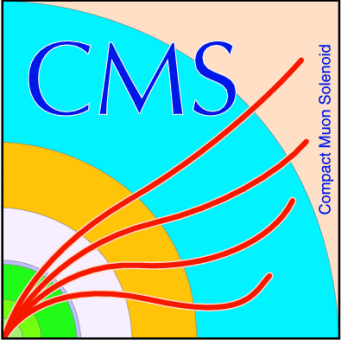

MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

ID and isolation muon efficiencies and scale factors for 2012ABCD dataset

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CIEMAT, MADRID

4th February 2013

Outline

Muon efficiencies for the full 2012 pp dataset (ABCD).

- ID efficiencies
  - Loose
  - Soft
  - Tight
  - HightPt

- Isolation efficiencies for Tight Muons
  - Tkr Rel Iso <0.1
  - CombPFrelIso with dBeta <0.12 and <0.20

Samples

- Root files from H→4l analysis

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

- Software: CMSSW_5_3_X

- Data:
  - Full 2012 statistics (18.7 fb^{-1})
  - 2012A. JSON: golden 13Jul(v2)
  - 2012B. JSON: golden 13Jul(v2)
  - 2012C. JSON: golden Prompt
  - 2012D. JSON: golden Prompt

- MC:
  - Madgraph Z+jets reweighted to the primary vertices distribution of data

Tag and Probe selection

- Tag muon: Tight Muon with pT >15 GeV
- Z mass between 70 and 130 GeV.
- PDF shape
  - Signal: sum of two voigtians
  - Background: exponential

ID Categories

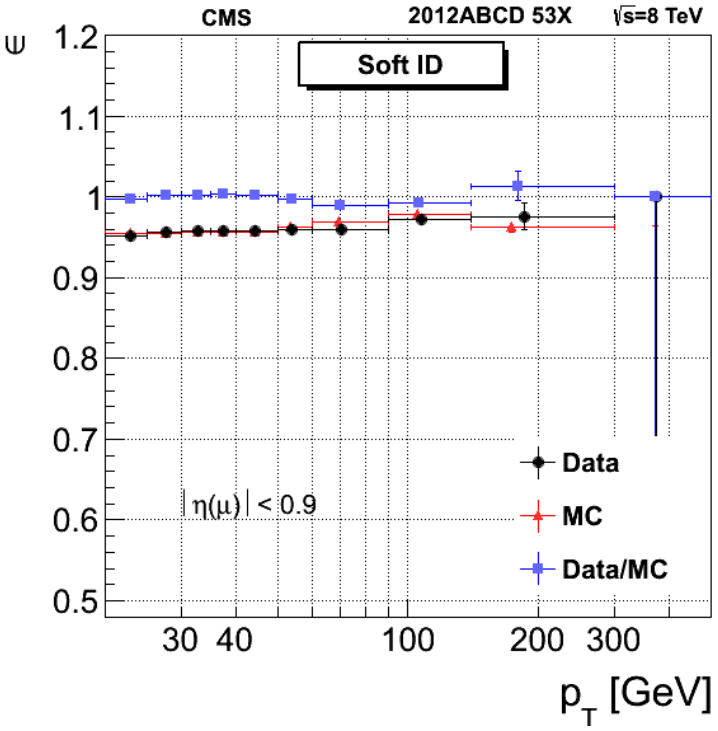
- Soft:
  - TMOneStationTight
  - trackerLayersWithMeasurement > 5
  - pixelLayersWithMeasurement > 1
  - track.normalizedChi2 < 1.8
  - $|d_z| < 30$ cm, $|d_{xy}| < 3$ cm
- Tight:
  - global muon
  - PF
  - globalTrack.normalizedChi2< 10
  - globalTrack.numberOfValidMuonHits > 0
  - numberOfMatchedStations > 1
  - |dxy| < 0.2 cm, |dz| < 0.5
  - numberOfValidPixelHits > 0
  - trackerLayersWithMeasurement > 5
- Loose:
  - PF
  - global or tracker muon
- HighPt:
  - global muon
  - globalTrack.numberOfValidMuonHits > 0
  - numberOfMatchedStations > 1
  - $|d_{xy}| < 0.2$ cm, $|d_z| < 0.5$ cm
  - numberOfValidPixelHits > 0
  - trackerLayersWithMeasurement > 5
  - sigmaptoverpt < 0.3

The HighPt category uses the new TuneP momentum assignment

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

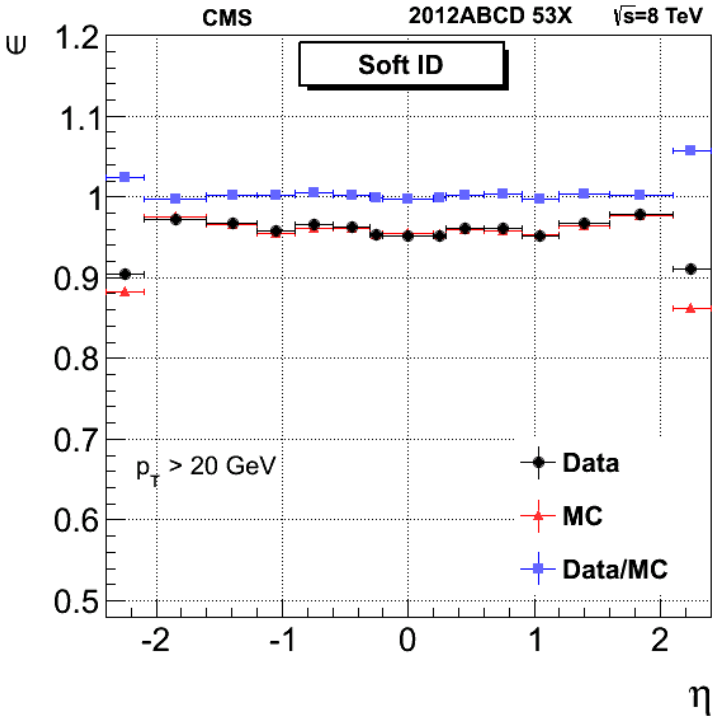
Soft ID

BARREL



Selected probes:
General tracks

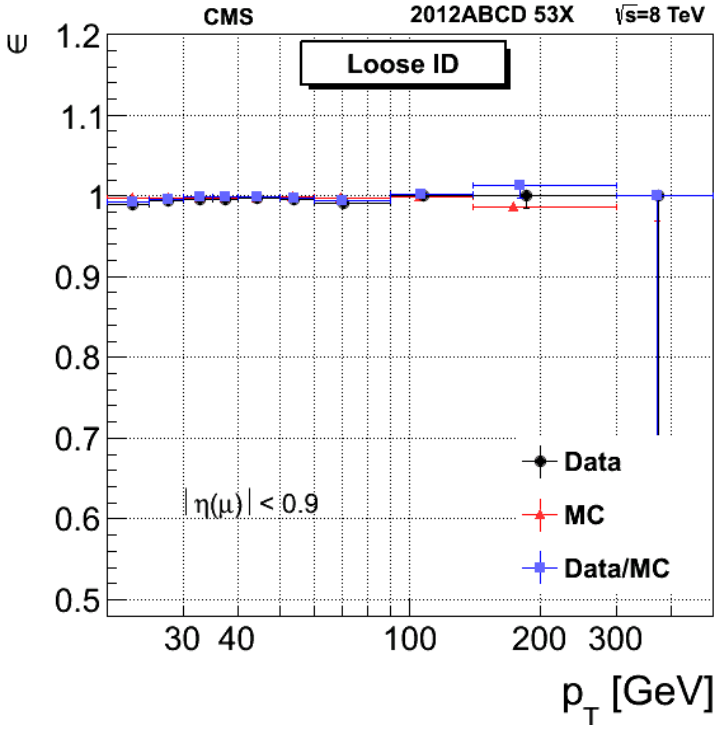
Passing probes:
Soft cuts



	p_T > 20 GeV	Data	MC	Scale Factor
Soft Muons	0<|η|<0.9	0. 9583±0.0001	0.9579±0.0001	1.0009±0.0002
	0.9<|η|<1.2	0.9537±0.0003	0.9540±0.0003	0.9997±0.0004
	1.2<|η|<2.1	0.9710±0.0001	0.9703±0.0001	1.0007±0.0002

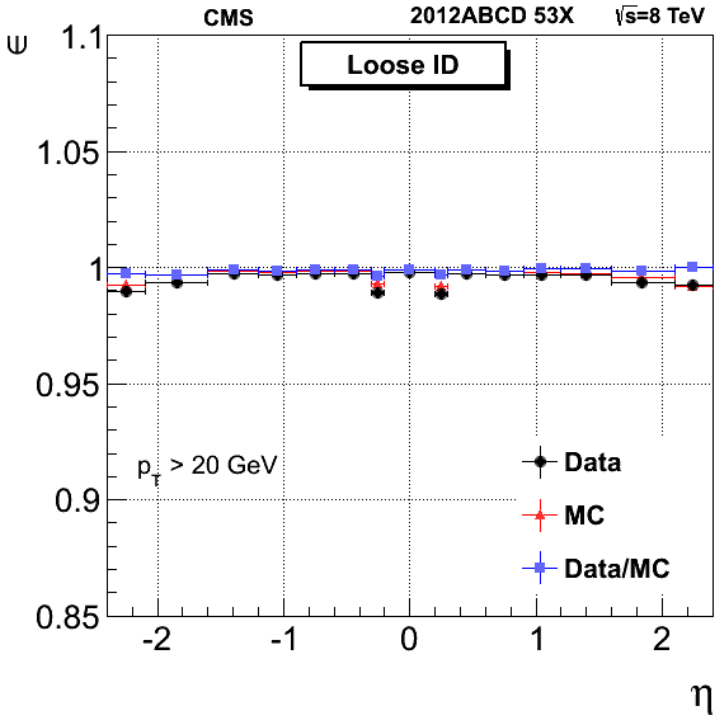
Loose ID

BARREL



Selected probes:
General tracks

Passing probes:
Loose cuts



Loose Muons	p_T > 20 GeV	Data	MC	Scale Factor
	0<|η|<0.9 (*)	0.9964 ±0.0001	0.9978±0.0001	0.9986±0.0001
	0.9<|η|<1.2	0.9968±0.0002	0. 9979±0.0001	0.9989±0.0002
	1.2<|η|<2.1	0.9954 ±0.0001	0.9970±0.0001	0.9984±0.0001

(*) weighted average A+B and C+D

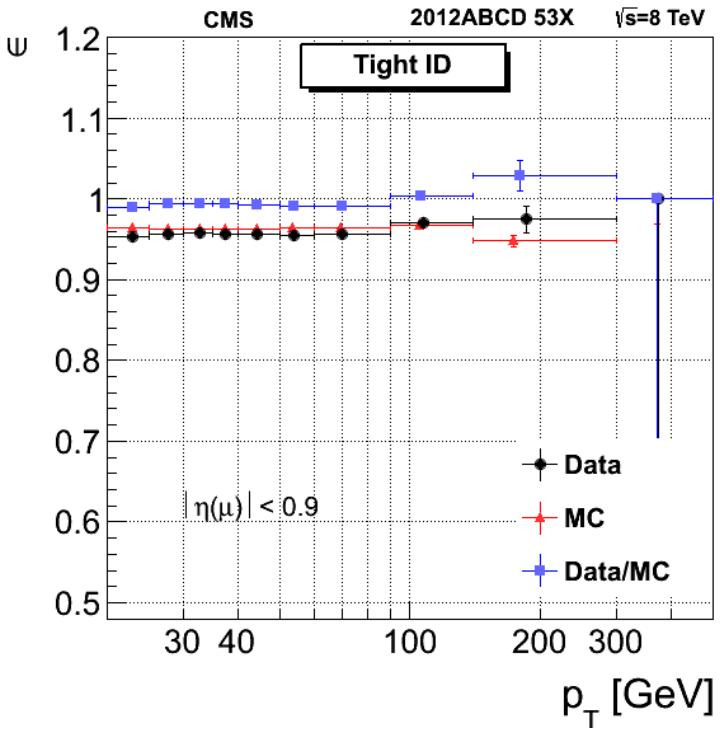
Loose ID

	p_T > 20 GeV	Data	MC	Scale Factor
Loose Muons A+B	0<|η|<0.9	0.9967±0.0002	0.9979±0.0002	0.9988±0.0002
	0.9<|η|<1.2	0.9973 ±0.0003	0.9798±0.0003	0.9993±0.0005
	1.2<|η|<2.1	0.9953±0.0002	0.9971±0.0001	0.9982±0.0002

	p_T > 20 GeV	Data	MC	Scale Factor
Loose Muons C+D	0<|η|<0.9	0.9963 ±0.0001	0.9978±0.0001	0.9985±0.0001
	0.9<|η|<1.2	0.9966±0.0002	0. 9978±0.0001	0.9988±0.0002
	1.2<|η|<2.1	0.9954 ±0.0001	0.9970±0.0001	0.9984±0.0001

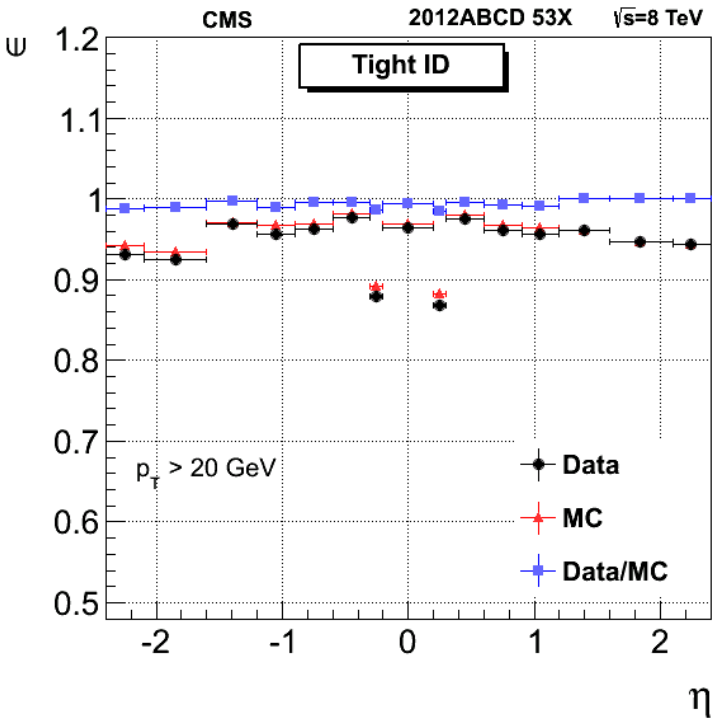
Tight ID

BARREL



Selected probes:
General tracks

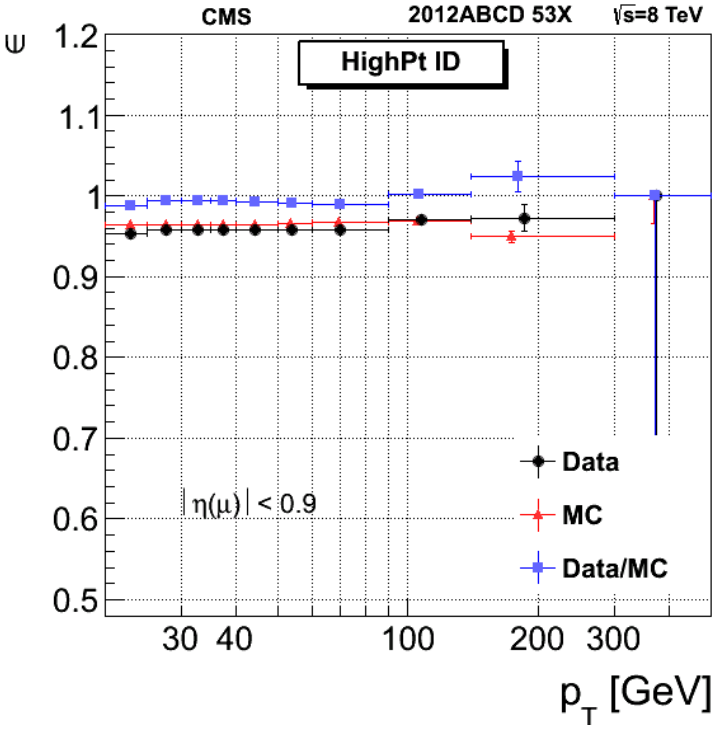
Passing probes:
Tight cuts



	p_T > 20 GeV	Data	MC	Scale Factor
Tight Muons	0<|η|<0.9	0.9576±0.0002	0.9634±0.0001	0.9939±0.0002
	0.9<|η|<1.2	0.9561±0.0002	0.9655±0.0002	0.9902±0.0003
	1.2<|η|<2.1	0.9496±0.0002	0.9525±0.0002	0.9970±0.0003

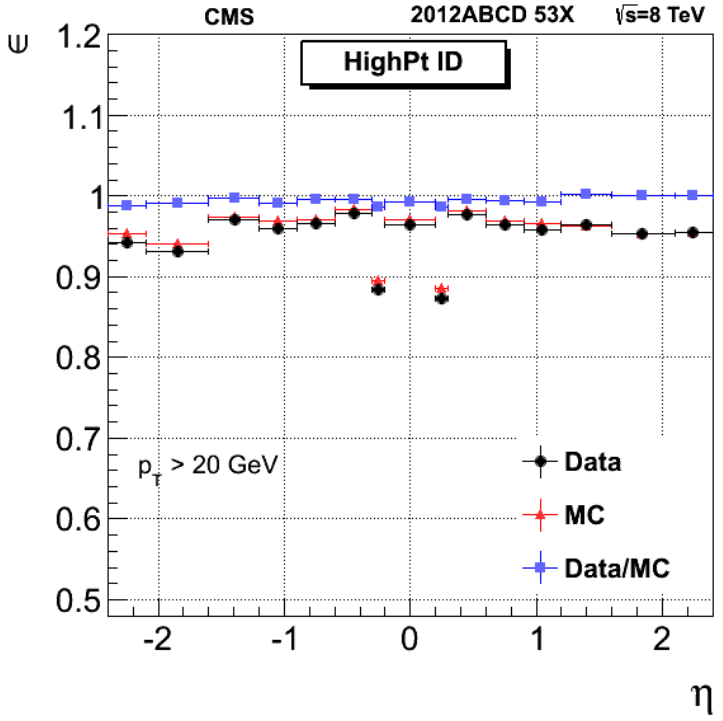
HighPt ID

BARREL



Selected probes:
General tracks

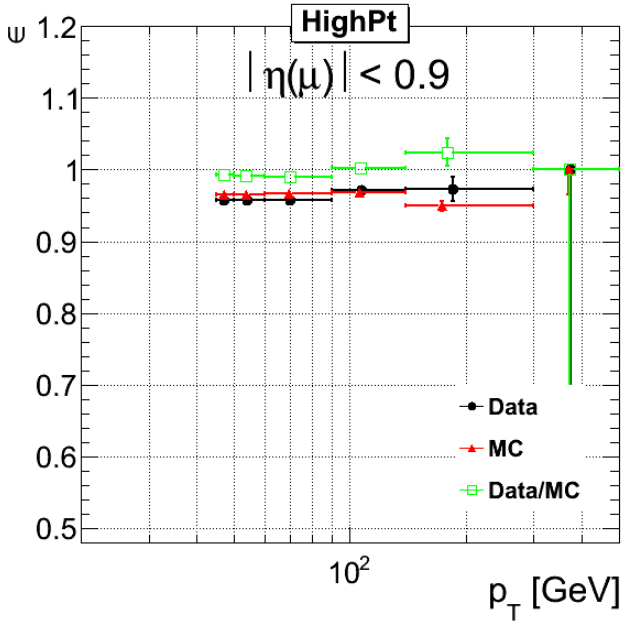
Passing probes:
HighPt cuts



High Pt Muons	p_T > 20 GeV	Data	MC	Scale Factor
	0<|η|<0.9	0. 9585±0.0001	0.9650±0.0001	0.9932±0.0002
	0.9<|η|<1.2	0.9582±0.0002	0.9668±0.0002	0.9911±0.0003
	1.2<|η|<2.1	0.9541±0.0002	0.9565±0.0002	0.9975±0.0002
	2.1<|η|<2.4	0.9478±0.0005	0.9530±0.0004	0.9946±0.0006

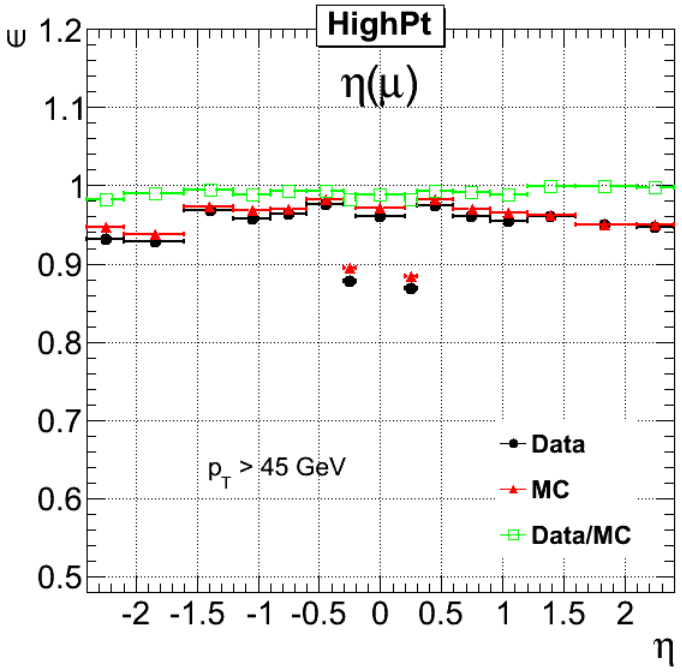
BARREL

HighPt ID (Pt>45 GeV)



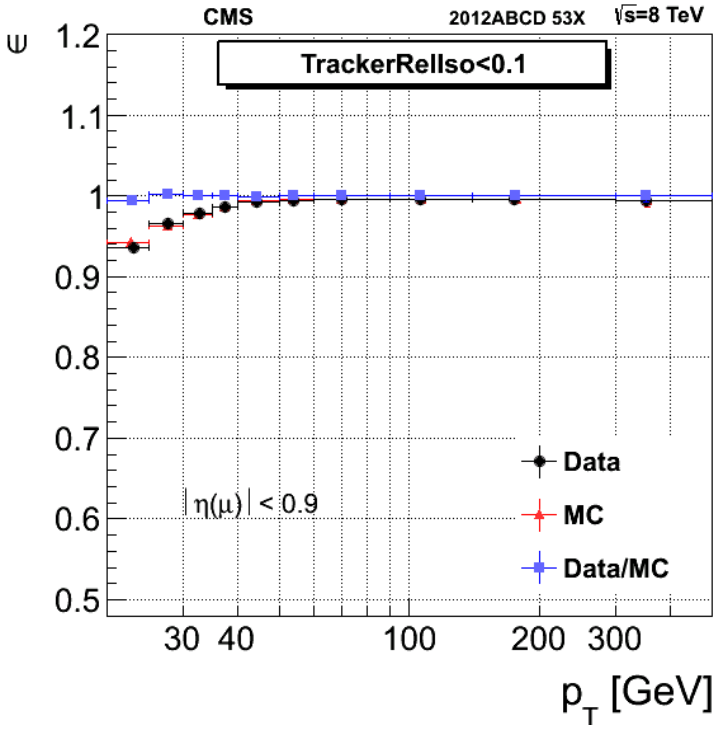
Selected probes:
General tracks

Passing probes:
HighPt cuts



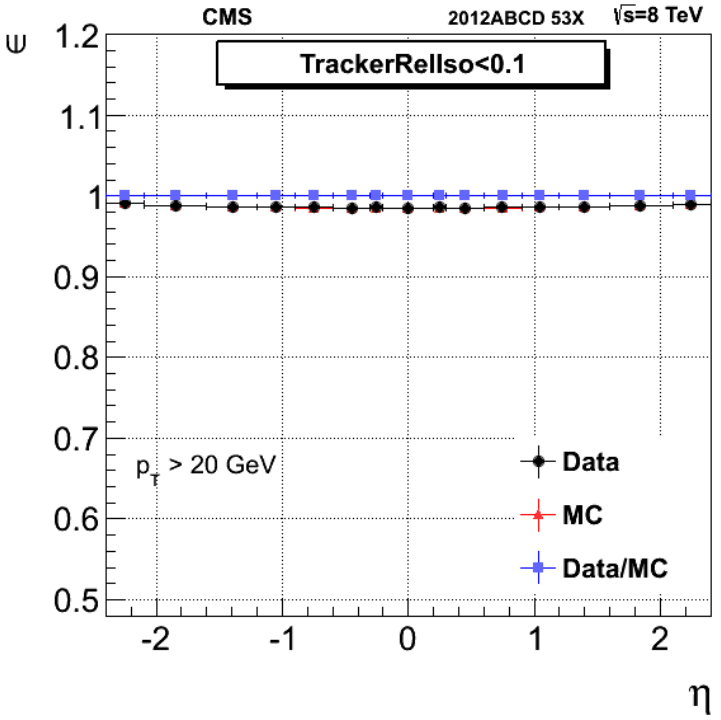
	p_T > 45 GeV	Data	MC	Scale Factor
High Pt Muons	0<|η|<0.9	0. 9553±0.0002	0.9650±0.0002	0.9899±0.0003
	0.9<|η|<1.2	0.9550±0.0004	0.9662±0.0004	0.9884±0.0006
	1.2<|η|<2.1	0.9514±0.0003	0.9554±0.0003	0.9958±0.0005
	2.1<|η|<2.4	0.9386±0.0010	0.9471±0.000	0.9910±0.0013

BARREL Tracker Relative Isolation < 0.1



Selected probes
Tight muons

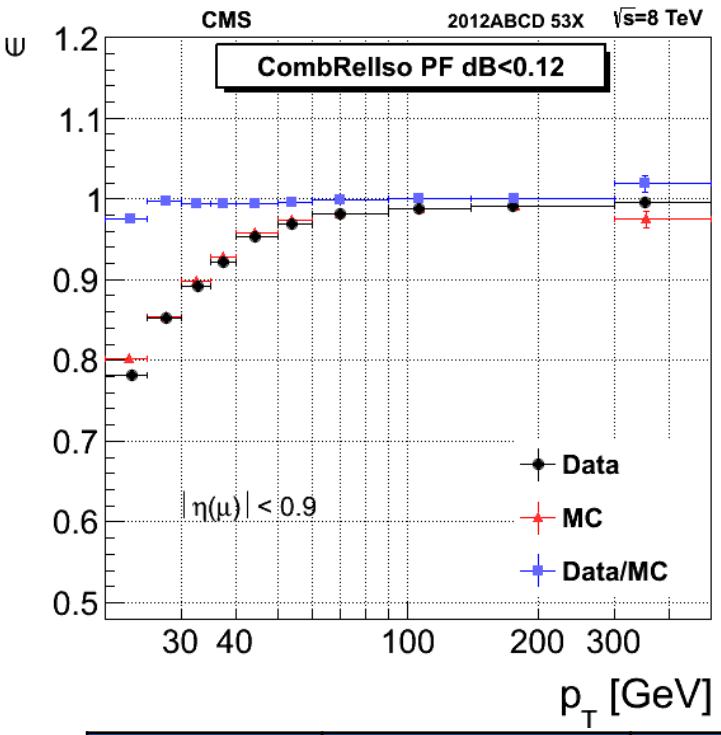
Passing probes:
tk. rel. iso < 0.1
(ΣpT(tk)/pT)
ΔR = 0.3



tkRelIso Muons	p_T > 20 GeV	Data	MC	Scale Factor
	0<|η|<0.9	0.98524±0.00004	0.98483±0.0007	1.00041±0.0009
	0.9<|η|<1.2	0.98606±0.00008	0.98543±0.0001	1.00064±0.0002
	1.2<|η|<2.1	0.98696±0.00005	0.98641±0.0008	1.00056±0.0010

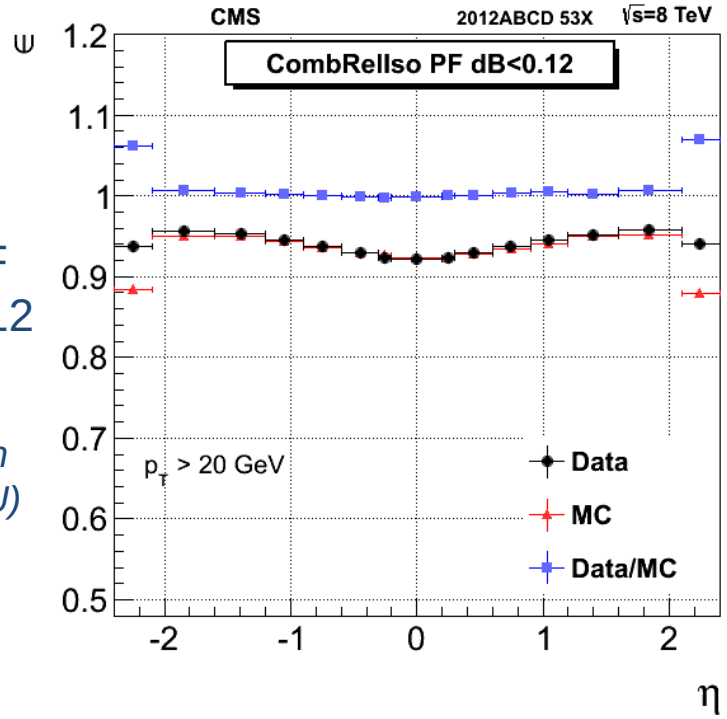
PF Comb. Rel. Isolation (dBeta) < 0.12

BARREL



Selected probes: Tight muons

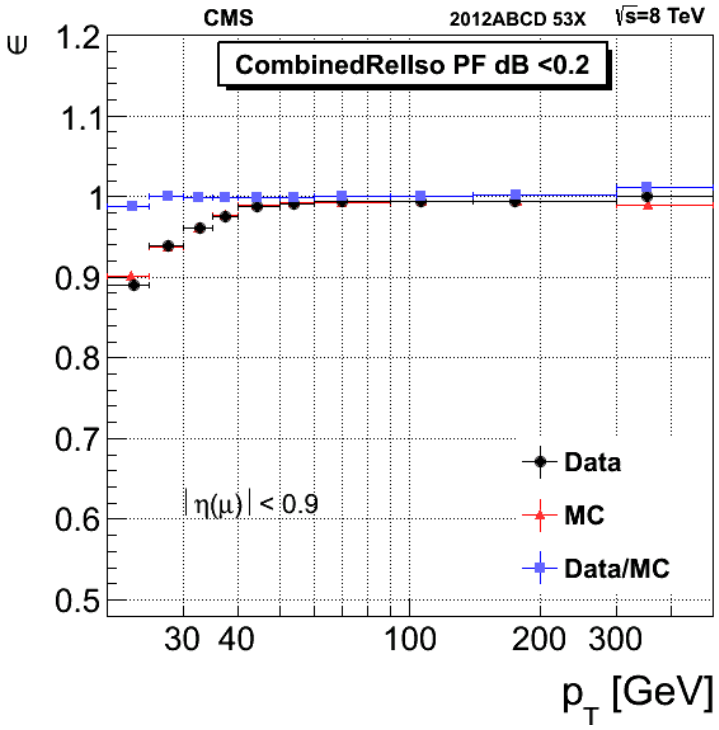
Passing probes: PF comb. rel. iso < 0.12 *(chargedHadronIso +neutralHadronIso +photonIso)/pt, isolation cone ΔR = 0.4, PFnoPU)*



	p_T > 20 GeV	Data	MC	Scale Factor
PFComb RelIso <0.12 Muons	0<|η|<0.9	0.92784±0.0001	0.9275±0.0002	1.0004±0.0002
	0.9<|η|<1.2	0.94346±0.0002	0.94055±0.0003	1.0031±0.0003
	1.2<|η|<2.1	0.953804±0.00009	0.94911±0.0002	1.0050±0.0002

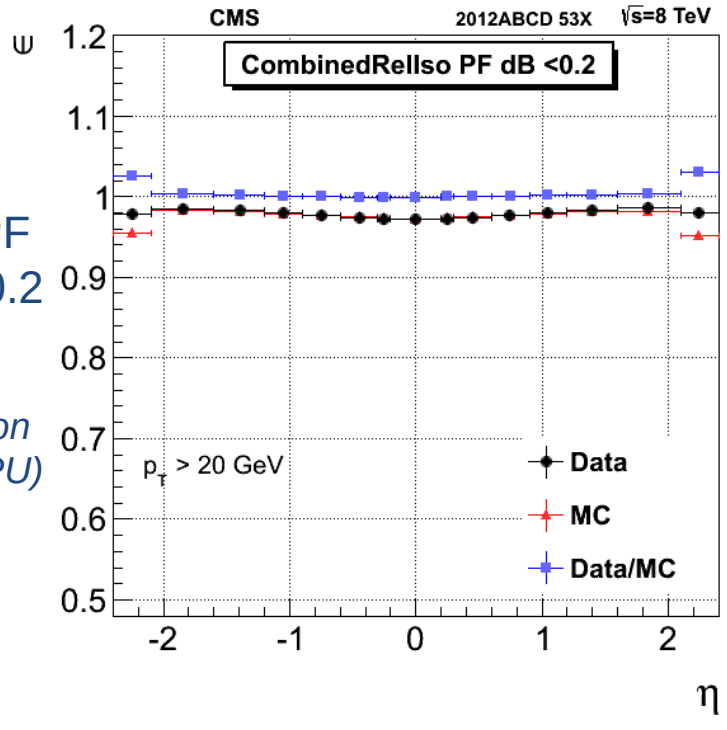
PF Comb. Rel. Isolation (dBeta) < 0.2

BARREL



Selected probes: Tight muons

Passing probes: PF comb. rel. iso < 0.2 *(chargedHadronIso +neutralHadronIso +photonIso)/pt, isolation cone ΔR = 0.4, PFnoPU)*



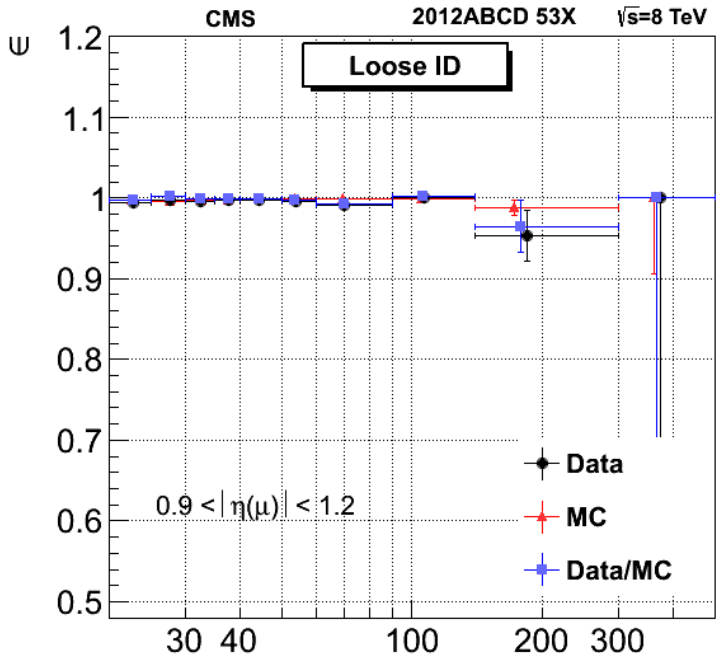
	p_T > 20 GeV	Data	MC	Scale Factor
PFComb RelIso <0.2 Muons	$0<\|\eta\|<0.9$	0.97341±0.00003	0.9738±0.0001	0.9999±0.0001
	$0.9<\|\eta\|<1.2$	0.97920±0.00006	0.9779±0.0002	1.0013±0.0002
	$1.2<\|\eta\|<2.1$	0.98388±0.00003	0.9817±0.0001	1.0023±0.0001

CONCLUSION

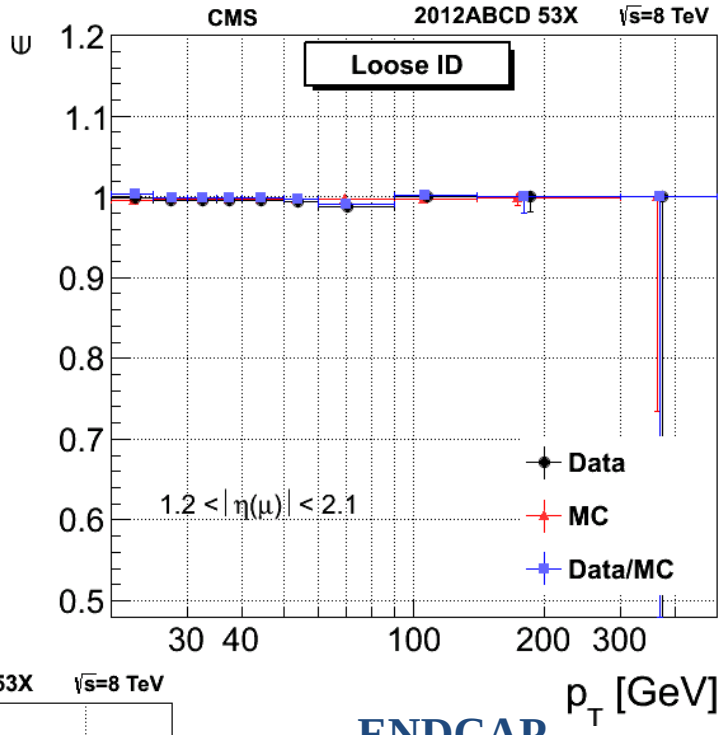
- Very good agreement between data and simulation.
- In the backup you can find plots of the efficiency in terms of pt (for the overlap and endcap regions) and the number of primary vertices.

BACKUP

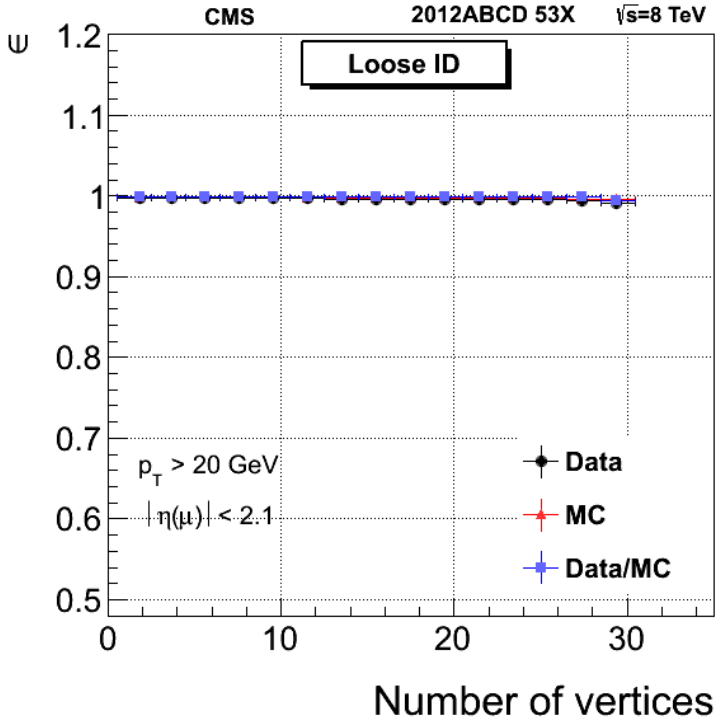
Loose ID



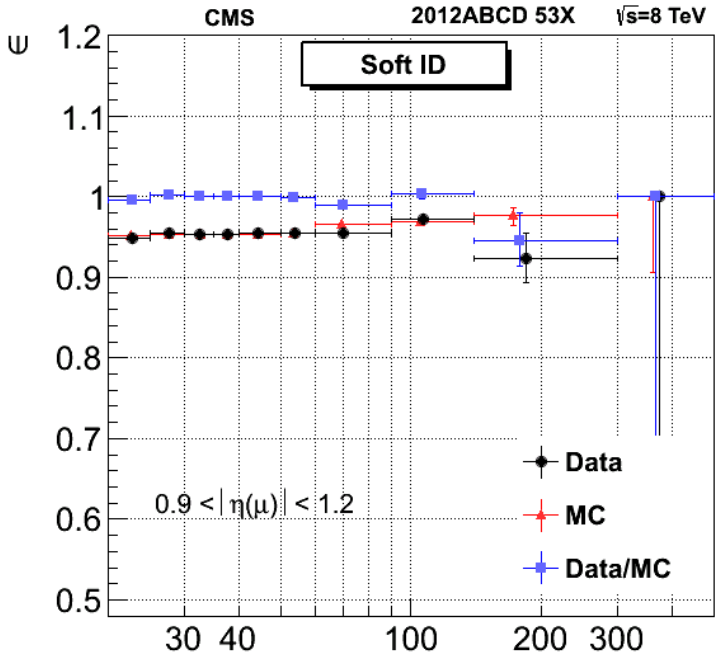
OVERLAP



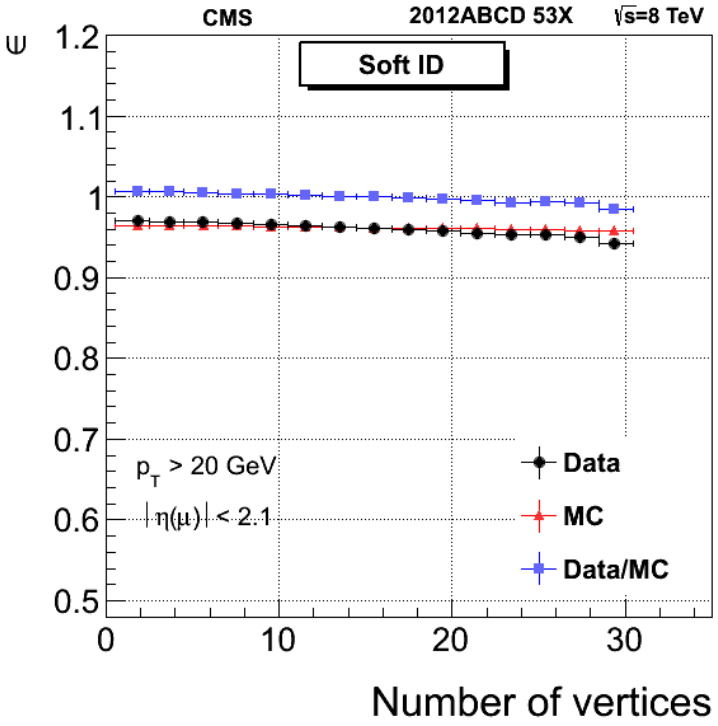
ENDCAP

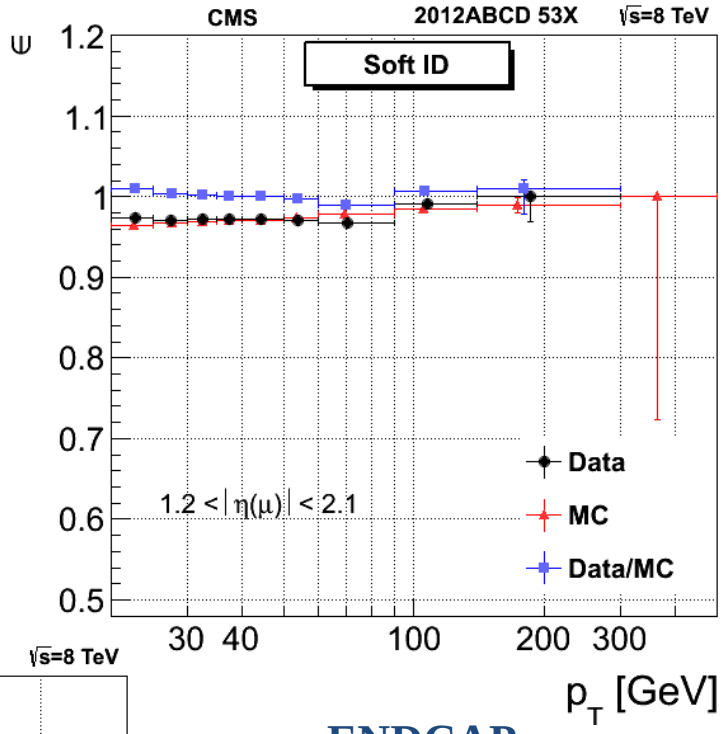


Soft ID



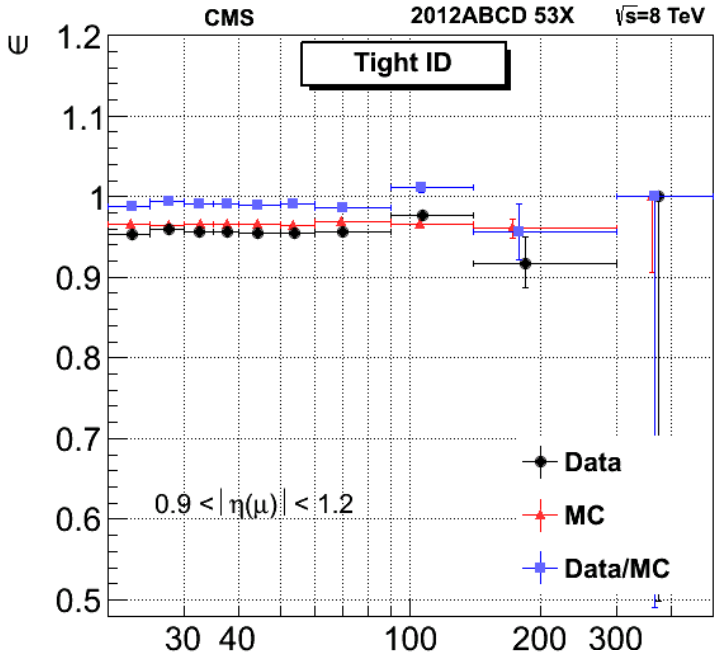
OVERLAP



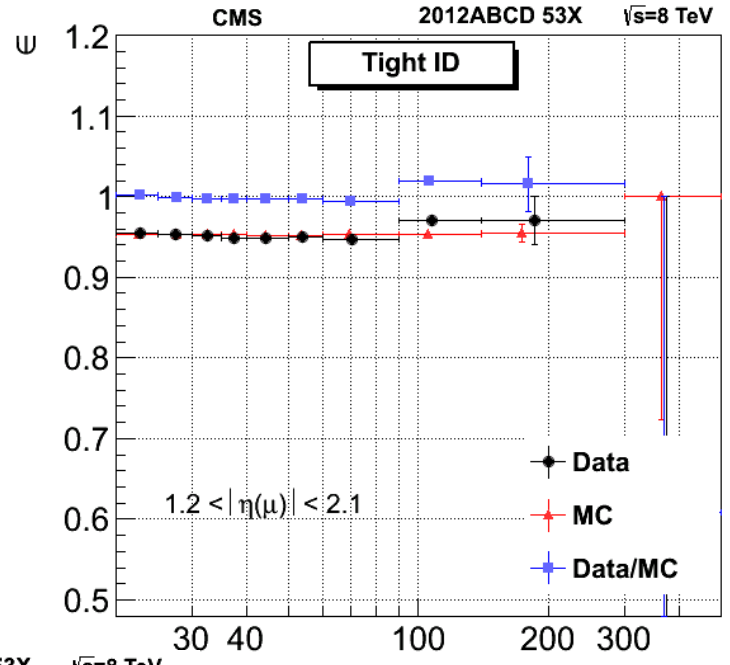


ENDCAP

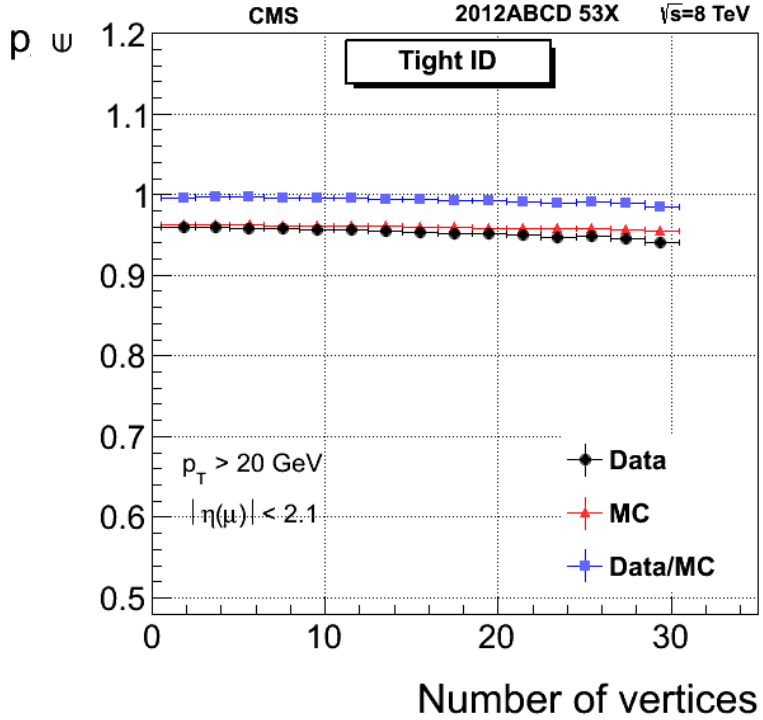
Tight ID



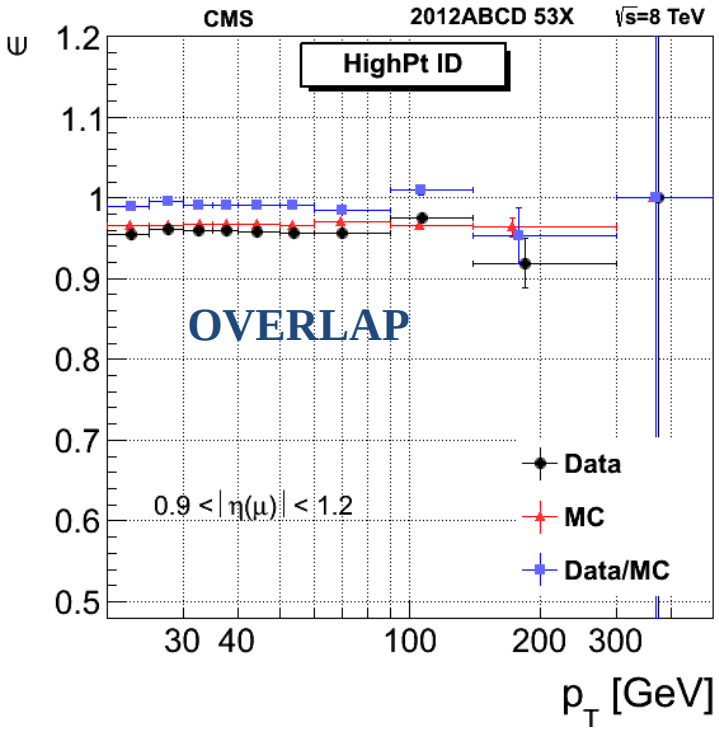
OVERLAP

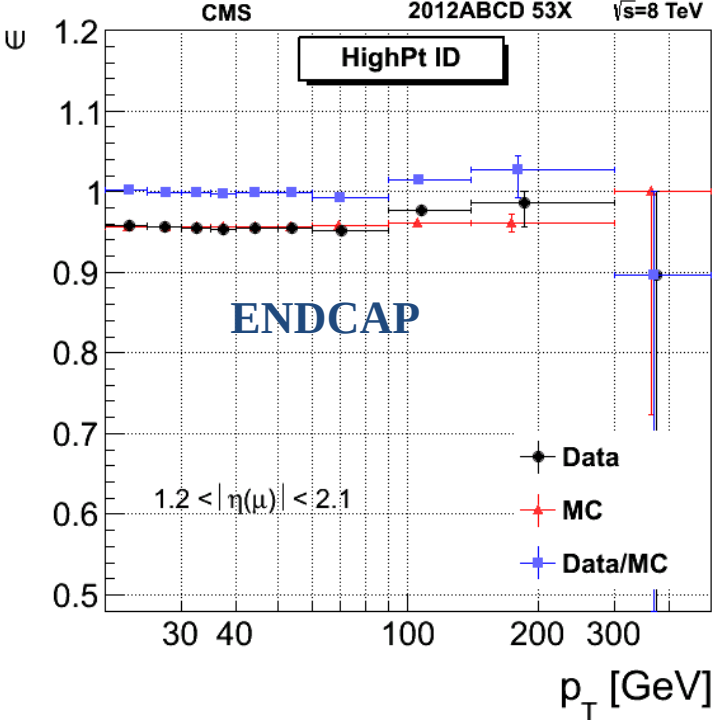


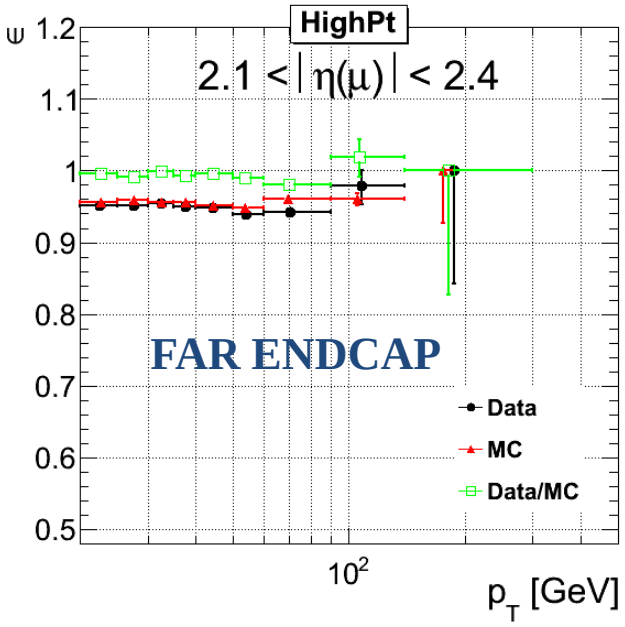
ENDCAP

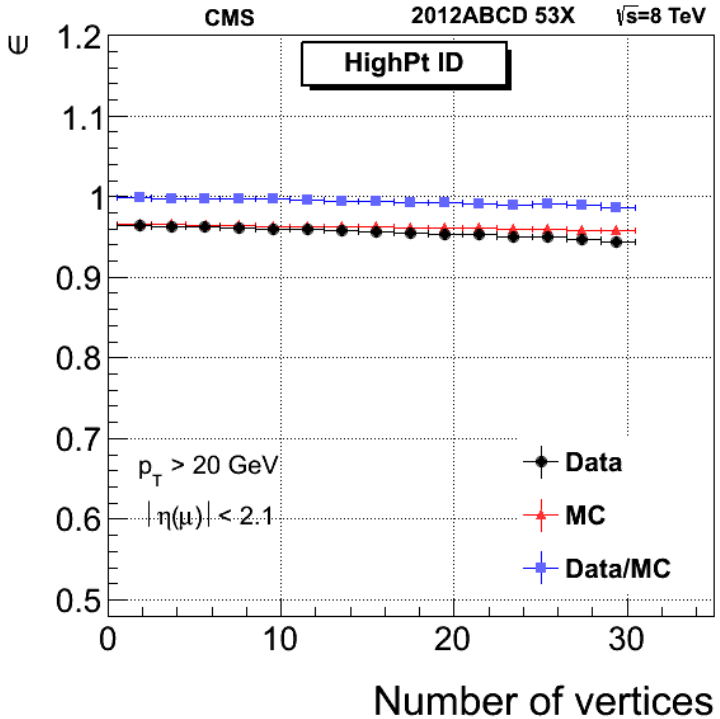


HighPt ID


CMS
2012ABCD 53X
√s=8 TeV
HighPt ID
OVERLAP
0.9 < |η(μ)| < 1.2
Data
MC
Data/MC
ε
p_T [GeV]

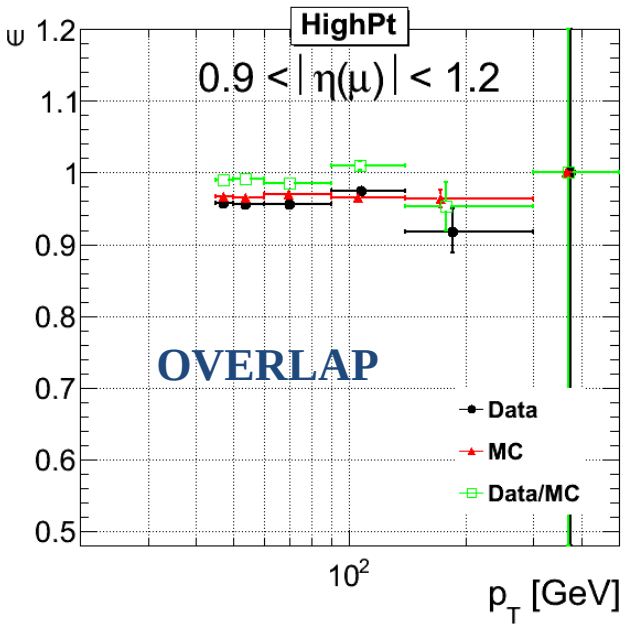

CMS
2012ABCD 53X
√s=8 TeV
HighPt ID
ENDCAP
1.2 < |η(μ)| < 2.1
Data
MC
Data/MC
ε
p_T [GeV]

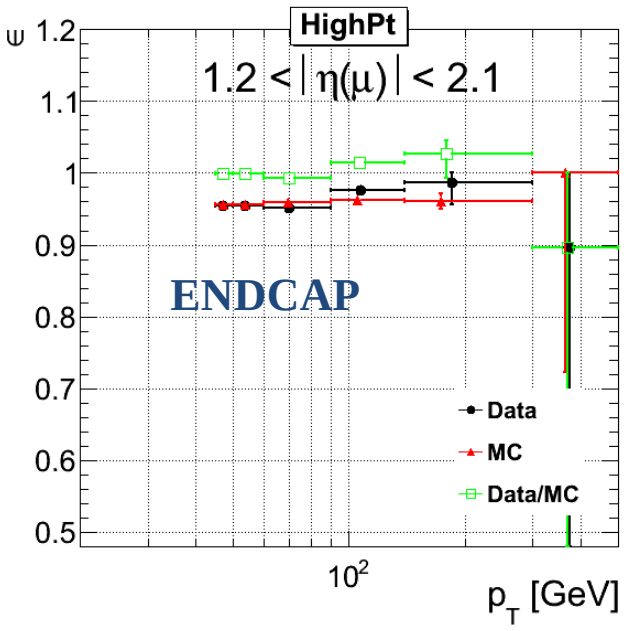

HighPt
2.1 < |η(μ)| < 2.4
FAR ENDCAP
Data
MC
Data/MC
ε
p_T [GeV]

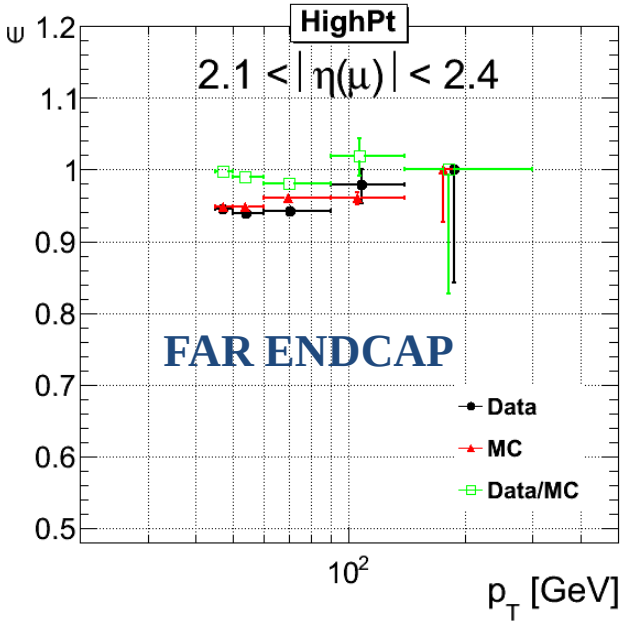

CMS
2012ABCD 53X
√s=8 TeV
HighPt ID
p_T > 20 GeV
|η(μ)| < 2.1
Data
MC
Data/MC
ε
Number of vertices

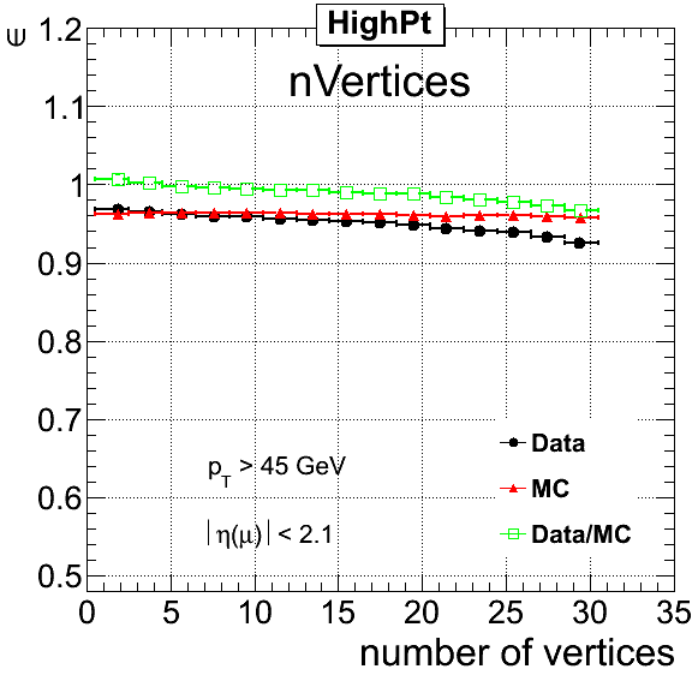
HighPt ID

Pt > 45 GeV

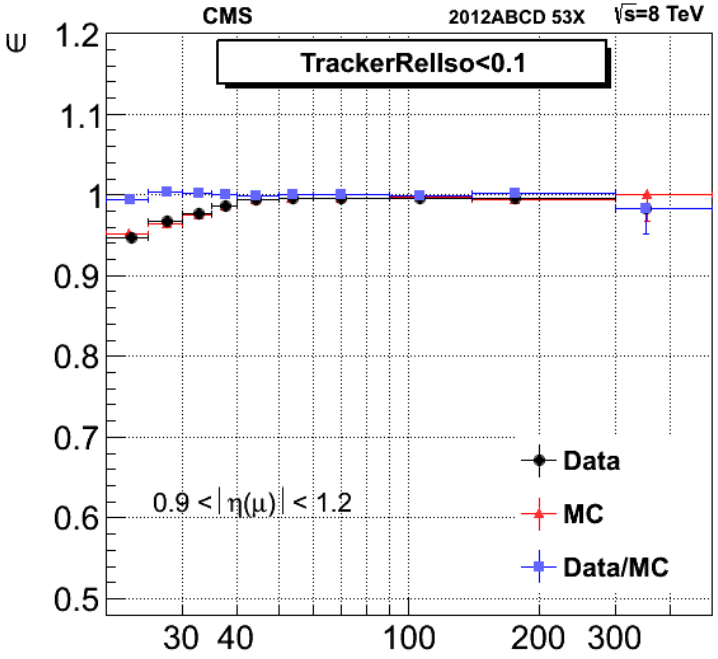




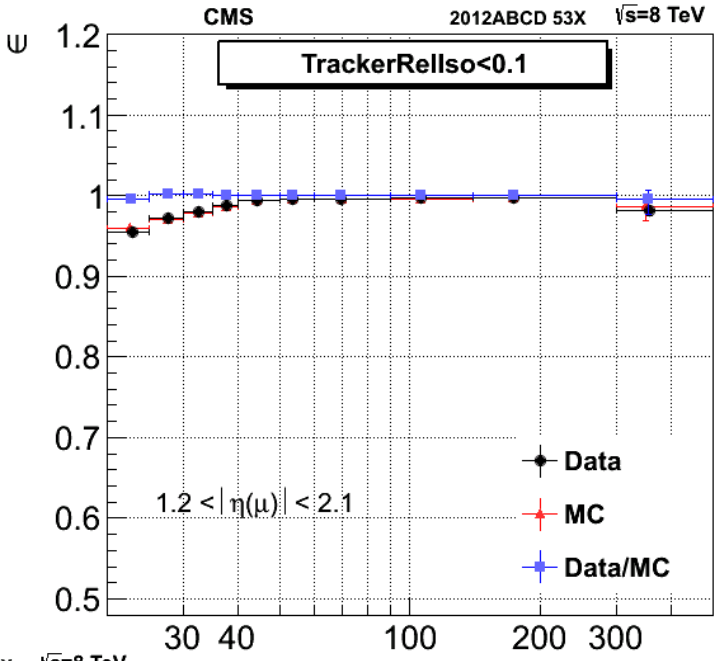




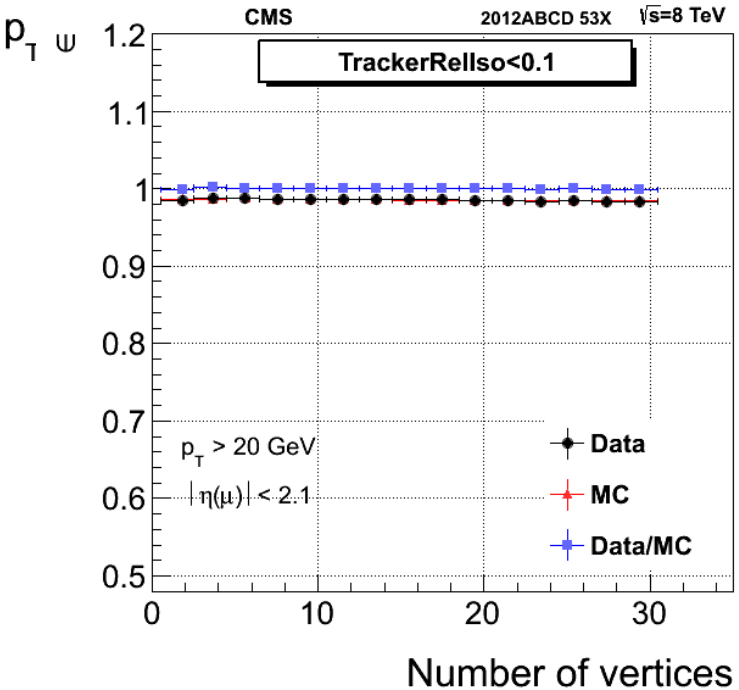
Tracker Relative Isolation < 0.1



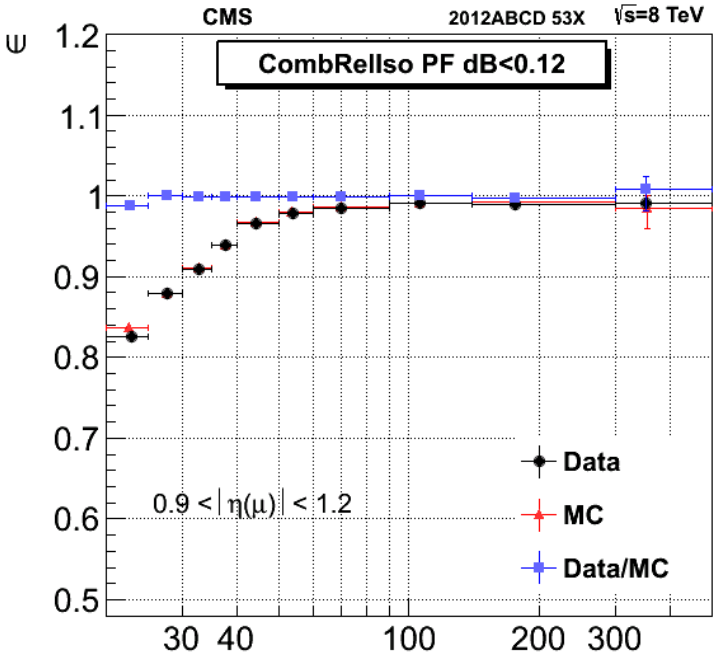
OVERLAP



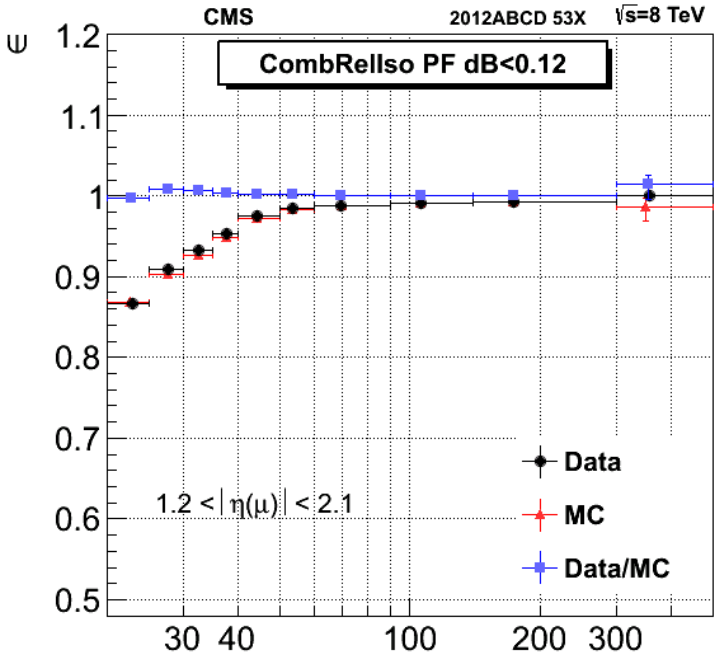
ENDCAP



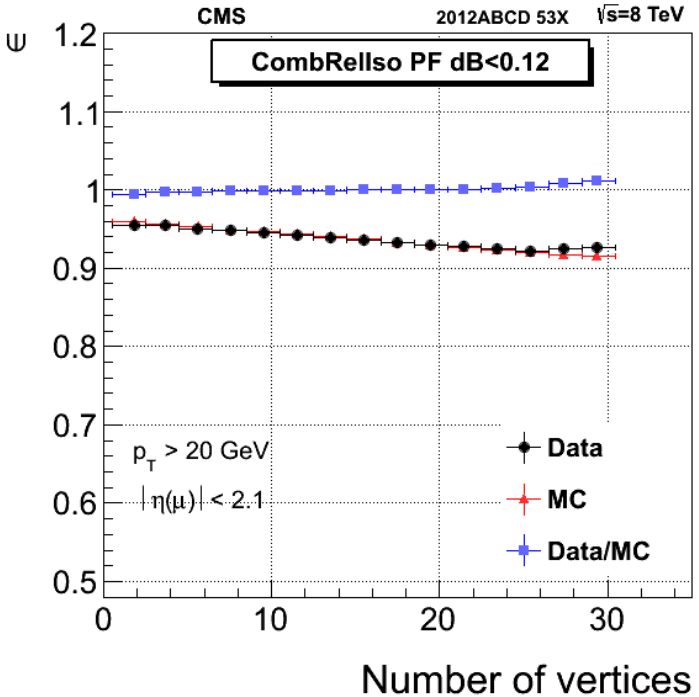
PF Comb. Rel. Isolation (dBeta) < 0.12



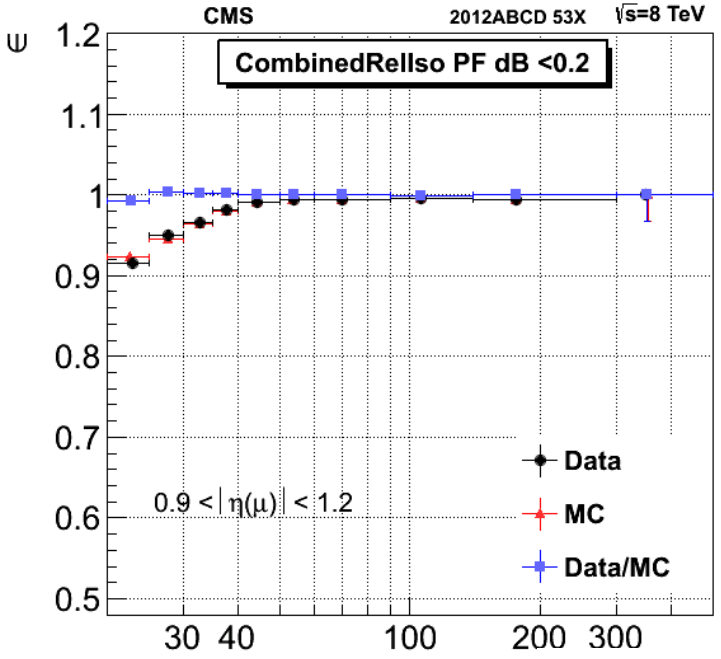
OVERLAP



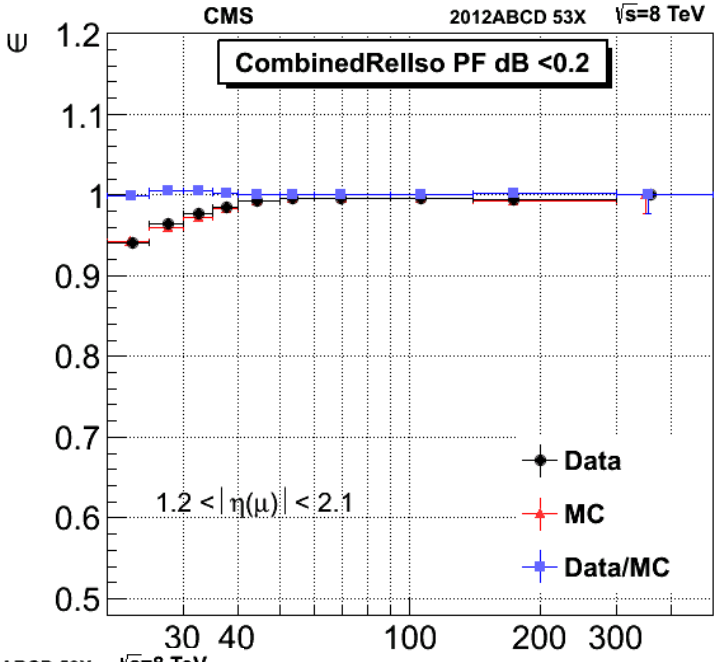
ENDCAP



PF Comb. Rel. Isolation (dBeta) < 0.2



OVERLAP



ENDCAP