Beam Magnetization Measurements

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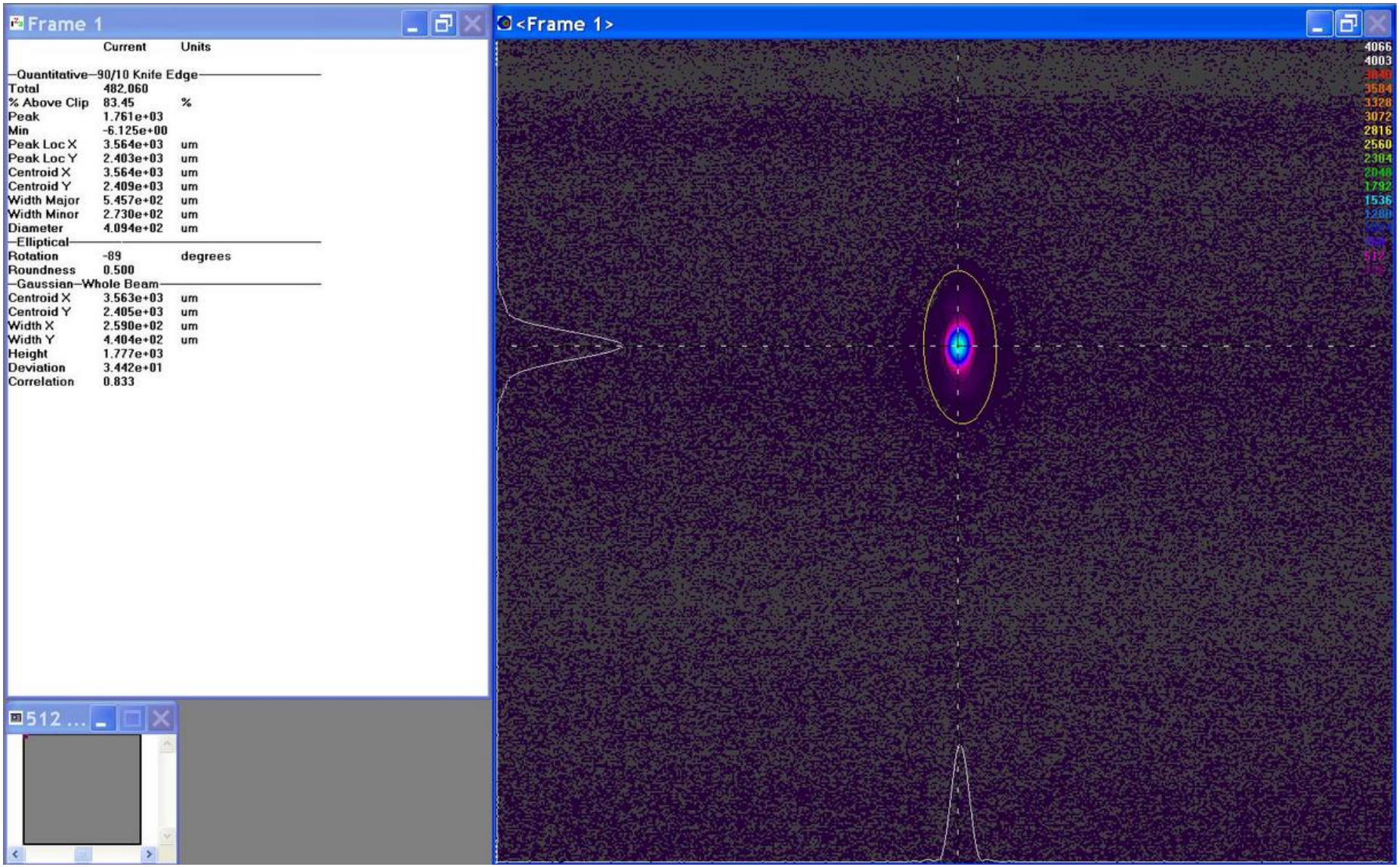
Beam rotation measurement

- Laser spot size, mm
  = 0.106 (RMS) = 0.251 (FWHM) = 0.426 ($1/e^2$)
- Gun HV = 300 kV
- Beam rotation included for solenoid currents
  = 0, 25, 50, 75, 100, 150, 200, 250, and 300 A
- The beam was centered on beamline solenoids and viewers for clean beam transport
- All the beamline solenoids were off during beam rotation measurement
- Slit on viewer-1 was used and Beam rotation measured on viewers 2 and 3
- Distance between viewers :
  V1-V2: 500 mm, V1-V3: 2296.5 mm, V2-V3: 1796.5 mm

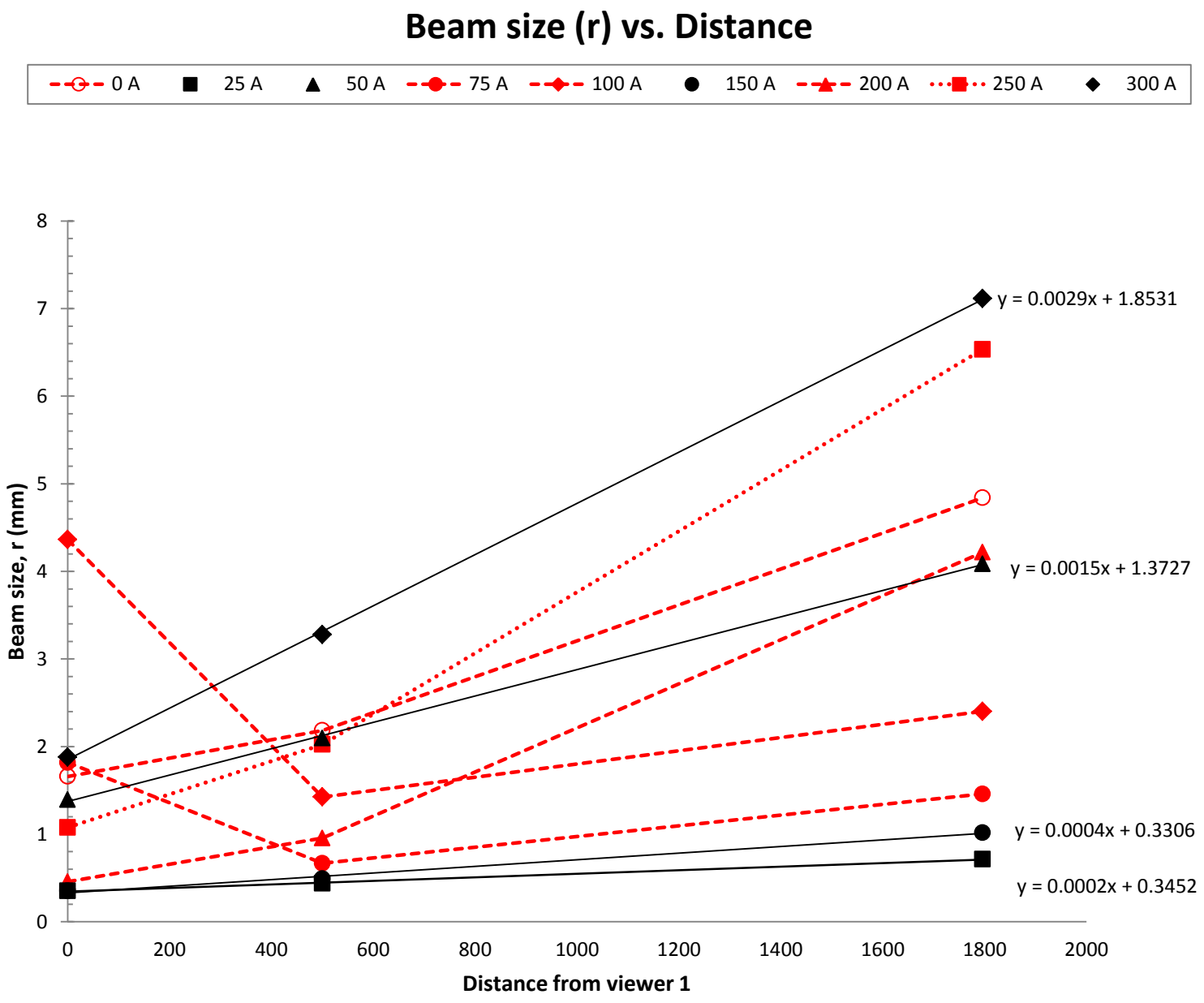
Virtual laser spot image

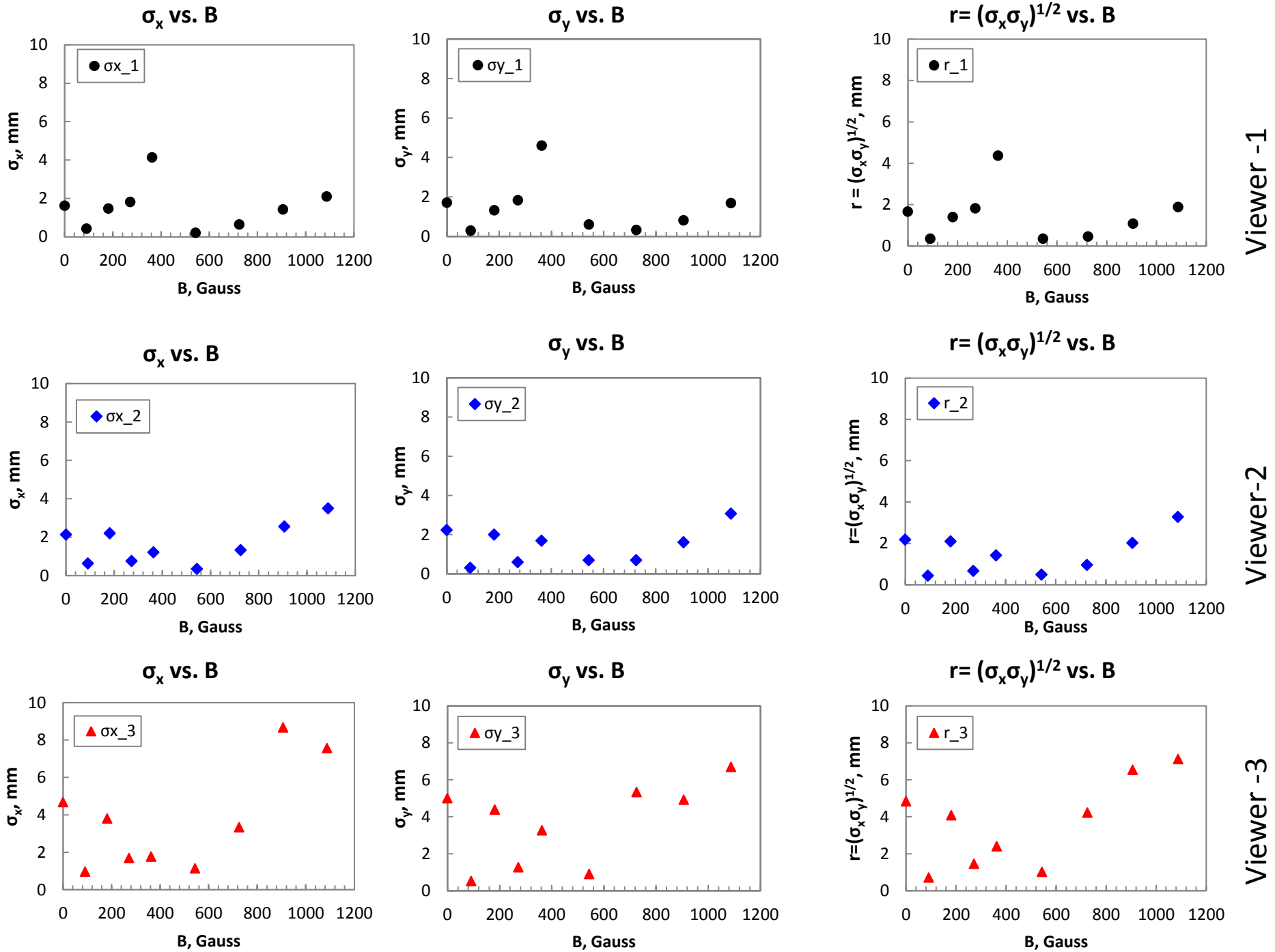


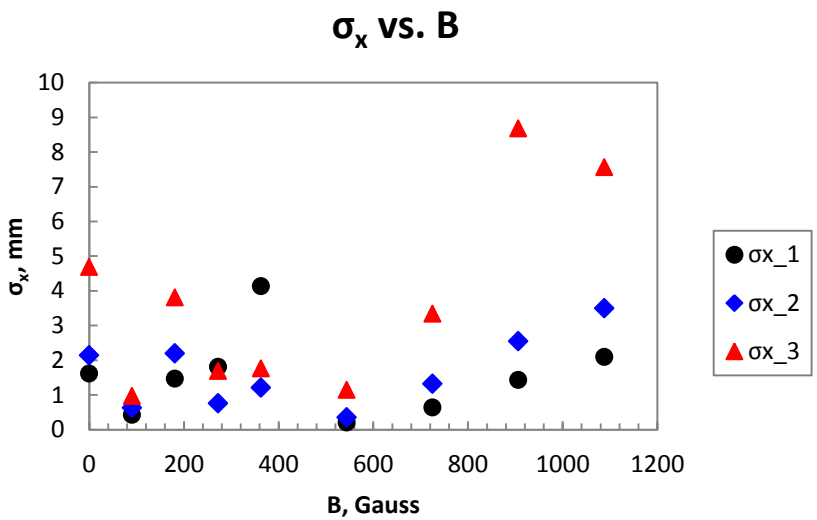
Beam sizes on viewers 1, 2 and 3

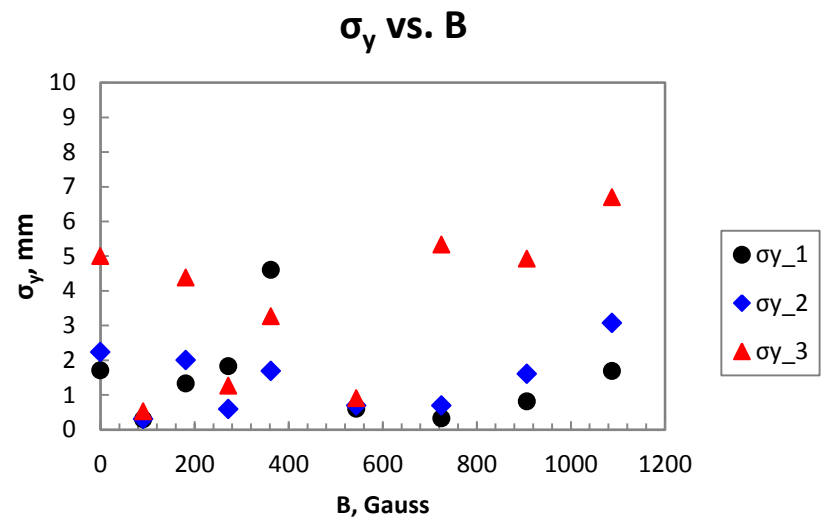
Solenoid current, A	Field (B) Gauss	Beam size measured on viewers 1,2 &3						$r=sqrt(\sigma_x\sigma_y)$		
		σx_1 mm	σy_1 mm	σx_2 mm	σy_2 mm	σx_3 mm	σy_3 mm	r_1 mm	r_2 mm	r_3 mm
0	0	1.616	1.703	2.136	2.233	4.684	5.003	1.659	2.184	4.841
25	90.65	0.425	0.292	0.626	0.305	0.970	0.525	0.352	0.437	0.714
50	181.31	1.466	1.326	2.197	2.000	3.806	4.384	1.394	2.096	4.085
75	271.95	1.808	1.826	0.754	0.592	1.686	1.263	1.817	0.668	○ 1.459
100	362.6	4.135	4.601	1.204	1.686	1.765	3.267	4.362	1.425	○ 2.401
150	543.9	0.204	0.604	0.349	0.690	1.139	0.905	0.351	0.491	1.015
200	725.2	0.640	0.325	1.321	0.690	3.335	5.335	0.456	0.954	4.218
250	906.5	1.426	0.813	2.547	1.607	8.678	4.921	1.077	2.023	6.535
300	1087.8	2.094	1.688	3.500	3.068	7.560	6.693	1.880	3.277	7.113

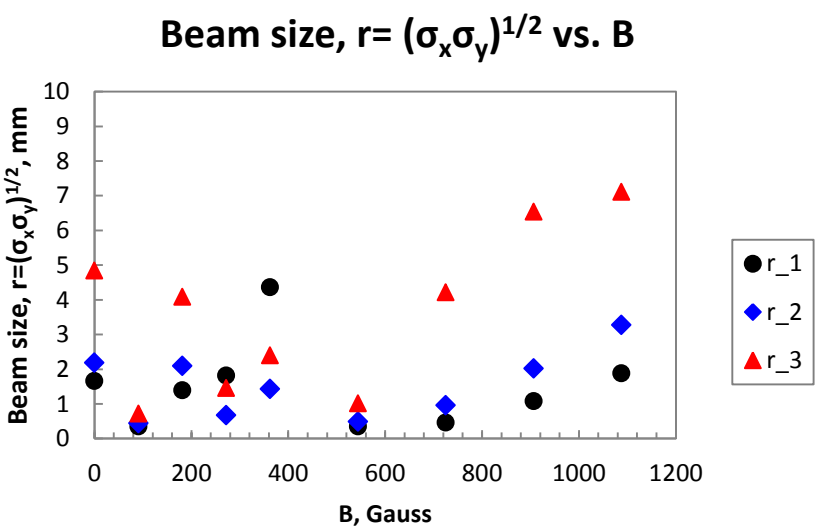
○ Focal point between V2 and V3

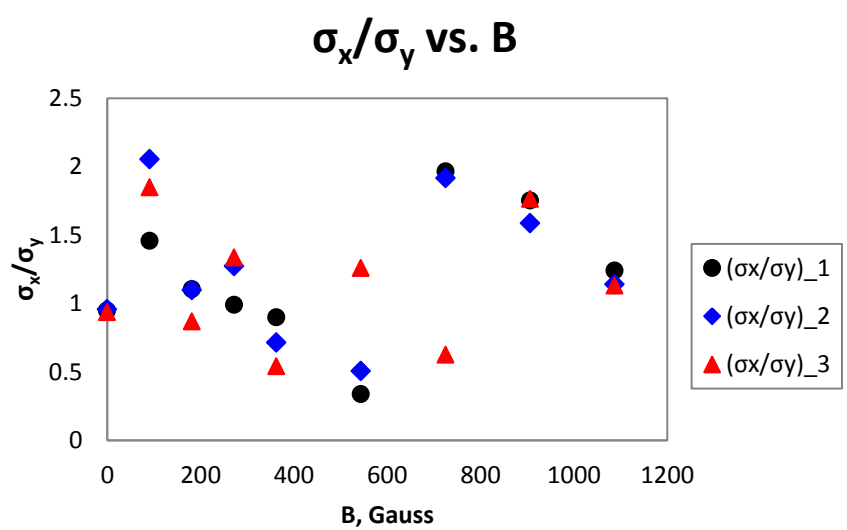

Beam size (r) vs. Distance
0 A
25 A
50 A
75 A
100 A
150 A
200 A
250 A
300 A
y = 0.0029x + 1.8531
y = 0.0015x + 1.3727
y = 0.0004x + 0.3306
y = 0.0002x + 0.3452
Beam size, r (mm)
Distance from viewer 1
0
1
2
3
4
5
6
7
8
0
200
400
600
800
1000
1200
1400
1600
1800
2000

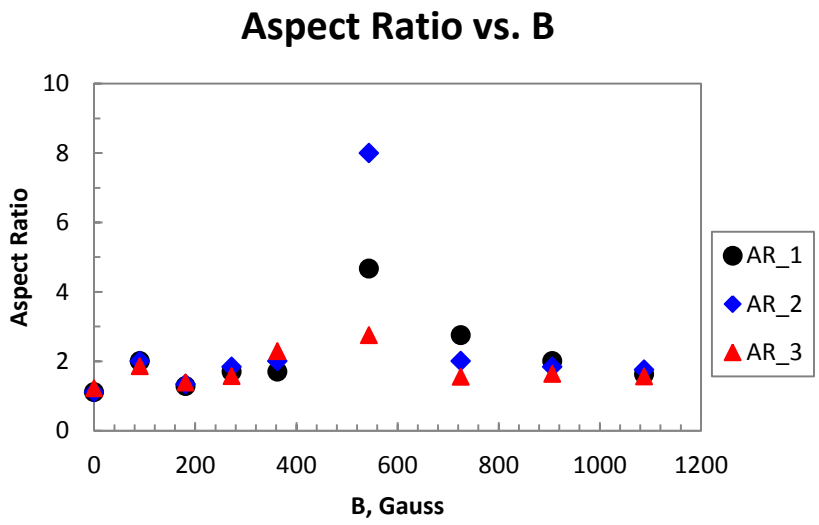

σx vs. B
σx_1
σx, mm
B, Gauss
σy vs. B
σy_1
σy, mm
B, Gauss
r= (σxσy)1/2 vs. B
r_1
r = (σxσy)1/2, mm
B, Gauss
Viewer -1
σx vs. B
σx_2
σx, mm
B, Gauss
σy vs. B
σy_2
σy, mm
B, Gauss
r= (σxσy)1/2 vs. B
r_2
r=(σxσy)1/2, mm
B, Gauss
Viewer-2
σx vs. B
σx_3
σx, mm
B, Gauss
σy vs. B
σy_3
σy, mm
B, Gauss
r= (σxσy)1/2 vs. B
r_3
r=(σxσy)1/2, mm
B, Gauss
Viewer -3

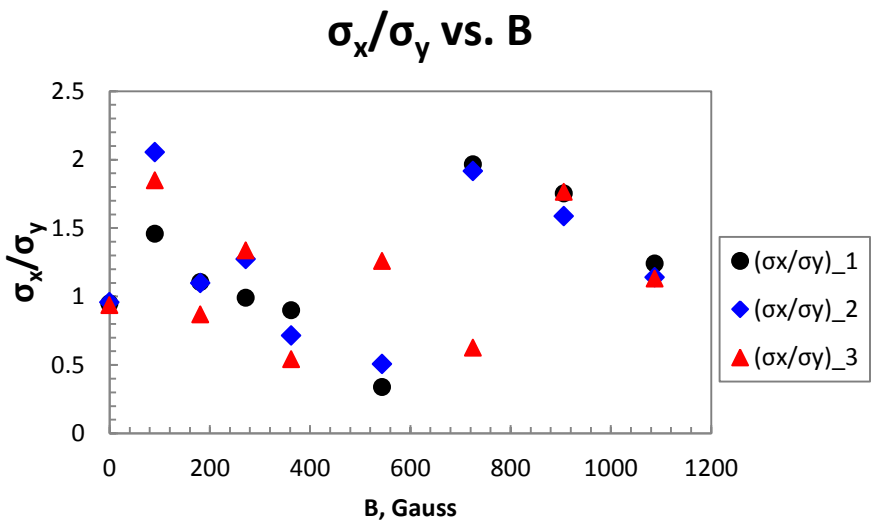

σx vs. B
σx, mm
B, Gauss
σx_1
σx_2
σx_3


σy vs. B
σy, mm
B, Gauss
σy_1
σy_2
σy_3


Beam size, r= (σxσy)1/2 vs. B
Beam size, r=(σxσy)1/2, mm
B, Gauss
r_1
r_2
r_3


σx/σy vs. B
σx/σy
B, Gauss
(σx/σy)_1
(σx/σy)_2
(σx/σy)_3

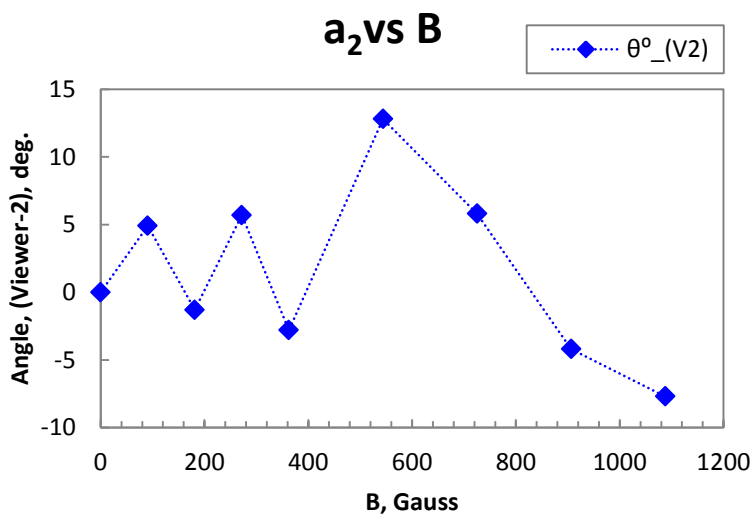

Aspect Ratio vs. B
Aspect Ratio
B, Gauss
0
2
4
6
8
10
0
200
400
600
800
1000
1200
AR_1
AR_2
AR_3

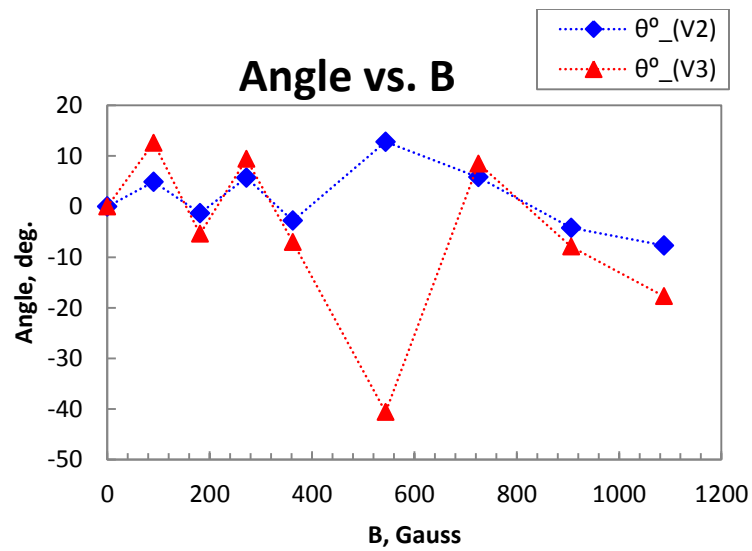

σx/σy vs. B
σx/σy
B, Gauss
0
0.5
1
1.5
2
2.5
0
200
400
600
800
1000
1200
(σx/σy)_1
(σx/σy)_2
(σx/σy)_3

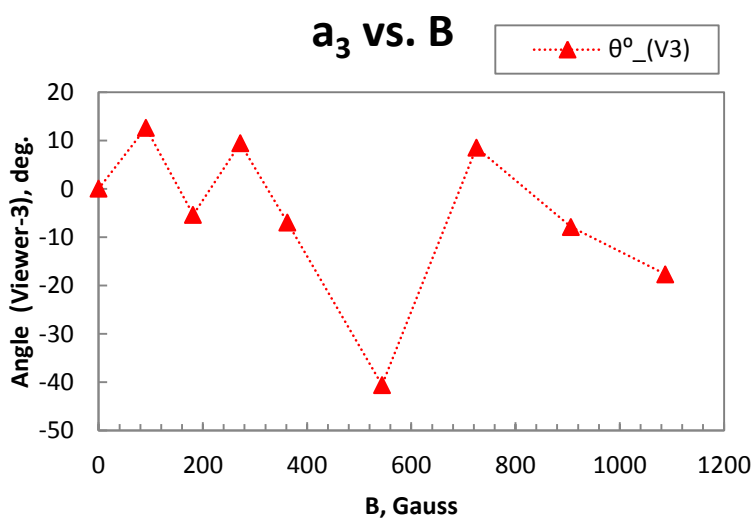
Beam Rotation
from slit 1 beam image on viewers 2 and 3

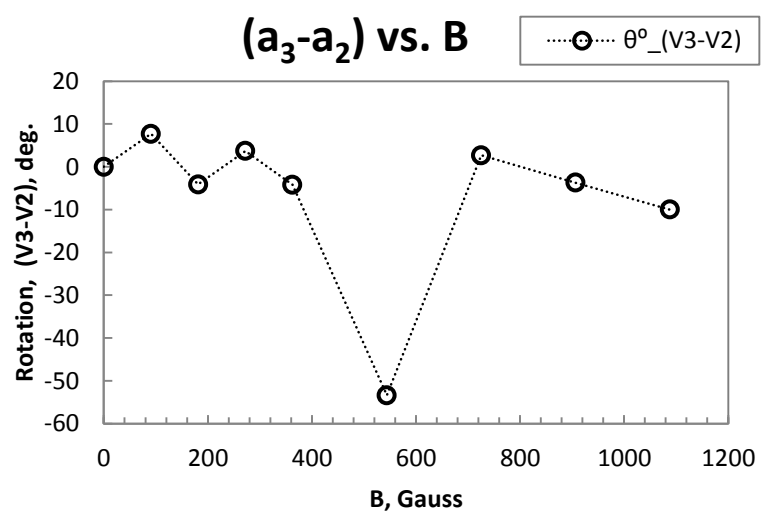
Solenoid current, A	Field (B) Gauss	Slit image angle a2 Rotation (°)	a3 Rotation (°)	a3-a2 Rotation (°)
0	0	0.00	0.00	0.00
25	90.65	4.90	12.60	7.70
50	181.31	-1.30	-5.40	-4.10
75	271.95	5.70	9.40	3.70
100	362.6	-2.80	-7.00	-4.20
150	543.9	12.80	-40.60	-53.40
200	725.2	5.80	8.50	2.70
250	906.5	-4.20	-7.90	-3.70
300	1087.8	-7.70	-17.70	-10.00

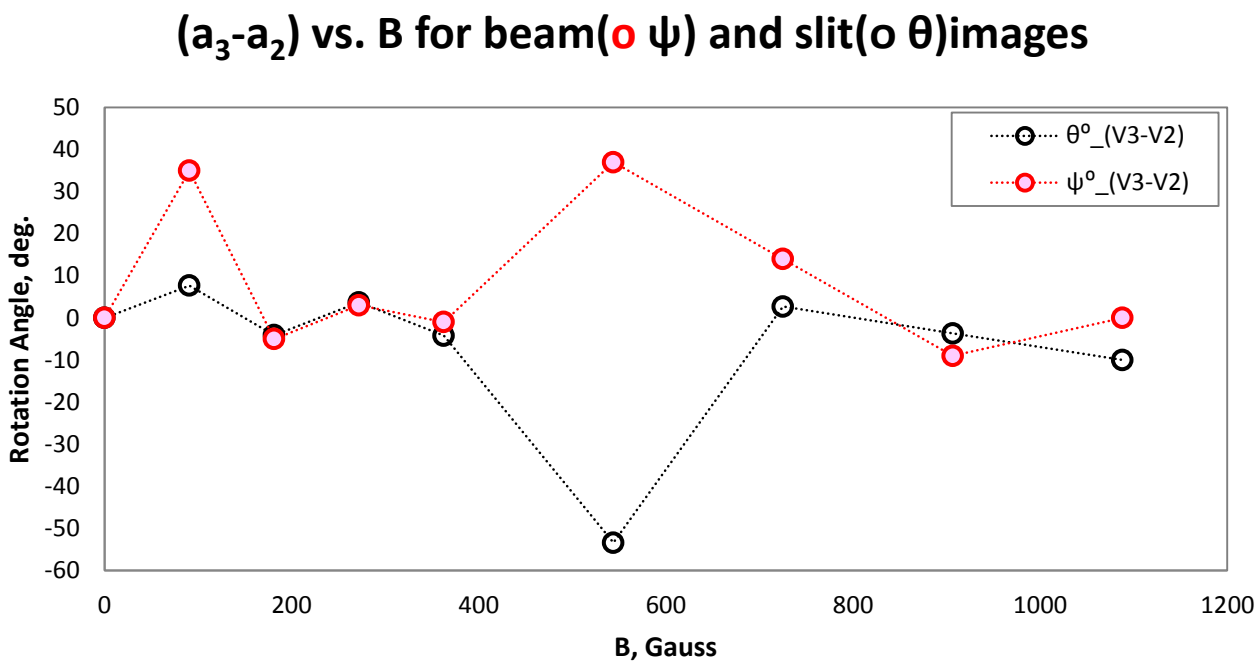
- Sign convention followed: +ve (ccw), -ve (cw)
- A 3° (ccw) angle was observed in slit image on viewer 3 at 0 A. Therefore, all the viewer 3 data is corrected by subtracting this amount.
- Last viewer's image was flipped about vertical axis to correct the camera orientation mismatch w.r.t. viewers 1 and 2.

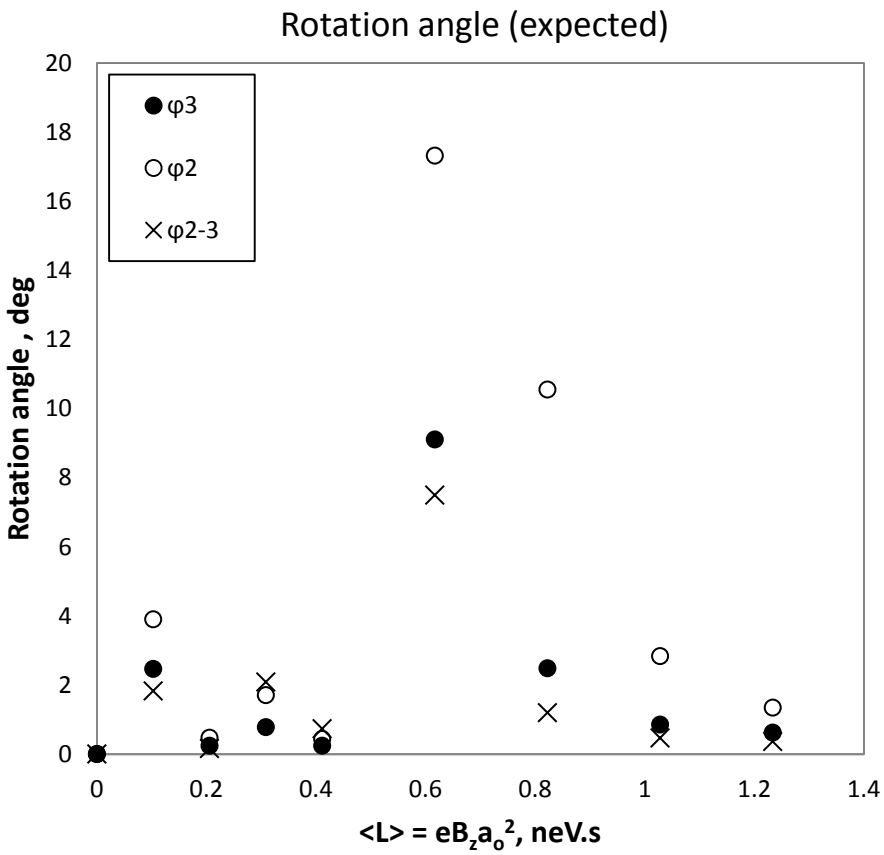

a2vs B
θo_(V2)
Angle, (Viewer-2), deg.
B, Gauss
15
10
5
0
-5
-10
0
200
400
600
800
1000
1200

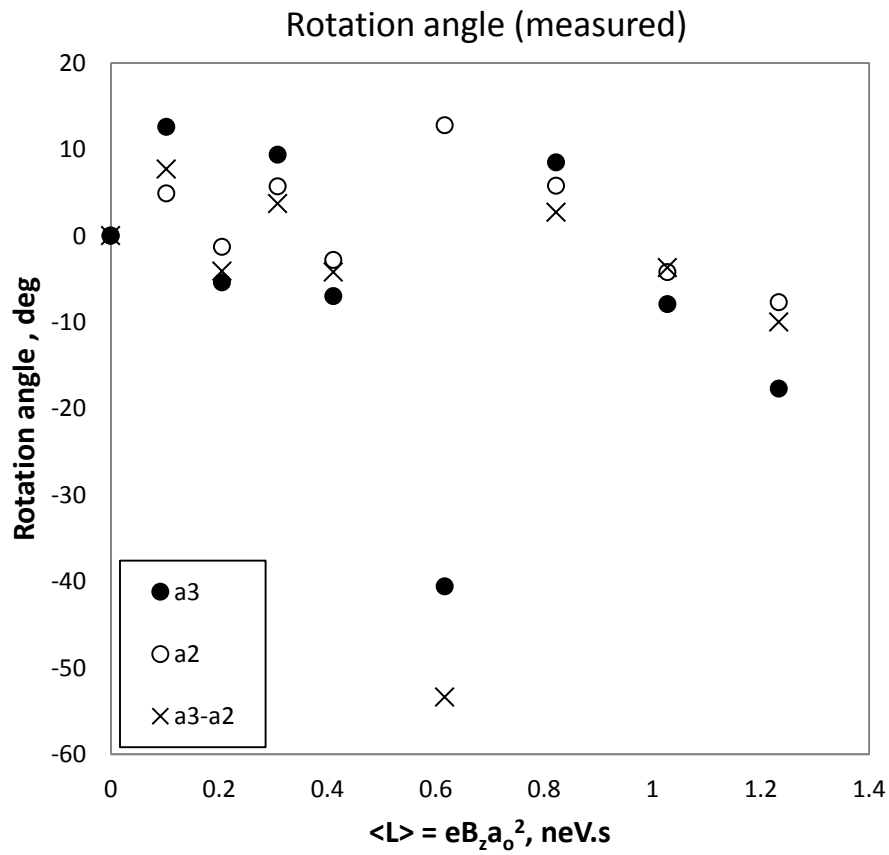

Angle vs. B
θo_(V2)
θo_(V3)
Angle, deg.
B, Gauss
20
10
0
-10
-20
-30
-40
-50
0
200
400
600
800
1000
1200

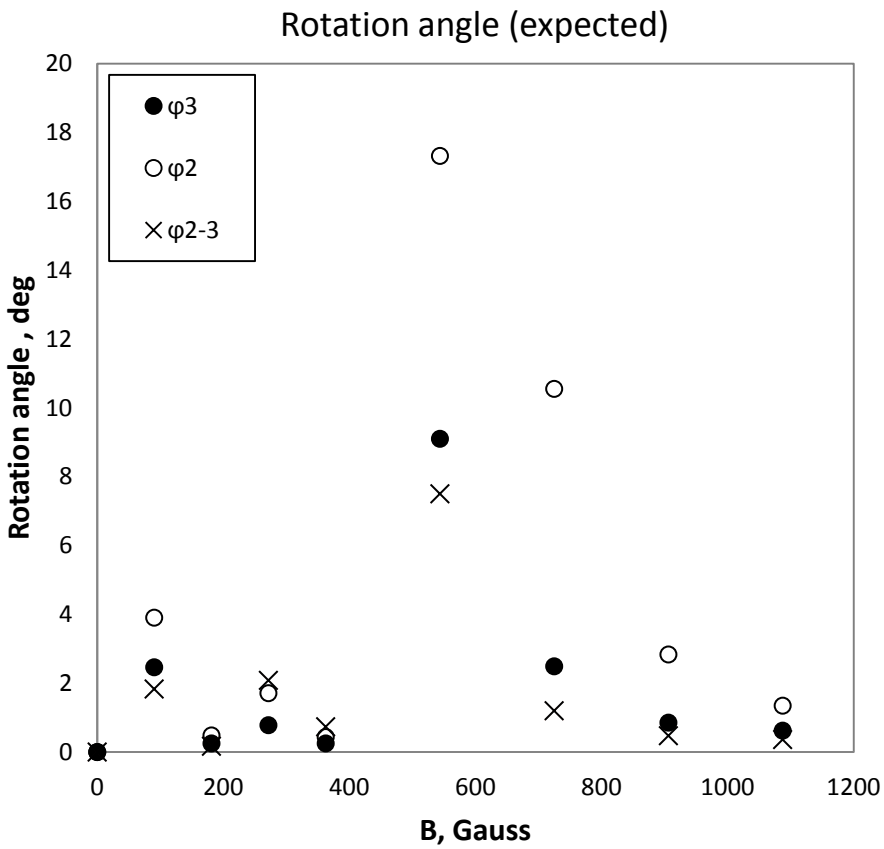

a3 vs. B
θo_(V3)
Angle (Viewer-3), deg.
B, Gauss
20
10
0
-10
-20
-30
-40
-50
0
200
400
600
800
1000
1200

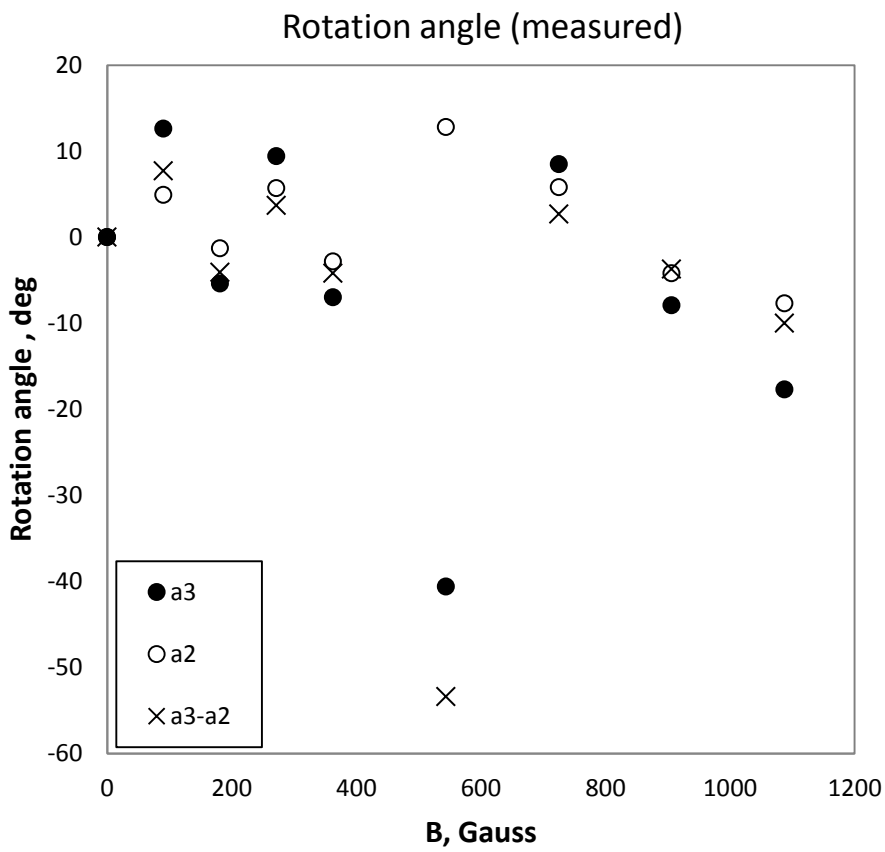

(a3-a2) vs. B
θo_(V3-V2)
Rotation, (V3-V2), deg.
B, Gauss
20
10
0
-10
-20
-30
-40
-50
-60
0
200
400
600
800
1000
1200

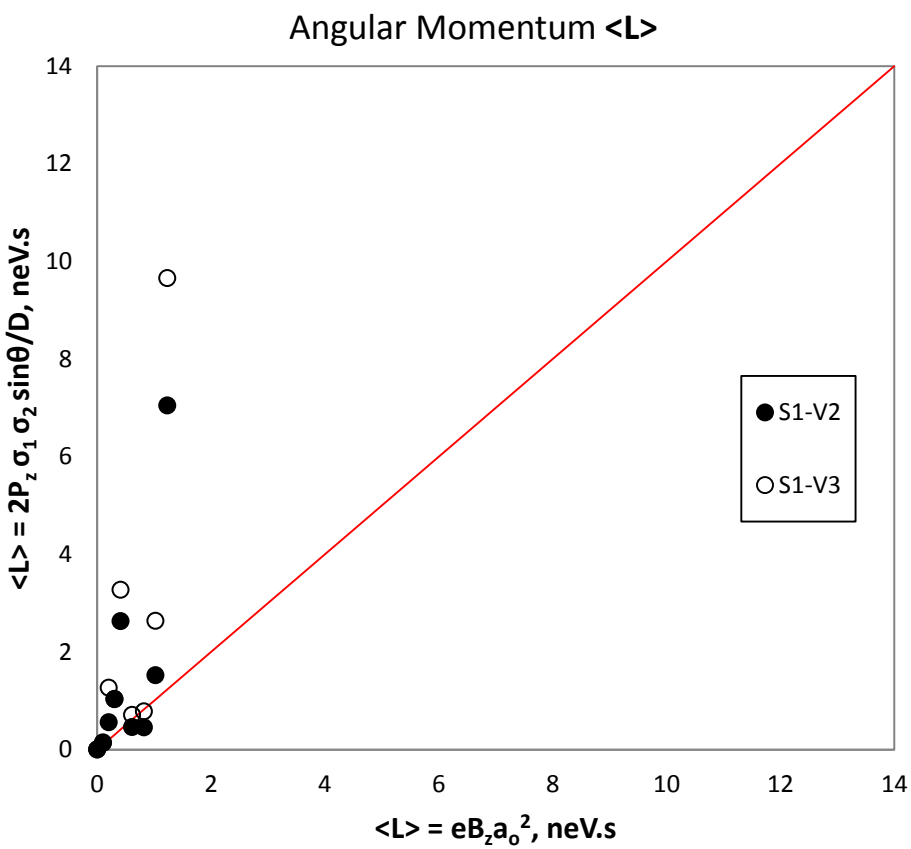

(a3-a2) vs. B for beam(o ψ) and slit(o θ)images
θo_(V3-V2)
ψo_(V3-V2)
Rotation Angle, deg.
B, Gauss
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
0
200
400
600
800
1000
1200

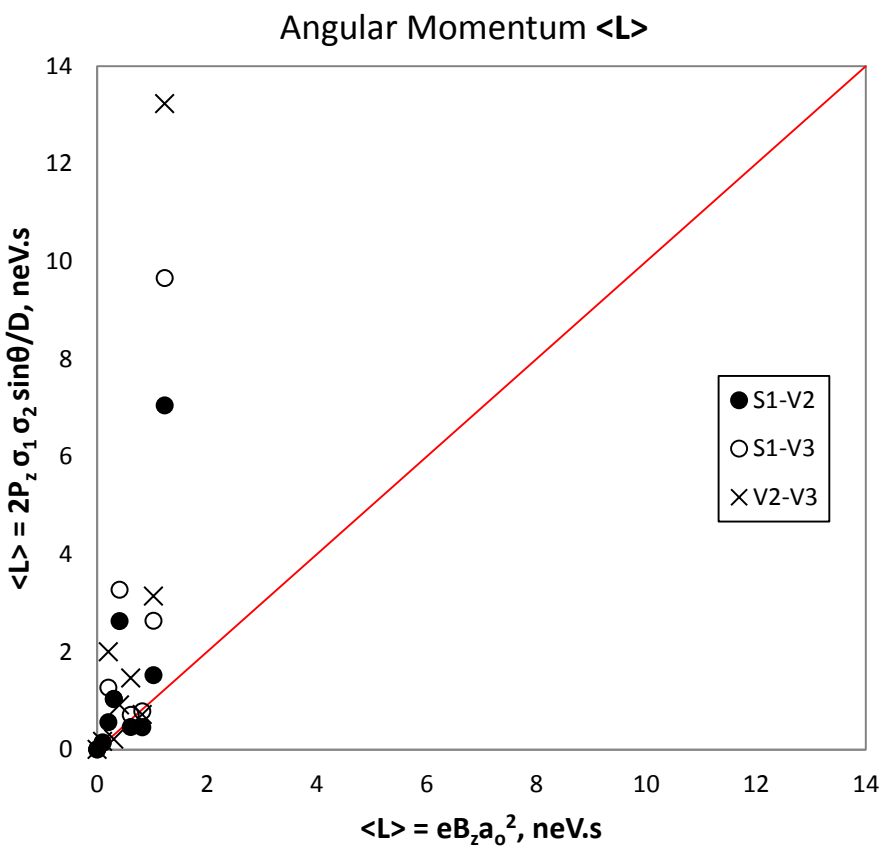

Rotation angle (expected)
φ3
φ2
φ2-3
Rotation angle , deg
<L> = eB$_z$a$_o$^{2}, neV.s
0
2
4
6
8
10
12
14
16
18
20
0
0.2
0.4
0.6
0.8
1
1.2
1.4


Rotation angle (measured)
a3
a2
a3-a2
Rotation angle , deg
<L> = eB$_z$a$_o$^{2}, neV.s
20
10
0
-10
-20
-30
-40
-50
-60
0
0.2
0.4
0.6
0.8
1
1.2
1.4


Rotation angle (expected)
φ3
φ2
φ2-3
Rotation angle , deg
B, Gauss
0
2
4
6
8
10
12
14
16
18
20
0
200
400
600
800
1000
1200

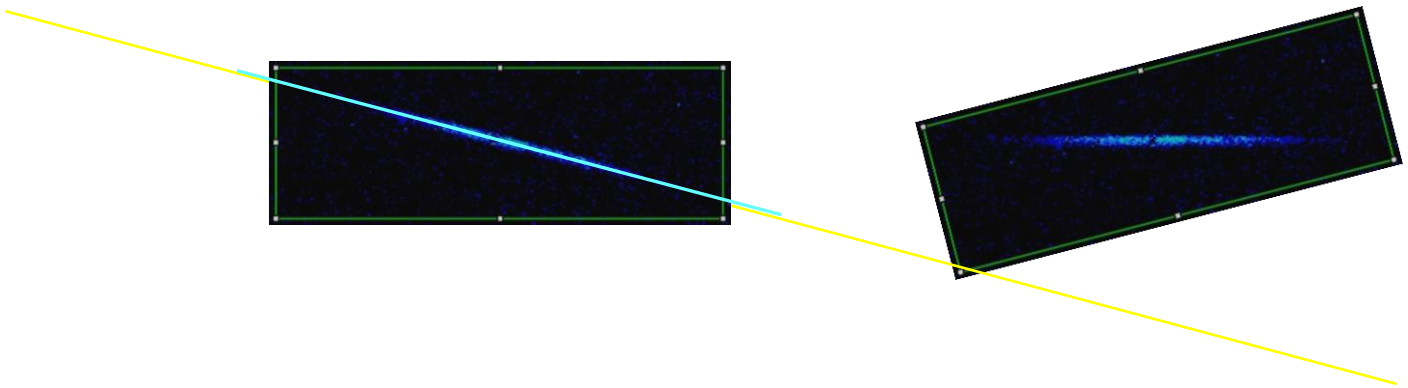

Rotation angle (measured)
a3
a2
a3-a2
Rotation angle , deg
B, Gauss
20
10
0
-10
-20
-30
-40
-50
-60
0
200
400
600
800
1000
1200


Angular Momentum <L>
<L> = 2P_z σ_1 σ_2 sinθ/D, neV.s
<L> = eB_z a_o^2, neV.s
S1-V2
S1-V3
0
2
4
6
8
10
12
14


Angular Momentum <L>
<L> = 2P_z σ_1 σ_2 sinθ/D, neV.s
<L> = eB_z a_o^2, neV.s
S1-V2
S1-V3
V2-V3
0
2
4
6
8
10
12
14

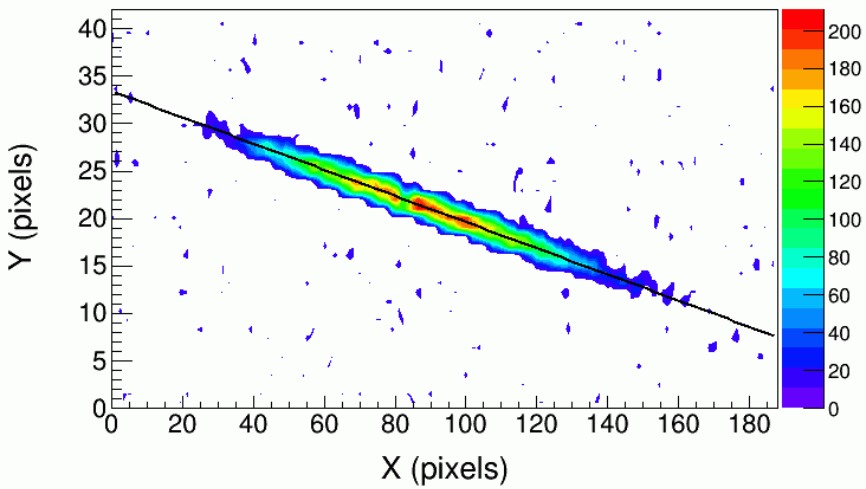
Backup
Data

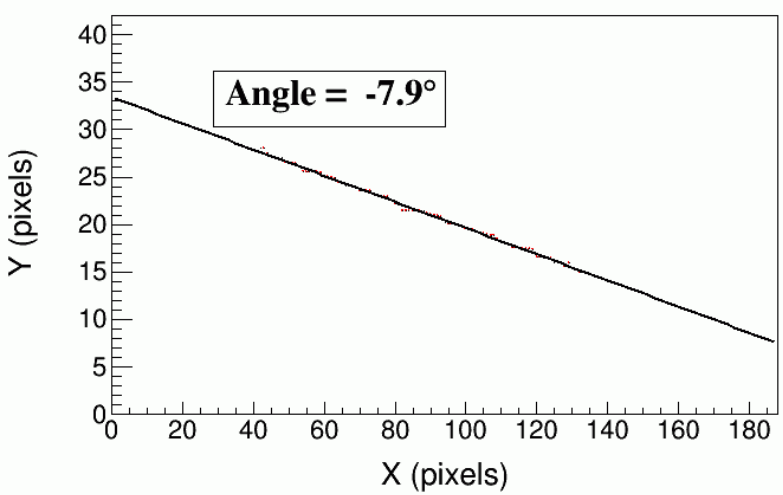
300A_300kV_S1_V3



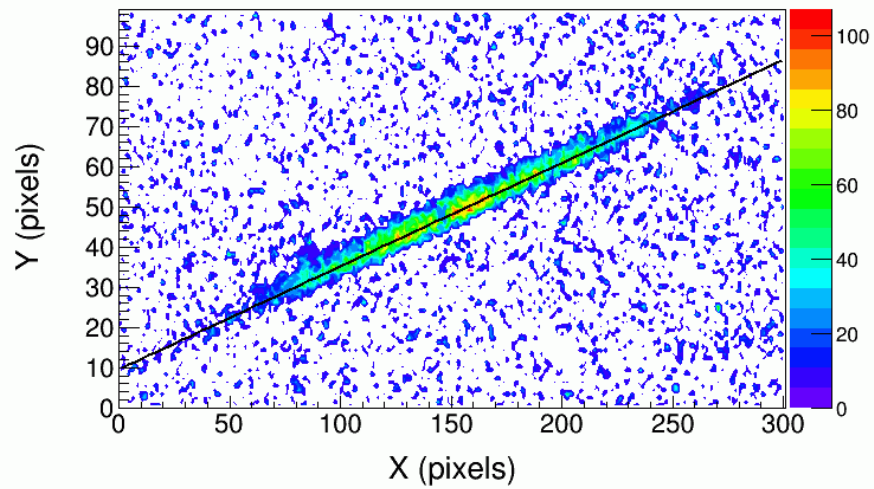
300A_300kV_S1_V2

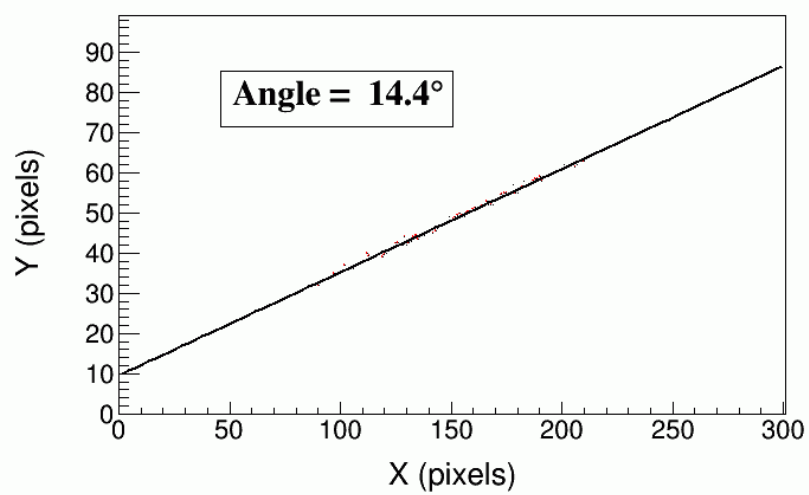
Rotation_Sol-300A_S1-V2_190_44_70



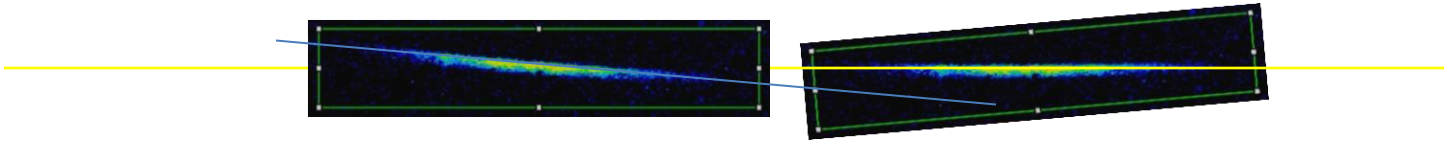


Rotation_Sol-300A_S1-V3_303_101_70

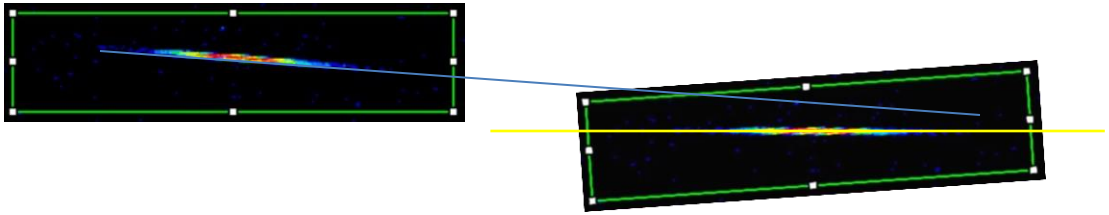




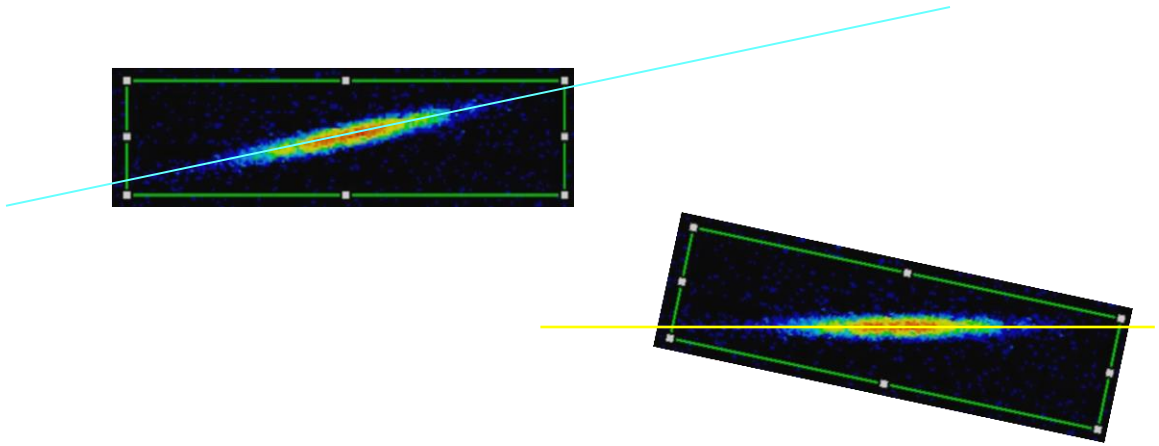
250A_300kV_S1_V3



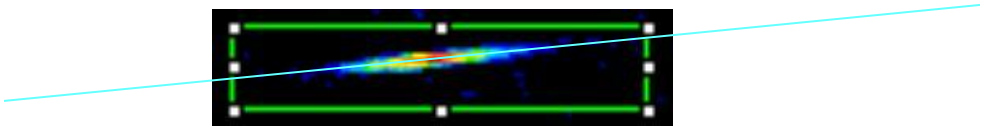
250A_300kV_S1_V2

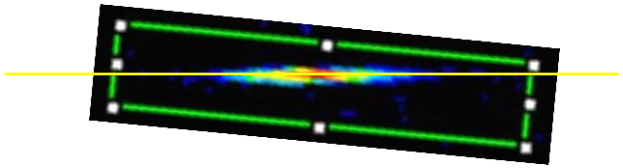


200A_300kV_S1_V3

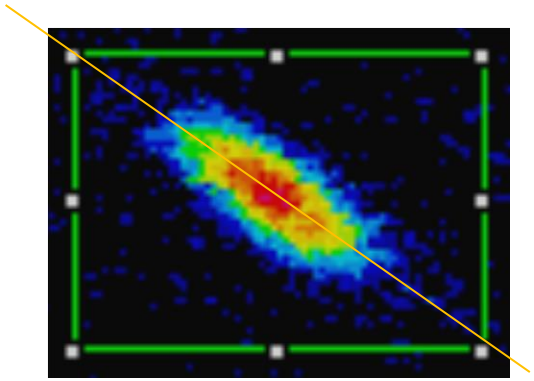


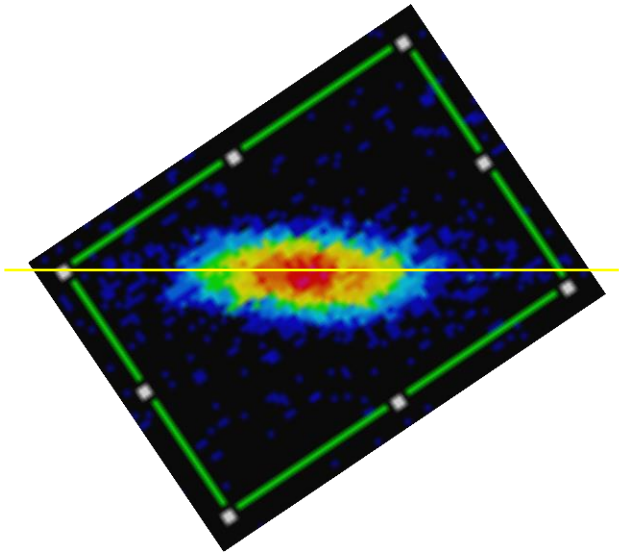
200A_300kV_S1_V2



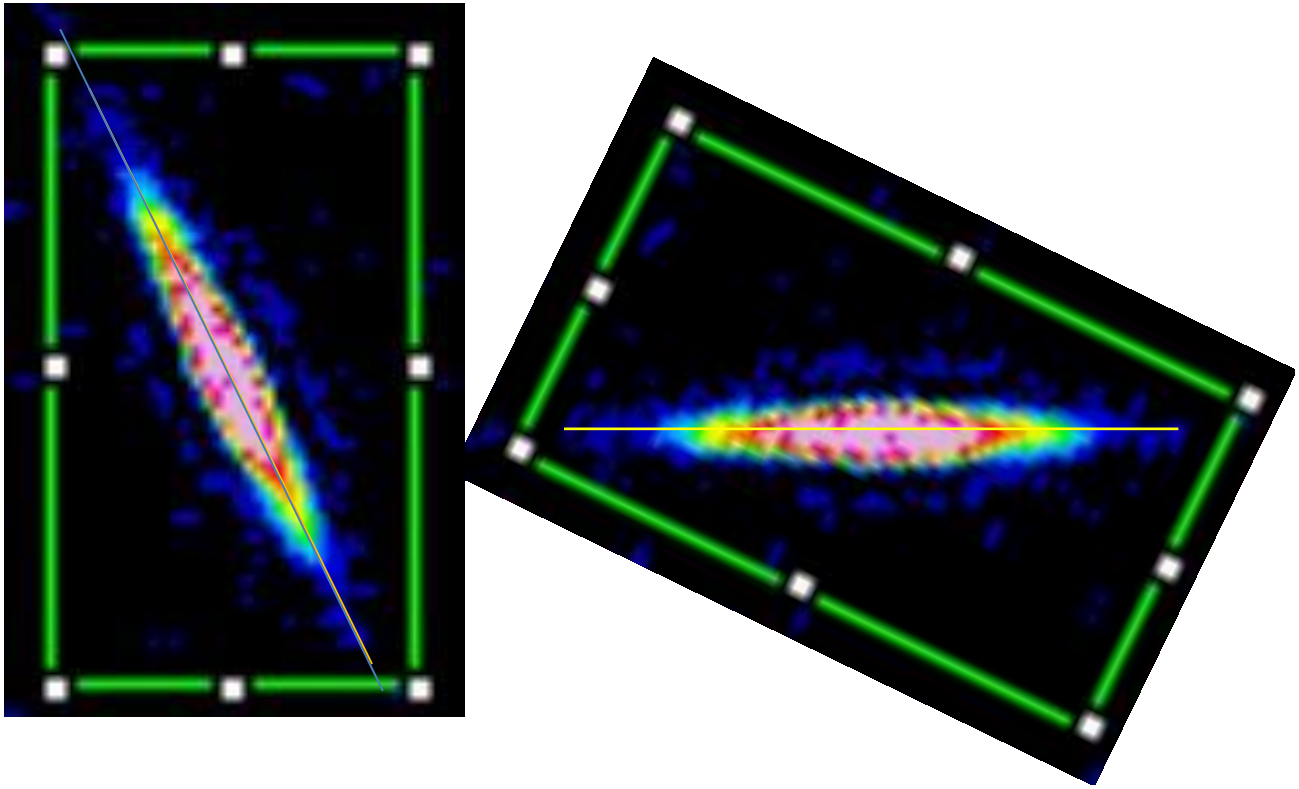


150A_300kV_V3

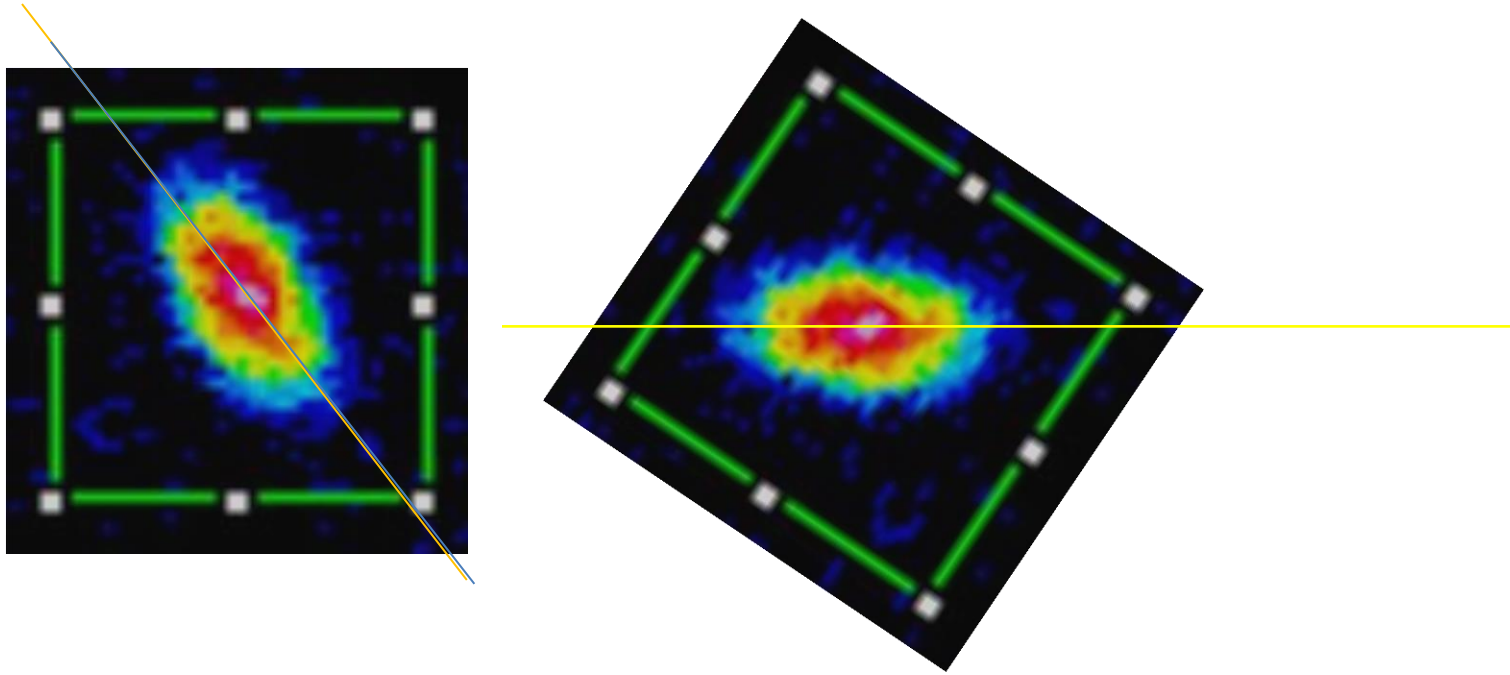




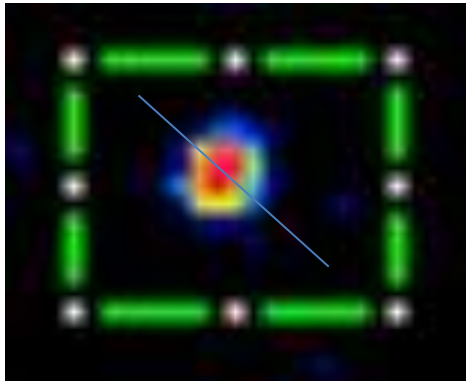
150A_300kV_V2

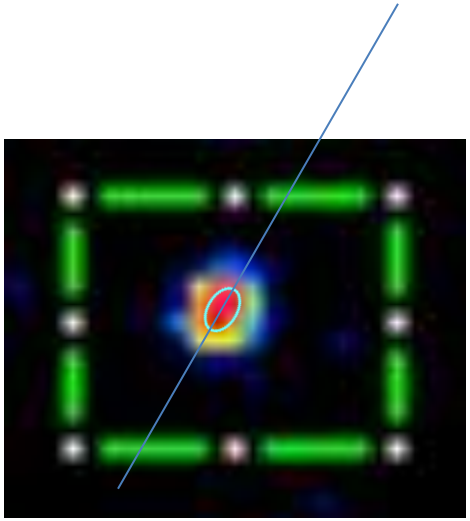


150A_300kV_S1_V3

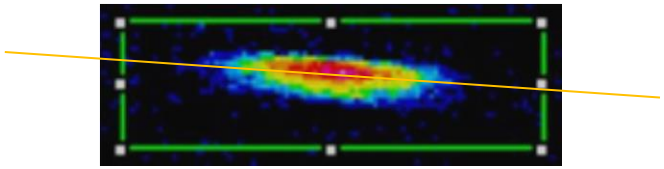


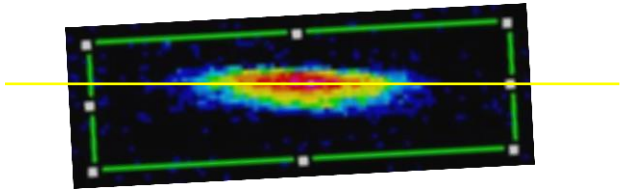
150A_300kV_S1_V2



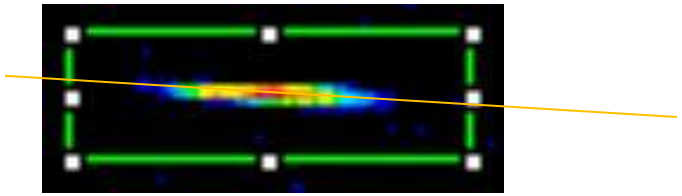


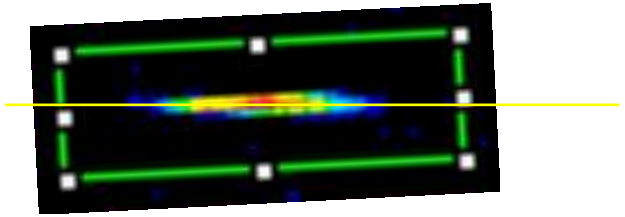
100A_300kV_S1_V3



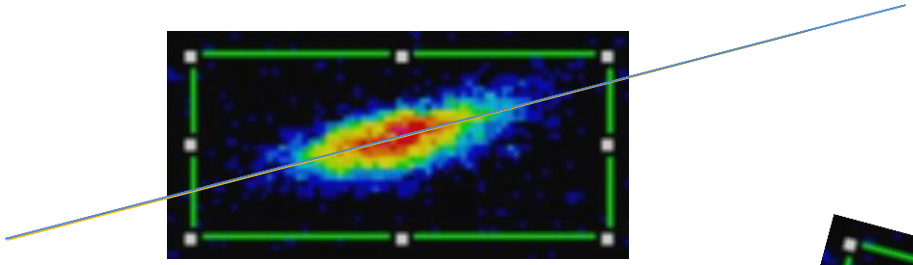


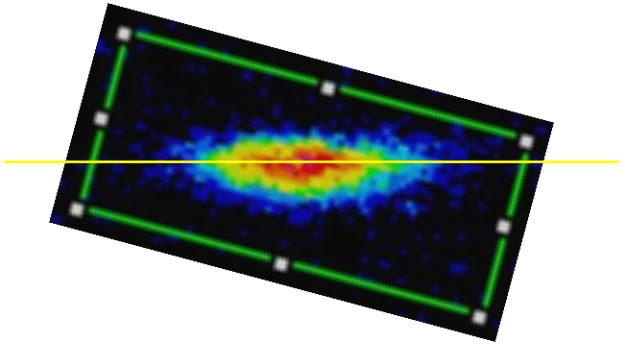
100A_300kV_S1_V2



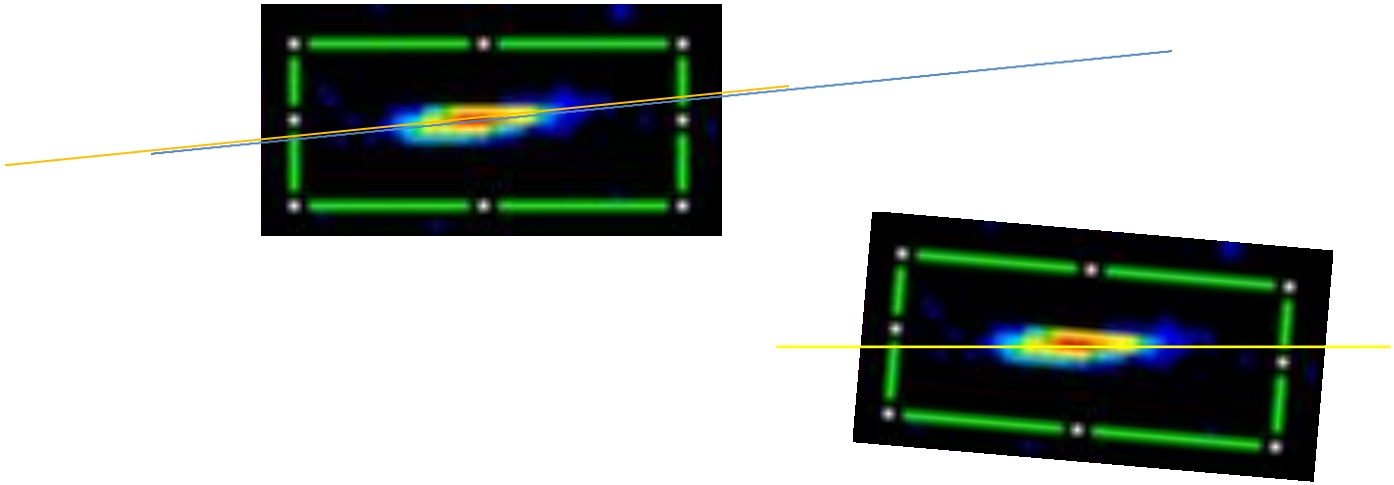


75A_300kV_S1_V3

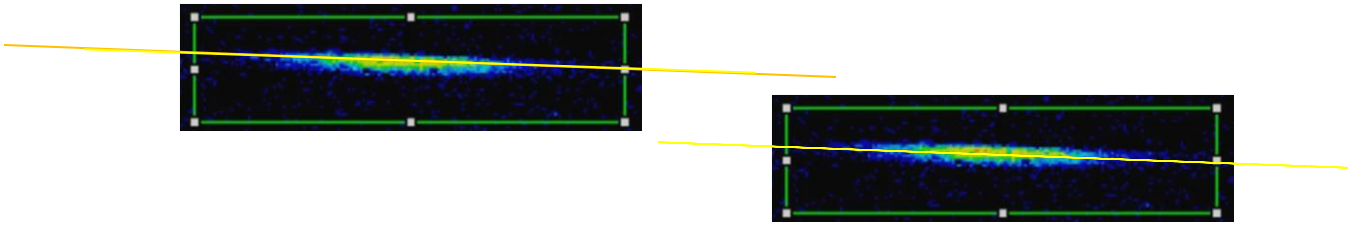




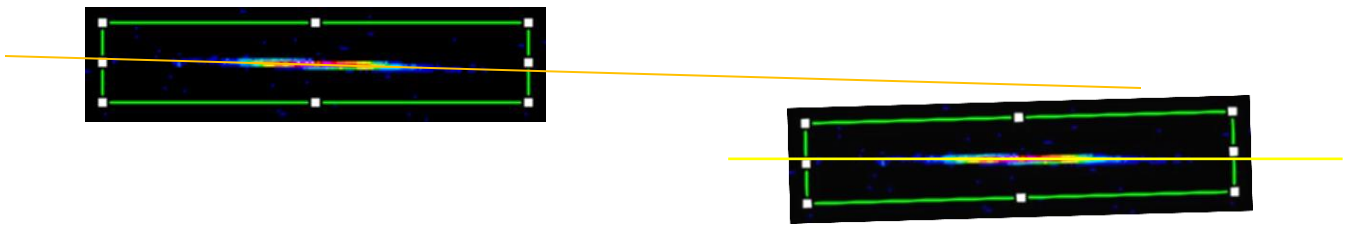
75A_300kV_S1_V2



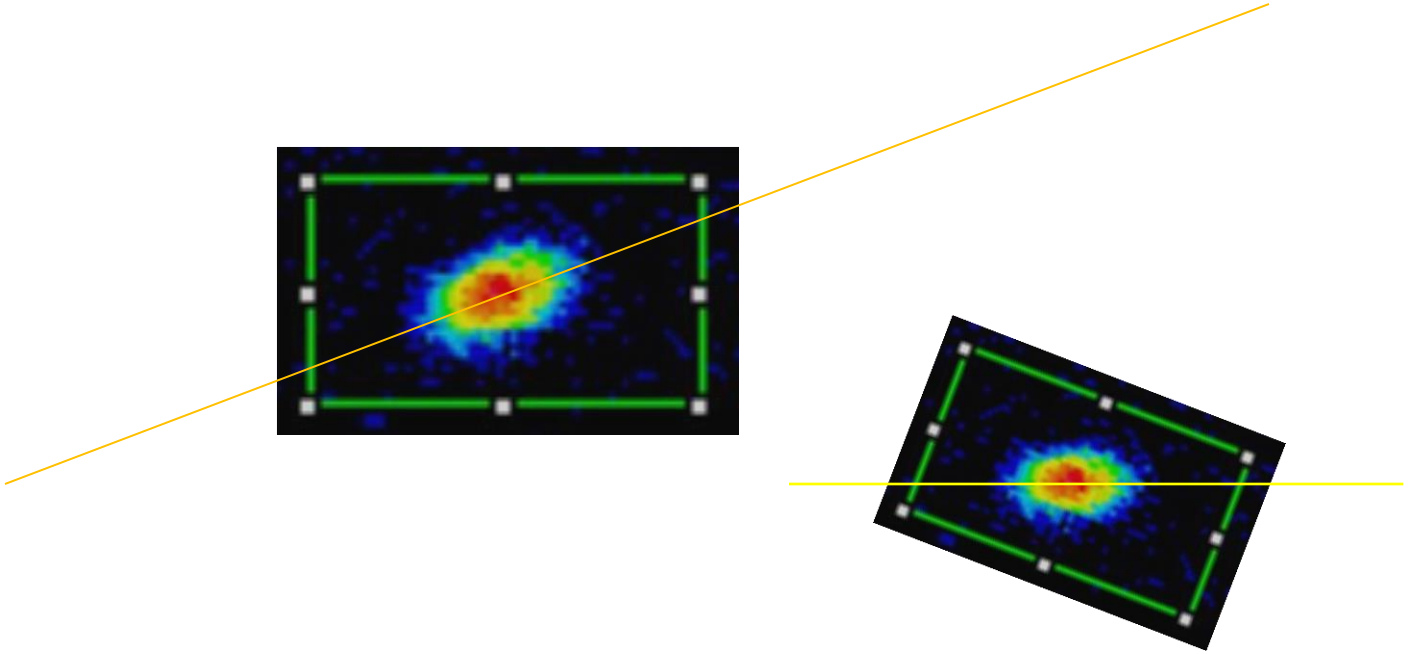
50A_300kV_S1_V3



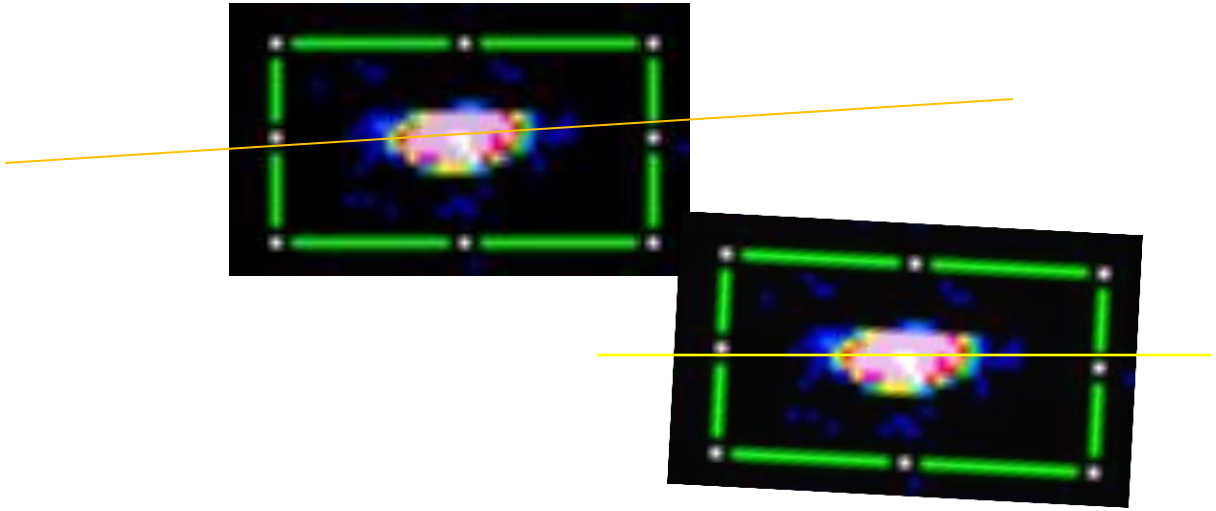
50A_300kV_S1_V2



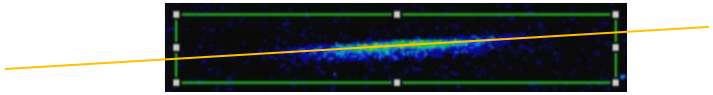
25A_300kV_S1_V3

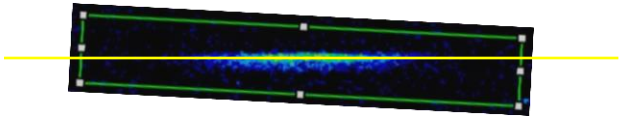


25A_300kV_S1_V2

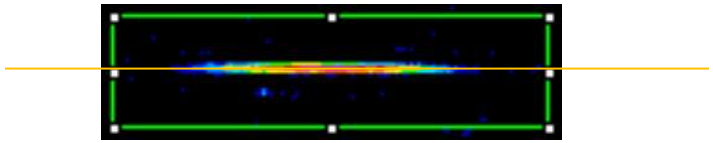


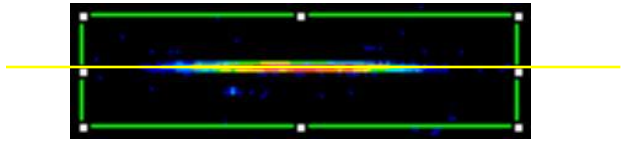
0A_300kV_S1_V3





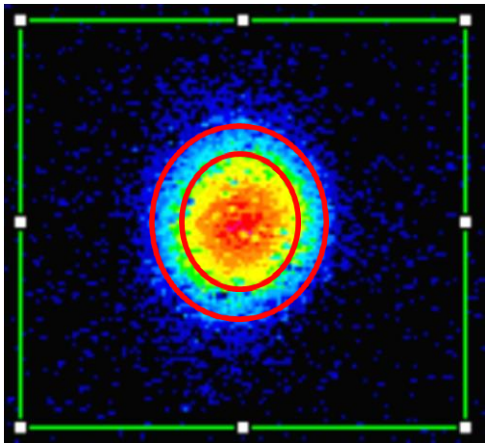
0A_300kV_S1_V2

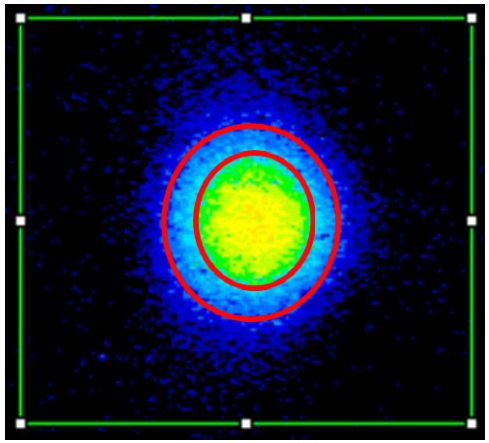


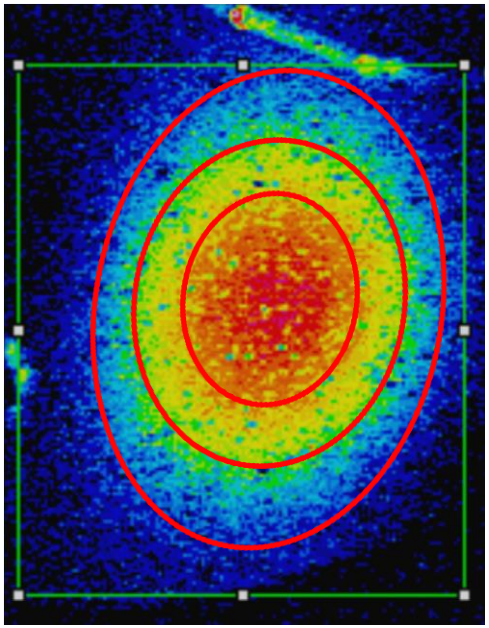


0A_300kV_V1_V2_V3

355,355,350



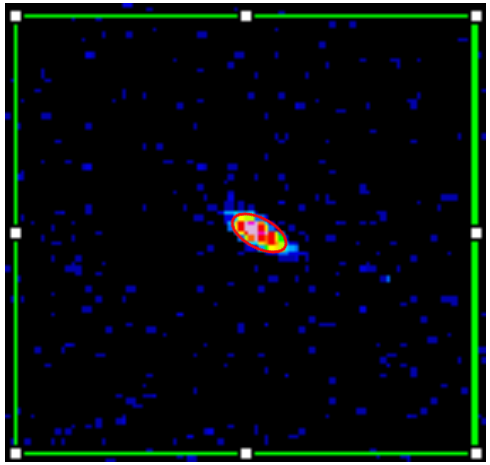


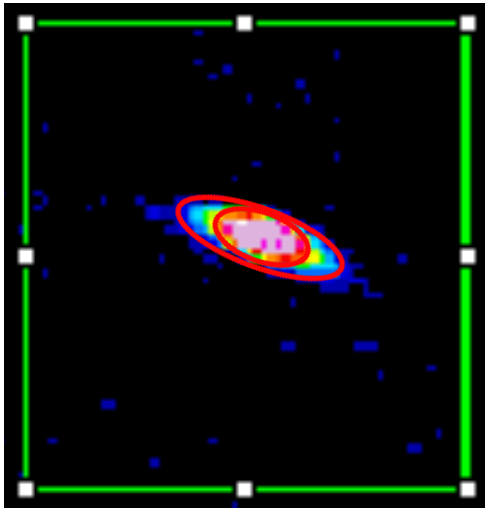


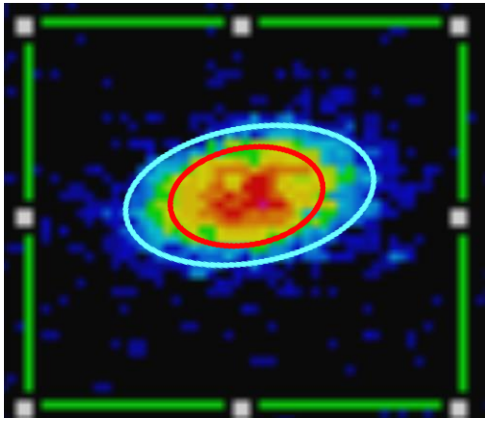
AR: 1/.9,1/.9,1.7/1.4

25A_300kV_V1_V2_V3

62,70,100



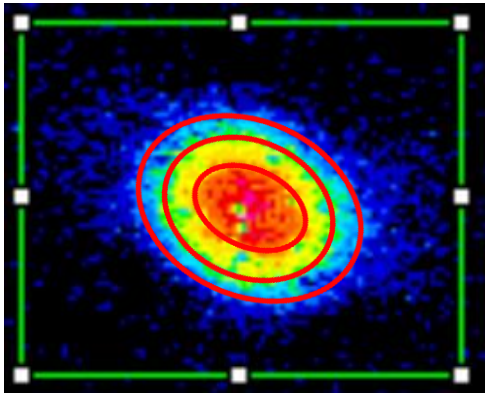


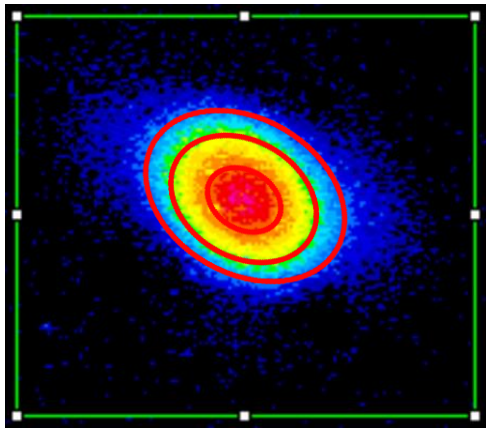


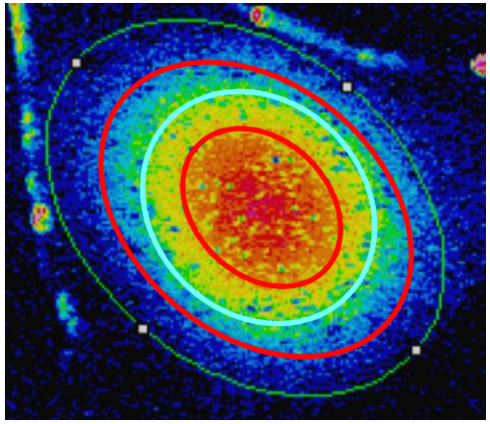
AR: .3/.15,.8/.3,1.3/.7

50A_300kV_V1_V2_V3

65,60,50



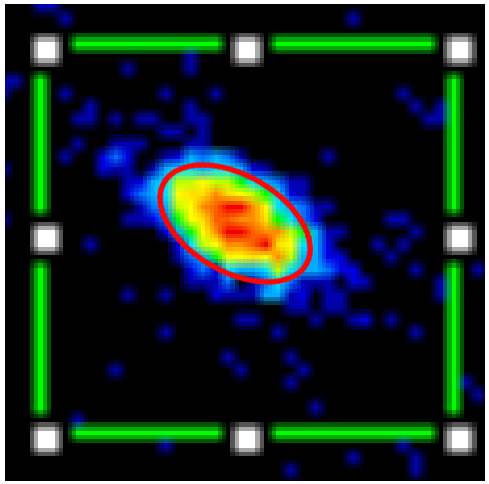


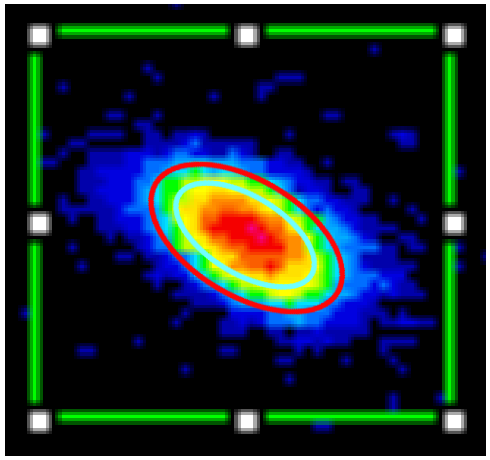


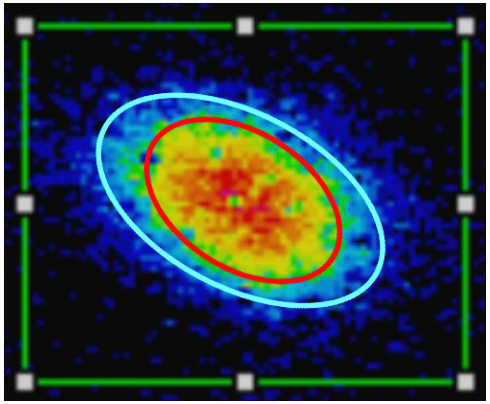
AR: .9/.7,.8/.6,1.8/1.3

75A_300kV_V1_V2_V3

60,59,57



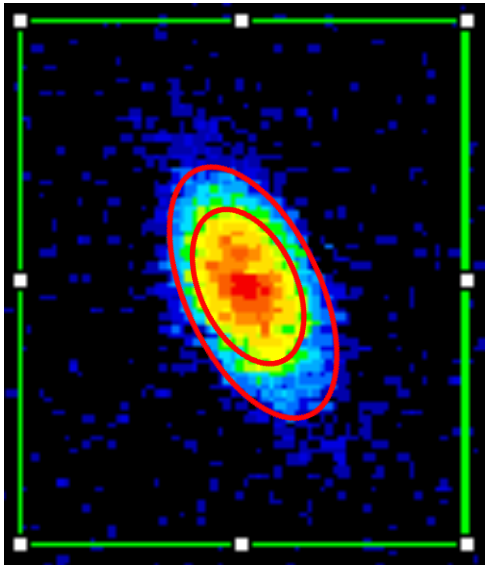


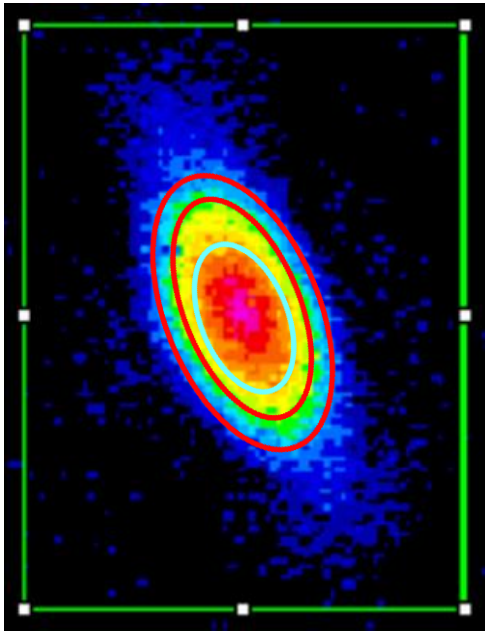


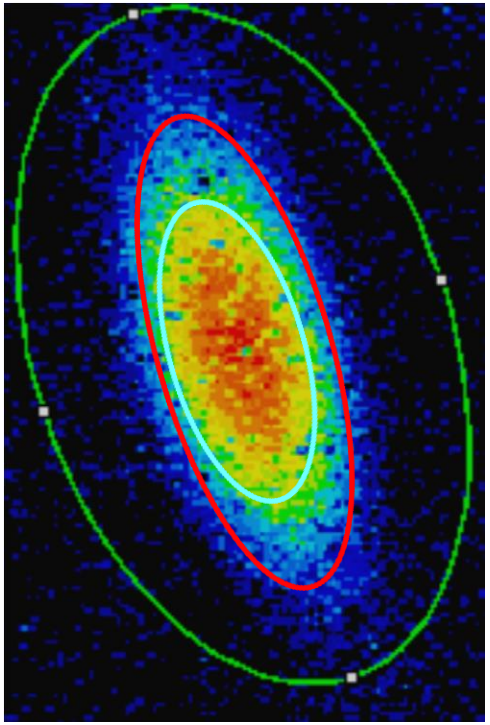
AR: .85/.5,1.1/.6,1.1/.7

100A_300kV_V1_V2_V3

25,22,16

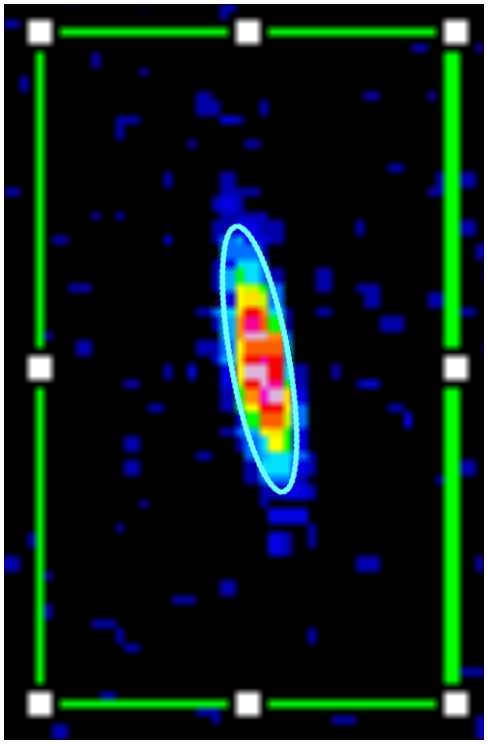


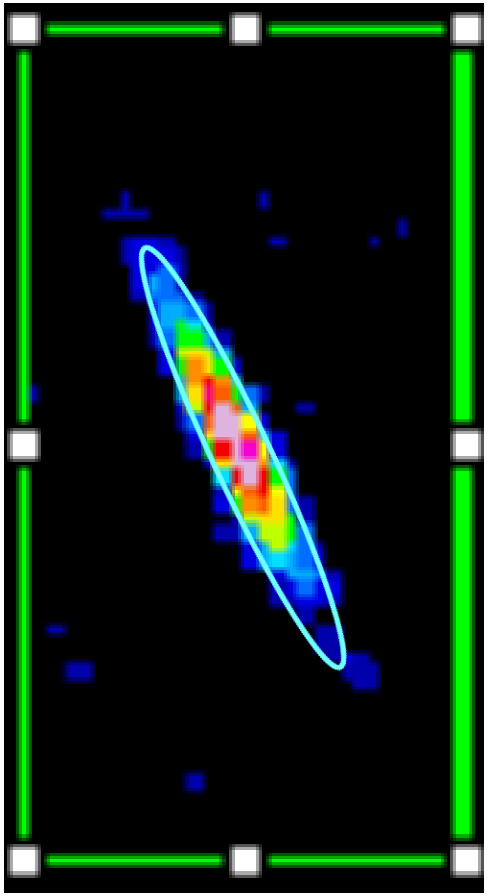




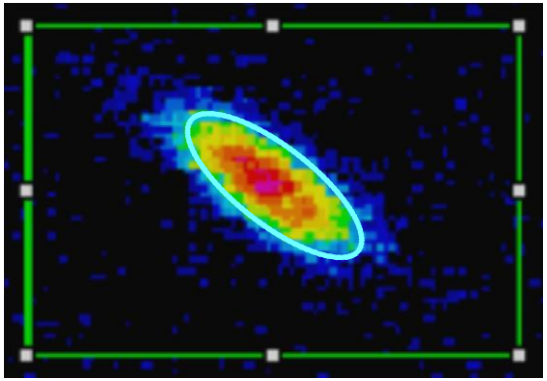
AR: .85/.5,1.6/.8,1.6/.7

150A_300kV_V1_V2_V3





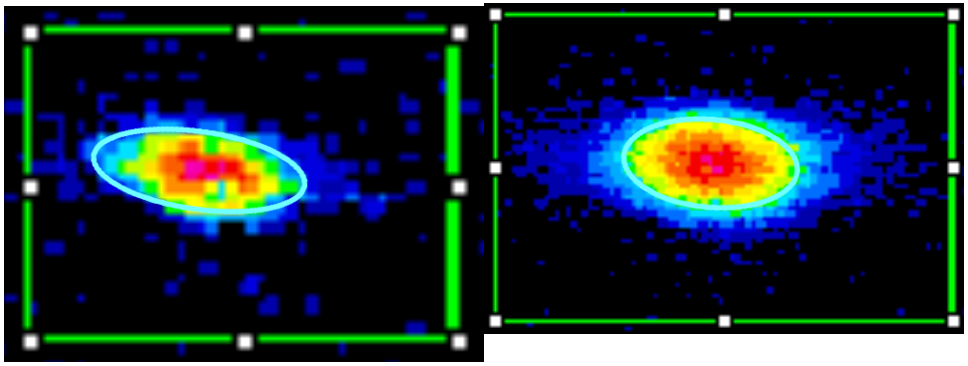
10,25,52

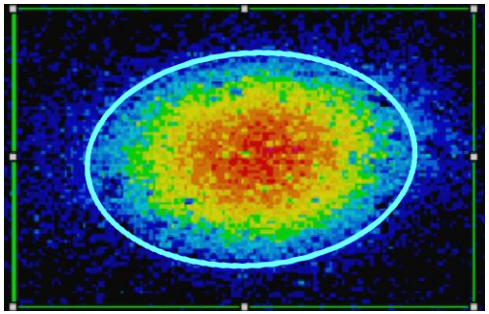


AR: 1.4/.3,2.4/.3,1.1/.4

200A_300kV_V1_V2_V3

82,85,94

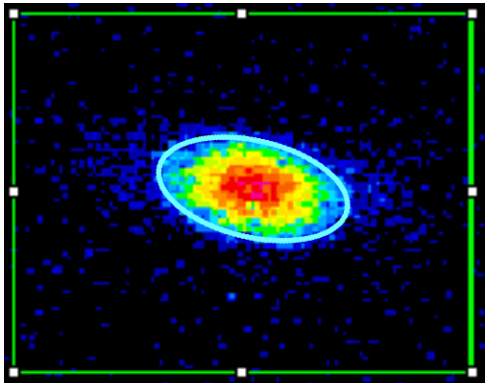


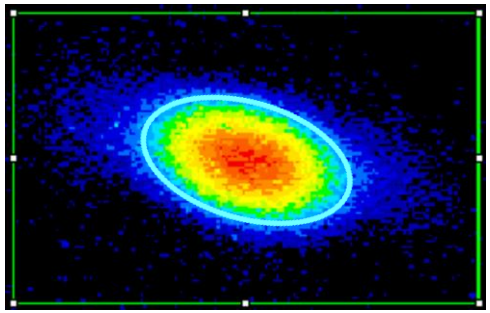


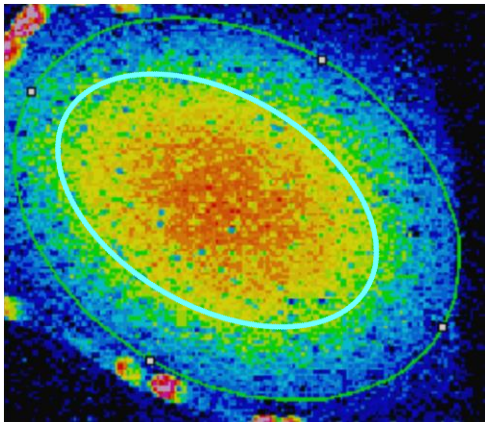
AR: 1.1/.4,1/.5,1.7/1.1

250A_300kV_V1_V2_V3

77,74,60



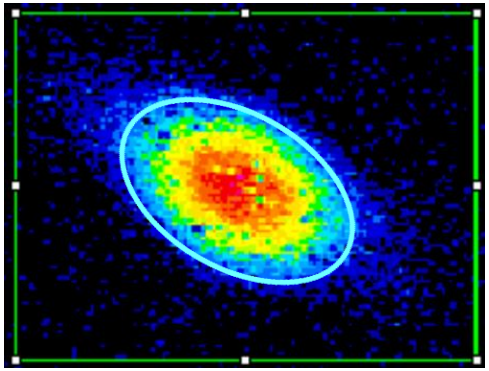


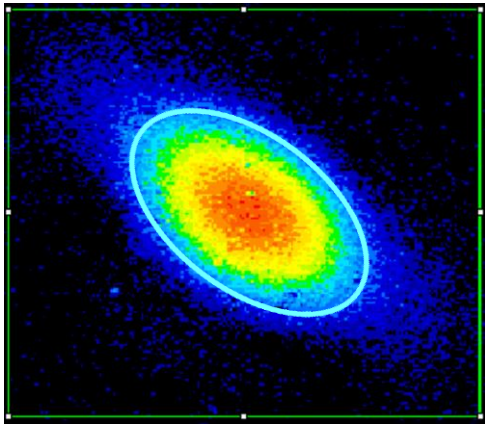


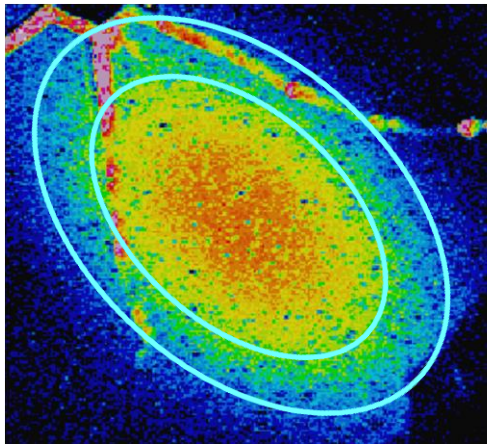
AR: 1/.5,1.1/.6,1.8/1.1

300A_300kV_V1_V2_V3

60,53,48







AR: 1.3/.8,1.4/.8,2.5/1.6