



GENEVE, SUISSE:

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**LHC-b - UX85 -Outer Tracker
T1-Q13-UX (OT1A) – A Side
Photogrammetric measurement
June 18th and 19th, 2007**

The EDMS document, **id: 862264** containing this report can be found at the address:

<https://edms.cern.ch/document/862264>

1 Photogrammetric Measurement Steps

The photogrammetric measurements were done in 2 steps, one for each side of the frame. Each project was calculated independently and then all were grouped in a single one using 3D best fit transformations. See §4.

2 C frame point positions and names:

2.1 Point names:

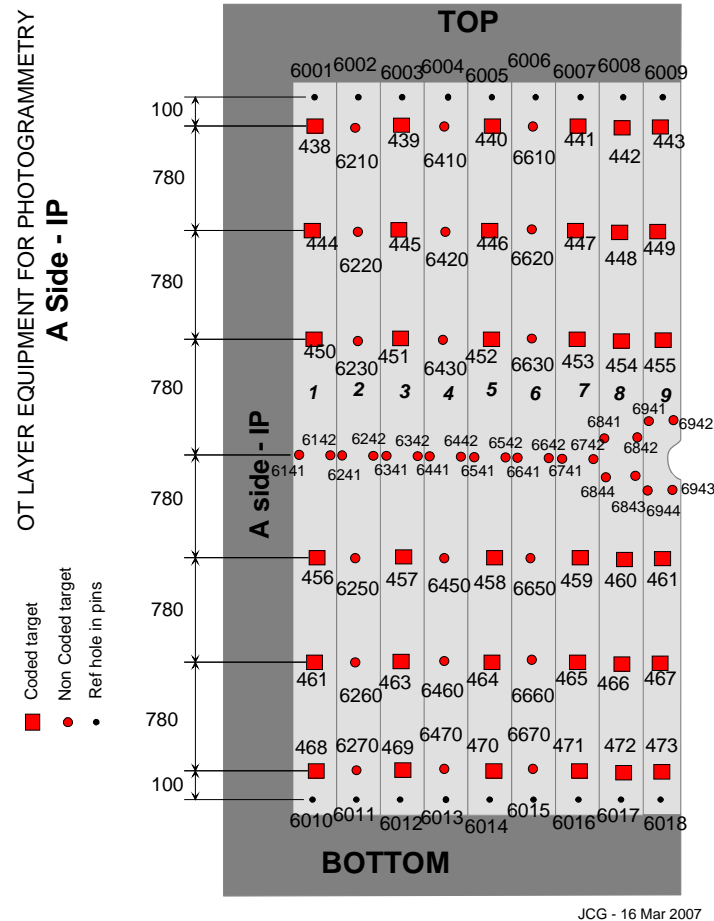


Figure 1 : Point positions – LV (IP) side

On IP side, the points are

- From 6001 to 6018 for the dowel pins (see §2.2.1)
- From 438 to 473 for the coded targets (see §2.2.2)
- 6nm for the uncoded targets, with n the panel number, m the row number, and x the point position (see §2.2.3)
- From 60000 for the additional targets (see §2.2.4)

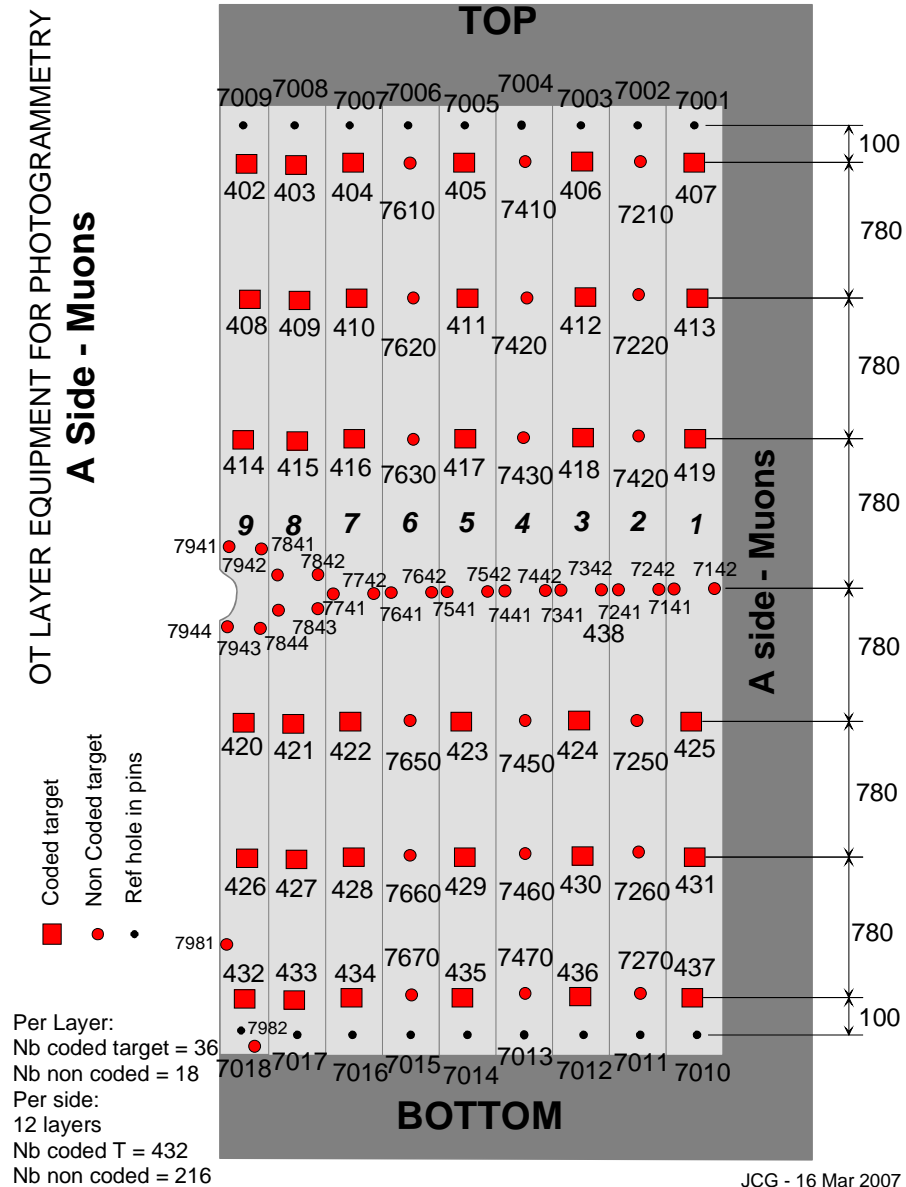


Figure 2 : Point position – LX (Muons) side

On Muon side, the points are

- From 7001 to 7018 for the dowel pins (see §2.2.1)
- From 402 to 437 for the coded targets (see §2.2.2)
- 7nm_x for the uncoded targets, with n the panel number, m the row number, and x the point position (see §2.2.3)
- From 70000 for the additional targets (see §2.2.4)

2.2 Measured points

The coordinates are given at the centre of the photogrammetric target.

2.2.1 Dowel pin points

IMPORTANT REMARK: The offset of the dowel pin points are not the same on IP side (LV) and on Muon Side (LX). On IP side, the point is measured at 30mm from the contact surface and on Muon Side the point is measured at 13mm from the contact surface.

For IP side, the points are numbered from 6001 to 6018.

For Muon side, the points are numbered from 7001 to 7018.



Figure 3 : Dowel pin point offset – LV (IP) side

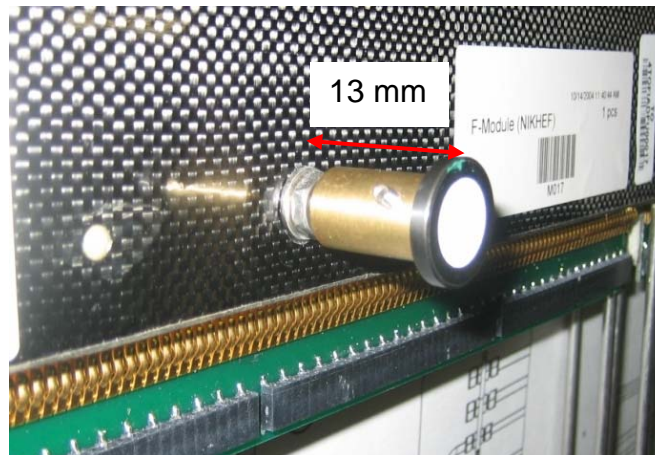


Figure 4 : Dowel pin point offset – LX (Muon) side

2.2.2 Coded targets

The coded targets are permanents and glued directly on the panels. The thickness of the target is 0.1mm.

For IP side, the points are numbered from 438 to 473.

For Muon side, the points are numbered from 402 to 437.

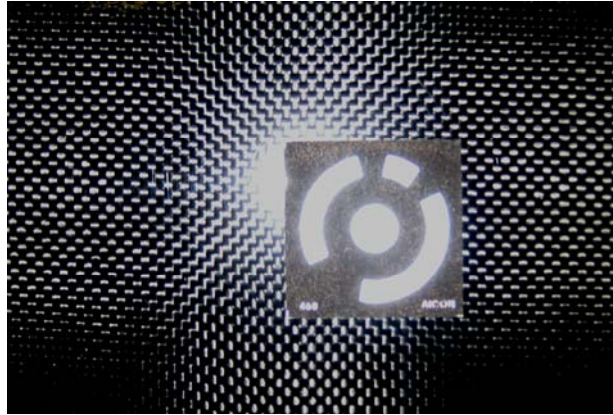


Figure 5 : Coded target glued on the C frame

2.2.3 Uncoded targets

The uncoded targets are permanents and glued directly on the panels. The thickness of the target is 0.1mm.

For IP side, the points are numbered from 6210 to 6670.

For Muon side, the points are numbered from 7210 to 7670.



Figure 6 : Uncoded target glued on the C frame

2.2.4 Additional targets

During the measurement, some additional coded targets were stuck on the frame. Please note, that these targets were removed at the end of the measurement. Their coordinates are published in order to have an idea of the geometry of the frame, but as they are not well glued on the surface, the results have to be taken with care.

For IP side, the points are numbered in range 60000.

For Muon side, the points are numbered in range 70000.

3 T1-Q13-UX local coordinate system

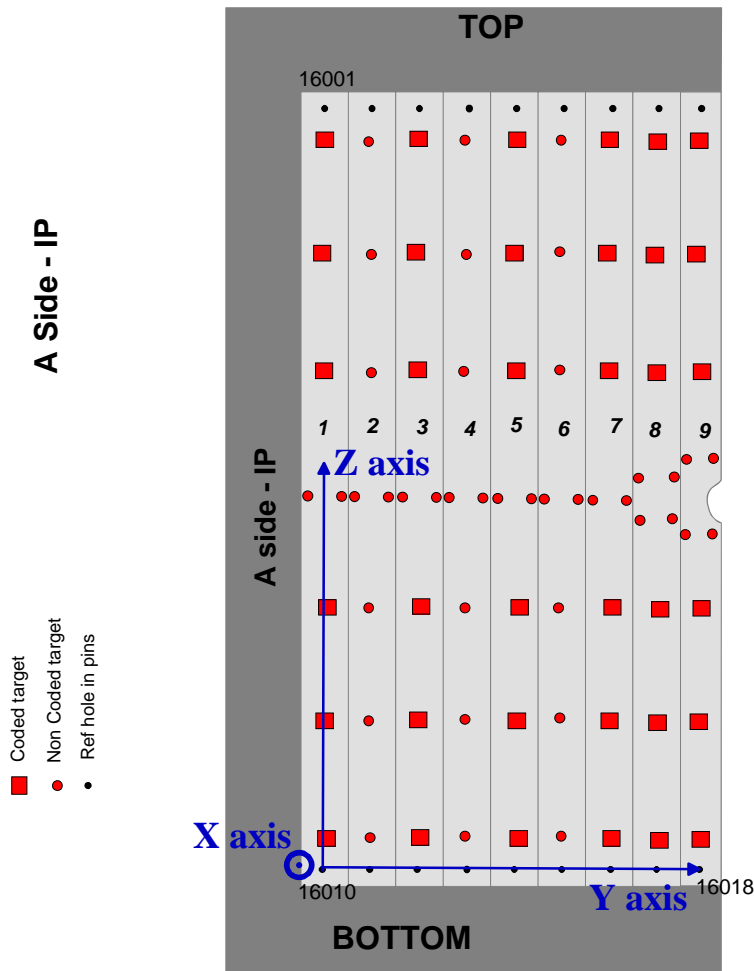


Figure 7 : T1-Q13-UX Coordinate system

The coordinate system is defined so as to have the YZ plane fitting with the mean plane of all permanent targets (coded and uncoded) glued on the panels. The result of the mean plane is given in §6. The projected points (16010, 16018 and 16001) of the dowel pins 6010, 6018 and 6001 define the axis.

- **Origin:** 16010, the projection of the point 6010 on the best fit plane
- **Y axis:** 16010-16018, positive from 16010 to 16018 (16018 the projection of the point 6018 to the plane)
- **YZ plane:** defined by the points 16010, 16018 and 16001 (16001 the projection of the point 6001 to the plane)
- **X axis:** perpendicular to the YZ plane (mean plane)

4 3D best fit transformation

The individual measurement of the frame on Muon side is transformed in the T1-Q13-UX local coordinate system using a 3D best fit transformation. The points used for this 3D transformation are 10 temporary extra points placed on the border of the frame and common to both the measurements (IP side measurement and Muon side measurement). Note that these points were placed there for measurement purposes only and are not representative of the geometry of the OT frame, so they are not given in this report. The residuals DX DY DZ on the coordinates after the best fit transformation and DD (= Norm of the vector (DX, DY, DZ)) are such that:

	DD (mm)	DX (mm)	DY (mm)	DZ (mm)
Average	0.31	0.02	-0.04	-0.05
sigma	0.14	0.15	0.22	0.24
min	0.10	-0.22	-0.36	-0.47
max	0.52	0.17	0.27	0.24

5 Coordinates of the points

All coordinates are given in the local coordinate system, defined in §3, at the centre of the survey target.

The precision in XYZ is 0.3mm at 1 sigma level.

5.1 IP Side frame (LV side)

Dowel pin points

Pnt. no.	X [mm]	Y [mm]	Z [mm]
6001	31.34	10.95	4900.00
6002	30.98	352.30	4899.21
6003	30.28	693.40	4898.57
6004	29.67	1034.96	4897.78
6005	29.35	1376.04	4897.37
6006	29.40	1717.39	4896.59
6007	29.11	2058.66	4896.20
6008	28.16	2399.96	4895.64
6009	27.83	2741.63	4888.18
6010	25.73	0.00	0.00
6011	26.31	340.89	-0.76
6012	26.75	682.07	-1.78
6013	27.77	1023.33	-2.55
6014	28.35	1364.58	-3.18
6015	28.91	1705.98	-4.19
6016	29.64	2047.15	-4.97
6017	30.36	2388.12	-5.88
6018	31.47	2729.63	0.00

Coded targets

Pnt. no.	X [mm]	Y [mm]	Z [mm]
438	2.74	13.31	4818.37
439	1.24	696.55	4813.25
440	0.13	1375.11	4815.41
441	-0.35	2065.87	4789.55
442	-0.92	2401.74	4800.60
443	-1.05	2745.86	4801.16
444	1.12	-1.84	3954.85
445	0.40	696.06	3994.44
446	-0.73	1353.30	3977.29
447	-0.47	2050.10	3978.94
448	-1.33	2399.61	3964.09
449	-1.29	2720.42	3955.04
450	0.32	5.14	3295.83
451	0.10	699.66	3333.81
452	-0.65	1386.70	3338.14
453	-0.56	2069.82	3367.58
454	-1.53	2416.38	3357.23
455	-1.04	2734.38	3368.47
456	-0.32	9.56	1680.73
457	-0.79	704.94	1742.13
458	0.10	1376.00	1783.64
459	1.45	2061.94	1757.58
460	1.04	2413.14	1768.12
461	0.56	2761.77	1757.72
462	-0.83	7.30	884.61
463	-1.44	701.40	908.70
464	0.11	1373.57	916.39
465	2.59	2059.10	913.38
466	2.28	2398.98	920.03
467	1.53	2742.71	928.47
468	-2.73	2.34	118.96
469	-2.14	682.97	117.69
470	-0.70	1363.86	112.98
471	1.66	2046.61	134.21
472	1.63	2394.34	127.53
473	2.29	2732.82	113.41

Uncoded permanent targets

Pnt. no.	X [mm]	Y [mm]	Z [mm]
6141	-0.46	-139.66	2453.72
6142	-0.62	152.18	2459.28
6210	2.23	352.51	4806.03
6220	1.79	344.74	3994.62
6230	0.87	353.18	3313.79
6241	-0.17	199.54	2459.64
6242	-0.32	493.11	2464.67
6250	0.08	333.47	1709.70
6260	0.02	349.25	892.87
6270	-2.15	349.60	141.85
6341	-0.74	547.27	2450.29
6342	-0.31	837.19	2443.55
6410	0.69	1037.83	4800.81
6420	0.04	1032.38	3999.75
6430	-0.28	1031.27	3344.12
6441	-0.32	881.72	2440.33
6442	-0.39	1177.35	2442.08
6450	0.49	1034.89	1750.89
6460	0.77	1018.92	887.20
6470	-0.72	1028.06	127.50
6541	-0.48	1231.38	2438.00
6542	-0.27	1508.35	2431.36
6610	0.36	1717.96	4824.41
6620	0.09	1703.33	3985.66
6630	-0.12	1723.62	3351.69
6641	0.15	1576.39	2426.76
6642	0.10	1846.66	2406.64
6650	1.47	1719.70	1788.43
6660	2.23	1694.25	925.29
6670	0.72	1718.21	124.89
6741	0.31	1925.03	2398.41
6742	-0.21	2196.55	2396.21
6841	-1.93	2244.45	2572.01
6842	-0.92	2541.34	2573.70
6843	-0.11	2546.87	2324.32
6844	-1.05	2247.01	2325.04
6941	-0.84	2587.12	2677.64
6942	-0.97	2882.94	2626.67
6943	-0.63	2879.47	2257.49
6944	-0.92	2584.85	2218.48

Additional targets

Pnt. no.	X [mm]	Y [mm]	Z [mm]
60033	-42.07	-99.94	-76.44
60043	1.74	-501.90	-363.26
60055	0.64	684.78	-441.43
60056	2.38	-497.96	29.81
60061	0.39	277.10	-429.04
60063	1.92	-888.27	4.87
60064	2.58	1501.00	-439.15
60066	-0.83	-89.72	-436.58
60068	1.59	1085.98	-431.05
60075	-42.11	-99.92	-76.46
60090	-41.57	364.89	-272.04
60095	-42.94	-344.78	-259.03
60101	10.63	-532.47	5045.19
60104	-42.47	-219.93	-128.49
60106	3.26	1928.44	-442.41
60108	5.02	2357.41	-440.80
60109	-36.51	2603.87	-84.50
60111	-35.94	2860.86	-185.30
60112	-37.78	2034.61	-90.65
60113	-37.23	2316.88	-173.65
60114	-39.14	1395.98	-92.93
60115	-38.26	1823.49	-115.11
60116	-39.71	1164.21	-176.17
60117	-40.71	804.24	-263.51
60120	2.61	-511.94	411.46
60121	3.25	-509.88	1565.83
60125	2.29	-871.44	379.82
60126	2.35	-1195.61	1559.96
60128	2.65	-538.86	835.79
60129	2.82	-524.32	1217.90
60130	2.70	-860.43	1566.06
60131	2.44	-874.30	1215.81
60132	2.31	-867.53	814.36
60134	2.92	-1184.03	1995.66
60135	3.20	-840.34	1995.37
60136	3.59	-1185.29	2378.84
60137	3.43	-490.99	1973.80
60138	3.83	-858.65	2368.89
60139	4.07	-502.89	2364.77
60140	9.78	-368.94	4702.07
60141	6.38	-1123.63	3561.01
60142	5.70	-786.72	3278.14
60143	4.61	-1157.98	2941.32
60144	6.99	-504.83	3796.09
60145	7.62	-854.87	3994.44

Pnt. no.	X [mm]	Y [mm]	Z [mm]
60147	8.51	-526.53	4305.62
60148	9.67	-795.34	4612.22
60149	8.29	-1153.84	4275.08
60151	4.59	-786.32	2785.19
60152	11.01	-617.80	5384.70
60153	11.05	-1120.48	5044.04
60155	5.66	1327.92	5288.72
60156	5.41	1681.39	5399.85
60157	4.12	2294.15	5399.54
60158	4.20	1979.18	5298.43
60160	6.76	649.48	5291.84
60162	-34.85	-123.64	5055.53
60163	-38.06	2342.34	5069.12
60164	-37.00	1724.39	5162.73
60165	-36.10	1061.66	5169.89
60166	9.37	-361.95	5060.90
60167	7.42	236.66	5360.40
60168	-37.49	2132.94	4991.40
60170	-35.95	587.09	5006.24
60173	4.60	997.71	5399.17
60174	-35.54	108.09	4994.01
60175	-35.36	355.51	5085.30
60176	-26.61	1755.54	-235.77
60177	-38.59	1605.66	-86.44
60178	-28.10	1066.31	-228.84
60179	-29.06	651.30	-227.23
60181	2.62	1702.14	-396.60
60183	-29.64	300.42	-227.43
60186	-25.76	2009.63	-228.47
60187	3.78	603.30	-556.44
60188	3.34	413.56	-557.27
60189	2.85	115.71	-550.71
60192	-1.04	59.25	-385.39
60193	1.94	-577.57	-145.05
60196	4.96	1038.12	-553.97
60197	2.26	-218.91	-551.55
60206	-25.00	2441.36	-227.14
60208	6.32	1477.77	-554.10
60209	8.05	2304.96	-559.00
60210	-27.67	1341.02	-230.28
60511	5.21	-591.85	726.88
60512	4.79	-317.93	728.84
60513	2.73	-453.61	593.52
60514	1.65	-453.71	855.34
60515	5.10	-421.86	727.49

5.2 Muon Side frame (LX side)

Dowel pin points

Pnt. no.	X [mm]	Y [mm]	Z [mm]
7001	-113.43	-214.12	4891.79
7002	-114.54	128.63	4891.20
7003	-114.79	471.13	4890.37
7004	-115.14	813.89	4889.56
7005	-115.60	1156.39	4888.86
7006	-117.26	1499.13	4888.28
7007	-116.35	1841.66	4887.64
7008	-116.94	2184.72	4887.17
7009	-117.57	2527.58	4879.06
7010	-119.37	202.73	9.95
7011	-119.05	544.95	9.04
7012	-118.41	887.81	8.22
7013	-117.84	1229.63	7.45
7014	-117.18	1572.05	6.63
7015	-116.44	1914.69	5.55
7016	-115.87	2257.07	4.46
7017	-115.07	2599.37	3.85
7018	-113.97	2941.44	9.84

Coded targets

Pnt. no.	X [mm]	Y [mm]	Z [mm]
402	-88.42	2533.84	4797.40
403	-88.50	2190.51	4810.61
404	-87.60	1848.16	4818.10
405	-86.68	1164.41	4796.93
406	-86.17	481.72	4798.91
407	-85.06	-208.10	4802.08
408	-88.71	2606.12	3967.45
409	-91.12	2262.08	3951.20
410	-89.38	1914.19	3914.34
411	-87.53	1235.69	3892.82
412	-88.52	557.57	3853.49
413	-88.30	-121.12	3808.14
414	-88.62	2669.78	3183.14
415	-90.30	2325.28	3169.54
416	-89.35	1983.90	3166.23
417	-87.56	1310.13	3144.79
418	-88.42	632.96	3115.95
419	-88.75	-69.63	3049.19
420	-87.78	2805.85	1732.59
421	-88.97	2423.34	1745.67
422	-88.91	2107.32	1755.93
423	-88.33	1424.86	1759.52
424	-88.45	743.44	1744.61
425	-89.09	50.62	1721.27
426	-87.01	2850.80	1099.47
427	-88.70	2489.03	1107.13
428	-88.81	2156.39	1110.15
429	-88.50	1475.53	1097.67
430	-88.84	784.09	1111.46
431	-89.59	92.17	1107.01
432	-85.36	2920.22	219.00
433	-86.70	2591.34	190.54
434	-87.51	2240.99	176.16
435	-88.17	1560.81	184.96
436	-89.10	878.71	189.39
437	-90.05	189.05	180.52

Uncoded permanent targets

Pnt. no.	X [mm]	Y [mm]	Z [mm]
7141	-87.98	148.44	2406.76
7142	-89.25	-151.47	2391.94
7210	-85.53	134.88	4811.17
7220	-86.70	211.80	3826.21
7230	-87.26	265.39	3080.90
7241	-87.53	489.19	2405.05
7242	-87.78	188.72	2408.31
7250	-88.13	388.51	1740.32
7260	-88.68	447.97	1106.26
7270	-89.49	562.10	200.82
7341	-88.05	831.90	2423.89
7342	-88.17	532.52	2411.60
7410	-86.19	820.03	4799.52
7420	-86.87	894.04	3857.45
7430	-87.27	953.79	3137.13
7441	-87.64	1173.87	2426.43
7442	-87.88	872.31	2422.88
7450	-88.39	1083.80	1748.75
7460	-88.56	1138.70	1095.27
7470	-88.49	1222.79	190.48
7541	-87.66	1518.16	2420.03
7542	-87.93	1217.27	2423.52
7610	-87.38	1510.12	4810.09
7620	-89.52	1585.21	3904.49
7630	-89.47	1637.18	3164.11
7641	-88.80	1860.19	2424.55
7642	-89.02	1557.72	2417.96
7650	-88.21	1769.88	1753.33
7660	-87.98	1814.40	1104.79
7670	-87.76	1902.32	185.25
7741	-88.85	2200.92	2435.55
7742	-88.87	1895.69	2426.22
7841	-88.97	2520.12	2572.48
7842	-88.29	2230.60	2544.93
7843	-88.36	2249.99	2321.36
7844	-89.01	2553.45	2341.53
7941	-87.68	2867.69	2642.49
7942	-88.30	2570.55	2664.08
7943	-88.69	2602.24	2204.60
7944	-87.06	2894.93	2268.01
7971	-85.77	2899.65	460.73
7972	-86.78	2785.58	242.55

Additional targets

Pnt. no.	X [mm]	Y [mm]	Z [mm]
70002	-98.80	-498.89	-303.07
70003	-48.95	1770.02	4973.49
70006	-42.56	-310.51	241.04
70007	-97.54	-825.18	1395.05
70008	-59.18	1430.61	5125.62
70009	-97.31	-505.33	1318.81
70010	-97.71	-538.88	777.67
70011	-42.55	-386.27	87.16
70013	-98.05	-671.07	572.32
70014	-98.49	-602.66	70.23
70015	-98.22	-701.11	312.83
70017	-98.89	-731.06	-212.24
70018	-98.44	-899.80	162.58
70019	-98.11	-1000.19	643.01
70022	-52.91	-201.04	-3.01
70024	-98.22	-1088.67	395.82
70025	-98.26	-1222.38	994.47
70026	-94.70	102.44	-387.27
70027	-97.92	-983.63	1216.13
70030	-98.76	-1218.60	170.54
70032	-53.58	-317.33	-168.13
70043	-86.48	2852.46	359.72
70056	-88.99	1115.31	5391.54
70057	-88.87	1400.50	5286.09
70063	-87.49	2525.18	309.85
70064	-58.99	1079.11	5120.99
70065	-85.06	478.74	5330.89
70066	-87.50	2691.37	455.72
70067	-85.09	2920.44	218.92
70071	-90.43	2427.66	-454.62
70072	-93.21	2617.56	-555.41
70073	-49.14	2229.40	-82.11
70074	-94.61	1492.76	-467.12
70075	-90.27	183.39	328.42
70077	-91.44	2237.47	-426.75
70078	-91.13	1906.94	-408.48
70079	-50.07	1677.69	-72.82
70080	-49.17	2033.74	-73.50
70081	-92.80	1148.03	-439.97
70086	-47.43	2847.60	-109.64
70087	-48.30	2590.44	-170.28
70089	-94.16	801.27	-478.71
70090	-89.21	-1231.69	5028.10
70092	-50.51	1513.71	-185.62
70094	-47.70	2698.09	-72.25
70095	-47.88	1284.81	4979.98
70096	-48.60	2398.07	-137.37
70097	-50.72	1372.66	-135.91
70099	-93.86	1648.49	-385.54
70101	-57.46	80.74	5124.91
70102	-49.70	1850.78	-136.58
70103	-51.09	1143.24	-84.60
70104	-89.33	862.50	368.58
70105	-92.59	1334.95	-491.15
70106	-49.16	2307.75	4988.50

Pnt. no.	X [mm]	Y [mm]	Z [mm]
70109	-94.81	2698.31	5450.36
70111	-91.21	740.46	5451.24
70112	-50.44	2799.69	4916.78
70113	-89.72	1753.02	5282.12
70114	-92.59	1511.49	5450.22
70120	-88.40	2195.48	399.46
70121	-88.17	1882.09	333.74
70125	-87.95	921.17	5289.50
70130	-95.64	-1239.96	2737.53
70135	-89.93	-462.93	5538.69
70136	-95.87	-687.32	2612.49
70137	-89.70	-886.59	4917.24
70138	-95.33	-958.69	2912.51
70139	-95.49	-494.19	2884.71
70140	-89.45	-723.46	5246.05
70141	-93.21	-785.34	3764.94
70142	-90.52	-1145.17	4500.13
70143	-97.03	-1117.85	2058.96
70144	-57.99	398.26	5128.07
70145	-92.81	-1242.15	3917.47
70147	-45.58	7.80	5078.21
70148	-45.85	-94.39	4984.27
70149	-89.54	-521.14	5423.62
70151	-97.52	-1231.86	1773.00
70152	-45.26	-339.18	5076.94
70153	-91.15	-663.76	4610.72
70155	-94.68	-1204.18	3330.80
70156	-96.37	-911.72	2364.88
70157	-94.88	-795.74	3170.52
70158	-89.69	-1200.06	4795.03
70160	-92.06	-874.23	4188.20
70162	-92.23	-488.49	4130.65
70163	-89.21	-1028.59	5179.31
70164	-91.11	1799.98	-500.17
70165	-94.13	-563.82	3419.77
70166	-93.92	-957.57	3497.74
70168	-97.02	-503.43	2067.52
70170	-97.05	-676.34	1849.17
70173	-90.01	-552.27	4995.24
70174	-58.64	831.53	5122.60
70175	-48.07	1469.45	4981.07
70176	-88.74	1487.32	460.42
70177	-60.15	2460.51	5124.85
70179	-88.96	1175.71	405.38
70181	-94.59	455.82	-478.10
70183	-49.50	2801.67	5177.45
70186	-49.65	2601.59	4964.87
70189	-87.87	21.12	5325.20
70192	-89.55	509.68	508.18
70196	-97.79	-642.78	1099.84
70197	-94.14	2361.88	5445.18
70207	-87.33	242.78	5288.75
70208	-90.57	188.34	5452.92
70209	-48.56	2073.04	5055.45
70210	-90.05	2284.71	5307.42

6 Mean plane on IP side

Results of Plane Fitting - Centroid Method

Date of Calculation: 8/15/2007

Time of Calculation: 2:23:01 PM

Equation and Direction Cosines of the Plane :

Eqn of a Plane: $X + B*Y + C*Z + D = 0$

B	0.000001	sig_B	0.15	mm/m
C	0.000002	sig_C	0.09	mm/m
D (m)	0.00000	sig_D	0.34	mm

Hence for Eqn of the form: $a*x + b*y + c*z + d = 0$ with a, b, c : Dir. Cosines of perp. Line to the Plane

a	1.000000
b	0.000001
c	0.000002
d (m)	0.00000

Bearing and Vertical Angle of the Vector from the origin to the plane

Bearing (Grades)	100.0000
Vertical Angle (Grades)	99.9999
Dist from the origin to the plane (m)	0.00000

Observed Coords (m)					Dist	dX	dY	dZ
Name	X (m)	Y (m)	Z (m)	Weight	(mm)	(mm)	(mm)	(mm)
438	0.00274	0.01331	4.81837	1.0	2.75	-2.75	0.00	0.00
439	0.00124	0.69655	4.81325	1.0	1.25	-1.25	0.00	0.00
440	0.00013	1.37511	4.81541	1.0	0.13	-0.13	0.00	0.00
441	-0.00035	2.06587	4.78955	1.0	-0.35	0.35	0.00	0.00
442	-0.00092	2.40174	4.80060	1.0	-0.91	0.91	0.00	0.00
443	-0.00105	2.74586	4.80116	1.0	-1.04	1.04	0.00	0.00
444	0.00112	-0.00184	3.95485	1.0	1.12	-1.12	0.00	0.00
445	0.00040	0.69606	3.99444	1.0	0.41	-0.41	0.00	0.00
446	-0.00073	1.35330	3.97729	1.0	-0.73	0.73	0.00	0.00
447	-0.00047	2.05010	3.97894	1.0	-0.47	0.47	0.00	0.00
448	-0.00133	2.39961	3.96409	1.0	-1.32	1.32	0.00	0.00
449	-0.00129	2.72042	3.95504	1.0	-1.28	1.28	0.00	0.00
450	0.00032	0.00514	3.29583	1.0	0.32	-0.32	0.00	0.00
451	0.00010	0.69966	3.33381	1.0	0.10	-0.10	0.00	0.00
452	-0.00065	1.38670	3.33814	1.0	-0.65	0.65	0.00	0.00
453	-0.00056	2.06982	3.36758	1.0	-0.55	0.55	0.00	0.00
454	-0.00153	2.41638	3.35723	1.0	-1.53	1.52	0.00	0.00
455	-0.00104	2.73438	3.36847	1.0	-1.03	1.03	0.00	0.00
456	-0.00032	0.00956	1.68073	1.0	-0.32	0.32	0.00	0.00
457	-0.00079	0.70494	1.74213	1.0	-0.79	0.79	0.00	0.00
458	0.00010	1.37600	1.78364	1.0	0.10	-0.10	0.00	0.00
459	0.00145	2.06194	1.75758	1.0	1.45	-1.45	0.00	0.00
460	0.00104	2.41314	1.76812	1.0	1.04	-1.04	0.00	0.00
461	0.00056	2.76177	1.75772	1.0	0.56	-0.56	0.00	0.00

462	-0.00083	0.00730	0.88461	1.0	-0.83	0.83	0.00	0.00
463	-0.00144	0.70140	0.90870	1.0	-1.44	1.44	0.00	0.00
464	0.00011	1.37357	0.91639	1.0	0.11	-0.11	0.00	0.00
465	0.00259	2.05910	0.91338	1.0	2.59	-2.59	0.00	0.00
466	0.00228	2.39898	0.92003	1.0	2.28	-2.27	0.00	0.00
467	0.00153	2.74271	0.92847	1.0	1.53	-1.53	0.00	0.00
468	-0.00273	0.00234	0.11896	1.0	-2.73	2.73	0.00	0.00
469	-0.00214	0.68297	0.11769	1.0	-2.15	2.15	0.00	0.00
470	-0.00070	1.36386	0.11298	1.0	-0.70	0.70	0.00	0.00
471	0.00166	2.04661	0.13421	1.0	1.65	-1.65	0.00	0.00
472	0.00163	2.39434	0.12753	1.0	1.62	-1.62	0.00	0.00
473	0.00229	2.73282	0.11341	1.0	2.29	-2.29	0.00	0.00
6141	-0.00046	-0.13966	2.45372	1.0	-0.46	0.46	0.00	0.00
6142	-0.00062	0.15218	2.45928	1.0	-0.62	0.62	0.00	0.00
6210	0.00223	0.35251	4.80603	1.0	2.24	-2.24	0.00	0.00
6220	0.00179	0.34474	3.99462	1.0	1.79	-1.79	0.00	0.00
6230	0.00087	0.35318	3.31379	1.0	0.87	-0.87	0.00	0.00
6241	-0.00017	0.19954	2.45964	1.0	-0.17	0.17	0.00	0.00
6242	-0.00032	0.49311	2.46467	1.0	-0.32	0.32	0.00	0.00
6250	0.00008	0.33347	1.70970	1.0	0.08	-0.07	0.00	0.00
6260	0.00002	0.34925	0.89287	1.0	0.02	-0.02	0.00	0.00
6270	-0.00215	0.34960	0.14185	1.0	-2.16	2.16	0.00	0.00
6341	-0.00074	0.54727	2.45029	1.0	-0.74	0.74	0.00	0.00
6342	-0.00031	0.83719	2.44355	1.0	-0.31	0.31	0.00	0.00
6410	0.00069	1.03783	4.80081	1.0	0.70	-0.70	0.00	0.00
6420	0.00004	1.03238	3.99975	1.0	0.05	-0.05	0.00	0.00
6430	-0.00028	1.03127	3.34412	1.0	-0.28	0.28	0.00	0.00
6441	-0.00032	0.88172	2.44033	1.0	-0.32	0.32	0.00	0.00
6442	-0.00039	1.17735	2.44208	1.0	-0.39	0.39	0.00	0.00
6450	0.00049	1.03489	1.75089	1.0	0.49	-0.49	0.00	0.00
6460	0.00077	1.01892	0.88720	1.0	0.77	-0.77	0.00	0.00
6470	-0.00072	1.02806	0.12750	1.0	-0.72	0.72	0.00	0.00
6541	-0.00048	1.23138	2.43800	1.0	-0.48	0.48	0.00	0.00
6542	-0.00027	1.50835	2.43136	1.0	-0.27	0.27	0.00	0.00
6610	0.00036	1.71796	4.82441	1.0	0.36	-0.36	0.00	0.00
6620	0.00009	1.70333	3.98566	1.0	0.09	-0.09	0.00	0.00
6630	-0.00012	1.72362	3.35169	1.0	-0.12	0.12	0.00	0.00
6641	0.00015	1.57639	2.42676	1.0	0.15	-0.15	0.00	0.00
6642	0.00010	1.84666	2.40664	1.0	0.10	-0.10	0.00	0.00
6650	0.00147	1.71970	1.78843	1.0	1.47	-1.47	0.00	0.00
6660	0.00223	1.69425	0.92529	1.0	2.23	-2.23	0.00	0.00
6670	0.00072	1.71821	0.12489	1.0	0.72	-0.72	0.00	0.00
6741	0.00031	1.92503	2.39841	1.0	0.31	-0.31	0.00	0.00
6742	-0.00021	2.19655	2.39621	1.0	-0.21	0.21	0.00	0.00
6841	-0.00193	2.24445	2.57201	1.0	-1.93	1.93	0.00	0.00
6842	-0.00092	2.54134	2.57370	1.0	-0.92	0.92	0.00	0.00
6843	-0.00011	2.54687	2.32432	1.0	-0.11	0.11	0.00	0.00
6844	-0.00105	2.24701	2.32504	1.0	-1.05	1.05	0.00	0.00
6941	-0.00084	2.58712	2.67764	1.0	-0.84	0.83	0.00	0.00

6942	-0.00097	2.88294	2.62667	1.0	-0.97	0.97	0.00	0.00
6943	-0.00063	2.87947	2.25749	1.0	-0.63	0.63	0.00	0.00
6944	-0.00092	2.58485	2.21848	1.0	-0.92	0.92	0.00	0.00

Dist = 'Signed' Dist. to Plane : (Sign - : Origin & Pt on same side / Plane)

(Sign + : Origin & Pt on opp. side / Plane)

dX, dY, dZ = Diff. co-ordinates :

(Diff. co-ordinates = Pt. proj. - Pt. obs.)

$$1.000000 * x + 0.000001 * y + 0.000002 * z + 0.000000 \text{ (m)}$$

Equation of the plane

$$= 0$$

Largest Distance from Plane on + side (mm) 2.748 At Point 438

Largest Distance from Plane on - side (mm) -2.731 At Point 468

Dist = 'Signed' Dist. to Plane (- => Origin & Pt on same side / Plane, + => Origin & Pt on opp. side / Plane)

7 Mean plane on Muon side

Results of Plane Fitting - Centroid Method

Date of Calculation: 8/15/2007

Time of Calculation: 4:01:46 PM

Equation and Direction Cosines of the Plane :

Eqn of a Plane: $X + B*Y + C*Z + D = 0$

B	0.00011	sig_B	0.18	mm/m
C	-0.00019	sig_C	0.13	mm/m
D (m)	0.08827	sig_D	0.48	mm

Hence for Eqn of the form: $a*x + b*y + c*z + d = 0$ with a, b, c : Dir. Cosines of perp. Line to the Plane

a	1.00000
b	0.00011
c	-0.00019
d (m)	0.08827

Bearing and Vertical Angle of the Vector from the origin to the plane

Bearing (Grades) 99.9931

Vertical Angle (Grades) 100.0124

Dist from the origin to the plane (m) 0.08827

Observed Coords (m)

Name	X (m)	Y (m)	Z (m)	Weight	Dist (mm)	dX (mm)	dY (mm)	dZ (mm)
7210	-0.08553	0.13488	4.81117	1.0	-1.82	-1.82	0.00	0.00
7220	-0.08670	0.21180	3.82621	1.0	-0.85	-0.85	0.00	0.00
7230	-0.08726	0.26539	3.08090	1.0	-0.44	-0.44	0.00	0.00
7241	-0.08753	0.48919	2.40505	1.0	-0.33	-0.33	0.00	0.00
7242	-0.08778	0.18872	2.40831	1.0	-0.04	-0.04	0.00	0.00
7250	-0.08813	0.38851	1.74032	1.0	0.16	0.16	0.00	0.00
7260	-0.08868	0.44797	1.10626	1.0	0.58	0.58	0.00	0.00

7270	-0.08949	0.56210	0.20082	1.0	1.20	1.20	0.00	0.00
7341	-0.08805	0.83190	2.42389	1.0	0.16	0.16	0.00	0.00
7342	-0.08817	0.53252	2.41160	1.0	0.31	0.31	0.00	0.00
7410	-0.08619	0.82003	4.79952	1.0	-1.24	-1.24	0.00	0.00
7420	-0.08687	0.89404	3.85745	1.0	-0.75	-0.74	0.00	0.00
7430	-0.08727	0.95379	3.13713	1.0	-0.49	-0.49	0.00	0.00
7441	-0.08764	1.17387	2.42643	1.0	-0.29	-0.29	0.00	0.00
7442	-0.08788	0.87231	2.42288	1.0	-0.02	-0.02	0.00	0.00
7450	-0.08839	1.08380	1.74875	1.0	0.34	0.34	0.00	0.00
7460	-0.08856	1.13870	1.09527	1.0	0.38	0.38	0.00	0.00
7470	-0.08849	1.22279	0.19048	1.0	0.12	0.12	0.00	0.00
7541	-0.08766	1.51816	2.42003	1.0	-0.31	-0.31	0.00	0.00
7542	-0.08793	1.21727	2.42352	1.0	0.00	0.00	0.00	0.00
7610	-0.08738	1.51012	4.81009	1.0	-0.12	-0.12	0.00	0.00
7620	-0.08952	1.58521	3.90449	1.0	1.84	1.84	0.00	0.00
7630	-0.08947	1.63718	3.16411	1.0	1.64	1.64	0.00	0.00
7641	-0.08880	1.86019	2.42455	1.0	0.79	0.79	0.00	0.00
7642	-0.08902	1.55772	2.41796	1.0	1.05	1.05	0.00	0.00
7650	-0.08821	1.76988	1.75333	1.0	0.09	0.09	0.00	0.00
7660	-0.08798	1.81440	1.10479	1.0	-0.27	-0.27	0.00	0.00
7670	-0.08776	1.90232	0.18525	1.0	-0.68	-0.68	0.00	0.00
7741	-0.08885	2.20092	2.43555	1.0	0.82	0.82	0.00	0.00
7742	-0.08887	1.89569	2.42622	1.0	0.86	0.86	0.00	0.00
7841	-0.08897	2.52012	2.57248	1.0	0.93	0.93	0.00	0.00
7842	-0.08829	2.23060	2.54493	1.0	0.27	0.27	0.00	0.00
7843	-0.08836	2.24999	2.32136	1.0	0.30	0.30	0.00	0.00
7844	-0.08901	2.55345	2.34153	1.0	0.92	0.92	0.00	0.00
7941	-0.08768	2.86769	2.64249	1.0	-0.39	-0.39	0.00	0.00
7942	-0.08830	2.57055	2.66408	1.0	0.27	0.27	0.00	0.00
7943	-0.08869	2.60224	2.20460	1.0	0.56	0.56	0.00	0.00
7944	-0.08706	2.89493	2.26801	1.0	-1.09	-1.09	0.00	0.00
7971	-0.08577	2.89965	0.46073	1.0	-2.72	-2.72	0.00	0.00
7972	-0.08678	2.78558	0.24255	1.0	-1.75	-1.75	0.00	0.00

Dist = 'Signed' Dist. to Plane : (Sign - : Origin & Pt on same side / Plane)

(Sign + : Origin & Pt on opp. side / Plane)

dX, dY, dZ = Diff. co-ordinates :

(Diff. co-ordinates = Pt. proj. - Pt. obs.)

$$1.000000 * x + 0.000109 * y + -0.000194 * z + 0.08827 \text{ (m)}$$

Equation of the plane = 0

Largest Distance from Plane on + side (mm) 1.840 At Point 7620

Largest Distance from Plane on - side (mm) -2.722 At Point 7971

Dist = 'Signed' Dist. to Plane (- => Origin & Pt on same side / Plane, + => Origin & Pt on opp. side / Plane)