

The longitudinal positions of the beam chambers in the 2004 CBT-EC2

The longitudinal positions of the BPCs and MWPCs in the 2004 H6 beam tests are presented, taking into account the available technical information about the chambers structure, the manual measurements of 2003 and the survey measurements of May, 2004.

1. Beam Profile Chambers

In 2003, the Beam Profile Chambers (BPCs) Z-positions were known from the measurements done by the ITEP group [1] (see Table 1). The relative BPC positions within the stations were measured with an accuracy of better than 1 mm. The distances between the stations were found using a tape ruler, by a chain of relative measurements with the overall accuracy of ~1 cm. See [2] for a general description of the BPCs.¹

BPC plane numbering. BPCs are numbered from 1 (at the Bend9) through 6 (at the cryostat), see Fig. 1. This numbering scheme was also used in 2003. The far station consists of BPC1 and 2, the middle station – of BPCs 3 and 4, and the near station - of BPCs 5 and 6. Each BPC contains 2 measurement gaps (“planes”): X and Y. The notation *IX* refers to the X-plane of BPC1 etc. The distance between X- and Y-planes of a BPC is 31¹ mm for BPCs 1, 2, 5 and 6. The middle-station BPCs are, in fact, pairs of physically separate single-plane chambers, so the X-to-Y distance is different in BPC3 and BPC4 (see Table 1).

Z-coordinates of BPC planes are positions of the corresponding anode planes.

Changes in 2004. In 2004, there were two major changes compared to the 2003 setup:

1. the BPC1 was moved towards Bend9 by about 345 mm [3], to get a longer base for tracking by BPC1 and BPC2;
2. the entire middle station (a common support with 4 physical chambers) was installed on a lifting table. This also resulted in some longitudinal shift of the station, but the chambers were not moved with respect to each other.

The near station was not touched, but its distance from the far station has been measured more accurately by the survey.

2004 survey [3]. The survey measurements of the BPCs, performed in May 2004, are summarized in Table 2. The measured locations were (see Figures 1, 2 and 3):

- for BPCs 1, 2 and 5: the upstream surfaces of the inner chamber frames. The longitudinal coordinates quoted in Section 4.2 of the Survey Report [4] must be corrected for the gauge offsets (CorrX = +10 mm) and the average frame-to-anode distance (15±1 mm).²
- for the old chambers composing the middle station: the upstream outer surface of the 3X housing and the downstream outer surface of the 4Y housing. The survey numbers have to be corrected for the gauge offsets (+10 mm and -10 mm, respectively) and the average housing-to-anode distances (+25 mm and -29 mm, respectively).

1 Earlier [2], the value 26 mm was wrongly quoted for the anode-to-anode distance in the new ITEP BPCs. However, the Table 1 gives the correct value 31 mm; see also Fig. 2.

2 It turned out that these aluminium frames were not good references (their distance to the corresponding anode planes is known only down to ±1 mm).

Survey vs 2003 measurements. The manual measurements [1] and [3] of the relative BPC positions in the far and middle stations are compatible within ~2 mm with the survey results.

According to the survey, the BPC1 is shifted backwards (towards the Bend9) by 346 mm compared to its 2003 location. The middle station as a whole is shifted backwards by ~28 mm compared to 2003. The actual distance between far and near stations is by 34 mm longer than it was assumed in 2003.

Table 3 gives the corrected absolute and relative positions of the BPC anode planes, obtained from the 2003 numbers by applying these three shifts. The absolute coordinates are based on the survey measurement of the BPC2. The survey measurement of 4Y is ignored, because the direct 2003 measurements of the anode planes in BPC3 and 4 were more accurate.

2. MWPCs

The longitudinal structure of the Dubna MWPCs is shown in Fig. 4. The survey measurements of the MWPC are summarized in Table 4. The MWPCs are numbered from 1 to 4, starting from the most upstream chamber. Like for the BPCs, the MWPC Z-coordinates correspond to anode planes.

- MWPC1 was measured at the outer surface of the upstream aluminium frame. The measured coordinates must be corrected for the gauge offsets (CorrX = -40 mm) and the average frame-to-anode distance (-20 mm for the Y-plane and -47 mm for the X-plane);
- The near-station MWPCs 2, 3 and 4 were all measured at their upstream “black” frames. The corrections are: the gauges +10 mm or +25 mm, the anode plane offsets +20 mm for X-planes, +47 mm for Y-planes.

Summary:

The resulting Z-coordinates of the BPC and MWPC anode planes are given in Table 5. The “absolute” coordinates are taken from Tables 3 and 4. The “relative” coordinates (the two bottom rows) are computed by assuming $Z=0$ at the *nominal outer* surface of the upstream aluminium frame of the MWPC1, i.e. -67 mm from the survey point “MWPC1”. All values are rounded to millimeters, to reflect the real precision with which the anode plane positions could be established with respect to the survey points.

References:

1. V.Epshteyn, V.Zaitsev (ITEP, Moscow), a private communication, September 2003.
2. The 2003 BPC ITEP note,
http://cern.ch/atlas-fcaltb/Memos/Hardware/BPC/BPC_2003_Note1.pdf
P.Gorbunov' presentation the at Nov. 2003 CBT-EC2 meeting,
<http://agenda.cern.ch/fullAgenda.php?ida=a036104>
3. P.Shatalov (ITEP), P.Gorbunov (UoT), a private communication, May 2004.
4. D.Mergelkuhl (TS/SU), A.Lippitsch (PH/TA-2), <http://edms.cern.ch/document/473257>
5. A.Shalyugin, a private communication, September 2004

Table 1: *The 2003 BPC Z-coordinates, mm (ITEP group measurements)*

Far station: BPC0 to BPC1 base: 177 mm		
Z(1X) = 0	Physical chamber number	1 (X-Y)
Z(1Y) = 31		
Z(2X) = 177	Physical chamber number	2 (X-Y)
Z(2Y) = 208		
Middle station: BPC(3-Y) to BPC(2-X) base = 11294-11076=218 mm		
Z(3X) = 11076	Physical chamber number	5 (X)
Z(3Y) = 11154	--	6 (Y)
Z(4X) = 11219	--	7 (X)
Z(4Y) = 11294	--	8 (Y)
Near station: BPC4 to BPC5 base: 100 mm		
Z(5X) = 27645	Physical chamber number	3 (X-Y)
Z(5Y) = 27676		
Z(6X) = 27745	Physical chamber number	6 (X-Y)
Z(6Y) = 27776		
ΔZ, mm: (2X-1X)=177; (3X-2X)=10899; (5X-2X)=27468		

Table 2: *The May 2004 survey measurement of the BPC Z-positions*

The survey Report [4] uses the physical BPC names. The numbers below are taken from the Section 4.2 of the Report and translated into mm. The measurements having no CorrX are discarded.

Physical BPC name	“BPC1”	“BPC2”	“BPC5”	“BPC8”	“BPC3”
The logical BPC plane	1X	2X	3X	4Y	5X
Measured Z-values	45076.7	45599.9	56462.0	56749.9	73102.8
	45077.1	45.600.1	56462.3	56754.5	73101.4
	45077.0	45599.9		56748.9	73102.5
		45600.3		56753.0	73102.1
Mean:	45076.9	45600.1	56462.2	56751.6	73102.2
Correction (gauge)	+10	+10	+10	-10	+10
Anode plane offset	+15.7	+15.7	+25	-29	+15.7
<i>Anode plane Z-coord.</i>	45102.6	45625.8	56497.2	56712.6	73127.9
Distance from 2X, survey	-523.2	0	10871.6	3X+215.4	27502.1
Distance from 2X, 2003	-177	0	10899	3X+218	27468
The change compared to 2003	-346 mm	0	-28 mm		+34 mm

Table 3: *The computed absolute BPC Z-positions in the survey coordinate system*

The 2003 BPC Z-coordinates are taken as a starting point, corrected for the changes given in Table 2 and transformed into the absolute survey system by using the BPC(2x) position as a reference.

	<i>BPC1</i>	<i>BPC2</i>	<i>BPC3</i>	<i>BPC4</i>	<i>BPC5</i>	<i>BPC6</i>
<i>X-planes, 2003</i>	0	177	11076	11219	27645	27745
<i>Y-planes, 2003</i>	31	208	11154	11294	27676	27776
<i>Shift in 2004</i>	-346	0	-28	-28	34	34
<i>X-planes, 2004</i>	-346	177	11048	11191	27679	27779
<i>Y-planes, 2004</i>	-315	208	11126	11266	27710	27810
<i>X-pl -BPC(2x)</i>	-523	0	10871	11014	27502	27602
<i>Y-pl -BPC(2x)</i>	-492	31	10949	11089	27533	27633
<i>Xpl abs, 2004</i>	45103	45626	56497	56640	73128	73228
<i>Ypl abs, 2004</i>	45134	45657	56575	56715	73159	73259

Table 4: The May 2004 survey measurement of the MWPC Z-positions

The numbers are taken from the Section 4.2 of the Report and translated into mm. The measurements having no CorrX are discarded.

MWPC name	“MWPC1”		“MWPC2”		“MWPC3”		“MWPC4”	
Measured Z-values/CorrX	44586.3/-40		71920.2/+10		72666.1/+10		73647.6/+10	
	44585.3/-40		71906.5/+25		72650.2/+25		73646.1/+10	
	44583.4/-40		71919.7/+10		72665.9/+10		73648.0/+10	
	44587.1/-40							
Mean(rounded to mm)	44546		71930		72676		73657	
Anode plane	1X	1Y	2X	2Y	3X	3Y	4X	4Y
Anode plane offset	-47	-20	+20	+47	+20	+47	+20	+47
<i>Anode plane Z-coord.</i>	44499	44526	71950	71977	72696	72723	73677	73704

Table 5: The computed Z-coordinates of the anode planes, in mm.

	<i>MWPC1</i>	<i>BPC1</i>	<i>BPC2</i>	<i>BPC3</i>	<i>BPC4</i>	<i>MWPC2</i>	<i>MWPC3</i>	<i>BPC5</i>	<i>BPC6</i>	<i>MWPC4</i>
<i>X-planes, abs</i>	44499	45103	45626	56497	56640	71950	72696	73128	73228	73677
<i>Y-planes, abs</i>	44526	45134	45657	56575	56715	71977	72723	73159	73259	73704
<i>X-to-Y</i>	27	31	31	78	75	27	27	31	31	27
<i>X-planes, rel</i>	20	624	1147	12018	12161	27471	28217	28649	28749	29198
<i>Y-planes, rel</i>	47	655	1178	12096	12236	27498	28244	28680	28780	29225

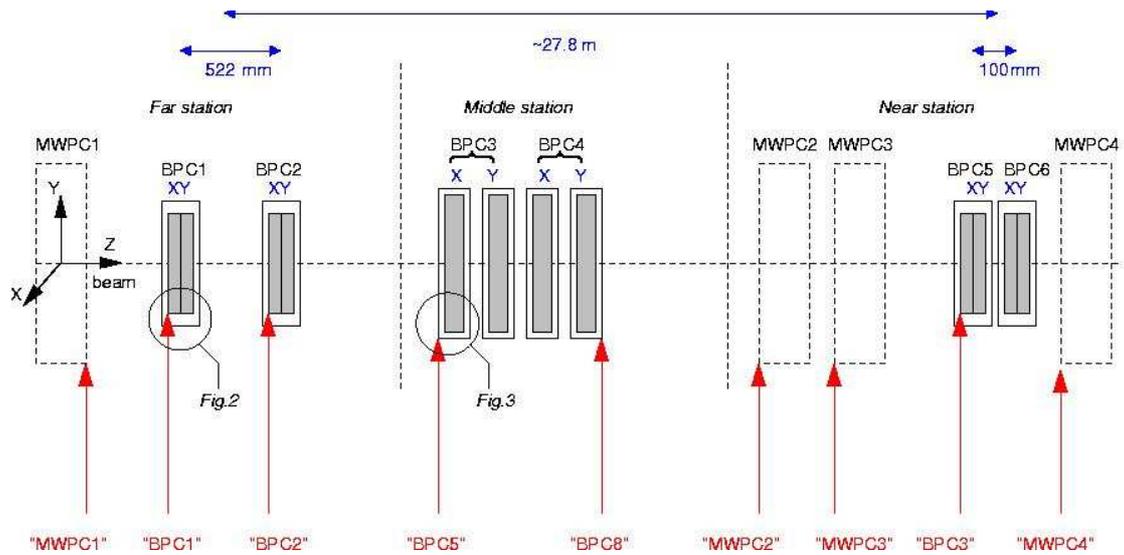


Figure 1: The beam chamber numbering scheme. The read arrows show the locations measured by the survey in May 2004.

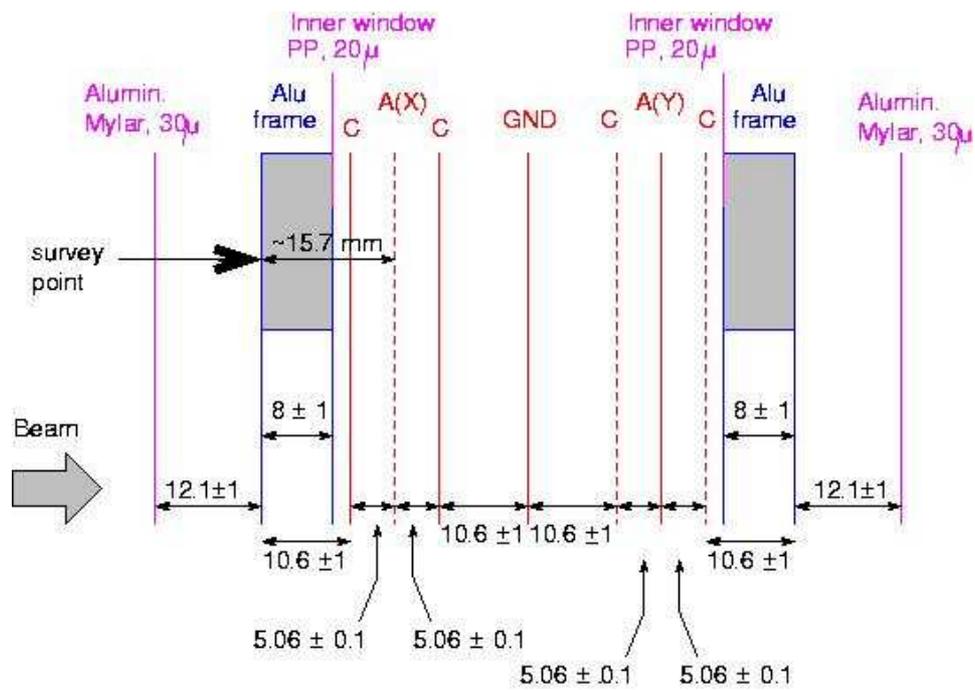


Figure 2: The longitudinal structure of a high-precision ITEP BPC (BPC1, 2, 5 and 6). The survey measurements were performed on the upstream surface of the inner aluminium frame. The X-anode is located in 15.7 ± 1 mm from the survey plane.

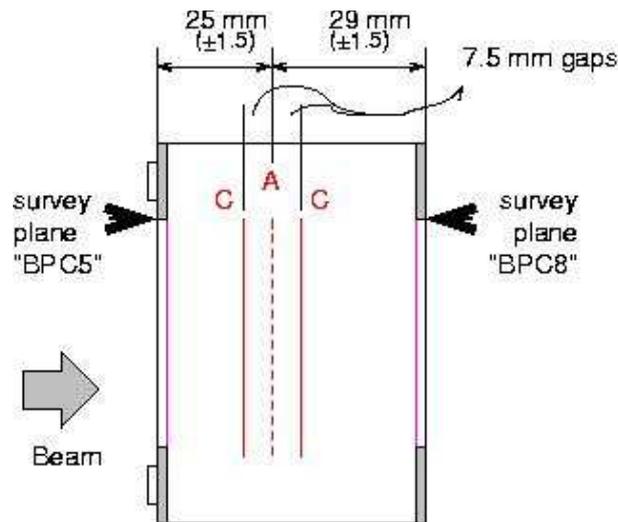


Figure 3: A schematical longitudinal structure of the “old” ITEP BPCs 3 and 4. The anode plane is located in 25 ± 1.5 mm and 27 ± 1.5 mm from the upstream and downstream box surfaces, on which the survey was performed.

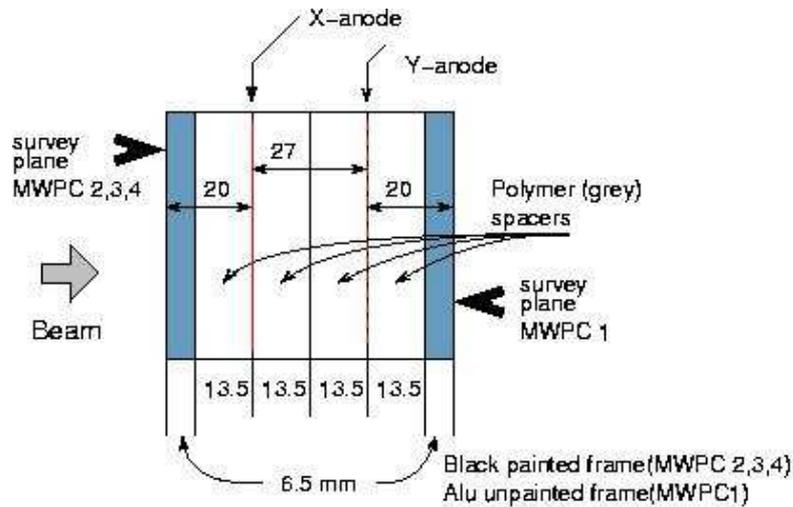


Figure 4: A schematical longitudinal structure of the MWPCs, with the dimensions according to [5]. The anode planes are located in 20 ± 0.5 mm from the external frame surfaces. The nominal distance between the X- and Y- anode planes is 27 mm^3 .

3 The precision of 0.5 mm is an estimate based on the direct measurement with a steel ruler, done by P.G. This measured thicknesses were slightly different from the nominal values shown in Fig.4; in particular, the Alu frame in MWPC1 turns out to be ~ 7.5 mm thick, and the spacers ~ 13 mm thick, on average. In MWPC 2,3 and 4, the black frame is about 6 mm thick, not 6.5 mm. These differences are negligible compared to the overall uncertainty of the survey measurements along Z, which is 1 mm, at best. The nominal values are used in the text.