X-ray Imaging

Rodolfo Montez Jr.

dmcopy “acis_repro_evt2.fits[…][…]” new_file.fits

X-ray Imaging

seriously

your new best friend

dmfiltering

data model filters

dmcopy “acis_repro_evt2.fits[…][…]” new_file.fits

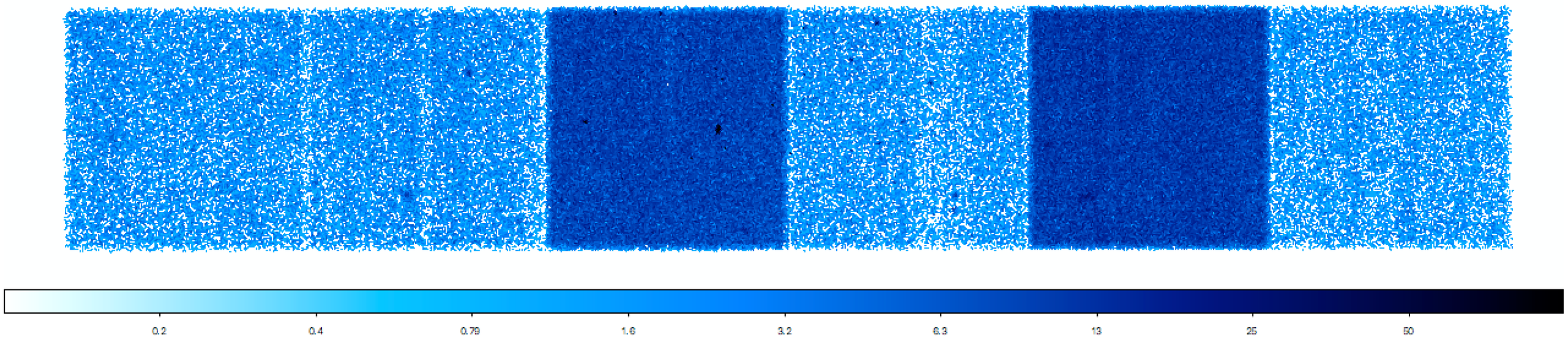
event file

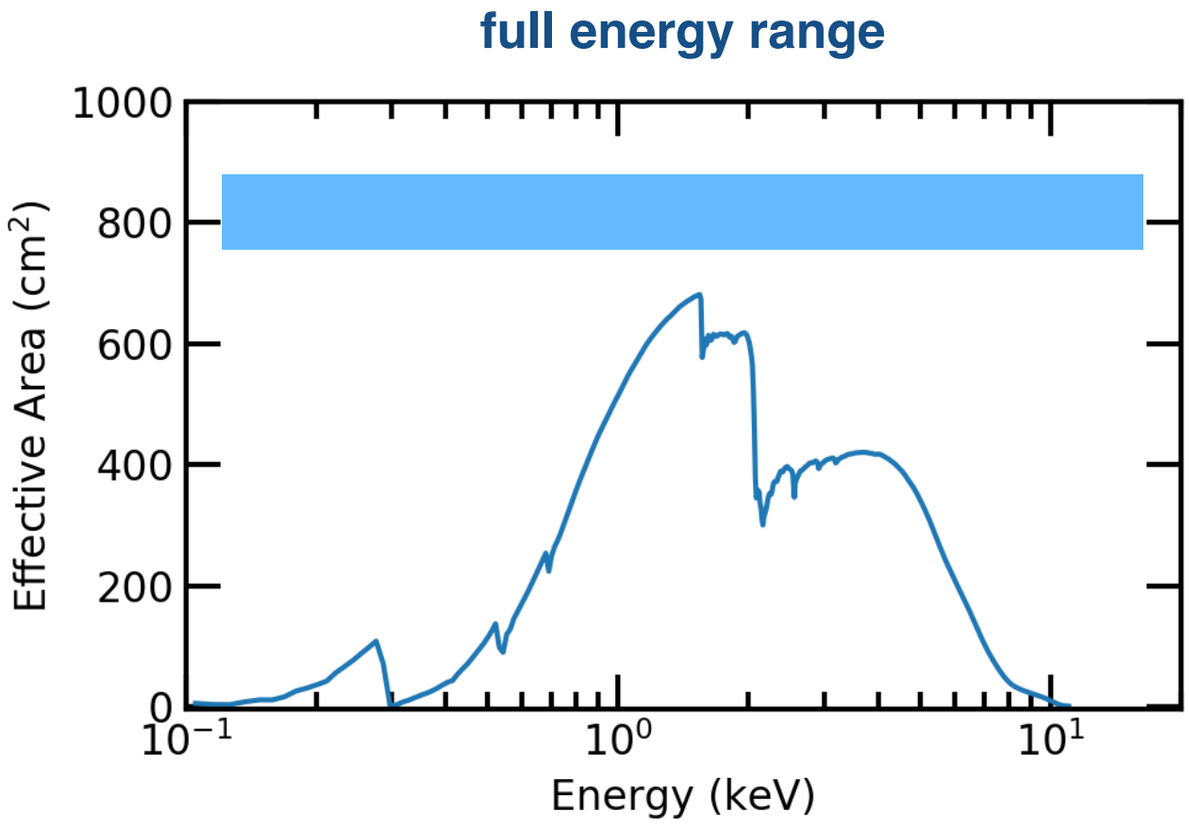
but it could be a fits image, ascii table, etc.

output file

*some **filters** will preserve the event list some will destroy it, **options** can give you more control*

X-ray Imaging

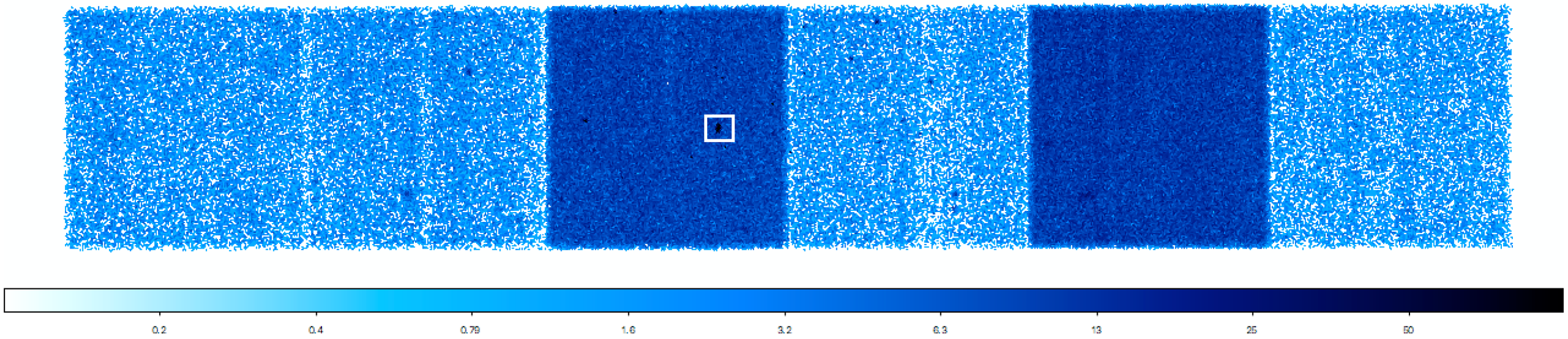


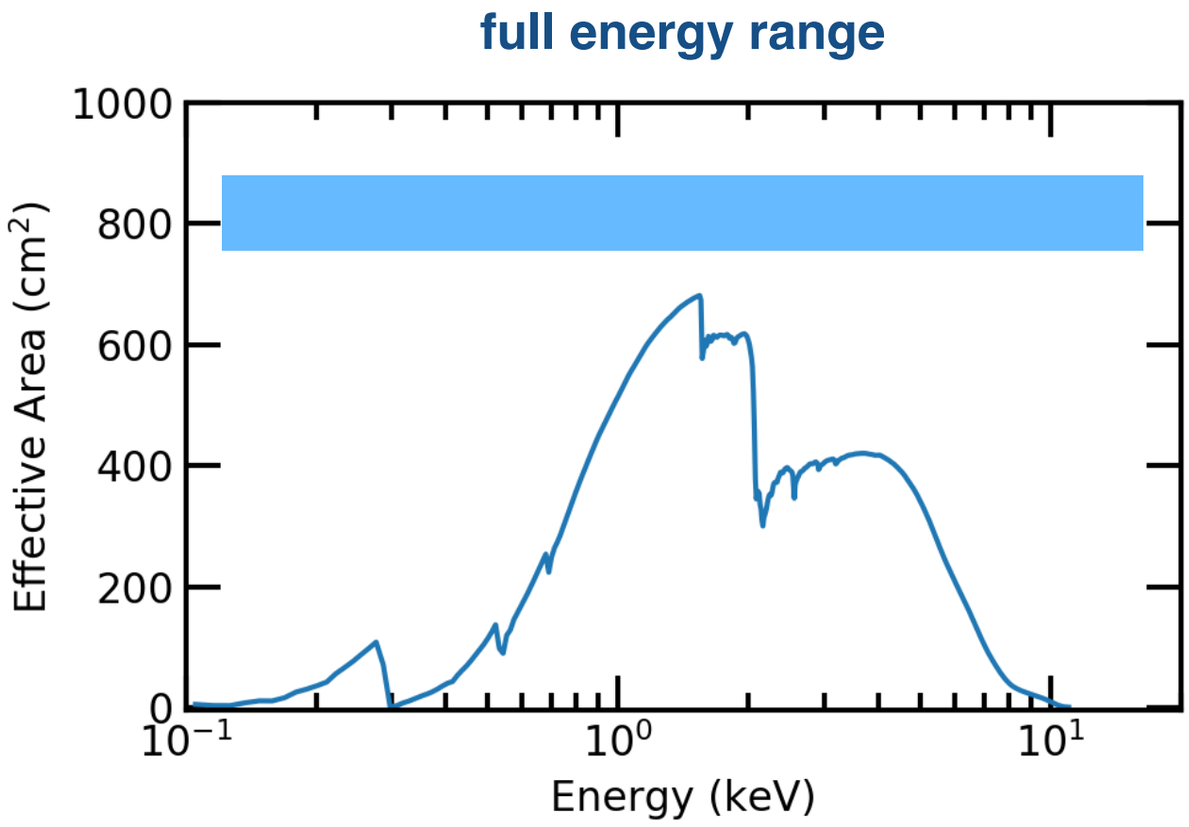


X-ray Imaging

here is the bin filter used in dmcopy

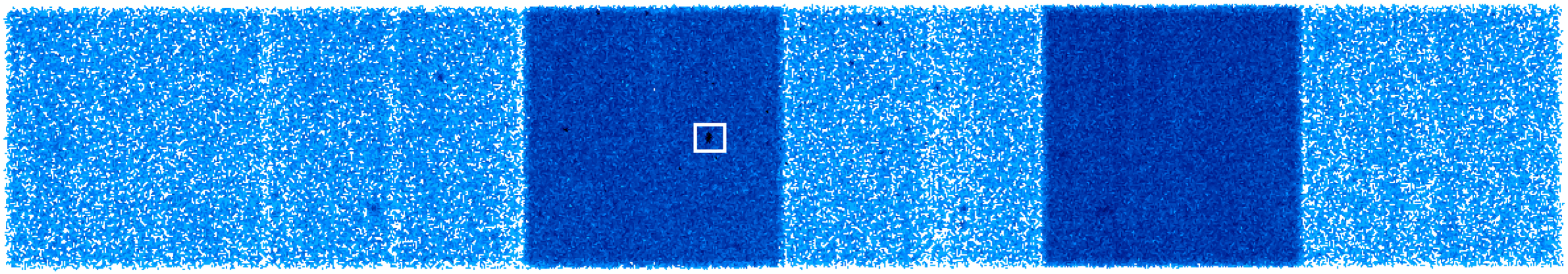
[bin x=::8,y=::8]

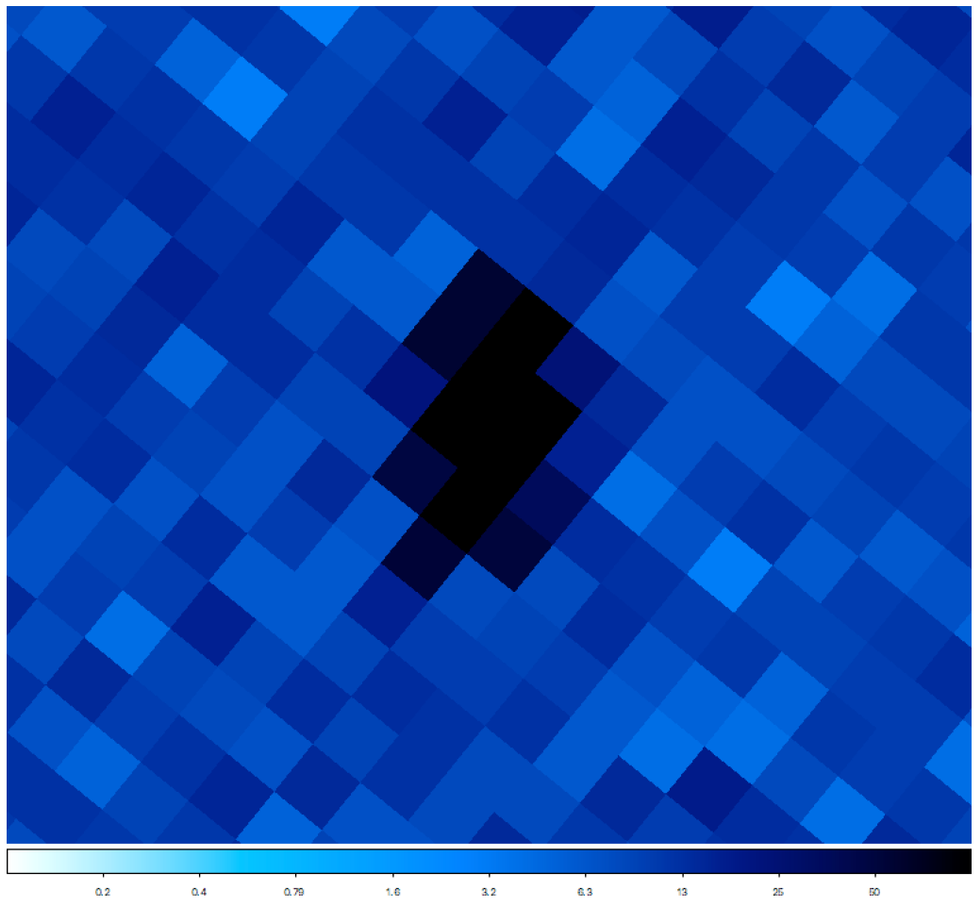


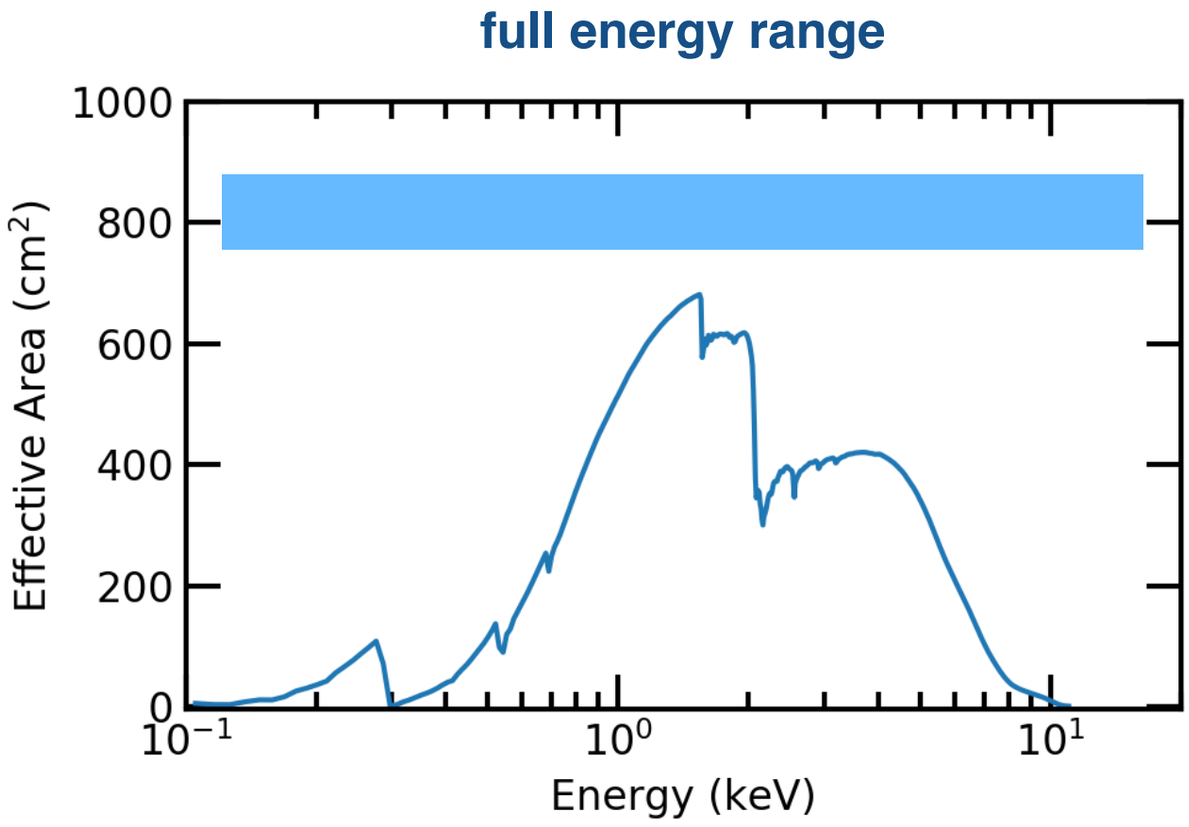


X-ray Imaging

[bin x=::8,y=::8]

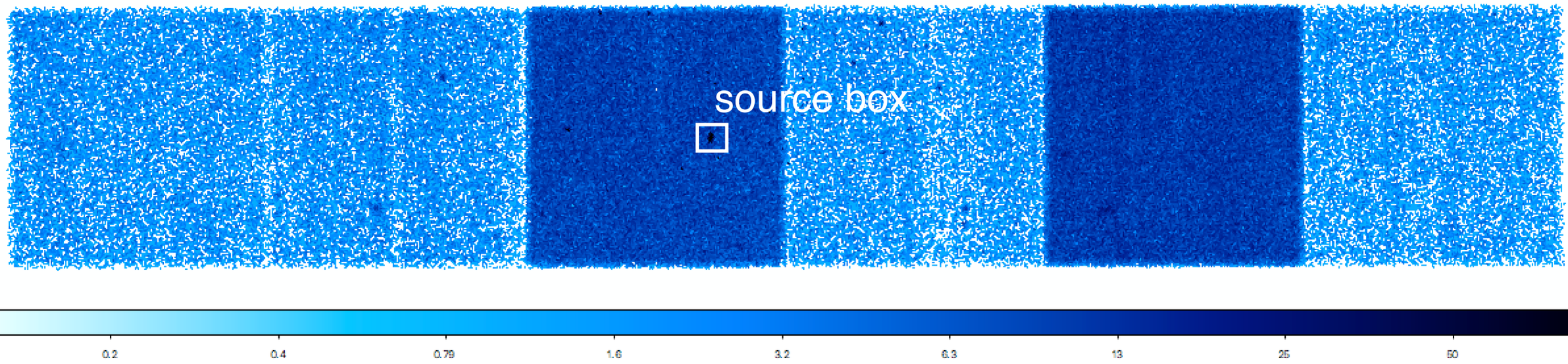


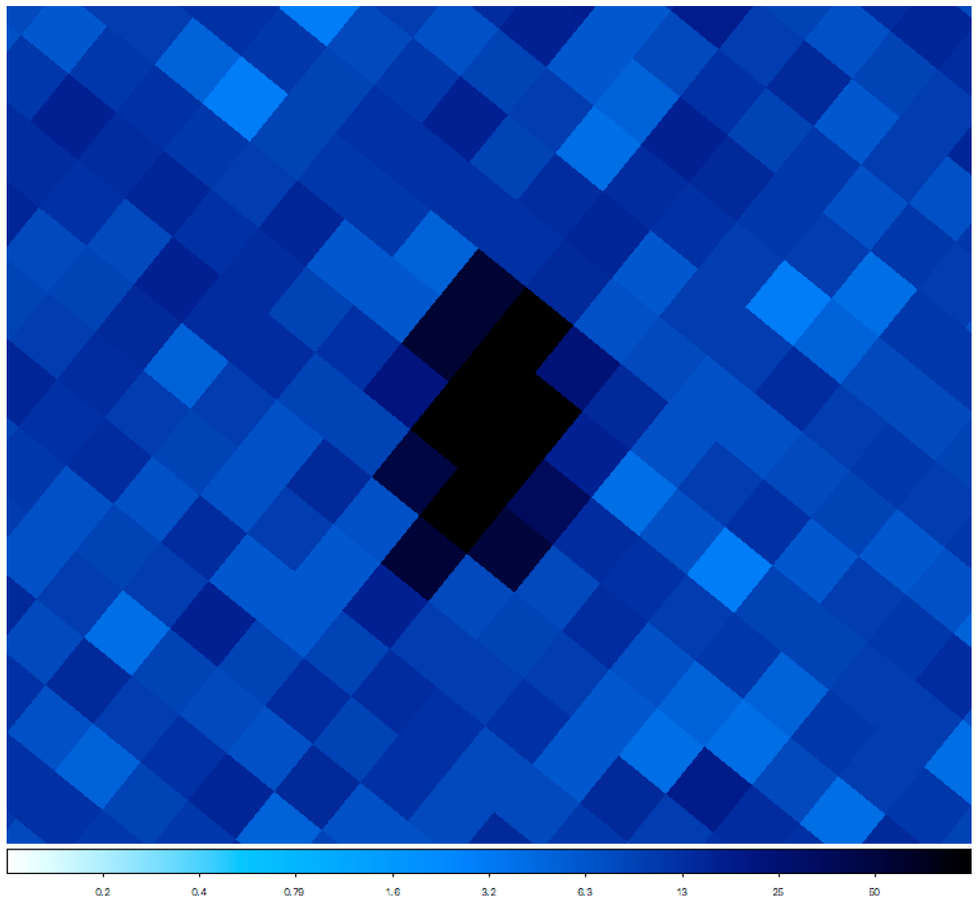


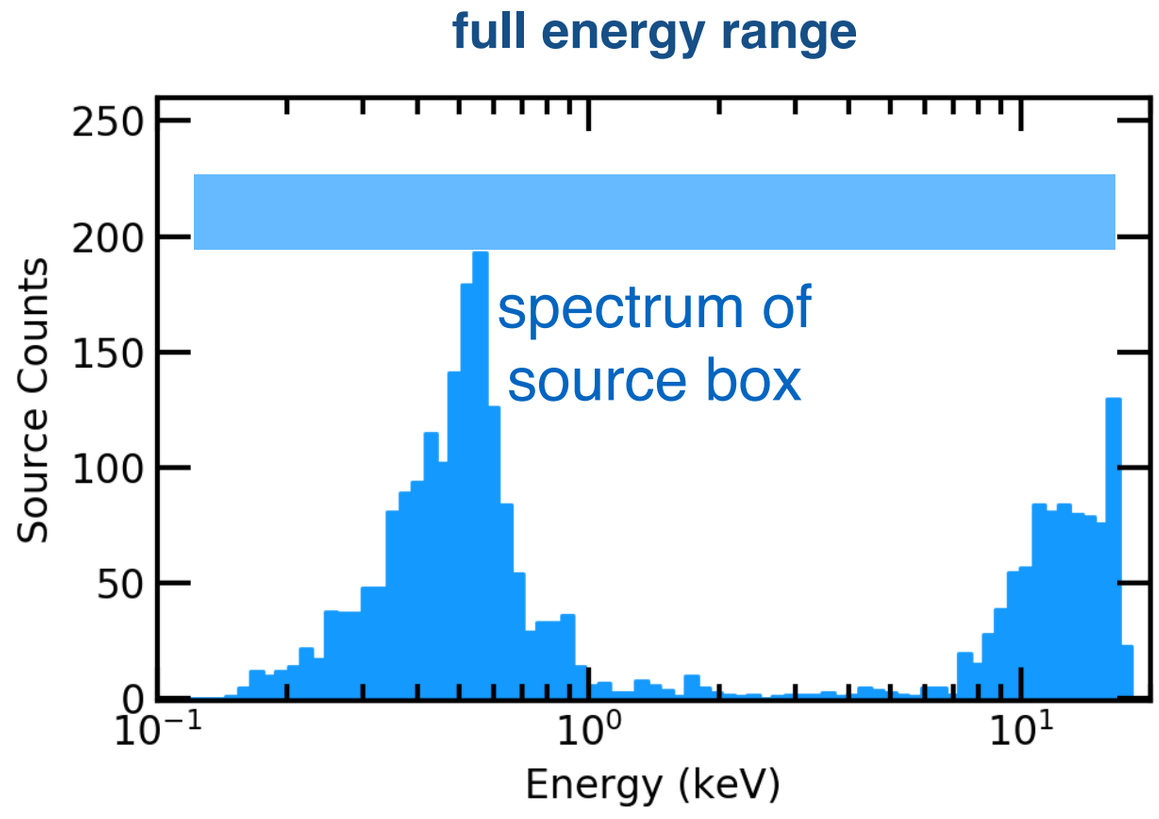


X-ray Imaging

[bin x=::8,y=::8]

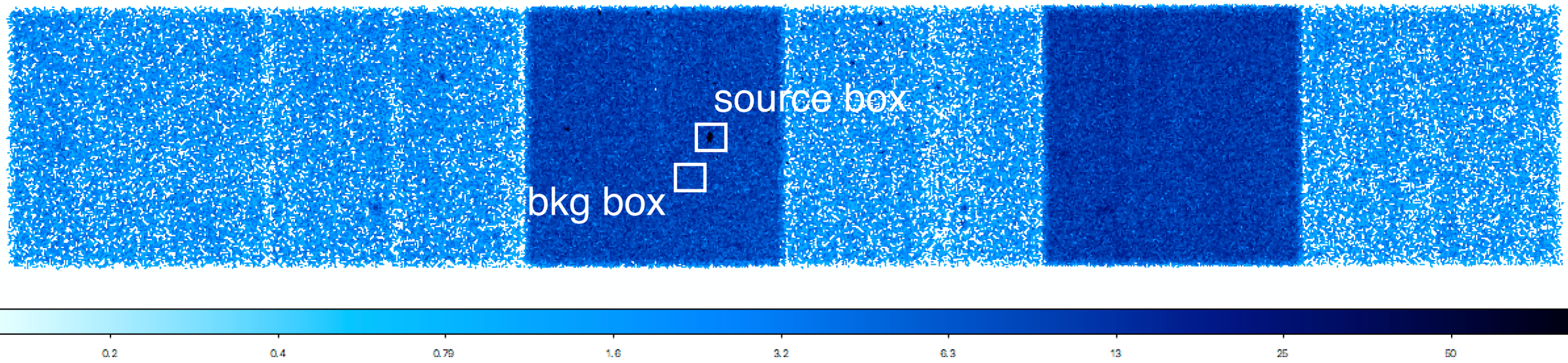


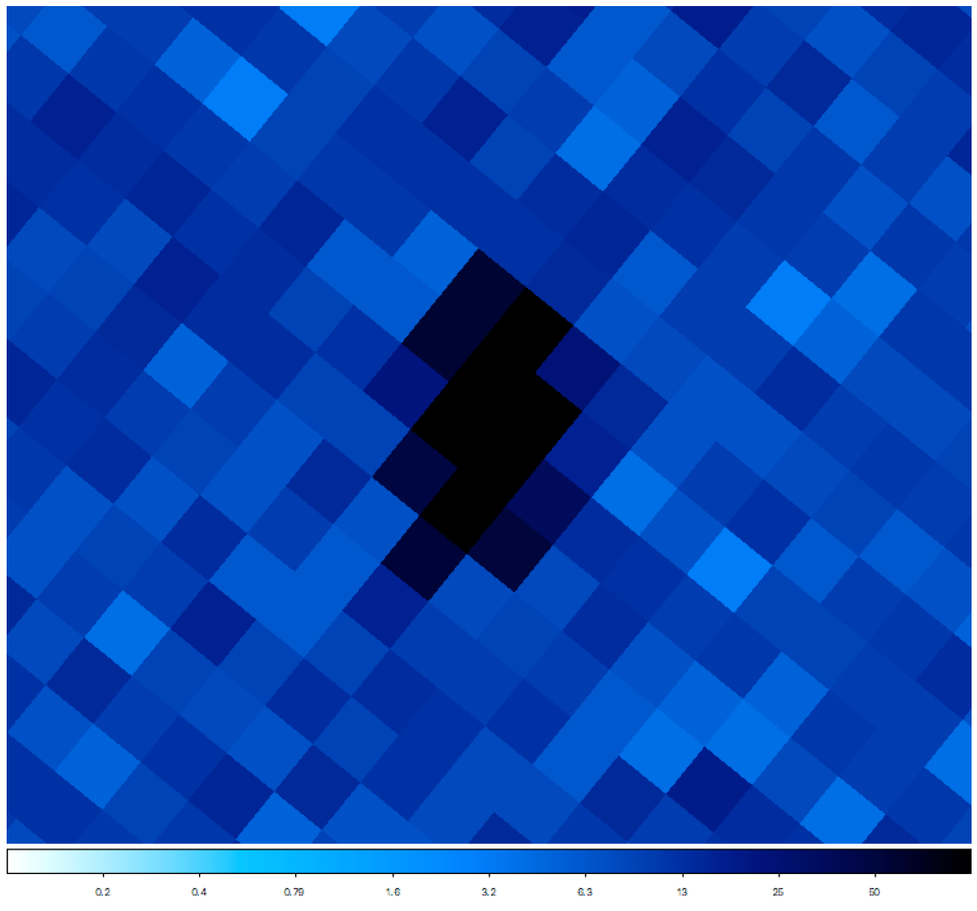


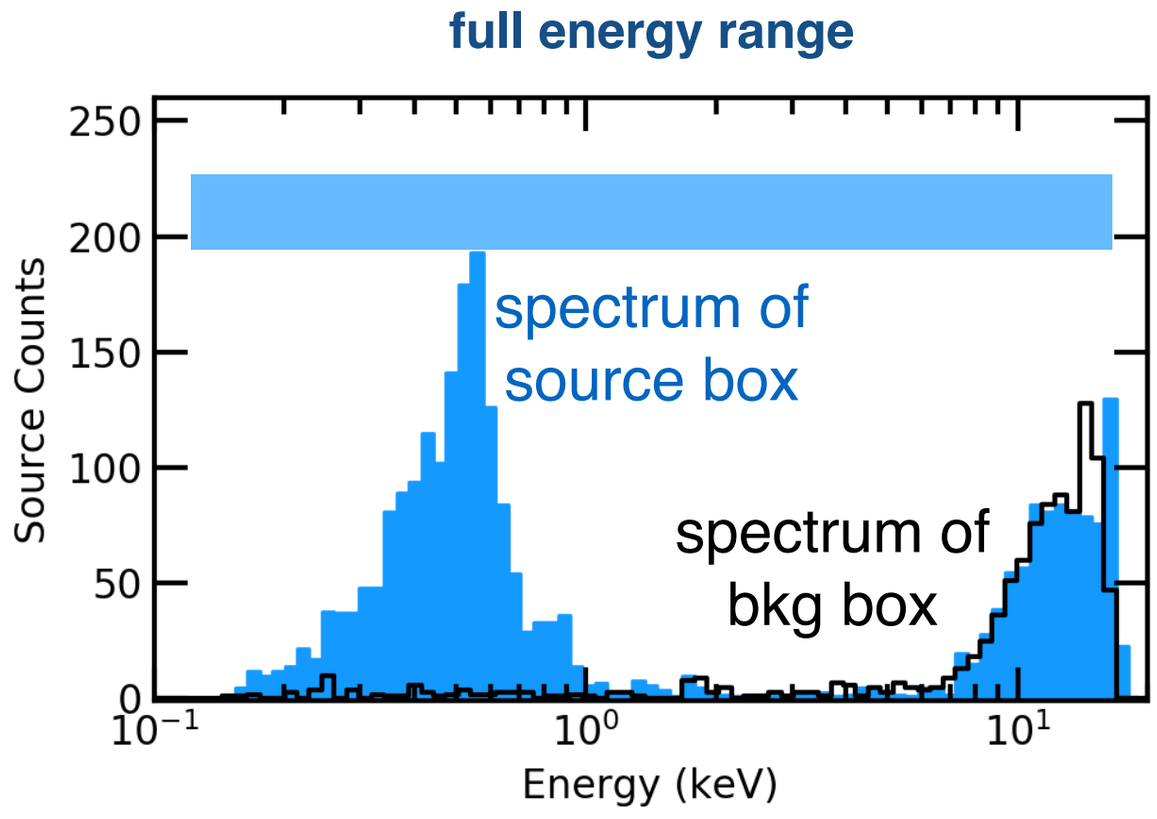


X-ray Imaging

[bin x=::8,y=::8]

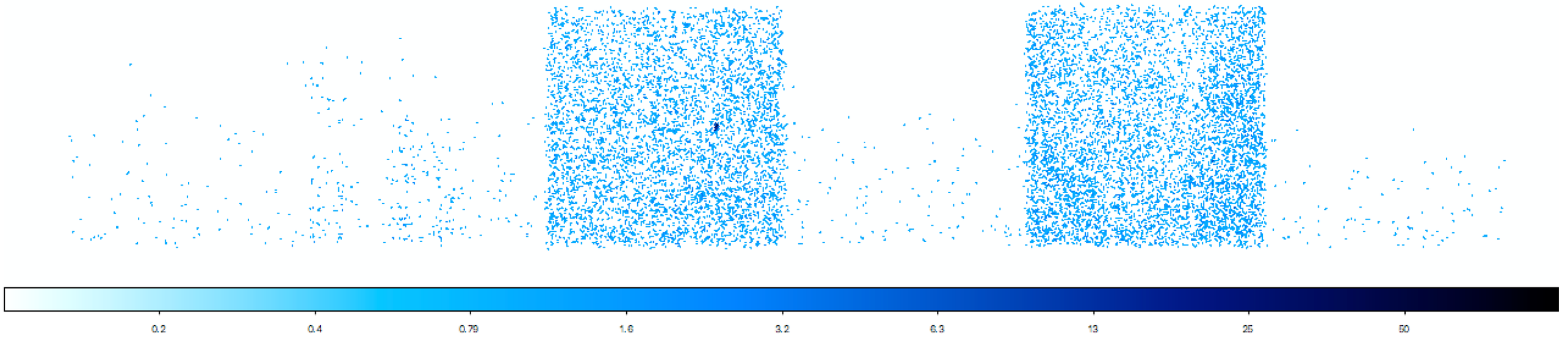


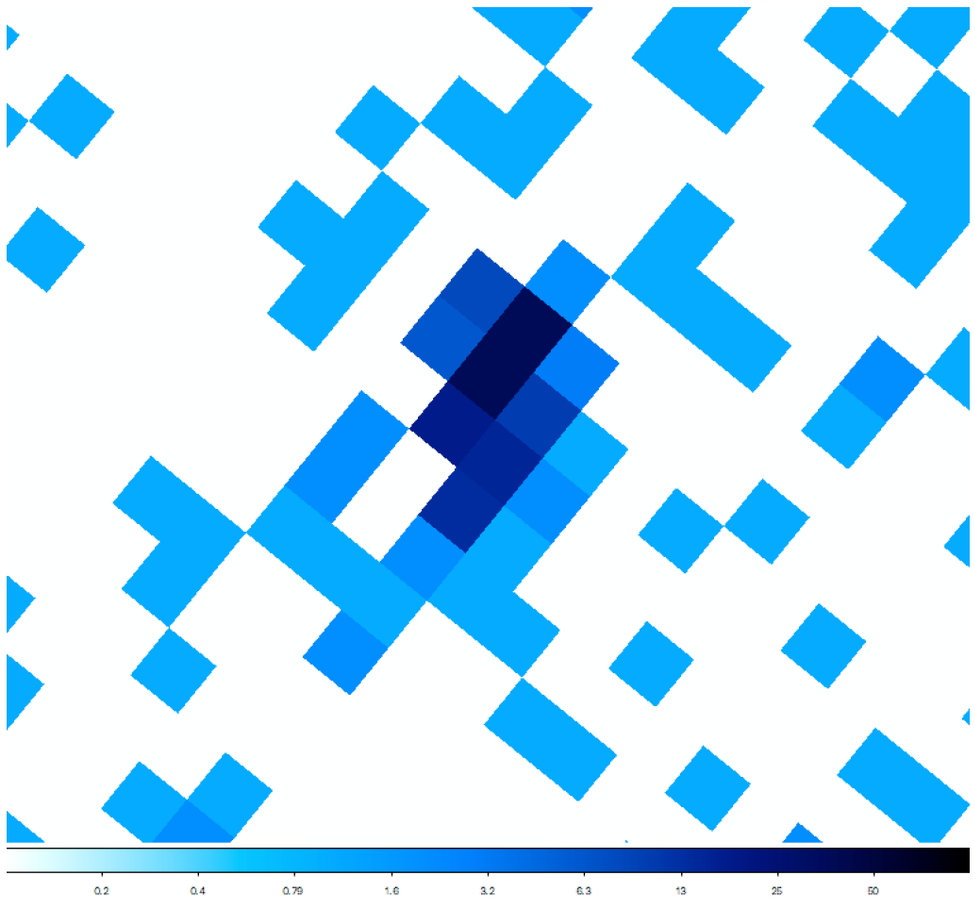




X-ray Imaging

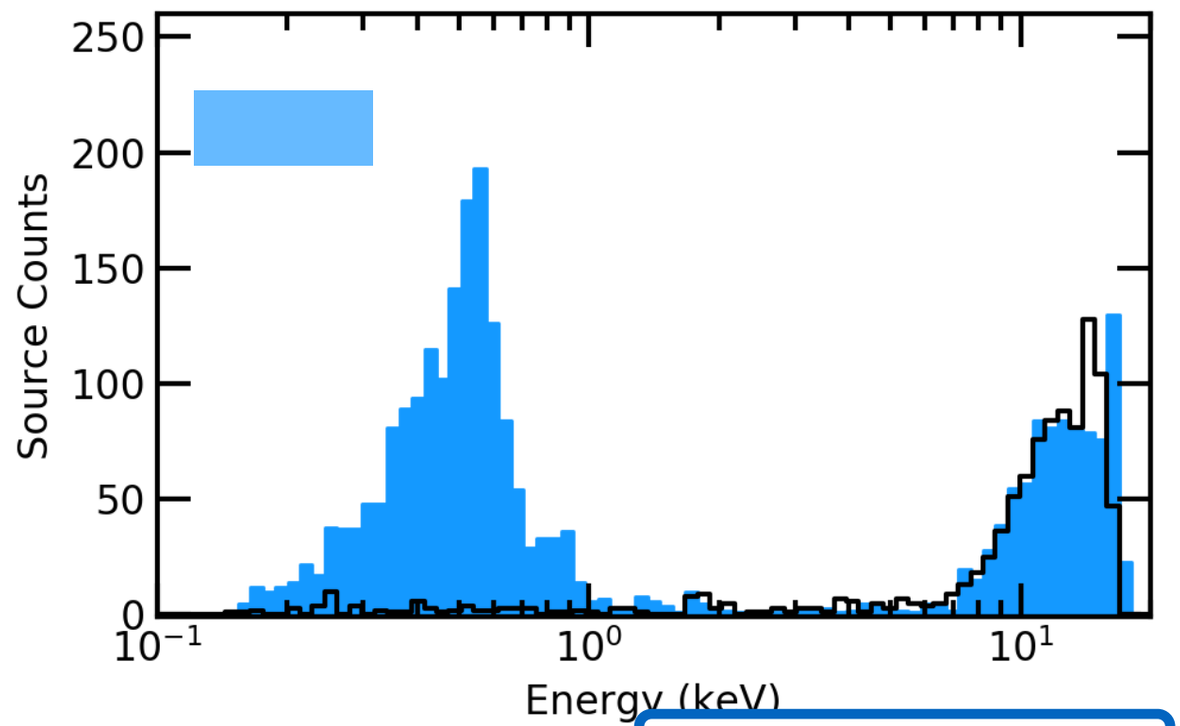
[bin x=::8,y=::8]





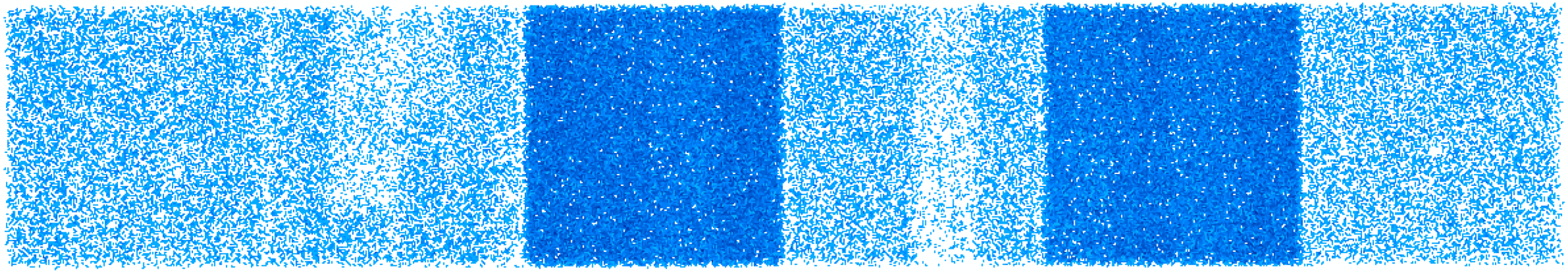
X-ray Imaging

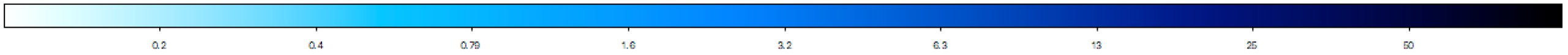
super soft E < 0.3 keV

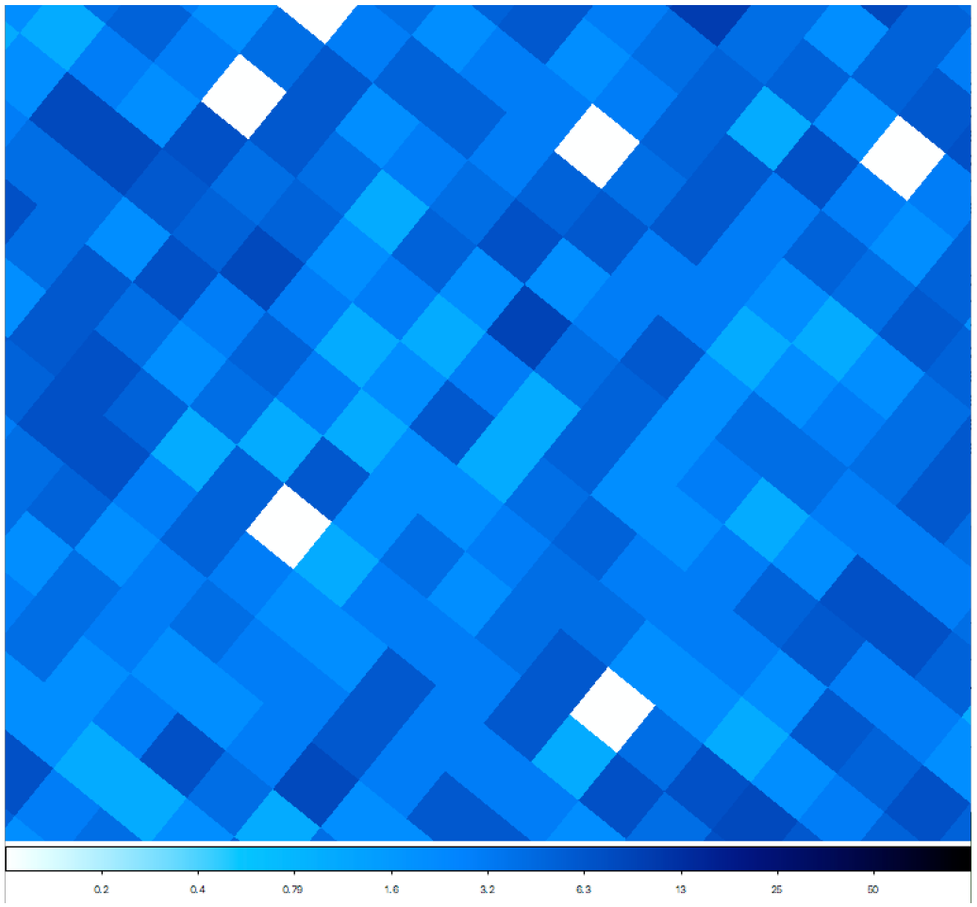


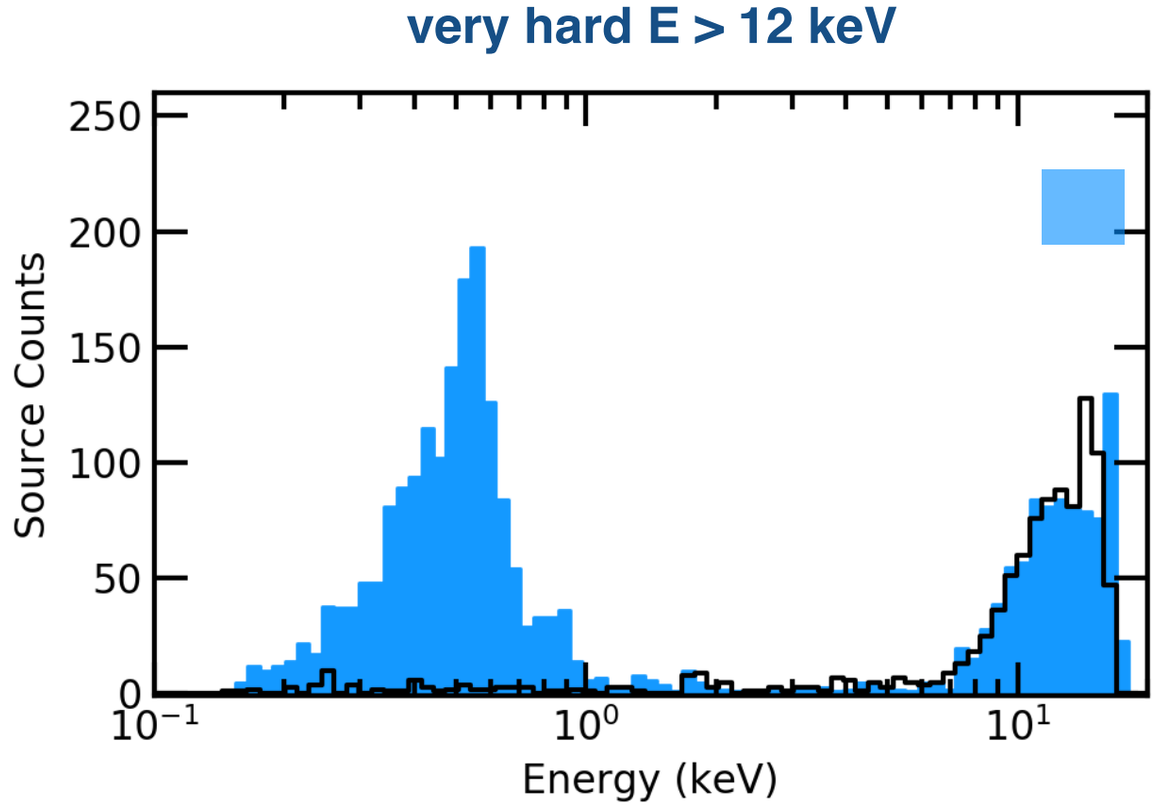
now filtering on the energy column

[bin x=::8,y=::8][energy=:300]



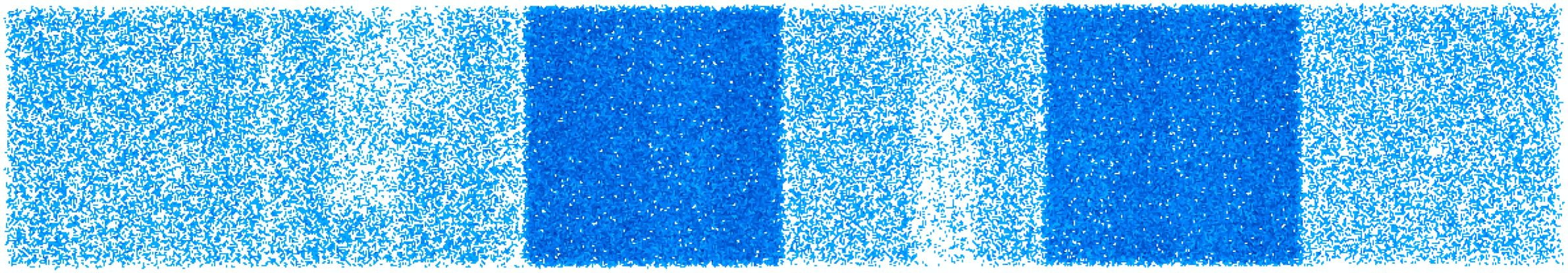


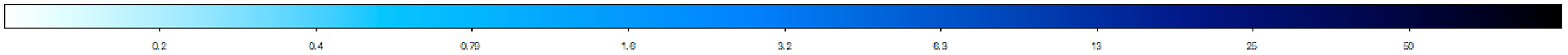


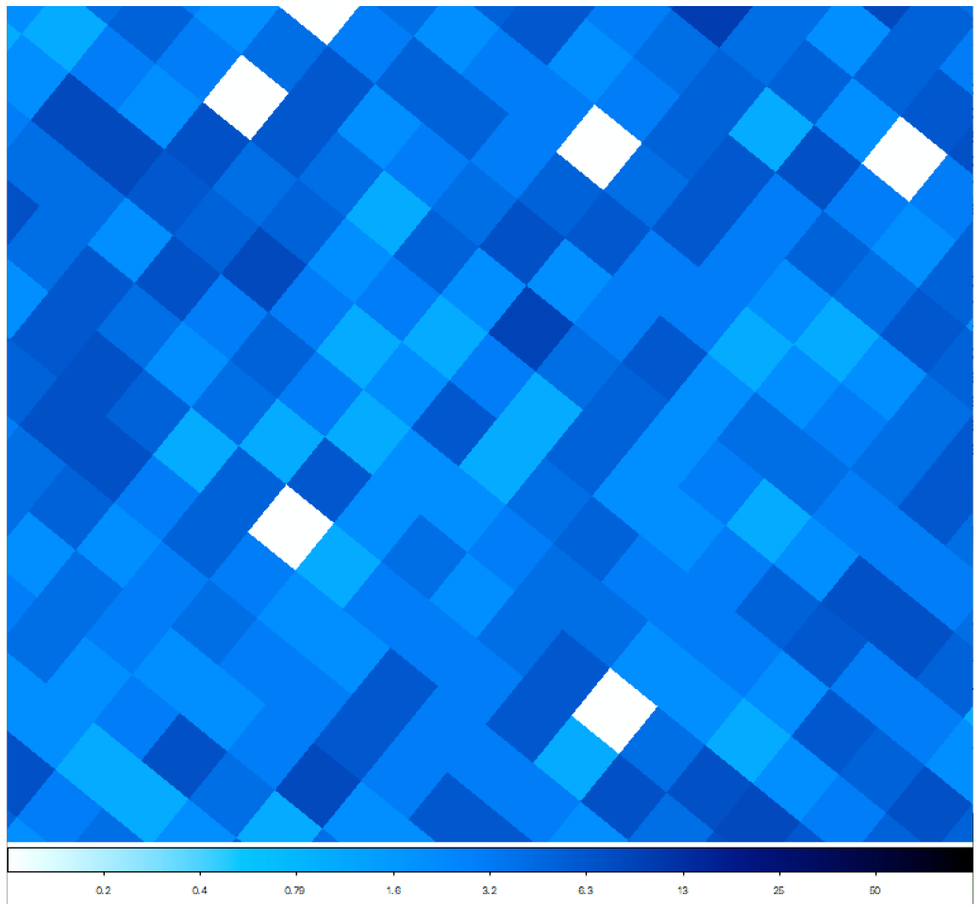


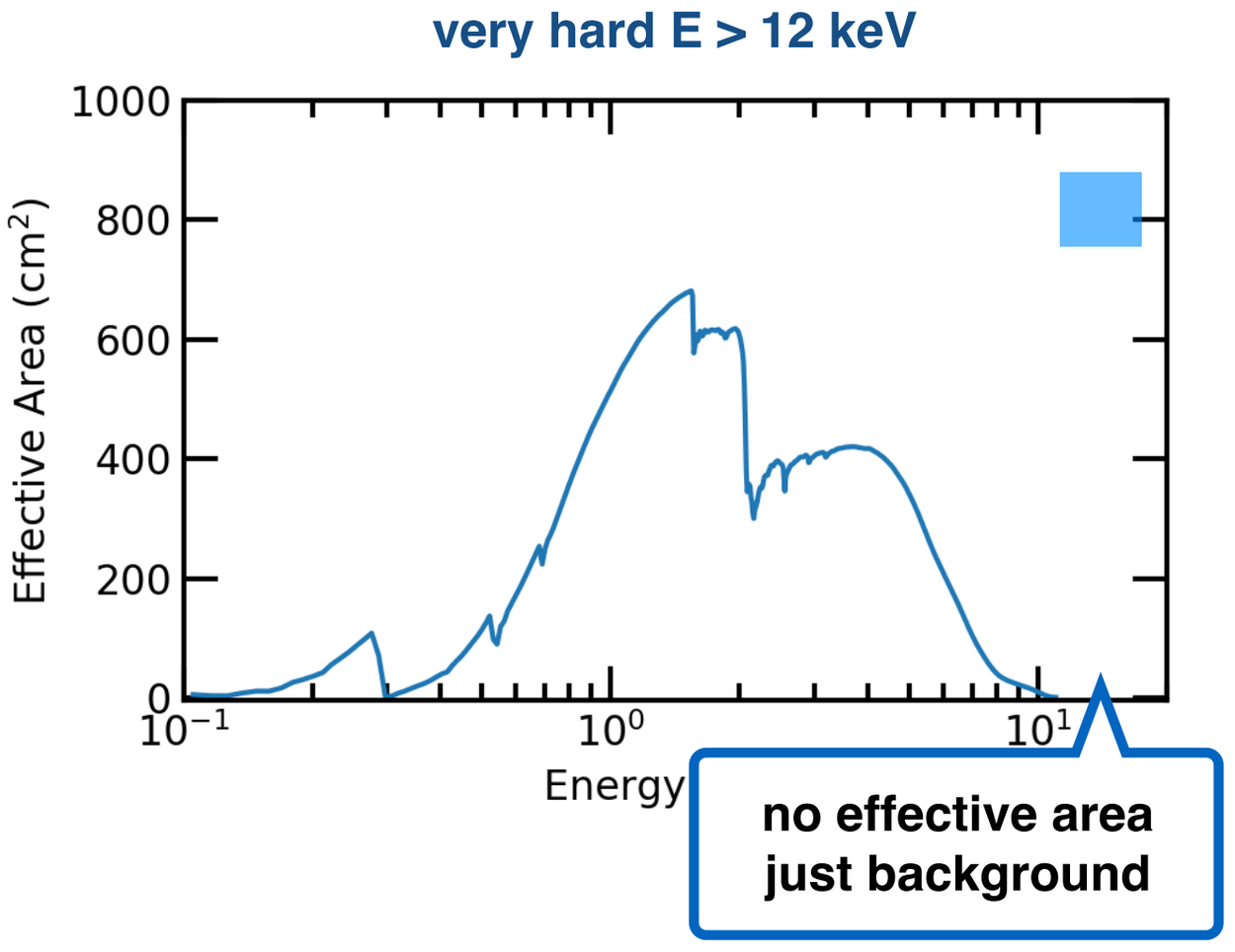
X-ray Imaging

[bin x=::8,y=::8][energy=12000:]



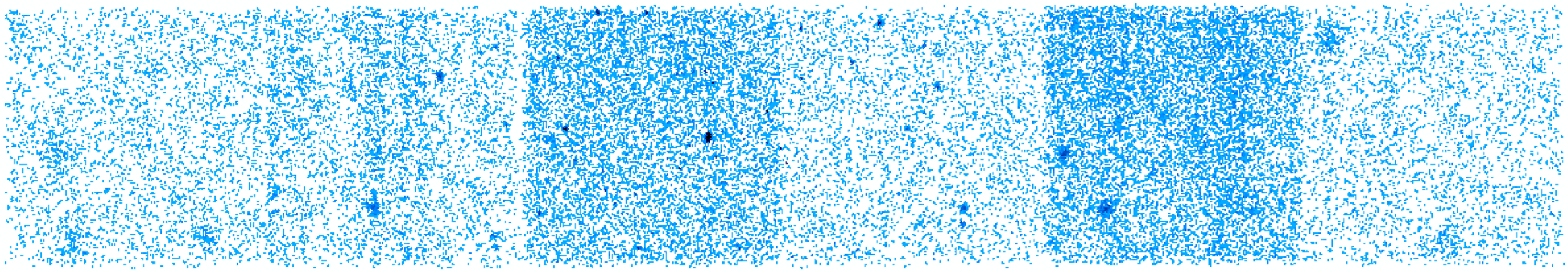


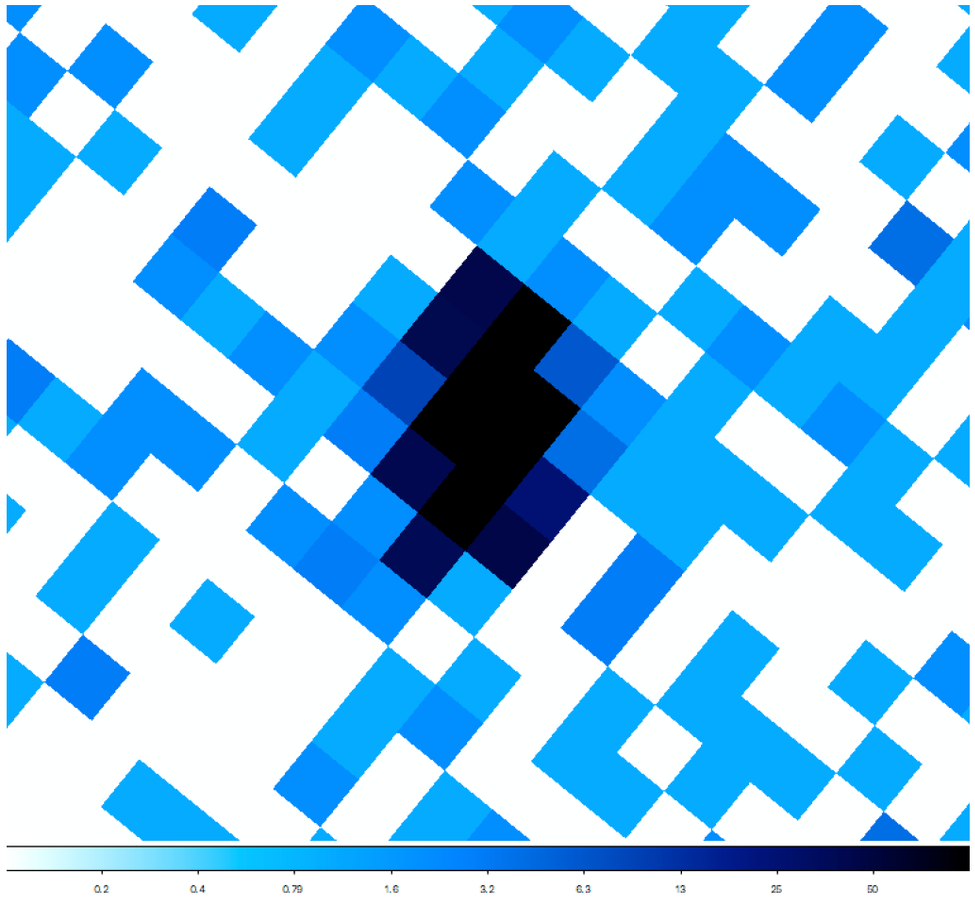




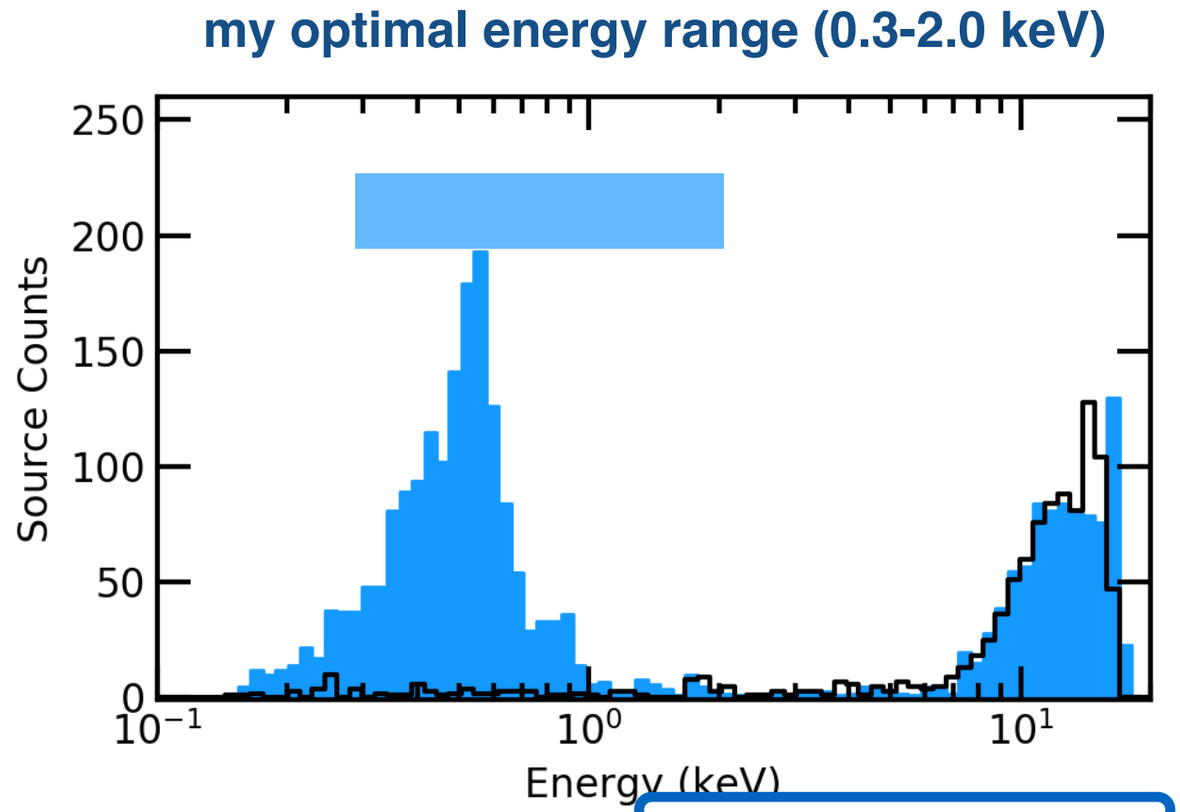
X-ray Imaging

[bin x=::8,y=::8][energy=12000:]

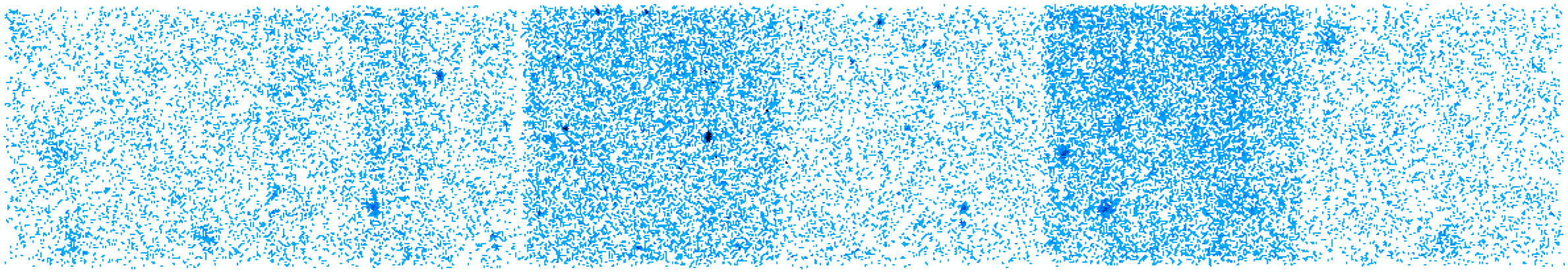


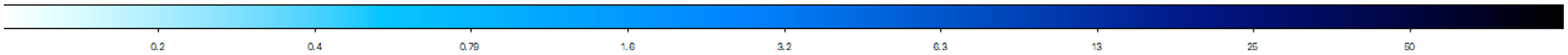


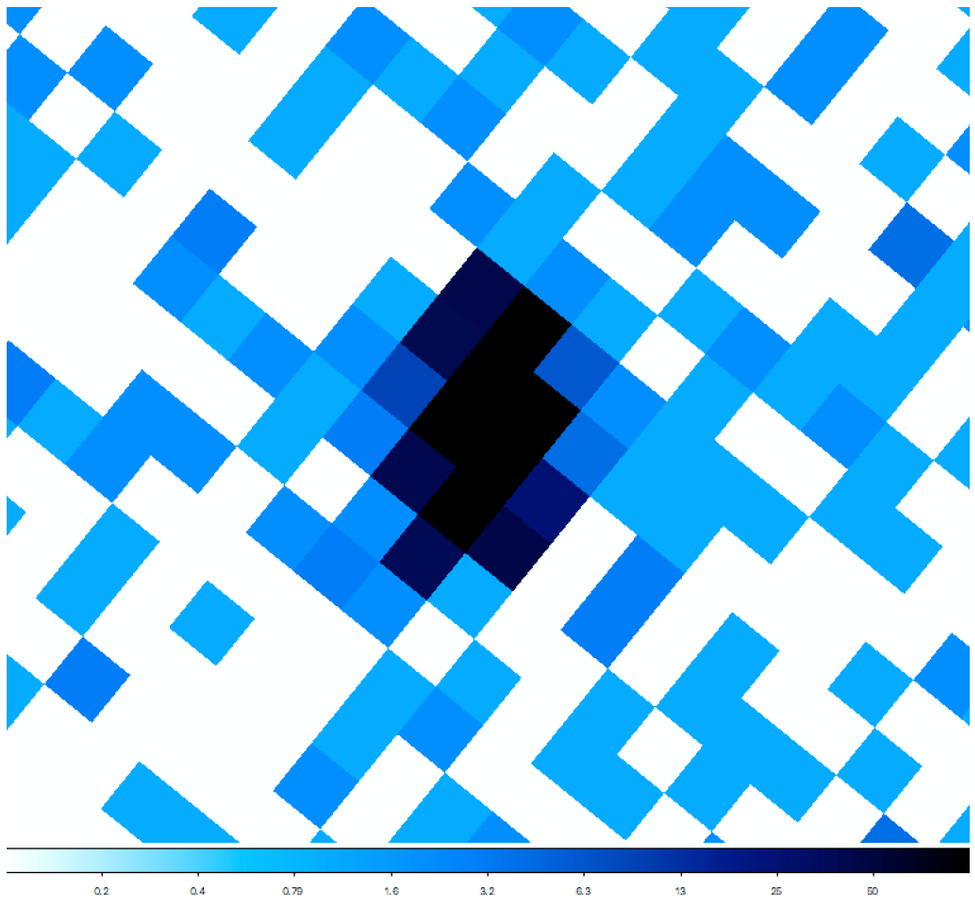
X-ray Imaging

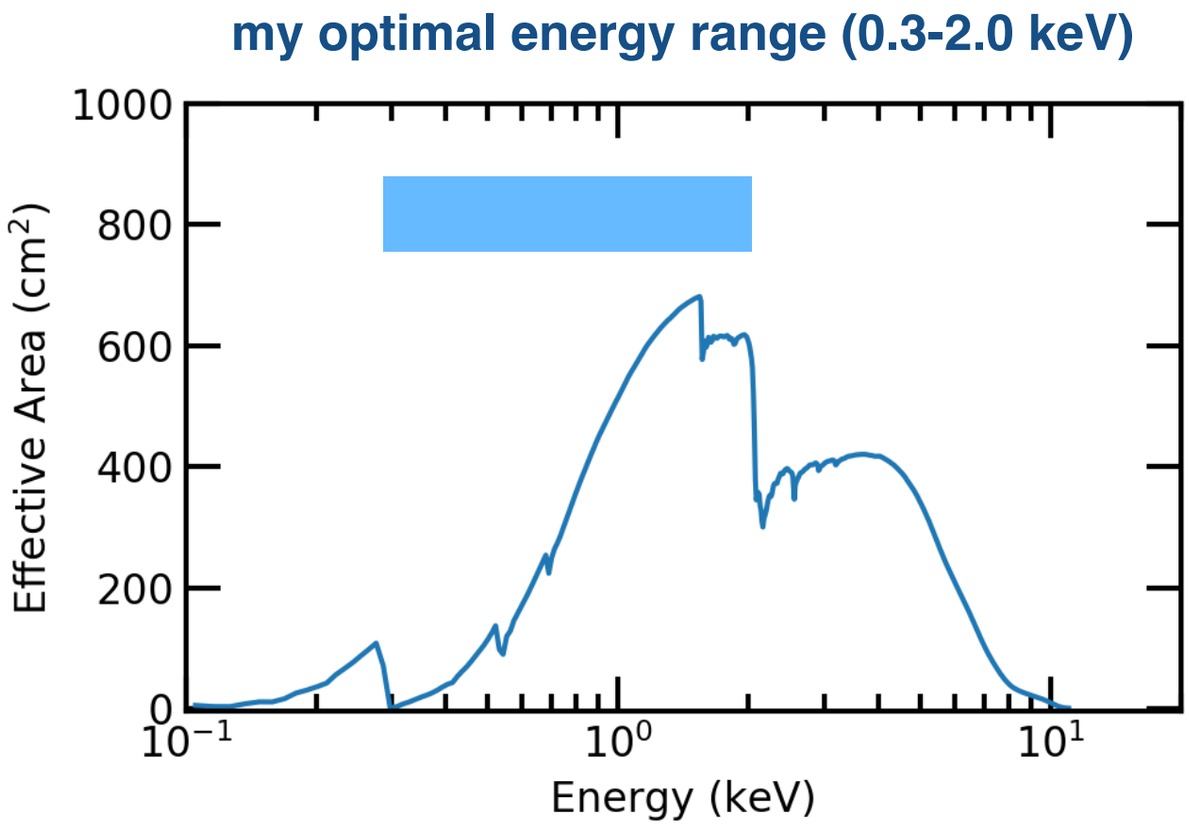


[bin x=::8,y=::8][energy=300:2000]









X-ray Imaging

[bin x=::8,y=::8][energy=300:2000]

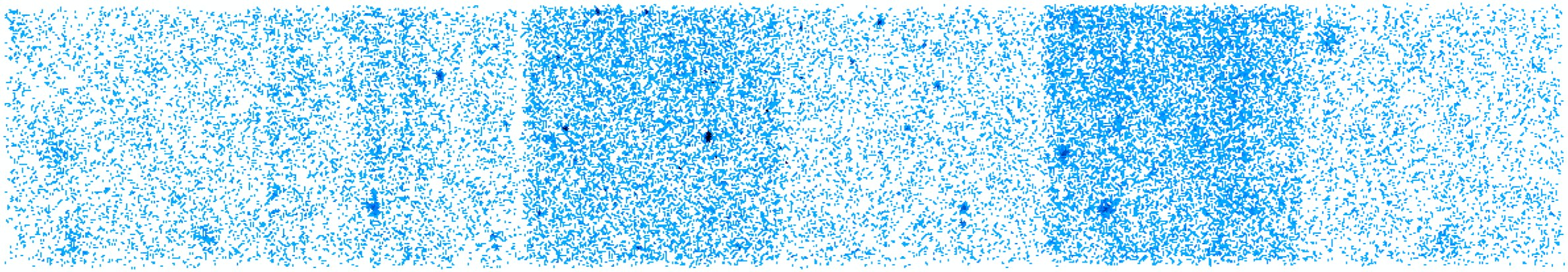
edge sources require caution when studying

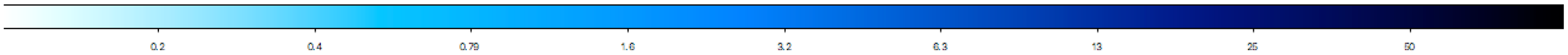
targeted source is extended

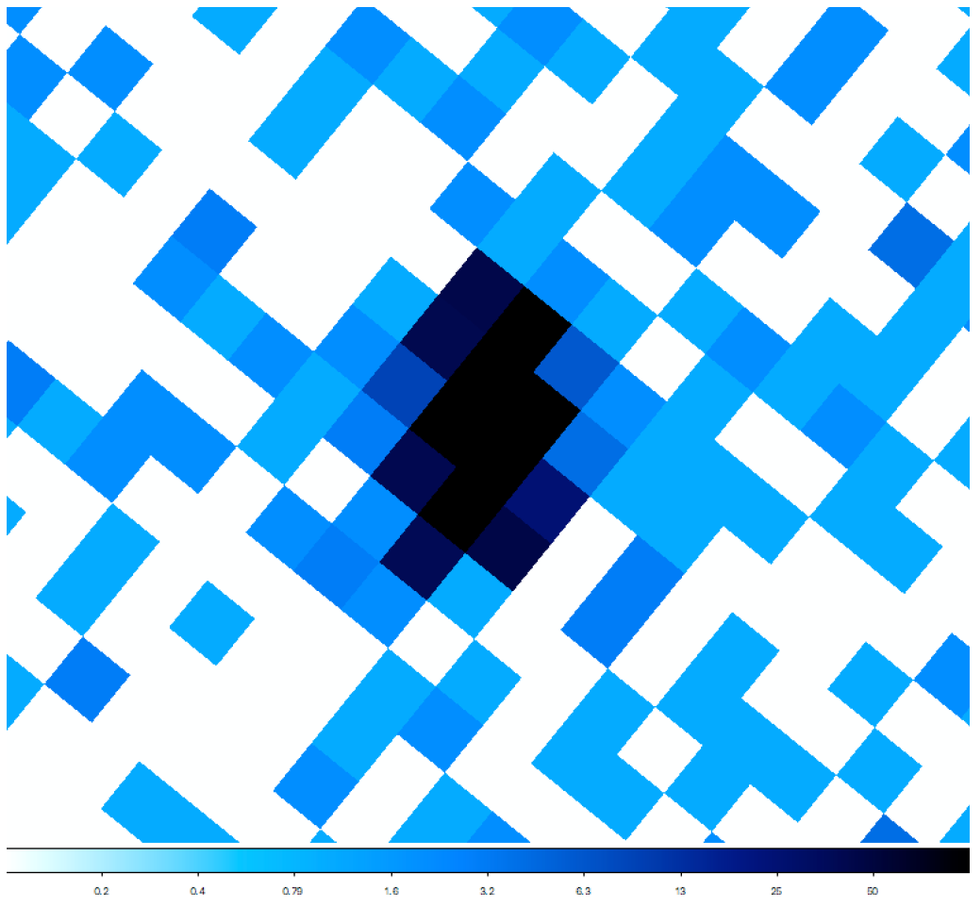
distant point sources appear extended due to off-axis PSF

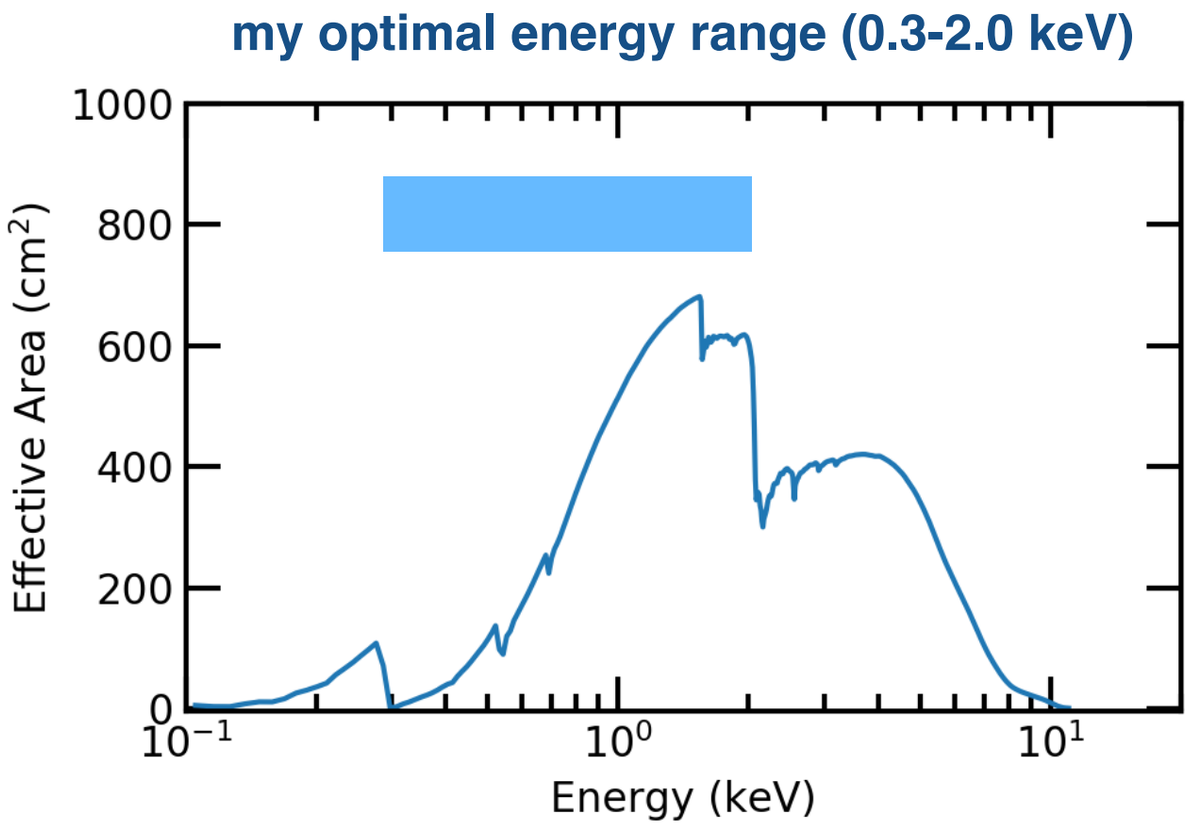
X-ray Imaging

[bin x=::8,y=::8][energy=300:2000]



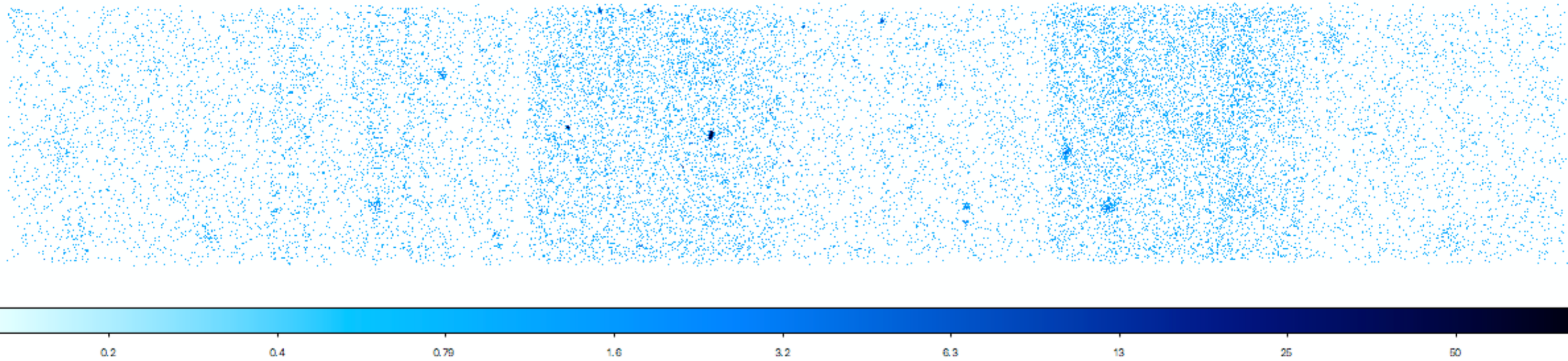


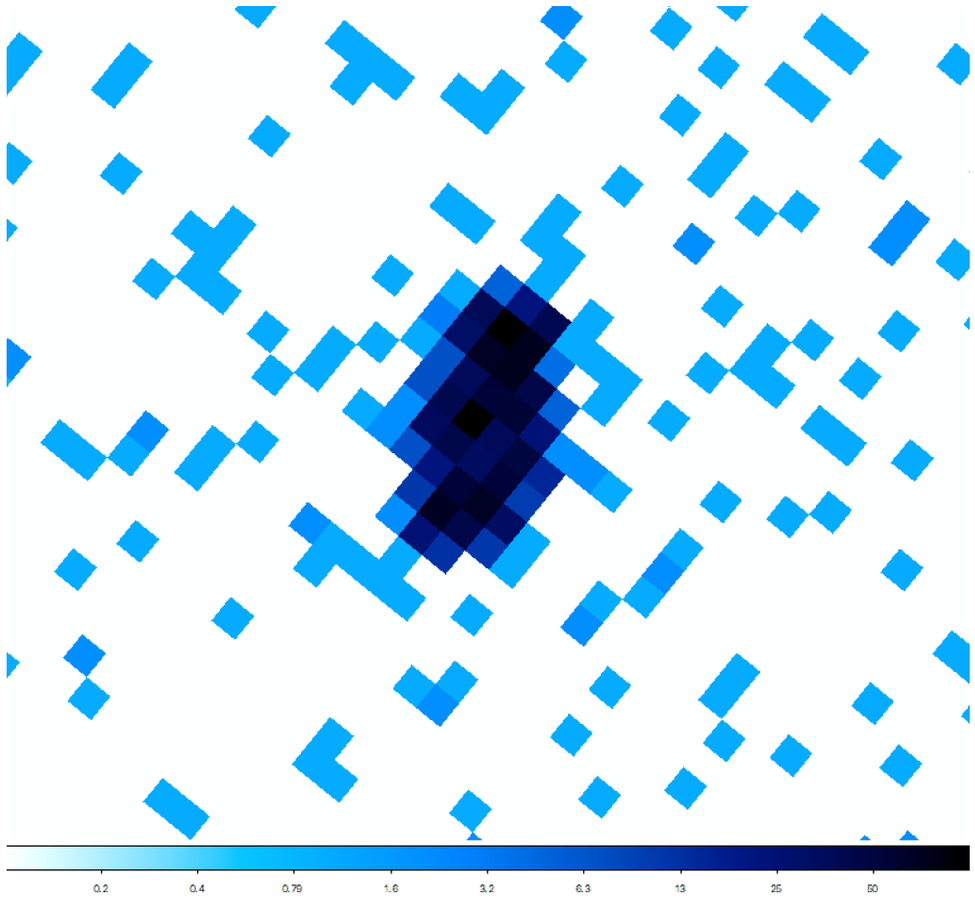




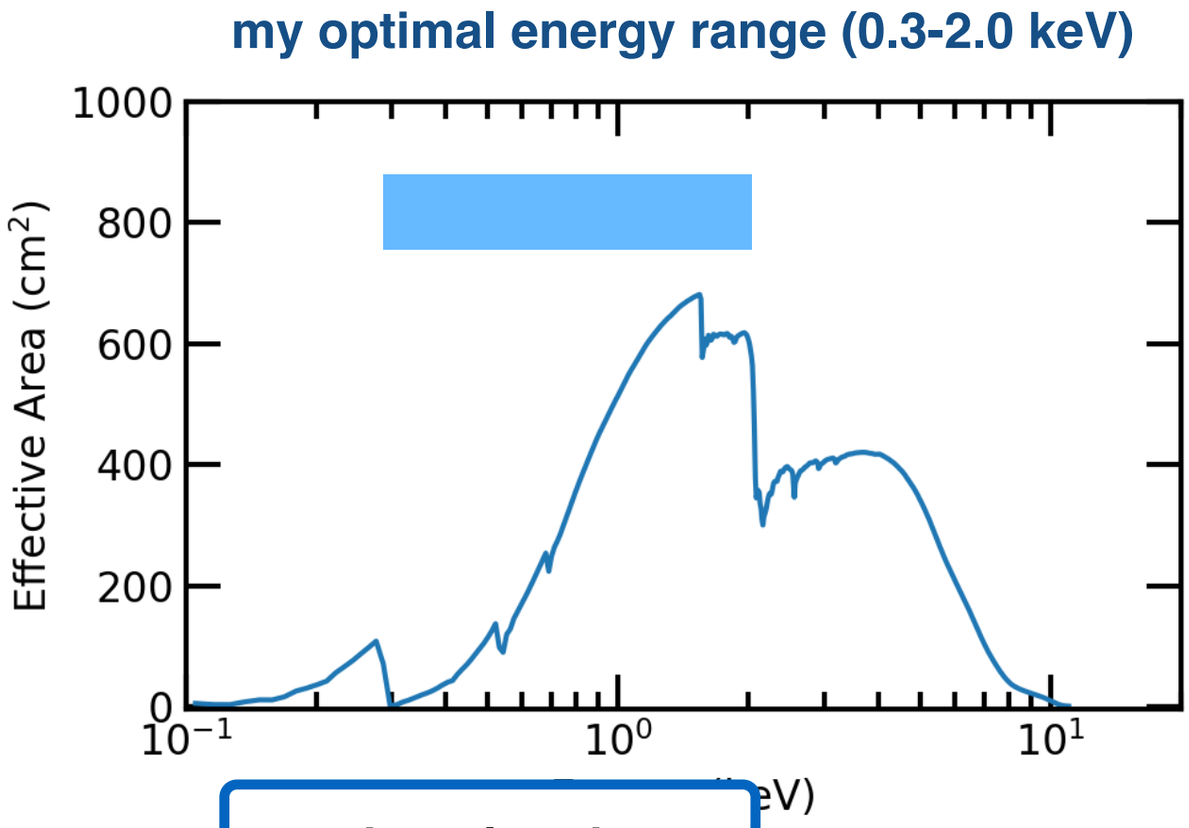
X-ray Imaging

[bin x=::8,y=::8][energy=300:2000]





X-ray Imaging



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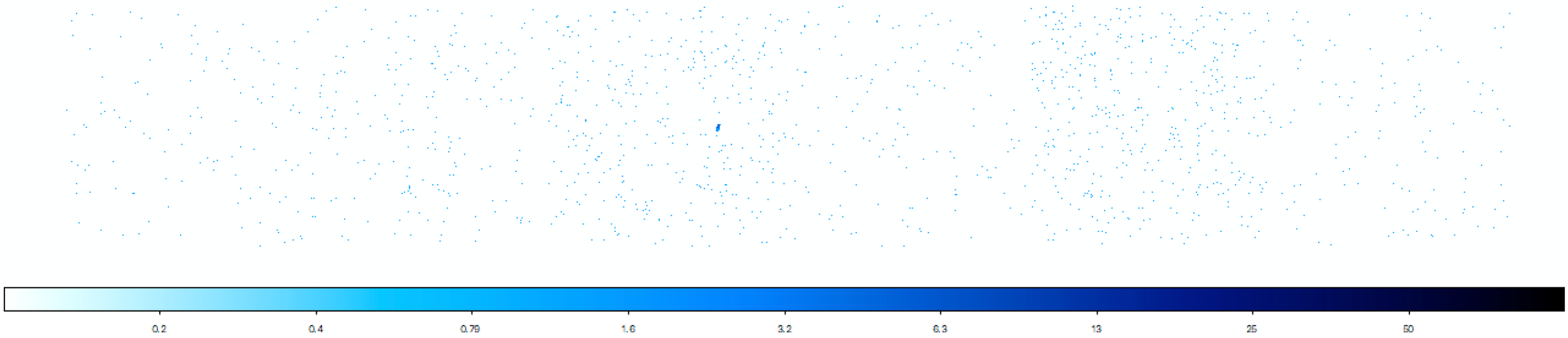
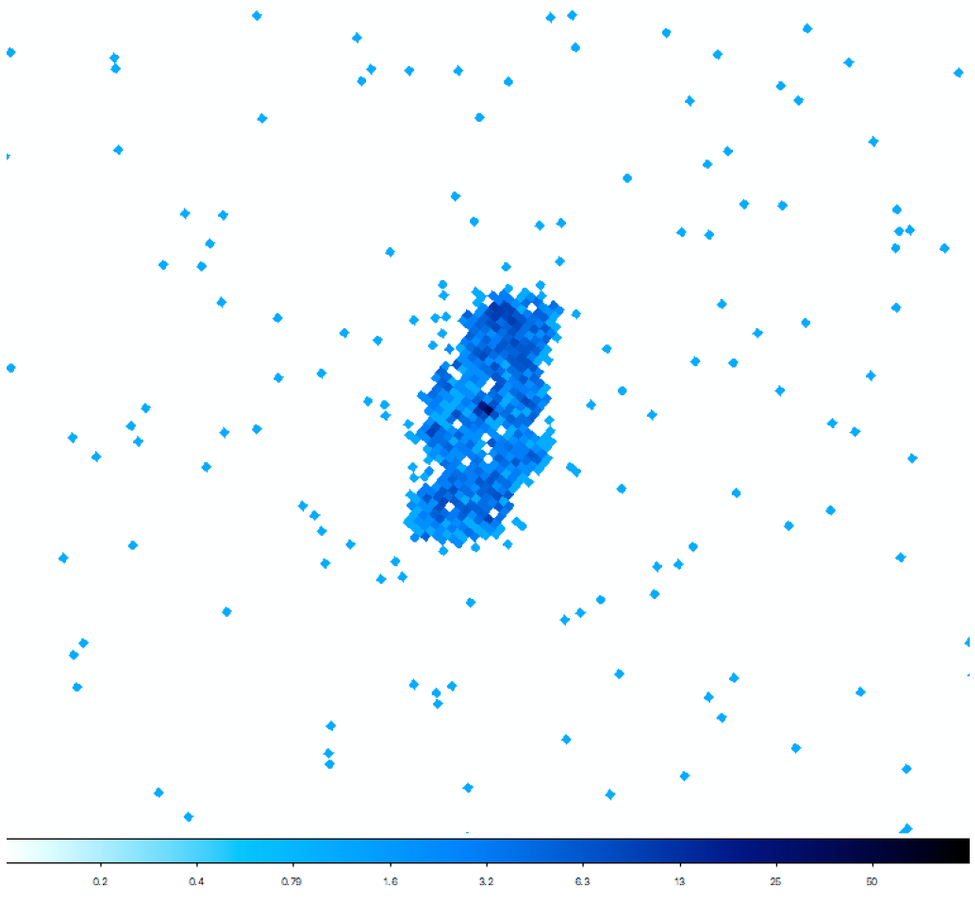
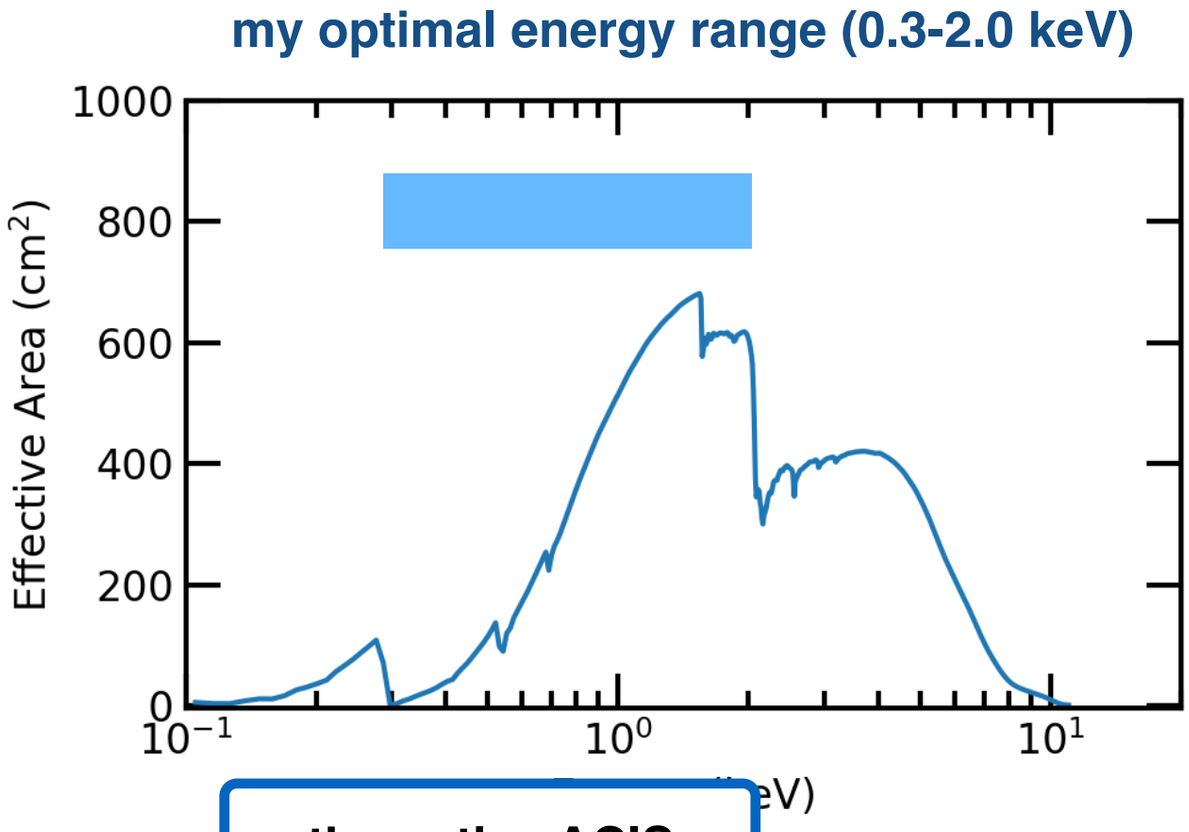
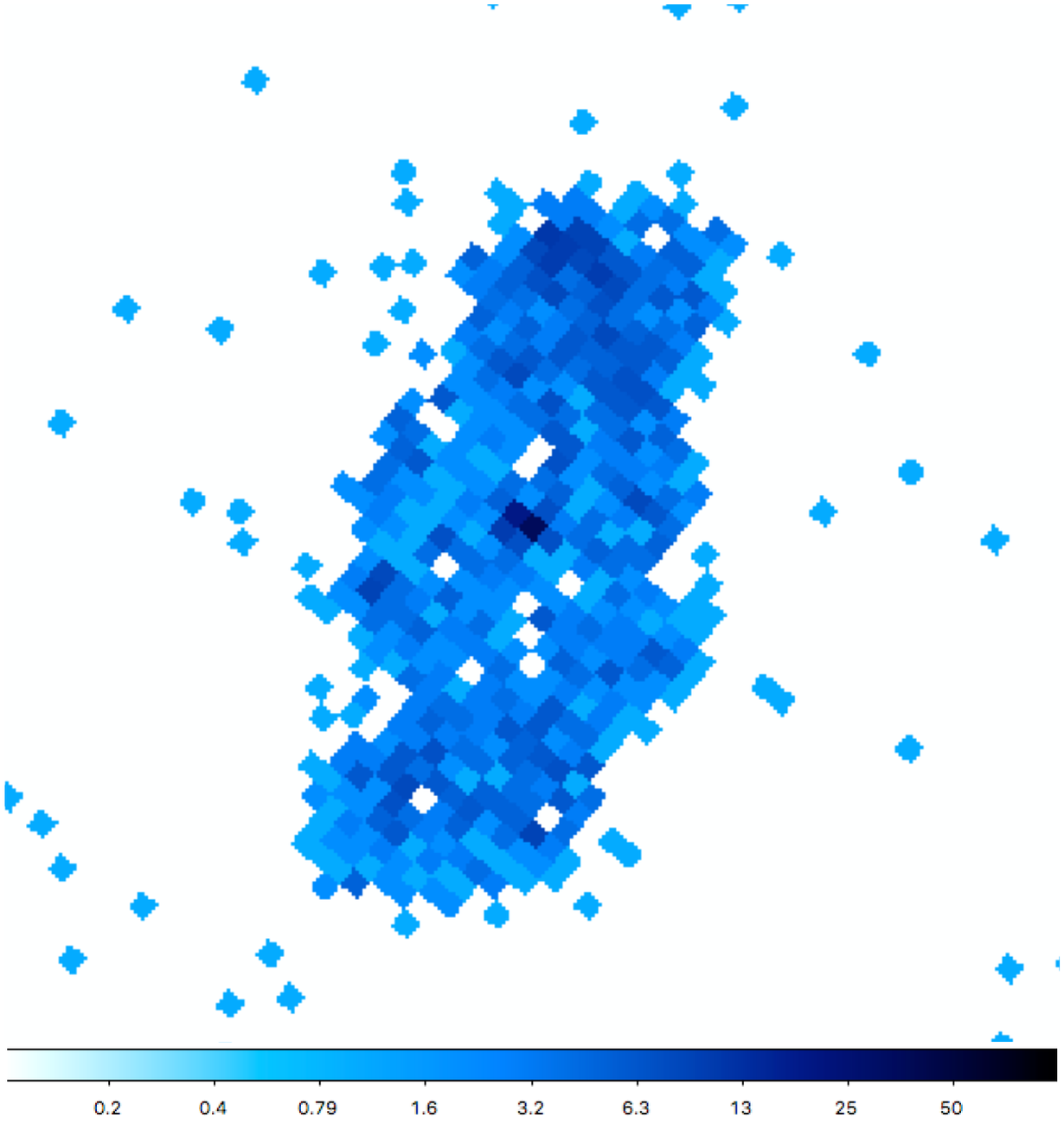


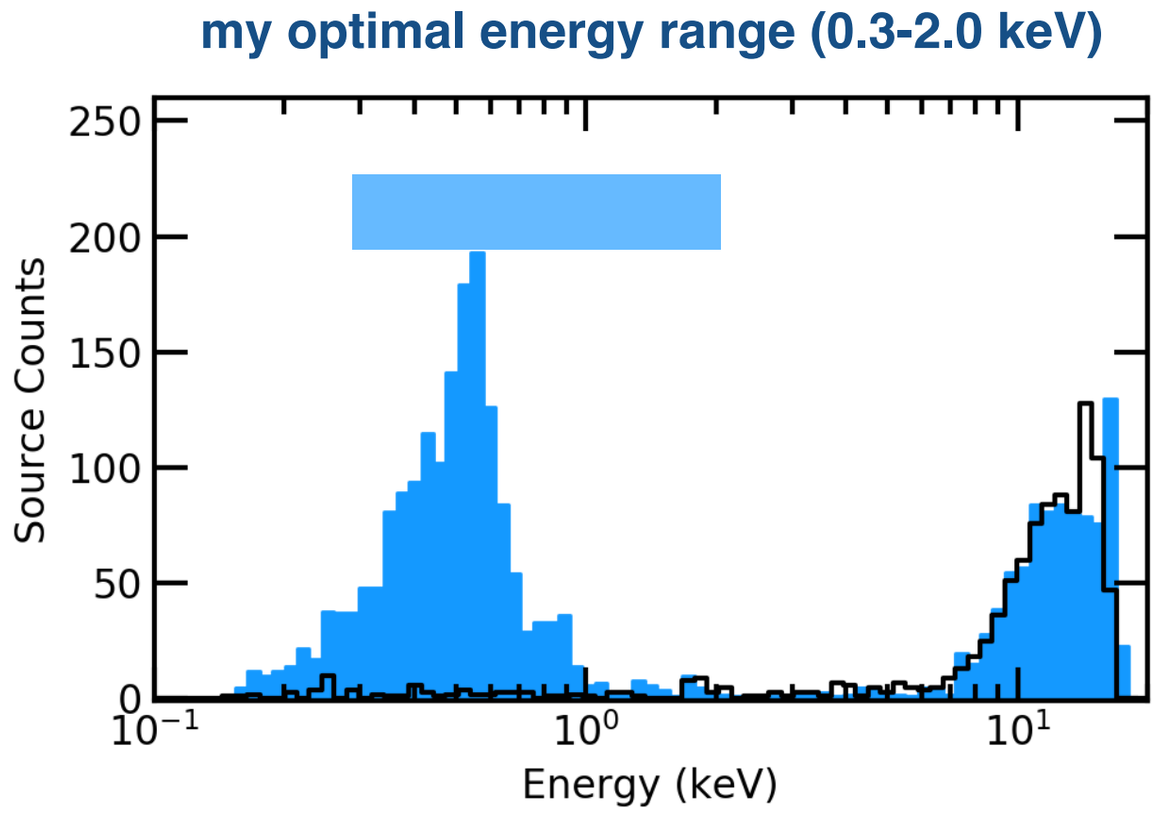


X-ray Imaging



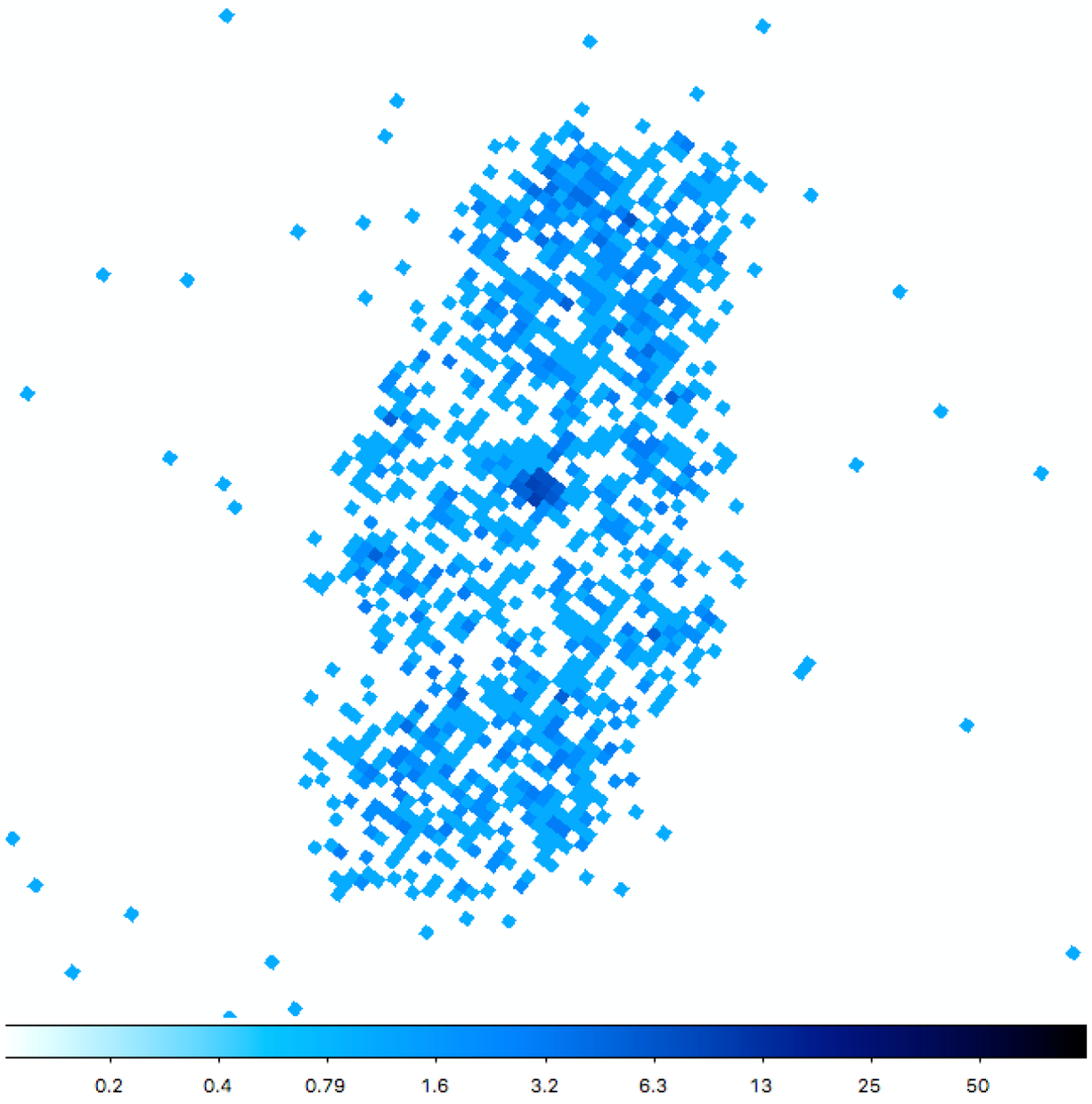
[bin x=::1,y=::1][energy=300:2000]

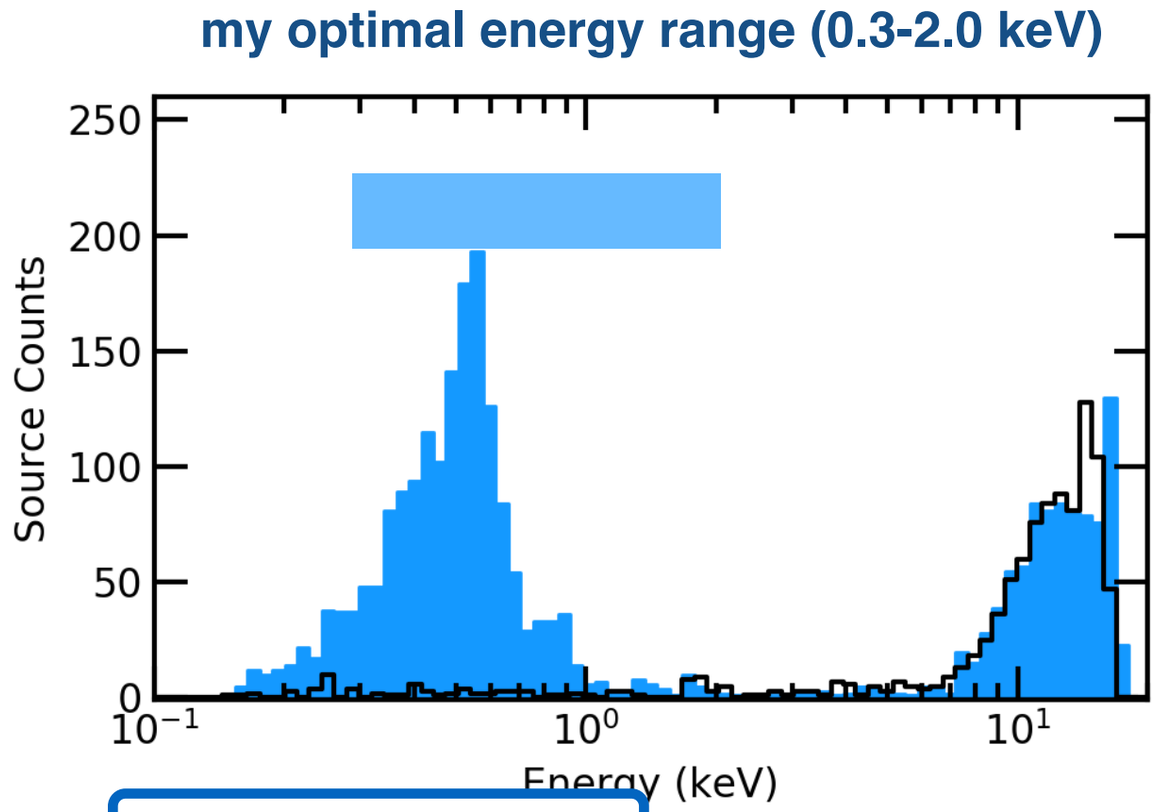




X-ray Imaging

[bin x=::1,y=::1][energy=300:2000]

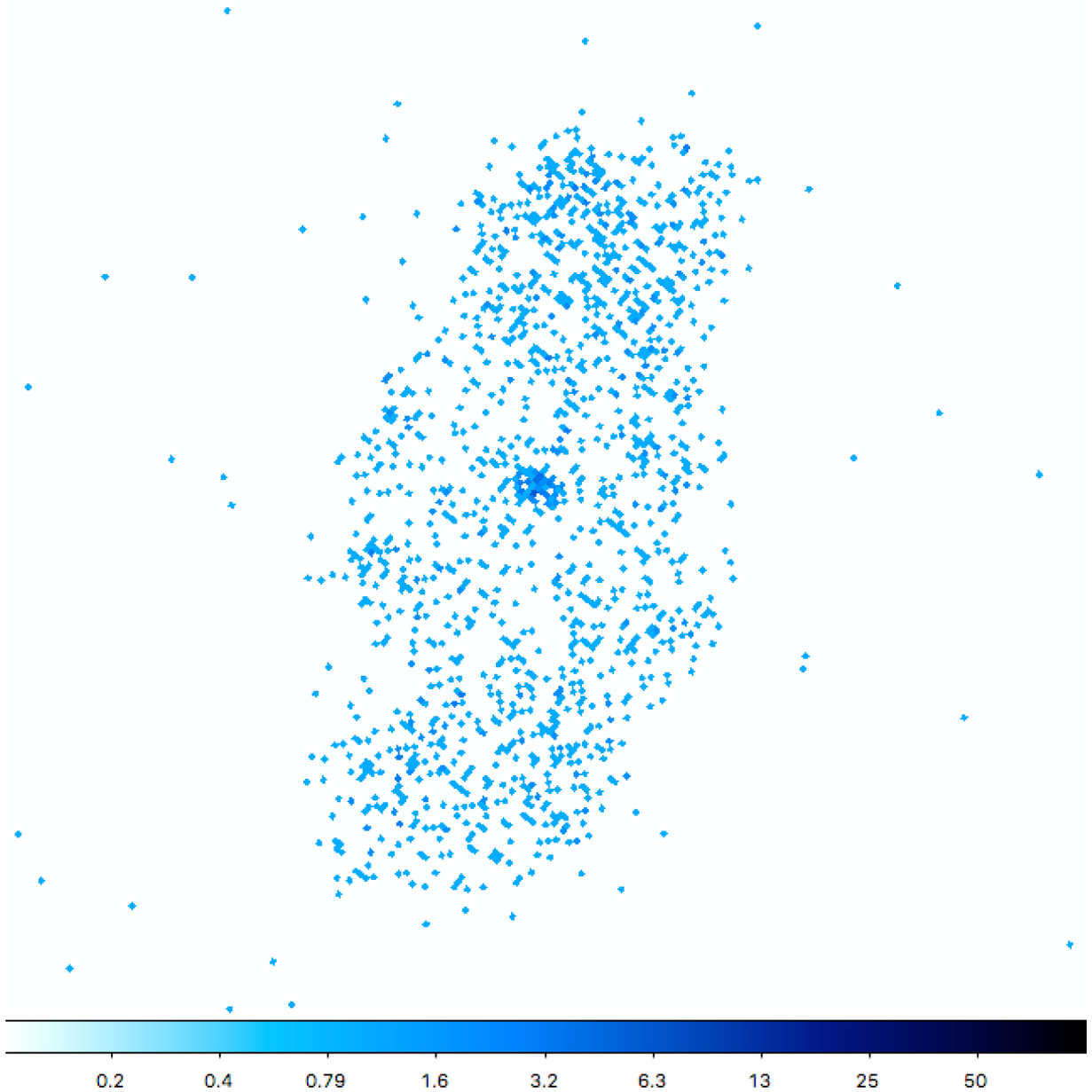


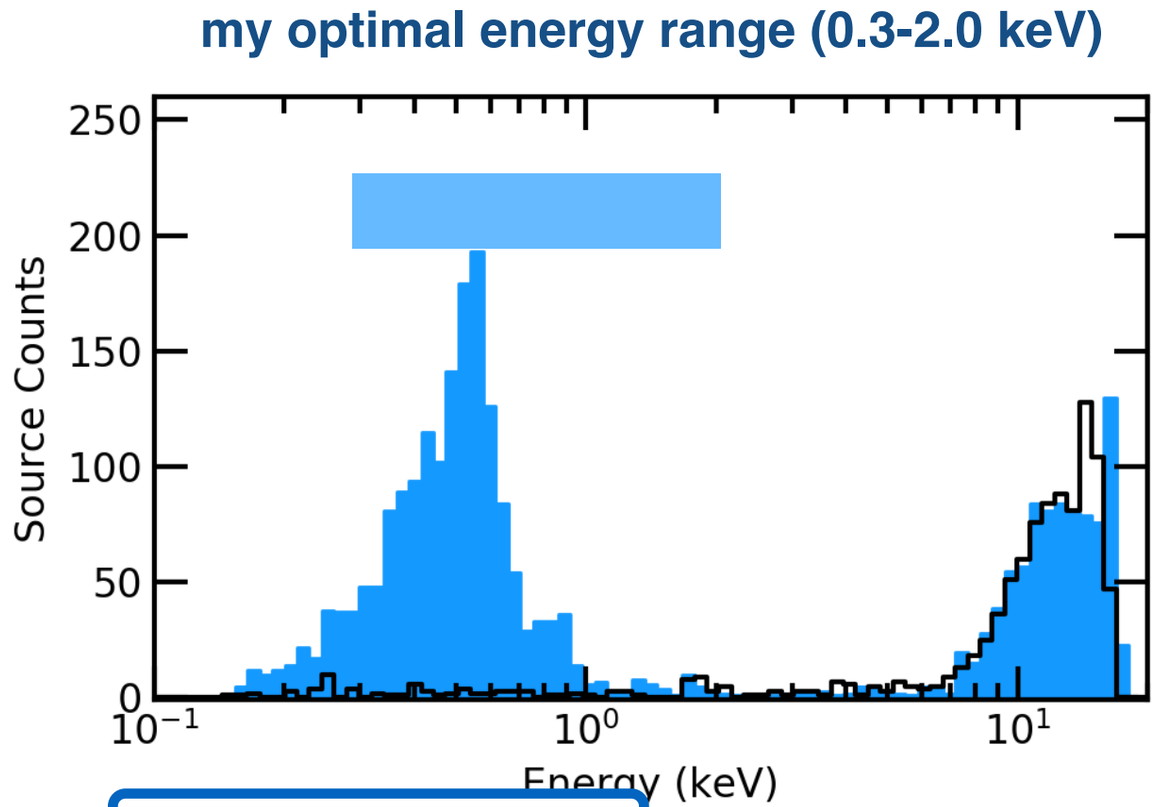


binning to sub pixels (use caution)

X-ray Imaging

[bin x=::0.5,y=::0.5][energy=300:2000]

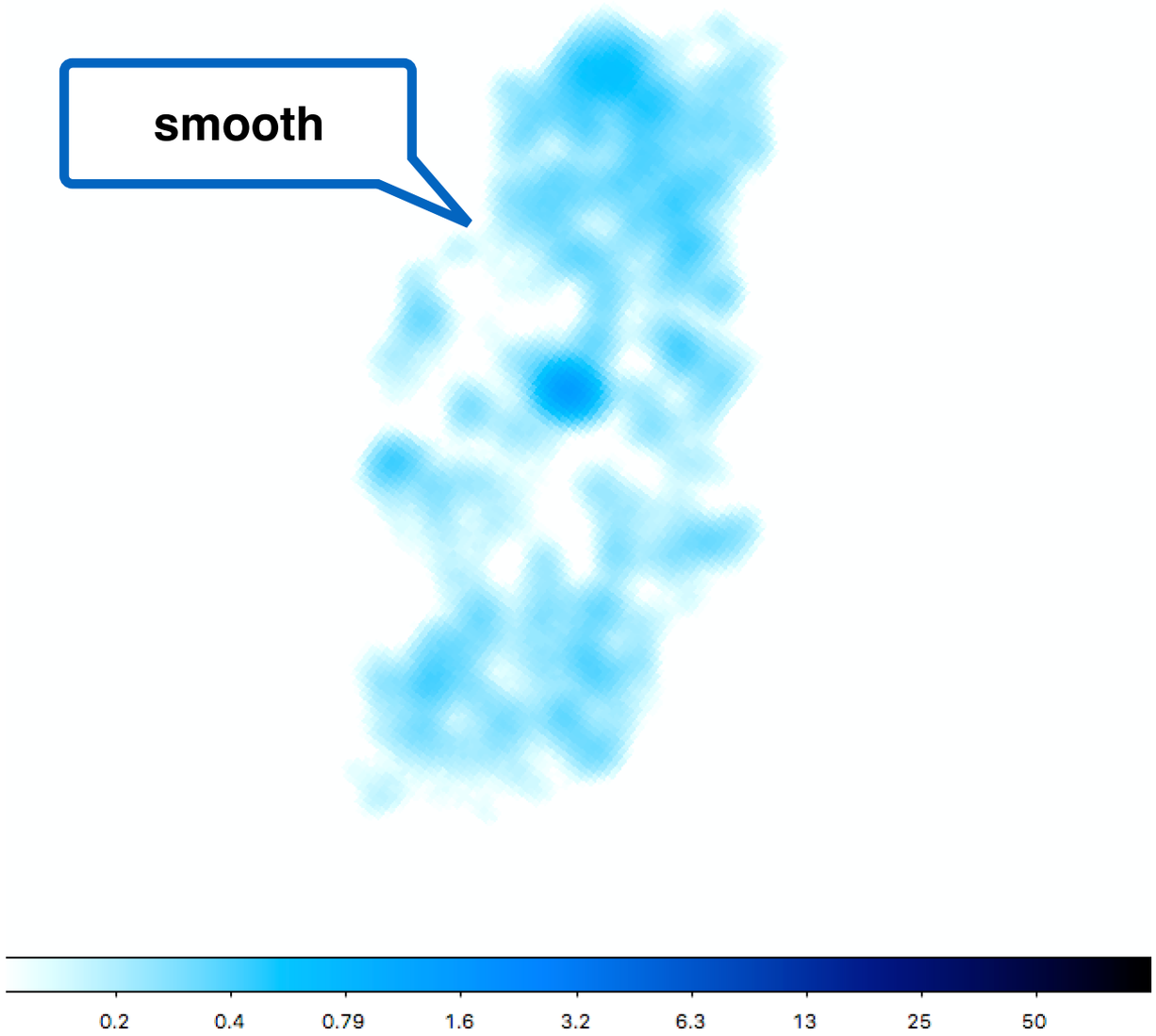


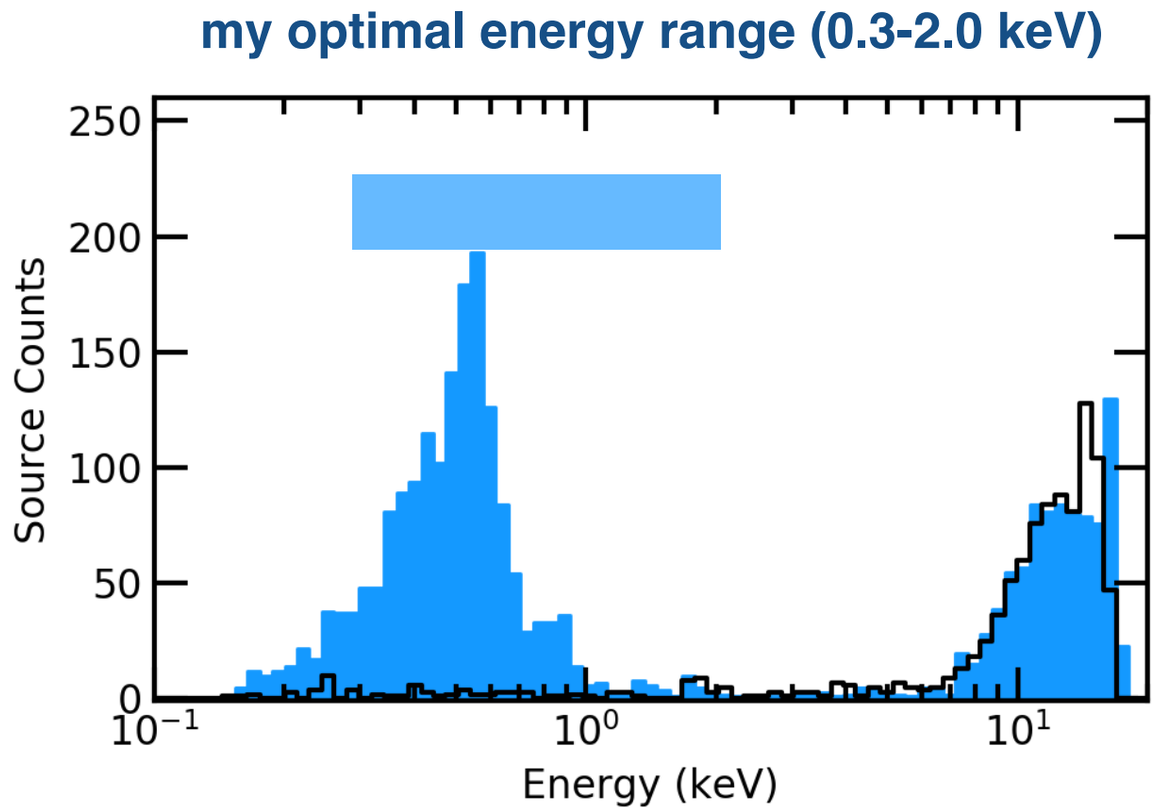


you better know what you are doing

X-ray Imaging

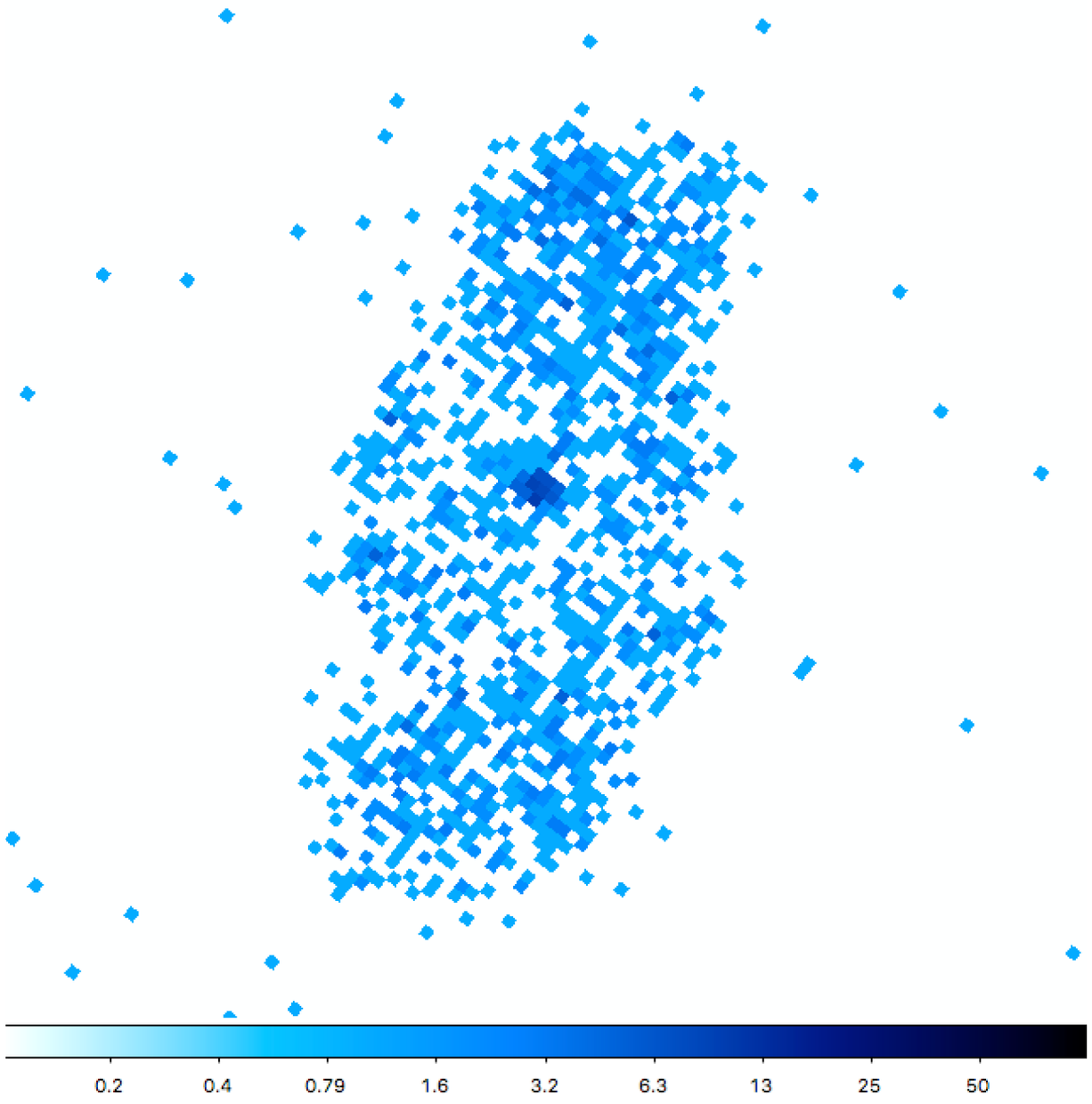
[bin x=::0.25,y=::0.25][energy=300:2000]

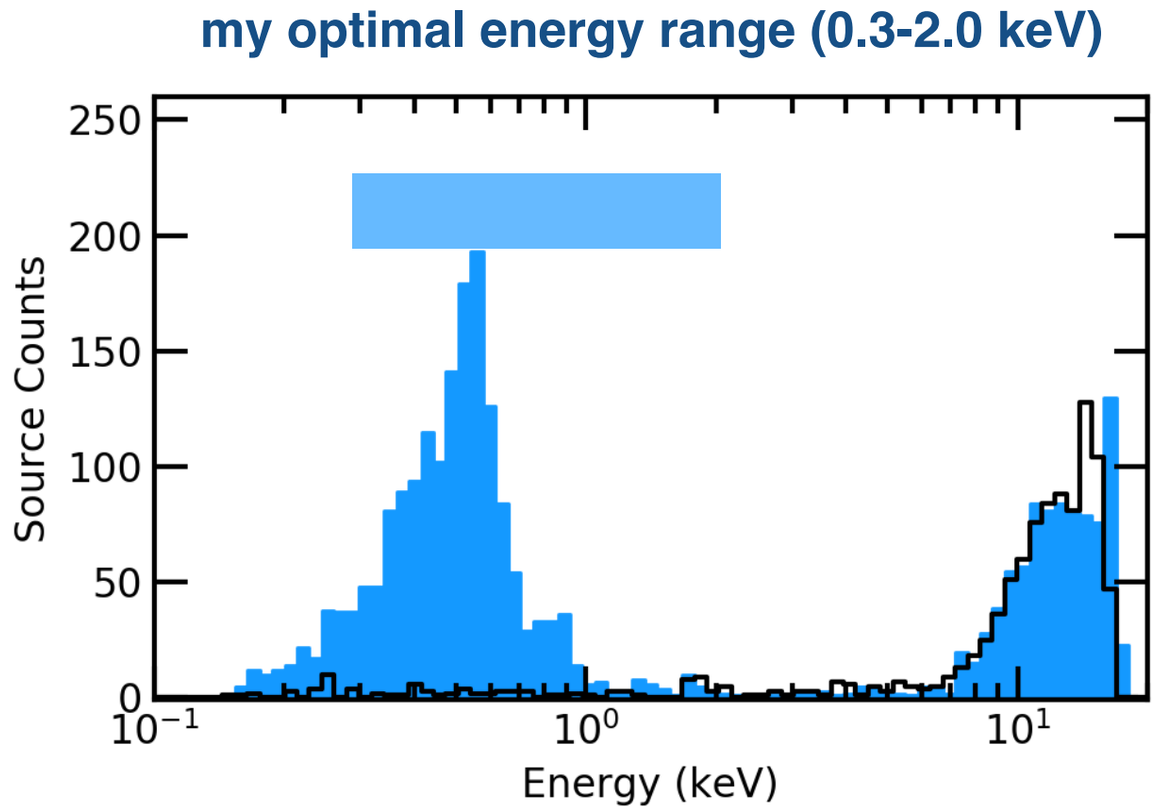




X-ray Imaging

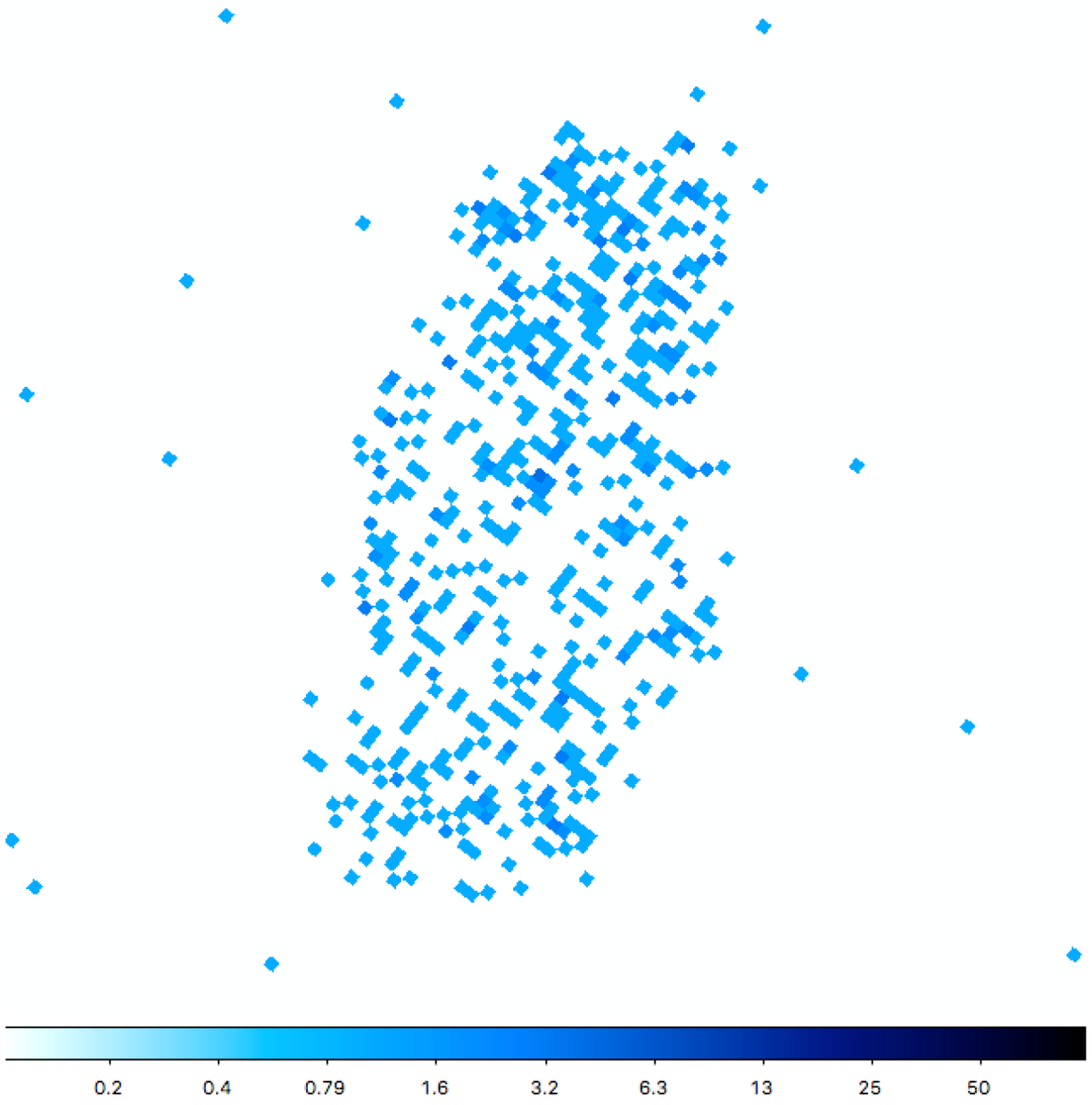
[bin x=::0.25,y=::0.25][energy=300:2000]

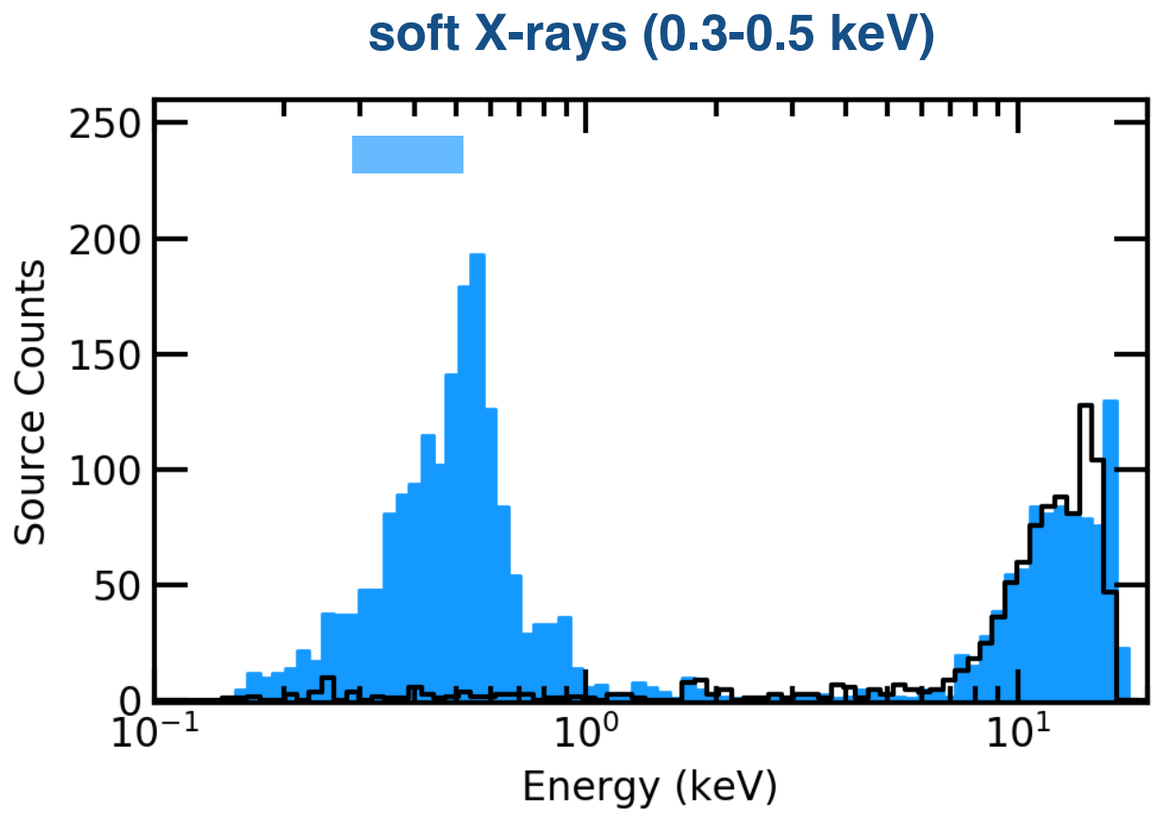




X-ray Imaging

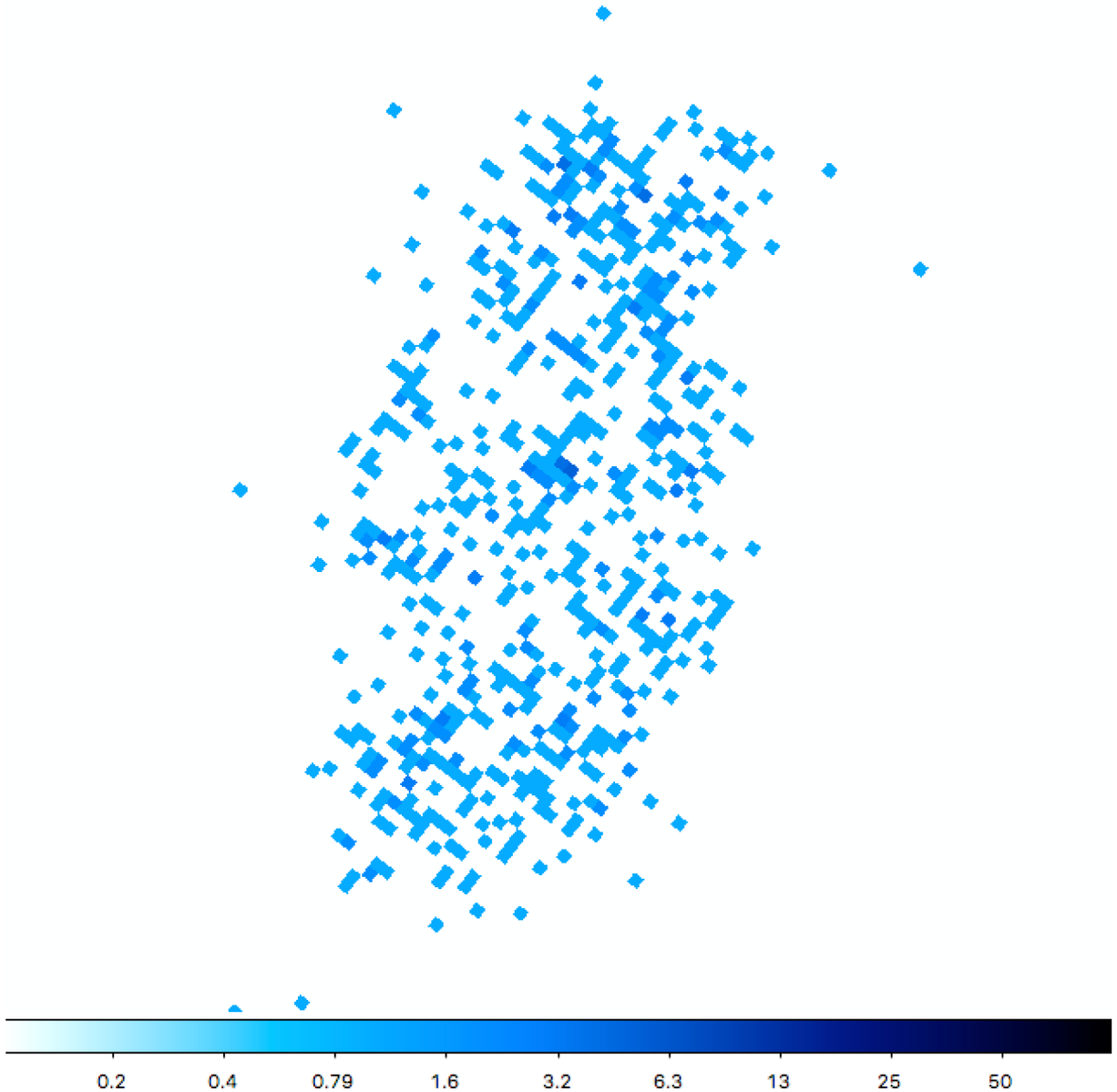
[bin x=::0.5,y=::0.5][energy=300:2000]

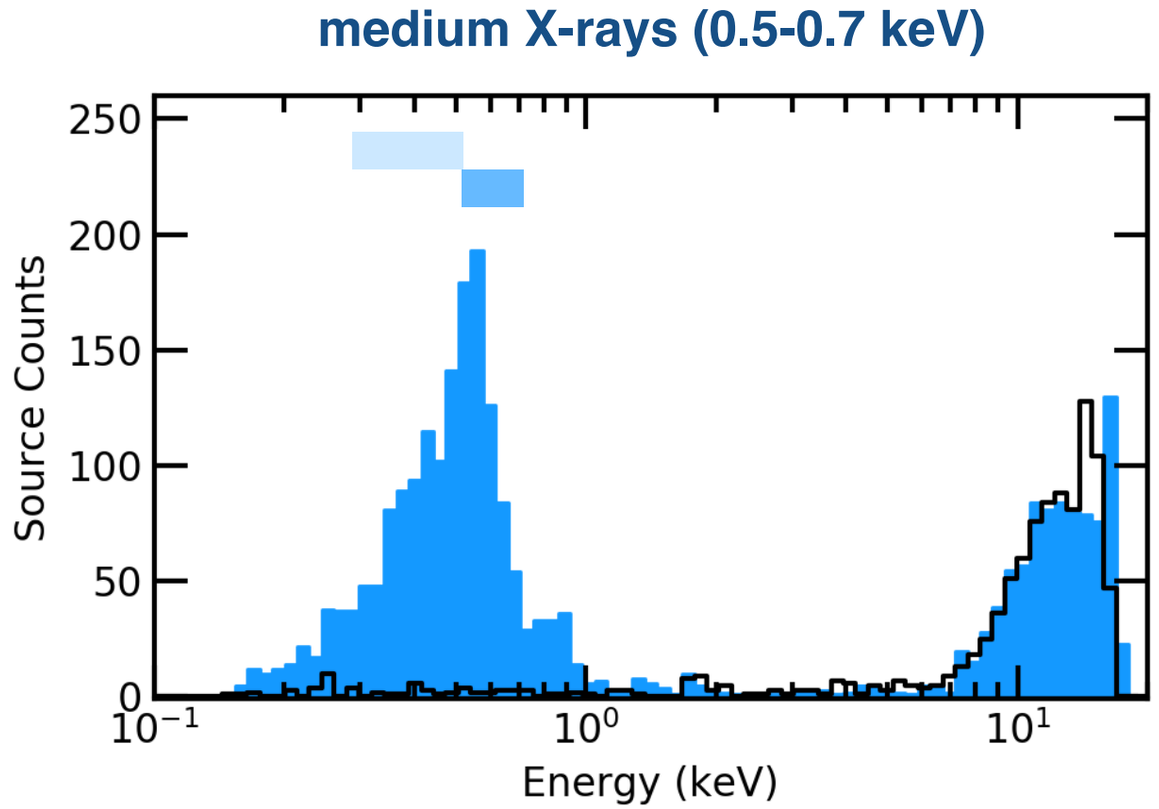




X-ray Imaging

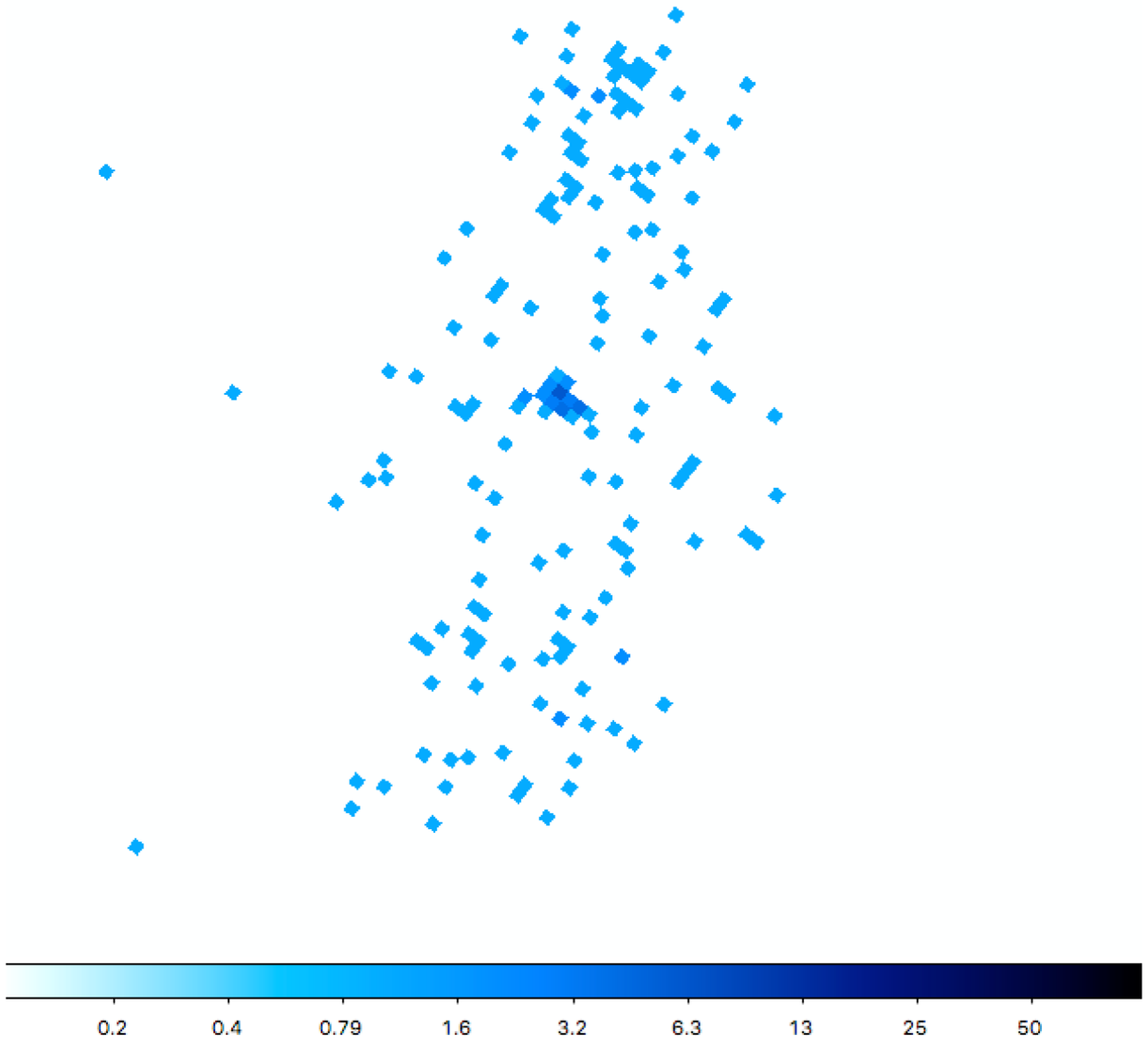
[bin x=::0.5,y=::0.5][energy=300:500]

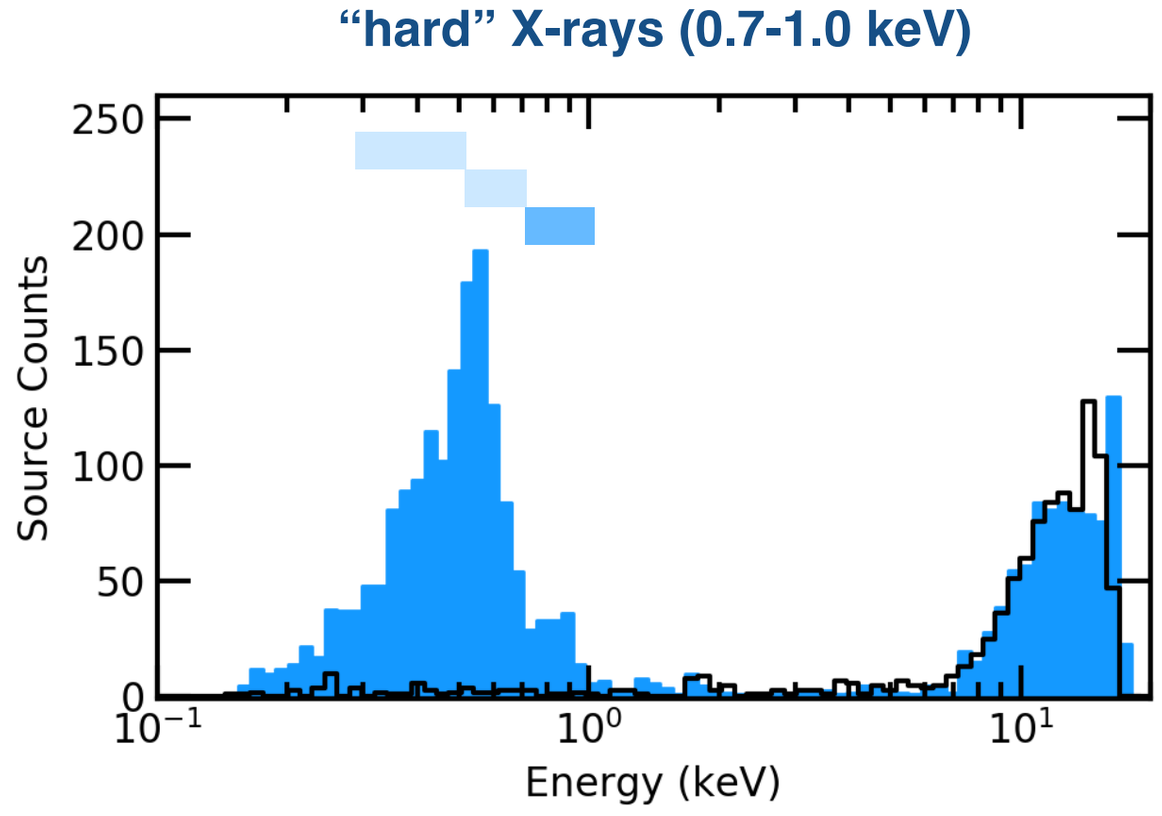




X-ray Imaging

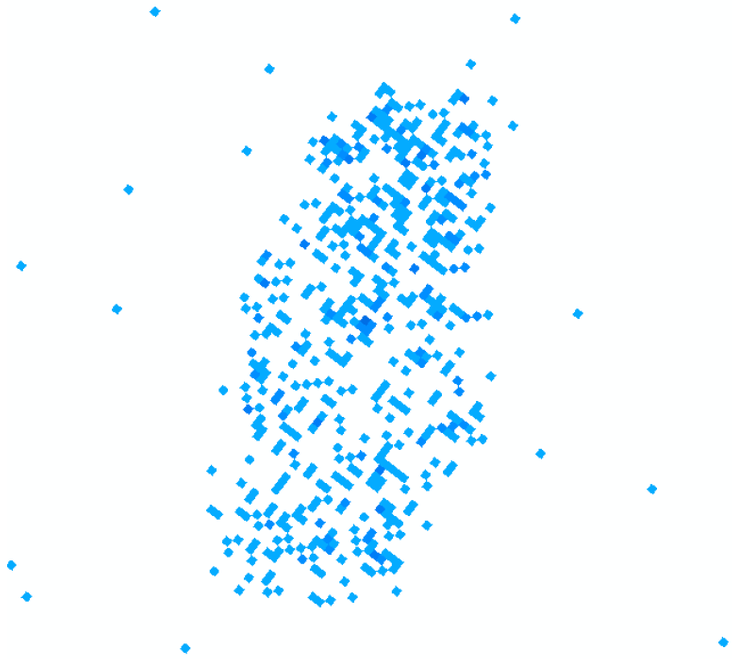
[bin x=::0.5,y=::0.5][energy=500:700]



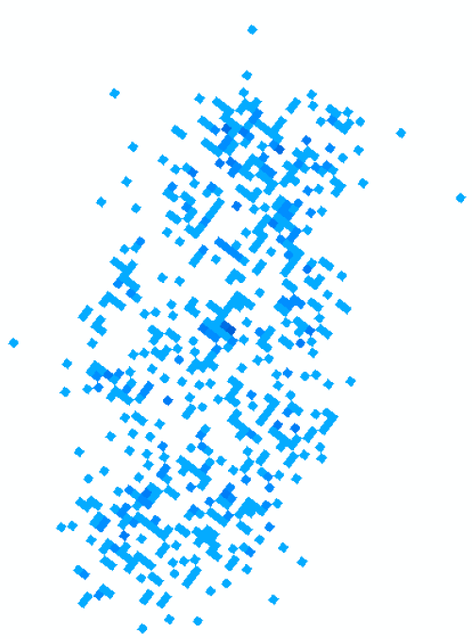


X-ray Imaging

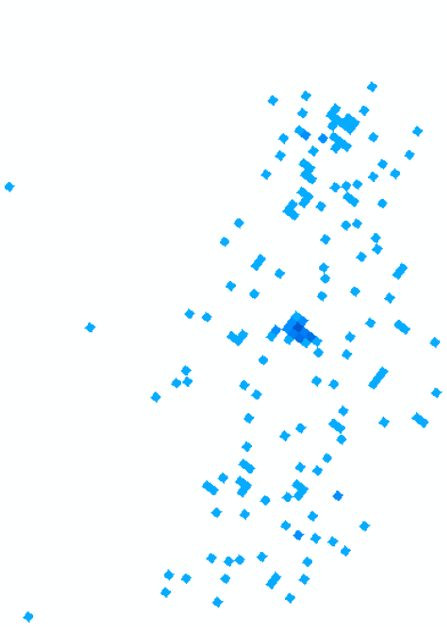
[bin x=::0.5,y=::0.5][energy=700:1000]



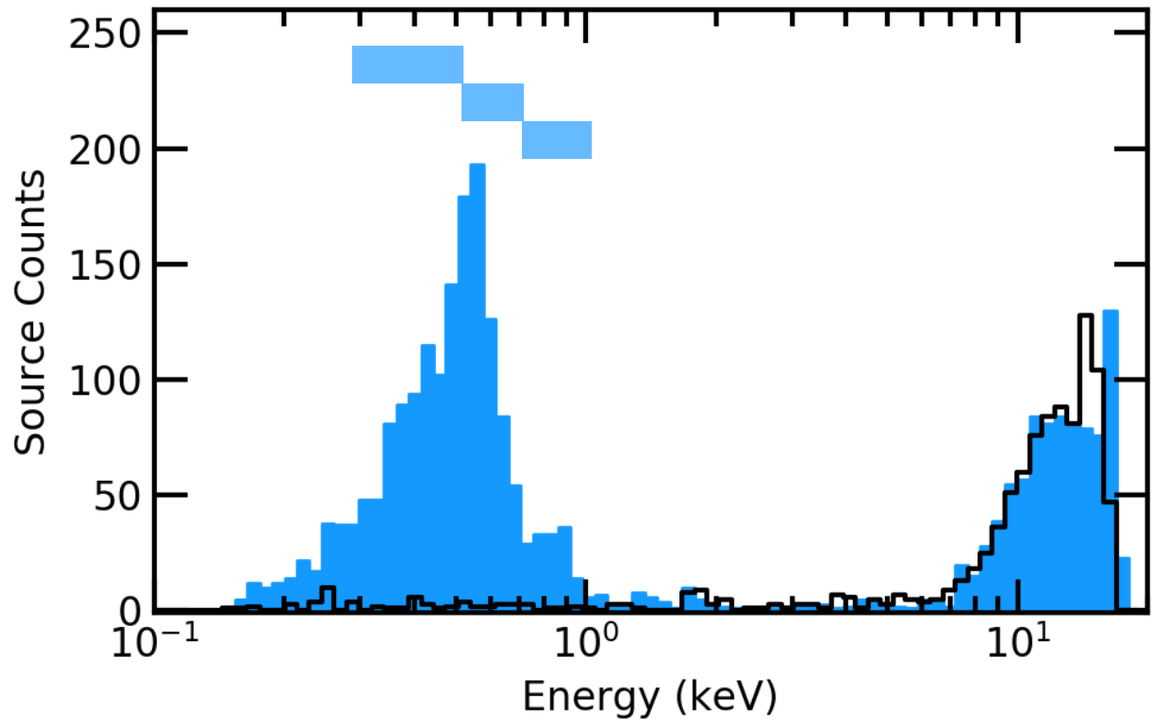
soft X-rays (0.3-0.5 keV)



medium X-rays (0.5-0.7 keV)



“hard” X-rays (0.7-1.0 keV)

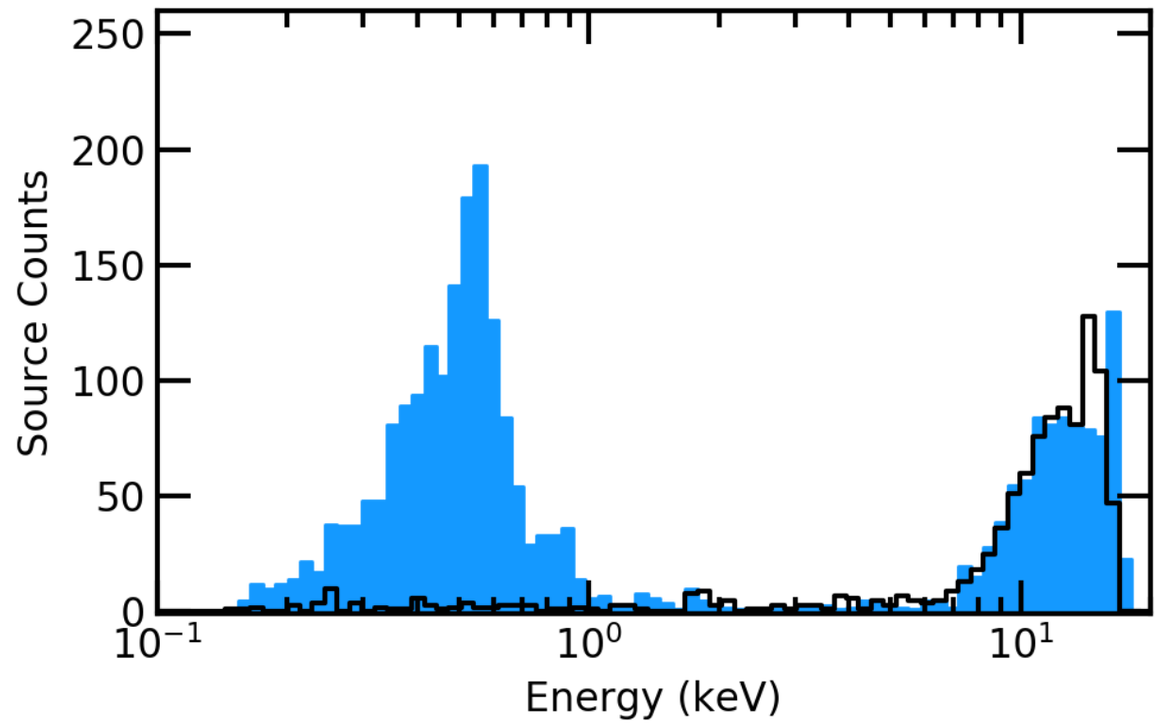


X-ray Imaging

dmcopy energy filtering

Mitigating Background

- Energy Filtering (ciao → *dmcopy*)



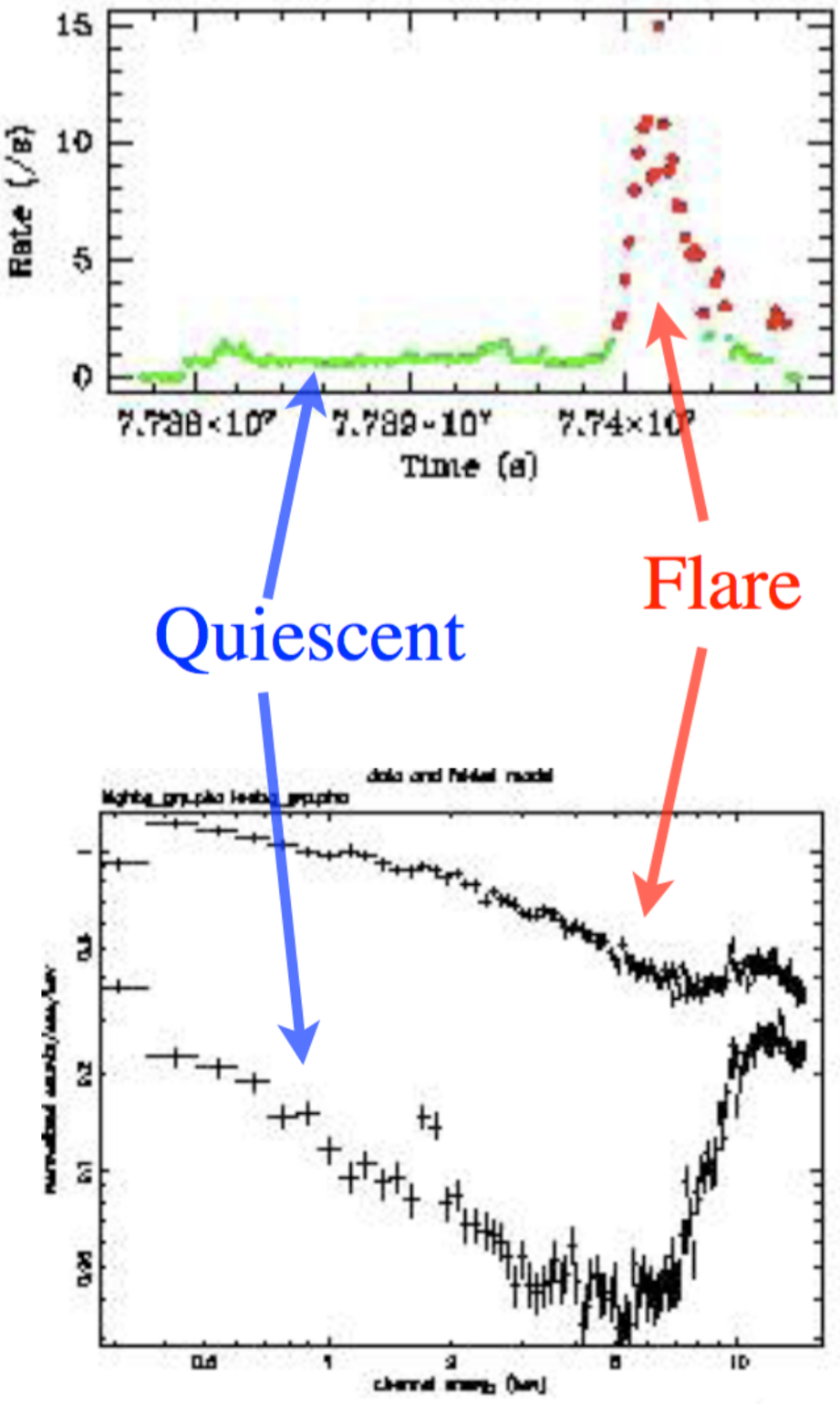
Mitigating Background

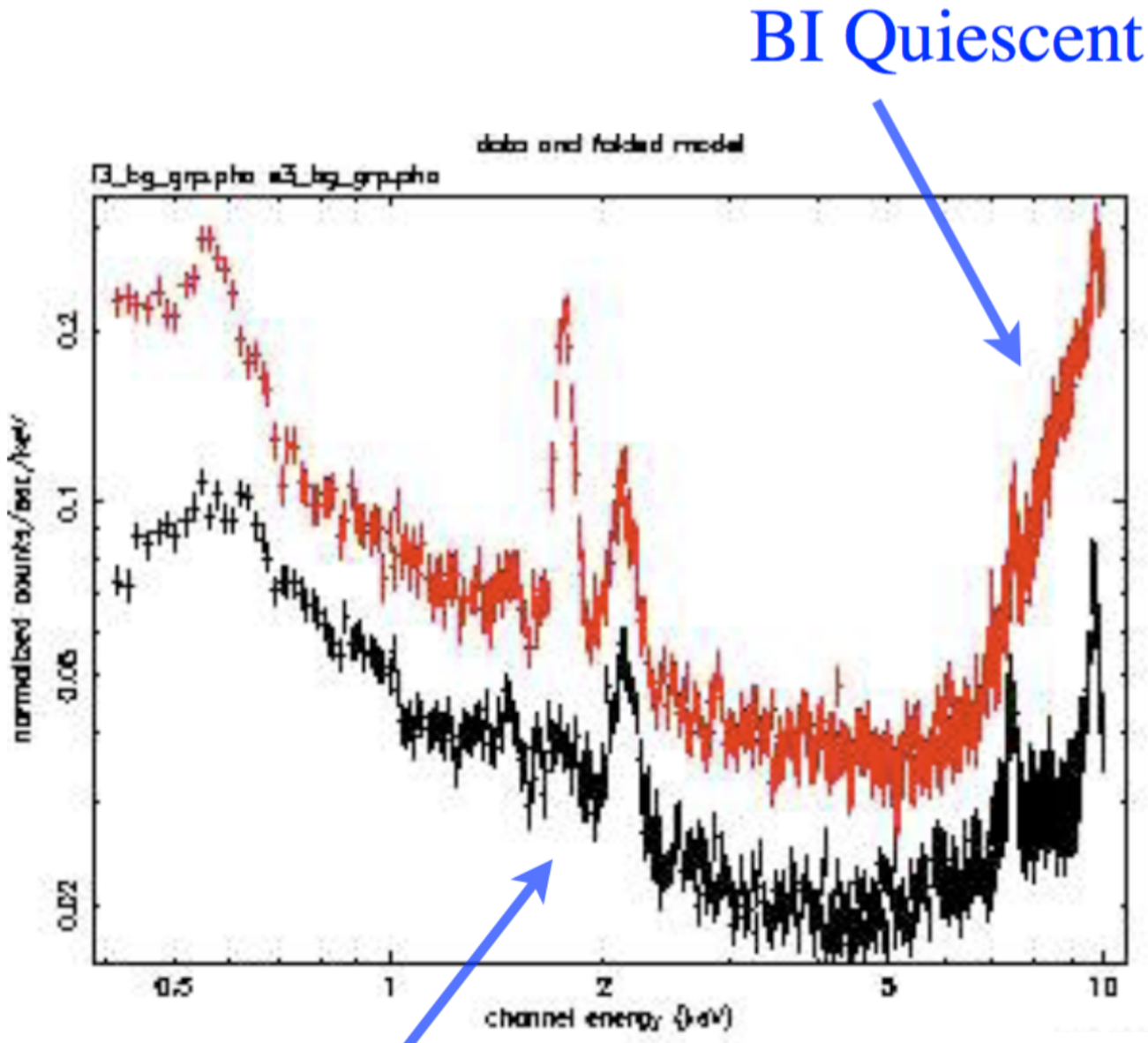
- Energy Filtering (ciao → *dmcopy*)

- Background Flares
    1. ciao → *dmextract* (make light curve)
    2. chips → *lc_clean(…)* (id high bg periods)
    3. ciao → *deflare* (remove high bg periods)

http://cxc.harvard.edu/ciao/threads/flare/

Mitigating Background





[time=START_TIME:END_TIME]

Mitigating Background

- Energy Filtering (ciao → *dmcopy*)

- Background Flares
    1. ciao → *dmextract* (make light curve)
    2. chips → *lc_clean(…)* (id high bg periods)
    3. ciao → *deflare* (remove high bg periods)

http://cxc.harvard.edu/ciao/threads/flare/

Mitigating Background

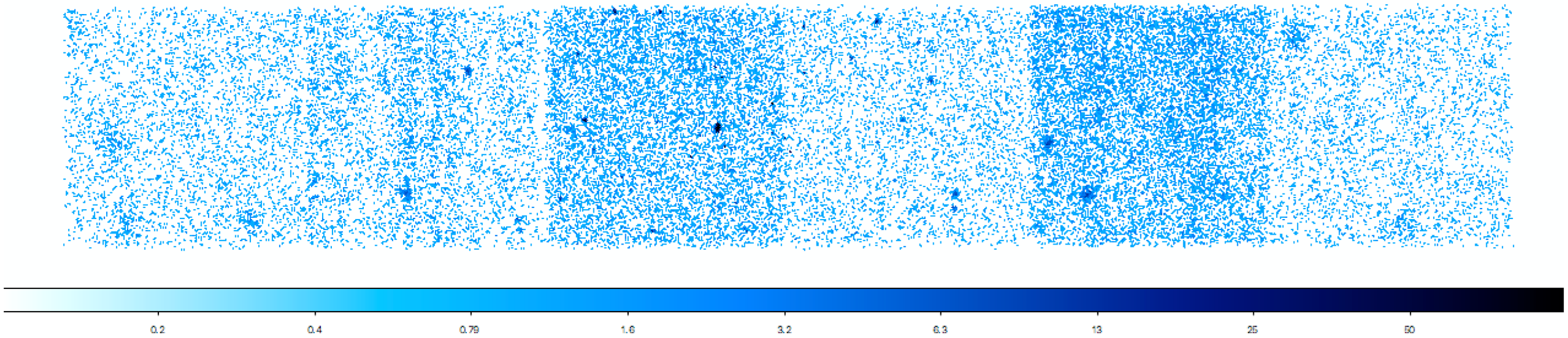
- Energy Filtering (ciao → *dmcopy*)

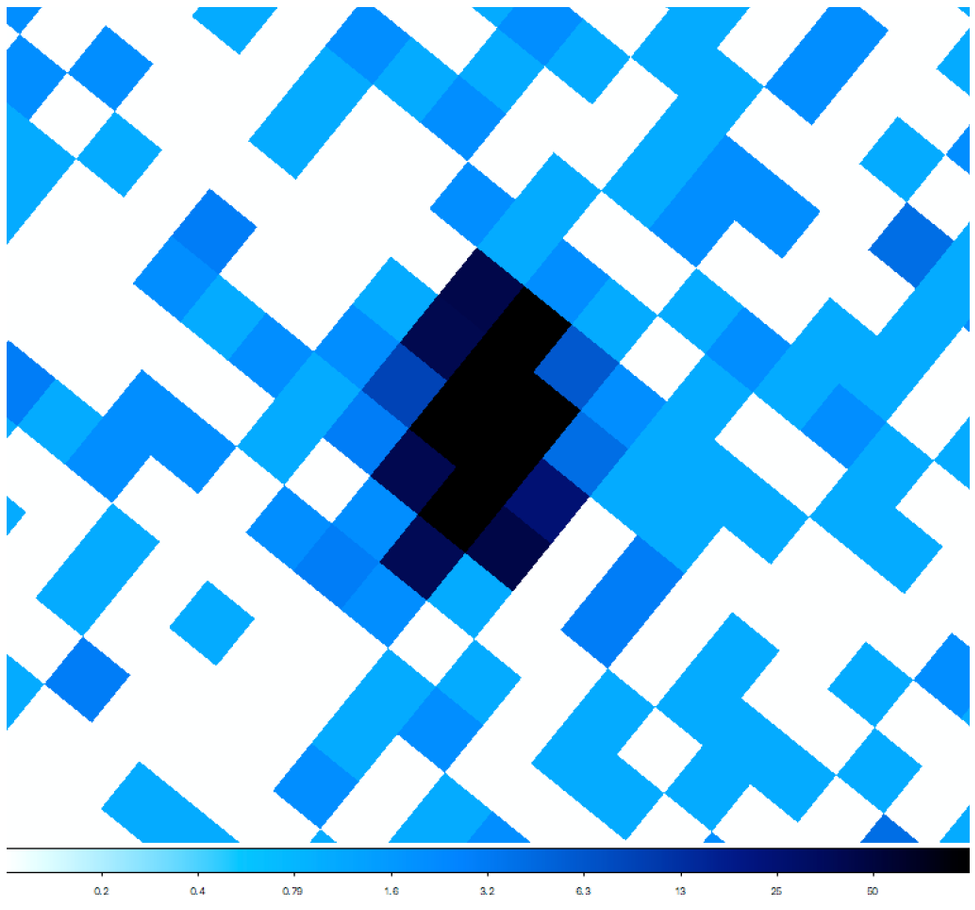
- Background Flares
    1. ciao → *dmextract* (make light curve)
    2. chips → *lc_clean(…)* (id high bg periods)
    3. ciao → *deflare* (remove high bg periods)

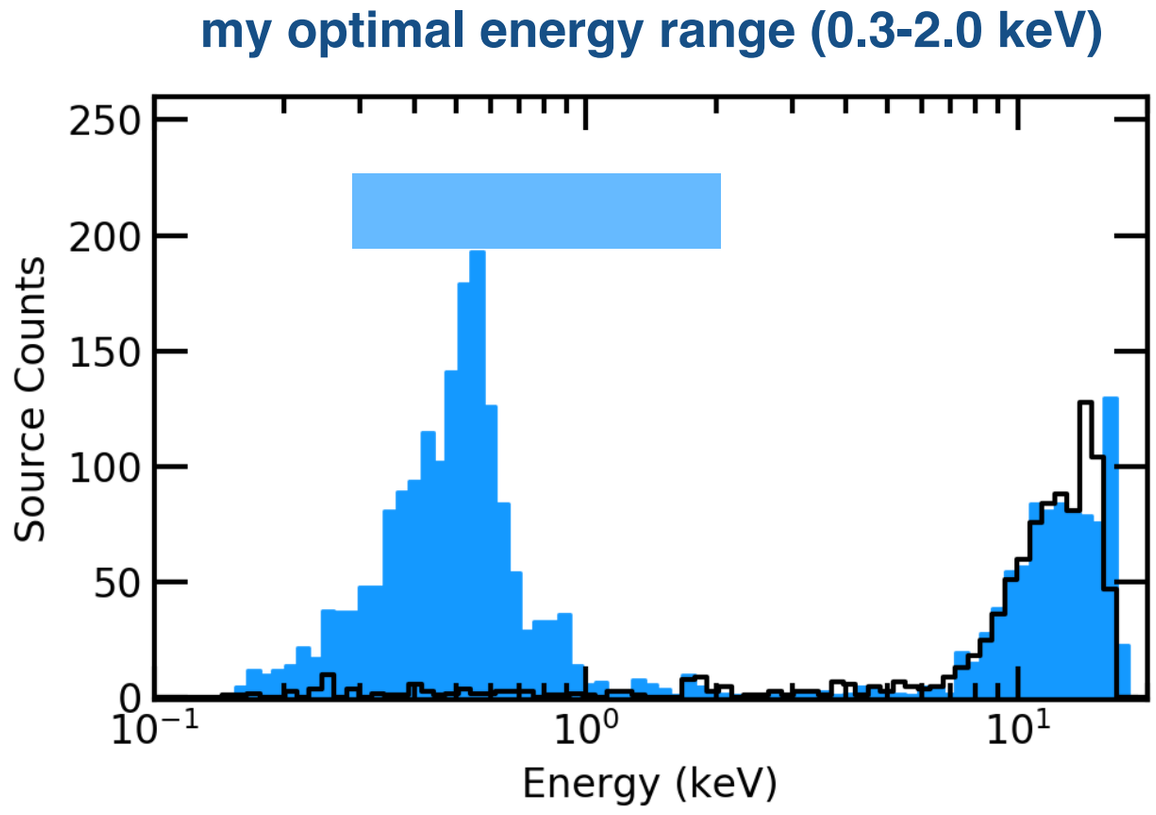
http://cxc.harvard.edu/ciao/threads/flare/

- Blank-sky Background
    1. remove high bg periods (ciao/chips/ciao)
    2. ciao → *blanksky* (blank bg tailored to obs)

http://cxc.harvard.edu/ciao/threads/acisbackground/







X-ray Imaging

[bin x=::8,y=::8][energy=300:2000]

To the notebook!

Jupyter notebook

What’s the Flux?

yesteryear

Creating a Fluxed Image

1. dmcopy (create counts image)
2. mkinstmap (create instrument map) [repeat]
3. mkexpmap (create exposure map) [repeat]
4. dmregrid (combine all the maps)
5. dmimgcalc (divide counts image by exp map)

Creating a Fluxed Image

1. dmcopy (create counts image)
   feel good
2. mkinstmap (create instrument map) [repeat]
   send helpdesk ticket
3. mkexpmap (create exposure map) [repeat]
   send apologetic helpdesk ticket
4. dmregrid (combine all the maps)
   send frantic helpdesk ticket
5. dmimgcalc (divide counts image by exp map)
   do science

there is better way to do this

What’s the Flux?

fluximage

expmap, fluxed image, etc.

output directory

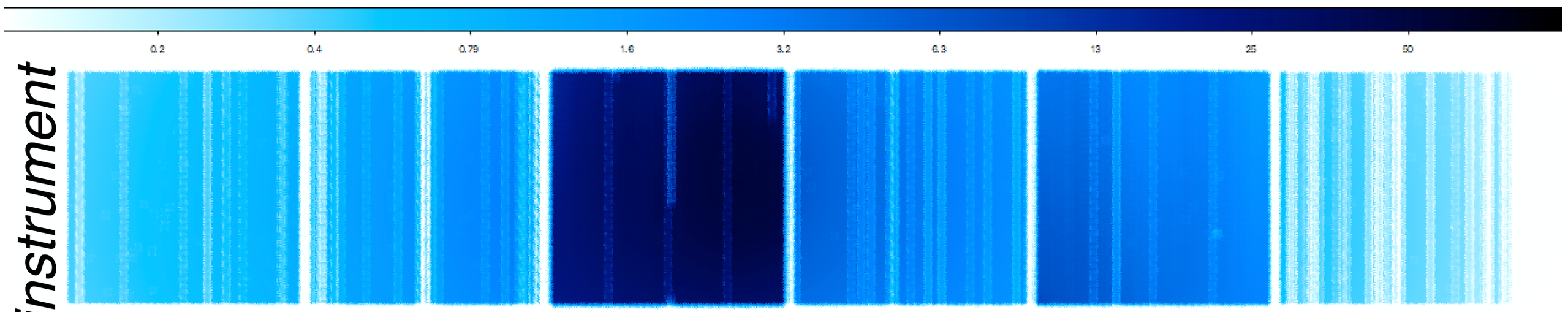
fluximage evt2.fits output/

event file

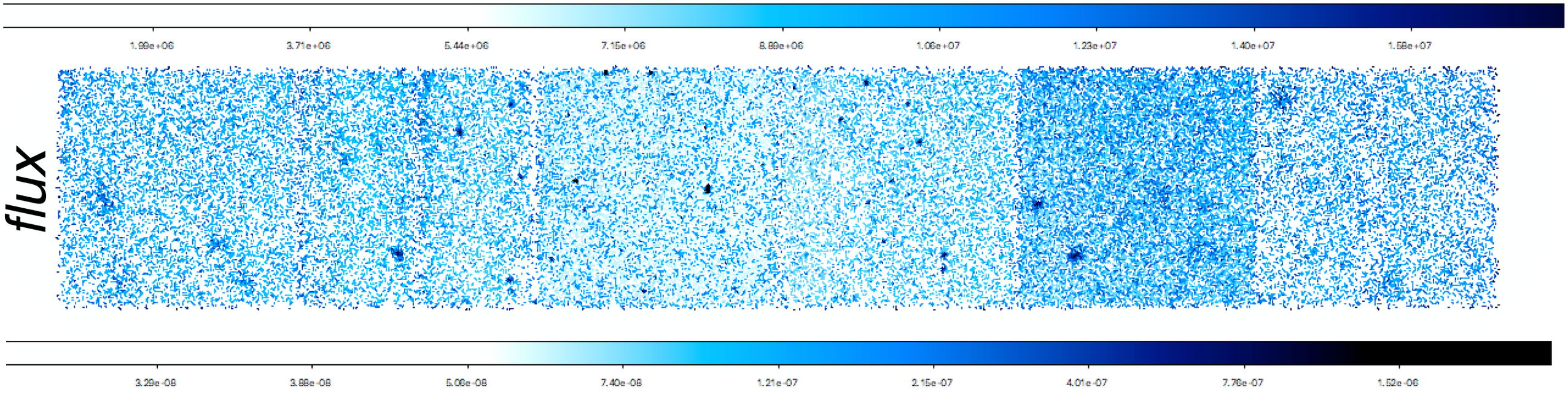
script will locate the
required ancillary files
(asol, bpix, msk, etc.)

Flux Images

counts



instrument



flux

Flux Images

fluximage

What’s the Flux?

srcflux

accuracy is your friend

source coordinates

srcflux evt2.fits “03:29:29.25 +31:18:34.73” output

event file

note

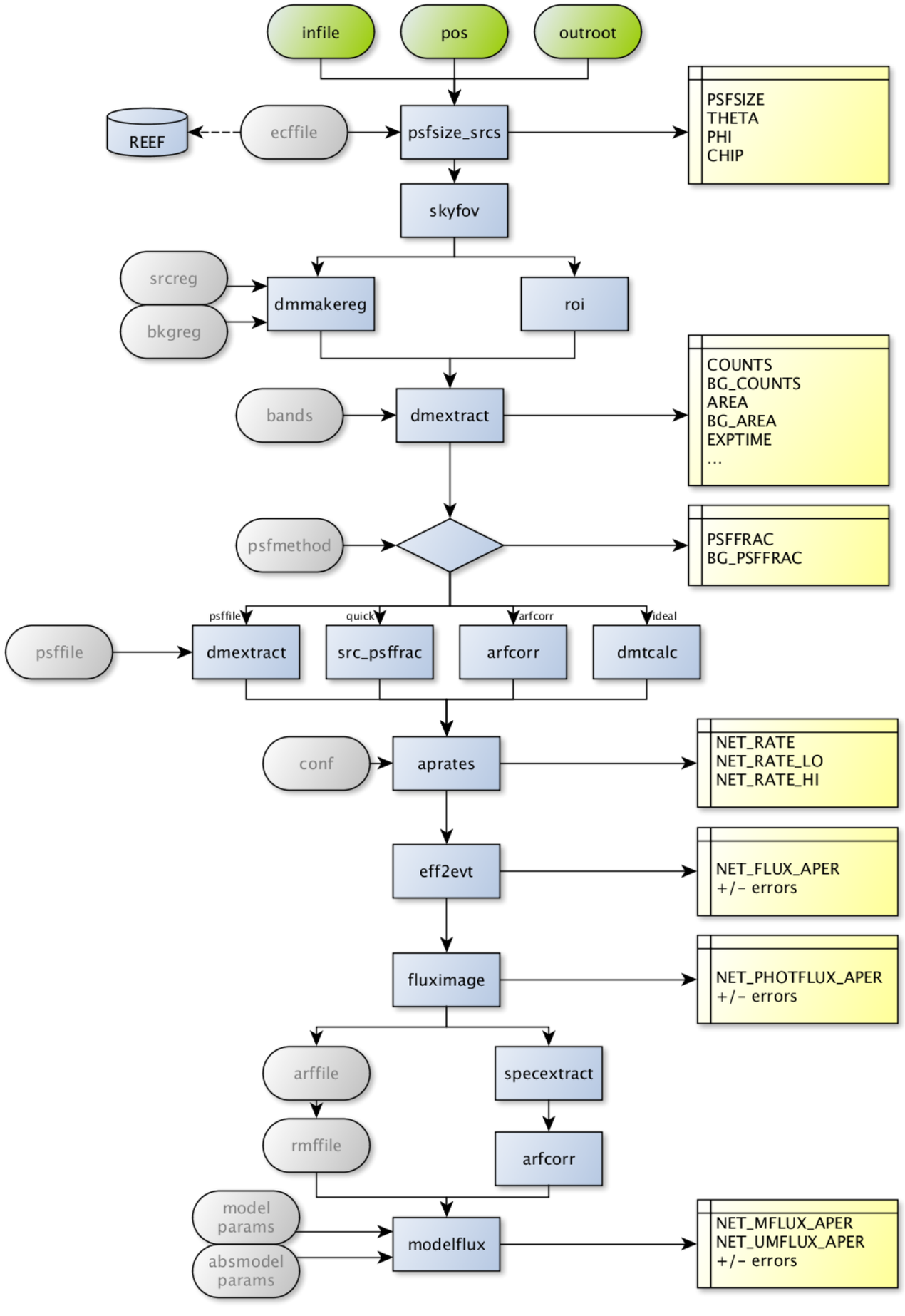
output file

contains parameters, count rates, fluxes, and model flues

Source Fluxes

Source Fluxes

under the hood of srcflux; so much stuff



Source Fluxes

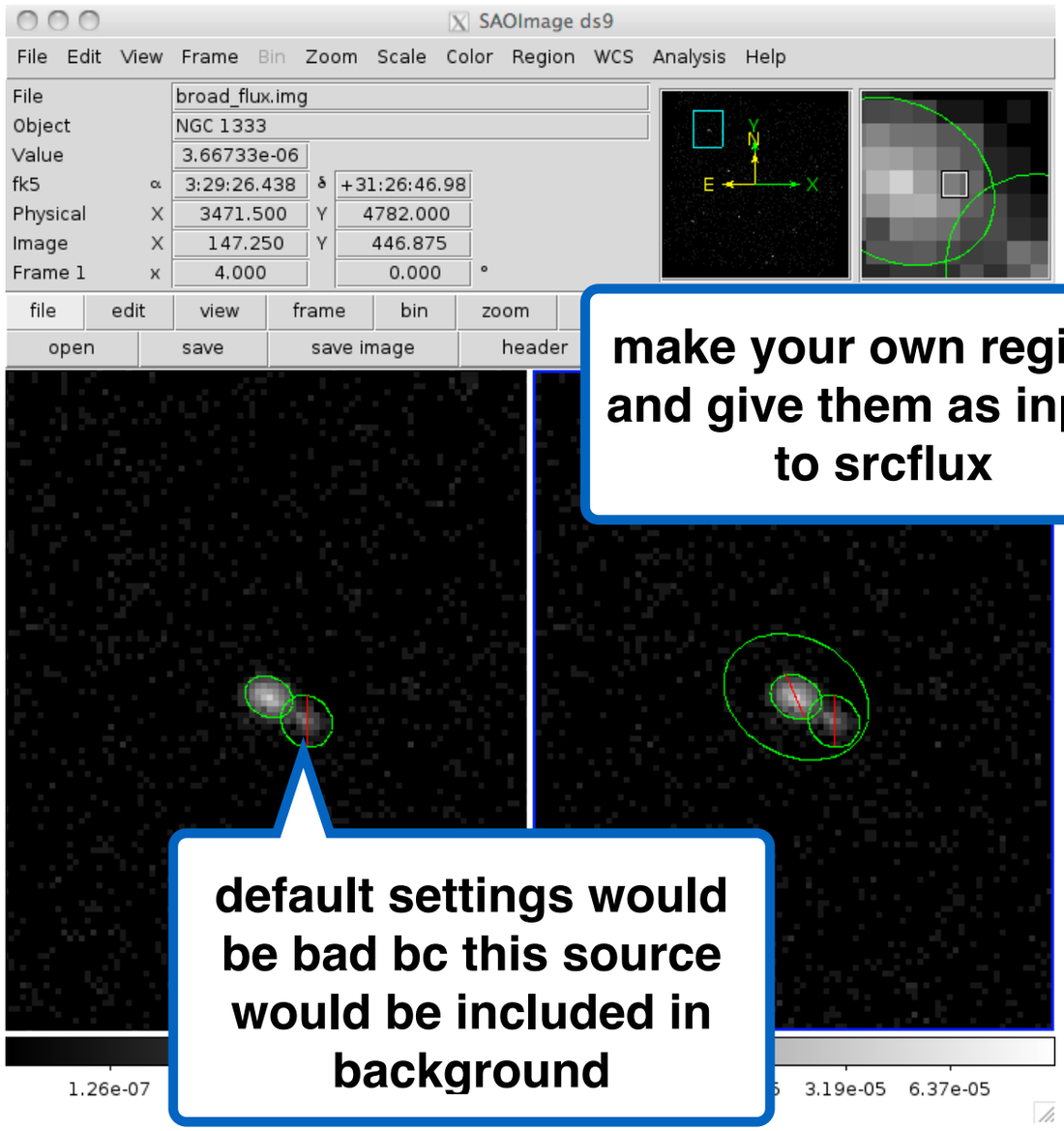
output

```
srcflux
          infile = repro/acisf06436_repro_evt2.fits
             pos = 03:29:29.250 +31:18:34.73
         outroot = single/run1
           bands = broad
          srcreg =
          bkgreg =
         bkgresp = yes
       psfmethod = ideal
         psffile =
            conf = 0.9
         rmffile =
         arffile =
           model = xsphabs.abs1*xspowerlaw.pow1
       paramvals = abs1.nH=0.0;pow1.PhoIndex=2.0
        absmodel =
       absparams =
           abund = angr
         fovfile =
        asolfile =
         mskfile =
        bpixfile =
         dtffile =
         ecffile = CALDB
        parallel = yes
           nproc = INDEF
          tmpdir = /tmp
         clobber = no
         verbose = 1
            mode = ql

Extracting counts
Setting Ideal PSF : alpha=1 , beta=0
Getting net rate and confidence limits
Getting model independent fluxes
Getting model fluxes
Getting photon fluxes
Running tasks in parallel with 4 processors.
Running eff2evt for single/run1_broad_0001_src.dat
Running aprates for single/run1_broad0001_rates.par
Running eff2evt for single/run1_broad_0001_bkg.dat
Making response files for single/run1_0001
Running modeflux for region 1
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
3 29 29.25 +31 18 34.7  Rate                0.0398 c/s (0.0381,0.0415)
                        Flux                5.17E-13 erg/cm2/s (4.94E-13,5.39E-13)
                        Mod.Flux            4.38E-13 erg/cm2/s (4.2E-13,4.57E-13)
```

```
Summary of source fluxes

Position                                    0.5 - 7.0 keV
                                            Value          90% Conf Interval
3 29 29.25 +31 18 34.7   Rate               0.0398 c/s (0.0381,0.0415)
                         Flux               5.17E-13 erg/cm2/s (4.94E-13,5.39E-13)
                         Mod.Flux           4.38E-13 erg/cm2/s (4.2E-13,4.57E-13)
```

show me the flux!

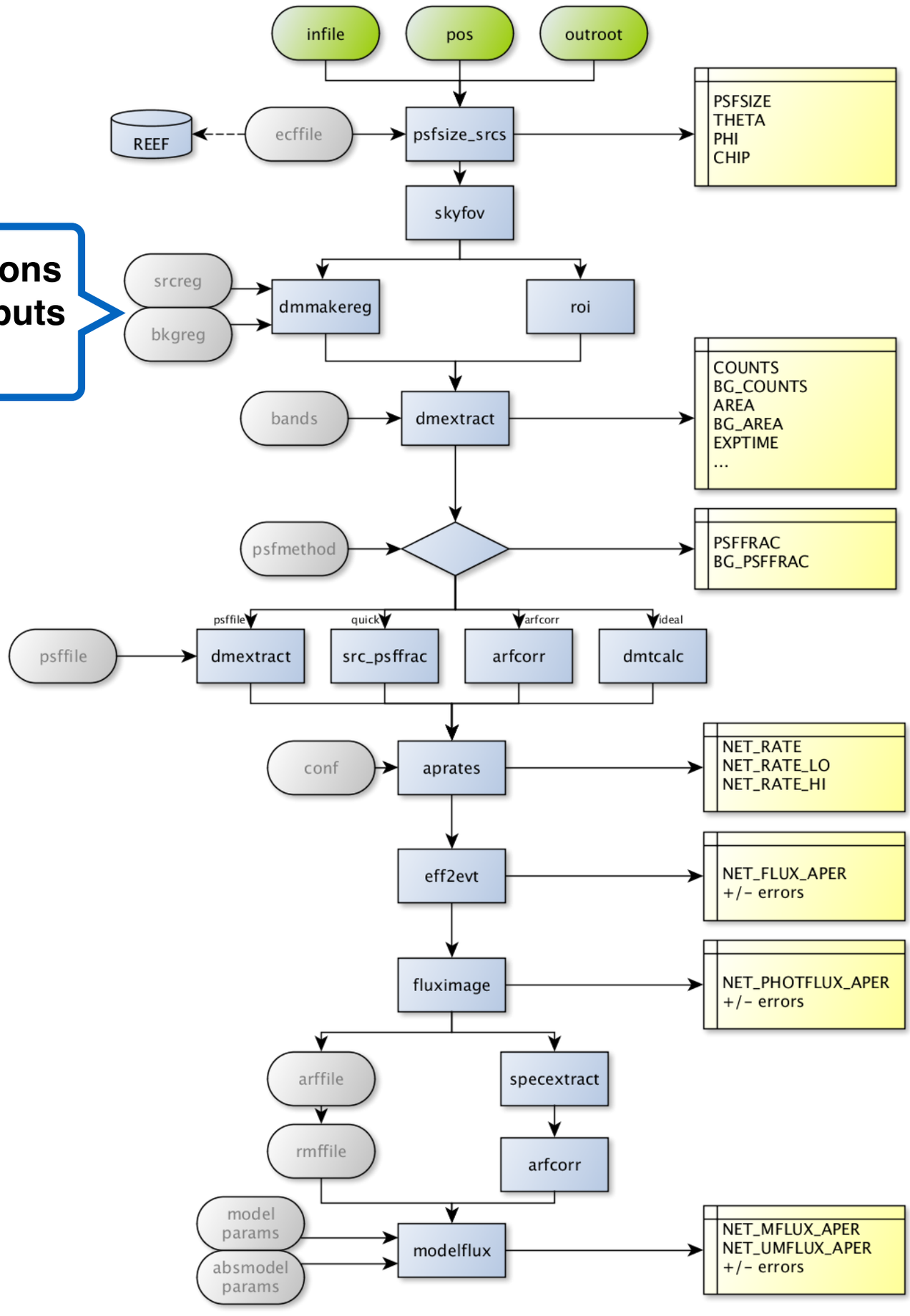
Source Fluxes

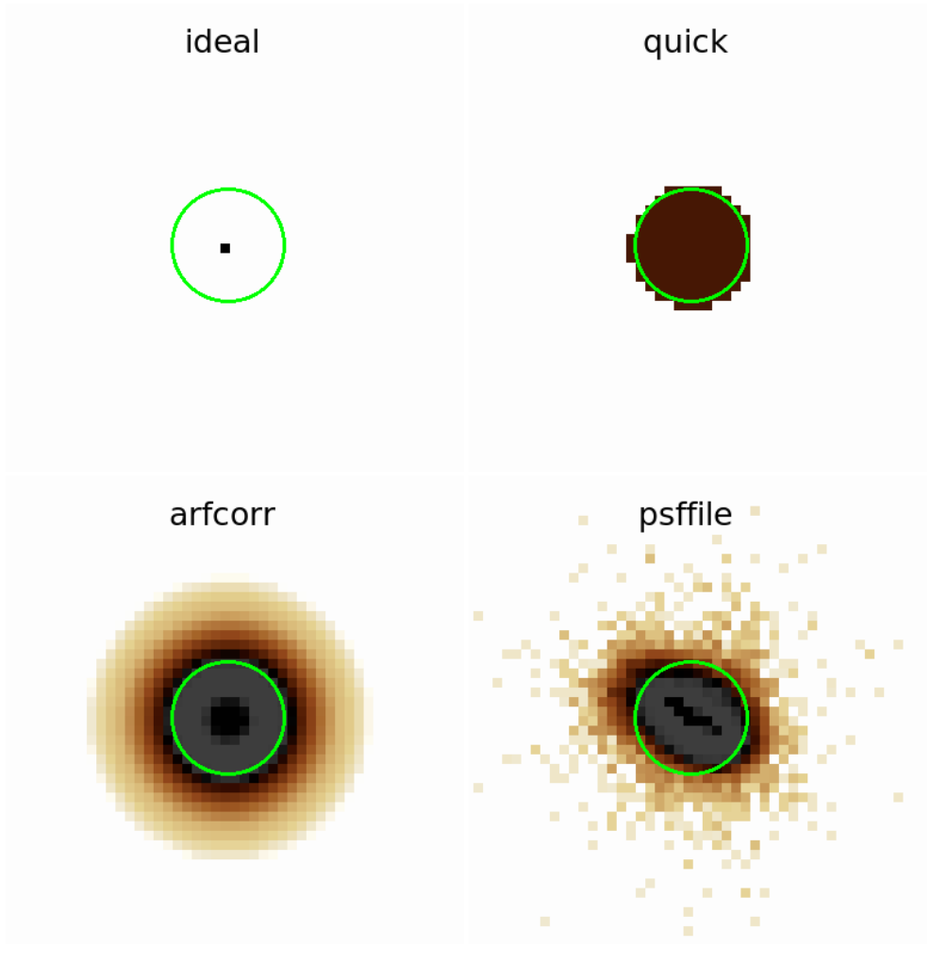


make your own regions and give them as inputs to srcflux

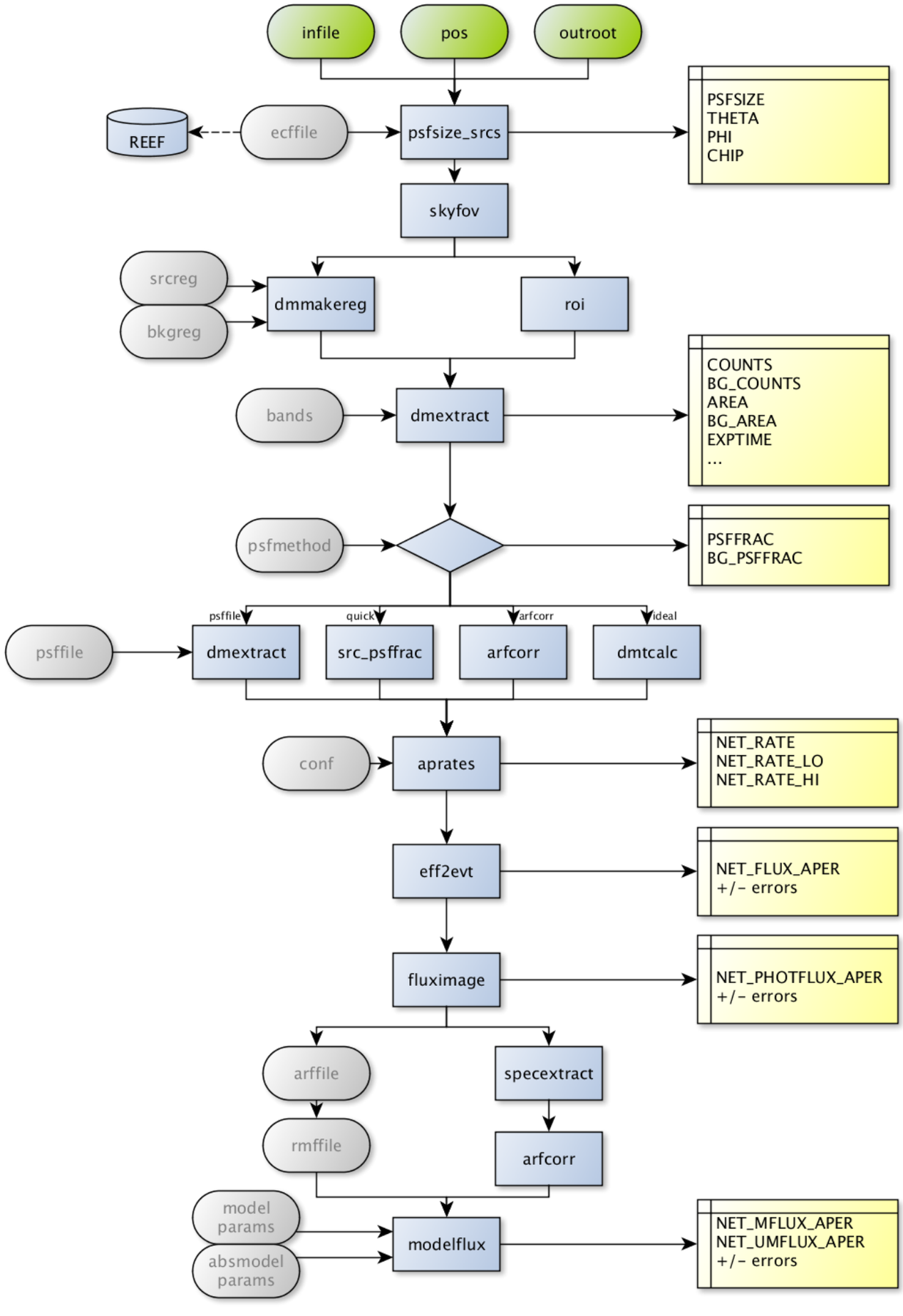
default settings would be bad bc this source would be included in background

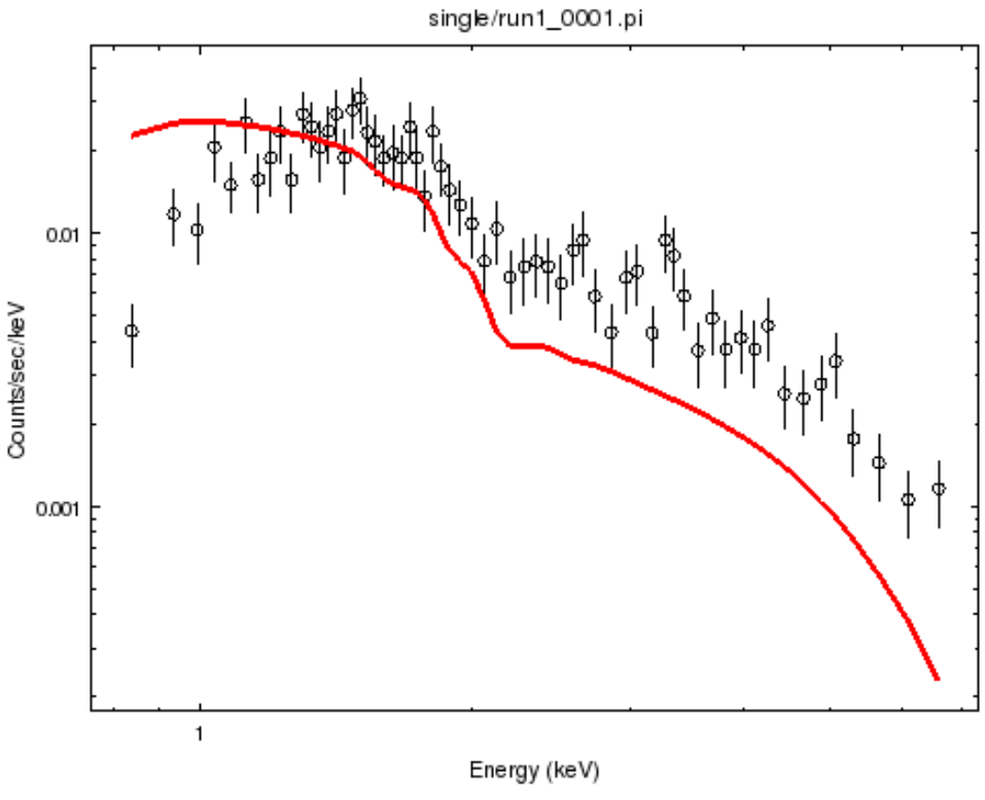
Source Fluxes





Source Fluxes





Source Fluxes