

Cluster Size Distributions: Present and Future

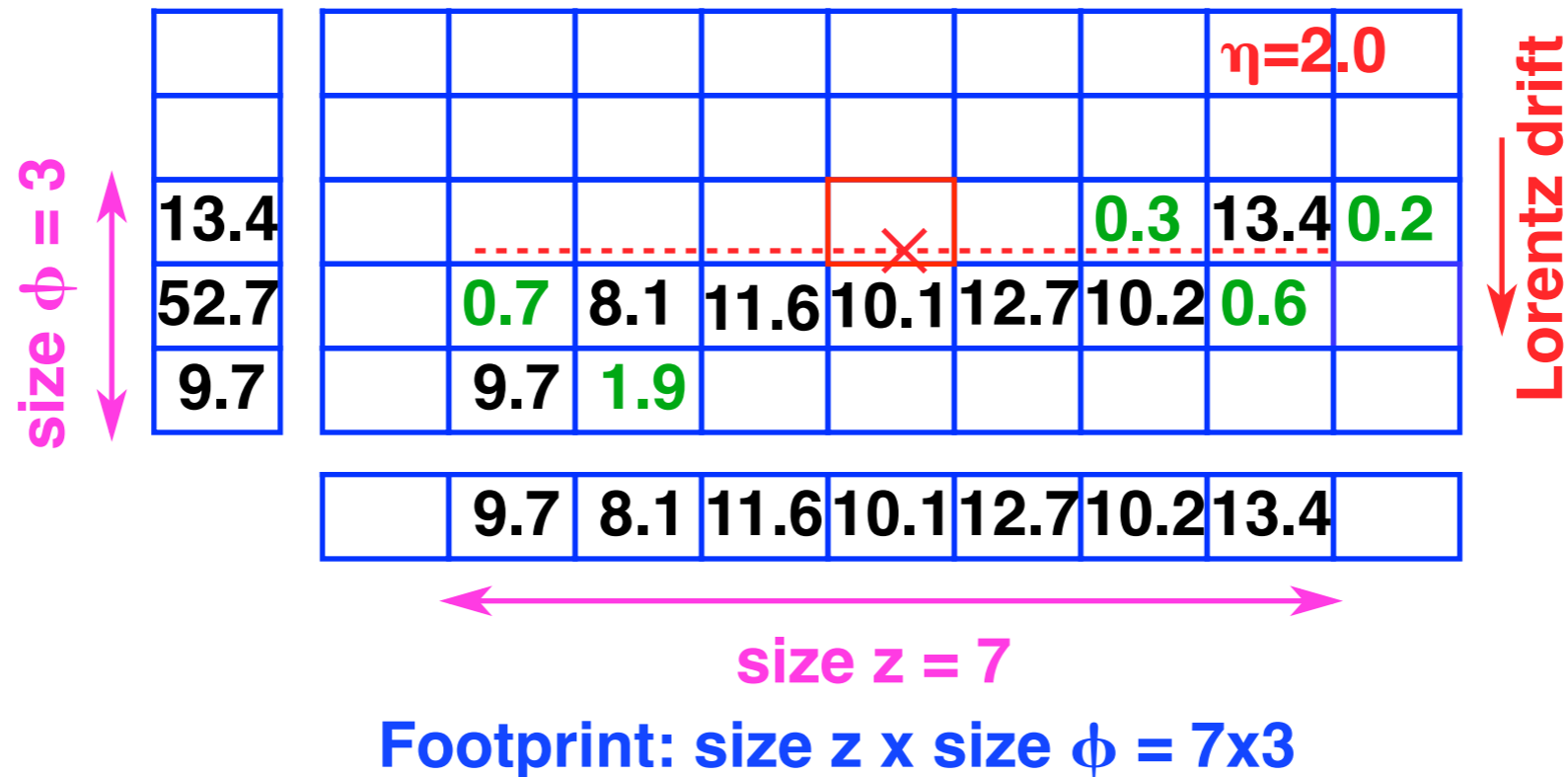
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Definitions

Pixel Barrel clusters have a distinctive elongated "L" shape with 1-2 pixels in each row of the sensor



The average number of struck pixels is $\sim(\text{size } z + 1)$ which is significantly smaller than the product $(\text{size } z) \times (\text{size } \phi)$

Footprint Distributions

They depend on a number of parameters:

- The three dimensions of the pixel cell $x\text{-dim} \times y\text{-dim} \times z\text{-dim}$
- The magnetic field, bias voltage, temperature
 - determine the Lorentz widths
- Readout chip thresholds
 - present ROC double column readout group has two “in-time” thresholds
 - * single hit in DCOL and multiple hit in DCOL
 - * behavior was not a design feature but an artifact of the design
- Distribution of local track angles
 - depends upon sensor location wrt IP and the IP luminous region shape
 - depends upon the PT distribution of all tracks
 - * inner planes see low PT “loopers” captured by B-field but not reconstructed
 - depends upon environmental factors
 - * beam halo/beam gas make “PKAM” clusters (caused significant readout problems)

Strategy for Simulations

Use real collision data as input to model Phase 2 detectors:

- Use a sample of minimum bias triggers
- Can correctly model the acceptance, PT, and environmental effects
- Any differences due to size and location of phase 2 planes are not modelled
- Make footprint distributions of clusters from Run 200091
 - use PixelTree ntuples
 - 1 file produces a sample of 53M clusters
 - make distributions for two different sets of clusters
 - * ALL clusters in each event
 - * only clusters on tracks
 - ▶ each of these is associated to a pair of local track angles and a track momentum
 - ▶ need this info to simulate clusters for other cases

All clusters: total = 52944248

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.097027	0.13007	0.038767	0.012262	0.0048937	0.0022583	0.0011772	0.00067506	0.0013264	0.28845
2	0.057824	0.14149	0.045677	0.015002	0.006593	0.0032664	0.0017744	0.0010575	0.0022362	0.27492
3	0.024716	0.07485	0.026763	0.0084269	0.0042022	0.0022102	0.0012611	0.00077288	0.0017764	0.14498
4	0.014863	0.049563	0.018329	0.0051272	0.0026904	0.0015455	0.00092917	0.00057738	0.0014349	0.09506
5	0.0092939	0.03334	0.013114	0.0033264	0.0017596	0.0010558	0.00068176	0.00043259	0.0011336	0.064138
6	0.0056963	0.021893	0.0091941	0.0022832	0.0011714	0.00073859	0.00049411	0.00033484	0.00093107	0.042736
7	0.0034377	0.014125	0.0062829	0.0015473	0.00082136	0.00050819	0.00034796	0.00024892	0.00075707	0.028076
8	0.0021826	0.0093969	0.0043881	0.0010718	0.00057627	0.00036713	0.00026099	0.00018664	0.00063138	0.019062
9	0.0014139	0.0063262	0.0031011	0.00076127	0.00041629	0.00027074	0.00018955	0.00013709	0.00051421	0.01313
10	0.00094365	0.0043489	0.0022254	0.00053736	0.00029639	0.00019922	0.00014497	0.00011111	0.00042686	0.0092338
11	0.00064331	0.0029586	0.0015899	0.00040013	0.00021409	0.00014404	0.00010911	8.2698e-05	0.00034867	0.0064905
12	0.00042134	0.0019401	0.0011104	0.00028611	0.00015705	0.00010954	8.2232e-05	6.4783e-05	0.00030682	0.0044784
13	0.00026028	0.0011891	0.0007168	0.00020083	0.0001147	7.8793e-05	6.188e-05	4.8229e-05	0.00025103	0.0029217
14	0.00015325	0.00069032	0.00045015	0.00014569	8.148e-05	5.9981e-05	4.7691e-05	4.0167e-05	0.00021567	0.0018844
15	8.4991e-05	0.0003802	0.000263	9.9001e-05	5.93e-05	4.5577e-05	3.5222e-05	2.9131e-05	0.00017622	0.0011726
16	4.5219e-05	0.0002032	0.00014931	6.5213e-05	4.2066e-05	3.4613e-05	2.5942e-05	2.4508e-05	0.0001526	0.00074267
17	2.3075e-05	0.00010291	8.6819e-05	4.289e-05	3.2212e-05	2.5798e-05	2.1606e-05	1.7235e-05	0.00012974	0.00048229
18	1.2541e-05	5.1704e-05	5.1776e-05	2.974e-05	2.2753e-05	1.9205e-05	1.7091e-05	1.5873e-05	0.00011369	0.00033438
OF	1.8847e-05	8.9434e-05	0.00011581	0.00010946	9.918e-05	9.1584e-05	8.3916e-05	7.7359e-05	0.001019	0.0017046
Sum	0.21906	0.49301	0.17238	0.051724	0.024244	0.013029	0.007746	0.004934	0.013881	

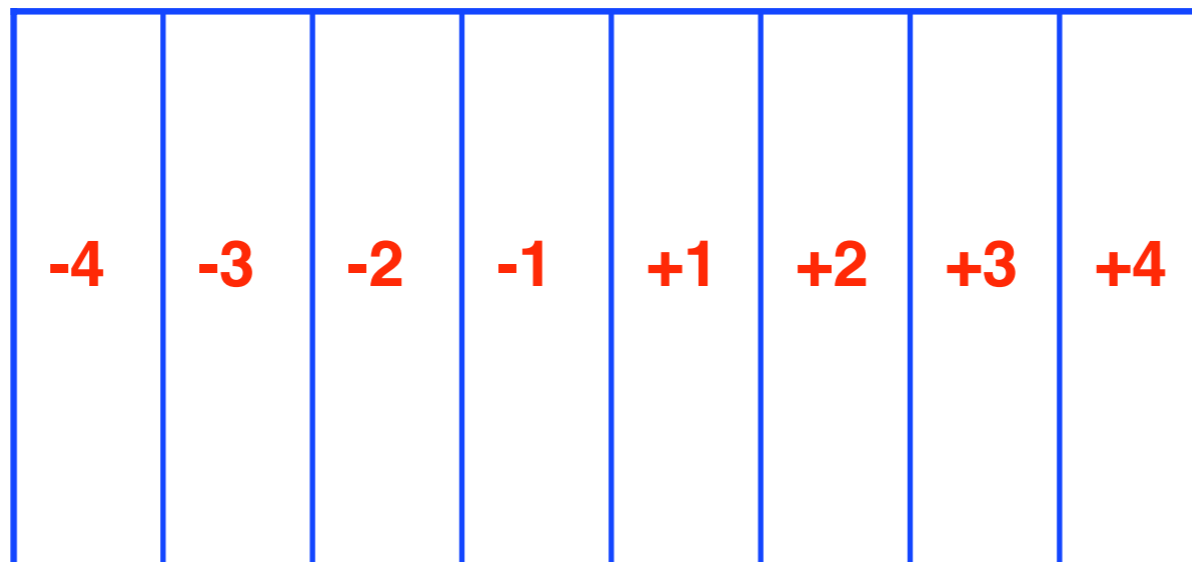
PKAMs?

low pt tracks?

Tracked clusters: = 21241126 = All Clusters/2.44

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.05768	0.12282	0.012904	0.00043901	0.00014411	6.0872e-05	3.2672e-05	2.015e-05	0.00010145	0.1942
2	0.055131	0.17787	0.024975	0.0011244	0.0003868	0.00016878	8.7519e-05	4.9291e-05	0.00019462	0.25999
3	0.028938	0.11691	0.022379	0.001528	0.00062304	0.0002716	0.00013747	7.396e-05	0.00021166	0.17107
4	0.017988	0.082772	0.019788	0.0014151	0.00061588	0.00030658	0.00015423	8.427e-05	0.00024551	0.12337
5	0.011345	0.057257	0.016408	0.0012613	0.00053218	0.00026166	0.00014994	8.4082e-05	0.00023139	0.08753
6	0.0067395	0.037115	0.012066	0.0010526	0.0004536	0.00022852	0.00012669	7.5702e-05	0.00021072	0.058069
7	0.0039896	0.023598	0.0083345	0.00081413	0.0003569	0.00018459	0.0001063	6.6287e-05	0.00018563	0.037636
8	0.0024424	0.015144	0.0058461	0.00062318	0.00028473	0.00014444	8.5447e-05	6.6851e-05	0.00015828	0.024796
9	0.0015726	0.0099074	0.0040695	0.00047356	0.00021868	0.00012518	7.0524e-05	5.5411e-05	0.00013286	0.016626
10	0.0010302	0.0065049	0.0028484	0.00036119	0.00016482	9.9853e-05	6.7134e-05	4.1994e-05	0.00011482	0.011233
11	0.00062916	0.0039672	0.0018701	0.00026016	0.0001241	8.1634e-05	4.9856e-05	3.4838e-05	9.1615e-05	0.0071087
12	0.00034118	0.0021519	0.0010855	0.00017339	8.766e-05	5.9178e-05	3.964e-05	2.4575e-05	7.9139e-05	0.0040421
13	0.00017287	0.0010154	0.00053345	0.00011143	6.6522e-05	4.2371e-05	2.7776e-05	1.9585e-05	6.2426e-05	0.0020518
14	6.8593e-05	0.00043265	0.00023793	6.445e-05	4.3548e-05	2.9047e-05	1.7843e-05	1.3653e-05	5.4234e-05	0.00096195
15	2.3822e-05	0.00014152	9.6935e-05	4.3548e-05	2.707e-05	1.9867e-05	1.4736e-05	9.7923e-06	4.4489e-05	0.00042178
16	6.4968e-06	4.5525e-05	3.9169e-05	2.5705e-05	2.0667e-05	1.5442e-05	1.0546e-05	8.0033e-06	3.9687e-05	0.00021124
17	4.7549e-06	2.5281e-05	2.4669e-05	1.756e-05	1.3653e-05	1.0122e-05	8.427e-06	6.7322e-06	3.2155e-05	0.00014335
18	2.3539e-06	1.29e-05	1.5065e-05	1.0875e-05	9.5569e-06	7.1559e-06	6.2614e-06	5.7436e-06	2.7965e-05	9.7876e-05
OF	3.9546e-06	2.3351e-05	4.1476e-05	3.9781e-05	3.7333e-05	3.046e-05	2.8294e-05	2.4857e-05	0.00021868	0.00044819
Sum	0.18811	0.65771	0.13356	0.0098393	0.0042108	0.0021473	0.0012213	0.00076578	0.0024373	

- Only ~40% of all clusters are associated with tracks!
 - there is a significant tail of large size clusters from low pt particles
 - there are many small clusters not associated with tracks (pixels from previous crossings?)
 - we need the tracking information to simulate clusters
- Make similar plots for the ± 1 rings (near IP) and the ± 4 rings (barrel ends)



Expect more small size z clusters in ± 1 rings and more large size z clusters in ± 4 rings

All clusters: +-1 rings

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.12236	0.21014	0.049237	0.012523	0.00481	0.0021979	0.0011612	0.0006671	0.0013421	0.40444
2	0.076716	0.21036	0.054951	0.01362	0.0055803	0.002738	0.0014691	0.0008846	0.0019263	0.36824
3	0.021573	0.072337	0.024459	0.0068703	0.0032994	0.0017638	0.00096361	0.00059202	0.0013883	0.13325
4	0.0071825	0.026533	0.010225	0.0031863	0.0018383	0.0010815	0.00065226	0.00041532	0.0010681	0.052183
5	0.0026133	0.010211	0.0044432	0.0014439	0.00094563	0.00063855	0.00044365	0.00028179	0.00081019	0.021831
6	0.0010149	0.0040518	0.0020255	0.00072083	0.00047118	0.00035361	0.00026796	0.00018748	0.00061989	0.0097131
7	0.00036643	0.0015362	0.00087482	0.00036755	0.00026504	0.00020198	0.00015972	0.00012555	0.00047152	0.0043688
8	0.00015219	0.00058898	0.0003879	0.00021367	0.0001559	0.00013039	9.8014e-05	7.6545e-05	0.00037609	0.0021797
9	5.1255e-05	0.00020581	0.00017759	0.00011206	9.4529e-05	7.5646e-05	5.9235e-05	5.103e-05	0.00026695	0.0010941
10	1.9895e-05	9.0595e-05	8.1828e-05	6.9014e-05	5.8786e-05	4.8894e-05	4.4736e-05	3.9116e-05	0.00021772	0.00067058
11	8.0929e-06	3.7542e-05	4.2488e-05	4.1364e-05	3.7092e-05	3.4282e-05	2.81e-05	2.574e-05	0.00015938	0.00041409
12	5.7324e-06	2.0007e-05	2.8775e-05	2.6639e-05	2.3717e-05	2.012e-05	2.293e-05	1.9558e-05	0.00014556	0.00031304
13	2.9224e-06	1.1465e-05	1.7085e-05	1.5849e-05	1.4387e-05	1.6748e-05	1.3039e-05	1.2477e-05	0.00010937	0.00021334
14	1.5736e-06	1.0116e-05	1.2139e-05	1.3938e-05	1.2364e-05	1.2701e-05	1.2139e-05	1.0004e-05	9.9587e-05	0.00018456
15	1.2364e-06	5.1704e-06	1.0116e-05	8.6549e-06	8.8797e-06	8.8797e-06	8.2053e-06	9.1045e-06	7.5196e-05	0.00013544
16	1.5736e-06	5.2828e-06	5.9572e-06	6.1821e-06	5.9572e-06	7.1937e-06	6.7441e-06	6.4069e-06	6.1483e-05	0.00010678
17	4.496e-07	3.7092e-06	4.8332e-06	4.7208e-06	5.5076e-06	5.62e-06	5.5076e-06	3.4844e-06	5.0356e-05	8.4188e-05
18	7.8681e-07	2.5852e-06	4.1588e-06	3.8216e-06	4.2712e-06	4.2712e-06	3.5968e-06	3.7092e-06	4.6984e-05	7.4185e-05
OF	2.248e-06	1.0903e-05	1.8546e-05	2.0457e-05	1.967e-05	1.9445e-05	1.8321e-05	2.3042e-05	0.00037171	0.00050434
Sum	0.23208	0.53616	0.14701	0.039268	0.017651	0.0093595	0.0054381	0.0034341	0.0096068	

Tracked clusters: +-1 rings

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.10565	0.24658	0.025003	0.00079771	0.00023347	9.2361e-05	4.8976e-05	2.7731e-05	7.0221e-05	0.3785
2	0.083136	0.27317	0.037001	0.0016558	0.00049535	0.0001845	9.2361e-05	4.8529e-05	0.00012032	0.3959
3	0.022748	0.094615	0.018324	0.0015111	0.00061075	0.00026053	0.00012837	5.7251e-05	0.00011696	0.13837
4	0.0073849	0.034563	0.0085216	0.00089566	0.00041015	0.00018875	0.00010131	5.5014e-05	0.00013731	0.052258
5	0.002634	0.013092	0.0039089	0.00048126	0.00025137	0.00013597	8.431e-05	4.428e-05	0.00010824	0.020741
6	0.0010005	0.005155	0.0018318	0.00026277	0.00013194	7.693e-05	4.9423e-05	3.3322e-05	8.3192e-05	0.0086249
7	0.0003482	0.0018826	0.00076684	0.00012904	7.2234e-05	4.3609e-05	3.7123e-05	2.1693e-05	6.3512e-05	0.0033648
8	0.00012367	0.0006472	0.0002943	6.5972e-05	4.2491e-05	2.7283e-05	1.5878e-05	1.9456e-05	4.1596e-05	0.0012778
9	3.6005e-05	0.00020373	0.0001145	2.952e-05	2.1916e-05	1.5878e-05	1.1629e-05	1.1405e-05	3.4887e-05	0.00047947
10	8.4981e-06	7.3129e-05	4.0478e-05	1.5431e-05	1.2747e-05	9.169e-06	8.7218e-06	5.3672e-06	2.4376e-05	0.00019792
11	2.46e-06	1.6996e-05	1.4984e-05	7.38e-06	7.6036e-06	7.38e-06	6.9327e-06	5.1436e-06	1.8562e-05	8.7441e-05
12	1.3418e-06	4.2491e-06	5.1436e-06	8.4981e-06	3.1309e-06	3.1309e-06	2.9073e-06	3.3545e-06	1.7667e-05	4.9423e-05
13	4.4727e-07	2.2363e-06	2.9073e-06	3.5782e-06	2.46e-06	2.9073e-06	2.0127e-06	1.3418e-06	1.0064e-05	2.7954e-05
14	0	1.1182e-06	2.0127e-06	8.9454e-07	1.5654e-06	2.6836e-06	1.7891e-06	1.5654e-06	1.1405e-05	2.3034e-05
15	0	4.4727e-07	2.46e-06	1.7891e-06	1.5654e-06	2.2363e-06	4.4727e-07	1.1182e-06	5.3672e-06	1.5431e-05
16	0	8.9454e-07	4.4727e-07	1.7891e-06	1.5654e-06	8.9454e-07	1.1182e-06	6.709e-07	6.0381e-06	1.3418e-05
17	2.2363e-07	4.4727e-07	2.2363e-07	1.3418e-06	1.1182e-06	6.709e-07	2.2363e-06	4.4727e-07	4.92e-06	1.1629e-05
18	2.2363e-07	2.2363e-07	4.4727e-07	2.2363e-07	1.3418e-06	4.4727e-07	2.2363e-07	1.1182e-06	3.8018e-06	8.0509e-06
OF	0	1.1182e-06	2.0127e-06	2.0127e-06	1.5654e-06	3.1309e-06	2.0127e-06	4.92e-06	2.9967e-05	4.674e-05
Sum	0.22307	0.67001	0.095836	0.0058718	0.0023043	0.0010585	0.00059778	0.00034373	0.0009084	

All clusters: +-4 rings

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.083975	0.075607	0.032727	0.012617	0.0051396	0.0023991	0.0012301	0.00069351	0.0012962	0.21568
2	0.037574	0.070069	0.038643	0.017868	0.0082618	0.004117	0.0022659	0.0013424	0.0026797	0.18282
3	0.015749	0.037625	0.020012	0.0096947	0.005276	0.0028168	0.0016986	0.0010343	0.0023239	0.09623
4	0.015899	0.046448	0.01886	0.0062541	0.0034356	0.0020282	0.00124	0.00076986	0.0019328	0.096867
5	0.015312	0.050044	0.020235	0.0051067	0.0025496	0.001463	0.00095723	0.0006012	0.0015472	0.097816
6	0.011529	0.041494	0.017562	0.0043143	0.0020093	0.0011839	0.00072067	0.00048577	0.0013028	0.080603
7	0.0076472	0.030276	0.013358	0.0032696	0.0016157	0.00091906	0.00060065	0.00038484	0.0011033	0.059174
8	0.0051983	0.022201	0.010259	0.0024412	0.0012376	0.00072636	0.00049733	0.00031877	0.0009576	0.043837
9	0.0036746	0.016703	0.0079788	0.0018614	0.00095503	0.00059992	0.00038025	0.00027528	0.00082565	0.033254
10	0.0027408	0.012983	0.0064855	0.0014391	0.00074049	0.00047329	0.00031804	0.0002338	0.00070691	0.026121
11	0.0021277	0.010053	0.0052594	0.0011483	0.00057771	0.00036153	0.0002606	0.00017728	0.00061974	0.020586
12	0.0015671	0.0072983	0.004035	0.00090181	0.00043787	0.000285	0.00019802	0.00015342	0.00055716	0.015434
13	0.0010365	0.0048128	0.0028106	0.00067351	0.00033932	0.00020903	0.00015929	0.00011268	0.00047843	0.010632
14	0.00064562	0.0029478	0.0018596	0.00051422	0.00024279	0.00016755	0.00012773	9.965e-05	0.00041989	0.0070249
15	0.00037364	0.0016807	0.0011031	0.00035951	0.00018627	0.00012773	9.0291e-05	7.4325e-05	0.00034428	0.0043398
16	0.00019691	0.00090878	0.00062947	0.00022848	0.00013323	9.7815e-05	6.7168e-05	6.4231e-05	0.00030684	0.0026329
17	0.00010295	0.00045512	0.00036226	0.0001514	0.00010167	7.2306e-05	5.8726e-05	4.4962e-05	0.00027216	0.0016216
18	5.4505e-05	0.00022279	0.0002116	0.00010185	7.1021e-05	5.3587e-05	4.8632e-05	4.1475e-05	0.00023435	0.0010398
OF	7.1572e-05	0.00031804	0.00038759	0.00033217	0.00028647	0.00024738	0.00022609	0.00020169	0.002213	0.004284
Sum	0.20548	0.43215	0.20278	0.069277	0.033597	0.018349	0.011145	0.0071095	0.020122	

Tracked clusters: +-4 rings

untracked clusters mask the angle effect

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.009487	0.002679	0.0006854	0.0002611	0.00012056	5.8615e-05	2.8642e-05	2.2647e-05	0.00010524	0.013448
2	0.0073955	0.013266	0.0026284	0.00049357	0.00021448	0.00012323	8.5925e-05	6.0614e-05	0.0002338	0.024502
3	0.014272	0.048193	0.0096902	0.00084459	0.00037434	0.00020316	9.6582e-05	7.7932e-05	0.00027576	0.074027
4	0.024394	0.10129	0.023856	0.0014374	0.00059215	0.00029707	0.00015853	9.0587e-05	0.00036435	0.15249
5	0.026678	0.12241	0.034685	0.0021315	0.00085925	0.00041231	0.00023579	0.0001199	0.00034703	0.18788
6	0.019902	0.10232	0.032061	0.0023866	0.00097315	0.00046559	0.0002631	0.00014987	0.00036901	0.15889
7	0.012771	0.073777	0.024751	0.0022687	0.00093851	0.00047292	0.00024379	0.0001492	0.0003477	0.11572
8	0.0086185	0.053208	0.019464	0.001887	0.00080063	0.00038699	0.00024845	0.00017318	0.00035103	0.085138
9	0.0062425	0.038571	0.015005	0.0016219	0.000766	0.00036568	0.00019583	0.00014521	0.00032771	0.063241
10	0.0044821	0.02842	0.011849	0.0013615	0.00060947	0.0003397	0.00020982	0.00012722	0.00026976	0.047668
11	0.0031526	0.019439	0.0087037	0.001151	0.00051422	0.0003044	0.00019183	0.00011856	0.00024978	0.033825
12	0.0019889	0.011575	0.0055944	0.00081062	0.000381	0.00022713	0.00015253	9.7248e-05	0.00021981	0.021047
13	0.0010531	0.0059714	0.0029647	0.00051888	0.00029041	0.00017118	0.00010258	5.9281e-05	0.00018051	0.011312
14	0.00043828	0.0023793	0.0013222	0.00036235	0.00019583	9.5916e-05	7.1271e-05	5.8615e-05	0.00015786	0.0050816
15	0.00014854	0.00088389	0.00058216	0.00021781	0.00011656	8.0596e-05	4.7292e-05	3.2638e-05	0.00012656	0.002236
16	4.6626e-05	0.00027309	0.0002298	0.00012323	6.8607e-05	4.7958e-05	3.8633e-05	3.1306e-05	0.00010857	0.00096782
17	2.1981e-05	0.00014854	0.00016186	8.4593e-05	4.596e-05	3.5969e-05	3.7301e-05	2.7309e-05	8.5259e-05	0.00064877
18	1.2656e-05	6.5276e-05	9.6582e-05	6.1946e-05	3.9965e-05	2.5311e-05	2.2647e-05	1.5986e-05	7.5267e-05	0.00041564
OF	1.865e-05	0.00010324	0.00017385	0.00016985	0.00012123	0.00010657	0.00010391	8.1262e-05	0.00058882	0.0014674
Sum	0.14112	0.62498	0.19451	0.018194	0.0080223	0.0042203	0.0025344	0.0016386	0.0047838	

We can simulate the tracked clusters easily. The untracked ones are more problematic. Try a re-weighting scheme to model the "All clusters" category: for each tracked cluster $[\text{cot}\alpha_i, \text{cot}\beta_i, p_i]$, weight the cluster by the ratio,

$$w_i = \frac{f_{\text{all}}(\text{size}x_i, \text{size}y_i)}{f_{\text{trk}}(\text{size}x_i, \text{size}y_i)}$$

- Assumes that the large size tails can be modelled by more tracked clusters in that bin
 - may not be the case
- Statistical issues
 - some "rare" tracked clusters will have large weights
 - simulation of millions of clusters is time consuming

Measured "All clusters"

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.097027	0.13007	0.038767	0.012262	0.0048937	0.0022583	0.0011772	0.00067506	0.0013264	0.28845
2	0.057824	0.14149	0.045677	0.015002	0.006593	0.0032664	0.0017744	0.0010575	0.0022362	0.27492
3	0.024716	0.07485	0.026763	0.0084269	0.0042022	0.0022102	0.0012611	0.00077288	0.0017764	0.14498
4	0.014863	0.049563	0.018329	0.0051272	0.0026904	0.0015455	0.00092917	0.00057738	0.0014349	0.09506
5	0.0092939	0.03334	0.013114	0.0033264	0.0017596	0.0010558	0.00068176	0.00043259	0.0011336	0.064138
6	0.0056963	0.021893	0.0091941	0.0022832	0.0011714	0.00073859	0.00049411	0.00033484	0.00093107	0.042736
7	0.0034377	0.014125	0.0062829	0.0015473	0.00082136	0.00050819	0.00034796	0.00024892	0.00075707	0.028076
8	0.0021826	0.0093969	0.0043881	0.0010718	0.00057627	0.00036713	0.00026099	0.00018664	0.00063138	0.019062
9	0.0014139	0.0063262	0.0031011	0.00076127	0.00041629	0.00027074	0.00018955	0.00013709	0.00051421	0.01313
10	0.00094365	0.0043489	0.0022254	0.00053736	0.00029639	0.00019922	0.00014497	0.00011111	0.00042686	0.0092338
11	0.00064331	0.0029586	0.0015899	0.00040013	0.00021409	0.00014404	0.00010911	8.2698e-05	0.00034867	0.0064905
12	0.00042134	0.0019401	0.0011104	0.00028611	0.00015705	0.00010954	8.2232e-05	6.4783e-05	0.00030682	0.0044784
13	0.00026028	0.0011891	0.0007168	0.00020083	0.0001147	7.8793e-05	6.188e-05	4.8229e-05	0.00025103	0.0029217
14	0.00015325	0.00069032	0.00045015	0.00014569	8.148e-05	5.9981e-05	4.7691e-05	4.0167e-05	0.00021567	0.0018844
15	8.4991e-05	0.0003802	0.000263	9.9001e-05	5.93e-05	4.5577e-05	3.5222e-05	2.9131e-05	0.00017622	0.0011726
16	4.5219e-05	0.0002032	0.00014931	6.5213e-05	4.2066e-05	3.4613e-05	2.5942e-05	2.4508e-05	0.0001526	0.00074267
17	2.3075e-05	0.00010291	8.6819e-05	4.289e-05	3.2212e-05	2.5798e-05	2.1606e-05	1.7235e-05	0.00012974	0.00048229
18	1.2541e-05	5.1704e-05	5.1776e-05	2.974e-05	2.2753e-05	1.9205e-05	1.7091e-05	1.5873e-05	0.00011369	0.00033438
OF	1.8847e-05	8.9434e-05	0.00011581	0.00010946	9.918e-05	9.1584e-05	8.3916e-05	7.7359e-05	0.001019	0.0017046
Sum	0.21906	0.49301	0.17238	0.051724	0.024244	0.013029	0.007746	0.004934	0.013881	

Simulated "All Clusters" (900k events)

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.060675	0.1668	0.018759	0.0012646	0.00067161	0.00030365	0.00016433	0.00010836	6.0731e-05	0.2488
2	0.056287	0.20381	0.029526	0.0015314	0.00041202	0.00020125	8.931e-05	3.0961e-05	1.9053e-05	0.29191
3	0.023611	0.10142	0.02054	0.0011003	0.0003882	0.0001429	0.00010598	3.0961e-05	1.3099e-05	0.14735
4	0.015657	0.071019	0.018267	0.0010443	0.00028698	0.00013218	0.00010241	3.5724e-05	1.7862e-05	0.10656
5	0.0088476	0.04437	0.012717	0.00074901	0.00024173	0.00010955	7.7402e-05	1.9053e-05	7.1448e-06	0.067138
6	0.0060278	0.031629	0.010211	0.00065018	0.00021434	0.0001036	6.3112e-05	2.7388e-05	1.3099e-05	0.048939
7	0.0032771	0.018359	0.0064017	0.00044298	0.00016314	8.4547e-05	6.7876e-05	2.7388e-05	1.6671e-05	0.02884
8	0.0023423	0.013087	0.0048442	0.0003501	0.00013218	5.2395e-05	6.9066e-05	1.9053e-05	1.9053e-05	0.020915
9	0.0014218	0.0080927	0.003027	0.00020958	0.00010717	6.4303e-05	5.2395e-05	2.6198e-05	4.1678e-05	0.013043
10	0.0011491	0.0062803	0.0026733	0.00019053	6.7876e-05	4.7632e-05	5.1204e-05	1.3099e-05	1.429e-05	0.010487
11	0.00074901	0.0040249	0.0016469	0.00014171	6.0731e-05	2.6198e-05	3.5724e-05	3.5724e-06	9.5264e-06	0.0066982
12	0.00051085	0.0026543	0.0011586	0.00010955	3.6915e-05	1.9053e-05	1.6671e-05	1.1908e-05	1.548e-05	0.0045334
13	0.00029056	0.0013873	0.00060016	4.7632e-05	1.3099e-05	2.0244e-05	9.5264e-06	2.2625e-05	8.3356e-06	0.0023995
14	0.00016433	0.00076092	0.00034533	4.406e-05	1.548e-05	7.1448e-06	3.5724e-06	3.2152e-05	5.954e-06	0.0013789
15	7.9784e-05	0.00029175	0.00014766	1.6671e-05	1.1908e-05	5.954e-06	1.1908e-06	3.5724e-06	1.9053e-05	0.00057754
16	2.3816e-05	7.2639e-05	5.3586e-05	5.954e-06	4.7632e-06	3.5724e-06	1.1908e-06	5.954e-06	1.7862e-05	0.00018934
17	1.1908e-05	2.8579e-05	1.3099e-05	4.7632e-06	1.1908e-06	1.1908e-06	0	2.3816e-06	3.5724e-06	6.6685e-05
18	0	3.6915e-05	3.6915e-05	5.954e-06	1.1908e-06	2.3816e-06	1.1908e-06	3.5724e-06	4.7632e-06	9.2882e-05
OF	4.7632e-06	3.6915e-05	2.7388e-05	3.5724e-06	2.3816e-06	0	0	0	5.954e-06	8.0974e-05
Sum	0.18113	0.67415	0.131	0.0079129	0.0028329	0.0013277	0.00091215	0.00042392	0.00031318	

Does OK with size z distribution but not well with the size ϕ distribution

Simulations of smaller pixel cells

Simulated 50x100x150um sensor (threshold 1500e)

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.059054	0.17544	0.023373	0.0013648	0.0007302	0.00039011	0.00017116	0.00016338	8.2245e-05	0.26076
2	0.059479	0.21402	0.037956	0.0017349	0.00056793	0.00028674	0.00017116	0.00011003	2.1117e-05	0.31435
3	0.026435	0.10984	0.027329	0.0014104	0.00043456	0.00022562	0.00014448	6.5573e-05	1.556e-05	0.1659
4	0.014897	0.06686	0.02015	0.0011414	0.0003801	0.00018783	0.00014226	7.4465e-05	1.556e-05	0.10385
5	0.0084645	0.040139	0.01339	0.00080466	0.00028008	0.00014226	0.00012559	5.7793e-05	1.556e-05	0.063419
6	0.0047157	0.022998	0.00828	0.00057793	0.00022117	0.00010892	9.5581e-05	4.3345e-05	2.8897e-05	0.03707
7	0.0026774	0.013343	0.0050947	0.00037899	0.00013004	9.8916e-05	0.00010003	4.2234e-05	4.7791e-05	0.021913
8	0.001746	0.0084623	0.0034854	0.00028119	0.00010447	6.5573e-05	6.0016e-05	3.8899e-05	2.8897e-05	0.014273
9	0.0011825	0.0054081	0.0023718	0.00018672	5.5571e-05	3.6677e-05	4.8902e-05	1.6671e-05	2.0005e-05	0.009327
10	0.0006524	0.0029319	0.0012892	0.00011225	4.5568e-05	2.2228e-05	1.8894e-05	2.6674e-05	2.1117e-05	0.0051203
11	0.00032342	0.0014804	0.00059683	4.1122e-05	2.5562e-05	1.1114e-05	1.3337e-05	3.4454e-05	2.2228e-05	0.0025485
12	0.00014337	0.00052125	0.0002334	2.2228e-05	1.8894e-05	2.2228e-06	7.7799e-06	1.2226e-05	2.0005e-05	0.00098138
13	4.3345e-05	0.00011114	7.113e-05	1.1114e-06	2.2228e-06	3.3342e-06	2.2228e-06	3.3342e-06	2.1117e-05	0.00025896
14	1.3337e-05	4.0011e-05	2.1117e-05	5.5571e-06	0	1.1114e-06	1.1114e-06	4.4456e-06	7.7799e-06	9.447e-05
15	4.4456e-06	5.0014e-05	4.3345e-05	3.3342e-06	3.3342e-06	1.1114e-06	1.1114e-06	4.4456e-06	4.4456e-06	0.00011559
16	2.2228e-06	6.6685e-06	5.5571e-06	0	0	0	0	0	1.1114e-06	1.556e-05
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	1.1114e-06	0	0	0	1.1114e-06
19	0	0	0	0	0	0	0	0	0	0
Sum	0.17983	0.66165	0.14369	0.0080666	0.0029997	0.0015849	0.0011036	0.00069797	0.00037343	

Simulated 50x100x100um sensor (threshold 1500e)

z/Phi	1	2	3	4	5	6	7	8	OF	Sum
1	0.21384	0.17031	0.0027719	0.00081911	0.00031008	0.00013337	1.2226e-05	1.7783e-05	1.6671e-05	0.38824
2	0.15387	0.18323	0.0039744	0.00072909	0.00021673	0.00010003	6.1128e-05	1.7783e-05	3.3342e-06	0.3422
3	0.054513	0.087534	0.002933	0.00056015	0.0001756	0.00010447	8.8913e-05	2.4451e-05	0	0.14593
4	0.022948	0.041329	0.002075	0.00033676	0.00015337	8.5579e-05	6.5573e-05	1.2226e-05	0	0.067006
5	0.0099238	0.019273	0.0011848	0.00020561	0.00013448	7.2242e-05	8.669e-05	1.1114e-05	2.2228e-06	0.030894
6	0.0050291	0.010027	0.00070575	0.00013782	6.6685e-05	4.4456e-05	2.5562e-05	1.1114e-05	5.5571e-06	0.016053
7	0.0021661	0.0042856	0.00034898	6.6685e-05	4.0011e-05	3.4454e-05	2.6674e-05	4.4456e-06	1.1114e-05	0.0069841
8	0.00063128	0.0012759	0.00011003	2.6674e-05	3.0008e-05	3.4454e-05	1.4448e-05	1.2226e-05	3.3342e-06	0.0021384
9	9.7804e-05	0.00020561	2.4451e-05	5.5571e-06	5.5571e-06	5.5571e-06	7.7799e-06	5.5571e-06	1.6671e-05	0.00037455
10	3.0008e-05	9.0024e-05	1.3337e-05	3.3342e-06	3.3342e-06	7.7799e-06	1.1114e-06	1.1114e-06	3.3342e-06	0.00015337
11	4.4456e-06	1.4448e-05	4.4456e-06	0	0	0	4.4456e-06	0	1.1114e-06	2.8897e-05
12	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
Sum	0.46306	0.51757	0.014146	0.0028908	0.0011359	0.00062239	0.00039455	0.00011781	6.3351e-05	

Conclusions

- We can measure the cluster footprint distributions of the present detector quite easily
 - only about 40% of all clusters are on tracks
 - untracked clusters have different footprint distributions
- The “regional” dependence of the footprints is masked by the low pt and background clusters
- [Opinion] changing the readout scheme in different regions should only be done if there are really significant advantages
 - present uniform detector has readout group artifacts [2 thresholds]
 - non-uniform detectors require lots of work to understand
 - * present detector is broken into 9 different parts due to radiation and threshold effects: if we had three readout schemes with unplanned artifacts, this would be completely unworkable
- We can simulate any geometry we like
 - simulation of **size ϕ** distribution due to non-tracked clusters is not reliable
 - **size z** distribution is probably OK