

Status Report

Mass Fit and bTagging Efficiency

(2016,2017,2018)

George Bakas



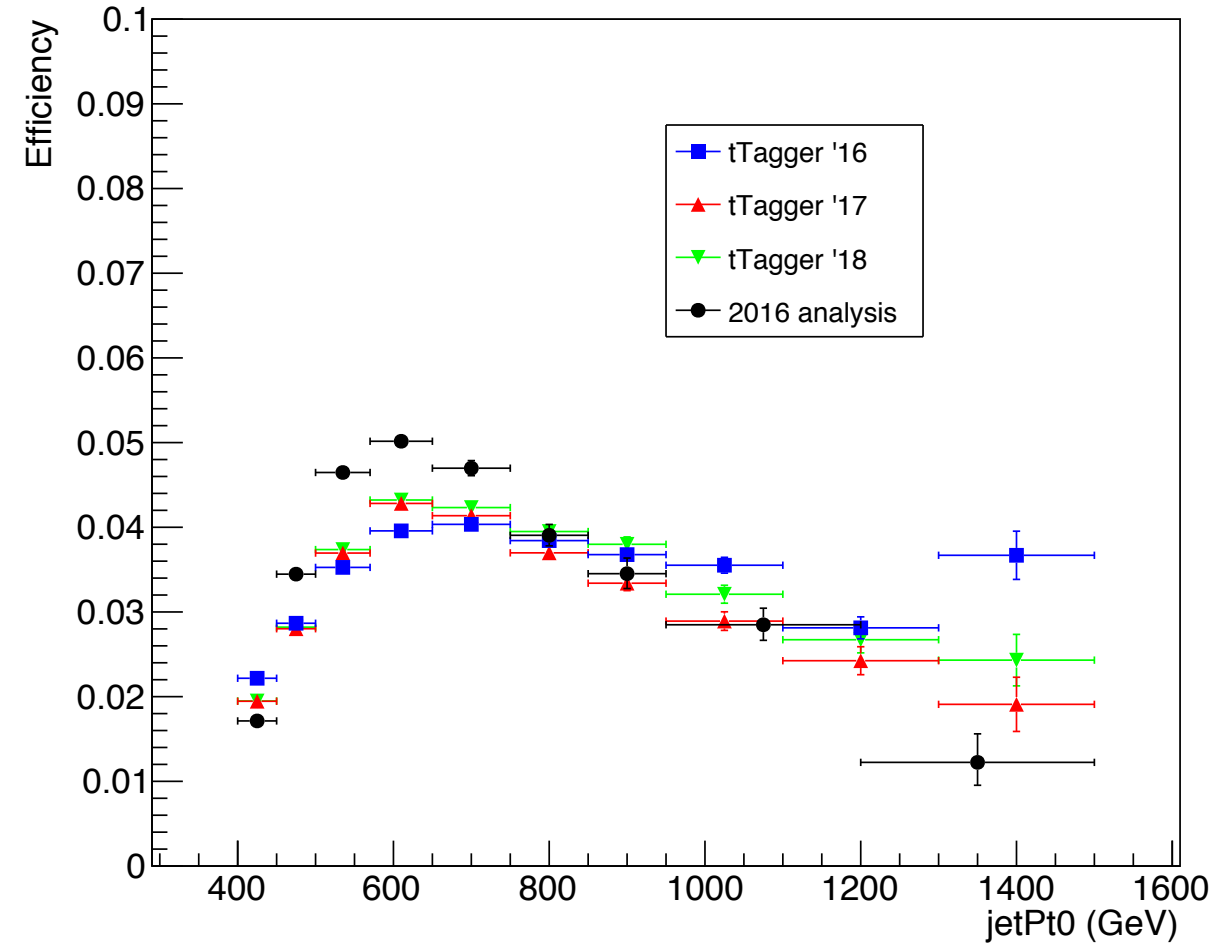
Status Report

- Analysis:
 - Define the template fit correctly in every region
 - Discrepancies in the $t\bar{t}$ template fits (all Regions) and CR from data
 - For CR from data specifically:
 - Not pure control region
 - From MC QCD: find a pdf that describes well QCD shape
 - From this fit keep the nuisance param outputs
 - Use this output as input for the fit of the CR from data
- R_{yield} used as a transfer factor from SR_A to SR defined as: $R_{\text{yield}} = \frac{N_{SR}}{N_{SR_A}}$
 - Check if this quantity is stable in all Regions (0, 1, 2 btag) for every year
- ttX meeting on 13/11:
 - Btag efficiency → Otto also commented on that saying that it has been found to be lower for 2017 and 2018 at higher P_t 's

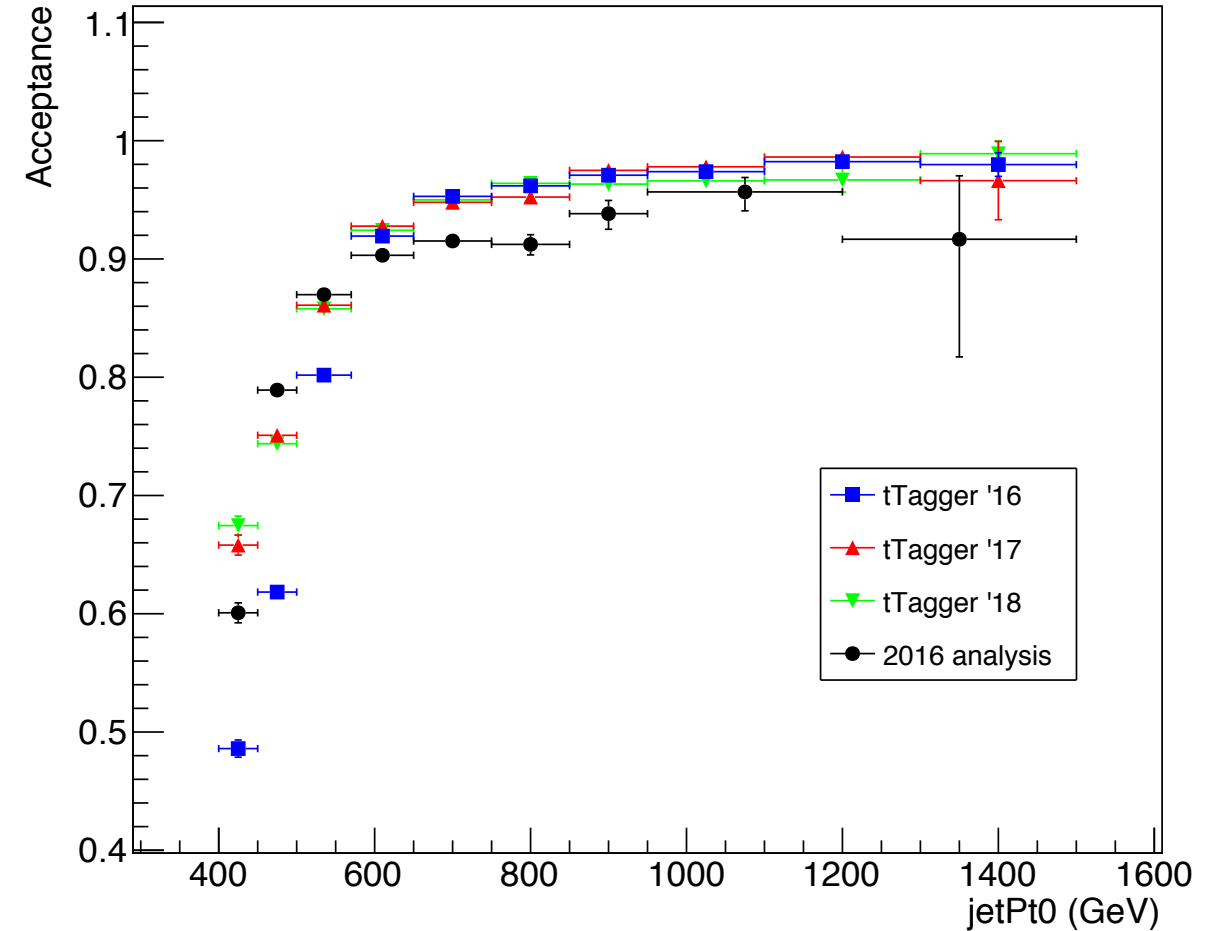


Efficiency and Acceptance for 2016, 2017 and 2018 and previous 2016 analysis

Efficiency '16,'17,'18

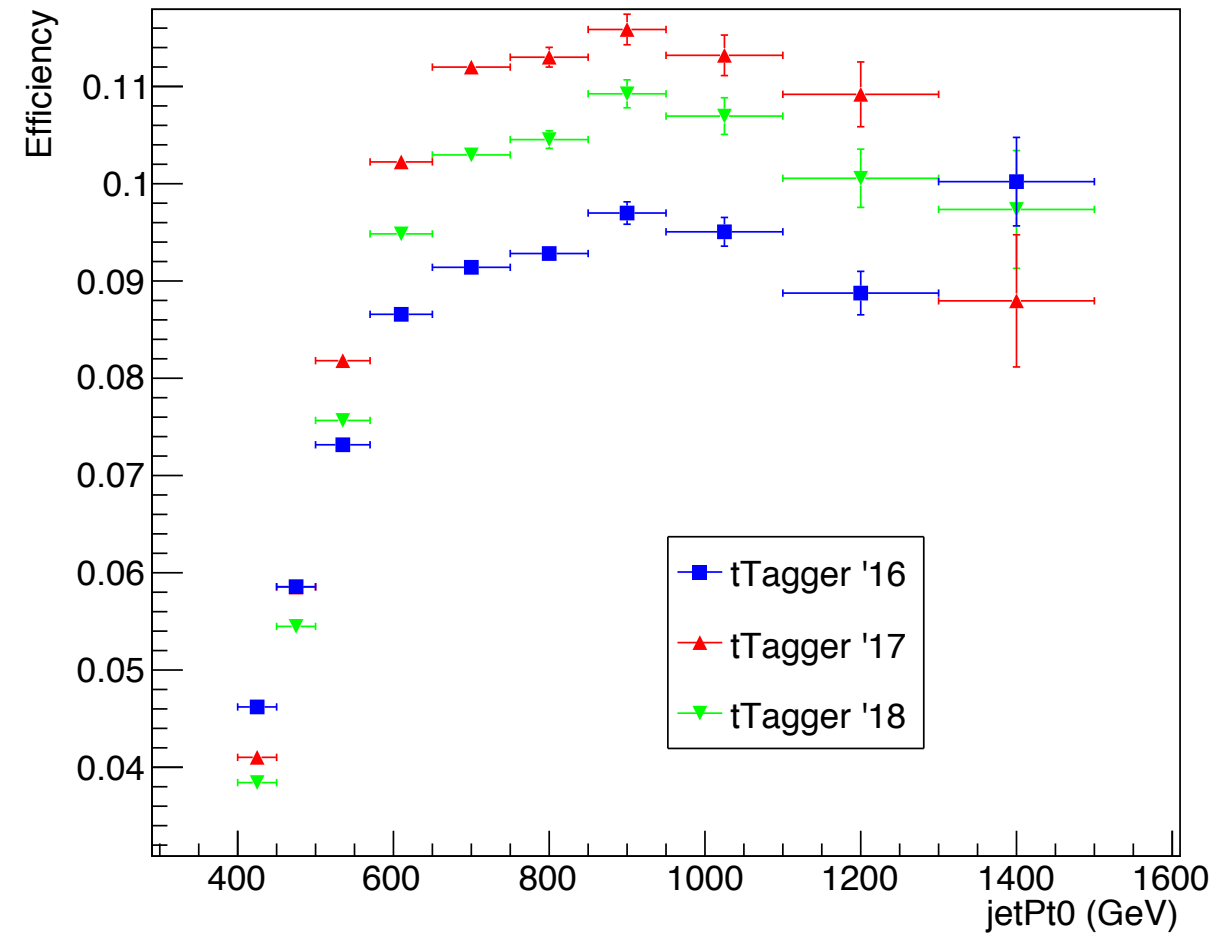


Acceptance '16,'17,'18

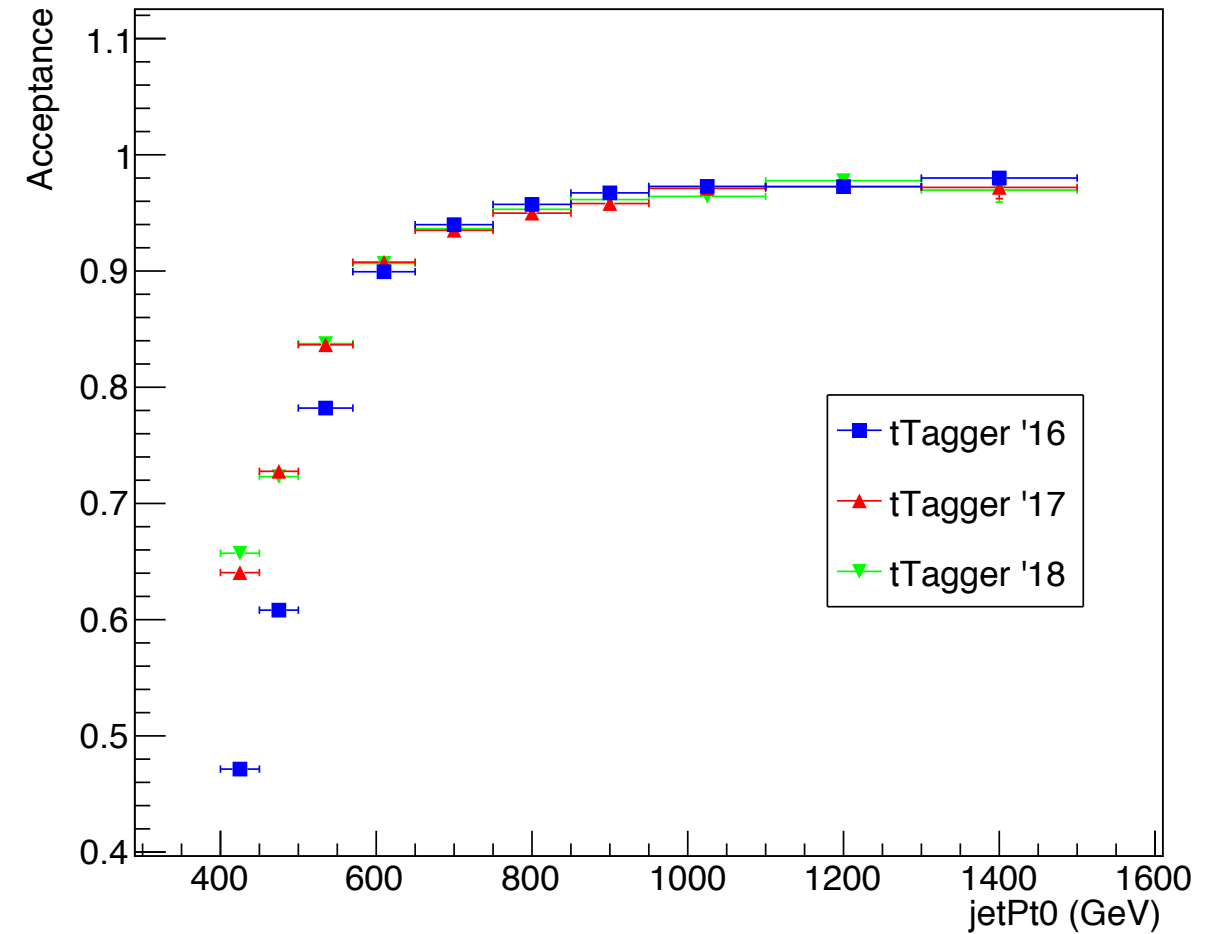


Efficiency and Acceptance for 2016, 2017 and 2018 with no btagging selection

Efficiency '16,'17,'18



Acceptance '16,'17,'18



Signal Extraction

$$S(x_{reco}) = D(x_{reco}) - C_{bkg}^{yield} N_{QCD}^{fit} C_{QCD}^{shape}(x_{reco}) Q(x_{reco}) - B(x_{reco})$$

Diagram illustrating the components of the signal extraction equation:

- Fiducial Yield**: Points to $S(x_{reco})$
- Measured dist from data**: Points to $D(x_{reco})$
- Fitted number of QCD events in SR_A** : Points to N_{QCD}^{fit}
- QCD shape taken from Data (CR)**: Points to $C_{QCD}^{shape}(x_{reco})$
- Transfer factor from SR_A to SR**: Points to C_{bkg}^{yield}
- QCD shape correction factor**: Points to $Q(x_{reco})$
- Subdominant bkg shape and contribution (MC)**: Points to $B(x_{reco})$

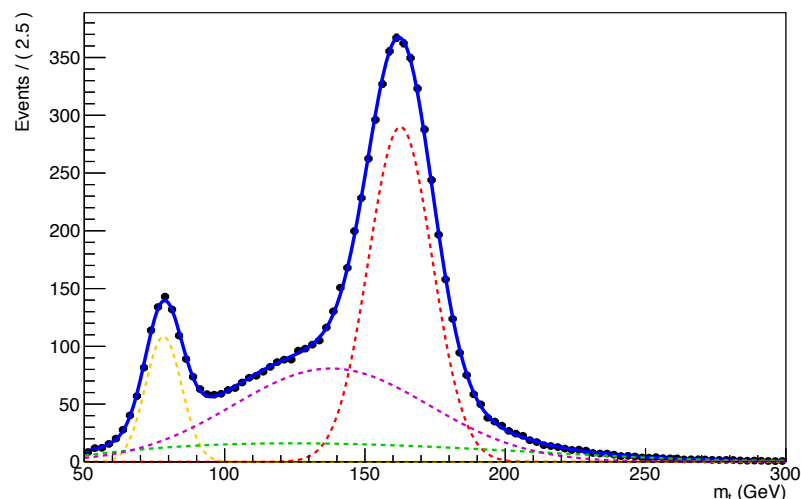
- Where x_{reco} is the respected variable of interest (ttbar mass, pt, rapidity, leading and subleading jetPt and |jetY|)
- We deploy a simultaneous fit in 3 regions (0,1,2 btag) because we do not have a pure Control Region.
 - Our data CR is ttbar contaminated

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

- We assume that $N_{tt}^{(0)} = (1 - e_b)^2 N_{tt}$, $N_{tt}^{(2)} = e_b^2 N_{tt}$ and $N_{tt}^{(1)} = 2(1 - e_b)e_b N_{tt}$ where e_b is the b tagging efficiency and N_{tt} is the total ttbar yield.

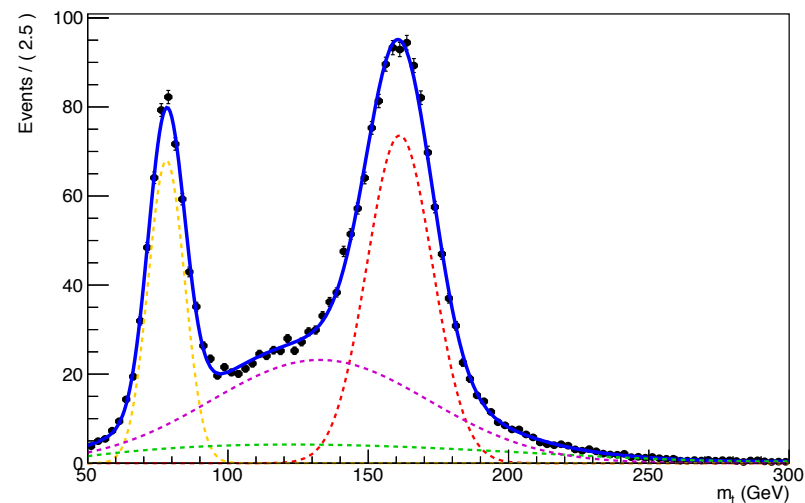


A RooPlot of "mTop"



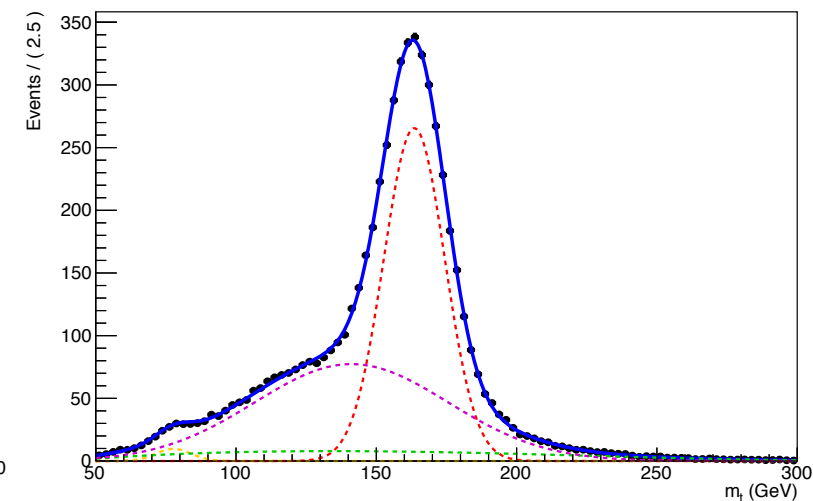
1btag region

A RooPlot of "mTop"



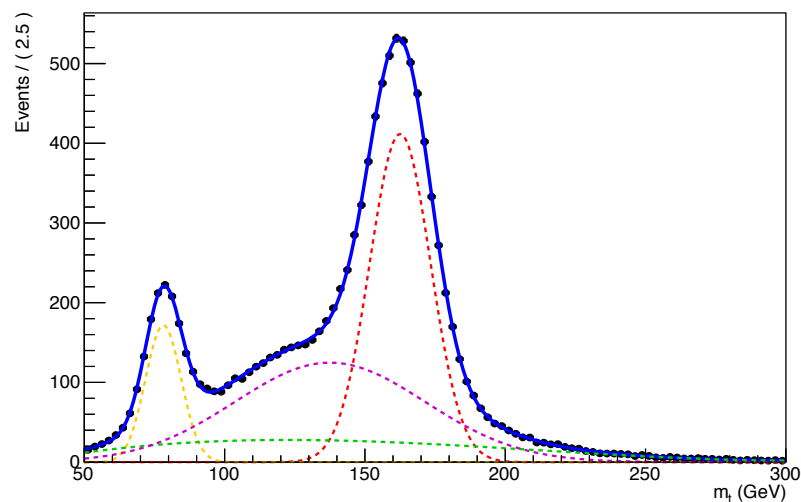
0btag region

A RooPlot of "mTop"

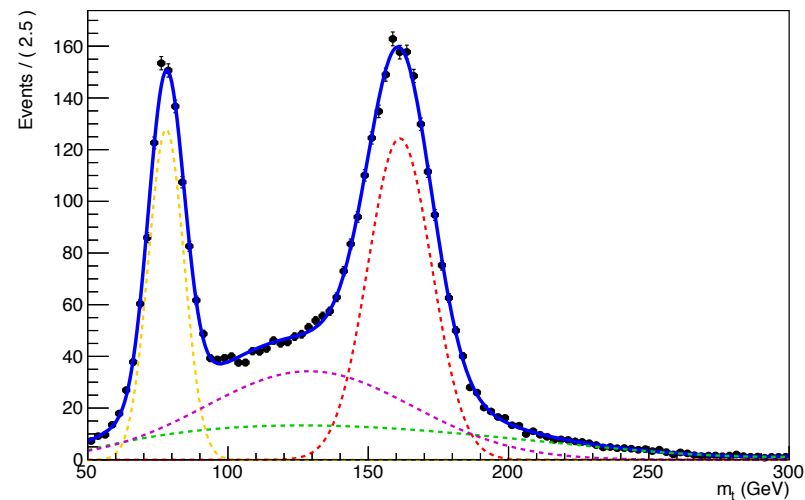


2btag region

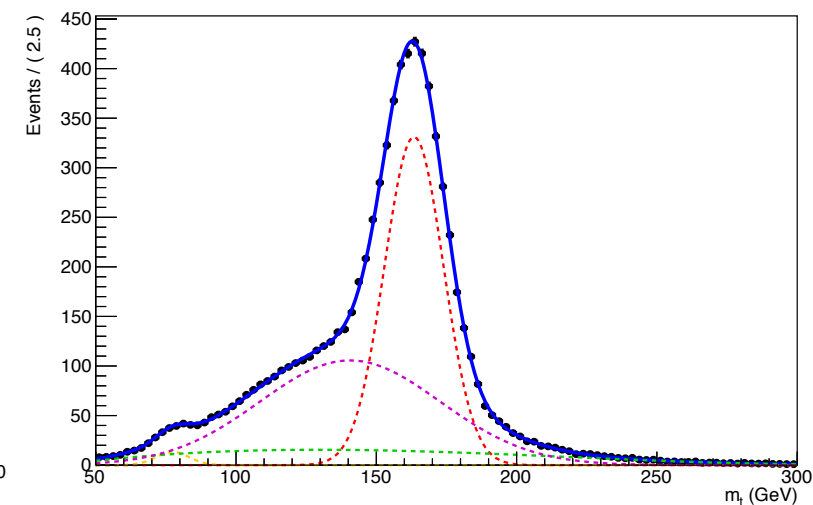
A RooPlot of "mTop"



A RooPlot of "mTop"



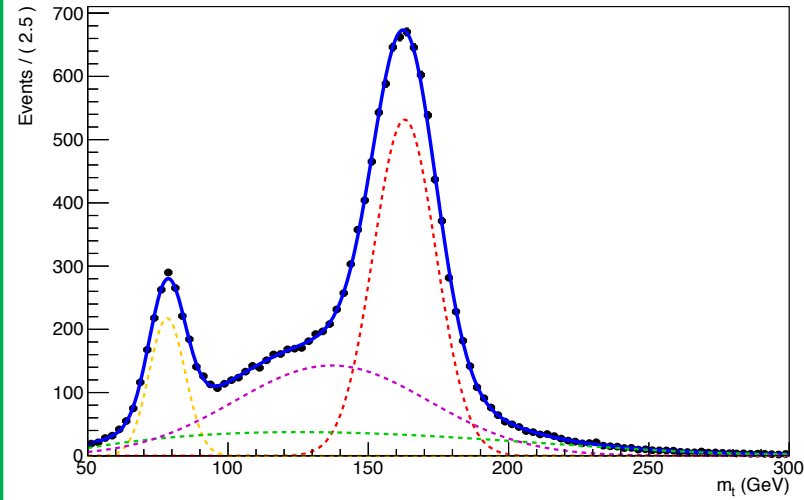
A RooPlot of "mTop"



Template fit results Signal Region A

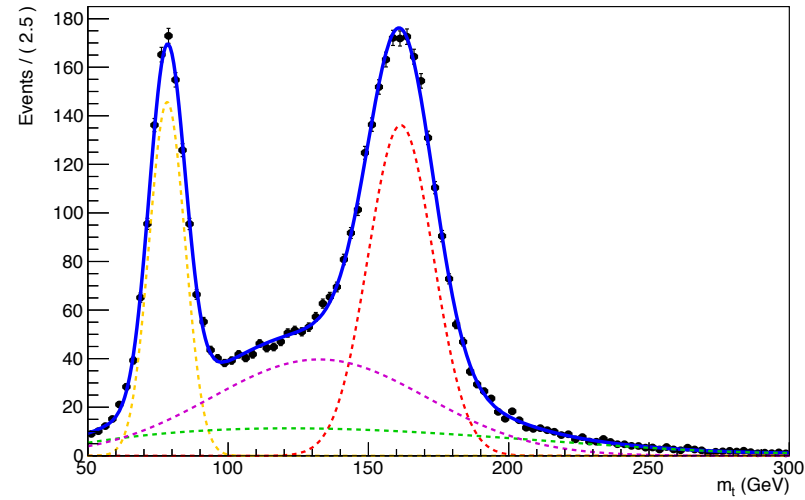
2018

A RooPlot of "mTop"



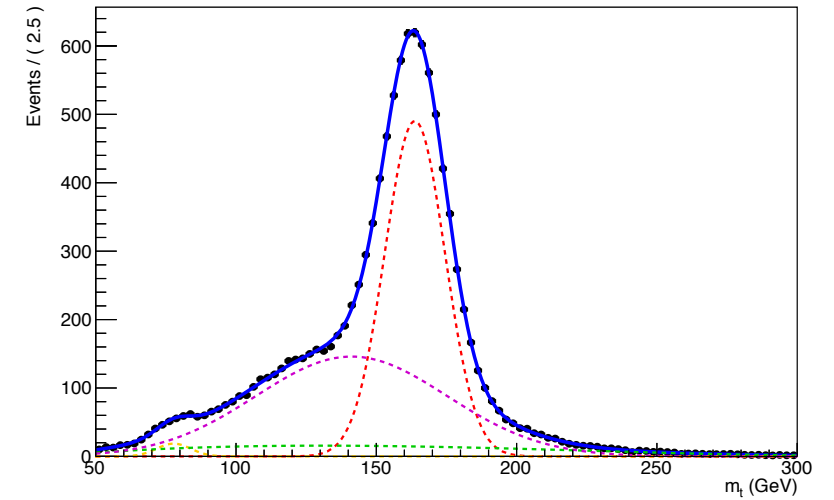
1btag region

A RooPlot of "mTop"



0btag region

A RooPlot of "mTop"



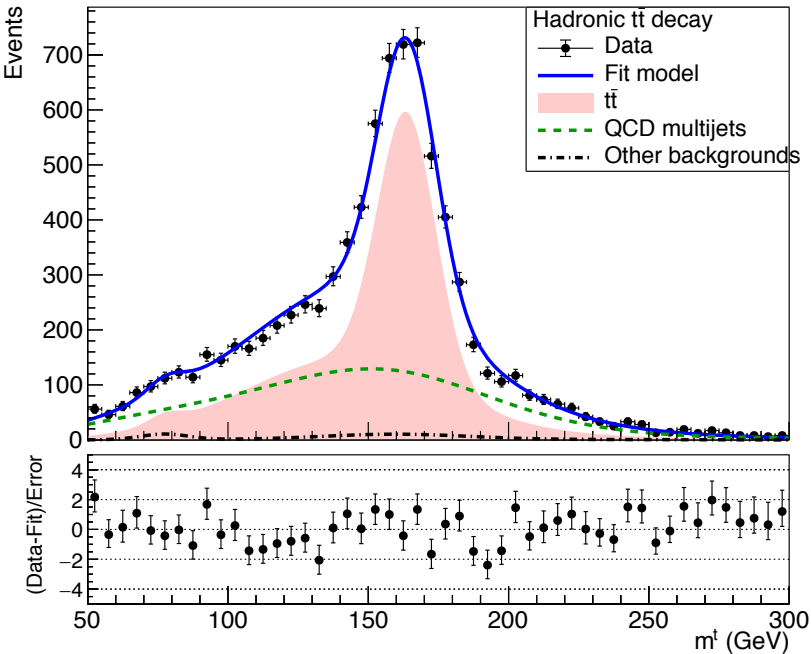
2btag region



Simultaneous Fit in 3 regions for 2016, 2017, 2018 when eb is free (SR)

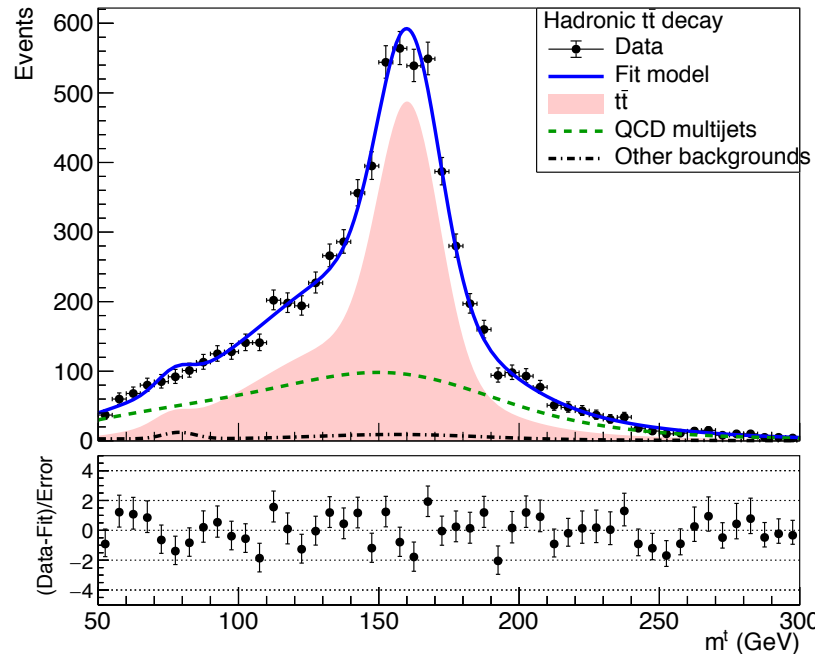
Signal Region (2btag) (2016)

A RooPlot of "mTop"



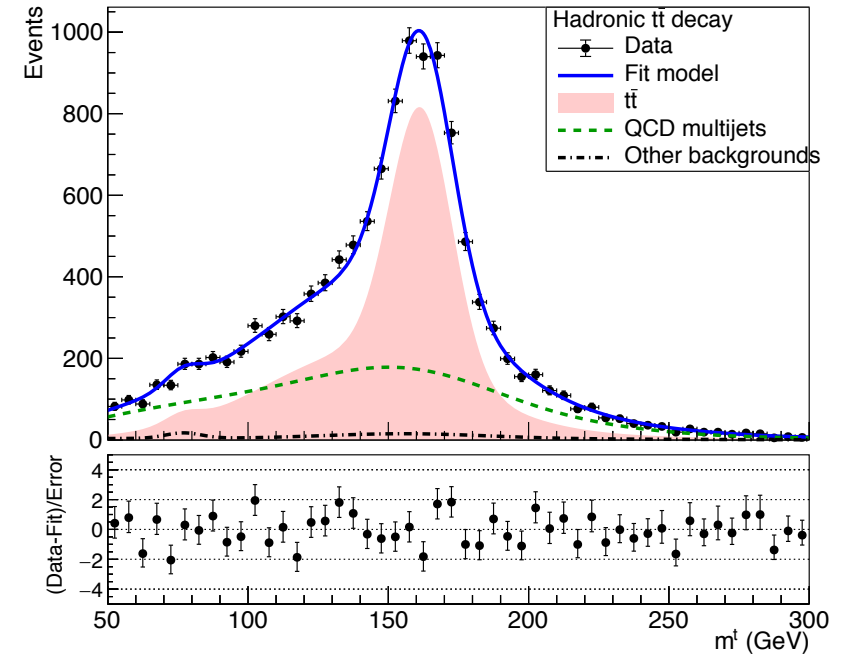
Signal Region (2btag) (2017)

A RooPlot of "mTop"



Signal Region (2btag) (2018)

A RooPlot of "mTop"

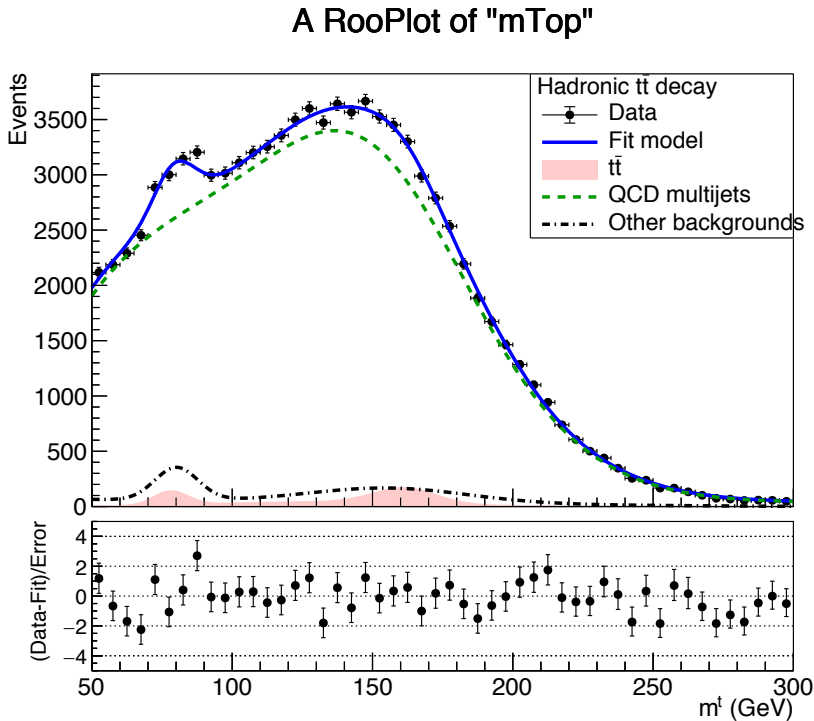


Result of the simultaneous fit on data in SR. The red line shows the $t\bar{t}$ contribution, the green line shows the QCD, and the black line shows the subdominant backgrounds

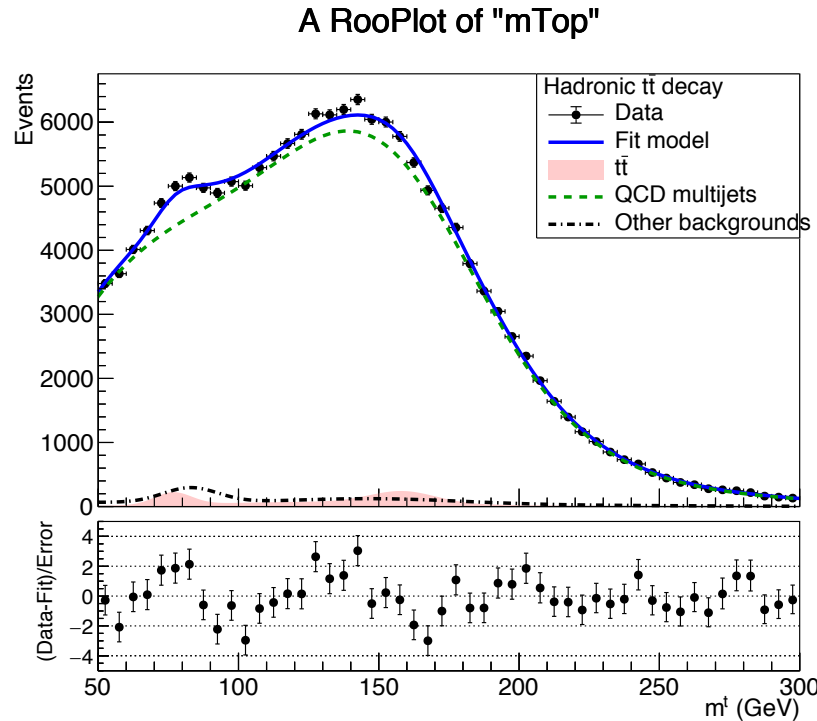


Simultaneous Fit in 3 regions for 2016, 2017, 2018 when eb is free (CR)

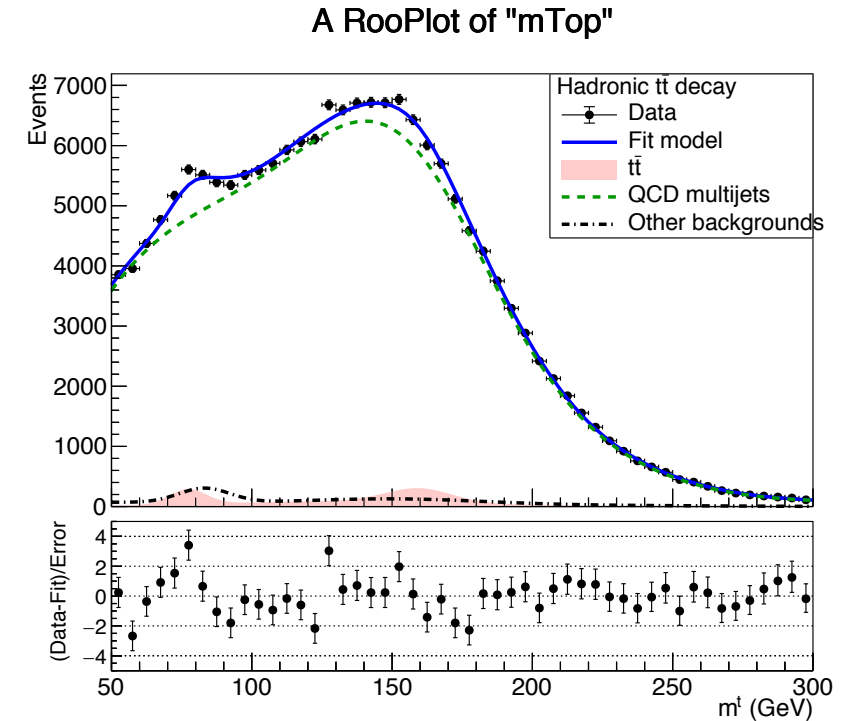
Control Region (0btag) (2016)



Control Region (0btag) (2017)



Control Region (0btag) (2018)



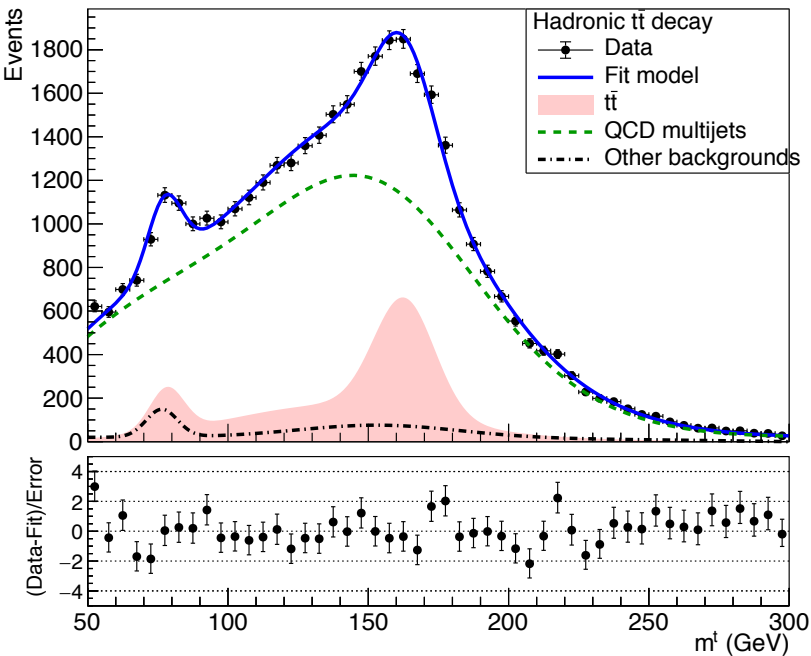
Result of the simultaneous fit on data in CR. The red line shows the $t\bar{t}$ contribution, the green line shows the QCD, and the black line shows the subdominant backgrounds



Simultaneous Fit in 3 regions for 2016, 2017, 2018 when eb is free (1btag region)

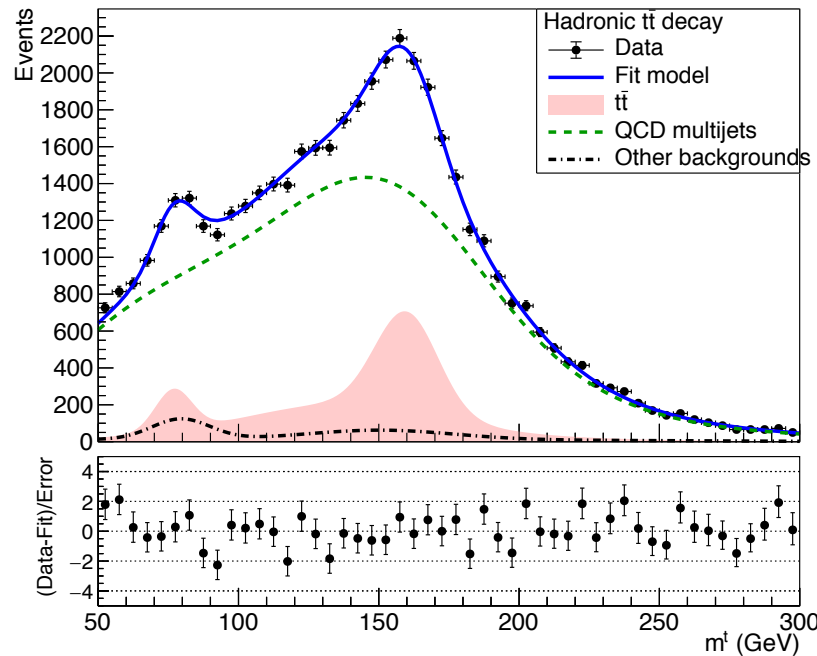
1btag region (2016)

A RooPlot of "mTop"



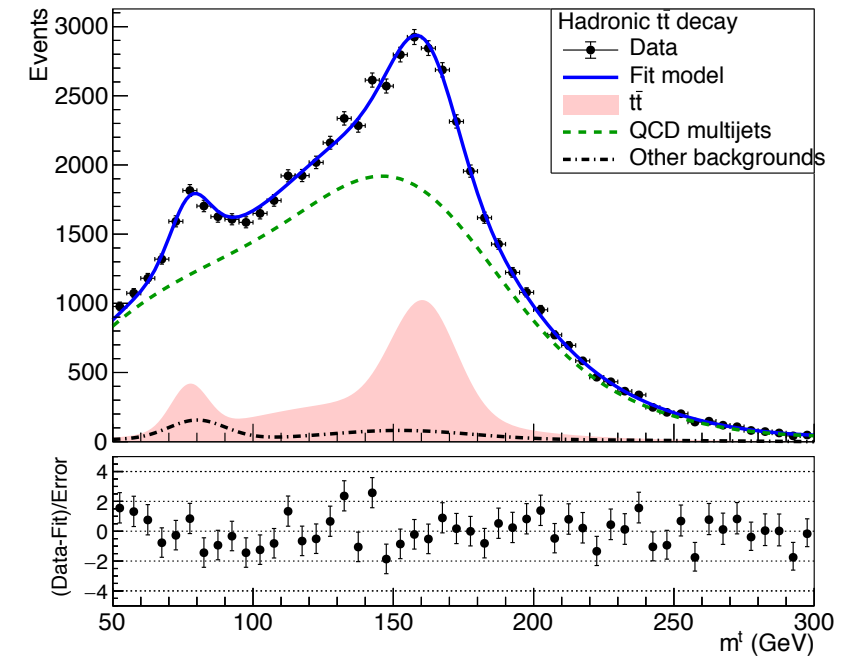
1btag region (2017)

A RooPlot of "mTop"



1btag region (2018)

A RooPlot of "mTop"



Result of the simultaneous fit on data in 1btag region. The red line shows the $t\bar{t}$ contribution, the green line shows the QCD, and the black line shows the subdominant backgrounds



Simultaneous Fit in 3 regions for 2016, 2017 and 2018 (nuisances) with free eb

2016

Floating Parameter	FinalValue	+/-	Error
btagEff	6.0786e-01	+/-	1.53e-02
kMassResol	9.5079e-01	+/-	2.42e-02
kMassScale	1.0009e+00	+/-	1.76e-03
kQCD_1b	6.0406e-03	+/-	5.05e-04
kQCD_2b	9.6764e-02	+/-	6.83e-02
nFitBkg_0b	4.5268e+03	+/-	6.84e+02
nFitBkg_1b	1.9110e+03	+/-	3.13e+02
nFitBkg_2b	1.9415e+02	+/-	2.48e+01
nFitQCD_0b	8.8132e+04	+/-	4.48e+02
nFitQCD_1b	3.0796e+04	+/-	4.61e+02
nFitQCD_2b	3.0802e+03	+/-	1.45e+02
nFitSig	1.4153e+04	+/-	7.33e+02
qcd_b0	6.6661e-01	+/-	5.74e-01
qcd_b1	1.4002e+00	+/-	1.62e+00
qcd_b2	3.3898e-02	+/-	5.46e-02
qcd_b3	3.3916e-02	+/-	3.37e-02
qcd_b4	1.6260e-02	+/-	1.52e-02
qcd_f1	6.9097e-01	+/-	2.57e-02
qcd_mean	1.5055e+02	+/-	1.05e+00
qcd_sigma	3.3739e+01	+/-	1.30e+00

Ntt expected: 16351
Ntt observed: 14153
Signal strength r: 0.865584

2017

Floating Parameter	FinalValue	+/-	Error
btagEff	5.4097e-01	+/-	1.39e-02
kMassResol	1.0289e+00	+/-	3.03e-02
kMassScale	9.8332e-01	+/-	2.06e-03
kQCD_1b	4.2097e-03	+/-	3.15e-04
kQCD_2b	1.5460e-02	+/-	5.16e-03
nFitBkg_0b	4.0852e+03	+/-	5.03e+02
nFitBkg_1b	1.6992e+03	+/-	2.84e+02
nFitBkg_2b	2.1330e+02	+/-	4.44e+01
nFitQCD_0b	1.5483e+05	+/-	5.41e+02
nFitQCD_1b	3.7067e+04	+/-	4.57e+02
nFitQCD_2b	2.4652e+03	+/-	1.32e+02
nFitSig	1.5594e+04	+/-	7.87e+02
qcd_b0	5.2866e-01	+/-	8.49e-02
qcd_b1	1.1003e+00	+/-	1.63e-01
qcd_b2	8.4662e-02	+/-	3.49e-02
qcd_b3	5.5285e-02	+/-	1.06e-02
qcd_b4	1.9483e-02	+/-	3.70e-03
qcd_f1	7.1106e-01	+/-	1.24e-02
qcd_mean	1.5184e+02	+/-	6.37e-01
qcd_sigma	3.2820e+01	+/-	6.76e-01

Ntt expected: 23721
Ntt observed: 15594
Signal strength r: 0.657402

2018

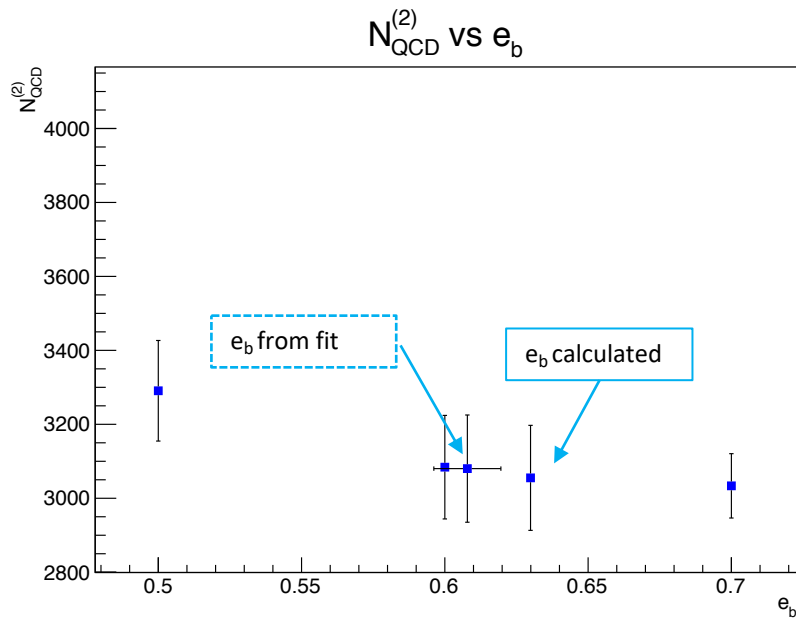
Floating Parameter	FinalValue	+/-	Error
btagEff	5.7371e-01	+/-	1.12e-02
kMassResol	1.0251e+00	+/-	2.43e-02
kMassScale	9.8728e-01	+/-	1.61e-03
kQCD_1b	3.6804e-03	+/-	2.60e-04
kQCD_2b	1.3533e-02	+/-	3.24e-03
nFitBkg_0b	4.1842e+03	+/-	5.05e+02
nFitBkg_1b	2.1675e+03	+/-	3.15e+02
nFitBkg_2b	3.4159e+02	+/-	7.52e+01
nFitQCD_0b	1.6842e+05	+/-	5.64e+02
nFitQCD_1b	4.9321e+04	+/-	5.36e+02
nFitQCD_2b	4.4306e+03	+/-	1.77e+02
nFitSig	2.2906e+04	+/-	8.92e+02
qcd_b0	4.0935e-01	+/-	6.23e-02
qcd_b1	8.5950e-01	+/-	1.25e-01
qcd_b2	1.0234e-01	+/-	2.32e-02
qcd_b3	2.4955e-02	+/-	6.63e-03
qcd_b4	1.1844e-02	+/-	2.02e-03
qcd_f1	7.3124e-01	+/-	1.01e-02
qcd_mean	1.5274e+02	+/-	5.33e-01
qcd_sigma	3.1322e+01	+/-	6.11e-01

Ntt expected: 30676
Ntt observed: 22906
Signal strength r: 0.746688

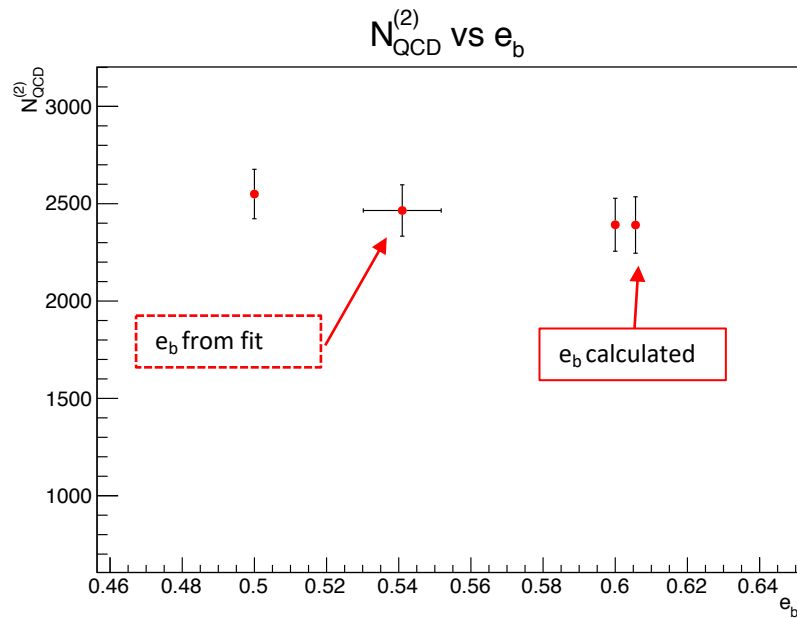


- We are checking for different values of e_b , the output of the $N_{\text{QCD}}^{(2)}$ for 2016 , 2017, 2018
- The values of e_b are picked when the fit output is efficient
 - Calculated btagging efficiency for all years
 - btagging efficiency when the parameter is set as a free nuisance in the simultaneous fit
- 2016: $e_b(\text{fit}) \approx 0.61$ and $e_b(\text{calculated}) \approx 0.63$
- 2017: $e_b(\text{fit}) \approx 0.55$ and $e_b(\text{calculated}) \approx 0.61$
- 2018: $e_b(\text{fit}) \approx 0.57$ and $e_b(\text{calculated}) \approx 0.63$
- Stable results (within error) of $N_{\text{QCD}}^{(2)}$ for a variety of b-tagging efficiency values

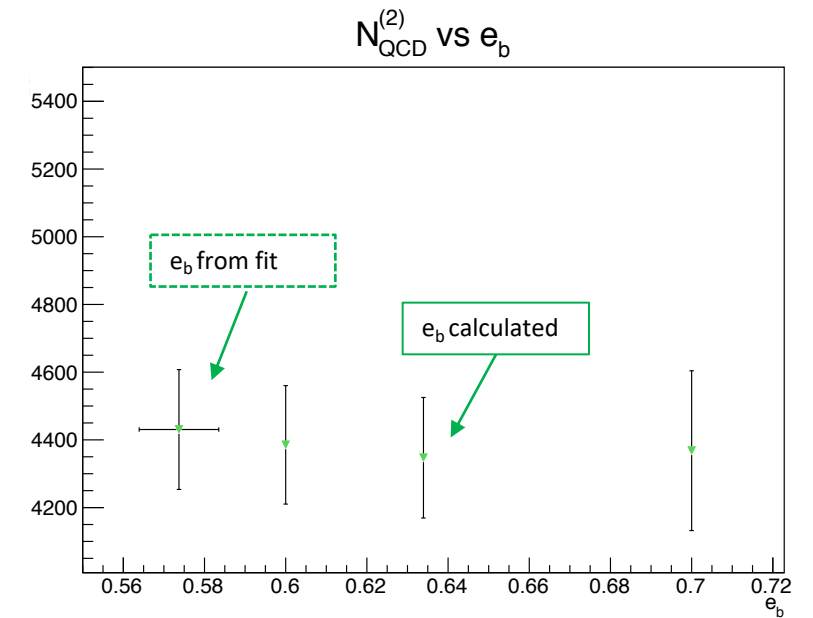
2016

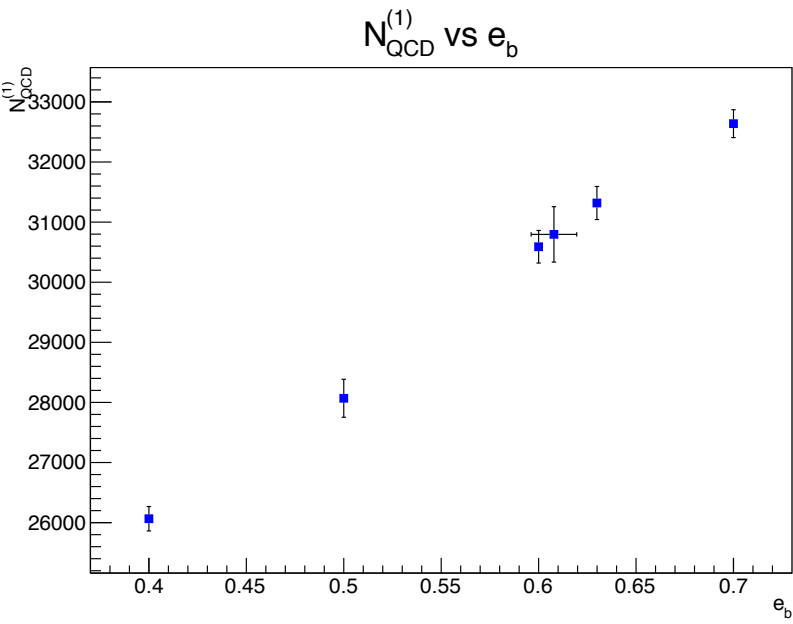


2017

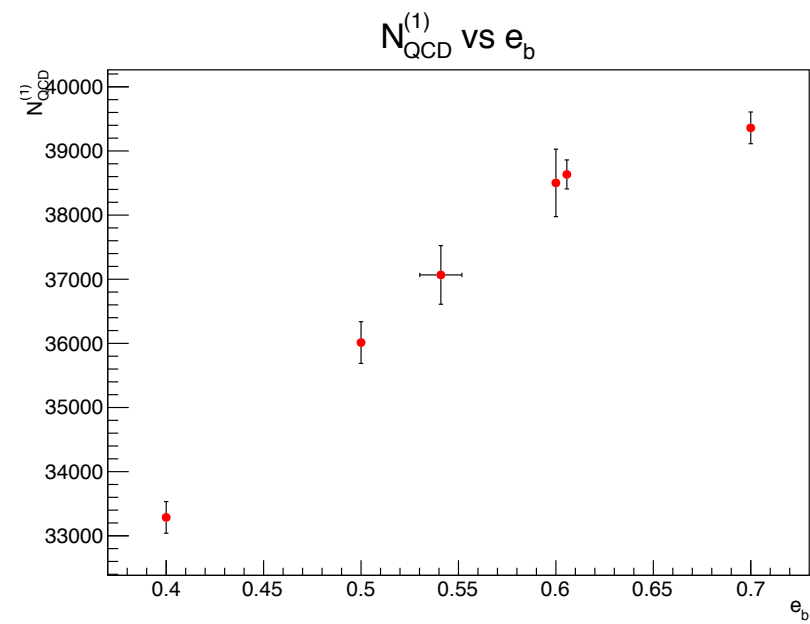
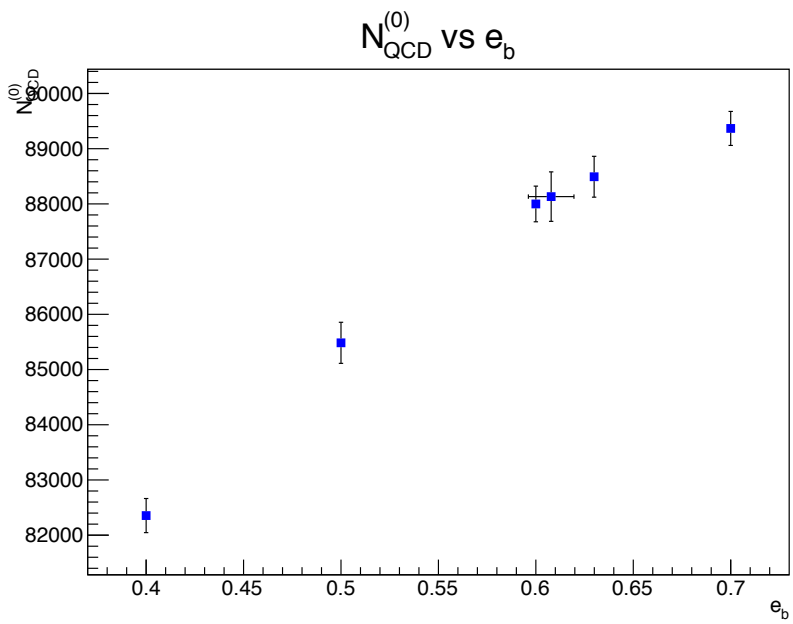


2018

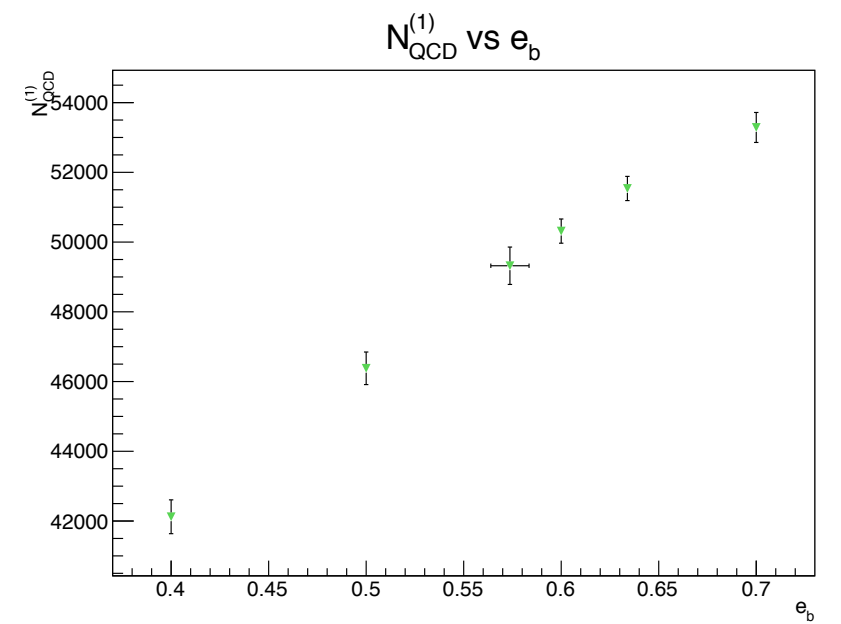
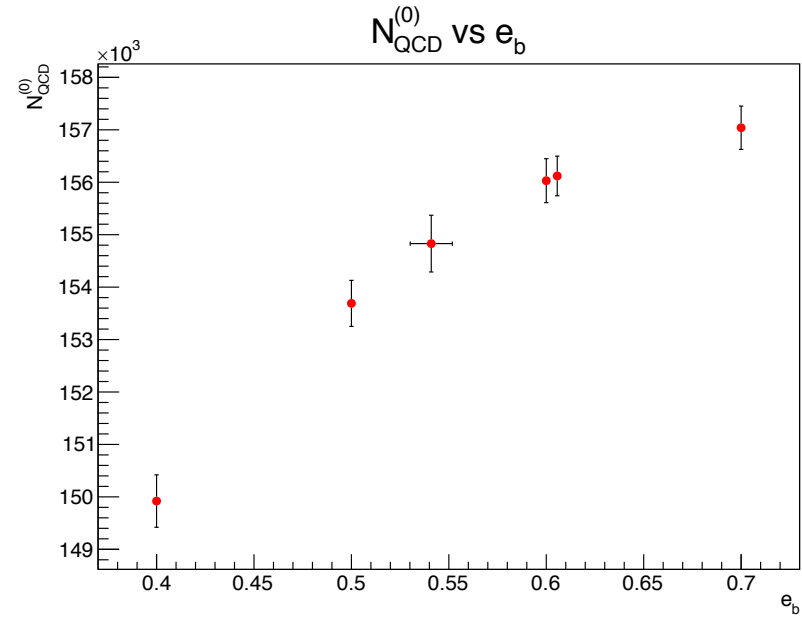




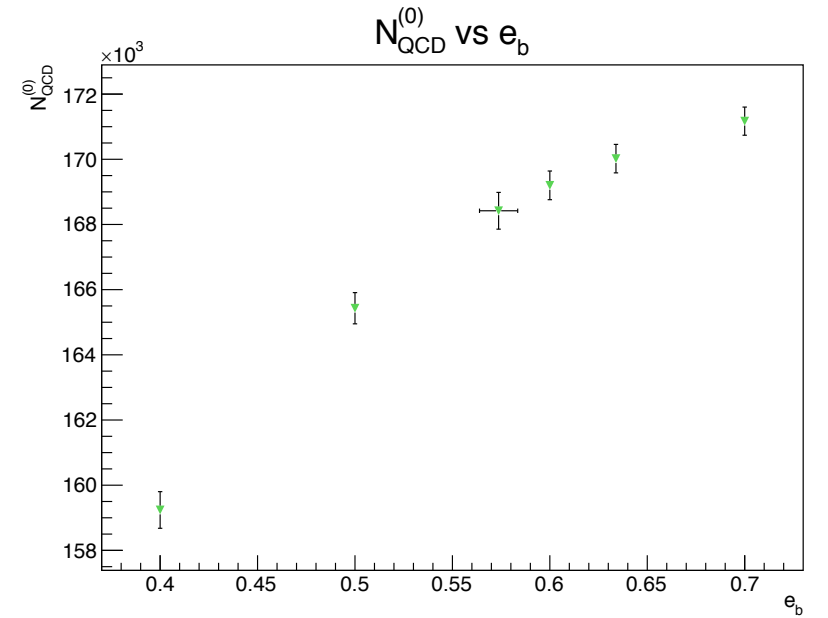
2016



2017



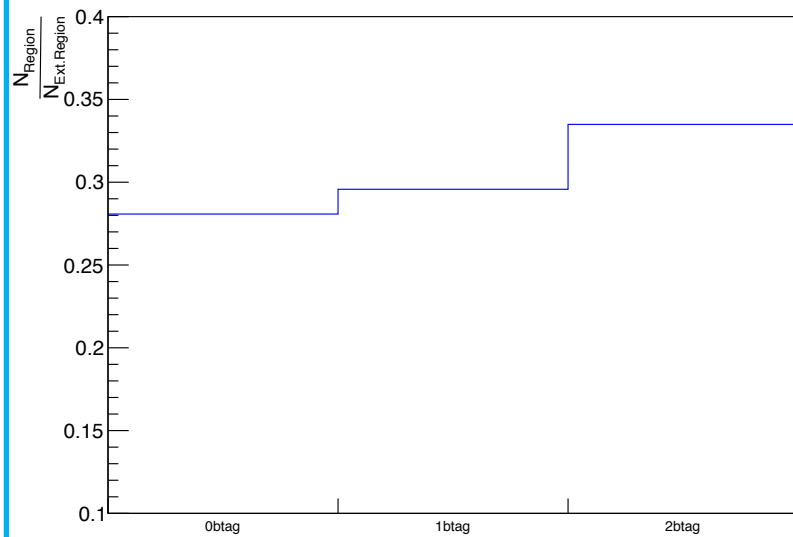
2018



R_{yield} Calculation

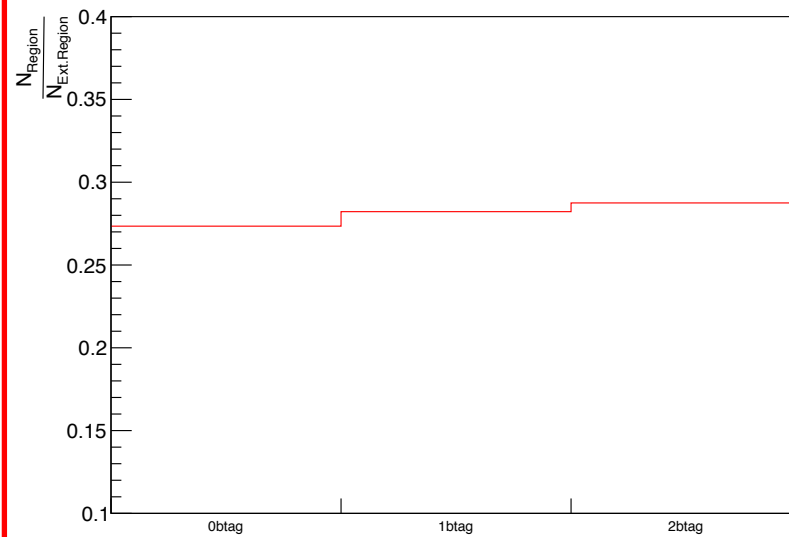
2016

R_{yield} transfer factor 2016



2017

R_{yield} transfer factor 2017



2018

R_{yield} transfer factor 2018

