Period 21 High PT Lepton Efficiencies and SF -Preliminary

Simona Rolli
Tufts

Electrons ID: Samples

Dataset bhelmm: Runs 268155-271047 (P21)
MC sample : zektei (Feb 2008)
GRL :GRL for P21 v27 Prelim
(goodrun_em_si_v27.list, goodrun_em_nosi_v27.list)

P21 skim leptons
MC dataset zektei (P14 and onward) 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.

P21 numbers vs P20

	Period 20		Period 21	
	bhelmm(P19)	zektei	bhelmm(P19)	zektei
CEM Eff	0.777+\-0.004	0.795 +\-0.001	0.768+\-0.003	0.795 +\-0.001
CEM SF	0.977 +\-0.005	N/A	0.965 +\-0.004	N/A
nisoCEM Eff	0.814 +\-0.004	0.825 +\-0.001	0.808 +\-0.003	0.825 +\-0.001
nisoCEM SF	0.987 +\-0.005	N/A	0.980 +\-0.004	N/A
LooseCEM Eff	0.903 +/- 0.003	0.907 +\-0.001	0.896 +/- 0.002	0.907 +\-0.001
LooseCEM SF	0.996 +\-0.004	N/A	0.988 +\-0.003	N/A
nisolooseCEM Eff	0.946+\-0.002	0.943 +\-0.001	0.942+\-0.002	0.943 +\-0.001
nisoloostCEM SF	1.003 +\-0.003	N/A	0.999 +\-0.002	N/A

	PHX		PHX	
Eff |Eta| < 2.0	0.692+\-0.007	0.744+\-0.002	0.672+\-0.005	0.744+\-0.002
SF |Eta| < 2.0	0.930+\-0.009	NA	0.903+\-0.007	NA
	PHX		PHX	
Eff |Eta| < 2.8	0.601+\-0.006	0.645+\-0.002	0.583+\-0.004	0.645+\-0.002
SF |Eta| < 2.8	0.930+\-0.007	NA	0.903+\-0.007	NA

CEM-PEM

P18

	PEM	
Eff |Eta| < 2.0	0.774+\-0.005	0.847+\-0.002
SF |Eta| < 2.0	0.914+\-0.006	NA

	PEM	
Eff |Eta| < 2.8	0.727+\-0.005	0.810+\-0.001
SF |Eta| < 2.8	0.898+\-0.006	NA

P19

	PEM	
Eff |Eta| < 2.0	0.761+\-0.006	0.847+\-0.002
SF |Eta| < 2.0	0.898+\-0.008	NA

	PEM	
Eff |Eta| < 2.8	0.720+\-0.006	0.810+\-0.001
SF |Eta| < 2.8	0.889+\-0.007	NA

P20

	PEM	
Eff |Eta| < 2.0	0.777+\-0.006	0.847+\-0.002
SF |Eta| < 2.0	0.917+\-0.007	NA

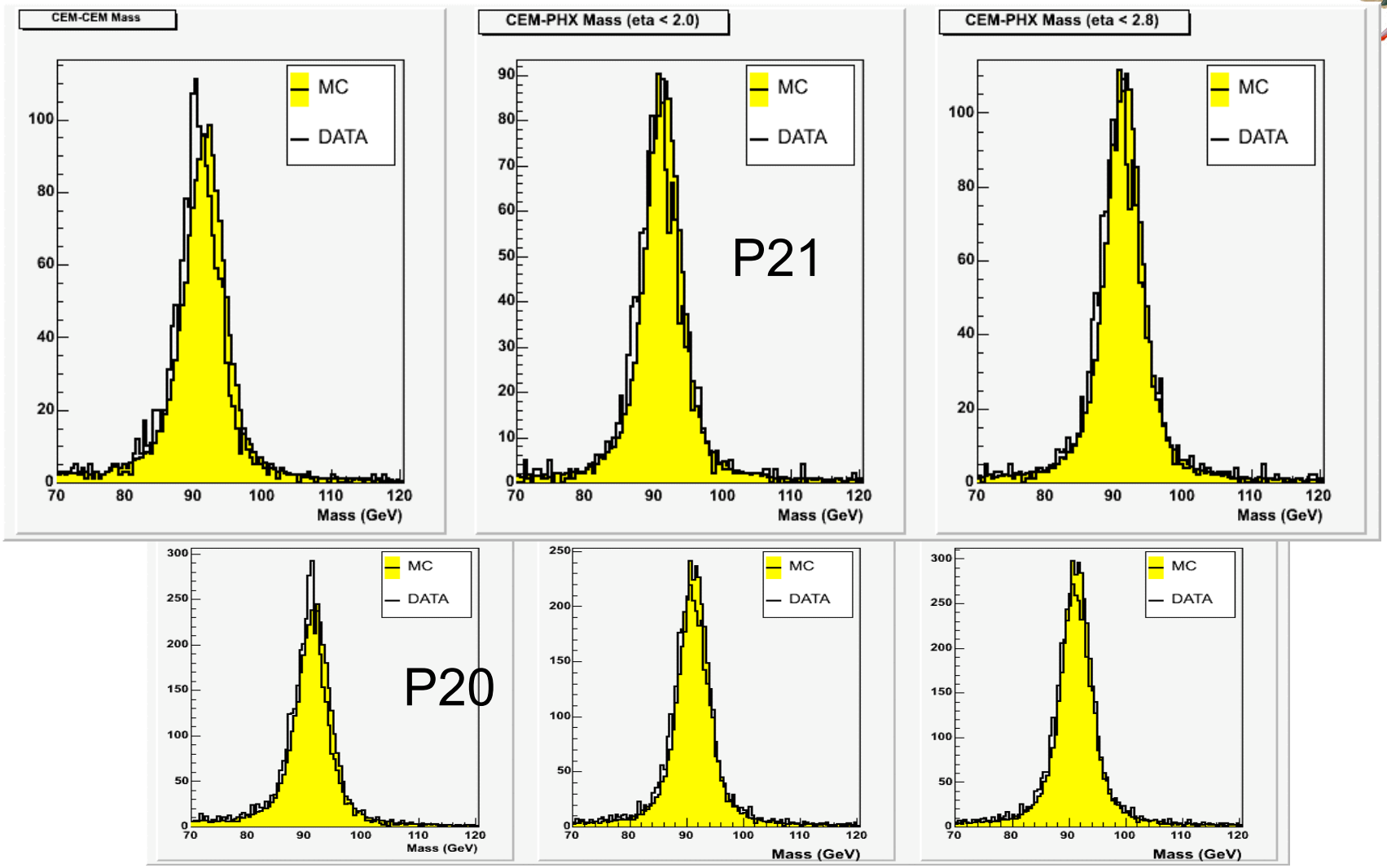
	PEM	
Eff |Eta| < 2.8	0.730+\-0.005	0.810+\-0.001
SF |Eta| < 2.8	0.901+\-0.007	NA

P21

	PEM	
Eff |Eta| < 2.0	0.757+\-0.004	0.847+\-0.002
SF |Eta| < 2.0	0.894+\-0.005	NA

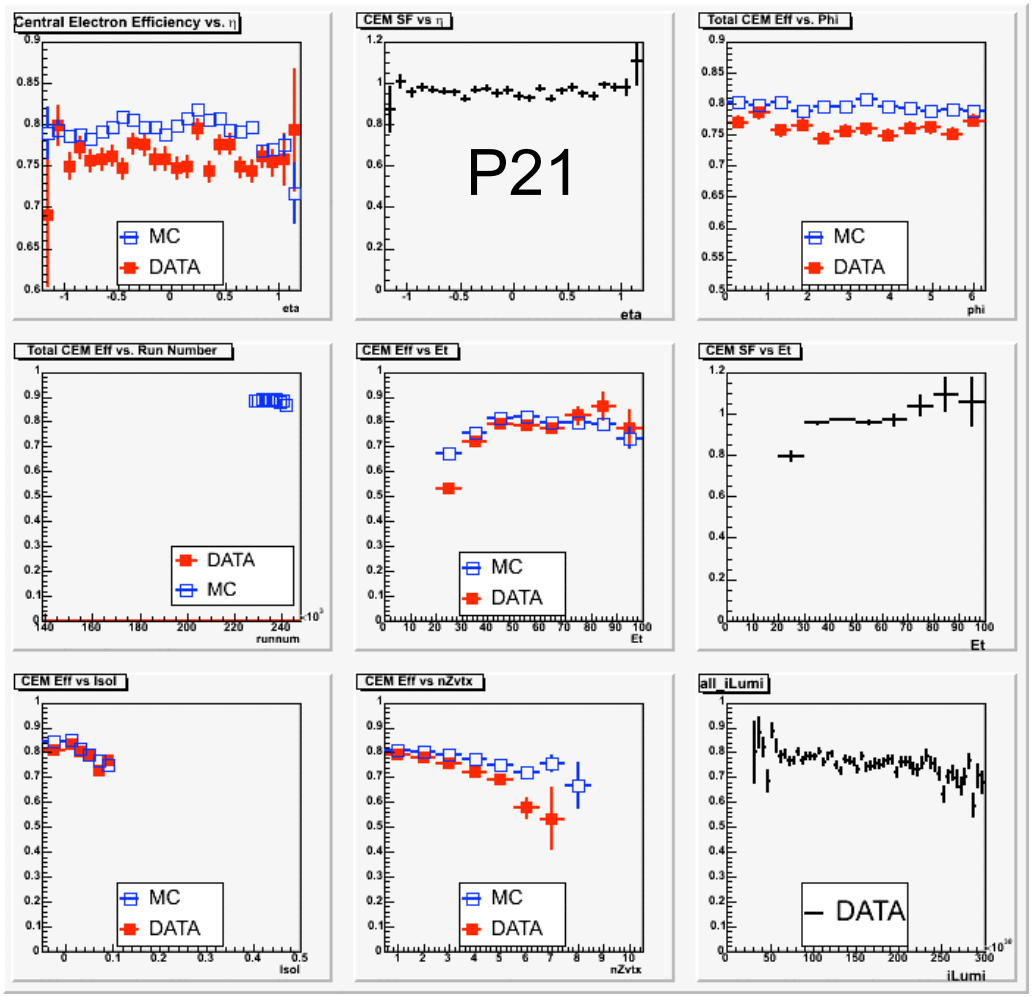
	PEM	
Eff |Eta| < 2.8	0.708+\-0.004	0.810+\-0.001
SF |Eta| < 2.8	0.874+\-0.005	NA

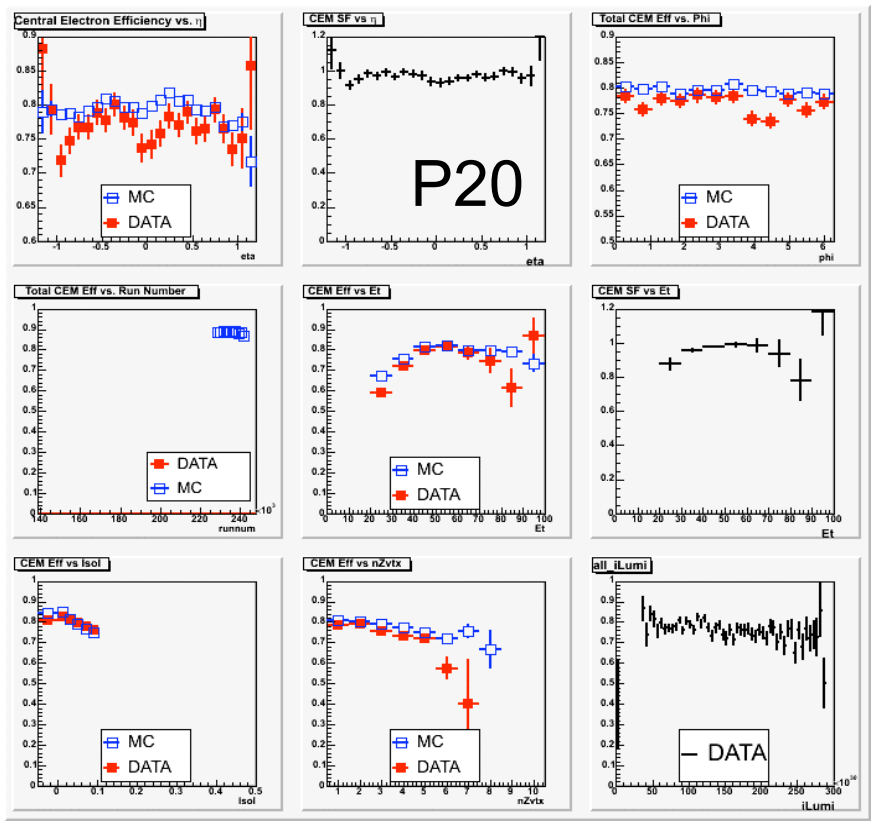
EleID Plots


CEM-CEM Mass
CEM-PHX Mass (eta < 2.0)
CEM-PHX Mass (eta < 2.8)
MC
DATA
P21
P20
Mass (GeV)

EleID Plots 1

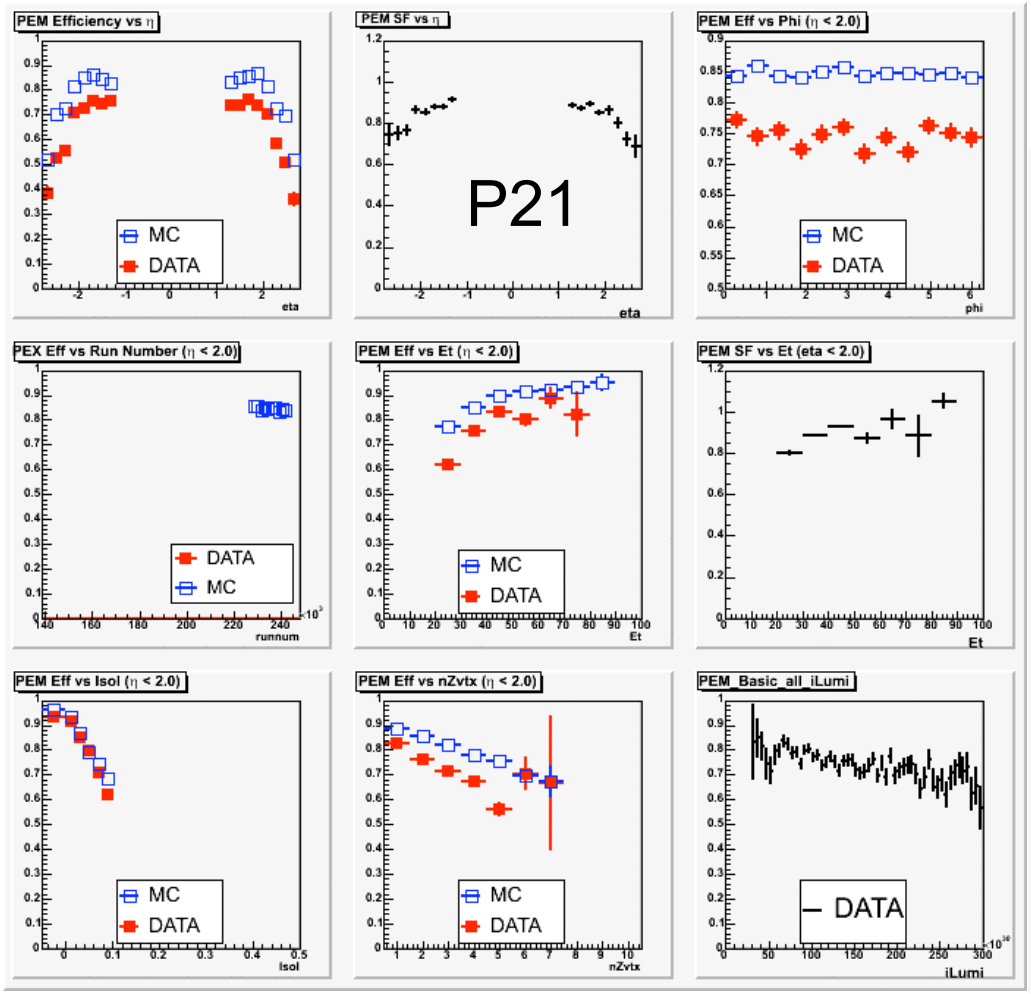
CEM Efficiencies

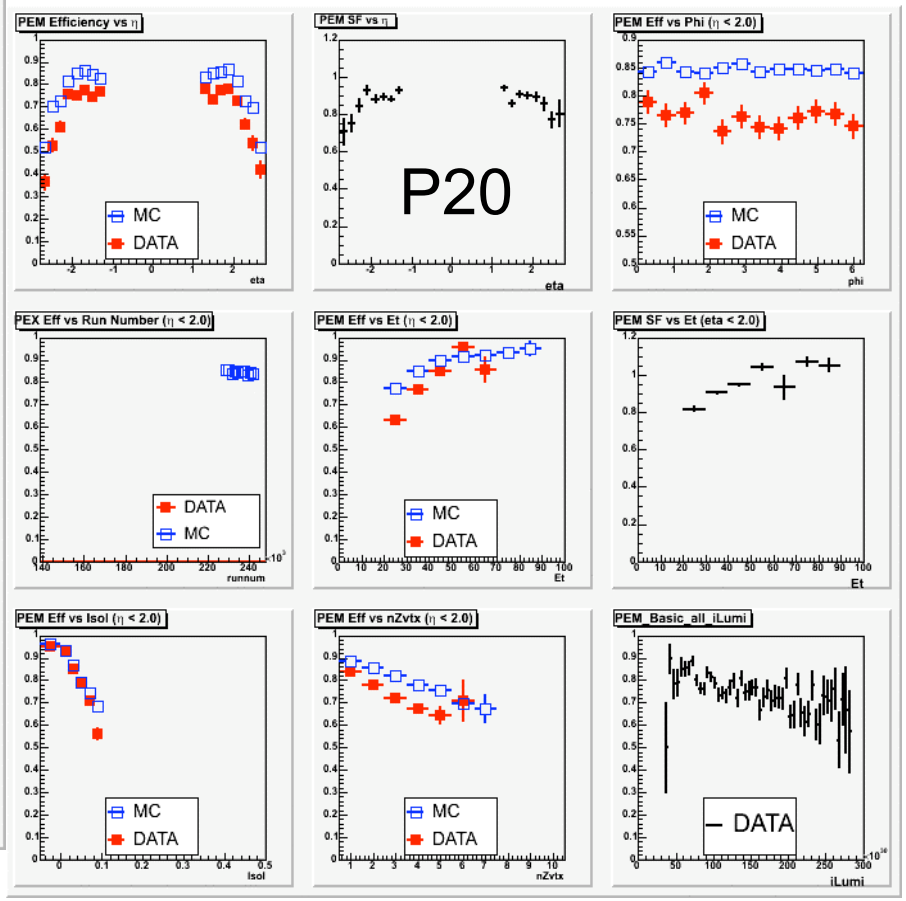




EleID Plots 2

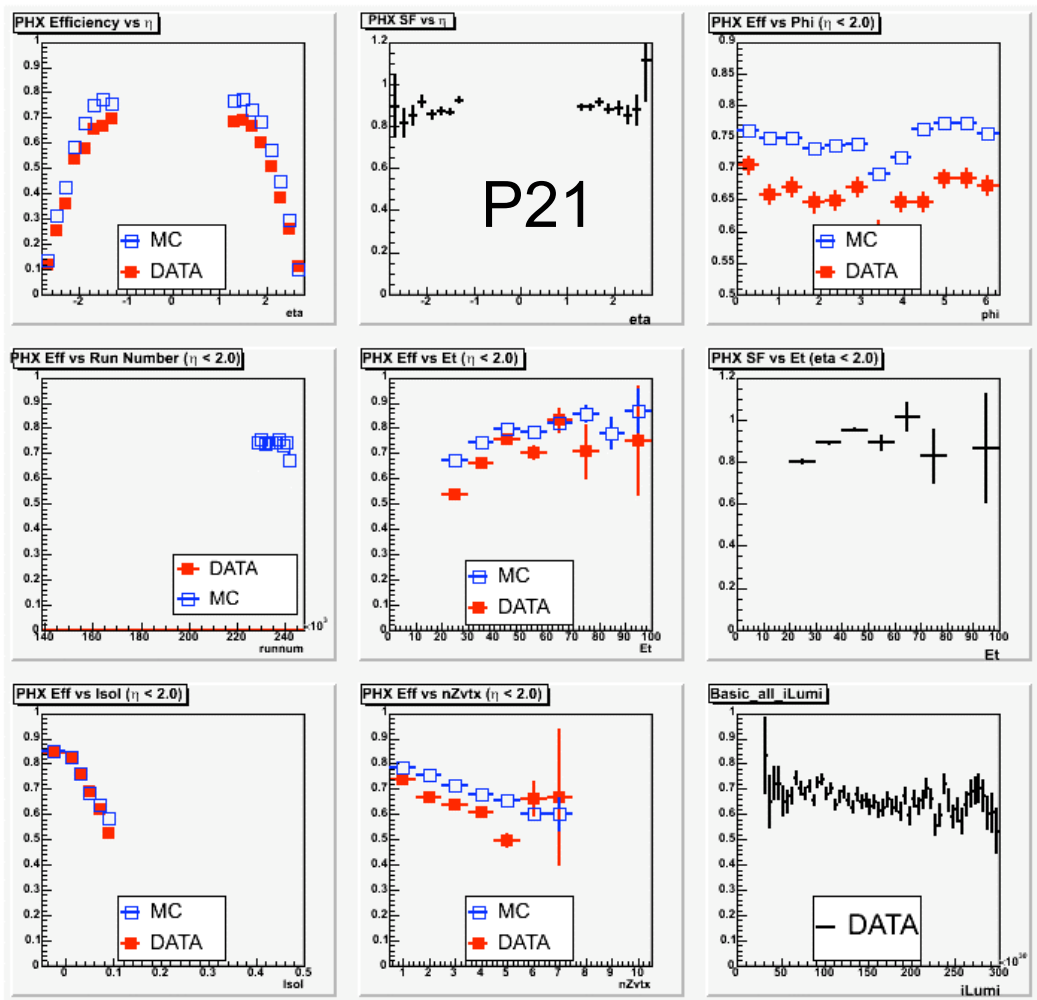
PEM Efficiencies

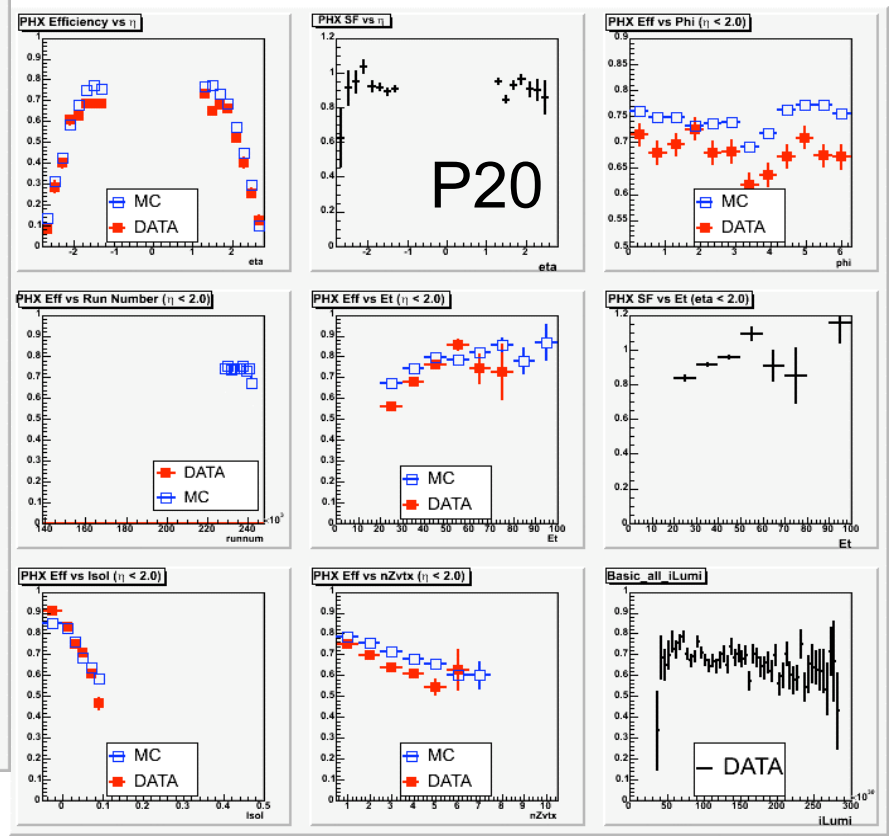




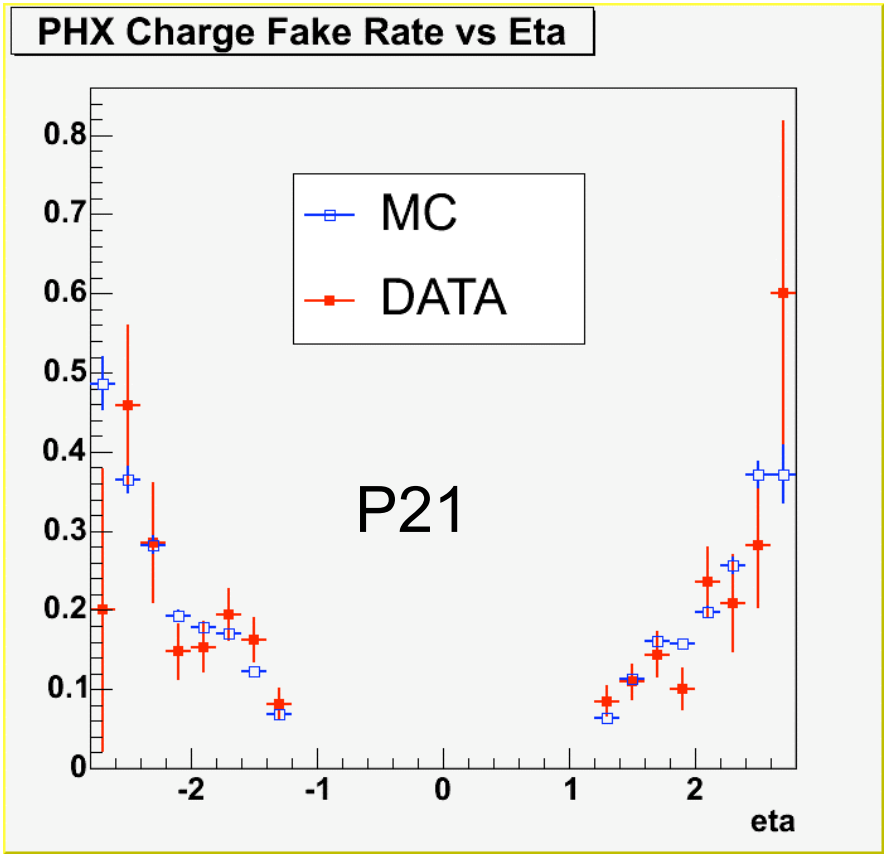
EleID Plots 3

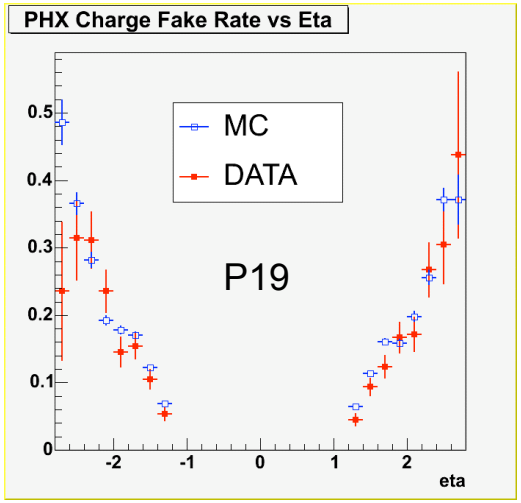
PHX Efficiencies



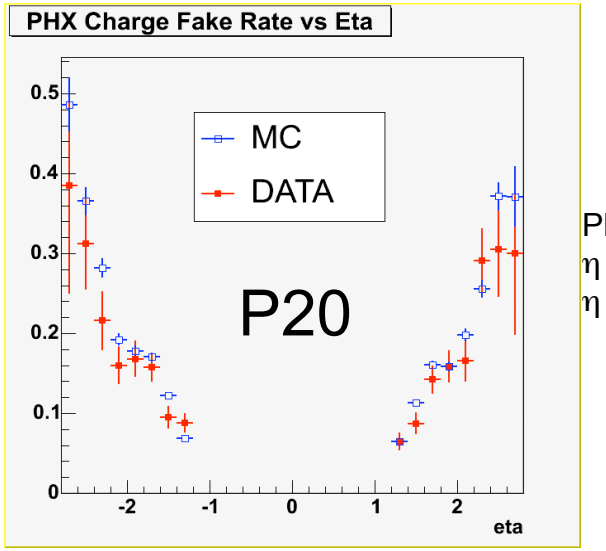


PHX Fake Charge Rate





Phoenix charge fake rate
$\eta < 2$ 0.1029 +/- 0.0055
$\eta < 2.8$ 0.1331 +/- 0.0055



Phenix charge fake rate
$\eta < 2.0$ 0.1139 +/- 0.0055
$\eta < 2.8$ 0.1352 +/- 0.0053

Phoenix charge fake rate
$\eta < 2.0$ 0.120 +/- 0.004
$\eta < 2.8$ 0.142 +/- 0.004

Electron Trigger: Tracking

1 electron with $E_T > 25GeV$
$\not{E}_T > 25GeV$
reject cosmic events

Table: Offline *W* selection.

Electron Variables	Current baseline cuts
E_T	> 20 GeV
p_T	> 10 GeV/c
N_{SL}^{axial} with 5 hits	≥ 3
N_{SL}^{stereo} with 5 hits	≥ 2
Fiducial	1
Had/Em	$< 0.055 + 0.00045E$
L_{shr}	< 0.2
E/p	< 2 (for $p_T < 50GeV$)
$\lvert Z_{vertex} \rvert$	< 60 cm
$\lvert \Delta X \rvert$	$-3.0 < Q_{trk}\Delta X < 1.5$ cm
$\lvert \Delta Z \rvert$	< 3 cm
χ^2_{strip}	< 10
Conversion	$\neq 1$ (not)

Table: Offline baseline cuts for central electrons.

L1 Tracking Efficiency

$$\epsilon(\text{L1_XFT_PT8}) = \frac{\text{numW \& passed L1_CEM8_PT8}}{\text{numW}}$$

numW means the number of *W* candidates that passed the W_NOTRACK path.

L2 Tracking Efficiency

At L2, there is no additional tracking done except for receiving the XFT information from L1.

$$\epsilon(\text{L2_XFT_PT8}) = \frac{\text{numW \& passed L1_CEM8_PT8 \& passed L2_CEM16_PT8}}{\text{numW \& passed L1_CEM8_PT8}}$$

L3 Tracking Efficiency

$$\epsilon(\text{L3_PT9}) = \frac{\text{numW \& passed L1_CEM8_PT8 \& L2_CEM16_PT8 \& L3_CEM18_PT9}}{\text{numW \& passed L1_CEM8_PT8 \& L2_CEM16_PT8}}$$

Electron Trigger: Calorimeter

L2 Calorimeter Efficiency

- Require at least 1 electron satisfying the baseline cuts and $E_T >$ 18GeV.
- Use ELECTRON_CENTRAL_18_NO_L2 path.
- Efficiency reaches 100% at about 25 GeV.

$$\epsilon(\text{L2_CEM16}) = \frac{\text{numEl \& passed L1_CEM8_PT8 \& L2_PS \& L2_CEM16}}{\text{numEl \& passed L1_CEM8_PT8 \& L2_PS}}$$

L3 Calorimeter Efficiency

- Use the calibration dataset(blpc).
- Use ELECTRON_CENTRAL_8_NO_L2 path.
- Efficiency reaches 100% at about 20 GeV.

$$\epsilon(\text{L3_CEM18}) = \frac{\text{numEl \& passed EL_CENT_8_NO_L2 \& L2_CEM16 \& L3_CEM18}}{\text{numEl \& passed EL_CENT_8_NO_L2 \& L2_CEM16}}$$

Electron Trigger Results

NofflW	231891
NcemL1	224493
NcemL2	224346
NcemL3	222168

Trigger	Period 17	Period 18	Period 19	Period 20	Period 21
L1_XFT_PT8	0.9694 ± 0.003	0.9697 ± 0.003	0.9674 ± 0.003	0.9686 ± 0.003	0.9681 ± 0.002
L2_XFT_PT8	0.9995 ± 0.003	0.9995 ± 0.003	0.9993 ± 0.003	0.9995 ± 0.003	0.9993 ± 0.002
L3 tracking	0.9929 ± 0.003	0.9919 ± 0.003	0.9909 ± 0.003	0.9911 ± 0.003	0.9903 ± 0.002
Total Tracking	0.9622 ± 0.003	0.9615 ± 0.003	0.9615 ± 0.003	0.9594 ± 0.003	0.9580± 0.002

Electron Trigger: Results Past Periods

Analyzed all data

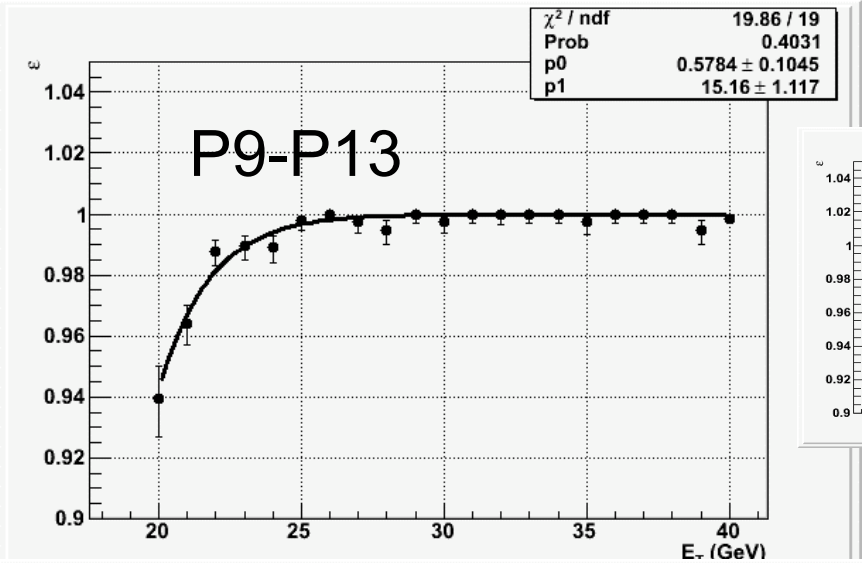
Trigger	Period 9	Period 10A	Period 10B
L1_XFT_PT8	0.9651(6)	0.9673(7)	0.9650(29)
L2_XFT_PT8	0.9992(1)	0.9993(1)	0.9992(5)
L3 tracking	0.9954(2)	0.9932(3)	0.9968(9)
Total Tracking	0.9598(7)	0.9600(8)	0.9611(31)

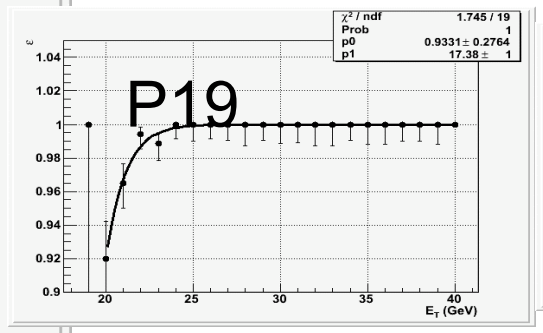
Trigger	Period 11	Period 12	Period 13	Period 14
L1_XFT_PT8	0.9688(4)	0.96857 ± 0.003	0.963922 ± 0.003	0.964755 ± 0.03
L2_XFT_PT8	0.9988(4)	0.9990 ± 0.003	0.998003 ± 0.003	0.999569 ± 0.03
L3 tracking	0.9935(4)	0.9940 ± 0.003	0.994608 ± 0.003	0.996055 ± 0.03
Total Tracking	0.9614(4)	0.9600 ± 0.003	0.95681 ± 0.003	0.960535 ± 0.03

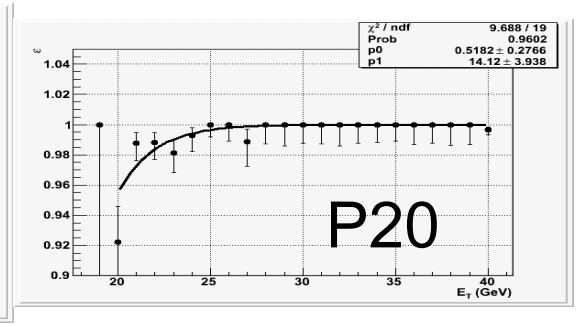
Trigger	Period 15	Period 16	Period 17	Period 18
L1_XFT_PT8	0.9695 ± 0.005	0.9684 ± 0.005	0.9694 ± 0.003	0.9697 ± 0.003
L2_XFT_PT8	0.9994 ± 0.005	0.9994 ± 0.005	0.9995 ± 0.003	0.9995 ± 0.003
L3 tracking	0.9940 ± 0.005	0.9927 ± 0.005	0.9929 ± 0.003	0.9919 ± 0.003
Total Tracking	0.9633 ± 0.005	0.9609 ± 0.005	0.9622 ± 0.003	0.9615 ± 0.003

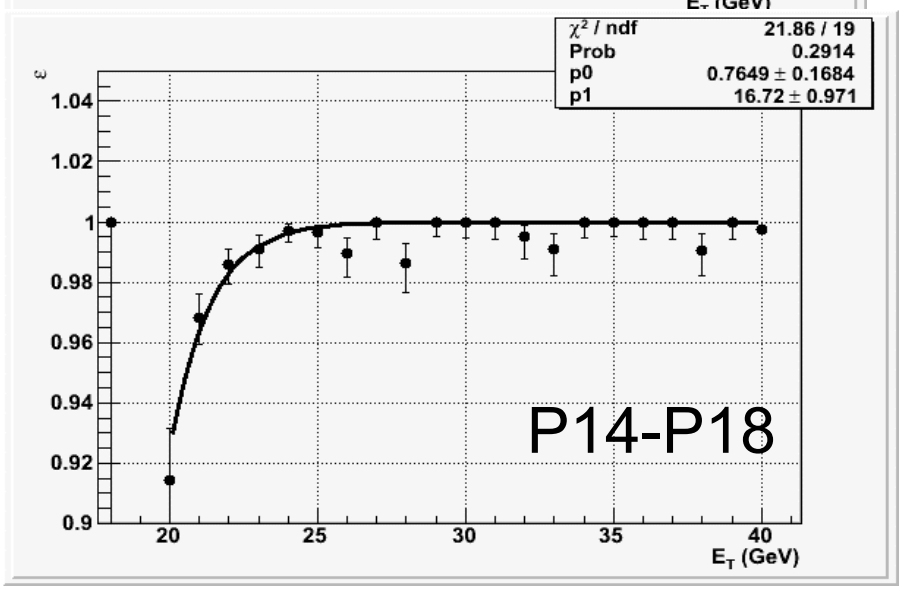
CEM Electron Trigger Results

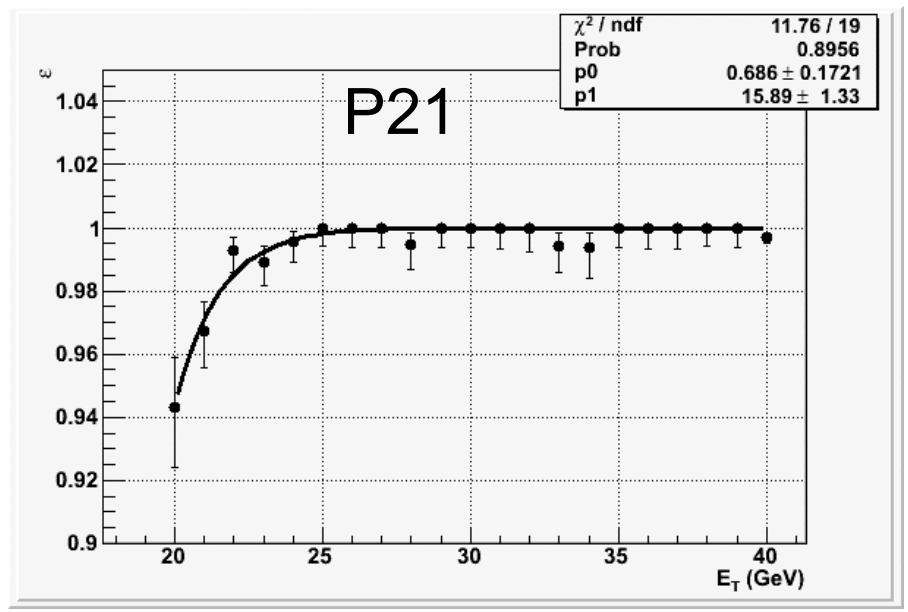
$$\epsilon = \frac{1}{1 + e^{-\beta(E_T - \alpha)}}.$$







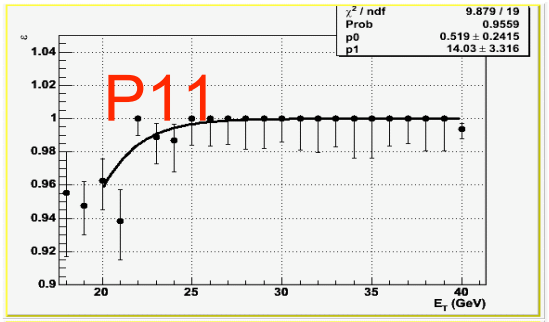


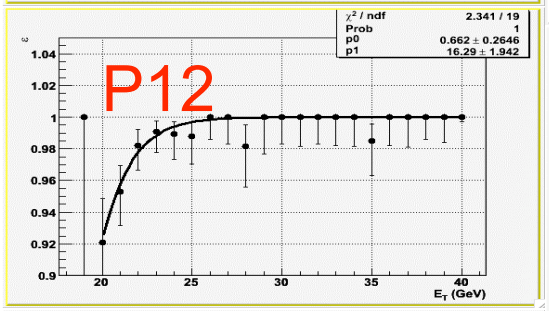


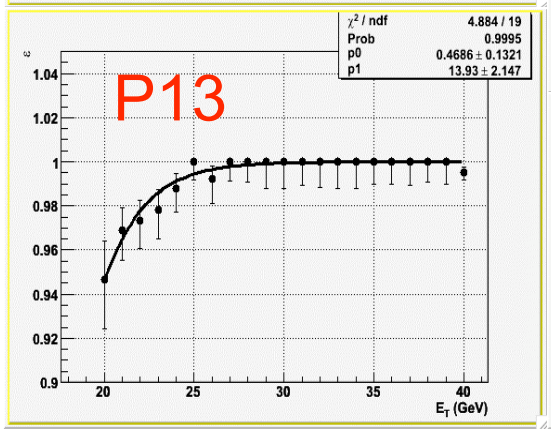
Electron Trigger :Past Periods

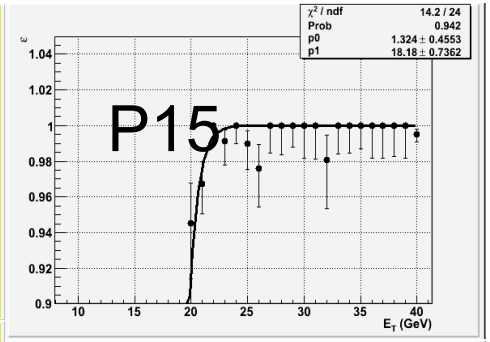
$$\epsilon = \frac{1}{1 + e^{-\beta(E_T - \alpha)}}.$$

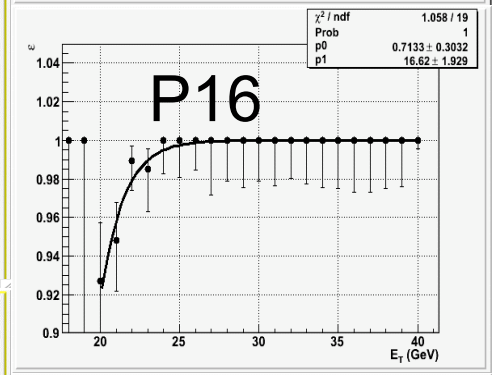
L2_CEM16 calorimeter efficiency

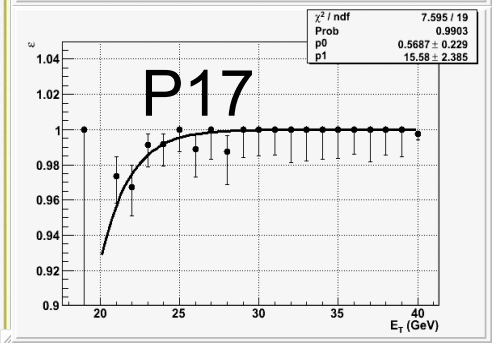


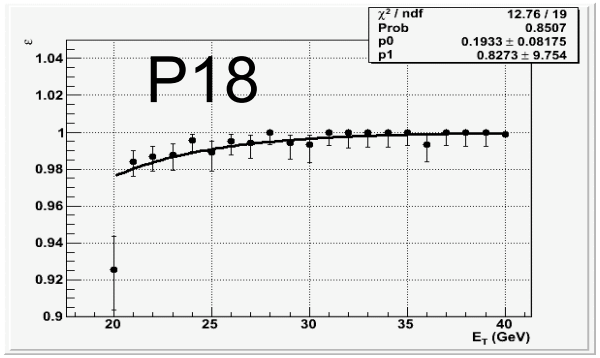


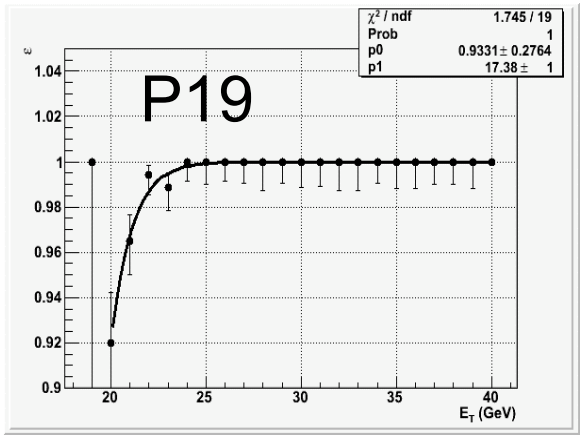












Muons

Dataset bhmumm: Runs 268155-271047
MC sample : zektim (Feb 2008)
GRL : GRL for P21 v27 Prelim
goodrun_em_mu_nosi_cmxignored_v27Prelim.list,
goodrun_em_mu_si_cmxignored_v27Prelim.list

Data: P21 Data on SAM : bhmumm
MC: dataset zektim on SAM
No dps accounting yet

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

P20

Cut	Count	Efficiency (%)
No cut	2917	
E_{EM} cut	2841	$97.39^{+0.29}_{-0.35}$
E_{HAD} cut	2868	$98.32^{+0.23}_{-0.29}$
COT hits cut	2914	$99.90^{+0.06}_{-0.10}$
d_0 cut	2873	$98.49^{+0.23}_{-0.26}$
Isolation cut	2774	$95.10^{+0.39}_{-0.44}$
Δx_{CMU} cut	2906	$99.62^{+0.11}_{-0.15}$
Δx_{CMP} cut	2846	$97.57^{+0.31}_{-0.32}$
All above cuts	2558	$87.69^{+0.64}_{-0.63}$
All cuts excl. isol.	2679	$91.84^{+0.52}_{-0.56}$
Sliding isol. cut	2821	$96.71^{+0.34}_{-0.35}$
All cuts (sliding isol.)	2599	$89.10^{+0.60}_{-0.57}$
χ^2 cut	2917	$100.00^{+0.00}_{-0.06}$
All cuts (χ^2)	2558	$87.69^{+0.64}_{-0.63}$
All track cuts	2627	$90.06^{+0.52}_{-0.56}$
All trk cuts excl. isol.	2754	$94.41^{+0.44}_{-0.44}$

TABLE I: Dataset bhmummP20: Muon ID efficiencies for CMUP

P21

Cut	Count	Efficiency (%)
No cut	4036	
E_{EM} cut	3922	$97.18^{+0.26}_{-0.28}$
E_{HAD} cut	3978	$98.56^{+0.18}_{-0.21}$
COT hits cut	4033	$99.93^{+0.04}_{-0.08}$
d_0 cut	4011	$99.38^{+0.12}_{-0.15}$
Isolation cut	3813	$94.47^{+0.37}_{-0.41}$
Δx_{CMU} cut	4023	$99.68^{+0.08}_{-0.11}$
Δx_{CMP} cut	3960	$98.12^{+0.21}_{-0.23}$
All above cuts	3555	$88.08^{+0.52}_{-0.51}$
All cuts excl. isol.	3756	$93.06^{+0.42}_{-0.41}$
Sliding isol. cut	3882	$96.18^{+0.32}_{-0.31}$
All cuts (sliding isol.)	3618	$89.64^{+0.47}_{-0.51}$
χ^2 cut	4036	$100.00^{+0.00}_{-0.05}$
All cuts (χ^2)	3555	$88.08^{+0.52}_{-0.51}$
All track cuts	3631	$89.97^{+0.49}_{-0.49}$
All trk cuts excl. isol.	3837	$95.07^{+0.37}_{-0.37}$

TABLE I: Dataset bhmummP21_SAM: Muon ID efficiencies for CMUP

CMUP ID SF

P20

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0124^{+0.0030}_{-0.0036}$
E_{HAD} cut	$0.9997^{+0.0023}_{-0.0029}$
COT hits cut	$0.9991^{+0.0006}_{-0.0010}$
d_0 cut	$0.9876^{+0.0023}_{-0.0026}$
Isolation cut	$0.9839^{+0.0040}_{-0.0046}$
Δx_{CMU} cut	$0.9963^{+0.0011}_{-0.0015}$
Δx_{CMP} cut	$0.9810^{+0.0031}_{-0.0033}$
All above cuts	$0.9650^{+0.0070}_{-0.0070}$
All cuts excl. isol.	$0.9787^{+0.0055}_{-0.0060}$
Sliding isol. cut	$0.9914^{+0.0035}_{-0.0036}$
All cuts (sliding isol.)	$0.9718^{+0.0066}_{-0.0063}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0006}$
All cuts (χ^2)	$0.9650^{+0.0070}_{-0.0070}$
All track cuts	$0.9857^{+0.0057}_{-0.0061}$
All trk cuts excl. isol.	$1.0006^{+0.0047}_{-0.0047}$

Dataset bhmummP20_zektim: Muon ID Scale Fact

P21

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0102^{+0.0027}_{-0.0029}$
E_{HAD} cut	$1.0022^{+0.0018}_{-0.0022}$
COT hits cut	$0.9994^{+0.0004}_{-0.0008}$
d_0 cut	$0.9965^{+0.0012}_{-0.0015}$
Isolation cut	$0.9775^{+0.0039}_{-0.0042}$
Δx_{CMU} cut	$0.9969^{+0.0008}_{-0.0011}$
Δx_{CMP} cut	$0.9865^{+0.0021}_{-0.0023}$
All above cuts	$0.9693^{+0.0057}_{-0.0056}$
All cuts excl. isol.	$0.9917^{+0.0045}_{-0.0044}$
Sliding isol. cut	$0.9860^{+0.0033}_{-0.0032}$
All cuts (sliding isol.)	$0.9778^{+0.0051}_{-0.0056}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0005}$
All cuts (χ^2)	$0.9693^{+0.0057}_{-0.0056}$
All track cuts	$0.9847^{+0.0054}_{-0.0054}$
All trk cuts excl. isol.	$1.0076^{+0.0039}_{-0.0039}$

TABLE I: Dataset bhmummP21_SAM_zektim: Muon ID Scale Factors for CMUP

CMX ID Efficiencies

P20

Cut	Count	Efficiency (%)
No cut	1985	
E_{EM} cut	1926	$97.03^{+0.36}_{-0.42}$
E_{HAD} cut	1943	$97.88^{+0.33}_{-0.40}$
COT hits cut	1984	$99.95^{+0.04}_{-0.12}$
d_0 cut	1959	$98.69^{+0.26}_{-0.33}$
Isolation cut	1896	$95.52^{+0.46}_{-0.52}$
Δx_{CMX} cut	1977	$99.60^{+0.15}_{-0.20}$
All above cuts	1773	$89.32^{+0.67}_{-0.70}$
All cuts excl. isol.	1854	$93.40^{+0.59}_{-0.58}$
Sliding isol. cut	1921	$96.78^{+0.42}_{-0.46}$
All cuts (sliding isol.)	1795	$90.43^{+0.64}_{-0.73}$
χ^2 cut	1985	$100.00^{+0.00}_{-0.09}$
All cuts (χ^2)	1773	$89.32^{+0.67}_{-0.70}$
All track cuts	1779	$89.62^{+0.66}_{-0.71}$
All trk cuts excl. isol.	1860	$93.70^{+0.58}_{-0.59}$

TABLE II: Dataset bhmummP20: Muon ID efficiencies for C

P21

Cut	Count	Efficiency (%)
No cut	2780	
E_{EM} cut	2705	$97.30^{+0.33}_{-0.35}$
E_{HAD} cut	2725	$98.02^{+0.25}_{-0.29}$
COT hits cut	2778	$99.93^{+0.04}_{-0.10}$
d_0 cut	2768	$99.57^{+0.13}_{-0.17}$
Isolation cut	2669	$96.01^{+0.36}_{-0.43}$
Δx_{CMX} cut	2769	$99.60^{+0.12}_{-0.16}$
All above cuts	2534	$91.15^{+0.50}_{-0.55}$
All cuts excl. isol.	2635	$94.78^{+0.41}_{-0.47}$
Sliding isol. cut	2701	$97.16^{+0.33}_{-0.36}$
All cuts (sliding isol.)	2563	$92.19^{+0.51}_{-0.52}$
χ^2 cut	2780	$100.00^{+0.00}_{-0.07}$
All cuts (χ^2)	2534	$91.15^{+0.50}_{-0.55}$
All track cuts	2543	$91.47^{+0.54}_{-0.58}$
All trk cuts excl. isol.	2644	$95.11^{+0.42}_{-0.45}$

TABLE II: Dataset bhmummP21_SAM: Muon ID efficiencies for CMX

CMX ID SF

P20

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0084^{+0.0038}_{-0.0044}$
E_{HAD} cut	$1.0004^{+0.0034}_{-0.0041}$
COT hits cut	$0.9996^{+0.0004}_{-0.0012}$
d_0 cut	$0.9891^{+0.0026}_{-0.0033}$
Isolation cut	$0.9859^{+0.0047}_{-0.0054}$
Δx_{CMX} cut	$0.9975^{+0.0015}_{-0.0020}$
All above cuts	$0.9809^{+0.0074}_{-0.0077}$
All cuts excl. isol.	$0.9958^{+0.0064}_{-0.0062}$
Sliding isol. cut	$0.9901^{+0.0043}_{-0.0047}$
All cuts (sliding isol.)	$0.9848^{+0.0070}_{-0.0080}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0009}$
All cuts (χ^2)	$0.9809^{+0.0074}_{-0.0077}$
All track cuts	$0.9827^{+0.0073}_{-0.0078}$
All trk cuts excl. isol.	$0.9974^{+0.0062}_{-0.0063}$

Dataset bhmummP20_zektim: Muon ID Scale Factors for

P21

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0113^{+0.0035}_{-0.0037}$
E_{HAD} cut	$1.0018^{+0.0025}_{-0.0030}$
COT hits cut	$0.9994^{+0.0004}_{-0.0010}$
d_0 cut	$0.9979^{+0.0013}_{-0.0017}$
Isolation cut	$0.9909^{+0.0037}_{-0.0044}$
Δx_{CMX} cut	$0.9976^{+0.0012}_{-0.0016}$
All above cuts	$1.0010^{+0.0055}_{-0.0061}$
All cuts excl. isol.	$1.0105^{+0.0044}_{-0.0051}$
Sliding isol. cut	$0.9940^{+0.0034}_{-0.0037}$
All cuts (sliding isol.)	$1.0040^{+0.0056}_{-0.0057}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0007}$
All cuts (χ^2)	$1.0010^{+0.0055}_{-0.0061}$
All track cuts	$1.0030^{+0.0060}_{-0.0064}$
All trk cuts excl. isol.	$1.0124^{+0.0046}_{-0.0049}$

TABLE II: Dataset bhmummP21_SAM_zektim: 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.

P18

Category	Fiducial	w/ Stub	Efficiency (%)
CMUP	4834	4307	$89.10^{+0.43}_{-0.45}$
CMX	2820	2673	$94.79^{+0.40}_{-0.48}$
CMX Arches	2242	2163	$96.48^{+0.37}_{-0.46}$
CMX Miniskirt	450	396	$88.00^{+1.55}_{-1.77}$
CMX Keystone	128	114	$89.06^{+2.93}_{-3.32}$
CMU-only	1171	1030	$87.96^{+0.96}_{-1.00}$
CMP-only	1377	1233	$89.54^{+0.84}_{-0.92}$
CMX MiniKey	578	510	$88.24^{+1.32}_{-1.42}$

P19

Category	Fiducial	w/ Stub	Efficiency (%)
CMUP	3087	2701	$87.50^{+0.64}_{-0.63}$
CMX	1922	1833	$95.37^{+0.50}_{-0.52}$
CMX Arches	1534	1493	$97.33^{+0.40}_{-0.48}$
CMX Miniskirt	307	270	$87.95^{+1.80}_{-2.11}$
CMX Keystone	81	70	$86.42^{+4.01}_{-4.97}$
CMU-only	757	661	$87.32^{+1.26}_{-1.28}$
CMP-only	851	753	$88.48^{+1.07}_{-1.23}$
CMX MiniKey	388	340	$87.63^{+1.73}_{-1.98}$

P20

Category	Fiducial	w/ Stub	Efficiency (%)
CMUP	3284	2845	$86.63^{+0.62}_{-0.65}$
CMX	2030	1929	$95.02^{+0.51}_{-0.52}$
CMX Arches	1568	1528	$97.45^{+0.38}_{-0.45}$
CMX Miniskirt	368	322	$87.50^{+1.66}_{-2.05}$
CMX Keystone	94	79	$84.04^{+4.04}_{-4.55}$
CMU-only	785	699	$89.04^{+1.09}_{-1.25}$
CMP-only	854	742	$86.89^{+1.10}_{-1.24}$
CMX MiniKey	462	401	$86.80^{+1.58}_{-1.74}$

P21

Category	Fiducial	w/ Stub	Efficiency (%)
CMUP	4474	3926	$87.75^{+0.51}_{-0.52}$
CMX	2852	2711	$95.06^{+0.43}_{-0.45}$
CMX Arches	2235	2165	$96.87^{+0.37}_{-0.41}$
CMX Miniskirt	491	430	$87.58^{+1.58}_{-1.74}$
CMX Keystone	126	116	$92.06^{+2.27}_{-3.20}$
CMU-only	1127	1002	$88.91^{+0.98}_{-0.97}$
CMP-only	1266	1089	$86.02^{+0.94}_{-1.01}$
CMX MiniKey	617	546	$88.49^{+1.25}_{-1.48}$

Reconstruction SF

P18

Category	Scale Factor
CMUP	$0.9144^{+0.0044}_{-0.0046}$
CMX	$0.9516^{+0.0041}_{-0.0048}$
CMX Arches	$0.9668^{+0.0038}_{-0.0046}$
CMX Miniskirt	$0.8883^{+0.0157}_{-0.0179}$
CMX Keystone	$0.9020^{+0.0297}_{-0.0337}$
CMU-only	$0.9015^{+0.0098}_{-0.0102}$
CMP-only	$0.9112^{+0.0085}_{-0.0094}$
CMX MiniKey	$0.8912^{+0.0133}_{-0.0133}$

P19

Category	Scale Factor
CMUP	$0.8979^{+0.0066}_{-0.0065}$
CMX	$0.9575^{+0.0051}_{-0.0052}$
CMX Arches	$0.9753^{+0.0040}_{-0.0048}$
CMX Miniskirt	$0.8878^{+0.0182}_{-0.0213}$
CMX Keystone	$0.8752^{+0.0406}_{-0.0504}$
CMU-only	$0.8950^{+0.0129}_{-0.0132}$
CMP-only	$0.9005^{+0.0109}_{-0.0125}$
CMX MiniKey	$0.8851^{+0.0174}_{-0.0174}$

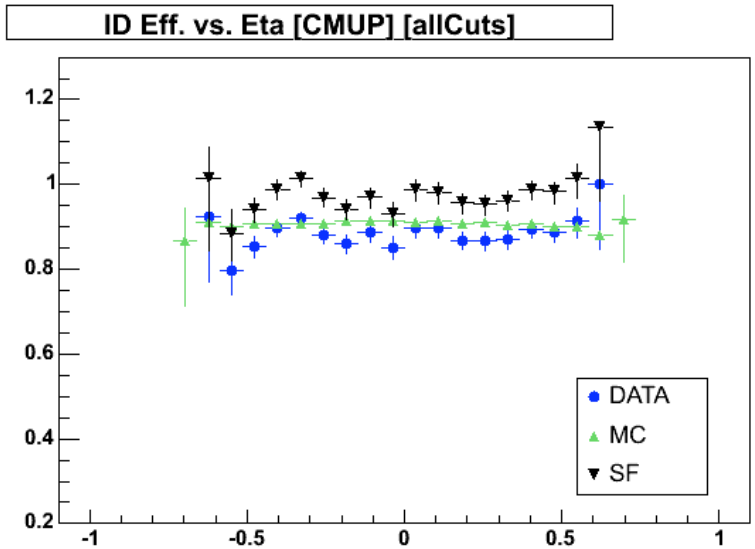
P20

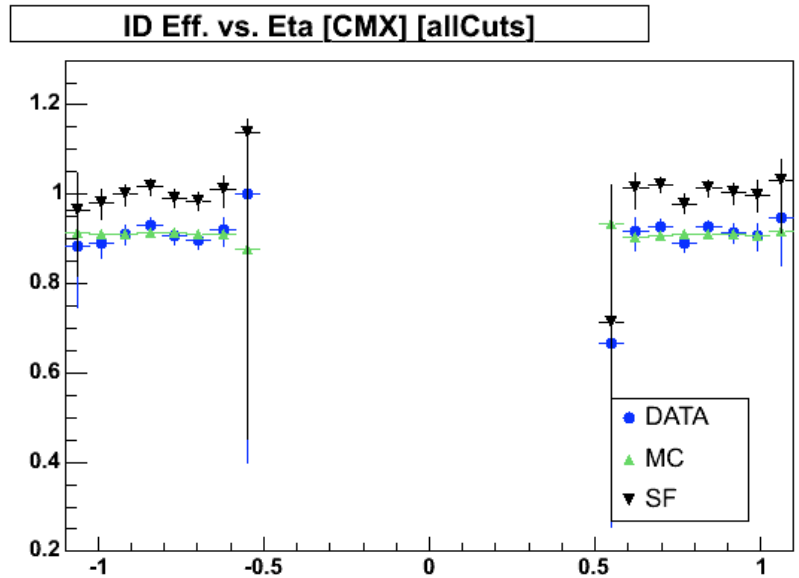
Category	Scale Factor
CMUP	$0.8891^{+0.0064}_{-0.0066}$
CMX	$0.9540^{+0.0051}_{-0.0052}$
CMX Arches	$0.9765^{+0.0038}_{-0.0045}$
CMX Miniskirt	$0.8832^{+0.0168}_{-0.0207}$
CMX Keystone	$0.8511^{+0.0410}_{-0.0461}$
CMU-only	$0.9127^{+0.0112}_{-0.0128}$
CMP-only	$0.8842^{+0.0112}_{-0.0126}$
CMX MiniKey	$0.8767^{+0.0160}_{-0.0160}$

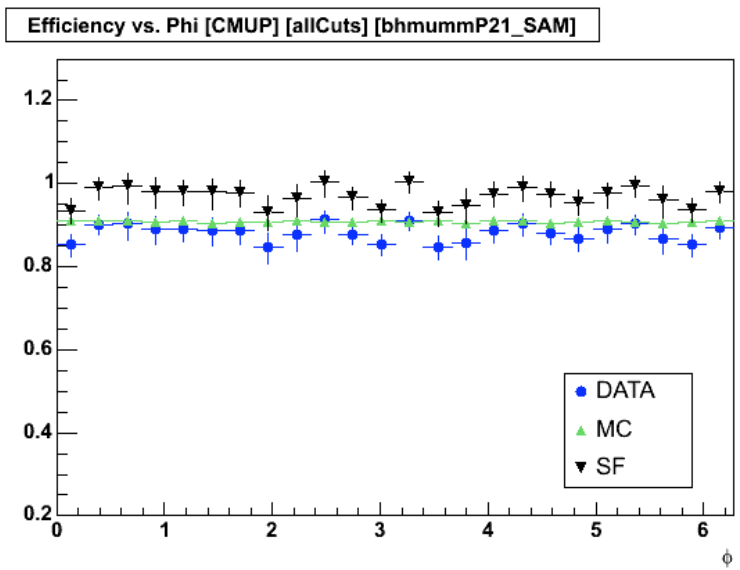
P21

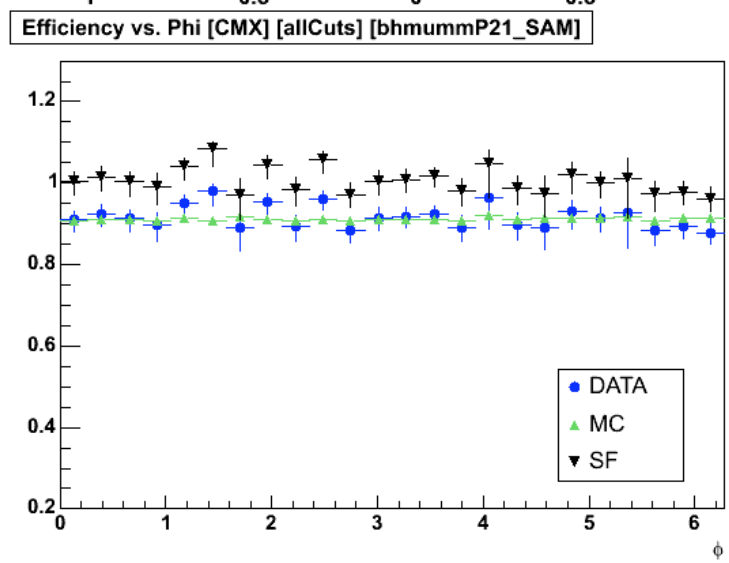
Category	Scale Factor
CMUP	$0.9005^{+0.0052}_{-0.0053}$
CMX	$0.9543^{+0.0043}_{-0.0045}$
CMX Arches	$0.9707^{+0.0037}_{-0.0041}$
CMX Miniskirt	$0.8840^{+0.0160}_{-0.0175}$
CMX Keystone	$0.9324^{+0.0230}_{-0.0324}$
CMU-only	$0.9113^{+0.0101}_{-0.0100}$
CMP-only	$0.8754^{+0.0096}_{-0.0103}$
CMX MiniKey	$0.8938^{+0.0127}_{-0.0127}$

Reco and ID Plots

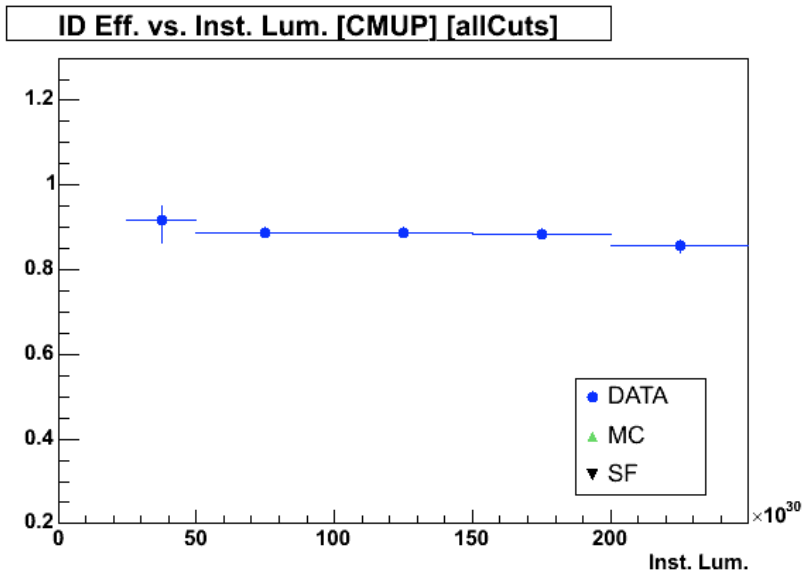


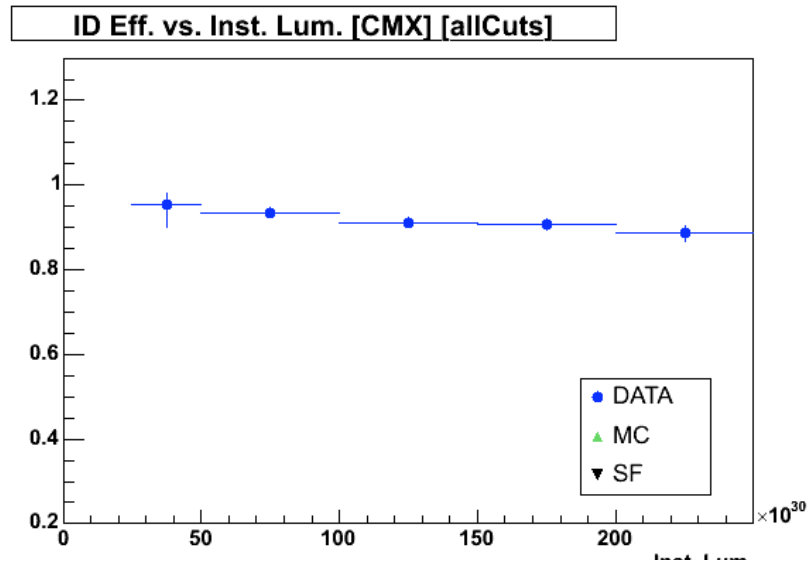


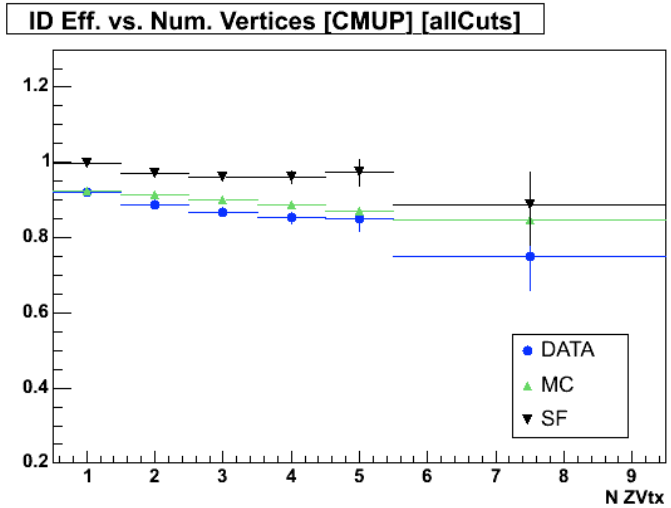


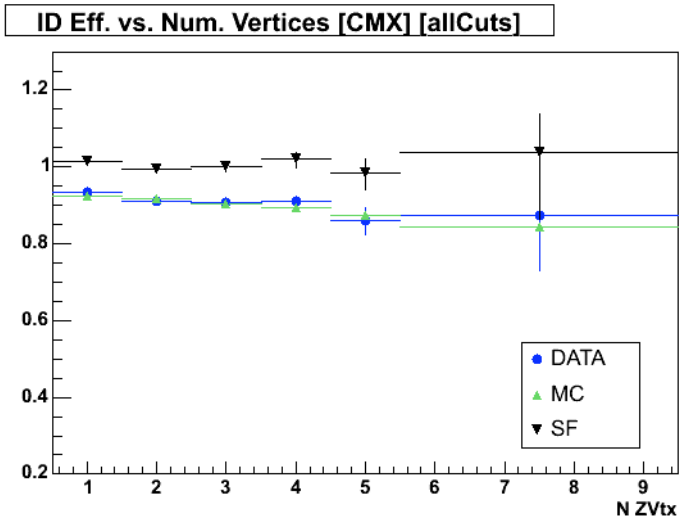


Reco and ID Plots

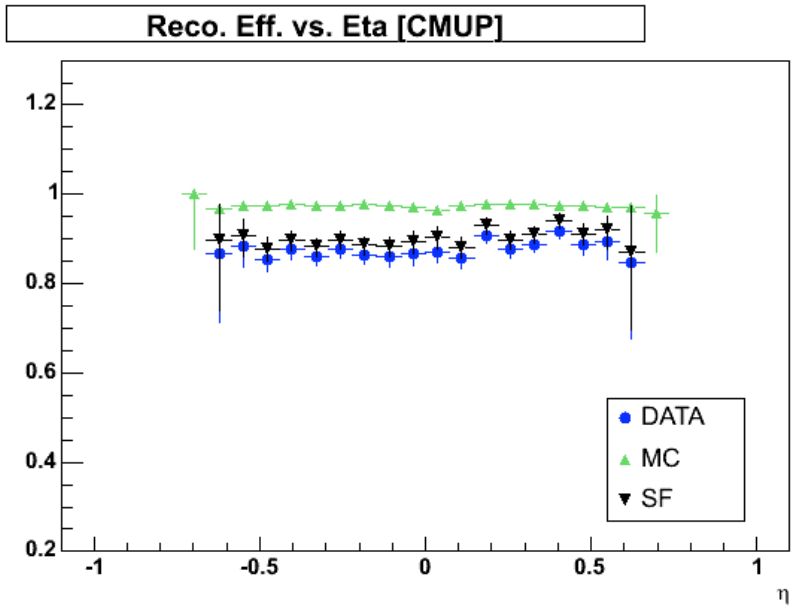


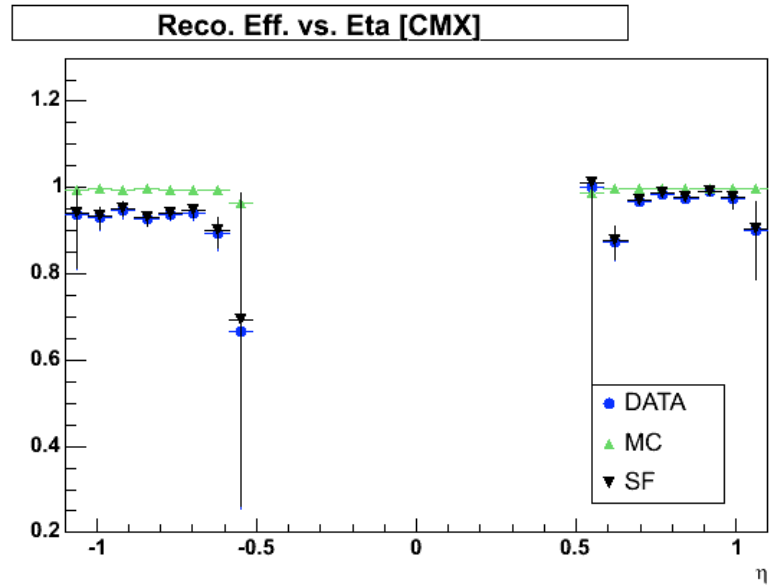


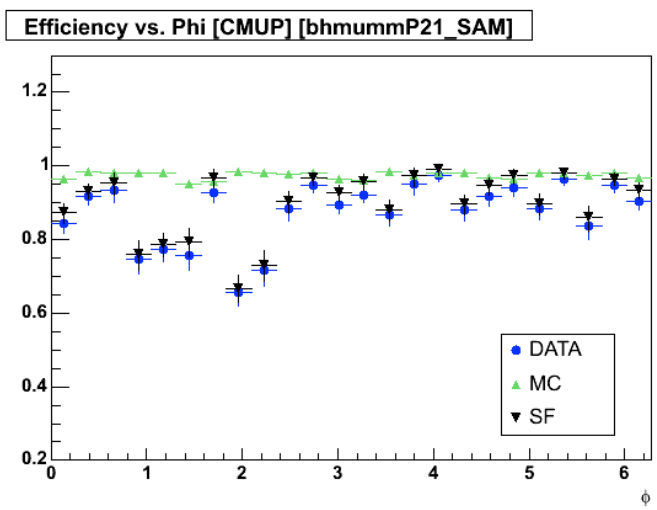


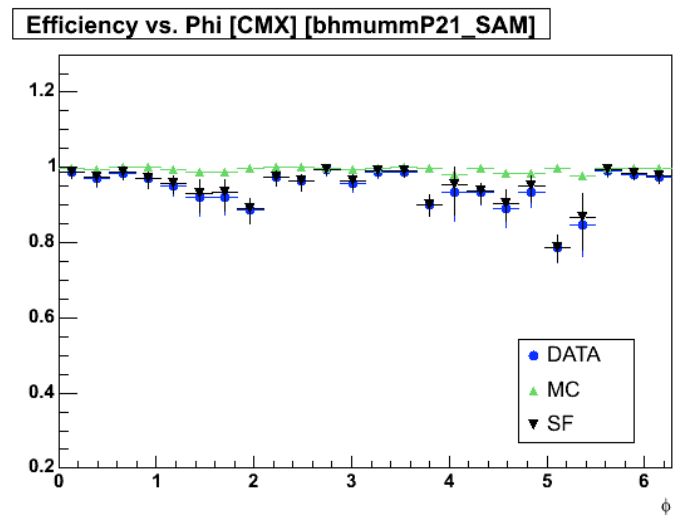


Reco and ID Plots









Conclusions

- P20 high PT electrons and muons analyzed:
  - Electron ID - slight drop in CEM efficiencies, will check with expert
  - Ele Trigger - in agreement with previous periods
  - Muon ID and Reco : ok
  - To be continued……
    - Muon Trigger: not dps yet
    - MET_PEM trigger
    - COT Eff