



# Jefferson Lab Alignment Group

## Data Transmittal

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

**DATE:** 10 Nov 2011

**FROM:** Kelly Tremblay

**Checked:**

**# :** C1418

**DETAILS:**

data: step2b\hallc\qweak\111101A

A check survey of the Qweak Region 3 wire chambers occurred on November 1<sup>st</sup>, 2011.

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 September 22, 2010 survey (report C1335), values and to the repeated values if a repeat was done for that position (repeats are the first six data sets).

Units are millimeters and decimal degrees. Columns labeled x/y\* are the square root values for the transverse (x/y coordinates) from the November 2011 and September 2010 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 2011 location is downstream of 2010, +dx is to the beam left and +dy is high.. The coordinate origin is the ideal center of the QTor magnet.

| Vader Home Position 0° |        |         |         |                                |     |      |     |      |                     |      |     |     |
|------------------------|--------|---------|---------|--------------------------------|-----|------|-----|------|---------------------|------|-----|-----|
| Nov 1, 2011 data       |        |         |         | Sept 22.2010 - Nov 1.2011 data |     |      |     |      | Nov 1 data - repeat |      |     |     |
| Point                  | Z      | X       | Y       | dz                             | dx  | dy   | rms | x/y* | dz                  | dx   | dy  | rms |
| VAH                    | 4593.9 | -2884.5 | 1146.3  | -0.4                           | 0.1 | -1.9 | 1.9 | 0.7  | -0.2                | 0.4  | 0.7 | 0.9 |
| VBH                    | 4422.6 | -2509.3 | 1147.2  | -0.4                           | 0.1 | -1.9 | 1.9 | 0.8  | -0.2                | 0.4  | 0.6 | 0.8 |
| VCH                    | 4347.2 | -2335.3 | 144.5   | -0.3                           | 0.1 | -1.9 | 1.9 | 0.2  | -0.2                | 0.1  | 0.5 | 0.6 |
| VDH                    | 4671.1 | -3052.9 | 142.7   | -0.4                           | 0.1 | -1.9 | 1.9 | 0.1  | -0.2                | 0.1  | 0.8 | 0.8 |
| VEH                    | 4671.2 | -3052.2 | -149.4  | -0.4                           | 0.1 | -1.9 | 1.9 | 0.0  | -0.2                | 0.0  | 0.8 | 0.8 |
| VFH                    | 4347.8 | -2334.5 | -147.5  | -0.3                           | 0.1 | -1.9 | 1.9 | 0.0  | -0.2                | 0.1  | 0.5 | 0.6 |
| VGH                    | 4426.2 | -2502.5 | -1151.4 | -0.3                           | 0.1 | -1.9 | 1.9 | -0.7 | -0.2                | -0.3 | 0.6 | 0.7 |
| VHH                    | 4595.3 | -2878.6 | -1152.6 | -0.3                           | 0.1 | -1.9 | 1.9 | -0.6 | -0.2                | -0.3 | 0.7 | 0.8 |

| Leia Home Position 0° |        |         |         |                                |     |      |     |      |                     |      |     |     |
|-----------------------|--------|---------|---------|--------------------------------|-----|------|-----|------|---------------------|------|-----|-----|
| Nov 1, 2011 data      |        |         |         | Sept 22.2010 - Nov 1.2011 data |     |      |     |      | Nov 1 data - repeat |      |     |     |
| Point                 | Z      | X       | Y       | dz                             | dx  | dy   | rms | x/y* | dz                  | dx   | dy  | rms |
| LAH                   | 5125.8 | -3102.5 | 1147.0  | -0.4                           | 0.0 | -1.8 | 1.9 | 0.7  | -0.2                | 0.4  | 0.8 | 0.9 |
| LBH                   | 4954.8 | -2727.3 | 1147.8  | -0.4                           | 0.0 | -1.9 | 1.9 | 0.8  | -0.2                | 0.4  | 0.7 | 0.8 |
| LCH                   | 4875.6 | -2556.2 | 144.7   | -0.4                           | 0.1 | -1.9 | 1.9 | 0.2  | -0.2                | 0.1  | 0.6 | 0.6 |
| LDH                   | 5202.1 | -3272.5 | 143.5   | -0.4                           | 0.0 | -1.8 | 1.9 | 0.1  | -0.2                | 0.1  | 0.8 | 0.9 |
| LEH                   | 5201.9 | -3272.5 | -148.6  | -0.4                           | 0.0 | -1.8 | 1.9 | 0.0  | -0.3                | 0.0  | 0.8 | 0.9 |
| LFH                   | 4876.1 | -2555.8 | -147.4  | -0.3                           | 0.1 | -1.9 | 1.9 | -0.1 | -0.2                | 0.0  | 0.6 | 0.6 |
| LGH                   | 4956.9 | -2724.0 | -1151.0 | -0.3                           | 0.1 | -1.9 | 1.9 | -0.7 | -0.2                | -0.3 | 0.7 | 0.8 |
| LHH                   | 5125.8 | -3100.1 | -1151.7 | -0.3                           | 0.0 | -1.8 | 1.9 | -0.6 | -0.3                | -0.3 | 0.8 | 0.9 |

| Yoda Home Position 0° |        |        |         |      |                                |      |     |      |     |                     |      |     |  |
|-----------------------|--------|--------|---------|------|--------------------------------|------|-----|------|-----|---------------------|------|-----|--|
| Nov 1, 2011 data      |        |        |         |      | Sept 22.2010 - Nov 1.2011 data |      |     |      |     | Nov 1 data - repeat |      |     |  |
| Point                 | Z      | X      | Y       | dz   | dx                             | dy   | rms | x/y* | dz  | dx                  | dy   | rms |  |
| YAH                   | 4424.7 | 2519.1 | 1136.9  | 0.0  | 0.0                            | -1.9 | 1.9 | 0.7  | 0.1 | 0.3                 | -0.7 | 0.8 |  |
| YBH                   | 4595.6 | 2894.5 | 1135.2  | -0.1 | 0.0                            | -1.8 | 1.8 | 0.6  | 0.1 | 0.3                 | -0.8 | 0.9 |  |
| YCH                   | 4342.0 | 2346.3 | 134.6   | -0.1 | 0.1                            | -1.9 | 1.9 | 0.0  | 0.1 | 0.1                 | -0.7 | 0.7 |  |
| YDH                   | 4667.7 | 3063.1 | 131.1   | -0.1 | 0.1                            | -1.8 | 1.8 | 0.0  | 0.2 | 0.0                 | -0.9 | 0.9 |  |
| YEH                   | 4341.6 | 2345.1 | -157.3  | -0.1 | 0.1                            | -1.9 | 1.9 | -0.2 | 0.1 | 0.0                 | -0.7 | 0.7 |  |
| YFH                   | 4666.9 | 3062.0 | -161.0  | -0.1 | 0.1                            | -1.8 | 1.8 | -0.2 | 0.2 | 0.0                 | -0.9 | 0.9 |  |
| YGH                   | 4420.7 | 2510.1 | -1161.5 | -0.1 | 0.2                            | -1.9 | 1.9 | -0.9 | 0.2 | -0.3                | -0.7 | 0.8 |  |
| YHH                   | 4591.3 | 2885.5 | -1163.2 | -0.1 | 0.2                            | -1.8 | 1.8 | -0.9 | 0.2 | -0.3                | -0.8 | 0.9 |  |

| Hans Home Position 0° |        |        |         |      |                                |      |     |      |     |                     |      |     |  |
|-----------------------|--------|--------|---------|------|--------------------------------|------|-----|------|-----|---------------------|------|-----|--|
| Nov 1, 2011 data      |        |        |         |      | Sept 22.2010 - Nov 1.2011 data |      |     |      |     | Nov 1 data - repeat |      |     |  |
| Point                 | Z      | X      | Y       | dz   | dx                             | dy   | rms | x/y* | dz  | dx                  | dy   | rms |  |
| HAH                   | 4955.4 | 2738.7 | 1135.1  | -0.1 | 0.1                            | -1.8 | 1.8 | 0.7  | 0.1 | 0.3                 | -0.8 | 0.8 |  |
| HBH                   | 5126.8 | 3113.6 | 1133.2  | -0.1 | 0.1                            | -1.8 | 1.8 | 0.6  | 0.2 | 0.3                 | -0.9 | 0.9 |  |
| HCH                   | 4873.8 | 2564.6 | 133.0   | -0.1 | 0.1                            | -1.9 | 1.9 | 0.0  | 0.2 | 0.0                 | -0.7 | 0.7 |  |
| HDH                   | 5201.1 | 3280.6 | 129.1   | -0.1 | 0.1                            | -1.8 | 1.8 | -0.1 | 0.2 | 0.0                 | -0.9 | 0.9 |  |
| HEH                   | 4873.3 | 2563.3 | -159.0  | -0.1 | 0.1                            | -1.9 | 1.9 | -0.2 | 0.2 | -0.1                | -0.7 | 0.7 |  |
| HFH                   | 5200.6 | 3279.3 | -162.9  | -0.1 | 0.1                            | -1.8 | 1.8 | -0.2 | 0.2 | -0.1                | -0.9 | 0.9 |  |
| HGH                   | 4951.6 | 2728.3 | -1163.5 | -0.1 | 0.2                            | -1.8 | 1.9 | -0.9 | 0.2 | -0.3                | -0.8 | 0.9 |  |
| HHH                   | 5121.9 | 3103.6 | -1165.5 | -0.1 | 0.2                            | -1.8 | 1.8 | -0.8 | 0.2 | -0.4                | -0.9 | 1.0 |  |

| Yoda +45°        |        |        |         |      |                                |      |     |      |     |                     |     |     |  |
|------------------|--------|--------|---------|------|--------------------------------|------|-----|------|-----|---------------------|-----|-----|--|
| Nov 1, 2011 data |        |        |         |      | Sept 22.2010 - Nov 1.2011 data |      |     |      |     | Nov 1 data - repeat |     |     |  |
| Point            | Z      | X      | Y       | dz   | dx                             | dy   | rms | x/y* | dz  | dx                  | dy  | rms |  |
| YAH              | 4420.4 | 2589.9 | -976.8  | -0.3 | 0.2                            | -1.1 | 1.1 | -0.5 | 0.0 | -0.2                | 0.3 | 0.4 |  |
| YBH              | 4590.9 | 2854.6 | -1243.3 | -0.4 | 0.3                            | -1.0 | 1.1 | -0.6 | 0.0 | -0.2                | 0.3 | 0.4 |  |
| YCH              | 4339.0 | 1759.2 | -1563.8 | -0.3 | 0.3                            | -1.3 | 1.4 | -1.1 | 0.0 | -0.1                | 0.3 | 0.3 |  |
| YDH              | 4663.9 | 2264.4 | -2072.8 | -0.4 | 0.5                            | -1.2 | 1.3 | -1.2 | 0.0 | -0.1                | 0.3 | 0.3 |  |
| YEH              | 4338.9 | 1552.1 | -1769.5 | -0.3 | 0.4                            | -1.3 | 1.4 | -1.3 | 0.0 | -0.1                | 0.2 | 0.3 |  |
| YFH              | 4663.4 | 2057.3 | -2278.7 | -0.4 | 0.6                            | -1.2 | 1.4 | -1.3 | 0.0 | -0.1                | 0.3 | 0.3 |  |
| YGH              | 4419.0 | 959.3  | -2596.6 | -0.3 | 0.6                            | -1.5 | 1.7 | -1.6 | 0.0 | -0.1                | 0.2 | 0.2 |  |
| YHH              | 4589.1 | 1224.0 | -2863.1 | -0.3 | 0.7                            | -1.5 | 1.7 | -1.6 | 0.0 | -0.1                | 0.2 | 0.2 |  |

| Hans +45°        |        |        |         |      |                                |      |     |      |     |                     |     |     |  |
|------------------|--------|--------|---------|------|--------------------------------|------|-----|------|-----|---------------------|-----|-----|--|
| Nov 1, 2011 data |        |        |         |      | Sept 22.2010 - Nov 1.2011 data |      |     |      |     | Nov 1 data - repeat |     |     |  |
| Point            | Z      | X      | Y       | dz   | dx                             | dy   | rms | x/y* | dz  | dx                  | dy  | rms |  |
| HAH              | 4950.8 | 2744.9 | -1133.3 | -0.3 | 0.3                            | -1.1 | 1.1 | -0.7 | 0.0 | -0.2                | 0.3 | 0.3 |  |
| HBH              | 5121.8 | 3009.1 | -1399.6 | -0.4 | 0.4                            | -1.0 | 1.1 | -0.7 | 0.0 | -0.1                | 0.3 | 0.3 |  |
| HCH              | 4870.5 | 1913.4 | -1719.3 | -0.3 | 0.4                            | -1.3 | 1.4 | -1.2 | 0.0 | -0.1                | 0.3 | 0.3 |  |
| HDH              | 5197.0 | 2417.8 | -2228.0 | -0.4 | 0.6                            | -1.2 | 1.4 | -1.2 | 0.0 | -0.1                | 0.3 | 0.3 |  |
| HEH              | 4870.4 | 1706.1 | -1924.9 | -0.3 | 0.5                            | -1.3 | 1.5 | -1.3 | 0.0 | -0.1                | 0.2 | 0.3 |  |
| HFH              | 5196.8 | 2210.5 | -2433.7 | -0.4 | 0.7                            | -1.2 | 1.4 | -1.3 | 0.0 | -0.1                | 0.3 | 0.3 |  |
| HGH              | 4949.6 | 1113.2 | -2752.2 | -0.3 | 0.7                            | -1.5 | 1.7 | -1.7 | 0.0 | -0.1                | 0.2 | 0.2 |  |
| HHH              | 5119.5 | 1377.6 | -3018.9 | -0.3 | 0.8                            | -1.4 | 1.7 | -1.7 | 0.0 | 0.0                 | 0.2 | 0.2 |  |

| Vader +45°       |        |         |        |                                |      |      |     |      |  |
|------------------|--------|---------|--------|--------------------------------|------|------|-----|------|--|
| Nov 1, 2011 data |        |         |        | Sept 22.2010 - Nov 1.2011 data |      |      |     |      |  |
| Point            | z      | x       | y      | dz                             | dx   | dy   | rms | x/y* |  |
| VAH              | 4596.8 | -1227.4 | 2848.1 | -1.5                           | -1.6 | -1.2 | 2.5 | 0.5  |  |
| VBH              | 4425.2 | -961.3  | 2583.8 | -1.5                           | -1.5 | -1.1 | 2.4 | 0.5  |  |
| VCH              | 4350.2 | -1546.4 | 1751.1 | -0.9                           | -0.9 | -1.5 | 2.0 | 0.6  |  |
| VDH              | 4674.7 | -2055.4 | 2256.5 | -0.9                           | -1.1 | -1.8 | 2.3 | 0.6  |  |
| VEH              | 4674.9 | -2261.2 | 2049.3 | -0.7                           | -1.0 | -2.0 | 2.3 | 0.6  |  |
| VFH              | 4350.9 | -1752.1 | 1543.8 | -0.7                           | -0.7 | -1.7 | 2.0 | 0.6  |  |
| VGH              | 4430.0 | -2580.0 | 951.7  | -0.1                           | -0.2 | -2.3 | 2.3 | 0.6  |  |
| VHH              | 4599.3 | -2846.9 | 1216.5 | -0.1                           | -0.3 | -2.4 | 2.5 | 0.6  |  |

| Leia +45°        |        |         |        |                                |      |      |     |      |  |
|------------------|--------|---------|--------|--------------------------------|------|------|-----|------|--|
| Nov 1, 2011 data |        |         |        | Sept 22.2010 - Nov 1.2011 data |      |      |     |      |  |
| Point            | z      | x       | y      | dz                             | dx   | dy   | rms | x/y* |  |
| LAH              | 5128.9 | -1380.7 | 3002.5 | -1.5                           | -1.5 | -1.1 | 2.4 | 0.4  |  |
| LBH              | 4957.6 | -1114.8 | 2738.0 | -1.5                           | -1.4 | -0.9 | 2.2 | 0.4  |  |
| LCH              | 4878.8 | -1702.2 | 1907.1 | -0.9                           | -0.8 | -1.4 | 1.8 | 0.6  |  |
| LDH              | 5205.9 | -2209.8 | 2412.1 | -0.9                           | -1.0 | -1.7 | 2.1 | 0.6  |  |
| LEH              | 5205.8 | -2416.1 | 2205.3 | -0.7                           | -0.8 | -1.9 | 2.1 | 0.6  |  |
| LFH              | 4879.4 | -1908.2 | 1700.0 | -0.7                           | -0.6 | -1.6 | 1.8 | 0.6  |  |
| LGH              | 4960.8 | -2736.0 | 1108.4 | -0.1                           | -0.1 | -2.2 | 2.2 | 0.7  |  |
| LHH              | 5130.1 | -3002.6 | 1373.5 | -0.1                           | -0.2 | -2.3 | 2.4 | 0.8  |  |

| Vader Negative 45° |        |         |         |                                |      |      |     |      |  |
|--------------------|--------|---------|---------|--------------------------------|------|------|-----|------|--|
| Nov 1, 2011 data   |        |         |         | Sept 22.2010 - Nov 1.2011 data |      |      |     |      |  |
| Point              | Z      | X       | Y       | dz                             | dx   | dy   | rms | x/y* |  |
| VAH                | 4591.0 | -2853.3 | -1235.4 | 0.0                            | -1.3 | 1.1  | 1.7 | -0.8 |  |
| VBH                | 4420.3 | -2588.8 | -968.8  | -0.1                           | -1.1 | 0.8  | 1.4 | -0.7 |  |
| VCH                | 4345.2 | -1755.9 | -1553.6 | -0.2                           | -1.7 | 0.0  | 1.7 | -1.3 |  |
| VDH                | 4667.9 | -2261.6 | -2063.3 | 0.0                            | -2.2 | 0.5  | 2.2 | -1.2 |  |
| VEH                | 4668.0 | -2054.3 | -2269.1 | 0.0                            | -2.4 | 0.3  | 2.4 | -1.4 |  |
| VFH                | 4345.8 | -1548.5 | -1759.2 | -0.2                           | -1.9 | -0.3 | 2.0 | -1.5 |  |
| VGH                | 4423.9 | -956.3  | -2587.1 | -0.3                           | -2.8 | -0.9 | 2.9 | -1.8 |  |
| VHH                | 4592.3 | -1221.4 | -2854.5 | -0.2                           | -3.0 | -0.6 | 3.1 | -1.7 |  |

| Leia Negative 45° |        |         |         |                                |      |      |     |      |  |
|-------------------|--------|---------|---------|--------------------------------|------|------|-----|------|--|
| Nov 1, 2011 data  |        |         |         | Sept 22.2010 - Nov 1.2011 data |      |      |     |      |  |
| Point             | z      | x       | y       | dz                             | dx   | dy   | rms | x/y* |  |
| LAH               | 5122.5 | -3008.3 | -1389.8 | 0.1                            | -1.3 | 1.4  | 1.9 | -0.6 |  |
| LBH               | 4952.2 | -2743.7 | -1123.4 | 0.0                            | -1.1 | 1.1  | 1.5 | -0.6 |  |
| LCH               | 4873.2 | -1912.5 | -1710.5 | -0.2                           | -1.7 | 0.2  | 1.8 | -1.2 |  |
| LDH               | 5198.6 | -2417.9 | -2218.9 | 0.0                            | -2.2 | 0.8  | 2.3 | -1.1 |  |
| LEH               | 5198.3 | -2211.1 | -2425.1 | 0.0                            | -2.4 | 0.5  | 2.5 | -1.2 |  |
| LFH               | 4873.7 | -1705.4 | -1916.5 | -0.2                           | -2.0 | 0.0  | 2.0 | -1.3 |  |
| LGH               | 4954.1 | -1113.7 | -2744.3 | -0.2                           | -2.8 | -0.6 | 2.9 | -1.7 |  |
| LHH               | 5122.5 | -1379.0 | -3011.3 | -0.1                           | -3.1 | -0.3 | 3.1 | -1.6 |  |

Note : Yoda and Hans were not observed at the negative 45 degree position.

| Vader Negative 90° |        |         |         |                                |      |      |     |      |
|--------------------|--------|---------|---------|--------------------------------|------|------|-----|------|
| Nov 1, 2011 data   |        |         |         | Sept 22.2010 - Nov 1.2011 data |      |      |     |      |
| Point              | z      | x       | y       | dz                             | dx   | dy   | rms | x/y* |
| VAH                | 4588.2 | -1142.8 | -2894.3 | 0.0                            | -0.2 | -1.7 | 1.7 | -1.7 |
| VBH                | 4417.7 | -1144.8 | -2518.7 | 0.0                            | -0.2 | -1.7 | 1.7 | -1.7 |
| VCH                | 4343.4 | -142.7  | -2341.2 | -0.2                           | -0.2 | -1.8 | 1.8 | -1.8 |
| VDH                | 4665.7 | -138.7  | -3059.5 | -0.1                           | -0.2 | -1.8 | 1.8 | -1.8 |
| VEH                | 4666.0 | 153.4   | -3057.8 | -0.2                           | -0.2 | -1.8 | 1.8 | -1.8 |
| VFH                | 4344.2 | 149.3   | -2339.4 | -0.2                           | -0.2 | -1.8 | 1.8 | -1.8 |
| VGH                | 4422.9 | 1153.8  | -2504.2 | -0.3                           | -0.2 | -1.9 | 1.9 | -1.6 |
| VHH                | 4591.1 | 1156.0  | -2880.7 | -0.3                           | -0.2 | -1.8 | 1.9 | -1.7 |

| Leia Negative 90° |        |         |         |                                |      |      |     |      |
|-------------------|--------|---------|---------|--------------------------------|------|------|-----|------|
| Nov 1, 2011 data  |        |         |         | Sept 22.2010 - Nov 1.2011 data |      |      |     |      |
| Point             | z      | x       | y       | dz                             | dx   | dy   | rms | x/y* |
| LAH               | 5119.6 | -1143.1 | -3113.4 | 0.0                            | -0.1 | -1.7 | 1.7 | -1.7 |
| LBH               | 4949.5 | -1145.0 | -2737.9 | 0.0                            | -0.1 | -1.7 | 1.7 | -1.6 |
| LCH               | 4871.3 | -142.4  | -2563.2 | -0.2                           | -0.1 | -1.8 | 1.8 | -1.8 |
| LDH               | 5196.2 | -139.1  | -3280.3 | -0.1                           | -0.1 | -1.8 | 1.8 | -1.8 |
| LEH               | 5196.2 | 153.0   | -3279.2 | -0.2                           | -0.1 | -1.8 | 1.8 | -1.8 |
| LFH               | 4871.9 | 149.7   | -2561.9 | -0.2                           | -0.1 | -1.8 | 1.8 | -1.8 |
| LGH               | 4953.0 | 1153.8  | -2726.9 | -0.3                           | -0.1 | -1.8 | 1.9 | -1.7 |
| LHH               | 5121.2 | 1155.6  | -3103.4 | -0.3                           | -0.1 | -1.8 | 1.9 | -1.7 |

| Yoda Negative 90° |        |         |        |                                |     |      |     |      |
|-------------------|--------|---------|--------|--------------------------------|-----|------|-----|------|
| Nov 1, 2011 data  |        |         |        | Sept 22.2010 - Nov 1.2011 data |     |      |     |      |
| Point             | z      | x       | y      | dz                             | dx  | dy   | rms | x/y* |
| YAH               | 4426.7 | -1149.0 | 2510.8 | 0.0                            | 0.0 | -1.9 | 1.9 | 1.7  |
| YBH               | 4598.4 | -1148.7 | 2885.9 | 0.0                            | 0.0 | -1.9 | 1.9 | 1.7  |
| YCH               | 4345.6 | -146.0  | 2341.0 | -0.1                           | 0.0 | -1.8 | 1.8 | 1.8  |
| YDH               | 4672.9 | -145.2  | 3057.1 | -0.1                           | 0.0 | -1.8 | 1.8 | 1.8  |
| YEH               | 4345.8 | 145.9   | 2340.7 | -0.2                           | 0.0 | -1.8 | 1.8 | 1.8  |
| YFH               | 4672.7 | 146.8   | 3056.8 | -0.2                           | 0.0 | -1.8 | 1.8 | 1.8  |
| YGH               | 4427.4 | 1149.4  | 2508.2 | -0.3                           | 0.0 | -1.7 | 1.7 | 1.6  |
| YHH               | 4598.8 | 1149.7  | 2883.3 | -0.3                           | 0.0 | -1.7 | 1.7 | 1.6  |

| Hans Negative 90° |        |         |        |                                |     |      |     |      |
|-------------------|--------|---------|--------|--------------------------------|-----|------|-----|------|
| Nov 1, 2011 data  |        |         |        | Sept 22.2010 - Nov 1.2011 data |     |      |     |      |
| Point             | z      | x       | y      | dz                             | dx  | dy   | rms | x/y* |
| HAH               | 4957.8 | -1148.9 | 2729.2 | 0.0                            | 0.0 | -1.9 | 1.9 | 1.7  |
| HBH               | 5130.1 | -1148.4 | 3103.8 | 0.0                            | 0.0 | -1.9 | 1.9 | 1.8  |
| HCH               | 4877.9 | -146.1  | 2558.2 | -0.1                           | 0.0 | -1.8 | 1.8 | 1.8  |
| HDH               | 5206.8 | -144.9  | 3273.4 | -0.1                           | 0.0 | -1.8 | 1.8 | 1.8  |
| HEH               | 4878.0 | 145.9   | 2557.7 | -0.2                           | 0.0 | -1.8 | 1.8 | 1.8  |
| HFH               | 5206.8 | 147.1   | 3272.9 | -0.2                           | 0.0 | -1.8 | 1.8 | 1.8  |
| HGH               | 4958.7 | 1149.7  | 2725.3 | -0.3                           | 0.0 | -1.7 | 1.7 | 1.6  |
| HHH               | 5129.8 | 1150.3  | 3100.3 | -0.3                           | 0.0 | -1.7 | 1.7 | 1.6  |

| Vader + 90°      |        |         |        |                                |     |      |     |      |
|------------------|--------|---------|--------|--------------------------------|-----|------|-----|------|
| Nov 1, 2011 data |        |         |        | Sept 22.2010 - Nov 1.2011 data |     |      |     |      |
| Point            | z      | x       | y      | dz                             | dx  | dy   | rms | x/y* |
| VAH              | 4596.3 | 1153.7  | 2880.2 | -0.9                           | 0.0 | -0.9 | 1.2 | 0.8  |
| VBH              | 4424.7 | 1154.4  | 2505.0 | -1.6                           | 0.0 | -0.5 | 1.7 | 0.5  |
| VCH              | 4350.4 | 151.7   | 2331.0 | -2.1                           | 0.0 | -0.3 | 2.1 | 0.3  |
| VDH              | 4674.7 | 150.2   | 3048.4 | -0.6                           | 0.0 | -1.0 | 1.2 | 1.0  |
| VEH              | 4675.2 | -141.9  | 3047.7 | -0.7                           | 0.0 | -1.0 | 1.2 | 1.0  |
| VFH              | 4351.3 | -140.3  | 2330.2 | -2.1                           | 0.0 | -0.3 | 2.2 | 0.3  |
| VGH              | 4431.0 | -1144.2 | 2498.1 | -1.9                           | 0.0 | -0.5 | 2.0 | 0.4  |
| VHH              | 4600.2 | -1145.1 | 2874.1 | -1.1                           | 0.0 | -0.8 | 1.4 | 0.7  |

| Leia + 90°       |        |         |        |                                |      |      |     |      |
|------------------|--------|---------|--------|--------------------------------|------|------|-----|------|
| Nov 1, 2011 data |        |         |        | Sept 22.2010 - Nov 1.2011 data |      |      |     |      |
| Point            | z      | x       | y      | dz                             | dx   | dy   | rms | x/y* |
| LAH              | 5128.3 | 1155.0  | 3097.8 | -0.4                           | -0.1 | -1.9 | 2.0 | 1.8  |
| LBH              | 4957.1 | 1155.6  | 2722.8 | -1.2                           | -0.1 | -1.6 | 2.0 | 1.5  |
| LCH              | 4878.9 | 152.4   | 2551.6 | -1.6                           | -0.1 | -1.4 | 2.2 | 1.4  |
| LDH              | 5205.8 | 151.6   | 3267.8 | -0.2                           | -0.1 | -2.1 | 2.1 | 2.1  |
| LEH              | 5206.0 | -140.5  | 3267.7 | -0.2                           | -0.1 | -2.1 | 2.1 | 2.1  |
| LFH              | 4879.7 | -139.7  | 2551.2 | -1.7                           | -0.1 | -1.4 | 2.2 | 1.4  |
| LGH              | 4961.7 | -1143.2 | 2719.3 | -1.4                           | -0.1 | -1.5 | 2.1 | 1.4  |
| LHH              | 5130.9 | -1143.7 | 3095.3 | -0.7                           | -0.1 | -1.9 | 2.0 | 1.7  |

| Yoda + 90°       |        |         |         |                                |     |      |     |      |
|------------------|--------|---------|---------|--------------------------------|-----|------|-----|------|
| Nov 1, 2011 data |        |         |         | Sept 22.2010 - Nov 1.2011 data |     |      |     |      |
| Point            | z      | x       | y       | dz                             | dx  | dy   | rms | x/y* |
| YAH              | 4419.0 | 1142.2  | -2523.6 | -0.1                           | 0.4 | -1.9 | 2.0 | -1.9 |
| YBH              | 4589.5 | 1140.8  | -2899.2 | -0.1                           | 0.4 | -1.9 | 2.0 | -1.9 |
| YCH              | 4339.1 | 139.8   | -2350.2 | -0.1                           | 0.4 | -2.0 | 2.0 | -2.0 |
| YDH              | 4664.0 | 136.8   | -3067.3 | -0.1                           | 0.4 | -2.0 | 2.0 | -2.0 |
| YEH              | 4339.4 | -152.1  | -2348.9 | -0.1                           | 0.4 | -2.0 | 2.0 | -1.9 |
| YFH              | 4664.0 | -155.2  | -3066.1 | -0.1                           | 0.4 | -2.0 | 2.0 | -2.0 |
| YGH              | 4421.0 | -1156.2 | -2513.5 | 0.0                            | 0.4 | -2.0 | 2.1 | -1.7 |
| YHH              | 4591.2 | -1157.6 | -2889.1 | 0.0                            | 0.4 | -2.0 | 2.1 | -1.7 |

| Hans + 90°       |        |         |         |                                |     |      |     |      |
|------------------|--------|---------|---------|--------------------------------|-----|------|-----|------|
| Nov 1, 2011 data |        |         |         | Sept 22.2010 - Nov 1.2011 data |     |      |     |      |
| Point            | z      | x       | y       | dz                             | dx  | dy   | rms | x/y* |
| HAH              | 4949.4 | 1141.7  | -2743.7 | -0.1                           | 0.4 | -1.9 | 2.0 | -1.9 |
| HBH              | 5120.4 | 1140.1  | -3118.8 | -0.1                           | 0.5 | -1.9 | 2.0 | -2.0 |
| HCH              | 4870.6 | 139.5   | -2569.1 | -0.1                           | 0.4 | -2.0 | 2.0 | -2.0 |
| HDH              | 5197.2 | 136.1   | -3285.4 | -0.1                           | 0.5 | -2.0 | 2.0 | -2.0 |
| HEH              | 4870.9 | -152.5  | -2567.6 | -0.1                           | 0.4 | -2.0 | 2.0 | -2.0 |
| HFH              | 5197.4 | -155.9  | -3284.0 | -0.1                           | 0.5 | -2.0 | 2.0 | -2.0 |
| HGH              | 4951.7 | -1156.8 | -2732.2 | 0.0                            | 0.4 | -2.0 | 2.1 | -1.7 |
| HHH              | 5121.6 | -1158.5 | -3107.8 | 0.0                            | 0.5 | -2.0 | 2.1 | -1.7 |