Measurement of Z boson cross section in pp collisions at $\sqrt{s} = 8$ TeV

Elizabeth Wicks

CMS, University of California San Diego

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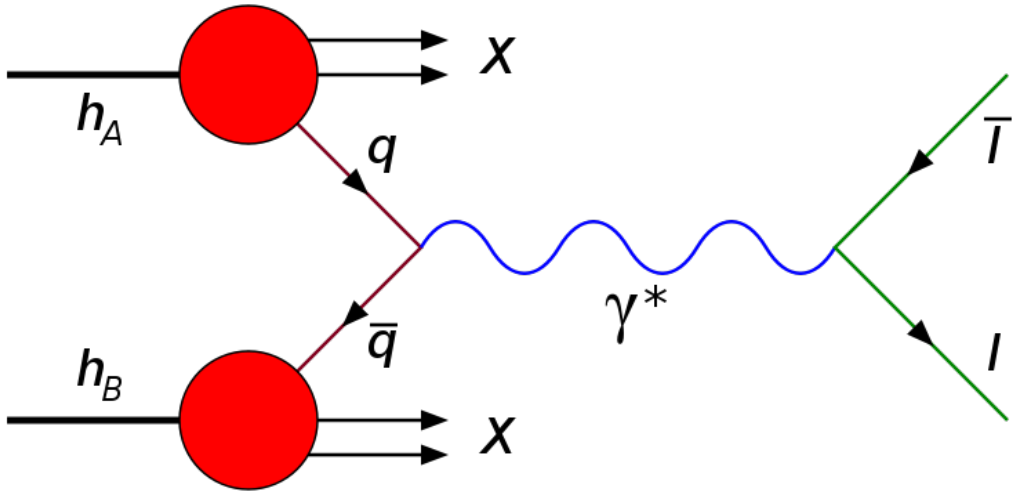
Drell-Yan Process

- We want to measure n, the true number of Drell-Yan events.
- We only consider decays to μ and e.



Our Signal

- We count the number of Drell-Yan events by finding two *prompt leptons* of opposite sign but the same flavor.
- A *prompt lepton* is one which emerges from the clean decay of a boson or virtual photon, and not a jet or secondary decay process.
- We select for prompt leptons which emerge from the decay of a virtual photon or Z boson.
- We can identify which leptons are prompt by examining their d_0 and d_z values, but we will still get backgrounds.

Measuring the Cross Section

Solving for σ

$$n = n_{obs} - n_{background} = L \cdot A \cdot BR \cdot \sigma,$$

where n is the true number of events undergoing the Drell-Yan process, L is the luminosity, A is the acceptance of the detector, BR is the branching ratio, and σ is the cross section.

- We know L and BR, and we can calculate A. The detector measures n_{obs}.
- Therefore we must calculate $n_{background}$ to solve for σ.

Identifying Backgrounds

- There are backgrounds that can mimic two prompt leptons of opposite sign but the same flavor.
- Recall that for each background,

$$n_{br} = L \cdot A \cdot BR_{br} \cdot \sigma_{br}.$$

- We use Monte Carlo methods to determine BR_{br} of each background, enabling us to calculate n_{br}.

List of Backgrounds

- QCD
- $\gamma^* Z \to \tau\tau$
- ZZ $\to 4l$
- ZZ $\to 2l +$ jets
- W $\to \tau\nu + 1$ fake
- WW $\to 2l\ 2\nu$
- WZ $\to 2l +$ jets
- WZ $\to 2l + l\nu$
- $t\bar{t} \to 2l$

Actual vs. Expected Yields

Actual Yields:

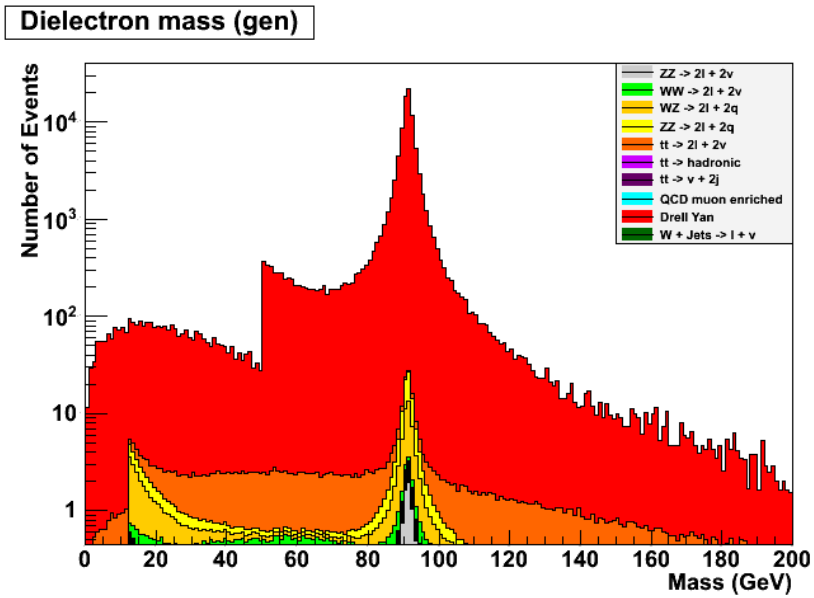
Dataset (Gen)	ee	ee error	μμ	μμ error
data	0	0	0	0
dy	99815.7	204.5	99462.1	204.1
qcdmu	0	0	0	0
tt2l2nu	230.9	1	230.4	1
tthad	0	0	0	0
ttlnujj	0	0	0	0
wjets	0	0	0	0
ww2l2nu	54.9	0.2	54.5	0.2
wz2l2q	62.5	0.1	62.7	0.1
wz3lnu	to be calculated			
zz2l2nu	10.3	0	10.3	0
zz2l2q	69.1	0.2	69	0.2
zz4l	to be calculated			

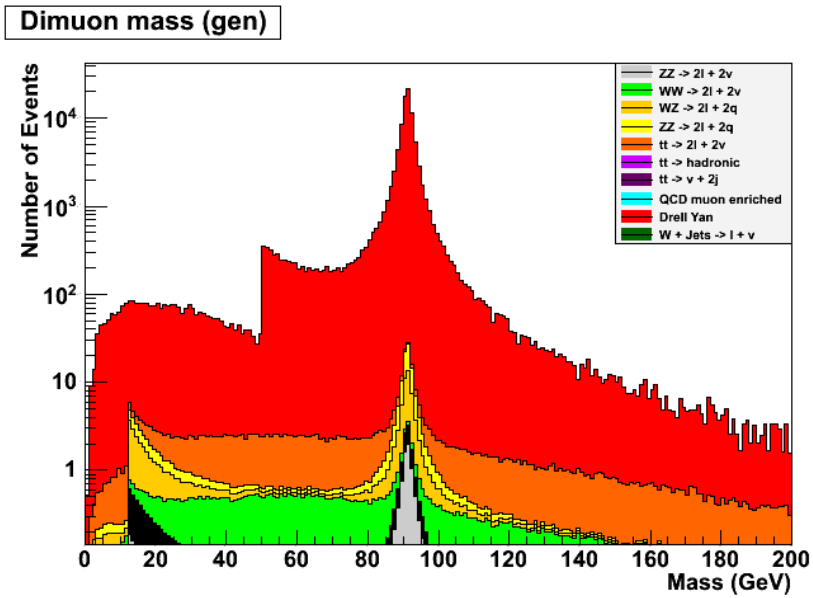
Dataset (Reco)	ee	ee error	μμ	μμ error
data	130527	361.3	106689	326.6
dy	59309.2	157.6	53483.7	149.7
qcdmu	21774.8	633.1	153141	1678.9
tt2l2nu	885.6	1.9	716.8	1.7
tthad	2398.9	5.5	1099.5	3.7
ttlnujj	2753.5	6.4	1641.1	4.9
wjets	70200.1	555.1	15204	258.3
ww2l2nu	50.6	0.2	45.5	0.2
wz2l2q	61.4	0.1	49.6	0.1
wz3lnu	to be calculated			
zz2l2nu	8.2	0	7.6	0
zz2l2q	74.9	0.2	59.9	0.1
zz4l	to be calculated			

Expected Yields:

Process	Calculation of σ*BR	Cross section (pb)	Branching Ratio	Number of Events
γ/Z → μμ	σ(pp → γ/Z)x[BR(γ/Z → μμ)]	34985	0.03366	96562.7982
γ/Z →ee	σ(pp → γ/Z)x[BR(γ/Z →ee)]	34985	0.03363	96476.7351
γ/Z→ττ→2μ	σ(pp → γ/Z)x[BR(γ/Z → ττ)xBR(τ → μνν)^2]	34985	0.001021474	2930.374819
γ/Z→ ττ→ 2e	σ(pp → γ/Z)x[BR(γ/Z → ττ)xBR(τ → eνν)^2]	34985	0.001071353	3073.465326
ZZ→4l/2l	σ(pp → ZZ) x[BR(Z → 2l)^2+2*BR(Z → 2l)*(1-3*BR(Z → 2l))]	17	0.061651695	85.94246308
t tbar→2l2v	σ(pp → t tbar)x[BR(t -> lν)^2]	248.9	0.011664	238.0599072
WW→2l+2v	σ(pp → WW) x[BR(W → lν)^2]	56	0.011664	53.561088
WZ→2l+...	σ(pp → WZ)x[BR(Z → 2l)]	33.6	0.033658	92.7345216

Gen Level Plots





Reco Level Plots