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Generating Calibration Reference Files with an OPUS Pipeline

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Abstract. Calibration reference file processing can be automated by incorporation into an OPUS pipeline. This paper outlines the processing steps necessary for production of calibration files that are applicable for long periods of time, as well as those that are applicable only to contemporaneous science data.

1. Introduction

OPUS is the data processing software system developed at STScI (Rose et al. 1995, Rose 1998, Swade & Rose 1998). In addition to performing data processing for HST, OPUS is currently being used by the FUSE, AXAF, SIRTF, and INTEGRAL missions.

The current data processing ground system configuration for HST utilizes the capabilities of OPUS with regards to constructing a complex data processing system using a number of OPUS pipelines. OPUS pipelines can be run standalone, in series, or in parallel. A processing step in one pipeline can bridge to another pipeline. This paper presents concepts on how OPUS can be used to incorporate calibration reference file processing into the pipeline production of science data. Two types of calibration reference data will be addressed.

1. Calibration reference files, such as optical and UV darks and flats, that are stable for time scales longer than a few days, can be created and associated with other relevant observations through a database mechanism. For HST, the Calibration DataBase System (CDBS) reference files exemplify this case.
2. For IR observations, the calibration data may only be applicable to a particular observation or set of exposures taken within a short time period. In this case, contemporaneous calibration reference files need to generated and associated with the corresponding science data.

This second mechanism for generating contemporaneous calibration reference files will become more important with future IR observations using the WFC3/IR channel on HST and the NGST science instruments.

2. CDBS Reference Files

Generation of routine calibration reference files can be incorporated into an OPUS pipeline. This provides a more timely mechanism for getting better calibrated data to users, as well as saving the manual effort involved in generating standard calibration reference files. The OPUS pipeline would perform the following steps to create and make available a CDBS reference file:

- In the science data processing pipeline, identify all exposures to be combined into a specific calibration reference file using keywords entered through the proposal submission process,
- Bridge over to the calibration reference file pipeline to collect all relevant associated calibration data with an OPUS Data Collector process,
    - Component exposures are also processed and individually archived,
- In a separate OPUS pipeline, run IRAF/STSDAS scripts to generate a calibration reference file from individual exposures,
- Copy the newly created calibration reference file to a disk in the science data processing pipeline,
- Install the calibration file in the OPUS pipeline by updating the database to use the new file,
    - From this point on, any science exposure entering Generic Conversion, the process in the science data processing pipeline that creates the FITS headers, will use the new calibration reference file,
- Archive the calibration reference file to DADS. It is now available for retrieval by data users.

In addition, the newly created calibration reference file is sent to the relevant science instrument team for evaluation of its quality and to be sure no problems exist with the file. The calibration reference file is installed in the CDBS system, after which it will be available for BESTREF.

3. WFPC2 Darks - a Specific Example

An example of a particularly labor intensive task is the generation of dark calibration images for the HST WFPC2. This process could not only be automated with an OPUS pipeline, but quality of calibration performed in the pipeline could also be improved.

Currently, the WFPC2 instrument executes five long dark exposures each week. These five exposures are combined to generate a weekly dark CDBS reference file. This file is inspected and placed in the science data processing pipeline. About once a year, each weekly dark taken over that period is combined to form a high quality super-dark. The super-dark is made available to data users through the archive, but is not used in the science data processing pipeline.

An OPUS pipeline could perform the following processing for WFPC2 darks:

- The five dark exposures each week could be automatically combined to form a weekly dark that is immediately placed in the science data processing pipeline, archived, and added to the CDBS system. This would both save the manual effort involved in generating the weekly dark and make that dark immediately available for pipeline calibration;
- Alternately, an OPUS pipeline could generate a running super-dark that consists of a combination of all weekly darks over a tunable time period. This running super-dark would be updated with each new weekly dark and used in pipeline calibration instead of the weekly darks;

- All dark files would be made available for inspection by the WFPC2 instrument scientists immediately after they are created.

An identical process could be used for WFPC2 bias exposures.

4. Contemporaneous Calibration Files

Contemporaneous reference files can be handled by OPUS in much the same manner as described above. In this case, there is no point in recording the existence of the file in a database, since it is only applicable to a small number of exposures. A better mechanism is to associate the calibration file directly to the science data through a keyword in the science data header. To generate and immediately use a contemporaneous reference file, an OPUS pipeline would perform the following steps:

- In the science data processing pipeline, identify all exposures to be combined into a specific calibration reference file using keywords entered through the proposal submission process,
- Hold all relevant science data until the expected calibration file is ready,
- Collect all associated calibration data with an OPUS Data Collector process,
    - Component exposures are also processed and individually archived,
- In a separate OPUS pipeline, run IRAF/STSDAS scripts to generate a calibration reference file from individual exposures,
- Make the newly created reference file available to the OPUS science data processing pipeline,
- Populate a keyword in the appropriate science data on hold with the name of the newly created reference file,
- Release the hold on science data, create FITS files, calibrate, and archive the science data,
- Archive the calibration reference file to DADS. It is now available for data users.

5. NICMOS Post-SAA Darks - a Potential Example

The second generation of NICMOS data will utilize a contemporaneous reference file in attempt to calibrate the effect of SAA persistence (Najita, Dickinson, & Holfeltz 1998). Internal dark exposures will be taken immediately after a SAA passage when science exposures are scheduled to follow within 50 minutes. These post-SAA darks will be used to generate a cosmic ray map that can be applied to an image in order to reduce noise from cosmic ray persistence induced by SAA charged particle hits on the detector.

However, generation of the cosmic ray map cannot be automated at this time because it is not possible to remove the DC pedestal prevalent in NICMOS data within a pipeline environment. When, or if, automation of DC pedestal removal is possible, an OPUS data processing pipeline would be capable of utilizing the above scheme to remove SAA persistence.

6. Conclusion

Both types of calibration reference file pipelines described above can be simultaneously integrated into the current OPUS science data processing system for HST. More timely, or contemporaneous, generation of calibration reference files would improve the quality of data produced by the HST science data processing pipeline.

The OPUS baseline system is currently distributed on CD-ROM to help other institutions with their data processing pipeline management (Swade & Rose 1999). The OPUS CD-ROM comes complete with the Process Manager, the Observation Manager, a set of sample applications, and all the resource files required to get a sample pipeline running. In addition, the OPUS CD-ROM and the sample pipeline are fully documented in the OPUS Frequently Asked Questions (FAQ). The FAQ is available on the OPUS CD-ROM or at `www.stsci.edu/software/OPUS/opusfaq.html`.

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