$WW \rightarrow l\nu l\nu$: 200 pb^{-1} Results

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- Summary of the Analysis & Extended Acceptance
- Acceptance Systematic Studies
- Backgrounds & Fake Rate Calculation
- Kinematic Distributions & Cross Section Measurement

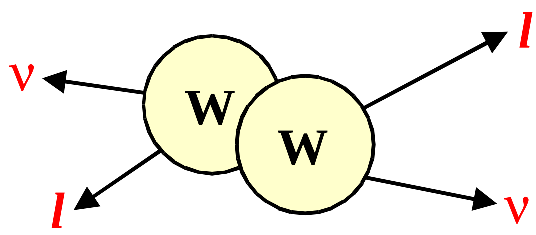
Documentation :

- Winter 2004 Analysis : CDF− 6909
- DY Background & MET−Sig. Studies : CDF−6834
- Summer 2003 Analysis : CDF−6611
- Winter 2003 Analysis : CDF−6323
- Preliminary Studies : CDF−6197

Web Page :

http://www−cdf.fnal.gov/internal/physics/WW

Summary of the Analysis



	Event Selection (Winter 2004)
1	two 20 GeV isolated leptons
2	remove if $76 < M_{ee,\mu\mu} < 106$ GeV and $\frac{\not{E}_T}{\sqrt{\sum E_T}} < 3$
3	$\not{E}_T > 25$ GeV
4	$\Delta\phi(\not{E}_T\text{, nearest } l \text{ or } j) > 20^\circ$ if $\not{E}_T < 50$ GeV
5	No jets with $E_T^{corr} > 15$ GeV, $\lvert\eta_{det}\rvert < 2.5$
6	opposite charge requirement

Changes :

→ **NEW : PHX–*lepton***

→ **NEW :** recovery of events in Z−mass window with MET−significance cut.

PLUS : several improvements to analysis.

Summary of the Analysis

e−e

TCE	TCE
	PHX
PHX	PHX

TRIGGER

NON−TRIGGER

e−μ

TCE	CMUP
	CMU
	CMP
	CMX
	CMIO
PHX	CMUP
	CMU
	CMP
	CMX
	CMIO

μ−μ

CMUP	CMUP
	CMU
	CMP
	CMX
	CMIO
CMX	CMU
	CMP
	CMX
	CMIO

Lepton ID Summary :

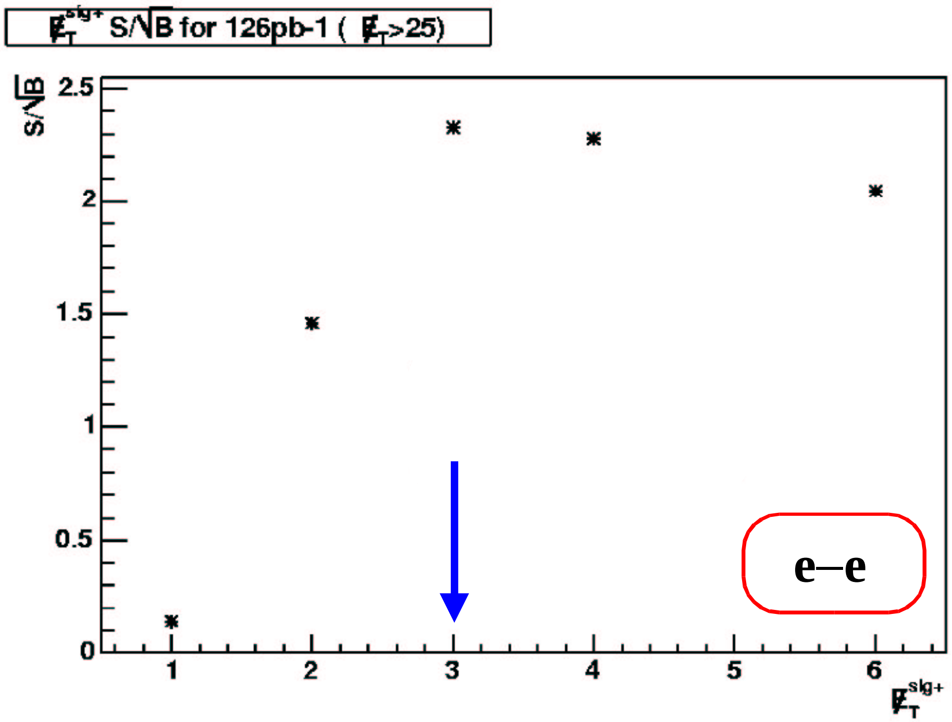
- **TCE** : baseline central electron with calorimeter and track isolation < 0.1
- **PHX** : baseline Phoenix electron with calorimeter isolation < 0.1
- **MUON** : minimum ionising track passing baseline muon cuts, categorised by stub content and fiducality

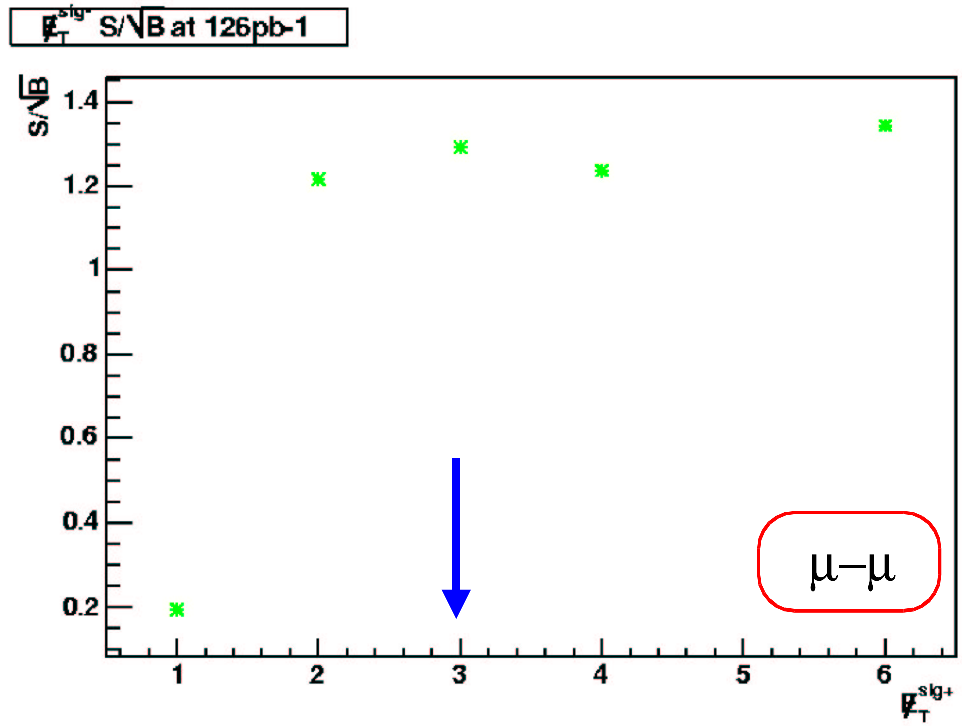
E_T or $P_T > 20$ GeV

Missing−Et Significance

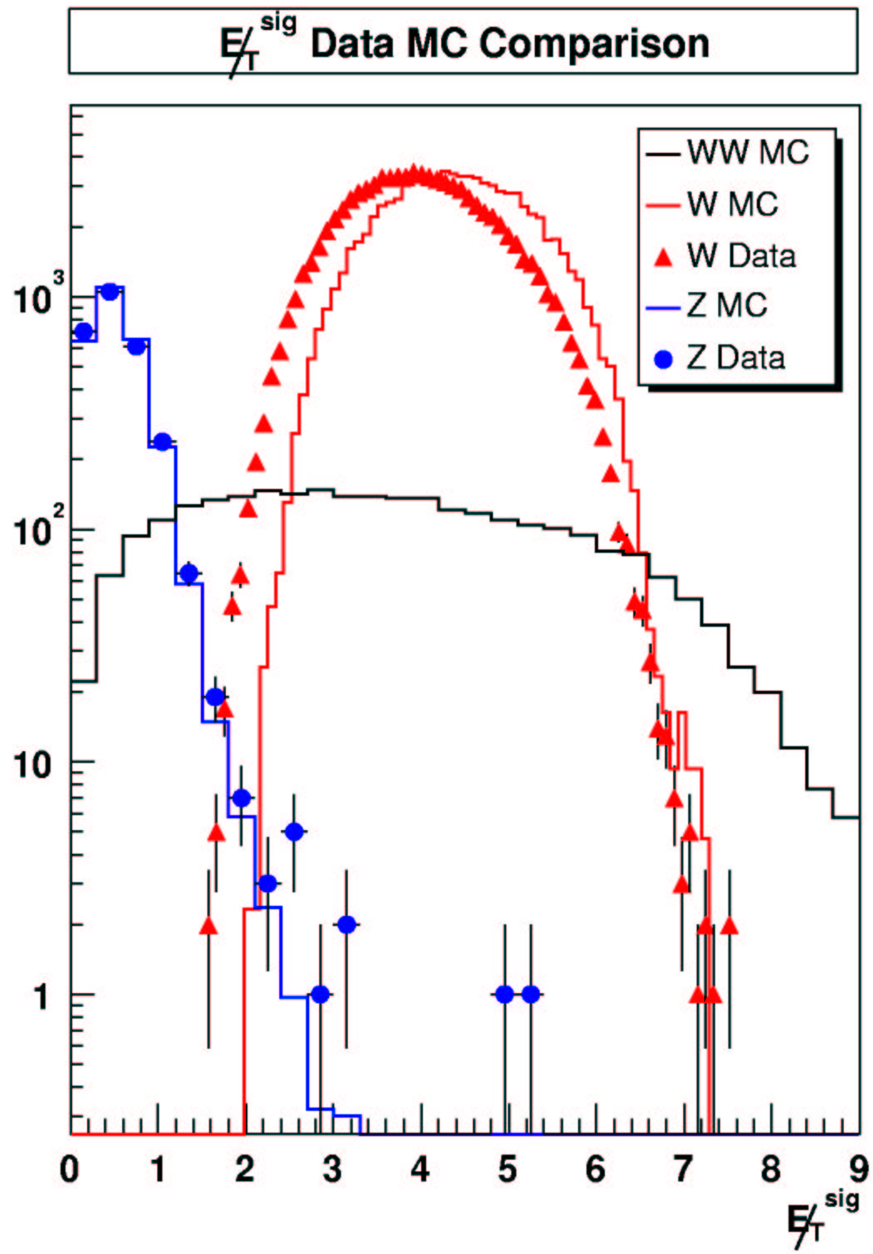
$$\frac{\not{E}_T}{\sqrt{\Sigma E_T}}$$

- An additional cut in the Z−mass window for like−flavour lepton pairs (previously discarded)
- Such events make up ~15% of our total acceptance.
- Recover 80% of WW events in Z−mass window (compared to simple veto) and reject 93% of DY background.
- Include leptons in transverse energy sum ("muon corrected")
- Definition and cut optimised using smaller data sample.
- Described in detail in CDF−6834.

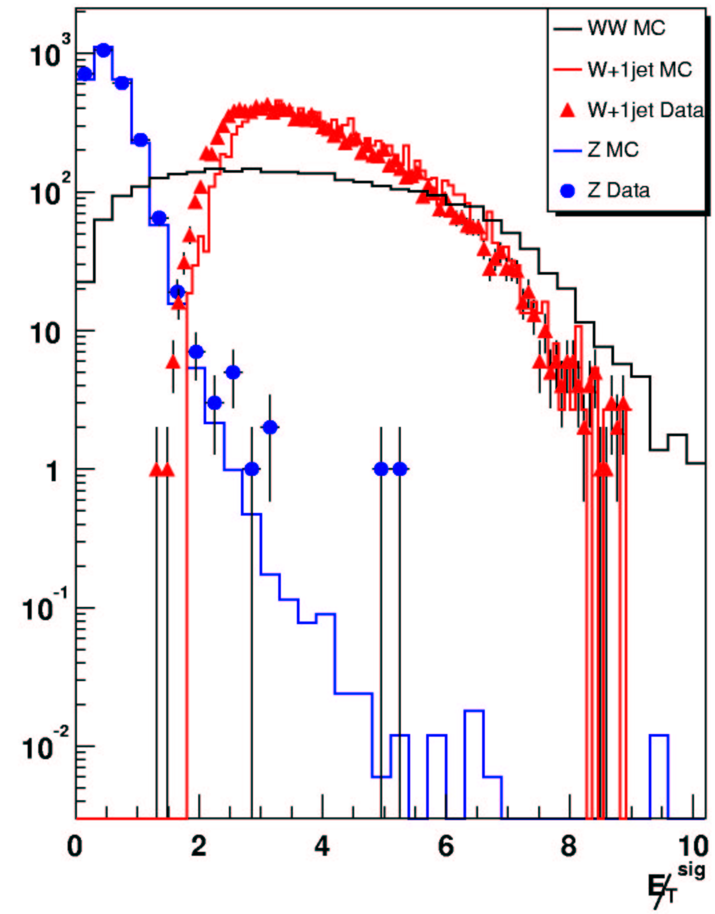




Missing−Et Significance



- Some discrepancy observed for W and W+1j data. BUT, only ~15% of our WW acceptance (same−flavour, Z−mass window) is affected by this cut.
- Systematic error from this source : 2%.



Acceptance

Cut	*WW*					
	ee		$\mu\mu$		$e\mu$	
		%		%		%
Lepton ID	25777	0.00 ± 0.00	22663	0.00 ± 0.00	46143	0.00 ± 0.00
Isolation	23300	90.39 ± 0.18	20856	92.03 ± 0.18	42176	91.40 ± 0.13
Conv+Cosmic	22878	98.19 ± 0.09	20856	100.00 ± 0.00	41771	99.04 ± 0.05
Z-veto	20258	88.55 ± 0.21	18219	87.36 ± 0.23	41771	100.00 ± 0.00
$\not{E}_T$ >25 GeV :	15848	78.23 ± 0.29	14159	77.72 ± 0.31	30230	72.37 ± 0.22
$\Delta\Phi > 20^\circ$ if $\not{E}_T$ <50	15297	96.52 ± 0.15	13642	96.35 ± 0.16	29080	96.20 ± 0.11
0 jets	12309	80.47 ± 0.32	10930	80.12 ± 0.34	23535	80.93 ± 0.23
Opposite Sign	12307	99.98 ± 0.01	10930	100.00 ± 0.00	23532	99.99 ± 0.01

- Not currently applied for PHX categories.
- Would reduce overall acceptance by 10% in e–e channel and 5% overall.

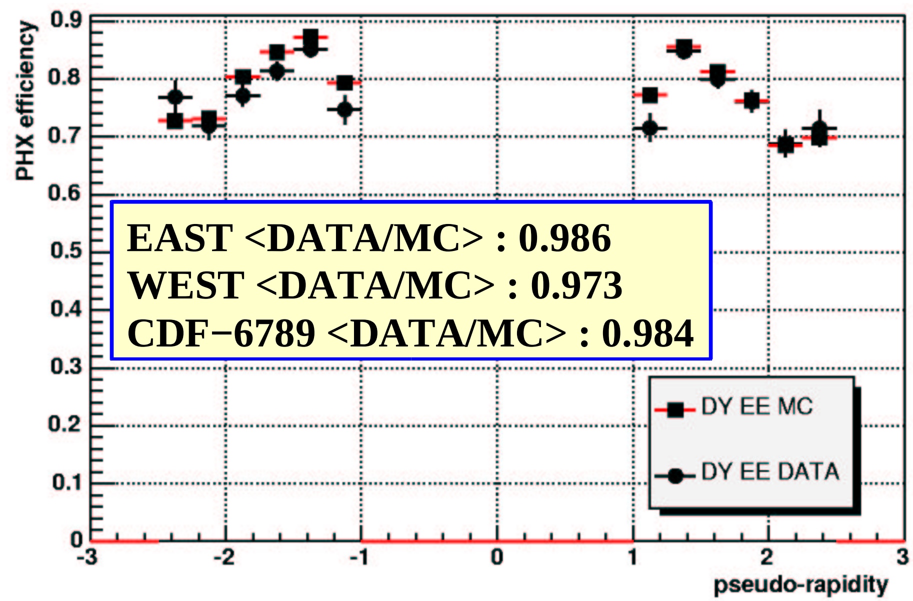
Scale Factors and Corrections

Scale Factor	Value	Reference	
Trigger Efficiency			
F_{TCE}	0.961	[3]	CDF−6234
F_{CMUP}	0.887	[4]	CDF−6825
F_{CMX}	0.954	[4]	
F_{METPEM}	0.955		L2 from CDF−6535 & L1 marginal for WW
Data/MC Reconstruction Efficiency			
F_{TCE}	0.965	[5]	CDF−6580
F_{PHX}	0.927	[6]	CDF−6789 and cross−checked :
F_{CMU}	0.890	[4]	
F_{CMP}	0.943	[4]	
F_{CMUP}	0.887	[4]	
F_{CMX}	1.008	[4]	
F_{CMIO}	1.000	[7]	CDF−6517
Data/MC $\lvert z0 \rvert < 60$ cm Efficiency			
F_{z0}	0.977	[8]	CDF−6331

$F_{TRK-ISO} = 1.0 \pm 0.04$ (comparing Z events in data and MC with and without track isolation requirement)

Run Range	Plug, $\eta > 0$	Plug, $\eta < 0$
141544 → 159600	1.069	1.057
159600 → 163600	1.097	1.084
163600 → 168890	1.089	1.077

plug energy SF



Acceptance Summary

not including separate category luminosities & SF, etc.

	A_{ee}	$A_{\mu\mu}$	$A_{e\mu}$	$A_{ee+\mu\mu+e\mu}$
A_{abs}	(0.163 ± 0.001) %	(0.145 ± 0.001) %	(0.312 ± 0.002) %	(0.620 ± 0.003) %
A_{rel}	26.3 %	23.4 %	50.3 %	100.0 %
$A_{abs}(SF)$	(0.140 ± 0.001) %	(0.114 ± 0.001) %	(0.252 ± 0.002) %	(0.505 ± 0.002) %
$A_{rel}(SF)$	27.7 %	22.5 %	49.8 %	100.0 %

including individual category luminosities & SF, etc.

- Acceptance has approximately doubled since Winter 2003 :
  - New categories including PHX
  - Use of MET_PEM trigger sample
  - New treatment of muon categories
  - Recovery of WW events in Z−mass window using $\not{E}_T^{sig}$.

WW Acceptance Systematic

(1) Jet Veto ("ISR")	6%
(2) Generator/Parton−Shower Model (Pythia vs. Herwig)	5%
(3) PDF/QCD−Scale (event yield)	[5%]
(4) Jet Energy Scale ($\pm 1\ \sigma$ correction variation)	3%
(5) Lepton ID (mainly from PHX contribution)	2%
(6) Track Isolation	4%
(7) Trigger Efficiency (mainly from MET_PEM)	1%
(8) METSIG	2%
(9) Combined	10%

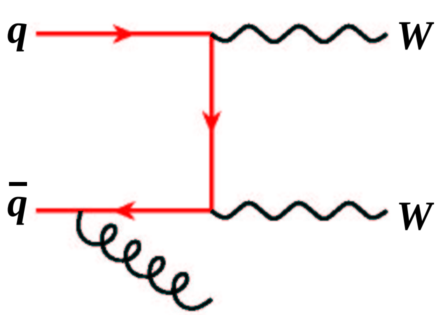
Yield only, doesn't contribute to acceptance systematic.

WW Acceptance Systematic

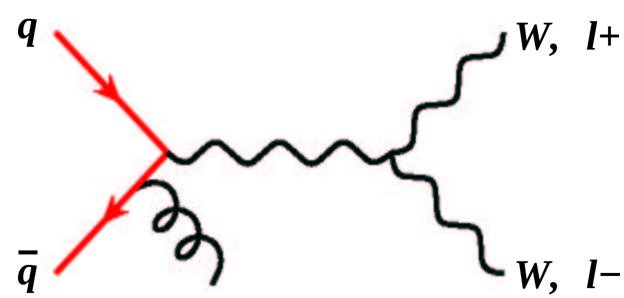
<u>Jet Veto ("ISR")</u>

- Problem : σ(WW) measurement uses 0−jet bin to reduce $t\bar{t}$ background.
- Need to estimate zero jet fraction of total production cross−section "$\mathbf{f}_{0j}$".
- Tools :
  - PYTHIA : full spin correlations, but will overestimate $\mathbf{f}_{0j}$ due to lack of hard parton emission.
  - MC@NLO : in principle the best tool for estimating the migration of events from 0−jet ≥1−jet, but does not include full spin correlations.
  - Drell−Yan events : comparison between data and Monte Carlo values for $\mathbf{f}_{0j}$.

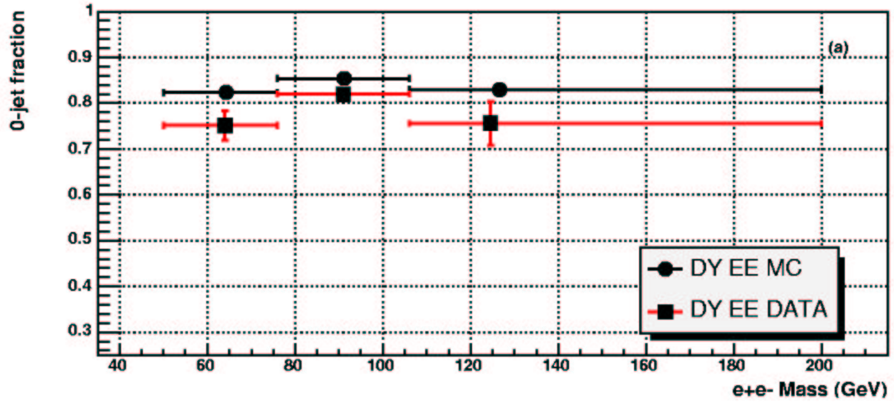
<u>WW</u>



<u>WW & Drell−Yan</u>



WW Acceptance Systematic

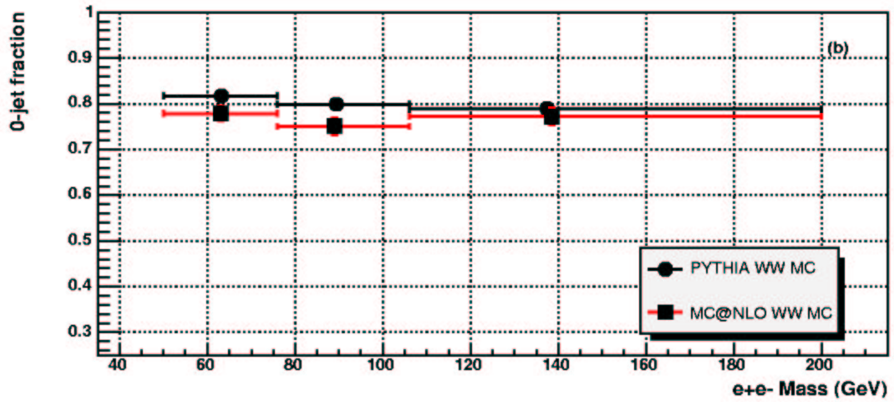


☆ Drell−Yan e+e−:

MC (PYTHIA) : $\langle \mathbf{f}_{0j} \rangle = 0.852 \pm 0.001$

DATA : $\langle \mathbf{f}_{0j} \rangle = 0.813 \pm 0.008$

DATA/MC : 0.955 ± 0.009

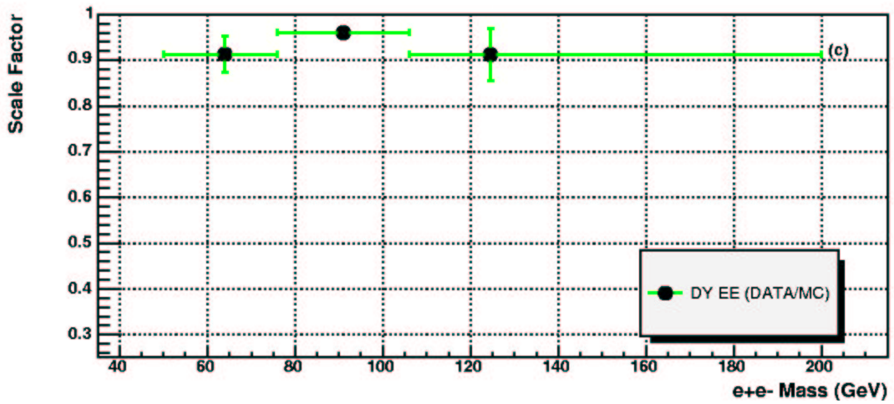


☆ ***WW→lνlν***

MC (PYTHIA) : $\langle \mathbf{f}_{0j} \rangle = 0.803 \pm 0.005$

MC (MC@NLO) : $\langle \mathbf{f}_{0j} \rangle = 0.767 \pm 0.010$

MC@NLO/PYTHIA : 0.955 ± 0.010



☆ Apply the mass averaged scale factor 0.955 to ***WW*** yield calculated from Pythia.

☆ Systematic error of 6% from difference between Drell−Yan data and MC@NLO value for $\mathbf{f}_{0j}$.

Backgrounds

Major Backgrounds & Uncertainties :

- **Drell−Yan**
  - Evaluated using Monte Carlo (k−factor corrected cross−sections).
  - Corrected for missing−E_T distribution observed in data $\Rightarrow$ largest source of uncertainty.
  - Cross−checked using a data−based background calculation.
- **WZ**
  - Evaluated using Monte Carlo (NLO cross−section).
  - Significantly reduced through tri−lepton rejection.
  - Similar systematic uncertainties to WW acceptance systematic.
- **$t\bar{t}$**
  - Evaluated using Monte Carlo (normalised to 7 pb)
  - Largest systematic uncertainty ($\approx$ 30%) from jet energy scale variation.
- **Fake**
  - Data−based estimate described below.

Other Potential Backgrounds :

- **$b\bar{b}$**
  - Negligible based on high−p_T $b\bar{b}$ Monte Carlo sample.
- **W+γ**
  - Negligible based on cross−section and assumed photon $\rightarrow$ lepton fake rate. Currently being checked using Monte Carlo.

Fake Background

- Origin of fakes : mainly W+jet events in which a jet is misidentified as a lepton (or contains a real lepton from heavy quark decay).
- Fake ratios calculated using QCD samples : Jet20, 50, 70, 100 : differences give one source of systematic error.
- Fake ratio applied to events in the signal sample that contain "fakable" (or "denominator") lepton but otherwise satisfy WW requirements.

$$R_{TCE\,(PHX)} = \frac{\text{Number of isolated TCE (PHX) [removing W's, Z's (MET} < 10\,\text{GeV, Z veto)]}}{\text{Number of jets with } |\eta| < 1.1\ (1.2 < |\eta| < 2.5)}$$

$$\text{raw}\,E_T > 20\ \ \text{GeV}$$

$$R_{\mu} = \frac{\text{Number of isolated } \mu \text{ [removing W's, Z's]}}{\text{Number of tracks consistent with MIP's}}$$

$$\text{corrected track } P_T > 20\ \ \text{GeV}$$

$$E/P < 1.0$$

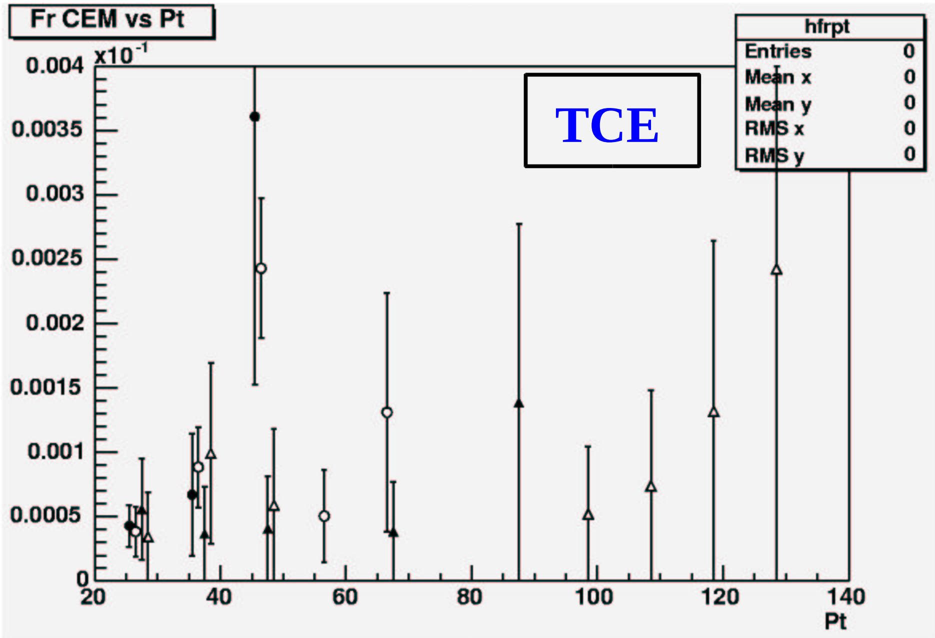
$$\text{track } |z_0| < 60.0\ \ \text{cm}$$

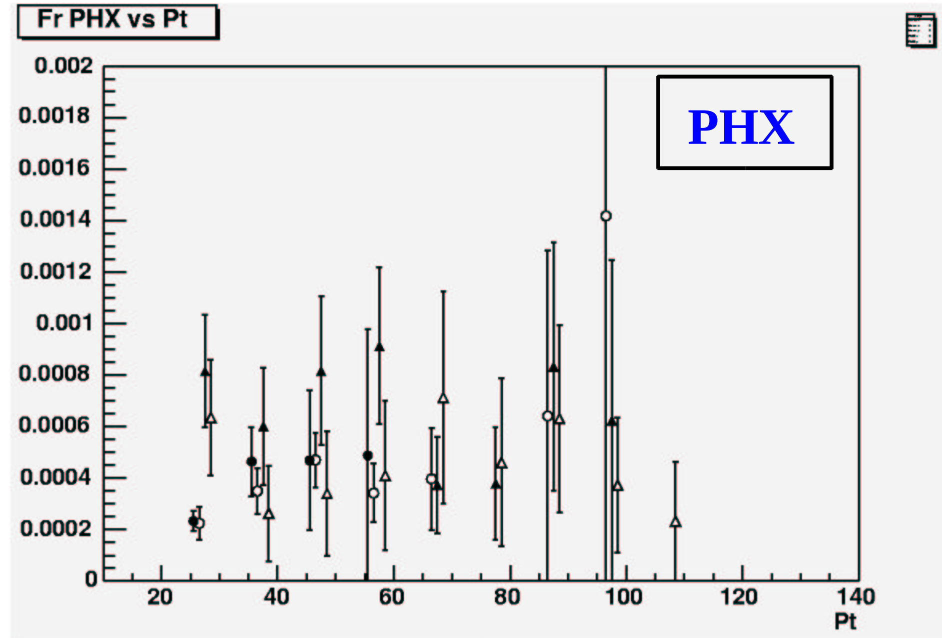
$$\text{track } |d_0| < 0.2\,\text{cm}\,, < 0.02\,\text{cm}\ \ \ \text{if SI hits}$$

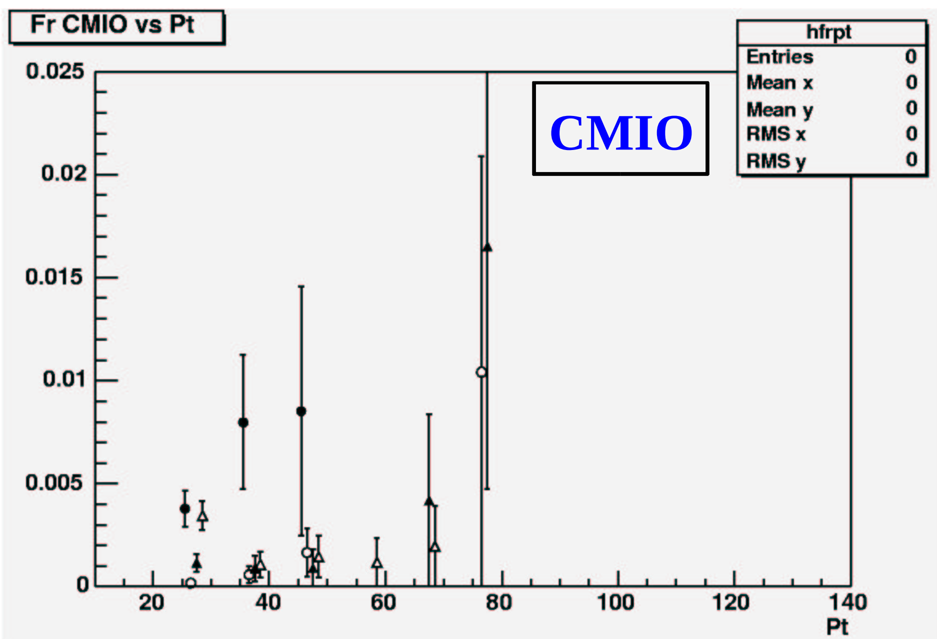
$$\text{non} - \text{cosmic}$$

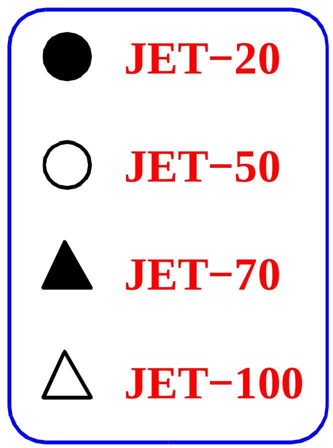
$$(\text{CMUP, CMU, CMP, CMX, CMIO})\ \text{based on muon fiducial tool}$$

Fake Ratios









- Samples consistent within (large) errors.
- Take average values across samples and E_T values.
- Spread gives systematic.

Fake Rates : Systematic Checks

- W and Z (real lepton) contamination
  - Procedure : vary missing−E_T (**10**, 15, 20, 25) and Z−veto (**76−106**, 66−116, 56−126) cuts.
  - Result : variation consistent with varying contamination based on prescale and threshold. Use 10 GeV cut to select purest fake sample. Residual error well within overall systematic.

- Denominator definition.
  - Procedure : vary EM fraction cut for electron FR (**NONE**, 0.5, 0.8) and E/P cut for muon FR (NONE, 0.5, **1.0**)
  - Result : no variation with EM fraction. Some variation with E/P cut : 50% systematic uncertainty on muon fake rates.

- Jet vs. Electron Energy.
  - Procedure : use EM component of jet only.
  - Result : 20% systematic variation of TCE and PHX fake rates.

- Fake Rate Summary :
  - **e–e :** 0.618 ± 0.174 (stat+samp) ± 0.124 (syst)
  - **e–μ :** 0.621 ± 0.164 (stat+samp) ± 0.210 (syst)
  - **μ–μ:** 0.149 ± 0.080 (stat+samp) ± 0.075 (syst)

- Large errors, but :
- Fake/Signal ≈ 0.1
- We want to do some additional cross checks

Drell−Yan Background Systematics

☆ Data cross−check :

$$n_{DY}^{tot} = R_{\frac{\mathrm{OUT}}{\mathrm{IN}}}\, n_{WW}^{\mathrm{in}} + R_{\frac{\bar{D}Y}{DY}}\, \bar{n}_{WW}^{\mathrm{in}}$$

DY background outside Z mass region

DY background inside Z mass region

old method

new method

$$R_{\frac{\bar{D}Y}{DY}} = \frac{n(\not{E}_T > 25 \wedge \not{E}_T^{sig} > 3) - n_{OTHER}^{MC}}{n(\not{E}_T < 25 \vee \not{E}_T^{sig} < 3)}$$

$$\bar{n}_{WW}^{\mathrm{in}}$$

"number of DY events at high $\not{E}_T$ and $\not{E}_T^{\mathrm{sig}}$, corrected for signal contamination"

"ordinary DY events"

"number of events passing all WW cuts except $\not{E}_T$ or $\not{E}_T^{\mathrm{sig}}$"

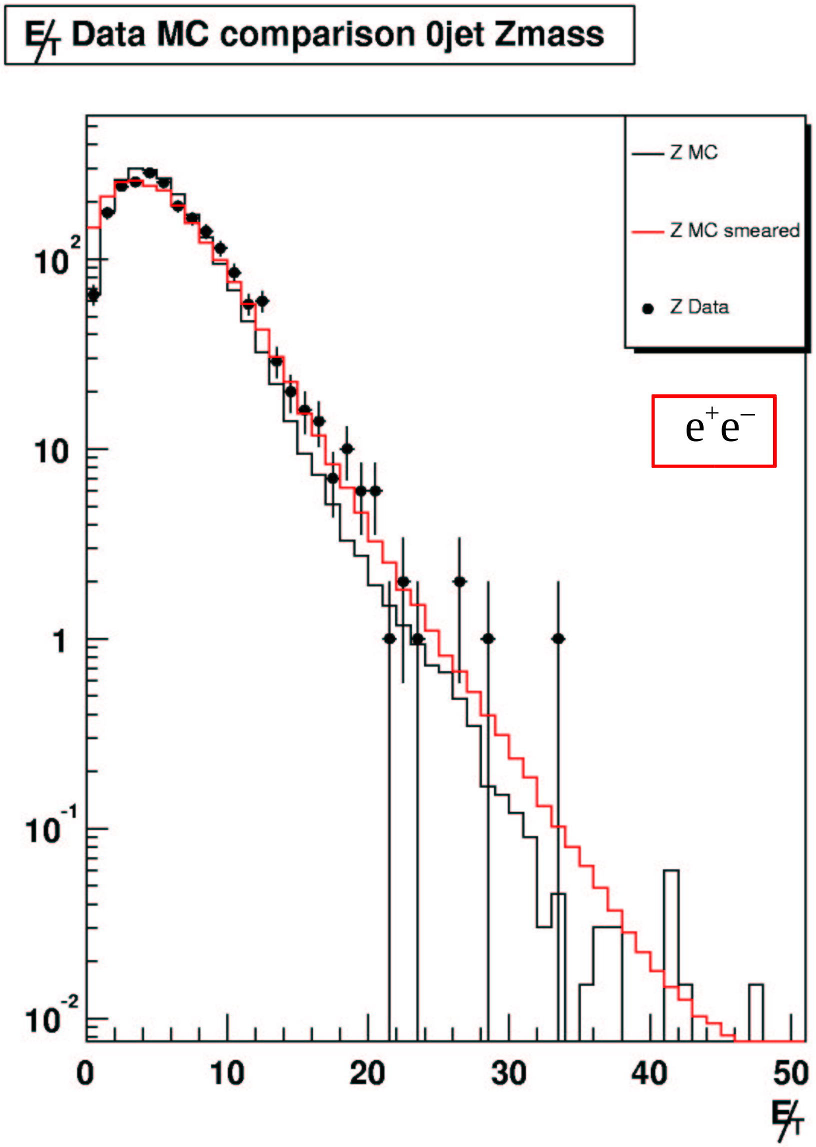
Drell−Yan Background Systematics

Data cross−check numbers :

Channel	Inside	Outside	Total	Monte-Carlo
ee	0.70 ± 1.09	0.21 ± 0.15	0.91 ± 1.10	0.62 ± 0.22
$\mu\mu$	0.35 ± 1.11	0.13 ± 0.13	0.49 ± 1.12	0.61 ± 0.24

- Consistent within errors.
- Data errors large due to small statistics.
- Prefer to use MC values and evaluate systematic error in other ways.
- **NOTE** : this with OS cut for PHX.

Drell−Yan Background Systematics



- Smear the MC to better describe the $\not{E}_T$ tail in data.
- Smearing $\propto \sqrt{\not{E}_T}$ or simple 6% shift both give a reasonable description of the tail and increase the fraction above 25 GeV by ~85%.
- Large error (40%) estimated on this fraction since there is little data (and significant signal contamination) above 25 GeV.
- $\mu^+\mu^-$ data : no evidence for systematic effect.

<u>Other background systematics :</u>

- Jet energy scale (important for $t\bar{t}$)

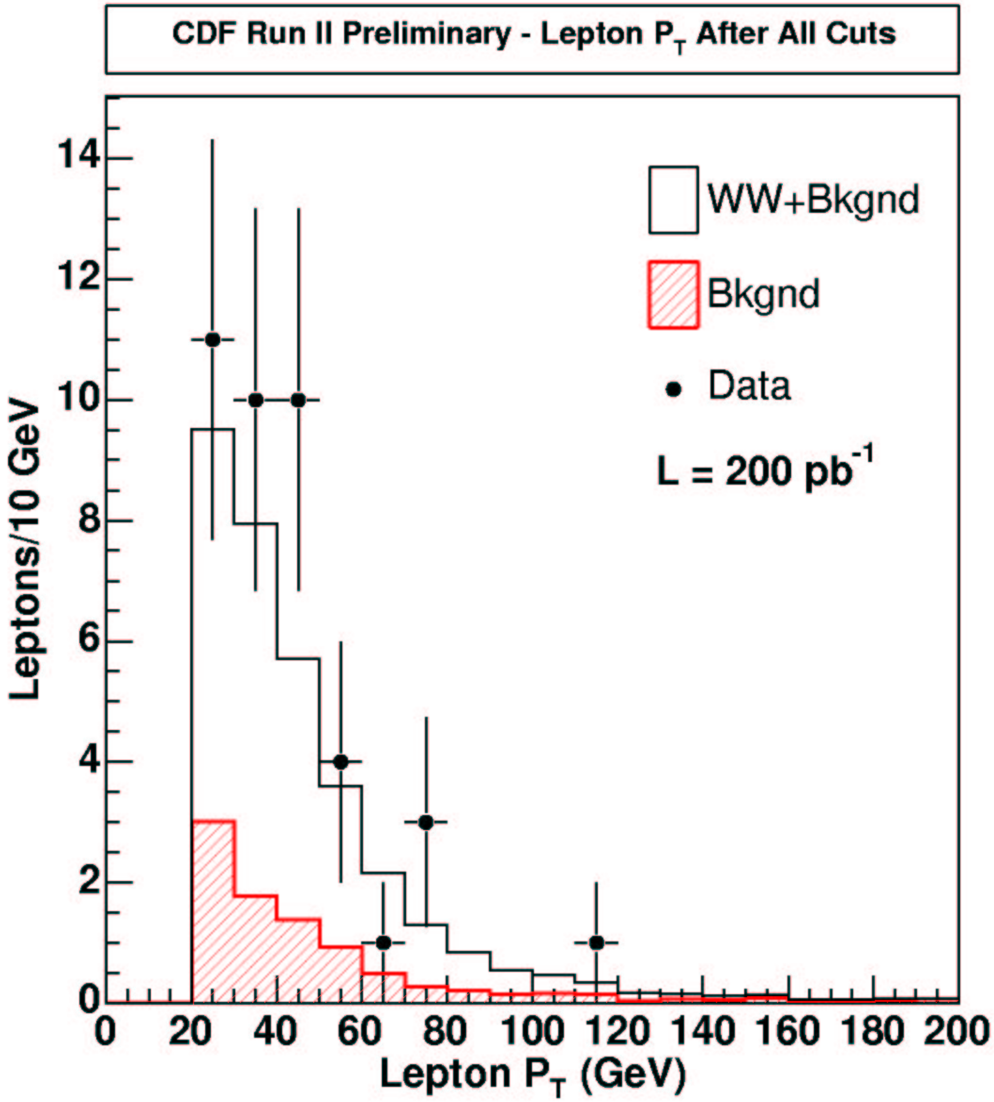
Grand Summary

	CDF Run II Winter 2004 Preliminary			
Source	ee	$\mu\mu$	$e\mu$	$\ell\ell$
Drell-Yan e^+e^-	1.17 ± 0.52	0.00 ± 0.00	0.072 ± 0.059	1.24 ± 0.52
Drell-Yan $\mu^+\mu^-$	0.00 ± 0.00	0.61 ± 0.24	0.48 ± 0.19	1.09 ± 0.31
Drell-Yan $\tau^+\tau^-$	0.051 ± 0.020	0.046 ± 0.018	0.10 ± 0.04	0.20 ± 0.05
WZ	0.36 ± 0.04	0.32 ± 0.03	0.22 ± 0.02	0.91 ± 0.07
$t\bar{t}$	0.013 ± 0.008	0.008 ± 0.005	0.033 ± 0.014	0.054 ± 0.017
Fake	0.62 ± 0.21	0.15 ± 0.11	0.62 ± 0.27	1.39 ± 0.36
Total Background	2.22 ± 0.56	1.14 ± 0.27	1.53 ± 0.34	4.88 ± 0.73
$WW \to$ dileptons	3.38 ± 0.40	2.75 ± 0.32	6.09 ± 0.71	12.2 ± 1.4
Run 2 Data	8	6	6	20

New Monte Carlo studies show :

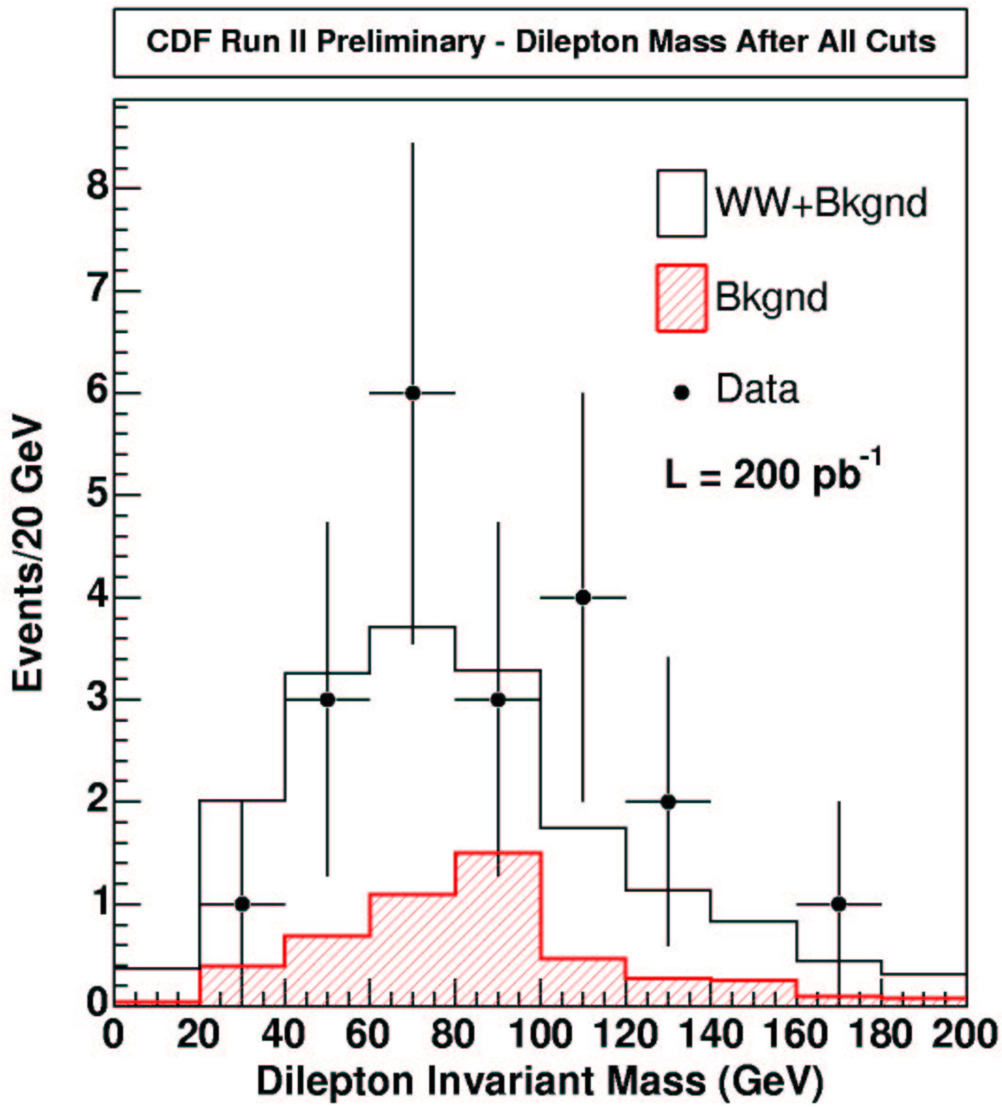
- $b\bar{b}$ background negligible
- W+γ very small (<0.1 events)

Plots



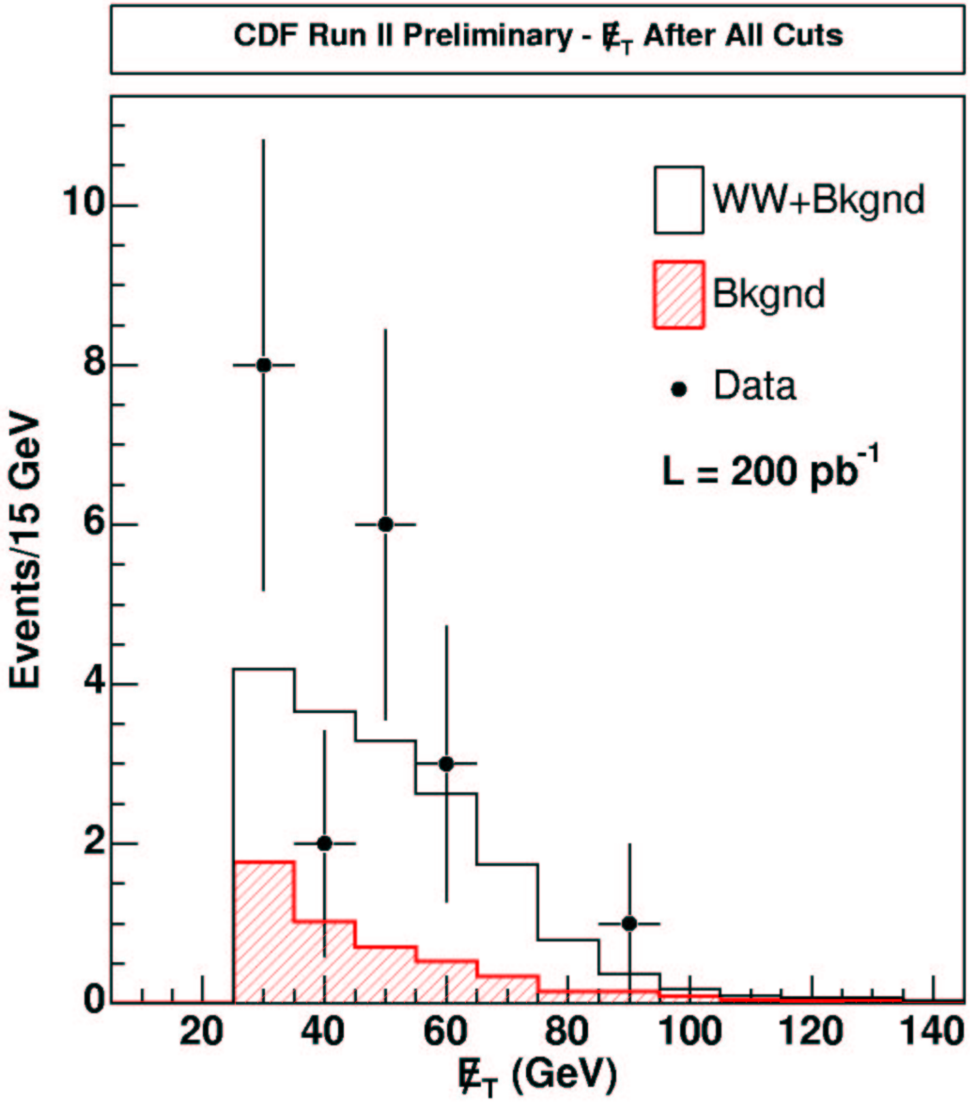
TO BLESS

Plots



TO BLESS

Plots



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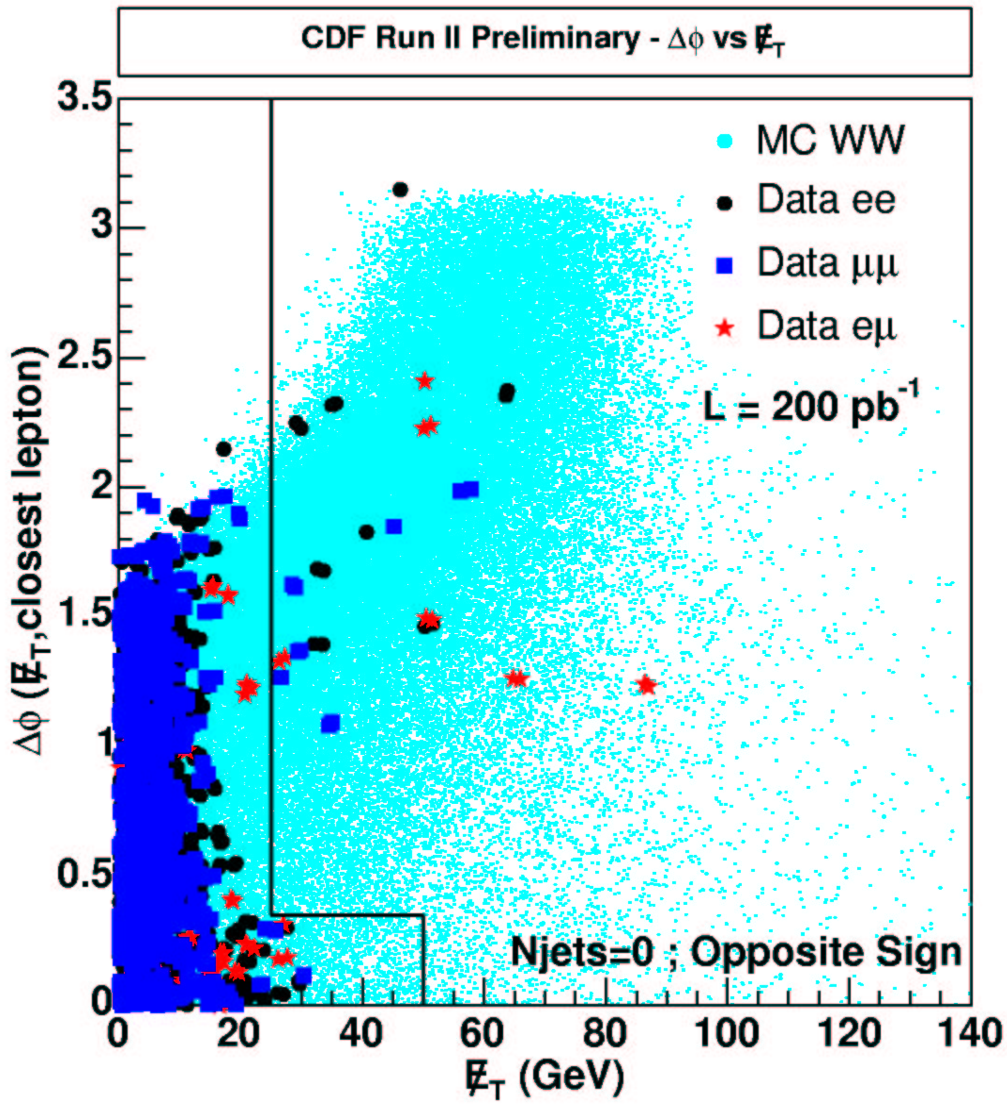
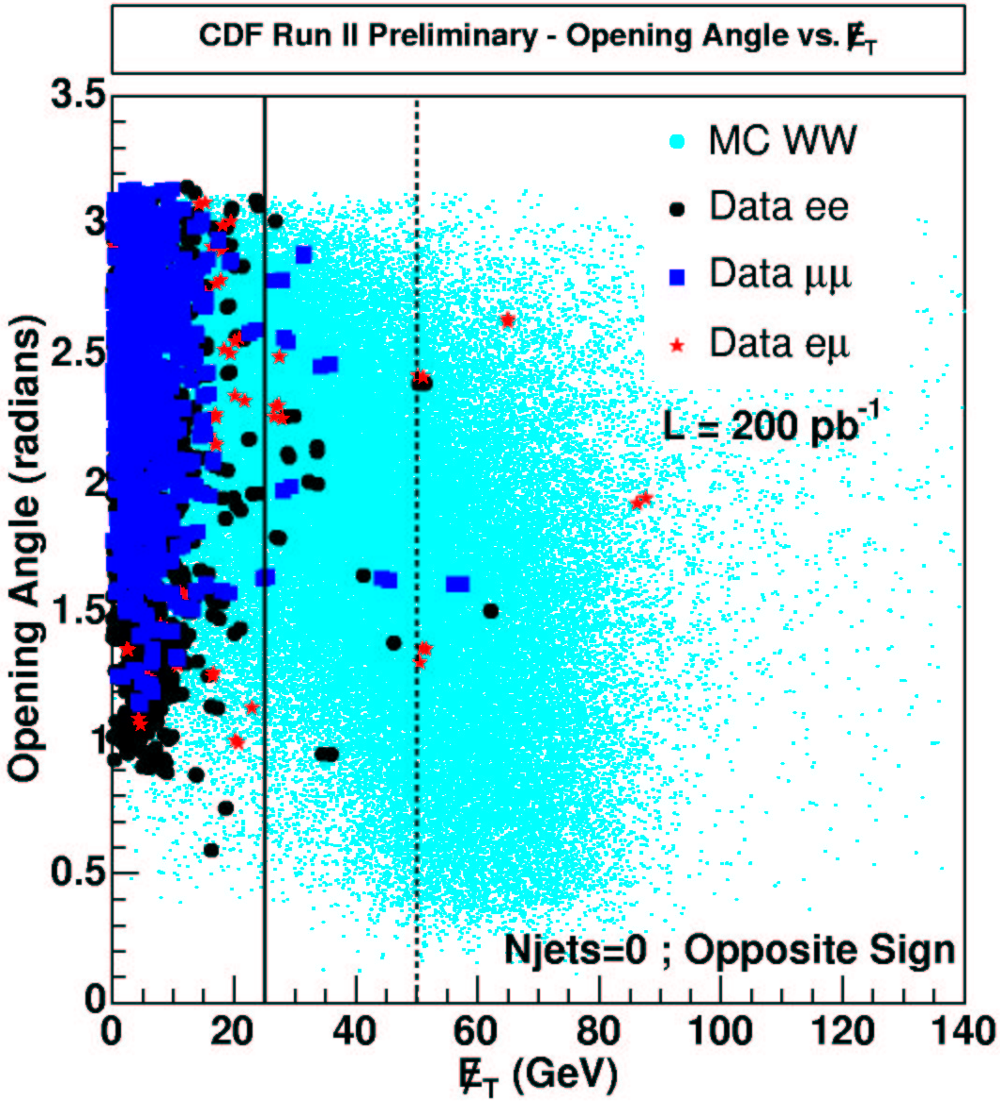
Plots



TO BLESS

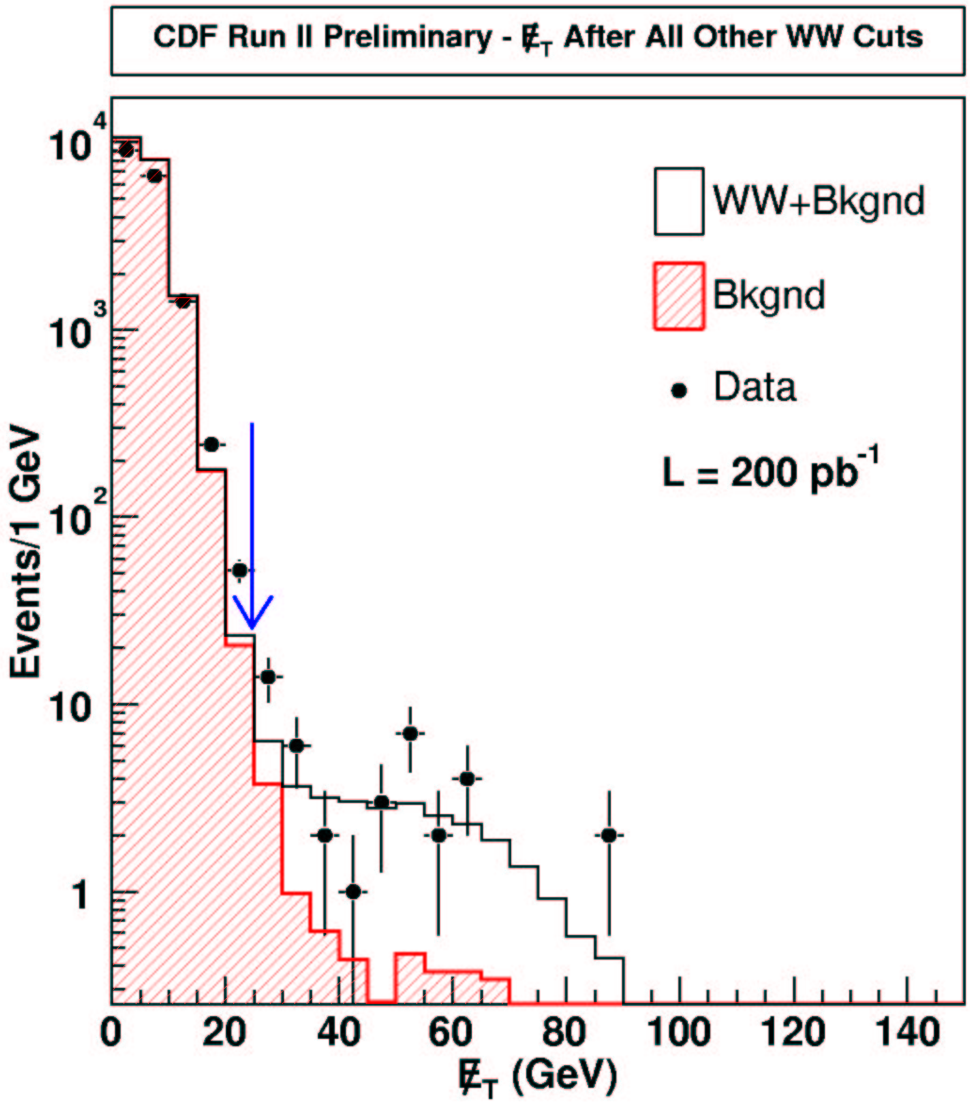
Plots



TO BLESS

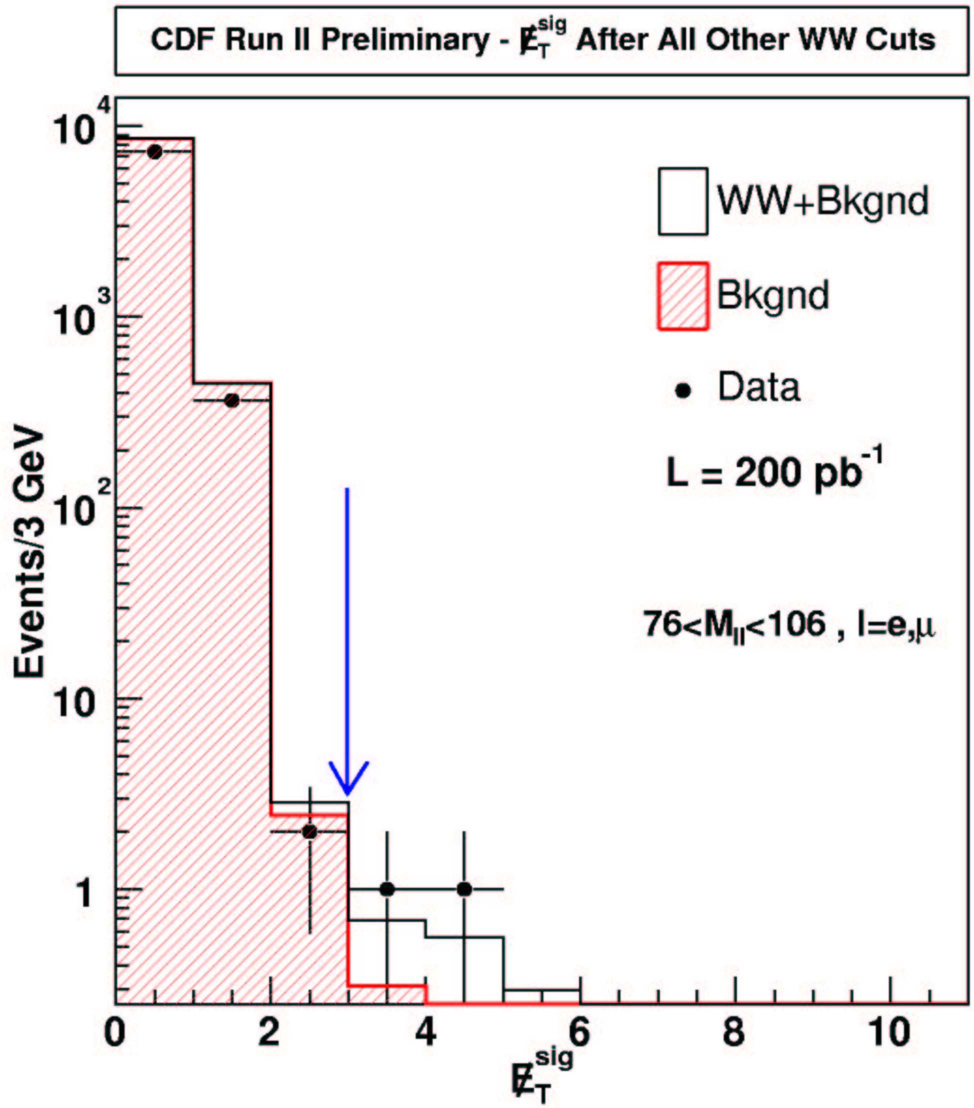
Plots

- Relax missing−E_T cut.
- Backgrounds still normalised to luminosity.
- Before any additional smearing of DY missing−E_T.

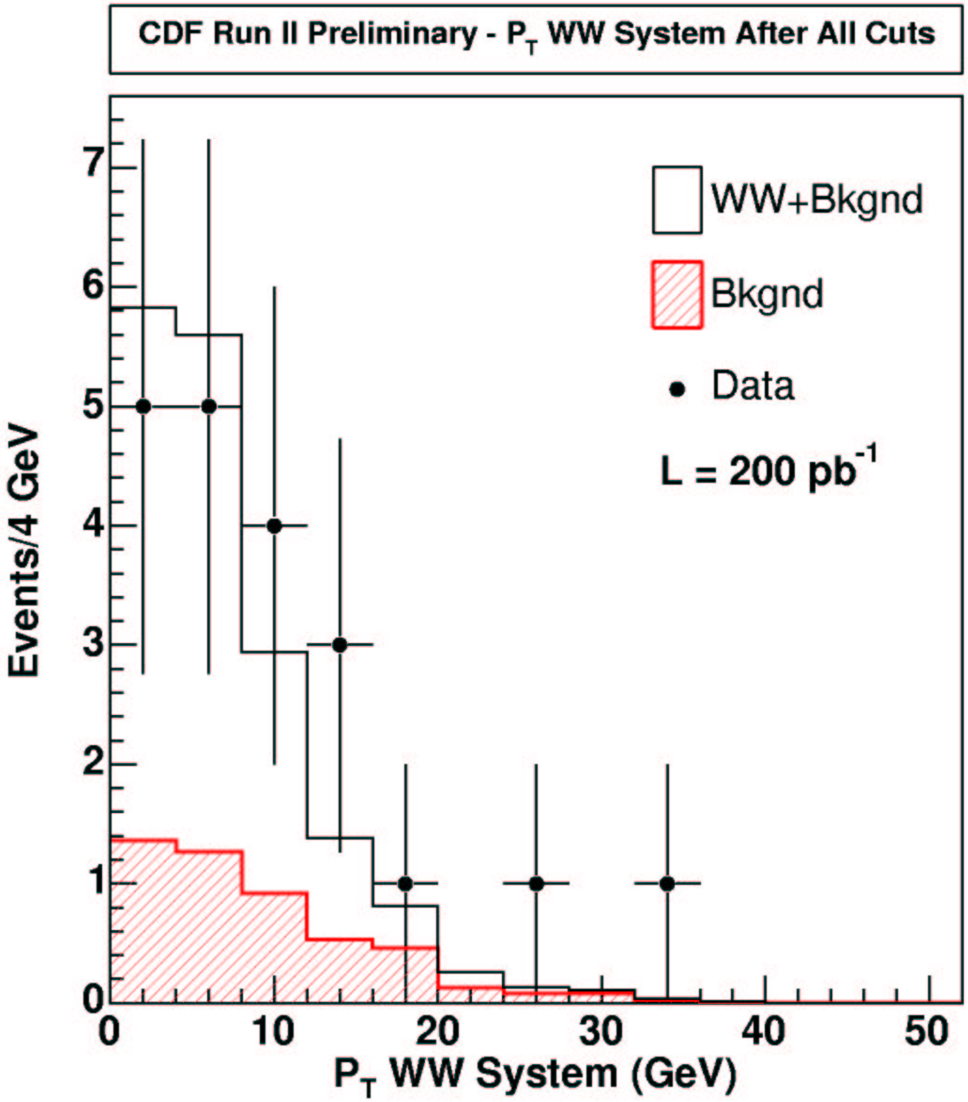


Plots

- Relax METSIG cut for data in Z−mass window.
- Backgrounds still normalised to luminosity.



Plots



TO BLESS

$$\left|\vec{p}_T(l^+)+\vec{p}_T(l^-)+\vec{\not{E}}_T\right|$$

- This distribution sensitive in principle to ISR effects (although statistics too poor to set a systematic).

Cross Section

- Use :

$$\sigma^{WW}_{meas} = \frac{(N_{obs} - N_{bk})}{\underbrace{N_{exp}}} \times \sigma^{WW}_{theory}$$

Takes into account different luminosities, scale factors etc. for different dilepton categories.

- Statistical error : Feldman & Cousins.
- Systematic error propagation :

$$\sigma^{WW}_{meas} = \frac{(N_{obs} - N_{bk})}{\epsilon \times L \times BR}$$

10% (mainly uncertainty due to jet veto)

6%

$\delta \boldsymbol{N}_{bk}$ = ~20 % (effect of missing−E_T cut, jet veto and fake uncertainties).

$$\boxed{\sigma^{WW}_{meas} = 16.4^{+5.7}_{-4.5}\ (\mathrm{stat}) \pm 1.8\ (\mathrm{syst}) \pm 1.0\ (\mathrm{lumi})\quad \mathrm{pb}}$$

THEORY : $\sigma^{WW}_{NLO} = 13.25 \pm 0.8 \quad \mathrm{pb}$

TO BLESS

W/Z Cross−Section Checks

- Uses identical lepton categories to WW analysis in all cases (except "LCE")
- Uses identical datasets, ntuples etc.

background fraction from σ(W,Z) analyses **Standard SF** **from MC**

process	ℓ_{det} type	N_{signal}	$p_{\mathrm{bg}}(\%)$	$\mathcal{L}_{\mathrm{int}}(/\mathrm{pb})$	$\epsilon_{\mathrm{trigger}}$	$f_{\mathrm{data/MC}}$	$A \cdot \epsilon_{\mathrm{ID}}$	$\sigma \cdot B \pm \mathrm{stat} \pm \mathrm{lumi}$ (nb)
$W \to e\nu$	TCE	117123	0.035	193.525	0.9621	0.964	0.2344	$2.686 \pm 0.008 \pm 0.161$
	PHX	69917	0.03	161.804	0.973	0.947	0.1803	$2.523 \pm 0.010 \pm 0.151$
$W \to \mu\nu$	CMUP	59466	0.0943	193.525	0.887	0.8874	0.1286	$2.750 \pm 0.012 \pm 0.165$
	CMX	32479	0.0921	175.302	0.954	1.0069	0.0632	$2.773 \pm 0.017 \pm 0.166$
$Z \to ee$	TCE-LCE	4929	0.0026	193.525	0.999	0.943	0.1072	$0.2517 \pm 0.0036 \pm 0.0151$
	TCE-PHX	3517	0.0015	161.804	0.963	0.817	0.1156	$0.2386 \pm 0.0040 \pm 0.0143$
$Z \to \mu\mu$	CMUP-μ	4355	0.0000	193.525	0.8921	0.8874	0.1063	$0.2675 \pm 0.0041 \pm 0.0161$
	CMX-μ	2345	0.0000	175.302	0.956	1.0069	0.0554	$0.2506 \pm 0.0052 \pm 0.0150$

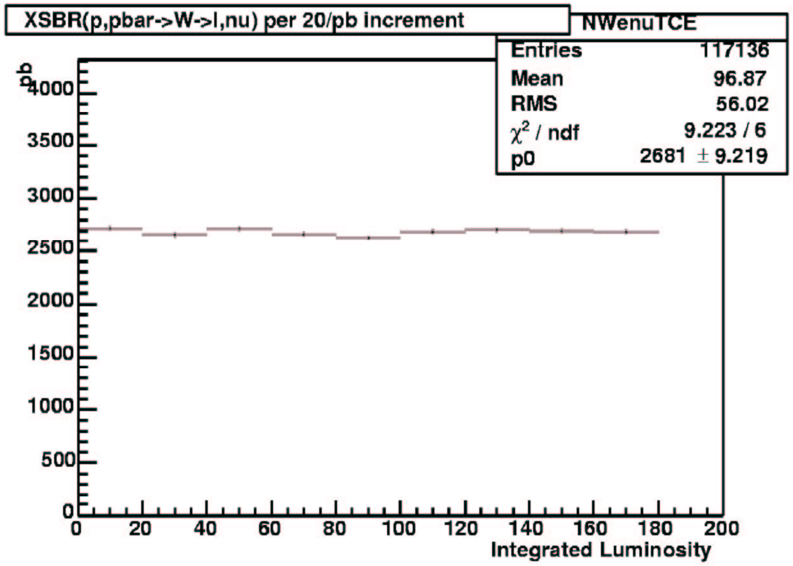
$$\sigma \times B_{SM}(W \to l\,\nu) = 2.731 \ \ \mathrm{nb}$$

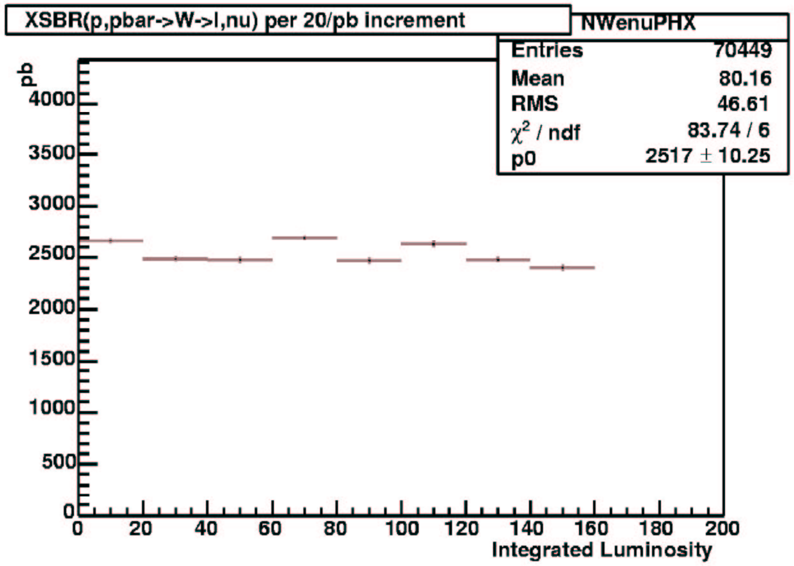
$$\sigma \times B_{SM}(Z \to l^+ l^-) = 0.2505 \ \ \mathrm{nb}$$

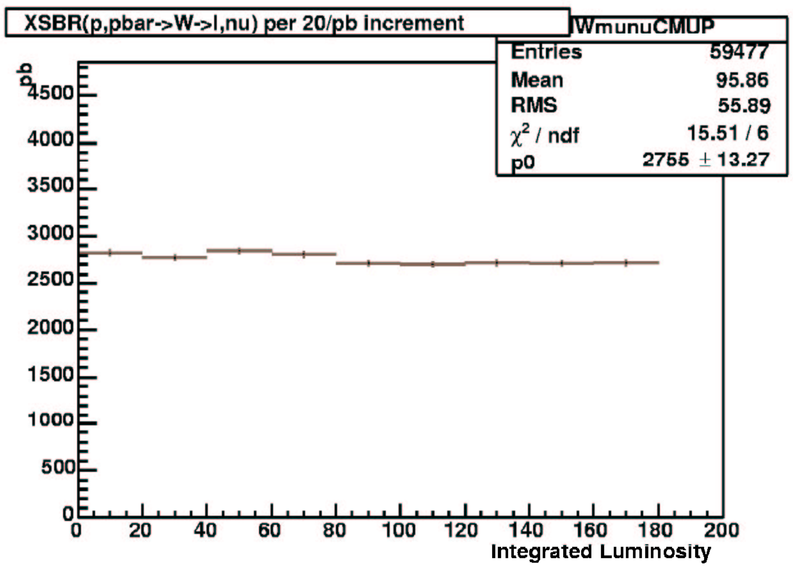
- Reasonable agreement with other CDF measurements.
- No systematic difference w&w/o trk iso requirement.

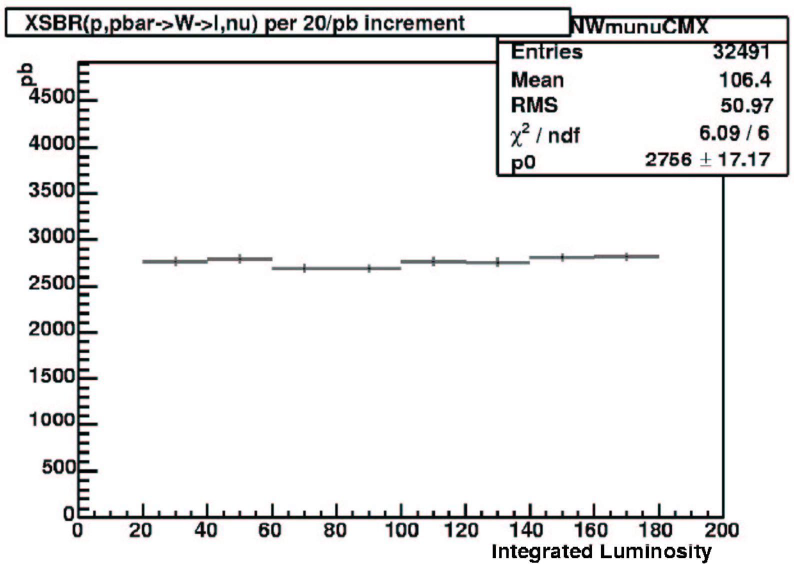
W/Z Cross−Section Checks

* W yield stability :



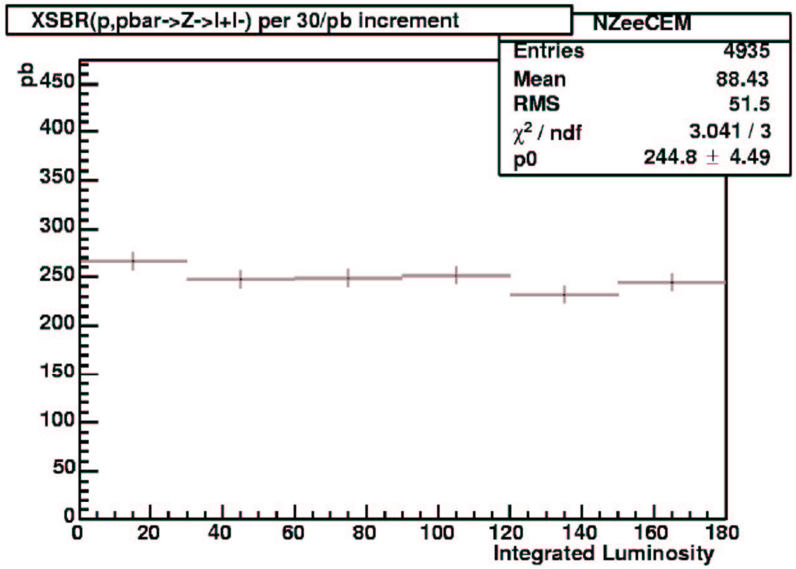


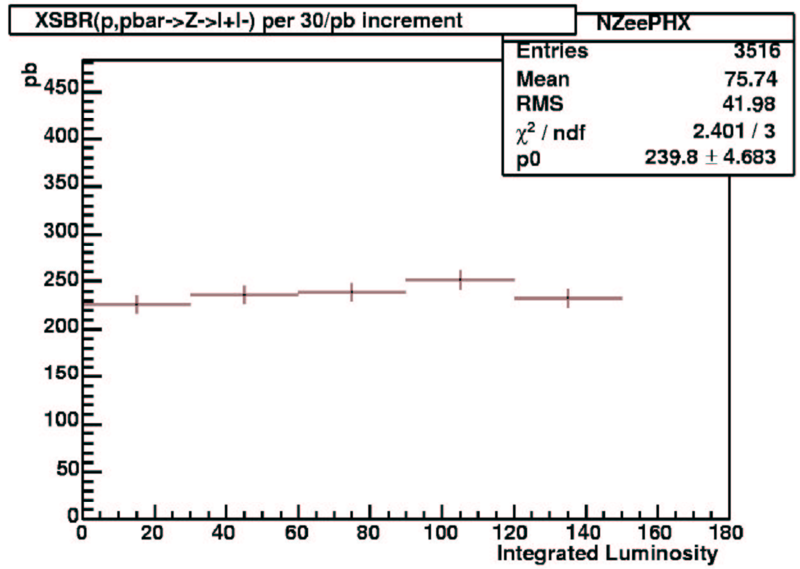


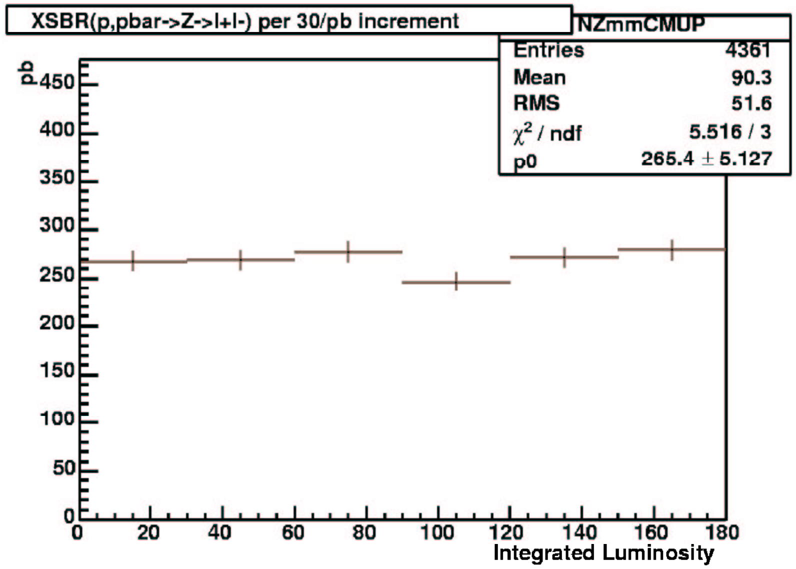


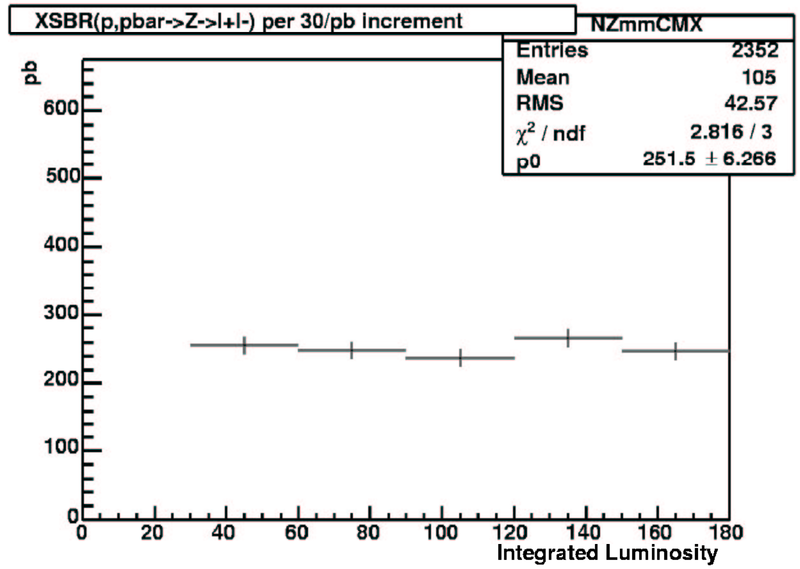
W/Z Cross−Section Checks

* Z yield stability :



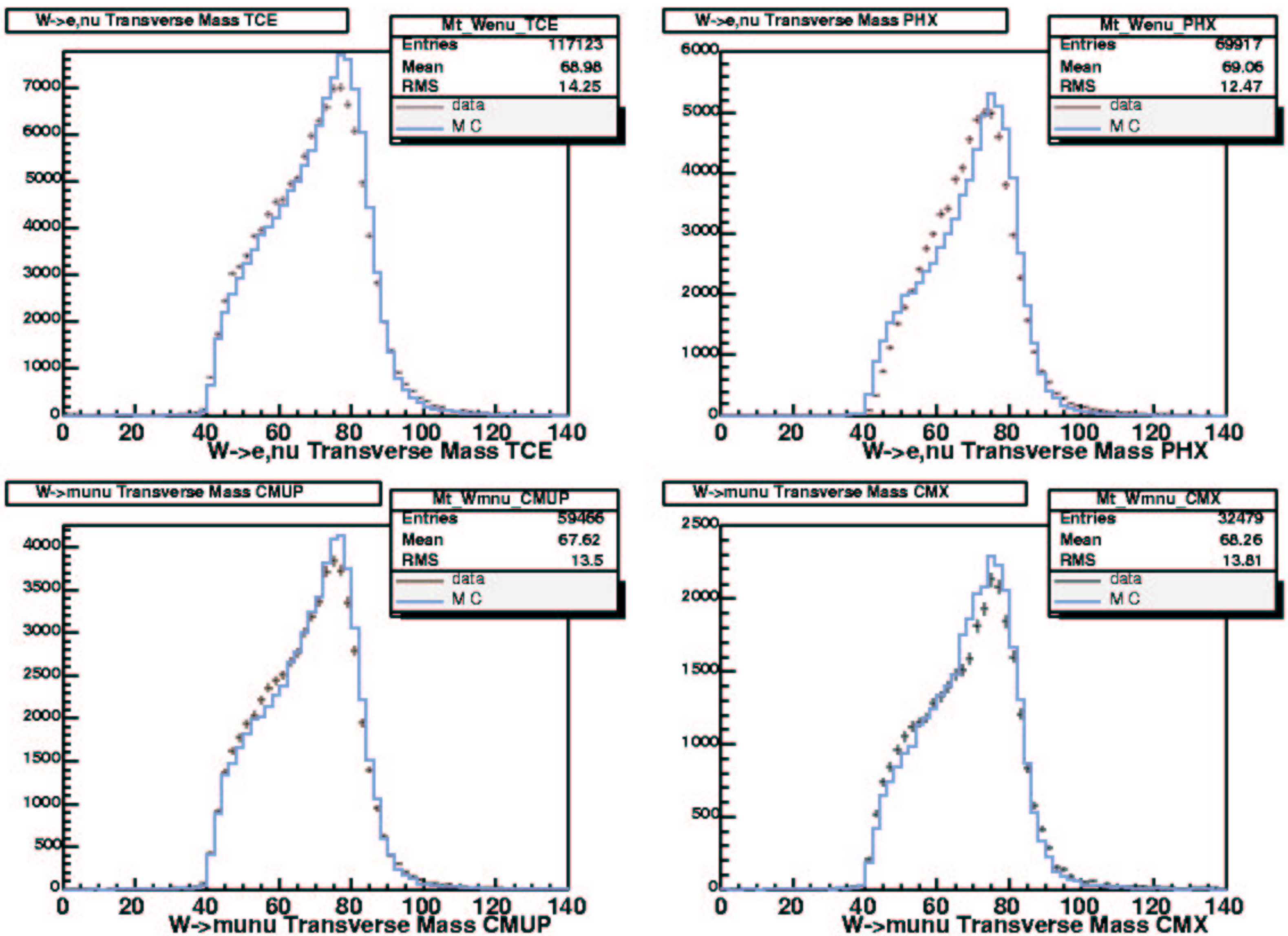






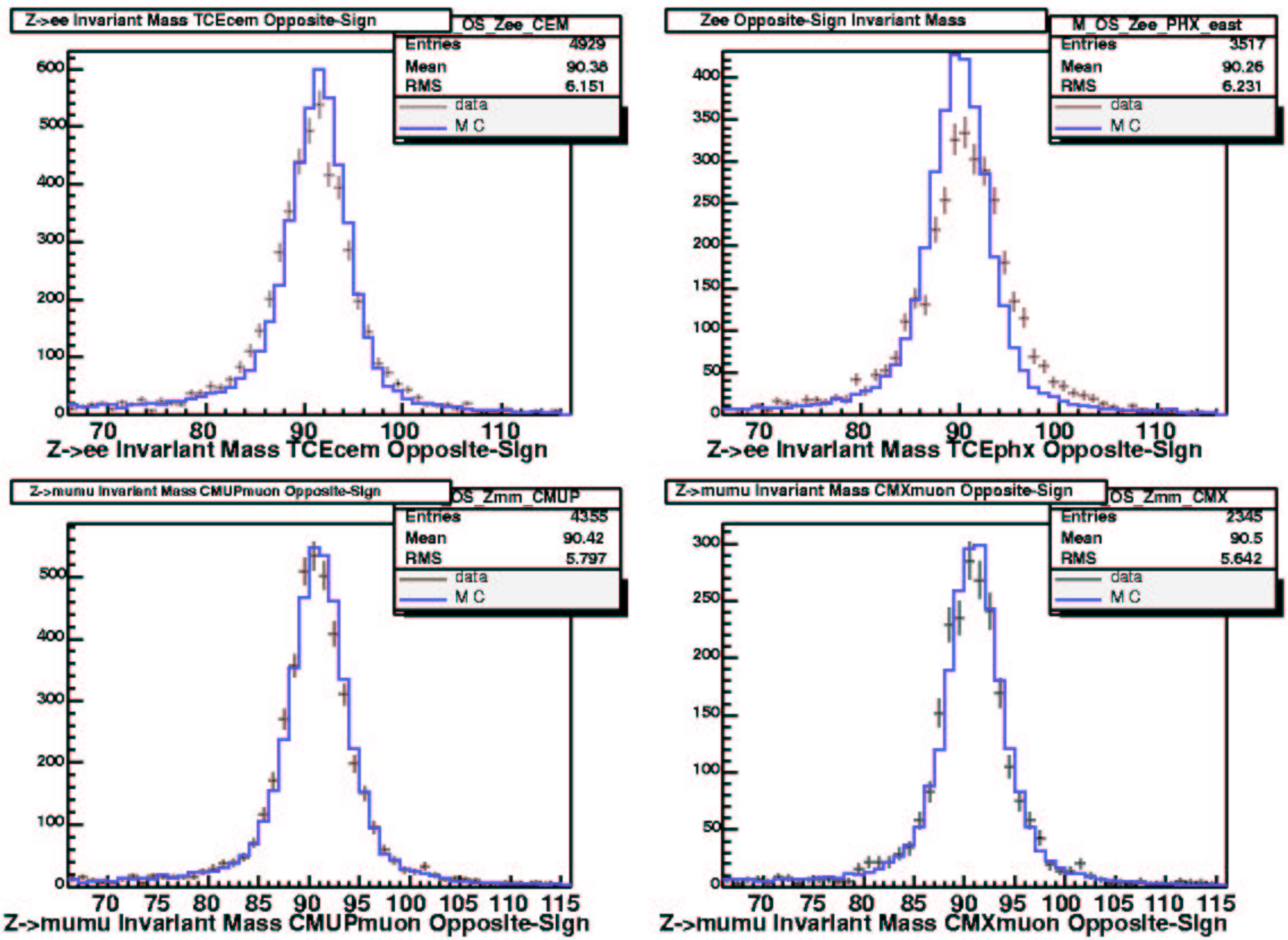
W/Z Cross−Section Checks

- W kinematics :



W/Z Cross−Section Checks

* Z kinematics :



BACKUP SLIDES

Baseline Lepton Definitions

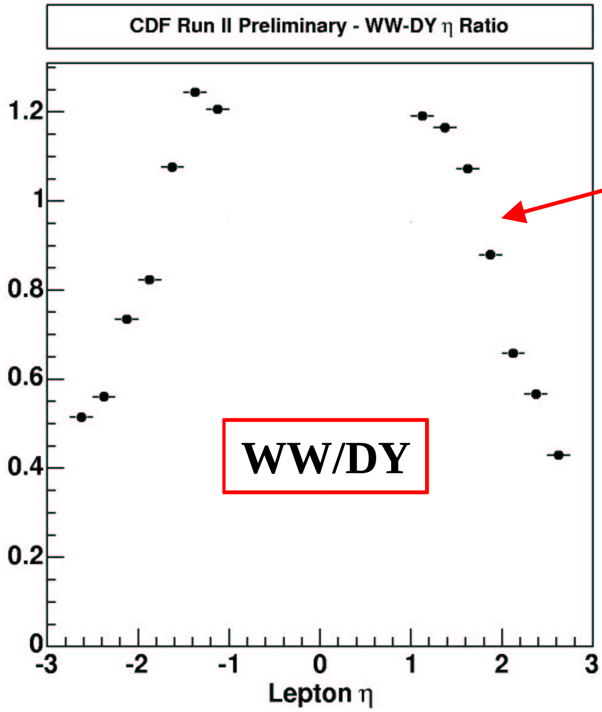
EM E_T	> 20 GeV
E_{HAD}/E_{EM}	$< 0.055 + 0.00045 \cdot E$
L_{shr}	< 0.2
Track P_T	$>$10 GeV/c (if EM $E_T \leq$100 GeV) $>$50 GeV/c (if EM $E_T >$100 GeV)
$\frac{E}{p}$	< 2 (if EM $E_T \leq$100 GeV)
$\mathrm{q_{track}} \cdot \Delta x$	[-3.0 cm, 1.5 cm]
$\|\Delta z\|$	< 3 cm
χ^2	< 10
track $\|z_0\|$	< 60 cm
Track quality	3 axial and 3 stereo SL with at least 7 out of 12 in each SL
Fiducial	*fidele*=1 (Ces $\|X\|$ <21 cm, 9< Ces $\|Z\|$ <230 cm Tower 9 excluded, most of tower next to chimney included)

Baseline Lepton Definitions

EM E_T	> 20 GeV
E_{HAD}/E_{EM}	$< 0.05 + 0.026 \cdot \ln(\frac{\mathrm{E_{EM}}}{100})$ (if E_{EM} >100 GeV) < 0.05 (if $E_{EM} \leq$100 GeV)
PEM 3×3 Fit tower	$\neq 0$
PEM 3×3 Fit χ^2	<10
PES 5×9 U and V	>0.65
Fiducial	PES based $1.2< \lvert\eta\rvert <2.5$
Silicon track Number of Silicon Hits Track $\lvert z_0\rvert$ Δ_R(Track, PES)	2D Phoenix track ≥ 3 < 60 cm <3

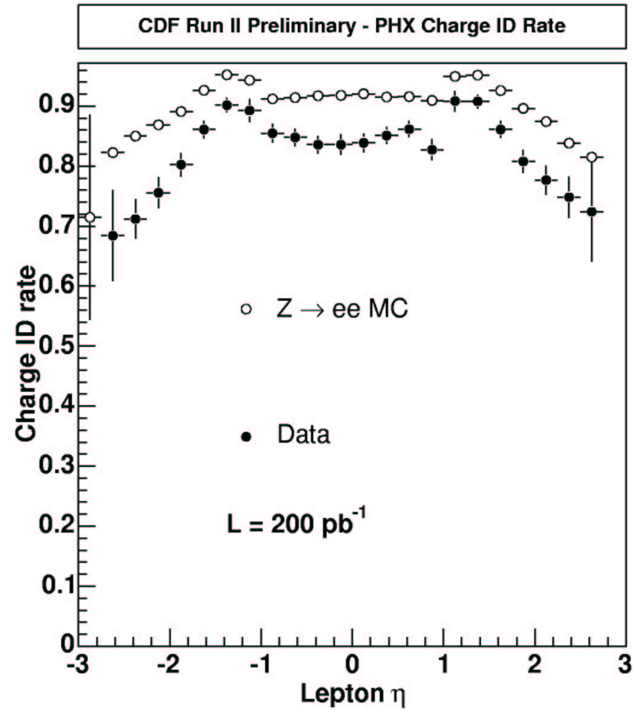
Track P_T	>20 GeV/c
Track $\lvert z_0\rvert$	< 60 cm
E_{EM}	< 2+Max(0,0.0115(P-100)) GeV
E_{HAD}	< 6+Max(0,0.028(P-100)) GeV
Track $\lvert d_0\rvert$	0.2 cm (if no silicon hits attached by OI) 0.02 cm (if silicon hits attached by OI)
Track quality	3 axial and 3 stereo SL with at least 7 out of 12 in each SL

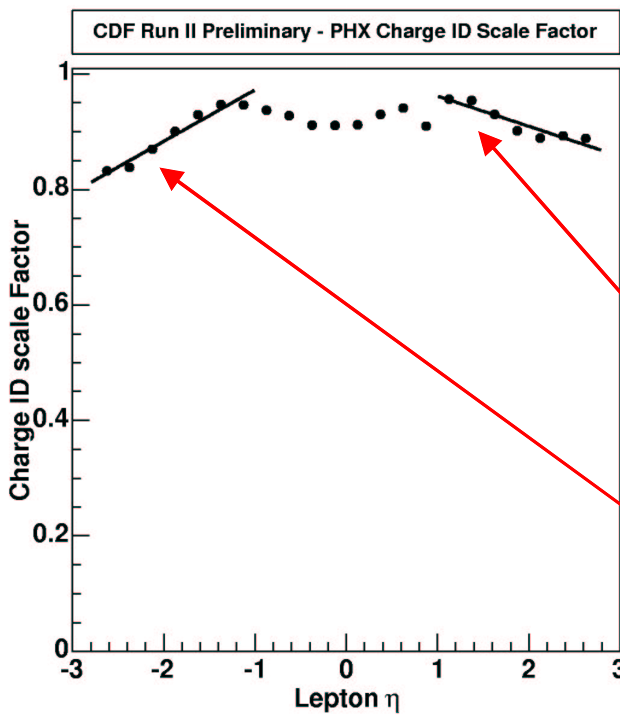
PHX Charge Mis−identification



- WW more central than DY.
- η averaged result from DY will not give correct result.

OS/(SS+OS)





$1.049 - 0.0071 \times \eta$

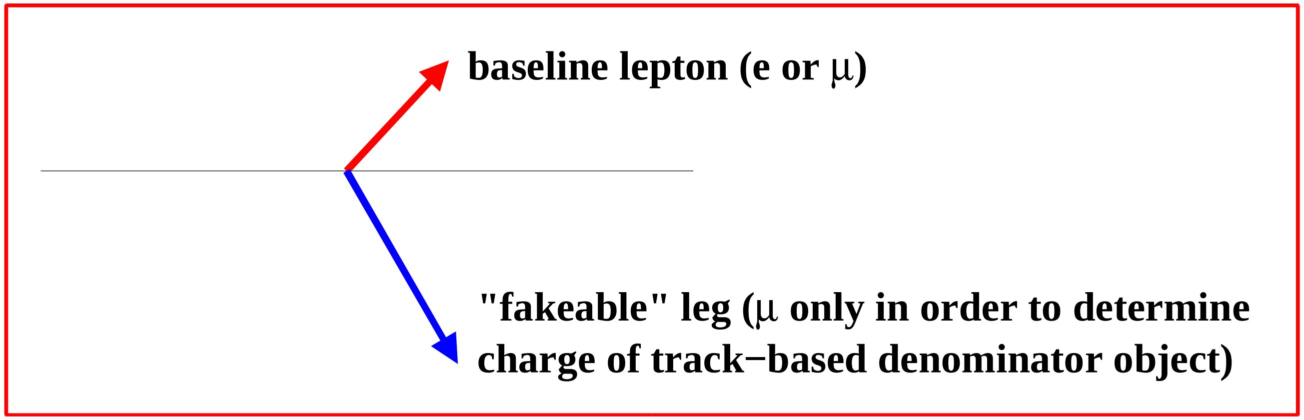
$1.069 + 0.0093 \times \eta$

Fake Rate for Different W/Z Rejection Cuts

CEM	$\not{E}_T < 10$	$\not{E}_T < 15$	$\not{E}_T < 20$	$\not{E}_T < 25$
JET20	$3.38\ 10^{-5} \pm 1.28\ 10^{-5}$	$3.97\ 10^{-5} \pm 1.20\ 10^{-5}$	$4.26\ 10^{-5} \pm 1.18\ 10^{-5}$	$4.44\ 10^{-5} \pm 1.19\ 10^{-5}$
JET50	$8.71\ 10^{-5} \pm 1.59\ 10^{-5}$	$6.94\ 10^{-5} \pm 1.13\ 10^{-5}$	$6.66\ 10^{-5} \pm 9.93\ 10^{-6}$	$6.34\ 10^{-5} \pm 9.24\ 10^{-6}$
JET70	$2.35\ 10^{-5} \pm 1.18\ 10^{-5}$	$4.25\ 10^{-5} \pm 1.23\ 10^{-5}$	$4.39\ 10^{-5} \pm 1.10\ 10^{-5}$	$4.08\ 10^{-5} \pm 9.89\ 10^{-6}$
JET100	$2.80\ 10^{-5} \pm 1.25\ 10^{-5}$	$4.84\ 10^{-5} \pm 1.25\ 10^{-5}$	$6.42\ 10^{-5} \pm 1.23\ 10^{-5}$	$5.94\ 10^{-5} \pm 1.08\ 10^{-5}$
PHX	$\not{E}_T < 10$	$\not{E}_T < 15$	$\not{E}_T < 20$	$\not{E}_T < 25$
JET20	2.73e-04 $\pm$ $3.83\ 10^{-5}$	3.22e-04 $\pm$ $3.70\ 10^{-5}$	3.21e-04 $\pm$ $3.57\ 10^{-5}$	3.19e-04 $\pm$ $3.52\ 10^{-5}$
JET50	3.46e-04 $\pm$ $4.36\ 10^{-5}$	3.67e-04 $\pm$ $3.64\ 10^{-5}$	4.33e-04 $\pm$ $3.61\ 10^{-5}$	4.67e-04 $\pm$ $3.61\ 10^{-5}$
JET70	6.66e-04 $\pm$ $9.51\ 10^{-5}$	5.67e-04 $\pm$ $6.93\ 10^{-5}$	6.14e-04 $\pm$ $6.44\ 10^{-5}$	6.53e-04 $\pm$ $6.28\ 10^{-5}$
JET100	4.26e-04 $\pm$ $8.51\ 10^{-5}$	4.85e-04 $\pm$ $6.99\ 10^{-5}$	5.43e-04 $\pm$ $6.44\ 10^{-5}$	5.99e-04 $\pm$ $6.25\ 10^{-5}$
CMIOS	$\not{E}_T < 10$	$\not{E}_T < 15$	$\not{E}_T < 20$	$\not{E}_T < 25$
JET20	$3.06\ 10^{-3} \pm 6.85\ 10^{-4}$	$2.43\ 10^{-3} \pm 5.07\ 10^{-4}$	$2.16\ 10^{-3} \pm 4.42\ 10^{-4}$	$2.17\ 10^{-3} \pm 4.26\ 10^{-4}$
JET50	$2.92\ 10^{-4} \pm 1.31\ 10^{-4}$	$7.15\ 10^{-4} \pm 1.60\ 10^{-4}$	$9.05\ 10^{-4} \pm 1.60\ 10^{-4}$	$1.00\ 10^{-3} \pm 1.59\ 10^{-4}$
JET70	$1.23\ 10^{-3} \pm 3.42\ 10^{-4}$	$1.57\ 10^{-3} \pm 2.96\ 10^{-4}$	$1.68\ 10^{-3} \pm 2.66\ 10^{-4}$	$2.07\ 10^{-3} \pm 2.72\ 10^{-4}$
JET100	$2.38\ 10^{-3} \pm 4.21\ 10^{-4}$	$2.47\ 10^{-3} \pm 3.22\ 10^{-4}$	$2.98\ 10^{-3} \pm 3.00\ 10^{-4}$	$3.41\ 10^{-3} \pm 2.90\ 10^{-4}$
CMIOS FIDELE	$\not{E}_T < 10$	$\not{E}_T < 15$	$\not{E}_T < 20$	$\not{E}_T < 25$
JET20	$2.18\ 10^{-3} \pm 7.28\ 10^{-4}$	$1.89\ 10^{-3} \pm 5.70\ 10^{-4}$	$1.79\ 10^{-3} \pm 5.18\ 10^{-4}$	$1.83\ 10^{-3} \pm 5.08\ 10^{-4}$
JET50	$1.85\ 10^{-4} \pm 1.31\ 10^{-4}$	$5.79\ 10^{-4} \pm 1.83\ 10^{-4}$	$9.40\ 10^{-4} \pm 2.10\ 10^{-4}$	$1.15\ 10^{-3} \pm 2.22\ 10^{-4}$
JET70	$1.37\ 10^{-3} \pm 4.55\ 10^{-4}$	$1.63\ 10^{-3} \pm 3.86\ 10^{-4}$	$1.87\ 10^{-3} \pm 3.61\ 10^{-4}$	$2.41\ 10^{-3} \pm 3.81\ 10^{-4}$
JET100	$1.81\ 10^{-3} \pm 4.54\ 10^{-4}$	$2.00\ 10^{-3} \pm 3.60\ 10^{-4}$	$2.94\ 10^{-3} \pm 3.74\ 10^{-4}$	$3.42\ 10^{-3} \pm 3.67\ 10^{-4}$

Fake Rate Charge Correlations

- Look at events in the W+1j data that can fake the WW+0j signal.
- Consider combinations for which charge correlations can be computed :



- Averaging across all such categories, we find :
  - OS/(OS+SS) = 63.3 ± 4.9%
- We can then correct our fake rates previously calculated assuming 50%.
- However, only a few categories are affected, since :
  - We have <u>dropped the OS cut</u> for PHX categories.
  - Where possible (i.e. where the fakeable leg is a track object), <u>OS cut was already being applied</u> to fakeable events, thereby including the effect of any charge correlations.
- The net result is an increase of 3% in fake rate estimate.

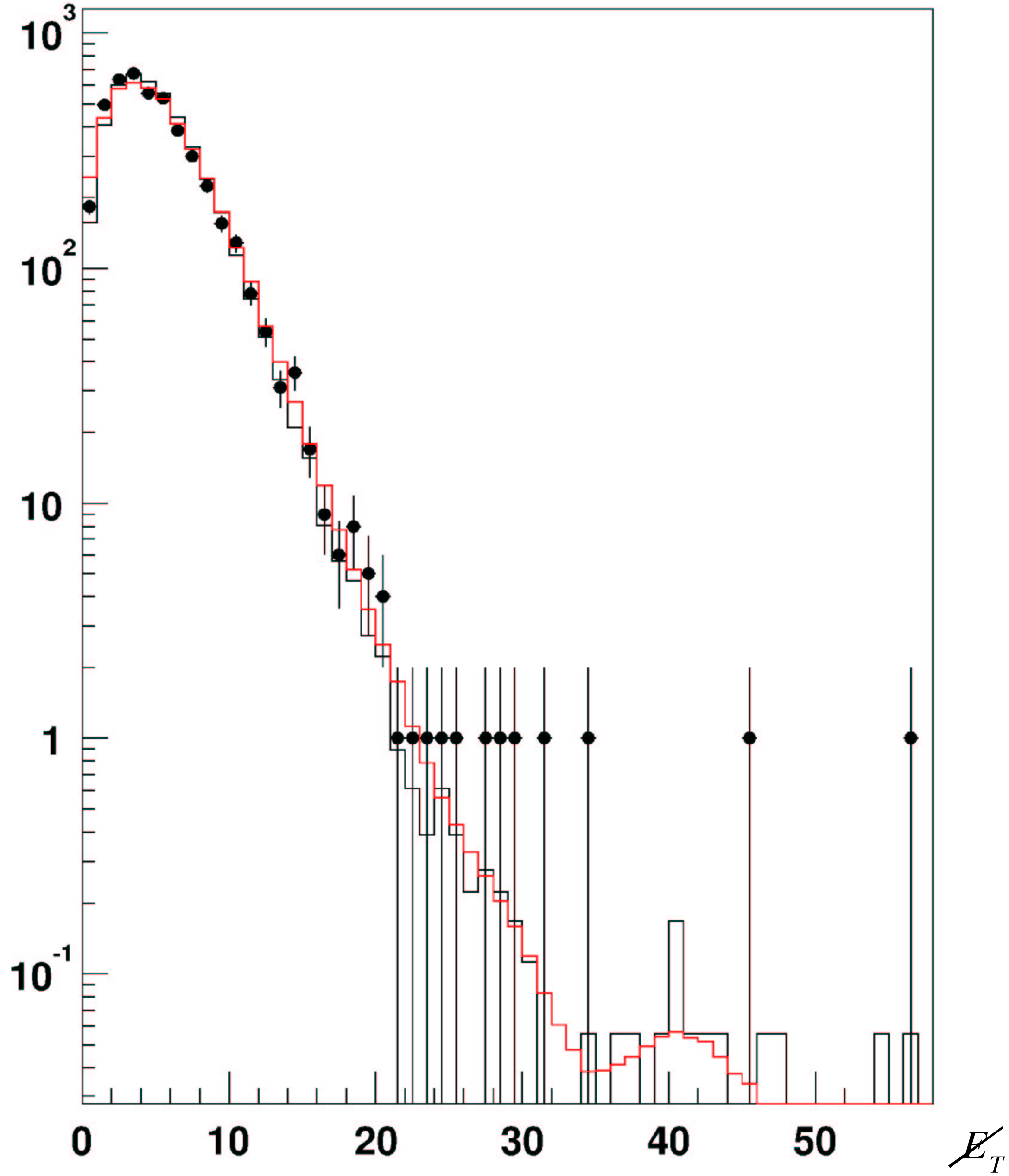
Luminosities

	Offline	+1.9% correction and 6% error
No Silicon (ee only)	199.973	203.8 ± 1.2
Good Silicon (ee only)	166.465	169.6 ± 1.0
No Silicon ($e\mu$ and $\mu\mu$)	189.917	193.5 ± 1.2
Good Silicon ($e\mu$ and $\mu\mu$) :	158.787	161.8 ± 1.0
No Silicon with CMX ($e\mu$ and $\mu\mu$):	172.033	175.3 ± 1.1
Good Silicon with CMX ($e\mu$ and $\mu\mu$):	147.26	150.1 ± 0.9

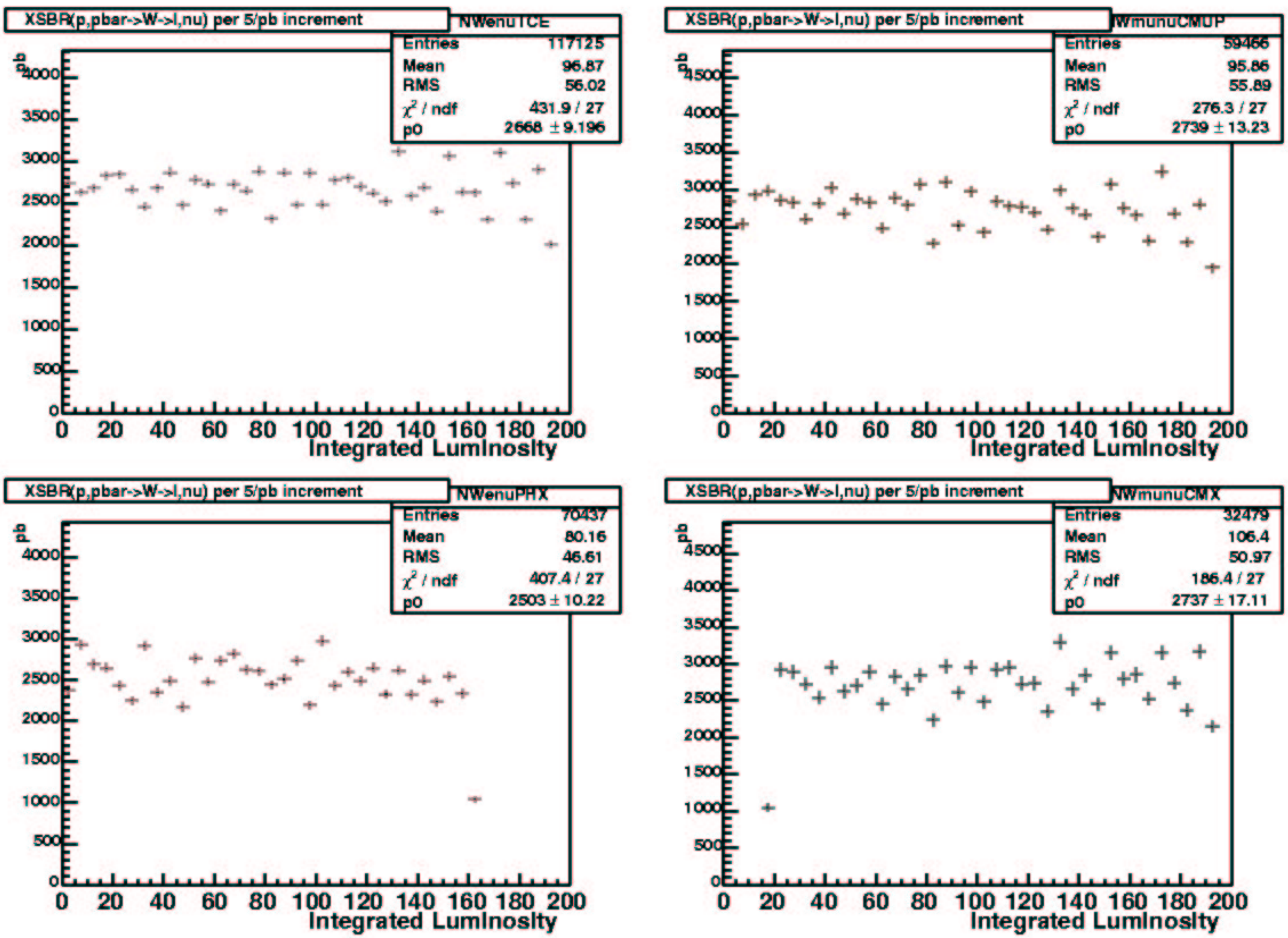
Data Cut Tables

Category	ID	ISO	Conv+Cosm	Z veto	$\not\!\!E_T > 25$ GeV	$\Delta\phi$	0j	OS
TCE-TCE	4227	3620	3455	402	15	7	4	4
TCE-PHX	4982	4452	4327	338	8	7	4	4
PHX-PHX	73	62	62	10	5	3	0	0
$e-e$	9282	8134	7844	750	28	17	8	**8**
TCE-CMUP	30	19	17	17	4	3	1	1
TCE-CMU	7	4	4	4	1	1	0	0
TCE-CMP	11	4	4	4	2	2	1	1
TCE-CMX	24	12	11	11	6	6	2	2
TCE-CMIO	46	16	16	16	3	2	0	0
PHX-CMUP	18	13	13	13	5	5	1	1
PHX-CMU	2	1	1	1	0	0	0	0
PHX-CMP	6	2	2	2	1	1	1	1
PHX-CMX	11	9	9	9	2	1	0	0
PHX-CMIO	23	5	5	5	0	0	0	0
$e-\mu$	178	85	82	82	24	21	6	**6**
CMUP-CMUP	1014	948	948	121	2	2	1	1
CMUP-CMU	429	405	405	41	1	0	0	0
CMUP-CMP	566	517	517	59	5	5	1	1
CMUP-CMX	1151	1079	1079	114	4	3	1	1
CMUP-CMIO	2076	1939	1939	218	4	4	2	2
CMX-CMX	404	363	363	36	1	1	0	0
CMX-CMU	259	249	249	26	0	0	0	0
CMX-CMP	263	243	243	32	0	0	0	0
CMX-CMIO	911	834	834	78	3	1	1	1
$\mu-\mu$	7073	6577	6577	725	20	16	6	**6**
TRILEPTON	8	8	8	4	1	1	1	1

Drell−Yan $\mu^+\mu^-$



W/Z Cross−Section Checks



W/Z Cross−Section Checks