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SDC
SOLENOIDAL DETECTOR NOTES

ACCEPTANCE AND ON-LINE MASS RESOLUTION STUDIES FOR SDC LOI MUON SUBSYSTEM DESIGN

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Acceptance and ON-LINE Mass Resolution Studies for SDC LoI Muon SubSystem Design

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This note summarizes updated results of a repeat of previous SDC muon acceptance and on-line mass resolution studies done by Jim Wiss and myself using the ISAJET V6.24 Monte Carlo event generator, smearing the final state muon momenta with parametrizations of the on-line muon momentum resolution for the central and intermediate region muon systems for the following SSC p-p /s = 40 TeV reactions:

A.) Z0 -> mu+mu-
B.) Z0' -> mu+mu- (Mz' = 200 GeV/c2)
C.) Z0' -> mu+mu- (Mz' = 500 GeV/c2)
D.) ZZ pairs -> 4 muons
E.) Higgs -> ZZ -> 4 muons (M_higgs = 400 GeV/c2)
F.) Higgs -> ZZ -> 4 muons (M_higgs = 800 GeV/c2)

In the present study, via use of his matrix mcs-weighted momentum resolution program, Jim has obtained parametrizations of the on-line muon momentum resolution for the LoI muon system design for the barrel region, and the intermediate region, for both the LoI iron core toroid and LoI air core toroid designs.

For the central region with the barrel toroid, the on-line momentum resolution has been obtained using the combined resolution of the outermost superlayer of the central tracker and the central muon chamber system.

For the intermediate region with an iron core toroid, the on-line momentum resolution has been obtained assuming the iron core toroid to be a stand-alone system.

For the intermediate region with an air core toroid, the on-line momentum resolution has been obtained assuming the air core toroid to be a standalone system.

These results are also applicable for OFF-line SDC performance for high-luminosity (L > 10**34 cm-2 s-1) running where the silicon strip detector and inner layers of the central tracker are essentially inoperative due to the high rates/particle fluxes.

The fractional momentum resolutions dP/P and dPt/Pt vs. eta for different momenta and transverse momenta values are shown in the attached figures for each case of central + ICT/ACT intermediate region muon systems.

```
      Momentum Smearing Code - Barrel Toroid Muons:  |eta_mu| < 1.7
      ==============================================================

      XK     = 1.0/PT
c
      IF (ABS(ETA).LE.1.0) THEN
        AA   = 5.3E-3
      ELSE
        AA   = 5.3E-3*ABS(ETA)
      ENDIF
      BB     = 9.0E-4
      RELCTD = SQRT(AA**2 + (BB*PT)**2)
c
      AA     = 0.16*SQRT(SIN(THETA))
      BB     = 5.45E-5
      RELMU  = SQRT(AA**2 + (BB*PT)**2)
c
      REL    = 1./SQRT(1./RELCTD**2 + 1./RELMU**2)
      XKSM   = XK + (XK*REL*GSS)
c
      PTSM = 1.0/XKSM

      Momentum Smearing Code - ICT/Intermediate Muons:  1.7 < |eta_mu| < 2.5
      ======================================================================

      XK    = 1.0/PT
c
      AA   = 0.110*SQRT(ABS(COS(THETA)))
      BB   = 7.50E-5*COS(THETA)/TAN(THETA)
      REL  = SQRT(AA**2 + (BB*PT)**2)
      XKSM = XK + (XK*REL*GSS)                ! GSS = random gaussian smear
c
      PTSM = 1.0/XKSM

      Momentum Smearing Code - ACT/Intermediate Muons:  1.7 < |eta_mu| < 2.5
      ======================================================================

      XK    = 1.0/PT
c
      AA   = 0.0335*SQRT(ABS(SIN(THETA)))
      BB   = 2.48E-4*COS**2(THETA)
      REL  = SQRT(AA**2 + (BB*PT)**2)
      XKSM = XK + (XK*REL*GSS)                ! GSS = random gaussian smear
c
      PTSM = 1.0/XKSM
```

A.) Z0 -> mu+mu- (100 x 1000 Events)

Sigma*B(Z0 -> mu+mu-) = 3.3 nb => 3.3 Hz @ L = 10**33 cm-2 s-1
=> 0.3*10**8 events for L*dt = 10**40.

Eta-Independent Pt-Acceptance for (Pt_mu1 .OR. Pt_mu2) > 20 GeV/c: 80.3%

Eta Region	Eta-Acceptance (incl. Pt_mu Cut)	Sigma_Mz (GeV/c2)		Mass Resolution (Per-Cent)	
C-C	22.6%	2.36		2.59%	
C-I	12.1%	1.77	5.30	1.95%	5.82%
I-I	3.3%	1.37	7.44	1.50%	8.16%
	38.0%	(ACT)	(ICT)	(ACT)	(ICT)
X-F	42.3%				

B.) Z0' -> mu+mu- (Mz' = 200 GeV/c2) (100 x 1000 Events)

NB: Mz' > 380 GeV/c2 @ 95% CL for SM couplings from CDF DY/Z e+e- data.

Sigma*B(Z0' -> mu+mu-) = 143.7 pb => 0.14 Hz @ L = 10**33 cm-2 s-1
=> 1.4*10**6 events for L*dt = 10**40.

Eta-Independent Pt-Acceptance for (Pt_mu1 .OR. Pt_mu2) > 20 GeV/c: 96.1%

Eta Region	Eta-Acceptance (incl. Pt_mu Cut)	Sigma_Mz (GeV/c2)		Mass Resolution (Per-Cent)	
C-C	25.0%	10.19		5.10%	
C-I	16.8%	6.49	12.71	3.24%	6.36%
I-I	4.4%	3.91	15.51	1.96%	7.76%
	46.2%	(ACT)	(ICT)	(ACT)	(ICT)
X-F	49.9%				

C.) Z0' -> mu+mu- (Mz' = 500 GeV/c2) (100 x 1000 Events)

Sigma*B(Z0' -> mu+mu-) = 0.7 pb => 7.0*10**-4 Hz @ L = 10**33 cm-2 s-1
=> 7000 events for L*dt = 10**40.

Eta-Independent Pt-Acceptance for (Pt_mu1 .OR. Pt_mu2) > 20 GeV/c: 98.6%

Eta Region	Eta-Acceptance (incl. Pt_mu Cut)	Sigma_Mz (GeV/c2)		Mass Resolution (Per-Cent)	
C-C	34.9%	37.58		7.52%	
C-I	20.9%	30.51	37.92	6.10%	7.58%
I-I	4.3%	23.21	39.34	4.64%	7.87%
	60.1%	(ACT)	(ICT)	(ACT)	(ICT)
X-F	38.5%				

NB: X-F = C-F + I-F + F-F

D.) ZZ Pairs -> 2(mu+mu-) (100 x 1000 Events)

Sigma*B(ZZ -> 2(mu+mu-)) = 25 fb => 25*10**-6 Hz @ L=10**33 cm-2 s-1
=> 250 events for L*dt = 10**40.

Eta-Independent Pt-Acceptance:

2 or more muons w/ Pt_mu > 20 GeV/c: 99.1%

Eta Region	Eta-Acceptance (incl. Pt_mu Cut)	Sigma_Mz (GeV/c2)		Mass Resolution (Per-Cent)	
C-C + C-C	13.0%	2.98		3.27%	
C-C + C-I	14.0%	2.62	4.19	2.87%	4.60%
C-I + C-I	2.3%	2.70	5.60	2.96%	6.15%
C-C + I-I	1.8%	2.51	4.87	2.75%	5.34%
C-I + I-I	0.8%	2.35	6.41	2.57%	7.03%
I-I + I-I	0.2%	1.68	7.11	1.85%	7.79%
	32.1%	(ACT)	(ICT)	(ACT)	(ICT)
X-Y + X-F	67.0%				

Eta Region	Sigma_Mzz (GeV/c2)		Mass Resolution (Per-Cent)	
C-C + C-C	9.43		3.49%	
C-C + C-I	8.12	12.17	3.01%	4.51%
C-I + C-I	9.51	15.76	3.52%	5.84%
C-C + I-I	11.21	17.87	4.15%	6.62%
C-I + I-I	8.77	15.34	3.25%	5.68%
I-I + I-I	5.15	18.68	1.91%	6.92%
	(ACT)	(ICT)	(ACT)	(ICT)

<M_zz> ~ 270 GeV/c2

NB: X-Y = C-C + C-I + C-F + I-I + I-F + F-F
X-F = C-F + I-F + F-F

E.) Higgs -> ZZ Pairs -> 4 mu (M_Higgs = 400 GeV/c2) (100 x 1000 Events)

Sigma*B(Higgs->ZZ-> 4mu) = 8.8 fb => 8.8*10**-6 Hz @ L=10**33 cm-2 s-1
=> 88 events for L*dt = 10**40.

Eta-Independent Pt-Acceptance:

2 or more muons w/ Pt_mu > 20 GeV/c: 99.6%

Eta Region	Eta-Acceptance (incl. Pt_mu Cut)	Sigma_Mz (GeV/c2)		Mass Resolution (Per-Cent)	
C-C + C-C	24.2%	4.55		4.99%	
C-C + C-I	16.5%	3.94	5.32	4.32%	5.83%
C-I + C-I	3.0%	3.13	5.90	3.44%	6.47%
C-C + I-I	3.7%	2.96	5.48	3.25%	6.01%
C-I + I-I	1.6%	2.99	6.90	3.28%	7.57%
I-I + I-I	0.0%	-	-	-	-
	49.0%	(ACT)	(ICT)	(ACT)	(ICT)
X-Y + X-F	50.6%				

Eta Region	Sigma_Mhiggs (GeV/c2)		Mass Resolution (Per-Cent)	
C-C + C-C	17.27		4.46%	
C-C + C-I	15.65	19.14	3.91%	4.79%
C-I + C-I	11.32	20.21	2.83%	5.05%
C-C + I-I	11.92	19.63	2.98%	4.91%
C-I + I-I	13.35	23.99	3.34%	6.00%
I-I + I-I	-	-	-	-
	(ACT)	(ICT)	(ACT)	(ICT)

NB: X-Y = C-C + C-I + C-F + I-I + I-F + F-F
X-F = C-F + I-F + F-F

F.) Higgs -> ZZ Pairs -> 4 mu (M_Higgs = 800 GeV/c2) (100 x 1000 Events

Sigma*B(Higgs->ZZ-> 4mu) = 1.5 fb => 1.5*10**-6 Hz @ L=10**33 cm-2 s-1
=> 15 events for L*dt = 10**40.

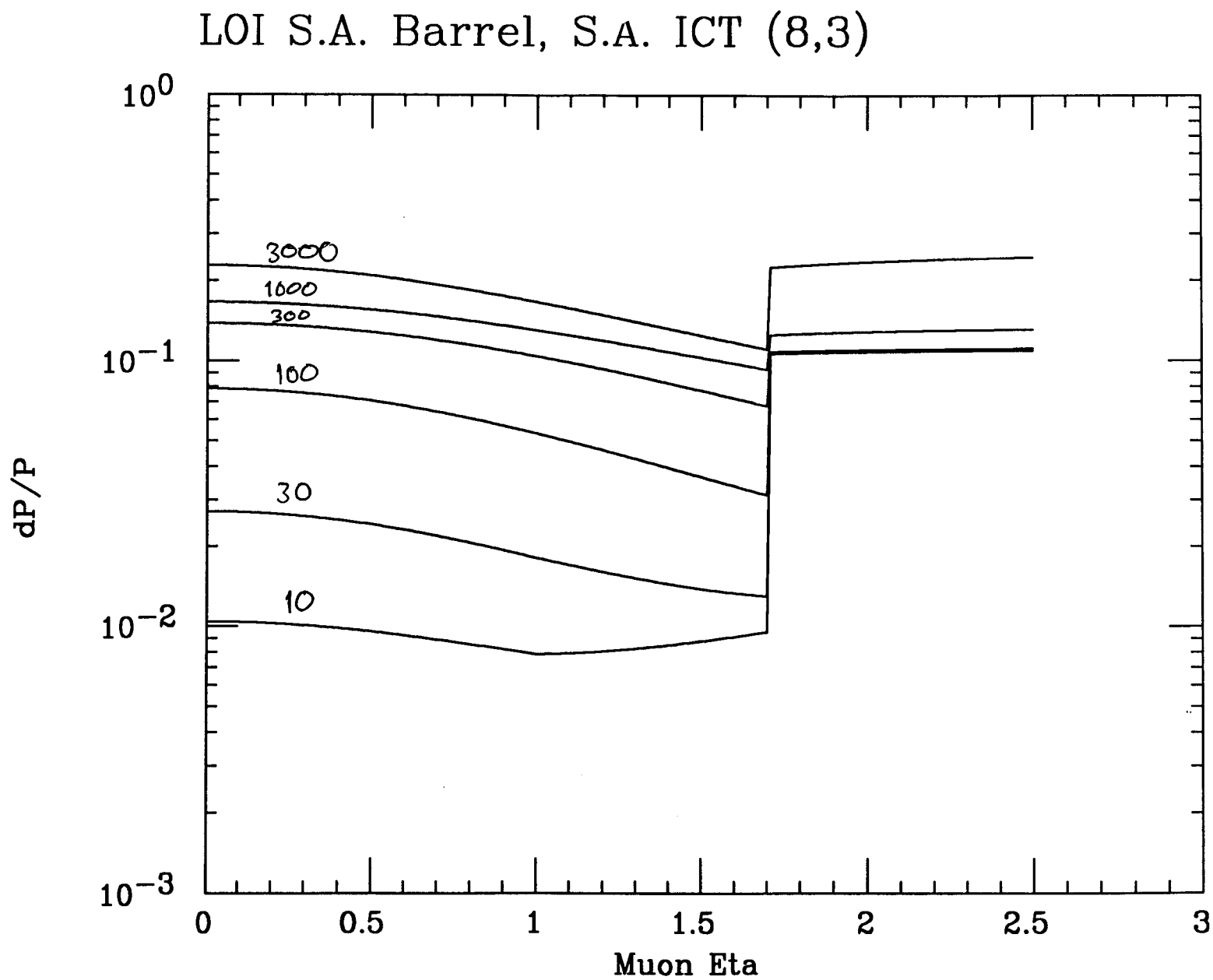
Eta-Independent Pt-Acceptance:

2 or more muons w/ Pt_mu > 20 GeV/c: 98.9%

Eta Region	Eta-Acceptance (incl. Pt_mu Cut)	Sigma_Mz (GeV/c2)		Mass Resolution (Per-Cent)	
C-C + C-C	24.2%	8.20		9.00%	
C-C + C-I	18.5%	6.92	8.57	7.59%	9.40%
C-I + C-I	1.5%	5.45	8.52	5.98%	9.35%
C-C + I-I	6.5%	5.57	8.35	6.11%	9.16%
C-I + I-I	2.3%	4.84	9.26	5.30%	10.16%
I-I + I-I	1.0%	3.54	9.36	3.88%	10.27%
	54.0%	(ACT)	(ICT)	(ACT)	(ICT)
X-Y + X-F	44.9%				

Eta Region	Sigma_Mhiggs (GeV/c2)		Mass Resolution (Per-Cent)	
C-C + C-C	41.52		5.19%	
C-C + C-I	36.26	39.46	4.53%	4.93%
C-I + C-I	29.66	38.59	3.71%	4.82%
C-C + I-I	35.10	42.76	4.39%	5.35%
C-I + I-I	27.71	40.51	3.46%	5.06%
I-I + I-I	25.57	42.82	3.20%	5.35%
	(ACT)	(ICT)	(ACT)	(ICT)

NB: X-Y = C-C + C-I + C-F + I-I + I-F + F-F
X-F = C-F + I-F + F-F


LOI S.A. Barrel, S.A. ICT (8,3)
10^0
10^{-1}
10^{-2}
10^{-3}
dP/P
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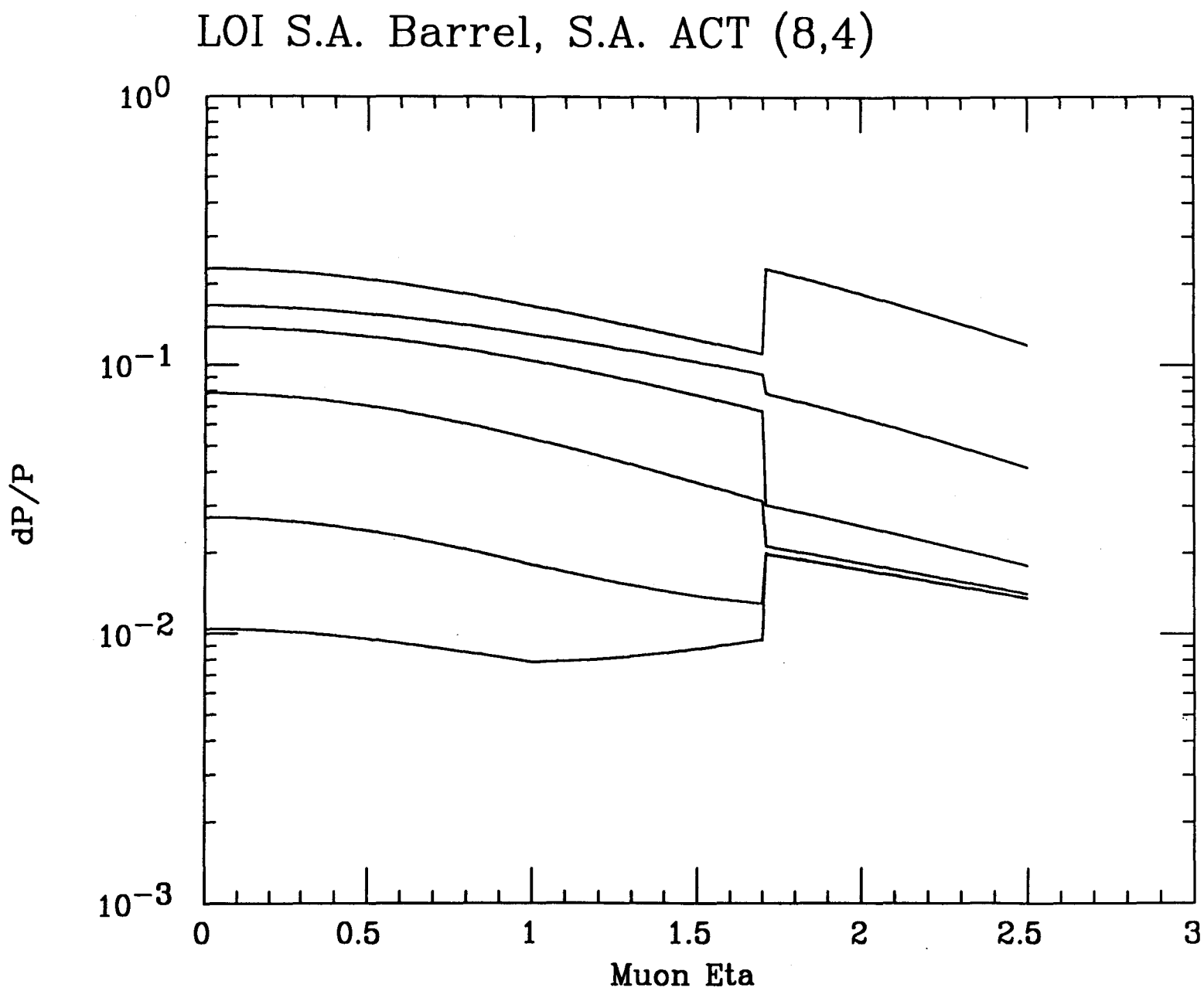
1000
300
100
30
10
0
0.5
1
1.5
2
2.5
3
Muon Eta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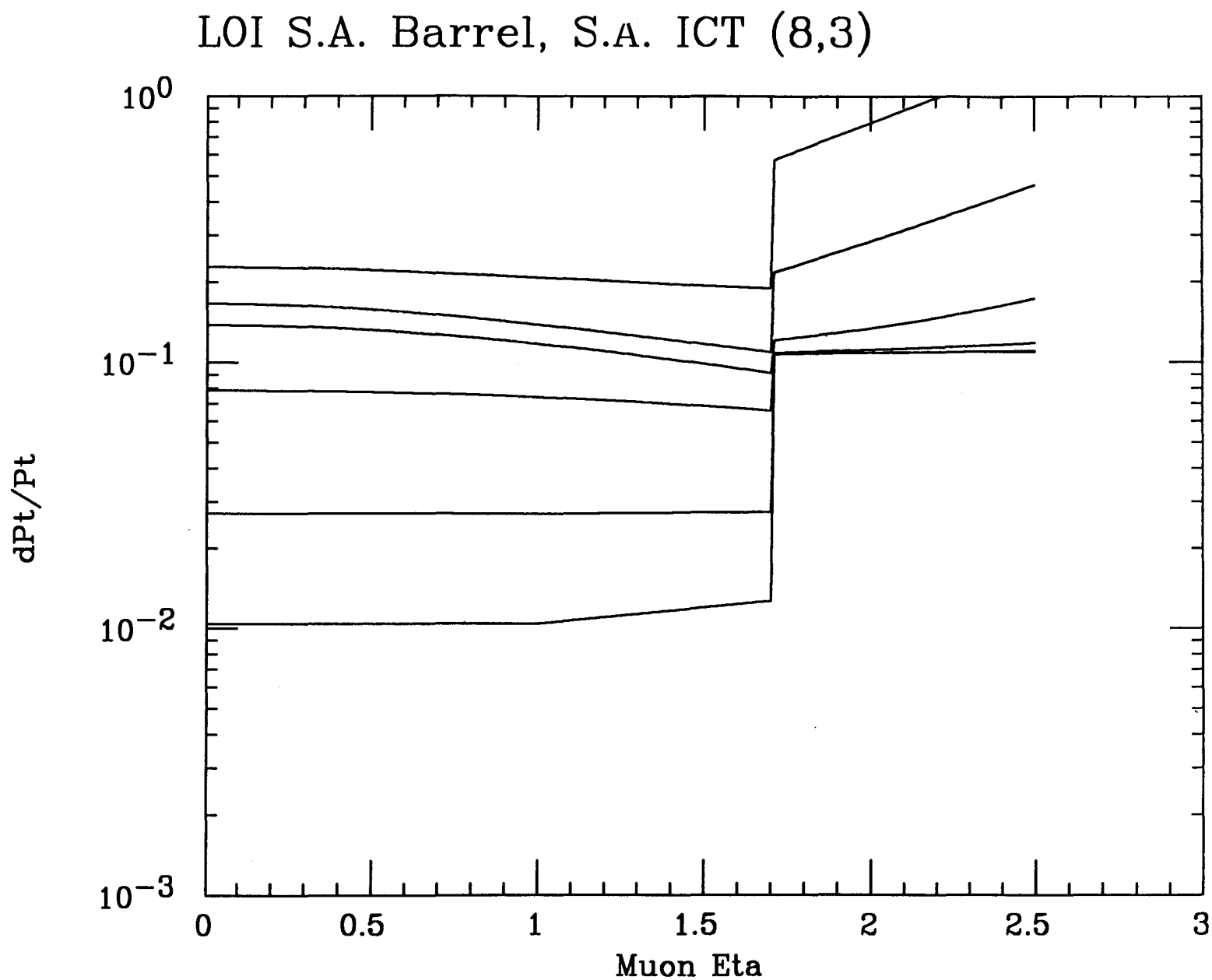
10^0
10^{-1}
10^{-2}
10^{-3}
dP/P
0
0.5
1
1.5
2
2.5
3
Muon Eta


LOI S.A. Barrel, S.A. ICT (8,3)
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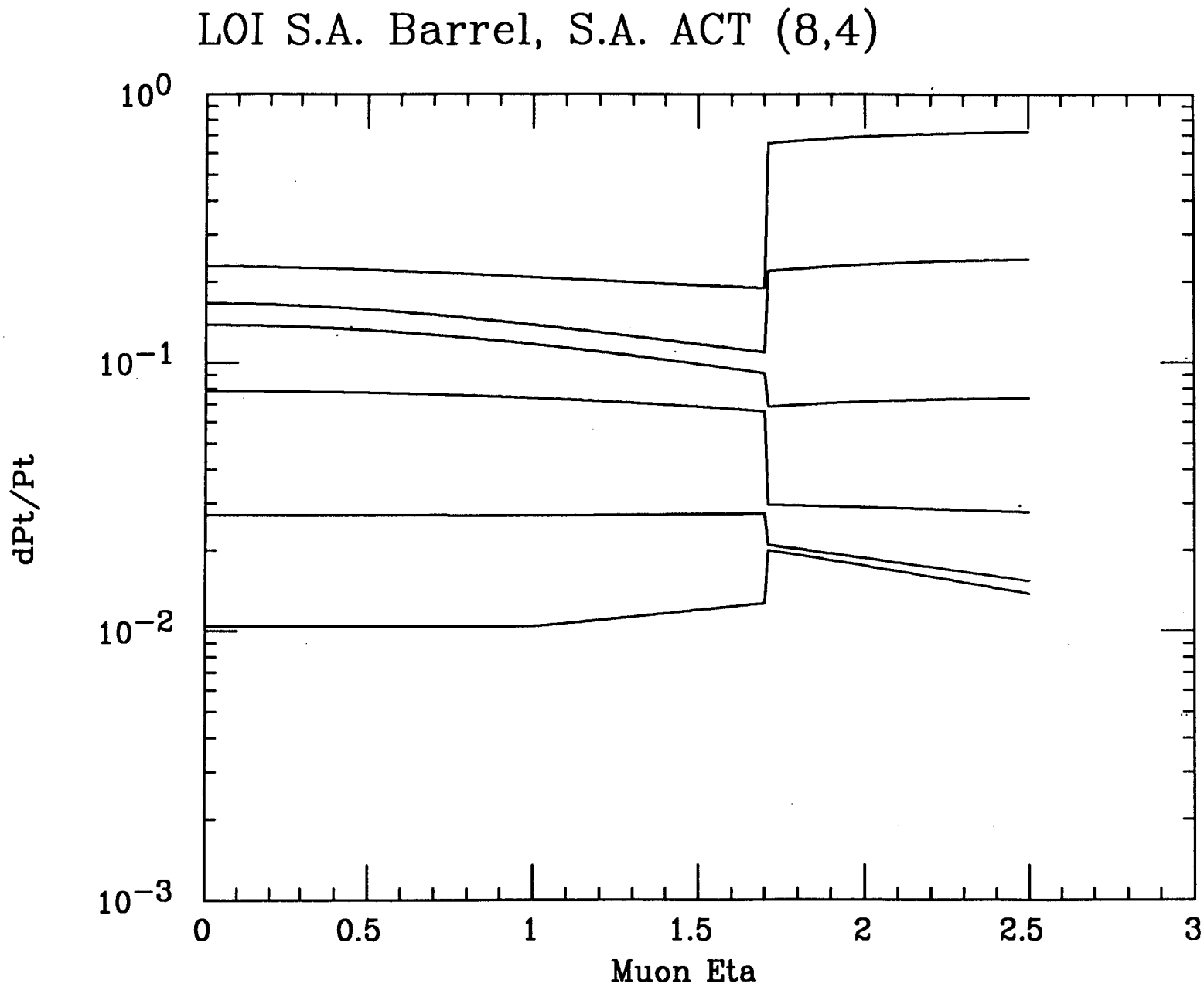
10^{-2}
10^{-3}
dPt/Pt
0
0.5
1
1.5
2
2.5
3
Muon Eta


LOI S.A. Barrel, S.A. ACT (8,4)
10^0
10^{-1}
10^{-2}
10^{-3}
dPt/Pt
0
0.5
1
1.5
2
2.5
3
Muon Eta