“Top” Secret

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Outline

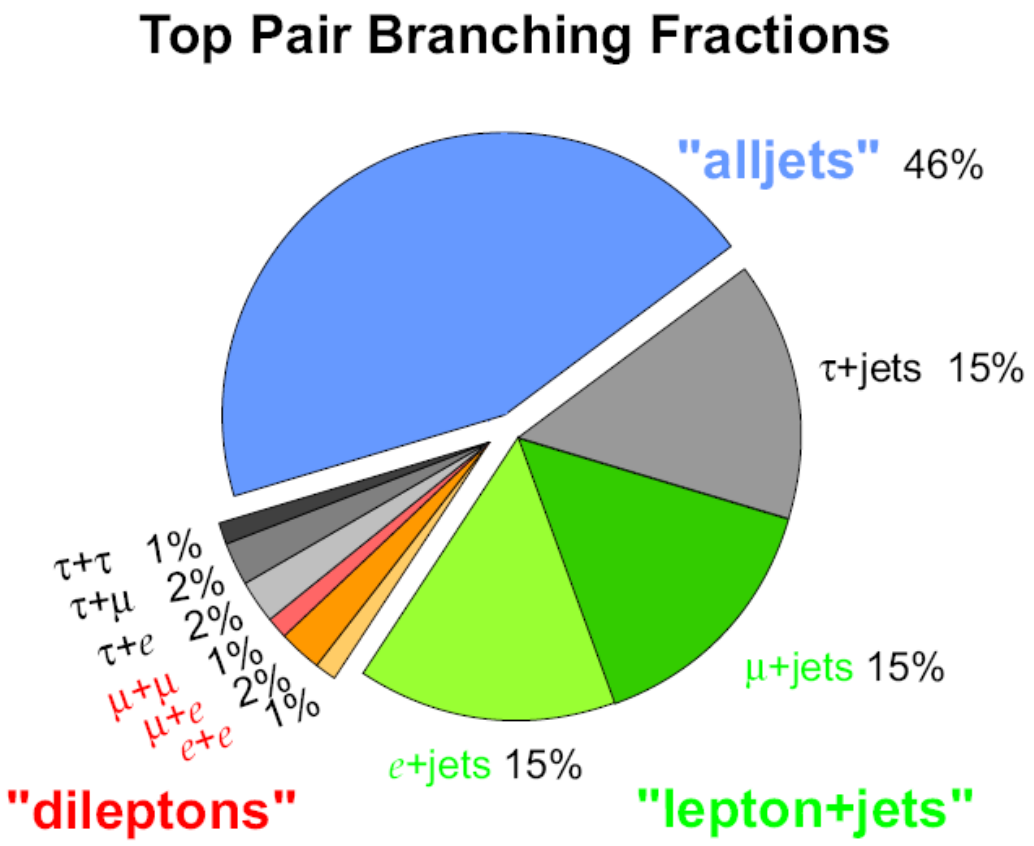
- Objectives
- Something about top
- Methods to get cross section
- Results
- Summary

Objectives

- Measure the top quark pair production cross section using events containing one isolated muon, 4 or more jets, and Missing Transverse Energy (MET)
- Apply data-driven methods to estimate the QCD multijet background (ABCD method)
- Have fun!

Motivation

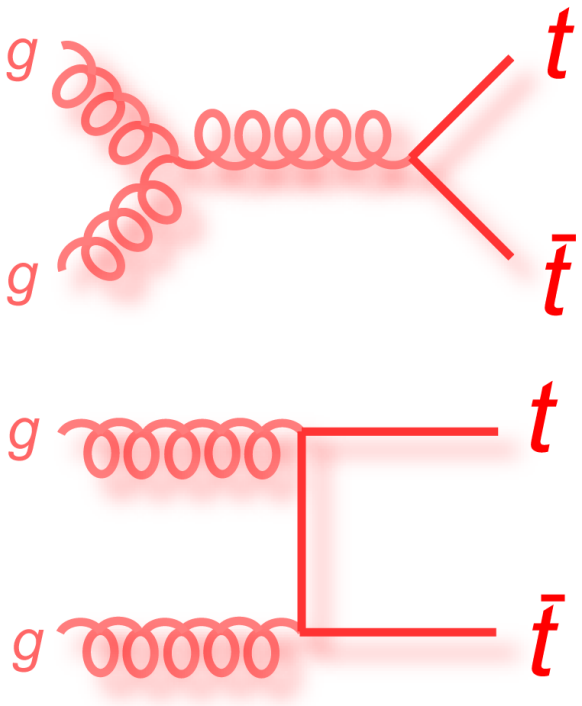
- Dicovered in 1995 by CDF & D0
- $m_t \sim 173$ GeV
- Couples strongly to Higgs
- Search for new physics
  - top as background

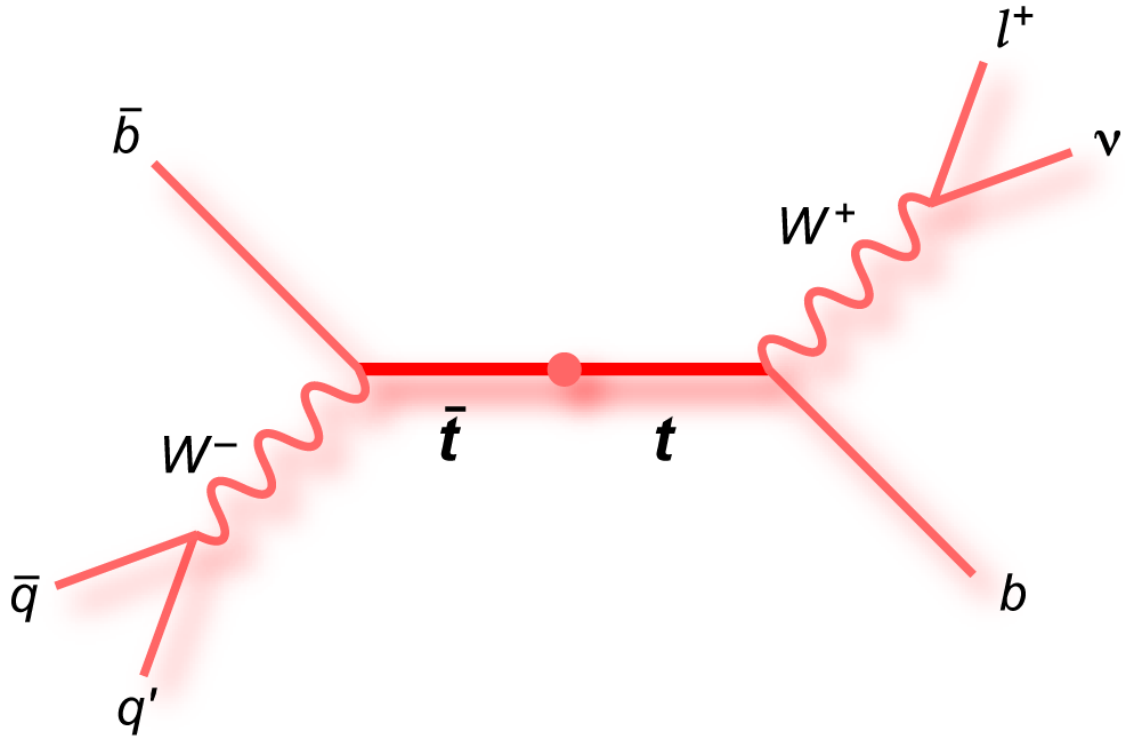


http://www-d0.fnal.gov/Run2Physics/top/top_public_web_pages/top_feynman_diagrams.html

ttbar @ LHC

- 85% gluons fusion





http://www-d0.fnal.gov/Run2Physics/top/top_public_web_pages/top_feynman_diagrams.html

Data sample

- CMS 2011, 7 TeV, L = 4.98 fb^{-1}
- Single muon trigger
- Preselection/Pattuples:
  - good muon p_t > 10 GeV
- Cuts on
  - Pt > 35 GeV
  - Iso < 0.2
  - MET > 20 GeV
  - >= 1 btag
  - >= 4 jets

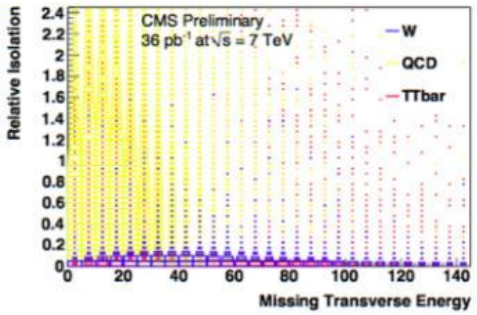
Backgrounds

- QCD
- W+jets
- Single top

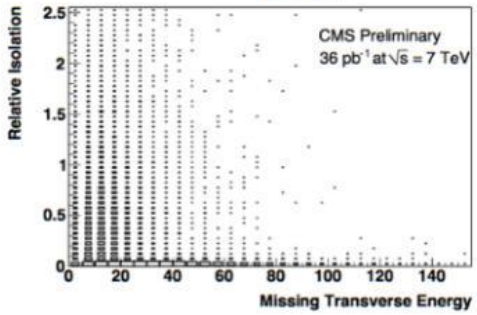
ABCD Method

- Before tagging

MC



Data



- Assumptions :

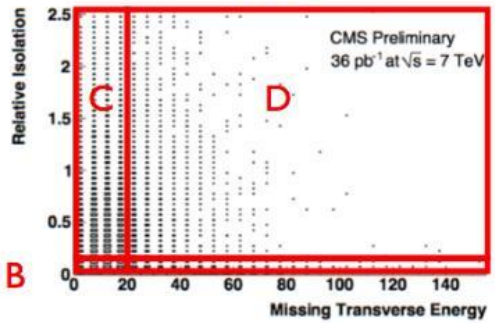
No signal leakage into background regions,

Variables are independent

Assume ABCD regions have similar ratio over each other for those background components of each region in the data

$Na/Nb = Nd/Nc$

Data



$N_A = N_B * N_D/N_C$

Estimation of N_{QCD}

- $N_A = N_B * N_D/N_C$

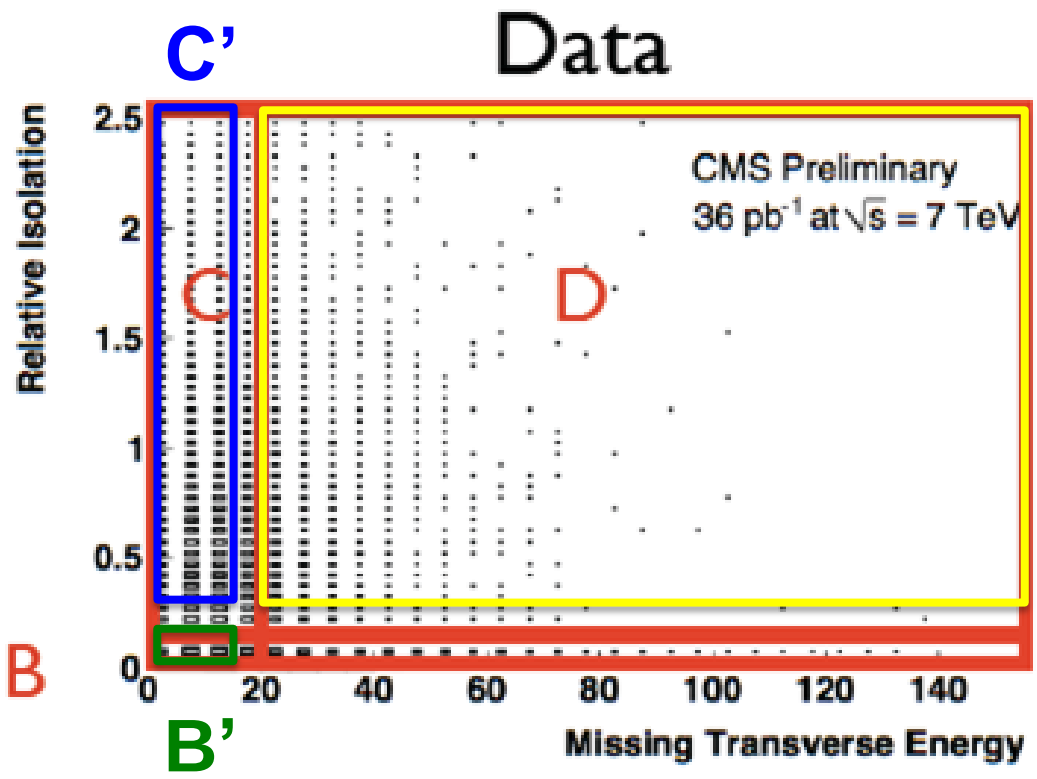
  where $N_B = N^{DATA}_{QCD\ in\ B} - N^{MC}_{ttbar\ in\ B} - N^{MC}_{wjets\ in\ B}$

: Because there are many ttbar and W+jet events in B region, to apply ABCD formula only to QCD events we should subtract those events(MC).

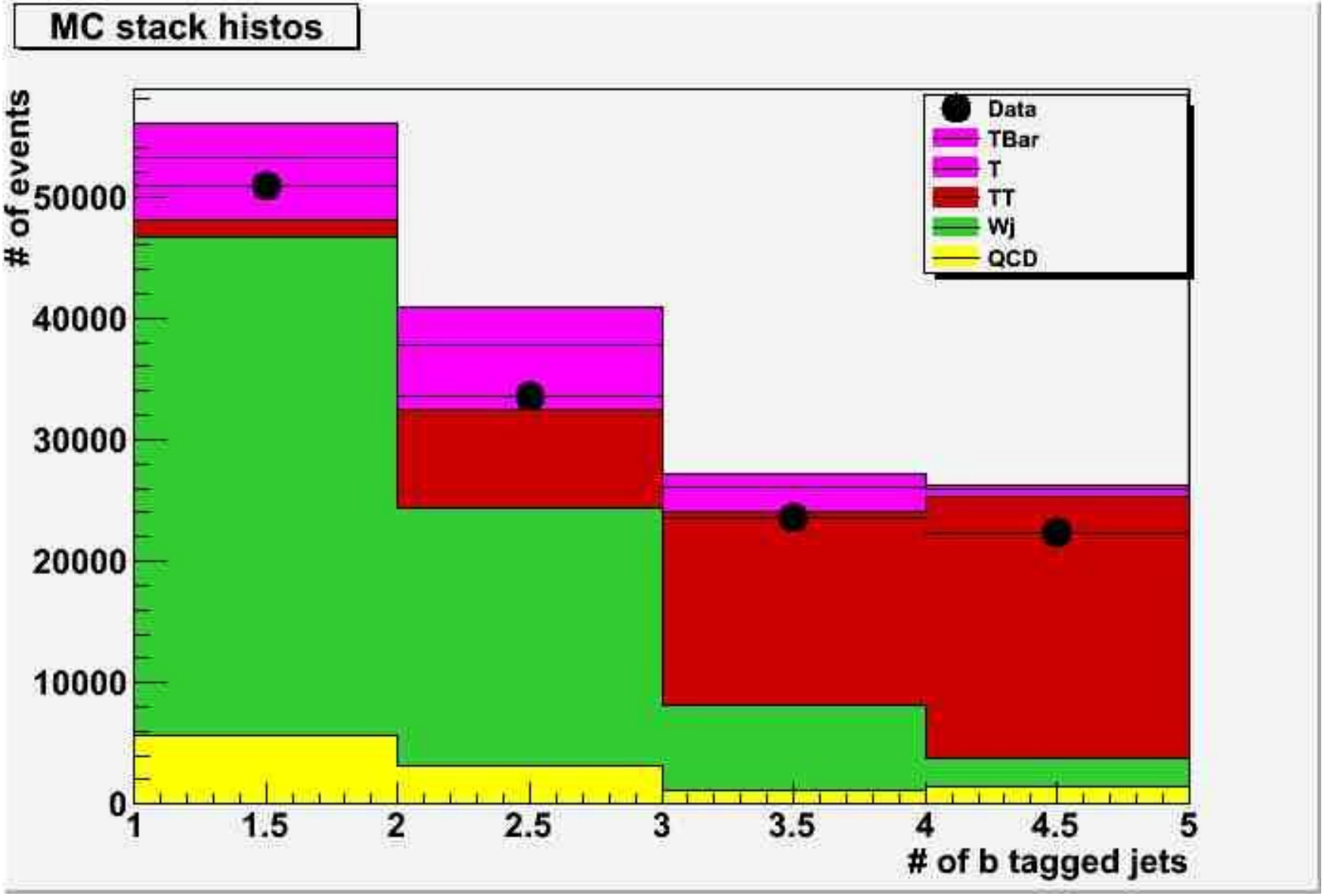
	$N_A = N_B * N_D/N_C$	Syst. error
njets == 1	5730 = (19688-117-11778)* 138205/187949	+/- 31%
njets == 2	3163 = (8748-687-4857) * 110060/111478	+/-38%
njets == 3	1161 = (4241-2027-1313) * 46549/36096	+/-84%
njets >= 4	1408 = (3410-2179-420) * 20410/11755	+/-81%

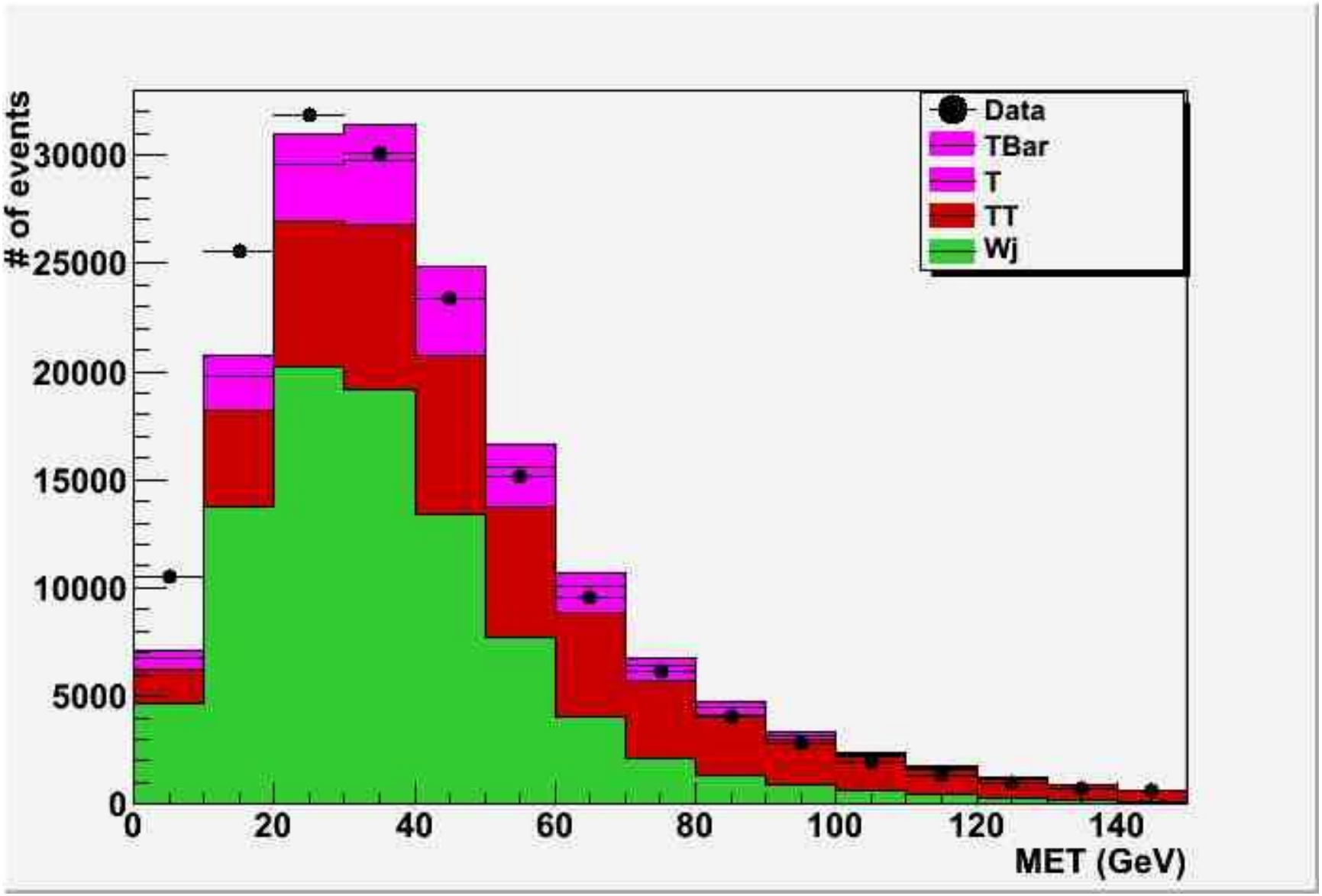
Systematic Errors

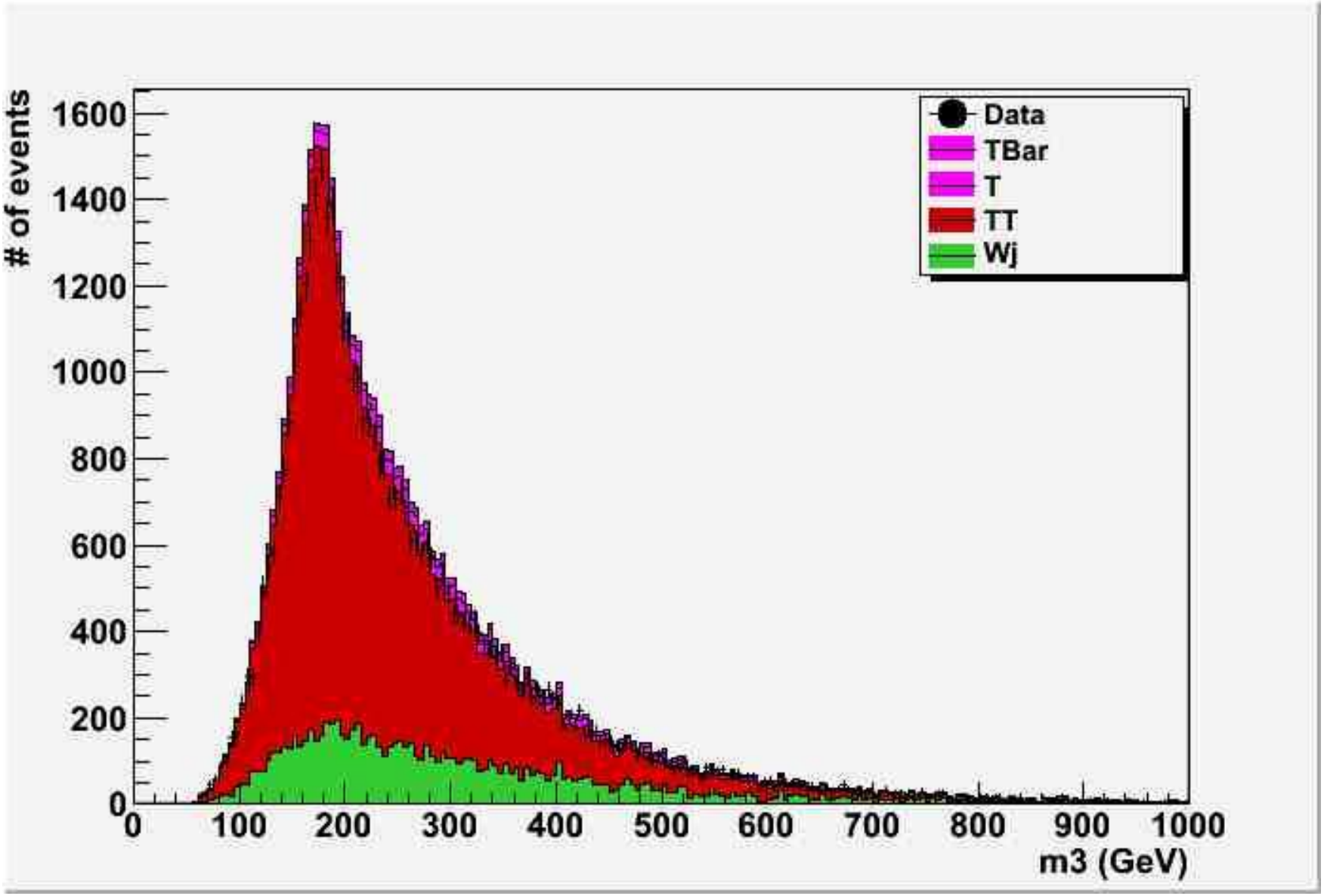
- To calculate systematic uncertainties muon isolation and MET cuts are changed by 10%.
- 0.2 → 0.22 for iso. cut & 20→18 for MET cut
- Only signal region A isn't changed



A : metRaw > 20 and lepIso < 0.2
B' : metRaw <= 18 and lepIso < 0.2
C' : metRaw <= 18 and lepIso >= 0.22
D' : metRaw > 20 and lepIso >= 0.22


MC stack histos
# of events
50000
40000
30000
20000
10000
0
1
1.5
2
2.5
3
3.5
4
4.5
5
# of b tagged jets
Data
TBar
T
TT
Wj
QCD


Data
TBar
T
TT
Wj
# of events
30000
25000
20000
15000
10000
5000
0
0
20
40
60
80
100
120
140
MET (GeV)


Data
TBar
T
TT
Wj
# of events
0
200
400
600
800
1000
1200
1400
1600
0
100
200
300
400
500
600
700
800
900
1000
m3 (GeV)

uncertainty

- Efficiency scale factors:
  * Muon trigger efficiency : 0.965 +- 0.029
  * B-tagging efficiency : 0.97 +- 0.03 per jet
- Experimental uncertainties:
  * Luminosity : 2.5%
  * Jet energy scale : 5%
  * Lepton ID / reco / trigger: 3.4%
  * Piluep : 2.5%
- Theoretical uncertainties:
  * PDF : 3.4%
  * Renormalization and factorization scale : 2%
  * Matching threshold : 2%
  * ISR and FSR : 2%

Cross section measurement

$$\sigma = \frac{N - B}{\varepsilon \cdot L}$$

$$\left(\frac{\Delta\sigma}{\sigma}\right)^2 = \left(\frac{\sqrt{N}}{N-B}\right)^2 + \left(\frac{\Delta B}{N-B}\right)^2 + \left(\frac{\Delta\varepsilon}{\varepsilon}\right)^2 + \left(\frac{\Delta L}{L}\right)^2$$

Results

$$\sigma = \frac{22406 - (1408 + 2303 + 833)}{(0.0263)\cdot(4980)}\ \text{pb}^{-1}$$

$$\left(\frac{\Delta\sigma}{136.5}\right)^2 = \left(\frac{\sqrt{22406}}{17860}\right)^2 + \left(\frac{1836}{17860}\right)^2 + (0.0485)^2 + (0.070)^2$$

$$\sigma_{t\bar{t}} = 136.5 \pm 1.1(\text{stat}) \pm 18.2(\text{syst})\ \text{pb}^{-1}$$

Acknowledgement

- Many thanks to Freya, Francisco and Chris
- CMSDASia 2012