Plan for Preliminary $Z\gamma$ Helicity Study

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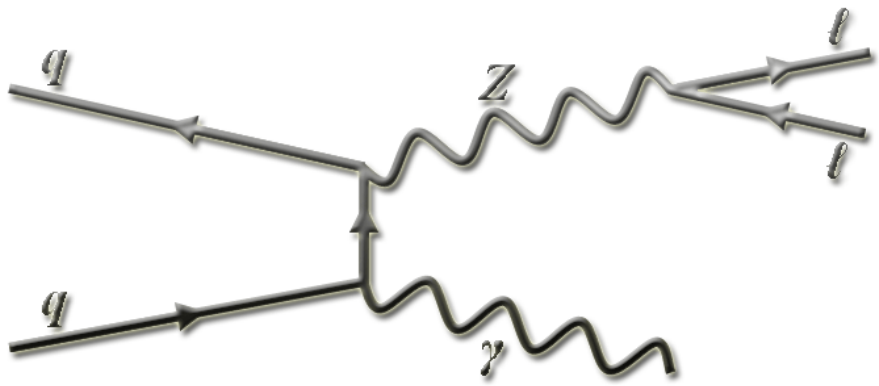
Outline

- General Description
- Angular Distribution
- Background
- Resolution
- Likelihood
- Acceptance/Efficiency
- Parameter Extraction
- Error Estimation
- Significance/Comparison of Different Hypothesis

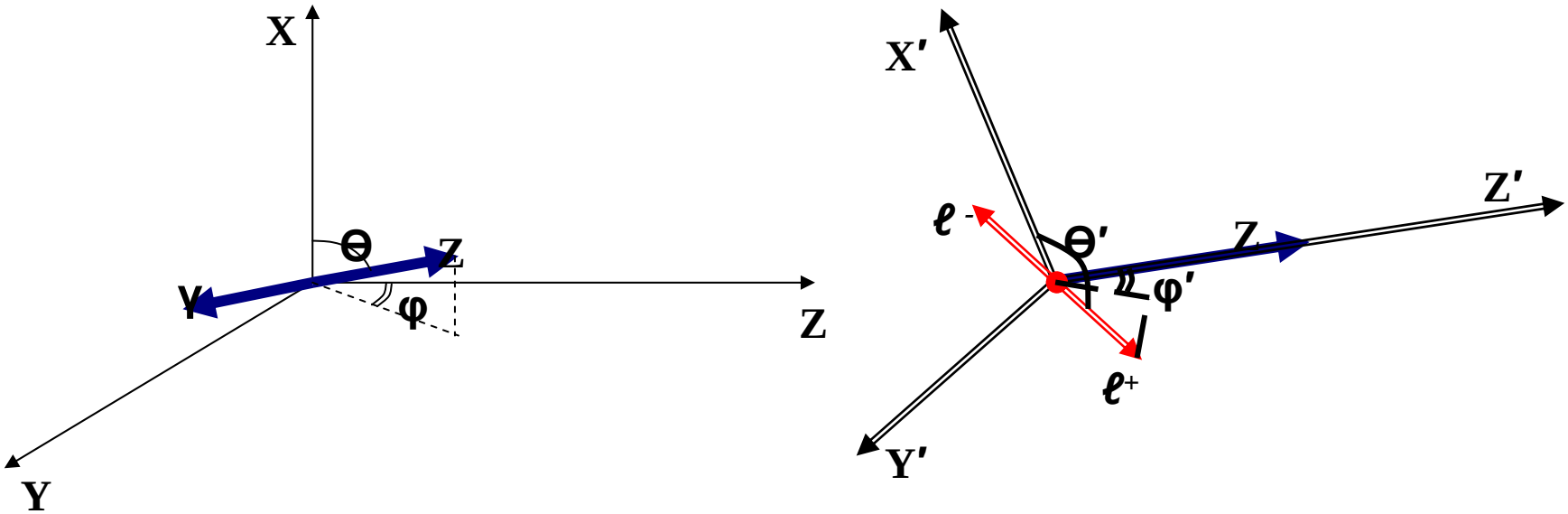
General Description

- SM $Z\gamma$ Production (via Initial State Radiation)
- Calculations made for Leading Order production



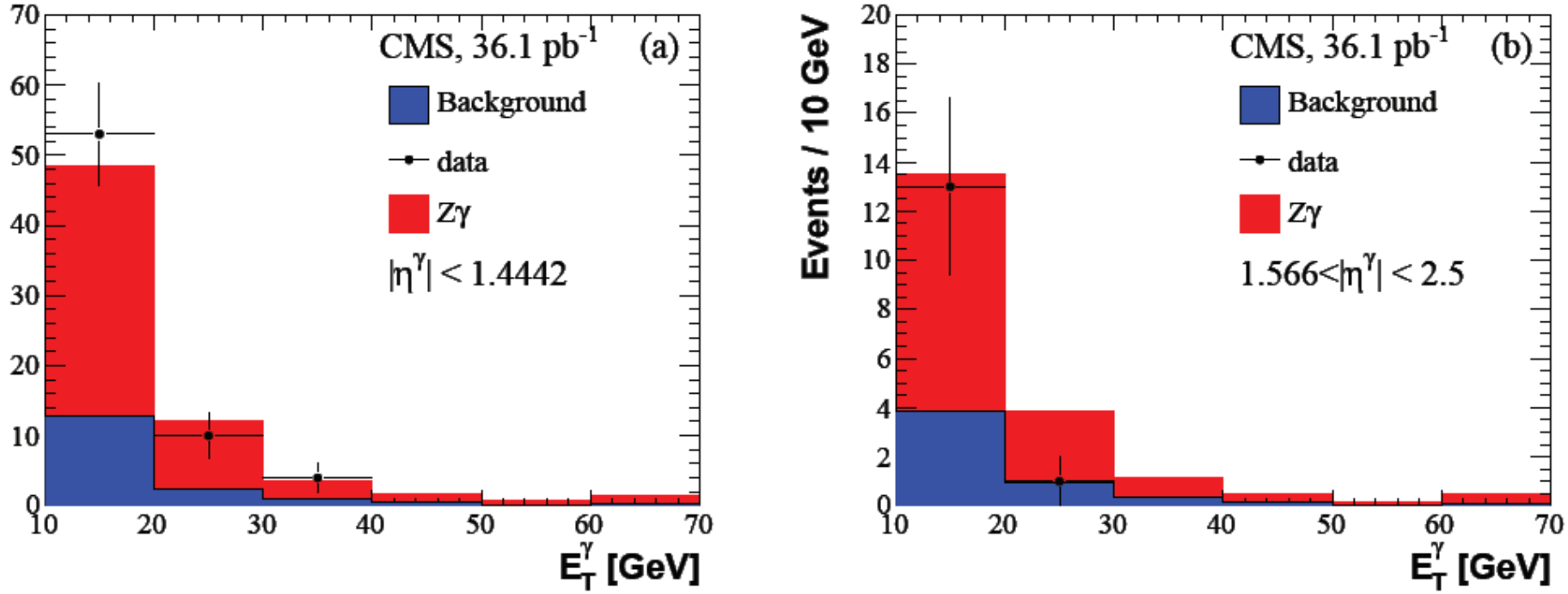
Angular Distribution

$$\frac{d\sigma}{d\Omega_Z d\Omega_\ell} = \sum_{\lambda_{\ell\ell}\lambda_\gamma} \left| \sum_{J\lambda_Z\lambda_{qq}} \begin{matrix} [2J+1] T^J_{\lambda_Z\lambda_\gamma\lambda qq} d^J_{\lambda_{Z\gamma}\lambda_{qq}}(\cos\theta_Z) \\ \otimes A_{\lambda_Z\lambda_{\ell\ell}} d^J_{\lambda_Z\lambda_{\ell\ell}}(\cos\theta_\ell) e^{i[(\lambda_{qq}-\lambda_Z)\varphi_Z - \lambda_Z\varphi_\ell]} \end{matrix} \right|^2$$



Background

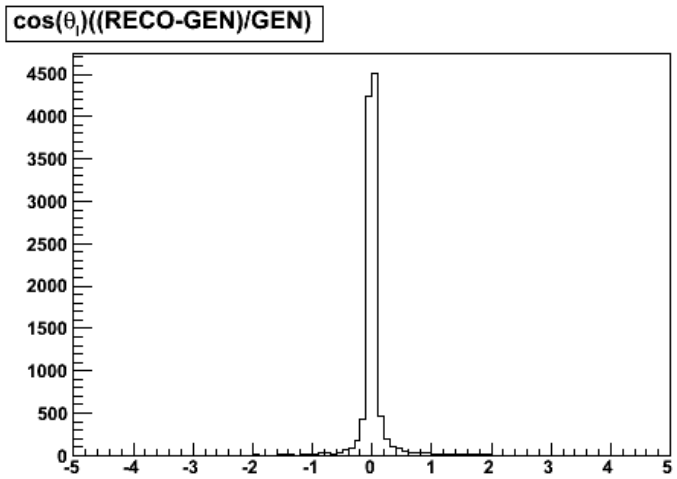
- Background strategy for preliminary study is suppress it by using a harsh cuts (e.g.E_t^{γ}>40 GeV)
  (plots borrowed from AN)

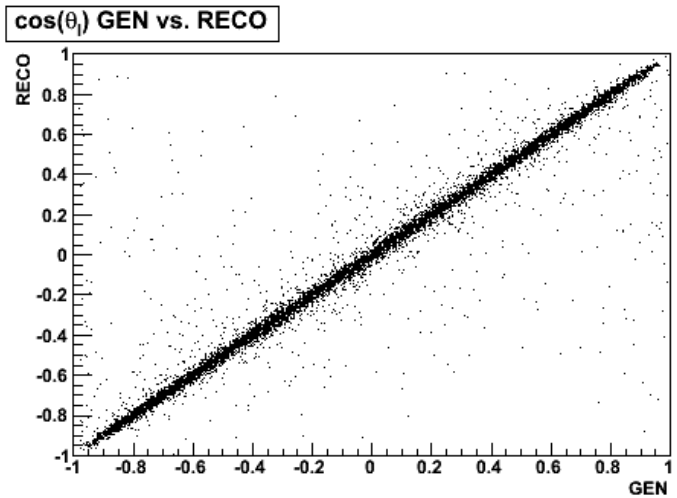


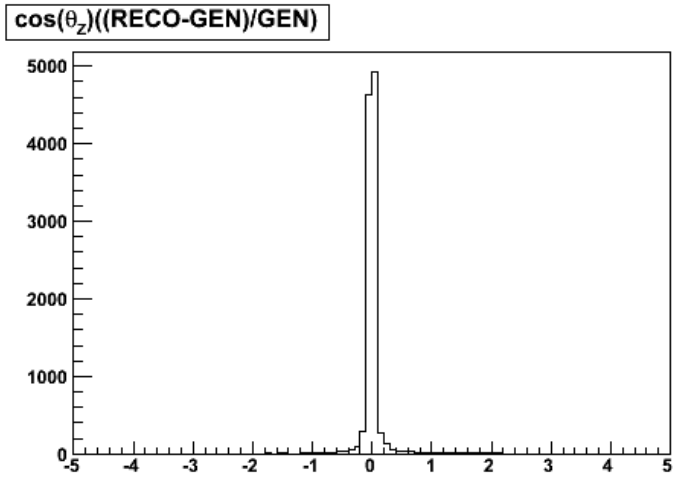
Resolution

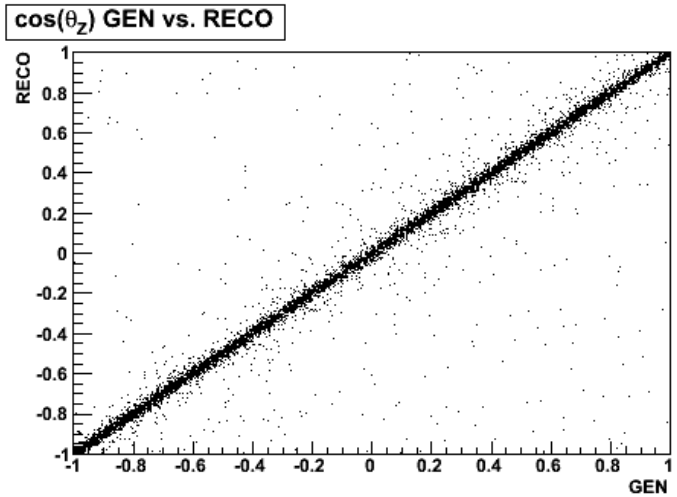
- Variables under study are angles
- Angles are usually measured pretty well so for now we ignore any resolution effects

Resolution

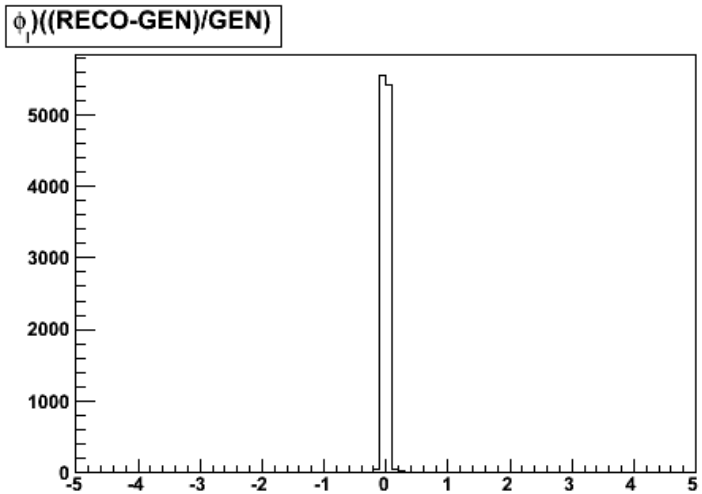

cos(θl)((RECO-GEN)/GEN)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-5 -4 -3 -2 -1 0 1 2 3 4 5

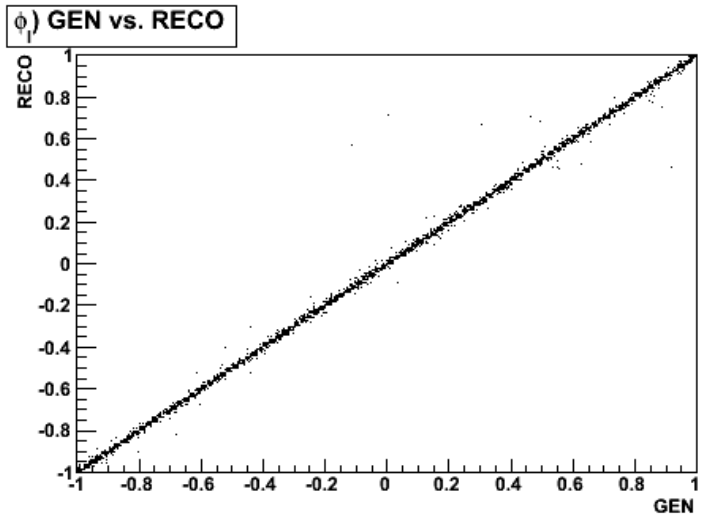

cos(θl) GEN vs. RECO
RECO
1 0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8 -1
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1
GEN

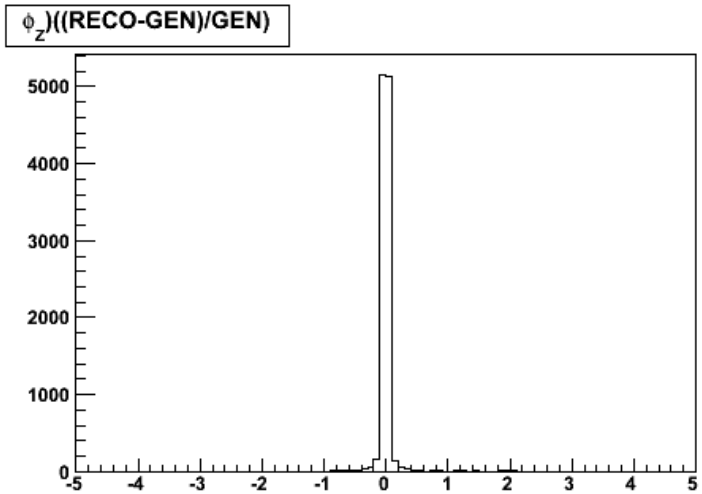

cos(θZ)((RECO-GEN)/GEN)
5000
4000
3000
2000
1000
0
-5 -4 -3 -2 -1 0 1 2 3 4 5

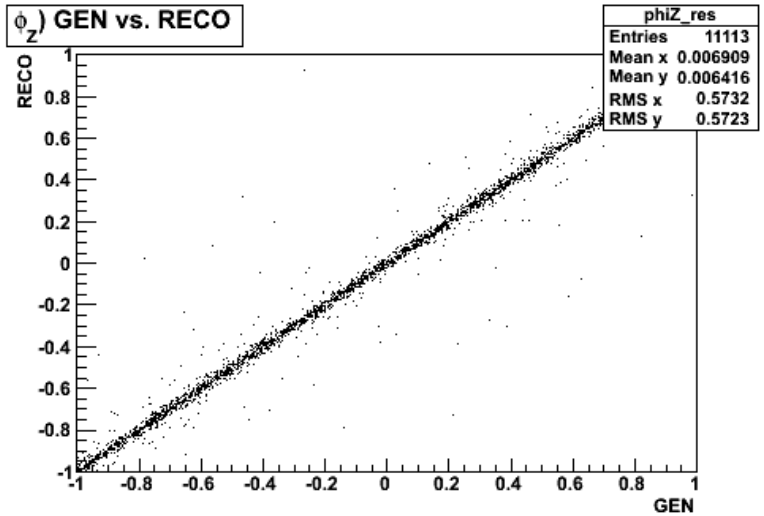

cos(θZ) GEN vs. RECO
RECO
1 0.8 0.6 0.4 0.2 0 -0.2 -0.4 -0.6 -0.8 -1
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1
GEN

Resolution


ϕ_l)((RECO-GEN)/GEN)


ϕ_l) GEN vs. RECO
RECO
GEN


ϕ_Z)((RECO-GEN)/GEN)


ϕ_Z) GEN vs. RECO
phiZ_res
Entries 11113
Mean x 0.006909
Mean y 0.006416
RMS x 0.5732
RMS y 0.5723
RECO
GEN

Likelihood

- If we write angular distribution in a following form

$$W(\Omega) = \sum_{n}^{N_{par}} A_n \omega_n(\Omega)$$

- Then negative log of likelihood will be:

$$-\ln L = -\sum_{n'}^{N_{data}} \ln \sum_{n}^{N_{par}} A_n \omega_n(\Omega_{n'}) + N_{data} \ln \sum_{n}^{N_{par}} A_n \varepsilon_n$$

Acceptance/Efficiency

- Weights of each event have to be calculated from MC samples for acceptance calculations:

$$\varepsilon_n = \frac{\sum_{n'}^{N_{MC}^{RECO}} \frac{\omega_n(\Omega_{n'})}{W_p(\Omega_{n'})}}{\sum_{n'}^{N_{MC}^{GEN}} \frac{1}{W_p(\Omega_{n'})}}$$

Minimization Results

- Extracted Parameters
- Errors
- Significance
- Comparison of different hypothesis (J=0,1,2)