Update on W,Z muon cross section measurement

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On behalf of:
INFN Cosenza, Frascati, Pavia, Roma2, Roma3

Talk outline:

- Muon Momentum Scale with $Z \rightarrow \mu\mu$
- Status of MC production for background samples
- $Z \rightarrow \mu\mu$ efficiency determination
- Scale and resolution of MET for $W \rightarrow \mu\nu$ events

Muon Momentum Scale with $Z \to \mu\mu$

Three -steps procedure:

1) Data correction:

Correction of the measured muon momenta using the Z peak constraint.
Based on a parametrization of the possible effects (misalignment, B field measurement errors, error on energy loss estimate)

2) Compute the Z lineshape using corrected muon momenta

3) “Momentum Scale Determination”:

Determine, through a minimization procedure, how the muon momentum in MC samples has to be affected (deteriorated) in order to match the (corrected) data samples.

- Same method developed by C. Gatti for the CSC analysis (See the chapter “In-Situ determination of the performance of the Muon Spectrometer” of the CSC Book)

- This study is also of interest for the Muon Combined Performance group (collaboration with this group already well established)

Muon Momentum Scale with Z → μμ

Correct the muon momentum as follows:

$$p_{corr} = p \cdot (r_{\alpha,\beta} + \delta_{\alpha})$$

r: momentum scale
δ: rnd number extracted with mean 0 and
sigma= σ_{α} additional smearing ($\sigma_{pcorr}^2=\sigma_p^2+\sigma_{\alpha}^2$)
α: barrel/endcap ; **β**: mu+/mu-

-the 'MC' Z lineshape is computed using p_{corr} ;

- **r,δ** are determined fitting the obtained 'MC' Z lineshape distribution to 'Data' Z lineshape ;

-defined for Barrel & EndCap (further split with increasing statistics?)

Muon Momentum Scale with Z→ μμ

We use 2 INDEPENDENT samples:

1. ‘MC’ sample (simulated Z events from MC08 production). Standard events without misalignments.

2. ‘data’ sample: events with known misalignments in the Muon Spectrometer (more details in the next slide). Take a misalignment of 100 μ as reasonable guess for the knowledge of detector geometry @ start).

Process them as follows in the full analysis chain:

- Compute a table(η,p) with Trigger and recostruction efficiency ratio between ‘data’ and ‘MC’
- Use this table to reweight MC events and create a third ‘modified MC’ sample (1’).
- Create invariant mass distribution with ‘modified MC’ sample and ‘data’ sample.
- Compute with a minimization procedures the parameters for the momentum scale which maps the ‘modified MC’ sample into the ‘data’ sample

Samples used

Signal sample (no misalignment):

mc08.106051.PythiaZmumu_1Lepton.recon.AOD.e347_s462_r541_tid028727

Misaligned signal samples:

•4 datasets produced for 4 different Muon Spectrometer misalignments, with respectively 30, 100, 200, 500 µm translations and 15, 50, 100, 250 µrad rotations of MDT chambers

•Datasets available on the grid (~250k events each).

user09.FulvioGaleazzi.PythiaZmumu_1Lepton.mc08.106051_misal.recon.AOD.e347_s462_r541_tid028727_misal_30u
user09.FulvioGaleazzi.PythiaZmumu_1Lepton.mc08.106051_misal.recon.AOD.e347_s462_r541_tid028727_misal_100u
user09.FulvioGaleazzi.PythiaZmumu_1Lepton.mc08.106051_misal.recon.AOD.e347_s462_r541_tid028727_misal_200u
user09.FulvioGaleazzi.PythiaZmumu_1Lepton.mc08.106051_misal.recon.AOD.e347_s462_r541_tid028727_misal_500u

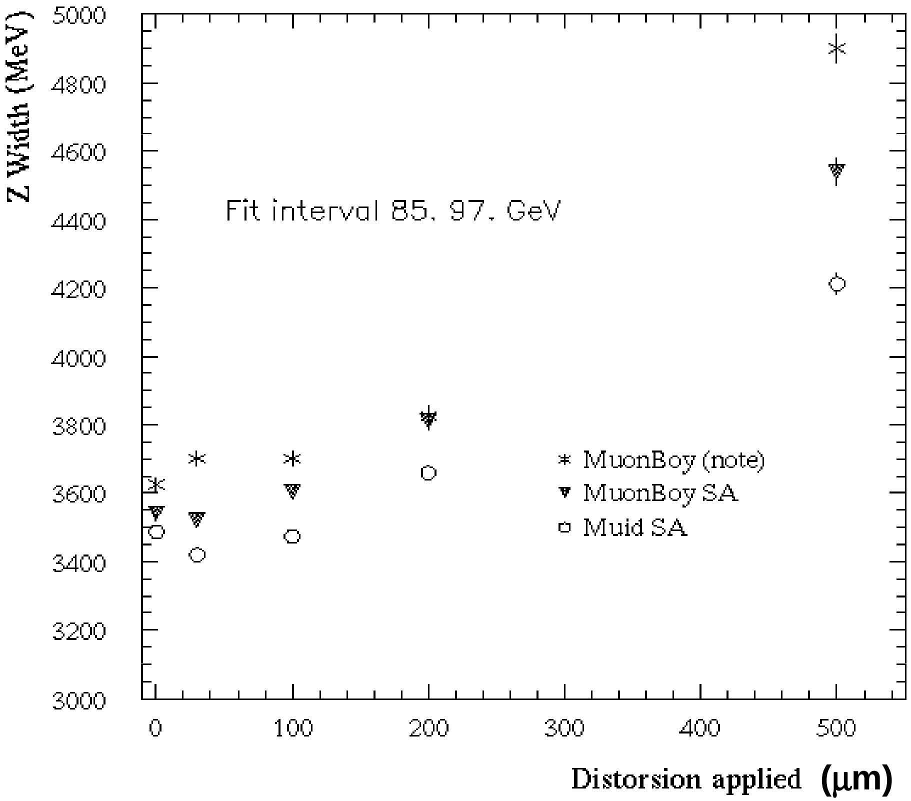
• Produced with RecExCommon (release 14.5.0) on the Roma Tre Tier3, starting from a local copy of centrally produced RDO (Muon Spectrometer geometry tags provided by the Saclay group)

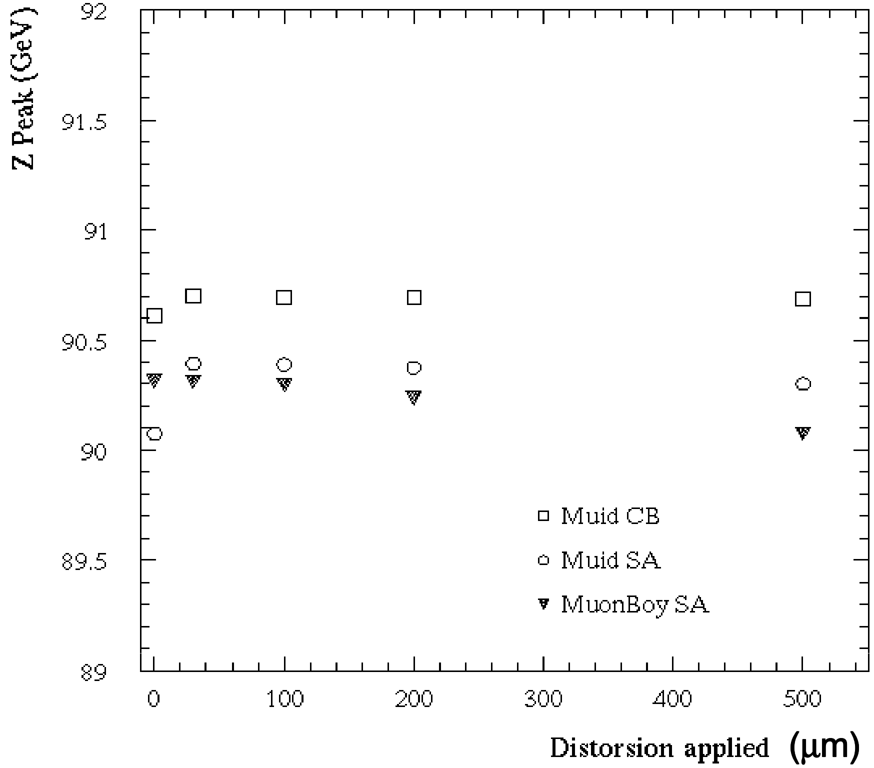
• D3PD produced with EWPA

•Analysis is presently done in ROOT on D3PDs, we will soon migrate the code into an athena tool

Z mass from datasets with misalignments

In the left plot we show a comparison with similar results obtained last year by the Saclay group with the CSC samples (ATL-PHYS-COM-2008-053):





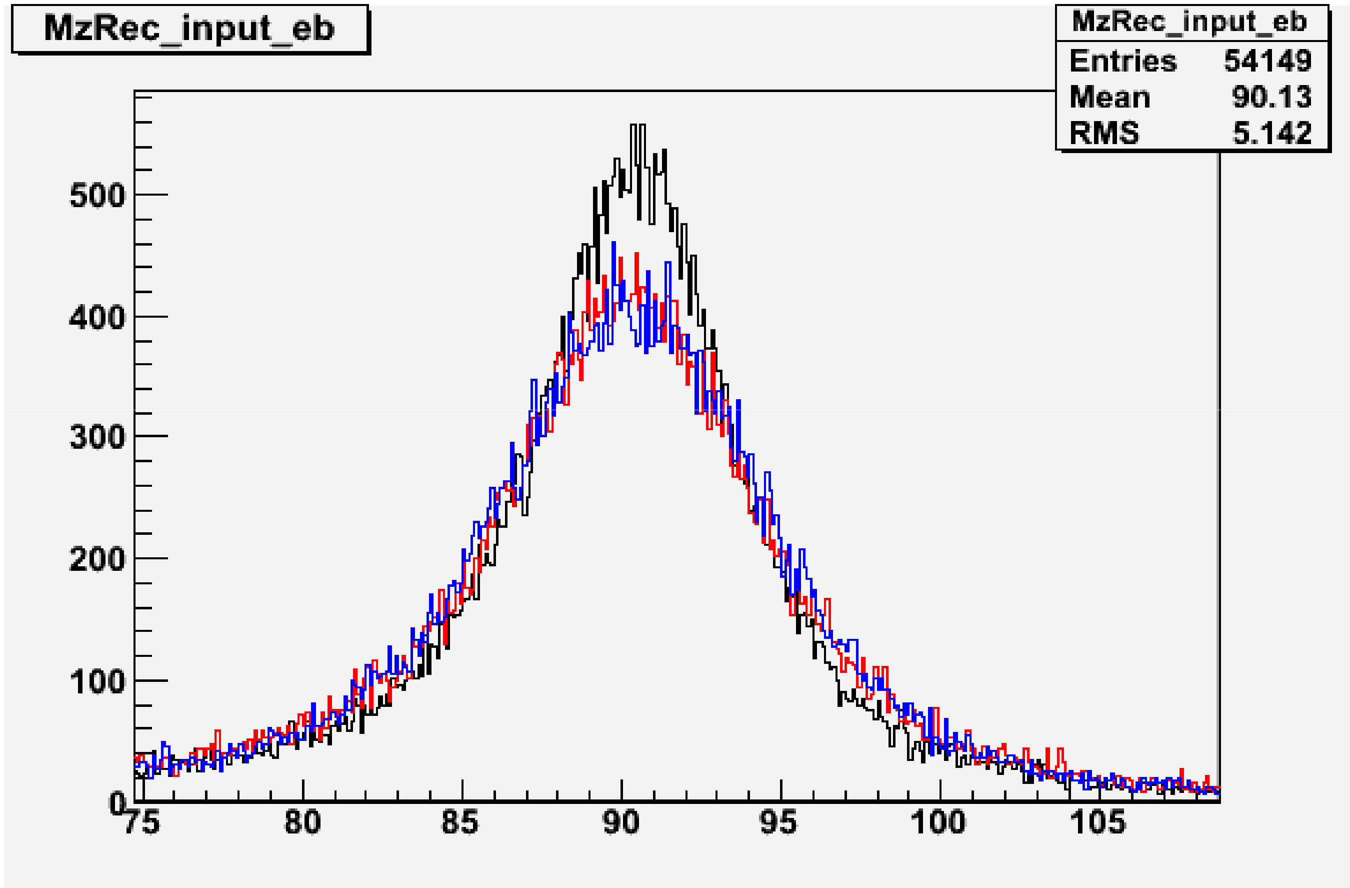
Different dataset used by the Saclay group:
misal1_csc11.005145.PythiaZmumu.digit.RDO.v12003103_tid003850
The observed discrepancy is mainly due to differences in the MC samples

Muon Momentum Scale with Z→ μμ

Only Z → μμ events considered in “data” and “MC” samples. No background added for the moment.

In the plot below you see the effect of the fit:

Black line : MC sample (before the fit)
Red line: data sample (misal 500 μm)
Blue line: MC sample (after the fit)

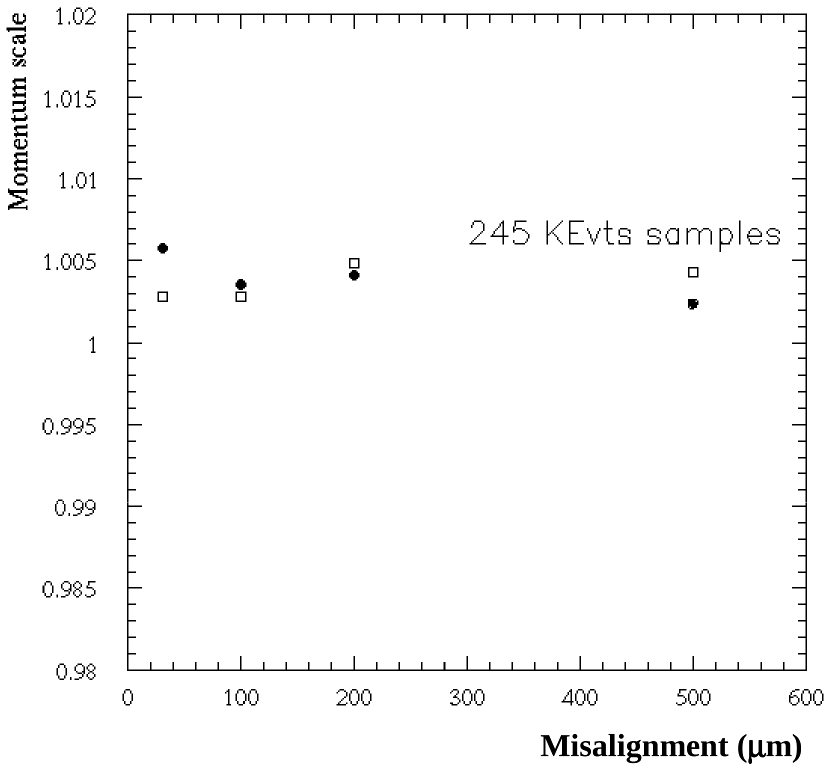


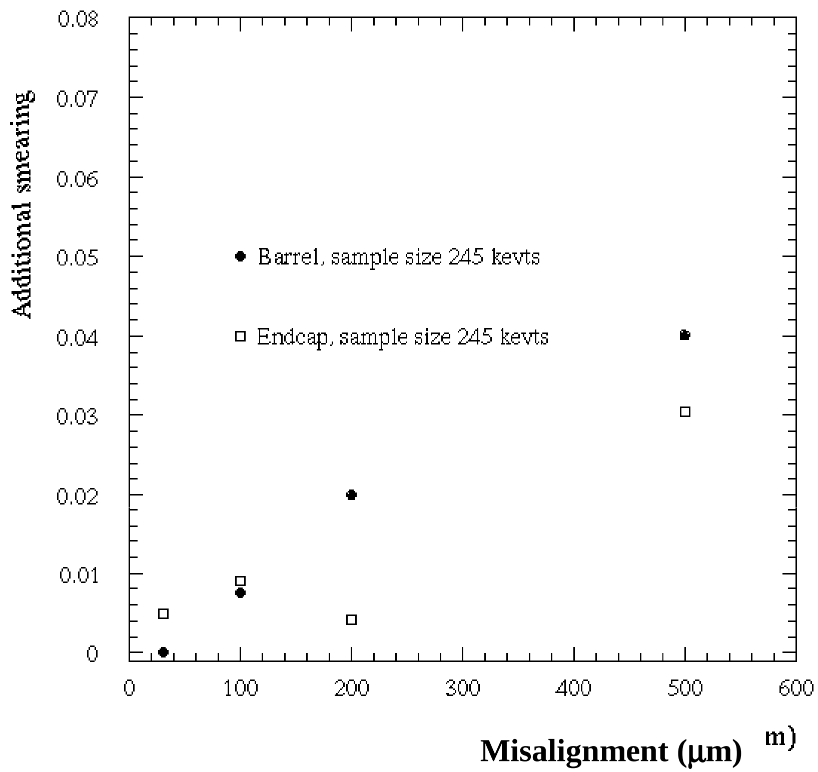
Event selection:

- two muons with opposite charge
- p_t> 20 GeV and |η|<2.5

Muon Momentum Scale with Z→ μμ

Variations of the parameters as a function of the misalignment in the "data"





Conclusions and plans

- Finalize the parametrization and the algorithm
- Migrate the code from the present ROOT macro into an athena tool to be used into EWPA and benchmark analysis
- Add new effects in the ‘data’ sample other than chamber misalignment (i.e. non-uniform magnetic filed)
- Start to introduce background samples

Status of MC production for background samples

Most of the background samples that we asked in January have been produced but we still miss the following samples (fast simulation):

bbmu15X (9 M events requested)
ccmu15X (9 M events requested)

For the bbmu15X the complete evgen dataset is available:

mc08.108405.PythiaB_bbmu15X.evgen.EVNT.e388_tid042962

Therefore we have recently agreed, with T. LeCompte and B. Kersevan, to proceed with a private production (atlfast II) on the italian cloud, using the available evgen dataset and all the official production scripts. A small sample of 100 k events is being produced in these days, we will use this sample to validate our private production.

A production test was performed few weeks ago on the Roma Tre Tier3 with release 14.5.1 (1 M events):
Production chain: EVNT-> HITS -> RDO -> AOD
We store HITS, RDO and AOD since we plan to re-run reconstruction with different conditions.

We should clarify a.s.a.p., with the production group, which is the status for the production of the ccmu15X

Z→μμ efficiency determination

Slides by C. Gatti

During the last meeting (April 17th) we showed the following result for the efficiency estimate of a pseudo-data sample, obtained by weighting the MC events with the ratio of single-particle efficiencies measured in pseudo-data and MC samples:

MC sample: 120,000 PythiaZmumu (r617)
Pseudo-data sample: 95,000 PythiaZmumu, misaligned MS O(500μm)

ε_{MC} **= (38.78 ± 0.14)%** MC selection efficiency
W = 0.9968 ± 0.0029 Weight
ε_{Corr}**= (38.66 ± 0.14** **(MCstat)** **± 0.11** **(EffiSignlePart)** **)%**

To be compared with the real selection efficiency of the pseudo-data:

ε_{pData} **= (38.18 ± 0.16)%** **Δ=(0.0048±0.0024)** a 2 σ effect

Is this 2 σ discrepancy a statistical or systematic effect?

Disentangling statistics from systematics

Decompose the selection efficiency in several steps:

MC Acceptance	fraction of true muons with p_T>15 GeV and $\|\eta\|$<2.5
Combined	fraction of events in acceptance with two combined muons
Kine	fraction of events with two combined muons satisfying: p_T>20 GeV and $\|\eta\|$<2.5
Iso	fraction of events satisfying isolation cuts
Trig	fraction of events satisfying the trigger μ20 requirement

MC Acceptance is a purely theoretical quantity: no reconstructed variables are used here. Any difference between the two samples, MC and p-data, may be only due to statistical fluctuations.

Disentangling statistics from systematics

We determine the efficiency for the various steps in two different ways and for both MC and p-data samples:

Direct method: Just count the fraction of events selected in each step:

$\varepsilon = \Sigma_{\text{selected events}} / \Sigma_{\text{events}}$

Weight method: Before each step (cut), weight the MC kinematics with the single-particle efficiency:

$\varepsilon = \Sigma_{\text{events}} \Pi\, \varepsilon(\text{single}) / \Sigma_{\text{events}}$

Disentangling statistics from systematics

Efficiencies obtained from direct selection:

	p-data	MC	1-(p-data/MC)
MC Acceptance	(49.23±0.23)%	(49.65±0.21)%	(-0.8±0.5)%
Combined	(89.14±0.14)%	(89.54±0.13)%	(-0.4±0.2)%
Kine	(92.49±0.13)%	(92.54±0.11)%	(-0.1±0.2)%
Iso	(97.542±0.079)%	(97.660±0.069)%	(-0.1±0.1)%
Trig	(96.400±0.096)%	(96.495±0.085)%	(-0.1±0.1)%

Efficiencies obtained by weighting MC kinematic with single-particle efficiencies:

	p-data	MC	1-(p-data/MC)
MC Acceptance	Only MC		
Combined	(89.592±0.067)%	(89.801±0.066)%	(-0.2±0.1)%
Kine	Not corrected yet		
Iso	(97.484±0.050)%	(97.633±0.050)%	(-0.2±0.1)%
Trig	(96.494±0.023)%	(96.467±0.022)%	(0.03±0.03)%

Disentangling statistics from systematics

At least half of the 2 σ effect is purely statistical (the MC and p-data samples are obtained from simulation of different events!).

Infact:

$(\varepsilon_{pdata}-\varepsilon_{MC})/\varepsilon= 0.015$ = 0.008 (Statistical) + 0.007 (Efficiency loss)

The only number that can be corrected is the efficiency-loss term: 0.007

Of this, 0.001 is due to the Kine cuts, that is not corrected yet.

Then we should measure a correction equal to 0.006,

corresponding to a weight: W=0.994

to be compared to what we measure: $W_{measured}=0.9968\pm0.0029$

Moreover, comparing the efficiencies obtained with the two methods we observe a nice agreement. Major discrepancy on the order of 0.3% observed for combined efficiencies (probably due to the large eta region), mostly cancels out in the ratio.

Study of scale and resolution of MET for W $\rightarrow\mu\nu$ events

Slides by M. Testa

Motivation:
Acceptance for the cross section W $\rightarrow\mu\nu$ measurement
Correction of MC shapes
Systematic due to MC shape for the counting of W $\rightarrow\mu\nu$ events

----> Need data driven estimate of scale and resolution from
Z $\rightarrow\mu\mu$ events for which MET~0

Scale and resolution evaluated wrt SumEt to take into account different hadronic recoil of W and Z

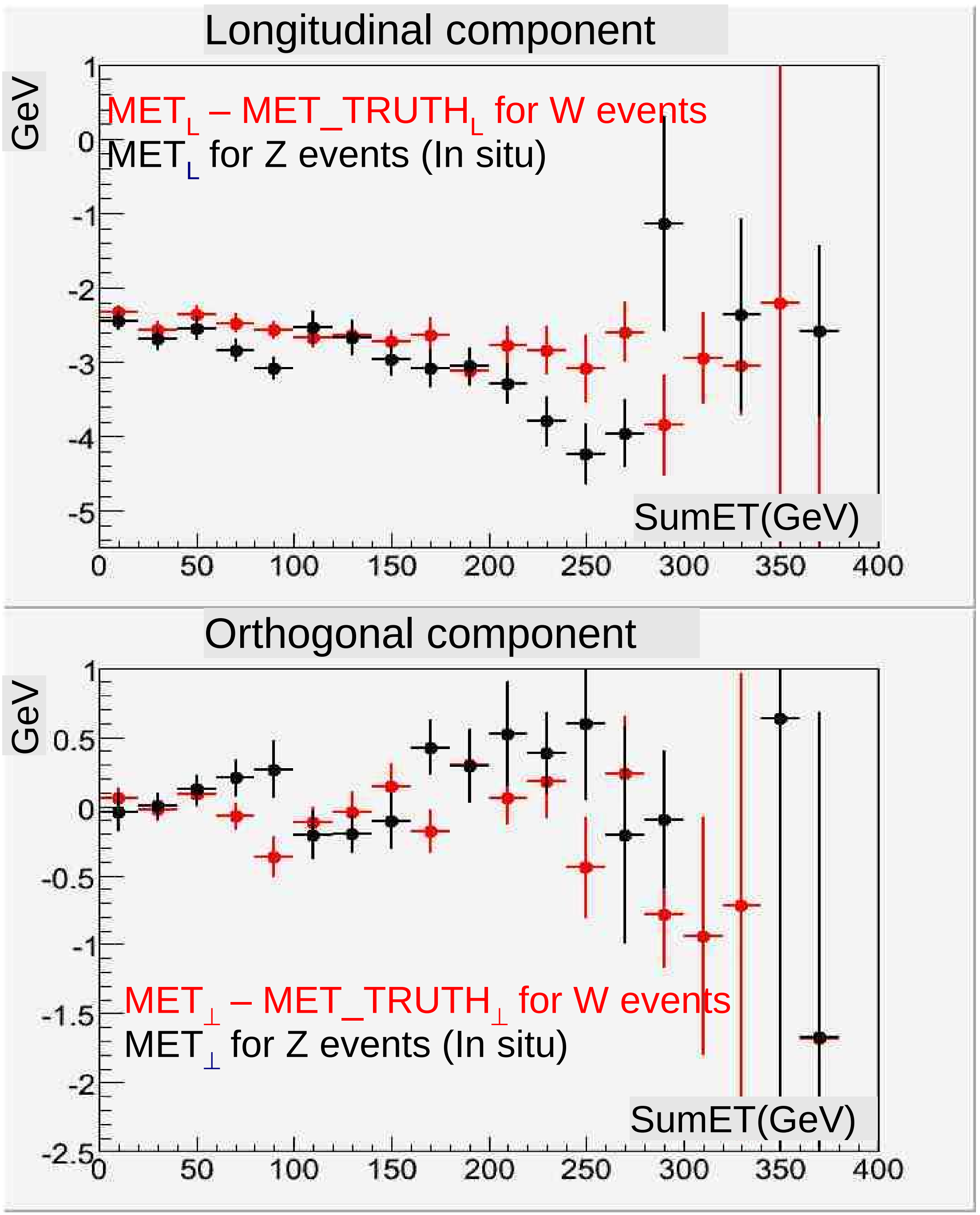
Decomposition of MET along the parallel and perpendicular direction of Z and W

Gaussian fit of the projections of MET – METTRUTH (MET) for W (Z) events in bins of SumET to evaluate linearity and resolution

Dataset used: PythiaZmumu_1Lepton, Pythia_Wmunu_1Lepton
from mc08 production (last reprocessing, reco tag r635)

Mean of MET-MET_TRUTH

Along the W and Z momentum direction bias of ~3GeV mostly independent on SumET. Good agreement between Z and W (low statistics for fits above 250 GeV)



No bias observed.
Good greement between
W and Z along the perpendicular direction

Resolution of MET-MET_TRUTH

Agreement between W and Z MET resolutions in both directions