e/γ results with early data ($\sqrt{s}$ = 900 GeV) on behalf of the ATLAS collaboration

Rencontres de Moriond EW 2010
06-13 March 2010

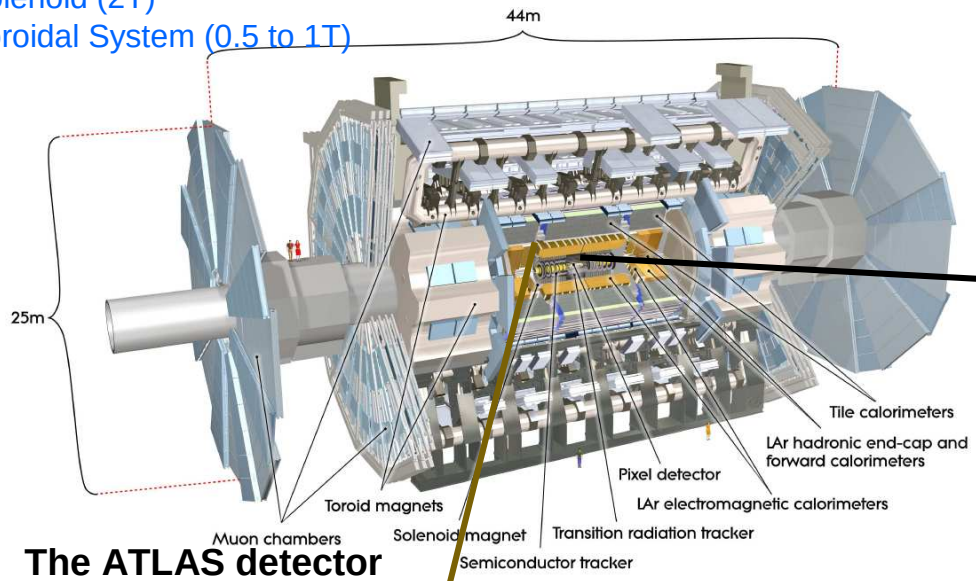
H. Abreu
Laboratoire de l'Accelerateur Lineaire (Orsay, France)

Outline:
- e/γ reconstruction
- simulation – data comparison
- Diphoton mass spectrum

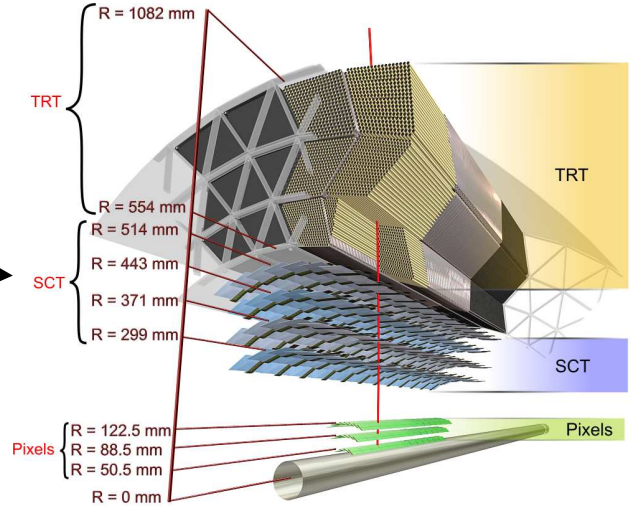
LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

The ATLAS detector and e/γ reconstruction

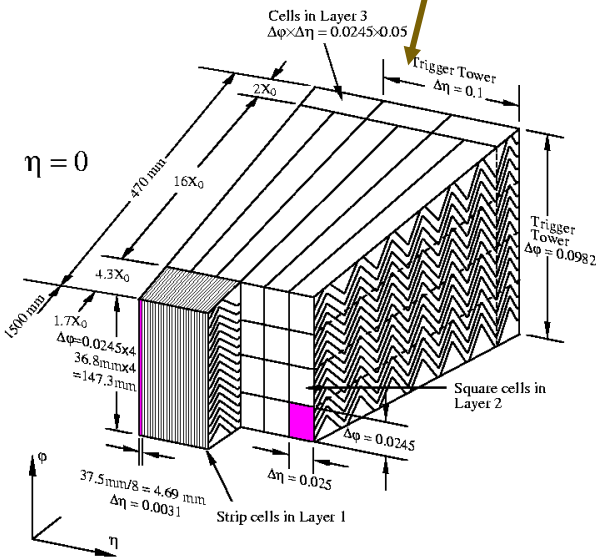
Solenoid (2T)
Toroidal System (0.5 to 1T)



The ATLAS detector



The Inner detector system.



Liquid-Argon Electromagnetic Calorimeter

Electron reconstruction:
EM clusters + track($p_T > 0.5$ GeV)
ID : loose, medium, tight

Photon reconstruction:
EM clusters without track.
unconverted photon candidate.

EM clusters + track($p_T > 0.5$ GeV , without B-layer hit)
converted photon candidate.
ID : loose, tight

The ATLAS detector and e/γ reconstruction

Solenoid (2T)
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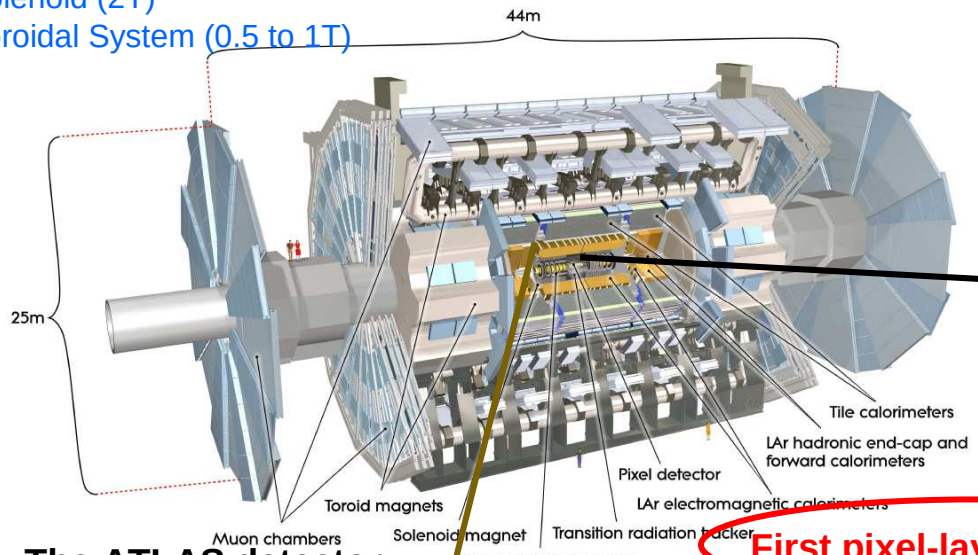
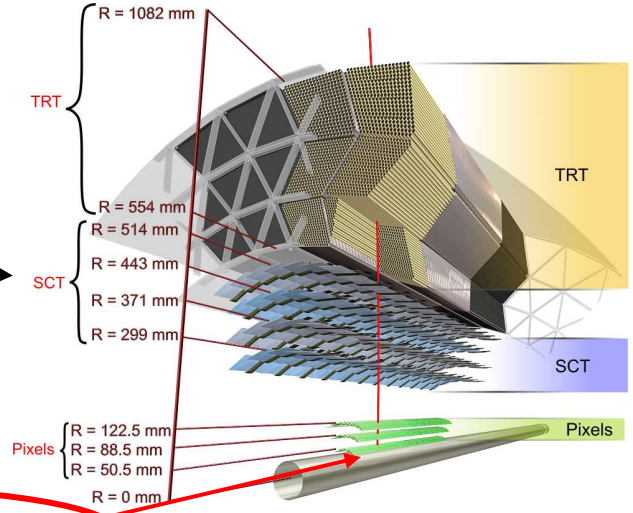


The ATLAS detector



First pixel-layer = 'B-layer'

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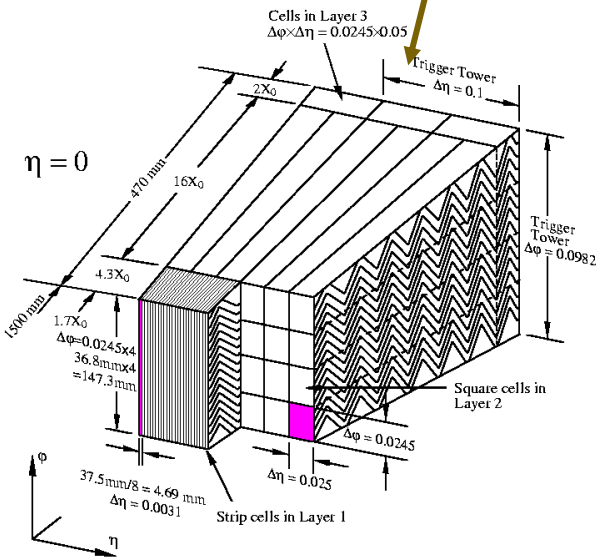

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Results from collisions at 900 GeV

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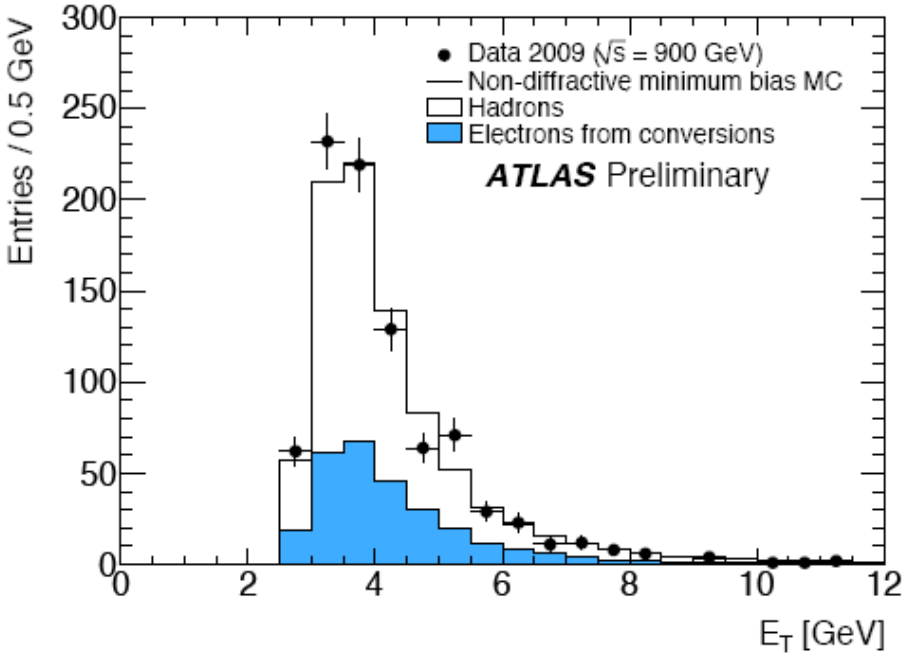
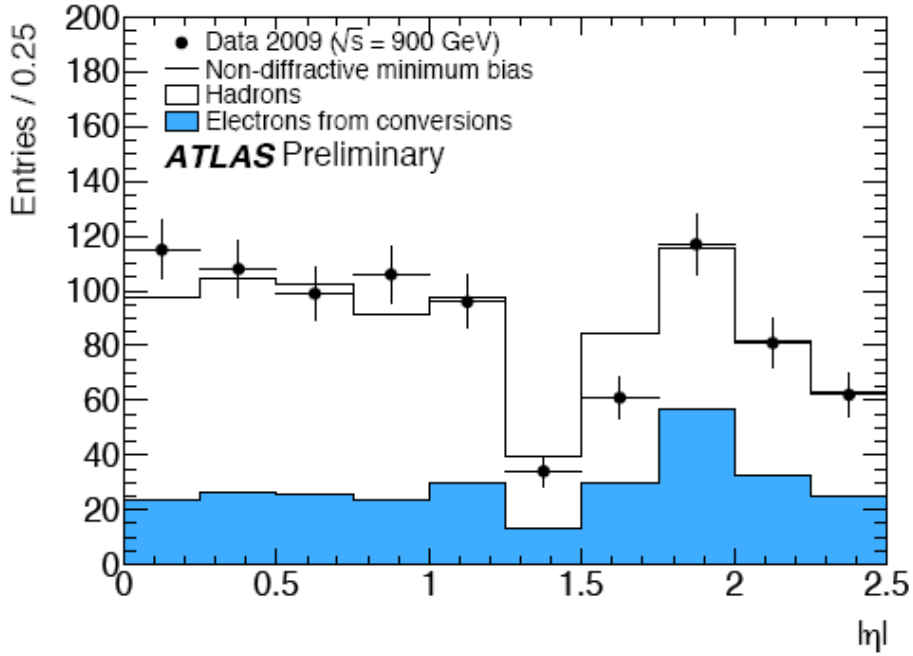


η (electron candidates)



The Monte Carlo sample shows two dominant components:

~ 66 % background fakes (mainly pions)
~ 33 % electrons from conversions.

* this category also includes a small component (~3 %) of background electrons from others sources (Dalitz decays).
* below 1% of prompt electrons from $b, c \rightarrow e$

Results from collisions at 900 GeV

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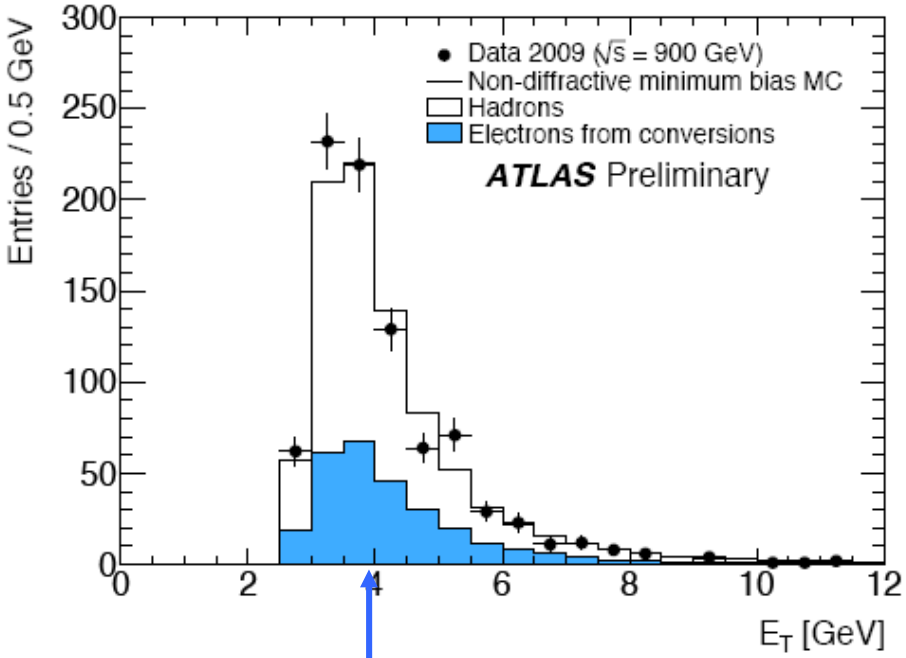

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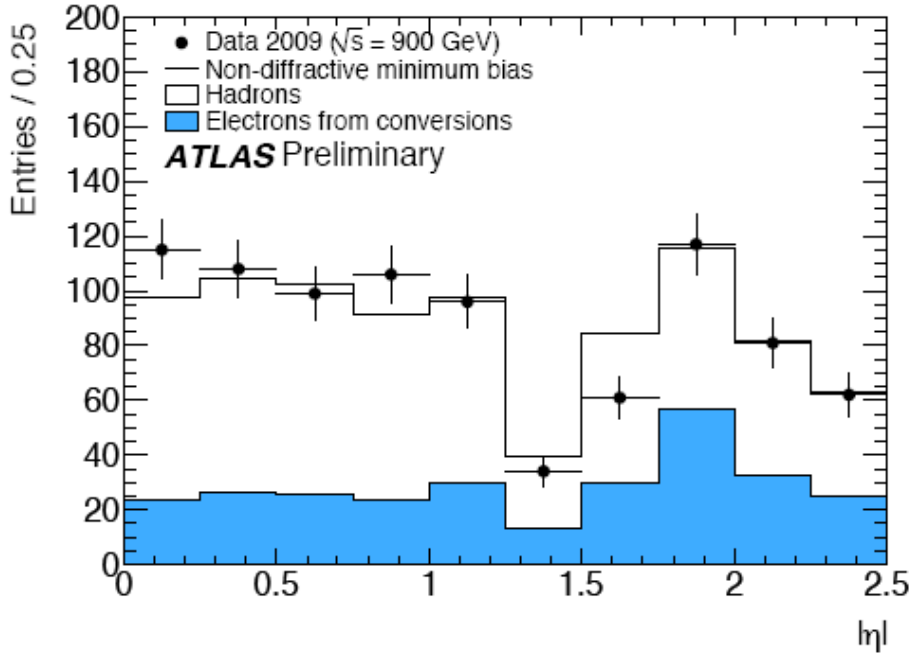

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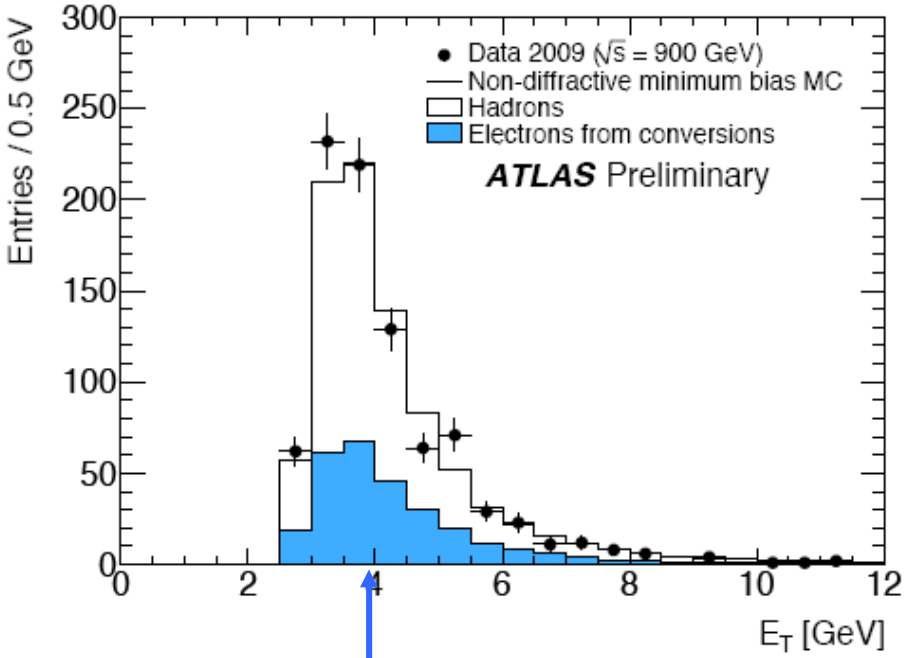

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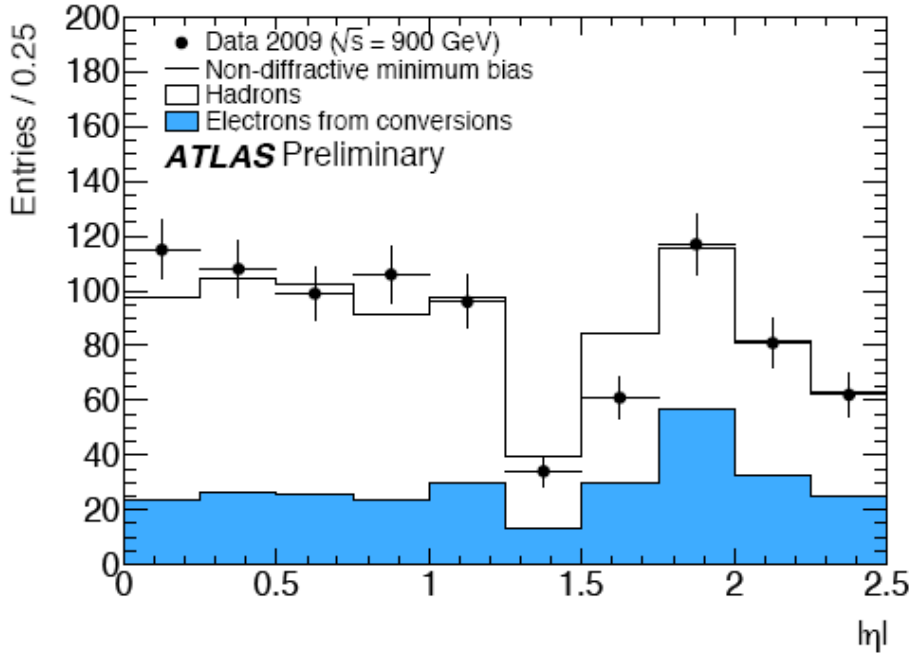

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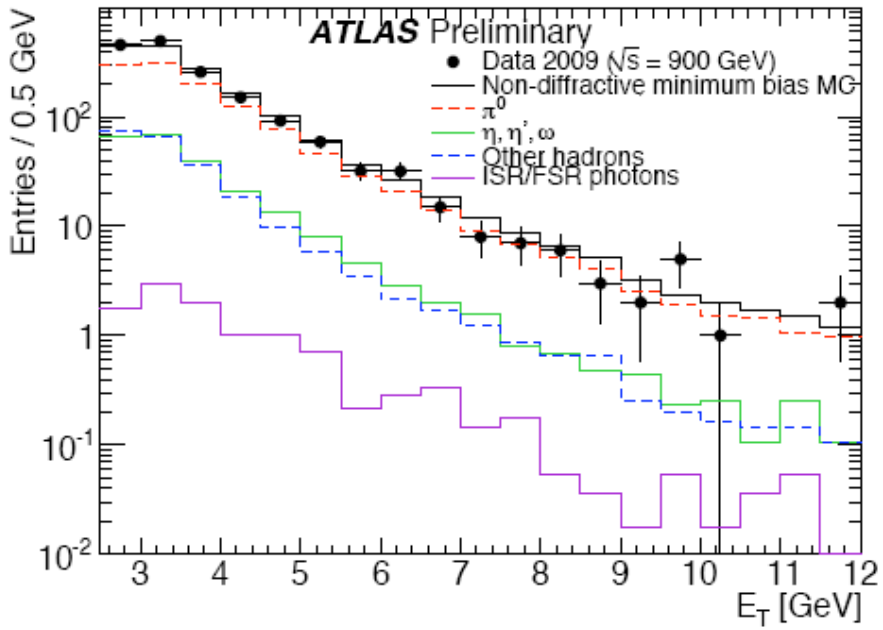

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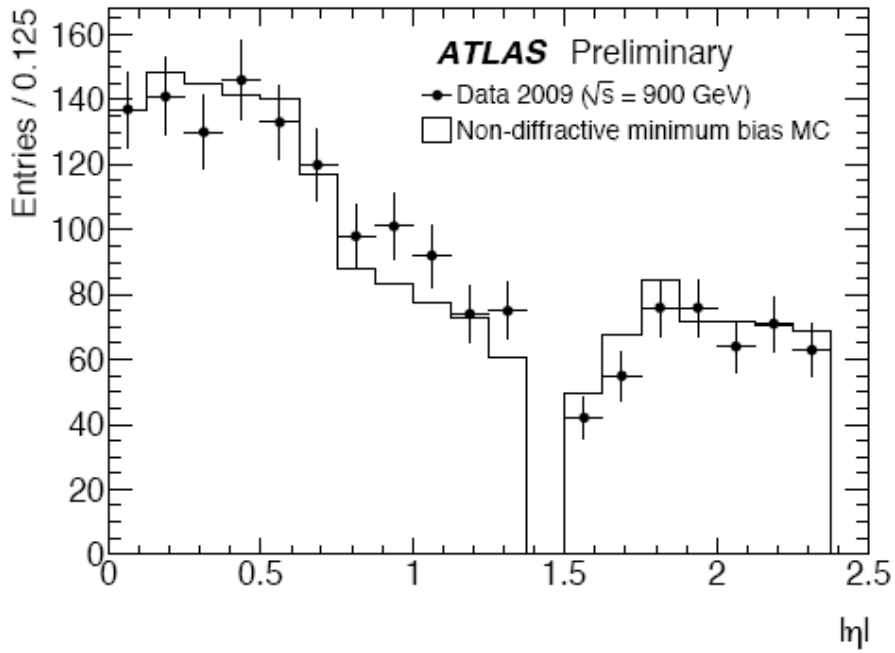

The Monte Carlo sample is sub-divided in this case into four components:

* Approximately 71% of the candidates correspond to photon from π^0 decay.
* An ~14% are from η, η', ω.
* An ~14% are from hadrons with complex decay process and particles interaction in the tracker material.
* Only a very small fraction of ~0.7% of all photon candidates are expected to be "prompt" at these energies .

Results from collisions at 900 GeV

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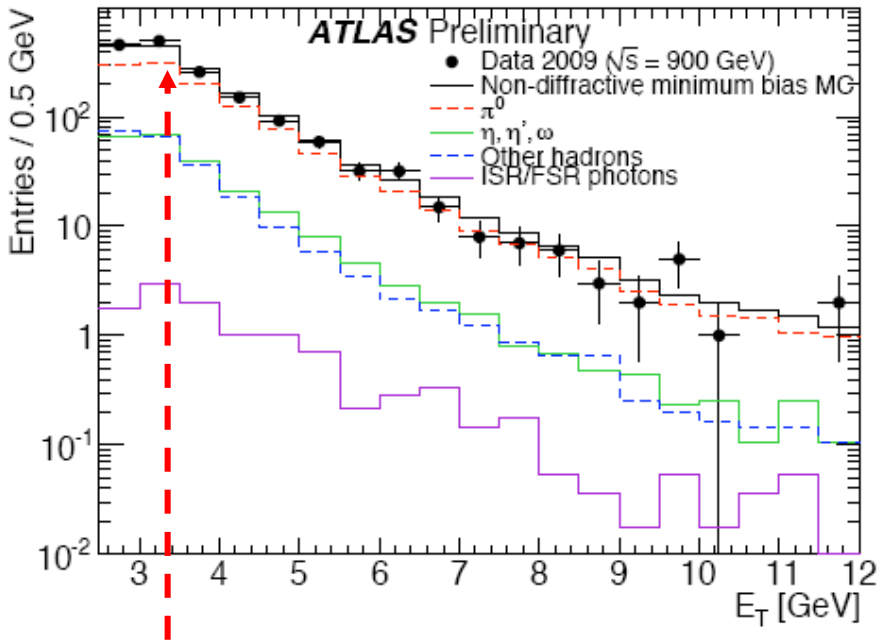

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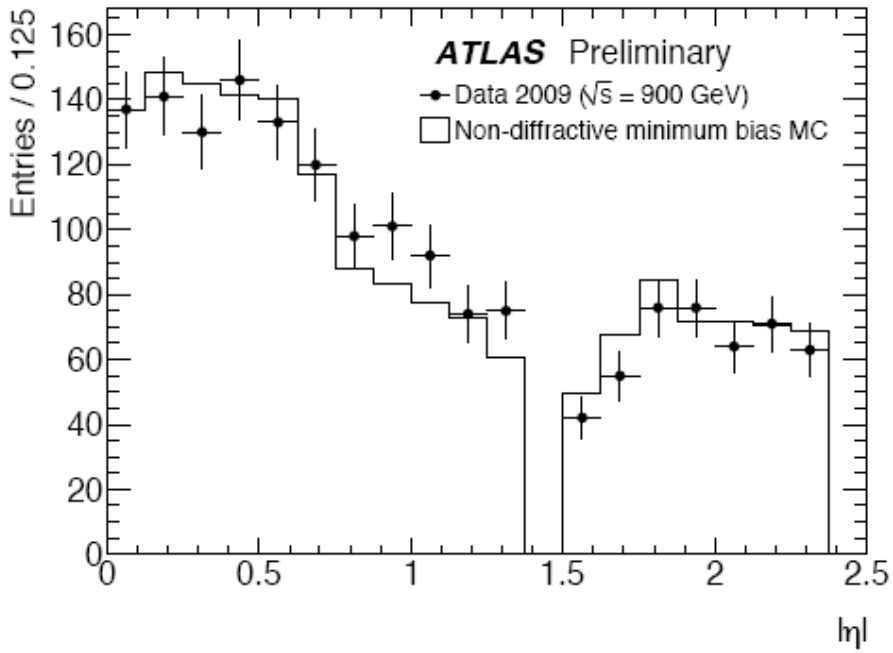

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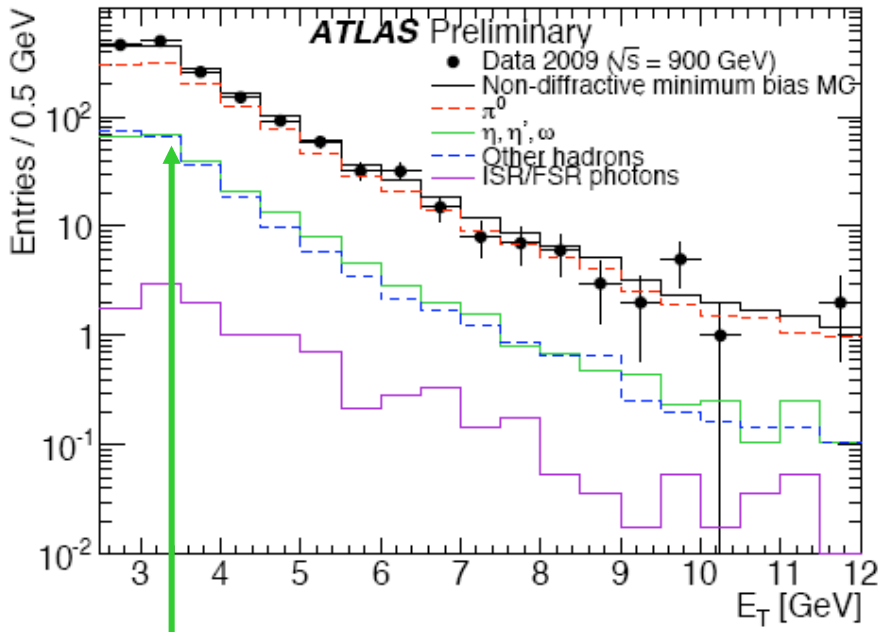

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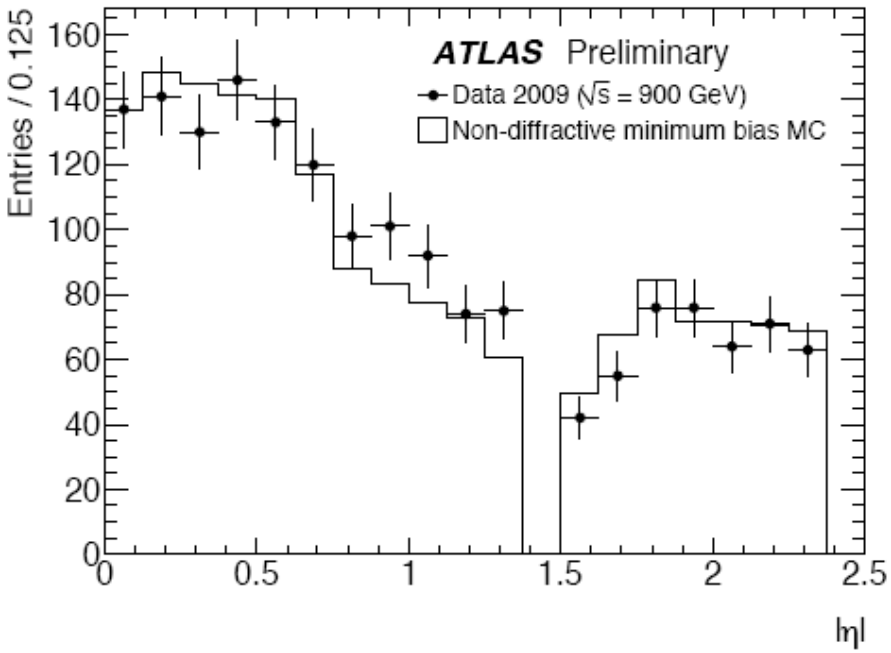

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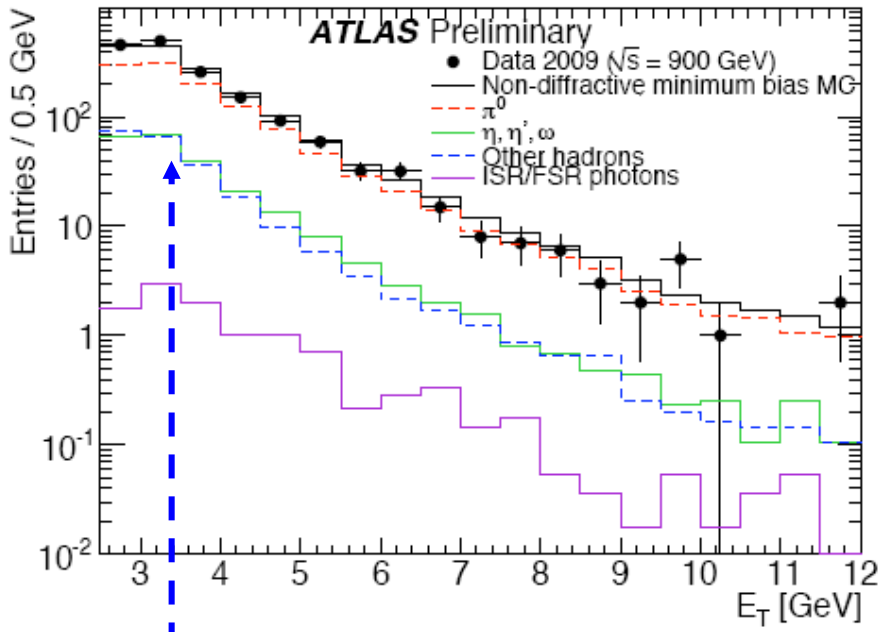

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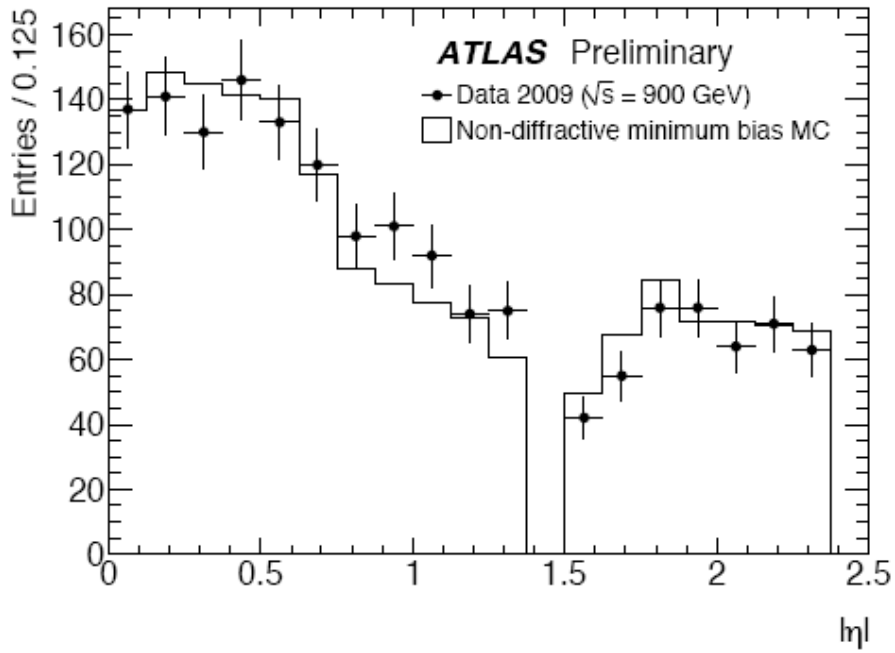

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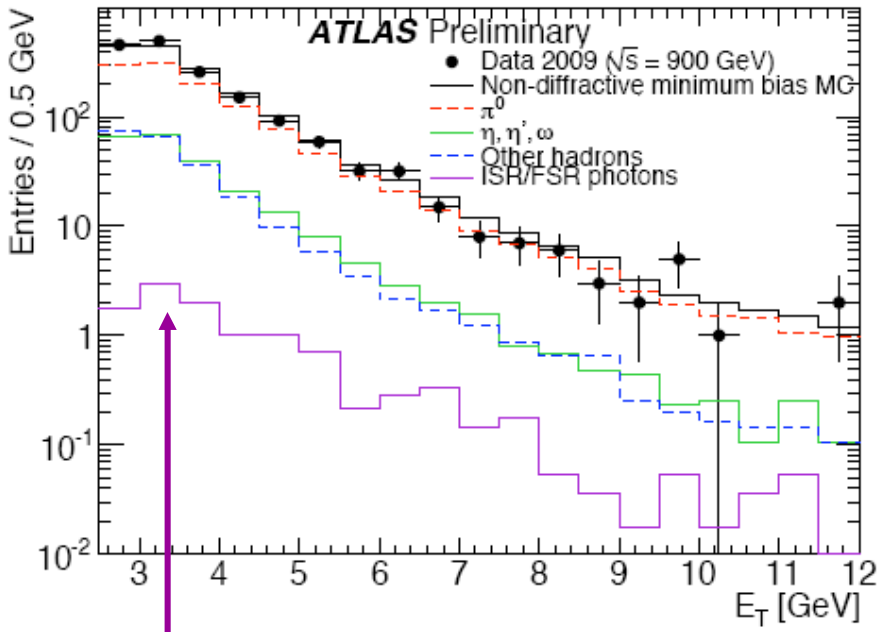

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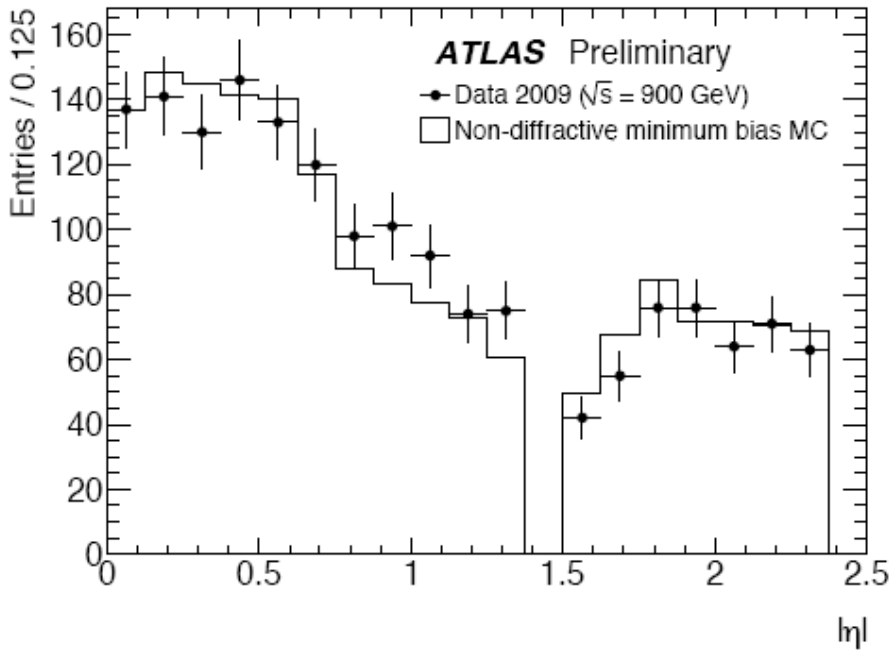

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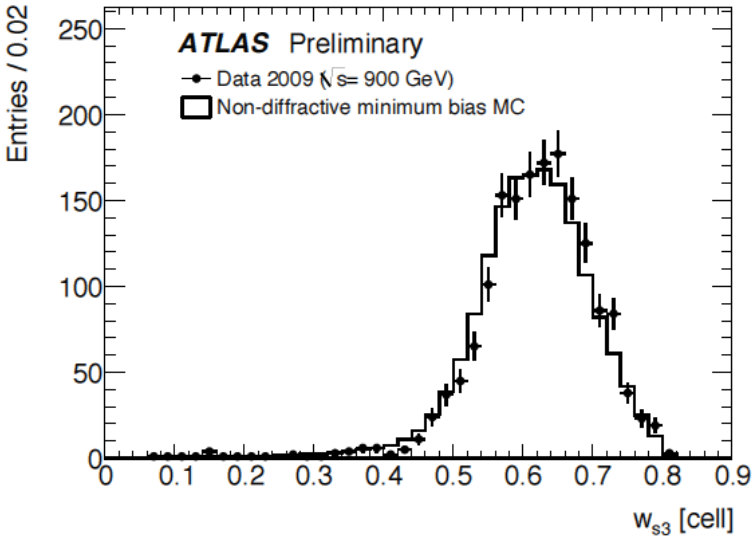
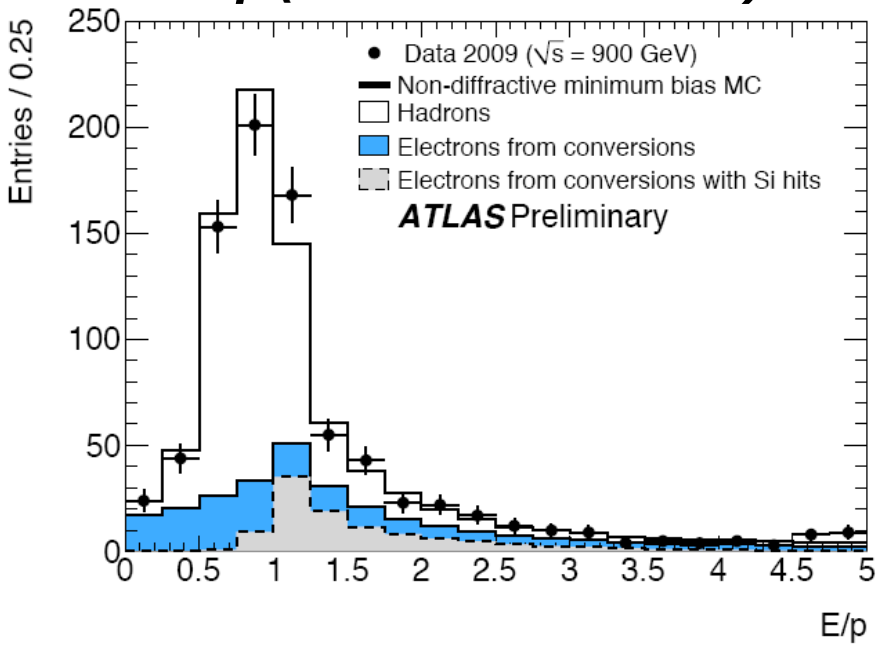
Results from collisions at 900 GeV

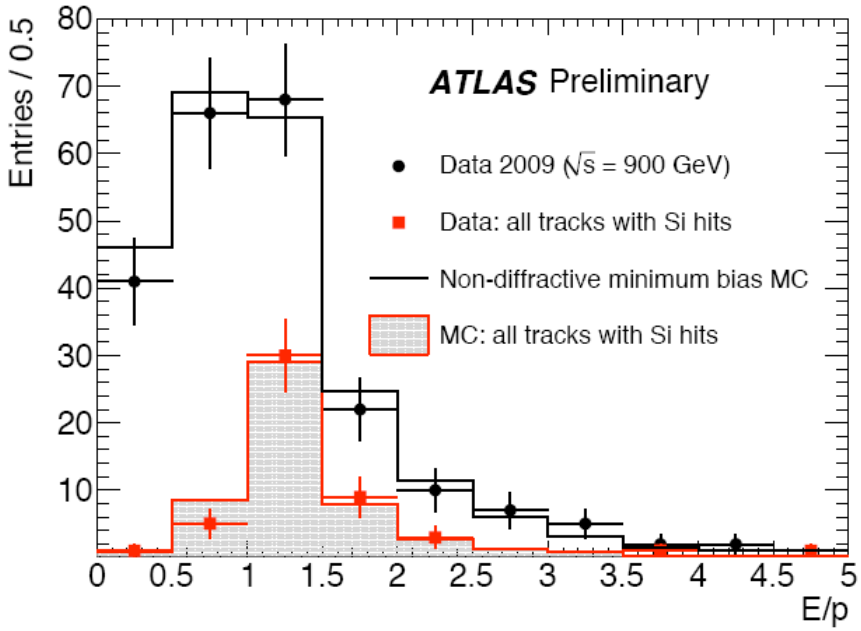
Shower width for three strips around maximum strip



E/p (electron candidates)



E/p (converted photon candidates)



Results from collisions at 900 GeV

Special calibration based in Longitudinal Weight , reconstruction seeding cluster

$E_T^{cluster}$>300MeV

selection cuts:

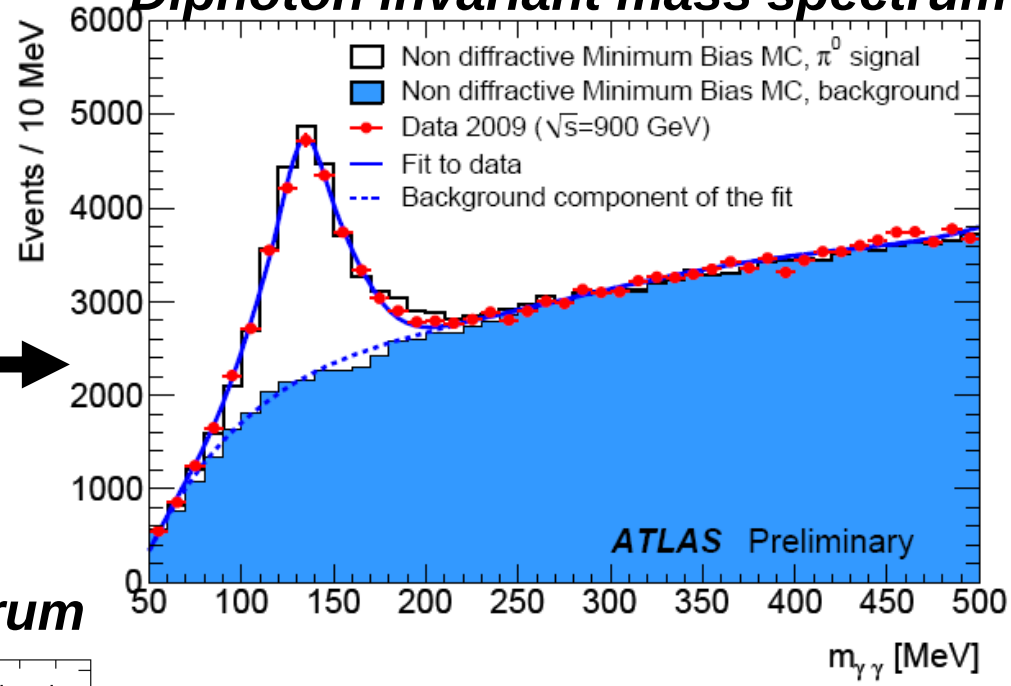
$E_T^{cluster}$>400MeV, p_T^{pair}>900MeV

$$m_{\pi^0}^{Data} = 134.0 \pm 0.8_{(stat)}\ MeV$$

$$m_{\pi^0}^{MC} = 132.9 \pm 0.2_{(stat)}\ MeV$$

$$m_{\pi^0}^{PDG} = 134.9766 \pm 0.0006\ \ MeV$$

Diphoton invariant mass spectrum



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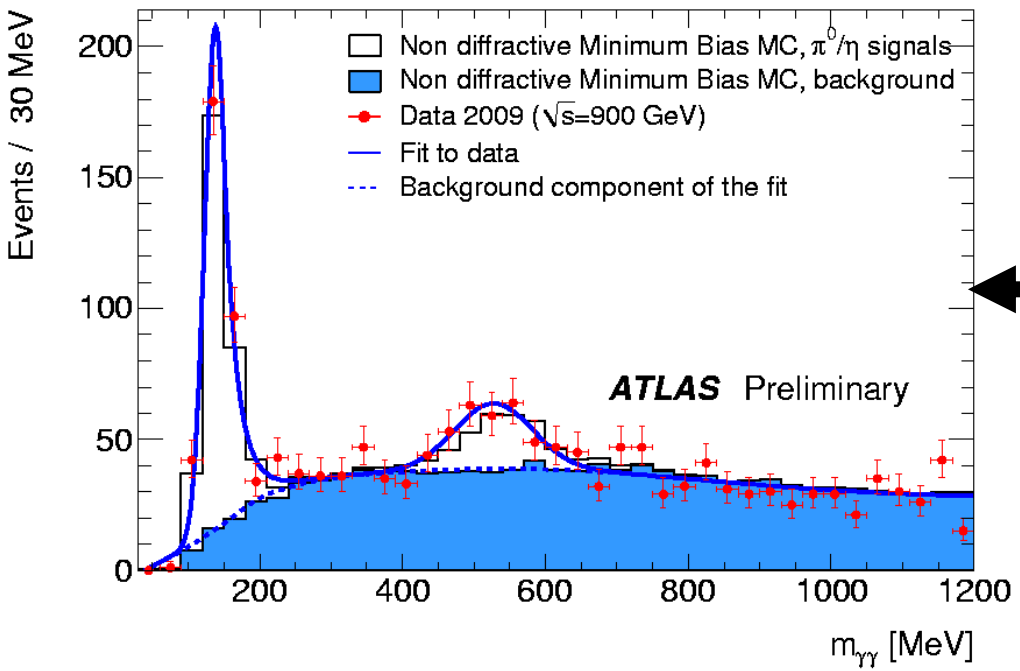


Selection cuts (tighter):

$E_T^{cluster}$>800MeV, p_T^{pair}>2200MeV, track veto applied.

$$m_{\eta}^{Data} = 527.0 \pm 11.0_{(stat)}\ MeV$$

$$m_{\eta}^{MC} = 544.0 \pm 3.0_{(stat)}\ MeV$$

$$m_{\eta}^{PDG} = 547.853 \pm 0.024\ \ MeV$$

Conclusions

- The data sample collected by ATLAS at $\sqrt{s} = 900\ GeV$.
  - reconstructed with $E_T > 2.5\ GeV$ before identification cuts:
    - 879 electron candidates
    - 1694 photon candidates
  - The performance of the reconstruction and identification algorithms. Remarkable agreement between data and simulation.
  - Extracted signal of $\pi^0 \rightarrow \gamma\gamma$ and $\eta \rightarrow \gamma\gamma$. The measured π^0 mass is within 1% of the nominal PDG value for both data and simulation.

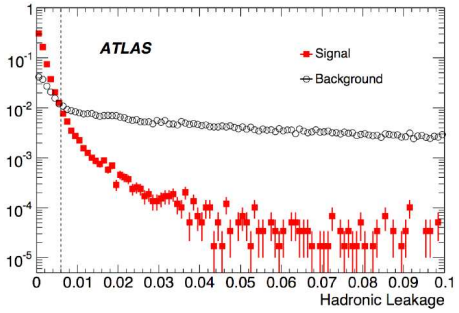
Back-up

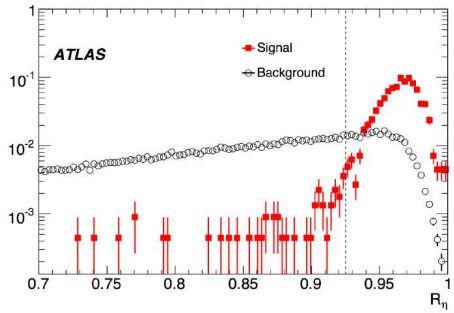
Introduction

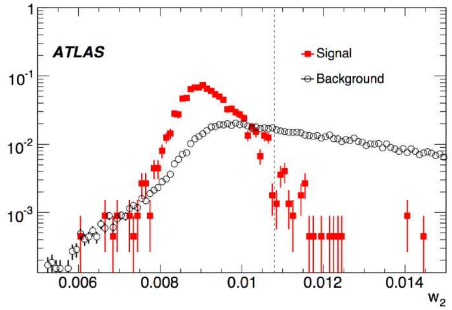
- Nov-Dec 2009: ATLAS enjoyed a series of stable LHC runs at centre-of-mass energy of 900 GeV.
  - A significant number of low-p_T electron and photon candidates were reconstructed
  - Despite of *ET (observed candidates)* << those for which the reconstruction and identification algorithms have been optimized. $\Rightarrow$ the measurements already provide a test about the reliability of the performance predictions in *ET* range from reconstruction of 2.5 GeV to almost 10 GeV.
  - Moreover, the performance of ATLAS EM calorimeter for $\pi^0 \rightarrow \gamma\gamma$ and $\eta \rightarrow \gamma\gamma$ events was made .

rectangular cuts to separate isolated e/γ from fakes ; bins of E_T, η

- Loose e/γ : ~middle EM calorimeter + hadronic leakage

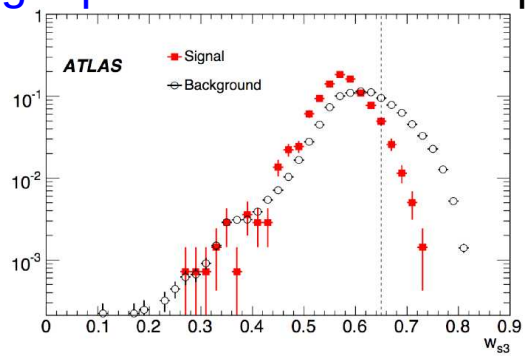


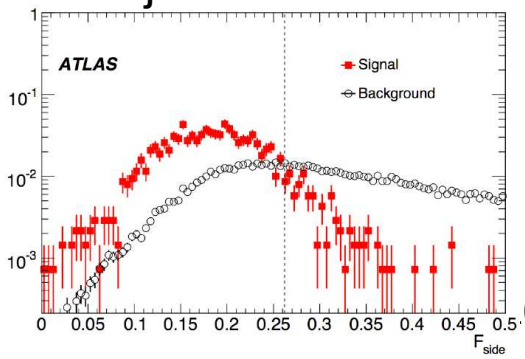


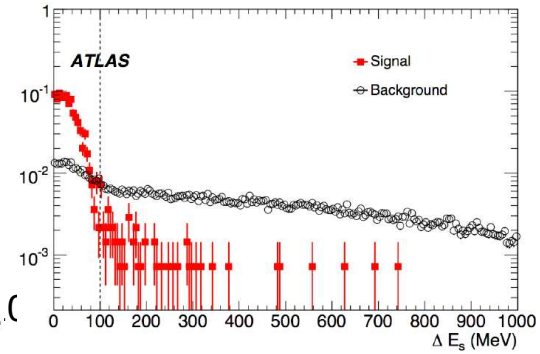


- Medium electrons: Loose + strips, track quality, track-cluster match
- Tight electrons :
  - -*E/p* and high-threshold hits TRT : reject charged hadrons
  - -hits in first pixel layer (b-layer): reject conversions
  - -tighter track-matching cuts, impact parameters

- Tight photon : Loose + strips to reject π^0







Results from collisions at 900 GeV

Electron candidates	All 879		Barrel 558		Endcap 321	
	Data (%)	MC (%)	Data (%)	MC (%)	Data (%)	MC (%)
Loose	46.5±1.7	50.9±0.2 (40.0±0.3)	47.3±2.1	51.8±0.3 (33.1±0.4)	45.2±2.8	49.5±0.4 (51.2±0.5)
Medium	10.6±1.0	13.1±0.2 (26.4±0.6)	11.1±1.3	12.9±0.2 (19.5±0.7)	9.6±1.6	13.3±0.3 (36.9±1.0)
Tight	2.3±0.5	2.4±0.1 (37.9±1.5)	1.6±0.5	1.8±0.1 (49.2±2.2)	3.4±1.0	3.3±0.1 (28.7±1.8)

Table 1. Breakdown of electron candidates according to identification cuts applied and to η-range. For each of these η-ranges, the percentages of identified loose, medium and tight candidates in data are compared to those predicted by Monte Carlo (MC). The numbers in brackets give the percentage of Monte Carlo electron candidates which are electrons from photon conversions or prompt electrons (the remainder are charged hadrons)

Photon candidates	All 1694		Barrel 1247		Endcap 447	
	Data (%)	MC (%)	Data (%)	MC (%)	Data (%)	MC (%)
Loose	25.4 ± 1.0	30.5 ± 0.1	24.3 ± 1.2	29.0 ± 0.1	28.4 ± 2.1	34.3 ± 0.3
Tight	4.1 ± 0.5	6.6 ± 0.1	3.6 ± 0.5	5.3 ± 0.1	5.8 ± 1.1	9.9 ± 0.2

Table 2. Breakdown of photon candidates according to identification cuts applied and to η-range. For each of these η-ranges, the percentages of identified loose and tight candidates in data are compared to those predicted by Monte Carlo (MC).

Fraction of energy deposited in layers

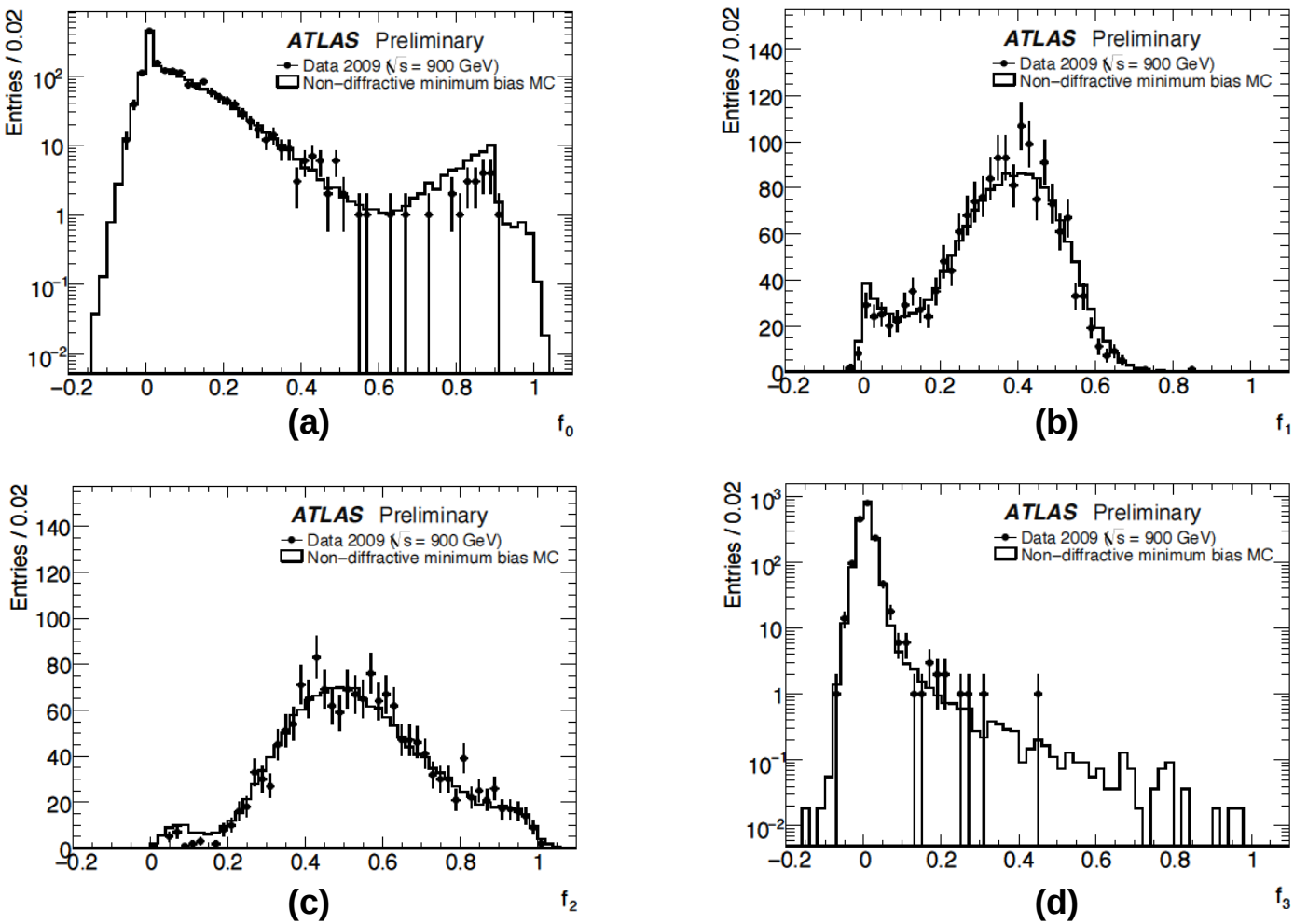


Figure 8: Fraction of energy deposited by photon candidates in each layer of the electromagnetic calorimeter for data and simulation. These fractions are labelled as f_0 for the presampler layer (a), f_1 for the strip layer (b), f_2 for the middle layer (c) and f_3 for the back layer (d) .

Distributions of calorimeter variables

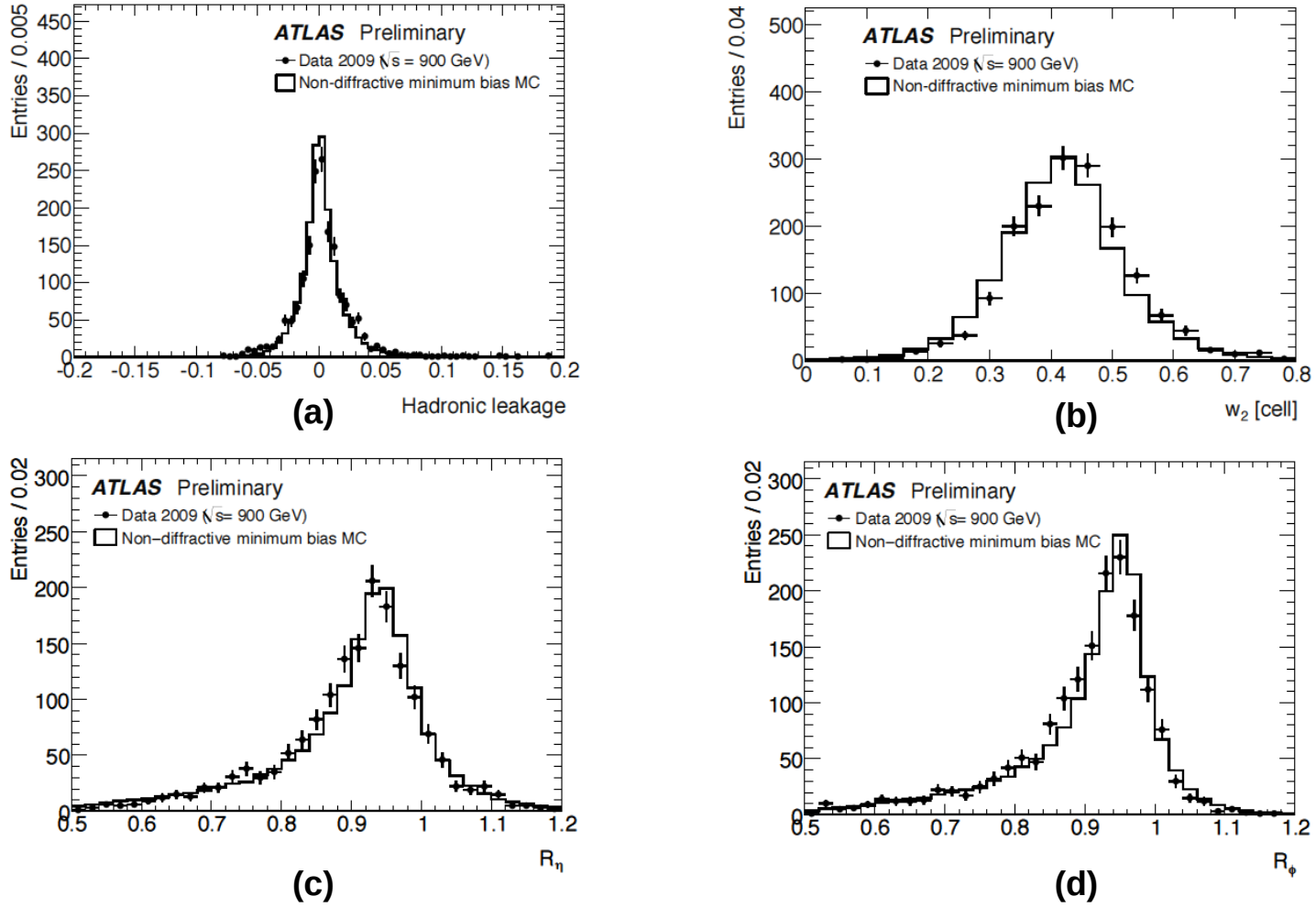


Figure 9: Distributions of calorimeter variables compared between data and simulation for all photon candidates. Shown are the hadronic leakage in the first layer of hadronic calorimeter (a), and the variables used for the loose selection definition cuts in the middle layer of the EM calorimeter, w_2 (b) , R_η (c), R_ϕ (d).

Distributions of shower-shape variables

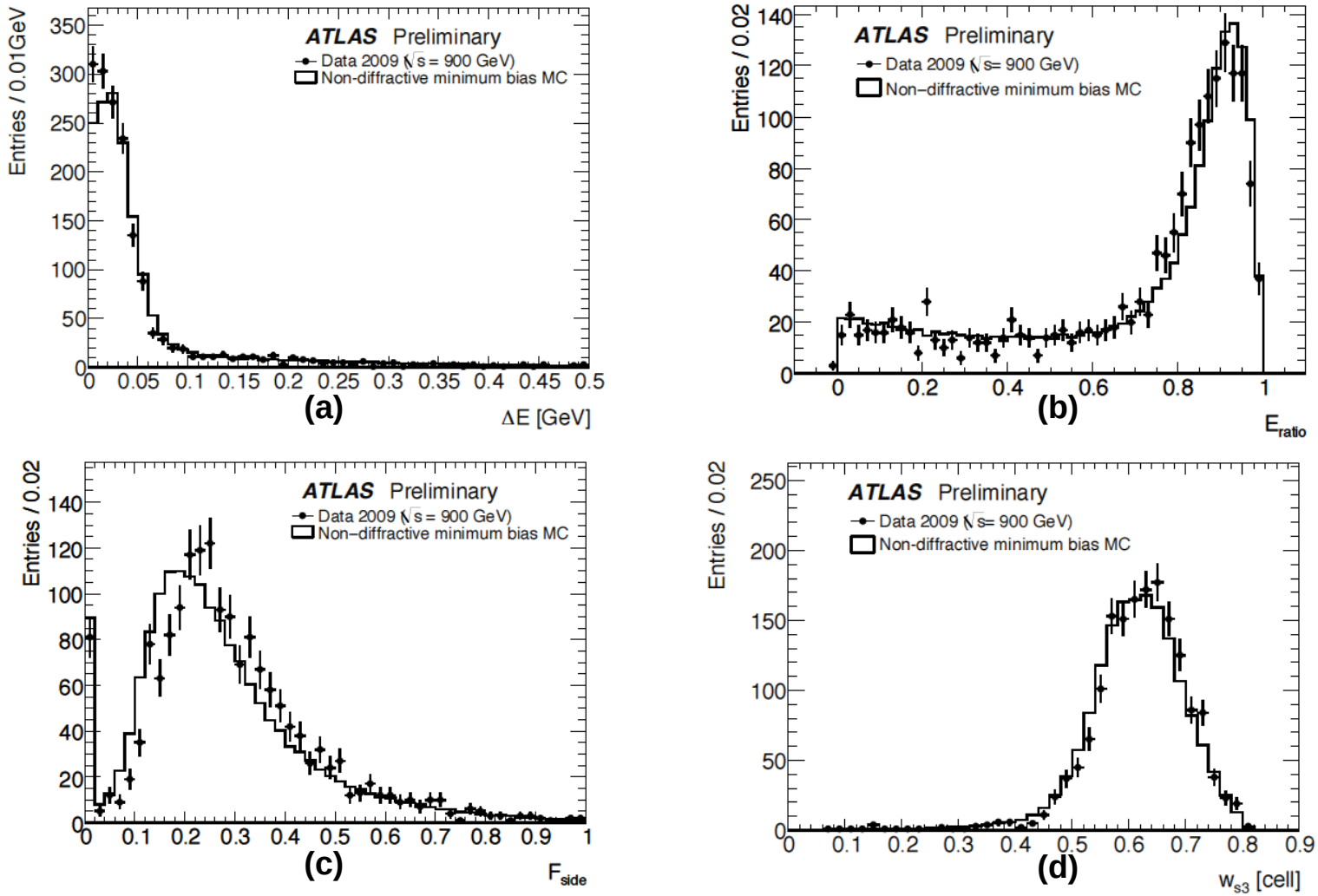


Figure 10: Distributions of shower-shape variables in the strip layer of the EM calorimeter compared between data and simulation for all photon candidates. Shown are several of the variables used for the tight photon cuts ΔE, E_{ratio} , F_{side} w_{s3}