

Chandra Source Catalog

Quality Assurance Specifications

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I. General

1. Quality Assurance Mechanisms

- *Chandra Source Catalog* quality assurance is achieved by two mechanisms that have different goals.
 - *Pipeline quality assurance* compares a subset of the output products (e.g., scalar data values, file-based data products, and processing log files) from *every* Level 3 processing pipeline against a predefined set of standards. Predefined actions are taken based on the results of the comparison.
 - *Snapshot quality assurance* creates complete sets of products for human review from a small subset of the Level 3 processing pipelines. No predefined actions follow on from snapshot quality assurance. Random human review supports statistical monitoring of Level 3 processing and considers the possibility that unexpected conditions may exist that are not evaluated by pipeline quality assurance.

1.1. Pipeline Quality Assurance

- Every Level 3 processing pipeline is subject to pipeline quality assurance, irrespective of whether or not snapshot quality assurance is performed for that pipeline.
- Predefined standards that are violated by the pipeline output products will be flagged in the quality assurance longwords (QAxxx). The predefined subsequent actions are either *automated* or *human-review*.
 - Automated actions typically result in termination of the processing thread for a subset of the input data. For example, if a detected source region exceeds a maximum size constraint, then further processing of that source region will be terminated at this point.
 - Human-review actions typically result when human review is necessary to assess whether standards are violated, and whether the processing thread should be terminated or not. For example, if too many source regions are detected within a small spatial area, human review is required to determine whether all of the source regions are real. The results of the review may be that some source regions are not real and should have their processing threads terminated.
 - All human reviews are performed via the Level 3 quality assurance GUI.

1.2. Snapshot Quality Assurance

- Snapshot quality assurance is performed on a *random* subset of Level 3 processing

pipelines, as determined by a snapshot probability parameter that may be different for each type of pipeline (calibrate, detect, source, master). A probability of 1.0 means that snapshot quality assurance processing is always performed, and a probability of 0.0 means that snapshot quality assurance processing is never performed.

- Typical snapshot probabilities for the mature Level 3 processing system are expected to be of order 0.01 for processing pipelines that run per-ObI, and of order 0.001 for processing pipelines that run per-source or per-source region.
- No automated actions result from snapshot quality assurance. The outcome of snapshot quality assurance has no impact on any current processing threads, and the results of snapshot quality assurance are not required for any processing thread to continue. Snapshot quality assurance results in procedural and operational feedback to Level 3 processing.
- Snapshot quality assurance and pipeline quality assurance are independent. Snapshot quality assurance may be performed for a pipeline irrespective of whether pipeline quality assurance was performed for that pipeline or not, and irrespective of whether that pipeline passed pipeline quality assurance.
 - Products for snapshot quality assurance may be produced concurrently with or after products are produced for pipeline quality assurance. Any products that are needed for both pipeline quality assurance and snapshot quality assurance can be produced once only.
 - The time phasing of pipeline and snapshot quality assurance is established by the requirement that the values of the `Qaxxx` longword output by the automated part of pipeline quality assurance (*i.e.*, prior to any manipulation by the Level 3 quality assurance GUI) is used by snapshot quality assurance.

II. Pipeline Quality Assurance

1. Calibrate Pipeline

1.1. Pipeline Log Processing

- Process the calibrate pipeline logs through pipeline log processing (see Section IV); flag pipeline error conditions in the `QAOBI` longword.

1.2. Input Data Validation

1.2.1. V&V Final State Validation

Note

This comparison should be performed as part of the `ObsId` submission process if possible, rather than as part of the quality assurance process.

- Identify the latest V&V version that corresponds to the version of the Level 1 data products that were input to the calibrate pipeline. Extract the final V&V state and V&V comments for that version from the V&V database.

- If the final V&V state is not “OK”, then proceed as follows:
 - Set the “VV State Not OK” bit in the QAOBI longword.
 - Highlight the extracted final V&V state and V&V comments on the Level 3 quality assurance GUI review pages for the pipeline.
 - The GUI shall provide the capability to clear the “VV State Not OK” bit in the QAOBI longword at the user's discretion after the extracted final V&V state and V&V comments have been reviewed.

1.2.2. ONTIME Validation

- Extract the ONTIMEN values for the current ObI from the flt1 data product that was input to the calibrate pipeline.
- Determine the difference between each of the ONTIMEN values extracted in the previous step and the ONTIMEN values extracted from the data re-calibrated by the calibrate pipeline.
- If any of the differences exceed \pm TBD percent or \pm TBD seconds, whichever is greater, then proceed as follows:
 - Set the “ONTIME Difference” bit in the QAOBI longword.
 - Create and link MTL plots for the current processing to the Level 3 quality assurance GUI review pages for the pipeline, and highlight the current and previous ONTIMEN values in a table on the review page.
 - The GUI shall provide the capability to clear the “ONTIME Difference” bit in the QAOBI longword at the user's discretion after the ONTIMEN values table has been reviewed.

2. Detect Pipeline

2.1. Pipeline Log Processing

- Process the detect pipeline logs through pipeline log processing (see Section IV); flag pipeline error conditions in the QAREG longword for all detected source regions.

2.2. Detected Sources Review

2.2.1. Source Detection Limit

- If the total number of detected source regions exceeds TBD, then proceed as follows:
 - Set the “Too Many Source Regions Detected” bit in the QAREG longword for every detected source region.
 - Link the broadband full field image with the detected source regions overlaid to the Level 3 quality assurance GUI review pages for the pipeline, as specified in section 2.2.3 (Detected Sources Display), and highlight the number of detected source regions on the review page.

- Note that if both of the the source detection limit and the source region crowding criteria are violated, then only a single image display that incorporates the information from both violations should be linked to the Level 3 quality assurance GUI.

2.2.2. Source Region Crowding

- For each detected source region, determine the number of nearby detected source regions that have positions closer than **TBD** arcseconds.
 - The **TBD** nearby source region separation criterion is a function of instrument (ACIS, HRC-I, HRC-S) and off-axis angle.
- If the number of nearby source regions exceeds **TBD**, then proceed as follows:
 - Set the “Source Region Too Crowded” bit in the QAREG longword for the source region.
 - The **TBD** maximum number of nearby source regions criterion is a function of instrument (ACIS, HRC-I, HRC-S) and off-axis angle.
 - The following steps are performed after all of the crowded source regions in the current ObI are identified, and apply to the ensemble of crowded source regions.
 - Link the broadband full field image with the detected source regions overlayed to the Level 3 quality assurance GUI review pages for the pipeline, as specified in section 2.2.3 (Detected Sources Display).
 - Note that if both of the the source detection limit and the source region crowding criteria are violated, then only a single image display that incorporates the information from both violations should be linked to the Level 3 quality assurance GUI.

2.2.3. Detected Sources Display

- A single broadband full field image with the detected sources overlayed shall be displayed in the Level 3 quality assurance GUI if any source regions have either the “Too Many Source Regions Detected” bit or the “Source Region Too Crowded” bit set in the QAREG longword.
 - A logarithmic scaling between the image minimum and maximum values shall be used to display the broadband full field image (**TBR**).
- The source regions are displayed in either the (static) broadband full field image display or the Interactive Live Display (Detect Pipeline) (see section 2.1.2 of part V) with different colors depending on the values of the status bits in the QAREG longword for the source region. The colors are determined by evaluating the following steps in order (*i.e.*, colors determined in subsequent steps override colors determined in prior steps).
 - If all of the bits in the QAREG longword are clear then displayed the source region in blue (**TBR**).
 - If the “Too Many Source Regions Detected” bit in the QAREG longword is set then display the source region in yellow (**TBR**).

- If the “Source Region Too Crowded” bit in the QAREG longword is set then display the source region in magenta (TBR).
- If the “Source Region Accepted Manually” bit in the QAREG longword is set then display the source region in green (TBR).
- If the “Source Region Rejected Manually” bit in the QAREG longword is set then display the source region in red (TBR).
- If any other bit set in the QAREG longword is set then display the source region in cyan (TBR).
- The GUI shall provide the capability to “Accept all source regions” or “Reject all source regions” at the user’s discretion after the full field image with the detected source regions overlaid has been reviewed.
 - “Accept all source regions” clears the “Source Region Too Crowded”, “Too Many Source Regions Detected”, and “Source Region Rejected Manually” bits in the QAREG longword for any source region that has any of these bits set. The “Source Region Accepted Manually” bit in the QAREG longword is set for any source regions that change as a result.
 - “Accept all source regions” does *not* clear any other bits in the QAREG longword.
 - “Reject all source regions” sets the “Source Region Rejected Manually” bit in the QAREG longword for every source region.
 - Clicking on the image display should access the Interactive Live Display (Detect Pipeline) which provides additional capabilities to the GUI reviewer to accept/reject individual source regions (see section 2.1.2 of part V).

2.3. Source Region Properties

Note

In this and subsequent sections, all numeric tests should be written so that single and double precision invalid values (*NaN*) will result in the test being *violated*. Single and double precision infinity values (*Inf*) should be treated as arbitrarily large numbers when performing the test.

- For each detected source region, determine the minimum source region ellipse radius in arcseconds, the maximum source region ellipse radius in arcseconds, and the source region ellipticity.
 - If the minimum source region ellipse radius is $< \text{TBD}$ arcseconds, then set the “Source Region Too Small” bit in the QAREG longword for that source region.
 - The **TBD** minimum source region ellipse radius criterion is a function of instrument (ACIS, HRC-I, HRC-S) and off-axis angle.
 - If the maximum source region ellipse radius is $> \text{TBD}$ arcseconds, then set the “Source Region Too Large” bit in the QAREG longword for that source

region.

- The **TBD** maximum source region ellipse radius criterion is a function of off-axis angle.
- If the source region ellipticity is $> \text{TBD}$, then set the “Source Region Too Elliptical” bit in the QAREG longword for that source region.
- If the source region detection significance output by `wavdetect` is $< \text{TBD}$, then set the “Detection Significance Too Low” bit in the QAREG longword for that source region.
- If the total number of events included in the source region of interest (*i.e.*, the source region ellipse with other overlapping source region ellipses excluded) is $< \text{TBD}$, then set the “Source ROI Counts Too Low” bit in the QAREG longword for that source region.
- If the area of the source region of interest (*i.e.*, the source region ellipse with other overlapping source region ellipses excluded) is $< \text{TBD}$, then set the “Source ROI Too Small” bit in the QAREG longword for that source region.
 - The **TBD** minimum source region of interest area criterion is a function of instrument (ACIS, HRC-I, HRC-S).
 - The implementation may choose to define the area in pixel units or square arcseconds.

2.4. Low Spatial Frequency Background Rate

- Compute the mean low spatial frequency background rate (per second) per square arcsecond over the detector from the low spatial frequency background map.
 - For ACIS, the background should be computed in the broad energy band only (**TBR**; may instead prefer the hard energy band) separately for each CCD detector.
 - For HRC, background should be computed in the broad energy band.
 - The implementation may choose to compute an approximation for the background rate for each detector by averaging over no less than 80% of the area of the detector. The implementation may approximate the low spatial frequency background for ACIS by masking, sigma-clipping, or applying an alternate algorithm to the total background to eliminate bright readout streaks.
- If the computed rate for any detector is $> \text{TBD}$, then set the “High Background” bit in the CIREG longword for every detected source region.
 - The **TBD** maximum low frequency background rate depends on the instrument, and for ACIS on whether the detector is a back-illuminated or front-illuminated CCD.

3. Source Pipeline

3.1. Pipeline Log Processing

- Process the source pipeline logs through pipeline log processing (see Section IV); flag pipeline error conditions in the QASRC longword.

3.2. Source Extent to PSF Size Ratios

- Compare the source extent major and minor axes with the PSF extent major and minor axes. Compute the ratios

$$\begin{aligned} \text{psf_ratio_mjr} &= \text{mjr_axis_raw} / \text{psf_mjr_axis_raw} \\ \text{and} \\ \text{psf_ratio_mnr} &= \text{mnr_axis_raw} / \text{psf_mnr_axis_raw}. \end{aligned}$$

- If either $\text{psf_ratio_mjr} < \text{TBD}$ lower limit or $\text{psf_ratio_mnr} < \text{TBD}$ lower limit (same **TBD** limit for both ratios), then set the “PSF Ratio Too Small” bit in the QASRC longword.
- If either $\text{psf_ratio_mjr} > \text{TBD}$ upper limit or $\text{psf_ratio_mnr} > \text{TBD}$ upper limit (same **TBD** limit for both ratios), then set the “PSF Ratio Too Large” bit in the QASRC longword.

3.3. Source Position

- Verify that the derived source position (ra, dec) falls within the elliptical source region defined by the parameters (ra_aper, dec_aper, mjr_axis_aper, mnr_axis_aper, and pos_angle_aper).
- If not, then set the “Bad Source Position” bit in the QASRC longword.

3.4. Source Counts

- Verify that the (background-subtracted) aperture source counts (src_cnts_aper) $> \text{TBD}$ in at least one science energy band.
- If not, then set the “Low Source Counts” bit in the QASRC longword.

3.5. PSF Fraction

- Verify that the PSF aperture fraction (psf_frac_aper) $> \text{TBD}$ in at least one science energy band.
- If not, then set the “Low PSF Fraction” bit in the QASRC longword.

3.6. Flux Significance

- If the flux significance $\text{flux_significance} < 3.0$ (**TBR**) in all science energy bands, then set the “Low Significance” bit in the CISRC longword.
 - The flux significance criterion is a function of instrument (ACIS, HRC-I, HRC-S) and off-axis angle.

3.7. Off-Axis Angle

- If the off-axis angle $\theta > \text{TBD}$, then set the “Off-Axis Angle Too Large” bit in the CISRC longword.
 - The **TBD** maximum off-axis angle criterion is a function of instrument (ACIS, HRC-I, HRC-S).

4. Master Pipeline

4.1. Pipeline Log Processing

- Process the master pipeline logs through pipeline log processing (see Section IV); flag pipeline error conditions in the QAMSRC longword.

4.2. Database Consistency Check

- If the expected state of the catalog database (i.e., the set of links between the current master source object and the set of source-by-observation objects) computed by the master pipeline does not match the actual state provided to the master pipeline by the database, then set the “Database Consistency” bit in the QAMSRC longword.
 - The execution of this check must be controllable via a run-time parameter, so that it can be selectively disabled. Control is not required on a pipeline-by-pipeline basis.

4.3. Source Significance

- If the source significance $\text{significance} < 3.0$ (TBR) in all science energy bands, then set the “Low Significance” bit in the CIMSRC longword.
 - The flux significance criterion is a function of instrument (ACIS, HRC-I, HRC-S) and off-axis angle.

III. Snapshot Quality Assurance

1. Calibrate Pipeline

1.1. Pipeline Log Processing

- Process the calibrate pipeline logs through pipeline log processing (see Section IV), with the exception that error condition flagging should not be performed, even if there are unexpected warnings and/or errors (the unexpected warnings/errors will be caught by pipeline quality assurance processing for the pipeline).

1.2. Snapshot Quality Assurance Data Products

- Construct the following review products for snapshot quality assurance and link them to the snapshot GUI QA review pages for the pipeline:
 - Table with the following data values:
obsid, obi, revision, instrument,
grating, datamode, readmode (ACIS only), cycle (ACIS only),
ra_nom, dec_nom, roll_nom, gti_start, gti_stop, ascdsver,
caldbver, crdate
 - These data values are derived from the Level 3 full field event file (evt3).

Bits that are set in the QAOBI and CIOBI longwords output from automated

pipeline quality assurance for the pipeline should be identified.

- JPEG full field image (`img3.jpg`) with the field of view (`fov3`) region overlaid. The largest blocking factor image should be displayed. Clicking on the image display should access (in `ds9`) a live version of the full field event file (`evt3`).
- JPEG equivalent of the broadband full field exposure map object (`exp3`). The largest blocking factor image should be displayed. Clicking on the image display should access (in `ds9`) a live version of the full field exposure map file (`exp3`).

2. Detect Pipeline

2.1. Pipeline Log Processing

- Process the detect pipeline logs through pipeline log processing (see Section IV), with the exception that error condition flagging should not be performed, even if there are unexpected warnings and/or errors (the unexpected warnings/errors will be caught by pipeline quality assurance processing for the pipeline).

2.2. Snapshot Quality Assurance Data Products

- Construct the following review products for snapshot quality assurance and link them to the snapshot GUI QA review pages for the pipeline:
 - Table with the following data values:
`obsid, obi, revision, instrument,`
`grating, datamode, readmode (ACIS only), cycle (ACIS only),`
`ra_nom, dec_nom, roll_nom, ascdsver, caldbver, crdate`
 - These data values are derived from the Level 3 full field event file (`evt3`).
 - `revision, ascdsver, caldbver, crdate`
 - These data values are derived from the Level 3 `wavdetect` source list file.

The total number of detected source regions should be identified.

Bits that are set in any of the `QAREG` and `CIREG` longwords output from automated pipeline quality assurance for the pipeline should be identified, with a count of the number of source regions to which each bit applies.

- JPEG broadband full field image with the detected source regions overlaid. The largest blocking factor image should be displayed. Highlight the number of detected source regions. Clicking on the image display should access (in `ds9`) a live version of the full field event file (`evt3`) with detected source regions overlaid. See section 2.2 of part II of this document for a detailed description of the image.
- JPEG broadband full field background image. The largest blocking factor image should be displayed. Highlight the number of detected source regions. Clicking on the image display should access (in `ds9`) a live version of the full field background image file (`bkimg3`).

3. Source Pipeline

3.1. Pipeline Log Processing

- Process the source pipeline logs through pipeline log processing (see Section IV), with the exception that error condition flagging should not be performed, even if there are unexpected warnings and/or errors (the unexpected warnings/errors will be caught by pipeline quality assurance processing for the pipeline).

3.2. Snapshot Quality Assurance Data Products

- Construct the following review products for snapshot quality assurance and link them to the snapshot GUI QA review pages for the pipeline:
 - Table with the following data values:
`obsid, obi, revision, instrument, grating, datamode, readmode (ACIS only), cycle (ACIS only), ra_nom, dec_nom, roll_nom, ascdsver, caldbver, crdate`
 - These data values are derived from the Level 3 full field event file (`evt3`).
`revision, ascdsver, caldbver, crdate`
 - These data values are derived from the Level 3 `wavdetect` source list file.
`region_id, source_id, ra, dec, err_ellipse_r0, err_ellipse_r1, err_ellipse_ang, theta, phi, chipx, chipy, detect_significance (in each source detection energy band), flux_significance (in each science energy band), revision, ascdsver, caldbver, crdate (TBR)`
 - These data values are derived from the Level 3 source properties file.
Bits that are set in the `QASRC` and `CISRC` longwords output from automated pipeline quality assurance for the pipeline should be identified.
 - JPEG source region image with the source and background regions overlaid. The science energy band with the highest value of `flux_significance` should be displayed. Clicking on the image display should access (in `ds9`) a live version of the source region event file (`regevt3`) with source and background regions overlaid.
 - JPEG point spread function image. The point spread function image should be in the same science energy band and at the same spatial scale as the JPEG source region image.
 - PNG plot of the source PI spectrum. If a model fit was performed, the model fit should be overlaid, with a second panel showing the fit errors.
 - This corresponds to the `plot_fit_resid` plot in `Sherpa2`.
 - PNG plot of the source and background light curves in the science energy band with the largest value of `variability_index`. If more than one science energy band has the same value of `variability_index`, then the order of preference is broad, medium, hard, soft (**TBR**). The source and background light

curves should be plotted in a strip chart style, with the same scales.

4. Master Pipeline

4.1. Pipeline Log processing

- Process the source pipeline logs through pipeline log processing (see Section IV), with the exception that error condition flagging should not be performed, even if there are unexpected warnings and/or errors (the unexpected warnings/errors will be caught by pipeline quality assurance processing for the pipeline).

4.2. Snapshot Quality Assurance Data Products

- Construct the following review products for snapshot quality assurance and link them to the snapshot GUI QA review pages for the pipeline:
 - Table with the following data values for the current ObI, other overlapping ObIs (if any), and the previous version of the current ObI (if any):
obsid, obi, revision, instrument, grating, datamode, readmode (ACIS only), cycle (ACIS only), ra_nom, dec_nom, roll_nom, ascdsver, caldbver, crdate
 - These data values are derived from the Level 3 full field event file (evt3).
revision, ascdsver, caldbver, crdate
 - These data values are derived from the Level 3 wavdetect source list file.
revision, ascdsver, caldbver, crdate
 - These data values are derived from the Level 3 master source properties file.
Record the following information: the number of newly created master sources; the number of existing master sources that have been updated; the number of existing master sources that have been deleted; the number of per-ObI sources for each ObI that have been merged, linked, marked unused, or flagged for review (TBR). Bits that are set in the QAMSRC and CIMSRC longwords output from automated pipeline quality assurance for the pipeline should be identified.

IV. Pipeline Log Processing

- Review pipeline logs for unexpected warnings and/or errors that indicate pipeline failures and/or incorrect processing.
- If unexpected warnings and/or errors are identified then proceed as follows:
 - If error condition flagging is required (pipeline quality assurance) then set the “Generic xxx Pipeline Error” bit in the QAxxx longword appropriate to the pipeline.
 - Link the relevant pipeline log to the Level 3 quality assurance GUI review pages for the pipeline, and color-code the warnings and/or errors in the pipeline log on the review page. Color-coded links at the top of the pipeline log display shall provide quick access to the location of each reported warning and/or error.
- The behavior of the pipeline log processor should be similar to existing V&V pipeline log

processor. However, a more rigorous analysis of the context of warnings and/or errors may be required since all warnings and/or errors called out as part of pipeline quality assurance by the Level 3 pipeline log processor will require human intervention to proceed. As an example, if certain warnings and/or errors are expected in some contexts and not in others, then the Level 3 log processor should not identify them as unexpected in those contexts.

V. Quality Assurance GUI

1. General

- The Level 3 quality assurance GUI is conceptually similar to existing V&V GUI. However, the detail of the presentation to the GUI user differs in several areas.
 - The Level 3 quality assurance GUI presents to the user as an entity for review the results of a single Level 3 pipeline, whereas the V&V GUI presents to the user as an entity the combined results of Level 0.5–Level 2 processing for an ObsId.
 - With the exception of snapshot quality assurance, the Level 3 quality assurance GUI only presents to the user for review pipelines that pipeline quality assurance has already flagged (by setting any bit in the high 16 bits of the appropriate QAxxx longword) as having an issue that requires human review, whereas the V&V GUI presents to the user for review every processed ObsId, regardless of the results of the automated V&V processing.
 - Data products from Level 3 quality assurance are not archived, and are not available for further review once the relevant products have been deleted from the quality assurance GUI. However, a status database that records issues identified by pipeline quality assurance, and the actions performed by the GUI users, is maintained.
 - Status information should record a means of identifying the reviewer, the date and time of the review submission, pipeline and data product identification (in general including obsid, obi, revision, cycle (ACIS only), and crdate for the principal pipeline output data product), any reviewer comments, and any state changes for the detect and master pipeline live displays,
 - Access to completed pipeline quality assurance reviews via the GUI should be supported for a minimum period of 90 (TBR) days after the review is completed, to allow for any follow-up analysis. Access to completed snapshot quality assurance reviews via the GUI should be supported for a minimum period of 30 (TBR) days after the review is completed, to allow for any follow-up analysis.

2. GUI Review Process

2.1. Pipeline Quality Assurance

- The Level 3 quality assurance GUI presents to the user all of the items to be reviewed for a pipeline as a group of one or more linked pages (one for each issue that requires human review as flagged in the high 16 bits of the appropriate QAxxx longword). The GUI shall lead the user page by page to review the data associated with each of the human-reviewable issues for the pipeline.

- After presenting for review the relevant data associated with each human-reviewable issue, the GUI shall provide the user with the option of (a) accepting the bad status identified by the pipeline quality assurance processing, or (b) resetting the status to be good. In the latter case, the GUI shall clear the appropriate status bit in the appropriate QAxxx longword.
- The GUI shall provide a mechanism for the user to indicate that the human-review of the pipeline issues is complete, and shall require confirmation of that indication. If all of the QAxxx status bits have been cleared as a result of the review, then processing of the thread shall continue normally. If any of the QAxxx status bits remain set, then processing of the thread shall terminate as defined elsewhere.
 - If the GUI user chooses to accept a bad status after reviewing the relevant data, then for efficiency the user may choose to submit the review as complete without being required to review any further pages.

2.1.1. Graphical Display

- Images and plots may either be displayed directly in the Level 3 quality assurance GUI, or may be displayed in a “thumbnail” representation that is linked to the full resolution image or plot display via a mouse click.
 - The approach to be used should be based on minimizing the number of screens of information that must be viewed (either directly or via mouse clicks).
 - In general, thumbnails should be used in those cases where the reviewer is expected to have to review the full resolution display infrequently. However, the thumbnail must be large enough and encode enough information for the user to be able to determine whether or not the full resolution display should be viewed (otherwise the user would have to click on every thumbnail, which defeats the purpose).
- Where specified elsewhere in these requirements, clicking on a full resolution image display should either (a) link to a version of the appropriate FITS file that can be download directly into ds9 (assuming that the MIME mappings are set to automatically start ds9 when a file with a .fits extension is downloaded) or (b) provide access to the appropriate data via the interactive live display (section 2.1.2).
 - If no access specification is provided, then clicking on a full resolution image display does nothing.

2.1.2. Interactive Live Display (Detect Pipeline)

- Clicking on the image display from detect pipeline quality assurance in the Level 3 quality assurance GUI should access (in ds9) a live version of the Level 3 full field event file (evt3) with the detected source regions overlaid as specified in section 2.2.3 of part II.
 - The GUI user may select one or more specific detected source regions in ds9 and flag those source region as manually rejected or accepted. One more more regions may be selected at one time.

- Manually rejecting a source region sets the “Source Region Rejected Manually” bit in the QAREG longword for that source region.
- Manually accepting a source region clears the “Source Region Too Crowded”, “Too Many Source Regions Detected”, and “Source Region Rejected Manually” bits in the QAREG longword for that source region.
 - Manually accepting a source region does *not* clear any other bits in the QAREG longword for that source region.
- The GUI shall provide the capability to “Accept all source regions” or “Reject all source regions” at the user’s discretion after the full field image with the detected source regions overlaid has been reviewed.
 - “Accept all source regions” clears the “Source Region Too Crowded”, “Too Many Source Regions Detected”, and “Source Region Rejected Manually” bits in the QAREG longword for any source region that has any of these bits set. The “Source Region Accepted Manually” bit in the QAREG longword is set for any source regions that change as a result.
 - “Accept all source regions” does *not* clear any other bits in the QAREG longword.
 - “Reject all source regions” sets the “Source Region Rejected Manually” bit in the QAREG longword for every source region.
- When the state of a source region changes (*i.e.*, when the QAREG longword is updated) in the live image display, then the color of the region is updated according to the specification outlined above.
- The GUI user may select a specific detected source regions in ds9 and modify the properties (position, ellipse parameters) of that source region. Only a single region may be selected and modified at one time.
 - The position and ellipse parameters may be modified by entering new values numerically, or by manipulating the source region in ds9.
 - The GUI shall provide a mechanism to “revert” to the original values determined by the pipeline prior to saving.
 - Once the GUI user is satisfied with any revisions, the user may direct that the updated source region properties may be saved. This action shall require confirmation, and will update the source region properties determined by the pipeline so that the modified values are used for subsequent processing. Multiple source regions may have their properties modified prior to a save request, which will modify the properties for all of source regions.
- The GUI shall provide a mechanism for the user to submit the updates to the set of source regions.

2.1.3. Interactive Live Display (Master Pipeline)

- TBD.

2.2. Snapshot Quality Assurance

- The Level 3 quality assurance GUI presents to the user all of the items to be reviewed for a pipeline as a group of one or more linked pages. The GUI shall lead the user page by page to review the data associated with the pipeline.
- Once all of the review pages have been displayed, the GUI shall provide a mechanism for the user to indicate that the human-review is complete and the outcome of the review.

VI. Pipeline Quality Assurance Status Bit Definitions

- The example status bit definitions listed below are illustrative and not mandatory. However, the intent is to (a) be able to identify each status separately, and (b) differentiate easily between status values that require human review via the Level 3 quality assurance GUI and status values that do not. In this illustrative context, we have split the quality assurance and catalog inclusion longwords as follows:
 - The low 16 bits of QAxxx longwords identify quality assurance issues that silently reject the data product(s) that they apply to. No human intervention is required.
 - The high 16 bits of QAxxx longwords identify quality assurance issues that must be reviewed in the Level 3 quality assurance GUI. Human intervention is required to determine whether the data products are acceptable “as-is”, should be rejected, or may need to be modified. Any quality assurance issues that may require a pipeline re-run to resolve fall into this category.
 - QAOBI
 - 65536 = Generic Calibrate Pipeline Error
 - 131072 = VV State Not OK
 - 262144 = ONTIME Difference
 - QAREG
 - 1 = Source Region Too Small
 - 2 = Source Region Too Large
 - 4 = Source Region Too Elliptical
 - 8 = Detection Significance Too Low
 - 16 = Source ROI Counts Too Low
 - 32 = Source ROI Too Small
 - 65536 = Generic Detect Pipeline Error
 - 131072 = Source Region Too Crowded
 - 262144 = Too Many Source Regions Detected
 - 524288 = Source Region Rejected Manually
 - 1048576 = Source Region Accepted Manually

■ QASRC

- 1 = PSF Ratio Too Small
- 2 = PSF Ratio Too Large
- 4 = Bad Source Position
- 8 = Low Source Counts
- 16 = Low PSF Fraction

65536 = Generic Source Pipeline Error

■ QAMSRC

65536 = Generic Master Pipeline Error

■ CIOBI

TBD

■ CIREG

- 1 = High Background

■ CISRC

- 1 = Low Significance
- 2 = Off-Axis Angle Too Large

■ CIMSRC

- 1 = Low Significance