Status of the Chandra Source Catalog Project

The *Chandra Source Catalog* project has recently moved from a development phase into an operational testing phase. With few exceptions, the science, software, and infrastructure tasks needed to commence production of the first release of the catalog are either completed or nearly complete. The remaining tasks will be completed during the next few months leading up to an anticipated start of production in late Spring.

Over the past year, development has continued at a rapid pace. We have completed design, development, and testing of several key algorithms. These include a new background algorithm that combines a low-spatial frequency Poisson mean with a high spatial-frequency streak map in order to suppress false source detections on ACIS readout streaks associated with bright sources. Aperture photometry of detected sources is performed using Bayesian estimators that have been developed to derive source fluxes and their associated confidence limits in several energy bands. Limiting sensitivity information is derived for each location in the field-of-view, using source and background apertures appropriate for that location, and local background estimates derived from the above-mentioned background maps. Several temporal analysis tools statistically evaluate source variability, both within a single observation and between multiple observations of the same source. Currently, source extent estimators are being implemented, and the algorithms that perform source matching between multiple observations that include the same region of the sky are being refined.

The progress that has been made with the catalog science pipelines has been mirrored in other areas needed to support catalog production and data management. Development of the catalog databases and interfaces, and enhancements to the *Chandra* data archive to support the new file-based data products, is largely complete, as are the extensions to the processing system infrastructure to support the distributed, Beowulf cluster-based processing architecture for catalog production.

We recently completed an end-to-end test on our second "Operational Testbed" catalog software release. The test was designed to provide an integrated dataset to evaluate the science pipelines and verify processing and archive performance projections. Five hundred ACIS observations completed processing in just under two weeks on our test hardware, generating roughly 22,000 sources that met the minimum flux significance criterion discussed below and also satisfied all quality assurance criteria. The production hardware should be at least a factor of two faster.

Catalog Contents

The catalog will include detected sources whose flux estimates are at least 3 times their estimated 1 σ uncertainties, typically corresponding to about 10 net source counts on-axis and roughly 20–30 net source counts off-axis. In the first release, multiple observations of the same field will be linked together with a single source name but will not be combined prior to source detection. Therefore the flux cutoff applies to each observation separately.

For each detected source and observation, we anticipate that the catalog will include the following tabulated properties (for all sources except where otherwise noted):

- Source position and errors,
- Aperture photometry fluxes and confidence intervals in several energy bands,
- Spectral hardness ratios,
- Power-law and thermal black-body spectral fits for bright (> 250 counts) sources,
- Source variability measures (Gregory-Loredo, K-S, and Kuiper tests),
- Estimate of the source extent compared to the local point spread function.

In addition, a number of file-based data products will be produced for each source individually in formats suitable for further analysis in CIAO. These include:

- Source region, background, and local point spread function images,
- Source region photon event list,
- Limiting sensitivity map,
- Auxiliary Response File (ARF),
- Source and background light-curves,
- Pulse invariant (PI) spectrum and Redistribution Matrix File (RMF) [for ACIS observations].

For a detailed description of the planned catalog contents, users are presently referred to the *Chandra Source Catalog* Requirements document, which is available on the catalog website.

Catalog Access and Organization

User access to the catalog will be through a web-based browser interface in the first instance. Catalog users will be able to query the tabulated source properties, and retrieve associated file-based data products for further analysis.

The first stable release of the catalog will be accompanied by a detailed statistical characterization, and is expected to be completed in the fall of this year. However, users will be able to access the "catalog database," including observations and sources processed to-date, starting roughly one month after the start of catalog production. The catalog database will be updated continually as observations are released publicly, and sources are processed. Unlike the official catalog release, the statistical properties of the catalog database are not guaranteed.

Each identified distinct X-ray source on the sky will be represented in the catalog by a single "master" catalog entry and one or more "source-by-observation" entries (one for each observation in which the source was detected). The master catalog entry records the best-estimates of the tabulated properties for a source, based on the data extracted from the set of observations in which the source was detected. The source-by-observation entries record all of the tabulated properties about a detection extracted from a single observation, as well as the file-based data products, which are observation-specific.

All of the tabulated properties included in both the master catalog and the source-by-observation

catalog entries will be searchable via the user interface. Links within the database maintain the connections between the master catalog entries and associated source-by-observation entries, so that users can access all observations of a single source seamlessly.

Information about the *Chandra Source Catalog* project, including the catalog requirements and associated documents, is now available on the CXC web site at the following URL: **http://cxc.cfa.harvard.edu/csc** . The catalog web site will be updated regularly as we approach catalog production and release.

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