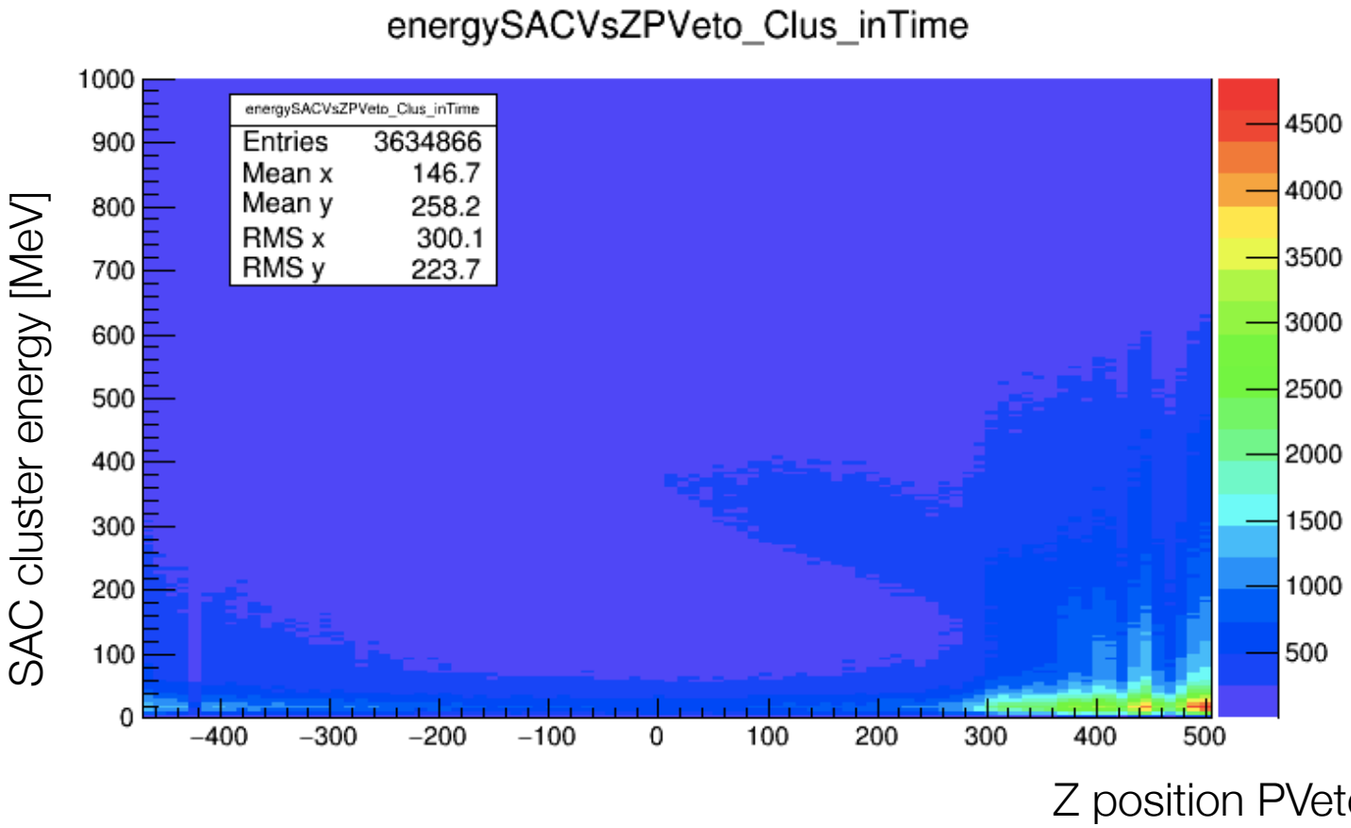
Update on Bremmstrahlung studies

F. Oliva on behalf of the PADME Lecce group

PADME internal Meeting, 29 th November 2019

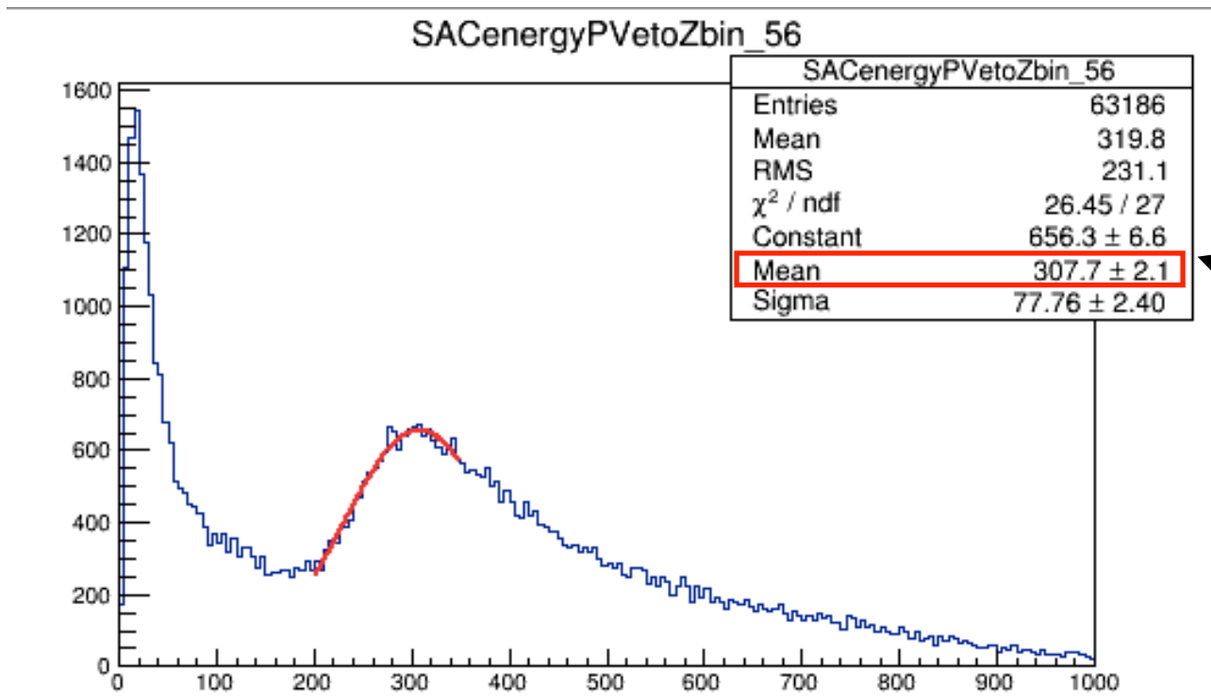
Use Bremsstrahlung candidate events to check magnetic field



Only time coincidence request

$t_{CIPVeto} - t_{CISAC} < 1ns$

Evaluate the photon energy from Single SAC cluster energy spectrum ..



$E_{e+} = E_{beam} - E_{\gamma SAC}$

$E_{e+} = 490\ MeV - E_{\gamma SAC}$

MC Fit not good **DATA**

ChId	E_{sac}	Z
0	412.856	-477.433
1	305.469	-466.567
2	168.29	-455.7
3	422.039	-444.833
4	422.45	-433.967
5	414.066	-423.1
6	381.508	-412.233
7	375.131	-401.367
8	418.655	-390.5
9	432.487	-379.633
10	430.27	-368.767
11	424.45	-357.9
12	244.089	-347.033
13	404.466	-336.167
14	405.962	-325.3
15	409.82	-314.433
16	412.219	-303.567
17	412.383	-292.7
18	410.175	-281.833
19	408.861	-270.967
20	409.876	-260.1
21	410.813	-249.233
22	407.338	-238.367
23	403.662	-227.5
24	397.022	-216.633
25	393.316	-205.767
26	393.973	-194.9
27	390.219	-184.033
28	385.217	-173.167
29	381.886	-162.3
30	377.506	-151.433

ChId	E_{e+}	Z
0	77.1437	-477.433
1	184.531	-466.567
2	321.71	-455.7
3	67.9612	-444.833
4	67.5496	-433.967
5	75.9336	-423.1
6	108.492	-412.233
7	114.869	-401.367
8	71.3452	-390.5
9	57.5134	-379.633
10	59.7302	-368.767
11	65.5504	-357.9
12	245.911	-347.033
13	85.5338	-336.167
14	84.0383	-325.3
15	80.1803	-314.433
16	77.7806	-303.567
17	77.617	-292.7
18	79.8255	-281.833
19	81.1391	-270.967
20	80.1237	-260.1
21	79.1866	-249.233
22	82.662	-238.367
23	86.338	-227.5
24	92.9777	-216.633
25	96.6843	-205.767
26	96.0272	-194.9
27	99.7814	-184.033
28	104.783	-173.167
29	108.114	-162.3
30	112.494	-151.433

ChId	E_{e+}	Z
0	250.05	-477.433
1	252.385	-466.567
2	259.063	-455.7
3	236.788	-444.833
4	251.044	-433.967
5	274.918	-423.1
6	249.374	-412.233
7	231.654	-401.367
8	199.467	-390.5
9	209.286	-379.633
10	225.34	-368.767
11	170.162	-357.9
12	115.638	-347.033
13	54.6033	-336.167
14	41.7315	-325.3
15	36.4005	-314.433
16	35.7773	-303.567
17	35.1945	-292.7
18	37.7516	-281.833
19	40.8684	-270.967
20	42.1503	-260.1
21	40.3268	-249.233
22	40.1868	-238.367
23	46.2716	-227.5
24	50.3301	-216.633
25	51.1381	-205.767
26	53.1796	-194.9
27	53.2199	-184.033
28	55.3222	-173.167
29	58.1233	-162.3
30	60.713	-151.433

ChId	E_{sac}	Z
0	239.95	-477.433
1	237.615	-466.567
2	230.937	-455.7
3	253.212	-444.833
4	238.956	-433.967
5	215.082	-423.1
6	240.626	-412.233
7	258.346	-401.367
8	290.533	-390.5
9	280.714	-379.633
10	264.66	-368.767
11	319.838	-357.9
12	374.362	-347.033
13	435.397	-336.167
14	448.268	-325.3
15	453.599	-314.433
16	454.223	-303.567
17	454.806	-292.7
18	452.248	-281.833
19	449.132	-270.967
20	447.85	-260.1
21	449.673	-249.233
22	449.813	-238.367
23	443.728	-227.5
24	439.67	-216.633
25	438.862	-205.767
26	436.82	-194.9
27	436.78	-184.033
28	434.678	-173.167
29	431.877	-162.3
30	429.287	-151.433

$$E_{e+} = E_{beam} - E_{sac}$$

MC

ChId	E_{sac}	Z
31	376.096	-140.567
32	373.626	-129.7
33	369.783	-118.833
34	364.964	-107.967
35	362.771	-97.1
36	357.278	-86.2333
37	352.532	-75.3667
38	351.44	-64.5
39	350.316	-53.6333
40	343.504	-42.7667
41	340.857	-31.9
42	334.179	-21.0333
43	329.662	-10.1667
44	324.064	0.7
45	320.872	11.5667
46	317.971	22.4333
47	312.05	33.3
48	306.924	44.1667
49	304.046	55.0333
50	299.114	65.9
51	293.559	76.7667
52	291.055	87.6333
53	284.773	98.5
54	282.032	109.367
55	274.582	120.233
56	269.694	131.1
57	265.05	141.967
58	260.196	152.833
59	254.071	163.7
60	249.177	174.567

ChId	E_{e+}	Z
31	113.904	-140.567
32	116.374	-129.7
33	120.217	-118.833
34	125.036	-107.967
35	127.229	-97.1
36	132.722	-86.2333
37	137.468	-75.3667
38	138.56	-64.5
39	139.684	-53.6333
40	146.496	-42.7667
41	149.143	-31.9
42	155.821	-21.0333
43	160.338	-10.1667
44	165.936	0.7
45	169.128	11.5667
46	172.029	22.4333
47	177.95	33.3
48	183.076	44.1667
49	185.954	55.0333
50	190.886	65.9
51	196.441	76.7667
52	198.945	87.6333
53	205.227	98.5
54	207.968	109.367
55	215.418	120.233
56	220.306	131.1
57	224.95	141.967
58	229.804	152.833
59	235.929	163.7
60	240.823	174.567

DATA

ChId	E_{e+}	Z
31	62.9694	-140.567
32	65.8742	-129.7
33	69.1263	-118.833
34	74.5049	-107.967
35	81.9334	-97.1
36	87.5028	-86.2333
37	90.7477	-75.3667
38	93.0406	-64.5
39	96.5603	-53.6333
40	98.1511	-42.7667
41	102.275	-31.9
42	107.504	-21.0333
43	116.244	-10.1667
44	118.933	0.7
45	121.904	11.5667
46	126.977	22.4333
47	133.632	33.3
48	138.01	44.1667
49	141.067	55.0333
50	146.033	65.9
51	150.537	76.7667
52	158.922	87.6333
53	169.076	98.5
54	172.049	109.367
55	173.928	120.233
56	181.914	131.1
57	186.95	141.967
58	191.514	152.833
59	196.092	163.7
60	211.239	174.567

ChId	E_{sac}	Z
31	427.031	-140.567
32	424.126	-129.7
33	420.874	-118.833
34	415.495	-107.967
35	408.067	-97.1
36	402.497	-86.2333
37	399.252	-75.3667
38	396.959	-64.5
39	393.44	-53.6333
40	391.849	-42.7667
41	387.725	-31.9
42	382.496	-21.0333
43	373.756	-10.1667
44	371.067	0.7
45	368.096	11.5667
46	363.023	22.4333
47	356.368	33.3
48	351.99	44.1667
49	348.933	55.0333
50	343.967	65.9
51	339.463	76.7667
52	331.078	87.6333
53	320.924	98.5
54	317.951	109.367
55	316.072	120.233
56	308.086	131.1
57	303.05	141.967
58	298.486	152.833
59	293.908	163.7
60	278.761	174.567

MC

ChId	E_{sac}	Z
61	244.769	185.433
62	239.609	196.3
63	233.456	207.167
64	224.416	218.033
65	218.851	228.9
66	213.796	239.767
67	208.125	250.633
68	202.479	261.5
69	196.67	272.367
70	191.01	283.233
71	184.814	294.1
72	176.622	304.967
73	168.414	315.833
74	161.947	326.7
75	155.729	337.567
76	147.354	348.433
77	141.212	359.3
78	135.055	370.167
79	126.751	381.033
80	120.553	391.9
81	114.038	402.767
82	105.996	413.633
83	98.0345	424.5
84	90.882	435.367
85	84.033	446.233
86	75.593	457.1
87	69.2778	467.967
88	61.5597	478.833
89	43.3214	489.7

Bin	E_{e+}	Z
61	245.231	185.433
62	250.391	196.3
63	256.544	207.167
64	265.584	218.033
65	271.149	228.9
66	276.204	239.767
67	281.875	250.633
68	287.521	261.5
69	293.33	272.367
70	298.99	283.233
71	305.186	294.1
72	313.378	304.967
73	321.586	315.833
74	328.053	326.7
75	334.271	337.567
76	342.646	348.433
77	348.788	359.3
78	354.945	370.167
79	363.249	381.033
80	369.447	391.9
81	375.962	402.767
82	384.004	413.633
83	391.966	424.5
84	399.118	435.367
85	405.967	446.233
86	414.407	457.1
87	420.722	467.967
88	428.44	478.833
89	446.679	489.7

DATA

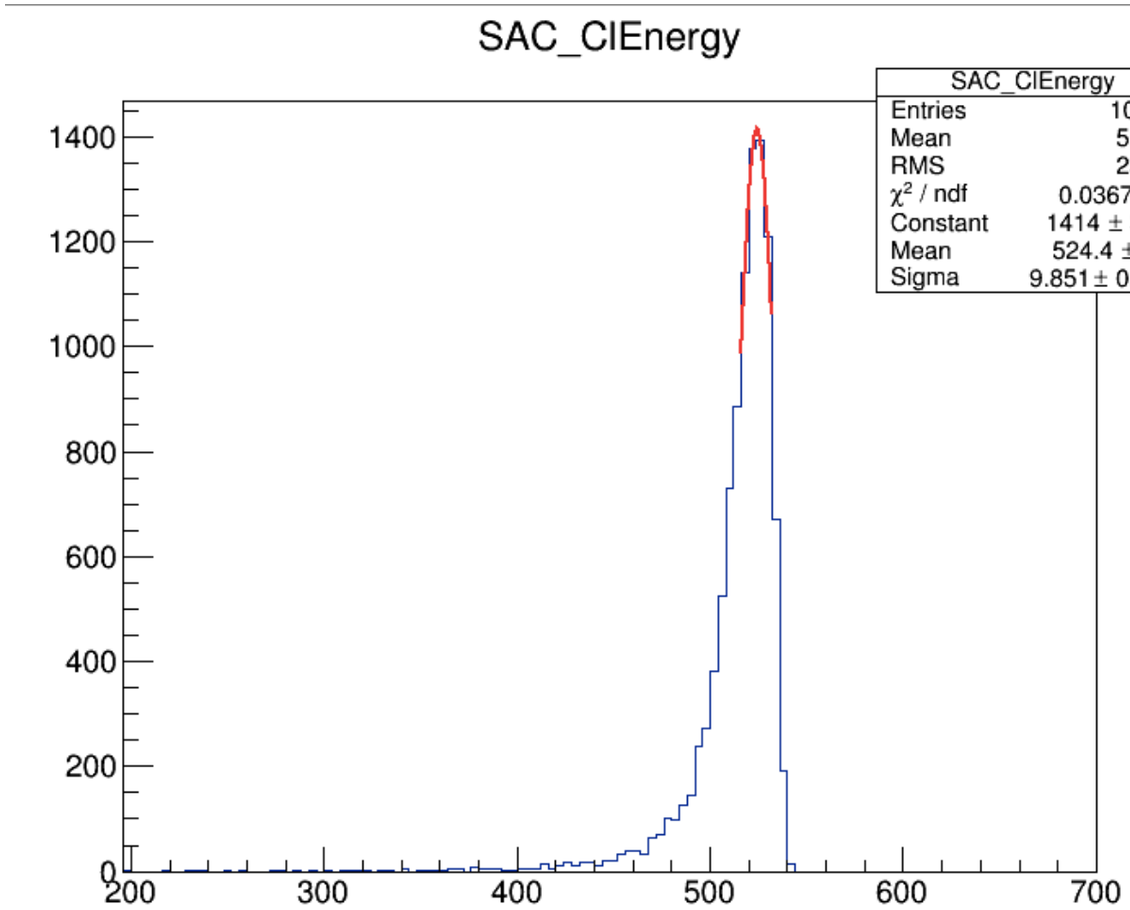
ChId	E_{e+}	Z
61	217.261	185.433
62	224.344	196.3
63	229.092	207.167
64	233.206	218.033
65	240.293	228.9
66	250.209	239.767
67	260.402	250.633
68	269.064	261.5
69	274.239	272.367
70	281.991	283.233
71	296.881	294.1
72	309.538	304.967
73	326.916	315.833
74	335.187	326.7
75	346.977	337.567
76	356.594	348.433
77	370.133	359.3
78	368.225	370.167
79	389.596	381.033
80	426.129	391.9
81	440.005	402.767
82	481.571	413.633
83	513.133	424.5
84	533.811	435.367
85	541.437	446.233
86	543.318	457.1
87	549.117	467.967
88	545.224	478.833
89	532.399	489.7

ChId	E_{sac}	Z
61	272.739	185.433
62	265.656	196.3
63	260.908	207.167
64	256.794	218.033
65	249.707	228.9
66	239.791	239.767
67	229.598	250.633
68	220.936	261.5
69	215.761	272.367
70	208.009	283.233
71	193.119	294.1
72	180.462	304.967
73	163.084	315.833
74	154.813	326.7
75	143.023	337.567
76	133.406	348.433
77	119.867	359.3
78	121.775	370.167
79	100.404	381.033
80	63.8714	391.9
81	49.9949	402.767
82	8.42922	413.633
83	-23.1332	424.5
84	-43.8115	435.367
85	-51.4366	446.233
86	-53.3178	457.1
87	-59.117	467.967
88	-55.2242	478.833
89	-42.399	489.7

For E_{e+}~100 MeV **ChId seed PVeto** ChId 27 for MC
ChId 41 for DATA

STUDY OF THE SAC RESPONSE IN DATA AND MC

MC production 10k photons on SAC



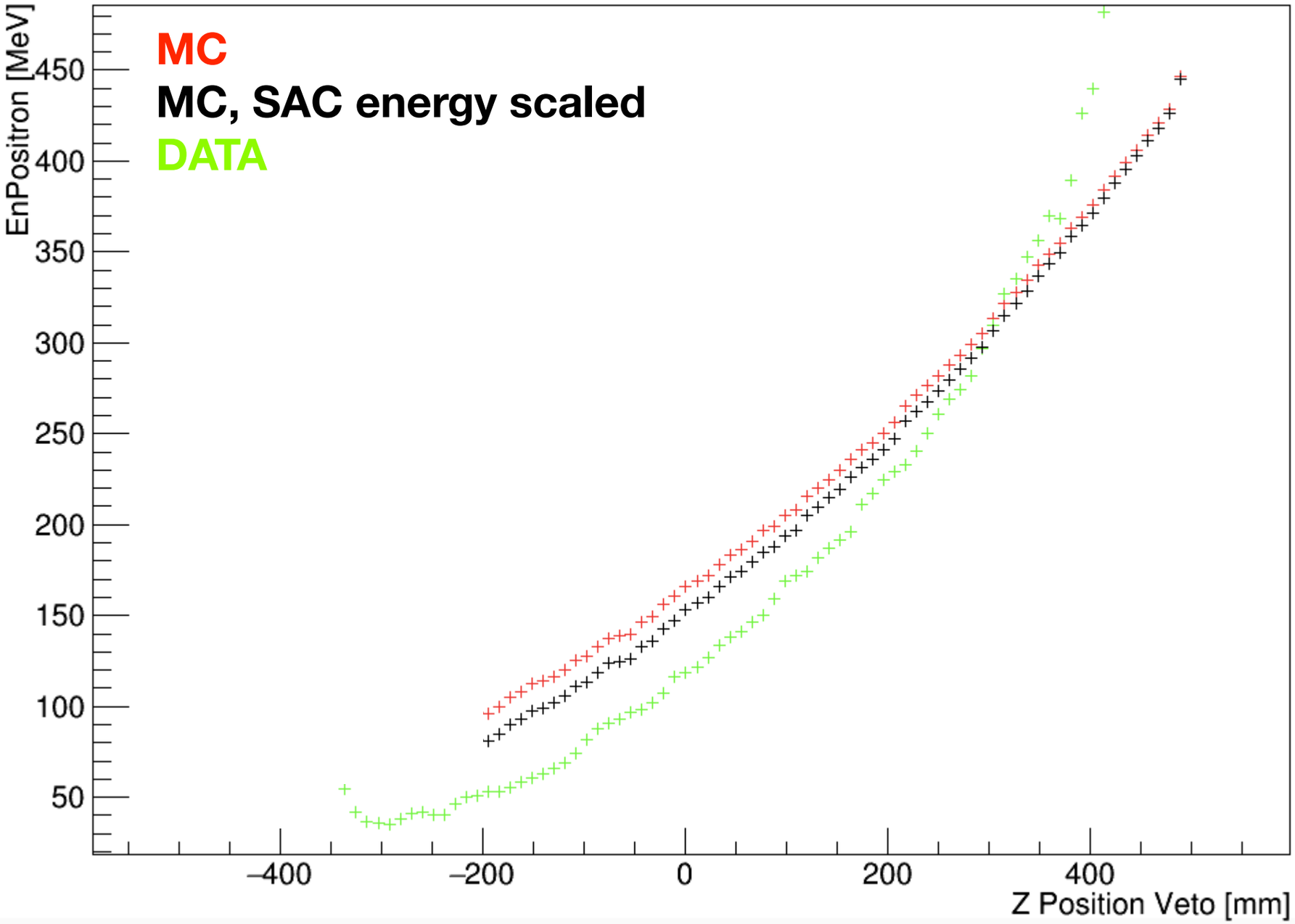
Gaussian Fit Mean (524.4 ± 0.3) MeV

E = 545 MeV

Scale E factor =545/524.4~1.039

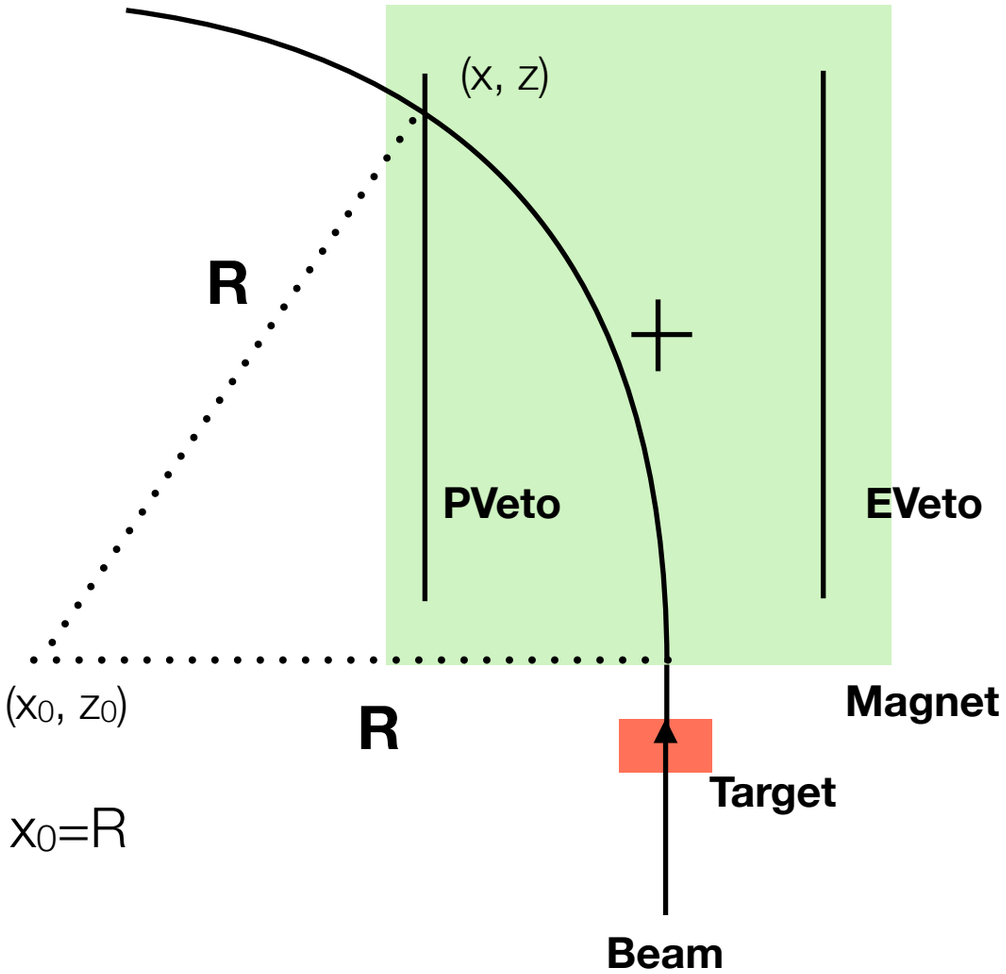
All the following studies have been performed both for MC and MC rescaling SAC energy

POSITRON ENERGY VS Z PVETO POSITION



MC and DATA points are not in agreement

Analytic function



Starting from the circumference equation..

$$(x-x_0)^2 + (z-z_0)^2 = R^2$$

Knowing that $R = p/0.3B$

It's possible to write:

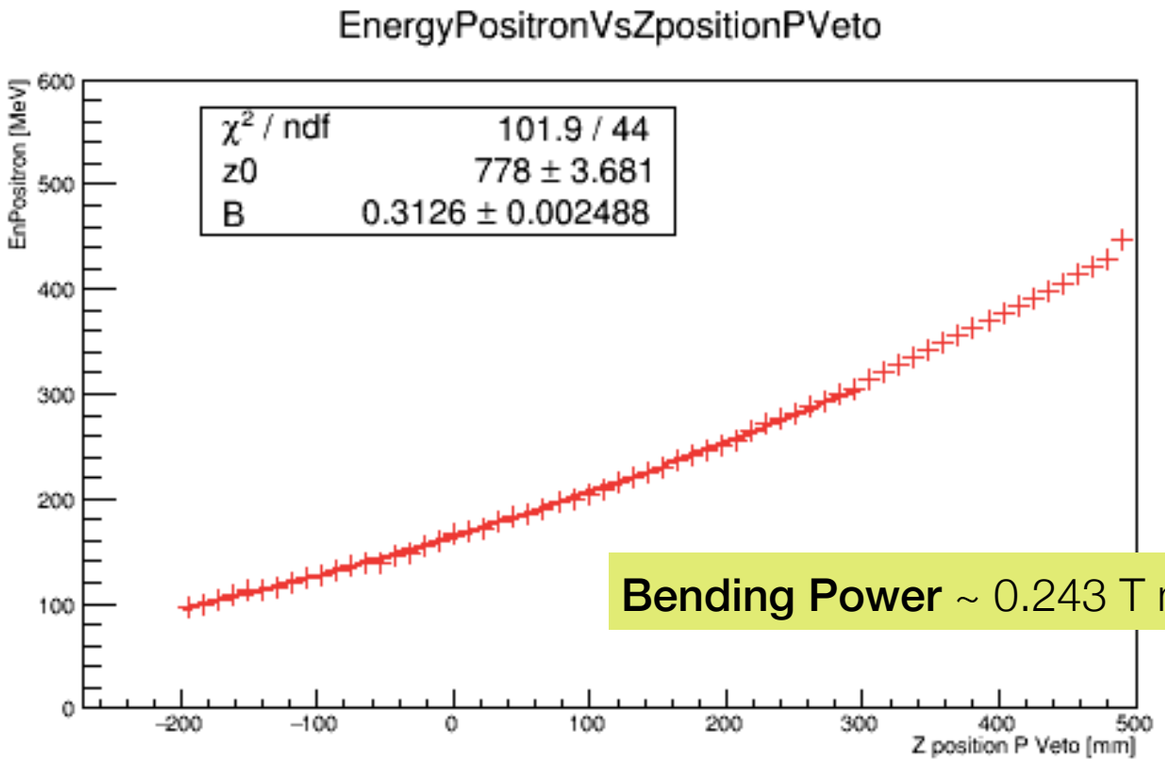
$$p = \frac{0.3\ B}{2x}\ [\ (z + z_0)^2 + x^2\ ]$$

Where..

z_0 starting point of the magnetic field, with a possible component due to a mismatch of the Z PVeto position

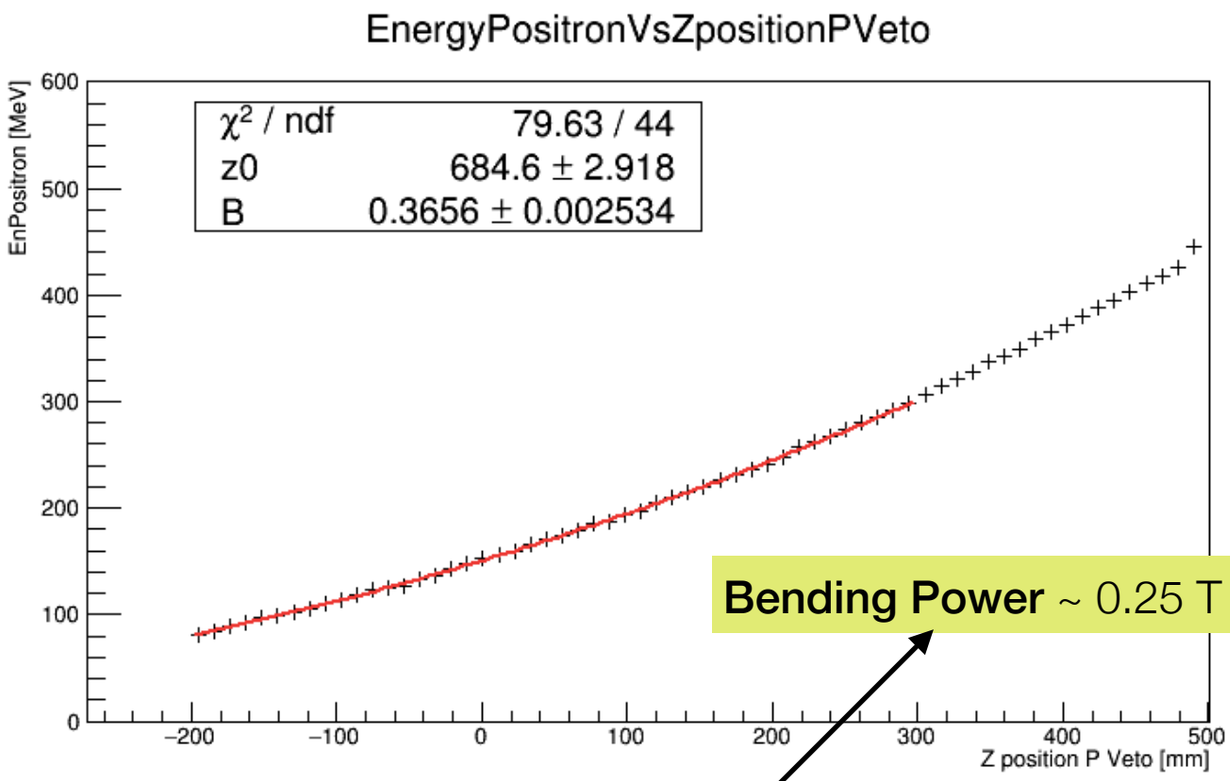
X position PVeto
182.5 mm

MC



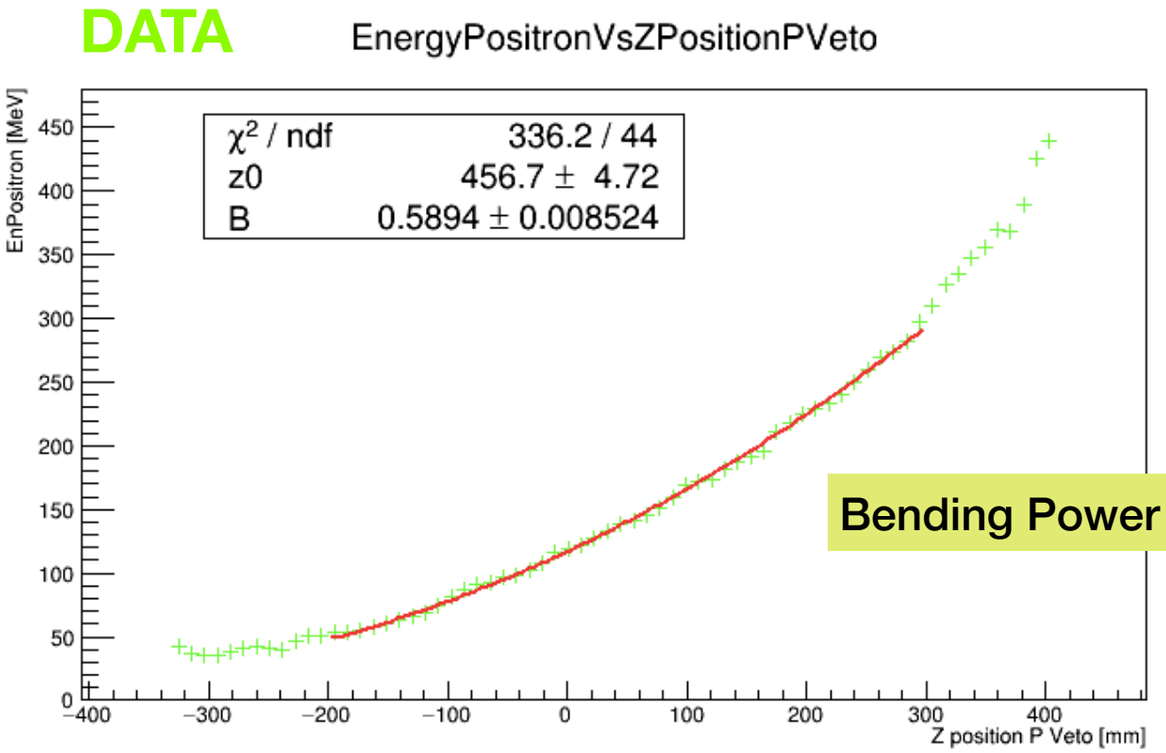
Bending Power ~ 0.243 T m

MC, SAC energy scaled



Bending Power ~ 0.25 T m

DATA



Bending Power ~ 0.27 T m

The **bending power** is defined as the field integral ∫Bdl
We can estimate it by:
Bending Power = B * z_0

Comparison between DATA and MC

Bending Power similar but..
B and Z_0 not in agreement

SOME CONSIDERATIONS

Looking at the previous tables for a given positron energy value

	ChId seed PVeto
E_{e+}~100 MeV	ChId 27 for MC ChId 41 for DATA

A positron of the same energy hits different PVeto fingers in MC and DATA

Check for MC done with MC single positron of different energies

Two possible explanations..

1. The position of the fingers of the PVeto is different in DATA and MC or the starting point of the magnetic field is different between DATA and MC

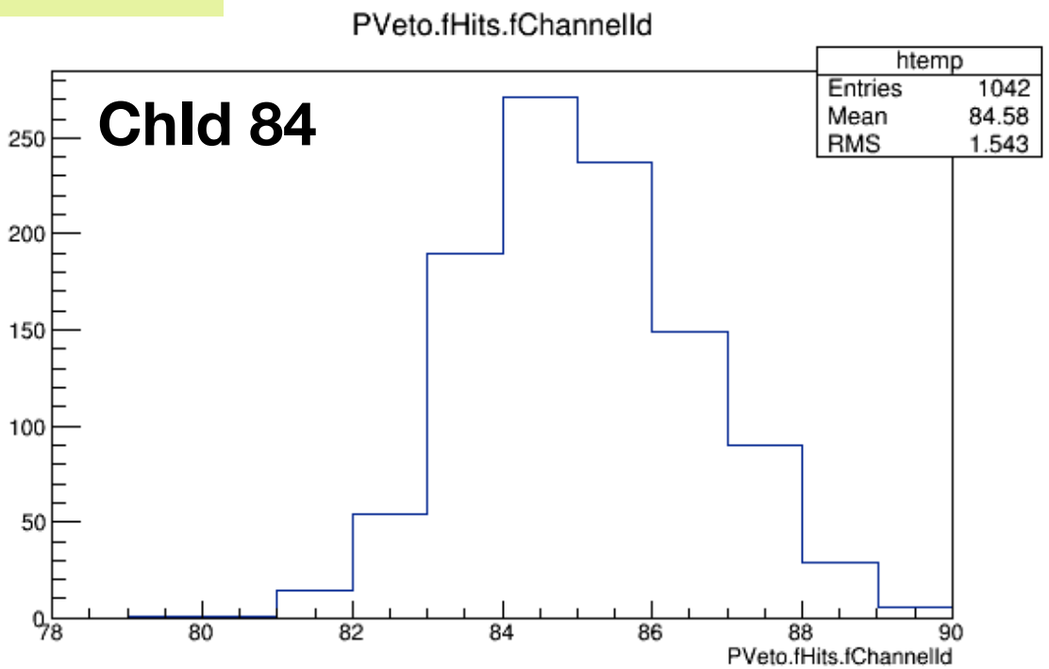
2. SAC energy response is not the same of MC
   - addiction component due to pile up in DATA
   - SAC Energy Calibration

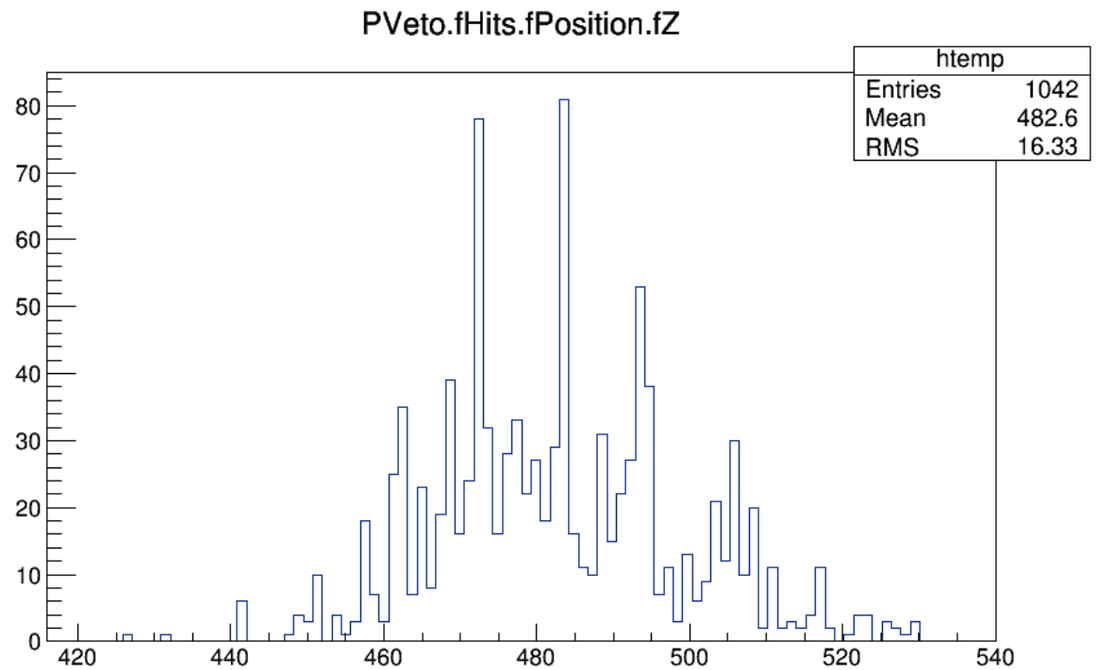
..Is the previous indirect study trustable?

MC with single positron at different energy hitting the PVeto was studied, in order to check the ChId of the PVeto hit

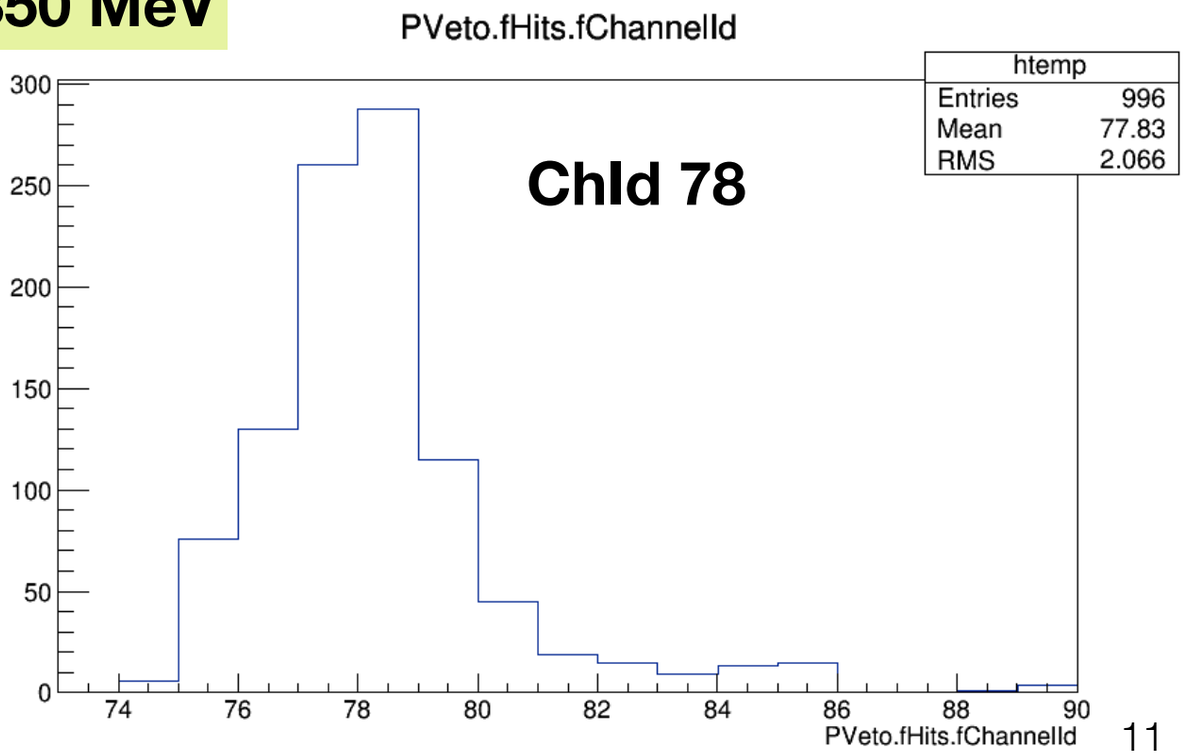
MC HITS ChannelId PVeto and Z Position

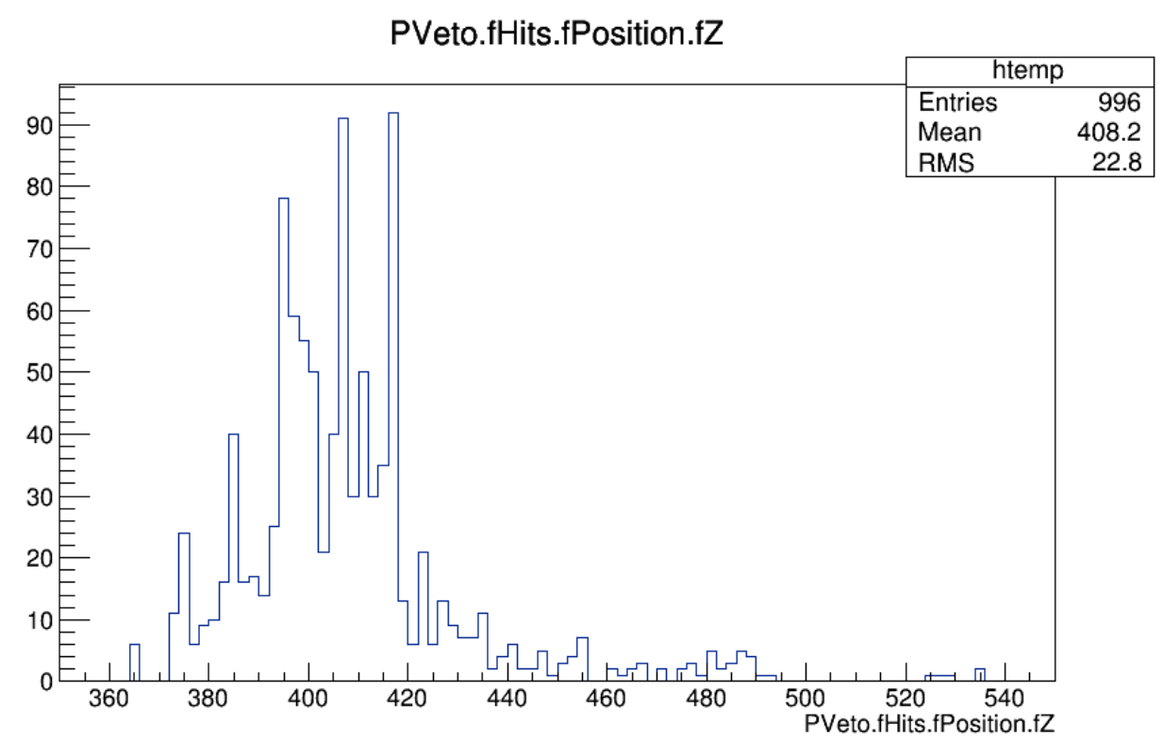
E=400 MeV



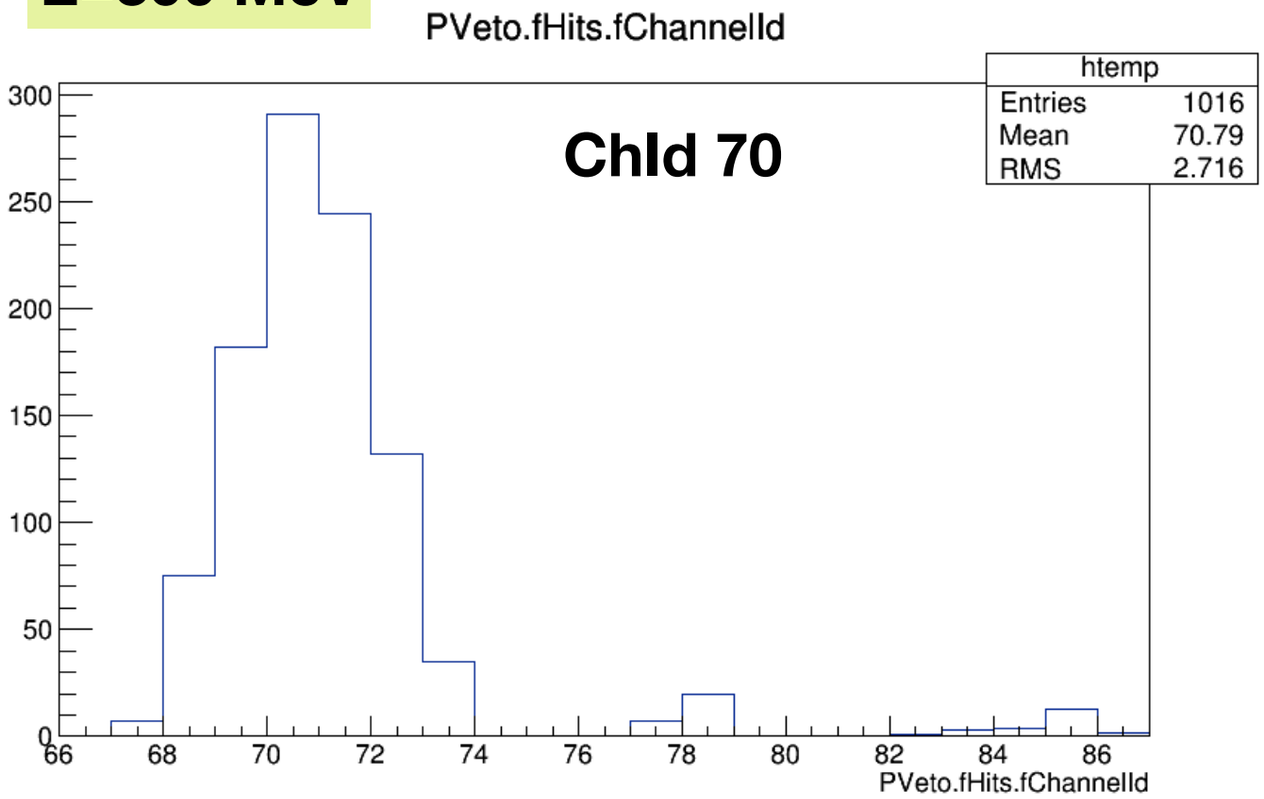


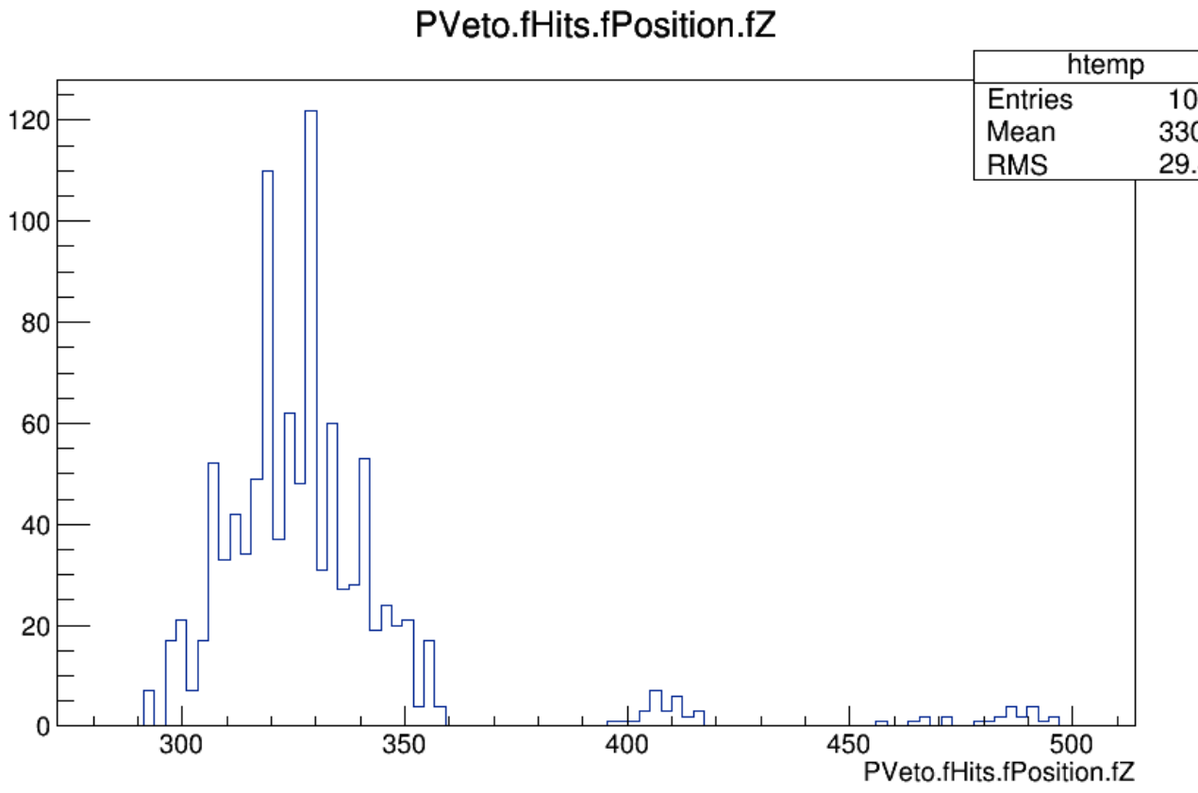
E=350 MeV



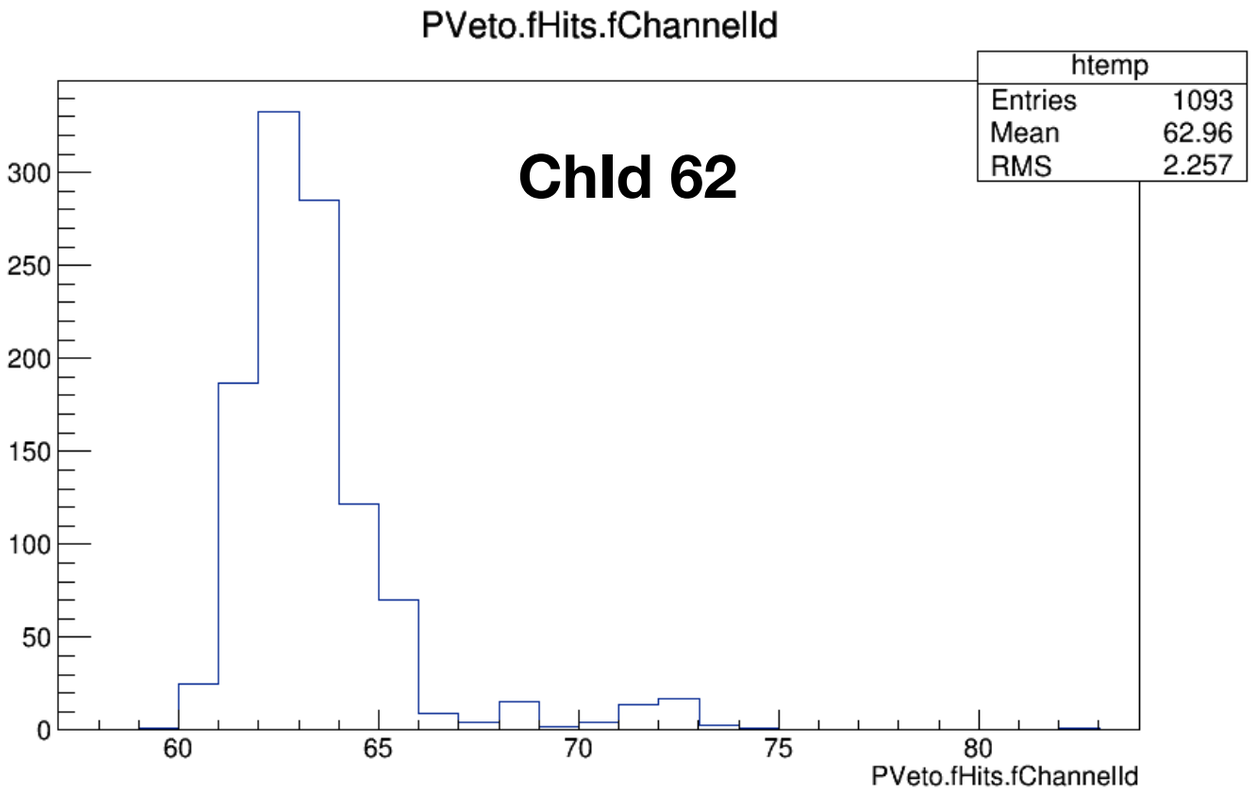


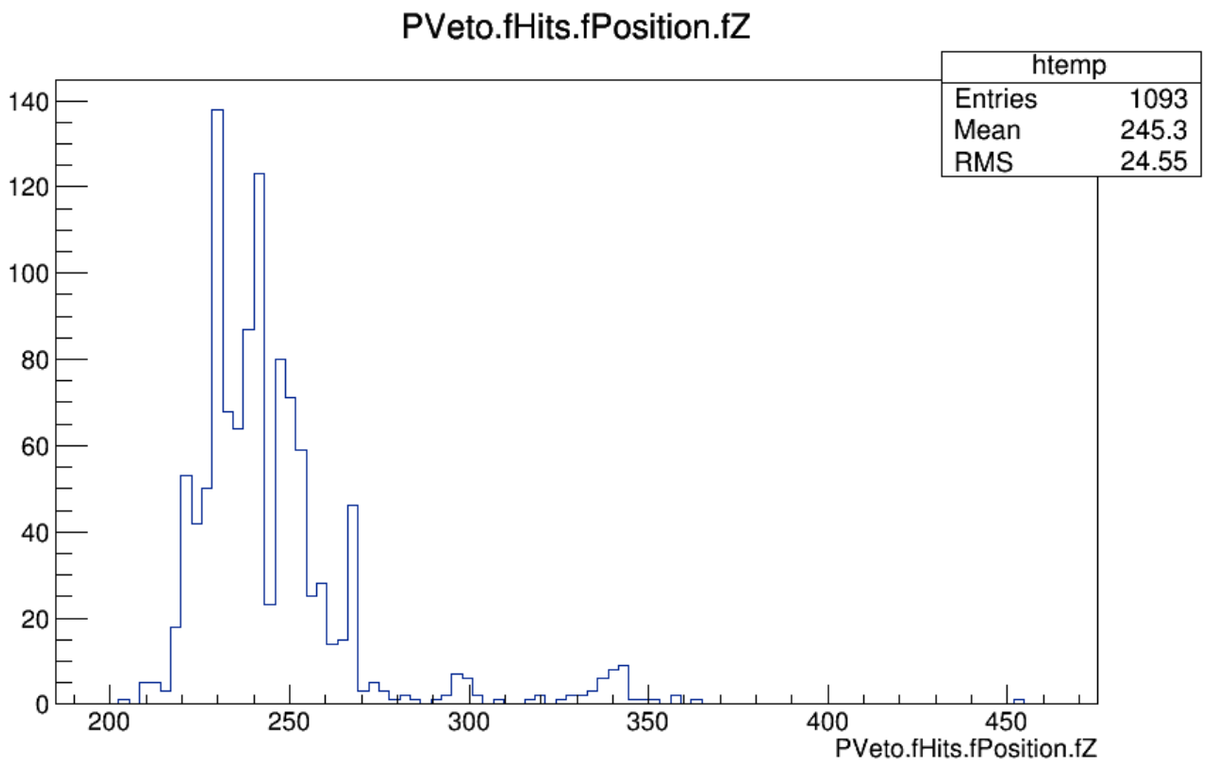
E=300 MeV



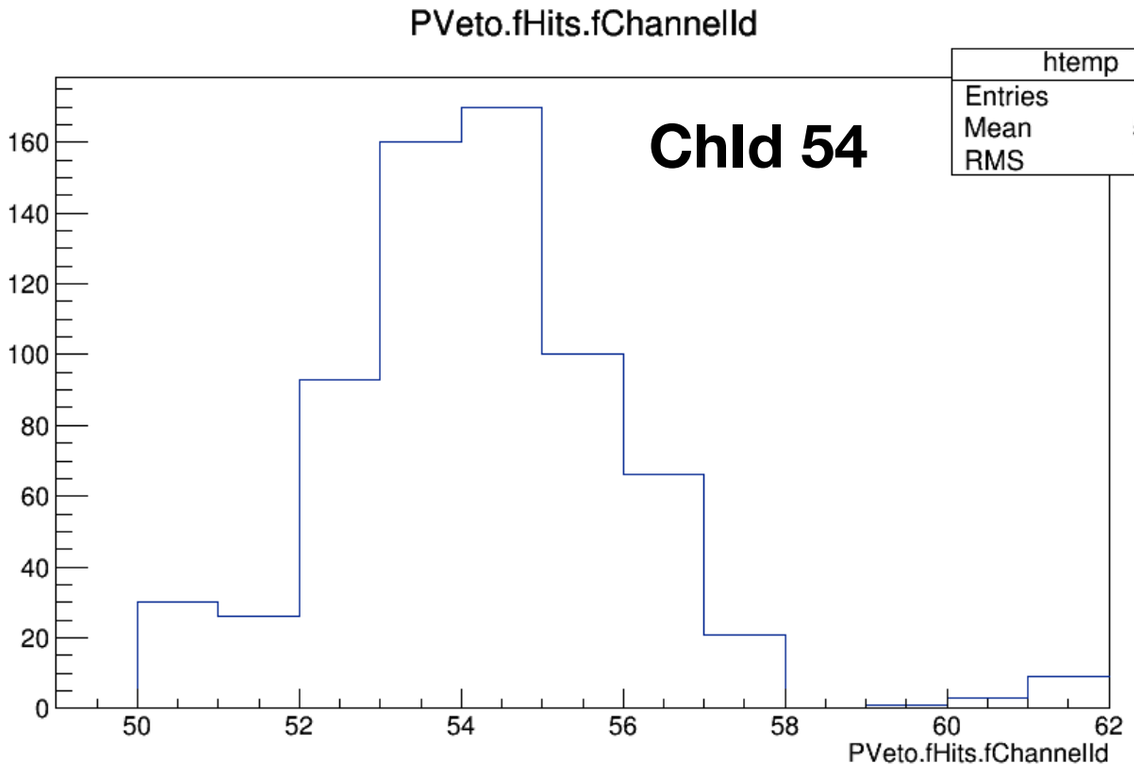


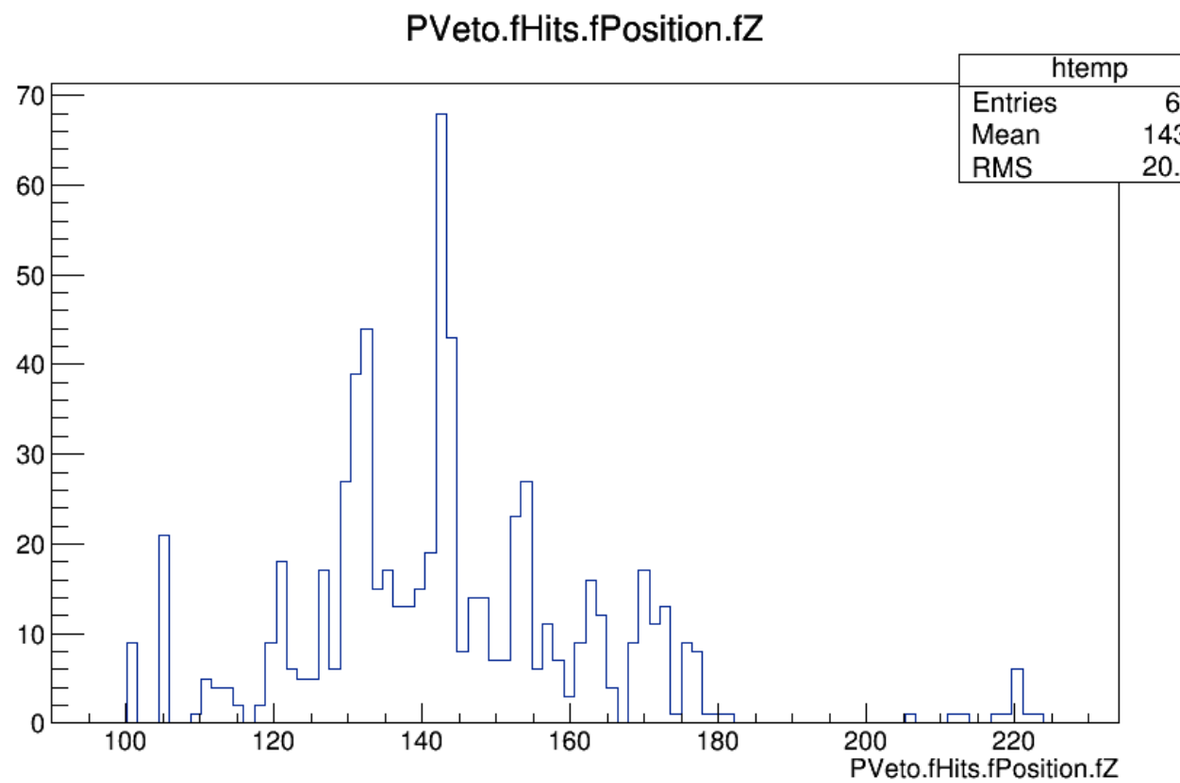
E=250 MeV



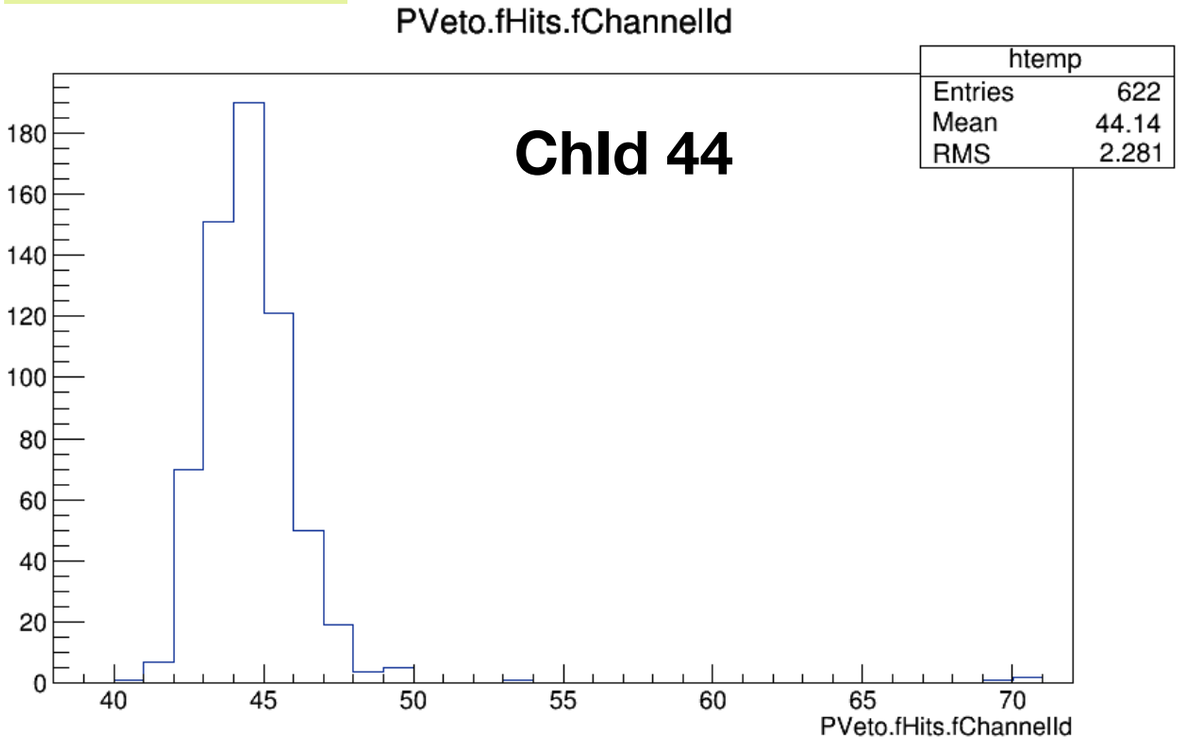


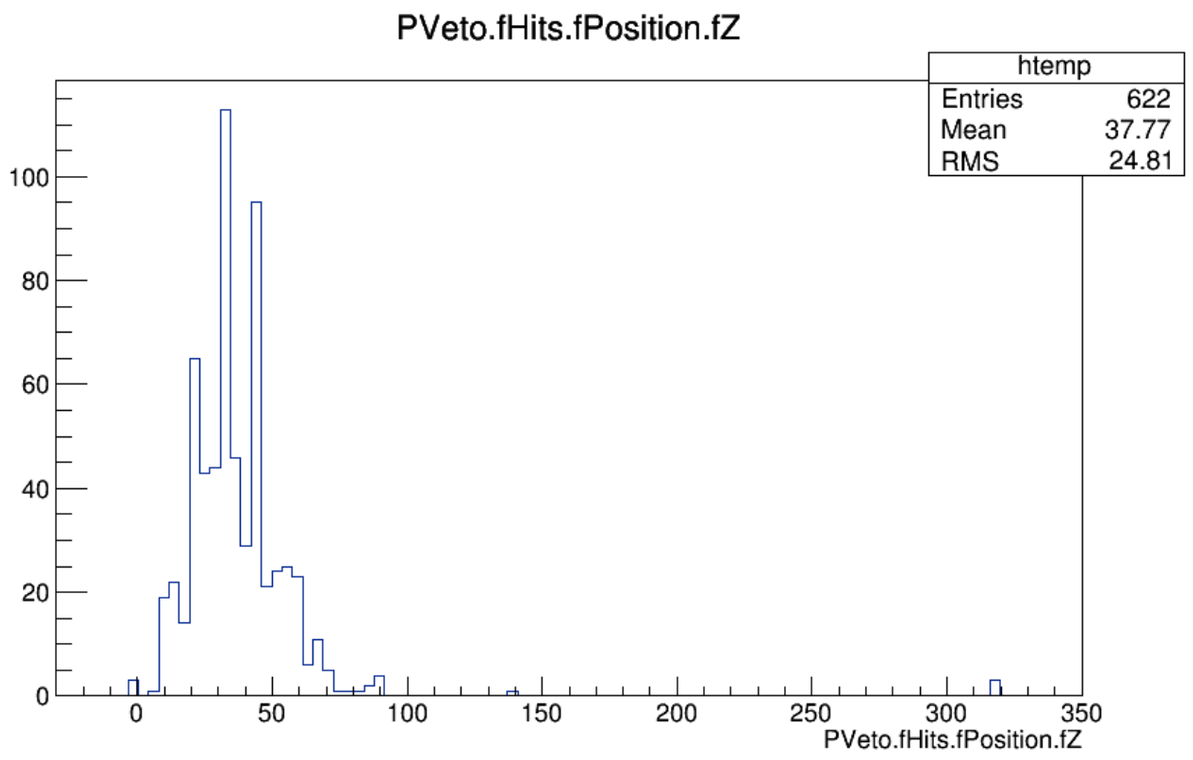
E=200 MeV



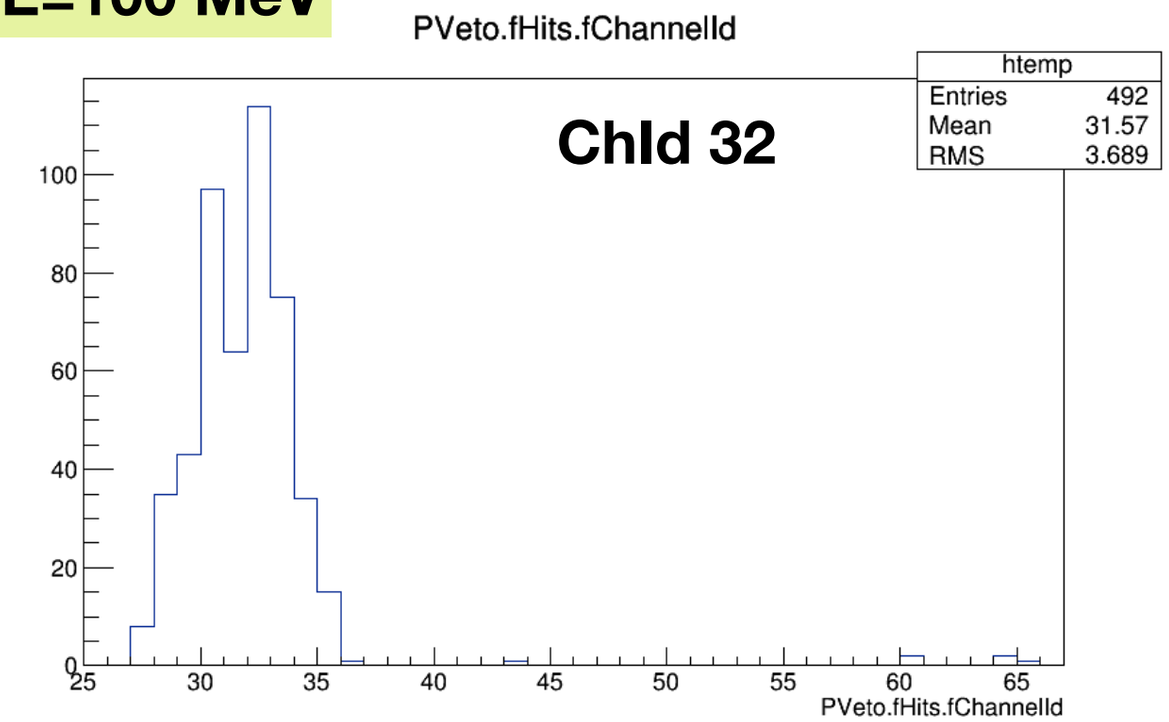


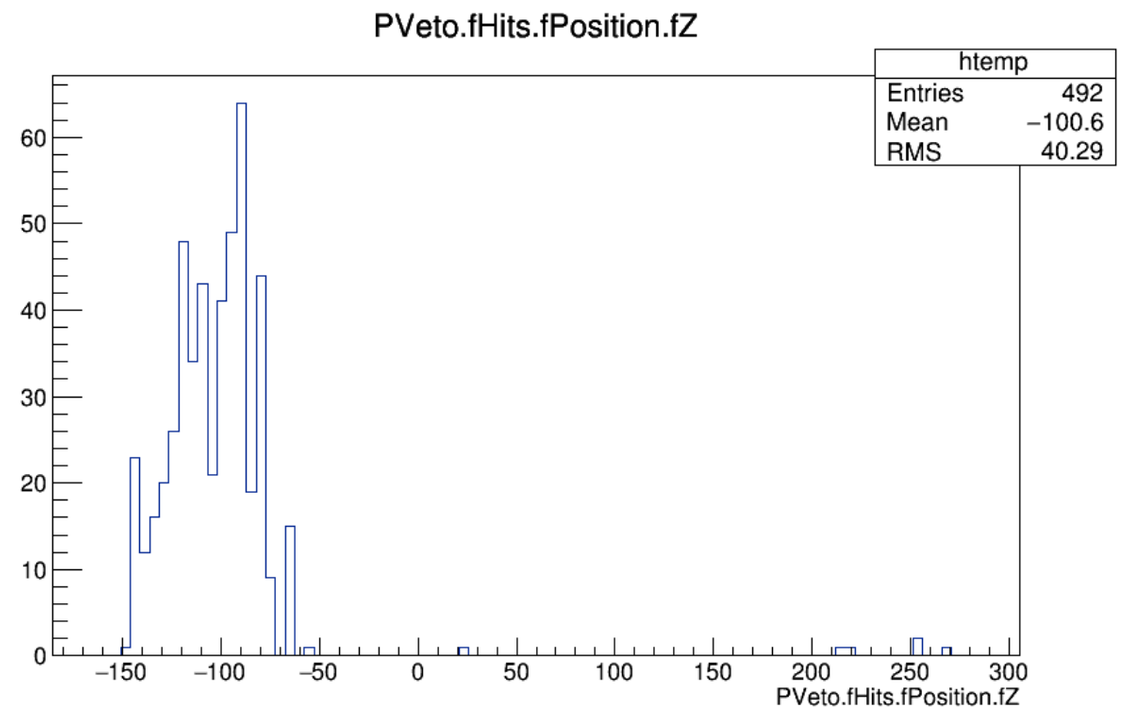
E=150 MeV



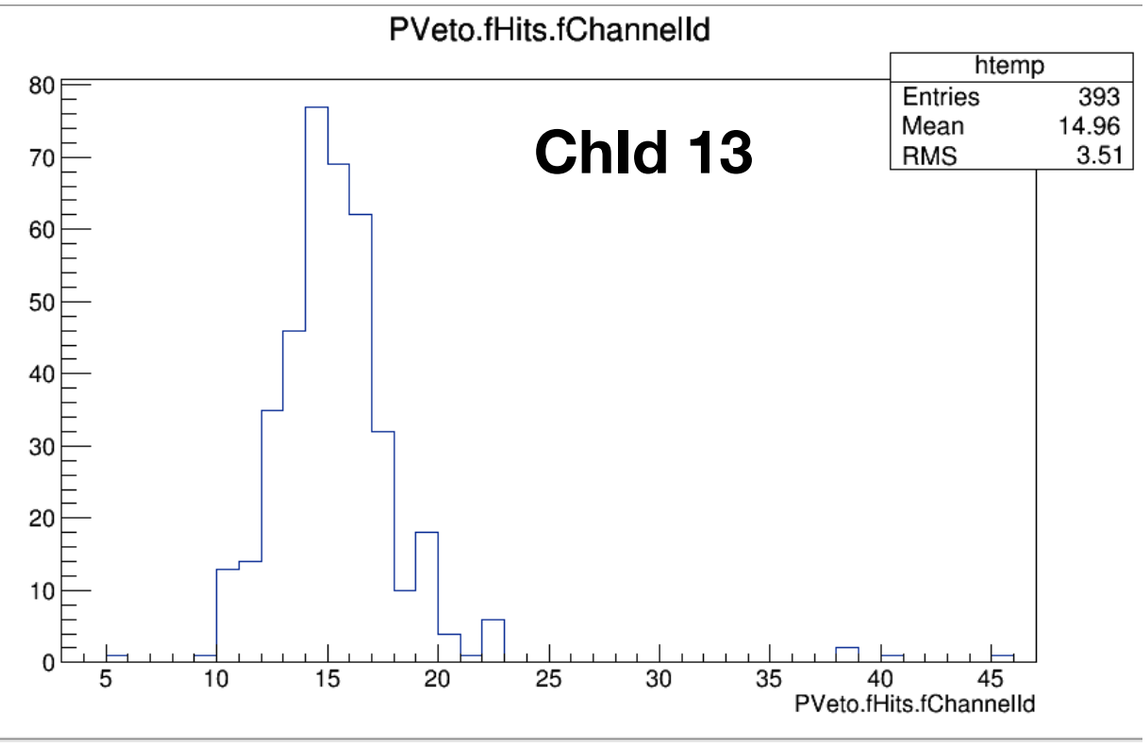


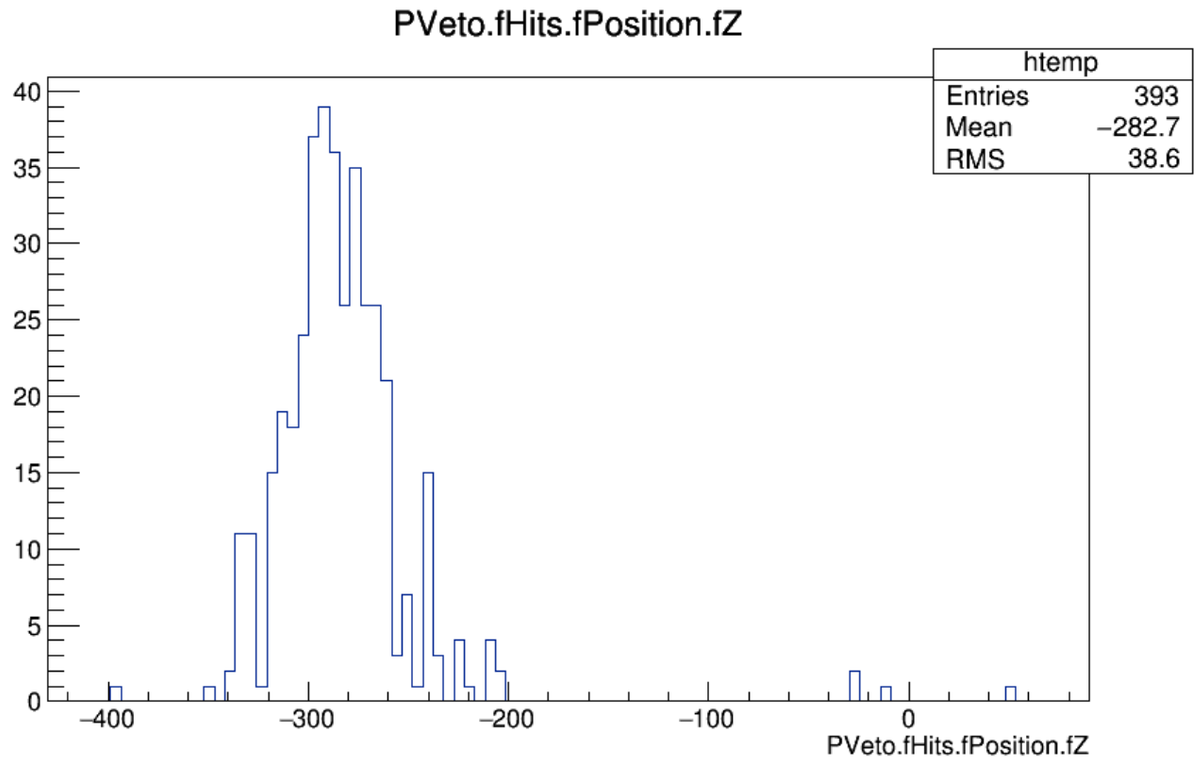
E=100 MeV





E=50 MeV



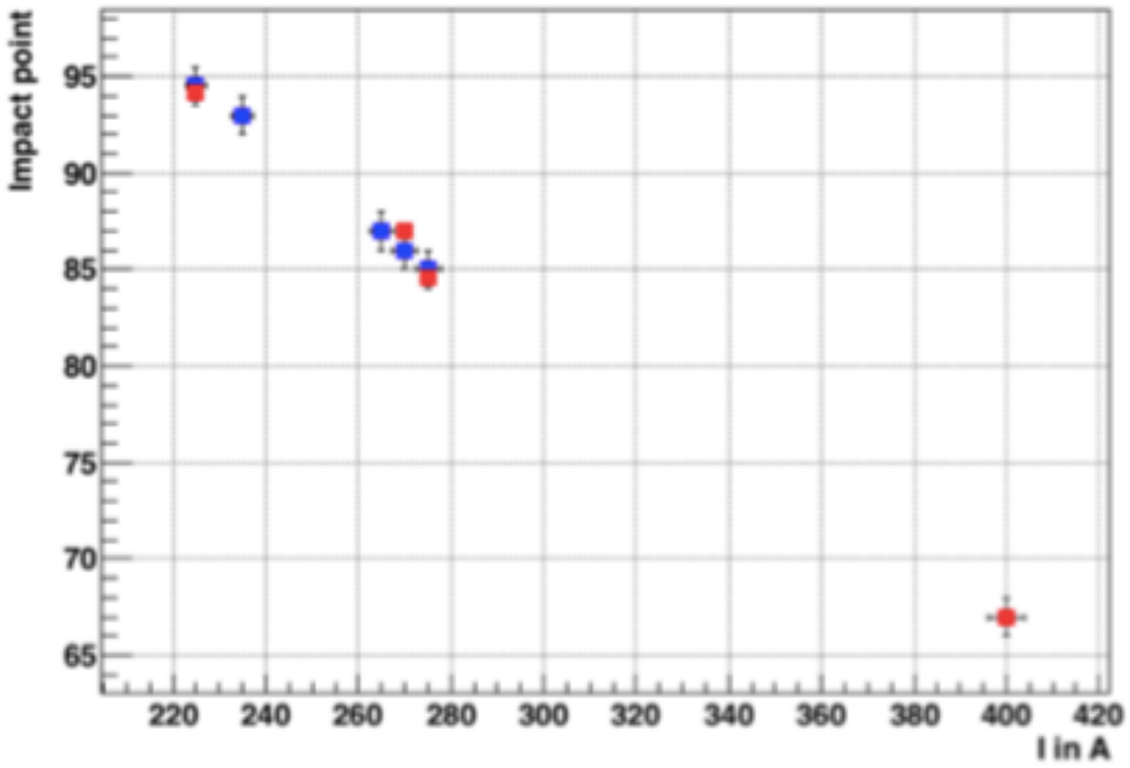


PVeto chld hit

E	MC Single Pos	MC	MC scaled	DATA
		from the previous tables		
50	13			
100	32	27	32	41
150	44	41	43-44	51
200	54	52	55	59
250	62	62	63	66
300	70	70-71	71	71-72
350	78	77	78	75-76
400	84	84	85	79-80

The study made with these MC production is in agreement with the MC, with SAC energy scaled

Looking back..November 2018



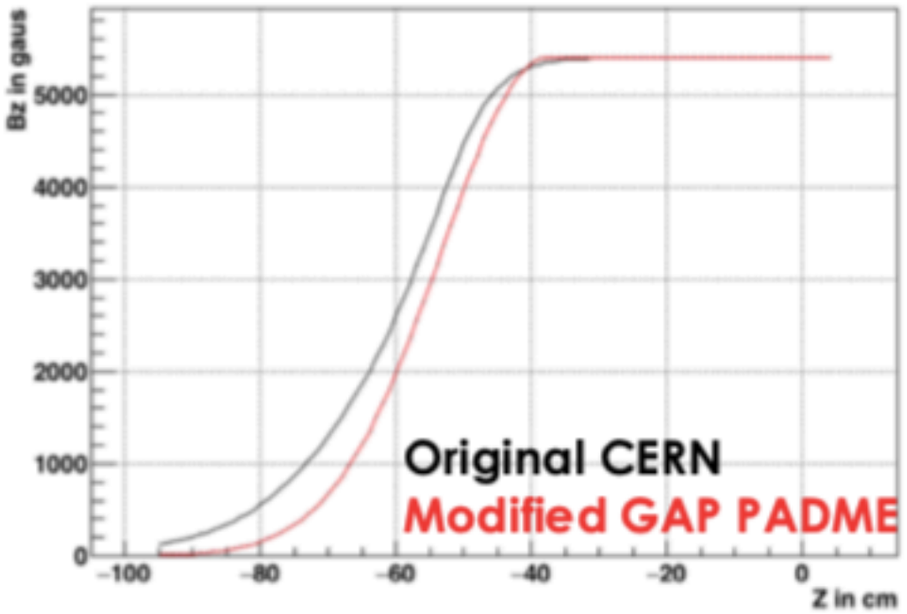
From this plot MC and DATA seem to be in agreement, considering the PVeto impact point

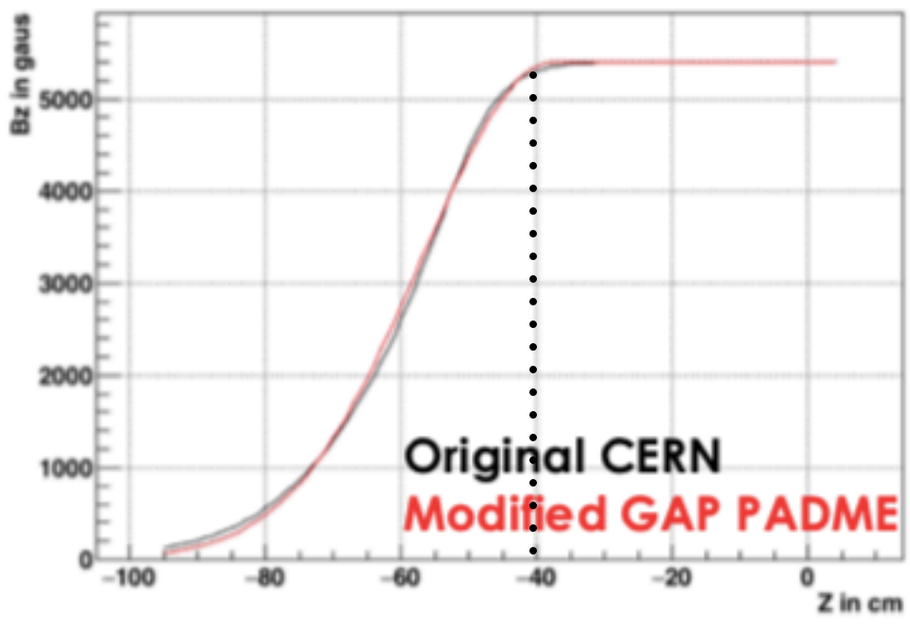
From Raggi's talk, 56th Scientific Committee Meeting

No need to think that something in the MC magnetic field has changed

A check was -anyway-performed

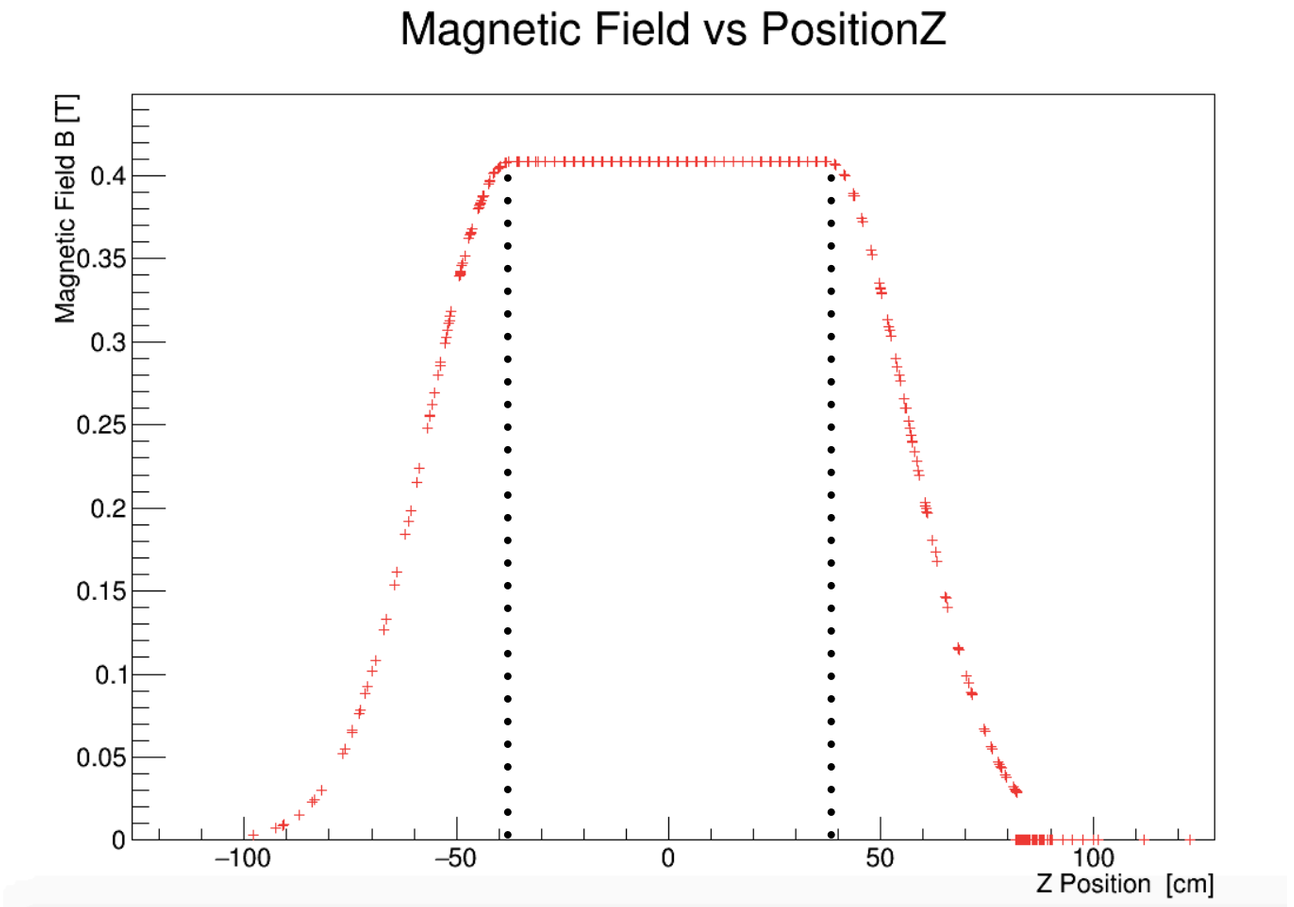
CHECK OF THE MAGNETIC FIELD MAP IN MC





-37.5

fConstantMagneticFieldZmin = -37.5*cm;
fConstantMagneticFieldZmax = 37.5*cm;

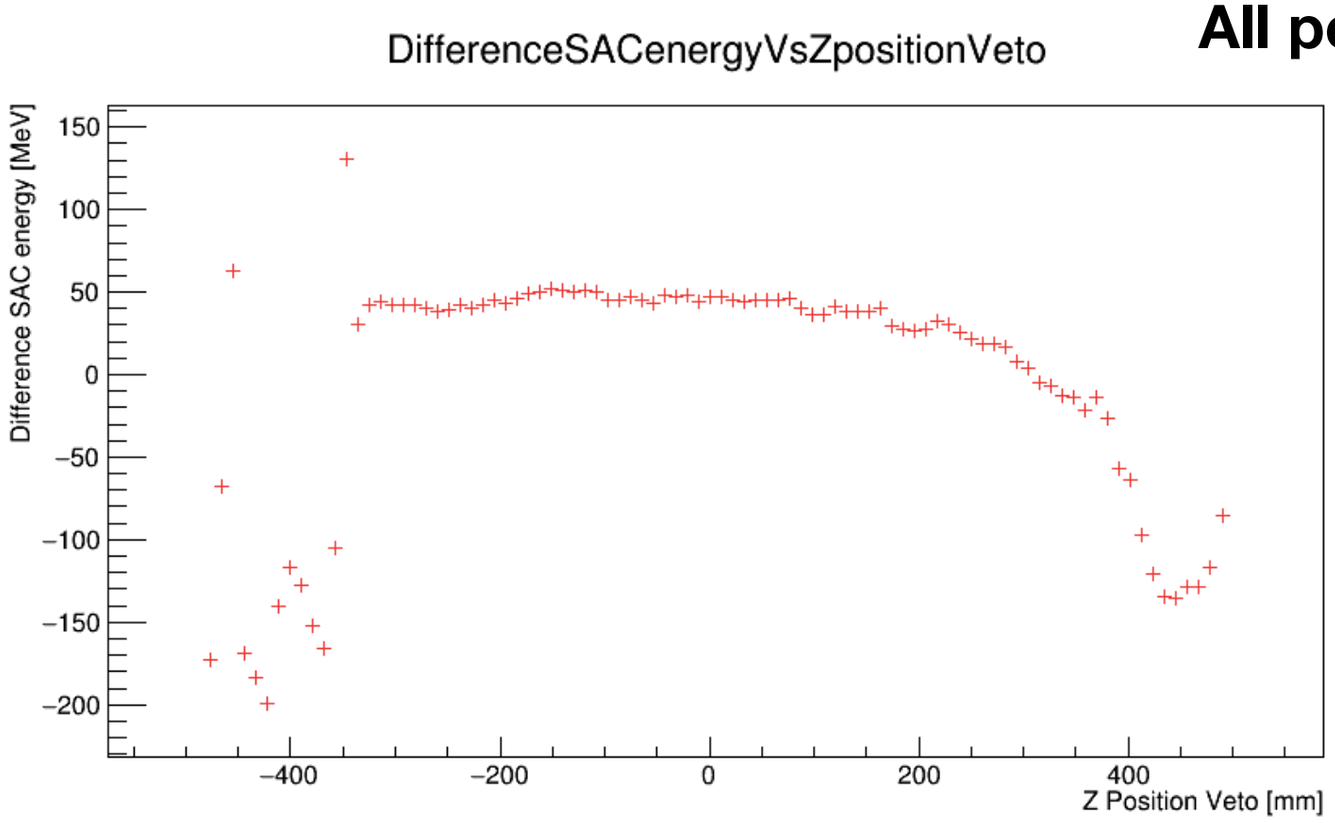


-37.5 cm 37.5 cm

E_{beam} 490 MeV

The center of the magnetic field is set at 0 in PADME frame

STUDY OF THE SAC ENERGY BETWEEN DATA AND MC

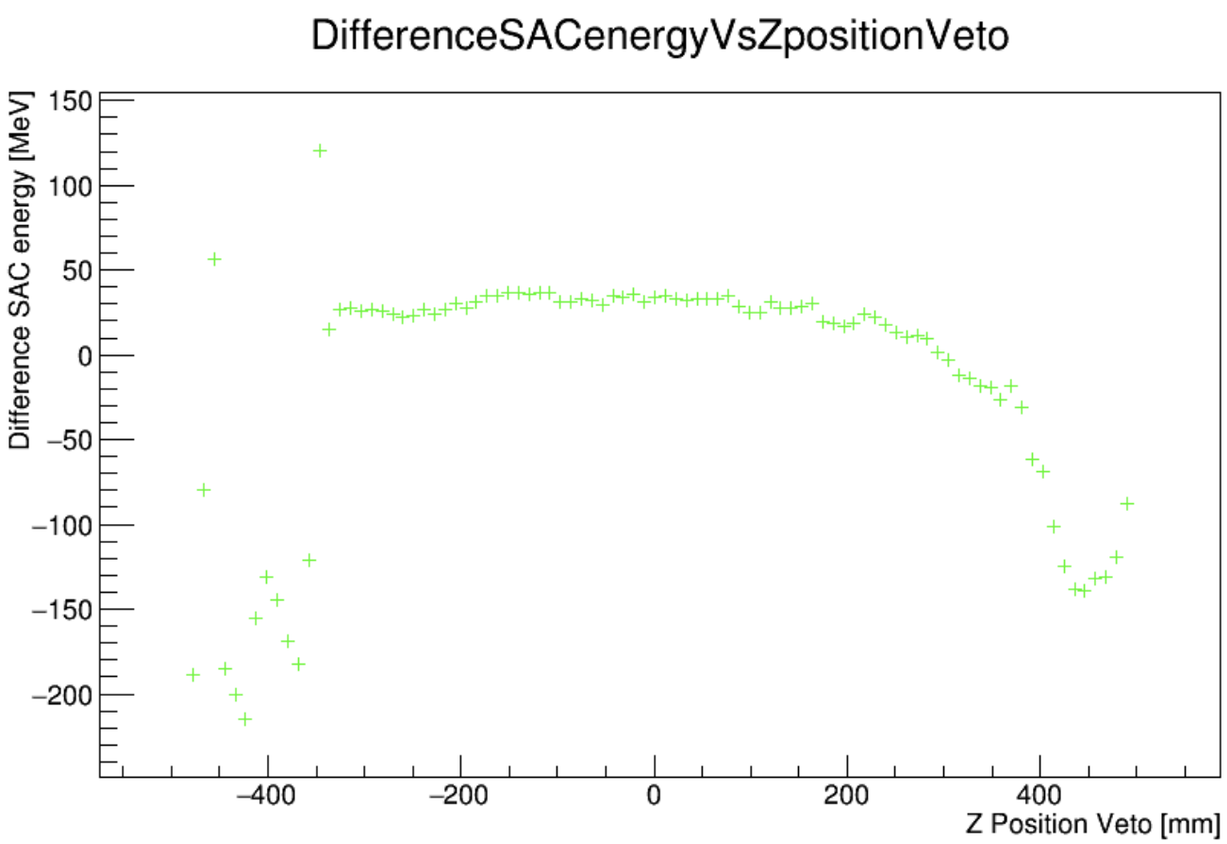


All points inserted

PileUp~50 MeV

In the region -200 < Z < 200

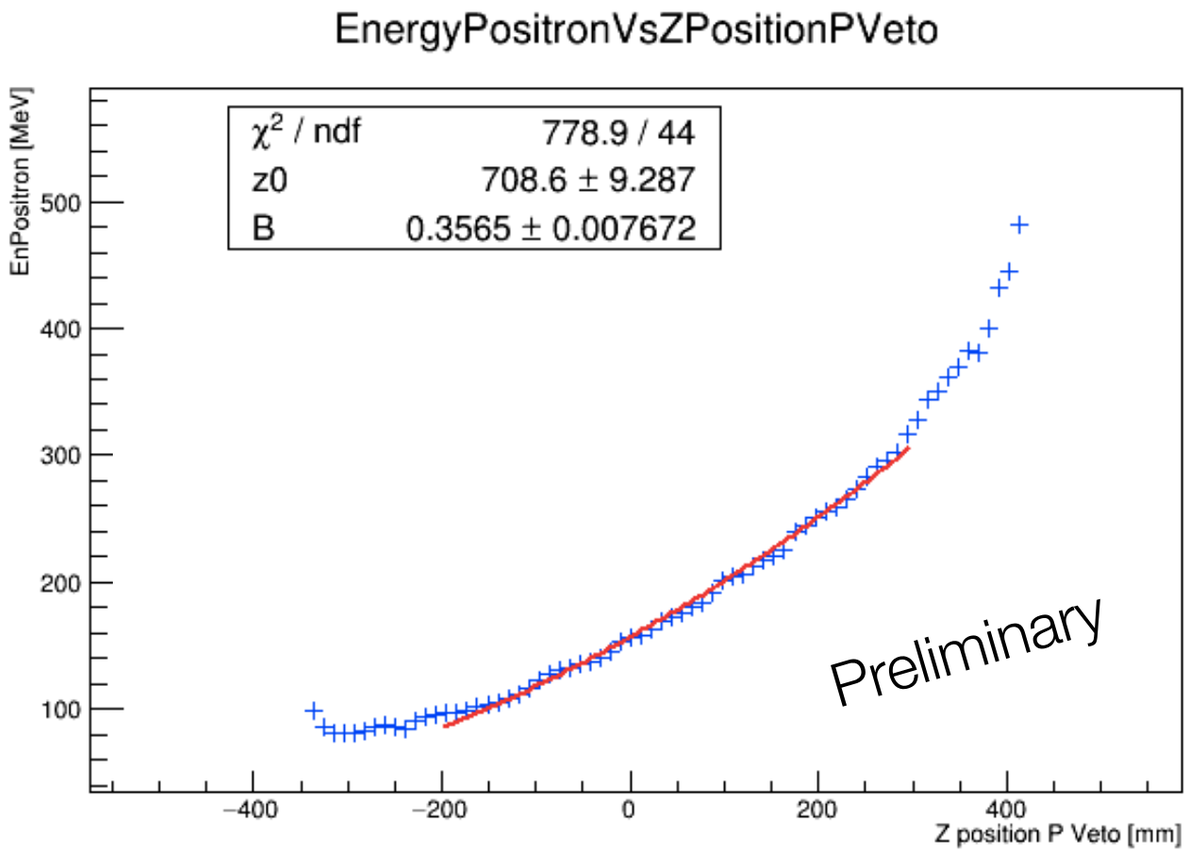
~45.3 MeV from a linear fit



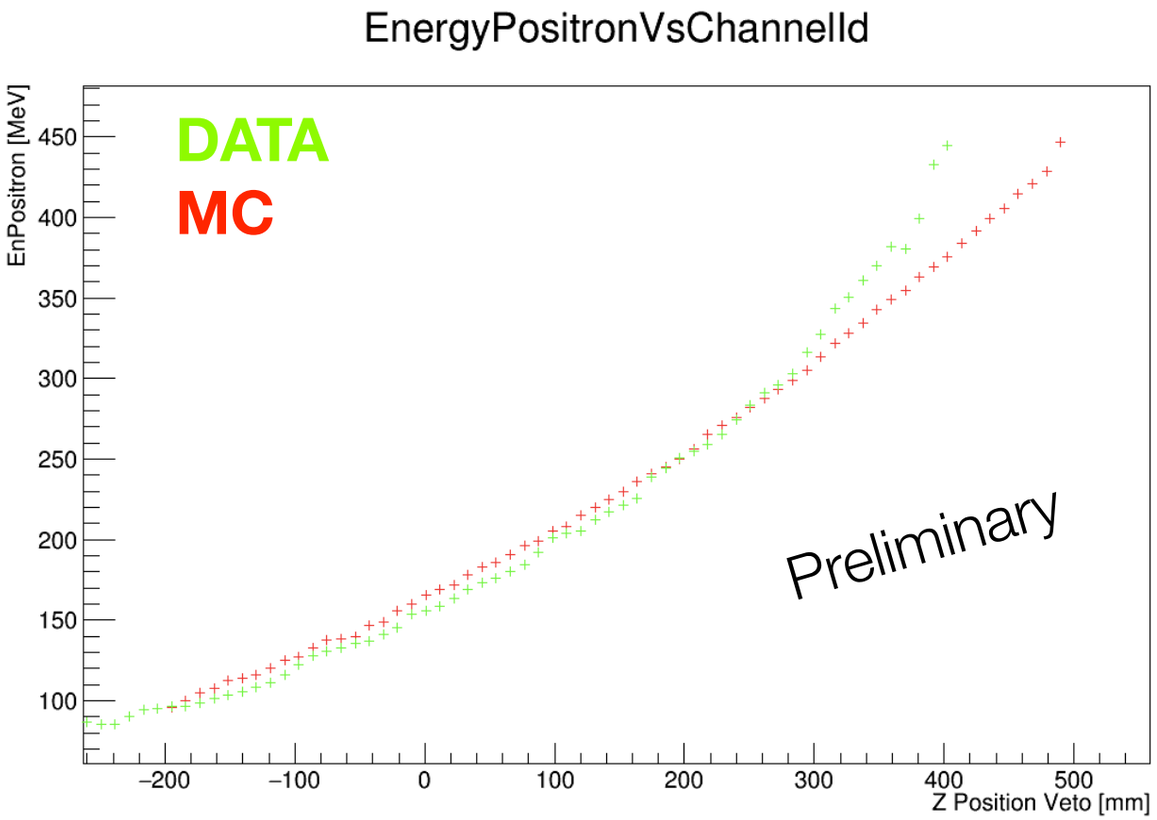
MC, SAC energy scaled

Pile Up ~ 30 MeV
rescaling MC SAC energy
Esac=Esac*1.039

Just trying… **Rescaling SAC energy for example of the 90%..**



In this way DATA parameters seem to be consistent



It’s possible to put an addiction parameter due to the SAC energy scale, to better perform the study

A short look at the HEP VETO..

Less Pile Up effect if we look at the HEP Veto

The study is still in progress

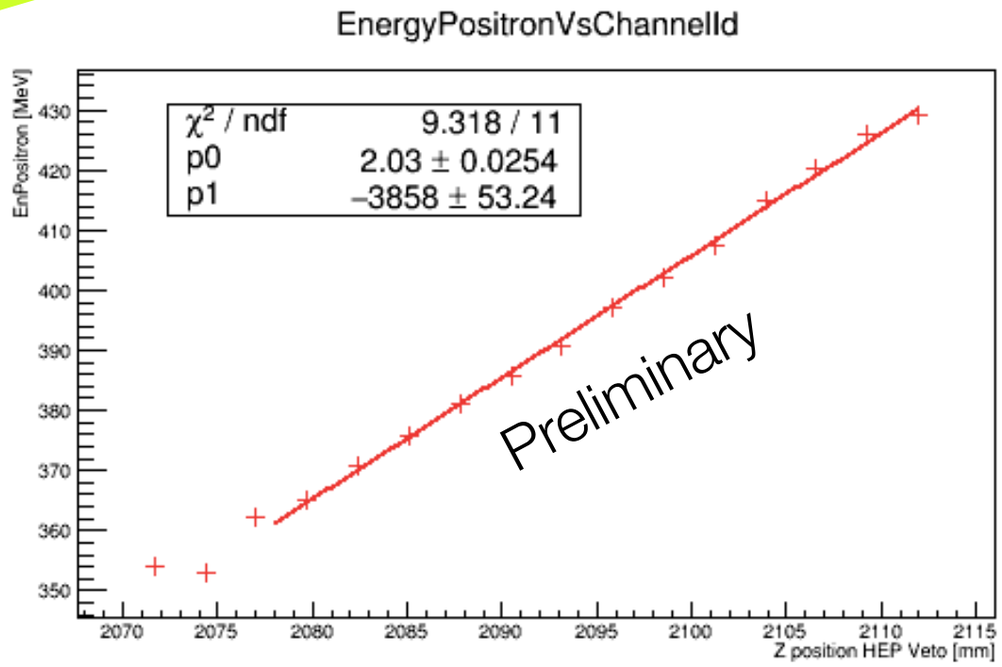
MC

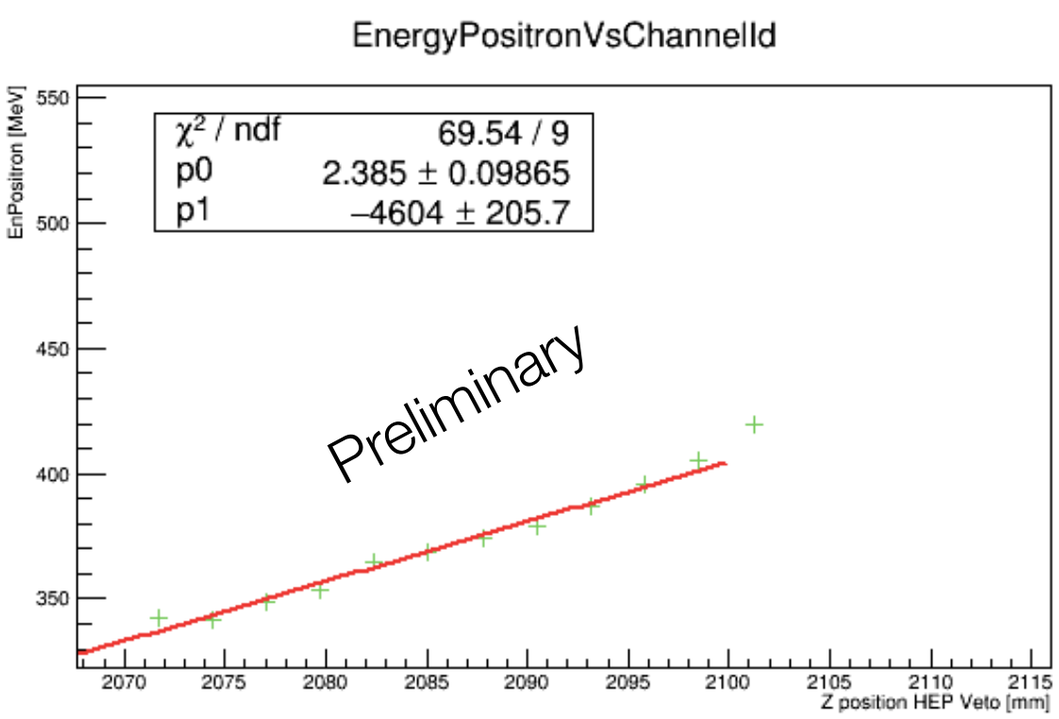
	E_{e+}	Z
0	352.979	2071.66
1	354.168	2074.34
2	362.28	2077.03
3	365.239	2079.72
4	370.871	2082.41
5	375.813	2085.09
6	381.169	2087.78
7	385.631	2090.47
8	390.738	2093.16
9	397.149	2095.84
10	402.096	2098.53
11	407.525	2101.22
12	414.897	2103.91
13	420.381	2106.59
14	425.842	2109.28
15	429.175	2111.97

DATA

	E_{e+}	Z
0	342.118	2071.66
1	341.87	2074.34
2	348.654	2077.03
3	353.353	2079.72
4	364.889	2082.41
5	368.922	2085.09
6	374.508	2087.78
7	379.377	2090.47
8	386.646	2093.16
9	395.466	2095.84
10	405.114	2098.53
11	419.453	2101.22
12	472.167	2103.91
13	494.618	2106.59
14	522.442	2109.28
15	535.641	2111.97

Fit not good





The analytic function doesn't describe well the trajectory of the positron that hits the HEP Veto.
For the moment a linear fit has been performed

CONCLUSIONS

- Looking at Bremmstrahlung events, a PVeto momentum calibration was performed, looking at MC and DATA

- Knowing the analytic function, it was possible to extract from this study the magnetic field value both for MC and DATA

- DATA and MC are not in agreement. The study is in progress to better understand the reason of this mismatch.