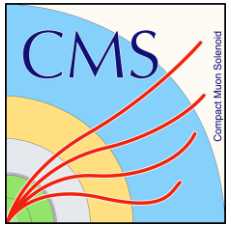
HEP NTUA
Weekly Report

24/2/2021

George Bakas



Summary

ttX analysis:

- Production of UL files
  - Production for 2018 again because files changed
  - 2016 is missing bTagging WP's and scale factors
- Chain of analysis:
  - Contamination
  - Closure tests
  - Mass Fit
  - Signal Extraction

  - Unfolding

  - Systematics

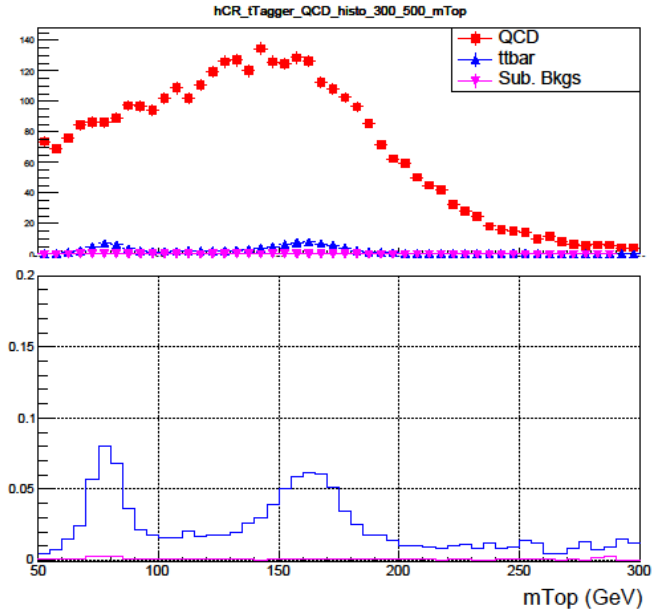
  - Combination
- Consistency checks with Giannis

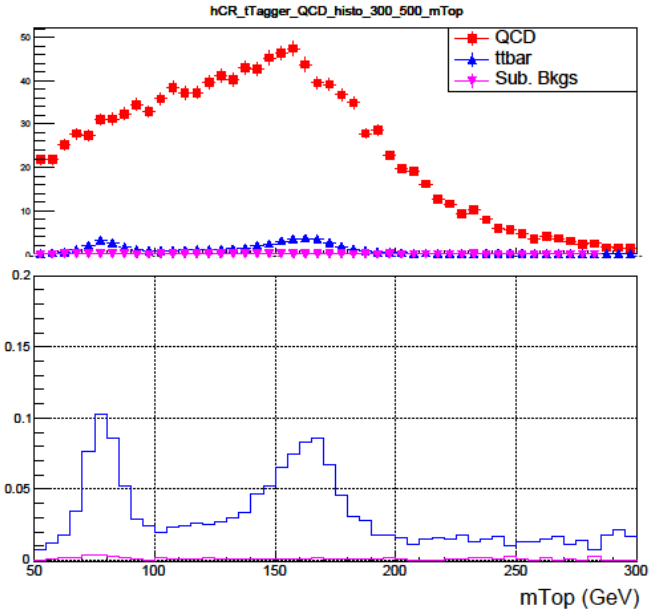
Z' analysis

- While mJJ cut raises, Z' signal "mimics" ttbar → Less sensitivity in angular distributions
- Trying to find solution: (angular ratio etc)

Contamination plots (mTop)

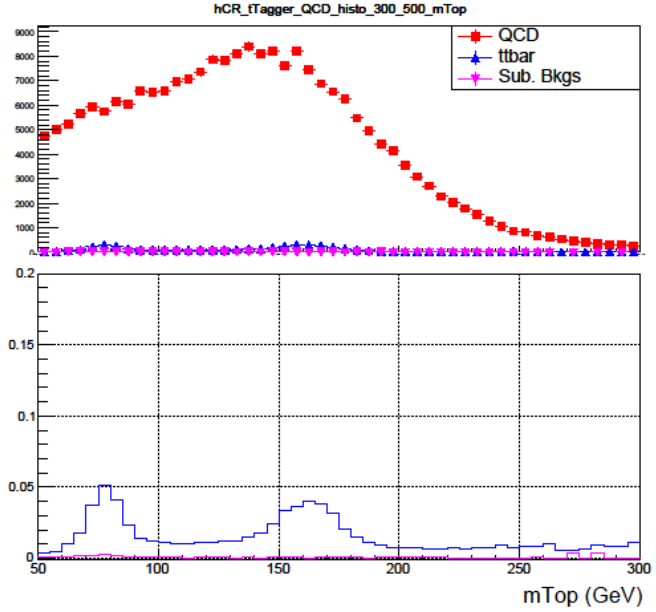
2016_preVFP

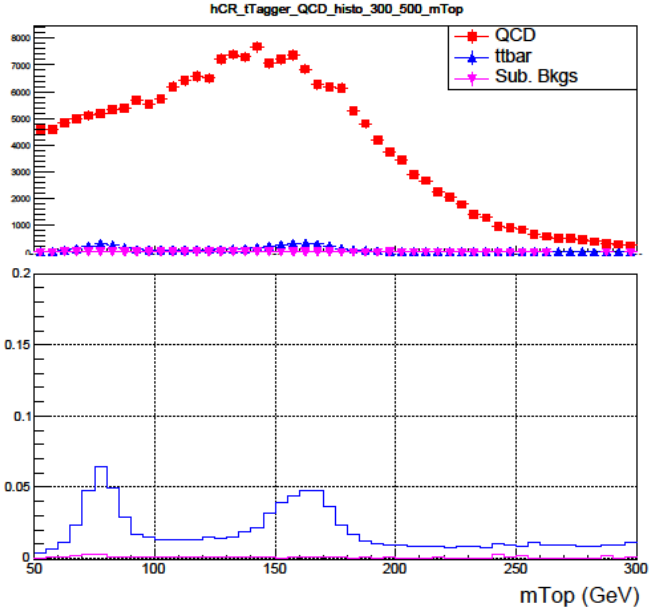




2016_postVFP

2017





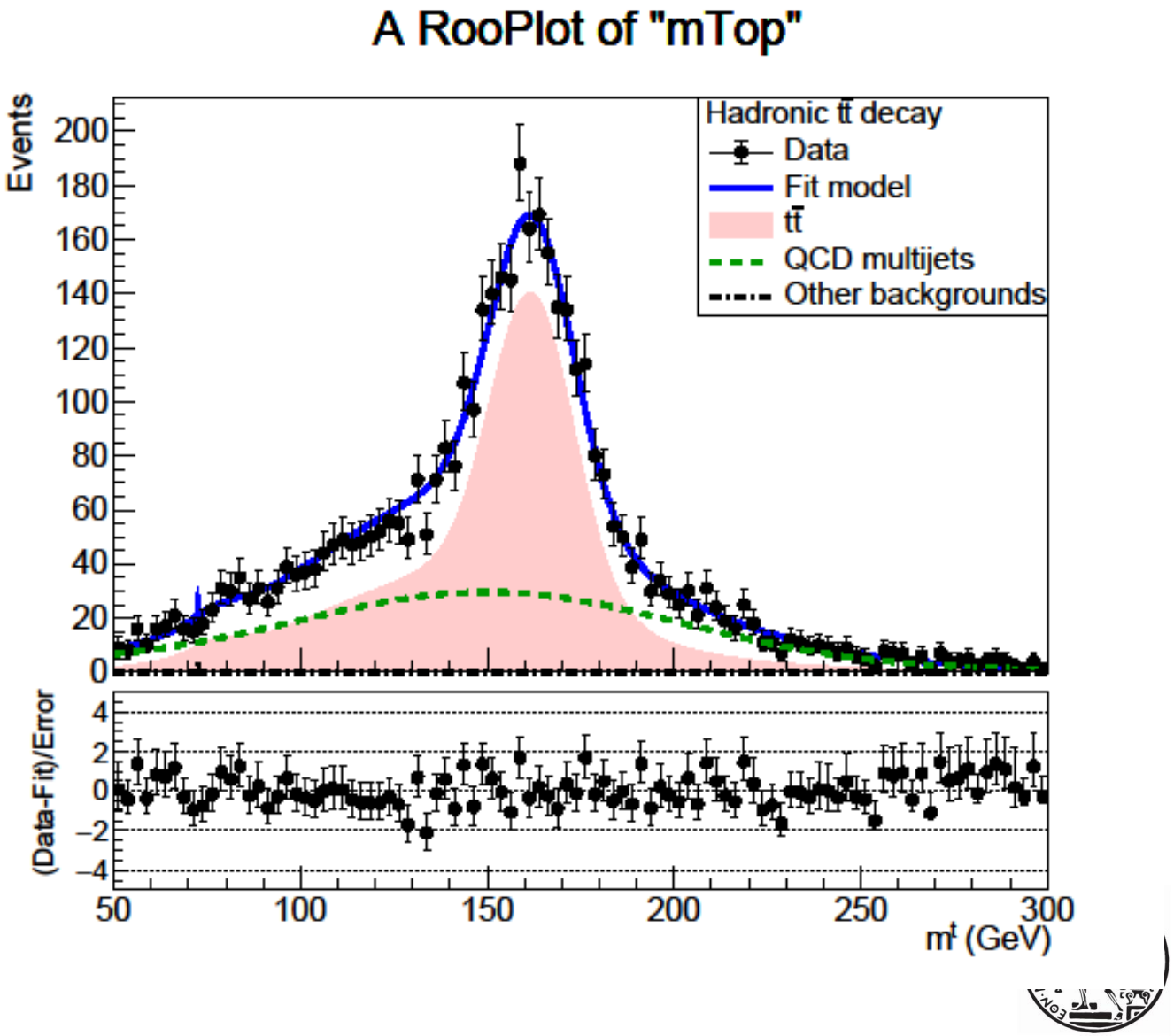
2018

Mass Fit with Results

2016_preVFP

Floating Parameter	FinalValue +/- Error
kMassResol	1.0152e+00 +/- 4.27e-02
kMassScale	9.8901e-01 +/- 3.23e-03
kQCD_2b	5.0274e-02 +/- 3.78e-02
nFitBkg_2b	1.1462e-04 +/- 1.37e+01
nFitQCD_2b	1.5480e+03 +/- 9.55e+01
nFitSig2b	2.6022e+03 +/- 1.01e+02

Signal strength: r = 0.702314 ± 0.0332752

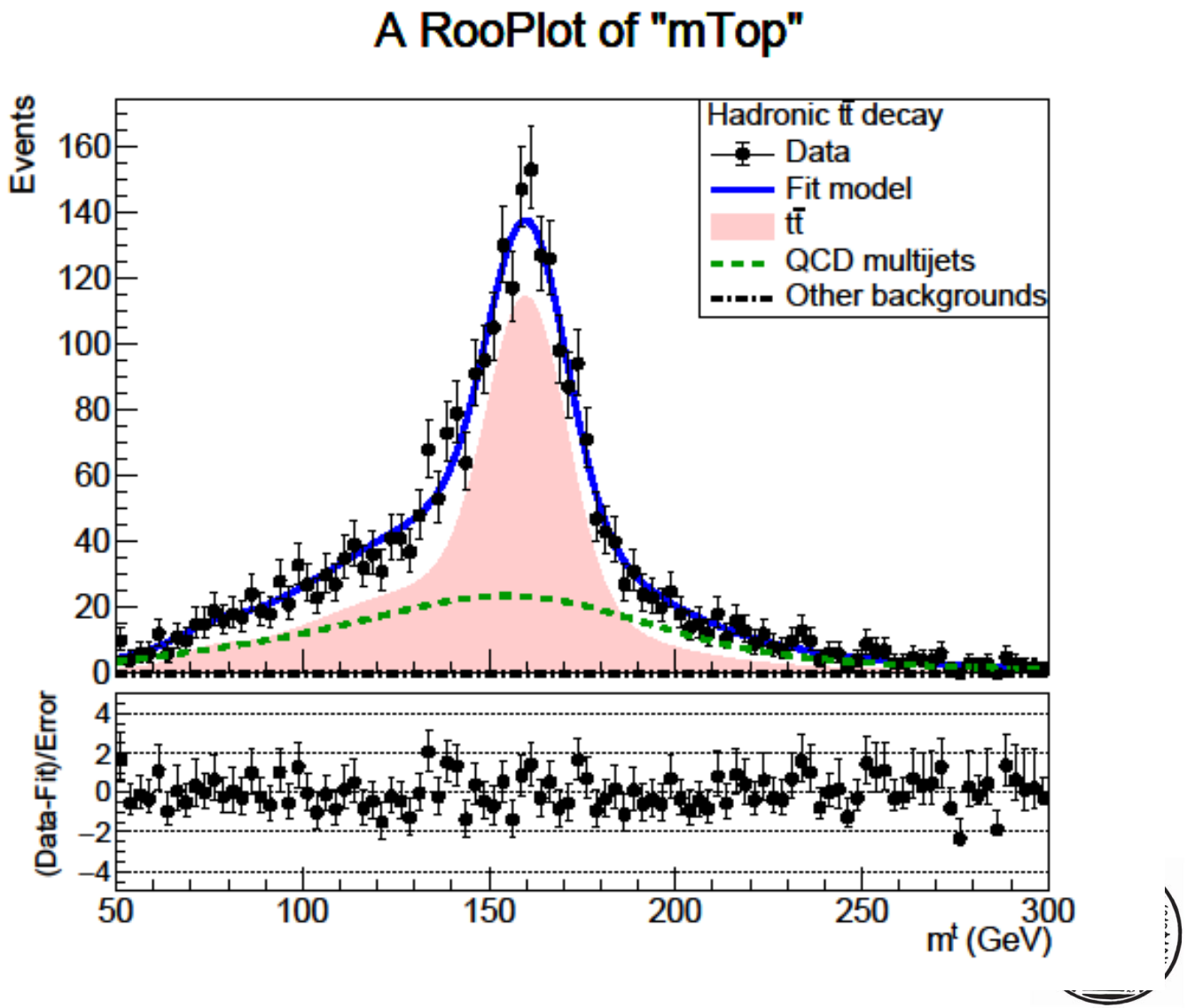


Mass Fit with Results

2016_postVFP

Floating Parameter	FinalValue +/- Error
kMassResol	9.6000e-01 +/- 4.90e-02
kMassScale	9.7883e-01 +/- 3.47e-03
kQCD_2b	3.9566e-01 +/- 1.39e+00
nFitBkg_2b	5.1107e-03 +/- 6.08e+01
nFitQCD_2b	1.0983e+03 +/- 1.12e+02
nFitSig2b	1.9929e+03 +/- 1.02e+02

Signal strength: r = 0.640463 ± 0.0388384

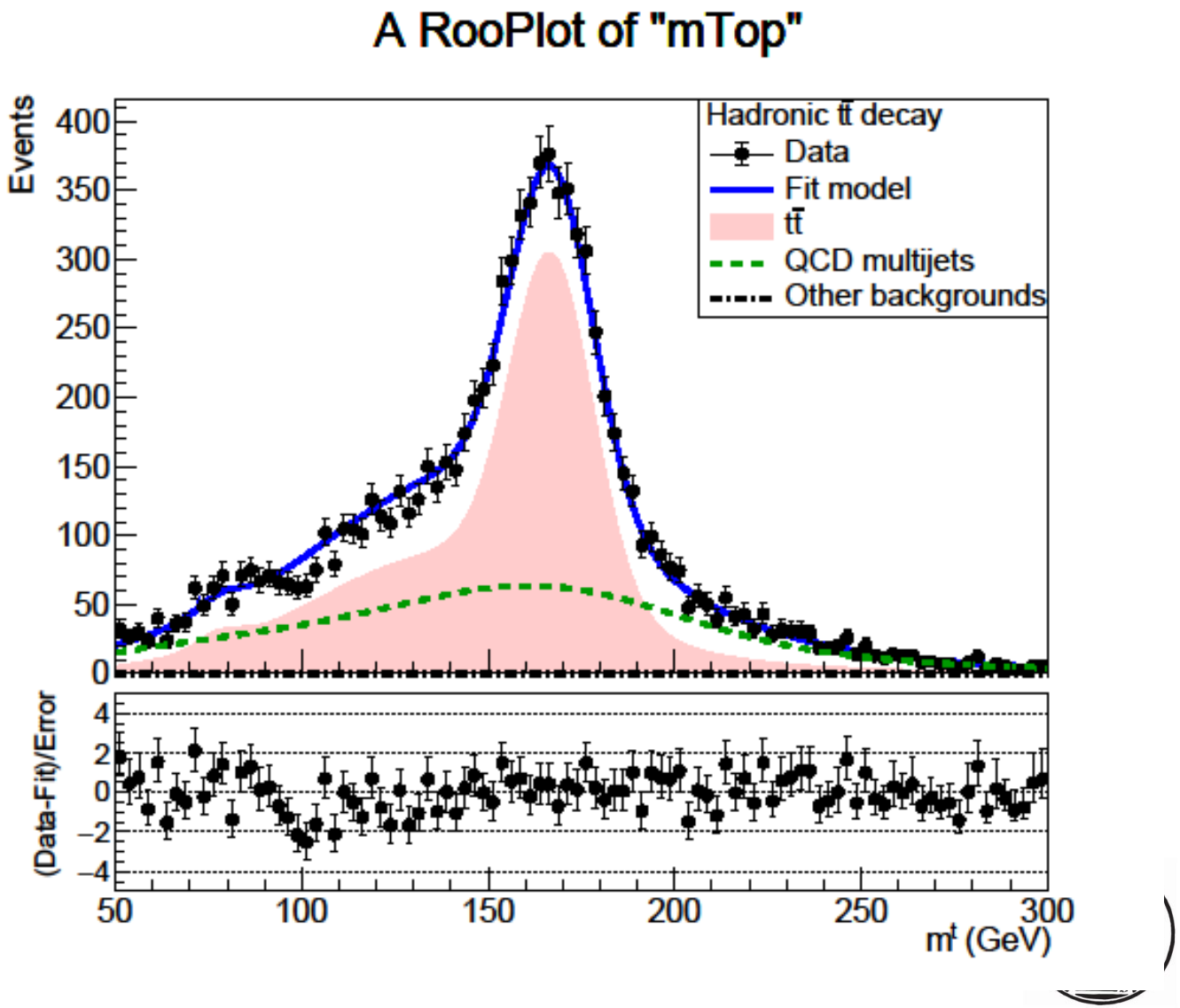


Mass Fit with Results

2017

Floating Parameter	FinalValue +/- Error
kMassResol	1.0047e+00 +/- 2.92e-02
kMassScale	1.0254e+00 +/- 2.17e-03
kQCD_2b	4.8315e-02 +/- 2.41e-02
nFitBkg_2b	9.1608e-04 +/- 2.58e+01
nFitQCD_2b	3.2792e+03 +/- 1.46e+02
nFitSig2b	5.9564e+03 +/- 1.55e+02

Signal strength: r = 0.662214 ± 0.0206756

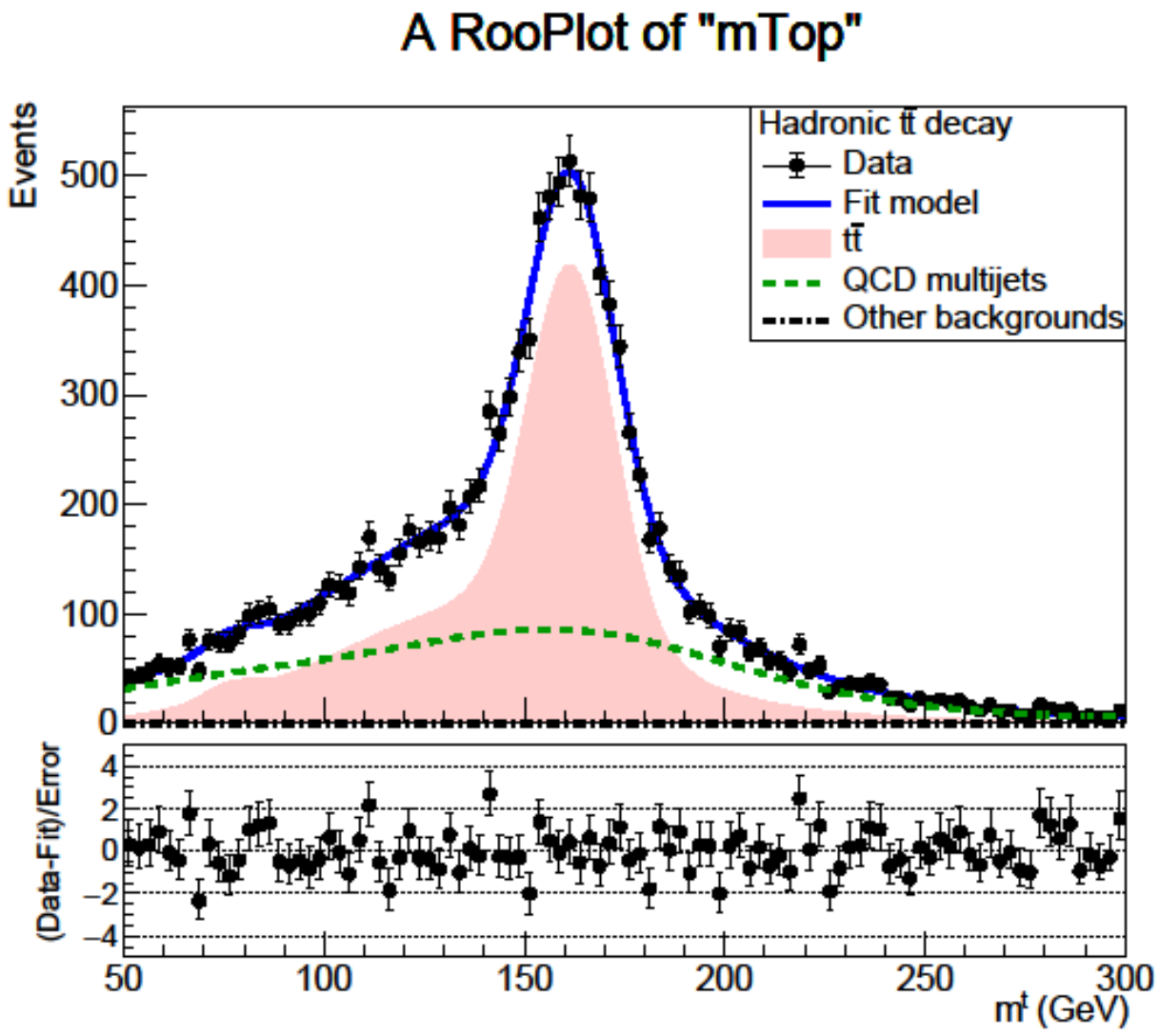


Mass Fit with Results

2018

Floating Parameter	FinalValue +/- Error
kMassResol	9.8311e-01 +/- 2.57e-02
kMassScale	9.9167e-01 +/- 1.85e-03
kQCD_2b	1.4152e-02 +/- 2.95e-03
nFitBkg_2b	3.2440e-04 +/- 3.15e+02
nFitQCD_2b	4.7403e+03 +/- 1.59e+02
nFitSig2b	7.6356e+03 +/- 1.68e+02

Signal strength: r = 0.673655 ± 0.0179039



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:

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