DØ note 6314
Version 1.2

Muon Momentum Oversmearing Update for Run IIb1 and Run IIb2 Data Taking Epochs and Run IIb2 Monte Carlo

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(Dated: February 29, 2012)

This is a muon momentum oversmearing study for Run IIb1 and Run IIb2 data taking epochs and Run IIb2 Monte Carlo. The method consists of oversmearing the transverse momentum of muons from $J/\psi \rightarrow \mu^+\mu^-$ and $Z, \gamma^\star \rightarrow \mu^+\mu^-$ resonances and getting parameters from a χ^2 fit when comparing dimuon invariant mass distributions of data and Monte Carlo events. This work is a complement of previous studies which analized other data taking epochs and Monte Carlo versions. Thus results presented here goes under the same method, including selection cuts and computation of statistical and systematic uncertainties as well.

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I. INTRODUCTION

The lastest updated studies ([1–3]) on the muon momentum oversmearing were performed for the following data taking epochs and Monte Carlo versions:

- DØ Note 6031:
  - Run IIb1 data / Run IIb1 MC (p20.09);
  - Run IIb2 data / Run IIb1 MC (p20.09);
  - Run IIb1+IIb2 data / Run IIb1 MC (p20.09).
- DØ Note 6190:
  - Run IIb2+IIb3 data / Run IIb1 MC (p20.09);
  - Run IIb2 data / Run IIb2 MC (p20.15);
  - Run IIb3 data / Run IIb2 MC (p20.15);
  - Run IIb2+IIb3 data / Run IIb2 MC (p20.15);
  - Run IIa data / Run IIa MC (p18.13);
- DØ Note 6312:
  - Run IIb3 data / Run IIb3 MC (p20.17)
  - Run IIb3+IIb4 data / Run IIb3 MC (p20.17)

A remaining study is for Run IIb1+IIb2 data taking epoch and Run IIb2 MC (p20.15), and has been documented in this Note.

The latest improvement in the muon-oversmearing method is written in detail in the DØ Note 6031 [1], being the same version used here, as well as the same way to compute systematic uncertainties. This method uses $J/\psi \to \mu^+\mu^-$ and $Z, \gamma^\star \to \mu^+\mu^-$ MC events produced by PYTHIA and ALPGEN respectively. Both data and MC ROOT-files for this round of muon-oversmearing study (Run IIb1+IIb2 data / Run IIb2 MC) are the same ones created for DØ Note 6190 [2], with exception of Run IIb1 data, which had to be created.

In order to help readers going through this document, there are more informations about data and Monte Carlo events (section II), as well as about the muon-oversmearing method (section III).

In section IV, results from muon-oversmearing studies are given by MC events oversmeared with only a *Single-Gaussian* since Run IIb2 MC needs very little oversmearing. In section V, muon-resolution parameters (computed using generated muon momenta at parton level MC instead of fully simulated MC) are given by both *Single* and *Double-Gaussian*, the latter being a more reasonable fit to get a better agreement between data and MC.

Muon-oversmearing studies based on the newest data taking epochs and MC versions, such as Run IIb3+IIb4 data and Run IIb3 MC have been performed and are detailed in [3].

II. DATA AND MONTE CARLO EVENTS

The selections cuts applied to data and MC events refer to [2]. Remaining number of $J/\psi \rightarrow \mu^+\mu^-$ and $Z, \gamma^\star \rightarrow \mu^+\mu^-$ events are listed in tables 1 and 2 for data and MC respectively.

Data Epoch	**Run Number**	**Remaining Events**	
		$\mathbf{J}/\psi \rightarrow \mu^+\mu^-$	$\mathbf{Z}, \gamma^\star \rightarrow \mu^+\mu^-$
Run IIb1	151,817 - 215,670	812,295	42,095
Run IIb2	234,207 - 251,282	4,127,858	191,101

Table 1. Remaining $J/\psi \rightarrow \mu^+\mu^-$ and $Z, \gamma^\star \rightarrow \mu^+\mu^-$ data events after selection cuts concerning reference [2].

	$\mathbf{J}/\psi \rightarrow \mu^+\mu^-$	$\mathbf{Z}, \gamma^\star \rightarrow \mu^+\mu^-$
DØrelease for Run IIb2 MC	p20.15.04	p20.15.00
CAF version	p21.24.00	p21.24.00
Version of CSG dataset definition	1	1
Remaining Events	15,744	722,156

Table 2. Remaining $J/\psi \rightarrow \mu^+\mu^-$ and $Z, \gamma^\star \rightarrow \mu^+\mu^-$ Monte Carlo events after selection cuts concerning reference [2].

Events correspondent to J/ψ PYTHIA Monte Carlo were created with Request IDs listed in table 3. Table 4 shows the complete list of Request IDs used to create $Z, \gamma^\star \rightarrow \mu^+\mu^-$ Monte Carlo events.

MC version	J/ψ **Monte Carlo Request IDs**
Run IIb 2	65872, 65873, 65874, 100772, 100773, 100774, 100775 100776, 100777, 100778, 100779, 100780, 100781, 110993

Table 3. Request IDs correspondent to J/ψ PYTHIA Monte Carlo.

III. TYPE OF TRACKS AND EVENTS

The transverse momentum of the muon is more accurately described when its track curvature have a reasonable number of hits in the SMT and CFT. The muon-oversmearing parameters may present different values depend on these hits. Such parameters are computed for three different type of dimuon events:

- *Type 1*: both muons have hits in the SMT and are in the central region ($|\eta_{CFT}| < 1.6$);
- *Type 2*: both muons have hits in the SMT and only one muon has $|\eta_{CFT}| < 1.6$;
- *Type 3*: only one muon has hits in the SMT.

The muon-oversmearing parameters are also computed considering three different type of muon track qualities (as defined in [4]): *Medium*, *Loose* and *New Medium*. When, for example, a *Medium* track quality is selected, it is placed as a central value, while *Loose* and *New Medium* track qualities are used as sources of systematic uncertainties. The other source of systematic uncertainties are described in [2].

Z **Monte Carlo Request IDs**		
Subprocess	**Mass range (in GeV)**	**Request IDs**
$Z, \gamma^\star + 0\text{lp} \to \mu^+\mu^- + 0\text{lp}$	15 — 75	114295, 114296, 114297, 114298, 114299, 114300
	75 — 130	114141, 114142, 114143, 114144, 114145, 114146
	130 — 250	114328
	250 — 1960	114348
$Z, \gamma^\star + 1\text{lp} \to \mu^+\mu^- + 1\text{lp}$	15 — 75	114301, 114302, 114303
	75 — 130	114147, 114148, 114149
	130 — 250	114329
	250 — 1960	114349
$Z, \gamma^\star + 2\text{lp} \to \mu^+\mu^- + 2\text{lp}$	15 — 75	114304, 114305, 114306
	75 — 130	114150, 114151, 114152
	130 — 250	114330
	250 — 1960	114350
$Z, \gamma^\star + 3\text{lp} \to \mu^+\mu^- + 3\text{lp}$	15 — 75	114307, 114308, 114309
	75 — 130	114153, 114154, 114155
	130 — 250	114331, 119124
	250 — 1960	114351

Table 4. Request IDs correspondent to Z ALPGEN Monte Carlo of Run IIb2 version.

IV. MUON-OVERSMEARING PARAMETERS

Through the muon-oversmearing method, it is possible to oversmear the muon transverse momentum using either a Single-Gaussian — taking care of corrections around J/ψ and Z resonances only — or a Double-Gaussian — expanding corrections over higher dimuon invariant mass ranges.

In summary, both methods used to oversmear the muon transverse momentum have 2 main parameters to be computed from the χ^2 fit in the dimuon invariant mass between data and MC: A is sensitive to geometrical effects, while B is sensitive to dead matterial of the detector. Generally, when it is found $A < 0.001$ GeV^{-1}, it is an indication that the analyzed MC version describes data rather well. Table 5 shows the muon-oversmearing parameters for Run IIb1+IIb2 data and Run IIb2 MC using a Single-Gaussian. Thus, in principle, very little oversmearing is necessary for this set of data and MC.

Since Run IIb1+IIb2 data taking epoch and Run IIb2 MC does not require to apply much oversmering to Monte Carlo, only a Single-Gaussian has been used to compute parameters. Looking at figure 1, one could say there is no need to apply an oversmearing. Indeed, $\chi^2/n.d.f.$ values on table 6 clealy shows a better data/MC agreement through a Single-Gaussian for Types 1 and 3. In case of Type 2, $\chi^2/n.d.f.$ values from non-oversmeared MC are lower than those ones related to Single-Gaussian. It is because A and B parameters are determined using both $J/\psi \to \mu^+\mu^-$ and $Z, \gamma^\star \to \mu^+\mu^-$ invariant mass distributions, but only $Z, \gamma^\star \to \mu^+\mu^-$ distribution is used to compute the $\chi^2/n.d.f.$ values. However, such values from Single-Gaussian are all about 1, being all acceptable.

Track Selection	**Type**	**A** ($\times 10^{-3}$)	**B** ($\times 10^{-2}$)	**Scale** ($\times 10^{-2}$)
Medium	1	$0.83 \pm 0.07 \pm 0.17$	$1.13 \pm 0.11 \pm 0.42$	$0.27 \pm 0.04 \pm 0.14$
	2	$0.28 \pm 0.50 \pm 0.28$	$0.93 \pm 0.71 \pm 0.93$	$0.59 \pm 0.11 \pm 0.59$
	3	$2.04 \pm 0.27 \pm 0.39$	$2.13 \pm 0.74 \pm 0.62$	$-0.27 \pm 0.13 \pm 0.27$
Loose	1	$0.80 \pm 0.09 \pm 0.06$	$1.43 \pm 0.18 \pm 0.21$	$0.29 \pm 0.04 \pm 0.13$
	2	$0.28 \pm 0.29 \pm 0.28$	$1.18 \pm 0.62 \pm 0.73$	$0.54 \pm 0.73 \pm 0.54$
	3	$2.28 \pm 0.25 \pm 0.38$	$1.71 \pm 0.31 \pm 1.09$	$-0.27 \pm 0.13 \pm 0.27$
New Medium	1	$0.83 \pm 0.06 \pm 0.11$	$1.38 \pm 0.23 \pm 0.37$	$0.28 \pm 0.04 \pm 0.16$
	2	$0.28 \pm 0.22 \pm 0.28$	$1.33 \pm 0.82 \pm 1.24$	$0.46 \pm 0.11 \pm 0.46$
	3	$2.20 \pm 0.18 \pm 0.25$	$1.4 \pm 0.4 \pm 1.4$	$-0.16 \pm 0.13 \pm 0.16$

Table 5. All **muon-oversmearing** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian. Three different types of dimuon events is showed for three different track quality of muons. The first uncertainty is statistical and the second is systematic one.

The third parameter in table 5 is a **Scale** factor applied to the muon transverse momentum to correct the difference in the Z

peak between data and Monte Carlo. All statistical and systematic uncertainties related to such muon-oversmearing paramters are listed in detail in Appendix A.

	Type 1			**Type 2**			**Type 3**		
Track Selection	ns-MC	DG	SG	ns-MC	DG	SG	ns-MC	DG	SG
Medium	1.20	—	1.13	0.49	—	1.07	1.21	—	1.02
Loose	2.19	—	1.64	0.71	—	0.99	1.40	—	1.24
New Medium	1.97	—	1.28	0.61	—	1.13	1.32	—	1.11

Table 6. Oversmearing-parametes: $\chi^2/n.d.f.$ values from comparison between data and MC dimuon invariant mass distributions in case of non-oversmeared MC (ns-MC) and oversmeared MC via Double-Gaussia (DG) and Single-Gaussian (SG).

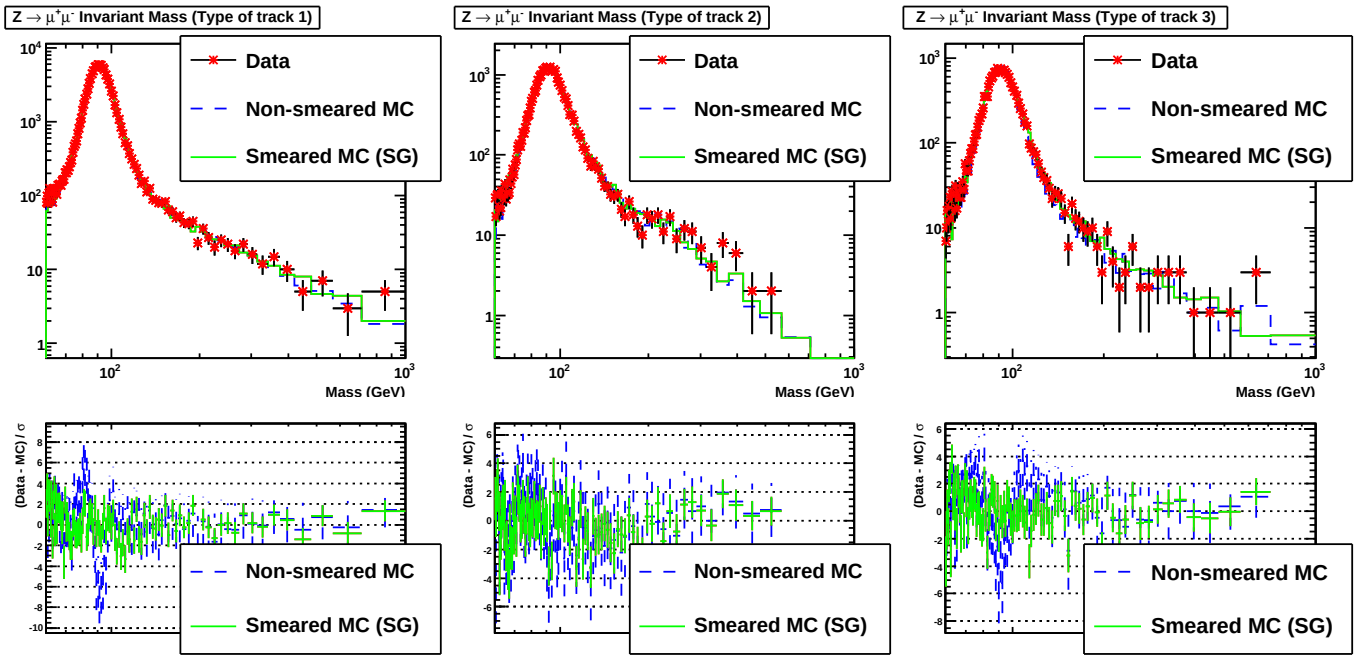

Figure 1. Data and reconstructed MC $Z/\gamma^* \rightarrow \mu^+\mu^-$ invariant mass distribution (figures on the top) and $(Data - MC)/\sigma$ (figures on the botton) for the 3 type of tracks in case of **Run IIb1+IIb2 data taking epoch / Run IIb2 MC** and *Medium track quality*. Data (dots) is compared with non-oversmeared MC (blue lines) and oversmeared MC via Single-Gaussian (green lines).

Figure 2 shows the $Z, \gamma^\star \rightarrow \mu^+\mu^-$ invariant mass comparing data and MC considering all 3 type of muon track qualities.

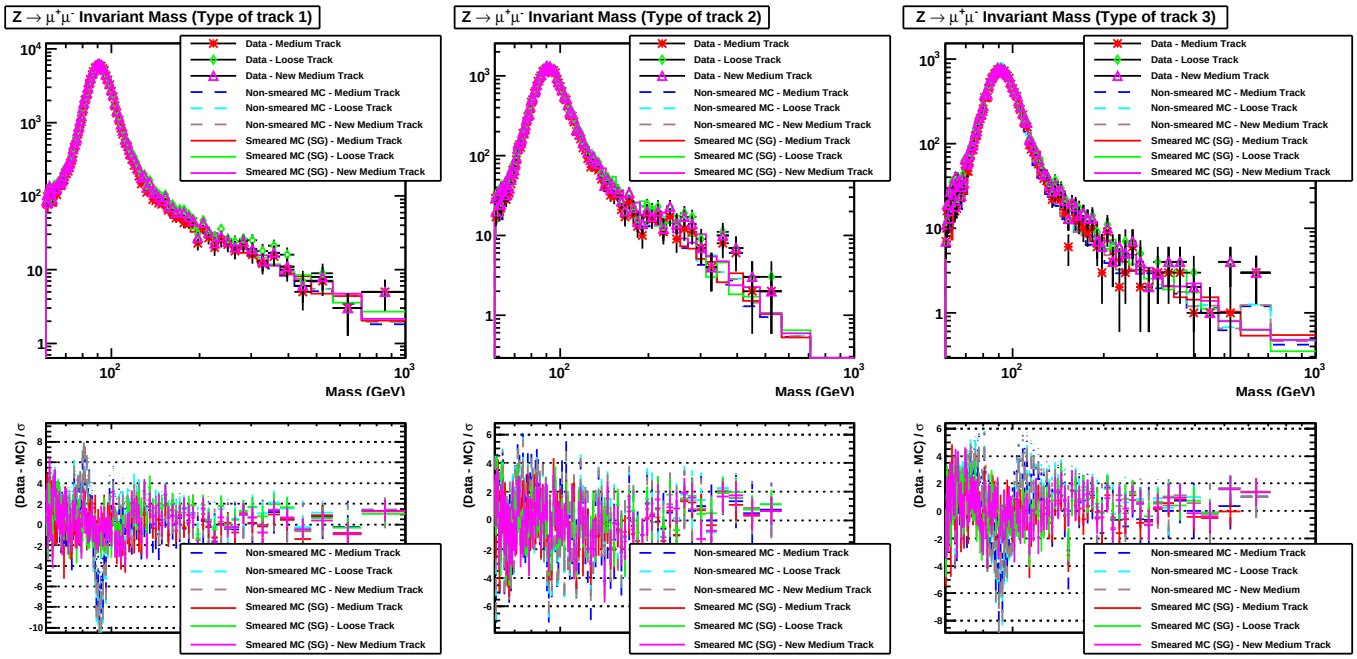

Figure 2. Data and reconstructed MC $Z/\gamma^* \to \mu^+\mu^-$ invariant mass distribution (figures on the top) and $(Data - MC)/\sigma$ (figures on the botton) for the 3 type of tracks via Single-Gaussian in case of **Run IIb1+IIb2 data taking epoch / Run IIb2 MC**. Data (dots) is compared with non-oversmeared MC (dashed lines) and oversmeared MC (full lines), taking *Medium track*, *Loose track* and *New Medium track* qualities.

V. MUON-RESOLUTION PARAMETERS

Muon-oversmearing parameters are obtained when data is compared with recontructed Monte Carlo. That is, Monte Carlo events are passed through the detector recontruction. Muon-resolution parameters, on the other hand, are a product from a comparison with MC at parton level (when no detector reconstruction is applied) being objects of interest for analysis which use muon transfer functions. Tables 7 and 8 list the muon-resolution parameters when a Double-Gaussian and a Single-Gaussian are applied respectively.

From figures 3 to 5, it is reasonable using a smeared Monte Carlo. $\chi^2/n.d.f.$ values on table 9 shows a better data/MC agreement when using a Double-Gaussian.

As seen in the section IV, the muon-oversmearing only required a Single-Gaussian as the Monte Carlo did a reasonable job in reproducing the data including the SMT and CFT inefficiencies. However, there are still non-Gaussian tails in the momentum resolution and a Double-Gaussian reproduces these better, and is so the best to use to determine the momentum resolution.

Track Selection	**Type**	**A** ($\times 10^{-3}$)	**B** ($\times 10^{-2}$)	**C** ($\times 10^{-2}$)	**D** ($\times 10^{-3}$)	**Scale** ($\times 10^{-2}$)
Medium	1	$2.06 \pm 0.03 \pm 0.18$	$2.24 \pm 0.07 \pm 0.21$	$8.9 \pm 1.4 \pm 6.5$	$5.1 \pm 0.2 \pm 1.8$	$0.39 \pm 0.39 \pm 0.20$
	2	$2.54 \pm 0.14 \pm 0.31$	$2.00 \pm 0.61 \pm 0.89$	$7.9 \pm 2.1 \pm 5.0$	$7.7 \pm 3.8 \pm 7.7$	$0.82 \pm 0.11 \pm 0.82$
	3	$3.66 \pm 0.20 \pm 0.33$	$2.3 \pm 0.7 \pm 1.2$	$2.6 \pm 2.8 \pm 2.6$	$12 \pm 10 \pm 9$	$0.1 \pm 0.1 \pm 0.1$
Loose	1	$2.14 \pm 0.02 \pm 0.11$	$2.40 \pm 0.06 \pm 0.16$	$6.5 \pm 0.3 \pm 1.7$	$6.9 \pm 0.1 \pm 1.3$	$0.43 \pm 0.04 \pm 0.10$
	2	$2.54 \pm 0.15 \pm 0.42$	$2.64 \pm 0.42 \pm 0.54$	$6.1 \pm 1.5 \pm 4.9$	$16 \pm 10 \pm 16$	$0.76 \pm 0.11 \pm 0.76$
	3	$3.82 \pm 0.11 \pm 0.43$	$2.50 \pm 0.33 \pm 0.63$	$8.0 \pm 2.8 \pm 7.7$	$8 \pm 14 \pm 8$	$0.50 \pm 0.13 \pm 0.50$
New Medium	1	$2.22 \pm 0.07 \pm 0.21$	$2.40 \pm 0.13 \pm 0.24$	$4.7 \pm 0.5 \pm 2.7$	$7.5 \pm 0.5 \pm 1.4$	$0.44 \pm 0.04 \pm 0.10$
	2	$2.78 \pm 0.13 \pm 0.61$	$1.8 \pm 0.2 \pm 1.8$	$4.3 \pm 1.4 \pm 3.8$	$13 \pm 12 \pm 13$	$0.52 \pm 0.11 \pm 0.52$
	3	$3.98 \pm 0.19 \pm 0.52$	$3.10 \pm 0.50 \pm 0.72$	$4.7 \pm 3.0 \pm 4.7$	$0.2 \pm 19.0 \pm 0.2$	$0.02 \pm 0.13 \pm 0.2$

Table 7. All **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Double-Gaussian. Three different types of dimuon events is showed for three different track quality of muons. The first uncertainty is statistical and the second is systematic one.

Track Selection	**Type**	**A** ($\times 10^{-3}$)	**B** ($\times 10^{-2}$)	**Scale** ($\times 10^{-2}$)
Medium	1	$2.30 \pm 0.06 \pm 0.11$	$2.24 \pm 0.07 \pm 0.29$	$0.47 \pm 0.04 \pm 0.17$
	2	$2.62 \pm 0.09 \pm 0.31$	$2.24 \pm 0.26 \pm 0.59$	$0.85 \pm 0.11 \pm 0.85$
	3	$3.66 \pm 0.10 \pm 0.30$	$3.3 \pm 0.6 \pm 1.6$	$0.23 \pm 0.13 \pm 0.23$
Loose	1	$2.30 \pm 0.01 \pm 0.11$	$2.48 \pm 0.06 \pm 0.16$	$0.51 \pm 0.04 \pm 0.16$
	2	$2.62 \pm 0.12 \pm 0.24$	$2.24 \pm 0.47 \pm 0.89$	$0.82 \pm 0.11 \pm 0.83$
	3	$3.98 \pm 0.12 \pm 0.47$	$2.90 \pm 0.27 \pm 0.40$	$0.31 \pm 0.14 \pm 0.31$
New Medium	1	$2.30 \pm 0.02 \pm 0.14$	$2.40 \pm 0.09 \pm 0.16$	$0.50 \pm 0.04 \pm 0.16$
	2	$2.78 \pm 0.11 \pm 0.44$	$2.0 \pm 0.4 \pm 1.6$	$0.57 \pm 0.11 \pm 0.57$
	3	$3.98 \pm 0.12 \pm 0.47$	$3.10 \pm 0.38 \pm 0.60$	$0.1 \pm 0.1 \pm 0.1$

Table 8. All **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian. Three different types of dimuon events is showed for three different track quality of muons. The first uncertainty is statistical and the second is systematic one.

All statistical and systematic uncertainties related to the muon-resolution paramters in tables 7 and 8 are listed in detail in Appendix B.

	Type 1		**Type 2**		**Type 3**	
Track Selection	DG	SG	DG	SG	DG	SG
Medium	0.87	2.84	1.02	1.81	1.07	1.32
Loose	0.91	6.11	1.11	3.25	0.96	1.66
New Medium	1.23	5.46	1.02	2.04	0.95	1.13

Table 9. $\chi^2/n.d.f.$ values from comparison between data and MC dimuon invariant mass distributions using resolution-parameters.

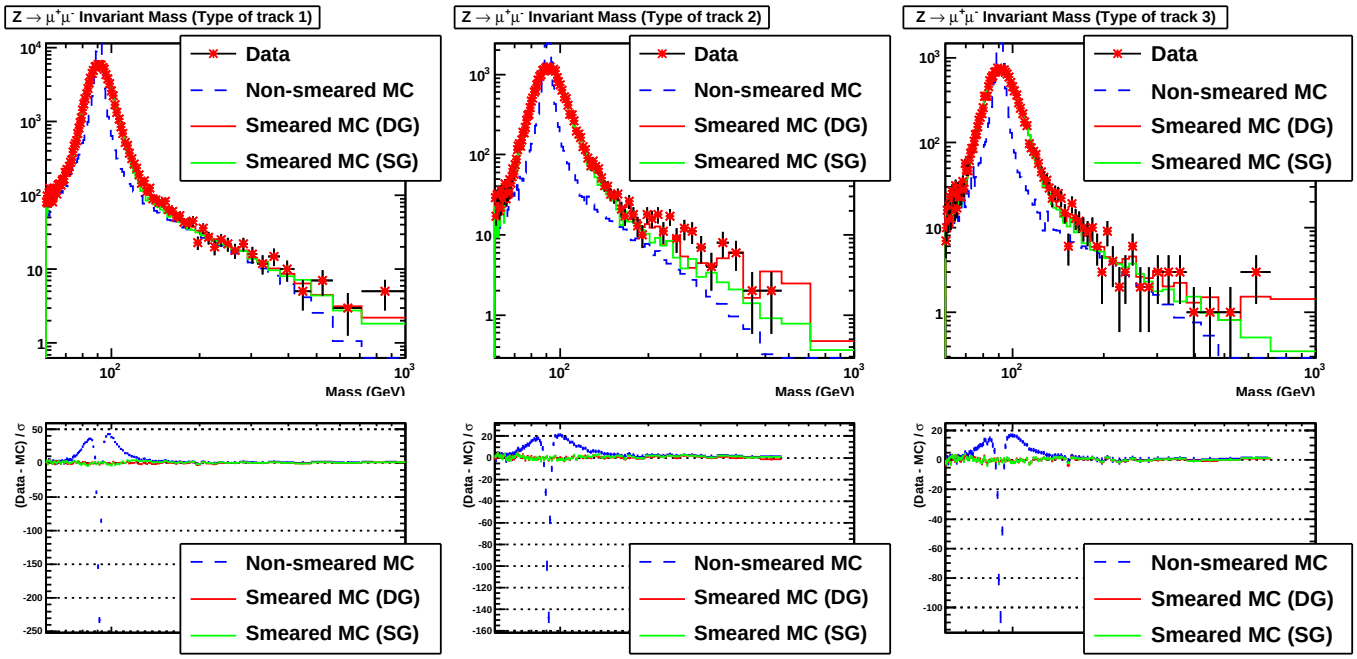

Figure 3. Data and generated MC $Z/\gamma^* \to \mu^+\mu^-$ invariant mass distribution (figures on the top) and $(Data - MC)/\sigma$ (figures on the botton) for the 3 type of tracks in case of **Run IIb1+IIb2 data taking epoch / Run IIb2 MC** and *Medium track quality*. Data (dots) is compared with non-smeared MC (blue lines), smearead MC via Double-Gaussian (red lines) and via Single-Gaussian (green lines).

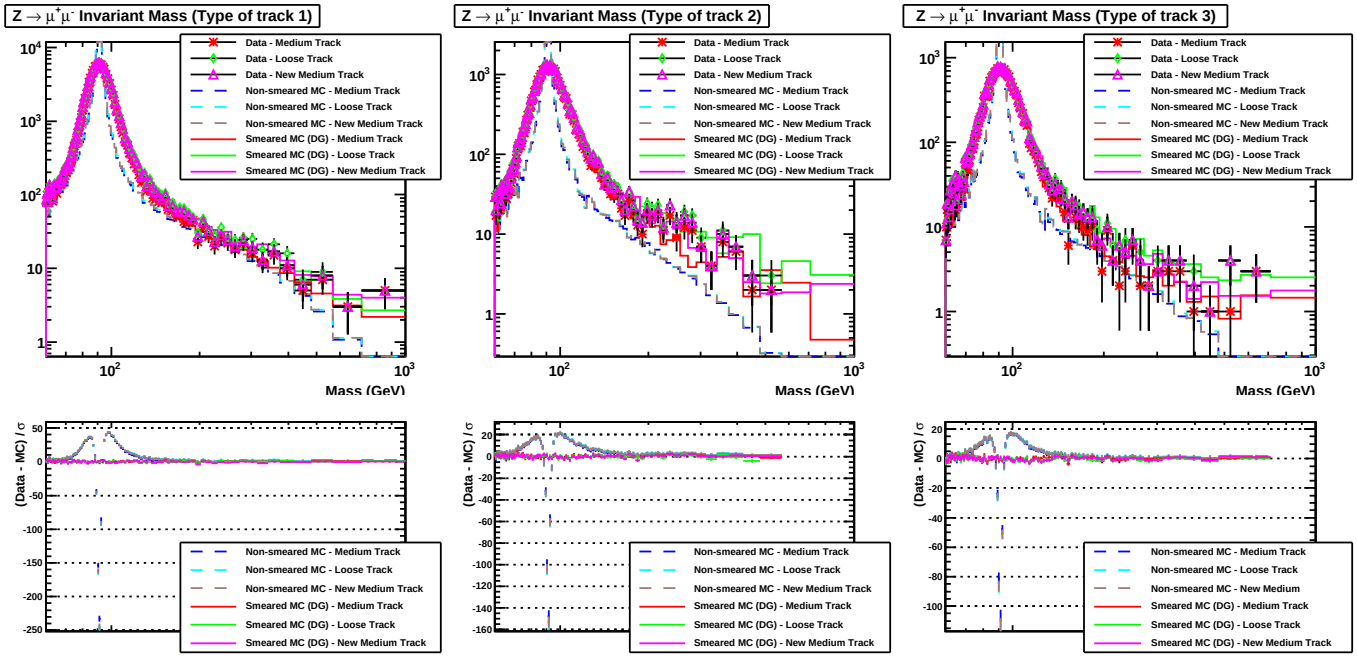

Figure 4. Data and generated MC $Z/\gamma^* \to \mu^+\mu^-$ invariant mass distribution (figures on the top) and $(Data - MC)/\sigma$ (figures on the botton) for the 3 type of tracks via Double-Gaussian in case of **Run IIb1+IIb2 data taking epoch / Run IIb2 MC**. Data (dots) is compared with non-smeared MC (dashed lines) and smearead MC (full lines), taking *Medium track*, *Loose track* and *New Medium track* qualities.

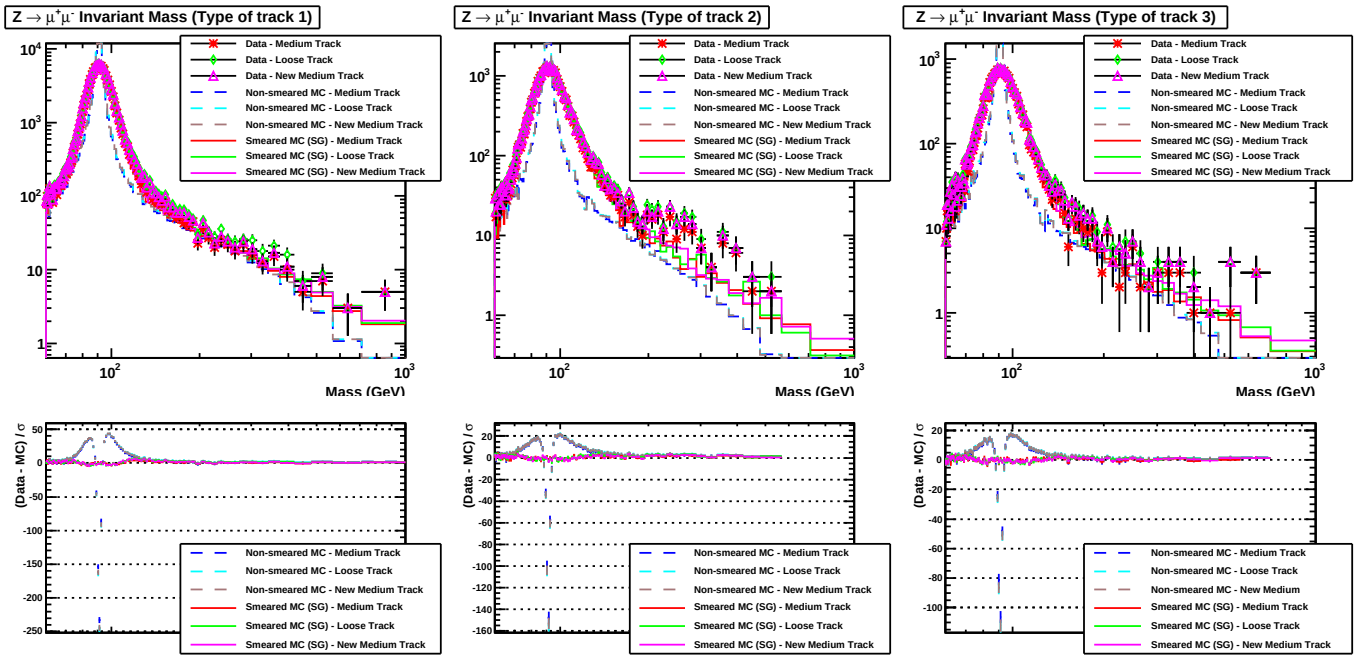

Figure 5. Data and generated MC $Z/\gamma^* \rightarrow \mu^+\mu^-$ invariant mass distribution (figures on the top) and $(Data - MC)/\sigma$ (figures on the botton) for the 3 type of tracks via Single-Gaussian in case of **Run IIb1+IIb2 data taking epoch / Run IIb2 MC**. Data (dots) is compared with non-smeared MC (dashed lines) and smearead MC (full lines), taking *Medium track*, *Loose track* and *New Medium track* qualities.

VI. CONCLUSION

The muon momentum oversmearing study for Run IIb1+IIb2 data taking epochs and Run IIb2 Monte Carlo (version p20.15) has observed a need of oversmearing transverse momentum of muons to well model Monte Carlo. Muon-oversmearing parameters are given by a Single-Gaussian only, since Run IIb2 MC requires very little oversmearing.

Muon-resolution parameters are computed by Double and Single-Gaussian. Monte Carlo events smeared by Double-Gaussian clearly results in a better data/MC agreement.

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[1] A. Croc, F. Déliot, V. Sharyy, B. Tuchming, M. Cooke, H. Greenlee, A.S. Santos, M. Vesterinen and T.R. Wyatt, *"Muon Mometum Oversmearing Update for p20 Data"* DØ Note **6031** (2010)

[2] O. Brandt, D. Hedin, A. Santos and B. Tuchming, *"Muon Mometum Oversmearing Update for Run IIa, Run IIb2 and Run IIb3 Data Taking Epochs and Monte Carlo p17 and p20"* DØ Note **6190** (2011)

[3] L. Feng and A. Santos, O. Brandt, D. Hedin, *"IIb3 and IIb4 Muon Smearing and Resolution"* DØ Note **6312** (2012)

[4] O. Brandt, S. Cho, M. Cooke, M. Eads, D. Hedin, A. Santos, B. Tuchming, Y. Yatsunenko and S. Youn, *"Muon Identifiation Certification for the Summer 2009 Extended Dataset (Run IIb-1 and -2)"* DØ Note **6025** (2010)

Appendix A: Statistical and Systematic Uncertainties for Muon-Oversmearing Parameters

All statistical and systematic uncertainties for the muon-oversmearing parameters are showed bellow considering each one of the 3 different type of muon track qualities (*Medium*, *Loose* and *New Medium*) as a central value.

1. Medium Track Selection

Tables 10 and 11 show statistical and systematic uncertainties for the muon-oversmearing parameters, in case of Type 1, 2, and 3, when *Medium* track quality is used as a central value.

		Single Gaussian	
	Statistical Uncertainty	$\mathbf{\Delta A(\times 10^{-3})}$	$\mathbf{\Delta B(\times 10^{-2})}$
Type 1	Data J/ψ	0	0
	Monte Carlo J/ψ	0.0280	0.088
	Data Z	0.0450	0.051
	Monte Carlo Z	0.0380	0.044
	Total errors	$\pm$ 0.0652	$\pm$ 0.111
Type 2	Data J/ψ	0	0
	Monte Carlo J/ψ	0.2560	0.495
	Data Z	0.3270	0.382
	Monte Carlo Z	0.2810	0.336
	Total errors	$\pm$ 0.5014	$\pm$ 0.710
Type 3	Data J/ψ	0.0170	0.058
	Monte Carlo J/ψ	0.1630	0.582
	Data Z	0.1790	0.402
	Monte Carlo Z	0.1260	0.218
	Total errors	$\pm$ 0.2734	$\pm$ 0.743

Table 10. Statistical uncertainties correspondent to **muon-oversmearing** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian, considering *Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

		Single Gaussian		
	Systematics	$\mathbf{A}(\times\mathbf{10^{-3}})$	$\mathbf{B}(\times\mathbf{10^{-2}})$	**Scale** $(\times\mathbf{10^{-2}})$
Type 1	Reference	0.8250	1.125	0.2725
	Loose muon	0.6750	1.525	0.3092
	New medium track	0.7650	1.175	0.2364
	Tight Z p_T cut (25 GeV)	0.8250	1.125	0.2389
	Tight J/ψ p_T cut (3.5 GeV)	0.8250	1.125	—
	J/ψ scale	—	—	0.3988
	Larger χ^2 range	0.7650	1.225	0.2725
	Loose track	0.8250	1.125	0.2725
	Total errors	$\pm$ 0.1723	$\pm$ 0.415	$\pm$ 0.1404
Type 2	Reference	0.2750	0.925	0.5859
	Loose muon	0.1750	1.225	0.4431
	New medium track	0.1750	0.075	0.5085
	Tight Z p_T cut (25 GeV)	0.5750	1.175	0.5765
	Tight J/ψ p_T cut (3.5 GeV)	0.3250	1.175	—
	J/ψ scale	—	—	1.3280
	Larger χ^2 range	0.0750	0.325	0.6117
	Loose track	0.2750	0.925	0.5859
	Total errors	$\pm$ 0.2750	$\pm$ 0.925	$\pm$ 0.5859
Type 3	Reference	2.0400	2.130	-0.2721
	Loose muon	1.9600	2.130	0.0010
	New medium track	2.2800	2.430	0.3233
	Tight Z p_T cut (25 GeV)	1.9600	2.130	-0.3224
	Tight J/ψ p_T cut (3.5 GeV)	1.9600	2.670	—
	J/ψ scale	—	—	0.3885
	Larger χ^2 range	1.7600	2.070	-0.2804
	Loose track	2.0400	2.130	-0.2721
	Total errors	$\pm$ 0.3939	$\pm$ 0.620	$\pm$ 0.2721

Table 11. Systematic uncertainties correspondent to **muon-oversmearing** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian, considering *Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

2. Loose Track Selection

Tables 12 and 13 show statistical and systematic uncertainties for the muon-oversmearing parameters, in case of Type 1, 2, and 3, when *Loose* track quality is used as a central value.

		Single Gaussian	
	Statistical Uncertainty	$\mathbf{\Delta A(\times 10^{-3})}$	$\mathbf{\Delta B(\times 10^{-2})}$
Type 1	Data J/ψ	0.0020	0.003
	Monte Carlo J/ψ	0.0550	0.141
	Data Z	0.0590	0.074
	Monte Carlo Z	0.0500	0.070
	Total errors	$\pm\, 0.0949$	$\pm\, 0.175$
Type 2	Data J/ψ	0	0
	Monte Carlo J/ψ	0.1670	0.457
	Data Z	0.1770	0.321
	Monte Carlo Z	0.1540	0.275
	Total errors	$\pm\, 0.2879$	$\pm\, 0.623$
Type 3	Data J/ψ	0	0.004
	Monte Carlo J/ψ	0.0930	0.292
	Data Z	0.2040	0.089
	Monte Carlo Z	0.1100	0.056
	Total errors	$\pm\, 0.2497$	$\pm\, 0.310$

Table 12. Statistical uncertainties correspondent to **muon-oversmearing** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian, considering *Loose Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

		Single Gaussian		
	Systematics	$\mathbf{A}(\times\mathbf{10^{-3}})$	$\mathbf{B}(\times\mathbf{10^{-2}})$	**Scale** $(\times\mathbf{10^{-2}})$
Type 1	Reference	0.7950	1.425	0.2941
	Loose muon	0.7350	1.475	0.2740
	New medium track	0.7950	1.225	0.2596
	Tight Z p_T cut (25 GeV)	0.7950	1.375	0.2815
	Tight J/ψ p_T cut (3.5 GeV)	0.7950	1.425	—
	J/ψ scale	—	—	0.4190
	Larger χ^2 range	0.7950	1.425	0.2993
	Medium track	0.7950	1.425	0.2941
	Total errors	$\pm$ 0.0600	$\pm$ 0.212	$\pm$ 0.1318
Type 2	Reference	0.2750	1.175	0.5427
	Loose muon	0.5250	0.725	0.5417
	New medium track	0.8750	0.625	0.4628
	Tight Z p_T cut (25 GeV)	0.0250	1.025	0.4826
	Tight J/ψ p_T cut (3.5 GeV)	0.2750	1.175	—
	J/ψ scale	—	—	1.1929
	Larger χ^2 range	0.2250	1.175	0.4126
	Medium track	0.2750	1.175	0.5427
	Total errors	$\pm$ 0.2750	$\pm$ 0.726	$\pm$ 0.5427
Type 3	Reference	2.2800	1.710	-0.2678
	Loose muon	2.0400	2.790	-0.3512
	New medium track	2.0800	1.830	0.1679
	Tight Z p_T cut (25 GeV)	2.3200	1.710	-0.4315
	Tight J/ψ p_T cut (3.5 GeV)	2.0800	1.830	—
	J/ψ scale	—	—	0.7111
	Larger χ^2 range	2.3200	1.710	-0.2529
	Medium track	2.2800	1.710	-0.2678
	Total errors	$\pm$ 0.3752	$\pm$ 1.093	$\pm$ 0.2678

Table 13. Systematic uncertainties correspondent to **muon-oversmearing** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian, considering *Loose Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

3. New Medium Track Selection

Tables 14 and 15 show statistical and systematic uncertainties for the muon-oversmearing parameters, in case of Type 1, 2, and 3, when *New Medium* track quality is used as a central value.

		Single Gaussian	
	Statistical Uncertainty	$\mathbf{\Delta A(\times 10^{-3})}$	$\mathbf{\Delta B(\times 10^{-2})}$
Type 1	Data J/ψ	0	0.072
	Monte Carlo J/ψ	0.0340	0.170
	Data Z	0.0370	0.096
	Monte Carlo Z	0.0320	0.090
	Total errors	$\pm\, 0.0595$	$\pm\, 0.227$
Type 2	Data J/ψ	0.0090	0.093
	Monte Carlo J/ψ	0.1020	0.511
	Data Z	0.1520	0.457
	Monte Carlo Z	0.1240	0.442
	Total errors	$\pm\, 0.2212$	$\pm\, 0.821$
Type 3	Data J/ψ	0.0270	0.022
	Monte Carlo J/ψ	0.0760	0.331
	Data Z	0.1390	0.136
	Monte Carlo Z	0.0780	0.073
	Total errors	$\pm\, 0.1786$	$\pm\, 0.366$

Table 14. Statistical uncertainties correspondent to **muon-oversmearing** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian, considering *New Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

		Single Gaussian		
	Systematics	$\mathbf{A}(\times\mathbf{10^{-3}})$	$\mathbf{B}(\times\mathbf{10^{-2}})$	**Scale** $(\times\mathbf{10^{-2}})$
Type 1	Reference	0.8250	1.375	0.2779
	Loose muon	0.7350	1.425	0.2779
	Medium track	0.7650	1.075	0.2414
	Tight Z p_T cut (25 GeV)	0.8250	1.475	0.2761
	Tight J/ψ p_T cut (3.5 GeV)	0.8250	1.475	—
	J/ψ scale	—	—	0.4380
	Larger χ^2 range	0.8550	1.225	0.2829
	Loose track	0.8250	1.375	0.2779
	Total errors	$\pm$ 0.1122	$\pm$ 0.367	$\pm$ 0.1642
Type 2	Reference	0.2750	1.325	0.4565
	Loose muon	0.2250	1.275	0.5115
	Medium track	0.5750	0.975	0.4590
	Tight Z p_T cut (25 GeV)	0.5750	1.125	0.4753
	Tight J/ψ p_T cut (3.5 GeV)	0.3750	0.175	—
	J/ψ scale	—	—	0.9013
	Larger χ^2 range	0.3750	1.075	0.3993
	Loose track	0.2750	1.325	0.4565
	Total errors	$\pm$ 0.2750	$\pm$ 1.244	$\pm$ 0.4522
Type 3	Reference	2.2000	1.350	-0.1664
	Loose muon	2.0800	2.190	-0.0066
	Medium track	2.0400	1.710	0.2389
	Tight Z p_T cut (25 GeV)	2.0800	1.410	-0.5052
	Tight J/ψ p_T cut (3.5 GeV)	2.1200	3.150	—
	J/ψ scale	—	—	0.6521
	Larger χ^2 range	2.2400	1.290	-0.1103
	Loose track	2.2000	1.350	-0.1664
	Total errors	$\pm$ 0.2497	$\pm$ 1.350	$\pm$ 0.1664

Table 15. Systematic uncertainties correspondent to **muon-oversmearing** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Single-Gaussian, considering *New Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

Appendix B: Statistical and Systematic Uncertainties for Muon-Resolution Parameters

All statistical and systematic uncertainties for the muon-resolution parameters are showed bellow considering each one of the 3 different type of muon track qualities (*Medium*, *Loose* and *New Medium*) as a central value.

1. Medium Track Selection

Tables 16 and 17 show statistical and systematic uncertainties for the muon-resolution parameters, in case of Type 1, 2, and 3, when *Medium* track quality is used as a central value.

		Double Gaussian				**Single Gaussian**	
	Statistical Uncertainty	$\mathbf{\Delta A}(\times\mathbf{10^{-3}})$	$\mathbf{\Delta B}(\times\mathbf{10^{-2}})$	$\mathbf{\Delta C}(\times\mathbf{10^{-2}})$	$\mathbf{\Delta D}(\times\mathbf{10^{-3}})$	$\mathbf{\Delta A}(\times\mathbf{10^{-3}})$	$\mathbf{\Delta B}(\times\mathbf{10^{-2}})$
Type 1	Data J/ψ	0	0.007	—	—	0	0
	Monte Carlo J/ψ	0	0.053	—	—	0.0270	0.064
	Data Z	0.0220	0.035	1.12	0.2	0.0370	0.011
	Monte Carlo Z	0.0130	0.030	0.85	0.1	0.0340	0.010
	Total errors	$\pm$ 0.0255	$\pm$ 0.071	$\pm$ 1.41	$\pm$ 0.2	$\pm$ 0.0570	$\pm$ 0.066
Type 2	Data J/ψ	0.0050	0.045	—	—	0	0
	Monte Carlo J/ψ	0.0880	0.361	—	—	0.0500	0.191
	Data Z	0.0800	0.346	1.33	1.6	0.0550	0.131
	Monte Carlo Z	0.0780	0.342	1.61	3.4	0.0470	0.115
	Total errors	$\pm$ 0.1423	$\pm$ 0.608	$\pm$ 2.09	$\pm$ 3.8	$\pm$ 0.0879	$\pm$ 0.259
Type 3	Data J/ψ	0.0510	0.250	—	—	0	0
	Monte Carlo J/ψ	0.1010	0.424	—	—	0.0720	0.504
	Data Z	0.1300	0.319	2.29	7.3	0.0620	0.244
	Monte Carlo Z	0.1080	0.301	1.68	7.2	0.0220	0.140
	Total errors	$\pm$ 0.2033	$\pm$ 0.659	$\pm$ 2.84	$\pm$ 10.3	$\pm$ 0.0975	$\pm$ 0.577

Table 16. Statistical uncertainties correspondent to **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Double-Gaussian and Single-Gaussian, considering *Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

		Double Gaussian					Single Gaussian		
	Systematics	**A**$(\times 10^{-3})$	**B**$(\times 10^{-2})$	**C**$(\times 10^{-2})$	**D**$(\times 10^{-3})$	**Scale** $(\times 10^{-2})$	**A**$(\times 10^{-3})$	**B**$(\times 10^{-2})$	**Scale** $(\times 10^{-2})$
Type 1	Reference	2.0600	2.240	8.85	5.1	0.3933	2.3000	2.240	0.4742
	Loose muon	2.0600	2.400	7.35	5.7	0.4687	2.2200	2.400	0.5323
	New medium track	2.1400	2.320	11.55	5.1	0.4150	2.3000	2.480	0.4633
	Tight Z p_T cut (25 GeV)	2.0600	2.160	8.85	5.1	0.2583	2.2200	2.240	0.3242
	Tight J/ψ p_T cut (3.5 GeV)	2.0600	2.320	—	—	—	2.3000	2.240	—
	J/ψ scale	—	—	—	—	0.5110	—	—	0.5136
	Larger χ^2 range	2.2200	2.240	3.15	6.9	0.4224	2.3000	2.240	0.4403
	Loose track	2.0600	2.240	8.85	5.1	0.3933	2.3000	2.240	0.4742
	Total errors	$\pm$ 0.1788	$\pm$ 0.211	$\pm$ 6.48	$\pm$ 1.8	$\pm$ 0.1977	$\pm$ 0.1131	$\pm$ 0.288	$\pm$ 0.1694
Type 2	Reference	2.5400	2.000	7.90	7.7	0.8240	2.6200	2.240	0.8529
	Loose muon	2.7000	2.240	9.90	4.7	0.9658	2.7000	2.480	0.9056
	New medium track	2.6200	2.400	9.70	7.2	0.8800	2.7800	2.080	0.8083
	Tight Z p_T cut (25 GeV)	2.3000	2.720	4.90	21.7	-0.1854	2.3800	2.720	-0.3148
	Tight J/ψ p_T cut (3.5 GeV)	2.5400	2.240	—	—	—	2.6200	2.160	—
	J/ψ scale	—	—	—	—	0.9112	—	—	0.8081
	Larger χ^2 range	2.6200	2.000	4.90	9.7	0.8775	2.7000	2.080	0.8959
	Loose track	2.5400	2.000	7.90	7.7	0.8240	2.6200	2.240	0.8529
	Total errors	$\pm$ 0.3098	$\pm$ 0.890	$\pm$ 5.02	$\pm$ 7.7	$\pm$ 0.8240	$\pm$ 0.3098	$\pm$ 0.587	$\pm$ 0.8529
Type 3	Reference	3.6600	2.300	2.55	12.2	0.0834	3.6600	3.300	0.2280
	Loose muon	3.6600	2.900	8.25	6.2	0.3391	3.8200	2.700	0.3476
	New medium track	3.9000	2.500	4.95	15.7	0.5128	3.9000	2.700	0.4138
	Tight Z p_T cut (25 GeV)	3.8200	2.500	2.55	12.2	-0.8545	3.6600	2.500	-0.7123
	Tight J/ψ p_T cut (3.5 GeV)	3.6600	2.300	—	—	—	3.6600	2.700	—
	J/ψ scale	—	—	—	—	0.5617	—	—	0.5550
	Larger χ^2 range	3.5000	3.300	12.15	6.7	0.1602	3.7400	2.300	0.2127
	Loose track	3.6600	2.300	2.55	12.2	0.0834	3.6600	3.300	0.2280
	Total errors	$\pm$ 0.3298	$\pm$ 1.200	$\pm$ 2.55	$\pm$ 8.8	$\pm$ 0.0834	$\pm$ 0.2993	$\pm$ 1.649	$\pm$ 0.2280

Table 17. Systematic uncertainties correspondent to **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Double-Gaussian and Single-Gaussian, considering *Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

2. Loose Track Selection

Tables 18 and 19 show statistical and systematic uncertainties for the muon-resolution parameters, in case of Type 1,2, and 3, when *Loose* track quality is used as a central value.

		Double Gaussian				Single Gaussian	
	Statistical Uncertainty	$\mathbf{\Delta A(\times 10^{-3})}$	$\mathbf{\Delta B(\times 10^{-2})}$	$\mathbf{\Delta C(\times 10^{-2})}$	$\mathbf{\Delta D(\times 10^{-3})}$	$\mathbf{\Delta A(\times 10^{-3})}$	$\mathbf{\Delta B(\times 10^{-2})}$
Type 1	Data J/ψ	0	0	—	—	0	0
	Monte Carlo J/ψ	0	0.058	—	—	0	0.055
	Data Z	0.0170	0.013	0.27	0.1	0.0060	0.007
	Monte Carlo Z	0.0110	0.012	0.15	0	0	0.003
	Total errors	$\pm$ 0.0202	$\pm$ 0.061	$\pm$ 0.31	$\pm$ 0.1	$\pm$ 0.0060	$\pm$ 0.056
Type 2	Data J/ψ	0	0.028	—	—	0	0
	Monte Carlo J/ψ	0.0810	0.295	—	—	0.0710	0.365
	Data Z	0.0950	0.215	0.96	7.0	0.0690	0.217
	Monte Carlo Z	0.0880	0.202	1.15	7.3	0.0600	0.205
	Total errors	$\pm$ 0.1527	$\pm$ 0.419	$\pm$ 1.50	$\pm$ 10.1	$\pm$ 0.1157	$\pm$ 0.472
Type 3	Data J/ψ	0	0	—	—	0.0180	0.045
	Monte Carlo J/ψ	0.0480	0.277	—	—	0.0630	0.205
	Data Z	0.0920	0.153	2.20	10.2	0.0810	0.127
	Monte Carlo Z	0.0440	0.083	1.70	10.1	0.0570	0.117
	Total errors	$\pm$ 0.1127	$\pm$ 0.328	$\pm$ 2.78	$\pm$ 14.4	$\pm$ 0.1187	$\pm$ 0.272

Table 18. Statistical uncertainties correspondent to **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Double-Gaussian and Single-Gaussian, considering *Loose Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

		Double Gaussian					Single Gaussian		
	Systematics	**A**$(\times 10^{-3})$	**B**$(\times 10^{-2})$	**C**$(\times 10^{-2})$	**D**$(\times 10^{-3})$	**Scale** $(\times 10^{-2})$	**A**$(\times 10^{-3})$	**B**$(\times 10^{-2})$	**Scale** $(\times 10^{-2})$
Type 1	Reference	2.1400	2.400	6.45	6.9	0.4327	2.3000	2.480	0.5096
	Loose muon	2.0600	2.400	5.55	5.7	0.4235	2.2200	2.400	0.5101
	New medium track	2.0600	2.400	4.95	6.3	0.3919	2.2200	2.400	0.4724
	Tight Z p_T cut (25 GeV)	2.1400	2.400	6.45	6.9	0.3485	2.3000	2.400	0.3930
	Tight J/ψ p_T cut (3.5 GeV)	2.1400	2.560	—	—	—	2.3000	2.560	—
	J/ψ scale	—	—	—	—	0.4060	—	—	0.4058
	Larger χ^2 range	2.1400	2.400	6.45	6.9	0.4327	2.3000	2.480	0.5077
	Medium track	2.1400	2.400	6.45	6.9	0.4327	2.3000	2.480	0.5096
	Total errors	$\pm$ 0.1131	$\pm$ 0.160	$\pm$ 1.74	$\pm$ 1.3	$\pm$ 0.0978	$\pm$ 0.1131	$\pm$ 0.160	$\pm$ 0.1603
Type 2	Reference	2.5400	2.640	6.10	15.7	0.7566	2.6200	2.240	0.8246
	Loose muon	2.3000	2.640	2.30	23.7	0.8118	2.4600	2.720	0.7674
	New medium track	2.3000	2.720	3.50	34.7	0.7475	2.5400	2.640	0.7121
	Tight Z p_T cut (25 GeV)	2.3000	2.400	7.70	30.2	-0.3517	2.4600	2.240	-0.2901
	Tight J/ψ p_T cut (3.5 GeV)	2.6200	2.160	—	—	—	2.6200	2.240	—
	J/ψ scale	—	—	—	—	0.7717	—	—	0.6645
	Larger χ^2 range	2.5400	2.640	6.70	15.7	0.7566	2.6200	2.880	0.8252
	Medium track	2.5400	2.640	6.10	15.7	0.7566	2.6200	2.240	0.8246
	Total errors	$\pm$ 0.4233	$\pm$ 0.542	$\pm$ 4.91	$\pm$ 15.7	$\pm$ 0.7566	$\pm$ 0.2400	$\pm$ 0.894	$\pm$ 0.8246
Type 3	Reference	3.8200	2.500	7.95	8.2	0.5028	3.9800	2.900	0.3127
	Loose muon	3.5000	2.900	6.45	0.7	0.1134	3.7400	2.900	0.1793
	New medium track	3.6600	2.100	14.85	3.2	0.4147	3.7400	2.500	0.4850
	Tight Z p_T cut (25 GeV)	3.5800	2.700	4.95	25.2	-0.8529	3.6600	2.900	-0.8914
	Tight J/ψ p_T cut (3.5 GeV)	3.8200	2.700	—	—	—	3.9800	2.900	—
	J/ψ scale	—	—	—	—	0.5153	—	—	0.4429
	Larger χ^2 range	3.8200	2.500	7.95	8.2	0.4655	3.9800	2.900	0.3174
	Medium track	3.8200	2.500	7.95	8.2	0.5028	3.9800	2.900	0.3127
	Total errors	$\pm$ 0.4308	$\pm$ 0.632	$\pm$ 7.67	$\pm$ 8.2	$\pm$ 0.5028	$\pm$ 0.4664	$\pm$ 0.400	$\pm$ 0.3127

Table 19. Systematic uncertainties correspondent to **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Double-Gaussian and Single-Gaussian, considering *Loose Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

3. New Medium Track Selection

Tables 20 and 21 show statistical and systematic uncertainties for the muon-resolution parameters, in case of Type 1, 2, and 3, when *New Medium* track quality is used as a central value.

		Double Gaussian				Single Gaussian	
	Statistical Uncertainty	$\mathbf{\Delta A(\times 10^{-3})}$	$\mathbf{\Delta B(\times 10^{-2})}$	$\mathbf{\Delta C(\times 10^{-2})}$	$\mathbf{\Delta D(\times 10^{-3})}$	$\mathbf{\Delta A(\times 10^{-3})}$	$\mathbf{\Delta B(\times 10^{-2})}$
Type 1	Data J/ψ	0.0200	0.019	—	—	0	0.018
	Monte Carlo J/ψ	0.0390	0.110	—	—	0.0110	0.074
	Data Z	0.0400	0.039	0.31	0.3	0.0130	0.037
	Monte Carlo Z	0.0400	0.039	0.40	0.4	0.0050	0.036
	Total errors	$\pm$ 0.0715	$\pm$ 0.125	$\pm$ 0.51	$\pm$ 0.5	$\pm$ 0.0177	$\pm$ 0.092
Type 2	Data J/ψ	0.0050	0	—	—	0.0040	0.041
	Monte Carlo J/ψ	0.0670	0.179	—	—	0.0630	0.262
	Data Z	0.0830	0.081	1.01	9.0	0.0710	0.171
	Monte Carlo Z	0.0750	0.057	0.97	8.7	0.0620	0.164
	Total errors	$\pm$ 0.1304	$\pm$ 0.204	$\pm$ 1.40	$\pm$ 12.5	$\pm$ 0.1134	$\pm$ 0.356
Type 3	Data J/ψ	0.0240	0.061	—	—	0	0
	Monte Carlo J/ψ	0.0990	0.419	—	—	0.0840	0.382
	Data Z	0.1200	0.184	2.53	14.1	0.0670	0.037
	Monte Carlo Z	0.0990	0.179	1.69	12.8	0.0440	0
	Total errors	$\pm$ 0.1859	$\pm$ 0.496	$\pm$ 3.04	$\pm$ 19.0	$\pm$ 0.1161	$\pm$ 0.384

Table 20. Statistical uncertainties correspondent to **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Double-Gaussian and Single-Gaussian, considering *New Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.

		Double Gaussian					Single Gaussian		
	Systematics	**A**$(\times 10^{-3})$	**B**$(\times 10^{-2})$	**C**$(\times 10^{-2})$	**D**$(\times 10^{-3})$	**Scale** $(\times 10^{-2})$	**A**$(\times 10^{-3})$	**B**$(\times 10^{-2})$	**Scale** $(\times 10^{-2})$
Type 1	Reference	2.2200	2.400	4.65	7.5	0.4399	2.3000	2.400	0.5080
	Loose muon	2.0600	2.400	2.85	6.9	0.4363	2.2200	2.400	0.4816
	Medium track	2.1400	2.240	2.85	6.9	0.4192	2.2200	2.400	0.4756
	Tight Z p_T cut (25 GeV)	2.1400	2.400	5.55	6.3	0.3560	2.3000	2.400	0.4181
	Tight J/ψ p_T cut (3.5 GeV)	2.1400	2.560	—	—	—	2.3000	2.560	—
	J/ψ scale	—	—	—	—	0.3848	—	—	0.3814
	Larger χ^2 range	2.2200	2.320	4.65	7.5	0.4437	2.3800	2.400	0.5080
	Loose track	2.2200	2.400	4.65	7.5	0.4399	2.3000	2.400	0.5080
	Total errors	$\pm$ 0.2116	$\pm$ 0.240	$\pm$ 2.70	$\pm$ 1.4	$\pm$ 0.1026	$\pm$ 0.1385	$\pm$ 0.160	$\pm$ 0.1607
Type 2	Reference	2.7800	1.840	4.30	13.2	0.5167	2.7800	2.000	0.5690
	Loose muon	2.6200	2.480	2.10	28.7	0.9312	2.5400	2.880	0.8109
	Medium track	2.3800	2.960	5.90	0.7	0.9069	2.7000	2.640	0.8780
	Tight Z p_T cut (25 GeV)	2.6200	1.920	6.90	39.2	-0.2122	2.6200	1.920	-0.3257
	Tight J/ψ p_T cut (3.5 GeV)	2.3800	3.120	—	—	—	2.4600	3.120	—
	J/ψ scale	—	—	—	—	0.7856	—	—	0.6737
	Larger χ^2 range	2.7800	1.920	4.30	13.2	0.5424	2.7800	1.920	0.5423
	Loose track	2.7800	1.840	4.30	13.2	0.5167	2.7800	2.000	0.5690
	Total errors	$\pm$ 0.6092	$\pm$ 1.820	$\pm$ 3.76	$\pm$ 13.2	$\pm$ 0.5167	$\pm$ 0.4381	$\pm$ 1.565	$\pm$ 0.5690
Type 3	Reference	3.9800	3.100	4.65	0.2	0.0197	3.9800	3.100	0.0905
	Loose muon	3.7400	2.700	13.65	1.2	-0.1128	3.7400	2.700	-0.0668
	Medium track	3.6600	3.100	13.65	1.2	0.3791	3.6600	3.100	0.3280
	Tight Z p_T cut (25 GeV)	3.7400	2.700	13.65	2.2	-0.3579	3.7400	2.700	-0.3839
	Tight J/ψ p_T cut (3.5 GeV)	3.8200	2.900	—	—	—	3.9000	2.900	—
	J/ψ scale	—	—	—	—	0.2488	—	—	0.1725
	Larger χ^2 range	3.8200	2.700	3.75	10.7	0.0694	3.9800	3.100	0.0606
	Loose track	3.9800	3.100	4.65	0.2	0.0197	3.9800	3.100	0.0905
	Total errors	$\pm$ 0.5184	$\pm$ 0.721	$\pm$ 4.65	$\pm$ 0.2	$\pm$ 0.0197	$\pm$ 0.4732	$\pm$ 0.600	$\pm$ 0.0905

Table 21. Systematic uncertainties correspondent to **muon-resolution** parameters for Run IIb1+IIb2 data taking epoch and Run IIb2 MC using Double-Gaussian and Single-Gaussian, considering *New Medium Track* as selection of reference. Uncertainties are showed for the three different types of dimuon events.