The new Hall C beam line

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Abstract

A Compton polarimeter must be added to the Hall C line to provide continuous polarization measurements for the Qweak experiment. This requires a complete rework of the Hall C beam line after the shield wall. Work by this author began early in FY07. The Hall A line was used as inspiration. 11 GeV capability was taken into account throughout the design. In this tech note I document the hall C beam line for use by Qweak and the slightly different line needed for 11 GeV service.

Design constraints

1. Reuse as many components as possible
2. Design new components for use at 1.165 and 11 GeV (and all energies between these)
3. Compton vertical offset requested: 57 cm at 1.165 GeV and 13 cm at 11 GeV
4. Electron beam size to match laser size at interaction point in Compton. Initially the target was 100 microns. It is now "as close to 50 microns" as possible.
5. Fast raster ~15m from pivot for 11 GeV capability
6. Beta function focus (alpha =0) at Qweak target or as close to it as possible given other constraints
7. 2.2 cm vertical chicane required to get beam from level exiting Lambertson to pivot height (error in CEBAF construction)
8. Simultaneous focuses in Compton chicane and at the physics target. It became clear very early in the process that space was not available to allow simultaneous Compton, Moller and physics beam use.
9. **Halo** (really a constraint on the accelerator) At the electron detector in hall A, acceptable background due to halo is 60-120 Hz/uA at 5mm from the beam. Desired distance for the electron detector was 3mm; CEBAF can't meet the background requirement at 3mm so the detector was moved back. 60 Hz/uA = 10^{-11} of the beam current! I am amazed we can meet this at 5 mm. As small a focus as is compatible with the laser spot is desired in the Compton chicane to reduce background at the electron detector.

Some of the choices will make more sense if I begin with the 11 GeV design. It uses two existing dipoles at low excitation for the vertical chicane. These dipoles are now used to compensate for the bending induced by the 5T University of Virginia polarized target and are positioned so they may do so again in the 11 GeV era. These dipoles will not be installed for Qweak so the space they'd occupy can be used for additional diagnostics. Pairs of MBD correctors are sufficient for the 2.2 cm chicane up to 2 GeV.

The Compton dipoles were designed Ernie Ihloff of MIT to field (BdL) requirements set by the author. They have a nominal length of 125 cm; steel length is ~121 cm. There are two sets of pole pieces. For the 57cm offset chicane, necessitating large sagitta with moderate field (5.5 kG) at 1.165 GeV, Ernie designed a set of wide pole pieces which diffuse the flux from the core. For the 13cm offset chicane at 11 GeV (12.1 kG), he designed narrower pole pieces which concentrate the flux. MIT is supplying the magnets and associated vacuum system as part of their contribution to the Qweak collaboration. These magnets allow for a Compton chicane about 70% of the length of that in Hall A. Since Hall C is significantly smaller than Hall A, this reduction was important. Compton offset is 30cm in hall A. At 11 GeV, 22cm is planned.

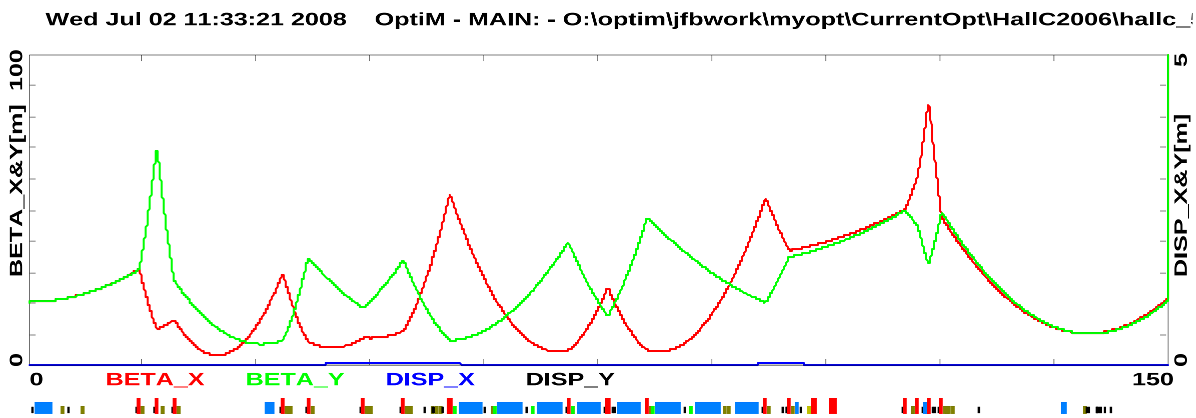


Figure 1. Present 4 GeV optics.

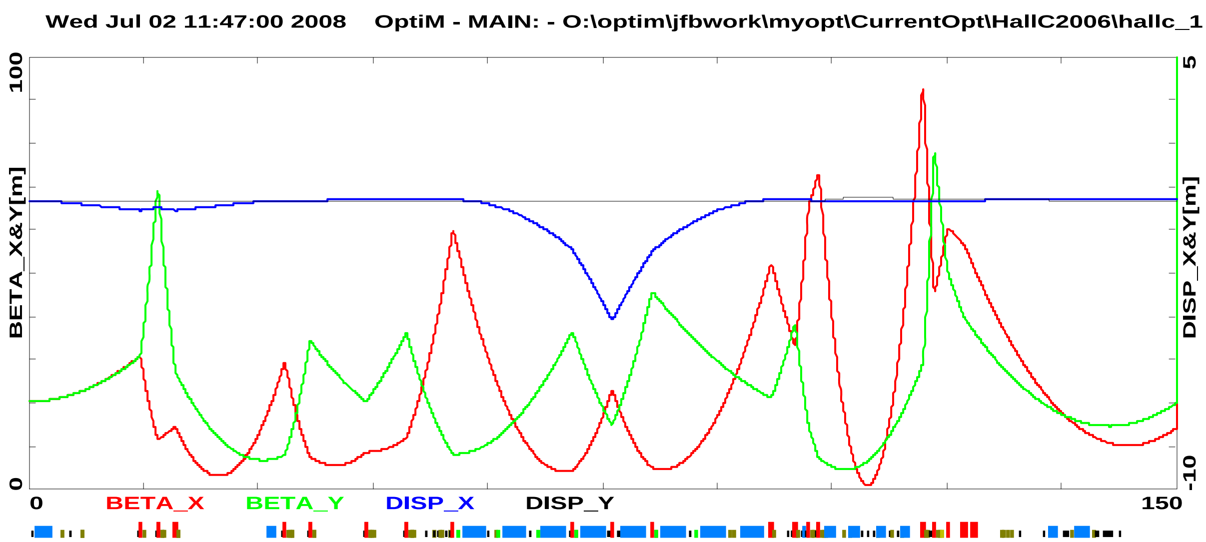


Figure 2. New hall C line at 11 GeV. Blue boxes are dipoles. Red boxes are quads. Black tick marks are correctors, instrumentation, and matching markers. The pivot is the rightmost tick mark at the bottom of the figure, ~144m. Red is horizontal beta function, green vertical. Blue and black are horizontal and vertical dispersion, referenced on the right hand Y axis. There are modest changes to the quad settings in the non-dispersive region before the arc from those in the 6 GeV optics. These are needed to help prepare the beam for the tight focus in the Compton chicane.

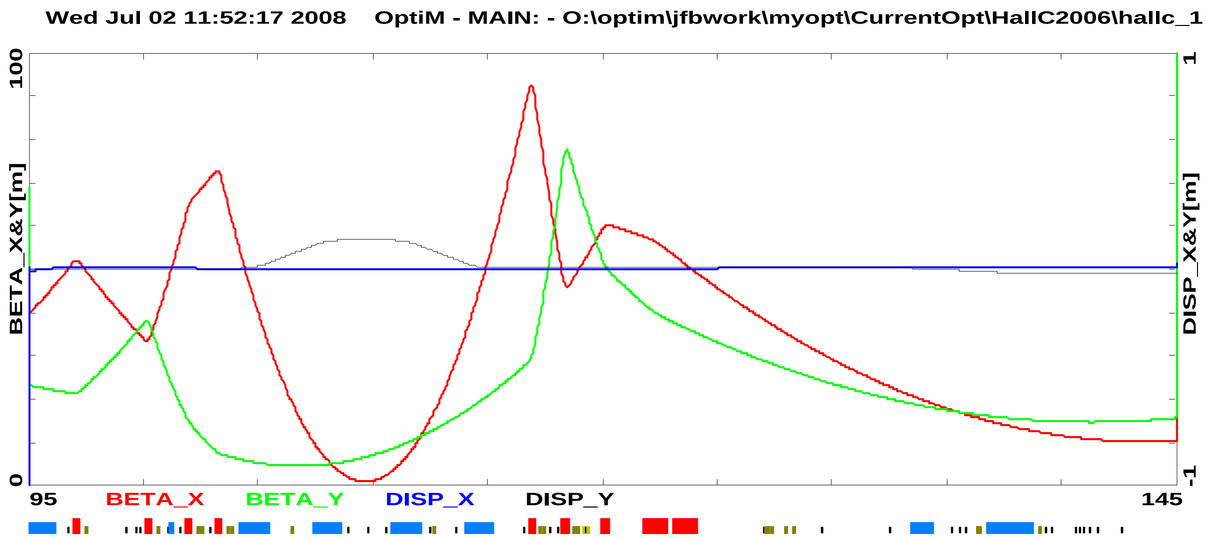


Figure 3. The region of the C beam line with physical changes. The blue box at the left is the end of the last arc dipole. It is followed by MQA3C16 (red) and the shield wall (gap). Three more QA quads follow. These four are the principle "knobs" for adjusting the beam in the Compton chicane. The four blue dipoles of the chicane proper follow. The black trace centered vertically in the figure is vertical dispersion. It shows the 13cm offset in the chicane and the 2.2cm offset at the end of the line. There are two more QAs following the Compton chicane and then the three Moller system quads. The two large Moller quads at the end of the line are one optical element in the Moller system, Thus again there is a quadruplet of sorts to prepare the beam at the target. For Moller measurements, the QA doublet after the Compton is used to prepare the beam at the Moller target. The Moller target solenoid isn't visible on this scale. The Moller quads are large bore and thus have limited gradient capability (steel saturates). The final pair of blue dipoles provide the 2.2cm vertical chicane.

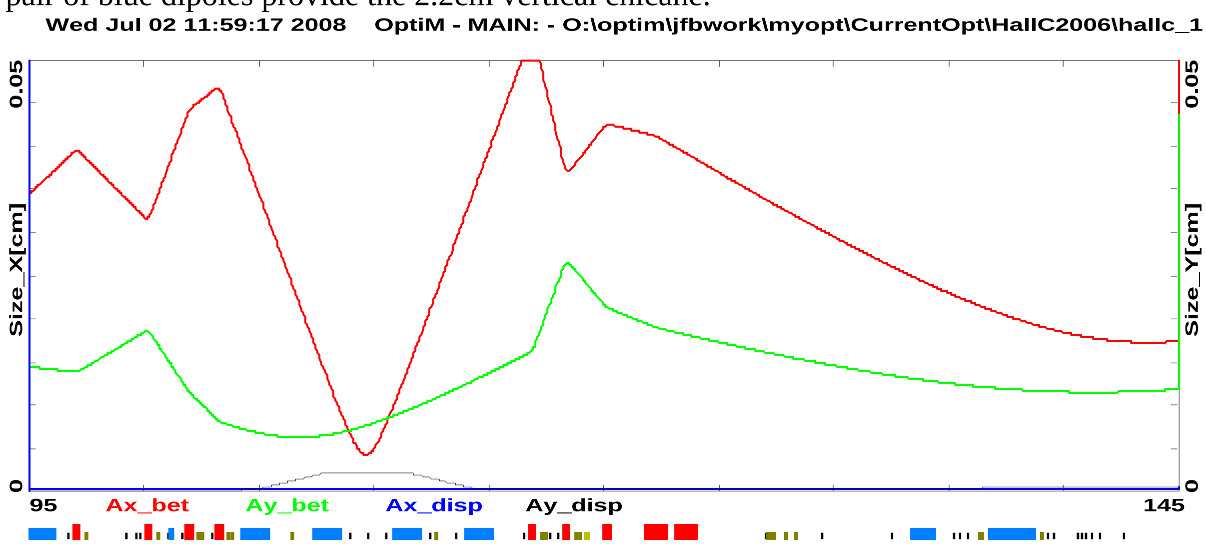


Figure 4. Beam envelopes at 11 GeV. Synchrotron radiation in the arcs increases the horizontal emittance to ~4x the vertical emittance. (DBA optics assumed.) Vertical axis is 0.05 cm, so beam size at Compton interaction point is below 100 microns but still larger than one would like. Dispersive component of beam size (black) must be added in quadrature to the betatron envelope size (green). Vertical beam envelope is ~125 microns at the electron detector Z location. Distance from the electron detector to the beam at 11 GeV is not known to the author.

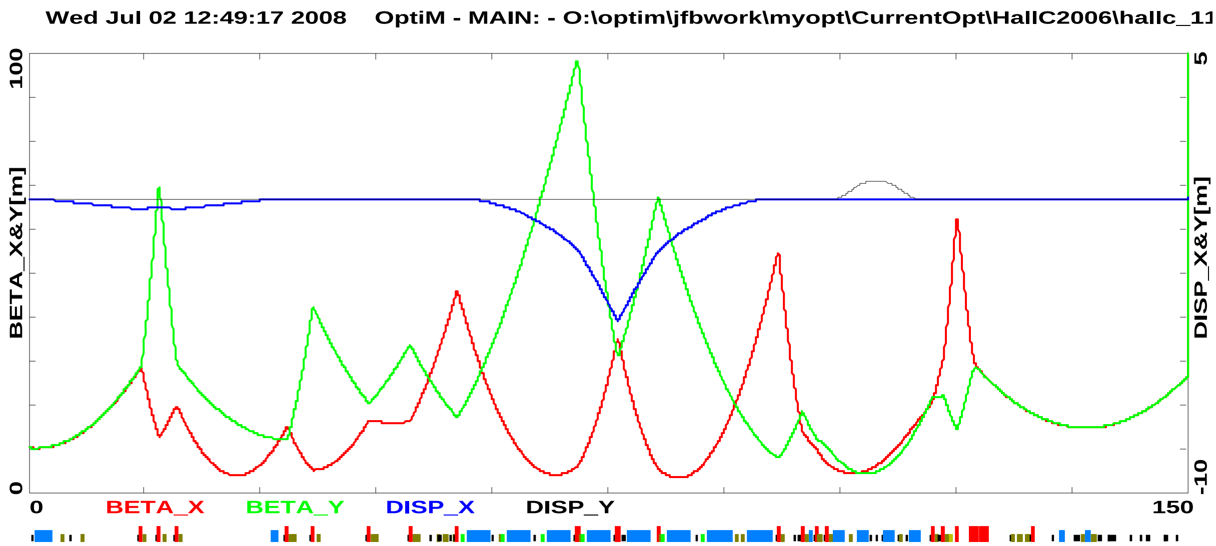


Figure 5. Qweak optics at 1.165 GeV with small beam in Compton. Input beta functions are 10m on passes 1-4. Note that the vertical beta function in the arc is rather different than that shown in either figure 1 or figure 2. This is due to the beam size constraint in the Compton.

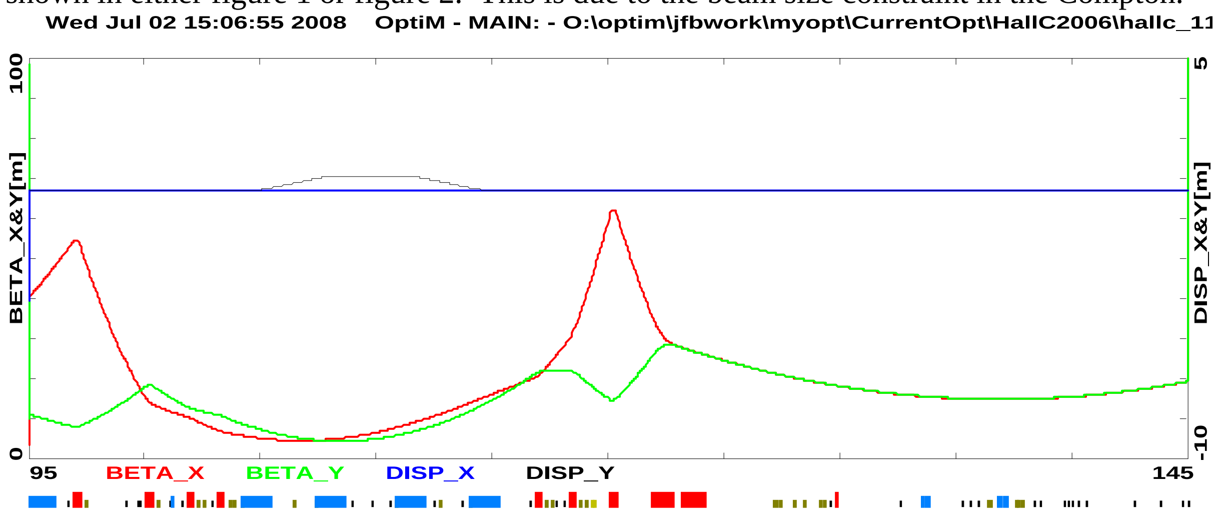


Figure 6. Optics in the 50m with all the changes in the beam line. Note that there are pairs of small blue boxes where the larger blue dipoles were in earlier figures and that there are more black ticks for instrumentation in the vicinity. These are the changes alluded to earlier.

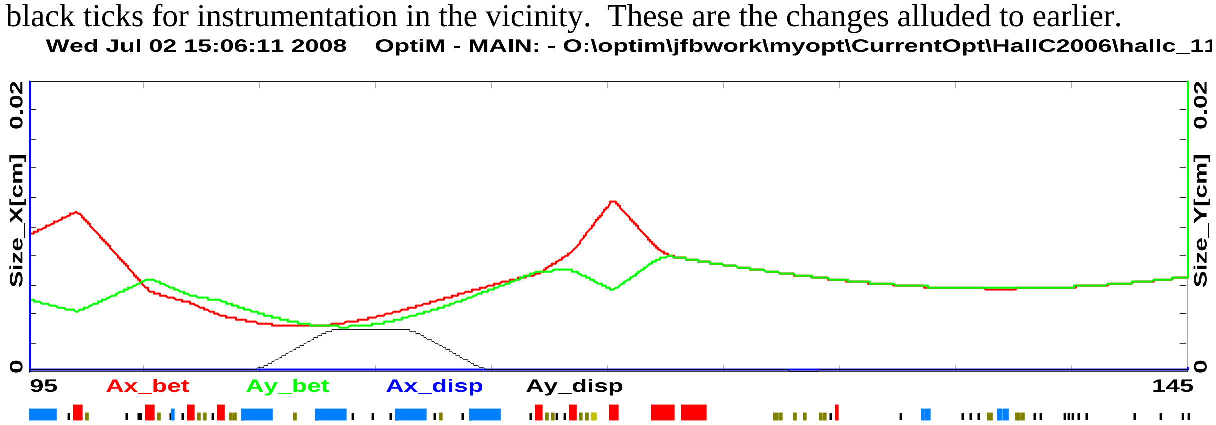


Figure 7. Beam envelopes for optics above. Note 0.02cm vertical scale and larger dispersive component of beam size.

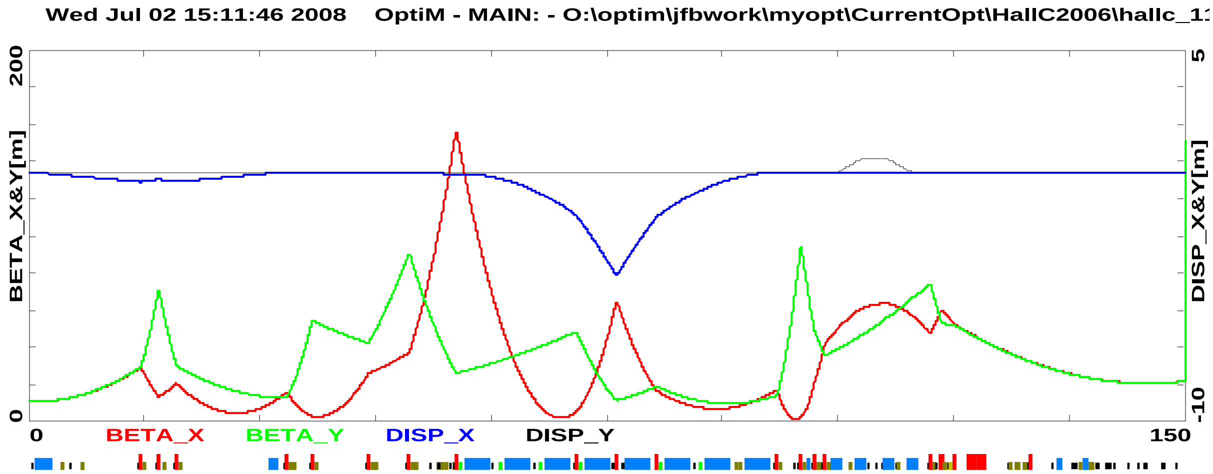


Figure 8. Original optics for 1.165 GeV Qweak. Compare with figure 5. Vertical axis is 200m here vs. 100m in figure 5. Horizontal beta function is larger at 3C12, the peak dispersion point.

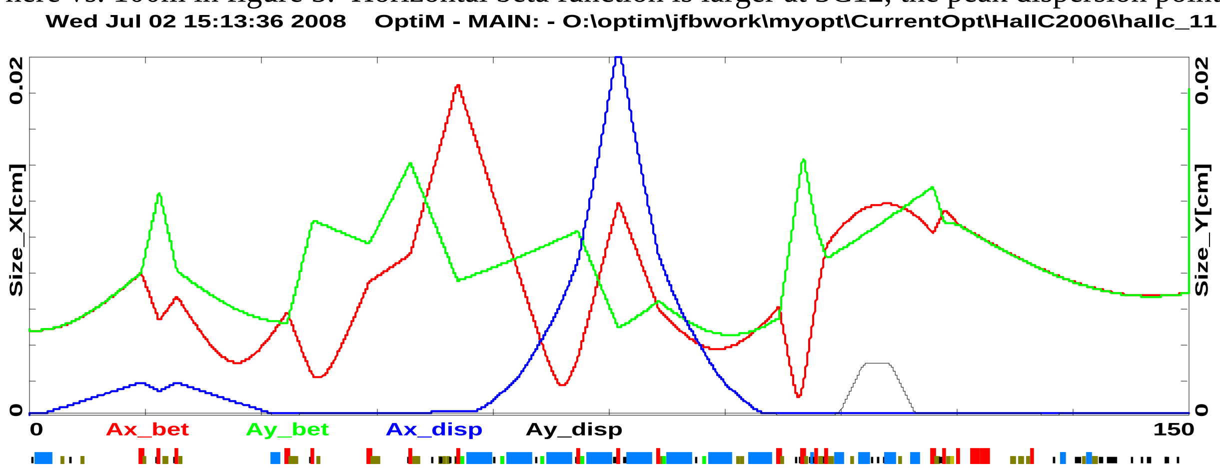


Figure 9. Beam envelopes for the line. Note the relative contribution of betatron envelope and dispersion to the beam size at 3C12, the peak dispersion. Note also that the envelope is close to constant and just over 100 microns in the Compton chicane. This was the original target given the author.

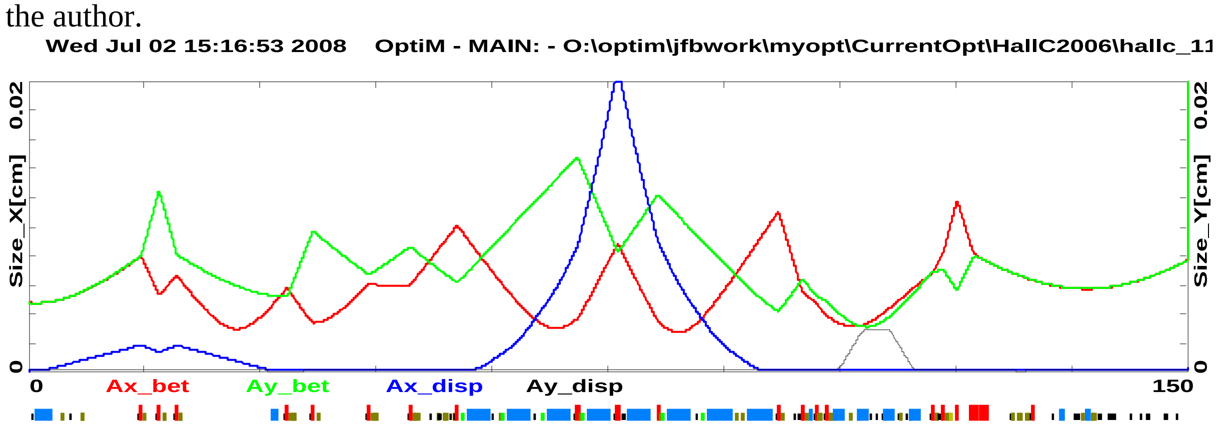


Figure 10. Beam envelope for the full line in the optics discussed on the previous page. Note that the horizontal betatron contribution to beam size is a smaller fraction of the dispersive peak, allowing better dp/p resolution with the synchrotron light interferometer. Beam focus is before the Qweak target, close to the pivot, which is not as desired. Quad spacing and field limits preclude a later focus with the small size in Compton.

Lattices for the 11 GeV and Qweak cases are given at the end of this tech note. The substantive differences between the Qweak and 11 GeV installations are:

1. use of correctors vs. dipoles for 2.2 cm vertical chicane. The dipoles exist.
2. "Hall C" diagnostic girder moved upstream ~1m for Qweak
3. MQA3C20 and MQA3C21 exceed the capacity of QA quads and so must be replaced with the new QR type. These are "drop-in" replacements which will deliver the required field. MQA3C17 is at 95% of QA capacity and should also be replaced as it is a tuning quad. MQA3C02 is at 98% of QA capacity.
4. Space has been left to double the fast raster capacity.
5. Qweak diagnostics and target post-pivot have been removed from the 11 GeV deck.

Hall C beam modulation for parity experiments

http://qweak.jlab.org/DocDB/0007/000759/002/AllFirstOrder3CDitheringMay8.pdf was written by Dave Mack. The optics shown in figures 8 and 9 was in use when this was written, 5/8/2008.

In April, Dave asked me whether it was possible to put a pure angle or offset at the target to determine where a single corrector upstream would have the desired effect. Or something to that effect. I realized that I could invert the beam line using Optim and add correctors to give either a pure angle or a pure offset at the target. The zero crossing of the orbit in the inverted line would then be optimal locations for modulation correctors. In less than an hour I had the figures Dave used in his inbox. On the next few pages I show the responses for three variations on Qweak optics, the two shown above and another which further limits the field in the Moller quads. I find it far easier to think about modulation coils in this manner than looking at phase advance.

The conclusion I draw from the following figures is that Accelerator Division must add instrumentation and devise procedures to match the incoming optics in the transport line upstream of the Lambertson rather than in the 3C04-3C08 region for parity experiments. The same holds true for hall A, of course. A harp and viewer may be placed before the dumplet between girders 3C05 and 3C06. Quads 3C04 and 3C05 will span the range needed to measure the beam Twiss parameters with the harp. Elegant may then be used to determine the quad changes needed in the transport line to get to design optics at the harp with the five hall quads which precede the harp at design values. Even with all the quads through 3C15 kept fixed, however, adjusting the four quads before the Compton to minimize background and the four optical elements (five quads) after the Compton to optimize the spot at the target will affect the modulation coil response. Fortunately, as long as the response doesn't become degenerate, it is still possible to deconvolve the response.

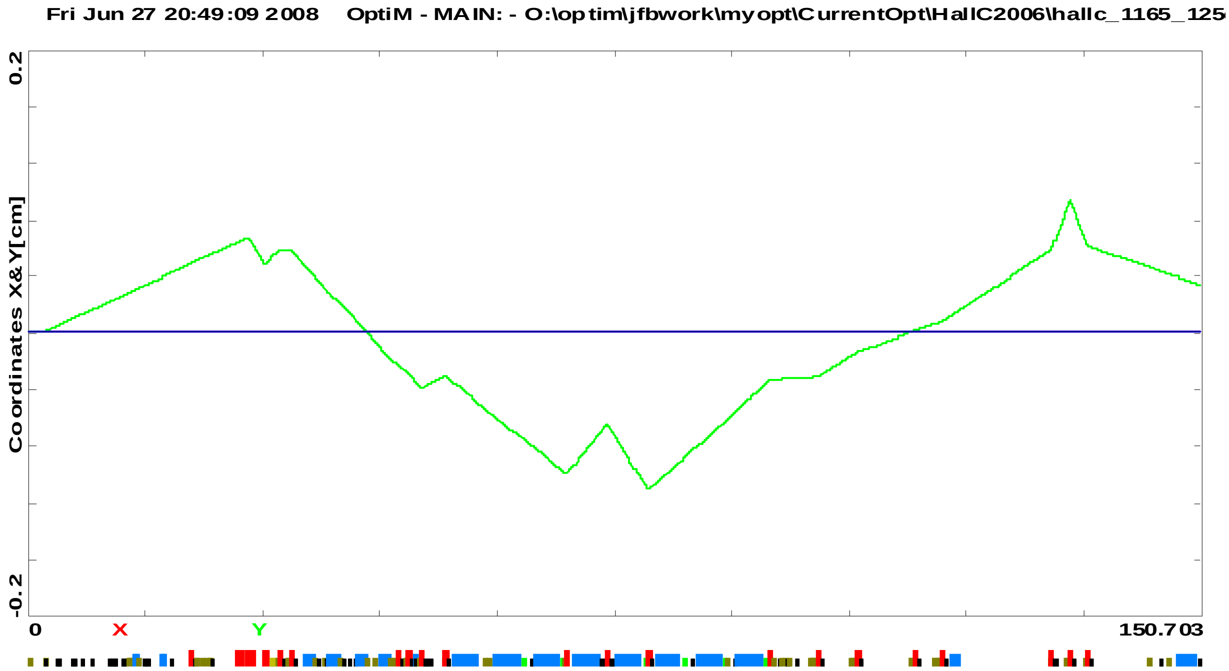


Figure 11. Pure vertical angle at target in inverted optics of figure 5. Putting a corrector immediately before or after quad 5 will provide a pure angle at the target in the normal line. 100 G-cm kick at target for this and the next three figures.

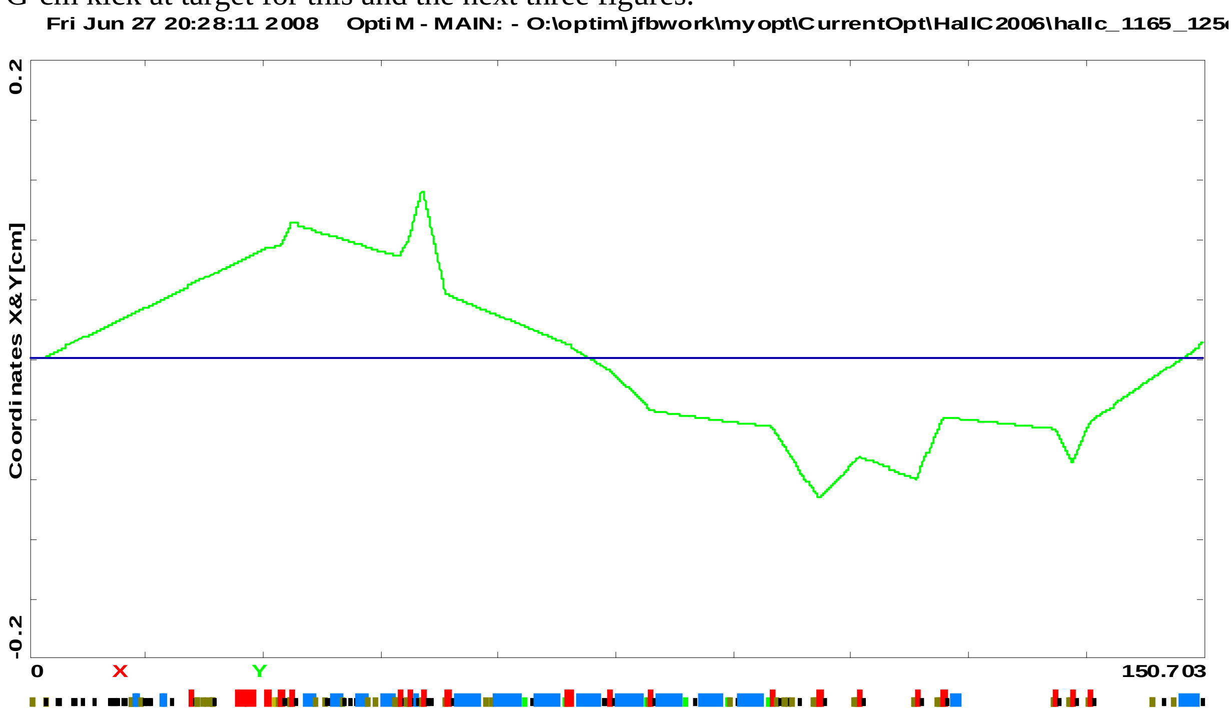


Figure 12. Pure vertical angle at target in inverted optics of figure 8. Putting a corrector immediately after the Lambertson will provide a pure angle at the target in the normal line.

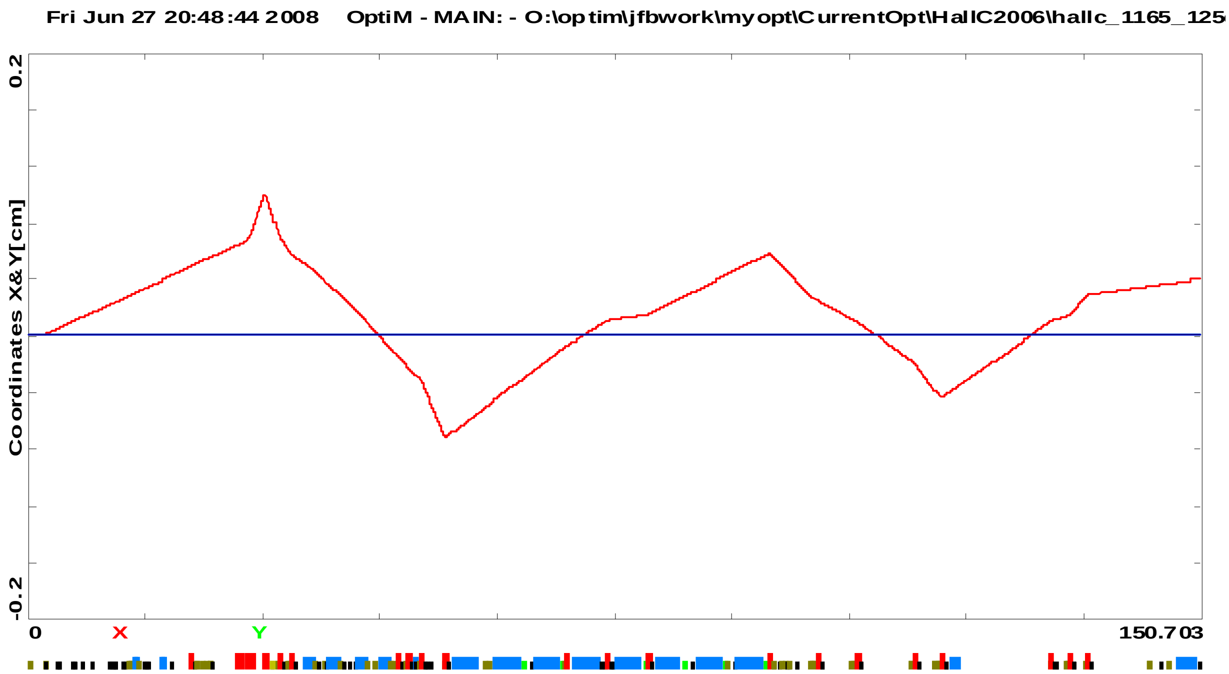


Figure 13. Pure horizontal angle at target in inverted optics of figure 5. Putting a corrector midway between quads 5 and 6 will provide a pure angle at the target in the normal line. Immediately after quad 3 is another option. There's horizontal dispersion in this region.

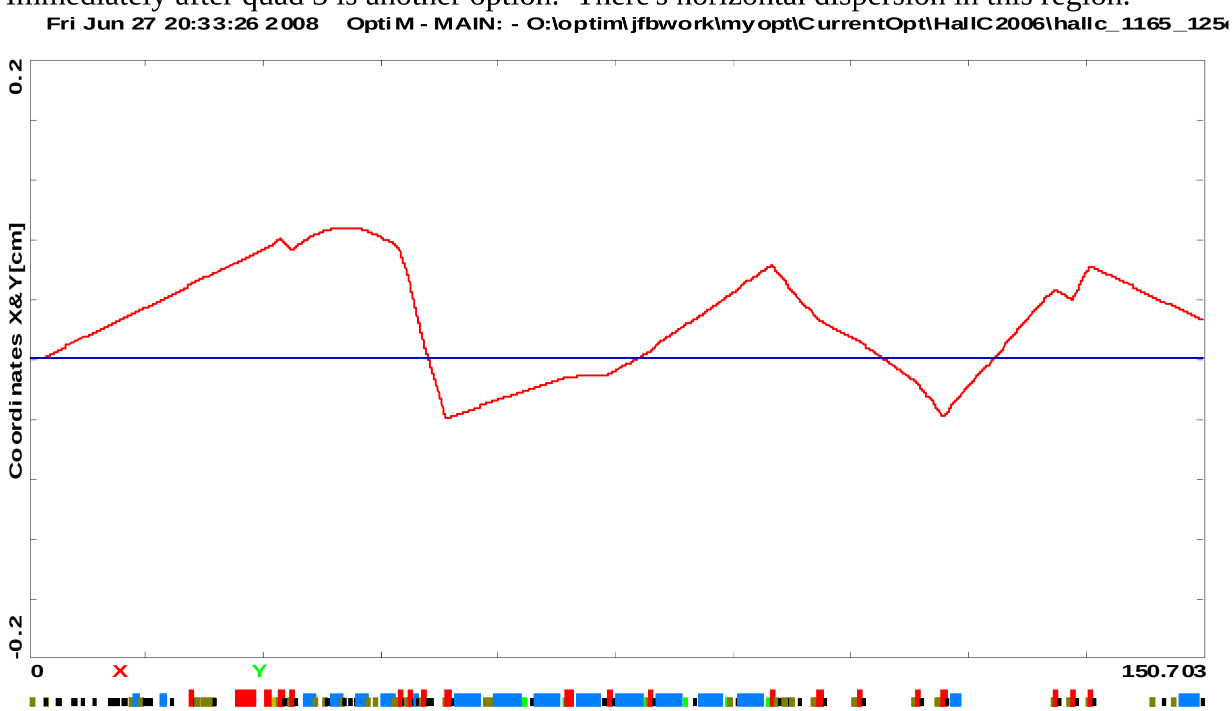


Figure 14. Pure horizontal angle at target in inverted optics of figure 8. Putting a corrector between quads 3 and 4 will provide a pure angle at the target in the normal line.

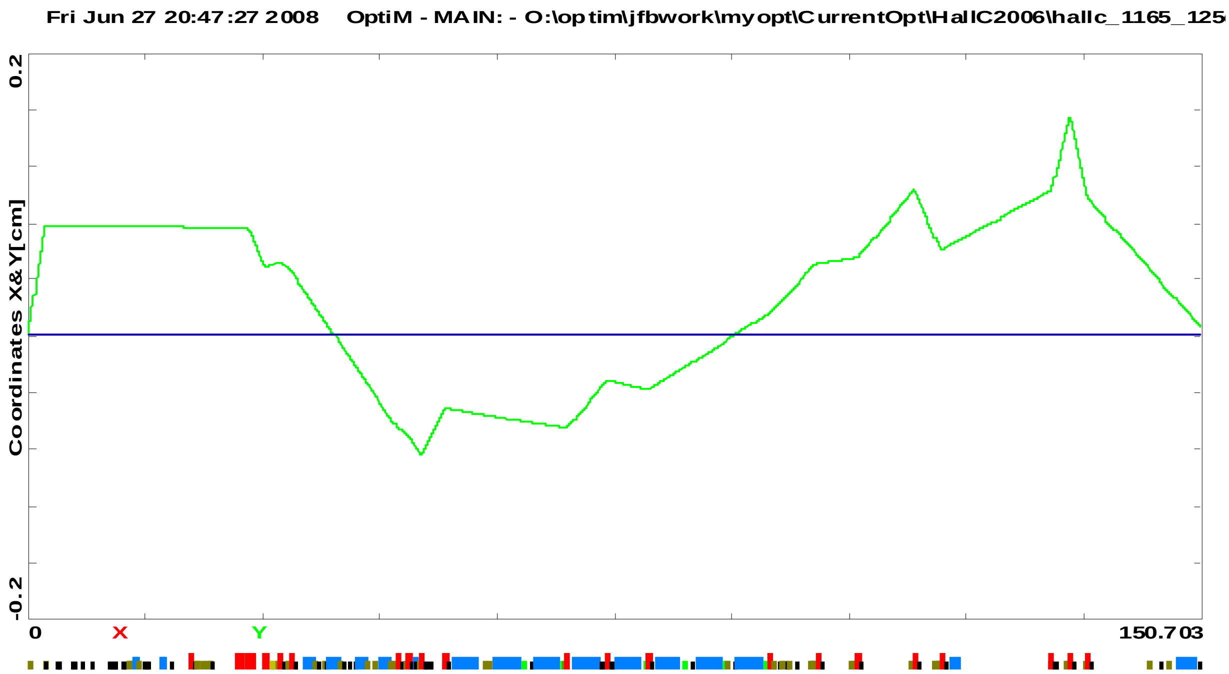


Figure 15. Pure vertical offset at the target in inverted line of optics of figure 5. Putting a corrector at 3C09 removes redundancy in energy measurement. The other option is immediately after the Lambertson, sacrificing some orthogonality. 1500 G-cm kicks separated by 2m for this and the next three figures.

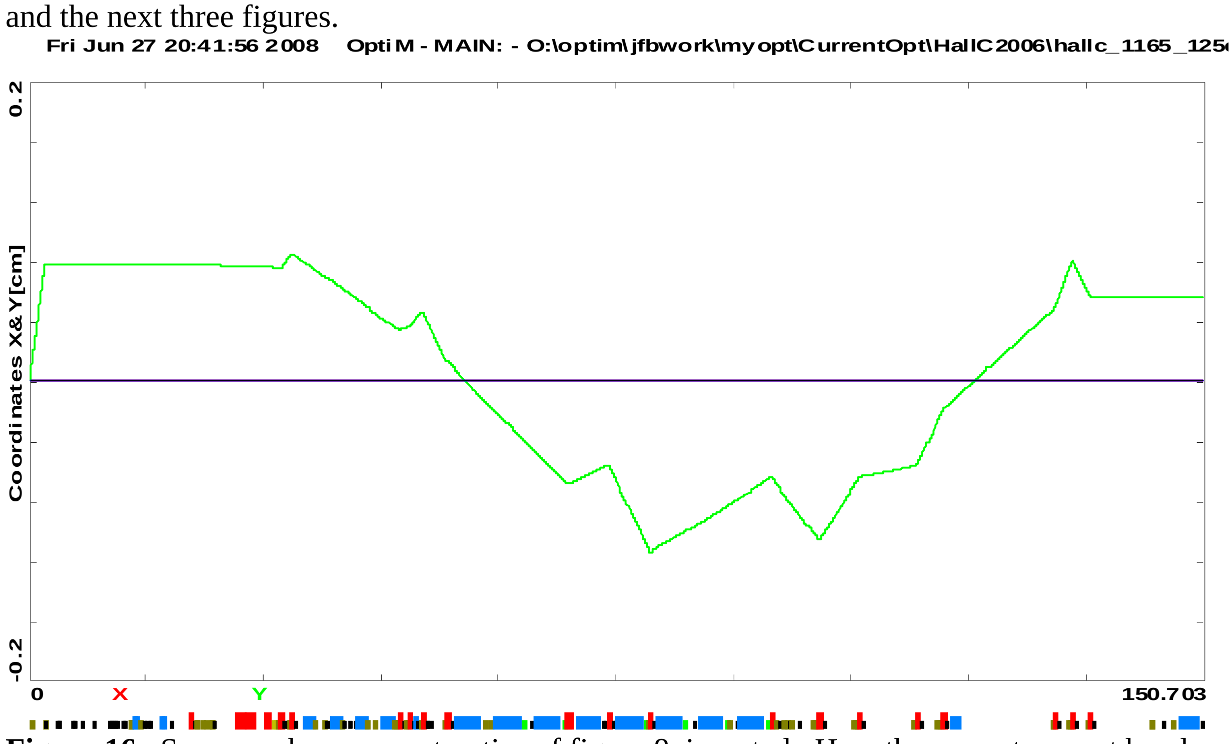


Figure 16. Same as above except optics of figure 8, inverted. Here the corrector must be placed about 60% of the distance between MQA3C03 and MBN3C04.

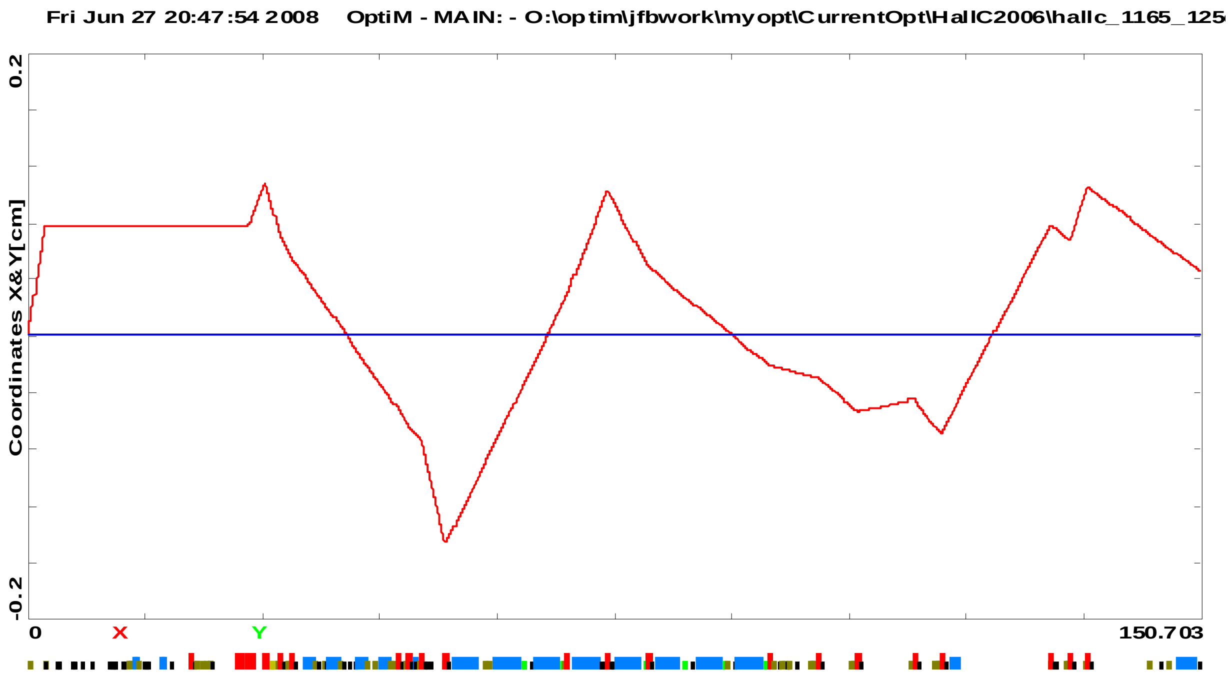


Figure 17. Pure horizontal offset at the target in inverted line of optics of figure 5. The best location for the horizontal offset here is about 60% of the distance between MQA3C03 and MBN3C04, similar to figure 16 - but that was a different optics.

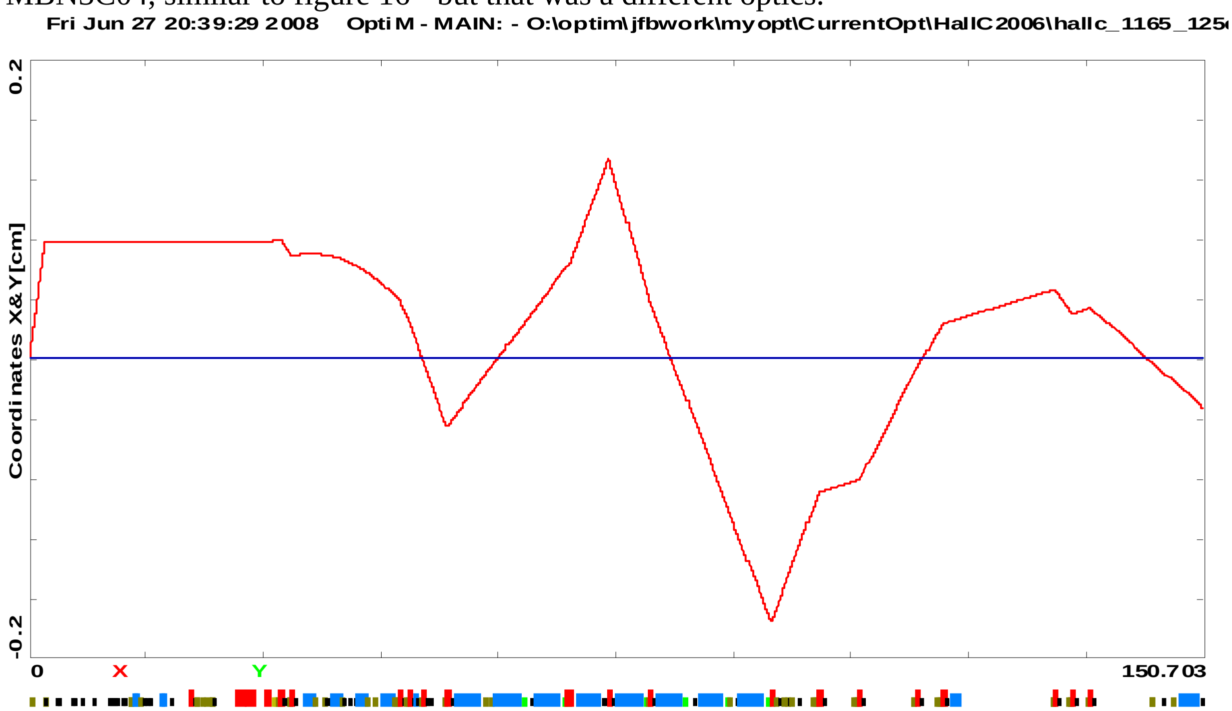


Figure 18. Pure horizontal offset at target in inverted line of figure 8. Best locations here are right after the Lambertson and just before MQA3C05.

In the table below I compare quad values for the figure 8 and figure 5 optics. The values are in inverted order because I had those files open when I created the table and I can't figure out how to reorder it. Units are (G/cm)cm, i.e. what EPICS uses.

Quads	figure 8 optics	figure 5 optics
MQE3M03.BDL	0.000	0.000
MQE3M02.BDL	0.000	-7120.218
MQF3M01.BDL	-732.690	12973.863
MQA3C21.BDL	4714.647	-4823.601
MQA3C20.BDL	-5214.495	-3572.874
MQA3C19.BDL	6383.373	-2439.244
MQA3C18.BDL	4415.694	2423.109
MQA3C17.BDL	-14514.249	-9025.758
MQA3C16.BDL	18599.646	9282.303
MQA3C13.BDL	-4273.722	-4273.722
MQA3C12.BDL	9515.925	9515.925
MQA3C11.BDL	-4751.139	-4751.139
MQA3C08.BDL	6234.354	5553.600
MQA3C07.BDL	-5446.695	-3793.218
MQA3C06.BDL	4096.176	4094.457
MQA3C05.BDL	-7046.892	-7452.429
MQA3C04.BDL	12848.781	10115.805
MQA3C03.BDL	7760.379	7760.379
MQA3C02.BDL	-12471.357	-12471.357
MQA3C01.BDL	7760.379	7760.379

Because the two big Moller quads are expensive to run (power costs), I decided to try shutting both of them off and re-optimize, changing only the last five quads. Their new values are
MQA3C20.BDL 8202.978
MQA3C21.BDL -14846.301
MQF3M01.BDL 7351.571
MQE3M02.BDL 0.000
MQE3M03.BDL 0.000

Figures analogous to those shown above follow for this variation.

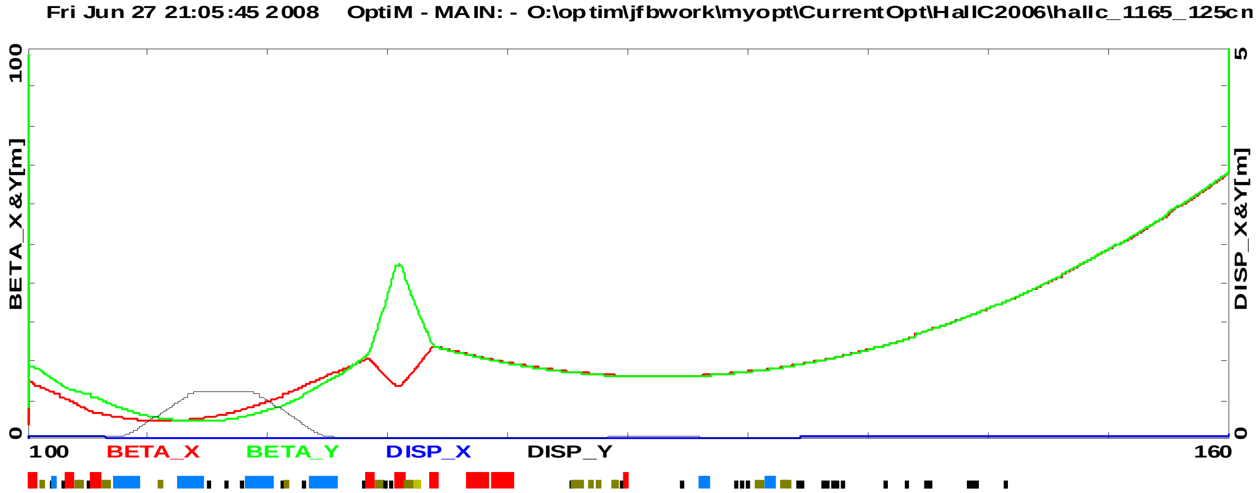


Figure 19. Alphas -1.1 at Qweak target whereas in figure 5 they are -0.8. Betas 34.5m vs. 24m. Is this a big deal? If having both the large Moller quads off is good for power savings and optics stability, this version might be preferred.

I now show the four responses in the inverted line, similar to figures 11-18 above.

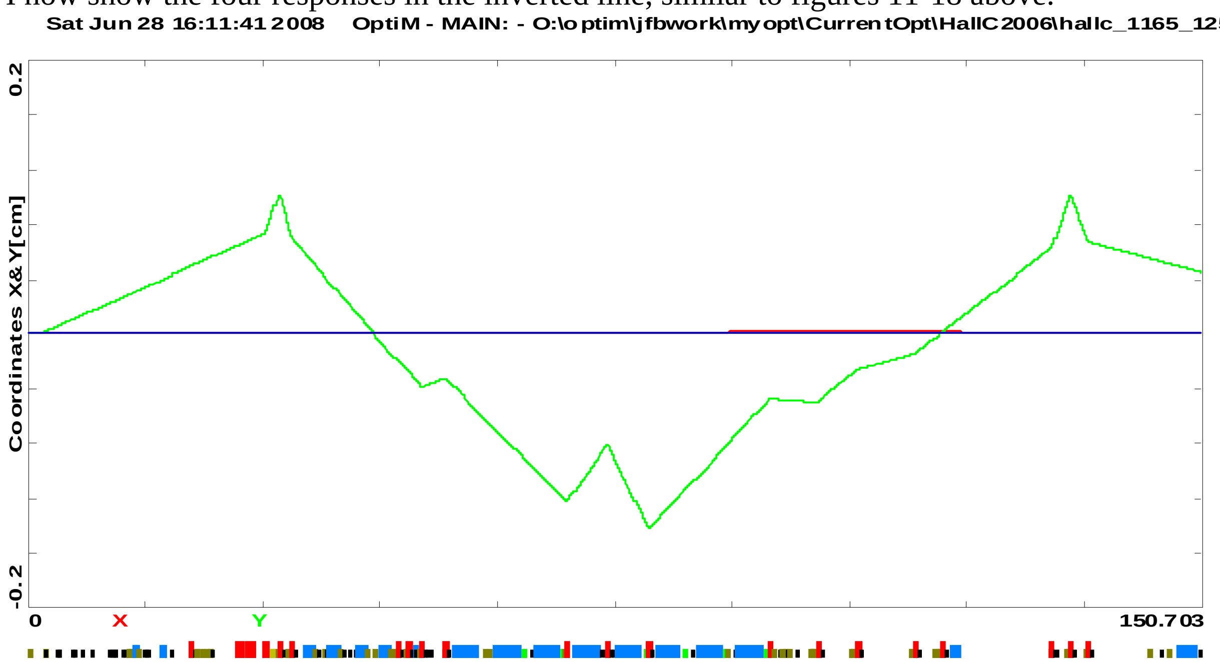


Figure 20. Pure vertical angle for optics with both big Moller quads = 0

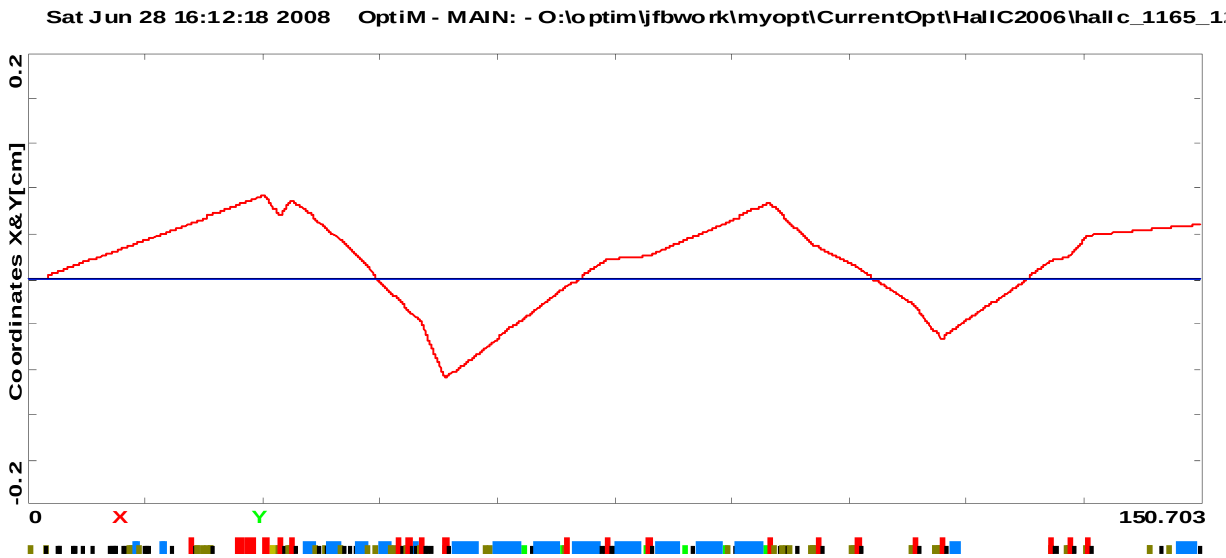
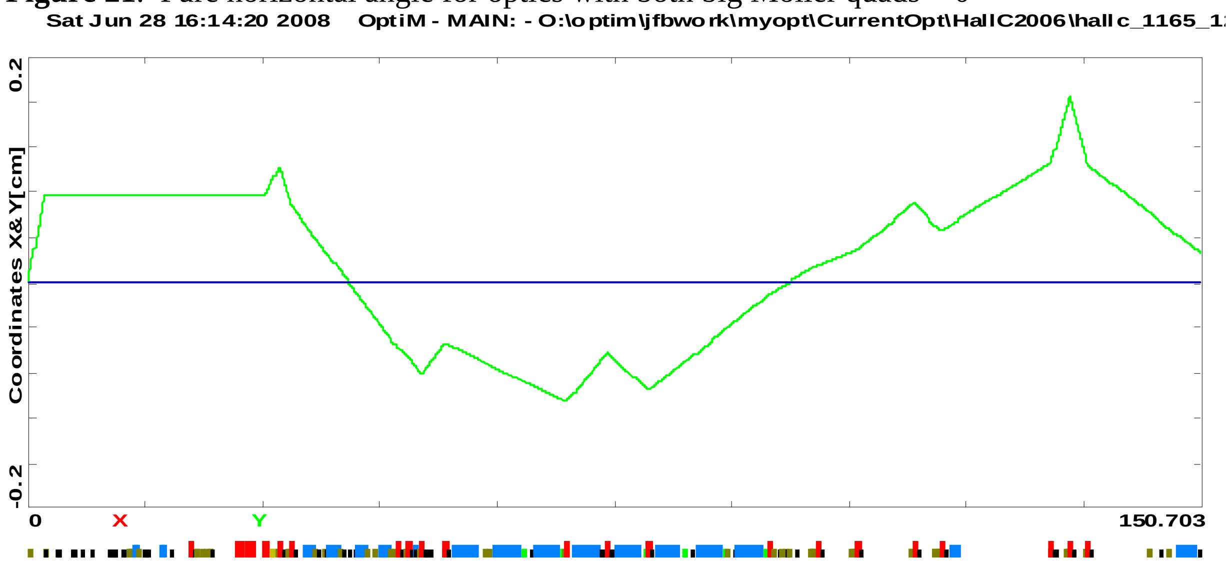
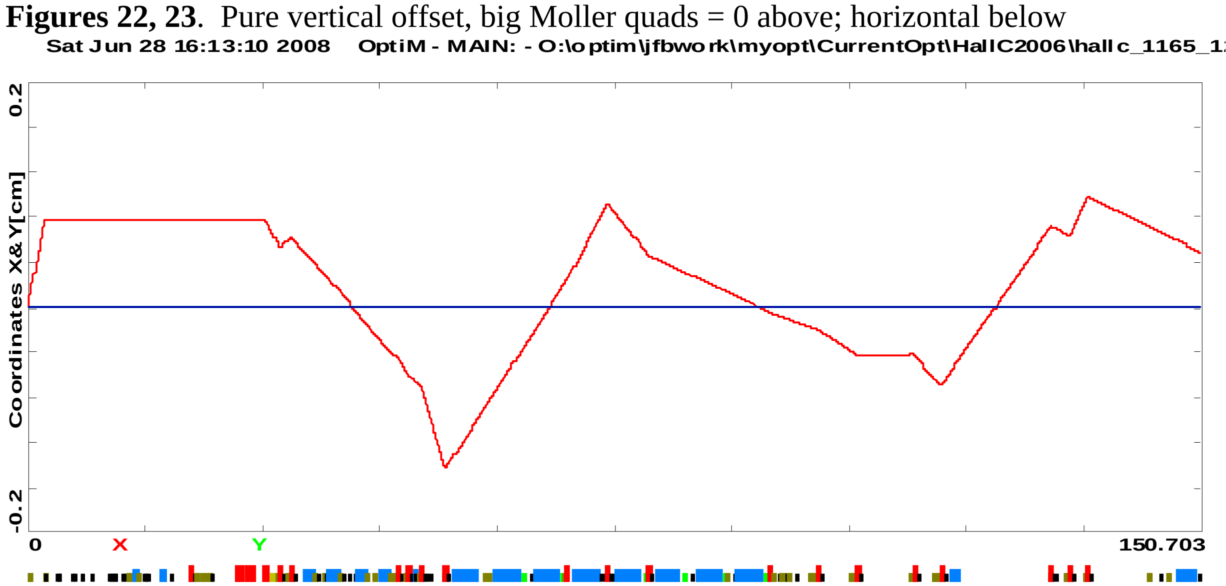


Figure 21. Pure horizontal angle for optics with both big Moller quads = 0





Figures 22, 23. Pure vertical offset, big Moller quads = 0 above; horizontal below

Figures 11-23 show that adjusting quads in the hall C line will have substantial effect on the response near the target to the modulation coils needed for parity experiments.

For HAPPEX and G0 we had seven modulation coils before the C08 girder. We tuned the line using the C04-C08 quads to get design optics at C09. In hall A we then used the five quads before the Compton to get to design optics just after the Compton. We manually tweaked two of the five to maximize Compton S:N. Finally, we used the five quads at the end of the Hall A line to optimize the spot at the target. After looking at the figures it is not surprising that the parity experiments never had four modulation coils close to orthogonal. It is a wonder that seven sufficed to get the desired information at the level of precision needed for those experiments. Since PREx and Qweak need far better precision, improvement in maintaining design optics in the hall lines is necessary. Hence the conclusion at the bottom of page six.

Note that the matching quads C04-C08 differ slightly in fifth pass versus the other four because the input beta functions are 20m in fifth pass and 10m for the lower four. This will change modulation coil response somewhat. I haven't explored this fully. The modulation coils are 16cm long MAT coils weighing ~500g so they aren't hard to move. Happex III and PREx run on lower passes while PV-DIS is at fifth pass; all in hall A starting August 2009. It will be interesting to see how modulation coils placed with this method work for these experiments.

Conclusions

A new hall C beam line has been designed for use over the full span of energy ranges. For Qweak locations of all elements have been settled and communicated to Mechanical Engineering. For higher energy experiments two dipoles must be re-installed and the modulation coils likely moved.

Separate from the major Hall C work is the need to install a diagnostic suite before the Hall A and C dumplets so the beams may be characterized and matched using transport line quads while the halls are in access.

Appendix 1 - Lattice for Qweak with optics of figure 5

N	Name	S[cm]	L[cm]	B[kG]	G[kG/cm]	S[kG/cm/cm]	Tilt[deg]	Tilt_out	BendAng[deg]
1	oD7000	44.55	44.55						
2	iITV2C00	44.55	0	0	0	0	0		
3	oD7001	80	35.45						
4	gMLA3C02	80	0	-0.472223	Angle[deg]=0	Eff.Length[cm]=0	Tilt[deg]=0		
5	bMLA3C02	310	230	-0.472223	0	0	0	-1.26894e-15	-1.6
6	GMLA3C02	310	0	-0.472223	Angle[deg]=1.6	Eff.Length[cm]=0	Tilt[deg]=0		
7	oD7002	436.3	126.3						
8	kMBD3C00V	436.3	1e-06	0	0	0	90		
9	oD7003	523	86.7						
10	iIPM3C00	523	0	0	0	0	0		
11	oD7004	686.3	163.3						
12	kMAT3C00H	686.3	1e-06	0	0	0	0		
13	kMAT3C00V	686.3	1e-06	0	0	0	90		
14	kMBD3C00AV	686.3	1e-06	0	0	0	90		
15	oD7005	1422.54	736.235						
16	iIPM3C01	1422.54	0	0	0	0	0		
17	oD7006	1445	22.465						
18	qMQA3C01	1475	30	0	0.258679	0	0		
19	oD7007	1494.32	19.315						
20	kMBC3C01H	1494.32	1e-06	0	0	0	0		
21	oD7008	1652.54	158.22						
22	iIPM3C02	1652.54	0	0	0	0	0		
23	oD7006	1675	22.465						
24	qMQA3C02	1705	30	0	-0.415712	0	0		
25	oD7009	1743.92	38.924						
26	kMAT3C02V	1743.92	1e-06	0	0	0	90		
27	kMBC3C02V	1743.92	1e-06	0	0	0	90		
28	oD7010	1760	16.076						
29	kMAT3C02AV	1760	1e-06	0	0	0	90		
30	oD7011	1882.54	122.535						

31	iIPM3C03	1882.54		0	0	0	0	0		
32	oD7006	1905	22.465							
33	qMQA3C03	1935	30	0	0.258679		0	0		
34	oD7007	1954.32		19.315						
35	kMBC3C03H	1954.32		1e-06	0	0	0	0		
36	kMAT3C03H	1954.32		1e-06	0	0	0	0		
37	kMAT3C03V	1954.32		1e-06	0	0	0	90		
38	oD7012	3135	1180.68							
39	gMBN3C04	3135	0	-1.08611	Angle[deg]=1.6		Eff.Length[cm]=0		Tilt[deg]=0	
40	bMBN3C04	3235	100	-1.08611		0	0	0	-1.26845e-15	-1.6
41	GMBN3C04	3235	0	-1.08611	Angle[deg]=0		Eff.Length[cm]=0		Tilt[deg]=0	
42	oD7013	3312.53		77.535						
43	iIPM3C04	3312.53		0	0	0	0	0		
44	oD7006	3335	22.465							
45	qMQA3C04	3365	30	0	0.337193		0	0		
46	oD7007	3384.31		19.315						
47	kMBC3C04H	3384.31		1e-06	0	0	0	0		
48	oD7014	3405	20.685							
49	kMBC3C04V	3405	1e-06	0	0	0	90			
50	oD7015	3425	20							
51	kMAT3C04H	3425	1e-06	0	0	0	0			
52	oD7015	3445	20							
53	kMAT3C04V	3445	1e-06	0	0	0	90			
54	oD7016	3642.53		197.535						
55	iIPM3C05	3642.53		0	0	0	0	0		
56	oD7006	3665	22.465							
57	qMQA3C05	3695	30	0	-0.248414		0	0		
58	oD7009	3733.92		38.924						
59	kMAT3C05H	3733.92		1e-06	0	0	0	0		
60	kMBC3C05V	3733.92		1e-06	0	0	0	90		
61	oD7017	4372.53		638.611						
62	iIPM3C06	4372.53		0	0	0	0	0		
63	oD7006	4395	22.465							

64	qMQA3C06	4425	30	0	0.136482		0	0	
65	oD7007	4444.31		19.315					
66	kMBC3C06H	4444.31		1e-06	0	0	0	0	
67	oD7015	4464.31		20					
68	kMBC3C06V	4464.31		1e-06	0	0	0	90	
69	oD7015	4484.31		20					
70	kMAT3C06V	4484.31		1e-06	0	0	0	90	
71	oD7015	4504.31		20					
72	kMAT3C06H	4504.31		1e-06	0	0	0	0	
73	oD7018	4902.53		398.22					
74	iIPM3C07	4902.53		0	0	0	0	0	
75	oD7006	4925	22.465						
76	qMQA3C07	4955	30	0	-0.126441		0	0	
77	oD7019	4974.31		19.314					
78	kMBC3C07H	4974.31		1e-06	0	0	0	0	
79	oD7020	4993.92		19.61					
80	kMBC3C07V	4993.92		1e-06	0	0	0	90	
81	oD7015	5013.92		20					
82	kMAT3C07V	5013.92		1e-06	0	0	0	90	
83	oD7015	5033.92		20					
84	kMAT3C07H	5033.92		1e-06	0	0	0	0	
85	oD7021	5200.04		166.116					
86	iIHA3C07A	5200.04		0	0	0	0	0	
87	oD7022	5303.19		103.158					
88	kMRK3C07V	5303.19		1e-06	0	0	0	90	
89	iIPM3C07A	5303.19		0	0	0	0	0	
90	oD7023	5331.86		28.666					
91	iITV3C07A	5331.86		0	0	0	0	0	
92	oD7024	5365.64		33.776					
93	kMRC3M01V		5365.64		1e-06	0	0	0	90
94	oD7025	5406.24		40.6					
95	kMRC3M02H		5406.24		1e-06	0	0	0	0
96	oD7026	5449.88		43.64					

97	iIHA3C07B	5449.88		0	0	0	0	0			
98	oD7027	5512.53		62.655							
99	kMAT3C08H	5512.53		1e-06	0	0	0	0			
100	iIPM3C08	5512.53		0	0	0	0	0			
101	oD7006	5535	22.465								
102	qMQA3C08	5565	30	0	0.18512		0	0			
103	oD7028	5599.49		34.497							
104	SMSA3C08	5614.49		15	0	0	0	0			
105	oD7029	5675	60.503								
106	gMBA3C05	5675	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0				
107	bMBA3C05	5975	300	-0.97015		-9.06341e-05		0	0	-3.395e-15	-4.28751
108	GMBA3C05	5975	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0				
109	oD7030	6003.15		28.15							
110	iIHA3C09	6003.15		0	0	0	0	0			
111	oD7031	6104.31		101.165							
112	kMBC3C09V	6104.31		1e-06	0	0	0	90			
113	oD7032	6119.49		15.182							
114	SMSA3C09	6134.49		15	0	0	0	0			
115	oD7029	6195	60.503								
116	gMBA3C06	6195	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0				
117	bMBA3C06	6495	300	-0.97015		-9.06341e-05		0	0	-3.3855e-15	-4.28751
118	GMBA3C06	6495	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0				
119	oD7033	6552.53		57.535							
120	iIPM3C10	6552.53		0	0	0	0	0			
121	oD7034	6639.49		86.962							
122	SMSA3C10	6654.49		15	0	0	0	0			
123	oD7029	6715	60.503								
124	gMBA3C07	6715	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0				
125	bMBA3C07	7015	300	-0.97015		-9.06341e-05		0	0	-3.37602e-15	-4.28751
126	GMBA3C07	7015	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0				
127	oD7033	7072.53		57.535							
128	iIPM3C11	7072.53		0	0	0	0	0			
129	oD7006	7095	22.465								

130	qMQA3C11	7125	30	0	-0.158371		0	0			
131	oD7007	7144.31		19.315							
132	kMBC3C11V	7144.31		1e-06	0	0	0	90			
133	oD7032	7159.49		15.182							
134	SMSA3C11	7174.49		15	0	0	0	0			
135	oD7029	7235	60.503								
136	gMBA3C08	7235	0	-0.97015	Angle[deg]=2.14375			Eff.Length[cm]=0		Tilt[deg]=0	
137	bMBA3C08	7535	300	-0.97015		-9.06341e-05		0	0	-3.36657e-15	-4.28751
138	GMBA3C08	7535	0	-0.97015	Angle[deg]=2.14375			Eff.Length[cm]=0		Tilt[deg]=0	
139	oD7035	7570.42		35.42							
140	iIHA3C12A	7570.42		0	0	0	0	0			
141	oD7036	7592.61		22.19							
142	iIPM3C12	7592.61		0	0	0	0	0			
143	oD7037	7615	22.39								
144	qMQA3C12	7645	30	0	0.317198		0	0			
145	oD7038	7685.46		40.46							
146	iIOR3C12	7685.46		0	0	0	0	0			
147	oD7039	7719.89		34.43							
148	iIHA3C12B	7719.89		0	0	0	0	0			
149	oD7040	7755	35.11								
150	gMBA3C09	7755	0	-0.97015	Angle[deg]=2.14375			Eff.Length[cm]=0		Tilt[deg]=0	
151	bMBA3C09	8055	300	-0.97015		0	0	0	-3.35715e-15	-4.28751	
152	GMBA3C09	8055	0	-0.97015	Angle[deg]=2.14375			Eff.Length[cm]=0		Tilt[deg]=0	
153	oD7041	8135	80								
154	qMQA3C13	8165	30	0	-0.142457		0	0			
155	oD7007	8184.31		19.315							
156	kMBC3C13V	8184.31		1e-06	0	0	0	90			
157	oD7032	8199.49		15.182							
158	SMSA3C13	8214.49		15	0	0	0	0			
159	oD7029	8275	60.503								
160	gMBA3C10	8275	0	-0.97015	Angle[deg]=2.14375			Eff.Length[cm]=0		Tilt[deg]=0	
161	bMBA3C10	8575	300	-0.97015		0	0	0	-3.34776e-15	-4.28751	
162	GMBA3C10	8575	0	-0.97015	Angle[deg]=2.14375			Eff.Length[cm]=0		Tilt[deg]=0	

163	oD7033	8632.53	57.535						
164	iIPM3C14	8632.53	0	0	0	0	0		
165	oD7034	8719.49	86.962						
166	SMSA3C14	8734.49	15	0	0	0	0		
167	oD7029	8795	60.503						
168	gMBA3C11	8795	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
169	bMBA3C11	9095	300	-0.97015	0	0	0	-3.33839e-15	-4.28751
170	GMBA3C11	9095	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
171	oD7042	9164.31	69.315						
172	kMKS3C15V	9164.31	1e-06	0	0	0	90		
173	oD7043	9224.31	60						
174	kMBC3C15V	9224.31	1e-06	0	0	0	90		
175	oD7044	9315	90.685						
176	gMBA3C12	9315	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
177	bMBA3C12	9615	300	-0.97015	0	0	0	-3.32905e-15	-4.28751
178	GMBA3C12	9615	0	-0.97015	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
179	oD7045	9672.61	57.61						
180	iIPM3C16	9672.61	0	0	0	0	0		
181	oD7037	9695	22.39						
182	qMQA3C16	9725	30	0	0.30941	0	0		
183	oD7007	9744.31	19.315						
184	kMBC3C16H	9744.31	1e-06	0	0	0	0		
185	oD7046	9919.6	175.285						
186	iIHA3C17A	9919.6	0	0	0	0	0		
187	oD7047	9967.69	48.097						
188	iITV3C17A	9967.69	0	0	0	0	0		
189	oD7048	9981.56	13.868						
190	iIPM3C17	9981.56	0	0	0	0	0		
191	oD7049	10005.9	24.335						
192	qMQA3C17	10035.9	30	0	-0.300859	0	0		
193	oD7050	10057.8	21.9						
194	kMBC3C17V	10057.8	1e-06	0	0	0	0		
195	oD7051	10107	49.23						

196	iIHA3C17B	10107	0	0	0	0	0				
197	oD7052	10114	6.938								
198	bMBD3C17H	10129	15	-0.0757		0	0	0	-1.29639e-17		-0.0167275
199	oD7053	10161.1		32.18							
200	iIPM3C18	10161.1		0	0	0	0	0			
201	oD7006	10183.6		22.465							
202	qMQA3C18	10213.6		30	0	0.0807703		0	0		
203	oD7007	10232.9		19.315							
204	kMBC3C18V	10232.9		1e-06	0	0	0	90			
205	oD7007	10252.2		19.315							
206	kMBC3C18H	10252.2		1e-06	0	0	0	0			
207	oD7054	10292.2		40							
208	iIPM3C19	10292.2		0	0	0	0	0			
209	oD7006	10314.7		22.465							
210	qMQA3C19	10344.7		30	0	-0.0813081		0	0		
211	oD7007	10364	19.315								
212	kMBC3C19V	10364	1e-06	0	0	0	90				
213	oD7007	10383.3		19.315							
214	kMBC3C19H	10383.3		1e-06	0	0	0	0			
215	oD7055	10422.8		39.5							
216	kMVS3P01	10422.8		1e-06	0	0	0	90			
217	gMMC3P01	10422.8		0	5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90			
218	bMMC3P01	10548.8		126	5.53281		0	0	90	90	10.2698
219	gMMC3P01	10548.8		0	5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90			
220	oD7056	10645.5		96.6886							
221	kMBT3P01H	10645.5		1e-06	0	0	0	0			
222	oD7057	10742.2		96.69							
223	kMVS3P02	10742.2		1e-06	0	0	0	90			
224	gMMC3P02	10742.2		0	-5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90			
225	bMMC3P02	10868.2		126	-5.53281		0	0	90	90	-10.2698
226	gMMC3P02	10868.2		0	-5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90			
227	oD7058	10897.7		29.5							
228	iIPM3P02A	10897.7		0	0	0	0	0			

229	oD7041	10977.7	80						
230	imatch	10977.7	0	0	0	0	0		
231	oD7041	11057.7	80						
232	iIPM3P02B	11057.7	0	0	0	0	0		
233	oD7058	11087.2	29.5						
234	kMVS3P03	11087.2	1e-06	0	0	0	90		
235	gMMC3P03	11087.2	0	-5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90		
236	bMMC3P03	11213.2	126	-5.53281	0	0	90	90	-10.2698
237	gMMC3P03	11213.2	0	-5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90		
238	oD7055	11252.7	39.5						
239	iIPM3P03A	11252.7	0	0	0	0	0		
240	oD7015	11272.7	20						
241	kMBT3P04H	11272.7	1e-06	0	0	0	0		
242	oD7059a	11366.6	93.88						
243	ielecdet	11366.6	0	0	0	0	0		
244	oD7059b	11406.6	40						
245	kMVS3P04	11406.6	1e-06	0	0	0	90		
246	gMMC3P04	11406.6	0	5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90		
247	bMMC3P04	11532.6	126	5.53281	0	0	90	90	10.2698
248	gMMC3P04	11532.6	0	5.53281	Angle[deg]=5.1349	Eff.Length[cm]=2	Tilt[deg]=90		
249	oD7060	11664.6	132.051						
250	iIPM3C20	11664.6	0	0	0	0	0		
251	oD7006	11687.1	22.465						
252	qMQA3C20	11717.1	30	0	-0.119096	0	0		
253	oD7007	11736.4	19.315						
254	kMBC3C20V	11736.4	1e-06	0	0	0	90		
255	oD7007	11755.7	19.315						
256	kMBC3C20H	11755.7	1e-06	0	0	0	0		
257	oD7015	11775.7	20						
258	iIHA3C20	11775.7	0	0	0	0	0		
259	oD7061	11810.7	35						
260	iIPM3C21	11810.7	0	0	0	0	0		
261	oD7006	11833.2	22.465						

262	qMQA3C21		11863.2		30	0	-0.160787		0	0
263	oD7007		11882.5		19.315					
264	kMBC3C20V		11882.5		1e-06	0	0	0	90	
265	oD7007		11901.8		19.315					
266	kMBC3C20H		11901.8		1e-06	0	0	0	0	
267	oD7062		11926.8		25					
268	cSol1	11932.9		6.1	0	0	0	0		
269	oD7063		11937.6		4.7					
270	iMOLLER		11937.6		0	0	0	0	0	
271	oD7063		11942.3		4.7					
272	cSol2	11948.4		6.1	0	0	0	0		
273	oD7064		12004.9		56.42					
274	qMQF3M01		12040.1		35.24	0	0.368157		0	0
275	oD7065		12188.3		148.166					
276	qMQE3M02		12287.3		99.06	0	-0.0718778		0	0
277	oD7066		12321.6		34.249					
278	qMQE3M03		12420.6		99.06	0	0	0	0	
279	oD7067		12713.4		292.79					
280	iIPM3H02		12713.4		0	0	0	0	0	
281	oD7068		12720.6		7.214					
282	kMBD3H02V		12735.6		15	0	0	0	90	
283	oD7069		12740.2		4.519					
284	kMBD3H02H		12755.2		15	0	0	0	0	
285	oD7070		12802.4		47.255					
286	kMFR3H03H		12802.4		1e-06	0	0	0	0	
287	oD7054		12842.4		40					
288	kMFR3H03V		12842.4		1e-06	0	0	0	90	
289	oD7071a		12918.4		75.946					
290	kMAT3H04H		12918.4		1e-06	0	0	0	0	
291	oD7071b		12930.4		12					
292	kMAT3H04V		12930.4		1e-06	0	0	0	90	
293	oD7071c		12960.4		30					
294	iIPM3H03A		12960.4		0	0	0	0	0	

295	oD7072a	12982.7	22.3						
296	qquad	12992.7	10	0	0	0	0		
297	oD7072b	13262.7	270						
298	iIPM3Hcav	13262.7	0	0	0	0	0		
299	oD7073	13351.7	89.078						
300	bMBD3H05a	13366.7	15	-0.86	0	0	90	90	-0.190035
301	oD7074a	13376.7	10						
302	bMBD3H05b	13391.7	15	-0.86	0	0	90	90	-0.190035
303	oD7074b	13532	140.3						
304	iIBC3H04	13532	0	0	0	0	0		
305	oD7075	13559.5	27.5						
306	iIUN3H04	13559.5	0	0	0	0	0		
307	oD7076	13593.5	34						
308	iIBC3H04A	13593.5	0	0	0	0	0		
309	oD7077	13642.5	49						
310	kMBD3H06V	13657.5	15	0	0	0	90		
311	oD7078	13683.4	25.879						
312	bMBD3H06a	13698.4	15	0.86	0	0	90	90	0.190035
313	oD7074a	13708.4	10						
314	bMBD3H06b	13723.4	15	0.86	0	0	90	90	0.190035
315	oD7090	13761.5	38.058						
316	kMAP3H07H	13761.5	1e-06	0	0	0	0		
317	oD7091	13774	12.5						
318	kMAT3H08H	13774	1e-06	0	0	0	0		
319	oD7091	13786.5	12.5						
320	kMAT3H08V	13786.5	1e-06	0	0	0	90		
321	oD7093	13811.5	25						
322	oD7080	13840.7	29.21						
323	iIPM3H07A	13840.7	0	0	0	0	0		
324	oD7081	13866	25.298						
325	iIHA3H07	13866	0	0	0	0	0		
326	oD7082	13965.4	99.42						
327	iIPM3H07B	13965.4	0	0	0	0	0		

328	oD7083	13985.4		19.969				
329	iITV3H07	13985.4		0	0	0	0	0
330	oD7084	14006.8		21.387				
331	iIHA3H07A	14006.8		0	0	0	0	0
332	oD7081	14032	25.298					
333	iIPM3H07C	14032	0	0	0	0	0	
334	oD7085	14066.6		34.516				
335	iIBC3H07	14066.6		0	0	0	0	0
336	oD7031a	14267.7		201.165				
337	ipivot	14267.7	0	0	0	0	0	
338	oD4070	14384.6		116.85				
339	iIBC3H3G0Z	14384.6		0	0	0	0	0
340	oD4071	14430.7		46.109				
341	oD4072	14449.7		19.05				
342	oD4073	14480.2		30.482				
343	iIPM3HG0	14480.2		0	0	0	0	0
344	oD4074	14505.5		25.299				
345	iIHA3HG0	14505.5		0	0	0	0	0
346	oD4075	14690.8		185.314				
347	iIOR3HG0	14690.8		0	0	0	0	0
348	oD4076	14709.8		18.947				
349	iIHA3HG0A	14709.8		0	0	0	0	0
350	oD4077	14735.3		25.5				
351	iIPM3HG0B	14735.3		0	0	0	0	0
352	oD7086a	14870.3		135				
353	iqwtarg	14870.3		0	0	0	0	0
354	oD7087	19612.3		4742				
355	iIDUMP	19612.3		0	0	0	0	0

Appendix 2 - Lattice for 11 GeV hall C with optics shown in figure 2

N	Name	S[cm]	L[cm]	B[kG]	G[kG/cm]	S[kG/cm/cm]	Tilt[deg]	Tilt_out	BendAng[deg]
1	oD7000	44.55	44.55						
2	iITV2C00	44.55	0	0	0	0	0		
3	oD7001	80	35.45						
4	gMLA3C02	80	0	-4.46445	Angle[deg]=0	Eff.Length[cm]=0	Tilt[deg]=0		
5	bMLA3C02	310	230	-4.46445	0	0	0	0	-1.6
6	GMLA3C02	310	0	-4.46445	Angle[deg]=1.6	Eff.Length[cm]=0	Tilt[deg]=0		
7	oD7002	436.3	126.3						
8	kMBD3C00V	436.3	1e-06	0	0	0	90		
9	oD7003	523	86.7						
10	iIPM3C00	523	0	0	0	0	0		
11	oD7004	686.3	163.3						
12	kMAT3C00H	686.3	1e-06	0	0	0	0		
13	kMAT3C00V	686.3	1e-06	0	0	0	90		
14	kMBD3C00AV	686.3	1e-06	0	0	0	90		
15	oD7005	1422.54	736.235						
16	iIPM3C01	1422.54	0	0	0	0	0		
17	oD7006	1445	22.465						
18	qMQA3C01	1475	30	0	2.44559	0	0		
19	oD7007	1494.32	19.315						
20	kMBC3C01H	1494.32	1e-06	0	0	0	0		
21	oD7008	1652.54	158.22						
22	iIPM3C02	1652.54	0	0	0	0	0		
23	oD7006	1675	22.465						
24	qMQA3C02	1705	30	0	-3.93019	0	0		
25	oD7009	1743.92	38.924						
26	kMAT3C02V	1743.92	1e-06	0	0	0	90		
27	kMBC3C02V	1743.92	1e-06	0	0	0	90		
28	oD7010	1760	16.076						
29	kMAT3C02AV	1760	1e-06	0	0	0	90		
30	oD7011	1882.54	122.535						

31	iIPM3C03	1882.54		0	0	0	0	0		
32	oD7006	1905	22.465							
33	qMQA3C03	1935	30	0	2.44559		0	0		
34	oD7007	1954.32		19.315						
35	kMBC3C03H	1954.32		1e-06	0	0	0	0		
36	kMAT3C03H	1954.32		1e-06	0	0	0	0		
37	kMAT3C03V	1954.32		1e-06	0	0	0	90		
38	oD7012	3135	1180.68							
39	gMBN3C04	3135	0	-10.2682	Angle[deg]=1.6	Eff.Length[cm]=0	Tilt[deg]=0			
40	bMBN3C04	3235	100	-10.2682		0	0	0	0	-1.6
41	GMBN3C04	3235	0	-10.2682	Angle[deg]=0	Eff.Length[cm]=0	Tilt[deg]=0			
42	oD7013	3312.53		77.535						
43	iIPM3C04	3312.53		0	0	0	0	0		
44	oD7006	3335	22.465							
45	qMQA3C04	3365	30	0	3.23935		0	0		
46	oD7007	3384.31		19.315						
47	kMBC3C04H	3384.31		1e-06	0	0	0	0		
48	oD7014	3405	20.685							
49	kMBC3C04V	3405	1e-06	0	0	0	90			
50	oD7015	3425	20							
51	kMAT3C04H	3425	1e-06	0	0	0	0			
52	oD7015	3445	20							
53	kMAT3C04V	3445	1e-06	0	0	0	90			
54	oD7016	3642.53		197.535						
55	iIPM3C05	3642.53		0	0	0	0	0		
56	oD7006	3665	22.465							
57	qMQA3C05	3695	30	0	-2.46808		0	0		
58	oD7009	3733.92		38.924						
59	kMAT3C05H	3733.92		1e-06	0	0	0	0		
60	kMBC3C05V	3733.92		1e-06	0	0	0	90		
61	oD7017	4372.53		638.611						
62	iIPM3C06	4372.53		0	0	0	0	0		
63	oD7006	4395	22.465							

64	qMQA3C06	4425	30	0	1.16133		0	0	
65	oD7007	4444.31		19.315					
66	kMBC3C06H	4444.31		1e-06	0	0	0	0	
67	oD7015	4464.31		20					
68	kMBC3C06V	4464.31		1e-06	0	0	0	90	
69	oD7015	4484.31		20					
70	kMAT3C06V	4484.31		1e-06	0	0	0	90	
71	oD7015	4504.31		20					
72	kMAT3C06H	4504.31		1e-06	0	0	0	0	
73	oD7018	4902.53		398.22					
74	iIPM3C07	4902.53		0	0	0	0	0	
75	oD7006	4925	22.465						
76	qMQA3C07	4955	30	0	-1.77628		0	0	
77	oD7019	4974.31		19.314					
78	kMBC3C07H	4974.31		1e-06	0	0	0	0	
79	oD7020	4993.92		19.61					
80	kMBC3C07V	4993.92		1e-06	0	0	0	90	
81	oD7015	5013.92		20					
82	kMAT3C07V	5013.92		1e-06	0	0	0	90	
83	oD7015	5033.92		20					
84	kMAT3C07H	5033.92		1e-06	0	0	0	0	
85	oD7021	5200.04		166.116					
86	iIHA3C07A	5200.04		0	0	0	0	0	
87	oD7022	5303.19		103.158					
88	kMRK3C07V	5303.19		1e-06	0	0	0	90	
89	iIPM3C07A	5303.19		0	0	0	0	0	
90	oD7023	5331.86		28.666					
91	iITV3C07A	5331.86		0	0	0	0	0	
92	oD7024	5365.64		33.776					
93	kMRC3M01V		5365.64		1e-06	0	0	0	90
94	oD7025	5406.24		40.6					
95	kMRC3M02H		5406.24		1e-06	0	0	0	0
96	oD7026	5449.88		43.64					

97	iIHA3C07B	5449.88	0	0	0	0	0		
98	oD7027	5512.53	62.655						
99	kMAT3C08H	5512.53	1e-06	0	0	0	0		
100	iIPM3C08	5512.53	0	0	0	0	0		
101	oD7006	5535	22.465						
102	qMQA3C08	5565	30	0	1.96596	0	0		
103	oD7028	5599.49	34.497						
104	SMSA3C08	5614.49	15	0	0	0	0		
105	oD7029	5675	60.503						
106	gMBA3C05	5675	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
107	bMBA3C05	5975	300	-9.17192	-0.000856866	0	0	0	-4.28751
108	GMBA3C05	5975	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
109	oD7030	6003.15	28.15						
110	iIHA3C09	6003.15	0	0	0	0	0		
111	oD7031	6104.31	101.165						
112	kMBC3C09V	6104.31	1e-06	0	0	0	90		
113	oD7032	6119.49	15.182						
114	SMSA3C09	6134.49	15	0	0	0	0		
115	oD7029	6195	60.503						
116	gMBA3C06	6195	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
117	bMBA3C06	6495	300	-9.17192	-0.000856866	0	0	0	-4.28751
118	GMBA3C06	6495	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
119	oD7033	6552.53	57.535						
120	iIPM3C10	6552.53	0	0	0	0	0		
121	oD7034	6639.49	86.962						
122	SMSA3C10	6654.49	15	0	0	0	0		
123	oD7029	6715	60.503						
124	gMBA3C07	6715	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
125	bMBA3C07	7015	300	-9.17192	-0.000856866	0	0	0	-4.28751
126	GMBA3C07	7015	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0		
127	oD7033	7072.53	57.535						
128	iIPM3C11	7072.53	0	0	0	0	0		
129	oD7006	7095	22.465						

130	qMQA3C11	7125	30	0	-1.49726		0	0			
131	oD7007	7144.31		19.315							
132	kMBC3C11V	7144.31		1e-06	0	0	0	90			
133	oD7032	7159.49		15.182							
134	SMSA3C11	7174.49		15	0	0	0	0			
135	oD7029	7235	60.503								
136	gMBA3C08	7235	0	-9.17192	Angle[deg]=2.14375			Eff.Length[cm]=0			Tilt[deg]=0
137	bMBA3C08	7535	300	-9.17192		-0.000856866		0	0	0	-4.28751
138	GMBA3C08	7535	0	-9.17192	Angle[deg]=2.14375			Eff.Length[cm]=0			Tilt[deg]=0
139	oD7035	7570.42		35.42							
140	iIHA3C12A	7570.42		0	0	0	0	0			
141	oD7036	7592.61		22.19							
142	iIPM3C12	7592.61		0	0	0	0	0			
143	oD7037	7615	22.39								
144	qMQA3C12	7645	30	0	2.99883		0	0			
145	oD7038	7685.46		40.46							
146	iIOR3C12	7685.46		0	0	0	0	0			
147	oD7039	7719.89		34.43							
148	iIHA3C12B	7719.89		0	0	0	0	0			
149	oD7040	7755	35.11								
150	gMBA3C09	7755	0	-9.17192	Angle[deg]=2.14375			Eff.Length[cm]=0			Tilt[deg]=0
151	bMBA3C09	8055	300	-9.17192		0	0	0	0	-4.28751	
152	GMBA3C09	8055	0	-9.17192	Angle[deg]=2.14375			Eff.Length[cm]=0			Tilt[deg]=0
153	oD7041	8135	80								
154	qMQA3C13	8165	30	0	-1.34681		0	0			
155	oD7007	8184.31		19.315							
156	kMBC3C13V	8184.31		1e-06	0	0	0	90			
157	oD7032	8199.49		15.182							
158	SMSA3C13	8214.49		15	0	0	0	0			
159	oD7029	8275	60.503								
160	gMBA3C10	8275	0	-9.17192	Angle[deg]=2.14375			Eff.Length[cm]=0			Tilt[deg]=0
161	bMBA3C10	8575	300	-9.17192		0	0	0	0	-4.28751	
162	GMBA3C10	8575	0	-9.17192	Angle[deg]=2.14375			Eff.Length[cm]=0			Tilt[deg]=0

163	oD7033	8632.53		57.535						
164	iIPM3C14	8632.53		0	0	0	0	0		
165	oD7034	8719.49		86.962						
166	SMSA3C14	8734.49		15	0	0	0	0		
167	oD7029	8795	60.503							
168	gMBA3C11	8795	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0			
169	bMBA3C11	9095	300	-9.17192		0	0	0	0	-4.28751
170	GMBA3C11	9095	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0			
171	oD7042	9164.31		69.315						
172	kMKS3C15V	9164.31		1e-06	0	0	0	90		
173	oD7043	9224.31		60						
174	kMBC3C15V	9224.31		1e-06	0	0	0	90		
175	oD7044	9315	90.685							
176	gMBA3C12	9315	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0			
177	bMBA3C12	9615	300	-9.17192		0	0	0	0	-4.28751
178	GMBA3C12	9615	0	-9.17192	Angle[deg]=2.14375	Eff.Length[cm]=0	Tilt[deg]=0			
179	oD7045	9672.61		57.61						
180	iIPM3C16	9672.61		0	0	0	0	0		
181	oD7037	9695	22.39							
182	qMQA3C16	9725	30	0	1.63422		0	0		
183	oD7007	9744.31		19.315						
184	kMBC3C16H	9744.31		1e-06	0	0	0	0		
185	oD7046	9919.6		175.285						
186	iIHA3C17A	9919.6		0	0	0	0	0		
187	oD7047	9967.69		48.097						
188	iITV3C17A	9967.69		0	0	0	0	0		
189	oD7048	9981.56		13.868						
190	iIPM3C17	9981.56		0	0	0	0	0		
191	oD7049	10005.9		24.335						
192	qMQA3C17	10035.9		30	0	-3.80271		0	0	
193	oD7050	10057.8		21.9						
194	kMBC3C17V	10057.8		1e-06	0	0	0	0		
195	oD7051	10107	49.23							

196	iIHA3C17B	10107	0	0	0	0	0					
197	oD7052	10114	6.938									
198	bMBD3C17H	10129	15	-0.715677		0	0	0	0	-0.0167275		
199	oD7053	10161.1		32.18								
200	iIPM3C18	10161.1		0	0	0	0	0				
201	oD7006	10183.6		22.465								
202	qMQA3C18	10213.6		30	0	1.44099		0	0			
203	oD7007	10232.9		19.315								
204	kMBC3C18V	10232.9		1e-06	0	0	0	90				
205	oD7007	10252.2		19.315								
206	kMBC3C18H	10252.2		1e-06	0	0	0	0				
207	oD7054	10292.2		40								
208	iIPM3C19	10292.2		0	0	0	0	0				
209	oD7006	10314.7		22.465								
210	qMQA3C19	10344.7		30	0	2.47227		0	0			
211	oD7007	10364	19.315									
212	kMBC3C19V	10364	1e-06	0	0	0	90					
213	oD7007	10383.3		19.315								
214	kMBC3C19H	10383.3		1e-06	0	0	0	0				
215	oD7055	10422.8		39.5								
216	kMVS3P01	10422.8		1e-06	0	0	0	90				
217	gMMC3P01	10422.8		0	12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90				
218	bMMC3P01	10547.8		125.009		12.098		0	0	90	90	2.35656
219	GMMC3P01	10547.8		0	12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90				
220	oD7056	10643.4		95.5726								
221	kMBT3P01H	10643.4		1e-06	0	0	0	0				
222	oD7057	10739	95.574									
223	kMVS3P02	10739	1e-06	0	0	0	90					
224	gMMC3P02	10739	0	-12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90					
225	bMMC3P02	10864	125.009		-12.098		0	0	90	90	-2.35656	
226	GMMC3P02	10864	0	12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90					
227	oD7058	10893.5		29.5								
228	iIPM3P02A	10893.5		0	0	0	0	0				

229	oD7041	10973.5	80						
230	imatch	10973.5	0	0	0	0	0		
231	oD7041	11053.5	80						
232	iIPM3P02B	11053.5	0	0	0	0	0		
233	oD7058	11083	29.5						
234	kMVS3P03	11083	1e-06	0	0	0	90		
235	gMMC3P03	11083	0	-12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90		
236	bMMC3P03	11208	125.009	-12.098	0	0	90	90	-2.35656
237	GMMC3P03	11208	0	12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90		
238	oD7055	11247.5	39.5						
239	iIPM3P03A	11247.5	0	0	0	0	0		
240	oD7015	11267.5	20						
241	kMBT3P04H	11267.5	1e-06	0	0	0	0		
242	oD7059a	11359.2	91.648						
243	ielecdet	11359.2	0	0	0	0	0		
244	oD7059b	11399.2	40						
245	kMVS3P04	11399.2	1e-06	0	0	0	90		
246	gMMC3P04	11399.2	0	12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90		
247	bMMC3P04	11524.2	125.009	12.098	0	0	90	90	2.35656
248	GMMC3P04	11524.2	0	12.098	Angle[deg]=1.182	Eff.Length[cm]=2	Tilt[deg]=90		
249	oD7060	11656.2	132.051						
250	iIPM3C20	11656.2	0	0	0	0	0		
251	oD7006	11678.7	22.465						
252	qMQA3C20	11708.7	30	0	4.38014	0	0		
253	oD7007	11728	19.315						
254	kMBC3C20V	11728	1e-06	0	0	0	90		
255	oD7007	11747.3	19.315						
256	kMBC3C20H	11747.3	1e-06	0	0	0	0		
257	oD7015	11767.3	20						
258	iIHA3C20	11767.3	0	0	0	0	0		
259	oD7061	11802.3	35						
260	iIPM3C21	11802.3	0	0	0	0	0		
261	oD7006	11824.8	22.465						

262	qMQA3C21	11854.8	30	0	-4.86768	0	0
263	oD7007	11874.1	19.315				
264	kMBC3C20V	11874.1	1e-06	0	0	0	90
265	oD7007	11893.4	19.315				
266	kMBC3C20H	11893.4	1e-06	0	0	0	0
267	oD7062	11918.4	25				
268	cSol1	11924.5	6.1	0	0	0	0
269	oD7063	11929.2	4.7				
270	iMOLLER	11929.2	0	0	0	0	0
271	oD7063	11933.9	4.7				
272	cSol2	11940	6.1	0	0	0	0
273	oD7064	11996.4	56.42				
274	qMQF3M01	12031.7	35.24	0	1	0	0
275	oD7065	12179.8	148.166				
276	qMQE3M02	12278.9	99.06	0	0.0881744	0	0
277	oD7066	12313.1	34.249				
278	qMQE3M03	12412.2	99.06	0	0	0	0
279	oD7067	12705	292.79				
280	iIPM3H02	12705	0	0	0	0	0
281	oD7068	12712.2	7.214				
282	kMBD3H02V	12727.2	15	0	0	0	90
283	oD7069	12731.7	4.519				
284	kMBD3H02H	12746.7	15	0	0	0	0
285	oD7070	12794	47.255				
286	kMFR3H03H	12794	1e-06	0	0	0	0
287	oD7054	12834	40				
288	kMFR3H03V	12834	1e-06	0	0	0	90
289	oD4372c	12951.9	117.946				
290	iIPM3H03A	12951.9	0	0	0	0	0
291	oDprast1	13204.2	252.3				
292	oDcavbpm	13254.2	50				
293	iIPM3Hcav	13254.2	0	0	0	0	0
294	oDcavbpm	13304.2	50				

295	oD4369	13343.3	39.078						
296	gMBE3H05	13343.3	0	0	Angle[deg]=0	Eff.Length[cm]=0	Tilt[deg]=90		
297	bMBE3H05	13443.3	100	-2.11962	0	0	90	90	-0.330279
298	GMBE3H05	13443.3	0	0	Angle[deg]=0	Eff.Length[cm]=0	Tilt[deg]=90		
299	oD4366	13523.6	80.3						
300	iIBC3H04	13523.6	0	0	0	0	0		
301	oD4367	13551.1	27.5						
302	iIUN3H04	13551.1	0	0	0	0	0		
303	oD4368	13585.1	34						
304	iIBC3H04A	13585.1	0	0	0	0	0		
305	oD4375	13634.1	49						
306	kMBD3H06V	13649.1	15	0	0	0	90		
307	oD4376	13675	25.879						
308	gMBZ3H06	13675	0	0	Angle[deg]=0	Eff.Length[cm]=0	Tilt[deg]=90		
309	bMBZ3H06	13875	200	1.05981	0	0	90	90	0.330279
310	GMBZ3H06	13875	0	0	Angle[deg]=0	Eff.Length[cm]=0	Tilt[deg]=90		
311	oD4376a	13903	28.058						
312	kMAP3H07H	13903	1e-06	0	0	0	0		
313	oD4378	13932.2	29.21						
314	iIPM3H07A	13932.2	0	0	0	0	0		
315	oD4379	13957.5	25.298						
316	iIHA3H07	13957.5	0	0	0	0	0		
317	oD4380	14057	99.42						
318	iIPM3H07B	14057	0	0	0	0	0		
319	oD4381	14076.9	19.969						
320	iITV3H07	14076.9	0	0	0	0	0		
321	oD4382	14098.3	21.387						
322	iIHA3H07A	14098.3	0	0	0	0	0		
323	oD4379	14123.6	25.298						
324	iIPM3H07C	14123.6	0	0	0	0	0		
325	oD4383	14158.1	34.516						
326	iIBC3H07	14158.1	0	0	0	0	0		
327	oD4384	14259.3	101.165						

328	ipivot	14259.3		0	0	0	0	0	
329	oD4385a		14698.7		439.42				
330	oD4385b		19440.7		4742				
331	iIDUMP		19440.7		0	0	0	0	0