SHMS Optics Studies

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→ work done in December 2009

SHMS Parameters

Started with latest SHMS specifications I could find on DocDB

SHMS2008 Magnet parameters
  → https://hallcweb.jlab.org/doc-private/ShowDocument?docid=538

TABLE I: *SHMS 2008 specifications.*

Property	HB	Q1	Q2	Q3	Dipole
Central Field (T)	3.10				4.76
Max field integral (T-m)	2.328				13.6
Central Gradient (T/m)		10.6	14.4	14.4	
Max gradient integral (T/m)m		19.905	23.2	23.2	
Mechanical Front (m)	1.21	2.92	5.62	8.27	10.79
Optical Front (m)	1.3845	3.21	5.995	8.65	11.45
Effective Length (m)	0.751	1.861	1.61	1.61	2.85
Optical Back (m)	2.14	5.07	7.61	10.26	14.30
Mechanical Back (m)	2.32	5.36	7.99	10.64	14.98
Physical Aperture (cm)	35/36	40	60	60	60
Location of Center (m)	1.76	4.14	6.80	9.45	12.88
Nominal Deflection (deg)	3				18.4
Overall Length (m)	1.11	2.44	2.37	2.37	4.19

SHMS Parameters

Layout from Hall C 12 GeV web page: http://www.jlab.org/Hall-C/upgrade/

→ http://www.jlab.org/~hornt/HALLC_12GEV/SHMS_Layout_new.pdf
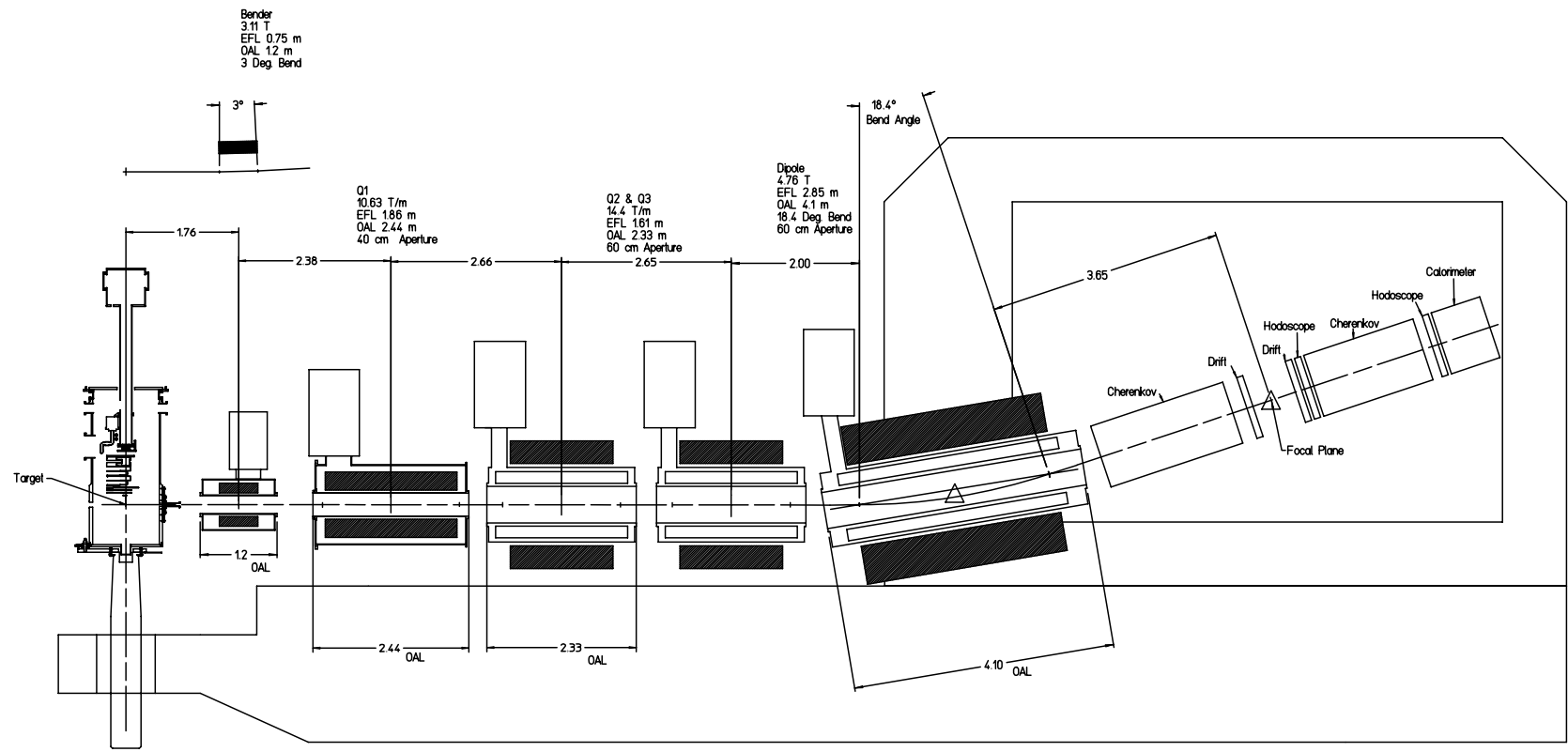
COSY Model

Started with COSY model from 2006 (?) when Dave Potterveld came to JLab to help work on "new concept" SHMS

2006 Changes
→Removed combined function magnet – replaced with separate Q3 and dipole
→First attempts at incorporating bender
→Q2 was still same size as Q1

Updates in 2009
→Used updated magnet positions and apertures from shms2008 table
→All magnets ideal COSY quads and dipoles
→Apertures increased by 5 cm relative to parameters in shms2008 (as in 2006): Rolf told me way back when to assume the physical poles were 5 cm from the effective physical aperture

COSY model can be found here:

/group/hallc_ana/xem/gaskelld/shms_cosy_2009
→shms-hsa-2009.fox   (determine tune) and
→shms-hsa-2009-monte.fox (generate maps)

COSY Model

Fitting the tune:

Potterveld technique involved fixing Q2 strength (at 11 GeV), letting Q1,Q3 float and trying to get a family of trajectories to form a focus at (xfp,yfp)=(0,0). There was also an additional term to bias the fit to "large fp tilts".

→Changes:
1. I let all 3 quads vary. It turned out that the resulting fit never exceeded maximum Q2 tip field (I think)
2. I reverted to "old style" fit technique: require particular constraints on matrix elements themselves. The requirements here were:
   → ME(1,2) (<x|theta>) =ME(3,4) (<y|phi>)=0 (point-to-point focus)
   → ME(5,2) = -1.2 → this was typically inserted in Chen Yan's TRANSPORT fit (R52=-0.12) – later I got rid of this constraint.

After fitting tune, generated forward matrix elements → put in mc_shms

mc_shms

Started with version on Hall C web page
→http://www.jlab.org/Hall-C/upgrade/mc_shms_update.tar.gz

Updated dipole geometry → existing description left over from 2006

Did not check or modify detector geometry

My version can be found here:

/group/hallc_ana/xem/gaskelld/mc_shms_dgmod

COSY Model and mc_shms

COSY FIT 1 (require ME(5,2) = -1.2)

Quad fields at 11 GeV/c
Q1=-2.12 T
Q2= 4.39 T
Q3=-2.86 T

Focal plane title = 4.4 degrees

ME(1,1) = -1.48   ME(1,6) = 1.69
ME(1,2)=ME(3,4) ~0

Solid angle from mc_shms ~ 4 msr (-10%<δ<22%); 4 cm target at 90 degrees

ME files in shms directory:
shms_hsa_2009_forward_cosy_daveme2.dat
shms_hsa_2009_recon_cosy_daveme2.dat

COSY Model and mc_shms

COSY FIT 2 (no constraint on ME(5,2))

Quad fields at 11 GeV/c
Q1=-2.44 T
Q2= 4.37 T
Q3=-2.47 T

Focal plane title = 2.9 degrees; resulting M(5,2) = -0.74 (TRANSPORT: R52=-0.074)

ME(1,1) = -2.28   ME(1,6) = 1.69
ME(1,2)=ME(3,4) ~0

Solid angle from mc_shms ~ 4.5 msr (-10%<δ<22%); 4 cm target at 90 degrees

ME files in shms directory:
shms_hsa_2009_forward_cosy_freefit.dat
shms_hsa_2009_recon_cosy_freefit.dat

Comments

1. Both fits result in focus at (xfp,yfp)=(0,0), reasonable looking delta acceptance.
2. Reconstruction matrices for both fits are garbage; I did not refit, and the default COSY reconstruction always has funny artifacts.
3. It appears we can trade of resolution for solid angle; not clear at what level.
4. This work was done over a couple weeks in late 2009 just before the PAC deadline – the quality-checking was not as thorough as I would have liked
5. If you look at COSY, mc_shms directories, I apologize for the mess of stuff you will find there. There were many explorations that were not fruitful that I did not describe here.