Measurements of W Boson Properties with the L3 Detector

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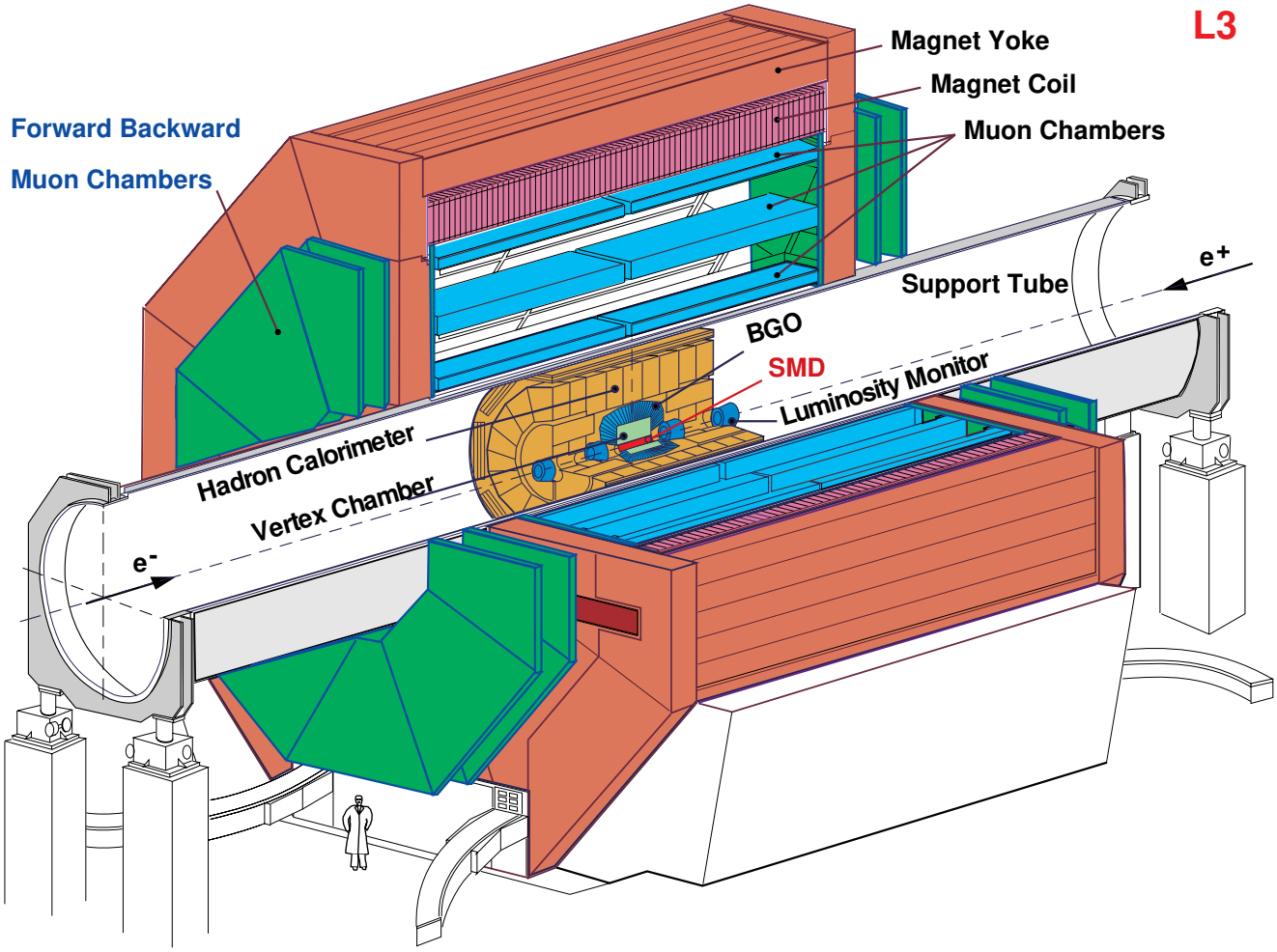
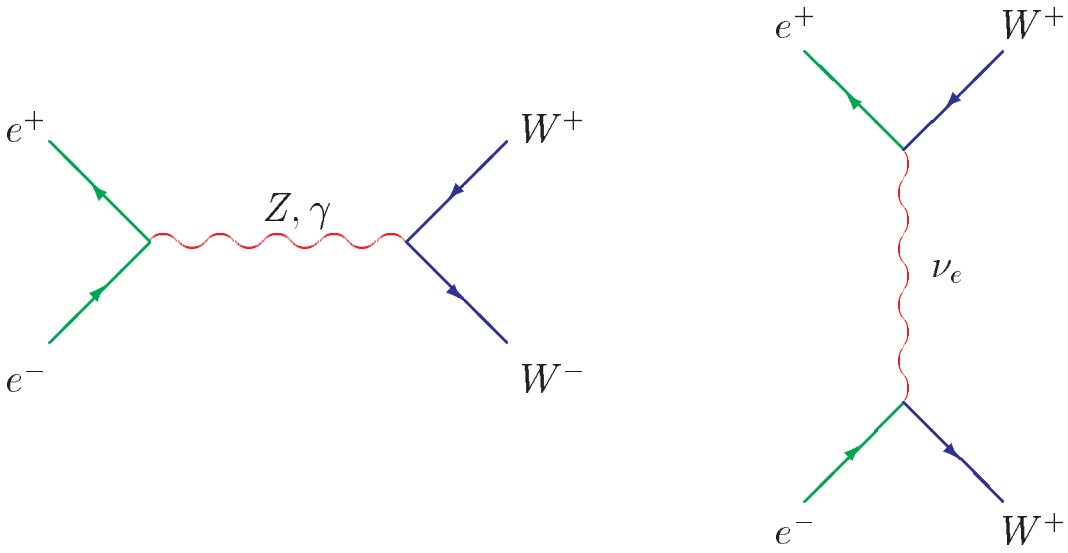
- L3 Detector
- Event Selection
- Cross Section & Branching Fractions
- Mass
- Anomalous Couplings
- Single W
- Conclusion

L3 Detector


L3
Magnet Yoke
Magnet Coil
Muon Chambers
Forward Backward
Muon Chambers
e+
Support Tube
BGO
SMD
Luminosity Monitor
Hadron Calorimeter
Vertex Chamber
e-

Introduction

- W Pair Production



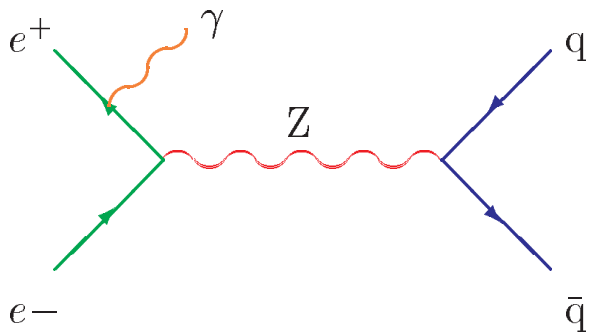
- Data Collected

Period	$\sqrt{s}$ (GeV)	$\mathcal{L}$ (pb^{-1})	σ_{WW} (pb)
96a	161	10.9	3.2
96b	172	10.3	12.2
97	183	55.5	15.5
98	189	176.4	16.5

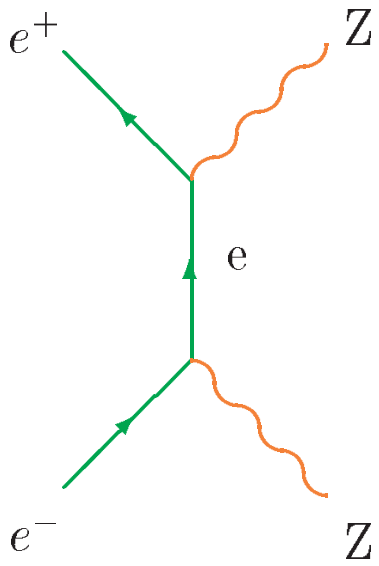
Event Selection

- 5 Decay Channels
  - $qqe\nu\Gamma qq\mu\nu\Gamma qq\tau\nu\Gamma qqqq\Gamma\ell\nu\ell\nu$

- Main Backgrounds



High Cross Section



Difficult to Reject

Event Selection

- $qq\ell\nu$
  - High Multiplicity
  - Jet-Jet Mass $\approx M_W$
  - Isolated Lepton
  - $M_{\ell\nu}$ (separates τ from e/μ)
  - $qq\mu\nu$: 11% gain from MIPS
  - $qq\tau\nu$: Neural Net to select τ jet

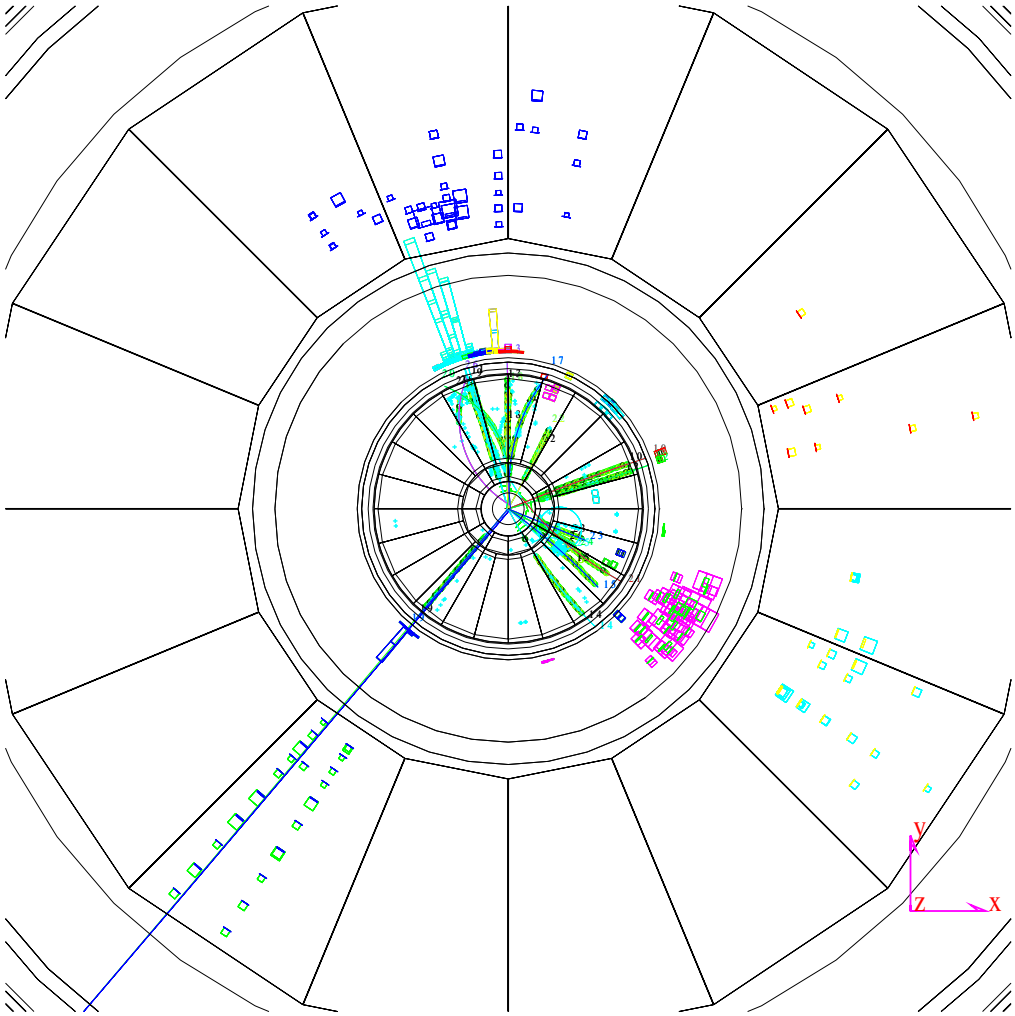
- qqqq
  - 8 Input Neural Net
  - 3 ways to pair 4 jets
    - 74% correct
    - lowest $\Delta M_W \Gamma$ not lowest $\sum M_W$

Channel	Efficiency	Non-WW Bg
qqeν	85.4%	6.1%
qq$\mu\nu$	77.0	5.2
qq$\tau\nu$	50.1	11.5
$qqqq$	87.5	19.4

(183 GeV)

Example Event

Run # 676304 Event # 3447 Total Energy : 148.00 GeV

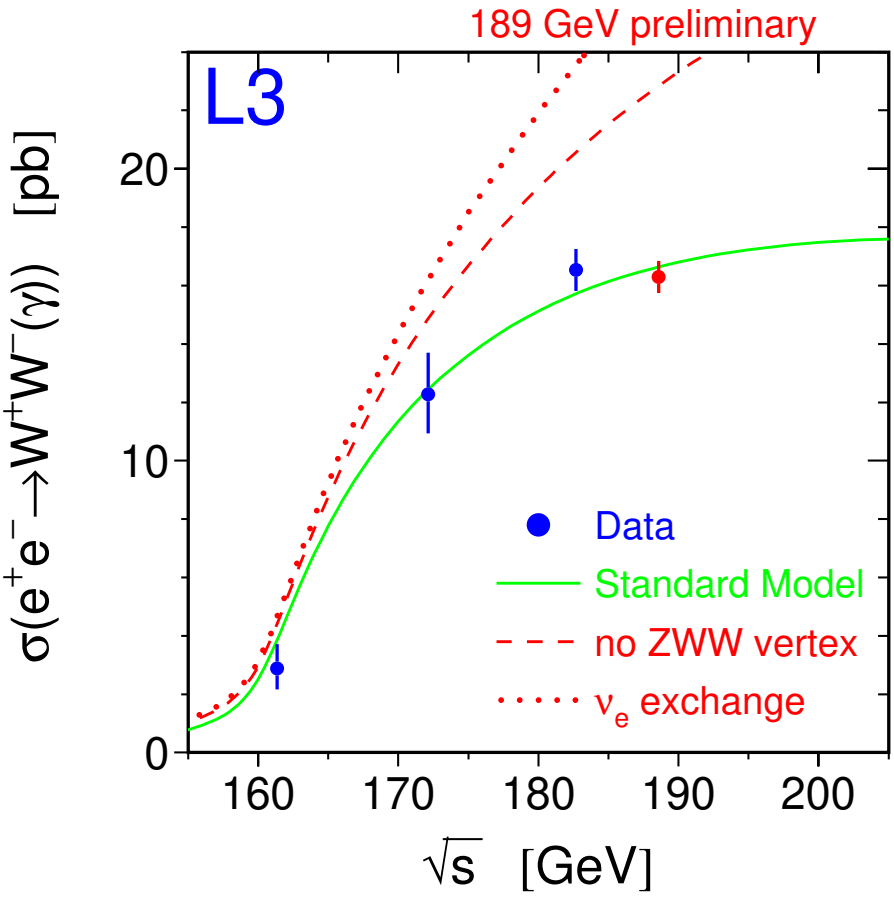


Transverse Imbalance :	.2108		**Longitudinal Imbalance :**	.0889	
Thrust :	.7158	**Major :**	.5913	**Minor :**	.1603
Event DAQ Time :	*970830 133050*				

824 Events @ $\sqrt{s} = 183$ GeV

$\sim$ 2600 Events @ $\sqrt{s} = 189$ GeV

Cross Section

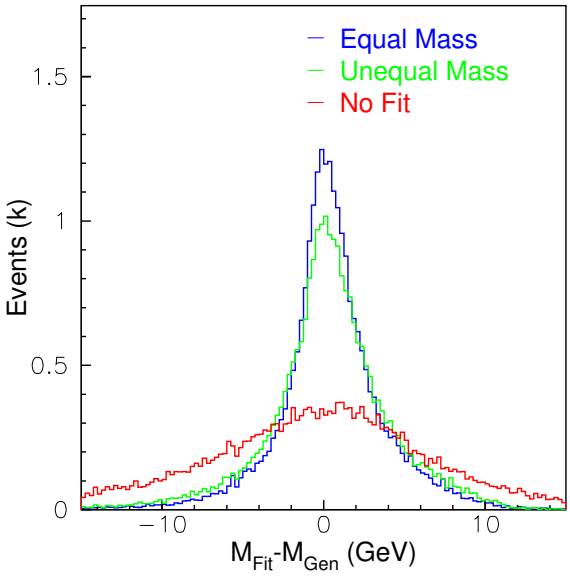


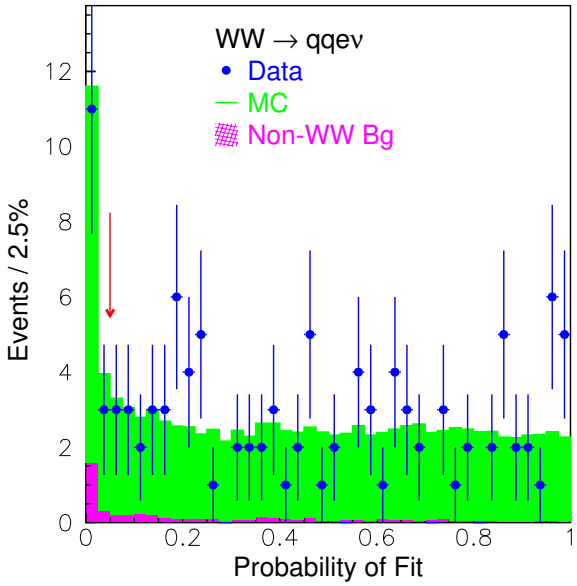
Channel	Branching Fraction (%)	SM (%)
$W\to e\nu$	10.22 ± 0.45	10.83
$W\to \mu\nu$	10.18 ± 0.47	10.83
$W\to \tau\nu$	11.08 ± 0.62	10.83
$W\to q\bar{q}$	68.53 ± 0.70	67.5

(All DataΓ Preliminary)

Mass Measurement

- Kinematic Fit





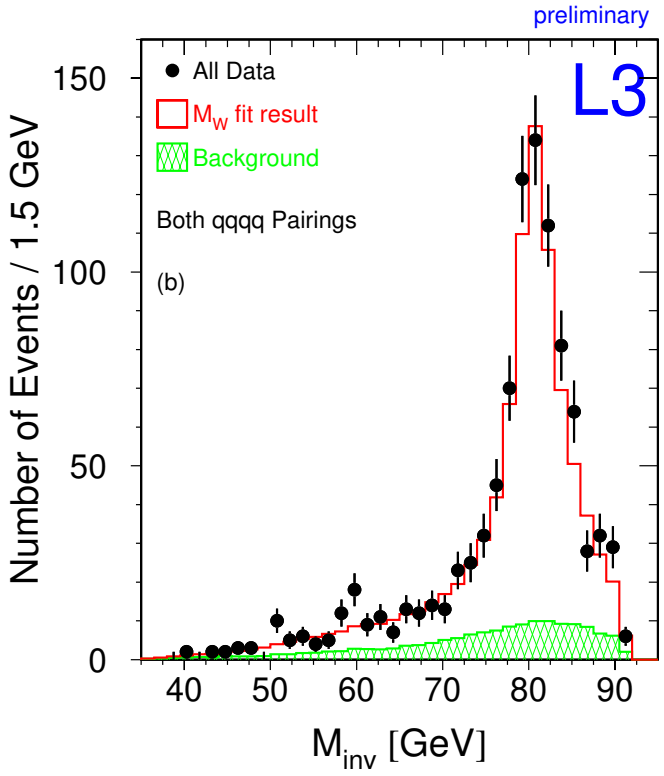
- Maximum Likelihood Fit

$$P(M_W) = \prod_{i=1}^{N_{Data}} P_i(M_W)$$

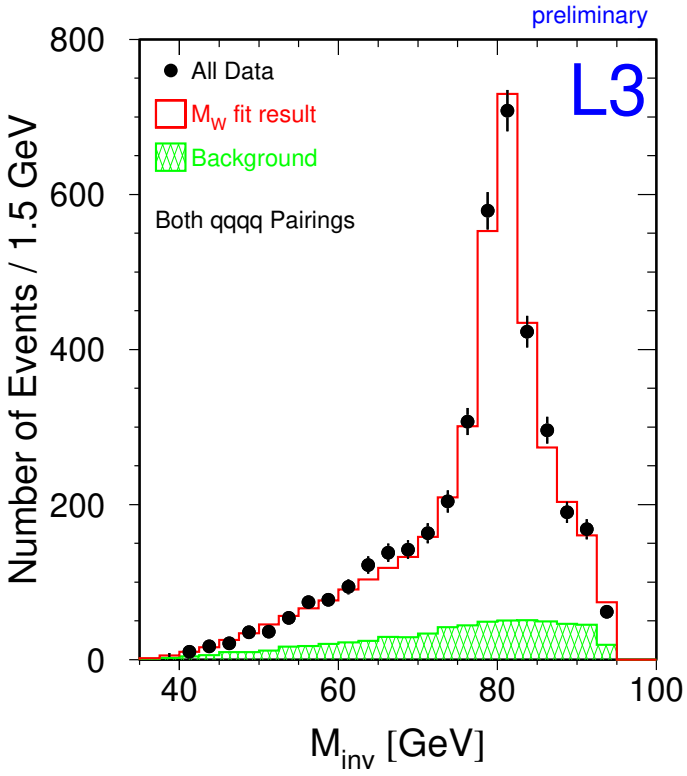
- Reweighting Method
  - MC Events are generated at a chosen M_W^{Gen}
  - Reweighted with $\frac{d\sigma(M_W)}{d\sigma(M_W^{Gen})}$
  - $P_i(M_W) = \frac{d\sigma}{dM_{rec}}(M_W)\Big|_{M_{rec}^i}$

Mass Measurement

183 GeV



189 GeV

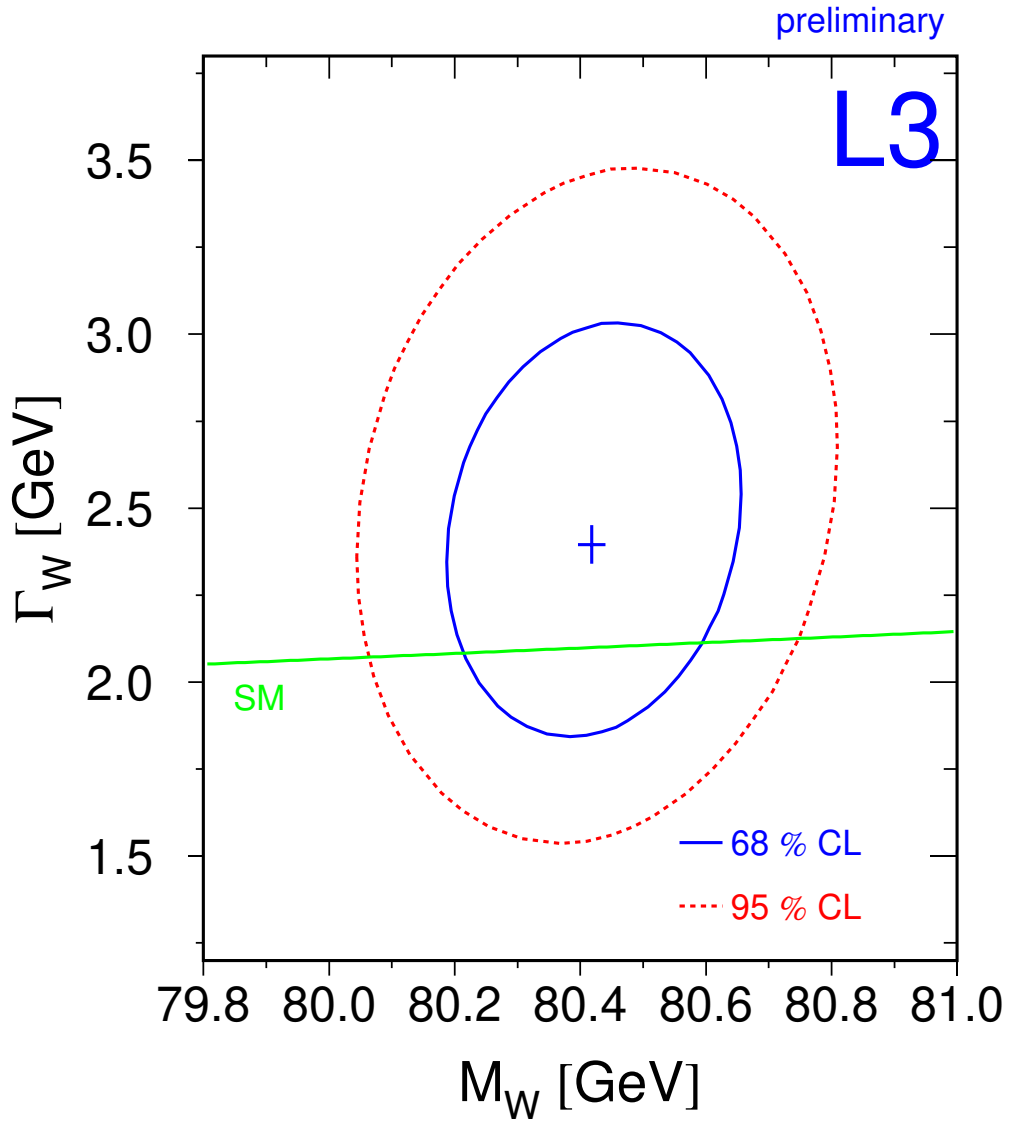


172+183	80.40	$\pm$ 0.15 (stat) $\pm$ 0.09 (syst) GeV
189	??	$\pm$ .093 (stat) GeV
All Data	??	$\pm$ .073 (stat) GeV

Systematics

Beam Energy	Detector Resolution
Initial State Radiation	Fragmentation
Final State Radiation	Color Reconnection
Bose-Einstein	

Width

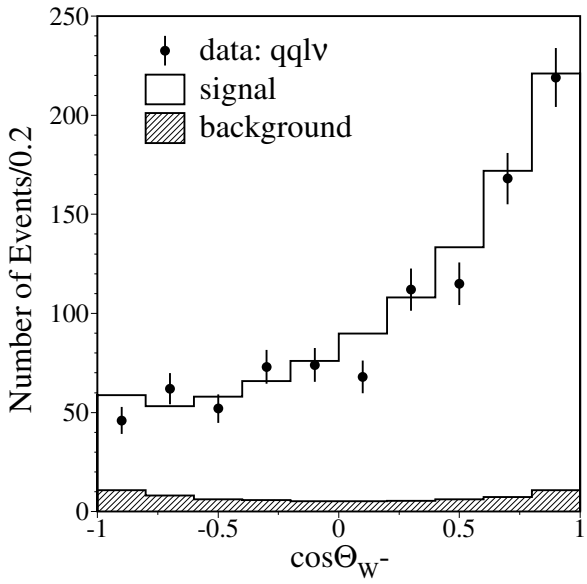


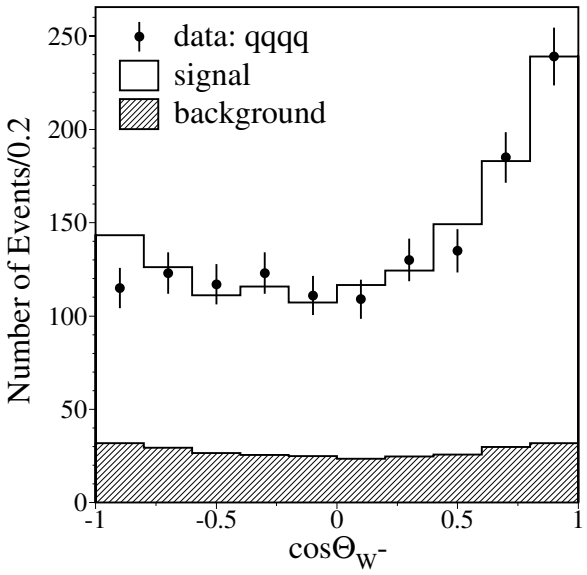
$$M_W = 80.41 \pm 0.15\ (\text{stat}) \pm 0.09\ (\text{syst})\ \text{GeV}$$
$$\Gamma_W = 2.41 \pm 0.39\ (\text{stat}) \pm 0.25\ (\text{syst})\ \text{GeV}$$

(172+183 GeV)

Anomalous Couplings

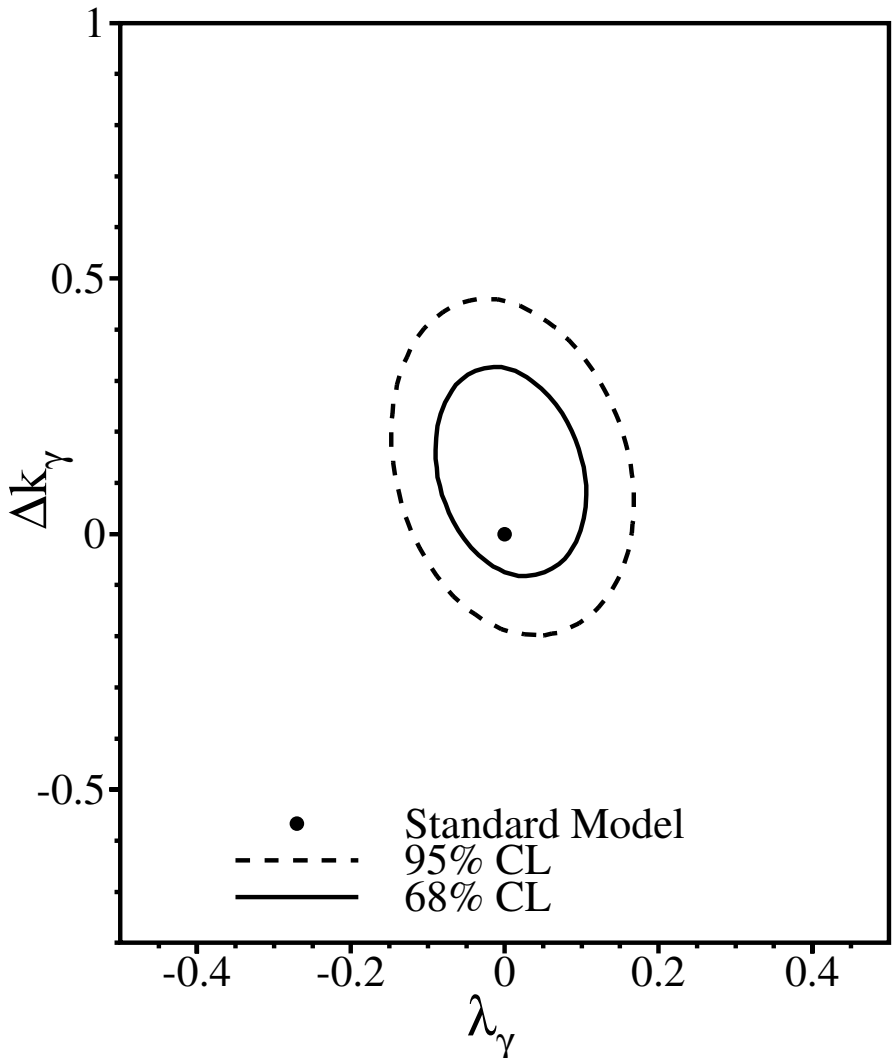
- Anomalous contributions to the γWW and ZWW vertexes
  - 7 variable parameterization
  - 3 parameters fitted $(\Delta g_1^Z, \Delta\kappa_\gamma, \lambda_\gamma)$
- Maximum Likelihood Fit
  - Total Cross Section
  - Differential Cross Sections $(\cos\Theta_W_\Gamma\ \cos\theta_\ell^*\Gamma\phi_\ell^*)$
- Jet Charge
  - 70% correct on correctly paired jets



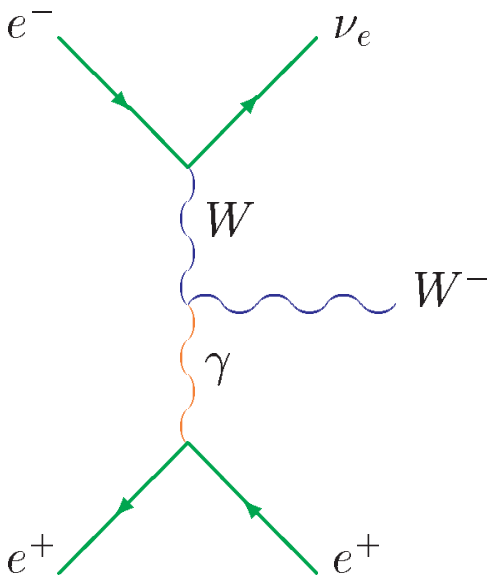


Anomalous Couplings

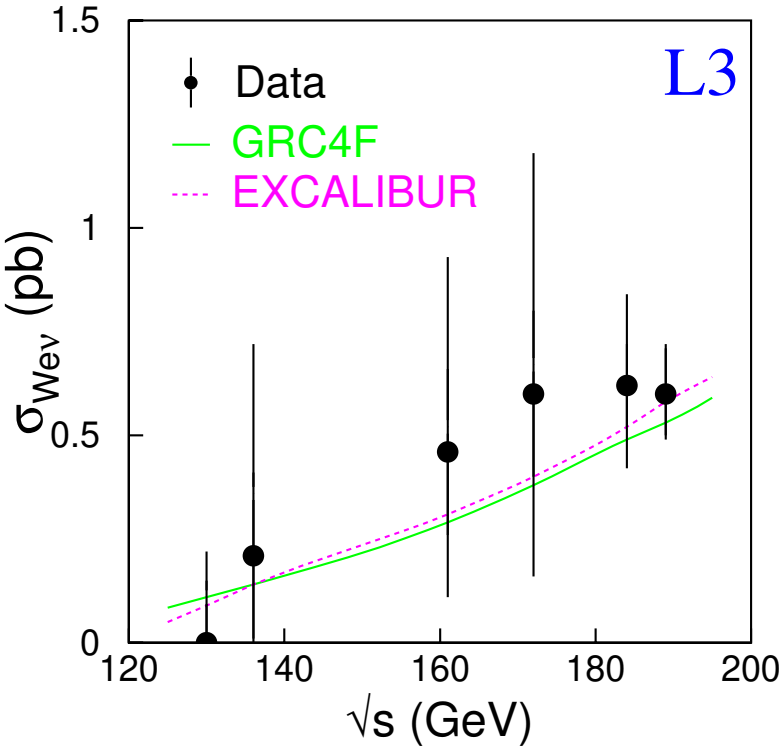
$$\Delta g_1^Z = -0.03 \pm 0.06$$
$$\Delta\kappa_\gamma = 0.12 \pm 0.13$$
$$\lambda_\gamma = 0.02 \pm 0.06$$



Single W, Cross Section

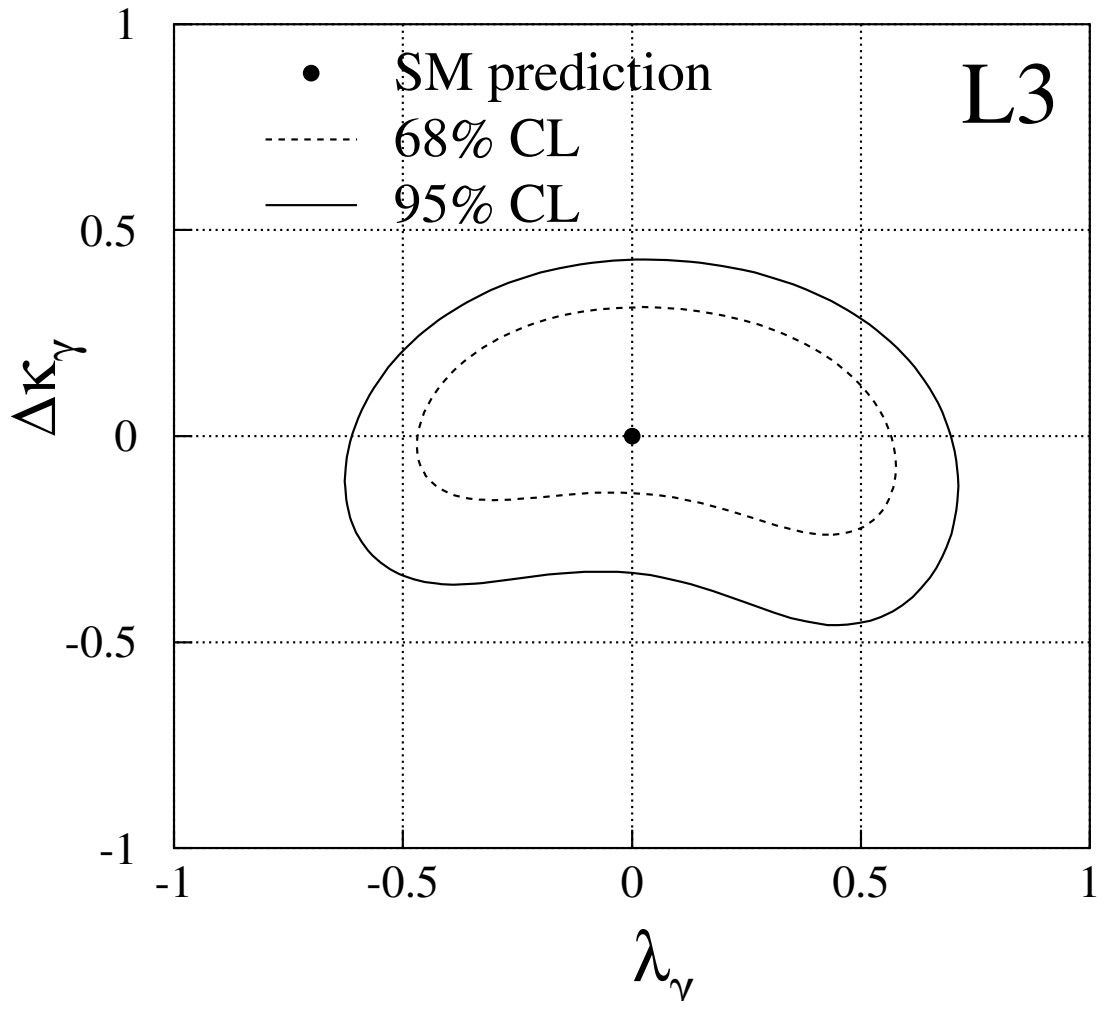


- Hadronic
  - Fit to Neural Net Output
- Leptonic (At 189 GeV)
  - 21 Events Seen
  - 25 Expected



Single W, Anomalous Couplings

- qq: Neural Net Output
- $\ell\nu$: Lepton Energy Spectrum
- γWW vertex
- $\Delta\kappa_\gamma$ limit comparable to W pairs



Conclusion

$\sim$ 3500 Events

Expected Statistical Error
on M_W of 73 MeV

Cross Sections & Anomalous Couplings
in agreement with SM

Expecting more Luminosity!