Period 25 High PT Lepton Efficiencies and SF -NEW MonteCarlo

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Tufts

Electrons ID: Samples

Dataset bhelmm: Runs 275873-277511 (P25)
MC sample : zektek (Feb 2009)
GRL :GRL for P25 Prelim
(goodrun_em_si_v31.list, goodrun_em_nosi_v31.list)

P25 skim leptons
MC dataset zektek on SAM

Electron ID: Cuts

CEM Selection Cuts

Variable	Tight (CEM)
Region	== CEM
Fiducial	Fiducial == 1
E_T	$\geq$ 20 GeV
Track Z_0	$\leq$ 60 cm
Track p_T	$\geq$ 10 GeV/c
COT Ax. Seg.	$\geq$ 3
COT St. Seg.	$\geq$ 2
Conversion	$\neq$ 1
Had/em	$\leq (0.055 + (0.00045 \times E))$
Isolation	$\leq$ 0.1
LshrTrk	$\leq$ 0.2
E/P	$\leq$ 2.0 unless $p_T \geq$ 50GeV/c
CES ΔZ	$\leq$ 3.0 cm
Signed CES ΔX	$-3.0 \leq q \times \Delta X \leq 1.5$
CES StripChi2	$\leq$ 10.0

Z candidates are used to calculate the efficiencies

Plug Selection Cuts

Variable	PHX	PEM
E_T	$\geq$ 20GeV	$\geq$ 20GeV
Pes2dEta	$1.2 \leq \lvert\eta\rvert \leq 2.8$	$1.2 \leq \lvert\eta\rvert \leq 2.8$
Had/Em	$\leq$ 0.05	$\leq$ 0.05
Pem3x3FitTow	$\neq$ 0	$\neq$ 0
Pem3x3Chisq	$\leq$ 10	$\leq$ 10
Pes5by9U	$\geq$ 0.65	$\geq$ 0.65
Pes5by9V	$\geq$ 0.65	$\geq$ 0.65
Isolation	$\leq$ 0.1	$\leq$ 0.1
ΔR	$\leq$ 3.0 cm	$\leq$ 3.0 cm
PhxMatch	TRUE	-
N_{hits}^{Si}	$\geq$ 3	-
$\lvert z_0^{PHX}\rvert$	$\leq$ 60 cm	-

We calculate efficiencies using a set of very loose, or "probe" electrons as the denominator. For each tight electron in the event which passes the trigger, we look for probe electrons which have the opposite sign and which, paired with the tight electron, have an invariant mass in the Z window 76 GeV/c^2 < M < 106 GeV/c^2. (Central-Central)

We calculate Phoenix electron efficiencies using central-plug Z candidates in the mass window 81 GeV/c^2 < M < 101 GeV/c^2. Due to the non-negligible, and η-dependent, Phoenix charge fake rate, there is no opposite-sign requirement.

P25

	Period 25		Period 25	
	bhelmm	zektei	bhelmm	zektek
CEM Eff	0.774+\-0.004	0.795 +\-0.001	0.774+\-0.004	0.793 +\-0.003
CEM SF	0.973 +\-0.006	N/A	0.975 +\-0.006	N/A
nisoCEM Eff	0.812 +\-0.004	0.825 +\-0.001	0.812 +\-0.004	0.825 +\-0.003
nisoCEM SF	0.985 +\-0.005	N/A	0.983 +\-0.005	N/A
LooseCEM Eff	0.901 +/- 0.003	0.907 +\-0.001	0.901 +/- 0.003	0.901 +\-0.003
LooseCEM SF	0.994 +\-0.004	N/A	1.000 +\-0.005	N/A
nisolooseCEM Eff	0.948+\-0.002	0.943 +\-0.001	0.948+\-0.002	0.940 +\-0.003
nisoloostCEM SF	1.005 +\-0.003	N/A	1.008 +\-0.004	N/A

	PHX	
Eff |Eta| < 2.0	0.654+\-0.006	0.746+\-0.004
SF |Eta| < 2.0	0.876+\-0.010	NA
	PHX	
Eff |Eta| < 2.8	0.569+\-0.006	0.644+\-0.004
SF |Eta| < 2.8	0.883+\-0.011	NA

CEM-PEM

	PEM	
Eff |Eta| < 2.0	0.739+\-0.006	0.843+\-0.003
SF |Eta| < 2.0	0.876+\-0.008	NA

	PEM	
Eff |Eta| < 2.8	0.697+\-0.005	0.803+\-0.003
SF |Eta| < 2.8	0.867+\-0.008	NA

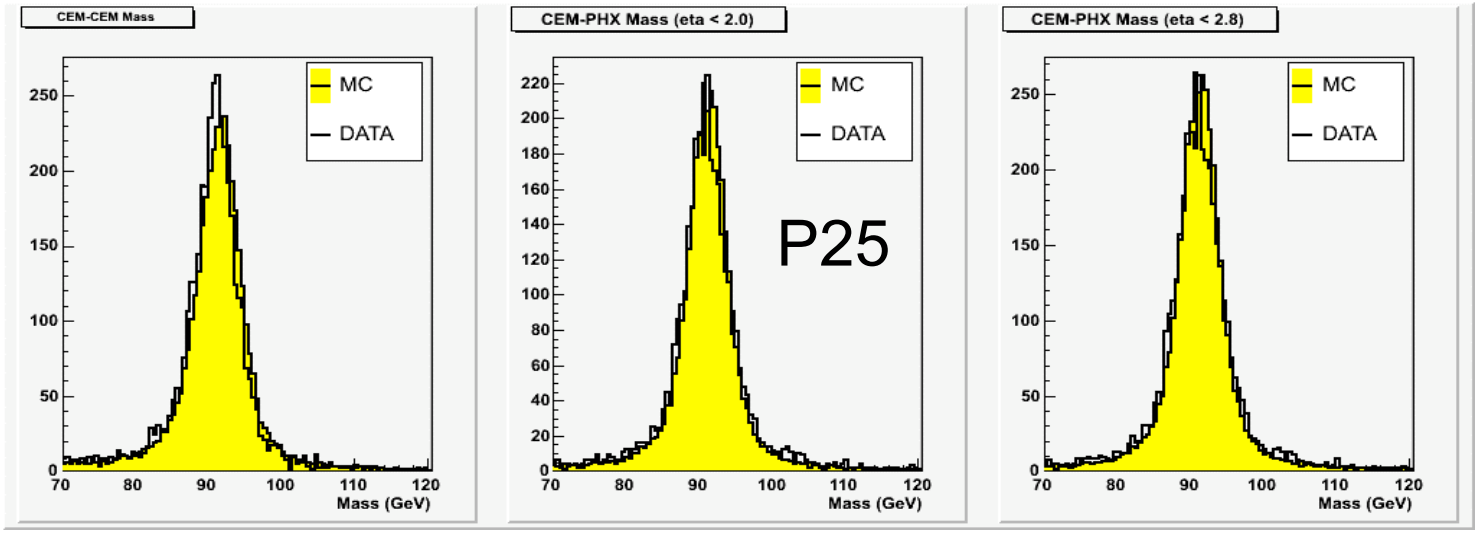
P25vs zektek

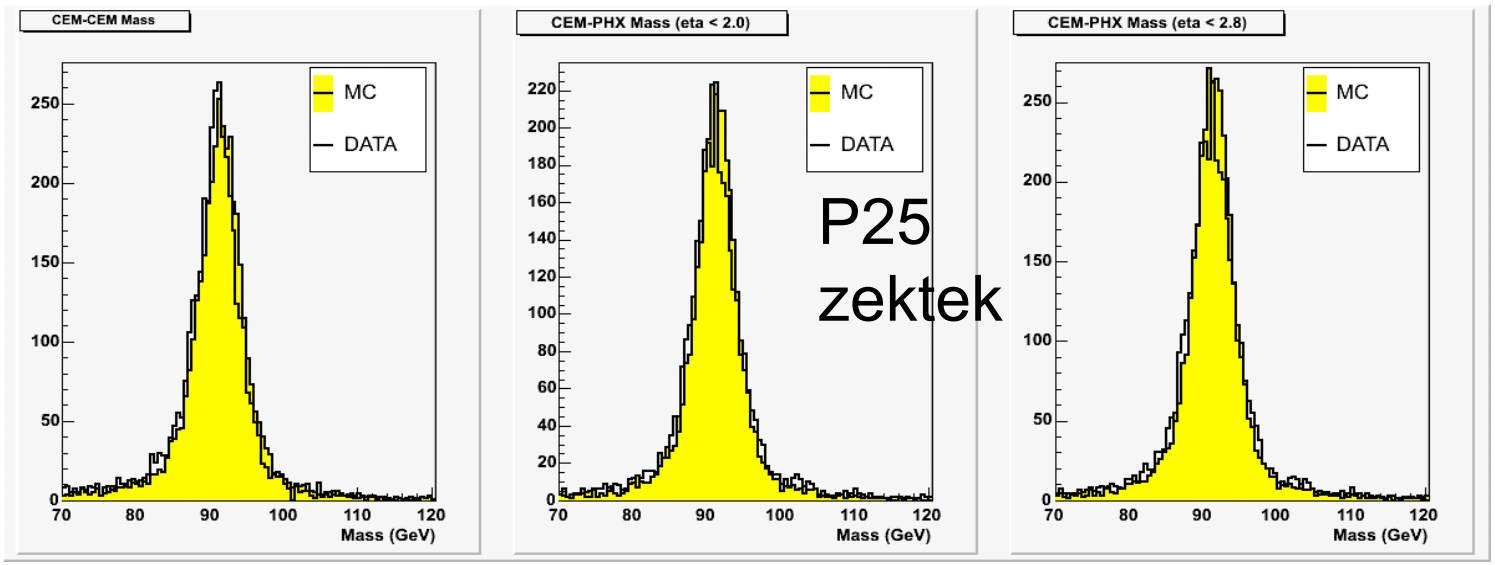
	PEM	
Eff |Eta| < 2.0	0.739+\-0.006	0.847+\-0.002
SF |Eta| < 2.0	0.873+\-0.008	NA

	PEM	
Eff |Eta| < 2.8	0.697+\-0.005	0.810+\-0.001
SF |Eta| < 2.8	0.861+\-0.007	NA

P25vs zektei

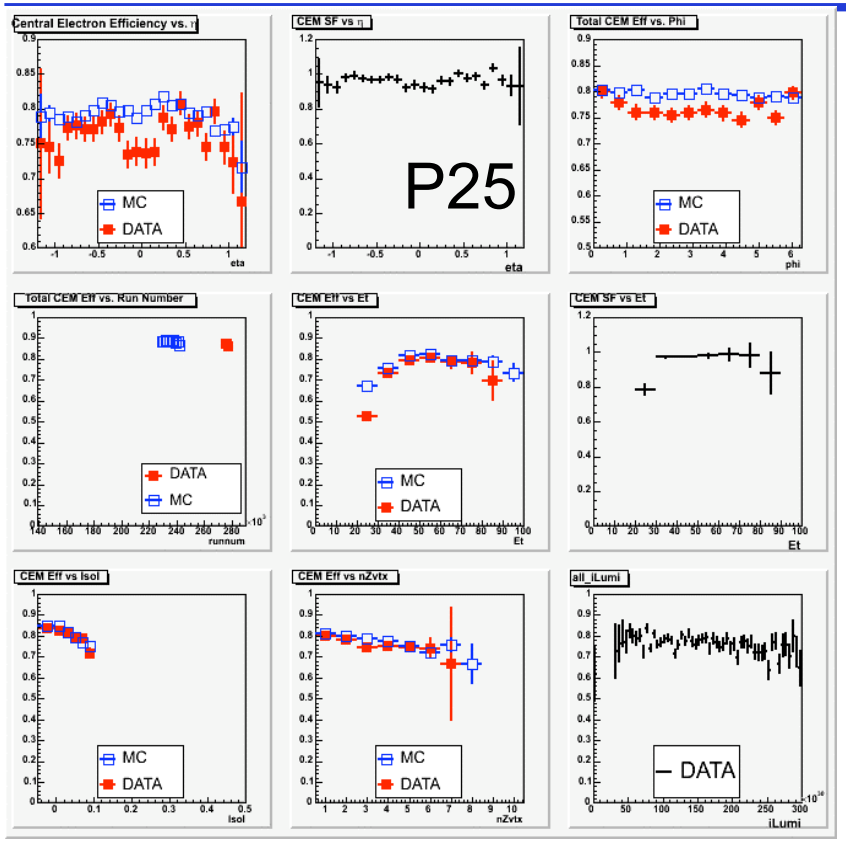
EleID Plots

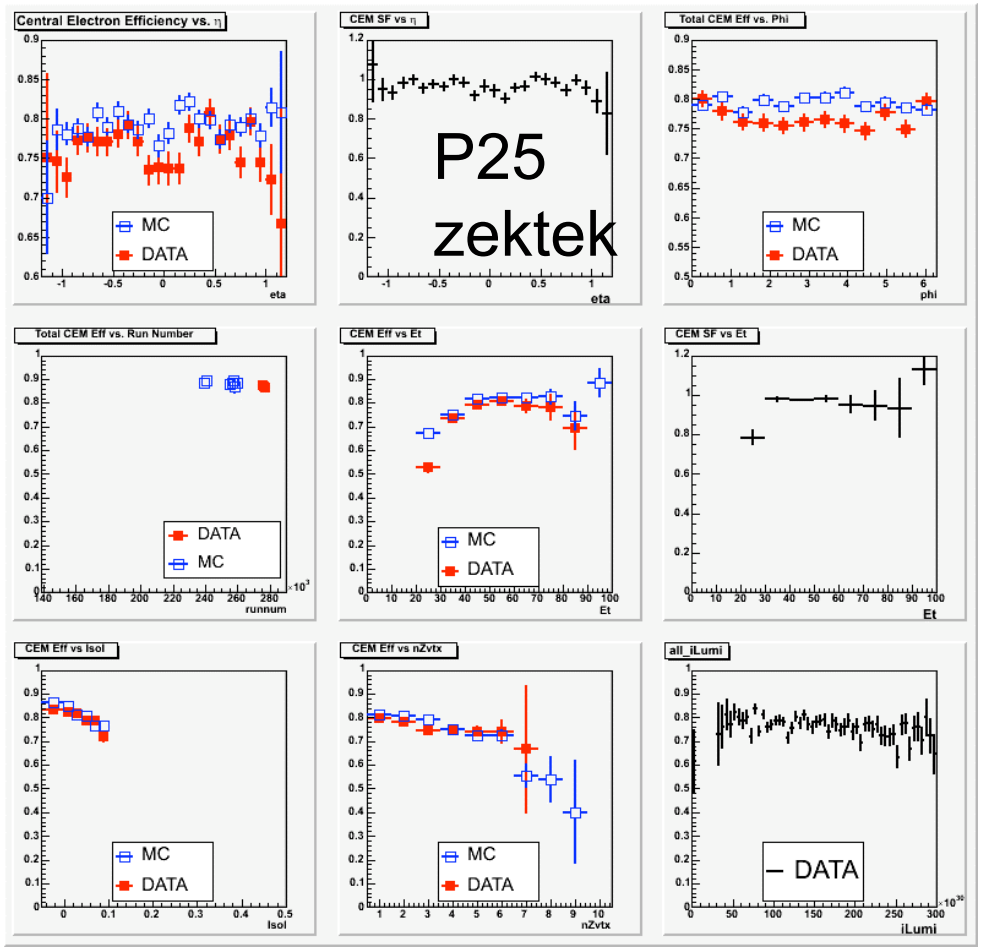

CEM-CEM Mass
CEM-PHX Mass (eta < 2.0)
CEM-PHX Mass (eta < 2.8)
MC
DATA
Mass (GeV)
P25


CEM-CEM Mass
CEM-PHX Mass (eta < 2.0)
CEM-PHX Mass (eta < 2.8)
MC
DATA
Mass (GeV)
P25
zektek

EleID Plots 1

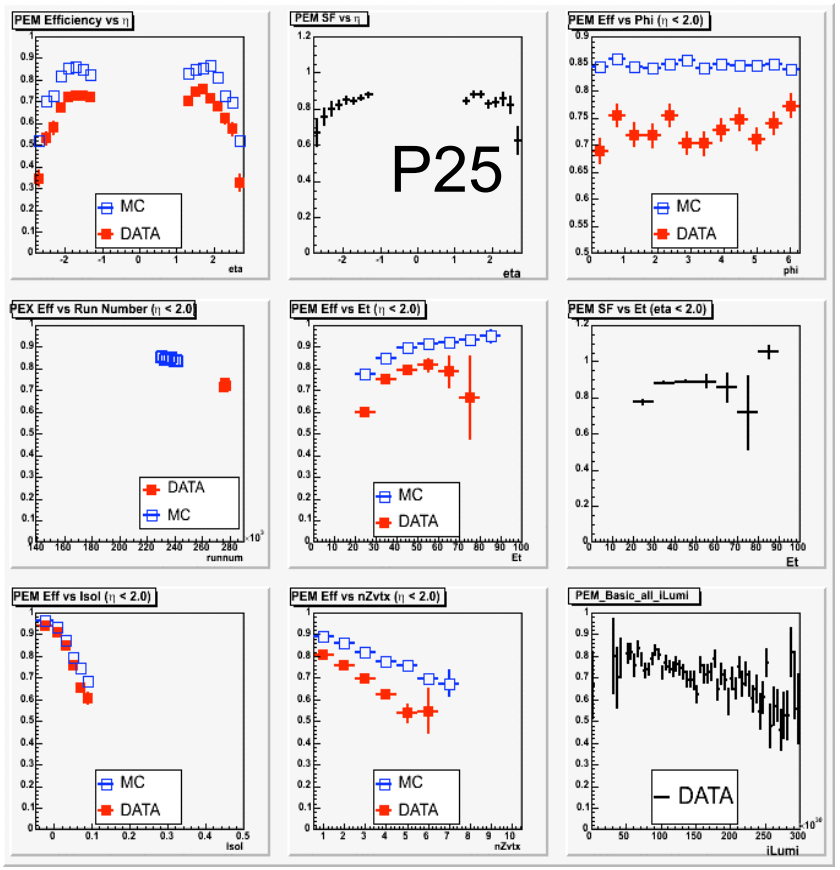
CEM Efficiencies

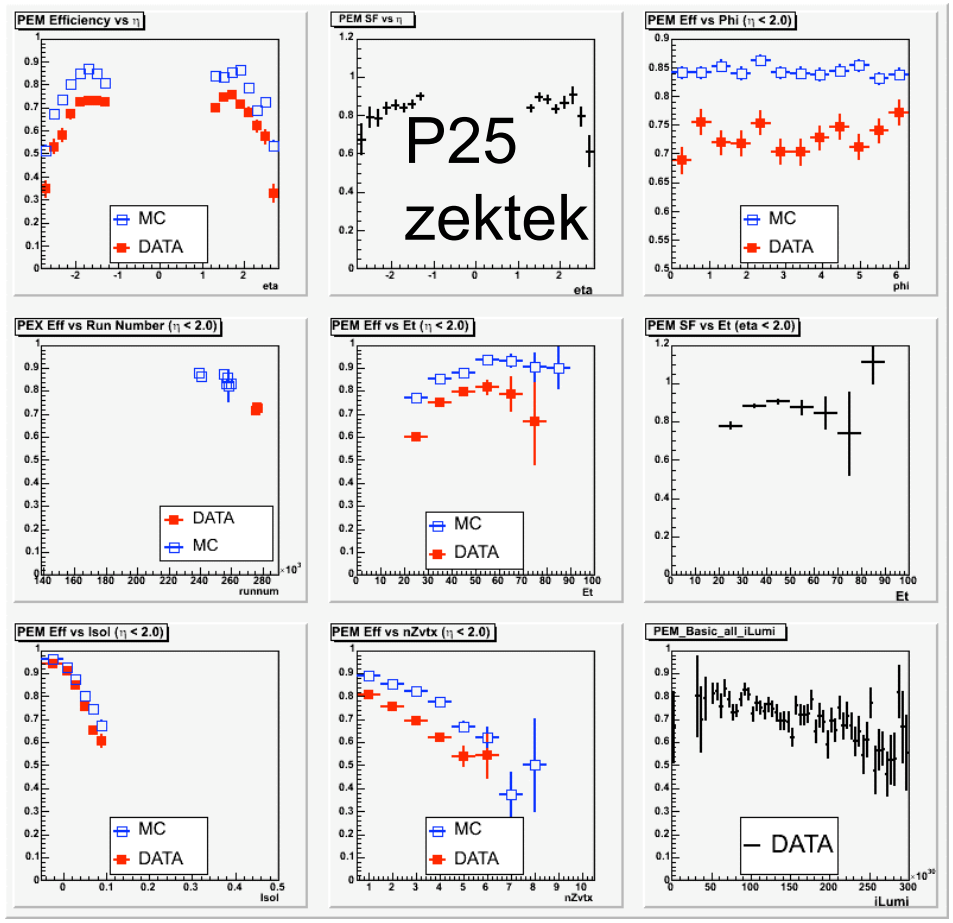




EleID Plots 2

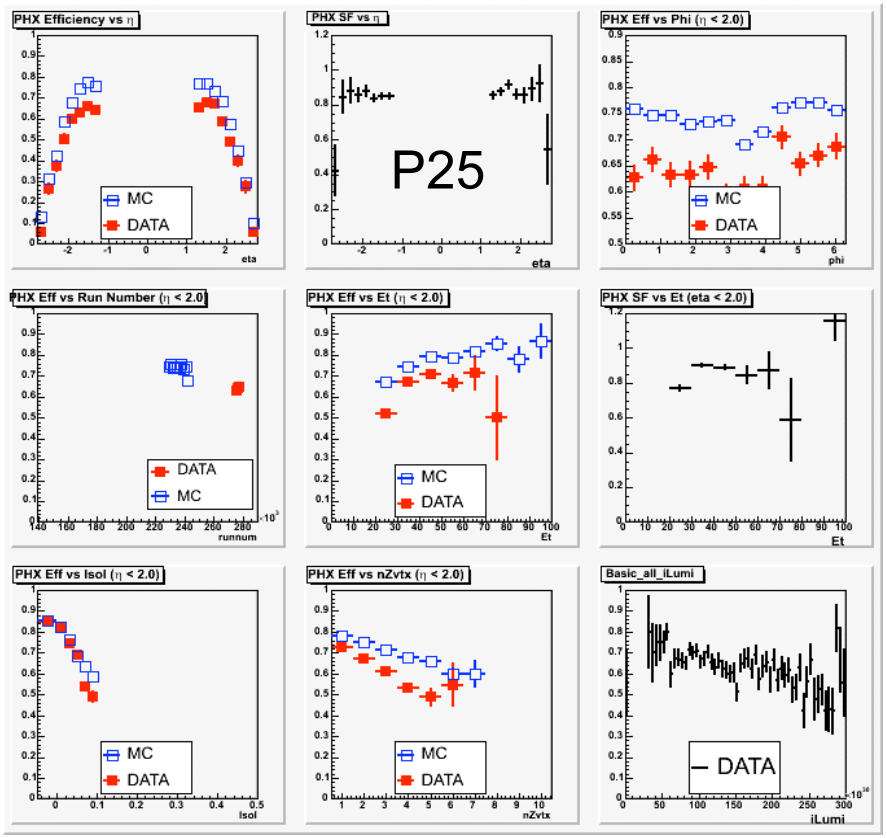
PEM Efficiencies

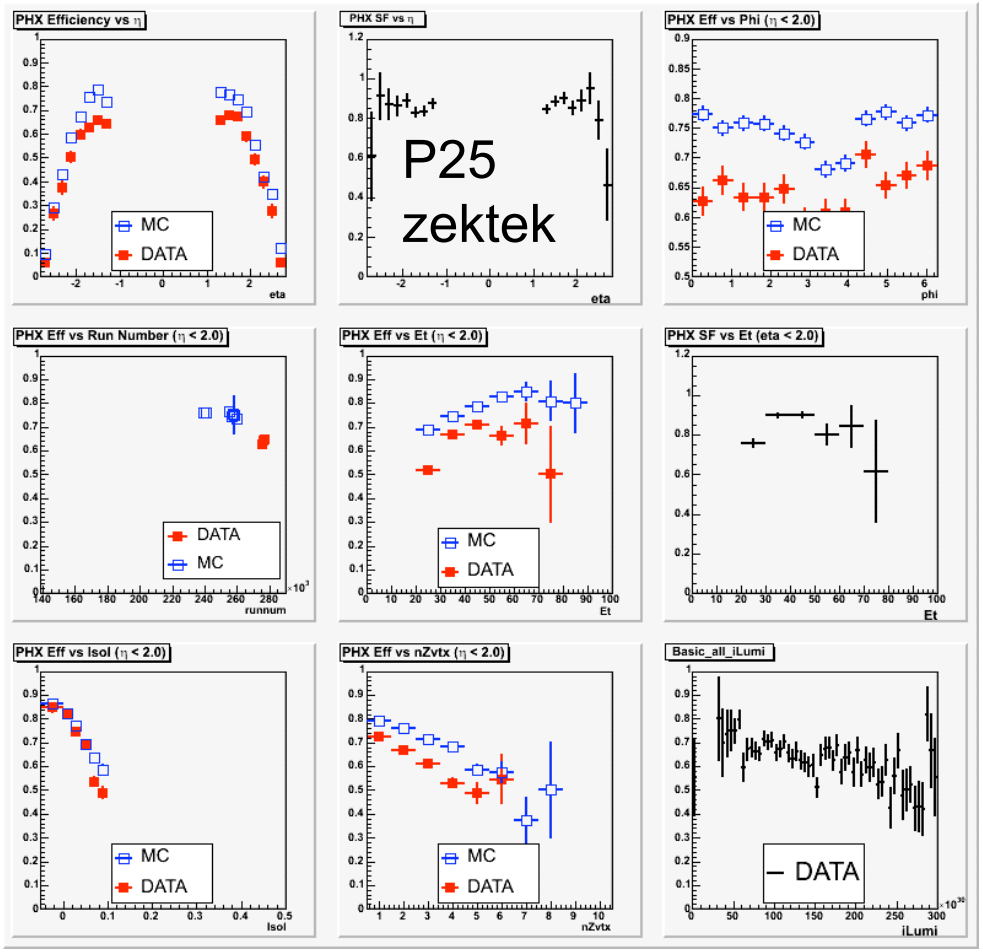




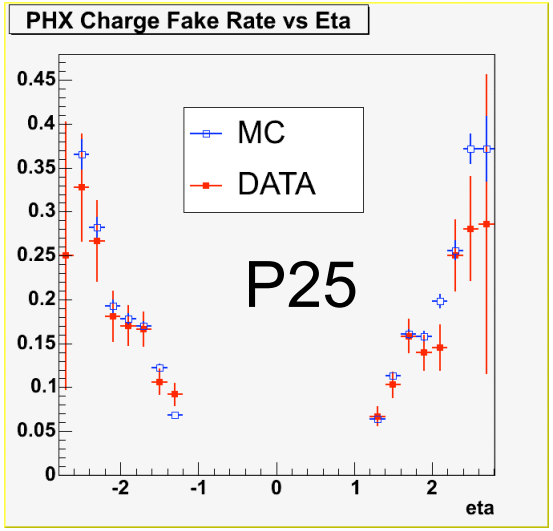
EleID Plots 3

PHX Efficiencies

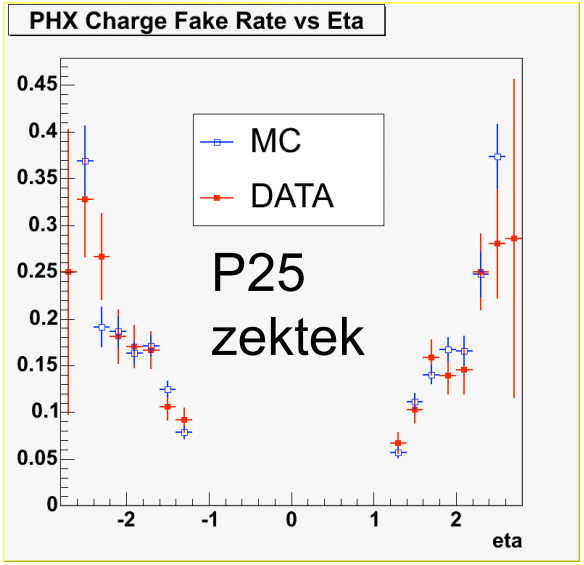


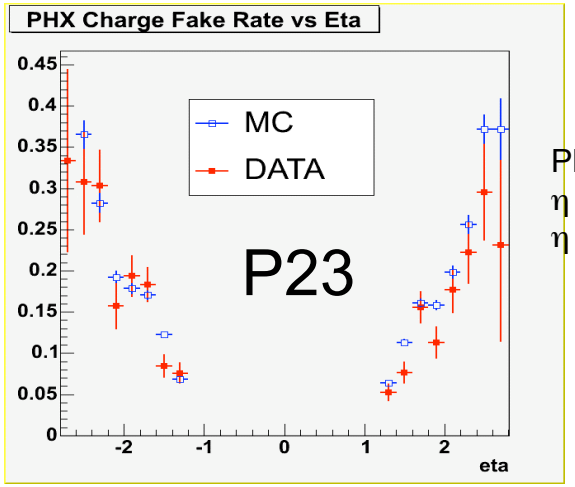


PHX Fake Charge Rate

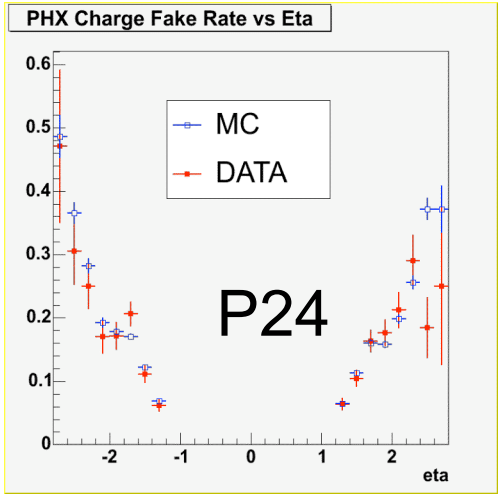


Phoenix charge fake rate
$\eta < 2.0$ 0.119 +/- 0.006
$\eta < 2.8$ 0.137 +/- 0.006





Phoenix charge fake rate
$\eta < 2.0$ 0.109 +/- 0.006
$\eta < 2.8$ 0.132 +/- 0.006



Phoenix charge fake rate
$\eta < 2.0$ 0.124 +/- 0.005
$\eta < 2.8$ 0.144 +/- 0.005

Muons

Dataset bhmumm: Runs 275873-277511 (P25)
MC sample : zemtjm (Feb 2009)
GRL : GRL for P25 v31 prelim
goodrun_em_mu_nosi_cmxignored_v31.list,
goodrun_em_mu_si_cmxignored_v31.list

Data: P25 Data on SAM : bhmumm
MC: dataset zemtjm on SAM

Muon ID Efficiency: ID Cuts

For all events:

No cosmic tag.

For all muon types (including stubless muons):

P_T	$>$	20 GeV/c
E_{EM}	$<$	$2+\max(0,(p-100)\cdot 0.0115)$ GeV
E_{HAD}	$<$	$6+\max(0,(p-100)\cdot 0.028)$ GeV
$E_T^{isol.}/P_T$	$<$	0.1
Number of axial SL with $\geq$ 5 hits	$\geq$	3
Number of stereo SL with $\geq$ 5 hits	$\geq$	2
$\lvert z_0 \rvert$	$<$	60 cm
Tracks w/ no silicon hits: $\lvert d_0 \rvert$	$<$	0.2 cm
Tracks w/ silicon hits: $\lvert d_0 \rvert$	$<$	0.02 cm

Additionally for tight CMUP muons:

$\lvert \Delta x_{CMU} \rvert$	$<$	7 cm
$\lvert \Delta x_{CMP} \rvert$	$<$	5 cm
No bluebeam muons, run	$<$	154449

Additionally for tight CMX muons:

$\lvert \Delta x_{CMX} \rvert$	$<$	6 cm
Run	$>$	150144
No miniskirt or keystone muons, run	$<$	190697
No muons in wedge 14 west, runs	$\geq$	190697 and $\leq$ 209760

Table 1: Standard muon ID cuts for 6.1.4 data MC.

Fiducial cuts

For CMUP muons:

Fiducial distance from CMU:		
x-fid	$<$	0 cm
z-fid	$<$	0 cm
Fiducial distance from CMP:		
x-fid	$<$	0 cm
z-fid	$<$	-3 cm
No muons from bluebeam region for run $<$ 154449		

For CMX muons:

ρ_{COT}	$>$	140 cm
Fiducial distance from CMX:		
x-fid	$<$	0 cm
z-fid	$<$	-3 cm
No muons from keystone region for run $<$ 190697		
No muons from miniskirt region for run $<$ 190697		
No muons wedge 14 west for runs $\geq$ 190697 and $\leq$ 209760		

Table 2: Suggested muon fiducial cuts for tight muons in release 6.1.4.

Arches:
$0^\circ \leq \phi \leq 75^\circ$ or $105^\circ \leq \phi \leq 225^\circ$ or $315^\circ \leq \phi < 360^\circ$
Additionally, for runs 190697 - 209760, remove:
$210^\circ < \phi \leq 225^\circ$ if $\eta < 0$
Keystone:
$75^\circ < \phi < 105^\circ$ and $\eta < 0$
Miniskirt:
$225^\circ < \phi < 315^\circ$

Table 3: Cuts on ϕ for distinguishing parts of the CMX detector when determining reconstruction efficiencies.

ID Efficiency Calculation

- A first leg must be a CMUP or CMX muon passing all the cuts given in Tables 1 and 2.
- A second leg must be a muon with a CMUP or CMX stub and satisfy:
  - $P_T > 20$ GeV.
  - fiducial requirements in Table 2.
- The event must not have a cosmic tag.
- The z_0 of the two legs must pass: $|z_0^{(1)} - z_0^{(2)}| < 4$ cm.
- The invariant mass of the two tracks must pass: $81 < m(\mu^+\mu^-)$ GeV/$c^2 < 101$.

We then test the second leg to determine if it passes each of the muon ID cuts given in Table 1.

CMUP ID Efficiency

P25

Cut	Count	Efficiency (%)
No cut	3039	
E_{EM} cut	2951	$97.10^{+0.28}_{-0.35}$
E_{HAD} cut	2980	$98.06^{+0.26}_{-0.28}$
COT hits cut	3036	$99.90^{+0.05}_{-0.09}$
d_0 cut	3020	$99.37^{+0.15}_{-0.17}$
Isolation cut	2865	$94.27^{+0.43}_{-0.45}$
Δx_{CMU} cut	3029	$99.67^{+0.10}_{-0.14}$
Δx_{CMP} cut	2973	$97.83^{+0.24}_{-0.29}$
All above cuts	2648	$87.13^{+0.61}_{-0.66}$
All cuts excl. isol.	2800	$92.14^{+0.47}_{-0.51}$
Sliding isol. cut	2920	$96.08^{+0.38}_{-0.41}$
All cuts (sliding isol.)	2694	$88.65^{+0.56}_{-0.61}$
χ^2 cut	3039	$100.00^{+0.00}_{-0.06}$
All cuts (χ^2)	2648	$87.13^{+0.61}_{-0.66}$
All track cuts	2718	$89.44^{+0.55}_{-0.62}$
All trk cuts excl. isol.	2874	$94.57^{+0.42}_{-0.45}$

Dataset bhmummP25_SAM: Muon ID efficiencies for CMUP

CMUP ID SF

P25

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0094^{+0.0030}_{-0.0037}$
E_{HAD} cut	$0.9971^{+0.0026}_{-0.0029}$
COT hits cut	$0.9991^{+0.0005}_{-0.0009}$
d_0 cut	$0.9964^{+0.0015}_{-0.0017}$
Isolation cut	$0.9754^{+0.0044}_{-0.0047}$
Δx_{CMU} cut	$0.9968^{+0.0010}_{-0.0014}$
Δx_{CMP} cut	$0.9836^{+0.0024}_{-0.0030}$
All above cuts	$0.9589^{+0.0067}_{-0.0073}$
All cuts excl. isol.	$0.9818^{+0.0050}_{-0.0055}$
Sliding isol. cut	$0.9850^{+0.0039}_{-0.0042}$
All cuts (sliding isol.)	$0.9669^{+0.0061}_{-0.0067}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0006}$
All cuts (χ^2)	$0.9589^{+0.0067}_{-0.0073}$
All track cuts	$0.9789^{+0.0061}_{-0.0068}$
All trk cuts excl. isol.	$1.0023^{+0.0045}_{-0.0048}$

Dataset bhmummP25_SAM_zektim: Muon ID Scale Factors for CMUP

P25 vs zemtjm

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0082^{+0.0030}_{-0.0037}$
E_{HAD} cut	$0.9969^{+0.0026}_{-0.0029}$
COT hits cut	$0.9991^{+0.0005}_{-0.0009}$
d_0 cut	$0.9951^{+0.0015}_{-0.0017}$
Isolation cut	$0.9675^{+0.0044}_{-0.0046}$
Δx_{CMU} cut	$0.9968^{+0.0010}_{-0.0014}$
Δx_{CMP} cut	$0.9836^{+0.0025}_{-0.0030}$
All above cuts	$0.9489^{+0.0067}_{-0.0072}$
All cuts excl. isol.	$0.9792^{+0.0050}_{-0.0054}$
Sliding isol. cut	$0.9820^{+0.0039}_{-0.0042}$
All cuts (sliding isol.)	$0.9615^{+0.0061}_{-0.0066}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0006}$
All cuts (χ^2)	$0.9489^{+0.0067}_{-0.0072}$
All track cuts	$0.9688^{+0.0060}_{-0.0067}$
All trk cuts excl. isol.	$0.9997^{+0.0045}_{-0.0048}$

Dataset bhmummP25_SAM_zemtjm_1: Muon ID Scale Factors for CMUP

CMX ID Efficiencies

P25

Cut	Count	Efficiency (%)
No cut	1935	
E_{EM} cut	1871	$96.69^{+0.40}_{-0.48}$
E_{HAD} cut	1893	$97.83^{+0.34}_{-0.39}$
COT hits cut	1934	$99.95^{+0.04}_{-0.12}$
d_0 cut	1930	$99.74^{+0.11}_{-0.17}$
Isolation cut	1838	$94.99^{+0.50}_{-0.53}$
Δx_{CMX} cut	1923	$99.38^{+0.17}_{-0.25}$
All above cuts	1733	$89.56^{+0.72}_{-0.74}$
All cuts excl. isol.	1815	$93.80^{+0.59}_{-0.59}$
Sliding isol. cut	1861	$96.18^{+0.43}_{-0.50}$
All cuts (sliding isol.)	1754	$90.65^{+0.71}_{-0.75}$
χ^2 cut	1935	$100.00^{+0.00}_{-0.10}$
All cuts (χ^2)	1733	$89.56^{+0.72}_{-0.74}$
All track cuts	1744	$90.13^{+0.64}_{-0.72}$
All trk cuts excl. isol.	1827	$94.42^{+0.55}_{-0.62}$

Dataset bhmummP25_SAM: Muon ID efficiencies for CMX

CMX ID SF

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Cut	Scale Factor
No cut	
E_{EM} cut	$1.0049^{+0.0042}_{-0.0050}$
E_{HAD} cut	$0.9999^{+0.0035}_{-0.0040}$
COT hits cut	$0.9996^{+0.0004}_{-0.0012}$
d_0 cut	$0.9996^{+0.0011}_{-0.0018}$
Isolation cut	$0.9804^{+0.0051}_{-0.0055}$
Δx_{CMX} cut	$0.9953^{+0.0017}_{-0.0025}$
All above cuts	$0.9836^{+0.0080}_{-0.0082}$
All cuts excl. isol.	$1.0000^{+0.0063}_{-0.0063}$
Sliding isol. cut	$0.9840^{+0.0044}_{-0.0051}$
All cuts (sliding isol.)	$0.9872^{+0.0078}_{-0.0082}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0010}$
All cuts (χ^2)	$0.9836^{+0.0080}_{-0.0082}$
All track cuts	$0.9883^{+0.0071}_{-0.0080}$
All trk cuts excl. isol.	$1.0051^{+0.0059}_{-0.0066}$

Dataset bhmummP25_SAM_zektim: Muon ID Scale Factors for CMX

P25 vs zemtjm

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0033^{+0.0042}_{-0.0050}$
E_{HAD} cut	$1.0011^{+0.0035}_{-0.0040}$
COT hits cut	$0.9995^{+0.0004}_{-0.0012}$
d_0 cut	$0.9983^{+0.0011}_{-0.0018}$
Isolation cut	$0.9744^{+0.0051}_{-0.0054}$
Δx_{CMX} cut	$0.9953^{+0.0017}_{-0.0025}$
All above cuts	$0.9765^{+0.0079}_{-0.0081}$
All cuts excl. isol.	$0.9982^{+0.0063}_{-0.0063}$
Sliding isol. cut	$0.9825^{+0.0044}_{-0.0051}$
All cuts (sliding isol.)	$0.9844^{+0.0078}_{-0.0082}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0010}$
All cuts (χ^2)	$0.9765^{+0.0079}_{-0.0081}$
All track cuts	$0.9813^{+0.0070}_{-0.0079}$
All trk cuts excl. isol.	$1.0034^{+0.0059}_{-0.0066}$

Dataset bhmummP25_SAM_zemtjm_1: Muon ID Scale Factors for CMX

Reconstruction Efficiency

The reconstruction efficiency is defined as the probability to find a muon stub and link it to a track. First, to know whether we should find a stub or not we have to know that the muon is fiducial in any of the muon chambers. We use the **MuonFiducialTool** class for this purpose. We define a track as being fiducial in a given muon system if it passes the cuts defined in Tables 2 and 3 for that system.

Events Selection
No cosmic tag and 2 tracks passing the following:

- Oppositely charged.
- $|z_0^{(1)} - z_0^{(2)}| < 4$ cm.
- $81\ \mathrm{GeV}/c^2 < m(\mu^+\mu^-) < 101\ \mathrm{GeV}/c^2$
- The first leg must be a reconstructed **CdfMuon** passing all the ID and fiducial cuts given in Tables 1 and 2. It must also match to the level 1 trigger information.
- The second leg must be fiducial in both the CMU and CMP sub-detectors (or the CMX sub-detector) and satisfy:
  - $P_T > 20$ GeV.
  - $E_{EM} < 1.5 \cdot (2+\max(0, (p-100) \cdot 0.0115))$ GeV
  - $E_{HAD} < 1.5 \cdot (6+\max(0, (p-100) \cdot 0.028)$ GeV

$$\varepsilon_{Reco} = \frac{\#\text{tracks fiducial and linked to a stub}}{\#\text{ tracks fiducial}}$$

Reconstruction Efficiency

The first leg must pass all the ID and Fid. cuts and must match to the level 1 trigger information. If the second leg is Fiducial, and pass "P_T, E_{EM}, E_{HAD}" cuts, we examine this track to see if is linked to a muon stub or not.

P25

Category	Fiducial	w/ Stub	Efficiency (%)
CMUP	3427	2961	$86.40^{+0.56}_{-0.61}$
CMX	1978	1863	$94.19^{+0.49}_{-0.58}$
CMX Arches	1561	1506	$96.48^{+0.47}_{-0.55}$
CMX Miniskirt	343	289	$84.26^{+1.97}_{-2.13}$
CMX Keystone	74	68	$91.89^{+3.23}_{-4.59}$
CMU-only	822	722	$87.83^{+1.13}_{-1.21}$
CMP-only	948	821	$86.60^{+1.14}_{-1.20}$
CMX MiniKey	417	357	$85.61^{+1.79}_{-1.92}$

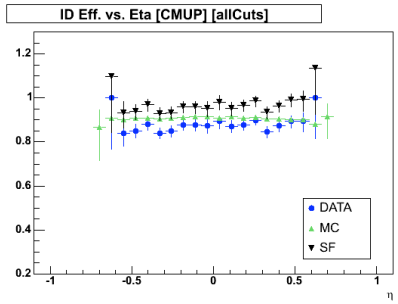
Category	Scale Factor
CMUP	$0.8867^{+0.0058}_{-0.0063}$
CMX	$0.9456^{+0.0049}_{-0.0059}$
CMX Arches	$0.9668^{+0.0047}_{-0.0056}$
CMX Miniskirt	$0.8505^{+0.0199}_{-0.0215}$
CMX Keystone	$0.9306^{+0.0327}_{-0.0465}$
CMU-only	$0.9003^{+0.0116}_{-0.0125}$
CMP-only	$0.8813^{+0.0116}_{-0.0122}$
CMX MiniKey	$0.8647^{+0.0181}_{-0.0181}$

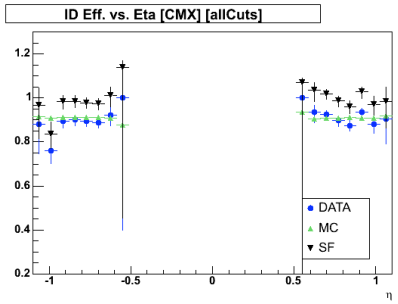
zektei

Category	Scale Factor
CMUP	$0.8857^{+0.0058}_{-0.0063}$
CMX	$0.9449^{+0.0049}_{-0.0058}$
CMX Arches	$0.9667^{+0.0047}_{-0.0056}$
CMX Miniskirt	$0.8509^{+0.0199}_{-0.0215}$
CMX Keystone	$0.9253^{+0.0325}_{-0.0462}$
CMU-only	$0.8998^{+0.0116}_{-0.0124}$
CMP-only	$0.8822^{+0.0116}_{-0.0123}$
CMX MiniKey	$0.8641^{+0.0181}_{-0.0181}$

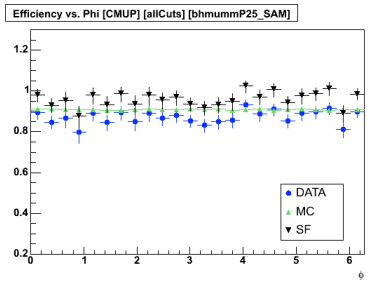
zemtjm

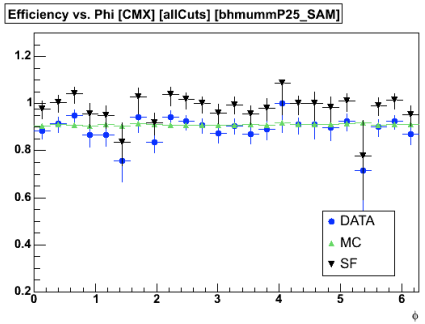
Reco and ID Plots

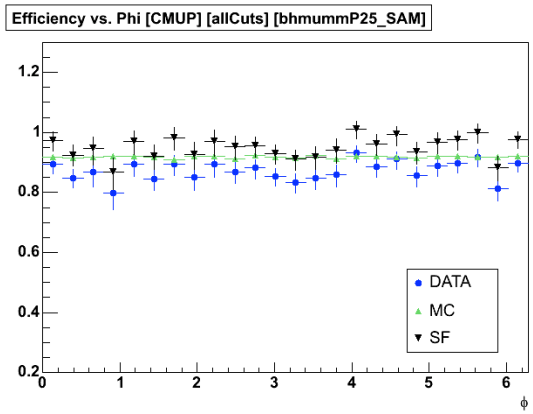


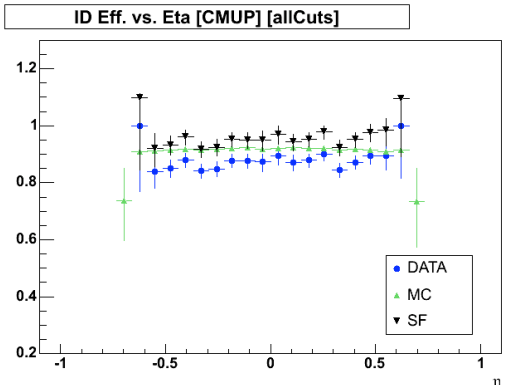


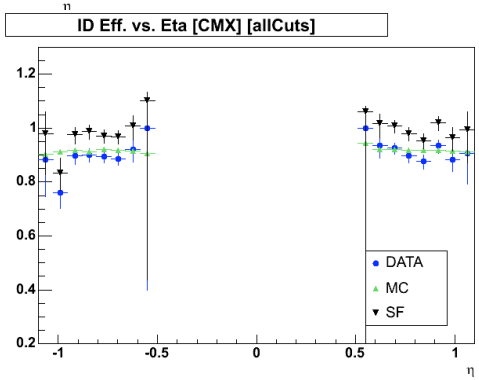
P25, zektei

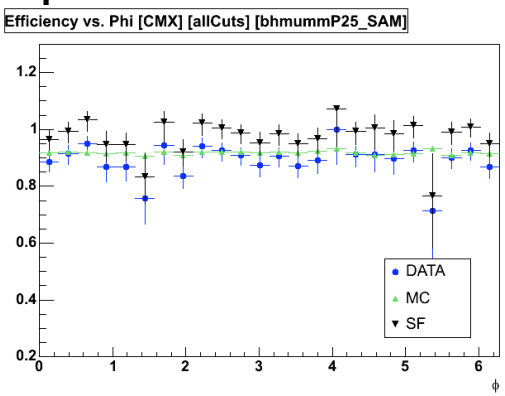






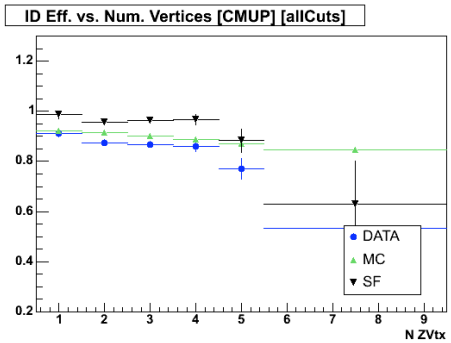




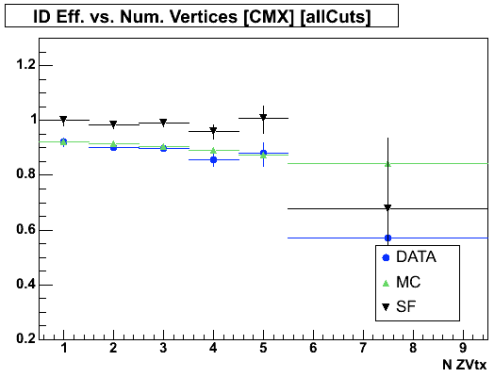


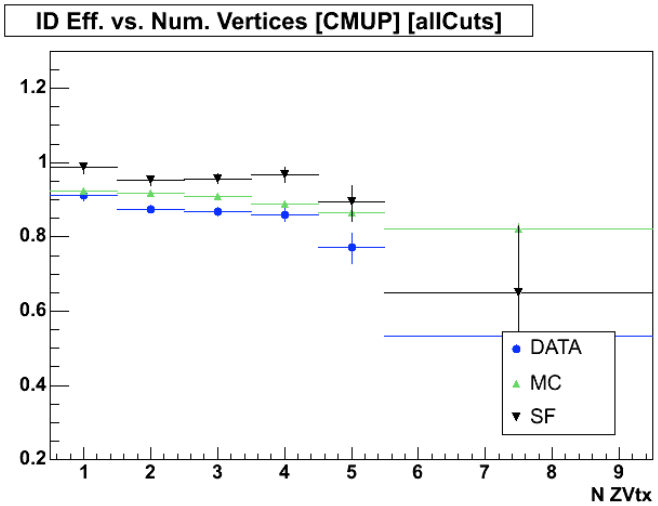
P25 vs zemtjm

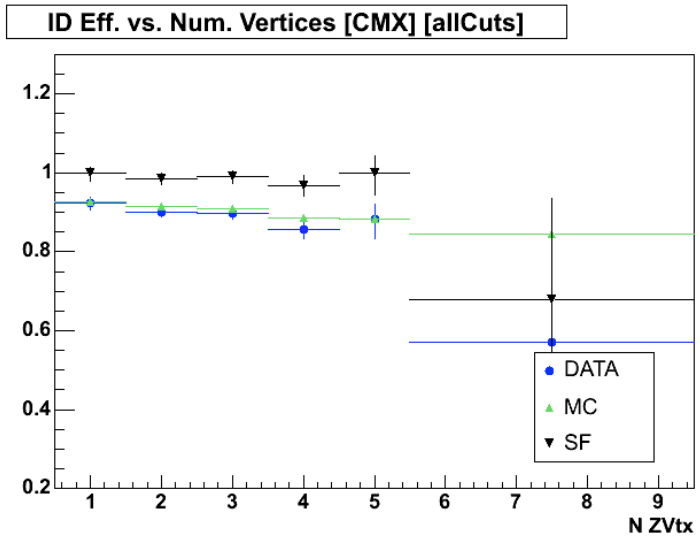
Reco and ID Plots



P25







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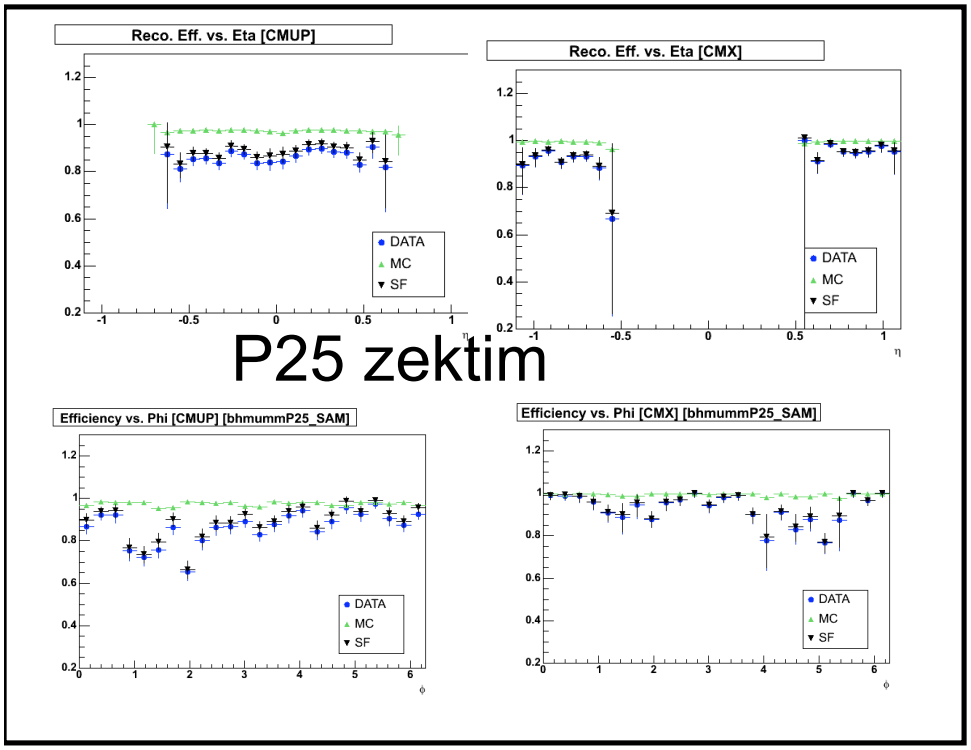

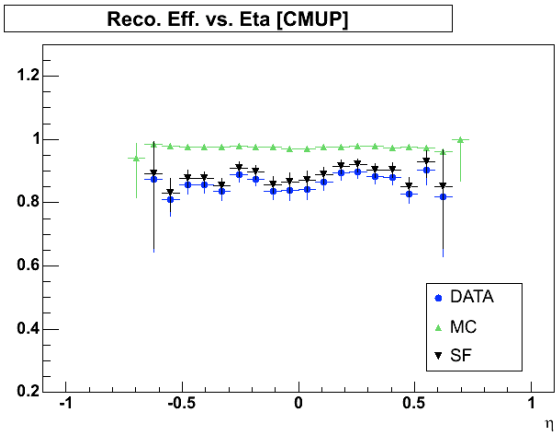

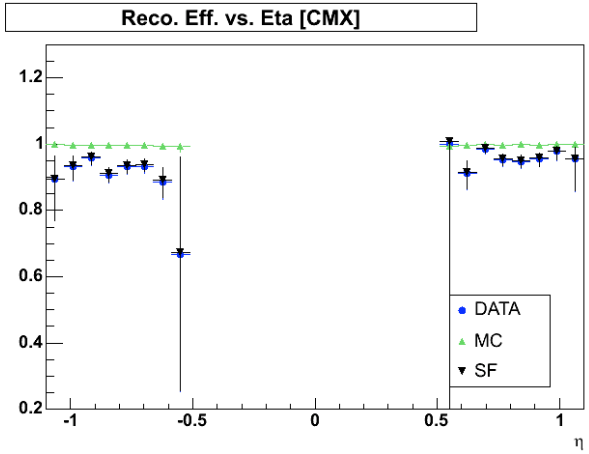

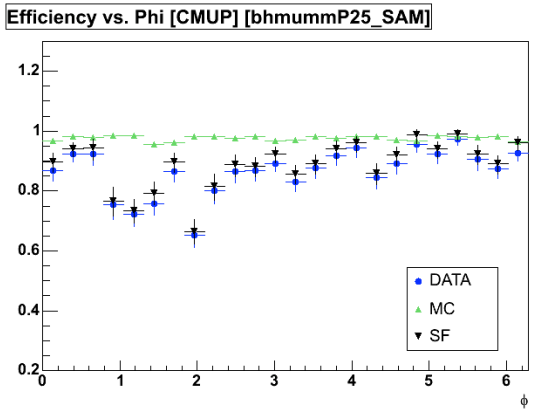

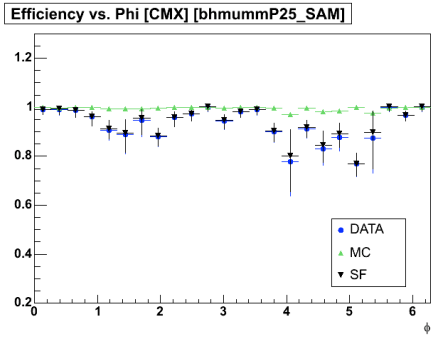

Conclusions

- P25 high PT electrons and muons compared with old and new MC:
  - No major differences found
  - Plan to use the new sets from now on