Ttbar Cross section via b-tagged jets

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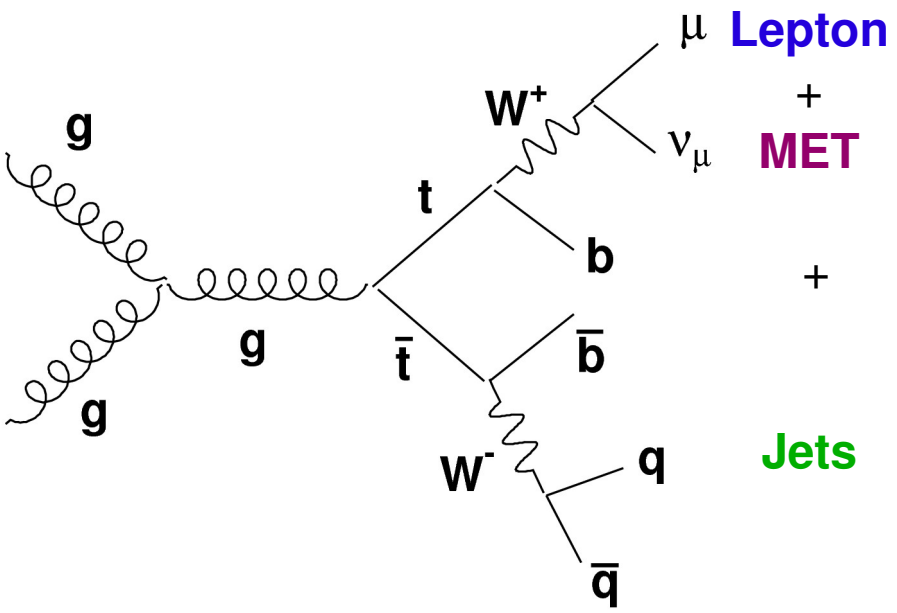
LJMET Parallel Session for LPC JTERM-III

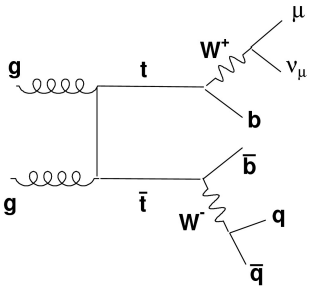
Outline:

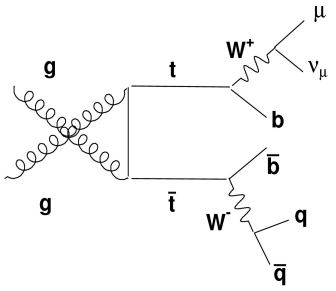
- **Introduction**
- **b-tag methods**
- **Soft Muon Tagger**
- **Outlook**

Introduction

Ttbar pairs at LHC are expected to be dominantly produced via gluon-gluon fusion mechanism.







Muon channel: BR 15%

Main backgrounds:

W+jets (Wjj->$l^{\mp}\nu$jj): can look like l+jets.
QCD: can produce fake muons (or real leptons) and MET (from mismeasured jets).

b-tag: refine analysis. Improve the ratio of signal to background.

@Tevatron: signal:background
2:1 with b-tag.
1:2 without b-tag.

A simple b-tag method could already be used in early LHC data.

B-tagging (on early data)

- Simple Secondary Vertex Tagger (SVT) – Uses presence of a reconstructed Secondary Vertex as b-tag, and time of flight as discriminator.

3% fake rate @ 35% efficiency.
1% fake rate @ 20% efficiency.
} Simple SVT @ startup (*)

- Track Counting – computes impact parameter and IP significance for all tracks within a jet. Uses IP significance to discriminate.

5% fake rate @ 40% efficiency.
1% fake rate @ 20% efficiency.
} Track Counting @ startup (*)

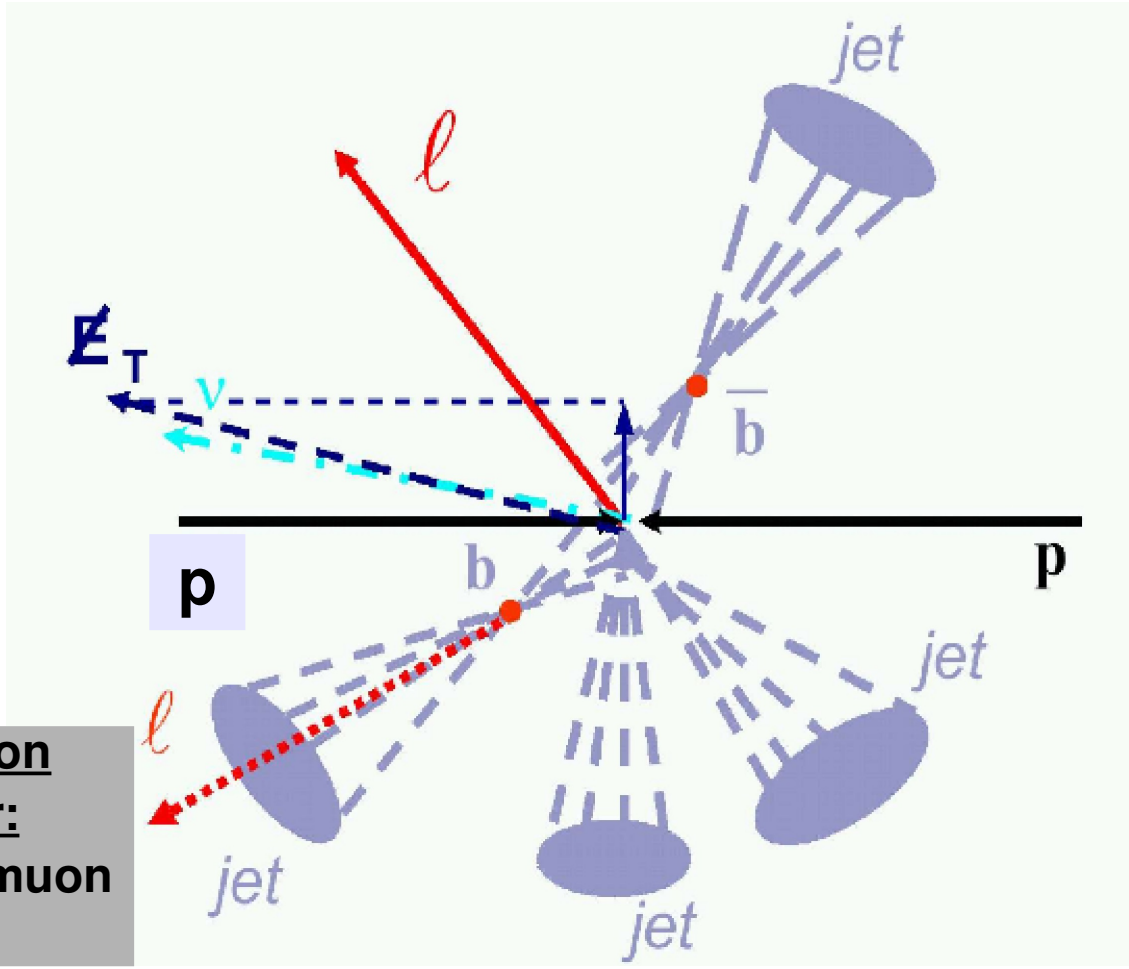
- Soft Lepton Tagger (SLT) – on this talk will concentrate on this tagger. It is a simple way of counting b-jets on early LHC data. Try to develop a simple Soft Muon Tagger for ttbar analysis.

(*) Numbers from talk of A. Bocci, 24/07/2008 – Plenary Physics Meeting.

Soft Muon Tagger

1 – pass kinematical cuts;
2 – Muon Selection;
3 – estimate efficiency of the tagger;
4 – estimate background.

For this talk items 1 and 2 were performed, although item 2 still needs several improvements (here it is meant as a simple exercise).



Soft Muon Tagger:
Look for a muon inside a jet

For requirements on a muon tagger for a ttbar analysis, see talk from Claudio Campagnari, 'Needs for muon tagger performance measurement':
http://indico.cern.ch/getFile.py/access?contribId=32&sessionId=2&resId=1&materialId=slides&confId=41353

1. Kinematical Cuts

- MC Sample:

- ttbar sample generated using PYTHIA with CMSSW_2_1_9 FAST SIMULATION, sqrt{s}=14TeV.
- 29999 generated events with σ_{ttbar} = 908 pb.
- no pile-up.

- Tight ttbar (semileptonic muon channel) event selection:

- ≥ 1 muon with $p_T \geq 30$ GeV and $|\eta| < 2.1$;

- ≥ 4 jets with $E_T \geq 40$ GeV and $|\eta| < 2.4$;

- Relative isolation of the muon ≥ 0.95;

- ΔR_{min}(muon, jets) ≥ 0.3 where all the jets with $E_T \geq 20$ GeV and $|\eta| < 2.4$ are included in the calculation;

- Veto on second isolated muon with $p_T \geq 30$ GeV;

Thanks to Tuula Mäki for providing original code of ttbar event selection.

2. Muon Selection (for the Muon Tagger)

For each muon of a ttbar event, look if it is inside a jet by inverting the cuts of an isolated muon (except for the $|\eta|$ cut):

- muon with $p_T \leq 30$ GeV and $|\eta| < 2.1$;

- Relative isolation of the muon ≤ 0.95;

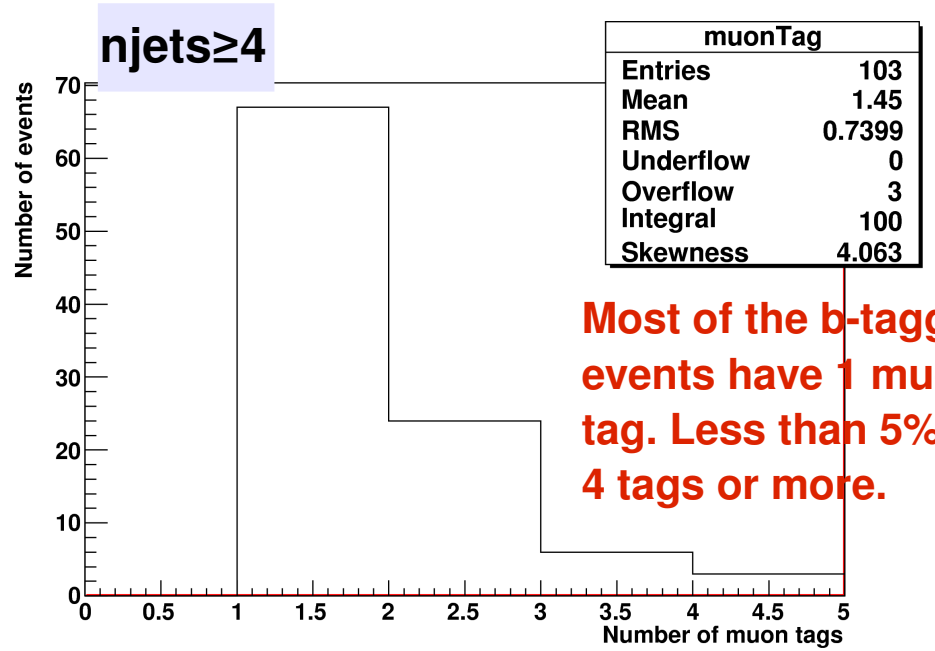
- ΔR_{min}(muon, jets) < 0.3 where all the jets with $E_T \geq 40$ GeV and $|\eta| < 2.4$ are included in the calculation;

obs.: *no muon identification applied*.

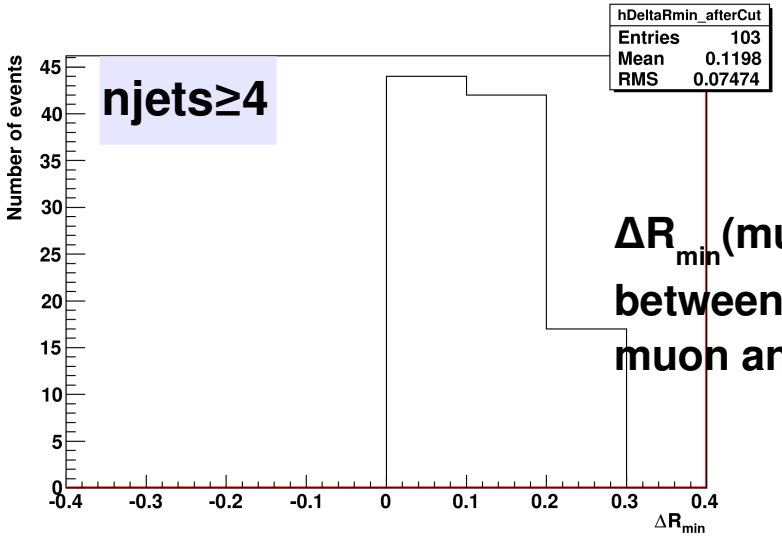
ttbar event selection and b-tag

Njets ≥ 4 (ttbar event selection): 511 events. b-tagged events: 103. ==> ~20% efficiency.

Number of tags per event:

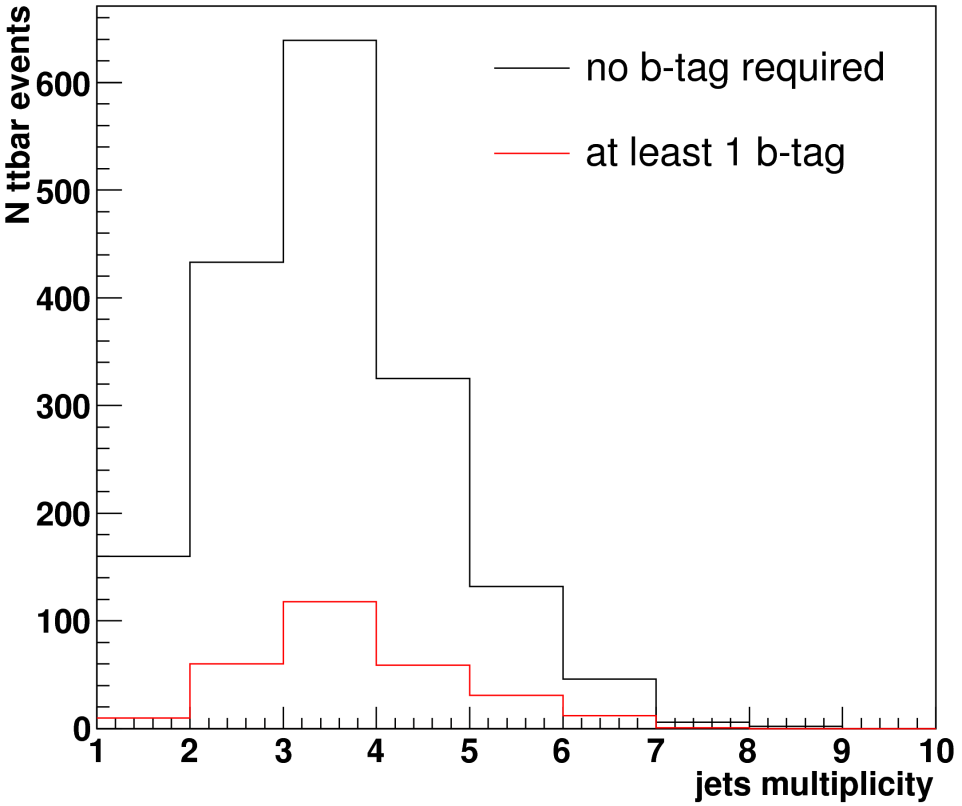


Most of the b-tagged events have 1 muon tag. Less than 5% with 4 tags or more.



ΔR_{min}(muon, jets) between tagged muon and jet.

Total number of ttbar events as a function of jet requirements in the ttbar selection:



Track Counting Tagger (from lepton+jets MVA analysis)

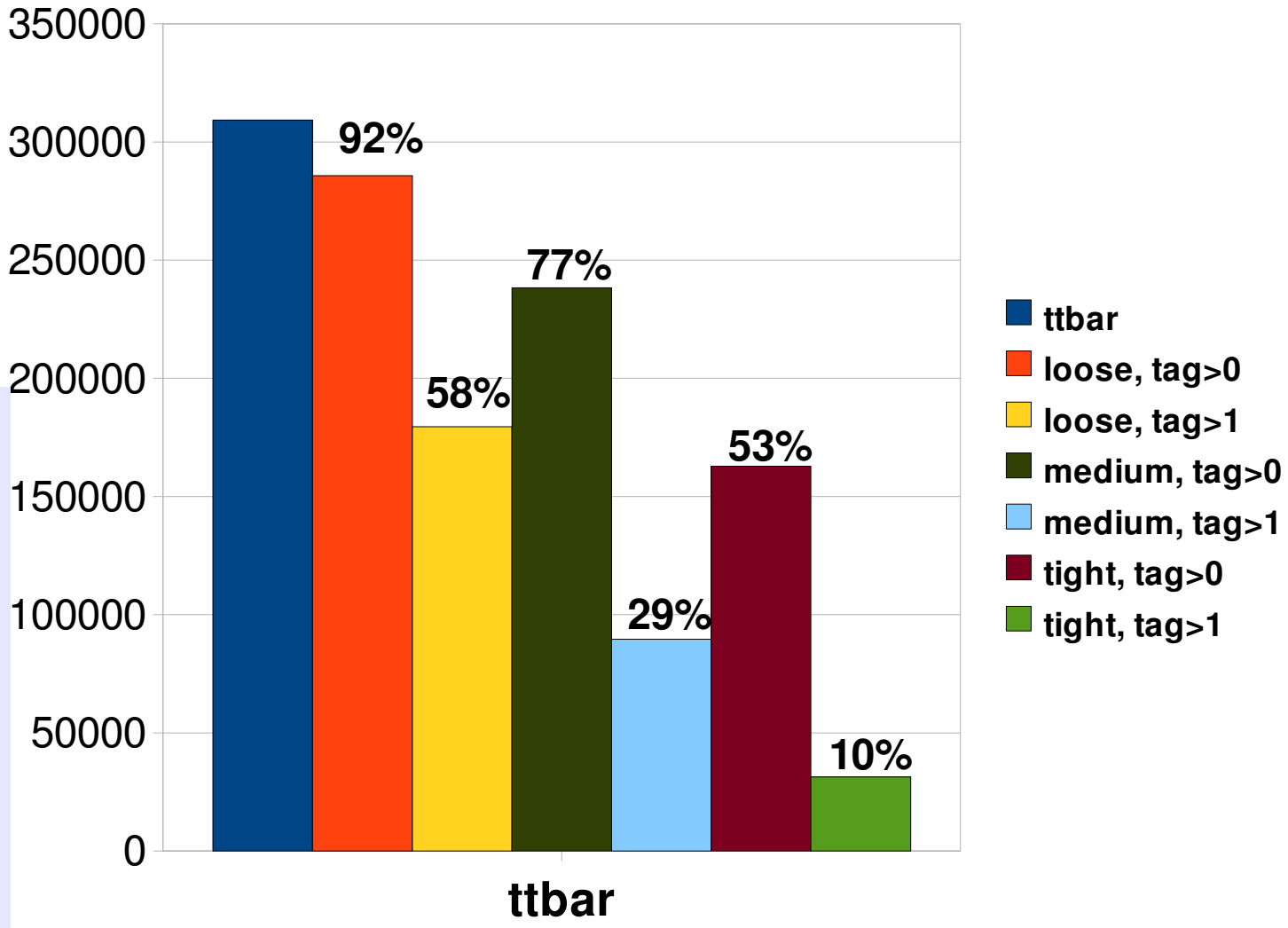
MC samples generated @ 10TeV.
Analysis details: https://twiki.cern.ch/twiki/bin/view/CMS/LJMETMVA

G. Kukartsev

cut1:

At least 4 jets with Et>25 GeV, |eta|<2.4

At least one lepton with pt>20 GeV, |eta|<2.1



@100pb-1:

S/B (no b-tag): 0.0005

loose_1tag: S/B = 0.01590
loose_2tags: S/B = 0.0260
medium_1tag: S/B = 0.0214
medium_2tags: S/B = 0.0376
tight_1tag: S/B = 0.0267
tight_2tags: S/B = 0.0464

Summary and Outlook

- First step towards trying to establish a muon tagger for ttbar analysis to be used in early data.
- Took existing code for ttbar event selection and have established a skeleton of the muon selection of the muon tagger – but still far from complete;
- b-tagged ttbar events found were ~20% of ttbar selected events with number of jets of at least 4.

- Improvements to be made to the muon selection:

-> Get in touch with the Muon Physics Object Group and use their Muon Identification in the tagger;

-> Vary the requirements on the muon cuts;

- Longer term Muon tagger tasks:

-> Establish a method for computing the muon tagger efficiency;

-> Establish a method for estimating the muon tagger background (most challenging).

- In parallel:

-> Look at other existing b-tags and compare results.

Comments and suggestions are very welcome! Please contact me: malbouis@cern.ch

Backup

Njets ≥ 8

One lepton 3023
8 jets 5
Isolated lepton 2
Delta(R) lepton 2
Dilepton veto 2
30 GeV +iso veto 2

** Soft Lepton Muon Tags: 0 **
** Soft Lepton Muon Tags (no pT cut): 0 **
** Soft Lepton Muon Tags (no rel iso cut): 0 **
** Soft Lepton Muon Tags (no deltaR cut): 0 **

Njets = 8

One lepton 3023
>=7 jets 29
Isolated lepton 13
Delta(R) lepton 8
Dilepton veto 8
30 GeV +iso veto 8

** Soft Lepton Muon Tags: 1 **
** Soft Lepton Muon Tags (no pT cut): 1 **
** Soft Lepton Muon Tags (no rel iso cut): 1 **
** Soft Lepton Muon Tags (no deltaR cut): 1 **

Njets ≥ 7

One lepton 3023
7 jets 22
Isolated lepton 11
Delta(R) lepton 6
Dilepton veto 6
30 GeV +iso veto 6

** Soft Lepton Muon Tags: 1 **
** Soft Lepton Muon Tags (no pT cut): 1 **
** Soft Lepton Muon Tags (no rel iso cut): 1 **
** Soft Lepton Muon Tags (no deltaR cut): 1 **

Njets = 7

One lepton 3023
Four jets 129
Isolated lepton 78
Delta(R) lepton 54
Dilepton veto 54
30 GeV +iso veto 54

** Soft Lepton Muon Tags: 13 **
** Soft Lepton Muon Tags (no pT cut): 15 **
** Soft Lepton Muon Tags (no rel iso cut): 14 **
** Soft Lepton Muon Tags (no deltaR cut): 13 **

Njets ≥ 6

One lepton 3023
6 jets 100
Isolated lepton 65
Delta(R) lepton 46
Dilepton veto 46
30 GeV +iso veto 46

** Soft Lepton Muon Tags: 12 **
** Soft Lepton Muon Tags (no pT cut): 14 **
** Soft Lepton Muon Tags (no rel iso cut): 13 **
** Soft Lepton Muon Tags (no deltaR cut): 12 **

Njets = 6

26%

One lepton 3023
>= 5 jets 396
Isolated lepton 246
Delta(R) lepton 186
Dilepton veto 186
30 GeV +iso veto 186

** Soft Lepton Muon Tags: 44 **
** Soft Lepton Muon Tags (no pT cut): 49 **
** Soft Lepton Muon Tags (no rel iso cut): 46 **
** Soft Lepton Muon Tags (no deltaR cut): 44 **

Njets ≥ 5

One lepton 3023
5 jets 267
Isolated lepton 168
Delta(R) lepton 132
Dilepton veto 132
30 GeV +iso veto 132 0 0 0

** Soft Lepton Muon Tags: 31 **
** Soft Lepton Muon Tags (no pT cut): 34 **
** Soft Lepton Muon Tags (no rel iso cut): 32 **
** Soft Lepton Muon Tags (no deltaR cut): 31 **

Njets = 5

23% b-tag

One lepton 3023
>=4 jets 1038
Isolated lepton 671
Delta(R) lepton 511
Dilepton veto 511
30 GeV +iso veto 511

Njets ≥ 4

**** Soft Lepton Muon Tags: 103 ****
**** Soft Lepton Muon Tags (no pT cut): 109 ****
**** Soft Lepton Muon Tags (no rel iso cut): 105 ****
**** Soft Lepton Muon Tags (no deltaR cut): 103 ****

One lepton 3023
Four jets 642
Isolated lepton 425
Delta(R) lepton 325
Dilepton veto 325
30 GeV +iso veto 325

Njets = 4

18% b-tag

** Soft Lepton Muon Tags: 59 **
** Soft Lepton Muon Tags (no pT cut): 60 **
** Soft Lepton Muon Tags (no rel iso cut): 59 **
** Soft Lepton Muon Tags (no deltaR cut): 59 **

One lepton 3023
>=3 jets 2083
Isolated lepton 1455
Delta(R) lepton 1150
Dilepton veto 1150
30 GeV +iso veto 1150

Njets ≥ 3

** Soft Lepton Muon Tags: 221 **
** Soft Lepton Muon Tags (no pT cut): 235 **
** Soft Lepton Muon Tags (no rel iso cut): 223 **
** Soft Lepton Muon Tags (no deltaR cut): 221 **

One lepton 3023
three jets 1045
Isolated lepton 784
Delta(R) lepton 639
Dilepton veto 639
30 GeV +iso veto 639 0 0 0

Njets = 3

18% b-tag

** Soft Lepton Muon Tags: 118 **
** Soft Lepton Muon Tags (no pT cut): 126 **
** Soft Lepton Muon Tags (no rel iso cut): 118 **
** Soft Lepton Muon Tags (no deltaR cut): 118 **

One lepton 3023
>=2 jets 2783
Isolated lepton 2003
Delta(R) lepton 1583
Dilepton veto 1583
30 GeV +iso veto 1583

** Soft Lepton Muon Tags: 281 **
** Soft Lepton Muon Tags (no pT cut): 299 **
** Soft Lepton Muon Tags (no rel iso cut): 283 **
** Soft Lepton Muon Tags (no deltaR cut): 281 **

Njets ≥ 2

One lepton 3023
two jets 700
Isolated lepton 548
Delta(R) lepton 433
Dilepton veto 433
30 GeV +iso veto 433

** Soft Lepton Muon Tags: 60 **
** Soft Lepton Muon Tags (no pT cut): 64 **
** Soft Lepton Muon Tags (no rel iso cut): 60 **
** Soft Lepton Muon Tags (no deltaR cut): 60 **

Njets = 2

14% b-tag

One lepton 3023
>=1 jets 3002
Isolated lepton 2187
Delta(R) lepton 1743
Dilepton veto 1743
30 GeV +iso veto 1743

** Soft Lepton Muon Tags: 291 **
** Soft Lepton Muon Tags (no pT cut): 309 **
** Soft Lepton Muon Tags (no rel iso cut): 293 **
** Soft Lepton Muon Tags (no deltaR cut): 291 **

Njets ≥ 1

One lepton 3023
1 jet 219
Isolated lepton 184
Delta(R) lepton 160
Dilepton veto 160
30 GeV +iso veto 160

** Soft Lepton Muon Tags: 10 **
** Soft Lepton Muon Tags (no pT cut): 10 **
** Soft Lepton Muon Tags (no rel iso cut): 10 **
** Soft Lepton Muon Tags (no deltaR cut): 10 **

Njets = 1

6% b-tag