# XMM-Newton data analysis: tutorial


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*Astrophysics Laboratory course: AA 2020/21*

26.02.2021

ssh -X(-Y) gruppo01@login01.iasfbo.inaf.it

**Gruppi 1-6**

ssh -X(-Y) gruppo01@login02.iasfbo.inaf.it

**Gruppi 7-12**

ssh -X node04 oppure node03

ssh -X(-Y) gruppo01@login03.iasfbo.inaf.it

**Gruppi 13-18**

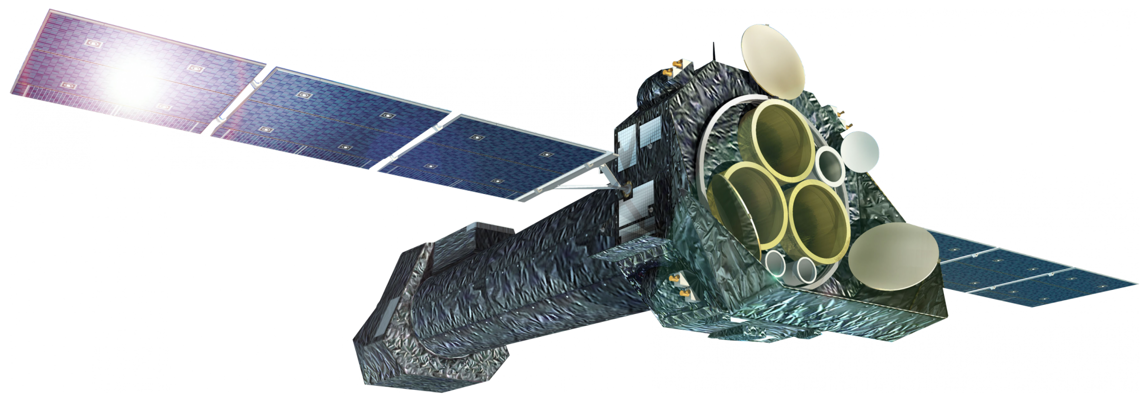

login01
login03
source setup_**login**.sh
login02-node04
source setup_**node**.sh

# Software setup

Chandra

**ciao**

XMM



**heainit**
**sas**
**heainit**

(login01, 03: ciao v.11)

(login02/node04: ciao v.12)

(login01, 03: sas v.18)

(login02/node04: sas v.19)

```
[torresi@login01]2009>ls
0552180101.tar.gz  evt  odf  pn  reduction_sas18.sh
[torresi@login01]2009>
```

2009.tar.gz

```
0231_0065940101_AttHk.ds                    0231_0065940101_EMOS2_S007_01_Badpixels.ds  0231_0065940101_EPN_S004_02_Badpixels.ds  0231_0065940101_EPN_S004_11_Badpixels.ds
0231_0065940101_EMOS1_S003_01_Badpixels.ds  0231_0065940101_EMOS2_S007_02_Badpixels.ds  0231_0065940101_EPN_S004_03_Badpixels.ds  0231_0065940101_EPN_S004_12_Badpixels.ds
0231_0065940101_EMOS1_S003_02_Badpixels.ds  0231_0065940101_EMOS2_S007_03_Badpixels.ds  0231_0065940101_EPN_S004_04_Badpixels.ds  0231_0065940101_EPN_S004_ImagingEvts.ds
0231_0065940101_EMOS1_S003_03_Badpixels.ds  0231_0065940101_EMOS2_S007_04_Badpixels.ds  0231_0065940101_EPN_S004_05_Badpixels.ds  ccf.cif
0231_0065940101_EMOS1_S003_04_Badpixels.ds  0231_0065940101_EMOS2_S007_05_Badpixels.ds  0231_0065940101_EPN_S004_06_Badpixels.ds  m1.evt
0231_0065940101_EMOS1_S003_05_Badpixels.ds  0231_0065940101_EMOS2_S007_06_Badpixels.ds  0231_0065940101_EPN_S004_07_Badpixels.ds  m2.evt
0231_0065940101_EMOS1_S003_06_Badpixels.ds  0231_0065940101_EMOS2_S007_07_Badpixels.ds  0231_0065940101_EPN_S004_08_Badpixels.ds  pn.evt
0231_0065940101_EMOS1_S003_07_Badpixels.ds  0231_0065940101_EMOS2_S007_ImagingEvts.ds   0231_0065940101_EPN_S004_09_Badpixels.ds
0231_0065940101_EMOS1_S003_ImagingEvts.ds   0231_0065940101_EPN_S004_01_Badpixels.ds    0231_0065940101_EPN_S004_10_Badpixels.ds
```

```
scp gruppo01@login01.iasfbo.inaf.it:/home/gruppo01/3C111_xmm/2009/2009.tar.gz ./
```

# Data structure

0552180101.tar.gz > tar -zxvf 0552180101.tar.gz

**MOS1 / MOS2**

```
0231_0065940101.TAR
0231_0065940101_M1S00300AUX.FIT
0231_0065940101_M1S00310IME.FIT
0231_0065940101_M1S00320IME.FIT
0231_0065940101_M1S00330IME.FIT
0231_0065940101_M1S00340IME.FIT
0231_0065940101_M1S00350IME.FIT
0231_0065940101_M1S00360IME.FIT
0231_0065940101_M1S00370IME.FIT
0231_0065940101_M1X00000HBH.FIT
0231_0065940101_M1X00000HCH.FIT
0231_0065940101_M1X00000HTH.FIT
0231_0065940101_M1X00000PEH.FIT
0231_0065940101_M1X00000PTH.FIT
0231_0065940101_M2S00700AUX.FIT
0231_0065940101_M2S00710IME.FIT
0231_0065940101_M2S00720IME.FIT
0231_0065940101_M2S00730IME.FIT
0231_0065940101_M2S00740IME.FIT
0231_0065940101_M2S00750IME.FIT
0231_0065940101_M2S00760IME.FIT
0231_0065940101_M2S00770IME.FIT
0231_0065940101_M2X00000HBH.FIT
0231_0065940101_M2X00000HCH.FIT
0231_0065940101_M2X00000HTH.FIT
0231_0065940101_M2X00000PEH.FIT
0231_0065940101_M2X00000PTH.FIT
```

**OM**

```
0231_0065940101_OMS00800IMI.FIT
0231_0065940101_OMS00800RFX.FIT
0231_0065940101_OMS00800THX.FIT
0231_0065940101_OMS00800WDX.FIT
0231_0065940101_OMS00801IMI.FIT
0231_0065940101_OMS01000IMI.FIT
0231_0065940101_OMS01000WDX.FIT
0231_0065940101_OMS01001IMI.FIT
0231_0065940101_OMS40000PAX.FIT
0231_0065940101_OMS40000RFX.FIT
0231_0065940101_OMS40100IMI.FIT
0231_0065940101_OMS40100RFX.FIT
0231_0065940101_OMS40100THX.FIT
0231_0065940101_OMS40100WDX.FIT
0231_0065940101_OMS40101IMI.FIT
0231_0065940101_OMS40200IMI.FIT
0231_0065940101_OMS40200RFX.FIT
0231_0065940101_OMS40200THX.FIT
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0231_0065940101_OMS40201IMI.FIT
0231_0065940101_OMS40300IMI.FIT
0231_0065940101_OMS40300RFX.FIT
0231_0065940101_OMS40300THX.FIT
0231_0065940101_OMS40300WDX.FIT
0231_0065940101_OMS40301IMI.FIT
0231_0065940101_OMS40400IMI.FIT
0231_0065940101_OMS40400RFX.FIT
0231_0065940101_OMS40400THX.FIT
0231_0065940101_OMS40400WDX.FIT
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0231_0065940101_OMS40500WDX.FIT
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0231_0065940101_OMU00200IMI.FIT
0231_0065940101_OMU00200WDX.FIT
0231_0065940101_OMU00201IMI.FIT
0231_0065940101_OMU00300IMI.FIT
0231_0065940101_OMU00300WDX.FIT
0231_0065940101_OMU00301IMI.FIT
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0231_0065940101_OMU00400WDX.FIT
0231_0065940101_OMU00401IMI.FIT
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0231_0065940101_OMU00700IMI.FIT
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0231_0065940101_OMU00701IMI.FIT
0231_0065940101_OMU00800IMI.FIT
0231_0065940101_OMU00800WDX.FIT
0231_0065940101_OMU00801IMI.FIT
0231_0065940101_OMX00000NPH.FIT
0231_0065940101_OMX00000PEH.FIT
```

**pn**

```
0231_0065940101_PNS00400AUX.FIT
0231_0065940101_PNS00400CCX.FIT
0231_0065940101_PNS00401IME.FIT
0231_0065940101_PNS00402IME.FIT
0231_0065940101_PNS00403IME.FIT
0231_0065940101_PNS00404IME.FIT
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0231_0065940101_PNS00406IME.FIT
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0231_0065940101_PNS00409IME.FIT
0231_0065940101_PNS00410IME.FIT
0231_0065940101_PNS00411IME.FIT
0231_0065940101_PNS00412IME.FIT
0231_0065940101_PNU00201DLI.FIT
0231_0065940101_PNU00302DLI.FIT
0231_0065940101_PNU00401ODI.FIT
0231_0065940101_PNU00402ODI.FIT
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0231_0065940101_PNU00404ODI.FIT
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0231_0065940101_PNU00410ODI.FIT
0231_0065940101_PNU00411ODI.FIT
0231_0065940101_PNU00412ODI.FIT
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0231_0065940101_PNU01312DLI.FIT
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0231_0065940101_PNX00000PMH.FIT
```

**RGS1**

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0231_0065940101_R1S00502SPE.FIT
0231_0065940101_R1S00503SPE.FIT
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0231_0065940101_R1S00506SPE.FIT
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0231_0065940101_R1S90102DII.FIT
0231_0065940101_R1S90203DII.FIT
0231_0065940101_R1S90304DII.FIT
0231_0065940101_R1S90405DII.FIT
0231_0065940101_R1S90506DII.FIT
0231_0065940101_R1S90608DII.FIT
0231_0065940101_R1S90709DII.FIT
0231_0065940101_R1S90801DII.FIT
0231_0065940101_R1S90902DII.FIT
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0231_0065940101_R1S91104DII.FIT
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0231_0065940101_R1S92401DII.FIT
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0231_0065940101_R1X00000D1H.FIT
0231_0065940101_R1X00000D2H.FIT
0231_0065940101_R1X00000OFX.FIT
0231_0065940101_R1X00000PFH.FIT
```

**RGS2**

```
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0231_0065940101_R2S00602SPE.FIT
0231_0065940101_R2S00603SPE.FIT
0231_0065940101_R2S00605SPE.FIT
0231_0065940101_R2S00606SPE.FIT
0231_0065940101_R2S00607SPE.FIT
0231_0065940101_R2S00608SPE.FIT
0231_0065940101_R2S00609SPE.FIT
0231_0065940101_R2S90001DII.FIT
0231_0065940101_R2S90102DII.FIT
0231_0065940101_R2S90203DII.FIT
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0231_0065940101_R2S90709DII.FIT
0231_0065940101_R2S90801DII.FIT
0231_0065940101_R2S90902DII.FIT
0231_0065940101_R2S91003DII.FIT
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0231_0065940101_R2S91601DII.FIT
0231_0065940101_R2S91702DII.FIT
0231_0065940101_R2S91803DII.FIT
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0231_0065940101_R2S92006DII.FIT
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0231_0065940101_R2S92208DII.FIT
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0231_0065940101_R2S92705DII.FIT
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0231_0065940101_R2X00000PFH.FIT
```

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0231_0065940101_RMX00100ESX.FIT
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0231_0065940101_SCX00000P1S.FIT
0231_0065940101_SCX00000P2S.FIT
0231_0065940101_SCX00000P3S.FIT
0231_0065940101_SCX00000P4S.FIT
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0231_0065940101_SCX00000P6S.FIT
0231_0065940101_SCX00000P7S.FIT
0231_0065940101_SCX00000P8S.FIT
0231_0065940101_SCX00000P9S.FIT
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0231_0065940101_SCX00000ROS.ASC
0231_0065940101_SCX00000SUM.ASC
0231_0065940101_SCX00000SUM.SAS
0231_0065940101_SCX00000TCS.FIT
0231_0065940101_SCX00000TCX.FIT
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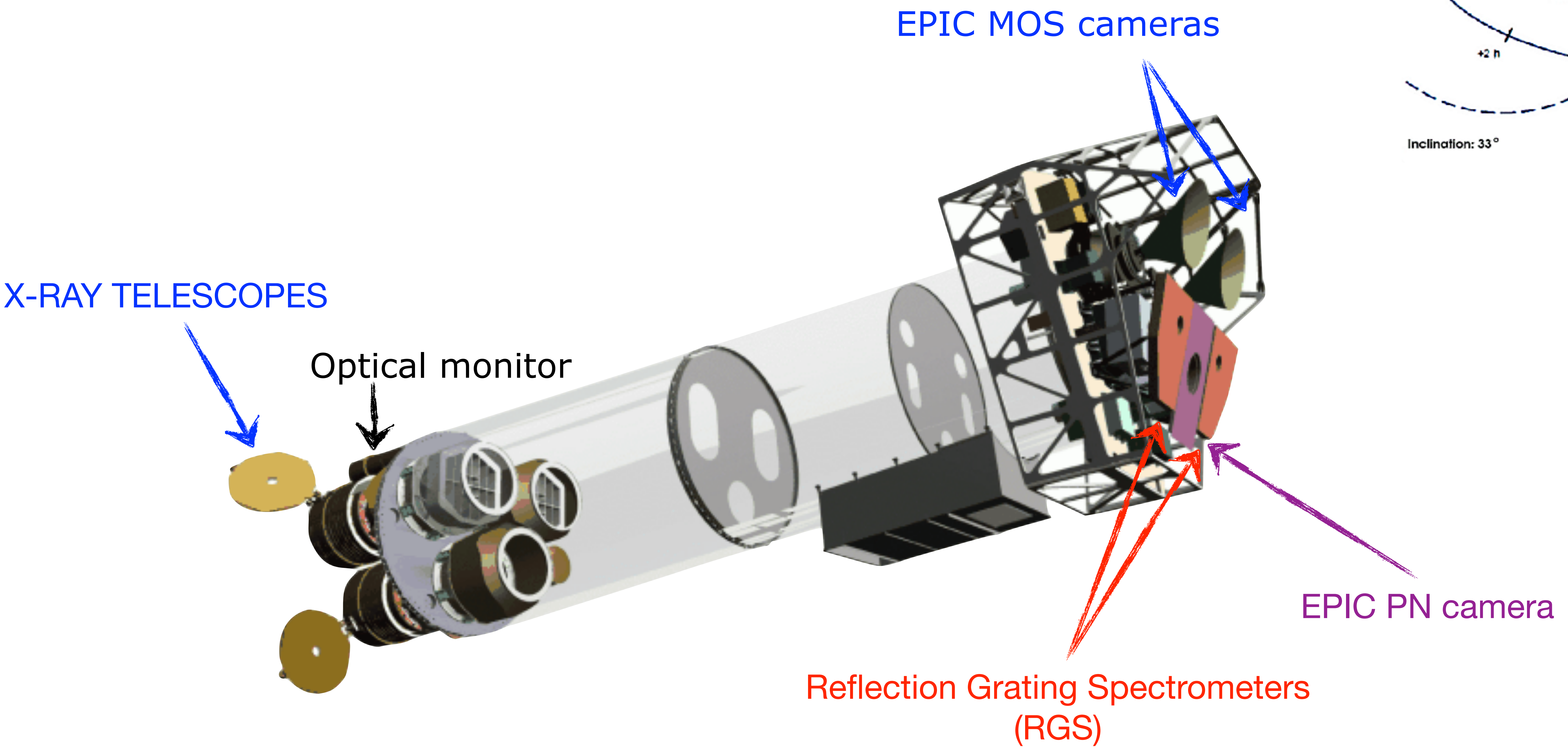
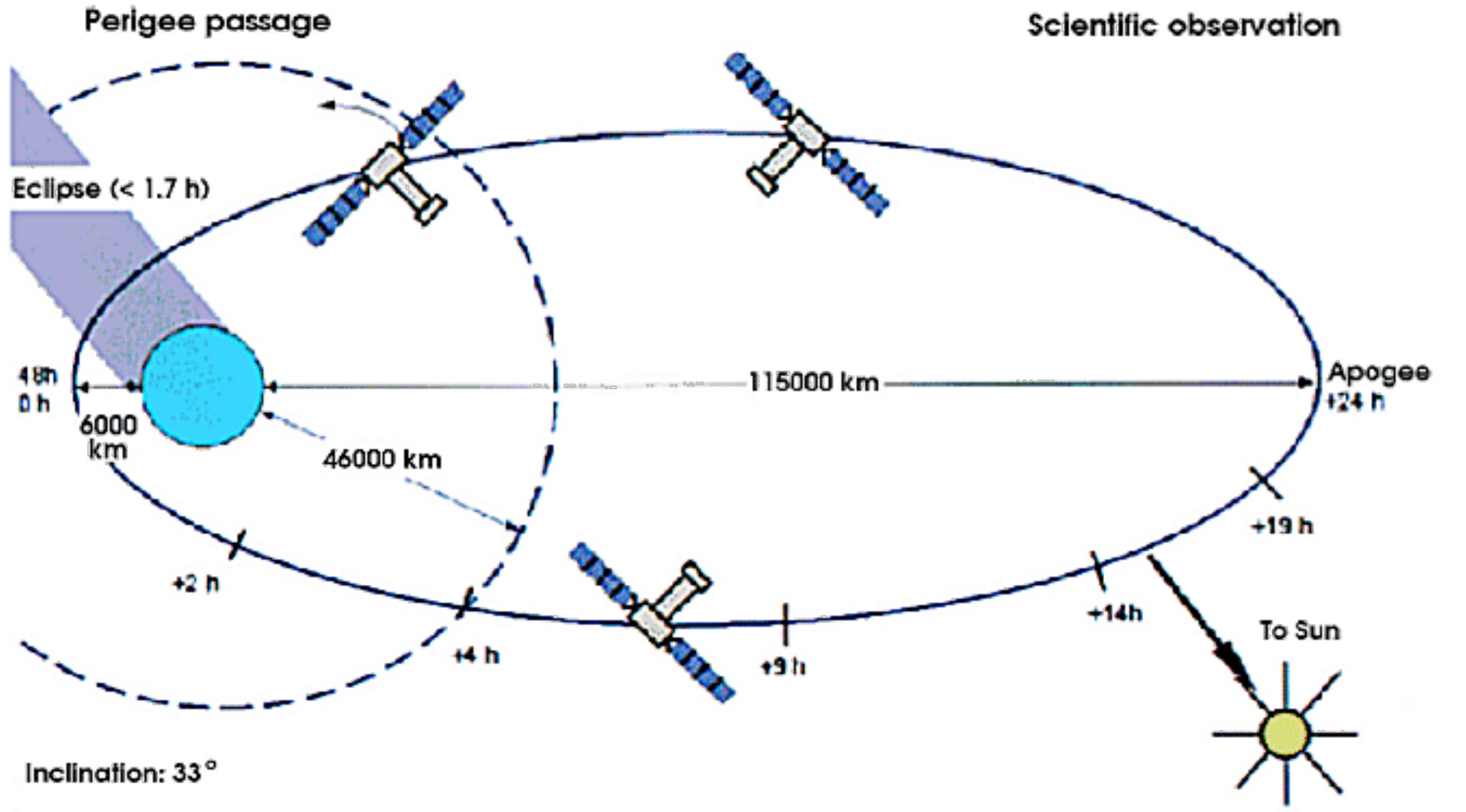
# The spacecraft




Eccentric 48-hour orbit around the Earth
Inclination 40 degrees to the Equator

Image courtesy of Dornier Satellitensysteme GmbH and ESA

# XMM-Newton archive & data download

https://www.cosmos.esa.int/web/xmm-newton/xsa

XMM-Newton » Archive, Pipeline & Catalogues » XMM-Newton Science Archive

- Home / Latest News
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## XMM-NEWTON SCIENCEX ARCHIVE (XSA)

### INDEX

- Access to XMM-Newton Data and Source Catalogues
- Download Full XMM-Newton Catalogues and datasets ***New***
- Tools
- Watchouts
- Notes on the XSA releases ***New***
- Documentation
- Questions, Comments

---

### ACCESS TO XMM-NEWTON DATA AND SOURCE CATALOGUES

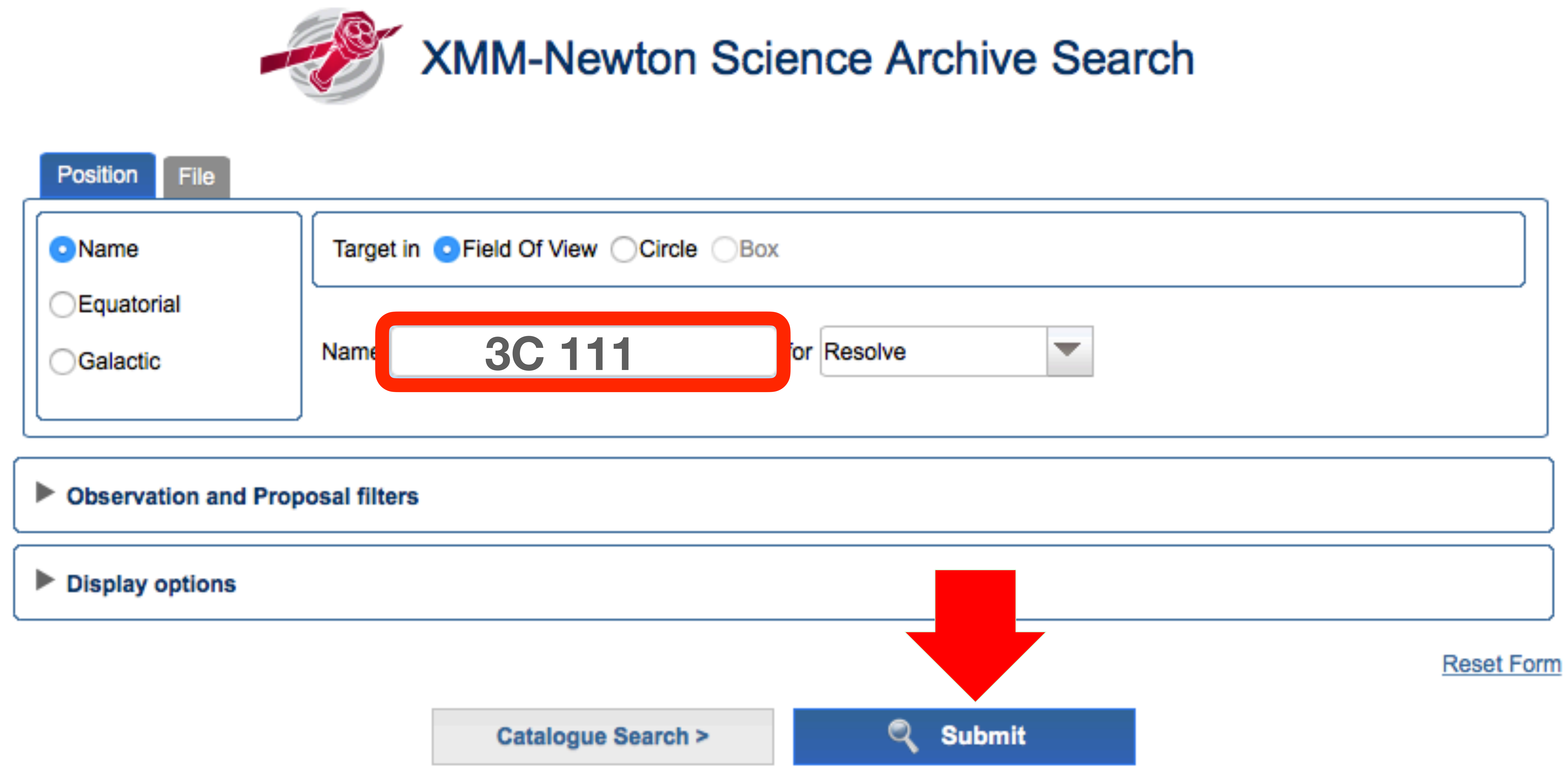
**Search the XMM-Newton Science Archive (XSA)**

Direct access to the XSA data via URL or AIO (Archive Inter… ystem):

**Command line and URL access to the XSA data**

Astroquery and TAP (Table Access Protocol) access to the XSA Database:

**Astroquery** and **TAP queries** to the XSA Database


XMM-Newton Science Archive Search
Position
File
Name
Equatorial
Galactic
Target in
Field Of View
Circle
Box
Name
3C 111
for
Resolve
Observation and Proposal filters
Display options
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Catalogue Search >
Submit

OBSERVATIONS (2)

Columns | Column units | Display selected | Add to Basket | Save table as | Send table to | RGS Spectra

| | | | Obs.ID | EPIC | RGS | BKGD | ESASky | Target | RA | DEC | Rev | Distance | Start Date | End Date | Dur. | Target Type | PI name | Prop. Program |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0552180101 | | | | | 3C111 | 04h 18m 21.27s | +38d 01' 35.7" | 1683 | 0 | 2009-02-15 17:25:11 | 2009-02-17 04:01:23 | 124572 | RADIO GALAXY RADIO LOUD/FLAT SPECT FLAT RADIO SP | MARSCHER, ALAN | GO |
| | | | 0065940101 | | | | | 3C 111 | 04h 18m 21.07s | +38d 01' 32.6" | 231 | 0.07 | 2001-03-14 12:56:44 | 2001-03-15 01:23:52 | 44828 | SEYFERT RADIO LOUD STEEP RADIO SP | Eracleous, Michael | GO |

| Public Date | PPS ver | Coord. Obs |
|---|---|---|
| Public data | 17.56_20190403_1200 | - |
| Public data | 17.56_20190403_1200 | RXTE |


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XMM-Newton Science Archive
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TAP QUERIES
ASTROQUERY
Basket
Back to Search
Close all
Results #1
OBSERVATIONS (2)
Columns
Column units
Display selected
Add to Basket
Save table as
Send table to
RGS Spectra
Obs.ID
EPIC
RGS
BKGD
ESASky
Target
RA
DEC
Rev
Distance
Start Date
End Date
0552180101
3C111
04h 18m 21.27s
+38d 01' 35.7"
1683
0
2009-02-15 17:25:11
0065940101
3C 111
04h 18m 21.07s
+38d 01' 32.6"
231
0.07
2001-03-14 12:56:44
Details for Observation 0065940101
EPIC Image
RGS fluxed spectrum
Summary
Science Exposures
Publications
Obs. ID
0065940101
Revolution
231
Target
3C 111
Exposures
3 EPIC, 14 OM, 2 RGS
Proposal Abstract
Structure of the Accretion Flows in Broad-Line Radio Galaxies
We propose to observe four of the X-ray brightest broad-line radio galaxies in order to investigate the differneces between the profiles of the Fe K lines of radio-loud and radio quiet AGNs. We will obtain spectra with very high signal-to-noise ratio with EPIC so that we can fit the line profiles with disk models and determine the range of radii in the disk where the lines originate. This constitutes a test of scenarios for the difference between radio-loud and radio-quiet AGNs since such scenrios predict different disk structures and by extension different line profiles.
Show Quality Report


0552180101.tar.gz

# Data analysis: *Standard Analysis System (SAS)*

**ODF**
(Observation Data Files)

→ **Data Processing** →

**EVT**
**ccf.cif** (Calibration Index Files)
**evt** (event files)

- cifbuild
- odfingest

SAS start-up

- emproc (for EPIC-MOS)
- epproc (for EPIC-pn)

# Data analysis: *Standard Analysis System (SAS)*

**ODF**

(Observation Data Files)

# Data Processing

**EVT**

ccf.cif (Calibration Index Files)

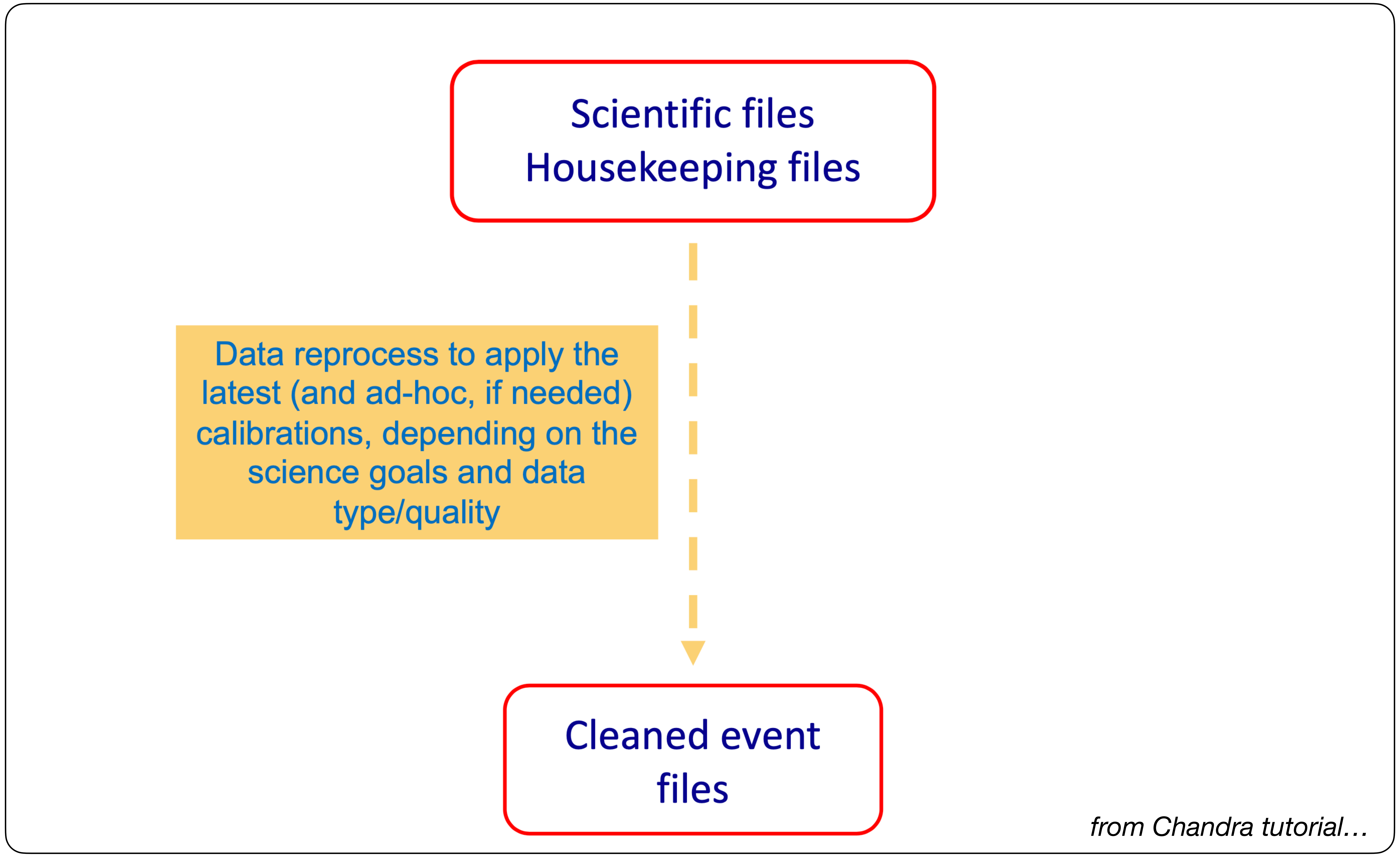
```
0231_0065940101_AttHk.ds                      0231_0065940101_EMOS2_S007_01_Badpixels.ds  0231_0065940101_EPN_S004_02_Badpixels.ds  0231_0065940101_EPN_S004_11_Badpixels.ds
0231_0065940101_EMOS1_S003_01_Badpixels.ds    0231_0065940101_EMOS2_S007_02_Badpixels.ds  0231_0065940101_EPN_S004_03_Badpixels.ds  0231_0065940101_EPN_S004_12_Badpixels.ds
0231_0065940101_EMOS1_S003_02_Badpixels.ds    0231_0065940101_EMOS2_S007_03_Badpixels.ds  0231_0065940101_EPN_S004_04_Badpixels.ds  0231_0065940101_EPN_S004_ImagingEvts.ds
0231_0065940101_EMOS1_S003_03_Badpixels.ds    0231_0065940101_EMOS2_S007_04_Badpixels.ds  0231_0065940101_EPN_S004_05_Badpixels.ds  ccf.cif
0231_0065940101_EMOS1_S003_04_Badpixels.ds    0231_0065940101_EMOS2_S007_05_Badpixels.ds  0231_0065940101_EPN_S004_06_Badpixels.ds  m1.evt
0231_0065940101_EMOS1_S003_05_Badpixels.ds    0231_0065940101_EMOS2_S007_06_Badpixels.ds  0231_0065940101_EPN_S004_07_Badpixels.ds  m2.evt
0231_0065940101_EMOS1_S003_06_Badpixels.ds    0231_0065940101_EMOS2_S007_07_Badpixels.ds  0231_0065940101_EPN_S004_08_Badpixels.ds  pn.evt
0231_0065940101_EMOS1_S003_07_Badpixels.ds    0231_0065940101_EMOS2_S007_ImagingEvts.ds   0231_0065940101_EPN_S004_09_Badpixels.ds
0231_0065940101_EMOS1_S003_ImagingEvts.ds     0231_0065940101_EPN_S004_01_Badpixels.ds    0231_0065940101_EPN_S004_10_Badpixels.ds
```

- ✔ odfingest

- ✔ emproc (for EPIC-MOS)
- ✔ epproc (for EPIC-pn)

export SAS_CCF='/home/gruppo01/3C111_xmm/2009/evt/ccf.cif'

# Data Reduction



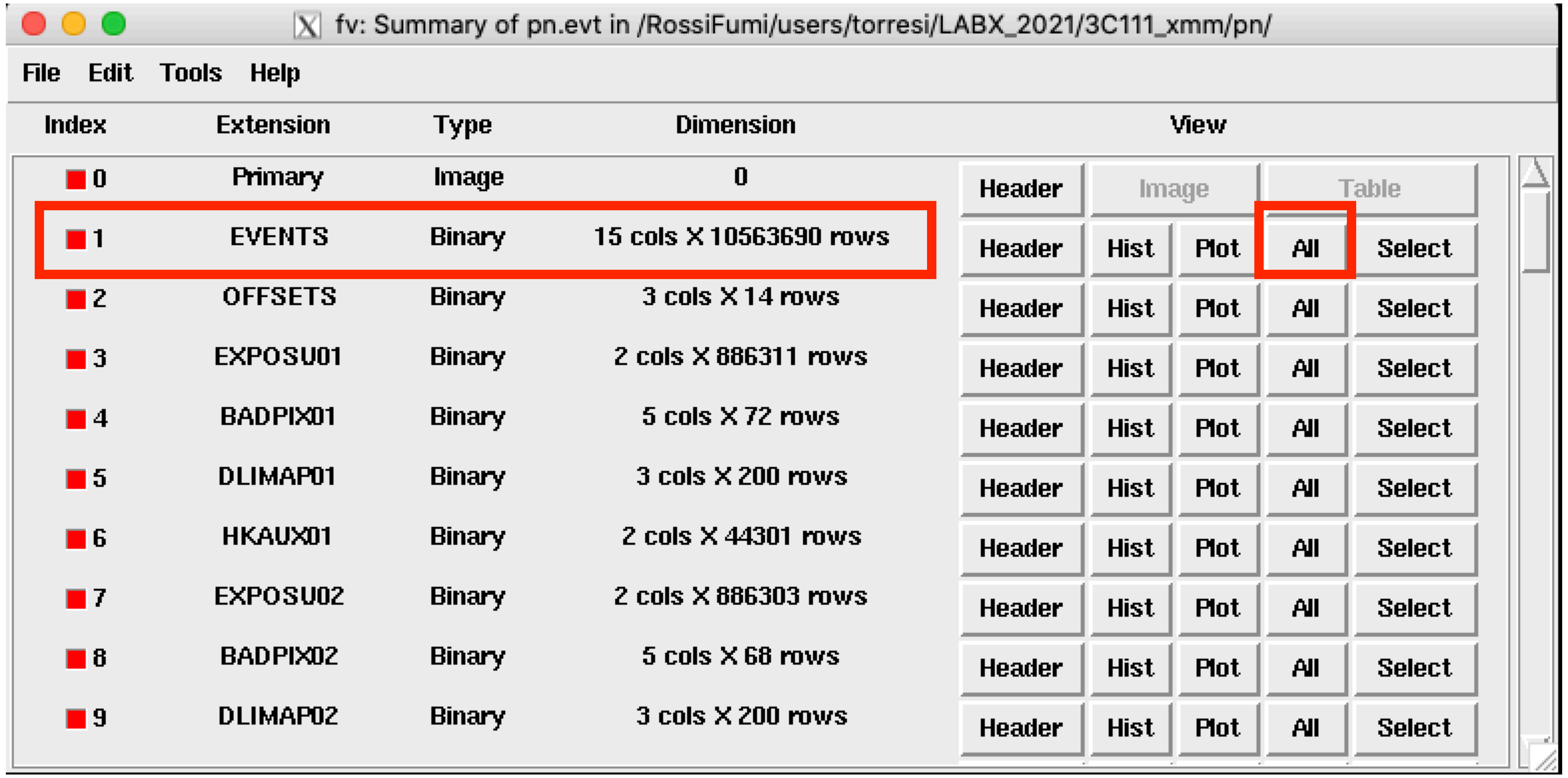

IMAGE

SPECTRUM

LIGHT CURVE

# fv pn.evt

#rows=#counts



fv: Summary of pn.evt in /RossiFumi/users/torresi/LABX_2021/3C111_xmm/pn/

File Edit Tools Help

| Index | Extension | Type | Dimension | View | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | Primary | Image | 0 | Header | Image | | Table | |
| 1 | EVENTS | Binary | 15 cols X 10563690 rows | Header | Hist | Plot | All | Select |
| 2 | OFFSETS | Binary | 3 cols X 14 rows | Header | Hist | Plot | All | Select |
| 3 | EXPOSU01 | Binary | 2 cols X 886311 rows | Header | Hist | Plot | All | Select |
| 4 | BADPIX01 | Binary | 5 cols X 72 rows | Header | Hist | Plot | All | Select |
| 5 | DLIMAP01 | Binary | 3 cols X 200 rows | Header | Hist | Plot | All | Select |
| 6 | HKAUX01 | Binary | 2 cols X 44301 rows | Header | Hist | Plot | All | Select |
| 7 | EXPOSU02 | Binary | 2 cols X 886303 rows | Header | Hist | Plot | All | Select |
| 8 | BADPIX02 | Binary | 5 cols X 68 rows | Header | Hist | Plot | All | Select |
| 9 | DLIMAP02 | Binary | 3 cols X 200 rows | Header | Hist | Plot | All | Select |

X,Y -> image
Time -> light curve
Energy -> spectrum

# fv pn.evt

fv: Summary of pn.evt in /RossiFumi/users/torresi/LABX_2021/3C111_xmm/pn/

File Edit Tools Help

#rows=

fv: Binary Table of pn.evt[1] in /RossiFumi/users/torresi/LABX_2021/3C111_xmm/pn/

File Edit Tools Help

| Select | TIME | RAWX | RAWY | DETX | DETY | X | Y | PHA | PI | FLAG | PATTERN | PAT_ID | PAT_SEQ | CCDNR | TIME_RAW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D | I | I | I | I | J | J | I | I | J | B | I | B | B | D |
| All | s | pixel | pixel | 0.05 arcsec | 0.05 arcsec | 0.05 arcsec | 0.05 arcsec | channel | eV | | | | | | s |
| Invert | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify | Modify |
| 1 | 1.009638769452E+08 | 12 | 117 | -3187 | 5809 | 22906 | 22156 | 1069 | 6095 | 0 | 2 | 5121 | 0 | 1 | 1.009638769231E+08 |
| 2 | 1.009638775018E+08 | 45 | 125 | -5930 | 5147 | 20370 | 23392 | 29 | 285 | 0 | 2 | 5121 | 0 | 1 | 1.009638774951E+08 |
| 3 | 1.009638775176E+08 | 46 | 132 | -6049 | 4557 | 20381 | 23994 | 31 | 291 | 0 | 3 | 5122 | 1 | 1 | 1.009638774951E+08 |
| 4 | 1.009638774790E+08 | 46 | 138 | -5980 | 4137 | 20539 | 24389 | 22 | 233 | 0 | 4 | 5123 | 4 | 1 | 1.009638774951E+08 |
| 5 | 1.009638775139E+08 | 46 | 150 | -5991 | 3091 | 20753 | 25413 | 23 | 241 | 0 | 3 | 5124 | 1 | 1 | 1.009638774951E+08 |
| 6 | 1.009638794362E+08 | 24 | 144 | -4198 | 3643 | 22385 | 24488 | 136 | 1031 | 0 | 1 | 5121 | 0 | 1 | 1.009638794493E+08 |
| 7 | 1.009638806363E+08 | 50 | 172 | -6326 | 1271 | 20817 | 27263 | 38 | 409 | 0 | 4 | 5121 | 0 | 1 | 1.009638806409E+08 |
| 8 | 1.009638806306E+08 | 55 | 172 | -6742 | 1298 | 20405 | 27326 | 34 | 340 | 0 | 2 | 5122 | 0 | 1 | 1.009638806409E+08 |
| 9 | 1.009638806432E+08 | 64 | 172 | -7476 | 1286 | 19691 | 27495 | 43 | 614 | 5 | 207 | 3 | 0 | 1 | 1.009638806409E+08 |
| 10 | 1.009638834399E+08 | 4 | 165 | -2579 | 1890 | 24343 | 25852 | 329 | 1700 | 0 | 0 | 0 | 0 | 1 | 1.009638834531E+08 |
| 11 | 1.009638856608E+08 | 6 | 181 | -2726 | 560 | 24486 | 27183 | 2334 | 19753 | 0 | 3 | 5121 | 1 | 1 | 1.009638856457E+08 |
| 12 | 1.009638866421E+08 | 2 | 174 | -2422 | 1127 | 24661 | 26563 | 872 | 7050 | 0 | 11 | 5121 | 1 | 1 | 1.009638866466E+08 |
| 13 | 1.009638878099E+08 | 12 | 185 | -3187 | 241 | 24104 | 27593 | 353 | 3002 | 0 | 7 | 5121 | 1 | 1 | 1.009638877905E+08 |
| 14 | 1.009638927632E+08 | 42 | 124 | -5690 | 5292 | 20573 | 23199 | 365 | 1899 | 0 | 0 | 0 | 0 | 1 | 1.009638927476E+08 |
| 15 | 1.009638928897E+08 | 33 | 200 | -4922 | -1024 | 22682 | 29202 | 1227 | 6470 | 4 | 0 | 0 | 0 | 1 | 1.009638928906E+08 |
| 16 | 1.009638944018E+08 | 56 | 102 | -6864 | 7074 | 19043 | 21711 | 49 | 470 | 5 | 1 | 1 | 0 | 1 | 1.009638944158E+08 |
| 17 | 1.009638957090E+08 | 1 | 142 | -2305 | 3806 | 24199 | 23922 | 292 | 1512 | 4 | 0 | 0 | 0 | 1 | 1.009638957028E+08 |
| 18 | 1.009638967794E+08 | 47 | 128 | -6129 | 4891 | 20231 | 23685 | 27 | 248 | 0 | 1 | 5121 | 2 | 1 | 1.009638967990E+08 |
| 19 | 1.009638967981E+08 | 47 | 140 | -6125 | 3905 | 20447 | 24647 | 24 | 236 | 0 | 1 | 5122 | 5 | 1 | 1.009638967990E+08 |
| 20 | 1.009638967894E+08 | 47 | 152 | -6104 | 2977 | 20667 | 25549 | 24 | 350 | 1 | 78 | 3 | 1 | 1 | 1.009638967990E+08 |
| 21 | 1.009638967825E+08 | 47 | 173 | -6104 | 1236 | 21041 | 27249 | 27 | 267 | 0 | 1 | 5124 | 4 | 1 | 1.009638967990E+08 |
| 22 | 1.009638968113E+08 | 15 | 175 | -3474 | 1002 | 23660 | 26912 | 611 | 3896 | 0 | 3 | 5125 | 1 | 1 | 1.009638967990E+08 |
| 23 | 1.009638993268E+08 | 5 | 188 | -2620 | -61 | 24723 | 27766 | 244 | 1509 | 0 | 1 | 5121 | 0 | 1 | 1.009638993252E+08 |
| 24 | 1.009639017368E+08 | 24 | 166 | -4212 | 1776 | 22773 | 26315 | 31 | 158 | 0 | 0 | 0 | 2 | 1 | 1.009639017561E+08 |
| 25 | 1.009639021557E+08 | 15 | 184 | -3465 | 323 | 23815 | 27573 | 128 | 676 | 0 | 0 | 0 | 0 | 1 | 1.009639021374E+08 |
| 26 | 1.009639033902E+08 | 3 | 169 | -2501 | 1536 | 24496 | 26181 | 1060 | 5469 | 0 | 0 | 0 | 0 | 1 | 1.009639033767E+08 |
| 27 | 1.009639071054E+08 | 62 | 104 | -7352 | 6869 | 18611 | 22016 | 21 | 209 | 0 | 3 | 5121 | 1 | 1 | 1.009639070944E+08 |
| 28 | 1.009639071103E+08 | 61 | 107 | -7282 | 6617 | 18734 | 22247 | 29 | 819 | 1 | 98 | 2 | 0 | 1 | 1.009639070944E+08 |
| 29 | 1.009639071140E+08 | 11 | 144 | -3162 | 3599 | 23406 | 24309 | 24 | 235 | 0 | 1 | 5123 | 2 | 1 | 1.009639070944E+08 |

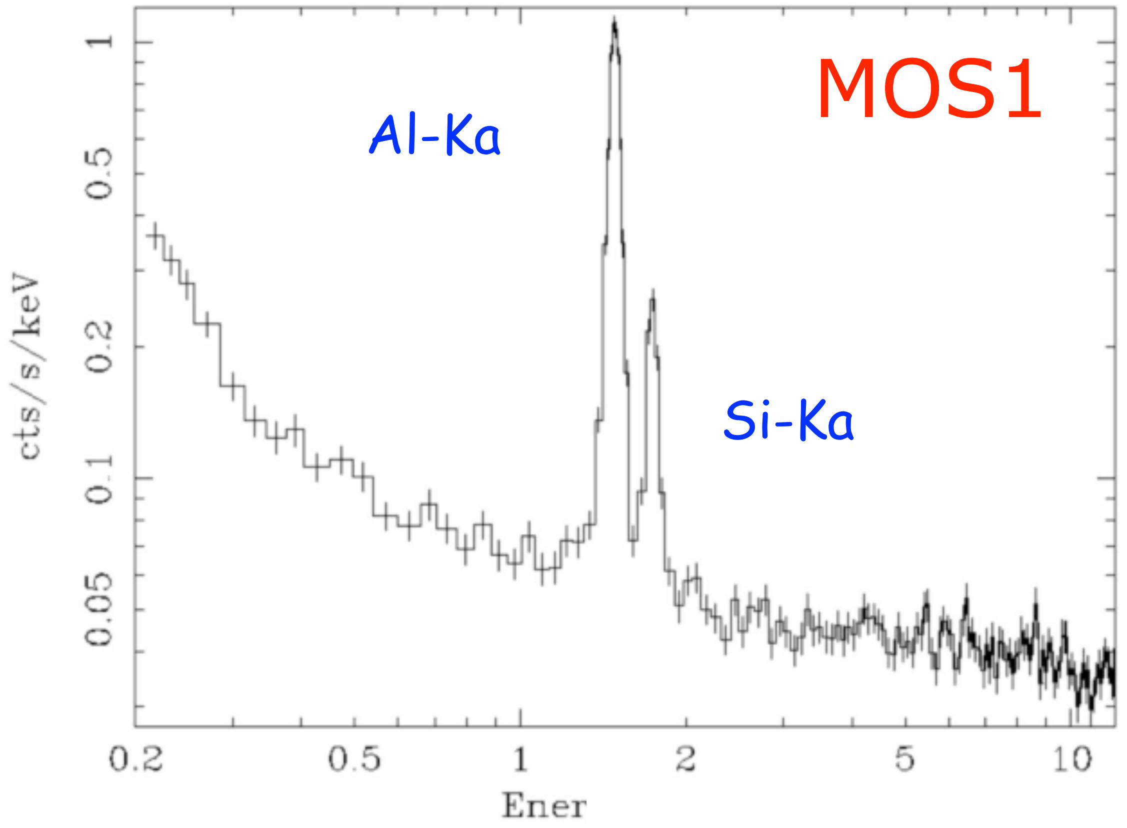
Go to: Edit cell:

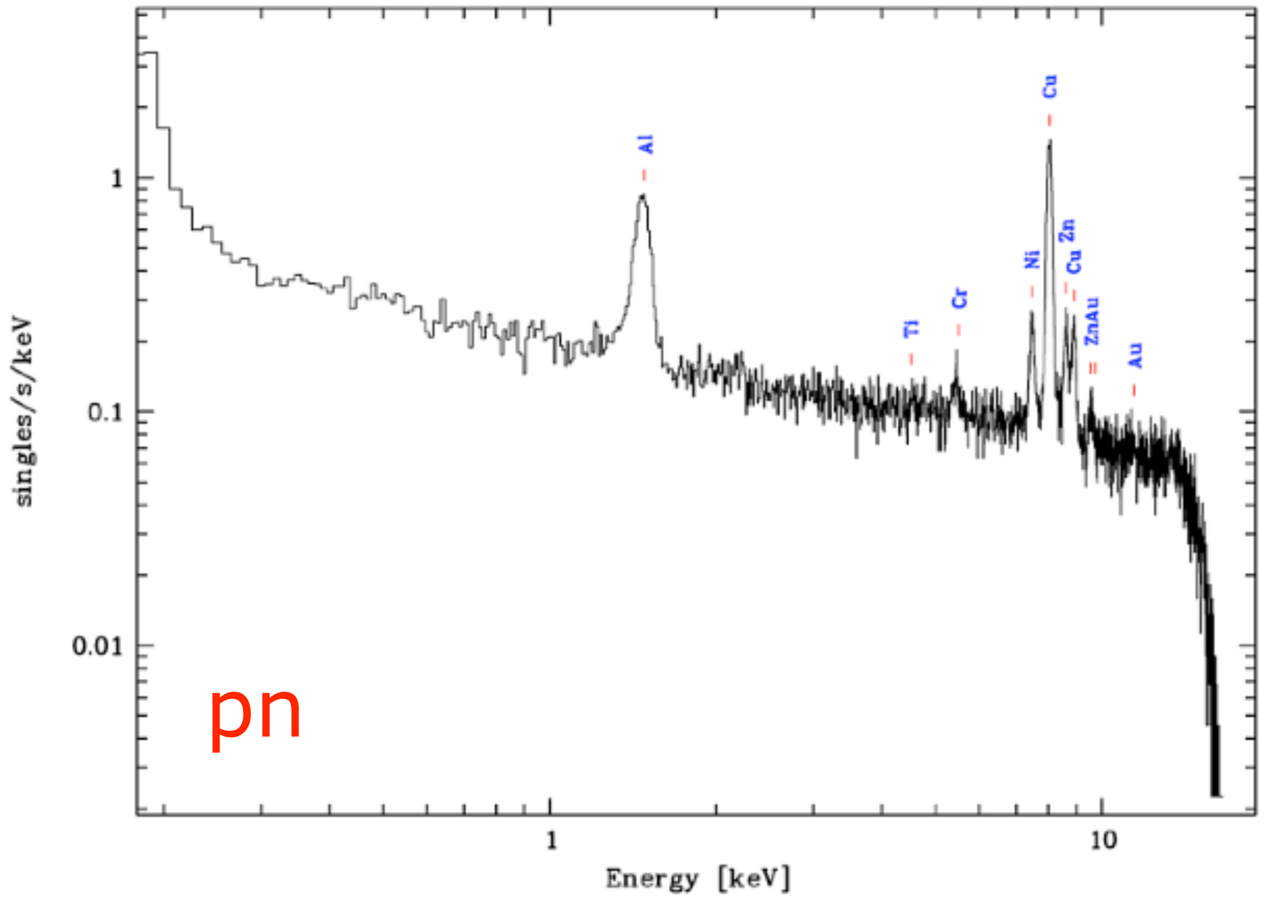
# Filtering against high background

## EPIC particle induced background

### Internal ‘quiescent’ component

high energy particles interacting with the structure surrounding the detectors and the detectors themselves



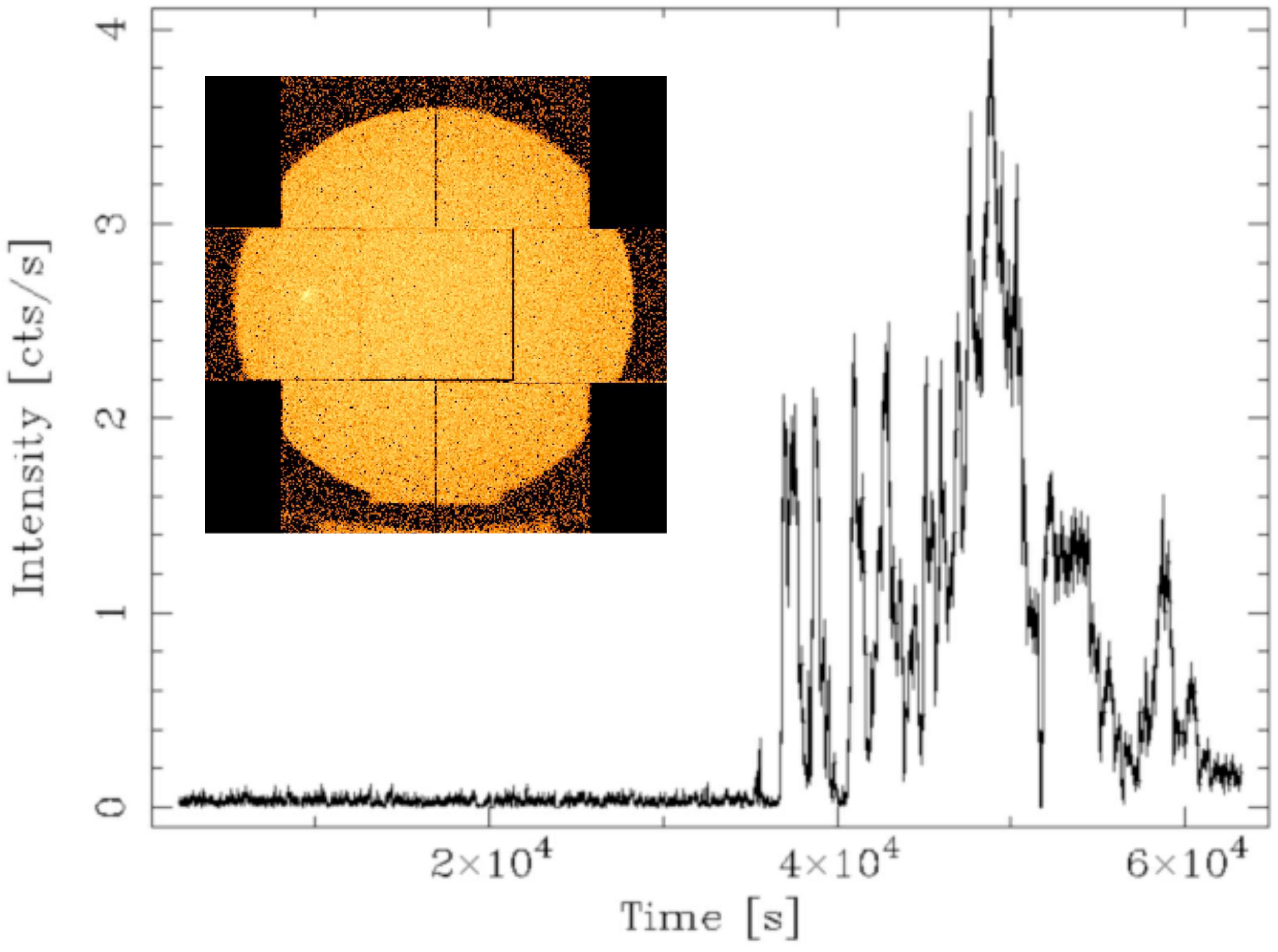



# Filtering against high background

## EPIC particle induced background

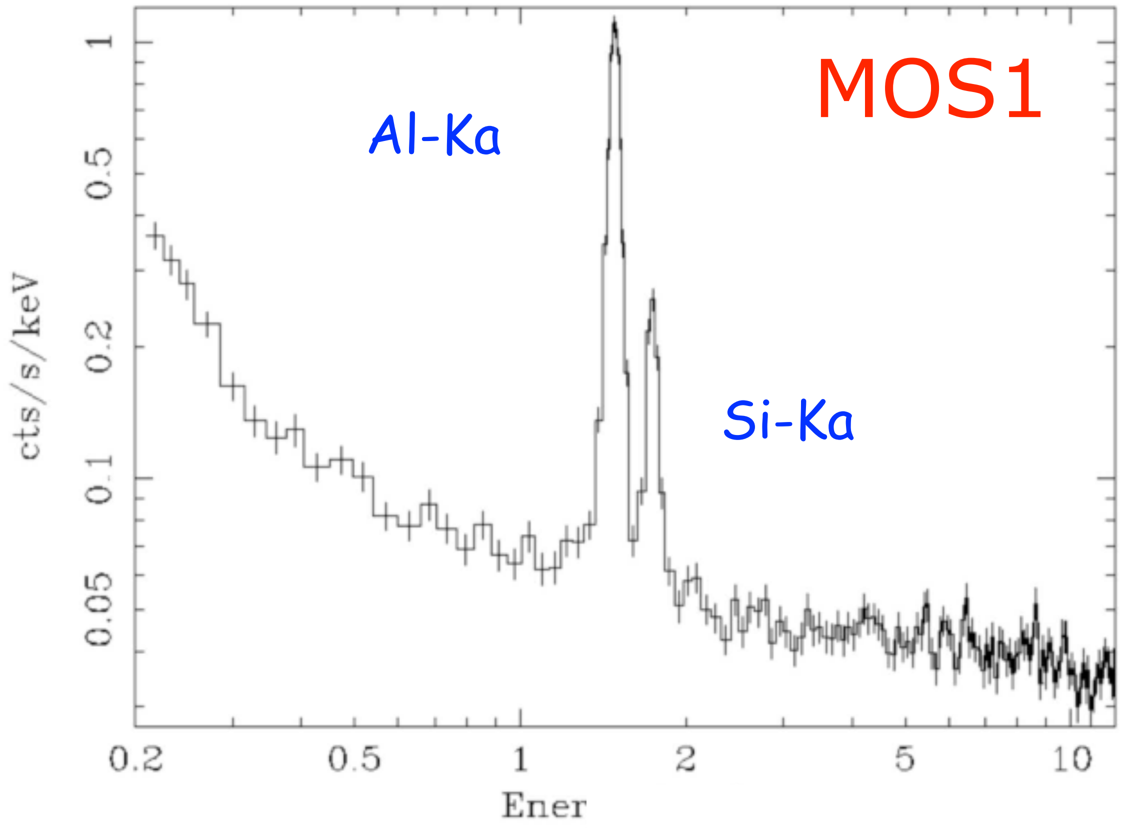
### External 'flaring' component

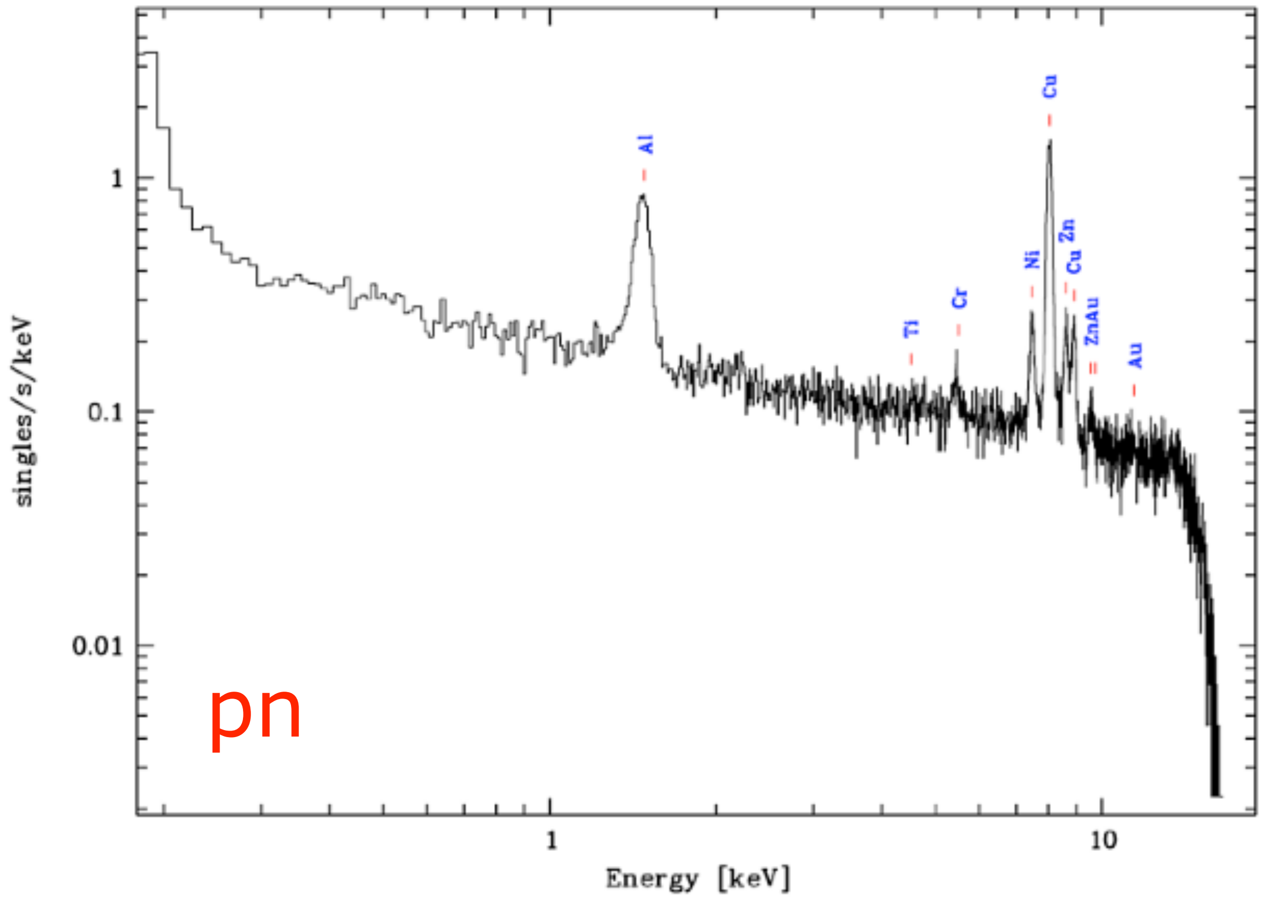
strong and rapid variability; currently attributed to soft protons ($E_p$ < a few 100 keV) likely organized in clouds populating the Earth's magneto-sphere




### Internal 'quiescent' component

high energy particles interacting with the structure surrounding the detectors and the detectors themselves



Extract a single event (i.e. pattern zero only), high energy light curve, from the event file to identify intervals of flaring particle background:

pn:

```
evselect table=pn.evt energycolumn=PI expression='#XMMEA_EP && (PI>10000&&PI<12000) && (PATTERN==0)'
withrateset=yes rateset="lcurve_sup10.lc" timebinsize=100 maketimecolumn=yes makeratecolumn=yes
```

MOS1:

```
evselect table=m1.evt energycolumn=PI expression='#XMMEA_EM && (PI>10000) &&(PATTERN==0)' withrateset=yes
rateset="lcurve_sup10.lc" timebinsize=100 maketimecolumn=yes makeratecolumn=yes
```

MOS2:

```
evselect table=m2.evt energycolumn=PI expression='#XMMEA_EM && (PI>10000) &&(PATTERN==0)' withrateset=yes
rateset="lcurve_sup10.lc" timebinsize=100 maketimecolumn=yes makeratecolumn=yes
```

**Table 7:** *List of EPIC event patterns*

| Camera | Mode | X-ray generated pattern | | | |
|---|---|---|---|---|---|
| | | singles | doubles | triples | quadruples |
| MOS | imaging | **0** | **1-4** | **5-8** | **9-12** |
| | | | | | |
| pn | imaging | **0** | **1-4** | 5-8 | 9-12 |
| | | | | | |

```
                        . . .
single event            . X .
                        . . .

                      . . . . .   . . . . .   . . . . .   . . . . .
                      . . x . .   . . . . .   . . . . .   . . . . .
double pattern        . . X . .   . . X x .   . . X . .   . x X . .
                      . . . . .   . . . . .   . . x . .   . . . . .
                      . . . . .   . . . . .   . . . . .   . . . . .

                      . . . . .   . . . . .   . . . . .   . . . . .
                      . . x . .   . . x . .   . . . . .   . . . . .
triple pattern        . x X . .   . . X x .   . . X x .   . x X . .
                      . . . . .   . . . . .   . . x . .   . . x . .
                      . . . . .   . . . . .   . . . . .   . . . . .

                      . . . . .   . . . . .   . . . . .   . . . . .
                      . m x . .   . . x m .   . . . . .   . . . . .
quadruple pattern     . x X . .   . . X x .   . . X x .   . x X . .
                      . . . . .   . . . . .   . . x m .   . m x . .
                      . . . . .   . . . . .   . . . . .   . . . . .
```

**Figure 13:** List of valid EPIC-pn patterns (cf. figure 12). Here "." marks a pixel without an event above threshold, "X" is the pixel with the maximum charge ("main pixel"), "x" is the pixel with a non-maximum charge, "m" is the pixel with the minimum charge. These 13 figures refer to the SAS PATTERN codes 0 (singles), 1-4 (doubles), 5-8 (triples) and 9-12 (quadruples), respectively. The RAWX co-ordinate is running rightward and the RAWY co-ordinate running upward.

# > lcurve

```
[torresi@login01]pn>lcurve

lcurve 1.0 (xronos6.0)

Number of time series for this task[1]
Ser. 1 filename +options (or @file of filenames +options)[lcurve_sup10.lc]
 Series 1 file    1:lcurve_sup10.lc

 Selected FITS extensions: 1 - RATE TABLE;

 Source ............                    Start Time (d) .... 11982 13:31:12.443
 FITS Extension ....  1 - `RATE      `   Stop Time (d) ..... 11983 01:16:11.936
 No. of Rows .......          423        Bin Time (s) ......    100.0
 Right Ascension ...                     Internal time sys.. Converted to TJD
 Declination .......                     Experiment ........ XMM      EPN
 Filter ............ Thin1
 Corrections applied: Vignetting - No ; Deadtime - No ; Bkgd - No ; Clock - Yes

 Selected Columns:  3- Time;  1- Y-axis;  2- Y-error;

 File contains binned data.

Name of the window file ('-' for default window)[-]

 Expected Start ... 11982.56333845733  (days)      13:31:12:443  (h:m:s:ms)
 Expected Stop .... 11983.05291592991  (days)       1:16:11:936  (h:m:s:ms)

 Minimum Newbin Time    100.00000      (s)
 for Maximum Newbin No..              423

 Default Newbin Time is:   100.00000    (s) (to have 1 Intv. of     423 Newbins)
 Type INDEF to accept the default value

Newbin Time or negative rebinning[100]

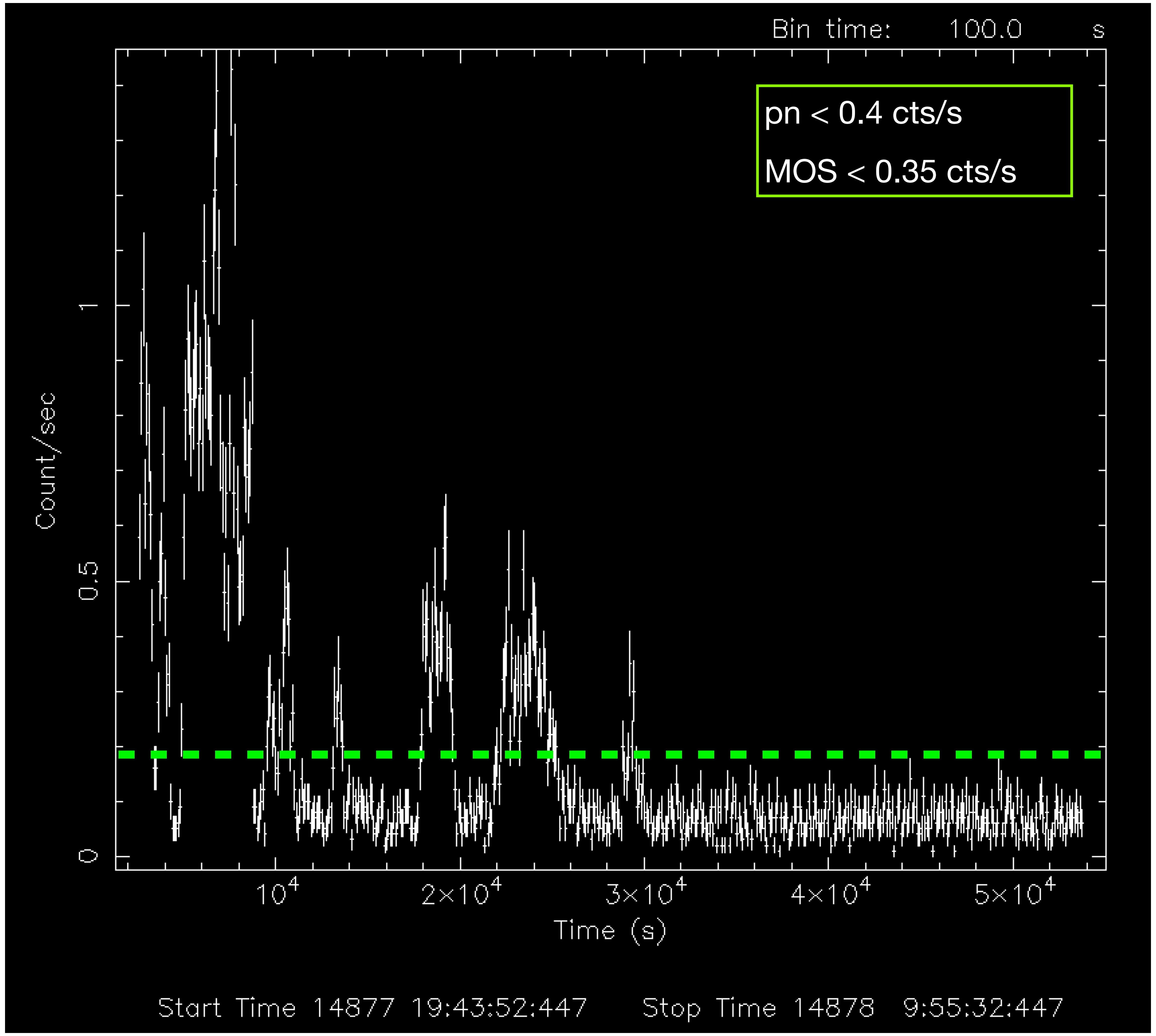
 Newbin Time ......     100.00000      (s)
 Maximum Newbin No.              423

 Default Newbins per Interval are:         423
 (giving       1 Interval of          423 Newbins)
 Type INDEF to accept the default value

Number of Newbins/Interval[423]
 Maximum of       1 Intvs. with          423 Newbins of       100.000     (s)
Name of output file[test.flc]
Do you want to plot your results?[yes]
Enter PGPLOT device[/xw]

    423 analysis results per interval

100% completed
```




Possible error!

```
PGPLOT /xw: cannot connect to X server [localhost:12.0]
 To plot  vs. Time (s), please enter
PGPLOT file/type:
```

# Selection of GOOD TIME INTERVALS (GTI)

tabgtigen table=lcurve_sup10.lc gtiset=good_bkg.gti expression=‘RATE<**0.2**’

# Generation of the cleaned event file

pn:

evselect table=**pn.evt** expression='#XMMEA_**EP** && (PI>150) && (GTI(good_bkg.gti,TIME))' withfilteredset=yes
keepfilteroutput=yes filteredset=**pn_new.evt** updateexposure=yes cleandss=yes writedss=yes

MOS1:

evselect table=**m1.evt** expression='#XMMEA_**EM** && (PI > 150) && (GTI(good_bkg.gti,TIME))' withfilteredset=yes
keepfilteroutput=yes filteredset=**mos1_new.evt** updateexposure=yes cleandss=yes writedss=yes

MOS2:

evselect table=**m2.evt** expression='#XMMEA_**EM** && (PI > 150) && (GTI(good_bkg.gti,TIME))' withfilteredset=yes
keepfilteroutput=yes filteredset=**mos2_new.evt** updateexposure=yes cleandss=yes writedss=yes

# Source & background extraction regions

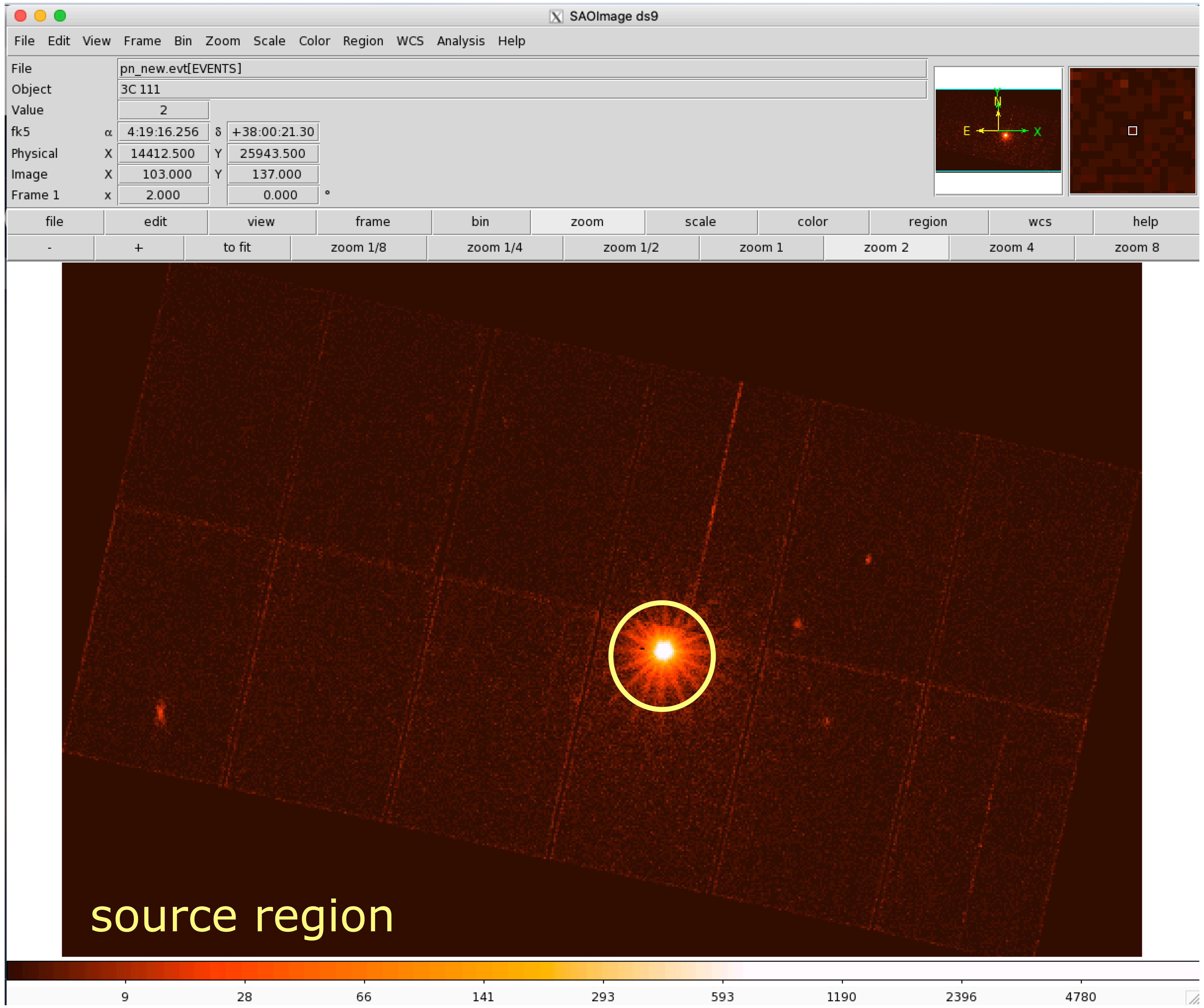
Display the cleaned pn image with ***ds9***

```
ds9 pn_new.evt &
```

> scale log
> bin (block 2, 4, …)

> Region
> save region
> file format ‘ds9’
> coordinates ‘physical’
> source.reg

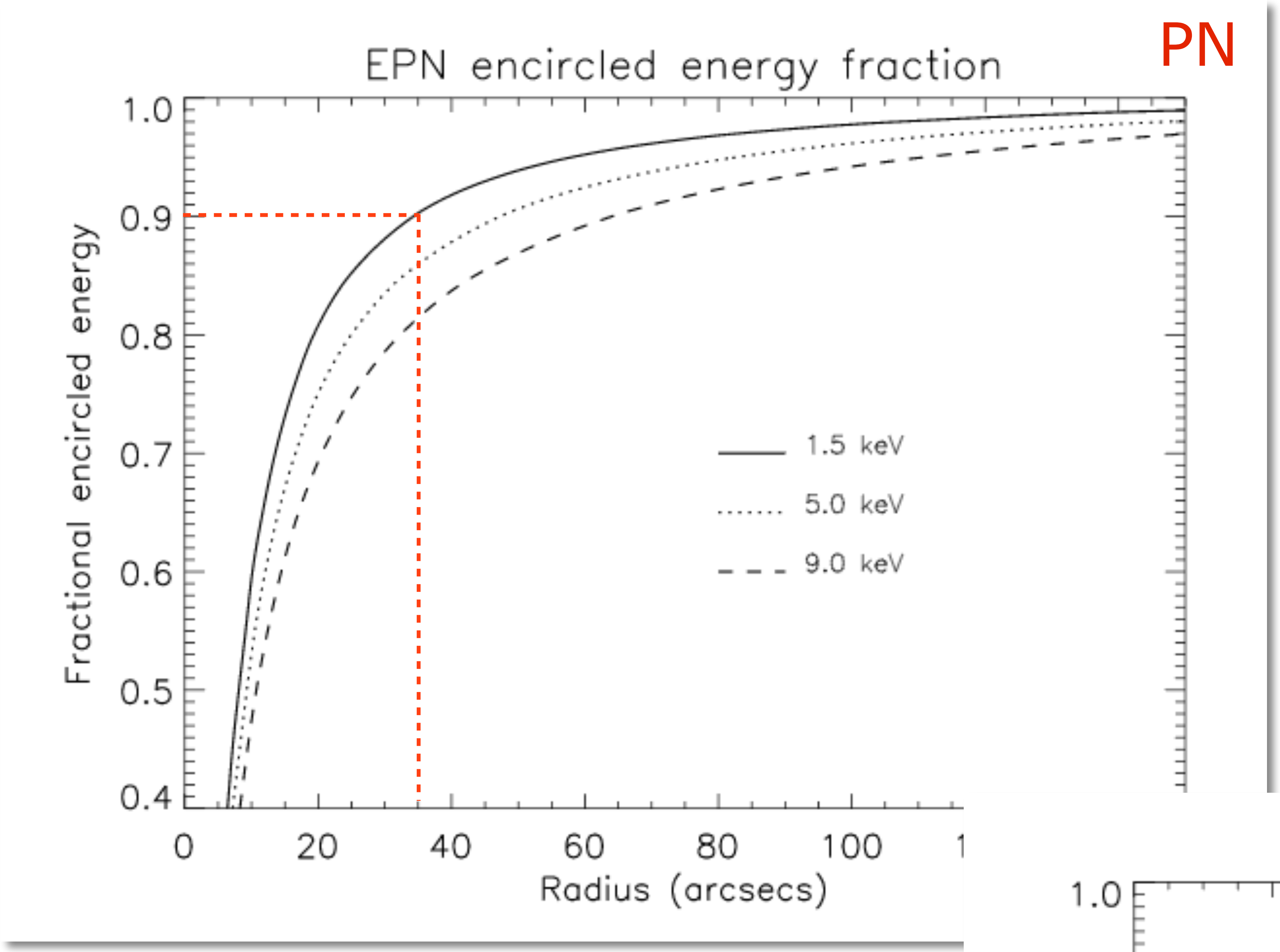
circle(27404.411,27351.501,799.99999)



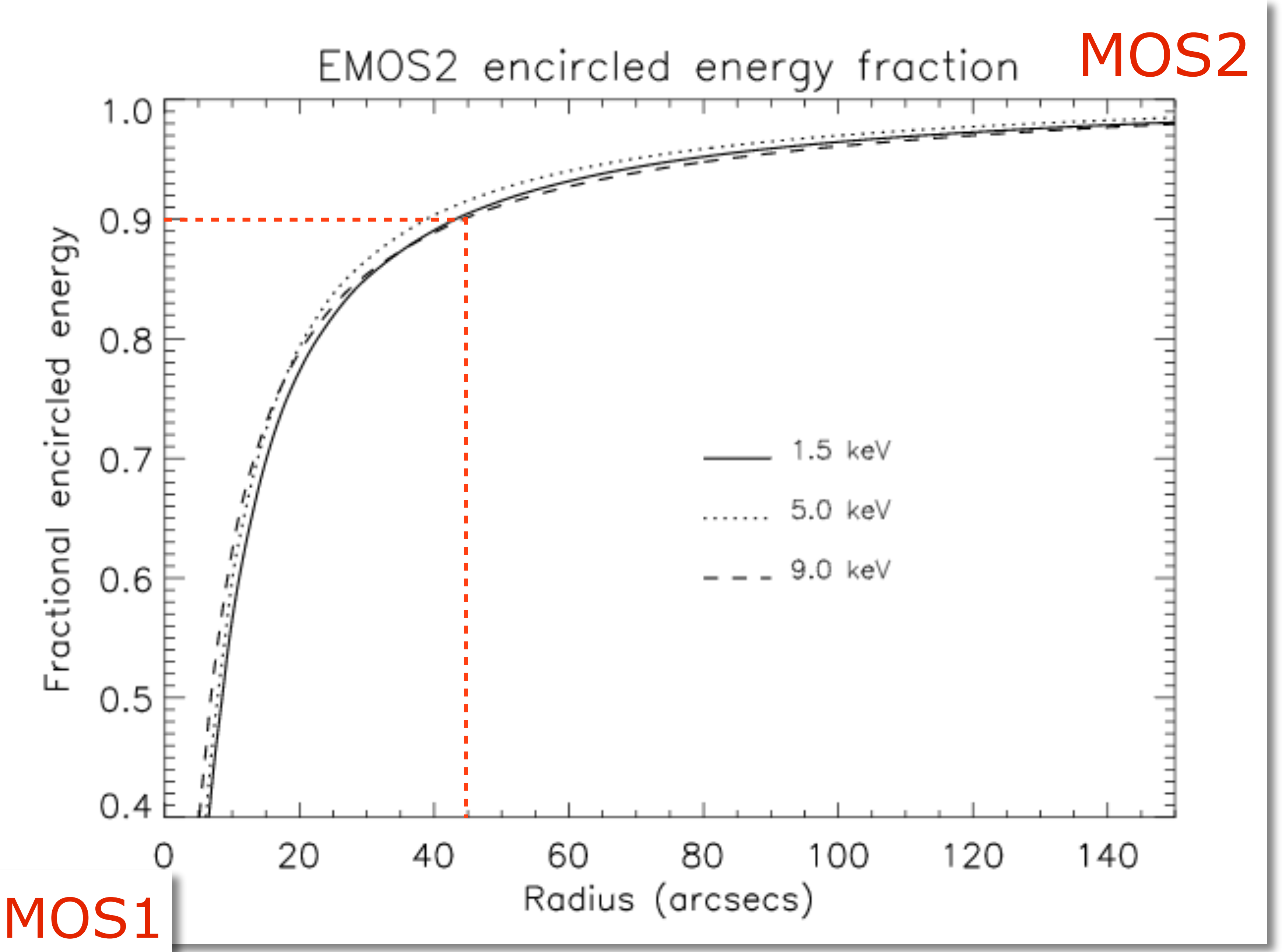

http://ds9.si.edu/doc/user/binning/index.html

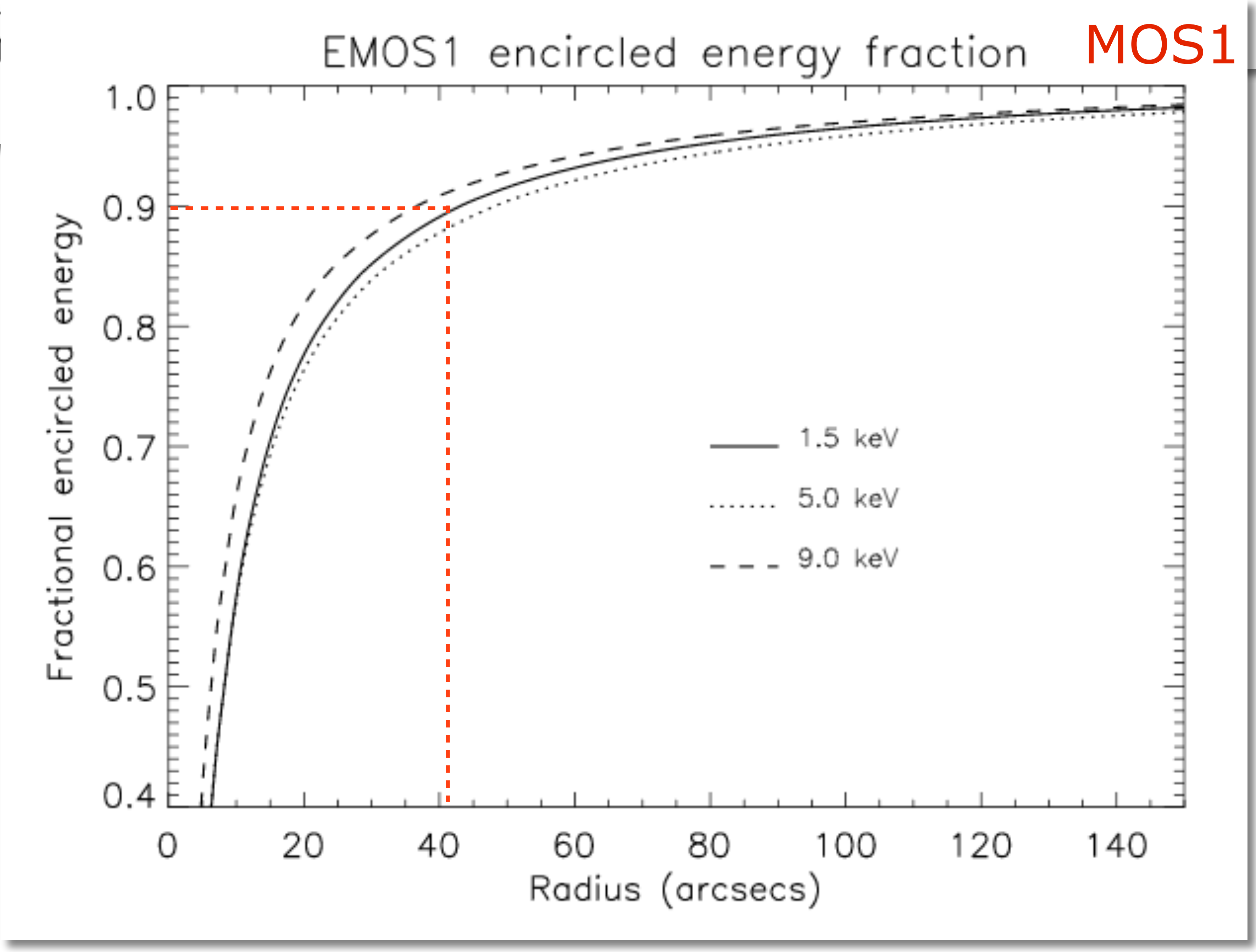
# *Encircled energy fraction*

Fraction of photons contained within a certain angular radius (on-axis)




| Extraction radius | Camera | | |
|---|---|---|---|
| (arcsec) | MOS-1 | MOS2 | EPN pointed |
| 15 | 0.68 | 0.69 | 0.71 |
| 30 | 0.83 | 0.83 | 0.88 |
| 45 | 0.89 | 0.89 | 0.93 |
| 60 | 0.92 | 0.93 | 0.95 |




see also Dadina’s lesson

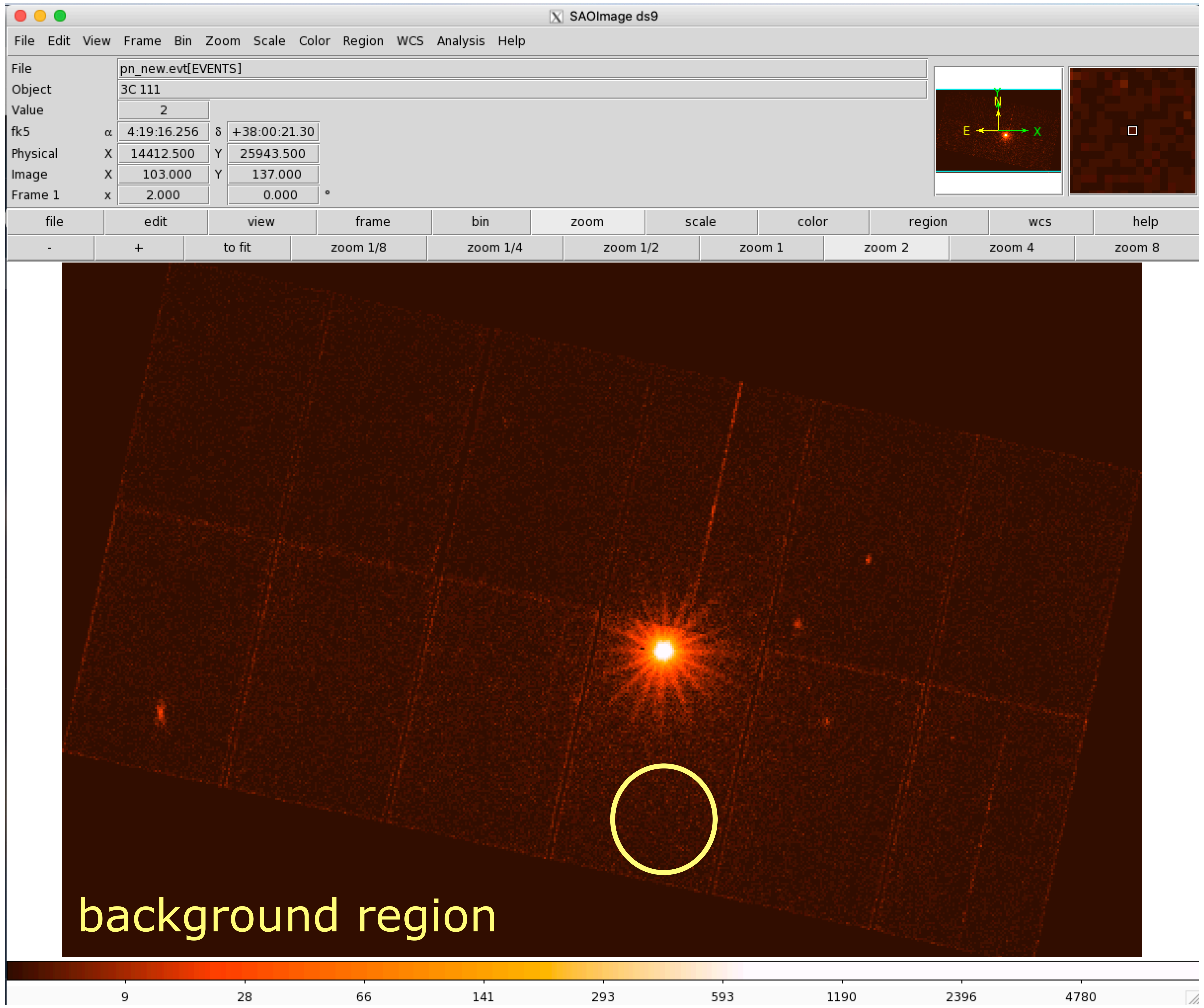
# Source & background extraction regions

Display the cleaned pn image with ***ds9***

ds9 pn_new.evt &

> scale log
> bin (block 2, 4, …)

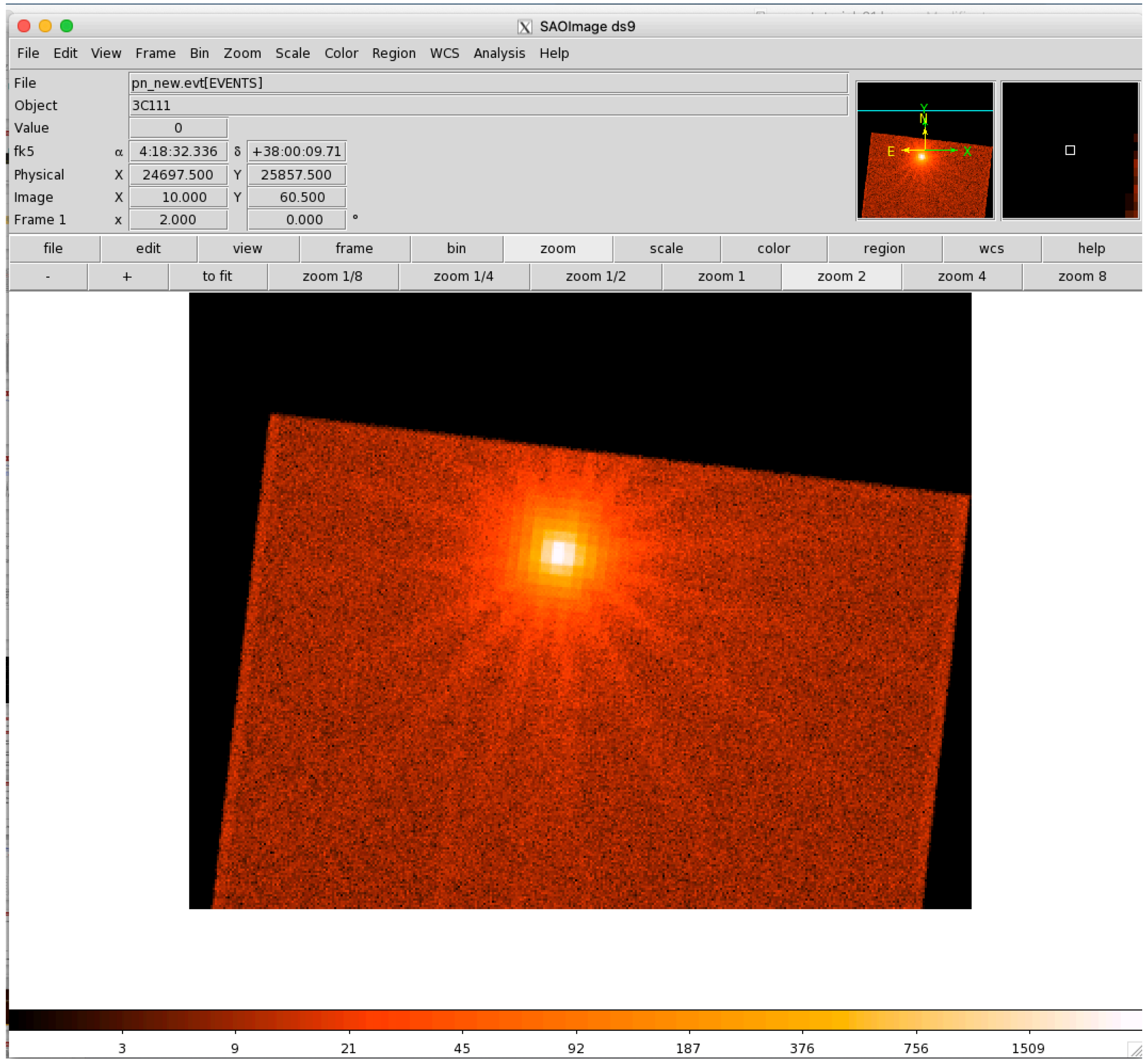
> Region
> save region
> file format 'ds9'
> coordinates 'physical'
> back.reg




circle(27948.55,22135.48,799.99999)

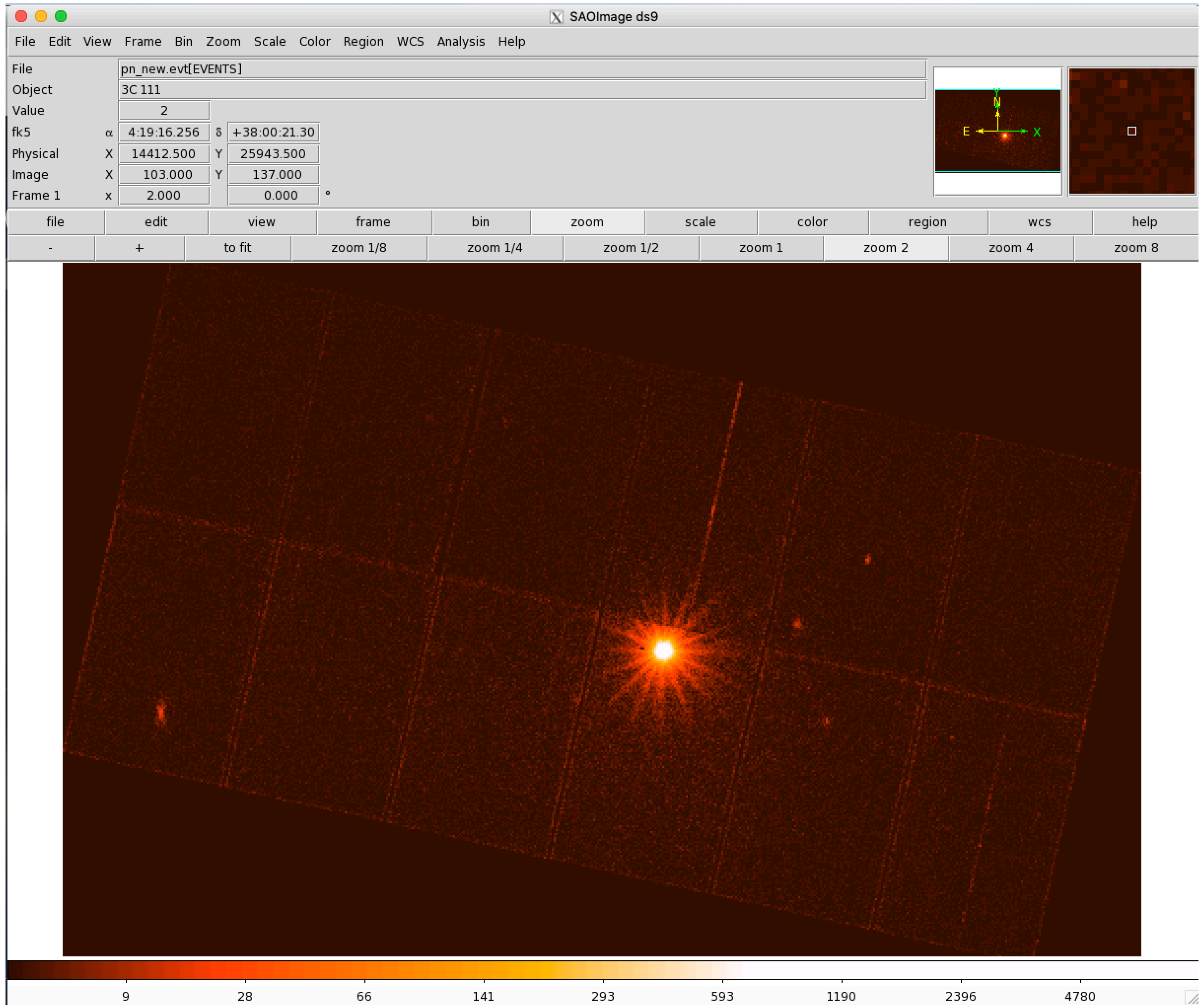
*http://ds9.si.edu/doc/user/binning/index.html*

## 2009



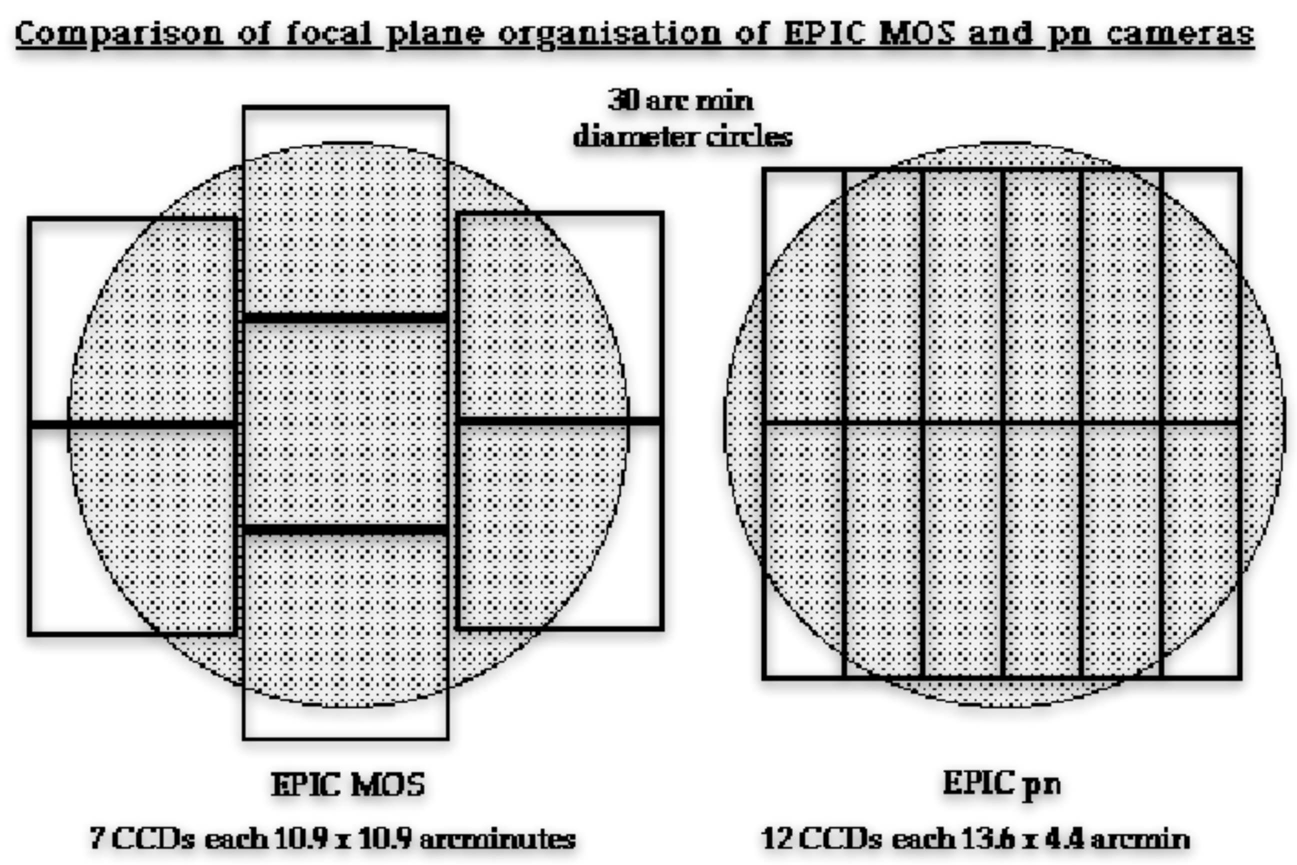

*small window*

## 2001




*large window*

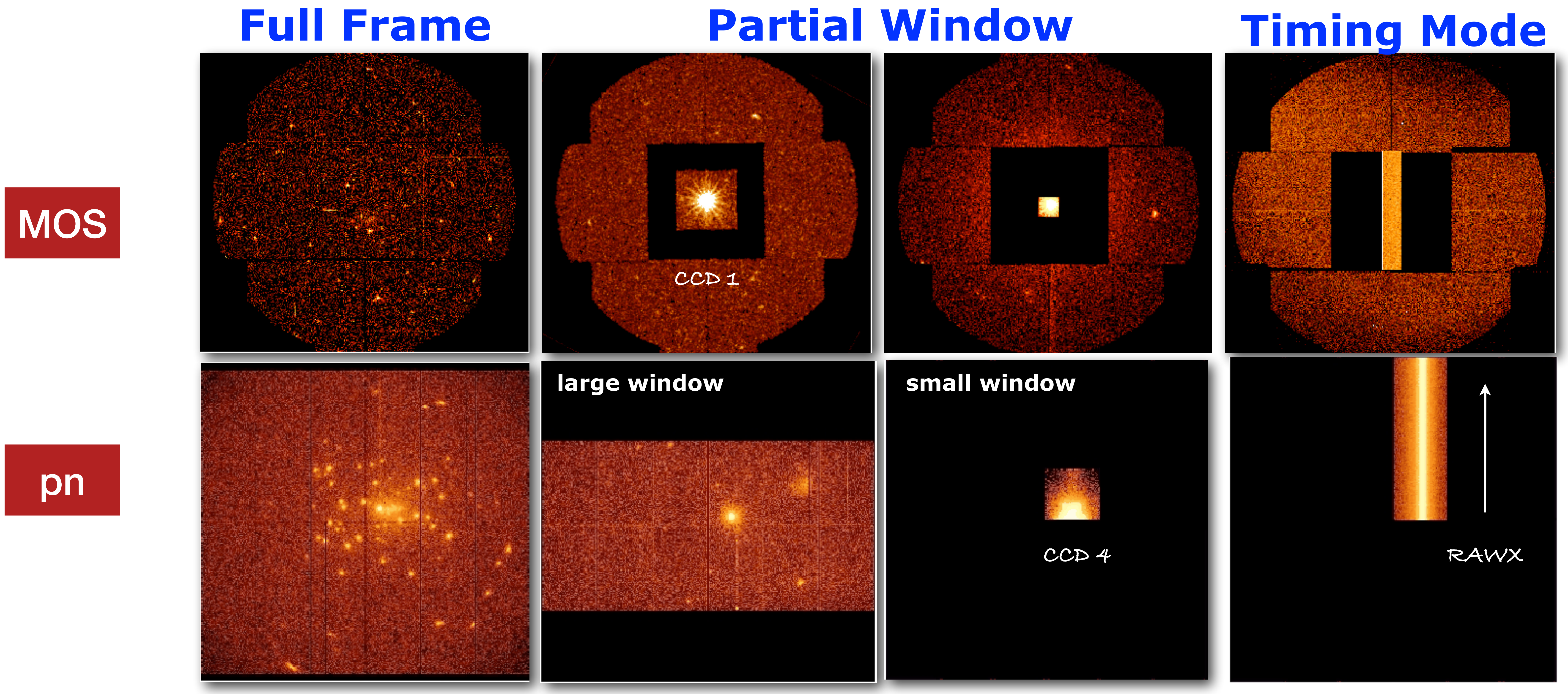
# EPIC Science Modes

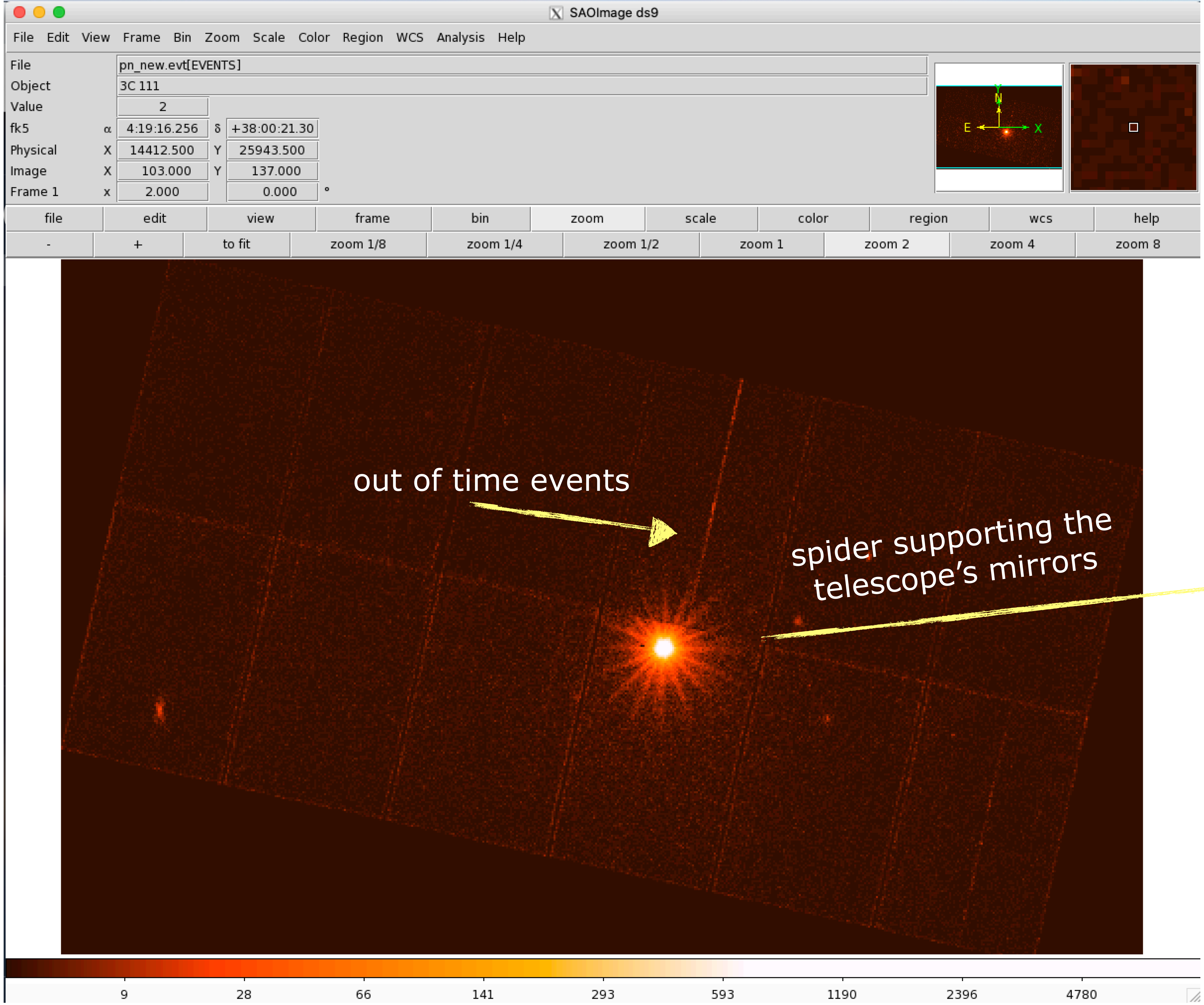


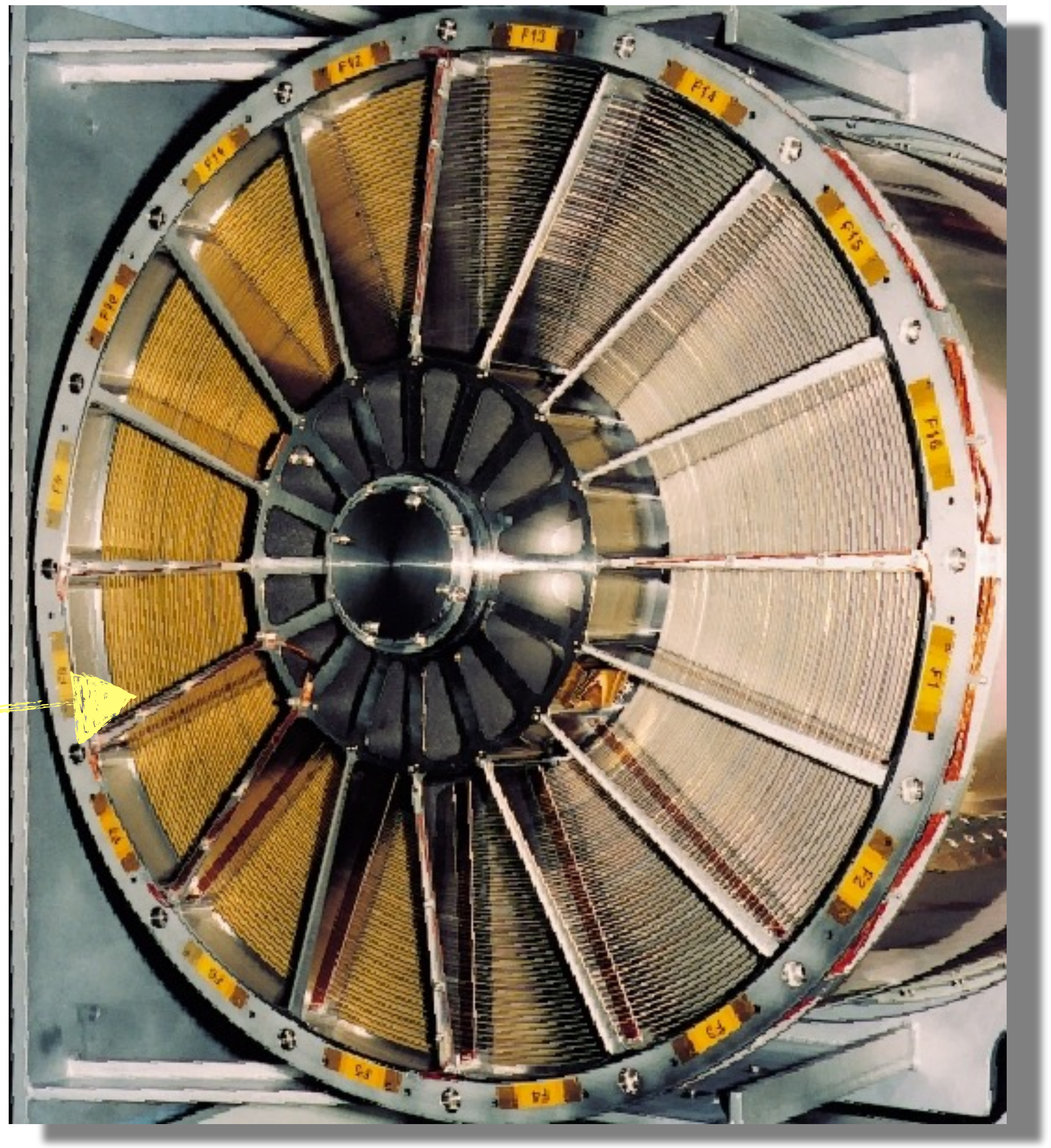

MOS

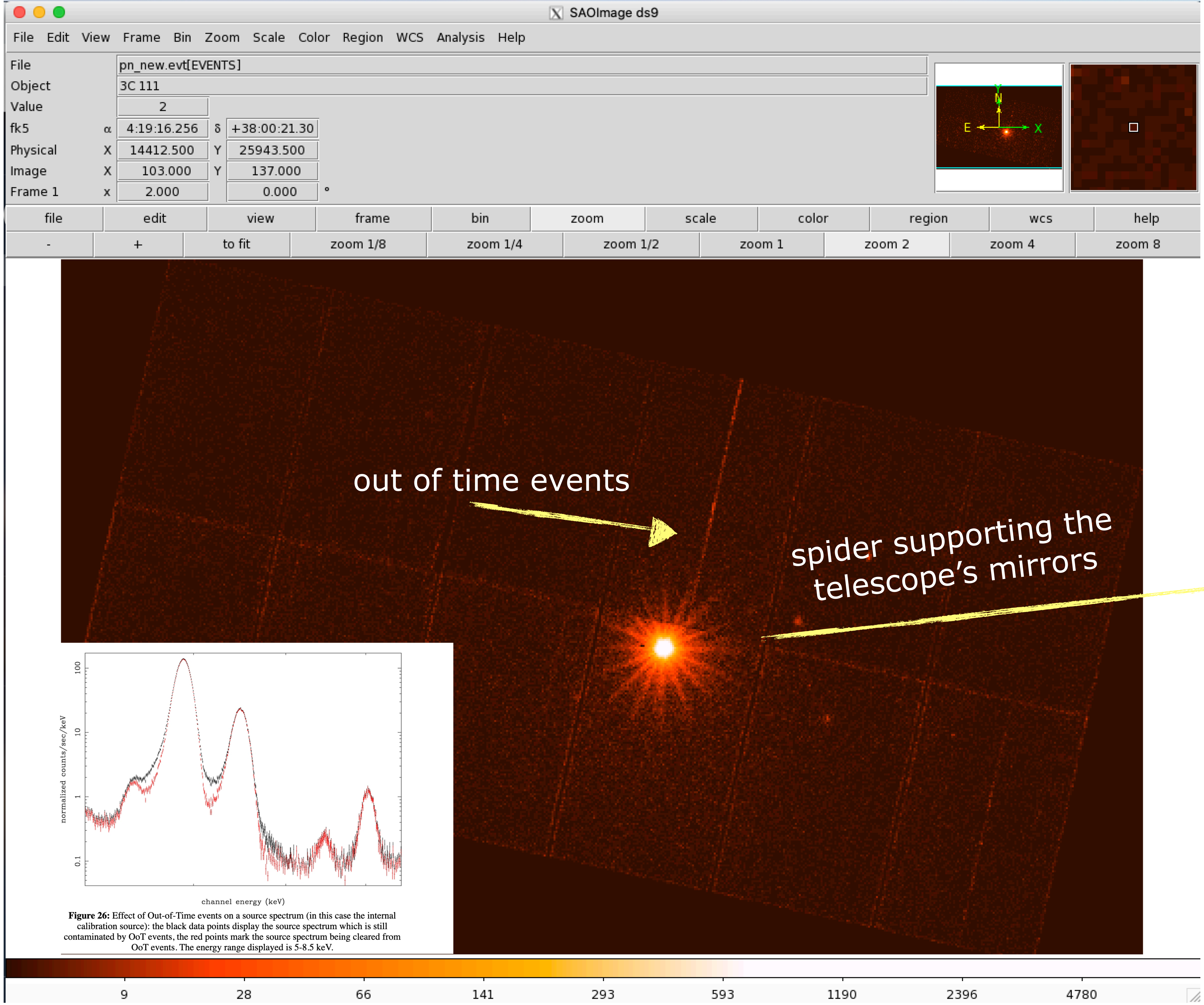
pn

XMM FoV 30’

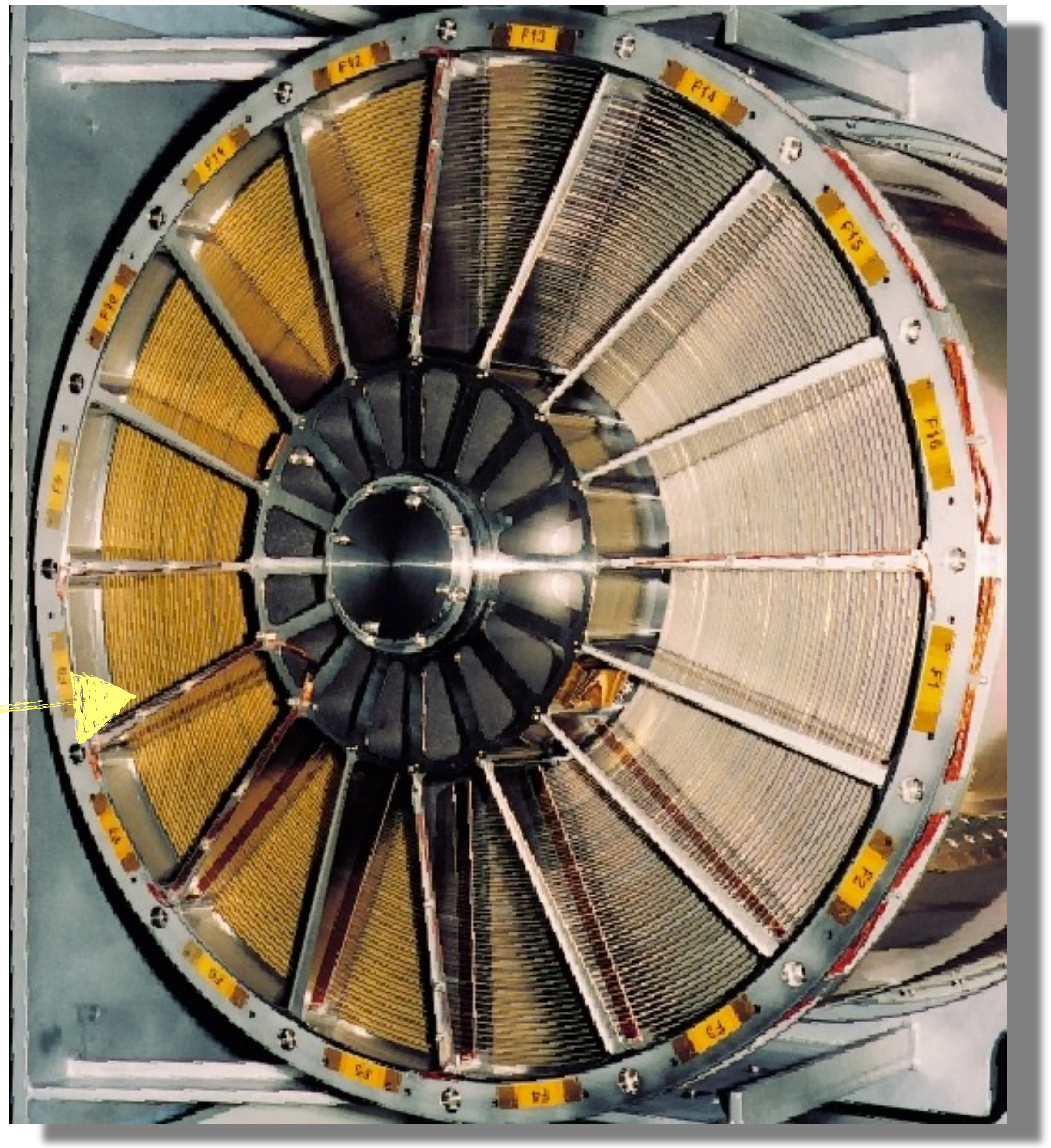



SAOImage ds9
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File pn_new.evt[EVENTS]
Object 3C 111
Value 2
fk5 α 4:19:16.256 δ +38:00:21.30
Physical X 14412.500 Y 25943.500
Image X 103.000 Y 137.000
Frame 1 x 2.000 0.000 °
file edit view frame bin zoom scale color region wcs help
- + to fit zoom 1/8 zoom 1/4 zoom 1/2 zoom 1 zoom 2 zoom 4 zoom 8
out of time events
spider supporting the telescope's mirrors
9 28 66 141 293 593 1190 2396 4780





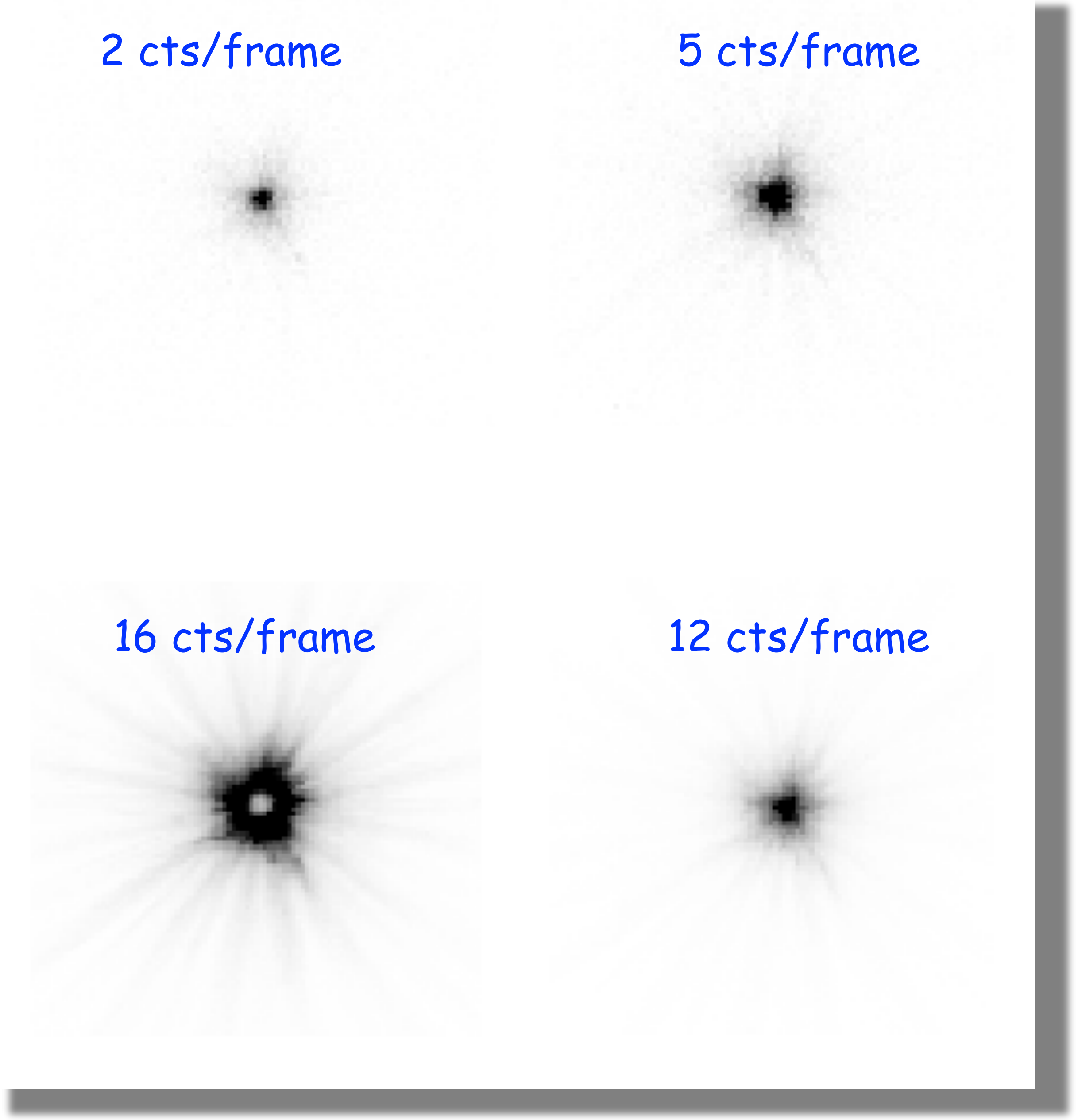
SAOImage ds9
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File pn_new.evt[EVENTS]
Object 3C 111
Value 2
fk5 α 4:19:16.256 δ +38:00:21.30
Physical X 14412.500 Y 25943.500
Image X 103.000 Y 137.000
Frame 1 x 2.000 0.000 °
file edit view frame bin zoom scale color region wcs help
- + to fit zoom 1/8 zoom 1/4 zoom 1/2 zoom 1 zoom 2 zoom 4 zoom 8
out of time events
spider supporting the telescope's mirrors
normalized counts/sec/keV
100
10
1
0.1
channel energy (keV)
Figure 26: Effect of Out-of-Time events on a source spectrum (in this case the internal calibration source): the black data points display the source spectrum which is still contaminated by OoT events, the red points mark the source spectrum being cleared from OoT events. The energy range displayed is 5-8.5 keV.
9 28 66 141 293 593 1190 2396 4780

# PILEUP

https://www.cosmos.esa.int/web/xmm-newton/sas-thread-epatplot

Arrival of two or more independent photons at nearby pixels that are erroneously read as one single event (whose energy is the sum of the energies of the individual photons) Jethwa et al. (2015)



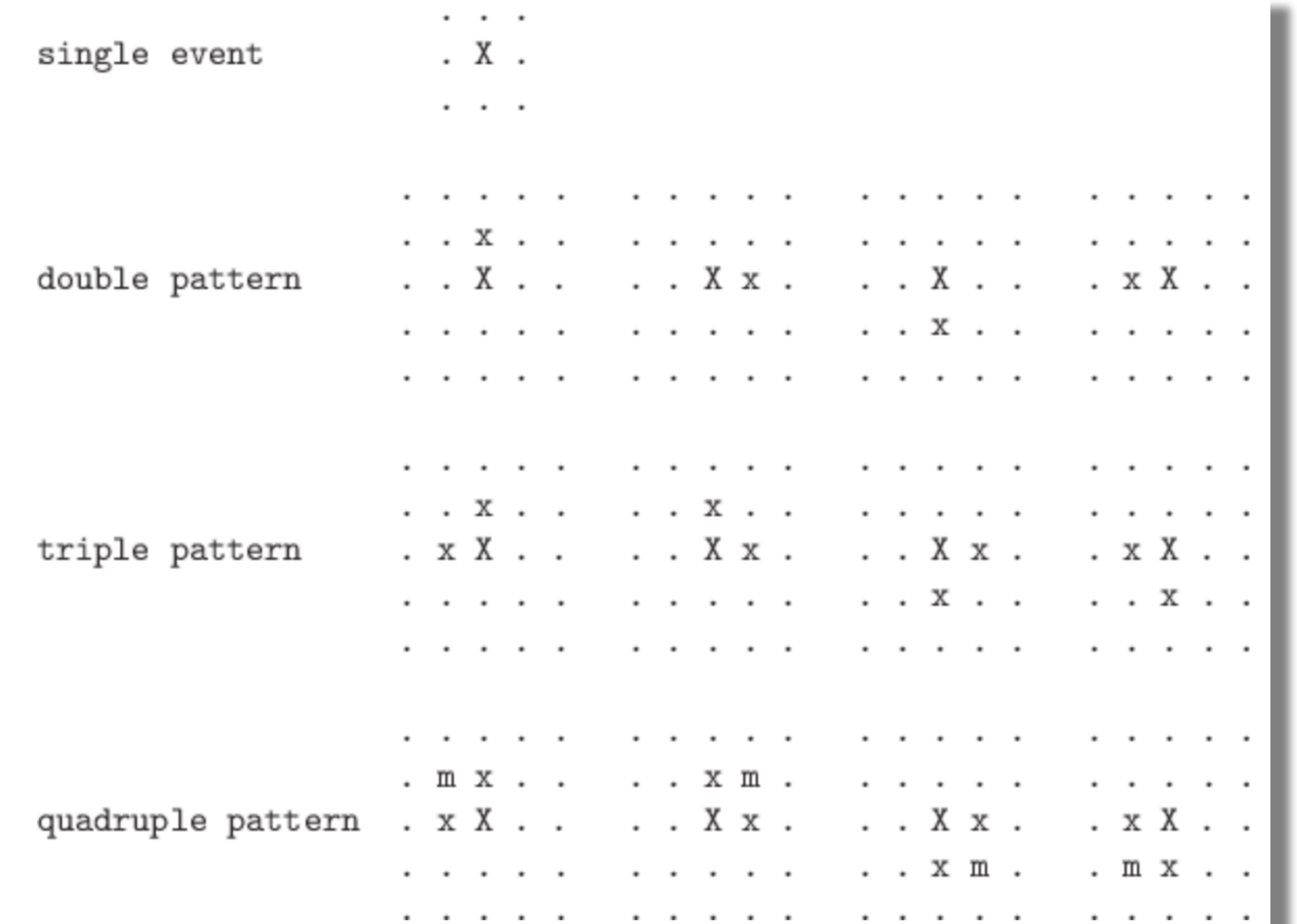




**Figure 13:** List of valid EPIC-pn patterns (cf. figure 12). Here "." marks a pixel without an event above threshold, "X" is the pixel with the maximum charge ("main pixel"), "x" is the pixel with a non-maximum charge, "m" is the pixel with the minimum charge. These 13 figures refer to the SAS PATTERN codes 0 (singles), 1-4 (doubles), 5-8 (triples) and 9-12 (quadruples), respectively. The RAWX co-ordinate is running rightward and the RAWY co-

- Photon loss
- Energy distortion
- Pattern migration

# epatplot

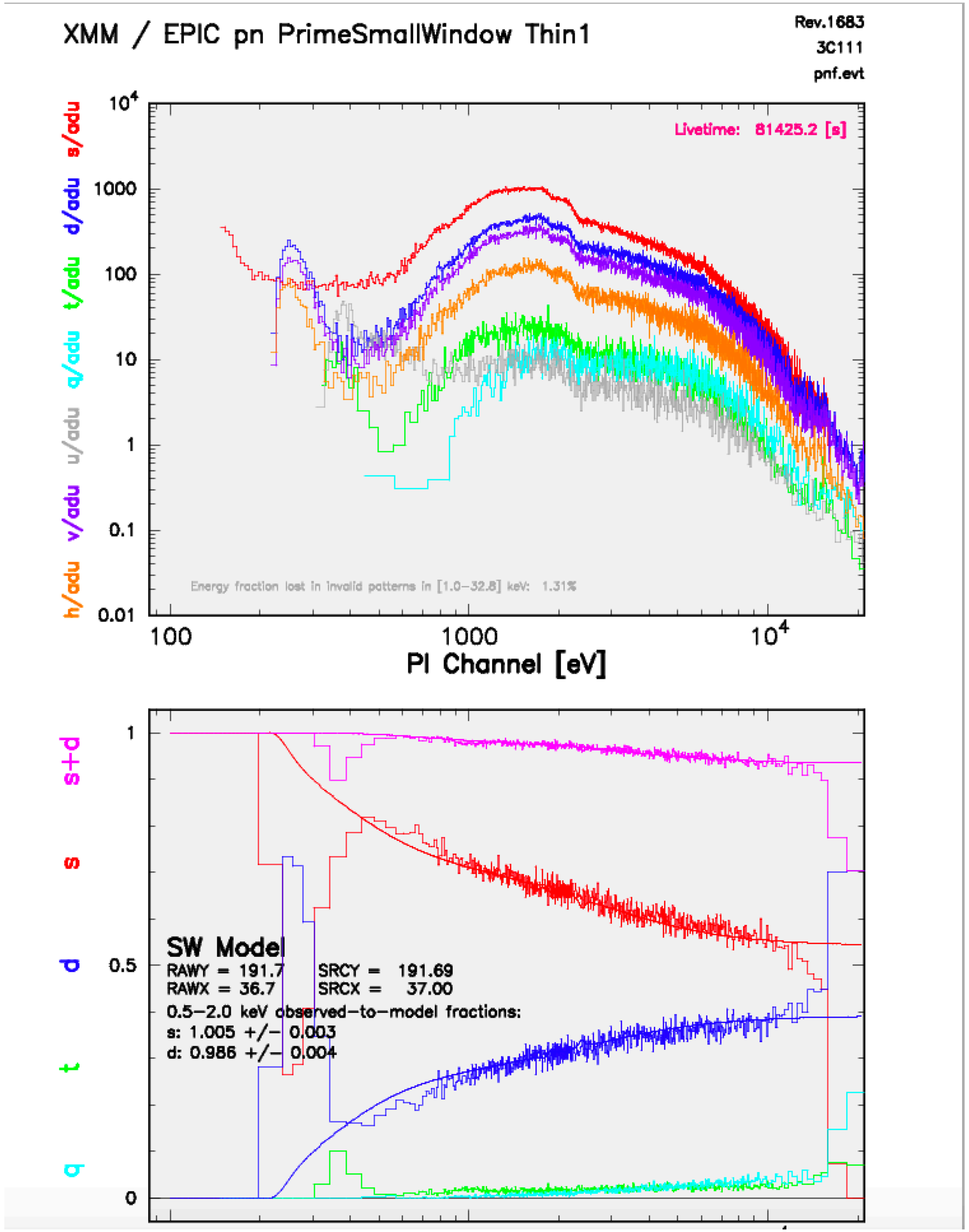
evselect table=**pn_new.evt** withfilteredset=yes filteredset=**pnf.evt** keepfilteroutput=yes expression="((X,Y) IN circle (25910.5,25870.5,400))”

epatplot set=**pnf.evt** device="/CPS" plotfile=“**pnf_pat.ps**"

```
epatplot:- epatplot (epatplot-1.22)  [xmmsas_20190531_1155-18.0.0] started:  2021-02-25T11:38:46.000
epatplot:-  epatplot 1.22 is running...
epatplot:-
epatplot:-        s       d       t       q
epatplot:-   0.6414  0.3234  0.0195  0.0157
epatplot:-
epatplot:- 0.5-2.0 keV observed-to-model fractions:
epatplot:- s: 1.005 +/- 0.003   d: 0.986 +/- 0.004
epatplot:-
epatplot:-  PostScript output written to file pnf_pat.ps
epatplot:- epatplot (epatplot-1.22)  [xmmsas_20190531_1155-18.0.0] ended:    2021-02-25T11:40:33.000
[torresi@login01]pn>
```

gv **pnf_pat.ps**

evince **pnf_pat.ps**

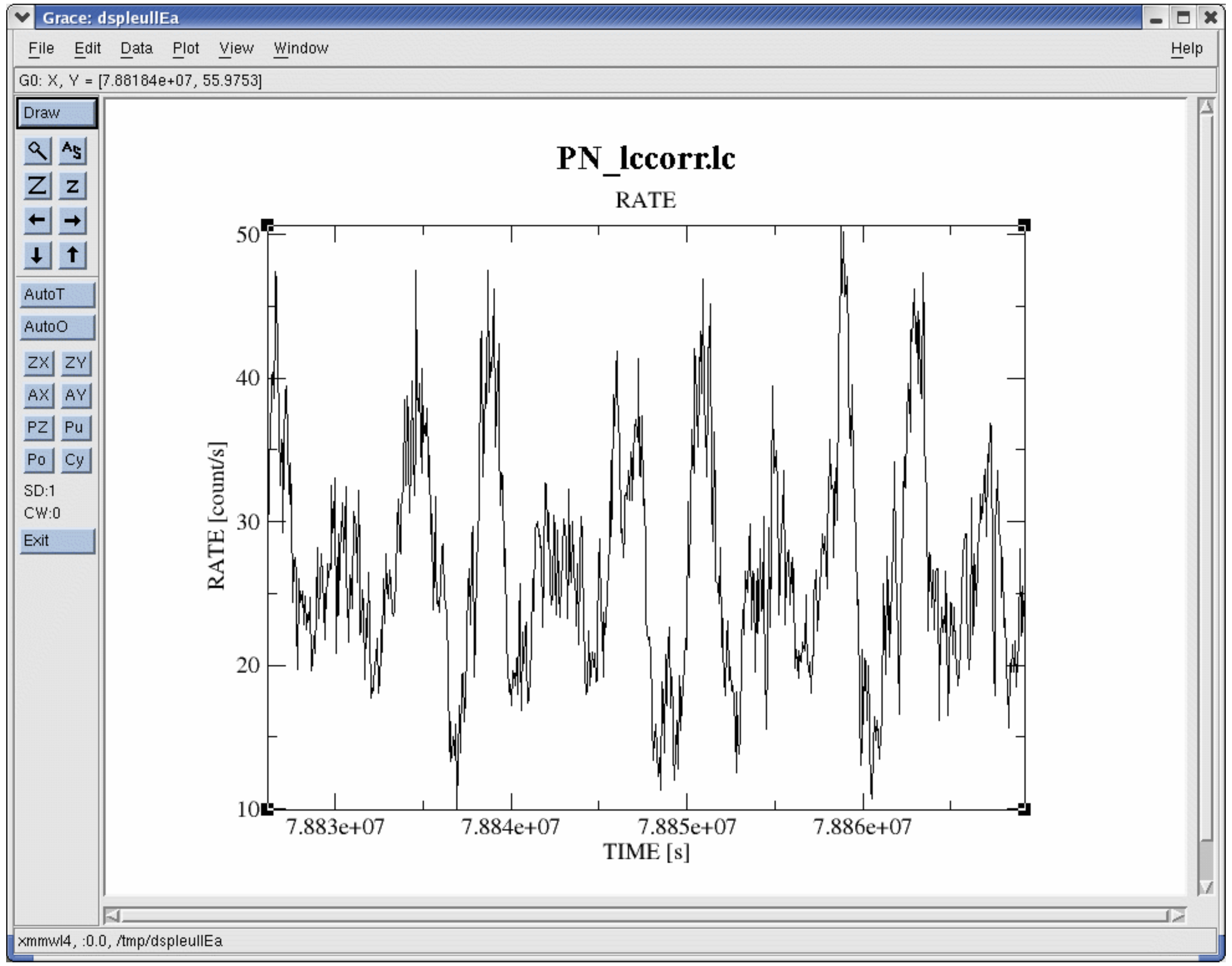


# LIGHT CURVE

https://www.cosmos.esa.int/web/xmm-newton/sas-thread-timing

A light curve is the plot of the flux of a source vs time. It shows if and how the flux of the source varies during a certain time series.

The variability of a source can manifest on different time scales.



# source+background lightcurve

pn:

```
evselect table=pn_new.evt energycolumn=PI expression='#XMMEA_EP&&(PATTERN<=4)&& ((X,Y) IN circle(25910.5,25870.5,400)&&
(PI in [200:10000]))’ withrateset=yes rateset="PN_source_lightcurve_raw.lc" timebinsize=100 maketimecolumn=yes makeratecolumn=yes
```

MOS1:

```
evselect table=mos1_new.evt energycolumn=PI expression='#XMMEA_EM&&(PATTERN<=12)&& ((X,Y) IN circle(25910.5,25870.5,400)&&
(PI in [200:10000]))’ withrateset=yes rateset="MOS_source_lightcurve_raw.lc" timebinsize=100 maketimecolumn=yes makeratecolumn=yes
```

**The longer is the temporal bin the lower is the resolution but the higher is the S/N.**

# background lightcurve

pn:

```
evselect table=pn_new.evt energycolumn=PI expression='#XMMEA_EP&&(PATTERN<=4)&& ((X,Y) IN circle(25910.5,25870.5,400)&&
(PI in [200:10000]))’ withrateset=yes rateset=“PN_light_curve_background_raw.lc" timebinsize=100 maketimecolumn=yes makeratecolumn=yes
```

MOS1:

```
evselect table=mos1_new.evt energycolumn=PI expression='#XMMEA_EM&&(PATTERN<=12)&& ((X,Y) IN circle(25910.5,25870.5,400)&&
(PI in [200:10000]))’ withrateset=yes rateset=“MOS_light_curve_background_raw.lc" timebinsize=100 maketimecolumn=yes
makeratecolumn=yes
```

# source-background lightcurve: **epiclccorr**

pn:

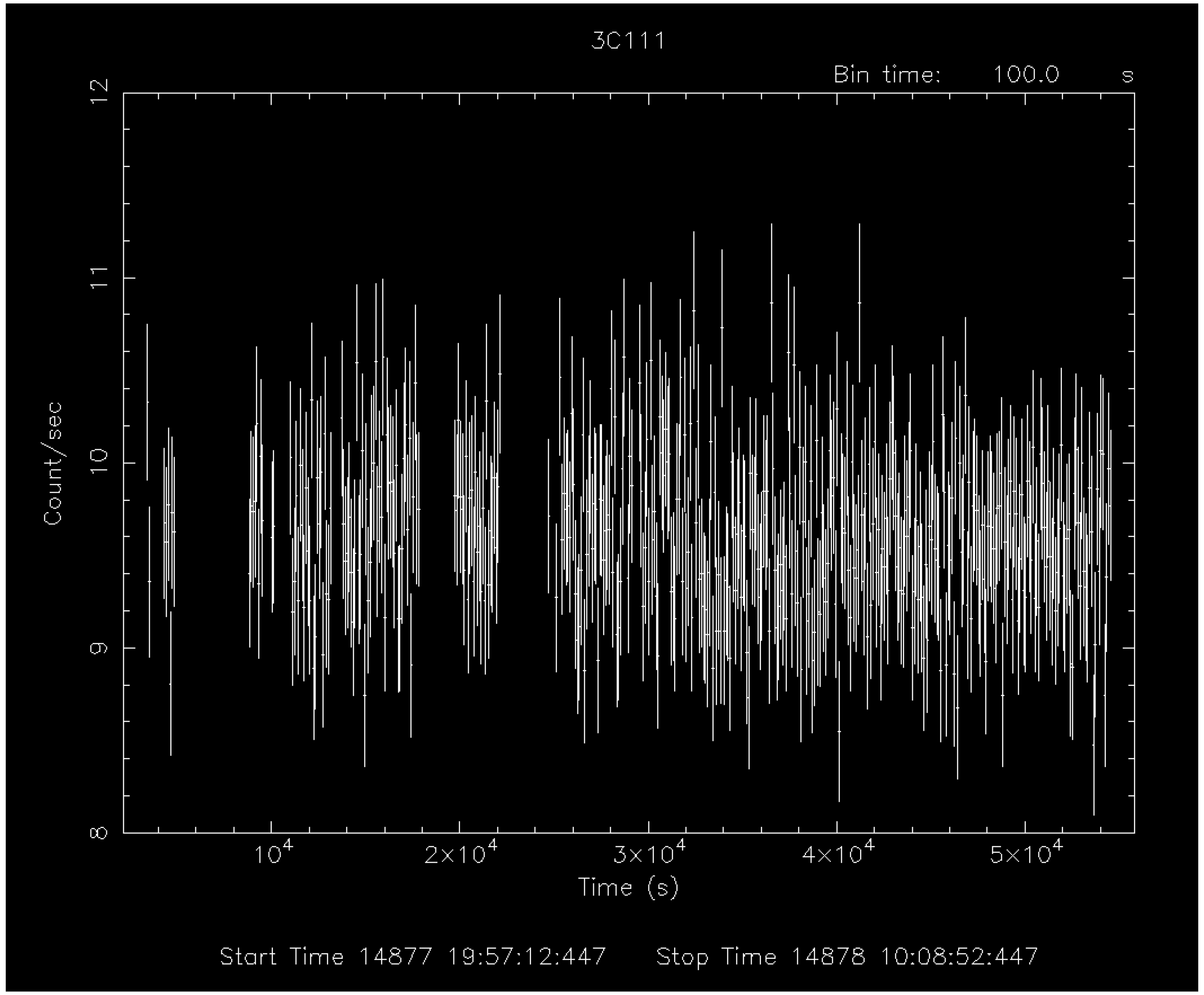
epiclccorr srctslist=**PN_source_lightcurve_raw.lc** eventlist=**pn_new.evt** outset=**PN_lccorr.lc** bkgtslist=**PN_light_curve_background_raw.lc** withbkgset=yes applyabsolutecorrections=yes

MOS1:

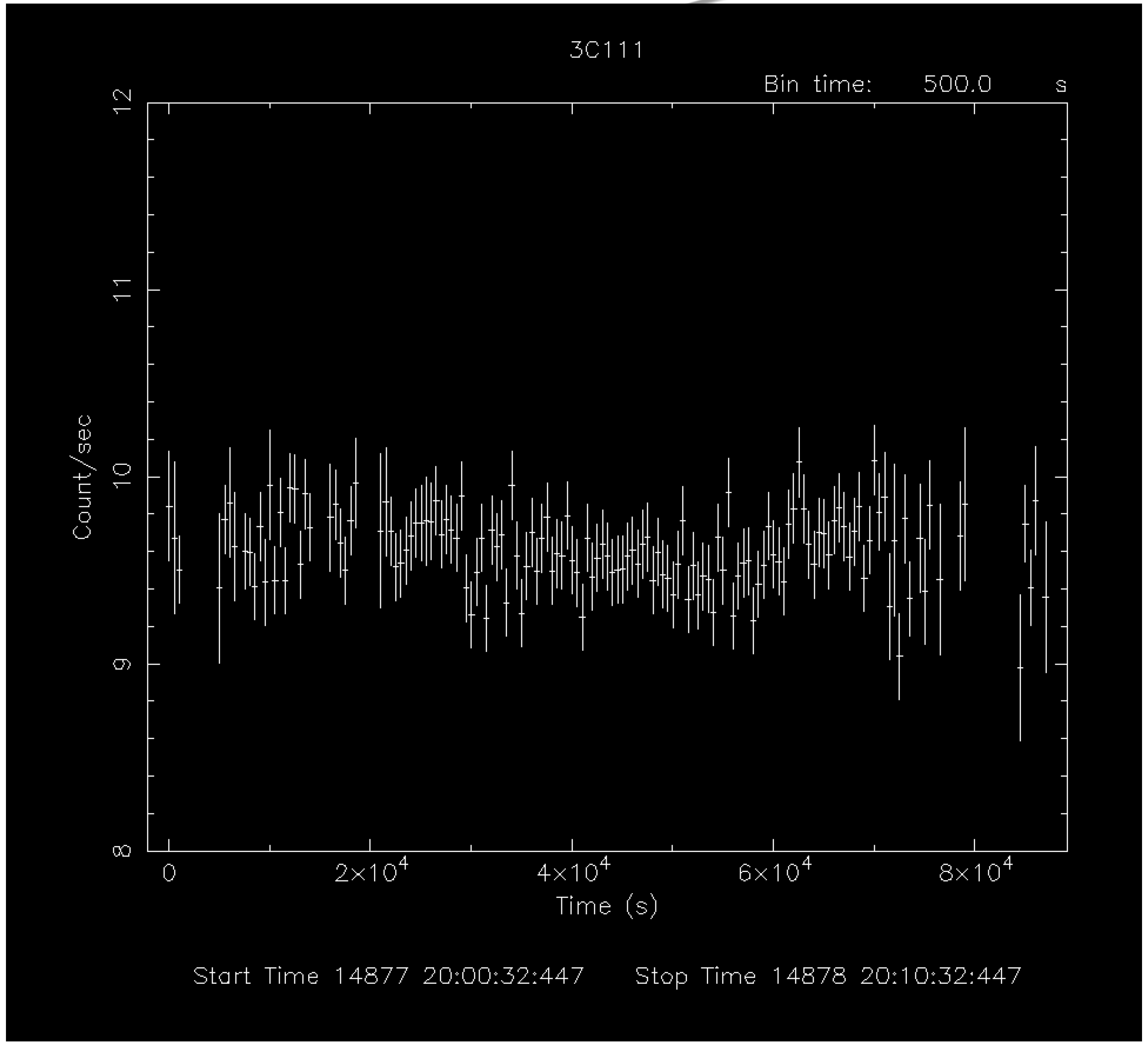
epiclccorr srctslist=**MOS1_source_lightcurve_raw.lc** eventlist=**mos1_new.evt** outset=**MOS1_lccorr.lc** bkgtslist=**MOS1_light_curve_background_raw.lc** withbkgset=yes applyabsolutecorrections=yes

# source-background lightcurve: **epiclccorr**

**The longer is the temporal bin the lower is the resolution but the higher is the S/N.**

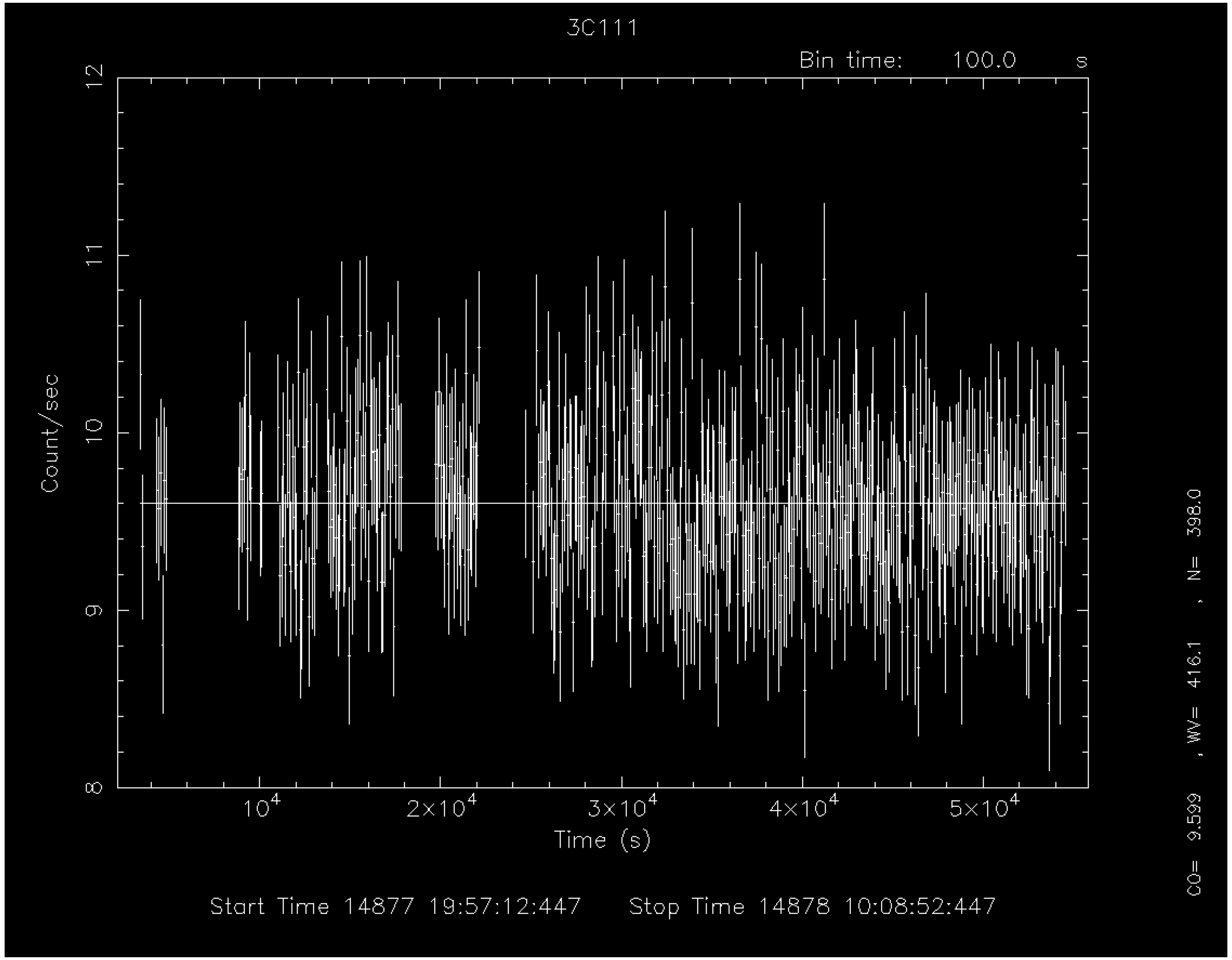



bin=100




bin=500

# source-background lightcurve: **epiclccorr**




$$\chi_\nu^2 = \frac{1}{\nu} \sum_{i=1}^{n} \frac{\left(c_i - \langle c \rangle\right)^2}{\sigma_i^2}$$

**$c_i$** observed counts in every temporal bin i;
**$\sigma_i$** Poissonian error;
**<c>** average count during the observation;
v**=n-1** degrees of freedom;

```
PLT> mo cons
  1 CO: VAL(  1.000    ), SIG(  0.000    ), PLO(  0.000    ), PHI(  0.000    )?

PLT> fit
 Fitting group   2,  from  2.155E+03 to  5.581E+04
 Fitting      398 points in a band of     398.
   1.00000000
 ( -3)   W-VAR= 416.3
 ( -4)   W-VAR= 416.1
 ( -5)   W-VAR= 416.1
   9.59943771
PLT> pl
PLT>
```

# SPECTRUM EXTRACTION

pn:

evselect table=**pn_new.evt** withspectrumset=yes spectrumset=**source_spectrum.fits** energycolumn=PI **spectralbinsize=5** withspecranges=yes **specchannelmin=0** **specchannelmax=20479** expression='(FLAG==0) && **(PATTERN<=4)** && ((X,Y) IN circle (27874.528,26645.58,699.99999))'

MOS1:

evselect table=**mos1_new.evt** withspectrumset=yes spectrumset=**source_spectrum.fits** energycolumn=PI **spectralbinsize=15** withspecranges=yes **specchannelmin=0** **specchannelmax=11999** expression='(FLAG==0) && **(PATTERN<=12)** && ((X,Y) IN circle (28090.5,24221.5,775.48791))'

# BACKGROUND EXTRACTION

pn:

evselect table=**pn_new.evt** withspectrumset=yes spectrumset=**back_spectrum.fits** energycolumn=PI **spectralbinsize=5** withspecranges=yes **specchannelmin=0 specchannelmax=20479** expression='(FLAG==0) && **(PATTERN<=4)** && ((X,Y) IN circle (,,,))’

MOS1:

evselect table=**mos1_new.evt** withspectrumset=yes spectrumset=back_**spectrum.fits** energycolumn=PI **spectralbinsize=15** withspecranges=yes **specchannelmin=0 specchannelmax=11999** expression='(FLAG==0) && **(PATTERN<=12)** && ((X,Y) IN circle (,,,))’

# BACKSCALE

The BACKSCALE task calculates the area of a source region used to make a spectral file.

This task takes into account any bad pixels or chip gaps and writes the result into the BACKSCAL keyword of the SPECTRUM table

The final value is:
**AREA= GEOMETRIC AREA-CCD GAPS-BAD PIXELS**

pn:

backscale spectrumset=**source_spectrum.fits** badpixlocation=**pn_new.evt**

backscale spectrumset=**back_spectrum.fits** badpixlocation=**pn_new.evt**

MOS1:

backscale spectrumset=**source_spectrum.fits** badpixlocation=**mos1_new.evt**

backscale spectrumset=**back_spectrum.fits** badpixlocation=**mos1_new.evt**

# Redistribution Matrix File (RMF)

rmfgen spectrumset=source_spectrum.fits rmfset=pn.rmf

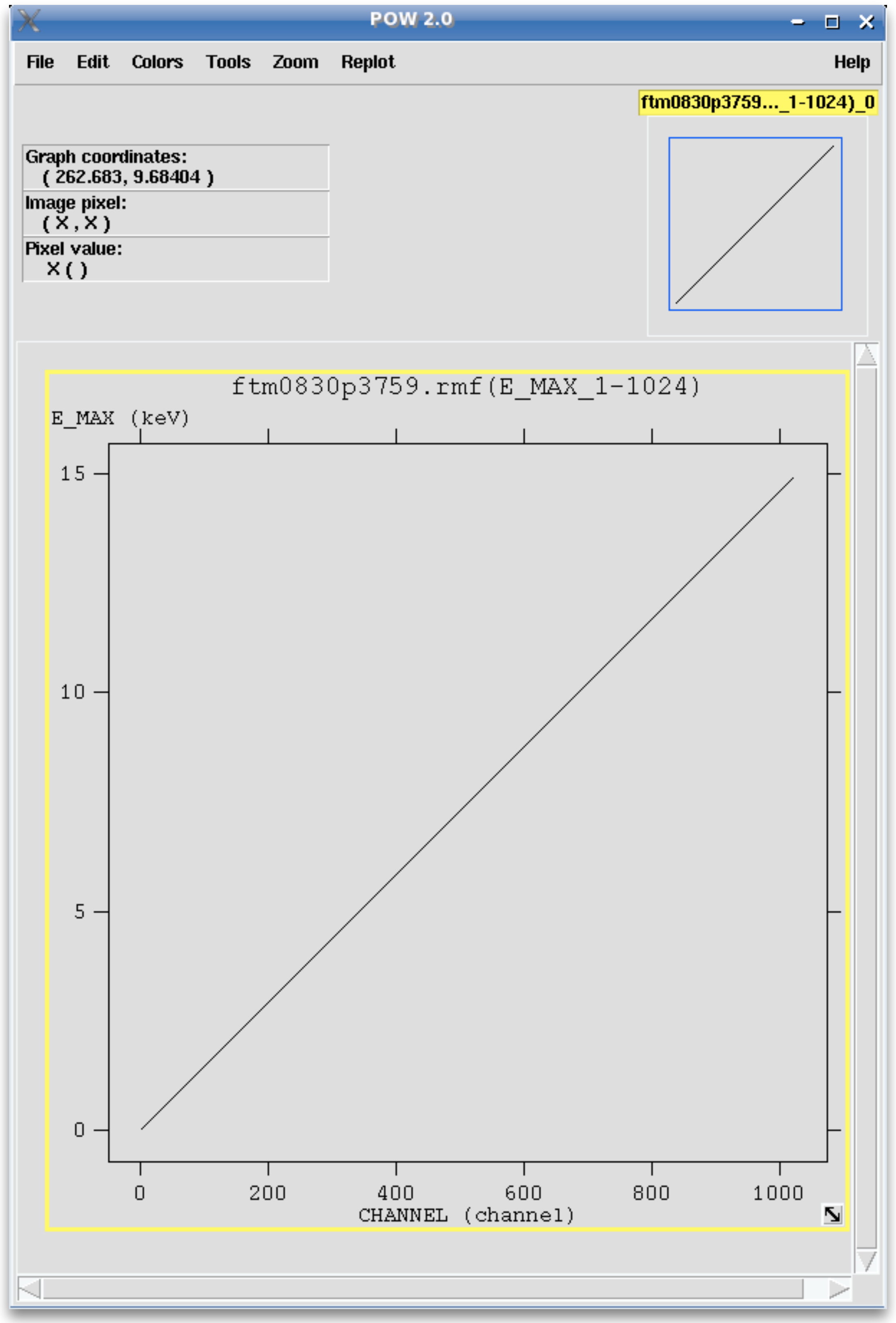
The RMF associates to each instrument channel (I) the appropriate photon energy (E)

fv: Binary Table of ftm0830p3759.rmf[2] in /ho

File Edit Tools Help

| Select | CHANNEL 1E channel | E_MIN 1E keV | E_MAX 1E keV |
|---|---|---|---|
| 1 | 1.000000E+00 | 1.460000E-03 | 1.460000E-02 |
| 2 | 2.000000E+00 | 1.460000E-02 | 2.920000E-02 |
| 3 | 3.000000E+00 | 2.920000E-02 | 4.380000E-02 |
| 4 | 4.000000E+00 | 4.380000E-02 | 5.840000E-02 |
| 5 | 5.000000E+00 | 5.840000E-02 | 7.300000E-02 |
| 6 | 6.000000E+00 | 7.300000E-02 | 8.760000E-02 |
| 7 | 7.000000E+00 | 8.760000E-02 | 1.022000E-01 |
| 8 | 8.000000E+00 | 1.022000E-01 | 1.168000E-01 |
| 9 | 9.000000E+00 | 1.168000E-01 | 1.314000E-01 |
| 10 | 1.000000E+01 | 1.314000E-01 | 1.460000E-01 |
| 11 | 1.100000E+01 | 1.460000E-01 | 1.606000E-01 |
| 12 | 1.200000E+01 | 1.606000E-01 | 1.752000E-01 |
| 13 | 1.300000E+01 | 1.752000E-01 | 1.898000E-01 |
| 14 | 1.400000E+01 | 1.898000E-01 | 2.044000E-01 |
| 15 | 1.500000E+01 | 2.044000E-01 | 2.190000E-01 |
| 16 | 1.600000E+01 | 2.190000E-01 | 2.336000E-01 |
| 17 | 1.700000E+01 | 2.336000E-01 | 2.482000E-01 |
| 18 | 1.800000E+01 | 2.482000E-01 | 2.628000E-01 |
| 19 | 1.900000E+01 | 2.628000E-01 | 2.774000E-01 |
| 20 | 2.000000E+01 | 2.774000E-01 | 2.920000E-01 |

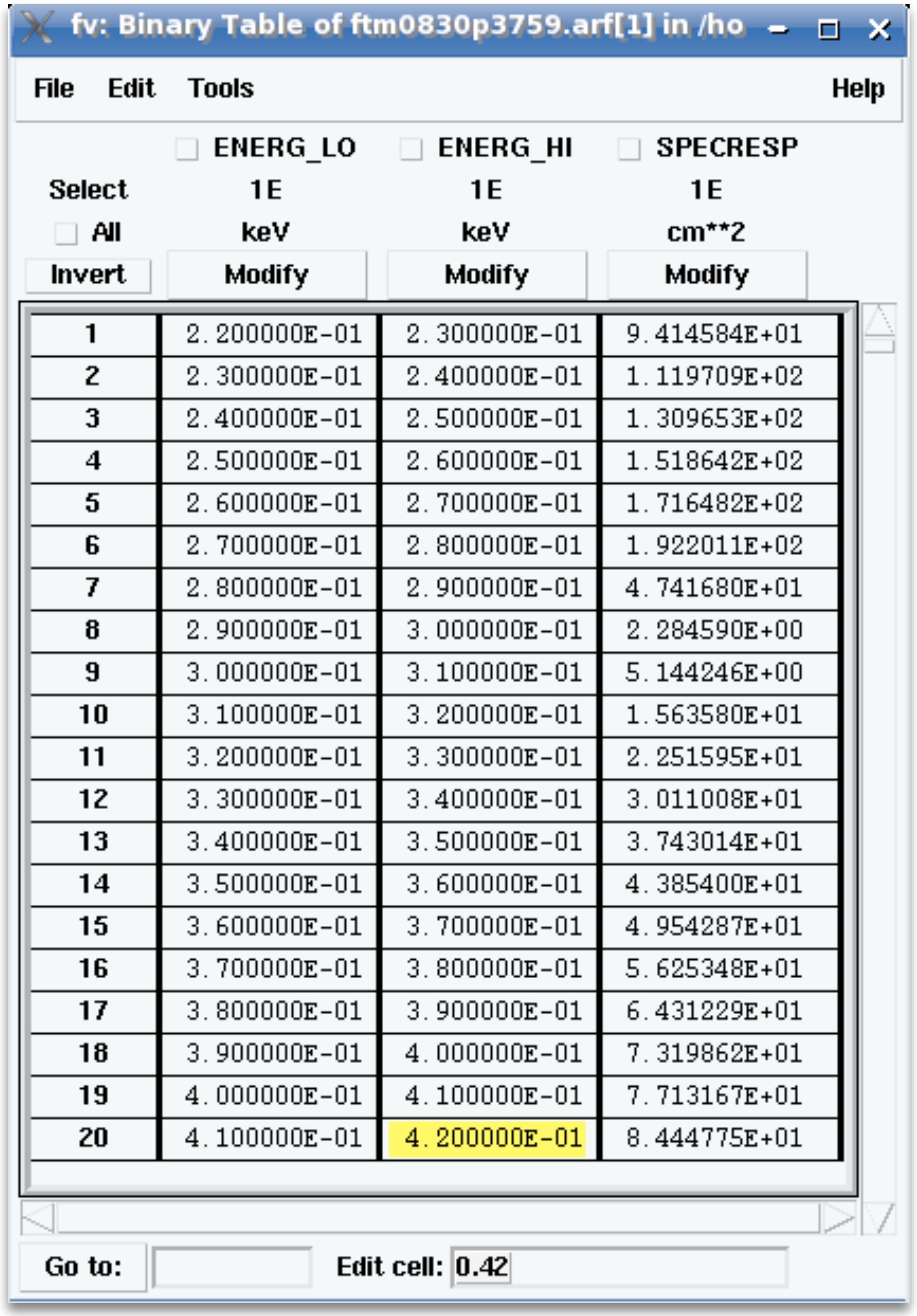
Go to: Edit cell: 0.219



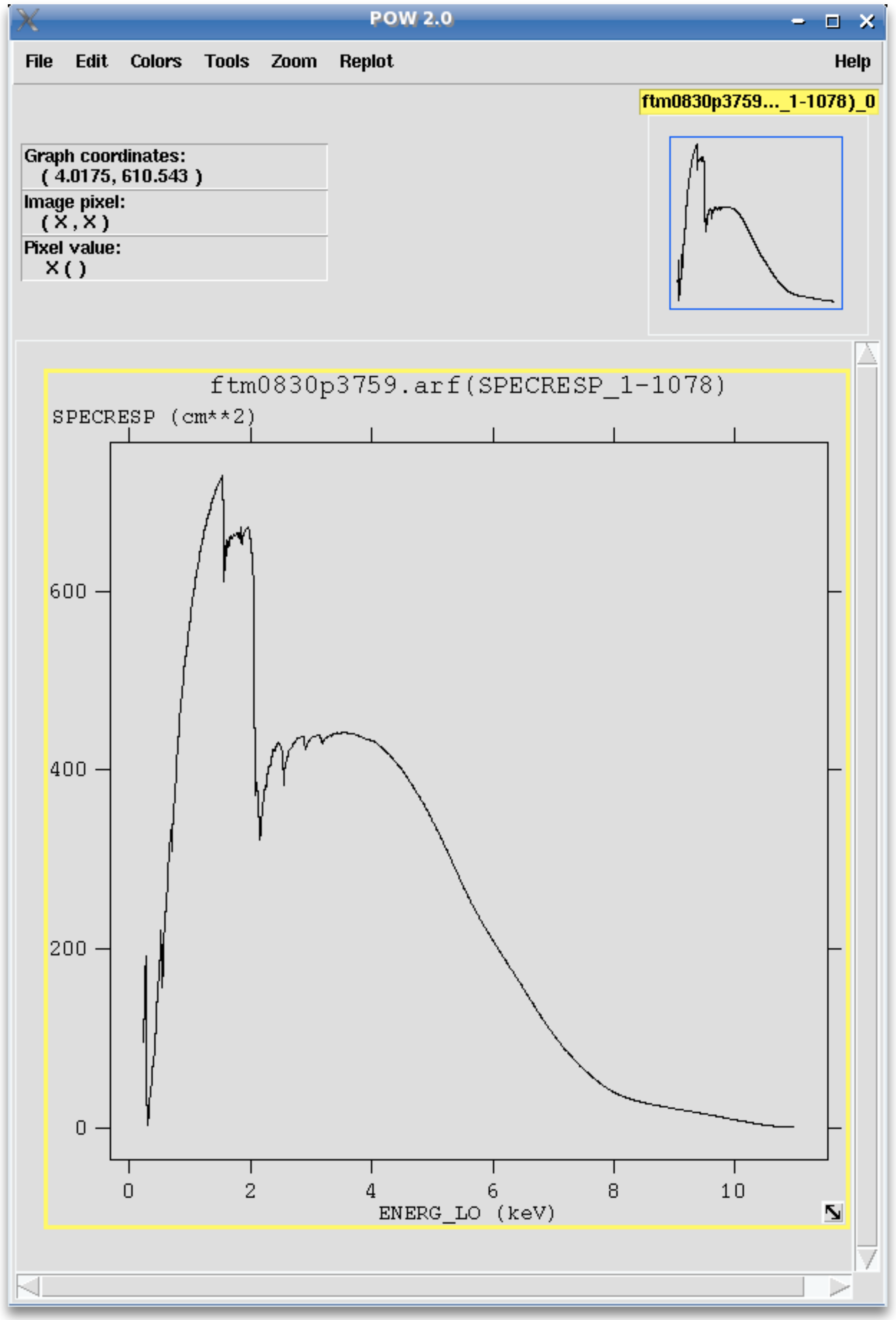
# Ancillary Response File (ARF)

```
arfgen spectrumset=source_spectrum.fits arfset=pn.arf withrmfset=yes rmfset=pn.rmf badpixlocation=pn_new.evt detmaptype=psf
```

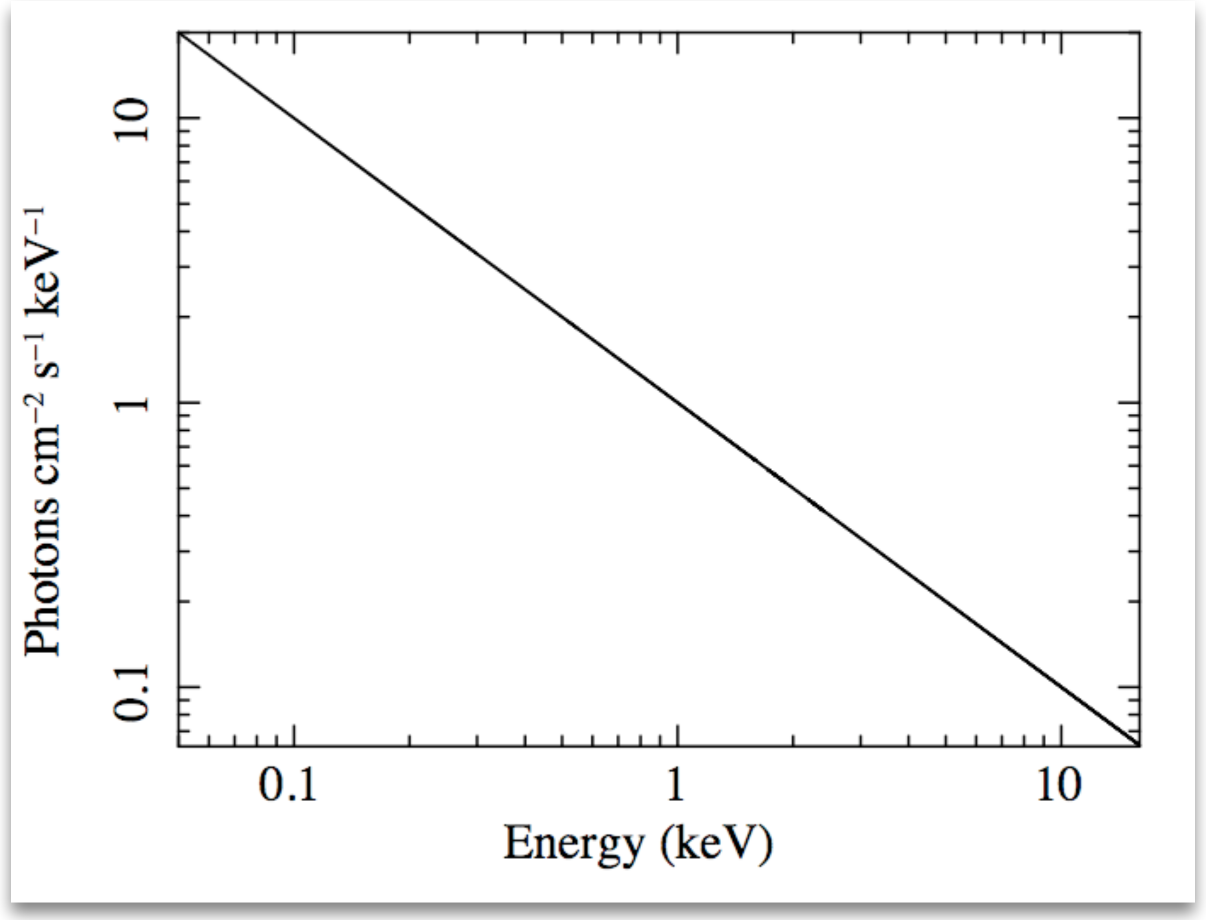
The ARF includes the information on the effective area, filter transmission and any additional energy-dependent efficiencies, i.e. the efficiency of the instrument in revealing photons



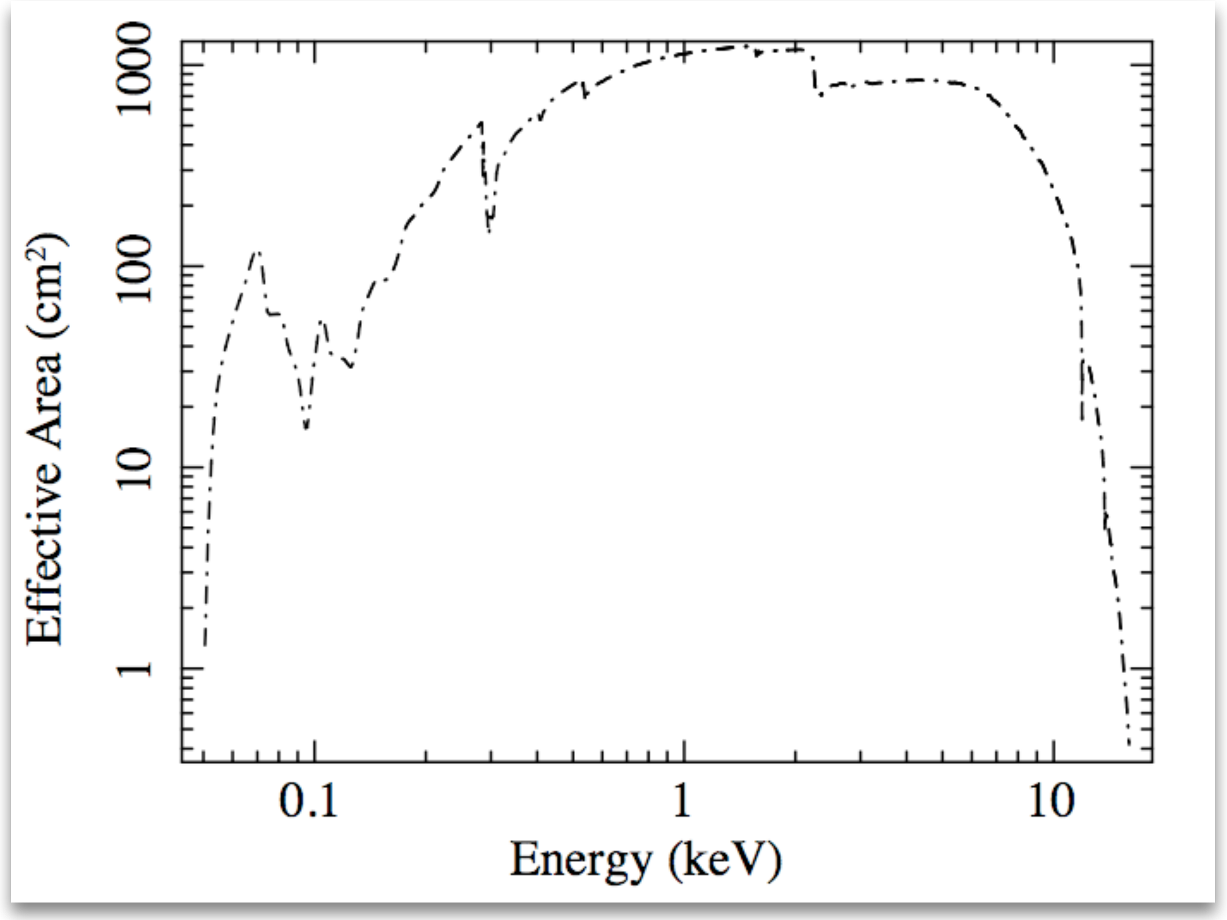

| Select | ENERG_LO | ENERG_HI | SPECRESP |
|---|---|---|---|
| All | 1E keV | 1E keV | 1E cm**2 |
| Invert | Modify | Modify | Modify |
| 1 | 2.200000E-01 | 2.300000E-01 | 9.414584E+01 |
| 2 | 2.300000E-01 | 2.400000E-01 | 1.119709E+02 |
| 3 | 2.400000E-01 | 2.500000E-01 | 1.309653E+02 |
| 4 | 2.500000E-01 | 2.600000E-01 | 1.518642E+02 |
| 5 | 2.600000E-01 | 2.700000E-01 | 1.716482E+02 |
| 6 | 2.700000E-01 | 2.800000E-01 | 1.922011E+02 |
| 7 | 2.800000E-01 | 2.900000E-01 | 4.741680E+01 |
| 8 | 2.900000E-01 | 3.000000E-01 | 2.284590E+00 |
| 9 | 3.000000E-01 | 3.100000E-01 | 5.144246E+00 |
| 10 | 3.100000E-01 | 3.200000E-01 | 1.563580E+01 |
| 11 | 3.200000E-01 | 3.300000E-01 | 2.251595E+01 |
| 12 | 3.300000E-01 | 3.400000E-01 | 3.011008E+01 |
| 13 | 3.400000E-01 | 3.500000E-01 | 3.743014E+01 |
| 14 | 3.500000E-01 | 3.600000E-01 | 4.385400E+01 |
| 15 | 3.600000E-01 | 3.700000E-01 | 4.954287E+01 |
| 16 | 3.700000E-01 | 3.800000E-01 | 5.625348E+01 |
| 17 | 3.800000E-01 | 3.900000E-01 | 6.431229E+01 |
| 18 | 3.900000E-01 | 4.000000E-01 | 7.319862E+01 |
| 19 | 4.000000E-01 | 4.100000E-01 | 7.713167E+01 |
| 20 | 4.100000E-01 | 4.200000E-01 | 8.444775E+01 |

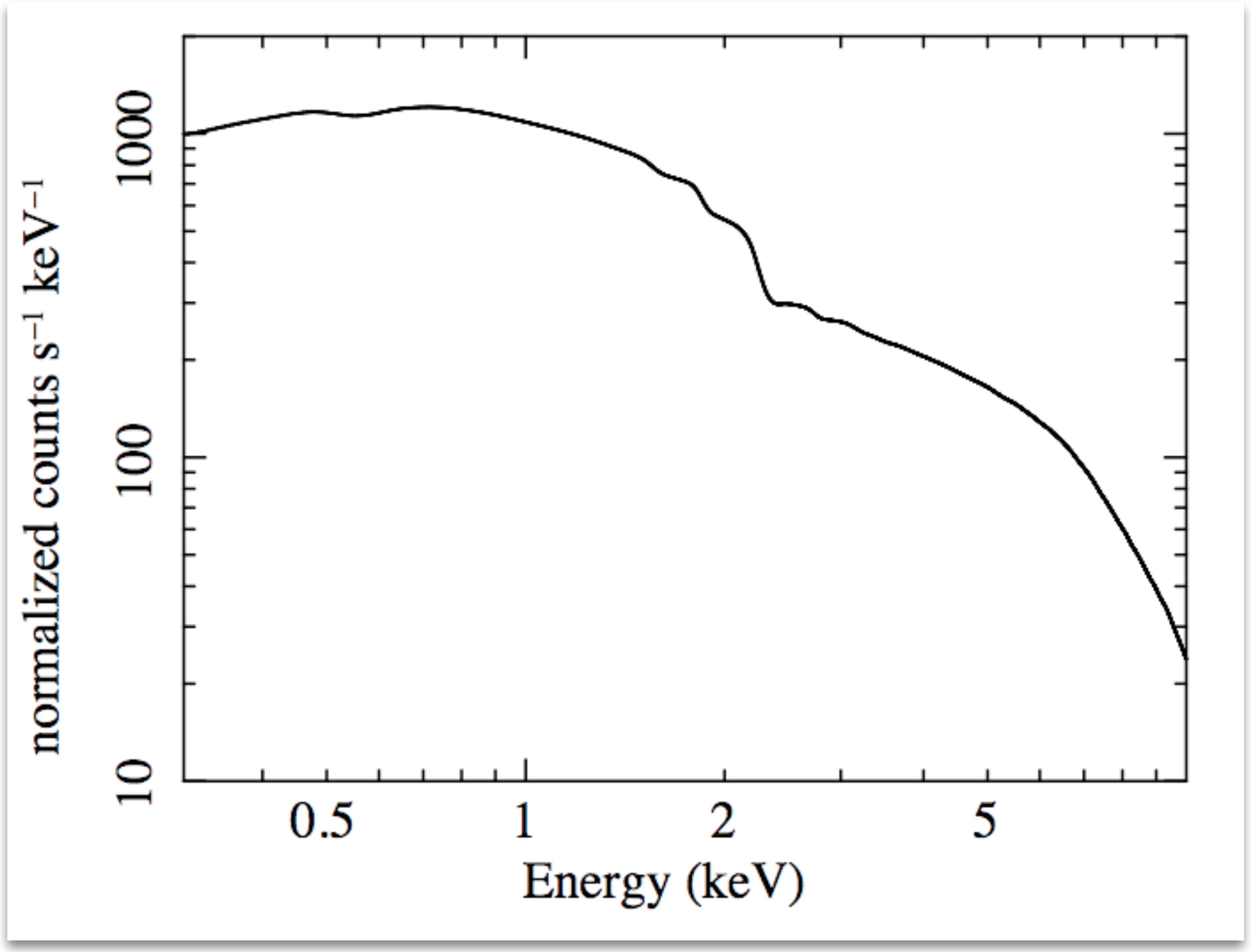


The combination of RMF and ARF produces the input spectrum weighted by telescope area and detector efficiencies versus energy.




⊗



# GROUPING

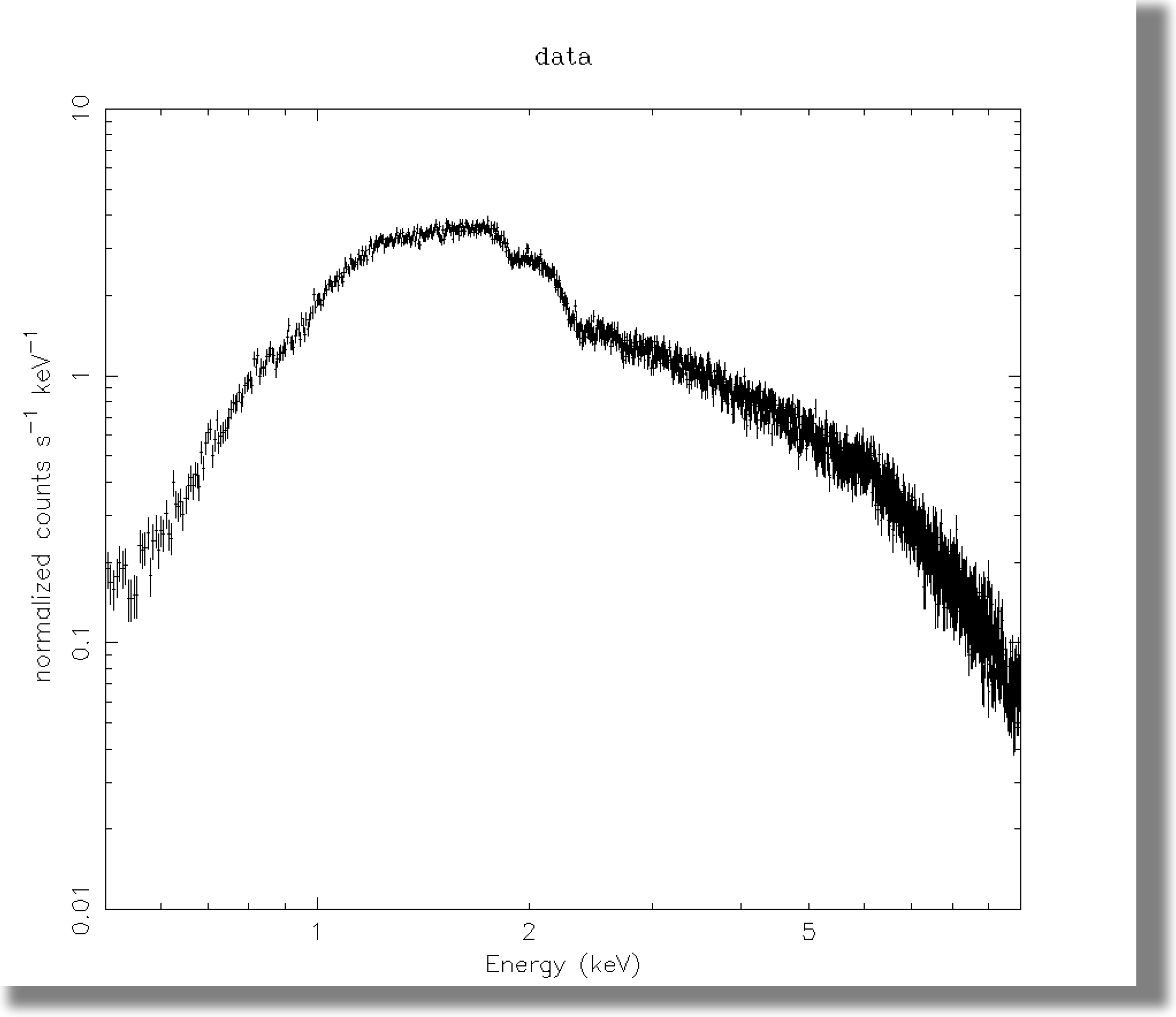
In order to apply the $\chi^2$ statistics (Gaussian distribution) you need to have at least 25 counts in each bin of your spectrum. Otherwise Cash statistics (Poisson distribution) is preferred (see also Statistics Tutorial).

grppha **source_spectrum.fits** pn_25.grp comm="chkey RESPFILE **pn.rmf** & chkey ANCRFILE **pn.arf** & chkey BACKFILE **back_spectrum.fits** & **group min 25** & exit"

# GROUPING

In order to apply the $\chi^2$ statistics (Gaussian distribution) you need to have at least 25 counts in each bin of your spectrum. Otherwise Cash statistics (Poisson distribution) is preferred (see also Statistics Tutorial).

grppha **source_spectrum.fits** pn_25.grp comm="chkey RESPFILE **pn.rmf** & chkey ANCRFILE **pn.arf** & chkey BACKFILE **back_spectrum.fits** & **group min 25** & exit"



# X-RAY LABORATORY 2021

22 February 2021 to 12 March 2021
Europe/Rome timezone



## USEFUL LINKS

### XMM-Newton (SAS)

- XMM-Newton ABC Guide
- SAS Users Guide
- XMM-Newton threads
- XMM-Newton Users Handbook
- XMM-Newton pile up:

### Chandra (CIAO)

- Introduction to CIAO
- Science Threads
- The Chandra ABC Guide to Pileup

https://indico.ict.inaf.it/e/labx21

### NuSTAR

- NuSTAR link

### ds9

- SAOImage DS9 Users Manual

### XSPEC

- XSPEC on-line manual