

# Fall 2014 Mott Target Replacement and Ladder Position Re-Calibration

JLAB-TN-14-026

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## Abstract

Target foils of gold, silver and copper used in the Spring 2014 re-commissioning of the Mott polarimeter were removed from the scattering chamber. A set of 14 gold foils to be used in a precision test of the polarimeter analyzing power was added, and sibling foils (same fabrication run) for target thickness measurements were identified. The home position of the target ladder was re-calibrated as a result of repairing a motor gear. Re-commissioning of the ladder position is discussed.

## Spring 2014 & Fall 2014 Target Foils

The Mott target ladder has 16 positions with two mount styles (11 round and 5 rectangular). The ladder drawing JLAB DWG 39300-E-0215 is shown Appendix A.

Table 1. The target foils discussed in this note are described.

Ladder		Foils for Spring 2014 Run Period					Foils for Fall 2014 Run Period (Installed 9/10/14)					Sibling
#	Type	Material	Thickness (micron)	Run	Foil ID	Material	Thickness (micron)	P/N #	Run	Foil ID	Mount	Foil ID
1	R	Cu	8	5248	A	Au	0.225	0.22Au-O-C1in.	7029	A	1" ID rectangle	B
2	R	Cu	1	7104	A	Au	0.625	0.62Au-O-C1in.	7028	A	1" ID rectangle	B
3	R	Ag	10	7102	A	Au	0.870	0.87Au-O-C1in.	3057	A	1" ID rectangle	C
4	R	Au	0.75	5134	A	Au	0.750	0.75Au-O-C1in.	5134	A	1" ID rectangle	B
5	R	Au	0.5	5275	B	Au	0.500	0.5Au-O-C1in.	5275	A	1" ID rectangle	C
6	C	Ag	4.5	6276	A	Au	0.070	0.07Au-O-L1	6405	A	10 mm ID circle	NONE
7	C	Ag	1.6	6719	A	Au	0.070	.07Au-O-C5mm	4605	A	5 mm ID circle	B
8	C	Ag	0.45	6274	A	Au	0.350	.35uAu-O-C1in	5613	B	1" ID circle	A
9	C	Thru	-	-	-	Thru	-	-	-	-	-	-
10	C	Viewer	-	-	-	Viewer	-	-	-	-	-	-
11	C	Cu	4.1	5585	A	Au	0.040	0.04Au-O-L0.5(Al)	6457	A	5mm ID circle	B
12	C	Au	0.05 (Torn)	6809	B	Au	0.050	0.05Au-O-1in	6845	A	1" ID circle	NONE
13	C	Au	0.05	6609	A	Au	0.050	0.05Au-O-1in	6809	A	1" ID circle	B
14	C	Au	0.35	5613	D	Au	0.350	0.35uAu-O-C1in	5613	C	1" ID circle	A
15	C	Au	1	5385	A	Au	1.000	1.0Au-O-C1in	5385	A	1" ID circle	B
16	C	Au	5	6693	A	Au	1.000	1.0Au-O-L1.0	5383	A	10mm ID circle	B

The Spring 2014 target arrangement (7 Au, 4 Ag, 3 Cu, 1 empty, 1 viewer) was installed on October 31, 2013 and used to re-commission the polarimeter (see Table 1). On September 12, 2014 the Mott chamber was vented and the targets were removed. All of the foils are in good condition except for the 0.05  $\mu$ m Au foil (position #12) which is separated from its backing material, possibly due to poor thermal contact to the ladder when tested at high current  $\sim 40$   $\mu$ A. Note that the foils are free standing over the scattering surface.

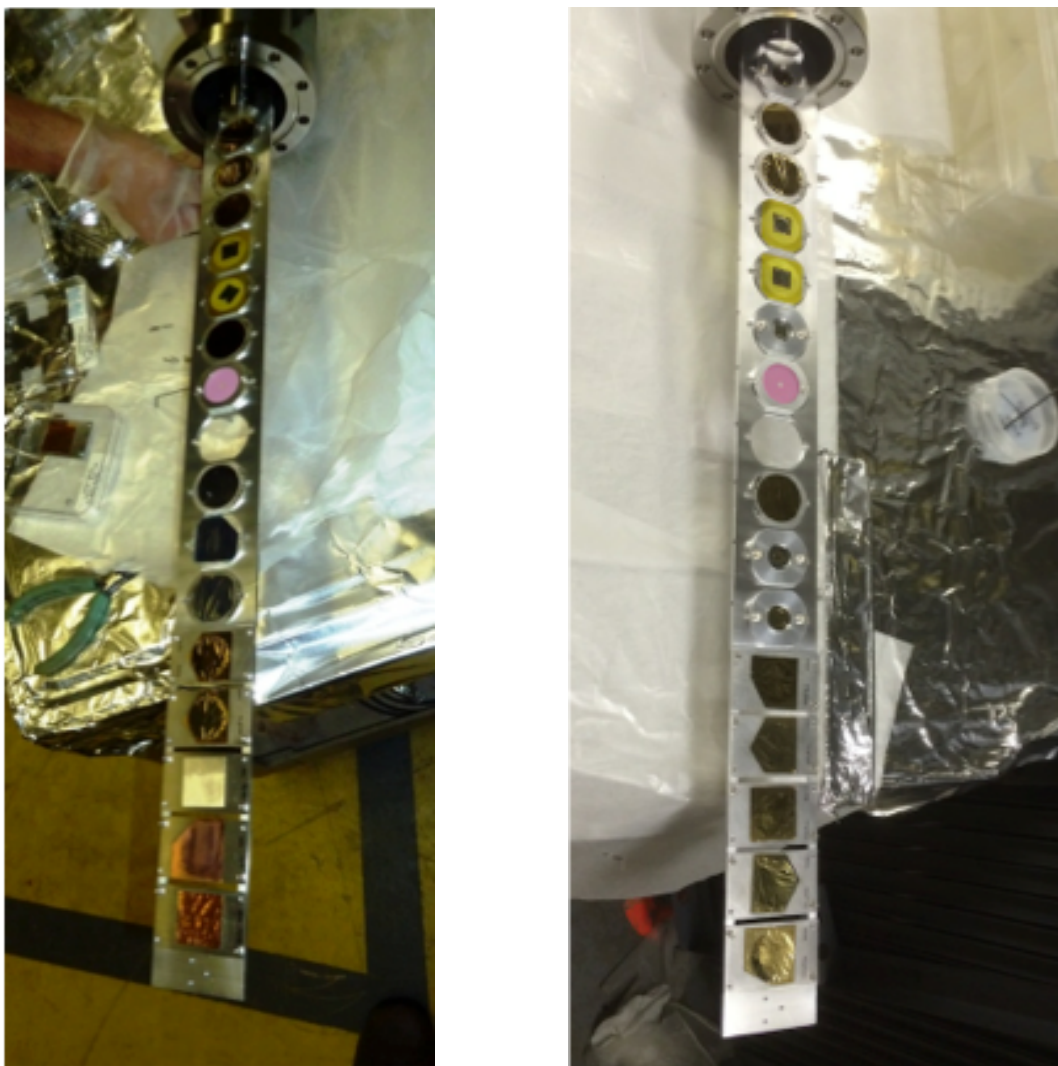


Fig. 1. The downstream surface of the ladder shows the Spring 2014 (left) and Fall 2014 (right) arrangements; position #1 is lowest.

A new set of targets (14 Au, 1 empty, 1 viewer) was added for the Fall 2014 precision test of the polarimeter analyzing power (see Table 1). Some thin 100 keV Mott polarimeter foils on 1 cm ID rings were mounted to round target ladder positions using fabricated aluminum adapters. Sibling foils to those installed were identified.

### **Spring 2014 Target Positions**

The target ladder positions used during the Spring 2014 re-commissioning were lab-surveyed in October 2013 and reported in data transmittal L1527 (see Appendix B). Motor positions that locate targets (spaced 1.425" apart) to the ideal chamber axis are provided and indicate targets are spaced by  $6617 \pm 76$  steps. A final tunnel-survey found the ladder assembly high by 0.2 mm, thus an offset of 36 steps ( $0.2\text{mm} * 1"/25.4 \text{ mm} * 6617 \text{ steps}/1"$ ) was added to the motor controls (see Fig. 2).

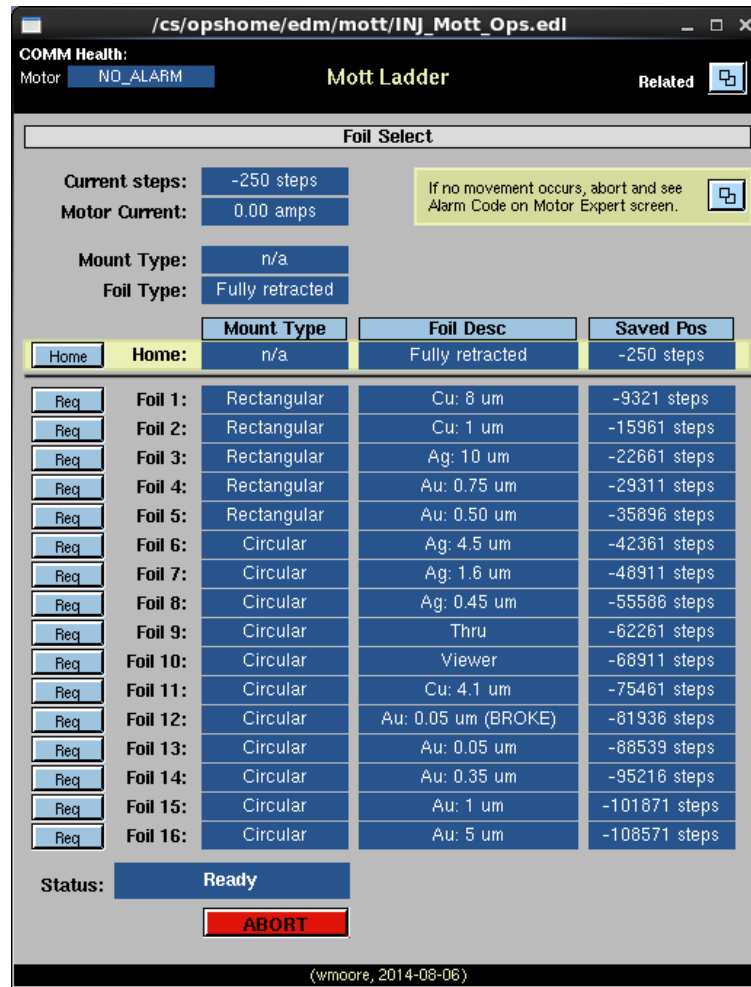


Fig. 2. Target ladder motor control screen for Spring 2014.

### Fall 2014 Target Positions

While replacing a damaged motor gear during the Summer 2014 maintenance shutdown the target ladder fell, even with the locking screw in place, a short but unknown distance ( $<0.5''$ ) losing the home position of the October 2013 survey. A new home position had to be found. The distance from the ladder flange to the lower ladder edge (S in Fig. 3) was determined for four positions (twice at soft home) using a large caliper and aluminum spacer. After subtracting the thickness of the spacer  $0.2477 \pm 0.0012''$  the value of S was found and reported in Table 2. Using the surveyed stepper resolution (4644 steps/inch) the new offset is determined by a linear fit of motor steps versus distance S (see Fig. 4) yielding,

$$\text{Motor Position [steps]} = (36453 \pm 75) - 4644 * S [\text{inches}].$$

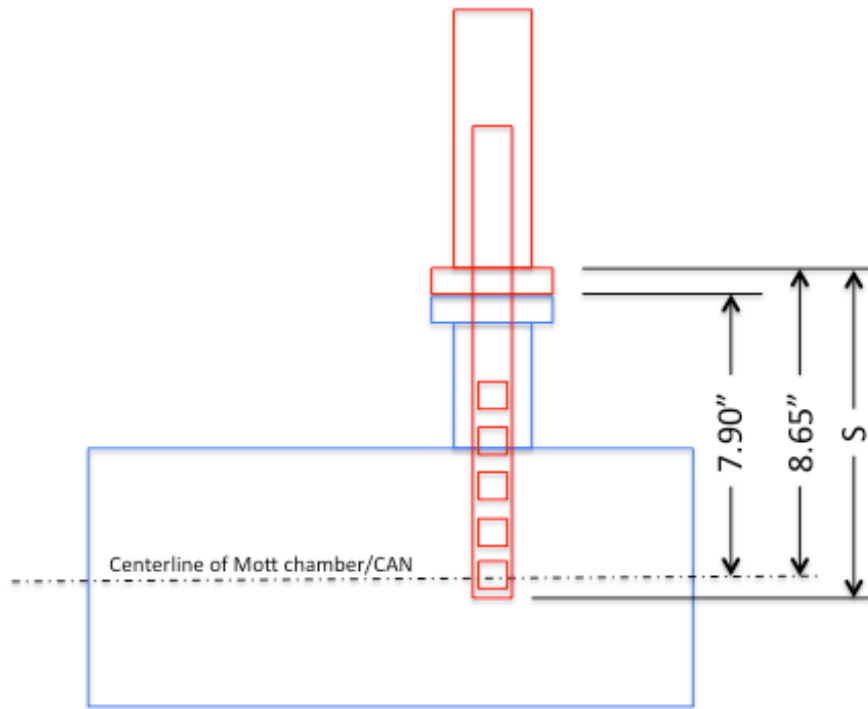


Fig. 3. Schematic shows the distance S used for re-calibration.

Table 2. Caliper measurements determine S [inches] as a function of motor position.

<i>Position</i>	<i>Hard Home</i>	<i>Soft Home</i>	<i>Soft Home</i>	<i>Pos A</i>	<i>Pos B</i>	<i>Pos C</i>
Motor Steps	5	-250	-250	-15961	-29311	-42361
Sample 1	8.0810	8.1410	8.1390	11.5230	14.3900	17.2970
Sample 2	8.0820	8.1400	8.1360	11.5240	14.3850	17.3030
Sample 3	8.0820	8.1410	8.1390	11.5230	14.3880	17.3070
S + Offset (ave)	8.0817	8.1407	8.1380	11.5233	14.3877	17.3023
S + Offset (sdev)	0.0006	0.0006	0.0017	0.0006	0.0025	0.0050
S (ave)	7.8340	7.8930	7.8903	11.2756	14.1400	17.0546
S (sdev)	0.0013	0.0013	0.0021	0.0013	0.0028	0.0052

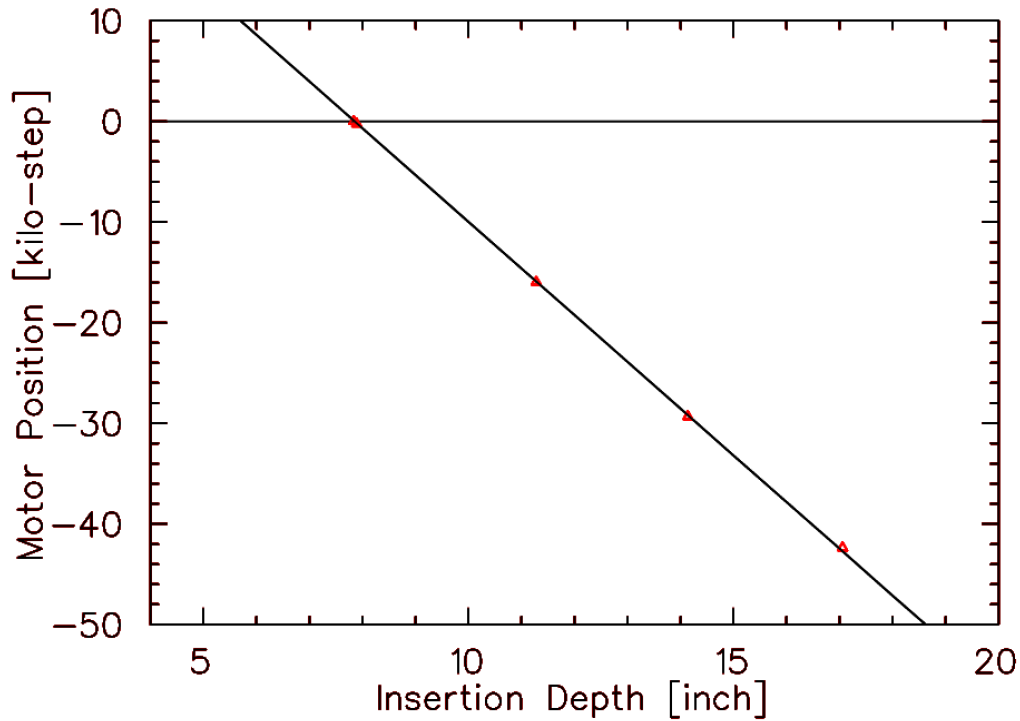


Fig. 4. Motor position and caliper insertion depth (S) to the target ladder edge.

Table 3. The ideal edge (from drawing), motor offset (from measurement), and motor resolution are used to compute Spring 2014 motor step for each target.

Target (#)	Ideal Edge Loc (inch)	Fall 2014 Ideal (Steps)	Spring 2014 (Steps)	Difference (Steps)	Difference (mm)
1	10.0850	-10372	-9321	-1051	-5.8560
2	11.5100	-16988	-15961	-1027	-5.7237
3	12.9350	-23604	-22661	-943	-5.2571
4	14.3600	-30220	-29311	-909	-5.0691
5	15.7850	-36837	-35896	-941	-5.2434
6	17.2100	-43453	-42361	-1092	-6.0866
7	18.6350	-50069	-48911	-1158	-6.4560
8	20.0600	-56686	-55586	-1100	-6.1287
9	21.4850	-63302	-62261	-1041	-5.8014
10	22.9100	-69918	-68911	-1007	-5.6134
11	24.3350	-76534	-75461	-1073	-5.9828
12	25.7600	-83151	-81936	-1215	-6.7702
13	27.1850	-89767	-88539	-1228	-6.8442
14	28.6100	-96383	-95216	-1167	-6.5057
15	30.0350	-103000	-101871	-1129	-6.2899
16	31.4600	-109616	-108571	-1045	-5.8232

Corresponding new motor steps of the target ladder positions are listed in Table 2. The new positions differ from the old by -5.97 mm meaning the ladder home is physically ~6 mm higher than before. The distribution of positions (0.53 mm) is dominated by the October 2013 survey distribution (0.42 mm). Note, the new target positions do not include the 0.2 mm (36 step) offset included in the Spring 2014 target ladder controls.

To mitigate future issues the vacuum feed-thru dial indicator was recorded for three reference positions described in Fig. 5.



Fig. 5. Three reproducible configurations of the dial indicator are shown; 22° metal-metal contact of the ladder (left), 349° hardware home position limit switch (center), and corresponding 337° software home position (right).

### Comparison of Spring 2014 and Fall 2014 Ladder Positions

The Mott target viewer video (UP=top left, DOWN=bottom right) using the Spring 2014 and Fall 2014 positions indicates the scale of the ~6 mm position difference; note the viewer hole is 5mm. Since even small bumps to the camera can affect the image is too subjective to confirm the new position.

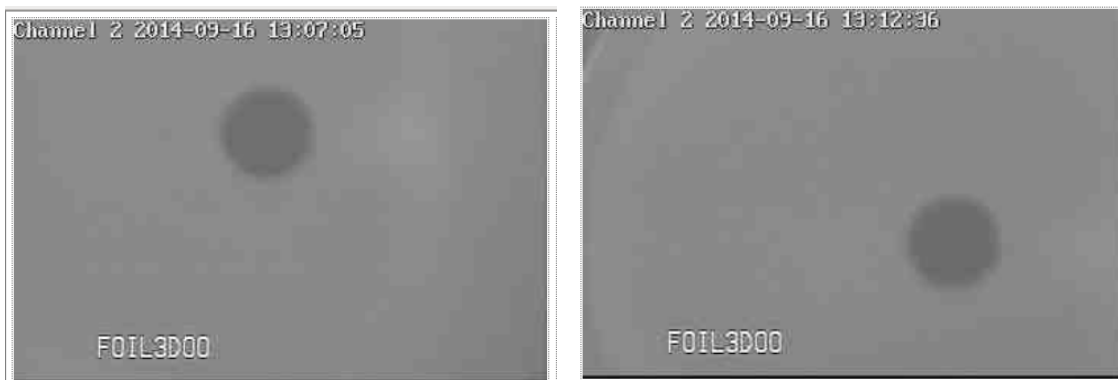


Fig. 6. Mott viewer positioned using Spring (left) and Fall (right) configurations.



## Conclusion

The Spring 2014 target foils were removed and replaced with gold foils to be used for the Fall 2014 precision analyzing power test of the polarimeter. The target ladder positions are corrected to account for a slippage of the linear actuator during repair. New target motor positions are calculated combining the October 2013 survey (4464 steps/inch) and caliper measurements of the ladder to determine a new motor offset (36453+/-75 steps) corresponding to a shift of -5.97 mm. The new values have been loaded into the control system (see Fig. 7). Beam studies to determine the detector rates, spectra and beam asymmetries will need to be made as a function of vertical position of the target and beam in order to validate the new positions.

The screenshot displays the 'Mott Ladder Expert' control window. At the top, it shows 'COMM Health: Motor NO\_ALARM' and a 'Related' icon. The main section is 'Foil Configuration', which includes 'Current steps: -69414 steps' and 'Motor Current: 0.00 amps'. A yellow warning box states: 'If no movement occurs, abort and see Alarm Code on Motor Expert screen.' Below this is a table of foil configurations:

	Mount Type	Foil Desc	New Pos	Save Pos	Saved Pos
Home	Home:	n/a	Fully retracted	-250	Save -250 steps
Req	Foil 1:	Rectangular	Au-0.225-7029-A-25	-10372	Save -10372 steps
Req	Foil 2:	Rectangular	Au-0.625-7028-A-25	-16988	Save -16988 steps
Req	Foil 3:	Rectangular	Au-0.870-3057-A-25	-23604	Save -23604 steps
Req	Foil 4:	Rectangular	Au-0.750-5134-A-25	-30220	Save -30220 steps
Req	Foil 5:	Rectangular	Au-0.500-5275-A-25	-36837	Save -36837 steps
Req	Foil 6:	Circular	Au-0.070-6405-A-10	-43453	Save -43453 steps
Req	Foil 7:	Circular	Au-0.070-4605-A-05	-50069	Save -50069 steps
Req	Foil 8:	Circular	Au-0.350-5613-B-25	-56686	Save -56686 steps
Req	Foil 9:	Circular	Thru	-63302	Save -63302 steps
Req	Foil 10:	Circular	Viewer	-69918	Save -69918 steps
Req	Foil 11:	Circular	Au-0.040-6457-A-05	-76534	Save -76534 steps
Req	Foil 12:	Circular	Au-0.050-6645-A-25	-83151	Save -83151 steps
Req	Foil 13:	Circular	Au-0.050-6809-A-25	-89767	Save -89767 steps
Req	Foil 14:	Circular	Au-0.350-5613-C-25	-96383	Save -96383 steps
Req	Foil 15:	Circular	Au-1.000-5385-A-25	-103000	Save -103000 steps
Req	Foil 16:	Circular	Au-1.000-5383-A-10	-109616	Save -109616 steps

Below the table, the 'Status' is 'Ready' with a red 'ABORT' button. The 'Jogging' section shows 'Current Steps: -69414 steps', 'Jog size (steps): 50', and buttons for 'Up', 'Down', 'STOP', 'CW', 'CCW', and 'GO'. The 'Absolute Position' section shows 'Position (steps): -69414' with 'STOP' and 'GO' buttons. The 'IOC' section shows 'Homer Status: Homing' and 'Mover Status: Homing'. The 'Homing' section shows 'Current Steps: -69414 steps', 'Final Position: -250', 'Status: 02/19/14 09:06:59', and buttons for 'ABORT' and 'Re-Home'. The footer indicates '(vmoore, 2013-10-08)'.

Fig. 7. Target ladder control screen for Spring 2014.

[illegible]



## Appendix B



# Jefferson Lab Alignment Group

## Data Transmittal

**TO:** J.Grames

**DATE:** 13 Nov 2013

**FROM:** Chris Gould

**Checked:**

**# :** L1527

### DETAILS:

M:\align\DATA\Step2B\INJ\131031B

Below are the results of the recent Mott Can and Ladder survey. Locations for the can are reported in CEBAF coordinates and in a beam following system where positive Z is downstream, positive Y is up and a positive X is to the beam left. Locations for the ladder are reported relative to CEBAF coordinates, beam following and relative to the MOTT Can. Yaw angles are given relative to ideal and are reported in degrees. A positive Yaw angle is counter-clockwise from above, a positive pitch angle is counter-clockwise from the beam right side and a positive roll angle is clockwise looking downstream. The step count for the ideal position of each target is also given where target 1 is the bottom most target and 16 is the top most target. It should also be noted that while fiducializing the target ladder 6 degrees of backlash in the yaw direction was observed.

	CEBAF COORDS (M)			BEAM FOLLOWING(mm)			dYaw	dPitch	dRoll			
	Z	X	Y	Z	X	Y						
TARGET CAN	-241.11774	81.05479	99.99963	-3.652	-0.29	-0.367	0.0	0.0	-0.1			
	CEBAF COORDS (M)			BEAM FOLLOWING(mm)			dYaw	dPitch	dRoll	RELATIVE TO MOTT CAN(mm)		
	Z	X	Y	Z	X	Y				Z	X	Y
TARGET LADDER	-241.11786	81.05602	99.999813	-3.514	0.938	-0.187	-0.4	0.1	0.2	0.11	1.25	0.2

Ideal Target position (Top of ladder to bottom)	Step Count
16	-108535
15	-101835
14	-95180
13	-88503
12	-81900
11	-75425
10	-68875
9	-62225
8	-55550
7	-48875
6	-42325
5	-35860
4	-29275
3	-22625
2	-15925
1	-9285