ING LA PALMA TECHNICAL NOTE NO. 135

Arc maps for the CuAr and CuNe lamps when used with ACAM/AUXCAM

Version 1.0 (February 2013)

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Introduction

This document gives line atlases for arc spectra obtained using the R400V grism with ACAM/AUXCAM at the WHT. The arcs were taken on 27th December 2011, with the Copper-Argon, Copper-Neon, and Copper-Argon+Copper-Neon lamp configurations. All exposures used the 1.0 arcsecond slit, no filters, and the standard ACAM window of [1:2148,800:3300].

Tables 1-3 give pixel positions for some identified lines for each lamp configuration. Table 4 give Copper-Argon and Copper-Neon laboratory spectral lines used for wavelength calibration. Figures 1-3 give the wavelength-calibrated arc spectra, whilst Figures 4-6 give the same plots but with pixel number as the x-axis variable instead of wavelength. Appendix A show the IDL atlas plotting code and Appendix B the ACAM observing calibration script used.

Table 1: Pixel numbers corresponding to prominent lines for the CuAr+CuNe arc spectra as measured on spatial pixel 1074 on the unwindowed CCD.

Pixel number (unwindowed CCD)	Pixel number (CCD window [*,800:3300])	Wavelength (Å)
1487	688	4158.59
1499	700	4199.63
1523	724	4275.11
1596	797	4510.73
1606	807	4545.05
1626	827	4609.57
1641	842	4657.90
1674	875	4764.87
1686	887	4806.02
1699	900	4847.81
1709	910	4879.86
1734	935	4965.08
1777	978	5105.54
1811	1012	5218.20
1866	1067	5400.56
2001	1202	5852.49
2010	1211	5881.90
2029	1230	5944.83
2038	1239	5975.53
2074	1275	6096.16
2110	1311	6217.28
2125	1326	6266.50
2136	1337	6304.79
2145	1346	6334.43
2196	1397	6506.53
2203	1404	6532.88
2223	1424	6598.95
2246	1447	6678.28
2258	1459	6717.04
2268	1469	6752.83
2303	1504	6871.29
2320	1521	6929.47
2331	1532	6965.43
2351	1552	7032.41
2361	1562	7067.22
2384	1585	7147.04
2392	1593	7173.94
2402	1603	7206.98
2413	1614	7245.17
2421	1622	7272.94
2454	1655	7383.98
2470	1671	7438.90
2527	1728	7635.12
2553	1754	7723.98
2618	1819	7948.18
2709	1910	8264.52
2720	1921	8300.33
2784	1985	8521.44
2825	2026	8667.94
2956	2157	9122.97
2985	2186	9224.50
3021	2222	9354.22

Table 2: Pixel numbers corresponding to prominent lines for the CuAr arc spectra as measured on spatial pixel 1074 of the unwindowed CCD.

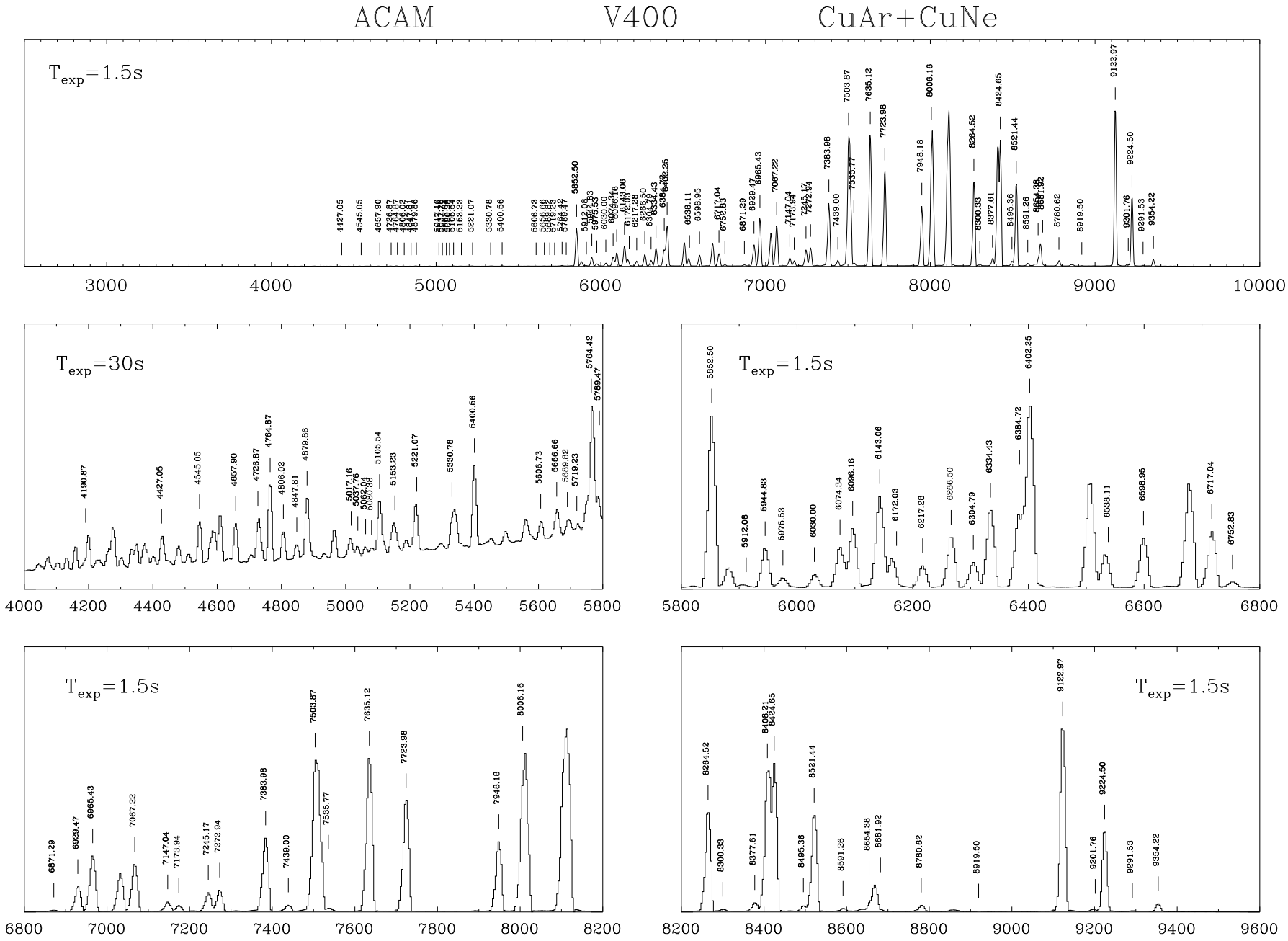
Pixel number (unwindowed CCD)	Pixel number (CCD window [*,800:3300])	Wavelength (Å)
1571	772	4427.05
1607	808	4545.05
1642	843	4657.90
1675	876	4764.87
1687	888	4806.02
1700	901	4847.81
1751	952	5017.16
1765	966	5062.04
1929	1130	5606.73
1942	1143	5650.71
2013	1214	5888.58
2097	1298	6172.03
2161	1362	6384.72
2170	1371	6416.31
2246	1447	6677.28
2269	1470	6752.83
2304	1505	6871.29
2331	1532	6965.43
2351	1552	7030.25
2361	1562	7067.22
2385	1586	7147.04
2402	1603	7206.98
2422	1623	7272.94
2454	1655	7383.98
2527	1728	7635.12
2553	1754	7723.98
2618	1819	7948.18
2710	1911	8264.52
2784	1985	8521.44
2826	2027	8667.94
2956	2157	9122.97
2985	2186	9224.50
3004	2205	9291.53
3022	2223	9354.22

Table 3: Pixel numbers corresponding to prominent lines for the CuNe arc spectra as measured on spatial pixel 1074 on the unwindowed CCD.

Pixel number (unwindowed CCD)	Pixel number (CCD window [*,800:3300])	Wavelength (Å)
1756	957	5037.76
1769	970	5080.38
1811	1012	5218.20
1866	1067	5400.56
1975	1176	5764.42
2001	1202	5852.50
2010	1211	5881.90
2054	1255	6030.00
2074	1275	6096.16
2088	1289	6143.06
2110	1311	6217.28
2125	1326	6266.50
2145	1346	6334.43
2165	1366	6402.25
2203	1404	6532.88
2246	1447	6678.28
2258	1459	6717.04
2351	1552	7032.41
2470	1671	7439.00
2720	1921	8300.33
2742	1943	8377.61
2754	1955	8418.43
2776	1977	8495.36
2804	2005	8591.26
2898	2099	8919.50
2963	2164	9148.68

Table 4. Copper-Argon and Copper-Neon laboratory spectral lines used for wavelength calibration in the low-resolution spectra.

3247.540	5080.383	6096.163	7435.368
3273.962	5090.495	6098.803	7438.899
3447.703	5105.541	6105.635	7471.164
3520.472	5116.503	6114.923	7488.872
3713.08	5141.783	6143.063	7503.869
3777.13	5153.235	6145.441	7514.652
3947.53	5162.285	6155.239	7723.98
4022.66	5187.746	6163.594	7891.075
4043.90	5218.202	6172.03	7943.180
4072.11	5221.07	6214.02	7948.176
4103.912	5253.13	6217.281	8006.157
4131.724	5330.778	6243.120	8014.786
4158.591	5341.091	6266.495	8053.309
4181.884	5373.494	6296.872	8082.458
4190.87	5400.5619	6304.789	8103.693
4198.317	5421.352	6307.657	8115.311
4259.362	5451.652	6334.428	8136.406
4275.11	5495.874	6369.575	8264.523
4277.528	5506.113	6382.991	8266.08
4300.101	5524.957	6384.717	8300.326
4331.31	5558.702	6402.247	8377.607
4348.064	5572.541	6416.307	8408.210
4370.753	5606.733	6506.528	8418.427
4427.05	5650.704	6532.882	8424.648
4474.759	5681.900	6598.953	8495.360
4481.811	5689.910	6677.282	8521.442
4510.733	5739.520	6678.277	8591.258
4530.82	5748.299	6684.293	8605.776
4545.052	5764.418	6717.043	8634.648
4579.350	5772.114	6752.834	8654.383
4589.899	5802.080	6871.289	8667.944
4609.567	5834.263	6929.468	8761.686
4651.13	5852.4878	6937.664	8849.970
4657.901	5860.310	6965.430	8853.866
4702.316	5881.8950	7030.252	8865.670
4704.395	5882.624	7032.413	8919.500
4726.868	5888.584	7067.218	9075.395
4735.906	5912.085	7107.478	9122.967
4764.865	5928.813	7125.820	9148.680
4806.021	5944.834	7147.042	9194.639
4847.810	5975.534	7173.939	9224.499
4879.864	5987.302	7206.980	9291.531
4884.915	5998.999	7245.167	9300.850
4889.042	6025.150	7272.936	9326.520
4933.209	6030.000	7311.716	9354.220
4965.08	6032.127	7353.293	9425.380
5009.334	6043.223	7372.118	9657.786
5017.163	6052.723	7383.981	9665.424
5037.7505	6059.373	7535.775	9784.503
5062.037	6074.338	7635.106	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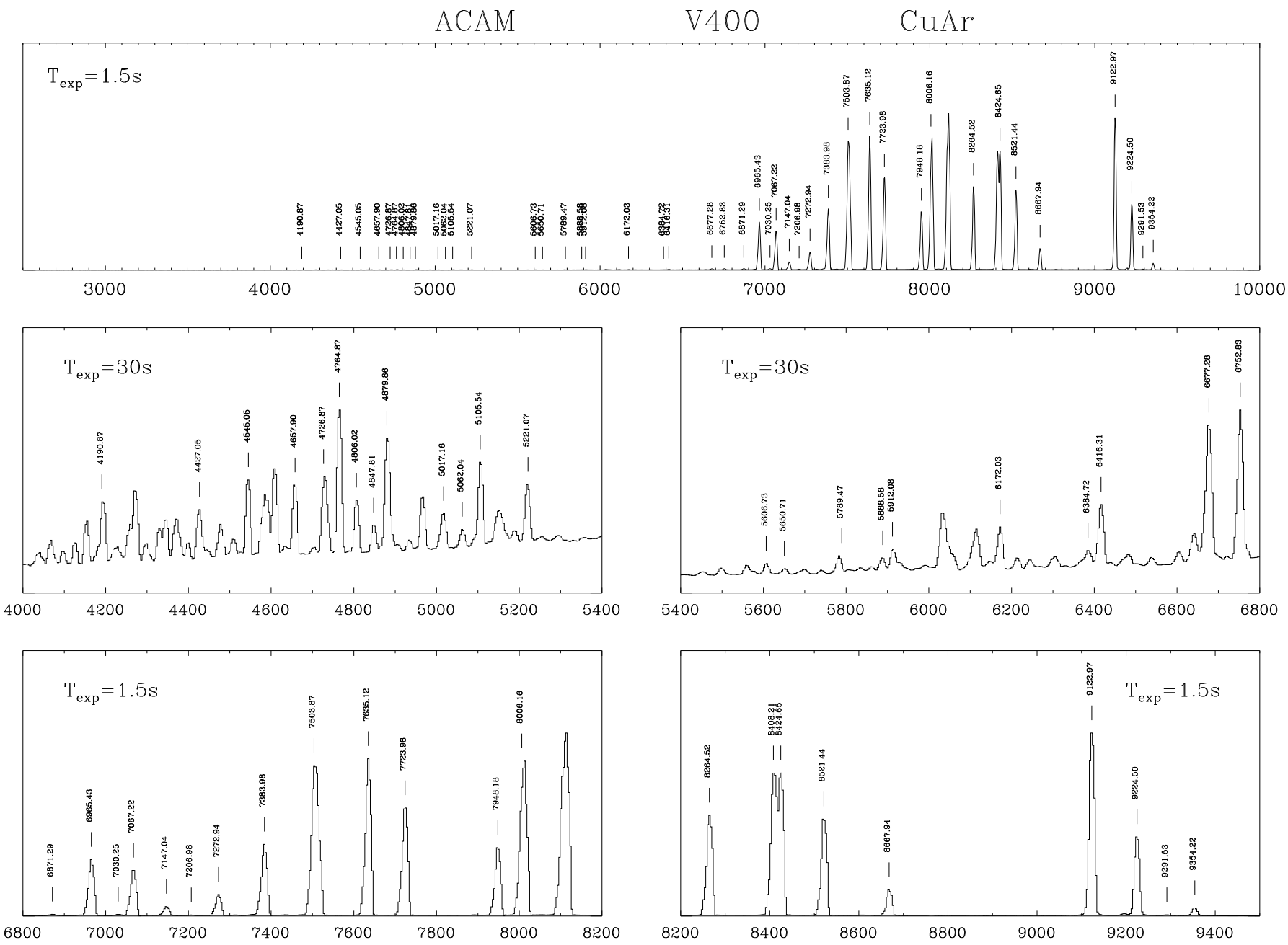
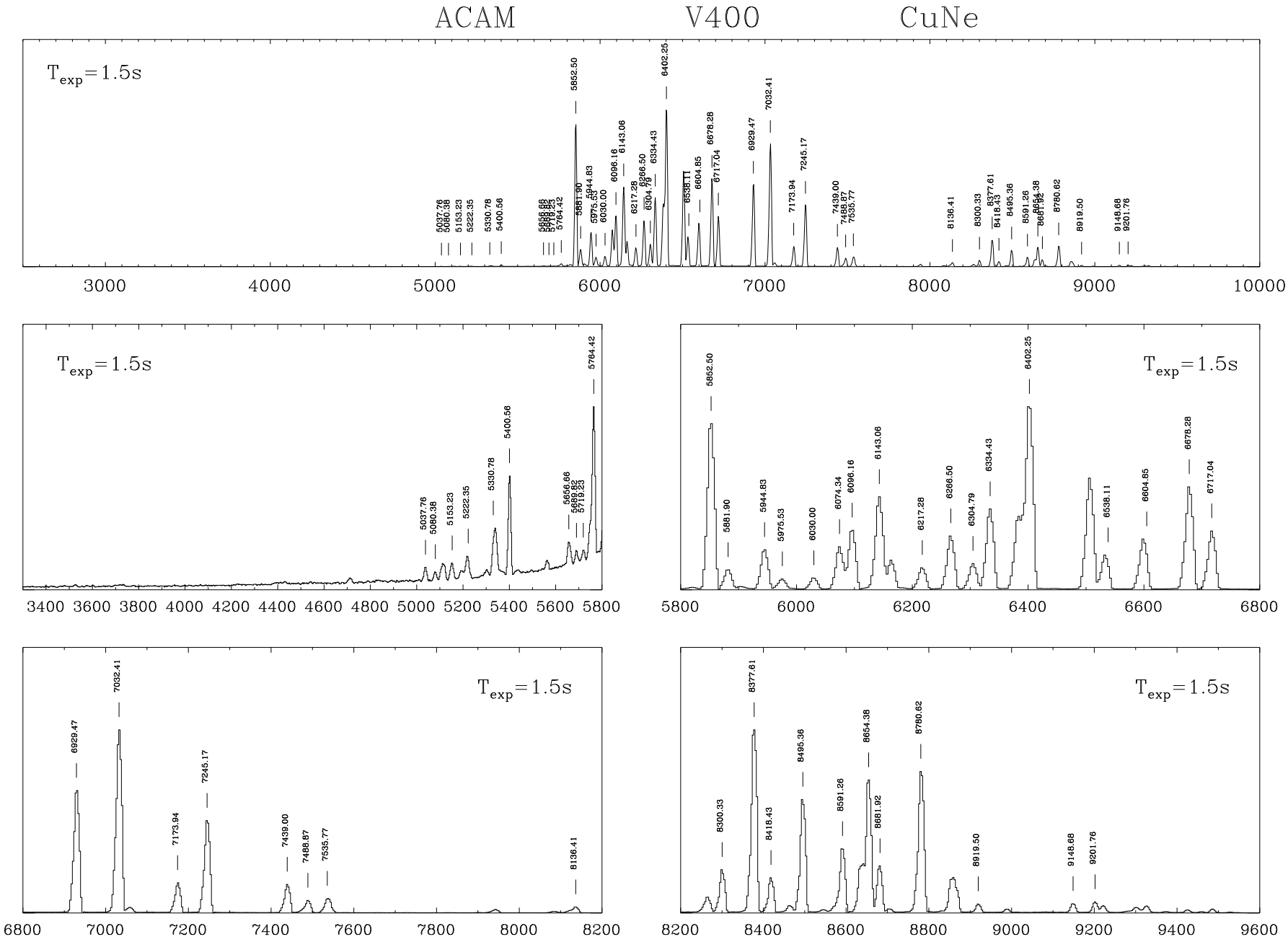
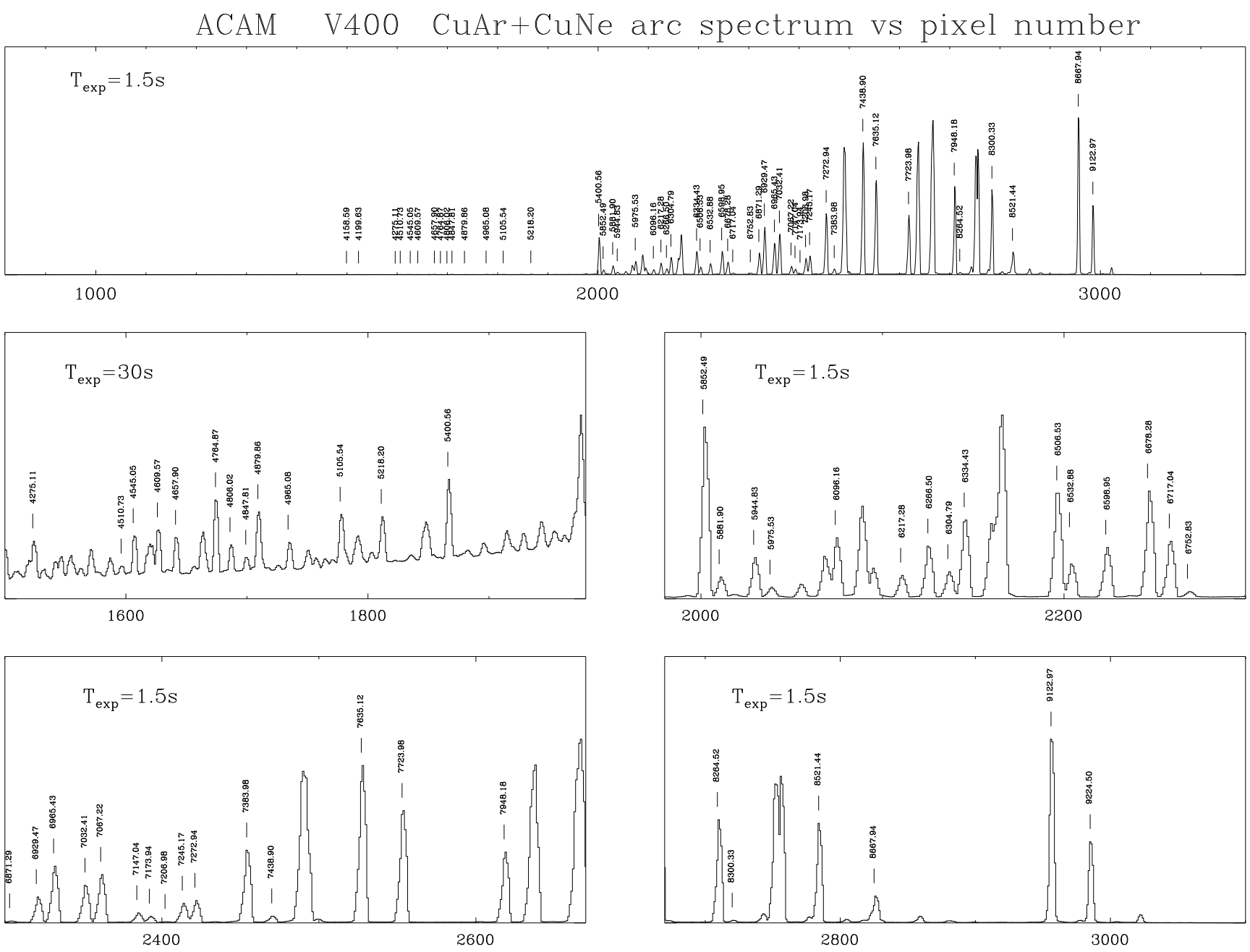
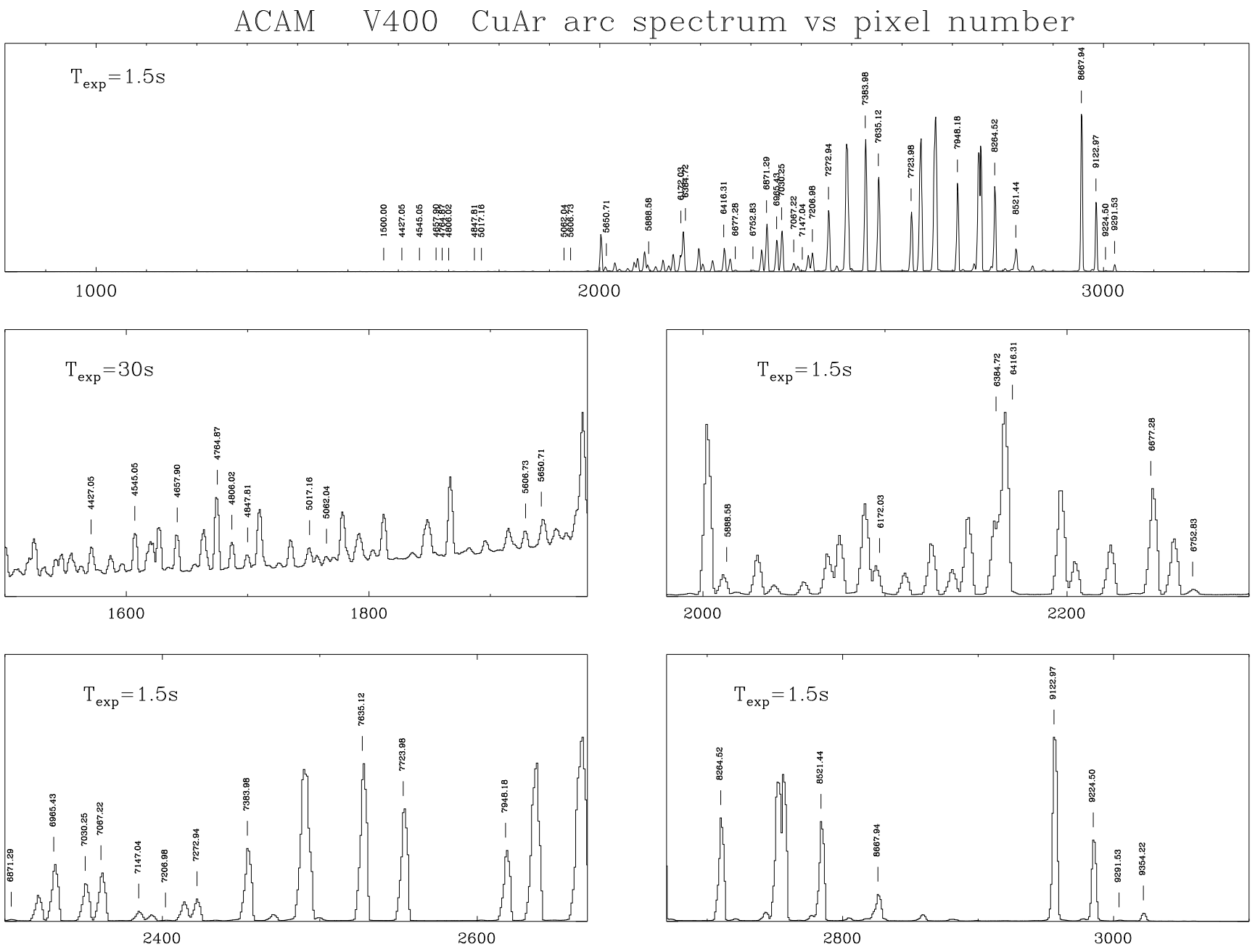
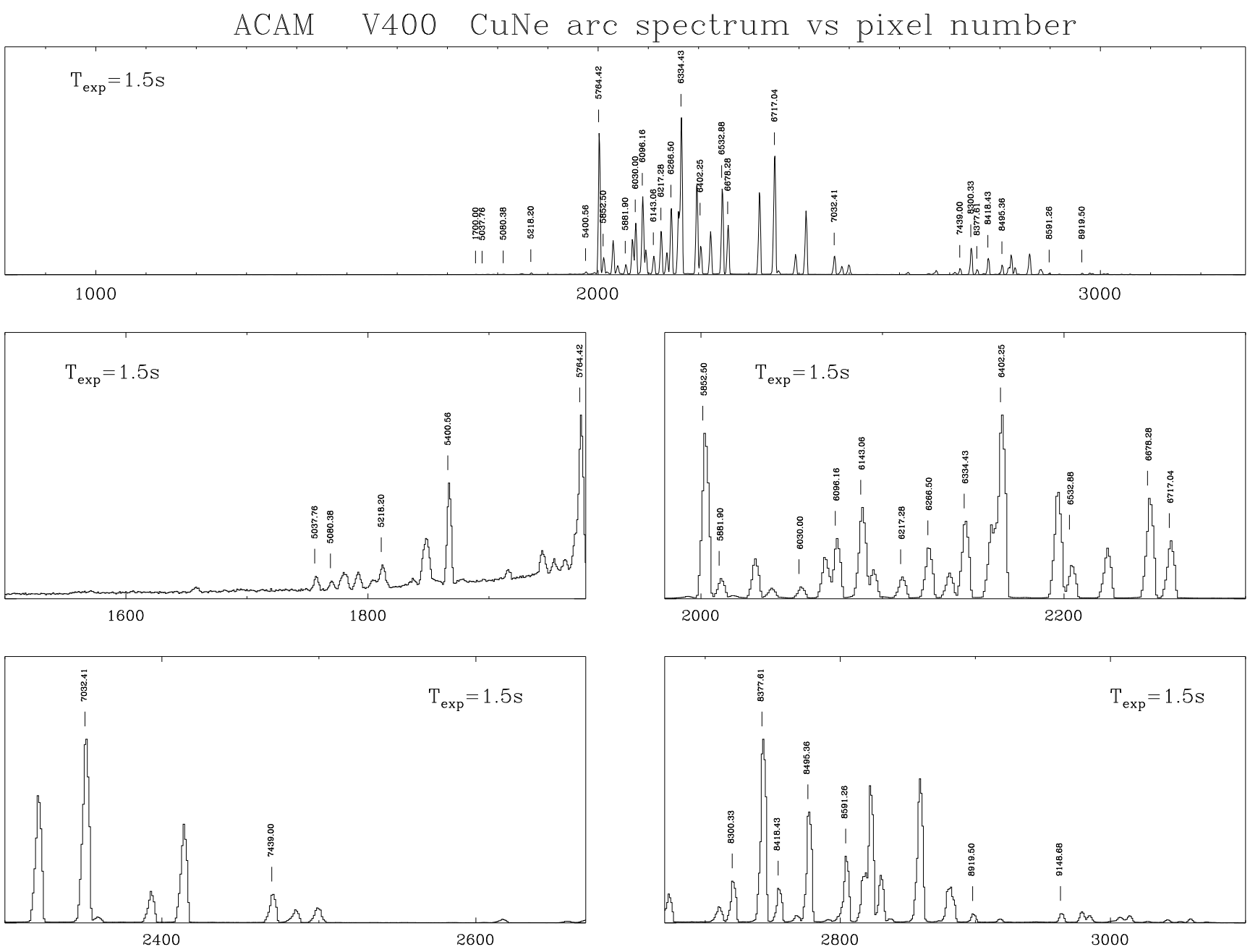
T_exp=30s
T_exp=1.5s
T_exp=1.5s
T_exp=1.5s


ACAM V400 CuAr
T_exp=1.5s
T_exp=30s
T_exp=30s
T_exp=1.5s
T_exp=1.5s


ACAM V400 CuNe
T_exp=1.5s
5037.76
5080.38
5153.23
5222.35
5330.78
5400.56
5656.66
5668.82
5719.23
5764.42
5852.50
5881.90
5944.83
5975.53
6030.00
6074.34
6096.16
6143.06
6217.28
6266.50
6304.79
6334.43
6402.25
6538.11
6604.85
6678.28
6717.04
6929.47
7032.41
7173.94
7245.17
7439.00
7488.87
7535.77
8136.41
8300.33
8377.61
8418.43
8495.36
8591.26
8654.38
8681.92
8780.62
8919.50
9148.68
9201.76
3000
4000
5000
6000
7000
8000
9000
10000
3400 3600 3800 4000 4200 4400 4600 4800 5000 5200 5400 5600 5800
5800
6000
6200
6400
6600
6800
6800
7000
7200
7400
7600
7800
8000
8200
8200
8400
8600
8800
9000
9200
9400
9600


ACAM V400 CuAr+CuNe arc spectrum vs pixel number
T_exp=1.5s
4158.59
4199.83
4275.11
4510.73
4545.05
4609.57
4657.90
4764.87
4806.02
4847.81
4879.86
4965.08
5105.54
5218.20
5400.56
5852.49
5975.53
6096.16
6217.28
6266.50
6334.43
6532.88
6598.95
6678.28
6717.04
6752.83
6871.29
6929.47
6965.43
7032.41
7067.22
7147.04
7173.94
7206.98
7245.17
7272.94
7383.98
7438.90
7635.12
7723.98
7948.18
8264.52
8300.33
8521.44
8867.94
9122.97
1000
2000
3000
T_exp=30s
1600
1800
T_exp=1.5s
2000
2200
T_exp=1.5s
2400
2600
T_exp=1.5s
2800
3000


ACAM V400 CuAr arc spectrum vs pixel number
T_exp=1.5s
1500.00
4427.05
4545.05
4657.90
4764.87
4806.02
4847.81
5017.16
5062.04
5606.73
5650.71
5888.58
6172.03
6384.72
6416.31
6677.28
6752.83
6871.29
6965.43
7030.25
7067.22
7147.04
7206.98
7272.94
7383.98
7635.12
7723.98
7948.18
8264.52
8521.44
8667.94
9122.97
9224.50
9291.53
1000
2000
3000
T_exp=30s
4427.05
4545.05
4657.90
4764.87
4806.02
4847.81
5017.16
5062.04
5606.73
5650.71
1600
1800
T_exp=1.5s
5888.58
6172.03
6384.72
6416.31
6677.28
6752.83
2000
2200
T_exp=1.5s
6871.29
6965.43
7030.25
7067.22
7147.04
7206.98
7272.94
7383.98
7635.12
7723.98
7948.18
2400
2600
T_exp=1.5s
8264.52
8521.44
8667.94
9122.97
9224.50
9291.53
9354.22
2800
3000


ACAM V400 CuNe arc spectrum vs pixel number
T_exp=1.5s
1700.00
5037.76
5080.38
5218.20
5400.56
5764.42
5852.50
5881.90
6030.00
6096.16
6143.06
6217.28
6266.50
6334.43
6402.25
6532.88
6678.28
6717.04
7032.41
7439.00
8300.33
8377.81
8418.43
8495.36
8591.26
8919.50
1000
2000
3000
T_exp=1.5s
5037.76
5080.38
5218.20
5400.56
5764.42
1600
1800
T_exp=1.5s
5852.50
5881.90
6030.00
6096.16
6143.06
6217.28
6266.50
6334.43
6402.25
6532.88
6678.28
6717.04
2000
2200
T_exp=1.5s
7032.41
7439.00
2400
2600
T_exp=1.5s
8300.33
8377.81
8418.43
8495.36
8591.26
8919.50
9148.68
2800
3000

Appendix A. Atlas plotting code.

This appendix gives the IDL code for plotting the arc spectra with the labels and ticks on some identified lines. The inputs are two files, one containing the wavelengths and the fluxes, and another one with the wavelengths of the lines to be marked. The output is a formatted pdf file showing five plots: one covers the entire spectrum and the other four zoom in four splits, in order to facilitate the line identification.

```
;*******************************************************
; all.pro procedure
; January 2013
; Authors: Hassan Fathivavsari, Javier Mendez and Liam Hardy
;*******************************************************
; It requires files *_XXXX_c*.txt, and ticksall_* in the
; same directory
;*******************************************************
; *_XXXX_c*.txt is the 1-D ascii file containing two columns:
; wavelength and flux.
;*******************************************************
; ticksall_* contains all the lines to mark. Example:
; 5100 5100 5100
; 5105.54 5105.54 5105.54
; 5330.78 5330.78 5330.78
; 5400.56 5400.56 5400.56
; 5500 5500 5500
; The 3 columns can be generated from a one-single column file
; with the following procedure:
;
; pro file,filename1,2 =enw + '_' + arc + '.txt'
; n=(filename1)
; readcol,1,ame2
; for i=do begin
; if (var1[i] GT min) AND (var1[i] LT max) then begin
; printf,i],rmat=F7.2)'
; endif
; endfor
; close,/all
; end
;
;*******************************************************
; Execute as follows:
; IDL>
all,'R900V','6500','cuarcune','CuAr+CuNe','low','high','low','low','high',3500
,5800,6600,8500,10500,5000
;*******************************************************

pro all,gra,cenw,arc,arc2,exp1,exp2,exp3,exp4,exp5,x1,x2,x3,x4,x5,xmargin

set_plot,'ps'

device,filename=gra + '_' + cenw + '_' + arc +
'.ps',/color,bits_per_pixel=8,/landscape
loadct, 39
!p.multi=[0,1,3]

ticksfile='ticksall_' + gra + '_' + cenw + '_' + arc + '.txt'
maximum = fltarr(5)
mm = fltarr(9)

filename_H=gra + '_' + cenw + '_' + arc + '_' + exp2 + '.txt'
n=file_lines(filename_H)
data_H=fltarr(2,n)
```

```
get_lun,lun
openr,lun,filename_H
readf,lun,data_H
free_lun,lun
wave_H=data_H(0,*)
flux_H=data_H(1,*)


filename_exp1=gra + '_' + cenw + '_' + arc + '_' + exp1 + '.txt'
n=file_lines(filename_exp1)
data_exp1=fltarr(2,n)
get_lun,lun
openr,lun,filename_exp1
readf,lun,data_exp1
free_lun,lun
wave_exp1=data_exp1(0,*)
flux_exp1=data_exp1(1,*)

filename_exp2=gra + '_' + cenw + '_' + arc + '_' + exp2 + '.txt'
n=file_lines(filename_exp2)
data_exp2=fltarr(2,n)
get_lun,lun
openr,lun,filename_exp2
readf,lun,data_exp2
free_lun,lun
wave_exp2=data_exp2(0,*)
flux_exp2=data_exp2(1,*)

filename_exp3=gra + '_' + cenw + '_' + arc + '_' + exp3 + '.txt'
n=file_lines(filename_exp3)
data_exp3=fltarr(2,n)
get_lun,lun
openr,lun,filename_exp3
readf,lun,data_exp3
free_lun,lun
wave_exp3=data_exp3(0,*)
flux_exp3=data_exp3(1,*)

filename_exp4=gra + '_' + cenw + '_' + arc + '_' + exp4 + '.txt'
n=file_lines(filename_exp4)
data_exp4=fltarr(2,n)
get_lun,lun
openr,lun,filename_exp4
readf,lun,data_exp4
free_lun,lun
wave_exp4=data_exp4(0,*)
flux_exp4=data_exp4(1,*)

filename_exp5=gra + '_' + cenw + '_' + arc + '_' + exp5 + '.txt'
n=file_lines(filename_exp5)
data_exp5=fltarr(2,n)
get_lun,lun
openr,lun,filename_exp5
readf,lun,data_exp5
free_lun,lun
wave_exp5=data_exp5(0,*)
flux_exp5=data_exp5(1,*)


;*******************************************************
;************* X-Range Definition **********************
;*******************************************************

xran=[fix(x1),fix(x2),fix(x3),fix(x4),fix(x5)]

x0b = xran(0)
x0e = xran(4)
x1b = xran(0)
```

```
x1e = xran(1)
x2b = xran(1)
x2e = xran(2)
x3b = xran(2)
x3e = xran(3)
x4b = xran(3)
x4e = xran(4)

;************************************************
;*************** MAX Code ************************
;************************************************

readcol, filename_exp1, var1,var2, f='(d,d)'
max=0

for i=value_locate(wave_exp1, x0b),value_locate(wave_exp1, x4e) do begin
if var2(i) gt max then max = var2(i)
endfor

maximum(0) = max

!Y.MARGIN=[4,6]
labels = [' ',' ',' ',' ']

plot, wave_exp1, flux_exp1 , xrange=[x0b, x0e],/xstyle , yrange=[0, $
max+0.45*max],/ystyle , xtickinterval=1000 , ytickinterval = 30000000 ,$
yticks=0 , thick = 0.65 , xticklen = 0.02 , yticklen=0.01 ,xcharsize=1.7 ,$
ytickname=labels ;, xtickname=labelsx

xyouts,xmargin,max+0.53*max, gra + '            !6!6!4k!3!6c = ' + cenw + ' $
' + arc2 + ' ' , charsize=1.5, charthick=0.8 ,/data

;******************** Ticks Mark *******************************

readcol, ticksfile, var1, var2, var3

t = var3
n = n_elements(var3)

dx = x0e - x0b
xx = 0.003666141 * dx

buffer = fltarr(2)
ticks = fltarr(n)

m = 0

for k=1,n-1 do begin

buffer(0) = t(k-1)
buffer(1) = t(k)

msb0 = value_locate(wave_exp1, buffer(0)) - 0
msb1 = value_locate(wave_exp1, buffer(1)) - 0

for j = 0, 6 do begin

mm(j) = flux_exp1(msb0 -4 + j)

endfor
mm0 = max(mm)

for j = 0, 6 do begin

mm(j) = flux_exp1(msb1 -4 + j)

endfor
```

```
mm1 = max(mm)

IF buffer(1) LT (buffer(0)+xx) THEN BEGIN
IF mm1 GT mm0 THEN ticks(m) = buffer(1) ELSE ticks(m) = buffer(0)
m = m + 1
ENDIF ELSE BEGIN
ticks(m) = buffer(0)
m = m + 1
ENDELSE

endfor

print, ticks


;************************************************************
;********** This Removes the Too Close Wavelengths **************
;************************************************************

t = ticks
n = n_elements(t)
m = 0
ticks2 = fltarr(n)
dx = x0e - x0b
xx = 0.003666141 * dx

for k = 1,n-1 do begin
IF ( t(k) GE (t(k-1)+xx) ) THEN BEGIN
ticks2(m) = t(k)
m = m + 1
ENDIF
endfor

t = ticks2

for i=0,m-1 do begin

msb = value_locate(wave_exp1, t(i)) -0

for j = 0, 8 do begin

mm(j) = flux_exp1(msb - 4 + j)

endfor

y = max(mm)

plots, [t(i),t(i)], [y + 0.07*max, y+ 3*0.05*max], thick=0.8

xyouts,t(i)+5,y+1.5*0.09*max,t(i) , charsize=0.4, alignment=0.2 ,
orientation=90, charthick=0.8 ,/data

endfor

;******* WINDOW For No. "" 1 "" ********

!p.multi=[4,2,3]
labels = [' ',' ',' ',' ']
!Y.MARGIN=[4,2]

;************************************************
;*************** MAX Code ************************
;************************************************

readcol, filename_exp2, var1,var2, f='(d,d)'
max=0
for i=value_locate(wave_exp2, x1b),value_locate(wave_exp2, x1e) do begin
if var2(i) gt max then max = var2(i)
```

```
endfor

maximum(1) = max

plot, wave_exp2, flux_exp2 , psym= 10 , xrange=[x1b, x1e],/xstyle, yrange=[0,$
max+0.45*max],/ystyle , xtickinterval=200 , ytickinterval = 30000000 ,$
yticks=0 , thick = 0.65 , xticklen = 0.02 , xminor=2 ,xcharsize=1.5  ,$
ytickname=labels


;******************** Ticks Mark ******************************
readcol, ticksfile, var1,var2,var3;, f='(d,d,d)'
t = var3
n=n_elements(var3)
for i=1,n-2 do begin
msb = value_locate(wave_exp2, t(i)) -0
for j = 0, 8 do begin
mm(j) = flux_exp2(msb -4 + j)
endfor
y = max(mm)
IF (t(i) gt x1b) AND (t(i) lt x1e) AND (t(i) ne 10)  THEN BEGIN

plots, [t(i),t(i)], [y + 0.07*max, y+ 3*0.05*max], thick=0.8

xyouts,t(i)+2,y+1.5*0.09*max,t(i) , charsize=0.4, alignment=0.2 ,$
orientation=90, charthick=0.8 ,/data

endif

endfor

;******* WINDOW For No. "" 2 "" ********

!p.multi=[3,2,3]
labels = [' ',' ',' ',' ']

;*************************************************
;*************** MAX Code ************************
;*************************************************

readcol, filename_exp3, var1,var2, f='(d,d)'

max=0
for i=value_locate(wave_exp3, x2b),value_locate(wave_exp3, x2e) do begin
if var2(i) gt max then max = var2(i)
endfor
maximum(2) = max

plot, wave_exp3, flux_exp3 , psym= 10 , xrange=[x2b, x2e],/xstyle,yrange=[0, $
max+0.45*max],/ystyle , xtickinterval=200 , ytickinterval = 30000000 ,$
yticks=0 , thick = 0.65 , xticklen = 0.02 , xminor=2 ,xcharsize=1.5 , $
ytickname=labels

;******************** Ticks Mark ******************************
readcol, ticksfile, var1,var2,var3;, f='(d,d,d)'
t = var3
n=n_elements(var3)
for i=1,n-2 do begin
msb = value_locate(wave_exp3, t(i)) -0
for j = 0, 8 do begin
mm(j) = flux_exp3(msb -4 + j)
endfor
y = max(mm)
IF (t(i) gt x2b) AND (t(i) lt x2e) THEN BEGIN

plots, [t(i),t(i)], [y + 0.07*max, y+ 3*0.05*max], thick=0.8
```

```
xyouts,t(i)+2,y+1.5*0.09*max,t(i) , charsize=0.4, alignment=0.2, $
orientation=90, charthick=0.8 ,/data

endif

endfor

;******* WINDOW For No. "" 3 "" ********

!p.multi=[2,2,3]
labels = [' ',' ',' ',' ']

;************************************************
;*************** MAX Code ***********************
;************************************************

readcol, filename_exp4, var1,var2, f='(d,d)'
max=0
for i=value_locate(wave_exp4, x3b),value_locate(wave_exp4, x3e) do begin
if var2(i) gt max then max = var2(i)
endfor
maximum(3) = max

plot, wave_exp4, flux_exp4, psym= 10, xrange=[x3b, x3e],/xstyle , yrange=[0, $
max+0.45*max],/ystyle , xtickinterval=200 , ytickinterval = 30000000 ,$
yticks=0 , thick = 0.65 , xticklen = 0.02 , xminor=2 ,xcharsize=1.5 , $
ytickname=labels ;, xtickname = labelsx


;******************** Ticks Mark ******************************

readcol, ticksfile, var1,var2,var3;, f='(d,d,d)'

t = var3

n=n_elements(var3)

for i=1,n-2 do begin

msb = value_locate(wave_exp4, t(i)) -0

for j = 0, 8 do begin
mm(j) = flux_exp4(msb -4 + j)
endfor

y = max(mm)

IF (t(i) gt x3b) AND (t(i) lt x3e) THEN BEGIN

plots, [t(i),t(i)], [y + 0.07*max, y+ 3*0.05*max], thick=0.8

xyouts,t(i)+1,y+1.5*0.09*max,t(i) , charsize=0.4, alignment=0.2 ,$
orientation=90, charthick=0.8 ,/data

endif

endfor

;******* WINDOW For No. "" 4 "" ********

!p.multi=[1,2,3]
labels = [' ',' ',' ',' ']

;************************************************
;*************** MAX Code ***********************
;************************************************

readcol, filename_exp5, var1,var2, f='(d,d)'
```

```
max=0
for i=value_locate(wave_exp5, x4b),value_locate(wave_exp5, x4e) do begin
if var2(i) gt max then max = var2(i)
endfor
maximum(4) = max

plot, wave_exp5, flux_exp5 , psym= 10, xrange=[x4b, x4e],/xstyle, yrange=[0, $
max+0.45*max],/ystyle , xtickinterval=200 , ytickinterval = 30000000 ,$
yticks=0 , thick = 0.65 , xticklen = 0.02 , xminor=2 ,xcharsize=1.5, $
ytickname=labels , xtickname=labelsx

;******************** Ticks Mark ******************************

readcol, ticksfile, var1,var2,var3;, f='(d,d,d)'

t = var3

n=n_elements(var3)

for i=1,n-2 do begin

msb = value_locate(wave_exp5, t(i)) -0

for j = 0, 8 do begin
mm(j) = flux_exp5(msb -4 + j)
endfor

y = max(mm)

IF (t(i) gt x4b) AND (t(i) lt x4e) THEN BEGIN

plots, [t(i),t(i)], [y + 0.07*max, y+ 3*0.05*max], thick=0.8

xyouts,t(i)+1,y+1.5*0.09*max,t(i) , charsize=0.4, alignment=0.2 ,
orientation=90, charthick=0.8 ,/data

endif

endfor

device, /close

spawn, 'rm -f out.pdf'
spawn, 'rm -f out2.pdf'
spawn, 'rm -f '+ gra + '_' + cenw + '_' + arc + '.pdf'

spawn, 'ps2pdf13 ' + gra + '_' + cenw + '_' + arc + '.ps out.pdf'

spawn, 'pdftk out.pdf cat 1-endW output out2.pdf'

spawn, 'acroread out2.pdf &'

spawn, 'pdftk out.pdf cat 1-endN output ' + gra + '_' + cenw + '_' + arc +
'.pdf'

print,'Output saved to ' + gra + '_' + cenw + '_' + arc + '.pdf'

end
```

Appendix B. Calibration observing script.

This appendix gives the c-shell code for a script which will take calibration frames (arcs/flats) with ACAM. A choice of lamp configuration is required, as well as short/long exposure times.

```
# Script for taking arcs with ACAM
#
# Version 1.0 (August 2012)
#
# Author: Liam Hardy


set noclobber

set startup = "This script requires 3 input parameters, and should be called
as
'source calib_acam.csh lamp exp1 exp2'. Enter 'none' as the 3rd parameter if
you
wish to only take one exposure. The script assumes the CCD, grism, slit and
filter
wheels are already set-up as required. For flats, enter the exposure time as
exp1,
and the number of exposures required as exp2."
#echo $startup

if ($?LAMP == 0) then
    setenv LAMP CuAr+CuNe
endif
if ($?EXP1 == 0) then
    setenv EXP1 5
endif
if ($?EXP2 == 0) then
    setenv EXP2 60
endif


echo '------------------------------------------------------------------'
switch ($#argv)
case 0:
echo  'Please choose a lamp configuration from CUAR, CUNE, CUAR+CUNE, or W
('$LAMP '):'
set temp1 = $<
if ($temp1 == '') then
    set lamp = $LAMP
else
    set lamp = $temp1
endif
echo 'Please choose the short exposure time ('$EXP1 'seconds):'
set temp1 = $<
if ($temp1 == '') then
    set exp1 = $EXP1
else
    set exp1 = $temp1
endif
echo 'Please choose the long exposure time or the number of flats requested if
taking flats. ('$EXP2 'seconds):'
set temp1 = $<
if ($temp1 == '') then
    set exp2 = $EXP2
else
    set exp2 = $temp1
endif
breaksw

case 1:
set lamp = $1
```

```
echo 'You have chosen' $lamp
echo 'Please choose the short exposure time ('$EXP1 'seconds):'
set temp1 = $<
if ($temp1 == '') then
    set exp1 = $EXP1
else
    set exp1 = $temp1
endif
echo 'Please choose the long exposure time or the number of flats requested if
taking flats. ('$EXP2 'seconds):'
set temp1 = $<
if ($temp1 == '') then
    set exp2 = $EXP2
else
    set exp2 = $temp1
endif
breaksw

case 2:
set lamp = $1
set exp1 = $2
echo 'You have chosen the following lamp(s):' $lamp 'with a short exposure
time of' $exp1
echo 'Please choose the long exposure time or the number of flats requested if
taking flats. ('$EXP2 'seconds):'
set temp1 = $<
if ($temp1 == '') then
    set exp2 = $EXP2
else
    set exp2 = $temp1
endif
breaksw

case 3:
set lamp = $1
set exp1 = $2
set exp2 = $3
breaksw


default:
echo "Error!" $startup
exit

endsw

echo "Lamp = " $lamp
echo "Short exposure time= " $exp1
echo "Long exposure time (/number of flats) = " $exp2
echo "Is this correct? (y/n)"
if ($< == 'y') then
    echo "Starting arc process..."
else
    echo "Goodbye!"
    setenv LAMP $lamp
    setenv EXP1 $exp1
    setenv EXP2 $exp2
    exit
endif

acamcal #insert mirror for calibration lamps

switch ( $lamp ) #start switch statement for each lamp config
case '[Cc][Uu][Aa][Rr]':
#echo 'CuAr';
complamps CuAr
arc acam $exp1
if ($exp2 == 'none' || $exp2 == 'None' || $exp2 == 'NONE') then
```

```
    breaksw;
endif
arc acam $exp2
breaksw;

case '[Cc][Uu][Nn][Ee]':
#echo 'CuNe';
complamps CuNe
arc acam $exp1
if ($exp2 == 'none' || $exp2 == 'None' || $exp2 == 'NONE') then
    breaksw;
endif
arc acam $exp2
breaksw;

case '[Cc][Uu][Aa][Rr]+[Cc][Uu][Nn][Ee]':
#echo 'CuAr+CuNe';
complamps CuAr+CuNe
arc acam $exp1
if ($exp2 == 'none' || $exp2 == 'None' || $exp2 == 'NONE') then
    breaksw;
endif
arc acam $exp2
breaksw;

case '[Cc][Uu][Nn][Ee]+[Cc][Uu][Aa][Rr]':
#echo 'CuAr+CuNe';
complamps CuAr+CuNe
arc acam $exp1
if ($exp2 == 'none' || $exp2 == 'None' || $exp2 == 'NONE') then
    breaksw;
endif
arc acam $exp2
breaksw;

case '[Ww]':
#echo 'W';
complamps W
multflat acam $exp2 $exp1
breaksw;

default:
echo "Error\! Unknown lamp configuration"
echo $startup
exit 2
endsw #end lamp config switch

complamps off #switch off lamps
agacam  #return to viewing sky

setenv LAMP $lamp
setenv EXP1 $exp1
setenv EXP2 $exp2

bell
```