ttbar and W+jet Background Estimate for Hadronic SUSY Searches @ CMS

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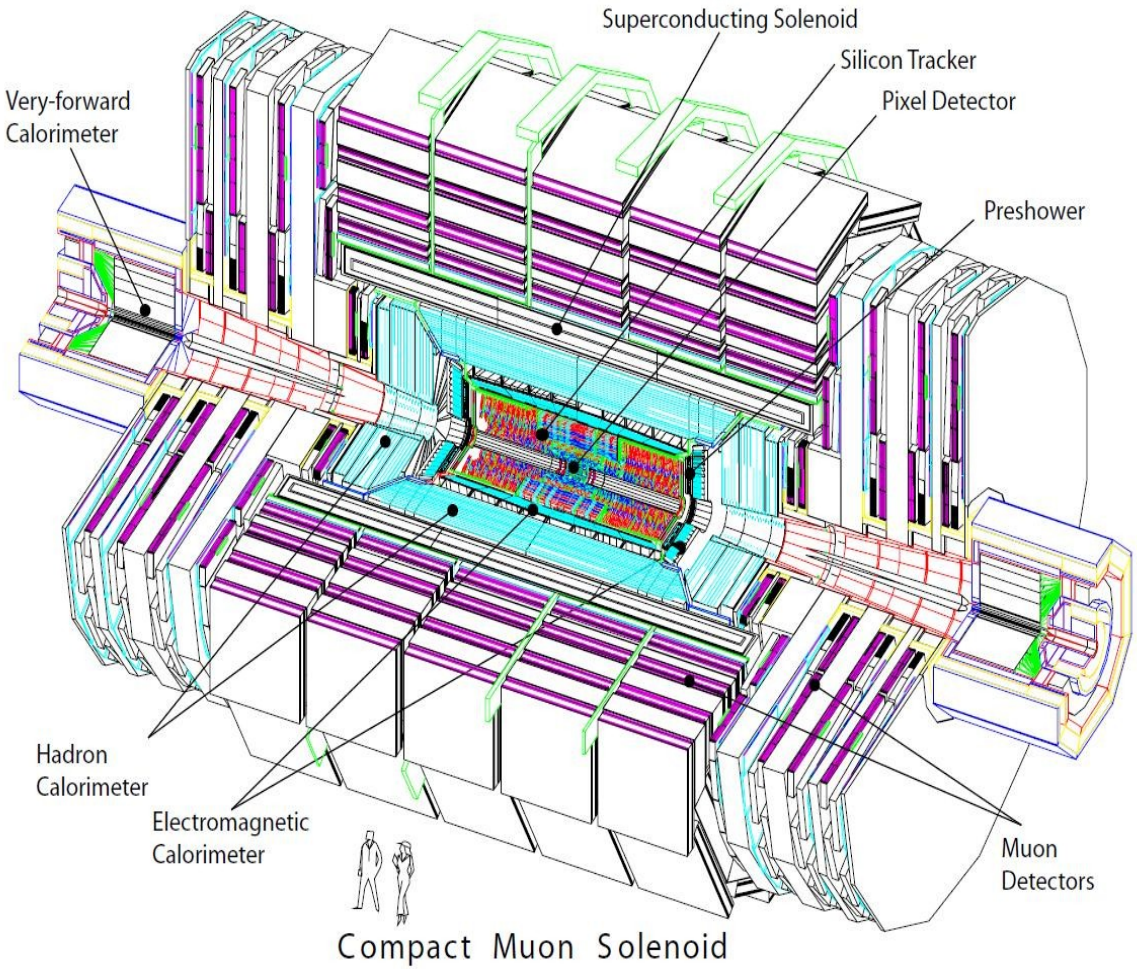
Outline

- Short introduction to LHC, CMS and Supersymmetry
- Standard model backgrounds for hadronic SUSY searches
- Description of data-driven background estimation method
- Closure test
- Summary

LHC and CMS



Some basic facts:

LHC:

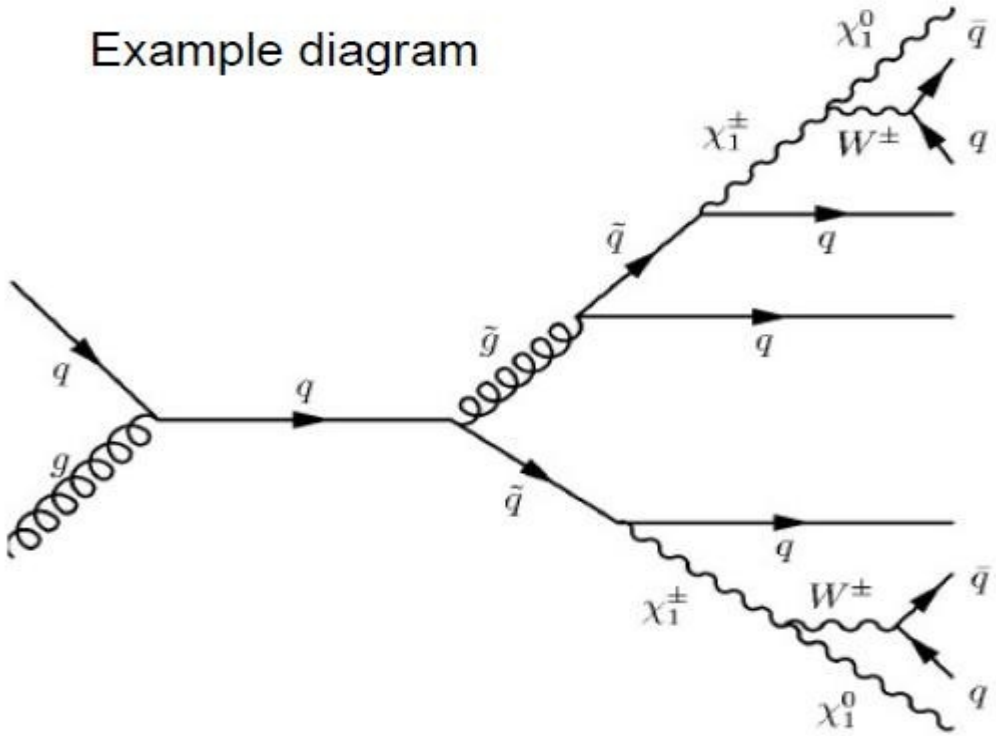
- pp-accelerator
- $\sqrt{s}$ = 14 TeV (design)
  = 7 TeV this year
  = 2.3 TeV last year

CMS:

- Multi-purpose-detector
- Large (3.8 T) magnetic field
- Weight = 12500 T
- Length = 21m
- Width = 18m

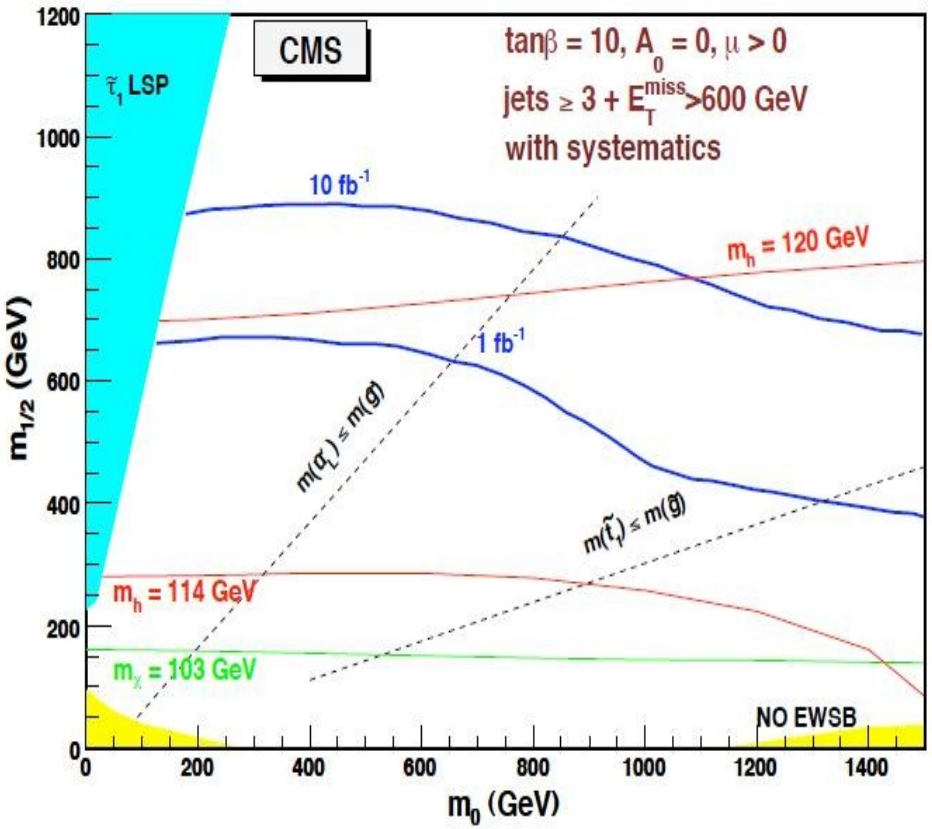
Supersymmetry

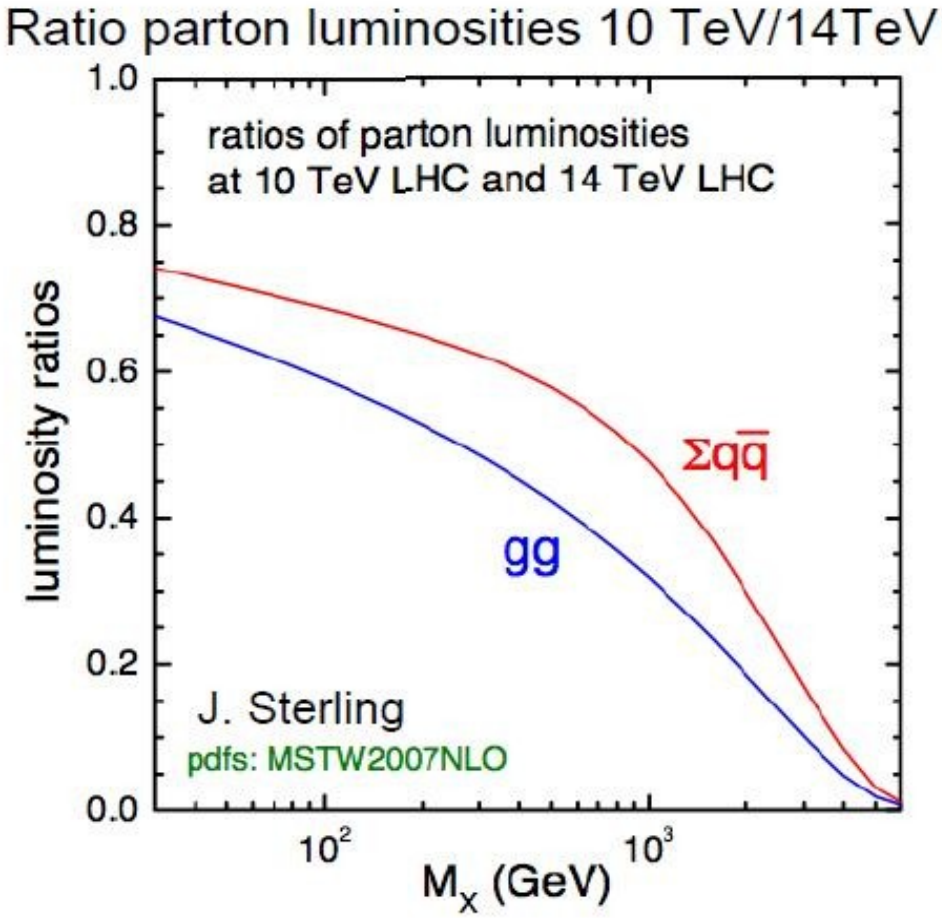
- Supersymmetry (SUSY) is a symmetry between bosons and fermions
- It solves many problems of the standard model (e.g. hierarchy problem
- It provides a dark matter candidate (lightest SUSY particle (LSP))



- R-parity conservation
  - → pair/associated SUSY production
  - → stable LSP
- Cascade decay of primary produced SUSY particles
  - → Missing E_T
  - → many Jets
  - → possibly leptons

Reach for 10 TeV is reduced



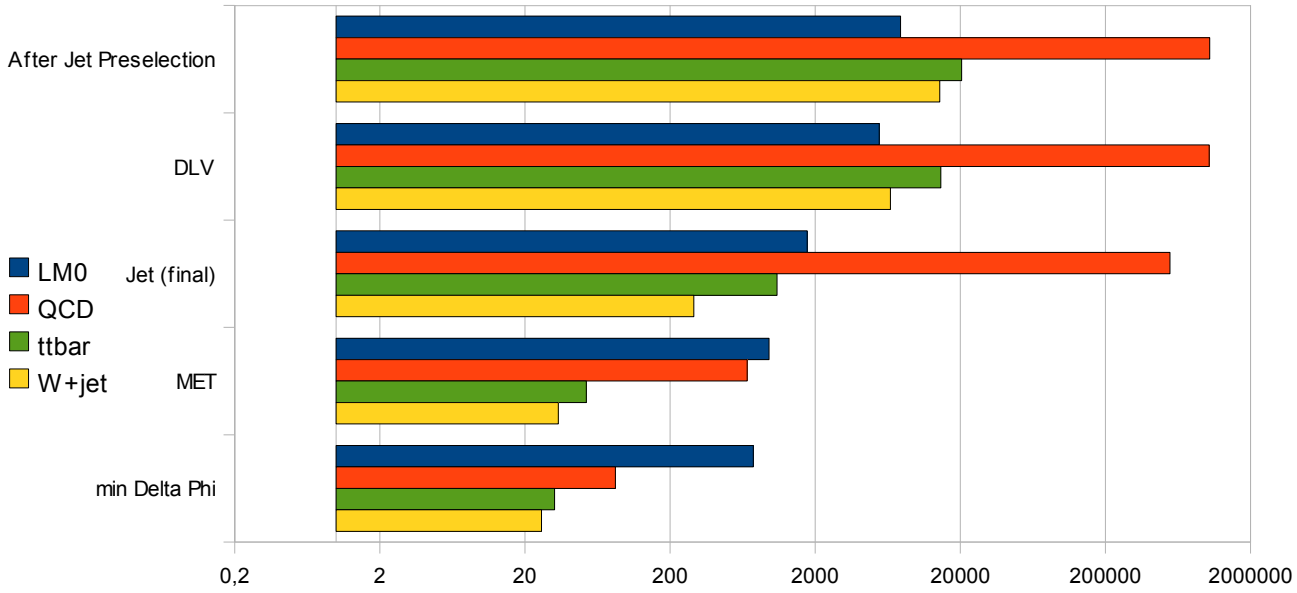


- With ~ 10 pb^{-1} reach beyond Tevatron limits (14 TeV)
- The inclusive search has the best reach for mSUGRA

Supersymmetry @ CMS

For the inclusive Njet SUSY search following cuts are applied:

P_T (Jet1) > 180 GeV, P_T (Jet2) > 150 GeV, P_T (Jet3) > 50 GeV
missing E_T > 150 GeV
min Delta (Jet1/2/3, missing E_T) > 0.3
Direct Lepton Veto (= no isolated lepton allowed)



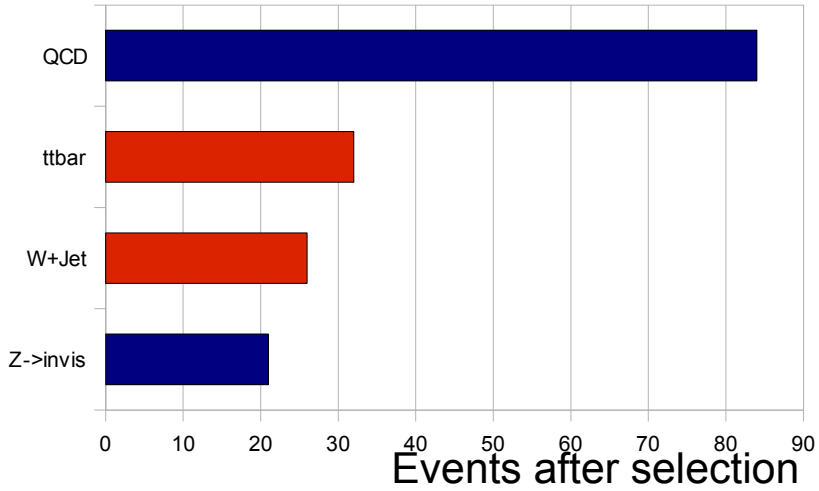
Log scale!

Events (100 pb^{-1})

Direct Lepton Veto (DLV) mainly rejects leptonic ttbar and W+jet events

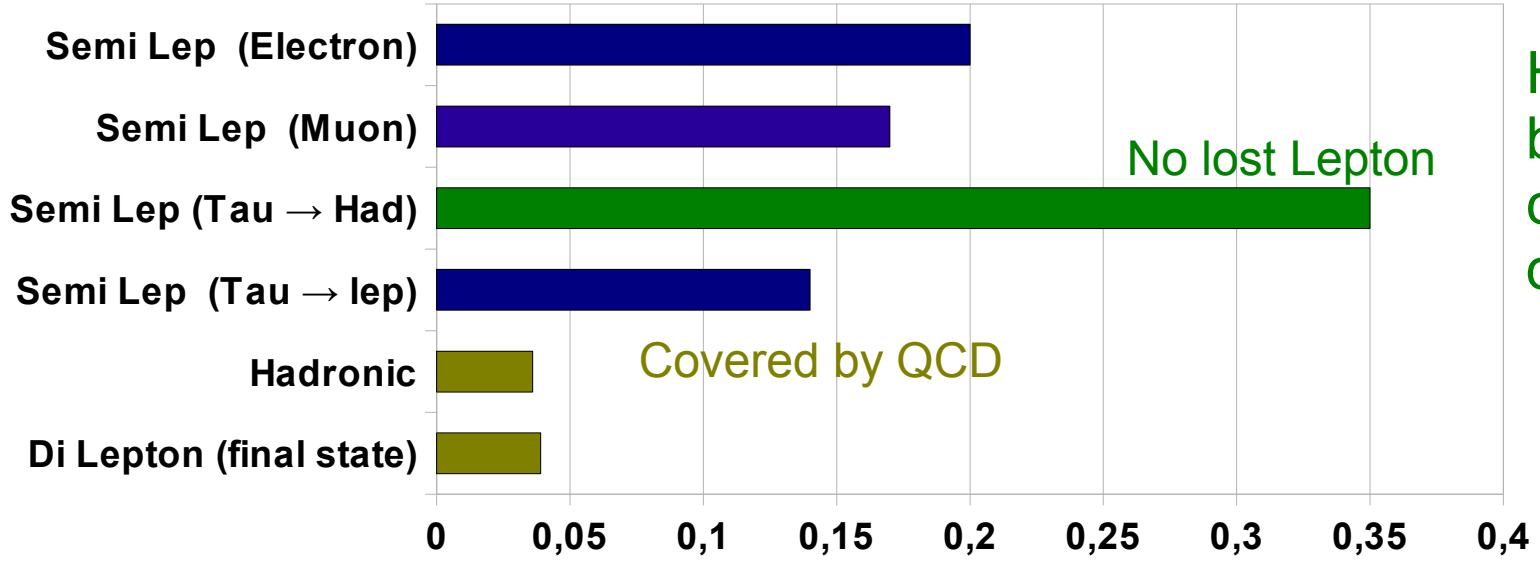
Background Properties

Background estimates should be data driven as simulations have large uncertainties – especially with early data



- ttbar and W+jet events have real missing E_T in leptonic channel
- This lepton is not identified
- It is difficult to seperate ttbar and W+jet events completely

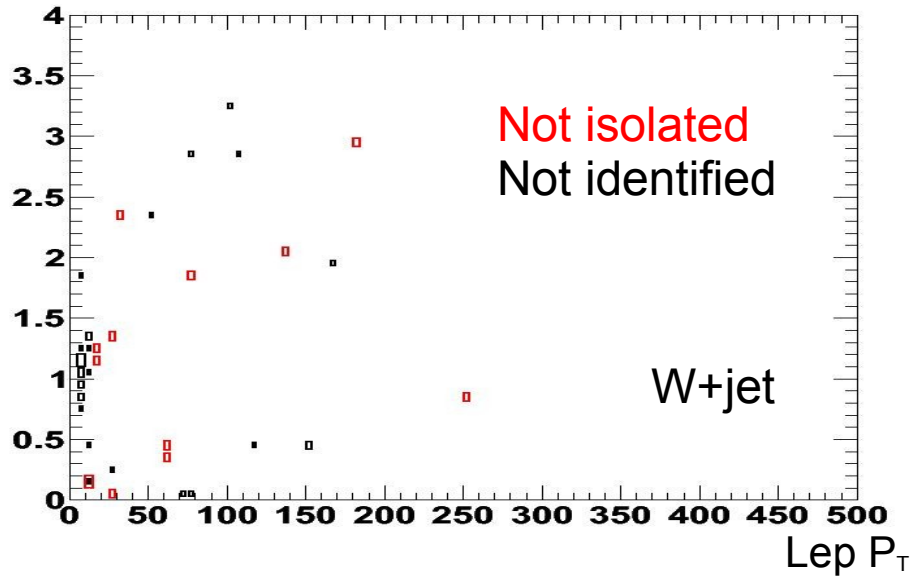
→ **Combine ttbar and W+jet**

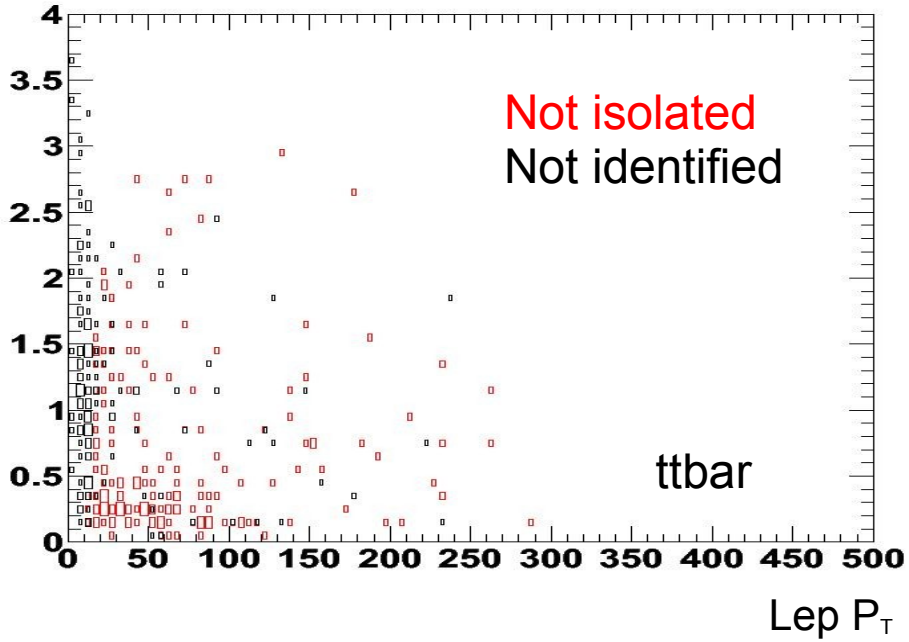


Hadronic tau background is cared for by a different approach

Background Properties

DR(lep,jet)





Problem:

Different topology in ttbar and W+jet events:

- Boosted top emits W (and therefore lepton) and b close to each other

→ Closest jet is in most cases the associated b-jet

→ Isolation efficiency lower for ttbar events

→ Efficiency in bins of ΔR

- In very hard pp-collisions more W^+ produced
- W polarization

→ More low P_T leptons in high missing E_T events

→ Increases syst. uncertainty

Idea of DLV-Cut Inversion

Direct **L**epton **V**eto: no lepton in event with:
P_T > 15, rel isolation < 0.1 (muon) / 0.5 (electron), passed quality cuts

	In acceptance	Out of acceptance
Isolated	Background C	Control Sample
Not Isolated	Background B	Background A (most important)

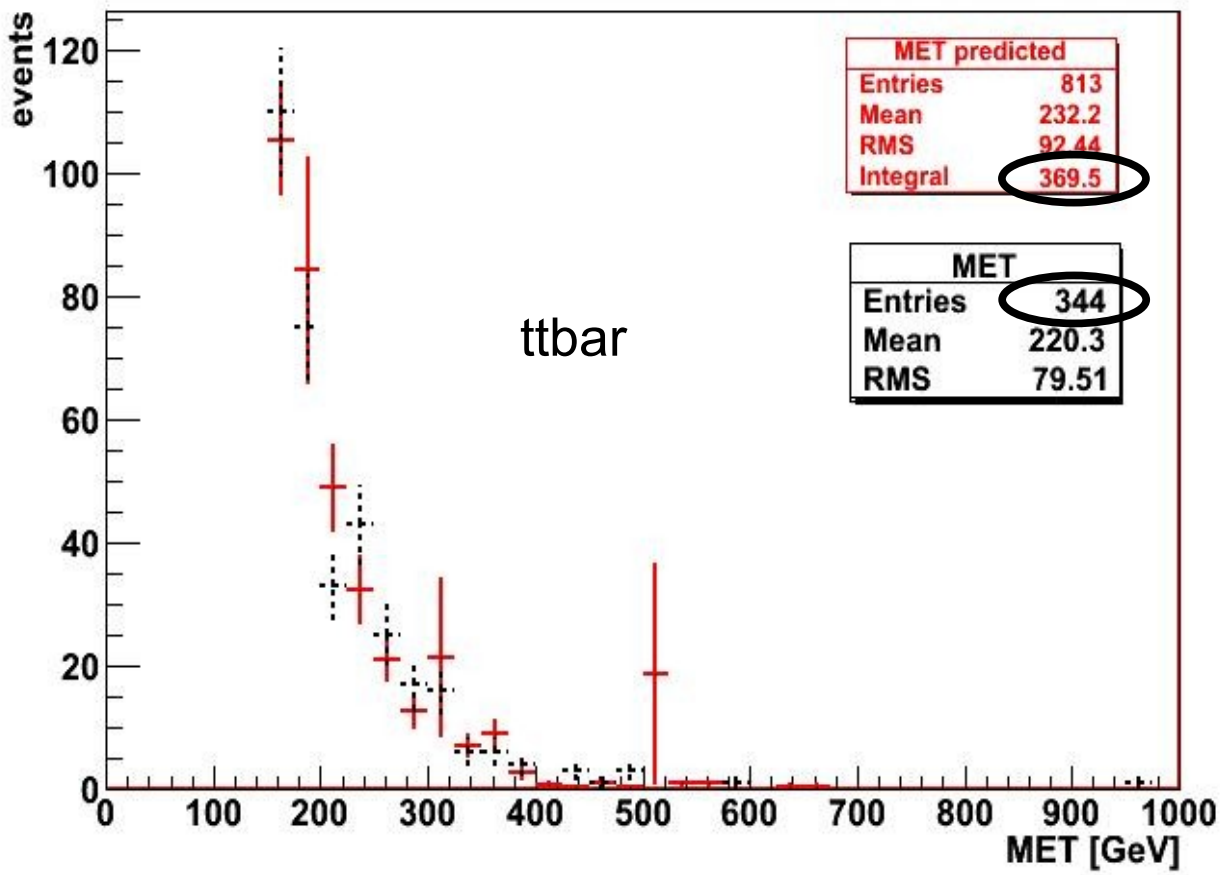
A = Control * (1 - Iso Eff)/Iso Eff
B = A * acceptance Ratio
C = Control * acceptance Ratio
Total Background: A + B + C
(corrected with RECO Eff)

Reconstruction efficiencies as a function of P_T are found from tag and probe method $Z \rightarrow \mu\,\mu$

Isolation efficiencies as a function of DR and P_T from tool similar to tag and probe method usable on ttbar & W+Jet. Plan to move to $Z \rightarrow \mu\,\mu$

P_T distribution and ratio of ttbar to W+jet from simulation as these information are quite reliable

Closure Test



- Work in progress. Result preliminary!
- Shape and predicted number of events agree within uncertainties
- Statistical uncertainties quite large as some events enter the prediction with large weights

Summary

- For a large part of the parameter space the inclusive search with no leptons yields the highest significance of signal vs. background
- A precise data-driven estimate for all standard model backgrounds is crucial for a discovery or exclusion limit
- W+jet and ttbar background are estimated together
- Closure test gives promising results
- A combination of all background predictions with a combined analysis of the uncertainties is in preparation