Period 20 High PT Lepton Efficiencies and SF -Preliminary

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Tufts

Electrons ID: Samples

Dataset bhelmm: Runs 266528-267718 (P20)
MC sample : zektei (Feb 2008)
GRL :GRL for P20 v26
(goodrun_em_si_v26.list, goodrun_em_nosi_v26.list)

P20 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.

P19 numbers vs P20

	Period 19		Period 20	
	bhelmm(P19)	zektei	bhelmm(P19)	zektei
CEM Eff	0.770+\-0.005	0.795 +\-0.001	0.777+\-0.004	0.795 +\-0.001
CEM SF	0.969 +\-0.006	N/A	0.977 +\-0.005	N/A
nisoCEM Eff	0.808 +\-0.004	0.825 +\-0.001	0.814 +\-0.004	0.825 +\-0.001
nisoCEM SF	0.980 +\-0.005	N/A	0.987 +\-0.005	N/A
LooseCEM Eff	0.900 +/- 0.003	0.907 +\-0.001	0.903 +/- 0.003	0.907 +\-0.001
LooseCEM SF	0.993 +\-0.004	N/A	0.996 +\-0.004	N/A
nisolooseCEM Eff	0.946+\-0.002	0.943 +\-0.001	0.946+\-0.002	0.943 +\-0.001
nisoloostCEM SF	1.003 +\-0.003	N/A	1.003 +\-0.003	N/A

	PHX		PHX	
Eff |Eta| < 2.0	0.667+\-0.007	0.744+\-0.002	0.692+\-0.007	0.744+\-0.002
SF |Eta| < 2.0	0.896+\-0.010	NA	0.930+\-0.009	NA
	PHX		PHX	
Eff |Eta| < 2.8	0.584+\-0.006	0.645+\-0.002	0.601+\-0.006	0.645+\-0.002
SF |Eta| < 2.8	0.905+\-0.010	NA	0.930+\-0.007	NA

CEM-PEM

P17

	PEM	
Eff |Eta| < 2.0	0.784+\-0.006	0.847+\-0.002
SF |Eta| < 2.0	0.926+\-0.008	NA

	PEM	
Eff |Eta| < 2.8	0.742+\-0.006	0.810+\-0.001
SF |Eta| < 2.8	0.915+\-0.007	NA

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

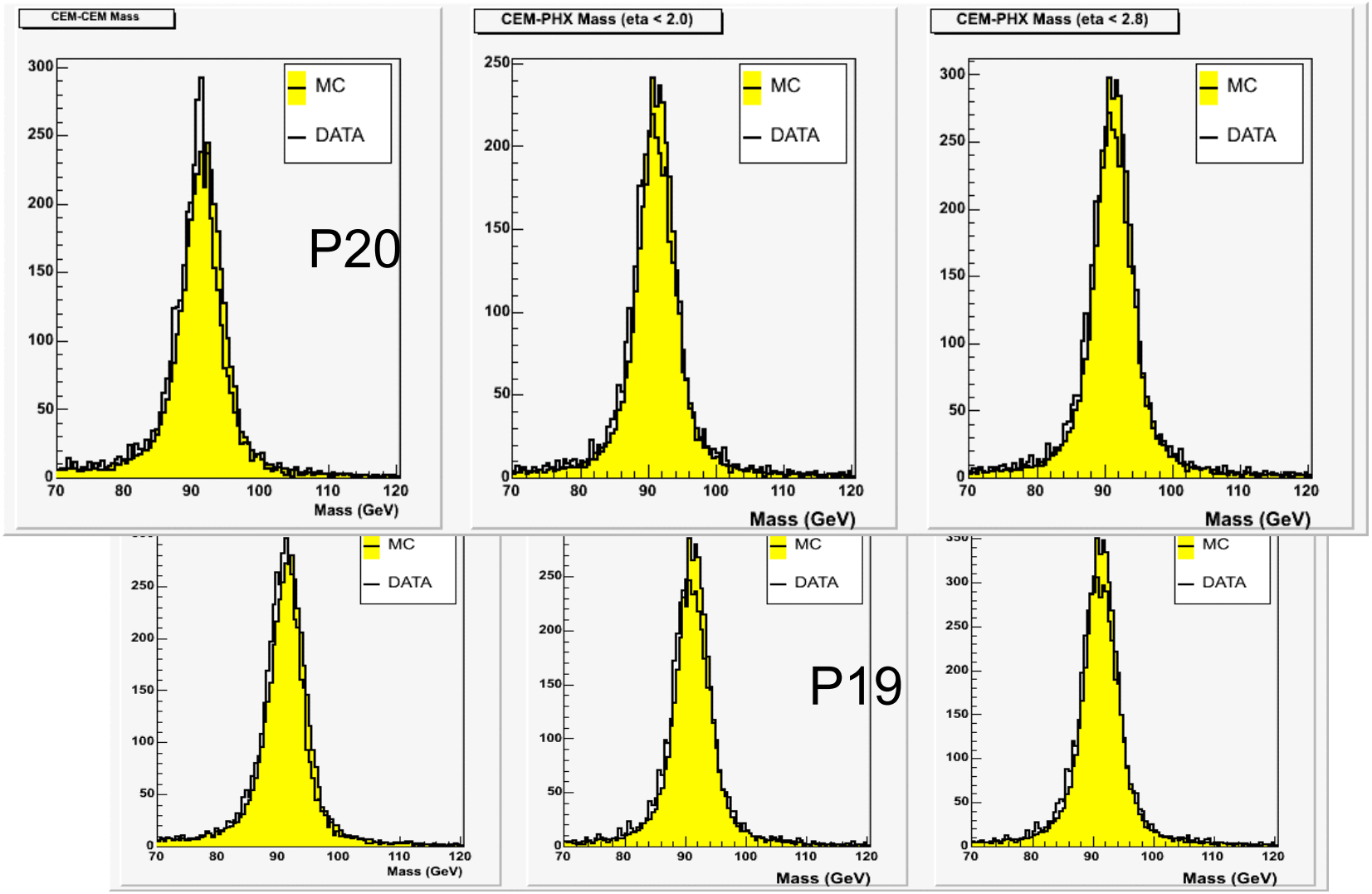
	PEM	
Eff |Eta| < 2.8	0.720+\-0.006	0.810+\-0.001
SF |Eta| < 2.8	0.889+\-0.007	NA

P20

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

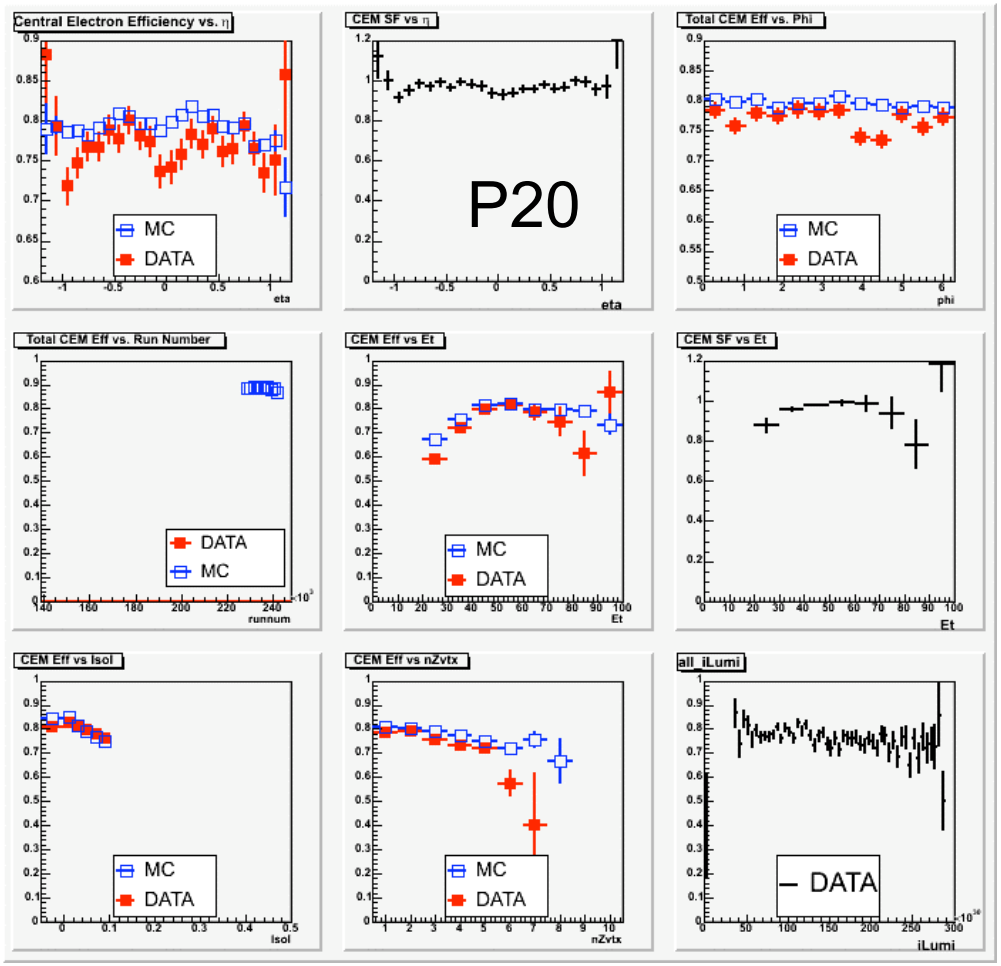
	PEM	
Eff |Eta| < 2.8	0.730+\-0.005	0.810+\-0.001
SF |Eta| < 2.8	0.901+\-0.007	NA

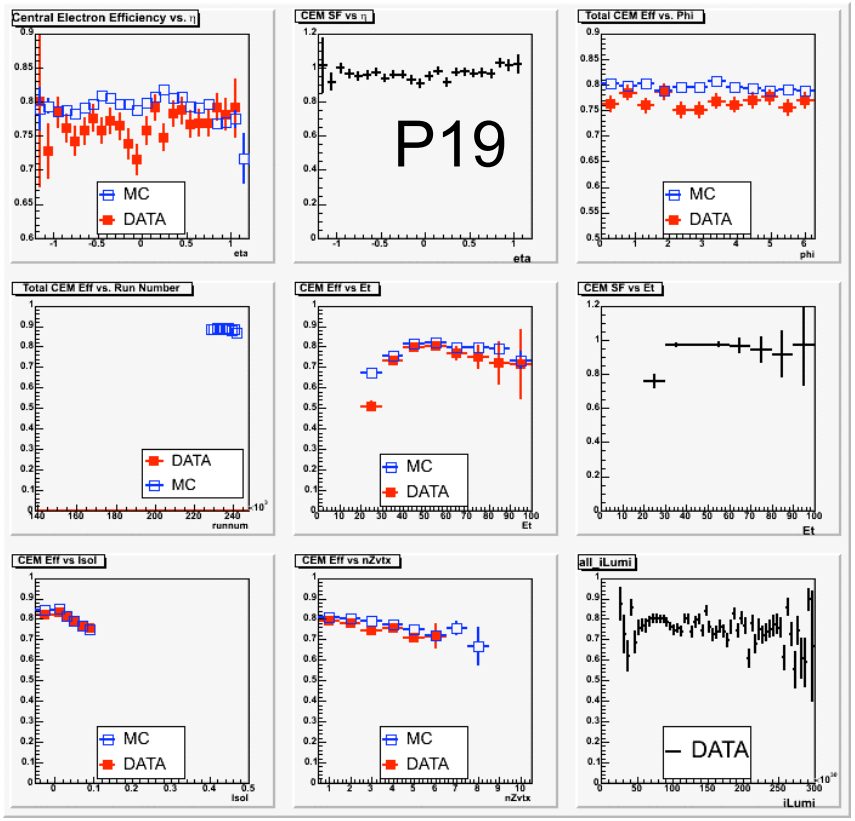
EleID Plots


CEM-CEM Mass
CEM-PHX Mass (eta < 2.0)
CEM-PHX Mass (eta < 2.8)
MC
DATA
P20
P19
Mass (GeV)

EleID Plots 1

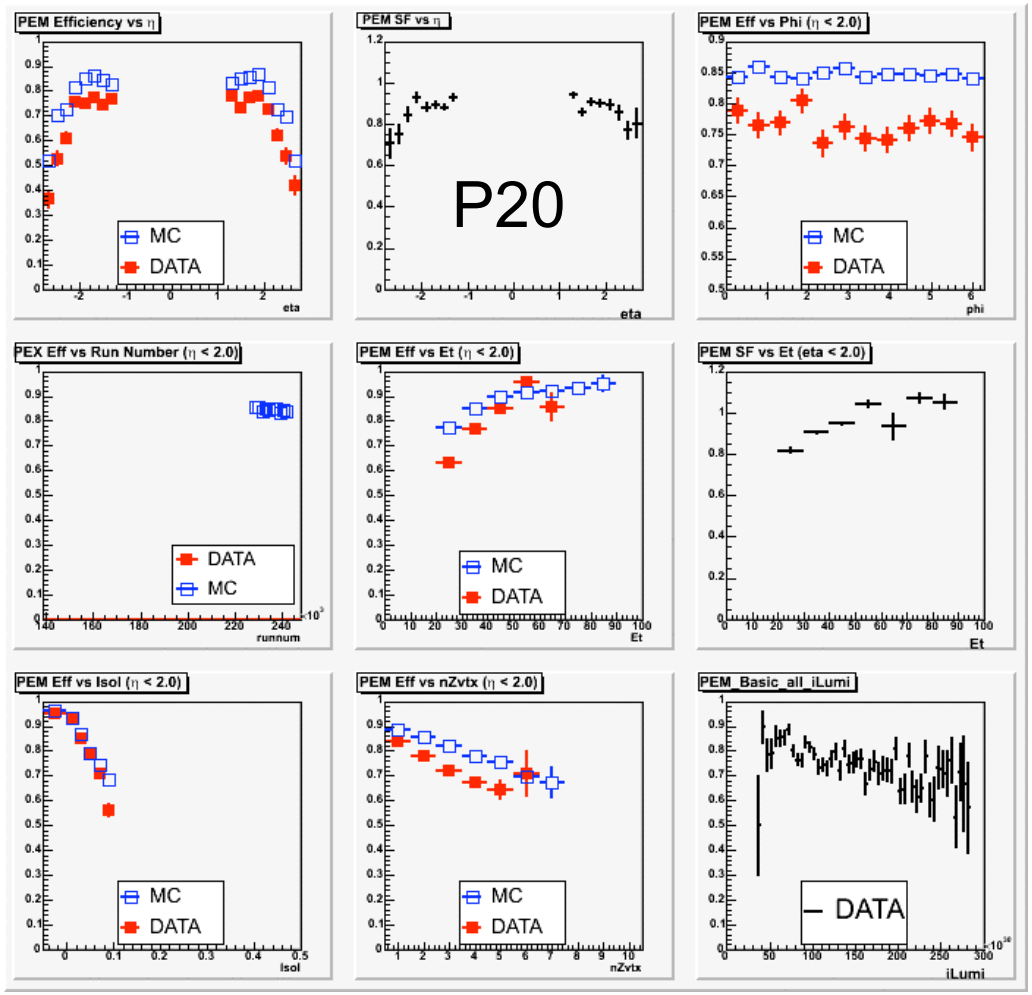
CEM Efficiencies

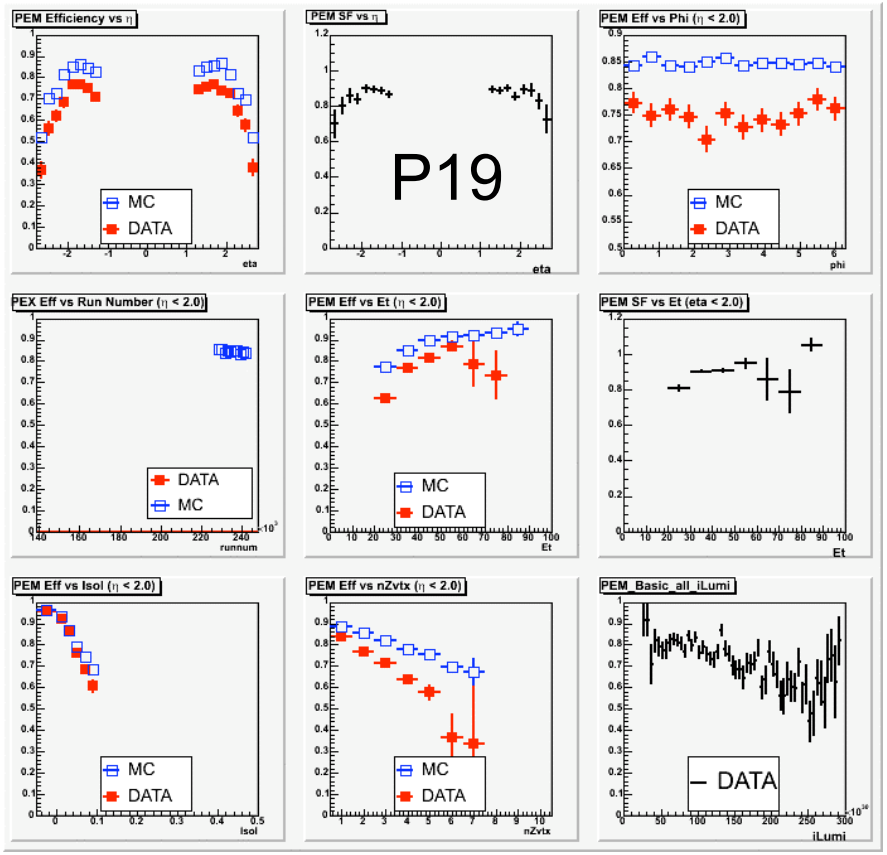




EleID Plots 2

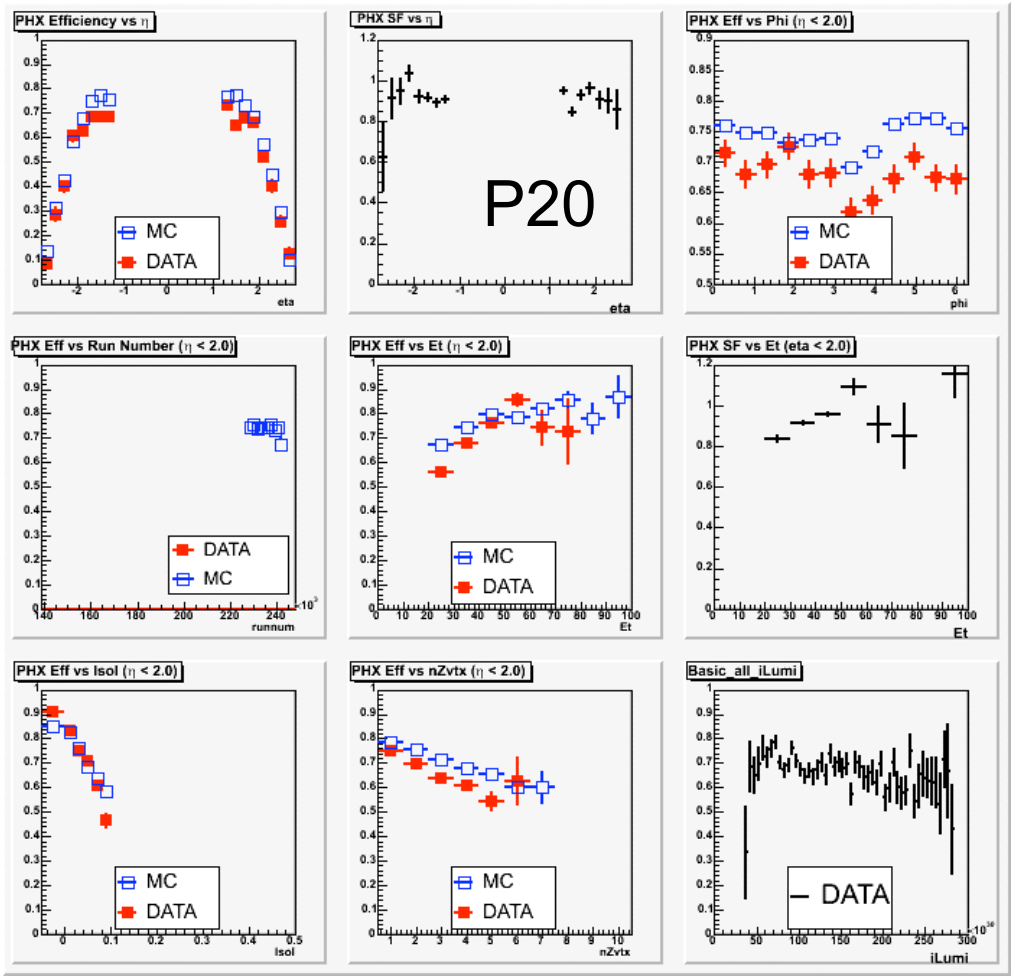
PEM Efficiencies

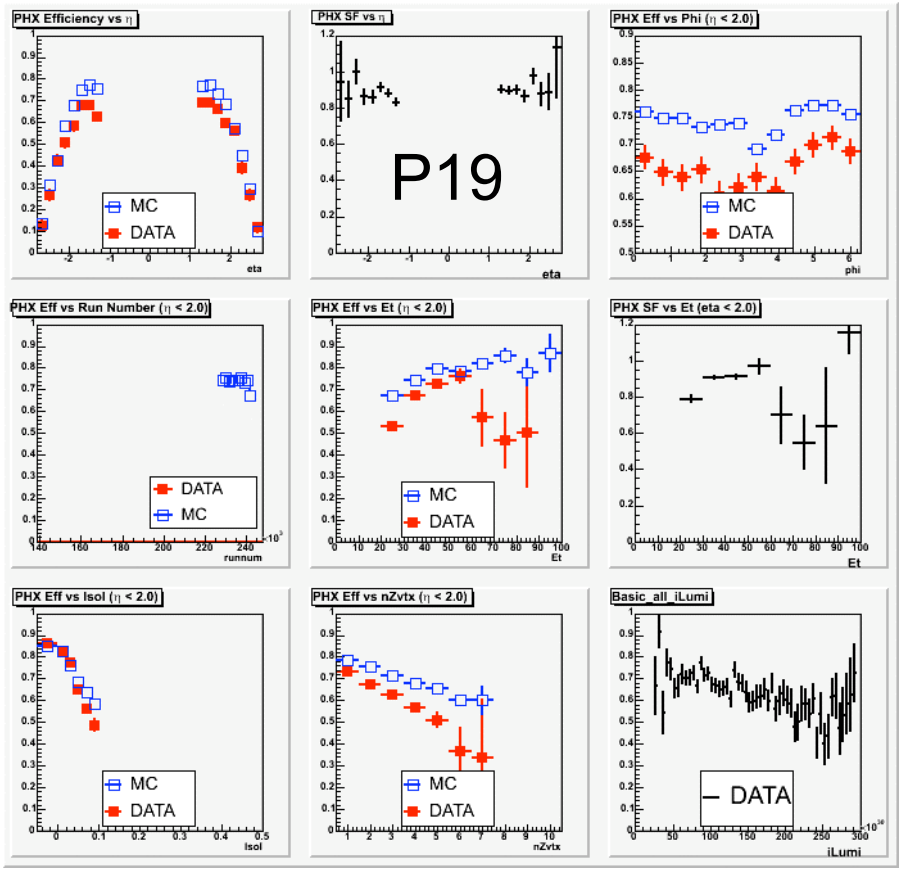




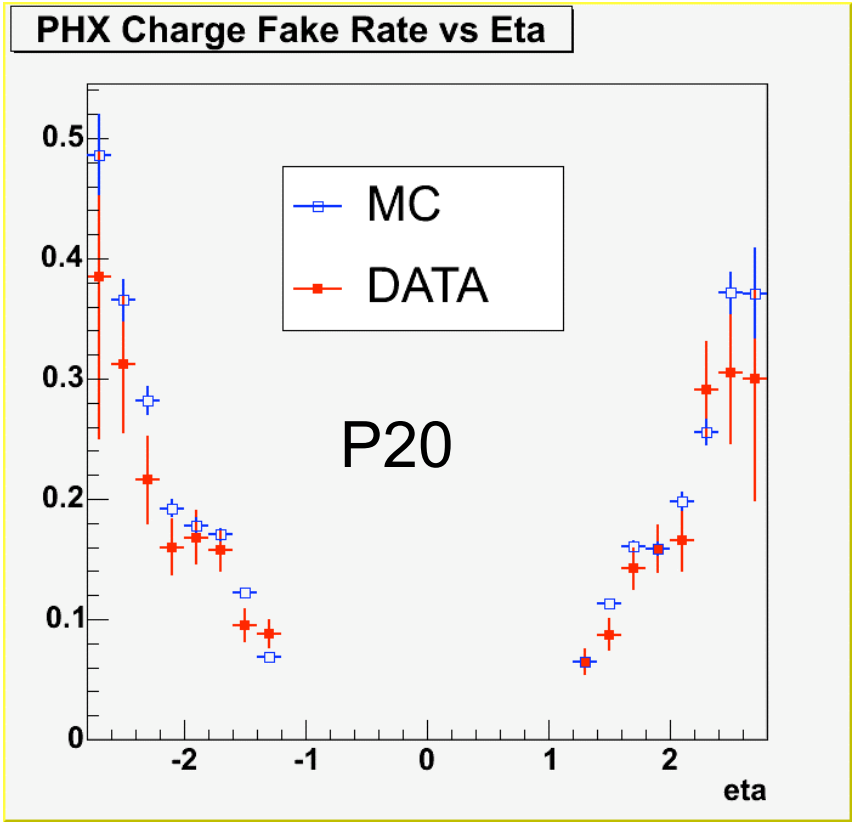
EleID Plots 3

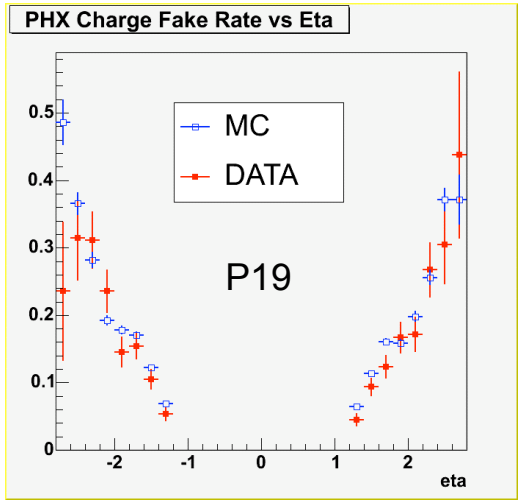
PHX Efficiencies



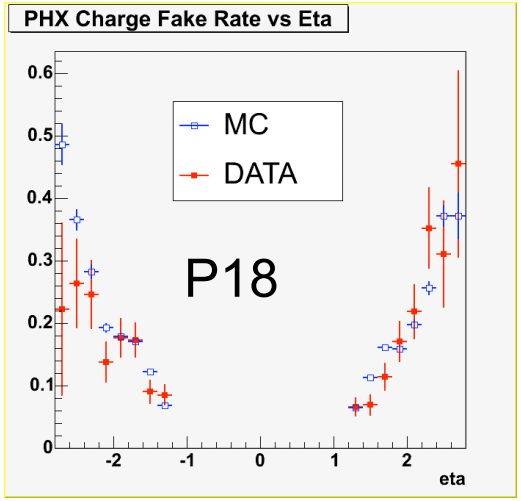


PHX Fake Charge Rate





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



Phoenix charge fake rate
$\eta < 2$ 0.1088 +/- 0.0078
$\eta < 2.8$ 0.1342 +/- 0.0076

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

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	118302
NcemL1	114588
NcemL2	114533
NcemL3	113510

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

Electron Trigger: Results Past Periods

Analyzed all data

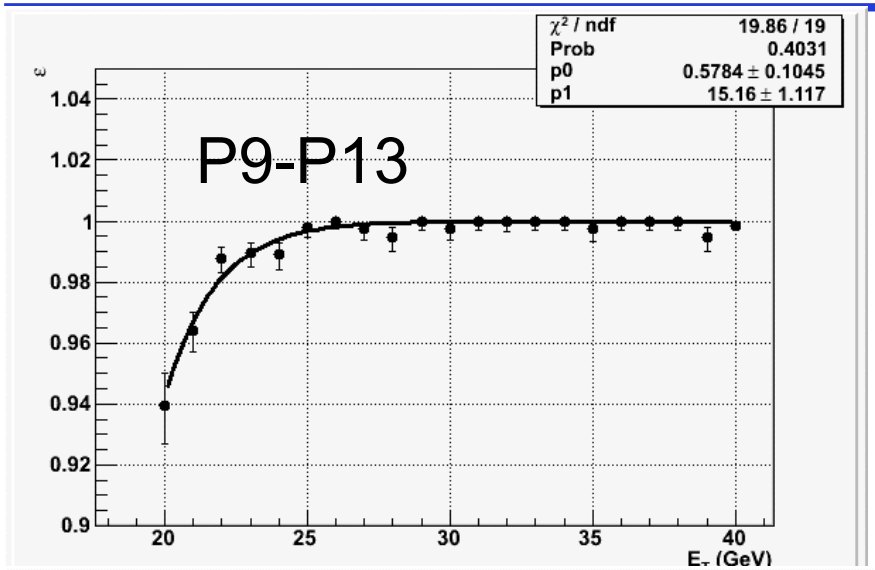
Trigger	Period 9	Period 10A	Period 10B
L1_XFT_PT8	0.9651(6)	0.9673(7)	0.9650(29)
L2_XFT_PT8	0.9992(1)	0.9993(1)	0.9992(5)
L3 tracking	0.9954(2)	0.9932(3)	0.9968(9)
Total Tracking	0.9598(7)	0.9600(8)	0.9611(31)

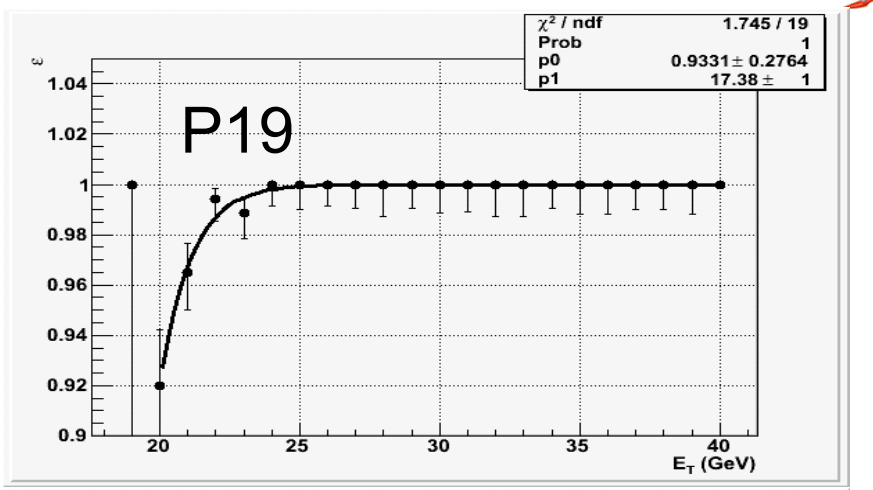
Trigger	Period 11	Period 12	Period 13	Period 14
L1_XFT_PT8	0.9688(4)	0.96857 ± 0.003	0.963922 ± 0.003	0.964755 ± 0.03
L2_XFT_PT8	0.9988(4)	0.9990 ± 0.003	0.998003 ± 0.003	0.999569 ± 0.03
L3 tracking	0.9935(4)	0.9940 ± 0.003	0.994608 ± 0.003	0.996055 ± 0.03
Total Tracking	0.9614(4)	0.9600 ± 0.003	0.95681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

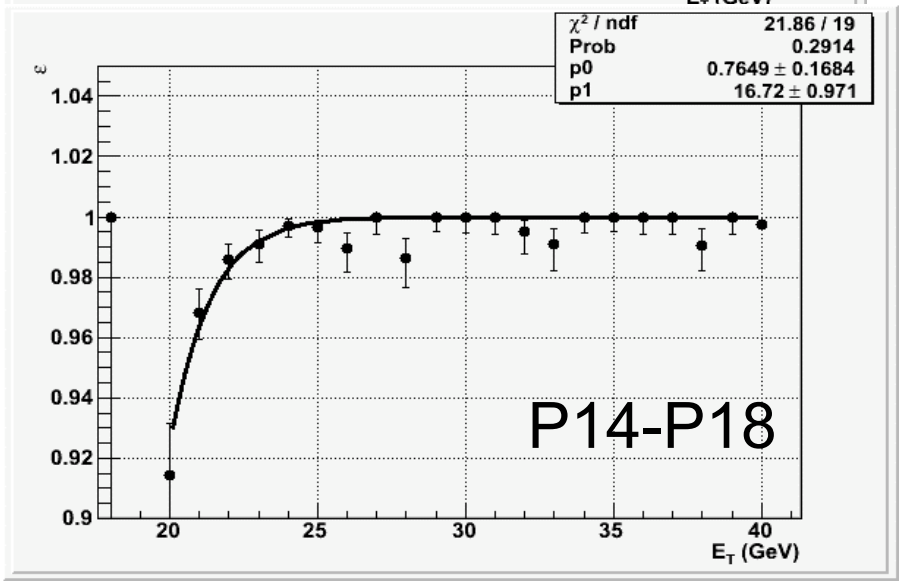
Trigger	Period 15	Period 16	Period 17	Period 18
L1_XFT_PT8	0.9695 ± 0.005	0.9684 ± 0.005	0.9694 ± 0.003	0.9697 ± 0.003
L2_XFT_PT8	0.9994 ± 0.005	0.9994 ± 0.005	0.9995 ± 0.003	0.9995 ± 0.003
L3 tracking	0.9940 ± 0.005	0.9927 ± 0.005	0.9929 ± 0.003	0.9919 ± 0.003
Total Tracking	0.9633 ± 0.005	0.9609 ±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

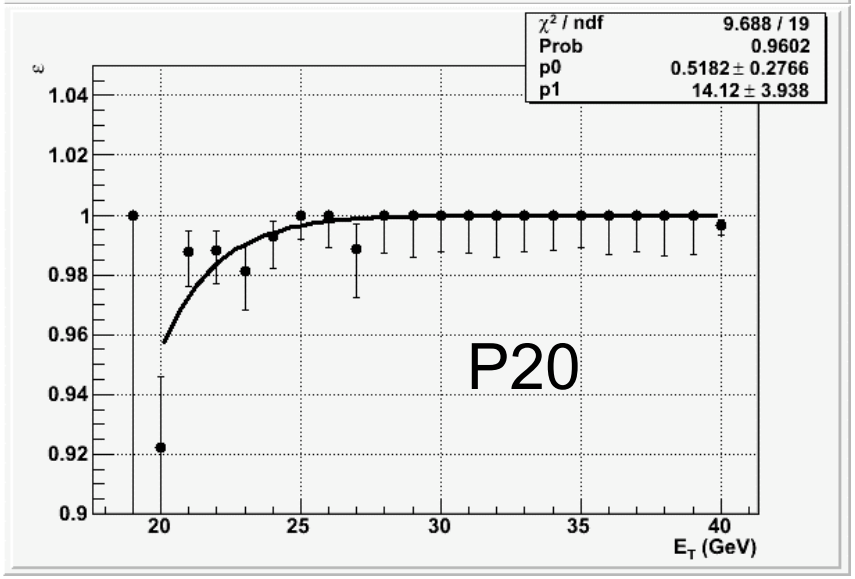
CEM Electron Trigger Results

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





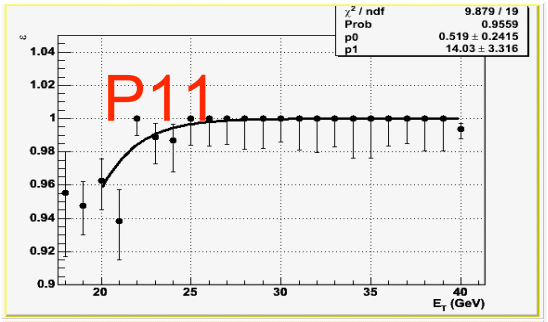


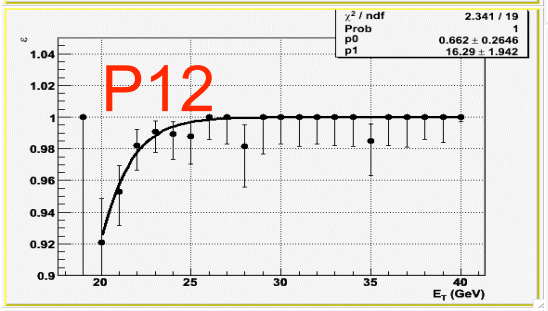


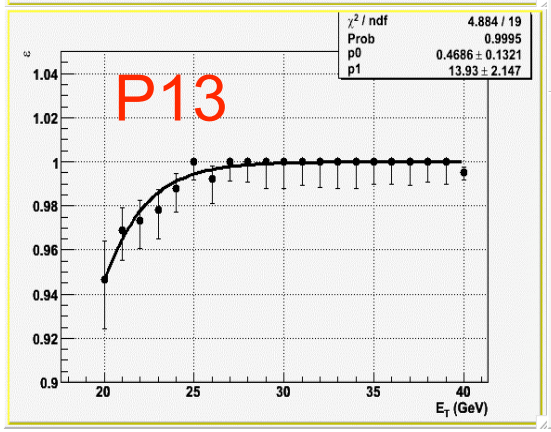
Electron Trigger :Past Periods

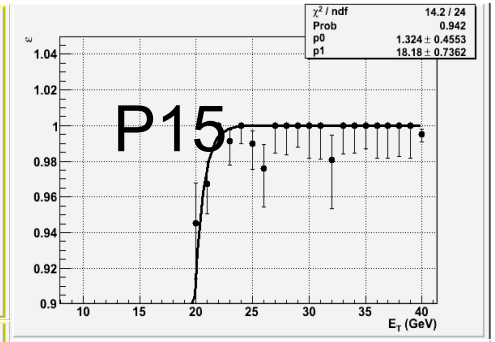
$$\epsilon = \frac{1}{1 + e^{-\beta(E_T - \alpha)}}.$$

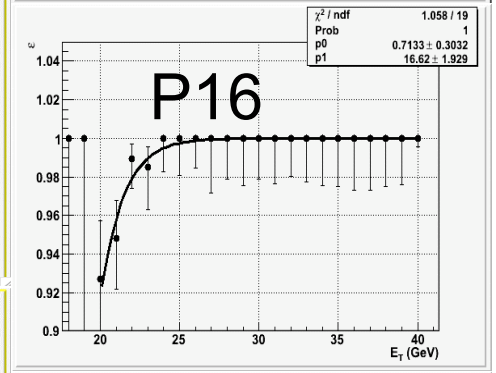
L2_CEM16 calorimeter efficiency

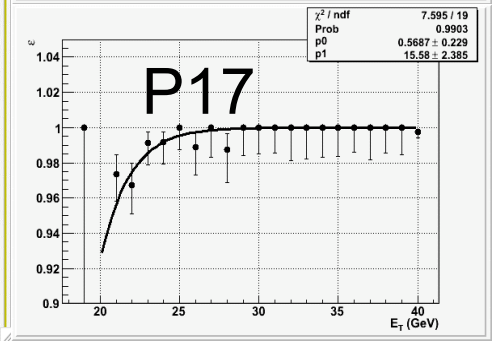


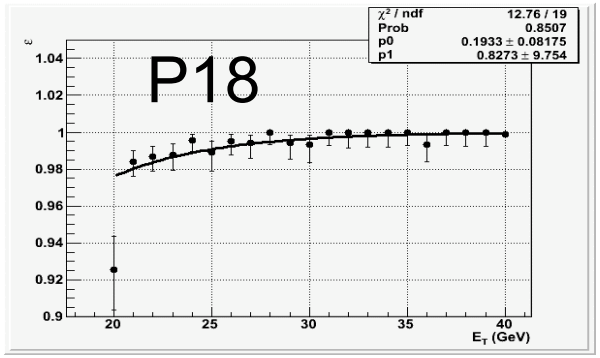


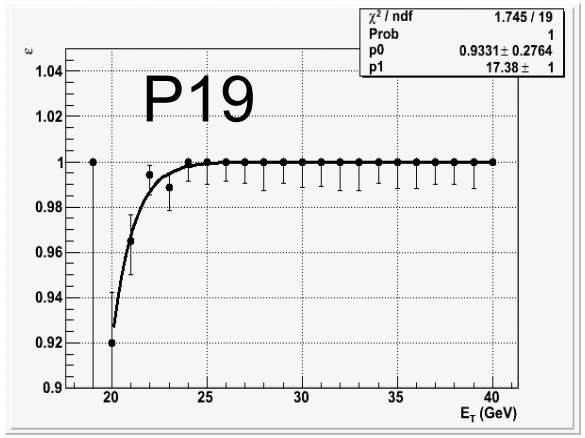












MET_PEM Trigger

Dataset bhelmm: Runs 266528-267718 (P20)
Dataset bpelmm (and high eta PHX): Runs 266528-267718

GRL :GRL for P20 v26

P20 dataset :bpelmm, bhelmm, skim leptons, goodrun_em_si_v26.list

MET_PEM Trigger: Evt Selection

Event Selection: $W \rightarrow e\nu$ and $Z \rightarrow e^+e^-$ (CP) candidates.

- Plug electrons selected according to the Phoenix Objects standard cuts,
- Central electrons are *UltraTight CEM* Objects
- Electron ID cuts: notes 8614 and 8274

Variable	UltraTight CEM	Variable	PHX
Region	== Central	Region	== plug
Fiducial	TrkFiducial == 1	*Pes2dEta*	$1.2 \leq \lvert\eta\rvert \leq 2.8$
E_T	$\geq$ 20 GeV	E_T	$\geq$ 20 GeV
Track Z_0	$\leq$ 60 cm	Had/Em	$\leq$ 0.05
Track p_T	$\geq$ 10 Gev	Pem3x3FitTow	$\neq$ 0
COT Ax. Seg.	$\geq$ 3	Pem3x3χ^2	$\leq$ 10
COT St. Seg.	$\geq$ 2	Pes5by9U	$\geq$ 0.65
Conversion	$\neq$ 1	Pes5by9V	$\geq$ 0.65
Had/Em	$\leq (0.055 + (0.00045 \times E))$	Isolation	$\leq$ 0.1
Isolation	$\leq$ 0.05 ($\leq$ 0.1 in TCEM)	ΔR	$\leq$ 3.0 cm
LshrTrk	$\leq$ 0.1 ($\leq$ 0.2 in TCEM)	PhxMatch	True
E/p	$\leq$ 2.0 unless $p_T \geq$ 50 GeV/c	$N^{siliconhits}$	$\geq$ 3
CES ΔZ	$\leq$ 3.0 cm	Z_0^{PHX}	$\leq$ 60 cm
Single CES ΔX	$-3.0 \leq q \times \Delta X \leq 1.5$		
CES Stripχ^2	$\leq$ 10.0		

MET_PEM:L1 and L3 MET15 Eff

MET_PEM		PLUG_ELECTRON_20	
L1	L1_EM8_MET15	L1	L1_EM8
L2	L2_PEM20_L1_EM8_MET15	L2	L2_PEM20_PS10 (PS25)
L3	L3_PEM20_MET15	L3	L3_PEM20

L1, L3 MET15 and L2, L3 PEM20 components of MET_PEM are separated thanks to PLUG_ELECTRON_20 back-up trigger.

- MET15: $W \to e\nu$ candidate searched in the bpel dataset:

$$\epsilon(\texttt{L1_MET15_L3_MET15}) = \frac{\texttt{PLUG_ELECTRON_20 \&\& MET_PEM}}{\texttt{PLUG_ELECTRON_20}} \quad (1)$$

- PEM20: $Z \to e^+e^-$ CP candidate searched in the bhel dataset:

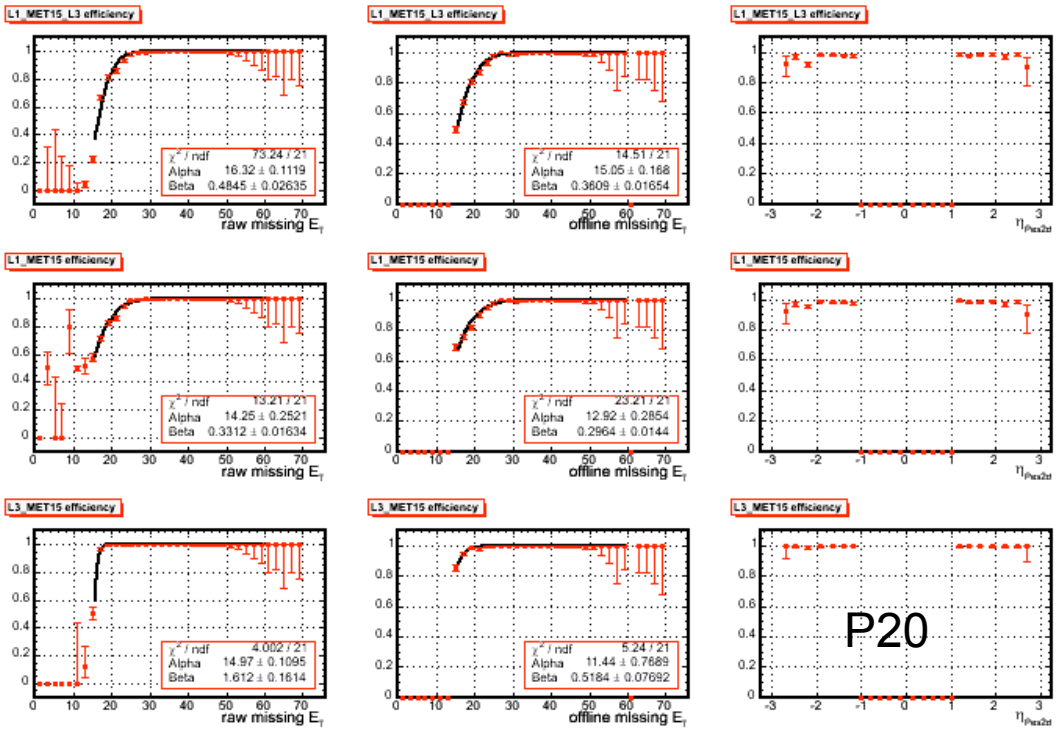
$$\epsilon(\texttt{L2_PEM20}) = \frac{Z \to e^+e^-(CP)\ \&\&\ \texttt{L2_PEM20_NoPS}}{Z \to e^+e^-(CP)} \quad (2)$$

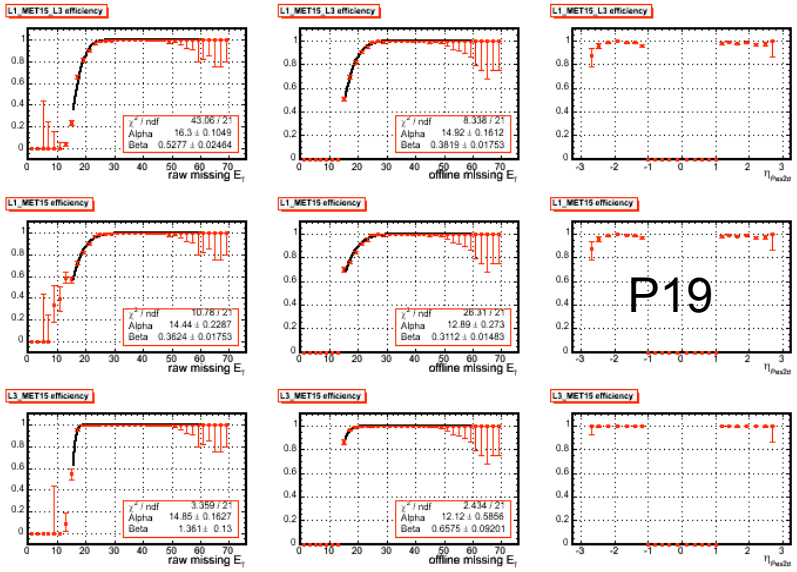
$$\epsilon(\texttt{L3_PEM20}) = \frac{Z \to e^+e^-(CP)\ \&\&\ \texttt{L2_PEM20_NoPS}\ \&\&\ \texttt{L3_PEM20}(L3Obj)}{Z \to e^+e^-(CP)\ \&\&\ \texttt{L2_PEM20_NoPS}} \quad (3)$$

Turn-on fit function

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

MET15 Results





MET15 Fit Results $1.2 \leq |\eta| \leq 2.8$

L1_MET15_L3_MET15 Fit Values (electron $1.2 \leq |\eta| \leq 2.8$)

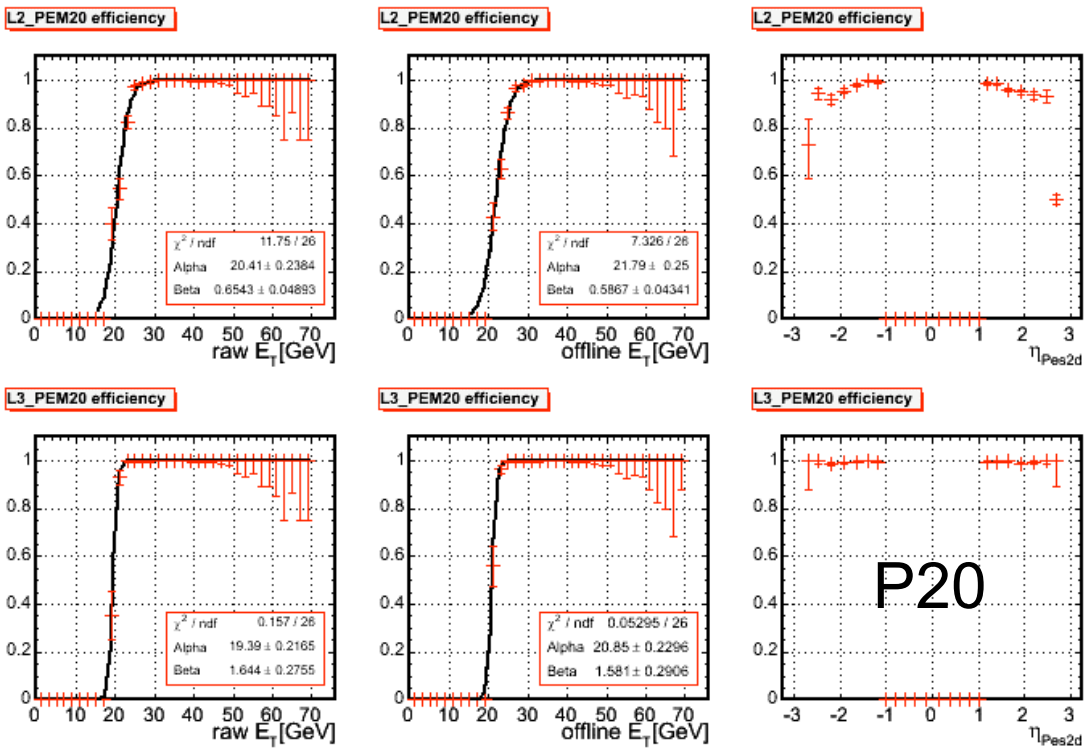
period	ϵ ($\not{E}_T > 20$ GeV)	α	β
$p00$	$98.52^{+0.20}_{-0.22}$	14.20 ± 0.24	0.35 ± 0.02
$[p01, p04]$	$97.89^{+0.26}_{-0.28}$	14.80 ± 0.22	0.34 ± 0.02
$[p05, p07]$	$98.64^{+0.09}_{-0.10}$	14.74 ± 0.10	0.35 ± 0.01
$p08$	$98.85^{+0.12}_{-0.12}$	14.38 ± 0.14	0.37 ± 0.01
$p09$	$98.92^{+0.14}_{-0.15}$	13.78 ± 0.20	0.37 ± 0.02
$p10$	$98.54^{+0.17}_{-0.19}$	14.62 ± 0.18	0.37 ± 0.02
$p11$	$98.47^{+0.18}_{-0.19}$	14.67 ± 0.18	0.38 ± 0.02
$p12$	$98.20^{+0.24}_{-0.26}$	15.15 ± 0.19	0.38 ± 0.02
$p13$	$98.36^{+0.18}_{-0.20}$	14.51 ± 0.18	0.37 ± 0.02
$p14$	$98.96^{+0.33}_{-0.41}$	13.57 ± 0.50	0.41 ± 0.05
$p15$	$98.44^{+0.21}_{-0.23}$	14.81 ± 0.19	0.39 ± 0.02
$p16$	$98.20^{+0.28}_{-0.32}$	15.34 ± 0.21	0.39 ± 0.03
$p17$	$98.23^{+0.22}_{-0.24}$	14.52 ± 0.21	0.39 ± 0.02
P18	$98.46^{+0.15}_{-0.16}$	15.05 ± 0.12	0.387 ± 0.014 $(1.2 \leq \lvert\eta\rvert \leq 2.8)$
P19	$98.48^{+0.18}_{-0.20}$	14.92+/-0.16	0.382+/-0.018 $(1.2 \leq \lvert\eta\rvert \leq 2.8)$
P20	$97.63^{+0.25}_{-0.26}$	15.05+/-0.17	0.361+/-0.017 $(1.2 \leq \lvert\eta\rvert \leq 2.8)$

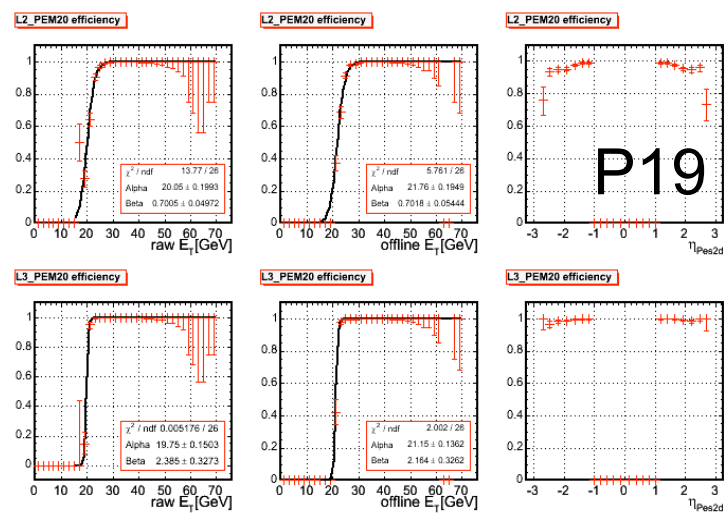
PEM_20: L3 Results

$1.2 \leq |\eta| \leq 2.8$

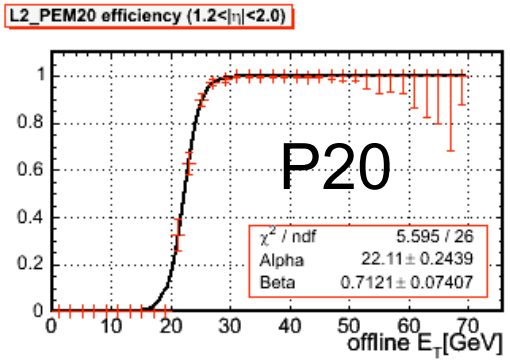
period	ϵ	α	β
$p00$	$99.65^{+0.06}_{-0.07}$	20.68 ± 0.23	1.38 ± 0.20
$[p01, p04]$	$99.67^{+0.06}_{-0.06}$	20.42 ± 0.21	1.53 ± 0.24
$[p05, p07]$	$99.67^{+0.06}_{-0.06}$	20.80 ± 0.22	1.40 ± 0.20
$p08$	$99.47^{+0.11}_{-0.13}$	21.03 ± 0.17	1.95 ± 0.33
$p09$	$99.59^{+0.10}_{-0.12}$	21.48 ± 0.21	1.94 ± 0.35
$p10$	$99.45^{+0.10}_{-0.11}$	20.95 ± 0.18	1.58 ± 0.24
$p11$	$99.69^{+0.08}_{-0.09}$	20.75 ± 0.23	1.88 ± 0.68
$p12$	$99.66^{+0.09}_{-0.11}$	20.73 ± 0.26	1.75 ± 0.42
$p13$	$99.59^{+0.08}_{-0.09}$	20.69 ± 0.23	1.49 ± 0.25
$p14$	$99.32^{+0.24}_{-0.32}$	21.00 ± 0.07	1.67 ± 0.37
$p15$	$99.59^{+0.10}_{-0.12}$	20.43 ± 0.30	1.55 ± 0.33
$p16$	$99.52^{+0.13}_{-0.16}$	20.62 ± 0.34	1.49 ± 0.35
$p17$	$99.51^{+0.11}_{-0.13}$	20.53 ± 0.34	1.21 ± 0.24
P18	$99.48^{+0.08}_{-0.09}$	20.91+/-0.18	1.45+/-0.18
P19	$99.49^{+0.10}_{-0.11}$	21.15+/-0.14	2.17+/-0.33
P20	$99.55^{+0.10}_{-0.12}$	20.85+/-0.23	1.73+/-0.34

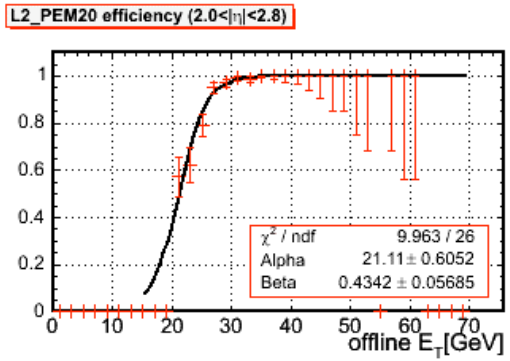
PEM_20 Plots

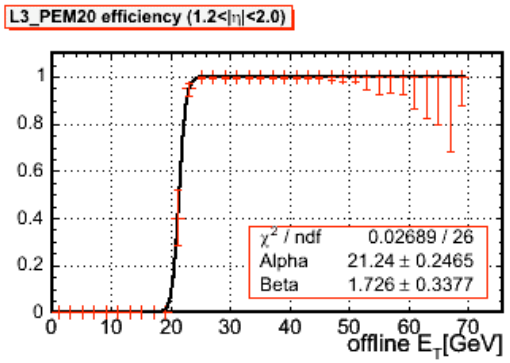

L2_PEM20 efficiency
χ^2 / ndf 11.75 / 26
Alpha 20.41 ± 0.2384
Beta 0.6543 ± 0.04893
raw E_T[GeV]
L2_PEM20 efficiency
χ^2 / ndf 7.326 / 26
Alpha 21.79 ± 0.25
Beta 0.5867 ± 0.04341
offline E_T[GeV]
L2_PEM20 efficiency
η_{Pes2d}
L3_PEM20 efficiency
χ^2 / ndf 0.157 / 26
Alpha 19.39 ± 0.2165
Beta 1.644 ± 0.2755
raw E_T[GeV]
L3_PEM20 efficiency
χ^2 / ndf 0.05295 / 26
Alpha 20.85 ± 0.2296
Beta 1.581 ± 0.2906
offline E_T[GeV]
L3_PEM20 efficiency
P20
η_{Pes2d}

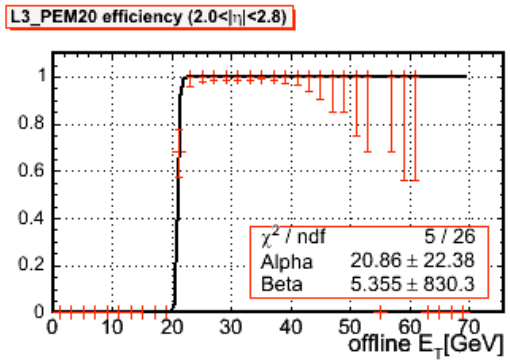

L2_PEM20 efficiency
χ^2 / ndf 13.77 / 26
Alpha 20.05 ± 0.1993
Beta 0.7005 ± 0.04972
raw E_T[GeV]
L2_PEM20 efficiency
χ^2 / ndf 5.761 / 26
Alpha 21.76 ± 0.1949
Beta 0.7018 ± 0.05444
offline E_T[GeV]
L2_PEM20 efficiency
P19
η_{Pes2d}
L3_PEM20 efficiency
χ^2 / ndf 0.005176 / 26
Alpha 19.75 ± 0.1503
Beta 2.385 ± 0.3273
raw E_T[GeV]
L3_PEM20 efficiency
χ^2 / ndf 2.002 / 26
Alpha 21.15 ± 0.1362
Beta 2.164 ± 0.3262
offline E_T[GeV]
L3_PEM20 efficiency
η_{Pes2d}

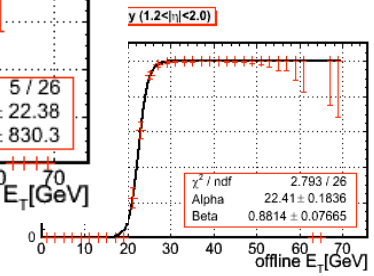
PEM_20 Plots

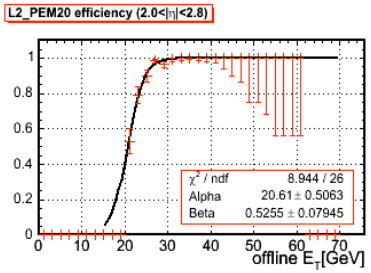




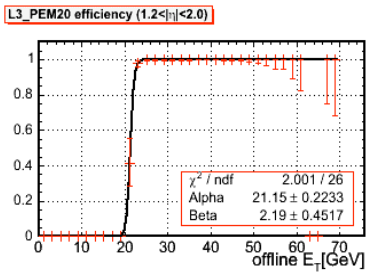


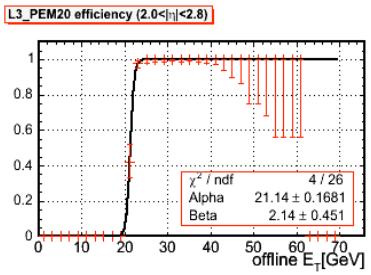






P19





Muons

Dataset bhmumm: Runs 266528-267718
MC sample : zektim (Feb 2008)
GRL : GRL for P20 v26
goodrun_em_mu_nosi_cmxignored_v26Prelim.list,
goodrun_em_mu_si_cmxignored_v26Prelim.list

Data: P20 Data on SAM and skim : 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

P19

Cut	Count	Efficiency (%)
No cut	3584	
E_{EM} cut	3485	$97.24^{+0.30}_{-0.29}$
E_{HAD} cut	3509	$97.91^{+0.25}_{-0.26}$
COT hits cut	3583	$99.97^{+0.02}_{-0.07}$
d_0 cut	3561	$99.36^{+0.14}_{-0.15}$
Isolation cut	3403	$94.95^{+0.39}_{-0.39}$
Δx_{CMU} cut	3575	$99.75^{+0.09}_{-0.11}$
Δx_{CMP} cut	3517	$98.13^{+0.22}_{-0.27}$
All above cuts	3169	$88.42^{+0.52}_{-0.55}$
All cuts excl. isol.	3329	$92.89^{+0.45}_{-0.48}$
Sliding isol. cut	3445	$96.12^{+0.34}_{-0.35}$
All cuts (sliding isol.)	3206	$89.45^{+0.51}_{-0.56}$
χ^2 cut	3584	$100.00^{+0.00}_{-0.05}$
All cuts (χ^2)	3169	$88.42^{+0.52}_{-0.55}$
All track cuts	3232	$90.18^{+0.52}_{-0.51}$
All trk cuts excl. isol.	3395	$94.73^{+0.37}_{-0.42}$

TABLE I: Dataset bhmummP19_SAM: Muon ID efficiencies for CMUP

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

CMUP ID SF

P19

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0108^{+0.0031}_{-0.0030}$
E_{HAD} cut	$0.9955^{+0.0025}_{-0.0027}$
COT hits cut	$0.9999^{+0.0002}_{-0.0007}$
d_0 cut	$0.9963^{+0.0014}_{-0.0015}$
Isolation cut	$0.9824^{+0.0040}_{-0.0041}$
Δx_{CMU} cut	$0.9976^{+0.0009}_{-0.0011}$
Δx_{CMP} cut	$0.9867^{+0.0022}_{-0.0027}$
All above cuts	$0.9730^{+0.0057}_{-0.0061}$
All cuts excl. isol.	$0.9898^{+0.0048}_{-0.0051}$
Sliding isol. cut	$0.9853^{+0.0035}_{-0.0036}$
All cuts (sliding isol.)	$0.9757^{+0.0056}_{-0.0061}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0005}$
All cuts (χ^2)	$0.9730^{+0.0057}_{-0.0061}$
All track cuts	$0.9871^{+0.0057}_{-0.0056}$
All trk cuts excl. isol.	$1.0039^{+0.0039}_{-0.0044}$

TABLE I: Dataset bhmummP19_SAM_zektim: Muon ID Scale Factors fc

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 Factors for CMUP

CMX ID Efficiencies

P19

Cut	Count	Efficiency (%)
No cut	2504	
E_{EM} cut	2422	$96.73^{+0.37}_{-0.41}$
E_{HAD} cut	2449	$97.80^{+0.32}_{-0.32}$
COT hits cut	2502	$99.92^{+0.05}_{-0.11}$
d_0 cut	2496	$99.68^{+0.11}_{-0.16}$
Isolation cut	2368	$94.57^{+0.48}_{-0.50}$
Δx_{CMX} cut	2493	$99.56^{+0.13}_{-0.18}$
All above cuts	2236	$89.30^{+0.60}_{-0.67}$
All cuts excl. isol.	2357	$94.13^{+0.48}_{-0.50}$
Sliding isol. cut	2407	$96.13^{+0.38}_{-0.45}$
All cuts (sliding isol.)	2272	$90.73^{+0.62}_{-0.65}$
χ^2 cut	2504	$100.00^{+0.00}_{-0.07}$
All cuts (χ^2)	2236	$89.30^{+0.60}_{-0.67}$
All track cuts	2242	$89.54^{+0.65}_{-0.62}$
All trk cuts excl. isol.	2364	$94.41^{+0.44}_{-0.49}$

TABLE II: Dataset bhmummP19_SAM: Muon ID efficiencies for CM

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 CMX

CMX ID SF

P19

Cut	Scale Factor
No cut	
E_{EM} cut	$1.0053^{+0.0039}_{-0.0043}$
E_{HAD} cut	$0.9996^{+0.0033}_{-0.0033}$
COT hits cut	$0.9993^{+0.0005}_{-0.0011}$
d_0 cut	$0.9990^{+0.0011}_{-0.0016}$
Isolation cut	$0.9761^{+0.0049}_{-0.0052}$
Δx_{CMX} cut	$0.9971^{+0.0013}_{-0.0018}$
All above cuts	$0.9807^{+0.0066}_{-0.0074}$
All cuts excl. isol.	$1.0036^{+0.0051}_{-0.0054}$
Sliding isol. cut	$0.9835^{+0.0039}_{-0.0046}$
All cuts (sliding isol.)	$0.9881^{+0.0068}_{-0.0071}$
χ^2 cut	$1.0000^{+0.0000}_{-0.0007}$
All cuts (χ^2)	$0.9807^{+0.0066}_{-0.0074}$
All track cuts	$0.9818^{+0.0072}_{-0.0068}$
All trk cuts excl. isol.	$1.0050^{+0.0047}_{-0.0052}$

TABLE II: Dataset bhmummP19_SAM_zektim: Muon ID Scale Factors for

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 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.

P17

Category	Fiducial	w/ Stub	Efficiency (%)
CMUP	2893	2574	$88.97^{+0.63}_{-0.64}$
CMX	1727	1643	$95.14^{+0.52}_{-0.56}$
CMX Arches	1355	1305	$96.31^{+0.52}_{-0.56}$
CMX Miniskirt	305	278	$91.15^{+1.72}_{-1.99}$
CMX Keystone	67	60	$89.55^{+3.61}_{-4.98}$
CMU-only	741	656	$88.53^{+1.22}_{-1.32}$
CMP-only	777	688	$88.55^{+1.20}_{-1.34}$
CMX MiniKey	372	338	$90.86^{+1.42}_{-1.70}$

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	$86.80^{+1.58}_{-1.74}$

Reconstruction SF

P16

Category	Scale Factor
CMUP	$0.9167^{+0.0082}_{-0.0089}$
CMX	$0.9532^{+0.0081}_{-0.0086}$
CMX Arches	$0.9683^{+0.0067}_{-0.0089}$
CMX Miniskirt	$0.8812^{+0.0282}_{-0.0349}$
CMX Keystone	$0.9749^{+0.0316}_{-0.0792}$
CMU-only	$0.9370^{+0.0150}_{-0.0171}$
CMP-only	$0.8871^{+0.0165}_{-0.0193}$
CMX MiniKey	$0.8956^{+0.0260}_{-0.0260}$

P17

Category	Scale Factor
CMUP	$0.9134^{+0.0064}_{-0.0066}$
CMX	$0.9551^{+0.0052}_{-0.0056}$
CMX Arches	$0.9650^{+0.0052}_{-0.0056}$
CMX Miniskirt	$0.9206^{+0.0174}_{-0.0201}$
CMX Keystone	$0.9066^{+0.0366}_{-0.0505}$
CMU-only	$0.9074^{+0.0125}_{-0.0136}$
CMP-only	$0.9013^{+0.0122}_{-0.0136}$
CMX MiniKey	$0.9181^{+0.0144}_{-0.0144}$

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	$0.8912^{+0.0133}_{-0.0133}$

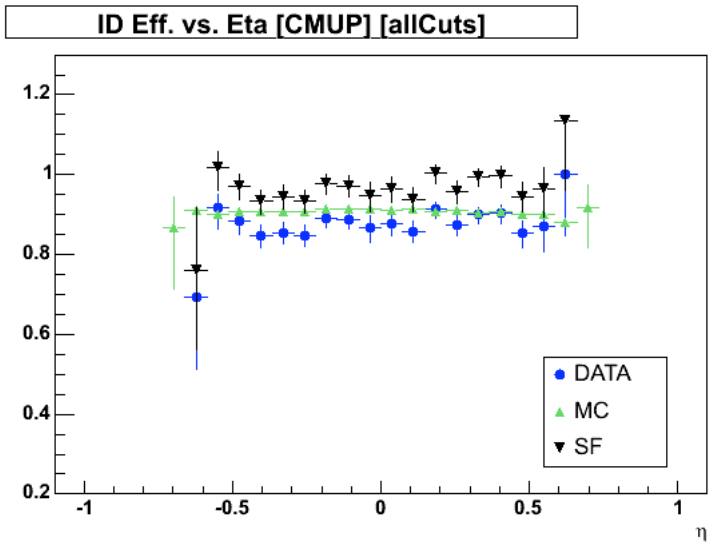
P19

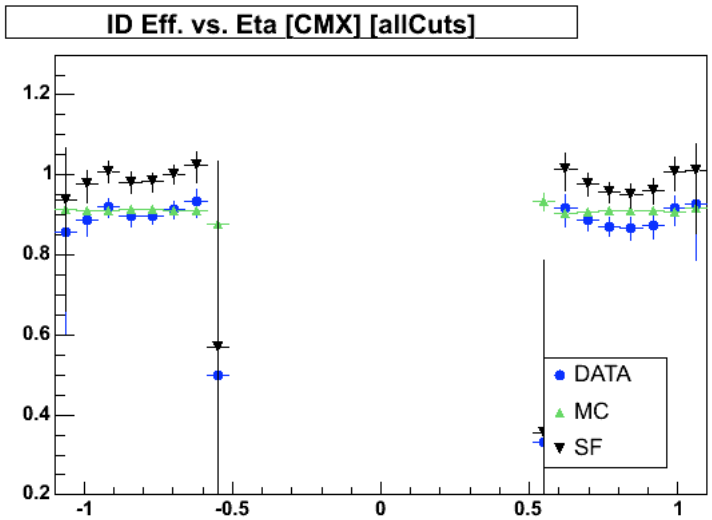
Category	Scale Factor
CMUP	$0.8979^{+0.0066}_{-0.0065}$
CMX	$0.9575^{+0.0051}_{-0.0052}$
CMX Arches	$0.9753^{+0.0040}_{-0.0048}$
CMX Miniskirt	$0.8878^{+0.0182}_{-0.0213}$
CMX Keystone	$0.8752^{+0.0406}_{-0.0504}$
CMU-only	$0.8950^{+0.0129}_{-0.0132}$
CMP-only	$0.9005^{+0.0109}_{-0.0125}$
CMX MiniKey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

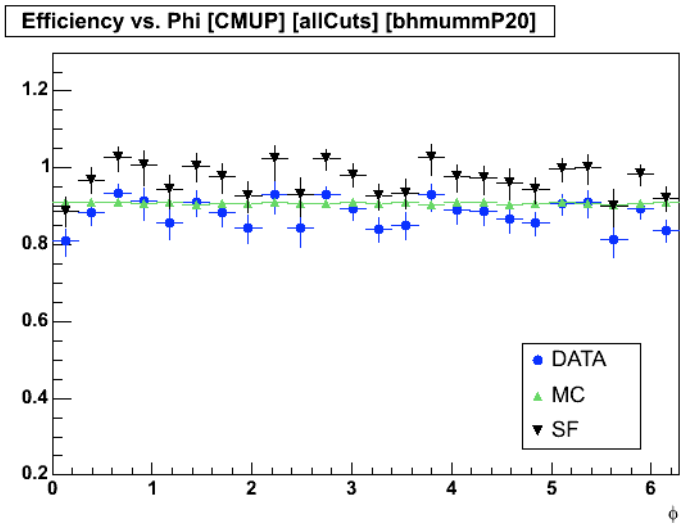
P20

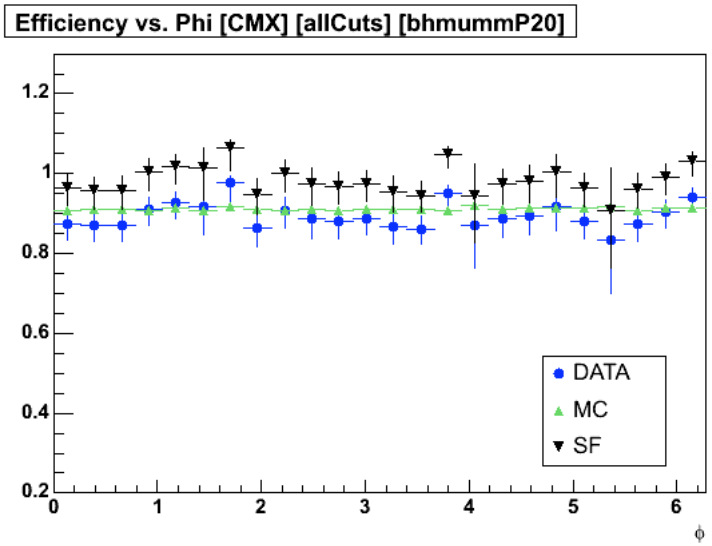
Category	Scale Factor
CMUP	$0.8891^{+0.0064}_{-0.0066}$
CMX	$0.9540^{+0.0051}_{-0.0052}$
CMX Arches	$0.9765^{+0.0038}_{-0.0045}$
CMX Miniskirt	$0.8832^{+0.0168}_{-0.0207}$
CMX Keystone	$0.8511^{+0.0410}_{-0.0461}$
CMU-only	$0.9127^{+0.0112}_{-0.0128}$
CMP-only	$0.8842^{+0.0112}_{-0.0126}$
CMX MiniKey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

Reco and ID Plots

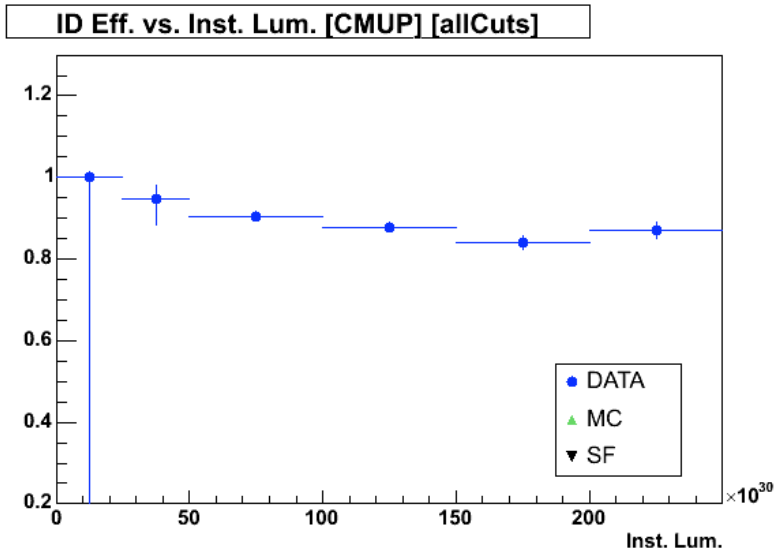


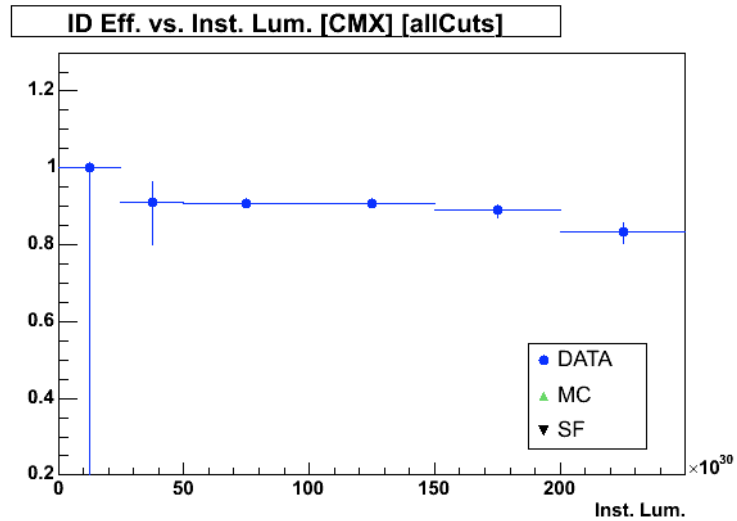


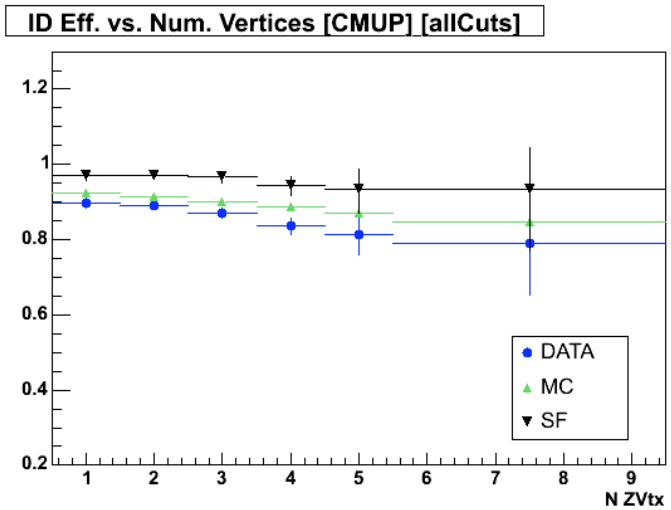


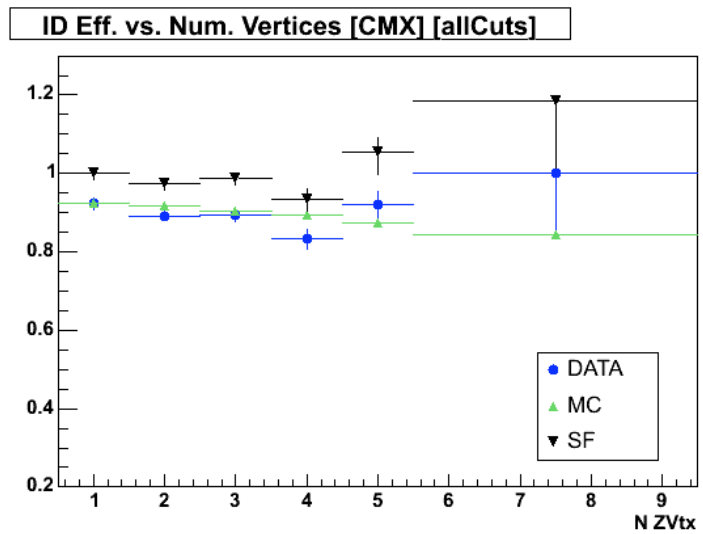


Reco and ID Plots

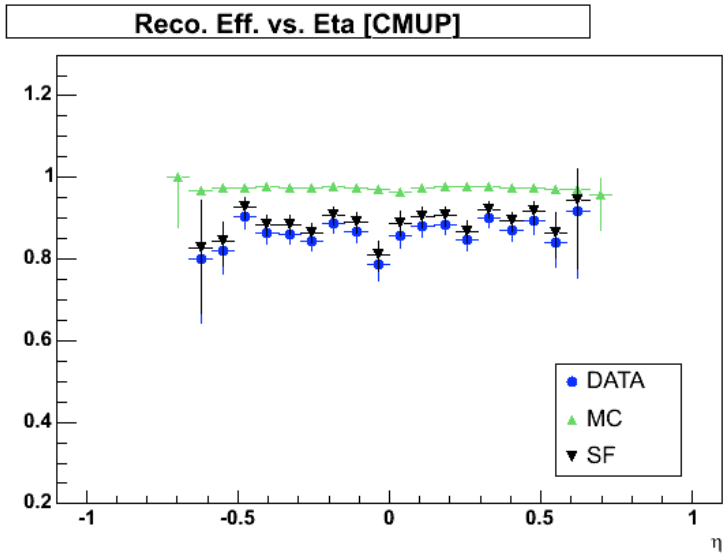


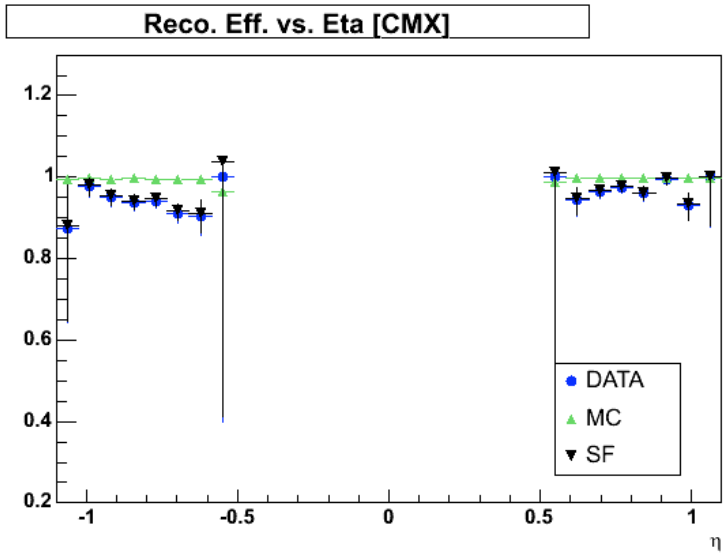


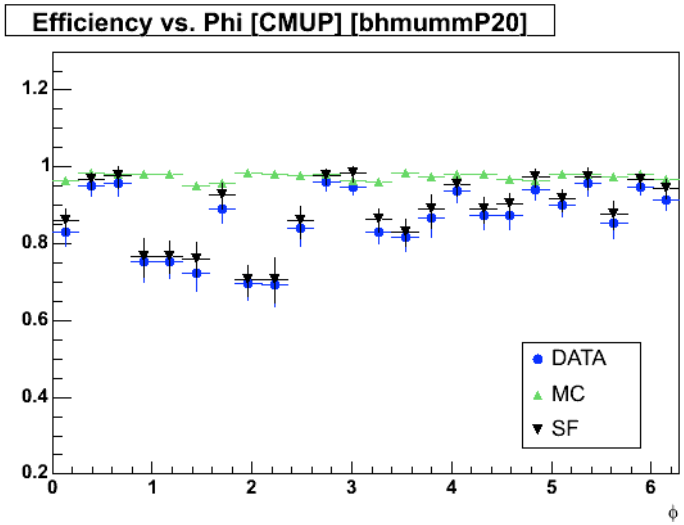


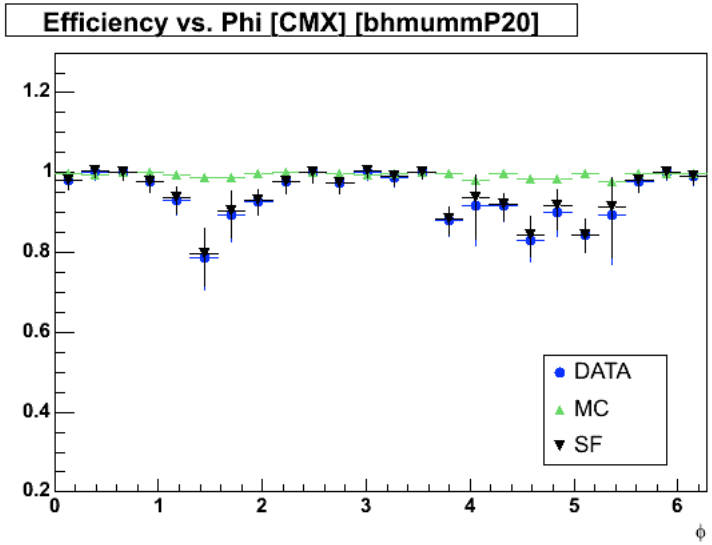


Reco and ID Plots









Trigger Efficiencies

Use the two legs from the reconstructed Z (both legs pass muon ID and fiducial cuts)

Level 1:

ε^{L1}_{CMUP} is calculated from 2 independent samples, using CMUP-CMUP and CMUP-CMX samples:

$$\mathring{a}^{L1(A)}_{CMUP} = \frac{\#\text{ of events with both legs triggered}}{\#\text{ of events with 1 CMX leg triggered}}$$

$$\mathring{a}^{L1(B)}_{CMUP} = \frac{2R}{1+R}$$

$$R = \frac{\#\text{ of events with both legs triggered}}{\#\text{ of events with} \geq 1\text{ CMUP leg triggered}}$$

The final efficiency is an average of $\varepsilon^{L1(A)}_{CMUP}$ and $\varepsilon^{L1(B)}_{CMUP}$ weighted by the errors.

Level 2: (both leg pass L1)

$$\mathring{a}^{L2}_{CMUP} = \frac{\#\text{ of events pass both L2 triggers}}{\#\text{ of events pass L2 CMX trigger}}$$

Level 3: (both leg pass L2)

$$\mathring{a}^{L3}_{CMUP} = \frac{\#\text{ of events pass both L3 triggers}}{\#\text{ of events pass L3 CMX trigger}}$$

CMX trigger efficiency is calculated in similar way.

Efficiencies not corrected for livetimes

L1

1st leg	2nd leg	1st passes	both pass	Efficiency (%)
CMUP	CMUP	873	773	-
CMX	CMUP	1140	1071	$93.93^{+0.52}_{-0.46}$
CMUP	CMX	1246	1071	-
CMX	CMX	406	301	$85.71^{+0.87}_{-0.84}$
CMUP	ARCH	1017	931	-
CMUP	MK	229	140	-
ARCH	ARCH	284	234	-
ARCH	MK	98	58	-
MK	ARCH	65	58	$91.13^{+0.80}_{-0.71}$
MK	MK	17	9	$72.63^{+2.70}_{-2.47}$

1st leg	2nd leg	1st passes	both pass	Efficiency (%)
CMUP	CMUP	962	842	-
CMX	CMUP	1136	1074	$93.87^{+0.49}_{-0.47}$
CMUP	CMX	1249	1074	-
CMX	CMX	456	354	$86.54^{+0.84}_{-0.77}$
CMUP	ARCH	981	906	-
CMUP	MK	268	168	-
ARCH	ARCH	315	272	-
ARCH	MK	110	65	-
MK	ARCH	69	65	$92.54^{+0.75}_{-0.68}$
MK	MK	27	17	$73.83^{+2.45}$

L2

P19

Category	Events Passing	Efficiency (%)
Pass L1	1071	-
CMUP	858	$98.21^{+0.45}_{-0.62}$
CMX	781	$89.39^{+1.08}_{-1.16}$
CMUP-CMX	767	-
CMUP-A	757	-
CMUP-MK	101	-
CMUP-CMX-A	681	$89.96^{+1.15}_{-1.24}$
CMUP-CMX-MK	86	$85.15^{+3.72}$

P20

Category	Events Passing	Efficiency (%)
Pass L1	1074	-
CMUP	903	$97.38^{+0.52}_{-0.66}$
CMX	841	$90.70^{+0.95}_{-1.10}$
CMUP-CMX	819	-
CMUP-A	766	-
CMUP-MK	137	-
CMUP-CMX-A	692	$90.34^{+1.16}_{-1.23}$
CMUP-CMX-MK	127	$92.70^{+2.42}_{-3.05}$

Category	Events Passing	Efficiency (%)
Pass L1	1071	-
CMUP-CMUP$_S$	814	-
CMX-CMX$_S$	755	-
CMUP-CMX-CMUP$_S$	741	$94.88^{+0.78}_{-0.88}$
CMUP-CMX-CMX$_S$	741	$86.36^{+1.23}_{-1.31}$
CMUP-CMX-CMX$_S$-A	656	$86.66^{+1.33}_{-1.40}$
CMUP-CMX-CMX$_S$-MK	85	$84.16^{+3.93}_{-4.67}$

Category	Events Passing	Efficiency (%)
Pass L1	1074	-
CMUP-CMUP$_S$	869	-
CMX-CMX$_S$	819	-
CMUP-CMX-CMUP$_S$	799	$95.01^{+0.75}_{-0.91}$
CMUP-CMX-CMX$_S$	799	$88.48^{+1.12}_{-1.13}$
CMUP-CMX-CMX$_S$-A	676	$88.25^{+1.10}_{-1.24}$
CMUP-CMX-CMX$_S$-MK	123	$89.78^{+2.60}_{-3.26}$

Efficiency calculation

$$\varepsilon(\text{CMUP})^{2D} = \frac{(\text{\# of events passing CMUP \& CMX})}{\text{\# of events passing CMUX}}$$

$$\varepsilon(\text{CMUP})^{3D} = \frac{(\text{\# of events passing 2D-CMUP \& 2D-CMX \& 3-D CMUP})}{(\text{\# of events passing 2D-CMUP \&\& 2D-CMX})} \times \text{2D-CMUP eff}$$

$$\varepsilon(\text{CMX})^{2D} = \frac{(\text{\# of events passing CMUP \& CMX})}{\text{\# of events passing CMUP}}$$

These ones increases for the bad runs

$$\varepsilon(\text{CMX})^{3D} = \frac{(\text{\# of events passing 2D-CMUP \& 2D-CMX \& 3-D CMX})}{(\text{\# of events passing 2D-CMUP \&\& 2D-CMX})} \times \text{2D-CMX eff}$$

Trigger Eff

L3

Category	Events Passing	Efficiency (%)
Pass L2	767	-
CMUP	763	$99.48^{+0.26}_{-0.43}$
CMX	764	$99.61^{+0.21}_{-0.38}$
CMUP-CMX	760	-
CMUPA	677	-
CMUPMK	86	-
CMUPARCH	675	$99.70^{+0.19}_{-0.40}$
CMUP-MK	85	$98.84^{+0.87}_{-2.65}$

Combined

Category	Efficiency (%)
CMUP	$91.77^{+0.70}_{-0.84}$
CMX	$76.31^{+1.22}_{-1.28}$
CMX A	$81.74^{+1.28}_{-1.34}$
CMX MK	$61.12^{+3.55}_{-4.16}$
CMUP SLAM	$88.66^{+0.91}_{-1.01}$
CMX SLAM	$73.73^{+1.30}_{-1.36}$
CMX SLAM A	$78.74^{+1.40}_{-1.45}$
CMX SLAM MK	$60.41^{+3.64}_{-4.25}$

P19

Category	Events Passing	Efficiency (%)
Pass L2	819	-
CMUP	812	$99.26^{+0.27}_{-0.46}$
CMX	815	$99.63^{+0.21}_{-0.35}$
CMUP-CMX	809	-
CMUPA	685	-
CMUPMK	127	-
CMUPARCH	683	$99.71^{+0.18}_{-0.38}$
CMUP-MK	126	$99.21^{+0.64}_{-1.80}$

Category	Efficiency (%)
CMUP	$90.74^{+0.72}_{-0.87}$
CMX	$78.20^{+1.13}_{-1.20}$
CMX A	$83.36^{+1.28}_{-1.33}$
CMX MK	$67.90^{+2.90}_{-3.28}$
CMUP SLAM	$88.52^{+0.87}_{-1.04}$
CMX SLAM	$76.29^{+1.23}_{-1.22}$
CMX SLAM A	$81.43^{+1.23}_{-1.33}$
CMX SLAM MK	$65.76^{+2.93}_{-3.33}$

P20

Comparison with previous periods

Combined (L1+L2+L3) CMUP 2-D Trigger efficiencies

Period	Measured (SR)	Livetime Corr.	Corr. Efficiency
0.9241(78)	1.0	0.9241(78)	
13	0.9090(61)	1.0	0.9090(61)
14	0.9197(2.22)	1.0	0.9197 (2.22)
15	0.9163(77)	1.0	0.9163 (77)
16	0.9172(116)	1.0	0.9172(116)
17	0.9203(76)	1.0	0.9203(76)
18	0.9210(56)	1.0	0.9210(56)
19	0.9177	1.0	0.9177
20			

CMUP

Expecting dps

Combined (L1+L2+L3) CMUP 3-D Trigger efficiencies

Period	2-D Efficiency	2-D+3-D/2-D (SR)	3-D Efficiency
0.9241(78)	0.9108(105)	0.8417(120)	
13	0.9090(61)		0.8284 (91)
14	0.9197(2.22)		0.8943 (2.22)
15	0.9163(77)		0.8790 (100)
16	0.9172(116)		0.8939(137)
17	0.9203 (76)		0.8885 (97)
18	0.9210(56)		0.8864(75)
19	0.9177		0.8866
20			

Comparison with previous periods

Combined (L1+L2+L3) CMX 2-D Trigger efficiencies

Arches-only:

Period	Measured (SR)	Livetime Corr.	Corr. Efficiency
0.8915 (85)	0.9601	0.9285 (85)	
14	0.9123 (239)	0.99	0.9215 (239)
15	0.9013 (117)	0.95	0.9487 (117)
16	0.8439 (204)	0.915	0.9223 (223)
17	0.8532 (127)	0.9128	0.9345 (127)
18	0.8522(96)	0.9031	0.9437 (96)
19	0.8174	0.871	0.9384
20			

CMX

Combined (L1+L2+L3) CMX 3-D Trigger efficiencies

Arches-only

Period	2-D Efficiency		3-D Efficiency
0.8915/0.9601=0.93 (85)		0.8569 / 0.9601 = 0.8926 (9)	
14	0.9123/0.99= 0.9215 (2.39)	0.8815/0.99	= 0.8904 (2.7)
15	0.9013/0.95= 0.9487 (117)	0.8765/0.95	= 0.9226 (128)
16	0.8439/0.915= 0.9223 (223)	0.8183/0.915	= 0.8943 (235)
17	0.8532/0.913= 0.9345 (127)	0.8195/0.913	= 0.8975 (142)
18	0.8522/0.9031=0.9437 (96)	0.8192/0.903	= 0.9072 (112)
19	0.8174/0.871=0.9384	0.7874/0.871	= 0.9040
20			

COT Efficiencies

Events are selected with Z_NOTRACK trigger
Z→ee events are selected using:
Calorimeter cuts only to select electrons

- Et > 25 GeV
- Fiduciality →fiducial_track or fiducial_smx
- Had/Em < 0.055 + 0.00045 x E
- IsoRatio < 0.1
- $\chi^2_{strip} < 10$
- $L_{shr} < 0.2$

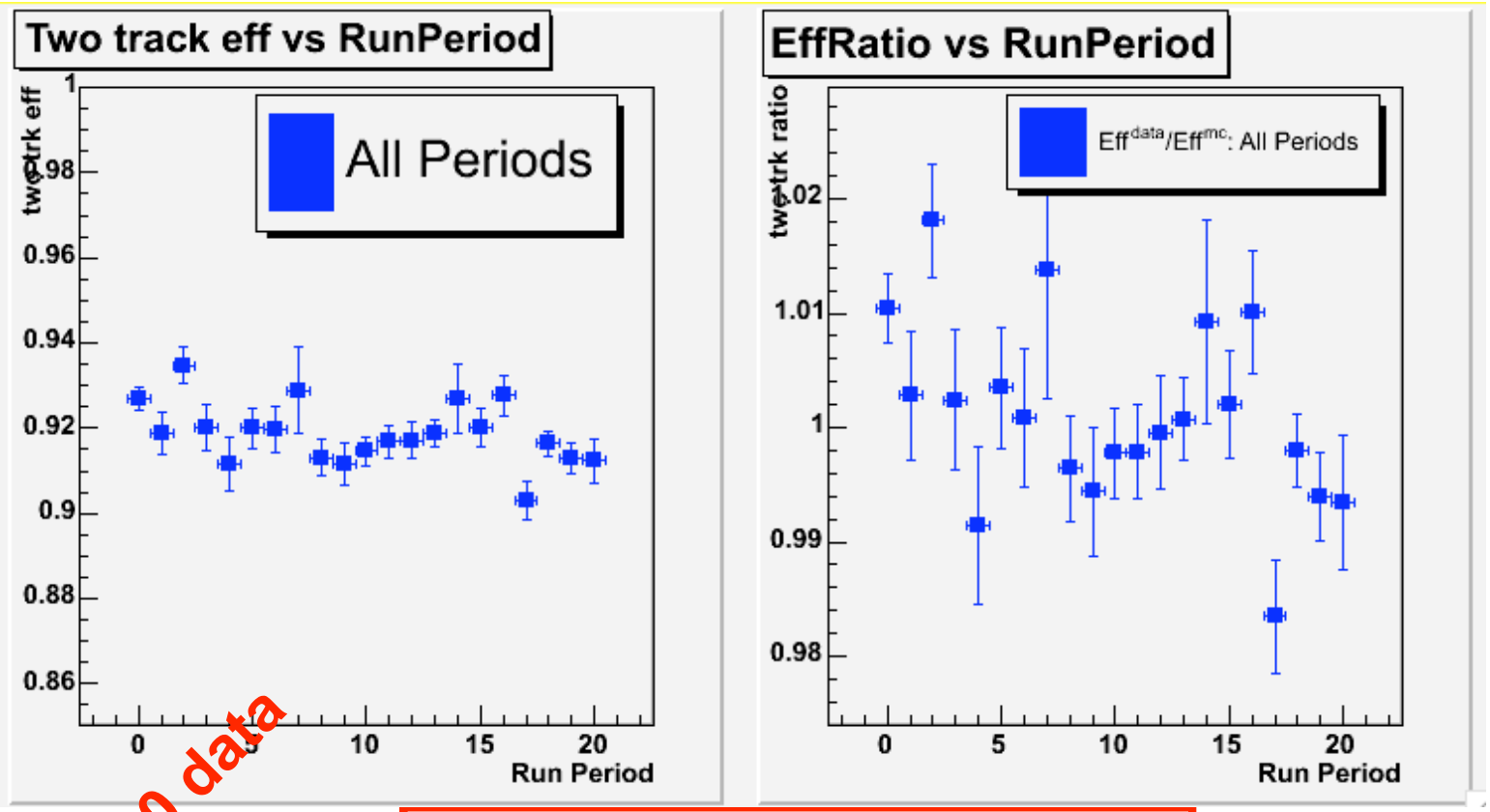
Calorimeter + tracking cuts

- trkPt > 10 GeV

$$e_{2trk} = \frac{\#\ Z(cc) \text{ with } TrkP_T > 10 \text{ GeV on both electrons}}{\#\ Z(cc) \text{ with two electrons}}$$

- 2 central electrons
- 82 < M(ee) < 102 GeV/c^2

COT Efficiencies: Run Number



Half of P20 data

$$e_{2trk}^{DATA} = 0.9180 \quad 0.0009$$

0.9184 ± 0.0030 up to P19

COT Efficiencies vs Periods

Period	Ncc	Ncc + 2trk	Efficiency	Error
0	9117	8452	0.927059	0.00272341
1	3013	2769	0.919018	0.00497001
2	3112	2909	0.934769	0.0044265
3	2492	2293	0.920144	0.00543008
4	2094	1909	0.911652	0.00620189
5	3351	3083	0.920024	0.00468589
6	2547	2342	0.919513	0.00539047
7	661	614	0.928896	0.00999611
8	4514	4122	0.913159	0.00419136
9	3089	2816	0.911622	0.00510706
10	6321	5781	0.91457	0.00351576
11	5566	5103	0.916816	0.00370159
12	3922	3597	0.917134	0.004402
13	6930	6368	0.918903	0.00327921
14	1025	950	0.926829	0.00813405
15	3908	3596	0.920164	0.00433566
16	2777	2576	0.92762	0.00491708
17	4284	3869	0.903128	0.00451907
18	9172	8406	0.916485	0.00288877
19	6203	5662	0.912784	0.00358246
20	2747	2506	0.912268	0.00539773

Conclusions

- P20 high PT electrons and muons analyzed:
  - Electron ID - in agreement with P17 and previous
    - Drop in P18/P19 disappeared
  - Ele Trigger - in agreement with previous periods
  - Muon ID and Reco : ok,
  - Muon Trigger: not dps weighted yet
  - MET_PEM trigger - in agreement with previous numbers
  - COT Eff - in agreement with previous periods (half period analyzed)