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Event generators for two charged and neutral pions production in proton-antiproton annihilation

Saro Ong* **and Jacques Van de Wiele**

Intitut de Physique Nucléaire, CNRS/IN2P3, Université Paris-Sud, F-91406 Orsay Cedex, France
* Also Université de Picardie Jules Verne, F-80000 Amiens, France

1 Motivations

The backgrounds study of the interesting channel $p\bar{p} \to e^+e^-$, for the proton time-like form factors measurement [1], gives us an opportunity to emphasize the physics case of two-body annihilation $p\bar{p}$.
These channels are interesting by themselves and the theoretical predictions need further investigation.
The differential cross section of the charged pions channel is about microbarns/Sr and events have been observed with values of S, the center of mass energy square, up to 20 GeV^2 [2-4] and 16 GeV^2 for the two neutral pions [5-6]. The data can be divided into the low energy region and the high energy one; the division takes place aroud $6 < S < 9$ GeV^2.
The energy range of FAIR corresponds to the transition domain between the soft mechanisms and the hard scattering ($S < 30$ GeV^2). There are many interesting tests namely :

- Dimensional Counting Rule (pQCD) for large S and fixed large angle [7-9]
- Quark Interchange Dominance in two-body exclusive processes [10]
- Anomalous Regge Behavior (for fixed t and large $S \gg -t$). The conventional Regge trajectory parameter should become a negative integrer at large $-t$ [11]
- Landshoff hard scattering mechanism [12] for large S and large cm. scattering angle
- Ralston-Pire oscillations scenario [13] observed in elastic pp scattering

2 Event Generators

In order to respect the previous available data, the event generators can be divided in two different parts. For the low energy part with $S < 6$ GeV^2, a Legendre polynomial fit can be performed for charged and neutral channels.

In the high energy range, namely for $S > 9$ GeV^2, we assume that the dimensional counting rule holds in respect to the energy dependance of the differential cross section [10]

$$\frac{d\sigma}{dt} = S^{-8} f(\theta) \tag{1}$$

The function $f(\theta)$ is very sensitive to the scattering mechanism. For the charged channels, The quark Interchange Dominance model predicts the shape of the cross section :

$$\frac{d\sigma}{dt} = C\ S^{-8} f(\theta) \tag{2}$$

$$f(\theta) = \frac{1}{2}(1-z^2)[2(1-z)^{-2} + (1+z)^{-2}]^2 \tag{3}$$

with $z = \cos\theta$ and the normalisation constant $C = 440$ mb GeV^{14} is determined from the $\pi^+ p$ elastic scattering at 10 GeV/c and at $\cos\theta = 0$.

Recently, the process $p\bar{p} \to \gamma\pi^0$, within the Handbag approach is investigated by Kroll et al. [14]. The Fermilab (E760) data [6] for $\pi^0\pi^0$ production in $p\bar{p}$ annihilation for $2.91 < \sqrt{S} < 4.27$ GeV exhibit the scaling behavior of the cross section as predicted by the Dimensional counting rule, with a $S^{-7.18}$ instead of S^{-8} . For our $\pi^0\pi^0$ event generator, we assume the following parametrization :

$$\frac{d\sigma}{d\cos\theta} = \frac{f(S,\theta)}{S^6(\sqrt{tu}/S)^4} \tag{4}$$

$$f(S,\theta) = \sum_i a_i(S) P_i(\cos\theta) \tag{5}$$

Where $P_i(\cos\theta)$ are the Legendre polynomes. Let us noticed that the denominator of the differential cross section reproduced the dependance of $\sin^4\theta$ when all masses are neglected in respect to the previous work of Kroll [14].

Numerical results are shown in tables 1 and 2 for the neutral channel with two values of the center of mass energy and in tables 3 and 4 for the charged channel. In the high energy regime (tables 2 and 4), the predictions are valid only for large cm angle scattering; the extrapolation to the forward and backward scatterings is not appropriate.

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Table 1: $\bar{p} + p \to \pi^0 + \pi^0$; $\sqrt{S} = 2.1\,GeV$

θ_{cm}	$\cos(\theta_{cm})$	$d\sigma/d\Omega\,(nb/sr)$
0.00	0.100000E+01	0.271000E+05
0.50	0.999962E+00	0.270980E+05
1.00	0.999848E+00	0.270921E+05
1.50	0.999657E+00	0.270822E+05
2.00	0.999391E+00	0.270683E+05
2.50	0.999048E+00	0.270504E+05
3.00	0.998630E+00	0.270284E+05
3.50	0.998135E+00	0.270024E+05
4.00	0.997564E+00	0.269724E+05
4.50	0.996917E+00	0.269381E+05
5.00	0.996195E+00	0.268998E+05
6.00	0.994522E+00	0.268103E+05
7.00	0.992546E+00	0.267034E+05
8.00	0.990268E+00	0.265787E+05
9.00	0.987688E+00	0.264356E+05
10.00	0.984808E+00	0.262735E+05
12.00	0.978148E+00	0.258896E+05
14.00	0.970296E+00	0.254217E+05
16.00	0.961262E+00	0.248643E+05
18.00	0.951057E+00	0.242126E+05
20.00	0.939693E+00	0.234627E+05
22.00	0.927184E+00	0.226120E+05
24.00	0.913545E+00	0.216601E+05
26.00	0.898794E+00	0.206087E+05
28.00	0.882948E+00	0.194626E+05
30.00	0.866025E+00	0.182294E+05
32.00	0.848048E+00	0.169205E+05
34.00	0.829038E+00	0.155502E+05
36.00	0.809017E+00	0.141366E+05
38.00	0.788011E+00	0.127006E+05
40.00	0.766044E+00	0.112660E+05
42.00	0.743145E+00	0.985869E+04
44.00	0.719340E+00	0.850584E+04
46.00	0.694658E+00	0.723528E+04

48.00	0.669131E+00	0.607432E+04
50.00	0.642788E+00	0.504876E+04
52.00	0.615661E+00	0.418179E+04
54.00	0.587785E+00	0.349294E+04
56.00	0.559193E+00	0.299710E+04
58.00	0.529919E+00	0.270367E+04
60.00	0.500000E+00	0.261591E+04
62.00	0.469472E+00	0.273050E+04
64.00	0.438371E+00	0.303732E+04
66.00	0.406737E+00	0.351961E+04
68.00	0.374607E+00	0.415437E+04
70.00	0.342020E+00	0.491300E+04
72.00	0.309017E+00	0.576231E+04
74.00	0.275637E+00	0.666572E+04
76.00	0.241922E+00	0.758461E+04
78.00	0.207912E+00	0.847985E+04
80.00	0.173648E+00	0.931341E+04
82.00	0.139173E+00	0.100499E+05
84.00	0.104528E+00	0.106579E+05
86.00	0.697565E-01	0.111117E+05
88.00	0.348995E-01	0.113920E+05
90.00	0.612303E-16	0.114867E+05
92.00	-0.348995E-01	0.113920E+05
94.00	-0.697565E-01	0.111117E+05
96.00	-0.104528E+00	0.106579E+05
98.00	-0.139173E+00	0.100499E+05
100.00	-0.173648E+00	0.931341E+04
102.00	-0.207912E+00	0.847985E+04
104.00	-0.241922E+00	0.758461E+04
106.00	-0.275637E+00	0.666572E+04
108.00	-0.309017E+00	0.576231E+04
110.00	-0.342020E+00	0.491300E+04
112.00	-0.374607E+00	0.415437E+04
114.00	-0.406737E+00	0.351961E+04
116.00	-0.438371E+00	0.303732E+04
118.00	-0.469472E+00	0.273050E+04
120.00	-0.500000E+00	0.261591E+04

122.00	-0.529919E+00	0.270367E+04
124.00	-0.559193E+00	0.299710E+04
126.00	-0.587785E+00	0.349294E+04
128.00	-0.615661E+00	0.418179E+04
130.00	-0.642788E+00	0.504876E+04
132.00	-0.669131E+00	0.607432E+04
134.00	-0.694658E+00	0.723528E+04
136.00	-0.719340E+00	0.850584E+04
138.00	-0.743145E+00	0.985869E+04
140.00	-0.766044E+00	0.112660E+05
142.00	-0.788011E+00	0.127006E+05
144.00	-0.809017E+00	0.141366E+05
146.00	-0.829038E+00	0.155502E+05
148.00	-0.848048E+00	0.169205E+05
150.00	-0.866025E+00	0.182294E+05
152.00	-0.882948E+00	0.194626E+05
154.00	-0.898794E+00	0.206087E+05
156.00	-0.913545E+00	0.216601E+05
158.00	-0.927184E+00	0.226120E+05
160.00	-0.939693E+00	0.234627E+05
162.00	-0.951057E+00	0.242126E+05
164.00	-0.961262E+00	0.248643E+05
166.00	-0.970296E+00	0.254217E+05
168.00	-0.978148E+00	0.258896E+05
170.00	-0.984808E+00	0.262735E+05
171.00	-0.987688E+00	0.264356E+05
172.00	-0.990268E+00	0.265787E+05
173.00	-0.992546E+00	0.267034E+05
174.00	-0.994522E+00	0.268103E+05
175.00	-0.996195E+00	0.268998E+05
176.00	-0.997564E+00	0.269724E+05
177.00	-0.998630E+00	0.270284E+05
178.00	-0.999391E+00	0.270683E+05
180.00	-0.100000E+01	0.271000E+05

Table 2: $\bar{p} + p \rightarrow \pi^0 + \pi^0$; $\sqrt{S} = 2.911\,GeV$

θ_{cm}	$\cos(\theta_{cm})$	$d\sigma/d\cos(\theta_{cm})\,(nb)$
35.00	0.8192E+00	0.5223E+06
36.00	0.8090E+00	0.4118E+06
37.00	0.7986E+00	0.3225E+06
38.00	0.7880E+00	0.2507E+06
39.00	0.7771E+00	0.1932E+06
40.00	0.7660E+00	0.1474E+06
41.00	0.7547E+00	0.1112E+06
42.00	0.7431E+00	0.8288E+05
43.00	0.7314E+00	0.6084E+05
44.00	0.7193E+00	0.4389E+05
45.00	0.7071E+00	0.3102E+05
46.00	0.6947E+00	0.2140E+05
47.00	0.6820E+00	0.1433E+05
48.00	0.6691E+00	0.9263E+04
49.00	0.6561E+00	0.5733E+04
50.00	0.6428E+00	0.3375E+04
51.00	0.6293E+00	0.1890E+04
52.00	0.6157E+00	0.1044E+04
53.00	0.6018E+00	0.6486E+03
54.00	0.5878E+00	0.5590E+03
55.00	0.5736E+00	0.6630E+03
56.00	0.5592E+00	0.8761E+03
57.00	0.5446E+00	0.1136E+04
58.00	0.5299E+00	0.1399E+04
59.00	0.5150E+00	0.1635E+04
60.00	0.5000E+00	0.1825E+04
61.00	0.4848E+00	0.1960E+04
62.00	0.4695E+00	0.2035E+04
63.00	0.4540E+00	0.2052E+04
64.00	0.4384E+00	0.2017E+04
65.00	0.4226E+00	0.1935E+04
66.00	0.4067E+00	0.1817E+04
67.00	0.3907E+00	0.1669E+04
68.00	0.3746E+00	0.1503E+04

69.00	0.3584E+00	0.1325E+04
70.00	0.3420E+00	0.1144E+04
71.00	0.3256E+00	0.9674E+03
72.00	0.3090E+00	0.7997E+03
73.00	0.2924E+00	0.6460E+03
74.00	0.2756E+00	0.5096E+03
75.00	0.2588E+00	0.3928E+03
76.00	0.2419E+00	0.2965E+03
77.00	0.2250E+00	0.2211E+03
78.00	0.2079E+00	0.1657E+03
79.00	0.1908E+00	0.1289E+03
80.00	0.1736E+00	0.1086E+03
81.00	0.1564E+00	0.1024E+03
82.00	0.1392E+00	0.1075E+03
83.00	0.1219E+00	0.1209E+03
84.00	0.1045E+00	0.1398E+03
85.00	0.8716E-01	0.1613E+03
86.00	0.6976E-01	0.1828E+03
87.00	0.5234E-01	0.2020E+03
88.00	0.3490E-01	0.2171E+03
89.00	0.1745E-01	0.2267E+03
90.00	0.6123E-16	0.2301E+03
91.00	-0.1745E-01	0.2267E+03
92.00	-0.3490E-01	0.2171E+03
93.00	-0.5234E-01	0.2020E+03
94.00	-0.6976E-01	0.1828E+03
95.00	-0.8716E-01	0.1613E+03
96.00	-0.1045E+00	0.1398E+03
97.00	-0.1219E+00	0.1209E+03
98.00	-0.1392E+00	0.1075E+03
99.00	-0.1564E+00	0.1024E+03
100.00	-0.1736E+00	0.1086E+03
101.00	-0.1908E+00	0.1289E+03
102.00	-0.2079E+00	0.1657E+03
103.00	-0.2250E+00	0.2211E+03
104.00	-0.2419E+00	0.2965E+03
105.00	-0.2588E+00	0.3928E+03

106.00	-0.2756E+00	0.5096E+03
107.00	-0.2924E+00	0.6460E+03
108.00	-0.3090E+00	0.7997E+03
109.00	-0.3256E+00	0.9674E+03
110.00	-0.3420E+00	0.1144E+04
111.00	-0.3584E+00	0.1325E+04
112.00	-0.3746E+00	0.1503E+04
113.00	-0.3907E+00	0.1669E+04
114.00	-0.4067E+00	0.1817E+04
115.00	-0.4226E+00	0.1935E+04
116.00	-0.4384E+00	0.2017E+04
117.00	-0.4540E+00	0.2052E+04
118.00	-0.4695E+00	0.2035E+04
119.00	-0.4848E+00	0.1960E+04
120.00	-0.5000E+00	0.1825E+04
121.00	-0.5150E+00	0.1635E+04
122.00	-0.5299E+00	0.1399E+04
123.00	-0.5446E+00	0.1136E+04
124.00	-0.5592E+00	0.8761E+03
125.00	-0.5736E+00	0.6630E+03
126.00	-0.5878E+00	0.5590E+03
127.00	-0.6018E+00	0.6486E+03
128.00	-0.6157E+00	0.1044E+04
129.00	-0.6293E+00	0.1890E+04
130.00	-0.6428E+00	0.3375E+04
131.00	-0.6561E+00	0.5733E+04
132.00	-0.6691E+00	0.9263E+04
133.00	-0.6820E+00	0.1433E+05
134.00	-0.6947E+00	0.2140E+05
135.00	-0.7071E+00	0.3102E+05
136.00	-0.7193E+00	0.4389E+05
137.00	-0.7314E+00	0.6084E+05
138.00	-0.7431E+00	0.8288E+05
139.00	-0.7547E+00	0.1112E+06
140.00	-0.7660E+00	0.1474E+06
141.00	-0.7771E+00	0.1932E+06
142.00	-0.7880E+00	0.2507E+06
143.00	-0.7986E+00	0.3225E+06
144.00	-0.8090E+00	0.4118E+06
145.00	-0.8192E+00	0.5223E+06

Table 3: $\bar{p} + p \rightarrow \pi^+ + \pi^-$; $\sqrt{S} = 2.016\,GeV$

θ_{cm}	$\cos(\theta_{cm})$	$d\sigma/d\Omega\,(nb/sr)$
0.00	0.100000E+01	0.133340E+06
0.50	0.999962E+00	0.133312E+06
1.00	0.999848E+00	0.133230E+06
1.50	0.999657E+00	0.133093E+06
2.00	0.999391E+00	0.132902E+06
2.50	0.999048E+00	0.132657E+06
3.00	0.998630E+00	0.132357E+06
3.50	0.998135E+00	0.132005E+06
4.00	0.997564E+00	0.131599E+06
4.50	0.996917E+00	0.131141E+06
5.00	0.996195E+00	0.130631E+06
6.00	0.994522E+00	0.129458E+06
7.00	0.992546E+00	0.128087E+06
8.00	0.990268E+00	0.126525E+06
9.00	0.987688E+00	0.124779E+06
10.00	0.984808E+00	0.122860E+06
12.00	0.978148E+00	0.118537E+06
14.00	0.970296E+00	0.113641E+06
16.00	0.961262E+00	0.108262E+06
18.00	0.951057E+00	0.102496E+06
20.00	0.939693E+00	0.964399E+05
22.00	0.927184E+00	0.901876E+05
24.00	0.913545E+00	0.838304E+05
26.00	0.898794E+00	0.774537E+05
28.00	0.882948E+00	0.711359E+05
30.00	0.866025E+00	0.649481E+05
32.00	0.848048E+00	0.589536E+05
34.00	0.829038E+00	0.532083E+05
36.00	0.809017E+00	0.477609E+05
38.00	0.788011E+00	0.426534E+05
40.00	0.766044E+00	0.379218E+05
42.00	0.743145E+00	0.335960E+05
44.00	0.719340E+00	0.297000E+05
46.00	0.694658E+00	0.262517E+05

48.00	0.669131E+00	0.232622E+05
50.00	0.642788E+00	0.207353E+05
52.00	0.615661E+00	0.186664E+05
54.00	0.587785E+00	0.170422E+05
56.00	0.559193E+00	0.158400E+05
58.00	0.529919E+00	0.150278E+05
60.00	0.500000E+00	0.145652E+05
62.00	0.469472E+00	0.144041E+05
64.00	0.438371E+00	0.144912E+05
66.00	0.406737E+00	0.147701E+05
68.00	0.374607E+00	0.151844E+05
70.00	0.342020E+00	0.156808E+05
72.00	0.309017E+00	0.162119E+05
74.00	0.275637E+00	0.167393E+05
76.00	0.241922E+00	0.172348E+05
78.00	0.207912E+00	0.176817E+05
80.00	0.173648E+00	0.180747E+05
82.00	0.139173E+00	0.184181E+05
84.00	0.104528E+00	0.187231E+05
86.00	0.697565E-01	0.190049E+05
88.00	0.348995E-01	0.192781E+05
90.00	0.612303E-16	0.195530E+05
92.00	-0.348995E-01	0.198316E+05
94.00	-0.697565E-01	0.201053E+05
96.00	-0.104528E+00	0.203534E+05
98.00	-0.139173E+00	0.205438E+05
100.00	-0.173648E+00	0.206359E+05
102.00	-0.207912E+00	0.205849E+05
104.00	-0.241922E+00	0.203487E+05
106.00	-0.275637E+00	0.198956E+05
108.00	-0.309017E+00	0.192124E+05
110.00	-0.342020E+00	0.183126E+05
112.00	-0.374607E+00	0.172433E+05
114.00	-0.406737E+00	0.160898E+05
116.00	-0.438371E+00	0.149768E+05
118.00	-0.469472E+00	0.140667E+05
120.00	-0.500000E+00	0.135532E+05

122.00	-0.529919E+00	0.136511E+05
124.00	-0.559193E+00	0.145821E+05
126.00	-0.587785E+00	0.165589E+05
128.00	-0.615661E+00	0.197661E+05
130.00	-0.642788E+00	0.243419E+05
132.00	-0.669131E+00	0.303613E+05
134.00	-0.694658E+00	0.378215E+05
136.00	-0.719340E+00	0.466329E+05
138.00	-0.743145E+00	0.566152E+05
140.00	-0.766044E+00	0.675003E+05
142.00	-0.788011E+00	0.789431E+05
144.00	-0.809017E+00	0.905373E+05
146.00	-0.829038E+00	0.101839E+06
148.00	-0.848048E+00	0.112395E+06
150.00	-0.866025E+00	0.121769E+06
152.00	-0.882948E+00	0.129576E+06
154.00	-0.898794E+00	0.135510E+06
156.00	-0.913545E+00	0.139365E+06
158.00	-0.927184E+00	0.141058E+06
160.00	-0.939693E+00	0.140632E+06
162.00	-0.951057E+00	0.138262E+06
164.00	-0.961262E+00	0.134242E+06
166.00	-0.970296E+00	0.128970E+06
168.00	-0.978148E+00	0.122919E+06
170.00	-0.984808E+00	0.116605E+06
171.00	-0.987688E+00	0.113514E+06
172.00	-0.990268E+00	0.110551E+06
173.00	-0.992546E+00	0.107778E+06
174.00	-0.994522E+00	0.105251E+06
175.00	-0.996195E+00	0.103020E+06
176.00	-0.997564E+00	0.101130E+06
177.00	-0.998630E+00	0.996197E+05
178.00	-0.999391E+00	0.985187E+05
180.00	-0.100000E+01	0.976246E+05

Table 4: $\bar{p} + p \rightarrow \pi^+ + \pi^-$; $T_{cin} = 5\,GeV$

θ_{cm}	$\cos(\theta_{cm})$	$d\sigma/d\Omega\,(nb/sr)$
35.00	0.8192E+00	0.3104E+03
36.00	0.8090E+00	0.2624E+03
37.00	0.7986E+00	0.2229E+03
38.00	0.7880E+00	0.1902E+03
39.00	0.7771E+00	0.1630E+03
40.00	0.7660E+00	0.1402E+03
41.00	0.7547E+00	0.1211E+03
42.00	0.7431E+00	0.1050E+03
43.00	0.7314E+00	0.9139E+02
44.00	0.7193E+00	0.7980E+02
45.00	0.7071E+00	0.6990E+02
46.00	0.6947E+00	0.6143E+02
47.00	0.6820E+00	0.5415E+02
48.00	0.6691E+00	0.4787E+02
49.00	0.6561E+00	0.4245E+02
50.00	0.6428E+00	0.3774E+02
51.00	0.6293E+00	0.3364E+02
52.00	0.6157E+00	0.3007E+02
53.00	0.6018E+00	0.2694E+02
54.00	0.5878E+00	0.2420E+02
55.00	0.5736E+00	0.2180E+02
56.00	0.5592E+00	0.1967E+02
57.00	0.5446E+00	0.1780E+02
58.00	0.5299E+00	0.1614E+02
59.00	0.5150E+00	0.1467E+02
60.00	0.5000E+00	0.1336E+02
61.00	0.4848E+00	0.1220E+02
62.00	0.4695E+00	0.1116E+02
63.00	0.4540E+00	0.1023E+02
64.00	0.4384E+00	0.9397E+01
65.00	0.4226E+00	0.8652E+01
66.00	0.4067E+00	0.7983E+01
67.00	0.3907E+00	0.7380E+01
68.00	0.3746E+00	0.6838E+01

69.00	0.3584E+00	0.6349E+01
70.00	0.3420E+00	0.5907E+01
71.00	0.3256E+00	0.5508E+01
72.00	0.3090E+00	0.5146E+01
73.00	0.2924E+00	0.4819E+01
74.00	0.2756E+00	0.4522E+01
75.00	0.2588E+00	0.4253E+01
76.00	0.2419E+00	0.4009E+01
77.00	0.2250E+00	0.3787E+01
78.00	0.2079E+00	0.3585E+01
79.00	0.1908E+00	0.3402E+01
80.00	0.1736E+00	0.3236E+01
81.00	0.1564E+00	0.3086E+01
82.00	0.1392E+00	0.2949E+01
83.00	0.1219E+00	0.2825E+01
84.00	0.1045E+00	0.2713E+01
85.00	0.8716E-01	0.2613E+01
86.00	0.6976E-01	0.2522E+01
87.00	0.5234E-01	0.2441E+01
88.00	0.3490E-01	0.2368E+01
89.00	0.1745E-01	0.2304E+01
90.00	0.6123E-16	0.2248E+01
91.00	-0.1745E-01	0.2200E+01
92.00	-0.3490E-01	0.2158E+01
93.00	-0.5234E-01	0.2123E+01
94.00	-0.6976E-01	0.2095E+01
95.00	-0.8716E-01	0.2074E+01
96.00	-0.1045E+00	0.2059E+01
97.00	-0.1219E+00	0.2050E+01
98.00	-0.1392E+00	0.2047E+01
99.00	-0.1564E+00	0.2051E+01
100.00	-0.1736E+00	0.2061E+01
101.00	-0.1908E+00	0.2077E+01
102.00	-0.2079E+00	0.2101E+01
103.00	-0.2250E+00	0.2131E+01
104.00	-0.2419E+00	0.2169E+01
105.00	-0.2588E+00	0.2215E+01

106.00	-0.2756E+00	0.2269E+01
107.00	-0.2924E+00	0.2331E+01
108.00	-0.3090E+00	0.2404E+01
109.00	-0.3256E+00	0.2487E+01
110.00	-0.3420E+00	0.2581E+01
111.00	-0.3584E+00	0.2687E+01
112.00	-0.3746E+00	0.2807E+01
113.00	-0.3907E+00	0.2942E+01
114.00	-0.4067E+00	0.3093E+01
115.00	-0.4226E+00	0.3263E+01
116.00	-0.4384E+00	0.3454E+01
117.00	-0.4540E+00	0.3668E+01
118.00	-0.4695E+00	0.3907E+01
119.00	-0.4848E+00	0.4176E+01
120.00	-0.5000E+00	0.4478E+01
121.00	-0.5150E+00	0.4818E+01
122.00	-0.5299E+00	0.5200E+01
123.00	-0.5446E+00	0.5631E+01
124.00	-0.5592E+00	0.6118E+01
125.00	-0.5736E+00	0.6668E+01
126.00	-0.5878E+00	0.7292E+01
127.00	-0.6018E+00	0.8002E+01
128.00	-0.6157E+00	0.8809E+01
129.00	-0.6293E+00	0.9732E+01
130.00	-0.6428E+00	0.1079E+02
131.00	-0.6561E+00	0.1200E+02
132.00	-0.6691E+00	0.1339E+02
133.00	-0.6820E+00	0.1500E+02
134.00	-0.6947E+00	0.1686E+02
135.00	-0.7071E+00	0.1903E+02
136.00	-0.7193E+00	0.2155E+02
137.00	-0.7314E+00	0.2451E+02
138.00	-0.7431E+00	0.2798E+02
139.00	-0.7547E+00	0.3207E+02
140.00	-0.7660E+00	0.3691E+02
141.00	-0.7771E+00	0.4267E+02
142.00	-0.7880E+00	0.4956E+02
143.00	-0.7986E+00	0.5782E+02
144.00	-0.8090E+00	0.6780E+02
145.00	-0.8192E+00	0.7990E+02