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Intermediate p_T muon Identification Efficiencies with the 1 fb^{-1} dataset

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Abstract

This note describes our preliminary results from studying the muon ID efficiencies and reconstruction efficiencies. It is an update of the study in note 7197 [1]. We report efficiencies and scale factors for stubbed muons, CMUP, CMX, and BMU, in both the gen5 and gen6 data.

Contents

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1 Introduction and cuts

We look at muons in the range from 5 to 20 GeV to cover a region widely used for exotics (multi-)lepton searches. The cuts proposed are a variation of the standard high p_T muon ID cuts from the Joint Physics class. A summary of the ID cuts studied are in table 1:

ID cut	$5 < p_T < 20$ GeV	$p_T \geq 20$ GeV
CMU Stub Matching	$\lvert\Delta_{CMU}\rvert < 7$ cm or $\chi^2 < 9$	$\lvert\Delta_{CMU}\rvert < 7$ cm
CMP Stub Matching	$\lvert\Delta_{CMP}\rvert < 5$ cm or $\chi^2 < 9$	$\lvert\Delta_{CMP}\rvert < 5$ cm
CMX Stub Matching	$\lvert\Delta_{CMX}\rvert < 6$ cm or $\chi^2 < 9$	$\lvert\Delta_{CMX}\rvert < 6$ cm
EM energy	$E_{em} < 2$ GeV	$E_{em} < 2 + max(0, (p - 100) \times 0.0115)$ GeV
Had energy	$E_{had} < \frac{p_T}{8} + 3.5$ GeV	$E_{had} < 6 + max(0, (p - 100) \times 0.028)$ GeV
COT Axial Segments	>= 3 (5hits)	>= 3 (5hits)
COT Stereo Segments	>= 2 (5hits)	>= 2 (5hits)
COT χ^2	See below	same
$\lvert d_0\rvert$	if Si hits, <0.02 cm; else, <0.2 cm	same
Calorimeter Isolation TIGHT	$<0.1 \times p_T$	$<0.1\times p_T$
Calorimeter Isolation LOOSE	< 2 GeV	$<0.1\times p_T$

Table 1: *The ID cuts under study. For high p_T muons the cuts are standard but listed here for completeness.*

The two selections for low p_T isolation are due to the already existing selection in some trilepton analyses [4] [5], although we would recommend the loose cuts. All muons are required to be fiducial and all candidate muonp_T 's are beam-constrained. For CMX muons we also cut on the exit radius ($\rho > 140$ cm) of the COT. At the moment we only consider CMX muons in the arches.

1.1 COT χ^2

This variable was dropped in previous studies of the efficiency using gen5, due to a bug in the standard MC. For this study we have included the cut as standard ID cut for data but do not recommend applying it to MC. We use the cut suggested by the high p_T muon efforts [6], that is, the cut value where the average data efficiency goes above 99%:

COT χ^2/ nDoF ≤ 2.8 for gen5

COT χ^2/ nDoF ≤ 2.3 for gen6

See figure .1 for distributions. The explicit low p_T efficiencies are listed in table 2.

2 Datasets

To measure the efficiencies in data we use the muon calibration sample, triggered by the CMUP8 and CMX8 trigger paths. The dataset names are blmc0d,h,i for gen 5 and gen6[2] data, respectively. The gen 5 ntuples were made with release 5.3.1 and not all of the gen 5 data was available at the time of production. The time period missing will be visible as empty spots in the run bins. It is the plan to reprocess the gen 5 part at a later time and then the missing run periods will be recovered. We use v13 of the good run list.

The 0h and 0i data are available from the Stntuple catalogs as bexo7h and bhmuai. For technical reasons we only have a small portion of the 0i data included at this point in time.

As Monte Carlo samples to determine the scale factors we use the 5.3.3 ewk $Z\to\mu^+\mu^-$sample, zewk6m. This sample was generated with v7_1001 good run list, and extra min-bias. The run range corresponds to the 0d dataset. The gen 6 version of this MC sample, made with the 0h run range, is also used. For illustration we have also looked at a non-minbias sample, z8v2gt [7], and a sample with both min bias and a more recent good runlist, sexoat, to check the variations given the different samples used by the multilepton group.

Offline versions used are 5.3.3 and 6.1.2, with Stntuple dev_242 and dev_243.

3 Trigger bias removal

For all CMUP muon candidates we match the offline object to the CMUP8 trigger object in the L3SummaryBlock. If only one leg matches, that muon candidate is not used for the efficiency measurements. If both legs match, both are considered unbiased and kept for the efficiency measurements. In addition we also require the trigger candidate to pass the ID cuts for the ID efficiency measurements, and to be CMUP fiducial for the reconstruction efficiency measurement. The p_T spectrum for the resulting CMUP muon candidates is shown in figure .2.

CMX muons are considered unbiased in the old dataset. In the data collected after the 2004 shutdown we remove CMX trigger bias in the same way as CMUP. Our trigger path does not have BMU requirements thus the BMU's are not biased by the trigger selection.

4 Background removal

4.1 Clean-up cuts

To reduce backgrounds we apply a set of clean-up cuts before selecting muon candidates. Cosmics are rejected by timing information (`HasNotOutgoingPair()` in Stntuple

[2]Gen 5: everything up to Summer 2004 shutdown. Gen 6 is 2005 data and later.

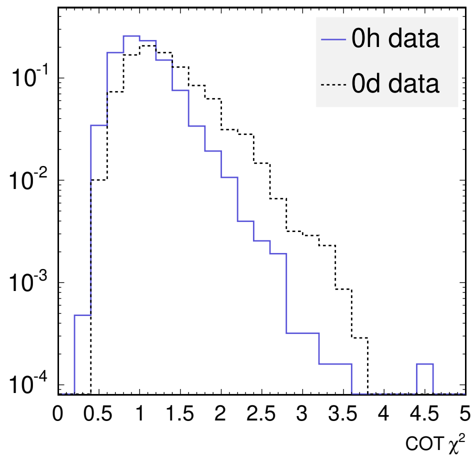

Figure .1: *COT χ^2 for gen 5 and 6 data*

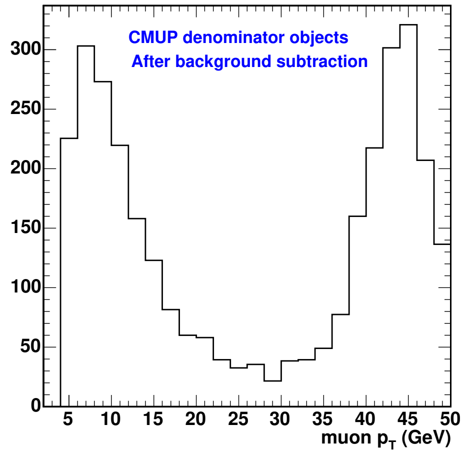

Figure .2: *p_T spectrum of CMUP denominator objects.*

), and by applying a dedicated cut on the acollinearity of events. As shown in figure 13 in [5] this latter cut is necessary in the older generations of 5.3 Stntuples. We require that the acollinearity is ≤ 3.1 radians.

We also require that $|z_0|$ <60 cm and that the the trigger muon candidates and the probe muon are back to back, ($\Delta\phi \geq 160$ degrees), $m_{\mu\mu} \geq 12$ GeV, and that the corrected $\not\!\!E_T \leq 10$ GeV to further reduce backgrounds.

4.2 Subtracting background

To cover a continuous p_T spectrum we decided to abandon the previously used method of selecting muon candidates in the J/ψ, Υ, and Z mass windows, and instead make a selection to target the full mass range Drell Yan. This also has the additional benefit that our denominator objects are presumably already prompt and isolated muons and therefore we can apply the isolation as a standard ID cut. Not having access to sidebands with the DY selection we use the SS events to estimate the backgrounds. However, the asymmetry between SS and OS fakes would cause us to underestimate the background at low p_T when only subtracting SS events. We estimate the same-sign to opposite-sign scaling k by computing the scaling factor for non-isolated muons (iso/p_T >0.2 for the tight iso and iso> 4 GeV otherwise). For CMUP we find a scaling factor of 1.7/2.0 in the different datasets for low pt, tight isolation, and 1.5 for the loose isolation. CMX has the same scaling for the loose isolation, and 1.7 for the tight. We also checked the scaling by estimating the OS background in the J/ψ, Υ, and Z mass peaks from looking at the events in the sidebands. We then get our scaling factor as the #OS events in the sidebands divided by the #SS events in the signal mass window. The statistical uncertainty on the scaling is very large with this method but gives values between 1.4 and 2.2, thus consistent with the other method.

We will assign a systematic to account for the variations in this important scaling factor. This factor is in principle pt dependent but as the background subtraction is only important at low pt we have ignored this variation.

The composition of OS and SS pairs in our dimuon candidate events (rejecting the Υ and J/ψ mass peaks) are shown in figure .3.

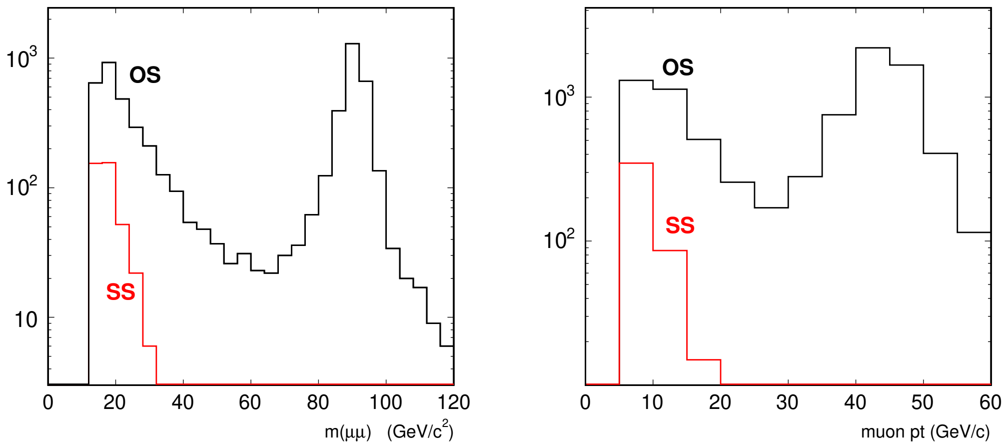

Figure .3: *Left: the mass spectrum for OS and SS muon pairs. On the right is the OS to SS ratio in p_T bins.*

Defining:

$$N_{OS/SS} = \#\text{unbiased muons from an OS/SS pair}$$

$$N^P_{OS/SS} = \#\text{unbiased muons from an OS/SS pair that pass ID cuts}$$

$N^{N-1}_{OS/SS}$ = # unbiased muons from an OS/SS pair that pass N-1 ID cuts but not necessarily cut N,

$$Total\ ID\ \varepsilon = \frac{N^P_{OS} - k \times N^P_{SS}}{N_{OS} - k \times N_{SS}}$$

and for individual cuts ("N-1" efficiencies):

$$\varepsilon_N = \frac{N^P_{OS} - k \times N^P_{SS}}{N^{N-1}_{OS} - k \times N^{N-1}_{SS}}$$

For the reconstruction efficiencies we look at muons that are fiducial for the category (CMX or CMUP) and check if they have stubs. In this case we also require the denominator muons to pass all the calorimeter and tracking ID cuts. (indicated by P').

$$Reco\ \varepsilon = \frac{N^{P'}_{OS}\text{ that have stub(s)} - k \times N^{P'}_{SS}\text{ that have stub(s)}}{N^{P'}_{OS} - k \times N^{P'}_{SS}}$$

5 Efficiency results

The efficiency results for low p_T data are reported in tables 2 to table 4 for the 3 datasets. Bear in mind that we only have a small subset of the 0i dataset filtered, therefore the statistics is low. There is not much information for the 0i yet but we include it to show that there is no sign of inconsistency between the 0h and 0i data.

The total efficiencies are illustrated in figures .4 to .6. Notice that the only cut with significant time dependence is the isolation cut, and also that the efficiciencies for the other ID cuts are almost independent of the isolation cut. This will ease studies of other isolation criteria.

5.1 Gen 5 Data (0d)

	iso $\leq$ 2 GeV		iso $\leq 0.1{\times}p_T$	
	CMUP	CMX	CMUP	CMX
EM energy	0.993 ± 0.003	0.993 ± 0.006	0.995 ± 0.003	0.996 ± 0.006
Had energy	0.995 ± 0.003	0.984 ± 0.007	0.998 ± 0.003	0.997 ± 0.008
COT χ^2	0.990 ± 0.003	0.995 ± 0.003	0.991 ± 0.004	0.994 ± 0.005
nStSeg	1.0 ± 0.001	1.0 ± 0.001	1.0 ± 0.001	1.0 ± 0.0004
nAxSeg	1.0 ± 0.001	0.989 ± 0.005	1.0 ± 0.001	0.993 ± 0.004
d0	0.992 ± 0.005	0.992 ± 0.008	0.992 ± 0.003	1.00 ± 0.005
Stub matching	0.988 ± 0.004	0.984 ± 0.006	0.982 ± 0.004	0.997 ± 0.004
Isolation	0.911 ± 0.012	0.871 ± 0.019	0.812 ± 0.012	0.755 ± 0.019
Total ID	0.863 ± 0.013	0.852 ± 0.024	0.777 ± 0.012	0.795 ± 0.023
Reconstruction	0.914 ± 0.010	0.973 ± 0.009	0.915 ± 0.010	0.973 ± 0.009

Table 2: *Individual ID efficiencies for $p_T \leq$ 20 GeV for (part of) the 0d dataset*

5.2 Gen 6 Data (0h)

	iso $\leq$ 2 GeV		iso $\leq 0.1 \times p_T$	
	CMUP	CMX	CMUP	CMX
EM energy	0.994 ± 0.002	0.992 ± 0.003	0.996 ± 0.002	1.0 ± 0.004
Had energy	0.993 ± 0.002	0.986 ± 0.005	0.995 ± 002	0.983 ± 0.005
COT χ^2	0.993 ± 0.002	0.988 ± 0.003	0.996 ± 0.002	0.991 ± 0.004
nStSeg	1.0 ± 0.001	1.0 ± 0.001	1.0 ± 0.001	1.0 ± 0.001
nAxSeg	1.0 ± 0.001	0.996 ± 0.002	1.0 ± 0.0001	0.996 ± 0.003
d0	0.993 ± 0.005	0.986 ± 0.008	0.994 ± 0.004	0.996 ± 0.006
Stub matching	0.986 ± 0.003	0.989 ± 0.004	0.987 ± 0.003	0.994 ± 0.005
Isolation	0.850 ± 0.009	0.8849 ± 0.017	0.708 ± 0.009	0.759 ± 0.016
Total ID	0.817 ± 0.010	0.850 ± 0.018	0.714 ± 0.010	0.718 ± 0.016
Reconstruction	0.914 ± 0.009	0.962 ± 0.009	0.916 ± 0.009	0.962 ± 0.009

Table 3: *Individual ID efficiencies for $p_T \leq 20$ GeV for gen 6 data. (0h only).*

5.3 Gen 6 Data (0i)

	iso $\leq$ 2 GeV	
	CMUP	CMX
EM energy	0.99 ± 0.01	0.99 ± 0.01
Had energy	0.99 ± 0.01	0.99 ± 0.01
COT χ^2	1.0 ± 0.005	0.97 ± 0.02
nStSeg	1.0 ± 0.005	1.0 ± 0.01
nAxSeg	1.0 ± 0.005	1.0 ± 0.01
d0	0.99 ± 0.01	0.98 ± 0.01
Stub matching	0.99 ± 0.01	0.99 ± 0.02
Isolation	0.90 ± 0.03	0.93 ± 0.05
Total ID	0.83 ± 0.03	0.87 ± 0.05
Reconstruction	0.91 ± 0.02	0.98 ± 0.02

Table 4: *Individual ID efficiencies for $p_T \leq 20$ GeV for gen 6 data. (0i only).*

5.4 Monte Carlo efficiencies and scale factors

Tables 5 and 6 show the efficiencies for two DY Monte carlo samples. We remind the reader that the run range for the gen 5 zewk6m is runs 141572 - 186598 and for the gen 6 version runs 190753 - 203799. If not specified, the gen 5 version is assumed.

The scale factors depends on the MC sample used, and table 12 has some more examples. We also notice that there is some p_T dependence of the reconstruction efficiencies but the effect is also seen in the MC and the resulting scale factor is flat within the uncertainties in p_T . Thus, the already blessed high p_T scale factors can be used throughout.

The ID efficiencies on the other hand are strongly p_T dependent. This is mainly caused by the isolation and EM energy cuts.

5.4.1 Gen 5 zewk6m

	iso $\leq$ 2 GeV		iso $\leq 0.1\times p_T$	
	CMUP	CMX	CMUP	CMX
EM energy	0.9826 ± 0.0006	0.9807 ± 0.0008	0.9835 ± 0.0006	0.9818 ± 0.0008
Had energy	0.9932 ± 0.0004	0.9849 ± 0.0007	0.9933 ± 0.0004	0.9851 ± 0.0008
nStSeg	$1.000 \pm 2 \cdot 10^{-5}$	$1.000 \pm 5 \cdot 10^{-5}$	$1.000 \pm 2 \cdot 10^{-5}$	$1.000 \pm 4 \cdot 10^{-5}$
nAxSeg	$1.000 \pm 2 \cdot 10^{-5}$	0.9963 ± 0.0004	$1.000 \pm 2 \cdot 10^{-5}$	0.9966 ± 0.0004
d0	0.9978 ± 0.0002	0.9977 ± 0.0003	0.9980 ± 0.0002	0.9976 ± 0.0003
Stub matching	0.9818 ± 0.0006	0.9915 ± 0.0005	0.9814 ± 0.0006	0.9916 ± 0.0006
Isolation	0.9380 ± 0.0010	0.9449 ± 0.0012	0.8610 ± 0.0013	0.8717 ± 0.0017
Total ID	0.8946 ± 0.0011	0.8960 ± 0.0015	0.8214 ± 0.0013	0.8267 ± 0.0018
Reconstruction	0.9632 ± 0.0007	0.9878 ± 0.0006	same	same
ID SF 0d data	0.965 ± 0.015	0.951 ± 0.027	0.946 ± 0.015	0.962 ± 0.028
ID SF 0h data	0.945 ± 0.009	0.949 ± 0.020	0.869 ± 0.012	0.869 ± 0.019

Table 5: *Individual ID MC efficiencies for $p_T \leq$ 20 GeV and the scalefactors to the data.*

5.4.2 Gen 6 zewk6m

	iso ≤ 2 GeV		iso $\leq 0.1 \times p_T$	
	CMUP	CMX	CMUP	CMX
EM energy	0.9825 ± 0.0006	0.9818 ± 0.0007	0.9834 ± 0.0006	0.9833 ± 0.0007
Had energy	0.9930 ± 0.0004	0.9867 ± 0.0006	0.9931 ± 0.0004	0.9867 ± 0.0007
nStSeg	1.0 ± 10^{-5}	$1.000 \pm 3 \cdot 10^{-5}$	1.0 ± 10^{-5}	$1.000 \pm 3 \cdot 10^{-5}$
nAxSeg	$1.000 \pm 3 \cdot 10^{-5}$	0.9971 ± 0.0003	$1.000 \pm 4 \cdot 10^{-5}$	0.9971 ± 0.0003
d0	0.9960 ± 0.0003	0.9968 ± 0.0003	0.9962 ± 0.0003	0.9968 ± 0.0003
Stub matching	0.9819 ± 0.0006	0.9917 ± 0.0005	0.9820 ± 0.0006	0.9917 ± 0.0005
Isolation	0.9296 ± 0.0011	0.9399 ± 0.0012	0.8614 ± 0.0014	0.8676 ± 0.0016
Total ID	0.8848 ± 0.0013	0.8938 ± 0.0014	0.8203 ± 0.0014	0.8253 ± 0.0017
Reconstruction	0.9531 ± 0.0008	0.9785 ± 0.0007	same	same
ID SF 0h	0.923 ± 0.011	0.951 ± 0.020	0.870 ± 0.012	0.870 ± 0.019
ID SF 0i	to come		n/a	

Table 6: *Individual ID MC efficiencies for $p_T \leq 20$ GeV and the scalefactors.*

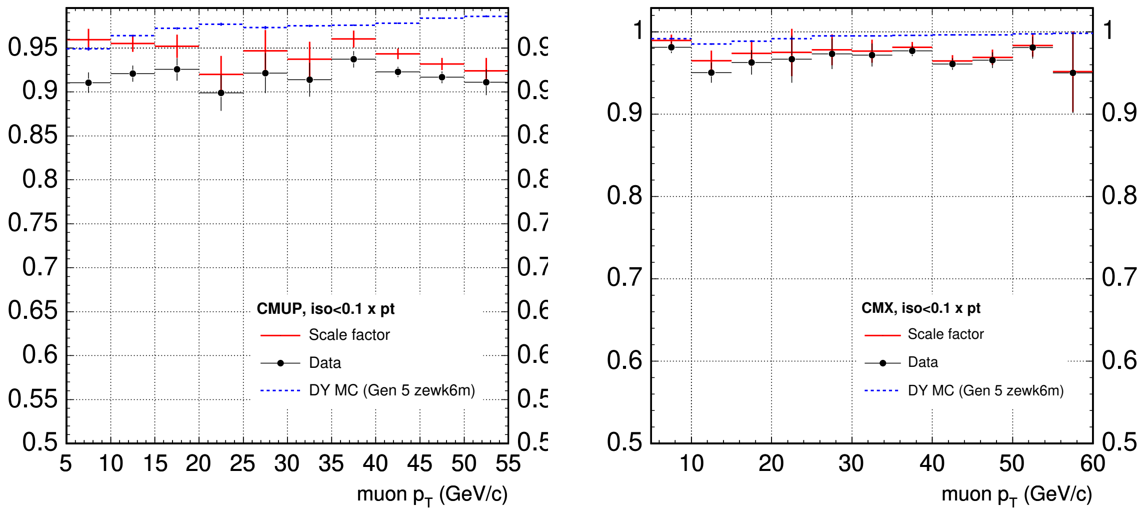

Figure .4: *Reconstruction efficiency with the gen 5 sample*

5.5 Further studies

On the following pages we show a set of plots with various dependencies for the efficiencies. To increase the statistics in the plots, the full DY p_T spectrum is included, and the 0d and 0h datasets are combined.

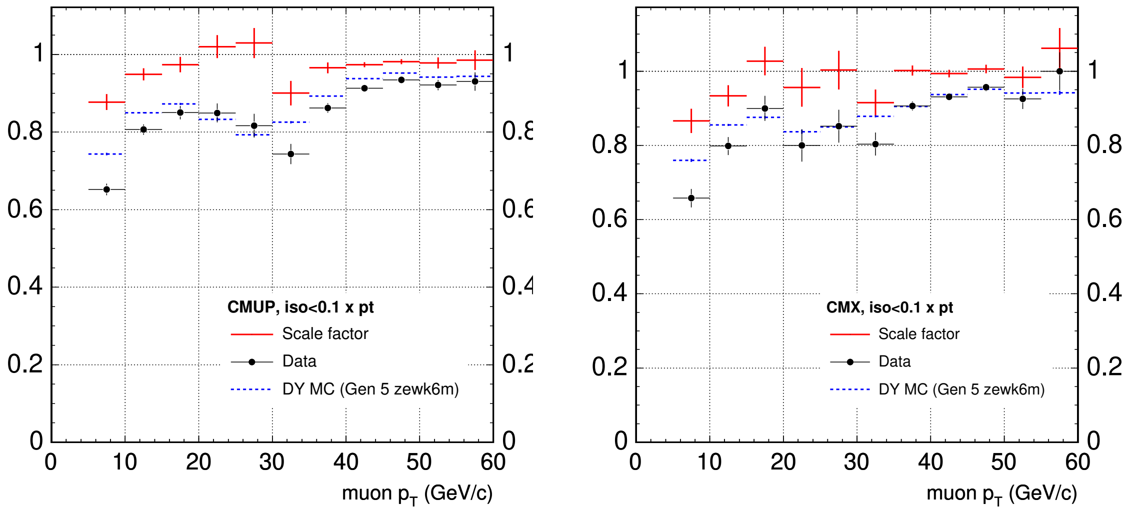

Figure .5: *ID scalefactor with the tight calorimeter isolation cut. (gen 5 MC sample)*

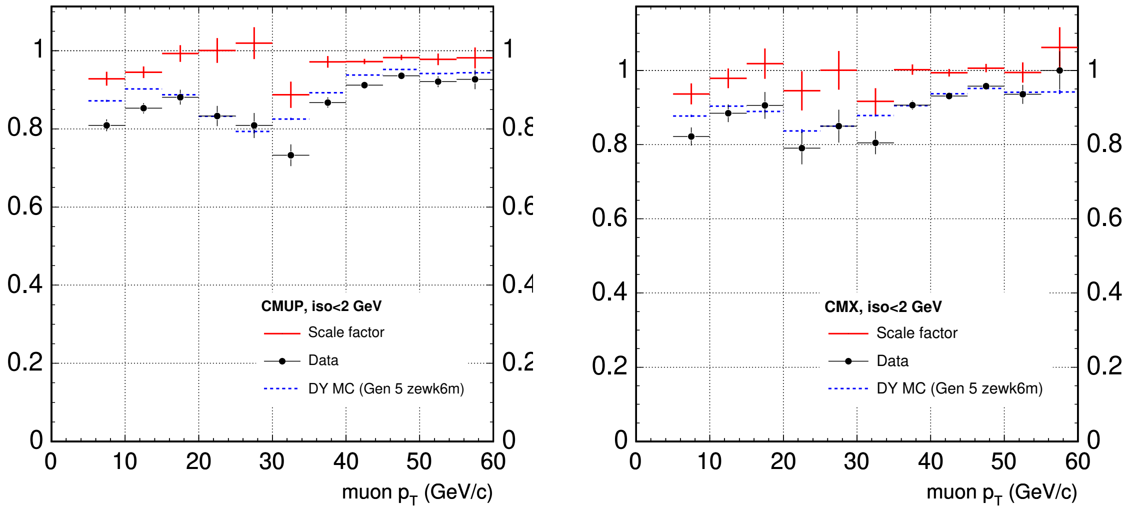

Figure .6: *Same with the loose calorimeter isolation cut. (gen 5 MC sample)*

For the MC we simply show the behavior of each sample separately.

6 Cross checks and systematics

It has been noted many times and in other notes that the isolation and maximum EM energy cut are very p_T dependent. This effect is believed to be essentially understood as radiation off muons, causing extra energy in the calorimeters. This happens for all p_T values but the radiative muons composite a much larger fraction of the total

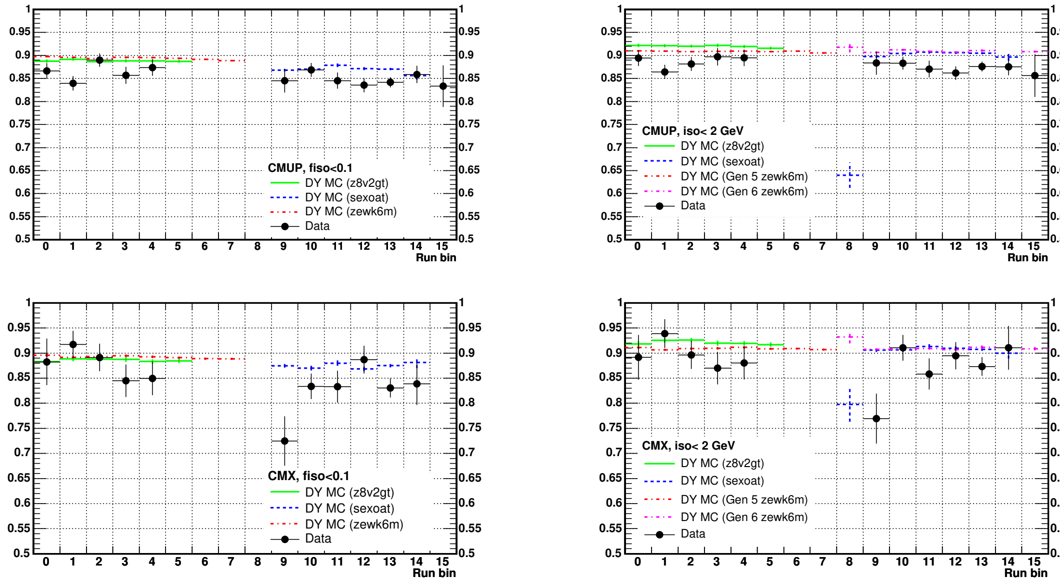

Figure .7: *Run dependence for data and various MC samples, with the tight calorimeter isolation cut left, and loose, right. We use the run binning defined at http://www-cdf.fnal.gov/internal/people/links/MonicaDOnofrio/runranges/run_ranges.html*

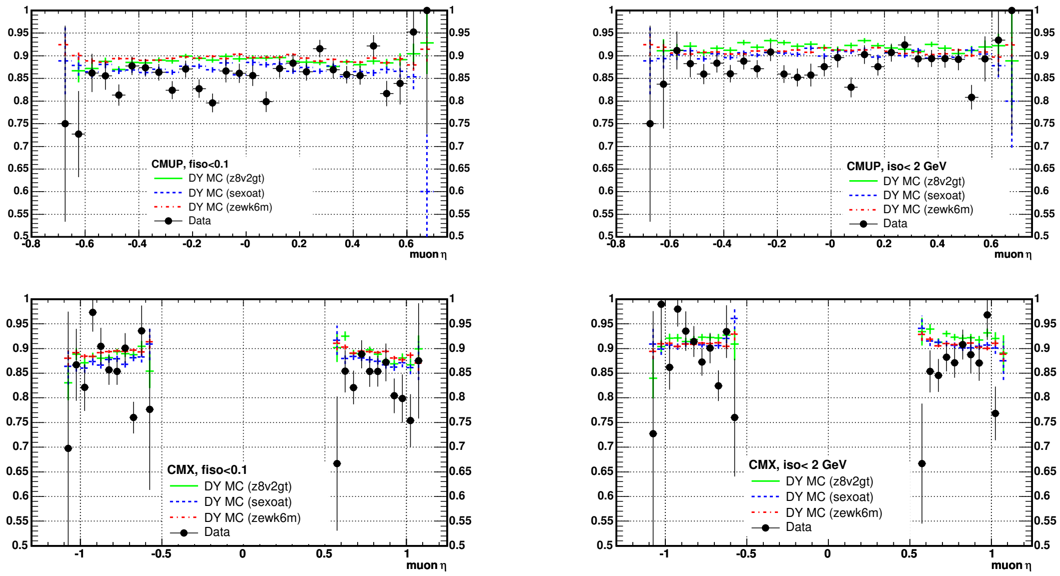

Figure .8: *η dependence.*

$Z^0 \to \mu^+\mu^-$between 20 and 30 GeV. See section 4.2 in [1] for plots and more details. As it can be seen from the plots, our MC attempts to describe this effect and does

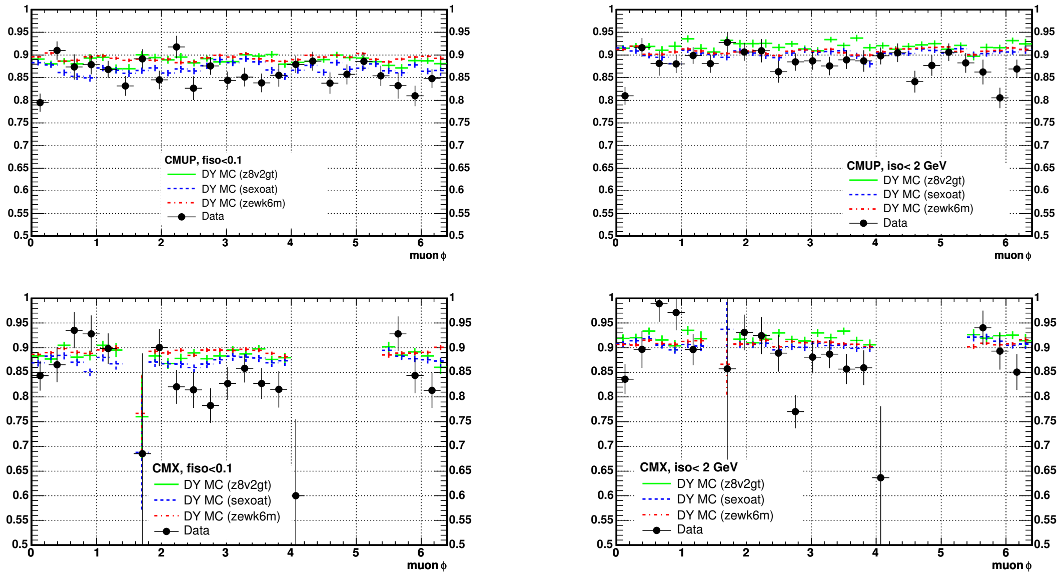

Figure .9: *ϕ dependence.*

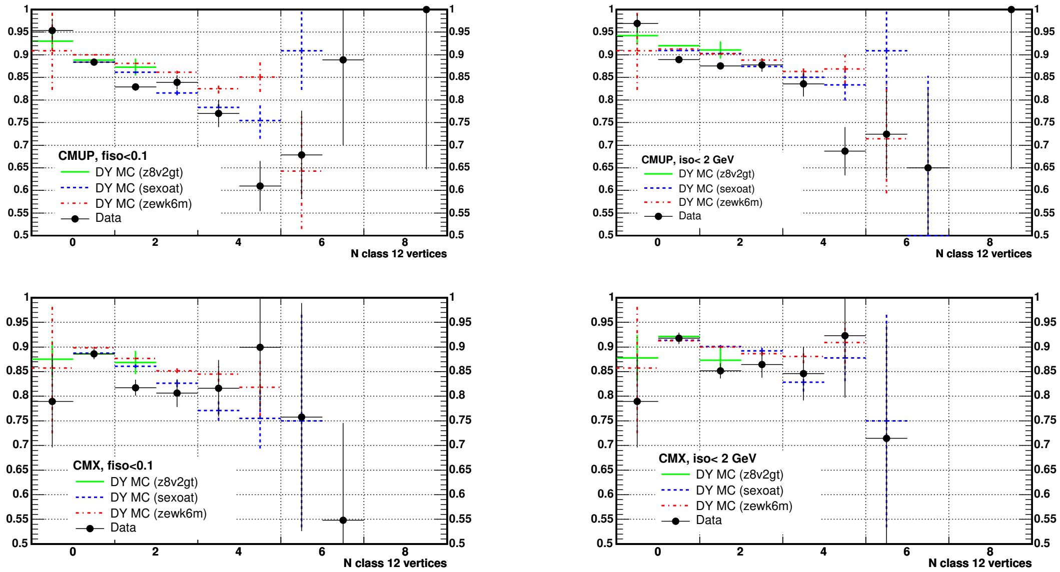

Figure .10: *vertex dependence.*

fairly well given the uncertainties.It is also visible in the mass plots.

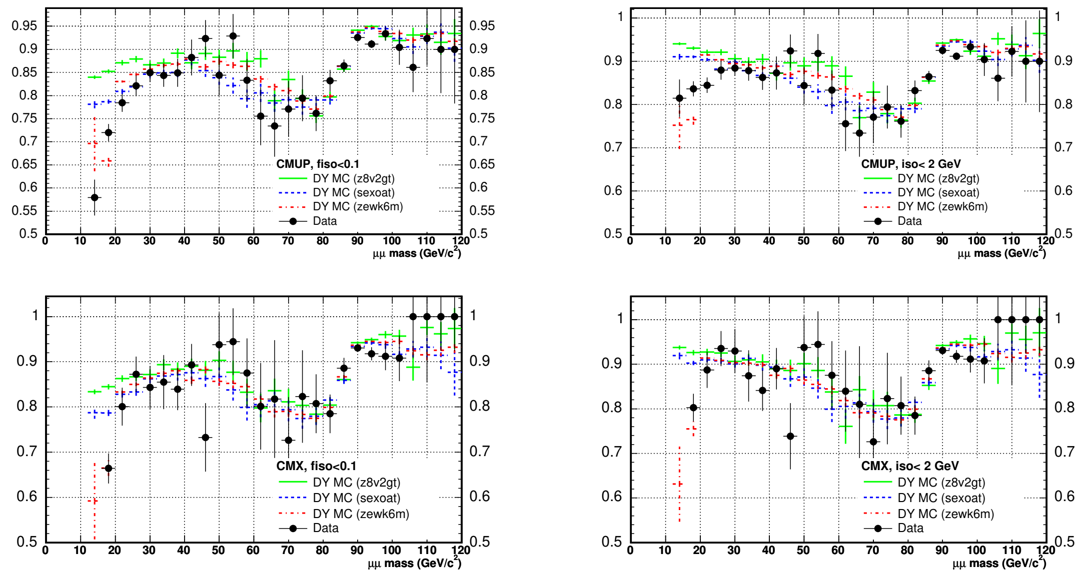

Figure .11: *mass dependence.*

6.1 Background fraction

The isolation efficiency is heavily dependent on the background subtraction and since our optimal background subtraction depends on the muon selection, we assign a systematics to cover the fluctuations in the SS to OS fake factor.

We take the systematics as half the difference between the scale factor obtained with the lower and upper bound on the scaling factor. The results are:

Loose iso, CMUP: 1.4%

Loose iso, CMX: 2.8%

Tight iso, CMUP: 2.5%

Tight iso, CMX: 5.5%

6.2 Quick comparison with high p_T results

For this comparison we abandoned the COT χ^2 cut and require both legs to be above 20 GeV. The rest of the selection is the same as before.

Only statistical errors are shown in these tables. We only see differences in the gen 6 reconstruction efficiencies, most notably for the CMX arches. The systematics quoted on the blessed numbers are between 1 and 2 % For the CMX arches the difference is only barely covered and there is a systematic undershoot. We will continue to investigate this. Part of the explanation could be differences in which parts we call fiducial. For the CMUP reconstruction efficiency the main problem seem to be that it is very jumpy (see also figure .15) but there is no systematic effect.

Gen 5 (0d)	CMUP(this)	CMUP [2]	CMX(this)	CMX [2]
ID cuts	0.9099 ± 0.0058	0.9089 ± 0.0041	0.9332 ± 0.0086	0.9342 ± 0.0051
Reconstruction	0.9217 ± 0.0057	0.9198 ± 0.0037	0.9820 ± 0.0047	0.9884 ± 0.0022
Gen 6 (0h)	CMUP(this)	CMUP [2]	CMX(this)	CMX [2]
ID cuts	0.9093 ± 0.0043	0.9104 ± 0.0036	0.9207 ± 0.0071	0.9165 ± 0.0044
Reconstruction	0.9253 ± 0.0040	0.9095 ± 0.0035	0.9589 ± 0.0055	0.9855 ± 0.0022

Table 7: *Comparison of efficiencies for $p_T \geq 20$ GeV in this study and [2].*

Gen 6 (0i)	CMUP(this)	CMUP [3]	CMX(this)	CMX [3]
ID cuts	0.8934 ± 0.0059	0.8988 ± 0.0045	0.9217 ± 0.0073	0.9268 ± 0.0054
Reconstruction	0.9069 ± 0.0057	0.9172 ± 0.0040	0.9631 ± 0.0055	0.9877 ± 0.0023

Table 8: *Comparison of gen 6 efficiencies 0i for $p_T \geq 20$ GeV in this study and [3].*

6.3 Comparison to efficiencies obtained by Υ mass peak

Since we are always requiring one leg to pass the ID cuts we could have a possible bias if certain ID cuts (for instance the impact parameter) are strongly correlated for the two legs.

We therefore studied the efficiencies again with a mass peak selection, using $\Upsilon's$ and sideband subtraction. The mass windows used are 9-10.5 GeV for signal and 6.5-8 and 11.5-13 for sidebands, (figure .16 in appendix), and we apply an isolation cut to our muon candiates. For these mass windows we do not have statistics in the pt bins above 15 GeV and thus the comparison is only done for the low pt bins. Results are in table 9. The statistics using upsilons is not great (the numbers above is only for the 0d

	CMUP (DY)	CMUP (Υ)
EM energy	0.995 ± 0.003	0.997 ± 0.002
Had energy	0.995 ± 0.003	0.999 ± 0.009
COT χ^2	0.990 ± 0.003	1.0 ± 0.00
nStSeg	1.0 ± 0.00	0.991 ± 0.004
nAxSeg	1.0 ± 0.00	0.994 ± 0.002
Stub matching	0.989 ± 0.004	0.988 ± 0.003
d0	0.993 ± 0.005	0.993 ± 0.004
Total	0.9583 ± 0.007	0.9695 ± 0.006

Table 9: *Quick comparisons of two background subtraction methods for CMUP.*

part) and we will include as much as we have of the full dataset to get more information about the systematics. At the moment the difference between the methods is small enough to be essentially covered by the statistical errors but we expect to include a systematics from this effect with the full dataset.

7 First look at low p_T BMU's:

We will only look at the loose isolation here since this cut is clearly more suitable for low pt. We use the same ID cuts as in table 1, and for the stub matching and COT track quality plots we use the cuts in [8]. We use the alternative COT cut because the number of expected COT hits is not available in our ntuples.

We do not apply any corrections for the misalligments and therefore we have not calculated reconstruction efficiencies yet.

	0d	zewk6m (gen 5)	zewk6m (gen6)
EM energy	0.976 ± 0.004	0.9799 ± 0.0009	0.9811 ± 0.0009
Had energy	0.978 ± 0.004	0.9799 ± 0.0009	0.9798 ± 0.0009
Isolation	0.921 ± 0.009	0.9500 ± 0.0014	0.9455 ± 0.0014
Segm cuts	0.992 ± 0.004	0.9968 ± 0.0004	0.9965 ± 0.0004
d0	0.984 ± 0.004	0.9847 ± 0.0008	0.9847 ± 0.0008
Stub matching	0.999 ± 0.003	0.9951 ± 0.0005	0.9946 ± 0.0006
Total ID	0.846 ± 0.013	0.8876 ± 0.0018	0.8813 ± 0.0018

Table 10: *BMU ID efficiencies for low pt.*

7.1 Comparison to high p_T

Dataset	BMU ID ε (this)	BMU ID ε [8]
0d	0.9260 ± 0.007	0.9130 ± 0.0071
0h	09186 ± 0.008	0.8977 ± 0.0057

Table 11: *Comparison of efficiencies for $p_T \geq 20$ GeV in this study and [8].*

The efficiencies measured in this note above consistently above the blessed numbers. It is not unreasonable given the errors, but we are investigating.

8 Conclusion

We have investigated the scale factors data/MC for certain sets of medium p_T muon ID cuts. Since we observed no significant p_T dependence of the reconstruction SF we

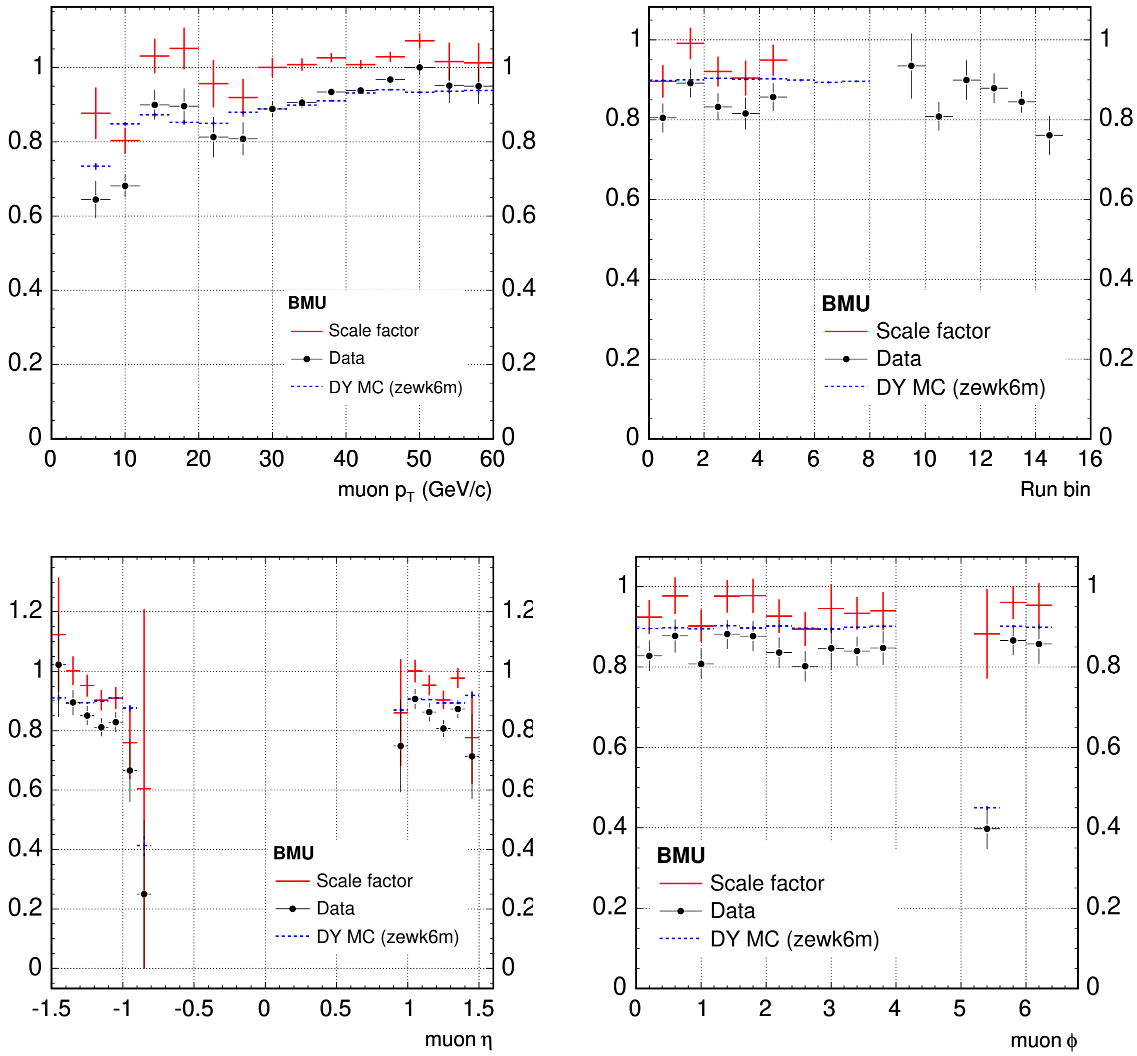

Figure .12: *BMU efficiency plots. (the pt plot is for the tight isolation cut)*

recommend using the blessed SF from the high p_T studies and report only the ID SF below.

The main difference between the different run periods was found to be in the isolation efficiency. During our analysis we also noticed several features in how the efficiency depends on certain variables.

The combined results using the zewk6m MC samples are summarized below for 0d and 0h:

The only systematics included at the moment is from the background subtraction.

As for the BMU's table 10 shows the first results and we hope to report final results soon. The preliminary values for the scale factors are found to be: 0.952 $\pm$ 0.015 for gen 5 data to gen 5 MC, and 0. $\pm$ 0.0 for gen 6 to gen6.

	Gen 5 zewk6m		Gen 6 zewk6m
Category	0d SF	0h SF	0h SF
CMUP, loose iso	0.965 ± 0.021	0.945 ± 0.017	0.923 ± 0.018
CMX, loose iso	0.951 ± 0.039	0.949 ± 0.034	0.951 ± 0.034
CMUP, tight iso	0.946 ± 0.029	0.862 ± 0.028	0.870 ± 0.028
CMX, tight iso	0.962 ± 0.062	0.869 ± 0.058	0.870 ± 0.058

These studies are ongoing. We will also extend our studies to CMIO's, and CMX muons in the miniskirt and keystone, in the near future.

9 Acknowledgments

We thank Ray Culbertson, Ai Nagano, and the Stntuple Task Force for providing the 0h and 0i (and hopefully soon new 0d) Stntuples.

References

[1] E.Lytken et al, "ID efficiency for isolated, intermediate p_T muons", CDFnote 7197

[2] U.Grundler et al.,"High-Pt muons recommended cuts and efficiencies for Winter 2006",CDF Note 7956

[3] U.Grundler et al.,"High-Pt muons recommended cuts and efficiencies for Summer 2006",CDF Note 8262

[4] G. Manca et al, "Search for the associated production of chargino and neutralino in the final state with two electrons and an additional lepton,", CDF note 7499

[5] A.Canepa et al, "Search for the associated production of chargino and neutralino in the final state with two muons and an additional lepton", CDF note

[6] U.Grundler,Blessing talk in the Joint Physics meeting, December 16, 2005.

[7] http://www-cdf.fnal.gov/internal/physics/exotic/mc/exoticsMC/MCdatasets.html

[8] S.Chuang et al, "High Pt Intermediate Muon Reconstruction and Identification with 5.3.3/6.1.2 Data vs 5.3.3 MC", CDF note 8088

A SF in Pt bins

The SF is not quite flat as a function of p_T . For completeness we also quote these numbers for the loose isolation cut in p_T bins.

For 0h compared to gen 6 zewk6m:

CMX:	5-10 GeV:	0.938 ± 0.028
	10-20 GeV:	0.983 ± 0.024
CMUP:	5-10 GeV:	0.920 ± 0.018
	10-20 GeV:	0.944 ± 0.014

B Results for other MC samples

The effect of min bias in the MC samples is illustrated in figure .13.

Efficiency	z8v2gt CMUP	z8v2gt CMX	sexoat CMUP	sexoat CMX
Loose iso	0.9270 ± 0.0021	0.9227 ± 0.0028	0.8978 ± 0.0013	0.9027 ± 0.0027
Tight iso	0.8504 ± 0.0020	0.8434 ± 0.0026	0.7945 ± 0.0022	0.8061 ± 0.0030
Reconstruction	0.9702 ± 0.0009	0.9924 ± 0.0006	0.9595 ± 0.0027	0.9888 ± 0.0019

ID Scale factor	gen5/z8v2gt	gen5/z8v2gt	gen6/sexoat	gen6/sexoat
Loose iso	0.931 ± 0.014	0.923 ± 0.026	0.910 ± 0.011	0.942 ± 0.020
Tight iso	0.925 ± 0.017	0.941 ± 0.035	0.899 ± 0.013	0.891 ± 0.020

Table 12: *Scale factor for more MC samples. Errors are statistical.*

C Additional plots

D MUON_CALIB Trigger Path example

```
1. Path MUON_CMUP8_NOL2_v-3
   1. Trigger L1_CMUP6_PT4_v-2 Bit: [40(22)]
         1. Specific option L1_CMUP6_PT4_v-1 Instance of MUON_CMU(P).
               1. CMU_STUB_PT = 6 GeV/c
               2. REQUIRE_CSP = 0
               3. REQUIRE_CMP = 1
               4. CMU_XFT_PT = 4.09 GeV/c
               5. REQUIRE_HTDC_CMU = 0
            Generated Down Load (Instance of MUON_CMU(P)):
               1. PREFRED_INPUT_BIT = 7 integer
```

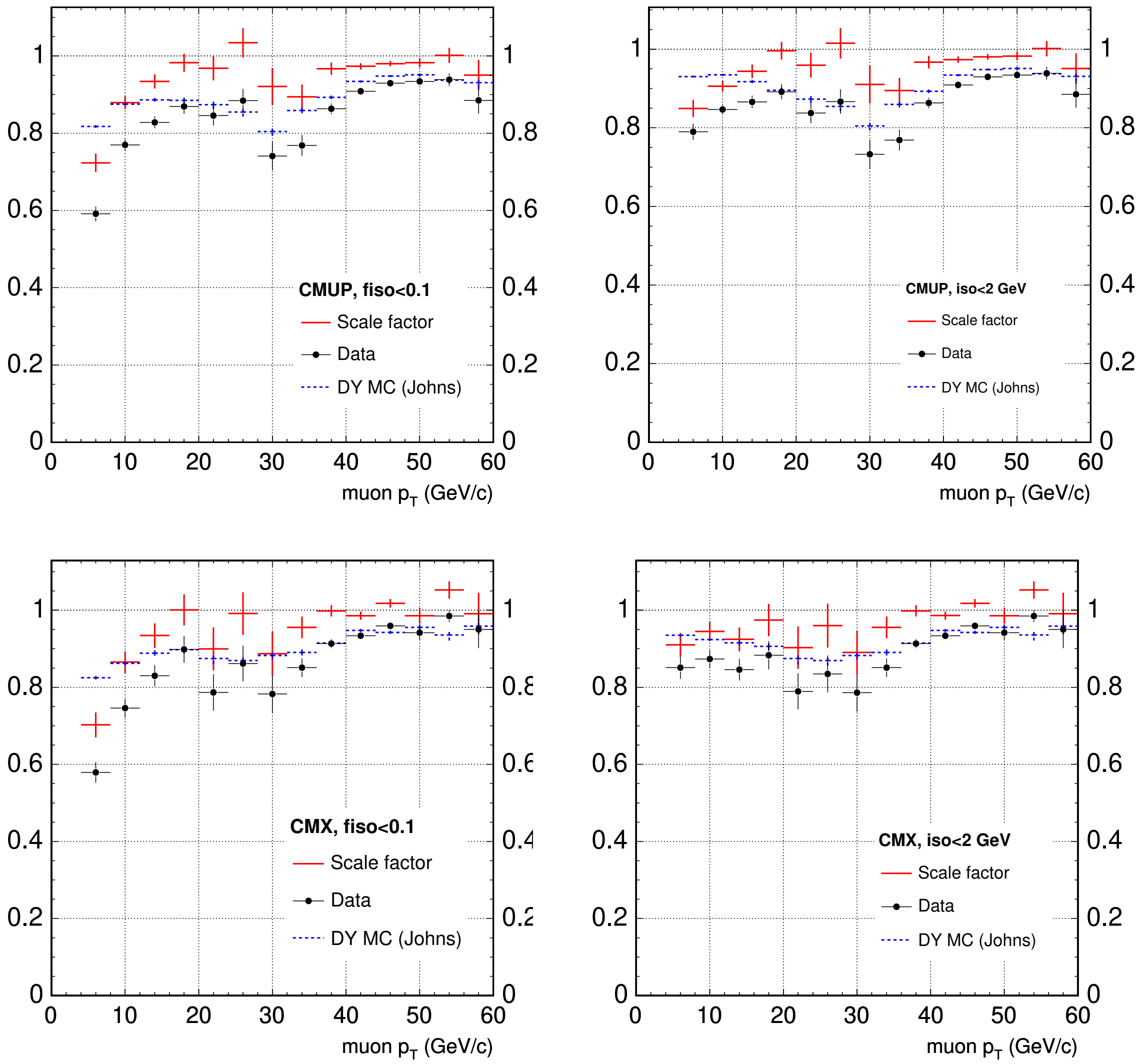

Figure .13: *ID Scale factors for CMUP and CMX with the isolation cuts with a no min bias sample (this is z8v2gt!).*

```
                    2. PREFRED_OUTPUT_BIT = 31 integer
                    3. FRED_INPUT_BIT = 40 integer
        2. Trigger L2_TRK8_PS100_L1_CMUP6_PT4_v-1 Bit: [96]
              1. Specific option L2_PRESCALE_100_v-3 Instance of L2_PRESCALE.
                    1. L2_PRESCALE_FACTOR = 100 integer
              2. Specific option L2_TRK8_v-1 Instance of XftTrack.
                    1. NUMBER = 1
                    2. XFT_PT = 8 GeV/c
                    3. TRACK_ISO_TYPE = 0
                    4. DELTA_PHI0_MAX = 180 degrees
```

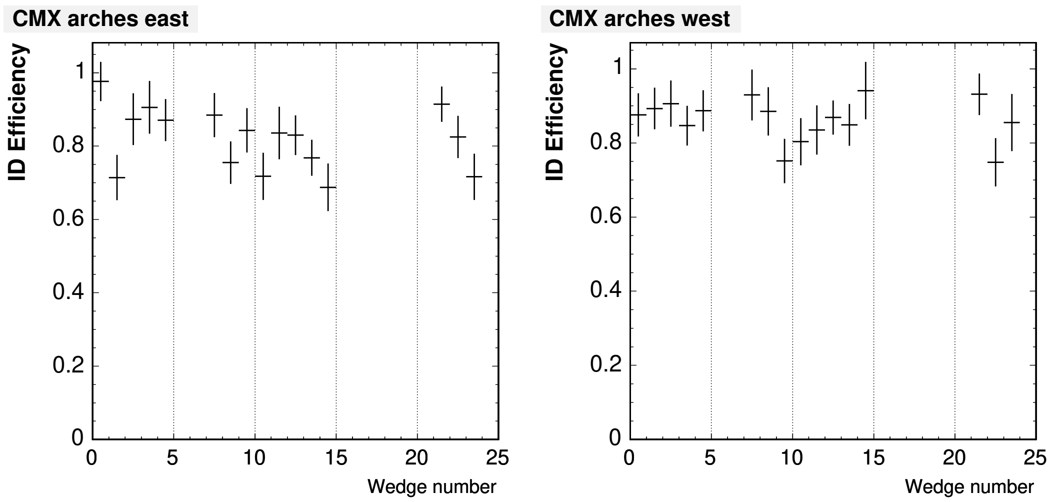

Figure .14: *Efficiency dependence for CMX arches as a function of wedge number*

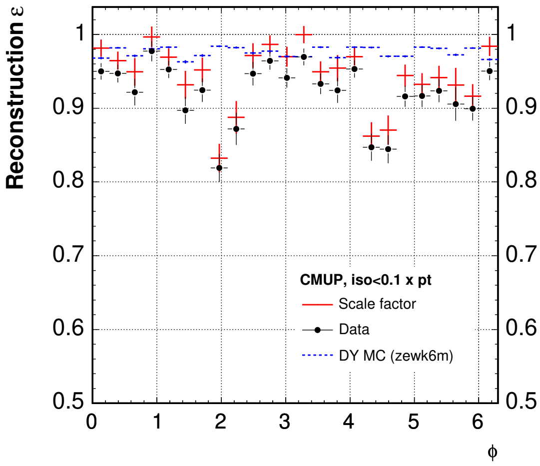

Figure .15: *CMUP reconstruction efficiency as a function of ϕ.*

```
                    5. DELTA_PHI0_MIN = 0 degrees
            3. Trigger L3_MUON_CMUP_8_v-3
                  1. L3 Instance: muonCMUP8_v1, of class L3MuonFilterModule_v-1
                        1. cmpDx = 20
                        2. cmuDx = 15
                        3. minPt = 8.0
                        4. nMuon = 1
                        5. selectCMUP = true
      2. Path MUON_CMUP8_v-10
            1. Trigger L1_CMUP6_PT4_v-2 Bit: [40(22)]
                  1. Specific option L1_CMUP6_PT4_v-1 Instance of MUON_CMU(P).
```

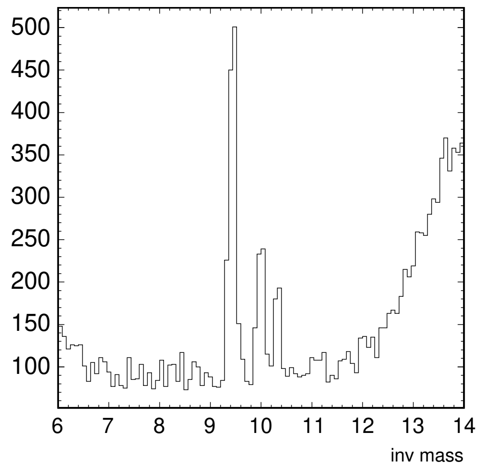

Figure .16: *$\mu\mu$ invariant mass in 0d around the Υ mass peak.*

```
            1. CMU_STUB_PT = 6 GeV/c
            2. REQUIRE_CSP = 0
            3. REQUIRE_CMP = 1
            4. CMU_XFT_PT = 4.09 GeV/c
            5. REQUIRE_HTDC_CMU = 0
         Generated Down Load (Instance of MUON_CMU(P)):
            1. PREFRED_INPUT_BIT = 7 integer
            2. PREFRED_OUTPUT_BIT = 31 integer
            3. FRED_INPUT_BIT = 40 integer
2. Trigger L2_CMUP6_PT8_v-1 Bit: [39(13)]
      1. Specific option L2_CMUP6_PT8_v-1 Instance of Muon.
            1. NUMBER = 1
            2. XFT_LAYERS = 4
            3. CALOR_TYPE = 0
            4. MUON_TYPE = 3
            5. XFT_PT = 8.34 GeV/c
      2. Specific option L2_READOUT_FADC_v-1 Instance of ReadOutList.
            1. READOUT_LIST = 3
3. Trigger L3_MUON_CMUP_8_v-3
      1. L3 Instance: muonCMUP8_v1, of class L3MuonFilterModule_v-1
            1. cmpDx = 20
            2. cmuDx = 15
            3. minPt = 8.0
            4. nMuon = 1
            5. selectCMUP = true
```