



# Jefferson Lab Alignment Group

## Data Transmittal

**TO:** S. Wood, B Sawatzky, D. Armstrong, D. Gaskell

**DATE:** 28 Oct 2010

**FROM:** Kelly Tremblay

**Checked:**

**# :** C1335

**DETAILS:**

data: step2b\hallc\qweak\100922A

A partial re-survey of the Qweak Region 3 wire chambers occurred on September 22<sup>nd</sup>, 2010. The goal of this survey was to check the reproducibility of the chambers.

A seven parameter transformation was used to calculate the standard hole locations for each of the four detectors based on the surveyed points at the home 0°, +/- 45° and +/- 90° positions, plus repeats as shown. The data is compared to the May 13/14<sup>th</sup> survey (report C1286), values and to the repeated values at each position.

There appears to be a consistent rotation difference between the September and May data. The transformation parameters (z/x/y shifts and the axial rotations) from the seven-par adjustment for the May/September positions, is shown at the end of this report.

Units are millimeters and decimal degrees. Columns labeled x/y\* are the square root values for the transverse (x/y coordinates) from the September and May data subtracted from one another. The x/y\* transverse data values are relatively small and could indicate that the detectors have repeated well radially from the Z axis but not angular. Columns labeled rms are the root mean square of the delta values for the repeated locations. For the deltas, a +dz indicates the location is downstream, +dx is to the beam left and +dy is high as compared to the first set of located data. The coordinate origin is the ideal center of the QTor magnet.

Vader Home Position 0°												
Sept 22 <sup>nd</sup> , 2010 data				Deltas wrt/ May 2010 data					Deltas repeat Sept 2010 data			
Point	Z	X	Y	dz	dx	dy	rms	x/y*	dz	dx	dy	rms
VAH	4594.30	-2884.60	1148.17	1.61	25.34	61.99	66.98	-0.10	0.06	-0.11	0.10	0.16
VBH	4422.96	-2509.38	1149.08	1.64	25.29	54.05	59.70	-0.15	0.01	-0.13	0.03	0.13
VCH	4347.53	-2335.37	146.41	1.16	3.83	50.60	50.76	0.11	0.05	-0.29	0.00	0.29
VDH	4671.47	-3052.94	144.56	1.10	3.93	65.77	65.90	0.10	0.15	-0.24	0.12	0.31
VEH	4671.58	-3052.24	-147.52	0.96	-2.32	65.83	65.87	0.15	0.16	-0.29	0.12	0.35
VFH	4348.14	-2334.54	-145.60	1.02	-2.41	50.65	50.71	0.20	0.07	-0.33	0.00	0.34
VGH	4426.52	-2502.53	-1149.57	0.52	-23.83	54.43	59.42	0.42	0.16	-0.46	0.03	0.49
VHH	4595.58	-2878.66	-1150.68	0.49	-23.79	62.38	66.77	0.35	0.20	-0.44	0.09	0.50
				Deltas wrt/ sep 22 repeat in/out					deltas sep 22 home repeat 2			
Point	dz	dx	dy	rms	dz	dx	dy	rms	dz	dx	dy	rms
VAH	0.09	-3.53	0.29	3.54	-0.11	0.14	0.23	0.29	-0.11	0.14	0.23	0.29
VBH	0.04	-3.55	0.67	3.61	-0.14	0.13	0.19	0.27	-0.14	0.13	0.19	0.27
VCH	0.02	-2.54	0.85	2.67	-0.16	0.03	0.17	0.24	-0.16	0.03	0.17	0.24
VDH	0.11	-2.49	0.11	2.50	-0.10	0.05	0.24	0.27	-0.10	0.05	0.24	0.27
VEH	0.10	-2.20	0.11	2.20	-0.10	0.03	0.24	0.26	-0.10	0.03	0.24	0.26
VFH	0.02	-2.24	0.85	2.39	-0.16	0.00	0.17	0.24	-0.16	0.00	0.17	0.24
VGH	0.03	-1.21	0.67	1.38	-0.15	-0.09	0.19	0.26	-0.15	-0.09	0.19	0.26
VHH	0.08	-1.19	0.29	1.22	-0.12	-0.07	0.22	0.26	-0.12	-0.07	0.22	0.26

**Leia Home Position 0°**

Sept 22<sup>nd</sup>, 2010 data

Deltas wrt/ May 2010 data

Deltas repeat Sept 2010 data

Point	z	X	y	dz	dx	dy	rms	x/y*	dz	dx	dy	rms
LAH	5126.18	-3102.53	1148.89	1.59	25.36	66.38	71.08	-0.04	0.09	-0.04	0.16	0.19
LBH	4955.20	-2727.38	1149.61	1.62	25.30	58.45	63.71	-0.07	0.04	-0.06	0.09	0.12
LCH	4875.95	-2556.21	146.54	1.15	3.83	55.06	55.21	0.08	0.08	-0.22	0.07	0.24
LDH	5202.50	-3272.55	145.39	1.09	3.94	70.21	70.33	0.07	0.17	-0.18	0.19	0.31
LEH	5202.26	-3272.50	-146.74	0.94	-2.30	70.28	70.32	0.10	0.19	-0.22	0.19	0.35
LFH	4876.40	-2555.86	-145.58	1.00	-2.41	55.12	55.18	0.14	0.10	-0.26	0.07	0.29
LGH	4957.15	-2724.04	-1149.15	0.50	-23.82	58.90	63.54	0.26	0.18	-0.40	0.09	0.45
LHH	5126.15	-3100.14	-1149.84	0.47	-23.77	66.86	70.96	0.20	0.23	-0.37	0.16	0.47
				Deltas wrt/ sep 22 repeat in/out					deltas sep 22 home repeat 2			
Point	z	X	y	dz	dx	dy	rms	dz	dx	dy	rms	
LAH				0.12	-3.46	0.06	3.46	-0.09	0.19	0.24	0.32	
LBH				0.07	-3.48	0.44	3.51	-0.12	0.17	0.21	0.30	
LCH				0.04	-2.47	0.62	2.55	-0.14	0.07	0.19	0.25	
LDH				0.13	-2.43	-0.11	2.44	-0.08	0.10	0.26	0.29	
LEH				0.13	-2.13	-0.11	2.14	-0.08	0.07	0.26	0.28	
LFH				0.04	-2.17	0.62	2.26	-0.14	0.04	0.19	0.24	
LGH				0.06	-1.14	0.45	1.23	-0.13	-0.04	0.21	0.25	
LHH				0.11	-1.12	0.06	1.13	-0.10	-0.03	0.24	0.27	

Yoda Home Position 0°												
Sept 22 <sup>nd</sup> , 2010 data				Deltas wrt/ May 2010 data					Deltas repeat Sept 2010 data			
Point	z	X	y	dz	dx	dy	rms	x/y*	dz	dx	dy	rms
YAH	4424.77	2519.04	1138.72	-0.24	23.72	-53.76	58.76	-0.09	-0.07	-0.16	-0.26	0.31
YBH	4595.71	2894.45	1137.03	-0.30	23.63	-61.76	66.13	-0.11	-0.09	-0.15	-0.28	0.33
YCH	4342.06	2346.21	136.43	0.05	2.26	-49.85	49.90	0.10	-0.02	-0.23	-0.25	0.35
YDH	4667.79	3062.98	132.91	-0.06	2.08	-65.12	65.16	0.06	-0.07	-0.21	-0.29	0.37
YEH	4341.62	2345.01	-155.48	0.13	-3.99	-49.76	49.92	0.16	-0.01	-0.25	-0.25	0.36
YFH	4667.01	3061.88	-159.15	0.02	-4.18	-65.03	65.17	0.11	-0.06	-0.23	-0.29	0.38
YGH	4420.81	2509.88	-1159.67	0.37	-25.54	-53.04	58.87	0.31	0.02	-0.32	-0.26	0.41
YHH	4591.41	2885.35	-1161.38	0.32	-25.64	-61.04	66.21	0.29	-0.01	-0.31	-0.28	0.42

Deltas wrt/ sep 22 repeat in/out Hans				
point	dz	dx	dy	rms
YAH	0.04	0.06	-0.55	0.56
YBH	-0.01	0.08	-0.63	0.64
YCH	0.01	-0.14	-0.51	0.53
YDH	-0.08	-0.10	-0.67	0.68
YEH	0.00	-0.20	-0.51	0.55
YFH	-0.10	-0.15	-0.67	0.69
YGH	-0.07	-0.38	-0.55	0.67
YHH	-0.12	-0.36	-0.63	0.74

Hans Home Position 0°												
Sept 22 <sup>nd</sup> , 2010 data				Deltas wrt/ May 2010 data					Deltas repeat Sept 2010 data			
Point	z	X	y	dz	dx	dy	rms	x/y*	dz	dx	dy	rms
HAH	4955.42	2738.60	1136.91	-0.28	23.72	-58.33	62.96	-0.21	-0.08	-0.12	-0.26	0.30
HBH	5126.88	3113.56	1135.01	-0.33	23.62	-66.32	70.40	-0.22	-0.11	-0.11	-0.28	0.32
HCH	4873.83	2564.49	134.83	0.02	2.26	-54.39	54.43	0.02	-0.03	-0.20	-0.25	0.32
HDH	5201.20	3280.45	130.87	-0.09	2.07	-69.64	69.67	-0.03	-0.09	-0.17	-0.29	0.35

HEH	4873.38	2563.15	-157.15	0.10	-3.99	-54.29	54.44	0.09	-0.02	-0.22	-0.25	0.33
HFH	5200.64	3279.13	-161.11	-0.01	-4.19	-69.55	69.68	0.03	-0.07	-0.19	-0.29	0.35
HGH	4951.71	2728.08	-1161.64	0.34	-25.55	-57.57	62.99	0.28	0.00	-0.28	-0.26	0.38
HHH	5122.00	3103.44	-1163.66	0.28	-25.65	-65.57	70.41	0.25	-0.03	-0.27	-0.28	0.39

Deltas wrt/ sep 22 repeat in/out Hans				
Point	dz	dx	dy	rms
HAH	0.01	0.13	-0.62	0.63
HBH	-0.04	0.16	-0.70	0.72
HCH	-0.02	-0.07	-0.58	0.59
HDH	-0.11	-0.03	-0.74	0.75
HEH	-0.03	-0.13	-0.58	0.60
HFH	-0.13	-0.08	-0.74	0.75
HGH	-0.10	-0.31	-0.62	0.70
HHH	-0.15	-0.29	-0.70	0.77

Vader - Negative 45°									
Sep 22,2010 Data				Deltas wrt/ May 2010 data					
Vader	Z	X	Y	dz	dx	dy	rms	xy*	
VAH	4590.98	-2852.00	-1236.49	-1.36	28.09	-67.19	72.84	0.10	
VBH	4420.38	-2587.73	-969.67	-1.21	22.07	-60.99	64.87	-0.02	
VCH	4345.38	-1754.16	-1553.50	-0.71	35.89	-41.81	55.10	0.20	
VDH	4667.92	-2259.48	-2063.86	-1.00	47.41	-53.66	71.61	0.35	
VEH	4668.06	-2051.96	-2269.39	-0.88	52.23	-48.90	71.56	0.41	
VFH	4346.02	-1546.60	-1758.90	-0.59	40.71	-37.04	55.04	0.29	
VGH	4424.16	-953.57	-2586.27	-0.23	60.03	-23.50	64.46	0.53	
VHH	4592.49	-1218.35	-2853.88	-0.38	66.07	-29.71	72.44	0.54	

Leia - Negative 45°									
Sep 22,2010 Data				Deltas wrt/ May 2010 data					
Point	Z	X	Y	dz	dx	dy	rms	xy*	
LAH	5122.44	-3007.00	-1391.15	-1.45	31.33	-70.82	77.45	0.40	
LBH	4952.19	-2742.64	-1124.51	-1.30	25.31	-64.62	69.41	0.28	
LCH	4873.37	-1910.79	-1710.64	-0.80	39.18	-45.47	60.03	0.43	
LDH	5198.52	-2415.74	-2219.63	-1.09	50.67	-57.32	76.51	0.58	
LEH	5198.32	-2208.64	-2425.66	-0.97	55.51	-52.57	76.45	0.61	
LFH	4873.85	-1703.49	-1916.45	-0.68	44.01	-40.72	59.96	0.49	
LGH	4954.37	-1110.88	-2743.68	-0.32	63.33	-27.18	68.91	0.63	
LHH	5122.63	-1375.94	-3010.98	-0.48	69.36	-33.40	76.98	0.66	

Vader Negative 90°												
Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data					Deltas repeat Sept 2010 data			
Point	Z	X	Y	dz	dx	dy	rms	x/y*	dz	dx	dy	rms
VAH	4588.25	-1142.60	-2892.57	1.42	-69.65	28.83	75.40	-1.00	0.04	-0.77	0.21	0.80
VBH	4417.76	-1144.65	-2516.97	1.44	-60.69	28.78	67.18	-1.08	0.06	-0.70	0.22	0.74
VCH	4343.54	-142.51	-2339.39	0.88	-56.74	4.56	56.93	-0.58	0.05	-0.67	0.03	0.67
VDH	4665.85	-138.49	-3057.69	0.83	-73.89	4.64	74.04	-0.48	0.01	-0.80	0.01	0.80
VEH	4666.20	153.58	-3055.99	0.66	-73.93	-2.40	73.97	-0.33	0.00	-0.80	-0.05	0.80
VFH	4344.39	149.49	-2337.58	0.71	-56.78	-2.49	56.84	-0.41	0.04	-0.67	-0.03	0.67
VGH	4423.20	1153.97	-2502.34	0.12	-61.00	-26.69	66.58	0.16	0.01	-0.70	-0.23	0.74
VHH	4591.41	1156.21	-2878.85	0.10	-69.99	-26.64	74.89	0.17	-0.01	-0.77	-0.24	0.80

**Leia Negative 90°**

Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data					Deltas repeat Sept 2010 data			
Point	Z	X	Y	dz	dx	dy	rms	x/y*	dz	dx	dy	rms
LAH	5119.63	-1143.02	-3111.70	1.40	-74.64	28.86	80.04	-0.96	0.03	-0.80	0.18	0.82
LBH	4949.50	-1144.87	-2736.17	1.43	-65.67	28.81	71.73	-1.04	0.05	-0.73	0.19	0.76
LCH	4871.46	-142.32	-2561.43	0.86	-61.79	4.58	61.97	-0.58	0.03	-0.70	0.00	0.70
LDH	5196.39	-139.00	-3278.50	0.82	-78.91	4.68	79.05	-0.49	0.00	-0.83	-0.02	0.83
LEH	5196.39	153.12	-3277.46	0.65	-78.97	-2.37	79.01	-0.35	-0.01	-0.83	-0.08	0.83
LFH	4872.15	149.79	-2560.09	0.70	-61.84	-2.47	61.90	-0.43	0.03	-0.70	-0.06	0.70
LGH	4953.34	1153.87	-2725.05	0.11	-66.07	-26.66	71.25	0.09	0.00	-0.73	-0.26	0.77
LHH	5121.48	1155.70	-3101.54	0.09	-75.06	-26.61	79.64	0.10	-0.02	-0.80	-0.27	0.84

**Yoda Negative 90°**

Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	Z	X	Y	dz	dx	dy	rms	x/y*
YAH	4426.70	-1148.94	2512.66	0.47	61.06	27.11	66.81	-0.44
YBH	4598.44	-1148.66	2887.72	0.34	70.14	27.06	75.18	-0.35
YCH	4345.78	-145.98	2342.81	0.39	56.66	2.93	56.74	-0.38
YDH	4673.04	-145.17	3058.89	0.13	73.99	2.82	74.04	-0.22
YEH	4345.96	145.92	2342.42	0.35	56.57	-4.11	56.72	-0.35
YFH	4672.89	146.89	3058.60	0.08	73.90	-4.23	74.02	-0.19
YGH	4427.67	1149.48	2509.93	0.14	60.33	-28.34	66.66	-0.20
YHH	4599.07	1149.77	2885.03	0.00	69.41	-28.40	74.99	-0.12

**Hans Negative 90°**

Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	Z	X	Y	dz	dx	dy	rms	x/y*
HAH	4957.83	-1148.87	2731.09	0.39	66.42	27.24	71.79	-0.45
HBH	5130.08	-1148.39	3105.69	0.26	75.48	27.18	80.23	-0.37
HCH	4878.01	-146.14	2559.95	0.31	61.98	3.06	62.06	-0.40
HDH	5206.92	-144.88	3275.22	0.05	79.29	2.95	79.35	-0.25
HEH	4878.20	145.85	2559.43	0.27	61.89	-3.98	62.02	-0.37
HFH	5206.99	147.10	3274.72	0.00	79.20	-4.10	79.30	-0.23
HGH	4959.04	1149.70	2726.99	0.06	65.65	-28.22	71.46	-0.24
HHH	5130.13	1150.30	3102.00	-0.08	74.72	-28.28	79.90	-0.16

**Vader Positive 90°**

Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	dz	dx	dy	dz	dx	dy	rms	x/y*
VAH	4597.14	1153.72	2881.02	-0.70	60.95	-23.65	65.38	-1.39
VBH	4426.38	1154.44	2505.55	-1.40	53.03	-23.27	57.93	-1.67
VCH	4352.50	151.69	2331.34	-1.87	49.58	-1.87	49.65	-1.88
VDH	4675.34	150.19	3049.41	-0.54	64.72	-2.59	64.78	-1.28
VEH	4675.82	-141.88	3048.68	-0.59	64.77	3.59	64.87	-1.27
VFH	4353.48	-140.32	2330.49	-1.92	49.63	4.32	49.85	-1.86
VGH	4432.89	-1144.21	2498.51	-1.76	53.40	25.38	59.15	-1.48
VHH	4601.37	-1145.13	2874.91	-1.06	61.33	25.01	66.24	-1.24

**Leia Positive 90°**

Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	Dz	dx	dy	dz	dx	dy	rms	x/y*
LAH	5128.68	1155.10	3099.77	-0.30	65.48	-24.71	69.99	-0.45

LBH	4958.28	1155.63	2724.36	-0.99	57.56	-24.33	62.50	-0.74
LCH	4880.58	152.48	2552.99	-1.46	54.17	-2.91	54.27	-0.90
LDH	5206.03	151.69	3269.83	-0.14	69.29	-3.65	69.38	-0.30
LEH	5206.17	-140.44	3269.76	-0.18	69.35	2.53	69.40	-0.29
LFH	4881.40	-139.64	2552.62	-1.51	54.23	3.28	54.35	-0.89
LGH	4963.18	-1143.12	2720.84	-1.35	58.00	24.33	62.91	-0.64
LHH	5131.60	-1143.63	3097.21	-0.65	65.94	23.95	70.15	-0.37

Yoda Positive 90°								
Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	Dz	dx	dy	dz	dx	dy	rms	x/y*
YAH	4419.11	1141.83	-2521.64	0.10	-53.24	-23.27	58.10	0.16
YBH	4589.65	1140.41	-2897.23	0.08	-61.12	-23.16	65.36	0.15
YCH	4339.15	139.40	-2348.28	0.37	-49.39	-2.16	49.43	0.25
YDH	4664.13	136.40	-3065.39	0.35	-64.42	-1.95	64.45	0.24
YEH	4339.46	-152.50	-2346.94	0.45	-49.29	4.00	49.46	0.27
YFH	4664.11	-155.66	-3064.16	0.43	-64.33	4.21	64.47	0.26
YGH	4421.06	-1156.56	-2511.45	0.72	-52.52	25.21	58.26	0.32
YHH	4591.27	-1158.00	-2887.10	0.71	-60.39	25.31	65.49	0.32

Hans Positive 90°								
Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	dz	dx	dy	dz	dx	dy	rms	x/y*
HAH	4949.53	1141.28	-2741.76	0.09	-57.74	-23.23	62.24	0.09
HBH	5120.59	1139.65	-3116.90	0.07	-65.61	-23.12	69.56	0.09
HCH	4870.69	139.08	-2567.12	0.37	-53.86	-2.13	53.90	0.23
HDH	5197.32	135.63	-3283.42	0.34	-68.87	-1.91	68.90	0.21
HEH	4871.00	-152.91	-2565.64	0.45	-53.76	4.03	53.91	0.26
HFH	5197.51	-156.35	-3281.97	0.42	-68.78	4.25	68.91	0.25
HGH	4951.73	-1157.26	-2730.21	0.71	-56.99	25.25	62.33	0.35
HHH	5121.63	-1159.01	-3105.75	0.70	-64.86	25.36	69.65	0.35

Vader Positive 45°								
Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	dz	dx	dy	dz	dx	dy	rms	x/y*
VAH	4598.33	-1225.82	2849.30	-0.45	63.57	27.81	69.39	-1.20
VBH	4426.70	-959.85	2584.83	-0.38	57.70	21.98	61.75	-1.22
VCH	4351.05	-1545.53	1752.62	0.07	39.64	34.95	52.85	-0.59
VDH	4675.53	-2054.27	2258.33	-0.08	50.86	46.09	68.64	-0.64
VEH	4675.61	-2260.23	2051.23	0.04	46.39	50.64	68.67	-0.45
VFH	4351.63	-1751.36	1545.48	0.19	35.16	39.50	52.88	-0.37
VGH	4430.04	-2579.81	954.00	0.57	22.45	57.78	61.99	0.32
VHH	4599.38	-2846.58	1218.99	0.49	28.33	63.61	69.64	0.22

Leia Positive 45°								
Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	Dz	dx	dy	dz	dx	dy	rms	x/y*
LAH	5130.37	-1379.21	3003.53	-0.50	67.06	31.35	74.03	-1.34
LBH	4959.11	-1113.42	2738.97	-0.42	61.18	25.54	66.30	-1.36
LCH	4879.64	-1701.41	1908.49	0.03	43.17	38.55	57.87	-0.70
LDH	5206.73	-2208.77	2413.83	-0.12	54.38	49.66	73.64	-0.75
LEH	5206.47	-2415.23	2207.16	0.00	49.91	54.22	73.69	-0.56

LFH	4880.06	-1907.65	1701.62	0.15	38.69	43.10	57.92	-0.47
LGH	4960.84	-2735.95	1110.56	0.52	25.99	61.38	66.66	0.24
LHH	5130.13	-3002.40	1375.82	0.45	31.87	67.21	74.39	0.14

Yoda Positive 45°								
Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	dz	dx	dy	dz	dx	dy	rms	x/y*
YAH	4420.72	2589.72	-975.71	-0.37	-22.23	-57.38	61.54	-0.12
YBH	4591.23	2854.35	-1242.27	-0.44	-28.18	-63.20	69.20	-0.15
YCH	4339.31	1758.87	-1562.54	-0.01	-35.14	-38.71	52.28	-0.02
YDH	4664.21	2263.92	-2071.68	-0.14	-46.51	-49.81	68.15	-0.07
YEH	4339.19	1551.68	-1768.18	0.08	-39.68	-34.03	52.27	0.01
YFH	4663.76	2056.70	-2277.50	-0.04	-51.05	-45.14	68.15	-0.04
YGH	4419.30	958.63	-2595.05	0.38	-57.95	-20.59	61.50	0.09
YHH	4589.46	1223.29	-2861.67	0.32	-63.90	-26.41	69.15	0.07

Hans Positive 45								
Sept 22 <sup>nd</sup> Data				Deltas wrt/ May 2010 data				
Point	dz	dx	dy	dz	dx	dy	rms	x/y*
HAH	4951.12	2744.59	-1132.21	-0.41	-25.57	-60.75	65.91	-0.26
HBH	5122.14	3008.76	-1398.60	-0.48	-31.51	-66.56	73.64	-0.30
HCH	4870.83	1912.99	-1717.98	-0.05	-38.46	-42.05	56.99	-0.12
HDH	5197.38	2417.16	-2226.87	-0.18	-49.82	-53.14	72.84	-0.17
HEH	4870.71	1705.65	-1923.57	0.05	-42.99	-37.38	56.97	-0.07
HFH	5197.14	2209.84	-2432.47	-0.08	-54.35	-48.47	72.82	-0.13
HGH	4949.95	1112.43	-2750.70	0.35	-61.27	-23.93	65.78	0.06
HHH	5119.80	1376.80	-3017.45	0.28	-67.23	-29.74	73.51	0.03

### TRANSFORMATION PARAMETERS

#### Home 0 Vader Leia

	May 13/14 data		Sep 22 data	
	mm	+/-	mm	+/-
Z shift	5041.29	0.20	5040.24	0.02
X shift	-2913.17	0.09	-2913.94	0.03
Y Shift	62.56	0.01	-0.10	0.01
	degrees	+/-	degrees	+/-
Rot Z axis	91.0482	0.0001	89.9450	0.0001
Rot X Axis	-0.4810	0.0006	0.0511	0.0001
Rot Y Axis	-24.4419	0.0001	-24.4511	0.0002

#### Home 0 Hans Yoda

	May 13/14 data		Sep 22 data	
	mm	+/-	mm	+/-
Z shift	5038.12	0.11	5038.12	0.05
X shift	2920.36	0.09	2921.33	0.04
Y Shift	-75.10	0.02	-13.14	0.02
	degrees	+/-	degrees	+/-
Rot Z axis	91.3894	0.0002	90.2785	0.0001
Rot X Axis	0.5337	0.0003	0.0096	0.0001
Rot Y Axis	24.5364	0.0002	24.5505	0.0002

#### Negative 45 Vader Leia

	May 13/14 data		Sep 22 data	
	mm	+/-	mm	+/-
Z shift	5037.87	0.02	5036.98	0.04
X shift	-2106.77	0.02	-2059.43	0.04
Y Shift	-2018.85	0.02	-2067.86	0.05
	degrees	+/-	degrees	+/-
Rot Z axis	48.7823	0.0000	47.4603	0.0001
Rot X Axis	16.6181	0.0001	17.0270	0.0003

Rot Y Axis	-18.0737	0.0001		-17.6574	0.0003
------------	----------	--------	--	----------	--------

<b>Negative 90 Vader Leia</b>					<b>Negative 90 Hans Yoda</b>				
May 13/14 data			Sep 22 data		May 13/14 data			Sep 22 data	
	mm	+/-	mm	+/-		mm	+/-	mm	+/-
Z shift	5035.82	0.01	5035.06	0.03	Z shift	5043.54	0.02	5043.38	1.07
X shift	-64.98	0.01	5.40	0.02	X shift	71.06	0.02	0.48	0.06
Y Shift	-2917.93	0.01	-2919.04	0.03	Y Shift	2916.34	0.02	2916.85	0.51
	degrees	+/-	degrees	+/-		degrees	+/-	degrees	+/-
Rot Z axis	1.2262	0.0000	-0.2910	0.0001	Rot Z axis	1.6281	0.0001	0.1070	0.0002
Rot X Axis	24.3134	0.0001	24.3206	0.0001	Rot X Axis	-24.6430	0.0001	-24.6729	0.0094
Rot Y Axis	-0.4672	0.0000	0.1905	0.0001	Rot Y Axis	0.6864	0.0001	0.0605	0.0005

<b>Positive 45 Vader - Leia</b>					<b>Positive 45 Hans - Yoda</b>				
May 13/14 data			Sep 22 data		May 13/14 data			Sep 22 data	
	mm	+/-	mm	+/-		mm	+/-	mm	+/-
Z shift	5043.69	0.03	5044.51	2.05	Z shift	5035.38	0.01	5034.98	0.03
X shift	67.77	0.03	6.02	0.09	X shift	-69.94	0.01	-8.63	0.01
Y Shift	2910.77	0.03	2910.96	0.97	Y Shift	-2923.00	0.01	-2924.06	0.03
	degrees	+/-	degrees	+/-		degrees	+/-	degrees	+/-
Rot Z axis	-358.7506	0.0001	359.9169	0.0004	Rot Z axis	181.6388	0.0000	-179.6890	0.0001
Rot X Axis	-155.5343	0.0002	-155.6370	0.0180	Rot X Axis	24.4781	0.0001	24.4900	0.0001
Rot Y Axis	-179.5708	0.0001	179.8685	0.0010	Rot Y Axis	-0.7353	0.0000	-0.1694	0.0001

**TRANSFORMATION PARAMETERS**

Positive 90 Vader - Leia					Positive 90 Hans - Yoda				
	May 13/14 data		Sep 22 data			May 13/14 data		Sep 22 data	
	mm	+/-	mm	+/-		mm	+/-	mm	+/-
Z shift	5043.69	0.03	5035.06	0.03	Z shift	5035.38	0.01	5034.98	0.03
X shift	67.77	0.03	5.40	0.02	X shift	-69.94	0.01	-8.63	0.01
Y Shift	2910.77	0.03	-2919.04	0.03	Y Shift	-2923.00	0.01	-2924.06	0.03
	degrees	+/-	degrees	+/-		degrees	+/-	degrees	+/-
Rot Z axis	-358.7506	0.0001	-0.2910	0.0001	Rot Z axis	181.6388	0.0000	-179.6890	0.0001
Rot X Axis	-155.5343	0.0002	24.3206	0.0001	Rot X Axis	24.4781	0.0001	24.4900	0.0001
Rot Y Axis	-179.5708	0.0001	0.1905	0.0001	Rot Y Axis	-0.7353	0.0000	-0.1694	0.0001