

WW  
Study of the 0 jet bin in  
Dilepton + MET

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This talk was given at the EWK meeting during  
CMS week.

# Goal of Exercise

Study  $WW \rightarrow l\nu l\nu$  in 0-jet bin in the context of a more general study of the Dilepton & MET & N-jets final state.

*No attempt is made at optimizing any cuts.* The goal is to learn about the detector and reconstruction software rather than pretending to do a realistic analysis.

Everything based on 1\_5\_x MC.

# Analysis Strategy & Outline of talk

- Define a common base selection for several analyses.
- Specialize from there for each analysis separately.
  - ttbar analysis presented at top group Feb. 19th 2008.
  - WW analysis presented at EWK group today.
- Focus Today on 0-jet bin only:
  - Brief look at lowering pT cut 20/20 -> 20/10
    - Stick to 20/20 for now because of prohibitive bkg from electron fakes.
  - Additional suppression of DY -> tautau -> emu & MET
  - Additional suppression of DY for same flavor
- Conclusions

# Standard Model Contributions to Dilepton & MET & 0-jets

**Categorize dilepton + MET + 0-jets in two categories:**

## ***. Irreducible***

- . WW  $\rightarrow$  (ee || mumu || emu) && MET
- . ZZ  $\rightarrow$  (ee || mumu) && MET
- . Drell-Yan  $\rightarrow$  tautau  $\rightarrow$  (ee || mumu || emu) && MET

## ***. Reducible***

- . Drell-Yan : Reduced by MET (& jet veto) & Z-veto for same flavor
- . ttbar: Reduced by jet veto
- . W + Jets : Reduced by lepton ID & isolation.
- . WZ: Reduced by Z-veto
- . ZZ  $\rightarrow$  4l : Reduced by Z-veto

***Understanding reducible backgrounds guides work in POGs.***

# Overview of Base Selection

## For electrons:

- .tight from ElectronIDAlgos/src/CutBasedElectronID.cc
- .  $\text{abs}(d_0) < 0.025\text{cm}$  (to suppress conversions)  
(<http://indico.cern.ch/contributionDisplay.py?contribId=2&confId=26395>)
- . Veto electrons if within  $dR < 0.1$  of a muon.
  - . To cut out muon+FSR from  $DY \rightarrow \mu\mu$  where FSR conversion gives electron.
- . Require Isolation

# Overview of Base Selection

**For muons:** (<http://indico.cern.ch/contributionDisplay.py?contribId=5&confId=20377>)

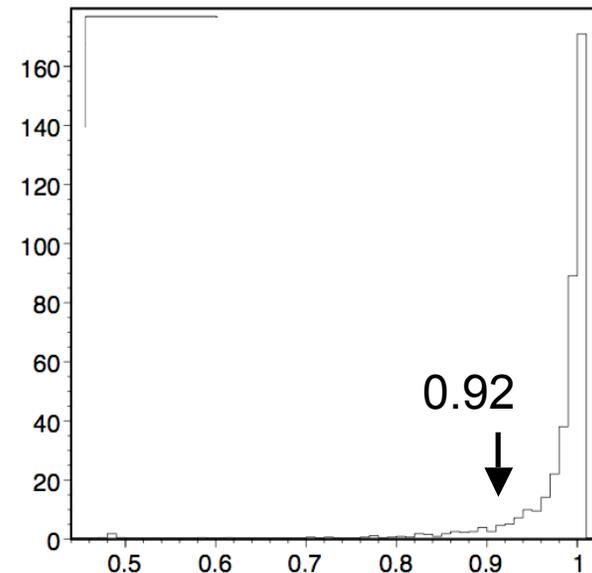
- . More than 6 valid tracker hits.
- .  $\text{abs}(d_0) < 0.25 \text{ cm}$
- .  $\text{Chi}^2/\text{NDOF}$  for global fit  $< 5.0$
- . Require Isolation

# Overview of Base Selection

## For Isolation:

- . Isolated ==  $p_T / (p_T + \text{SumEt}) > 0.92$
- .  $p_T$  is the  $p_T$  of the lepton
- .  $\text{SumEt}$  = sum of  $p_T$  (or  $\text{ET}$ ) within cone of  $dR < 0.3$ .
- . Electrons: use sum  $p_T$  of tracks above  $1.8\text{GeV}$ .
- . Muons: use in addition  $\text{ECAL}$  and  $\text{HCAL ET}$ .

Isolation for muons in  
WW for base selection.  
~9% efficiency loss

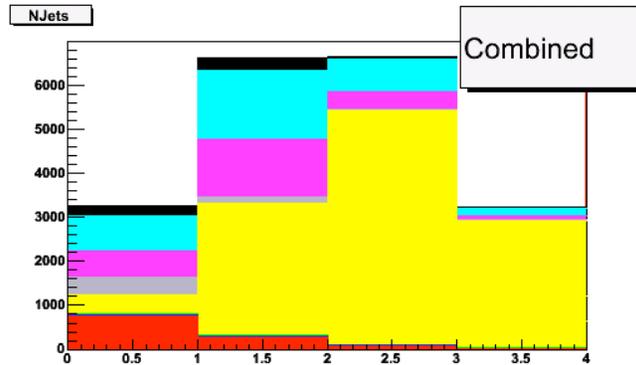
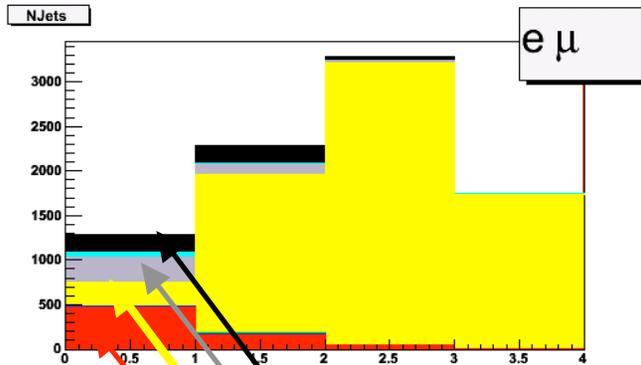
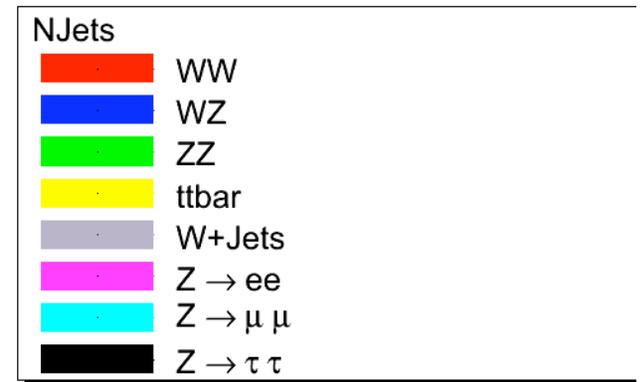
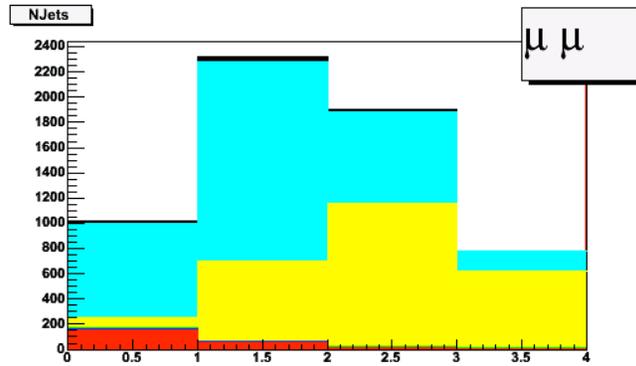
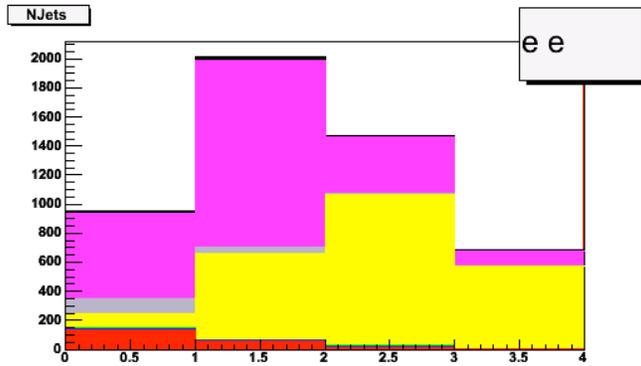


# Overview of Base Selection

## For the Event:

- Two opposite sign leptons with  $p_T > 20 \text{ GeV}$
- $MET > 20(30) \text{ GeV}$  for  $emu (ee || mumu)$ 
  - MET corrected for muons if part of di-lepton hypothesis
- $MET/P_T(\text{dilep}) > 0.6$  OR  $|\pi - \Delta\Phi(\text{MET-dilep})| > 0.25 \text{ rad}$  for  $(ee || mumu)$  only
- Z-veto  $[76\text{GeV}; 106\text{GeV}]$  for  $(ee || mumu)$
- trilepton Z-veto with no isolation requirement on 3rd lepton
- 0 jets (Jets have  $ET > 15$  and  $|\eta| < 3.0$ )
  - Uncorrected jets

# Njet Distribution after base selection



Normalized to 1fb<sup>-1</sup>

DYtautau  
wjets  
ttbar  
WW

**Conclusions thus far:**

- Treat emu separately from (ee || mumu).
- Emu
  - Eliminate DY -> tautau
  - Study lepton fakes in W+jets
- Same flavor
  - DY suppression

# Yields Normalized to 1fb-1 after base selection in 0-jet bin.

	WW	DYee	DYmm	DYtt	ttbar	Wjets	WZ	ZZ
mumu	160	0	870	19	78	4	9	6
ee	140	680	0	16	95	110	5	6
emu	470	2	60	240	270	280	18	1
Total	770	682	930	275	443	394	32	13

***Large bkg from DY, ttbar, and Wjets at this point !***

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Total	770	682	930	275	443	394	32	13

***Let's start with emu, as that's closer to where we need to be.***

**1st: Are there any gains in lowering pT cut to 20/10 ?**

**2nd: How do we address DY->tautau ?**

**3rd: What's going on in W+jets ?**

**We'll punt for now on addressing the ttbar.**

**Work on improving jet counting just starting.**

# Lowering pT to 20/10 in emu

emu	WW	DYee	DYmm	DYtt	ttbar	Wjets	WZ	ZZ
20/20	470	2	60	240	270	280	18	1
20/10	600	7	160	1200	330	780	30	4

**30% increase for WW**

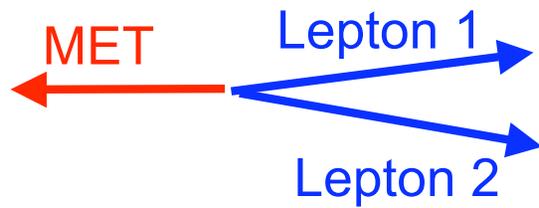
**x5 increase  
in DYtautau**

**~x3 increase  
in Wjets**

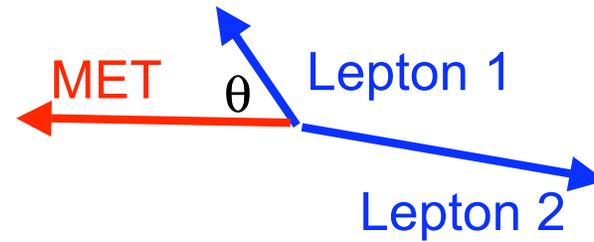
**Let's focus on DYtautau first as that's easier to eliminate.**

# "Projected MET" (pMET) for DY $\rightarrow$ tautau

If (lepton is in same hemisphere as MET) **then** cut on MET transverse to lepton.  
**Else** cut on MET.



**Use normal MET**



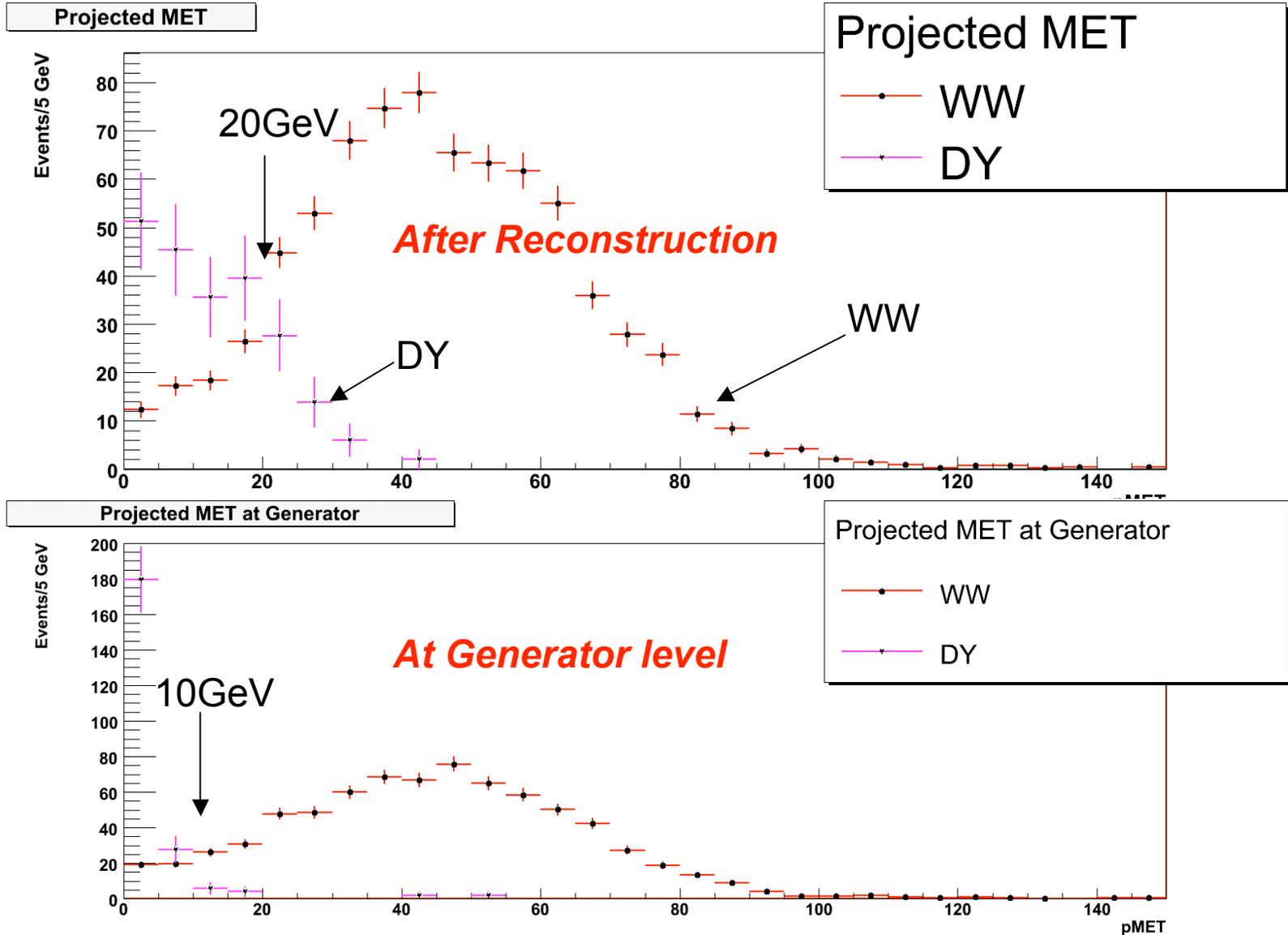
**Use MET x Sin( $\theta$ )**

This variable was used in CDF WW, H  $\rightarrow$  WW, ZZ  $\rightarrow$   $l\nu\nu$  analyses to suppress:

- . DY  $\rightarrow$  tautau
- . Fake MET due to tails in lepton resolution function.
- . Fake MET due to tails in jet resolution function
  - . CDF allowed 0 or 1 jet for these analyses.

***Z  $\rightarrow$  tau tau  $\rightarrow$   $l\nu\nu$   $l\nu\nu$  has two back to back tau's in  $R-\phi$  .  
Neutrinos tend to be aligned with leptons because  $m_\tau \ll m_Z$  .***

# Eliminating DY->tautau for pT 20/10



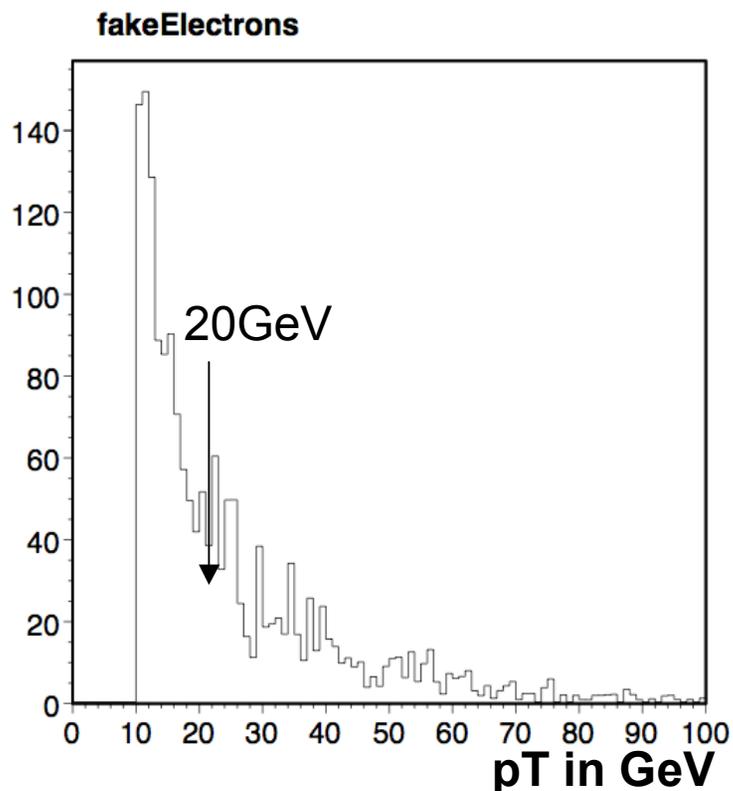
**A cut at 20GeV was chosen for now.**

**This reduces WW by 15% and DY -> tau tau by x10.**

# Fake Electrons in W+Jets

Require base selection && geometric matching for lepton from W.

Plot pT of 2nd lepton. **90% of lepton fakes are fake electron candidates.**



## Origin of electron fakes:

e from HF	Photon	Hadron
12%	37%	51%

Disclaimer:

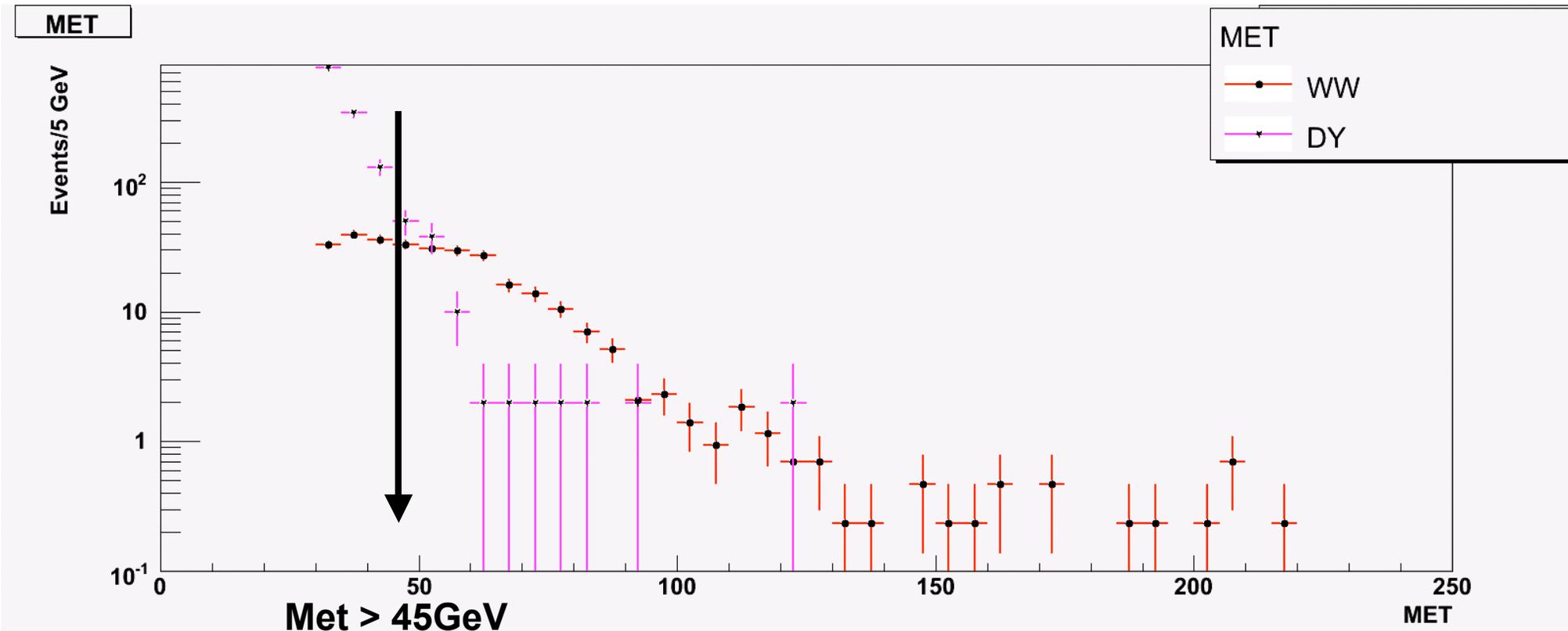
W+jets Alpgen sample does not contain correct HF fraction.

***For now, we eliminate all lepton candidates below 20GeV.***

Ongoing work on e reco, ID and isolation improvements.

# DY in (ee || mumu)

Back to pT 20/20



This MET cut was picked pretty much arbitrarily.

***As promised, this analysis is in no way shape or form optimized !!!***

# Summary of Cuts

- Base Selection
  - Leptons  $p_T$ : 20/20 (gave up on 20/10, for now)
  - 0-jet bin
  - ...
- $p_{MET} > 20\text{GeV}$ 
  - to suppress  $DY \rightarrow \tau\tau$ , especially in  $e\mu$
- If same flavor then require  $MET > 45\text{GeV}$ 
  - to suppress the rest of  $DY$ .

# Yields for 1fb-1 in 0-jet bin after all cuts.

	WW	DYee	DYmm	DYtt	ttbar	Wjets	WZ	ZZ
mumu	99	0	77	0	58	2	6	4
ee	84	34	0	0	72	51	4	4
emu	410	2	42	52	230	230	15	1
Total	590	36	120	52	360	283	25	9

**Conclusion:** **We need better e reco, Id and isolation.**  
**We need better jet counting.**

# Njet distribution after all cuts, except Njet==0.

