

# **Imaging Spectral Analysis**

**Also called**

**Imaging Spectroscopy**

- An entire section of the Analysis Threads is devoted to this subject
- **READ THE THREADS** line by line at least the first time!
- **READ THE AHELP** line by line at least once!

## Imaging Spectroscopy

[WHAT'S NEW](#) | [WATCH OUT](#)

[Top](#) | [All](#) | [Intro](#) | [Data Prep](#) | [Imag](#) | [Imag Spec](#) | [Grating](#) | [Timing](#) | [psf](#) | [TTT](#) | [ChIPS](#) | [Sherpa](#) | [Proposal](#) | [PSF Central](#)

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After extracting source and background PI or PHA spectra from an imaging observation, the appropriate response files ([ARF](#), [RMF](#)) are created so that the data may be modeled and fit. In the case of multiple or extended sources, a weighted ARF and RMF are built for the spectral analysis.

- **Extracting ACIS Spectra & Creating Response Files:**
  - [Extract Spectrum and Response Files for a Pointlike Source](#)
  - [Extract Spectrum and Response Files for an Extended Source](#)
  - [Extract Spectrum and Response Files for Multiple Sources](#)
  - [Coadding Spectra and Responses](#)
  - [A Note on Responses for XSpec Users](#)
  
- **Special Science Cases:**
  - [Analysing the ACIS Background with the "Blank-Sky" Files](#)
  - [Extract a Spectrum from the ACIS Readout Streak](#)
  - [Extracting a Spectrum of a Solar System Object](#)
  - [A Note on HRC Spectra](#)
  - [Adding Old Chandra Calibration Data to PIMMS](#)
  
- **Modeling & Fitting Spectral Data with Sherpa**  
**(from the Sherpa analysis threads):**
  - [Introduction to Fitting PHA Spectra](#)
  - [Changing the grouping scheme of a data set within Sherpa](#)
  - [Introduction to Fitting ASCII Data with Errors: Single-Component Source Models](#)
  - [Simultaneously Fitting Two Data Sets](#)
  - [Simulating 1-D Data: the Sherpa FAKE\\_PHA Command](#)
  - [Simulating Chandra ACIS-S Spectra with Sherpa](#)
  - [Fitting PHA Data with Multi-Component Source Models](#)
  - [Independent Background Responses](#)
  - [Using A Pileup Model](#)

## REMINDER!

When starting from an event file which has information on **(x,y,E,t)** for each event

Spatial Analysis (*lose time and energy information*)

**Spectral Analysis** (*lose time and spacial information*)

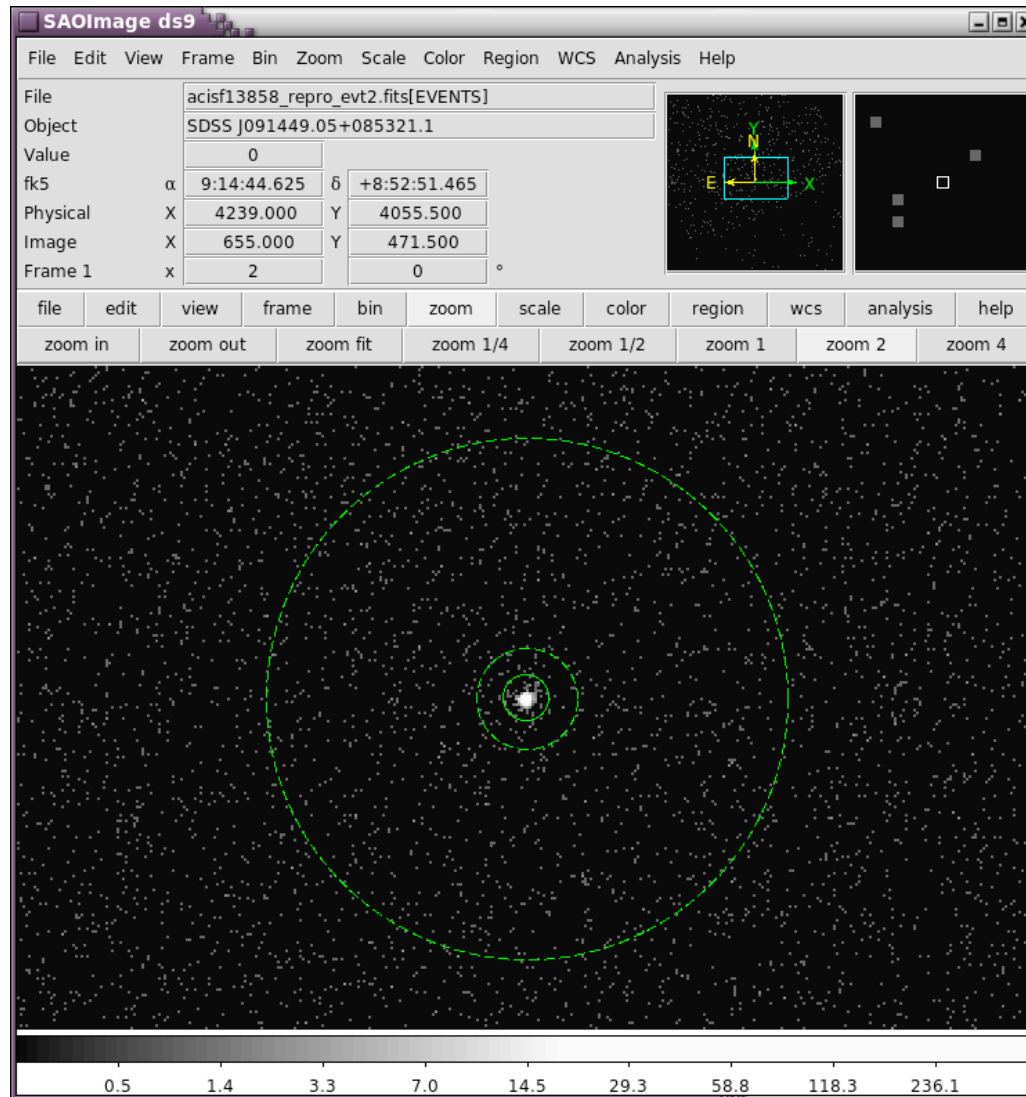
Timing analysis (*lose spectral and spacial information*)

## What is the goal?

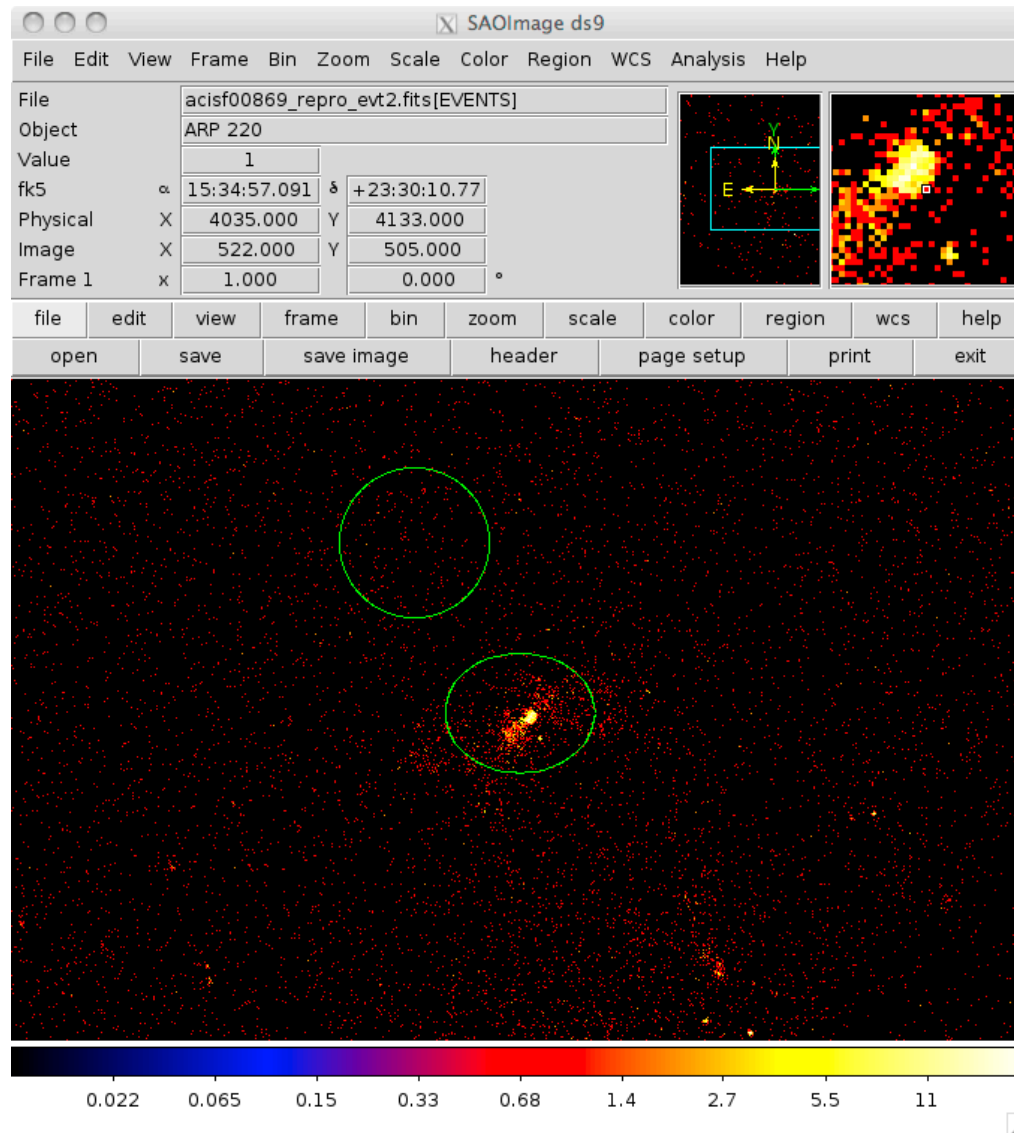
- Extract a spectrum of a source detected in an ACIS imaging observation (very limited energy information on the HRC instrument) or a zeroth-order grating observation
- Create the appropriate response files
  - ✓ ARF: Ancillary Response File
  - ✓ RMF: Response Matrix File

So that the spectrum can be modeled and fit to derive physical information about the source (spectral slope, temperature, abundances, absorption, etc.)

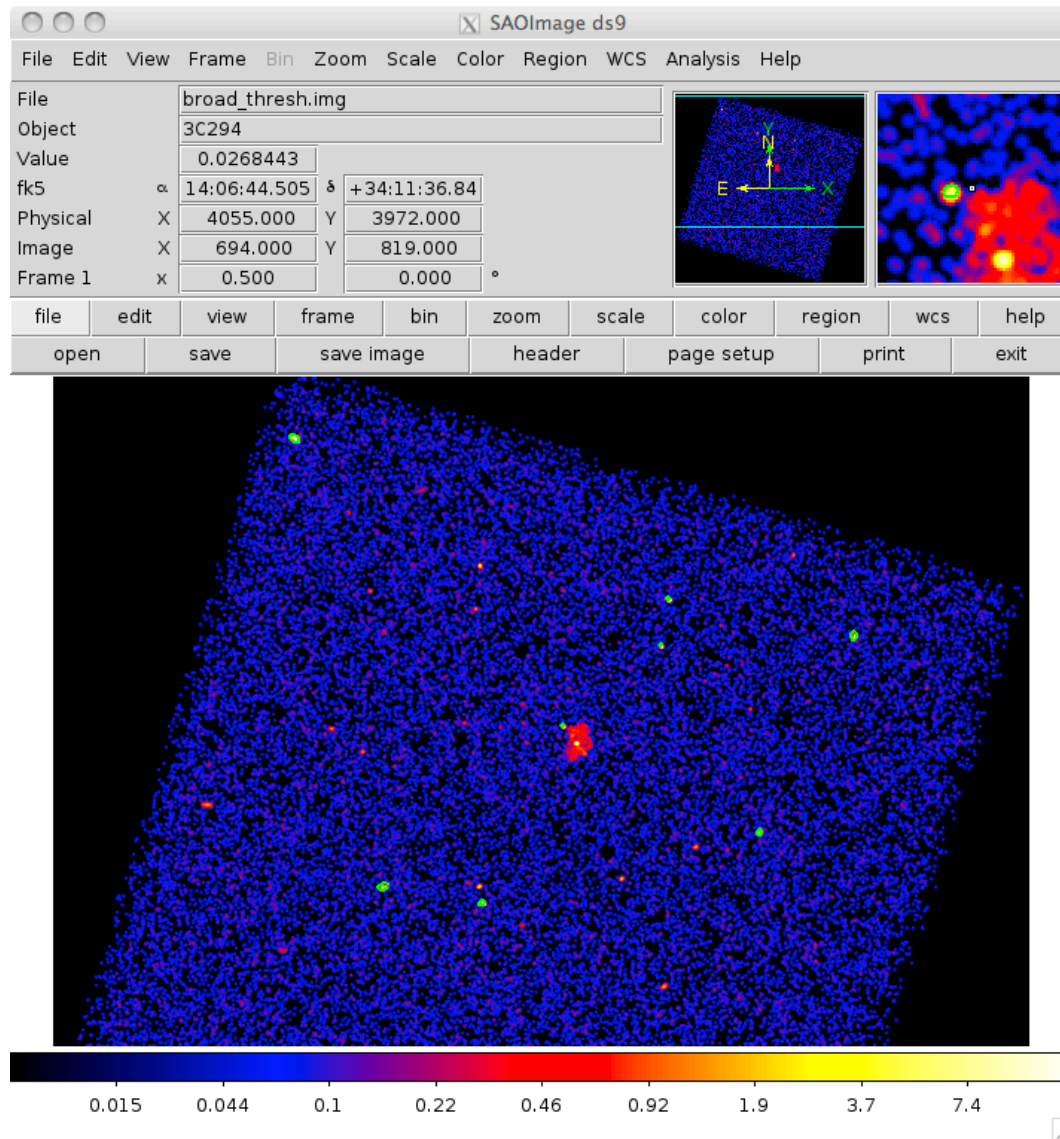
# Extract Spectrum and Response Files for a Pointlike Source



# Extract Spectrum and Response Files for an Extended Source



## Extract Spectrum and Response Files for Multiple Sources





Until a few years ago the procedure required running \*many\* different tools to perform the various steps

Now you have one “script”

**SPEXTRACT**

However...

- Run the Step-by-Step Guide at least once!
- You also want to use the step-by-step guide as reference in case you have a special case, you want to check a specific output, etc.
- You want to understand some of the **specextract** parameters in more depth

But in general...

1. Open **ds9** and identify the extraction regions for the source and the background (**src.reg**, **bkg.reg**)
2. Set the **specextract** parameters and run the tool

**specextract evt2.fits[sky=region(src.reg)] output**

## Main decisions a user has to make

- Is the source extended enough or far off-axis so that the responses need to be weighted by the count distribution within the aperture? (the **weight** and **weight\_rmf** parameters)
- Should the ARF be corrected for events falling outside the finite size and shape of the aperture (**correctpsf** parameter)
- Do I want a background spectrum? (is the source much brighter than the background? Is my source extended?) (**bkg\*** parameters)
- Do I want a single spectrum or many spectra (for multiple regions) (**combine** parameter)

## Parameters in specextract.par

<b>infile =</b>	<b>Source event file(s)</b>
<b>outroot =</b>	<b>Output directory path + root name for output files</b>
<b>(bkgfile = )</b>	<b>Background event file(s)</b>
(asp = )	Source aspect solution or histogram file(s)
(dtffile = )	Input DTF files for HRC observations
(mskfile = )	Maskfile (input to mkwarf)
(rmffile = CALDB)	rmffile input for CALDB
(badpixfile = )	Bad pixel file for the observation
(dafile = CALDB)	Dead area file (input to mkwarf)
(bkgresp = yes)	Create background ARF and RMF?
<b>(weight = yes)</b>	<b>Should response files be weighted?</b>
(weight_rmf = no)	Should RMF also be weighted?
(refcoord = )	RA and Dec of responses?
<b>(correctpsf = no)</b>	<b>Apply point source aperture correction to ARF?</b>
<b>(combine = no)</b>	<b>Combine ungrouped output spectra and responses?</b>
(grouptype = NUM_CTS)	Spectrum grouping type (same as grouptype in dmgroup)
(binspec = 15)	Spectrum grouping specification (NONE,1:1024:10,etc)
(bkg_grouptype = NONE)	Background spectrum grouping type (NONE, BIN, SNR, NUM_BINS, NUM_CTS, or ADAPTIVE)
(bkg_binspec = )	Background spectrum grouping specification (NONE,10,etc)
(energy = 0.3:11.0:0.01)	Energy grid
(channel = 1:1024:1)	RMF binning attributes
(energy_wmap = 300:2000)	Energy range for (dmextract) WMAP input to mkacismrf
(binarfcrr = 1)	Detector pixel binning factor for (arfcrr) to determine size and scale of PSF to derive aperture corrections at each energy step.
(binwmap = tdet=8)	Binning factor for (dmextract) WMAP input to mkacismrf
(binarfmap = 1)	Binning factor for (sky2tdet) WMAP input to mkwarf
(tmpdir = \${ASCDS_WORK_PATH} -> /tmp)	Directory for temporary files
(clobber = no)	OK to overwrite existing output file?
(verbose = 1)	Debug Level(0-5)
(mode = ql)	

## Extract Spectrum and Response Files for a Pointlike Source

```
% pset specextract infile="acisf13858_repro_evt2.fits[sky=region(src.reg)]"  
% pset specextract bkgfile="acisf13858_repro_evt2.fits[sky=region(bkg.reg)]"  
% pset specextract outroot=spec  
% pset specextract correctpsf=yes  
% pset specextract weight=no  
% specextract  
Source event file(s) (acisf13858_repro_evt2.fits[sky=region(src.reg)]):  
Output directory path + root name for output files (spec):  
Running specextract  
Version: 14 March 2017  
[...]
```

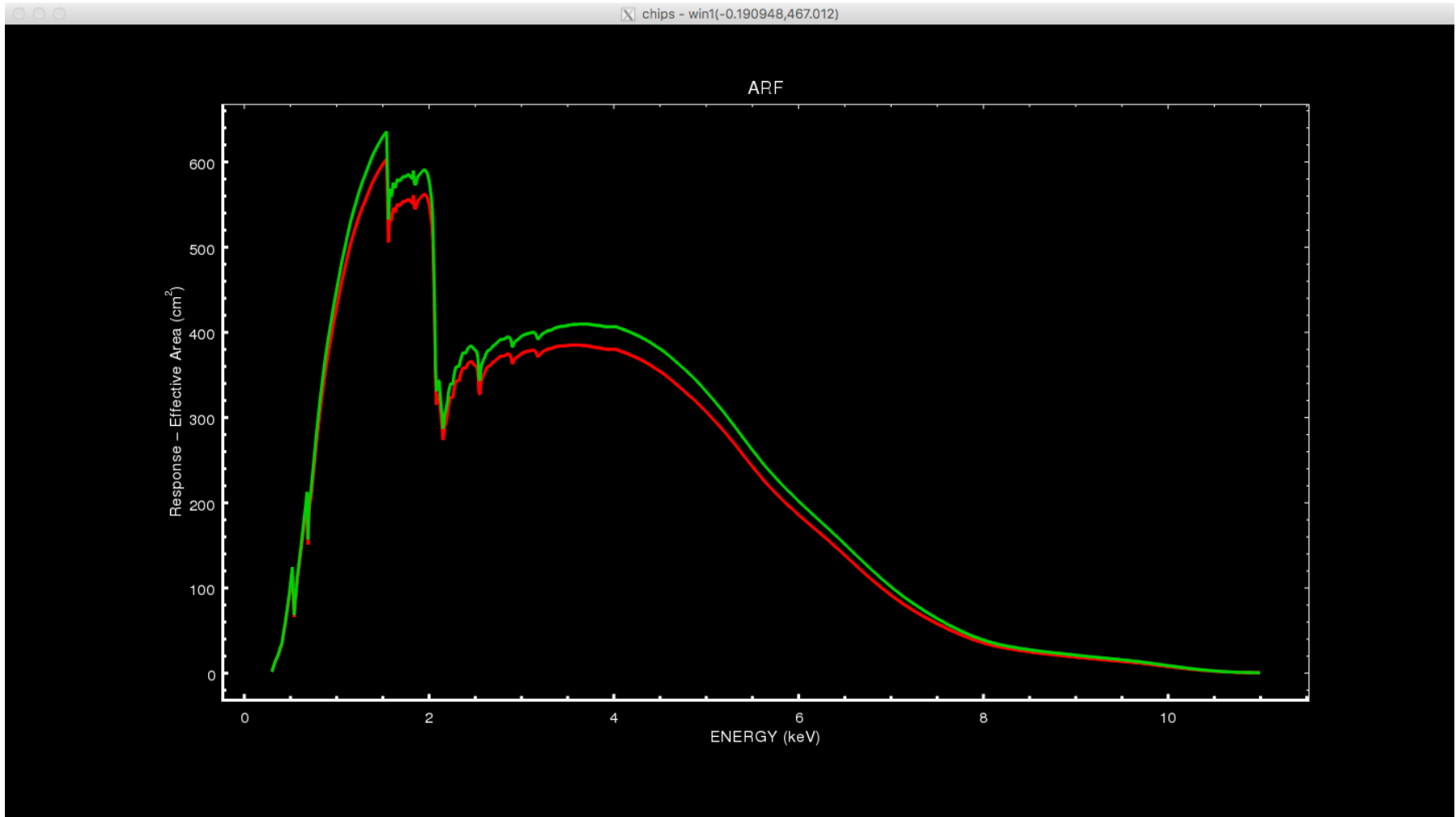
## OUTPUT

```
% ls -l
```

```
spec.arf          [source ARF]  
spec.corr.arf     [corrected ARF]  
spec.pi           [source binned spectrum]  
spec.rmf          [source RMF]  
spec_bkg.arf     [background ARF]  
spec_bkg.pi      [background binned spectrum]  
spec_bkg.rmf     [background RMF]  
spec_grp.pi      ["grouped" source spectrum]
```

spec.arf

spec.corr.arf

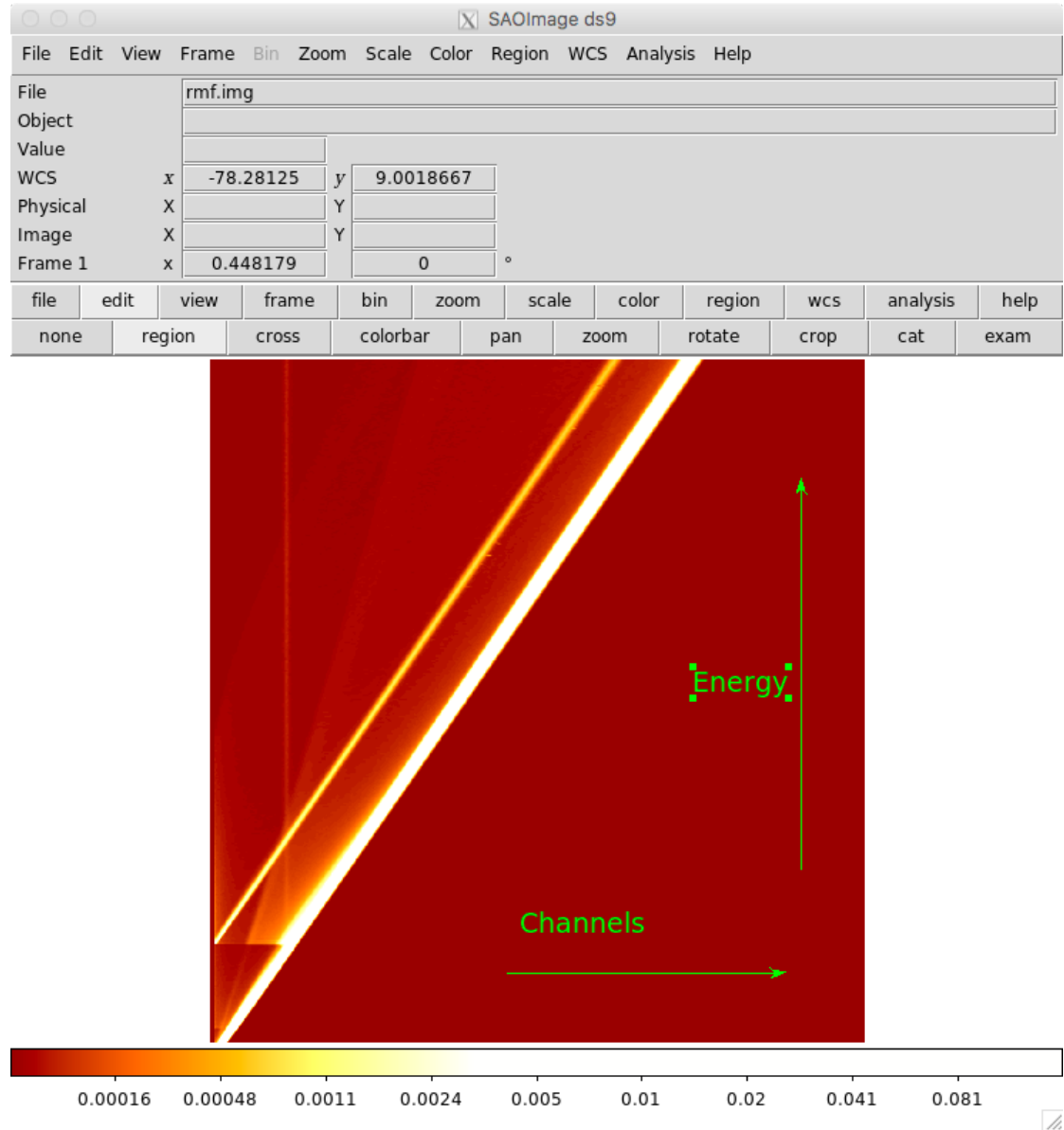




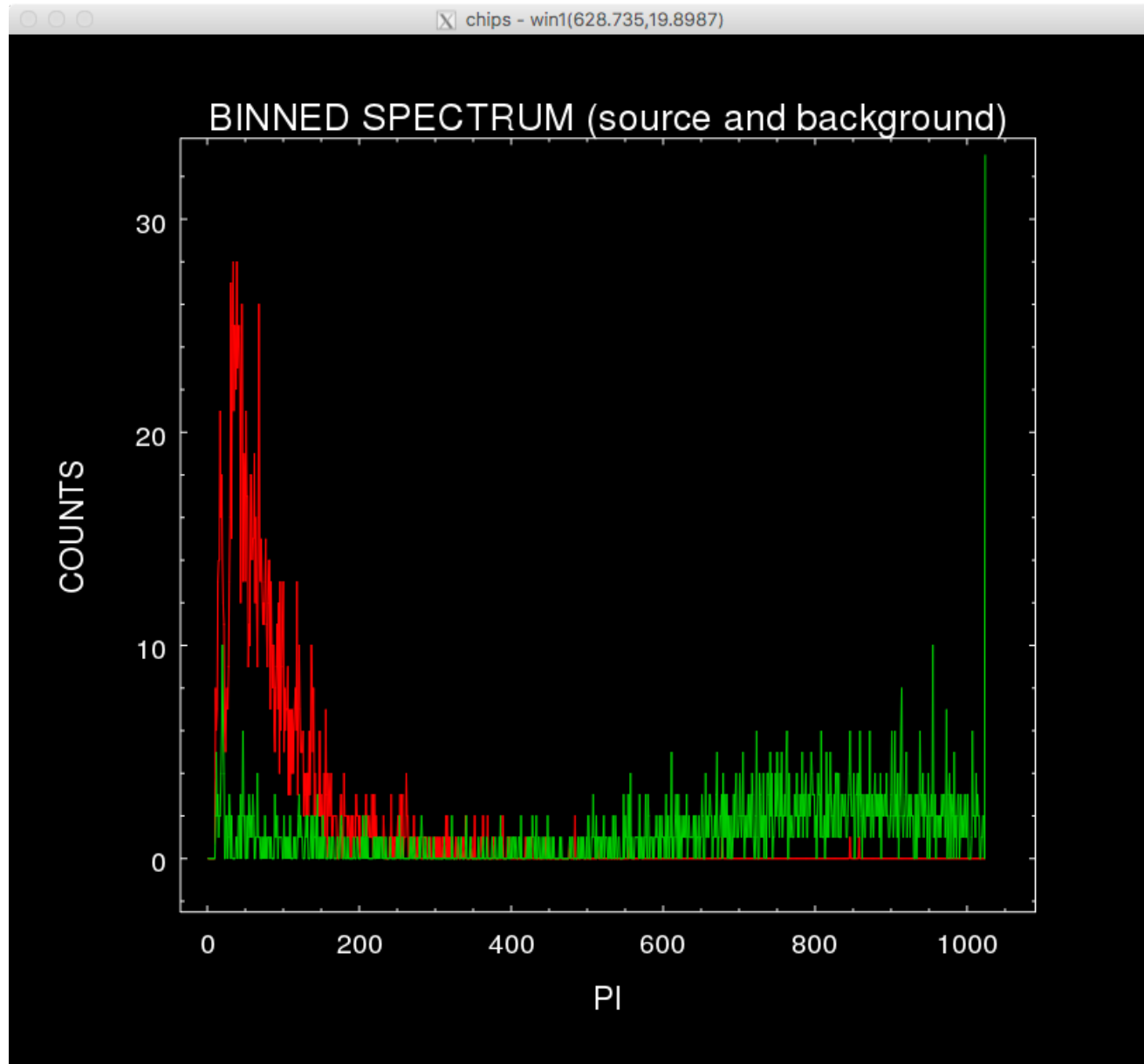
rmf.img

An image representation of spec.rmf

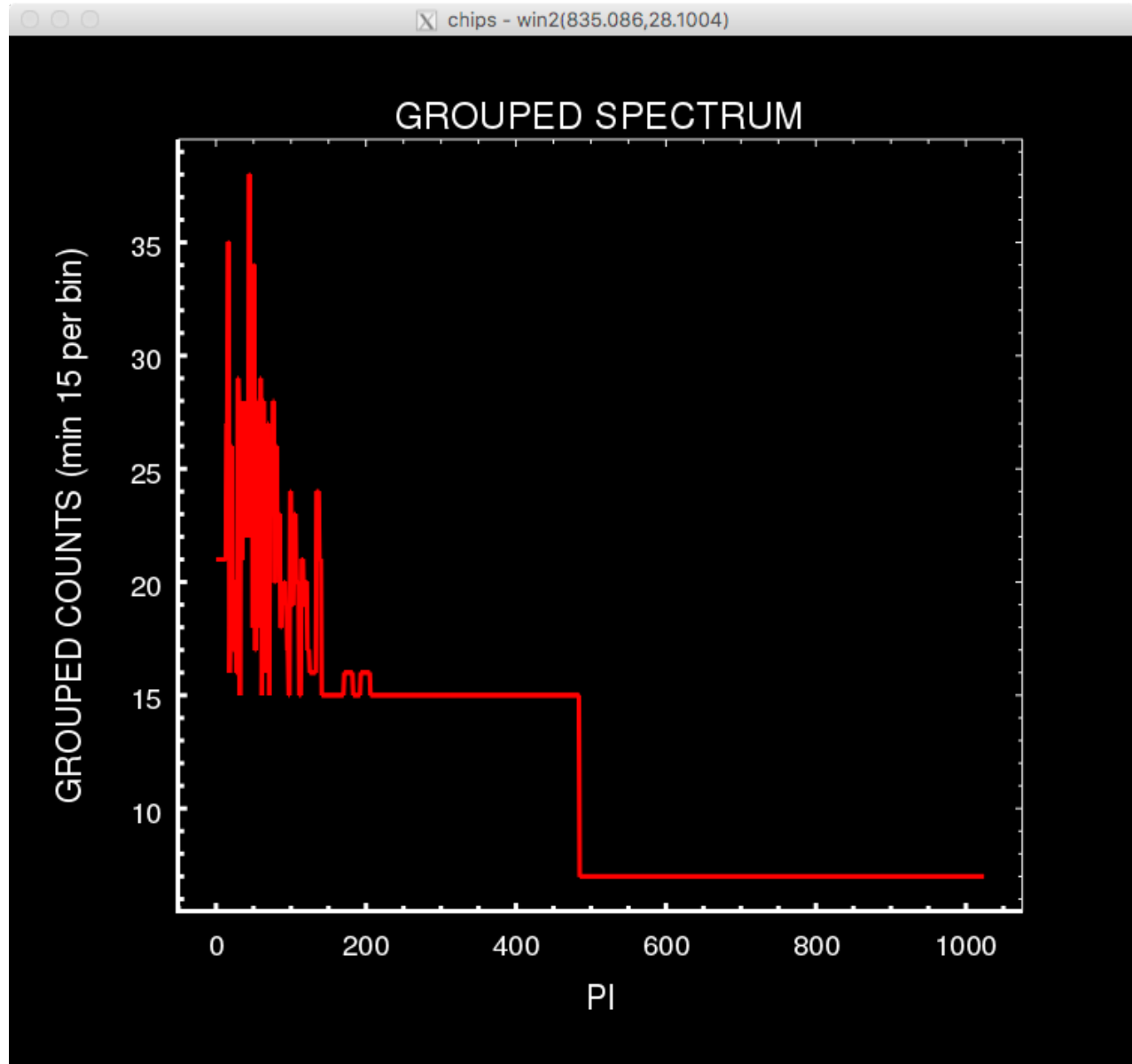
(generated with **rmfimg**)



spec.pi  
spec\_bkg.pi



spec\_grp.pi



## NEXT STEP

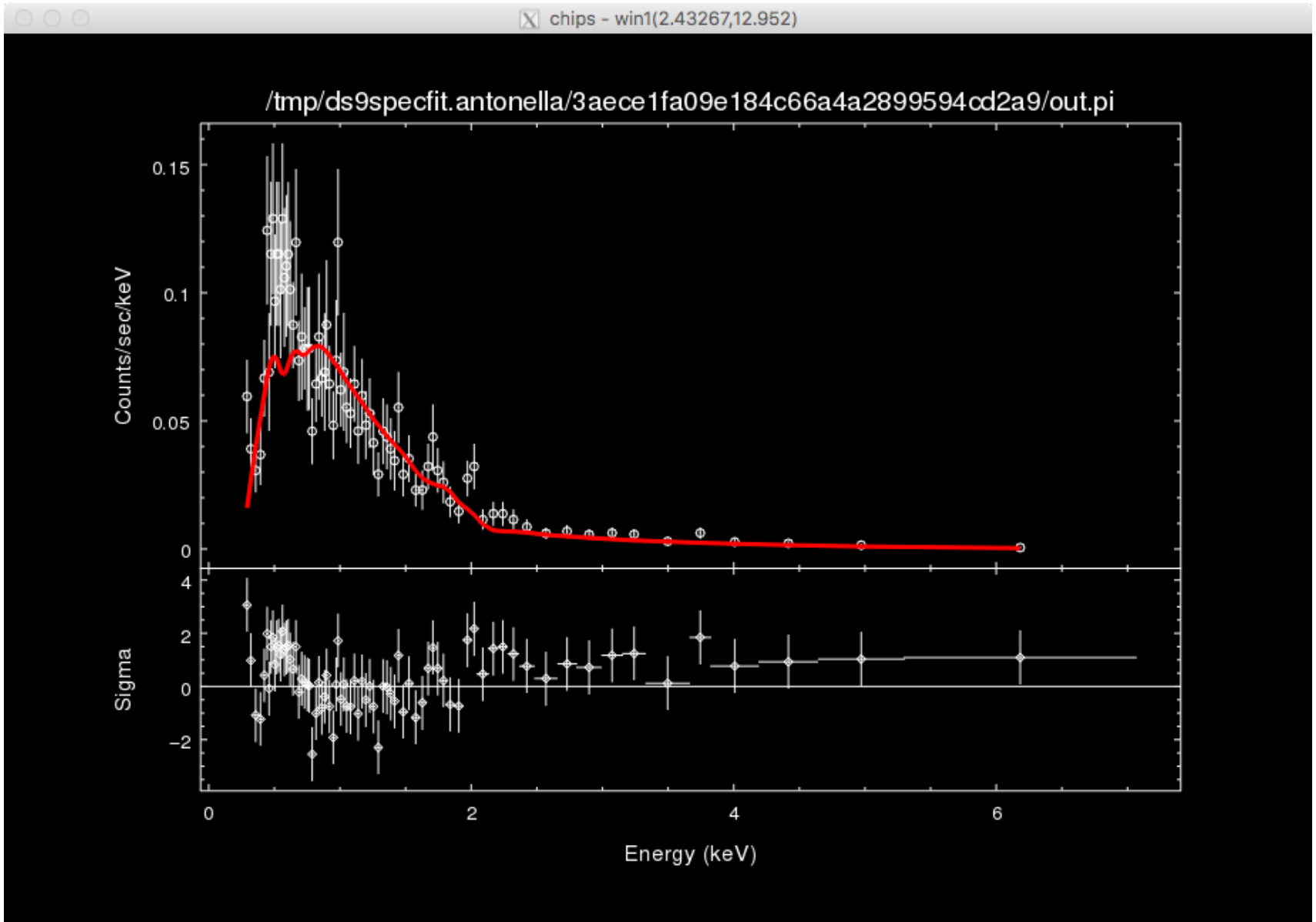
Go into the Sherpa application to perform modeling and fitting

Or...

**Do it all in ds9 via dax!**

Quick demo

<https://www.youtube.com/user/4ciaodemos>



## CIAO/CHANDRA on social media

<https://www.facebook.com/ChandraCIAO/>  
<https://twitter.com/chandraCIAO>

<https://www.youtube.com/user/4ciaodemos>

<https://www.facebook.com/chandraCDO>  
<https://twitter.com/chandraCDO>

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[chandra-announce+subscribe@cfa.harvard.edu](mailto:chandra-announce+subscribe@cfa.harvard.edu)

# CHANDRA PROPOSALS

Call For Proposal ~December 15

Proposal Deadline ~March 15

**THIS YEAR: Due Date: 14 March 2019, 6 p.m. EDT**

Peer Review ~June

Results ~July

Observations start ~Nov



# <http://cxc.harvard.edu/proposer/>

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## Chandra Proposal Information

Submit a Proposal (CPS)

What's New this Cycle?

Call for Proposals (CfP)

Proposers' Observatory Guide (POG)

FAQ

DDT & TOO

HelpDesk

### Announcements

12/13/18 Cycle 21 [CfP](#) and [POG](#) released. See [What's New this Cycle?](#)

#### Proposal Submission

What's New this Cycle? **New!**

Call for Proposals (CfP) **Updated!**

Submit a Proposal (CPS)

Guide to Proposing with CPS **New!**

Science Justification LaTeX Template

Generating a PDF Science Justification

Previous Chandra Experience LaTeX Template

DDT & TOO Requests

#### Instrument & Observatory Information

Proposers' Observatory Guide (POG) **Updated!**

Chandra Instruments & Calibration

Effective Area General Information

Effective Area Plots

Grating RMFs & ARFs

ACIS Aimpoint & Off-Axis RMFs/ARFs

PSF Central

PSF General Information

#### Count Rate Estimation & Simulators

Overview of proposal tools

PIMMS: count-rate & flux prediction (online version)

PIMMS: count-rate & flux prediction (command-line version)

MARX: Chandra data simulator

Sherpa: CIAO spectral analysis & simulation package

XSPEC: HEASARC spectral analysis & simulation package

WebSpec: web version of XSPEC

Colden: NH Calculator

#### Targets Observed & Scheduled with Chandra

ChaSeR: query Chandra observations

Chandra Source Catalog (CSC)

Accepted Proposal Search Tool

Target Lists & Schedules

Cool Attitude Targets (CATs)

#### Observation Visualization & Planning

ObsVis: visualizing Chandra field of view

PRoVis: pitch, roll & visibility by date for celestial target

PSF viewer: visualizing the on-/off-axis PSF behavior

Spectrum Visualization Tool

Precess: astronomical coordinate conversion tool

Dates: calendar time & conversion tool

Coordinate systems used in proposal tools

Timescales used in proposal tools

Future Chandra Orbits

CIAO: Chandra data analysis package

#### Cost Proposals & Grant Info

Cost proposal preparation & submission

General grant information with Terms & Conditions

Instructions for Stage-2 Cost Proposal Submission

Keeping Track of Chandra Publications

## **Call For Proposal (CfP)**

**<http://cxc.harvard.edu/proposer/CfP/>**

## **Proposers' Observatory Guide (POG)**

**<http://cxc.harvard.edu/proposer/POG/>**

## **Frequently Asked Questions**

**<http://cxc.harvard.edu/proposer/faqs.html>**