Precision Measurement of the Boron to Carbon Flux Ratio in Cosmic Rays from 1.9 GV to 2.6 TV with the Alpha Magnetic Spectrometer on the International Space Station
- SUPPLEMENTAL MATERIAL -

(The AMS Collaboration)

TABLE SM I: The boron to carbon flux ratio (B/C) as a function of rigidity including errors due to statistics (stat.), contributions to the systematic error from the backgrounds subtraction (back.), the trigger and the acceptance calculation (acc.), the unfolding procedure and the rigidity resolution function (unf.), the absolute rigidity scale (scale), and the total systematic error (syst.).

Rigidity [GV]	(B/C)	$\sigma_{\text{stat.}}$	$\sigma_{\text{back.}}$	$\sigma_{\text{acc.}}$	$\sigma_{\text{unf.}}$	σ_{scale}	$\sigma_{\text{syst.}}$
1.92 – 2.15	0.2994	0.0018	0.0012	0.0128	0.0014	0.0002	0.0129
2.15 – 2.40	0.3098	0.0017	0.0012	0.0123	0.0013	0.0001	0.0124
2.40 – 2.67	0.3143	0.0015	0.0011	0.0119	0.0012	0.0001	0.0120
2.67 – 2.97	0.3173	0.0014	0.0011	0.0115	0.0012	0.0001	0.0116
2.97 – 3.29	0.3212	0.0013	0.0011	0.0111	0.0012	0.0001	0.0112
3.29 – 3.64	0.3230	0.0013	0.0011	0.0107	0.0011	0.0000	0.0108
3.64 – 4.02	0.3251	0.0013	0.0011	0.0103	0.0010	0.0000	0.0104
4.02 – 4.43	0.3243	0.0012	0.0011	0.0098	0.0010	0.0000	0.0099
4.43 – 4.88	0.3213	0.0011	0.0011	0.0092	0.0009	0.0001	0.0093
4.88 – 5.37	0.3214	0.0011	0.0011	0.0087	0.0009	0.0001	0.0089
5.37 – 5.90	0.3165	0.0011	0.0011	0.0081	0.0008	0.0001	0.0083
5.90 – 6.47	0.3113	0.0011	0.0011	0.0076	0.0007	0.0001	0.0077
6.47 – 7.09	0.3059	0.0010	0.0011	0.0070	0.0008	0.0001	0.0071
7.09 – 7.76	0.2994	0.0010	0.0011	0.0064	0.0008	0.0001	0.0065
7.76 – 8.48	0.2968	0.0010	0.0011	0.0059	0.0008	0.0001	0.0060
8.48 – 9.26	0.2911	0.0010	0.0011	0.0054	0.0008	0.0001	0.0055
9.26 – 10.1	0.2880	0.0011	0.0011	0.0049	0.0007	0.0001	0.0051
10.1 – 11.0	0.2844	0.0011	0.0011	0.0046	0.0007	0.0001	0.0047
11.0 – 12.0	0.2775	0.0011	0.0011	0.0042	0.0008	0.0001	0.0044
12.0 – 13.0	0.2726	0.0012	0.0011	0.0039	0.0008	0.0002	0.0041
13.0 – 14.1	0.2671	0.0012	0.0011	0.0036	0.0008	0.0002	0.0039
14.1 – 15.3	0.2628	0.0013	0.0011	0.0035	0.0007	0.0002	0.0037
15.3 – 16.6	0.2546	0.0013	0.0011	0.0033	0.0007	0.0002	0.0035
16.6 – 18.0	0.2523	0.0013	0.0010	0.0032	0.0007	0.0002	0.0034
18.0 – 19.5	0.2451	0.0013	0.0010	0.0030	0.0007	0.0002	0.0033
19.5 – 21.1	0.2372	0.0013	0.0010	0.0029	0.0007	0.0002	0.0031
21.1 – 22.8	0.2359	0.0014	0.0010	0.0029	0.0008	0.0002	0.0031
22.8 – 24.7	0.2280	0.0014	0.0010	0.0028	0.0008	0.0002	0.0030
24.7 – 26.7	0.2246	0.0014	0.0009	0.0027	0.0007	0.0002	0.0030
26.7 – 28.8	0.2182	0.0015	0.0009	0.0027	0.0007	0.0002	0.0029
28.8 – 31.1	0.2112	0.0015	0.0009	0.0026	0.0007	0.0002	0.0028
31.1 – 33.5	0.2058	0.0016	0.0009	0.0025	0.0007	0.0002	0.0028
33.5 – 36.1	0.2020	0.0016	0.0009	0.0025	0.0008	0.0002	0.0028
36.1 – 38.9	0.1942	0.0017	0.0009	0.0024	0.0009	0.0002	0.0027
38.9 – 41.9	0.1899	0.0018	0.0009	0.0023	0.0009	0.0002	0.0027
41.9 – 45.1	0.1889	0.0019	0.0009	0.0023	0.0009	0.0002	0.0027

Table continued

TABLE SM I – *(Continued).*

Rigidity [GV]	(B/C)	$\sigma_{\text{stat.}}$	$\sigma_{\text{back.}}$	$\sigma_{\text{acc.}}$	$\sigma_{\text{unf.}}$	σ_{scale}	$\sigma_{\text{syst.}}$
45.1 – 48.5	0.1837	0.0020	0.0009	0.0023	0.0009	0.0002	0.0026
48.5 – 52.2	0.1745	0.0021	0.0009	0.0022	0.0008	0.0002	0.0025
52.2 – 56.1	0.1710	0.0022	0.0009	0.0021	0.0008	0.0002	0.0025
56.1 – 60.3	0.1637	0.0023	0.0008	0.0021	0.0008	0.0002	0.0024
60.3 – 64.8	0.1613	0.0024	0.0008	0.0020	0.0008	0.0003	0.0024
64.8 – 69.7	0.1552	0.0025	0.0008	0.0020	0.0009	0.0002	0.0024
69.7 – 74.9	0.1517	0.0026	0.0008	0.0020	0.0010	0.0002	0.0024
74.9 – 80.5	0.1513	0.0028	0.0009	0.0020	0.0011	0.0003	0.0024
80.5 – 86.5	0.1425	0.0028	0.0008	0.0019	0.0011	0.0002	0.0024
86.5 – 93.0	0.1399	0.0030	0.0008	0.0019	0.0011	0.0002	0.0024
93.0 – 100	0.1329	0.0031	0.0008	0.0018	0.0011	0.0002	0.0023
100 – 108	0.1299	0.0031	0.0008	0.0018	0.0011	0.0002	0.0023
108 – 116	0.1337	0.0035	0.0008	0.0019	0.0012	0.0003	0.0024
116 – 125	0.1224	0.0035	0.0008	0.0017	0.0011	0.0003	0.0022
125 – 135	0.1195	0.0036	0.0008	0.0016	0.0011	0.0003	0.0021
135 – 147	0.1230	0.0037	0.0008	0.0016	0.0012	0.0003	0.0022
147 – 160	0.1140	0.0039	0.0008	0.0015	0.0012	0.0003	0.0021
160 – 175	0.1153	0.0040	0.0008	0.0015	0.0014	0.0003	0.0022
175 – 192	0.1103	0.0041	0.0008	0.0014	0.0014	0.0003	0.0022
192 – 211	0.1145	0.0046	0.0008	0.0015	0.0016	0.0004	0.0024
211 – 233	0.1082	0.0047	0.0008	0.0014	0.0017	0.0004	0.0024
233 – 259	0.0955	0.0046	0.0007	0.0013	0.0016	0.0004	0.0022
259 – 291	0.0870	0.0045	0.0007	0.0012	0.0016	0.0004	0.0022
291 – 330	0.0966	0.0052	0.0008	0.0013	0.0020	0.0005	0.0026
330 – 379	0.0925	0.0053	0.0008	0.0012	0.0022	0.0005	0.0026
379 – 441	0.0882	0.0057	0.0007	0.0011	0.0023	0.0006	0.0027
441 – 525	0.0936	0.0064	0.0008	0.0012	0.0027	0.0007	0.0032
525 – 660	0.0787	0.0058	0.0007	0.0010	0.0026	0.0007	0.0030
660 – 880	0.0661	0.0058	0.0006	0.0009	0.0025	0.0008	0.0028
880 – 1300	0.0495	0.0124	0.0005	0.0007	0.0021	0.0007	0.0023
1300 – 2600	0.0450	0.0138	0.0005	0.0006	0.0023	0.0011	0.0027

TABLE SM II: The boron to carbon flux ratio (B/C) as a function of kinetic energy including errors due to statistics (stat.), contributions to the systematic error from the backgrounds subtraction (back.), the trigger and the acceptance calculation (acc.), the unfolding procedure and the rigidity resolution function (unf.), the absolute rigidity scale (scale), the error associated to rigidity to kinetic energy conversion due to uncertainties in the boron isotopic composition (conv.), and the total systematic error (syst.).

E_K [GeV/n]	(B/C)	$\sigma_{\text{stat.}}$	$\sigma_{\text{back.}}$	$\sigma_{\text{acc.}}$	$\sigma_{\text{unf.}}$	σ_{scale}	$\sigma_{\text{conv.}}$	$\sigma_{\text{syst.}}$
0.406 – 0.491	0.3210	0.0018	0.0013	0.0149	0.0015	0.0001	0.0031	0.0154
0.491 – 0.588	0.3251	0.0017	0.0012	0.0142	0.0013	0.0000	0.0033	0.0147
0.588 – 0.696	0.3214	0.0015	0.0012	0.0134	0.0012	0.0000	0.0035	0.0140
0.696 – 0.821	0.3213	0.0014	0.0011	0.0128	0.0012	0.0000	0.0036	0.0134
0.821 – 0.959	0.3188	0.0013	0.0011	0.0122	0.0011	0.0001	0.0037	0.0128
0.959 – 1.11	0.3174	0.0012	0.0011	0.0115	0.0010	0.0001	0.0038	0.0123
1.11 – 1.28	0.3142	0.0012	0.0011	0.0109	0.0009	0.0001	0.0039	0.0117
1.28 – 1.47	0.3082	0.0011	0.0011	0.0102	0.0009	0.0001	0.0040	0.0110
1.47 – 1.68	0.3060	0.0010	0.0011	0.0096	0.0008	0.0001	0.0041	0.0105
1.68 – 1.91	0.3008	0.0010	0.0011	0.0089	0.0007	0.0001	0.0041	0.0099
1.91 – 2.16	0.2941	0.0010	0.0011	0.0082	0.0007	0.0002	0.0041	0.0093
2.16 – 2.43	0.2872	0.0010	0.0011	0.0076	0.0007	0.0002	0.0041	0.0087
2.43 – 2.73	0.2794	0.0010	0.0010	0.0069	0.0007	0.0002	0.0041	0.0081
2.73 – 3.06	0.2745	0.0009	0.0010	0.0063	0.0008	0.0002	0.0041	0.0076
3.06 – 3.41	0.2691	0.0010	0.0010	0.0058	0.0007	0.0001	0.0041	0.0072
3.41 – 3.79	0.2645	0.0010	0.0010	0.0053	0.0007	0.0001	0.0041	0.0068
3.79 – 4.20	0.2609	0.0010	0.0010	0.0049	0.0006	0.0002	0.0041	0.0065
4.20 – 4.65	0.2539	0.0010	0.0010	0.0045	0.0007	0.0002	0.0041	0.0062
4.65 – 5.14	0.2496	0.0011	0.0010	0.0042	0.0007	0.0002	0.0041	0.0060
5.14 – 5.63	0.2433	0.0011	0.0010	0.0039	0.0007	0.0002	0.0040	0.0057
5.63 – 6.18	0.2378	0.0011	0.0010	0.0037	0.0007	0.0002	0.0040	0.0055
6.18 – 6.78	0.2327	0.0012	0.0010	0.0035	0.0006	0.0002	0.0040	0.0054
6.78 – 7.42	0.2281	0.0012	0.0010	0.0033	0.0006	0.0002	0.0039	0.0053
7.42 – 8.12	0.2236	0.0012	0.0009	0.0032	0.0006	0.0002	0.0039	0.0052
8.12 – 8.86	0.2157	0.0012	0.0009	0.0030	0.0006	0.0002	0.0038	0.0050
8.86 – 9.66	0.2122	0.0012	0.0009	0.0029	0.0007	0.0002	0.0038	0.0049
9.66 – 10.5	0.2055	0.0012	0.0009	0.0028	0.0007	0.0002	0.0037	0.0048
10.5 – 11.5	0.2040	0.0012	0.0009	0.0028	0.0007	0.0002	0.0038	0.0048
11.5 – 12.5	0.1970	0.0013	0.0008	0.0027	0.0007	0.0002	0.0037	0.0047
12.5 – 13.5	0.1895	0.0013	0.0008	0.0026	0.0006	0.0002	0.0036	0.0045
13.5 – 14.6	0.1854	0.0014	0.0008	0.0025	0.0007	0.0002	0.0035	0.0045
14.6 – 15.8	0.1818	0.0015	0.0008	0.0024	0.0008	0.0002	0.0035	0.0044
15.8 – 17.1	0.1725	0.0015	0.0008	0.0023	0.0008	0.0002	0.0034	0.0042
17.1 – 18.5	0.1706	0.0016	0.0008	0.0023	0.0009	0.0002	0.0034	0.0042

Table continued

TABLE SM II – *(Continued).*

E_K [GeV/n]	(B/C)	$\sigma_{\text{stat.}}$	$\sigma_{\text{back.}}$	$\sigma_{\text{acc.}}$	$\sigma_{\text{unf.}}$	σ_{scale}	$\sigma_{\text{conv.}}$	$\sigma_{\text{syst.}}$
18.5 – 20.0	0.1682	0.0017	0.0008	0.0022	0.0009	0.0002	0.0034	0.0042
20.0 – 21.6	0.1652	0.0018	0.0008	0.0022	0.0009	0.0002	0.0034	0.0042
21.6 – 23.3	0.1557	0.0018	0.0008	0.0021	0.0008	0.0002	0.0032	0.0040
23.3 – 25.2	0.1531	0.0019	0.0008	0.0020	0.0008	0.0002	0.0032	0.0039
25.2 – 27.1	0.1465	0.0020	0.0008	0.0019	0.0007	0.0002	0.0031	0.0038
27.1 – 29.2	0.1426	0.0021	0.0007	0.0019	0.0007	0.0002	0.0031	0.0038
29.2 – 31.5	0.1397	0.0022	0.0008	0.0018	0.0008	0.0002	0.0031	0.0037
31.5 – 33.9	0.1347	0.0023	0.0007	0.0018	0.0009	0.0002	0.0030	0.0037
33.9 – 36.5	0.1351	0.0025	0.0008	0.0018	0.0010	0.0002	0.0031	0.0038
36.5 – 39.3	0.1284	0.0025	0.0007	0.0018	0.0010	0.0002	0.0029	0.0037
39.3 – 42.3	0.1258	0.0027	0.0007	0.0018	0.0010	0.0002	0.0029	0.0037
42.3 – 45.6	0.1188	0.0027	0.0007	0.0017	0.0010	0.0002	0.0028	0.0035
45.6 – 49.1	0.1173	0.0028	0.0007	0.0017	0.0010	0.0002	0.0028	0.0035
49.1 – 53.1	0.1158	0.0029	0.0007	0.0017	0.0010	0.0003	0.0029	0.0036
53.1 – 57.1	0.1104	0.0032	0.0007	0.0016	0.0010	0.0003	0.0028	0.0034
57.1 – 61.6	0.1054	0.0032	0.0007	0.0015	0.0010	0.0003	0.0027	0.0033
61.6 – 66.6	0.1101	0.0034	0.0007	0.0015	0.0012	0.0003	0.0029	0.0036
66.6 – 72.6	0.1049	0.0034	0.0007	0.0015	0.0012	0.0003	0.0028	0.0035
72.6 – 79.1	0.1031	0.0036	0.0007	0.0015	0.0013	0.0003	0.0028	0.0035
79.1 – 86.6	0.0966	0.0037	0.0007	0.0014	0.0013	0.0003	0.0027	0.0034
86.6 – 95.1	0.1008	0.0039	0.0007	0.0015	0.0015	0.0004	0.0029	0.0037
95.1 – 104.6	0.0978	0.0042	0.0007	0.0015	0.0016	0.0004	0.0029	0.0037
104.6 – 115.6	0.0883	0.0042	0.0007	0.0014	0.0016	0.0004	0.0027	0.0035
115.6 – 128.6	0.0834	0.0043	0.0006	0.0013	0.0016	0.0004	0.0026	0.0034
128.6 – 144.6	0.0823	0.0044	0.0007	0.0013	0.0018	0.0004	0.0026	0.0035
144.6 – 164.1	0.0838	0.0048	0.0007	0.0014	0.0020	0.0005	0.0027	0.0037
164.1 – 188.6	0.0814	0.0050	0.0007	0.0014	0.0021	0.0005	0.0027	0.0038
188.6 – 219.6	0.0809	0.0054	0.0007	0.0014	0.0023	0.0006	0.0028	0.0040
219.6 – 261.6	0.0785	0.0058	0.0007	0.0014	0.0025	0.0007	0.0027	0.0041
261.6 – 329.1	0.0708	0.0055	0.0006	0.0013	0.0025	0.0008	0.0025	0.0039
329.1 – 439.1	0.0571	0.0053	0.0005	0.0011	0.0023	0.0009	0.0021	0.0035
439.1 – 649.1	0.0469	0.0120	0.0005	0.0007	0.0022	0.0008	0.0018	0.0030
649.1 – 1299.1	0.0475	0.0142	0.0005	0.0007	0.0026	0.0014	0.0018	0.0036

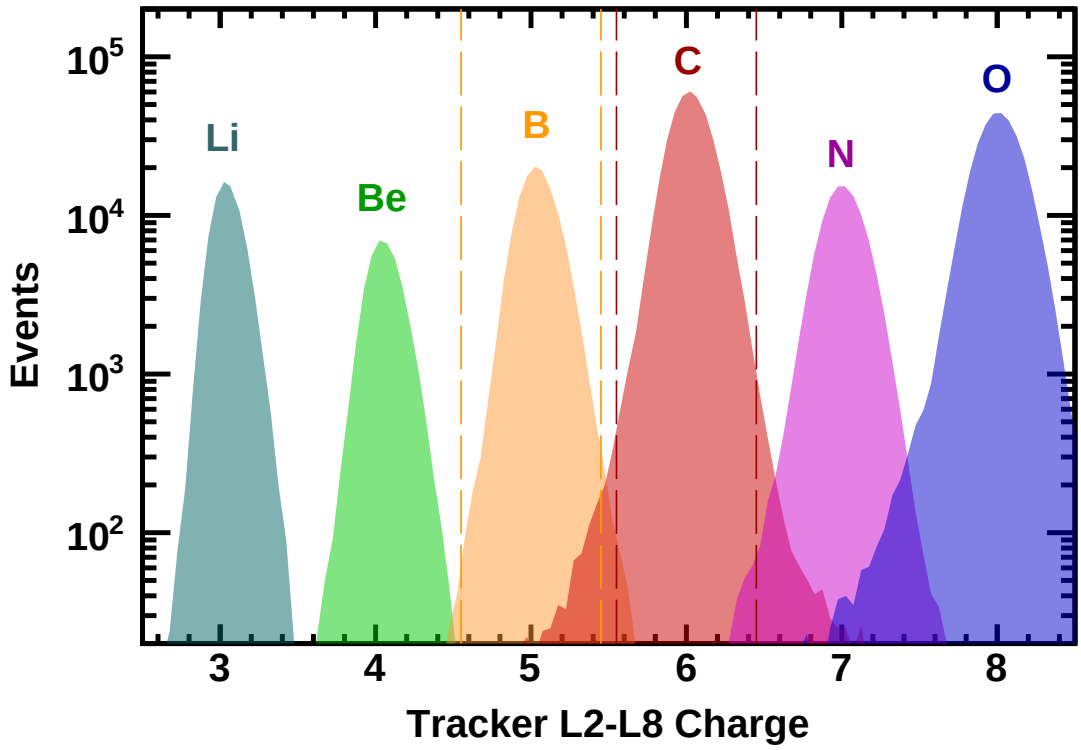

FIG. SM 1. Charge distribution of inner (L2-L8) tracker for samples from $Z = 3$ to $Z = 8$ in the rigidity range from 4 GV to 10 GV, selected by charge on tracker L1, upper TOF and lower TOF. The vertical dashed lines correspond to the charge selection in the inner tracker for boron (orange) and carbon (red).

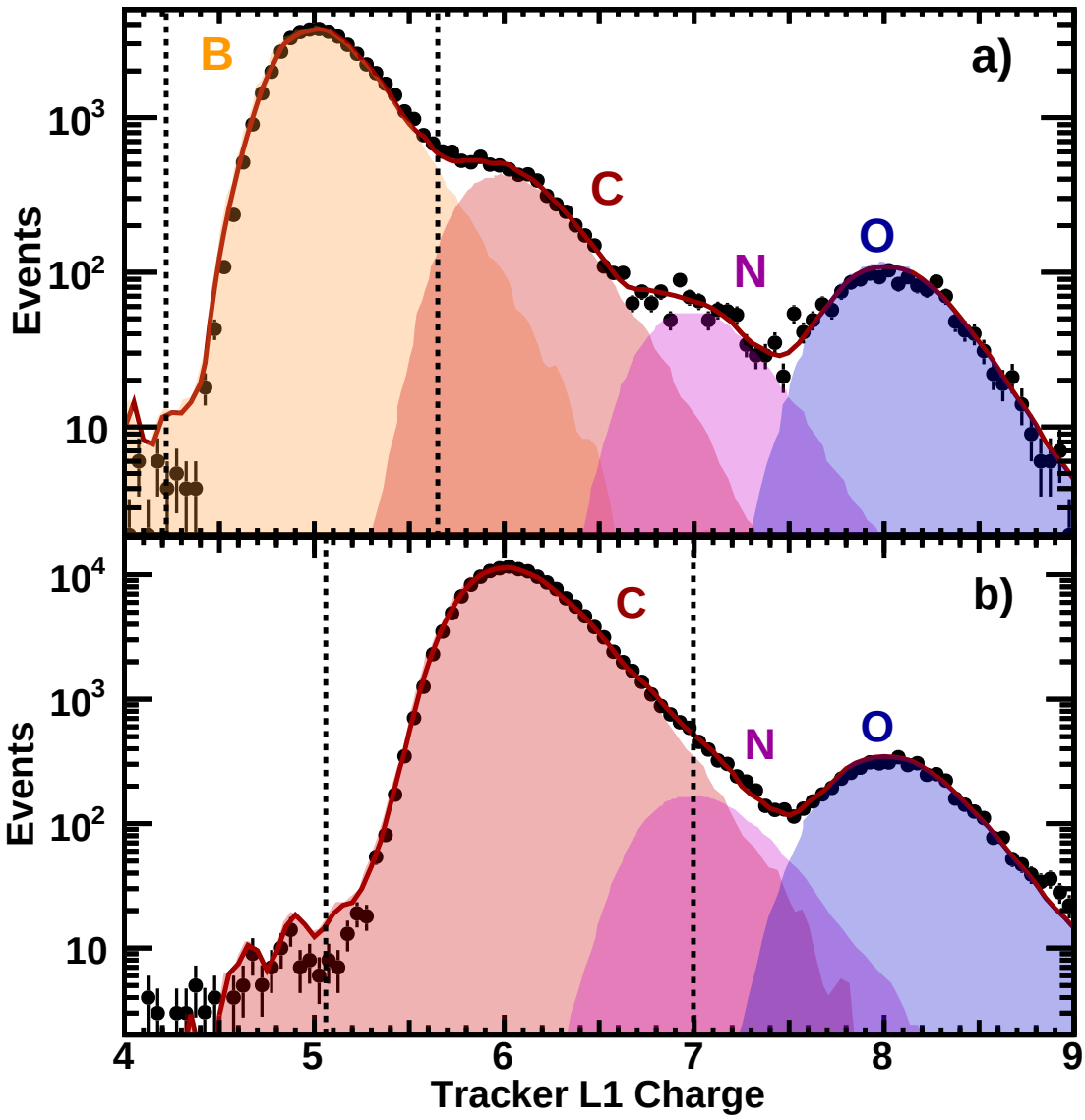

FIG. SM 2. Charge distributions measured by tracker L1 for a) boron and b) carbon events selected by inner tracker in the rigidity range between 9 and 11 GV (dots). The solid red lines show the fit of the charge distribution templates B, C, N, and O, to the data. The templates are obtained from a selection of non-interacting samples on L2 by the use of the charge measurement with L1 and L3-L8. The charge selections applied on tracker L1 are shown as vertical dashed lines. The residual backgrounds to the boron and carbon samples are calculated by integrating the charge templates distribution in the selection range, and found to be <3% for boron sample and <0.5% for carbon.

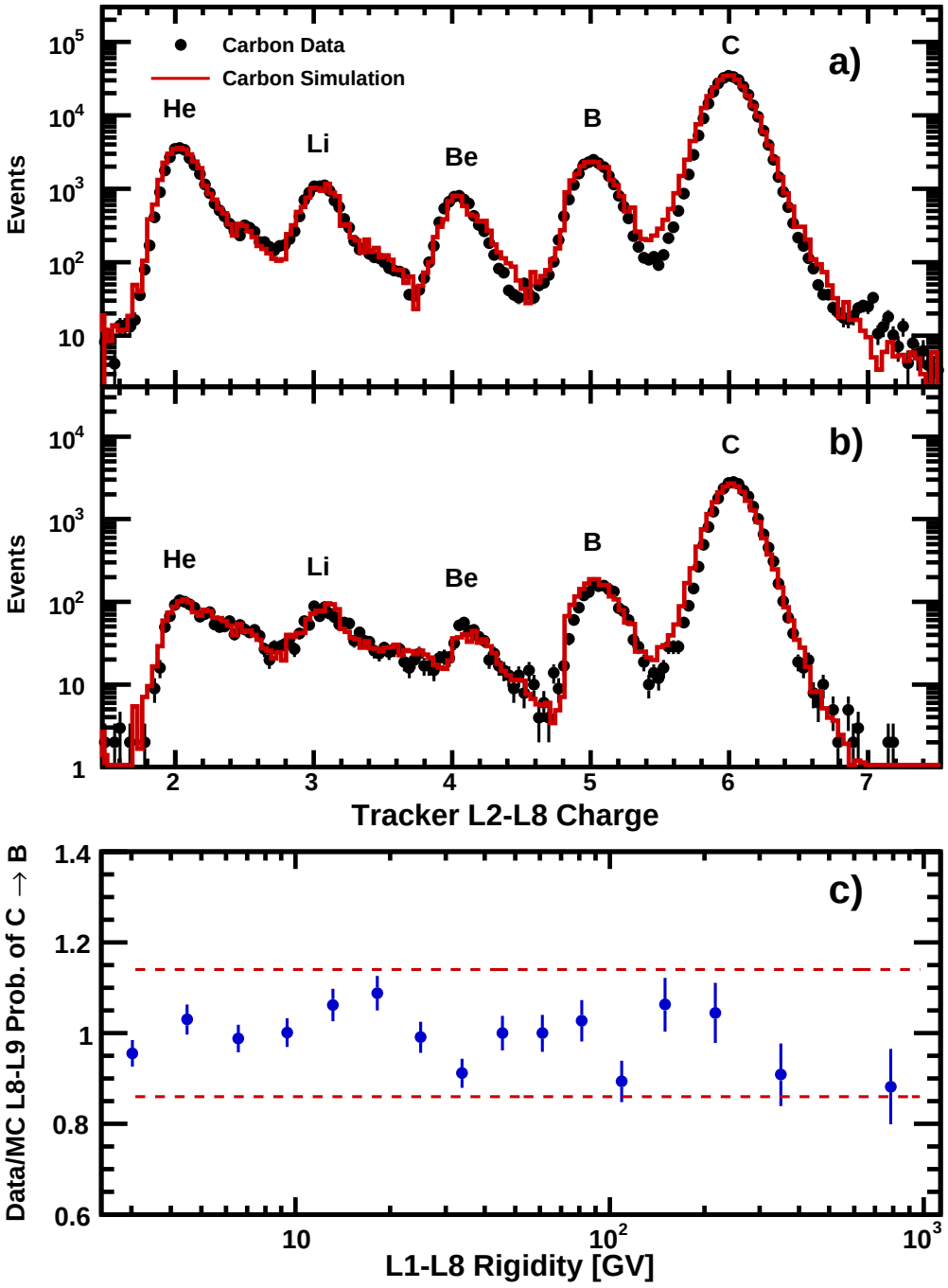

FIG. SM 3. (a,b) Charge distribution measured by inner (L2-L8, MDR $\sim$ 550 GV) tracker for a sample of carbon selected with the tracker L1 in the rigidity range between (a) 27 and 36 GV and (b) 192 and 525 GV. MC (histogram) distributions are normalized to the non-interacting carbon peak measured in the data (points). (c) The ratio of the data to the simulation (MC) of the probability of carbon fragmenting to boron between L8 and L9 of the tracker (which has a similar amount of material as between L1 and L2) as a function of the L1 to L8 rigidity which has an MDR of 1.2 TV. As seen, the ratio is well within assigned systematic error of 13% (dashed lines). The agreement between data and simulation validates the C + C,Al $\rightarrow$ B + X cross sections used in the simulation.

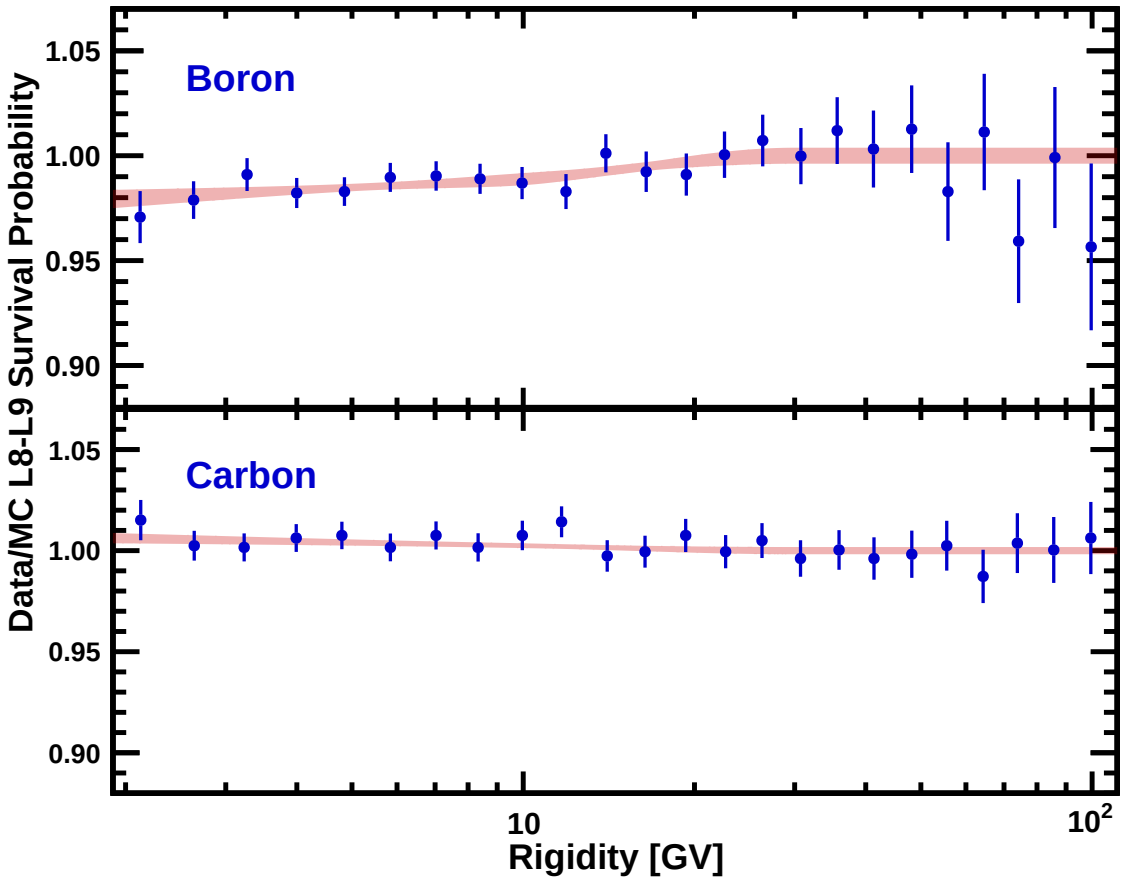

FIG. SM 4. The Data/MC ratio of boron and carbon survival probability between tracker L8 and L9. The shaded areas show the systematic error range (68% CL) obtained from the spline fit to data points.

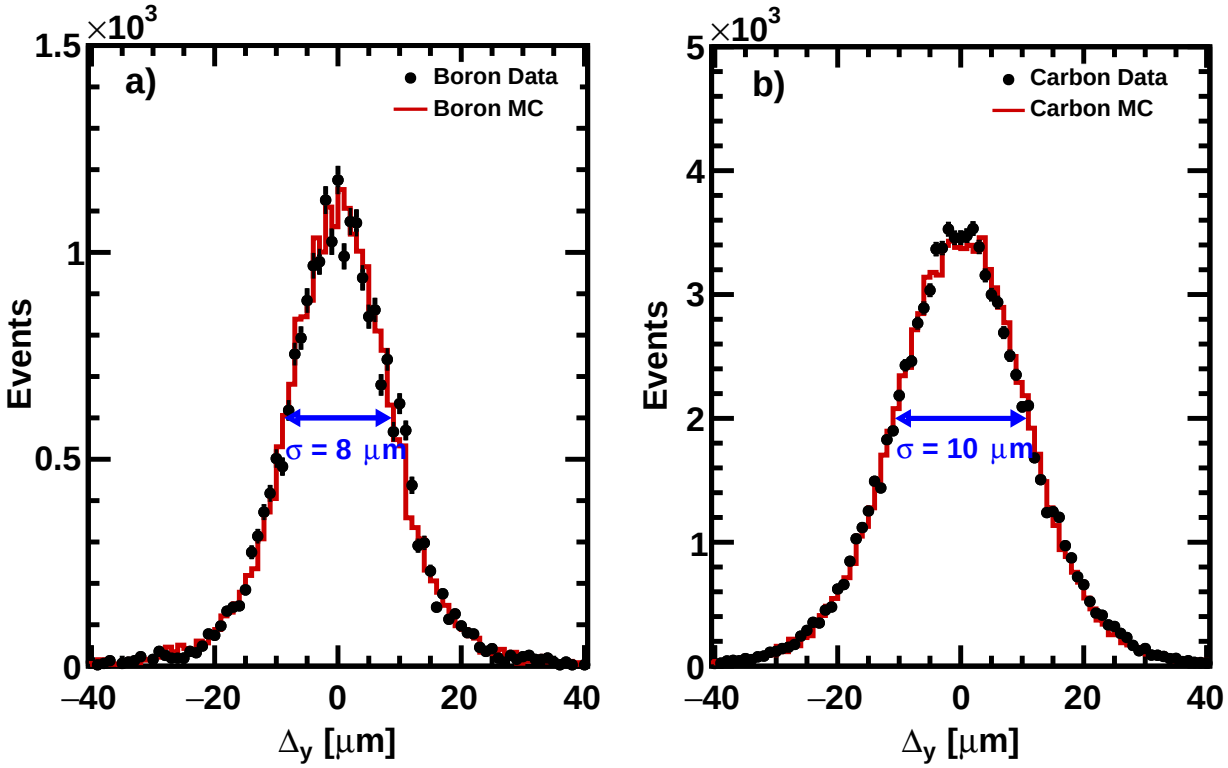

FIG. SM 5. Comparison of the differences of the coordinates measured in L3 or L5 to those obtained from the track fit using the measurements from L1, L2, L4, L6, L7 and L8 between data and simulation in the rigidity range $40 < R < 47$ GV for a) boron sample and b) carbon sample. The observed bending coordinate accuracy is 8 μm for boron and 10 μm carbon.

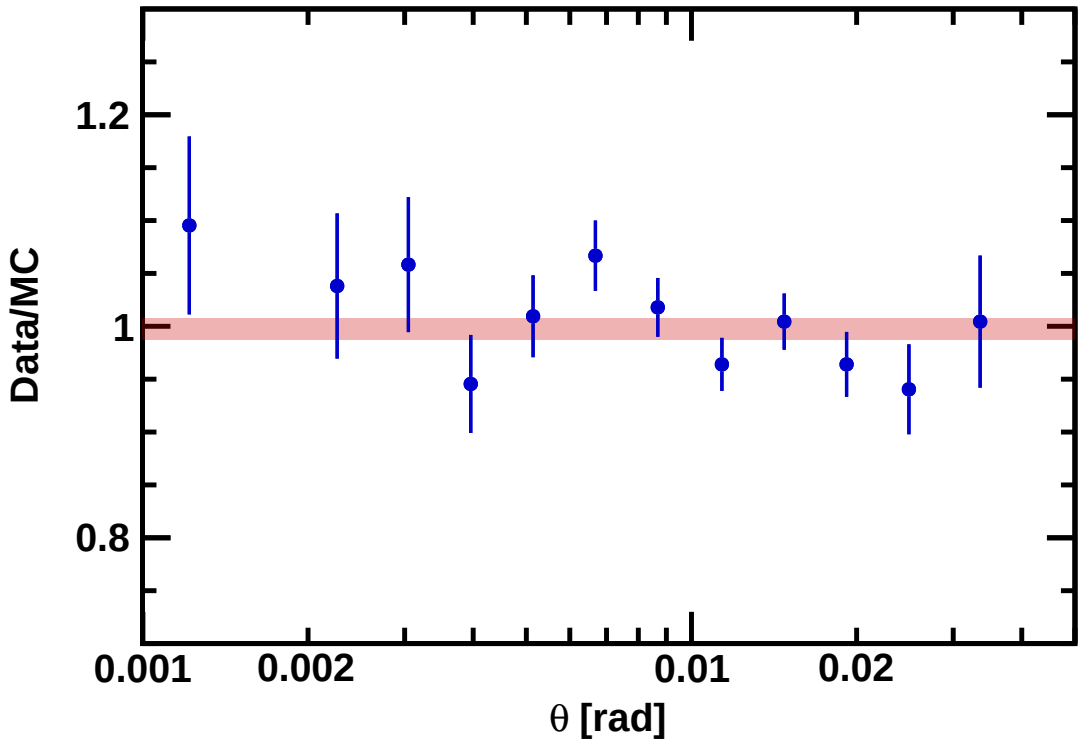

FIG. SM 6. The comparison of data to MC (Data/MC) scattering angle θ distribution of carbon samples in the rigidity range $120 < R < 180$ GV. The red area indicate the error band associated to a flat fit of the ratio. The scattering angle is defined as the difference between the inner tracker track and the L1 to L2 trajectory.

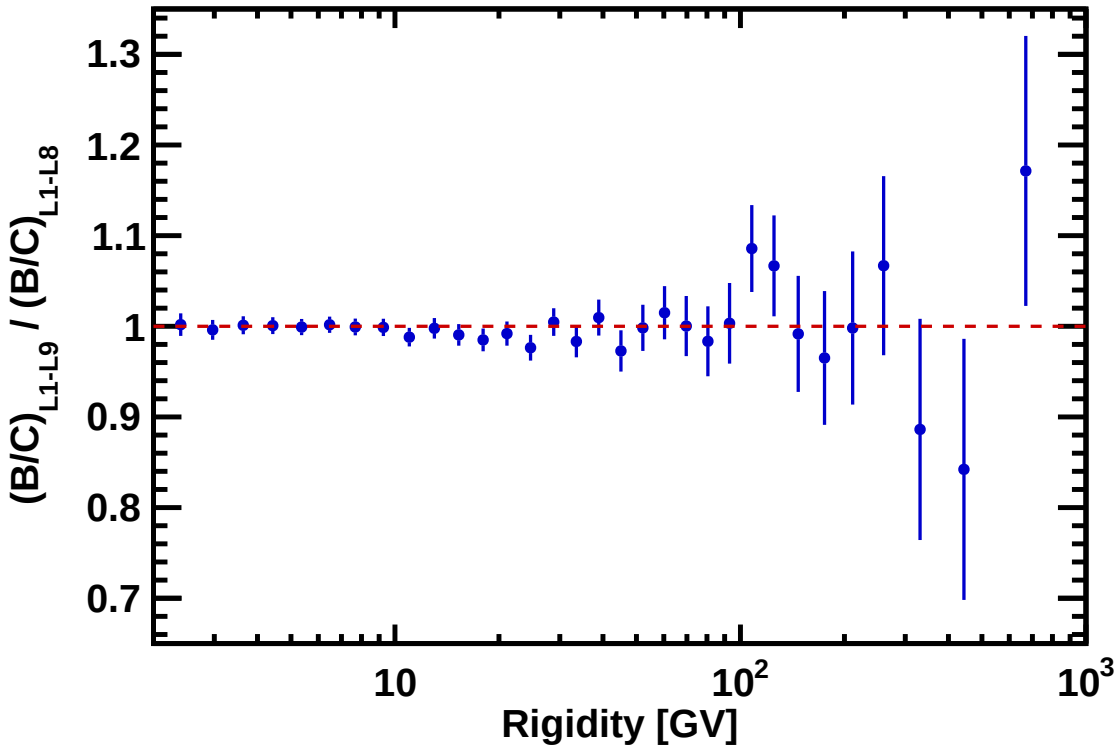

FIG. SM 7. The ratio of B/C measured with events passing through L1 to L9 over the events passing through L1 to L8. The error is the quadratic sum of statistics and systematic errors. As seen the ratio is centered at 1.0.