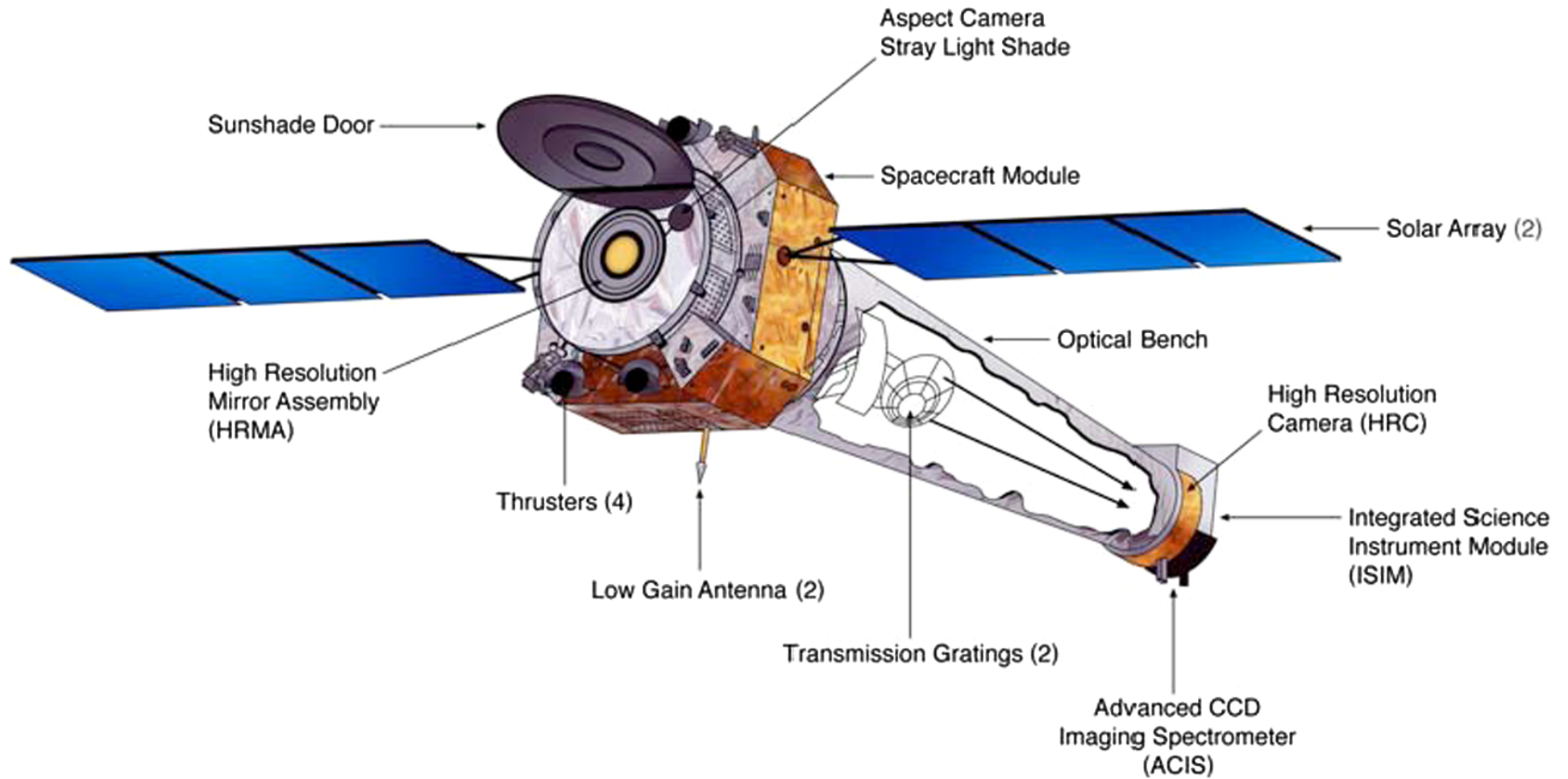


Chandra Tutorial

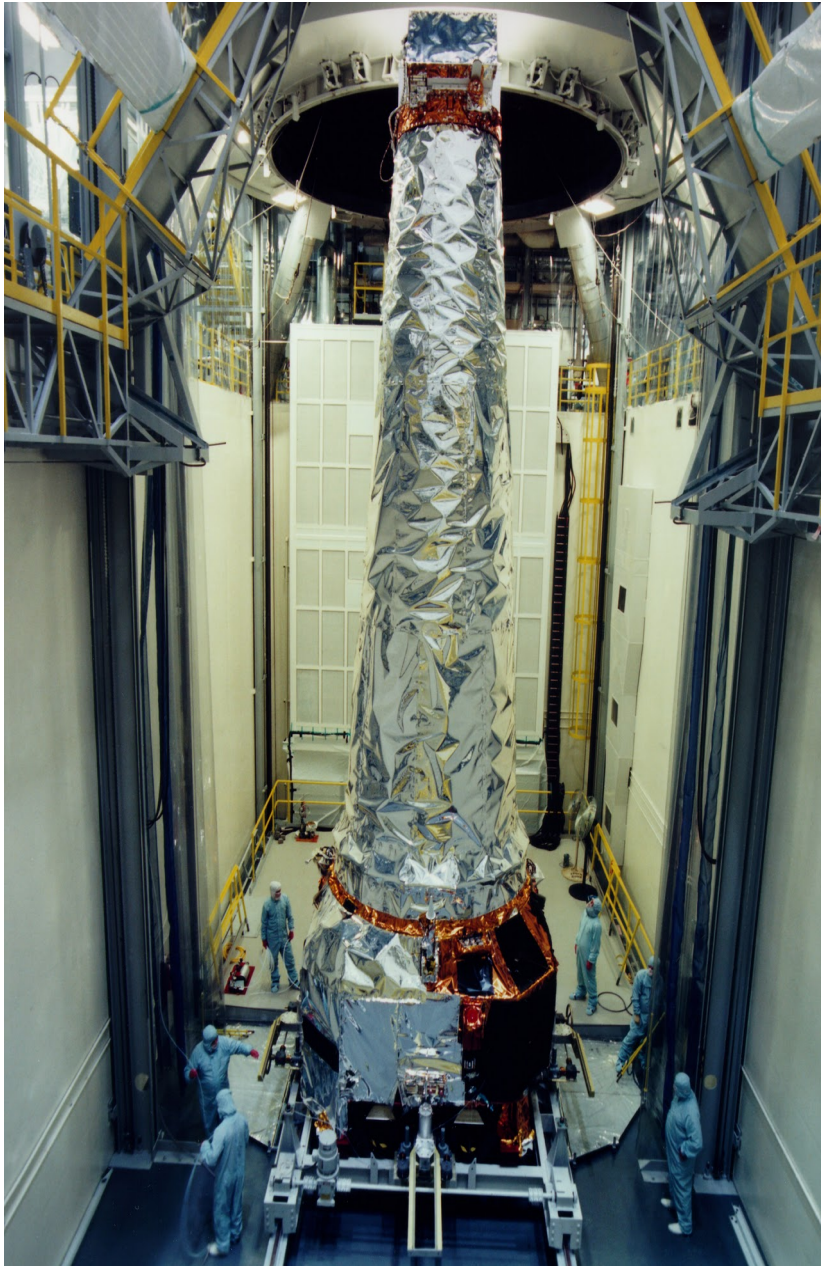


Laboratorio di Astrofisica 2014

The spacecraft



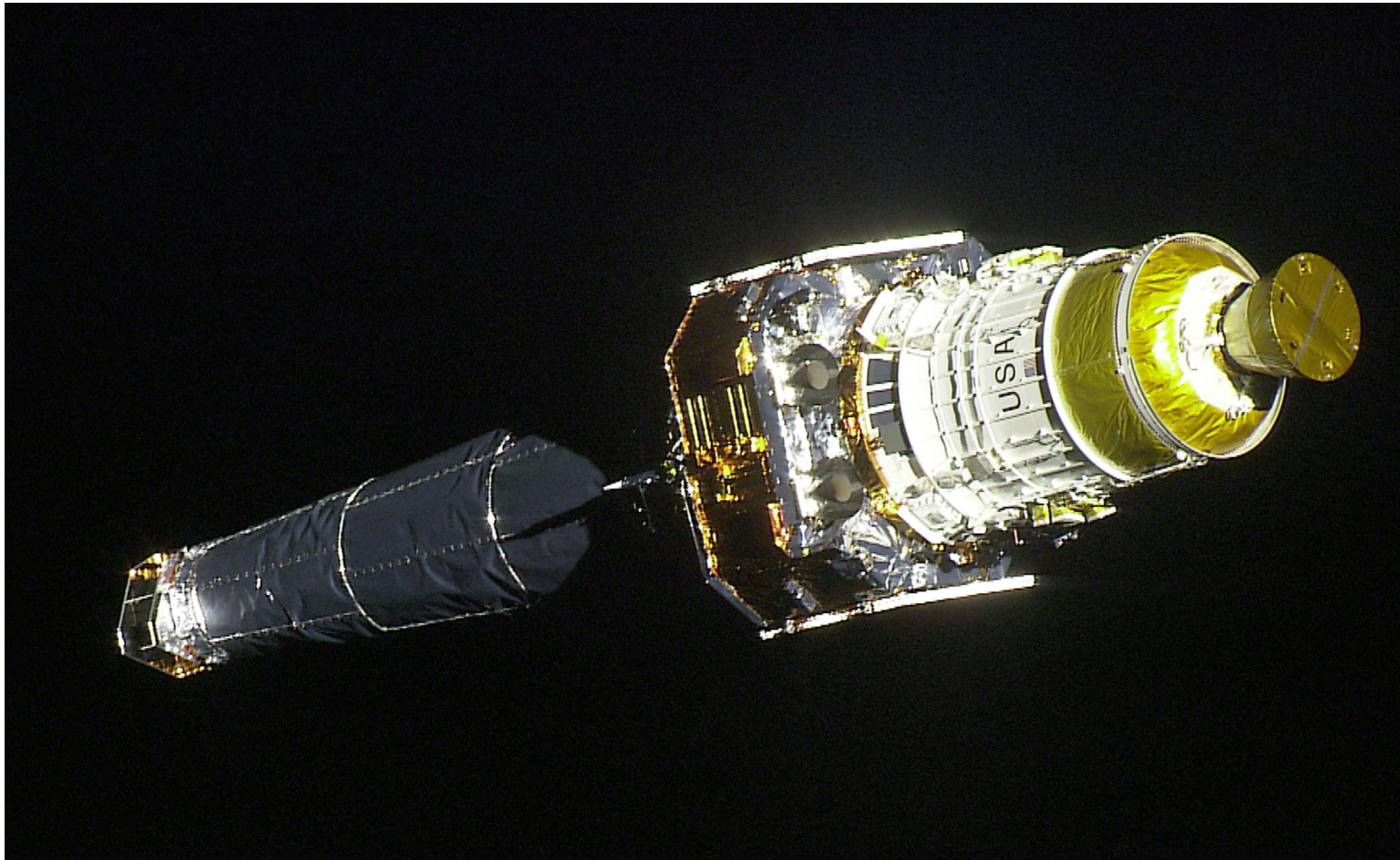
The real spacecraft



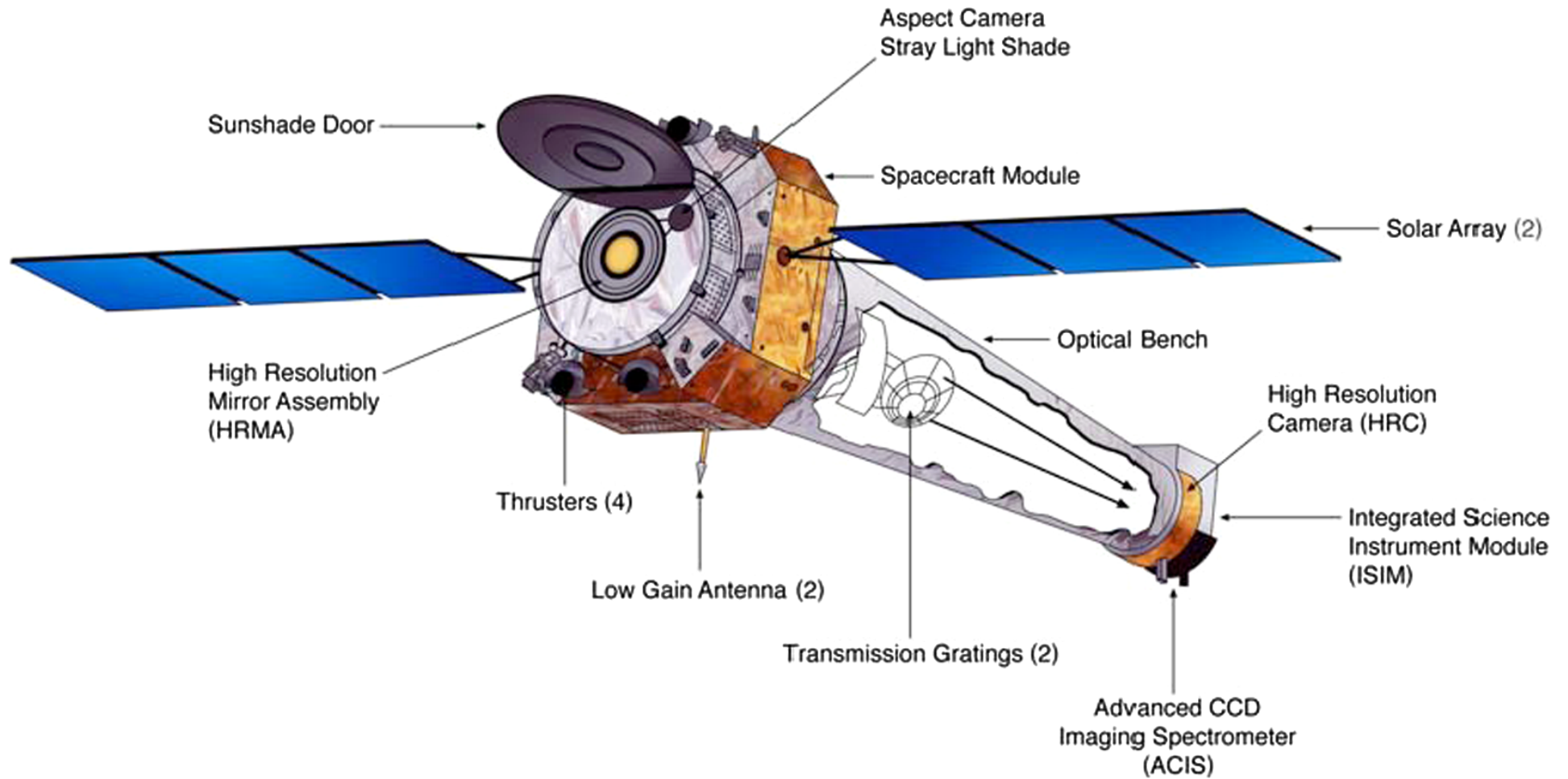
Launched:
July 23, 1999



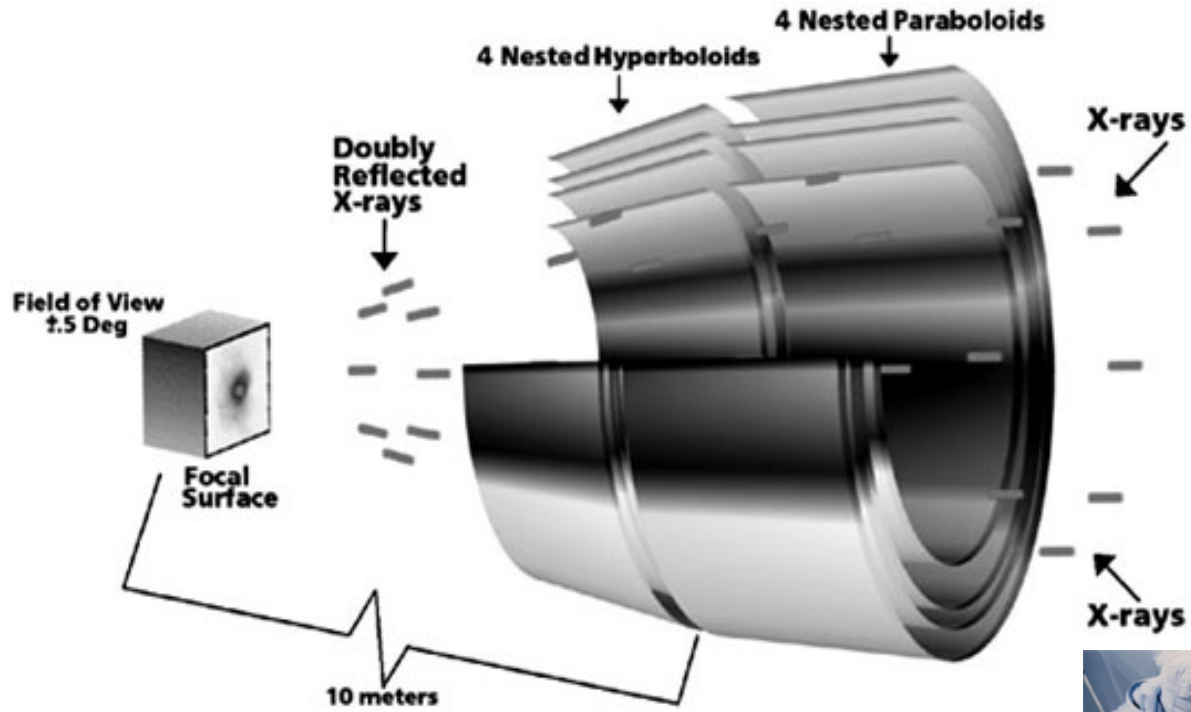
The real spacecraft



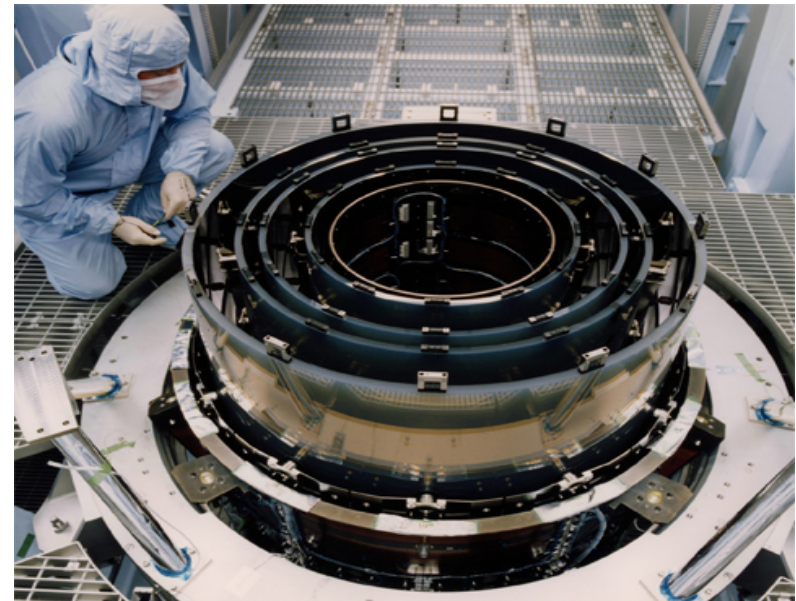
The spacecraft



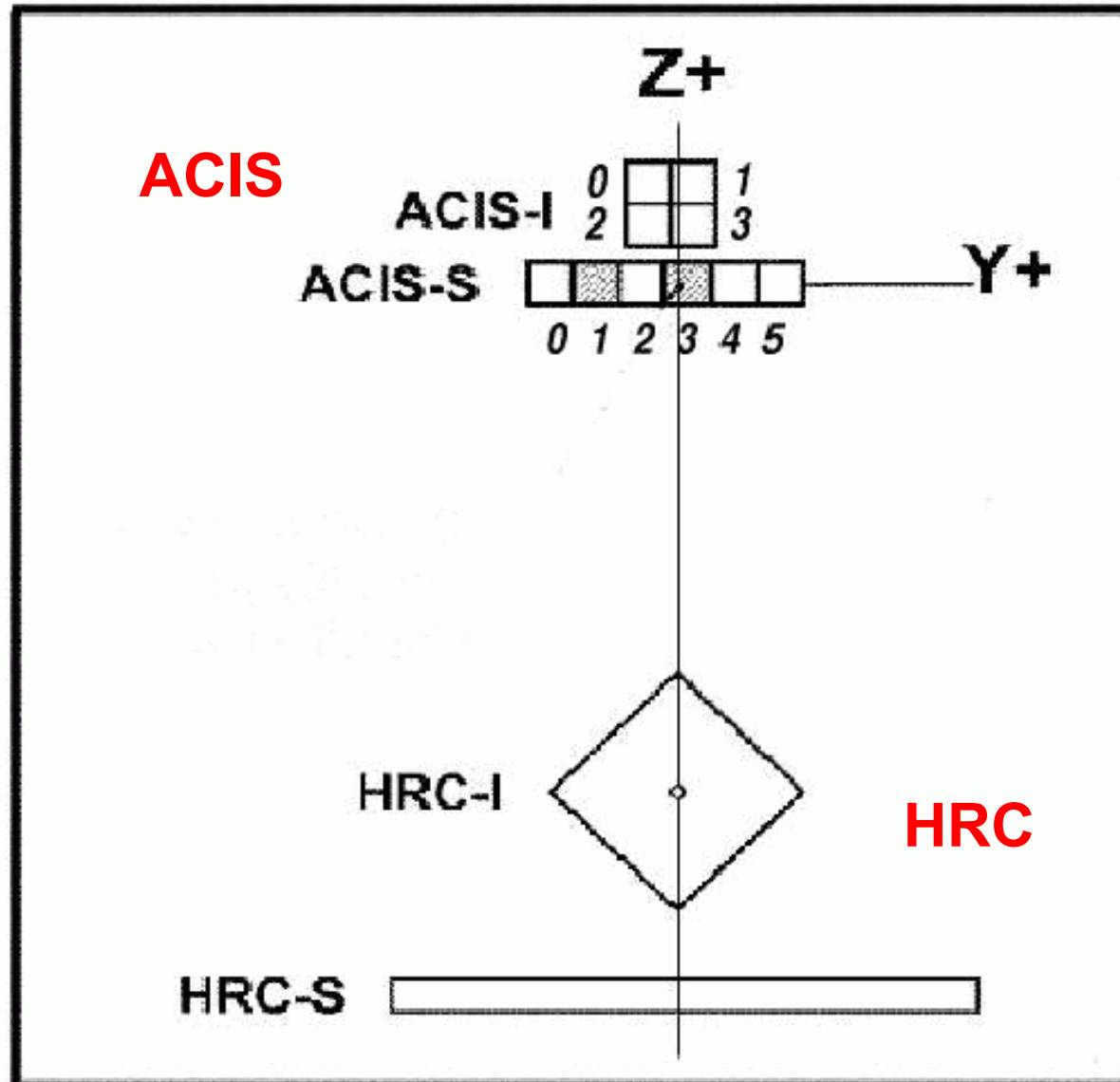
Mirrors



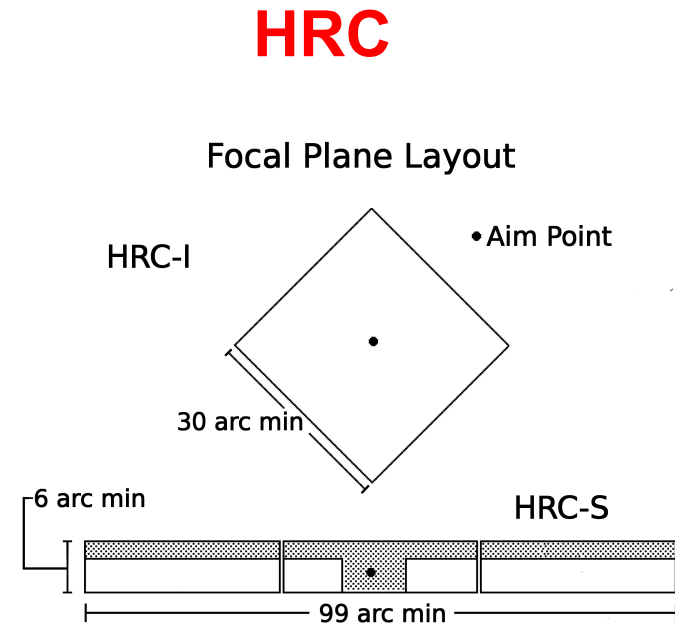
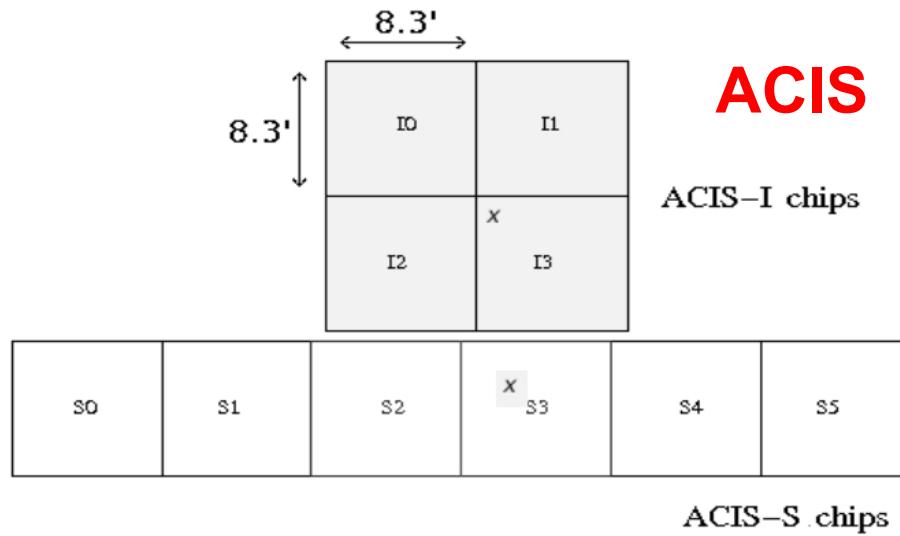
Mirror elements are 0.8 m long and from 0.6 m to 1.2 m diameter



The detectors:

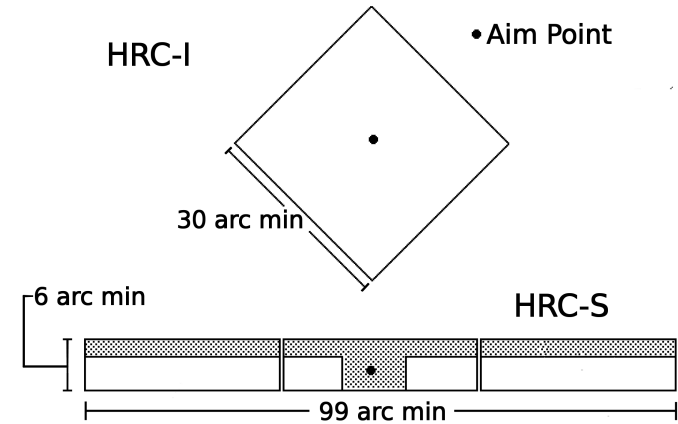
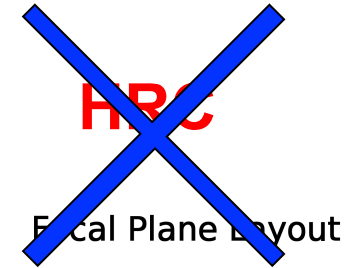
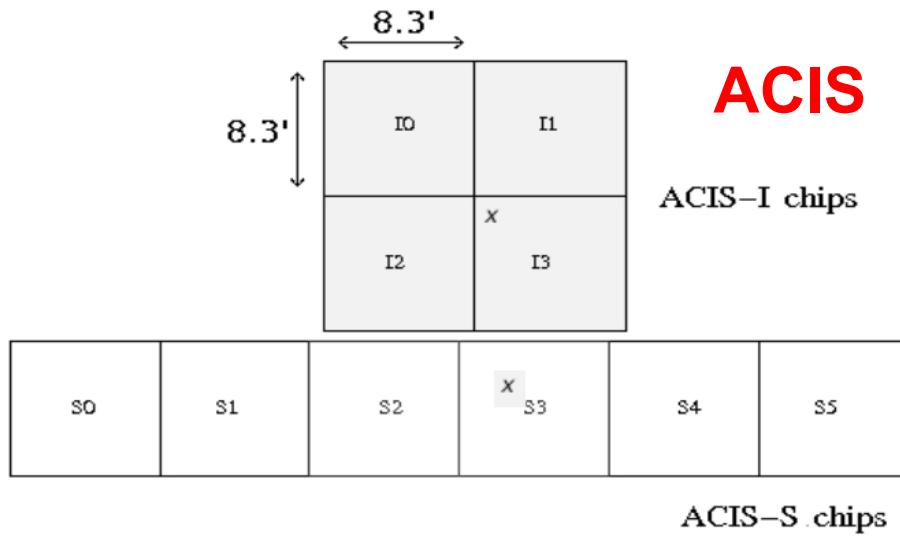


The detectors:



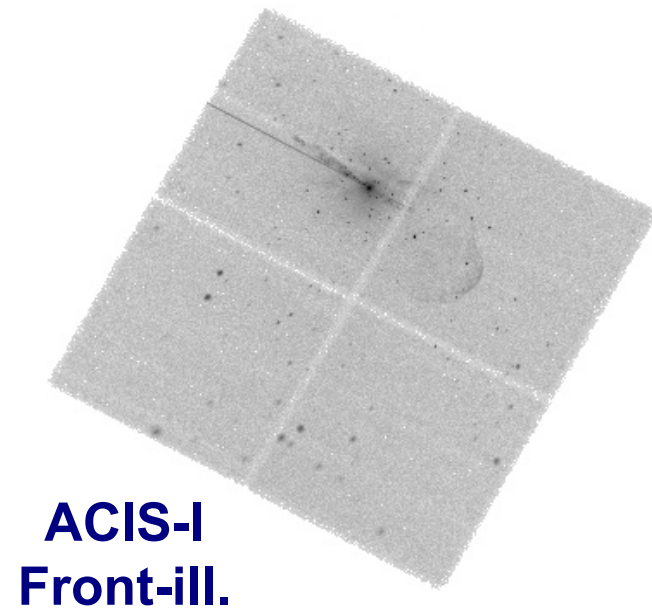
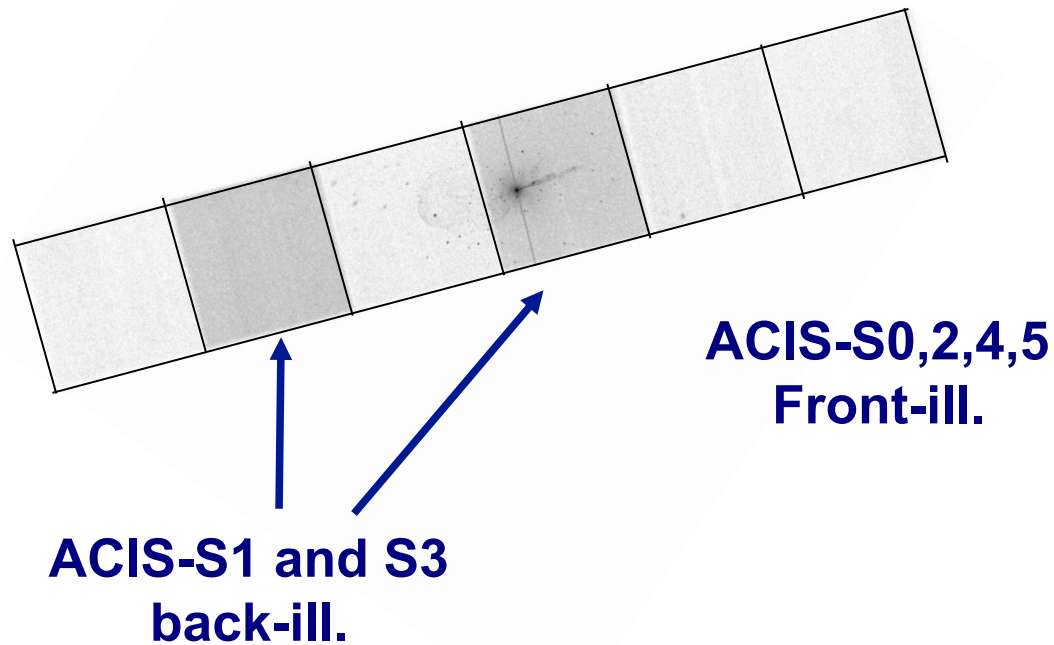
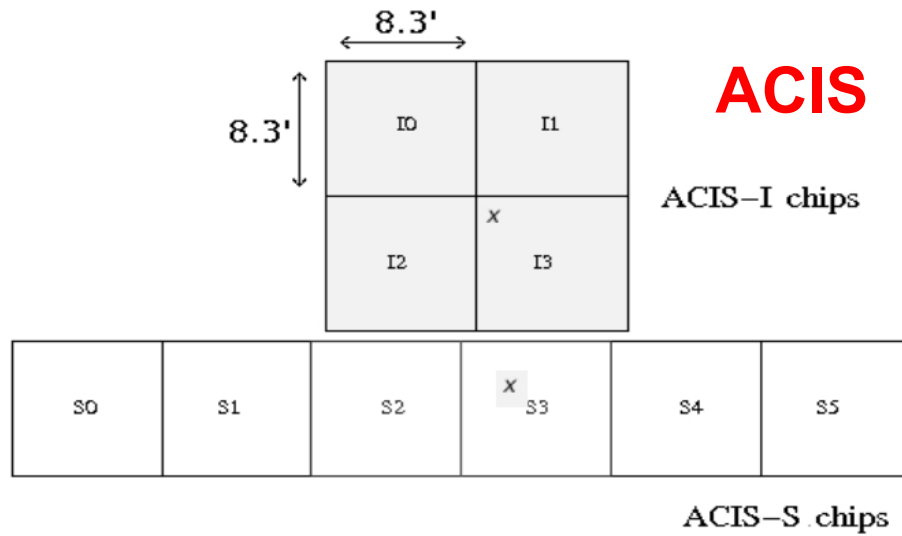
**+HETG and LETG
dispersive spec.**

The detectors:



~~+HETG and LETG
dispersive spec.~~

The detectors:

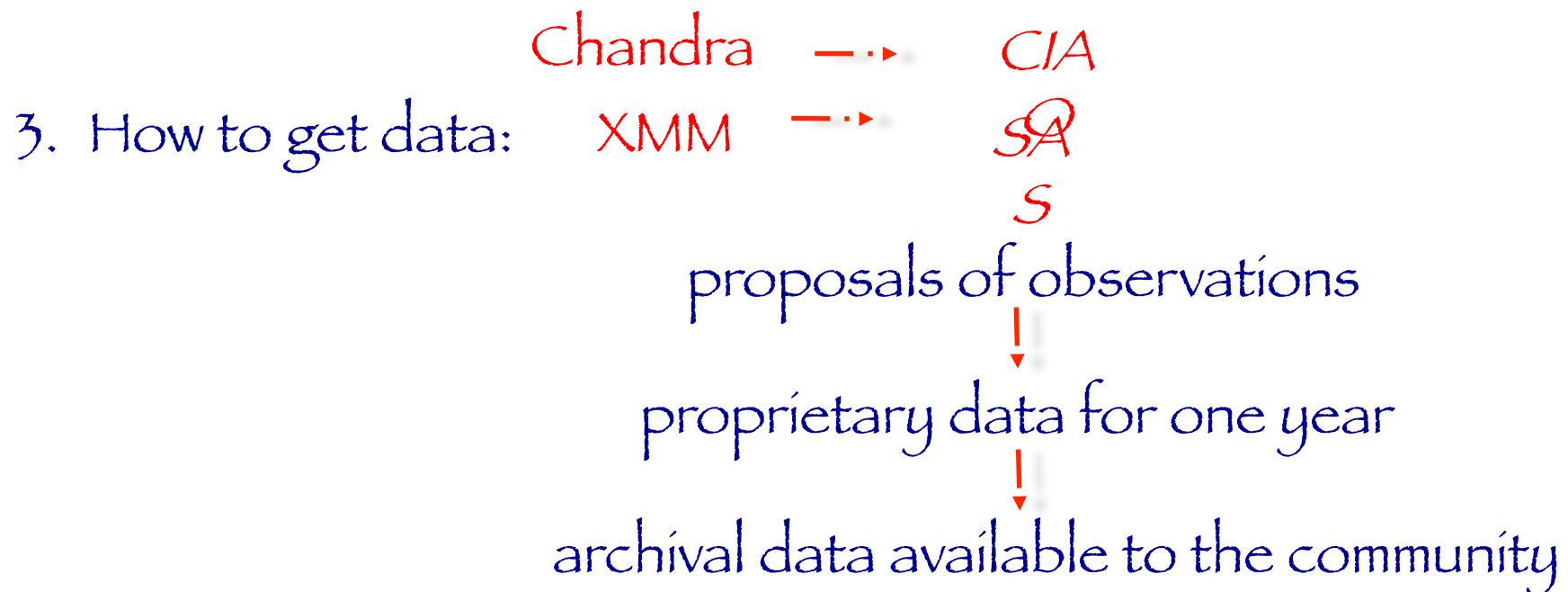


1. The fundamental rules to reduce X-ray data are the same in most of the cases BUT a good knowledge of the properties of X-ray satellites and their instruments is important to maximize the scientific output

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2. X-ray data from each satellite are usually accompanied by specific software and tools to make a proper and easy data reduction and analysis

Chandra → CIA
XMM → SA
S

1. The fundamental rules to reduce X-ray data are the same in most of the cases BUT a good knowledge of the properties of X-ray satellites and their instruments is important to maximize the scientific output
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- How to download X-ray data from a public archive
- How the downloaded files look like
- How to reduce X-ray (*Chandra*) data
- How to create the radio and/or X-ray contours for an extended object

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- How to reduce X-ray (*Chandra*) data
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Where can I find X-ray data archives?

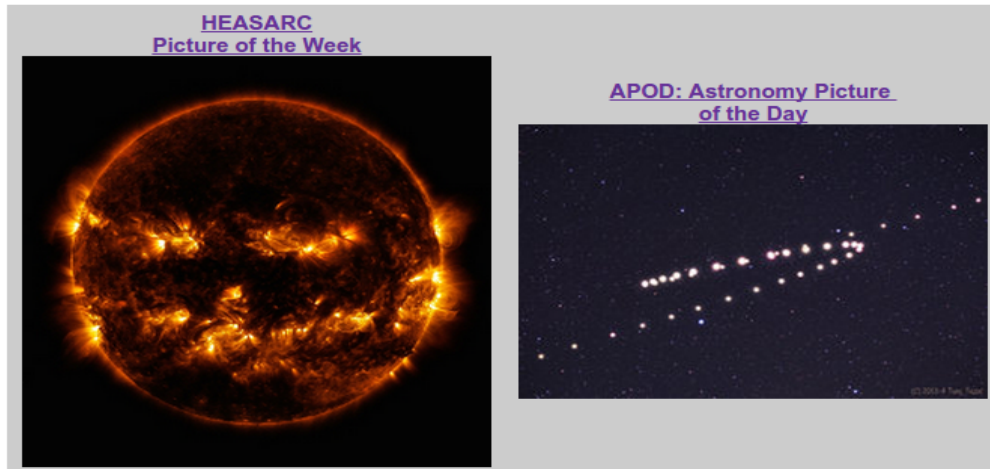


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<http://heasarc.nasa.gov/> → Archive → Browse

Guest Observer Facilities & Science Centers	
AGILE	ASCA
Astro-H	BeppoSAX
COBE	CGRO
Chandra	EUVE
Fermi	GALEX
HETE-2	INTEGRAL
MAXI	NICER
NuSTAR	ROSAT
RXTE	Suzaku
Swift	WMAP
XMM-Newton	
NASA Archives	
ADS	AstroGravS
EOSDIS	ExoArchive
HORIZONS	IRSA
KOA	LAMBDA
MAST	NExSci
NED	NSSDC

The High Energy Astrophysics Science Archive Research Center (HEASARC) is the primary archive for NASA's (and other space agencies') missions studying electromagnetic radiation from extremely energetic cosmic phenomena ranging from black holes to the Big Bang. Since its merger with the Legacy Archive for Microwave Background Data Analysis (LAMBDA) in 2008, the HEASARC archive contains not only data obtained by high-energy astronomy missions observing in the extreme-ultraviolet (EUV), X-ray, and gamma-ray bands, but also data from space missions, balloons, and ground-based facilities that have studied the relic cosmic microwave background (CMB).




Latest News

- [Chandra Observatory Identifies Impact of Cosmic Chaos on Star Birth](#) (28 Oct 2014)
[Zhuravleva et al. \(2014, Nature, In press\)](#) have analyzed the Chandra data for the nearby cool-core clusters of galaxies Perseus and Virgo and conclude that turbulence may be preventing hot gas there from cooling, addressing a long-standing question of why galaxy clusters do not form large numbers of stars.
- [INTEGRAL IBIS AGN Catalog](#) (24 Oct 2014)
 This catalog of the classification and X-ray properties of 272 active galactic nuclei which have been detected by the INTEGRAL IBIS instrument (from [Mazzia et al. 2012, MNRAS, 476, 1750](#)) is now available in Browse and [Xamin](#).
- [5th NuSTAR Public Data Release](#) (23 Oct 2014)
 214 new NuSTAR data sets from the first 24 months of observations were released to the public NuSTAR archive on September 23rd. NuSTAR data are accessible via the usual HEASARC archive interfaces, i.e., [Xamin](#) and [Browse](#), by querying the NuSTAR master table (numaster). NuSTAR data can also be accessed from the HEASARC [FTP site](#).

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Hera
HELP

Other Browse interfaces:
[Notification Service](#) | [Batch](#) | [Correlation](#) | [Index of all tables](#) | [Keyword Search](#)

Query File And Session Uploads

Start Search Reset Detailed Mission/Catalog Search

1. Do you want to search around a position ... ?
 (If you want to search on parameters other than object name or coordinates, select "Detailed Mission/Catalog Search".)

Object Name or Coordinates: and/or **Select Local File:** No file chosen

e.g. Cyg X-1 or 12 00 00, 4 12 6 or Cyg X-2; 12.235, 15.345 (Note use of semi-colons (;) to separate multiple object names or coordinate pairs)

Coordinate System: J2000 **Search Radius:** Default arcmin

Default uses the optimum radius for each catalog searched.

... and/or search by date?

Observation Dates: YYYY-MM-DD hh:mm:ss or MJD: DDDDD.ddd


Not all tables have observation dates. For those that do, the time portion of the date is optional. Separate multiple dates/ranges with semicolons (;). Range operator is '..'. (e.g. 1992-12-31; 48980.5; 1995-01-15 12:00:00; 1997-03-20 .. 2000-10-18)

2. What missions and catalogs do you want to search? (Bold text indicates mission is active)

- [Most Requested Missions](#)
- [Chandra](#) [**CXC,CSC**]
 [Fermi](#)
 [NuSTAR](#) [**CalTech**]
 [ROSAT](#)
- [RXTE](#)
 [Suzaku](#)
 [Swift](#)
 [WMAP](#)
- [XMM-Newton](#) [**XSA**]
- [Other X-Ray and EUV Missions](#)
- [Ariel V](#)
 [ASCA](#)
 [BBXRT/Astro-1](#)
 [BeppoSAX](#)
- [Copernicus](#)
 [Einstein](#)
 [EUVE](#) [**MAST**]
 [EXOSAT](#)

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Other Browse interfaces: [Notification Service](#) | [Batch](#) | [Correlation](#) | [Index of all tables](#) | [Keyword Search](#) [Query File And Session Uploads](#)

[Start Search](#) [Reset](#) [Detailed Mission/Catalog Search](#)

1. Do you want to search around a position ... ?
(If you want to search on parameters other than object name or coordinates, select "Detailed Mission/Catalog Search".)

Object Name or Coordinates: and/or [Select Local File:](#) No file chosen

e.g. Cyg X-1 or 12 00 00, 4 12 6 or Cyg X-2; 12.235, 15.345 (Note use of semi-colons (;) to separate multiple object names or coordinate pairs)

File should contain objects and/or coordinate pairs one per line or separated by semi-colons.

Coordinate System: J2000

Search Radius: Default **arcmin**

Default uses the optimum radius for each catalog searched.

... and/or search by date?

Observation Dates: YYYY-MM-DD hh:mm:ss or MJD: DDDDD.ddd

Not all tables have observation dates. For those that do, the time portion of the date is optional. Separate multiple dates/ranges with semicolons (;). Range operator is '..'. (e.g. 1992-12-31; 48980.5; 1995-01-15 12:00:00; 1997-03-20 .. 2000-10-18)

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- Most Requested Missions**
 - Chandra** [CXC,CSC]
 - RXTE
 - XMM-Newton [XSA]
 - Fermi
 - Suzaku
 - NuSTAR [CalTech]
 - Swift
 - ROSAT
 - WMAP
- Other X-Ray and EUV Missions**
 - Ariel V
 - Copernicus
 - ASCA
 - Einstein
 - BBXRT/Astro-1
 - EUVE [MAST]
 - BeppoSAX
 - EXOSAT

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[Query Information](#) **[Query Results](#)** [Data Products Retrieval](#) [Help](#)

[chandra](#)

[chanmaster](#) [cxoxassist](#)

Click mission tabs (middle tab level) to display table tabs. Move cursor over tabs to see more information.

Table Legend:

🔍 Display all parameters for a row
 ↓ Sort by a column in order: 1,2,3 ↑ Sort by column in reverse order: 3,2,1 ↓/↑ Current table sort
 Services links: O: Digitized Sky Survey image, R: ROSAT All-Sky Survey image, N: NED objects near coordinates,
 S: SIMBAD objects near coordinates, D: get list of data products, B: ADS bibliography holdings, F: FOV plot for observation

Data Products: Click checkbox to add row to Data Product Retrieval List

[Chandra Observations \(chanmaster\)](#) [Bulletin](#) [Note](#)
 Search radius used: 21.00 '

Select	Related Links	Services	obsid	status	name	ra	dec	time	detector	grating	exposure	type	pi	public date	Search Offset
<input type="checkbox"/> All			↓↑	↓↑	↓↑	↓↑	↓↑	↓↑	↓↑	↓↑	↓↑ [s]	↓↑	↓↑	↓↑	['] from (target)
<input type="checkbox"/>	ASCA ROSAT RXTE XMM	O R N S D	16219	unobserved	3C 111	04 18 21.30	+38 01 35.8	2014-11-12	ACIS-S	HETG	150000	GO	Tombesi		0.004 (3c111)
<input type="checkbox"/>	ASCA ROSAT RXTE XMM	O R N S D B F	14990	archived	3C 111	04 18 21.30	+38 01 36.0	2013-01-10 04:29:04	ACIS-S	NONE	122250	GO	Perlman	2014-01-15	0.006 (3c111)
<input type="checkbox"/>	ASCA ROSAT RXTE XMM	O R N S D B F	9279	archived	0415+379	04 18 21.30	+38 01 35.8	2008-12-08 06:04:09	ACIS-S	NONE	10140	GO	Lister	2009-12-08	0.004 (3c111)

3 rows retrieved from chanmaster

<p>Data Product Retrieval</p> <ul style="list-style-type: none"> Select the checkboxes for the rows of interest above. Un-check any data products below you are not interested in Select the Data Product Retrieval tab for retrieval options <p>Data Products available for chanmaster</p> <p><input checked="" type="checkbox"/> All</p> <p><input checked="" type="checkbox"/> Chandra Proposal Abstracts (abstracts)</p> <p><input checked="" type="checkbox"/> Events Lists (events)</p> <p><input checked="" type="checkbox"/> FITS and JPEG Images (images)</p> <p><input checked="" type="checkbox"/> Miscellaneous Files (misc)</p>	<p>Further Actions:</p> <p>Do you want to plot your chanmaster results using <input type="button" value="Java Plot"/> (help) or <input type="button" value="Xamin"/> (notes)?</p> <p>Do you want to <input type="button" value="Cross-correlate"/> your chanmaster results with another catalog or table? (help)</p>
---	--

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Archive Data Products for selected row in Chandra Observations

- Do you want to view a data product? Click on its hyperlinked data format.
- Do you want to retrieve data products in a tarfile? Check the boxes beside each product and click one of the buttons at the bottom of the page.

Select all products for all rows

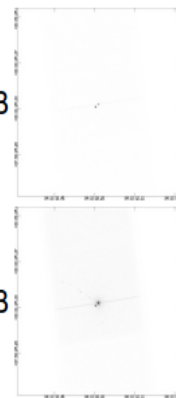
[Chandra Observations \(chanmaster\)](#) [FTOOLS](#)

obsid	status	name	ra	dec	time	detector	grating	exposure	type	pi	public_date
14990	archived	3C 111 04	18 21.30	+38 01 36.0	2013-01-10 04:29:04	ACIS-S	NONE	122250	GO	Perlman	2014-01-15

Select all products in this row

FITS and JPEG Images

- Center Image (acisf14990N001_e1_cntr_img2.fits.gz) [FITS](#) 837 kB updated: 2013/01/12 00:00:00
- Center Image (acisf14990N001_e2_cntr_img2.fits.gz) [FITS](#) 945 kB updated: 2013/01/12 00:00:00
- Center Image (acisf14990N001_e1_cntr_img2.jpg) [JPEG](#) 85 kB updated: 2013/01/12 00:00:00
- Center Image (acisf14990N001_e2_cntr_img2.jpg) [JPEG](#) 223 kB updated: 2013/01/12 00:00:00
- Full Image (acisf14990N001_e1_full_img2.fits.gz) [FITS](#) 828 kB updated: 2013/01/12 00:00:00
- Full Image (acisf14990N001_e2_full_img2.fits.gz) [FITS](#) 844 kB updated: 2013/01/12 00:00:00



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<input type="checkbox"/> Aspect Quality (pcadf474179932N001_aqual1.fits.gz)	FITS	1869 kB	updated: 2013/01/12 00:00:00
<input checked="" type="checkbox"/> Aspect Solution (pcadf474179932N001_asol1.fits.gz)	FITS	30450 kB	updated: 2013/01/12 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474175484N001_osol1.fits.gz)	FITS	348 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474182044N001_osol1.fits.gz)	FITS	345 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474188604N001_osol1.fits.gz)	FITS	345 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474195164N001_osol1.fits.gz)	FITS	345 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474201724N001_osol1.fits.gz)	FITS	252 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474206447N001_osol1.fits.gz)	FITS	345 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474213007N001_osol1.fits.gz)	FITS	345 kB	updated: 2013/01/11 00:00:00
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<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474232687N001_osol1.fits.gz)	FITS	101 kB	updated: 2013/01/11 00:00:00
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<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474288054N001_osol1.fits.gz)	FITS	159 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474291038N001_osol1.fits.gz)	FITS	348 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> OBC Aspect Solution (pcadf474297598N001_osol1.fits.gz)	FITS	344 kB	updated: 2013/01/11 00:00:00
<input checked="" type="checkbox"/> Orbit Ephemeris (orbitf474120303N001_eph1.fits.gz)	FITS	310 kB	updated: 2013/02/08 00:00:00
Events Lists			
<input checked="" type="checkbox"/> Events List (acisf14990N001_e1_evt2.fits.gz)	FITS	2813 kB	updated: 2013/01/12 00:00:00
<input checked="" type="checkbox"/> Events List (acisf14990N001_e2_evt2.fits.gz)	FITS	21138 kB	updated: 2013/01/12 00:00:00
Miscellaneous Files			
<input checked="" type="checkbox"/> Bad Pixel List (acisf14990_000N001_e1_bpix1.fits.gz)	FITS	8 kB	updated: 2013/01/12 00:00:00
<input checked="" type="checkbox"/> Bad Pixel List (acisf14990_000N001_e2_bpix1.fits.gz)	FITS	29 kB	updated: 2013/01/12 00:00:00
<input checked="" type="checkbox"/> Observation Index File (oif.fits)	FITS	31 kB	updated: 2014/01/15 15:18:00
<input checked="" type="checkbox"/> Secondary Products (secondary)	DIRECTORY	263085 kB	updated: 2014/01/15 22:26:39

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[Archive](#)

Retrieve Data Products

Estimated size of TAR file: 314 MB

Your TAR file is being created now. When finished you may retrieve it via the following link

<http://heasarc.gsfc.nasa.gov/FTP/retrieve/w3browse/w3browse-164971.tar>

Please wait until the "TAR complete" message appears below before retrieving.

Below are data products included in the TAR file: (filenames ending in '.gz' or '.Z' have been compressed for faster downloading.)

Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e2_full_img2.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e2_evt2.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990_000N001_e1_bpix1.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e2_full_img2.jpg
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e1_evt2.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/oif.fits
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e1_full_img2.jpg
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/pcadf474179932N001_asol1.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e1_full_img2.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e1_cntr_img2.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e1_cntr_img2.jpg
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990_000N001_e2_bpix1.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e2_cntr_img2.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/acisf14990N001_e2_cntr_img2.jpg
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/primary/orbitf474120303N001_eph1.fits.gz
Tarred: /FTP/chandra/data/science/ao14/cat7//14990/secondary

TAR complete: Actual size: 314 MB.

Remote files are not included in the tar file. Use the **Create Download Script** option to retrieve remote files.

XMM-Newton Science Operations Centre (ESA-Vilspa, Spain)

<http://xmm.esac.esa.int/xsa/>

XMM-Newton Science Archive 6.5

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esa XMM-Newton Science Archive European Space Agency

Query Specification Latest Results Shopping Basket Login/Register Logout Request Monitor

Not Logged In Idle

Execute Query Cancel Query View/Edit SQL

Results Display Observations Sort Criterion Observation Start Time

Close **Principal Search Criteria**

Observation ID File with Observation ID List Locate File

Search Target By Name Equatorial Galactic Ecliptic Radius Target In FOV Box Ignore FOV

Name for SIMBAD Radius 5 arcmin

File With Target List Locate File Coordinates Display Sexagesimal

Obs. Status Any Obs. Mode Any Observations Availability Any

Open **Orbit and Data Processing**

Open **Proposal**

Open **Exposures**

Open **XMM-Newton EPIC Source Catalogue**

see XMM tutorial...

ASI Scientific Data Center (ASDC- Frascati, Roma)

<http://www.asdc.asi.it/>

asdc
ASI Science Data Center

ASI Science Data Center

agenzia spaziale italiana

Home About Public Outreach Quick Look/Current Missions Multimission Archive Catalogs Tools Links Bibliographic services

AGILE SWIFT FERMI HERSCHEL PLANCK BeppoSAX NUSTAR Gaia

Astrophysics and Cosmology Exploration of the Solar System Astroparticle Physics

Space astrophysics cosmology astroparticle physics solar system exploration

TOP RESULTS/PRESS RELEASES

- October 7, 2010: The Crab "goes wild" in gamma-rays
- September 15, 2010: Planck discovery of a supercluster of galaxies through SZ effect
- July 26, 2010: AGILE-GRID detects its brightest Gamma-Ray Burst


Chandra X-ray Center (CXC-CFA, Cambridge-Boston)


<http://cxc.harvard.edu/cda/>

Chandra Data Archive: Observation Search

webchaser

<http://cda.harvard.edu/chaser/>

 **Chandra X-ray Center** [New Search](#)

Observation Search [Retrieval List](#) [Help](#)  Chandra Data Archive

Search Reset

Target Name	<input type="text"/>	Resolve Name	RA/Long/l <input type="text"/>	Dec/Lat/b <input type="text"/>
Name Resolver	<input type="text" value="SIMBAD/NED"/>	Coordinate System	<input type="text" value="Equatorial J2000"/>	Equinox
Observation ID	<input type="text"/>	Sequence Number	<input type="text"/>	Proposal Number
Proposal Title	<input type="text"/>	PI Name	<input type="text"/>	Observer Name
Start Date	<input type="text"/>	Public Release Date	<input type="text"/>	Exposure Time (ks)

Status	<input type="text" value="Archived"/> <input type="text" value="Observed"/> <input type="text" value="Scheduled"/> <input type="text" value="Unobserved"/> <input type="text" value="Canceled"/>	Science Category	<input type="text" value="Solar System"/> <input type="text" value="Stars and WD"/> <input type="text" value="WD Binaries and CV"/> <input type="text" value="BH and NS Binaries"/> <input type="text" value="SN, SNR and Isolated NS"/>	Join			
Instrument	<input type="text" value="ACIS-I"/> <input type="text" value="ACIS-S"/> <input type="text" value="HRC-I"/> <input type="text" value="HRC-S"/>	Grating	<input type="text" value="None"/> <input type="text" value="LETG"/> <input type="text" value="HETG"/>	Type	<input type="text" value="GO"/> <input type="text" value="GTO"/> <input type="text" value="TOO"/> <input type="text" value="DDT"/> <input type="text" value="CAL"/>	Observing Cycle	<input type="text" value="A00"/> <input type="text" value="A01"/> <input type="text" value="A02"/> <input type="text" value="A03"/> <input type="text" value="A04"/>

Customize Output:

[Sort Order](#) ascending descending

[Display](#) [Format](#) [Row Limit](#)

[Coordinate System](#) [Equinox](#) [Format](#)



Chandra
X-ray Center [New Search](#)

Search Results

[Retrieval List](#) [Help](#)



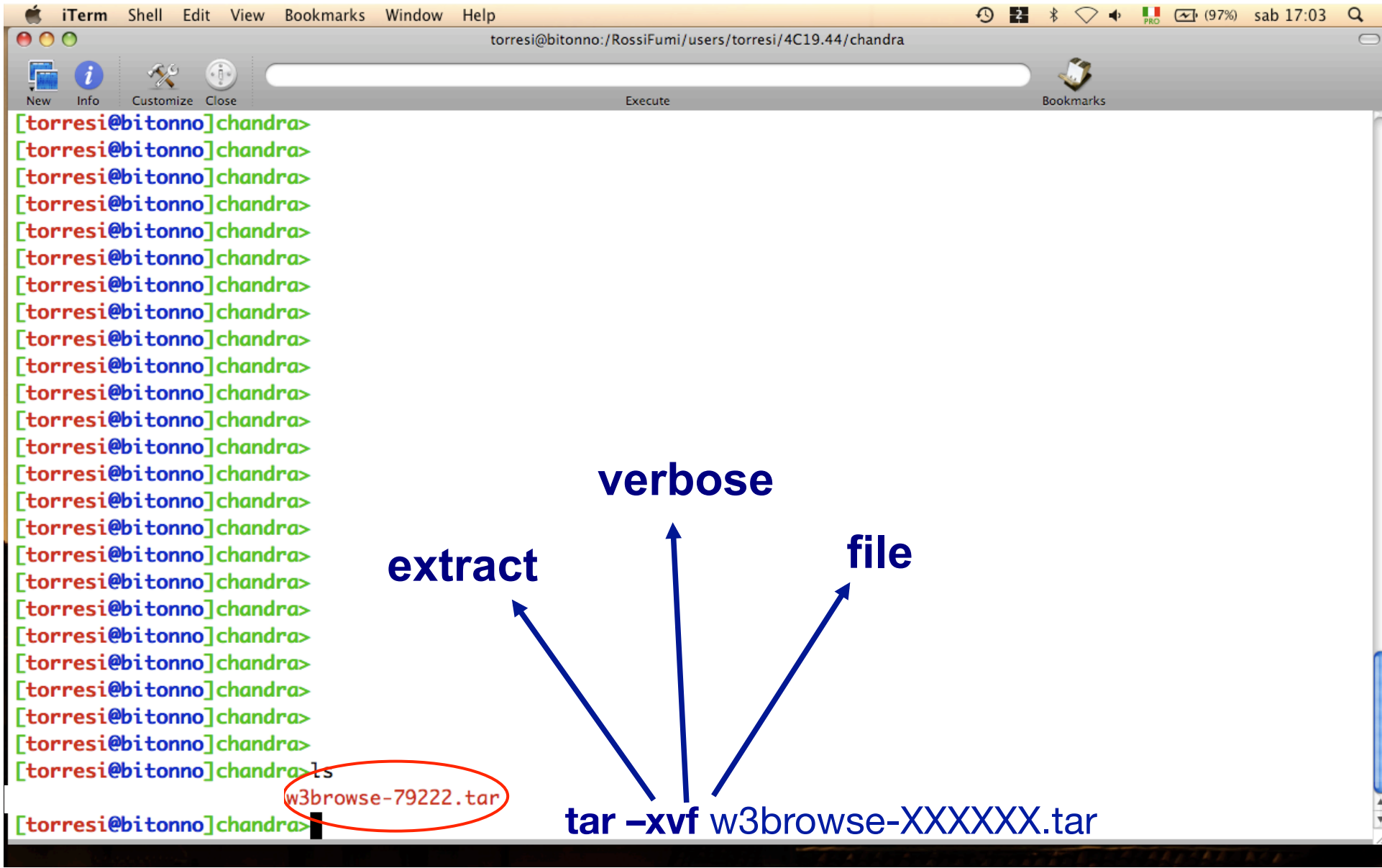
View Observation Information | Add to Retrieval List

[Primary products](#)
 [Secondary products](#)

[Select all](#) | [Unselect all](#)

Select	Row	Seq Num	Obs ID	Instrument	Grating	Appr Exp (ks)	Exposure (ks)	Target
<input type="checkbox"/>	1	700743	4064	ACIS-S	NONE	5.0	4.73	BR 0331-1622
<input type="checkbox"/>	2	700744	4065	ACIS-S	NONE	4.0	4.12	BR 0353-3820
<input type="checkbox"/>	3	700745	4066	ACIS-S	NONE	4.0	4.04	BR 0418-5723
<input type="checkbox"/>	4	700746	4067	ACIS-S	NONE	5.0	4.73	BR 0424-2209
<input type="checkbox"/>	5	700747	4068	ACIS-S	NONE	5.0	4.59	PSS 0747+4434
<input type="checkbox"/>	6	700748	4069	ACIS-S	NONE	5.0	5.12	PSS 1058+1245
<input type="checkbox"/>	7	700749	4070	ACIS-S	NONE	5.0	4.76	BRI 1117-1330
<input type="checkbox"/>	8	700750	4071	ACIS-S	NONE	5.0	4.92	PSS 1506+5220
<input type="checkbox"/>	9	700751	4072	ACIS-S	NONE	5.0	4.91	PSS 1646+5514
<input type="checkbox"/>	10	700752	4073	ACIS-S	NONE	5.0	4.96	BR 2213-6729

- How to download X-ray data from a public archive
- How the downloaded files look like
- How to reduce X-ray (*Chandra*) data
- How to create the radio and/or X-ray contours for an extended object



extract

verbose

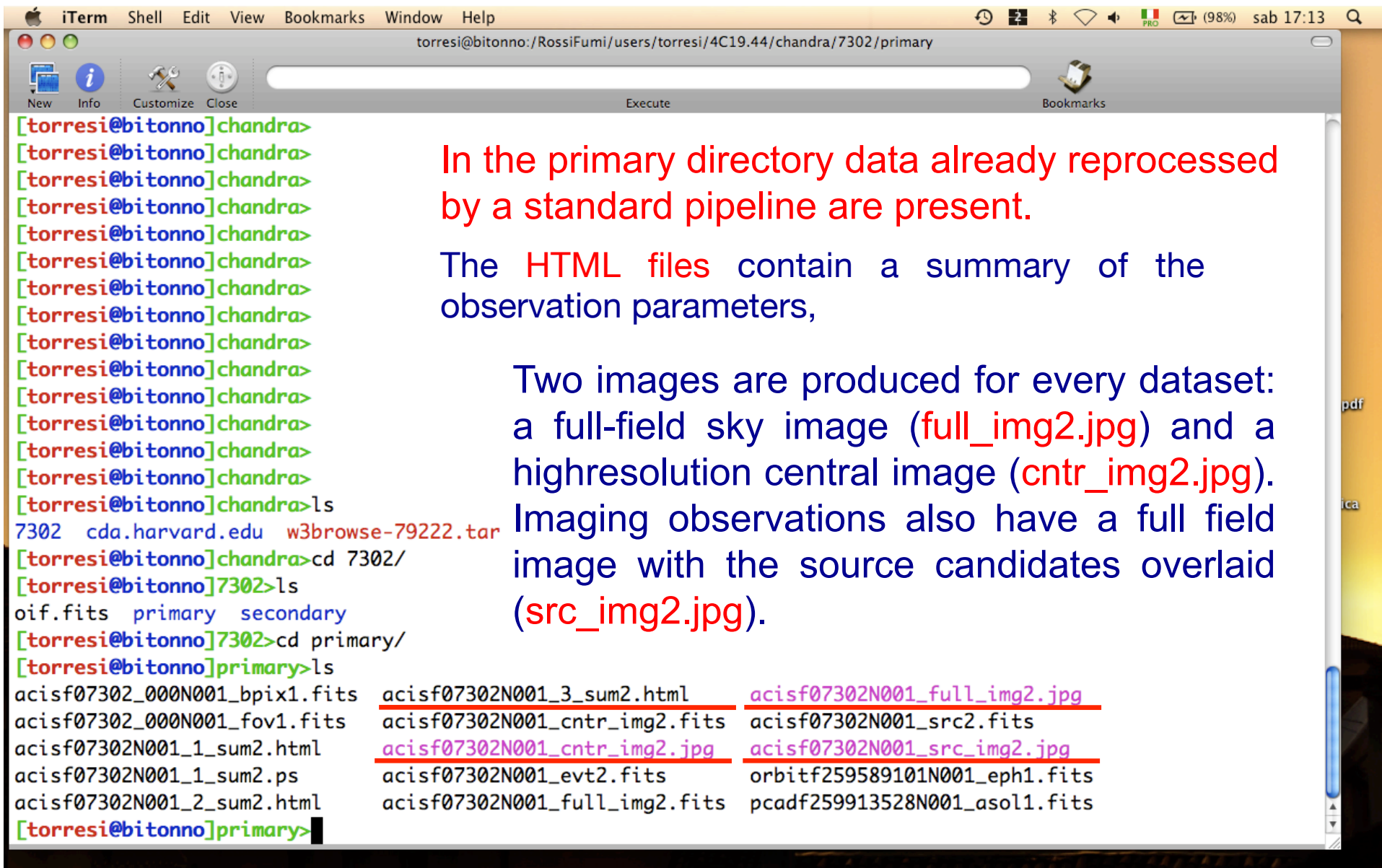
file

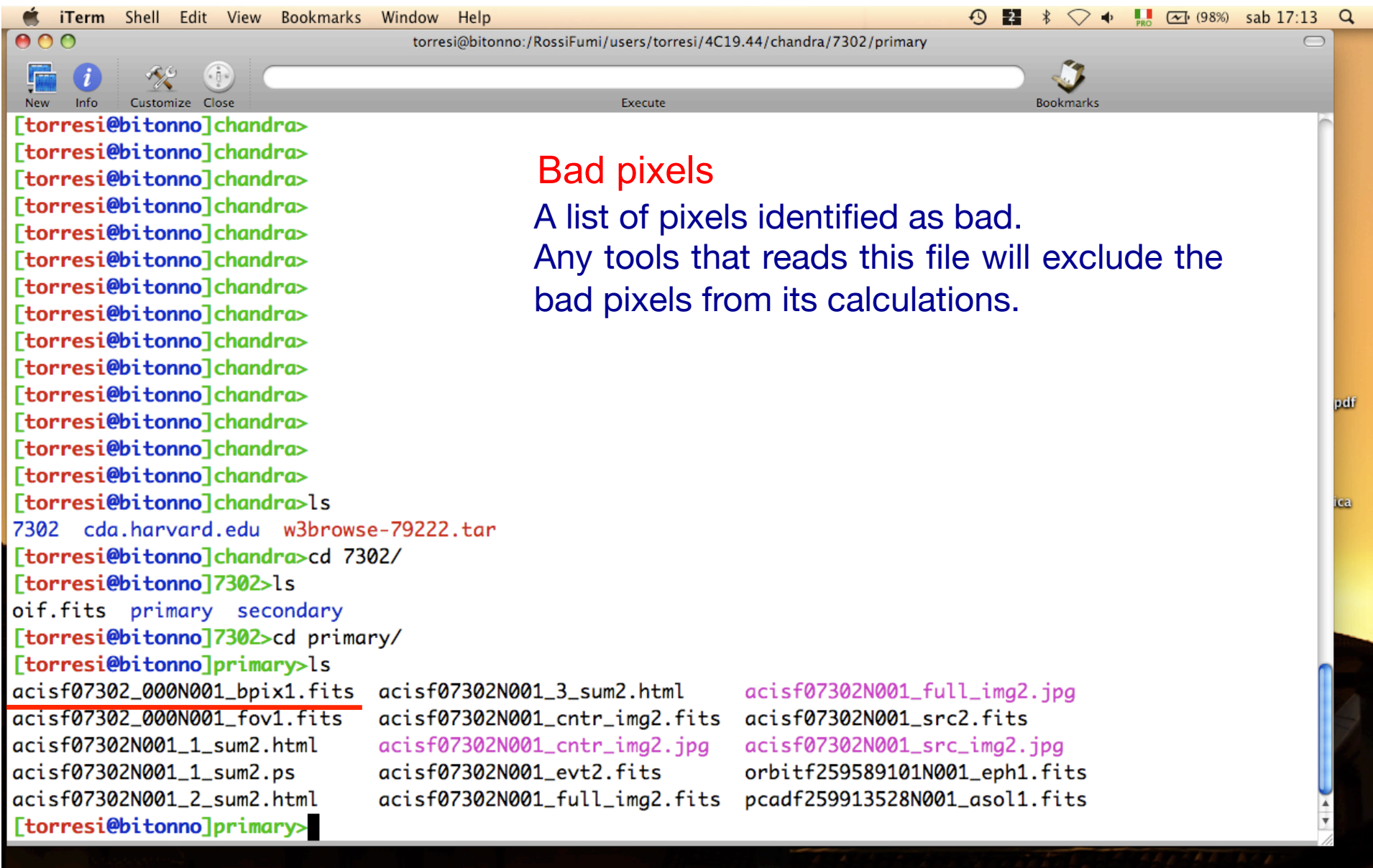
w3browse-79222.tar

tar -xvf w3browse-XXXXXX.tar



```
iTerm Shell Edit View Bookmarks Window Help
torresi@bitonno: /RossiFumi/users/torresi/4C19.44/chandra/7302
New Info Customize Close Execute Bookmarks
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
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[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>ls
7302 cda.harvard.edu w3browse-79222.tar
[torresi@bitonno]chandra>cd 7302/
[torresi@bitonno]7302>ls
oif.fits primary secondary
[torresi@bitonno]7302>
```





Bad pixels

A list of pixels identified as bad.
Any tools that reads this file will exclude the bad pixels from its calculations.

```
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
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[torresi@bitonno]chandra>
[torresi@bitonno]chandra>ls
7302 cda.harvard.edu w3browse-79222.tar
[torresi@bitonno]chandra>cd 7302/
[torresi@bitonno]7302>ls
oif.fits primary secondary
[torresi@bitonno]7302>cd primary/
[torresi@bitonno]primary>ls
acisf07302_000N001_bpix1.fits  acisf07302N001_3_sum2.html  acisf07302N001_full_img2.jpg
acisf07302_000N001_fov1.fits  acisf07302N001_cntr_img2.fits  acisf07302N001_src2.fits
acisf07302N001_1_sum2.html    acisf07302N001_cntr_img2.jpg  acisf07302N001_src_img2.jpg
acisf07302N001_1_sum2.ps     acisf07302N001_evt2.fits     orbitf259589101N001_eph1.fits
acisf07302N001_2_sum2.html   acisf07302N001_full_img2.fits  pcadf259913528N001_asol1.fits
[torresi@bitonno]primary>
```

```
iTerm Shell Edit View Bookmarks Window Help
torresi@bitonno:/RossiFumi/users/torresi/4C19.44/chandra/7302/primary
New Info Customize Close Execute Bookmarks
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
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[torresi@bitonno]chandra>
[torresi@bitonno]chandra>
[torresi@bitonno]chandra>ls
7302 cda.harvard.edu w3browse-79222.tar
[torresi@bitonno]chandra>cd 7302/
[torresi@bitonno]7302>ls
oif.fits primary secondary
[torresi@bitonno]7302>cd primary/
[torresi@bitonno]primary>ls
acisf07302_000N001_bpix1.fits acisf07302N001_3_sum2.html acisf07302N001_full_img2.jpg
acisf07302_000N001_fov1.fits acisf07302N001_cntr_img2.fits acisf07302N001_src2.fits
acisf07302N001_1_sum2.html acisf07302N001_cntr_img2.jpg acisf07302N001_src_img2.jpg
acisf07302N001_1_sum2.ps acisf07302N001_evt2.fits orbitf259589101N001_eph1.fits
acisf07302N001_2_sum2.html acisf07302N001_full_img2.fits pcadf259913528N001_asol1.fits
[torresi@bitonno]primary>
```

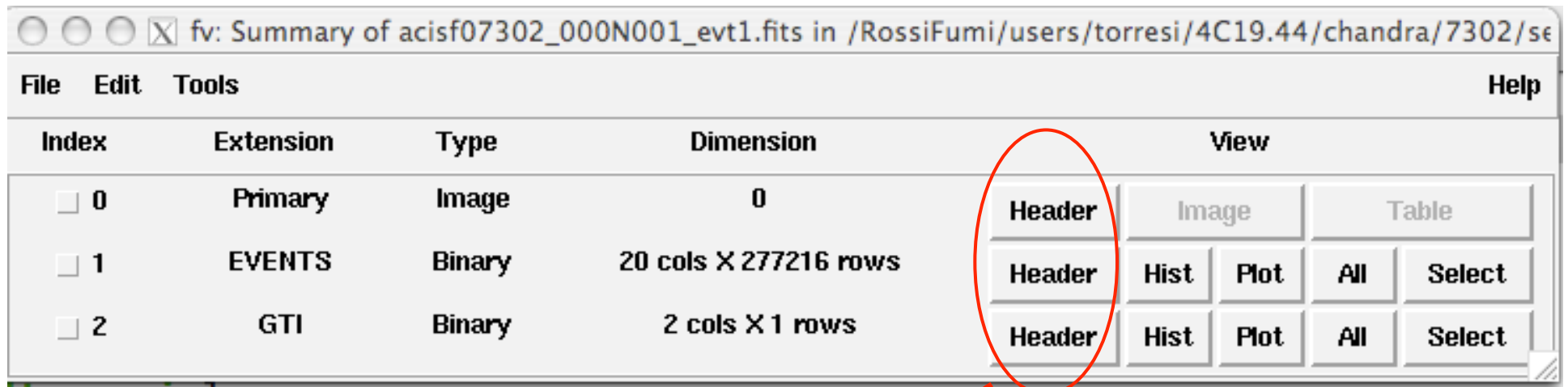
Aspect solution

Describes the *orientation of the telescope as a function of time*. The detected position of an event and the corresponding telescope aspect are combined for an accurate determination of the celestial position of that event.

Good Time Intervals

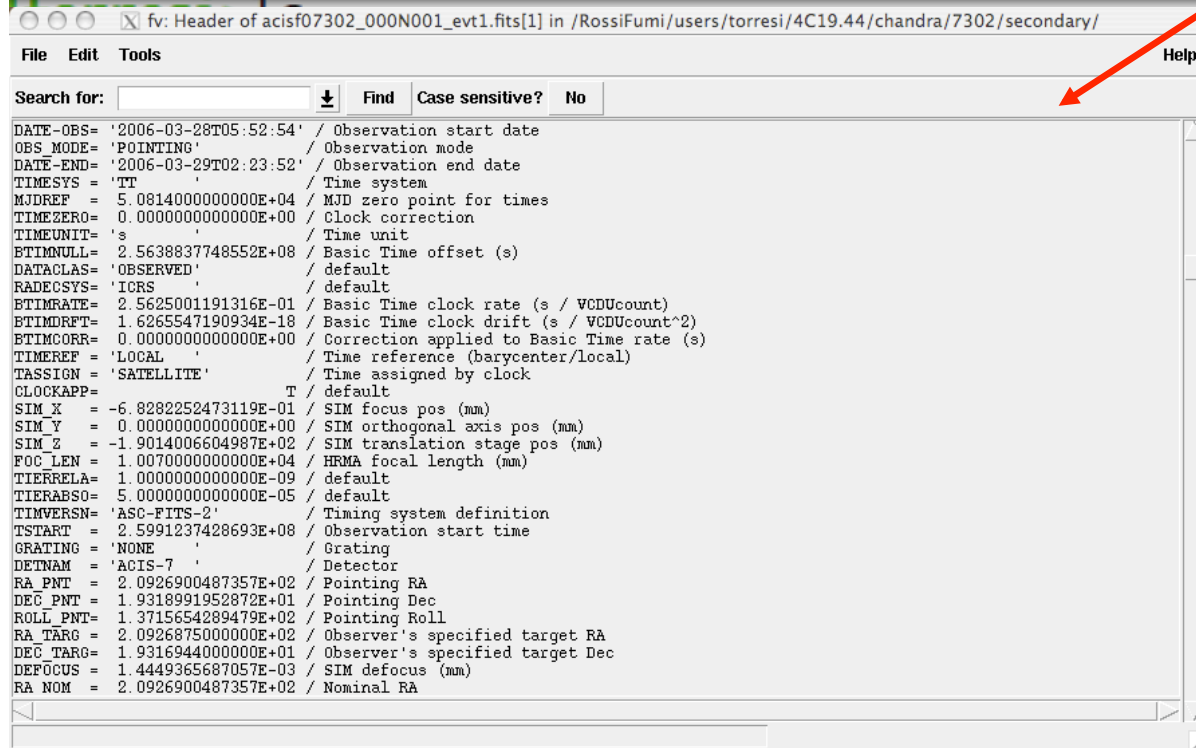
The GTI information for the observation, e.g. the start and stop times of all accepted time intervals over the observation. The major contributor to creating GTIs is information about when there is aspect data and when that aspect data is good. When the event file is filtered, the GTIs are stored as extensions of the data file, creating a record of the time filters applied to the data.

All the information of your observation are contained in the header of the fits file. You can visualize it by using the FTOOL command *fv*



fv: Summary of acisf07302_000N001_evt1.fits in /RossiFumi/users/torresi/4C19.44/chandra/7302/se

Index	Extension	Type	Dimension	View
<input type="checkbox"/> 0	Primary	Image	0	Header Image Table
<input type="checkbox"/> 1	EVENTS	Binary	20 cols X 277216 rows	Header Hist Plot All Select
<input type="checkbox"/> 2	GTI	Binary	2 cols X 1 rows	Header Hist Plot All Select



fv: Header of acisf07302_000N001_evt1.fits[1] in /RossiFumi/users/torresi/4C19.44/chandra/7302/secondary/

Search for: [] Find Case sensitive? No

```
DATE-OBS= '2006-03-28T05:52:54' / Observation start date
OBS_MODE= 'POINTING' / Observation mode
DATE-END= '2006-03-29T02:23:52' / Observation end date
TIMESYS = 'TT' / Time system
MJDREF = 5.081400000000000E+04 / MJD zero point for times
TIMEZERO= 0.000000000000000E+00 / Clock correction
TIMEUNIT= 's' / Time unit
BTIMNULL= 2.5638837748552E+08 / Basic Time offset (s)
DATACLASS= 'OBSERVED' / default
RADECSYS= 'ICRS' / default
BTIMRATE= 2.5625001191316E-01 / Basic Time clock rate (s / VCDUcount)
BTIMDRFT= 1.6265547190934E-18 / Basic Time clock drift (s / VCDUcount^2)
BTIMCORR= 0.000000000000000E+00 / Correction applied to Basic Time rate (s)
TIMEREF = 'LOCAL' / Time reference (barycenter/local)
TASSIGN = 'SATELLITE' / Time assigned by clock
CLOCKAPP= 'T' / default
SIM_X = -6.8282252473119E-01 / SIM focus pos (mm)
SIM_Y = 0.000000000000000E+00 / SIM orthogonal axis pos (mm)
SIM_Z = -1.9014006604987E+02 / SIM translation stage pos (mm)
FOC_LEN = 1.007000000000000E+04 / HRMA focal length (mm)
TIERRELA= 1.000000000000000E-09 / default
TIERRABSO= 5.000000000000000E-05 / default
TIMVERSN= 'ASC-FITS-2' / Timing system definition
TSTART = 2.5991237428693E+08 / Observation start time
GRATING = 'NONE' / Grating
DETNAM = 'ACIS-7' / Detector
RA_PNT = 2.0926900487357E+02 / Pointing RA
DEC_PNT = 1.9318991952872E+01 / Pointing Dec
ROLL_PNT= 1.3715654289479E+02 / Pointing Roll
RA_TARG = 2.092687500000000E+02 / Observer's specified target RA
DEC_TARG= 1.931694400000000E+01 / Observer's specified target Dec
DEFOCUS = 1.4449365687057E-03 / SIM defocus (mm)
RA_NOM = 2.0926900487357E+02 / Nominal RA
```

All the information of your observation are contained in the header of the fits file. You can visualize it by using the FTOOL command *fv*

fv: Summary of acisf07302_000N001_evt1.fits in /RossiFumi/users/torresi/4C19.44/chandra/7302/se

File Edit Tools Help

Index	Extension	Type	Dimension	View
<input type="checkbox"/> 0	Primary	Image	0	Header Image Table
<input type="checkbox"/> 1	EVENTS	Binary	20 cols X 277216 rows	Header Hist Plot All Select
<input type="checkbox"/> 2	GTI	Binary	2 cols X 1 rows	Header Hist Plot All Select

fv: Binary Table of acisf07302_000N001_evt1.fits[1] in /RossiFumi/users/torresi/4C19.44/chandra/7302/secondary/

File Edit Tools

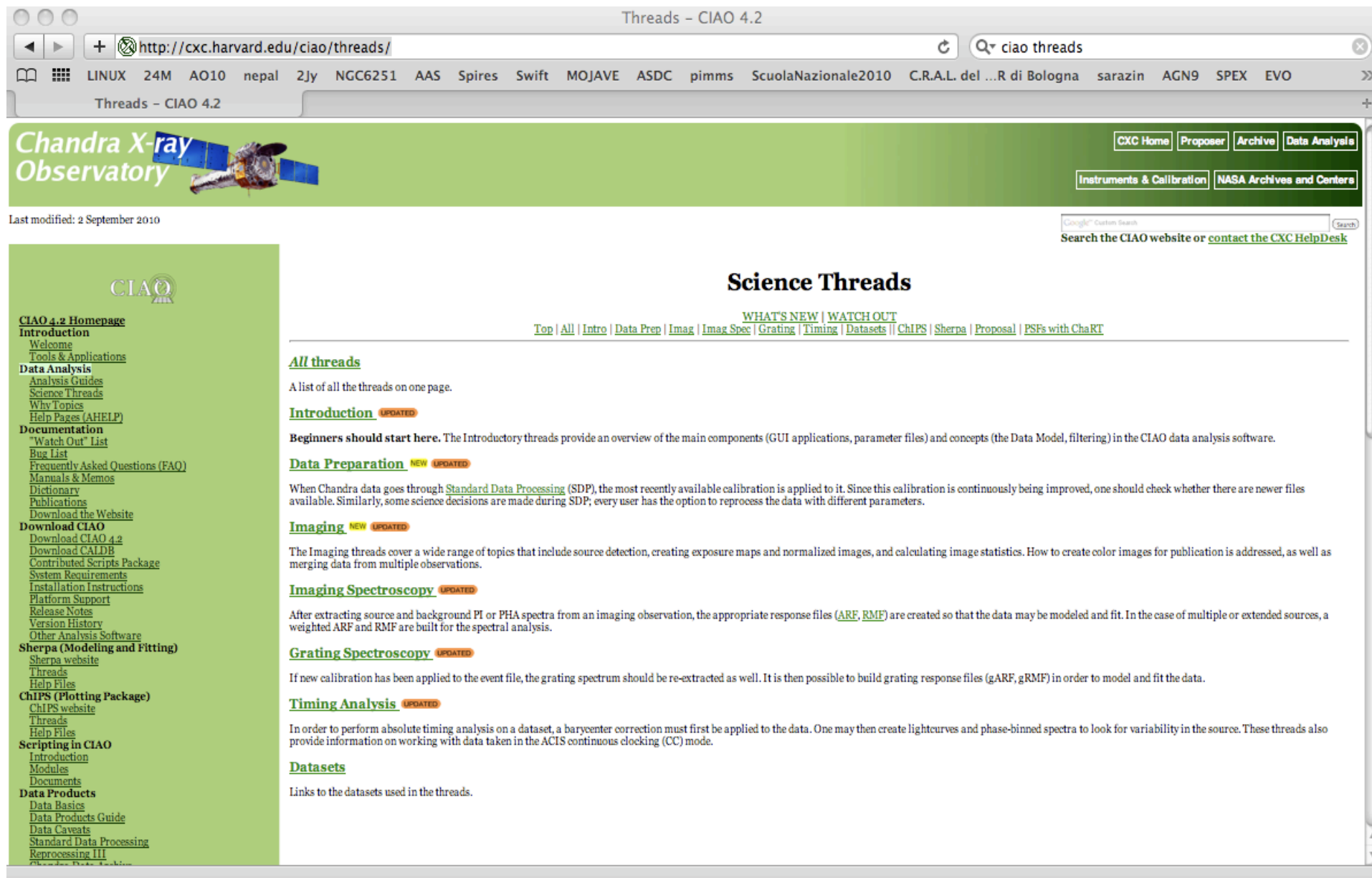
Select	time	ccd_id	node_id	expno	chipx	chipy	tdetx	tdety	detx	dety	x	y
1D	1I	1I	1J	1I	1I	1I	1I	1I	1E	1E	1E	1E
s	Modify	Modify	Modify	Modify	pixel	pixel	pixel	pixel	pixel	pixel	pixel	pixel
Invert	Modify	Modify	Modify	Modify	Modify	Modify	Modify	Modify	Modify	Modify	Modify	Modify
1	2.599123745351E+08	7	3	293	984	391	4901	2093	4.858813E+03	4.237318E+03	2.541800E+05	-1.430559E+05
2	2.599123745351E+08	7	2	293	591	474	4508	2176	4.466738E+03	4.154643E+03	2.536133E+05	-1.429493E+05
3	2.599123745351E+08	7	3	293	1008	552	4925	2254	4.882676E+03	4.076576E+03	2.541747E+05	-1.428487E+05
4	2.599123745351E+08	7	1	293	387	607	4304	2309	4.262277E+03	4.021737E+03	2.532966E+05	-1.427781E+05
5	2.599123753762E+08	7	0	294	95	431	4012	2133	3.971257E+03	4.197373E+03	2.529332E+05	-1.430042E+05
6	2.599123762172E+08	7	2	295	520	557	4437	2259	4.395667E+03	4.071814E+03	2.534944E+05	-1.428426E+05
7	2.599123770582E+08	7	2	296	541	441	4458	2143	4.416224E+03	4.186880E+03	2.535506E+05	-1.429908E+05
8	2.599123770582E+08	7	2	296	531	474	4448	2176	4.406479E+03	4.154062E+03	2.535292E+05	-1.429485E+05
9	2.599123770582E+08	7	3	296	989	511	4906	2213	4.864095E+03	4.116981E+03	2.541585E+05	-1.429008E+05
10	2.599123770582E+08	7	1	296	471	555	4388	2257	4.346301E+03	4.073634E+03	2.534261E+05	-1.428449E+05
11	2.599123778992E+08	7	0	297	117	493	4034	2195	3.992845E+03	4.135629E+03	2.529486E+05	-1.429248E+05
12	2.599123795813E+08	7	2	299	725	594	4642	2296	4.599758E+03	4.033951E+03	2.537699E+05	-1.427938E+05
13	2.599123795813E+08	7	3	299	858	628	4775	2330	4.733125E+03	4.000127E+03	2.539477E+05	-1.427502E+05
14	2.599123795813E+08	7	0	299	14	639	3931	2341	3.889811E+03	3.989590E+03	2.527703E+05	-1.427368E+05
15	2.599123804223E+08	7	1	300	458	468	4375	2170	4.333020E+03	4.159923E+03	2.534282E+05	-1.429560E+05
16	2.599123804223E+08	7	1	300	461	469	4378	2171	4.336413E+03	4.158963E+03	2.534327E+05	-1.429548E+05
17	2.599123804223E+08	7	2	300	611	604	4528	2306	4.486265E+03	4.024730E+03	2.536094E+05	-1.427820E+05
18	2.599123804223E+08	7	1	300	281	634	4198	2336	4.156607E+03	3.994792E+03	2.531430E+05	-1.427435E+05
19	2.599123804223E+08	7	0	300	169	635	4086	2337	4.044641E+03	3.993877E+03	2.529869E+05	-1.427423E+05
20	2.599123804223E+08	7	0	300	161	636	4078	2338	4.036815E+03	3.992568E+03	2.529757E+05	-1.427406E+05
21	2.599123812634E+08	7	2	301	667	502	4584	2204	4.542446E+03	4.126568E+03	2.537121E+05	-1.429131E+05
22	2.599123812634E+08	7	1	301	439	533	4356	2235	4.314266E+03	4.095672E+03	2.533867E+05	-1.427733E+05
23	2.599123812634E+08	7	1	301	326	633	4243	2335	4.201720E+03	3.995774E+03	2.532060E+05	-1.427447E+05
24	2.599123821044E+08	7	0	302	70	517	3987	2219	3.946417E+03	4.111916E+03	2.528783E+05	-1.428942E+05
25	2.599123821044E+08	7	0	302	102	579	4019	2281	3.978182E+03	4.049786E+03	2.529077E+05	-1.428143E+05
26	2.599123829454E+08	7	0	303	78	434	3995	2136	3.953673E+03	4.194752E+03	2.529081E+05	-1.430008E+05
27	2.599123829454E+08	7	3	303	769	593	4686	2295	4.644235E+03	4.035675E+03	2.538323E+05	-1.427960E+05
28	2.599123829454E+08	7	1	303	476	598	4393	2300	4.351685E+03	4.030826E+03	2.534233E+05	-1.427898E+05

Go to: Edit cell:

- How to download X-ray data from a public archive
- How the downloaded files look like
- How to reduce X-ray (*Chandra*) data
- How to create the radio and/or X-ray contours for an extended object

Chandra data reduction

<http://cxc.harvard.edu> → Data Analysis → Threads



The screenshot shows a web browser window titled "Threads - CIAO 4.2". The address bar contains "http://cxc.harvard.edu/ciao/threads/". The browser's bookmark bar lists various links like "LINUX", "24M", "AO10", "nepal", "2Jy", "NGC6251", "AAS", "Spire", "Swift", "MOJAVE", "ASDC", "pimms", "ScuolaNazionale2010", "C.R.A.L. del ...R di Bologna", "sarazin", "AGN9", "SPEX", and "EVO". The page header features the "Chandra X-ray Observatory" logo and navigation buttons for "CXC Home", "Proposer", "Archive", "Data Analysis", "Instruments & Calibration", and "NASA Archives and Centers". A search bar is present with the text "Search the CIAO website or [contact the CXC HelpDesk](#)".

The main content area is titled "Science Threads" and includes a navigation menu: "Top | [All](#) | [Intro](#) | [Data Prep](#) | [Imag](#) | [Imag Spec](#) | [Grating](#) | [Timing](#) | [Datasets](#) | [ChIPS](#) | [Sherpa](#) | [Proposal](#) | [PSFs with ChaRT](#)".

Under "All threads", there is a link to "Introduction" with a "UPDATED" tag. The text states: "Beginners should start here. The Introductory threads provide an overview of the main components (GUI applications, parameter files) and concepts (the Data Model, filtering) in the CIAO data analysis software."

Next is "Data Preparation" with "NEW" and "UPDATED" tags. The text explains: "When Chandra data goes through [Standard Data Processing](#) (SDP), the most recently available calibration is applied to it. Since this calibration is continuously being improved, one should check whether there are newer files available. Similarly, some science decisions are made during SDP; every user has the option to reprocess the data with different parameters."

Then is "Imaging" with "NEW" and "UPDATED" tags. The text says: "The Imaging threads cover a wide range of topics that include source detection, creating exposure maps and normalized images, and calculating image statistics. How to create color images for publication is addressed, as well as merging data from multiple observations."

Following is "Imaging Spectroscopy" with an "UPDATED" tag. The text notes: "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."

Next is "Grating Spectroscopy" with an "UPDATED" tag. The text states: "If new calibration has been applied to the event file, the grating spectrum should be re-extracted as well. It is then possible to build grating response files (gARF, gRMF) in order to model and fit the data."

Then is "Timing Analysis" with an "UPDATED" tag. The text explains: "In order to perform absolute timing analysis on a dataset, a barycenter correction must first be applied to the data. One may then create lightcurves and phase-binned spectra to look for variability in the source. These threads also provide information on working with data taken in the ACIS continuous clocking (CC) mode."

Finally, there is a "Datasets" section with the text: "Links to the datasets used in the threads."

The left sidebar contains a "CIAO 4.2" logo and a list of links: "CIAO 4.2 Homepage", "Introduction", "Welcome", "Tools & Applications", "Data Analysis", "Analysis Guides", "Science Threads", "Why Topics", "Help Pages (AHELP)", "Documentation", "Watch Out List", "Bug List", "Frequently Asked Questions (FAQ)", "Manuals & Memos", "Dictionary", "Publications", "Download the Website", "Download CIAO", "Download CIAO 4.2", "Download CALDB", "Contributed Scripts Package", "System Requirements", "Installation Instructions", "Platform Support", "Release Notes", "Version History", "Other Analysis Software", "Sherpa (Modeling and Fitting)", "Sherpa website", "Threads", "Help Files", "ChIPS (Plotting Package)", "ChIPS website", "Threads", "Help Files", "Scripting in CIAO", "Introduction", "Modules", "Documents", "Data Products", "Data Basics", "Data Products Guide", "Data Caveats", "Standard Data Processing", "Reprocessing III", and "Chandra Data Archiving".

Scientific files
Housekeeping files

Scientific files Housekeeping files

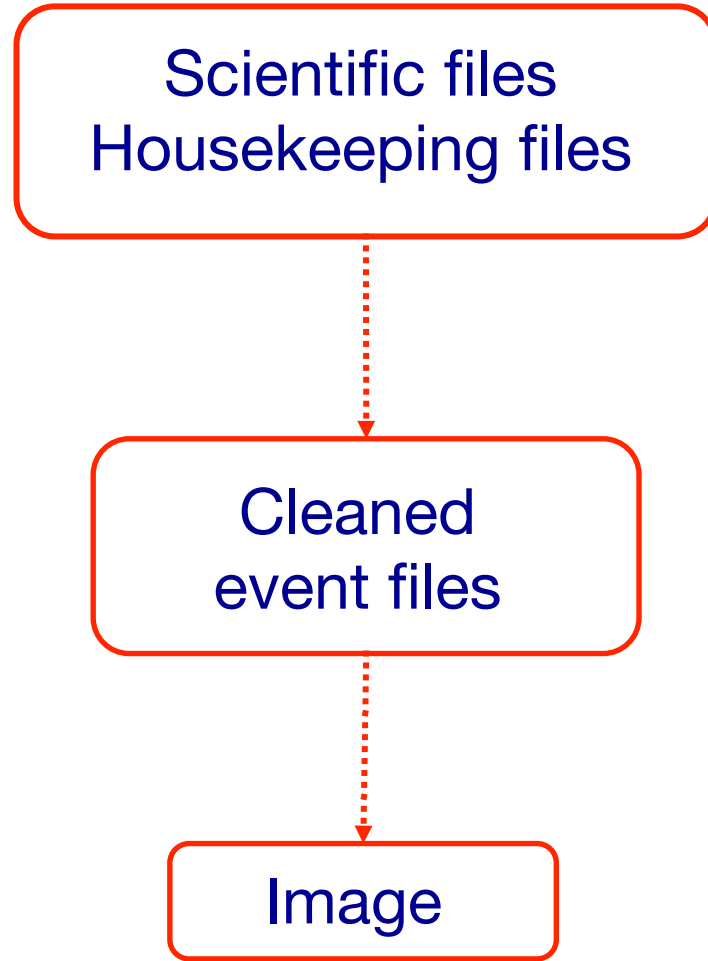
- removal of hot pixels or afterglows
acis_run_hotpix
- creation of a new event file
acis_process_events
- run *dstreak* in case the ACIS-S4 chip (ccd_id=8) has been used
- filtering for bad grades and application of *Good Time Intervals (GTI)*
- creation of the background light curve

Cleaned
event files

Scientific files
Housekeeping files

Cleaned
event files

Image



DS9:

The screenshot displays the SAOImage ds9 software interface. The main window shows a visualization of the source 3C 111, appearing as a bright, elongated structure against a dark background. The interface includes a menu bar (File, Edit, View, Frame, Bin, Zoom, Scale, Color, Region, WCS, Analysis, Help) and a control panel with the following sections:

- File:** obs14990_057keV_repro_evt2.fits[EVENTS]
- Object:** 3C 111
- Value:** (empty)
- WCS:** (empty)
- Physical:** X, Y
- Image:** X, Y
- Frame 1:** x, 0.963, 0.000 °

Annotations in red text are overlaid on the control panel:

- PIXEL VALUE** (over the Value field)
- SKY COORDIANTES** (over the WCS field)
- DETECTOR/IMAGE COORDIANTES** (over the Physical and Image fields)

On the right side, there is a small thumbnail image with a coordinate system (X, Y, E) and a large white box with the text **ZOOM**.

The control panel features several buttons, some of which are circled in red:

- bin** (circled)
- zoom** (with sub-buttons: zoom 1/8, zoom 1/4, zoom 1/2, zoom 1, zoom 2, zoom 4, zoom 8)
- scale** (circled)
- color**
- region** (circled)
- wcs**
- help**

At the bottom of the window, a scale bar is visible with the following values: 0.3, 1.0, 2.4, 5.2, 10.8, 21.8, 43.7, 87.9, 175.4.

DS9:

The image shows the SAOImage ds9 software interface. At the top, there is a menu bar with options: File, Edit, View, Frame, Bin, Zoom, Scale, Color, Region, WCS, Analysis, Help. Below the menu bar, the main window displays the following information:

- File: obs14990_057keV_repro_evt2.fits[EVENTS]
- Object: 3C 111
- Value: **PIXEL VALUE**
- WCS: **SKY COORDIANTES**
- Physical: X, Y
- Image: X, Y
- Frame 1: x, 0.963, 0.000 °

On the right side, there is a small plot showing a coordinate system with X, Y, and E axes, and a button labeled **ZOOM**.

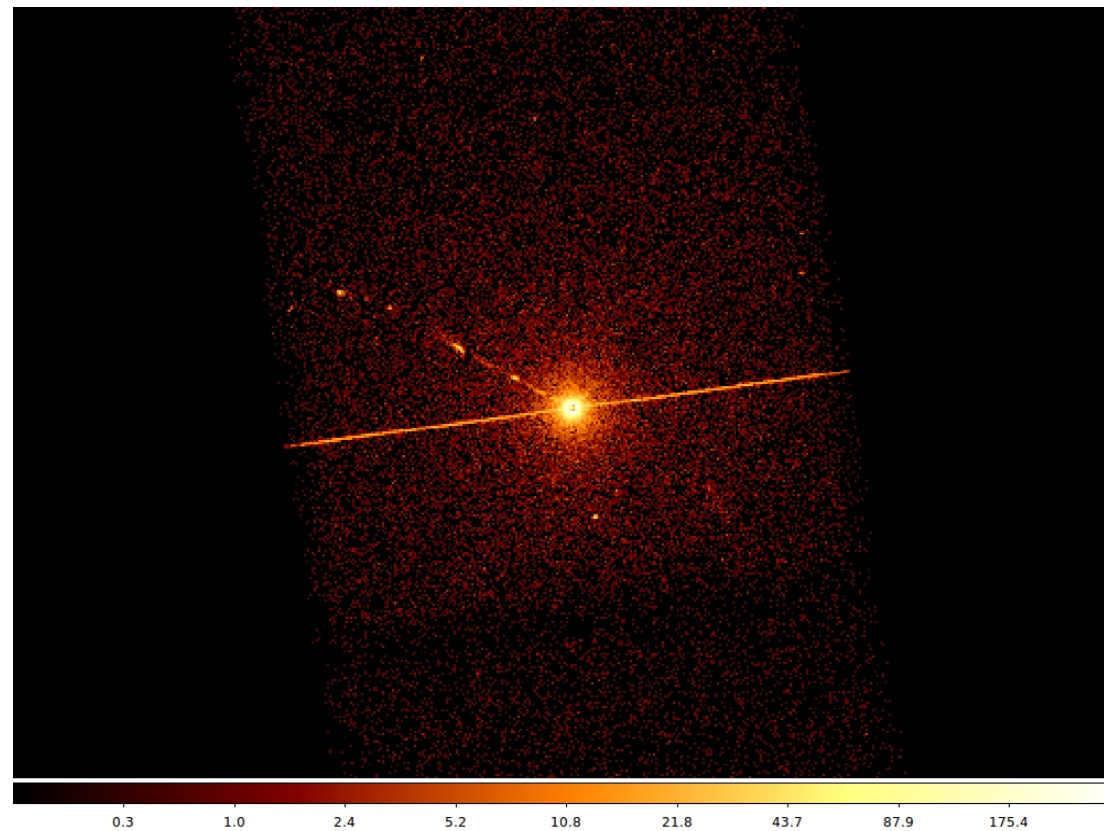
The main control bar contains the following buttons: file, edit, view, frame, **bin**, zoom, **scale**, color, **region**, wcs, help. Below these are zoom level buttons: -, +, to fit, zoom 1/8, zoom 1/4, zoom 1/2, zoom 1, zoom 2, zoom 4, zoom 8.

The main visualization area shows a dark field with a bright source and a white line. A vertical red double-headed arrow on the left is labeled **CONTRAST**. A horizontal red double-headed arrow at the bottom is labeled **LEVEL**.

At the bottom of the window, there is a scale bar with values: 0.3, 1.0, 2.4, 5.2, 10.8, 21.8, 43.7, 87.9, 175.4.

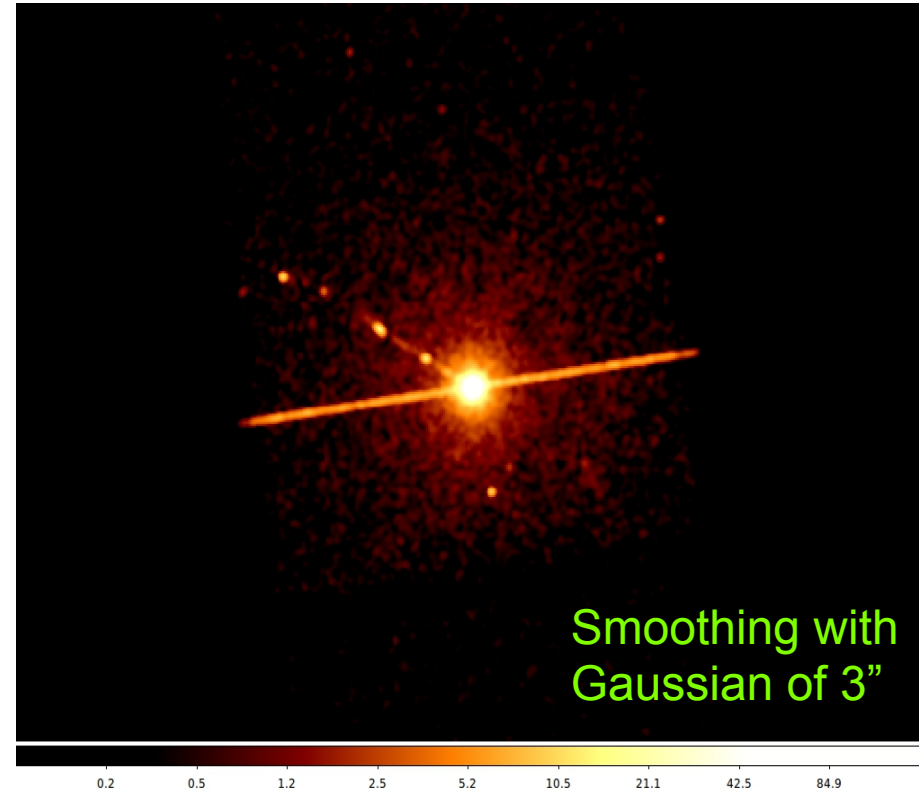
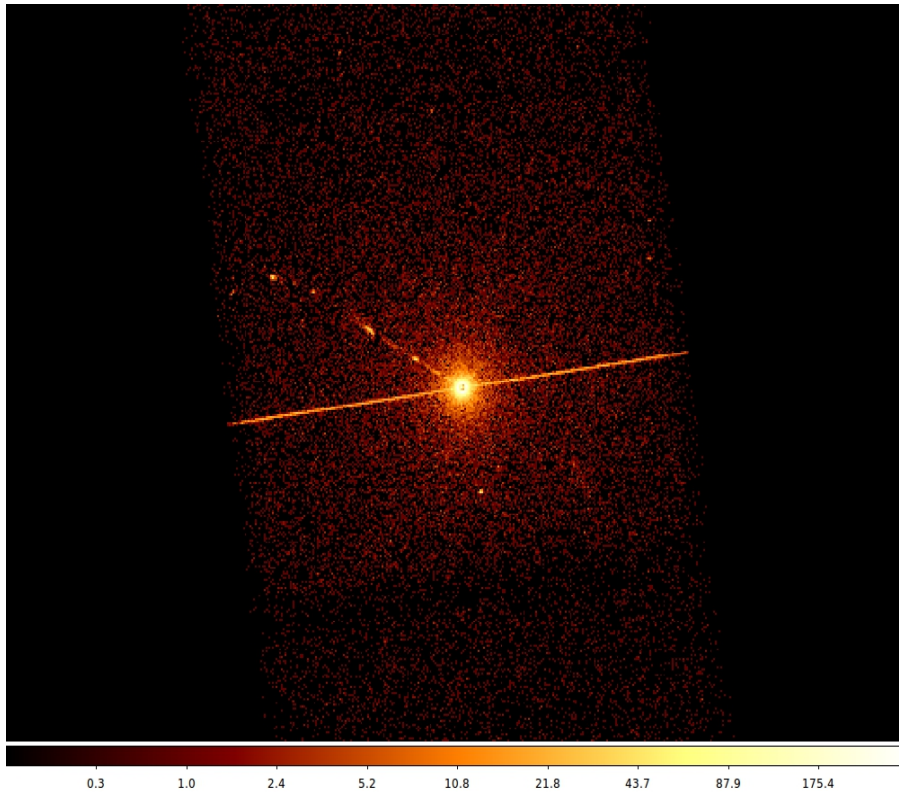
Most important information deducible from an image:

- Detection (calculate the source counts and verify if the observed excess is real or due to background fluctuations)
- Morphology (the source is pointlike or extended? obtain and fit a radial profile);
- X-ray counterparts of structures seen in other wavebands.



It is possible to improve the image look

smoothing



To **smooth an image** means to substitute the value of each pixel for the value obtained by weighting the pixels nearby with a certain function, that generally is a Gaussian.

Scientific files
Housekeeping files



Cleaned
event files

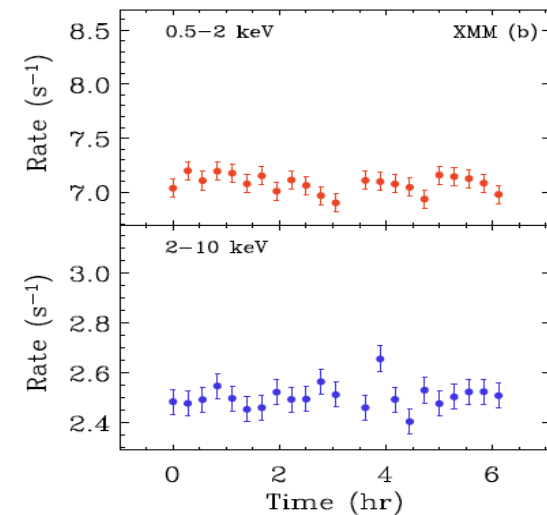
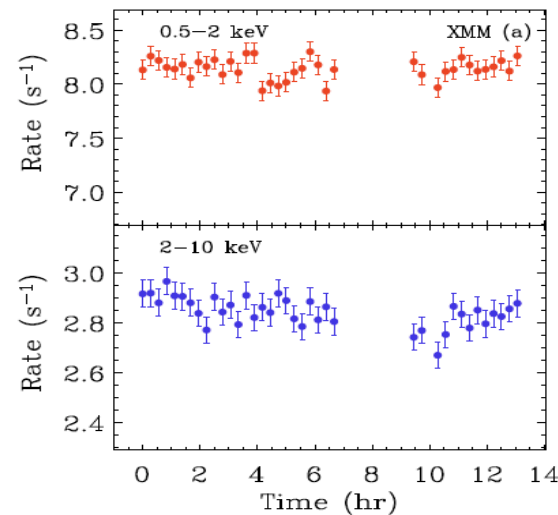
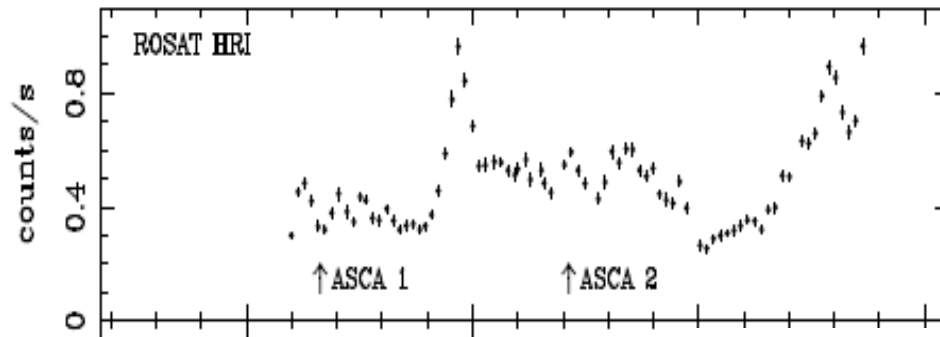
Image

Light curve

see XMM tutorial...

A light curve is the plot of the flux of a source versus time. It shows if and how the flux of the source varies during a certain time. The variability of a source can manifest on different time scales.

The light curve of a source is the sum of all the events at every time t , independently from the energy of a single event, that fall within a fixed spatial region.



How to extract a lightcurve

1) select a source and background region

2) identify the ccd:

> punlearn dmstat

> dmstat "acisf00953N003_evt2.fits[sky=region(src1.reg)][cols ccd_id]"

3) extract the lightcurve (background subtracted)

> punlearn dmextract

> pset dmextract infile="acisf00953N003_evt2.fits

[ccd_id=3,sky=region(src2.reg)][bin time= : : 2000]"

> pset dmextract outfile="src_sub_lc.fits"

> pset dmextract bkg="acisf00953N003_evt2.fits

[ccd_id=3,sky=region(bkg.reg)]"

> pset dmextract opt="lrc1"

> dmextract

How to extract a lightcurve

1) select a source and background region

2) identify the ccd:

> punlearn dmstat

> dmstat "acisf00953N003_evt2.fits[sky=region(src1.reg)][cols ccd_id]"

3) extract the lightcurve (background subtracted)

> punlearn dmextract

> pset dmextract infile="acisf00953N003_evt2.fits
[ccd_id=3,sky=region(src2.reg)][bin time = : : 2000]"

> pset dmextract outfile="src_sub_lc.fits"

> pset dmextract bkg="acisf00953N003_evt2.fits
[ccd_id=3,sky=region(bkg.reg)]"

> pset dmextract opt="lrc1"

> dmextract

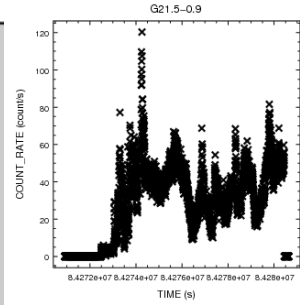


MIN:MAX:STEP

There are several ways to visualize a light curve. Here are two examples:

Chips provided by CIAO

```
unix% chips
-----
Welcome to ChIPS: CXC's Plotting Package
-----
CIAO 4.3 ChIPS version 1 Thursday, December 2, 2010
chips> make_figure("src2_sub_lc.fits[cols time,net_rate,err_rate]", "line.color=red")
```



The fool lcurve

```
Default
New Info Customize Close Execute Bookmarks
eleonora:pn eleonora$ lcurve

lcurve 1.0 (xronos5.22)

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) .... 12931 23:33:28.493
FITS Extension .... 1 - `RATE ` Stop Time (d) .... 12932 11:11:04.570
No. of Rows ..... 419 Bin Time (s) ..... 100.0
Right Ascension ... Internal time sys.. Converted to TJD
Declination ..... Experiment ..... XMM EPN
Filter ..... Medium
Corrections applied: Vignetting - No ; Deadtime - No ; Bkgd - No ; Clock - Yes

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

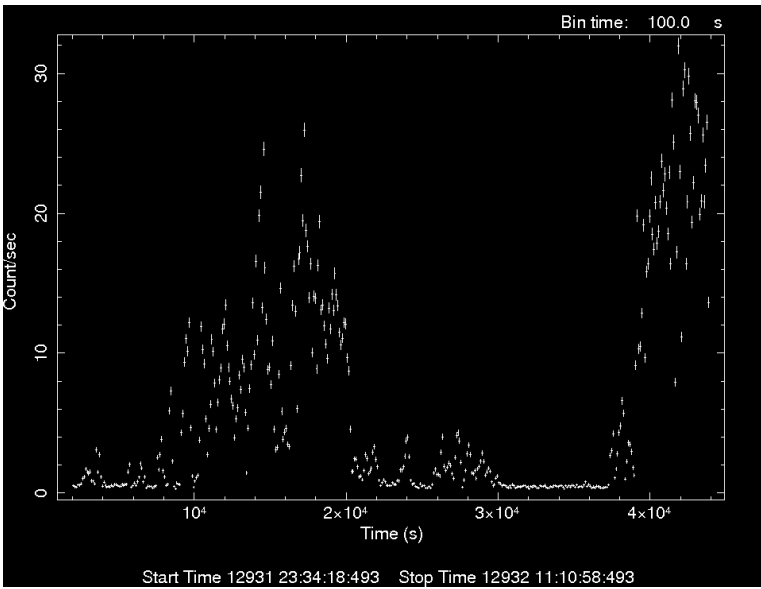
File contains binned data.

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

Expected Start ... 12931.98157977479 (days) 23:33:28.493 (h:m:s:ms)
Expected Stop .... 12932.46602511985 (days) 11:11: 4:570 (h:m:s:ms)

Minimum Newbin Time 100.00000 (s)
for Maximum Newbin No.. 419

Default Newbin Time is: 100.00000 (s) (to have 1 Intv. of 419 Newbins)
Type INDEF to accept the default value
```



A light-curve can be built in different temporal bins, e.g. if the observation is 10^3 s long, it is possible to extract a light-curve with 10 bins of 100s, or 100 bins of 10s. The longer the bin the lower the resolution but higher the S/N

To establish if a source varied during the observation we can apply the

χ^2 test

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

c_i observed counts in every temporal bin i ;

$\langle c \rangle$ average count during the observation;

σ_i Poissonian error;

$\nu = n-1$ degrees of freedom;

Compute the null hypothesis probability that the source is not varied

this test should be repeated for several temporal bins.

See the IDL tutorial...

Scientific files
Housekeeping files

Cleaned
event files

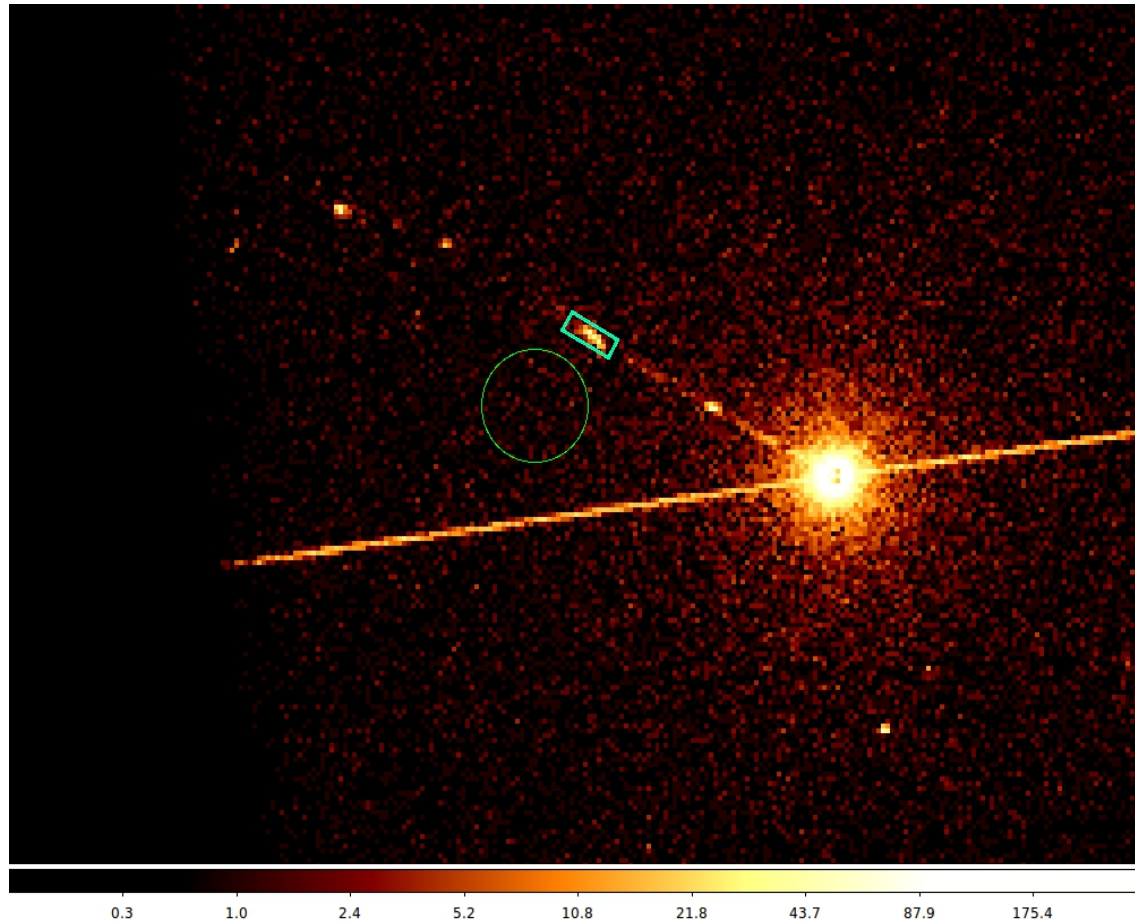
Spectrum

Image

Light curve



Extract source and background spectra



ds9 nomefile

Region ->

File Format -> CIAO

-> File Coordinate
system -> Physical

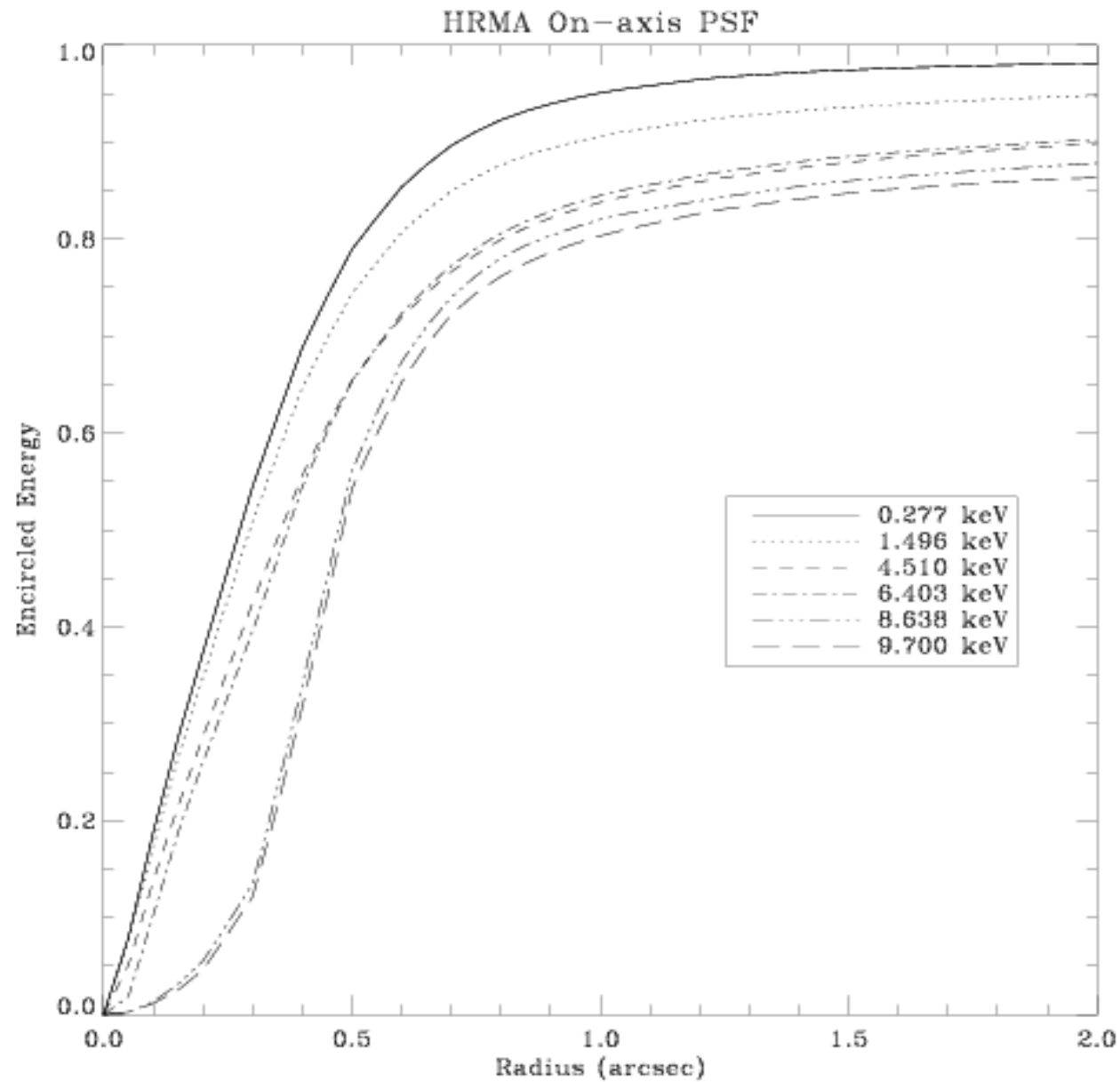
To extract the spectrum of a *pointlike* source...

```
-> punlearn specextract
-> pset specextract infile="acisf00547N002_evt2.fits[sky=region
(src.reg)]"
-> pset specextract outroot=prova
-> pset specextract bkgfile="acisf00547N002_evt2.fits[sky=region
(bkg.reg)]"
-> pset specextract weight=no
-> pset specextract correct=yes
-> pset specextract asp=pcadf089424455N002_asol1.fits
-> pset specextract mskfile=acisf00547_000N002_msk1.fits
-> pset specextract badpixfile=acisf00547_000N002_bpix1.fits
-> pset specextract pbkfile=acisf089424366N002_pbk0.fits
-> pset specextract grouptype=NUM_CTS binspec=15
-> specextract verbose 2
```

specextract runs the following tools

- [dmextract](#): to extract source and (optionally) background spectra. This tool also creates the WMAP used as input to `mkacisrmf`.
- [mkarf](#): to create ARF(s).
- [arfcorr](#): to apply an energy-dependent point-source aperture correction to the source ARF file.
- [mkrmf](#) or [mkacisrmf](#): to build the RMF(s), depending on which is appropriate for the data and the calibration; see the [Creating ACIS RMFs why topic](#) for details.
- [dmgroup](#): to group the source spectrum and/or background spectrum.
- [dmhedit](#): to update the BACKFILE, RESPFILE and ANCRFILE keys in the source and background spectrum files.

Fractional encircled energy



About 90% of photons
coming from a
pointlike source fall
within
1" @ 1.5 keV

...to extract the spectrum of an *extended* source

```
-> punlearn specextract
-> pset specextract infile="acisf00547N002_evt2.fits[sky=region
(src.reg)]"
-> pset specextract outroot=prova
-> pset specextract bkgfile="acisf00547N002_evt2.fits[sky=region
(bkg.reg)]"
-> pset specextract weight=yes
-> pset specextract correct=no
-> pset specextract asp=pcadf089424455N002_asol1.fits
-> pset specextract mskfile=acisf00547_000N002_msk1.fits
-> pset specextract badpixfile=acisf00547_000N002_bpix1.fits
-> pset specextract pbkfile=acisf089424366N002_pbk0.fits
-> pset specextract grouptype=NUM_CTS binspec=15
-> specextract verbose 2
```

specextract runs the following tools

- [dmextract](#): to extract source and (optionally) background spectra. This tool also creates the WMAP used as input to [mkacisrmf](#).
- [sky2tdet](#): to create the WMAP input for [mkwarf](#).
- [mkwarf](#): to create weighted ARF(s).
- [mkrmf](#) or [mkacisrmf](#): to build the RMF(s), depending on which is appropriate for the data and the calibration; see the [Creating ACIS RMFs why topic](#) for details.
- [dmgroup](#): to group the source spectrum and/or background spectrum.
- [dmhedit](#): to update the BACKFILE, RESPFILE and ANCRFILE keys in the source and background spectrum files.

The response matrix is composed by

1. The *Redistribution Matrix File (RMF)*: associates to each instrument channel (I) the appropriate photon energy (E)

2. The *Auxiliary Response File (ARF)*: includes information on the effective area, filter transmission and any additional energy-dependent efficiencies, i.e. **the efficiency of the instrument in revealing photons.**

The quantum efficiency (QE) is the *fraction of incident photons registered by a detector*. For an ideal detector, this is 100% (every incoming photon results in a single count). In reality, however, no detector is 100% efficient. If, for instance, the detector is 70% efficient, then every 100 photons would result in 70 counts.

The combination of RMF and ARF produces the input spectrum, convolved with the telescope effective area and detector efficiencies versus energy.

File Edit Tools **RMF** Help

CHANNEL E_MIN E_MAX

Select 1E 1E 1E

All channel keV keV

Invert Modify Modify Modify

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:

File Edit Tools **ARF** Hel

ENERG_LO ENERG_HI SPECRESP

Select 1E 1E 1E

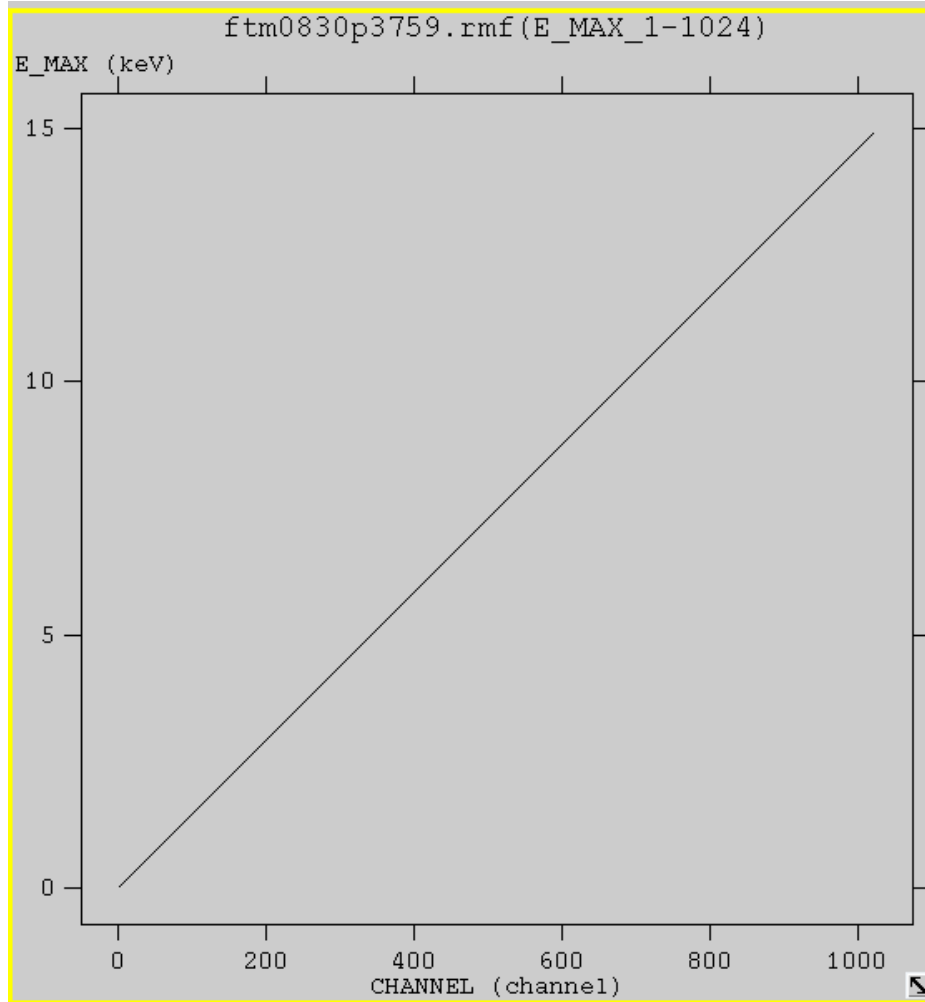
All keV keV cm**2

Invert Modify Modify Modify

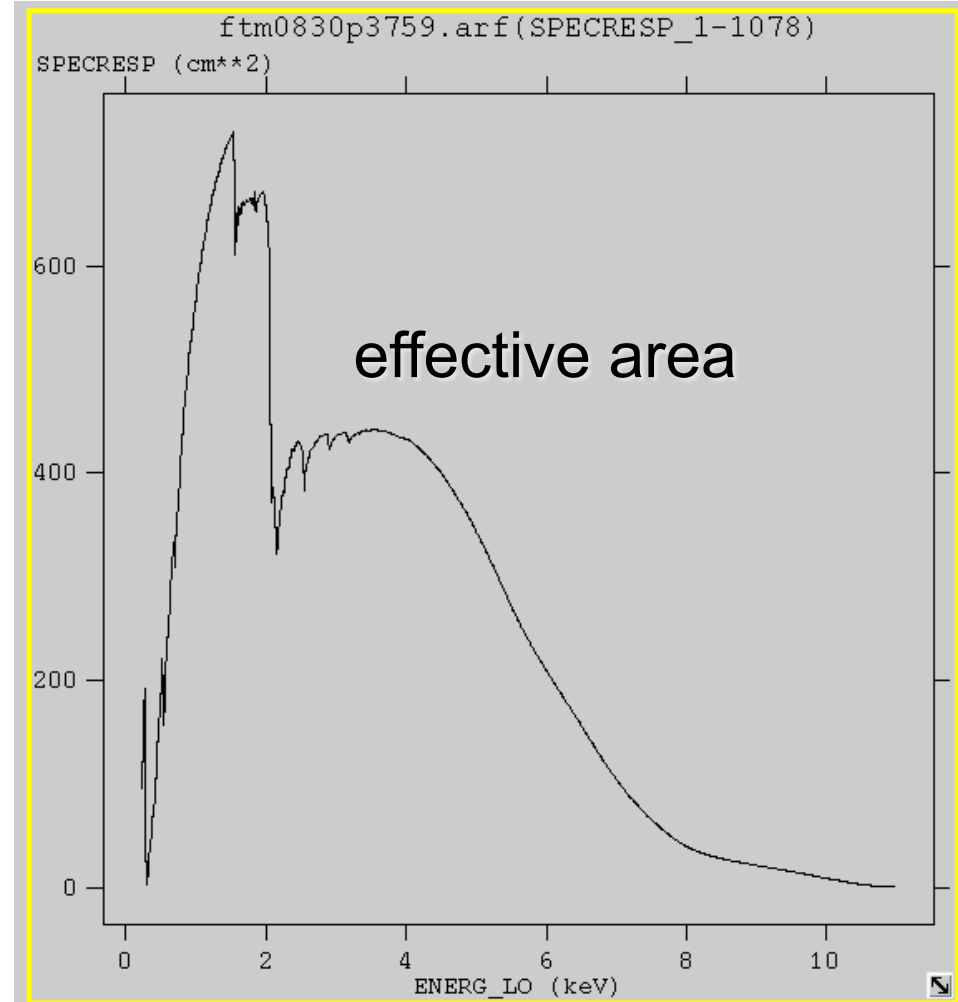
1	2.200000E-01	2.300000E-01	9.414584E+01
2	2.300000E-01	2.400000E-01	1.119709E+02
3	2.400000E-01	2.500000E-01	1.309653E+02
4	2.500000E-01	2.600000E-01	1.518642E+02
5	2.600000E-01	2.700000E-01	1.716482E+02
6	2.700000E-01	2.800000E-01	1.922011E+02
7	2.800000E-01	2.900000E-01	4.741680E+01
8	2.900000E-01	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

Go to: Edit cell:

RMF



ARF

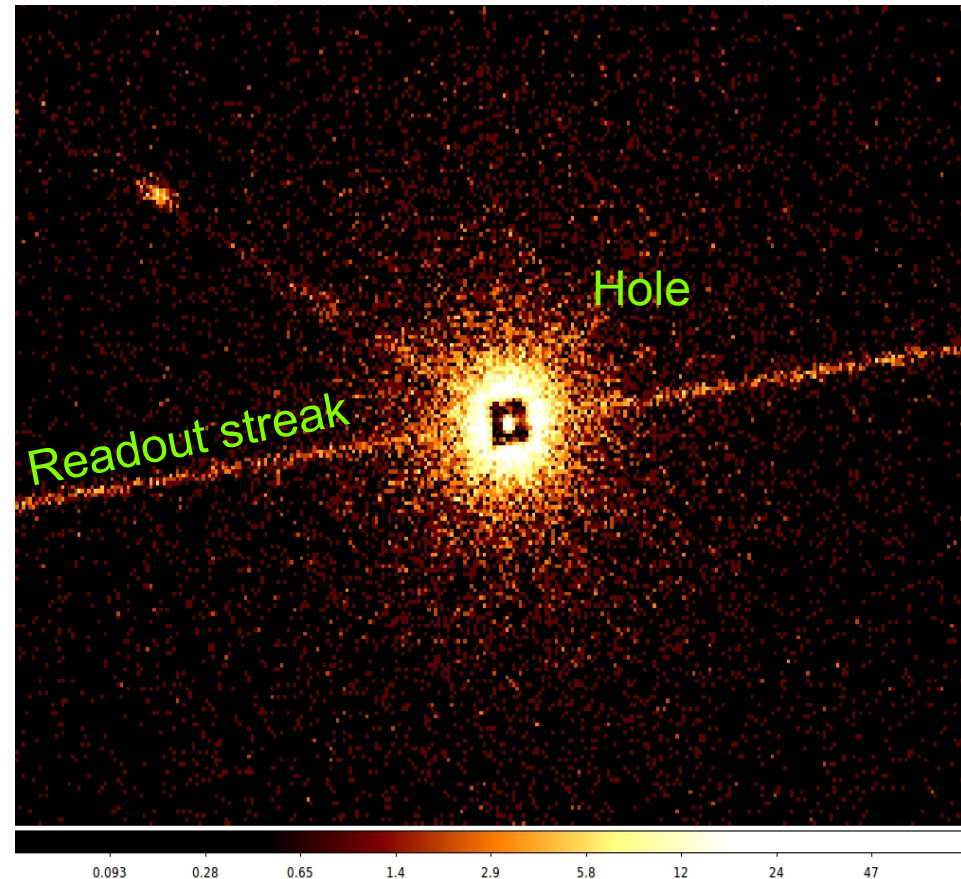


Pileup

http://cxc.harvard.edu/ciao/download/doc/pileup_abc.pdf

Two or more photon events overlapping in a single detector frame and being read as a single event

→ loss of information from these events



Pileup two major effects are:

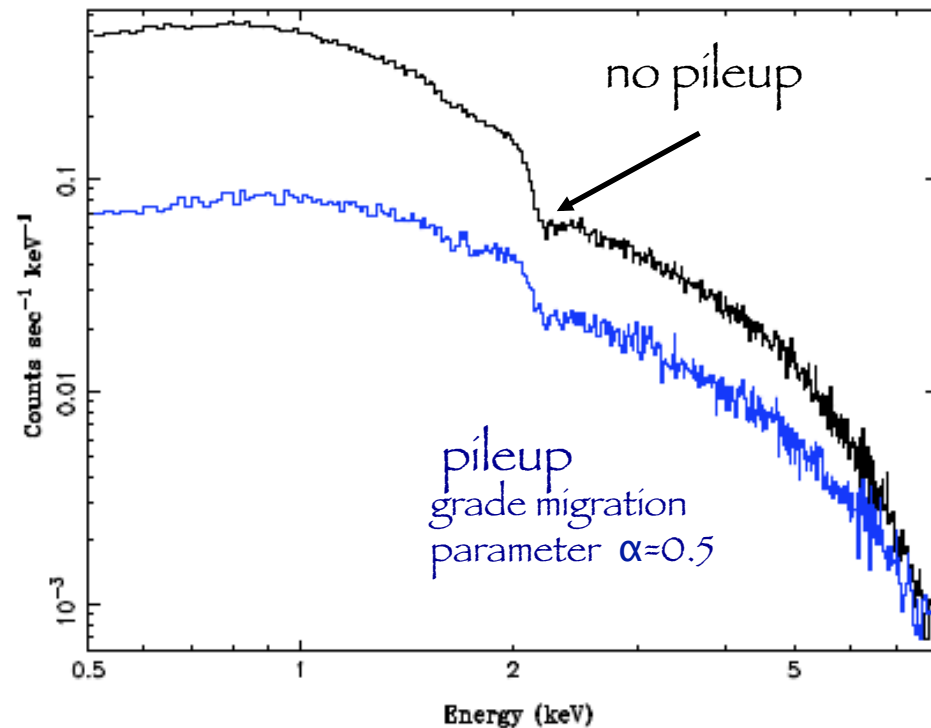
ENERGY MIGRATION photon energies sum to create a detected event with higher energy;

GRADE MIGRATION event grades migrate towards values inconsistent with real photon events.

- net decrease of the observed count rate

- net decrease in the fractional rms variability of the lightcurve

detected spectral shape of the source distorted



Avoid pileup: reduce the counts per frame pixels (PIMMS)

Pileup mitigation: use an XSPEC – pileup model

Scientific files
Housekeeping files



Cleaned
event files

Spectrum

Image

Light curve



Scientific analysis

see Xspec
Tutorial...

- How to download X-ray data from a public archive
- How the downloaded files look like
- How to reduce X-ray (*Chandra*) data
- How to create the radio and/or X-ray contours for an extended object

<http://ned.ipac.caltech.edu/>

News & Featured Updates — September 2014

- [New help system in the new user interface](#)
- [22 million XIDs and new objects from the GALEX MSC](#)
- [494 new Redshift-Independent Distances \(NED-D\)](#)
- [Latest articles in Level 5](#)

Please help us improve NED by taking the [2014 NED User Survey](#).
 Responses are being collected through November 30th.

NED is embarking on a major transformation: We invite you to [preview a new interface](#) providing a drop-down menu and a form to search for objects By Name directly on the landing page (future homepage). A new Near Position search option includes catalog sources that are undergoing integration into NED. All users should read about [these significant changes](#). Further streamlining of the interface, including consolidation of search forms, will be released incrementally with new content and evolving functionality.

OBJECTS	DATA	LITERATURE	TOOLS	INFO
By Name	Images by Object Name Region	References by Object Name	Coordinate Transformation & Extinction Calculator	Introduction Latest News/Updates
Near Name	Photometry & SEDs	References by Author Name	Velocity Calculator	Features FAQ
Near Position	Spectra	Text Search	Cosmology Calculators	Overview (pdf)
IAU Format	Redshifts	Knowledgebase	Extinction-Law Calculators	Source Nomenclature
By Parameters	Redshift-Independent Distances	Galaxy Distance Tabulations (NED-D)	Galaxy Environment by Precomputed Parameters Radial Velocity Constraint	Web Links New Interface
By Classifications Types, Attributes	Classifications by Object Name	Abstracts	X/Y offset to RA/DEC	Glossary & Lexicon
By Refcode	Positions	Thesis Abstracts	Batch Job Submission Help Pick Up Results	Team
Object Notes	Diameters		Build Data Table from Input List By Name Near Name/Position (Cross-Matching)	Contact Us or Comment

If your research benefits from the use of NED, we would appreciate the following acknowledgement in your paper: *This research has made use of the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.*

NASA JPL Caltech ipac

You have selected the following parameters to search on:

Parameters for Distances and Cosmology: $H_0 = 73.0$; $\Omega_{\text{matter}} = 0.27$; $\Omega_{\text{vacuum}} = 0.73$;
 Derived Quantities use a Redshift corrected to a Reference Frame defined by the 3K CMB

NED results for object 3C 111

1 objects found in NED.

SOURCE LIST

Row No.	Object Name (* => Essential Note)	EquJ2000.0 RA	EquJ2000.0 DEC	Object Type	Velocity/Redshift km/s	Mag./ z	Separ. arcmin	Refs	Notes	Number of Phot	Posn	Vel/z	Diam	Asso	Images	Spectra	Row No.
1	3C 111	04h18m21.3s	+38d01m36s	G	14540	0.048500	18.1V	...	430	9	106	6	2	3	1	Retrieve	1

Detailed information for each object

Object No. 1 - 3C 111

INDEX for 3C 111

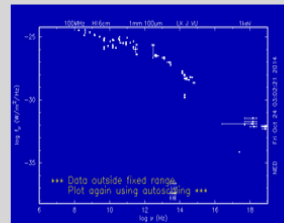
Essential Data (jump to sub-section of this query report):

- [Essential Note](#)
- [Cross-IDs](#)
- [Coordinates](#)
- [Basic Data](#)
- [Quantities Derived from Redshift](#)
- [Redshift-Independent Distances](#)
- [Quick-Look Photometry and Luminosities](#)
- [Quick-Look Angular and Physical Sizes](#)
- [Classifications](#)
- [Foreground Galactic Extinction](#)
- [External Services](#)

Detailed Data (NED queries):

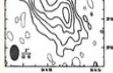


[Images](#)



[106 Photometric data point\(s\) and SED](#)

- [Spectra](#)
- [Redshift-Independent Distances](#)
- [430 Reference\(s\)](#)
- [6 Position data point\(s\)](#)
- [2 Redshift data point\(s\)](#)
- [3 Diameter data point\(s\)](#)
- [9 Note\(s\)](#)
- [1 Association\(s\)](#)

	97KB JPG image Retrieve	N/A	N/A	6cm	N/A	N/A	Cambridge_5km	1977MNRAS...84...01J
	4368KB FITS image Retrieve Display FITS Header		8.4GHz , 3.6cm	10.2 x 10.2	2.50	VLA	1997MNRAS.291...20L	
	1503KB FITS image Retrieve Display FITS Header		8.4GHz , 3.6cm	0.6 x 0.6	0.32	VLA	1997MNRAS.291...20L	
	5088KB FITS image Retrieve Display FITS Header		8.4GHz , 3.6cm	4.3 x 3.2	1.60	VLA	1997MNRAS.291...20L	
	71KB JPG image Retrieve Display Caption	N/A	10.7GHz , 2.8cm	N/A	N/A	Cambridge_5km	1981MNRAS.195...261L	
	1258KB JPG image Retrieve	N/A	N/A	15GHz , 2cm	0.001 x 0.001	0.001	VLBA	2005AJ....130.1389L
	4392KB JPG image Retrieve	N/A	N/A	15GHz , 2cm	0.002 x 0.002	0.001	VLBA	2005AJ....130.1389L
								

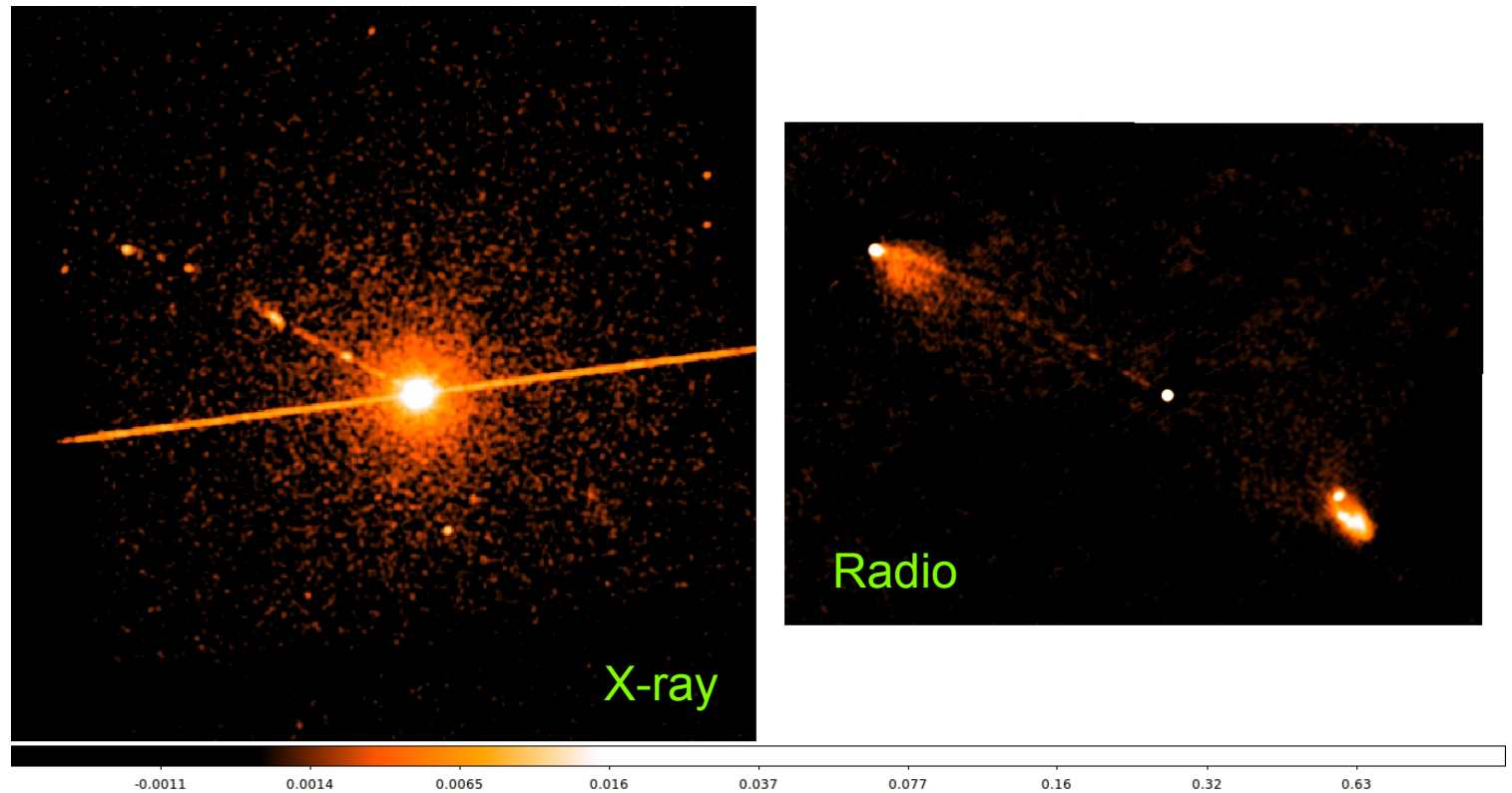


Other useful links

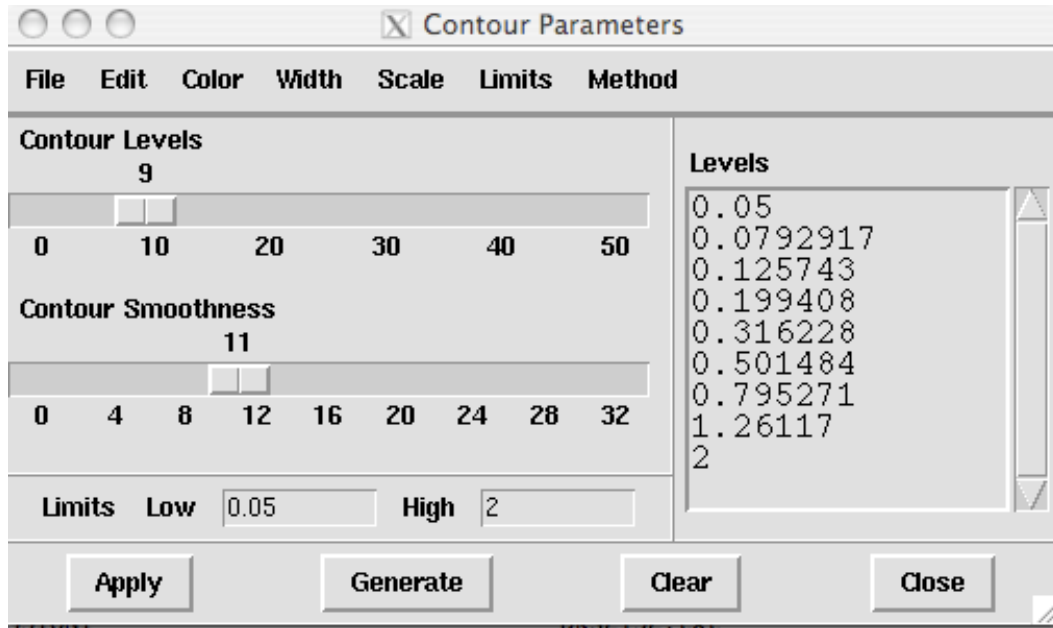
- <http://www.jb.man.ac.uk/atlas/icon.html>
- http://2jy.extragalactic.info/2Jy_home_page.html
- <http://www.jb.man.ac.uk/atlas/dragons.html>

> ds9 X-ray_image radio_image

Frame → match frames
→ WCS

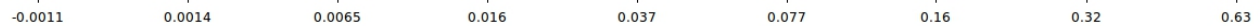
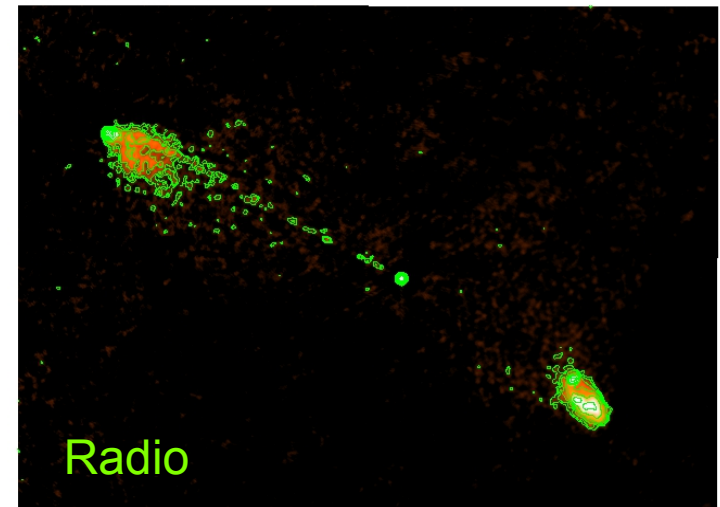
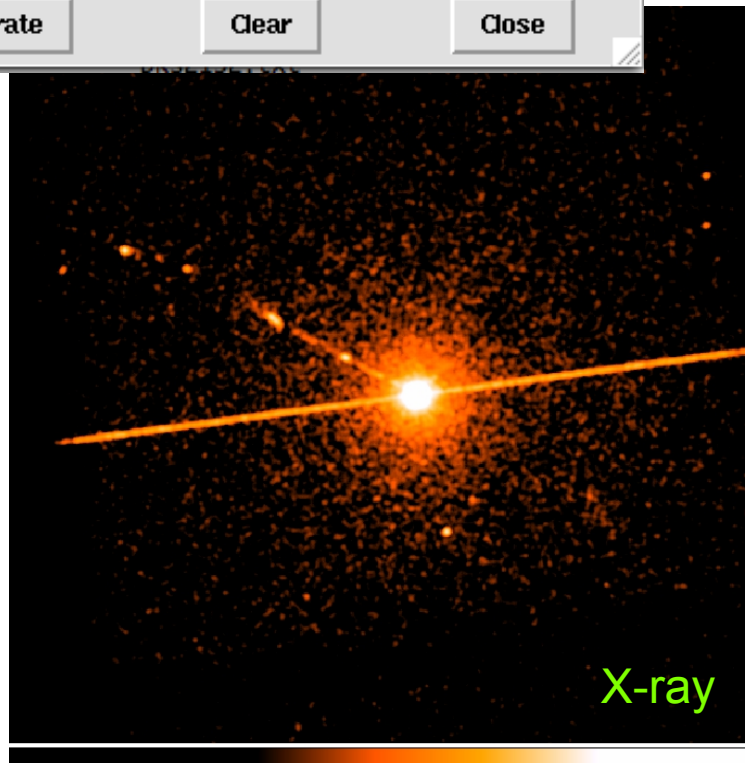


> ds9 X-ray_image radio_image

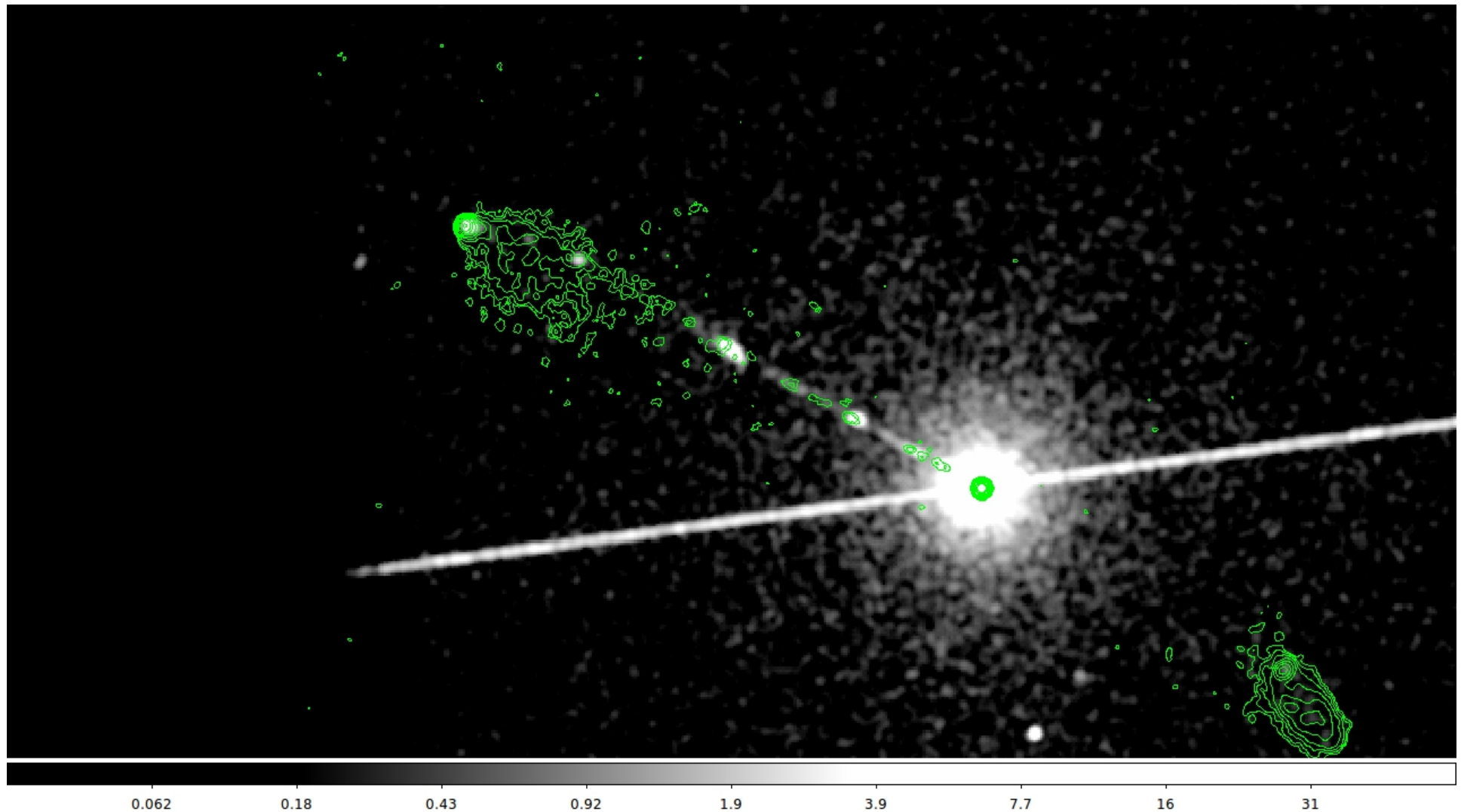


Analysis -> contours
parameters

File -> save contours



- Analysis → Contour parameters
- File
- Load contours



Not only radio/X...

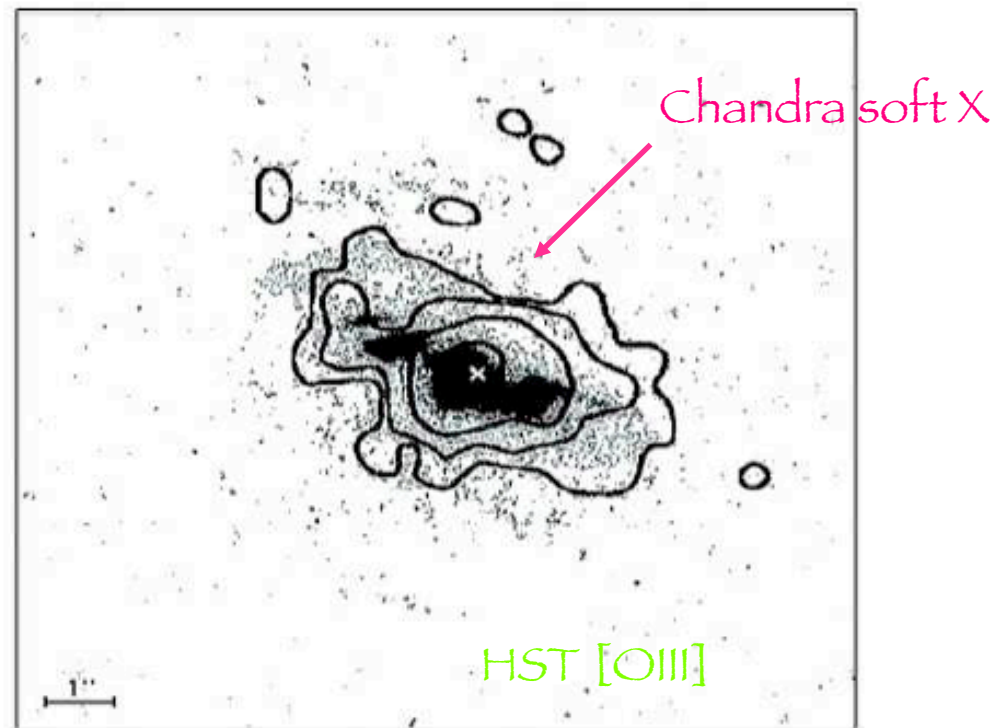


Fig.4. Superposition of the *Chandra* soft X-ray (<2 keV) contours on an *HST* image taken through a linear ramp filter at redshifted [OIII] λ 5007. The sign "x" indicates the centre of the hard X-ray source, north is up, east to the left. The X-ray image was smoothed with a Gaussian of FWHM \sim 6 pixels. The contours correspond to four logarithmic intervals in the range 1-60% of the peak flux.



THE END