Calorimeter non-uniformity and Calorimeter non-linearity

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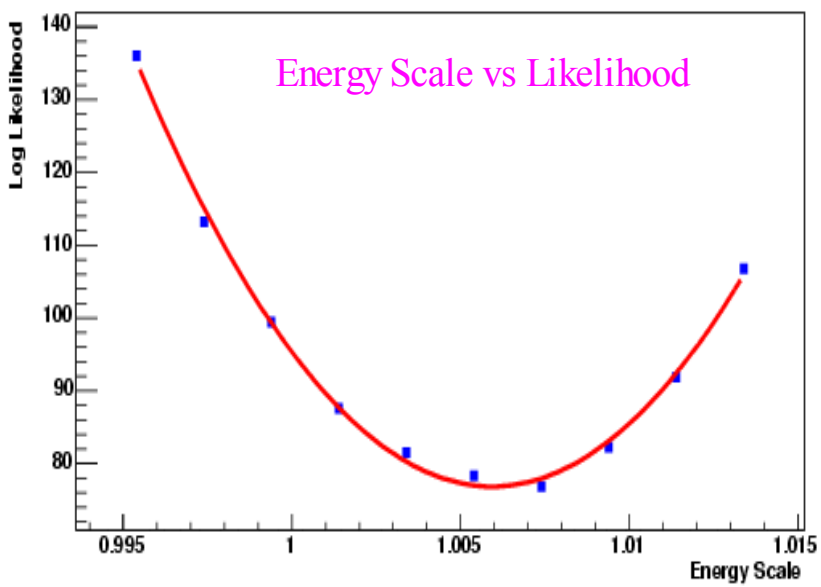
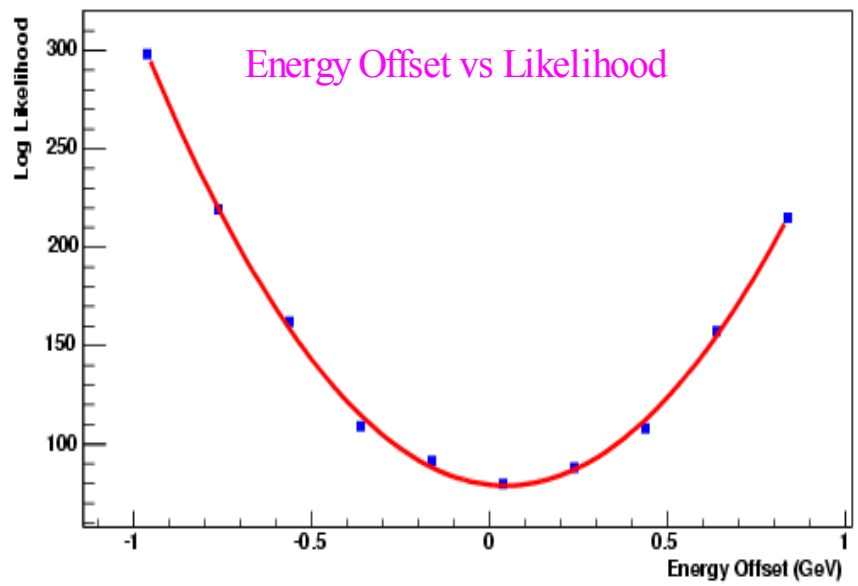
Introduction

- We often use $Z \rightarrow ee$ events to calibrate the calorimeter response (only deal with electrons and tune Z invariant mass spectrum)
- We also can use electrons from W decay to study the calorimeter response once we understand the missing Et resolution
  - At least 10 times more electrons
  - Study the response for individual module in CC
  - Study the calorimeter non-linearity

Z→ee calibration

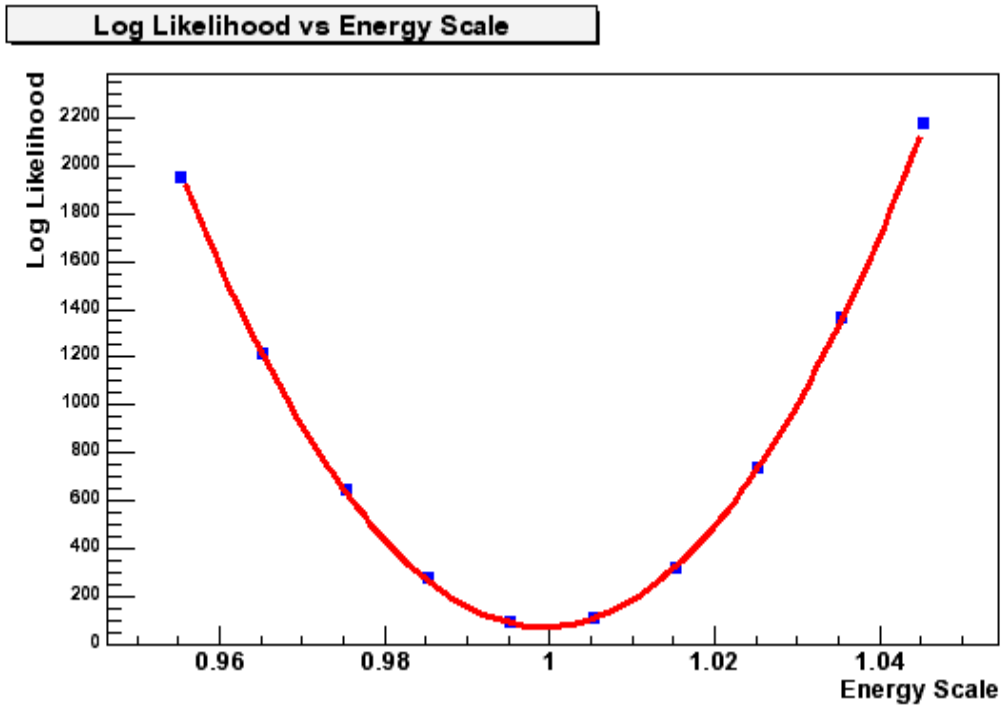
- Binned Maximum Likelihood Method
  - Bin the invaraint mass distribution from 75 to 105 GeV
  - Fix energy offset (energy scale) and vary energy scale (energy offset) in PMCS
  - Calculate a maximum likelihood $L = -\sum_{bins}[x_i \times ln(y_i) - y_i - ln(x_i!)]$
  - Energy Scale: 1.0054 ± 0.0010 Energy Offset: 0.038 ± 0.048 GeV (consisten with zero)





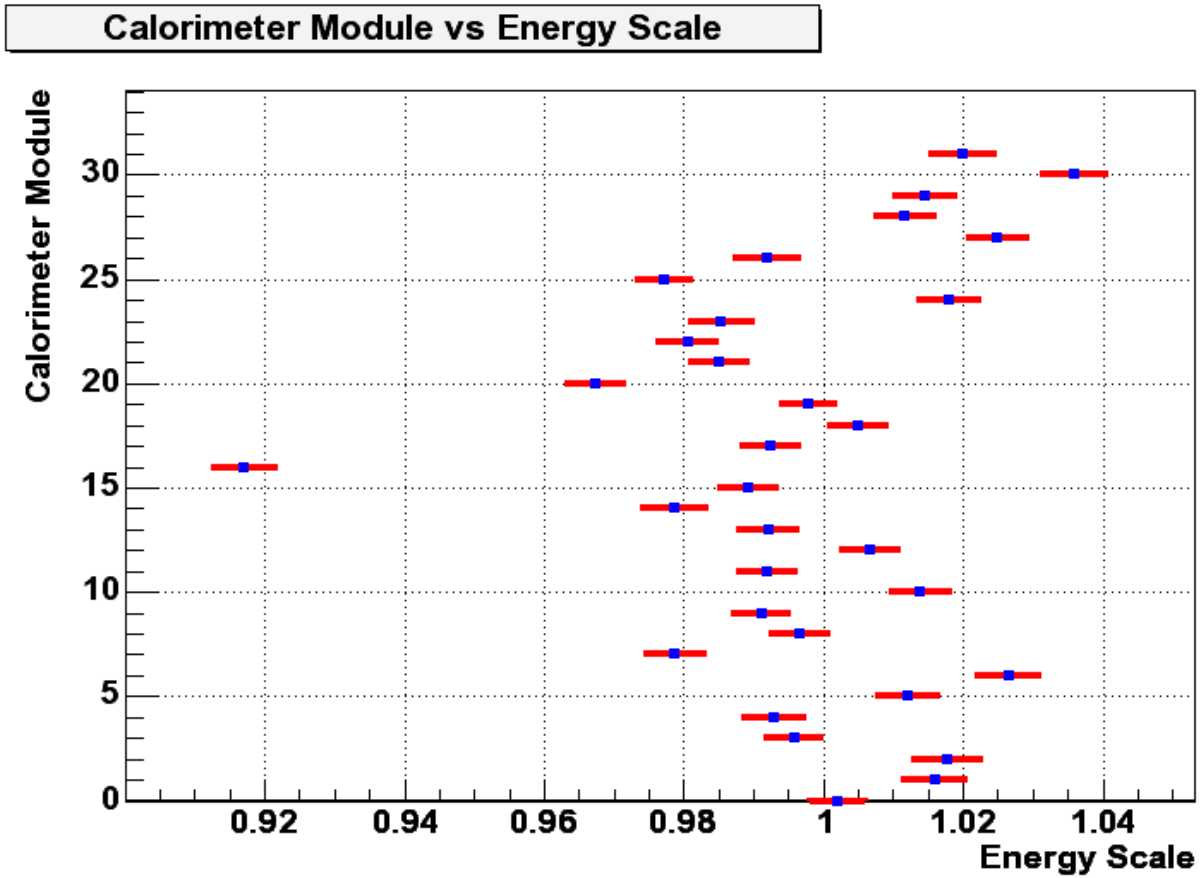
W→eν Calibration

- Similar to Z→ee calibration, just compare electron pT spectrum (require the electron has a matched track, no background subtraction for data yet)
- Set energy offset to 0, just change energy scale
- Energy Scale: 0.9993 ± 0.0007



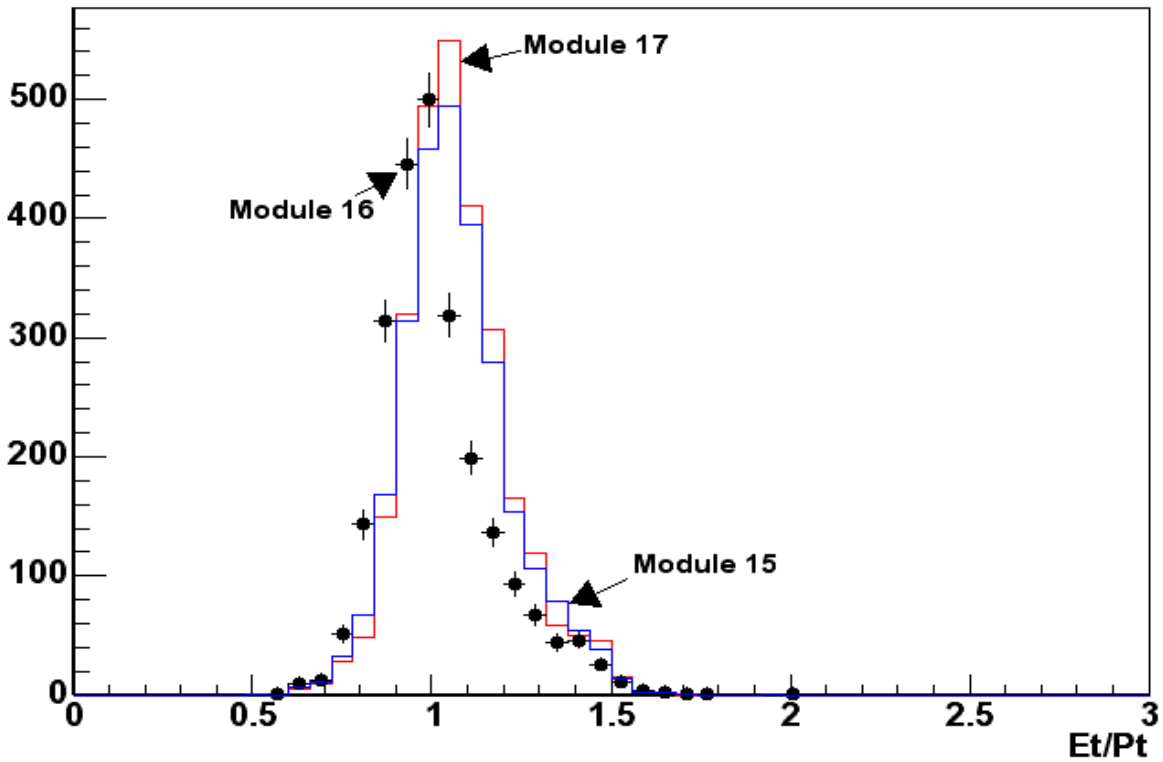
Calorimeter non-uniformity (I)

- Divide electrons into 32 modules, compare electron pT spectrum between data and MC
- Set energy offset to 0, just change energy scale



Calorimeter non-uniformity (II)

- Module 16 seems to have very low energy response
- Also shows up in the E/P distribution (Do not know what happened with this module)



Calorimeter non-linearity

- Average pT for electrons from Z: sqrt(pT1 * pT2) ~43 GeV
- Energy Scale determined using electrons from Z: 1.0054 ± 0.0010
- Average pT for electrons from W: ~37.6 GeV
- Energy Scale determined using electrons from W: 0.9993 ± 00007
- Assume the only difference is we use electrons at different pT region, we can get the non-linearity: (1.0054-0.9993)/(43-37.6) = 0.0011 (GeV-1)
- Run I: $$E_{true} = \alpha E^{obs} + \beta + 0.0001 \times (E^{obs} - 45.6)^2$$

  Note: squared

  Average electron energy from Z

- If I also assume the same formula, the non-linearity is close to 0.0002

Conclusion

- Very rough studies for non-uniformity and non-linearity
- Need to understand the non-uniformity better
- Work with Pierre Petroff to use E/P to calibrate the central calorimeter