# Science Data Systems report to the Chandra Users Committee

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- on behalf of -

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The SDS Team

# Topics

- SDS Status and Plans
- Releases and Staffing
- Chandra Source Catalog
- Sherpa/CHiPS
- Bad Pixel Files
- SAOSAC  (Time Permitting)

# Status summary

- Data system release DS7.68 - June
- Resync pipeline with CIAO3.3
- HRC dead time file for L2
- Other infrastructure:
  - Data system release Aug - aspect upgrades
  - Data system release Sep. - optional chips

# Status summary

- CIAO 3.4 Release with Serial CTI, Tools
- Catalog - Working through science issues, preparing for production runs
- Sherpa/ChIPS
  - Substantial progress, although interface not yet complete
  - Working applications, science functionality under test
  - Release plan: Beta release scheduled for Feb

# Plans for 2007 and Beyond

- Merging observation scripts - early 2007
- CIAO4 Beta - Feb. 2007
- Catalog - Spring 2007
- CIAO4 full (with Sherpa/CHiPS CLI) - 2007
- Improved spectral extraction and PSFs (R&D)

# CIAO 3.4

- Release early December
- Depends on Cal delivery of new ACIS CTI calibration, and assuming no further changes to algorithm
- Final testing underway
- Highlights:
  - Support for serial CTI correction on BI chips
  - HRC support tools
  - PHA channel bug fixed

# CIAO 3.4: ACIS CTI

- Cal is providing serial CTI data
- Infrastructure must allow users to get correct responses from CALDB in multiple cases, e.g.:
  - No CTI Correction
  - Parallel CTI Correction but no Serial CTI
  - Serial and Parallel both Corrected
- Requires additional bookkeeping keywords in 10 tools, and proper responses generated for each possible combination
- New serial CTI algorithm in acis_process_events

# CIAO 3.4: Dead area

- Up to 4 percent effect - Cosmic rays removed onboard, but reduces effective area in each frame
- Correction algorithm implemented
  - ✳ Being tested for 3.4 release
  - ✳ Extensible format for future similar applications (e.g., if Cal creates a "dead area image")
- Treat on statistical basis, with spatial dependence
- Optional parameter in mkarf; off by default

# CIAO 3.4: HRC

- hrc_build_badpix and hrc_dtfstats provided for users
- Tools added to pipeline DS7.6.8 (June 2006)
- Time-dependent dead time correction for HRC; can significantly change after user filtering
- hrc_build_badpix allows users to make their own HRC bad pixel data; uses degap solution
- Without it, hrc_process events could improve degap photon coordinates, but badpix file would be incorrectly registered

# SDS team

- Jonathan McDowell – management, Catalog
- Mike Nowak – management, instruments (pileup, timing), Gratings
- Frank Primini – Catalog lead, source detection, HRC lead
- Margarita Karovska –Testing, Catalog, PSFs
- Glenn Allen – ACIS lead
- Dave Huenemorder – Gratings lead, V&V
- John Davis – Responses, ACIS, MARX
- John Houck – Responses, instruments, Sherpa, ISIS
- Antonella Fruscione – Docs and release support; merging observations
- Doug Burke – Infrastructure (DM/regions), CHiPS lead, tools, Sherpa
- Aneta Siemiginowska – Sherpa lead, stat. methods
- Nancy Brickhouse (part time: spectroscopy data); K Ishibashi (departing)

# Catalog team

- DS science: Ian Evans, Pepi Fabbiano, Arnold Rots, Mike McCollough
- SDS science: Frank Primini, Margarita Karovska, Jonathan McDowell, Mike Nowak
- Science help: Dong-Woo Kim, Scott Wolk; forthcoming: John Houck, John Davis
- Software team: Janet Deponte Evans; team leads Kenny Glotfelty, Yulie Zografou, Dave Pummer and the development staff

# Status summary

- Source catalog pipeline:
  - May, internal release 2.2: archive output files, per-observation pipeline prototype
  - September, internal release 2.3: improved infrastructure and new Beowulf software
- Updating per-observation pipeline with revised requirements
- Merge pipeline definition nearly complete, implementation pending

# Catalog status

- Source catalog:
  - ✳ Requirements document revised, updated
  - ✳ Characterization plan developed, evolving
- Identified prioritization for release 1 and descope; replaced PSF fitting by: aperture photometry for count rates, and moments analysis for extent
- Identified tasks to be completed before production
- Energy bands finalized, tested detection of sources with unusual spectra
- Comparing fluxes with COUP, CHAMP

L3 Tasks and Dependencies

| Item# | Task | Effort | R1 Lien | Dependencies |
|---|---|---|---|---|
| 1 | Develop scripts to summarize and display source output. | S | Y | None |
| 2 | Examine summary outputs for test OBSIDS. | S | Y | 1 |
| 3 | Unit-test new L3 Tools, especially dmellipse and mkpsfsize. | M | Y | None |
| 4 | Determine Optimum Energy Bands for Source Detection for various spectral models. | M | Y | None |
| 5 | Evaluate current variability tests. | S | Y | None |
| 6 | Characterize flux accuracy vs. counts, background, spectral shape. | S | Y | None |
| 7 | Characterize systematic errors in PSFs generated from SAOSAC/PSF_PROJECT_RAY vs. energy band, theta, phi, instrument, and ray density. | L | Y | 4 |
| 8 | Develop and test S/W to compute aperture corrections for single source and multiple, overlapping source regions. | M | Y | 3 |
| 9 | Develop and test S/W to compute aperture fluxes, including overlapping sources. | S | Y | 3,8 |
| 10 | Develop and test S/W to compute limiting sensitivity maps and sky coverage. | S | Y | None |
| 11 | Stage 1A characterization - real datasets, subdivided to provide a range of exposure/background. Characterize limiting sensitivity, sky coverage, false source rates, detection probability, completeness, source resolution efficiency, flux accuracy, absolute astrometric uncertainty. | L | Y | 3,4,5,6,7,8,9,10 |
| 12 | Moments analysis - develop and test S/W to estimate source size from image and PSF moments | M | Y | None |
| 13 | Generate background maps - develop algorithm for generating maps from data, including read-out streaks, and test on 100 OBSIDs. | M-L | Y | None |
| 14 | Characterize accuracy of background maps vs. exposure and instrument and for extended sources of different size and intensity. | L | Y | 4,13 |
| 15 | Develop and test S/W to simulate sources with known flux, extent and variability and inject into L3 datasets. | M-L | Y | None |
| 16 | Stage 1B characterization - Stage 1A plus use of bgd maps, extent vs. flux, exposure, energy band, theta, and relative astrometric uncertainties. | M | Y | 11,12,13,14,15 |
| 17 | Spatial fitting - evaluate algorithms, develop and test S/W | M-L | N | 15 |
| 18 | Determine limiting flux vs. background for S/N derived from spatial fits. | M | N | 17 |
| 19 | Develop and test S/W for handling time-variable exposure in variability tests. | S-M | N? | 15 |
| 20 | Stage 2 characterization - Stage 1A&1B, plus 2-D fitting and time-variable exposure. | L | N? | 16,17,18,19 |
| 21 | Investigate alternatives to forward-fitting for computing fluxes. | M | N | None |
| 22 | Develop and test S/W for combining datasets for aperture photometry, spatial and spectral fitting. | L | N | ? |
| 23 | Analyze gratings data. | ? | N | ? |
| 24 | Investigate vtpdetect, shapelets, etc. for complex and/or large extended sources. | ? | N | ? |

# Catalog tasks - before production

- Scripts to summarize output (done)
- Unit test new tools (done)
- Determine energy bands (done)
- Characterize systematic errors in PSF (to do)
- Software for aperture correction (done)
- Moments analysis (working)
- Background maps (working)
- Simulations (working)

# Catalog tasks - during production

- Characterize flux accuracy
- Evaluate variability tests
- Characterize background map properties
- Stage 1 characterization:
  - Limiting sensitivity, sky coverage, false source rate, detection probability, flux, and astrometric accuracy...

# Catalog short term tasks

- Background:
  - First remove streak map
  - Remove sources and then apply filter
  - Current process still leaves traces of bright sources, experimenting with other filters
- Extent estimate:
  - Working on algorithm to determine error on extent
  - Revised rules for merging sources
  - Needed for merging sources from different obsids
- Simulations
  - Adopted simulation process from D-W Kim

# Sherpa rewrite

- Infrastructure problems, robustness, GPL compliance, performance, maintainability
- New smaller code base, independent from CIAO
- Improved optimization methods
  - LMDIF - improved Levenberg-Marquardt
  - MINIM - simplex method (Sherpa 1 had license issue)
  - New 'Neldermead' simplex under test
  - Monte Carlo with improved convergence method
- Retain existing Sherpa concepts
  - e.g., named components - easier, e.g., for fitting many emission lines in gratings data

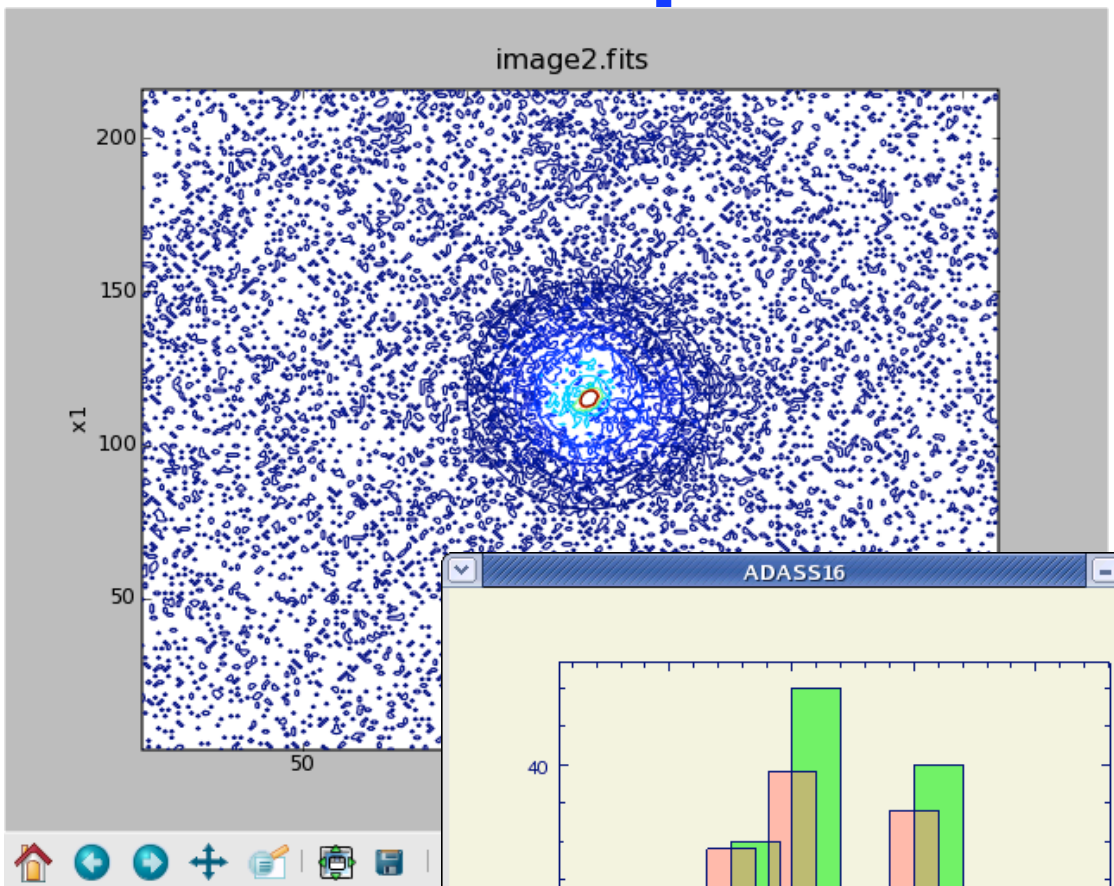
# Sherpa rewrite - 2

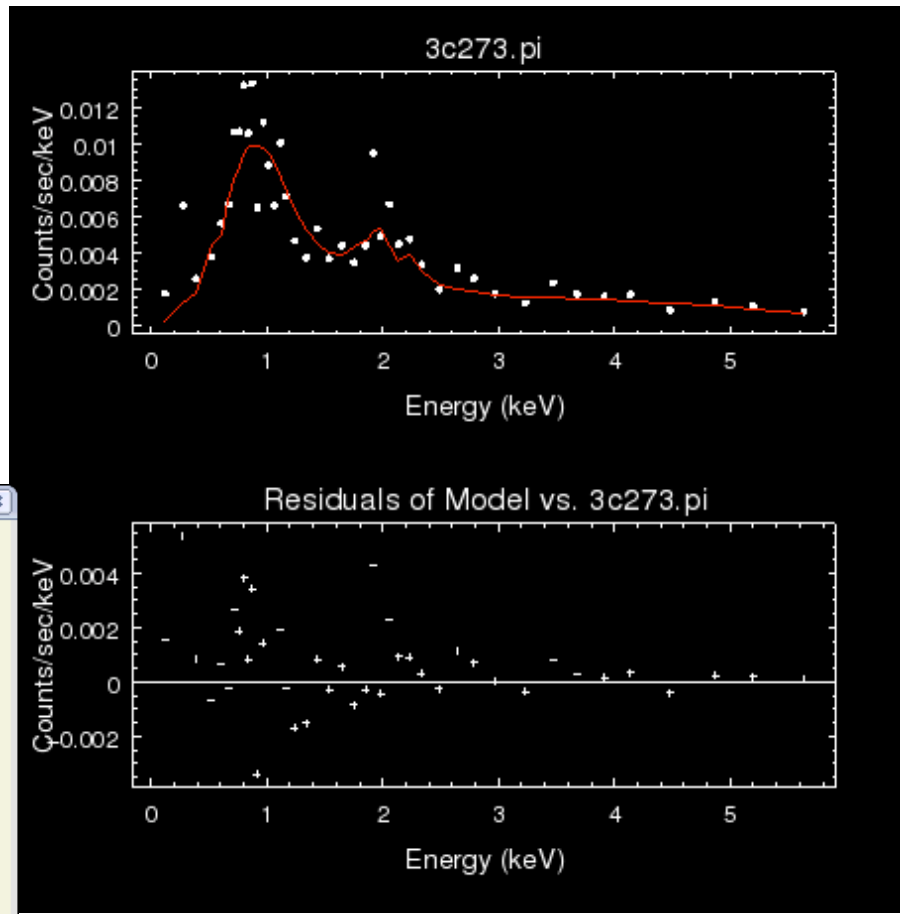
- Improved scripting and plotting
- S-lang and Python interfaces on top of Python API
- Improved integration with Chips package
- Both Sherpa and Chips now modular, standalone
- User survey on interface:
  - ✳ Strong support for command-line interface
  - ✳ Survey and individual feedback confirm "two user types"
    - Most users want simple functionality, and find scripting interface difficult
    - Advanced users who are comfortable with programming-style approach and want the extra power

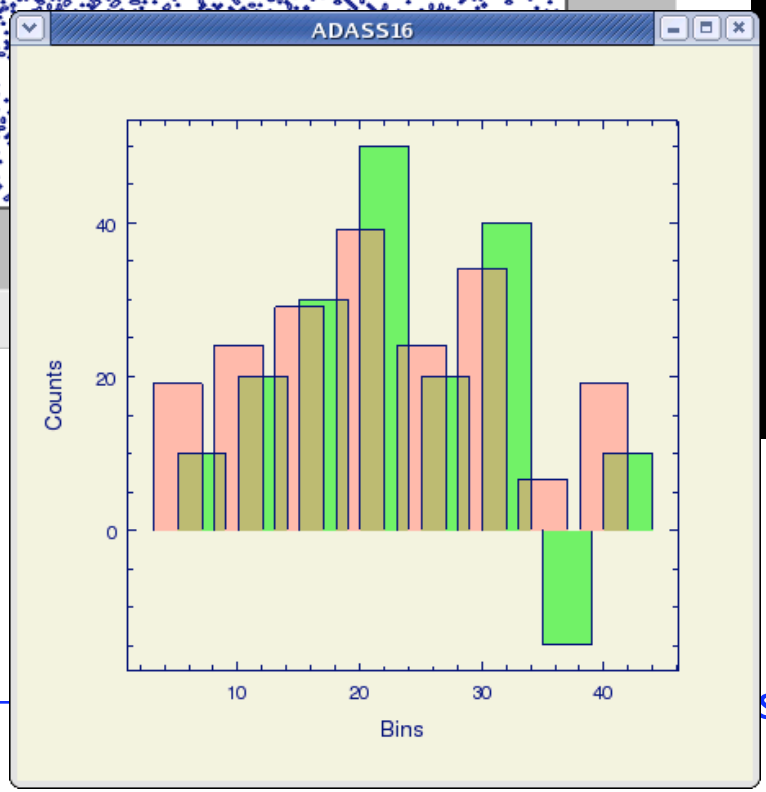
# ChIPS rewrite

- New ChIPS based on VTK
- Line plotting
- Advanced capabilities:
  - Select lines, curves and change their individual properties
  - Define multiple layers, frames
- Consistent infrastructure with S-lang, Python APIs

# Sherpa/ChIPS status



# Sherpa/ChIPS Status

- 4 cycles of internal code release & science testing since last CUC
- Important functionality still being worked on for releases Oct 27, Nov 27
- Implemented new architecture with C++ algorithmic code, Python as application 'glue' and API interface.
- Implemented user interfaces in Python and S-lang.
- Command line interface not yet implemented

# Sherpa/ChIPS Release Plan

- Early demo at ADASS (today!)
  - ✳ Feedback from other developers
- Pre-Beta demo at AAS (January)
  - ✳ Early feedback from astronomers
- Beta release Feb. 2007 (TBR) - Sherpa/ChIPS and tools with improved infrastructure
  - ✳ Science functionality will be complete and robust
  - ✳ S-lang, Python scripting, but no command-line interface
  - ✳ Give exposure to, and get feedback from, advanced users
- Continue to support old Sherpa in CIAO 3.4

# CIAO4 release plan

- Full CIAO 4.0 release later in 2007
- Sherpa/ChIPS with command-line interface similar to existing Sherpa/ChIPS
- Data Model ASCII kernel
- CIAO 4.0 tool set (mostly further bug fixes, some enhancements) with infrastructure improvements
- Also maintain standalone Sherpa/ChIPS releases
  - ✳ Useful for non-Chandra community and other NASA projects needing a fitting package...
  - ✳ ...in turn, useful for Chandra, which is often used as part of multi-wavelength campaigns

# Bad Pixel Files

- Current Bad Pixel Files are our (SDS/DS/Cal) best assessment of what most users need most of the time
- Detector characterization and calibration are easier with limited, reasonable choices
- Customization might be desirable for advanced users
- Exploring providing two choices:
  - Coarse, but simple, control
  - Fine, but complex, control
  - Possibly available on a CIAO 4.0 time scale, or later CIAO release

# Bad Pixel Files

- Simple, coarse control with a 'parameter mask', e.g., ="1111111111111111111111111111111"
  - 0 = no, 1 = yes, 2 = yes (but not adjacent pixels)
  - controls the 32 current bad pixel status bits, e.g.,
    - status bit 2 = bias parity error
    - status bit 5 = events at CHIPX edges
    - status bit 14 = "hot pixels" for entire observation
  - Would turn on/off that "category" for the entire observation
  - Could provide examples of "common" settings

# Bad Pixel Files

- Fine, complex, control with parameter usrfile="bad_pixels.txt", which contains columns:
  - CCD_ID, CHIPX_LO, CHIPX_HI, CHIPY_LO, CHIPY_HI, TIME, TIME_STOP, ACTION (i.e., include/exclude)
  - Would give full control, but necessarily be more complex.
- We are open to other suggestions, but again, there is value in having a limited number of "standard" options

# SAOSAC

- Progress made, but problems encountered. D. Jerius and T. Gaetz (Cal group) working. Recently:
  - 30 packages modified; 45/56 ready for release
  - MultilayerReflect program rewritten
    - Found numerical issues, recoded for stability
    - Reflectivity differences between Solaris, Linux
- 10 percent errors at some energies for some input parameters
- Scattering code bug found, evaluating
- Aperture propagation code rewritten

# SAOSAC

- Work remaining:
  - 11 packages still need work
  - Complete work on scattering code
  - Update surface-intercept code (6 underlying libraries)
  - Port perl scripts (small job)
  - Package up parameter data
  - Resolve OSAC license issue

# SAOSAC - Plan

- Phase 0.5: Provide version to run on Linux, but with possibly wrong answers
- Oct. 06, help with architecture and timing for L3
- Phase 1: Run correctly on Linux
  - ✳ Goal is Nov. 06; Ready for Level 3 source catalog
- Phase 2: Remove hard-coded /proj/axaf paths
  - ✳ Ready to begin wrapping for user release
- Phase 3: Improve architecture, maintainability
- Phase 4: Port other engineering optics code to Linux for long term use by Cal & mission team