

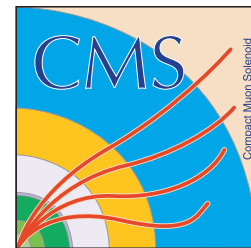
Low p_T Muon ID Efficiencies from J/ψ

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Muon POG Meeting

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Institute of High Energy Physics



Samples

- Data sample:
 - MuOnia-22Jan2013 (not including parked data)
 - Full 2012 run range (A-D)
 - JSON: golden 22Jan2013
- MC sample:
 - Inclusive J/ψ with $p_T > 3.5$ GeV
- Software: CMSSW_5_3_10

<https://twiki.cern.ch/twiki/bin/viewauth/CMS/TagAndProbeForHIG>

Muon IDs

- Loose

- PF muon
- Global or tracker muon

- Soft

- TMOneStationTight
- trackerLayersWithMeasurement > 5
- pixelLayersWithMeasurement > 1
- track.normalizedChi2 < 1.8
- $|d_z| < 30 \text{ cm}$, $|d_{xy}| < 3 \text{ cm}$

- New Soft

- TMOneStationTight
- trackerLayersWithMeasurement > 5
- pixelLayersWithMeasurement > 0
- $|d_z| < 20 \text{ cm}$, $|d_{xy}| < 0.3 \text{ cm}$
- track highpurity flag

- Tight

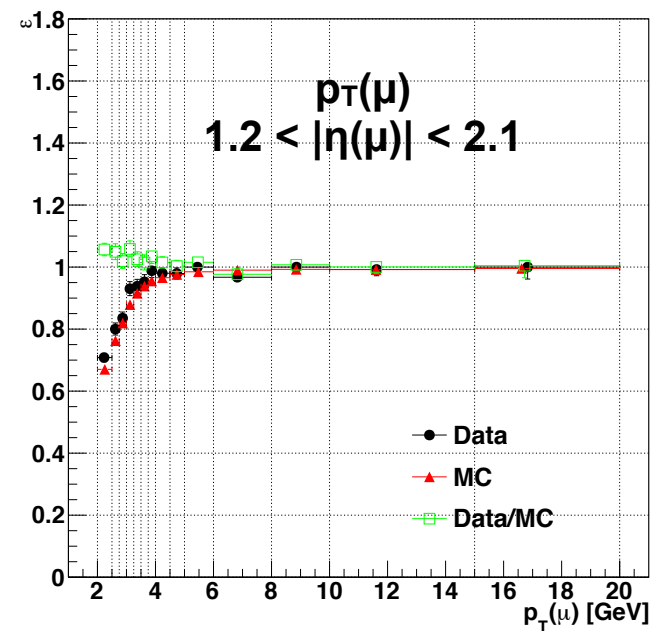
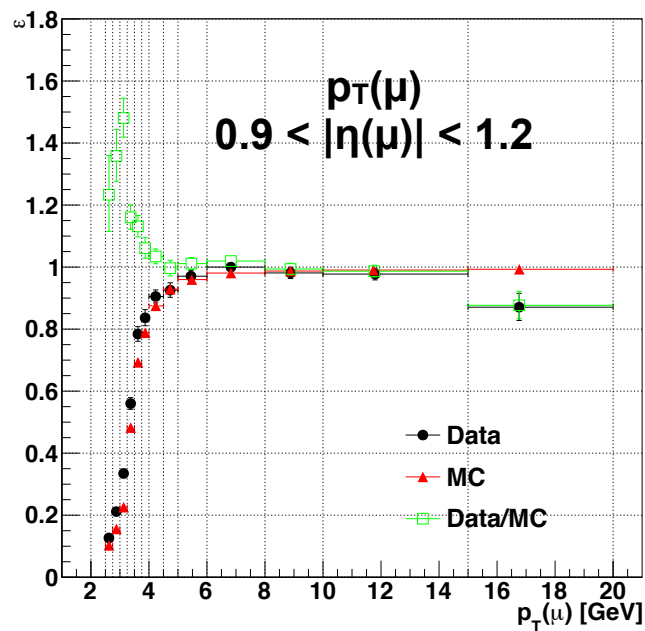
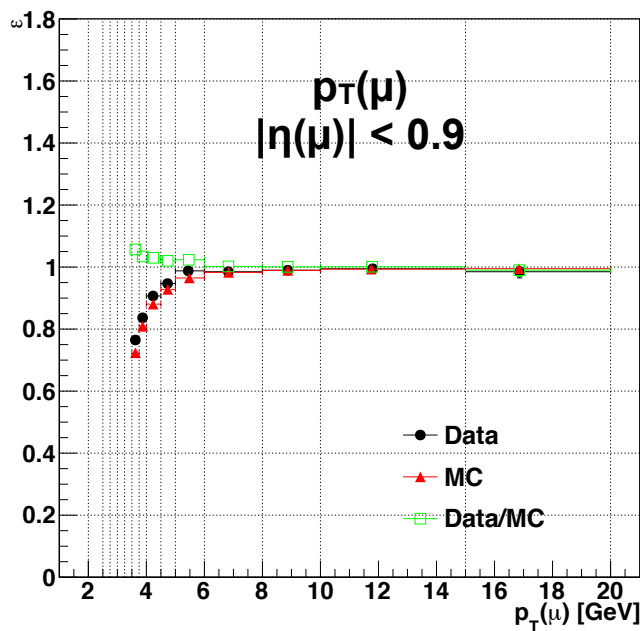
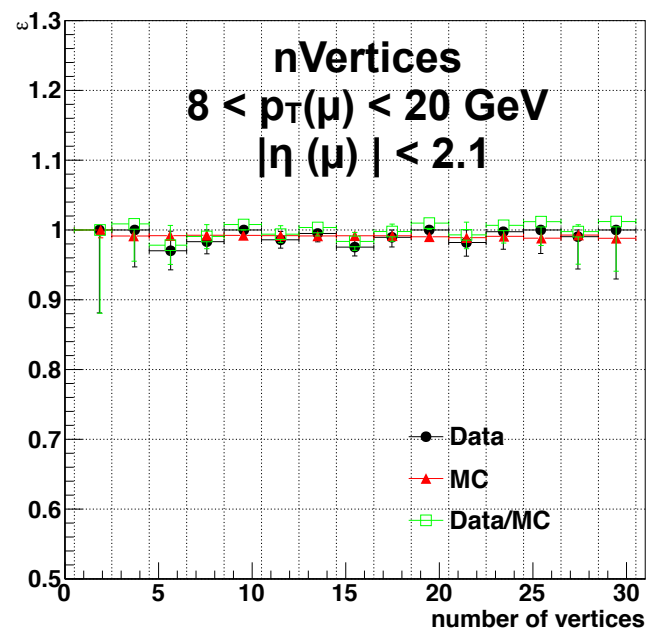
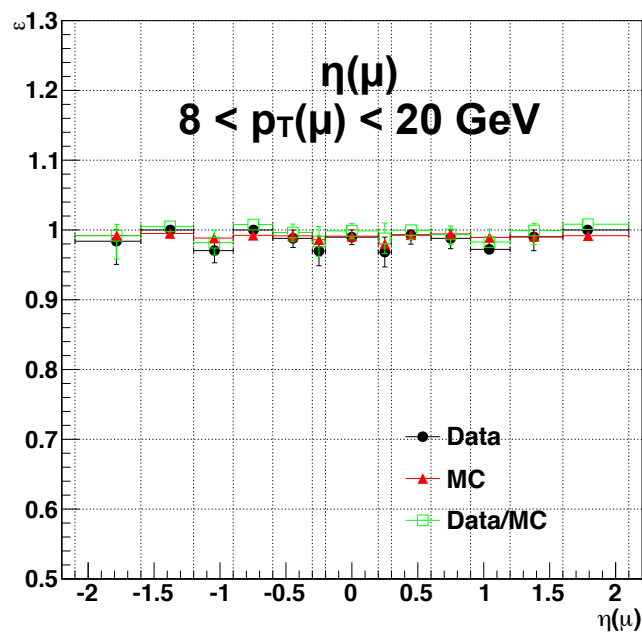
- Global muon
- PF muon
- globalTrack.normalizedChi2 < 10
- globalTrack.numberOfValidMuonHits > 0
- numberOfMatchedStations > 1
- $|d_{xy}| < 0.2 \text{ cm}$, $|d_z| < 0.5 \text{ cm}$
- numberOfValidPixelHits > 0
- trackerLayersWithMeasurement > 5

<https://twiki.cern.ch/twiki/bin/view/CMSPublic/SWGuideMuonId>

TnP Selection

- Tag muon: muon matched to Mu part of HLT_Mu5_Track2_Jpsi for or HLT_Mu7_Track7_Jpsi trigger
- Probes:
 - General tracks with match to Track leg of HLT_Mu5_Track2_Jpsi or HLT_Mu7_Track7_Jpsi trigger
 - Passing probes: probes passing the given Muon ID criteria
- Used efficiency triggers:
 - $p_T < 8$ GeV: HLT_Mu5_Track2_Jpsi
 - $p_T > 8$ GeV: HLT_Mu7_Track7_Jpsi trigger
- Tag and probe are separated by $dR(M1) > 0.5$
- Changed J/ ψ mass window: $2.9 < m < 3.3$ GeV
- PDF shape:
 - Signal = Crystal Ball function
 - Background = exponential

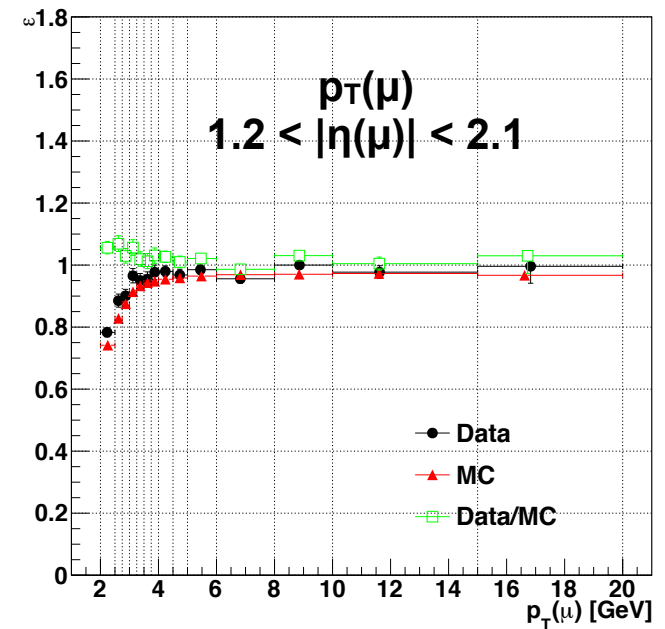
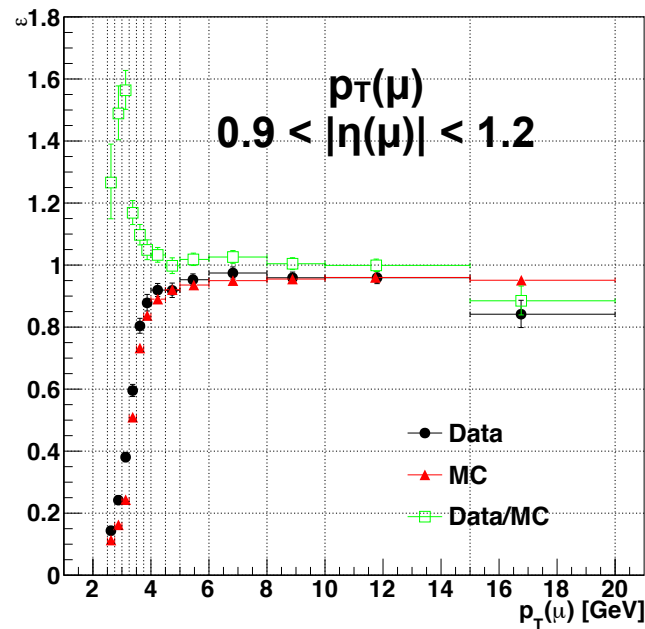
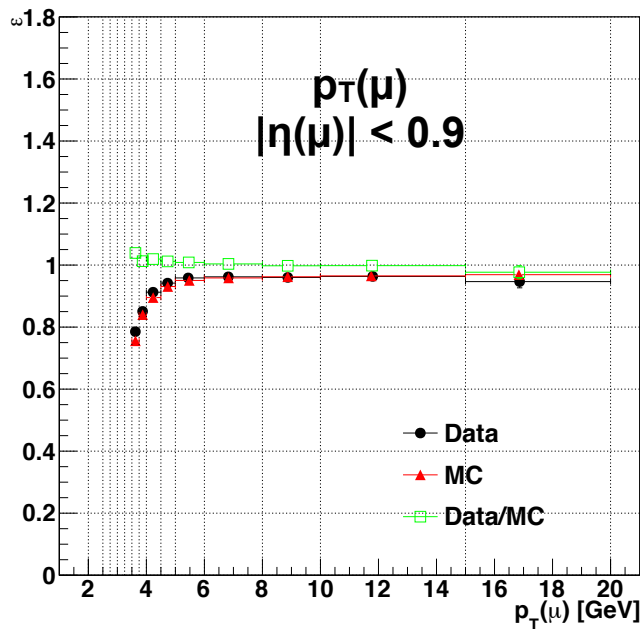
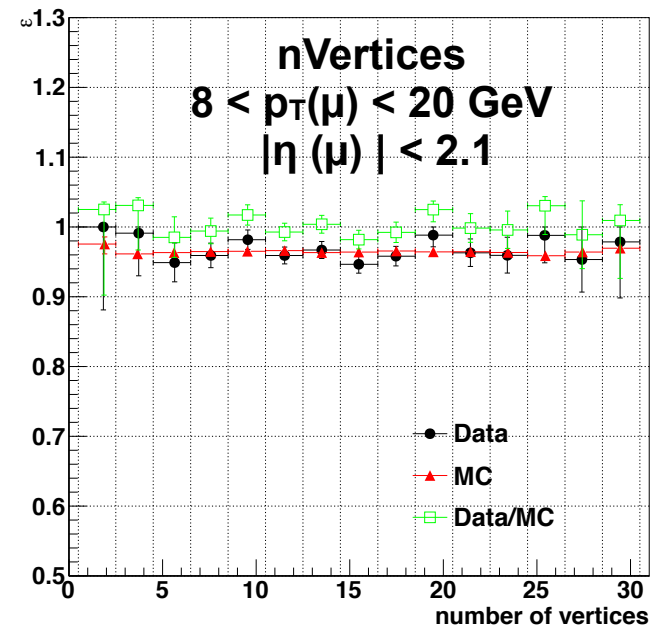
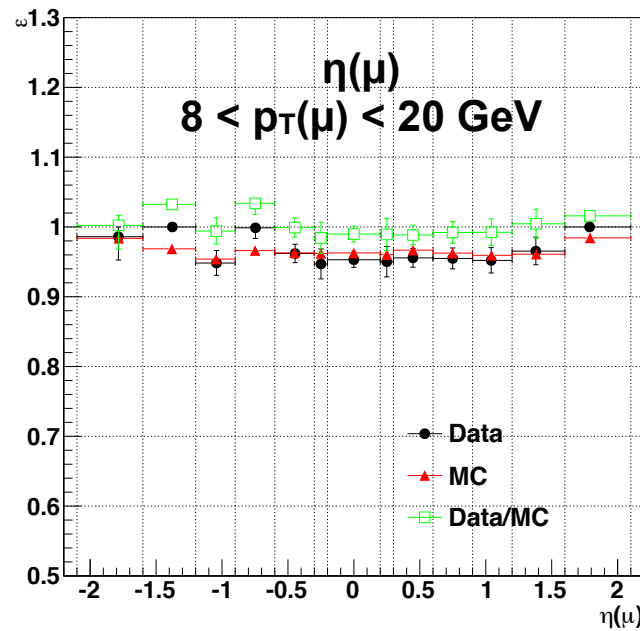
Loose ID



Loose ID

$8 < p_T < 20 \text{ GeV}$	Data	MC	Ratio data/MC
$0 < \eta < 0.9$	$0.9915^{+0.0055}_{-0.0055}$	$0.9913^{+0.0004}_{-0.0004}$	$1.0002^{+0.0055}_{-0.0055}$
$0.9 < \eta < 1.2$	$0.9714^{+0.0127}_{-0.0125}$	$0.9888^{+0.0008}_{-0.0008}$	$0.9824^{+0.0128}_{-0.0127}$
$1.2 < \eta < 2.1$	$1.0000^{+0.0000}_{-0.0038}$	$0.9926^{+0.0006}_{-0.0006}$	$1.0075^{+0.0006}_{-0.0038}$

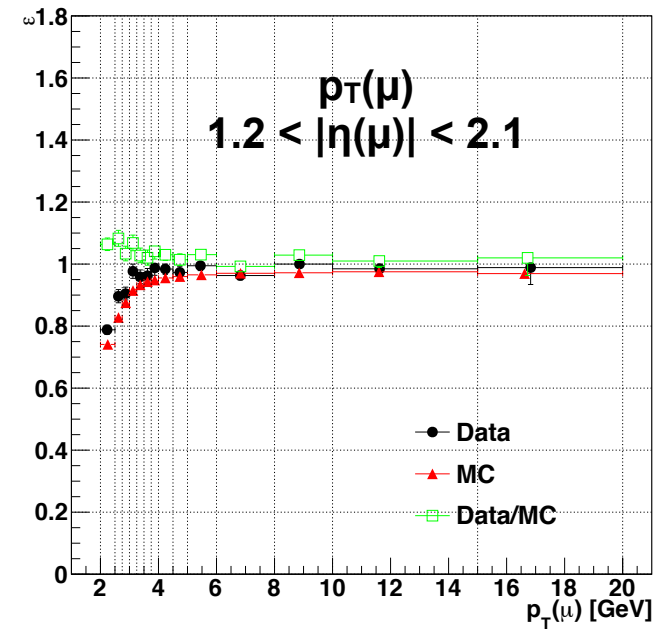
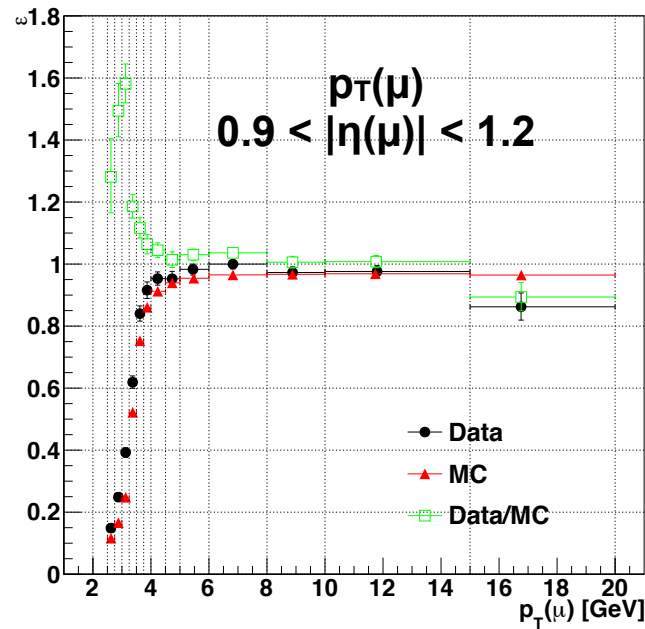
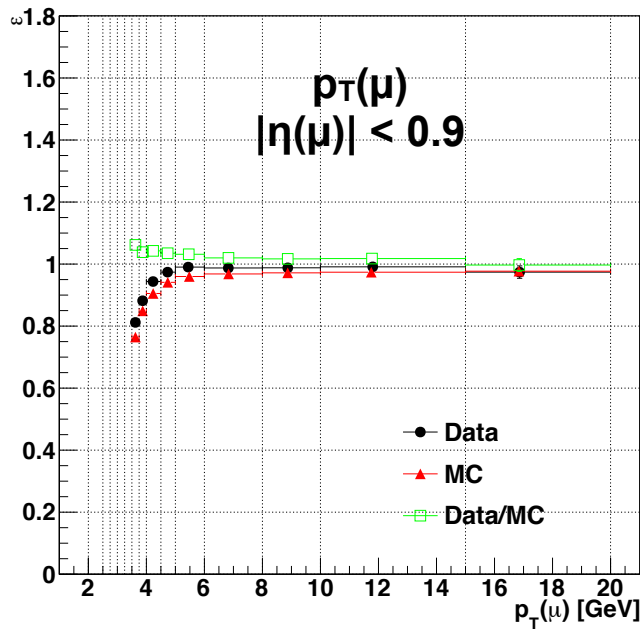
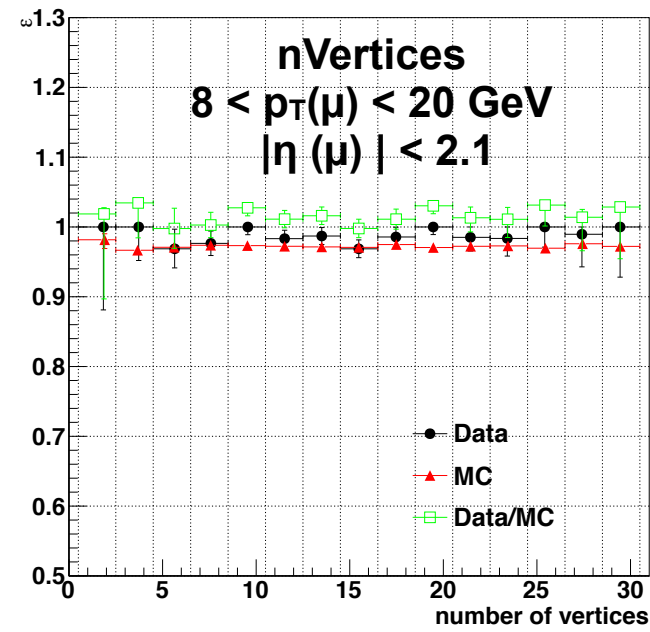
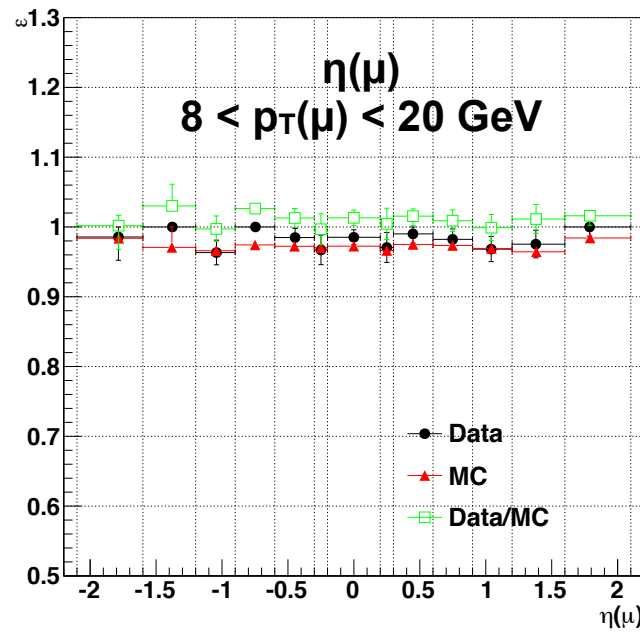
Soft ID



Soft ID

$8 < p_T < 20 \text{ GeV}$	Data	MC	Ratio data/MC
$0 < \eta < 0.9$	$0.9605^{+0.0056}_{-0.0055}$	$0.9639^{+0.0007}_{-0.0007}$	$0.9965^{+0.0058}_{-0.0058}$
$0.9 < \eta < 1.2$	$0.9503^{+0.0128}_{-0.0126}$	$0.9566^{+0.0016}_{-0.0016}$	$0.9934^{+0.0134}_{-0.0133}$
$1.2 < \eta < 2.1$	$1.0000^{+0.0000}_{-0.0087}$	$0.9712^{+0.0012}_{-0.0012}$	$1.0296^{+0.0012}_{-0.0091}$

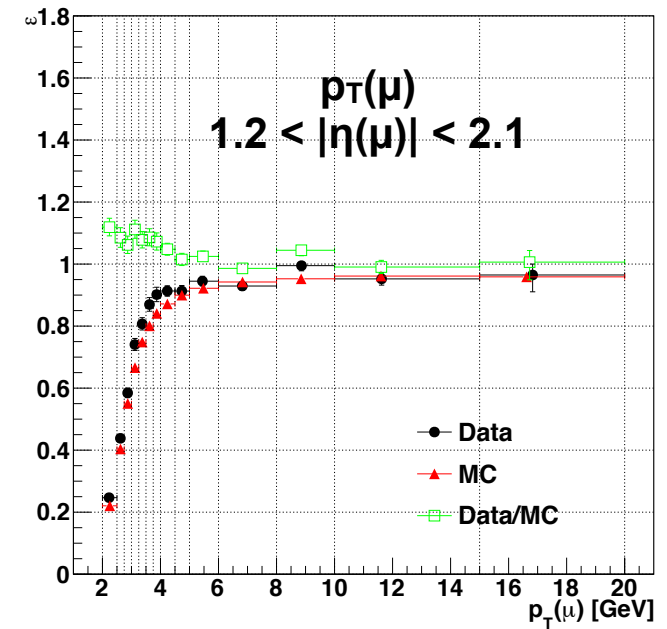
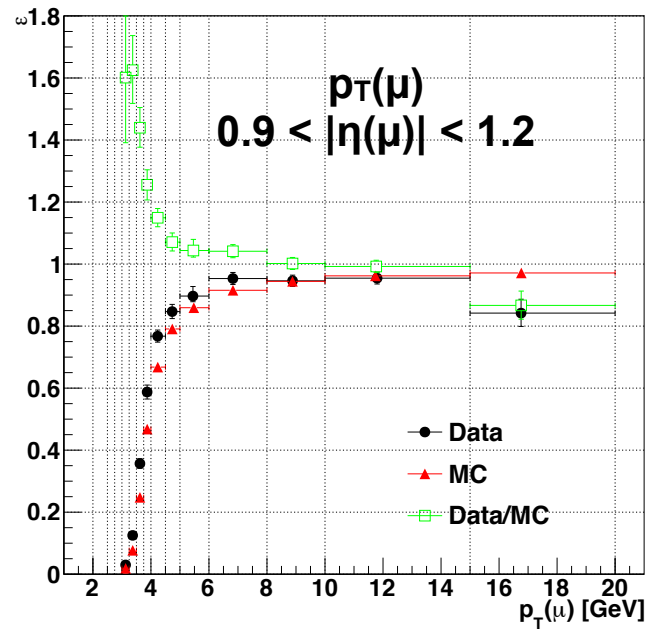
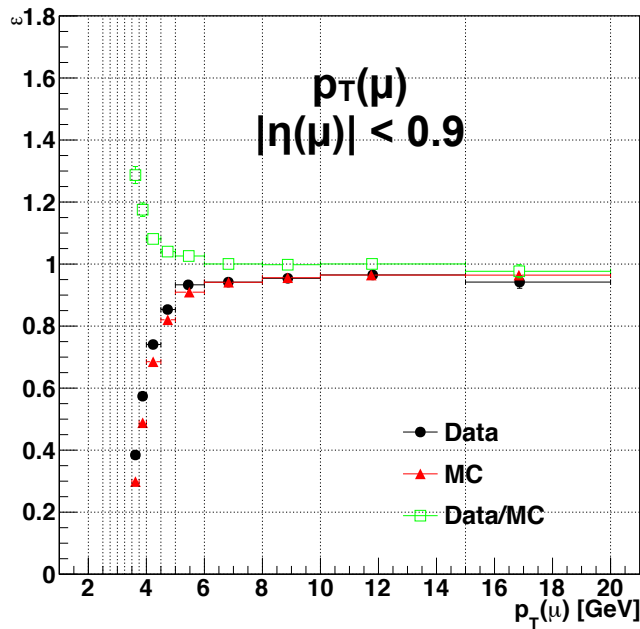
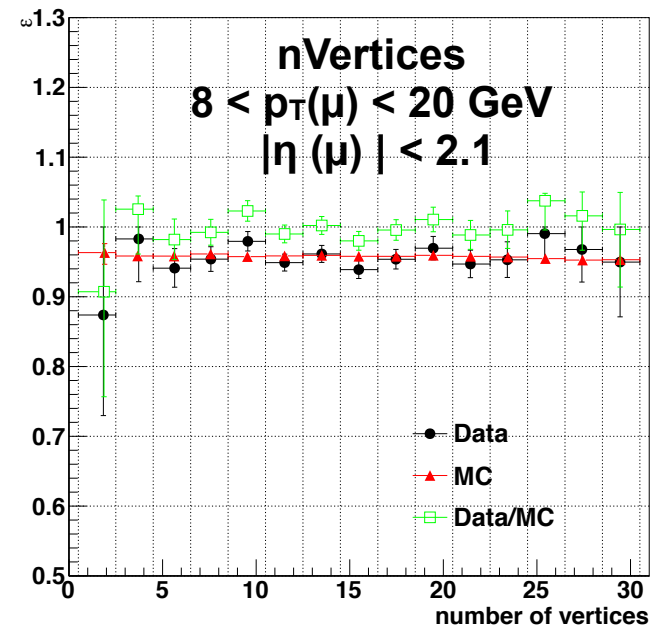
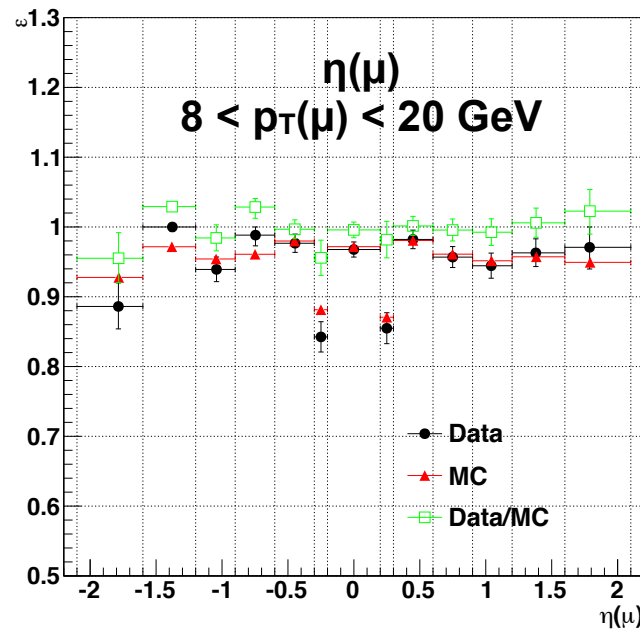
New Soft ID



New Soft ID

$8 < p_T < 20 \text{ GeV}$	Data	MC	Ratio data/MC
$0 < \eta < 0.9$	$0.9882^{+0.0055}_{-0.0055}$	$0.9729^{+0.0006}_{-0.0006}$	$1.0157^{+0.0057}_{-0.0057}$
$0.9 < \eta < 1.2$	$0.9658^{+0.0127}_{-0.0125}$	$0.9676^{+0.0013}_{-0.0014}$	$0.9982^{+0.0132}_{-0.0130}$
$1.2 < \eta < 2.1$	$1.0000^{+0.0000}_{-0.0063}$	$0.9731^{+0.0011}_{-0.0012}$	$1.0277^{+0.0012}_{-0.0066}$

Tight ID



Tight ID

$8 < p_T < 20 \text{ GeV}$	Data	MC	Ratio data/MC
$0 < \eta < 0.9$	$0.9576^{+0.0055}_{-0.0055}$	$0.9600^{+0.0008}_{-0.0008}$	$0.9975^{+0.0058}_{-0.0058}$
$0.9 < \eta < 1.2$	$0.9419^{+0.0127}_{-0.0125}$	$0.9528^{+0.0016}_{-0.0016}$	$0.9885^{+0.0134}_{-0.0133}$
$1.2 < \eta < 2.1$	$0.9780^{+0.0127}_{-0.0126}$	$0.9559^{+0.0014}_{-0.0014}$	$1.0231^{+0.0134}_{-0.0132}$

Systematic Check

- Efficiencies calculated for $dR(M1) > 0.5$, seagull dimuons, $\text{distM1} > 200$ cm
- Relative difference to default efficiencies ($dR(M1) > 0.5$)

	$8 < p_T < 20$ GeV	loose ID	soft ID	new soft ID	tight ID
Data	$ \eta < 0.9$	-0.0014	-0.0021	-0.0020	-0.0031
	$0.9 < \eta < 1.2$	-0.0044	-0.0055	-0.0047	-0.0052
	$1.2 < \eta < 2.1$	0.0000	-0.0000	-0.0000	0.0161
MC	$ \eta < 0.9$	-0.0001	0.0001	-0.0002	-0.0006
	$0.9 < \eta < 1.2$	-0.0002	-0.0004	-0.0006	0.0009
	$1.2 < \eta < 2.1$	-0.0004	-0.0048	-0.0039	0.0033
Ratio	$ \eta < 0.9$	-0.0013	-0.0022	-0.0018	-0.0025
	$0.9 < \eta < 1.2$	-0.0042	-0.0051	-0.0041	-0.0061
	$1.2 < \eta < 2.1$	-0.0004	0.0048	0.0039	0.0128

Bias Due To Efficiency Trigger

- Efficiency trigger introduces bias
- Bias is most pronounced in soft ID
- Correction factor calculated as $\varepsilon(\text{MC no trigger})/\varepsilon(\text{MC})$
- Correction factor should only be applied to absolute DATA efficiencies - NOT recommended

$8 < p_T < 20 \text{ GeV}$	Loose ID	Soft ID	New soft ID	Tight ID
$0 < \eta < 0.9$	$1.0007^{+0.0004}_{-0.0004}$	$0.9879^{+0.0009}_{-0.0009}$	$0.9926^{+0.0008}_{-0.0008}$	$0.9965^{+0.0009}_{-0.0009}$
$0.9 < \eta < 1.2$	$1.0021^{+0.0009}_{-0.0009}$	$0.9880^{+0.0019}_{-0.0019}$	$0.9930^{+0.0016}_{-0.0017}$	$0.9958^{+0.0019}_{-0.0020}$
$1.2 < \eta < 2.1$	$1.0014^{+0.0007}_{-0.0007}$	$0.9877^{+0.0014}_{-0.0014}$	$0.9940^{+0.0013}_{-0.0013}$	$0.9990^{+0.0016}_{-0.0016}$
average	-	$< \approx 1.2 \%$	$< \approx 0.8 \%$	$< \approx 0.5 \%$