EIC Simulation Updates

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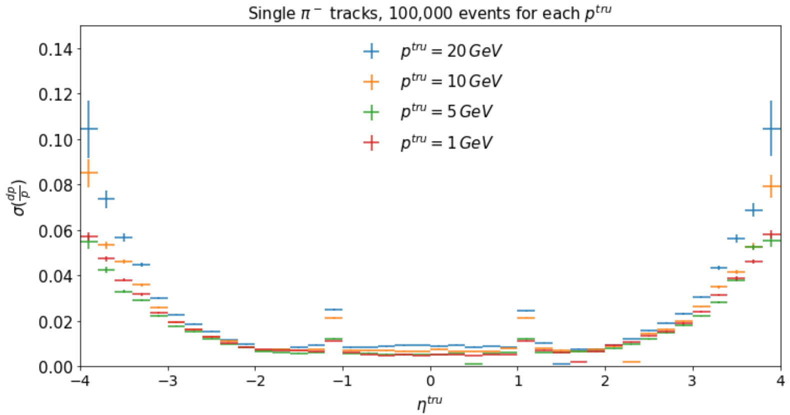
Parameters

- Single π^- going through all Si detector
- 100,000 events for each p_{truth} value: $p = 1, 5, 10, 20$ GeV
- $-5.0 < \eta < 5.0$, full ϕ coverage

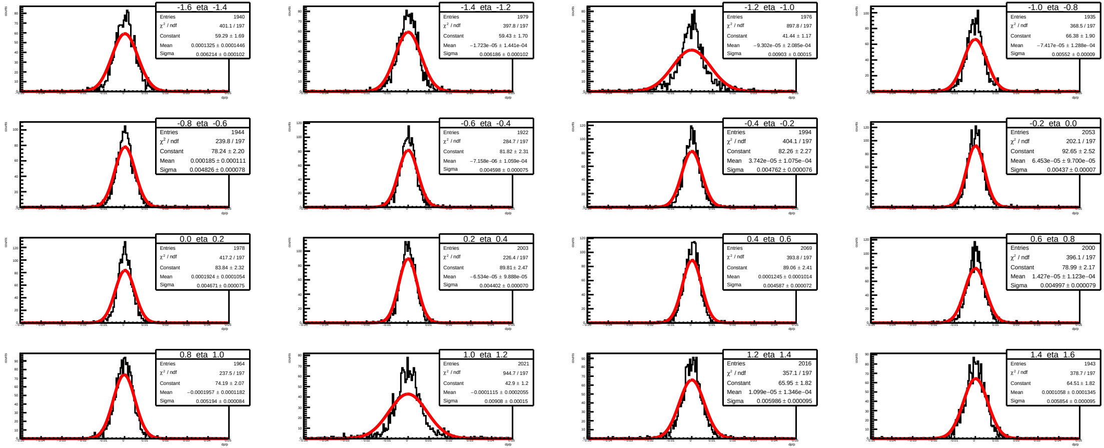
$\sigma(\frac{dp}{p})$ vs η

- Single Gaussian fit for each bin. But how well does the Gaussian fit?
- Very low values come from errors due to fitting. I tried to set initial conditions for the fit parameters, but that led to divergence in different η bins.



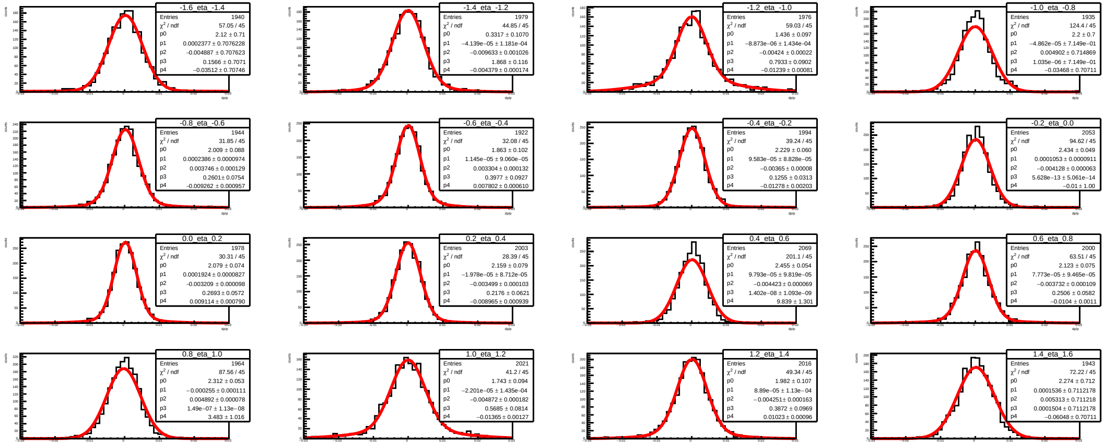
1 GeV: Single Gaussian

- In $-1.2 < \eta < -1.0$ and $1.0 < \eta < 1.2$, the distributions have long tails.
- We could try narrowing the x range and fit a sum of two Gaussians.

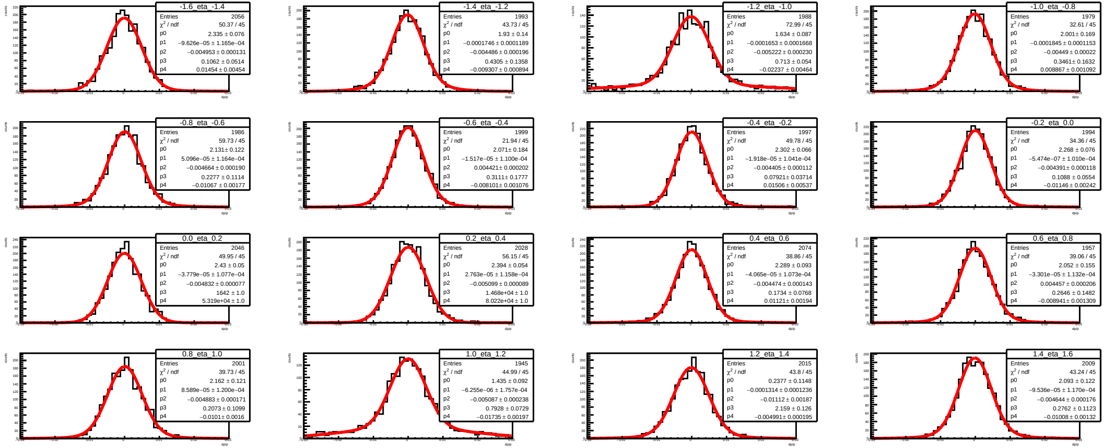


1 GeV: $f(x) = \frac{p_0}{\sqrt{2\pi p_2^2}} \exp\left(\left(-\frac{1}{2}\right)\left(\frac{x-p_1}{p_2}\right)^2\right) + \frac{p_3}{\sqrt{2\pi p_4^2}} \exp\left(\left(-\frac{1}{2}\right)\left(\frac{x-p_1}{p_4}\right)^2\right)$

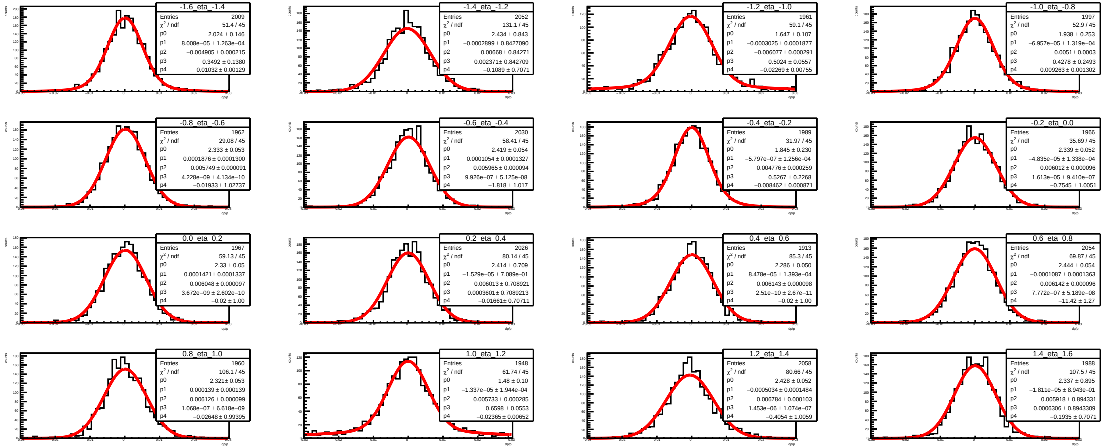
- Still divergent for some cases. I generated these plots in one batch. For each initial condition, e.g., $p_2 = p_4 = 0.01$, there could be a few η bins divergent, but with $p_2 = p_4 = 0.015$, some other bins become divergent.



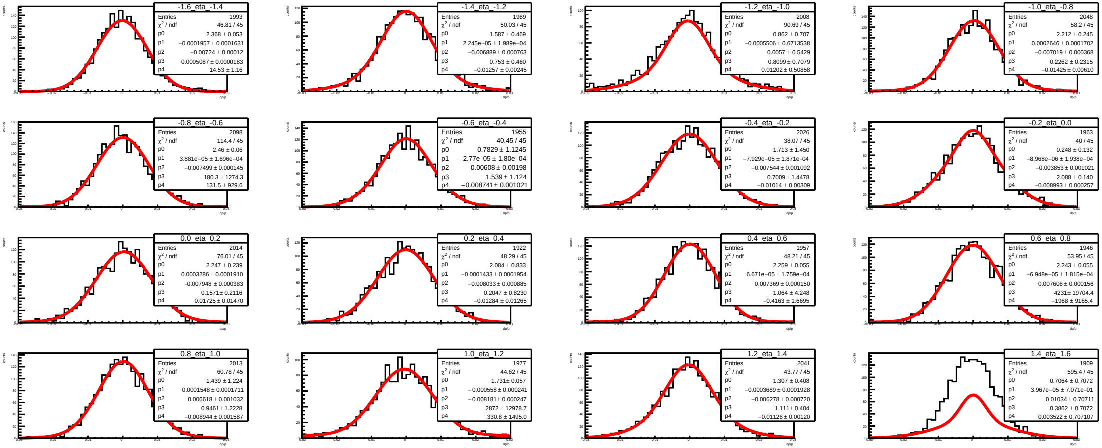
5 GeV: $f(x) = \frac{p_0}{\sqrt{2\pi p_2^2}} \exp\left(\left(-\frac{1}{2}\right)\left(\frac{x-p_1}{p_2}\right)^2\right) + \frac{p_3}{\sqrt{2\pi p_4^2}} \exp\left(\left(-\frac{1}{2}\right)\left(\frac{x-p_1}{p_4}\right)^2\right)$



10 GeV: $f(x) = \frac{p_0}{\sqrt{2\pi p_2^2}} \exp\left(\left(-\frac{1}{2}\right)\left(\frac{x-p_1}{p_2}\right)^2\right) + \frac{p_3}{\sqrt{2\pi p_4^2}} \exp\left(\left(-\frac{1}{2}\right)\left(\frac{x-p_1}{p_4}\right)^2\right)$



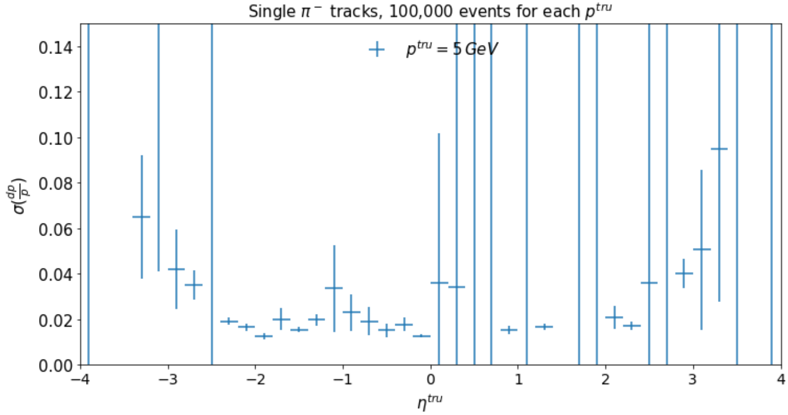
20 GeV: $f(x) = \frac{p_0}{\sqrt{2\pi p_2^2}} \exp((-\frac{1}{2})(\frac{x-p_1}{p_2})^2) + \frac{p_3}{\sqrt{2\pi p_4^2}} \exp((-\frac{1}{2})(\frac{x-p_1}{p_4})^2)$



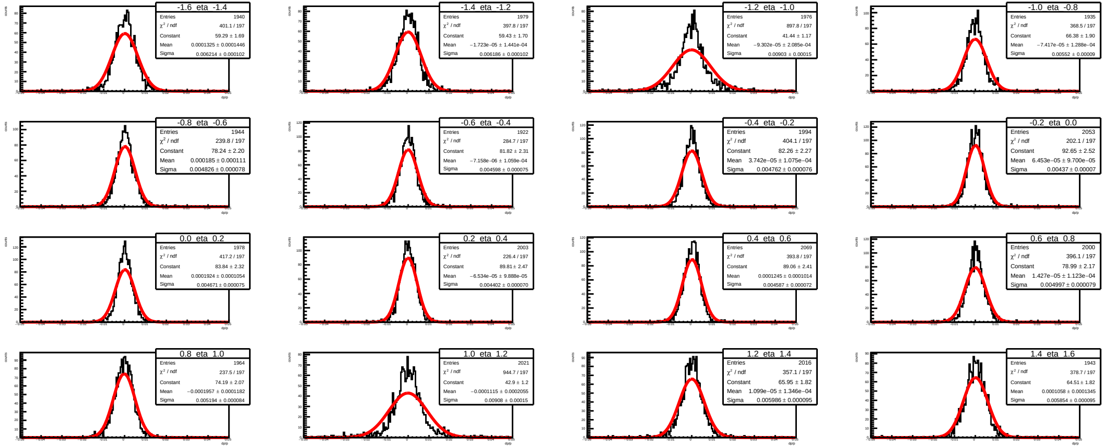
Backup / worse plots

Original plan for $\sigma(\frac{dp}{p})$ vs η

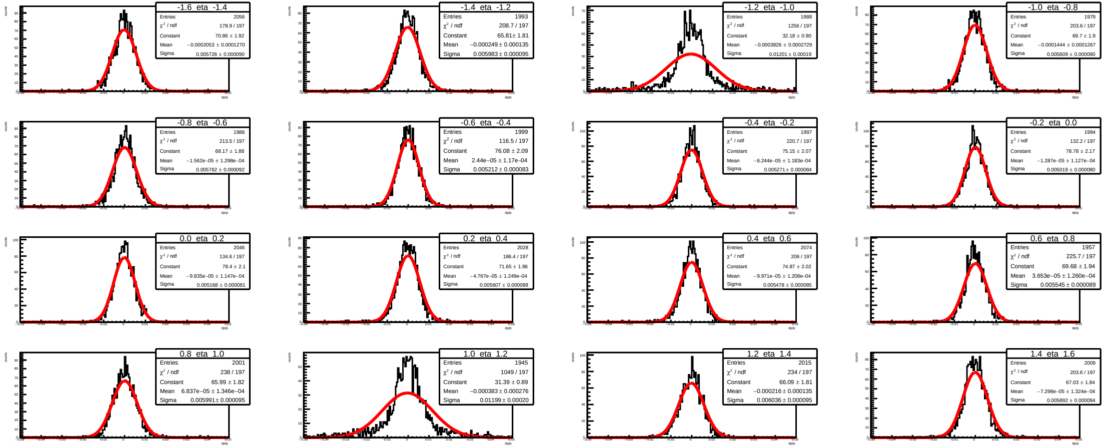
- Fit each η bin with $\frac{p_0}{\sqrt{2\pi p_2^2}} \exp(-\frac{(x-p_1)^2}{2p_2}) + \frac{p_3}{\sqrt{2\pi p_4^2}} \exp(-\frac{(x-p_1)^2}{2p_4})$. Take $\sigma = \frac{|p2|+|p4|}{2}$ (where horizontal bars are), and error on $\sigma = \sqrt{\sigma_{p_2}^2 + \sigma_{p_4}^2}$ (vertical bars). (I am not too sure about this ...)



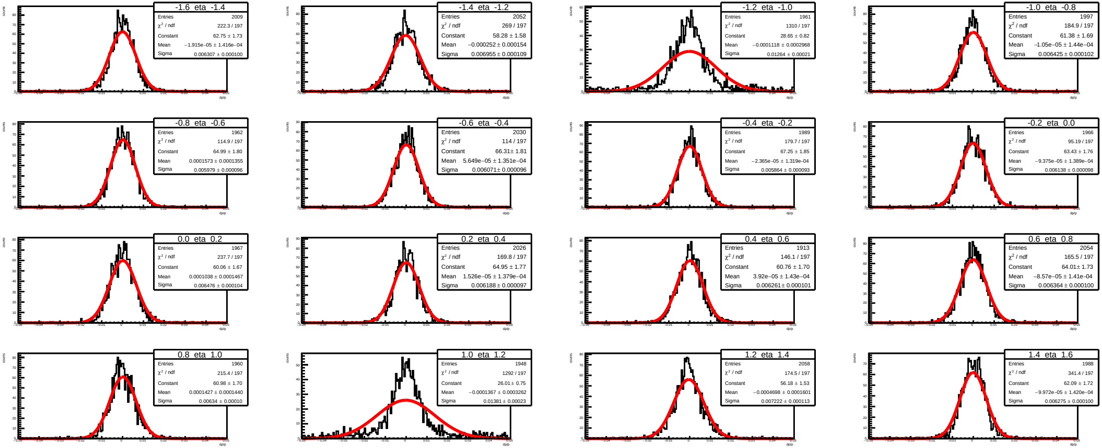
1 GeV


-1.6 eta -1.4
Entries 1940
χ² / ndf 401.1 / 197
Constant 59.29 ± 1.69
Mean 0.0001325 ± 0.0001446
Sigma 0.006214 ± 0.000102
-1.4 eta -1.2
Entries 1979
χ² / ndf 397.8 / 197
Constant 59.43 ± 1.70
Mean −1.723e−05 ± 1.441e−04
Sigma 0.006186 ± 0.000102
-1.2 eta -1.0
Entries 1976
χ² / ndf 897.8 / 197
Constant 41.44 ± 1.17
Mean −9.302e−05 ± 2.085e−04
Sigma 0.00903 ± 0.00015
-1.0 eta -0.8
Entries 1935
χ² / ndf 368.5 / 197
Constant 66.38 ± 1.90
Mean −7.417e−05 ± 1.288e−04
Sigma 0.00552 ± 0.00009
-0.8 eta -0.6
Entries 1944
χ² / ndf 239.8 / 197
Constant 78.24 ± 2.20
Mean 0.000185 ± 0.000111
Sigma 0.004826 ± 0.000078
-0.6 eta -0.4
Entries 1922
χ² / ndf 284.7 / 197
Constant 81.82 ± 2.31
Mean −7.158e−06 ± 1.059e−04
Sigma 0.004598 ± 0.000075
-0.4 eta -0.2
Entries 1994
χ² / ndf 404.1 / 197
Constant 82.26 ± 2.27
Mean 3.742e−05 ± 1.075e−04
Sigma 0.004762 ± 0.000076
-0.2 eta 0.0
Entries 2053
χ² / ndf 202.1 / 197
Constant 92.65 ± 2.52
Mean 6.453e−05 ± 9.700e−05
Sigma 0.00437 ± 0.00007
0.0 eta 0.2
Entries 1978
χ² / ndf 417.2 / 197
Constant 83.84 ± 2.32
Mean 0.0001924 ± 0.0001054
Sigma 0.004671 ± 0.000075
0.2 eta 0.4
Entries 2003
χ² / ndf 226.4 / 197
Constant 89.81 ± 2.47
Mean −6.534e−05 ± 9.888e−05
Sigma 0.004402 ± 0.000070
0.4 eta 0.6
Entries 2069
χ² / ndf 393.8 / 197
Constant 89.06 ± 2.41
Mean 0.0001245 ± 0.0001014
Sigma 0.004587 ± 0.000072
0.6 eta 0.8
Entries 2000
χ² / ndf 396.1 / 197
Constant 78.99 ± 2.17
Mean 1.427e−05 ± 1.123e−04
Sigma 0.004997 ± 0.000079
0.8 eta 1.0
Entries 1964
χ² / ndf 237.5 / 197
Constant 74.19 ± 2.07
Mean −0.0001957 ± 0.0001182
Sigma 0.005194 ± 0.000084
1.0 eta 1.2
Entries 2021
χ² / ndf 944.7 / 197
Constant 42.9 ± 1.2
Mean −0.0001115 ± 0.0002055
Sigma 0.00908 ± 0.00015
1.2 eta 1.4
Entries 2016
χ² / ndf 357.1 / 197
Constant 65.95 ± 1.82
Mean 1.099e−05 ± 1.346e−04
Sigma 0.005986 ± 0.000095
1.4 eta 1.6
Entries 1943
χ² / ndf 378.7 / 197
Constant 64.51 ± 1.82
Mean 0.0001058 ± 0.0001345
Sigma 0.005854 ± 0.000095

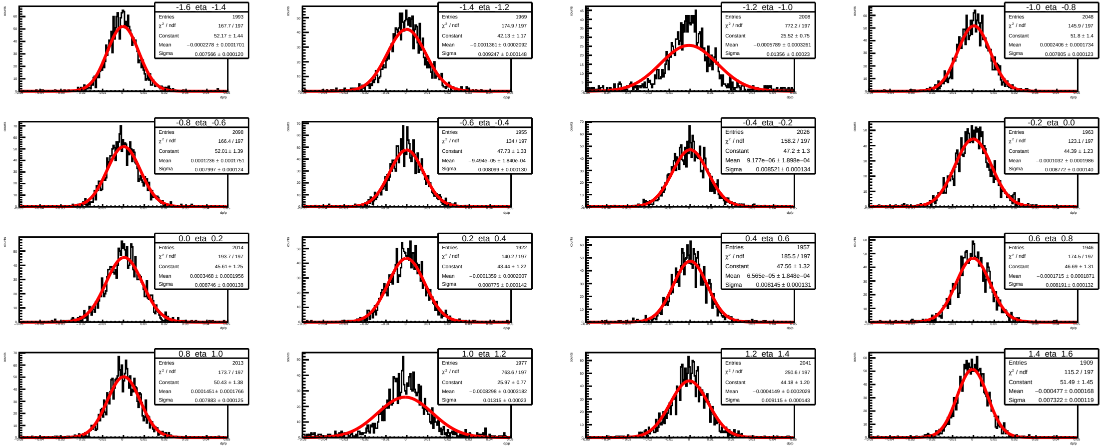
5 GeV


-1.6 eta -1.4
Entries 2056
χ² / ndf 178.9 / 197
Constant 70.86 ± 1.92
Mean −0.0002053 ± 0.0001270
Sigma 0.005726 ± 0.000090
-1.4 eta -1.2
Entries 1993
χ² / ndf 208.7 / 197
Constant 65.81± 1.81
Mean −0.000249 ± 0.000135
Sigma 0.005983 ± 0.000095
-1.2 eta -1.0
Entries 1988
χ² / ndf 1256 / 197
Constant 32.18 ± 0.90
Mean −0.0003826 ± 0.0002729
Sigma 0.01201 ± 0.00019
-1.0 eta -0.8
Entries 1979
χ² / ndf 203.6 / 197
Constant 69.7 ± 1.9
Mean −0.0001444 ± 0.0001267
Sigma 0.005609 ± 0.000090
-0.8 eta -0.6
Entries 1986
χ² / ndf 213.5 / 197
Constant 68.17 ± 1.88
Mean −1.562e−05 ± 1.298e−04
Sigma 0.005762 ± 0.000092
-0.6 eta -0.4
Entries 1999
χ² / ndf 116.5 / 197
Constant 76.08 ± 2.09
Mean 2.44e−05 ± 1.17e−04
Sigma 0.005212 ± 0.000083
-0.4 eta -0.2
Entries 1997
χ² / ndf 220.7 / 197
Constant 75.15 ± 2.07
Mean −6.244e−05 ± 1.183e−04
Sigma 0.005271 ± 0.000084
-0.2 eta 0.0
Entries 1994
χ² / ndf 132.2 / 197
Constant 78.78 ± 2.17
Mean −1.287e−05 ± 1.127e−04
Sigma 0.005019 ± 0.000080
0.0 eta 0.2
Entries 2046
χ² / ndf 134.6 / 197
Constant 78.4 ± 2.1
Mean −9.835e−05 ± 1.147e−04
Sigma 0.005168 ± 0.000081
0.2 eta 0.4
Entries 2028
χ² / ndf 186.4 / 197
Constant 71.65 ± 1.96
Mean −4.767e−05 ± 1.249e−04
Sigma 0.005607 ± 0.000088
0.4 eta 0.6
Entries 2074
χ² / ndf 206 / 197
Constant 74.87 ± 2.02
Mean −9.971e−05 ± 1.208e−04
Sigma 0.005478 ± 0.000085
0.6 eta 0.8
Entries 1957
χ² / ndf 225.7 / 197
Constant 69.68 ± 1.94
Mean 3.653e−05 ± 1.260e−04
Sigma 0.005545 ± 0.000089
0.8 eta 1.0
Entries 2001
χ² / ndf 238 / 197
Constant 65.99 ± 1.82
Mean 6.837e−05 ± 1.346e−04
Sigma 0.005991 ± 0.000095
1.0 eta 1.2
Entries 1945
χ² / ndf 1049 / 197
Constant 31.39 ± 0.89
Mean −0.000383 ± 0.000276
Sigma 0.01199 ± 0.00020
1.2 eta 1.4
Entries 2015
χ² / ndf 234 / 197
Constant 66.09 ± 1.81
Mean −0.000216 ± 0.000135
Sigma 0.006036 ± 0.000095
1.4 eta 1.6
Entries 2009
χ² / ndf 203.6 / 197
Constant 67.03 ± 1.84
Mean −7.298e−05 ± 1.324e−04
Sigma 0.005892 ± 0.000094
counts
dp/p

10 GeV


-1.6 eta -1.4
Entries 2009
χ^2 / ndf 222.3 / 197
Constant 62.75 ± 1.73
Mean −1.915e−05 ± 1.416e−04
Sigma 0.006307 ± 0.000100
-1.4 eta -1.2
Entries 2052
χ^2 / ndf 269 / 197
Constant 58.28 ± 1.58
Mean −0.000252 ± 0.000154
Sigma 0.006955 ± 0.000109
-1.2 eta -1.0
Entries 1961
χ^2 / ndf 1310 / 197
Constant 28.65 ± 0.82
Mean −0.0001118 ± 0.0002968
Sigma 0.01264 ± 0.00021
-1.0 eta -0.8
Entries 1997
χ^2 / ndf 184.9 / 197
Constant 61.38 ± 1.69
Mean −1.05e−05 ± 1.44e−04
Sigma 0.006425 ± 0.000102
-0.8 eta -0.6
Entries 1962
χ^2 / ndf 114.9 / 197
Constant 64.99 ± 1.80
Mean 0.0001573 ± 0.0001355
Sigma 0.005979 ± 0.000096
-0.6 eta -0.4
Entries 2030
χ^2 / ndf 114 / 197
Constant 66.31 ± 1.81
Mean 5.649e−05 ± 1.351e−04
Sigma 0.006071 ± 0.000096
-0.4 eta -0.2
Entries 1989
χ^2 / ndf 179.7 / 197
Constant 67.25 ± 1.85
Mean −2.365e−05 ± 1.319e−04
Sigma 0.005864 ± 0.000093
-0.2 eta 0.0
Entries 1966
χ^2 / ndf 95.19 / 197
Constant 63.43 ± 1.76
Mean −9.375e−05 ± 1.389e−04
Sigma 0.006138 ± 0.000098
0.0 eta 0.2
Entries 1967
χ^2 / ndf 237.7 / 197
Constant 60.06 ± 1.67
Mean 0.0001038 ± 0.0001467
Sigma 0.006476 ± 0.000104
0.2 eta 0.4
Entries 2026
χ^2 / ndf 169.8 / 197
Constant 64.95 ± 1.77
Mean 1.526e−05 ± 1.379e−04
Sigma 0.006188 ± 0.000097
0.4 eta 0.6
Entries 1913
χ^2 / ndf 146.1 / 197
Constant 60.76 ± 1.70
Mean 3.92e−05 ± 1.43e−04
Sigma 0.006261 ± 0.000101
0.6 eta 0.8
Entries 2054
χ^2 / ndf 165.5 / 197
Constant 64.01 ± 1.73
Mean −8.57e−05 ± 1.41e−04
Sigma 0.006364 ± 0.000100
0.8 eta 1.0
Entries 1960
χ^2 / ndf 215.4 / 197
Constant 60.98 ± 1.70
Mean 0.0001427 ± 0.0001440
Sigma 0.00634 ± 0.00010
1.0 eta 1.2
Entries 1948
χ^2 / ndf 1292 / 197
Constant 26.01 ± 0.75
Mean −0.0001367 ± 0.0003262
Sigma 0.01381 ± 0.00023
1.2 eta 1.4
Entries 2058
χ^2 / ndf 174.5 / 197
Constant 56.18 ± 1.53
Mean −0.0004698 ± 0.0001601
Sigma 0.007222 ± 0.000113
1.4 eta 1.6
Entries 1988
χ^2 / ndf 341.4 / 197
Constant 62.09 ± 1.72
Mean −9.972e−05 ± 1.420e−04
Sigma 0.006275 ± 0.000100

20 GeV



-1.6 eta -1.4
Entries 1993
χ^2 / ndf 167.7 / 197
Constant 52.17 ± 1.44
Mean −0.0002278 ± 0.0001701
Sigma 0.007566 ± 0.000120
-1.4 eta -1.2
Entries 1969
χ^2 / ndf 174.9 / 197
Constant 42.13 ± 1.17
Mean −0.0001361 ± 0.0002092
Sigma 0.009247 ± 0.000148
-1.2 eta -1.0
Entries 2008
χ^2 / ndf 772.2 / 197
Constant 25.52 ± 0.75
Mean −0.0005789 ± 0.0003261
Sigma 0.01356 ± 0.00023
-1.0 eta -0.8
Entries 2048
χ^2 / ndf 145.9 / 197
Constant 51.8 ± 1.4
Mean 0.0002406 ± 0.0001734
Sigma 0.007805 ± 0.000123
-0.8 eta -0.6
Entries 2098
χ^2 / ndf 166.4 / 197
Constant 52.01 ± 1.39
Mean 0.0001236 ± 0.0001751
Sigma 0.007997 ± 0.000124
-0.6 eta -0.4
Entries 1955
χ^2 / ndf 134 / 197
Constant 47.73 ± 1.33
Mean −9.494e−05 ± 1.840e−04
Sigma 0.008099 ± 0.000130
-0.4 eta -0.2
Entries 2026
χ^2 / ndf 158.2 / 197
Constant 47.2 ± 1.3
Mean 9.177e−06 ± 1.898e−04
Sigma 0.008521 ± 0.000134
-0.2 eta 0.0
Entries 1963
χ^2 / ndf 123.1 / 197
Constant 44.39 ± 1.23
Mean −0.0001032 ± 0.0001986
Sigma 0.008772 ± 0.000140
0.0 eta 0.2
Entries 2014
χ^2 / ndf 193.7 / 197
Constant 45.61 ± 1.25
Mean 0.0003468 ± 0.0001956
Sigma 0.008746 ± 0.000138
0.2 eta 0.4
Entries 1922
χ^2 / ndf 140.2 / 197
Constant 43.44 ± 1.22
Mean −0.0001359 ± 0.0002007
Sigma 0.008775 ± 0.000142
0.4 eta 0.6
Entries 1957
χ^2 / ndf 185.5 / 197
Constant 47.56 ± 1.32
Mean 6.565e−05 ± 1.848e−04
Sigma 0.008145 ± 0.000131
0.6 eta 0.8
Entries 1946
χ^2 / ndf 174.5 / 197
Constant 46.69 ± 1.31
Mean −0.0001715 ± 0.0001871
Sigma 0.008191 ± 0.000132
0.8 eta 1.0
Entries 2013
χ^2 / ndf 173.7 / 197
Constant 50.43 ± 1.38
Mean 0.0001451 ± 0.0001766
Sigma 0.007883 ± 0.000125
1.0 eta 1.2
Entries 1977
χ^2 / ndf 763.6 / 197
Constant 25.97 ± 0.77
Mean −0.0008298 ± 0.0003182
Sigma 0.01315 ± 0.00023
1.2 eta 1.4
Entries 2041
χ^2 / ndf 250.6 / 197
Constant 44.18 ± 1.20
Mean −0.0004149 ± 0.0002029
Sigma 0.009115 ± 0.000143
1.4 eta 1.6
Entries 1909
χ^2 / ndf 115.2 / 197
Constant 51.49 ± 1.45
Mean −0.000477 ± 0.000168
Sigma 0.007322 ± 0.000119