Progress Report

Ian Evans (CXCDS)
On behalf of the Chandra Source Catalog Project Team

Chandra Users' Committee Meeting
October 15, 2008

Executive Summary

Summary

- Significant progress has been made since the last CUC meeting!

The catalog release 1 production run started on September 15

The catalog database was made available for public access on October 8

At that time, the database included ~50,000 source detections, corresponding to ~35,000 distinct sources on the sky

Formal release 1 of the catalog is still expected to be in January 2009

Science Highlights

Science Highlights Since Last CUC Meeting

- Completed testing of "Production Prototype" (CAT 2.8), and "Production Release" (CAT 3.0) systems and approved for start of production
  - Roughly 750 ObsIds were processed through the production prototype system and evaluated by the science (and software) team
- Statistical characterization progressing
- Catalog production started!
- Public web site has been updated with detailed user documentation and now provides access to the CSCview catalog GUI
  - **http://cxc.cfa.harvard.edu/csc/**
- Documents delivered
  - "A Statistic for a Crater Detection Algorithm", J. Davis (SDS/MIT)
  - "Systematic Errors in ChaMP Positional Uncertainty Relations", F. Primini (SDS)
  - "CSC Release 1: Missing sources in crowded fields", J. McDowell (SDS) & A. Mossman (CXCDS)
  - "Position Angles and their Errors", A. Rots (CXCDS)
  - "Chandra Source Catalog Requirements version 0.9", I. Evans (CXCDS)
    - Version 1.0 will be released with the formal catalog release in January

Software Highlights

Software Highlights Since Last CUC Meeting

- CAT 2.8 (Pre-production test system) build released
  - BEHR updates, variability updates for GTIs, MHO/iss updates and extent errors added, position angle updates
  - Master QA and merge review support, catalog GUI release

CAT 2.8.1.1.2	Jul 01	L3 Thread completion
CAT 2.8.2	Jul 18	Science data review feedback
CAT 2.8.2.1	Aug 01	Pre-production test I
CAT 2.8.3	Aug 14	Pre-production test II

- CAT 3.0 (Production system) build released
  - QA updates, position angle updates held from CAT 2.8, efficiency updates
  - GUI updates

CAT 3.0	Sep 15	Chandra Source Catalog Operations Release
CAT 3.0.1	Sep 24	CSC QA update / few bug-fixes (no science changes)
CAT 3.0.2	Oct 06	CSC GUI update / few bug-fixes (no science changes)

- Software team is currently running catalog processing operations
  - Plan to transition to DSops team over next 1−2 months

Catalog Production

- Commenced on September 15, with software release CAT 3.0
  - Two minor patches since, to address operational (non-science) issues
- Production processing runs on a 16 node Sun Fire X2200 M2 Beowulf cluster, with each node having two 2.8 GHz dual-core CPUs (total of 64 processors), and a Sun UltraSPARC T1 server with 8 quad-core CPUs (total of 32)
- Observations to be processed satisfy several pre-filters
  - Initially including ACIS imaging observations only; TIMED readout mode, FAINT, VFAINT, or FAINT_BIAS exposure modes; 128 row sub-arrays excluded
  - Plan to add HRC-I observations later in the processing run
  - All observations must have been processed through Repro III or more recently in AP, and must have good V&V status
  - Observations with obviously extended emission will not be processed initially; we will add ACIS observations that include extended emission confined to a single chip (by filtering the data to remove the offending chip) later in the processing run
- Overlapping observations are processed together (clustered) for efficiency
- Currently processing about 500 observations per week

Catalog Characterization

Catalog Characterization

- Catalog statistical characterization is currently progressing
  - Priority is to characterize source position, aperture photometry, limiting sensitivity, completeness, and false source rate
  - Detailed characterization using real and simulated data will available with catalog release 1
- Simulation pipeline currently supports creation of blank sky datasets and injection of simulated sources into real event lists
  - Blank sky and simulated point sources run through the pipeline are the highest priority

Characterization Approaches

- Three major approaches towards characterization, each having different but complementary goals:
  - Comparison of CSC results with existing studies/surveys
    - Useful for assessing completeness and false source rates
    - Wide range of "messy" fields with full range of instrumental effects
    - But limited statistics, and no control studies
  - Simulations run through the CSC pipeline
    - Controlled studies where all input parameters are known
    - Realistic Log N-Log S distributions
    - Point sources with power law and blackbody spectra
    - Will be used for assessing detect rates, as well as position/extent accuracy, flux/spectra accuracy, false source variability rates (steady source inputs)

Catalog Characterization (cont.)

Characterization Approaches (cont.)

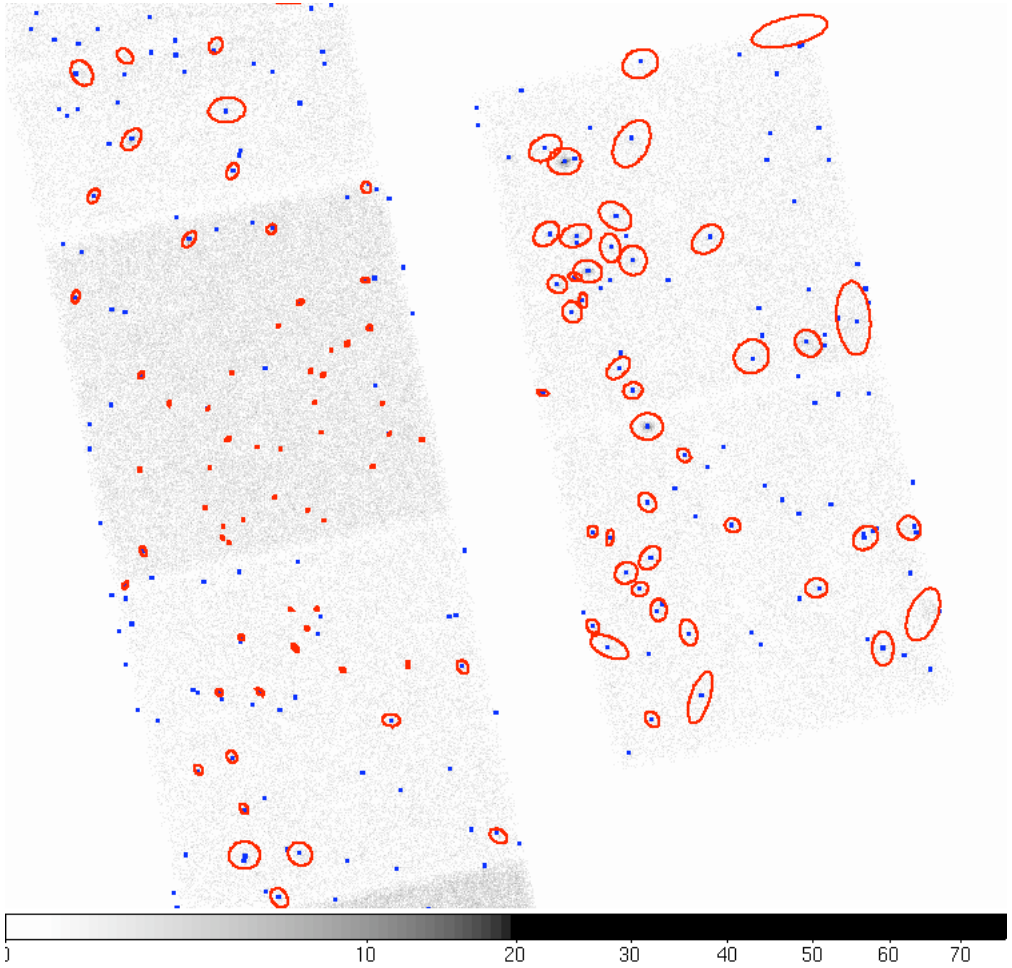
- Simulations run outside the CSC pipeline
  - The rate at which simulations can be processed through pipeline is limited, but many pipeline algorithms can be quickly run
  - Will allow us to explore a wider range of questions, and later migrate a subset to run through the pipeline
  - Complex, multi-parameter studies
    - » Extent studies: many ways sources can be extended: elliptical Gaussians, uniform disks, central dominate plus extended halo, …
    - » Variability studies: many kinds of variability: red noise, with varying root mean square variability, other power spectral shapes, discrete flares, fast rise/exponential decay, …

- Characterization will be an ongoing, evolving process

Source Simulation Pipeline

Simulated Observation

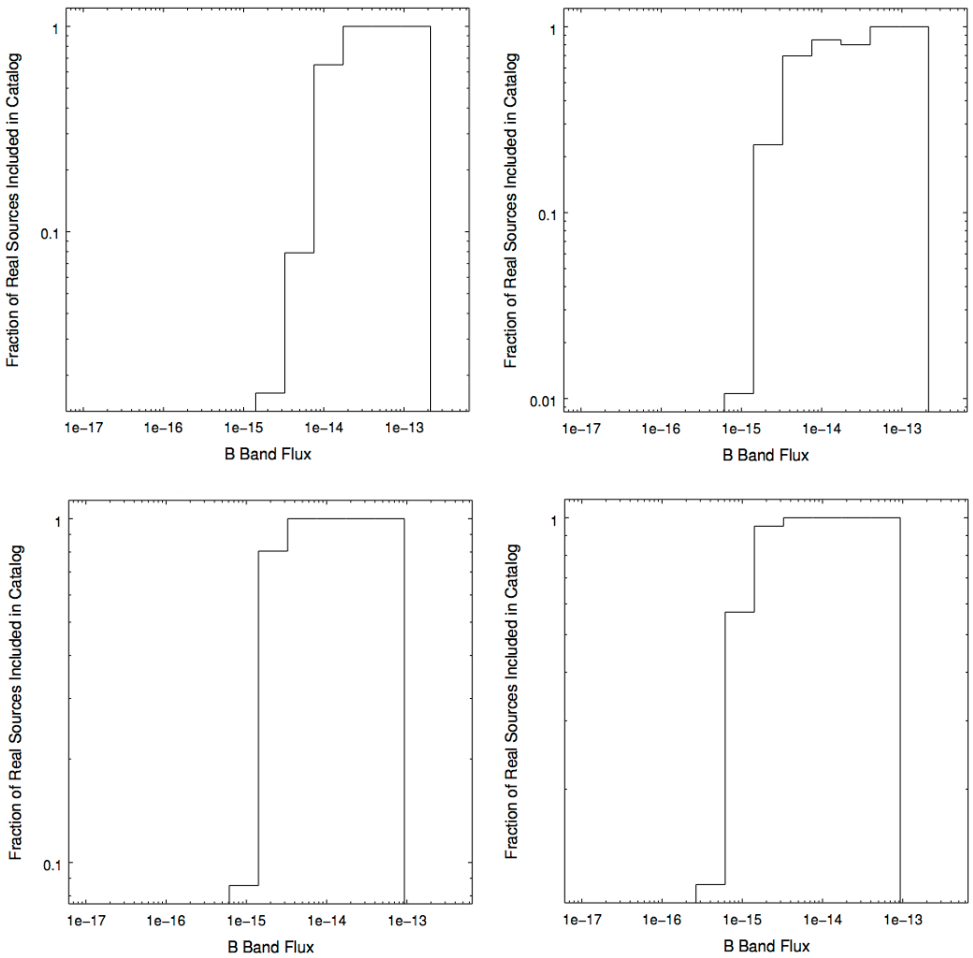
- Figure shows a simulated observation with injected sources, run through the CSC pipeline
  - Blue dots show positions of injected sources, which do go down below the expected source detection threshold
  - Red ellipses show detected sources; all near-on-axis red ellipses include blue dots, although this is not obvious close to on-axis because of the plotting
    - Note that the catalog quality assurance and catalog inclusion filters have not been applied to the detected sources in this plot



Completeness (Preliminary)

Completeness Function

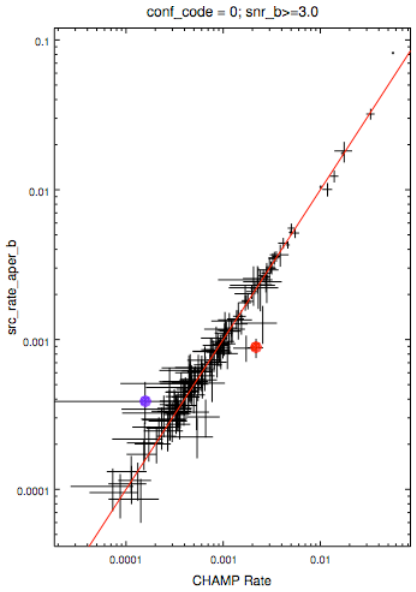
- Preliminary CSC completeness function from the ratio of the number of CSC sources detected to number of external catalog sources vs. flux
  - Top left and right: ObsIds 2386 (10 ks) and 3388 (50 ks) vs. CDF-N survey (2 Ms)
  - Bottom left and right: ObsIds 1708 (61 ks) and 927 (125 ks) vs. Spices-II survey (185 ks; Stern et al. 2002)
  - Published catalogs are assumed to be complete at the level of the individual ObsIds
  - Band fluxes are approximate, since energy bands do not match exactly
  - Histograms show differential source count fraction in each flux bin (not cumulative count fraction)

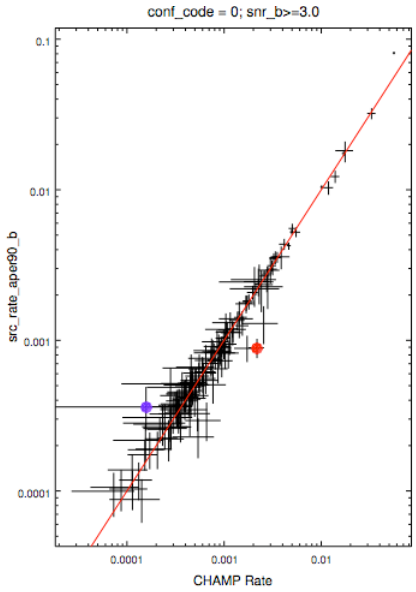


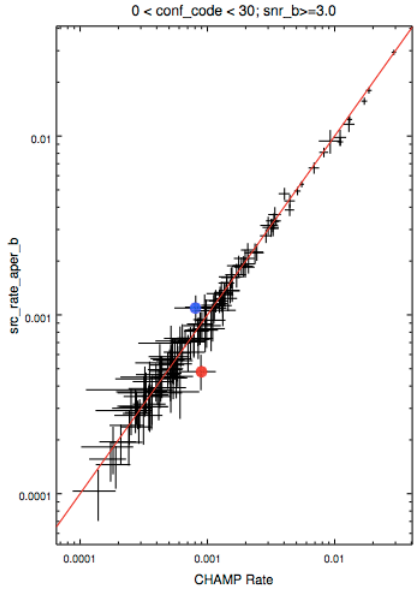
Aperture Photometry (Preliminary)

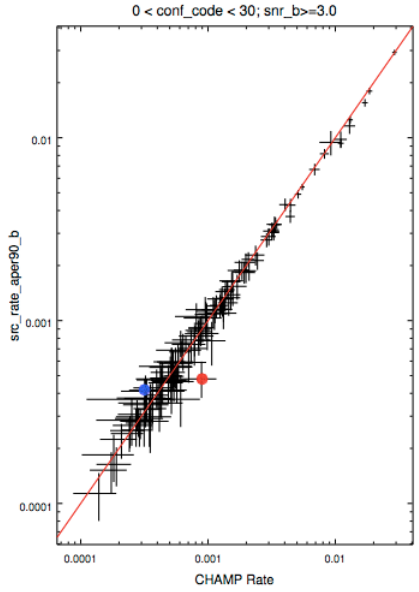
Aperture Photometry

- The two figures on the left show the CSC ACIS "b" band count rate in the source region aperture (left) and the 90% ECF aperture (right) vs. ChaMP rates for isolated sources with S/N ≥ 3.0
- The two figures on the right show the same information for mildly confused sources (background-background regions or source-background regions overlap, but source-source regions do not overlap) with S/N ≥ 3.0
- Median (standard deviation) percentage differences are 0.2% (23%) for the isolated source case and -3.1% (13%) for the mildly confused case





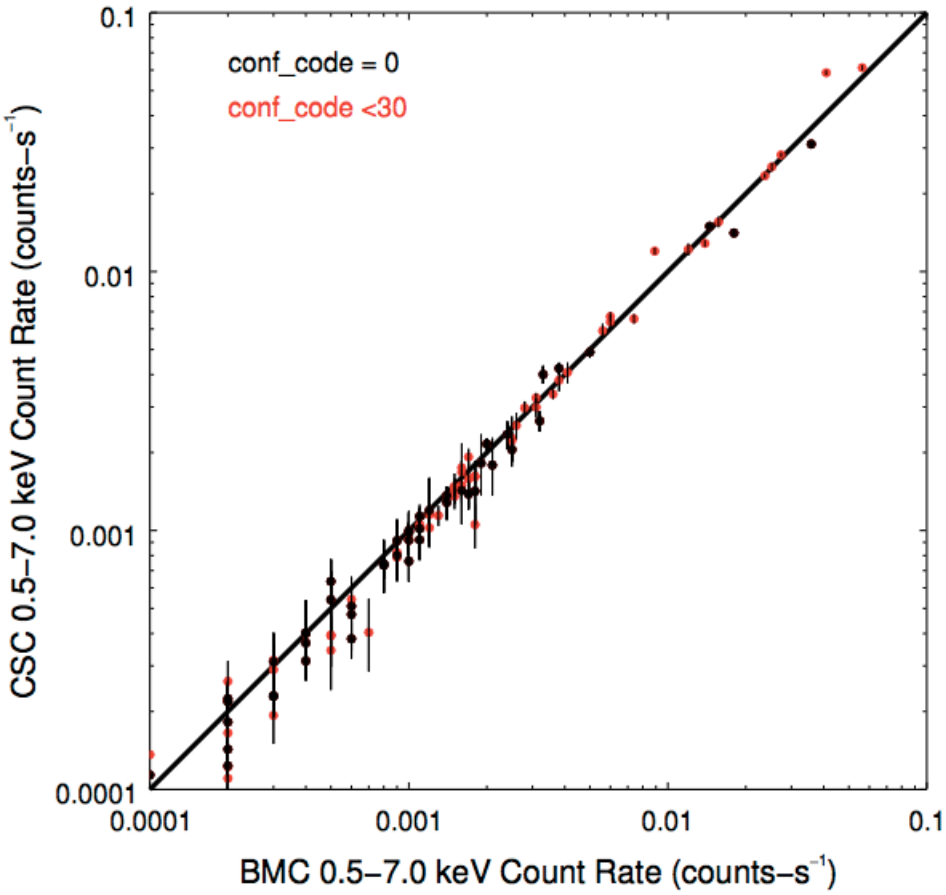




Aperture Photometry (Preliminary; cont.)

Aperture Photometry

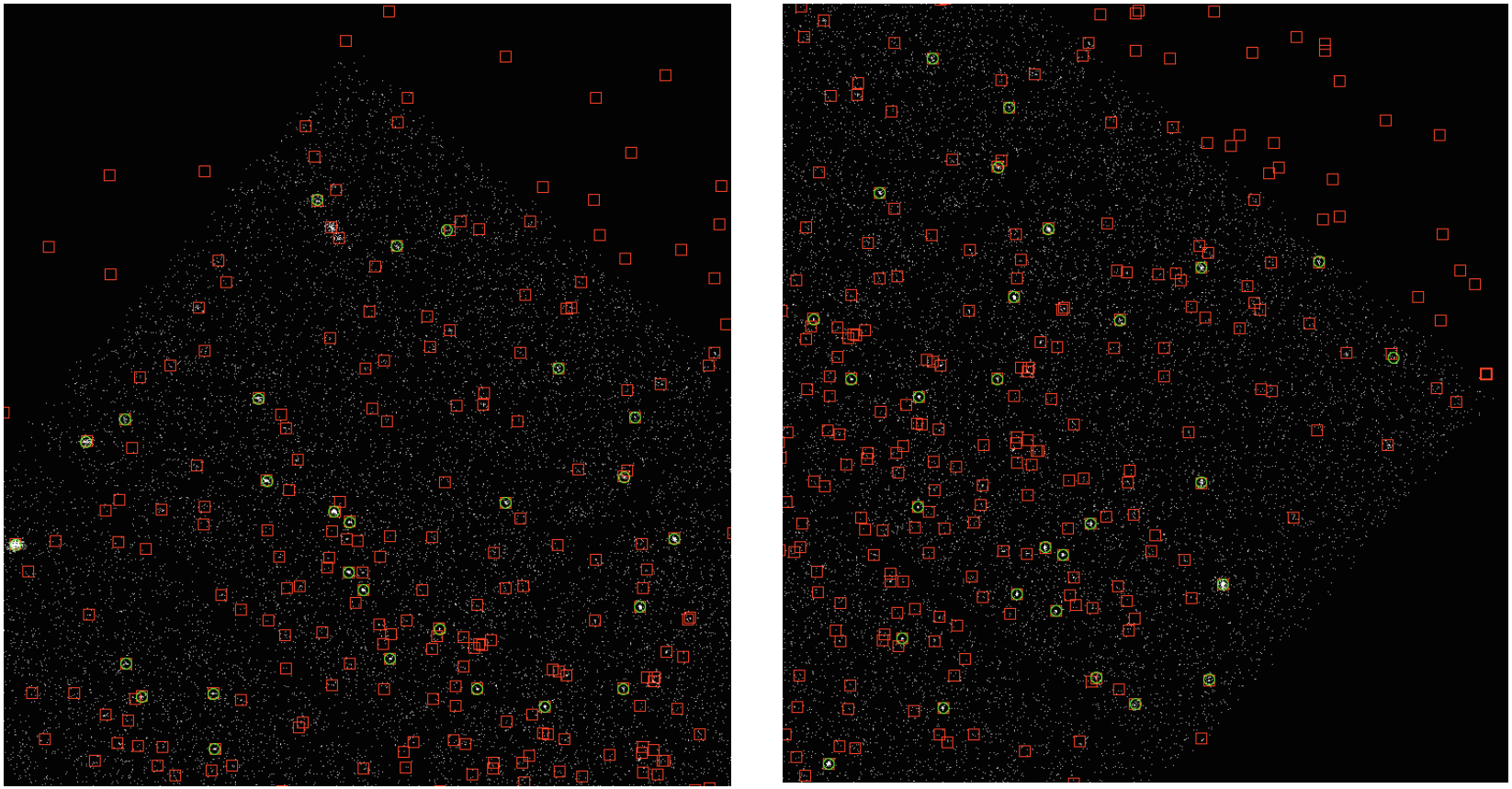
- This figure shows the CSC count rate vs. the Brera Catalog (Romano et al. 2008) for sources observed in the same ObsId (this removes the uncertainty due to variable sources)
  - `conf_code < 30` implies source regions do not overlap any other source regions
  - `conf_code = 0` implies source and background regions do not overlap any other source or background regions



False Source Rate (Preliminary)

Field False Source Rate

- Field false source rate is < 1 false source per 50 ks observation
  - False source rate in areas of enhanced background (e.g., readout streaks) will be characterized as part of detailed false source rate study



Comparison of CSC source detections (green circles) for ObsId 3388 (50 ks) with 2 Ms HDF-N composite catalog (red squares; Alexander et al. 2003) indicates that all CSC source detections are associated with deep HDF-N detections.

CHANDRA SOURCE CATALOG

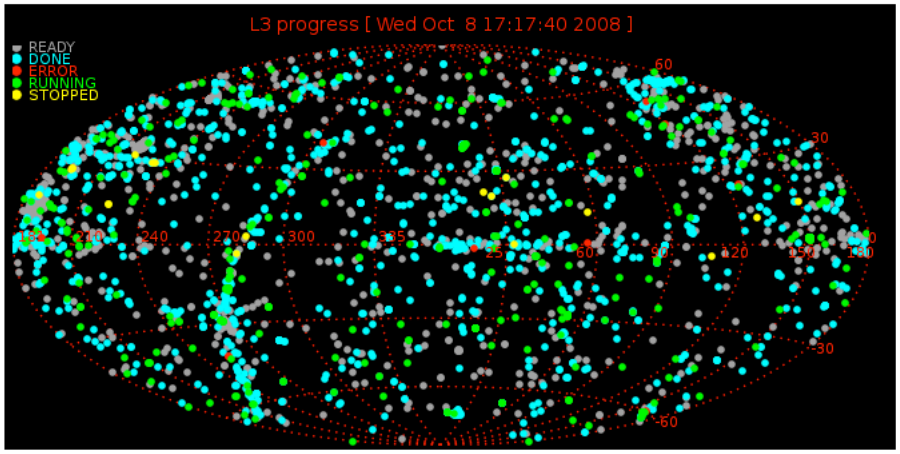
CSC Data Access

Using CSCView

CSCView Software Requirements

Catalog Processing Status

The Chandra Source Catalog



The Chandra Source Catalog (CSC) is the definitive catalog of all X-ray sources detected by the Chandra X-Ray Observatory. The CSC contains positions and multi-band count rates for the sources, as well as derived spatial, spectral and temporal calibrated source properties that may be compared with data obtained by other telescopes. The CSC also includes associated data products for each source, including images, photon event lists, light curves, and spectra.

The first release of the CSC (January 2009) will include information about sources detected in public ACIS imaging observations from roughly the first eight years of the Chandra mission. Only point sources, and compact sources with extents < ~30 arcsec, will be included. Highly extended sources, and sources located in selected fields containing bright, highly extended sources, will be excluded.

Each distinct source on the sky (i.e., object at a specific RA and Dec) is recorded in a single "master source" table entry and one or more "individual source" table entries. The individual source entries contain the properties of a single detection from a single observation. The master source entry is the best estimate of all the properties of a source, based on the data extracted from the individual source entries. The Catalog Organization page contains further details.

The Schedule and Status page has the current processing status and release schedule.

Users are urged to review the catalog Caveats and Limitations prior to using the CSC for their scientific investigations. Questions about the CSC may be submitted to the CXC Helpdesk.

Catalog User Website Contents

Website Contents

- The new CSC user website provides:
  - Links to launch the catalog GUI (CSCview), and associated documentation
  - Catalog processing status
  - A high level description of the catalog, how the catalog is organized, and the views into the catalog that are available to users
  - Catalog caveats and limitations
  - How the catalog was created, including observation selection and catalog processing
  - Descriptions of the contents of the catalog tables and the catalog data products
  - Detailed explanations for certain topics
  - Links to useful documents
- The documentation on the website is aimed at catalog end users, including those users that may be visiting from other wavebands and may be unfamiliar with X-ray astronomy and Chandra
- The website will be constantly revised and updated as processing continues and additional capabilities become available
  - For example, as statistical characterization proceeds, the results will be posted

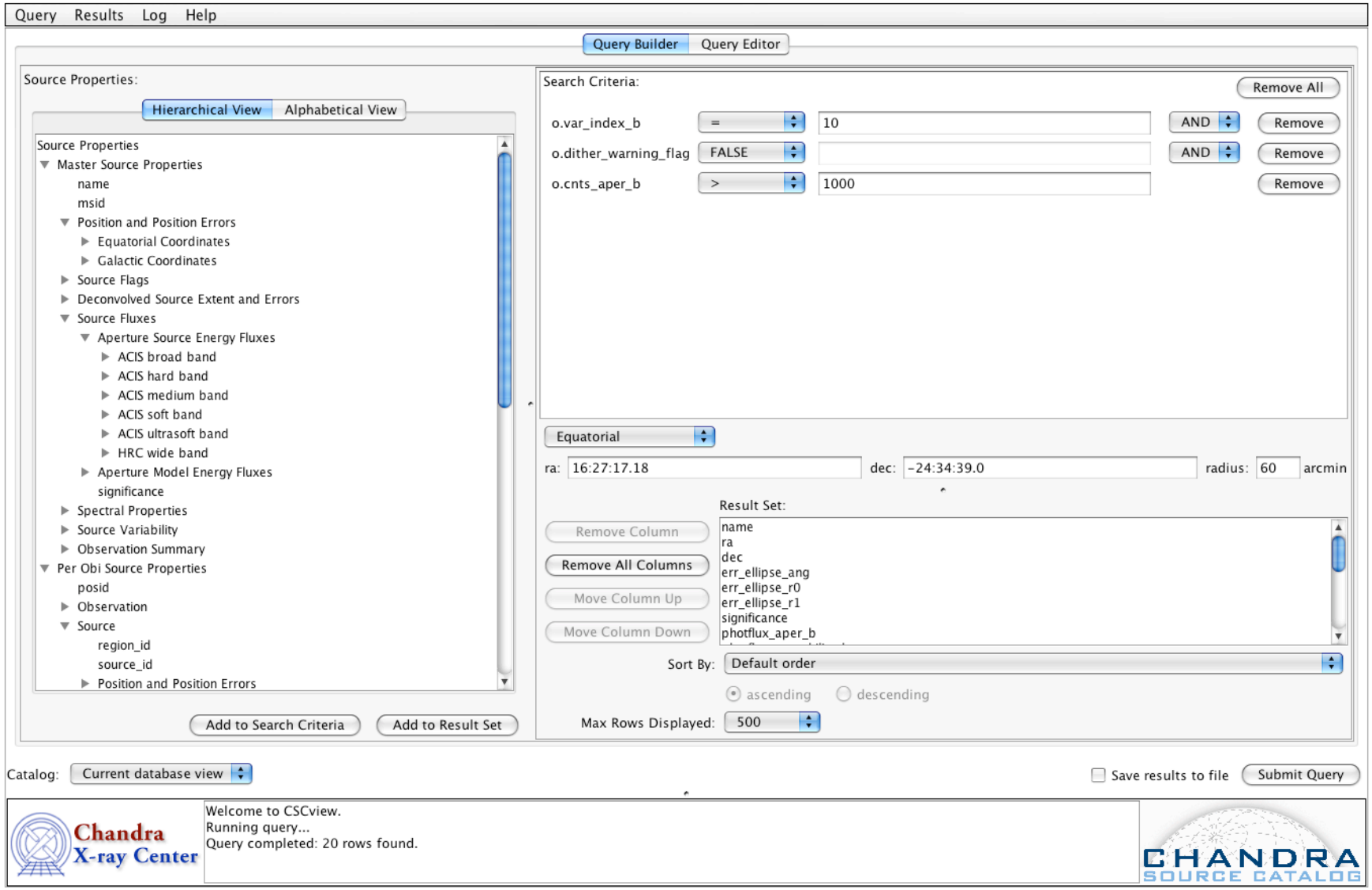
Catalog Web Interface (CSCview)

CSCview

- The primary user interface to the catalog is available on the web via the new catalog user website
  - The interface runs in the user's web browser, and is written in Java (requires Java version 1.5 [aka J2SE 5.0] or later)
- CSCview allows the user to construct queries of any source properties, and return a table with selected source properties for matching sources
  - Users can also perform a cone search around specified coordinates, with or without additional query constraints
  - Users can view the results of the query on the screen or save the results to a file
  - Users can also download observation- or source-specific data products for selected sources matching their query
- The current version of CSCview should be considered to be a beta release
  - Some important functionality is still missing
    - Pre-canned "simple" queries, "simple" data subset display, "property" or "band" priority source property hierarchies, display of JPEG images, …
      - » Definition of some of these capabilities will be based on studies of usage patterns
    - Support for ADQL and VO standards
  - The layout of the user interface will change to accommodate the missing functionality
  - Many of these updates are expected to be in-place for the formal catalog release 1 in January 2009

Catalog Web Interface (CSCview) Query Form

CXC



Catalog Web Interface (CSCview) Results Form

CXC

Query Results Log Help

Back to Query

20 rows loaded at 2008-10-08T18:23:46

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name	ra	dec	err_ellipse_ang	err_ellipse_r0	err_ellipse_r1	significance	photflux_aper_b	photflux_aper_hilim_b	photflux_aper_lolim_b	photflux_aper90_b	photflux
CXO J162538.1-242235	16 25 38.13	-24 22 35.57	180.0	0.66	0.66	36.16	7.373e-05	7.570e-05	7.178e-05	7.230e-05	
CXO J162602.2-242348	16 26 02.22	-24 23 48.10	0.0	1.70	1.70	10.58	8.639e-06	9.453e-06	7.832e-06	9.611e-06	
CXO J162603.1-242336	16 26 03.10	-24 23 36.68	0.0	1.02	1.02	280.20	3.202e-03	3.213e-03	3.191e-03	3.066e-03	
CXO J162603.1-242336	16 26 03.10	-24 23 36.68	0.0	1.02	1.02	280.20	3.202e-03	3.213e-03	3.191e-03	3.066e-03	
CXO J162604.3-242252	16 26 04.36	-24 22 52.41	0.0	2.44	2.44	3.19	1.096e-06	1.438e-06	7.566e-07	9.867e-07	
CXO J162616.8-242223	16 26 16.85	-24 22 23.20	0.0	0.19	0.19	46.53	8.871e-05	9.033e-05	8.706e-05	9.102e-05	
CXO J162622.3-242253	16 26 22.39	-24 22 53.07	0.0	0.14	0.14	78.53	2.269e-04	2.293e-04	2.245e-04	2.265e-04	
CXO J162624.0-242448	16 26 24.05	-24 24 48.19	90.0	0.14	0.14	50.41	1.035e-04	1.055e-04	1.016e-04	1.021e-04	
CXO J162704.5-242715	16 27 04.56	-24 27 15.47	90.0	0.37	0.37	69.26	1.026e-04	1.040e-04	1.011e-04	9.739e-05	
CXO J162709.4-243719	16 27 09.43	-24 37 19.03	0.0	0.19	0.19	33.22	4.009e-05	4.129e-05	3.889e-05	3.915e-05	
CXO J162715.4-242640	16 27 15.46	-24 26 40.10	0.0	0.49	0.49	34.96	5.007e-05	5.149e-05	4.867e-05	4.923e-05	
CXO J162715.8-243843	16 27 15.88	-24 38 43.58	90.0	0.23	0.23	32.82	8.248e-05	8.496e-05	7.997e-05	7.982e-05	
CXO J162718.1-242852	16 27 18.15	-24 28 52.99	0.0	0.28	0.28	40.08	6.566e-05	6.730e-05	6.404e-05	5.709e-05	
CXO J162719.5-244140	16 27 19.51	-24 41 40.51	90.0	0.29	0.29	92.46	3.194e-04	3.228e-04	3.160e-04	3.241e-04	
CXO J162726.9-244050	16 27 26.93	-24 40 50.86	0.0	0.33	0.33	52.22	1.106e-04	1.127e-04	1.085e-04	1.088e-04	
CXO J162727.0-243217	16 27 27.07	-24 32 17.92	90.0	0.17	0.17	33.44	4.096e-05	4.218e-05	3.975e-05	3.902e-05	
CXO J162728.0-243933	16 27 28.02	-24 39 33.54	0.0	0.17	0.17	139.27	7.743e-04	7.798e-04	7.688e-04	7.358e-04	
CXO J162733.1-244115	16 27 33.12	-24 41 15.31	0.0	0.40	0.40	52.63	1.162e-04	1.184e-04	1.140e-04	1.173e-04	
CXO J162739.4-243915	16 27 39.43	-24 39 15.63	0.0	0.28	0.28	82.46	2.516e-04	2.546e-04	2.486e-04	2.469e-04	
CXO J162752.0-244049	16 27 52.04	-24 40 49.81	180.0	0.51	0.51	61.26	3.041e-04	3.085e-04	2.998e-04	3.006e-04	

Data Products

Filetypes:

regevt3	sensity	asphist
evt3	bkgimg	badpix3
regimg	psf	fov3
ecorrimg	expmap	ecorrimg_jpg
spectrum	regexpmap	psf_jpg
srcreg	arf	regimg_jpg
lightcurve	rmf	reg3img_jpg

Browse Products

Download Products

Download Batch File

Chandra X-ray Center

Welcome to CSCview.
Running query...
Query completed: 20 rows found.

CHANDRA SOURCE CATALOG

Other Catalog Interfaces

Current Catalog Interfaces

- A cURL interface is provided for users who want to query the catalog using a command-line interface, possibly from a script
  - Example:
```
curl --form query='SELECT TOP 50 m.name,
m.significance, FROM cscat WHERE (m.significance > 10.0 AND
m.pileup_flag = FALSE)'
'http://cda.cfa.harvard.edu/cscview /getProperties'
```

Planned Catalog Interfaces

- We are coordinating with the `ds9` development team to include a simplified view of the CSC through the `ds9` "catalog" interface
  - Expected to appear in the January 2009 `ds9` release
- We are planning to support a Python scripting interface to the catalog, similar to the cURL interface
  - A "vanilla" version of the Python interface would be made available for users who do not want to use CIAO (e.g., PyRAF users from other wavebands)
  - A version of the interface that makes use of CRATES will be provided for CIAO users

Future Directions

Short Term Plans

- CSCview GUI
  - Predefined common queries and results display
  - Addition of name resolver support (e.g., for cone searches)
  - Support for cross-matching with user supplied catalogs
  - Additional output file formats for query results
- CIAO tools
  - A number of the catalog-related tools will be made available to users over the next ~year
    - Examples include: aprates, BEHR, dmellipse, eff2evt, glvary, lim_sens, MHO/iss
    - Details discussed in SDS CIAO presentation
- Web Services
  - Catalog limiting sensitivity service, VO standard cone search and footprint services

Longer Term Plans

- Release 2
  - Combining observations that were split due to thermal constraints, prior to source detection; the exact limitations on what can be combined are not clear, but likely include "similar" instrument configurations and pointings
  - Improved background modeling, particularly in areas of extended emission
- Release 3+
  - Support for extended sources
  - "Simultaneous" multi-observation detection