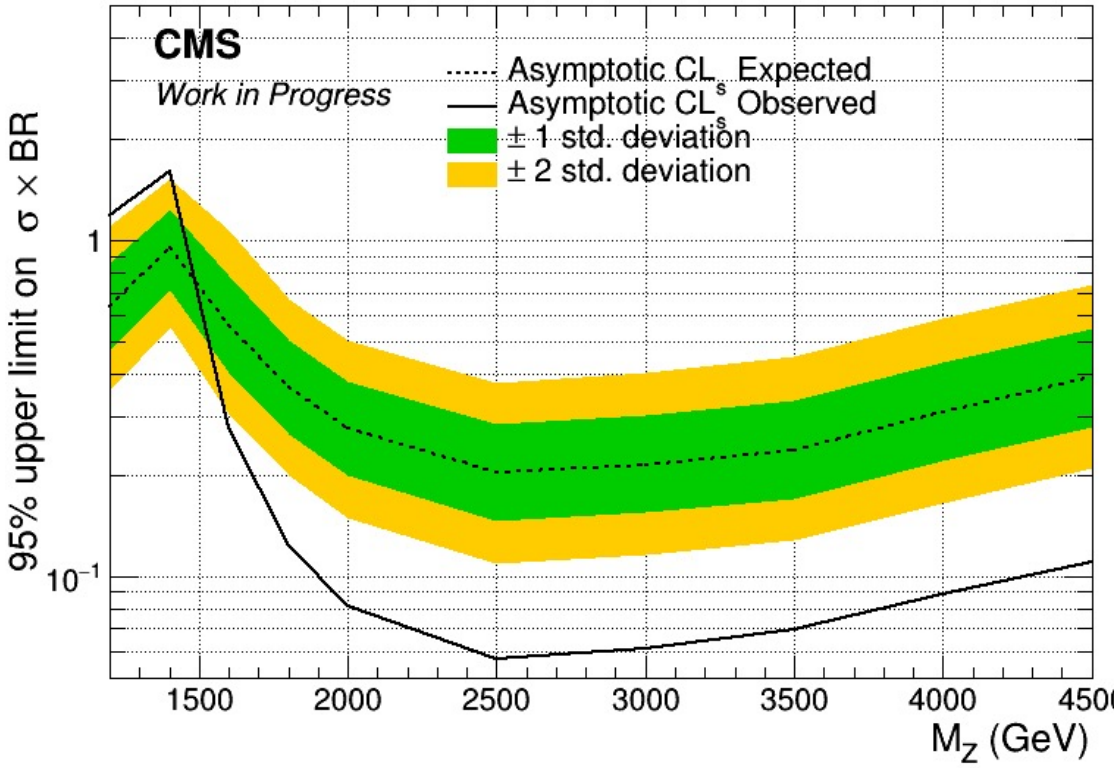
# Angular Distributions (Brazilian Plot using data!!!!)

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



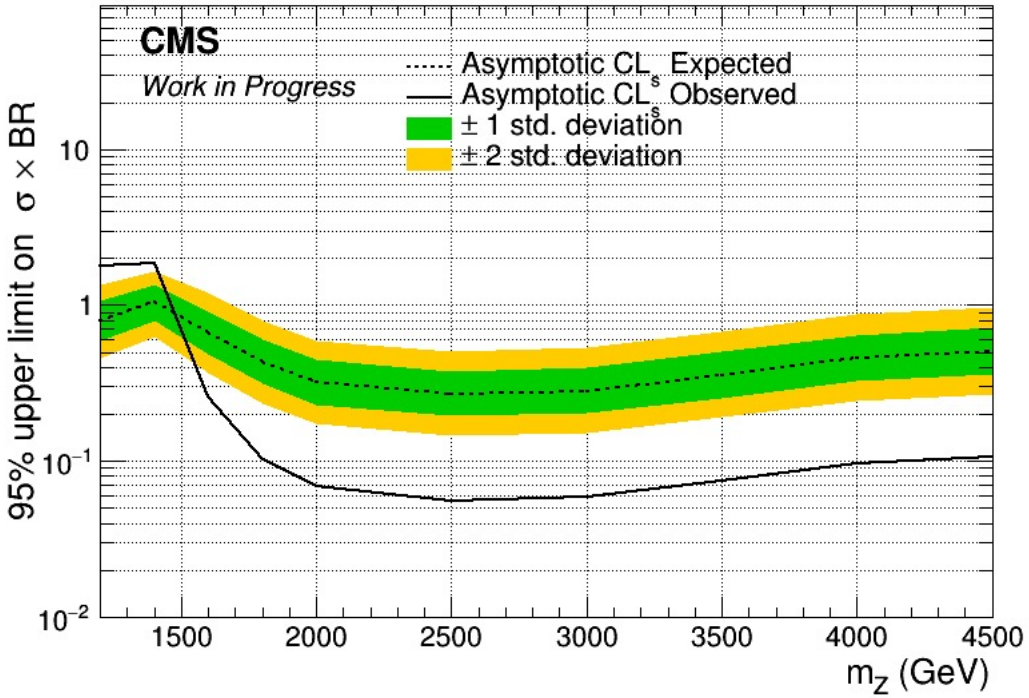

2018



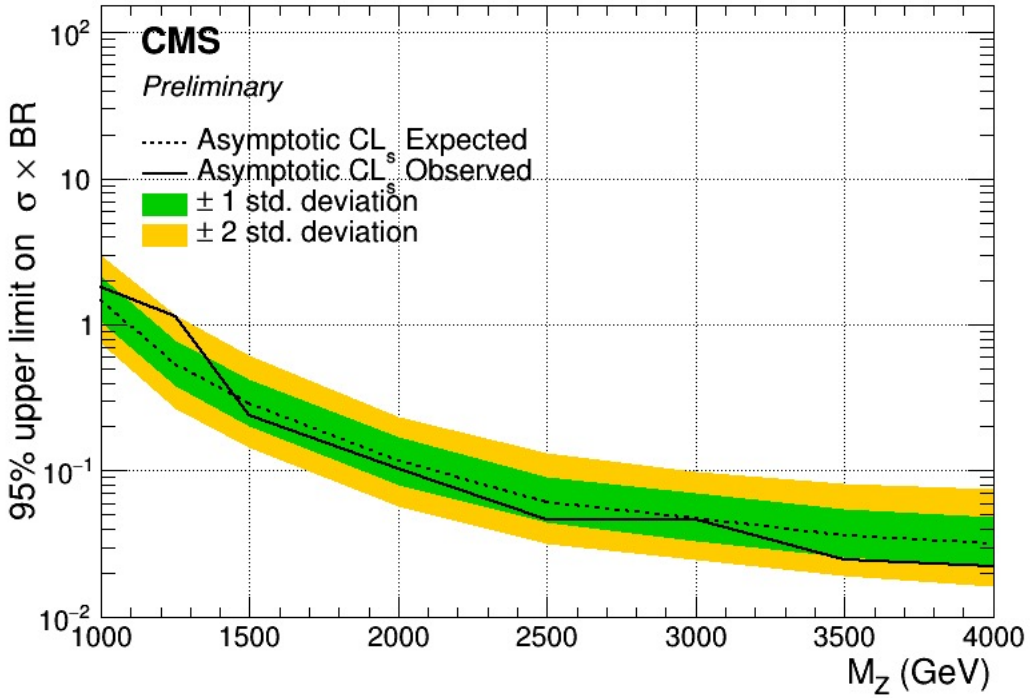
# Angular Distributions (Brazilian Plot using extracted signal!!) vs B2G-16-015

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



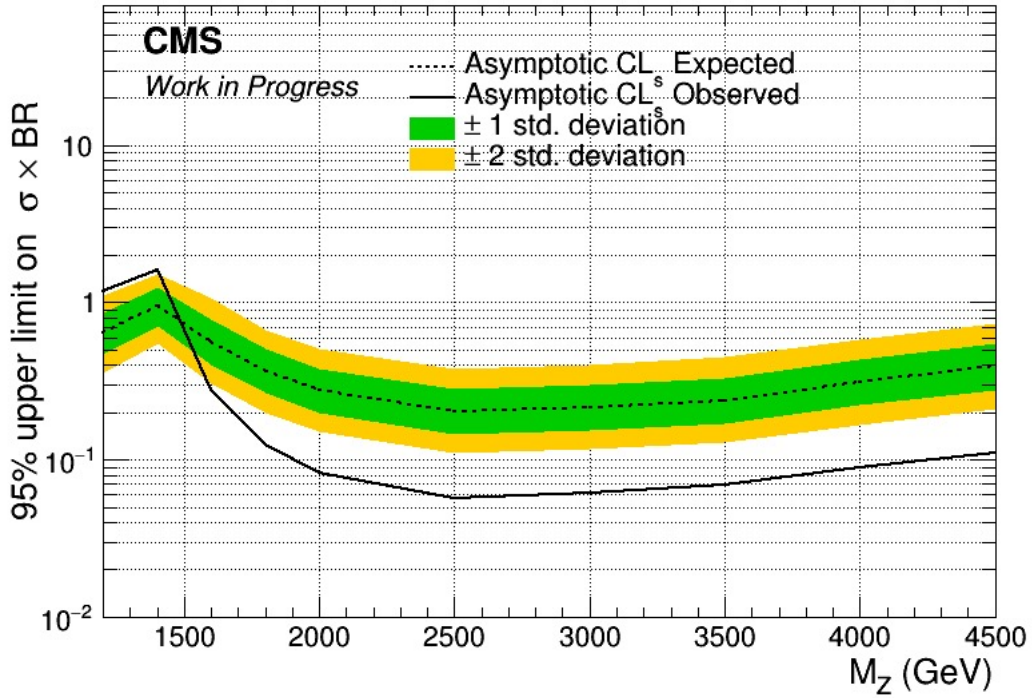

B2G-16-015



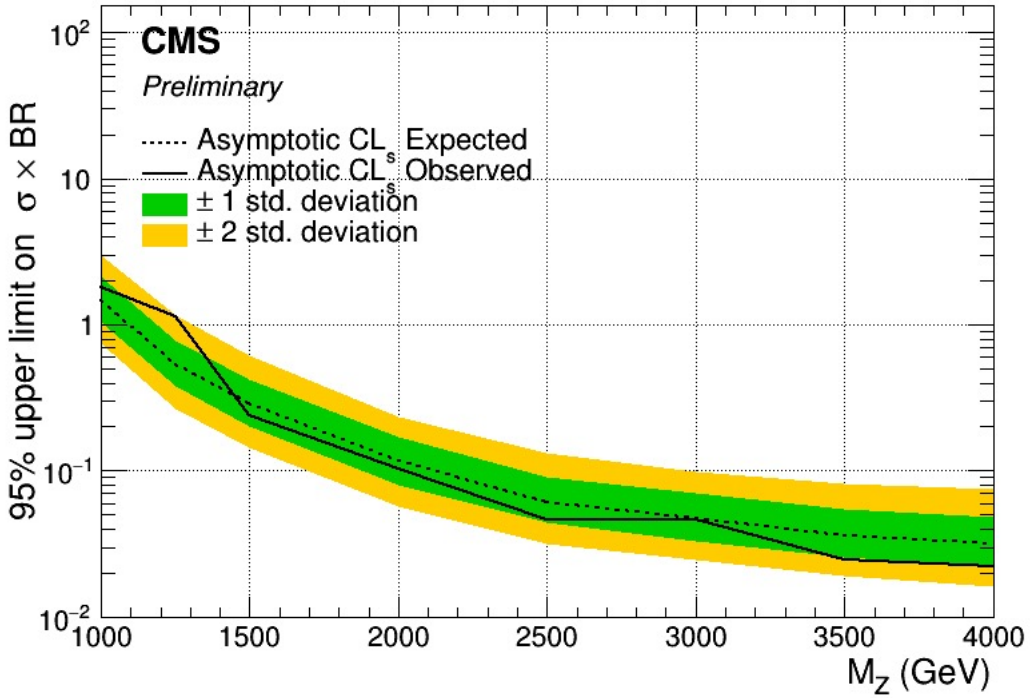
# Angular Distributions (Brazilian Plot using extracted signal!!) vs B2G-16-015

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:

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

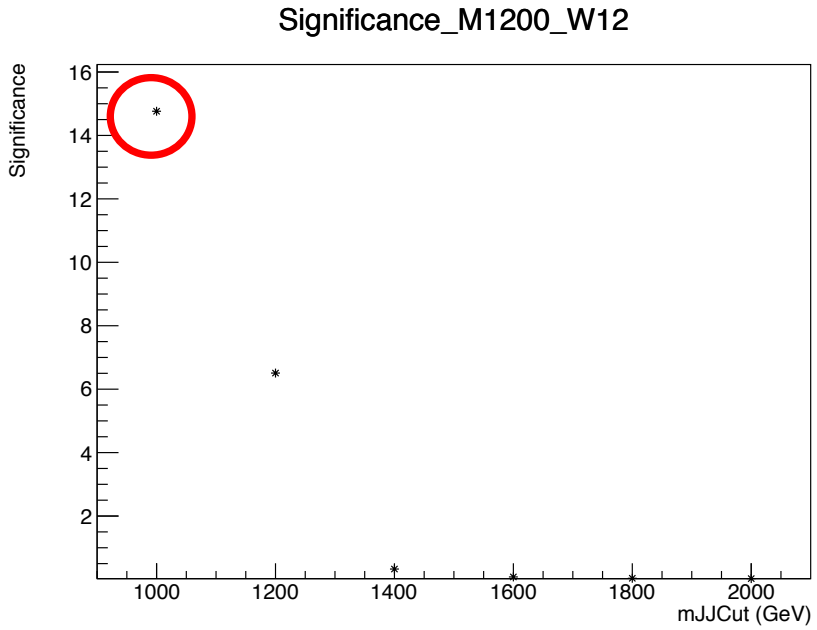
X is defined as $\chi = e^{|y^*|} = e^{|y_1 - y_2|}$ (1) and can be measured by creating the TLorentzVector, boost it to the ZMF and find the rapidity difference of the two leading jets

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:

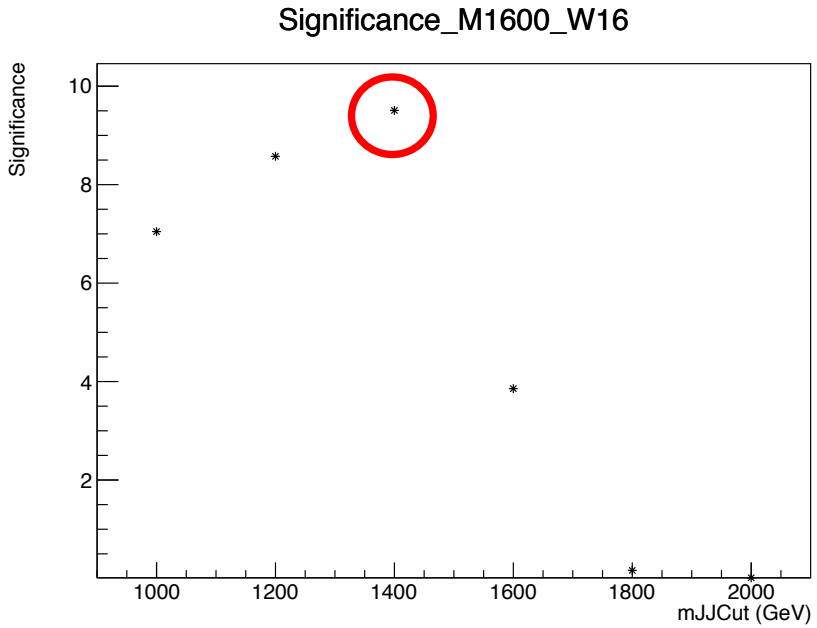
$$\chi = \frac{1 + |cos\theta^*|}{1 - |cos\theta^*|}$$

# Significance Graphs (2017)

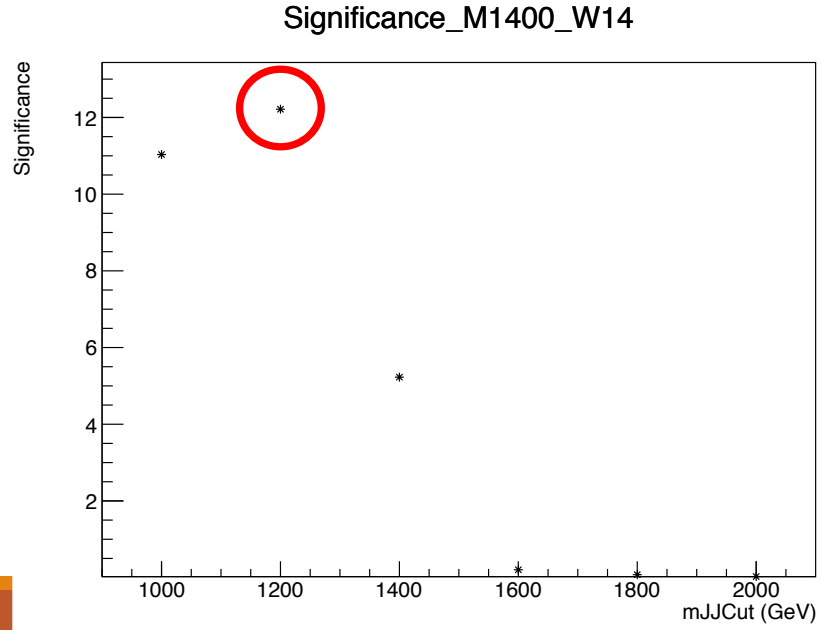
$M_{z'}$ =1200, w = 1%



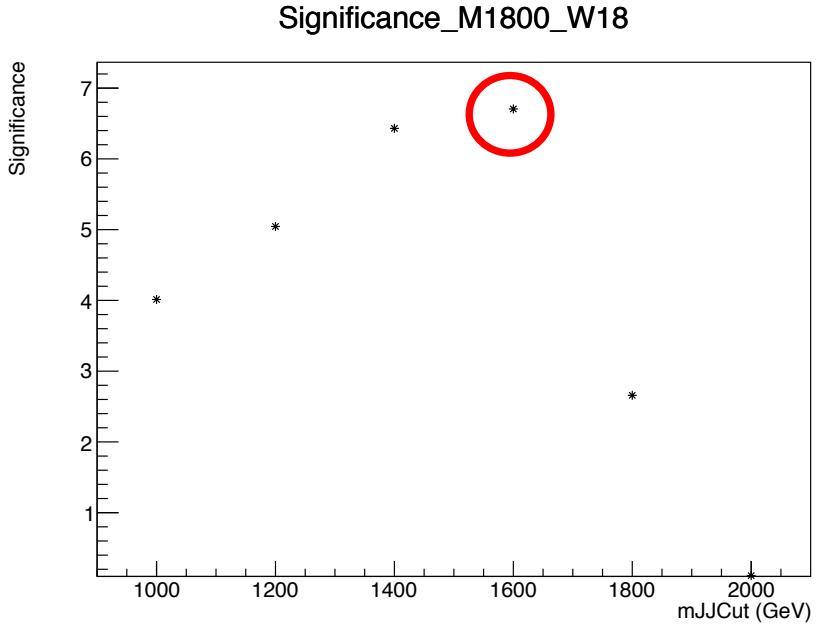

$M_{z'}$ =1600, w = 1%




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

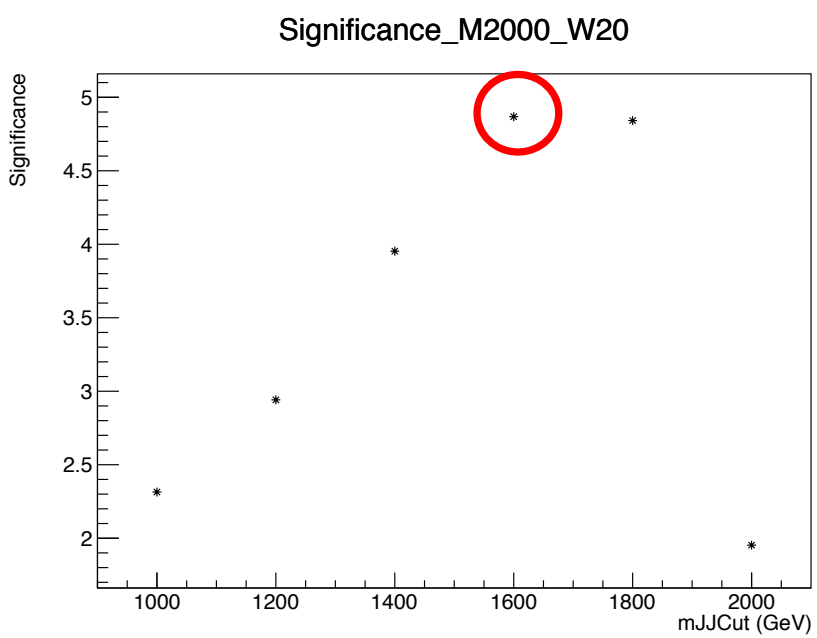


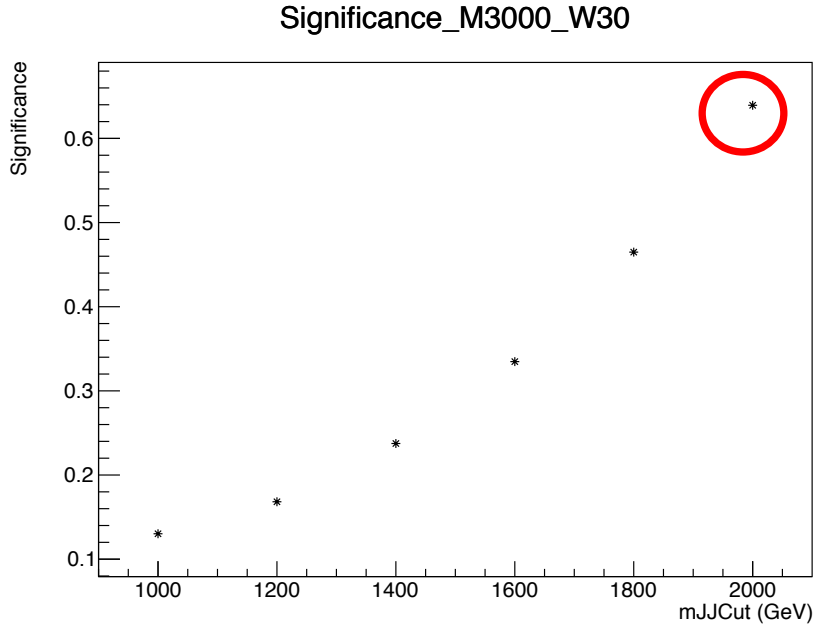

$M_{z'}$ =1800, w = 1%



# Significance Graphs (2017)

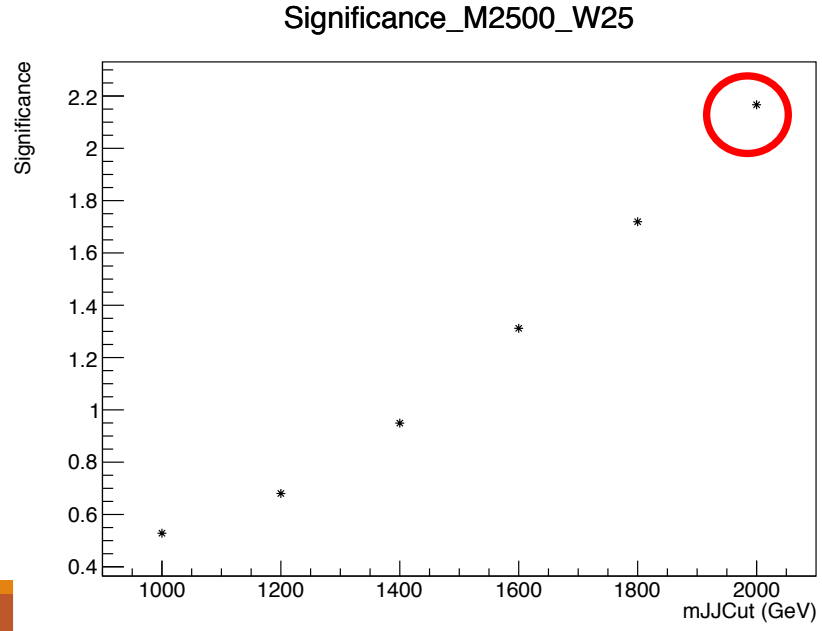
$M_{z'}$ =2000, w = 1%

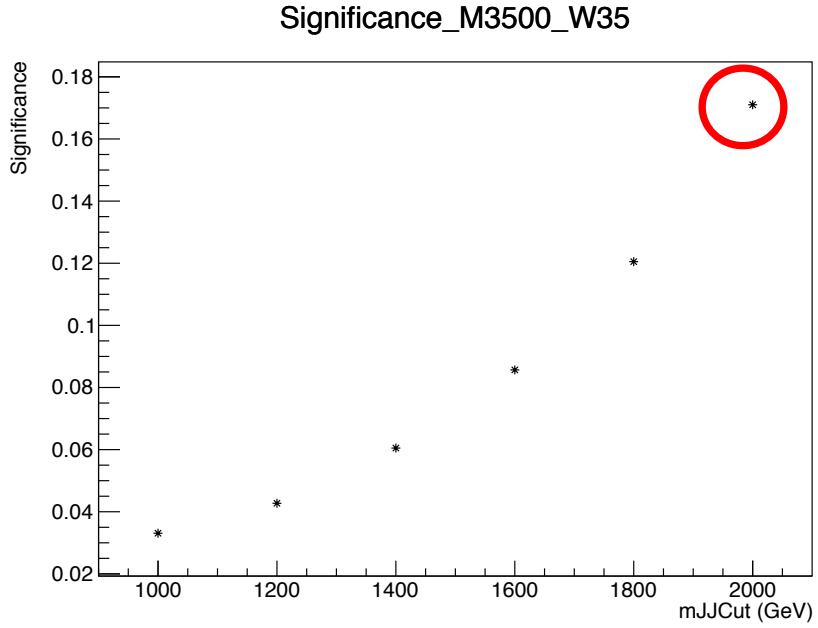



$M_{z'}$ =3000, w = 1%

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

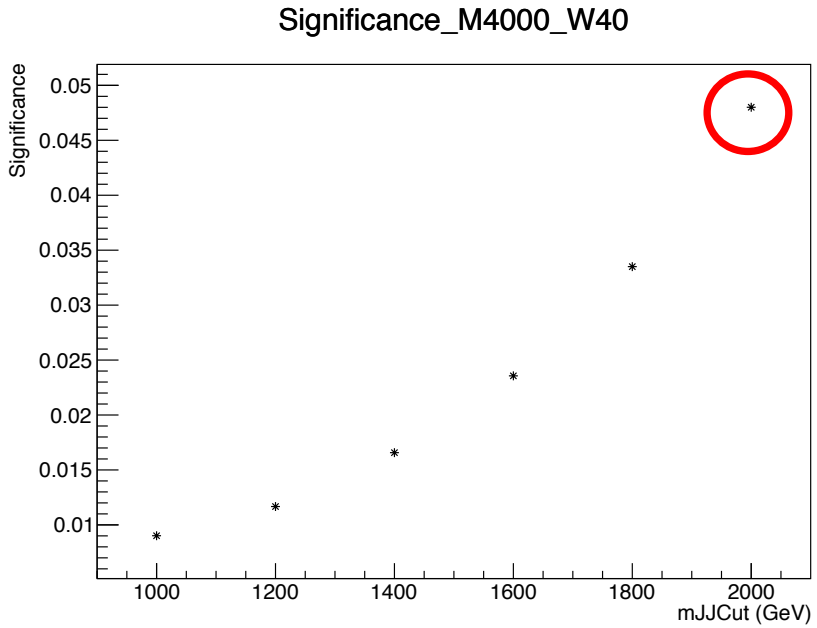


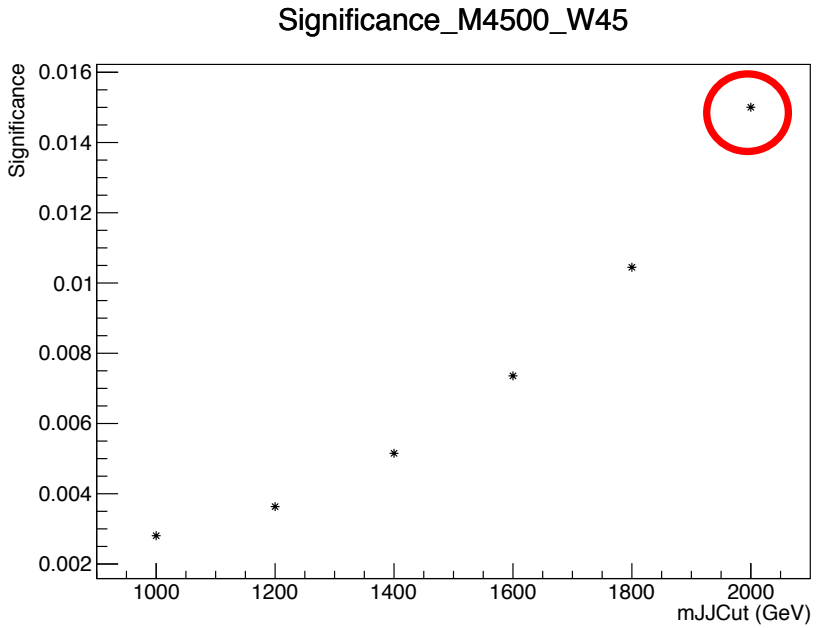




$M_{z'}$ =3500, w = 1%

# Significance Graphs (2017)

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

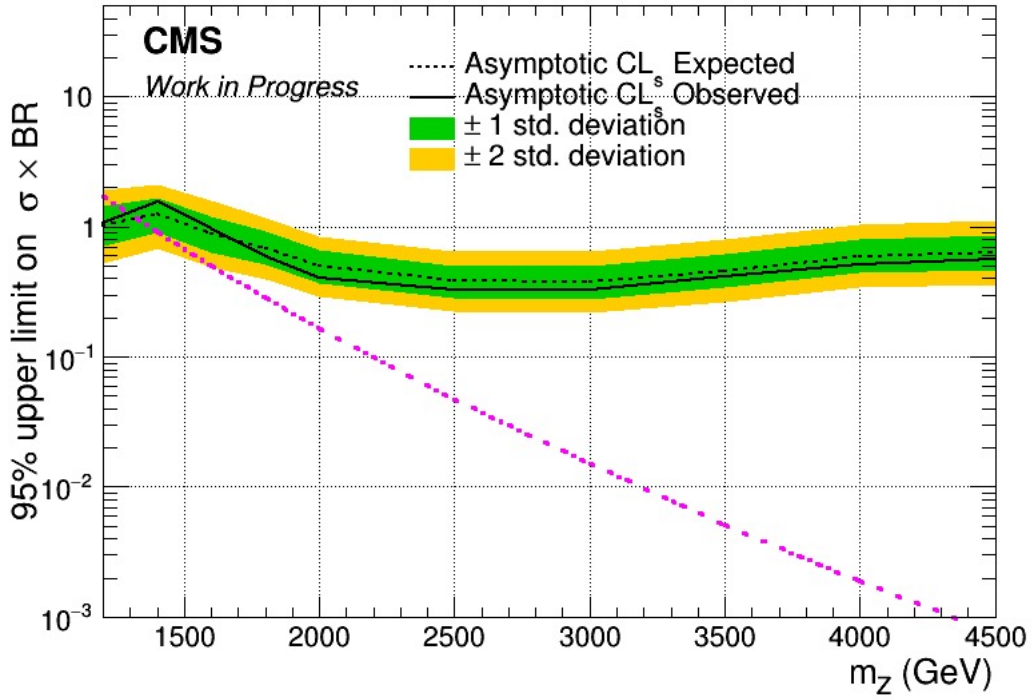


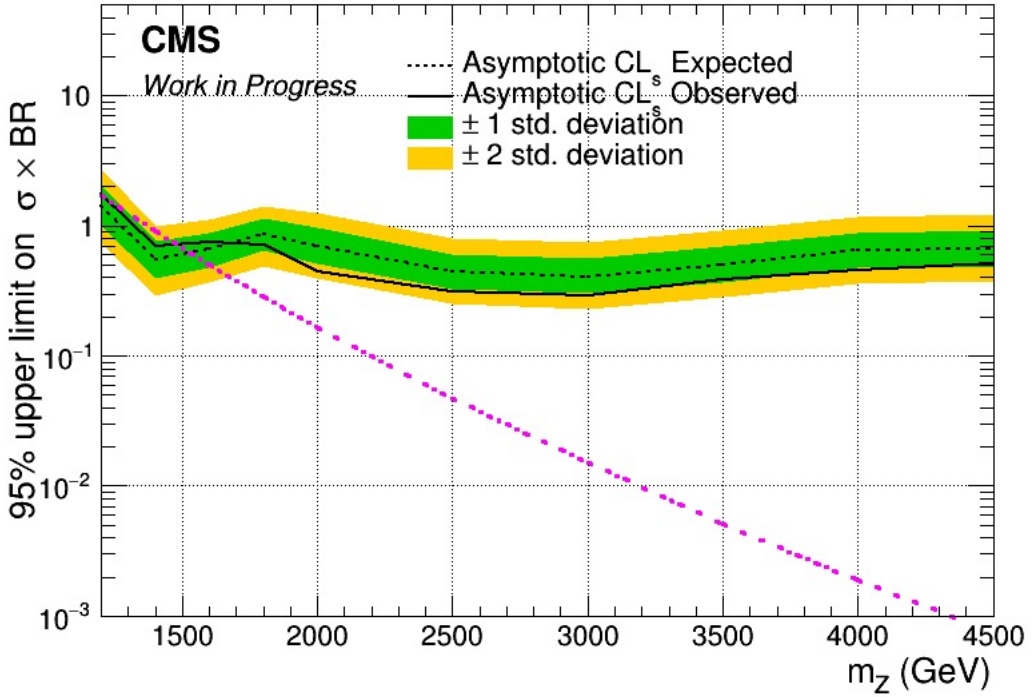

$M_{Z'}$ =4500, w = 1%

# Brazilian Plots (2017)

mJJ > 1000 GeV

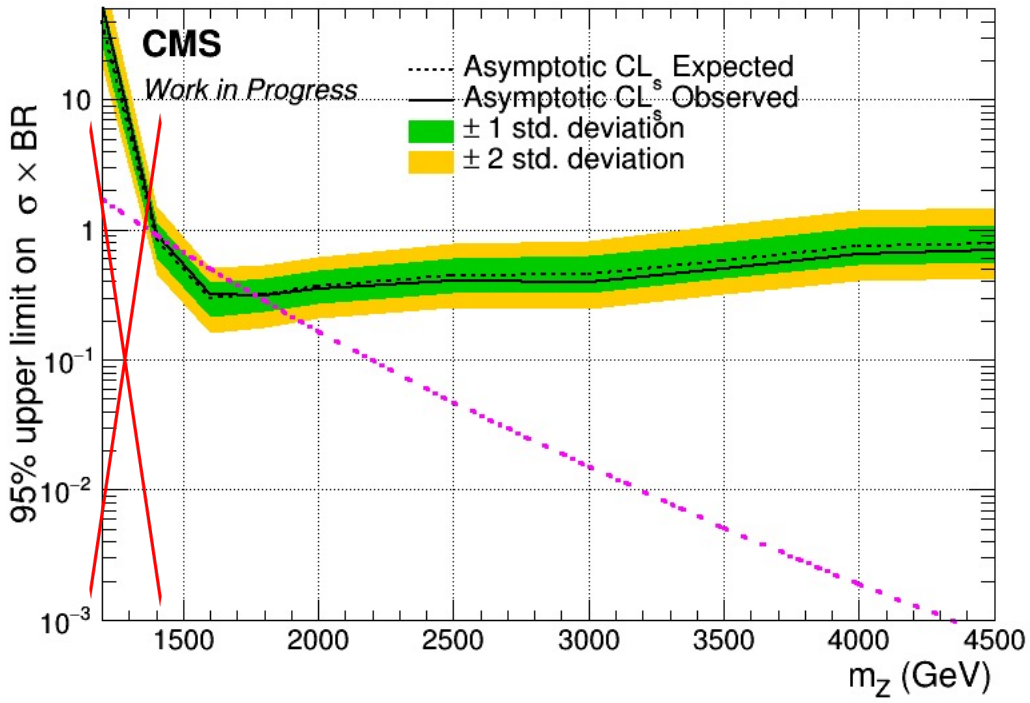



mJJ > 1200 GeV

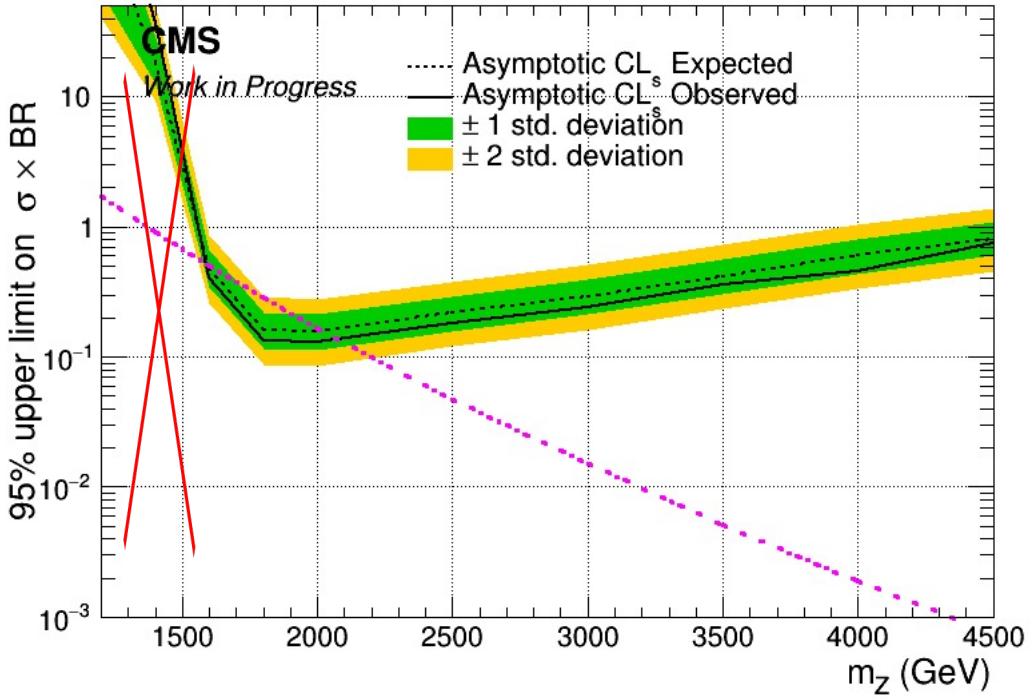


# Asymptotic Limits - Brazilian Plots (2017)

mJJ > 1400 GeV

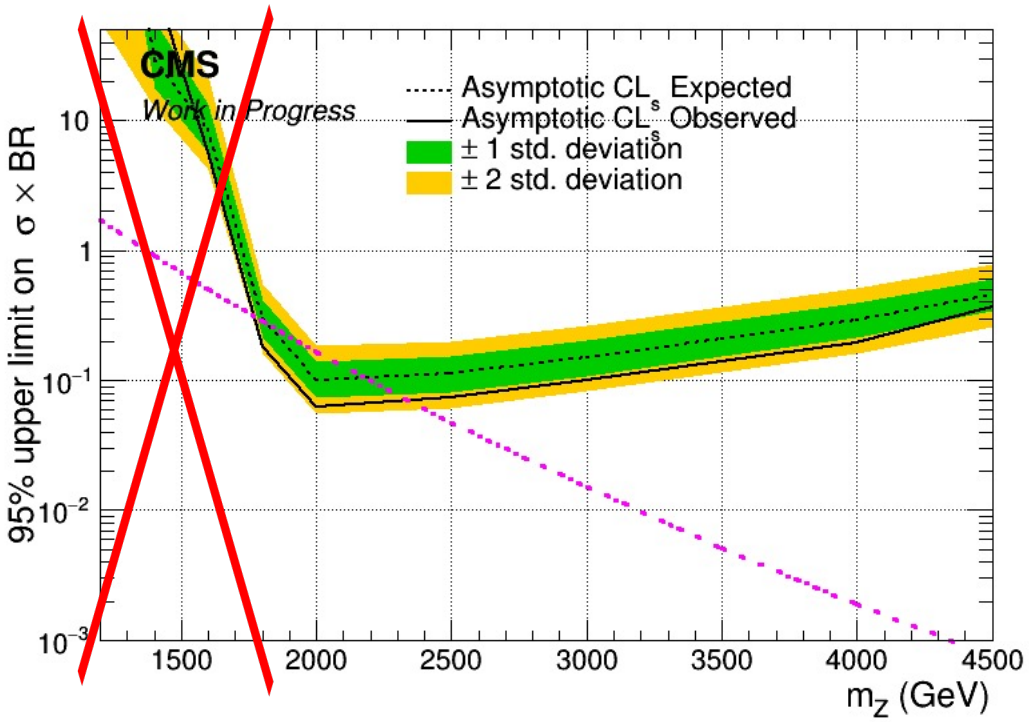



mJJ > 1600 GeV



# Brazilian Plots (2017)

mJJ > 1800 GeV




mJJ > 2000 GeV