Mott Analysis
Run 1 Systematic Studies

Asymmetry vs

- Deadtime
- Dump Dipole Settings
- Beam Position on Target
- Beam Size
- Energy Spread

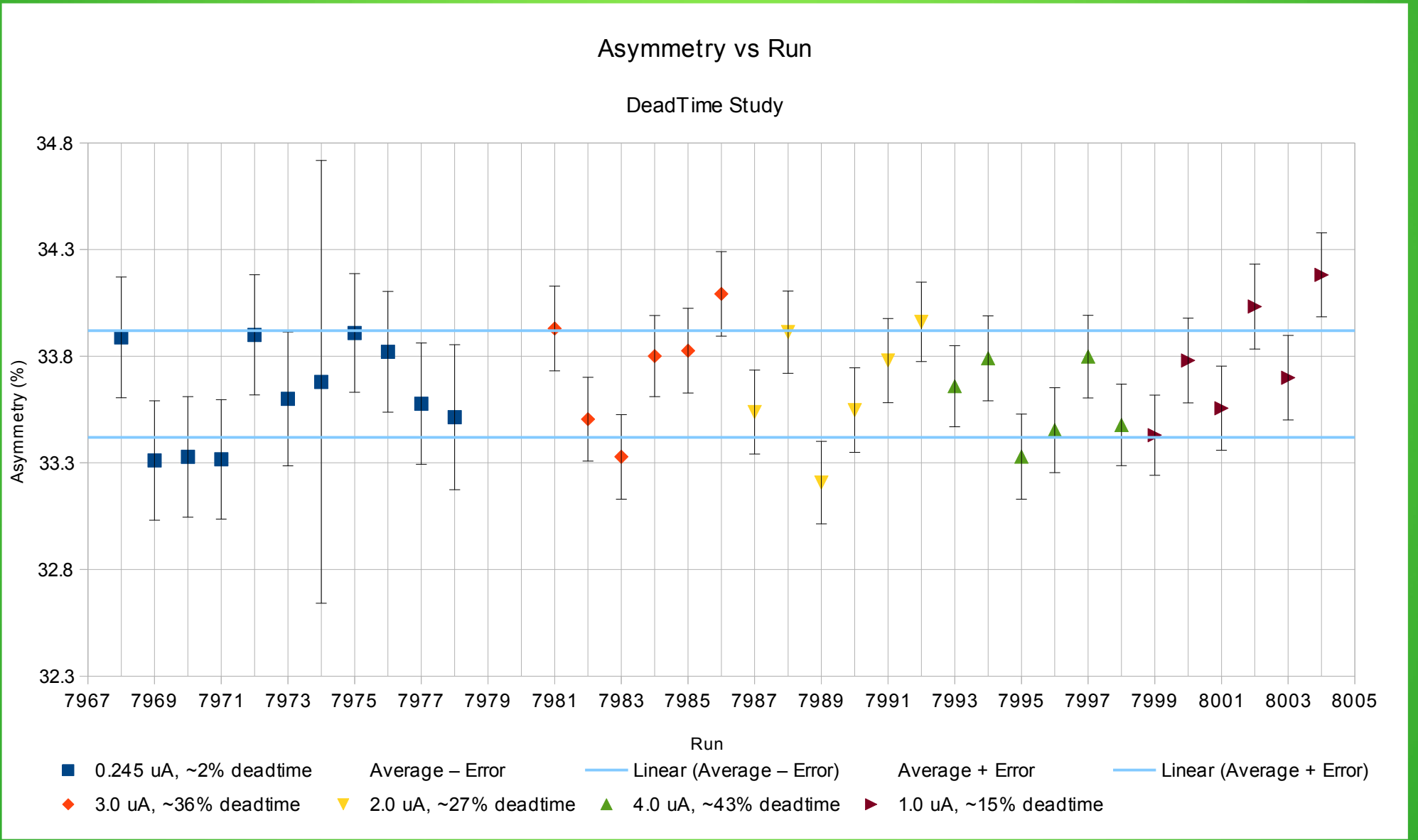
Deadtime Study

- Varied current on Foil 15, 1000 nm 25mm x 25mm, looking at elastic events per run and deadtime of DAQ to determine optimal current and run time for data collection
- 5 currents – 0.245, 1, 2, 3, 4 uA – alternating IN/OUT states of IHWP
- p_0 = 5.5 MeV
- Average Asymmetry = 33.67 +/- 0.25 %

Current (uA)	Number of Runs	Events per Run	Elastic Events per Run	Deadtime
0.245	10	500k	400k	2-3%
1	6	1M	500k	14-16%
2	6	1M	-	27-28%
3	6	1M	440k	35-37%
4	6	1M	480k	42-44%

Deadtime Study

Average Asymmetry = 33.67 +/- 0.25 %

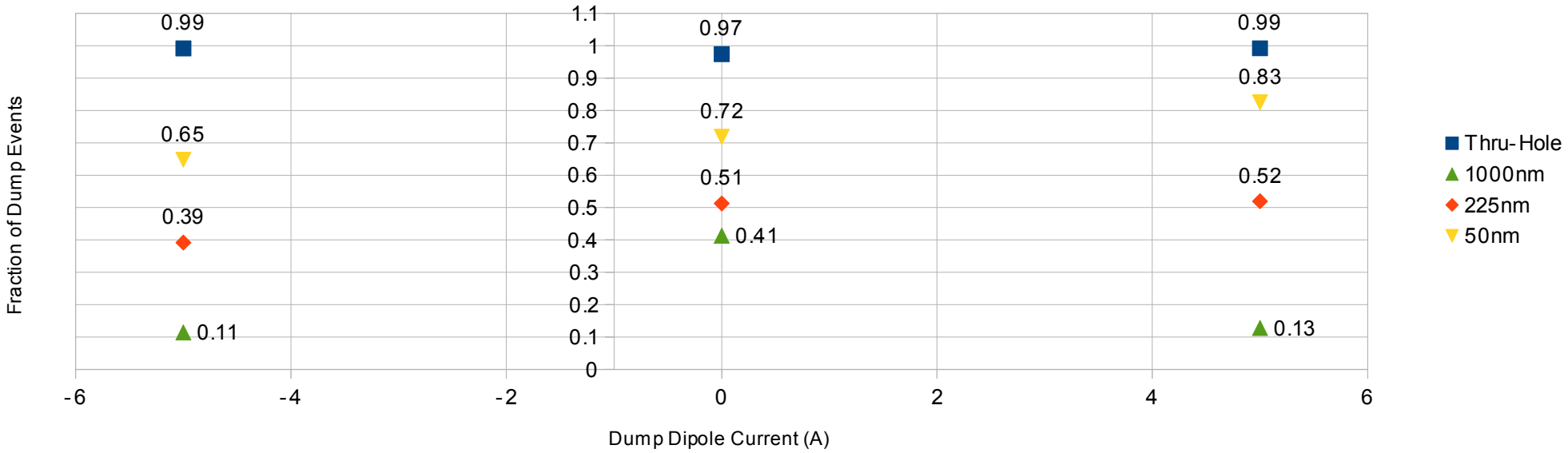


Dump Dipole Study

- Current at ~2.5 uA, low-threshold on PMT -25 mV, p_0 = 5.5 MeV, alternating IHWP
- 4 Foils: Thru-hole, 1000nm, 225nm, 50nm
- Dump dipole – MDT3D00 and MDT3D01 always at the same current – -5, 0 and 5 A
- Rough estimate of fraction of dump events – events between 60 and 70 ns over total

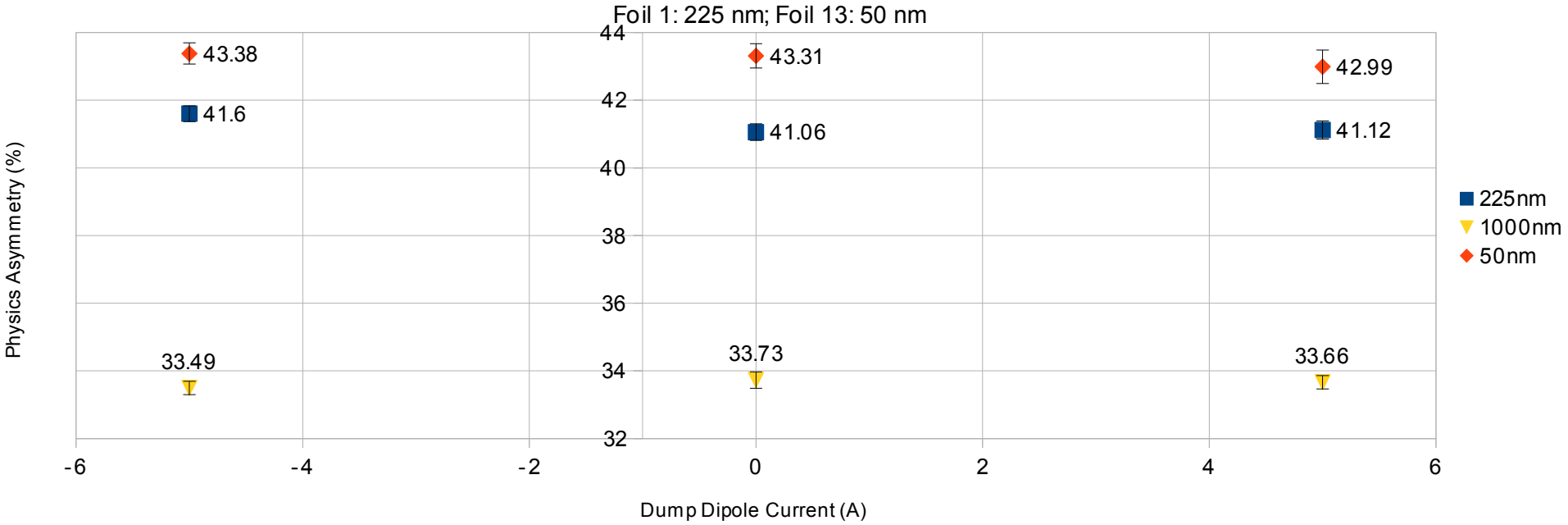
Target	Dump Dipole	L Dump Fraction	R Dump Fraction	U Dump Fraction	D Dump Fraction	Average	Physics Asym	dA
Thru-Hole	5	0.9832	0.9988	0.9868	0.9993	0.9920		
Thru-Hole	0	0.9707	0.9587	0.9689	0.9974	0.9739		
Thru-Hole	-5	0.9904	0.9859	0.9921	0.9983	0.9917		
1000nm	5	0.1422	0.1736	0.1139	0.0836	0.1283	33.6632	0.19821
1000nm	0	0.4462	0.4796	0.3772	0.3489	0.4130	33.7254	0.24359
1000nm	-5	0.1269	0.1511	0.1042	0.0764	0.1147	33.4935	0.19891
225nm	5	0.5022	0.6668	0.4685	0.4404	0.5195	41.1207	0.26668
225nm	0	0.5305	0.5705	0.4647	0.4847	0.5126	41.0562	0.24620
225nm	-5	0.4226	0.4446	0.3678	0.3325	0.3919	41.6014	0.23415
50nm	5	0.8068	0.9266	0.7954	0.7726	0.8254	42.9893	0.49453
50nm	0	0.7224	0.7633	0.7017	0.6863	0.7184	43.3106	0.35891
50nm	-5	0.6838	0.6886	0.6324	0.5868	0.6479	43.3801	0.31401

Average Fraction of Events from Dump vs Dump Dipole Current



Asymmetry vs Dump Dipole Current

Foil 1: 225 nm; Foil 13: 50 nm



Beam Position/Displacement Study

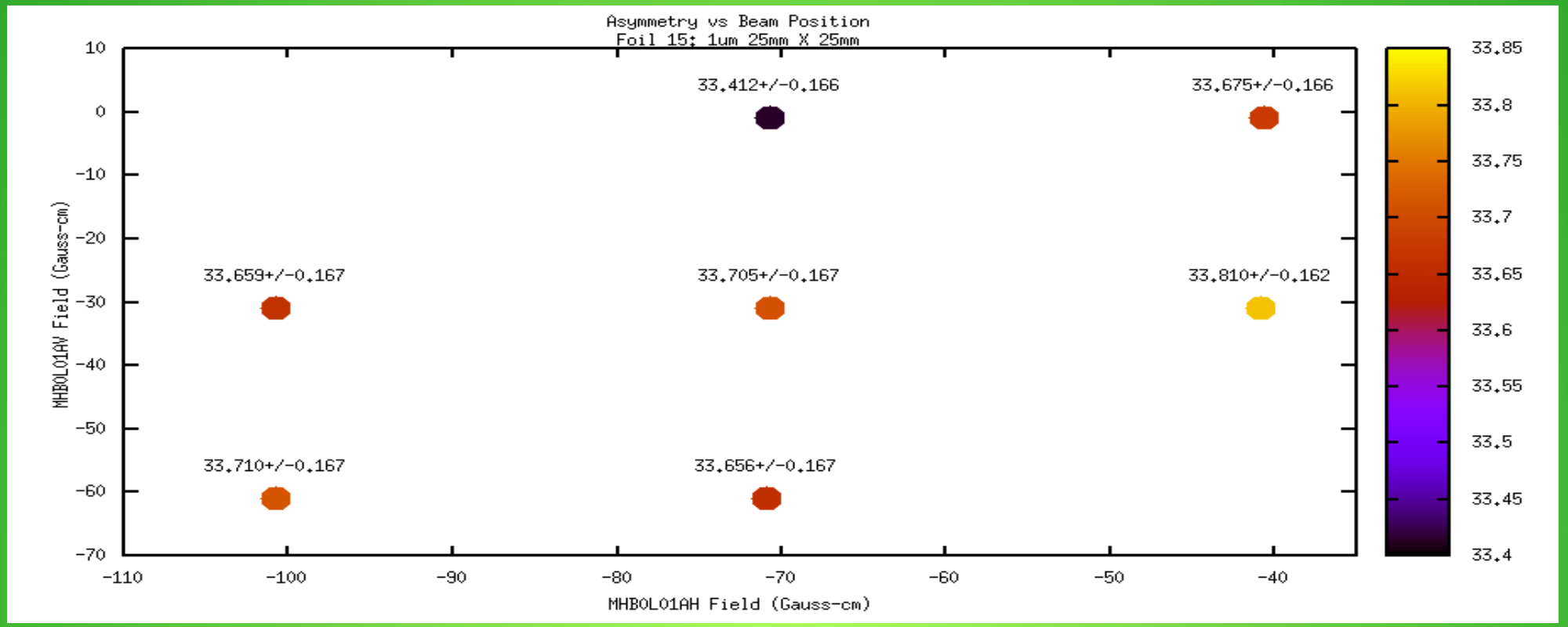
- Two foils: foil 15, ~1000nm 25x25mm at 2 uA, high threshold, deadtime ~18%
  foil 1, ~0.225nm 25x25mm at 4.2 uA, high threshold, deadtime ~12%
  p_0 = 5.5 MeV
  alternating IHWP
- MHB0L01A{H/V} used to move beam ~1 beam diameter based on OTR at 3D00
- Beam full diameter ~0.48 mm
- ~30 mA of change in either corrector corresponds to ~1 full beam diameter
- Nominal: MHB0L01AH: -70.7 mA MHB0L01AV: -30.9 mA

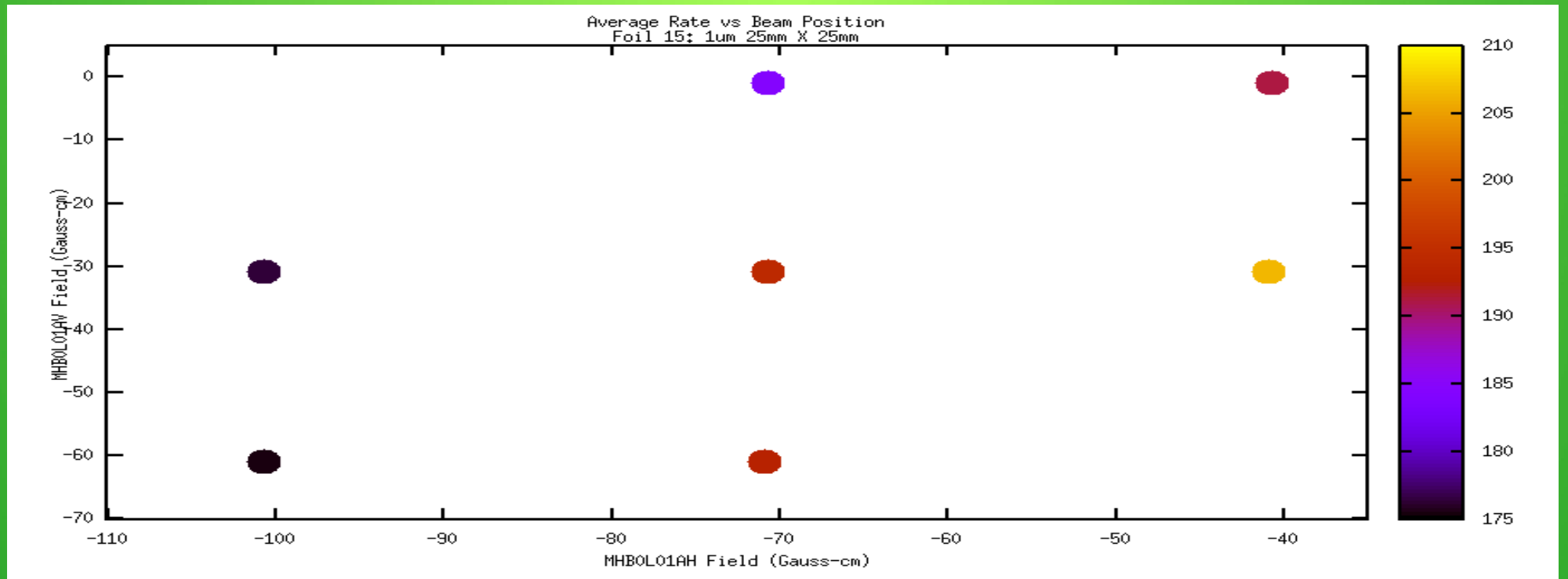
Note: Axes in following plots should have units of mA and not G-cm

Beam Position/Displacement Study
1 um Foil 15

Foil 15, ~1000nm 25x25mm at 2 uA, high threshold, deadtime ~18%

Movement	0L01AH (mA)	0L01AV (mA)	Asymmetry	dA	Average Rate
control	-70.7	-30.9	33.705	0.167516	194.0525
+vertical (up)	-70.7	-0.9	33.412	0.166174	184.326
-vertical (down)	-70.9	-60.9	33.65625	0.167557	192.9535
+horizontal (right)	-40.9	-30.9	33.81035	0.166706	206.27
-horizontal (left)	-100.7	-30.9	33.6596	0.167352	176.2900
-diagonal (down + left)	-100.7	-60.9	33.71075	0.168045	175.3675
+diagonal (up + right)	-40.7	-0.9	33.6751	0.167531	191.045

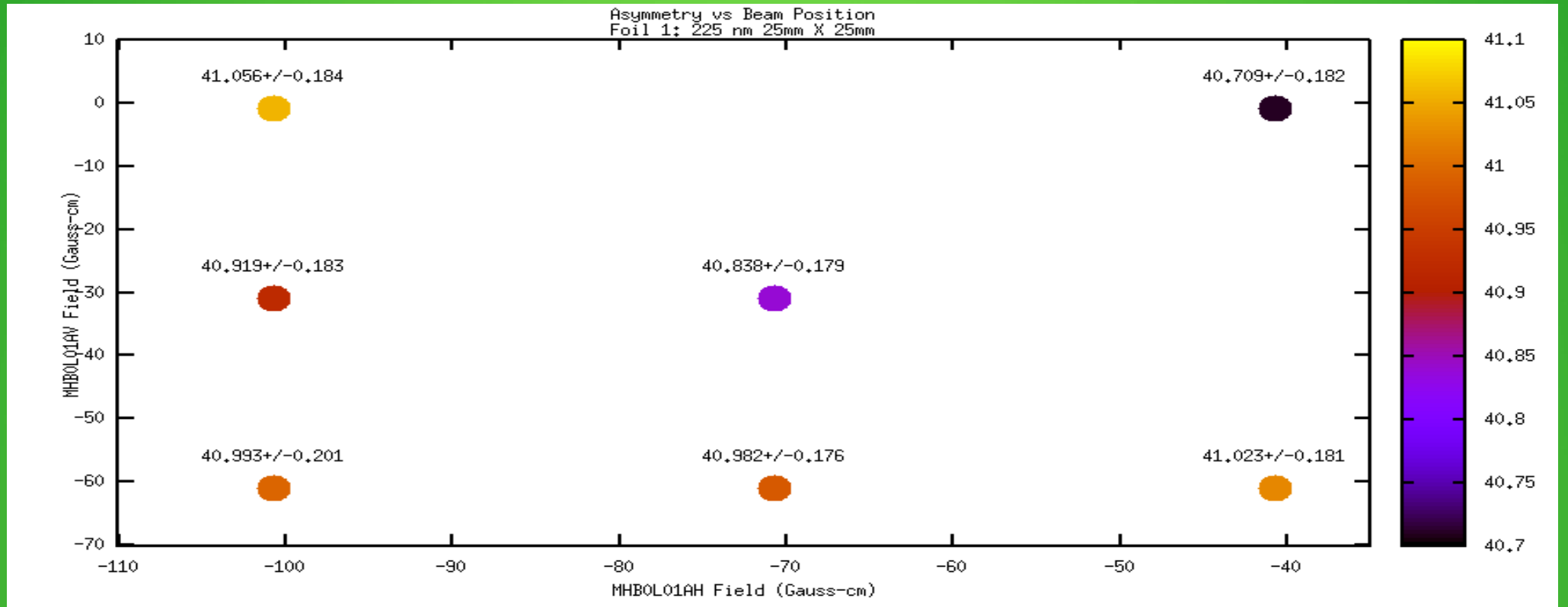

Asymmetry vs Beam Position
Foil 15: 1um 25mm X 25mm
33.412+/-0.166
33.675+/-0.166
33.659+/-0.167
33.705+/-0.167
33.810+/-0.162
33.710+/-0.167
33.656+/-0.167
MHB0L01AV Field (Gauss-cm)
MHB0L01AH Field (Gauss-cm)
10
0
-10
-20
-30
-40
-50
-60
-70
-110
-100
-90
-80
-70
-60
-50
-40
33.85
33.8
33.75
33.7
33.65
33.6
33.55
33.5
33.45
33.4

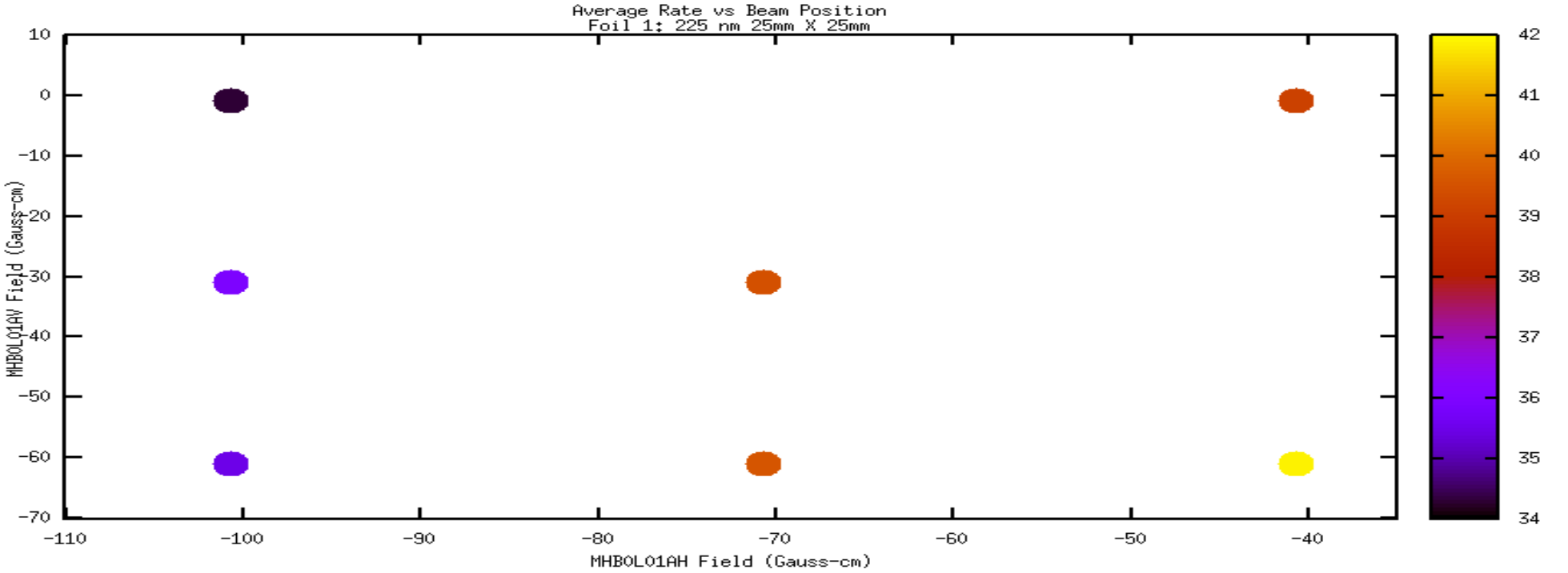

Average Rate vs Beam Position
Foil 15: 1um 25mm X 25mm
MHB0L01AV Field (Gauss-cm)
MHB0L01AH Field (Gauss-cm)
0
-10
-20
-30
-40
-50
-60
-70
-110
-100
-90
-80
-70
-60
-50
-40
210
205
200
195
190
185
180
175

Beam Position/Displacement Study 0.225 um Foil 1

Foil 1, ~0.225nm 25x25mm at 4.2 uA, high threshold, deadtime ~12%

Movement	0L01AH (mA)	0L01AV (mA)	Asymmetry	dA	Average Rate
control	-70.7	-30.9	40.8384	0.178795	39.445
diagonal (down + left)	-100.7	-60.9	40.9929666667	0.200644	35.4636
diagonal (up + left)	-100.7	-0.9	41.05645	0.183995	34.2758
diagonal (up + right	-40.7	-0.9	40.70855	0.181803	39.06795
diagonal (down + right)	-40.7	-60.9	41.02345	0.181278	41.85525
- vertical (down)	-70.7	-60.9	40.98165	0.175660	39.5455
- horizontal (left)	-100.7	-30.9	40.91875	0.183060	35.91845

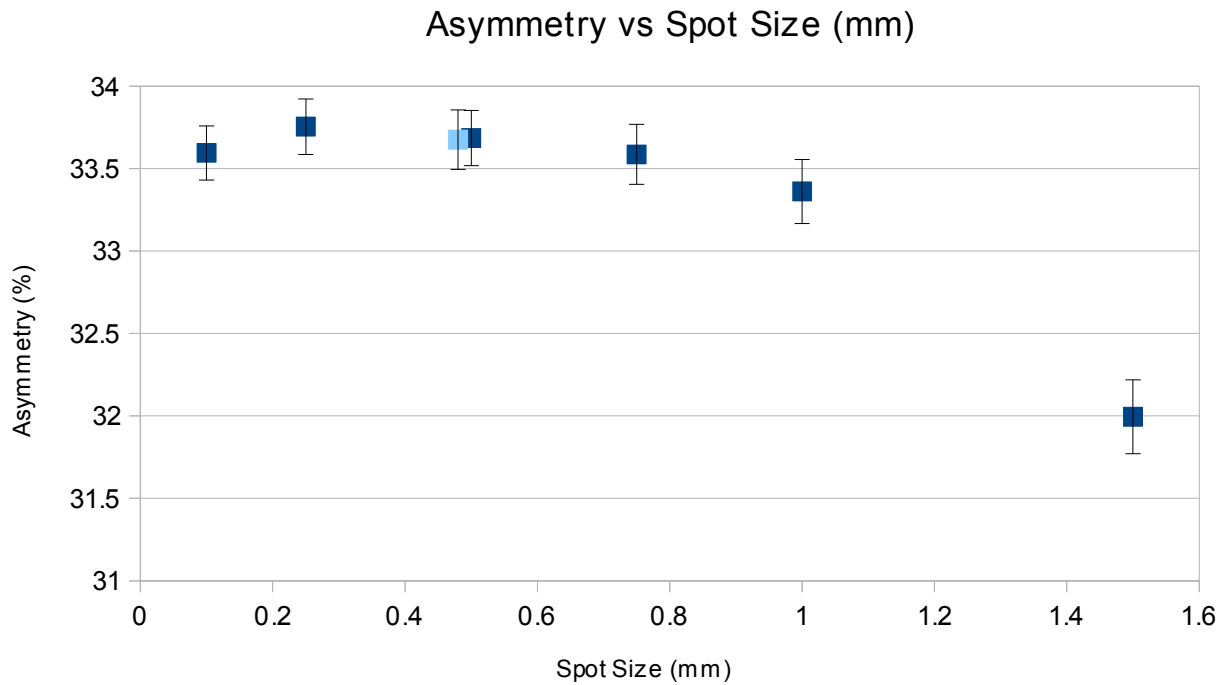

Asymmetry vs Beam Position
Foil 1: 225 nm 25mm X 25mm
41.056+/-0.184
40.709+/-0.182
40.919+/-0.183
40.838+/-0.179
40.993+/-0.201
40.982+/-0.176
41.023+/-0.181
MHBOL01AV Field (Gauss-cm)
MHBOL01AH Field (Gauss-cm)
10
0
-10
-20
-30
-40
-50
-60
-70
-110
-100
-90
-80
-70
-60
-50
-40
41.1
41.05
41
40.95
40.9
40.85
40.8
40.75
40.7

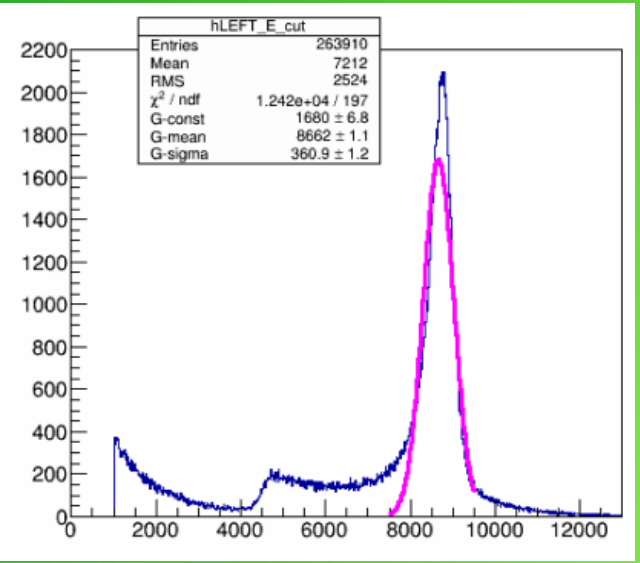

Average Rate vs Beam Position
Foil 1: 225 nm 25mm X 25mm
MHBOL01AV Field (Gauss-cm)
MHBOL01AH Field (Gauss-cm)
10
0
-10
-20
-30
-40
-50
-60
-70
-110
-100
-90
-80
-70
-60
-50
-40
42
41
40
39
38
37
36
35
34

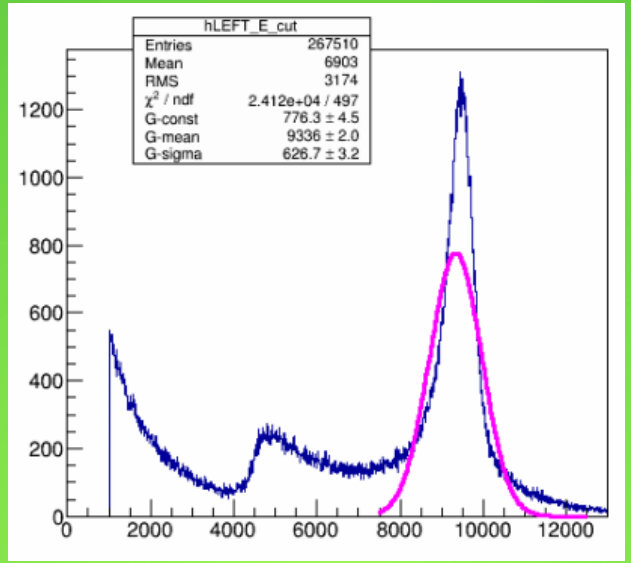
Beam Size Study

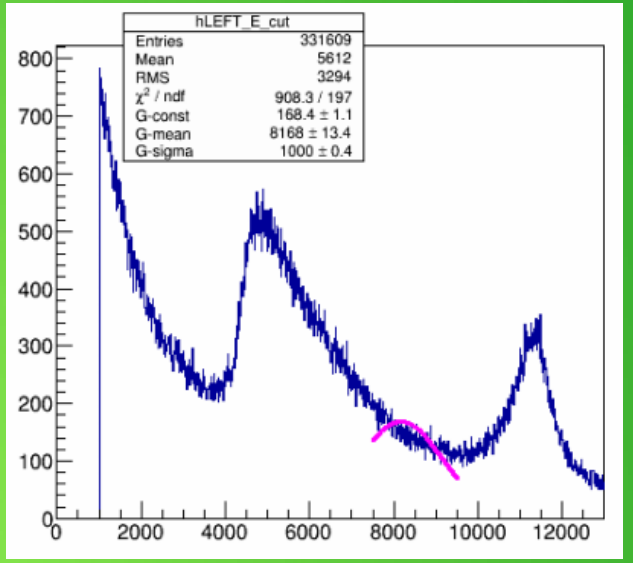
- Foil 15, ~1000nm 25x25mm at 2 uA, high threshold, deadtime ~18%, p_0 = 5.5 MeV, alternating IHWP, nominal beam size 0.48 mm
- Crested cryounit with nominal beam
- Using elegant model and OTR viewer at 3D00 adjusted quads MQJ0L02 and MQJ0L02A to achieve desired beam size, correcting for energy spread each time
- 2 mm spot size data difficult to fit, overwhelmed by background?

Spot Size (mm)	Asym-metry	dA
0.10	33.5953	0.1644
0.25	33.7543	0.1685
0.48	33.6760	0.1799
0.50	33.6857	0.1673
0.75	33.5857	0.1820
1.00	33.3615	0.1943
1.50	31.9942	0.2243





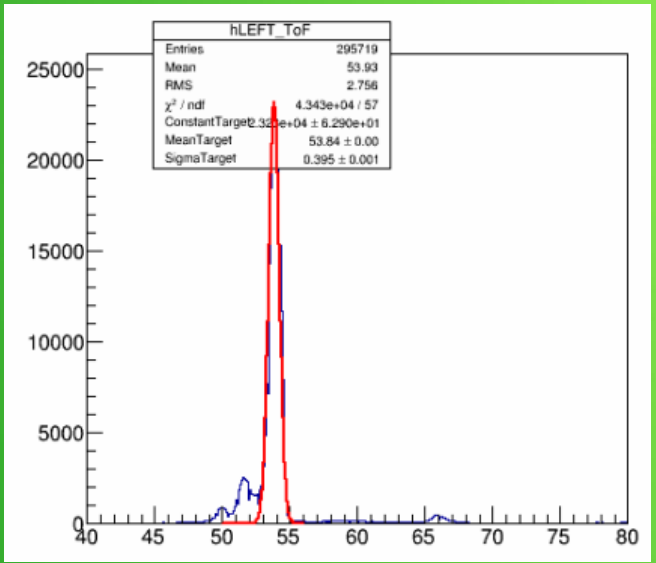


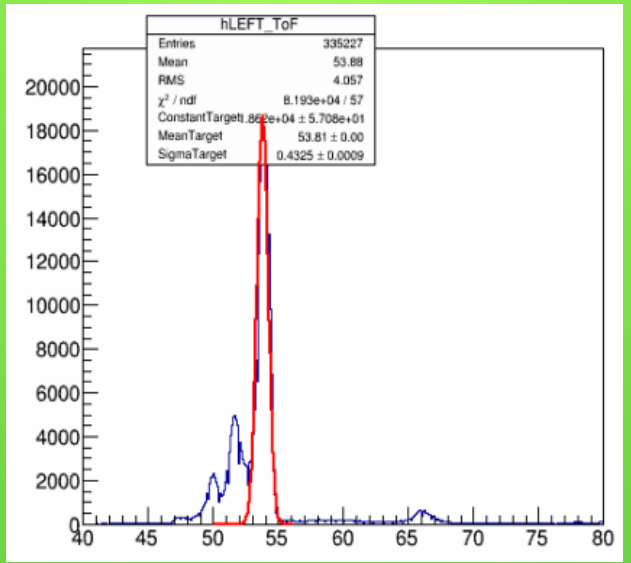


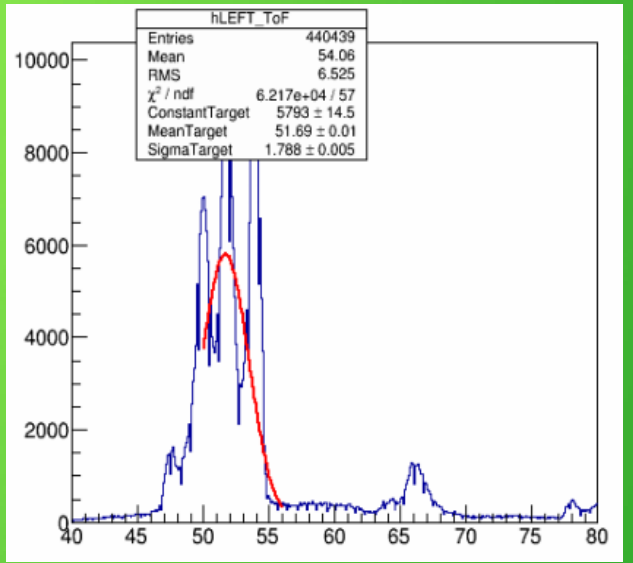
Left Detector: 0.75mm

1.00 mm

2.00 mm



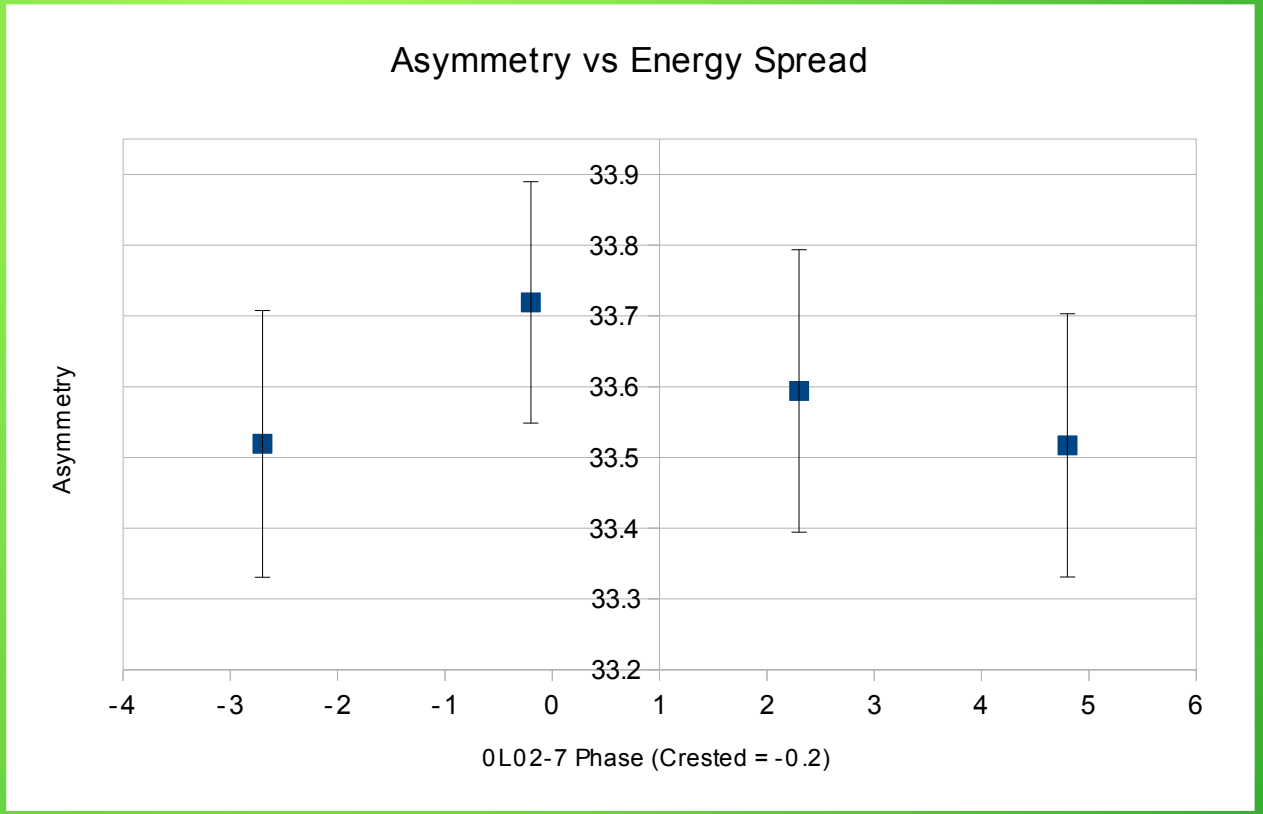




Energy Spread Study

- Foil 15, ~1000nm 25x25mm at 2 uA, high threshold, deadtime ~19%, p_0 = 5.5 MeV, alternating IHWP
- Varied phase of 0L02-7 from crested value of -0.2deg while keeping energy constant to achieve variation in energy spread
- Minor steering with horizontal corrector MAD3D00H to keep beam on target

0L02-7 Phase	Asym-metry	dA
-0.2	33.7191	0.17068
4.8	33.5171	0.18611
-2.7	33.5192	0.18834
2.3	33.5939	0.19957



Mott Analysis
Run 1 Systematic Studies

- Foil 15, ~1000nm 25x25mm, p_0 = 5.5 MeV:

  A = 33.6 +/- 0.2

- Run Dump Dipoles at -5A
- Center beam on foil, +/- one beam size any way from center still within statistical error
- As beam size grows, asymmetry dilutes, keep size < 1 mm
- Greater the beam energy spread, the less the measured asymmetry

- Other systematic studies from Run 1 not covered --
  - Asymmetry vs aperture study