On-the-fly and Grid Analysis of Astronomical Images

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http://www.xassist.org

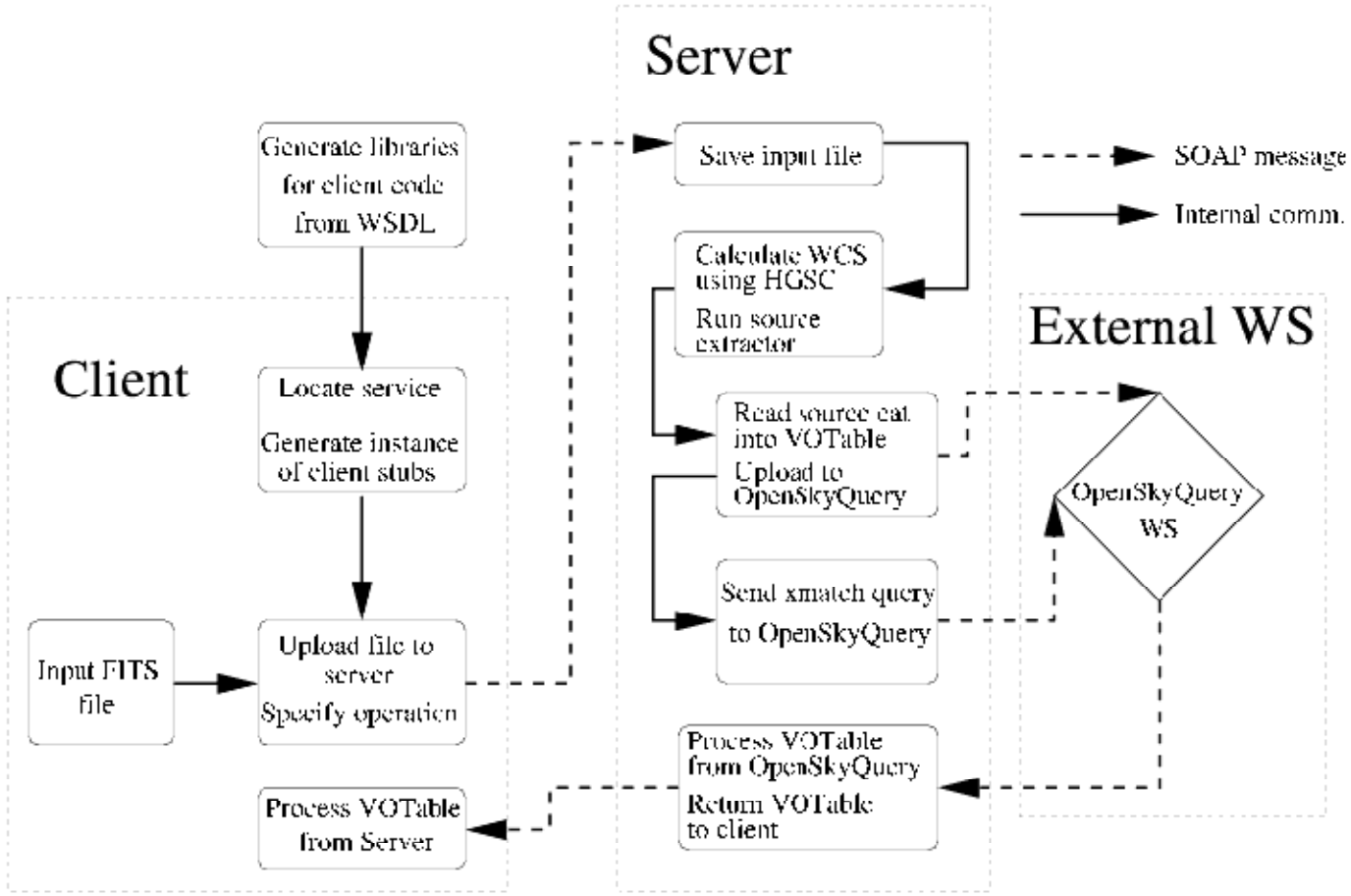
Thanks to Joe and the AISR program for support!

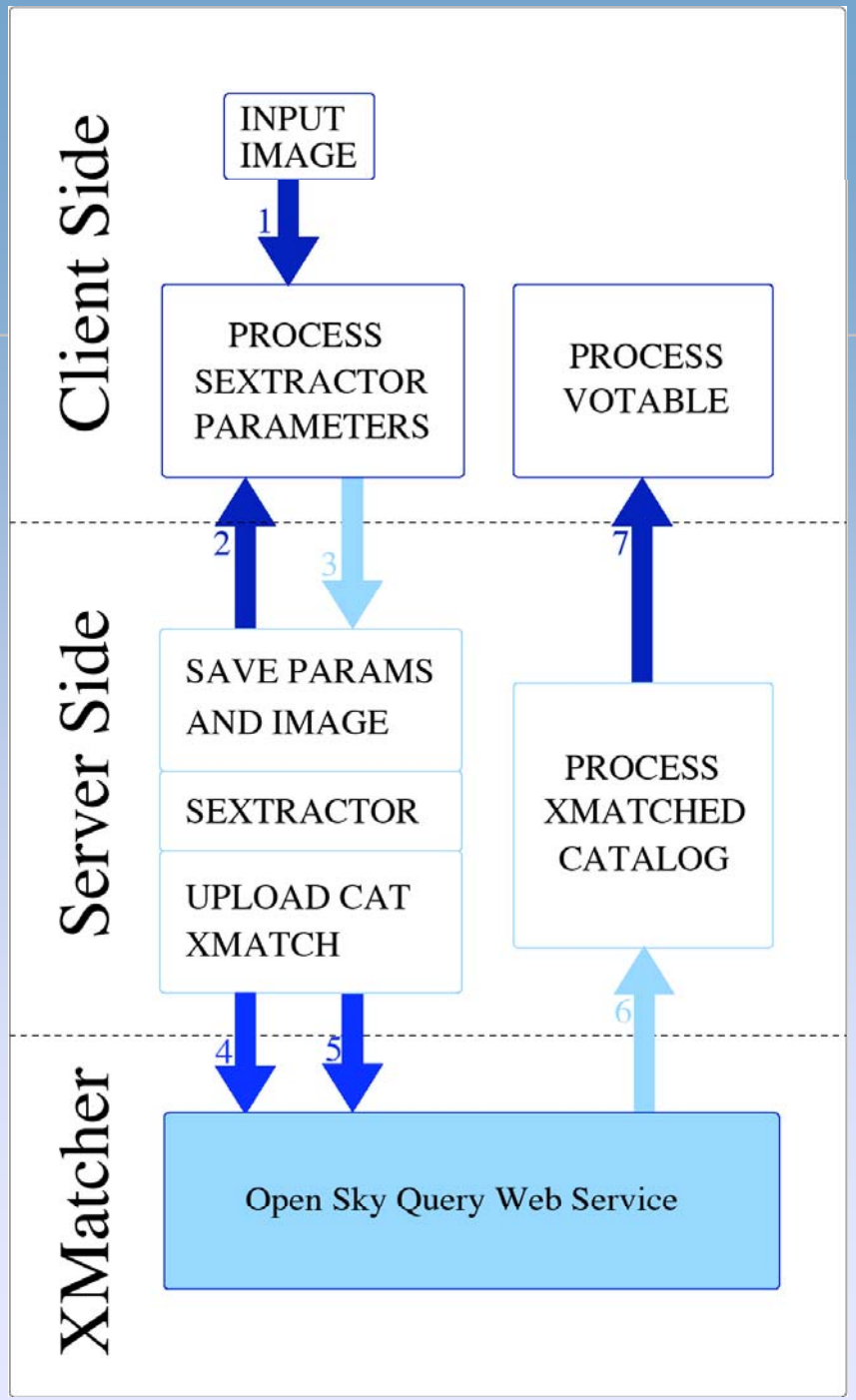
Overview

- WESIX is a web service for running the source detection and photometry program SExtractor on (optical) images
- XAssist is a package for automatically analyzing X-ray data
- AISR project goals:
  - Add web services to XAssist
  - Combine XAssist and WESIX into similar web services
  - Create a common framework for web service analysis of multi-wavelength data

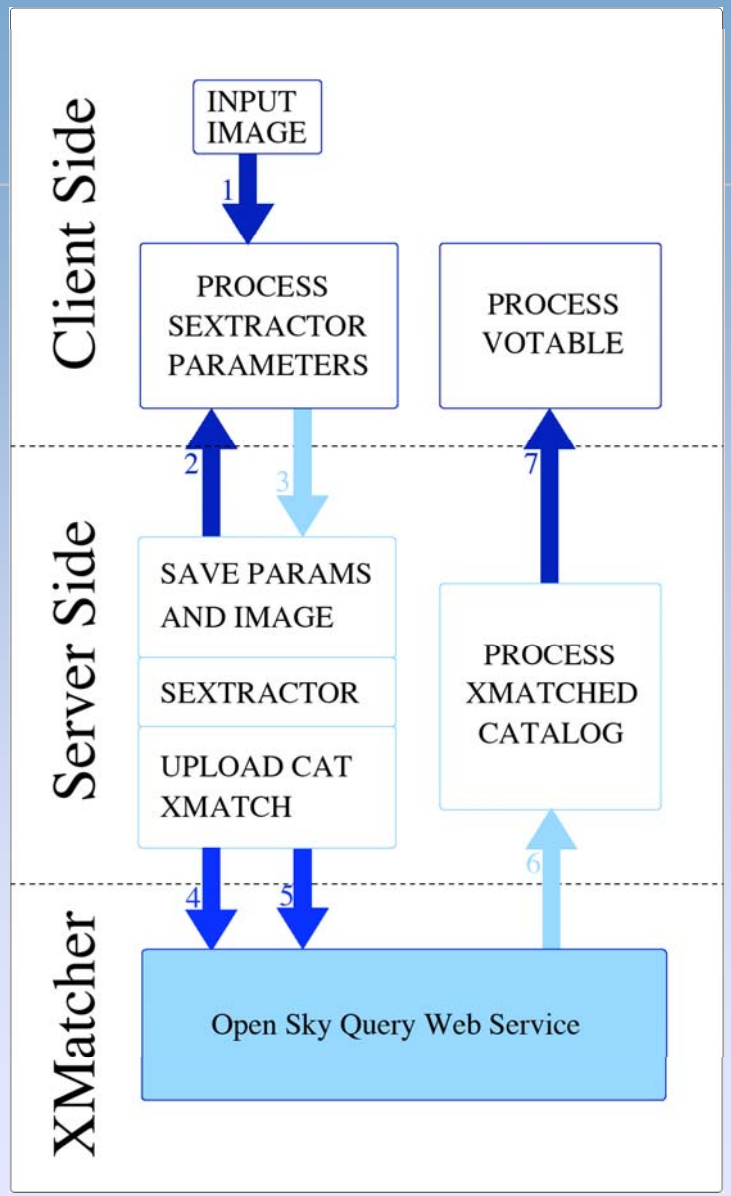
Introduction to WESIX

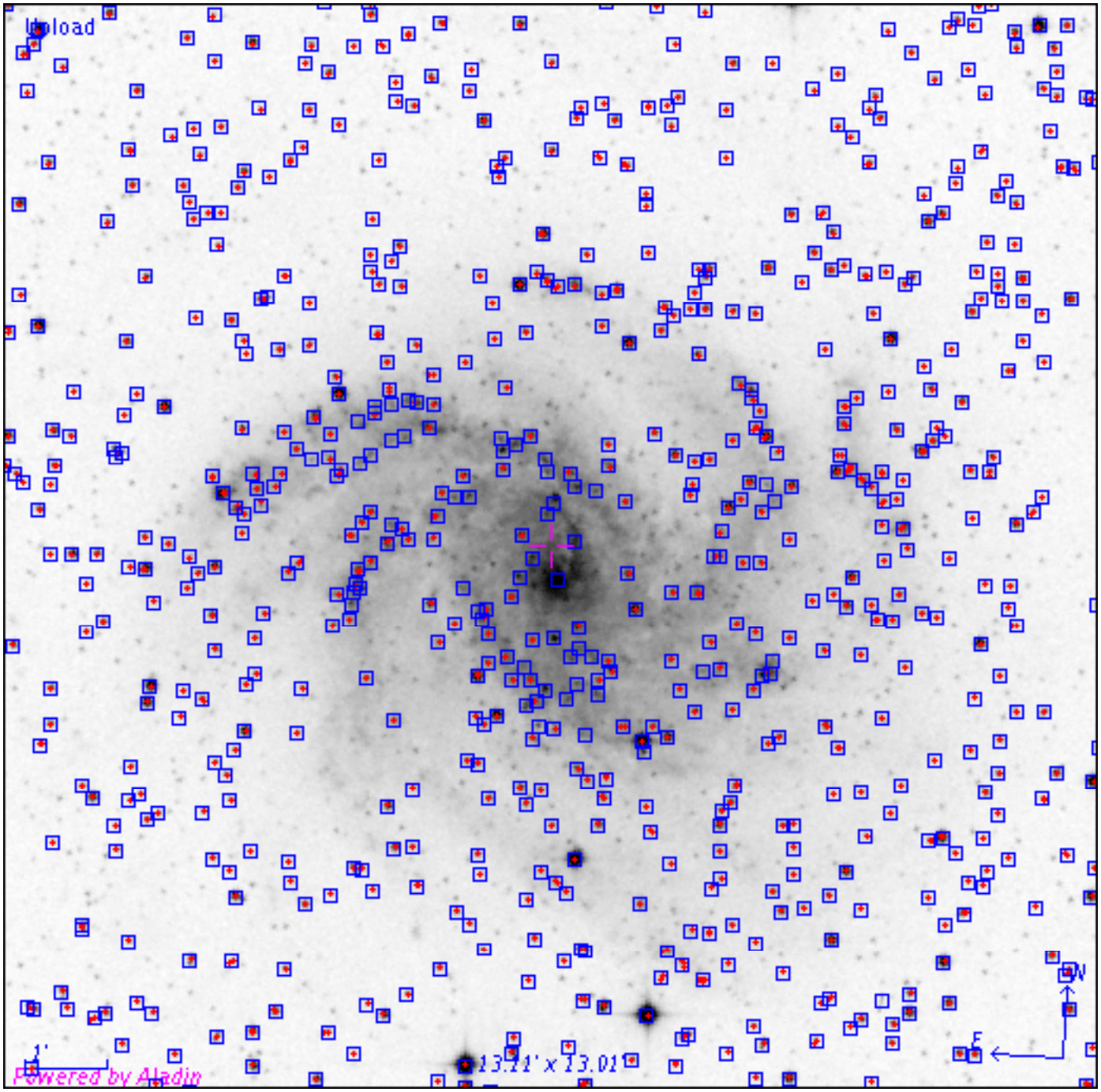
- WESIX is:
  - Web-Enabled Source Identification with X-matching
  - A web service with web page front end for extracting and cross matching sources in an astronomical image
  - Inputs are a FITS file with extraction parameters and catalog fields for output
  - Uses the SkyNode protocol from IVOA for cross matching with published catalogs.


Server
Generate libraries for client code from WSDL
Save input file
SOAP message
Internal comm.
Calculate WCS using HGSC
Run source extractor
External WS
Client
Locate service
Generate instance of client stubs
Read source cat. into VOTable
Upload to OpenSkyQuery
OpenSkyQuery WS
Send xmatch query to OpenSkyQuery
Input FITS file
Upload file to server
Specify operation
Process VOTable from OpenSkyQuery
Return VOTable to client
Process VOTable from Server


Client Side
INPUT IMAGE
1
PROCESS SEXTRACTOR PARAMETERS
PROCESS VOTABLE
2
3
7
Server Side
SAVE PARAMS AND IMAGE
SEXTRACTOR
UPLOAD CAT XMATCH
PROCESS XMATCHED CATALOG
6
4
5
XMatcher
Open Sky Query Web Service

1. Read FITS image with WCS
2. Request default parameters
3. Send image and parameters
4. Upload source list
5. Send ADQL query
6. Receive XMatched catalog
7. Return catalog to client.




Upload
1'
13.21' x 13.01'
N
E
Powered by Aladin

Recent Development

- SOAP, Java, Axis → Python, XML-RPC
- Improvements:
  - No SOAP implementation issues
  - Multiple input images for weighted source identification and detect+measure images
  - Vector quantities for measurement of multiple apertures
  - Generalized framework for interaction with other source identification applications (XAssist)

WESIX Exposure

- Inclusion in the NVO Summer School 2005-2008
- Inclusion in the NVO book: *The National Virtual Observatory: Tools and Techniques for Astronomical Research*
- Integrated with the NOAO-NVO Portal (http://portal-nvo.noao.edu)
- Inclusion in the ESO Reflex (ESO Recipe Flexible Execution Workbench) presented ADASS 2007

XAssist

- Started as a previous AISR project (1998-2001)
- Written mostly in Python and scripts existing mission-specific software as much as possible (CIAO for *Chandra*, XMM-SAS for *XMM-Newton*, HEADAS for *Suzaku*)
- XAssist running pipelines to process *Chandra* and *XMM-Newton* data
  - Pipeline source lists searchable via HEASARC, which links search results to field reports at XAssist web site
  - Support for Japanese/US satellite *Suzaku* in beta testing

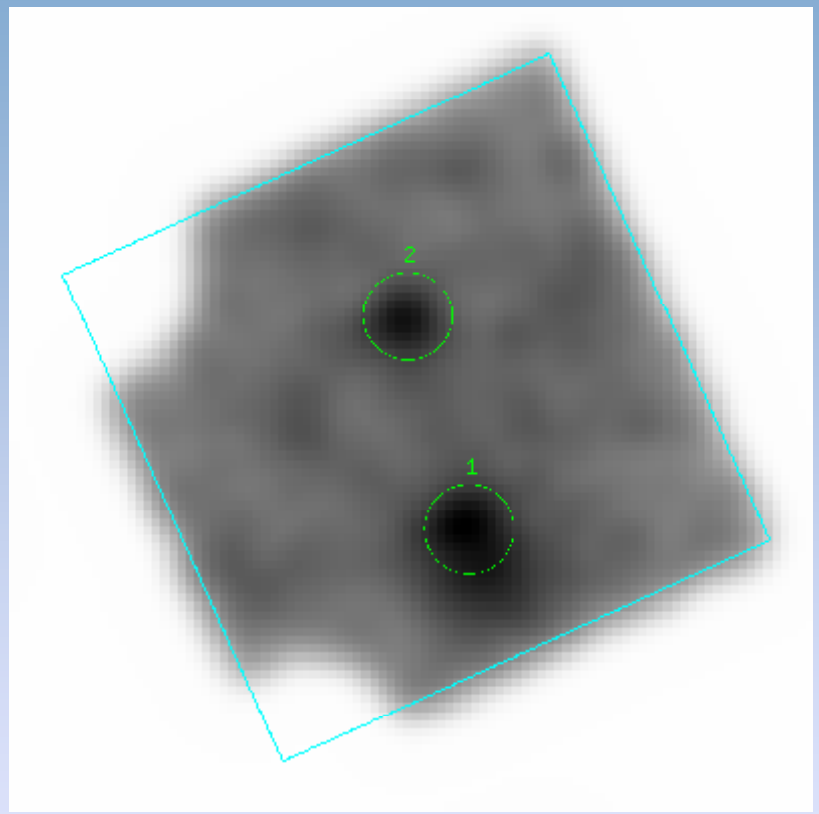
XAssist Features

- Downloads data
- Reprocesses data
- Creates detector mask
- Detects sources
- Excludes times of high background
- Fits each source with “simple” (i.e., not including PSF) model to establish source extent and (Poisson-correct) significance

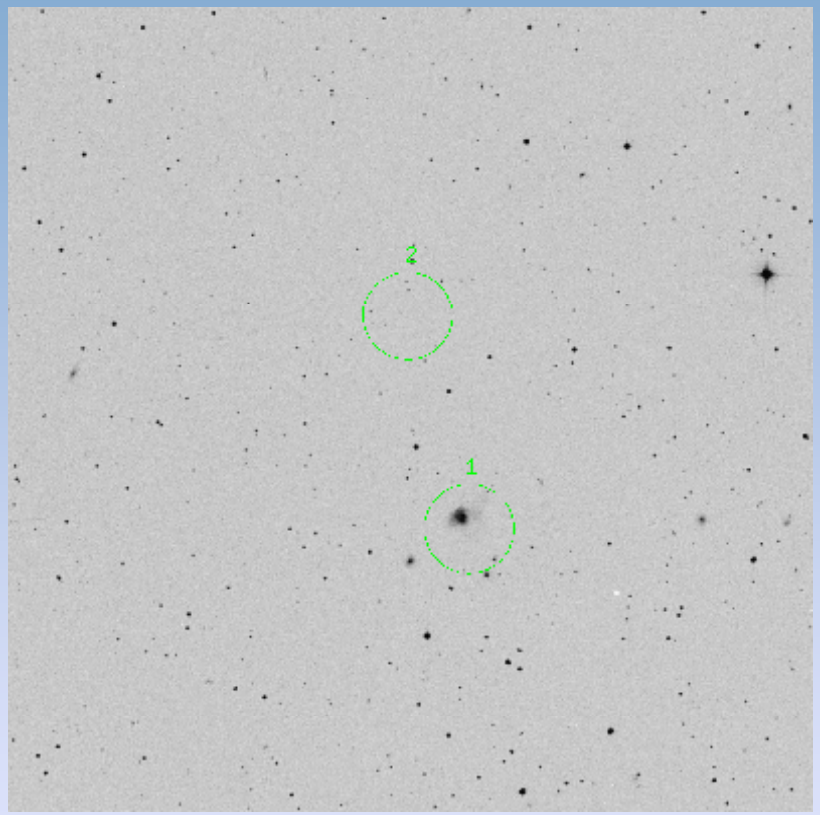
XAssist Features

- Flags extended, confused and problematic sources
- Median (or mean) background level is determined
- Extracts spectra, “postage stamp” images, and light curves of each source for more detailed analysis
  - Computes hardness ratios
  - Fits spectra with enough counts with simple power-law spectral model
- Analysis can be restricted to an energy band
- Optionally correlate source list with several HEASARC tables (USNO-B, Veron QSOs)
- Large emphasis on detailed reporting

Suzaku Observation of Arp 220

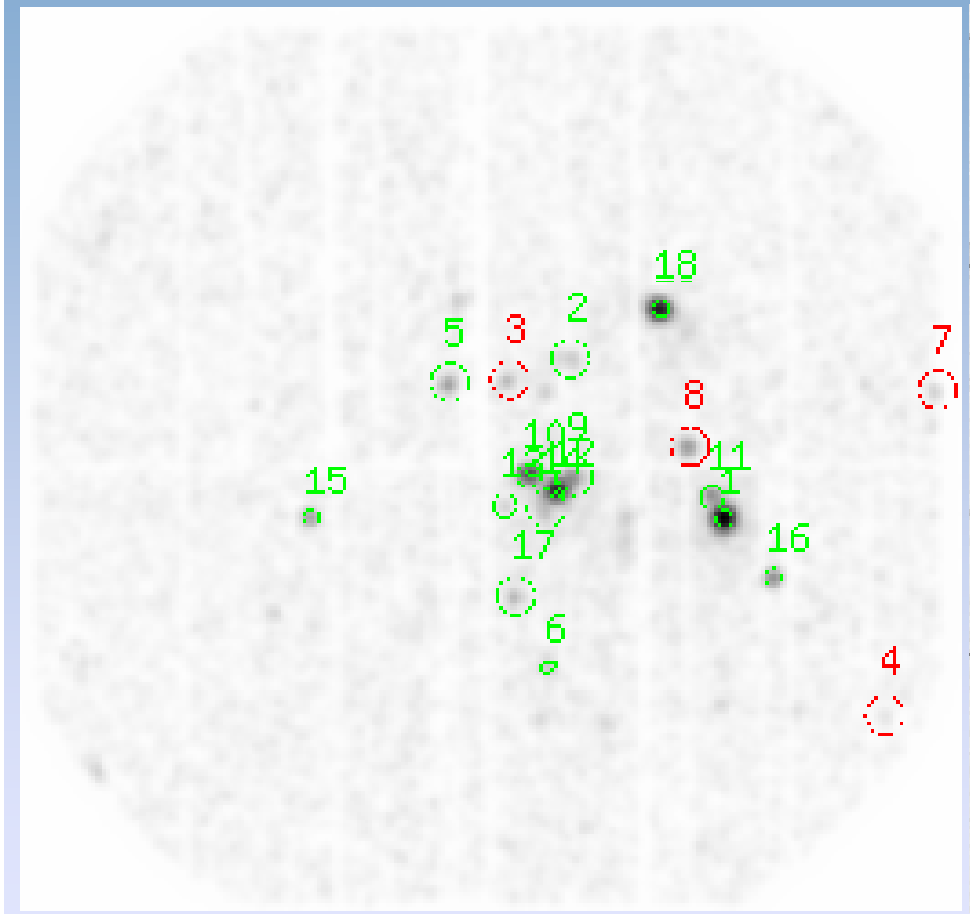


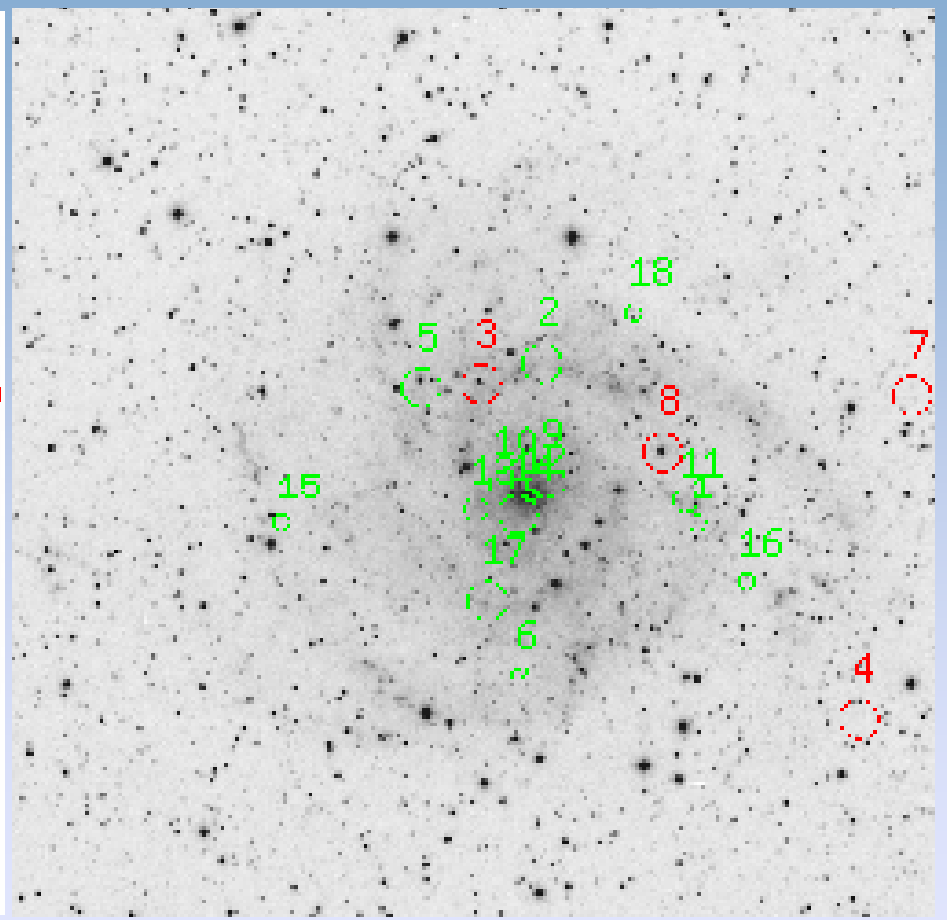
X-ray



Digital Sky Survey

XMM-Newton Observation of IC 342

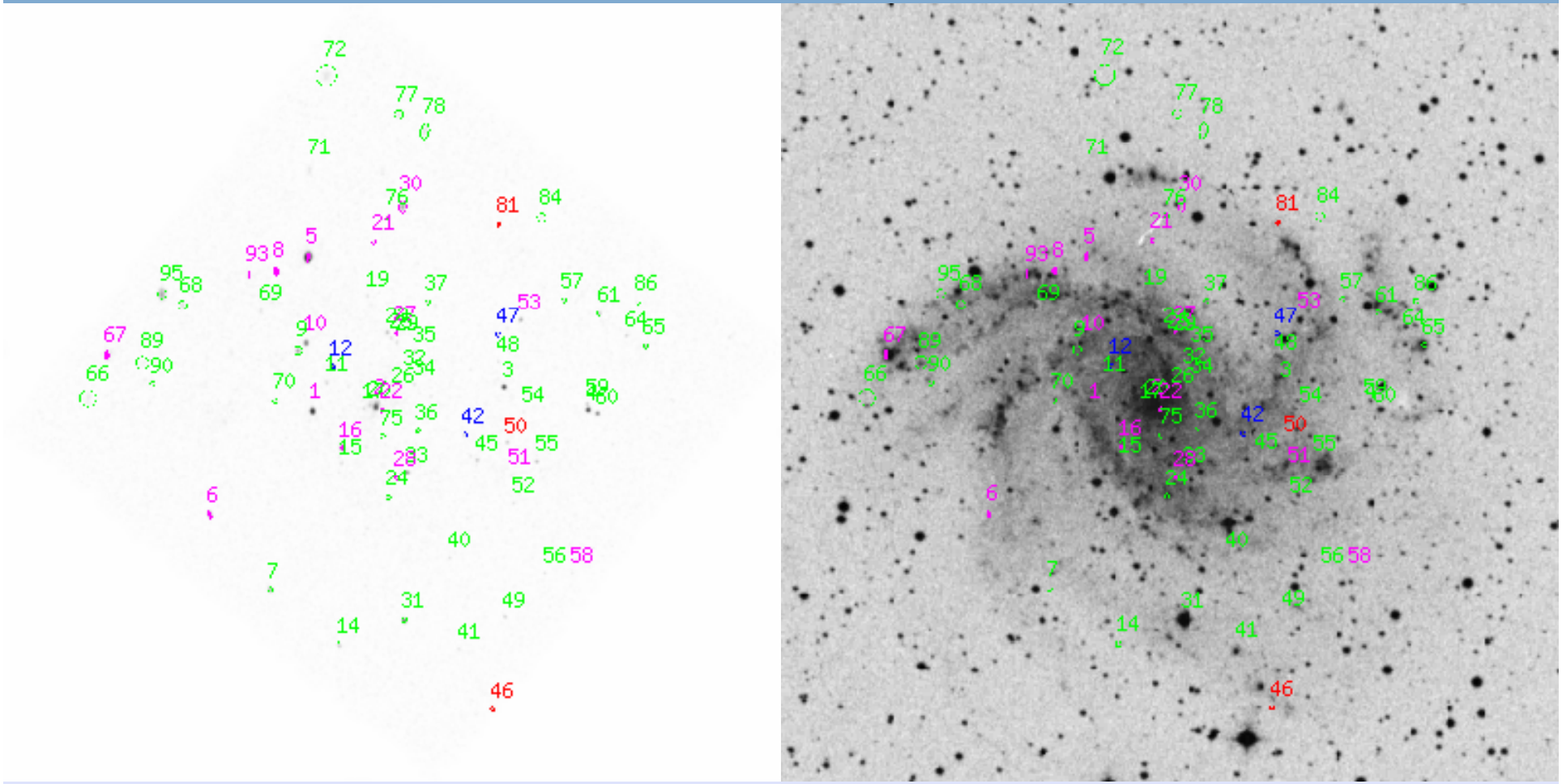




X-ray

Digital Sky Survey

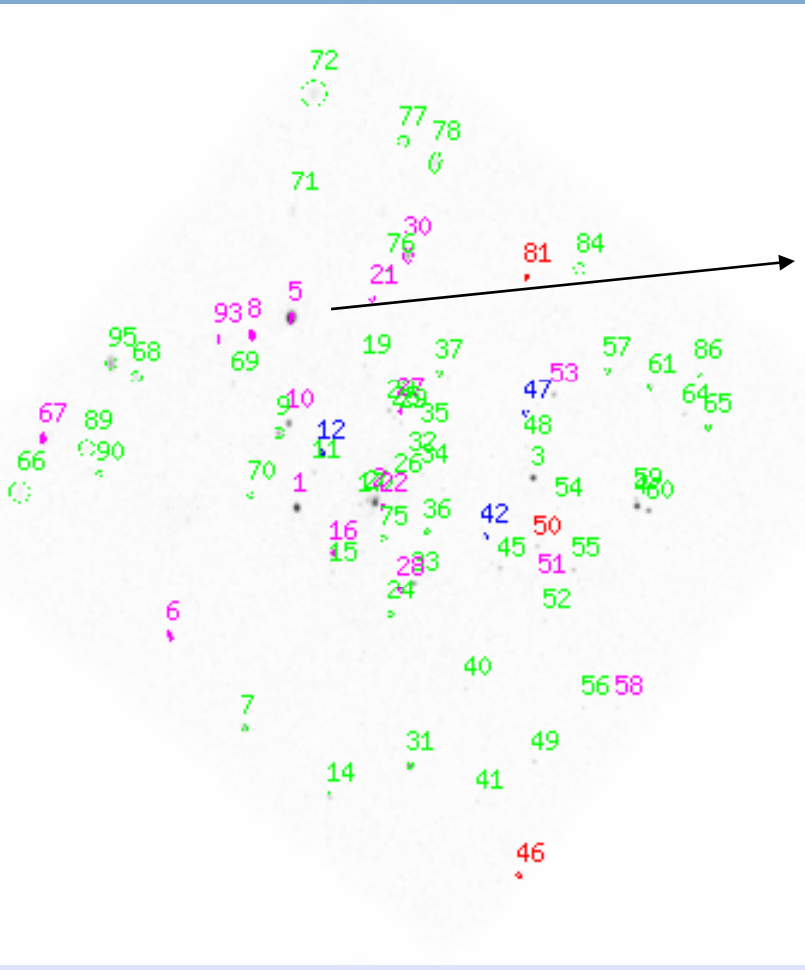
Chandra ACIS Observation of NGC 6946



X-ray

Digital Sky Survey

Chandra ACIS Observation of NGC 6946

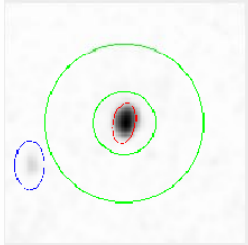


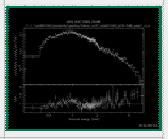
Source 5

http://xassist.pha.jhu.edu/pipeline3/chandra/1043

Latest Headlines | Yahoo! | News | Scientific Linux | Distros | macosxhints.com – ... | Getting Started | Latest Headlines

Source 5



Analysis Type	Results	Plot
Spatial	Source position = 20 35 0.80 60 11 30.4 Source region radii = 6.5" , 3.7" Background annulus = 9.8" - 24.5"	N/A
Spectral	Nh = 0.235 (0.217 - 0.255) Gamma = 2.59 (2.5 - 2.7) Final chisq(dof) = 350.474(217) F(0.5-2.0 keV) = 3.785e-13 F(2.0-10.0 keV) = 3.647e-13 F(0.3-8.0) = 7.323e-13	
Temporal	K-S test against local background: d = 0.0486202, prob = 0.418468 K-S test against global background: d = 0.0133424, prob = 0.161803	N/A
Counterparts	Check SIMBAD	

Return to source list

Notes:

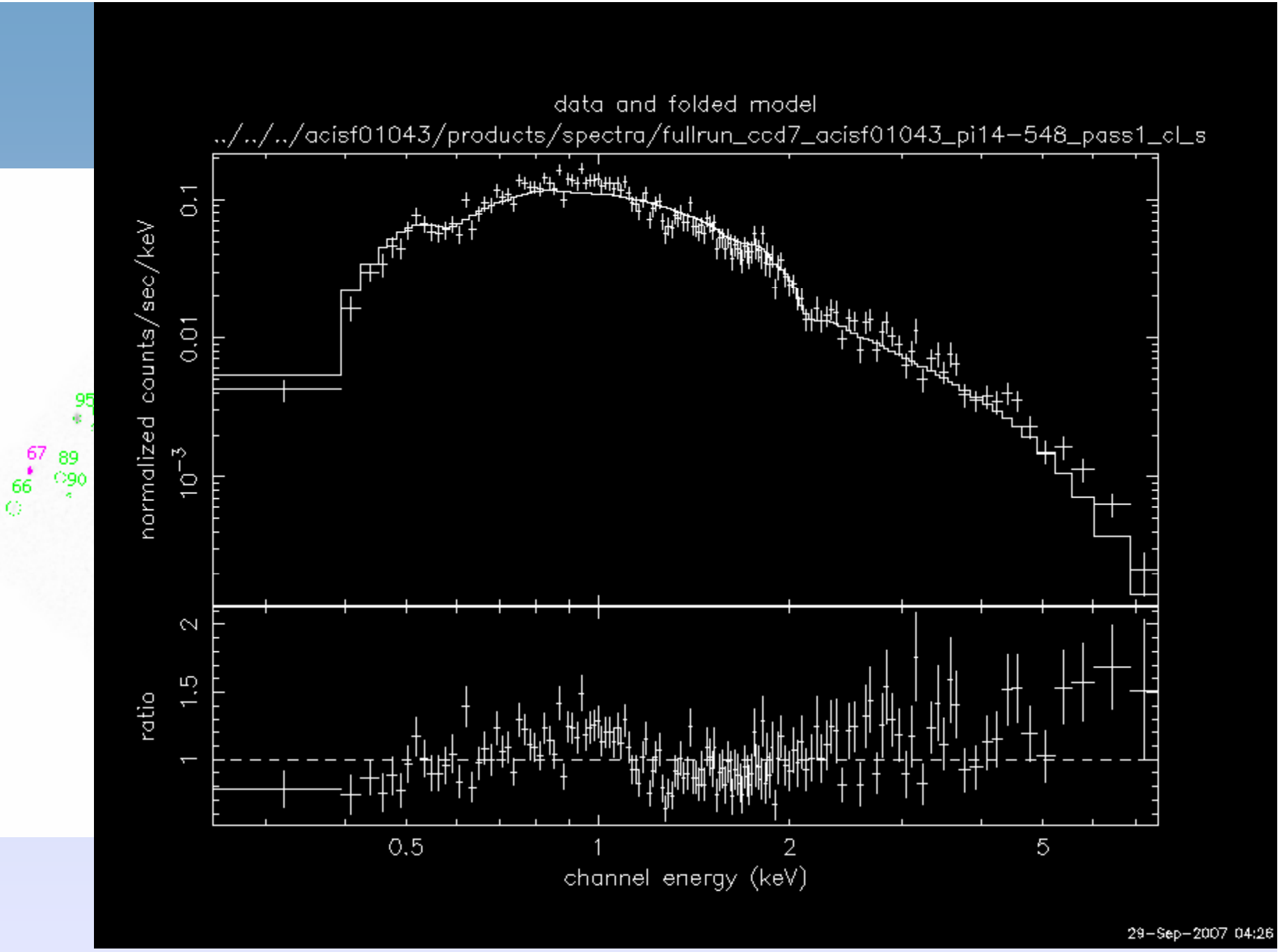
Regions give source ellipse (red) and bgd. annulus used in product extraction (green), other ellipse show nearby sources that have been excluded (blue, if any).N.B., nearby sources are NOT excluded from the source regions since in many cases that would also remove many source photons for the source of interest, and this case is more properly handled manually

Source variability probability gives the probability that the source light curve is consistent with the background light curve. "Local" background is taken from the annulus shown. "Global" background is the background light curve shown on the main report page.

Find: 342 | Next | Previous | Highlight all | Match case

Baltimore, MD: Tue 10:20 | Japan: Tue 23:20 | Spain: Tue 16:20 | Los Angeles: Tue 07:20 | Done

X-ray

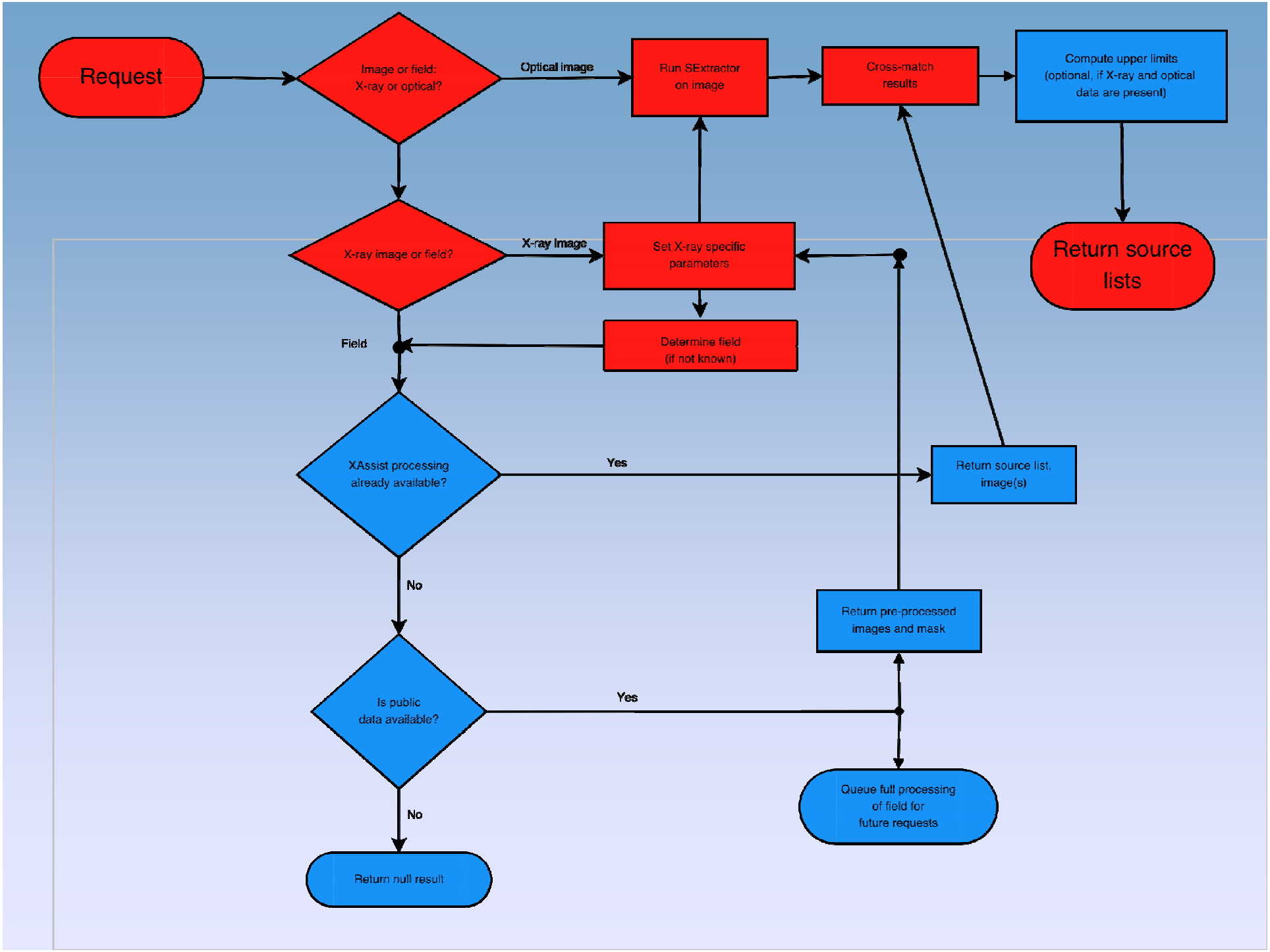

data and folded model
../../../acisf01043/products/spectra/fullrun_ccd7_acisf01043_pi14-548_pass1_cl_s
normalized counts/sec/keV
0.1
0.01
10^{-3}
ratio
2
1.5
1
0.5
1
2
5
channel energy (keV)
29-Sep-2007 04:26
95
67
89
90
66

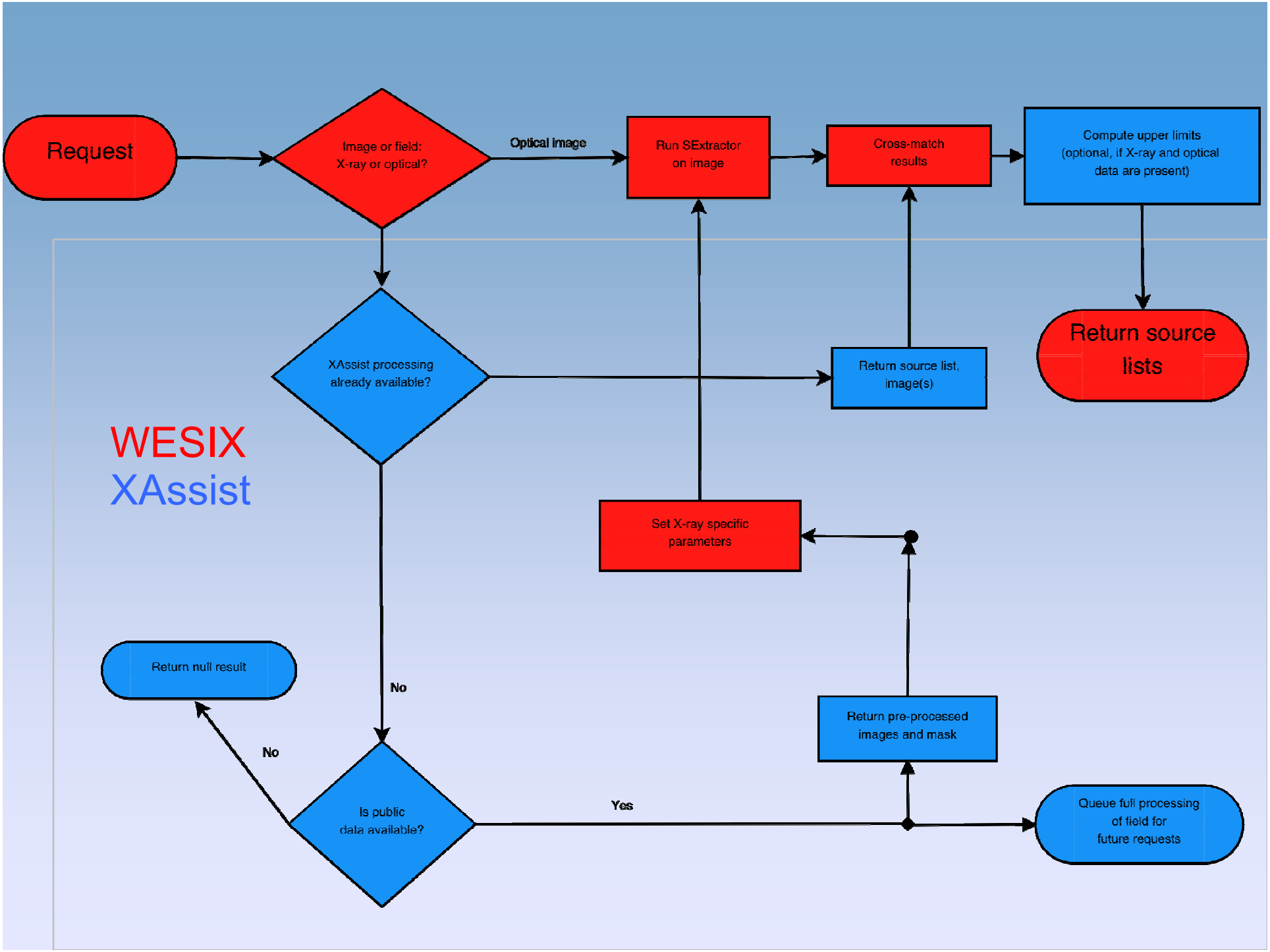
Recent Development

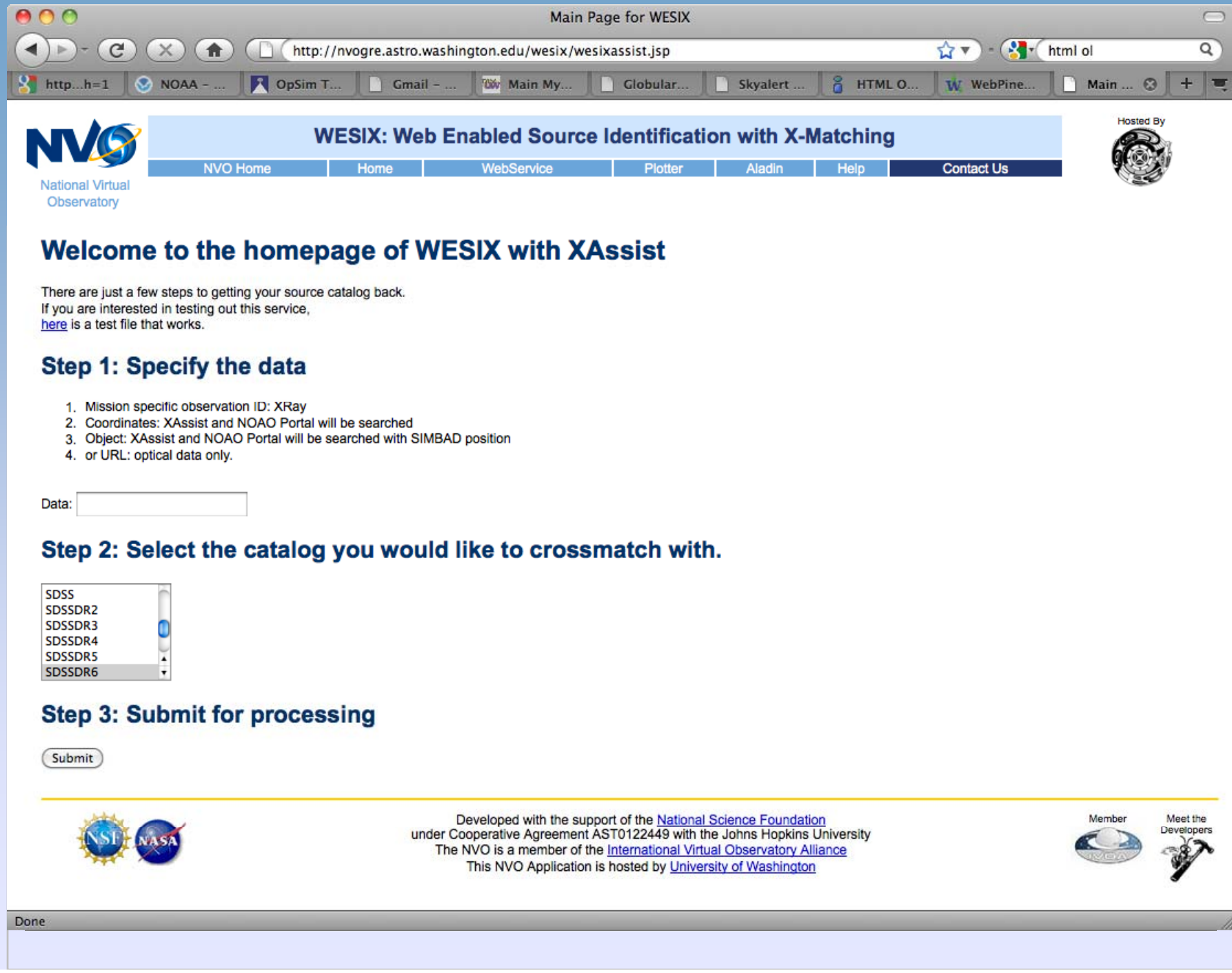
- Added web service for querying pipeline status, searching pipeline database and requesting processing
- User can specify “region-of-interest” to limit processing (for shorter run times)
- Web services to access low-level Xassist functionality
  - Exposure at a given position (“footprint”)
  - Extracting spectra and image for a given source or position
  - Limiting flux at a position

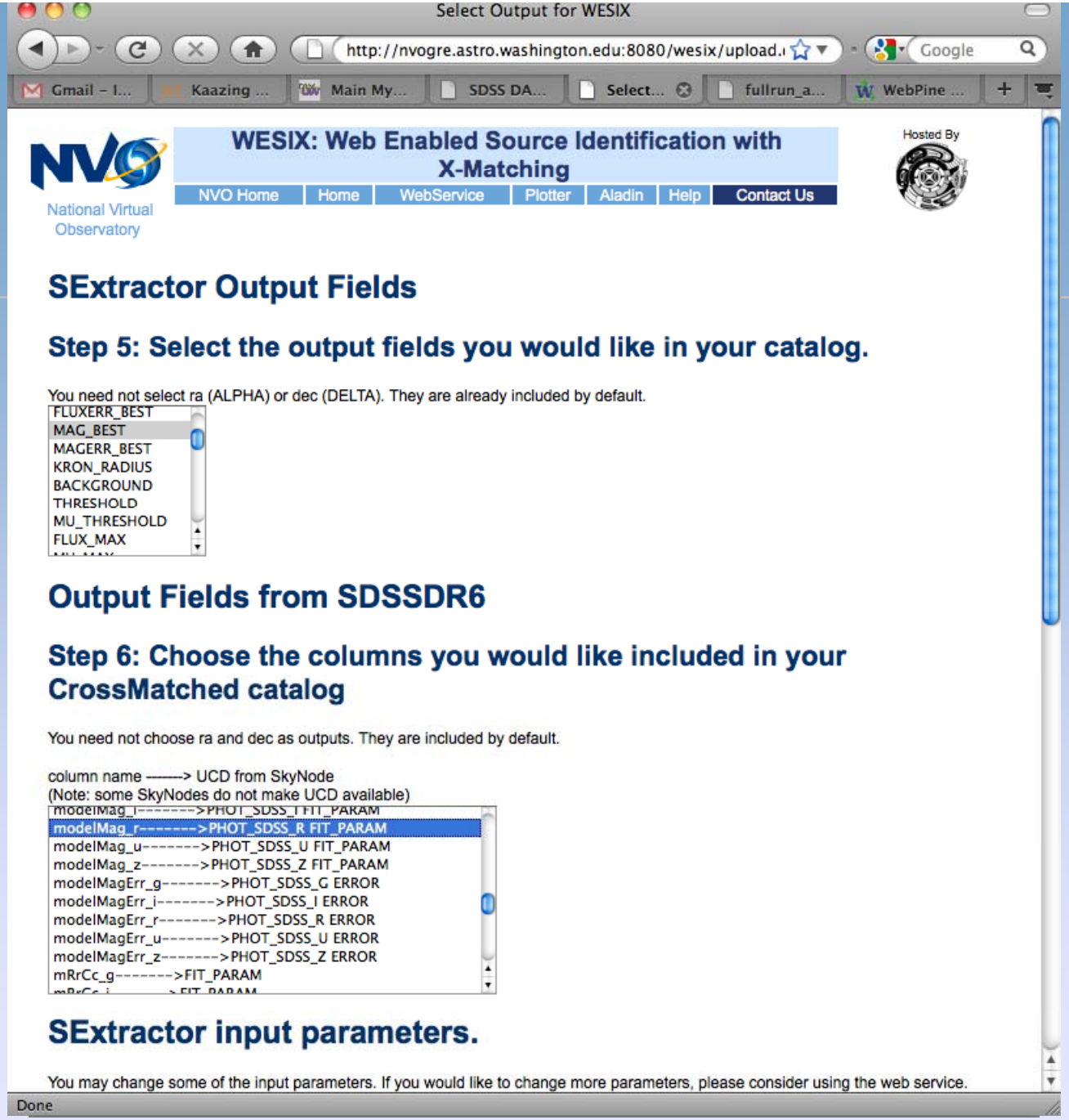
Joint WESIX/XAssist Development

- Testing/calibration of SExtractor on X-ray images
- WESIX sends request to XAssist web service to check for existing processing of field
  - Yes: return data
  - No: start quick-look processing: XAssist returns quick-look image and detector mask
    - WESIX returns Sextractor source list in seconds
    - Quick-look XAssist processing spawned (~ minutes)
    - Full processing of field queued (up to ~ hours)


Request
Image or field:
X-ray or optical?
Optical image
Run SExtractor
on image
Cross-match
results
Compute upper limits
(optional, if X-ray and optical
data are present)
Return source
lists
X-ray image or field?
X-ray image
Set X-ray specific
parameters
Field
Determine field
(if not known)
XAssist processing
already available?
Yes
Return source list,
image(s)
No
Return pre-processed
images and mask
Is public
data available?
Yes
Queue full processing
of field for
future requests
No
Return null result


Request
Image or field:
X-ray or optical?
Optical image
Run SExtractor
on image
Cross-match
results
Compute upper limits
(optional, if X-ray and optical
data are present)
Return source
lists
XAssist processing
already available?
Return source list,
image(s)
WESIX
XAssist
Set X-ray specific
parameters
Return null result
No
No
Return pre-processed
images and mask
Is public
data available?
Yes
Queue full processing
of field for
future requests


Main Page for WESIX
http://nvogre.astro.washington.edu/wesix/wesixassist.jsp
html ol
WESIX: Web Enabled Source Identification with X-Matching
NVO Home
Home
WebService
Plotter
Aladin
Help
Contact Us
National Virtual Observatory
Hosted By
Welcome to the homepage of WESIX with XAssist
There are just a few steps to getting your source catalog back.
If you are interested in testing out this service,
here is a test file that works.
Step 1: Specify the data
1. Mission specific observation ID: XRay
2. Coordinates: XAssist and NOAO Portal will be searched
3. Object: XAssist and NOAO Portal will be searched with SIMBAD position
4. or URL: optical data only.
Data:
Step 2: Select the catalog you would like to crossmatch with.
SDSS
SDSSDR2
SDSSDR3
SDSSDR4
SDSSDR5
SDSSDR6
Step 3: Submit for processing
Submit
Developed with the support of the National Science Foundation
under Cooperative Agreement AST0122449 with the Johns Hopkins University
The NVO is a member of the International Virtual Observatory Alliance
This NVO Application is hosted by University of Washington
Member
Meet the Developers
Done


Select Output for WESIX
http://nvogre.astro.washington.edu:8080/wesix/upload.
Google
Gmail – I...
Kaazing ...
Main My...
SDSS DA...
Select...
fullrun_a...
WebPine ...
National Virtual Observatory
WESIX: Web Enabled Source Identification with X-Matching
NVO Home
Home
WebService
Plotter
Aladin
Help
Contact Us
Hosted By
SExtractor Output Fields
Step 5: Select the output fields you would like in your catalog.
You need not select ra (ALPHA) or dec (DELTA). They are already included by default.
FLUXERR_BEST
MAG_BEST
MAGERR_BEST
KRON_RADIUS
BACKGROUND
THRESHOLD
MU_THRESHOLD
FLUX_MAX
Output Fields from SDSSDR6
Step 6: Choose the columns you would like included in your CrossMatched catalog
You need not choose ra and dec as outputs. They are included by default.
column name ------> UCD from SkyNode
(Note: some SkyNodes do not make UCD available)
modelMag_r-------->PHOT_SDSS_R FIT_PARAM
modelMag_u-------->PHOT_SDSS_U FIT_PARAM
modelMag_z-------->PHOT_SDSS_Z FIT_PARAM
modelMagErr_g------->PHOT_SDSS_G ERROR
modelMagErr_i------->PHOT_SDSS_I ERROR
modelMagErr_r------->PHOT_SDSS_R ERROR
modelMagErr_u------->PHOT_SDSS_U ERROR
modelMagErr_z------->PHOT_SDSS_Z ERROR
mRrCc_g------->FIT_PARAM
SExtractor input parameters.
You may change some of the input parameters. If you would like to change more parameters, please consider using the web service.
Done

fullrun_acis_acisf01031_pi14-548_cl

http://xassist.pha.jhu.edu/pipeline3/chandra/1031/acisf

Gmail – I... | Kaazing ... | Main My... | SDSS DA... | Main Pag... | fullru... | WebPine ...

fullrun_acis_acisf01031_pi14-548_cl

Processing completion:

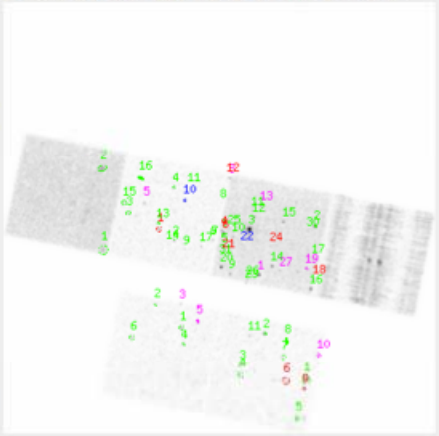
Field: acisf01031

Detector	Exposure (OriginallCleaned)	Image binning	Plate scale ("/pixel)	Bgd. level (orig/cl, counts/sq. arcmin/s)	GTI file	Bgd. light curves	Roll angle	CCD counts	Extra info
ccd2	39257 | 39257	1.00	0.49	0.003/0.003	Yes	orig clean			
ccd3	39257 | 39257	1.00	0.49	0.0029/0.0029	Yes	orig clean			
ccd5	39257 | 38056	1.00	0.49	0.018/0.015	Yes	orig clean			
ccd6	39253 | 39253	1.00	0.49	0.0033/0.0033	Yes	orig clean			
ccd7	39257 | 37740	1.00	0.49	0.015/0.012	Yes	orig clean			
acis	39257 | 37108	4.00	1.97	0/0	Yes	orig clean	11.0	ccd2:8559 ccd3:8811 ccd5:49626 ccd6:9569 ccd7:44302 ccd8:36422	datamode=FAINT readmode=TIMED gainfile=acisD2000-01-29gain_ctiN0006.fits CCD Temp=-120 object=Mrk 231 firstrow=1 nrows=1024 date-obs=2000-10-19T12:51:04 roll_angle=11.229408885 timedel=3.24 (full readout) CIAO_version=CIAO3.3

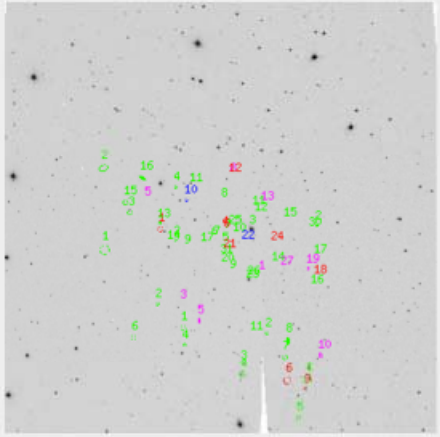
Source List (gives positions and fluxes and links for detailed analyses)

65 source(s) in memory
Iteration: 2
Images:
lccd2 lccd3 lccd5 lccd6 lccd7 lacis l

Package	State
init	Complete
acquire	Complete
reduce	Complete
detect	Complete
timeclean	Complete
simplespatial	Complete
assess	Complete
extract	Complete
reassess	Complete
spectral	Complete
temporal	Complete
spatial	Complete
correl	Skip
sim	Skip
qlook	Skip



Xray image, smoothed with a 2 pixel gaussian



Skyview image(s) of FOV (with X-ray sources marked)

Color code (marks may only appear on detector-specific images for multi-detector missions, see links above): green = point source, red = problematic/questionable source, blue = extended source, magenta = asymmetric source (may be extended), cyan = estimated detector boundary

Python version = 2.5.2 (r252:60911, Mar 11 2008, 11:51:00) [GCC 4.1.1 20070105 (Red Hat 4.1.1-52)]
Headas version = 6.3.1
CIAO version = 3.3.0
XAssist version = 0.977
numpy version = 1.0.4
Pyfits version = 1.1
XAssist originally started on this data set at Thu Jun 11 17:55:45 2009
This data set was last accessed on Thu Jun 11 17:55:45 2009

Done

Plotter for WESIX

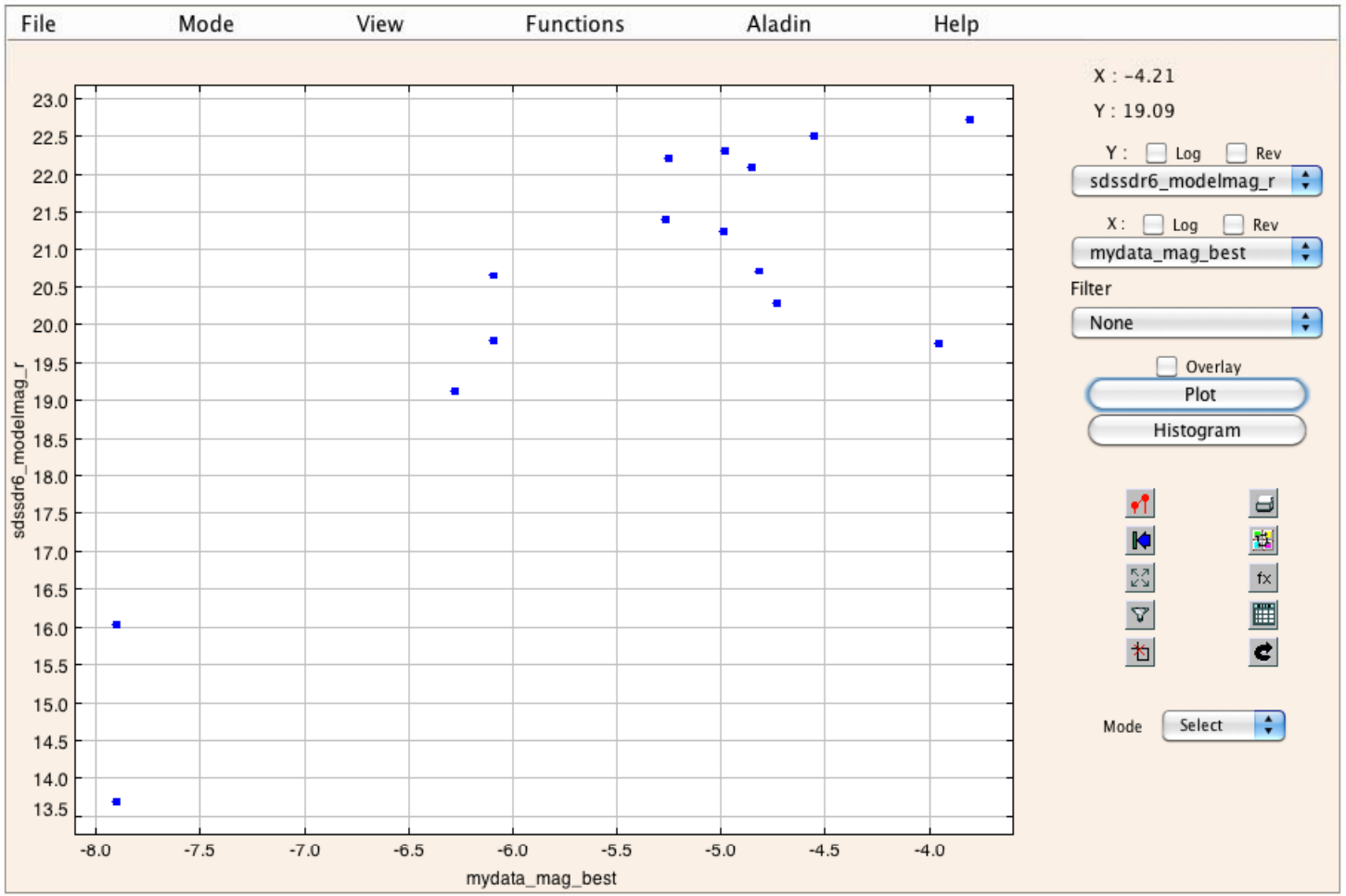
Gmail – Inbox (39... | Kaazing — Downl... | Main MyUW Page | SDSS DAS Version 2 | Plotter for WESIX | aisrp – Google Se... | WebPine – WebPine

National Virtual Observatory

WESIX: Web Enabled Source Identification with X-Matching

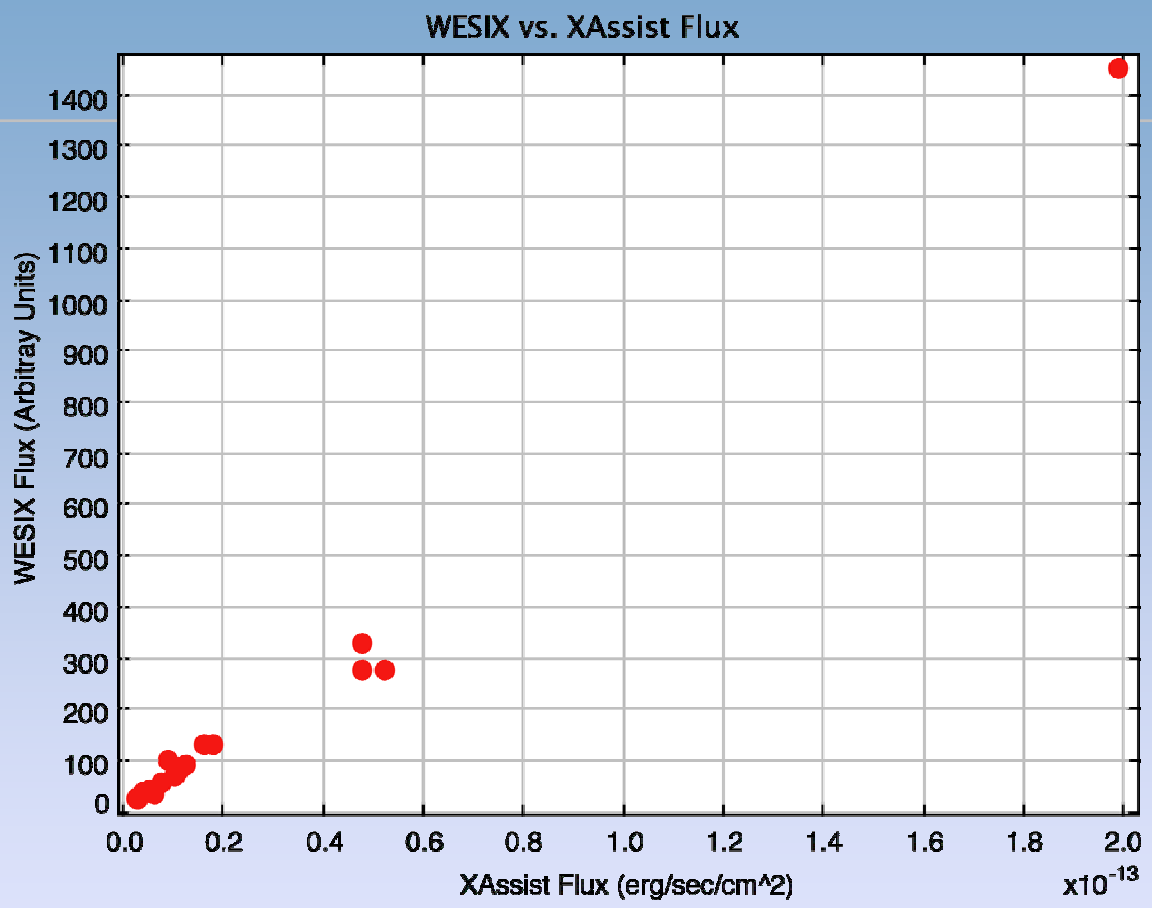
NVO Home | Home | WebService | Plotter | Aladin | Help | Contact

Plotter for WESIX data

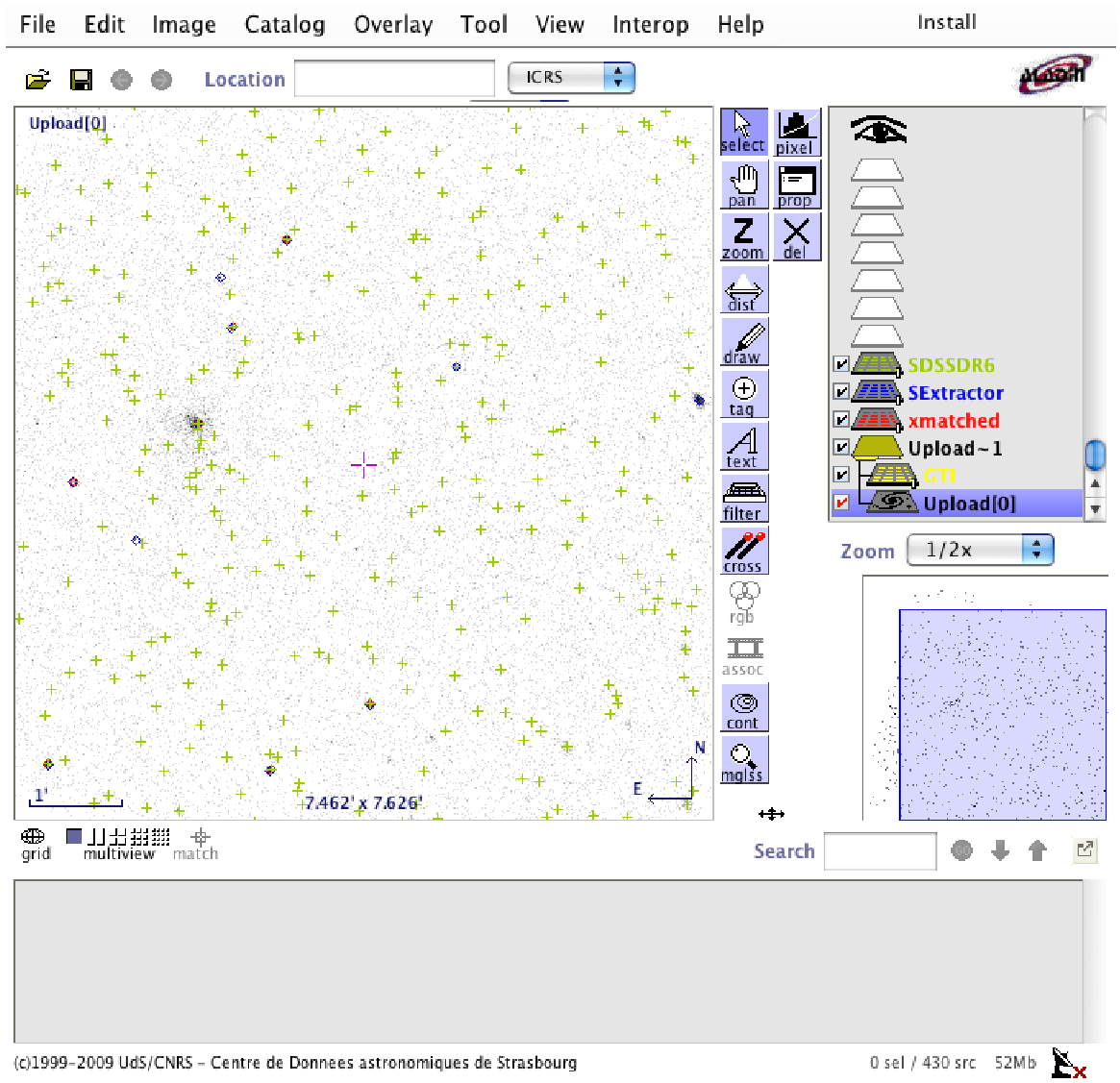


This plotting utility was developed by VO-India for plotting data in the VOTable format.
Click here for more information.

Developed with the support of the National Science Foundation
under Cooperative Agreement AST0122449 with the Johns Hopkins University


WESIX vs. XAssist Flux
WESIX Flux (Arbitray Units)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
XAssist Flux (erg/sec/cm^2)
x10^-13

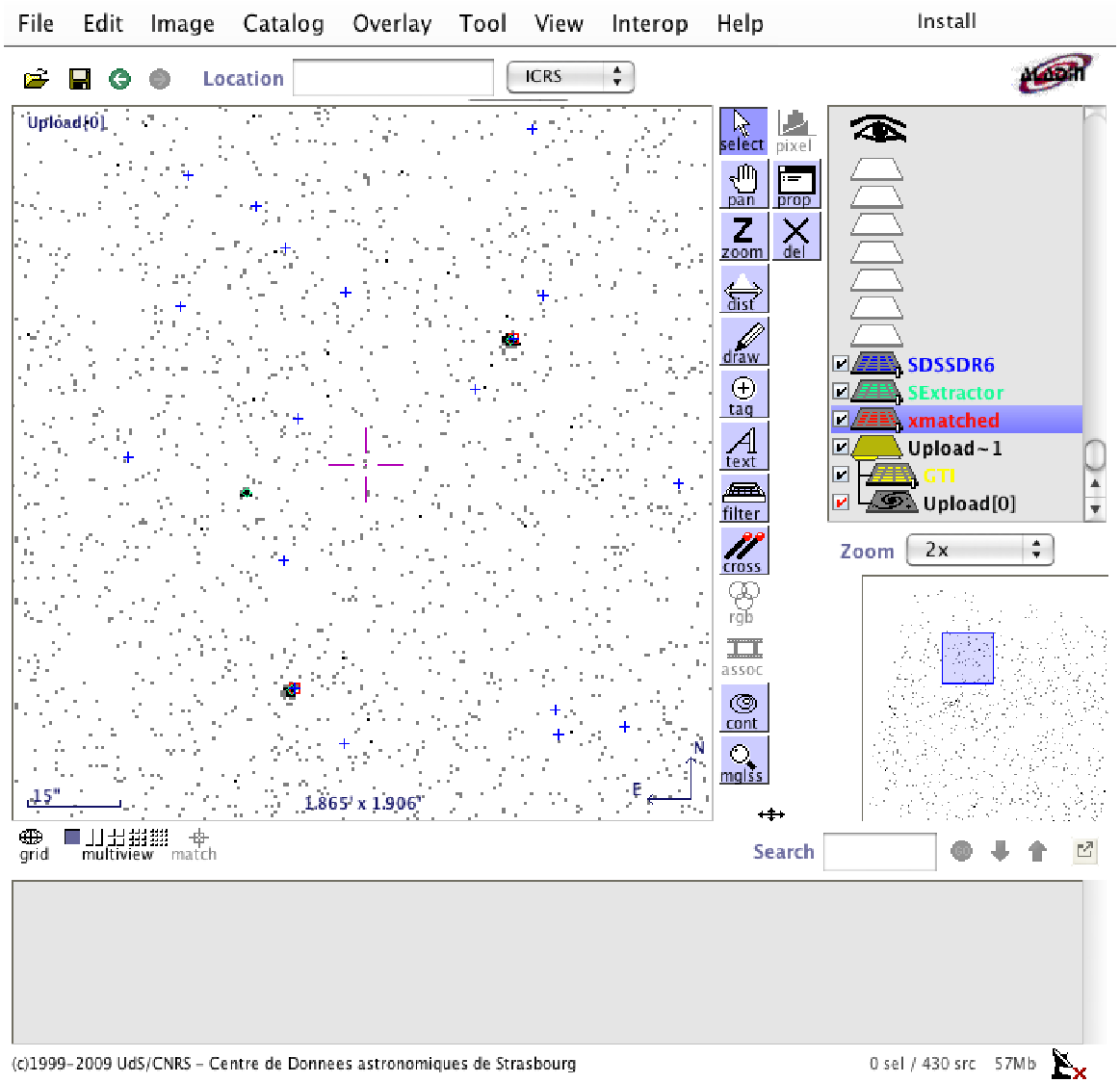
Aladin sky atlas



Aladin sky atlas

Gmail - Inbox (39... | Kaazing — Downl... | Main MyUW Page | SDSS DAS Version 2 | Aladin sky atlas | aisrp - Google Se... | WebPine - WebPine

Aladin sky atlas



Integration into the VO

- Started discussions with Chris Miller at NOAO to integrated combined WESIX/XAssist web service into their Virtual Observatory portal (http://portal-nvo.noao.edu/)
- Example use case:
  - New wide field telescope goes online, want to quickly check for X-ray counterparts

Future Plans

- Web service access to XAssist and WESIX lends itself to distributed processing of X-ray and optical data
  - Will start joint analysis of Chandra, XMM and optical data
    - Optical images archived at major observatories
    - HST overlap with Chandra and XMM
- AJAX GUI for XAssist and WESIX
- Creating portal to allow users to specify source lists and/or regions to monitor for available data
  - Current XAssist web site running Plone for content management (users, documentation and news) and Django for web applications

Summary

- WESIX and XAssist are separately being developed to be more flexible and capable
- Joint web service access to both will open up multi-wavelength virtual observatory analysis capability using “intelligent” systems
  - Distributed analysis of large datasets that are public
  - Correlations even when there are “upper-limits” (often precludes simply using catalogs)
  - Will be online by the end of this year

- Exposing individual XAssist processing steps as web services
  - Exposure at a given position (“footprint”)
  - Extracting spectra and image for a given source or position
    - Computing Bayesian confidence intervals for source significance
- Adding “quick-look” processing option
  - SExtractor for source detection
  - Streamlined (and often approximate) versions of other processing steps
- Simulation for completeness and Eddington bias correction