

Survey 2002

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Analysis Note 40
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The survey analysis has been completed. This note describes the procedure and at the end I give a table which contains the 'final' recommended geometries that we should use, and that should be inserted into the geometry database. Some auxiliary detectors have yet to be added on i.e. the pp MRS counters, the MRS fibers; they were surveyed but the values were not present on the disk/text I got from the survey group. Thus this is yet to come. The checking and fine-tuning of tracking geometries were done by Pawel Staszal and Eun-Joo Kim, who is thanked for their effort.

Survey

The C-AD survey group carried out the survey during February 2002. To facilitate the survey additional fiducial markers were placed on several detector components. Some remarks on what the survey points are present is discussed for individual detectors right below. Very few of these points are precise with the exception of the Drift Chambers, and the additional marker pos for T1, and T2.

- TPC. As many corners of the Lucite box as possible was surveyed. This includes all 8 corners for MTP1 and MTP2, but fewer for T1 and T2. In addition T1 and T2 had some survey fixtures (1/2" markers) attached to either 3 or 4 positions on the top-plate; the positions are determined by a set of screw-holes.
- H1, H2. On each 4 marker i.e. paper with a cross was placed on the 2 and the last slat top and bottom. Though not firmly attached to the slats (the black wrap is not quite tight around the slats) this is much better than attempting to survey the frame. See also additional information from E.Baker who attached the survey markers in the footnote¹
- C1. The outside corners in the ridge between the main box and the frame that hold the seal.
- DC. Various survey sighting balls were held on the survey positions, thus defining a point perpendicular to the survey marker and at a determined distance of 1/2, 3/4 inch from the actual point. In some cases the survey 'hole' itself was sighted.
- TOFW had 6 measurements per panel. Two at first and last slat at the edge, and 4 at markers set top and bottom in the center of the slat. The markers were not placed symmetrically top and bottom, so those are only used to derive the x and z positions, not the height. The values derived is a grand average, overall the agreement except for the top measurements where two deviates by about ~0.2cm when positions are evaluated from the average.
- MRS was measured for the TPCs at nominal 90 deg, 90 degrees moved back by 50 cm and moved to the 60-degree position.

The survey was carried out with the Front Spectrometer at its 8-degree position, and with the MRS at 90 and 60 degree. The MRS in addition was done with the front plate in its normal and the +50 cm position. In addition to the detectors many fiducial points of platforms, magnets and stands were recorded.

Analysis method

The data from the survey were put into spreadsheets based on the model used previous. The general idea is that say for the TPC with 8 corners measured one can construct 12 vectors, 4 in each direction x, y and z calculate unit vectors, angles etc. From these one gets dimensions that can be checked as well as rotation angle, and center positions. Depending on the detector corrective terms (to adjust from external to internal centers are taken into account) The best center position and angles are evaluated based on these vectors, and position. In addition the spreadsheet will use dimension of the detector and calculate the positions of

all corners, and a deviation from each measurement. This thus also enables one to check any different position, rotation that one might attempt to use e.g from software.

Comments in regard to specific detectors.

- The survey points on the RICH are on the box corners which (apparently has different width at front and back). The Center is calculated assuming the front positions, the measured width and a Box length of 156.8 cm (with center at half this distance from the front center).
- There seems to be an apparent increase in y position by +0.2 cm for TPM2 when going to the +50 cm position. TPM1 does not change.
- The TOFW seems to have dy offsets of as much as 0.5 cm from the nominal beam height. The panel 5 is slightly back of the other panels and there is a clear vertical tilt difference at the dividing line to panel 4. This comes according to Dana from the installation procedure. The tilts for all panels are approximately between 0.2 –1.0 degree.

Survey Summary

This first table gives the results as obtained from the survey directly, without any modifications to fine-tune geometries for the looking at tracking results.

Detector	#datapoints	x-center Cm	z-center Cm	Theta Degrees	y-center Cm	Beta Degrees
TPM1	8	94.90	0.13	90.10		
TPM2	8	286.96	-0.11	89.64	Dy =0	
TPM1+50	6	145.13	0.15	90.12		
TPM2+50	8	337.13	-0.08	89.67	Dy=+0.2	
T1	3+4	-90.626	494.19	-10.03	0.8	--
T2	3+3	-151.36	799.55	-11.88	0.8	--
H1	4	-164.36	857.57	-11.60	-0.4	~0
C1	6	-177.88	913.93	-11.94	-0.06	
T3	8+1	-209.53	1074.14	-11.72	0.2	~+.1
T4	7	-297.50	1438.21	-13.55	0.22	0.018+- 0.005
T5		-386.32	1781.1	-15.61	0.38	-0.1->-0.2
H2	4	-399.13	1838.65	-15.45	-0.1	
RICH	4	-435.243	1963.36	-15.45	-0.05	0
<i>TOFW</i>	(at 90 deg position)					
TFP1	6	425.083	-66.323	104.941	-0.10	
TFP2	6	430.597	-41.084	99.336	-0.22	
TFP3	6	433.557	-14.748	93.094	-0.25	
TFP4	6	433.554	11.816	86.903	-0.40	
TFP5	6	431.033	38.256	80.762	-0.45	
TFP6	6	425.162	64.098	75.236	-0.40	

Comparison with tracking

To checkout the geometries the zero field run 6443 (from pp), which has clean DC tracking using the latest calibrations from Pawel. A first attempt to tune the geometry was also done. The result looked good and Pawel did a detailed study and fine tuning of the parameters for the forward spectrometer; checking several different zero field runs, and has arrived a set of fine-tuned geometry parameters for the tracking detectors in FFS and BFS. These give very good matching between tracking detectors, and are apart from the exceptions listed later within the survey values for the detector components. Some examples of matching between tracking detectors can be found on his NBI web page www.nbi.dk/~staszef/fs/index.html

Final Geometry Values

This set should be considered the final set for the FS i.e. the values in bold overrides the survey numbers.

Detector	x-center	z-center	Theta	y-center	Beta
	Cm	Cm	Degrees	Cm	Degrees
T1	-90.5791 -90.626	494.1821 494.19	-10.0160 -10.03	0.8	0
T2	-151.3170 -151.36	799.5387 799.55	-11.90 -11.88	0.8	0
H1	-164.36	857.57	-11.60	-0.4	~0
C1	-177.88	913.93	-11.94	-0.06	
T3	-209.5258 -209.53	1074.1440 1074.14	-11.6860 -11.72	0.35 0.2	0.35 ~+.1
T4	-297.4249 -297.50	1438.2377 1438.21	-13.5870 -13.55	0.2795 0.22	0.02 0.018+- 0.005
T5	-386.2449 -386.32	1781.1240 1781.1	-15.6387 -15.61	0.2380 0.38	-0.1446 -0.1->-0.2
H2	-399.13	1838.65	-15.45	-0.1	
RICH	-435.243	1963.36	-15.45	-0.05	0

The angles for the Tof detectors C1 and RICH cannot be determined from the tracking, so the geometry should be that of the survey, and not be modified to the of angle of last tracking detector as has been done some times. Neither can tracking determine the positions to better than sub mm precession, at least until Tof hit matching takes into account the odd-even effect in calculating hit position differences.

The MRS values are in good agreement with the values derived from the first survey, and stored in the geometry database The one exception is the in-plane rotation of TPM1 that consistently shows a -0.1 degree value; this will make the zero filed matching flawed. The recommendation from JH,EJK and myself is to keep the geometry for TPM1 and TPM2 as used so far, , except for the y=+.2 cm for the +50 cm position. Though the TOFW is very close to the previous used value, this survey is of higher quality and should be used.

Detector	x-center	z-center	Theta	y-center	Beta
	Cm	Cm	Degrees	Cm	Degrees
TPM1	94.90	0.13	90.10		
TPM2	286.96	-0.11	89.64	Dy =0	
TPM1+50	145.13	0.15	90.12		
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TOFW					
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TFP4	433.554	11.816	86.903	-0.40	
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FootNotes

ⁱ) H2 targets: Please be aware wrap on slats appears "loose", i.e. does not closely conform to scintillator slat. Although I tried to center target as best I could, this may contribute to errors in X (this may also cause small error in Z). Vertical dimensions were taken from detector frame. As I don't know how closely this was manufactured, there may also be errors in Y. My feeling is that if whoever made this detector can document how closely frame(s) were manufactured; it might be better to use corners on frame for survey.

2) H1 targets: I placed 4 targets today like I did H2 yesterday (1 each at top and bottom of 2 downstream outside slats). Notes on accuracy for H2 (above) also apply here. In addition, there may be parallax errors because the array only slides out a few inches, and it was difficult to estimate slat centers.

Also please note on H1: There is no mechanism I can see that holds H1 in place horizontally except friction on the slides. There are tie-wraps, but they hold the cables only. It appeared to be in against the stop, but who knows.