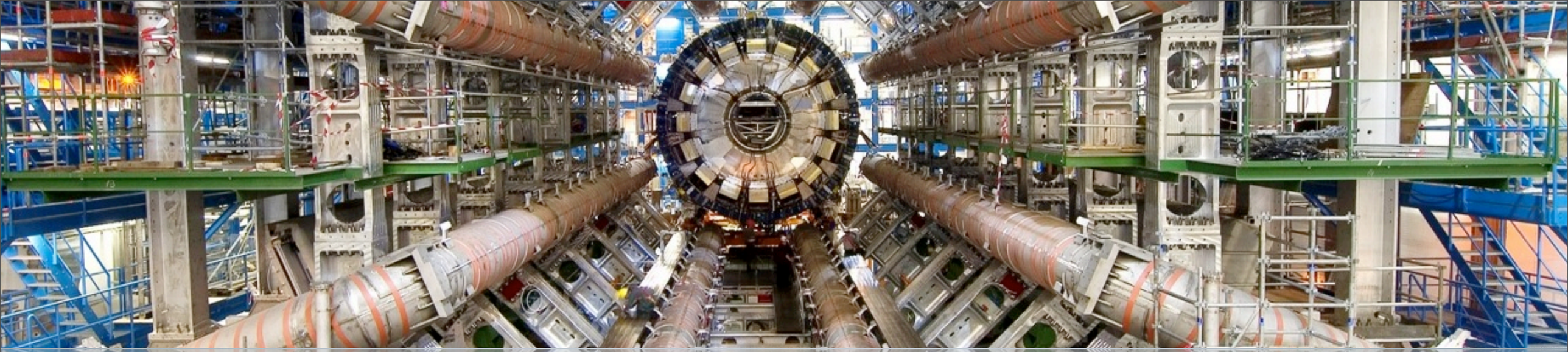


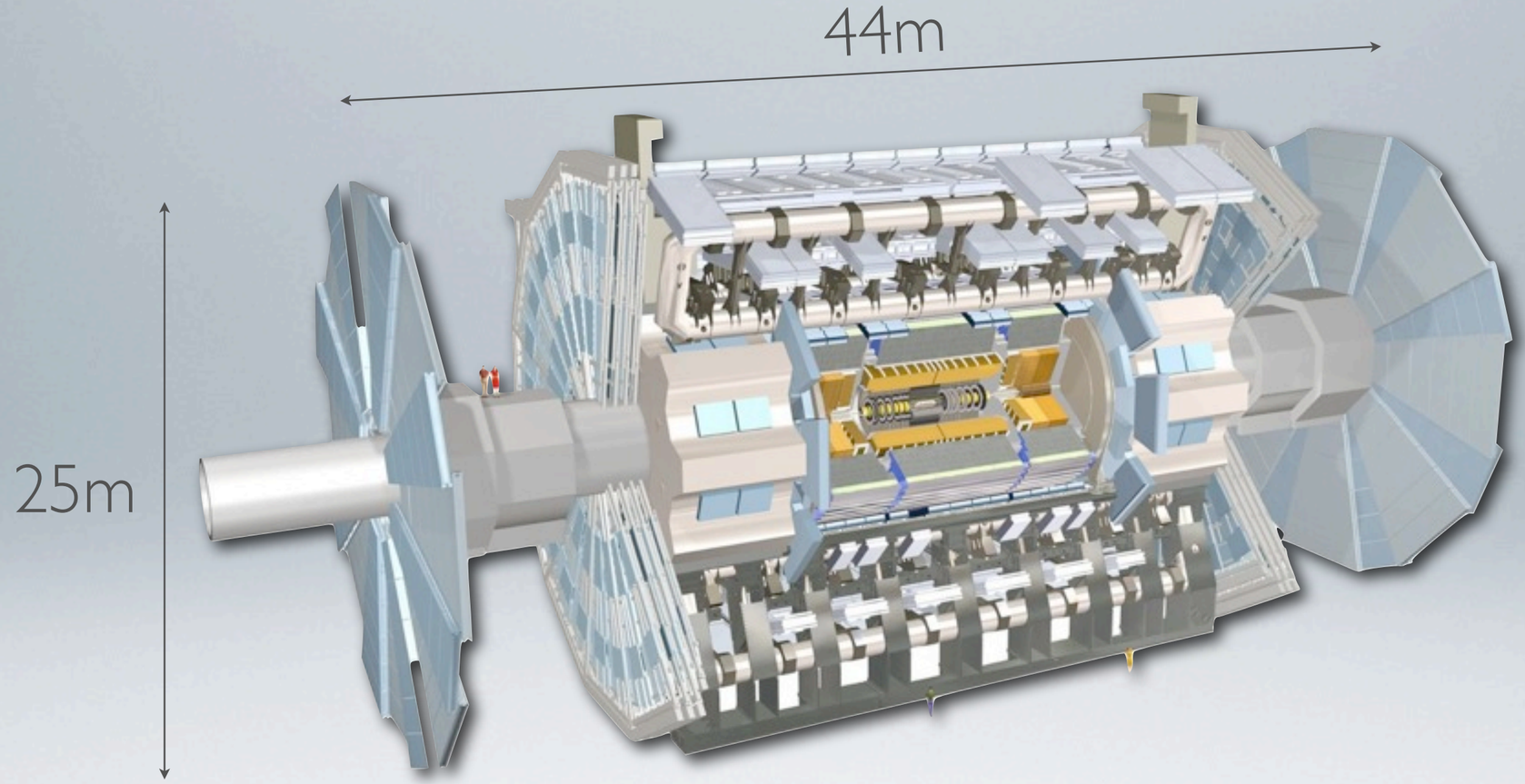
ELECTRON PERFORMANCE MEASUREMENTS WITH THE ATLAS DETECTOR USING THE 2010 LHC PROTON-PROTON COLLISION DATA

Josu Hernandez - Calum Johnstone

HASCO 2012

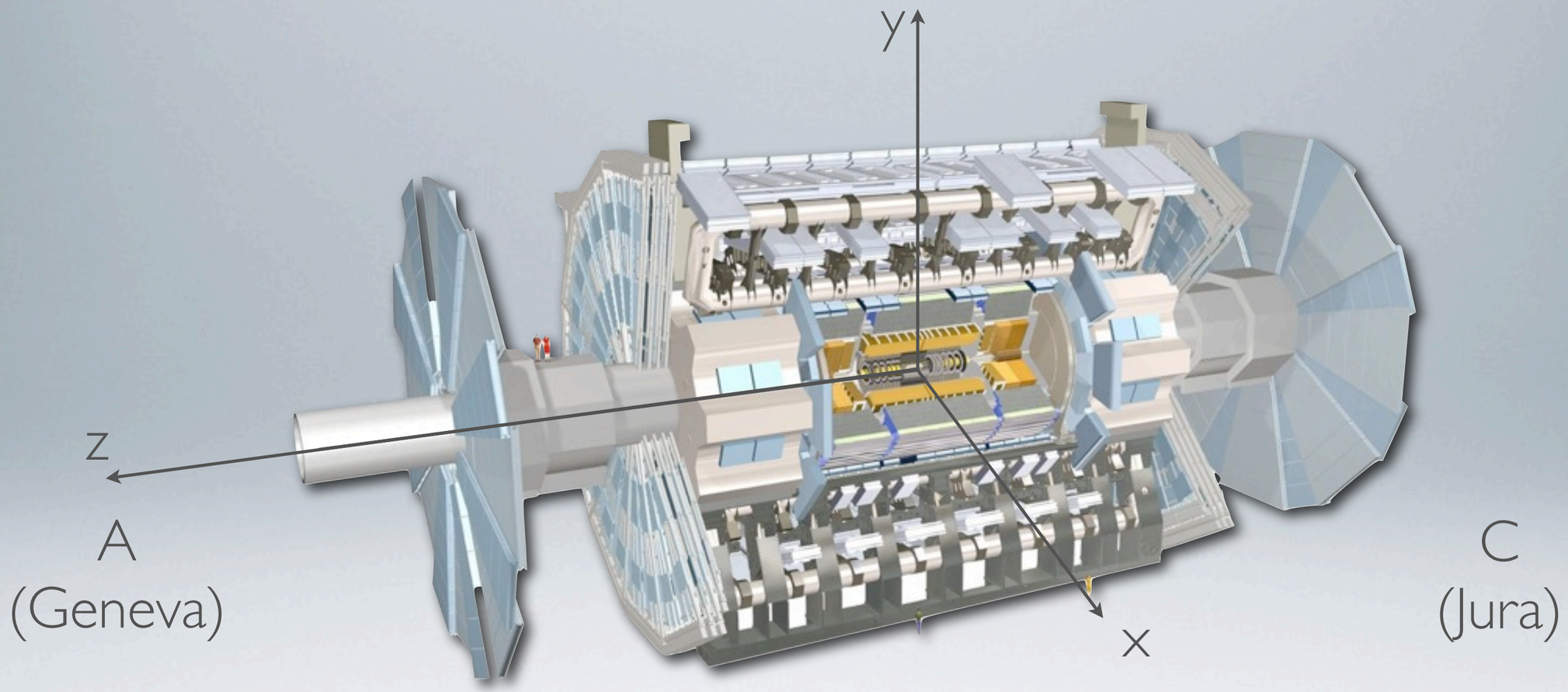
INTRODUCTION

INTRODUCTION



ATLAS Detector

INTRODUCTION



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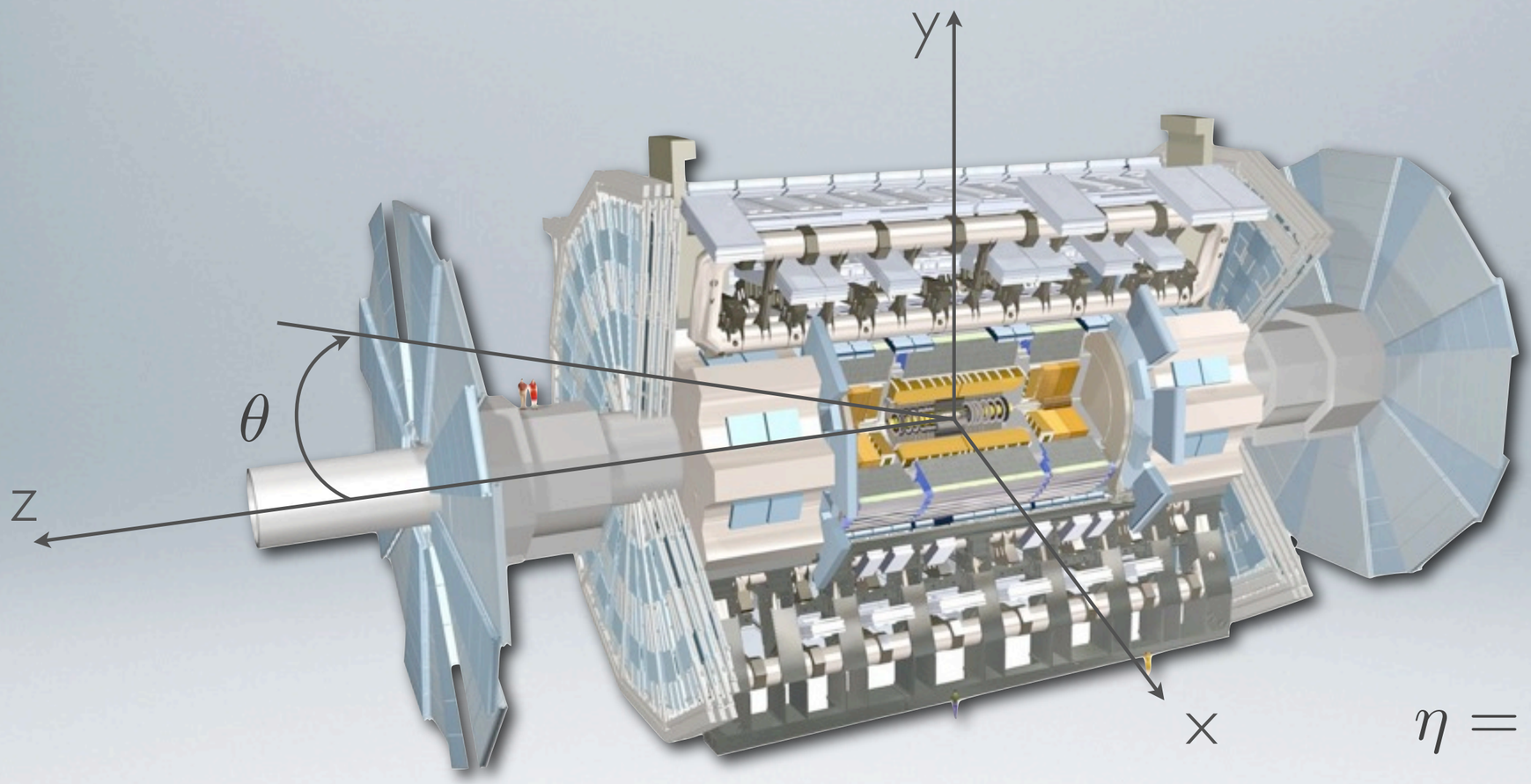
INTRODUCTION

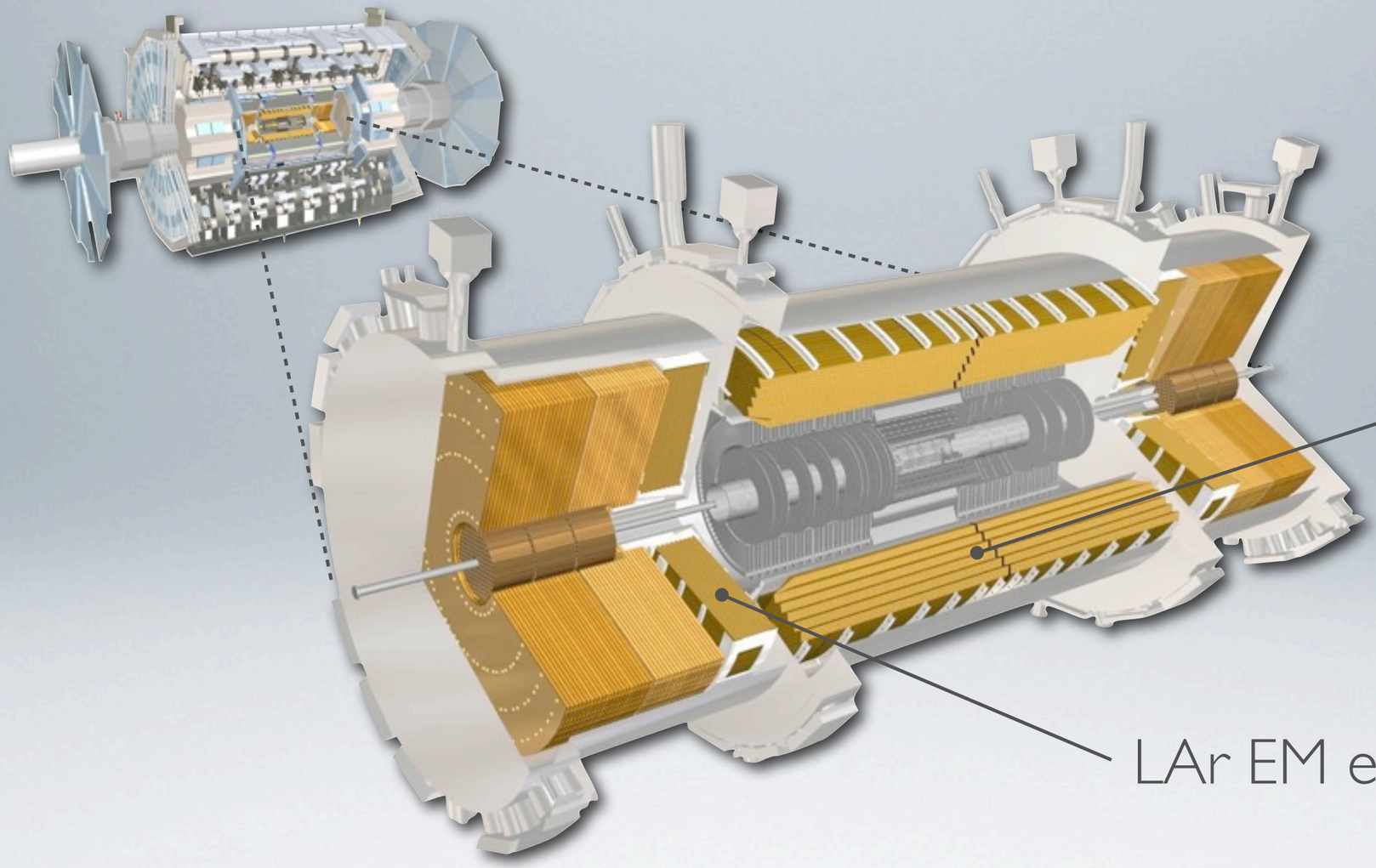


ATLAS Detector

$$\eta = -ln\left(\tan\frac{\theta}{2}\right)$$

Pseudorapidity

INTRODUCTION

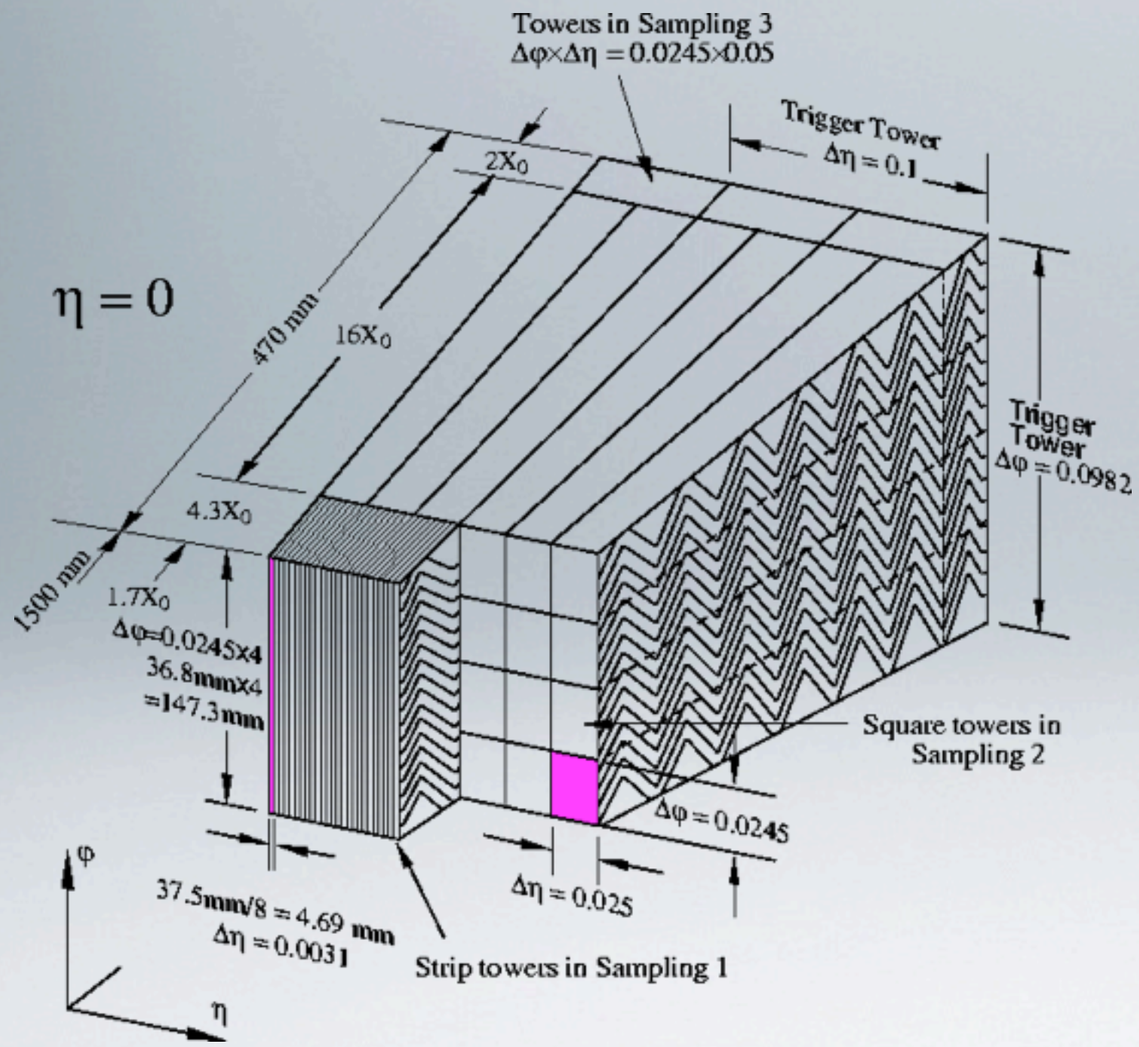


LAr EM barrel

$|\eta| < 3.2$

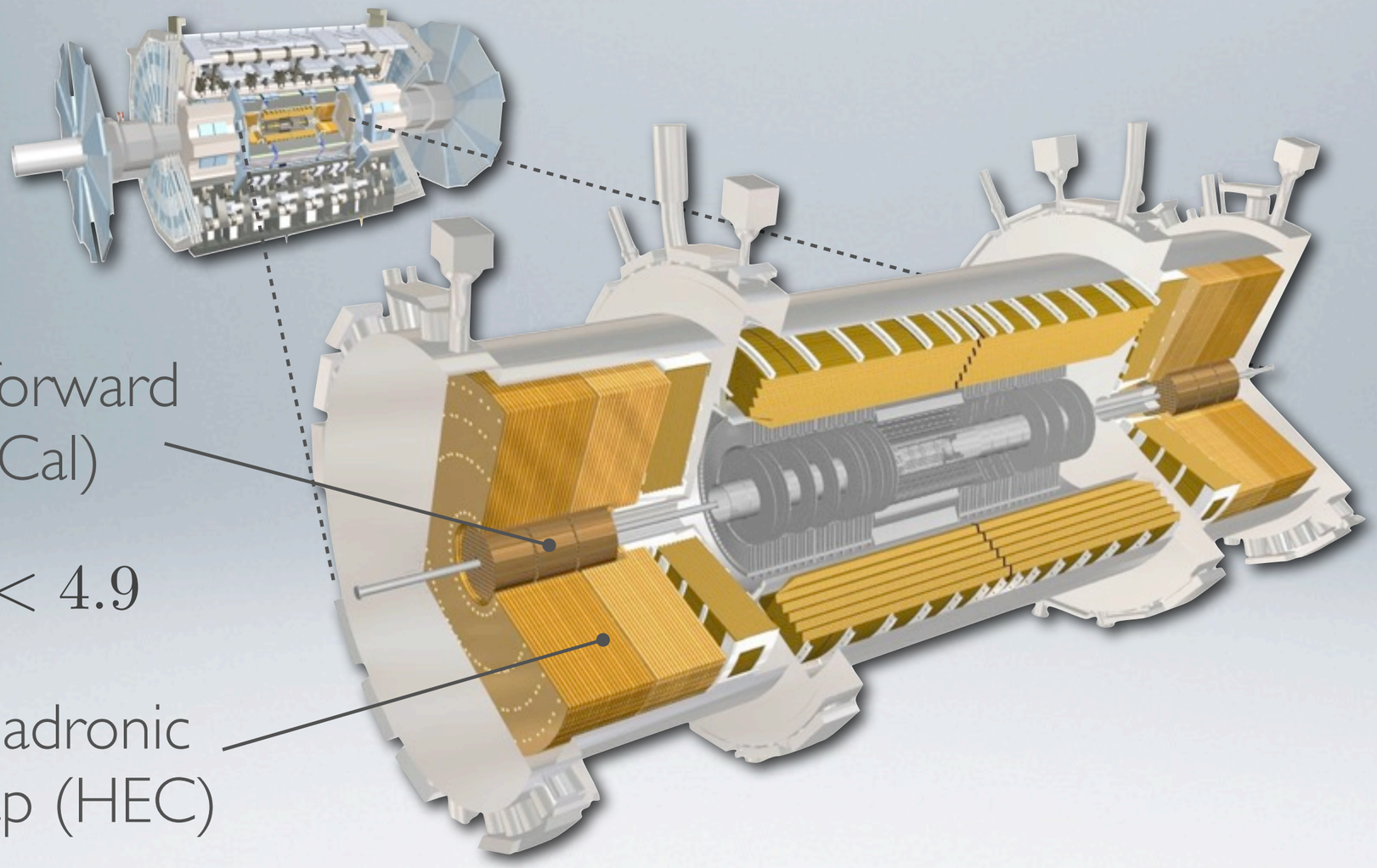
LAr EM end-cap (EMEC)

Electromagnetic calorimeter



Layer	Granularity $\Delta\eta \times \Delta\phi$	Radiation lenght
Strips	0.003×0.1	$4.3X_o$
Middle	0.025×0.025	$16X_o$
Back	0.05×0.025	$2X_o$

INTRODUCTION

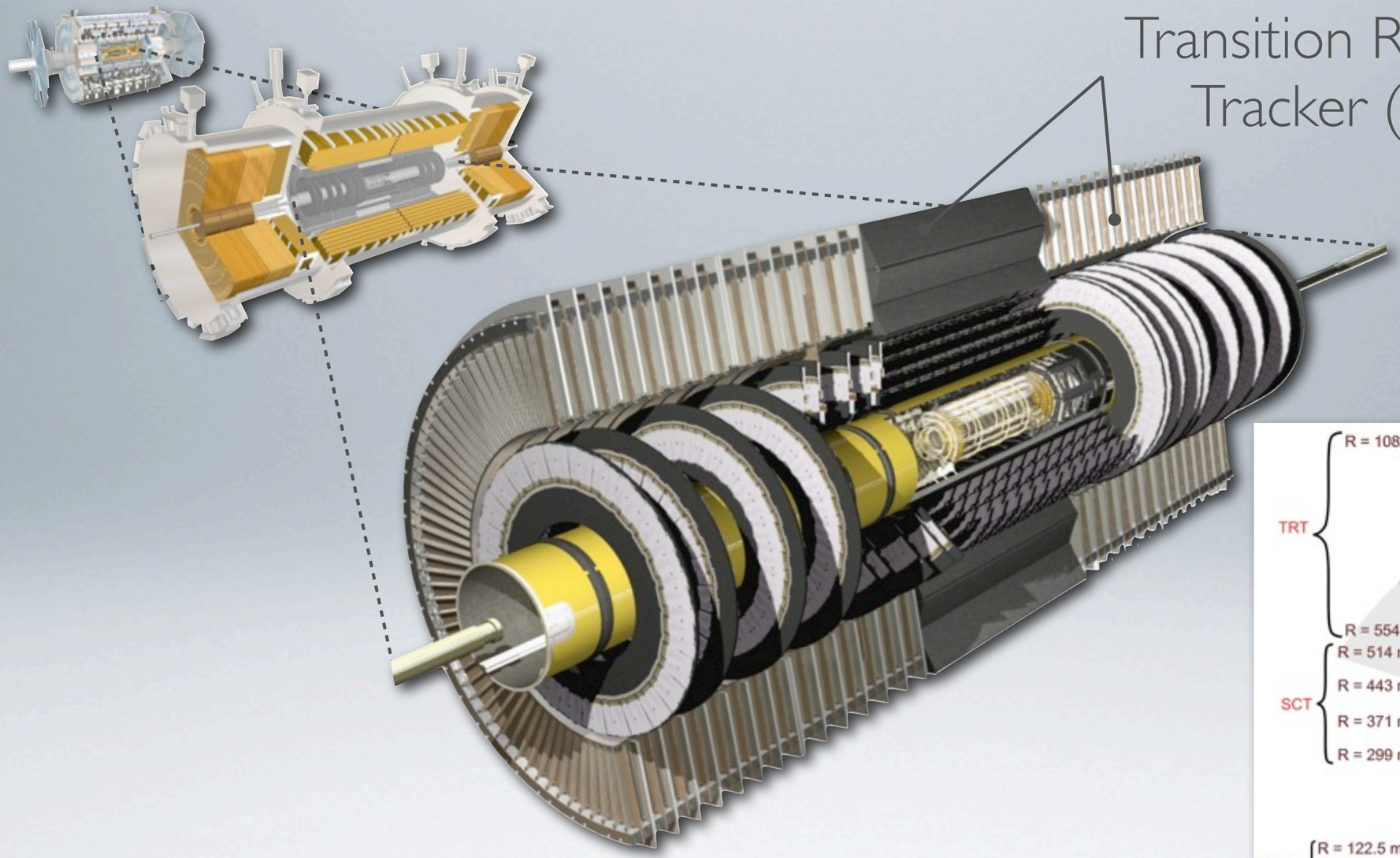


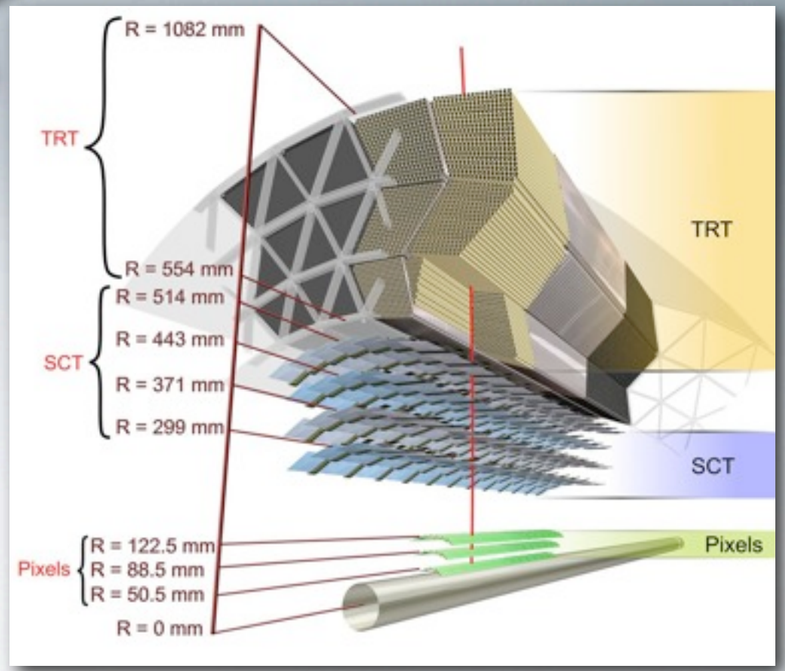
LAr forward (FCal)

$|\eta| < 4.9$

LAr hadronic end-cap (HEC)

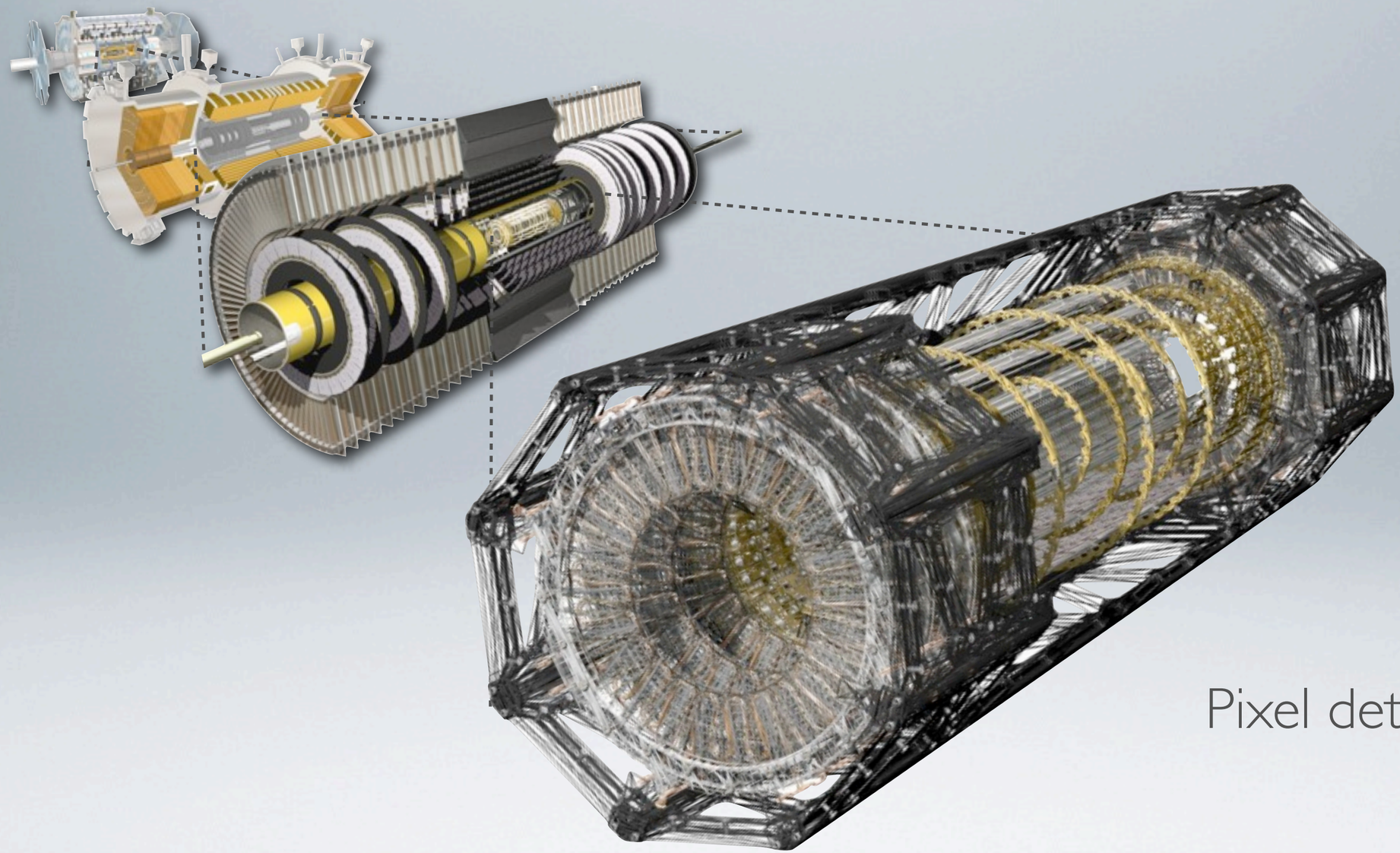
INTRODUCTION





Inner detector $|\eta| < 2.5$

INTRODUCTION

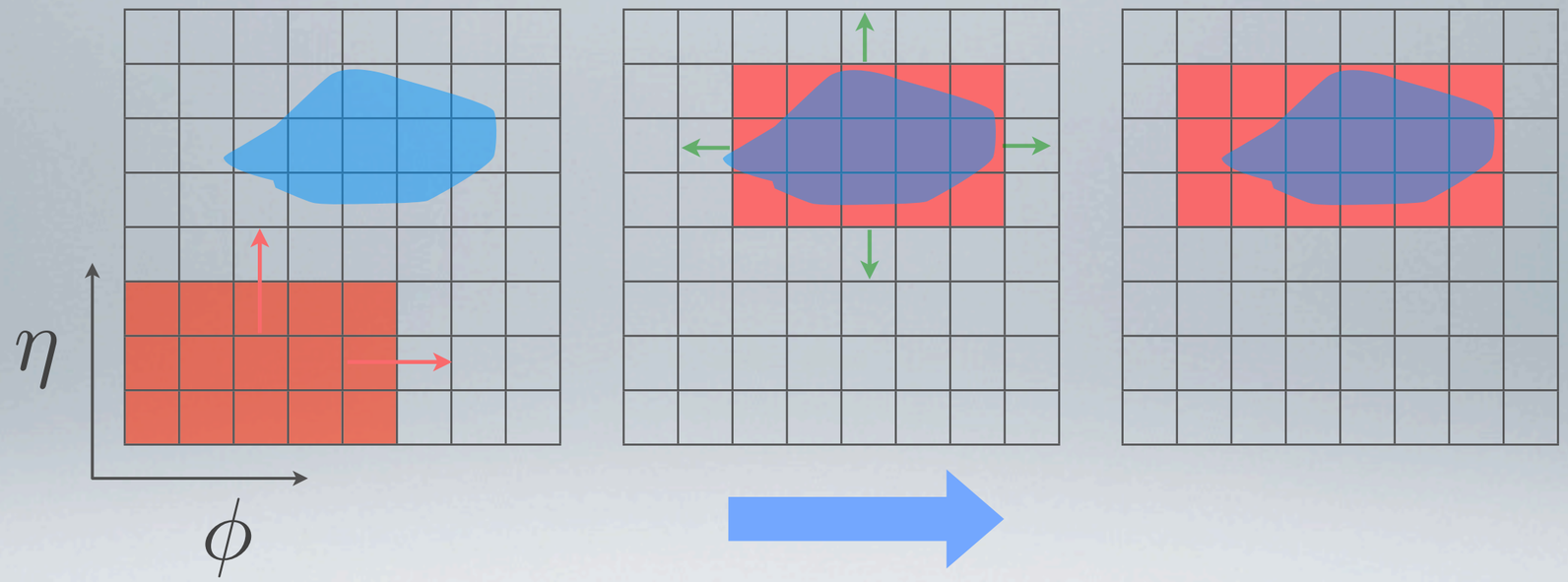


Pixel detector

ELECTRON IDENTIFICATION

ELECTRON IDENTIFICATION

- CLUSTERS



ELECTRON IDENTIFICATION

- LOOSE SELECTION Expected jet rejection of about 500

Type	Description	Name
Loose selection		
Acceptance	$\|\eta\| < 2.47$	
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 $\|\eta\| > 1.37$)	R_{had1}
	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_{had}
Middle layer of EM calorimeter	Ratio of the energy in 3×7 cells over the energy in 7×7 cells centred at the electron cluster position	R_η
	Lateral shower width, $\sqrt{(\Sigma E_i \eta_i^2)/(\Sigma E_i) - ((\Sigma E_i \eta_i)/(\Sigma E_i))^2}$, where E_i is the energy and η_i is the pseudorapidity of cell i and the sum is calculated within a window of 3×5 cells	$w_{\eta 2}$

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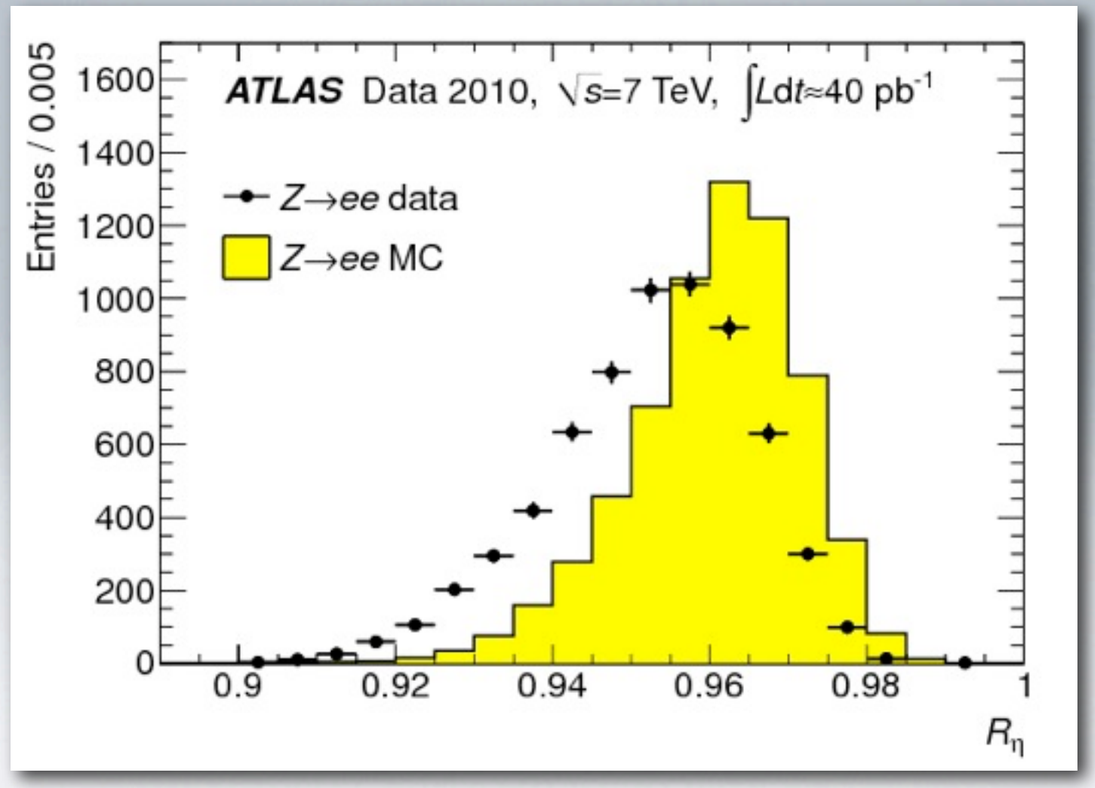

ELECTRON IDENTIFICATION

- MEDIUM SELECTION Expected jet rejection of about 5000

Type	Description	Name
Medium selection (includes loose)		
Strip layer of EM calorimeter	Shower width, $\sqrt{(\Sigma E_i (i - i_{\max})^2)(\Sigma E_i)}$, where i runs over all strips in a window of $\Delta\eta \times \Delta\phi \approx 0.0625 \times 0.2$, corresponding typically to 20 strips in η, and $i_{\max}$ is the index of the highest-energy strip	w_{stot}
	Ratio of the energy difference between the largest and second largest energy deposits in the cluster over the sum of these energies	E_{ratio}
Track quality	Number of hits in the pixel detector (≥ 1)	n_{pixel}
	Number of total hits in the pixel and SCT detectors (≥ 7)	n_{Si}
	Transverse impact parameter ($\lvert d_0 \rvert$ <5 mm)	d_0
Track–cluster matching	$\Delta\eta$ between the cluster position in the strip layer and the extrapolated track ($\lvert\Delta\eta\rvert < 0.01$)	$\Delta\eta$

ELECTRON IDENTIFICATION

- TIGHT SELECTION Expected jet rejection of about 50000

Type	Description	Name
Tight selection (includes medium)		
Track–cluster matching	$\Delta\phi$ between the cluster position in the middle layer and the extrapolated track ($\lvert\Delta\phi\rvert < 0.02$)	$\Delta\phi$
	Ratio of the cluster energy to the track momentum	E/p
	Tighter $\Delta\eta$ requirement ($\lvert\Delta\eta\rvert < 0.005$)	$\Delta\eta$
Track quality	Tighter transverse impact parameter requirement ($\lvert d_0\rvert$ <1 mm)	d_0
TRT	Total number of hits in the TRT	n_{TRT}
	Ratio of the number of high-threshold hits to the total number of hits in the TRT	f_{HT}
Conversions	Number of hits in the b-layer (≥ 1)	n_{BL}
	Veto electron candidates matched to reconstructed photon conversions	

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EFFICIENCY MEASUREMENTS

EFFICIENCY MEASUREMENTS

- METHODOLOGY

$$C = \epsilon_{event} \cdot \alpha_{reco} \cdot \epsilon_{ID} \cdot \epsilon_{trig} \cdot \epsilon_{isol}$$

$$\epsilon_{ID} = \frac{\mathcal{N}_{AI}^{data} - \mathcal{N}_{AI}^{bgd}}{\mathcal{N}_{BI}^{data} - \mathcal{N}_{BI}^{bgd}}$$

$$\mathrm{AI} = \text{After Identification}$$

$$\mathrm{BI} = \text{Before Identification}$$

EFFICIENCY MEASUREMENTS

- PROBE SELECTION

Efficiency of electron identification performed on:

$$W \to e\nu \qquad Z \to e^+e^- \qquad J/\psi \to e^+e^-$$

Central region of the EM calorimeter:

$$|\eta| < 2.47$$

$$E_T \in (4, 50)\, GeV$$

EFFICIENCY MEASUREMENTS

- PROBE SELECTION

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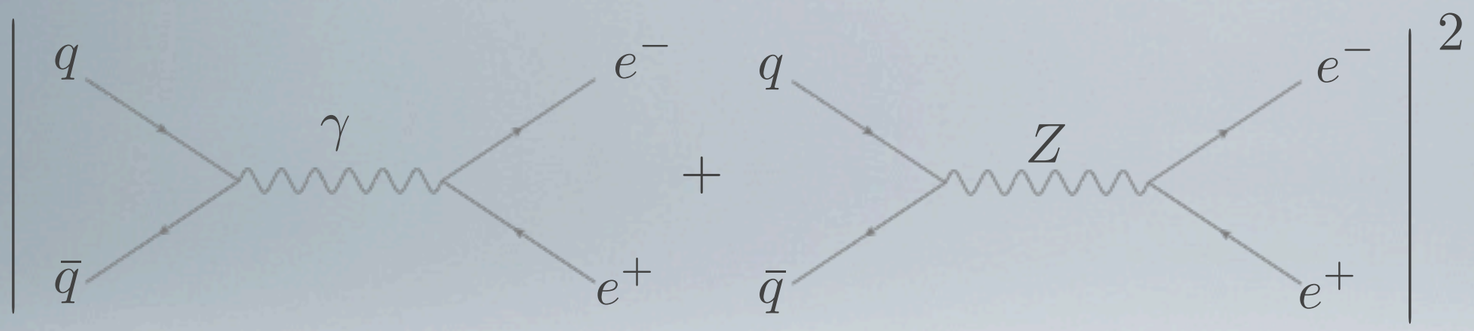
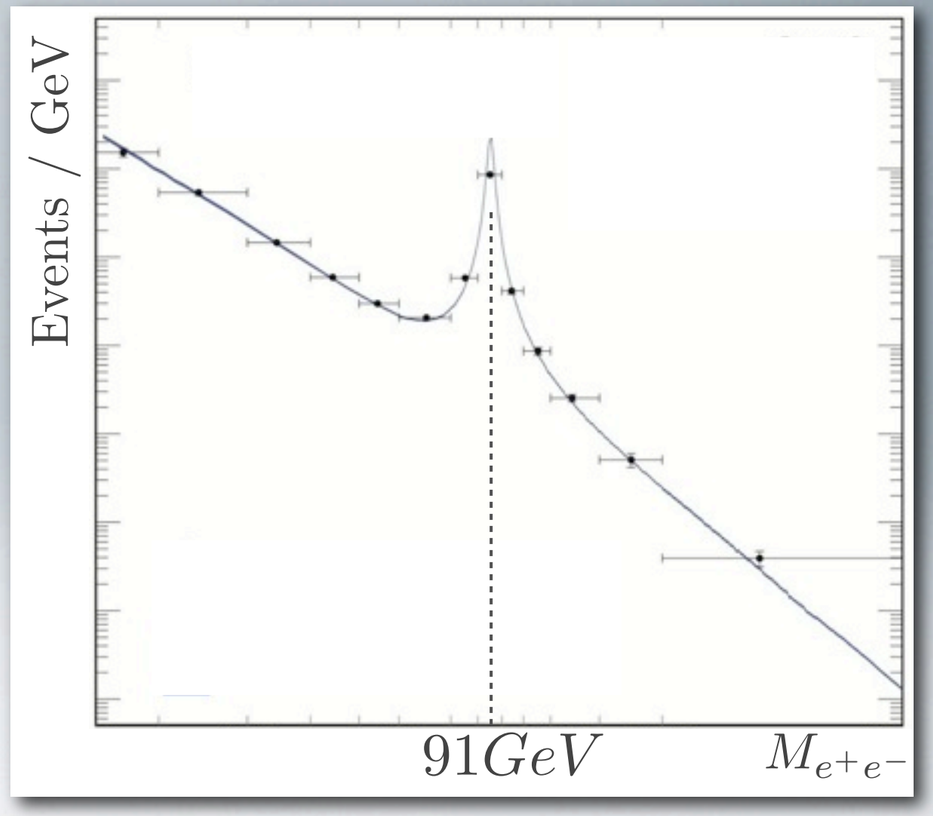
EFFICIENCY MEASUREMENTS

- PROBE SELECTION $Z \to e^+e^-$

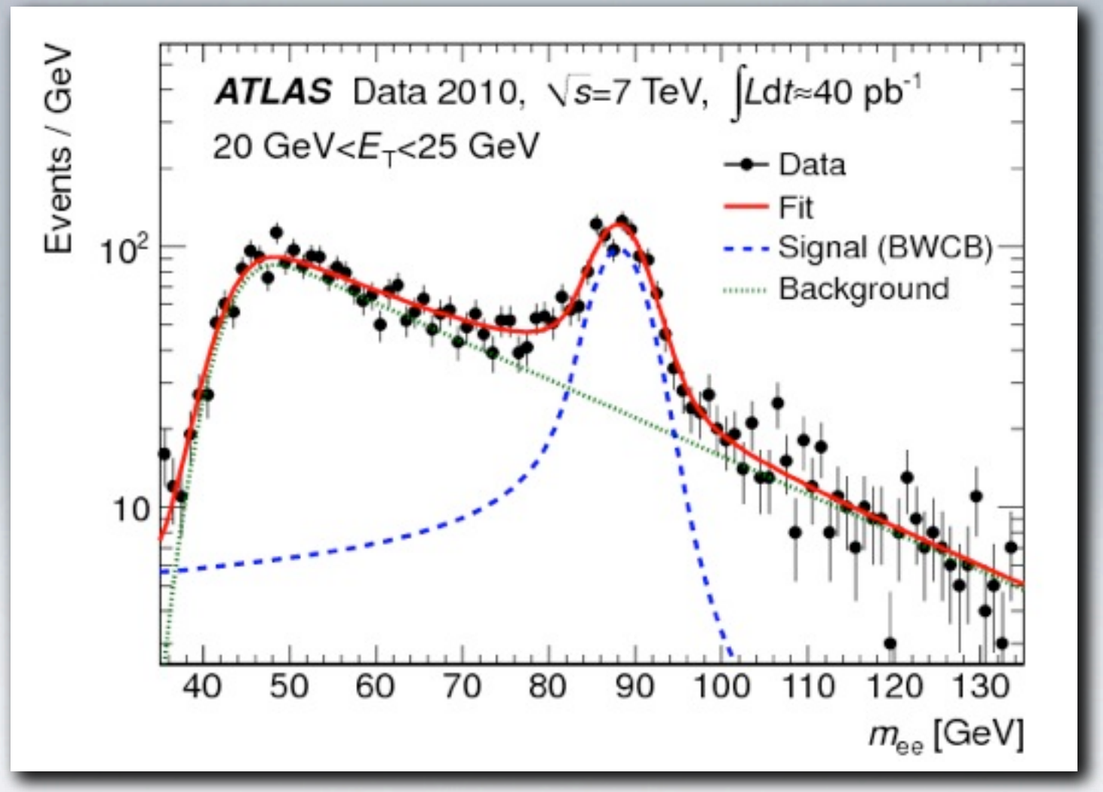


Drell - Yan



EFFICIENCY MEASUREMENTS

- BACKGROUND SUBSTRACTION



EFFICIENCY MEASUREMENTS

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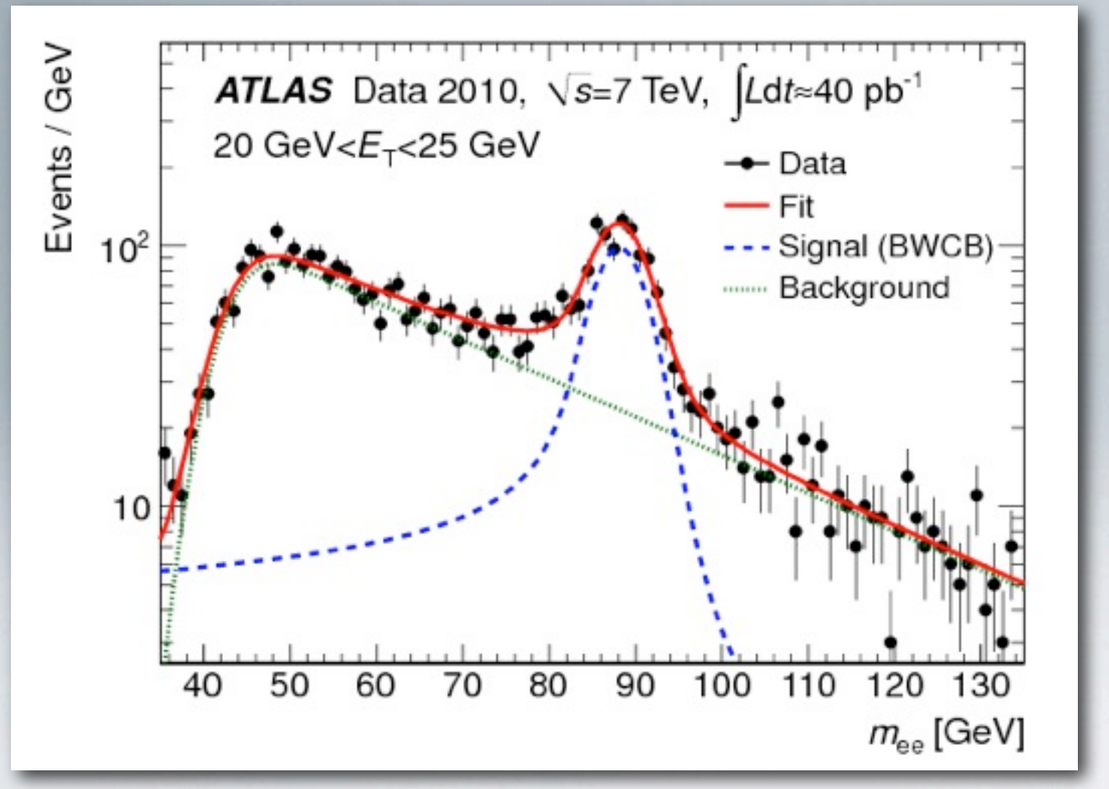
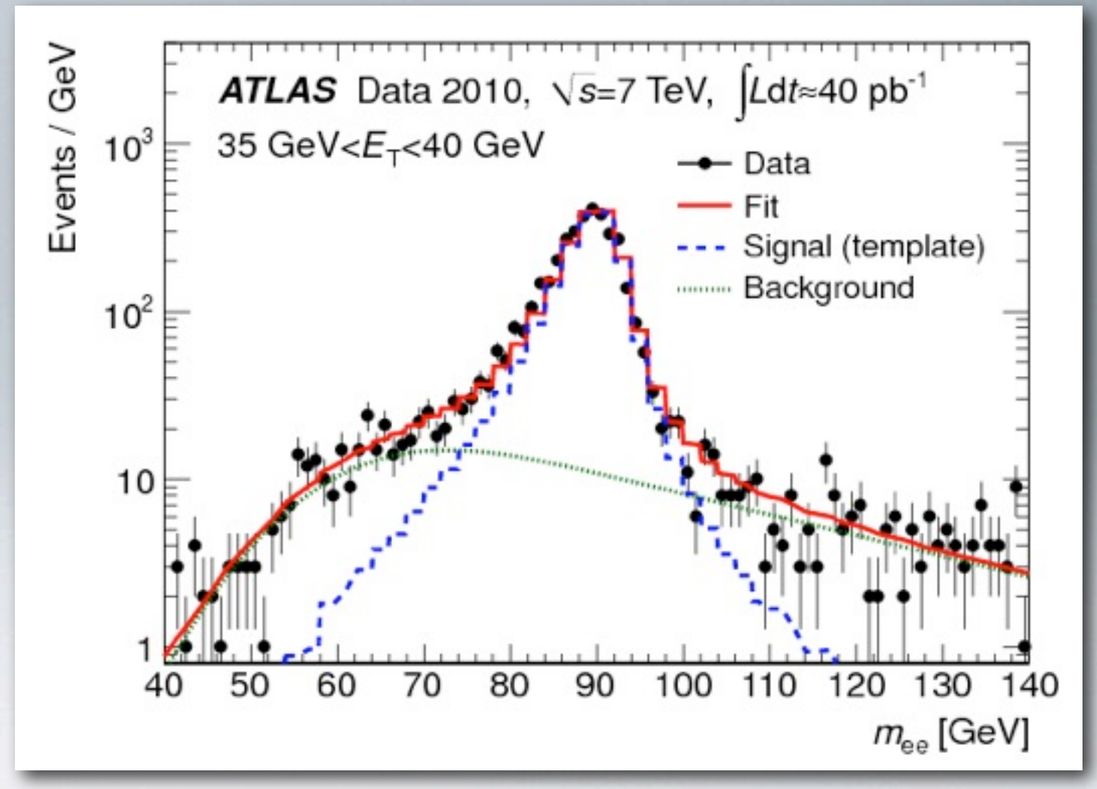
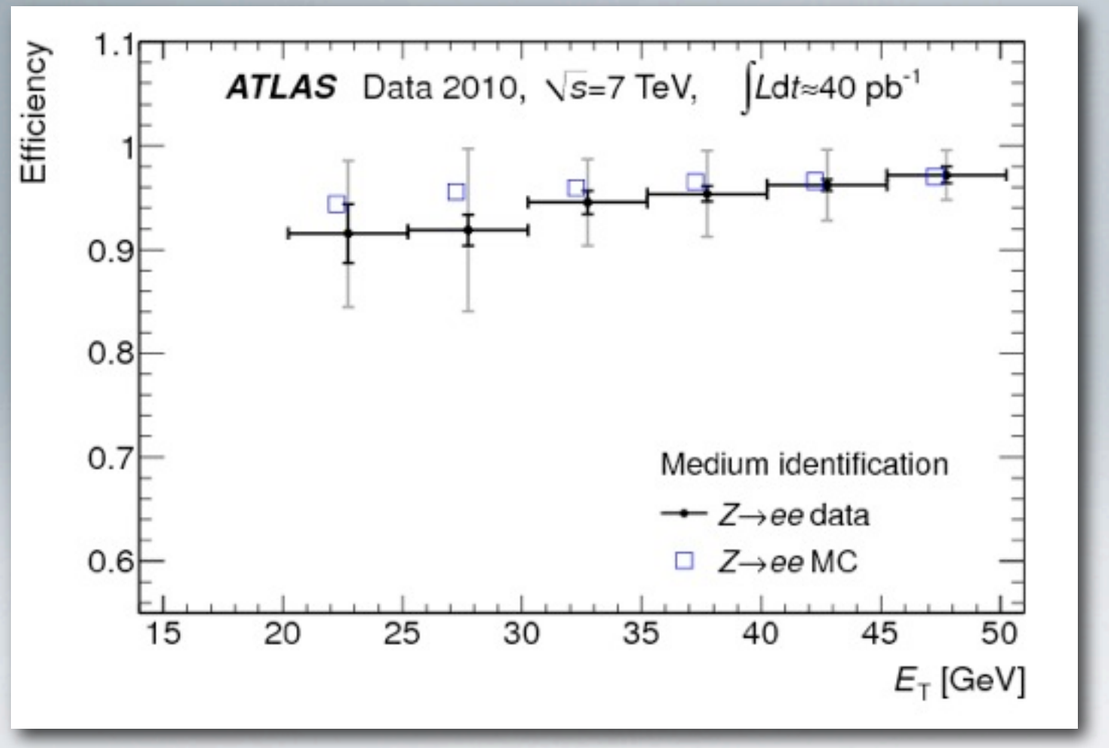


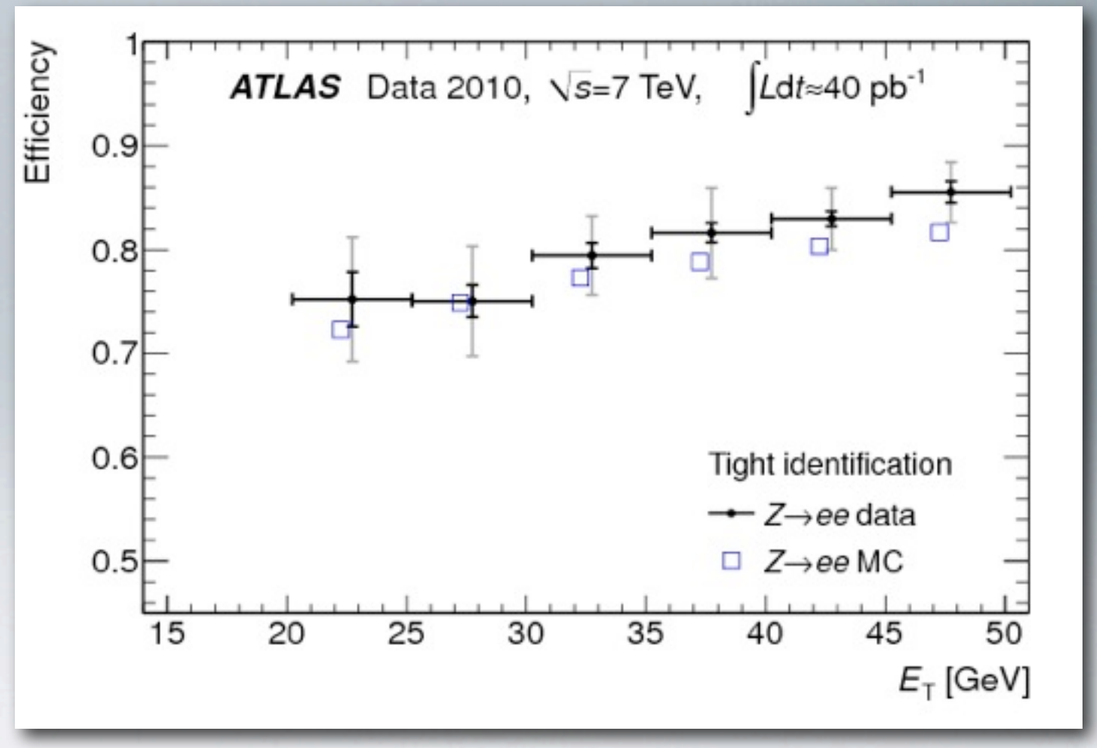


EFFICIENCY MEASUREMENTS

- MEASURED EFFICIENCIES

$$\epsilon_{ID} = \frac{\mathcal{N}_{AI}^{data} - \mathcal{N}_{AI}^{bgd}}{\mathcal{N}_{BI}^{data} - \mathcal{N}_{BI}^{bgd}}$$





Integrated over $|\eta| < 2.47$ excluding $1.37 < \eta < 1.52$

EFFICIENCY MEASUREMENTS

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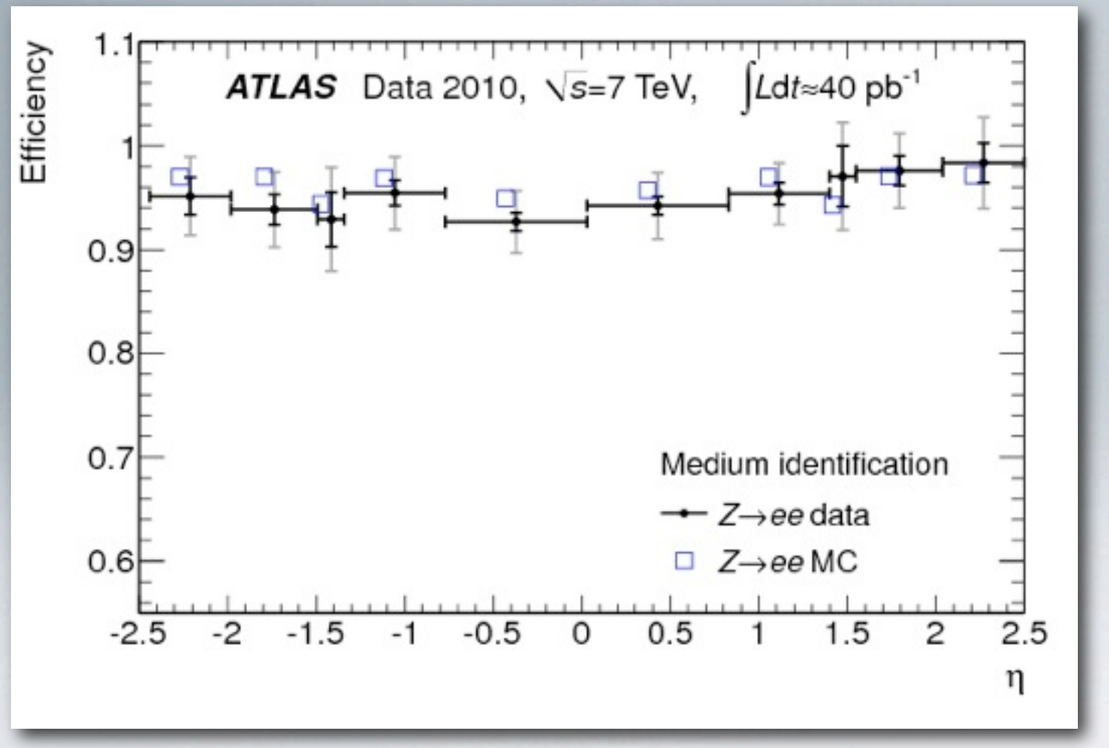
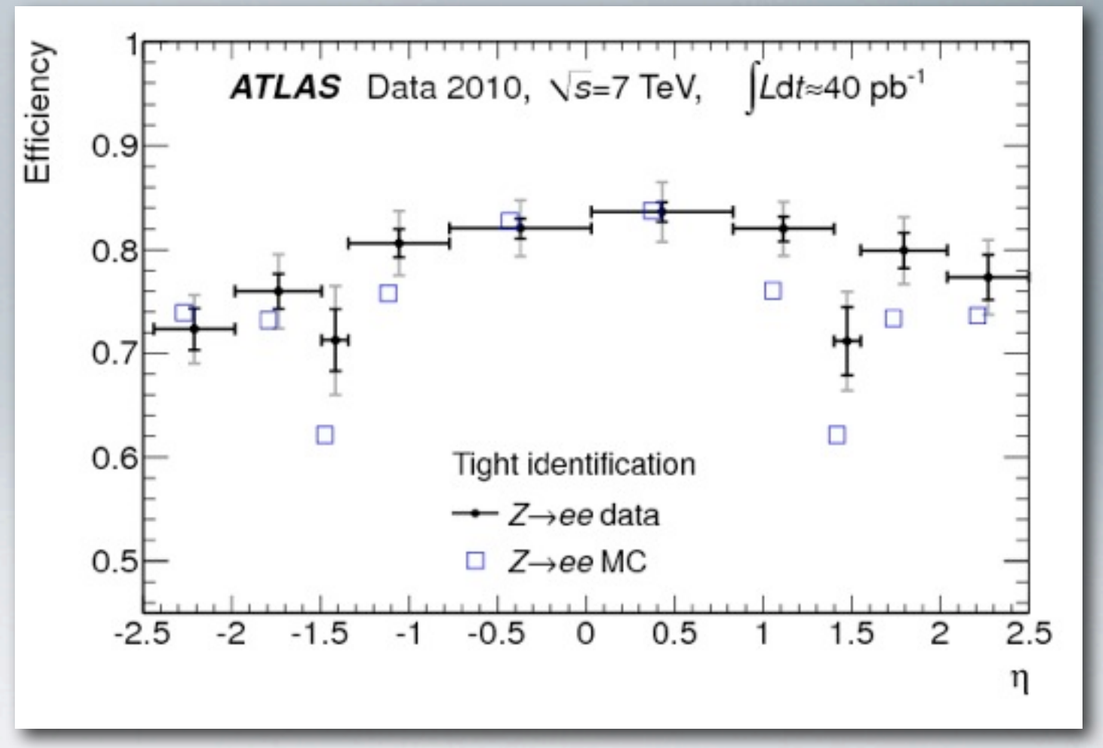




Integrated over $E_T \in (20, 50)\, GeV$

EFFICIENCY MEASUREMENTS

- MEASURED EFFICIENCIES

$$\epsilon_{ID} = \frac{\mathcal{N}_{AI}^{data} - \mathcal{N}_{AI}^{bgd}}{\mathcal{N}_{BI}^{data} - \mathcal{N}_{BI}^{bgd}}$$

Selection	Data [%]	MC [%]	Ratio
Medium	$94.7 \pm 0.4 \pm 1.5$	96.3	$0.984 \pm 0.004 \pm 0.015$
Tight	$80.7 \pm 0.5 \pm 1.5$	78.5	$1.028 \pm 0.006 \pm 0.016$

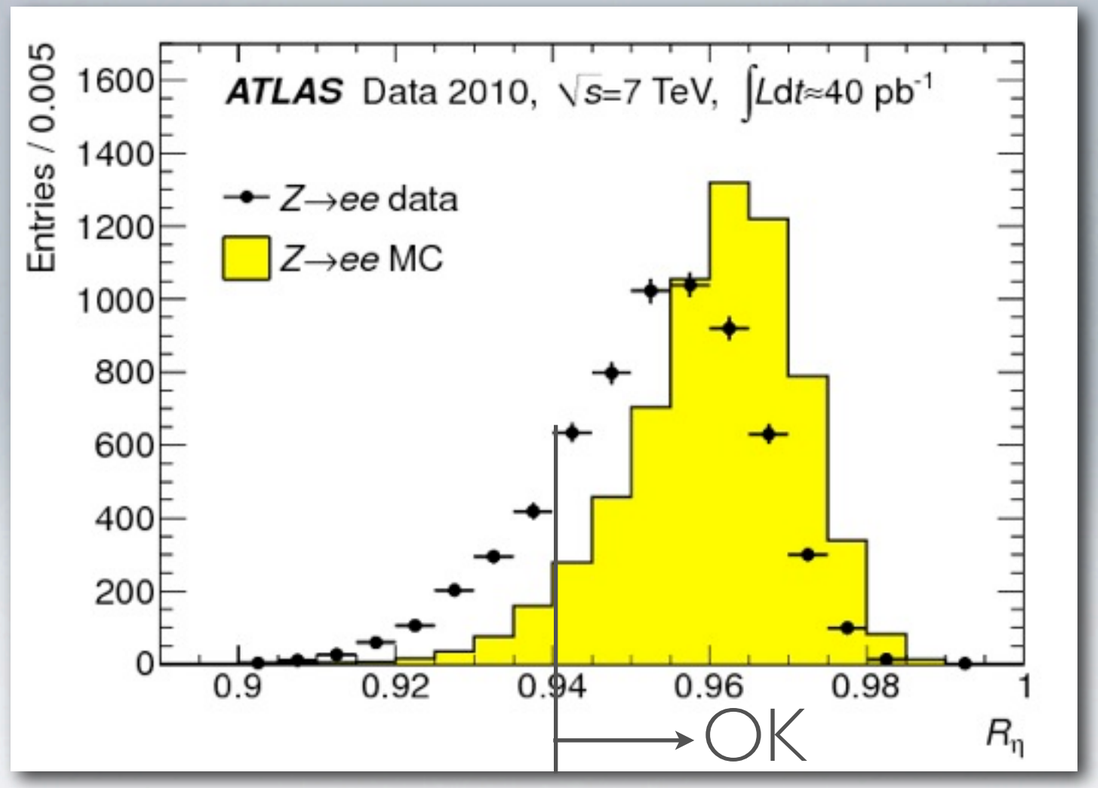
Integrated over $|\eta| < 2.47$ excluding $1.37 < \eta < 1.52$

and over $E_T \in (20, 50)\, GeV$

EFFICIENCY MEASUREMENTS

- MEASURED EFFICIENCIES

$$\epsilon_{ID} = \frac{\mathcal{N}_{AI}^{data} - \mathcal{N}_{AI}^{bgd}}{\mathcal{N}_{BI}^{data} - \mathcal{N}_{BI}^{bgd}}$$



Electron shower shape in the range $E_T \in (40, 50)\, GeV$

CONCLUSIONS

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- Performance of the ATLAS inner detector and EM calorimeters established

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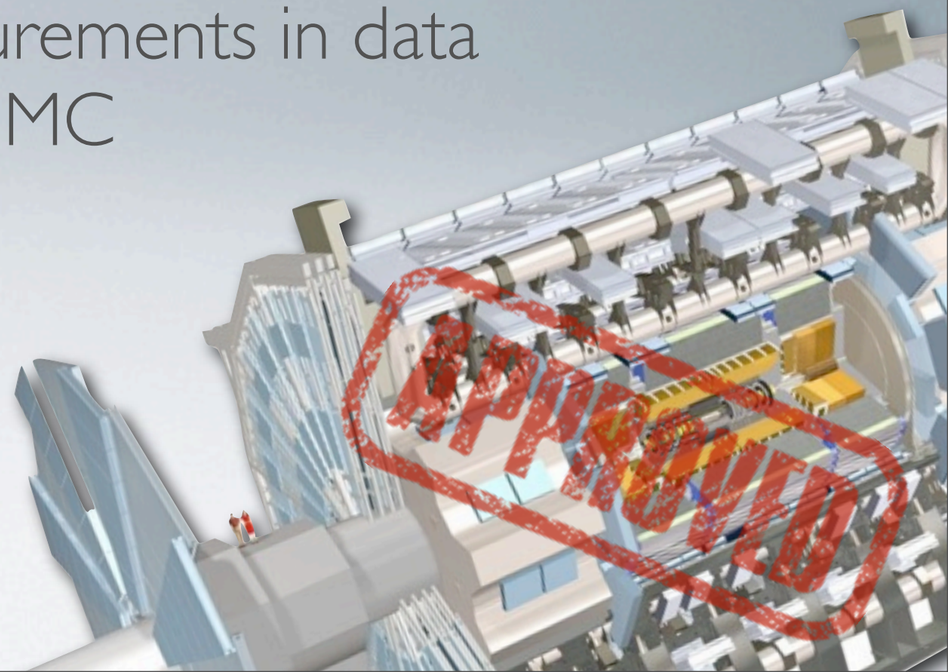

THANK YOU!

WAKE UP!

THANK YOU!