CIAO 2.2

Presentations:

Extended Source Analysis:
Martin Elvis, Michael Wise

Grating Analysis:
Dave Huenemoerder

CC-mode Analysis:
Jonathan McDowell, Glenn Allen

CIAO 2.2

Primary focus:

Extended Source Analysis at direction of CUC, users' inputs.

Also:

Improved Grating analysis

Sherpa **enhancements (speed)**

ChIPS **GUI Beta release?**

Many bug fixes, new scripts, threads.

CIAO 2.2

Extended Source Analysis

Analysis Task	**tool**	**current status**
Small Sources		
‘<100% PSF in region’ for `mkarf`	**mkarf**	**underway**
`mkpsf` **output 8 images, weights**	**mkpsf**	**in test**
make chip region on the sky	**skyfov**	**in test**
NaN in DM for a region	**datamodel**	**in test**
profiles counts/area	**dmextract**	**underway**
`Sherpa` **to use 2-D PSF library**	**Sherpa**	**in daily**
`SAOSac` **WWW interface**	**saosac**	**planning**
Large Sources		
Very Faint (5x5) bkgd flagging	**‘part55’**	**in test**
fill image holes	**dmfilth**	**in test**
RMF/ARF averaging	**mkwarf**	**underway**

output 8 interpolation images, weights `mkpsf`

`mkpsf` **in CIAO 2.1 and earlier, outputs a single interpolated image.**

The CIAO 2.2 upgrade will:

(1) allow the (optional) output of all of the 8 *(4 positions, 2 energies)* **images used to interpolate. This will allow the user to assess the accuracy of the** `mkpsf` **interpolation, or to employ their own interpolation scheme.**

(2) allow the (optional) output of the weights applied to each PSF, so allowing for proper normalization of the PSF to the user's source. *(i.e. correcting for the counts in the true PSF that spilled off the area of the stored image. (Inevitably this is a non-zero number.)*

For many purposes a user wants to filter an event or image file to include just the pixels on a single detector element (e.g. ACIS chip).

(e.g. `celldetect` *runs much quicker.)*

`skyfov` **will create a region file including only area that lies on the detector element.**

In CIAO 2.1 pixel values outside of a region used for filtering in the DM (e.g. dmcopy) are currently set to 0. This confuses subsequent programs (e.g. dmstat) into giving incorrect results.

CIAO 2.2 will be able to set pixel values outside a filter region to "NaN" (not a number). This will greatly aid in deriving properties of extended sources, and in using Sherpa to fit several regions simultaneously. The new syntax is

```
[opt null=NaN]
```

and we also support

```
[opt null=-99.99]
```

Example:

```
dmcopy "evt.fits[sky=region(ds9.reg)][bin sky][opt type=r4,null=NaN]" null.img
```

Note: 0, not NaN remains the default because:

(1) When binning a table to an image, one must start off with all pixels zero. No iteration through the region is needed if the null value is zero; in contrast, if the null value is NaN, a computationally expensive iteration through each pixel in the image is required, testing whether it is in or out.

(2) NaNs are still only spottily supported in astronomical software at large. We recommend NaN be used sparingly whenever you might want to use the data files outside of the CIAO environment.

counts/area in radial profiles `dmextract`

CIAO 2.1 `dmextract` **does not include a column of counts normalized to annulus area.**

CIAO 2.2 will add this feature to `dmextract`**.**

In CIAO 2.0 and earlier *Sherpa* cannot use a PSF as a convolution kernel.

CIAO 2.2 will allow the use of the 2-D PSFs provided by `mkpsf` as a kernel,
and also the use of the 1-D radial PSFs derived using `dmextract` from the 2-D PSFs.

Both 1-D and 2-D fits can then be made in *Sherpa* to determine extent parameters for marginally resolved sources.

The PSF libraries, even with interpolation, are too coarsely sampled to provide PSFs that are accurate enough for deconvolution. Hence features that are of order the PSF size are harder to study than they should be.

The correct solution is for users to be able to create a PSF for exactly their source, including *off-axis position*, *focus*, *SIM position* **and** *source spectrum*.

`SAOsac` **is the ray trace suite developed at the CXC to calibrate the Chandra HRMA.** `SAOsac` **was not designed as a portable tool and it would take over a year to convert to a CIAO tool.**

To expedite user access to `SAOsac` **we therefore plan to provide a WWW-based service via a form.**

`SAOsac` **is compute-intensive, so that parallel processing on a number of machines is needed. Even so requests for large numbers of ray traces will not be processed instantly and users will be warned to expect a ∼2-day turnaround.**

Small numbers of ray traces will be processed automatically with an estimated ∼1 hour turnaround.

Since this project does not involve CIAO software it has a schedule which is asynchronous with the CIAO 2.2 release, but we hope to deliver this service on a similar timescale.

Large Extended Source Analysis

flag background in ACIS V.Faint mode `‘clean55’`

In very faint mode ACIS telemeters back 5x5 event islands. These can be used to filter out residual background.
(*as in Maxim Markevitch presentation earlier today.*

CIAO 2.2 will use the algorithm developed by Alexei Vikhlinin to perform this filtering.

See ‘Chandra Contributed Software‘ page:
`http://asc.harvard.edu/cont-soft/software/clean55.1.0.html`

Fill holes in filtered images `dmfilth`

Excising e.g. point sources from an extended source leaves a 'swiss cheese' image. Such images are hard to analyse further, e.g. contour, smooth or fit.

CIAO 2.2 will have a new tool to interpolate across such gaps in an image using a constant value, or a 2-D linear interpolation with Poisson noise added.

The tool is called `dmfilth` for 'fill the hole'.

RMF/ARF averaging `mkwrsp`

Variations in instrument QE (ARF) and gain/resolution (RMF) make it problematic to simply add spectra from different regions.

Under some circumstances this is the preferred method, rather than simultaneous fitting with many responses, or choosing one typical response. An RMF Averaging Report was prepared by a special team which evaluated the requirements.

CIAO 2.2 will adapt the in 'calcrmf' algorithm of A. Vikhlinin for combining RMFs and ARFs with suitable weights.

See the Software swap page:

`http://asc.harvard.edu/cont-soft/software/calcrmf.1.00.html`

The weighting scheme will be enhanced by using *exposure corrected weights*.

A new tool `mkwrsp` **(make weighted response) will be created for this purpose.**

A thread is being written to help in the decision of when it is better to use averaged RMFs, a single RMF or to fit in parallel multiple regions with different RMFs. *(see Mike Wise presentation.)*

CIAO 2.2 Schedule

Date	Description
05 Mar 00	Start CIAO 2.2
15 Mar 01	Start weekly preinstall builds
	for developers and testers
21 May 01	Got SDS specs for RMF averaging code
	(last major 2.2 component)
10 Jun 01	First tools in preinstall for SDS test
29 Jun 01	⇐ *Chandra Users Committee* ⇐ Now
15 Jul 01	Science Unit Test deadline # 1
01 Aug 01	Science Unit Test deadline # 2
10 Aug 01	SW Code freeze
14 Aug 01	Science Unit Test deadline # 3
14 Aug 01	1st complete successful build of CIAO2.2
21 Aug 01	Science Thread Test deadline
24 Aug 01	Complete TOOL regression tests
	on SUN/Linux/Alpha, including new ports
01 Sep 01	Science Unit, Thread, regression Final test deadline
	for early tools
21 Sep 01	Complete SDS regression tests on SUN
	- new code/enhancements
	(includes interation with developers)
05 Oct 01	Complete TOOL regression tests on
	SUN/Linux/Alpha
	with incorporation of new SDS regression tests
12 Oct 01	DS ready to release (development stable)
12 Oct 01	SDS complete XML documentation
12 Oct 01	SDS all documentation/threads done
	DS packaging complete
15 Oct 01	Package testing and WWW updates complete
15 Oct 01	CIAO 2.2 Release

CIAO 2.2 Schedule: Potential Time Savings

Experimenting with new procedures to accelerate 'code freeze to release' timescale:

- **All tools unit tested on all platforms by DS before science testing by SDS.**

- **SDS science testing beginning well ahead of code freeze.**

- **Documentation (ahelp, threads, scripts) beginning well ahead of code freeze.**

- **BUT: MAJOR tools come last (Sherpa, mkwrmf, ChIPS)**
  ⇒ biggest headaches expected there.

Grating Analysis: CIAO 2.2 Changes

Tools & Scripts:

`mkgrmf`: *New tool* **creates grating RMF defining LSF.** *New threads* **create multi-order LETGS response.**

`tg_create_mask`: **Creates FITS regions by default, automatically propagated.**

Zero-order diffraction coordinates: **enhanced for extended source analysis.**

tgextract parameters: **Separate grid parameters for each grating**

CC-Mode: **Bugs fixed in** `tg_resolve_events` **order-sorting.**

mkgarf scripts: **added parameter I/F**

`tg_bkg`: *(script)* **Adds the adjacent background arrays, output to file.**

`add_grating_orders` *(script)* **Adds mutiple orders, Adds +−1st orders**

`add_grating_spectra` *(script)* **Adds adds HEG & MEG spectra. (counts and spectral responses)**

Grating Analysis: CIAO 2.2 Changes - 2

Documentation:

Analysis Guide for Chandra High Resolution Spectroscopy **On WWW. Prominently linked on CIAO pages.**

Planned:

Grating background

Order and grating combination issues.

Destreak effect on grating spectra.

Multi-source extraction. **Grating tools have always been able to accomodate up to 10 sources simultaneously. A thread will make it clearer which parameters to adjust.**

Grating Analysis: CIAO 2.2 Changes - 3

TENTATIVE:

Items are work in progress which could come in CIAO 2.2 as slang scripts.

`Zero-order detection:`

Work in progress on script to intersect streak and MEG trace.

`Summary plots:`

Slang scripts to show:
order-sorting;
zero-order region w/ src position

`Sky region overlay:`

Slang script to overlay approximate wavelength scales in the sky field.

`Visualization, summary scripts:`

Quick-look at the binned spectrum (planned).

Grating Analysis in CIAO 2.2: Details - 1

`mkgrmf`:

New tool: **will create grating RMF which defines the LSF redistribution. This will permit customization of the grid for non-OTS use. Also incorporates updated LSF calibration data containing LSF coefficient parameterizations (as part of CALDB).**

Multi-order response script: **For use with LETGS in assessing high-order contamination, combines ARFs and RMFS for different orders.**

`tg_create_mask`: **Creates FITS regions by default. Regions are automatically appended by tg_resolve_events.**

0-order diffraction coordinates:

To assist extended sources w/ gratings, the zero-order is assigned angular diffraction coordinates (tg_r, tg_d) in the same sense as the non-zero orders. When both HETG arms are extracted, MEG angle is used. If a single-arm mask is used, then the zero-order has tg_r,tg_d aligned with that mask.

This is useful for example, for adding an offset to zero-order to compare w/ diffracted line's image. (and to avoid having to know that the effective plate scale is different from imaging mode).

tgextract parameters more explicit:

Separate grid parameters for each grating type to provide customized grids for MEG, HEG, and LEG. (but due to Type II format, all arrays are still restricted to have the same number of bins).

Grating Analysis in CIAO 2.2: Details -2

CC-Mode:

Bugs fixed in tg_resolve_events order-sorting algorithm. Algorithm failed when a grating arm went off the top or bottom of the array (as for large sim_z offset for dangerously bright sources).

`mkgarf` *scripts:*

Script to run mkgarf (chip-based response) over all chips will be improved to make it a param i/o-style script (so it looks and behaves like other tools).

Background script `tg_bkg`*:*

Adds the two histograms extracted adjacent to the source region and writes to separate PHA file.

Add multiple orders, add gratings spectra:

Scripts have been written to do this. While this is sometimes desired, it is not clear that it is desirable. The preferred technique is joint analysis of multiple PHA spectra.

However, visualization of combined orders and gratings is useful. Slang scripts planned.