Changes in TAGH counter coordinates and energies due to Fall 2016/Spring 2017 survey

D. Sober

CUA

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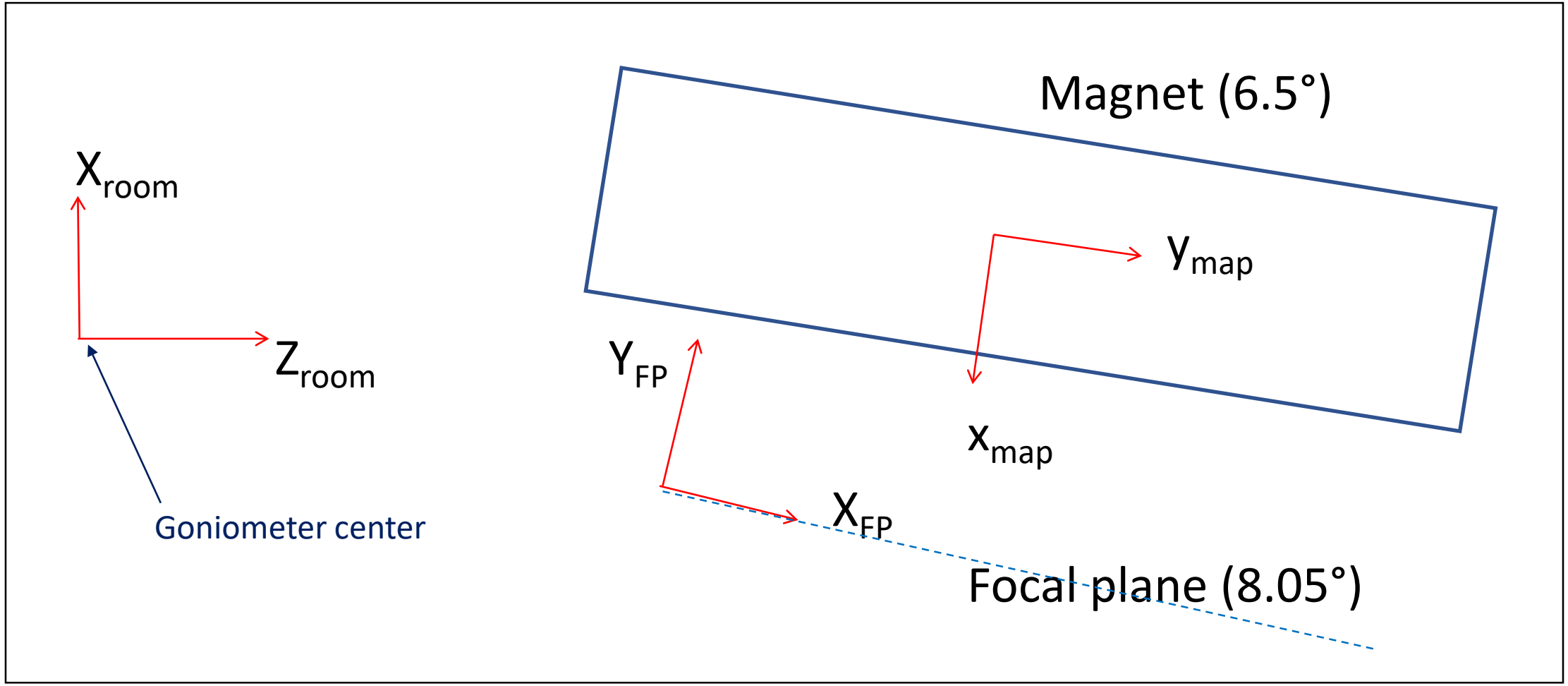
On 11/28/16, Tim Whitlatch sent results of new surveys of various beamline components -- revised in Spring 2017 for Plates 3-5 and Microscope

All Z points relative to the current as found foil Z position — Spring 2017
X and Y points are relative to the theoretical beam centerline

DESCRIPTION	COMPONENT	MACHINE COORDINATE(M)			DELTA ANGLE (DEG)		
		Z	X	Y	YAW	PITCH	ROLL
TAGGER GONIOMETER FOIL	TAGGON	-0.02400					
GONIOMETER DIAMONDS		0.00000					
AMORPHOUS RADIATOR	TAGRAD	0.60046	0.00026	-0.00047	0.00430	0.0284	-0.0060
TAGGER QUAD (MQPAD00)		1.05124					
TAGGER MAGNET	HDTAGG	6.27471	-0.29767	-0.00063	-6.50040	0.0034	-0.0009
TAGGER MAGNET - Pole entrance		3.17284					
HODOSCOPE PLT1 US BR TOP	HODPL1	3.98581	-0.88206	0.06997	-8.04499	-0.00714	-0.01138
HODOSCOPE PLT2 US BR TOP	HODPL2	5.27506	-1.06328	0.07006	-8.04996	-0.00403	-0.21296
HODOSCOPE PLT3 US BR TOP	HODPL3	6.55612	-1.24584	0.07029	-8.09729	0.03943	0.06641
HODOSCOPE PLT4 US BR TOP	HODPL4	7.54558	-1.38524	0.07025	-8.01648	-0.02706	-0.13892
HODOSCOPE PLT5 US BR TOP	HODPL5	8.59061	-1.53217	0.06980	-8.12193	-0.00883	-0.21264
HODOSCOPE PLT6 US BR TOP	HODPL6	9.78627	-1.70071	0.06919	-8.09374	0.03328	-0.26762
HODOSCOPE PLT7 US BR TOP	HODPL7	11.02934	-1.87798	0.07017	-8.06104	-0.01043	-0.00380
HODOSCOPE PLT8 US BR TOP	HODPL8	12.45085	-2.07408	0.07010	-8.04356	-0.01609	-0.18133
TAGGER MICROSCOPE US CENTER	HDMICR	7.41009	-1.16666	-0.00009	-8.05220	0.00660	-0.02380

I have used these data to recalculate the TAGH counter positions, and used the new counter positions to derive a new energy table.

Reminder of coordinate systems (not to scale)



Since raytracing is done in map coordinates, I define the origin of the Focal Plane coordinate system to be fixed relative to the center of the magnet.

Some facts about the new survey:

1. The surveyed magnet angle is -6.5004° (compared to nominal -6.5°), so I assume no change in angle.
2. The measured "yaw angles" of the plates vary between -8.0036° and -8.1141° (compared to nominal -8.05°), so these rotations must be taken into account.
3. Relative to the nominal positions, the center of the magnet is displaced by

   ΔZ_{room} = -1.931 cm, ΔX_{room} = +0.043 cm

   Since the FP shifts with the magnet, ΔZ_{room} has ≈no effect on raytracing.

   The transverse shift ΔX_{room} has a small effect on raytracing, because it affects the point at which electrons enter the field. From the derivatives tables, I estimate the energy shift to be ≤ 1 MeV, so I will not consider it further at this point.

For reference, here are the conversions between the 3 coordinate systems, both nominal and after the Fall 2016 survey: (only the shaded boxes have changed)

Usage: Coordinate in column 1 given by constants in same row,
e.g. xFP =-418.800 + Xroom*(-sin 8.05) + Zroom*cos 8.05

Nominal coordinates: (Units: cm, degrees)

	Room			Map			Focal plane		
	const	Xroom	Zroom	const	xmap	ymap	const	xFP	yFP
Xroom	0	1	0	-29.810	-cos 6.5	-sin 6.5	-69.400	-sin 8.05	cos 8.05
Zroom	0	0	1	629.402	-sin 6.5	cos 6.5	415.090	cos 8.05	sin 8.05
xmap	41.632	-cos 6.5	- sin 6.5	0	1	0	63.596	sin 1.55	-cos 1.55
ymap	-628.731	-sin 6.5	cos 6.5	0	0	1	-208.453	cos 1.55	sin 1.55
xFP	-420.718	-sin 8.05	cos 8.05	206.656	sin 1.55	cos 1.55	0	1	0
yFP	10.588	cos 8.05	sin 8.05	69.211	-cos 1.55	sin 1.55	0	0	1

After Fall 2016 survey of magnet center: (Units: cm, degrees)

	Room			Map			Focal plane		
	const	Xroom	Zroom	const	xmap	ymap	const	xFP	yFP
Xroom	0	1	0	-29.767	-cos 6.5	-sin 6.5	-69.357	-sin 8.05	cos 8.05
Zroom	0	0	1	627.471	-sin 6.5	cos 6.5	413.159	cos 8.05	sin 8.05
xmap	41.456	-cos 6.5	- sin 6.5	0	1	0	63.596	sin 1.55	-cos 1.55
ymap	-626.807	-sin 6.5	cos 6.5	0	0	1	-208.453	cos 1.55	sin 1.55
xFP	-418.800	-sin 8.05	cos 8.05	206.656	sin 1.55	cos 1.55	0	1	0
yFP	10.816	cos 8.05	sin 8.05	69.211	-cos 1.55	sin 1.55	0	0	1

(Parenthetically)
New (Spring 2017) survey of **Microscope position (Upstream Center)**

Zroom, Xroom = 7.41009 m, -1.16666 m Angle = -8.05220°

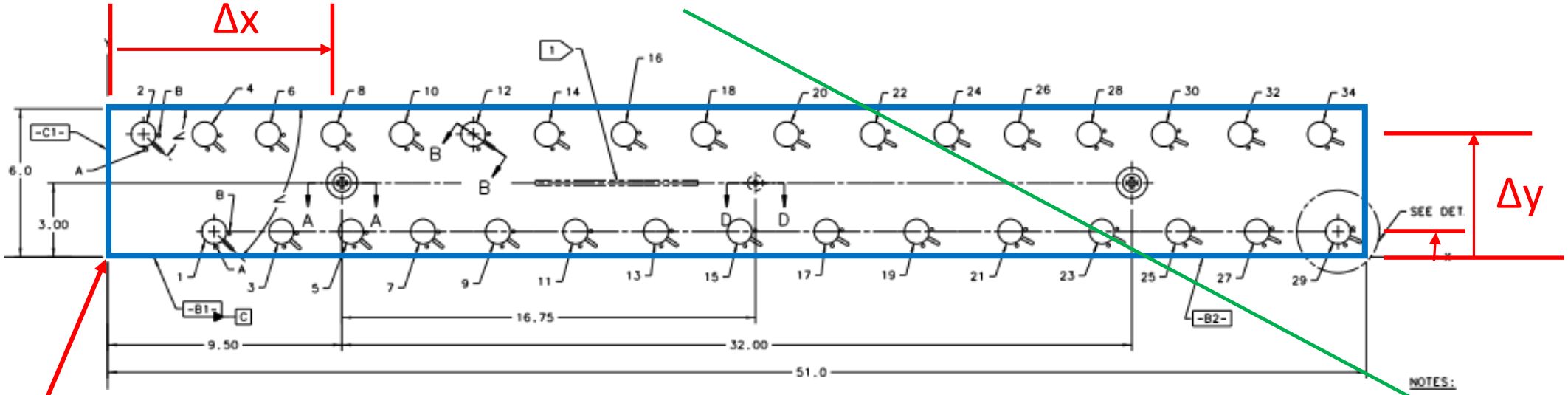
In new coordinates (including magnet center shift) microscope is at

xmap, ymap = 73.488 cm, 122.645 cm
xFP, yFP = 331.245 cm, -0.932 cm

Change in angle is negligible.

TAGH counter positions

Counter plate 1 (counters 1-30, 32, 34): from Drawing D00001901-203



Reference point (survey table)

Electron path

Δx and Δy values come from Bill Crahn's spreadsheet or drawings.

Nominally, $\Delta y = 1.03150$ inch → $y_{FP} = -18$ cm

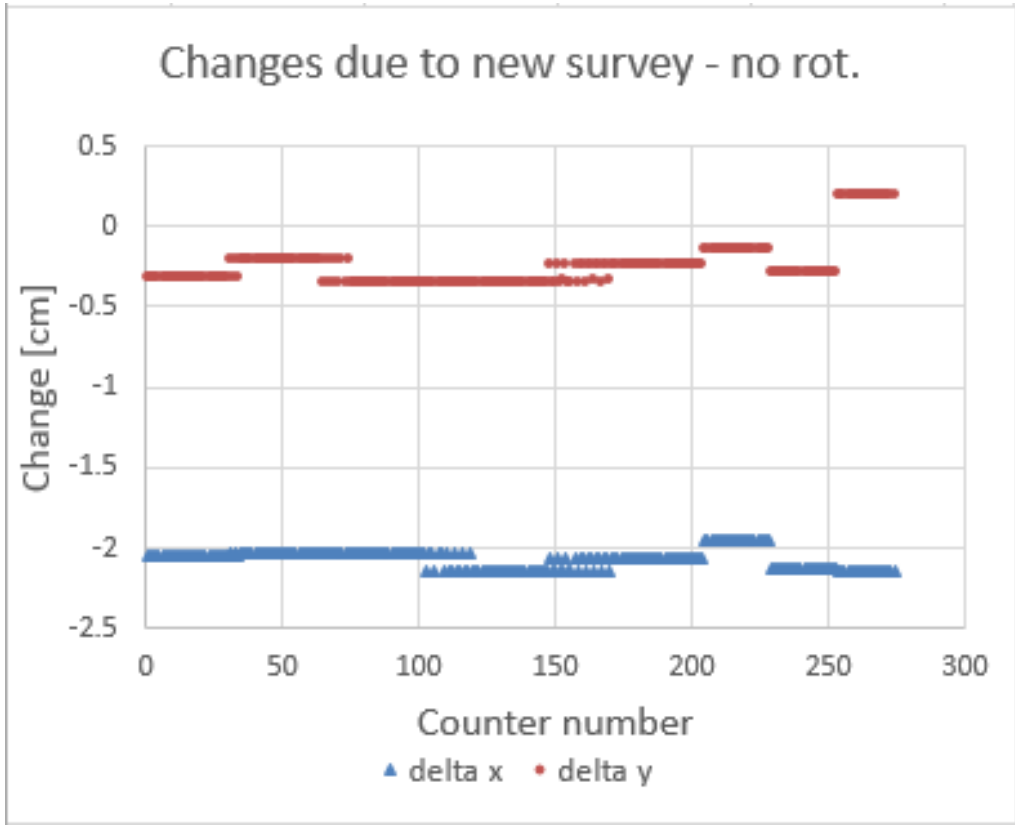
$\Delta y = 4.96851$ inch → $y_{FP} = -8$ cm

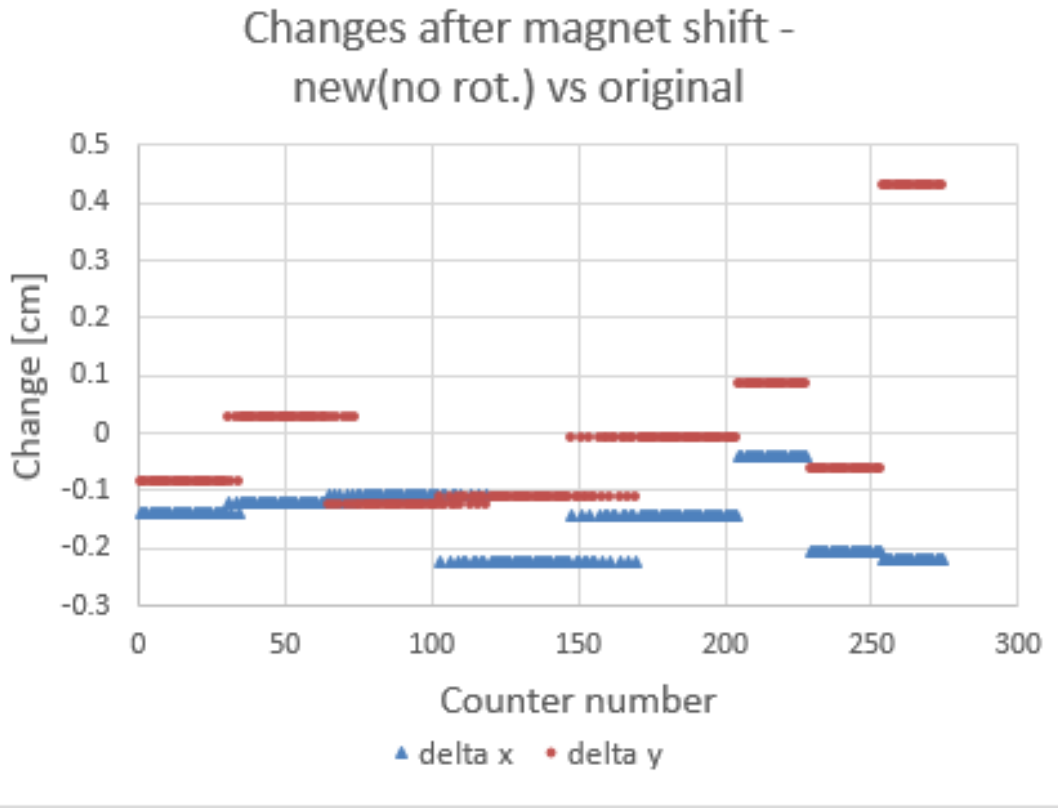
To calculate positions of counter mounting centers in FP coordinates (relative to magnet center),

1. Calculate position of plate corner in FP coordinates (using survey data for plate corner and magnet center in room coordinates)
2. In FP coordinate system, calculate new position of each counter using tables of Δx and Δy (from Bill Crahn's spreadsheet) and change in plate rotation angle (from Fall 2016 survey)
3. Calculate new angle of each counter using Bill Crahn's table corrected by rotation angle of each plate.

With this information, can now generate new tables of counter positions and angles: Counter_table2017.txt replaces Counter_table.txt (7/1/2014).
Then, using raytracing tables calculated with SNAKE using final field maps, Interpolate to find new counter energy boundaries (for 0-angle electrons).

Ignoring (for the moment) the rotation of the plates, the shift in counter position is constant on each plate: Δx in blue, Δy in red
Left plot: without magnet shift, right plot: with magnet shift
Except for plate 8, all shifts are < 2.5 mm.

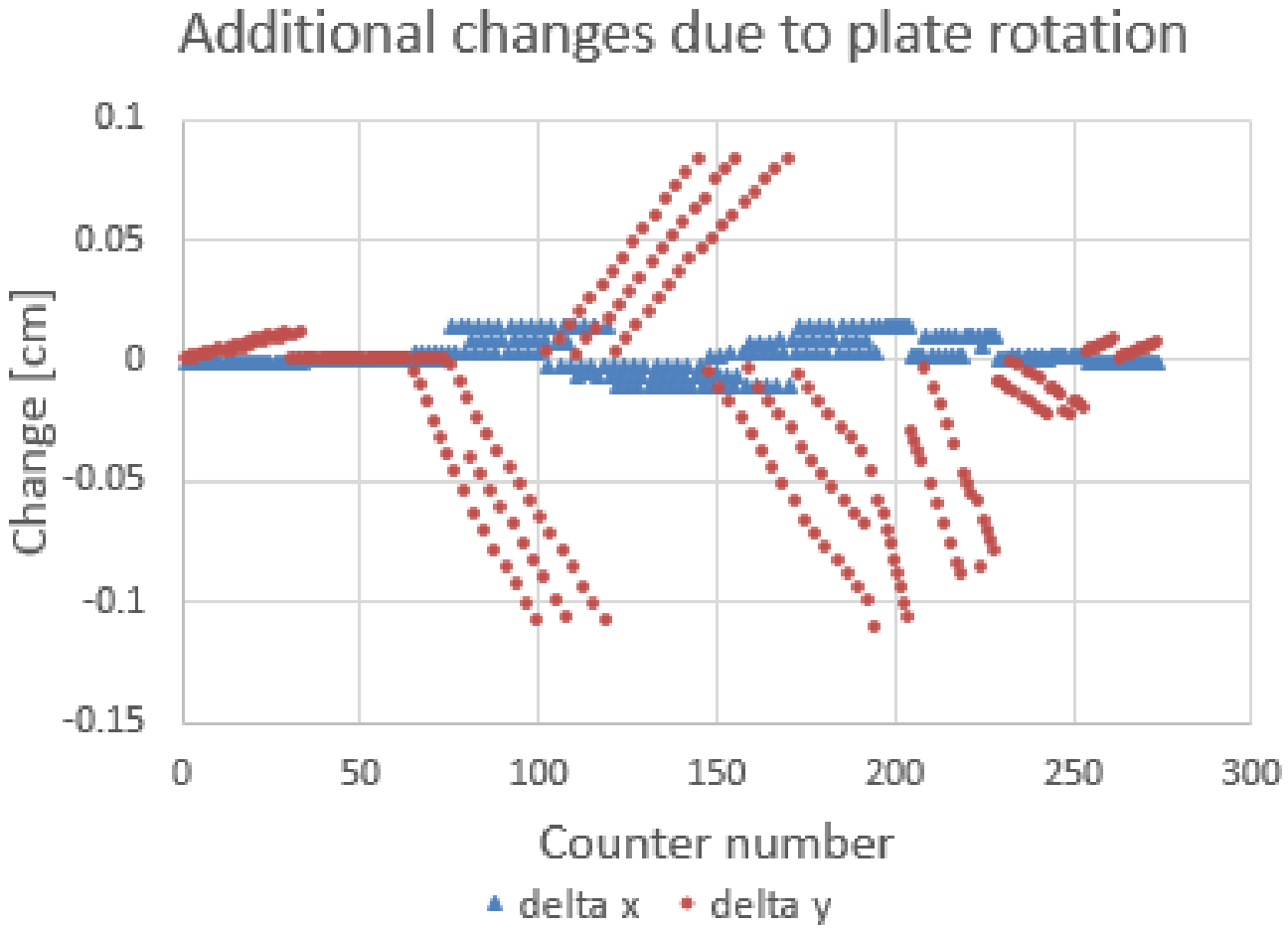




Summary of changes for each counter plate

Plate	Raw shifts -no rotation			Relative to magnet - no rotation			Change in		Relative to magnet - with rotation			
	dx[cm]	dy[cm]		dx[cm]	dy[cm]		angle [deg]		dx[cm]		dy[cm]	
									Min	Max	Min	Max
1	-2.055	-0.313		-0.137	-0.085		0.0050		-0.139	-0.138	-0.085	-0.073
2	-2.039	-0.202		-0.121	0.026		0.0000		-0.121	-0.121	0.026	0.026
3	-2.026	-0.351		-0.108	-0.123		-0.0641		-0.105	-0.094	-0.232	-0.126
4	-2.141	-0.341		-0.223	-0.113		0.0464		-0.234	-0.225	-0.111	-0.030
5	-2.061	-0.236		-0.143	-0.008		-0.0625		-0.140	-0.129	-0.119	-0.011
6	-1.959	-0.143		-0.041	0.085		-0.0437		-0.039	-0.032	-0.005	0.082
7	-2.123	-0.288		-0.205	-0.060		-0.0110		-0.204	-0.202	-0.083	-0.061
8	-2.137	0.202		-0.219	0.430		0.0064		-0.220	-0.219	0.430	0.438

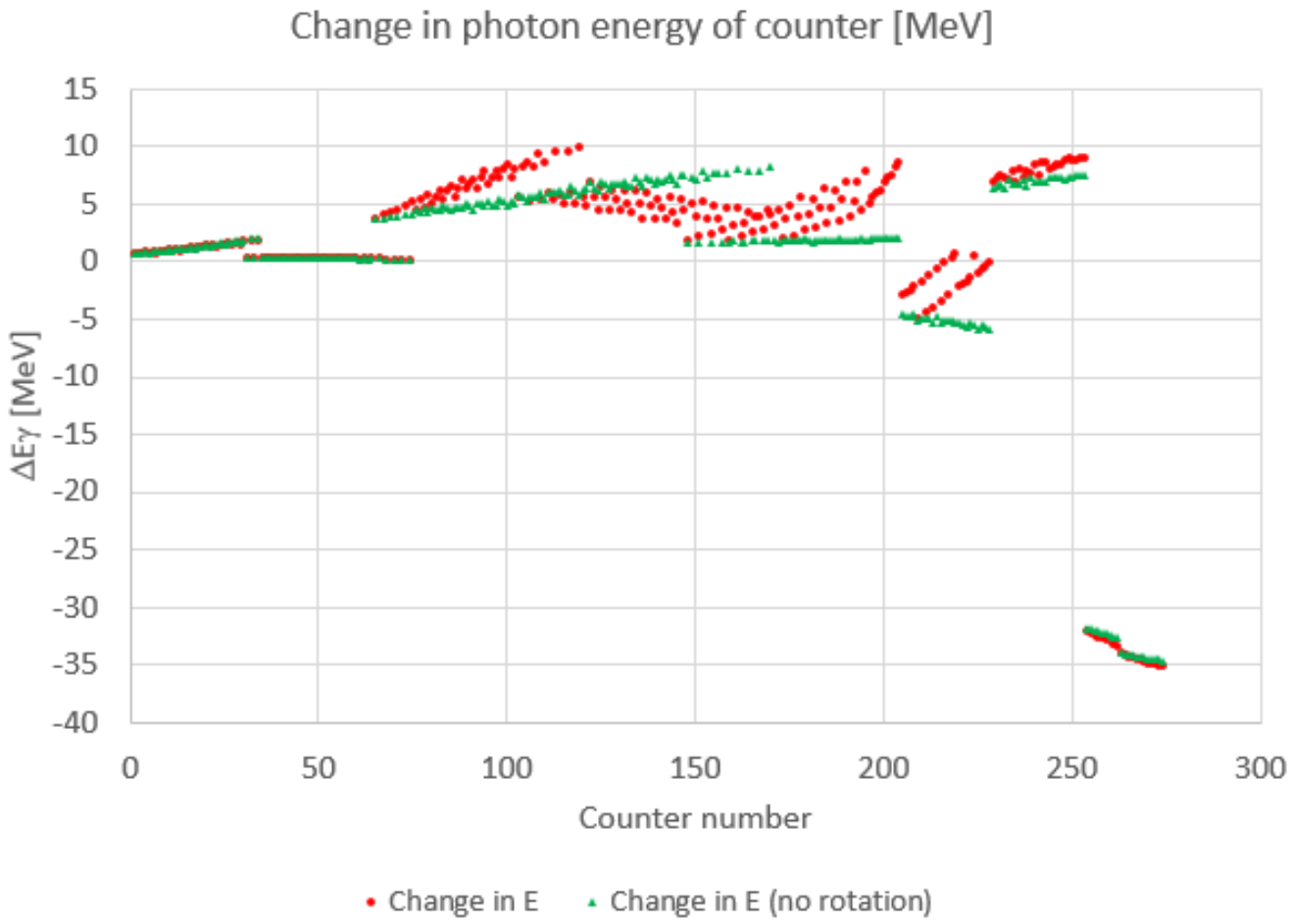
Including plate rotations changes Δx (blue points) negligibly (<0.1 mm), Δy (red points) by < 1 mm:
Note effect of multiple counter planes on Plates 1-6 (especially on 3-6):



Results of raytracing (0-angle rays) using new counter position file

Green: ΔE_γ without plate rotation Red: ΔE_γ with plate rotation

Except for Plate 8, differences are less than 10 MeV (compare to channel width 20-30 MeV)



Note added 30-Jan-2017:

The preceding tables and figures were produced using the Fall 2016 survey.

Using the new Spring 2017 survey values for Plates 3, 4 and 5 (Counters 65-204) produces very small changes compared to Fall 2016:

$$-0.036\ \text{cm} < \Delta x_{FP} < 0.006\ \text{cm}$$
$$0 < \Delta y_{FP} < 0.055\ \text{cm}$$
$$-0.013^\circ < \Delta\theta_{counter} < 0.017^\circ$$
$$-2.0\ \text{MeV} < \Delta E_\gamma < 0$$

The new values are incorporated into the posted versions (dated 1/30/2017) of Counter_table2017.txt and counterbounds2017.out

Comparison of new and old counter files

Old (Counter_table.txt, 7/1/14)

```
#Counter_table2.xlsx                          7/1/2014
#Counter table revised to agree with mounting plates (6/30/2014)
#(Nominal energies from Franz's 2013 table on Wiki)
#counter        E?high  E?low   xcenter ycenter angle   width
1       11.780  11.770  -0.695  -18.000 44.0776 2.1
2       11.770  11.760  -7.963  -8.000  43.0868 2.1
3       11.760  11.749  6.211   -18.000 42.1164 2.1
4       11.749  11.738  -1.669  -8.000  41.1618 2.1
5       11.738  11.726  13.382  -18.000 40.2374 2.1
6       11.726  11.714  4.859   -8.000  39.3326 2.1
7       11.714  11.701  20.808  -18.000 38.4513 2.1
8       11.701  11.688  11.632  -8.000  37.5929 2.1
9       11.688  11.674  28.506  -18.000 36.7554 2.1
10      11.674  11.660  18.669  -8.000  35.9417 2.1
11      11.660  11.645  36.494  -18.000 35.1487 2.1
12      11.645  11.629  25.982  -8.000  34.3760 2.1
13      11.629  11.613  44.783  -18.000 33.6228 2.1
14      11.613  11.596  33.581  -8.000  32.8880 2.1
15      11.596  11.578  53.389  -18.000 32.1720 2.1
16      11.578  11.560  41.480  -8.000  31.4744 2.1
17      11.560  11.541  62.328  -18.000 30.7931 2.1
18      11.541  11.521  49.695  -8.000  30.1310 2.1
19      11.521  11.500  71.609  -18.000 29.4851 2.1
20      11.500  11.478  58.238  -8.000  28.8547 2.1
```

New (Counter_table2017.txt, 1/30/17)

```
#Counter_table2017.txt                        30-Jan-2017
#x, y data from mounting plates (6/30/2014) and Spring 2017 survey, units=cm
#Using magnet shift, plate shift+rotation, and rotation of counter angle
#Neg. counter no. -> omitted in std config.; widths 179-217 revised 09-Mar-2016
#(Nominal energies Egam_hi, Egam_lo from Franz's 2013 table on Wiki)
#number Egam_hi Egam_lo x[cm]   y[cm]  angle[deg] width[cm]
1       11.780  11.770  -0.832  -18.084 44.0826 2.1
2       11.770  11.760  -8.102  -8.085  43.0918 2.1
3       11.760  11.749  6.073   -18.084 42.1214 2.1
4       11.749  11.738  -1.808  -8.084  41.1668 2.1
5       11.738  11.726  13.244  -18.083 40.2424 2.1
6       11.726  11.714  4.720   -8.084  39.3376 2.1
7       11.714  11.701  20.670  -18.082 38.4563 2.1
8       11.701  11.688  11.493  -8.083  37.5979 2.1
9       11.688  11.674  28.368  -18.082 36.7604 2.1
10      11.674  11.660  18.531  -8.082  35.9467 2.1
11      11.660  11.645  36.356  -18.081 35.1537 2.1
12      11.645  11.629  25.844  -8.082  34.3810 2.1
13      11.629  11.613  44.645  -18.080 33.6278 2.1
14      11.613  11.596  33.443  -8.081  32.8930 2.1
15      11.596  11.578  53.251  -18.079 32.1770 2.1
16      11.578  11.560  41.341  -8.080  31.4794 2.1
17      11.560  11.541  62.190  -18.079 30.7981 2.1
18      11.541  11.521  49.556  -8.080  30.1360 2.1
19      11.521  11.500  71.471  -18.078 29.4901 2.1
20      11.500  11.478  58.099  -8.079  28.8597 2.1
21      11.478  11.456  81.116  -18.077 28.2467 2.1
22      11.456  11.433  66.982  -8.078  27.6498 2.1
```

Have generated new table of energy boundaries and centers for zero-angle electrons (counterbounds2017.out):

counterbounds2017.out
Output of counterbounds.f (program version 24-Jan-2017) 30-Jan-2017
Boundaries of new counter table using July 2015 raytracing
Counter file = Counter_table2017.txt Ray file = LE+HE.RAYS

New rays (Jul 2015) and counters (Jan 2017))

ctr	xc[cm]	yc[cm]	wid[cm]	ang[deg]	Ehi[GeV]	Elo[GeV]	ang_high	ang_low	Eav[GeV]	ang_avg
1	-0.832	-18.084	2.100	44.0826	11.77878	11.77001	44.6713	43.7770	11.77439	44.2241
2	-8.102	-8.085	2.100	43.0918	11.76959	11.75934	43.7354	42.7595	11.76446	43.2474
3	6.073	-18.084	2.100	42.1214	11.75853	11.74896	42.6853	41.8312	11.75375	42.2582
4	-1.808	-8.084	2.100	41.1668	11.74847	11.73732	41.7887	40.8543	11.74290	41.3215
5	13.244	-18.083	2.100	40.2424	11.73644	11.72602	40.7830	39.9666	11.73123	40.3748
6	4.720	-8.084	2.100	39.3376	11.72553	11.71339	39.9292	39.0400	11.71946	39.4846
7	20.670	-18.082	2.100	38.4563	11.71244	11.70107	38.9728	38.1961	11.70676	38.5844
8	11.493	-8.083	2.100	37.5979	11.70056	11.68734	38.1623	37.3170	11.69395	37.7396
9	28.368	-18.082	2.100	36.7604	11.68632	11.67393	37.2542	36.5148	11.68013	36.8845
10	18.531	-8.082	2.100	35.9467	11.67337	11.65898	36.4826	35.6794	11.66618	36.0810
11	36.356	-18.081	2.100	35.1537	11.65789	11.64440	35.6209	34.9176	11.65115	35.2692
12	25.844	-8.082	2.100	34.3810	11.64381	11.62817	34.8877	34.1247	11.63599	34.5062
13	44.645	-18.080	2.100	33.6278	11.62701	11.61232	34.0702	33.4014	11.61967	33.7358
14	33.443	-8.081	2.100	32.8930	11.61169	11.59469	33.3734	32.6492	11.60319	33.0113
15	53.251	-18.079	2.100	32.1770	11.59344	11.57748	32.5982	31.9625	11.58546	32.2804
16	41.341	-8.080	2.100	31.4794	11.57682	11.55841	31.9367	31.2482	11.56761	31.5925
17	62.190	-18.079	2.100	30.7981	11.55707	11.53979	31.2000	30.5946	11.54843	30.8973
18	49.556	-8.080	2.100	30.1360	11.53908	11.51915	30.5706	29.9161	11.52912	30.2434
19	71.471	-18.078	2.100	29.4901	11.51773	11.49902	29.8711	29.2949	11.50838	29.5830
20	58.099	-8.079	2.100	28.8597	11.49825	11.47672	29.2720	28.6497	11.48749	28.9608
21	81.116	-18.077	2.100	28.2467	11.47521	11.45497	28.6074	28.0595	11.46509	28.3335
22	66.982	-8.078	2.100	27.6498	11.45416	11.43088	28.0383	27.4482	11.44252	27.7433
23	90.519	-18.076	1.600	27.1351	11.42960	11.41299	27.4167	27.0193	11.42129	27.2180
24	74.541	-8.078	1.600	26.7002	11.41243	11.39355	27.0063	26.5760	11.40299	26.7912

Summary

- I have calculated TAGH counter positions based on the Fall 2016 survey of the counter plates.

- I have calculated the zero-angle energy boundaries for the counters using the new positions. The shifts are less than ≈1/2 of a channel width except for Plate 8 (counters 254-274)

- The new counter position table Counter_table2017.txt
  and energy boundary table counterbounds2017.out
  are (or will soon be) posted on my web page
  https://userweb.jlab.org/~sober/HallD/
  and the GlueX Wiki