Standard Model $Z \rightarrow ee$ Analysis

and

Fast Shower Simulation Validation

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Outline

Tools for $Z->ee$ analysis

- Motivation
- Tool development
- Electron distributions
- $Z \rightarrow ee$ distributions

Use this tools to validate Fast Simulation

- Validation by electrons
- Validation by Z boson

- Summary and Outlook

Motivation

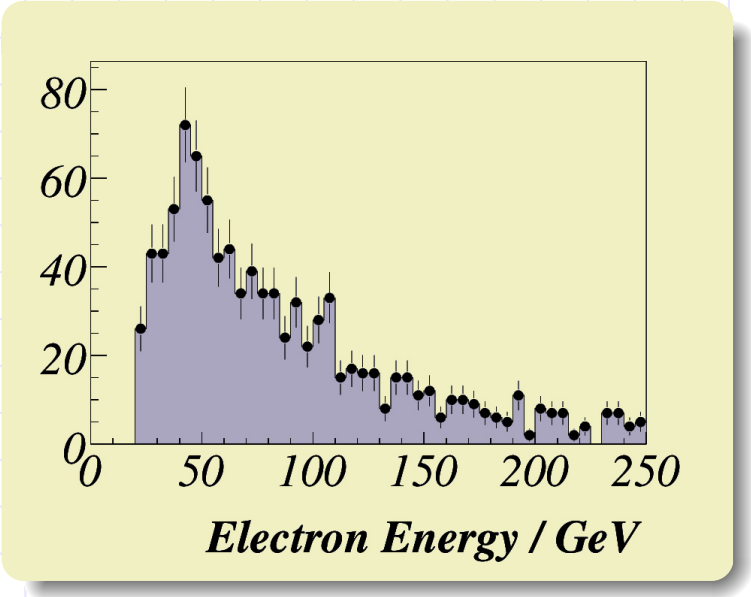
- Start of SM analysis. Take the simplest channel: Z boson production.
- Develop tools on *AOD* level for future more complex analyses (i.e. pseudo-W)
- Physics:
  - Z production as a function of rapidity (sensitive to PDFs)
  - $W^{\pm}$ production asymmetry: $\frac{W^+ - W^-}{W^+ + W^-}$
  - W - mass
- Use $Z \rightarrow ee$ to validate fast simulation.

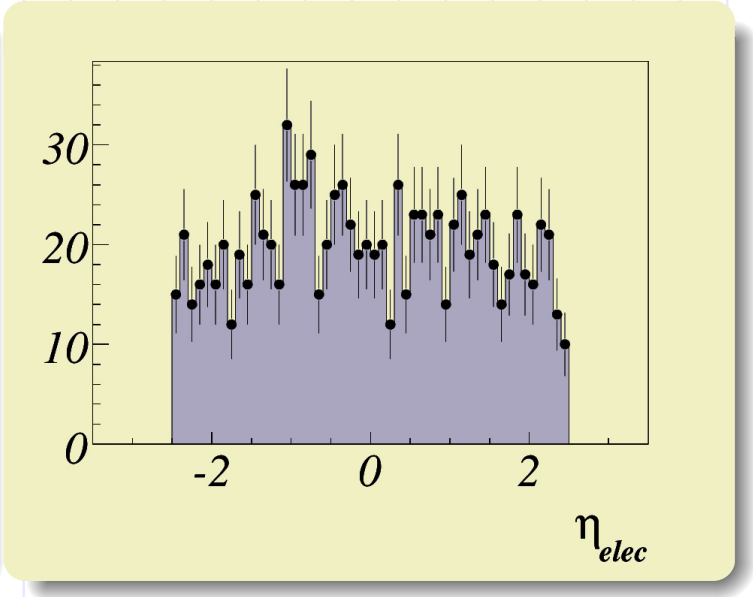
Developing a Tool

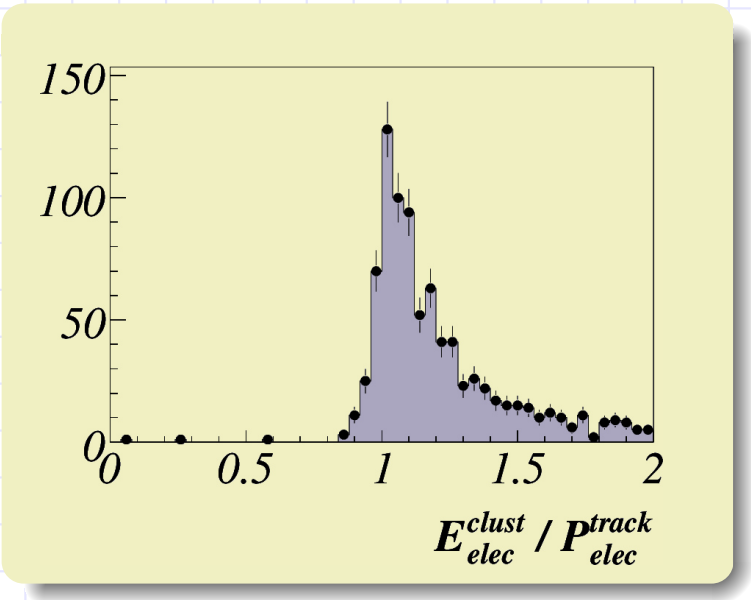
- Use ElectronAODCollection container
- Take 13.0.20 Athena release
- Start from $Z \rightarrow ee$ example
- Apply selection:
  - Electron *isEm* bit = 16
  - $E_T^{electron} > 20.0$ GeV
  - $|\eta^{electron}| < 2.5$
  - A pair of two electrons with an opposit charge to form Z
- Generated information

Container	Data Access Key
TruthParticleContainer	"SpclMC"
McEventCollection	"GEN_AOD"

Electron Distributions

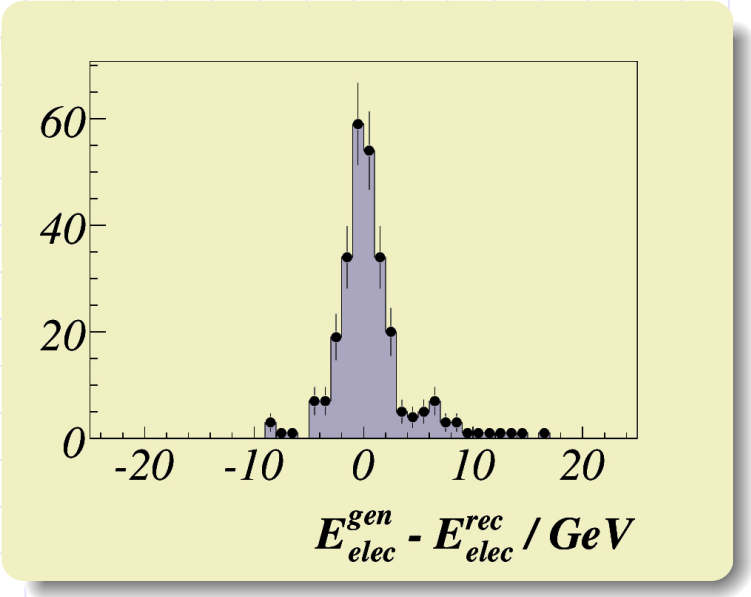


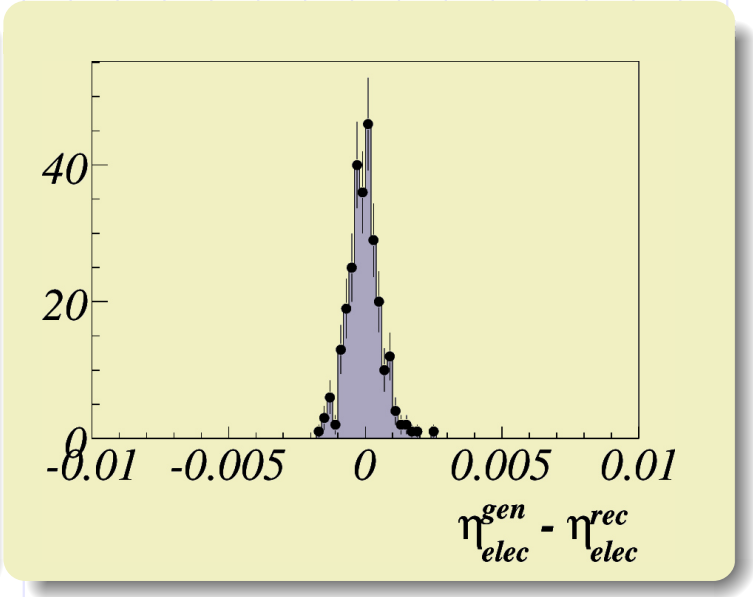


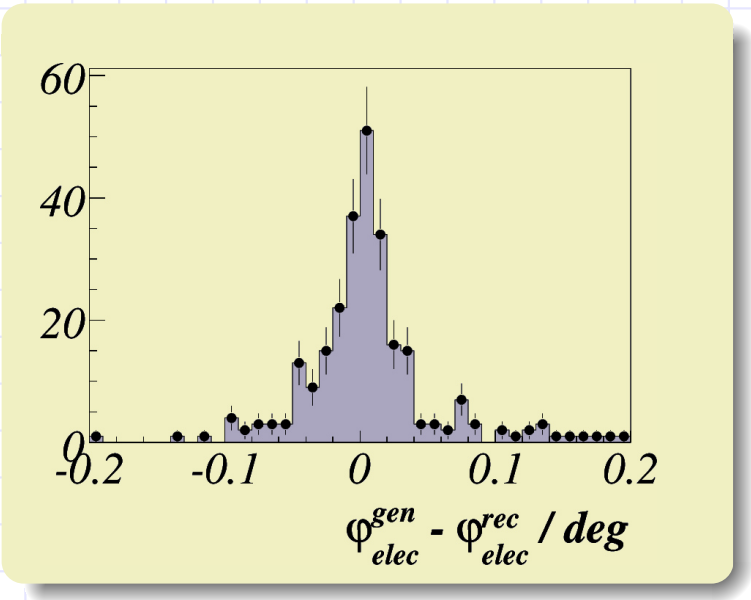


Use *ElectronAODCollection* container to study properties of the selected electrons from $Z \rightarrow ee$

Electron Reconstruction Resolution

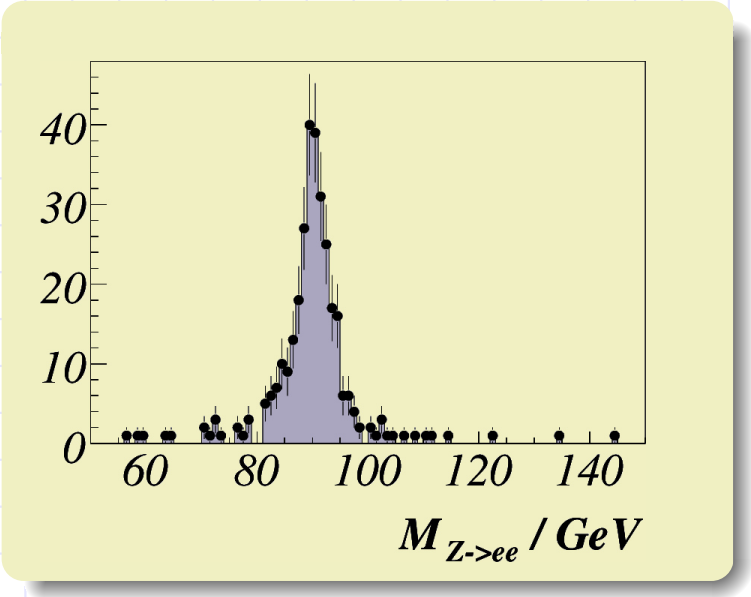


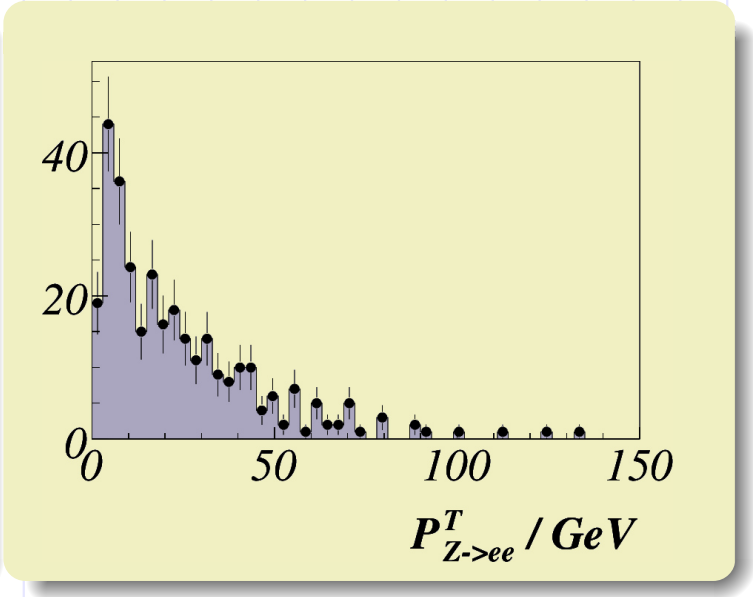


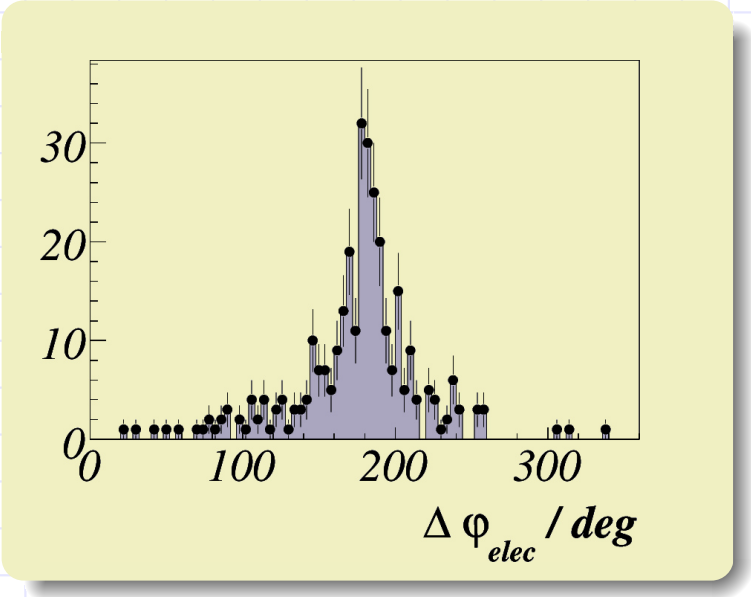


Compare reconstructed variables with the generated information in order to study resolution, acceptance, etc.

Z Boson Reconstruction

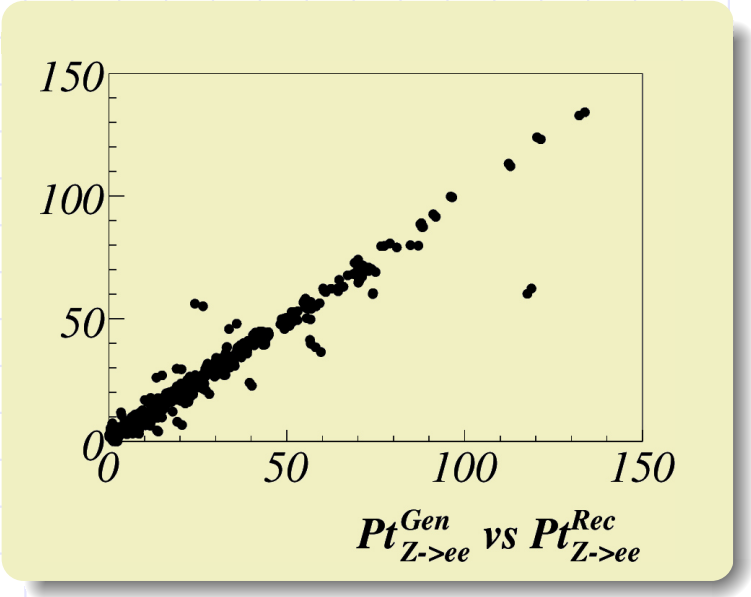


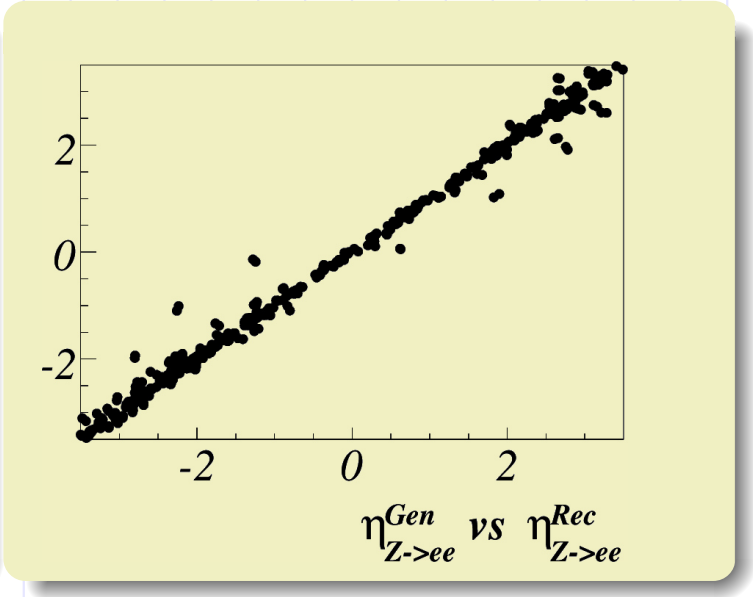


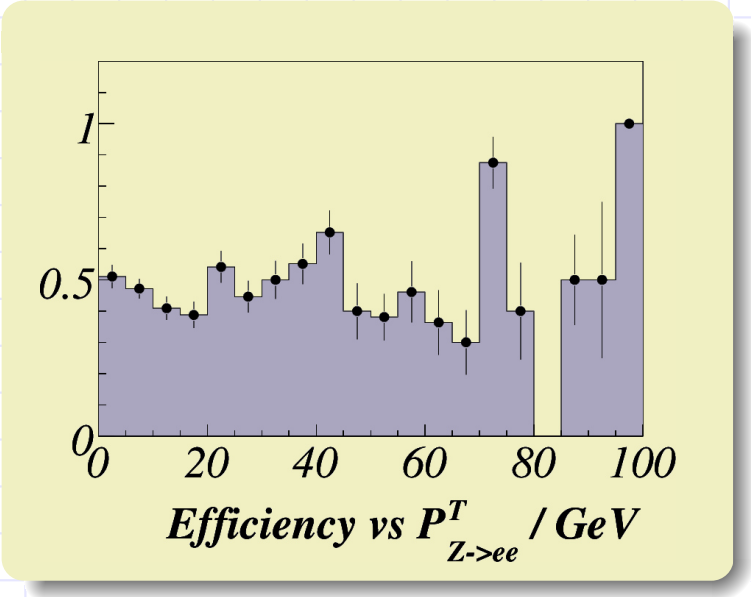


Use two electron candidates of an opposite charge to reconstruct Z boson

Z Boson Reconstruction







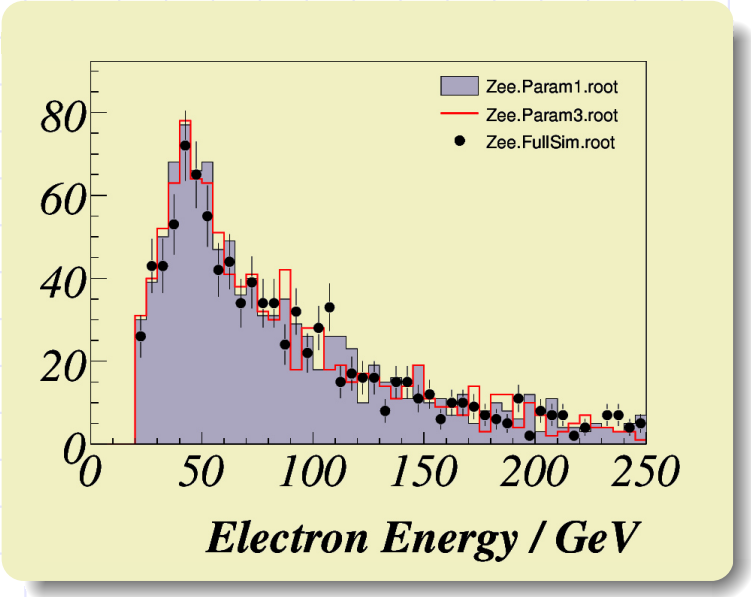
- Good resolution
- Current $Z \rightarrow ee$ efficiency is too low
- Reconstruction selection criteria need optimisation

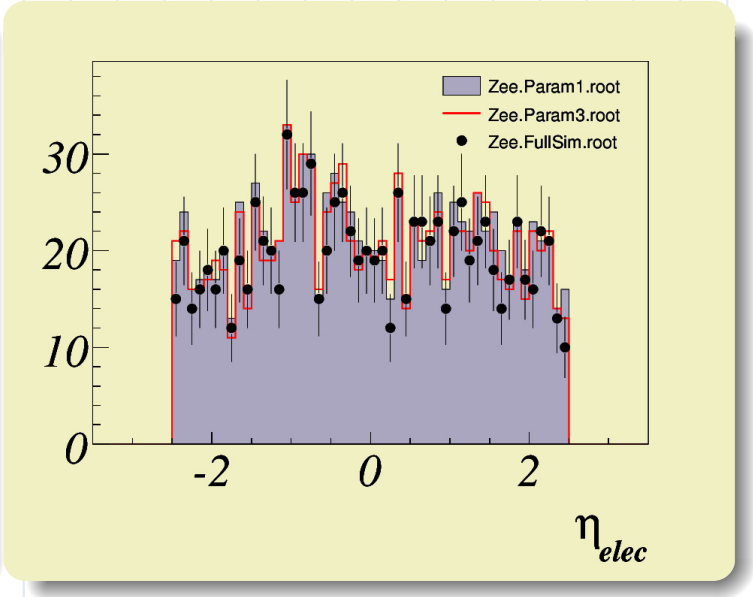
Validation of the Fast Simulation

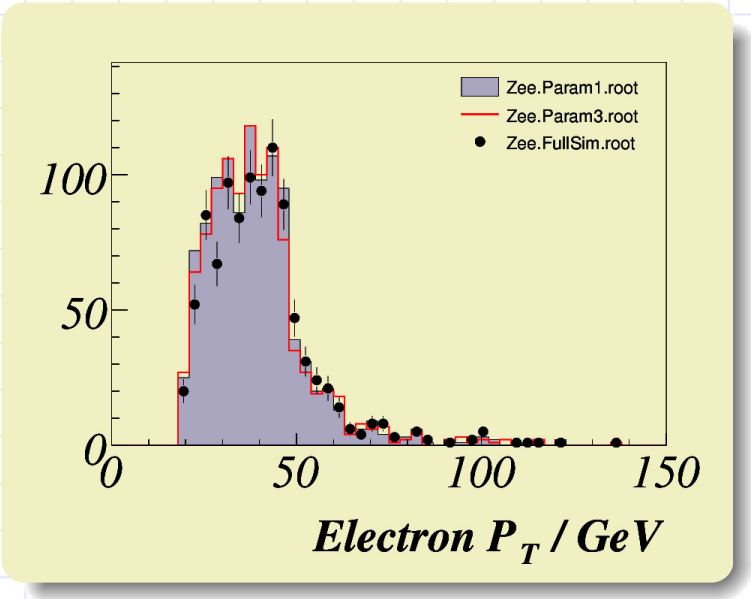
- Use this tool to validate Fast Simulation with different options
- Make accent into calorimetric properties of the reconstructed particles
- Use self-generated $Z \rightarrow ee$ MC samples:

File name	Nr. Events	Release	Comments
Zee.FullSim.root	1000	13.0.20	Full simulation
Zee.Param1.root	1000	13.0.30	Option 1: Frozen shower approach
Zee.Param3.root	1000	13.0.30	Option 3: in addition to frozen showers uses parameterization

Validation of the Fast Simulation: Electrons

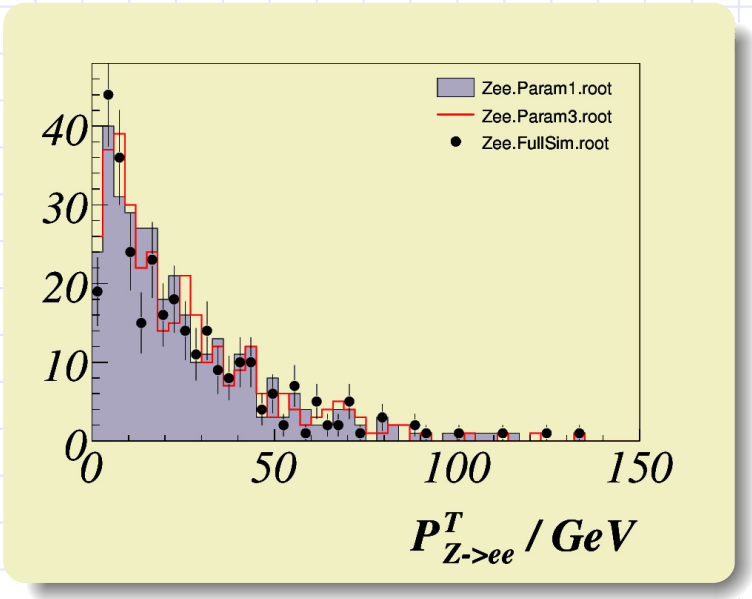


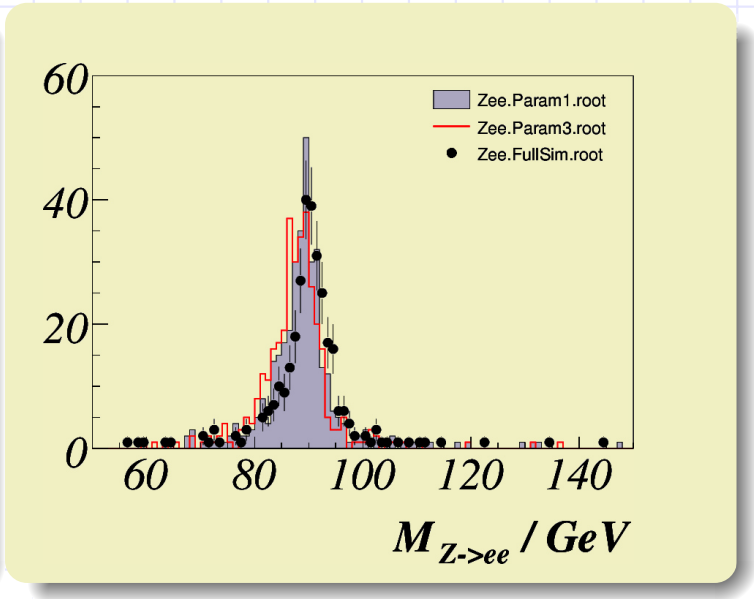




- Very good agreement between all three MC

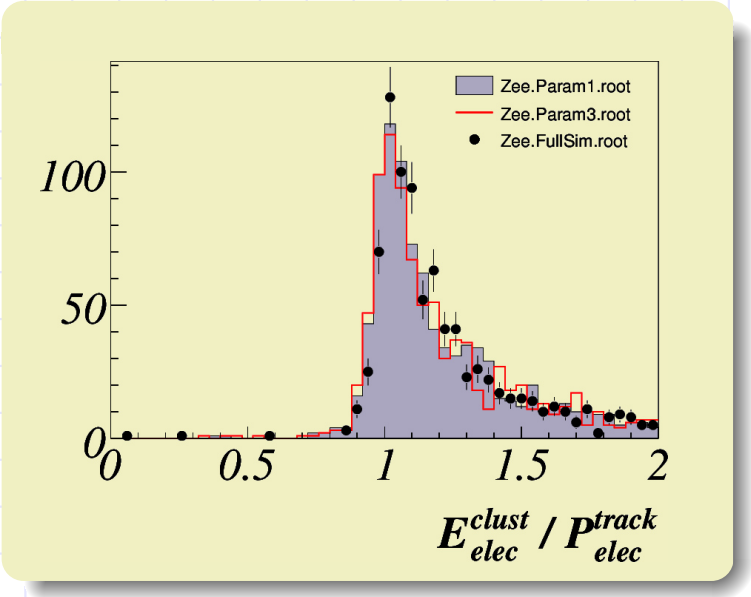
Validation of the Fast Simulation: Z boson

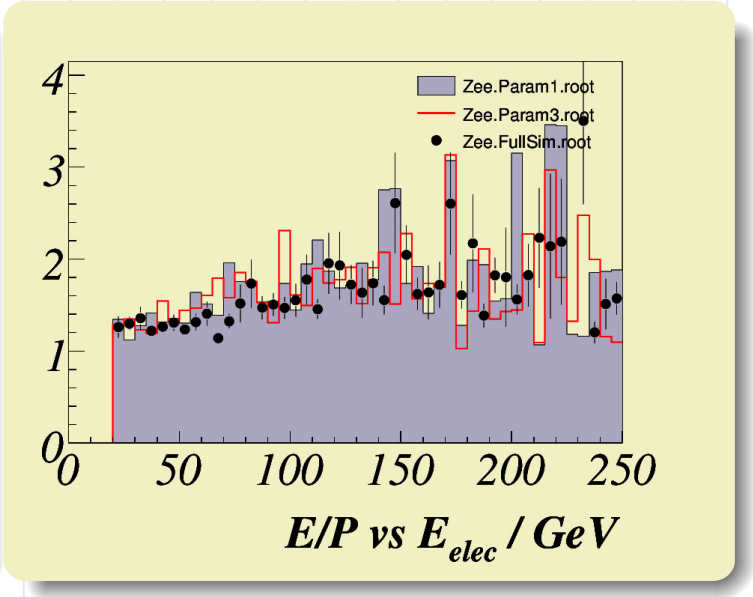


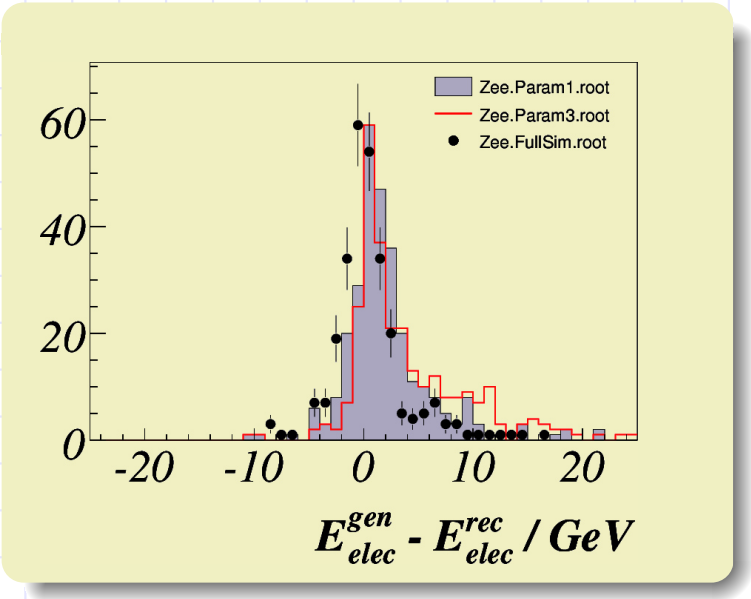


- Invariant mass distributions seems to be slightly shifted for param 1 MC
- This effect is related to energy scale problem which is now understood
- MC with inclusion of analytic shower parameterization into the barrel and EMEC (param 3) has worse description

Validation of the Fast Simulation: Electron Energy



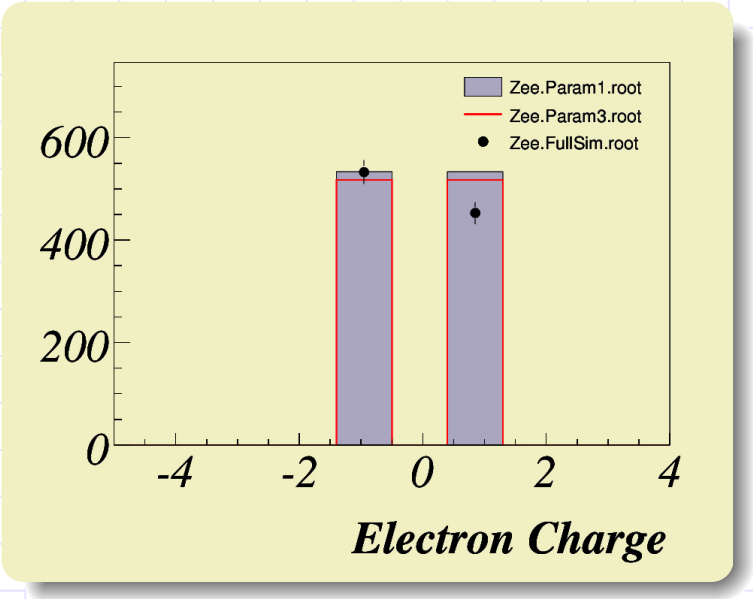




- Energy scale is slightly shifted for param 1
- Param 3 performs a little bit worse

Pit Falls and Observations

- While developing the Tool we also observe some problems which indicate to the potential bugs in the software
- One of such cases:



- Number of electrons should be equal to the number of positrons
- Full simulation MC displays a “charge asymmetry”
- Is it a bug related to the 3.0.20 release?

Summary and Outlook

- Start to work on a tool, first experience with AOD work. Will continue. Want to use AODs on NAF etc.
- Efficiency needs to be understood for cross section type measurement.
- Fast simulation is basically OK, but there is an energy scale problem which is now understood.