Single top t-channel analysis | CP-violation

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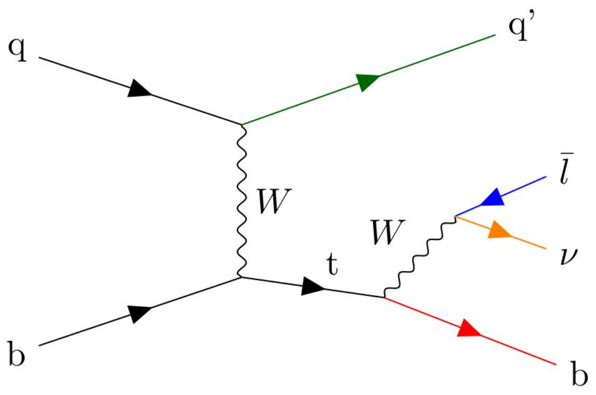


Objects and cuts

2017 and 2018 Object selection

Tight Electrons:

Electron_cutBased == 4

Electron_pt > 32GeV

abs(Electron_eta) < 2.1

Barrel electrons: abs(Electron_eta+Electron_deltaEtaSC) <= 1.4442 && abs(Electron_dxy) < 0.05 && abs(Electron_dz) < 0.1

Endcap electrons: abs(Electron_eta+Electron_deltaEtaSC) > 1.5660 && abs(Electron_dxy) < 0.1 && abs(Electron_dz) < 0.2

Cuts on the relative combined PF isolation are already included in the electron ID (to be tested)

Veto Electrons:

Electron_cutBased >= 1

Electron_pt > 15GeV

abs(Electron_eta) < 2.5

Barrel electrons: abs(Electron_eta+Electron_deltaEtaSC) <= 1.4442 && abs(Electron_dxy) < 0.05 && abs(Electron_dz) < 0.1

Endcap electrons: abs(Electron_eta+Electron_deltaEtaSC) > 1.5660 && abs(Electron_dxy) < 0.1 && abs(Electron_dz) < 0.2

Cuts on the relative combined PF isolation are already included in the electron ID (to be tested)

2017 and 2018 Object selection

Tight Muons:

Muon_tightId == true

abs(Muon_eta) < 2.4

Muon_pt > 30GeV

Muon_pfRelIso04_all < 0.06

Loose Muons:

Muon_looseId == true

abs(Muon_eta) < 2.4

Muon_pt > 10GeV

Muon_pfRelIso04_all < 0.2

2017 and 2018 Object selection

Good Jets:

Jet_jetId == 6 (Strictly tight ID jets)

Low eta jets: abs(Jet_eta) > 0 && abs(Jet_eta) < 2.4 && Jet_pt > 40

High eta jets: abs(Jet_eta) >= 2.4 && abs(Jet_eta) < 4.7 && Jet_pt > 60

➡ Only keep Jets with DeltaR > 0.4 between the jet and the lepton.

B jets:

All B-jets must be Good Jets and all B-jets must have abs(goodJets_eta) < 2.5

Tight tagged B-Jets: Jet_btagDeepFlavB > 0.7476

Medium tagged B-jets: Jet_btagDeepFlavB > 0.3040

Loose tagged B-jets: Jet_btagDeepFlavB > 0.0532

Event cuts:

Electron channel:
genWeight ∈ [-400 , 400]

NtightElectrons == 1
NvetoElectrons == 1 (same electron)
NlooseMuons == 0

HLT paths:
2016:
HLT_Ele32_eta2p1_WPTight_Gsf

2017:
HLT_Ele30_eta2p1_WPTight_Gsf_CentralPFJet35_EleCleaned
HLT_Ele35_WPTight_Gsf

2018:
HLT_Ele30_eta2p1_WPTight_Gsf_CentralPFJet35_EleCleane
HLT_Ele32_WPTight_Gsf

Muon channel:
genWeight ∈ [-400 , 400]

NtightMuons == 1
NlooseMuons == 1 (same muon)
NtightElectrons == 0
NvetoElectrons == 0

HLT paths:
2016:
HLT_IsoTkMu24
HLT_IsoMu24

2017:
HLT_IsoMu27

2018:
HLT_IsoMu24

Regions definitions:

Signal region (2j1t):

Ngood_jets == 2
Ntight_bjets >= 1

WJets region (2j0t)

Ngood_jets == 2
Ntight_bjets == 0

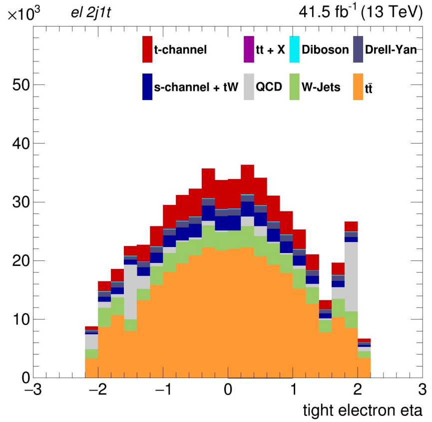
TTbar region (3j2t)

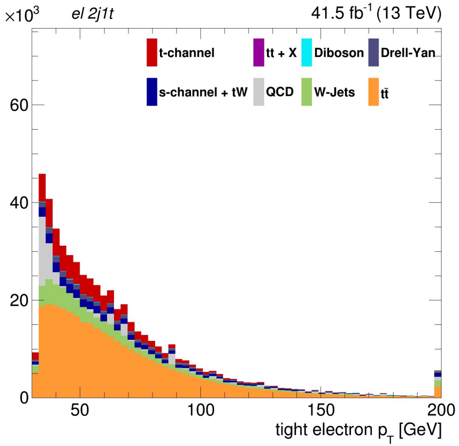
Ngood_jets >= 3
Ntight_bjets >= 2

Stackplots with FLY

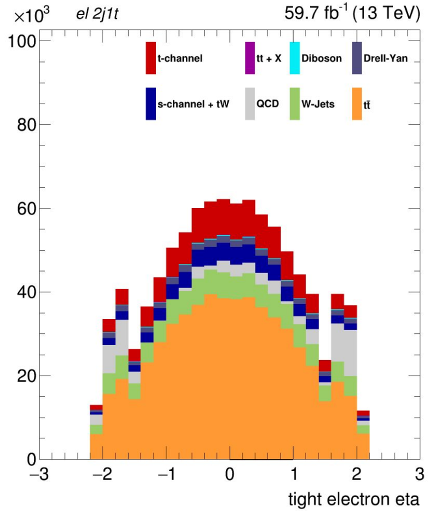
Electron channel signal region (2j1t):

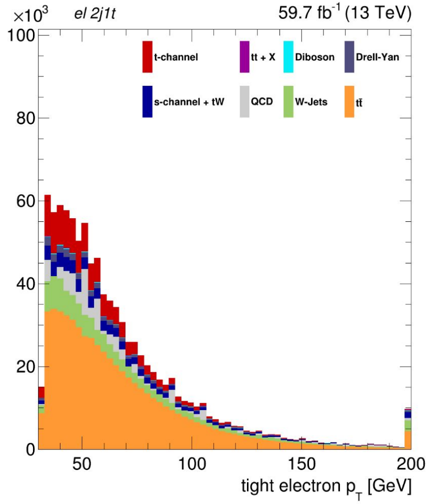
2017





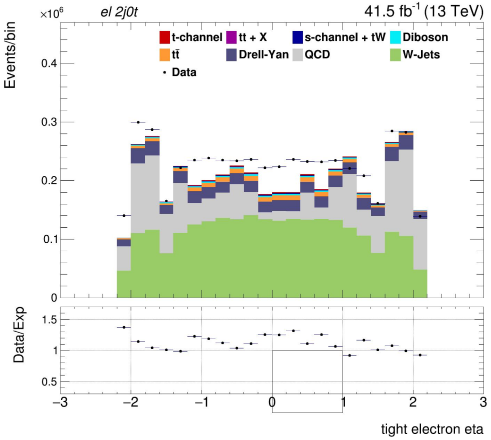
2018

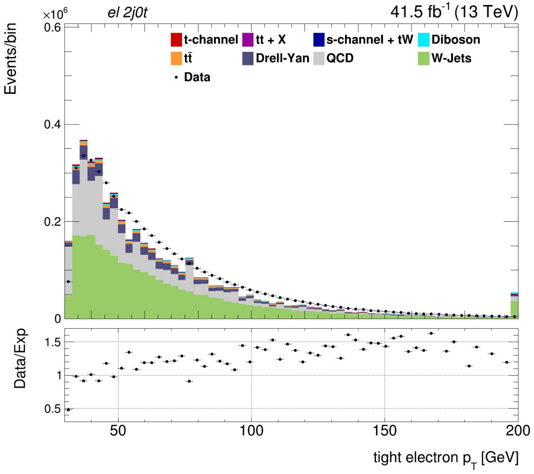




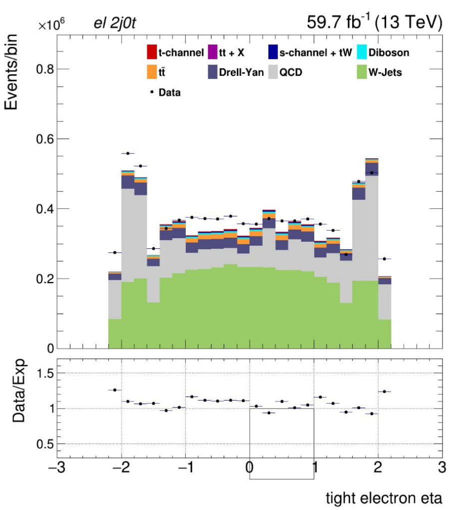
Electron channel Wjets region (2j0t):

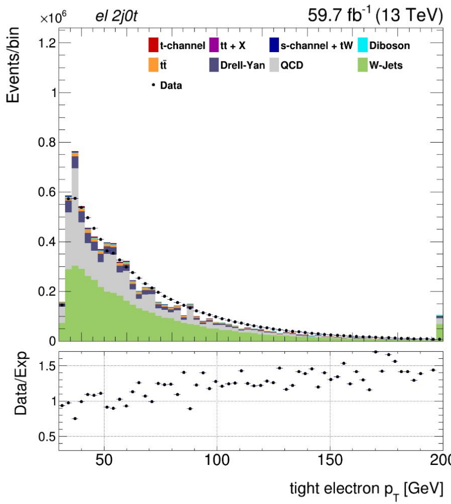
2017





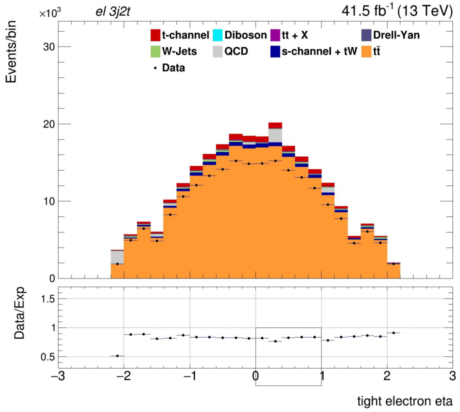
2018

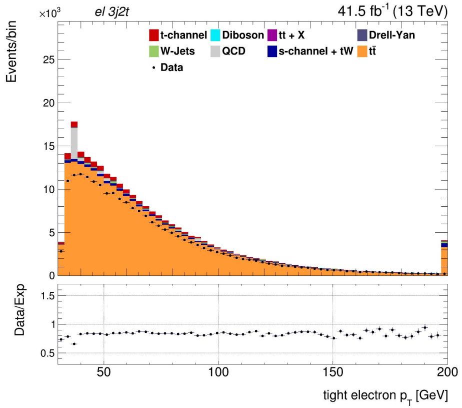




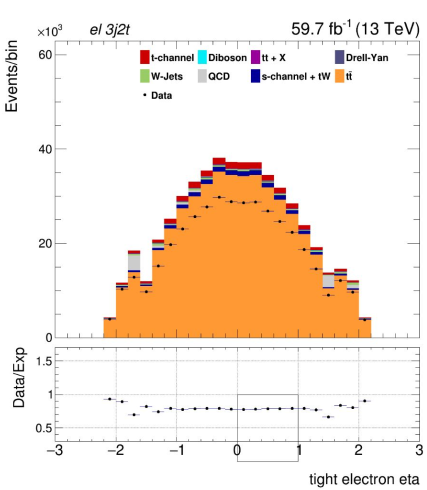
Electron channel ttbar region (3j2t):

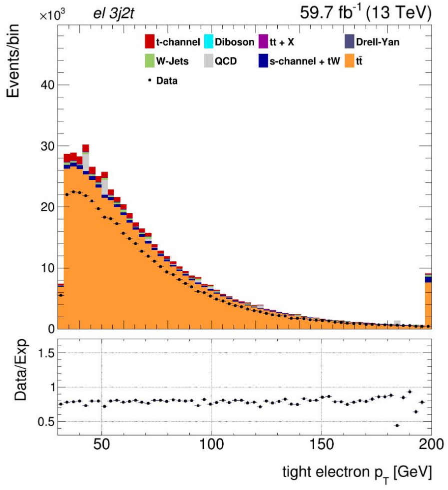
2017





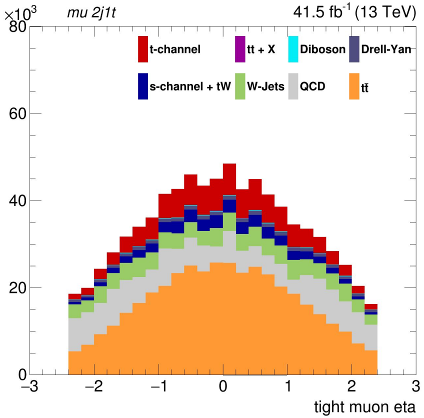
2018

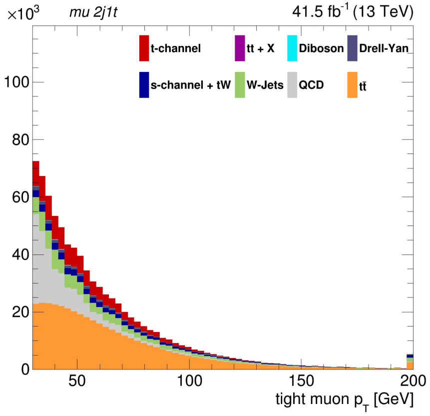




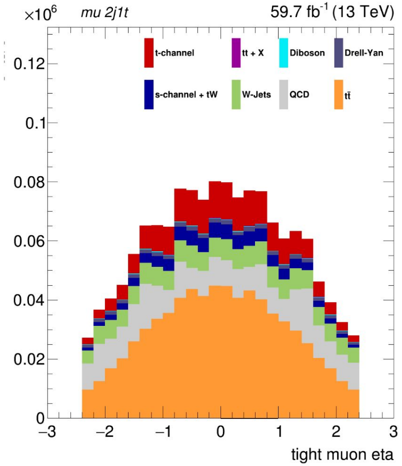
Muon channel signal region (2j1t):

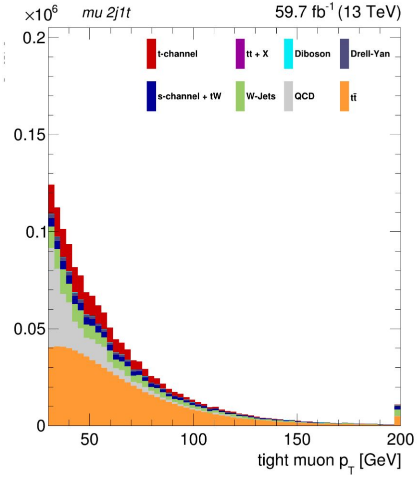
2017





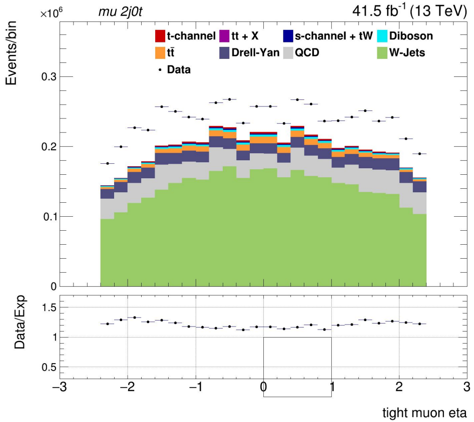
2018

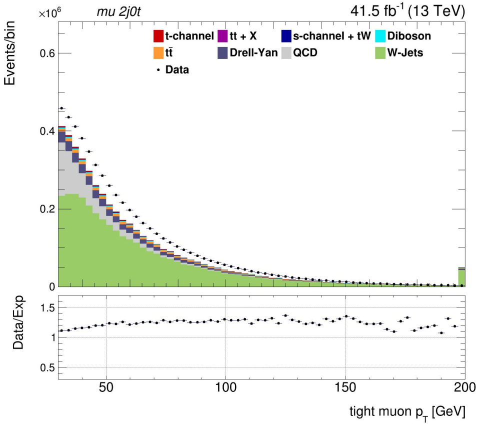




Muon channel Wjets region (2j0t):

2017





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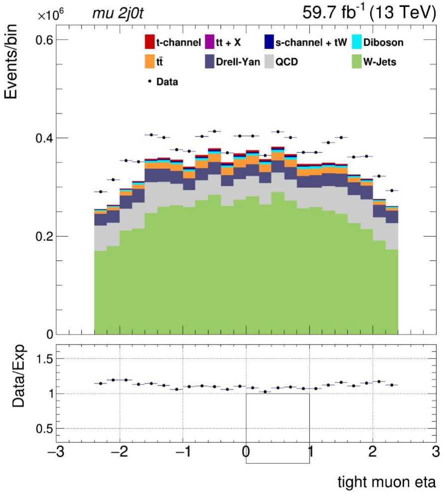
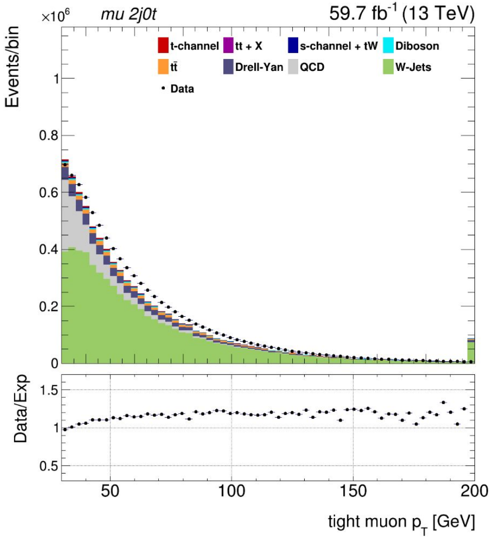
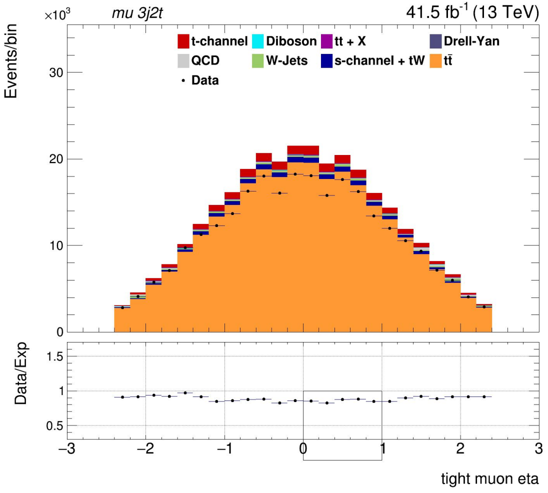
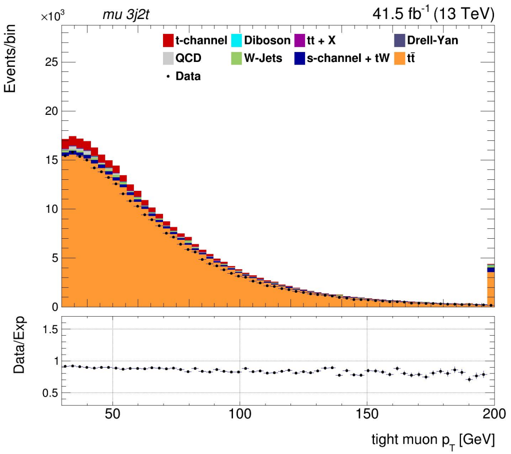




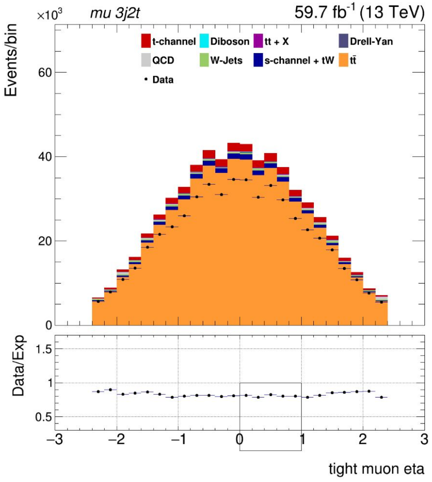
Muon channel ttbar region (3j2t):

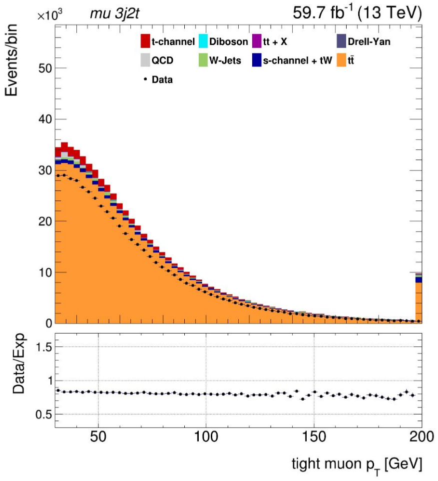
2017





2018





- Whats next?
  - QCD background estimation
    - Reverse isolation on leptons to maximize QCD in a side region
    - A maximum-likelihood fit is performed to determine the amount of QCD events together with the number of signal events on the transverse mass of the W boson
  - Implement the top quark reconstruction on FLY

QCD background estimation using data

Motivation: The probability for a simulated multijet event to mimic the final state of the signal process is very low. It becomes impractical to generate a sufficiently large number of QCD events.

So the QCD background is estimated in a 2-step process in a side region based on data.

QCD side regions:

Electron channel:

anti_iso_electron:
Electron_cutBased >= 0 &&
Electron_pt > 15 &&
abs(Electron_eta) < 2.1 &&
Electron_pfRelIso03_all < 1 (PF relative isolation dR=0.3)

Event must contain:
Nanti_iso_electrons == 1
Nanti_iso_muons == 0
NtightMuons == 0
NlooseMuons == 0
NtightElectrons == 0 (with pT > 15GeV)
NvetoElectrons == 0

Muon channel:

anti_iso_muon:
Muon_tightId == 1 &&
Muon_pt > 15 &&
abs(Muon_eta) < 2.4 &&
Muon_pfRelIso04_all > 0.2 (PF relative isolation dR=0.4)

Event must contain:
Nanti_iso_electrons == 0
Nanti_iso_muons == 1
NtightMuons == 0 (with pT > 10GeV)
NlooseMuons == 0
NtightElectrons == 0
NvetoElectrons == 0

According to the analysis note CMS AN-18-305, the QCD background estimation method is the following:

- a QCD template (?) must be extracted from the side regions.
- a maximum-likelihood fit is performed to determine the amount of QCD events together with the number of signal events on the transverse mass of the W boson
- two additional free parameters are added to the ML fit:
  - one that scales QCD in the barrel region
  - one that scales QCD in the endcap region
- For the fit two templates are used:
  - One for QCD background which is taken from the side region with data
  - One for non-QCD background which is taken from simulation (?)
- Then a ML fit with two parameters is performed:

$$F(x) = N_{\mathrm{QCD}} \cdot Q(x) + N_{\mathrm{non-QCD}} \cdot B(x).$$

- Triggers with no Isolation requirements must be used for the side regions

What I understood on QCD background estimation:

- ➔ Create a side region rich in QCD
- ➔ normalize the W transverse mass distribution to get scale factor (?)
- ➔ Search the fraction of data associated to each process contribution
- ➔ Use this QCD scale factor in other regions to data or mc to improve data/mc ratio