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The STIS Calibration Pipeline

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Abstract. The STIS calibration pipeline is a complex collection of software tasks and processes managed by many groups at STScI. The current pipeline for STIS differs in several significant ways from previous pipelines at STScI including data structures and software implementation. CALSTIS can be run both under the IRAF environment and completely outside of IRAF as the user chooses. The STIS pipeline is up and running with all of the basic capabilities for processing STIS data.

1. The STIS Calibration Pipeline Is More than CALSTIS

The collection of software, processes, and personnel that are responsible for the routine calibration of STIS data is quite extensive. Typically, the calibration pipeline is most strongly associated with CALSTIS, the software that actually performs the science calibration of the STIS data. In fact, the pipeline is much more. The complexity of the pipeline process is shown schematically in Figure 1. This figures details the various groups within STScI that are responsible for some portion of the pipeline process as well as the the interactions among the groups. Missing from the diagram, but not missing from the process, is the STIS group at STScI. The instrument group monitors, provides specifications, and supports troubleshooting for STIS-related issues with the pipeline.

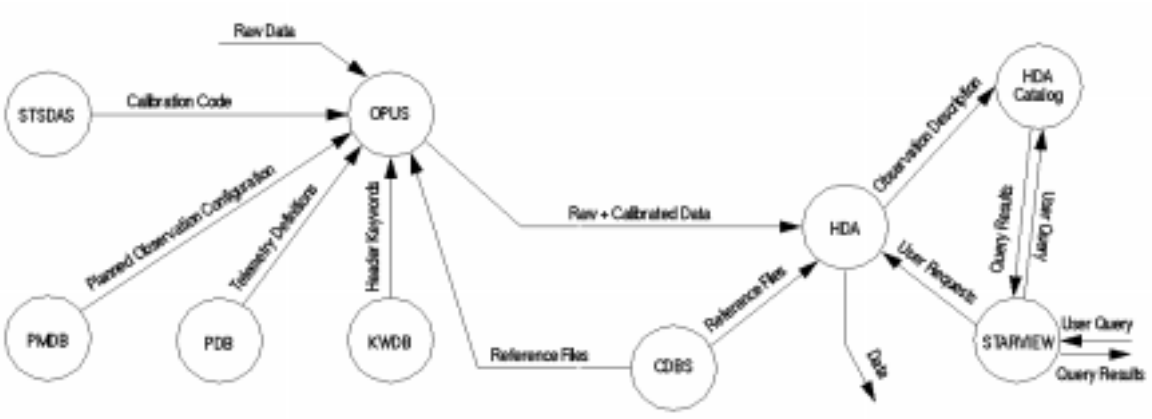

Figure 1. Interactions among STScI groups that form the STIS calibration pipeline.

2. Differences from Previous Pipelines

The current implementation of the routine calibration pipeline for STIS differs from previous pipelines in significant (albeit) technical ways. For example:

- Separate STIS exposures can be (and are) associated in a single file (e.g., WAVECALs, CRSPLITs and REPEATs)
- FITS file I/O is used rather then GEIS. Thus the science, error estimates, and data quality data are image extensions in a single FITS file (this collection of extensions is called an imset) instead of residing in separate files.
- CALSTIS, the software that actually calibrates the data, uses a new interface (`hstio`) for FITS I/O. Additionally, a FITS kernel for images has been added to IRAF and most of the `ttools` have been updated to use the HEASARC FITSIO routines to permit easy access to the new data structures.
- CALSTIS (usually) reads the entire image set into memory making CALSTIS a memory intensive program.
- The CALSTIS code is written in ANSI C and linked with IRAF.
- CALSTIS uses a new C interface (cvos) to IRAF routines.
- CALSTIS tasks can be run as either host programs or IRAF tasks. This simply means the the tasks can be run within IRAF or completely outside of IRAF at the unix operating system level.

3. Running CALSTIS

A single executable is used to perform all calibration steps in the operation pipeline (OPUS). This single executable is also the "parallel" pipeline version available in the STIS package of STSDAS running under IRAF. The single task version of CALSTIS reads calibration switches from the header. We also provide individual executables to perform subsets of the calibration processing. These tasks have pipeline functions but are called individually. In this case, each executable takes switches from the command line. The major components of the calibration software are described in Table 1.

Examples for data processing by the pipeline software are shown in a series of three figures, highlighting important modes of reduction: cosmic ray removal, 2-D rectification and 1-D spectral extraction. Figure 2 shows the processing of CRSPLIT data wherein three raw frames are combined in such a way as to remove the cosmic rays. Figure 3 shows the rectification of a two-dimensional long slit exposure. Figure 4 shows the extraction of the multiple orders of an echelle spectrum and the production of calibrated spectra.

Table 1. Major tasks in the STIS package

Task Name	Processing
CALSTIS	all processing steps
BASIC2D	bias and dark subtraction, flat-fielding
OCRREJECT	cosmic-ray rejection
WAVECAL	WAVECAL processing
X2D	2-D spectral rectification
X1D	1-D spectral extraction
INTTAG	Convert TIMETAG event stream to ACCUM image

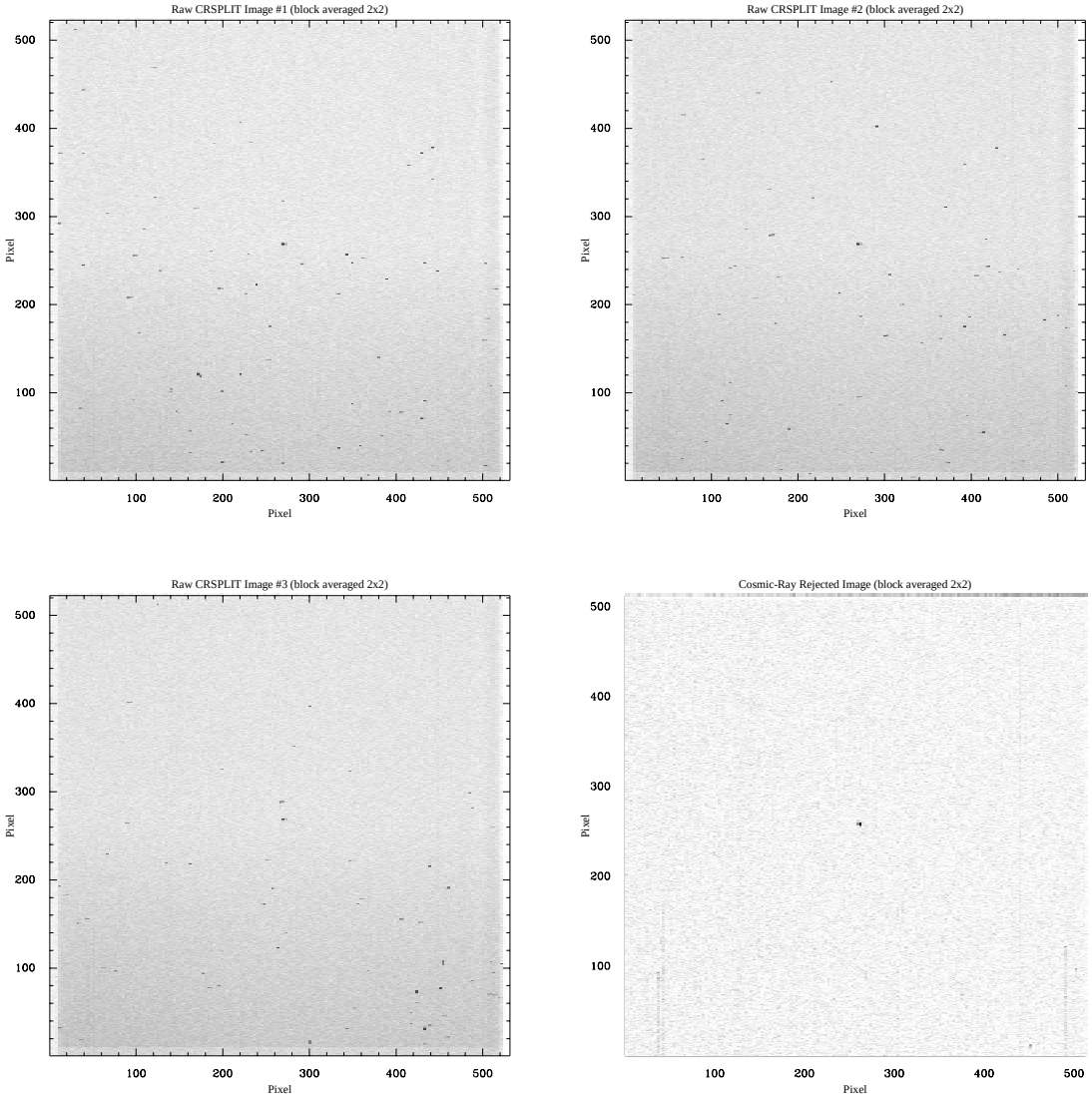

Figure 2. Removal of cosmic rays from a set of STIS imaging exposures. The top two and bottom left images show the raw frames complete with cosmic rays. Can you find the target? The bottom left image shows the corrected image with cosmic rays removed. Now can you see the target?

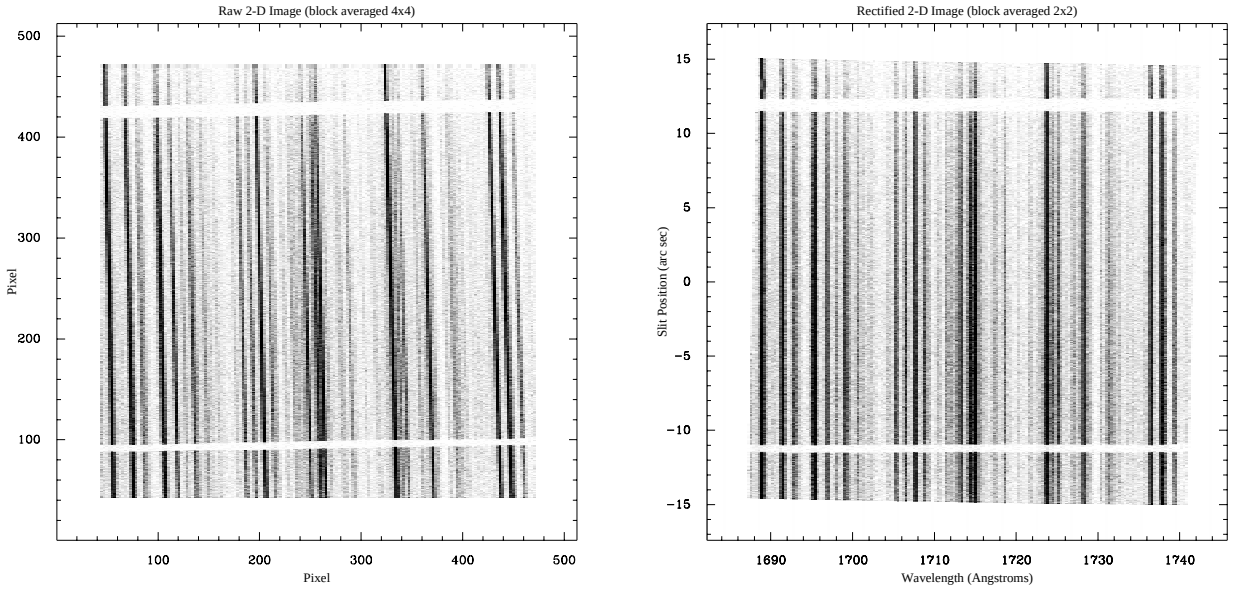

Figure 3. 2-D rectification of a STIS longslit exposure. The raw data are shown in the image on the left. The processed data are shown on the right. In the rectified image, the data have been interpolated onto linear wavelength and spatial scales.

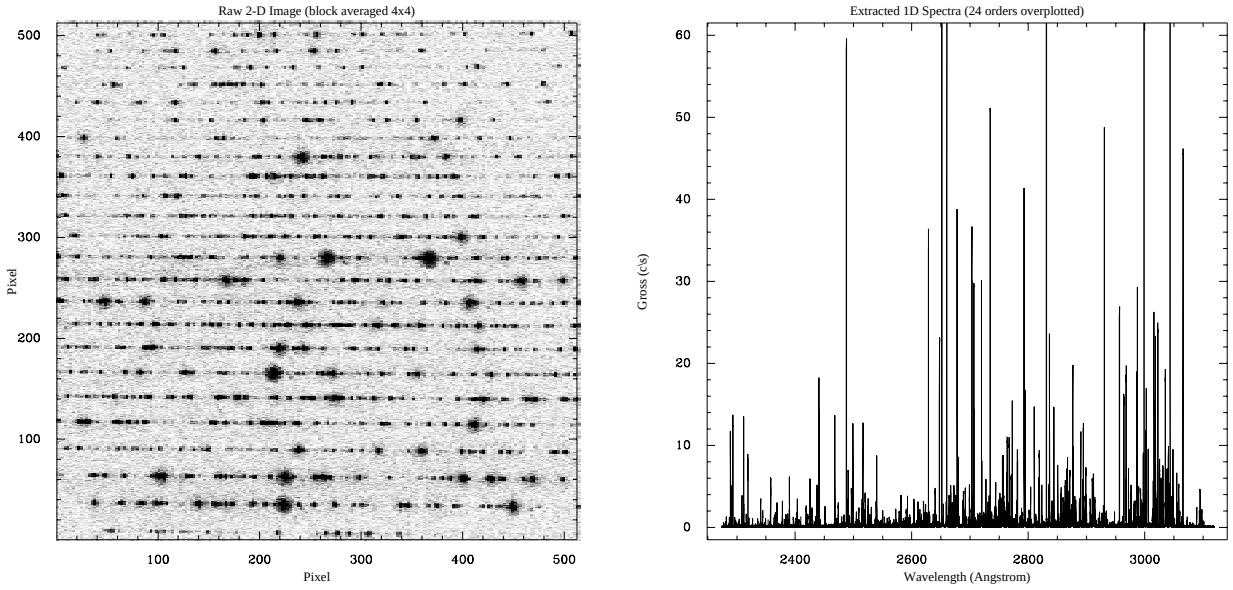

Figure 4. 1-D spectral extraction of multiple orders of an echelle exposure. Raw data on the left; extracted spectra on the right. A total of 24 orders were extracted and overplotted in the line plot. In this case the wavelength scales have not been linearized.

4. Calibration Pipeline Status

The current capabilities of the pipeline include: creation of (associated) STIS data files in FITS format, tracking of STIS calibration reference files, 1-D extraction of echelle observations by CALSTIS, 2-D rectification of longslit observations by CALSTIS and archiving and retrieval of STIS observations. Currently, observations processed through CALSTIS using SMOV (and ground) calibrations have relative wavelengths good to 0.2-1.0 pixels (from dispersion solution), wavelength zeropoints accurate to less than 8 pixels without a WAVECAL and to 0.1-0.2 pixels with a WAVECAL, spatial zeropoints good to 0.2-0.5 pixels and fluxes good to +/- 50%. Please note that the flux accuracies are quite setting dependent; a sensitivity update is planned by the beginning of 1998 after which we expect flux accuracies of +/- 10%.

The best way to keep informed of the status of the STIS calibration pipeline is to regularly visit the STIS web page at `http://www.stsci.edu/ftp/instrument_news/STIS`

5. Planned Enhancements to STIS pipeline

Future enhancements to CALSTIS in the planning stages are primarily expected to be changes to 1-D extraction of spectra. These changes will include: improved background subtraction using the cross dispersion profiles of the spectral orders to properly model the background, flux corrections for point sources for different 1-D extraction boxes and support for optimal extraction. Additionally, the capability to extract 1-D spectra for 1st order grating/longslit observations will be implemented.

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