FSR in Electron Energy Calibration for W Mass

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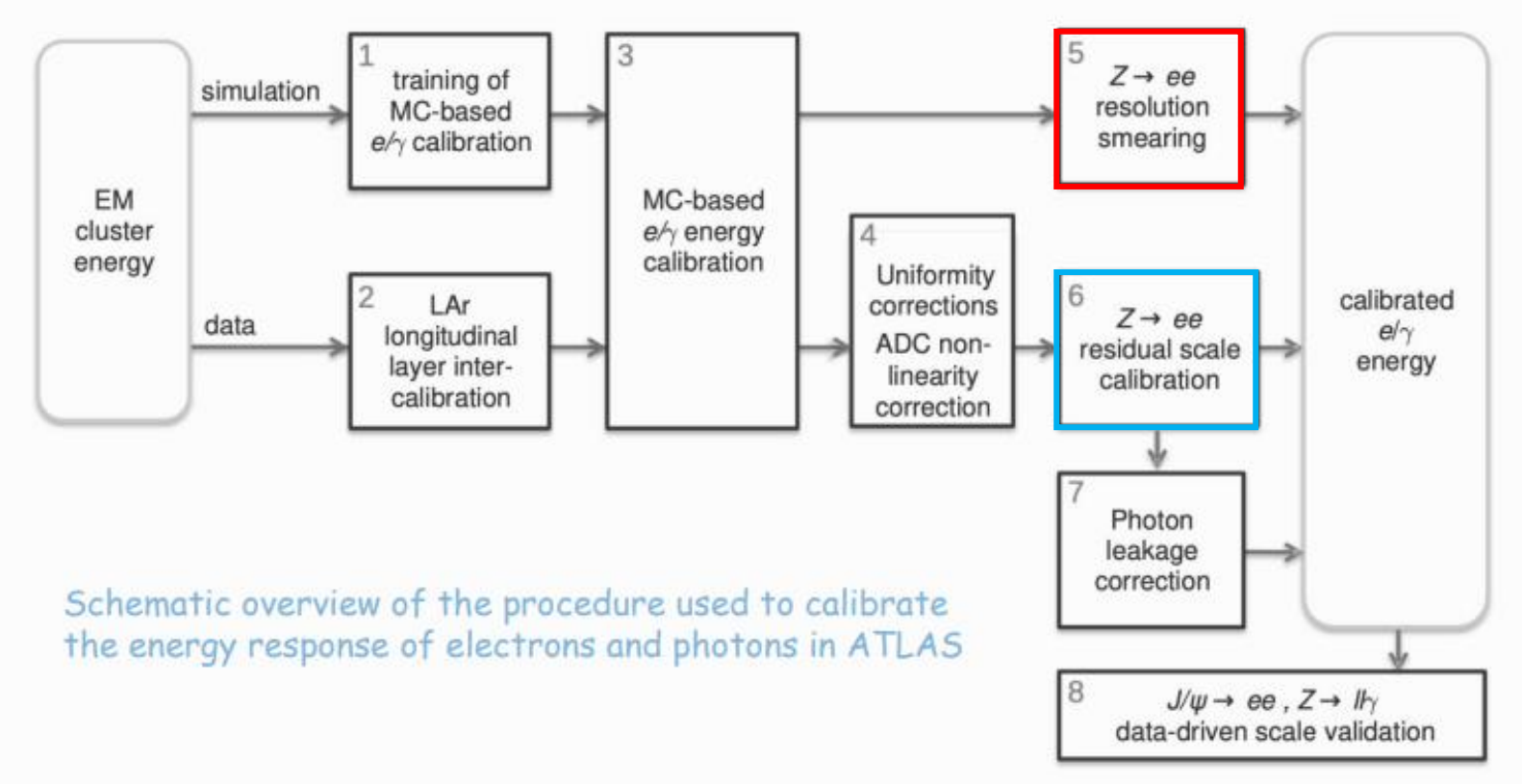
Introduction - Electron Calibration Overview



- Calibration is performed using low pileup Z mass resonance data at 5 and 13 TeV:
  - Gaussian Smearing, c (constant term):

$$\left(\frac{\sigma(E)}{E}\right)^{data} = \left(\frac{\sigma(E)}{E}\right)^{MC} \oplus C\left(\eta^{calo}\right)$$

  - Energy Shift, α (scale factor):

$$E^{data} = E^{MC}\left(1 + \alpha\left(\eta^{calo}\right)\right)$$

Motivation for FSR Studies

Motivation:

•Z → ee data show an excess of energy tails, since ever (Run1, Run2, sliding windows and supercluster reco) this generates energy scale systematics (from fit window variations) that limit the overall calibration precision.

•Muons behave better

Mainly affecting W&Z analysis

Possible causes studied over the years:

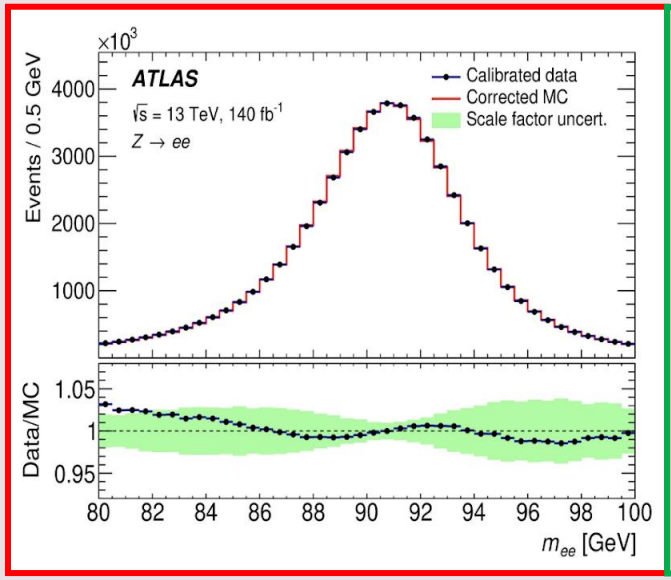
•Intercalibration of the Presampler and the accordion layers, even S3

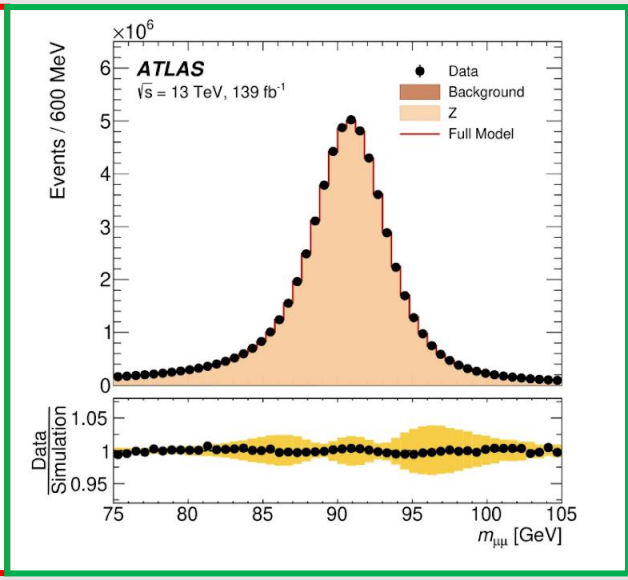
•Readout non-linearity

•Lateral shower shapes

•Passive Material variation

Not yet investigated effects resulting from imperfect modelling of FSR in MVA calibration stage…





Potential effects of FSR on MVA calibration

•MVA is trained <u>without</u> FSR

If E1/E2 energy distribution are affected by FSR energy, MVA could over/under correct the mass :

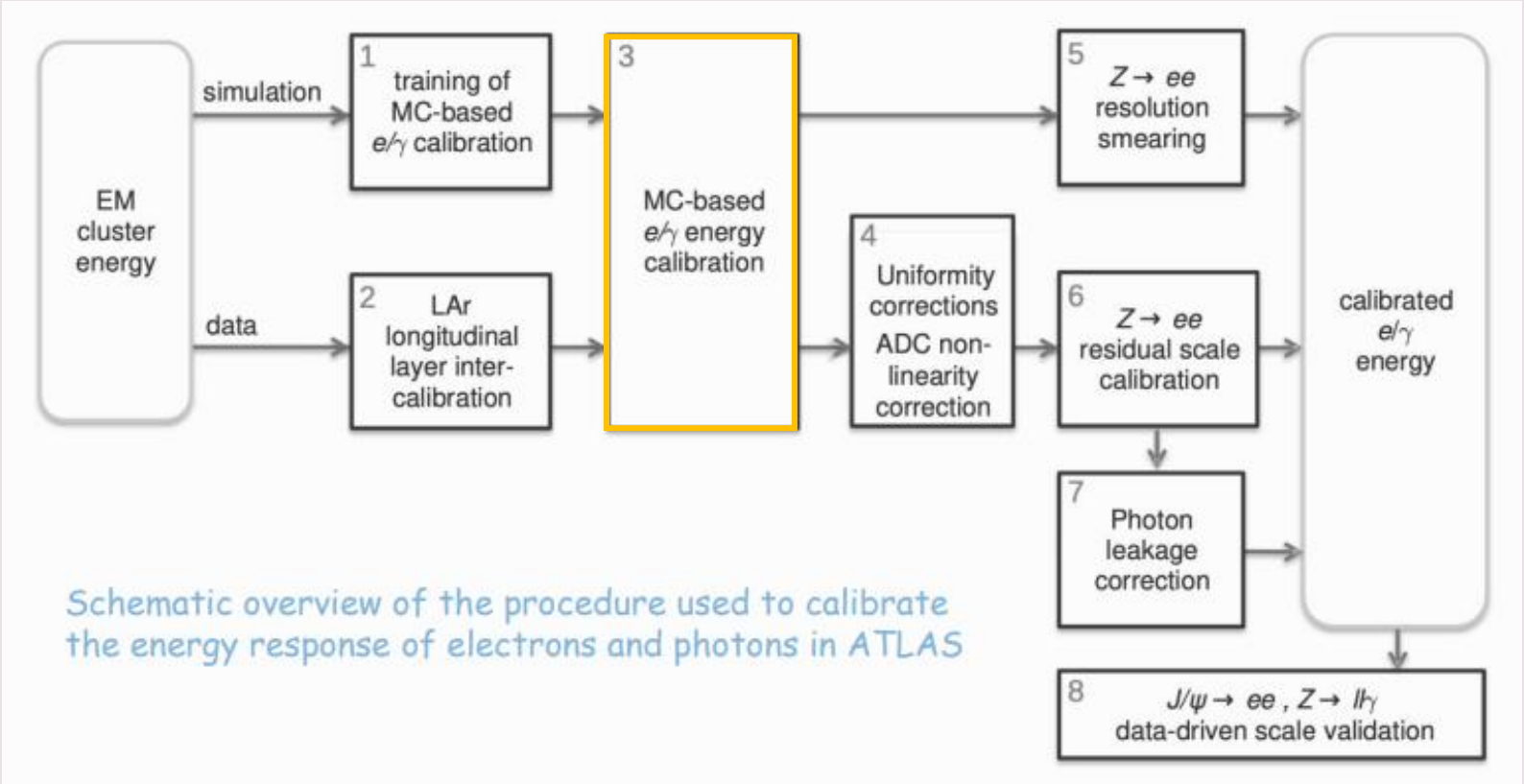
•Situation 1: A slightly harder FSR (usually larger dR) can modify E0,E1,E2, E1/E2

•Situation 2: FSR is too hard (dR too large) to be within the cluster

- This is lateral leakage, we completely lose FSR information in this case
- MVA would not correct the energy, and consider this as a lower energy electron

Ideally, the effect of FSR on MVA is the same between data and MC, so cancels. But FSR is not perfectly modelled.

Aim to study Mee w/ different FSR to see if we can reproduce the data/MC lineshape



Schematic overview of the procedure used to calibrate the energy response of electrons and photons in ATLAS

Categorising events based on FSR

Events are categorised based on dR region containing highest total FSR pT:

- Consider all available FSR photons and match with either leading or subleading electron based on minimum dR
- Calculate sum of FSR pT in each region (defined by boundaries in dEta, dPhi and dR)
- Label electron accordingly with region containing highest total FSR pT