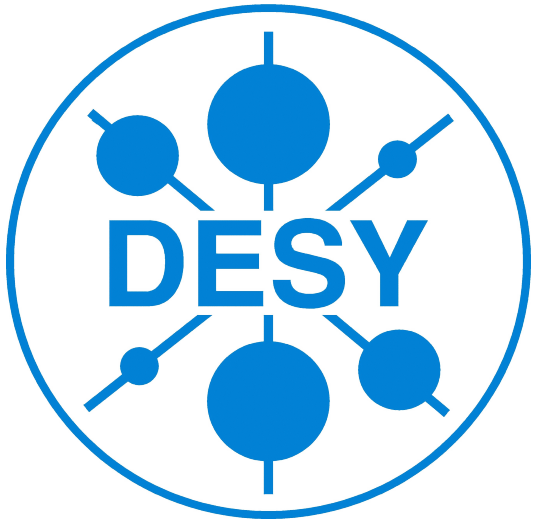


Tau ID Efficiency Measurements with W→τν Events in Run2 : MC Study

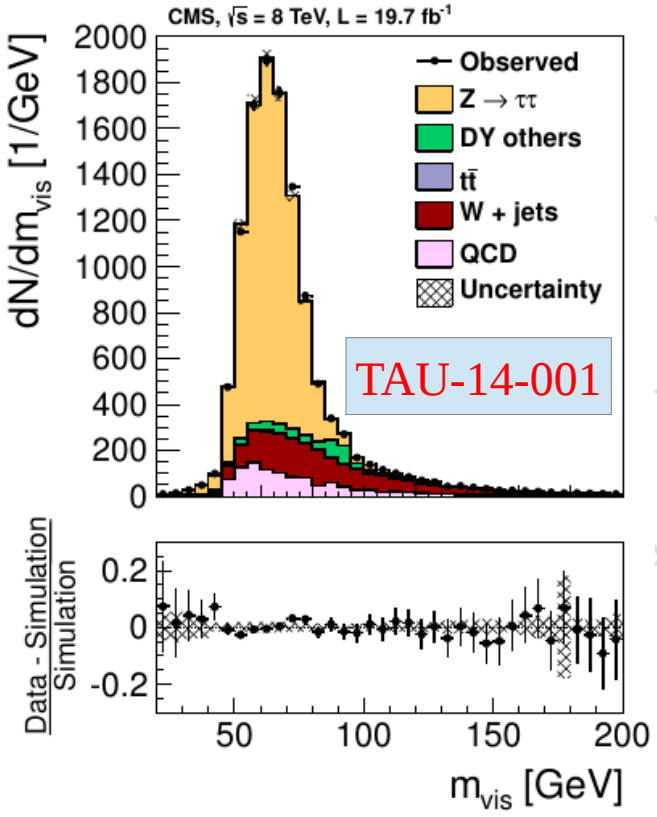
Alexei Raspereza

UHH-DESY Meeting, June 2nd 2015

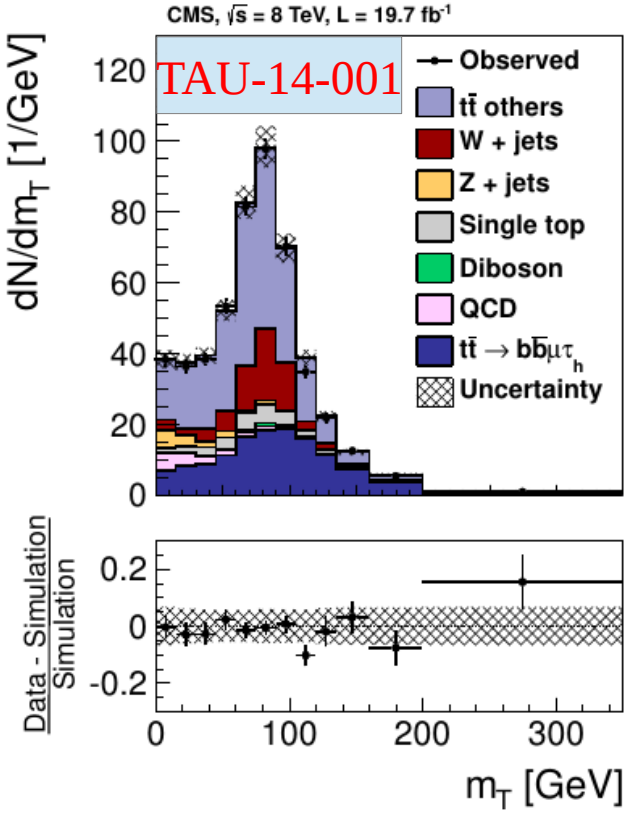
Introduction

- **Tau ID efficiency for low/medium tau p_T :**
  - **$p_T \leq 80$ GeV (SM H→ττ and low mass MSSM H→ττ search) :** $Z \to \tau_\mu \tau_h$
  - **medium p_T range (medium mass MSSM H→ττ search) :** $t\bar{t} \to b\bar{b}\mu\tau_h$

$Z \to \tau_\mu \tau_h$

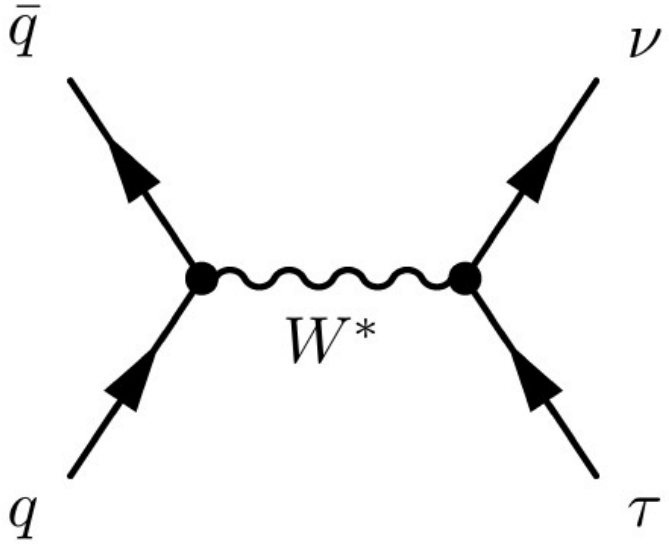


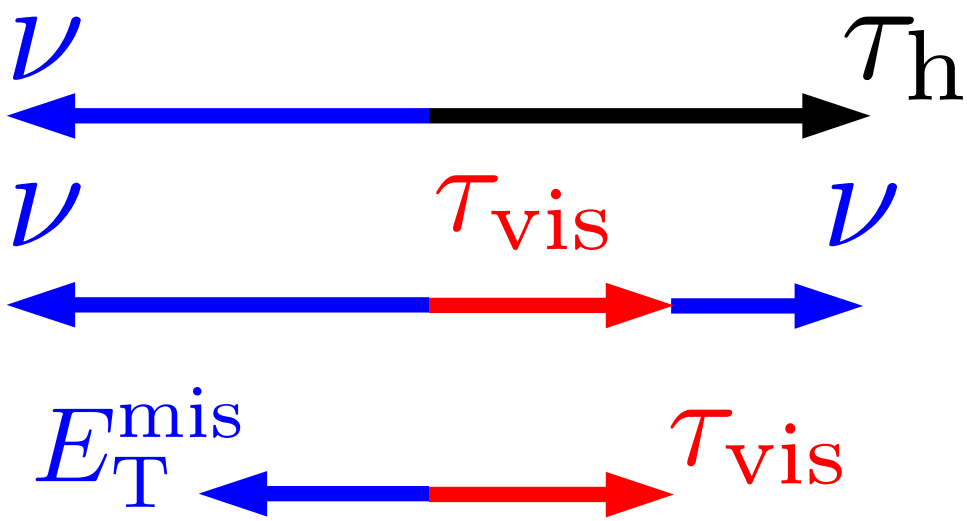
$t\bar{t} \to b\bar{b}\mu\tau_h$



Tau ID for high tau p_T

- **Tau ID efficiency for taus with high p_T :**
  - **$W^* \to \tau\nu$ events**
    - **highly virtual W*** : $m_{\tau\nu} > m_W$
    - **little hadronic activity** : $p_{\mathrm{T}}^{W} \to 0$





- **Signatures : single jet (tau), MET in opposite direction w.r.t. jet p_T**
- **Latest presentation on this topic (talk by Klaas Padeken)**

https://indico.cern.ch/event/367538/contribution/2/material/slides/0.pdf

TauID in W*→τν events with Run2 data

- **LHC Running strategy in 2015**
  - **13 TeV, BX=50ns, L = 5x10^{33} cm^{-2}s^{-1} (PU ~ 30), ~ 1/fb**
  - **13 TeV, BX=25ns, L = 7x10^{33} cm^{-2}s^{-1} (PU ~ 20), ~ 5/fb**
  - **13 TeV, BX=25ns, L = 1.4x10^{34} cm^{-2}s^{-1} (PU ~ 40), ~ 10/fb**
- **Triggers (from Exotica group)**
  - **5e33 and 7e33 menu =>**

    HLT_PFMETNoMu90_NoiseCleaned_PFMHTNoMu90_IDTight_v1 (used in study)

    HLT_MonoCentralPFJet80_PFMETNoMu90_PFMHTNoMu90_NoiseCleaned_v1
  - **1.4e34 menu =>**

    HLT_PFMETNoMu120_NoiseCleaned_PFMHTNoMu120_IDTight_v1

    HLT_MonoCentralPFJet80_PFMETNoMu120_PFMHTNoMu120_NoiseCleaned_v1
  - **these triggers are not present in PHYS14 samples**
    - **trigger logic is emulated with offline cuts on reconstructed quantities**

$$\vec{E}^{\mathrm{mis}}_{\mathrm{T,no}\mu} = \vec{E}^{\mathrm{mis}}_{\mathrm{T}} + \sum_{\mu} \vec{p}_{\mathrm{T},\mu} \quad , \qquad \vec{H}^{\mathrm{mis}}_{\mathrm{T,no}\mu} = -\sum_{j} \vec{p}_{\mathrm{T},j} + \sum_{\mu} \vec{p}_{\mathrm{T},\mu}$$

MC samples (13 TeV)

- **MC samples used in the study (assume 5/fb)**

  Phys14DR-PU20bx25_PHYS14 (MINIAOD)

MC Sample	xsec [pb]	events	ev. weight
QCD_Pt-30to50_Tune4C_13TeV_pythia8	161500000	2.0M	406000
QCD_Pt-50to80_Tune4C_13TeV_pythia8	22110000	2.0M	55265
QCD_Pt-80to120_Tune4C_13TeV_pythia8	3116000	2.0M	7790
QCD_Pt-120to170_Tune4C_13TeV_pythia8	493000	2.0M	1230
QCD_Pt-170to300_Tune4C_13TeV_pythia8	12000	2.0M	30
QCD_Pt-300to470_Tune4C_13TeV_pythia8	7400	1.8M	21
QCD_Pt-470to600_Tune4C_13TeV_pythia8	590	2.0M	1.5
QCD_Pt-600to800_Tune4C_13TeV_pythia8	170	2.0M	0.42
QCD_Pt-800to1000_Tune4C_13TeV_pythia8	28	1.0M	0.14
WJetsToLNu_13TeV-madgraph-pythia8-tauola	50100	9.5M	26
TT_MSDecaysCKM_central_Tune4C_13TeV-madgraph	430	2.8M	0.75

Selection

Selection as proposed by Klaas Padeken (RWTH)

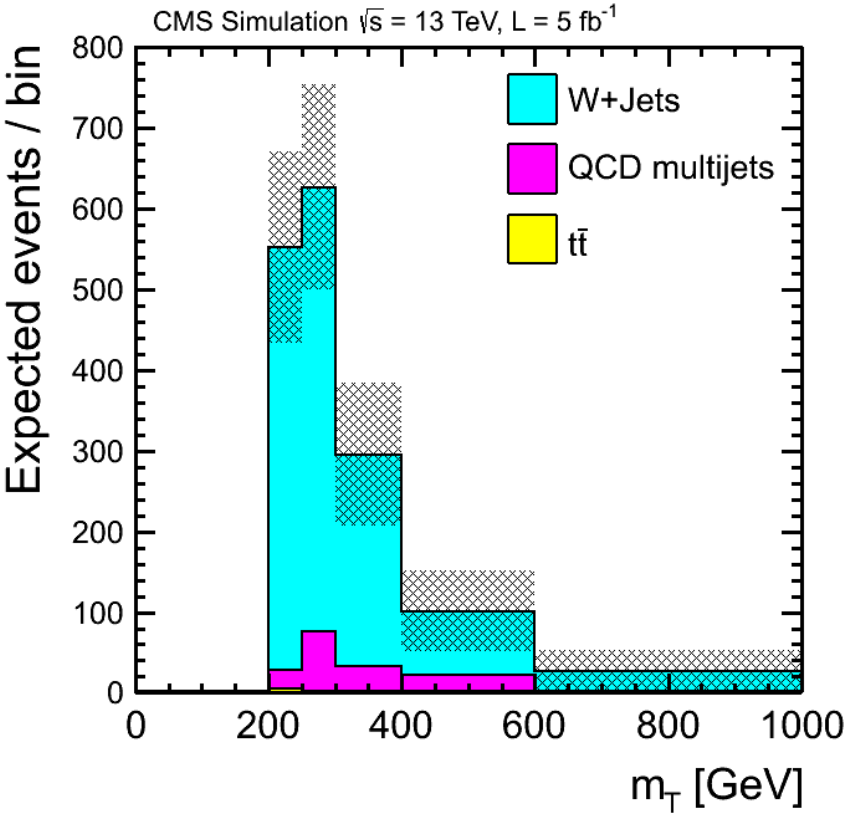
https://indico.cern.ch/event/367538/contribution/2/material/slides/0.pdf

- Good PV (pv.ndof()>4, pv.z() < 24 cm, pv.d() < 2 cm)
- Trigger : HLT_PFMETNoMu90_NoiseCleaned_PFMHTNoMu90_IDTight_v
- Exactly one tau
  - pt > 50 GeV, eta < 2.3
  - decayModeFindingNewDMs
  - againstElectronVLooseMVA5 && againstMuonLoose3
  - tau.z() == primaryVertex.z()
  - Isolation
    - byLooseCombinedIsolationDeltaBetaCorr3Hits
    - byTightCombinedIsolationDeltaBetaCorr3Hits
- MET > 120 GeV
- 0.7 < pt(tau)/MET < 1.5
- deltaPhi(tau, MET) > 2.4

* no cut on leading tau track pt > 25 GeV (present in original study)

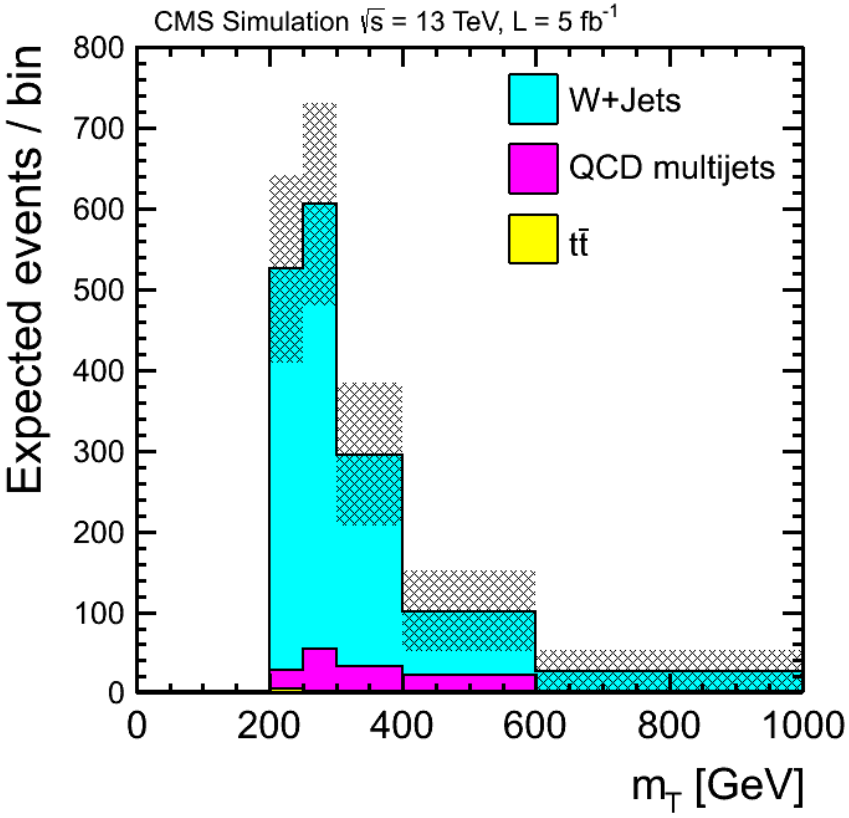
Selected Sample (loose tau Iso)

no HLT



- **TTJets = 8 ± 2**
- **QCD = 152 ± 60**
- **Wjets = 1443 ± 195**

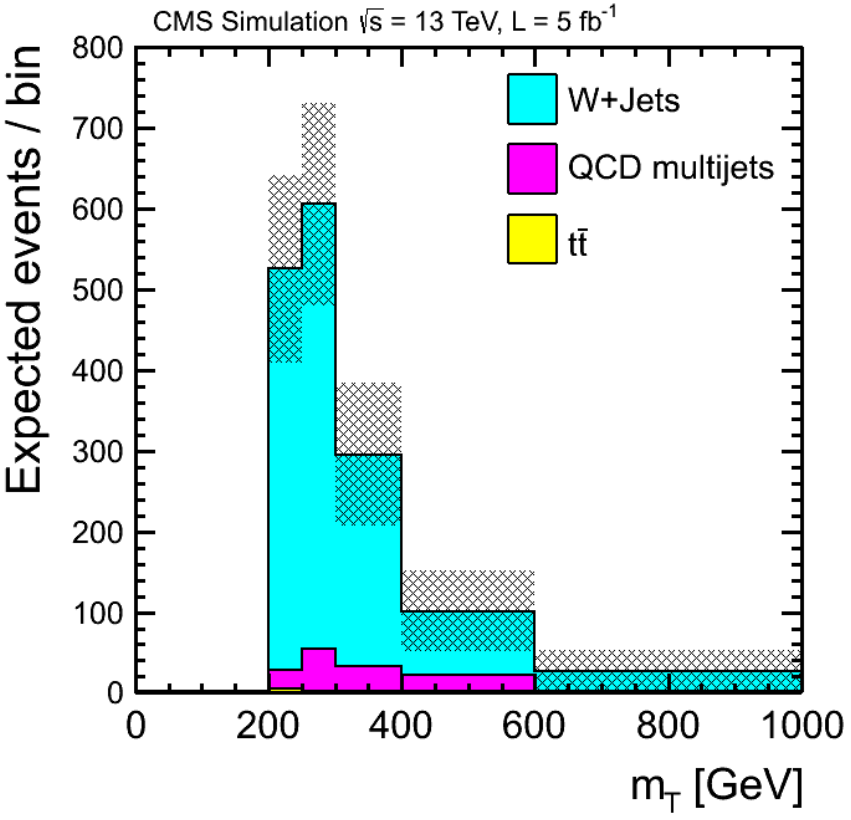
simulated HLT

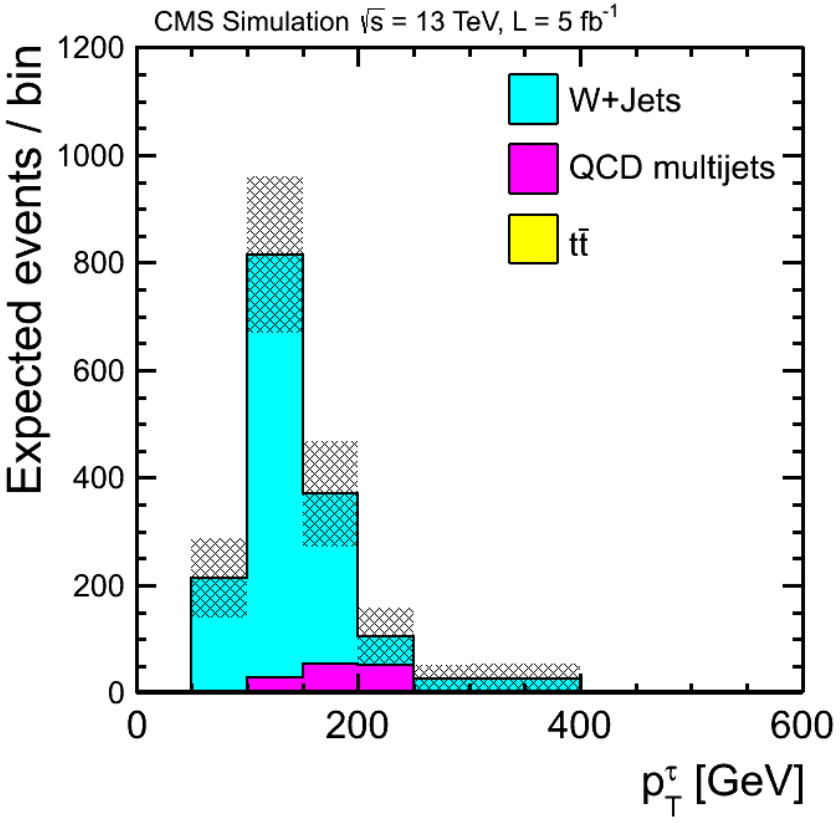


- **TTJets = 8 ± 2**
- **QCD = 131 ± 56**
- **Wjets = 1416 ± 192**

Selected Sample (loose tau Iso)

simulated HLT

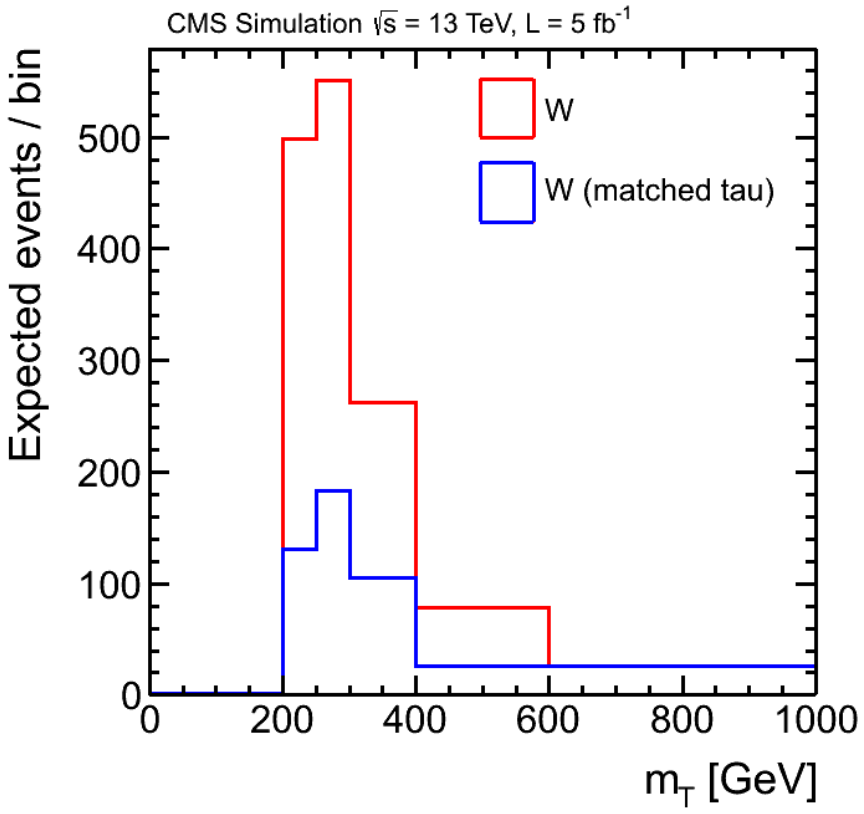


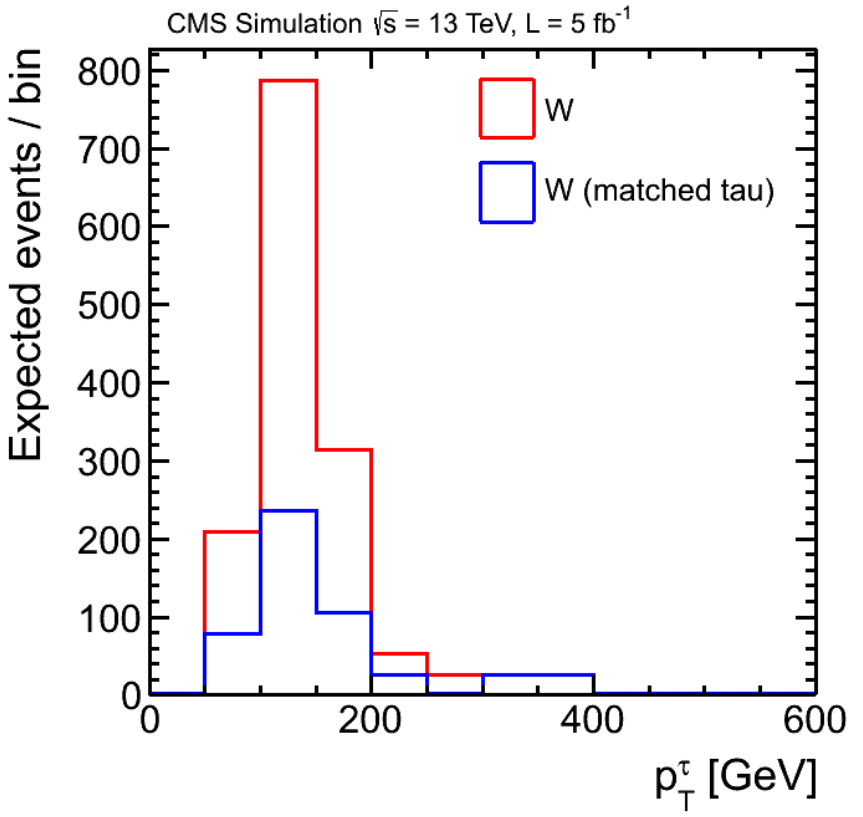


- **TTJets = 8 ± 2**
- **QCD = 131 ± 56**
- **Wjets = 1416 ± 192**

Inspecting selected W+Jets events

- **Apply matching of reco tau and gen tau**
  - ✔ **deltaR(reco tau, gen tau) < 0.3**
  - ✔ **gen tau comes from W decay**

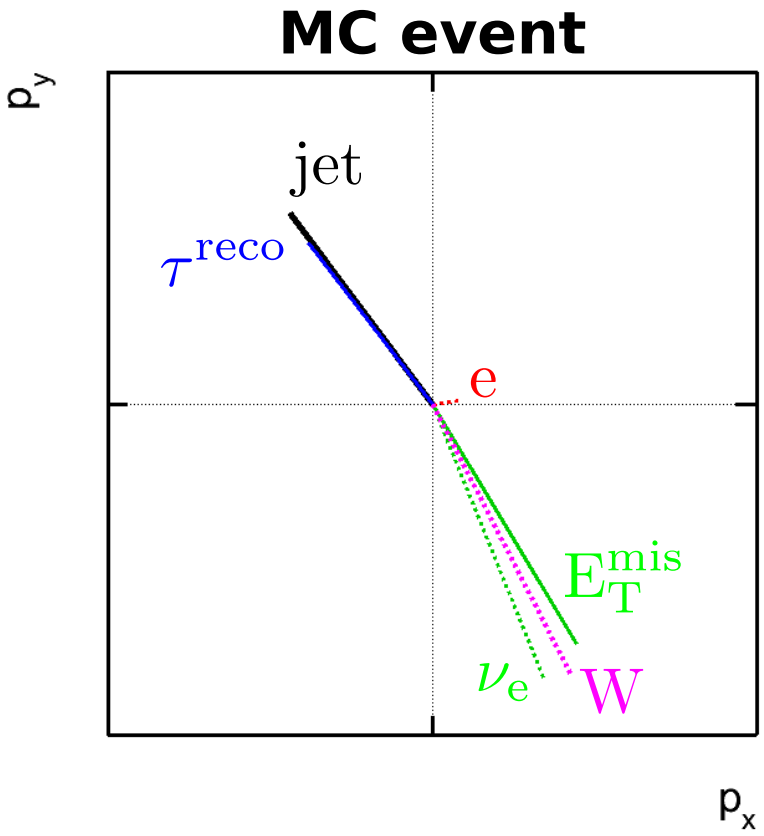


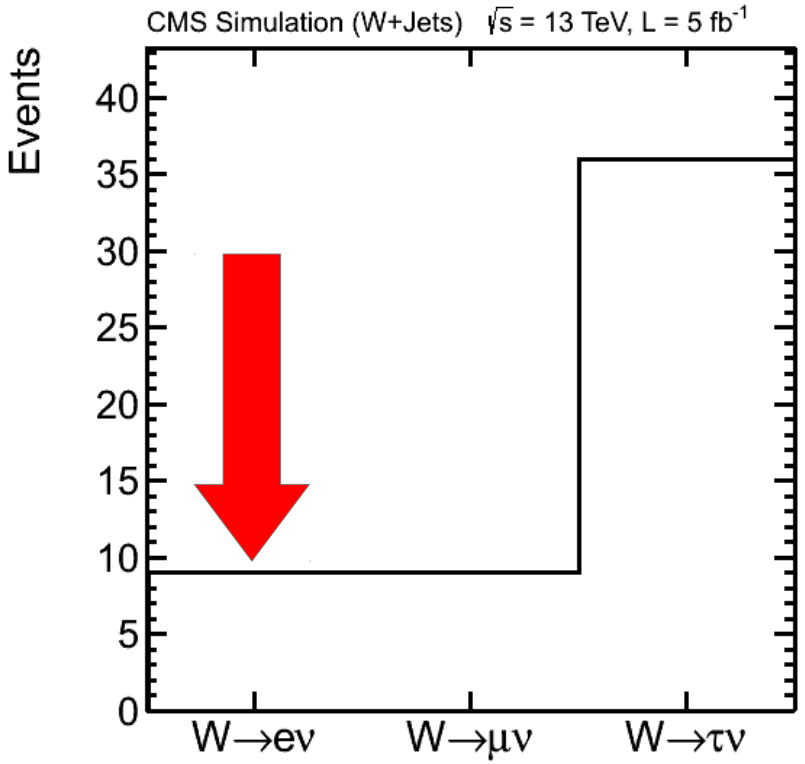


- **Only in ~ 1/3 of selected W+Jets events reconstructed tau matches generated tau (!)**

Inspecting selected W+Jets events

- **Check decay of W in the sample of selected W+Jets events**

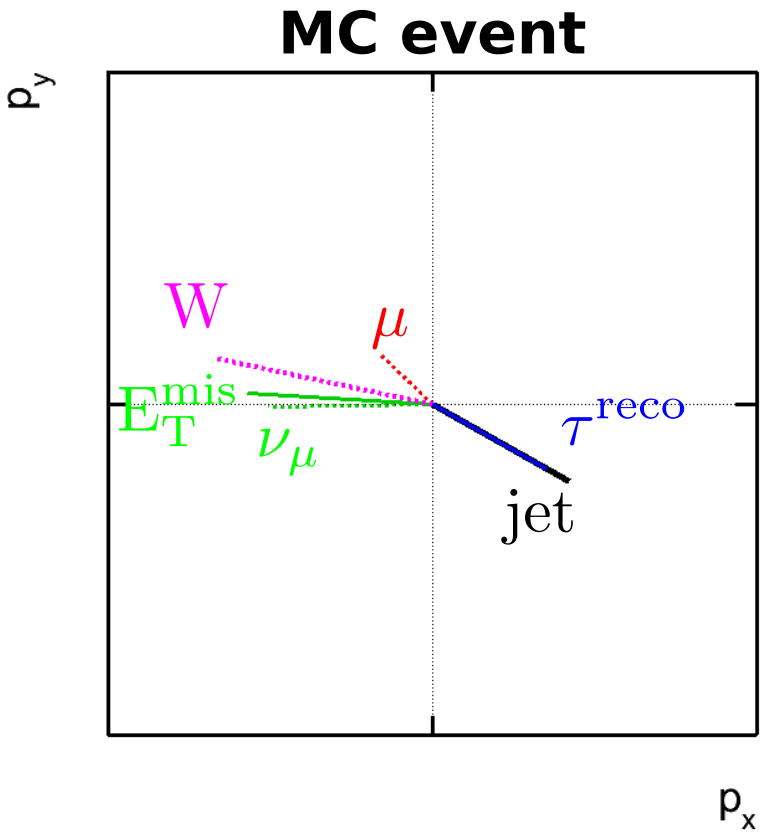


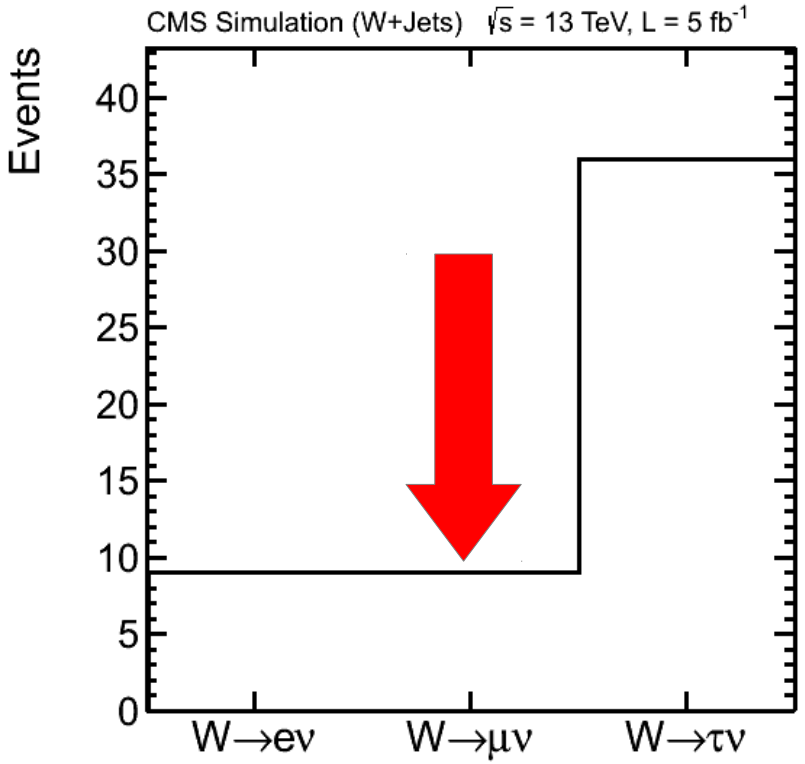


- **Boosted W and one hadronic jet, W → eν**
- **Reconstructed tau matches hadronic jet**

Inspecting selected W+Jets events

- **Check decay of W in the sample of selected W+Jets events**



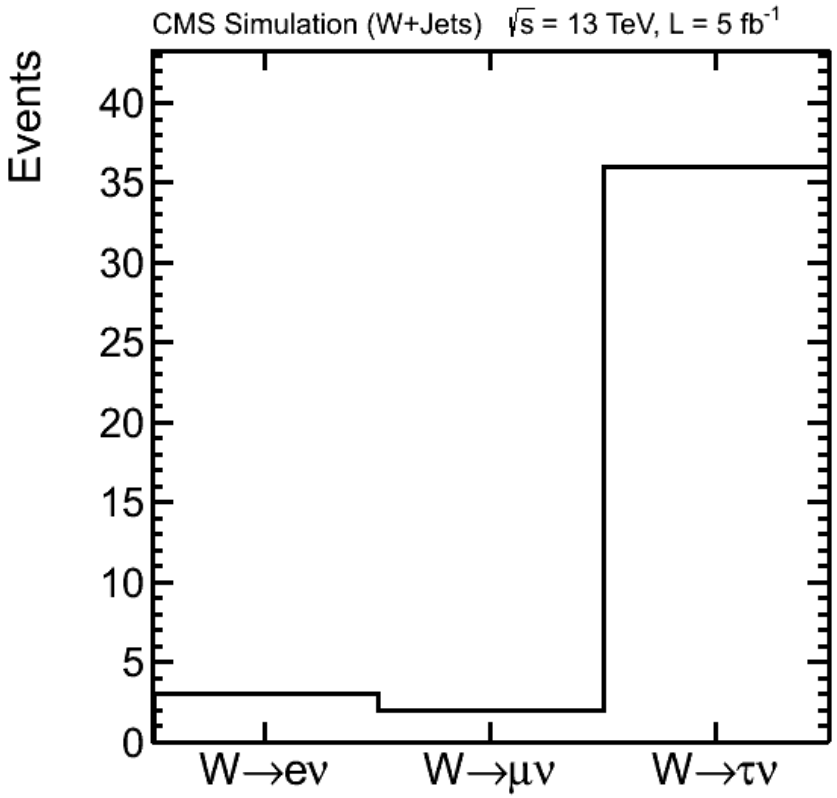


- **Boosted W and one hadronic jet , W → μν**
- **Reconstructed tau matches hadronic jet**

Applying lepton veto

Applying lepton veto

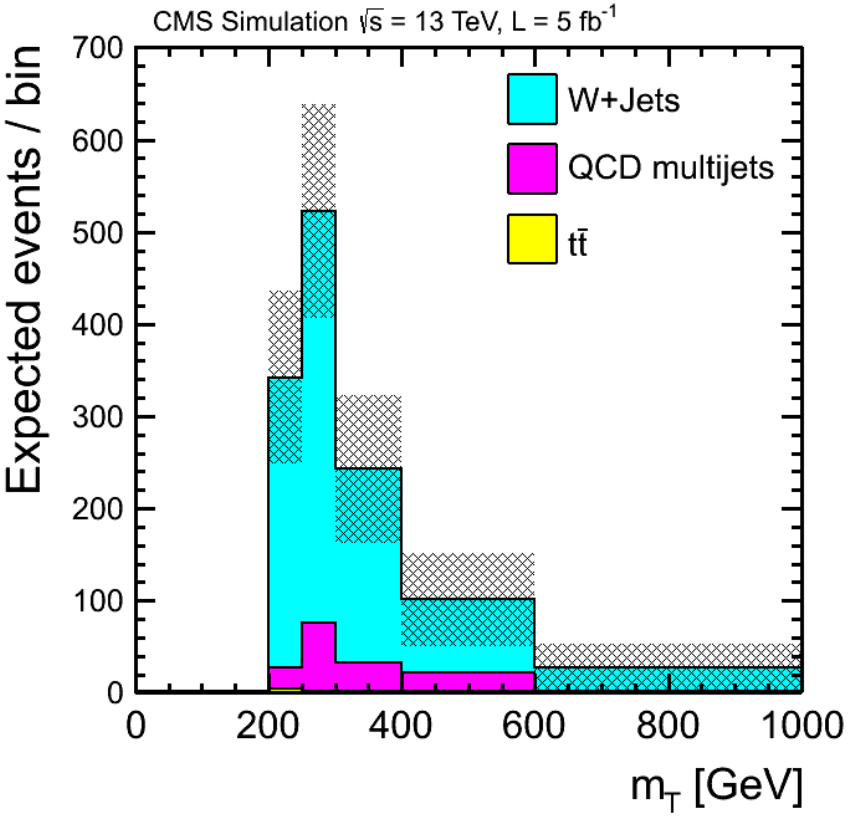
- → no isolated electrons
  - pt > 10 GeV, eta<2.3
  - relIso(dbeta-corr) < 0.3
  - Loose MVA id
- → no isolated muons
  - pt > 10 GeV, eta < 2.3
  - relIso(dbeta-corr) < 0.3
  - Loose muon ID

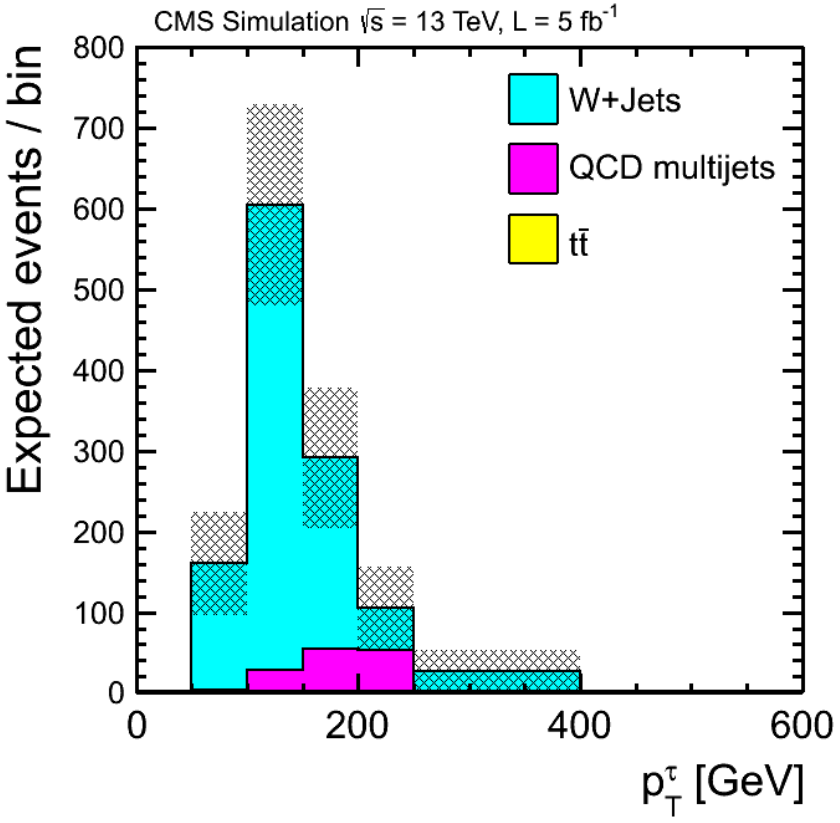


- Fraction of W → e(μ)ν events is reduced to ~ 1/8

Selected Sample (simulated HLT)

Loose tau Iso + lepton veto

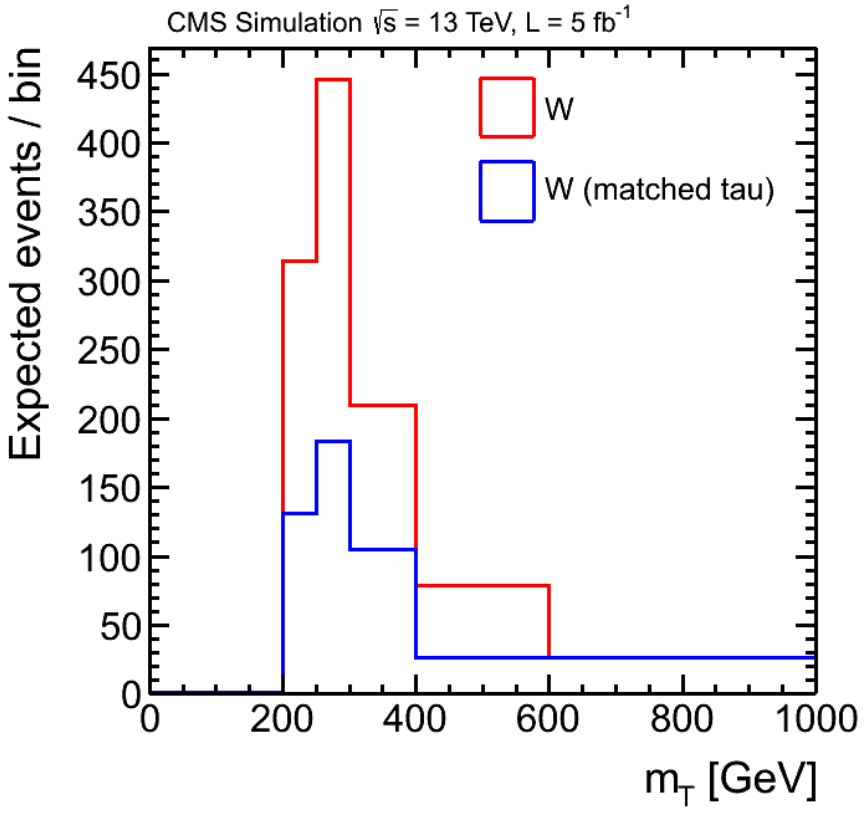


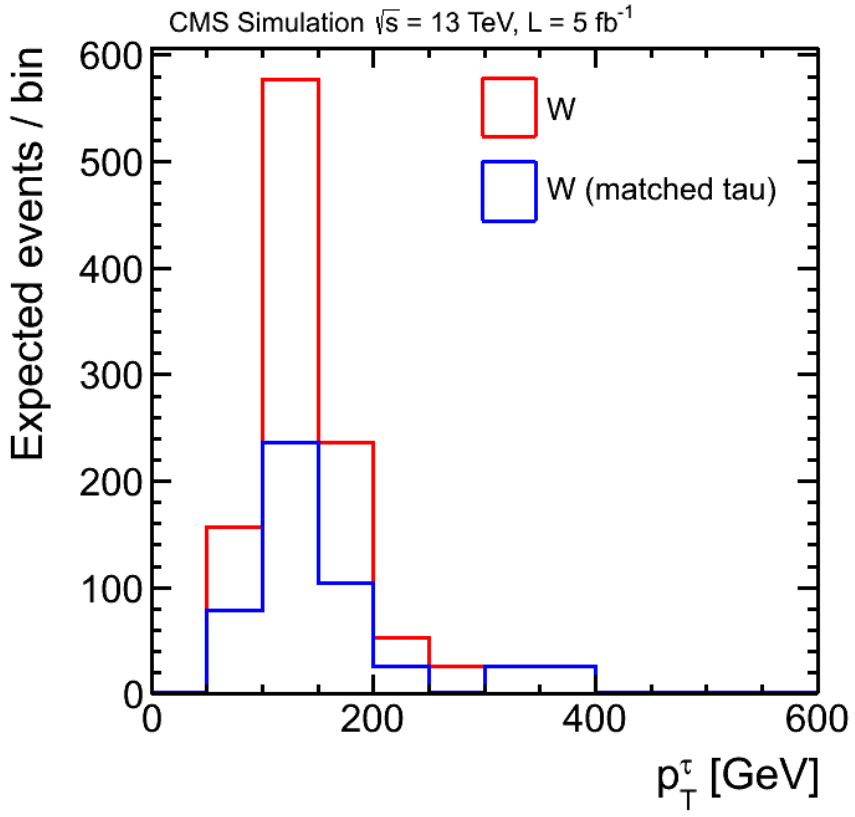


- **TTJets = 7 ± 2**
- **QCD = 131 ± 56**
- **Wjets = 1075 ± 168**

Inspecting selected W+Jets

Loose Iso + lepton veto

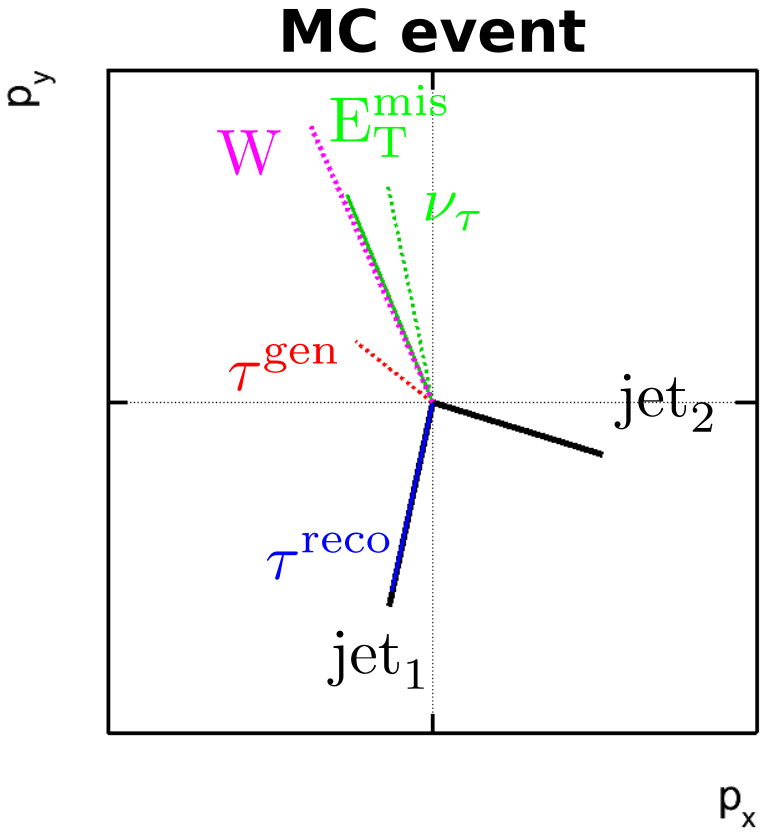


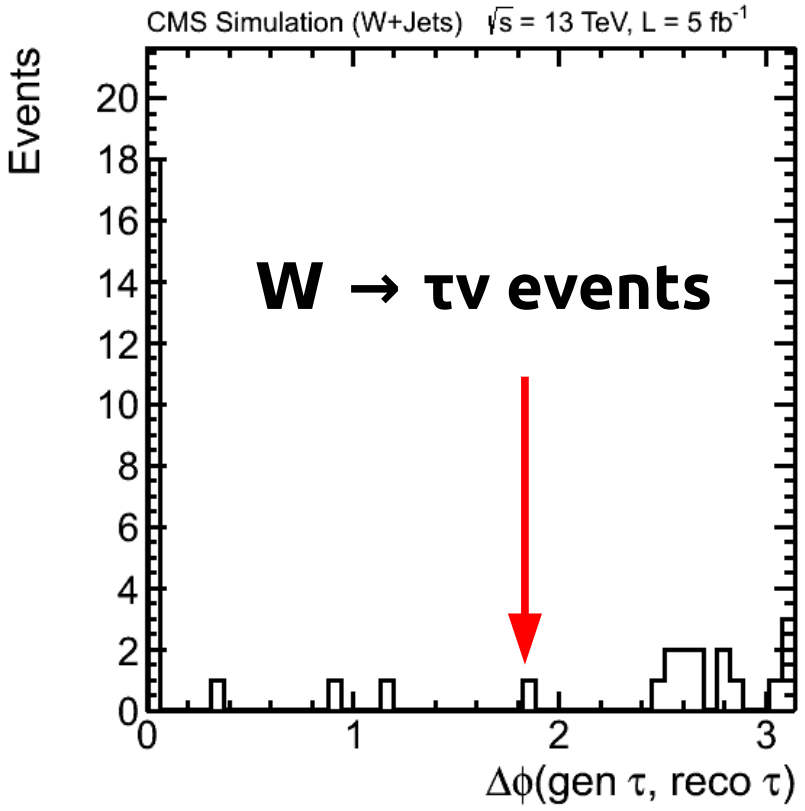


- **Still in ~ 56% of cases reco tau does not match generated tau from W decay => let's have a look at these “misinterpreted” events**

Inspecting selected W+Jets events

- **Monitor events with W → τν**

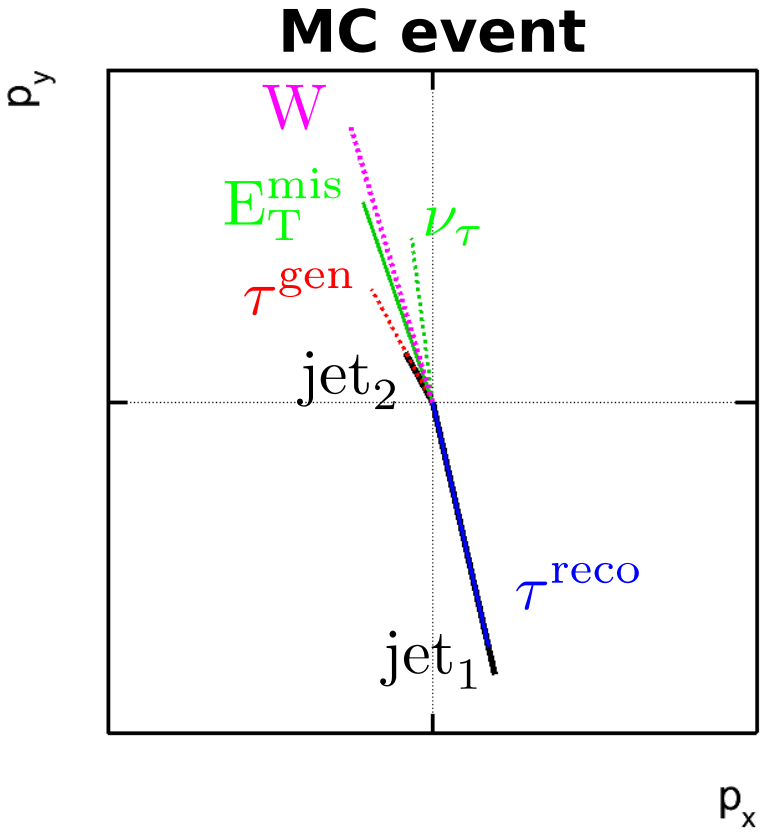


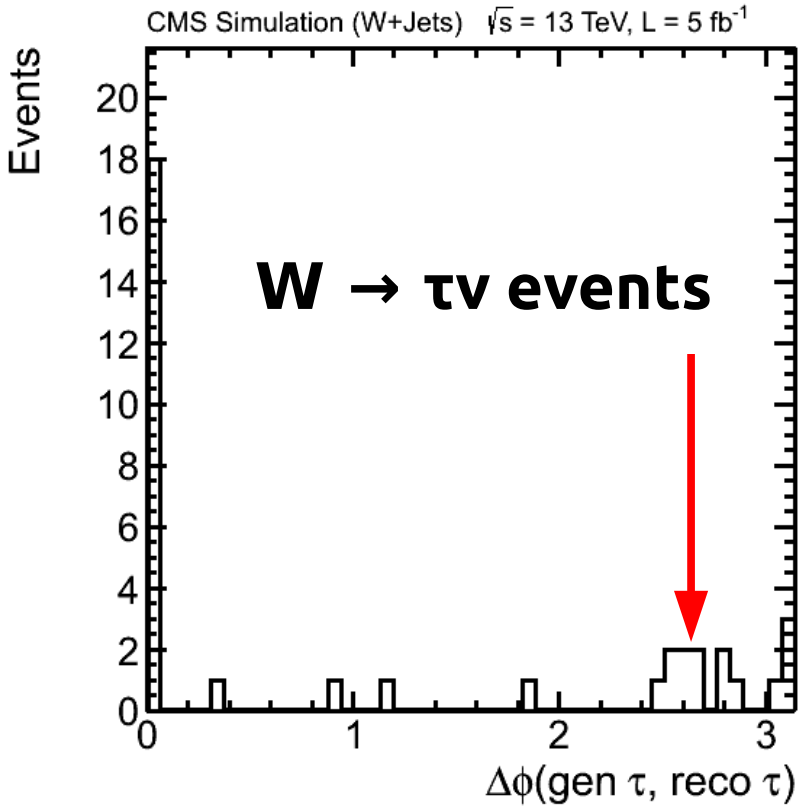


- **Boosted W event with pt(tau) < 30 GeV and 2 hadronic jets**
- **reconstructed tau matches harder hadronic jets**

Inspecting selected W+Jets events

- **Monitor events with W → τν**

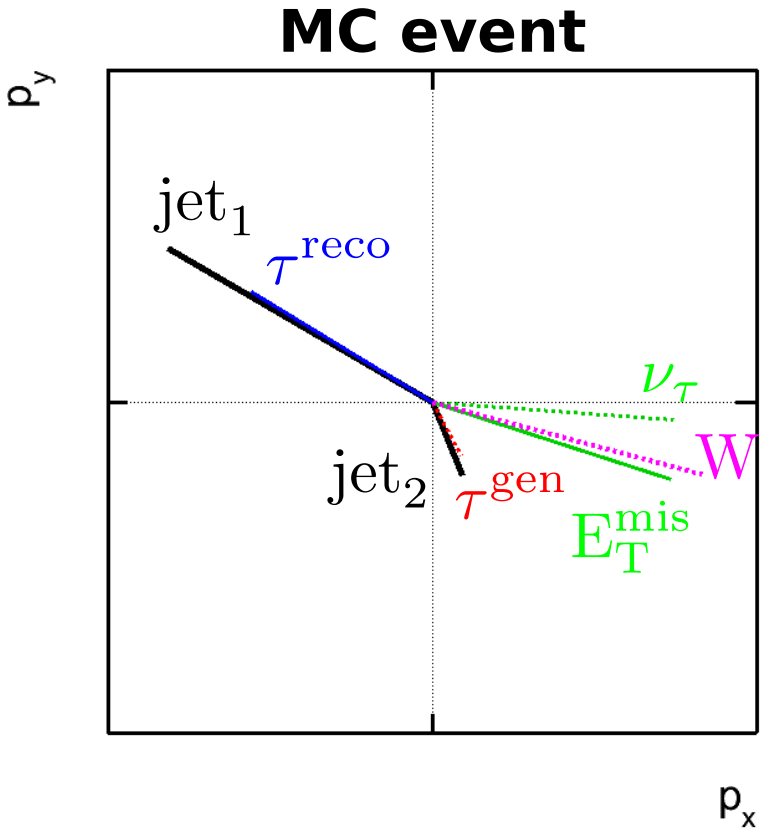


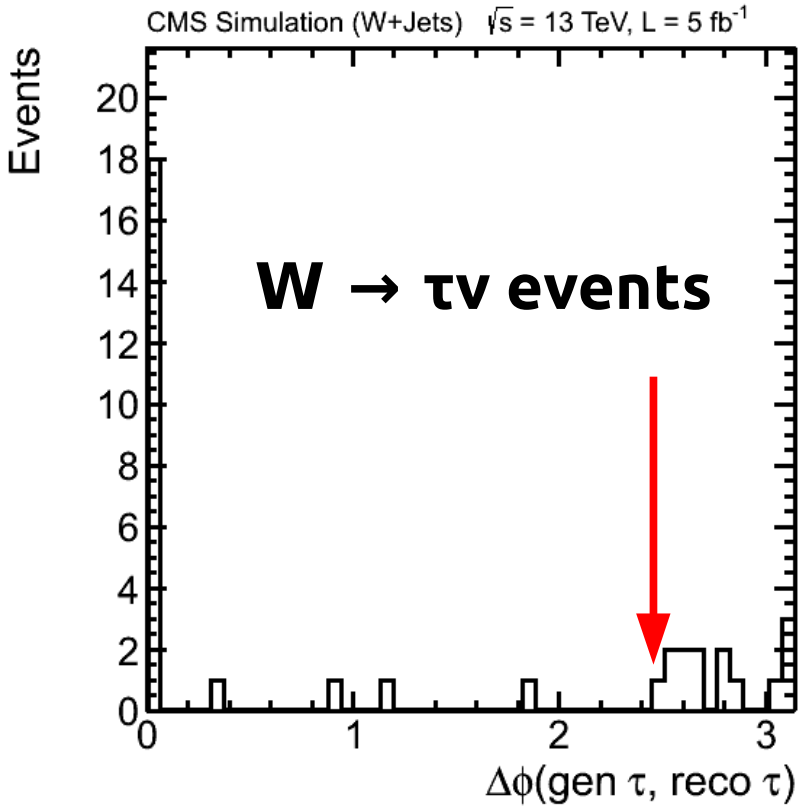


- **Boosted W event with one hadronic jet**
- **reconstructed tau matches hadronic jet**

Inspecting selected W+Jets events

- **Monitor events with W → τν**



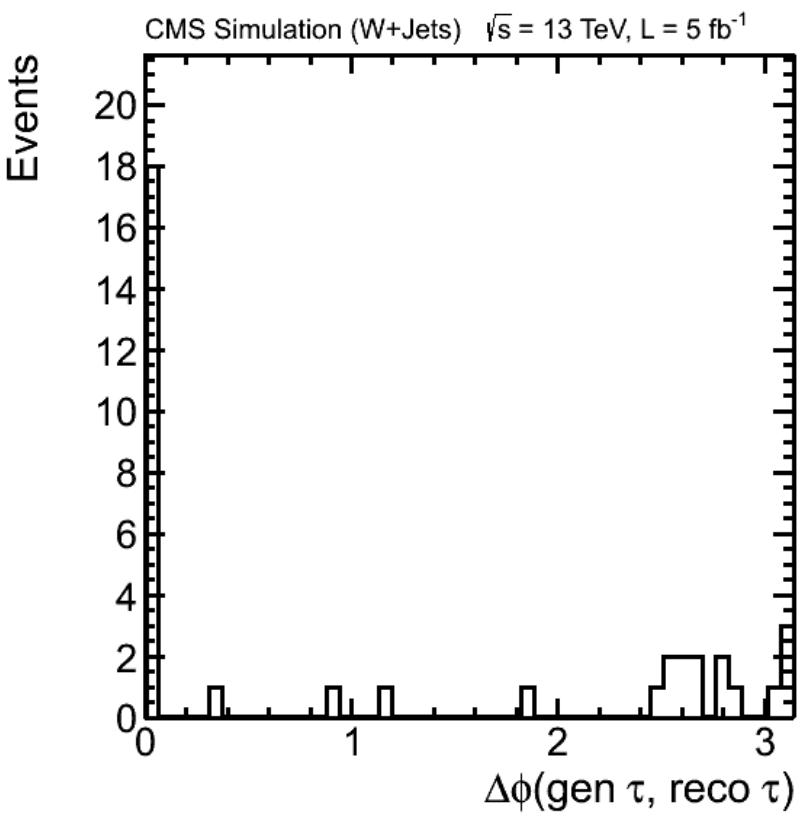


- **Boosted W event with one hadronic jet**
- **reconstructed tau matches hadronic jet**

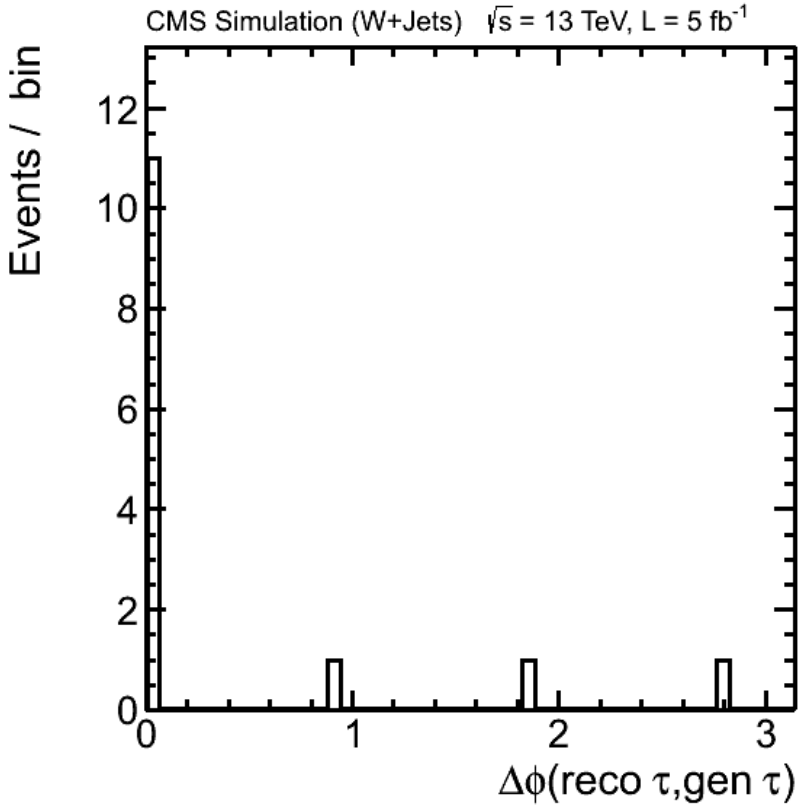
Applying jet veto

Jet veto => only one jet with pt>30 GeV and eta<4.5 (loose PFJet Id)

no jet veto

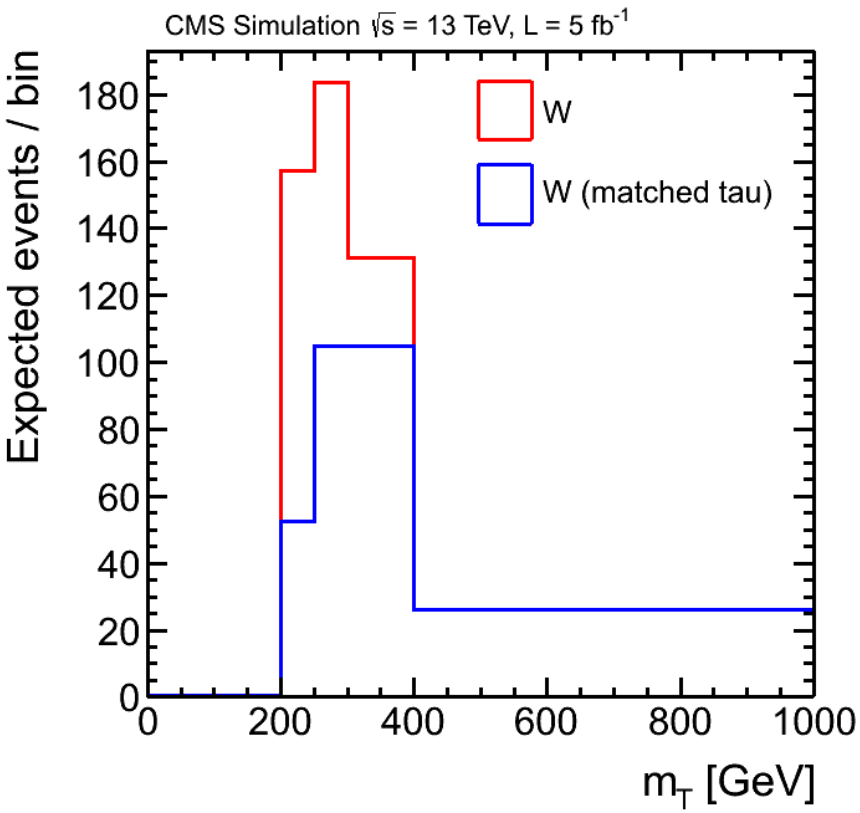


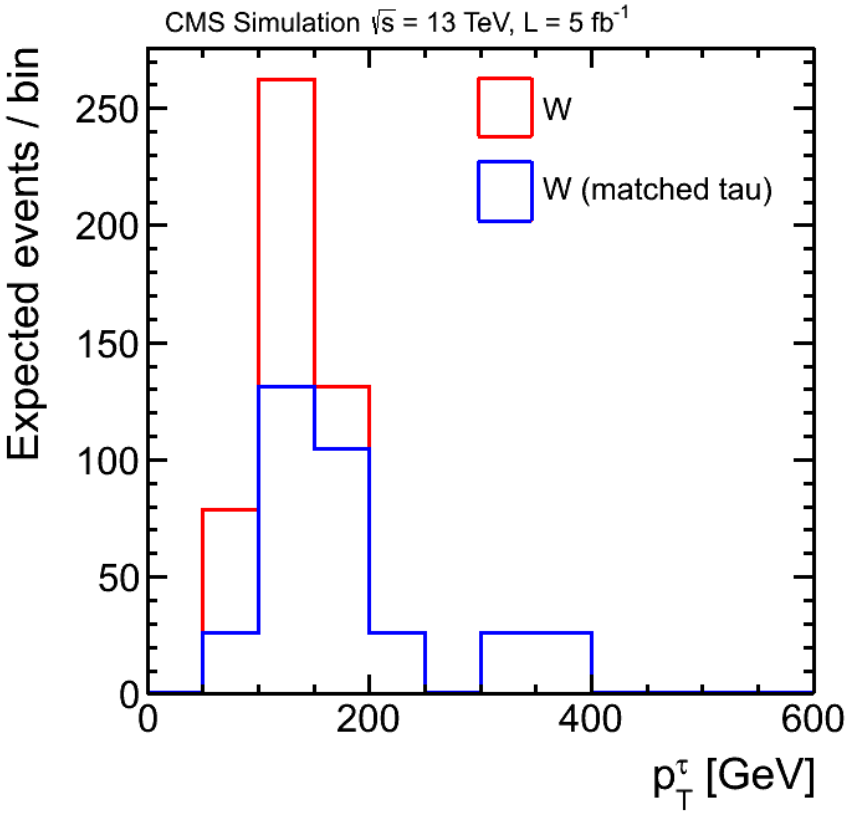
with jet veto



Selected W+Jets events

- **HLT + lepton veto + jet veto**
- **Loose tau Isolation**

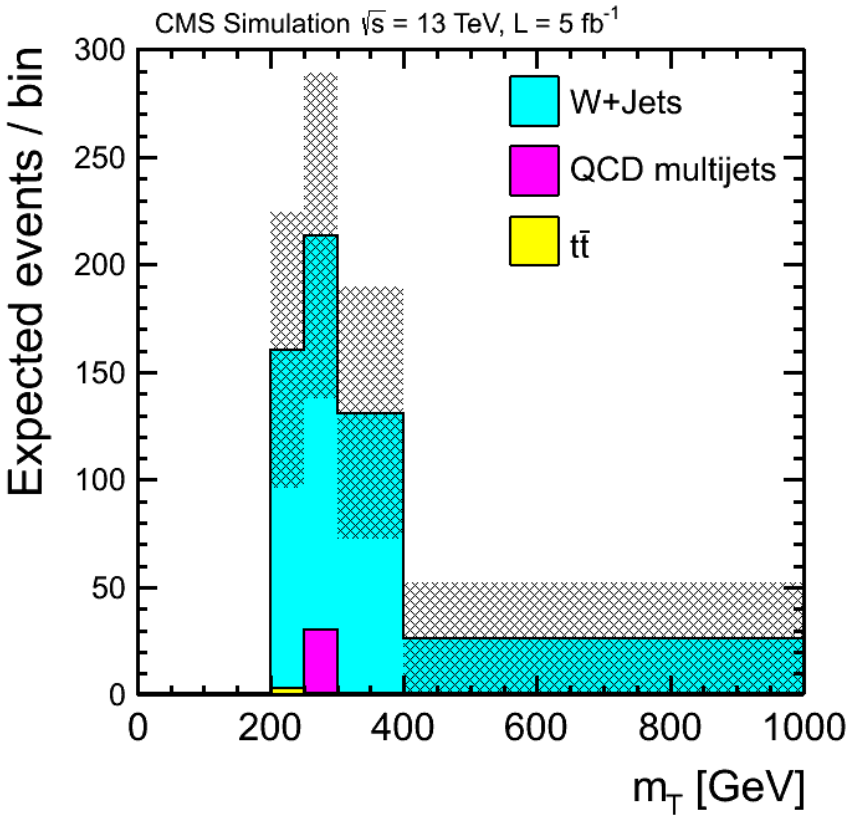


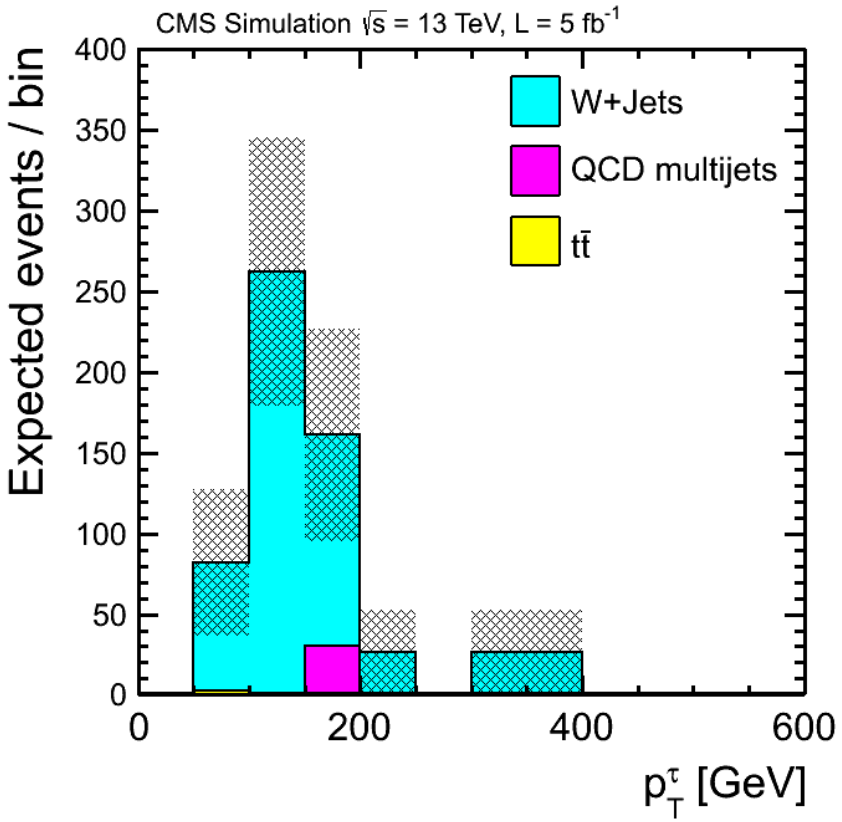


- **In ~ 60% of events reco tau matches generated tau from W decay**

Selected Sample (simulated HLT)

- **lepton veto + jet veto**
- **Loose tau isolation**

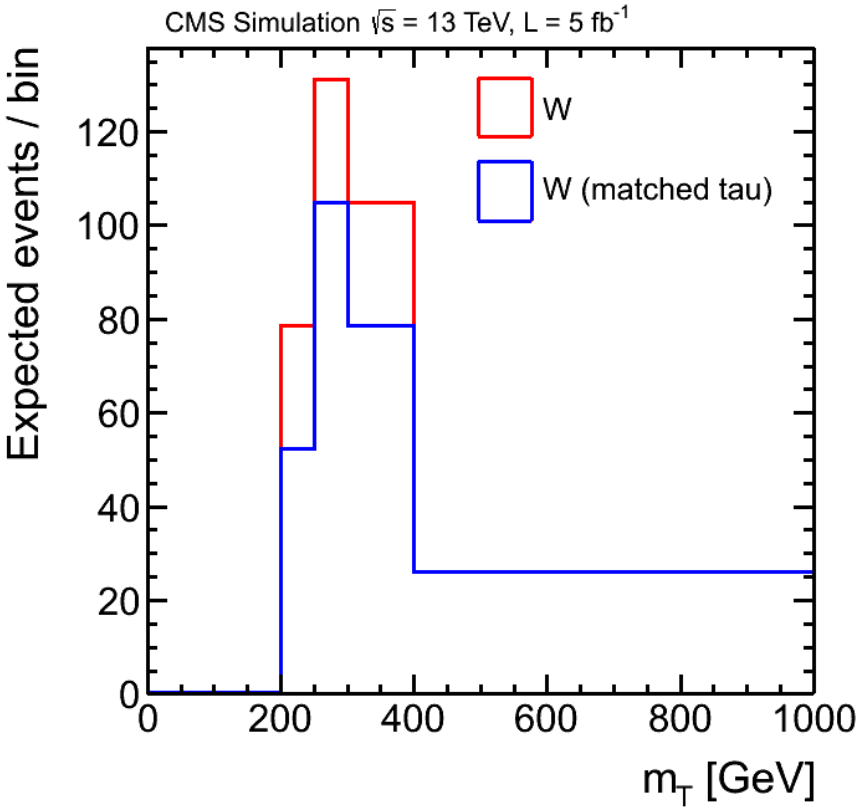


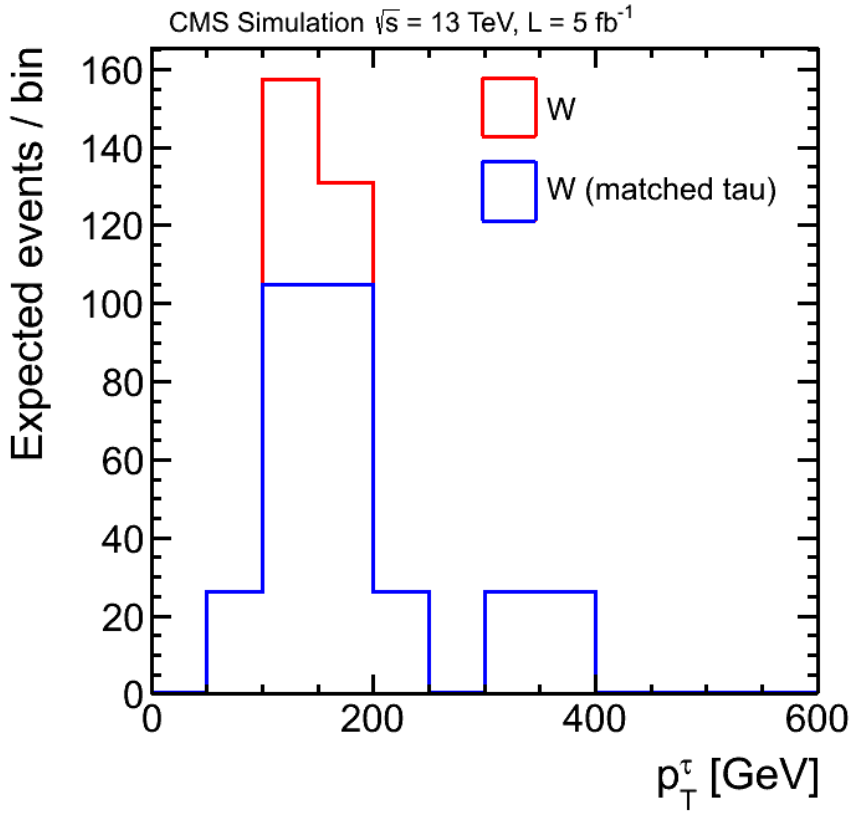


- **TTJets = 1 ± 1**
- **QCD = 30 ± 30**
- **Wjets = 525 ± 117**

Selected W+Jets events (simulated HLT)

- **lepton veto + jet veto**
- **Tight tau Isolation**

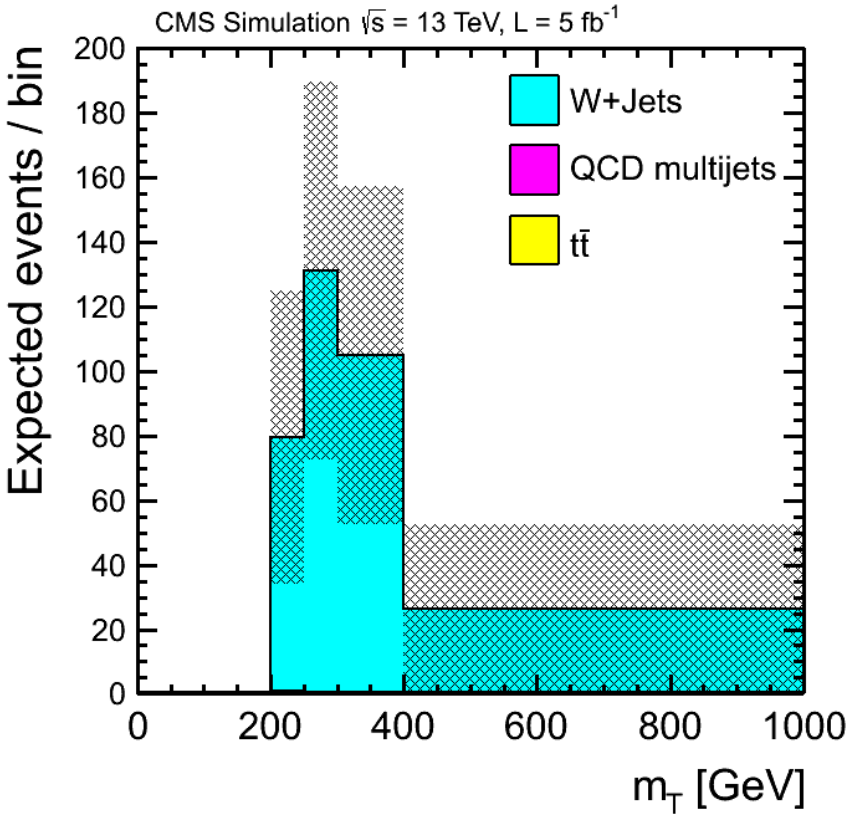


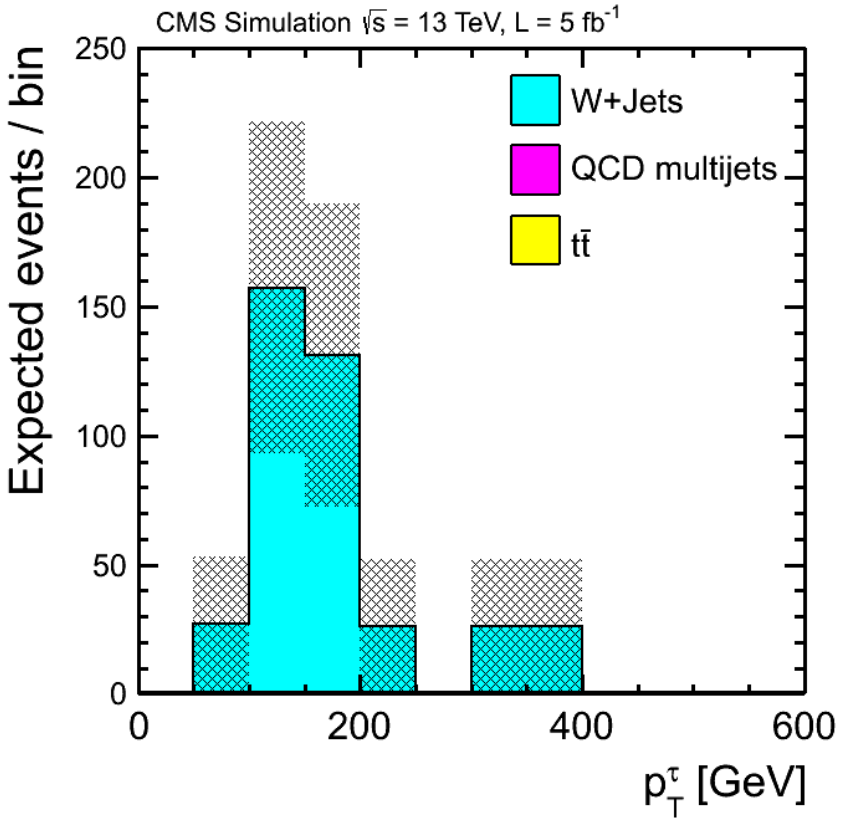


- **In ~ 80% of events reco tau matches generated tau from W decay**

Selected Sample (simulated HLT)

- **lepton veto + jet veto**
- **Tight tau isolation**





- **TTJets = 1 ± 1**
- **QCD = 0**
- **Wjets = 370 ± 98**

Summary

- Initial MC study shows principle feasibility of TauId efficiency measurements with W→τν events in Run2
  - Phys14 samples (bx=25ns PU=20)
    - W+jets, TT+Jets, pt-hat binned QCD
  - assumed luminosity : L = 5/fb
- Large fraction of selected W+Jets events are “misinterpreted”
  - reconstructed tau is fake
  - the fraction of W events with fake tau can be reduced by applying lepton (e/μ) and jet veto
- Low MC statistics does not allow to perform comprehensive studies (e.g. investigating # of tracks around tau as discriminating variable)
- MC statistics needed
  - W+Jets (Private samples being produced)
    - o 5 M in M_W bin = [100,200]
    - o 2 M in M_W bin = [200,400]
    - o 0.5 M in M_W bin = [400,Inf]
  - QCD background → data-driven, but would be nice to have more MC statistics for closure tests
    - MC closure tests : 20 – 100 M MC events for different pt-hat bins starting from pt-hat = 120 GeV
  - Z(νν)+Jets → data-driven
    - MC closure tests : 10 M events in different HT bins [100,200,400,600,Inf]