Performance of E_T^{miss} reconstruction in first ATLAS data

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on behalf of ATLAS collaboration

Pheno10 symposium

Collider signature 1 session

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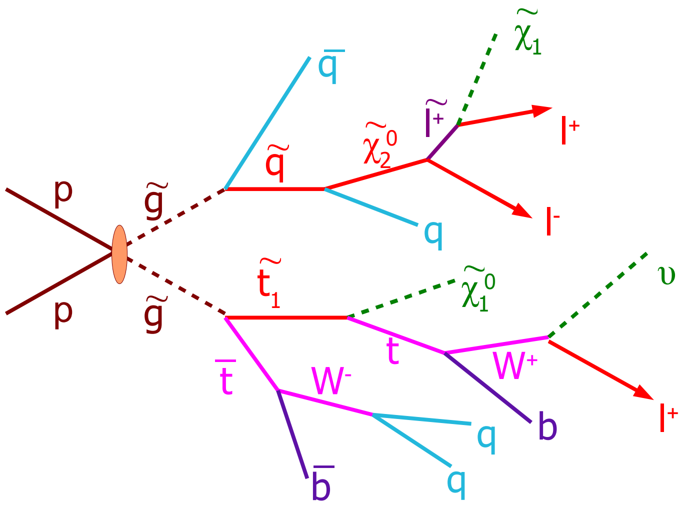
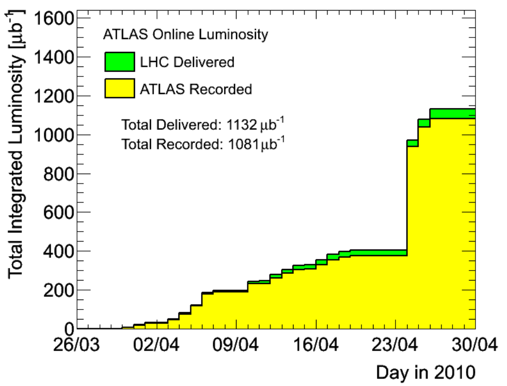
Motivations

- **New physics**
  - SUSY
  - Heavy gauge bosons
  - Extradimensions

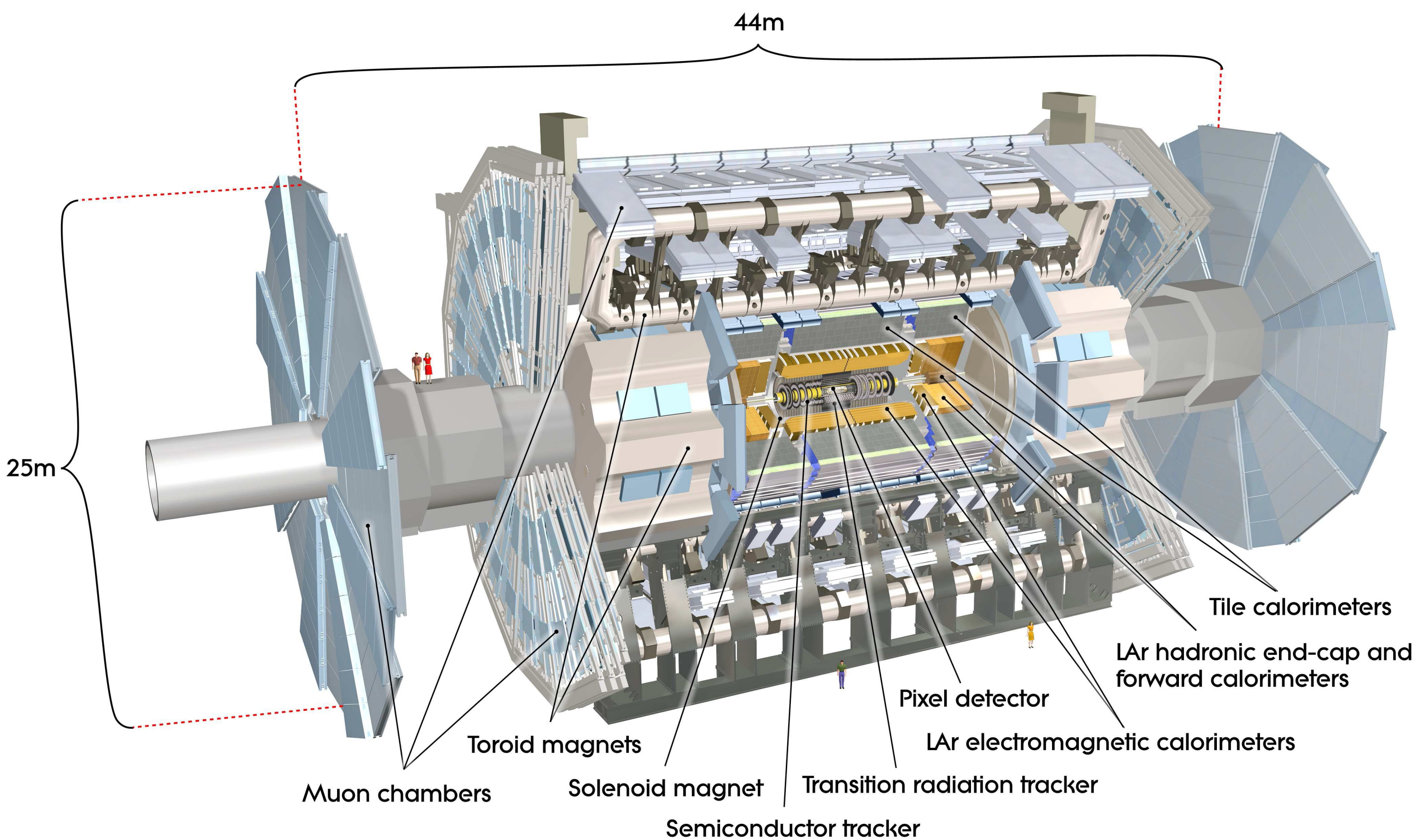


➔ Missing E_T is a key signature to discover new physics

- **Standard candles from standard model**
  - W bosons
  - top quark
  - $Z \rightarrow \tau\tau$



ATLAS detector



	Inner detector, $|\eta| < 2.5$		
	Pixel	SCT	TRT
# channels	80 M	6.3 M	350 k
operational	97,5%	99,3%	98,0%

Calorimeter system, $|\eta| < 4.9$			
LAr EM	LAr HEC	LAr FCal	Tile
170 k	5,6 k	3,5 k	9,8 k
98,5%	99,9%	100,0%	97,3%

Muon spectrometer, $|\eta| < 2.7$			
MDT	CSC	RPC	TGC
350 k	31 k	370 k	320 k
99,7%	98,5%	97,3%	98,8%

➔ All ATLAS detector operational to measure E_T^{miss}

E_T^{miss} reconstruction

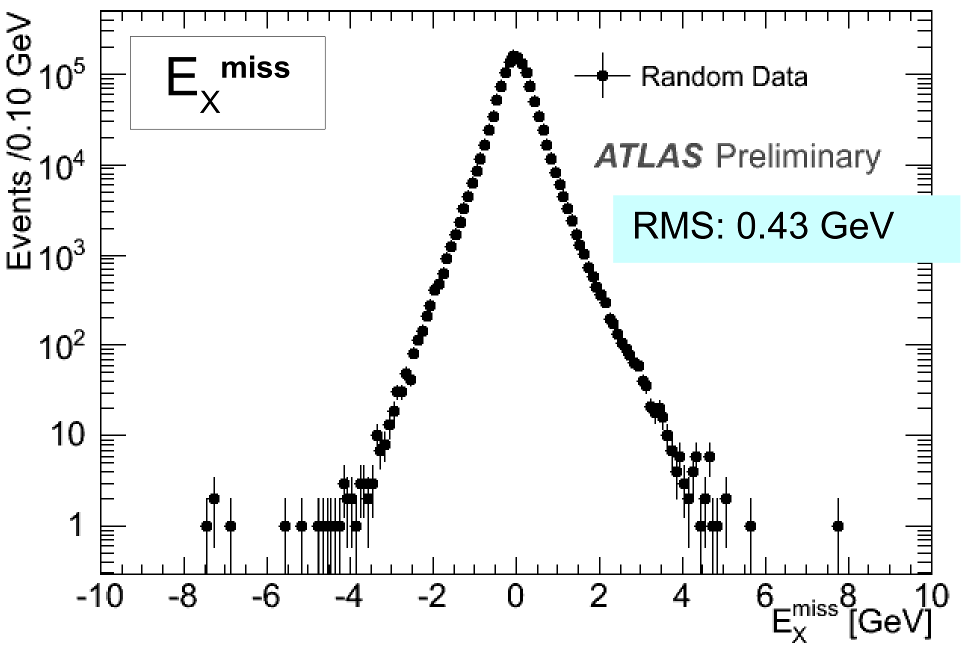
- Missing transverse energy: $\mathbf{E_T^{miss}} = \sqrt{E_X^{miss\,2} + E_Y^{miss\,2}}$
  - opposite of vectorial transverse energy sum projected on x, y-axis: $\mathbf{E_{X,Y}^{miss}}$
  - scalar sum of transverse energy: $\mathbf{\Sigma E_T}$

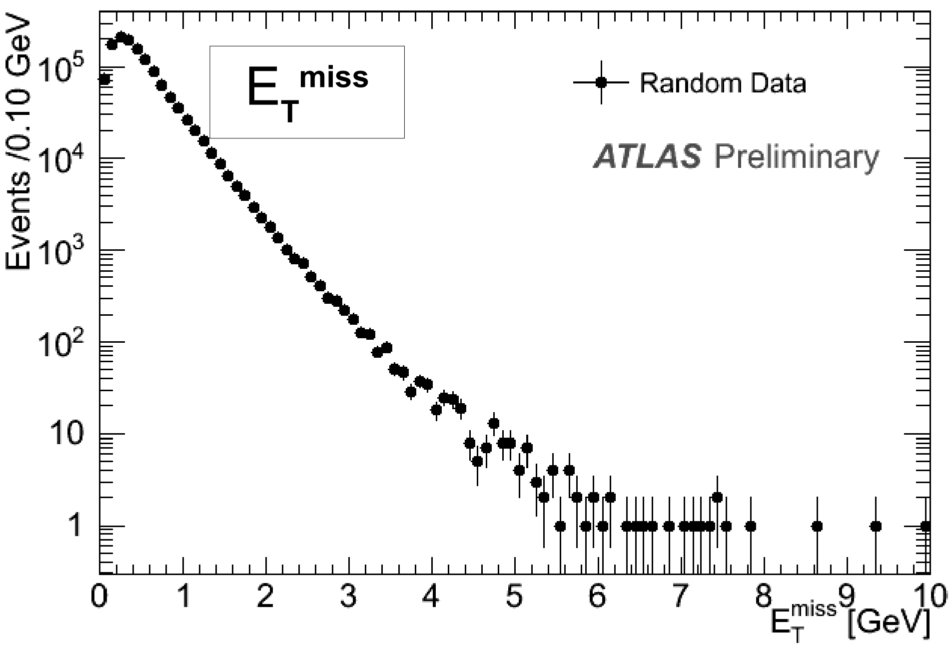
- 3 reconstruction schemes:
  - Calorimeter-based ⟶ default in this talk
    - Noise suppression with topoclusters
  - Object-based
  - Track-based
  - \+ muons and dead zones

- Missing transverse energy from commissioning data 2009/2010:
  - All plots at **EM scale**
  - Random events: $\langle E_X^{miss} \rangle = \langle E_Y^{miss} \rangle = 0, \langle \Sigma E_T \rangle = 0$
  - Minimum bias events: $\langle E_X^{miss} \rangle = \langle E_Y^{miss} \rangle = 0$, ΣE_T in [0;100] GeV

Randomly triggered events

- No energy deposit



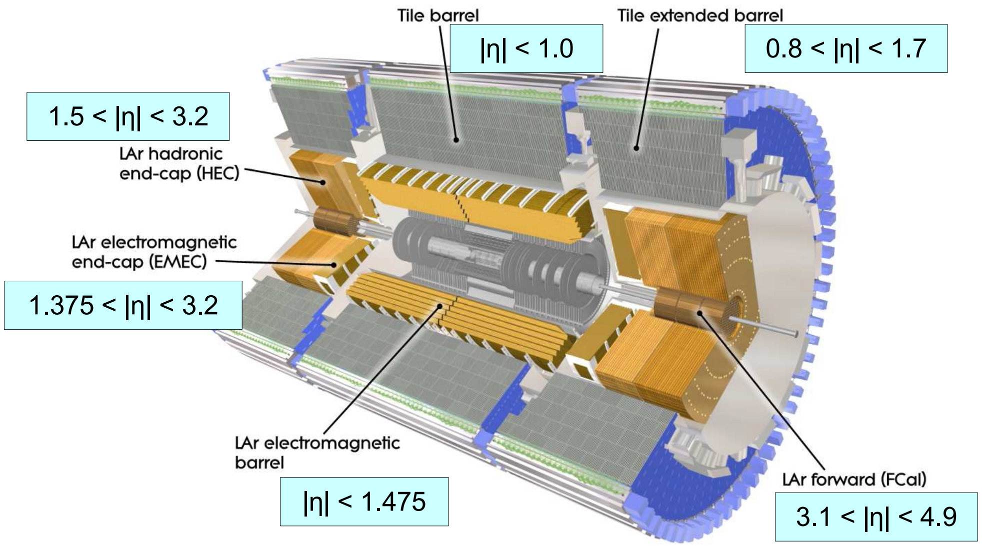


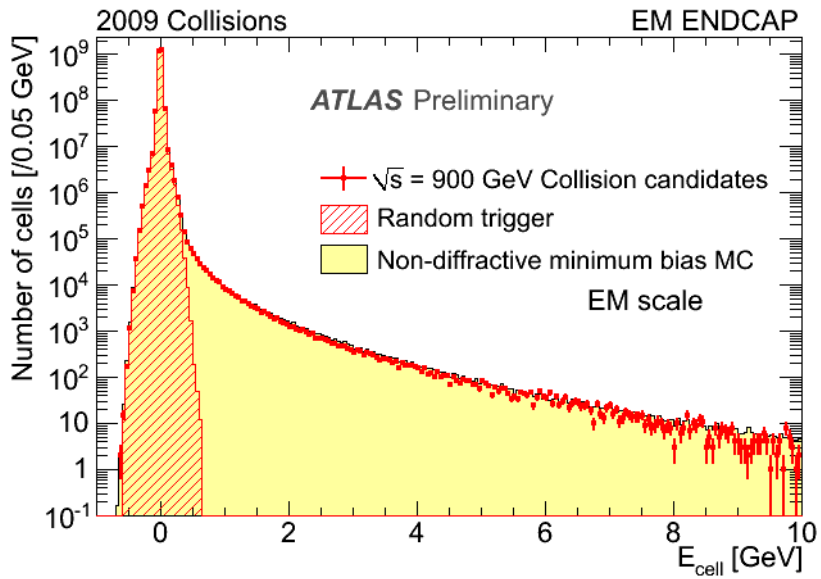
➔ Centred on 0

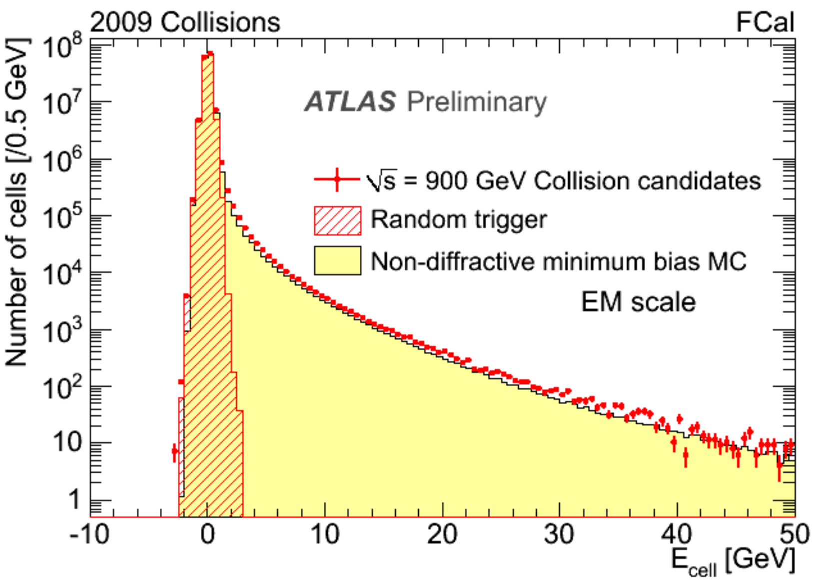
➔ No tails > 10 GeV

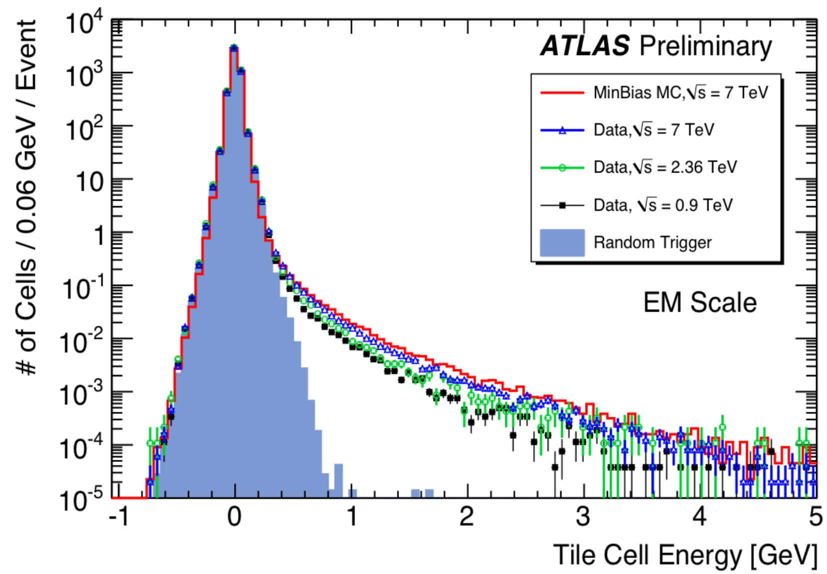
➔ Thanks to noise rejection, no contribution to resolution for physics

Collision events: cell level response









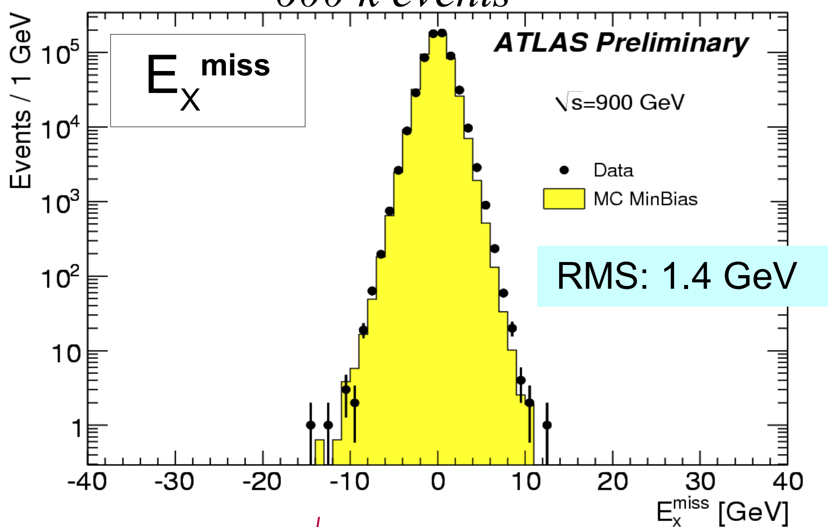
➔Fair agreement data-MC in all calorimeter subdetectors

Calorimeter-based E_T^{miss} (1)

- Energy deposits in the calorimeters

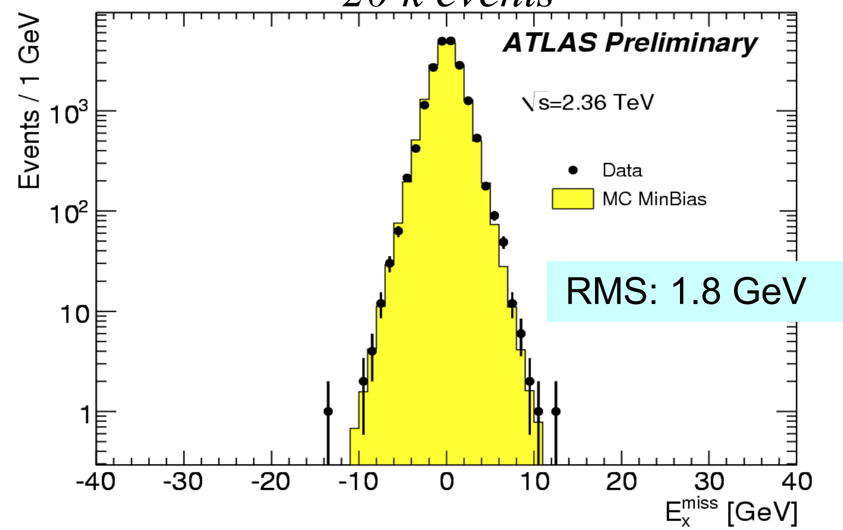
√s = 900 GeV

~600 k events



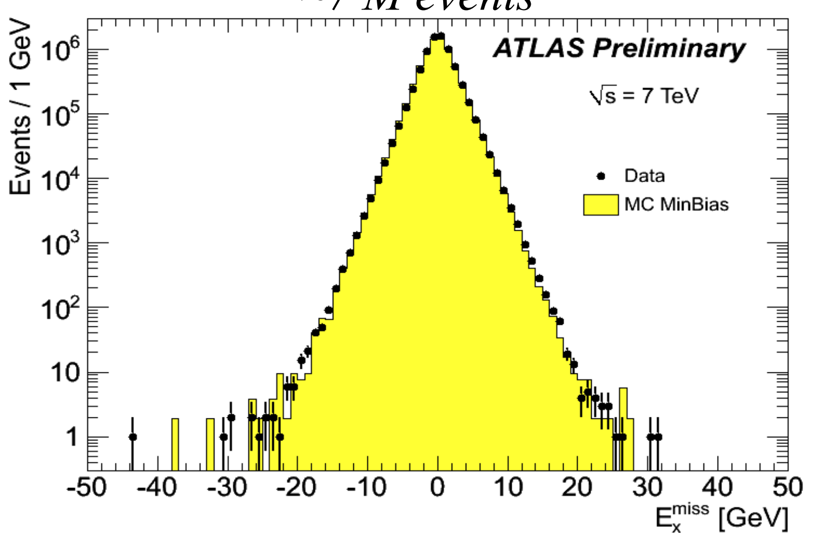
√s = 2.36 TeV

~20 k events



√s = 7 TeV

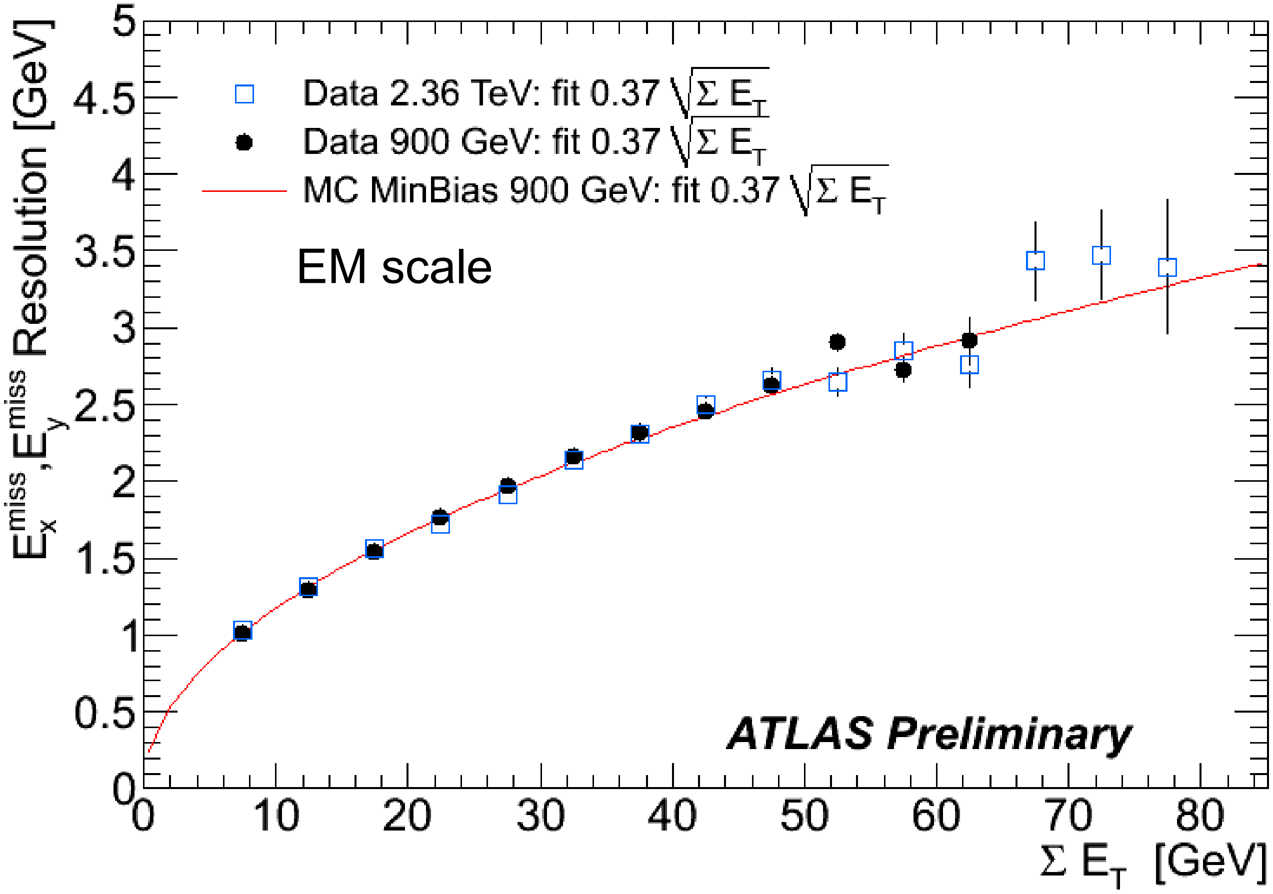
~7 M events



➔ Good agreement data/MC

Calorimeter-based E_T^{miss} (2)

- Resolution plot

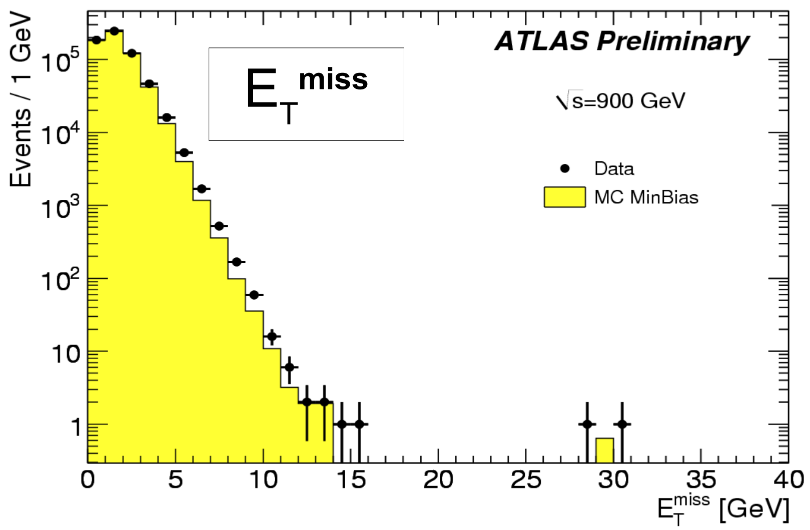


➔ Very good agreement data/MC at both √s

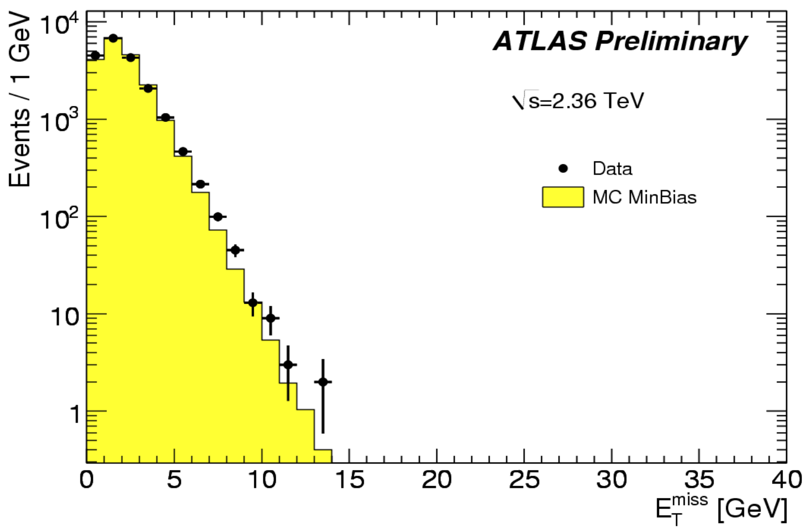
➔ Resolution of $\sigma(E_{X,Y}^{miss}) = 0.37 * \sqrt{\Sigma E_T}$

Calorimeter-based E_T^{miss} (3)

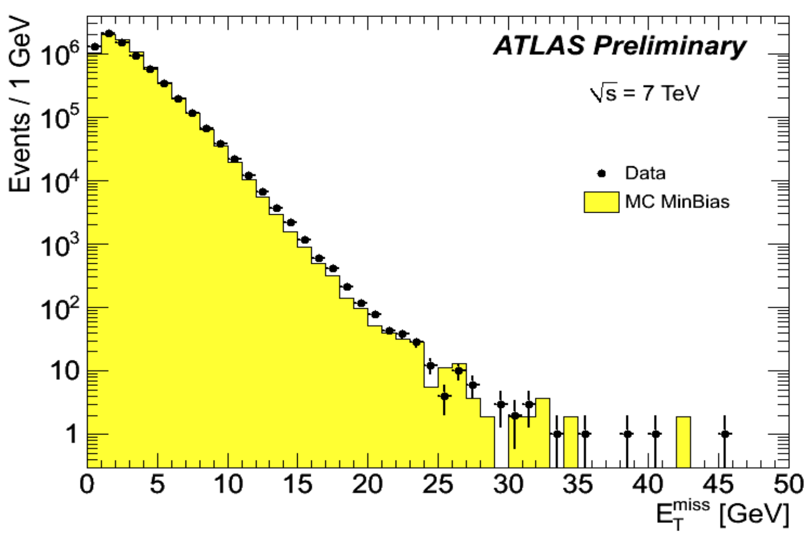
√s = 900 GeV



√s = 2.36 TeV



√s = 7 TeV

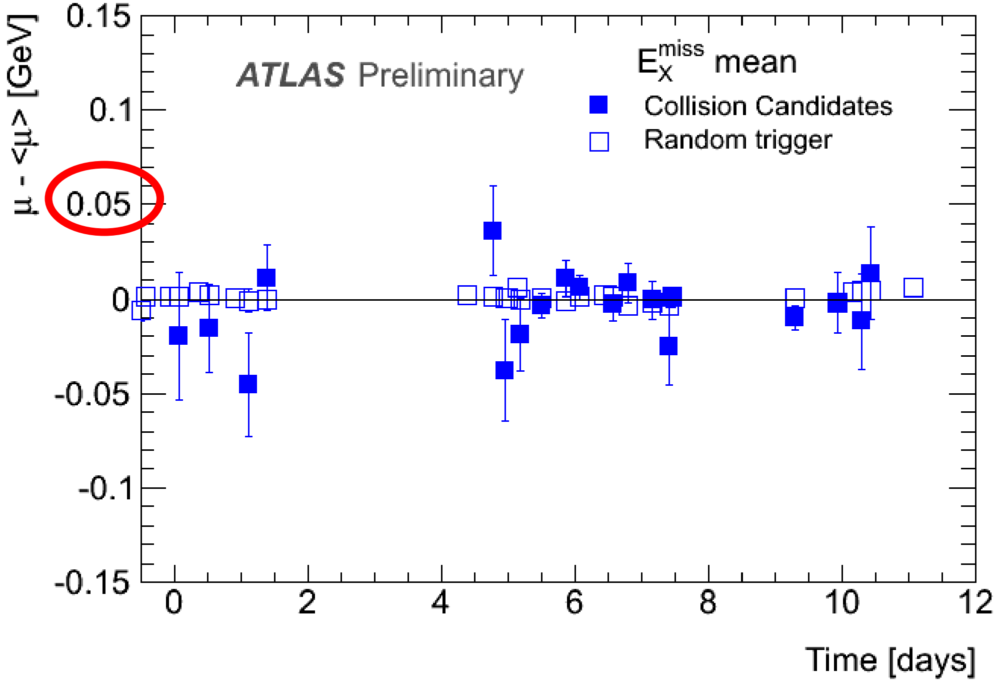


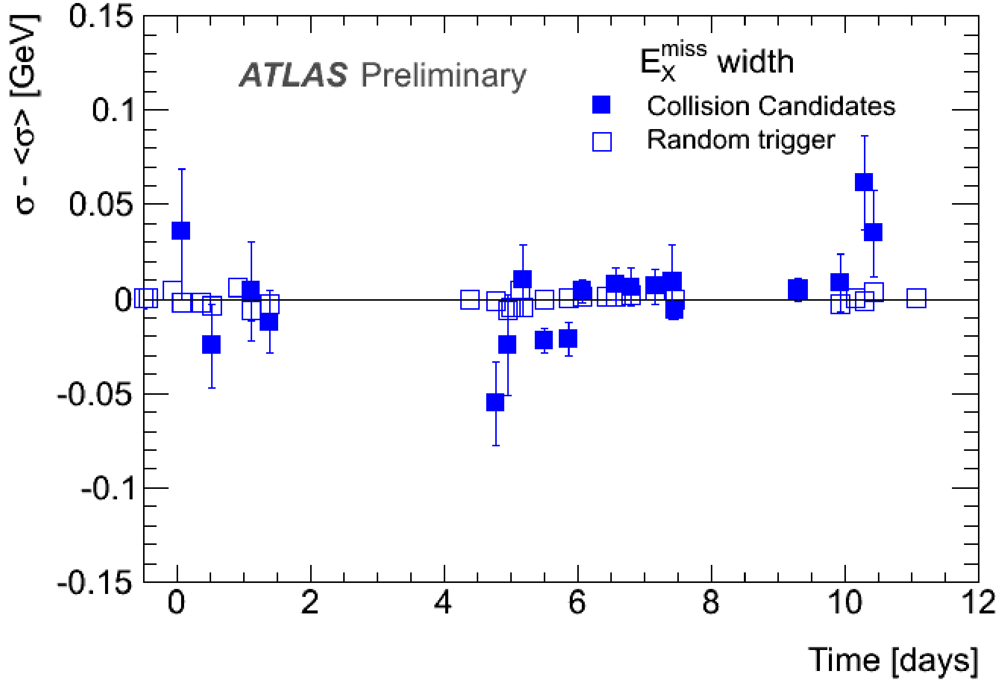
- Good agreement data/MC
- No high E_T^{miss} tails
  - Promising for physics with real E_T^{miss}

Time stability

$\sqrt{s}$ = 900 GeV

- Mean (< >) and width (σ) of E_X^{miss}:



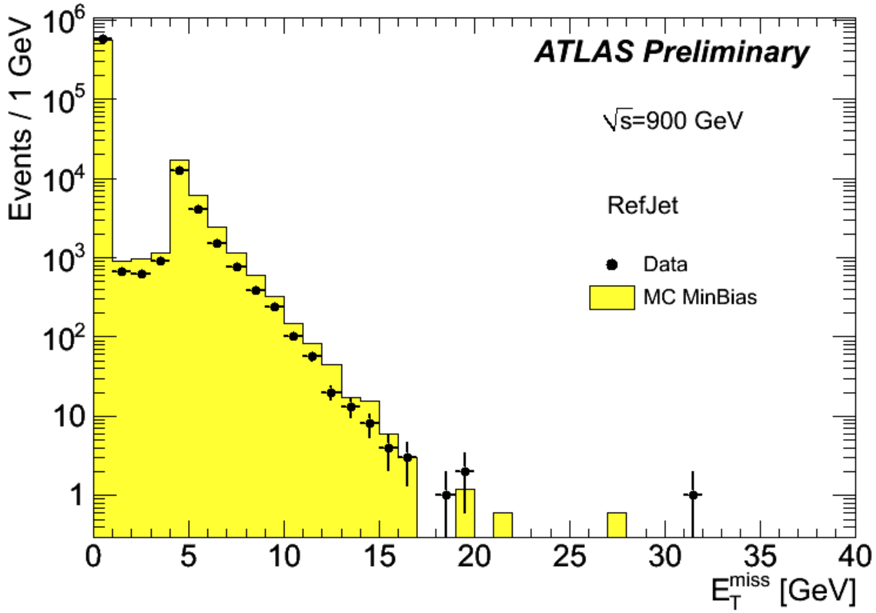


➔ Very good stability of previous results

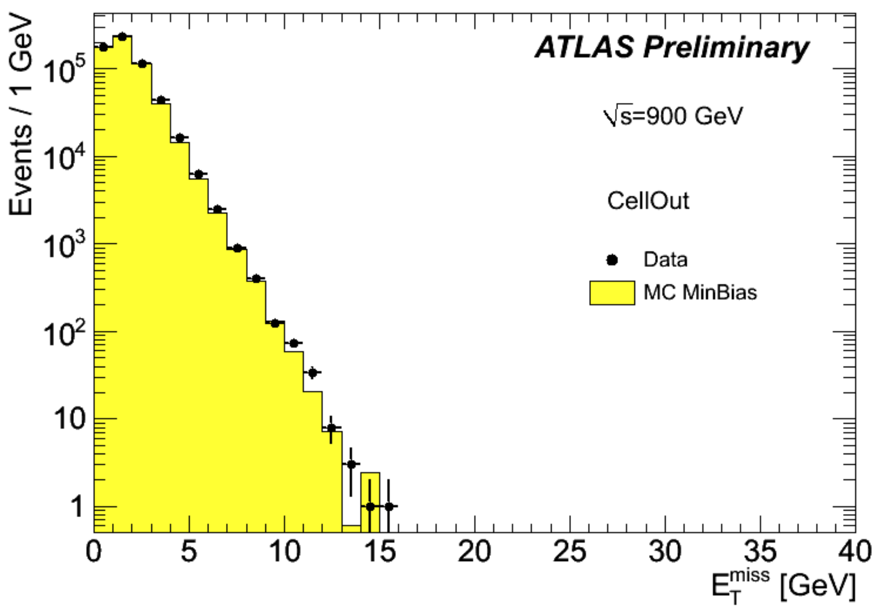
Towards object-based E_T^{miss}

$\sqrt{s}$ = 900 GeV

- Jets:
  - AntiKt algorithm (R = 0.6)



- Deposits of energy not associated to reconstructed objects:

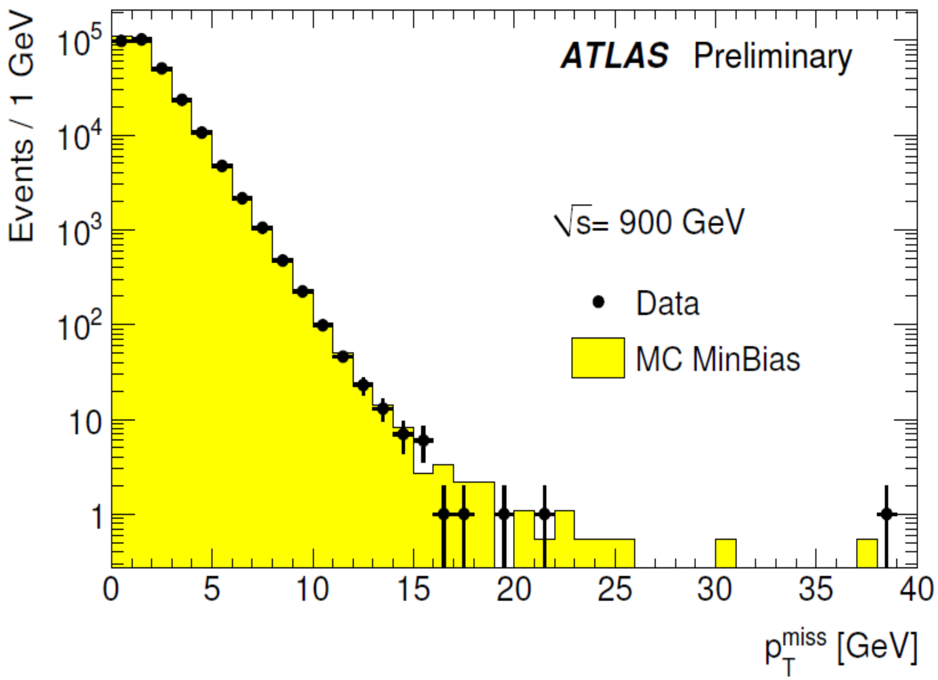


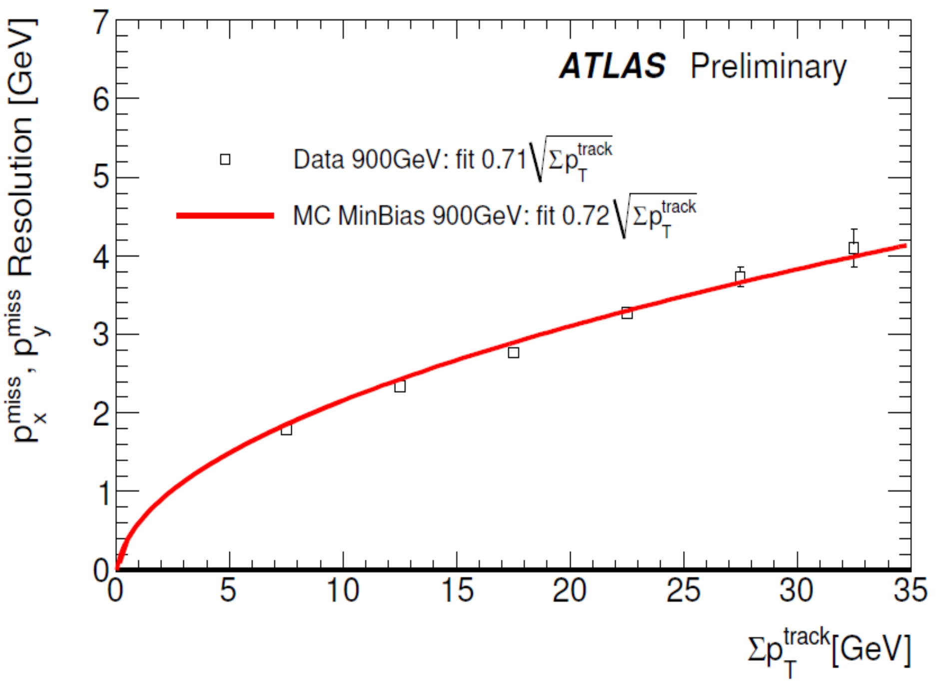
➔Good agreement data/MC

Track-based E_T^{miss}

√s = 900 GeV

- Reconstructed tracks in the Inner detector





➔ Good agreement data/MC

➔ Resolution of $\sigma(E_{X,Y}^{miss}) = 0.72*\sqrt{\Sigma E_T}$

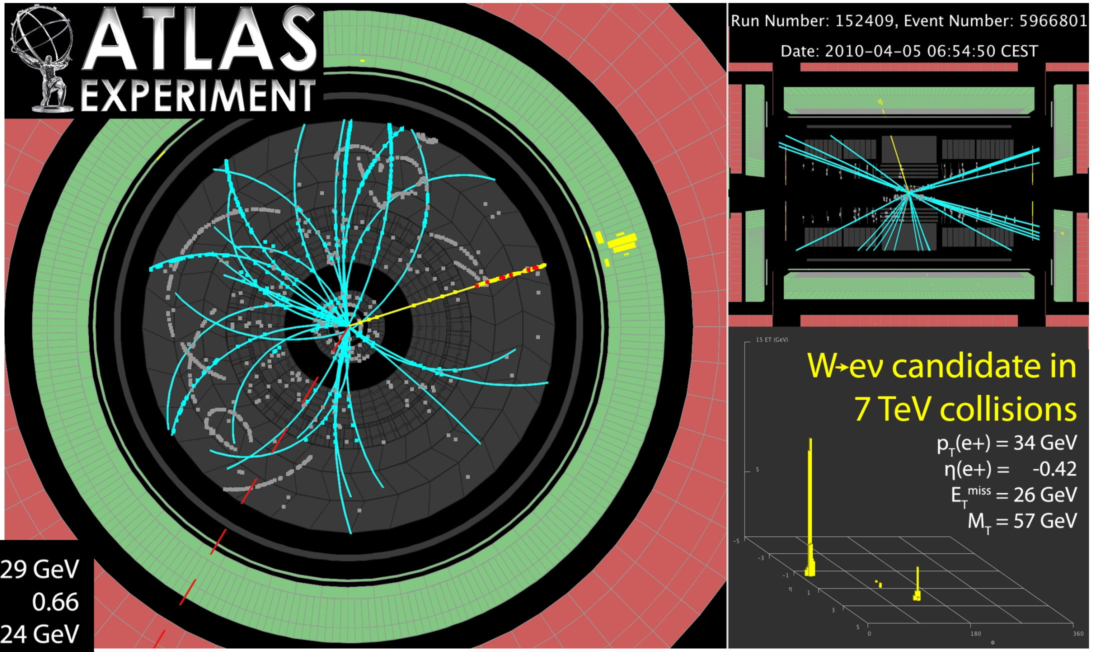
Conclusion

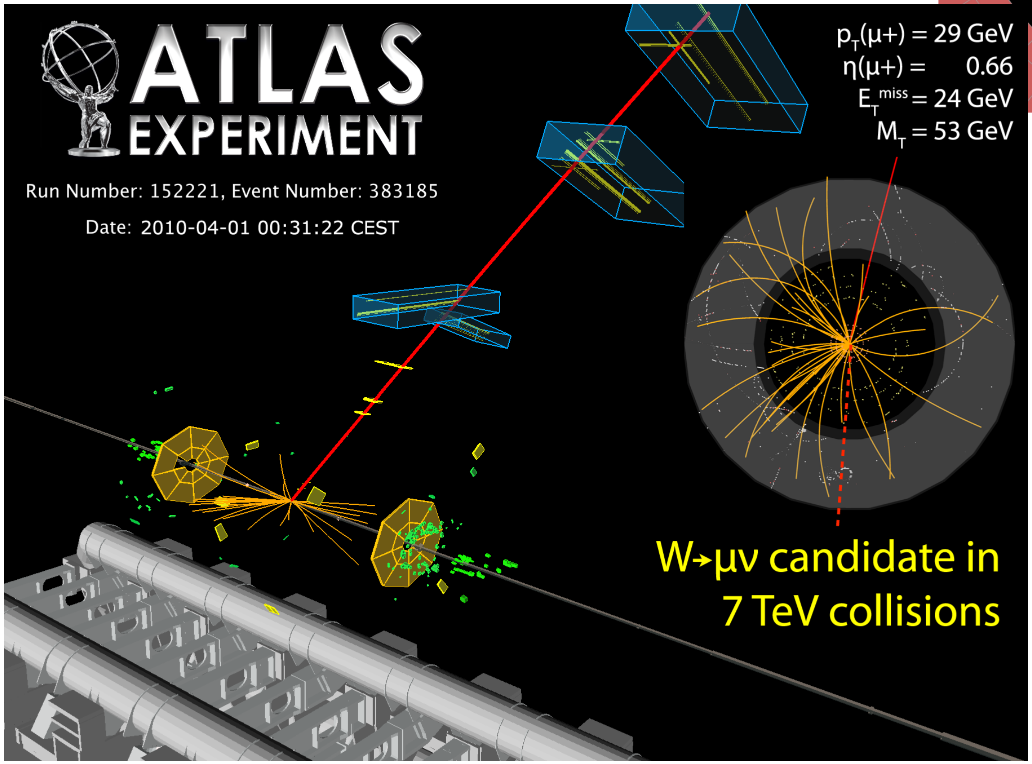
- 600k of 900 GeV, 20k of 2.36 TeV and 7M of 7 TeV Minimum Bias events recorded in November-December 2009 and April 2010
- Calorimeter-based E_T^{miss} at EM scale well understood
  - very good agreement data/MC
  - resolution: $\sigma(E_{X,Y}^{miss}) = 0.37*\sqrt{\Sigma E_T}$
  - Good stability with time
- First steps towards object-based and track-based E_T^{miss}
- Very encouraging for physics with real E_T^{miss}

Outlook

First W→lν candidates

at √s = 7 TeV !

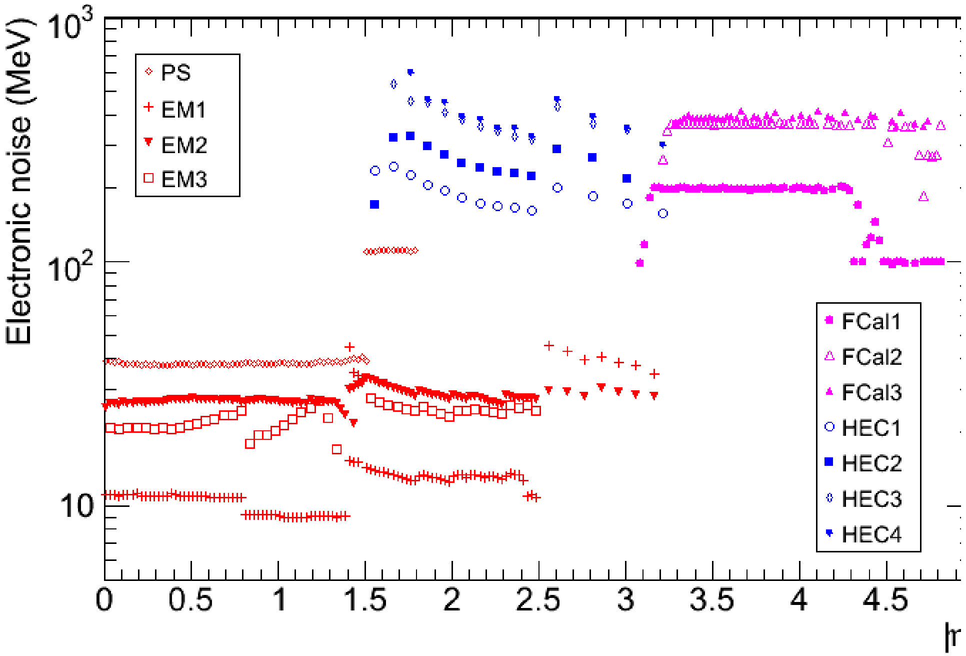




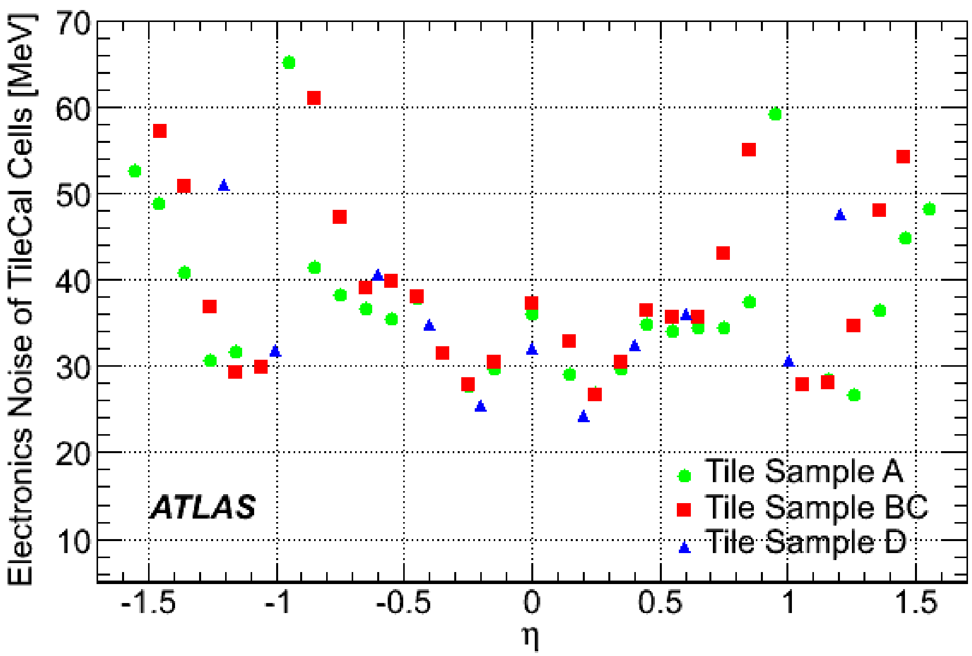
Back-up

Electronic noise

LAr

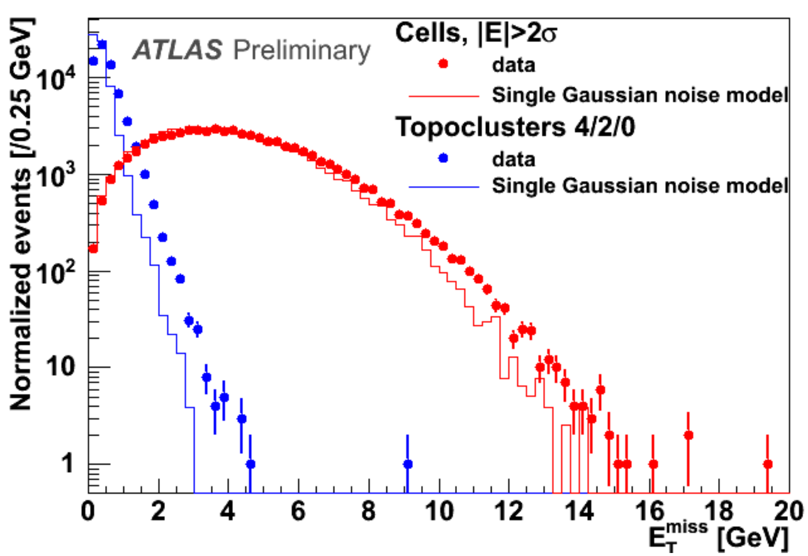


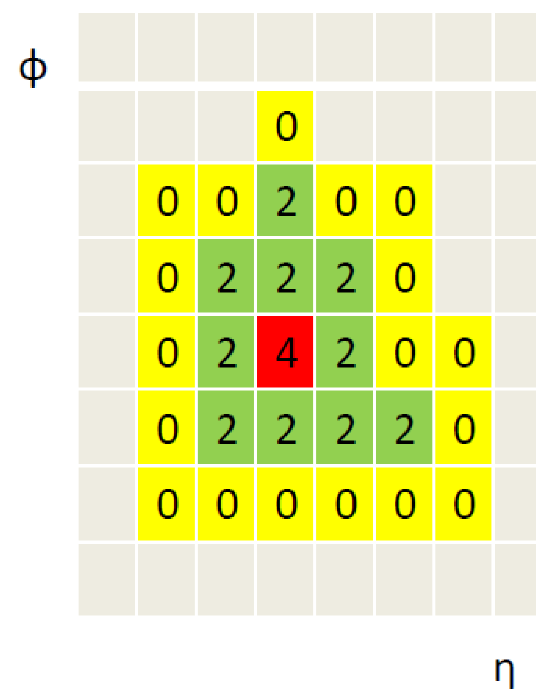
Tile



Topological clustering

- Input to Calorimeter-E_T^{miss} reconstruction: 4/2/0 topoclusters
- 3-dimensional group of calorimeter cells:
  - seed cells with $|E_{cell}| > 4*\sigma_{noise}$
  - iteratively add neighbours with $|E_{cell}| > 2*\sigma_{noise}$
  - add perimeter cells with $|E_{cell}| > 0*\sigma_{noise}$



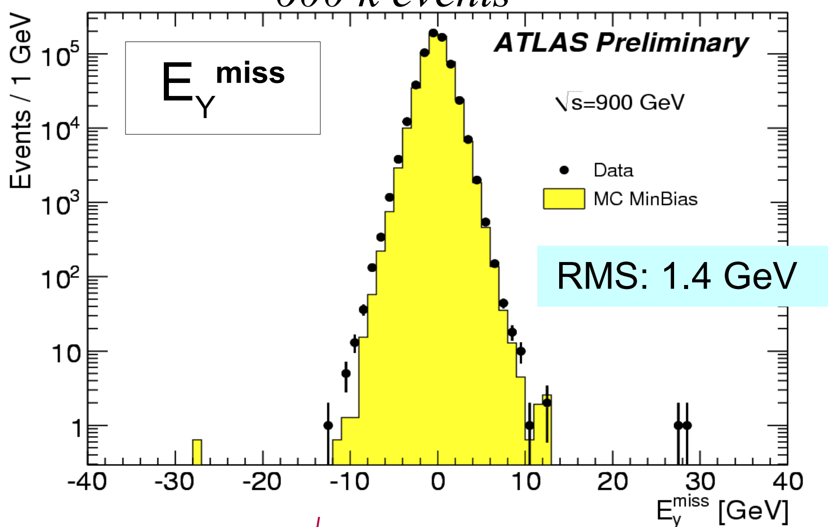


Calorimeter-based E_T^{miss} (4)

- Energy deposits in the calorimeters

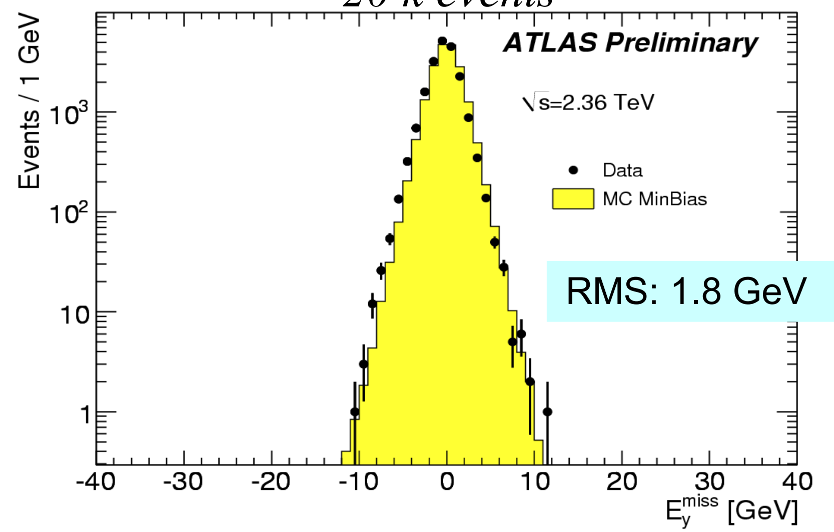
√s = 900 GeV

~600 k events



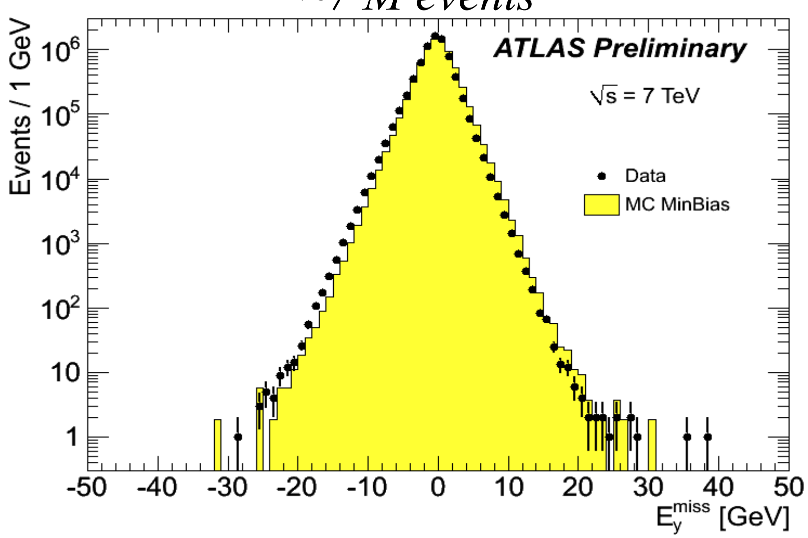
√s = 2.36 TeV

~20 k events



√s = 7 TeV

~7 M events



➔ Good agreement data/MC