

$Z \rightarrow e^+e^-, \mu^+\mu^-$ Cross Section

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Updated 4/25

Strategy

- We measure the cross section by counting the number of events that pass signal selection, minus the predicted background yield, using calculated luminosity and acceptance
 - $\sigma(pp \rightarrow Z) * BR(Z \rightarrow l^+l^-) = (N_{\text{obs}} - N_{\text{bkg}}) / (\mathcal{L} * A)$
- The signal of the Drell-Yan process is the two, opposite charge, same flavor leptons, with p_t peaking around 45GeV, half of m_Z
 - We search for “prompt” leptons, those that are isolated and originate from the primary vertex

Background

- There are background contributions from processes with at least two leptons in the final state, as well as those with Initial State Radiation (ISR) that can fake two leptons in the final state
 - $ZZ \rightarrow 4l$ and $ZZ \rightarrow 2l + \text{jets}$
 - $WZ \rightarrow 2l + \text{jets}$ and $WZ \rightarrow 2l + l\nu$
 - $WW \rightarrow l\nu l\nu$
 - $t\bar{t} \rightarrow 2l 2\nu + \text{other}$
 - $Z \rightarrow \tau\tau \rightarrow 2l 4\nu$
 - $W \rightarrow l\nu$ with ISR \rightarrow fake lepton
 - $g \rightarrow \text{jets}$ with ISR \rightarrow pair production

Expected Yields

Process	8TeV Cross Section (pb)	Branching Ratio	Events	Process	Branching Ratio (%)	Luminosity (pb ⁻¹)
$\sigma(pp \rightarrow Z) \times BR(Z \rightarrow \mu\mu)$	34985	3.366E-02	96563	BR(Z \rightarrow ee)	3.363%	82
$\sigma(pp \rightarrow Z) \times BR(Z \rightarrow ee)$	34985	3.363E-02	96477	BR(Z \rightarrow $\mu\mu$)	3366%	
				BR(Z \rightarrow $\tau\tau$)	3.370%	
			Total DY Signal	BR(Z \rightarrow ll)	3.3658%	
			193040	BR(Z \rightarrow hadrons)	90%	
Backgrounds				BR(W \rightarrow hadrons)	67.6%	
$\sigma(pp \rightarrow ZZ) \times BR(ZZ \rightarrow 4l)$	8.2	3.399E-03	2	BR(W \rightarrow lv)	10.8%	
$\sigma(pp \rightarrow ZZ) \times BR(ZZ \rightarrow 2l+jets)$	8.2	6.058E-02	41	BR($\tau \rightarrow$ lvv)	17%	
$\sigma(pp \rightarrow W^+ Z) \times BR(W^+ Z \rightarrow 2l+jets)$	15.1	4.551E-02	56	BR(t \rightarrow lv)	10.6%	
$\sigma(pp \rightarrow W^- Z) \times BR(W^- Z \rightarrow 2l+jets)$	8.6	4.551E-02	32			
$\sigma(pp \rightarrow W^+ Z) \times BR(W^+ Z \rightarrow 2l+lv)$	15.1	1.454E-02	18			
$\sigma(pp \rightarrow W^- Z) \times BR(W^- Z \rightarrow 2l+lv)$	8.6	1.454E-02	10			
$\sigma(pp \rightarrow WW) \times BR(WW \rightarrow 2l+2\nu)$	56	2.333E-02	107			
$\sigma(pp \rightarrow tt) \times BR(tt \rightarrow 2l)$	248.9	2.247E-02	459			
$\sigma(pp \rightarrow Z) \times BR(Z \rightarrow \tau\tau \rightarrow 2l)$	34985	1.948E-03	5588			
$\sigma(pp \rightarrow QCD) \times BR(QCD \rightarrow 2 \text{ fakes})$						
$\sigma(pp \rightarrow W) \times BR(W \rightarrow lv) + \text{ISR fake}$			Total BKG w/o $\tau\tau$			
			725			

Pre-Selection Yields

Gen yields are in good agreement with our estimates

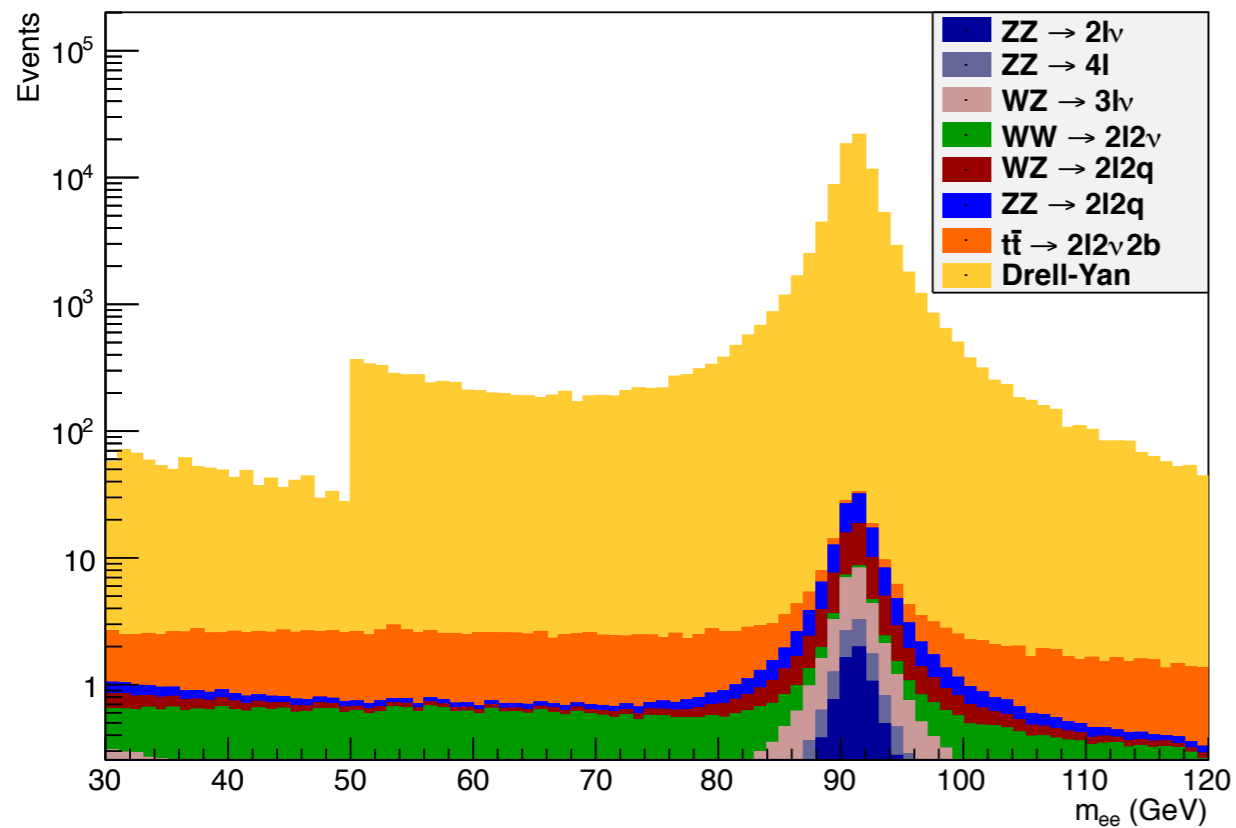
Gen Dataset	e^+e^- yield	$\mu^+\mu^-$ yield	Total
Drell-Yan	99815.7 ± 204.5	99462.1 ± 204.1	199277.8 ± 288.9
Drell-Yan ($\tau^+\tau^-$ only)	3240.9 ± 36.8	3061.2 ± 35.8	6302.2 ± 51.4
$W \rightarrow l + \nu$	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
$t\bar{t} \rightarrow 2l + 2\nu 2b$	230.9 ± 1.0	230.4 ± 1.0	461.3 ± 1.4
$t\bar{t} \rightarrow l + q$	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
$t\bar{t} \rightarrow$ hadrons	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
QCD	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
$WW \rightarrow 2l + 2\nu$	54.9 ± 0.2	54.5 ± 0.2	109.4 ± 0.3
$WZ \rightarrow 2l + 2q$	62.5 ± 0.1	62.7 ± 0.1	125.2 ± 0.2
$WZ \rightarrow 3l + \nu$	29.9 ± 0.1	29.8 ± 0.1	59.6 ± 0.1
$ZZ \rightarrow 2l + 2q$	69.1 ± 0.2	69.0 ± 0.2	138.1 ± 0.2
$ZZ \rightarrow 2l + \nu$	10.3 ± 0.0	10.3 ± 0.0	20.6 ± 0.0
$ZZ \rightarrow 4l$	8.1 ± 0.0	5.1 ± 0.0	13.2 ± 0.0

Reco Dataset	e^+e^- yield	$\mu^+\mu^-$ yield	Total
Data	130527	106689	237216
Drell-Yan	59309.2 ± 157.6	53483.7 ± 149.7	112792.8 ± 217.4
$W \rightarrow l + \nu$	70200.1 ± 555.1	15204.0 ± 258.3	85404.1 ± 612.3
$t\bar{t} \rightarrow 2l + 2\nu 2b$	885.6 ± 1.9	716.8 ± 1.7	1602.3 ± 2.5
$t\bar{t} \rightarrow l + q$	2753.5 ± 6.4	1641.1 ± 4.9	4394.6 ± 8.0
$t\bar{t} \rightarrow$ hadrons	2398.9 ± 5.5	1099.5 ± 3.7	3498.4 ± 6.6
QCD	21774.8 ± 633.1	153141.4 ± 1678.9	174916.2 ± 1794.3
$WW \rightarrow 2l + 2\nu$	50.6 ± 0.2	45.5 ± 0.2	96.2 ± 0.3
$WZ \rightarrow 2l + 2q$	61.4 ± 0.1	49.6 ± 0.1	111.0 ± 0.2
$WZ \rightarrow 3l + \nu$	23.3 ± 0.1	22.9 ± 0.1	46.2 ± 0.1
$ZZ \rightarrow 2l + 2q$	74.9 ± 0.2	59.9 ± 0.1	134.7 ± 0.2
$ZZ \rightarrow 2l + \nu$	8.2 ± 0.0	7.6 ± 0.0	15.7 ± 0.0
$ZZ \rightarrow 4l$	6.4 ± 0.0	6.5 ± 0.0	12.8 ± 0.0

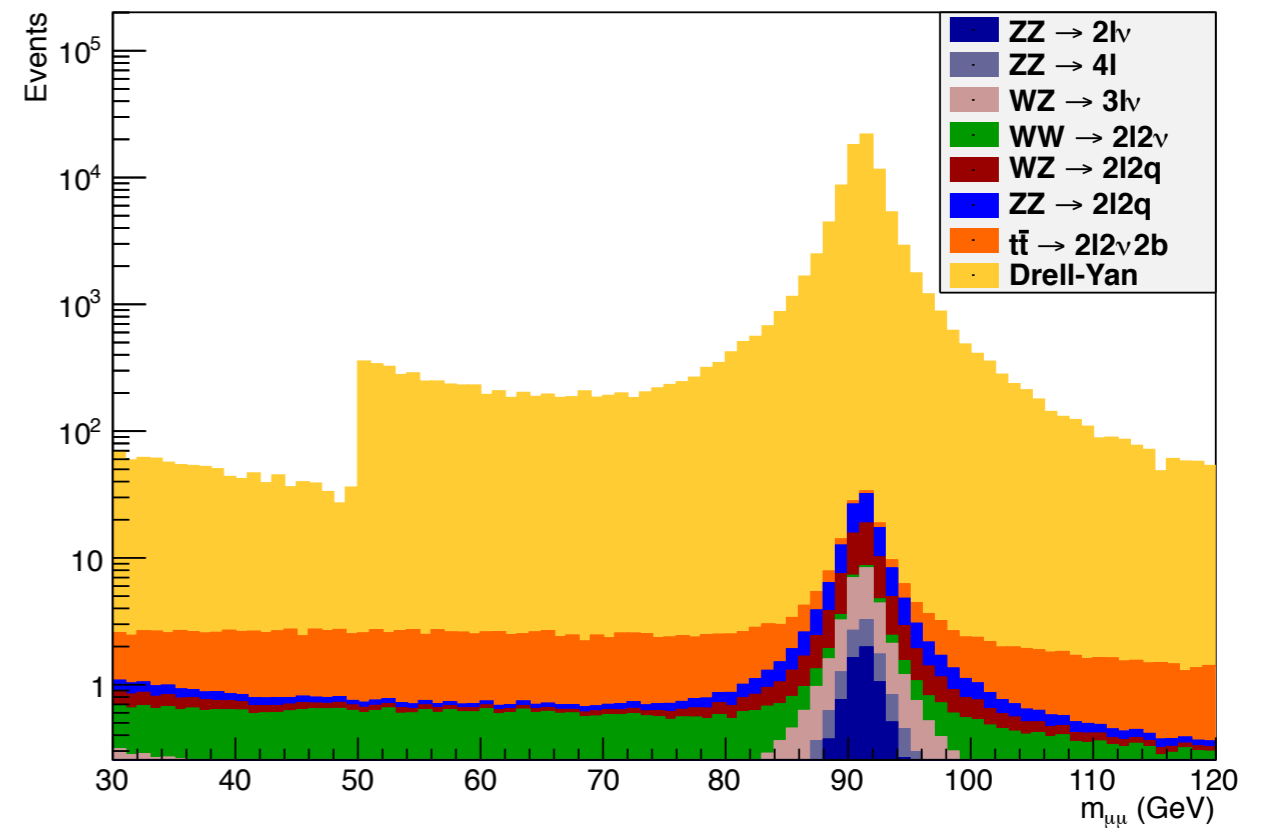
The Reco table counts all dilepton mass hypotheses

Pre-Selection Gen Yields

Gen Dielectron Mass



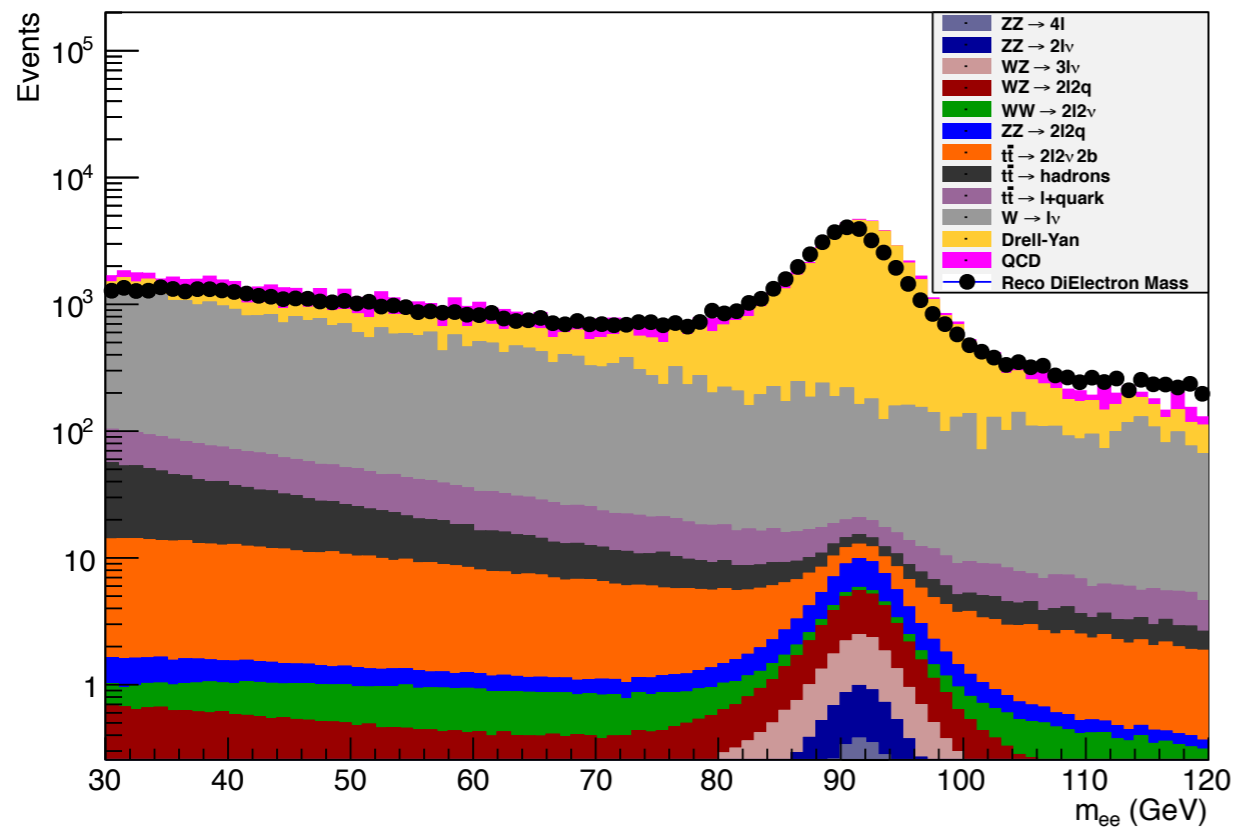
Gen Dimuon Mass



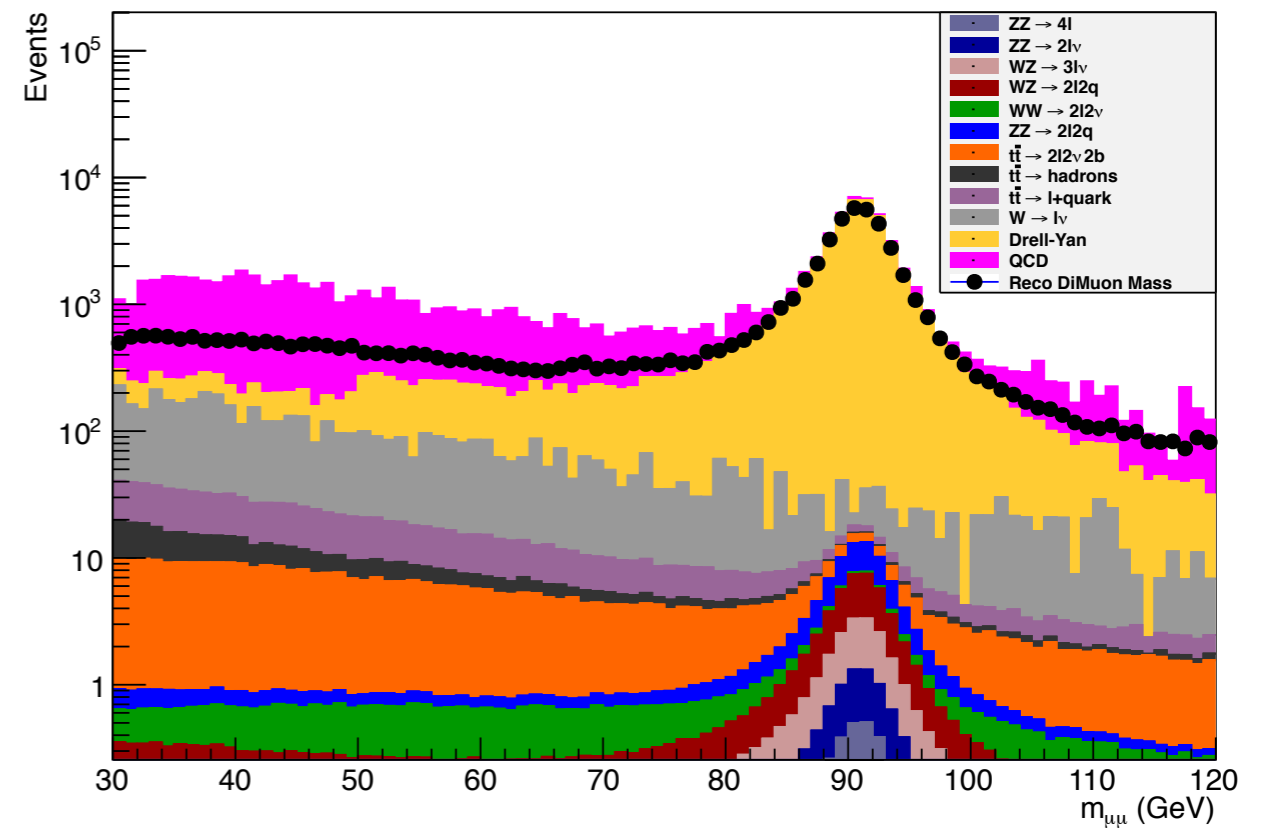
Gen dilepton mass plots for the MC datasets. Events with multiple OSSF lepton pairs have all dilepton mass hypotheses recorded. The sharp drop in Drell-Yan events at 50 GeV corresponds to a generator-level mass cut.

Pre-Selection Reco Yields

Reco Dielectron Mass



Reco Dimuon Mass



Reco dilepton mass plots for the MC datasets, with data overlaid. Events with multiple OSSF lepton pairs have all dilepton mass hypotheses recorded.