First results on 7 TeV data on W+jets and QCD background to Tt cross section

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Introduction

Motivation

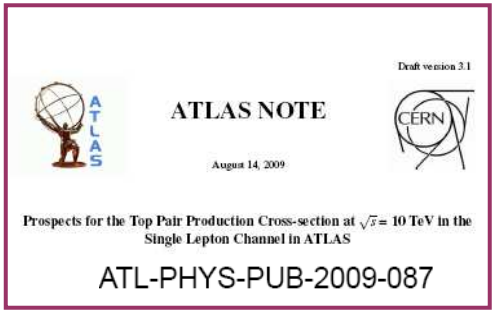
Which is our goal?
Give an estimation of W+jets background to top quark pair production in e+jets channel

- We have developed a technique based on W/Z ratio measurement:

$$W_{SR} = C_{MC} * W_{CR} * (Z->ee + Z->\mu\mu)_{SR} / (Z->ee + Z->\mu\mu)_{CR}$$

C_{MC} = coefficient estimated from Monte Carlo
CR = low jet multiplicity region: exactly one jet
SR = Tt selection cuts applied

- Results at 10 TeV reported in a note last summer
- Repeated the analysis with 7 TeV MC samples



- What we can do with first data?

- Start to look at W/Z ratio at low jet multiplicity.
- Study QCD background contamination to W+1jet CR (one of the main sources of uncertainty of the method).
  We use a matrix method based on the assumption that ETmiss shape is independent from lepton ID cuts :
  - select a sample with a loose electron: sample dominated by QCD ,
  - background is estimated from loose lepton rate scaled by defaultLeptons/looseLeptons ratio measured in low ETmiss region: 5 GeV < ETmiss < 10 GeV.

Outline

- ✓ What we have done so far with data? We have a look at:
  - ✓ electron cinematic variables,
  - ✓ ETmiss distribution in events with one electron,
  - ✓ jet cinematic variables,
  - ✓ first W(ev) candidates
  - ✓ electron pairs invariant mass distributions
- ✓ Monte Carlo studies to be done & technical issues

Some details

- Data samples:
  - data10_7TeV.00152166.physics_L1CaloEM
  - data10_7TeV.00152214.physics_L1CaloEM
  - data10_7TeV.00152221.physics_L1CaloEM
  - data10_7TeV.00152345.physics_L1CaloEM
  - data10_7TeV.00152409.physics_L1CaloEM
  - data10_7TeV.00152441.physics_L1CaloEM
  - data10_7TeV.00152508.physics_L1CaloEM
  - data10_7TeV.00152777.physics_L1CaloEM
  - data10_7TeV.00152845.physics_L1CaloEM

→ 267 μb^{-1}

- MC samples:
  - mc09_7TeV.105009.J0_pythia_jetjet.merge.AOD.e468_s624_s633_r1064_r1051_tid108144_00
  - mc09_7TeV.105010.J1_pythia_jetjet.merge.AOD.e468_s624_s633_r1064_r1051_tid108147_00
  - mc09_7TeV.105011.J2_pythia_jetjet.merge.AOD.e468_s624_s633_r1064_r1051_tid108146_00
  - mc09_7TeV.105012.J3_pythia_jetjet.merge.AOD.e468_s624_s633_r1064_r1051_tid108145_00
  - mc09_7TeV.105013.J4_pythia_jetjet.merge.AOD.e468_s624_s633_r1064_r1051_tid108143_00
  - mc09_7TeV.105802.JF17_pythia_jet_filter.merge.AOD.e505_s624_s633_r1114_r1113
  - mc09_7TeV.106043.PythiaWenu_no_filter.merge.AOD.e468_s624_s633_r1064_r1051
  - mc09_7TeV.106046.PythiaZee_no_filter.merge.AOD.e468_s624_s633_r1064_r1051

First results on data

Electrons in first data: cut flow

- Electron selection cuts (standard top group selection cuts except for p_T cut):
  - p_T > 10 GeV,
  - |η|<2.47 and no crack,
  - medium,
  - top group standard isolation cuts: 4 GeV + 0.023 p_T.

- Number of electrons after each cut
  - J0-J4 samples used,
  - Monte Carlo is normalized to data integrate luminosity.

Cuts	MC	$DATA$
All electrons	65000±1700	31500±200
$P_T > 10GeV$	4800±400	1690±40
Medium	1700±300	630±30
$eta < 2.47$	1700±300	630±30
Isolation	1200±200	460±20
no crack	1100±200	430±20

Big difference between data and Monte Carlo predictions: factor 2.

Different **trigger rate** between Monte Carlo and data, indeed:
- ✓ MC triggered events: 170638
- ✓ Data triggered events: 88709

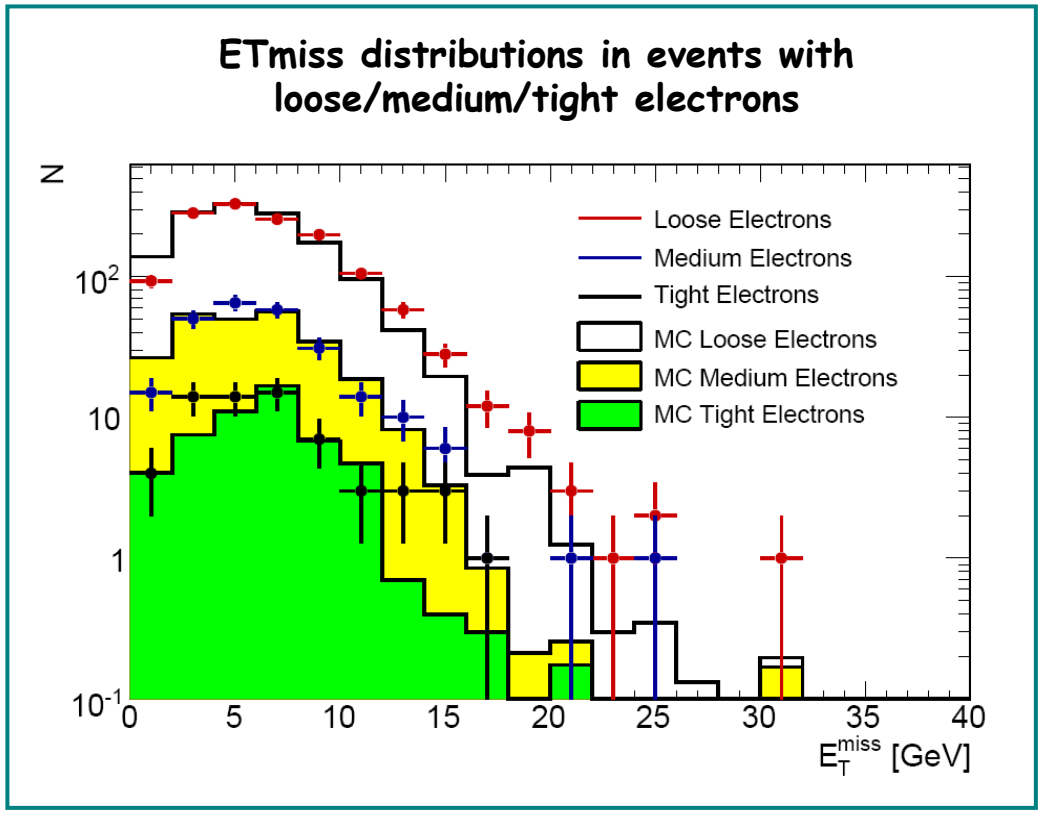
- Efficiency:

Cuts	Cut efficiency MC	Cut efficiency DATA
$P_T > 10GeV$	0.074±0.007	0.05±0.0013
Medium	0.36±0.06	0.37±0.017
$eta < 2.47$	1.±0.2	1.±0.06
Isolation	0.7±0.17	0.73±0.04
no crack	0.9±0.2	0.93±0.06

Similar efficiencies

ETmiss in events with an electron

- Event selection:
  - Trigger EM3_L1 passed,
  - one good offline electron:
    - $10 < p_T < 15$ GeV, → QCD sample!!
    - no cuts on isolation and η.

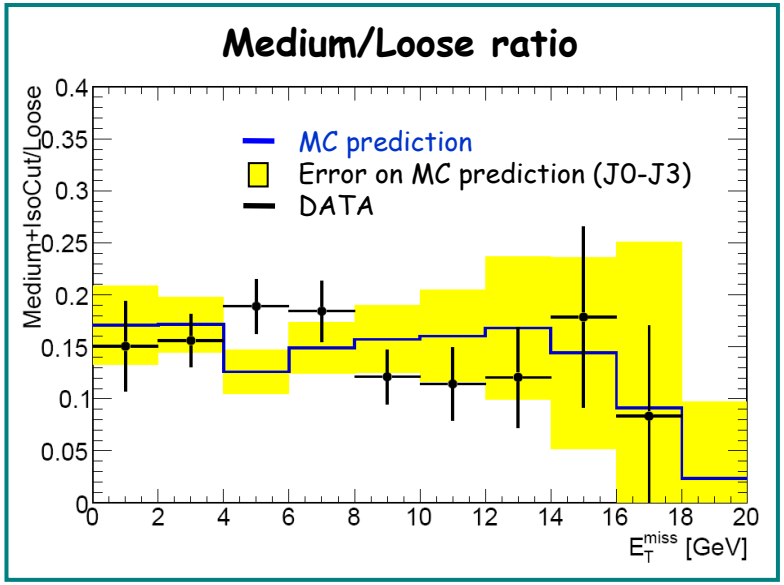


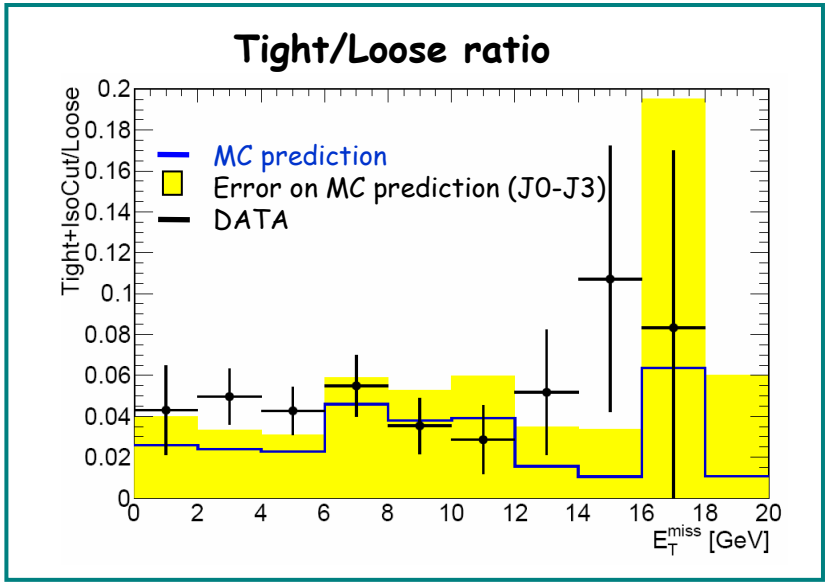
- Monte carlo distributions are normalized to data,
- the same MC normalization has been used for loose, medium and tight electrons.

Very good agreement between data and Monte Carlo both in shape and ratios!

Electron ratios as a function of ETmiss

- Event selection:
  - Trigger EM3_L1 passed,
  - one good offline electron:
    - $10 < p_T < 15$ GeV,
    - no cuts on η,
    - standard top isolation cu applied for medium and tight electrons.





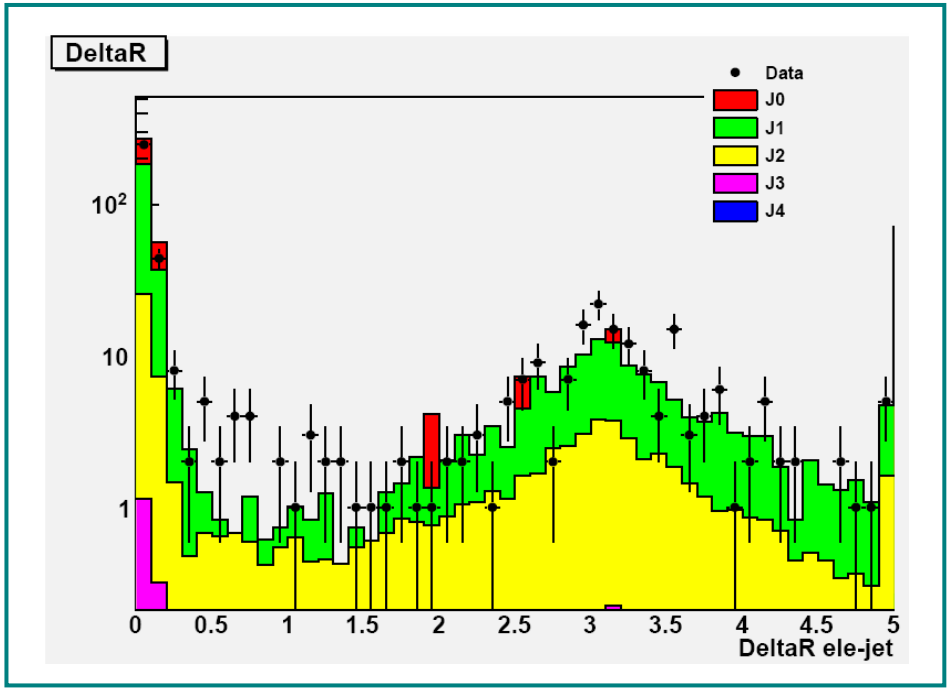
- Results and comparisons are limited by available J# statistics.
- Data ratios are flat within errors (wich are still big due to low statistics).

ΔR between electrons and jets

Need to check that overlp removal method developped on Monte Carlo samples can be applied to data.

Compare ΔR(e-jet) distributions for data and Monte Carlo .

- Plot done for events that pass EM3_L1 trigger and with at least one good electron.
- Good electrons selected asking:
  - p_T >10 GeV,
  - |η|<2.47 and no crack,
  - medium,
  - top standard isolation cut.
- Good jet selected asking:
  - |η|<2.5,
  - p_T >20 GeV.
- Monte Carlo distributions are normalized to data.

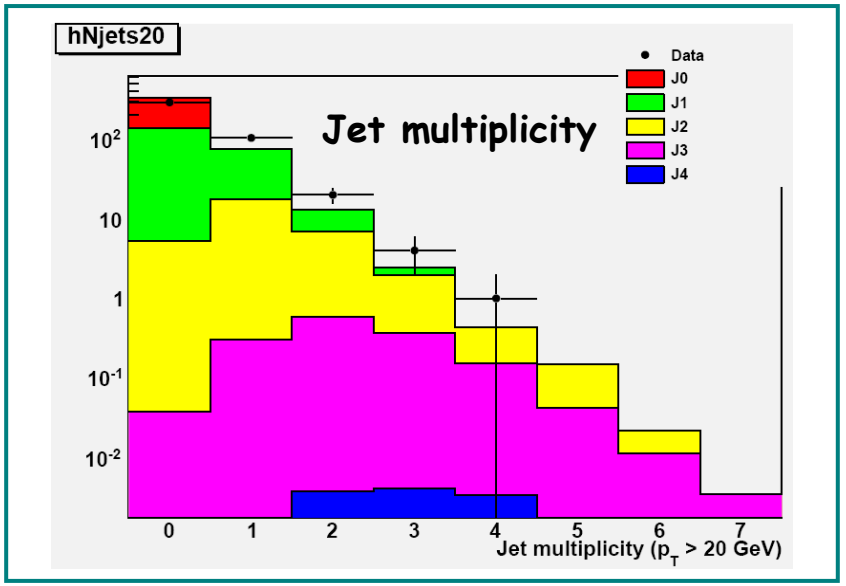


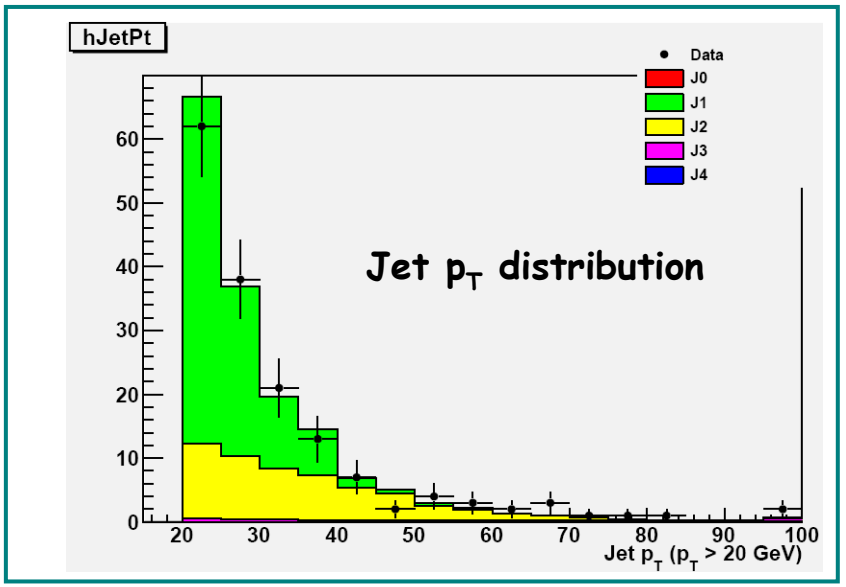
Quite good agreement, but still low statistics!

Jets after overlap removal

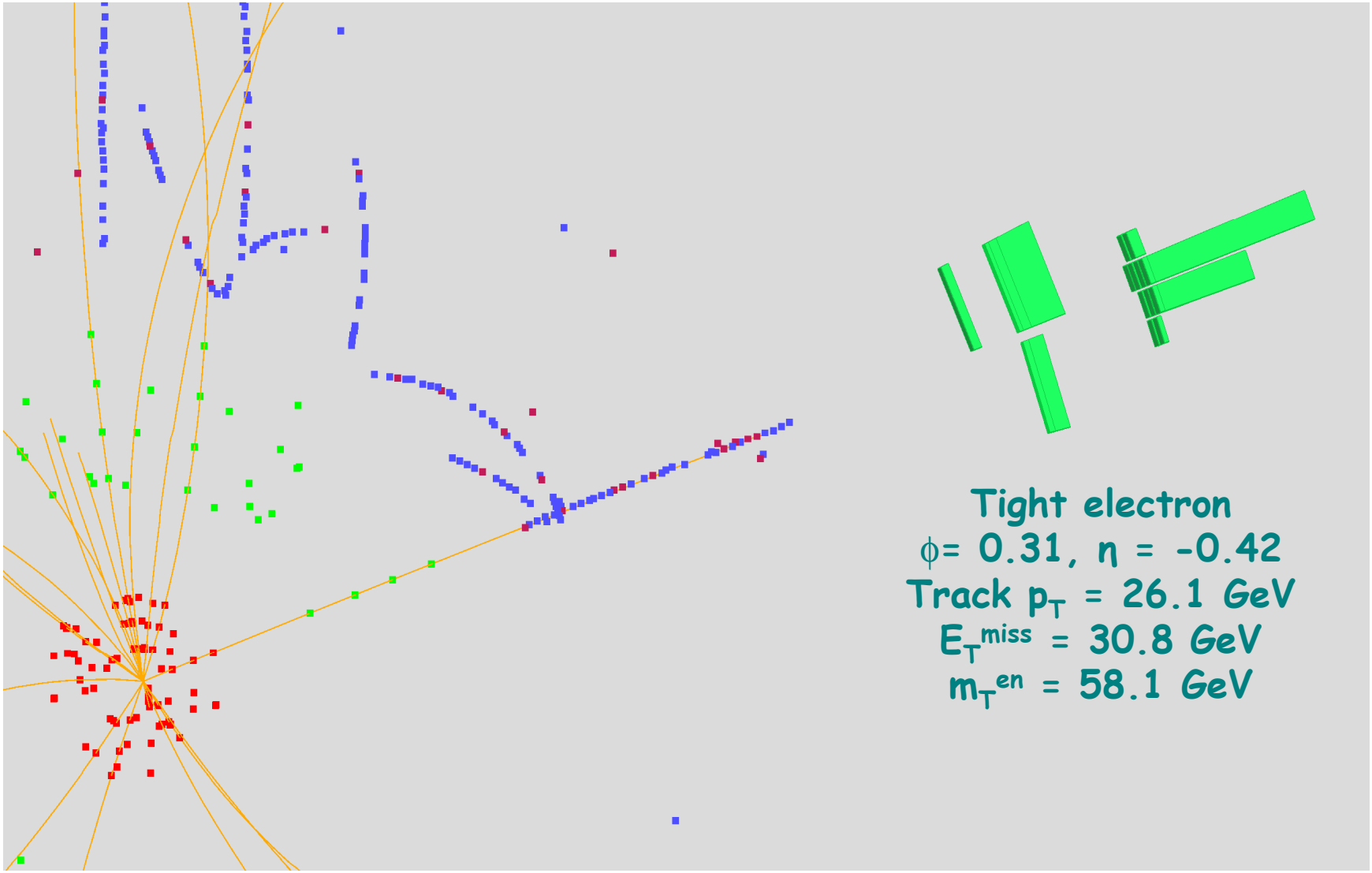
- Plot done for events that pass EM3_L1 trigger and with at least one good electron.
- Good electrons selected asking:
  - p_T >10 GeV,
  - |η|<2.47 and no crack,
  - medium,
  - top standard isolation cut.
- Good jet selected asking:
  - |η|<2.5,
  - p_T >20 GeV,
  - DeltaR(ele-jet)>0.4.
- Monte Carlo distributions are normalized to data.

Quite good agreement, but still low statistics!





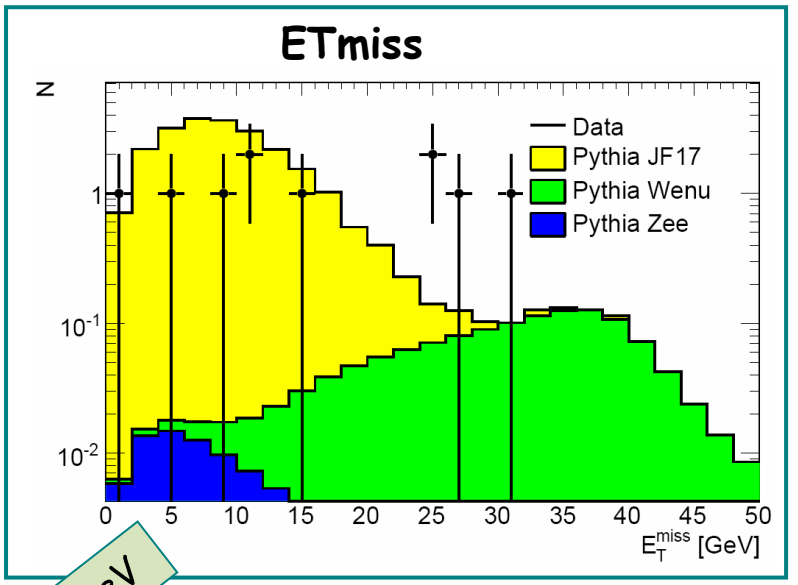
W(ev) candidates: event 5966801



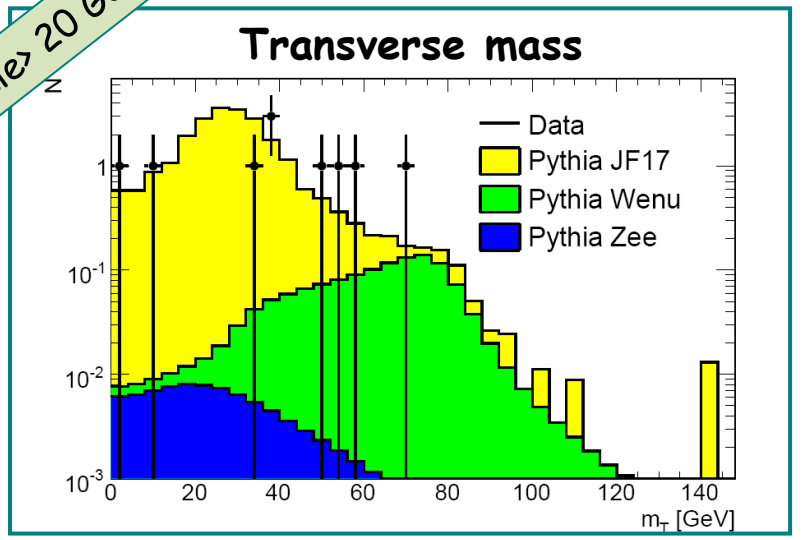
Tight electron
ϕ= 0.31, η = -0.42
Track p_T = 26.1 GeV
E_T^{miss} = 30.8 GeV
m_T^{en} = 58.1 GeV

W (ev) candidates: 4!?

- **Run Number 152441 , event 3455894**
  - 1 medium ele (not tight: no b-layer hit, softele opposite charge nearby)
    - p_T, η, φ = (28.73 GeV, 1.58, -0.597)
    - etiso20 = 1.96 GeV
  - etmiss = 24.47 GeV, ETmiss φ = 2.6440137
  - MT(ele,ETmiss) = 53.0 GeV
  - 3 jets after jet-ele overlap removal:
    - p_T, η, φ = (35.08 GeV, 1.18, -3.06), n90 = 184 FCor = 0.0003
    - p_T, η, φ = (30.93 GeV, -0.819, -0.879), n90 = 86 FCor = -0.0002
    - p_T, η, φ = (12.43 GeV, -0.120, 1.682) n90 = 60 FCor = 0
- **Run Number 152441, event 6583857**
  - 1 medium ele (not tight: no b-layer hit, bad calo cell nearby),
    - p_T, η, φ = (44.33 GeV, -2.02, 2.040)
    - etiso20 = 2.66 GeV
  - ETmiss = 26.62 GeV, ETmiss φ = -1.205289
  - MT(ele,ETmiss) = 68.7 GeV
  - 1 jet after jet-ele overlap removal:
    p_T, η, φ = (31.99 GeV, -1.92, -0.95) n90 =143, FCor=0
- **Run Number 152777, event number 3276028**
  - 1 tight electron
    - p_T, η, φ = (22.7 GeV, -0.64, -2.5)
    - etiso20 = 0.344551 GeV
  - ETmiss = 36.8918, ETmiss φ = 0.0326501
  - MT = 55.2804 GeV



p_T ele> 20 GeV



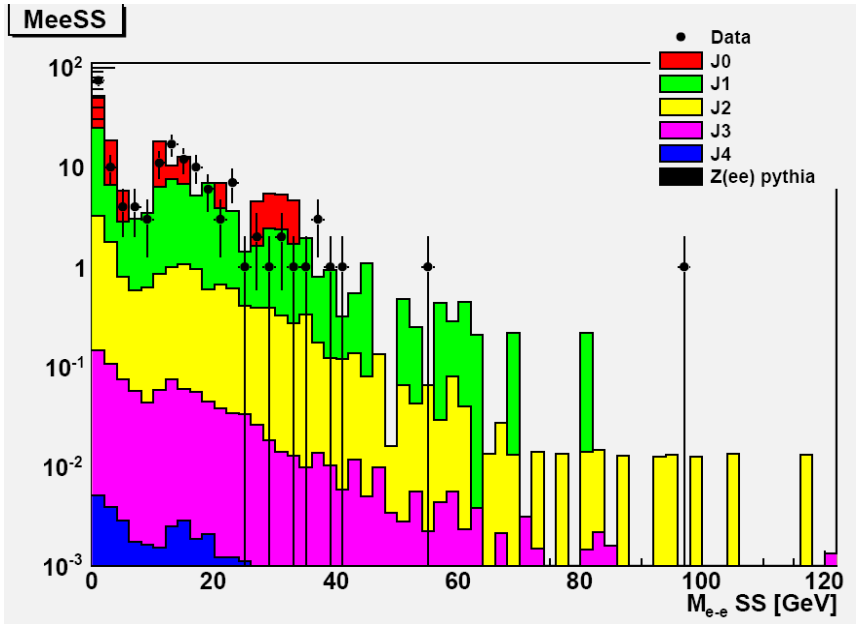
Electrons in first data: conversions

- Too many W (ev) candidates: 2 of them have medium electrons failing b-layer requirement cut.
- Problem:
  in release 15 electrons coming from conversions are saved in electron container!
- We want to select electrons that are not coming from conversions.
- Idea: reject all the electrons that have a match with a photon:
  $\Delta R(e\text{- photon}) > 0.05$.
- Very preliminary studies, but:

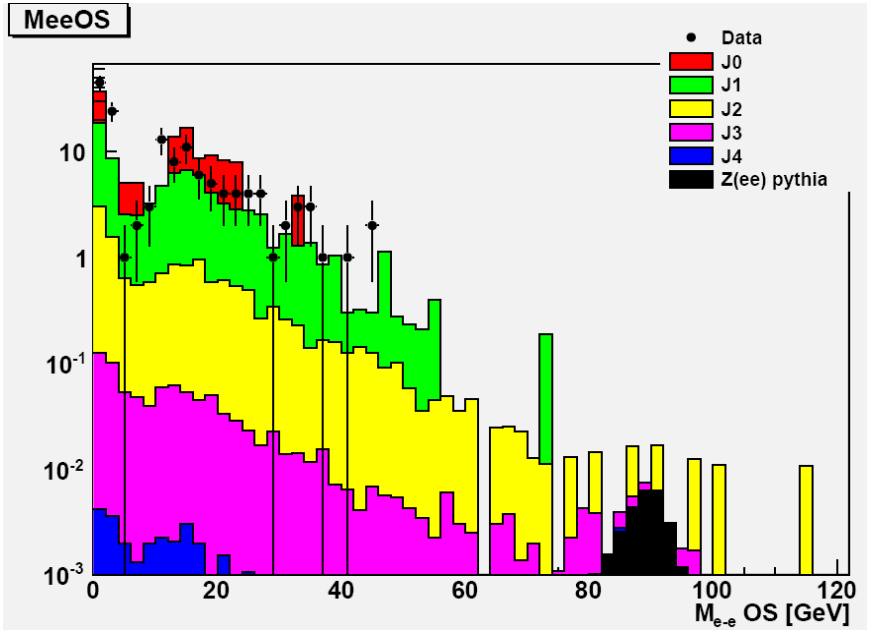
Event 6583857 is rejected!

Looking for Z events

Invariant mass of electron pairs same sign



Invariant mass of electron pairs opposite sign



- Plots done for events passing trigger EM3_L1 and exactely 2 good electrons.
- Good electrons selected asking:
  - p_T >5 GeV,
  - $|\eta|$<2.47 and no crack,
  - loose.
- Monte Carlo distributions are normalized to data.

→ **No Z candidate found: $\sigma_Z = 1/10*\sigma_W$ indeed!**

MC studies to be done and technical issues

Work to be done on Monte Carlo I

- Study of W/Z ratio:
  - Comparison between Alpgen and Sherpa: some discrepancies found.
    See:
    http://indico.cern.ch/contributionDisplay.py?contribId=5&confId=80549
    Work in progress: try to figure out where they come from.
  - Study Alpgen samples with varying parameters: waiting for datasets production.

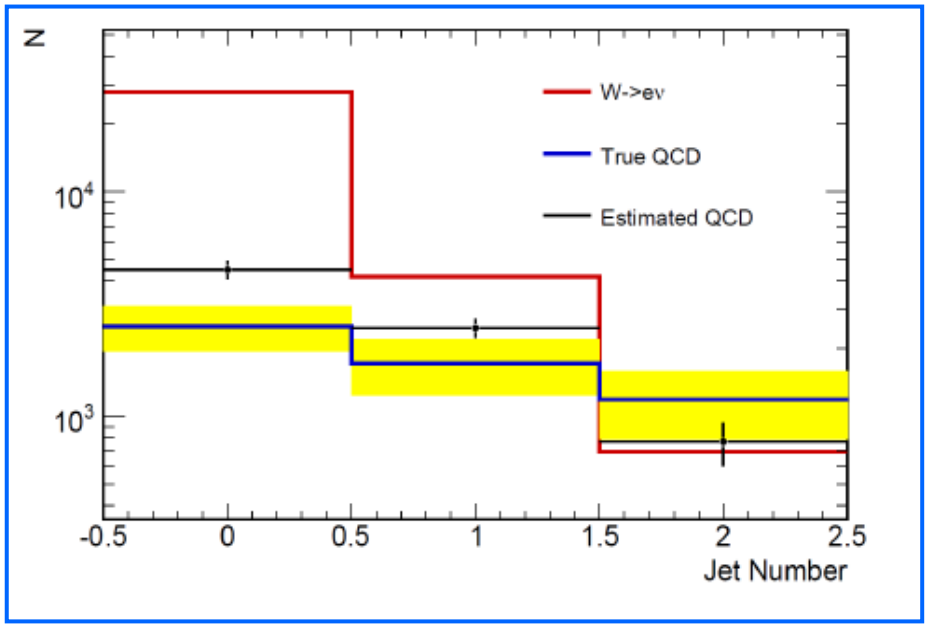
- Estimation of other background to W(enu)+1jet sample:
  - W (τν)
  - Z (ττ)
  - Z (ee)
  - Tt

Work to be done on Monte Carlo II

- On QCD background estimation:
  - Our technique for the measurement of the QCD background to W+Njets selection is based on the tight/loose rate being independent of missing energy.
  - This is unfortunately not very accurate according to 7 TeV Montecarlo (JF17),

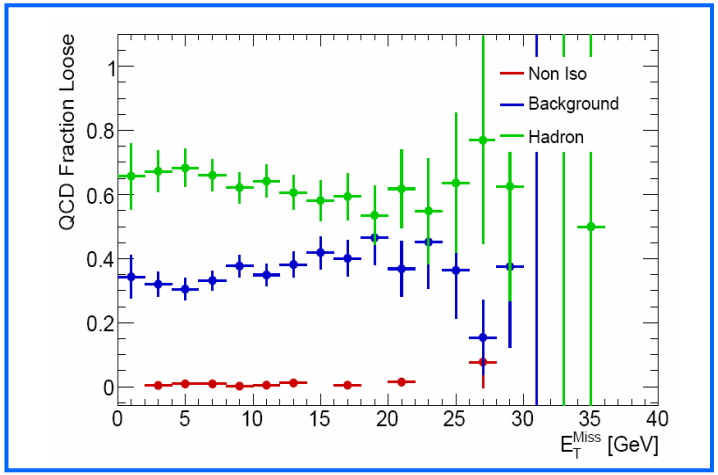
    ↓

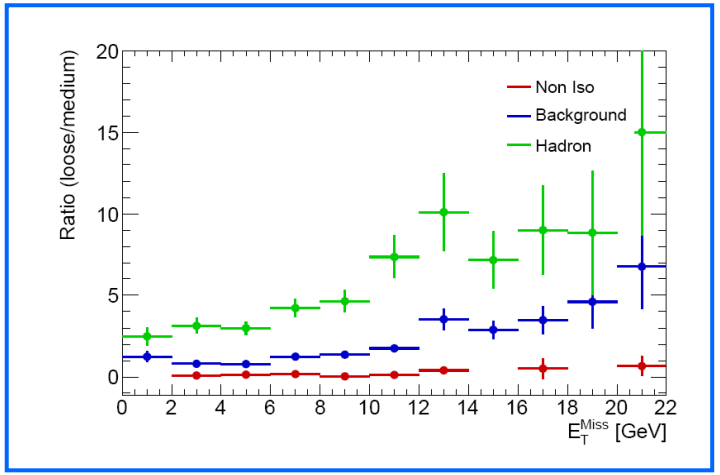
    overestimation of background.
  - This **needs to be understood and improved** if we want to measure W rate, especially in 0-jet bin (1jet and 2jet rates might be estimated accurately enough) !



Work to be done on Monte Carlo III

- On QCD background estimation II:
  - The composition of control sample (left) has a small variation with ETmiss.
  - Even for a given component, the ratio is correlated with ETmiss (right).





We are investigating possible solutions, this is highest priority for QCD background estimation work:

- Additional control samples can be used to measure tight/loose ratio for QCD even at high ETmiss (lower pt electrons, ETmiss aligned with electron, ETmiss aligned with jet)

We are looking into this!!

AOB

- Involved in the preparation of a note on W+jets background estimation from data:
  - first draft: one month.
- Involved in top group note on QCD background estimation:
  - first draft: one month.
- Technical work to do in order to interface our private code with top group standard code.