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**LHC-b - UX85**  
**Outer Tracker – T2-Q02 (C frame B3 position)**  
**August, the 29th 2006**

The EDMS document, **id: 771339** containing this report can be found at the address:

<https://edms.cern.ch/document/771339>

## 1 T2-Q02 – Introduction:

The aim of the measurement was to adjust and control the C-frame on the rail B3 (for the name of the rail, see the document EDMS <https://edms.cern.ch/document/756237>). This C-frame is called T2-Q02.

In a first time was made a test to be sure that the C-frame comes back at the same position, after been moved along the rail and points on the surface were measured to estimate if there is any deformations on this plane.

In a second time, the C-frame was adjusted on the right position.

After adjustment, all points were measured.

## 2 LHC-b Survey Co-ordinate System

- Origin: Interaction Point IP;
- $Z_{SU}$  axis: **vertical**, positive to the top;
- $X_{SU}$  axis: beam projection in the **horizontal** plane, positive from cavern to IP;
- $Y_{SU}$  axis: **horizontal**, perpendicular to the XZ plane, positive to the LHC centre

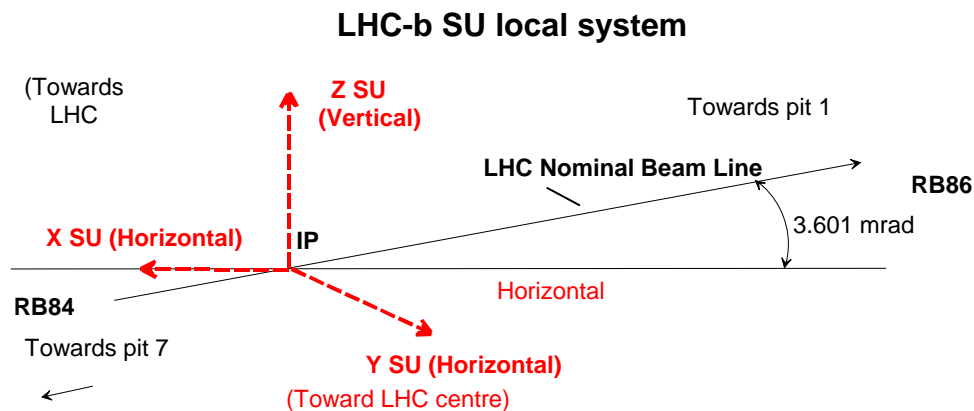


Figure 1 : LHCb Co-ordinate systems

### 3 C frame point positions and names:

#### 3.1 Point names:

Point names are **B3\_LSnB** or **B3\_LSnT** with:

- S : Side of the frame, LV is on the magnet side and LX on the Rich2 side.
- n : Chamber number on the frame, from 1 (Cryo side), to 9 (PZ side)
- B or T : for Bottom or Top

Example: B3\_LV5T is on the magnet side, on the chamber 5, on the top.

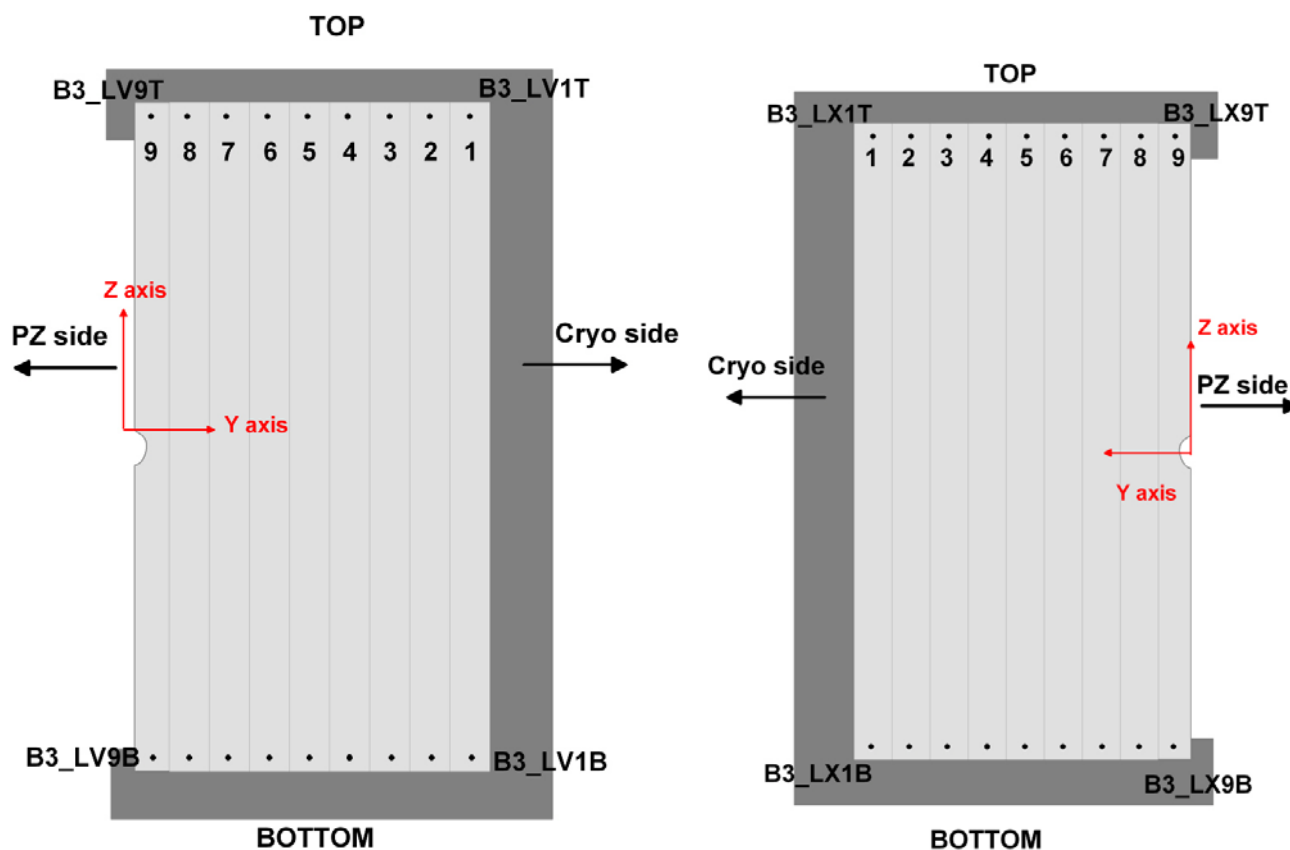


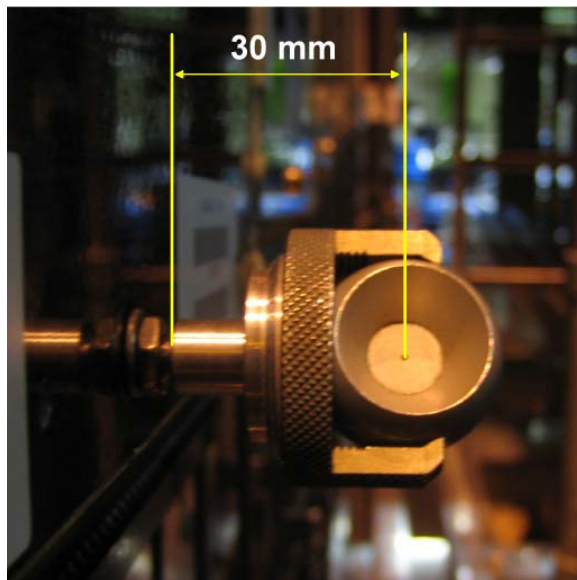
Figure 2 : point positions – LV side (view from IP side) and LX side (view from RICH2 side)

### 3.2 Measured points

The coordinates are given at the centre of the Survey target, at a horizontal distance of **30mm** from the contact surface, see figure 3.



Point position on the frame



*Figure 3 : Point position and target*

## 4 Repeatability test

### 4.1 Point positions

In order to adjust the C-frame, we measured the point on each corner of the frame:

- B3\_LV8B, on the left bottom corner
- B3\_LV1B, on the right bottom corner
- B3\_LV8T on the left top corner
- B3\_LV2T, on the right top corner

### 4.2 Results of repeatability test

The coordinates are given at the centre of the Survey target, at a distance of 30mm from the contact surface, see figure 3. The precision of XYZ coordinates is: 0.5mm at 1 sigma level.

	Point	X (m)	Y (m)	Z (m)
Iteration 1	B3_LV8B	-8.6077	0.2199	-2.4116
	B3_LV1B	-8.6089	2.6175	-2.4118
	B3_LV8T	-8.6058	0.6475	2.4717
	B3_LV2T	-8.6060	2.7035	2.4698
Iteration 2	B3_LV8B	-8.6077	0.2199	-2.4115
	B3_LV1B	-8.6090	2.6176	-2.4117
	B3_LV8T	-8.6062	0.6475	2.4717
	B3_LV2T	-8.6063	2.7034	2.4700
Iteration 3	B3_LV8B	-8.6077	0.2199	-2.4116
	B3_LV1B	-8.6090	2.6177	-2.4116
	B3_LV8T	-8.6063	0.6476	2.4718
	B3_LV2T	-8.6064	2.7032	2.4700
Iteration 4	B3_LV8B	-8.6084	0.2114	-2.4107
	B3_LV8T	-8.6063	0.6425	2.4715
	B3_LV2T	-8.6091	2.6954	2.4692
Iteration 5	B3_LV8B	-8.6094	0.2119	-2.4107
	B3_LV8T	-8.6093	0.6413	2.4720
Iteration 6	B3_LV8B	-8.6094	0.2121	-2.4108
	B3_LV8T	-8.6097	0.6402	2.4710
	B3_LV2T	-8.6089	2.6960	2.4693
Iteration 7	B3_LV8B	-8.6092	0.2132	-2.4108
	B3_LV8T	-8.6095	0.6407	2.4726
	B3_LV2T	-8.6087	2.6969	2.4702

## 5 Points after adjustment

The coordinates are given in the survey reference system.

Precision of the coordinates along X, Y and Z axis is 0.5 mm at 1 sigma level.

Note: B3\_LV1T was hidden and for B3\_LX4B there was no hole to put the target.

Layer V (magnet side)			
Point on the bottom of the frame			
	X (m)	Y (m)	Z (m)
B3_LV1B	-8.6096	2.6108	-2.4110
B3_LV2B	-8.6091	2.2681	-2.4110
B3_LV3B	-8.6089	1.9256	-2.4110
B3_LV4B	-8.6090	1.5832	-2.4111
B3_LV5B	-8.6088	1.2405	-2.4108
B3_LV6B	-8.6087	0.8982	-2.4112
B3_LV7B	-8.6102	0.5551	-2.4111
B3_LV8B	-8.6093	0.2130	-2.4111
B3_LV9B	-8.6062	-0.0448	-2.4117

Layer X (RICH2 side)			
Points on the bottom of the frame			
	X (m)	Y (m)	Z (m)
B3_LX1B	-8.7692	2.8139	-2.4210
B3_LX2B	-8.7691	2.4726	-2.4209
B3_LX3B	-8.7691	2.1314	-2.4209
B3_LX5B	-8.7688	1.4488	-2.4209
B3_LX6B	-8.7684	1.1075	-2.4203
B3_LX7B	-8.7683	0.7662	-2.4206
B3_LX8B	-8.7682	0.4252	-2.4208
B3_LX9B	-8.7681	0.1677	-2.4206

Layer V (magnet side)			
Point on the top of the frame			
	X (m)	Y (m)	Z (m)
B3_LV2T	-8.6088	2.6969	2.4702
B3_LV3T	-8.6091	2.3545	2.4707
B3_LV4T	-8.6087	2.0116	2.4708
B3_LV5T	-8.6085	1.6690	2.4712
B3_LV6T	-8.6088	1.3261	2.4716
B3_LV7T	-8.6089	0.9836	2.4719
B3_LV8T	-8.6096	0.6410	2.4723
B3_LV9T	-8.6096	0.3826	2.4725

Layer X (RICH2 side)			
Points on the top of the frame			
	X (m)	Y (m)	Z (m)
B3_LX8T	-8.7695	0.4265	2.4805
B3_LX9T	-8.7695	0.1693	2.4809

## 6 Plane

### 6.1 Points positions

The points were taken on the surface with an offset of 52.3 mm in the X direction (see figure 4).



Figure 4 : Offset

### 6.2 Points names

**Points are  $B3\_PLn\_p$  with:**

- $n$ , the chamber number (see figure 5)
  - $p$  the position on the chamber, from 1 (on the bottom), to 5 (on the top).
- As the chamber 2 is composed by 2 plates, joined on the middle, 2 points were taken, on just above this plane variation, and one below. As a consequence, there is  $B3\_PL2\_3A$  and  $B3\_PL2\_3B$ .

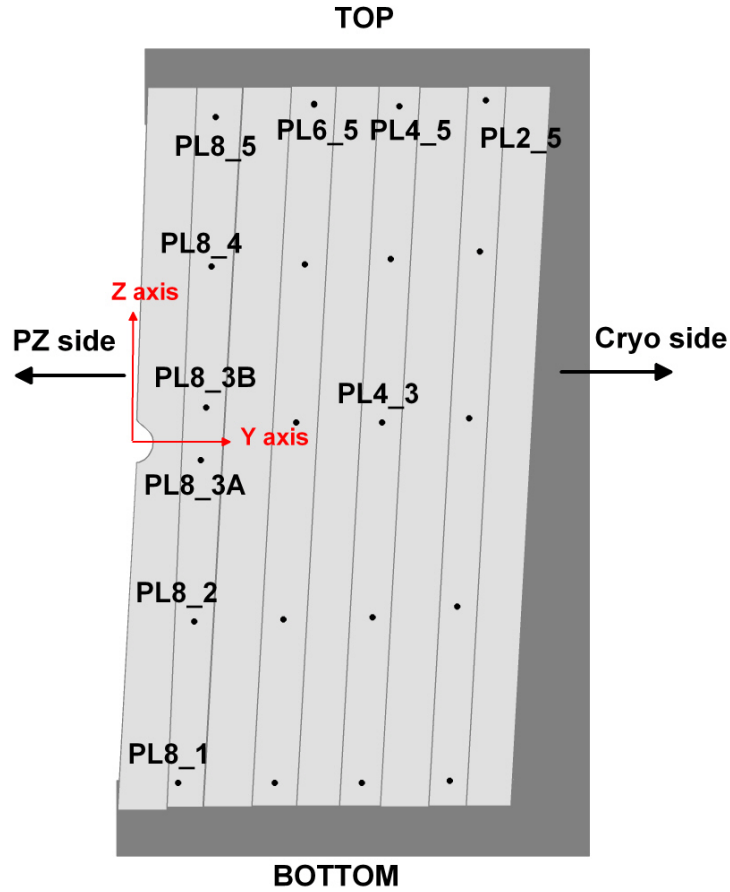


Figure 5 : Point positions

### 6.3 Transformation

The coordinates of the XYZ points are given in the final position of the C-frame after 3D transformation.



## 6.4 Plane fitting and results

### *Results of Plane Fitting - Centroid Method*

Equation and Direction Cosines of the Plane :

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

B	-0.000024	sig_B	0.175	mm/m
C	0.000039	sig_C	0.083	mm/m
D (m)	8.59346	sig_D	0.281	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	-0.000024
c	0.000039
d (m)	8.59346

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

Bearing (Grades)

Vertical Angle (Grades) 99.9975

Dist from the origin to the plane (m) 8.59346

Observed Coords (m)				Dist	dX	dY	dZ	
Name	X (m)	Y (m)	Z (m)	Weight	(mm)	(mm)	(mm)	(mm)
PL8_1	-8.5933	0.2334	-2.2628	1.0	-0.1	-0.1	0.0	0.0
PL8_2	-8.5933	0.2967	-1.3593	1.0	-0.1	-0.1	0.0	0.0
PL6_1	-8.5929	0.9163	-2.2863	1.0	-0.4	-0.4	0.0	0.0
PL6_2	-8.5937	1.0007	-1.3108	1.0	0.3	0.3	0.0	0.0
PL4_1	-8.5930	1.5937	-2.2948	1.0	-0.3	-0.3	0.0	0.0
PL4_2	-8.5925	1.6867	-1.3136	1.0	-0.8	-0.8	0.0	0.0
PL2_1	-8.5933	2.2620	-2.2948	1.0	0.0	0.0	0.0	0.0
PL2_2	-8.5928	2.3629	-1.3417	1.0	-0.5	-0.5	0.0	0.0
PL8_3A	-8.5936	0.4263	-0.0940	1.0	0.1	0.1	0.0	0.0
PL8_3B	-8.5938	0.4396	0.1656	1.0	0.4	0.4	0.0	0.0
PL6_3	-8.5945	1.1169	0.0829	1.0	1.0	1.0	0.0	0.0
PL4_3	-8.5940	1.8081	0.1248	1.0	0.6	0.6	0.0	0.0
PL2_3	-8.5944	2.4923	0.1069	1.0	1.0	1.0	0.0	0.0
PL2_4	-8.5945	2.5913	1.3430	1.0	1.0	1.0	0.0	0.0
PL4_4	-8.5936	1.9206	1.3231	1.0	0.1	0.1	0.0	0.0
PL6_4	-8.5938	1.2280	1.2694	1.0	0.3	0.3	0.0	0.0
PL8_4	-8.5933	0.5584	1.3125	1.0	-0.1	-0.1	0.0	0.0
PL8_5	-8.5934	0.6376	2.3994	1.0	-0.1	-0.1	0.0	0.0
PL6_5	-8.5927	1.3313	2.3827	1.0	-0.8	-0.8	0.0	0.0
PL4_5	-8.5929	1.9973	2.3626	1.0	-0.6	-0.6	0.0	0.0
PL2_5	-8.5926	2.7030	2.4173	1.0	-0.9	-0.9	0.0	0.0

**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. )

*Summary of the data in the Calculated Co-ordinate Axis*

Equation of the plane  $1.000000 * x + -0.000024 * y + 0.000039 * z + 8.59346 \text{ (m)} = 0$

Largest Distance from Plane on + side (mm) 1.0 At Point PL2\_3

Largest Distance from Plane on - side (mm) -0.9 At Point PL2\_5

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