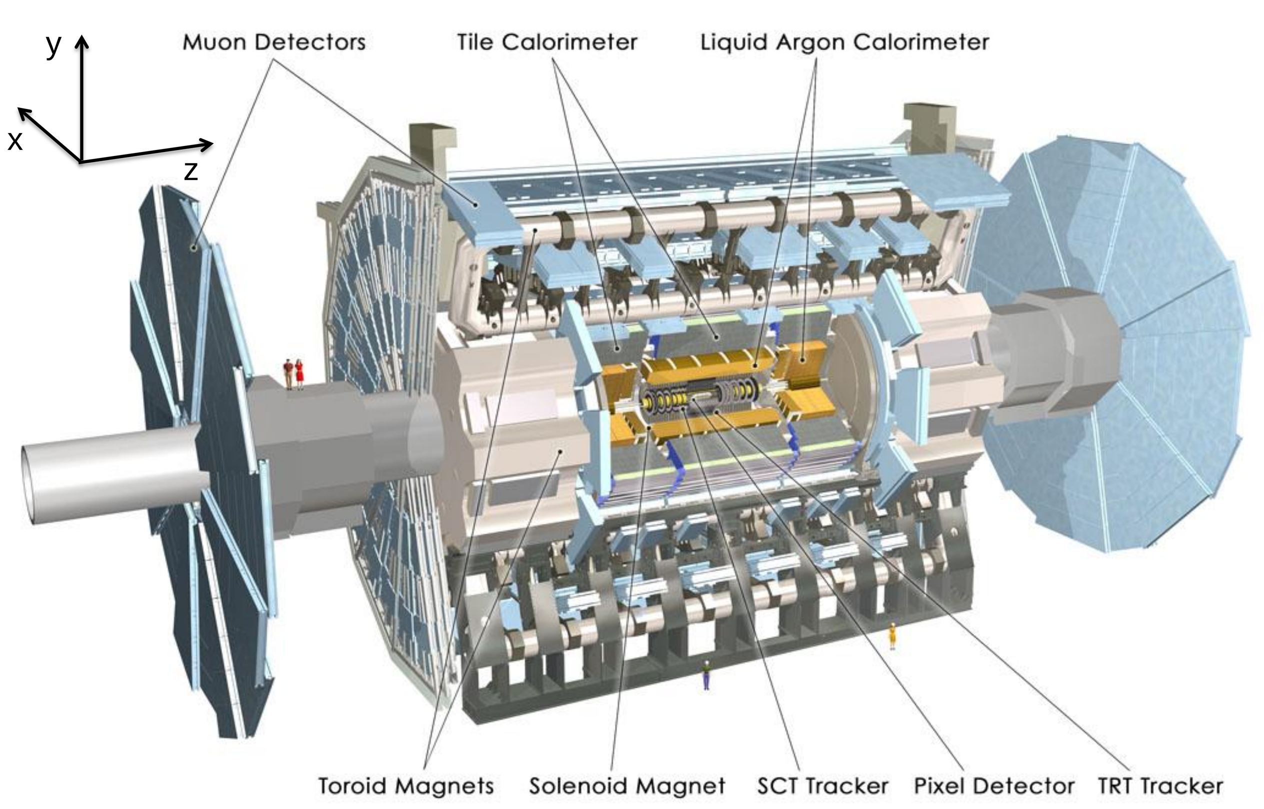
HCP POSTER SESSION – Paris, November 2011

Refined reconstruction and calibration of the missing transverse energy in the ATLAS detector

Intruduction: E_T^{miss} motivation

The missing transverse energy (E_T^{miss}) signals the presence of either weakly interacting particles or particles missing detection or any problem in the detector. So, an optimal E_T^{miss} evaluation, including the setting of its absolute scale, is crucial for the study of many physics channels in the Standard Model as W, tt, H→ ττ or of discovery channels for SUSY and extra dimensions.

E_T^{miss} definition



E_T^{miss} is a complex event quantity, It is calculated adding all significant signals from all detectors:

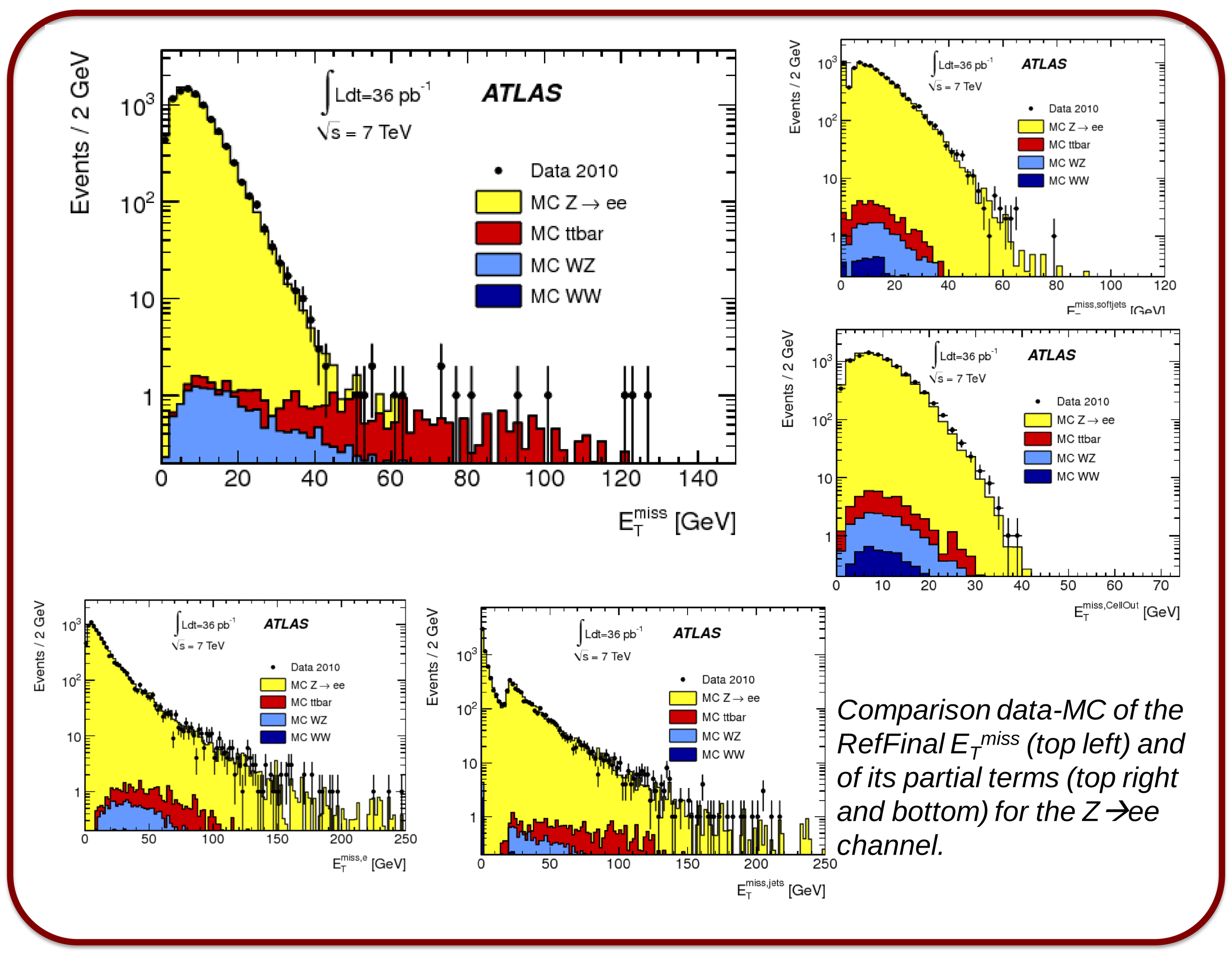
- Calorimeters signals
- Muon signals
- Tracks in region where the Calorimeter and the Muon Spectrometer are inefficient

E_T^{miss} is obtained by asking for energy conservation in the transverse (x-y) plane:

$$E_{x,y}^{miss} = -\sum E_{x,y} \quad \{ \text{Sum of energy of all particles seen in the detector}$$

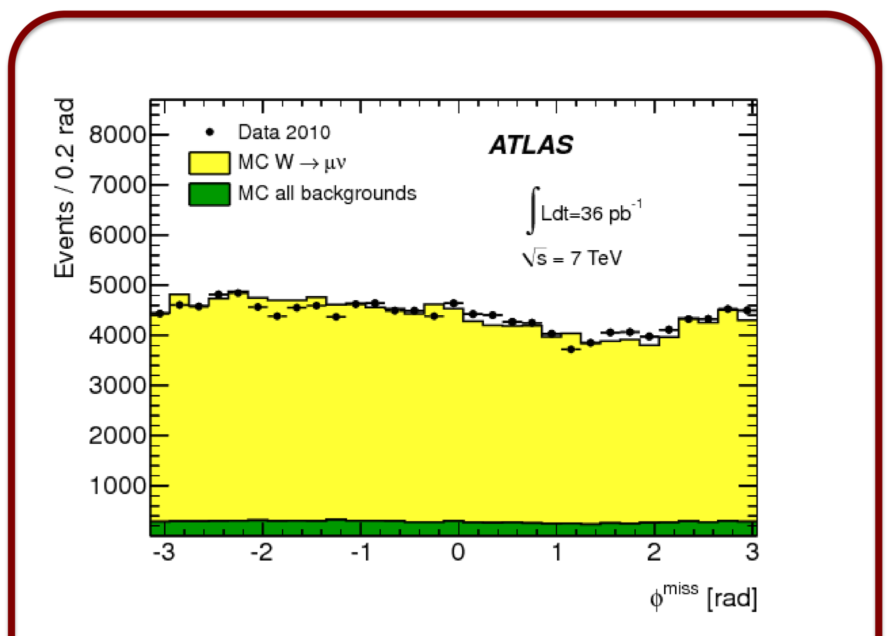
$$E_T^{miss} = \sqrt{(E_x^{miss})^2 + (E_y^{miss})^2} \qquad \phi^{miss} = \arctan(E_y^{miss} / E_x^{miss})$$

Main results with 2010 data

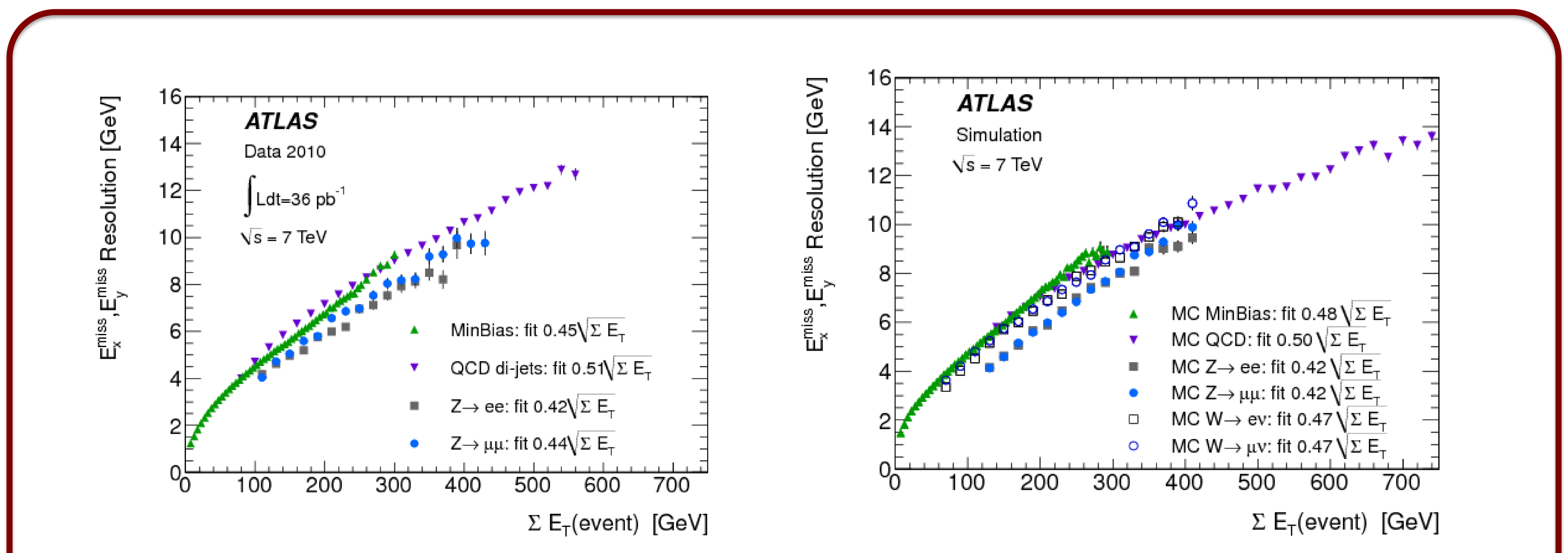


Comparison data-MC of the RefFinal E_T^{miss} (top left) and of its partial terms (top right and bottom) for the Z→ee channel.

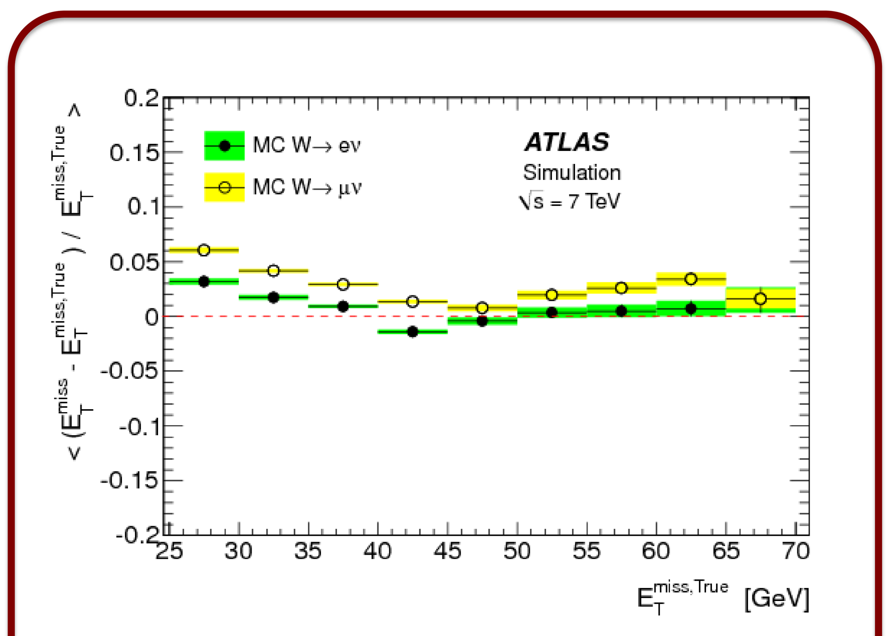
Main results with 2010 data



Comparison data-MC for the ϕ^{miss} distribution for the W→μν channel.



E_T^{miss} resolution for data (left) and MC (right) for different physics channels.



Linearity distribution (MC) for W→eν and W→μν channel.

RefFinal algorithm

The E_T^{miss} is calculated from cells in topoclusters and from muons. TopoCluster cells are calibrated on the basis of the reconstructed physics object they belong to. The algorithm is very flexible and allows one to use the best calibration from each object.

Electrons | Photons | Taus | Jets | SoftJets | Muons | TopoClusters not in objects

Go back to constituent Calorimeter Topoclusters → Cells → apply overlap removal at Cell level → Cell calibration weights dependent on the object → add them to calculate partial terms

MET_RefEle + MET_RefGamma + MET_RefTau + MET_RefJet + MET_SoftJets + MET_RefMuon + MET_CellOut + MET_Muon = MET_RefFinal

$$\vec{E}_T^{miss,calo} + \vec{E}_T^{miss,muon} = \vec{E}_T^{miss}$$

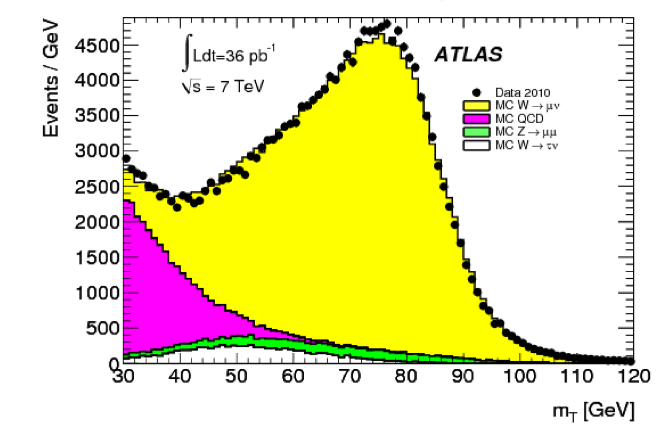
The **Local Hadron Calibration (LCW)** classifies calorimeter clusters as hadronic or electromagnetic, according to cluster topology. Then, it weights each cell in clusters according to cluster properties.

Object	Selection/Algo	p_T threshold	Calibration
Electrons	"robustMediumWithTrack"	> 10 GeV	default electron calibration
Photons	"Tight"	> 10 GeV	EM scale
Taus	"Tight"	> 10 GeV	LCW
Soft jets	anti-k_t R=0.6	7-20 GeV	LCW
Jets	anti-k_t R=0.6	> 20 GeV	LCW+JES
Muons	"Staco combined and Mutag"		
Topoclusters outside objects			LCW+Tracks

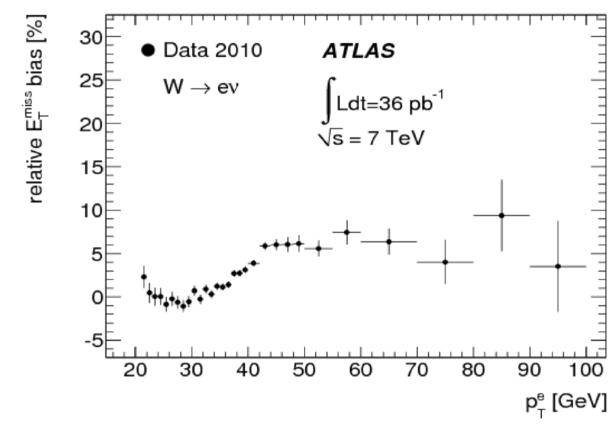
Configuration giving the best performance

Etmiss scale determination with Wln events in 2010 data

E_T^{miss} scale can be determined from data with two methods. The first uses a fit to the distribution of transverse mass, m_T, of the lepton E_T^{miss} system. The second uses the dependence between the neutrino and lepton momenta. The uncertainty on the scale is is about 2% with 36pb^{-1} for both methods



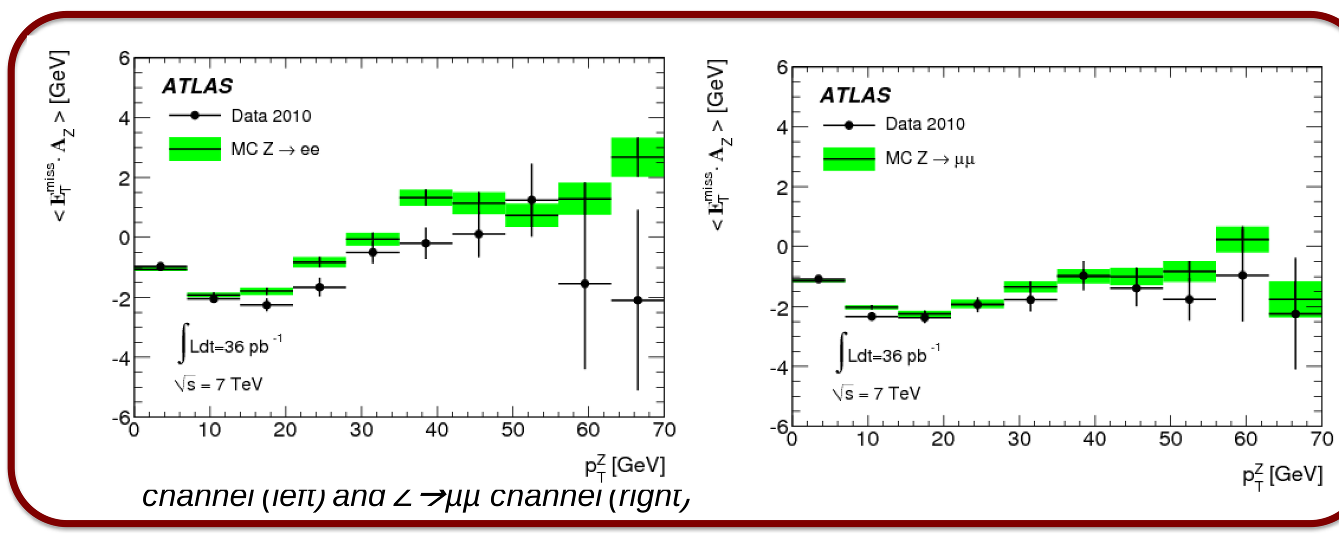
Fit to m_T distribution for W → μν events



Relative bias in the reconstructed E_T^{mis} for W→eν

Main results with 2010 data

In Z events along the Z direction no E_t^{miss} is expected, because the Z is balanced by the hadronic recoil. A negative bias for low values of p_T^Z is seen, probably due to underestimation of the hadronic recoil.



channel (left) and Z→μμ channel (right)

E_T^{miss} Systematic Uncertainty

It can be calculated from the uncertainty on each high p_T reconstructed object and from the uncertainty on SoftJets and CellOut terms, which are evaluated to be

CellOut Systematic uncertainty ~ 13 %

SoftJets Systematic uncertainty ~ 10%

In W→ lν events the overall E_t^{miss} systematic uncertainty is on average 2.6% for both electron and muon channel

Algorithm for TopoClusters not in objects

The TopoClusters not in objects (CellOut term) are improved using reconstructed tracks:

- add tracks which do not reach the calorimeter or do not seed a topocluster
- when a track is associated to a topocuster the track momentum is used instead of the topocluster energy.

Conclusion

- MC describes data well
- No large tails are observed
- Good resolution
- The calibration for low energy contributions entering in the E_T^{miss} computation has to be further improved

References:

[1] ATLAS Collaboration, *Performance of Missing Transverse Momentum in Proton-Proton Collisions at √s=7TeV with ATLAS*, arXiv:1108.5602

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