Memorandum

To: CSC Distribution

From: F. Primini

Date: September 5, 2013

Subject: Aperture Photometry Specifications for CSC R2

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1 Introduction

This memo provides an overview of the specifications for Aperture Photometry tools for Release 2 of the Chandra Source Catalog. Many of the details have been presented in documents already circulated to catdev, and those documents' contents are summarized here, with links to the appropriate references. In the following sections I summarize the algorithms, describe required inputs and desired outputs, and highlight areas requiring special attention.

2 Analyzing Sources in a Single Bundle in a Single OBI

As in Release 1, we will use a Bayesian formalism to determine the marginalized posterior probability distribution (MPDF) for photon flux for each source in each photometric energy band (U,S,M,H,B for ACIS, W for HRC). However, if there are multiple sources in the bundle, their MPDFs will be determined simultaneously, rather than separately, as they were in Release 1.

2.1 Basic Algorithm

The algorithm is described in detail in Sec. 2&3 of [1]. We use Bayes' Theorem to write the joint posterior probability distribution (JPDF) for obtaining source fluxes $\{s_i\}$ and background flux b, given source and background aperture counts $\{C_i\}$, B, aperture areas $\{\Omega_i\}$, Ω_b, and aperture exposures $\{E_i\}$, E_b as the product of the likelihood of obtaining $\{C_i\}$, B assuming $\{s_i\}$, b and the prior probability of $\{s_i\}$, b:

$$P(s_1 \dots s_n, b | C_1 \dots C_n, B) = K \times P(C_1 \dots C_n, B | s_1 \dots s_n, b) P(s_1 \dots s_n, b). \tag{1}$$

Here, K is a normalization constant and symbols and definitions are as described in Table 1. Assuming statistical independence of source and background counts, the JPDF may be written

$$P(s_1 \dots s_n, b | C_1 \dots C_n, B) = K \times P(b) P_{Pois}(B \,|\, \phi) \prod P(s_i) P_{Pois}(C_i \,|\, \theta_i), \tag{2}$$

where the expected fluxes $\{\theta_i\}$, ϕ in source and background apertures are given by (see Table 1)

$$\theta_i = E_i \times \left[\sum_{j=1}^{n} f_{ij} s_j \; + \; \Omega_i b \right]; \; \phi = E_b \times \left[\sum_{i=1}^{n} g_i s_i \; + \; \Omega_b b \right]. \tag{3}$$

Symbol	Definition
x, y	Image Coordinates
X_i, Y_i	Source Position for source i
$psf(X_i, Y_i, x, y)dxdy$	Telescope Point Spread Function at location x, y for a source at X_i, Y_i.
R_i	Source Aperture for source i
R_b	Background Aperture
Ω_i	Area of Source Aperture for source i (e.g. $pixel^{\,2}$)
Ω_b	Area of Background Aperture
E_i	Average Exposure Map Value in Source Aperture i
E_b	Average Exposure Map Value in Background Aperture
r_i	Ratio of Background to Source Aperture, $r_i = \Omega_b/\Omega_i$
C_i	Total Counts in Source Aperture i
B	Total Counts in Background Aperture
s_i	Net Source Counts for source i
b	Background Density (e.g. $counts - pixel^{-2}$)
f_{ij}	Fraction of PSF for source j enclosed in R_i, e.g., $\int_{R_i} psf(X_j, Y_j, x, y)dxdy$
g_i	Fraction of PSF for source i enclosed in R_b, e.g., $\int_{R_b} psf(X_i, Y_i, x, y)dxdy$
θ_i	Expected total counts in Source Aperture i: $\theta_i = \sum_{j=1}^{n} f_{ij}s_j + \Omega_i b$
ϕ	Expected total counts in Background Aperture: $\phi = \sum_{i=1}^{n} g_i s_i + \Omega_b b$

Table 1: Symbols and Definitions

The MPDF for a single source is obtained by marginalizing the JPDF over background and all other sources. Assuming non-informative (i.e., flat) prior distributions for $\{s_i\}$, b , and setting $K = 1$ (the MPDF will be explicitly renormalized at the end), we have

$$P(s_i|\, C_1 \ldots C_n,\, B) = \int_0^{\infty} db \underset{\substack{s_j = 0 \\ j \neq i}}{\int\!\cdots\!\int^{\infty}} \left(\prod_{j \neq i} ds_j \right) P(s_1 \ldots s_n,\, b|C_1 \ldots C_n,\, B). \tag{4}$$

The JPDF will be evaluated on a hyper-cube of $n+1$ dimensions, for an n-source bundle. The cube in each dimension will range from $max(\overline{s} - 5\sigma, 1.0 \times 10^{-10})$ to $\overline{s} + 5\sigma$ in 20 (TBR) steps, where $\overline{s}\,, \sigma$ are the maximum likelihood value for flux and its error, for that source or background, as defined in Sec. 4 of [1]. (Note, "maximum likelihood" here *does not* refer to the output of the MLE pipelines.) The evidence term in the JPDF will be set to 1.

The MPDF for a particular source or background will be determined by numerical integration of the JPDF hyper-cube over all other dimensions, and will be explicitly renormalized to 1.

2.2 Defining Bundle Membership

Bundles are defined as sets of sources with overlapping source regions, which are analyzed together in MLE. (REF) An example is shown in Figure 1. In fact, most source regions do not overlap others and can be considered single source bundles. However, as FIgure 2 indicates, a significant fraction ($\sim 18\%$) of bundles will include two or more sources, with $\sim 2\%$ including 5 or more.

For the purposes of aperture photometry, the bundles defined by MLE will be taken as a starting point, and their sources will be called *primary sources*. Bundles may be edited as follows:

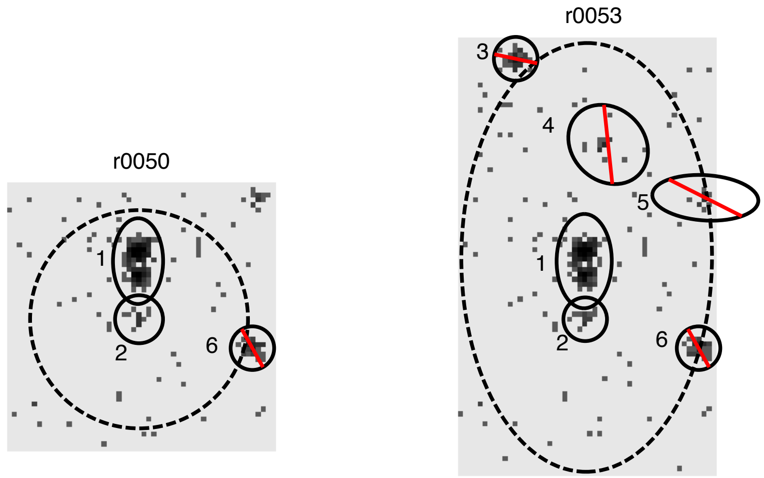

Figure 1: *Overlapping source regions (1&2) defining a bundle in cohort 2000_07_02. Note the different image dimensions and background regions.*

1. The background region of the photometric bundle will be the union of the background regions of the primary sources. In Figure 1, for example, the bundle background region will be the union of the regions for sources 1 & 2.

2. Other sources which contaminate the augmented background region may be promoted to bundle membership, even if their source regions do not overlap others, if spillover counts from their source regions are comparable to the statistical error in the background. This condition may be approximated as

$$(1 - ECF) \times (total\, counts\, in\, source\, region) \gtrsim n \times \sqrt{total\, counts\, in\, background\, region} \qquad (5)$$

   where ECF is the integral of the PSF within the source region and $n \sim 1$ (TBR). These sources will be called *secondary sources*. If Equation 5 does not hold, the contaminating source regions will simply be excluded from the background region. Secondary sources will be included in the construction and analysis of the JPDF, but their aperture photometry results will be reported from other bundles in which they are primary sources.

3. If the number of primary and secondary sources in a bundle is more than 5 (TBR), primary sources may be demoted from bundle membership to reduce the bundle size. It should be noted that this will result in the creation of new bundles. Sources may be demoted from bundle membership if the spillover counts from their source region into adjacent source regions (i.e., source regions with which they overlap directly) are comparable to the statistical error in the adjacent regions. This condition may be approximated as

$$\int_{R_i} PSF_j \times (T_j - B_j)/ECF_j \gtrsim n \times \sqrt{T_i} \qquad (6)$$

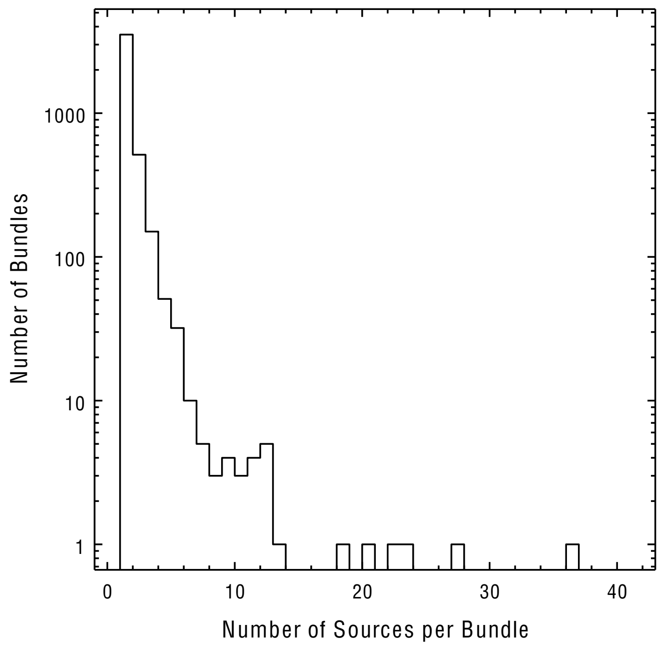

Figure 2: *Number of sources per bundle, for a subset of CAT4.1.1 cohorts.* $\sim 18\%$ *of the bundles include two or more sources and* $\sim 2\%$ *contain 5 or more.*

where T_j and B_j are total and background counts in region R_j, ECF_j is the integral of PSF_j in region R_j, and $n \sim 1$ (TBR). Sources which are demoted from bundle membership will form new bundles. They may also be considered as secondary sources in the reduced bundles formed from the breakup of the original bundle. Similarly, those sources may be considered secondary sources for the new bundle.

It is likely that fluxes for a given source will be determined more than once, for the bundle for which the source is a primary member, and for other bundles for which it is a secondary source. Only the primary source flux will be used.

2.3 Allocating Counts in Overlapping Source Regions

Counts in overlap regions, i.e., regions that are included in two or more source regions, should only be counted once, to ensure statistical independence of the regions. The results of simulations of close pairs of sources indicate that better photometric results are obtained when counts in the overlap region of two sources are assigned to the source region of the brighter source.

2.4 Input/Output

2.4.1 Input

The input files for this step will be obtained from the output of the individual L3<A|H>MLE pipes. For each source in the bundle, the following files will be used:

<rnnnn><band>_psf3.fits Point Spread Function postage stamp image;

<rnnnn><band>_expmap3.fits Exposure map postage stamp image;

<rnnnn><band>_reg3.fits Region files, including extensions for both source and background regions.

Here, <rnnnn> represents the region id and <band> represents the energy band. In addition, reg3, psf3, and expmap3 files for secondary sources in the bundle will be required.

Counts data for the bundle will be obtained from the bundle event list, defined as the events in the appropriate band contained in the bounding box of the augmented background region, as described in Section 2.2.

2.4.2 Output

For each source in the bundle and for background, a binary fits file extension will be output, containing the photon flux and MPDF value at each of the grid points in the JPDF hypercube in that dimension. In addition, the mode of the MPDF will be determined as the photon flux at the vertex of the parabola that passes through the three highest values of the MPDF. If the highest value of the MPDF is at 0 photon flux, that will be reported as the mode and a flag will be set. Confidence bounds will be determined by regridding the MPDF to a finer grid of 50 (TBR) points using an Akima interpolation of $ln(MPDF)$ and numerically integrating above and below the mode until the desired confidence limit is obtained. if the lower limit of the flux grid is reached before integration is complete, that limit will be set as the lower confidence bound, integration will continue with values above the mode, and a flag will be set.

2.5 Test Results

Test code and datasets can be found in /data/L3/fap/REL2/NAP/Specs/TestCode/naprates/. The directory includes all code and datasets plus a log file illustrating a successful run.

3 Determining OBIs To Be Combined In Computing Master Source Flux

If a source is observed in multiple obis, the data from the different obis can be combined, with the MPDF from one obi used to refine the prior distribution assumed for another. However, for variable sources, the MPDF from one obi may not be a good candidate for the prior flux distribution for a subsequent obi. The Baysean Blocks algorithm of Scargle et al. [2] will be used to determine which sets of obis can be analyzed together. Additional details are provided in [3]. The resulting MPDF for the set with the longest total exposure (TBR) will be reported as the master source flux.

3.1 Basic Algorithm

We wish to determine those groups or *blocks* of obis $\{B_i\}$ within which all the MPDFs are consistent with a single flux. The probability of obtaining a set of blocks $\{B_i\}$ given a set of obis $\{O_j\}$ may be written as

$$P(\{B_i\}\,|\,O_j) = P(N_{blocks}) \prod_{i=1}^{N_{Blocks}} F(B_i\,|O_j \in B_i) \tag{7}$$

where the function $P(N_{blocks})$ is the prior probability distribution for the number of blocks N_{blocks} , and is assumed to have the form

$$P(N_{Blocks}) \sim \gamma^{N_{Blocks}},\, 0 < \gamma < 1. \tag{8}$$

The *Fitness Function* $F(B_i\,|O_j \in B_i)$ is a measure of how well the data in the obis comprising the block may be represented by a single source flux. For our purposes, we define it as the the product of the MPDFs of the individual obi source fluxes in the block, namely

$$F(B_i\,|O_j \in B_i) = \int_0^\infty ds \left[\prod_{j\,|\,O_j \in B_i} MPDF_j(s) \right] . \tag{9}$$

The actual blocking is determined by selecting that set of blocks $\{B_i\}$ that maximizes $log[P(\{B_i\}\,|\,O_j)]$, where

$$log[P(\{B_i\}\,|\,O_j)] = N_{Blocks} log\gamma + \sum_{i=1}^{N_{Blocks}} log[F(B_i)] = \sum_{i=1}^{N_{Blocks}} [log[F(B_i)] - ncprior] \,, \tag{10}$$

where the parameter $ncprior = |log(\gamma)|$ is determined from simulations. Initial investigations indicate that $ncprior \sim 2$.

3.2 Input/Output

3.2.1 Input

Blocks will be determined on a source-by-source basis, using the MPDFs from all obis from all cohorts in which the source was observed *or was visible*. If a source was not detected but was visible in a particular cohort, a circular source region corresponding to the 90% ECF in the B or W band will be used to estimate the MPDF according to the procedure described in Section 2.

Individual MPDFs will be regridded to a common flux grid using an Akima interpolation of $ln(MPDF)$. Since the Fitness Function is a product of probability distributions, data from different photometric bands will be summed in computing $log(F(B_i)$, so a single set of blocks will describe data from all bands. However, separate sets of blocks will be determined for ACIS and HRC observations.

3.2.2 Output

Output will consist of a list of blocks. Each list entry will include the start time of the first obi in the block, the total exposure time in the block, and the list of obis comprising the block.

3.3 Test Results

Test code and datasets can be found in /data/L3/fap/REL2/NAP/Specs/TestCode/bbsim/. The directory includes all code and datasets plus a log file illustrating a successful run.

4 Computing Master Source Flux

Master source flux for source s_k in an $n-$ source bundle will be computed from data in the s_k block with the largest exposure (TBR), in each energy band.

4.1 Basic Algorithm

The data from different obis in the block will be combined by "chaining" MPDFs. The obis will be re-sorted in terms of increasing total counts in the s_k source aperture. The single obi MPDF for the lowest count obi will then be used as the prior probability distribution for the combined data from that obi and the next lowest count obi. The resulting MPDF will then be used as the prior distribution for the combined data from those two obis and the next lowest count obi, etc.

Since the fluxes for background and the other sources in the bundle can vary independently of the flux for s_k, their fluxes in each obi will be treated as separate parameters in constructing the chain JPDF. For a chain of m obis, the JPDF may be written as

$$\begin{aligned} P(s_k,\, \{s^j_{i,i\neq k}\},\, \{b^j\}\,|\,\{C^j_i\},\, \{B^j\}) \;&=\; P(s_k)\times \\ &\prod_{j=1}^{m}\left[P(b^j)\times P_{Pois}(B^j\,|\,\phi^j)\times\, P_{Pois}(C^j_k|\theta^j_k)\prod_{i=1,i\neq k}^{n} P(s^j_i)\times P_{Pois}(C^j_i\,|\,\theta^j_i)\right] \end{aligned} \tag{11}$$

where $s^j_{i,i\neq k}$ refers to the other sources in the bundle for obi j, and terms like $\{C^j_i\}$ are shorthand for enumeration of all indices, e.g., $\{C^j_i\} \rightarrow \{C^1_1, C^2_1 \ldots C^1_2, C^2_2 \ldots\}$ etc. In principle, the new MPDF for s_k can be computed as before, by marginalization over all other source fluxes and all background fluxes

$$P(s_k|\,\{C^j_i\},\,\{B^j\}) = \int\!\!\cdots\!\!\int_{\{b^j\}=0,\{s^j_{i,i\neq k}\}}^{\infty} \{db^j\}\{ds^j_{i,i\neq k}\}P(s_k,\,\{s^j_{i,i\neq k}\},\,\{b^j\}\,|\,\{C^j_i\},\,\{B^j\}). \tag{12}$$

However, the dimensionality of the JPDF hypercube is much larger than that for a single obi. For an n-source bundle, the single obi JPDF has $n+1$ dimensions, whereas the JPDF for an n-source bundle in a chain of m obis has $1+n\times m$ dimensions, since all other sources *and* background must be treated separated for each obi in the chain. The increased dimensionality may make the simple numerical integration scheme outlined in Section 2.1 impractical. The marginalization integral in Equation 12 will therefore be approximated by replacing the prior distributions for source or background flux with delta functions about the modes determined from single-obi analysis. In other words,

$$P(b^j) \approx \delta(b^j - \hat{b}^j);\; P(s^j_{i,i\neq k}) \approx \delta(s^j_{i,i\neq k} - \hat{s}^j_{i,i\neq k}). \tag{13}$$

With these approximations, Equation 12 may be rewritten as

$$P(s_k|\,\{C^j_i\},\,\{B^j\}) \cong P(s_k)\prod_{j=1}^{m}\left[P_{Pois}(B^j\,|\,\hat{\phi}^j)\times\, P_{Pois}(C^j_k|\hat{\theta}^j_k)\prod_{i=1,i\neq k}^{n} P_{Pois}(C^j_i\,|\,\hat{\theta}^j_i)\right], \tag{14}$$

where in $\hat{\phi}$ and $\hat{\theta}$, the appropriate modes are used for all fluxes except s_k. Determination of the combined MPDF at any stage in the chain for source s_k then reduces to evaluating Equation 14 on a source flux grid that spans the range of MPDFs for s_k in the chain, in 50 (TBR) steps.

4.2 Input/Output

4.2.1 Input

For each obi to be combined, all aperture quantities (e.g., psf's, expmap's, event lists, source and background regions) for all sources and backgrounds described in Section 2.4.1 will be required. In addition, modes for all source and background MPDFs for all obis will be required.

4.2.2 Output

As in Section 2.4.2, a binary fits file with flux and MPDF values for s_k will be output. The MPDF mode and confidence bounds will also be reported.

5 Extended Sources

Aperture photometry will be performed on two types of extended sources - large extended sources like galaxy cores, defined by convex hulls, and compact extended sources deteremined either by MLE or *mkvtbkg*.

5.1 Convex Hull Sources

Only approximate results will be provided for convex hulls, since the source regions themselves are only approximate descriptions of the source extent. Photometry will be performed on cohort data only, in each photometric band. If a convex hull source is observed in more than one cohort (e.g. a cluster observed off-axis in a mosaic observation) the convex hulls, event lists, and full-field exposure maps of the cohorts should be merged. The source should be treated as a single-source bundle. Other point or compact sources contaminating either source or background regrions should simply be excluded from those regions. Background should be obtained from a circular annulus surrounding the convex hull and of comparable area. For the convex hull source, the encircled counts fraction should be set to 1.0 in the convex hull source region (f in Equation 3) and 0.0 in the background region (g in Equation 3).

5.1.1 Input

Input to the convex hull photometry should include the following, for all contributing cohorts:

- full field event lists;
- full field exposure maps in all photometric bands;
- point and compact extended source regions for contaminating sources in all photometric bands.

5.1.2 Output

Output will consist of an MPDF fits file, mode, and confidence bounds, as described in Section 2.4.2, for each photometric band.

5.2 Compact Extended Sources

These are sources which are determined either through fits to extended source models in MLE, or through detection within convex hulls through mkvtbkg. In either case, it is assumed that the extent will be modelled as a two-dimensional Gaussian with $\sigma_x \neq \sigma_y$, where x, y are major and minor axes. The relation between σ and $fwhm$ is $fwhm = 2 \times \sigma \times \sqrt{2 \times ln(2)}$.

Extent is accounted for in the photometric anaysis by convolving the extent model with the source psf, generating a new psf image for each photometric band. The convolved psf image should not be renormalized or resized. These convolutions may be performed for any qualifying source prior to single bundle/single obi analysis.

5.2.1 Input

Input will consist of

- extent model parameters σ_x, σ_y and position angle Θ in each photometric band;
- psf image in each photometric band.

5.2.2 Output

Output will consist of convolved psf images in each photometric band.

References

[1] https://icxc2.cfa.harvard.edu/soft/L3R2/wiki/lib/exe/fetch.php?media=r2_apphot_notes_01.pdf, "Revised Algorithm for Estimating Posterior Probability Distribution for Source Intensity"

[2] Scargle, J. et al. 2013, ApJ, 764, 167.

[3] https://icxc2.cfa.harvard.edu/soft/L3R2/wiki/lib/exe/fetch.php?media=bb_walkthrough.pdf, "Combining Aperture Photometry Results from Multiple OBSIDs"

Appendices

A E-mail Discussion Threads

A.1 Dealing with Confused Sources in Computing Master Source Flux

Hi Frank,

I'm a little confused by what you term "master source flux" here, since it appears to be your best estimate (based on the choice of ObIs to combined from the Bayesian Blocks analysis) for the stack source flux.

At the master level, we will also have the possibility of combining data from multiple stacks, where the bundles will potentially be different and the sources may have significantly different off-axis angles (which may be why those ObIs weren't combined into a single stack). Do you anticipate using the same approach for combining the per-ObI data from the different stacks for the master sources fluxes, or are you thinking of a different approach?

Thanks, –Ian

Hi Ian,

My intent is to collect the per-obi results from all of the stacks in which the source appears, and use that as input to the Bayesian Blocks analysis, and hence the computation of master flux. This is mentioned, in passing, in Section 3.2.1:

"Blocks will be determined on a source-by-source basis, using the MPDFs from all obis from all cohorts in which the source was observed or was visible."

In hindsight, I should probably have given this point more emphasis, since it is rather important.

Sorry for the confusion.

Frank

Hi Frank,

Thanks for the clarification. I was thinking of the cases where sources may be located at significantly different off-axis angles across the cohorts, and wonder whether that impacts the computations? When an off-axis source in one cohort is confused with multiple on-axis sources in another cohort, I presume that you ignore the confused source (although in principle, it's flux could be used as an upper limit for the ambiguously matching sources - this could also be relevant when we have an upper limit only at an off-axis position whose PSF is larger enough to match multiple on-axis sources in another cohort)? It would probably be good to be explicit about how we will deal with such cases.

Cheers, –Ian

Hi Ian,

I've thought some more about this and I think the best things to do are the following:

1) If a source is observed in multiple cohorts but is confused in some cohorts, ignore those data for which the source is confused in computing its master source flux. In practice, this means don't use the data in the Bayesian Blocks analysis.

2) If a source is observed in one or more cohorts, and is in the field-of-view in other cohorts but not detected:

define a source aperture corresponding to the ~90%(TBR) ECF circle in the non-detection cohort observations (i.e. for each obi in the cohort). Then

a) if no other sources in the non-detection observation fall within the source aperture, then use the non-detection observation data to compute a source upper limit and include it in the computation of master source flux. Note this does not mean that it would actually affect the flux value, only that it would be a member of some Bayesian block. That block may or may not be the one used to compute master source flux.

The term "fall within" is a bit vague - the intent is to identify and avoid situations in which a single source at the location in question with the given circular aperture size would be confused with multiple on-axis sources from other cohorts. I suggest using the same algorithm we used in Release 1, with the exception that one of the apertures is not from a source detection, but simply the circular aperture defined above. If this isn't feasible, I would adopt the definition that "fall within" means the other source centroid is within the aperture. Note that even if there are multiple on-axis sources in other observations that fall within the source aperture in the non-detection observation, they are themselves not detected and so the upper limit computed should be a conservative upper limit for a single source at the location of the circular aperture.

b) if there are other sources in the non-detection observation that "fall within" the circular aperture, ignore the data from this observation.

A.2 Summary of Data Groupings 14-Jun-2016

To: catdev@head.cfa.harvard.edu

From: Frank Primini

Subject: Definition of Aperture Photometry Groupings: Request for Comments

I'm trying to clarify the definitions of the various groupings of aperture photometry data for individual sources and thought I'd circulate my current thinking for comments. Any and all will be appreciated, but I'd particularly like input from Mike N., Mike M., and Ian. I'd like to achieve a consensus in the next couple of days so I can update the Aperture Photometry Specs.

For brevity, in what follows I'll just use the term 'flux', but it should be understood that I'm referring to probability distributions (MPDFs), from which we determine modes and lower and upper confidence bounds. Also, I'll just use the term 'aperture', although at present, we plan to compute fluxes for both ecf90 apertures (aper90) and source region apertures (aper).

We plan to compute fluxes in each energy band for the following data groupings:

obsid: We will compute a flux for each valid per-obsid aperture, for all obsids in a cohort, for all detected sources in the cohort. In addition, we will compute a per-obsid upper limit for sources detected in other cohorts, which have valid per-obsid apertures in the cohort. For sources detected only in other cohorts, the master source position will be used to define the location of the aperture in the cohort.

time-ordered bayesian blocks: We will sort all per-obsid fluxes or upper limits for a source in increasing start time of observation and perform a bayesian blocks analysis on the resulting list of fluxes. We will compute a flux for each block so determined, by combining the per-obsid aperture data for all the obsids in the block, either by jointly fitting a single flux to all the per-obsid aperture data or chaining the individual obsid MPDFs.

flux-ordered bayesian blocks: We will sort all per-obsid fluxes or upper limits for a source in increasing flux and perform a bayesian blocks analysis on the resulting list of fluxes. We will compute a flux for each block so determined, by combining the per-obsid aperture data for all the obsids in the block, either by jointly fitting a single flux to all the per-obsid aperture data or chaining the individual obsid MPDFs.

Master Source: We will promote the flux from the 'best' flux-ordered bayesian block as the Master Source Flux. At present, 'best' means the block with the longest total exposure but other definitions are possible.

Master Average: We will combine the per-obsid aperture data for all obsids in which a flux or upper limit has been computed for a source into a single Master Average Flux. Per-obsid aperture data will be combined either by jointly fitting a single flux to all the per-obsid aperture data or chaining the individual obsid MPDFs.

Open Questions: 1) Should we compute a flux for each cohort? My initial inclination is to say no, that grouping is somewhat arbitrary, and the fluxes are better described by the bayesian blocks or Master Average. On the other hand, sources are detected on the cohort level, and it might make sense to provide a flux based on the same grouping of data. I'm willing to be convinced of this, but if we do decide to include a cohort flux, I think it should be computed in the same way that we compute the Master Average, not as the result of a bayesian blocks analysis.

2) Should we compute fluxes for both ecf90 (aper90) apertures and source region (aper) apertures? The argument for doing this in Release 1 was that inconsistent aper90 and aper fluxes might indicate

that a source was extended. That may be useful, but I don't know that it has ever been used. Keeping both essentially doubles the number of data products.

Frank

Open Questions Resolved during Weekly Status Meeting 15-Jun-2016:

1. Cohort-average fluxes will be computed, using the same approach applied in the Master-Averages. No Bayesian Blocks analysis will be applied to determine which obsids in the cohort will be used. Rather, all valid apertures in the cohort will be used to calculate the cohort-average.
2. Fluxes will be computed using both ecf90 and source region apertures for all flux quantities.