

CENTER FOR

ASTROPHYSICS

HARVARD & SMITHSONIAN

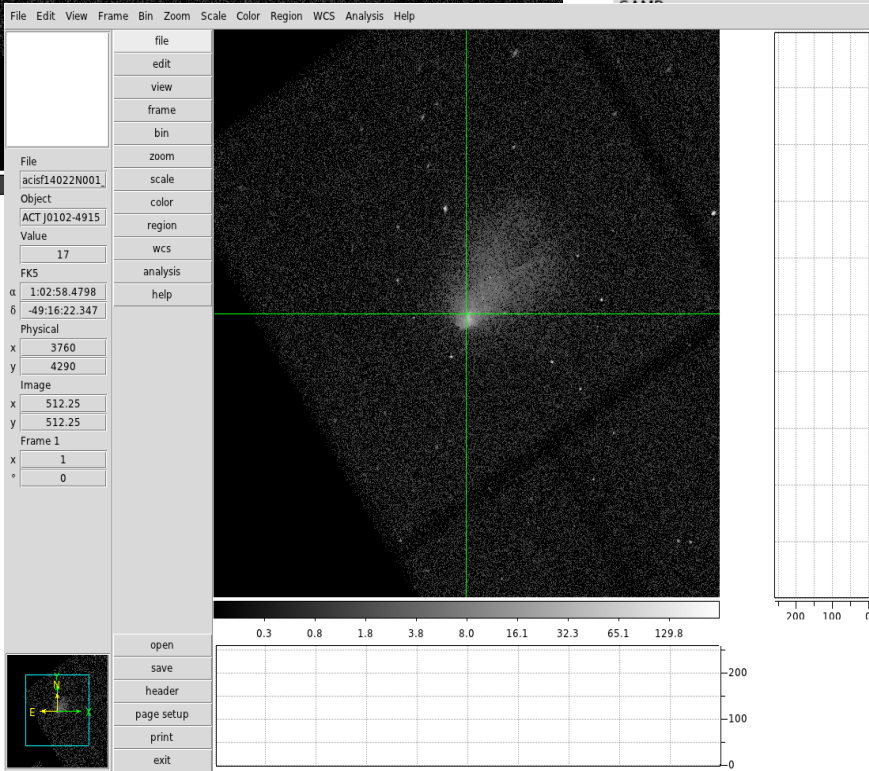
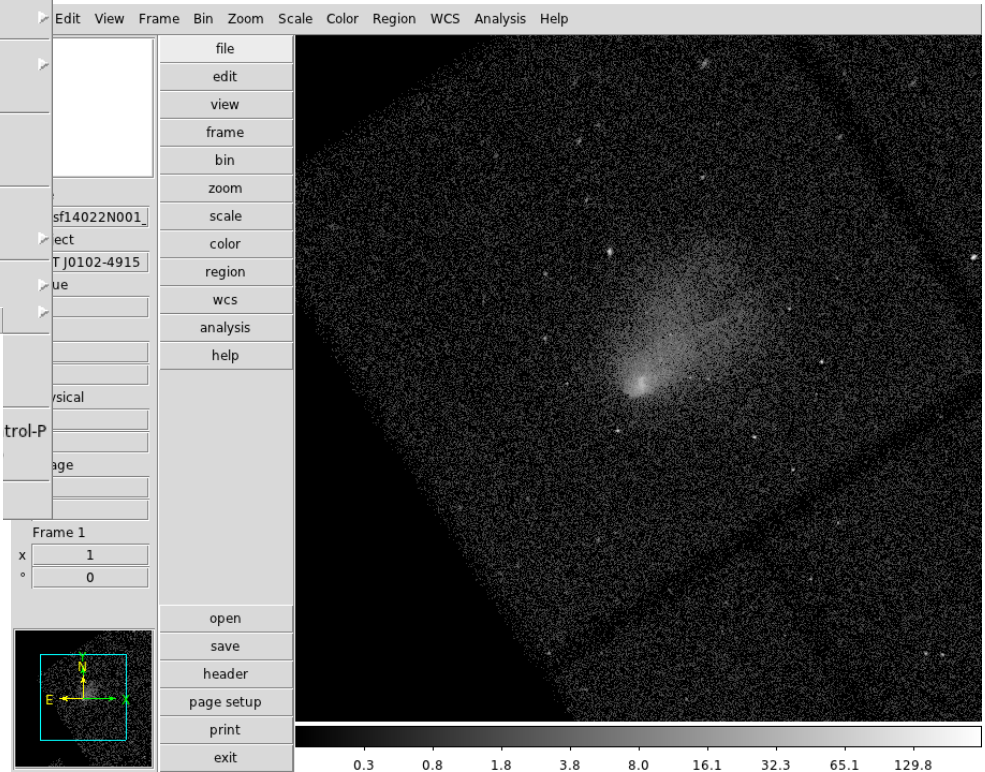
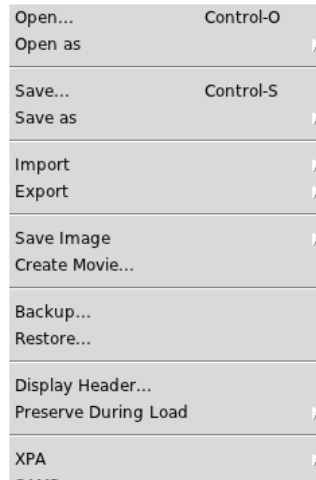
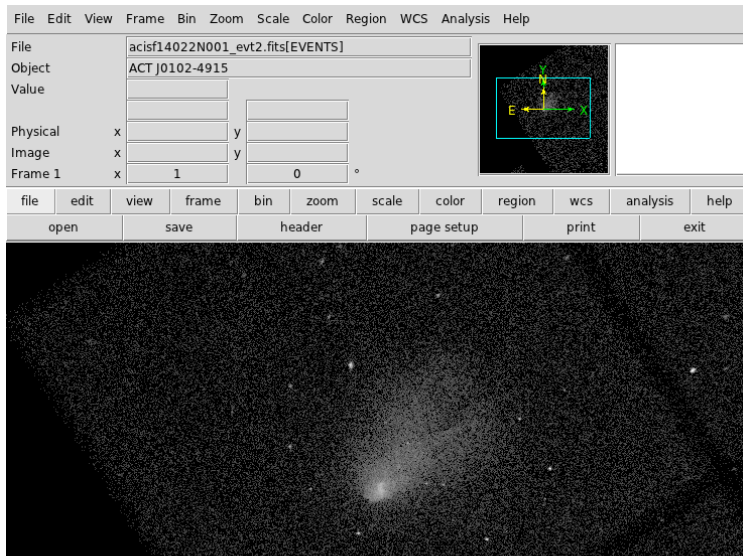
Using SAOImage ds9 and dax

Kenny J. Glotfelty

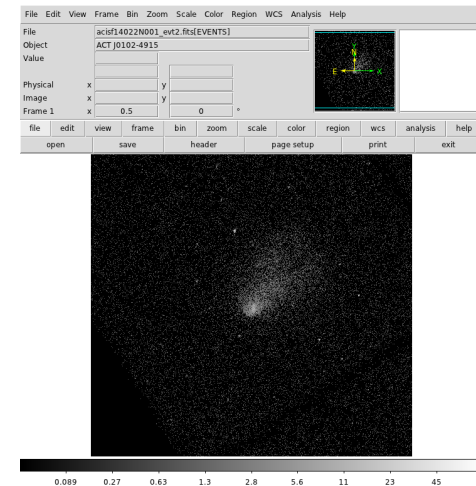
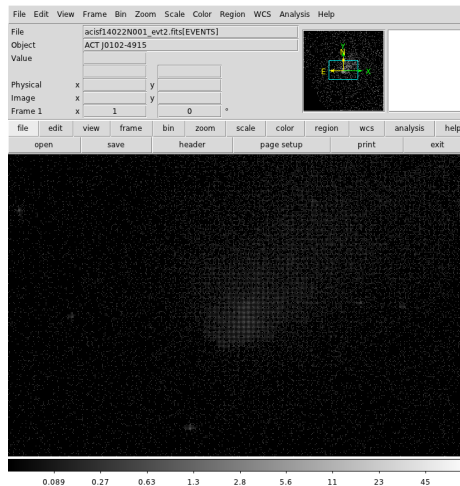
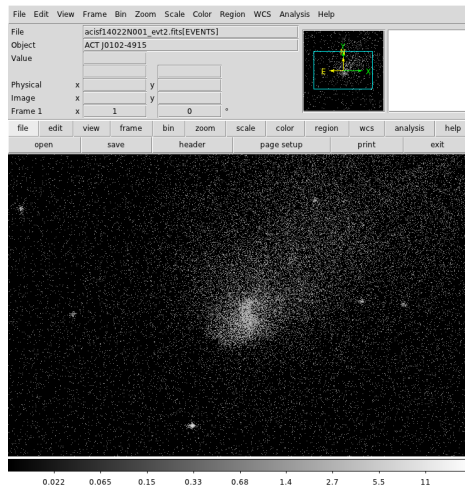
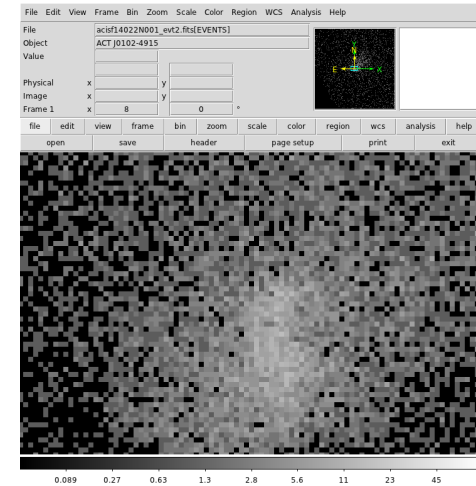
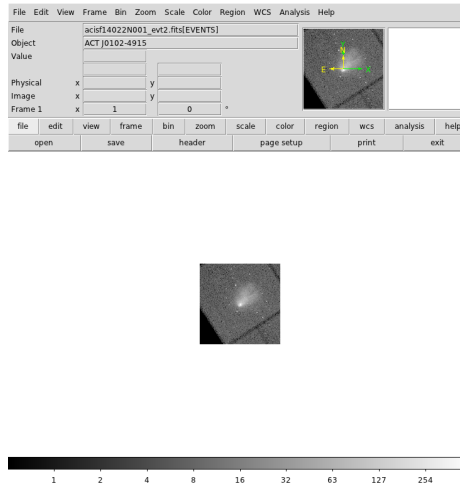
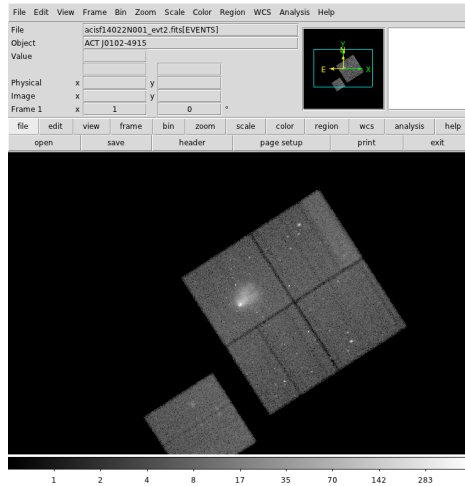
Introduction

- Reference these Jupyter notebooks:
https://github.com/kglotfelty/ds9_dax_demo
- Some basic and advanced ds9 features

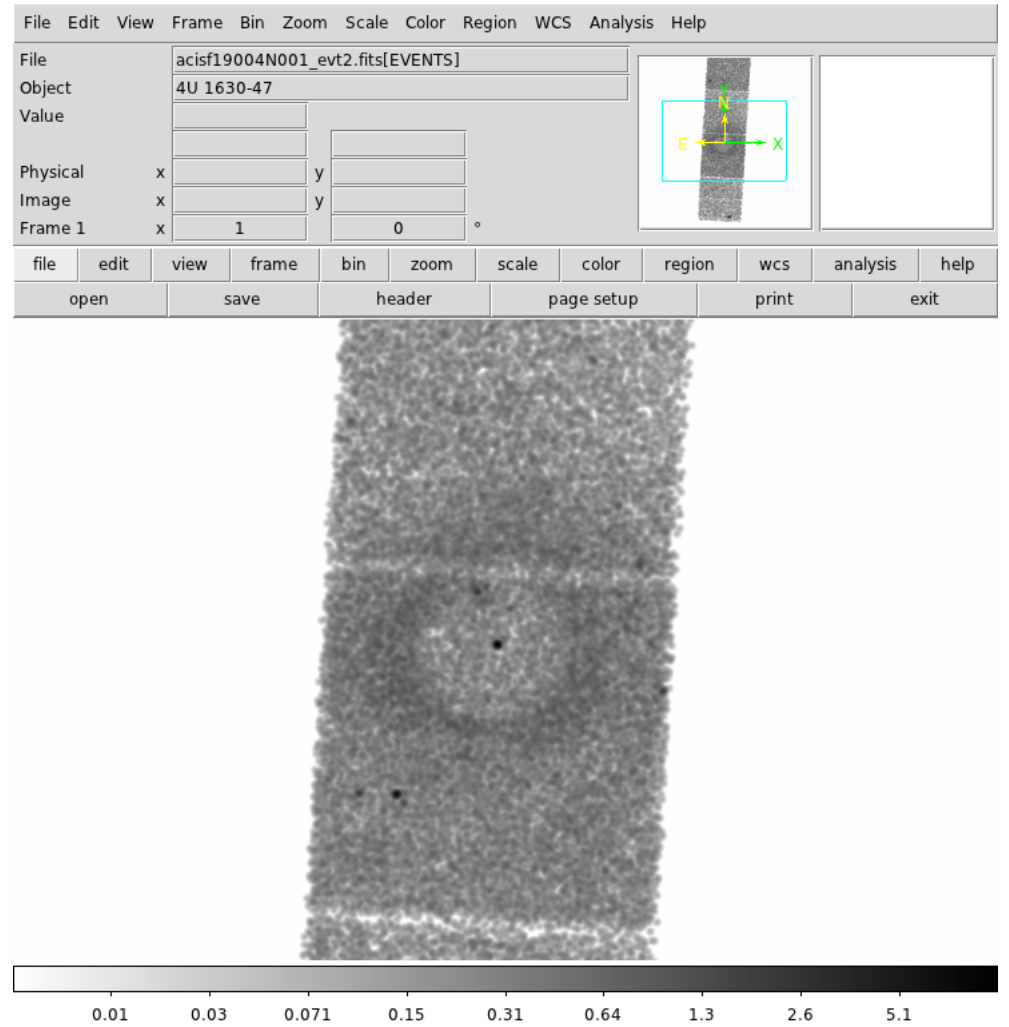
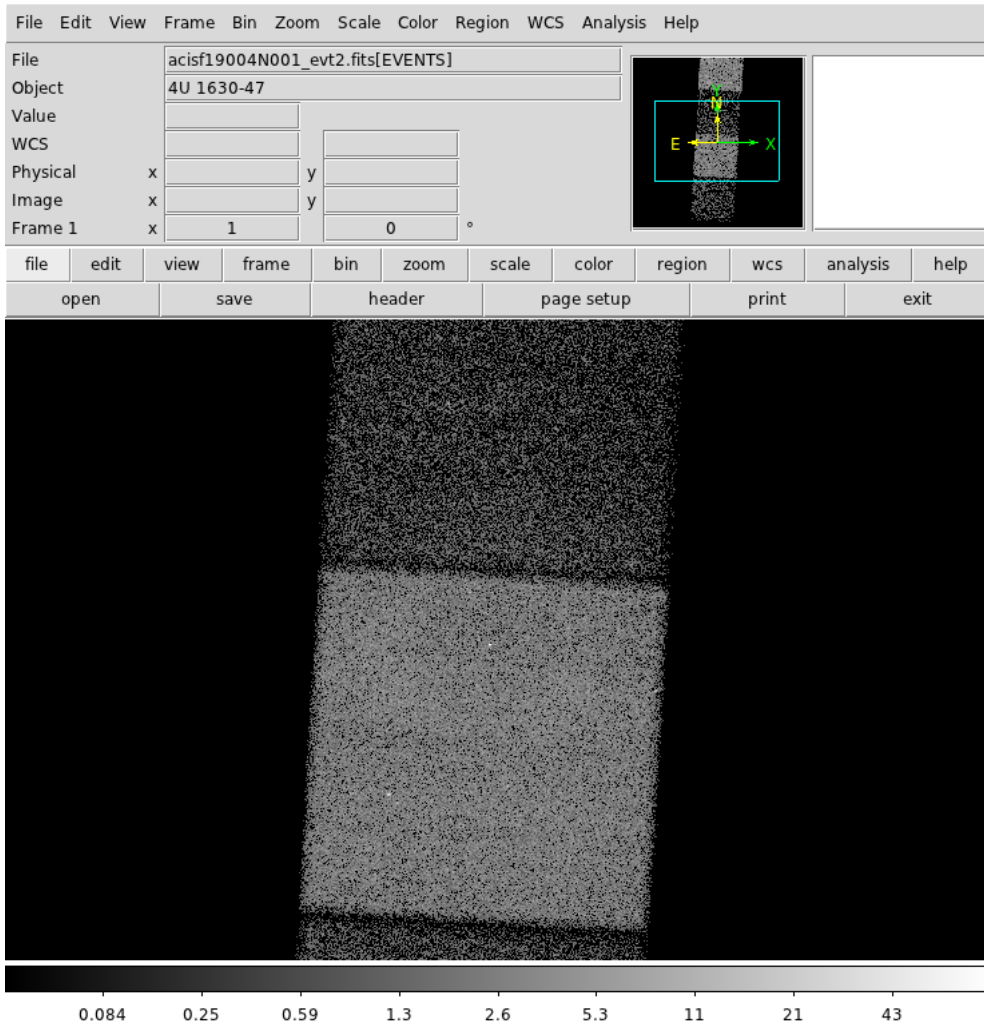
ds9 | Adjusting the User Interface



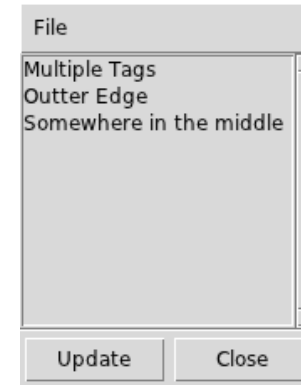
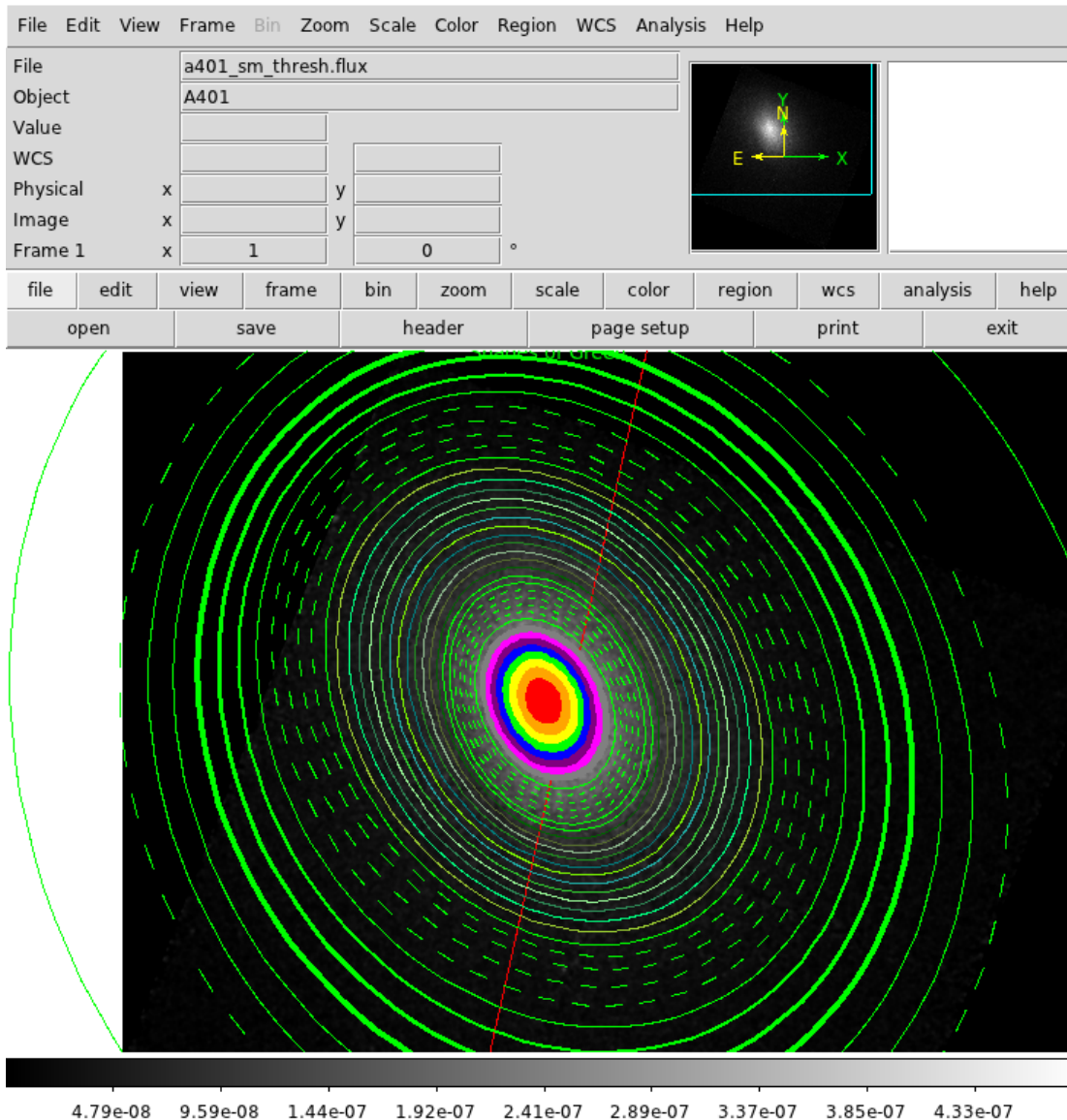
ds9 | Bin, Block, Zoom



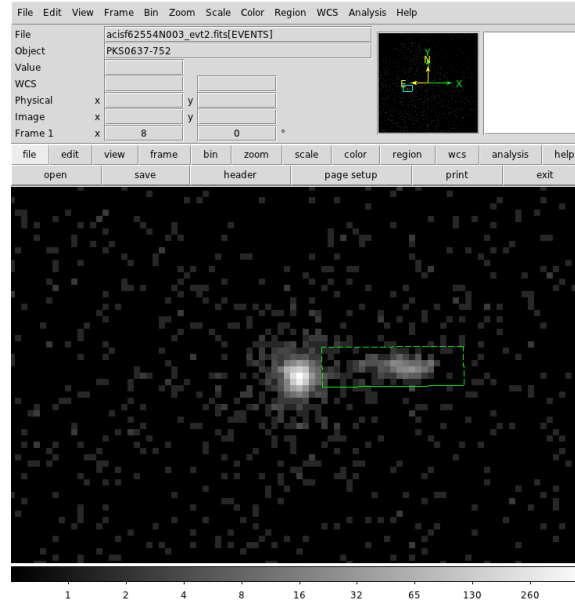
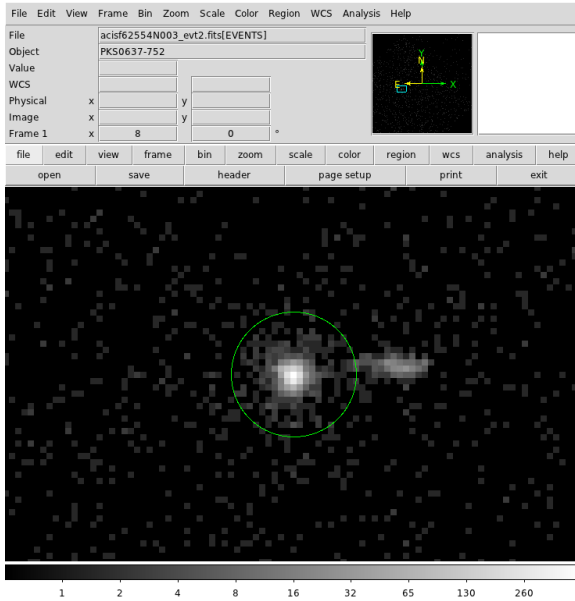
ds9 | Filtering



ds9 | Regions | Decorations



ds9 | Regions | Analysis

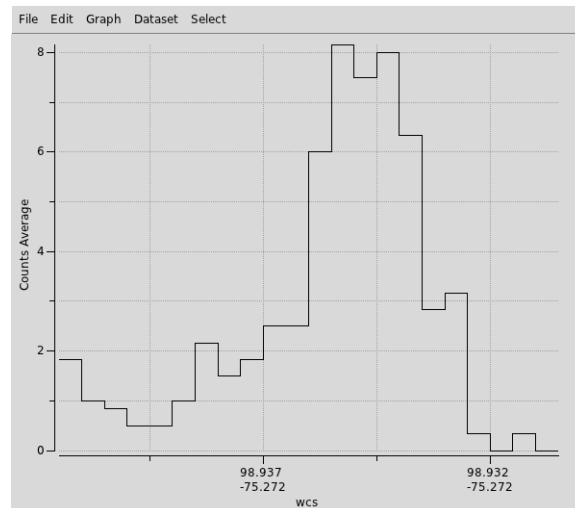


File Edit Font

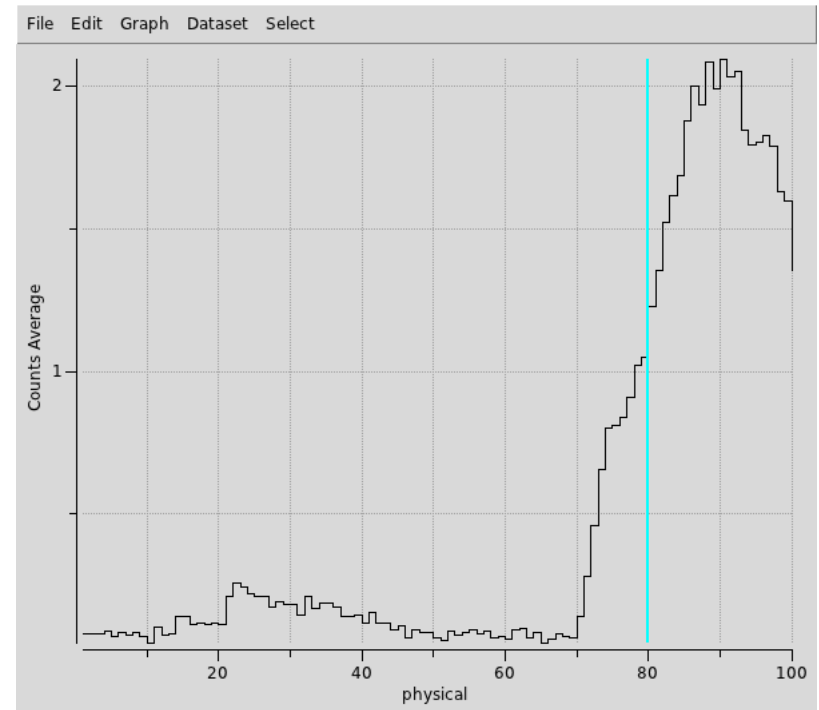
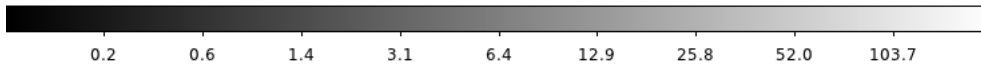
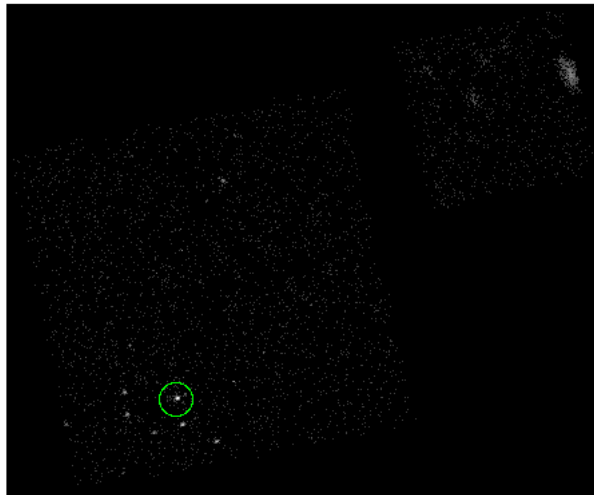
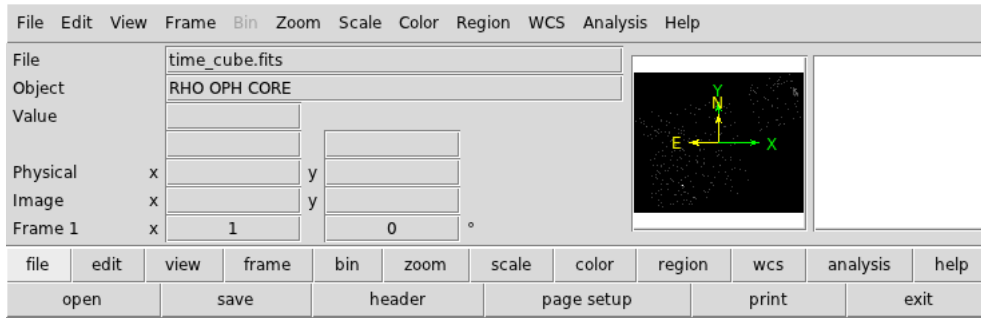
```
center=98.944 -75.271288
fk5
1 pixel = 0.49200001 arcsec
```

reg	sum	error	area (arcsec**2)	surf_bri (sum/arcsec**2)	surf_err (sum/arcsec**2)
1	2662	51.5946	76.7343	34.6911	0.67238

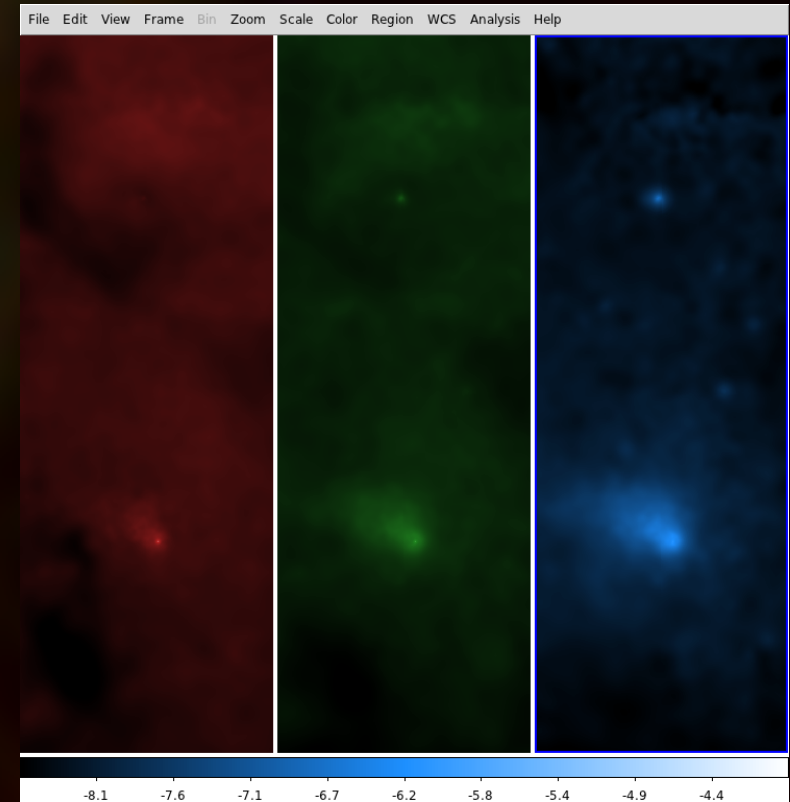
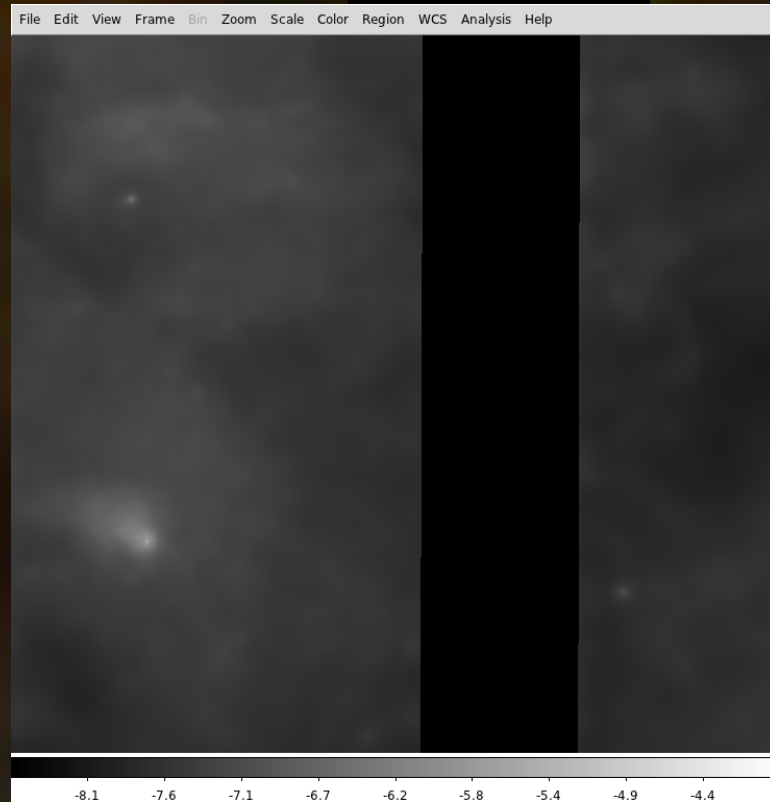
reg	sum	npix	mean	median	min	max	var	stddev	rms
1	2662	317	8.39748	1	0	519	1685.91	41.0598	41.9097



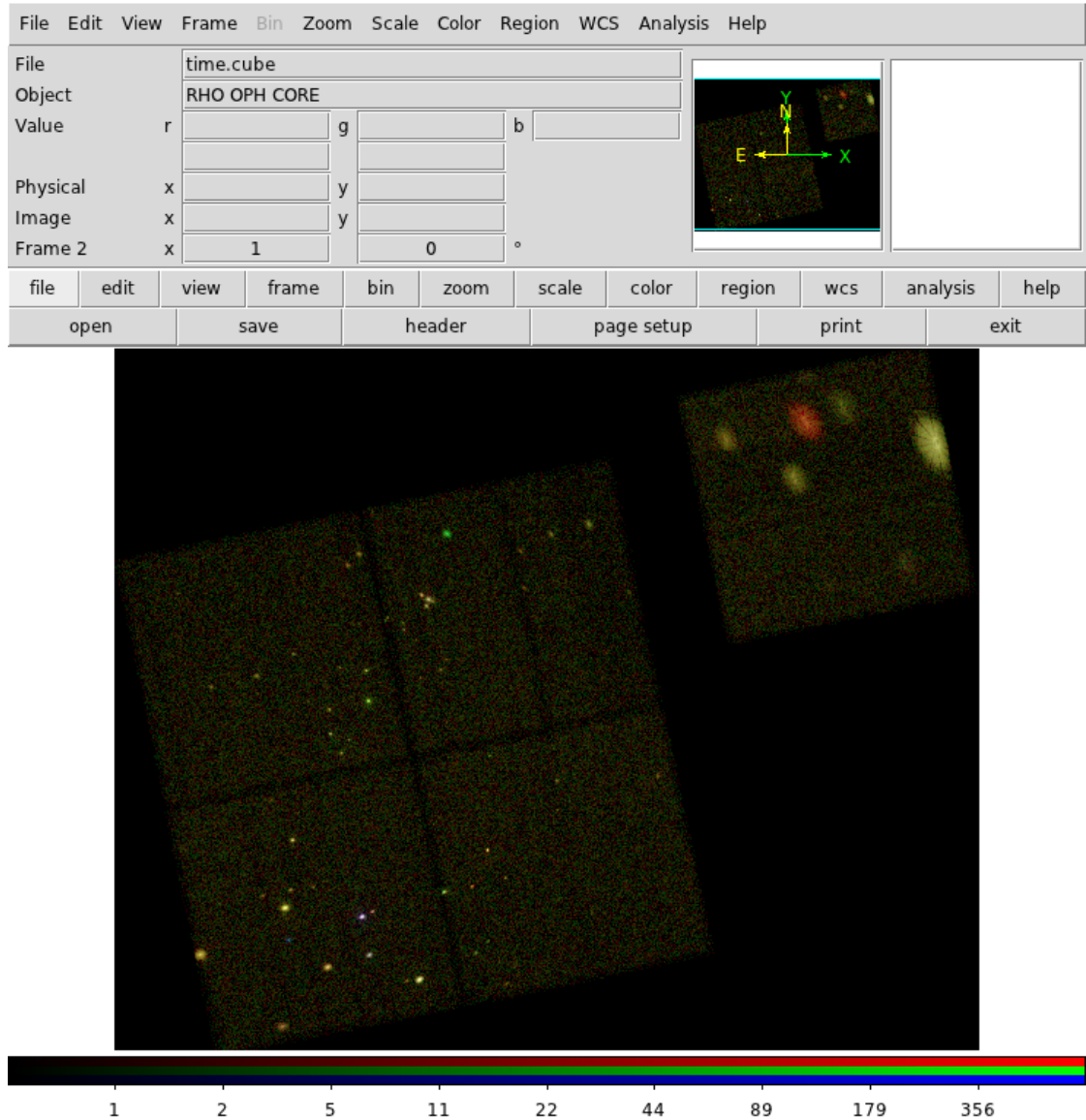
ds9 | Regions | Cubes



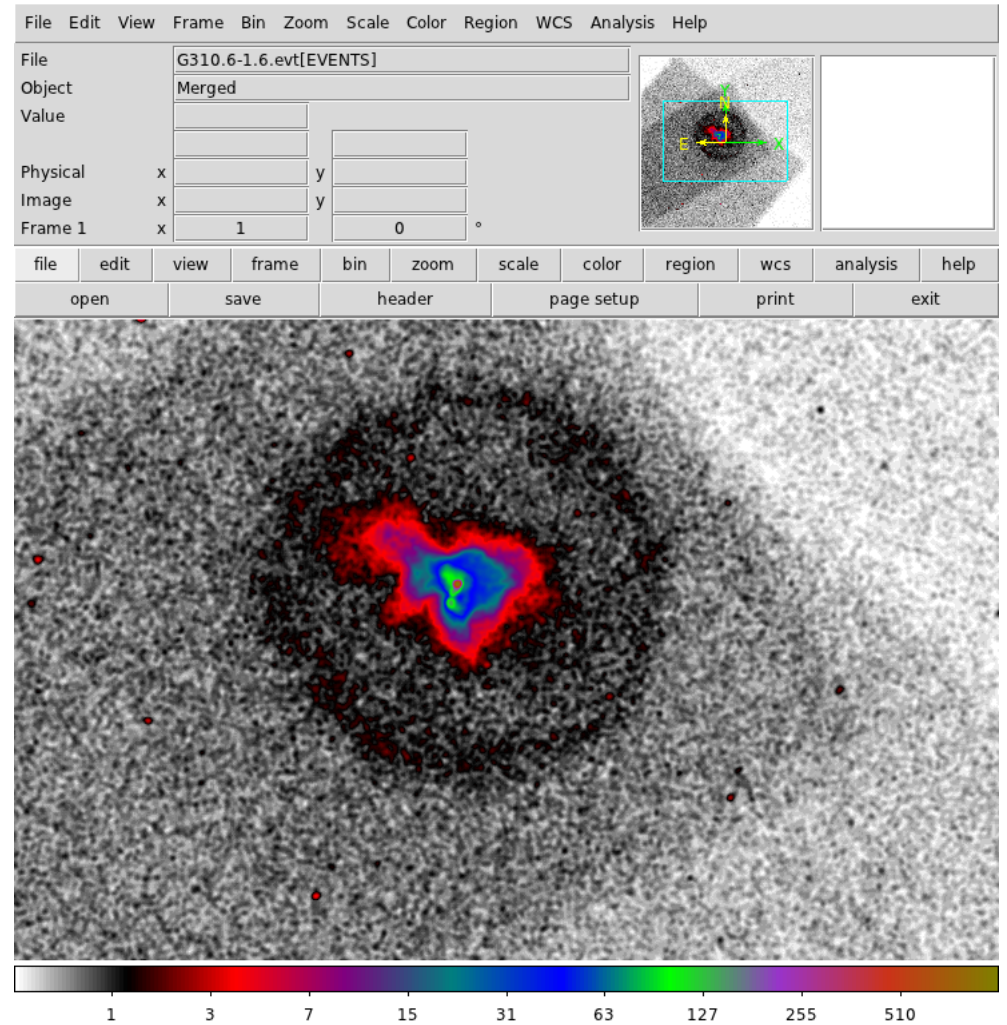
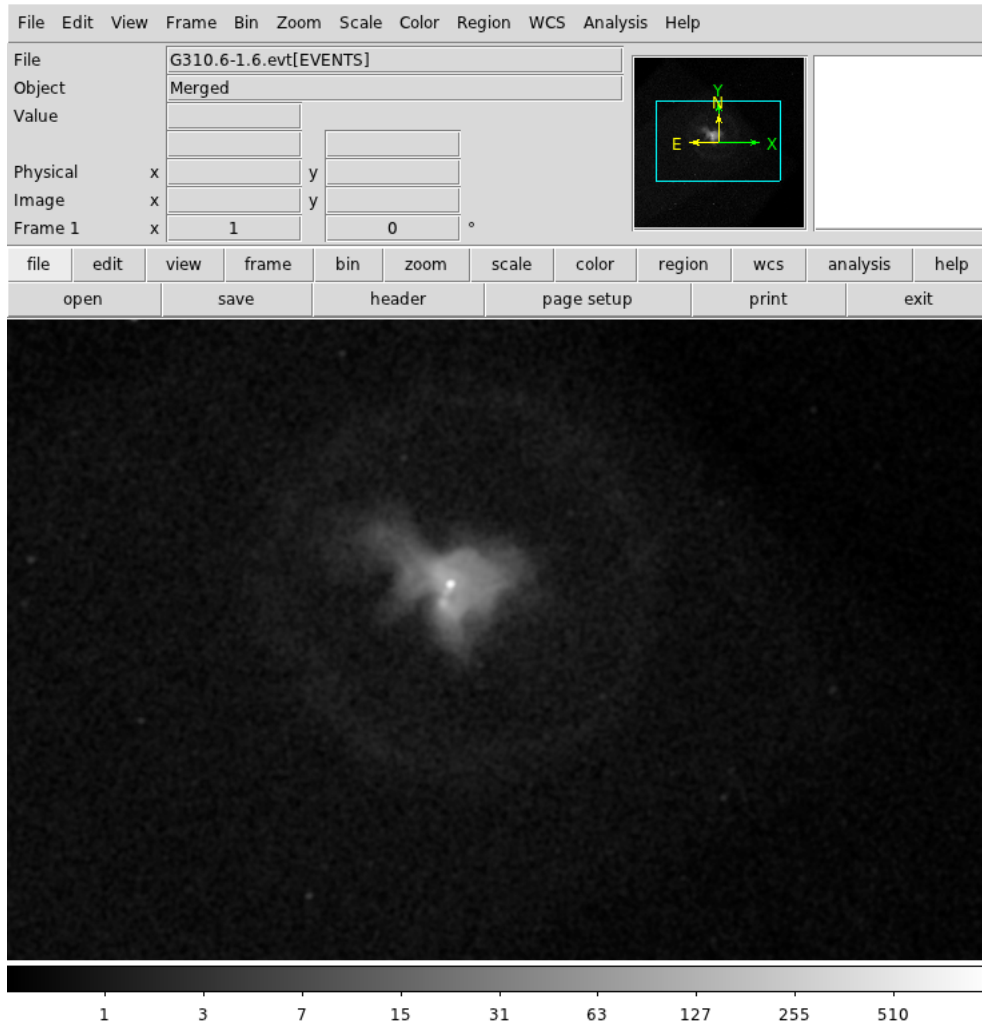
ds9 | RGB | Multi-Wavelength



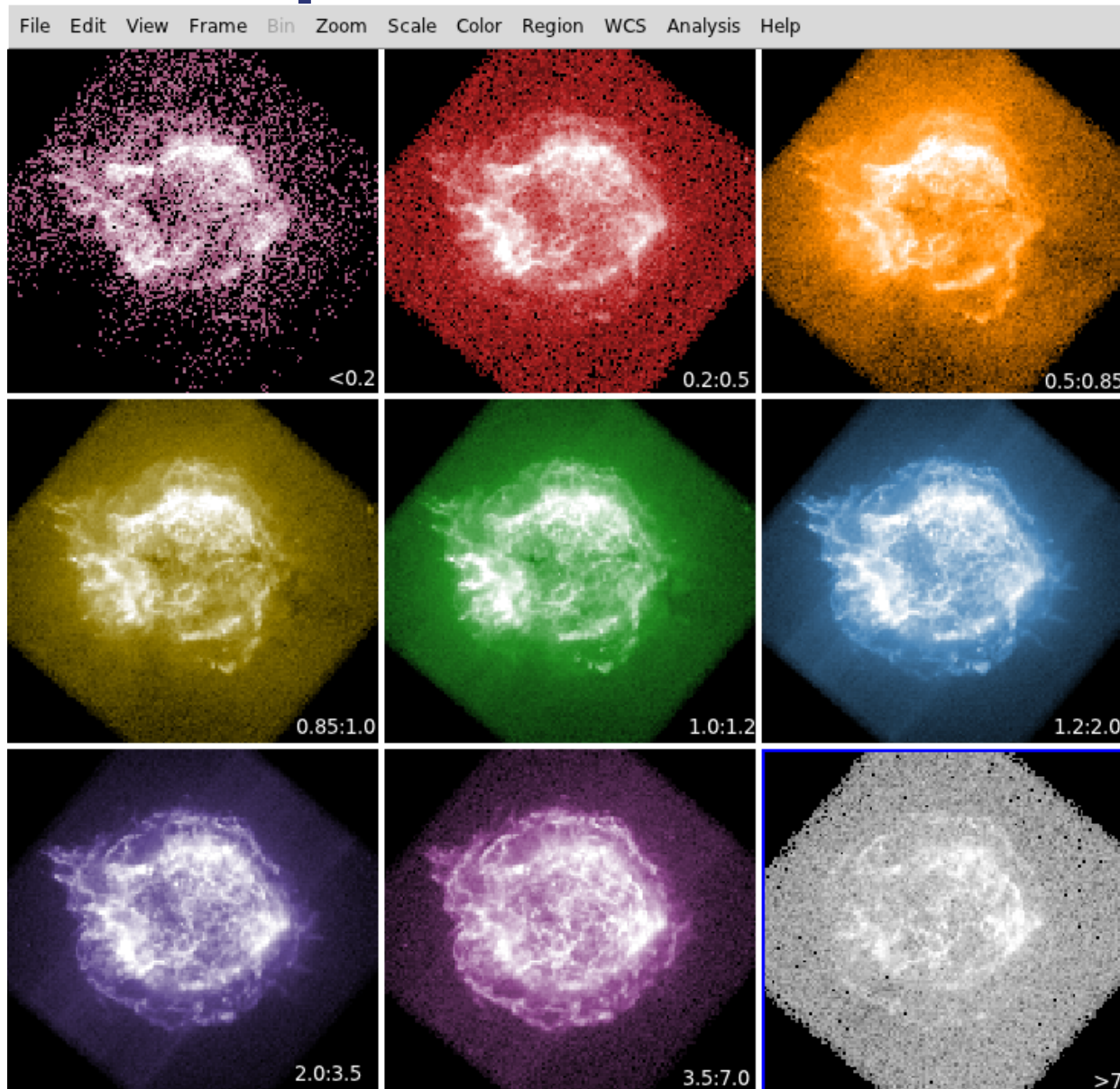
ds9 | RGB | Time



ds9 | Color Look Up Tables



ds9 | Backup & Restore



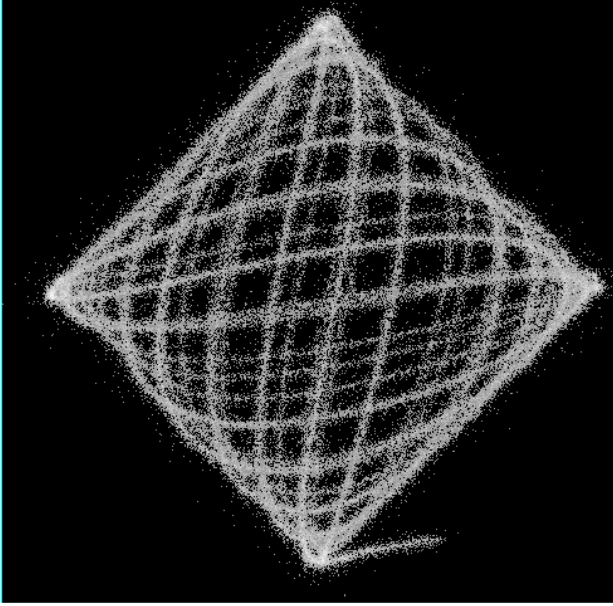
ds9 | 3D Rendering

File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help

File: ar_lac.cube
Object: ArLac
Value:

Physical: x y z
Image: x y z
Frame 2: x 1 y 0 z °

file edit view frame bin zoom scale color region wcs analysis help
open save header page setup print exit



0.016 0.047 0.11 0.24 0.49 0.99 2 4 8

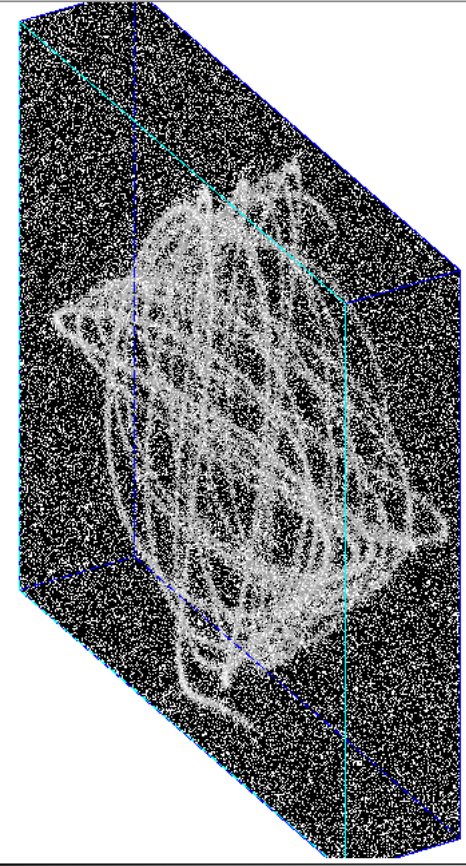
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help

file
edit
view
frame
bin
zoom
scale
color
region
wcs
analysis
help

File: ar_lac.cube
Object: ArLac
Value:

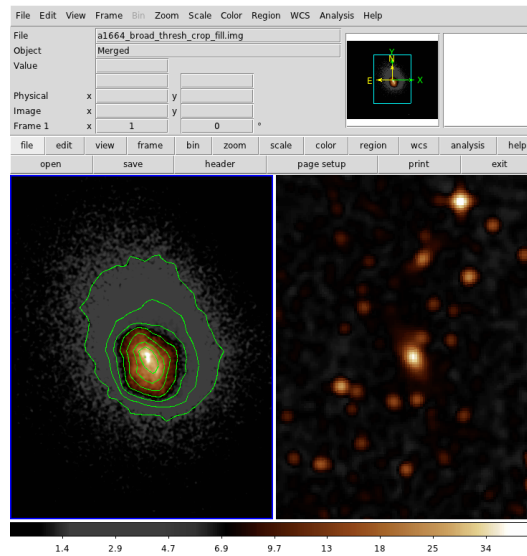
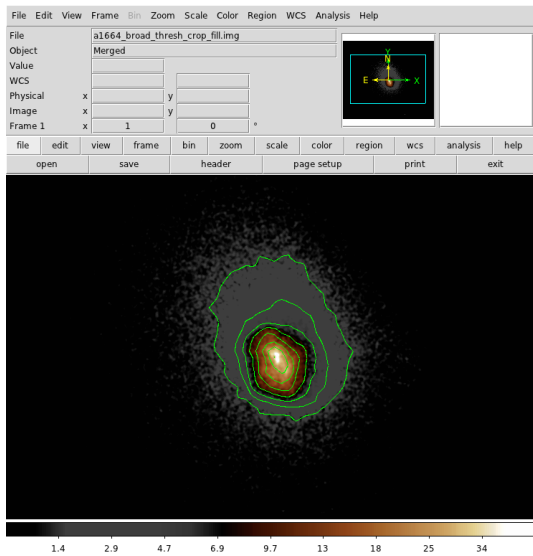
Physical: x y z
Image: x y z
Frame 2: x 1 y 0 z °

open
save
header
page setup
print
exit

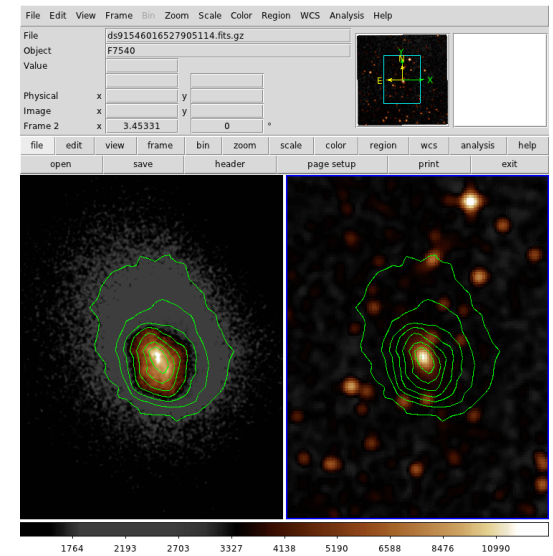


0.016 0.047 0.11 0.24 0.49 0.99 2 4 8

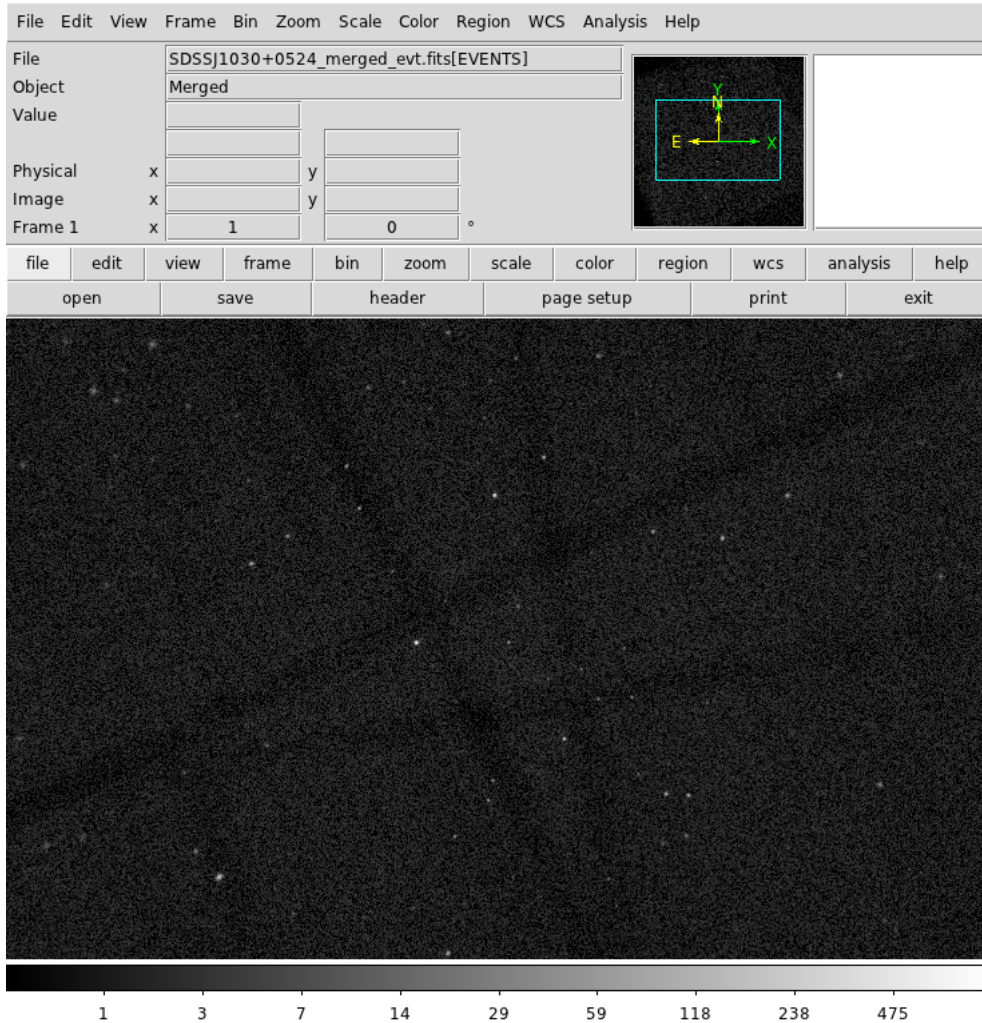
ds9 | Contours



- Apply
- Generate
- Clear
- Copy Contours
- Paste Contours...
- Load Contours...
- Save Contours...
- Load Contour Levels...
- Save Contour Levels...
- Convert to Polygons
- Close



ds9 | Analysis Menu



ds9 | Catalog

File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help

File: acisf03750N003_evt2.fits[EVENTS]
Object: ROSETTE NEBULA / NGC 2244

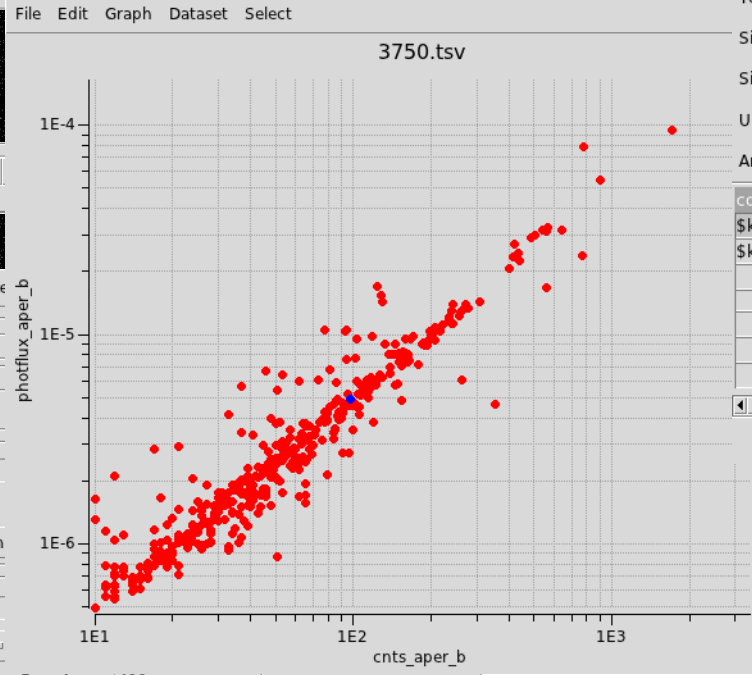
Physical Image Frame 1: x, y, x, y, x, y

File Edit View Frame Bin Zoom Scale Color
open save header page setup

File Edit Catalog Server Name Selection
Catalog Name: 3750.tsv
Identification: tool
Object Name: α , δ
Radius: arcmin
Table Filter: Sort: Max Rows: 5000 Found: 411
 α : ra δ : dec fk5

name	ra	dec	instrument	obsid	obi	region_id	m
CXO J063120	97.83474	4.84090	ACIS	3750	0	495	u
CXO J063120	97.83684	4.83460	ACIS	3750	0	478	u
CXO J063121	97.84108	4.81201	ACIS	3750	0	496	u
CXO J063122	97.84565	4.82249	ACIS	3750	0	493	u
CXO J063123	97.84818	4.86180	ACIS	3750	0	387	u
CXO J063125	97.85515	4.94484	ACIS	3750	0	380	u
CXO J063125	97.85617	4.82539	ACIS	3750	0	185	u
CXO J063125	97.85626	4.88125	ACIS	3750	0	472	u
CXO J063125	97.85751	4.97069	ACIS	3750	0	154	u
CXO J063126	97.86073	4.98583	ACIS	3750	0	358	u
CXO J063127	97.86445	4.89609	ACIS	3750	0	344	u
CXO J063127	97.86481	4.86460	ACIS	3750	0	506	u
CXO J063127	97.86519	4.90085	ACIS	3750	0	228	u
CXO J063128	97.86843	4.91401	ACIS	3750	0	238	u
CXO J063128	97.87008	4.87038	ACIS	3750	0	333	u

Status Done
Retrieve Cancel Filter Clear SAMP Plot Close



File Edit

If: $\$ks_prob_b > 0.9$ Edit

Then

Shape: circle point

Color: green

Width: 1

Font: helvetica

Text: \$name Edit

Size/Radius: Edit

Size/Radius 2: Edit

Units: physical

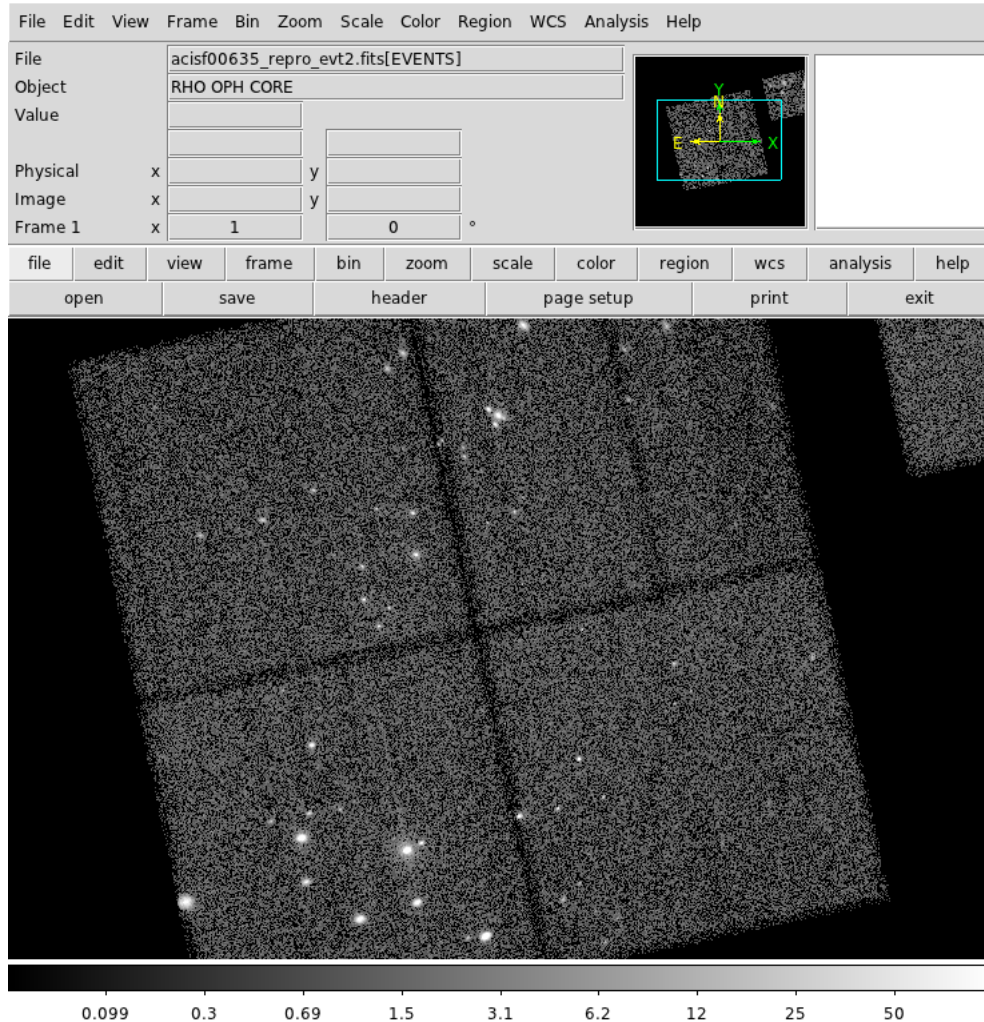
Angle: Edit

condition	shape	color	width	dash	font	font size
$\$ks_prob_b > 0.9$	circle point	green	1	0	helvetica	10
$\$ks_prob_b \leq 0.9$	box point	yellow	1	0	helvetica	10

Apply Add Delete Close help

none region cross colorbar pan zoom rotate crop cat exam

dax | Introduction



- Statistics
- Histograms
- Coords
- Detect (Images Only)
- Regions
- Sherpa
- Image Processing
- CIAO Help

dax | Statistics

```
File Edit Font
#==== 2018-12-28 12:08:57 =====
#File: acisf00635_repro_evt2.fits[EVENTS]

#Background subtracted data

#COMPONENT    NET_COUNTS    NET_ERR    NET_RATE    CEL_AREA    CEL_BRI    CEL_BRI_ERR
#              count          count      count/s     arcsec**2   count/arcsec**2 count/arcsec**2
1              22893         151.304    0.227383    1539.94     14.8661    0.0982531

#source region(s):
#circle(3814,3466,45)

#COMPONENT    COUNTS        COUNT_RATE    AREA
#              count          count/s       pixel**2
1              22893         0.227383     6361.73
```

```
File Edit Font
Adding net rates to output
Appending flux results onto output
Appending photflux results onto output
Computing Net fluxes
Adding model fluxes to output
Scaling model flux confidence limits

Summary of source fluxes

Position                                0.5 - 7.0 keV
Value          90% Conf Interval
#0001|16 27 28.02 -24 39 33.6 Rate      0.209 c/s (0.206,0.211)
Flux          5.15E-12 erg/cm2/s (5.09E-12,5.21E-12)
Mod.Flux      2.06E-12 erg/cm2/s (2.04E-12,2.09E-12)
Unabs Mod.Flux 2.54E-12 erg/cm2/s (2.51E-12,2.57E-12)

Output files are located in /tmp/ds9aper.kjg/4162/
```

```
File Edit Font

#source region(s):
#circle(3814,3466,45)

#COMPONENT    COUNTS        COUNT_RATE    AREA
#              count          count/s       pixel**2
1              22893         0.227383     6361.73

#==== 2018-12-28 12:09:14 =====
#File: acisf00635_repro_evt2.fits[EVENTS]

#Background subtracted data

#COMPONENT    NET_COUNTS    NET_ERR    NET_RATE    CEL_AREA    CEL_BRI    CEL_BRI_ERR    BGREG_COUNTS    BGREG_ERR
#              count          count      count/s     arcsec**2   count/arcsec**2 count/arcsec**2 count          count
1              22457.3       151.759    0.223055    1539.94     14.5832    0.0985485     435.691         11.7412

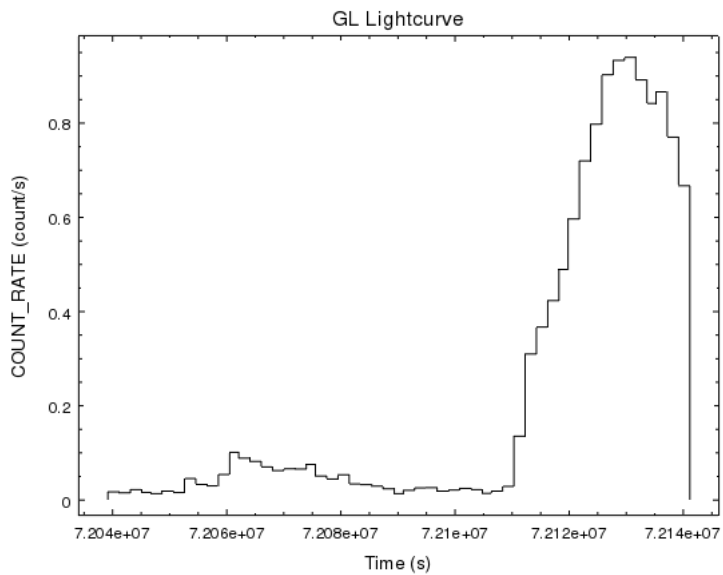
#source region(s):
#circle(3814,3466,45)

#COMPONENT    COUNTS        COUNT_RATE    AREA
#              count          count/s       pixel**2
1              22893         0.227383     6361.73

#background region(s):
#circle(3878,3742,80)

#BG_COUNTS    BG_RATE    BG_AREA
#count        count/s    pixel**2
1377          0.0136769 20106.2
```

dax | Histograms



File Edit Annotate View Plugin Help

pan range zoom select undo redo print clear

Coordinates

plot: ax1 & ay1

Data Extent

X 7.20392e+07 .. 7.21411e+07

Y 0.0136547 .. 0.939526

X 72034066.1878 72146242.1757 log flip auto

Y -0.0326388605516 0.985819501958 log flip auto

Info

Objects	Id
Window	win1
Frame	frm1
Plot	plot1
Axis	ax1
Axis	ay1
Histogram	hist1

Histogram Properties

Lines / Fill Symbols Error Bars General

Lines

Color █ Style solid

Thickness 1.0 Droplines

Fill

Color █ Style no fill

Opacity 1.00

Shell Errors

IPython profile: chips

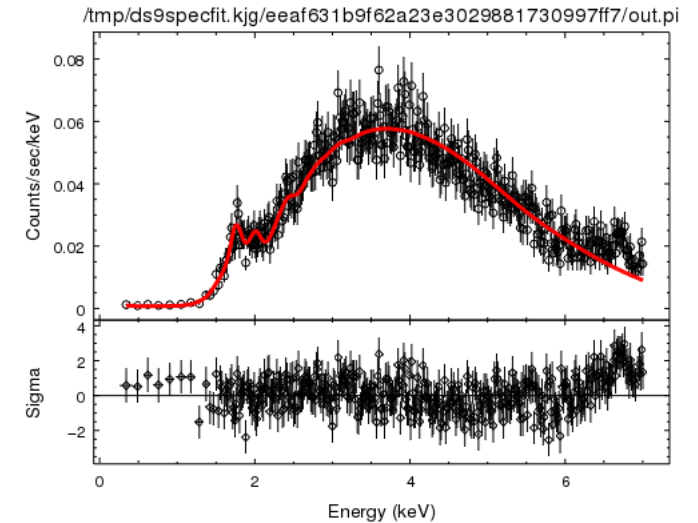
```
chips In [1]:
```

dax | Sherpa

```
File Edit Font
Confidence Method = confidence
Iterative Fit Method = None
Fitting Method = levmar
Statistic = chi2gehrels
confidence 1-sigma (68.2689%) bounds:
Param Best-Fit Lower Bound Upper Bound
-----
mdl1.gamma 1.42077 -0.0550169 0.0559544
mdl1.ampl 0.00166345 -0.000141195 0.000155083
abs1.nH 4.97287 -0.133045 0.138046

Photon Flux = 0.000998217708037 photon/cm^2/s
Energy Flux = 8.90021162459e-12 ergs/cm^2/s

To restore session, start sherpa and type
restore('/tmp/ds9specfit.kjg/eeaf631b9f62a23e3029881730997ff7/sav')
```



File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help

Object Value

Physical x y

Image x y

Frame 2 x 1 0

file edit view frame bin zoom scale color region wcs analysis help

open save header page setup print exit

0.099 0.3 0.69 1.5 3.1 6.2 12 25 50

```
File Edit Font
(3/3) Doing fit
Dataset = 1
Method = levmar
Statistic = chi2gehrels
Initial fit statistic = 2.49434e+08
Final fit statistic = 1018 at function evaluation 50
Data points = 400
Degrees of freedom = 393
Probability [Q-value] = 5.72264e-57
Reduced statistic = 2.59033
Change in statistic = 2.49433e+08
mdl1.fwhm 9.52724 +/- 0.0553045
mdl1.xpos 3817.18 +/- 0.0279098
mdl1.ypos 3467.66 +/- 0.0218753
mdl1.ellip 0.368214 +/- 0.00512283
mdl1.theta 0.490983 +/- 0.00842472
mdl1.ampl 5044.22 +/- 56.8002
bkg1.c0 2.84876 +/- 0.146525
Done!
```


Summary

- **Some interesting topics not covered**
 - **Mosaics**
 - **SAMP**
 - **Masks**
 - **Composite and Template Regions**