**Chandra Users Committee Report**

*Committee Meeting of September 30, 2015*

## Preamble

The consensus among the members of the CUC users committee was that the observatory is in good shape, the instruments are performing well, and the CXC is doing a good job taking care of business. We commend the CXC staff for the efforts and we hope that they will continue performing at this level. We give below our more specific comments and recommendations, focusing on areas where we feel some improvements can be made and on several topics where we feel we can make useful recommendations.

## Overview and Manager's and Director's Reports

The Director's presentation included a discussion of efforts to coordinate large programs with other facilities. The CUC was very pleased to see that the Director's office is pursuing such initiatives. The CUC suggested the possibility that early proposals can be solicited for multi-observatory time-domain projects that require extensive coordination between a variety of different facilities. For example, the proposals can be submitted in advance of the cycle in which the data would be obtained (e.g. they could be submitted at the AO-18 call for implementation in AO-19), reviewed, and, if successful, they would be executed only of all the necessary facilities are participating. The Director was receptive to this idea. The Director is exploring a related initiative to put together a multi-facility observing program with its own call for proposals, allowing joint large programs, which would appropriate for time-domain programs among others.

The CUC heard an update on the CXC's efforts in Education and Public Outreach. As one of NASA's Great Observatories, it is very important for Chandra to communicate the scientific return from this investment to the general public. Chandra is also in a great position to communicate to students the excitement of scientific discovery, and to illustrate the scientific process. We encourage the Mission to continue its efforts in Education and Public Outreach, and applaud them for the recent success of their proposal to support further efforts in Education.

*Recommendations:*

1. We recommend continuing the practice of exchanging time with other facilities, such as national observatories and space missions. We also encourage the director to continue to pursue new opportunities for such exchange programs. Specific examples include ASTROSAT, which was just launched successfully, and ASTRO-H which will launch in the not-so-distant future. If possible, we think it would be useful to have joint observations with these missions during their PV phases.

*Astro-H*

*Discussions with Professors Takahashi (Astro-H PI) and Ohashi (Project Scientist) in September 2015 resulted in an agreement that joint time would begin in their Cycle 2, our Cycle 19, once their PV phase observations are underway. We will discuss the details in the spring, most likely at the HEAD meeting. We expect the arrangements to be similar to those of*

*the joint program with Suzaku. We will also be coordinating with them to facilitate relevant joint calibration observations and to discuss their submission of Chandra proposals in Cycle 18 to observe Astro-H PV-phase targets.*

*ASTROSAT*

*The satellite has now launched and is in the checkout process. We have contacted the ASTROSAT team to open discussions on possible joint time with Chandra.*

**Chandra Source Catalog**

The committee heard a report from Dr. Evans on the status of the work on version 2 of the source catalog. The production run for version 2 of the catalog started in April 2015 and about 70% of the stacks were processed by the second half of September 2015. The catalog at the moment includes both secure and marginal detections. Manual quality checks seem to be the critical step since they are slow and are holding up the production. To mitigate this situation a number of additional people have been recruited and are now being trained to help with this labor-intensive task. The goal is to include many source properties in the final catalog (more than a thousand columns per source are anticipated). According to the current schedule for completion of the work, a few new steps will be carried out in winter 2015/16. The projected date of completion has been revised from May 2016 to summer 2016.

The committee thanks the CXC and the catalog team in particular for their Herculean efforts to produce a detailed, carefully checked and verified catalog with value-added products. We were glad to see that many of the technical problems, specifically hardware problems, that caused delays in the past have been overcome. However, we are concerned about the fact that the project is still slipping and that the projected completion date has been moved again. We feel it is imperative to finish the catalog as quickly as possible since it will be a tremendous resource for the community and since the community has been expecting this of the CXC for quite some time.

*Recommendations:*

1. The committee reiterates, and reinforces the recommendation from previous years that the catalog be completed as quickly as possible.
2. It would be extremely valuable, in our opinion, to release at least the basic properties of the sources quickly and continue to work on additional source properties after that. Therefore, we recommend very strongly that the release should not be delayed beyond summer 2016. The work should be prioritized so that the basic catalog can be ready by that time even if work on additional source properties and a thorough evaluation of the uncertainties has to be delayed. We recommend that the CSC team delay analysis of regions of the sky and/or particularly complex datasets that require a disproportionate amount of effort in the interests of an earlier release of the majority of the data.
3. We were concerned that a number of ancillary tasks, such as development of algorithms for Sherpa that are unrelated to the source catalog, seem to be interfering with the work on the catalog. We recommend that the work on the catalog remain focused on its primary goal, timely completion of at least the basic catalog. In this spirit, we recommend that algorithm development also be focused on those algorithms that are

essential for the completion of the catalog and the development of other algorithms receive lower priority.

4. We suggest that the catalog team consider the *XMM-Newton* source catalog (now 3XMM) as a model for the basic version of the Chandra source catalog in terms of a reasonable level of sophistication of the analysis and complexity of the data products.

5. The CUC asks that a status report on the catalog production is presented at the intermediate CUC meeting next spring.

*CXC Response:*

1. *The CXC agrees with the committee recommendation that the catalog be completed as quickly as possible, and has brought additional resources to support that effort where possible. At the same time, we believe that it is critical that the CXC release a product that the community will find both scientifically robust and reliable. The most important criteria in this respect are an acceptable false source rate and robust source positions, with secondary properties being good detection sensitivity and aperture photometry. We believe that we are on track to deliver release 2 of the CSC that satisfies these criteria on the schedule that we discussed at the CUC meeting.*

2. *We will continue to make basic properties available to the user community through updates to the preliminary detections list once the new reprocessing steps scheduled for winter 2015 are completed. Updates to the preliminary detection list will be our path to quickly make basic properties available until the final archived catalog release is ready. In terms of source properties, robust positions require matching detections from multiple observation stacks that overlap the same region of the sky. This task, which is complicated by the large variation of the Chandra PSF size with off-axis angle, requires reliable estimates of the detection positions and uncertainties. A prototype of the master match algorithm that implements this step is currently being fine-tuned and tested. Updates to the remaining source properties algorithms are all in-hand, and are largely evolutionary in nature and so not expected to impact the catalog completion schedule.*

   *We appreciate the suggestion to delay analysis of regions of the sky that include particularly complex datasets. The regions that are likely of most interest to the community (e.g., Sgr A*, M31, the Trapezium) are also the most complex datasets, and the ones most likely to be delayed using such an approach. Furthermore, the release 2 catalog algorithms and processing system were designed under the assumption that each phase of processing (Phase I [currently underway]: calibration, source detection, MLE, and Stacker; Phase II: master match; Phase III: source properties) would be completed for all data prior to the next phase being initiated. While it may be possible to redesign and reimplement the algorithms and processing system to eliminate this assumption, additional resources and time would be required to do so. Given the current catalog production schedule, we do not believe that this effort is either necessary or beneficial.*

3. *Overall, the CXC works to balance priorities between mission operations, catalog development and production, and support for current observers and archival science users. While support for Chandra mission operations has the highest priority, support*

*for other aspects of algorithm and software development has received a lower priority recently to maximize resources for catalog development and production.*

*Sherpa is heavily used in many aspects of the catalog pipelines related to computing source properties and associated errors (including the determination of robust source positions which are fundamental to the success of the catalog), and much recent Sherpa development directly supports catalog production. Sherpa is also used to support Chandra mission flight operations (e.g., modeling and predicting spacecraft component temperatures during day-to-day operations, to ensure that thermal limits are not exceeded), and some ancillary tasks may be related to updates in support of these areas.*

*While we understand and share the CUC's concern that Sherpa algorithm development should not interfere with the catalog production, this is not currently the case. Furthermore, the very limited resources used for non-catalog-related work in general are not the pacing items for catalog completion.*

4. *We appreciate the suggestion of the CUC. We have used the XMM-Newton source catalog as one input in developing the CSC release 2 system - for example, the migration to a maximum likelihood estimator based process for evaluating candidate detections. In addition to the XMM-Newton source catalog model, we continue to monitor the usage of the current release of the CSC to understand how our catalog science users are actually using the catalog data products, and this information has guided the updates that will be included in release 2.*

   *The content of the preliminary detections list already includes many of the core detection properties that are currently available. Where appropriate, we will add a small number of additional properties (e.g., assigned catalog source name) to the preliminary detections list once the additional properties are computed, in advance of the final catalog release.*

5. *The catalog team will be happy to provide an update at that time.*

**Proposal Cycles: Update and Plans for Future Cycles**

The committee was impressed that the proposal process continued to run smoothly in the most recent cycle, that the oversubscription rate remained high, and that there was no evidence of any gender equity problems with the proposal success rate. The committee had one concern with the time allocation process from this past year, which is that time was moved from the GO program to the LP program after proposals were submitted, in response to proposal pressure. While the committee believes that that was a sensible decision, it was concerned that the decision changed the amount of time available in certain categories from what was stated in the call for proposals, after the call for proposals had already been issued.

There are concerns from the CDO that the number of large proposals being submitted leads to negative consequences at the peer review. The Big Project panel was asked to read 72 proposals this past cycle, a load which is barely manageable, and each of these proposals was also read by two subject-specific panels, further increasing the burden on the time allocation committees. Additionally, the conflict of interest rules for the Large Projects make it difficult to find reviewers for those projects. Dr. Prestwich also noted that the distribution of requested

exposure times indicates that the requests are often engineered so they do not fall just below the level of a Large Project.

An analysis of the value of programs in different size ranges done by Ms. Winkelman showed more papers being published per unit time from smaller proposals than from larger ones. In the absence of results from the recent XVP programs, analysis of aggregates put together of both individual proposals, and cases where the same target had been observed in different cycles but in the same instrument configuration, were used to gauge the relative impact of different program sizes. At the Megasecond level, the trend started to reverse, with the most highly cited papers being disproportionately from the programs which used XVP levels of time. These high impact papers were predominantly from the deep fields rather than from other aggregates which used similar amounts of time.

*Recommendations:*

1. The committee recommends that specific criteria and procedures be laid out ahead of time in the call for proposals that discuss under what circumstances time may be moved among GO, LP and other classes of proposals.

2. Regarding the issue of too many LPs being submitted relative to what the peer review process can handle, the committee recommends implementing Dr. Prestwich's proposal to increase the threshold for LPs from 300 to 400 ksec. The committee additionally recommends that the CXC release detailed rates for probability of success of proposals as a function of the amount of time requested. This may lead to fewer proposals being engineered upward to exactly the threshold for an LP, as proposers realize that the proposals may have a better chance of being accepted as GO programs.

3. The committee recommends continuing publication analysis of different sizes of programs/aggregates before making a decision about whether the XVPs should return in Cycle 19. Waiting another year will allow the impact of the first actual XVP proposals to be considered which is important given that the large aggregates are mostly cases of proposals that amassed time over a long span, having shown strong intermediate results along the way, and they may not be reflective of the value of the bona fide new ideas that need at least 1 Msec immediately. A new discussion should take place one year from now about whether Cycle 19 should have an XVP component. The committee would also like to see the same type of weighted analysis on the citation data (i.e. citations per unit of time awarded) as on the publication data.

CXC Response:

1. *The Cycle 18 Call for Proposals reads: "We anticipate that 4 Msec will be allocated to the Big Project Panel (BPP) for LPs and JCLPs and 12.2 Msec allocated to the topical panels for regular GO proposals (typically less than 400 ksec). These allocations are updated before the peer review to account for the actual observing efficiency during the current observing cycle. The unlikely event of an adjustments >5% will be announced to the community."*
2. *We have posted acceptance rates as a function of exposure request at: http://cxc.harvard.edu/proposer/LP_boundary.html. In addition, this document explains the reasons for moving the LP boundary from 300 to 400 ks.*

3. *The Director's Office will continue working with the archive group to gather publication/citation statistics on aggregates and XVPs. We will give an update on this effort at the fall CUC.*

**Mission Planning**

Mission planning and scheduling are quite complex, and very ably handled by the mission in a manner that keeps their efforts almost completely transparent to users. This is particularly impressive due to the continual introduction of new challenges as the spacecraft ages. These new challenges motivate the committee to emphasize the importance and value of maintaining staffing levels in these areas.

The CUC heard a summary of the continuing effect of overall heating of the observatory and the instruments. The gradual heating results in the mission planning becoming more complex with time in order to continue to shed heat successfully between observations. The implications for observing programs will eventually be that long integrations will become more difficult to fit into schedules in certain situations. It will also become more difficult to schedule time sensitive observations.

The CXC has a philosophy of minimising the amount of information given to proposers about mission constraints, preferring to handle difficult constraints with manipulation of the schedule. To date it has not been a big problem to fit all approved programs into the schedule this way. CXC has urged proposers to contact them well ahead of the deadline for assistance with constraints but if proposers are not aware that their programs may have constraints, as noted by Dr. Slane, they do not follow this guidance. Dr. Slane indicated a concern that proposers may make incorrect assumptions about potential constraints on the one hand, and on the other they may make observing requests that are difficult to schedule without indicating what kind of flexibility might be acceptable at the scheduling stage.

As time goes on and the spacecraft heating continues to put pressure on the scheduling capabilities, it may be advisable for the CXC to consider involving the proposers in some simple aspects of the schedulability of their proposed observations. The CUC understands that this has been considered thoroughly before and that it is difficult to illustrate schedulability because it depends on the manner in which the schedule is actually built for prior observations.

*Recommendations:*

1. The Committee recommends that the scheduling team and the proposal review team work together to determine whether the proposal forms can be modified in a way that draws out more information from the proposers about what their real constraints are.

2. The Committee recommends that the CXC pay close attention to the staffing needs of the mission planning team. As the scheduling becomes more and more complex with the addition of constraints, the job of this team will become more demanding. Therefore, their staffing levels should be adequate for them to handle their difficult job.

*CXC Response:*

1. *The Mission Planning team has worked with the Director's Office to review the content of the RPS documentation on constraints, as well as that in the Call for Proposals for the upcoming Observing Cycle. We also reviewed suggestions for treating requests for*

*coordinating observations with several observatories as "EASY" constraints (or no constraints at all) given that these observatories often simply follow the Chandra scheduling of observations, but concluded that the actual level of effort involved in scheduling and tracking such observations still merits classification as constrained programs at current difficulty levels. We also discussed with the Director's Office manners in which to handle observations through the new "Joint Contingent Large Projects" program from a planning/constraint perspective. However, addressing the issues raised here by the CUC is surely a continuing process. We will continue to identify particular examples of "hidden" or poorly-specified constraints and attempt to provide further information to proposers on such issues, while continuing to attempt to identify such issues during both technical reviews of proposals and during the peer review process.*

2. *We appreciate the recognition of the importance of staffing levels to continue the planning and scheduling of Chandra observing programs in the face of increasing spacecraft and instrument constraints. This is indeed something to which close attention has been paid. At present, we believe the Mission Planning staffing is adequate for the task, particularly given crucial and evolving contributions from other CXC teams in helping to characterize constraints and strategize about how these can best be met.*

**Instrument Performance and Calibration**

The CUC is pleased that instrument operations is running smoothly, and that no major issue related to instrument operations has affected the observation efficiency during the last 12 months. We express our appreciation to the teams in charge of instrument operations.

The CUC expresses also its congratulations to the calibration teams for their continuous efforts to monitor the instrument performance, and improve their calibration. The range of calibration activities covered by Dr. David in his presentation is truly impressive, and the outcome in terms of update of CALDB files outstanding. The new calibration files being released or soon to be released (ACIS Quantum Efficiency (QE), ACIS low energy gain, HCR-I gain, HRC QE, ACIS background files for the latest 3 years of the mission, empirical HRC-I PSF) will contribute to improving the quality and fidelity of a broad range of *Chandra*-based scientific results, from grating spectral analysis of fainter sources to accurate image deconvolution.

*Recommendations:*

1. The CUC agrees that achieving a full characterization of the time evolution, spatial distribution, and chemical composition of the contaminant on the ACIS filter is the single most important calibration challenge facing the *Chandra* Project, and endorses the choice of investing a substantial fraction of the current in-flight calibration observation plan to understand it. The CUC acknowledges that the problem is complex. It applauds the release by the end of this year of a new contamination model that will allow proper characterization of its spatial-dependence. The CUC recommends continued monitoring of the time evolution, spatial dependence, and chemical

characterisation of the contaminant layer on the ACIS filter as the highest-priority calibration objective.

2. The CUC is pleased that a discussion has started in the *Chandra* Project to evaluate the possibility of CCD annealing (baking-out) to ameliorate the contamination issue. It is understood that this option is not devoid of risks, and should be therefore carefully studied. The CUC endorses the ongoing study and asks that a report on the possible outcomes and risks of this operation are presented to the Committee as soon as the Project considers that a contribution from the community would be useful.

3. In some segments of the astronomical community concerns are expressed on the inter-calibration status among different observatories. Most notably in the galaxy cluster community a lively debate is on-going on how the current uncertainties in the cross-calibration of the effective area of instruments on different observatories (primarily *Chandra* ACIS *vs. XMM-Newton* EPIC) could limit the accuracy of cosmological parameters derived from the galaxy cluster mass function. The CUC acknowledges that the issue is complex, and is aware that efforts are on-going in the framework of the International Astronomical Consortium for High-Energy Calibration to address this issue. The CUC asks the Project to provide its own assessment on whether these discrepancies can be reconciled, and to indicate the paths it intends to follow to achieve this goal. The CUC asks for a short report on this assessment to be presented at the next intermediate CUC meeting in the spring of 2016.

4. The CUC thanks the *Chandra* project for their response to the recommendation on the "single entry point" calibration documentation raised at the prior meeting. The CUC asks the Chandra Project to implement the plan presented to address the "single entry point" CUC request (reported hereafter):

   *"1. Post a single web page that summarizes all calibration uncertainties. This will be a living document that presents the current (based on the latest released version of the CALDB) uncertainties in the effective area, gain and resolution for each detector/ grating as appropriate.*

   *2. Add a link from each uncertainty to the relevant calibration memos, plots and presentations.*

   *3. Most of the work in generating a referred paper will be simultaneously completed during step 2, i.e., the compilation of all relevant materials to include in a paper.*

   *4. Generate a paper to be submitted to A&A.*

   *5. One question which we can discuss at the next CUC meeting, is whether to resubmit the Chandra calibration paper to A&A every few years as the calibration changes, or just keep a living paper on the Chandra web pages."*

   As far as Point#5 is concerned, the CUC recommends that the A&A calibration paper, once accepted, is kept as a living document on the Chandra web pages. A second, and final, version of the calibration paper should be published only after the end of science operations.

*CXC Response:*

1. *The calibration team agrees with the CUC that continued monitoring and calibration of the contamination that is building up on the ACIS filters is the single most important problem facing the CXC calibration team. Over the past year we have carried-out approximately 500 ksec of calibration observations dedicated to monitoring the contamination build-up. For example, we have noticed changes to the chemical composition and condensation rate of the contaminant between July and December 2015. We are presently incorporating these changes in the behavior of the contaminant into our next contamination model which should be released in the Spring of 2016.*
2. *The CXC is continuing to evaluate the risks and rewards of an ACIS bake-out and several decision trees have been created concerning what criteria must be met before giving the go-ahead to a bake-out. Many simulations of the ACIS bake-out process have already been completed and these simulations continue to be refined to determine what focal plane temperatures and bake-out durations are required to remove a significant fraction of the contaminant without producing any detrimental effects on the detector. We appreciate the offer of the CUC to assist with this decision process and will certainly seek their guidance once we have progressed further along the decision tree.*
3. *Discussions have been held during the past few IACHEC meetings concerning a means of reconciling Chandra and XMM-Newton results. A statistical method is presently under development that will hopefully produce concordant EPIC and ACIS effective areas that yield consistent results for all Chandra and XMM-Newton data, not just for clusters of galaxies. The calibration team will give a status report on this project at the intermediate meeting of the CUC as requested.*
4. *The CXC calibration team continues to develop a summary Chandra calibration status page. Most of the work at present concerns updating linked memos and plots so they can be posted on our public web pages. The CXC has also made progress on an A&A paper and we agree with the CUC that this paper should be kept as a living document on the CXC web pages.*

**CIAO Update**

Dr. McDowell presented updates on CIAO, which is a well-documented and sophisticated suite of analysis software tools for *Chandra*. The CIAO team continues to add new useful tools to the suite, further enhancing the capabilities of CIAO; e.g., subpixel simulations are largely improved, a new tool can model the background due to readout steaks, and support for CC grating data is improved. The CUC is pleased with the efforts to improve the PSF-related threads.

Dr. McDowell also provided an update on community support efforts, which include the helpdesk, various workshops, and participation in major meetings. These activities are great avenues to introduce new scientists to Chandra and X-ray astronomy, and help to maintain the vitality of the mission and field. We commend this continued outreach, engagement, and support of the astronomical community.

Last year the CUC recommended that the CXC "consider reallocating resources to scientifically higher priority tasks (e.g., the source catalog)". Dr. McDowell's presentation shows that higher priority is given to the source catalog by the CXC software teams.

The Sherpa team plans to improve documentation and characterization of the MCMC tools, which make Sherpa very powerful for X-ray spectral analysis with complex systematic errors.

*Recommendations:*

1. The CUC recommends that the CXC software teams continue to assign the highest priority to the timely release of the source catalog.
2. The CUC recommends that Sherpa run PyBlocks as the default mode for ACIS spectral analysis, outputting the confidence intervals on the spectral model parameters due to the systematic calibration uncertainties on the effective area besides the purely statistical uncertainties. This innovation should trigger users to ask if calibration systematic uncertainties affect their science, and to be aware of the associated - and very good - PyBlocks-related refereed papers and on-line documentation. However, to adhere to the spirit of the previous recommendation, we also recommend that implementing this recommendation be prioritized so that it does not interfere with the timely completion of the source catalog.
3. We recommend continuing the effort towards community support through workshops and other means, as outlined in the presentation.

Response from CXC/SDS:

1. *We concur that the timely release of CSC Rel 2 remains the highest priority for 2016.*

*2. The suggestion that PyBlocks be the default fitting mode for Sherpa ACIS spectral analysis is interesting. We feel that we are not quite ready to do this; in particular, we think that more user-friendly interfaces to expose and visualize the details of the MCMC fitting process will be needed to let the average astronomer have sufficient confidence in their own understanding to publish results obtained in this way. We intend to pursue this as resources allow, but progress is likely to be slow until the catalog work is complete.*

*3. We are glad the CUC supports our efforts on community support and we are enthusiastic about continuing them.*

**Einstein Fellowship program**

The Einstein Fellowship program continues to be a valuable resource for talented young scientists in NASA's Physics of the Cosmos research areas, and CDO's stewardship of this program is commendable. The oversubscription rate of factors of ten and higher demonstrate the high desirability of such positions. Efforts underway by the CDO to produce a guide of practical information for fellows, and move the institutional endorsement letter to after the acceptance phase, are good steps in keeping the focus on the excellent science projects while minimizing worries and reducing work for applicants and sponsors. The committee was especially pleased to hear about the fellowship changing to accommodate life situations in relaxing the strict 3 year upper limit since PhD to include an additional year (with justification). Efforts to make NASA fellowships more uniform with respect to employment status are also good steps. Specifically, the fellows will have the option of having either employ or stipendiary status at their host institution. This is mandated by NASA and is intended to provide more flexibility to the fellows regarding benefits, taxes, visa status, travel regulations, etc.

The committee was pleased to hear about efforts to collect information on alumni and their current status, as well as to connect current Einstein fellows with alumni through an informal mentoring network.

*Recommendations:*

1. The committee recommends a couple of possible ways to strengthen the alumni-fellow connection, either by inviting one or more alumni to the symposia, possibly in keynote speaker roles, or to move the symposium to different locations for a larger interaction cross section with the alumni community.

Response from the Einstein Fellowship Program:

*We appreciate the CUC's endorsement of recent program efforts. Alumni were invited to the Oct 2015 symposium, and will be invited for future symposia. Hosting in other locales adds additional cost overhead to fly in program staff, so has not been seriously considered in the past. However, every several years, we offer to host the symposium at GSFC. Connection of current fellows with alumni is being expanded through the new mentorship program; we are monitoring its early use, and soliciting and considering ideas for expansion and possible coordination across all 3 NASA named fellowship programs.*