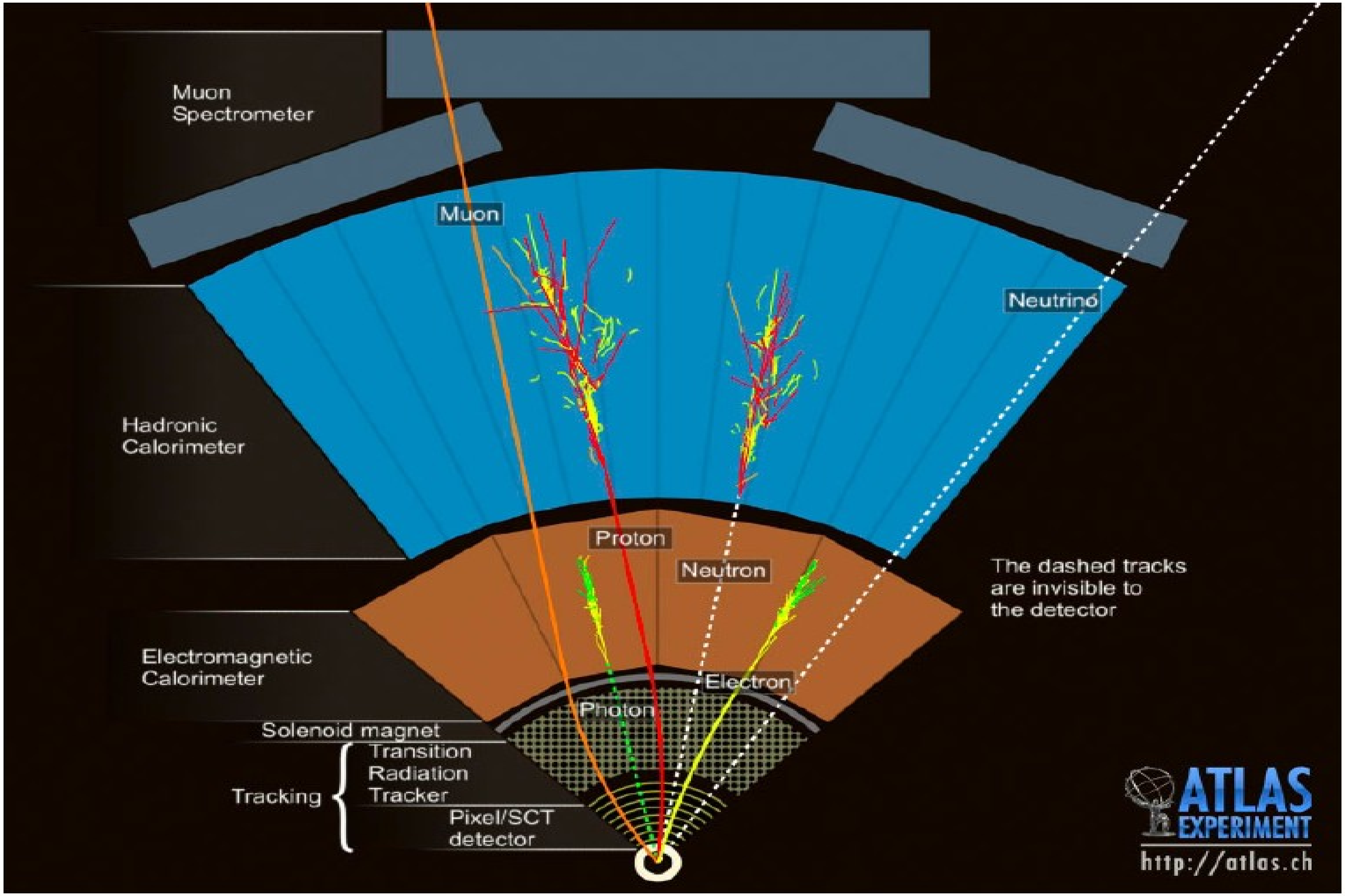
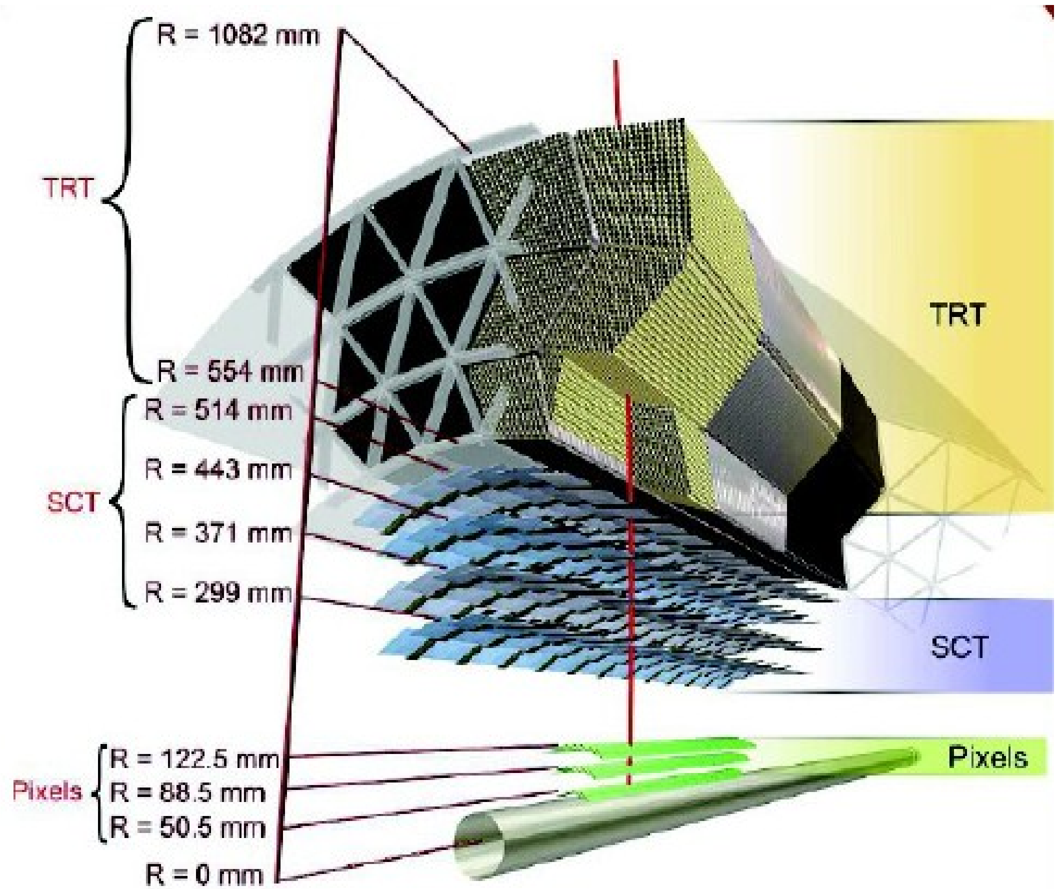
Particle identification

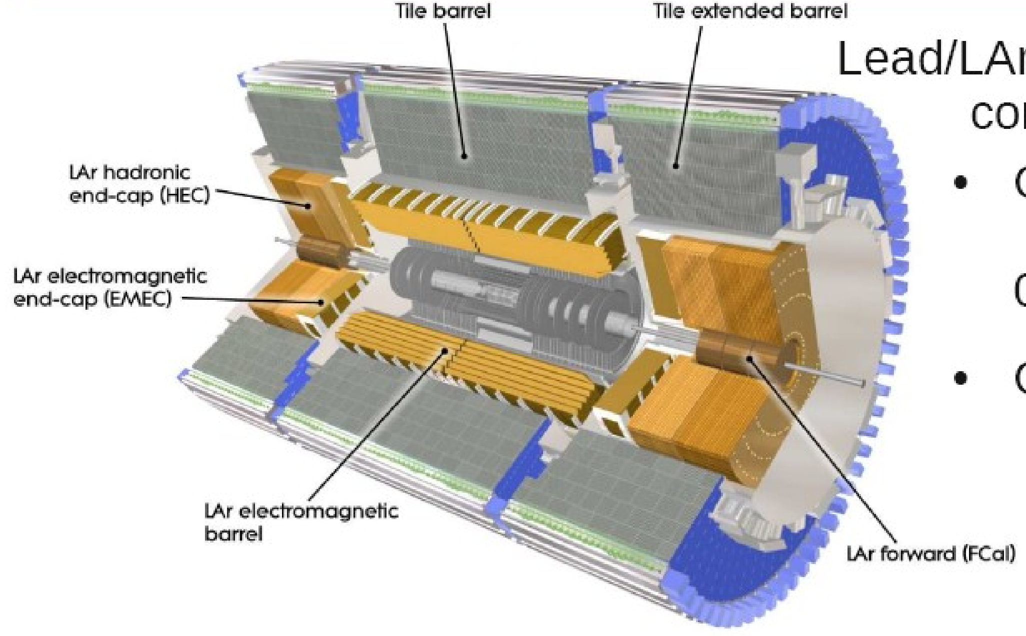


The ATLAS Inner Detector

- Hits in Pixel and Silicon detectors
- High and low threhold hits in TRT detector

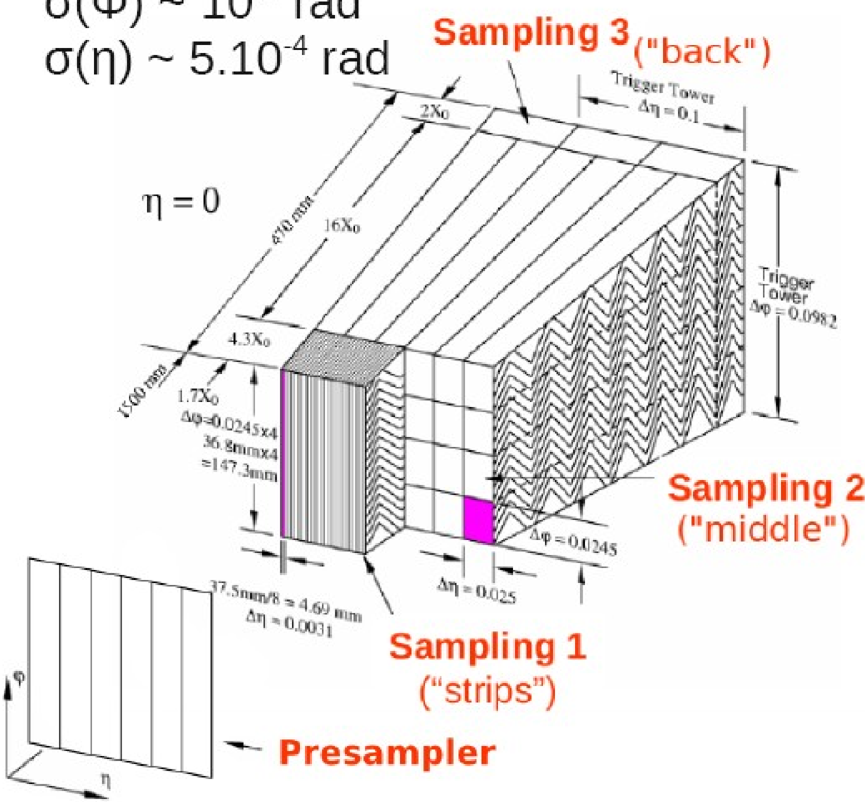


The ATLAS electromagnetic calorimeter



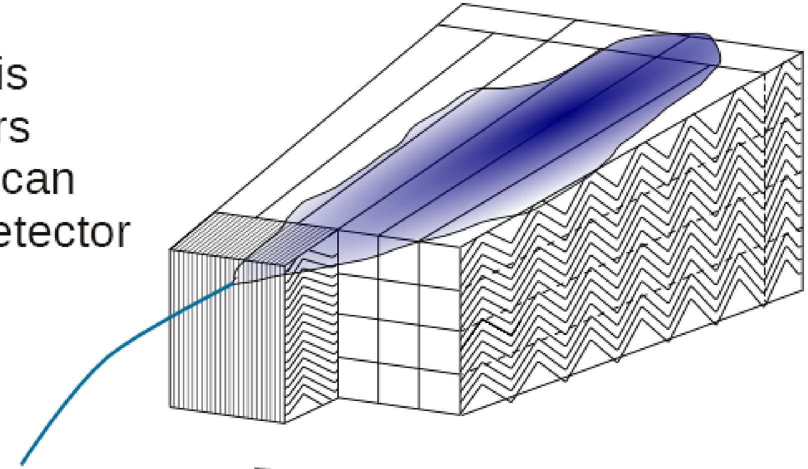
Lead/LAr EM calorimeter divided in 3 longitudinal compartments + Pre-sampler in front

- Good energy resolution :
  $\sigma(E)/E = a/E \oplus b/\sqrt{E} \oplus c$ (with a ~ 0.3 GeV, b ~ 10%, c ~ 0.7%)
- Good angular resolution :
  $\sigma(\Phi) \sim 10^{-3}$ rad
  $\sigma(\eta) \sim 5.10^{-4}$ rad



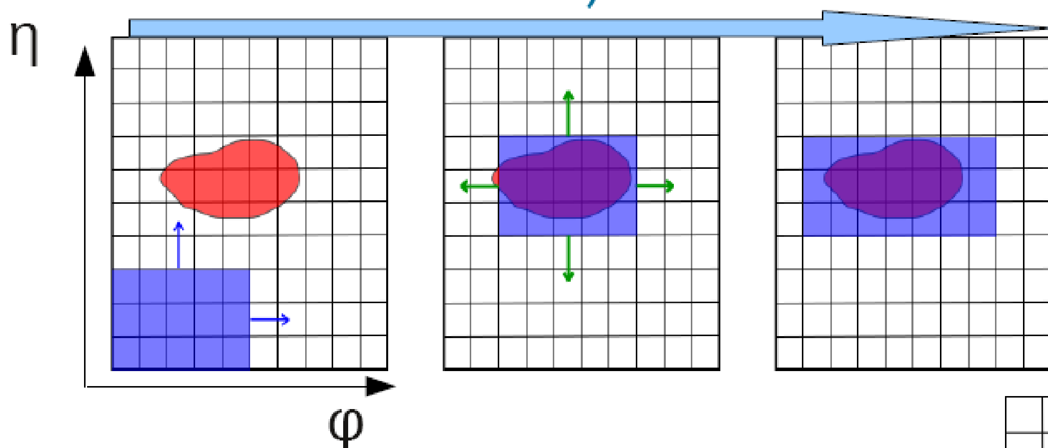
Layer	Granularity $\Delta\eta \times \Delta\varphi$	Radiation length
Pre-sampler	0.025 x 0.1	
Strips	0.003 x 0.1	4.3 X_0
Middle	0.025 x 0.025	16 X_0
Back	0.05 x 0.025	2 X_0

Electromagnetic objects in ATLAS

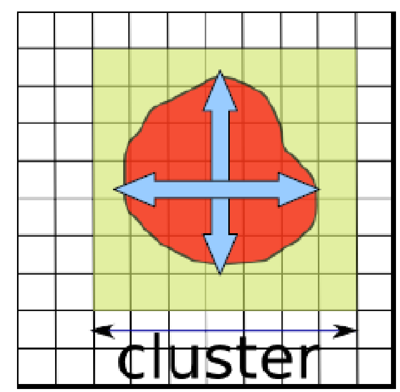


- In ATLAS an electron or a photon candidate is defined as a cluster of cells in the calorimeters representing the energy deposit to which we can associate tracks reconstructed in the inner detector

- Sliding window algorithm to reconstruct the energy deposits :

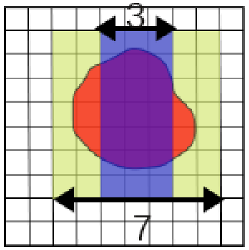


- The identification of such objects is then based on :
  - The shower shape in the calorimeter
  - Track quality (number of hits, direction wrt the cluster,...)
  - Transition radiation (TRT “high threshold hits”)
  - E/p

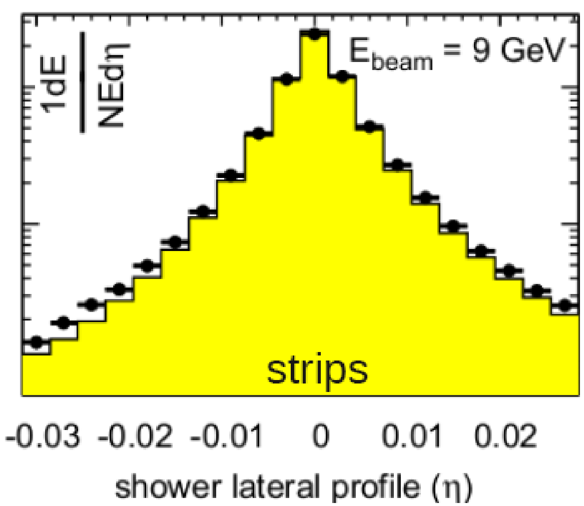


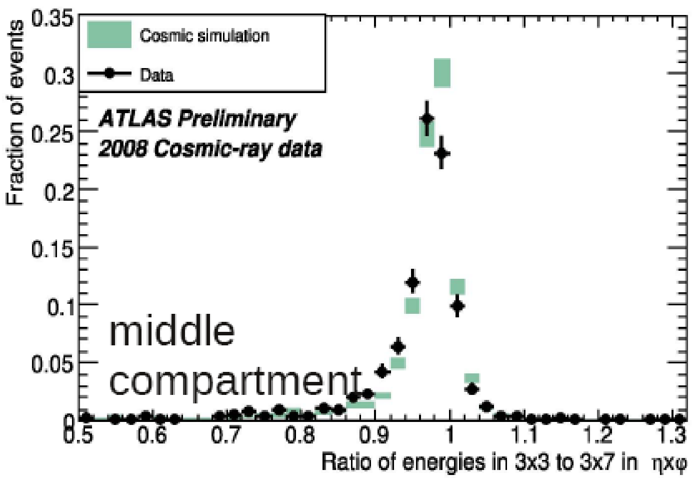
Shower shape discriminant variables

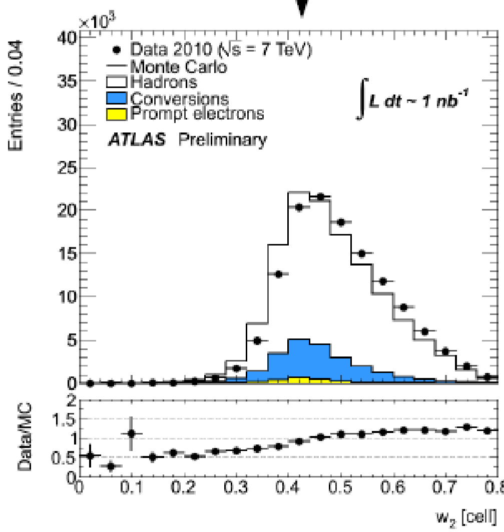
- The shower shape in the calorimeter allows for the rejection of a large fraction of background (O(1000))
- Benefiting from the thin granularity and the segmentation of the calorimeter, ATLAS defined a few variables illustrating the shower width in eta/phi and its longitudinal extension



- Even if the agreement is fairly good, the simulation does not perfectly predict the key distributions for the lateral development
- This has been observed during the test beam, the cosmics, and the collisions data-taking







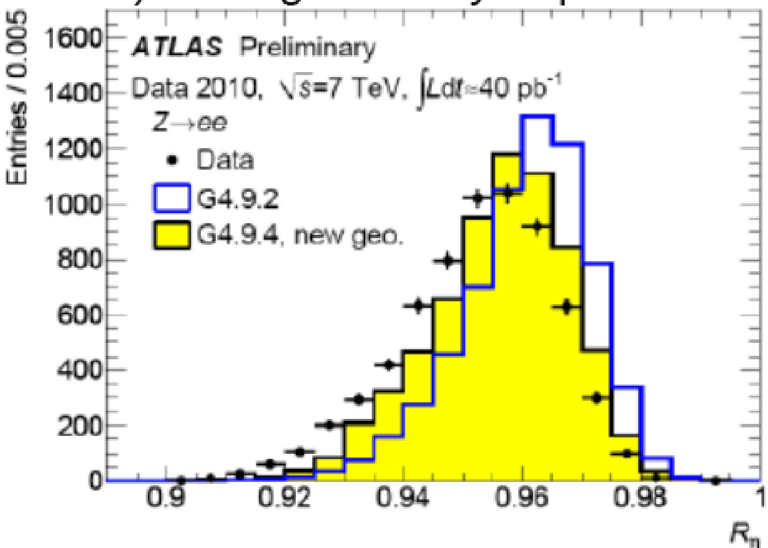
LAr absorber simulation

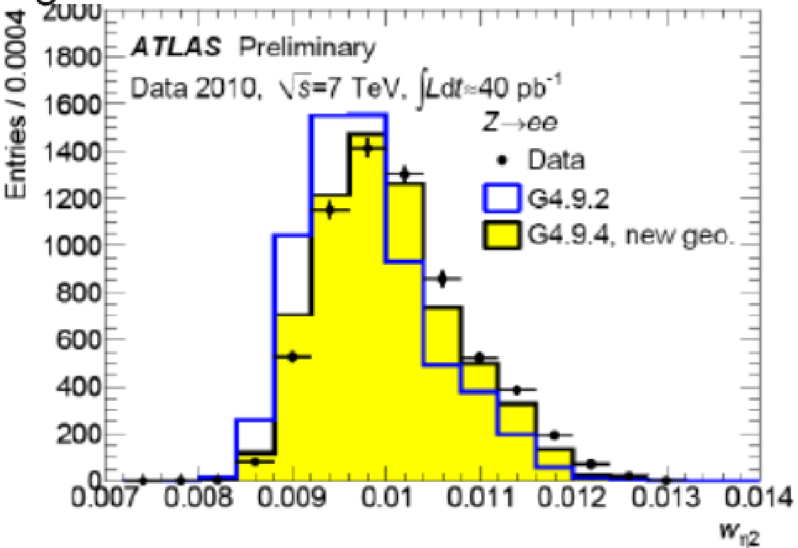
- We have tracked down that a large part of the disagreement was due to an improper simulation of the EM calorimeter absorber
- Real absorber is a sandwich Iron-Glue-Lead-Glue-Iron but it was described as a blended material made of Lead, Iron and Glue

Detailed geometry

Blended geometry

- Running the detailed simulation costs an CPU time increase (30-60% for EM showers) but significantly improved the agreement.

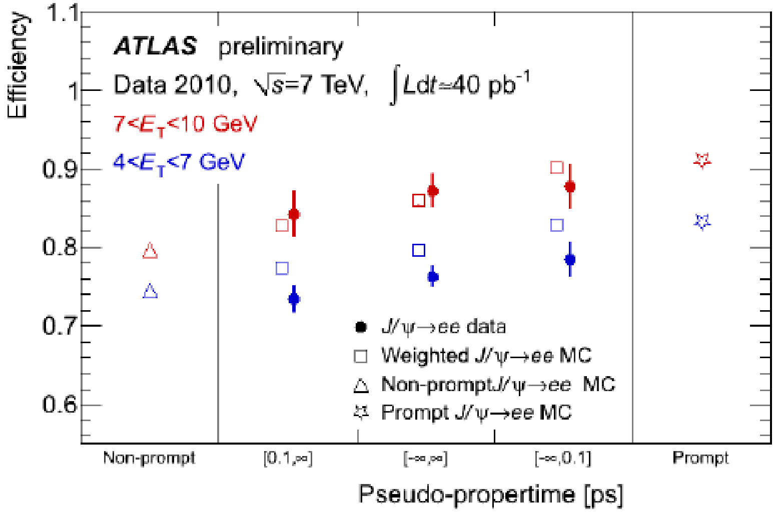


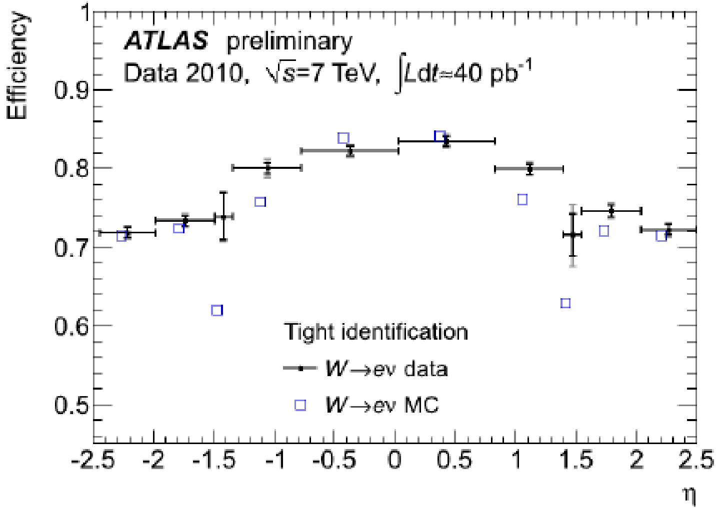


- Have checked impacts of cross-talk, material, geometry (accordion, sagging,...), misalignment,... Unfortunately, yet no good explanation for the remaining discrepancies.

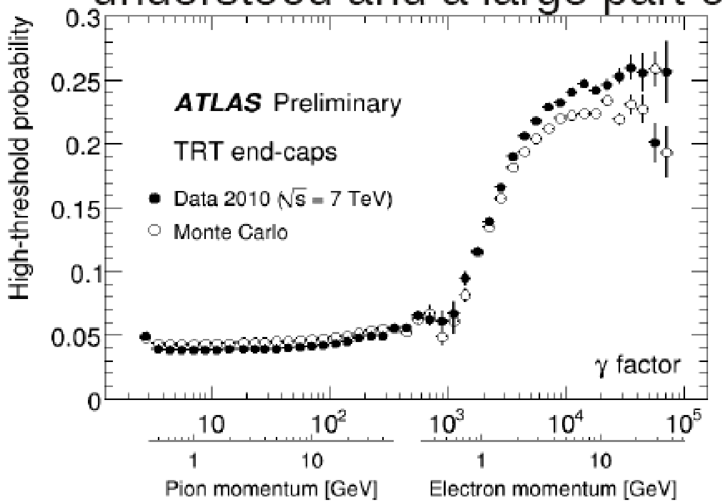
Impact of other aspects of simulation

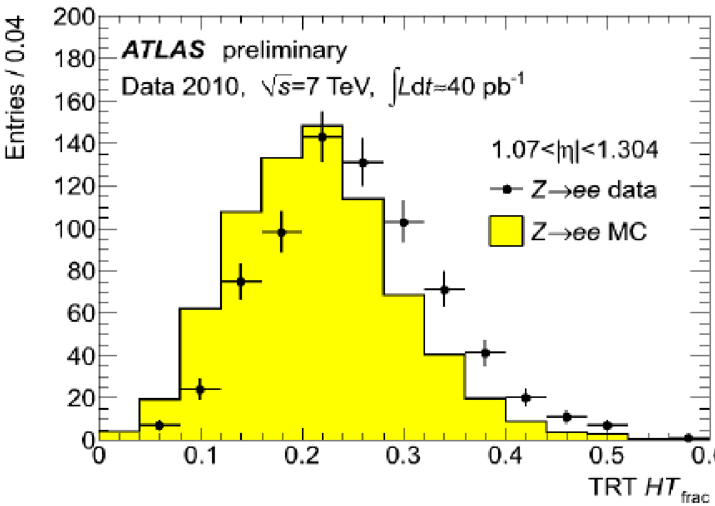
- To select the electrons, we usually cut on many variables and correct the MC predictions by data/MC scale factors measured using T&P-based methods





- Certain regions exhibit higher efficiencies in data than in MC. The reasons are understood and a large part of the effect is due to the transition radiation modelling resulting in a higher probability for an $e^{\pm}$ to have high-energy TRT hits
  - Tuning ongoing





Electron identification

- Calorimetric variables
  - Float_t el_f1;
  - Float_t el_f3;
  - Float_t el_etas1;
  - Float_t el_etas2;
  - Float_t el_weta2;
  - Float_t el_Emax2;
  - Float_t el_emaxs1;
  - Float_t el_wstot;
  - Float_t el_Ethad;
  - Float_t el_Ethad1;
  - Float_t el_reta;
  - Float_t el_rphi;
- Tracking variables
  - Int_t el_nBLHits;
  - Int_t el_nPixHits;
  - Int_t el_nSCTHits;
  - Int_t el_nTRTHits;
  - Int_t el_nTRTHighTHits;
  - Int_t el_nSiHits;
  - Float_t el_TRTHighTHitsRatio;
  - Float_t el_trackd0;

Electron identification

- float eratio = (el_emaxs1 - el_Emax2)/(el_emaxs1 +el_Emax2) ;
- float Rhad = el_Ethad/(el_cl_E * cosh(el_etas2));
- float HadLeak = el_Ethad1/(el_cl_E * cosh(el_etas2));

Electron identification

- Calorimetric & tracking variables
  - Float_t el_deltaeta1;
  - Float_t el_deltaeta2;
  - Float_t el_deltaphi2;
  - Int_t el_isConv;

LOOSE identification

Hadronic leakage	⋆ Ratio of E_T in the first layer of the hadronic calorimeter to E_T of the EM cluster (used over the range $\|\eta\| < 0.8$ and $\|\eta\| > 1.37$) ⋆ Ratio of E_T in the hadronic calorimeter to E_T of the EM cluster (used over the range $\|\eta\| > 0.8$ and $\|\eta\| < 1.37$)	R_{had1} R_{had}
Second layer of EM calorimeter	⋆ Ratio in η of cell energies in 3×7 versus 7×7 cells. ⋆ Lateral width of the shower.	R_η $w_{\eta 2}$

MEDIUM identification

Medium cuts (includes Loose)		
First layer of EM calorimeter.	⋆ Total shower width. ⋆ Ratio of the energy difference associated with the largest and second largest energy deposit over the sum of these energies	w_{stot} E_{ratio}
Track quality	⋆ Number of hits in the pixel detector (≥ 1). ⋆ Number of hits in the pixels and SCT (≥ 7). ⋆ Transverse impact parameter (<5 mm).	 d_0
Track matching	⋆ $\Delta\eta$ between the cluster and the track (< 0.01).	$\Delta\eta_1$

TIGHT identification

Tight cuts (includes Medium)		
b-layer	⋆ Number of hits in the b-layer (≥ 1).	
Track matching	⋆ $\Delta\phi$ between the cluster and the track (< 0.02). ⋆ Ratio of the cluster energy to the track momentum ⋆ Tighter $\Delta\eta$ cut (< 0.005)	$\Delta\phi_2$ E/p $\Delta\eta_1$
Track quality	⋆ Tighter transverse impact parameter cut ($<$1 mm).	d_0
TRT	⋆ Total number of hits in the TRT. ⋆ Ratio of the number of high-threshold hits to the total number of hits in the TRT.	
Conversions	⋆ Electron candidates matching to reconstructed photon conversions are rejected	