The following atlas contains arc line identifications for most of the most commonly used gratings for use with the Double Spectrograph. If any mistakes are found, or if you have requests for gratings and/or arc line combinations which are not here, please send them to `hmj@deimos.caltech.edu`.

In addition, I would like to keep a log of angles *vs.* central wavelength in order to improve the values given in Figure 1. These values were from my own measurements, and I have found them to be very repeatable. If you have an *accurate* measurement of the central wavelength of your setup (*e.g.* from running ARC), could you please note down on the following list the camera (red or blue), grating and order used, the angle of the grating, and the central wavelength.

Helen Johnston

Camera	Grating	Order	Angle	Central λ	Observer

Atlas of arc lines for the Double Spectrograph

Helen Johnston, Caltech 1990 X4051

The following atlas contains wavelength identifications for the six arcs in use with the Double Spectrograph, at the dispersions provided by the various gratings and covering the whole of the useful wavelength range. The exposure times used for the arcs are given in Table 1. These exposure times were chosen so as to avoid saturating the lines, and so can be used as a guide, although the strength of the lamps does vary somewhat over time.

Table 1.
Exposure times

Arc	Grating		Exposure		
	g mm^{-1}	Å pix^{-1}	time (s)	Figure	Page
		Blue camera			
Argon	300	2.1	5	2	8
Helium			0.2	3	10
He+Hg			0.2	4	12
Hollow cathode			5	5	14
Mercury			0.2	6	16
Argon	600	1.1	5	7	18
Helium			5	8	20
He+Hg			2	9	24
Hollow cathode			30	10	28
Hollow cathode	1200	0.55	10	11	32
		Red camera			
Argon	158	6.1	0.1	12	38
Helium			0.1	13	39
Neon			0.2	14	40
Ne+Ar			0.2	15	41
Hollow cathode	316	3.1	1	16	42
Neon			1	17	44
Neon	1200	0.8	5	18	46

Arcs are shown for each lamp individually, as well as some combinations which may be found useful. For the high dispersion gratings, a range of grating angles was used to cover the whole wavelength range, as indicated by the grating angle shown at the top of each plot.

The arc lines were fit using the FIGARO program ARC, using a 3rd order polynomial. Note that all wavelengths and pixel numbers are increasing from left to right: this corresponds to performing YSTRACT on a raw DBSP CCD image followed by an IREVX, *i.e.*

$ YSTRACT IM = S1N XS = 100 XE = 110 SP = ARC.

Alternatively, the same result can be acheived by rotating the image so the dispersion runs along the x-axis, followed by an EXTRACT without reversal, *i.e.*

$ ROTATE IM = S1N OUT = S1N.

See the FIGARO manual for more information. A detailed description of ARC can be obtained by typing HELP FIGARO TECHNIQUES ARC.

Caution should be exercised when using the hollow cathode (FeAr) lamp at low dispersions. Many of the lines are blends, as can be seen in the high dispersion plots, and so wavelength calibration will not be precise if these lines are used blindly.

Figure 1 shows a plot of the angle required to achieve a certain wavelength. The data points show the measurements taken by the author; the lines are 2nd order fits to the points. Wavelengths have been found to be repeatable to a few pixels from run to run, provided care is taken setting the angles. The dotted lines show gratings for which measurements were not taken; these angles as a function of wavelength were taken from the Double Spectrograph Manual.

The equations of the fitted lines are

$$\theta = a_0 + a_1\lambda + a_2\lambda^2$$

with θ measured in degrees and λ in Å. The coefficients for the various gratings are given in Table 2.

Table 2.
Coefficients for $\theta(\lambda)$

Camera	Grating $g\,mm^{-1}$	a_0	a_1	a_2
Blue	1200	21.2688	2.81308×10^{-3}	$1.06511 \times 10-7$
	1200 II	21.7660	5.51355×10^{-3}	$3.74213 \times 10-7$
	600	19.2724	1.98818×10^{-3}	$-1.88961 \times 10-8$
	300	20.1026	6.99267×10^{-4}	$1.63843 \times 10-8$
	158 II	19.1775	9.60567×10^{-4}	$5.03633 \times 10-11$
Red	1200	20.5918	2.55617×10^{-3}	$1.00824 \times 10-7$
	600	17.6405	1.74601×10^{-3}	$7.29582 \times 10-9$
	316	16.9188	9.99774×10^{-4}	$-1.26147 \times 10-9$
	158	17.2271	4.75943×10^{-4}	...

The arcs themselves are shown in Figures 2–18. The tables following contain the wavelengths of the various arcs. The data was taken from the *CRC Handbook* (1982) [1], and (for the hollow cathode lamp), from Stathakis and Hunstead (1986) [2]. The columns show the wavelength in air (in Å), an approximate intensity, and the ionization state. (In the case of the hollow cathode arc, no line strengths or ionization states are given; instead, the element is indicated). The intensity value should be approached with caution, particularly when comparing intensities from different species. The arcs themselves in the Figures are the best guide to intensities in the spectrograph.

These wavelength tables can be accessed from FIGARO. They are essentially the files found in FIGARO_PROG_L:xxx.ARC, and can be accessed by the program ARC by specifying the name at the top of the table in response to the prompt ARCTYPE.

References

[1] *CRC Handbook of Chemistry and Physics, 63rd edition*, ed. R.C. Weast and M.J. Astle (Boca Raton: CRC Press)

[2] Stathakis, R.A. and Hunstead, R.W. 1986, "Atlas for the iron-argon hollow cathode lamp from 3000 to 7700Å", AAO UM 4.

Figure 1a

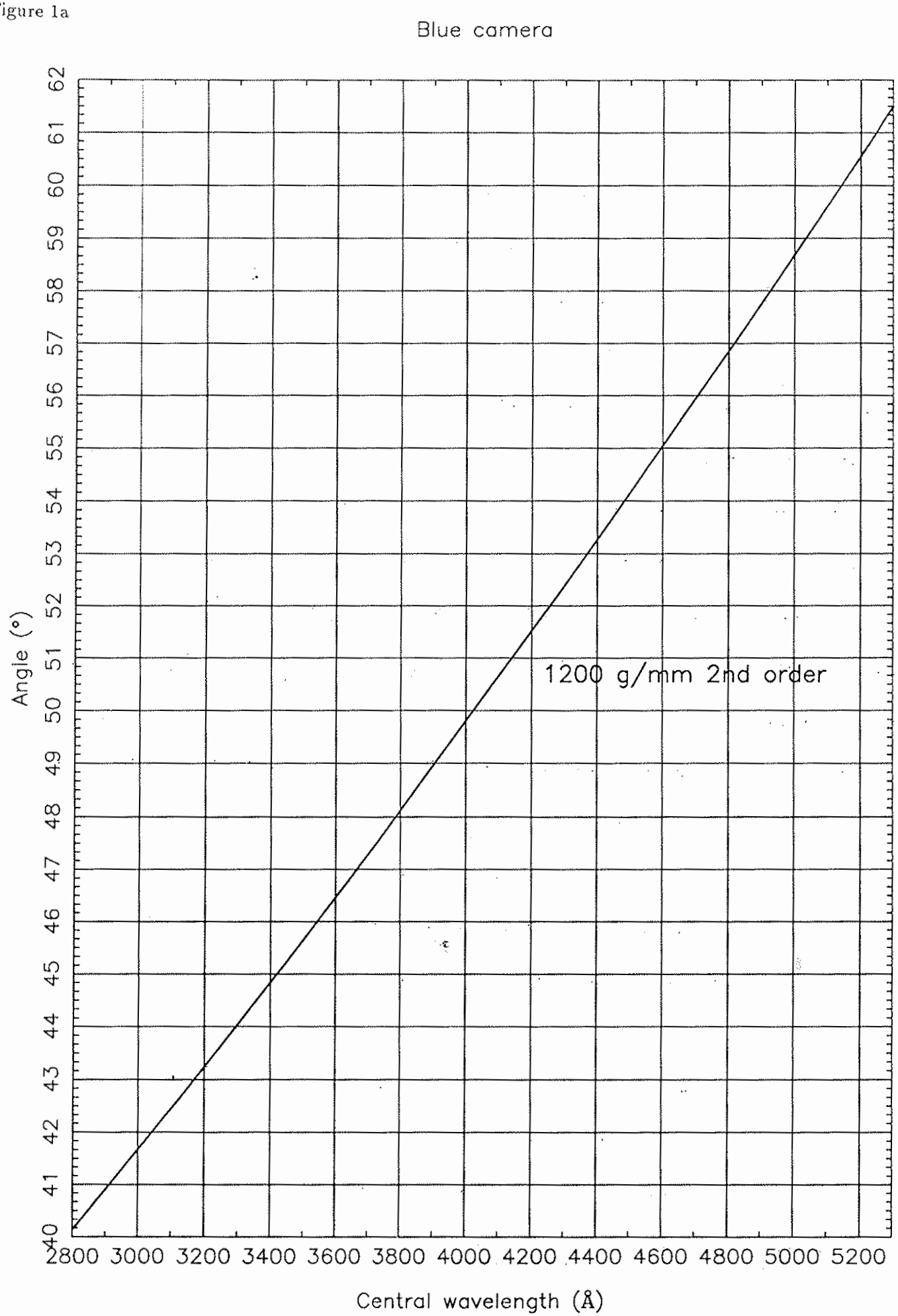

Blue camera
Angle (°)
40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62
1200 g/mm 2nd order
2800 3000 3200 3400 3600 3800 4000 4200 4400 4600 4800 5000 5200
Central wavelength (Å)

Figure 1b

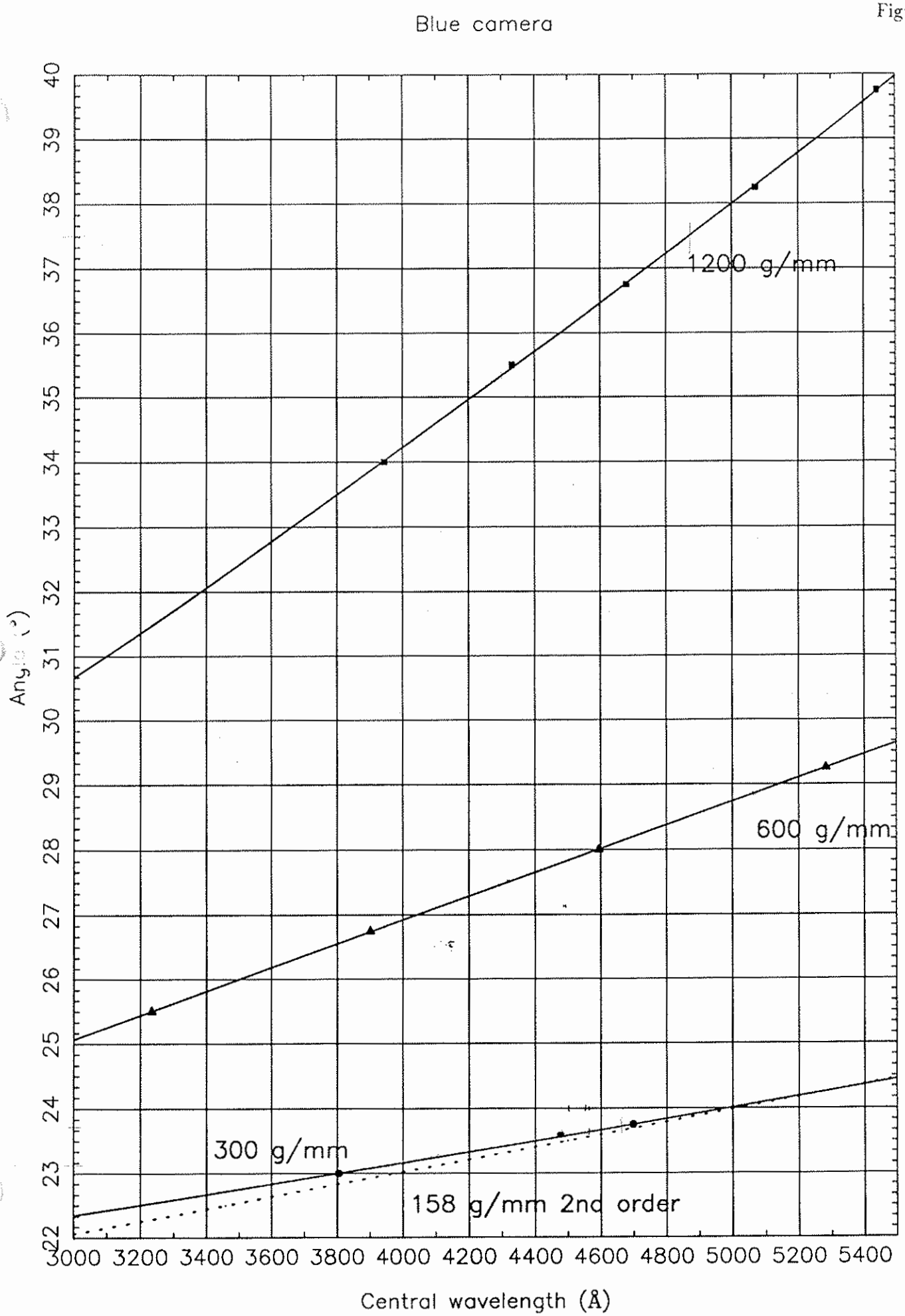
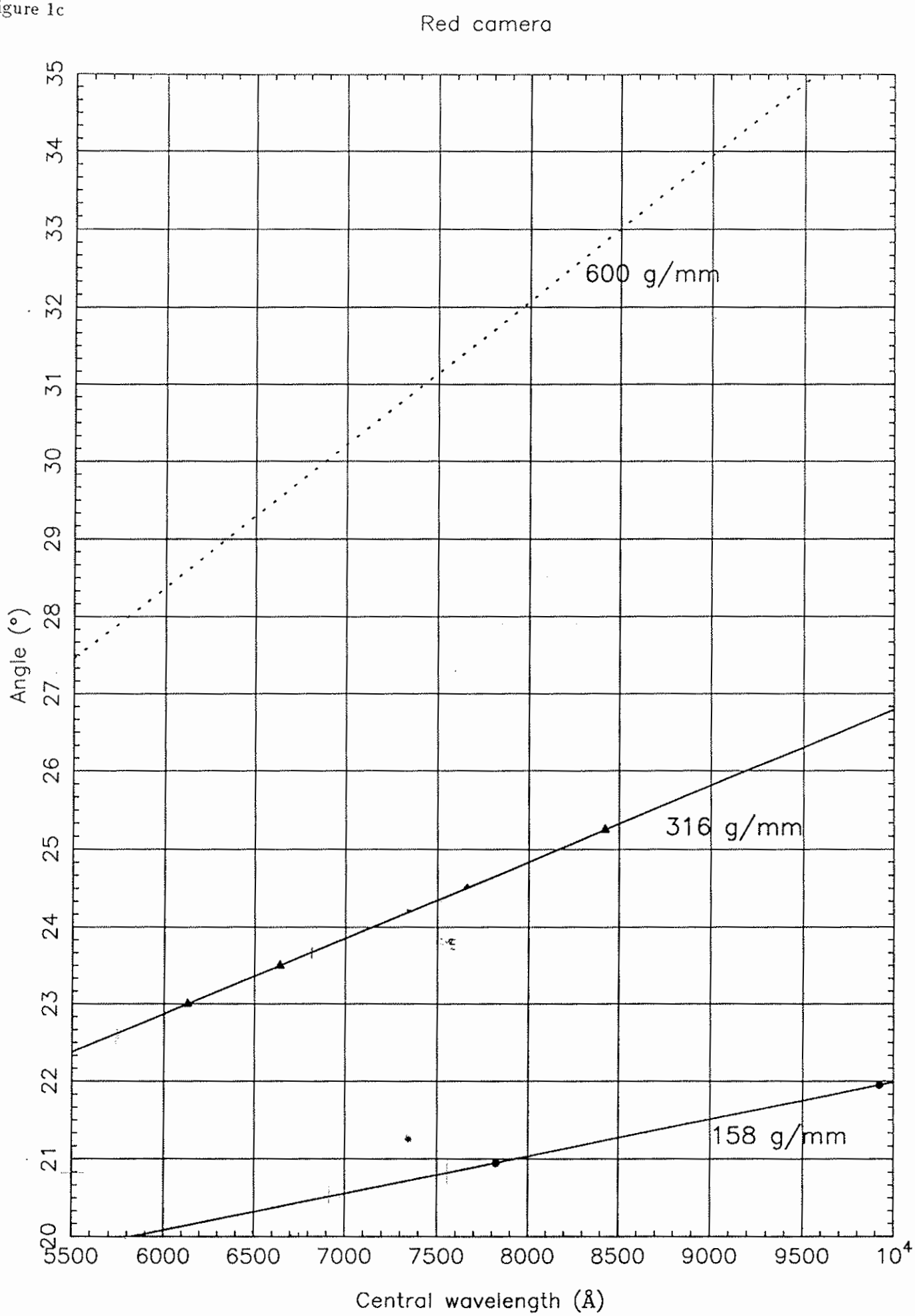

Blue camera
1200 g/mm
600 g/mm
300 g/mm
158 g/mm 2nd order
Central wavelength (Å)

Figure 1c


Red camera
600 g/mm
316 g/mm
158 g/mm
Angle (°)
Central wavelength (Å)
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
5500
6000
6500
7000
7500
8000
8500
9000
9500
10^4

RED CAMERA 600/9500@30 32 NE3SEC 4/2/99

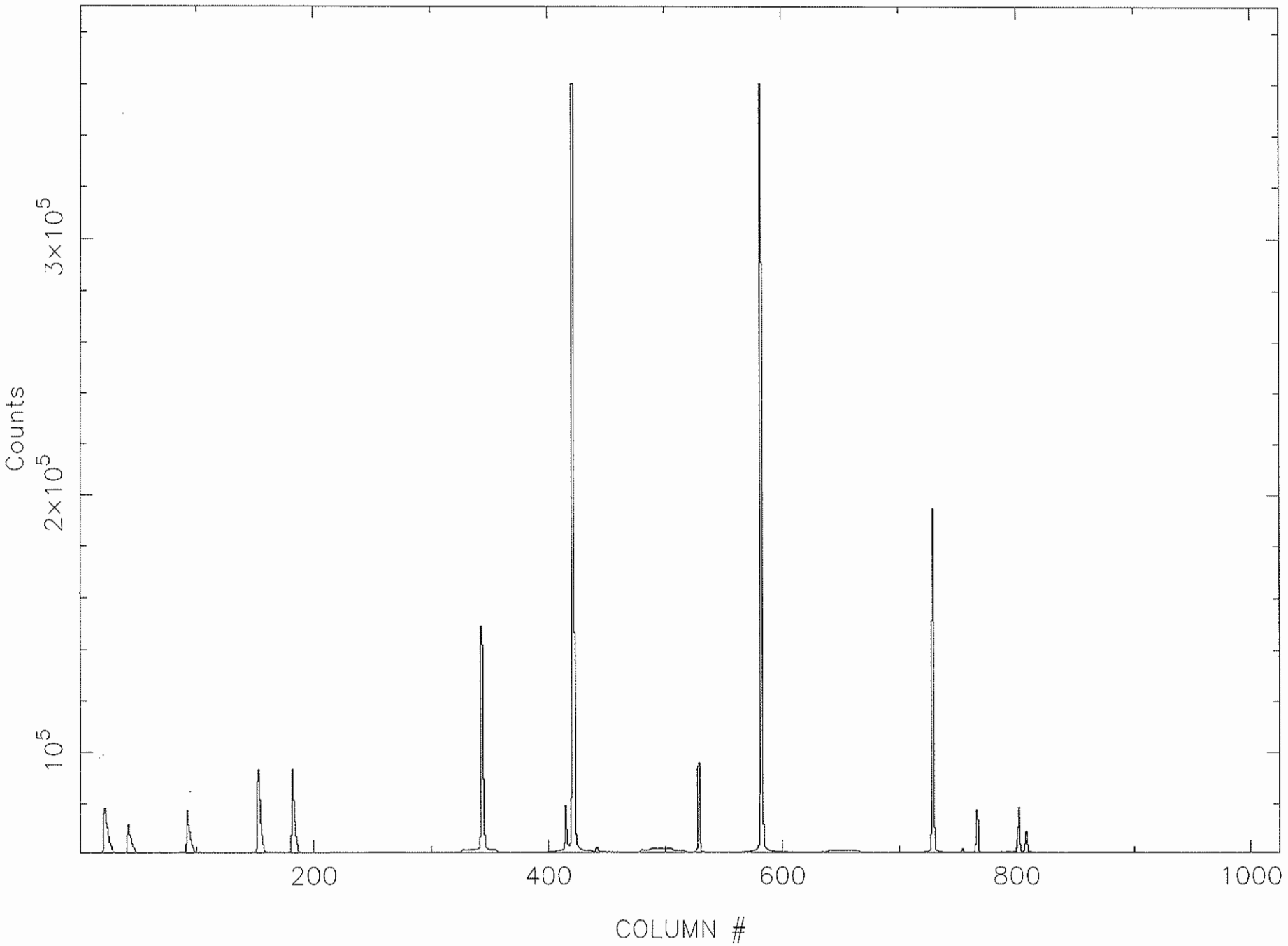


Figure 1d

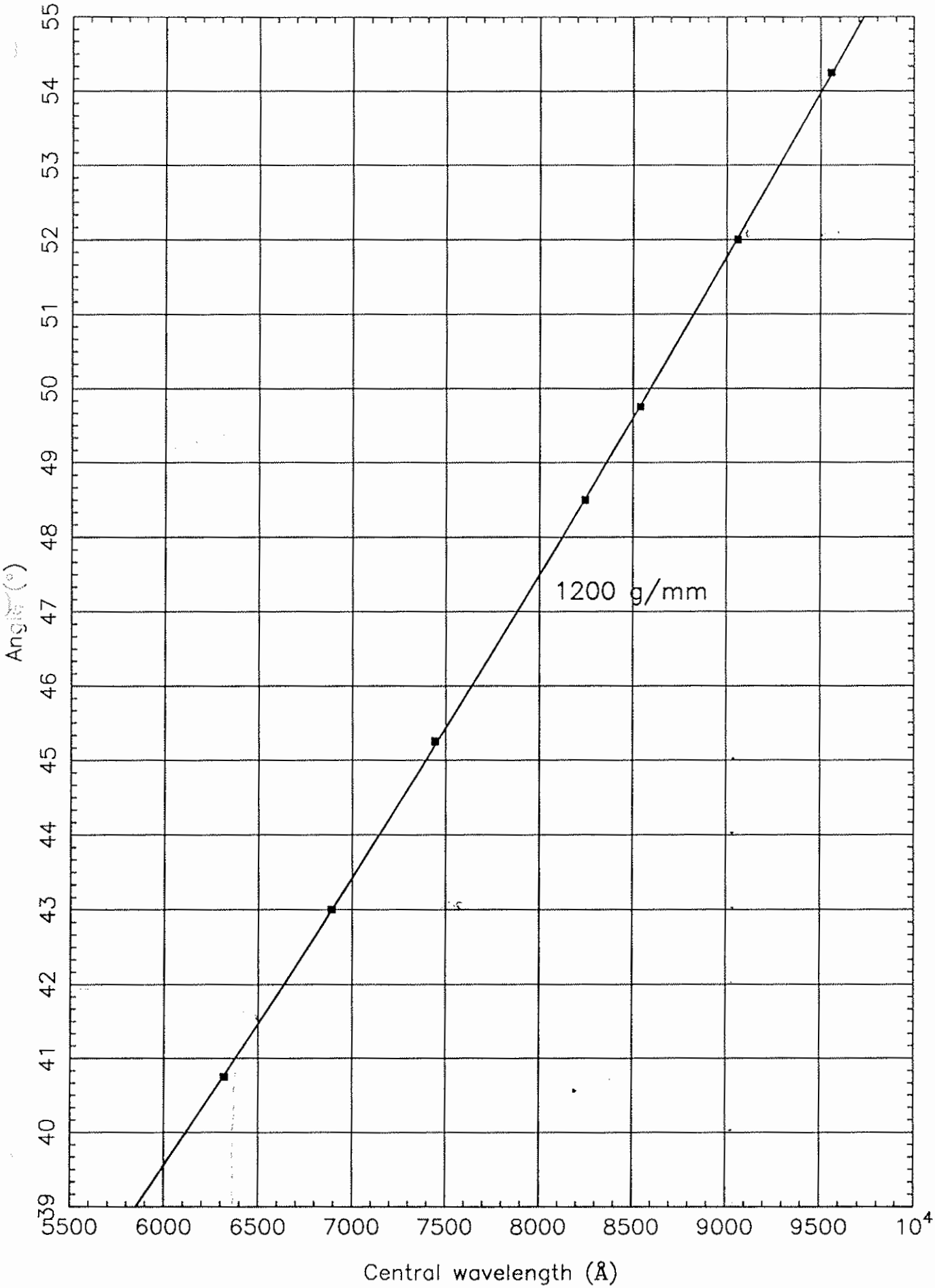

Red camera
1200 g/mm
Angle (°)
Central wavelength (Å)
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
5500
6000
6500
7000
7500
8000
8500
9000
9500
10⁴

Figure 2a

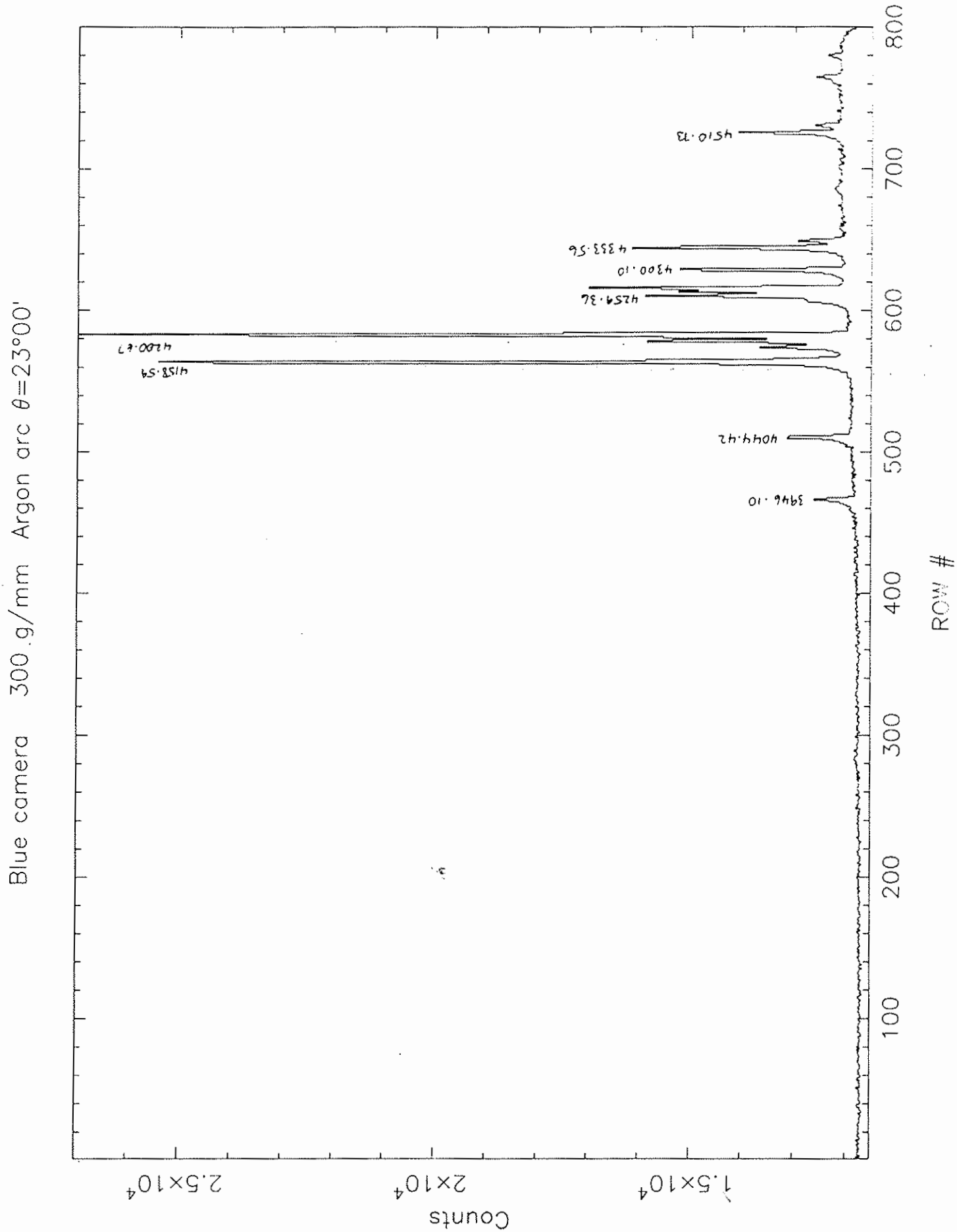

Blue camera 300 g/mm Argon arc θ=23°00'
Counts
1.5×10⁴
2×10⁴
2.5×10⁴
ROW #
100
200
300
400
500
600
700
800
4946.10
4944.42
4158.54
4200.67
4259.36
4300.10
4333.56
4510.73

Figure 2b

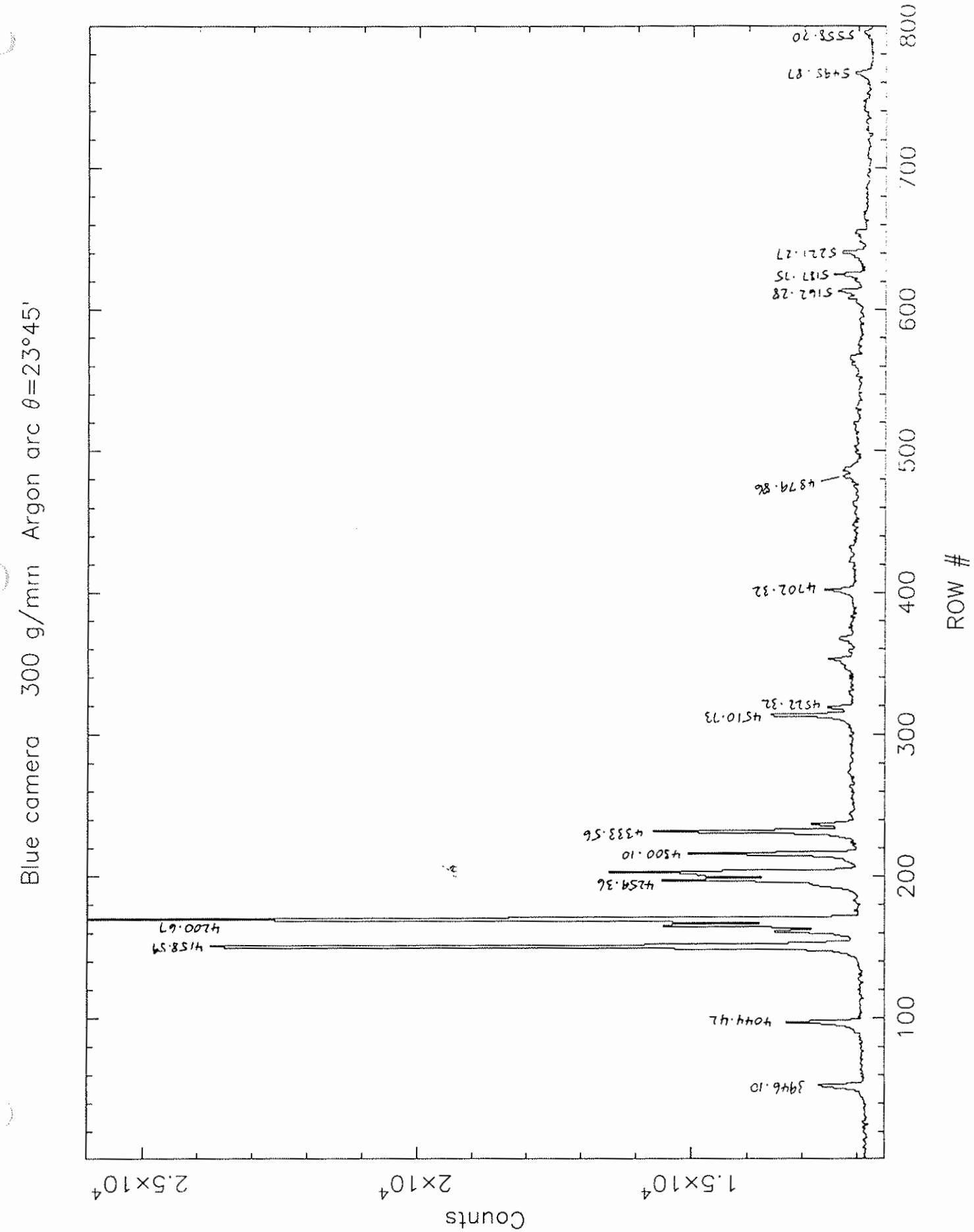
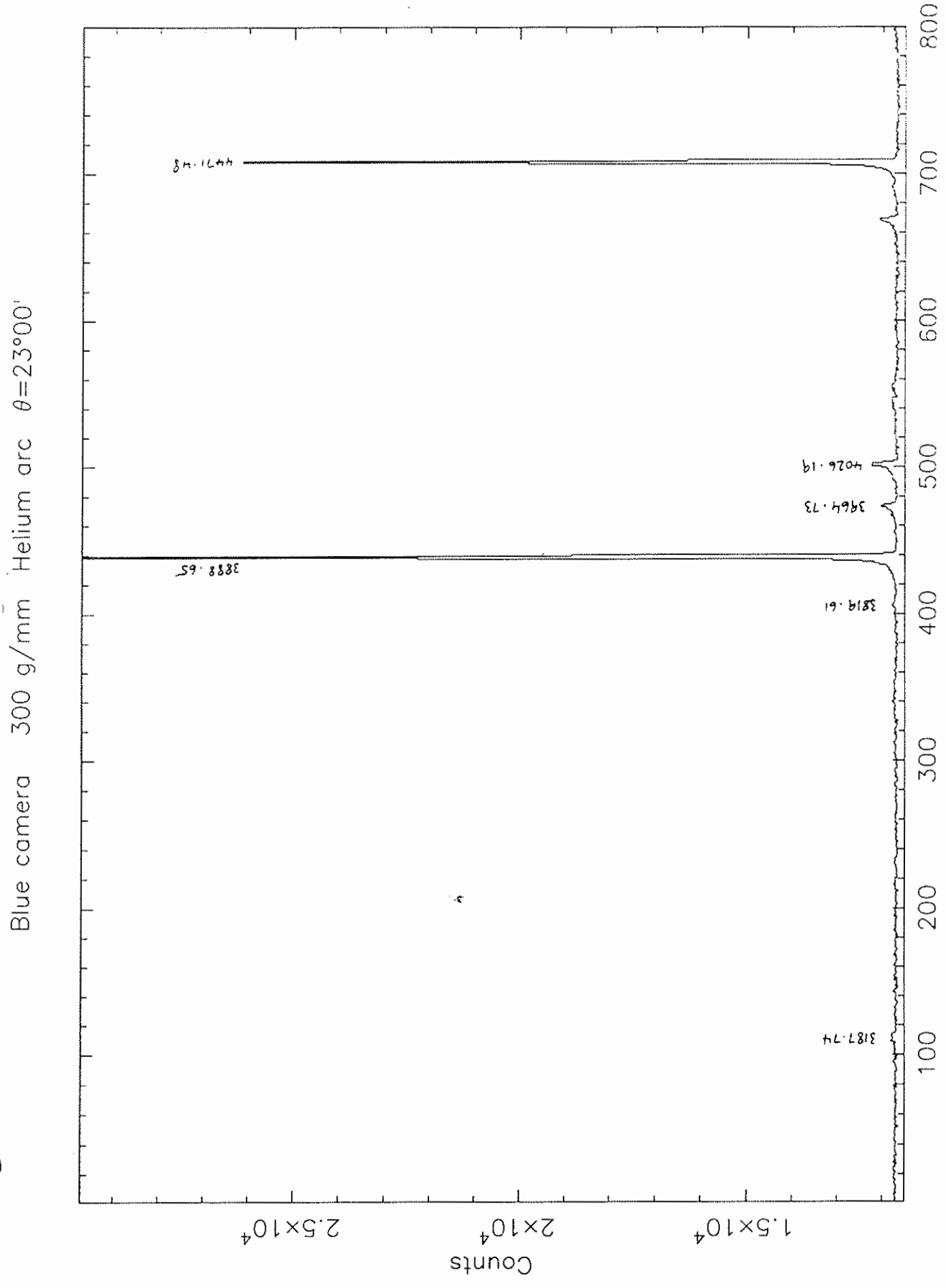

Blue camera 300 g/mm Argon arc θ=23°45'
Counts
1.5×10⁴
2×10⁴
2.5×10⁴
ROW #
100
200
300
400
500
600
700
800
3946.10
4044.42
4158.59
4200.67
4254.36
4300.10
4333.56
4510.73
4522.32
4702.32
4874.86
5162.28
5187.75
5221.27
5445.87
5558.20

Figure 3a


Blue camera 300 g/mm Helium arc θ=23°00'
Counts
1.5×10⁴
2×10⁴
2.5×10⁴
100
200
300
400
500
600
700
800
3187.74
3819.61
3888.65
3964.73
4026.19
4471.48

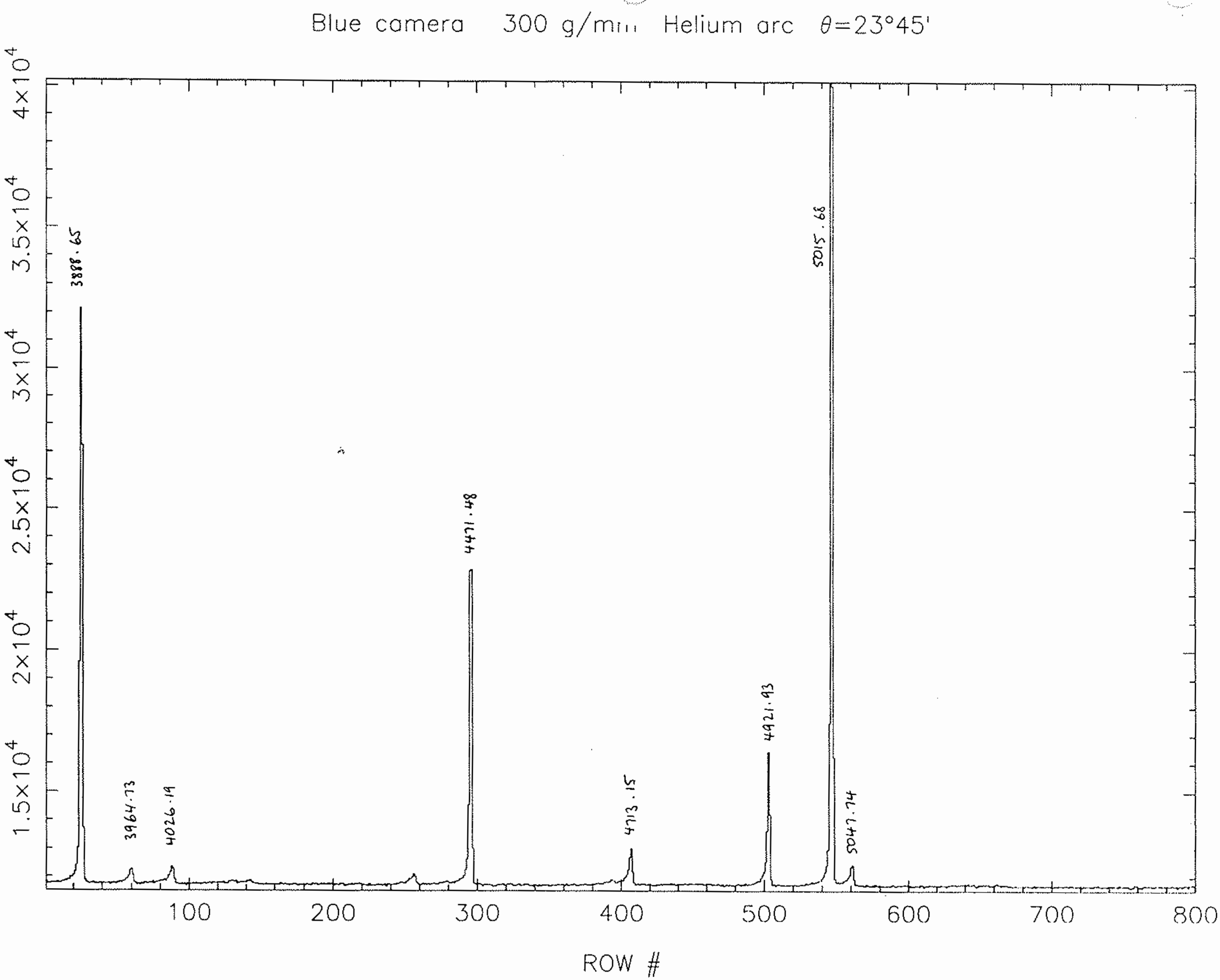
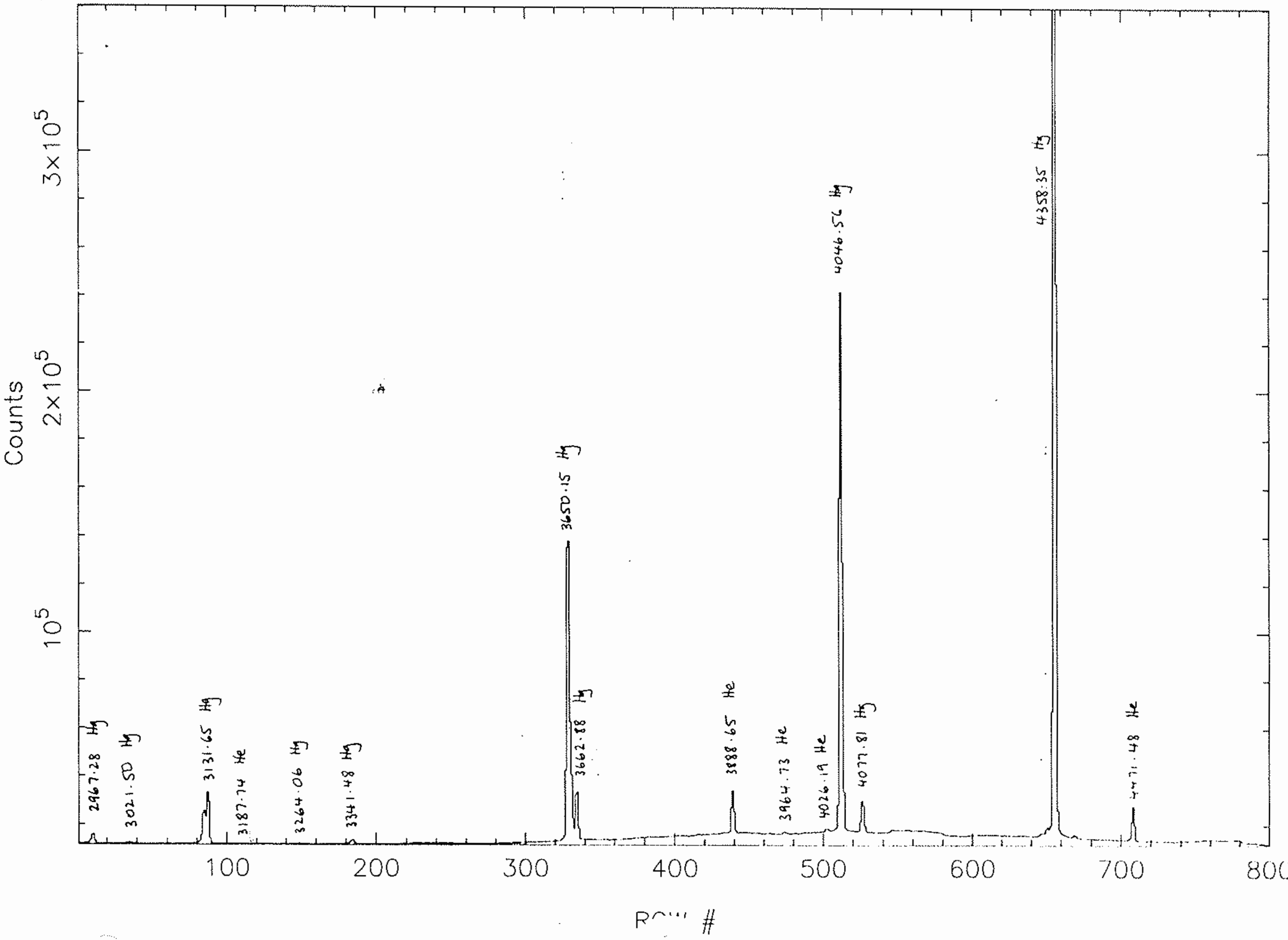

Blue camera 300 g/mm Helium arc θ=23°45'
Counts
ROW #
4×10^4
3.5×10^4
3×10^4
2.5×10^4
2×10^4
1.5×10^4
100
200
300
400
500
600
700
800
3888.65
3964.73
4026.19
4471.48
4713.15
4921.93
5015.68
5047.74

Figure 3b

Blue camera 300 g/mm Helium+mercury arc θ=23°00'



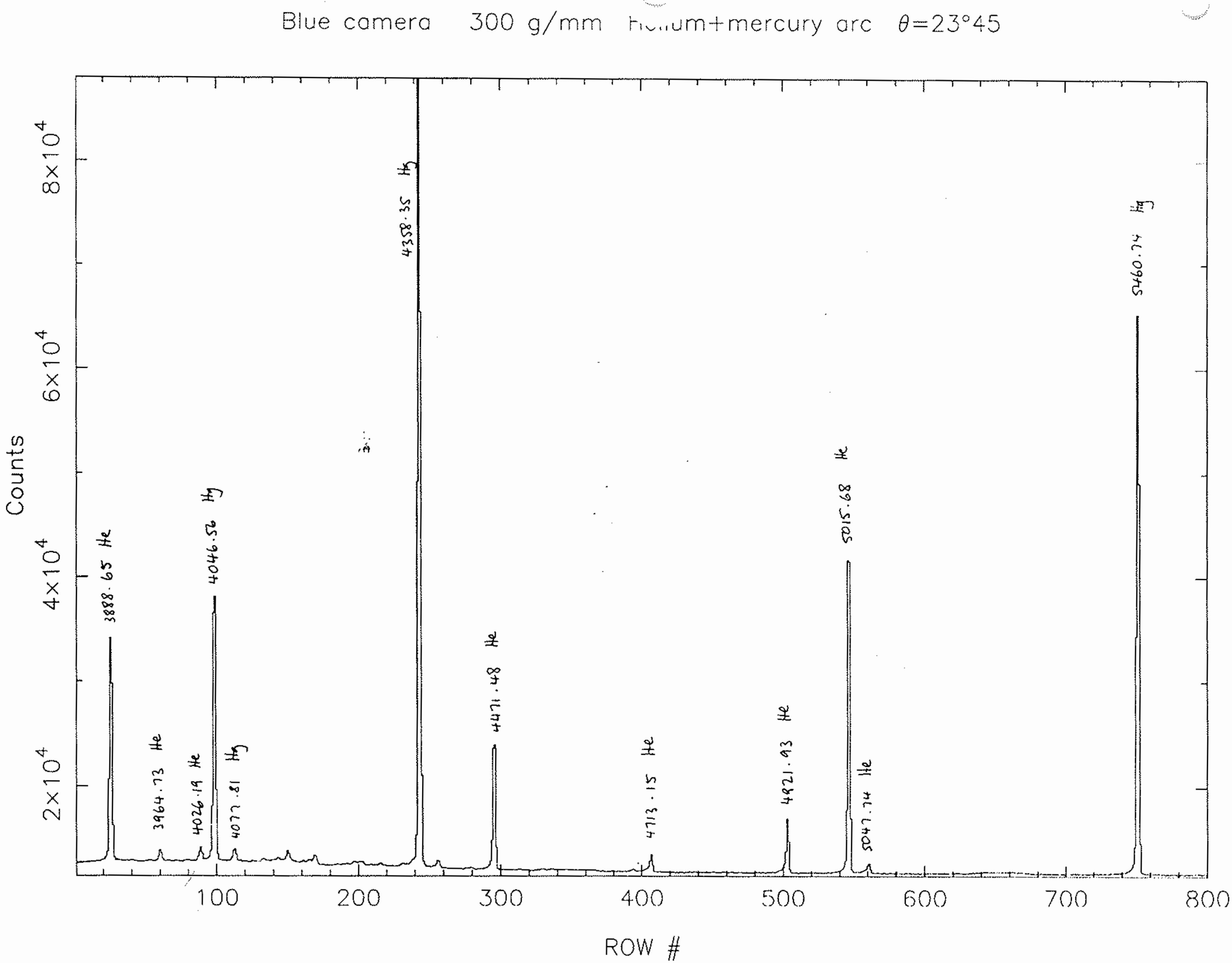
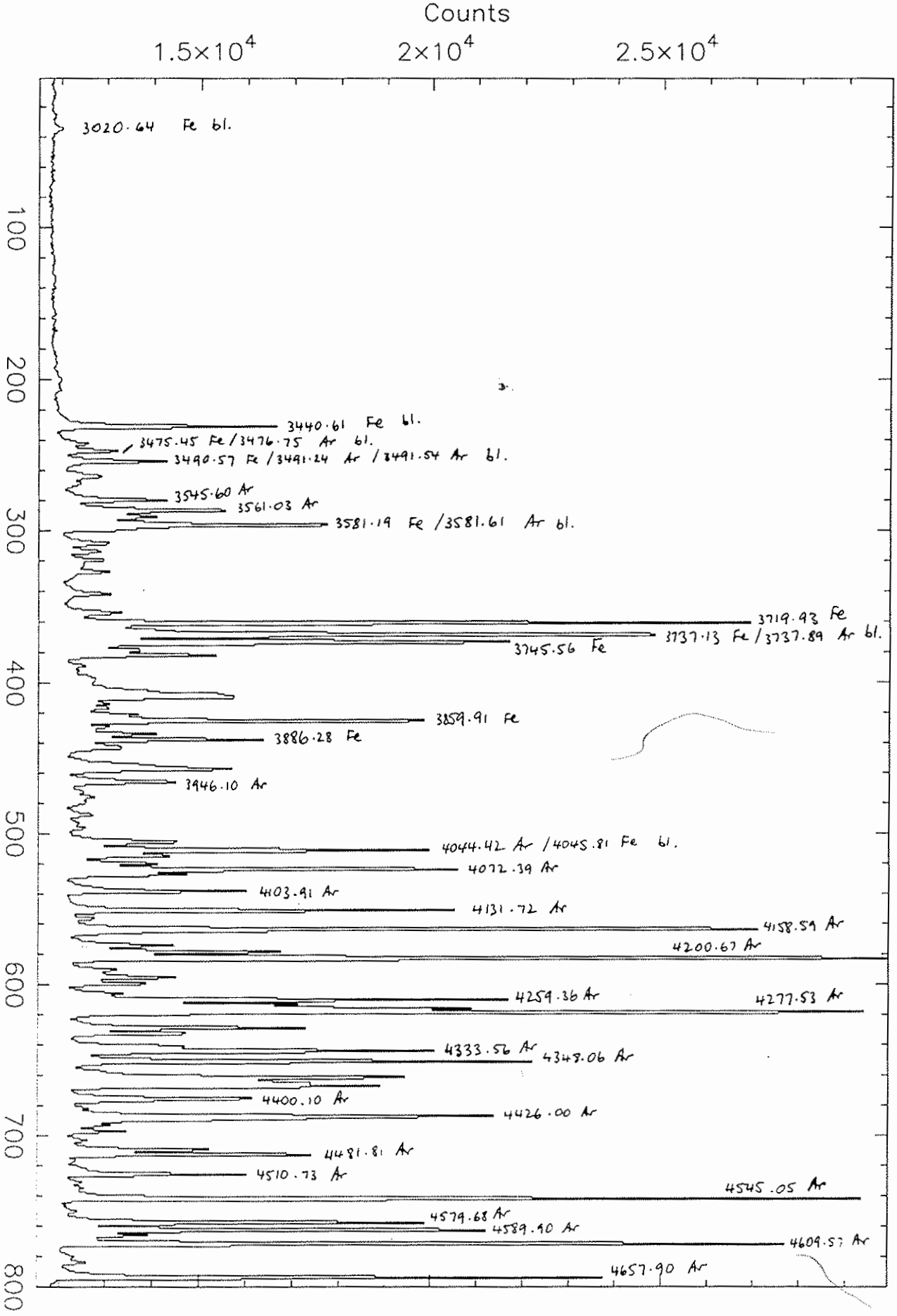

Blue camera
300 g/mm
+mercury arc
θ=23°45
Counts
ROW #
2×10^4
4×10^4
6×10^4
8×10^4
100
200
300
400
500
600
700
800
3888.65 He
3964.73 He
4026.19 He
4046.56 Hg
4077.81 Hg
4358.35 Hg
4471.48 He
4821.93 He
5015.68 He
5047.74 He
5460.74 Hg

Figure 4b

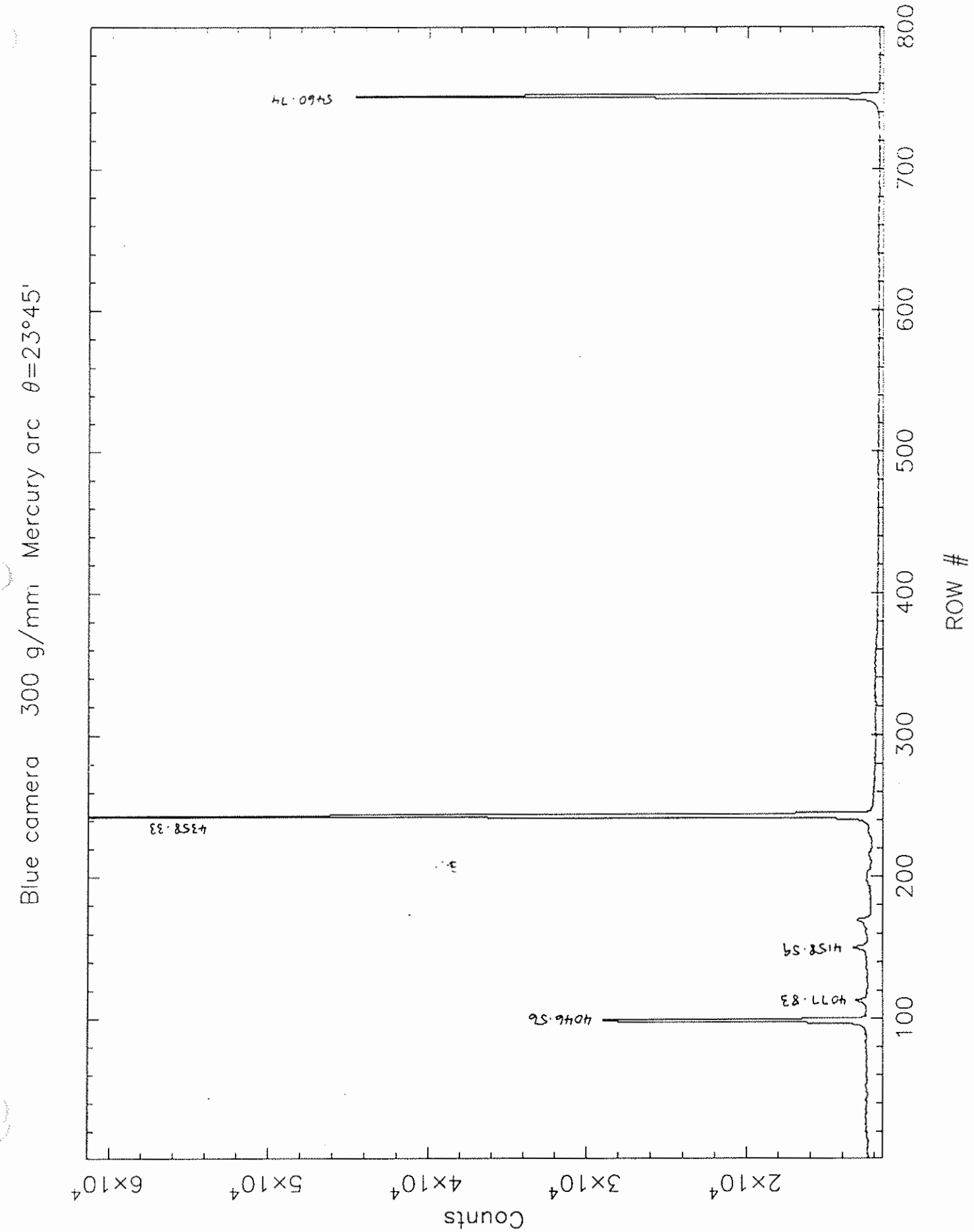


Blue camera 300 g/mm. Hollow cathode (FeAr) arc $\theta = 23°00'$

Pr. #

Figure 5a

Figure 6b


Blue camera 300 g/mm Mercury arc θ=23°45'
Counts
2×10⁴
3×10⁴
4×10⁴
5×10⁴
6×10⁴
ROW #
100
200
300
400
500
600
700
800

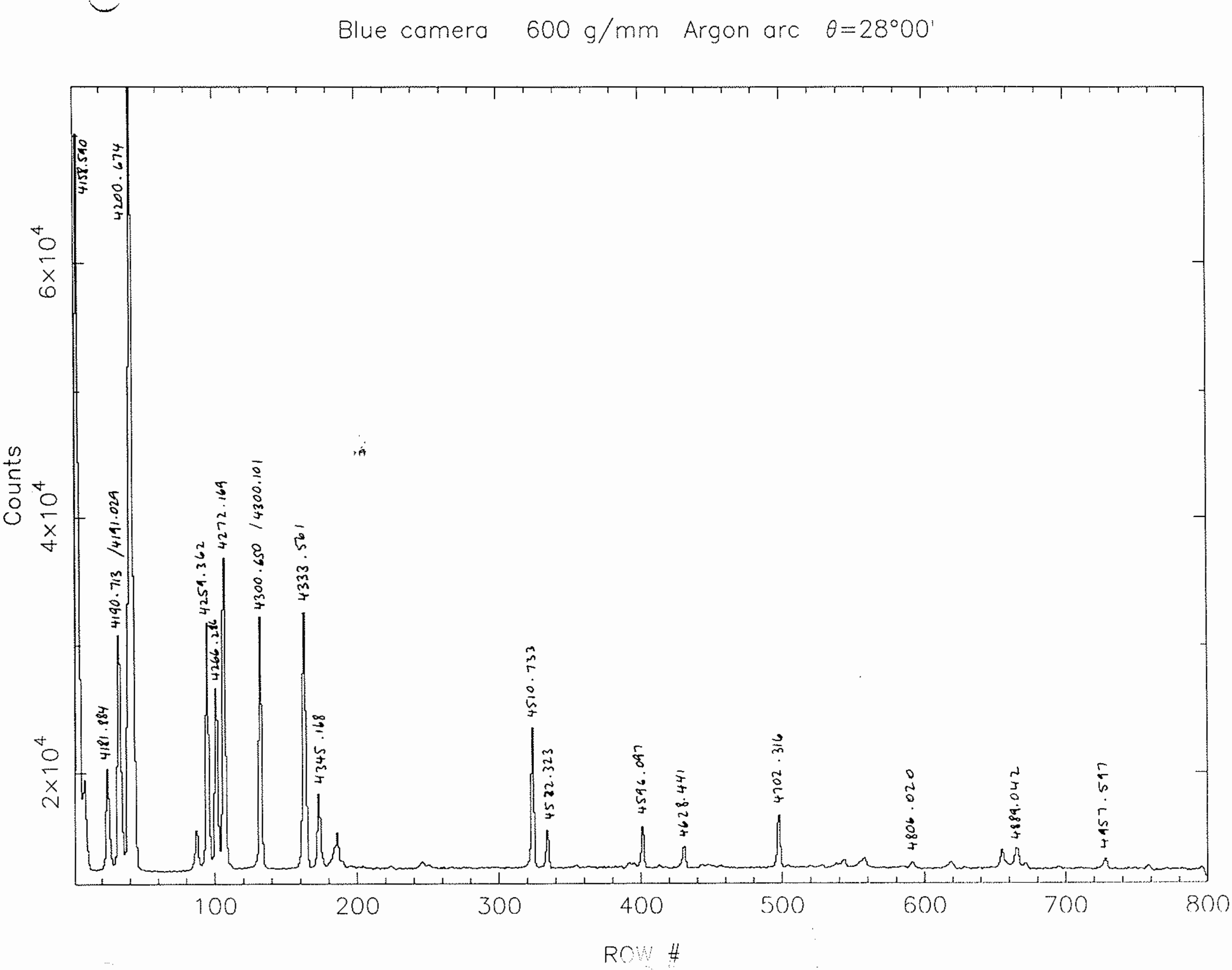

Blue camera 600 g/mm Argon arc θ=28°00'
Counts
6×10^4
4×10^4
2×10^4
100
200
300
400
500
600
700
800
ROW #
4158.590
4200.674
4181.884
4190.713 /4191.029
4259.362
4266.286
4272.169
4300.650 /4300.101
4333.561
4345.168
4510.733
4522.323
4596.097
4628.441
4702.316
4806.020
4889.042
4957.597

Figure 7a

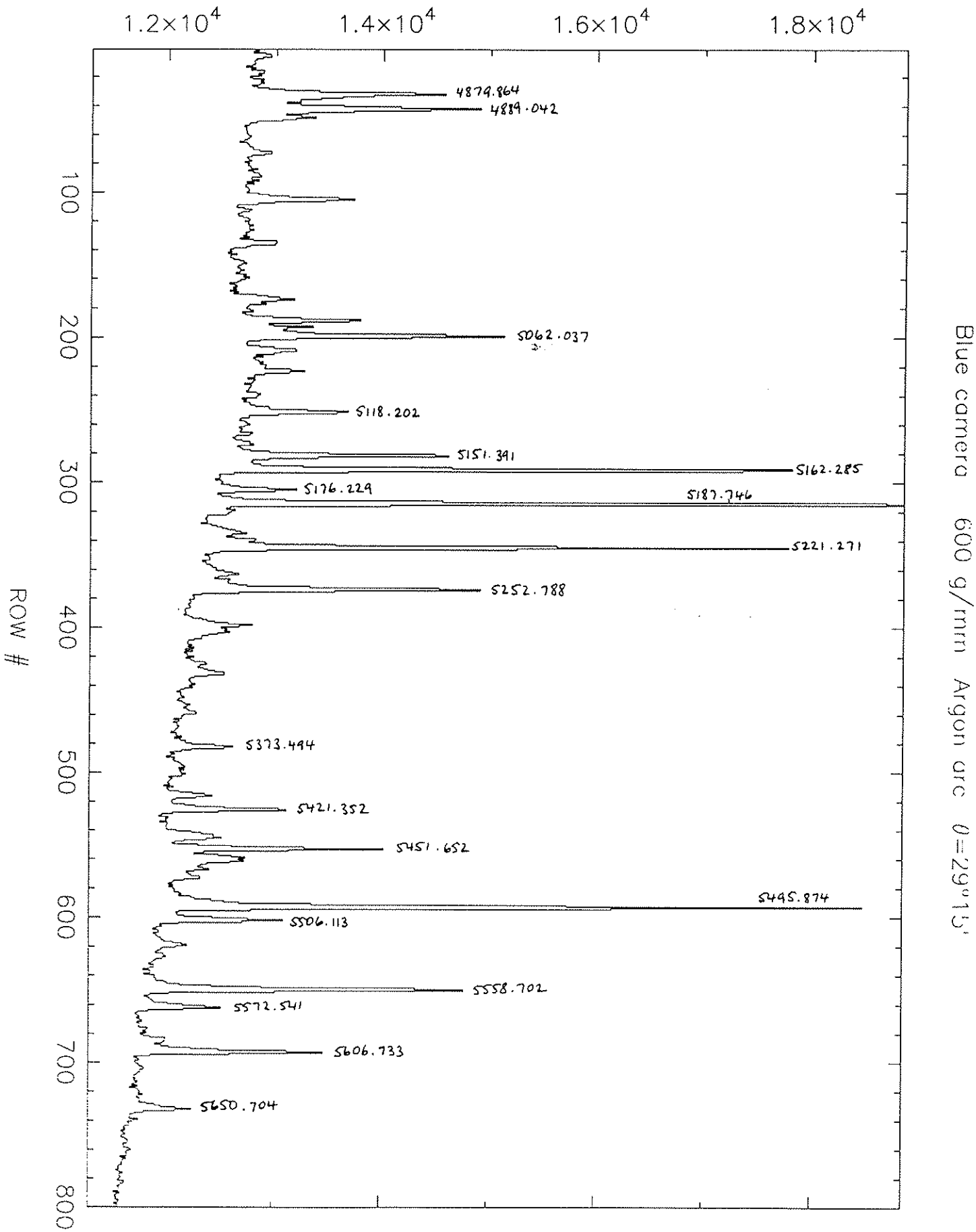
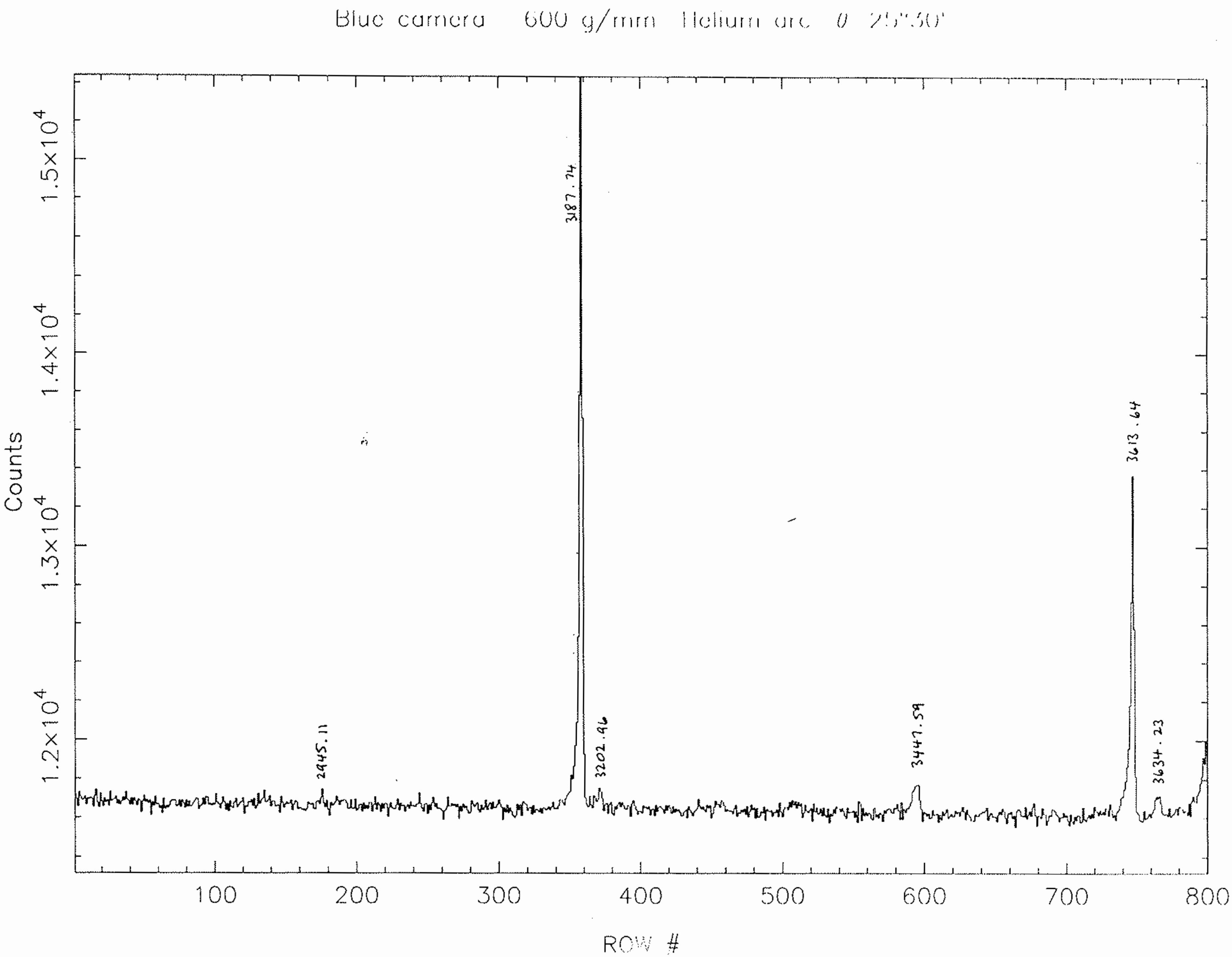

Counts
1.2×10^4
1.4×10^4
1.6×10^4
1.8×10^4
ROW #
100
200
300
400
500
600
700
800
4879.864
4889.042
5062.037
5118.202
5151.391
5162.285
5176.229
5187.746
5221.271
5252.788
5373.494
5421.352
5451.652
5495.874
5506.113
5558.702
5572.541
5606.733
5650.704
Blue camera 600 g/mm Argon arc θ=29°15'

Figure 7b

Figure 8a



Blue camera 600 g/mm Helium arc 0 25"30"
Counts
1.5×10^4
1.4×10^4
1.3×10^4
1.2×10^4
ROW #
100
200
300
400
500
600
700
800
2945.11
3187.74
3202.96
3447.59
3613.64
3634.23

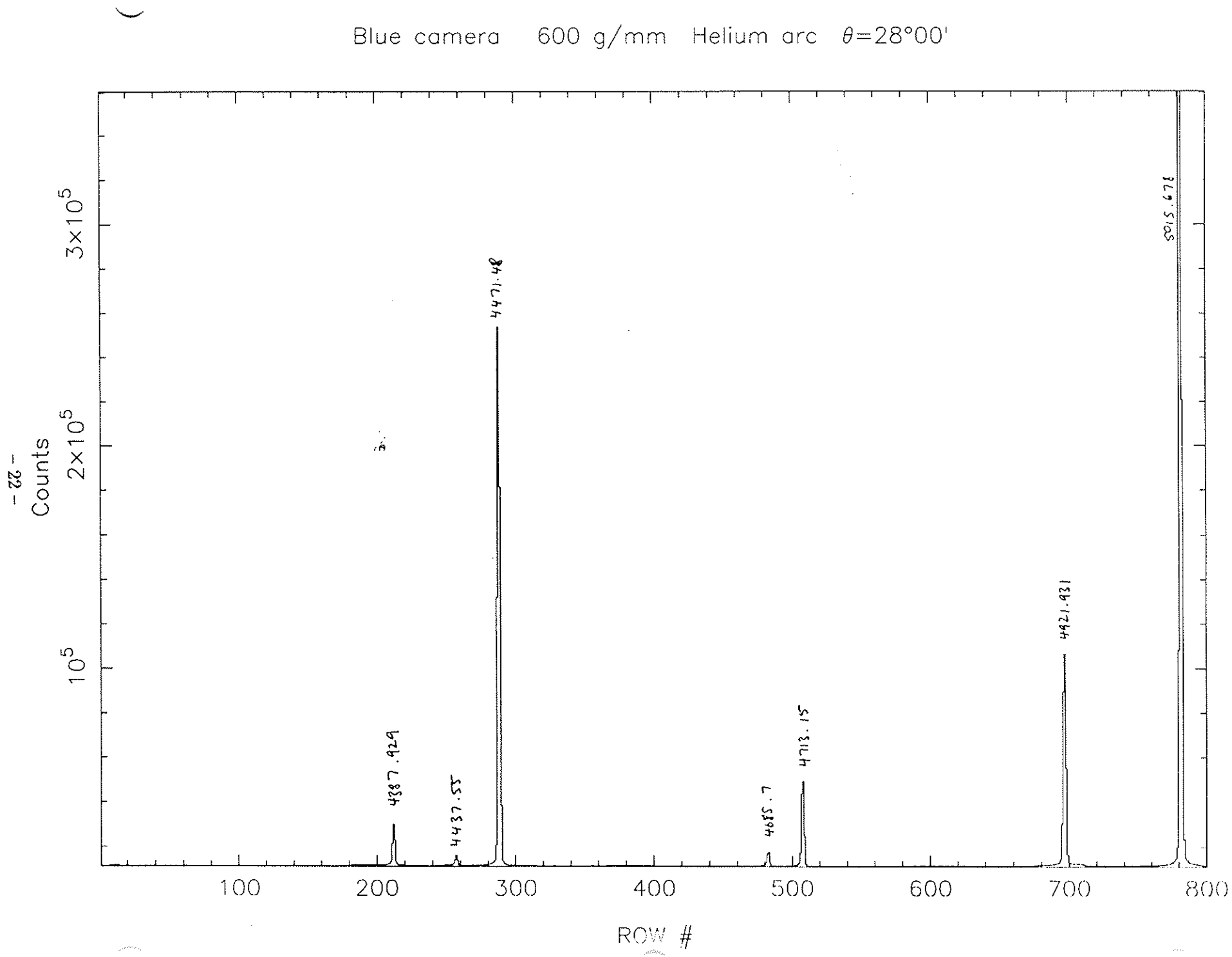

Blue camera 600 g/mm Helium arc θ=28°00'
Counts
3×10^5
2×10^5
10^5
100
200
300
400
500
600
700
800
ROW #
4387.929
4437.535
4471.48
4685.7
4713.15
4921.931
5015.678

Figure 8c

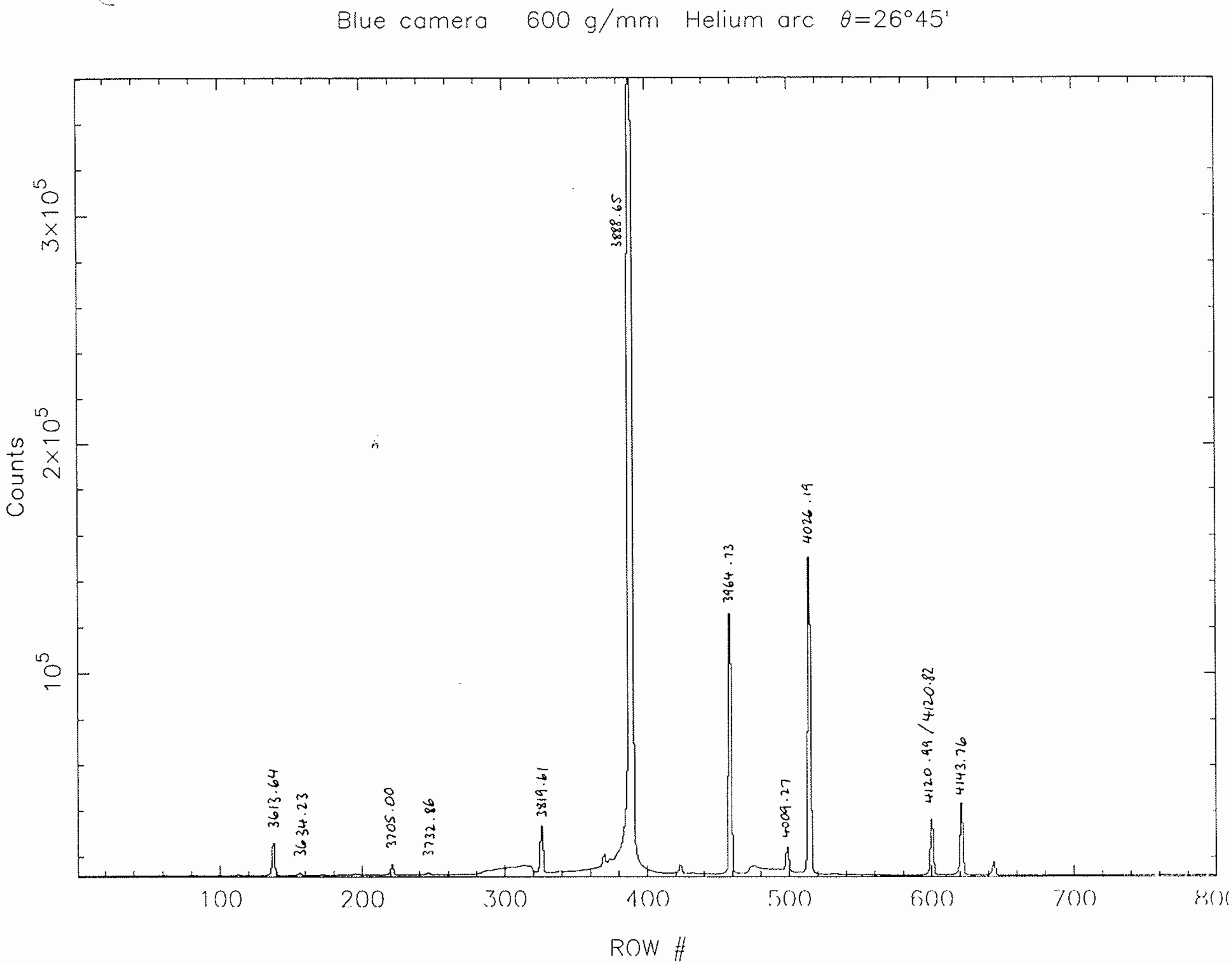

Blue camera 600 g/mm Helium arc θ=26°45'
Counts
3×10^5
2×10^5
10^5
ROW #
100
200
300
400
500
600
700
800
3613.64
3634.23
3705.00
3732.86
3819.61
3888.65
3964.73
4009.27
4026.19
4120.99 / 4120.82
4143.76

Figure 8b

Blue camera 600 g/mm Helium arc θ=29°15'

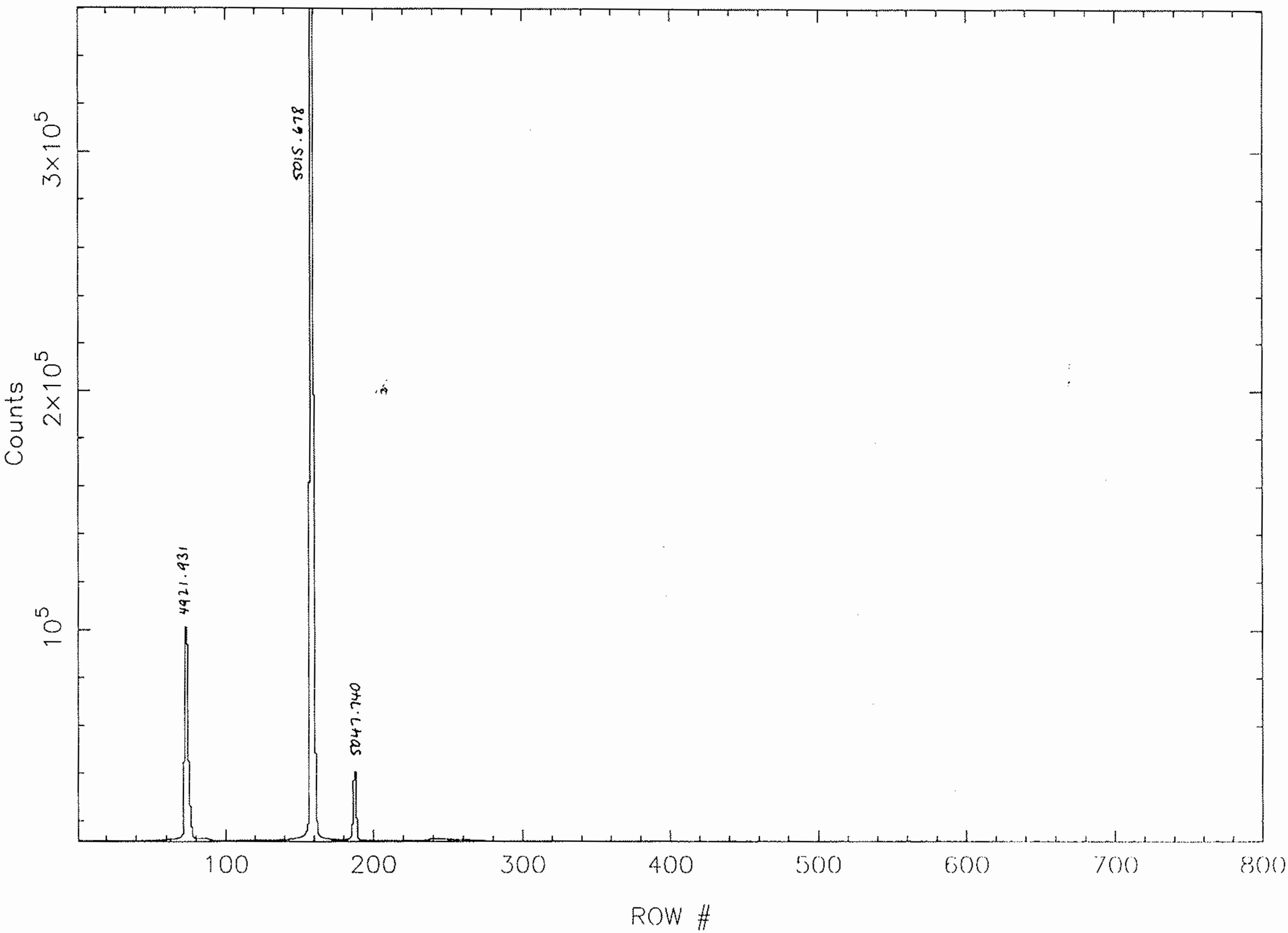


Figure 8d

1 sec exp 600/4000 grating

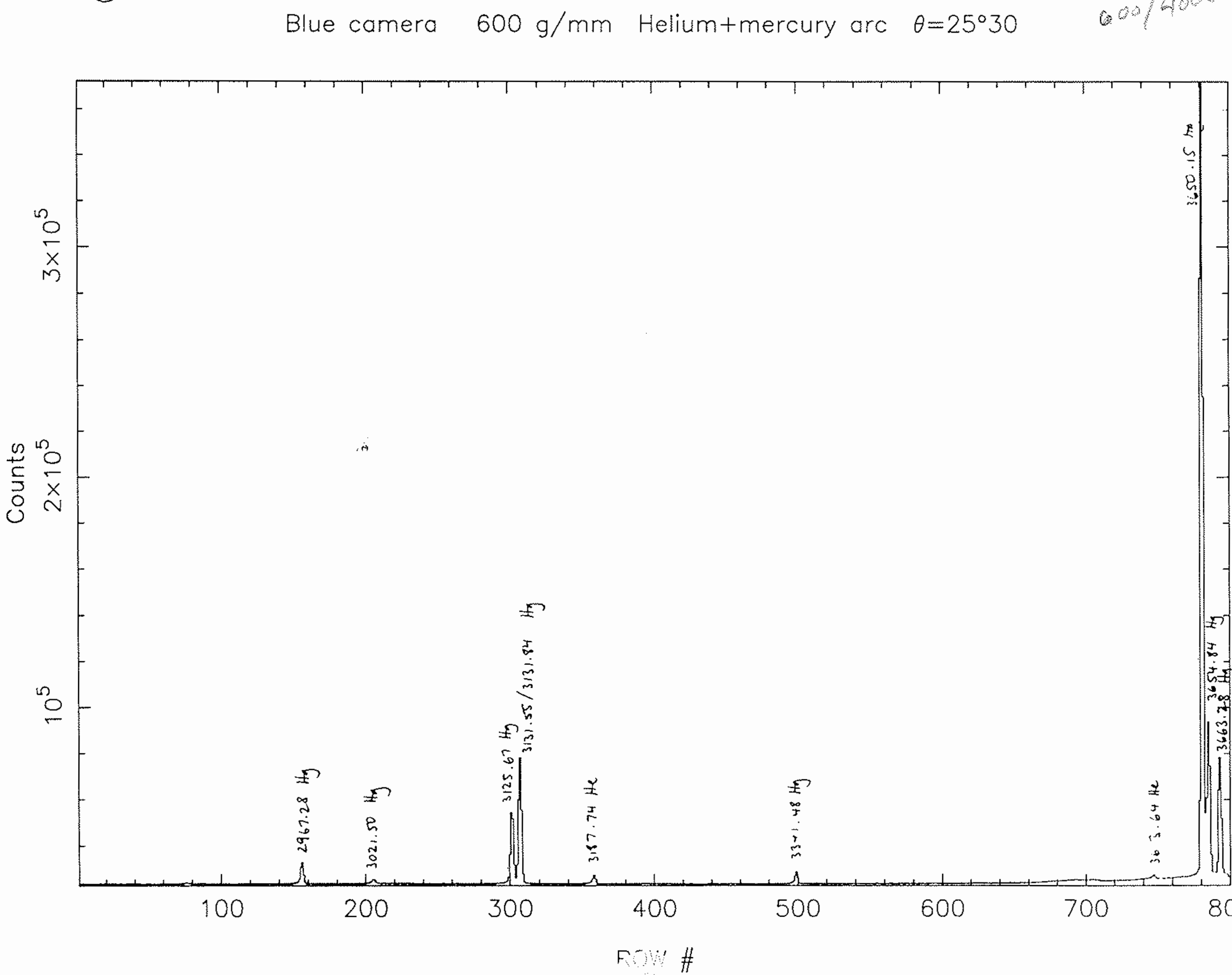


Figure 9a

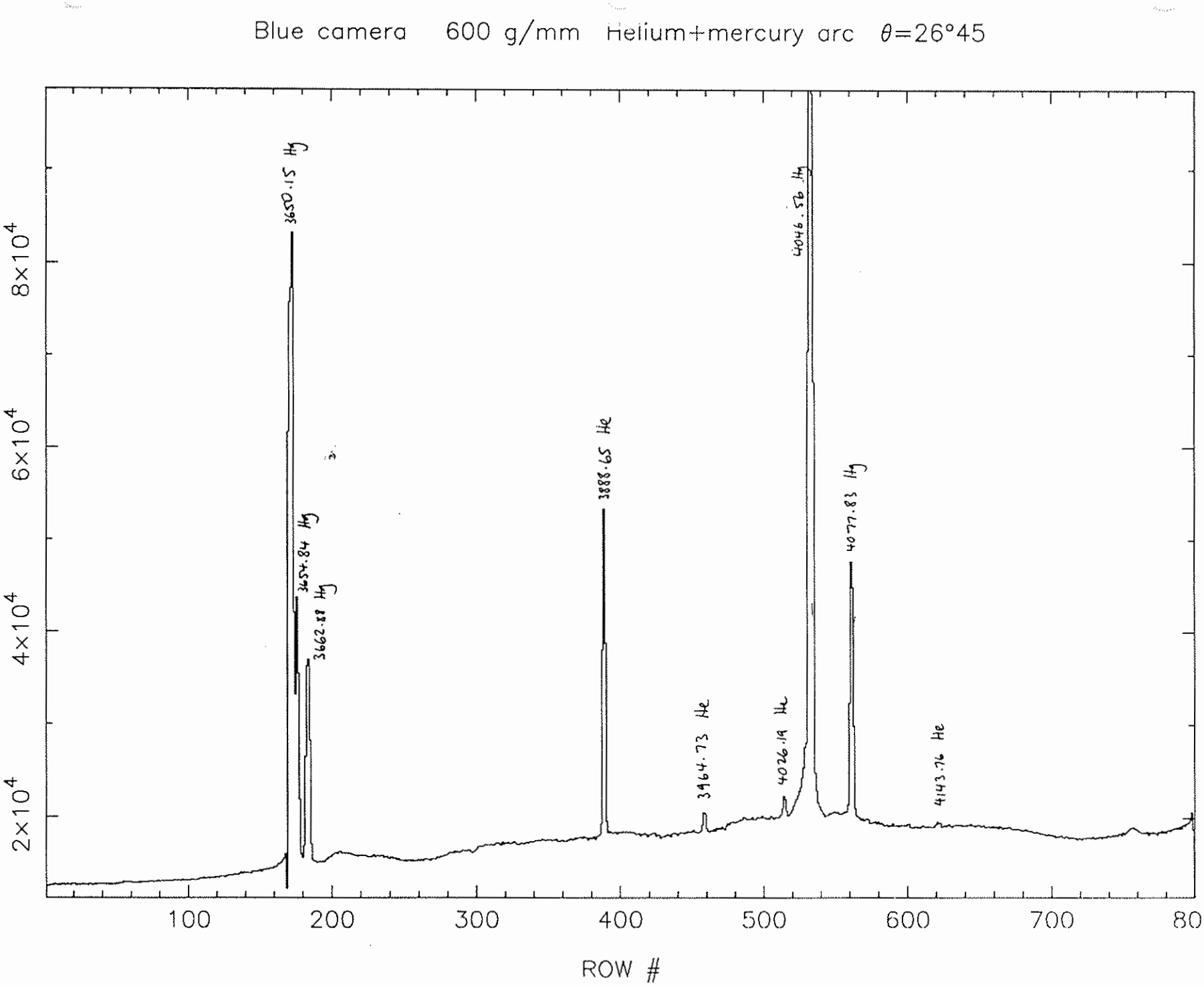
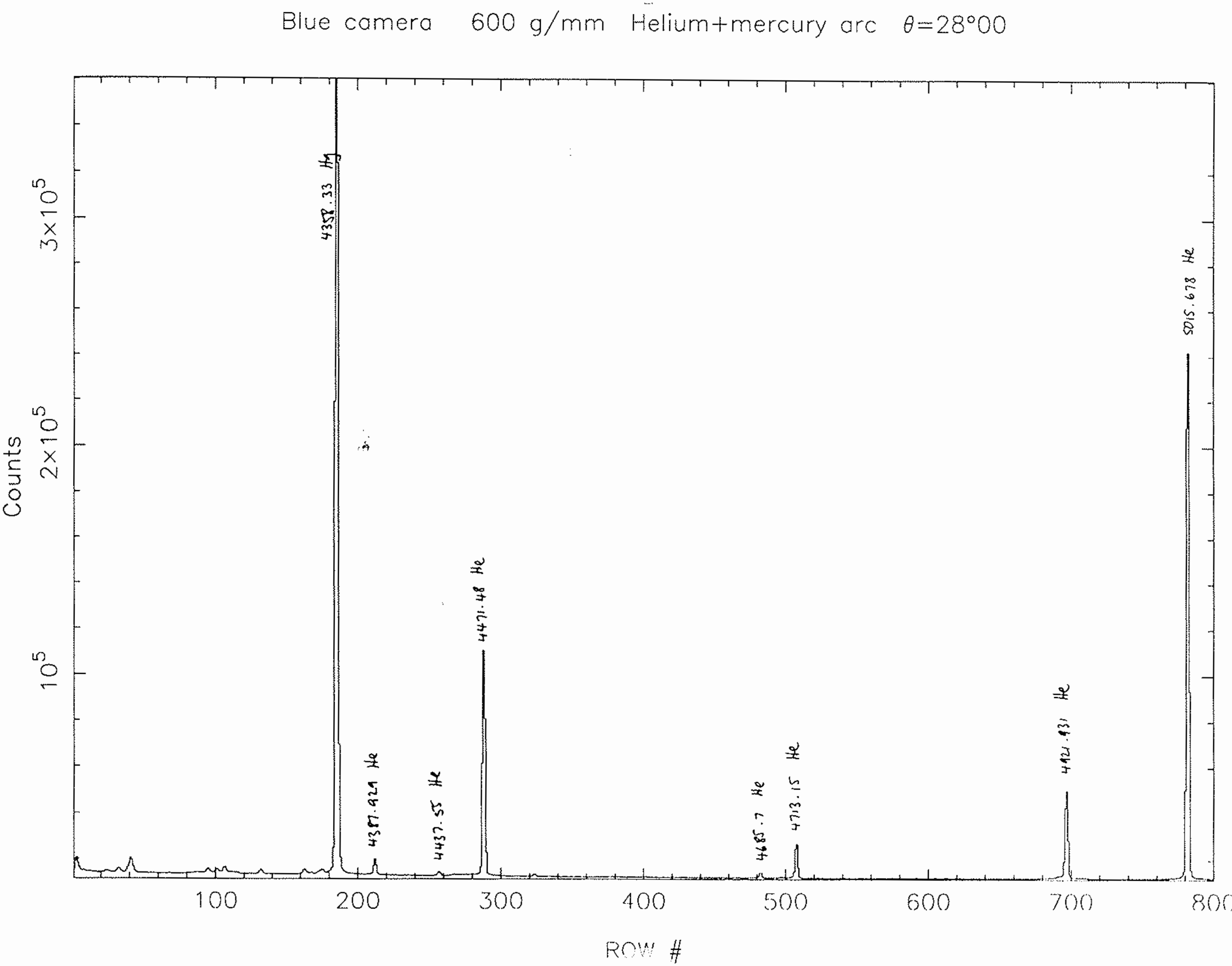
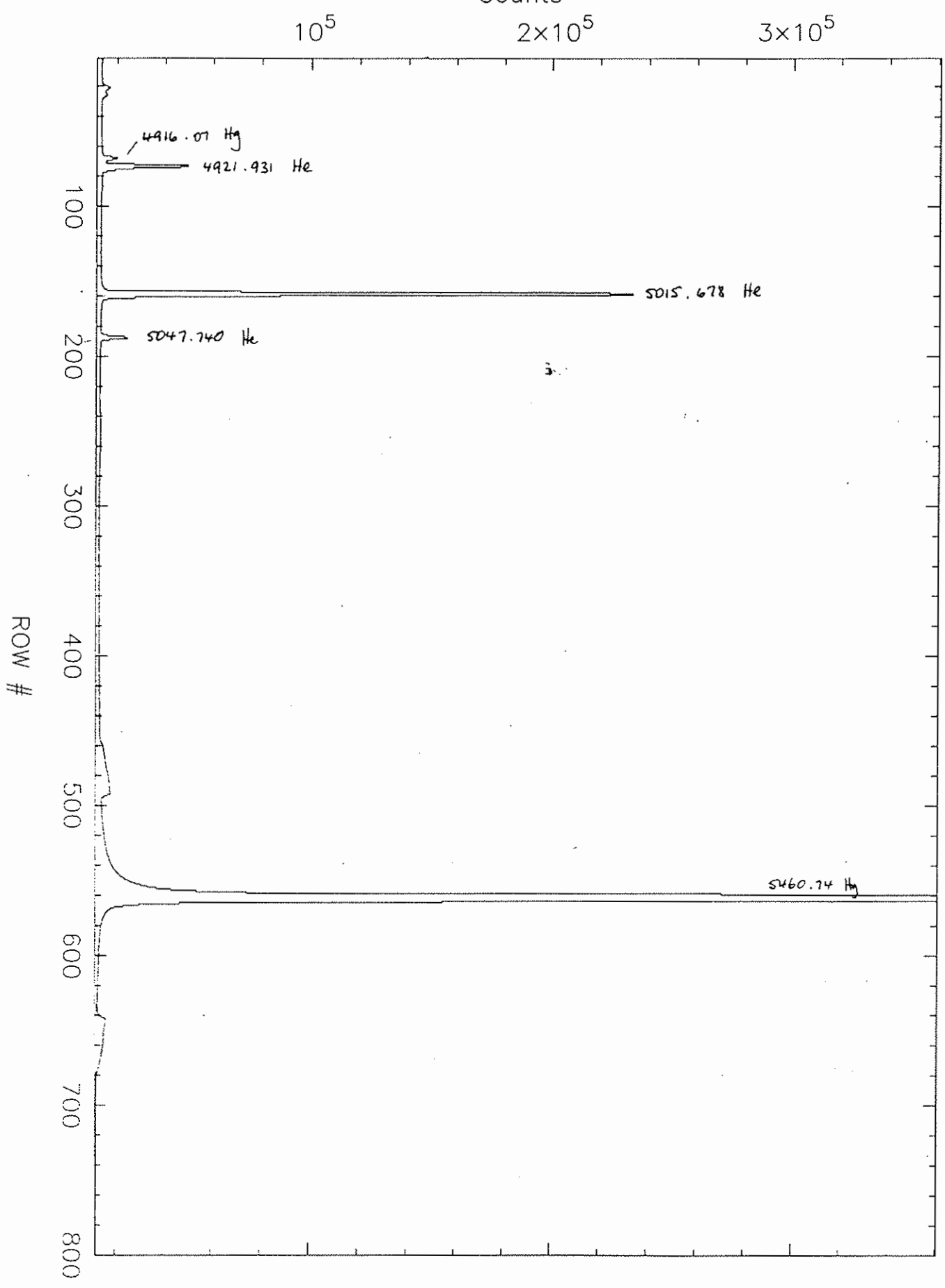

Blue camera 600 g/mm Helium+mercury arc θ=26°45
Counts
2×10^4
4×10^4
6×10^4
8×10^4
100
200
300
400
500
600
700
800
ROW #
3650.15 Hg
3654.84 Hg
3662.88 Hg
3888.65 He
3964.73 He
4026.19 He
4046.56 Hg
4077.83 Hg
4143.76 He

Figure 6b

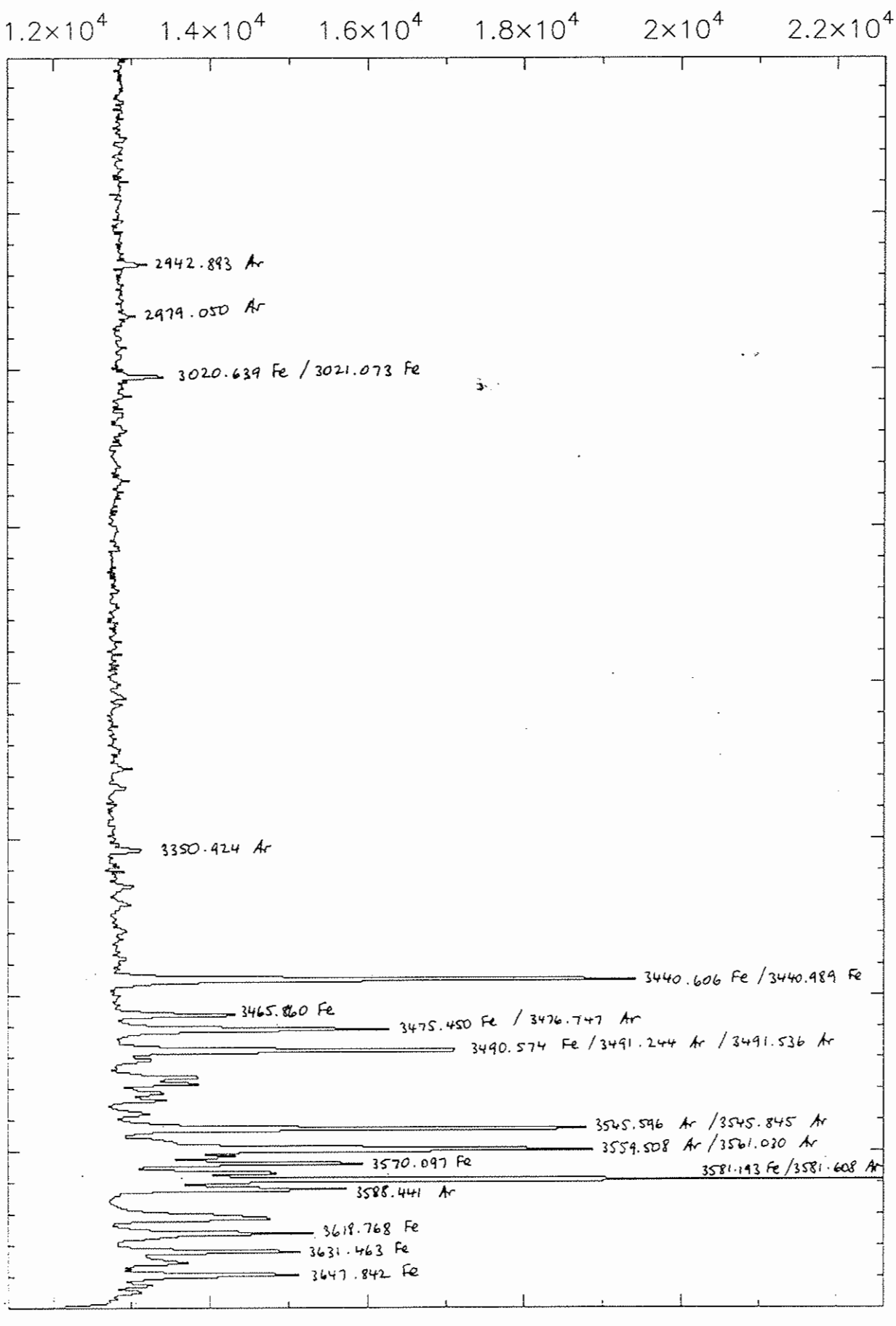


Blue camera 600 g/mm Helium+mercury arc θ=28°00
Counts
3×10^5
2×10^5
10^5
ROW #
100
200
300
400
500
600
700
800
4358.33 Hg
4387.929 He
4437.55 He
4471.48 He
4685.7 He
4713.15 He
4921.931 He
5015.678 He



Blue camera 600 g/mm Helium+mercury arc $\theta = 29°15$

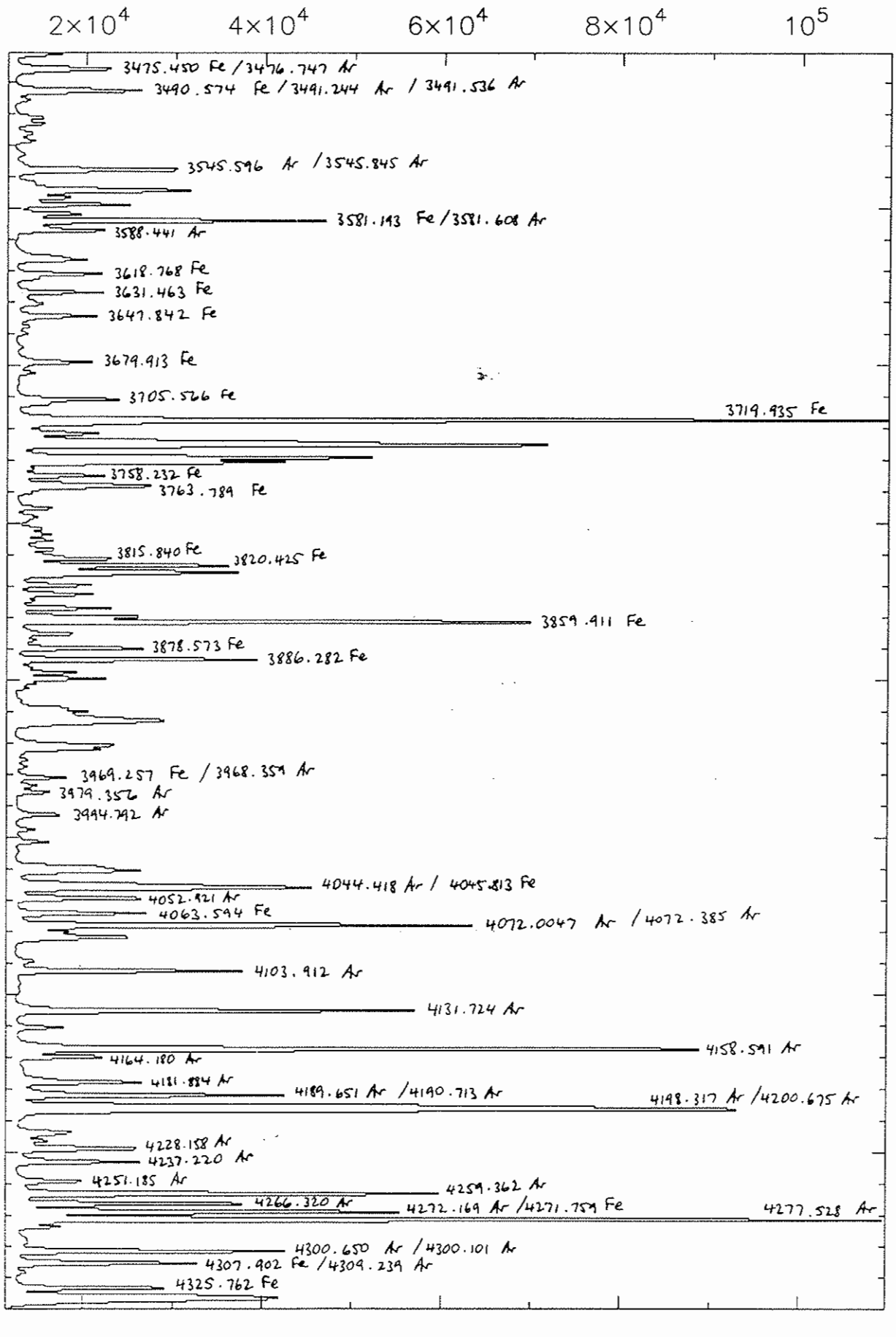
Figure 9d



Blue camera 600 g/mm Hollow cathode (FeAr) arc $\theta = 25°30'$

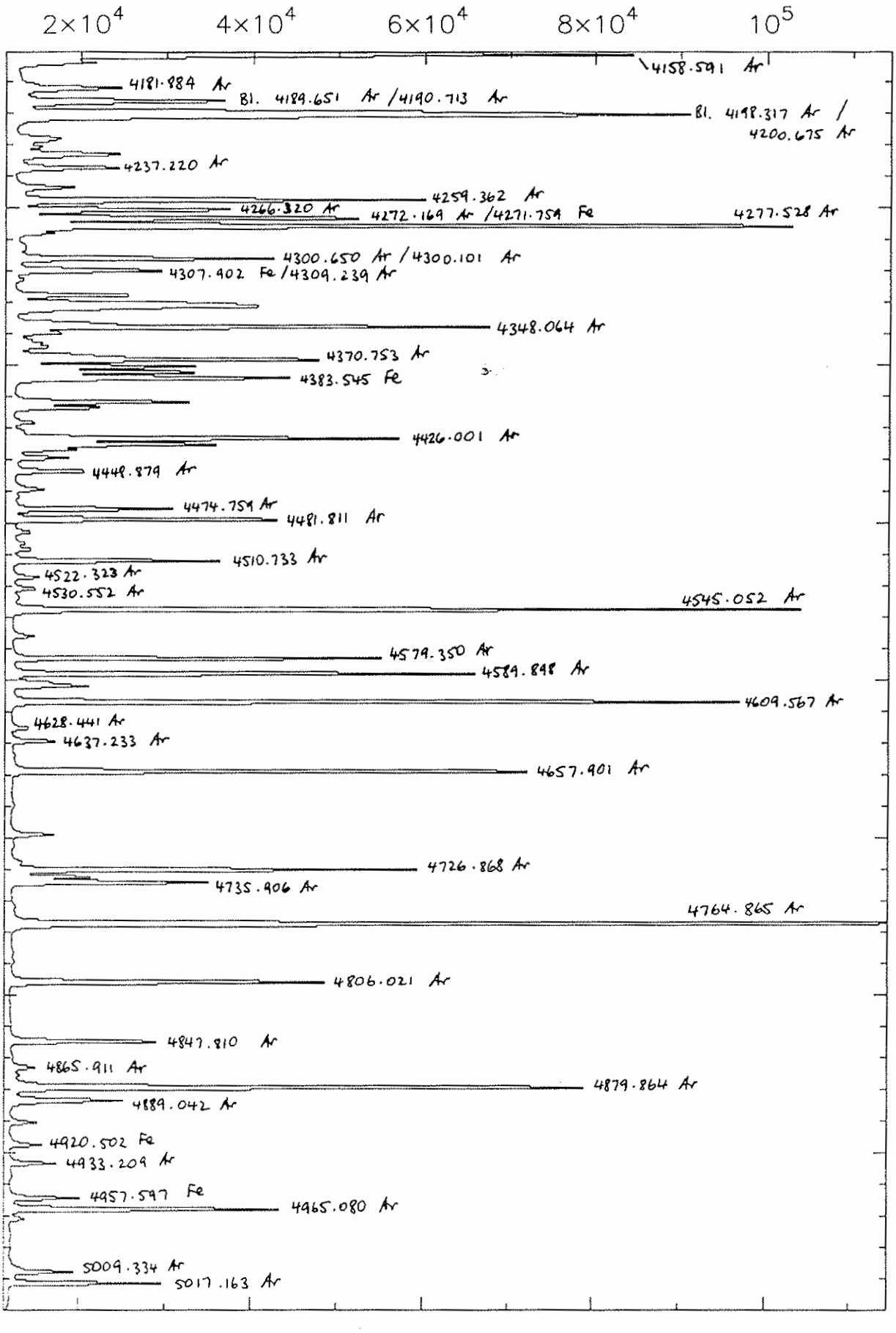
ROW #

Figure 10a



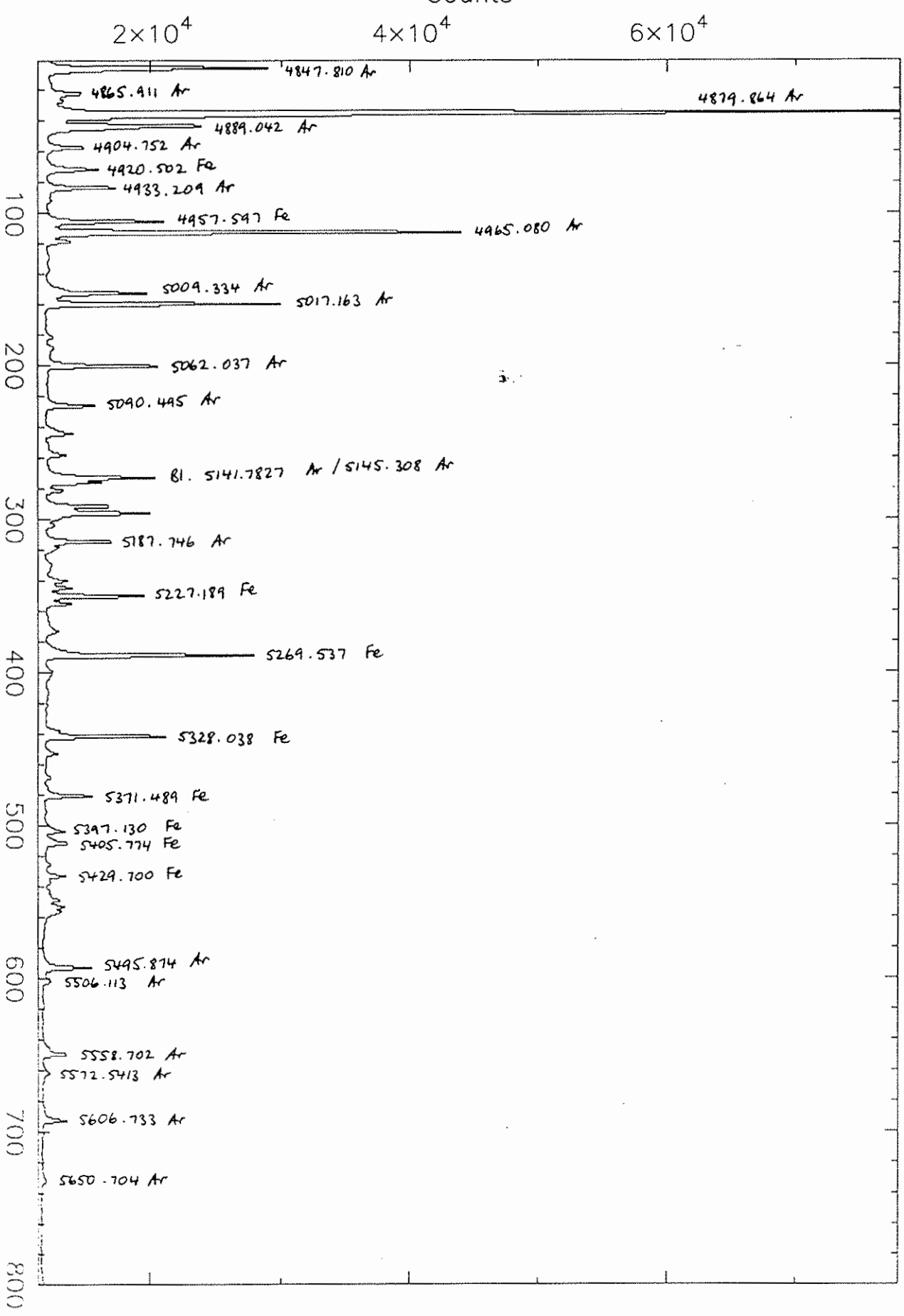
Blue camera 600 g/mm Hollow cathode (FeAr) arc $\theta = 26°45'$

Figure 10b



Blue camera 600 g/mm Hollow cathode (FeAr) arc θ=28°00'

Figure 10c

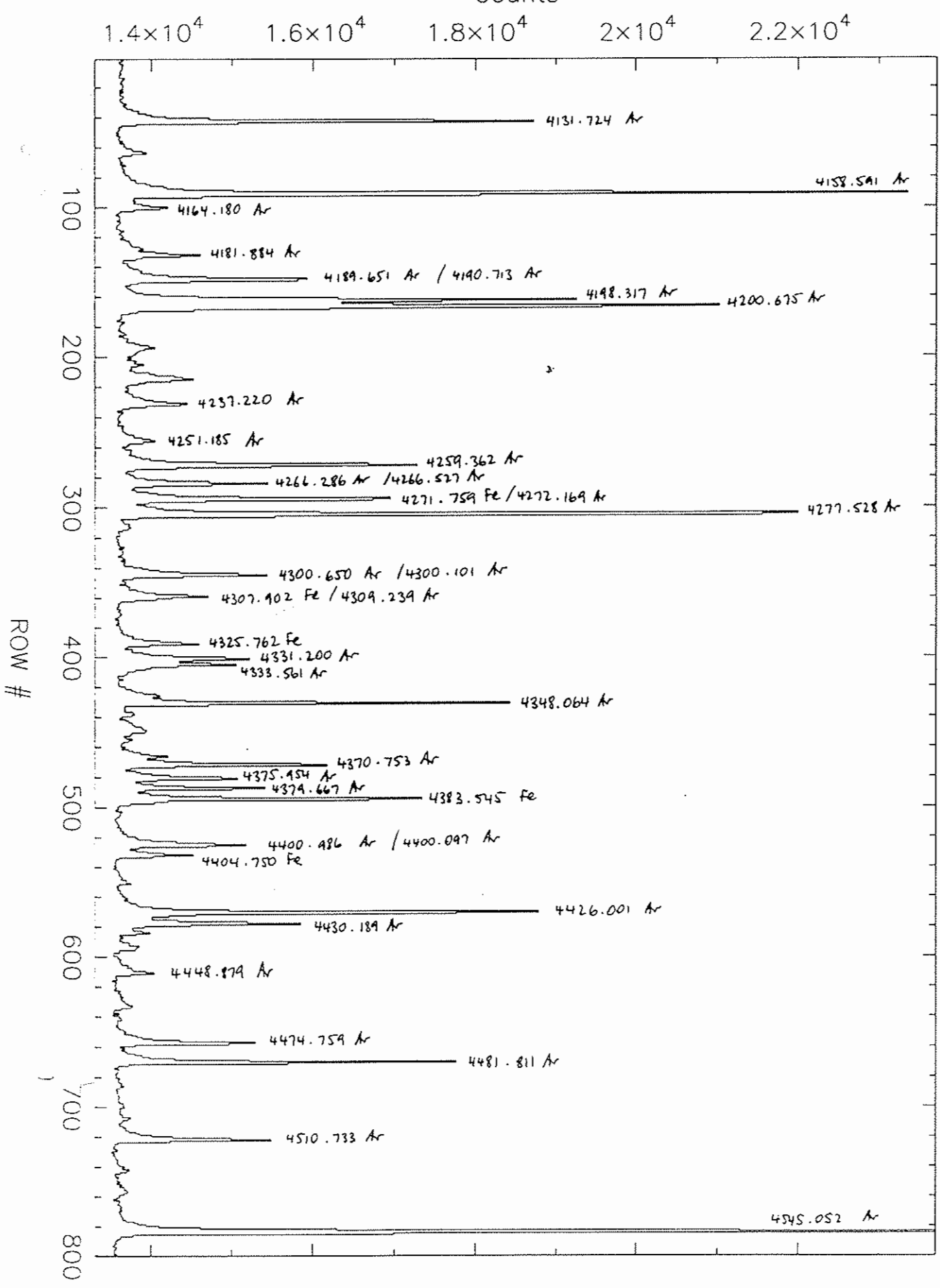


Blue camera 600 g/mm Hollow cathode (FeAr) arc 0.29"15'

Figure 10d

Blue camera 1200 g/mm Hollow cathode (FeAr) arc θ=34°00'
Counts
1.5×10^4
2×10^4
2.5×10^4
3×10^4
3.5×10^4
100
200
300
400
500
600
700
800
ROW 4
3722.563 Fe
3724.304 Ar
3734.864 Fe
3737.131 Fe / 3737.889 Ar
3745.561 Fe
3748.262 Fe / 3749.485 Fe
3758.232 Fe
3780.840 Ar
3803.172 Ar
3804.456 Ar
3815.840 Fe
3820.425 Fe
3834.222 Fe
3841.047 Fe
3850.581 Ar
3859.911 Fe
3868.528 Ar
3878.573 Fe
3886.282 Fe
3895.658 Fe
3899.707 Fe
3920.258 Fe
3922.912 Fe
3927.920 Fe
3930.296 Fe
3946.097 Ar
3994.792 Ar
4005.363 Ar
4013.857 Ar
4033.809 Ar
4035.460 Ar
4042.894 Ar
4045.813 Fe
4052.921 Ar
4063.594 Fe
4072.005 Ar / 4072.385 Ar
4076.628 Ar / 4076.943 Ar
4082.387 Ar
4103.912 Ar
4131.724 Ar
4143.869 Fe / 4143.415 Fe
4158.590 Ar
4164.180 Ar

Figure 11a

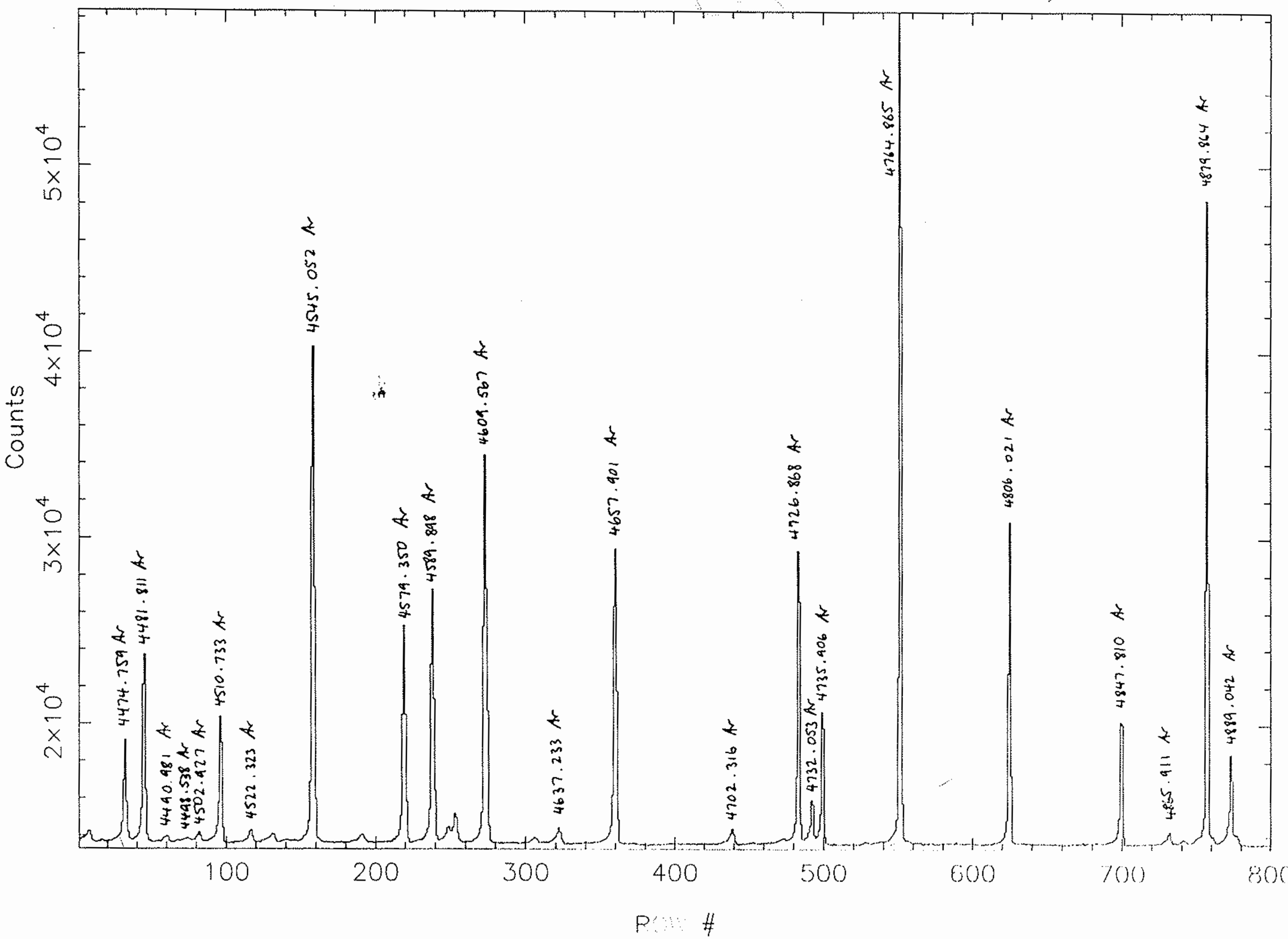


Blue camera 1200 g/mm Hollow cathode (FeAr) arc $\theta = 35°30'$

Figure 11b

Figure 11c

Blue camera 1200 g/mm Hollow cathode (FeAr) arc $\theta=36°45'$



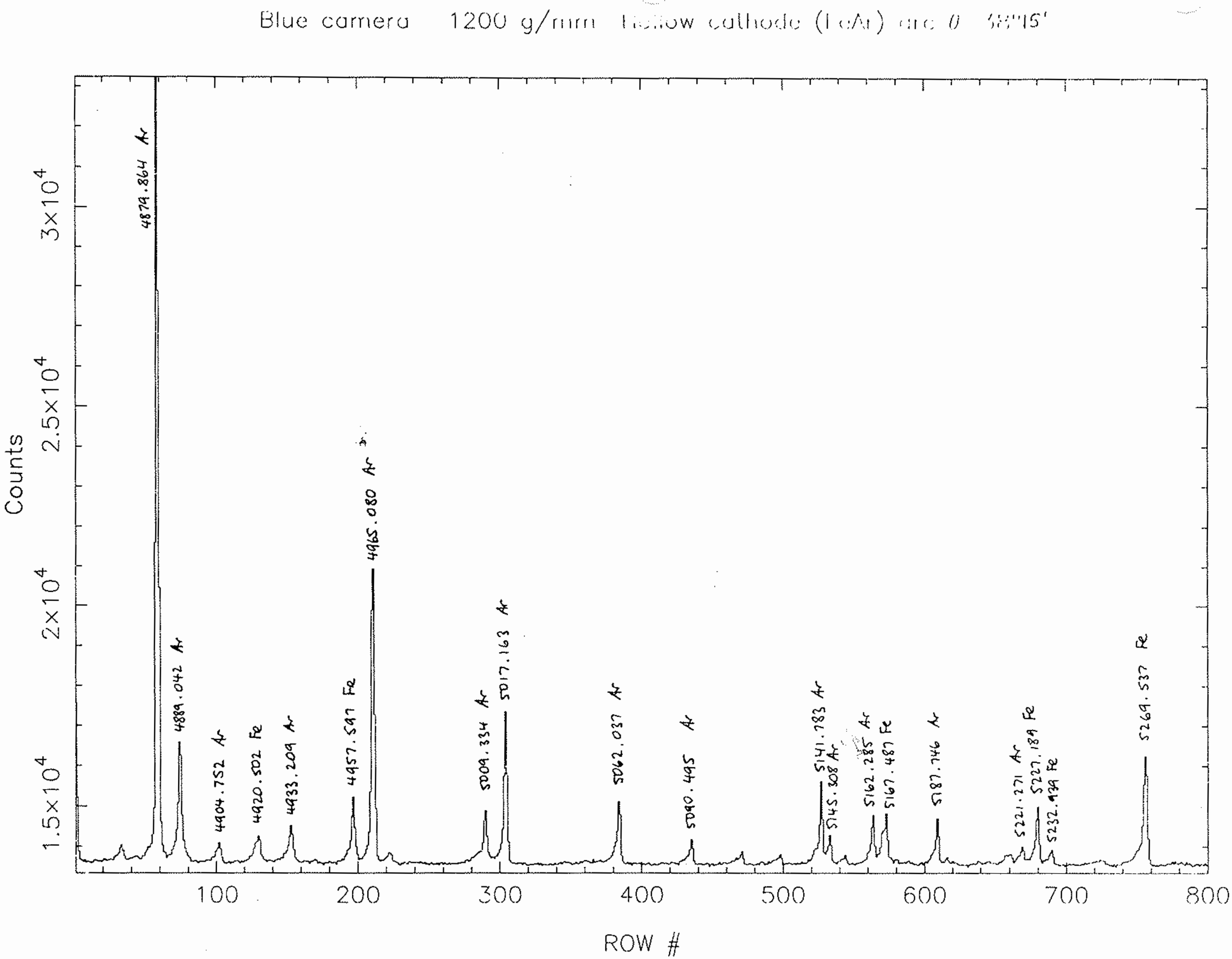
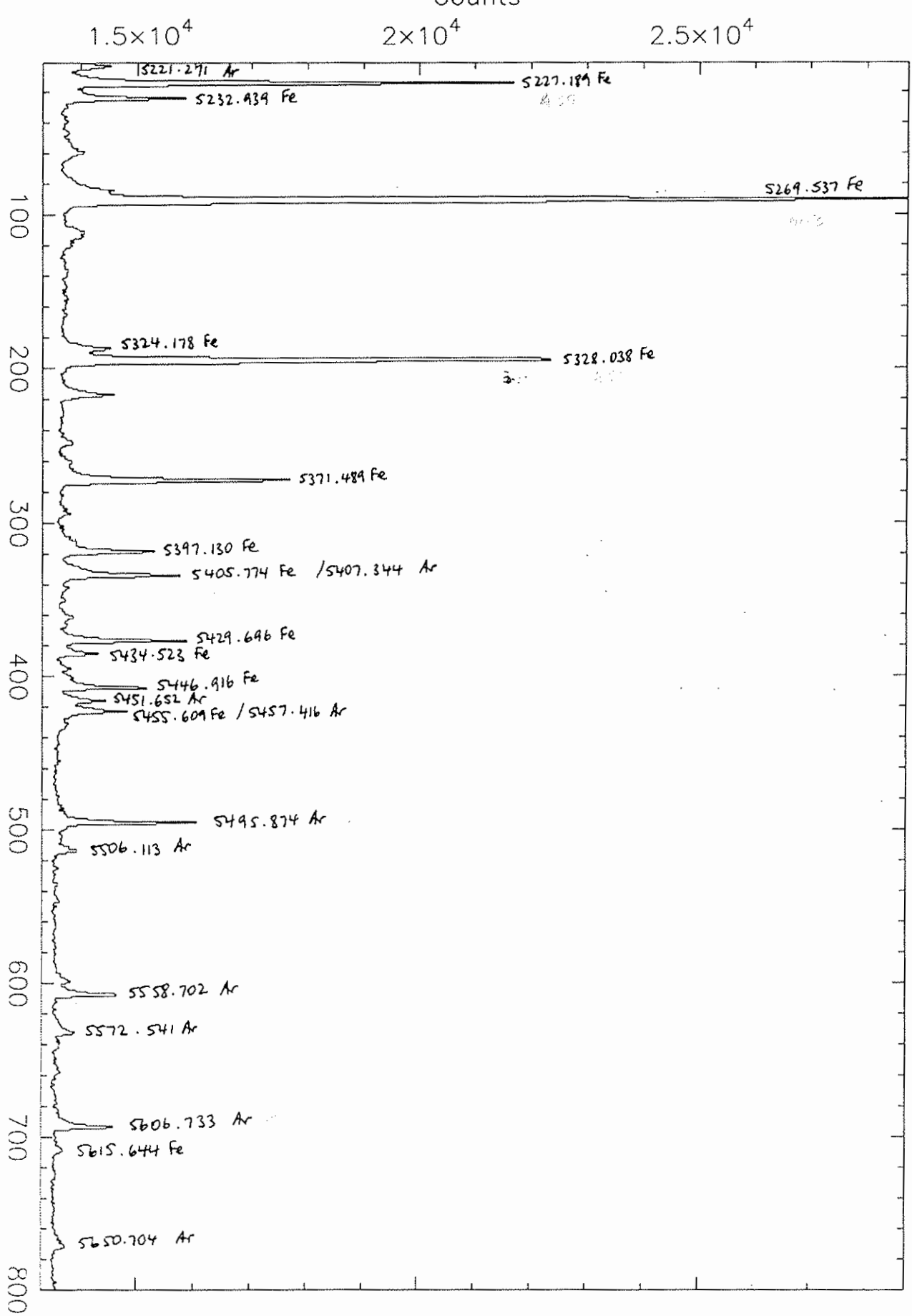

Blue camera 1200 g/mm
Counts
ROW #
1.5×10^4
2×10^4
2.5×10^4
3×10^4
100
200
300
400
500
600
700
800
4879.864 Ar
4889.042 Ar
4904.752 Ar
4920.502 Fe
4933.209 Ar
4957.597 Fe
4965.080 Ar
5009.334 Ar
5017.163 Ar
5062.037 Ar
5090.495 Ar
5141.783 Ar
5145.308 Ar
5162.285 Ar
5167.487 Fe
5187.746 Ar
5221.271 Ar
5227.189 Fe
5232.939 Fe
5269.537 Fe

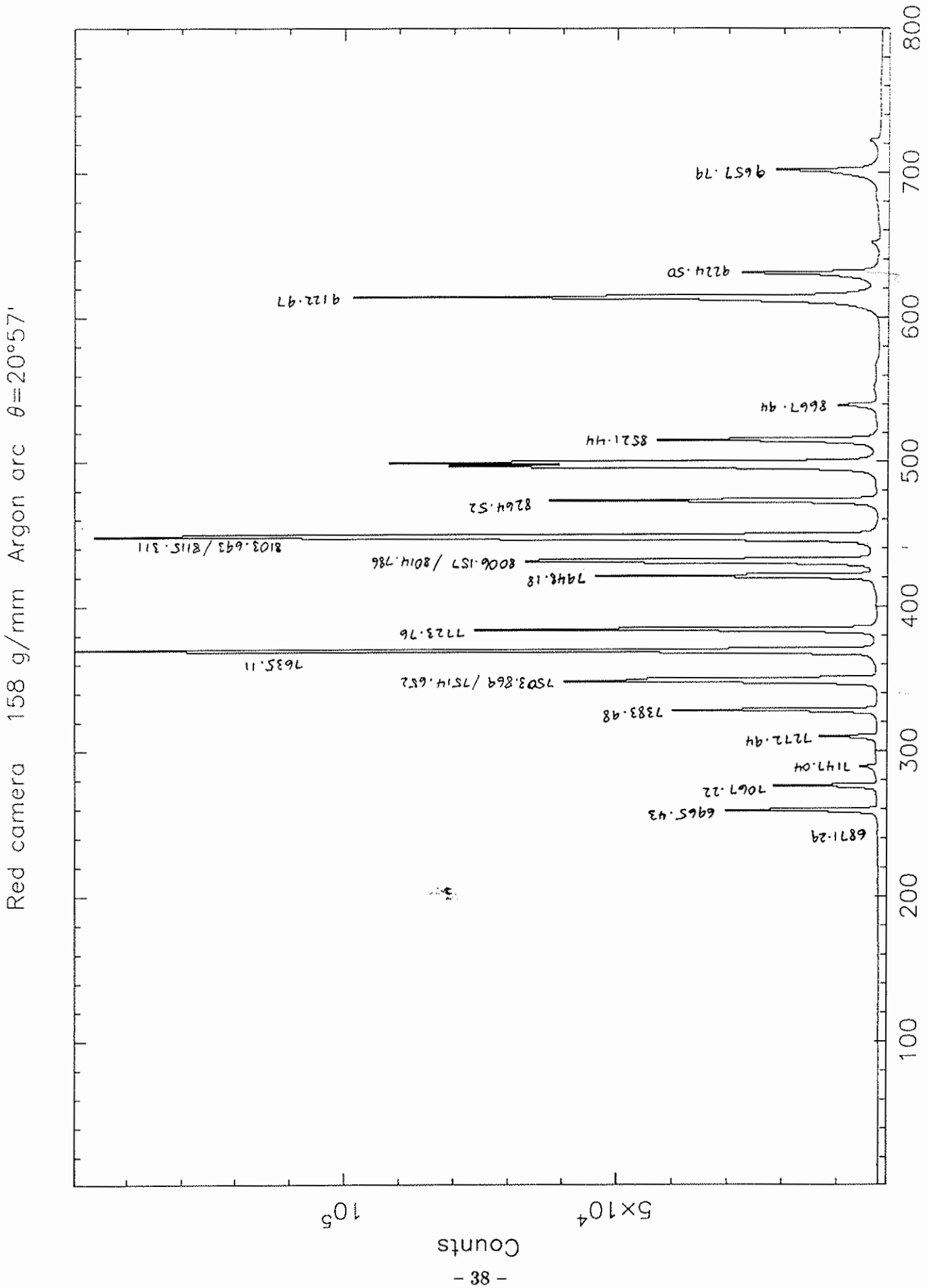
Figure 11d



Blue camera 1200 g/mm Hollow cathode (FeAr) arc $\theta = 39°45'$

Figure 11e

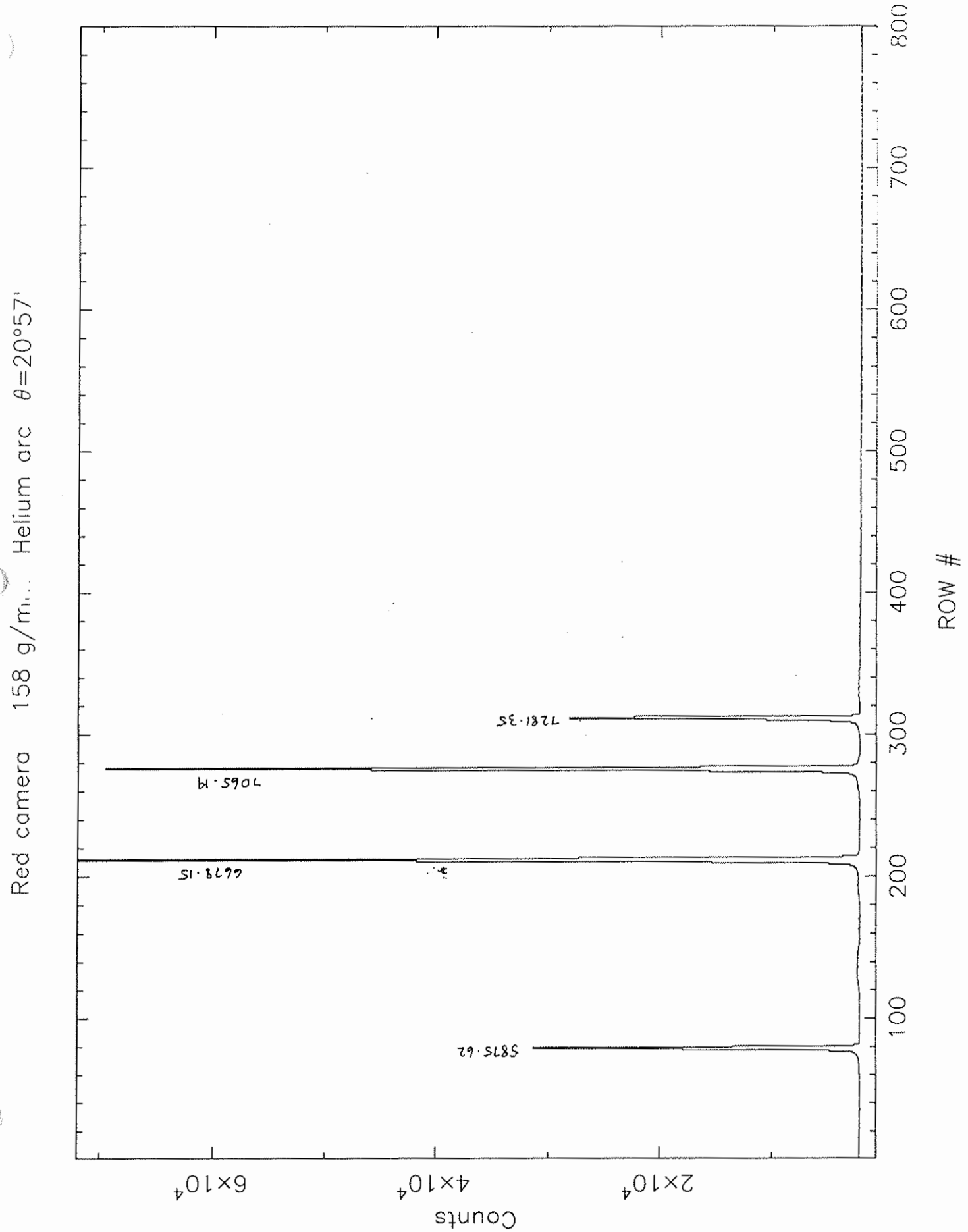
Figure 12


Red camera 158 g/mm Argon arc θ=20°57'
Counts
5×10⁴
10⁵
ROW #
100
200
300
400
500
600
700
800
6871.24
6965.43
7067.22
7147.04
7272.44
7383.48
7503.864 /7514.652
7635.11
7723.76
7948.18
8006.157 /8014.786
8103.643 /8115.311
8264.52
8521.444
8667.44
9122.47
9224.50
9657.74

A. A. Michelson at the University of Chicago made notable contributions to the art of ruling gratings ... However, he would be satisfied with nothing short of perfection, and so in fact produced very few gratings. The one grating which did appear to satisfy him he subsequently dropped and broke at a dinner party.

— M. C. Hutley, *Diffraction Gratings*.

Figure 13


Red camera 158 g/m... Helium arc θ=20°57'
Counts
2×10⁴
4×10⁴
6×10⁴
ROW #
100
200
300
400
500
600
700
800
5875.62
6678.15
7065.19
7281.35

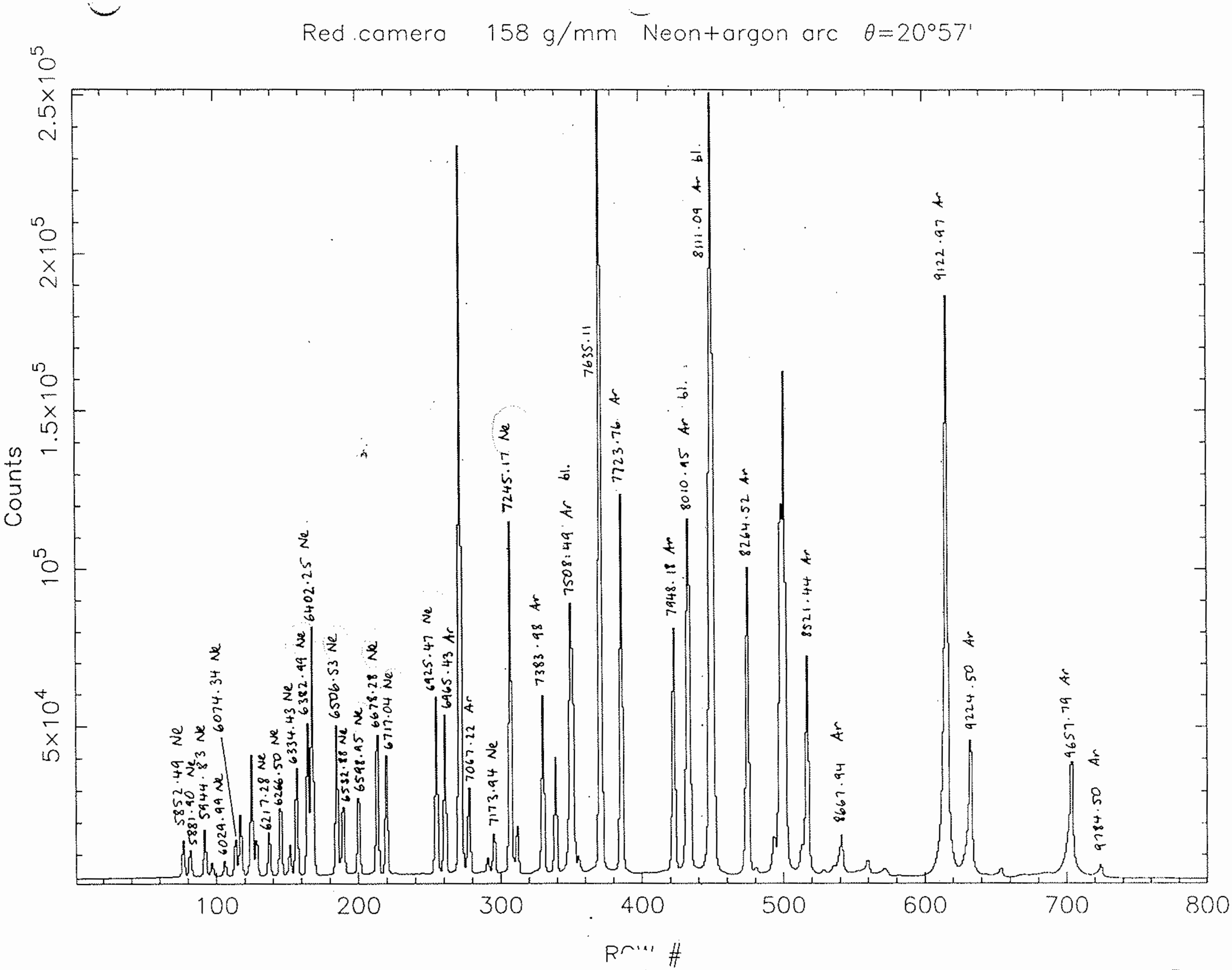

Red camera 158 g/mm Neon+argon arc θ=20°57'
Counts
ROW #
5×10^4
10^5
1.5×10^5
2×10^5
2.5×10^5
100
200
300
400
500
600
700
800
5852.49 Ne
5881.90 Ne
5944.83 Ne
6024.99 Ne
6074.34 Ne
6217.28 Ne
6266.50 Ne
6334.43 Ne
6382.99 Ne
6402.25 Ne
6506.53 Ne
6532.88 Ne
6598.95 Ne
6678.28 Ne
6717.04 Ne
6925.47 Ne
6965.43 Ar
7067.22 Ar
7173.94 Ne
7245.17 Ne
7383.98 Ar
7508.49 Ar bl.
7635.11
7723.76 Ar
7948.18 Ar
8010.45 Ar bl.
8111.09 Ar bl.
8264.52 Ar
8521.44 Ar
8667.94 Ar
9122.97 Ar
9224.50 Ar
9657.79 Ar
9784.50 Ar

Figure 14

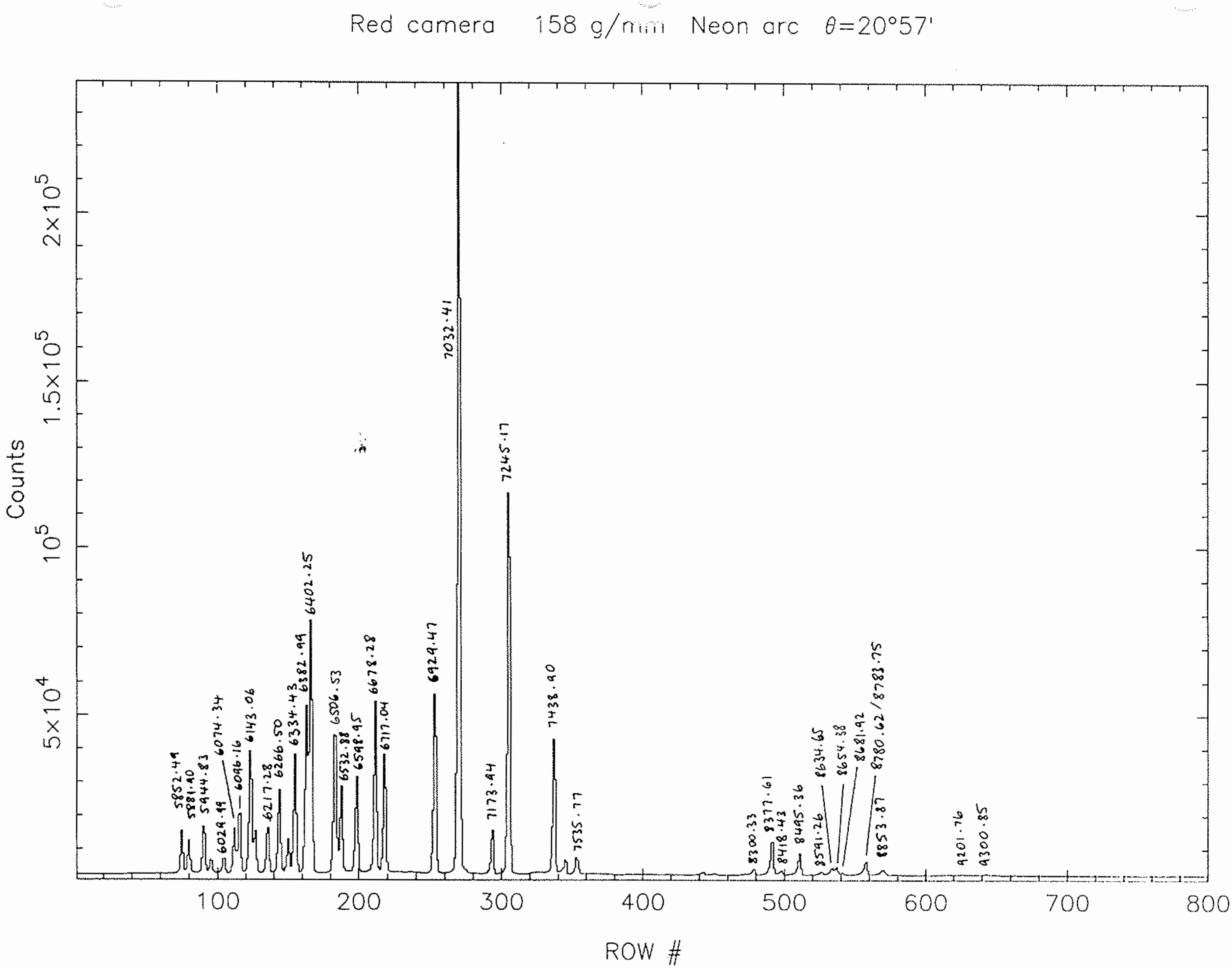

Red camera 158 g/mm Neon arc θ=20°57'
Counts
ROW #
5×10⁴
10⁵
1.5×10⁵
2×10⁵
100
200
300
400
500
600
700
800
5852.49
5881.40
5944.83
6029.99
6074.34
6096.16
6143.06
6217.28
6266.50
6334.43
6382.99
6402.25
6506.53
6532.88
6598.95
6678.28
6717.04
6929.47
7032.41
7173.94
7245.17
7438.90
7535.77
8300.33
8377.61
8418.43
8495.36
8591.26
8634.65
8654.38
8681.92
8780.62/8783.75
8853.87
9201.76
9300.85

Figure 15

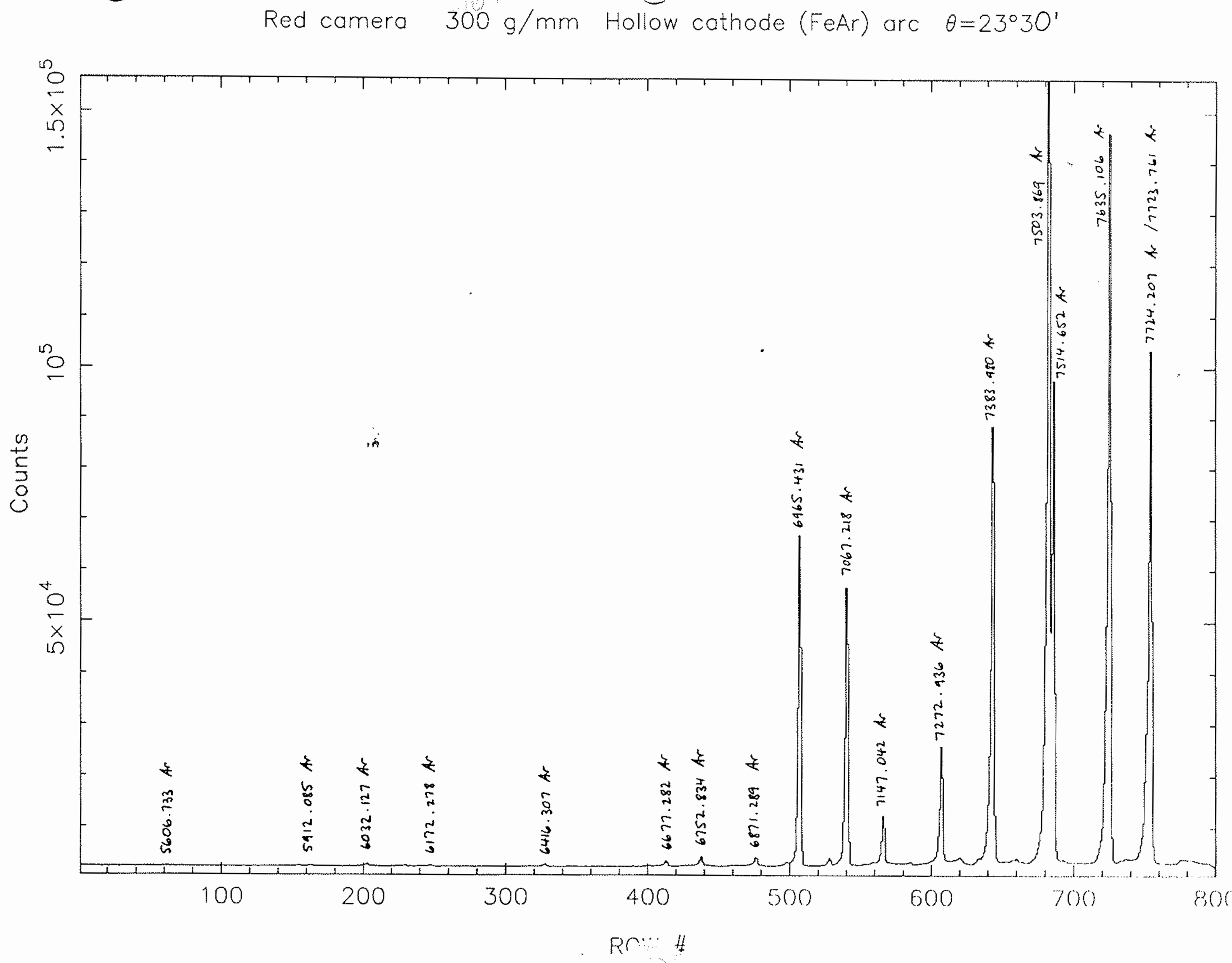
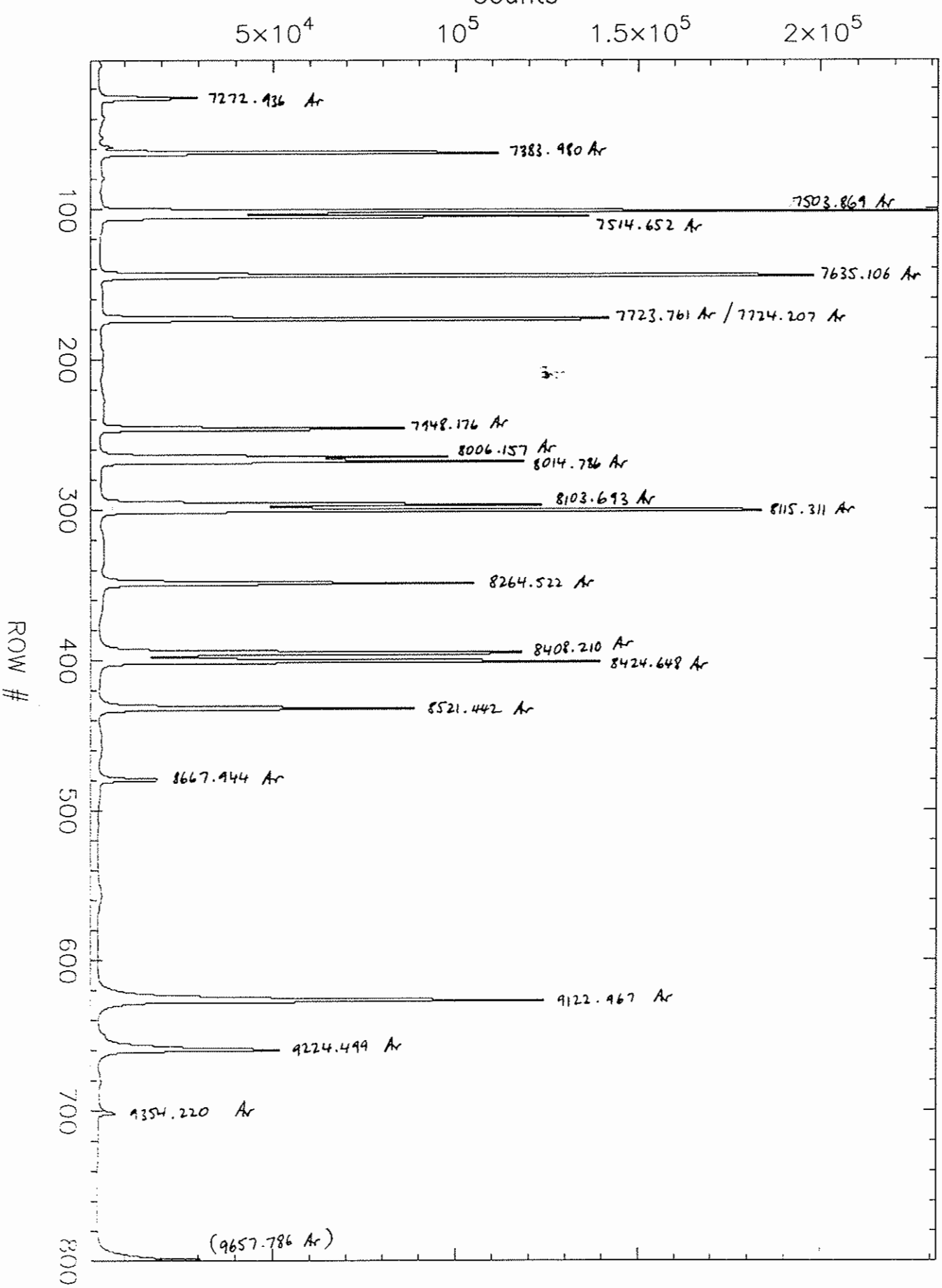

Red camera 300 g/mm Hollow cathode (FeAr) arc θ=23°30'
Counts
1.5×10^5
10^5
5×10^4
100
200
300
400
500
600
700
800
5606.733 Ar
5912.085 Ar
6032.127 Ar
6172.278 Ar
6416.307 Ar
6677.282 Ar
6752.834 Ar
6871.289 Ar
6965.431 Ar
7067.218 Ar
7147.042 Ar
7272.936 Ar
7383.980 Ar
7503.869 Ar
7514.652 Ar
7635.106 Ar
7724.207 Ar / 7723.761 Ar

Figure 16a

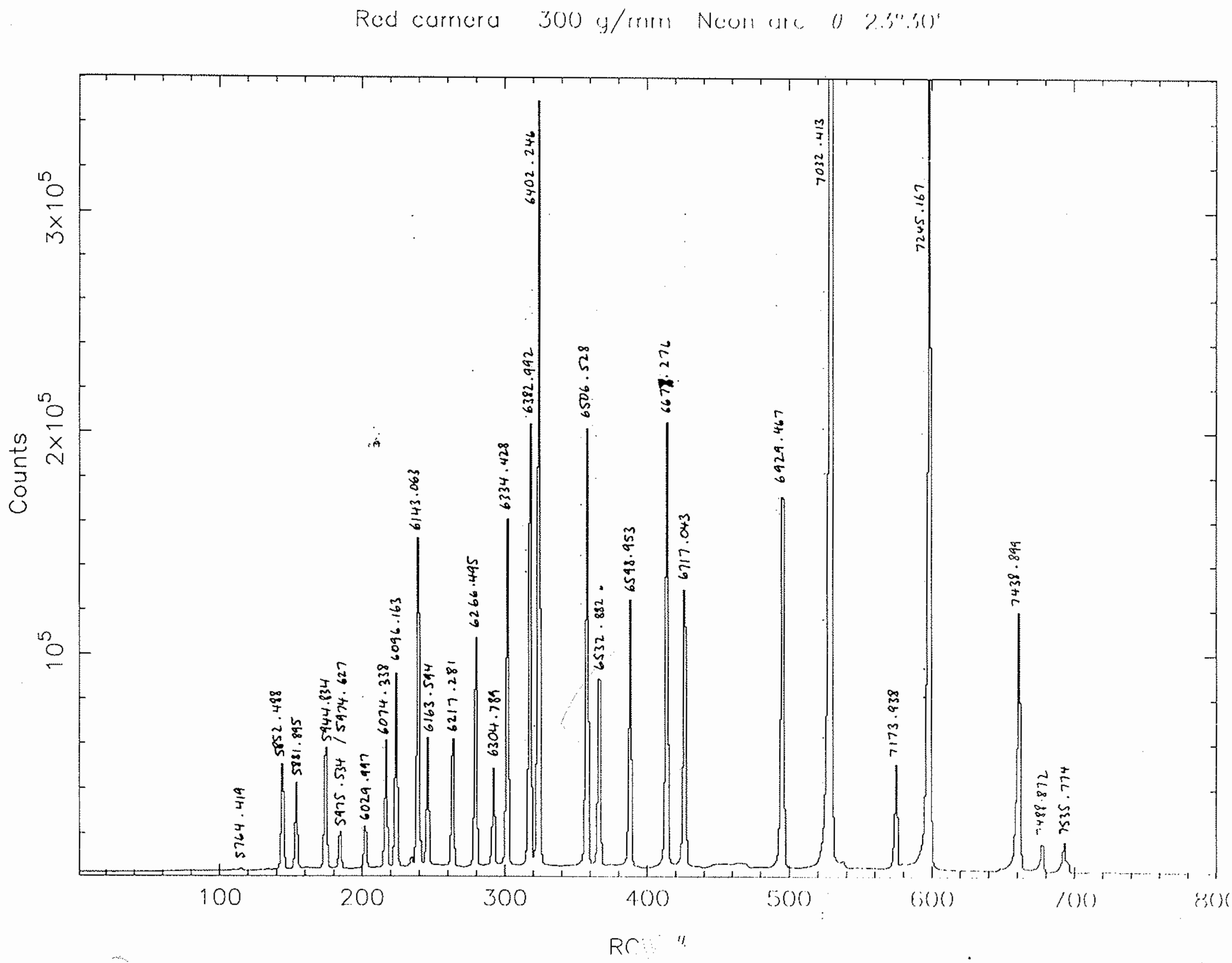


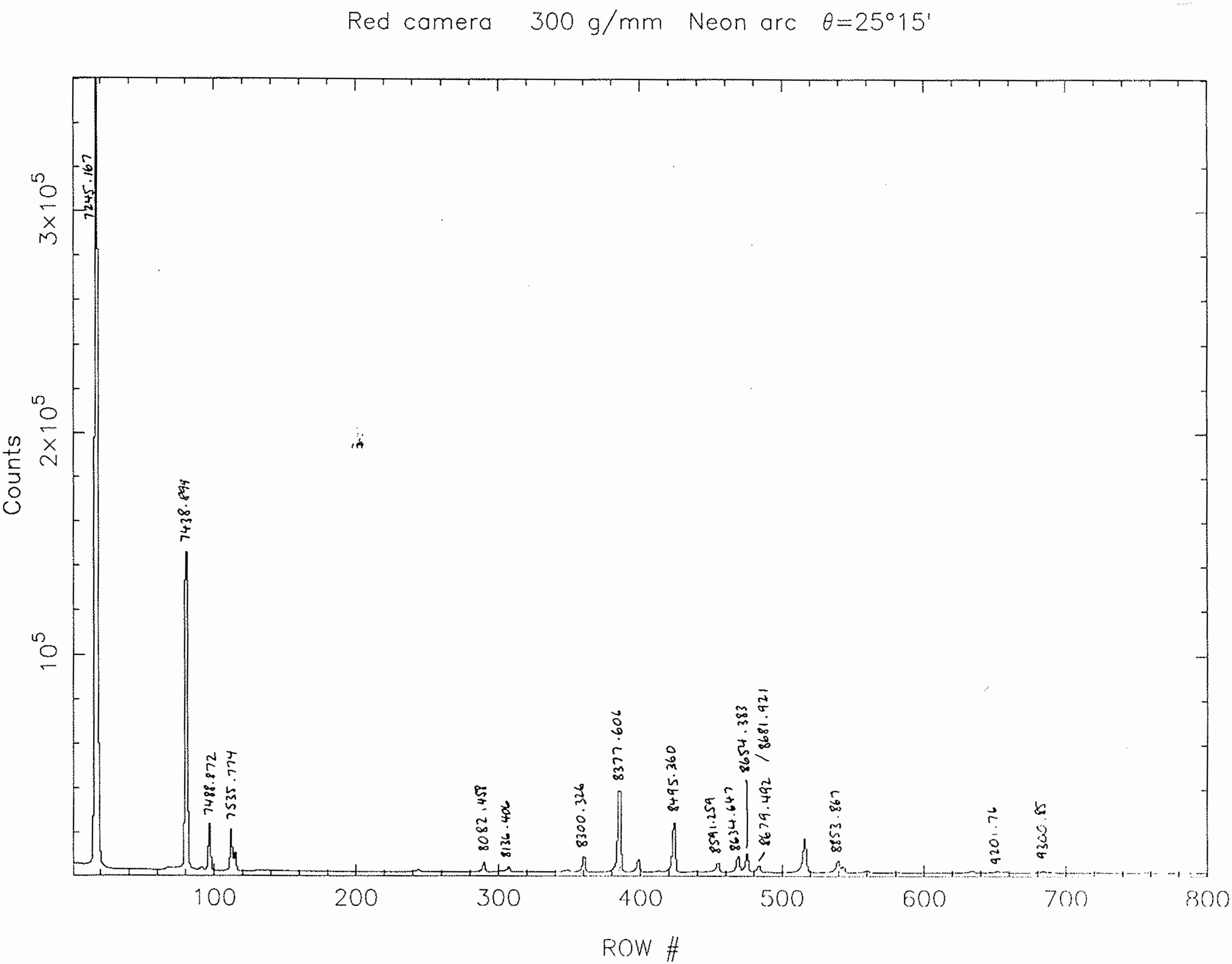
Red camera 300 g/mm Holo cathode (FeAr) arc $\theta = 25°15'$

Figure 16b

0.5 sec exp 316/7500 grating

Figure 17a

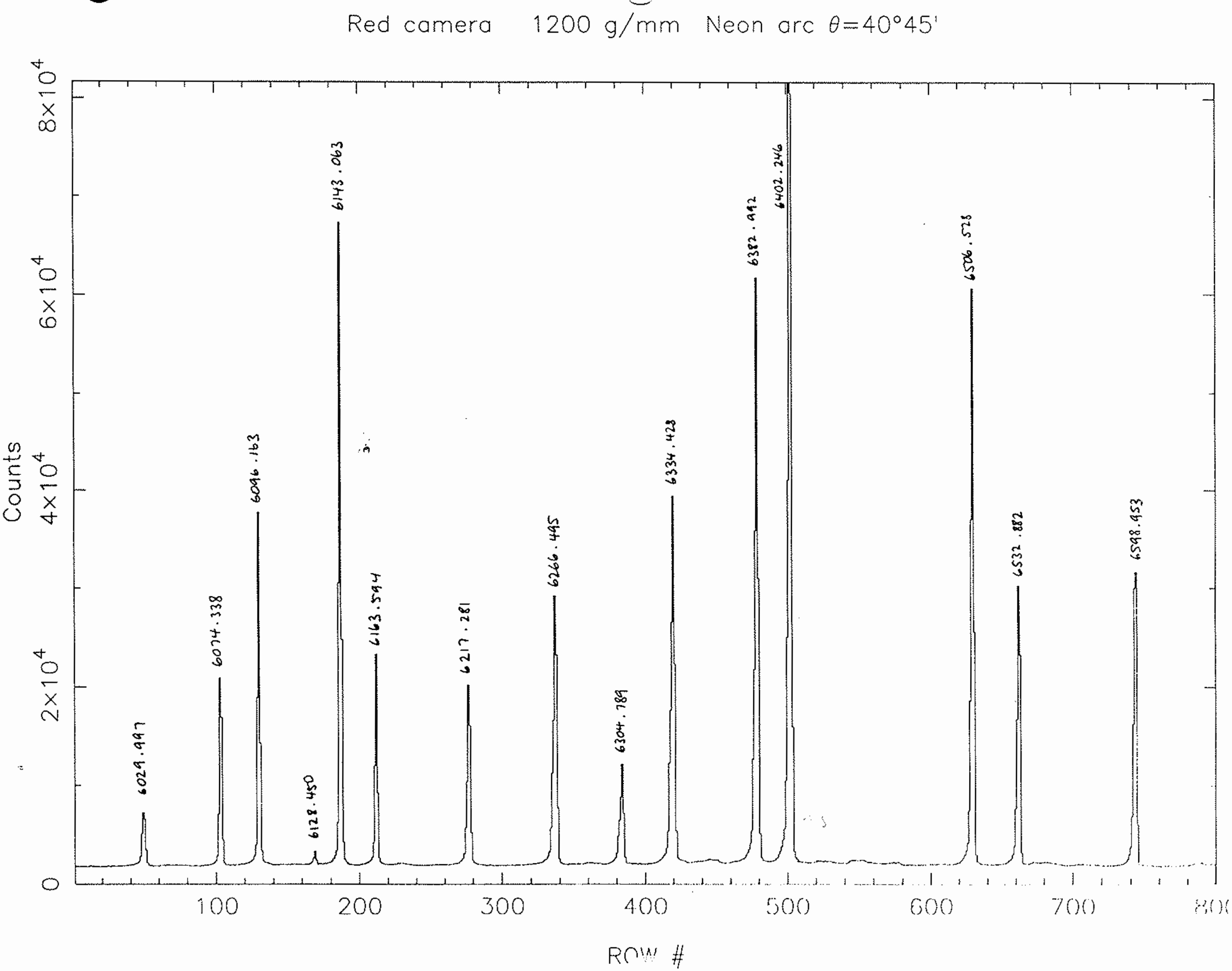




Red camera 300 g/mm Neon arc θ=25°15'
Counts
3×10^5
2×10^5
10^5
ROW #
100
200
300
400
500
600
700
800
7245.167
7438.894
7488.872
7535.774
8082.458
8136.406
8300.326
8377.606
8495.360
8591.259
8634.647
8654.383
8679.492
8681.921
8853.867
9201.76
9300.85

Figure 17b

Figure 18a



Red camera 1200 g/mm Neon arc θ=40°45'
Counts
ROW #
0
2×10^4
4×10^4
6×10^4
8×10^4
100
200
300
400
500
600
700
800
6029.997
6074.338
6096.163
6128.450
6143.063
6163.594
6217.281
6266.495
6304.789
6334.428
6382.992
6402.246
6506.528
6532.882
6598.953

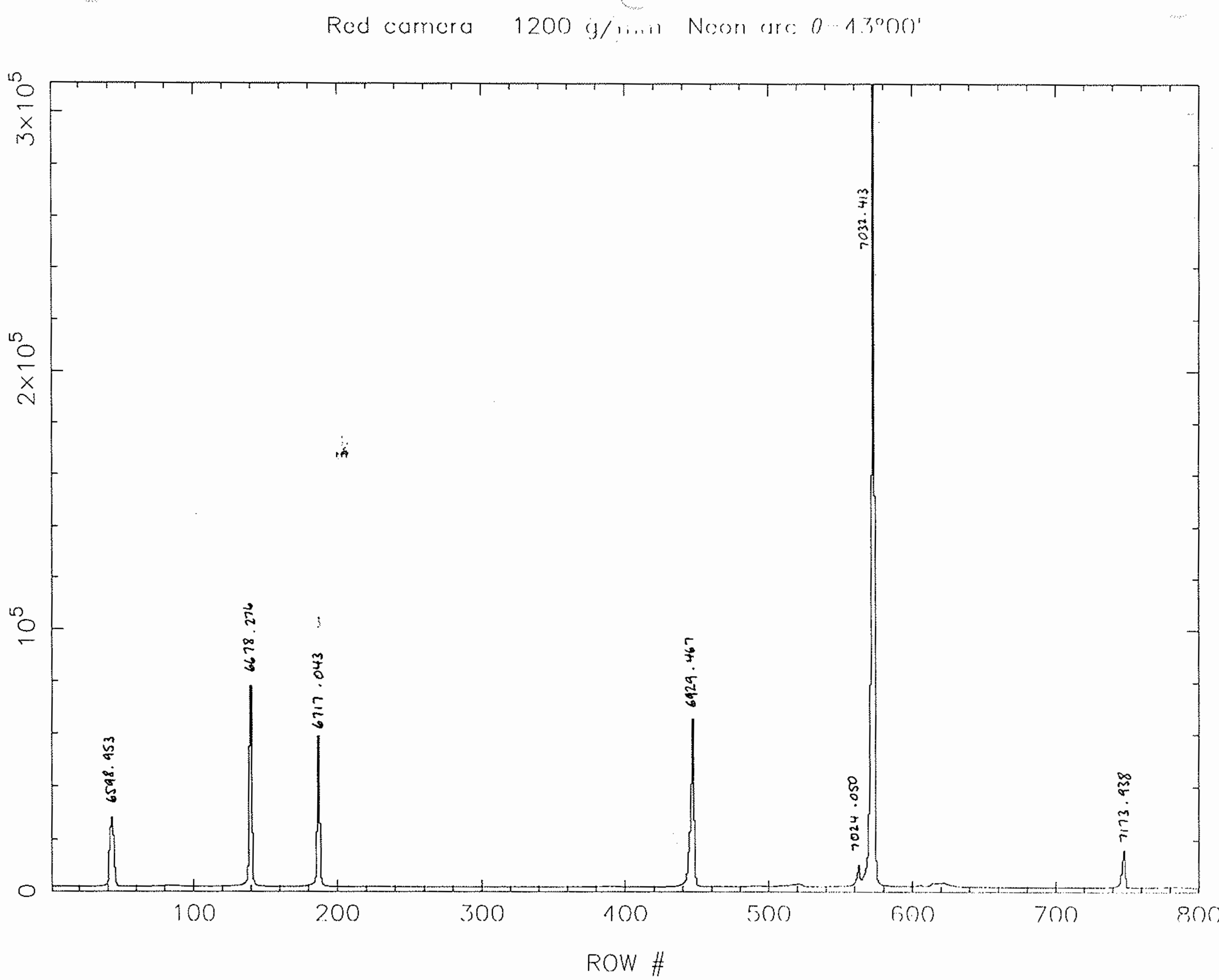
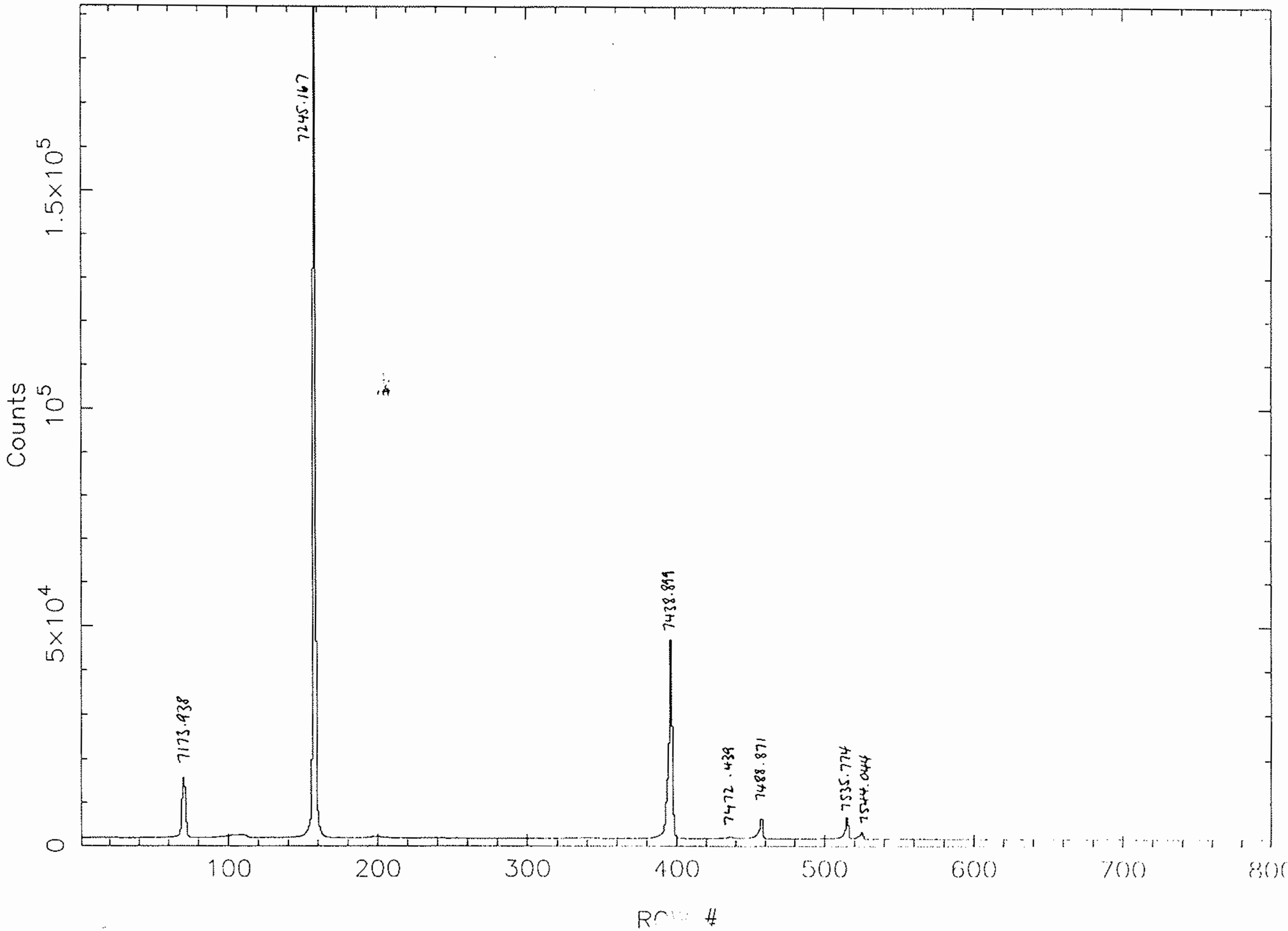

Red camera 1200 g/mm Neon arc θ=43°00'
Counts
3×10^5
2×10^5
10^5
0
100
200
300
400
500
600
700
800
ROW #
6598.953
6678.276
6717.043
6929.467
7024.050
7032.413
7173.938

Figure 13b

Red camera 1200 g/mm Neon arc @ 45°15'

Figure 18c



Red camera 1200 g/mm Neon arc θ=48°30'

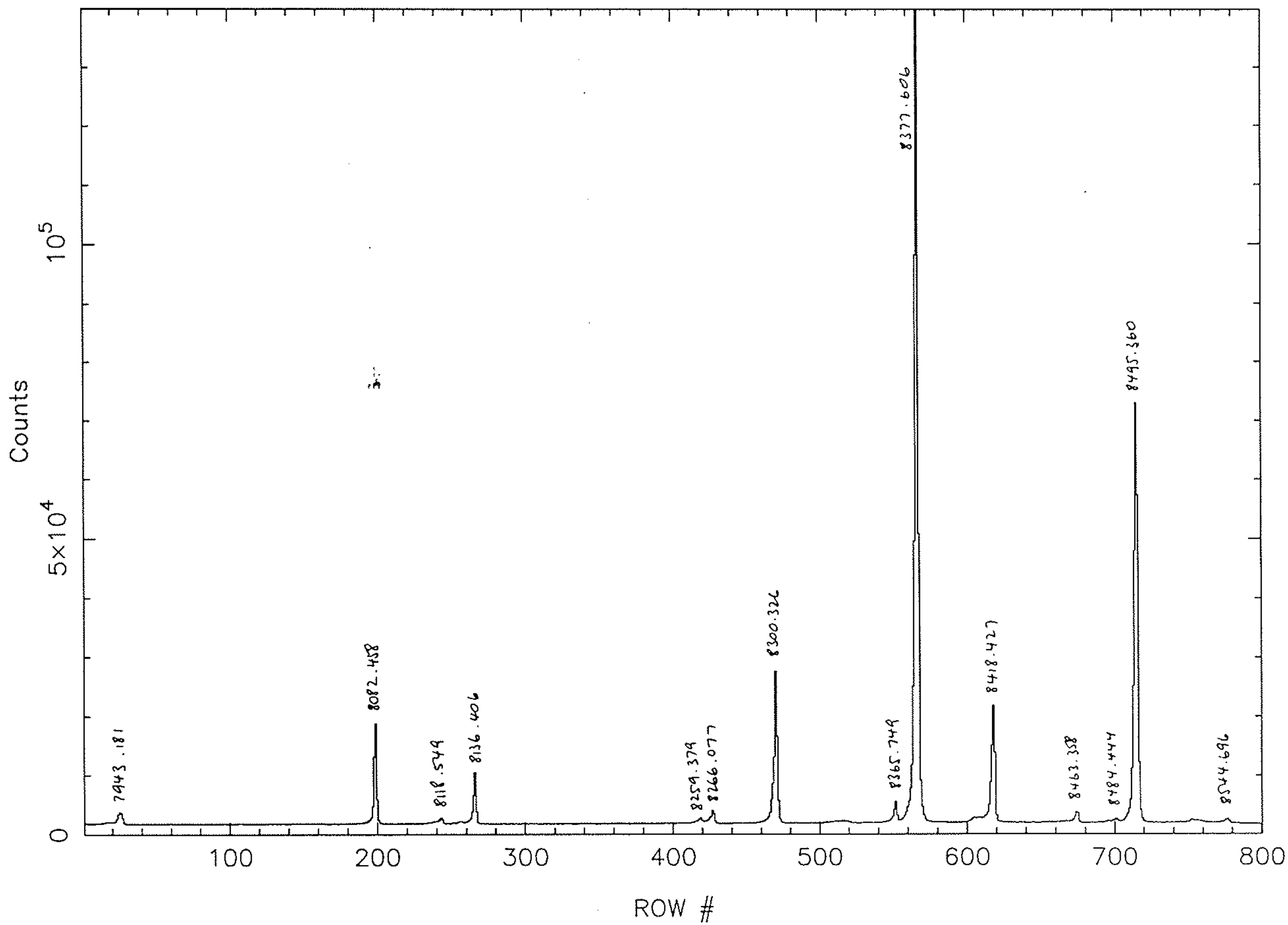
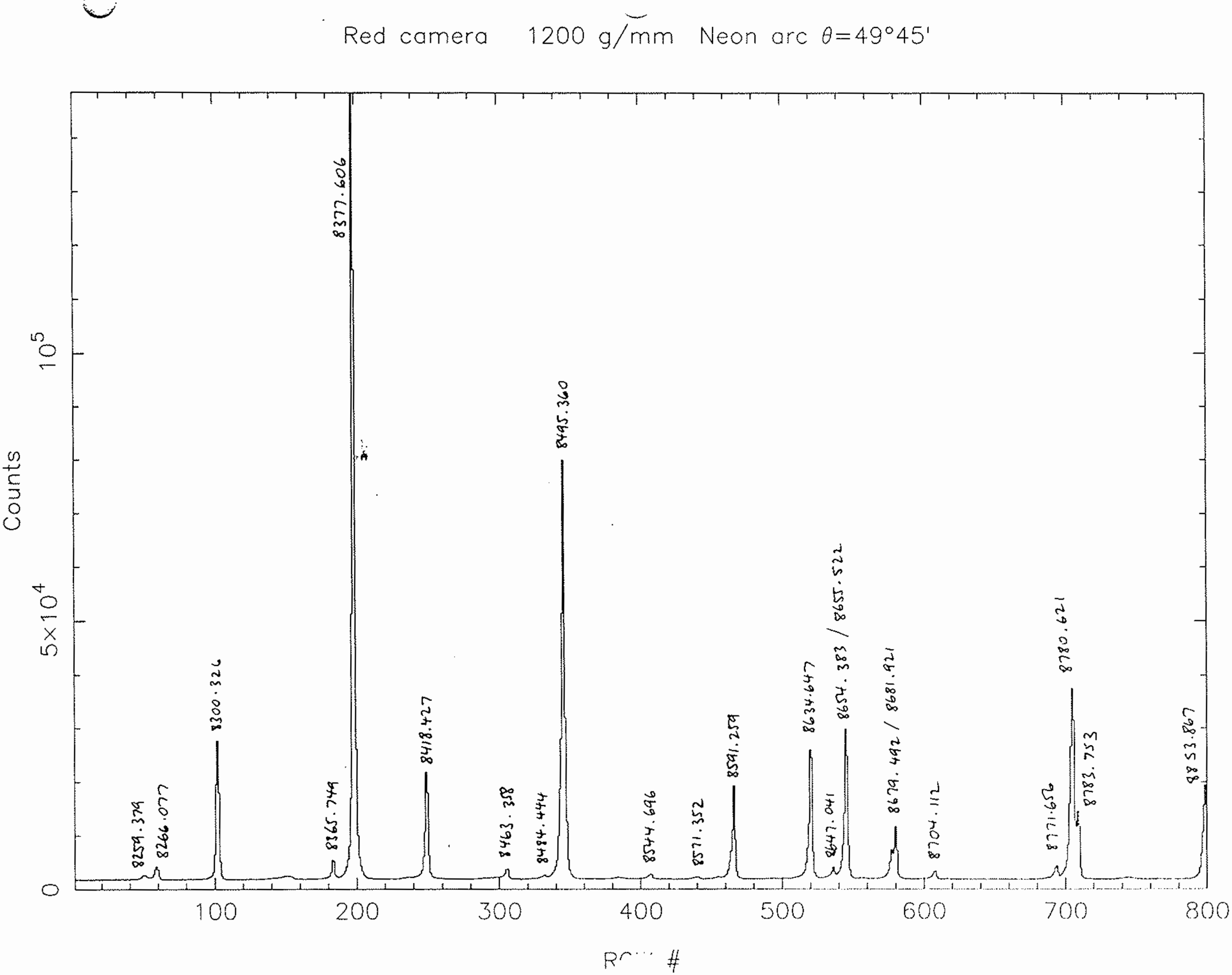


Figure 18d


Red camera 1200 g/mm Neon arc θ=49°45'
Counts
0
5×10^4
10^5
100
200
300
400
500
600
700
800
8259.379
8266.077
8300.326
8365.749
8377.606
8418.427
8463.358
8484.444
8495.360
8544.696
8571.352
8591.259
8634.647
8647.041
8654.383 / 8655.522
8679.492 / 8681.921
8704.112
8771.656
8780.621
8783.753
8853.867

Red camera 1200 g/mm Neon arc θ=52°00'

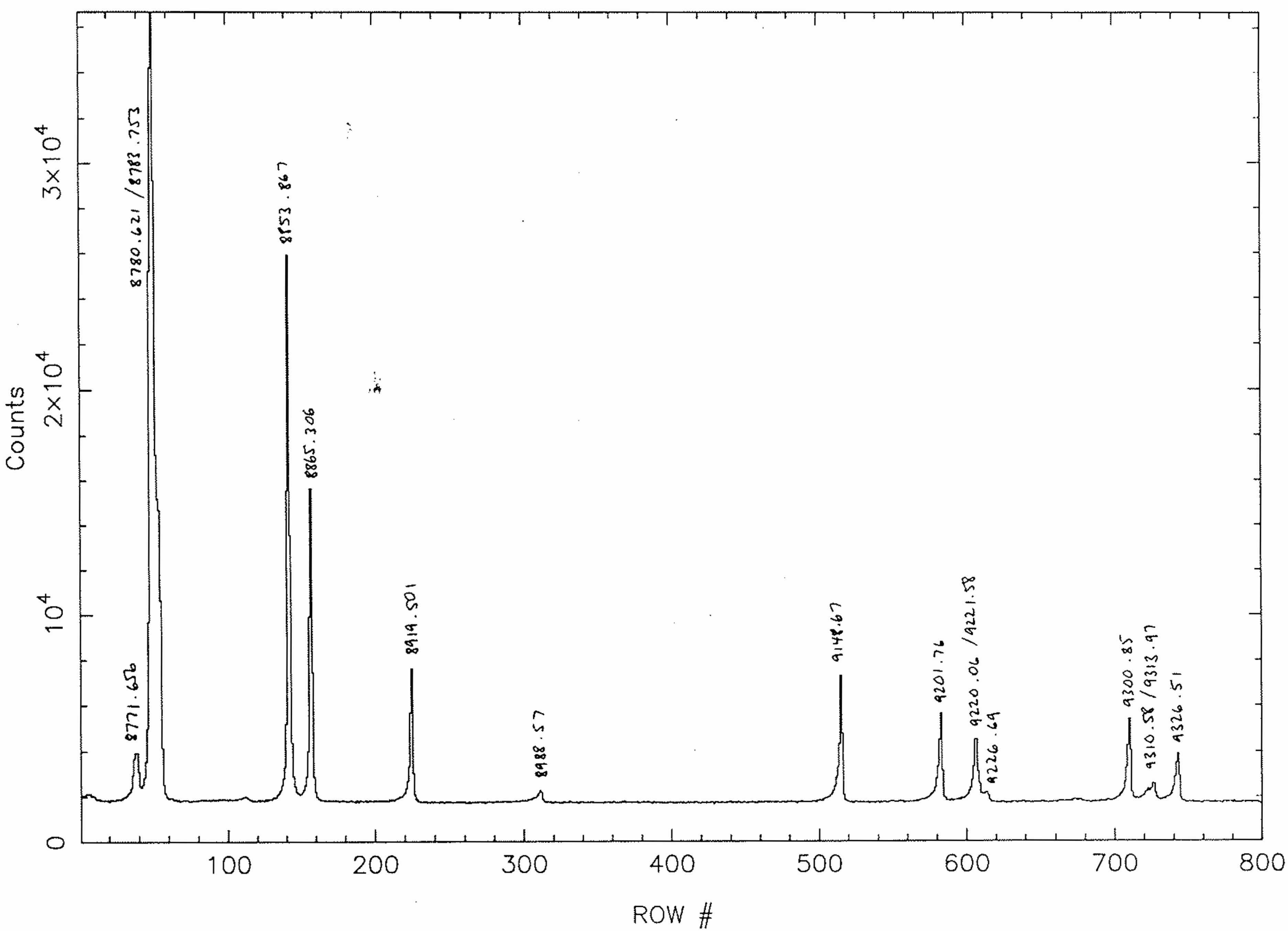


Figure 18f

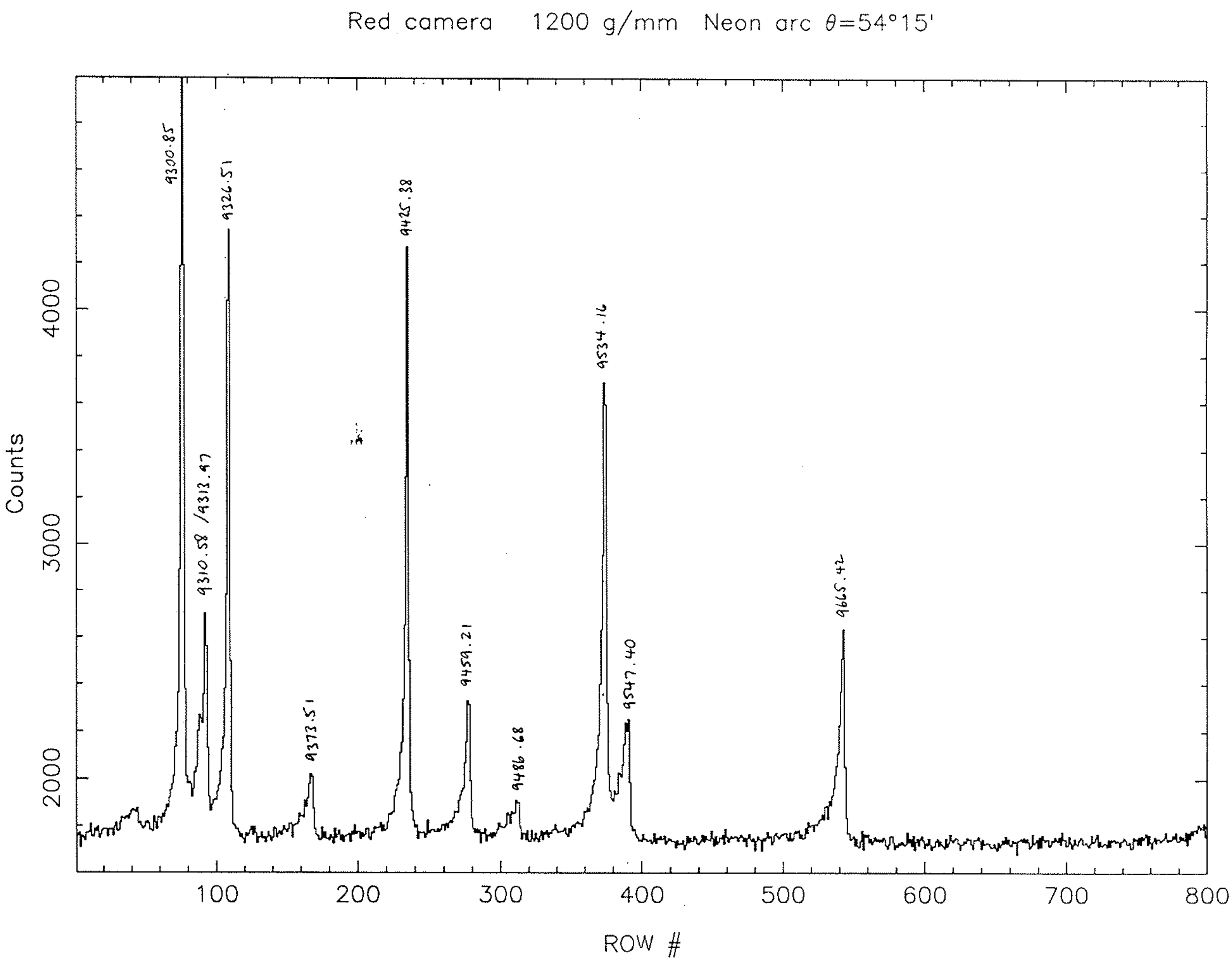

Red camera 1200 g/mm Neon arc θ=54°15'
Counts
ROW #
2000
3000
4000
100
200
300
400
500
600
700
800
9300.85
9310.58 /9313.97
9326.51
9373.51
9425.38
9459.21
9486.68
9534.16
9547.40
9665.42

Figure 18g

Table 3.
Argon wavelengths (AR.ARC)

λ (Å)	I	Ion	λ (Å)	I	Ion	λ (Å)	I	Ion
3476.7474	70	II	4522.323	20	I	6052.7229	10	I
3491.536	100	II	4545.0519	400	II	6059.3725	20	I
3509.7785	70	II	4579.3495	400	II	6098.8031	7	I
3514.3877	70	II	4589.8978	400	II	6105.6351	10	I
3545.596	70	II	4596.097	15	I	6114.9234	100	II
3545.845	70	II	4609.567	550	II	6145.4411	10	I
3559.5081	100	II	4628.4409	7	I	6170.1740	7	I
3561.0304	100	II	4657.9012	400	II	6172.2778	150	II
3576.6156	70	II	4702.316	15	I	6173.0964	10	I
3588.4407	70	II	4726.8683	550	II	6212.5031	10	I
3729.3087	70	II	4735.9058	300	II	6243.1201	25	II
3765.2700	150	II	4764.8646	800	II	6296.8722	7	I
3850.5813	70	II	4806.0205	550	II	6307.6570	15	I
3946.0971	70	II	4847.8095	150	II	6369.5748	7	I
4042.8937	150	II	4879.8635	800	II	6384.7169	20	I
4044.4179	50	I	4889.0422	70	II	6416.307	70	I
4052.9208	100	II	4965.0795	200	II	6483.0825	25	I
4054.5258	200	II	5017.1628	70	II	6538.1120	15	I
4072.385	70	I	5062.0371	70	II	6604.8534	15	I
4103.9121	150	II	5141.7827	100	II	6638.2207	25	II
4131.7235	300	II	5145.3083	70	II	6639.7403	20	II
4158.5905	400	I	5151.3907	5	I	6643.6976	50	II
4181.8836	50	I	5162.2846	15	I	6666.3588	25	II
4190.713	100	I	5176.2292	3	II	6677.2817	100	I
4191.029	50	I	5187.7462	20	I	6684.2929	35	II
4198.3170	200	I	5221.2710	7	I	6752.8335	150	I
4200.6745	400	I	5254.4648	3	I	6766.6117	15	I
4228.158	100	II	5373.494	5	I	6861.2688	20	II
4237.2198	100	II	5421.3517	5	I	6871.2891	150	I
4259.3619	200	I	5451.6520	10	I	6888.1742	10	I
4266.2864	100	I	5495.8738	25	I	6937.6642	50	I
4266.527	70	II	5506.1128	5	I	6965.4307	10000	I
4272.1689	150	I	5558.7020	25	I	7030.2514	150	I
4277.5282	550	II	5572.5413	10	I	7067.2181	10000	I
4300.1008	100	I	5606.7330	35	I	7147.0416	1000	I
4309.2392	70	II	5650.7043	20	I	7272.9359	2000	I
4331.1995	200	II	5739.5196	10	I	7311.7159	10000	I
4333.5612	100	I	5834.2633	5	I	7503.869	20000	I
4348.0640	800	II	5860.3103	10	I	7514.6518	15000	I
4370.7532	200	II	5882.6242	15	I	7635.1060	25000	I
4379.6668	150	II	5888.5841	25	I	7723.761	15000	I
4400.0968	70	II	5912.0853	50	I	7724.207	10000	I
4400.9863	200	II	5928.8130	15	I	7948.1764	20000	I
4426.0011	400	II	5942.6686	5	I	8006.1567	20000	I
4430.1890	150	II	5998.9987	5	I	8014.7857	25000	I
4474.7594	100	II	6025.1500	5	I	8103.6931	20000	I
4481.8107	200	II	6032.1274	70	I	8115.3110	35000	I
4510.7332	100	I	6043.2233	35	I	8264.5225	10000	I

Table 3. (cont.)
Argon wavelengths

λ (Å)	I	Ion	λ (Å)	I	Ion	λ (Å)	I	Ion
8408.2096	15000	I	9122.9674	35000	I	9784.5028	4500	I
8424.6475	20000	I	9224.4992	15000	I	10470.0535	1600	I
9354.2198	1600	I	8521.4422	15000	I			
8667.9442	4500	I	9657.7863	25000	I			

Table 4.
Neon wavelengths (NE.ARC)

λ (Å)	I	Ion	λ (Å)	I	Ion	λ (Å)	I	Ion
5330.78	25	I	7024.050	90	I	8679.492	5000	I
5400.56	60	I	7032.413	100	I	8681.921	5000	I
5764.419	80	I	7173.938	100	I	8704.112	2000	I
5852.488	500	I	7245.167	100	I	8771.656	4000	I
5872.828	100	I	7438.899	60	I	8780.612	12000	I
5881.895	100	I	7472.439	40	I	8783.753	10000	I
5944.834	100	I	7488.871	90	I	8853.867	7000	I
5965.471	100	I	7535.774	80	I	8865.306	1000	I
5974.627	100	I	7544.044	60	I	8865.755	1000	I
5975.534	120	I	7943.181	2000	I	8919.50	3000	I
5987.907	80	I	8082.458	2000	I	8988.57	2000	I
6029.997	100	I	8118.549	1000	I	9148.67	6000	I
6074.338	100	I	8136.406	3000	I	9201.76	6000	I
6096.163	80	I	8259.379	2500	I	9220.06	4000	I
6128.450	60	I	8266.077	2500	I	9221.58	2000	I
6143.063	100	I	8300.326	6000	I	9226.69	2000	I
6163.594	120	I	8365.749	1500	I	9275.52	1000	I
6182.146	250	I	8377.606	8000	I	9300.85	6000	I
6217.281	150	I	8417.159	1000	I	9310.58	1500	I
6266.495	150	I	8418.427	4000	I	9313.97	3000	I
6334.428	100	I	8463.358	1500	I	9326.51	6000	I
6382.992	120	I	8484.444	800	I	9373.31	2000	I
6402.246	200	I	8495.360	5000	I	9425.38	5000	I
6506.528	150	I	8544.696	600	I	9459.21	3000	I
6532.882	60	I	8571.352	1000	I	9486.68	5000	I
6598.953	150	I	8591.259	4000	I	9534.16	5000	I
6652.093	70	I	8634.647	6000	I	9547.40	3000	I
6678.276	90	I	8647.041	3000	I	9665.42	1000	I
6717.043	20	I	8654.383	15000	I	10295.42	800	I
6929.467	100	I	8655.522	4000	I	10562.41	2000	I

Table 5.
Helium wavelengths (HE.ARC)

λ (Å)	I	Ion	λ (Å)	I	Ion	λ (Å)	I	Ion
2945.11	10	I	4009.27	1	I	4921.931	20	I
3013.7	40	I	4026.19	50	I	5015.678	100	I
3187.74	20	I	4120.82	12	I	5047.740	10	I
3202.96	3	II	4120.99	2	I	5875.62	500	I
3203.10	15	II	4143.76	3	I	5875.97	100	I
3447.59	2	I	4387.93	10	I	6678.15	100	I
3613.64	3	I	4437.55	3	I	7065.19	200	I
3634.23	2	I	4471.48	200	I	7065.71	30	I
3705.00	3	I	4471.68	25	I	7281.35	50	I
3732.86	1	I	4685.4	6	II	10829.34	300	I
3819.61	10	I	4685.7	30	II	10830.25	1000	I
3888.65	500	I	4713.15	30	I	10830.34	2000	I
3964.73	20	I	4713.38	4	I			

Table 6.
Mercury wavelengths (HG.ARC)

λ (Å)	I	Ion	λ (Å)	I	Ion	λ (Å)	I	Ion
2916.27	150	II	3650.15	2800	I	5675.86	160	I
2935.94	150	II	3654.84	300	I	5769.60	240	I
2947.08	400	II	3662.88	80	I	5789.66	100	I
2967.28	1200	I	3663.28	240	I	5790.66	280	I
3021.50	300	I	3806.38	100	II	5803.78	140	I
3023.47	120	I	3918.92	100	II	6149.50	1000	II
3125.67	400	I	3983.96	200	II	6716.43	160	I
3131.65	320	I	4046.56	1800	I	6907.52	250	I
3131.84	320	I	4077.83	150	I	7081.90	250	I
3208.20	400	II	4339.22	250	I	7091.86	200	I
3264.06	400	II	4347.49	400	I	7485.87	100	II
3341.48	80	I	4358.33	4000	I	7944.66	100	II
3385.25	100	II	4398.62	100	II	10139.75	2000	I
3451.69	400	II	5128.45	100	II			
3549.42	200	II	5460.74	1100	I			

Table 7.
Hollow cathode (FeAr) wavelengths (HOCATH.ARC)

λ (Å)	Element	λ (Å)	Element	λ (Å)	Element	λ (Å)	Element
2942.893	Ar	3497.8404	Fe	3827.8226	Fe	4228.1580	Ar
2944.4269	Fe	3499.4765	Ar	3850.5813	Ar	4237.2198	Ar
2979.050	Ar	3509.7785	Ar	3856.3717	Fe	4251.1846	Ar
3000.4450	Ar	3514.3877	Ar	3859.9114	Fe	4259.3619	Ar
3000.9477	Fe	3535.3196	Ar	3868.5284	Ar	4266.2864	Ar
3008.1390	Fe	3545.5956	Ar	3878.8730	Fe	4266.5271	Ar
3020.6391	Fe	3545.8450	Ar	3886.2820	Fe	4271.7593	Fe
3021.0727	Fe	3559.5081	Ar	3899.7073	Fe	4272.1689	Ar
3028.9137	Ar	3561.0304	Ar	3920.2577	Fe	4277.5282	Ar
3033.5083	Ar	3565.3786	Fe	3922.9115	Fe	4282.8976	Ar
3037.3889	Fe	3570.0971	Fe	3925.7188	Ar	4300.1008	Ar
3047.6043	Fe	3576.6056	Ar	3927.9197	Fe	4300.6495	Ar
3057.4456	Fe	3581.1925	Fe	3930.2962	Fe	4307.9015	Fe
3059.0856	Fe	3581.6084	Ar	3932.5466	Ar	4309.2392	Ar
3060.9057	Ar	3582.3546	Ar	3946.0971	Ar	4325.7615	Fe
3067.2441	Fe	3588.4407	Ar	3948.9789	Ar	4331.1995	Ar
3075.7193	Fe	3605.8792	Ar	3968.3594	Ar	4333.5612	Ar
3093.4019	Ar	3606.6797	Fe	3969.2570	Fe	4335.3397	Ar
3139.0176	Ar	3608.8587	Fe	3974.4766	Ar	4337.0708	Ar
3161.3726	Ar	3618.7676	Fe	3979.3559	Ar	4345.1680	Ar
3169.6685	Ar	3622.1375	Ar	3994.7918	Ar	4348.0640	Ar
3181.0376	Ar	3631.4629	Fe	4005.3628	Ar	4352.2049	Ar
3204.3210	Ar	3639.8329	Ar	4013.8566	Ar	4362.0662	Ar
3206.3248	Fe	3647.8424	Fe	4033.8093	Ar	4367.8316	Ar
3243.6887	Ar	3655.2782	Ar	4035.4600	Ar	4370.7532	Ar
3249.8003	Ar	3660.4370	Ar	4042.8937	Ar	4375.9542	Ar
3263.5712	Ar	3687.4564	Fe	4044.4179	Ar	4379.6668	Ar
3281.7016	Ar	3705.5657	Fe	4045.8130	Fe	4383.5445	Fe
3293.6403	Ar	3709.2459	Fe	4052.9208	Ar	4385.0566	Ar
3293.9246	Ar	3718.2065	Ar	4063.5939	Fe	4400.0968	Ar
3307.2283	Ar	3719.9346	Fe	4072.0047	Ar	4400.9863	Ar
3350.9243	Ar	3722.5625	Fe	4072.3849	Ar	4404.7499	Fe
3376.4359	Ar	3729.3087	Ar	4076.6284	Ar	4415.1222	Fe
3388.5309	Ar	3734.8636	Fe	4076.9432	Ar	4426.0011	Ar
3407.4585	Fe	3737.1313	Fe	4082.3872	Ar	4430.1890	Ar
3427.1192	Fe	3737.8890	Ar	4103.9121	Ar	4433.8380	Ar
3440.6058	Fe	3745.5608	Fe	4131.7235	Ar	4439.4614	Ar
3440.9887	Fe	3748.2617	Fe	4156.0860	Ar	4448.8792	Ar
3443.8762	Fe	3749.4847	Fe	4158.5905	Ar	4474.7594	Ar
3454.0952	Ar	3758.2324	Fe	4164.1795	Ar	4481.8107	Ar
3465.8603	Fe	3763.7885	Fe	4181.8836	Ar	4490.9816	Ar
3475.4500	Fe	3780.8398	Ar	4189.6511	Ar	4498.5384	Ar
3475.7474	Ar	3803.1724	Ar	4190.7129	Ar	4502.9268	Ar
3478.2324	Ar	3809.4561	Ar	4198.3170	Ar	4510.7332	Ar
3480.5055	Ar	3815.8397	Fe	4200.6745	Ar	4522.3230	Ar
3490.5737	Fe	3820.4251	Fe	4201.9715	Ar	4530.5523	Ar
3491.2439	Ar	3824.4436	Fe	4226.6089	Ar	4545.0519	Ar
3491.5360	Ar	3825.8805	Fe	4226.9876	Ar	4547.7589	Ar

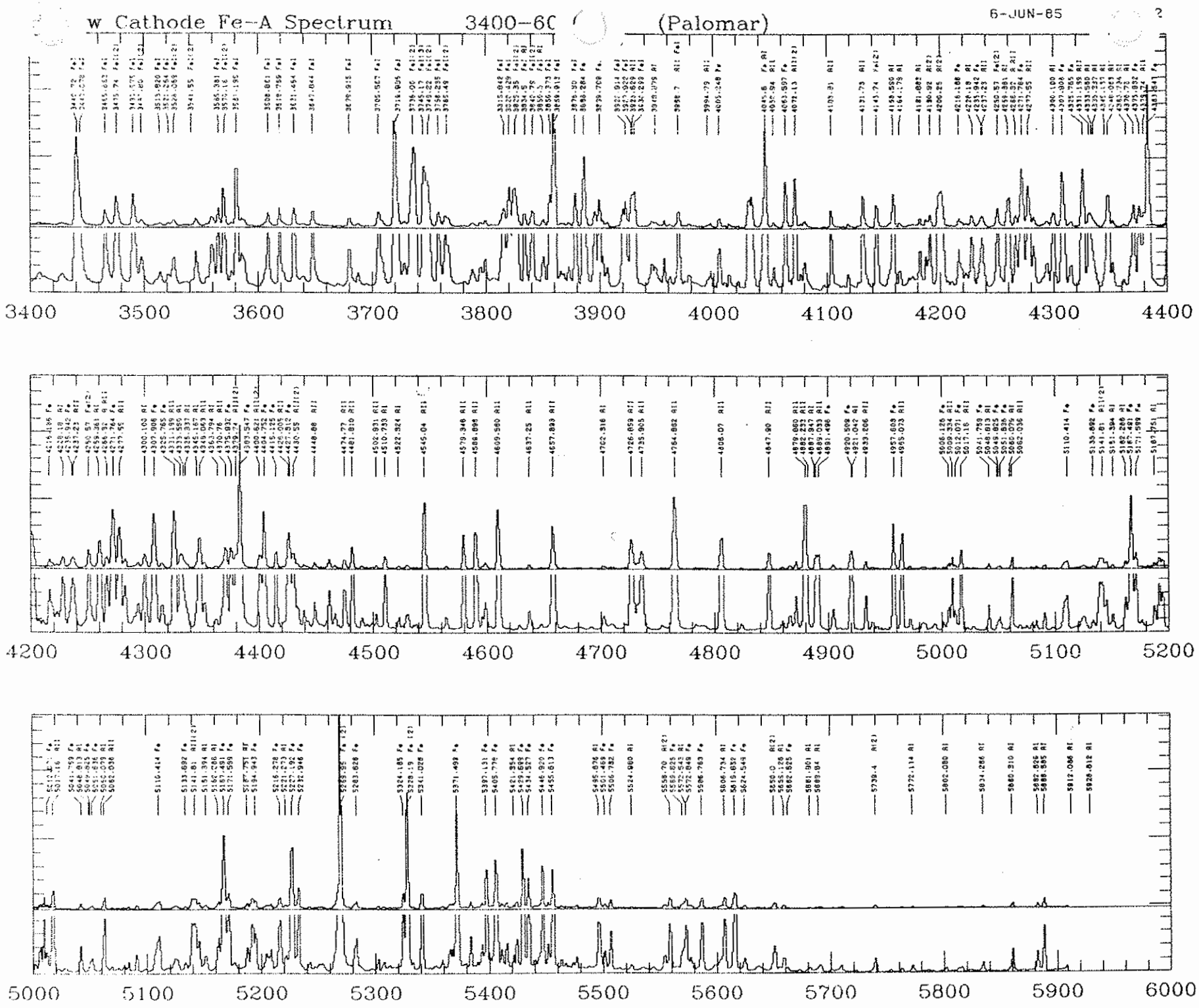
Table 7. (cont.)

Hollow cathode (FeAr) wavelengths

λ (Å)	Element	λ (Å)	Element	λ (Å)	Element	λ (Å)	Element
4579.6795	Ar	5305.6880	Ar	5860.3103	Ar	6322.7452	Ar
4589.8978	Ar	5311.9787	Ar	5882.6242	Ar	6339.3370	Ar
4596.0967	Ar	5324.1782	Fe	5885.7866	Ar	6362.0752	Ar
4609.5673	Ar	5328.0376	Fe	5888.5841	Ar	6369.5748	Ar
4628.4409	Ar	5371.4892	Fe	5912.0853	Ar	6384.7169	Ar
4637.2328	Ar	5373.4943	Ar	5928.8130	Ar	6386.4516	Fe
4657.9012	Ar	5393.5995	Ar	5933.7964	Fe	6393.8562	Fe
4702.3161	Ar	5397.1296	Fe	5940.1990	Fe	6408.642	Ar
4721.5910	Ar	5402.6048	Ar	5942.6686	Ar	6416.3071	Ar
4726.8683	Ar	5405.7741	Fe	5946.4704	Fe	6428.0222	Fe
4732.0532	Ar	5407.3439	Ar	5958.1006	Ar	6444.1332	Fe
4735.9058	Ar	5421.3517	Ar	5967.1396	Fe	6451.5700	Fe
4764.8646	Ar	5429.6955	Fe	5988.8538	Fe	6466.5526	Ar
4806.0205	Ar	5434.5228	Fe	6001.8954	Fe	6483.0825	Ar
4847.8905	Ar	5439.9891	Ar	6016.2780	Fe	6487.3774	Ar
4865.9105	Ar	5446.9161	Fe	6025.1500	Ar	6499.6006	Ar
4879.8635	Ar	5451.6520	Ar	6032.1274	Ar	6527.1424	Ar
4889.0422	Ar	5455.6090	Fe	6041.2781	Fe	6538.1124	Ar
4904.7516	Ar	5457.4157	Ar	6042.1454	Fe	6546.6344	Ar
4920.5018	Fe	5467.1608	Ar	6043.2233	Ar	6563.4032	Ar
4933.2091	Ar	5473.4516	Ar	6052.7229	Ar	6587.2806	Ar
4942.9214	Ar	5495.8738	Ar	6057.8274	Ar	6587.8492	Ar
4957.5966	Fe	5506.1128	Ar	6059.3725	Ar	6604.8534	Ar
4965.0765	Ar	5524.9570	Ar	6067.0166	Ar	6614.4566	Ar
4972.1597	Ar	5545.0495	Ar	6074.7774	Fe	6620.9665	Ar
5009.3344	Ar	5558.7020	Ar	6090.7848	Ar	6638.2207	Ar
5017.1628	Ar	5572.5413	Ar	6095.2086	Fe	6639.7403	Ar
5062.0371	Ar	5577.6845	Ar	6098.8031	Ar	6643.6976	Ar
5090.4951	Ar	5587.7553	Fe	6101.1615	Ar	6656.9386	Ar
5118.2023	Ar	5588.7200	Ar	6103.5390	Ar	6660.6761	Ar
5125.7654	Ar	5597.4756	Ar	6105.6351	Ar	6664.0510	Ar
5141.7827	Ar	5601.1216	Ar	6114.9234	Ar	6666.3586	Ar
5145.3083	Ar	5606.7330	Ar	6118.1712	Fe	6677.2817	Ar
5151.3907	Ar	5615.6436	Fe	6121.8114	Ar	6684.2929	Ar
5162.2846	Ar	5641.3751	Ar	6127.4160	Ar	6701.8486	Ar
5165.7728	Ar	5648.6863	Ar	6134.4882	Fe	6719.2184	Ar
5167.4873	Fe	5650.7043	Ar	6145.4411	Ar	6752.8335	Ar
5171.5953	Fe	5659.1272	Ar	6155.2385	Ar	6752.8718	Ar
5176.2292	Ar	5681.9001	Ar	6170.1740	Ar	6766.6177	Ar
5187.7462	Ar	5691.6612	Ar	6172.2778	Ar	6777.0618	Ar
5221.2710	Ar	5700.8730	Ar	6173.0984	Ar	6814.9170	Fe
5227.1892	Fe	5738.3869	Ar	6186.8038	Ar	6861.2688	Ar
5232.9394	Fe	5739.5196	Ar	6212.5031	Ar	6863.5350	Ar
5252.7880	Ar	5772.1143	Ar	6215.9383	Ar	6871.2891	Ar
5254.4648	Ar	5783.5360	Ar	6243.1201	Ar	6881.2116	Fe
5269.5366	Fe	5802.0798	Ar	6278.0352	Ar	6881.9774	Fe
5281.6285	Ar	5812.7592	Ar	6296.8722	Ar	6887.7524	Fe
5286.8870	Ar	5834.2633	Ar	6307.6570	Ar	6931.7206	Fe

Table 7. (cont.)
Hollow cathode (FeAr) wavelengths

λ (Å)	Element	λ (Å)	Element	λ (Å)	Element	λ (Å)	Element
6937.6642	Ar	7163.2168	Ar	7445.1250	Fe	7712.7434	Fe
6950.9000	Fe	7164.7092	Ar	7458.6174	Ar	7719.8228	Fe
6951.4776	Ar	7176.8814	Ar	7469.7272	Fe	7723.7611	Ar
6953.4032	Fe	7206.9804	Ar	7474.2626	Fe	7724.2072	Ar
6953.4948	Ar	7211.7584	Ar	7475.7780	Ar	7737.0568	Ar
6965.4307	Ar	7213.7174	Fe	7491.1216	Fe	7757.1460	Fe
6981.1474	Fe	7237.5253	Fe	7496.5234	Fe	7948.176	Ar
6982.4878	Ar	7244.2750	Ar	7498.9694	Fe	8006.157	Ar
6983.0720	Ar	7262.9258	Fe	7503.8691	Ar	8014.786	Ar
7019.5570	Ar	7272.9359	Ar	7514.6518	Ar	8103.693	Ar
7028.8854	Ar	7279.6658	Ar	7530.5400	Ar	8115.311	Ar
7030.2514	Ar	7295.6848	Fe	7532.2372	Ar	8264.522	Ar
7067.2181	Ar	7311.7159	Ar	7534.3828	Fe	8408.210	Ar
7091.2806	Fe	7353.2930	Ar	7606.3448	Ar	8424.648	Ar
7091.6900	Ar	7356.5402	Ar	7618.9122	Ar	8521.442	Ar
7119.0162	Ar	7359.8264	Fe	7631.6794	Fe	8667.944	Ar
7122.0608	Ar	7372.1184	Ar	7635.1060	Ar	9122.967	Ar
7130.7572	Fe	7383.9805	Ar	7640.8502	Fe	9224.499	Ar
7140.1942	Fe	7411.1314	Fe	7651.7610	Fe	9354.220	Ar
7147.0416	Ar	7436.4130	Ar	7668.4444	Fe	9657.786	Ar
7153.2312	Ar	7439.8692	Fe	7701.1626	Ar		


w Cathode Fe-A Spectrum 3400-60 (Palomar)
6-JUN-85
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
4200
4300
4400
4500
4600
4700
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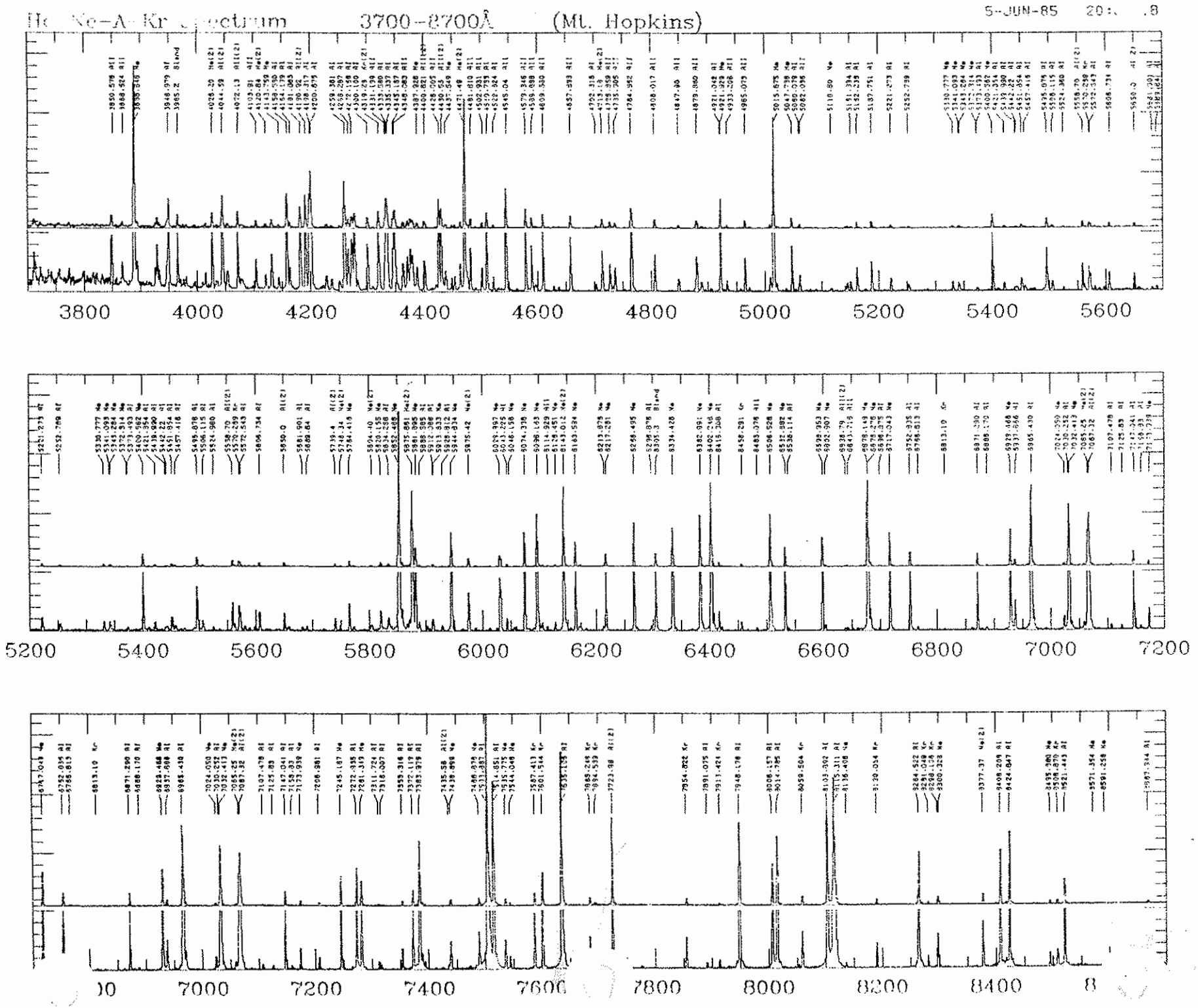
5400
5500
5600
5700
5800
5900
6000


He Ne-A Kr Spectrum 3700-8700Å (Mt. Hopkins)
5-JUN-85
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
5200
5400
5600
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7000
7200
7400
7800
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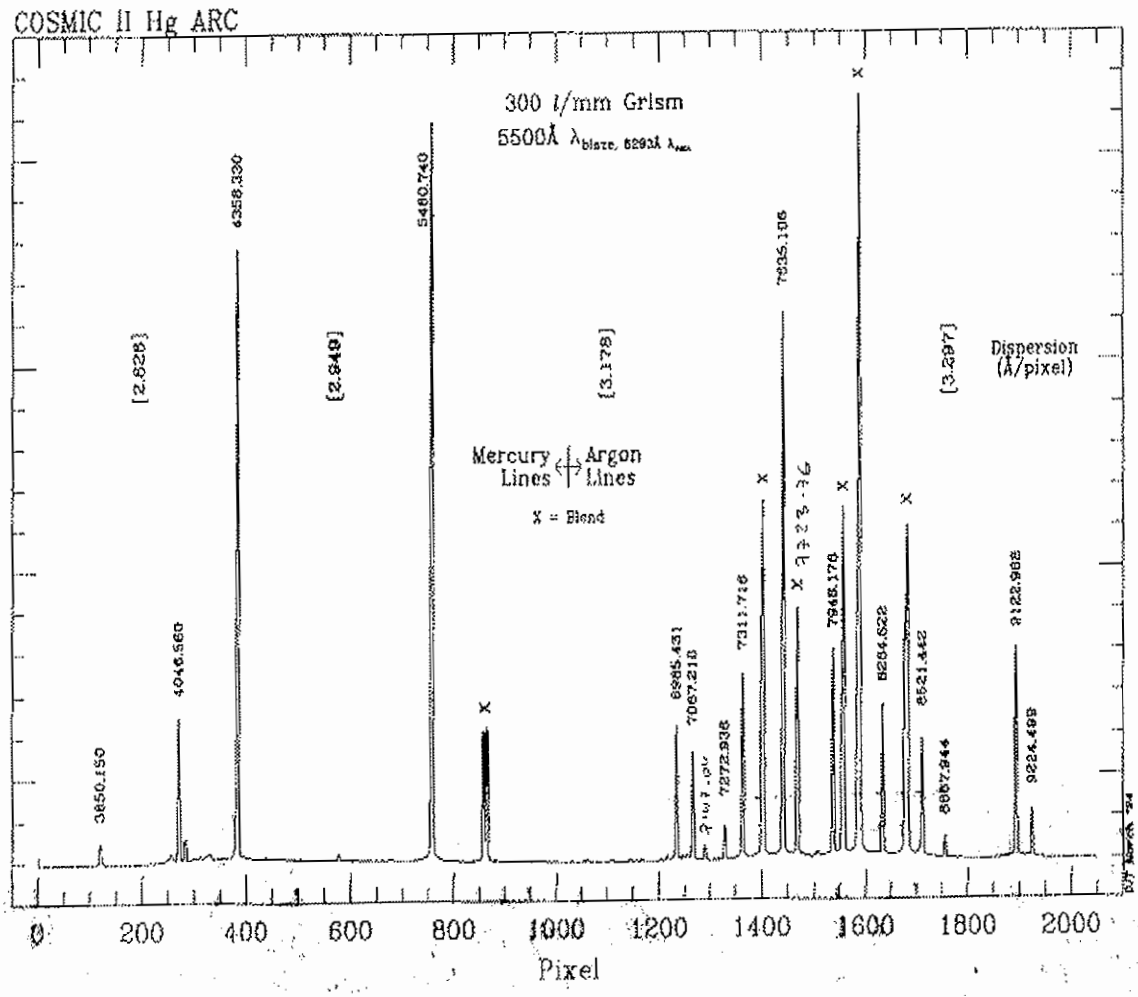
8200
8400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[3.178]
[3.297]
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Argon Lines
X = Blend
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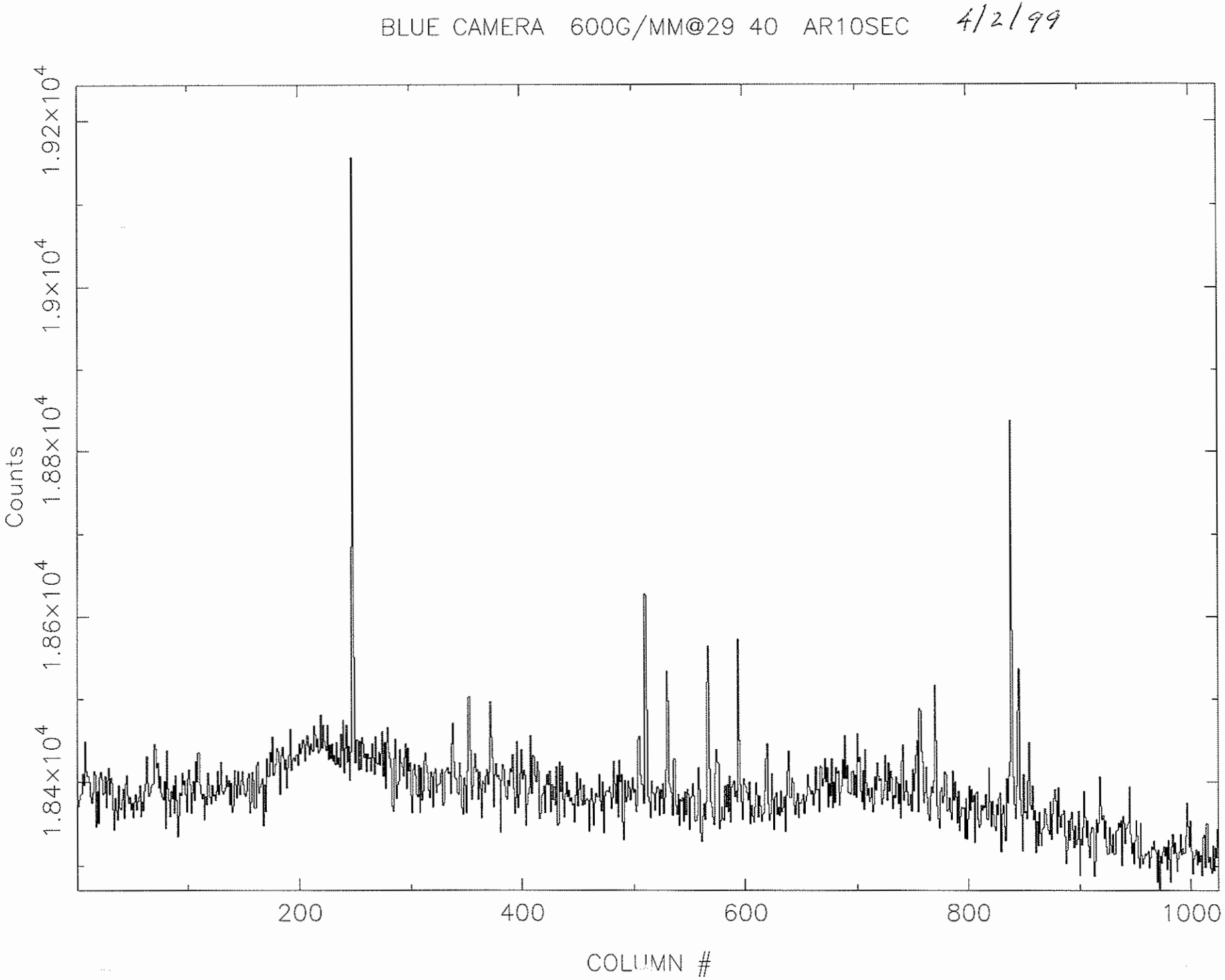
4358.330
5460.740
6965.431
7067.218
7272.938
7311.716
7635.106
7948.176
8264.522
8521.442
8667.944
9122.968
9224.498
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Pixel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1.86×10^4
1.88×10^4
1.9×10^4
1.92×10^4
200
400
600
800
1000
COLUMN #