

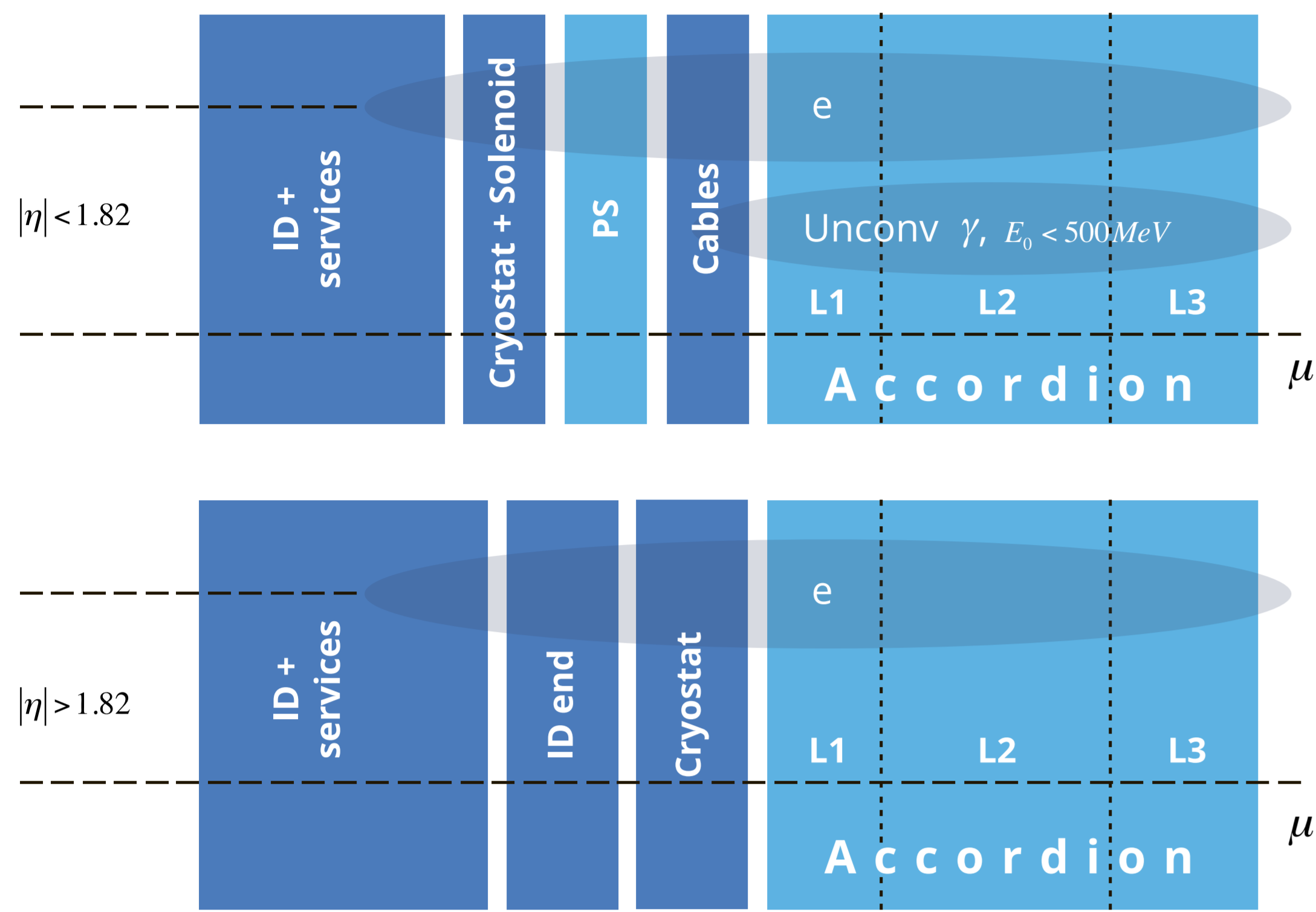


ELECTRON AND PHOTON ENERGY CALIBRATION

with the ATLAS detector using LHC Run 1 data



Shower development in the EM calorimeter

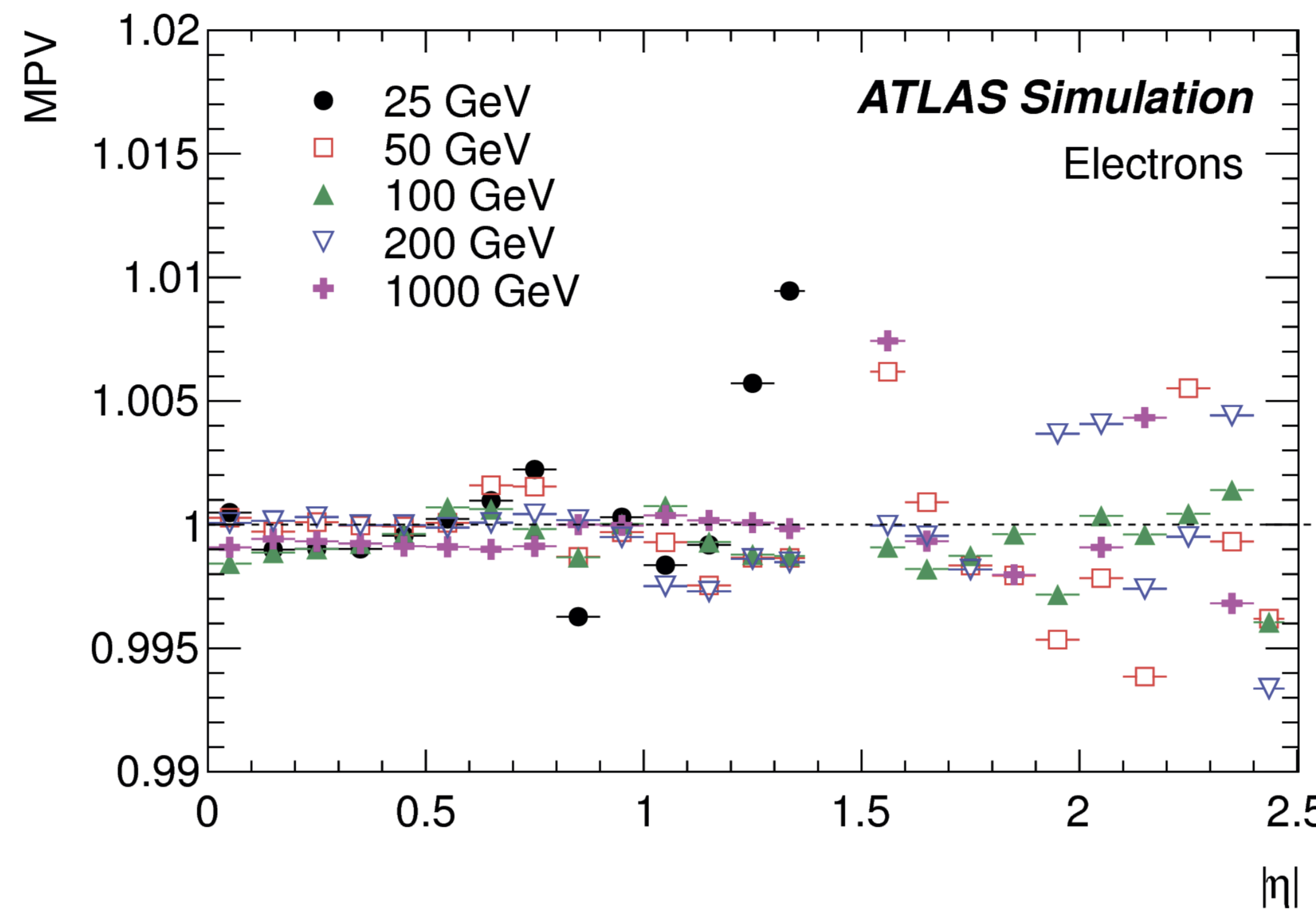


- $E_1/E_2 = E_{1/2}$ is used to constrain material before the calorimeter and between calorimeter and presampler (combining electron and photon measurements)



Multivariate algorithm (MC-based)

- Optimize E_{MVA}/E_{true} separately for $e/\gamma_{conv}/\gamma_{unconv}$ in 10×9 bins $|\eta_{cluster}| \times E_T^{calo}$ independently

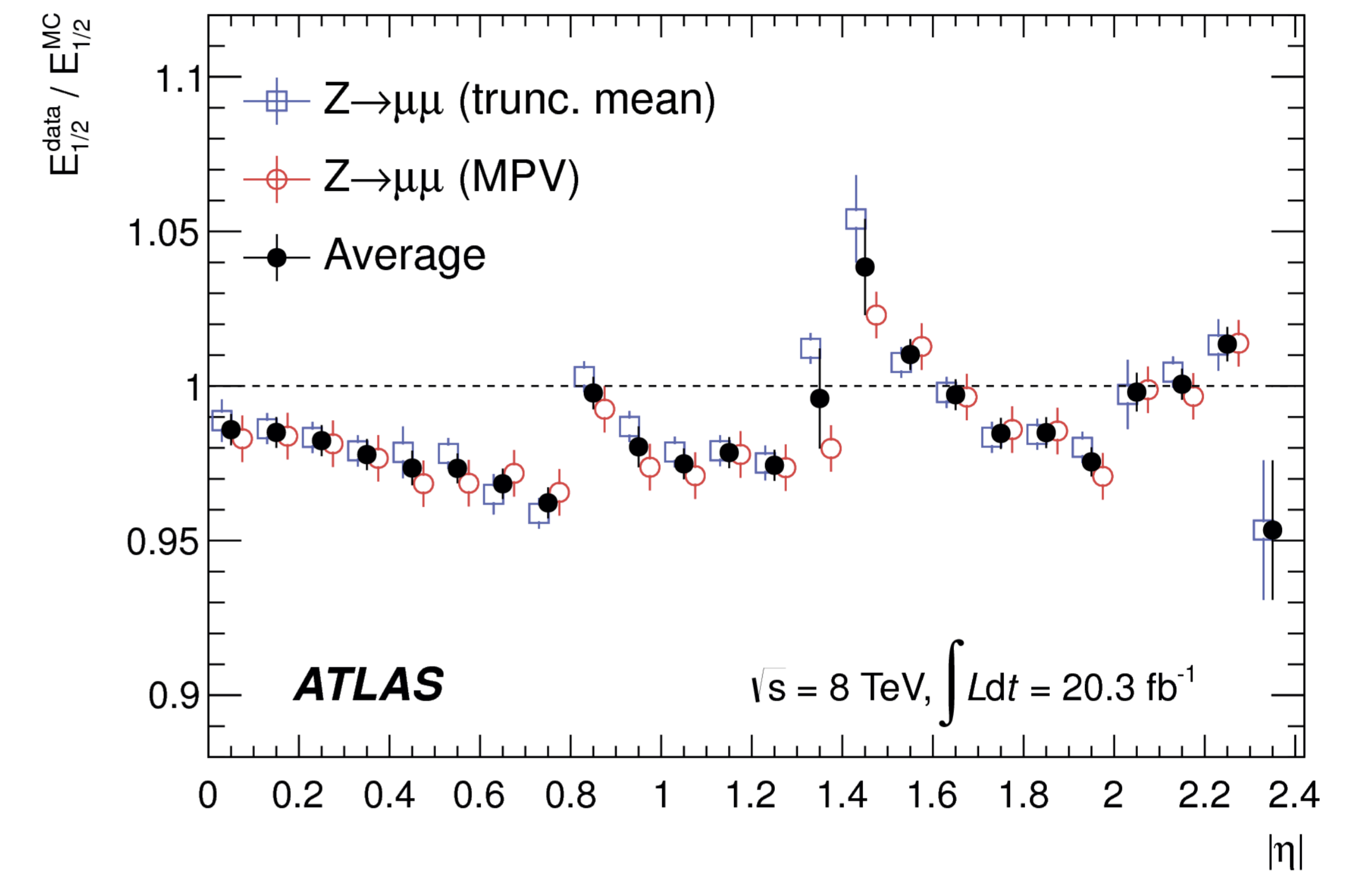


- Inputs: $E_{calo}, E_0/E_{calo}, X, \eta_{cluster}, \eta_{cluster}^{calo}, \phi_{cluster}^{calo}$
- Additional for converted γ : $p_T^{conv}/E_{calo}, p_T^{max}/p_T^{conv}$



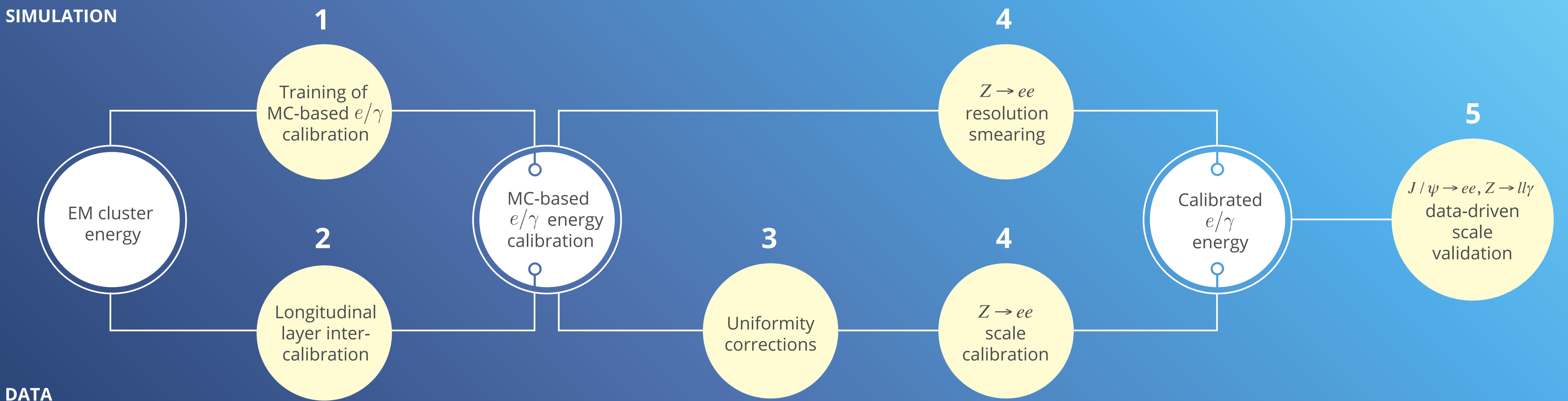
Longitudinal layer intercalibration

- Intercalibration of the first (L1) and second (L2) calorimeter layers made with muons from $Z \rightarrow \mu\mu$



- $\alpha_{1/2} = \langle E_{1/2} \rangle_{Z \rightarrow \mu\mu}^{data} / \langle E_{1/2} \rangle_{Z \rightarrow \mu\mu}^{MC}$
- $E_2^{corr} = E_2 \times \alpha_{1/2}$
- E_{PS} calibrated relative to E_{accor}

SIMULATION

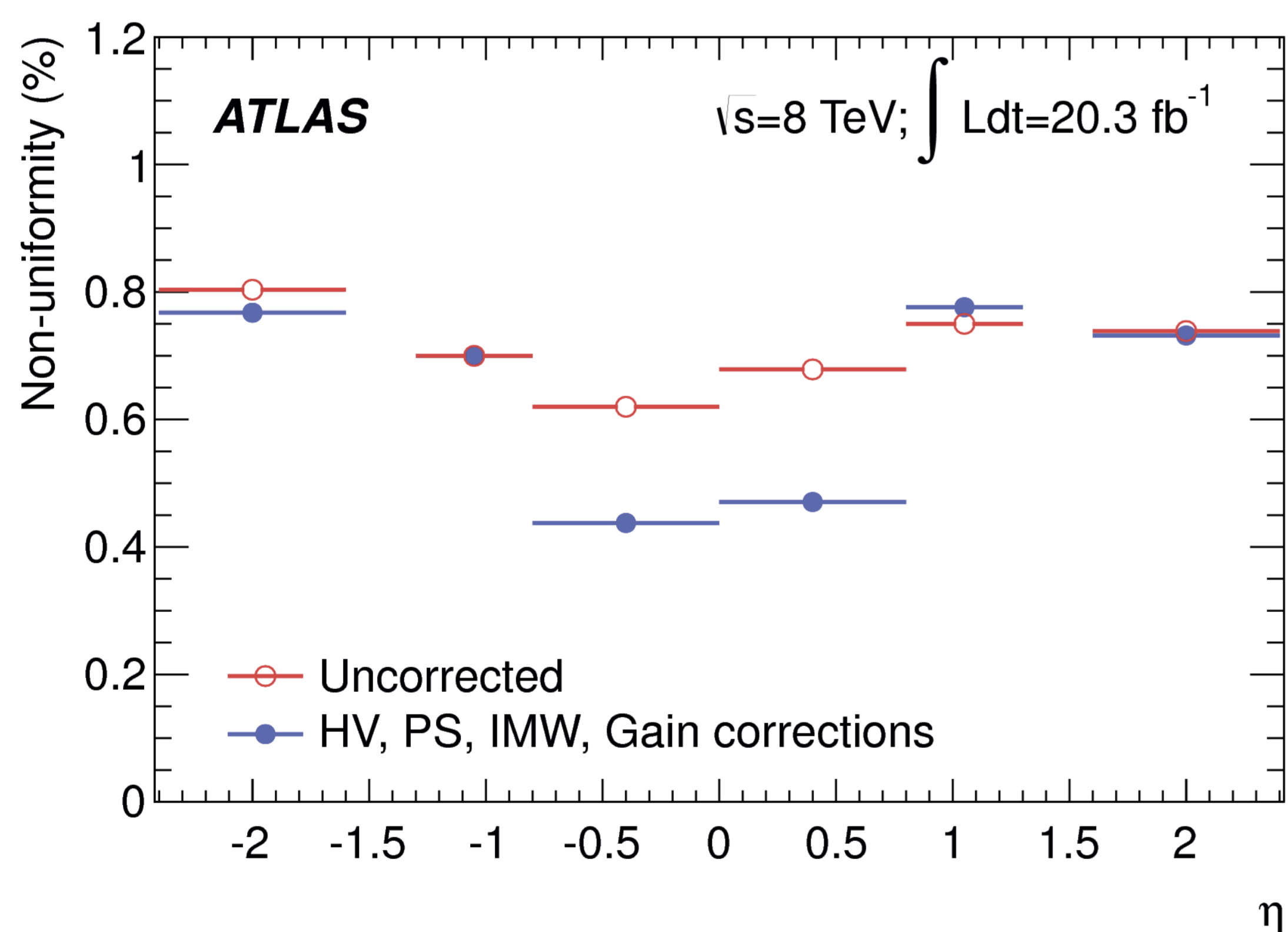


DATA



Corrections

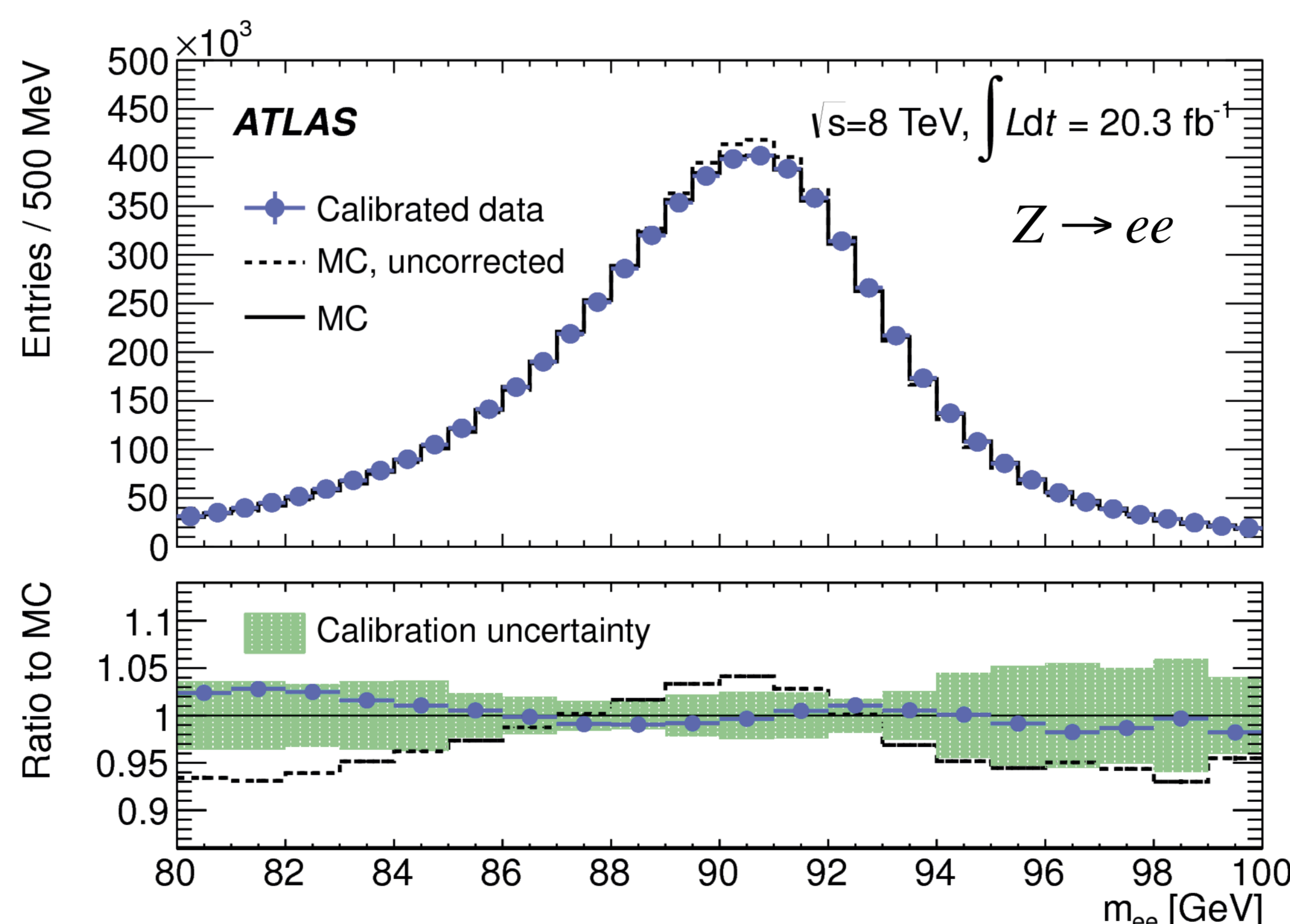
- Non-optimal HV regions
- Electronic gain
- Energy loss btw modules (IMW)
- Pedestals
- Time dependence of the PS HV



Scale factors Resolution smearing correction

$$m_{ij}^{data} = m_{ij}^{MC} (1 + \alpha_{ij}), \quad \left(\frac{\sigma_m}{m} \right)_{ij}^{data} = \frac{1}{2} \left[\left(\frac{\sigma_E}{E} \right)_i^{MC} \oplus c_i \oplus \left(\frac{\sigma_E}{E} \right)_j^{MC} \oplus c_j \right]$$

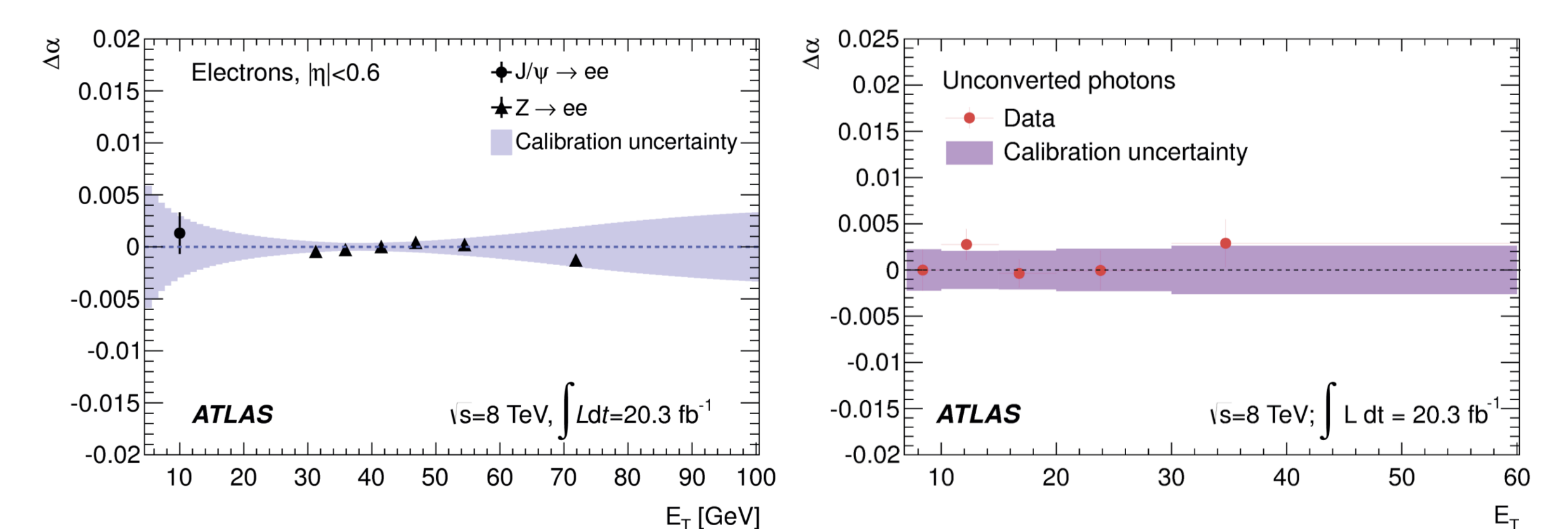
i, j corresponds to the η bin of the two electrons



Scale validation with

$J/\psi \rightarrow ee$

$Z \rightarrow ll\gamma$



Summary of systematic uncertainties

$ \eta $ range	Unconverted photons, $E_T = 60$ GeV				
	0-0.6	0.6-1	1-1.37	1.55-1.82	1.82-2.47
$Z \rightarrow ee$ calibration	0.03	0.04	0.08	0.16	0.05
Gain, pedestal	0.03	0.02	0.01	0.89	0.55
Layer calibration	0.15	0.20	0.20	0.25	0.26
ID material	0.06	0.12	0.19	0.07	0.12
Other material	0.09	0.17	0.40	0.96	0.09
Total	0.19	0.31	0.50	1.35	0.63

NEW CALIBRATION PROCESS FEATURES

- Improved detector material description $\Delta X/X_0 \sim 5-10\%$ vs $|\eta|$
- Electromagnetic calorimeter layer recalibration L1/L2 ($\sim 3\%$)
- E_{calo} measurement optimised using MVA techniques and applying uniformity corrections
- Absolute energy-scale corrections from $Z \rightarrow ee$ decays and validated with $J/\psi \rightarrow ee$ and $Z \rightarrow ll\gamma$

ENERGY RESOLUTION IMPROVED WRT OLD CALIBRATION BY

- 10% unconverted photons
- 20% converted photons
- 5-30% for electrons

Impact on m_H measurement

(combined $H \rightarrow \gamma\gamma$ and $H \rightarrow Z^*Z \rightarrow 4l$)

$$+0.5 \text{ (sys) GeV (1)}$$

$$-0.6 \text{ (sys) GeV (1)}$$

$$125.36 \pm 0.37(\text{stat}) \pm 0.18(\text{sys}) \text{ GeV (2)}$$

Factor ~ 2.5 improvement!