$Z' \to ll$ for Snowmass

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Seattle. 2nd of July 2013.

Introduction

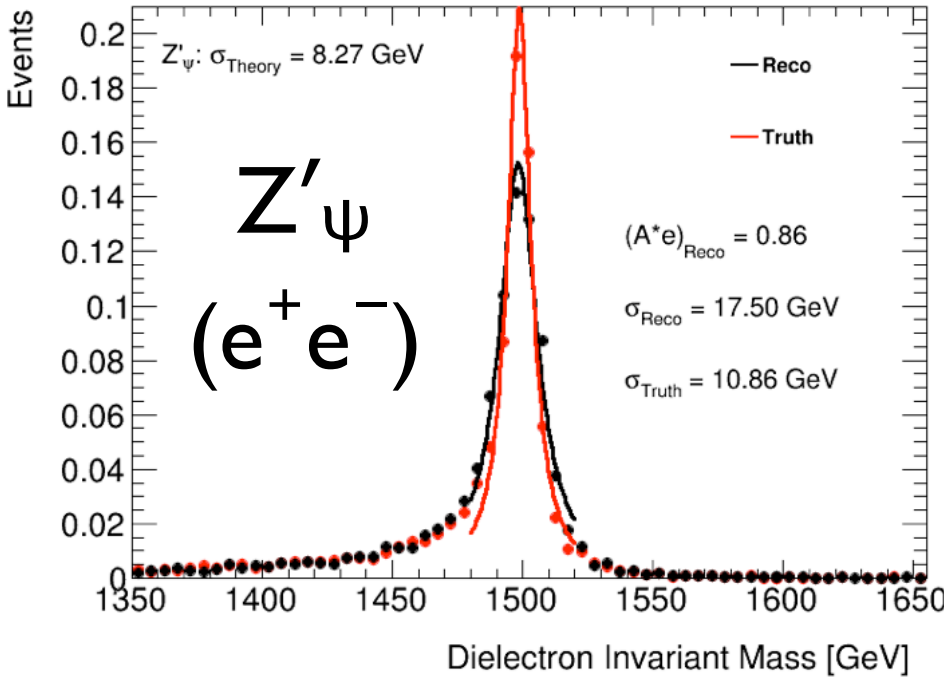
A large emphasis on "discovery stories", if we saw a bump how would we convince ourselves it was your favourite Z′ model?

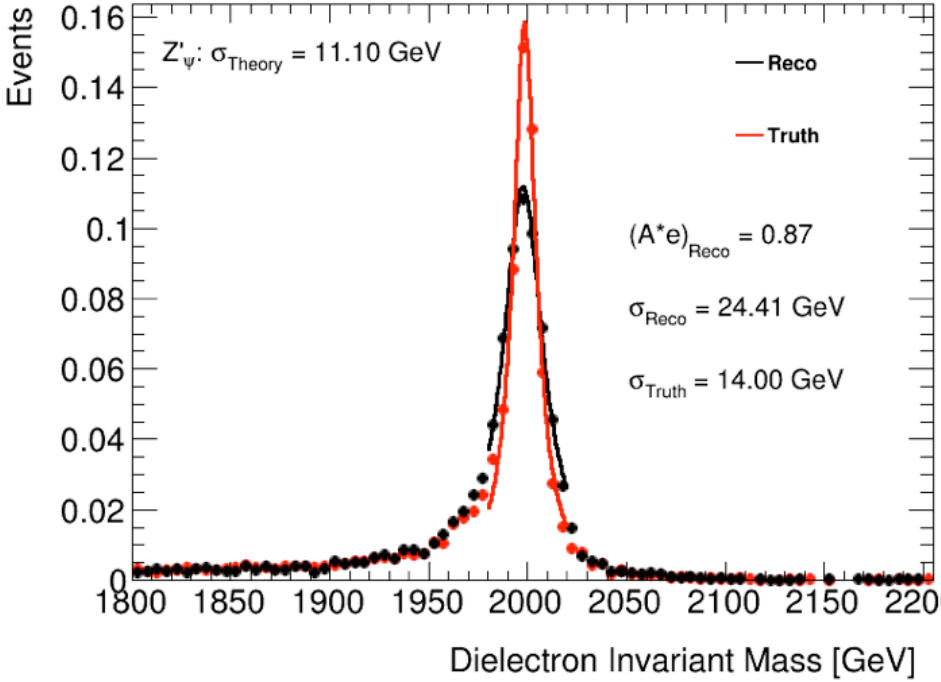
Some initial key measurements:

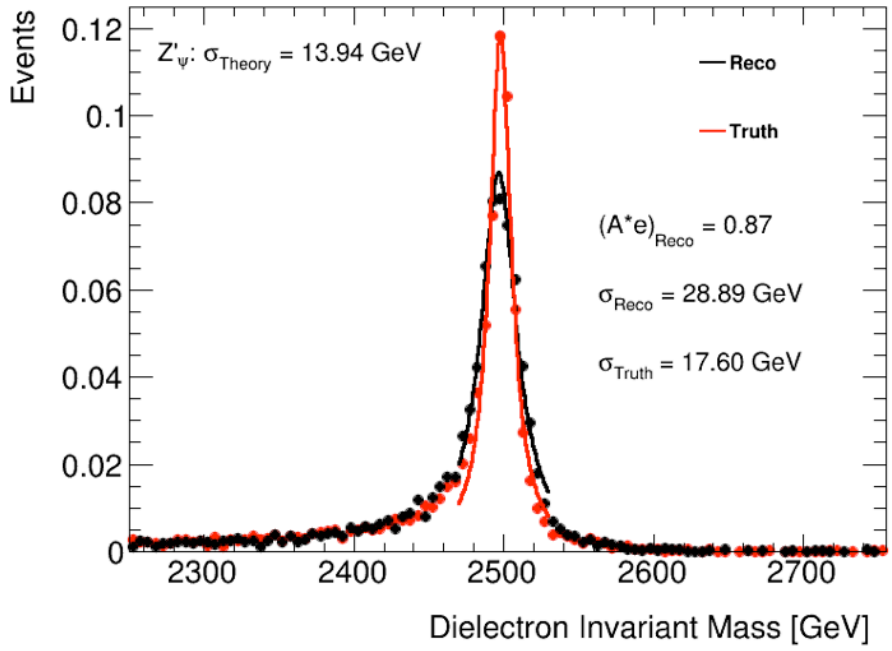
➡ Pole-mass (some systematics may shift peak position).
➡ Width (highly sensitive to detector resolution).
➡ Forward-Backward Asymmetry (charge MisID, dilution).

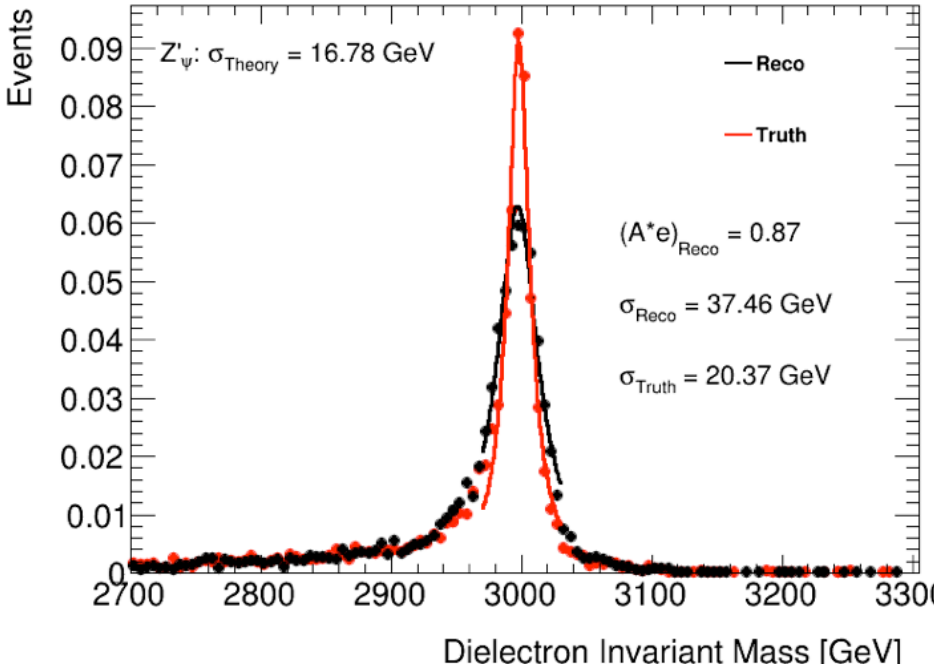
Initial study focussed on understanding our new detector, comparing the truth and reconstructed width for the Z′ at various working points, to see what a signal would look like:

- $\sqrt{s}$ = 8, 14, 33 TeV.
- Pileup = 0, 50 interactions.
- $E6_{\psi}$ (0.5% width) and SSM (3% width).
- Delphes(Snowmass) and Delphes(ATLAS) detector.


Z'ψ: σTheory = 8.27 GeV
Reco
Truth
Z′ψ
(e+e−)
(A*e)Reco = 0.86
σReco = 17.50 GeV
σTruth = 10.86 GeV
Events
Dielectron Invariant Mass [GeV]

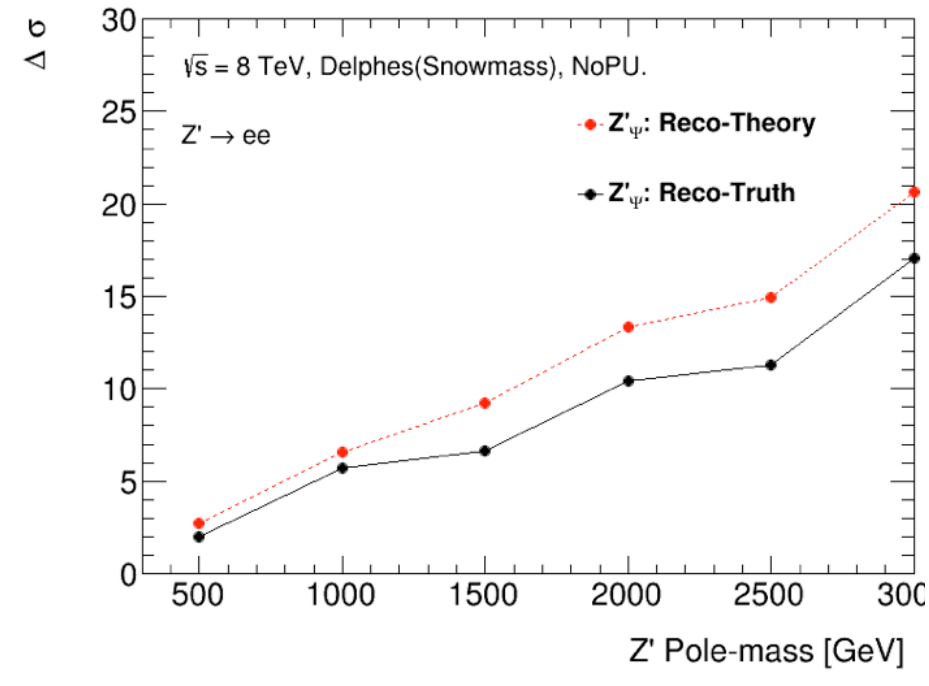

Z'ψ: σTheory = 11.10 GeV
Reco
Truth
(A*e)Reco = 0.87
σReco = 24.41 GeV
σTruth = 14.00 GeV
Events
Dielectron Invariant Mass [GeV]


Z'ψ: σTheory = 13.94 GeV
Reco
Truth
(A*e)Reco = 0.87
σReco = 28.89 GeV
σTruth = 17.60 GeV
Events
Dielectron Invariant Mass [GeV]

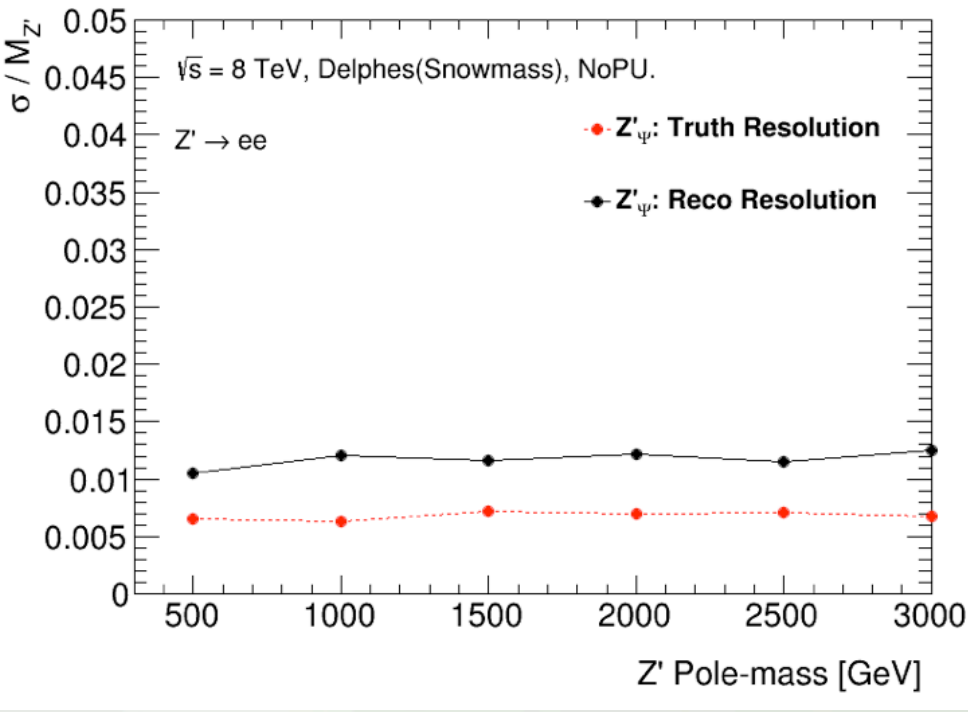

Z'ψ: σTheory = 16.78 GeV
Reco
Truth
(A*e)Reco = 0.87
σReco = 37.46 GeV
σTruth = 20.37 GeV
Events
Dielectron Invariant Mass [GeV]

Delphes (Snowmass) - Electron Channel

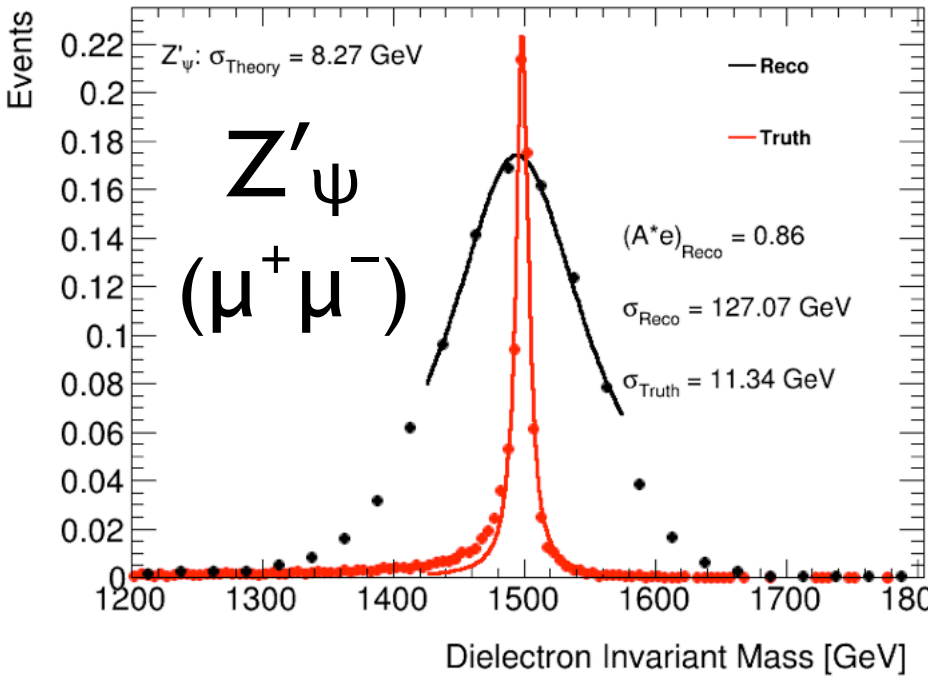
Δσ

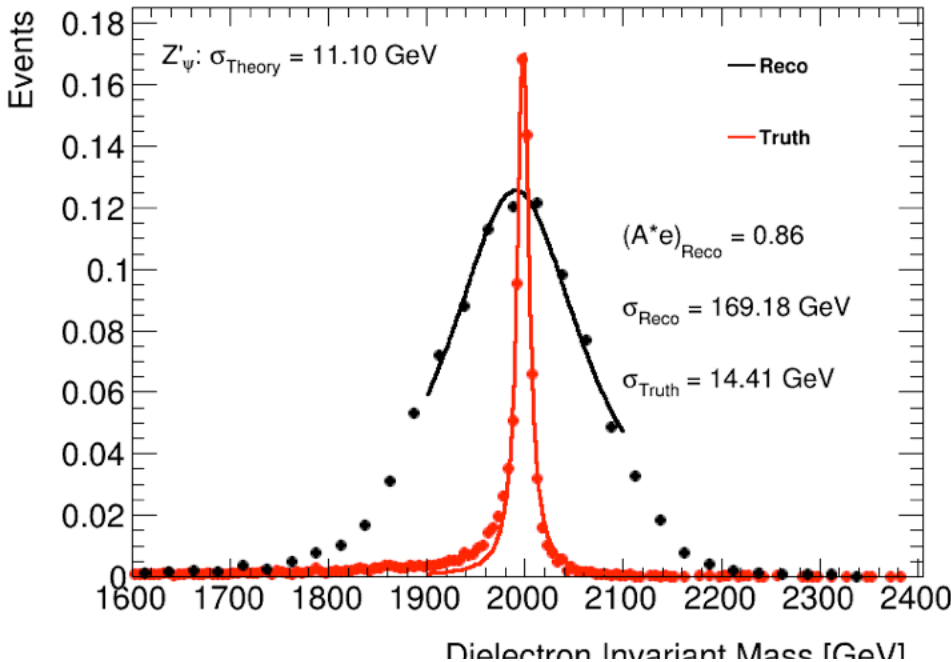


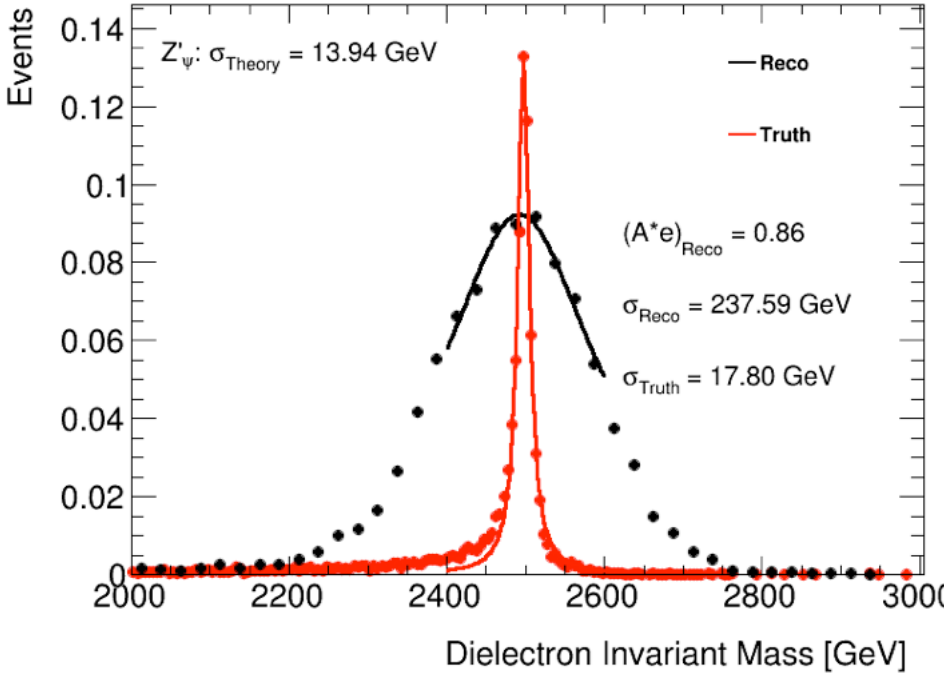
σ/M

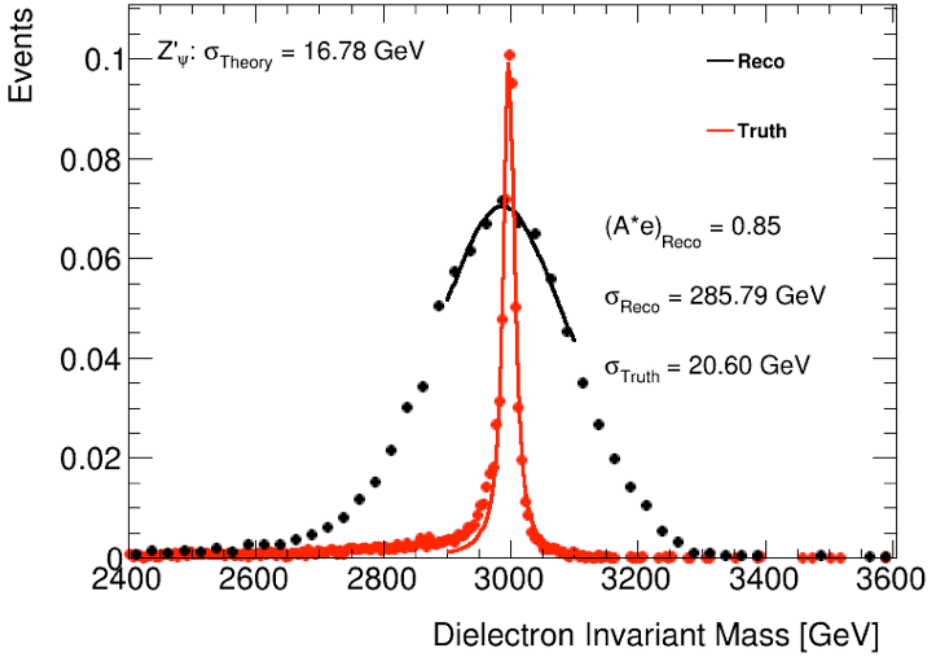


Dielectron Invariant Mass Resolution is good, agrees with what we expect from previous experience.


Z′ψ
(μ⁺μ⁻)
Z'ψ: σTheory = 8.27 GeV
Reco
Truth
(A*e)Reco = 0.86
σReco = 127.07 GeV
σTruth = 11.34 GeV
Events
Dielectron Invariant Mass [GeV]

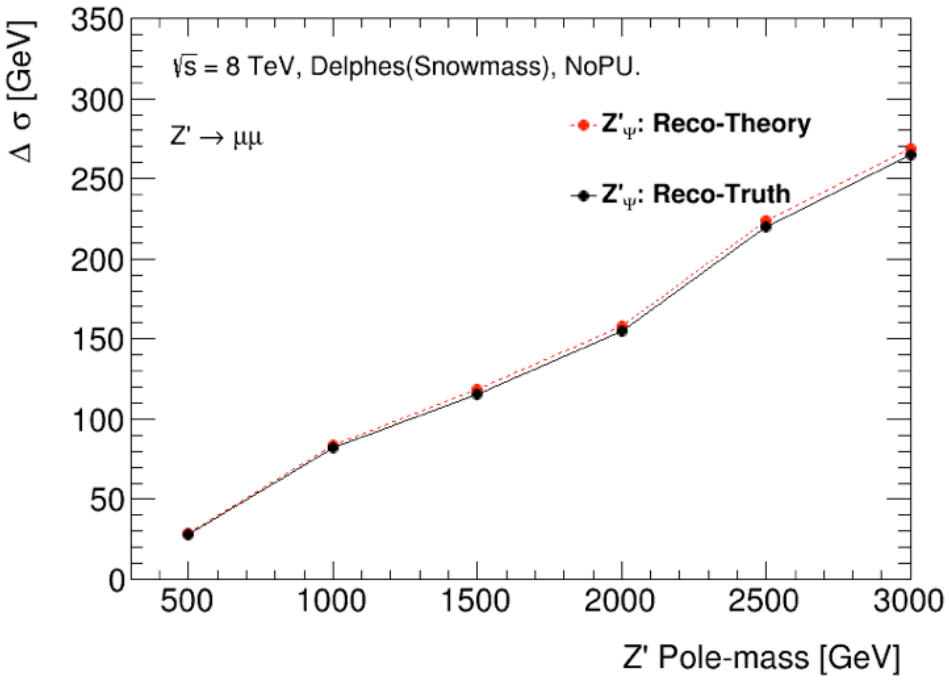

Z'ψ: σTheory = 11.10 GeV
Reco
Truth
(A*e)Reco = 0.86
σReco = 169.18 GeV
σTruth = 14.41 GeV
Events
Dielectron Invariant Mass [GeV]


Z'ψ: σTheory = 13.94 GeV
Reco
Truth
(A*e)Reco = 0.86
σReco = 237.59 GeV
σTruth = 17.80 GeV
Events
Dielectron Invariant Mass [GeV]

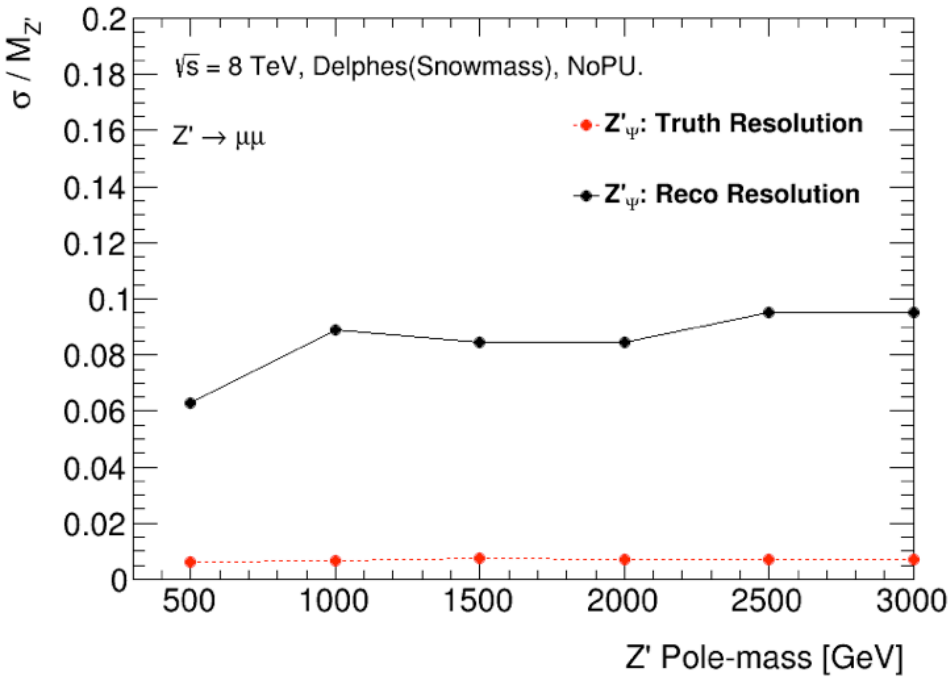

Z'ψ: σTheory = 16.78 GeV
Reco
Truth
(A*e)Reco = 0.85
σReco = 285.79 GeV
σTruth = 20.60 GeV
Events
Dielectron Invariant Mass [GeV]

Delphes (Snowmass) - Muon Channel

Δσ

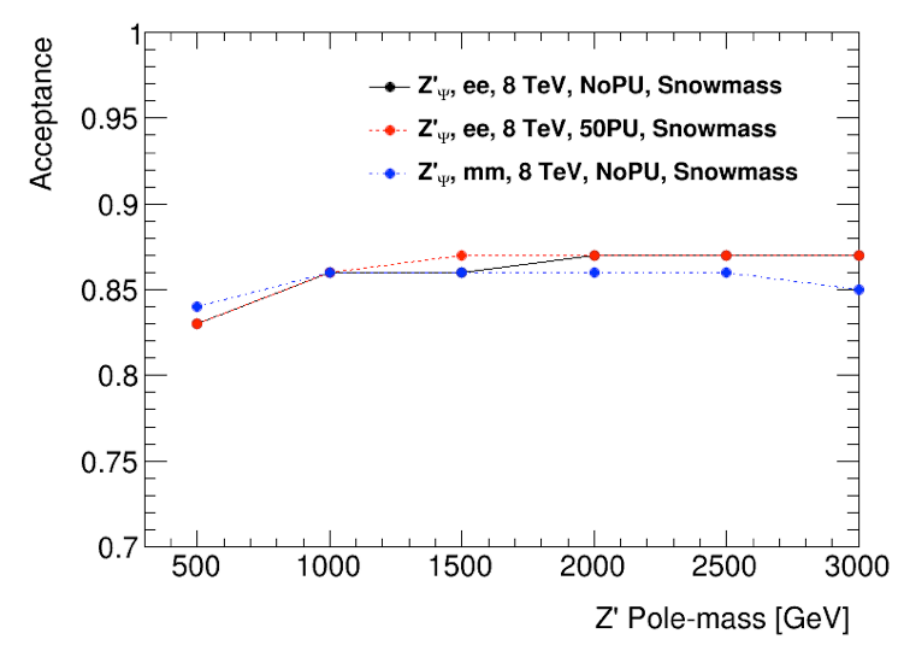


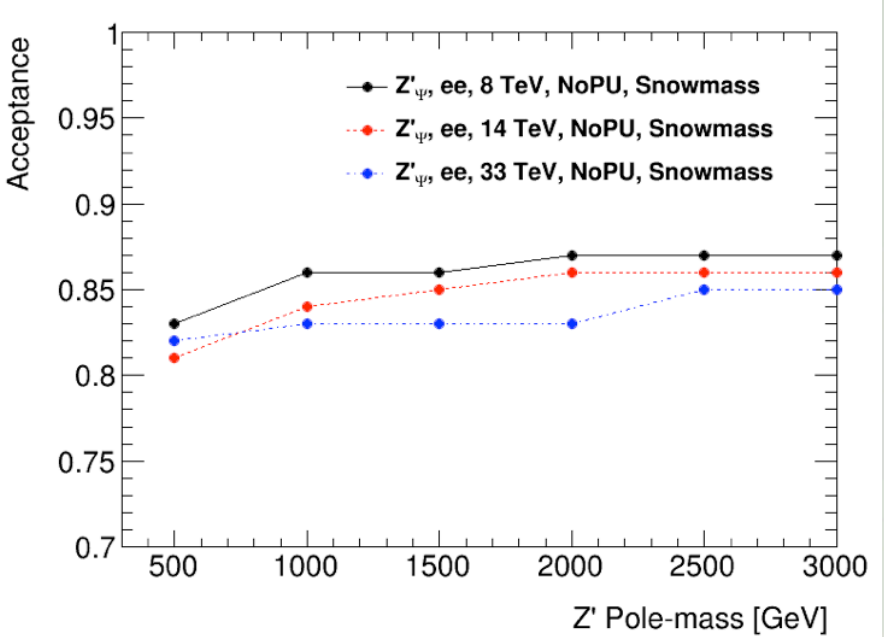
σ/M



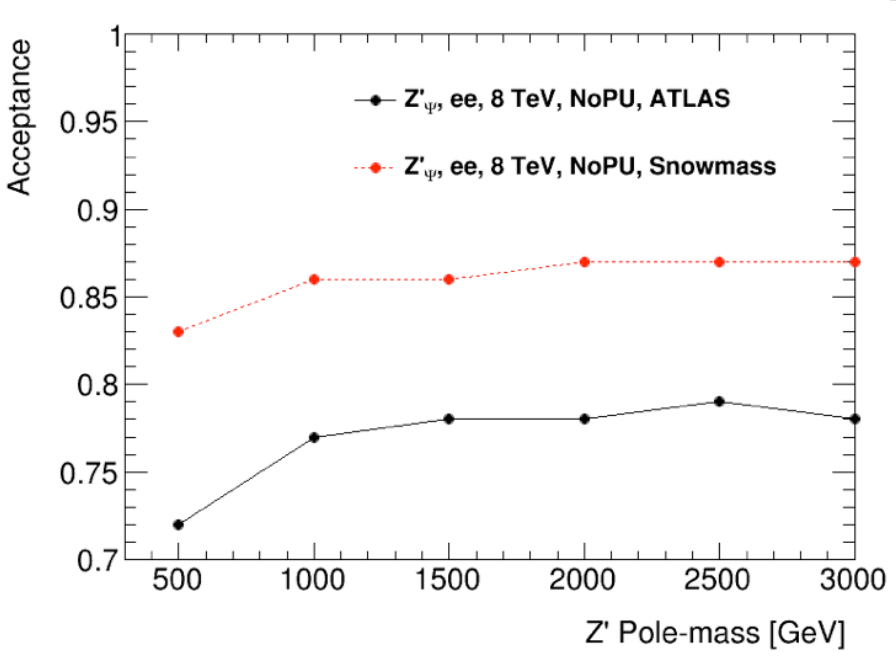
Dimuon Invariant Mass Resolution is much worse at ~9%.
As opposed to ~1% Resolution for dielectrons.
This is also inline with what we expect, but indicates challenge for model-dependent width discrimination.

Acceptance: PileUp and √s Dependence



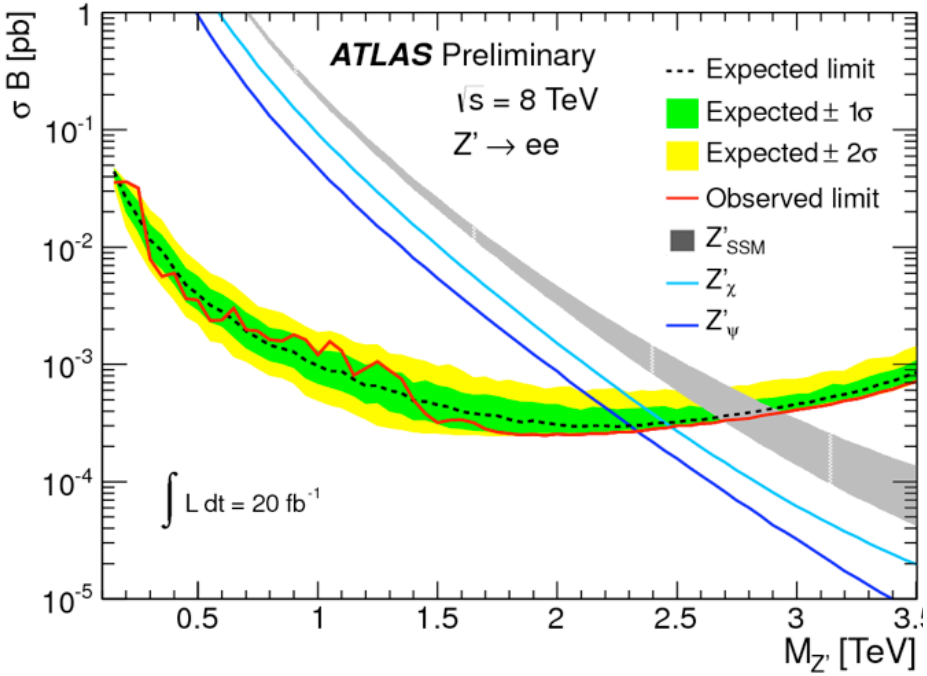


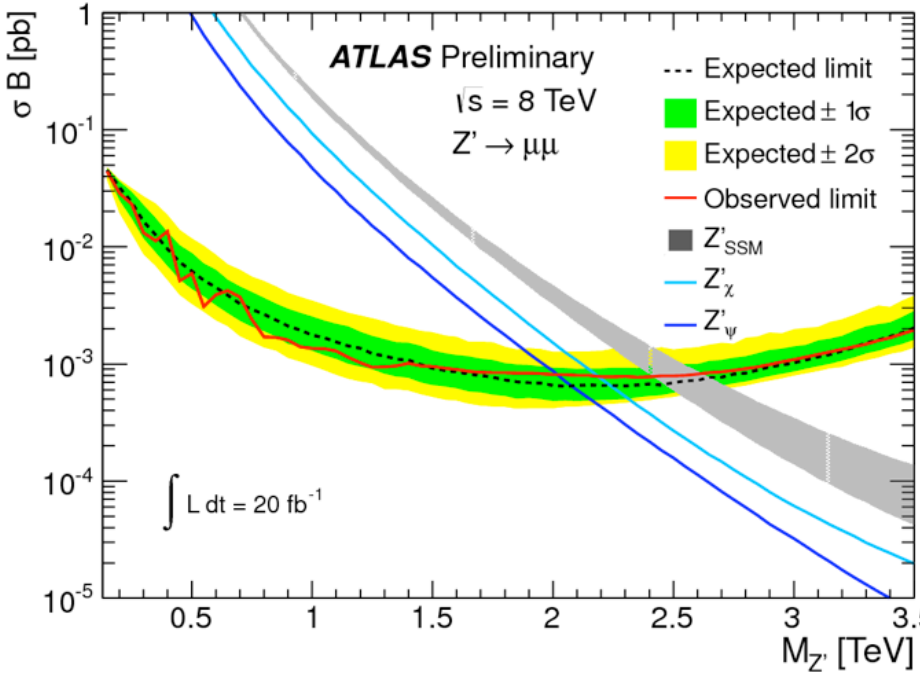
- Acceptance does not appear to be adversely affected by Pileup in the dilepton channel.
- Small dependence on √s.
- Snowmass Detector has overall better acceptance, compared to ATLAS card.
- Similar acceptance between lepton flavours.



Current Official Limits (ATLAS)

Use full line shape, BAT statistical framework.





Expected Limits for Snowmass Detector

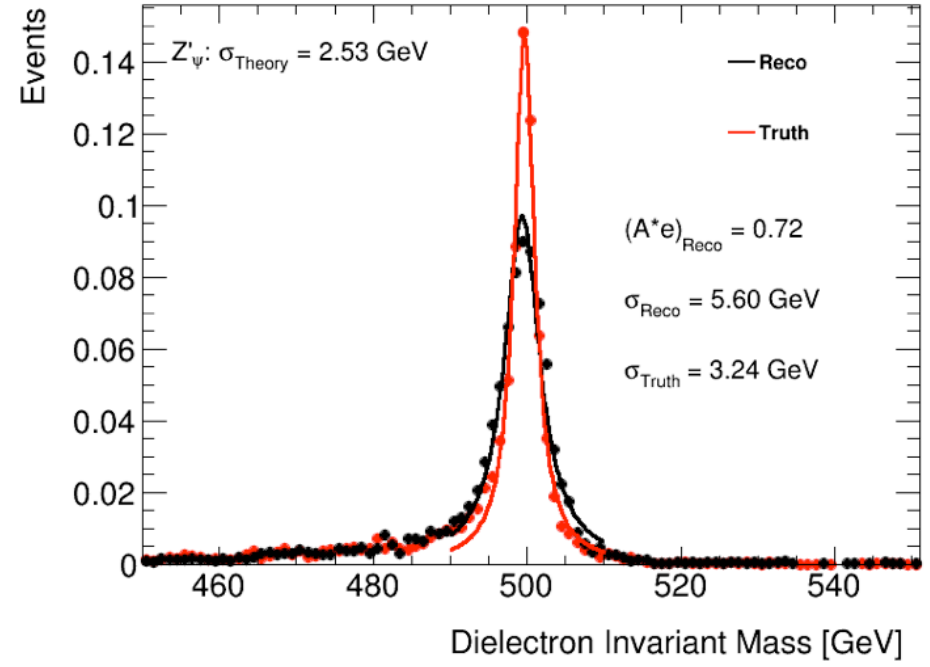
Will use signal/bkg shapes from Delphes(Snowmass)

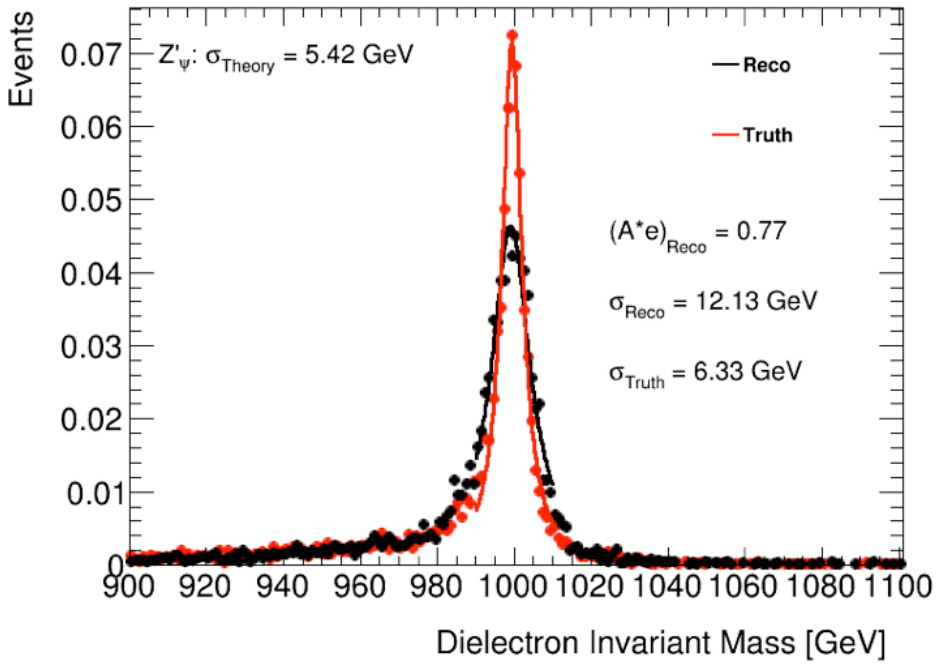
Extract Limits for $\sqrt{s}$ =14, 33, 100 TeV ($\int$ L.dt = 30, 3000 ifb)

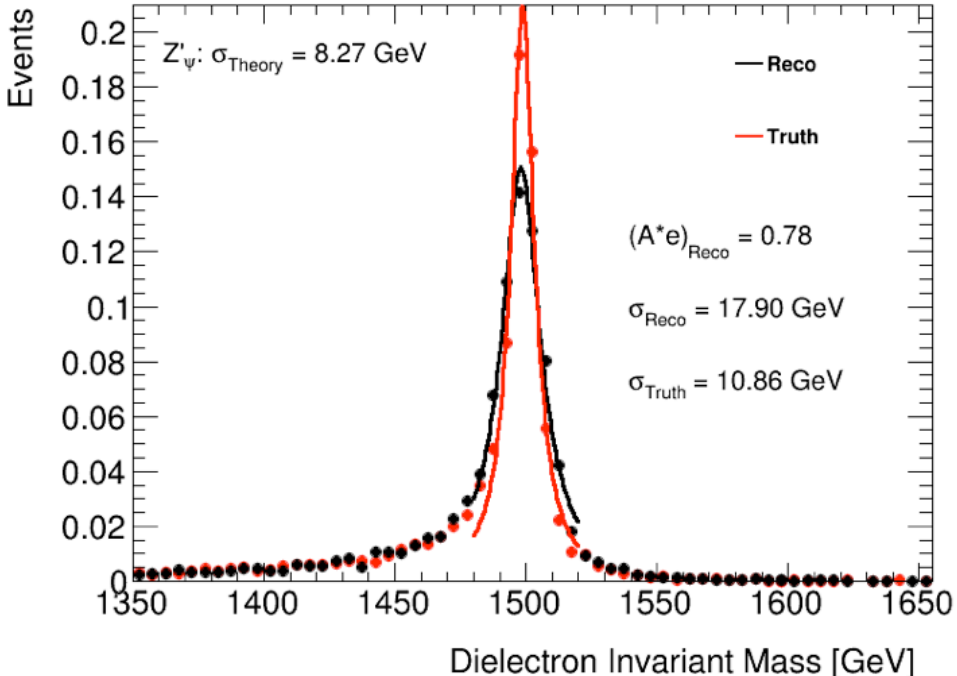
Backup

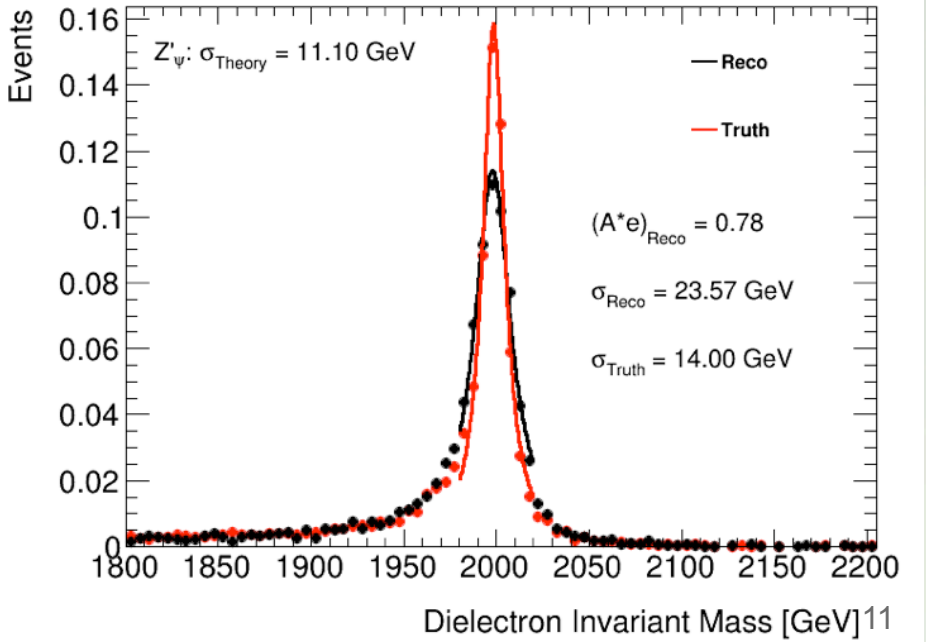
E6ψ

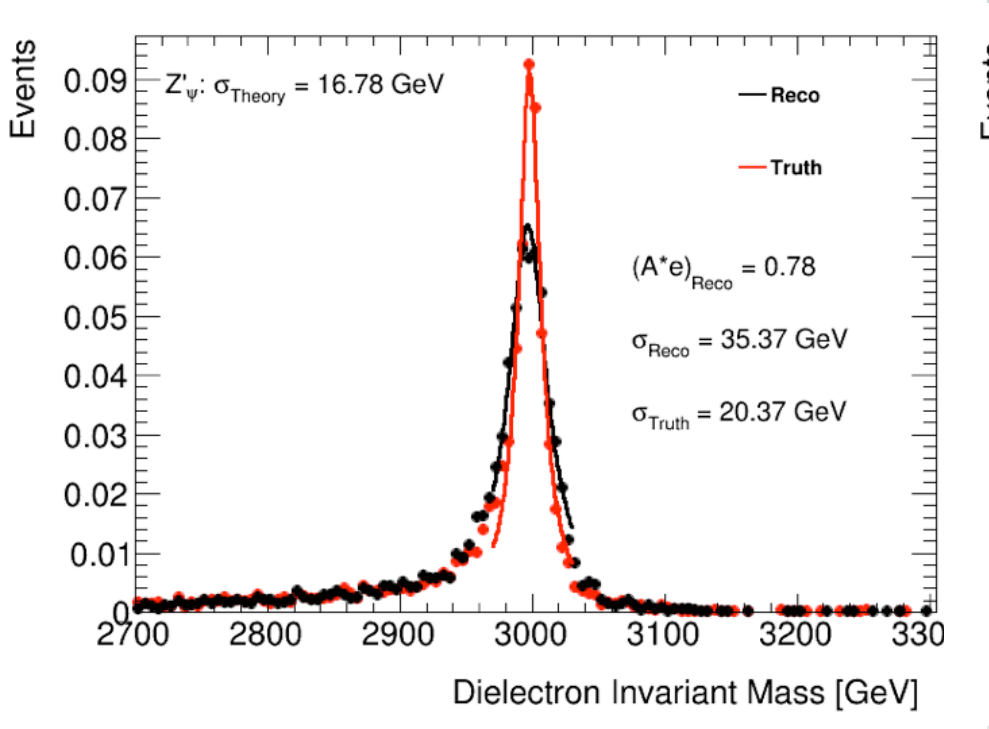
Delphes ATLAS Detector - Electron Channel - NoPU

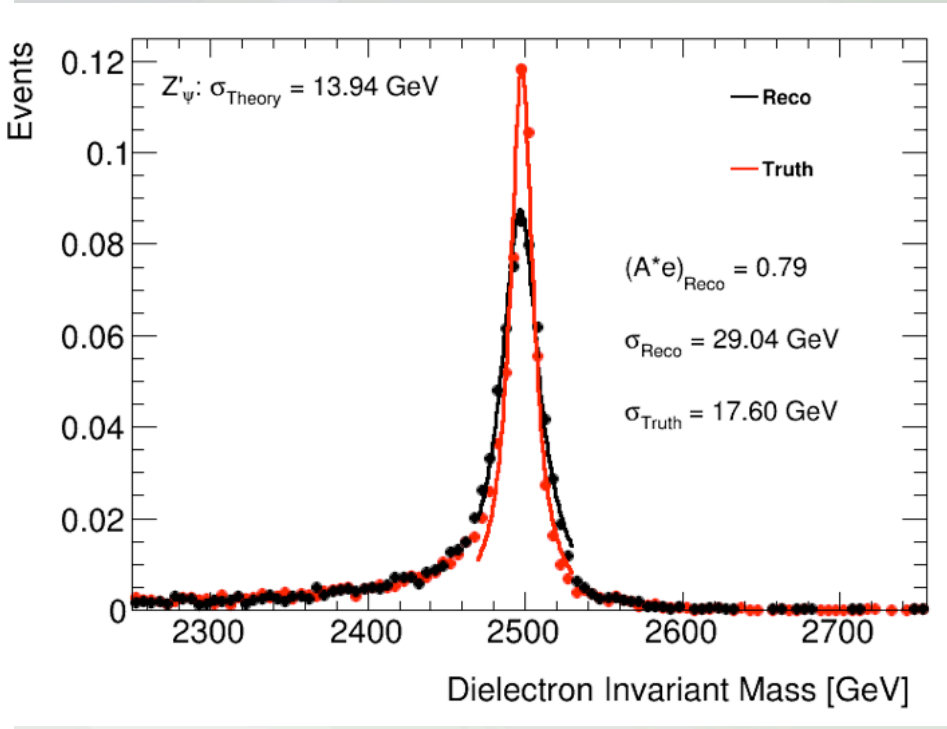

Events
Z'ψ: σTheory = 2.53 GeV
Reco
Truth
(A*e)Reco = 0.72
σReco = 5.60 GeV
σTruth = 3.24 GeV
Dielectron Invariant Mass [GeV]


Events
Z'ψ: σTheory = 5.42 GeV
Reco
Truth
(A*e)Reco = 0.77
σReco = 12.13 GeV
σTruth = 6.33 GeV
Dielectron Invariant Mass [GeV]


Events
Z'ψ: σTheory = 8.27 GeV
Reco
Truth
(A*e)Reco = 0.78
σReco = 17.90 GeV
σTruth = 10.86 GeV
Dielectron Invariant Mass [GeV]

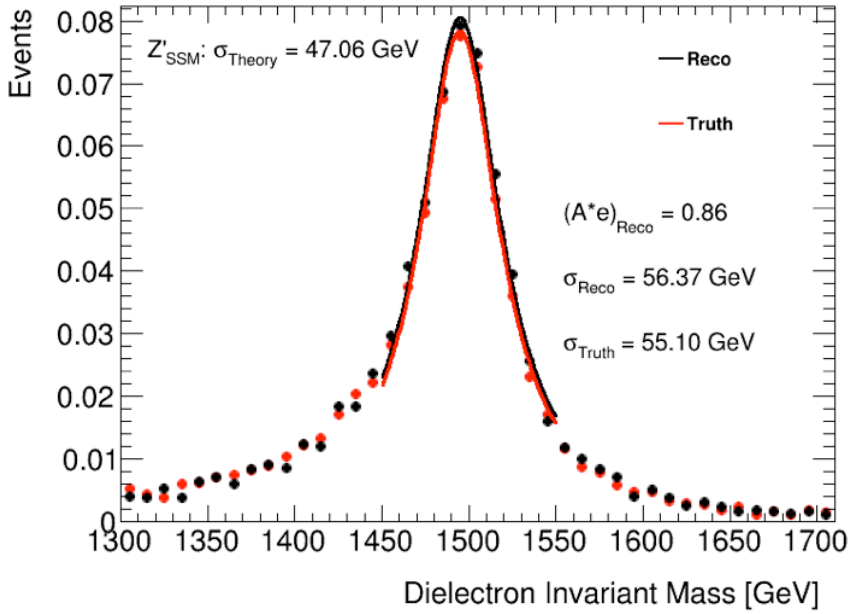

Events
Z'ψ: σTheory = 11.10 GeV
Reco
Truth
(A*e)Reco = 0.78
σReco = 23.57 GeV
σTruth = 14.00 GeV
Dielectron Invariant Mass [GeV]

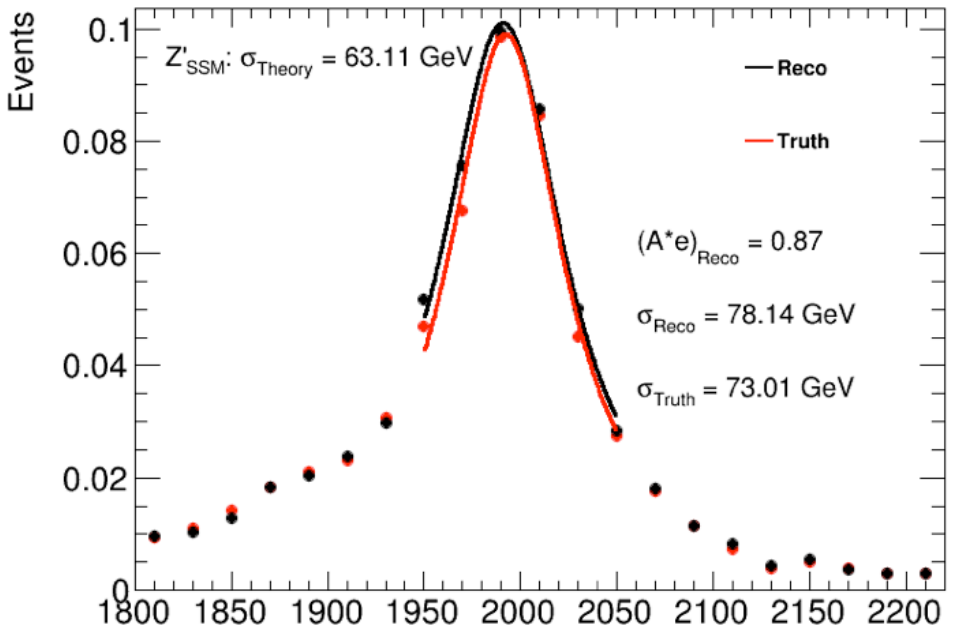

Events
Z'ψ: σTheory = 16.78 GeV
Reco
Truth
(A*e)Reco = 0.78
σReco = 35.37 GeV
σTruth = 20.37 GeV
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
2700
2800
2900
3000
3100
3200
330
Dielectron Invariant Mass [GeV]

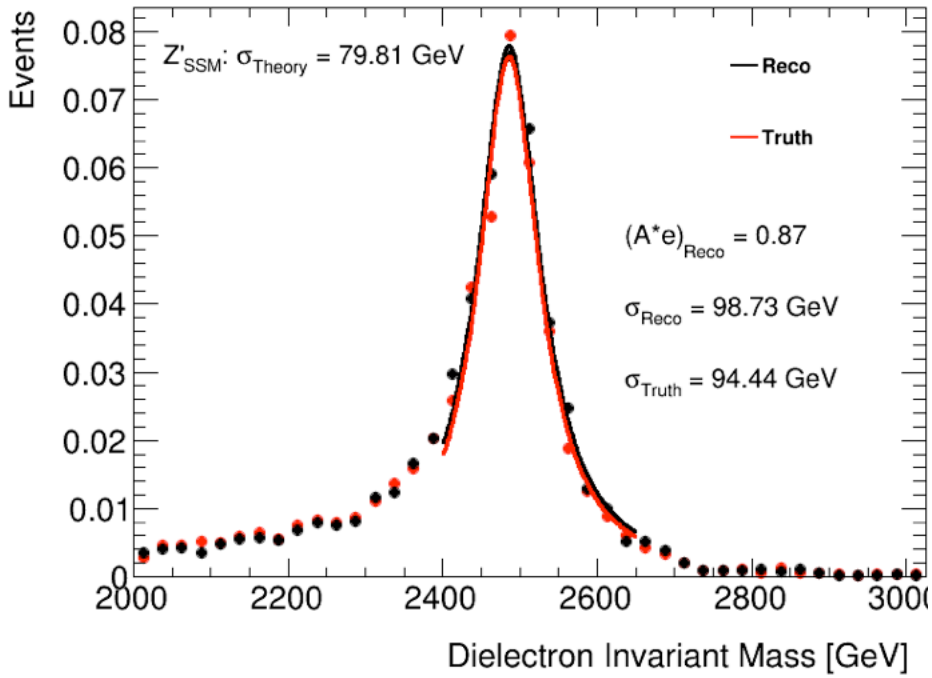

Events
Z'ψ: σTheory = 13.94 GeV
Reco
Truth
(A*e)Reco = 0.79
σReco = 29.04 GeV
σTruth = 17.60 GeV
0.12
0.1
0.08
0.06
0.04
0.02
0
2300
2400
2500
2600
2700
Dielectron Invariant Mass [GeV]

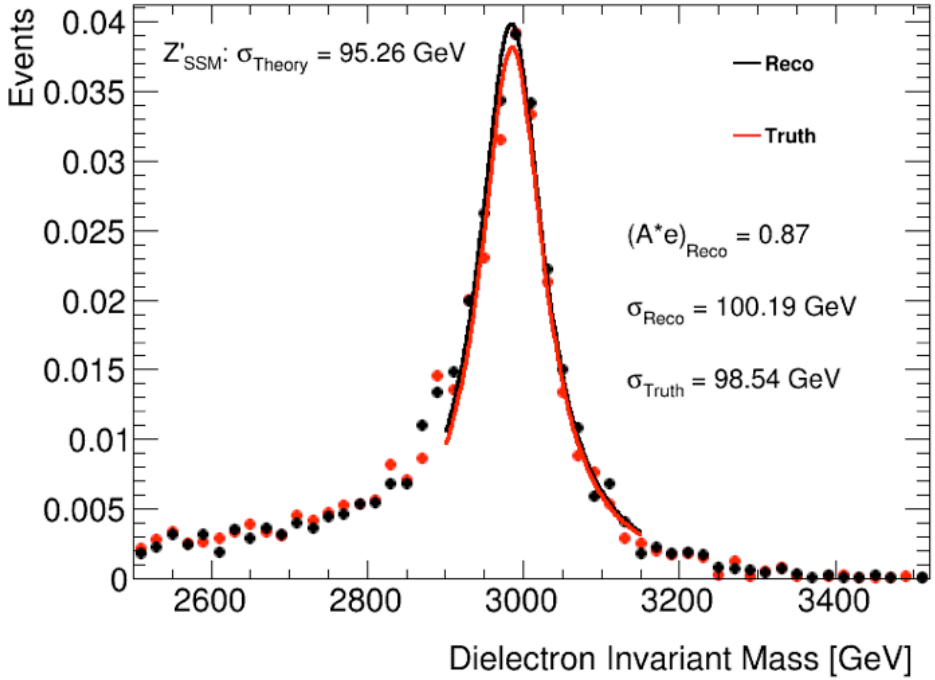
SSM

Snowmass Detector - Electron Channel - 50PU


Z'SSM: σTheory = 47.06 GeV
Reco
Truth
(A*e)Reco = 0.86
σReco = 56.37 GeV
σTruth = 55.10 GeV
Events
Dielectron Invariant Mass [GeV]


Z'SSM: σTheory = 63.11 GeV
Reco
Truth
(A*e)Reco = 0.87
σReco = 78.14 GeV
σTruth = 73.01 GeV
Events


Z'SSM: σTheory = 79.81 GeV
Reco
Truth
(A*e)Reco = 0.87
σReco = 98.73 GeV
σTruth = 94.44 GeV
Events
Dielectron Invariant Mass [GeV]


Z'SSM: σTheory = 95.26 GeV
Reco
Truth
(A*e)Reco = 0.87
σReco = 100.19 GeV
σTruth = 98.54 GeV
Events
Dielectron Invariant Mass [GeV]