Analysis of Top Quark

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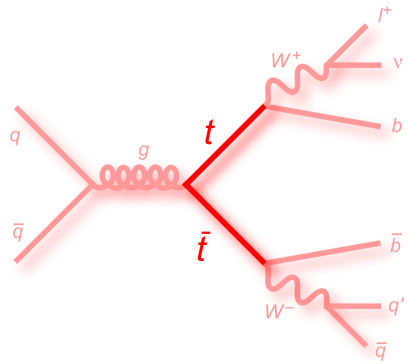
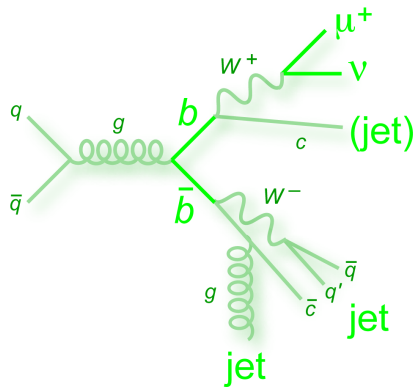
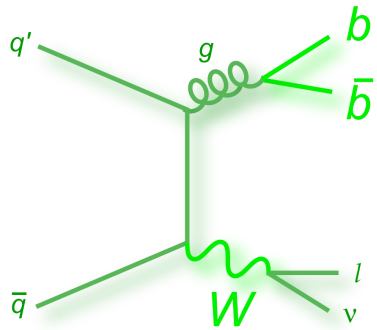
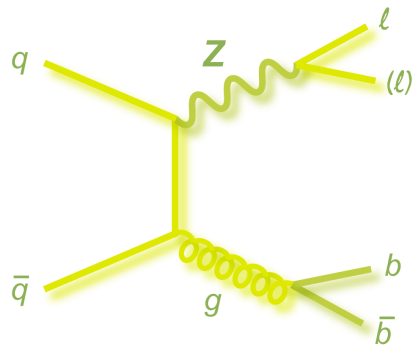
Goals

- Top-Antitop (ttbar) cross section measurement.
- Comparison of background and signal (MC): selections, purity and trigger efficiencies.
- Application to data

Signal and Backgrounds

Table 1: Images from Useful Feynman Diagrams

Signal: ttbar	Background: QCD
	
Background: W+jets	**Background: Z+jets**
	

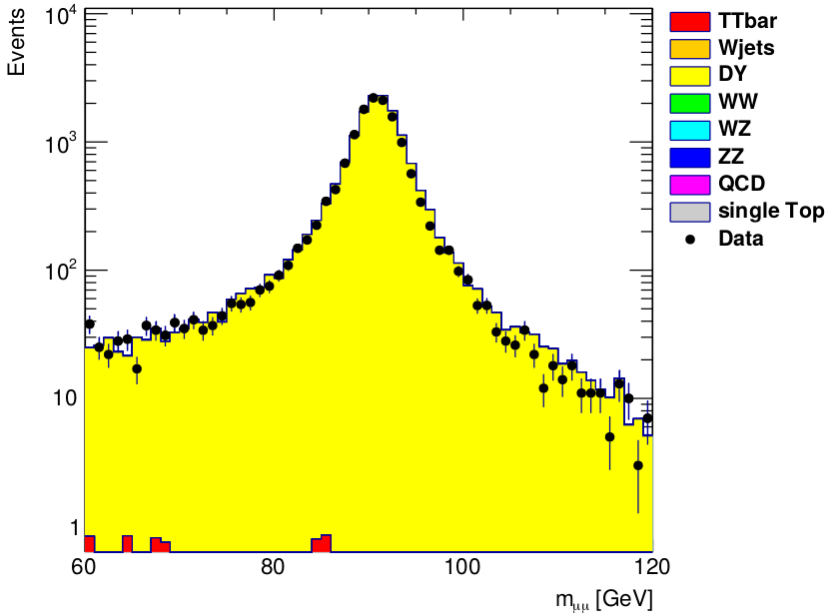
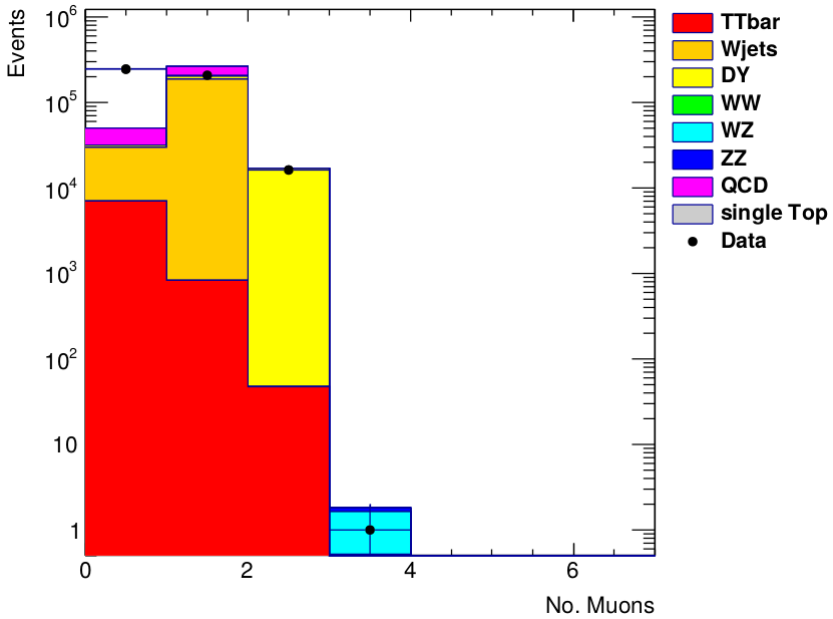
Invariant Di-Muon Mass

Code block: *Exercise 1*

```
int N_IsoMuon = 0, N_IsoTriggerMuon = 0;
MyMuon *muon1, *muon2;

for (vector<MyMuon>::iterator jt = Muons.begin();
     jt != Muons.end(); ++jt){
   if (jt->IsIsolated(MuonReIsoCut)){
      ++N_IsoMuon;
      if (N_IsoMuon == 1) muon1 = &(*jt);
      if (N_IsoMuon == 2) muon2 = &(*jt);
   }

   if (jt->IsIsolated(MuonReIsoCut) && (triggerIsoMu24 == 1)){
      ++N_IsoTriggerMuon;
   }
}

  if (N_IsoMuon > 1 && triggerIsoMu24){
     if (muon1->Pt()>MuonPtCut){
        h_Mmumu->Fill((*muon1 + *muon2).M(), EventWeight);
     }
  }
```

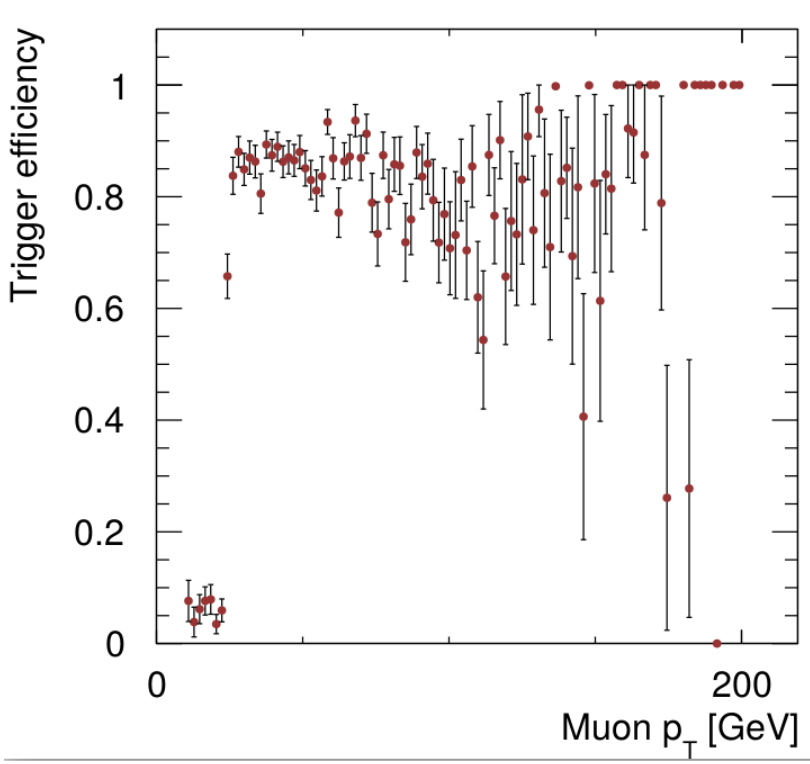
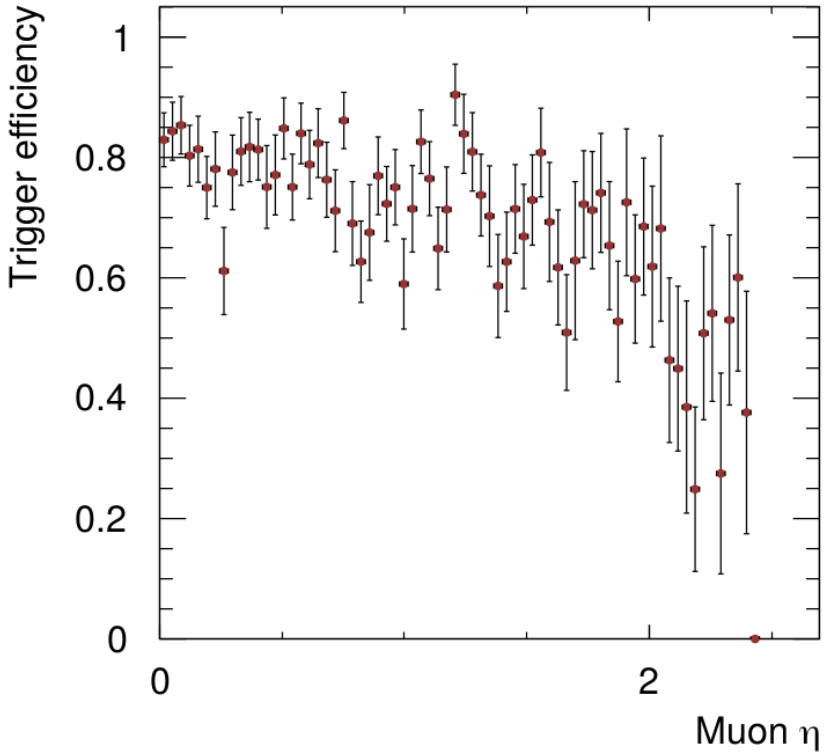
Results: Invariant Di-Muon Mass

Table 2: Plots obtained for $m_{\mu\mu}$

Invariant Di-Muon Mass	Muon trigger selection
	

Results: Trigger efficiency

Table 3: Results from exercise 1

Trigger Eff pT	Trigger Eff Eta
	

Top Kinematics

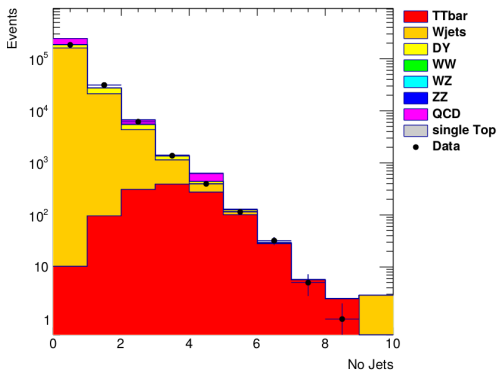
Code block: *Exercise 2*

```
int N_Jets = 0, N_BJets = 0;
MyJet *jet1, *jet2, *jet3, *jet4, *bjet1, *bjet2;

if (N_IsoMuon > 0) {
    for (vector<MyJet>::iterator jt = Jets.begin(); jt != Jets.end(); ++jt){
++N_Jets;
         if (jt->Pt()>30){ // Jets with pT > 30 GeV
             if (N_Jets == 1) jet1 = &(*jt);
             if (N_Jets == 2) jet2 = &(*jt);
             if (N_Jets == 3) jet3 = &(*jt);
             if (N_Jets == 4) jet4 = &(*jt);
         }
         if (jt->IsBTagged() == 1){
             ++N_BJets;
             if (N_BJets == 1) bjet1 = &(*jt);
             if (N_BJets == 2) bjet2 = &(*jt);
         }
    }
 }
```

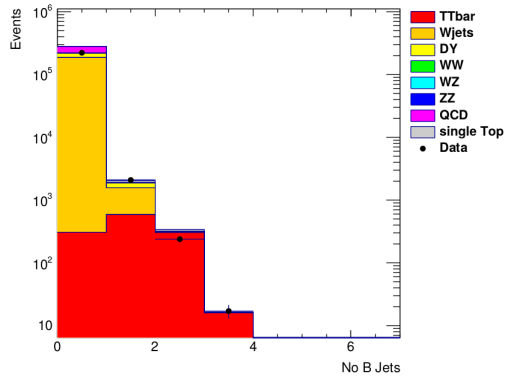
Results: Jet multiplicity, MET and Pileup

Table 4: Results from exercise 2

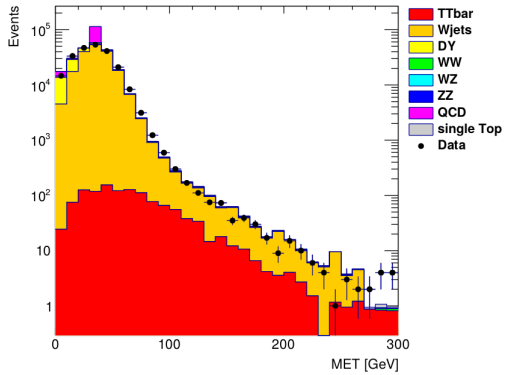
Jet Multiplicity



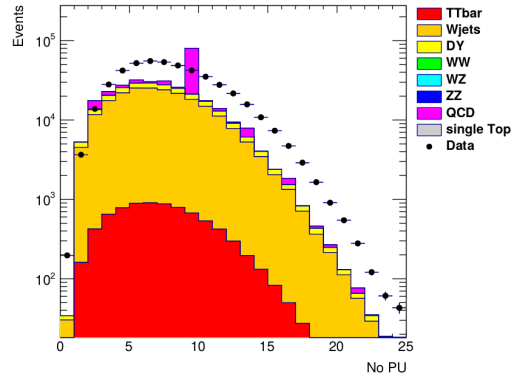
B Jet Multiplicity



Missing Transverse Energy



Pileup



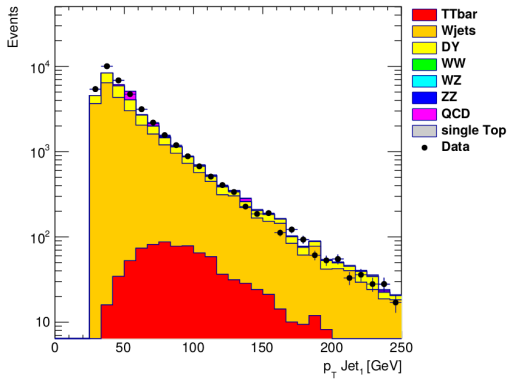
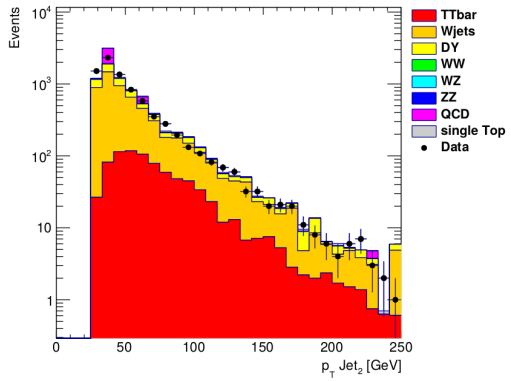
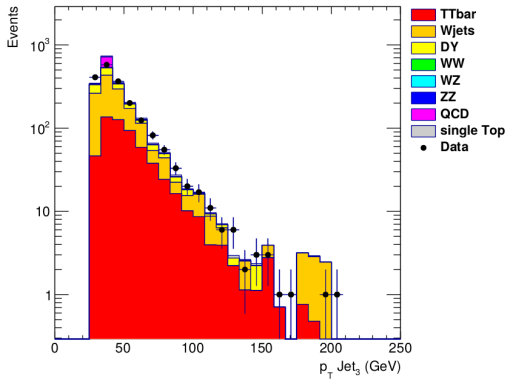
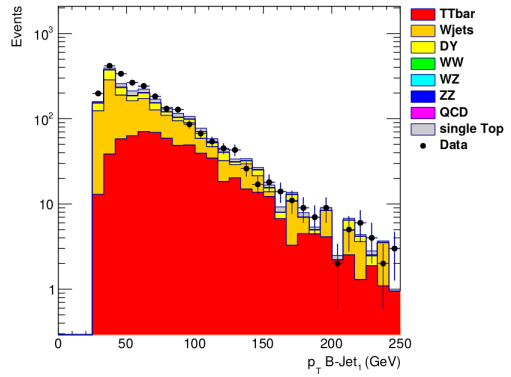
Top kinematics

Code block: *Exercise 2*

```
if (N_Jets > 0 && triggerIsoMu24 == 1){
     h_trigJet1_pt->Fill((*jet1).Pt(), EventWeight);
}
if (N_Jets > 1 && triggerIsoMu24 == 1){
     h_trigJet2_pt->Fill((*jet2).Pt(), EventWeight);
}
if (N_Jets > 2 && triggerIsoMu24 == 1){
     h_trigJet3_pt->Fill((*jet3).Pt(), EventWeight);
}
if (N_BJets > 0 && triggerIsoMu24 == 1){
     h_trigBJet1_pt->Fill((*bjet1).Pt(), EventWeight);
}
```

Results: Transverse momenta of jets

Table 5: Results from exercise 2

Jet 1	Jet 2
	
Jet 3	**B-Jet 1**
	

Results: MET after cuts

Code block: *Exercise 3*

```
if (N_IsoMuon > 0 && triggerIsoMu24 == 1){
        if (N_Jets > 1 && N_BJets > 1){
                h_NEvents_sel->Fill(1.0, EventWeight);
                h_ttbar->Fill(met.Pt(), EventWeight);
        }
}
```

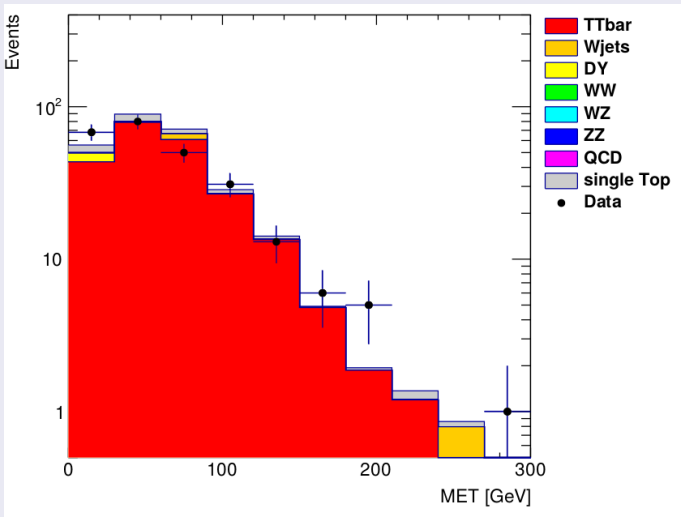


Figure 1: MET after selection

Results: Acceptance, Purity and Efficiency

	ttbar	DY	Total
NEvents_Sel	231.901	7.155	269.278
NEvents_1l	1215.68	32314.6	—
Data	255	—	224217
Purity	—	—	$94.69\% \pm 5.30\%$
Acceptance	—	—	$19\% \pm 2\%$
Efficiency	—	—	0.029 ± 0.003
X-section	—	—	149.38 ± 15.61 [pb]

Modified Cross Section Formula

$$\sigma = \frac{N_{data} - N_{bkg}^{MC}}{L \times \epsilon \times BR}$$