



GENEVE, SUISSE

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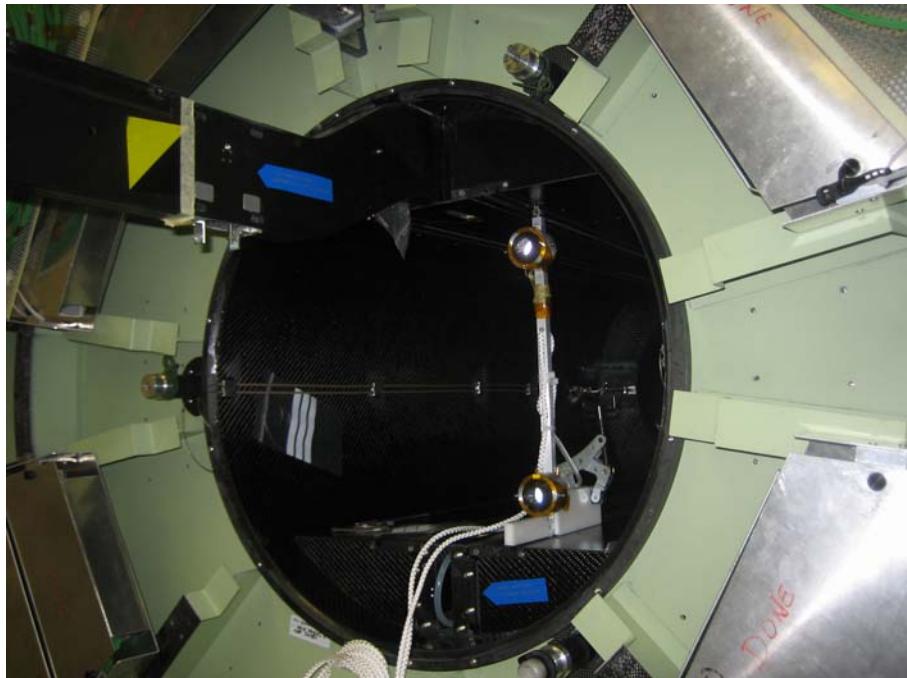
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CMS-TK-UR-0030  
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## CMS – TRACKER – TST

### MEASUREMENT OF THE TST BOTH FACES AND THE PIXEL SUPPORT RAILS

CERN – HALL 186 – 12 JULY 2007



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## 1 INTRODUCTION

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This report presents the results for the connection of both faces of the TST and for the measurement done on the rails of the pixel support tube from both Z- and Z+ sides. The measurement has been made by theodolite on the 12<sup>th</sup> of July 2007.

The measurement has been done on:

- ✓ The reference points on TEC+, TEC- and TST both sides.
- ✓ The pixel support rails. Measurements have been made twice at several positions along each rail. The two measurements at each position are provided.

**The coordinates are given in the centre of the target**

**Accuracy of the global theodolite measurement RMS (XYZ): +/- 0.3 mm**

## 2 COORDINATES SYSTEM

The coordinate system is the global CMS coordinate system, with the origin at the “interaction point”, Z-axis along the beam, X towards the centre of LHC, and Y upwards orthogonal to Z and X.

- The Rail end reference targets of the straighter\* support rail (Points 1 and 2) are used as reference for defining the Z-direction. Point 1 is at the Jura end of the rail.
- Z=0 is at the mid point between Point 1 and 2.
- The Rail end reference target on the Jura end of the other rail define the 3rd point (Point 3), thus defining the XZ-plane.
- X=0 shall be at the mid distance between Points 1 and 3.
- Y=0 is in the XZ-plane at X=0 and Z=0.

\* Rail –X proved to be the ‘straighter’ rail and thus is used as reference.

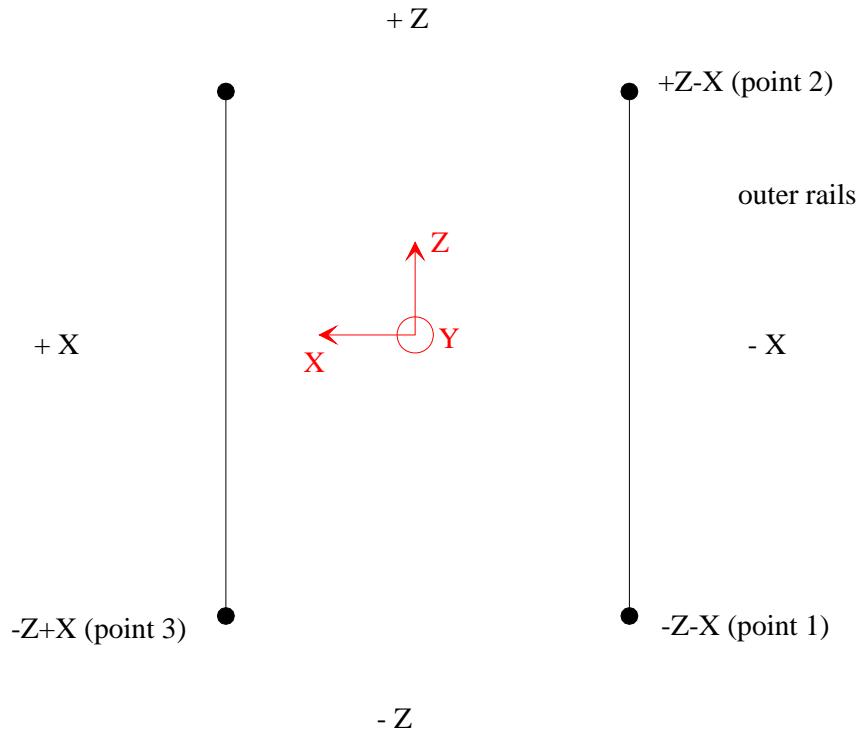


Figure 1 : Coordinate system – top view

The coordinates have been obtained as a best-fit calculation done on the coordinates of the reference points of the TST, TEC+ and TEC- measured on 22<sup>nd</sup> of March 2007 (please see report on EDMS 822597).

### 3 DEFINITION OF THE POINT NAMES AND DISTRIBUTION

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#### 3.1 Measured points – TEC+

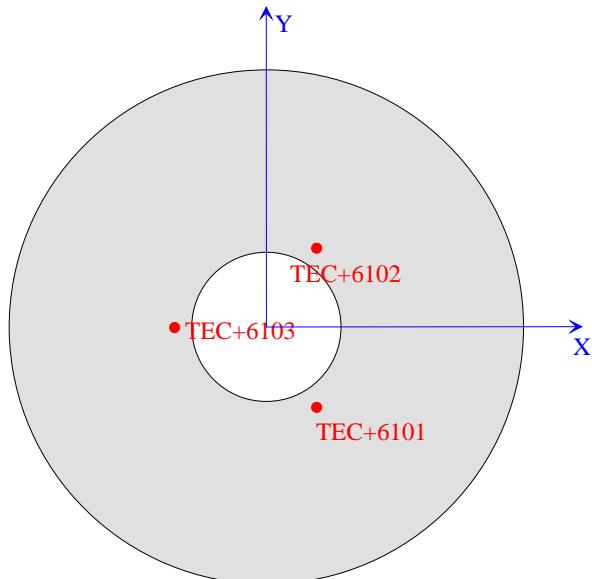


Figure 2 : TEC+ – Measured reference points

#### 3.2 Measured points – TEC-

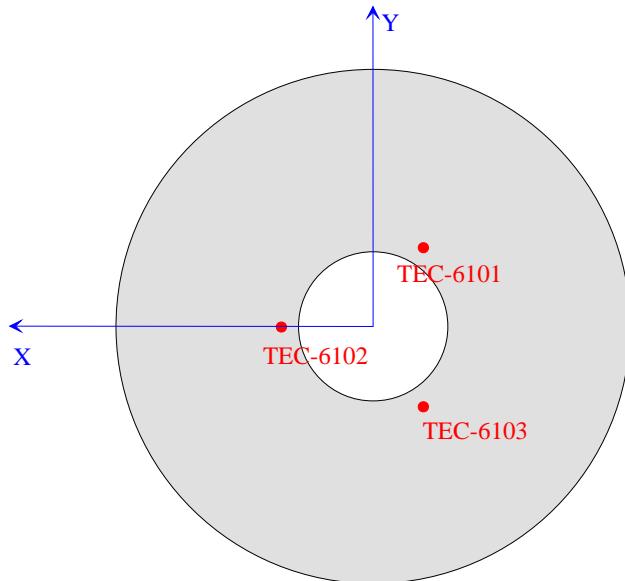


Figure 3 : TEC- – Measured reference points

### 3.3 Measured points – TST face +Z

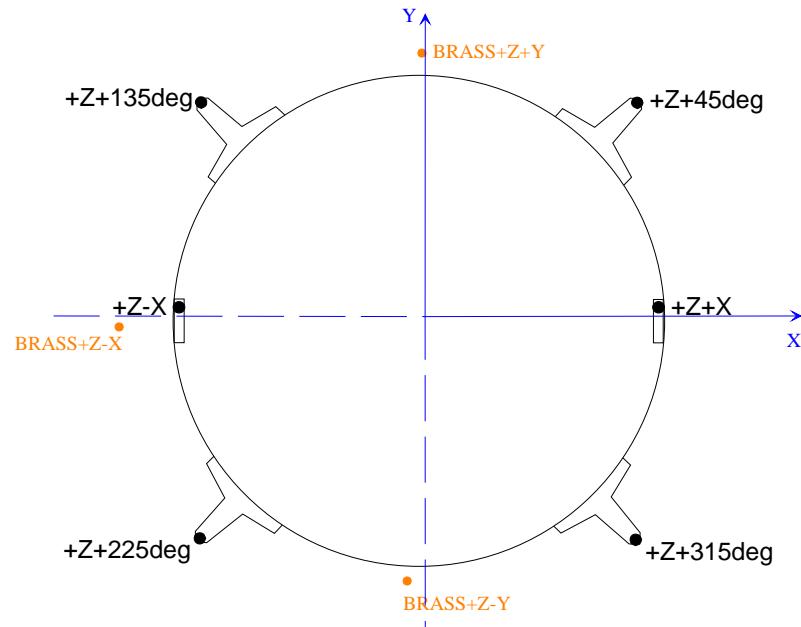


Figure 4 : TST – Measured reference points on +Z face

### 3.4 Measured points – TST face -Z

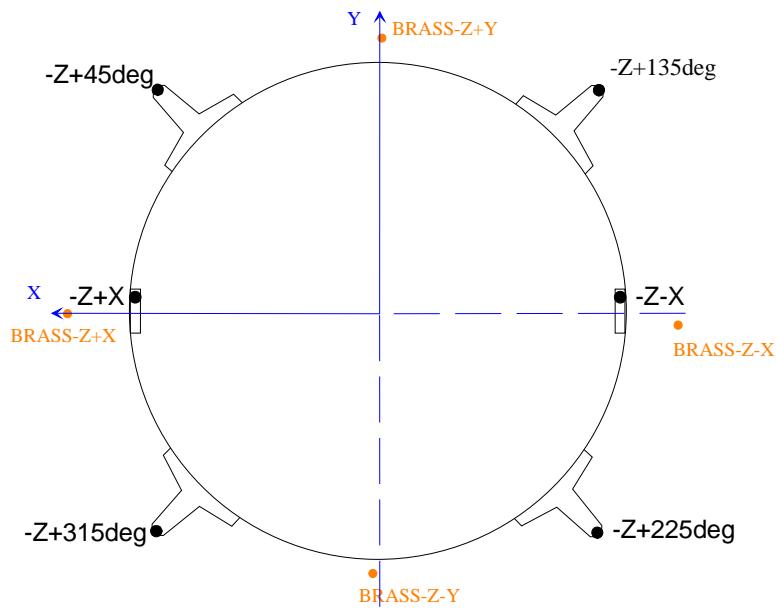


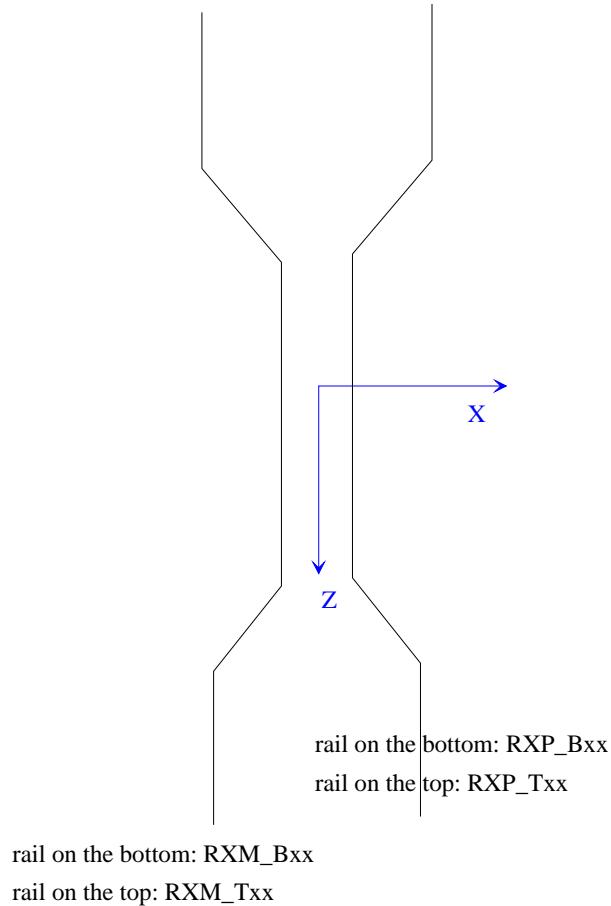
Figure 5 : TST – Measured reference points on -Z face

### 3.5 Measured points along the rails

The pixel support tube is equipped with four rails: two on the bottom part and two others on the top part. Thanks to the special adapter (version 2) provided by Paolo PETAGNA, four positions have been measured along the rails, with a 200 mm step. These points are named:

- ✓ ZyRXM\_Txx for the rail on the top, -X side, with xx from 01 to 27.
- ✓ ZyRXM\_Bxx for the rail on the bottom, -X side, with xx from 01 to 27.
- ✓ ZyRXP\_Txx for the rail on the top, +X side, with xx from 01 to 27.
- ✓ ZyRXP\_Bxx for the rail on the bottom, +X side, with xx from 01 to 27.

In “Zy”, y is “+” if the measure is done from the Z+ side and “–“ in the contrary case.



*Figure 6 : Measured points along the rails*

## 4 DETAILS FOR SURVEY TARGETS AND EXTENSIONS

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### 4.1 20 mm theodolite target

The complete measurement of all reference devices has been done with theodolite. Some points have been measured thanks to a theodolite target presenting a 20 mm offset with respect to the contact surface.

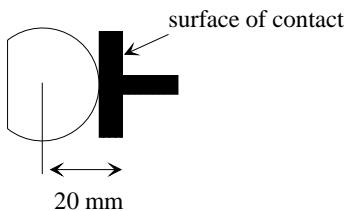


Figure 7 : 20 mm theodolite target.

### 4.2 Adapter for rail measurement

Points on the rails have been measured thanks to an adapter version 2 provided by Paolo PETAGNA. This adapter slides along a bottom rail and its corresponding top rail.

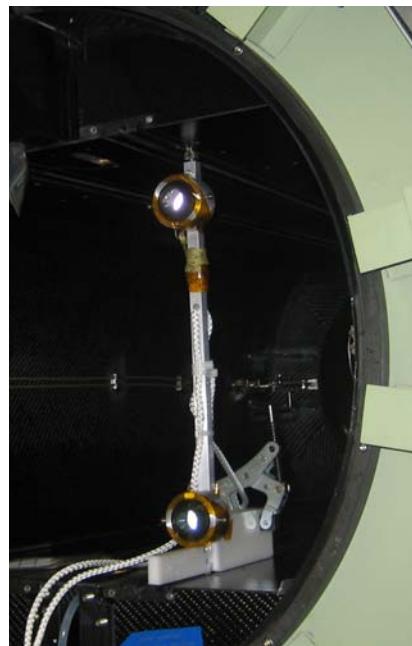
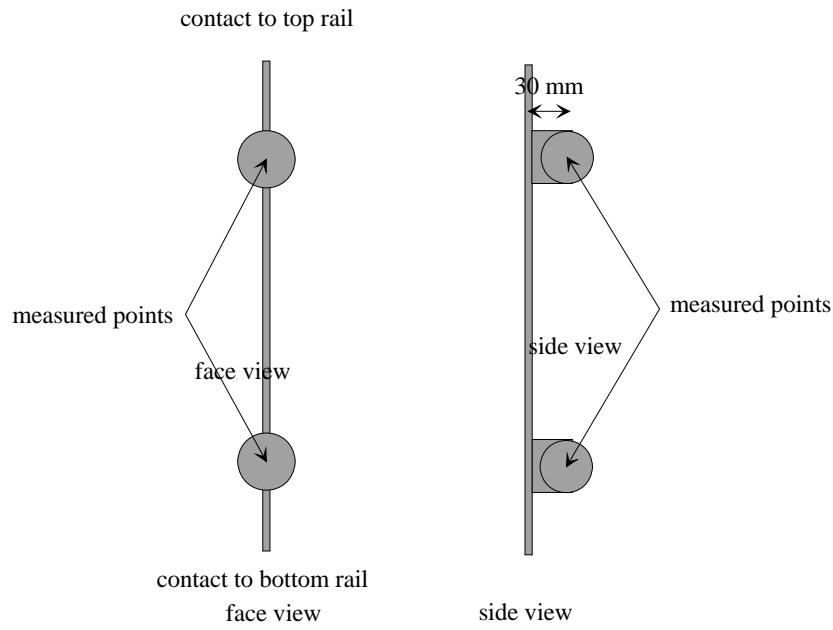
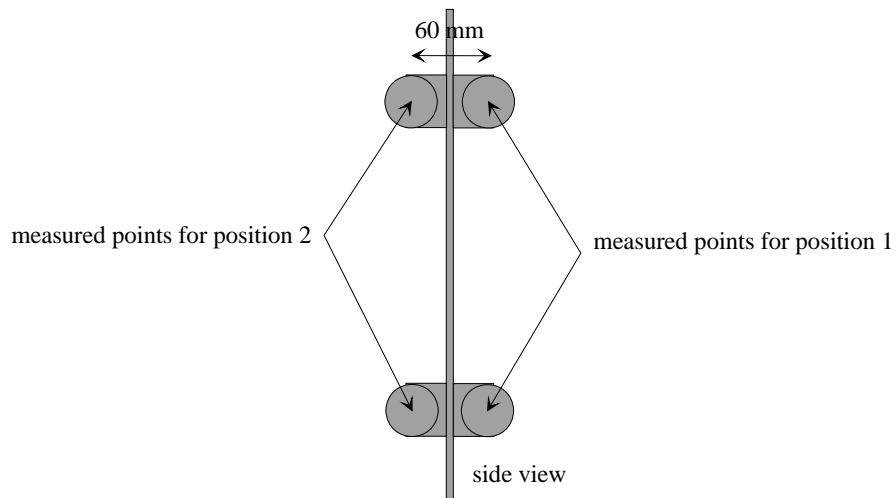


Figure 8 : Adapter used for the rail measurement.



*Figure 9 : Adapter used for the rail measurement.*

Several positions have been measured along the rails. Each position has been measured twice: the first from Z- side and then from Z+ side. But, for one position of the adapter, the centre of the survey target is shift from 60 mm.



*Figure 10 : Adapter used for the rail measurement for measurement in both way.*

## 5 RESULTS - COORDINATES

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### 5.1 Coordinates – Reference points on TST, TEC+ and TEC-

#### Points on TST side Z+

Points	Measured on 12 <sup>th</sup> of July 2007			Measured on 22 <sup>nd</sup> of March 2007			Comparison		
	X [mm]	Y [mm]	Z [mm]	X [mm]	Y [mm]	Z [mm]	dX [mm]	dY [mm]	dZ [mm]
+Z+135DEG	-982.67	984.56	2683.48	-982.90	984.81	2683.78	0.23	-0.25	-0.30
+Z+225DEG	-978.63	-980.95	2682.43	-979.01	-981.07	2682.40	0.38	0.12	0.03
+Z+315DEG	984.92	-984.45	2682.77	985.15	-984.61	2682.54	-0.23	0.16	0.23
+Z+45DEG				982.03	984.24	2684.30			
BRASS+Z+X	1242.03	100.26	2709.50	1242.67	100.39	2709.48	-0.64	-0.13	0.02
BRASS+Z-X	-1241.55	93.95	2709.20	-1242.18	93.98	2709.35	0.63	-0.03	-0.15

#### Points on TST side Z-

Points	Measured on 12 <sup>th</sup> July 2007			Measured on 22 <sup>nd</sup> March 2007			Comparison		
	X [mm]	Y [mm]	Z [mm]	X [mm]	Y [mm]	Z [mm]	dX [mm]	dY [mm]	dZ [mm]
-Z+135DEG	-983.96	982.46	-2683.70	-984.13	982.66	-2683.77	0.17	-0.20	0.07
-Z+225DEG	-981.28	-983.15	-2681.99	-981.54	-983.42	-2682.13	0.26	0.27	0.14
-Z+315DEG	982.08	-978.73	-2688.80	982.16	-978.88	-2688.80	-0.08	0.15	0.00
-Z+45DEG	981.80	986.29	-2683.19	982.07	986.65	-2683.31	-0.27	-0.36	0.12
BRASS-Z+X	1238.80	97.11	-2709.62	1239.43	96.96	-2709.57	-0.63	0.15	-0.05
BRASS-Z-X	-1241.86	90.43	-2709.04	-1242.34	90.25	-2709.24	0.48	0.18	0.20

#### Points on TEC+

Points	Measured on 12 <sup>th</sup> July 2007			Measured on 22 <sup>nd</sup> March 2007			Comparison		
	X [mm]	Y [mm]	Z [mm]	X [mm]	Y [mm]	Z [mm]	dX [mm]	dY [mm]	dZ [mm]
TEC+6101	281.63	-198.43	2927.99	282.09	-198.61	2928.09	-0.46	0.18	-0.10
TEC+6102	117.61	323.27	2928.17	117.46	323.38	2928.40	0.15	-0.11	-0.23
TEC+6103	-345.19	-1.02	2928.39	-345.20	-0.99	2928.44	0.01	-0.03	-0.05

#### Points on TEC-

Points	Measured on 12 <sup>th</sup> July 2007			Measured on 22 <sup>nd</sup> March 2007			Comparison		
	X [mm]	Y [mm]	Z [mm]	X [mm]	Y [mm]	Z [mm]	dX [mm]	dY [mm]	dZ [mm]
TEC-6101	-197.96	282.01	-2931.31	-198.03	282.05	-2931.38	0.07	-0.04	0.07
TEC-6102	344.91	-0.49	-2931.32	345.05	-0.46	-2931.51	-0.14	-0.03	0.18
TEC-6103	-197.84	-283.35	-2931.41	-197.89	-283.31	-2931.22	0.05	-0.04	-0.19

## 5.2 Coordinates – Points along the rails

Rails on X- side – bottom target measured

Points	X [mm]	Y [mm]	Z [mm]	Points	X [mm]	Y [mm]	Z [mm]
Z+RMX_B01	-93.66	-145.73	2795.51	Z-RMX_B01	-86.70	-145.64	2636.68
Z+RMX_B02	-89.66	-145.65	2707.30	Z-RMX_B02	-75.68	-145.34	2391.40
Z+RMX_B03	-81.27	-145.63	2519.32	Z-RMX_B03	-66.40	-145.27	2168.84
Z+RMX_B04	-71.45	-145.64	2306.76	Z-RMX_B04	-60.46	-145.23	1960.54
Z+RMX_B05	-63.76	-145.44	2094.59	Z-RMX_B05	-56.41	-145.41	1747.22
Z+RMX_B06	-58.49	-145.34	1886.20	Z-RMX_B06	-55.09	-145.58	1533.36
Z+RMX_B07	-55.43	-145.62	1664.28	Z-RMX_B07	-46.57	-145.31	1319.84
Z+RMX_B08	-55.53	-145.43	1450.51	Z-RMX_B08	-31.24	-145.42	1101.07
Z+RMX_B09	-35.46	-145.47	1238.69	Z-RMX_B09	-32.51	-145.60	893.25
Z+RMX_B10	-31.84	-145.69	1019.12	Z-RMX_B10	-32.39	-145.61	678.04
Z+RMX_B11	-31.92	-145.58	811.77	Z-RMX_B11	-32.49	-145.60	465.28
Z+RMX_B12	-31.92	-145.73	592.61	Z-RMX_B12	-32.40	-145.49	248.31
Z+RMX_B13	-32.10	-145.60	383.86	Z-RMX_B13	-32.39	-145.74	55.19
Z+RMX_B14	-31.89	-145.70	165.94	Z-RMX_B14	-32.30	-145.69	-162.53
Z+RMX_B15	-31.90	-145.72	-49.50	Z-RMX_B15	-32.40	-145.56	-378.19
Z+RMX_B16	-31.66	-145.65	-258.36	Z-RMX_B16	-32.45	-145.44	-591.82
Z+RMX_B17	-31.84	-145.55	-470.46	Z-RMX_B17	-32.19	-145.52	-806.98
Z+RMX_B18	-31.71	-145.57	-684.62	Z-RMX_B18	-32.36	-145.41	-1017.11
Z+RMX_B19	-31.84	-145.69	-899.22	Z-RMX_B19	-34.93	-145.44	-1230.62
Z+RMX_B20	-30.52	-145.49	-1112.83	Z-RMX_B20	-55.75	-145.80	-1453.71
Z+RMX_B21	-46.11	-145.62	-1328.55	Z-RMX_B21	-54.75	-146.40	-1649.34
Z+RMX_B22	-54.26	-146.14	-1541.18	Z-RMX_B22	-58.10	-145.65	-1863.57
Z+RMX_B23	-55.67	-145.93	-1757.04	Z-RMX_B23	-62.87	-145.62	-2069.70
Z+RMX_B24	-59.42	-145.67	-1968.42	Z-RMX_B24	-70.44	-145.56	-2286.66
Z+RMX_B25	-66.01	-145.61	-2196.11	Z-RMX_B25	-79.69	-145.39	-2496.16
Z+RMX_B26	-74.54	-145.62	-2404.47	Z-RMX_B26	-89.76	-145.28	-2714.61
Z+RMX_B27	-85.34	-145.26	-2643.53	Z-RMX_B27	-93.68	-145.32	-2803.06

Rails on X- side – top target measured

Points	X [mm]	Y [mm]	Z [mm]	Points	X [mm]	Y [mm]	Z [mm]
Z+RMX_T01	-94.15	139.15	2795.71	Z-RMX_T01	-86.56	139.04	2638.22
Z+RMX_T02	-90.07	139.12	2707.77	Z-RMX_T02	-75.15	139.42	2392.49
Z+RMX_T03	-81.64	139.35	2519.19	Z-RMX_T03	-66.11	139.58	2169.82
Z+RMX_T04	-71.95	139.26	2306.65	Z-RMX_T04	-59.89	139.37	1961.48
Z+RMX_T05	-64.17	139.34	2094.37	Z-RMX_T05	-56.08	139.42	1747.94
Z+RMX_T06	-59.18	139.29	1885.84	Z-RMX_T06	-54.52	139.29	1534.22
Z+RMX_T07	-55.74	139.12	1664.42	Z-RMX_T07	-46.28	139.27	1320.48
Z+RMX_T08	-55.96	139.13	1450.69	Z-RMX_T08	-30.93	139.47	1101.50
Z+RMX_T09	-35.46	139.30	1238.48	Z-RMX_T09	-32.15	139.23	893.85
Z+RMX_T10	-32.05	139.11	1019.21	Z-RMX_T10	-31.89	139.39	678.56
Z+RMX_T11	-32.17	139.05	811.94	Z-RMX_T11	-31.86	139.21	465.73
Z+RMX_T12	-32.18	139.07	592.70	Z-RMX_T12	-31.94	139.23	248.05
Z+RMX_T13	-32.40	139.15	383.96	Z-RMX_T13	-31.90	139.07	55.56
Z+RMX_T14	-31.90	139.21	165.50	Z-RMX_T14	-32.14	138.96	-161.85
Z+RMX_T15	-31.79	139.17	-49.65	Z-RMX_T15	-31.81	139.37	-377.50
Z+RMX_T16	-32.25	138.88	-258.14	Z-RMX_T16	-31.90	139.19	-591.59
Z+RMX_T17	-32.25	139.28	-470.57	Z-RMX_T17	-31.87	139.24	-806.73
Z+RMX_T18	-32.03	138.88	-684.61	Z-RMX_T18	-31.76	139.31	-1016.51
Z+RMX_T19	-31.99	139.05	-899.01	Z-RMX_T19	-34.29	139.49	-1230.07
Z+RMX_T20	-30.83	139.41	-1113.47	Z-RMX_T20	-55.64	138.94	-1454.05
Z+RMX_T21	-46.52	139.27	-1329.30	Z-RMX_T21	-55.27	138.89	-1648.93
Z+RMX_T22	-54.35	138.79	-1541.20	Z-RMX_T22	-57.62	139.10	-1862.21
Z+RMX_T23	-56.21	138.89	-1756.64	Z-RMX_T23	-62.26	139.26	-2068.80
Z+RMX_T24	-60.02	139.02	-1968.52	Z-RMX_T24	-69.82	139.36	-2285.88
Z+RMX_T25	-66.46	139.00	-2195.70	Z-RMX_T25	-79.20	139.50	-2495.20
Z+RMX_T26	-74.99	139.55	-2404.47	Z-RMX_T26	-89.33	139.55	-2713.83
Z+RMX_T27	-85.76	139.59	-2644.11	Z-RMX_T27	-93.25	139.54	-2802.49

Rails on X+ side – bottom target measured

Points	X [mm]	Y [mm]	Z [mm]	Points	X [mm]	Y [mm]	Z [mm]
Z+RPX_B01	93.57	-145.72	2796.91	Z-RPX_B01	86.22	-145.60	2636.83
Z+RPX_B02	89.63	-145.61	2707.46	Z-RPX_B02	75.44	-145.12	2393.65
Z+RPX_B03	80.41	-145.54	2504.34	Z-RPX_B03	66.50	-145.52	2174.55
Z+RPX_B04	71.15	-145.49	2290.06	Z-RPX_B04	60.66	-145.33	1959.46
Z+RPX_B05	63.95	-145.57	2079.37	Z-RPX_B05	56.81	-145.58	1746.43
Z+RPX_B06	58.79	-145.59	1854.67	Z-RPX_B06	55.70	-145.51	1535.17
Z+RPX_B07	56.43	-145.74	1656.34	Z-RPX_B07	48.15	-145.63	1326.75
Z+RPX_B08	56.80	-145.66	1446.06	Z-RPX_B08	32.23	-145.27	1113.81
Z+RPX_B09	35.95	-145.67	1219.40	Z-RPX_B09	33.75	-145.48	902.11
Z+RPX_B10	34.03	-145.64	1013.77	Z-RPX_B10	33.56	-145.45	690.00
Z+RPX_B11	34.02	-145.67	799.31	Z-RPX_B11	33.58	-145.46	481.75
Z+RPX_B12	34.01	-145.46	581.49	Z-RPX_B12	33.65	-145.54	267.15
Z+RPX_B13	34.08	-145.62	367.14	Z-RPX_B13	33.63	-145.76	51.79
Z+RPX_B14	34.24	-145.97	161.18	Z-RPX_B14	33.57	-145.70	-160.97
Z+RPX_B15	34.03	-145.89	-53.48	Z-RPX_B15	33.58	-145.68	-376.07
Z+RPX_B16	34.27	-145.91	-269.49	Z-RPX_B16	33.65	-145.58	-591.88
Z+RPX_B17	34.37	-145.72	-482.15	Z-RPX_B17	33.72	-145.62	-804.93
Z+RPX_B18	34.30	-145.71	-697.37	Z-RPX_B18	33.63	-145.55	-1020.39
Z+RPX_B19	34.06	-145.85	-908.82	Z-RPX_B19	35.64	-145.37	-1228.84
Z+RPX_B20	32.90	-145.12	-1120.28	Z-RPX_B20	56.00	-146.04	-1439.15
Z+RPX_B21	48.92	-145.93	-1334.39	Z-RPX_B21	56.25	-146.18	-1655.16
Z+RPX_B22	56.45	-146.29	-1544.84	Z-RPX_B22	58.88	-145.71	-1865.45
Z+RPX_B23	58.22	-146.12	-1767.44	Z-RPX_B23	63.80	-145.73	-2080.46
Z+RPX_B24	61.84	-145.73	-1972.32	Z-RPX_B24	70.79	-145.51	-2286.88
Z+RPX_B25	67.68	-145.71	-2181.08	Z-RPX_B25	80.02	-145.39	-2494.24
Z+RPX_B26	76.53	-145.72	-2396.21	Z-RPX_B26	89.87	-145.47	-2714.30
Z+RPX_B27	87.35	-145.51	-2643.13	Z-RPX_B27	93.78	-145.88	-2803.27

Rails on X+ side – top target measured

Points	X [mm]	Y [mm]	Z [mm]	Points	X [mm]	Y [mm]	Z [mm]
Z+RPX_T01	93.20	139.25	2796.76	Z-RPX_T01	86.48	139.37	2637.96
Z+RPX_T02	89.18	139.19	2707.42	Z-RPX_T02	75.81	139.18	2394.53
Z+RPX_T03	80.15	139.21	2504.13	Z-RPX_T03	67.02	139.46	2175.27
Z+RPX_T04	70.67	139.21	2289.55	Z-RPX_T04	60.92	139.36	1960.30
Z+RPX_T05	63.42	139.43	2079.08	Z-RPX_T05	57.31	139.38	1746.94
Z+RPX_T06	58.42	139.33	1854.23	Z-RPX_T06	56.24	139.27	1535.63
Z+RPX_T07	56.26	139.05	1656.46	Z-RPX_T07	48.71	139.45	1327.47
Z+RPX_T08	56.41	139.14	1446.09	Z-RPX_T08	32.51	139.52	1114.41
Z+RPX_T09	35.58	139.26	1219.22	Z-RPX_T09	33.98	139.30	902.66
Z+RPX_T10	33.67	139.00	1013.89	Z-RPX_T10	33.82	139.26	690.34
Z+RPX_T11	33.87	139.22	799.42	Z-RPX_T11	33.94	139.30	482.06
Z+RPX_T12	33.80	139.08	581.49	Z-RPX_T12	33.98	139.21	267.81
Z+RPX_T13	33.98	138.83	366.85	Z-RPX_T13	33.83	139.26	52.45
Z+RPX_T14	33.91	138.70	160.80	Z-RPX_T14	33.88	139.00	-160.29
Z+RPX_T15	33.78	138.68	-53.65	Z-RPX_T15	33.86	139.24	-375.41
Z+RPX_T16	33.89	138.87	-269.49	Z-RPX_T16	33.88	139.25	-591.32
Z+RPX_T17	33.95	139.13	-482.31	Z-RPX_T17	34.09	139.27	-804.59
Z+RPX_T18	33.86	139.15	-697.45	Z-RPX_T18	34.06	139.39	-1019.96
Z+RPX_T19	33.64	138.82	-909.18	Z-RPX_T19	36.24	139.51	-1228.55
Z+RPX_T20	32.49	139.22	-1121.19	Z-RPX_T20	56.56	138.86	-1439.20
Z+RPX_T21	49.34	138.79	-1335.05	Z-RPX_T21	56.76	138.79	-1654.60
Z+RPX_T22	56.17	138.39	-1544.72	Z-RPX_T22	59.19	139.19	-1864.41
Z+RPX_T23	57.60	138.37	-1767.27	Z-RPX_T23	64.21	139.28	-2079.87
Z+RPX_T24	61.34	139.09	-1972.32	Z-RPX_T24	71.32	139.39	-2286.08
Z+RPX_T25	67.37	139.04	-2181.02	Z-RPX_T25	80.34	139.51	-2493.66
Z+RPX_T26	75.96	139.04	-2396.39	Z-RPX_T26	90.22	139.39	-2714.04
Z+RPX_T27	87.49	139.01	-2643.39	Z-RPX_T27	93.89	139.00	-2803.79