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e^+e^- Workshop
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The Measurement of Tri-Linear Gauge Boson Couplings at e^+e^- Colliders

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1. Effective Lagrangians and TGV's
2. Calculational Approach
3. Issues and Results
4. Things to Do

- Study $e^+e^- \to 4f$ evaluating all tree level diagrams
- Which channels to use?

$$\begin{aligned} e^+e^- &\to \ell\nu\ell'\bar{\nu} \\ &\to \nu\bar{\nu}\mu^+\mu^- \\ &\to q\bar{q}q'\bar{q}' \\ &\to \ell\nu q\bar{q} \\ &\to e\nu q\bar{q} \end{aligned}$$

1 Effective Lagrangians and TGV's

- Which coupling parametrization to use?
- Limits on specific non-SM models?

Most General Parametrization

$$\begin{aligned}\mathcal{L}_{eff} &= -ig_V[g_1^V(W^+_{\mu\nu}W^{-\mu} - W^{+\mu}W_{\mu\nu})V^\nu + \kappa_V W^+_\mu W^-_\nu V^{\mu\nu} \\ &\quad + \frac{\lambda}{M_W^2} W^+_{\lambda\mu} W^{-\mu}_\nu V^{\nu\lambda}]\end{aligned}$$

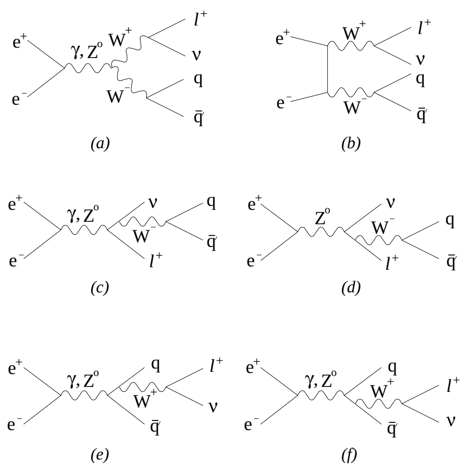
Linearly Realized Goldstone Bosons

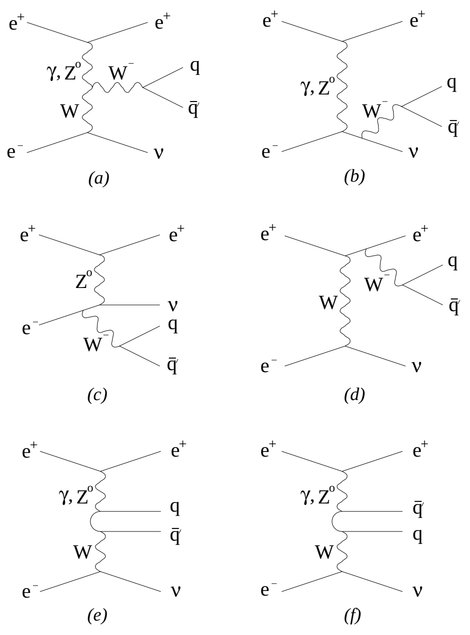
$$\begin{aligned}\mathcal{L} &= ig'\frac{\varepsilon_B}{\Lambda^2}(D_\mu\Phi)^\dagger B^{\mu\nu}(D_\nu\Phi) + ig\frac{\varepsilon_W}{\Lambda^2}(D_\mu\Phi)^\dagger W^{\mu\nu}(D_\nu\Phi) \\ &\quad + \frac{2i}{3}\frac{L_\lambda}{\Lambda^2} g^3 Tr[W_{\mu\nu}W^{\nu\rho}W^\mu_\rho]\end{aligned}$$

Non-Linearly Realized Goldstone Bosons

$$\begin{aligned}\mathcal{L}^{(4)}_{VVV} &= -ig\frac{L_{9L}}{16\pi^2}Tr[W^{\mu\nu}D_\mu\Sigma D_\nu\Sigma^\dagger] - ig'\frac{L_{9R}}{16\pi^2}Tr[B^{\mu\nu}D_\mu\Sigma^\dagger D_\nu\Sigma] \\ &\quad + gg'\frac{L_{10}}{16\pi^2}Tr[\Sigma B^{\mu\nu}\Sigma^\dagger W_{\mu\nu}]\end{aligned}$$

2 Calculational Approach

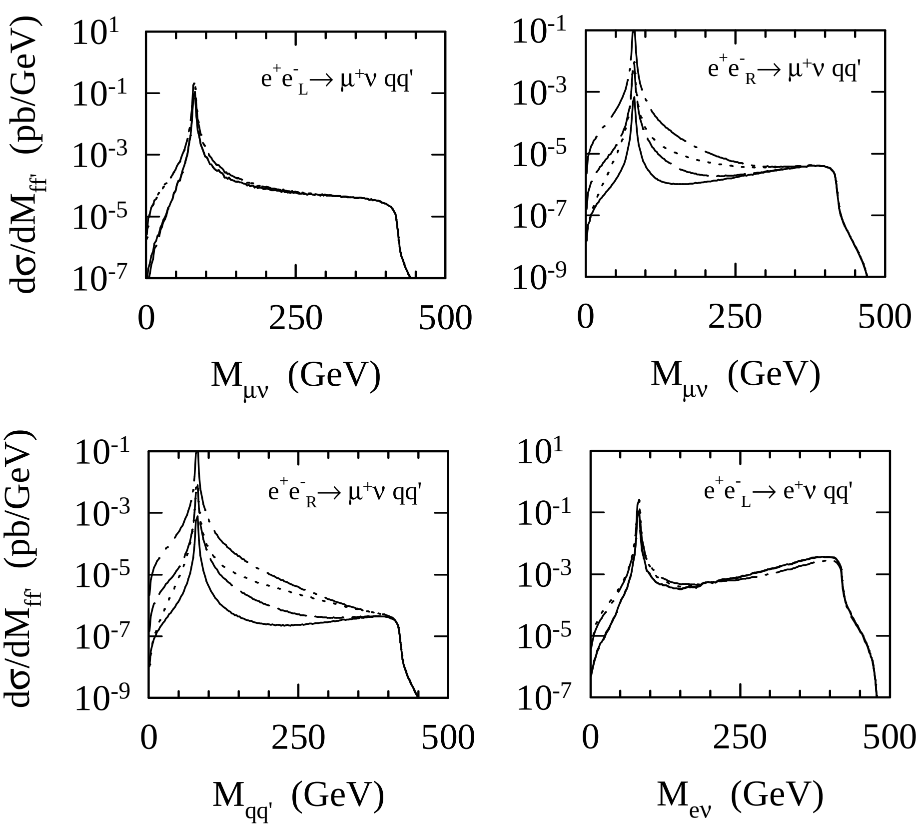


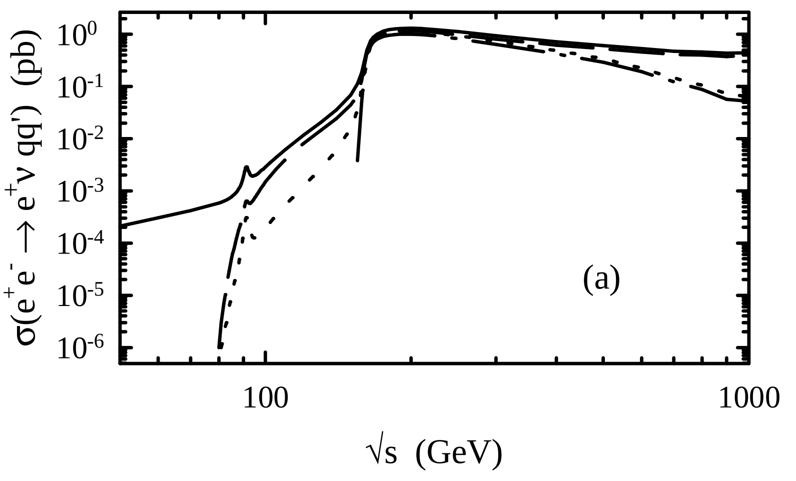


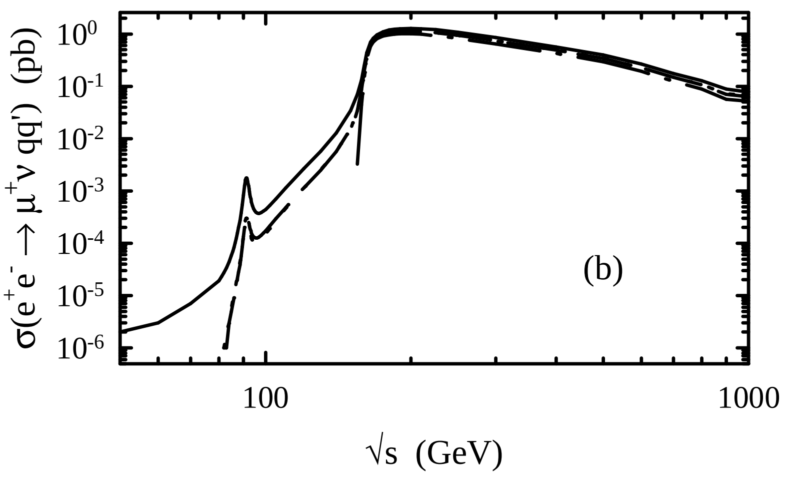
Used CALKUL helicity amplitude method and Monte Carlo Integration

3 Issues and Results

- What is the effect of finite W width?





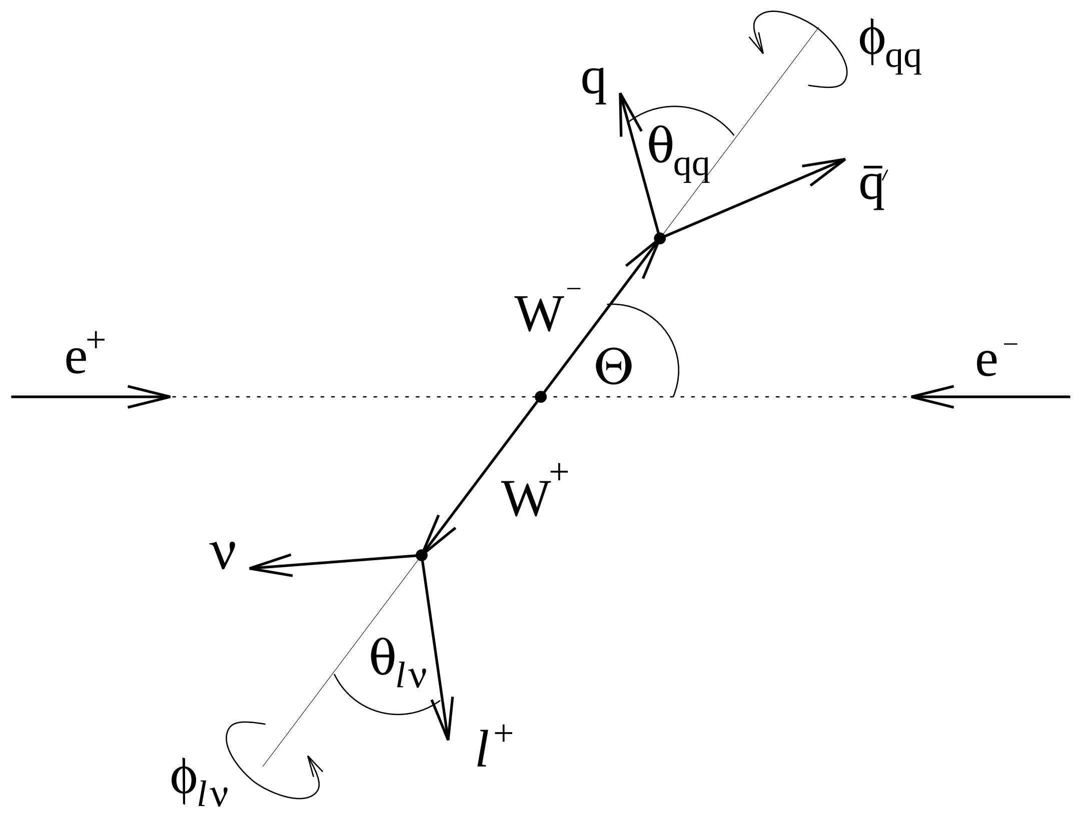


$\sqrt{s}$	ℓ	no cut	$M_{q\bar{q}}$	$M_{\ell\nu}$	both cuts
500	μ	0.39	0.34	0.34	0.29
	e	0.62	0.53	0.34	0.29
1000	μ	0.077	0.063	0.064	0.052
	e	0.44	0.39	0.064	0.052

Used maximum likelihood method to determine if deviations are measurable

$$\frac{d^5\sigma}{d\cos\Theta d\cos\theta_q d\phi_{qq} d\cos\theta_\ell d\phi_{l\nu}}$$

- Θ is angle of outgoing W's
- θ, ϕ give angular distributions of qq' ($\ell\nu$) in W rest frame



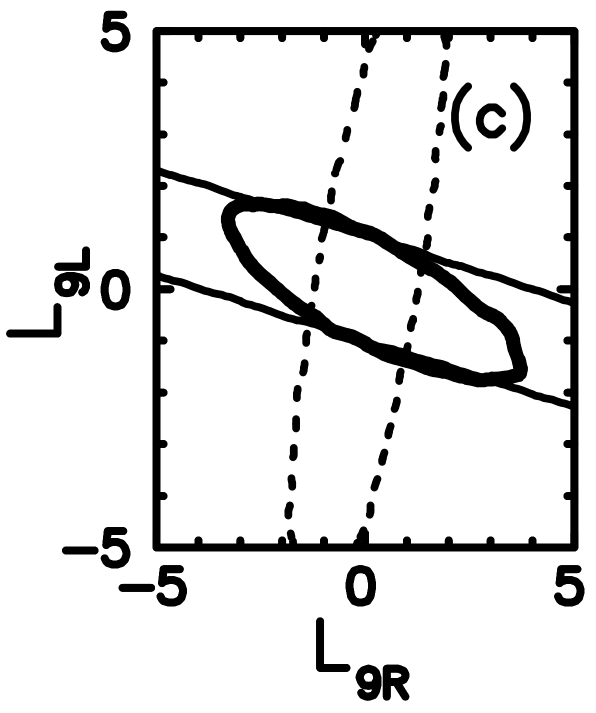
$$\ln\mathcal{L} = \sum_i [-r_i + r_i\ln(r_i) + \mu_i - r_i\ln(\mu_i)]$$

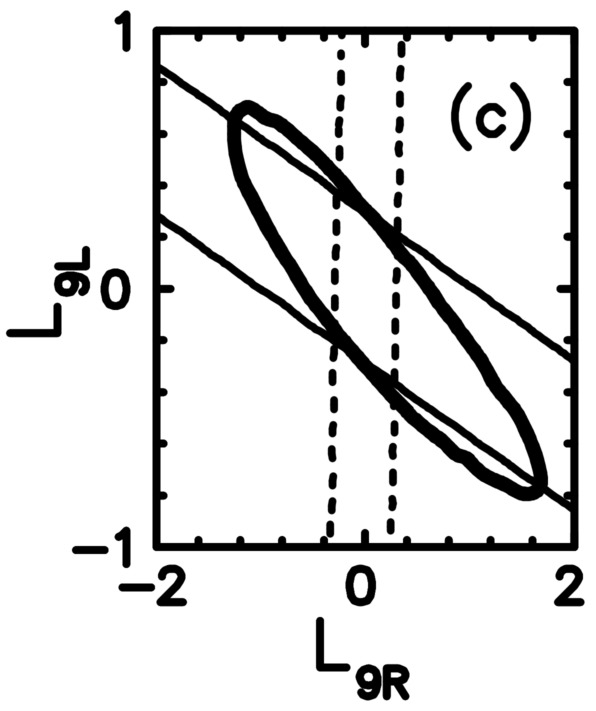
- r is measured
- μ is expected

- What is the sensitivity to binning?

$\sqrt{s} = 500$ GeV, L=50 fb^{-1}, 95% C.L.	
Binning	$\delta\kappa_Z$
64 bins 4^3	$\sim \pm 0.01$
1024 bins 4^5	$\sim \pm 0.0056$
243 bins 3^5	$\sim \pm 0.0064$
event by event	$\sim \pm 0.0046$

- What is the best luminosity allotment per polarization?





4 Things to Do

1. Unweighted Monte Carlo to put through detector.
2. Include initial state radiation.
3. Electroweak Radiative Corrections
4. Final state radiation
5. Gluon radiation and reconstructing hadronic W decays
6. Required detector resolution
7. Tagging of quark flavour in hadron decays.
8. Selection efficiency and backgrounds