Demo Z-Analysis

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Intro

- This is a simple MC level study to touch some of the aspects of CMSSW
- Look at Z → ll events
  - l refers to either e or μ, τ's are excluded
- The tasks were:
  - Using an EDProducer, create a simple tree containing relevant information on the z-boson and its decay products
  - Using an EDFilter, remove Z → ττ events
  - Using an EDAnalyzer, book and fill relevant histograms
  - Using ROOT code, create formatted plots and overlays
  - Write a short set of slides to summarize

Quick Study

- I'd like to see the following plots at least:
  - mass of the Z
  - Compare the dilepton invariant mass at gen level and reco level
  - for ee, μμ and both together
  - Compare p_T and η of the leptons (gen and reco level)
  - Resolution of the Z mass vs Z mass
  - Resolution of the lepton p_T vs p_T (e and μ separately)
  - Efficiency of reconstructing the lepton vs p_T (e and μ separately)

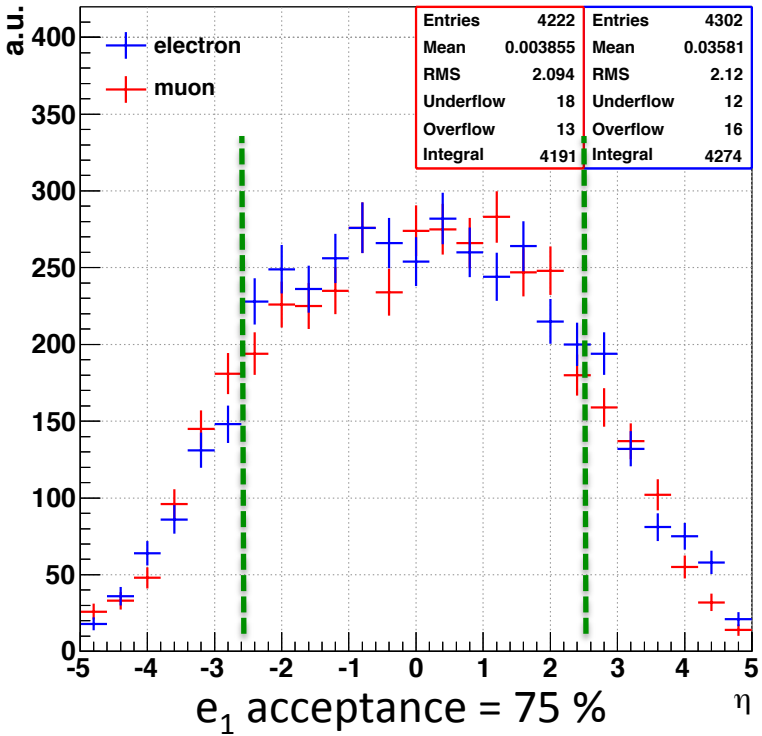
Setup

- MC dataset on the uaf
  - /nfs-7/userdata/edm/53X/DYJetsToLL_M-50_TuneZ2Star_8TeV-madgraph-tarball_AODSIM_PU_S10_START53_V7A-v1.root
- Use CMSSW_5_2_3_patch4
- Created Simple TTree with
  - Generated Z boson p4
    - Z → ee and μμ only
  - Generated Z boson's daughter leptons (l1 and l2, sorted by p_T)
    - p4, charge, pdg ID, reco match boolean
  - Daughter's matched reco object
    - Simple ΔR matching → found the reco e/μ with smallest ΔR(reco lep, gen lep).
    - ΔR < 0.2 (same as CMS2)
    - p4, charge, ΔR

Lepton η Acceptance

- Generator Leptons may not fall within detector acceptance
  - lose ~25 % at $|\eta| > 2.5$

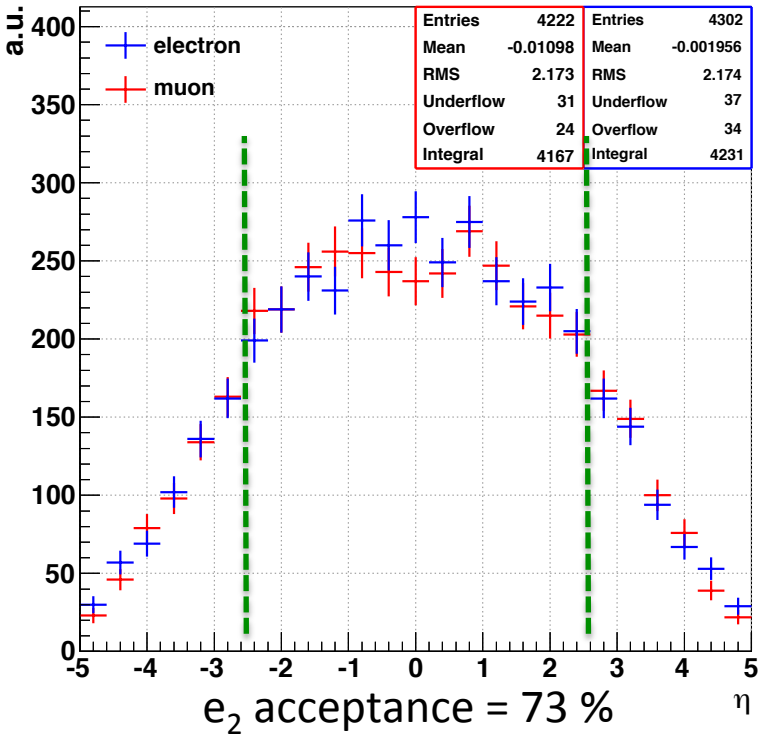
l_1 η



e_1 acceptance = 75 %

μ_1 acceptance = 75 %

l_2 η

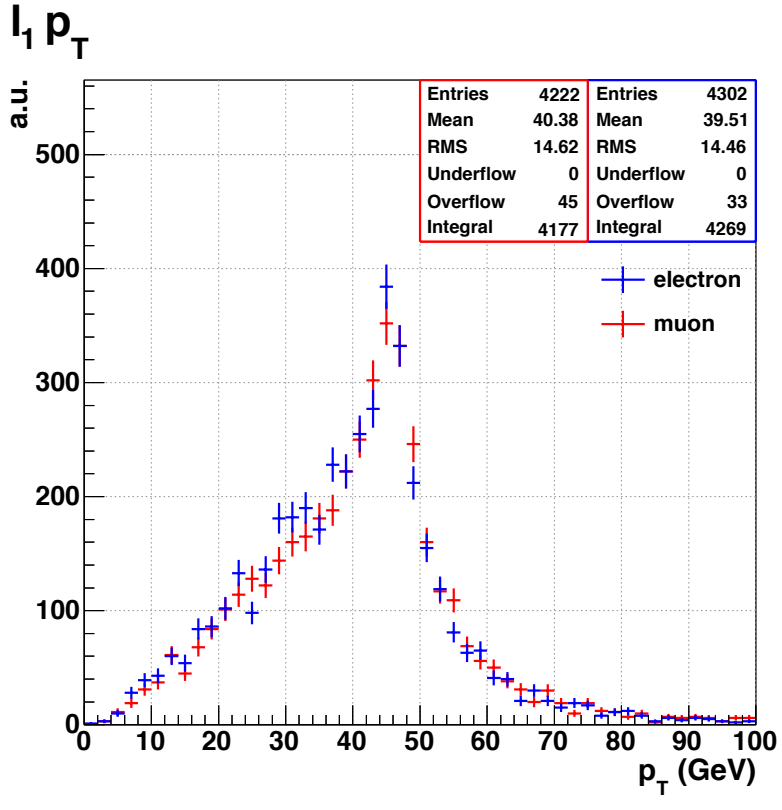


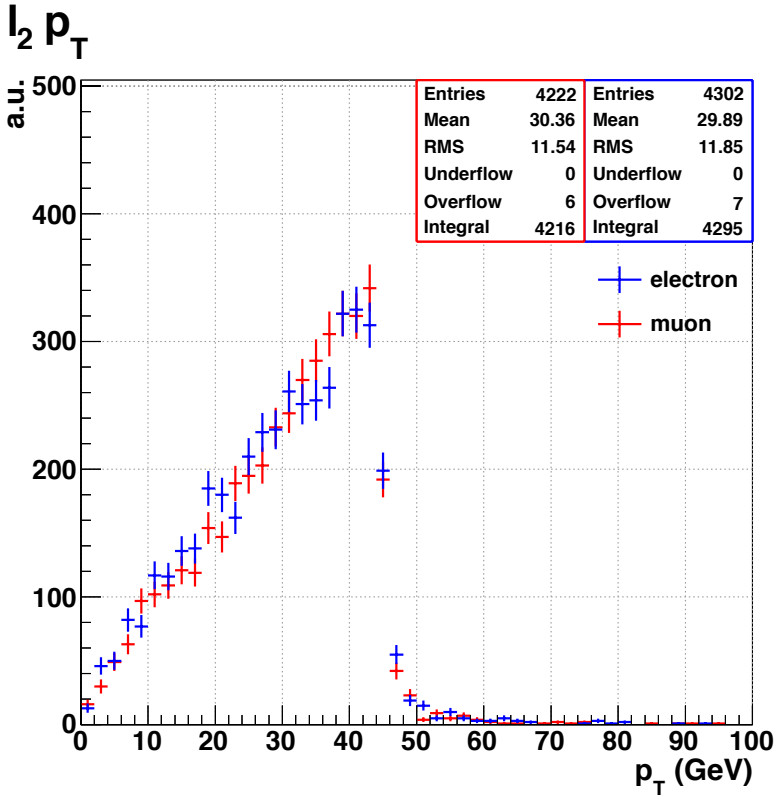
e_2 acceptance = 73 %

μ_2 acceptance = 73 %

Lepton p_T Acceptance

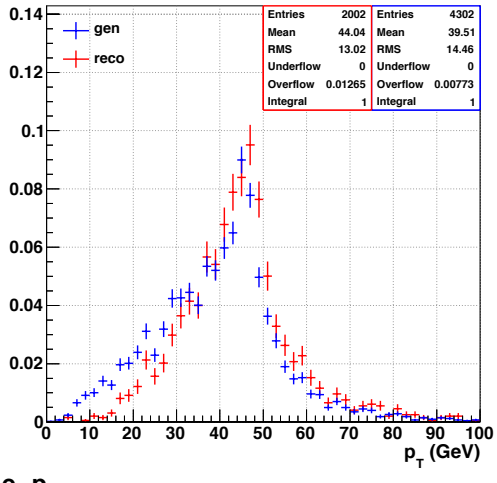
- Can reconstruct down to ~300 MeV
- ~100 % acceptance



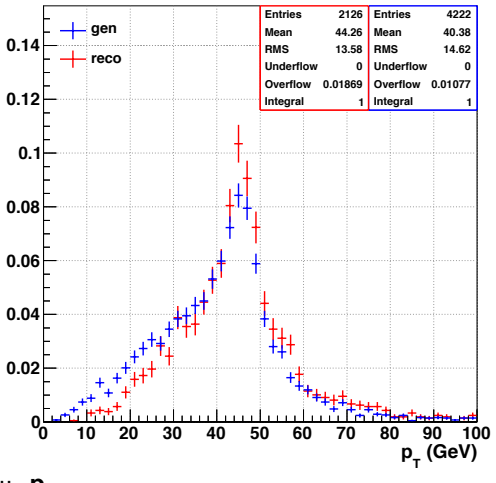


Matched Reco

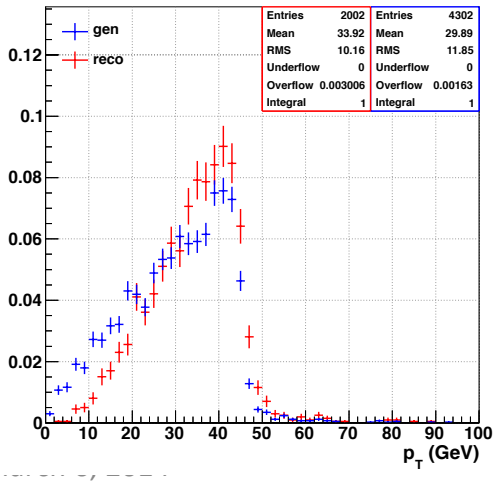
e_1 p_T



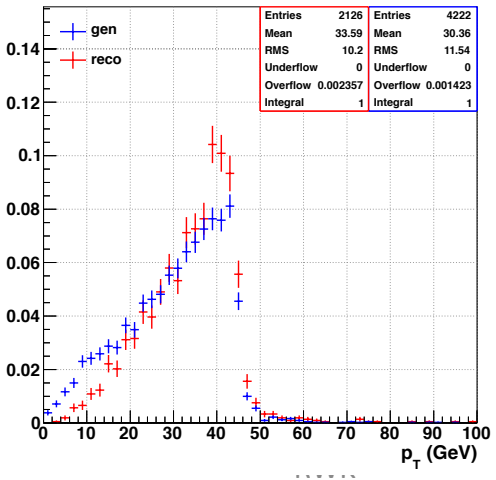
μ_1 p_T



e_2 p_T



μ_2 p_T



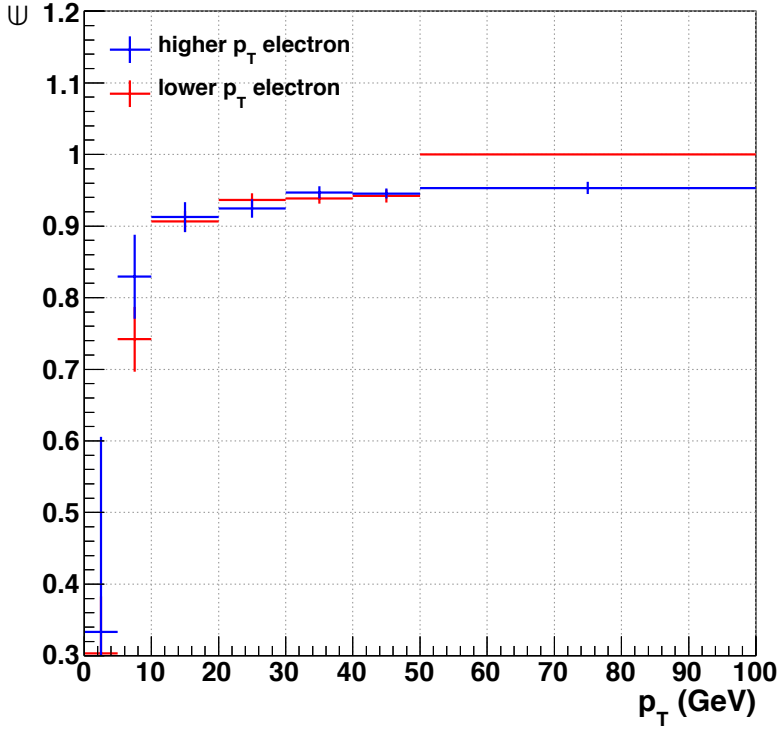
- leptons are ΔR matched to gen level
- slight bias towards higher p_T for leptons

Lepton p_T Acceptance

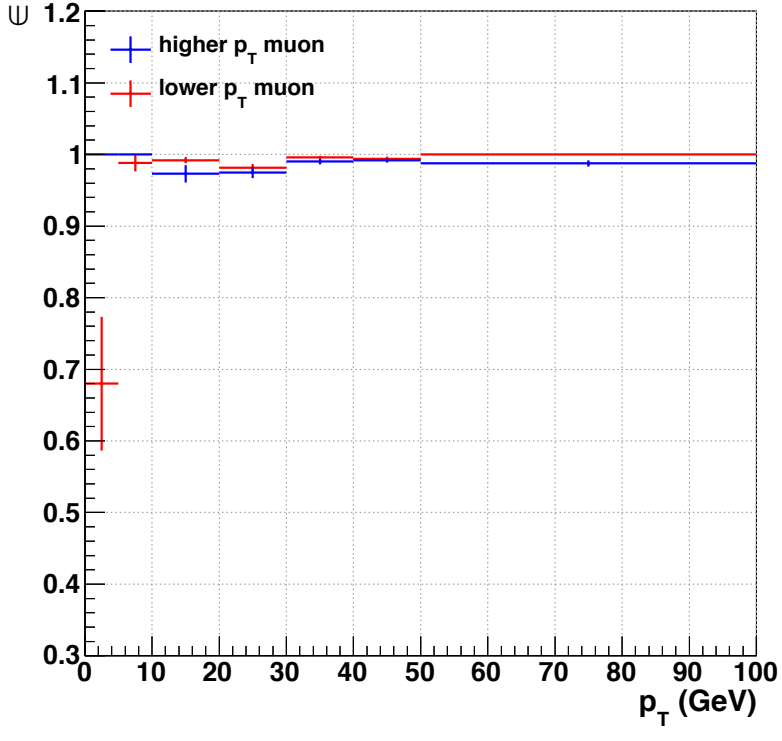
- To be fair, require $|\eta| < 2.5$

$$\epsilon = \frac{\Delta\mathrm{R\ matched\ generator\ lepton}\ p_T\ \mathrm{with}\ |\eta| < 2.4}{\mathrm{generator\ lepton}\ p_T\ \mathrm{with}\ |\eta| < 2.4}$$

electron efficiency vs p_T



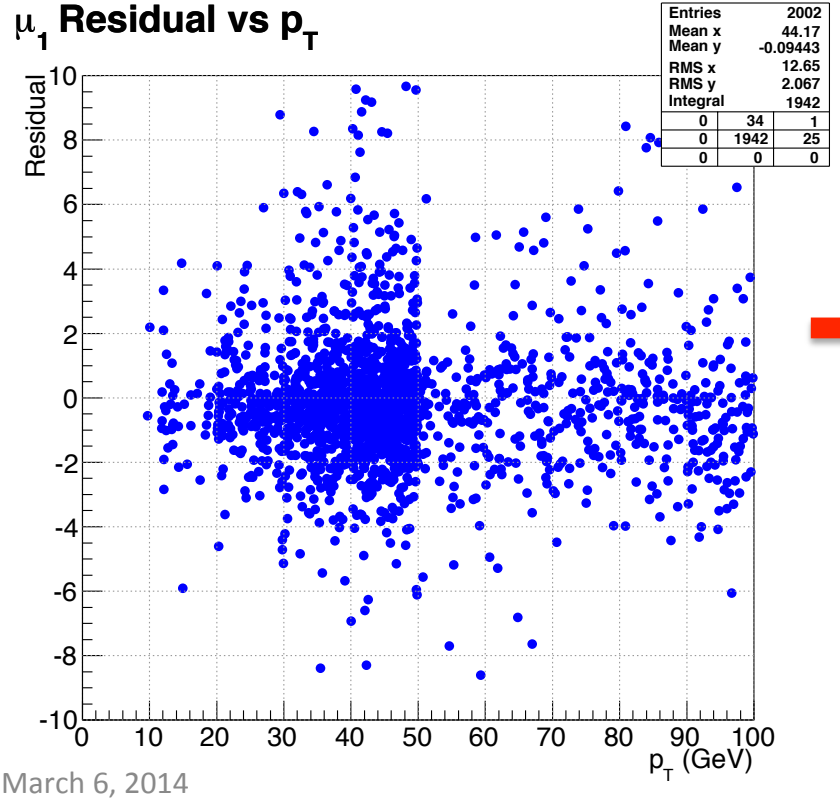
muon efficiency vs p_T

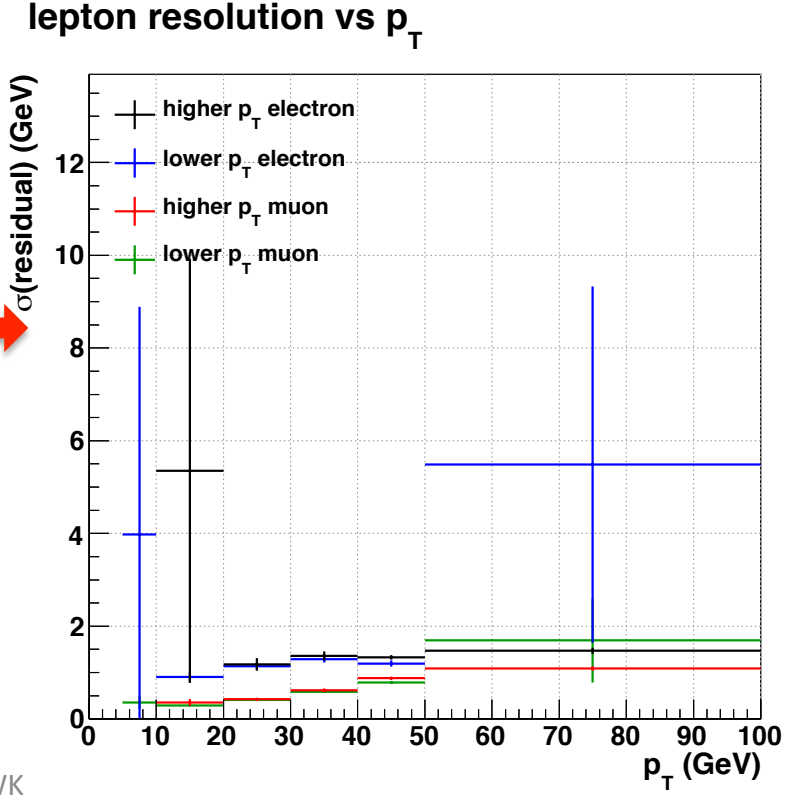


Lepton Resolution

- Fit the 2D residual vs p_T and plot the sigma of the fit in each p_T "slice"
- $\lesssim$ 2(1) GeV electron(muon) resolution after $p_T \gtrsim$ 20 GeV
- Stats too low at lower pT → need a better sample to measure low p_T resolution

$$residual = True - Measured$$

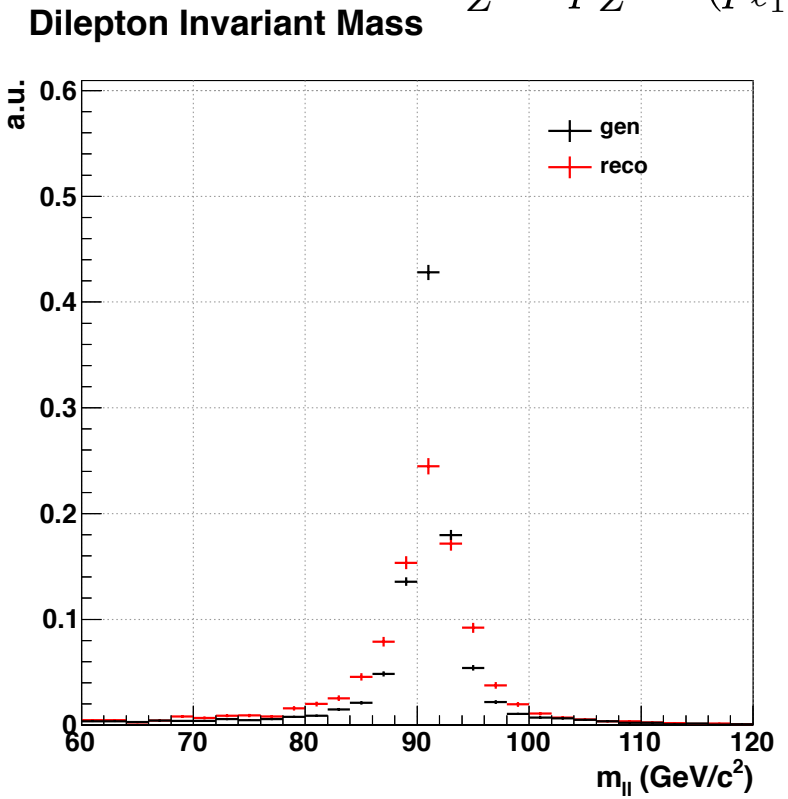


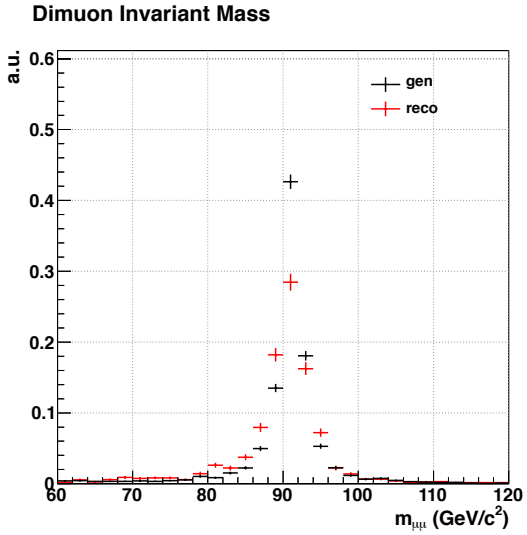


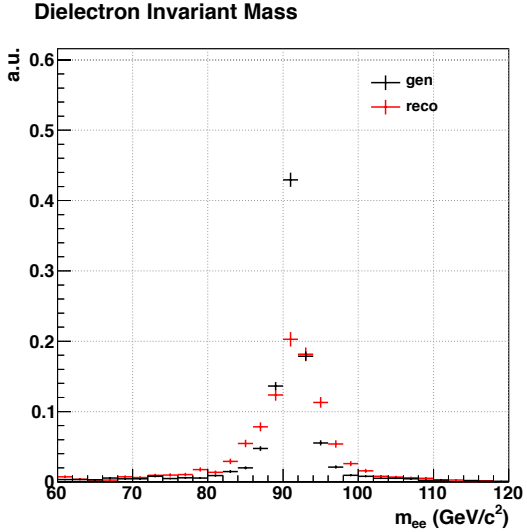
Invariant Mass

- Normalized to unit area

$$m_Z^2 = p_Z^2 = (p_{\ell_1} + p_{\ell_2})^2$$







Invariant Mass Resolution

- Fit the 2D residual vs p_T and plot the sigma of the fit in each p_T "slice"
- Poor stats and mass far from 91 GeV
- near 90 GeV, see about 2 -3 GeV resolution