PAPI Documentation

Release 1.0.1

J.M.Ibanez (IAA-CSIC)

December 14, 2011

CONTENTS

Contents:

CHAPTER

ONE

INTRODUCTION

PAPI is an automatic image processing pipeline for data taken with the PAnoramic Near Infrared Camera (PANIC) on the 2.2m Telescope at Calar Alto Observatory. The pipeline currently supports imaging data from camera and is written in Python and C making it portable across many platforms. The automated processing steps include basic calibration (removeing instrumental signature), cosmic-ray removal, treatment for post-SAA cosmic ray persistence and electronic ghosts, sky subtraction, non-linear count-rate correction, artifact masking, robust alignment and registration for large mosaics, weight map generation, and drizzling onto a final image mosaic.

Development Team: Jose M. Ibanez (IAA-CSIC)

1.1 Caveats

Currently it is only possible for PANIC to reduce data taken with the Observing Tool (OT), but not manually with GEIRS. PAPI was primarily developed and optimized for reducing broad-band imaging data of extragalactic sources (such as imaging data taken for field galaxy surveys and galaxy cluster surveys). Other types imaging data have been reduced with PAPI but YMMV (See *troubleshooting* for tips). PAPI is **not** designed to reduce any kind of field taken with PANIC.

1.2 Prerequisites

These software must be install for PAPI to run:

- python (2.4 or 2.5)
- sqlite (v3.0 > if using Python 2.4)
- pysqlite (v2.2.0 > if using Python 2.4)
- stsci_python (v2.2 >)
- SExtractor (v2.3.2 >)
- SAO DS9 and XPA (if applying user defined masks)

1.3 Download

Download the papi_latest.tgz file and the papi_reffiles.tgz file.

- papi_latest.tgz

- papi_reffiles.tgz

1.4 Installing

1. Unzip and untar the PAPI files in a suitable location.
   - tar zxf papi_X.X.X.tgz
   - ln -s papi_X.X.X papi
   - cd papi
   - tar zxf papi_reffiles.tgz
2. Build the source
   - cd src
   - make
   - make install
3. Edit `papi_setup` script
   - Modify the PAPI_DIR and PAPI_PIPE in the papi_setup.[sh][.csh] file in the PAPI bin directory
   - Add the papi_setup.[sh][.csh] to your .bash_profile or .cshrc (.tcshrc)
     - Bash: `.  $PAPI_DIR/bin/papi_setup.sh`
     - CSH: `source $PAPI_DIR/bin/papi_setup.csh`

Example papi_setup.sh:

```
#-----------------------------------------------------------------------------
# User Configurable Settings
#-----------------------------------------------------------------------------

# path to PAPI directory
export PAPI_DIR=${HOME}/pipelines/papi

# path to PAPI output data products
export PAPI_PIPE=${HOME}/Data

#-----------------------------------------------------------------------------
# Fixed Settings
#-----------------------------------------------------------------------------
# path to PAPI reference files
export PAPI_REF=${PAPI_DIR}/PAPI_REF
export PATH=${PATH}:${PAPI_DIR}/bin
export PYTHONPATH=${PYTHONPATH}:${PAPI_DIR}/lib
```

CHAPTER TWO

USER GUIDE

This will contain instructions for end users of the application.

CHAPTER

THREE

DEVELOPER GUIDE

This will contain instructions for developers of the application.

CHAPTER

FOUR

MODULES

The PAPI pipeline includes N processing steps from basic calibration to generating final co-added registered mosaics (See table below). Among these steps are steps for successfully handling three of the most common PANIC anomalies: electronic ghosting, the pedestal effect and cosmic-ray persistence. Electronic ghosts occur when a bright object is observed in one of the four quadrants on a PANIC detector. This results in an echo of the bright object in the other three quadrants. The module undopuft attempts to remove these artifacts. The pedestal effect is the result of variable biases in each of the four PANIC quadrants - leaving a significant pedestal signature in the processed data.

Module	Description
`papi`	Ingest uncalibrated data and builds a SQLite database containing fits header data
`calDark`	Removes electronic ghosts (a.k.a. the “Mr. Staypuft” effect)
`calDarkModel`	Basic calibration, sky subtraction/pedestal effect removal, cosmic-ray rejection
`calBPM`	Removes cosmic-ray persistence signal if target was observed shortly after the SAA
`calDomeFlat`	Removes residual instrument signatures by subtracting a “super-median” reference image
`calTwFlat`	Uses bicubic spline to flatten the background
`calSuperFlat`	Corrects for count-rate non-linearity
`calGainMap`	Apply user-defined masks (optional)
`calNonLinearity`	Uses object matching algorithms to improve image alignment and registration
`checkQuality`	Creates accurate *RMS* maps for use with MultiDrizzle
`eval_focus_serie`	Creates final CR-cleaned, distortion-free drizzled image mosaics using multidrizzle
`astrowarp`	Create final aligned and coadded frame using SEx,SCAMP and SWARP

4.1 papi

The `papi` module in the main PAPI routine that start the data reduction. It starts by creating a subdirectory in the `PAPI_DIR` using the run name give on the command line. Within the run directory the following subdirectories are created:

Directory	Description
`CALIB`	A copy of all the uncalibrated input data and the output processed data products for modules `undupuft` through `nonl`
`ALIGN`	Output processed data products for modules `weightmap` through `mdrizzle`
`FINAL`	The final data products (final image mosiacs, weightmaps and context images)

NICRED creates a SQLite database to store the uncalibrated input data fits headers and pipeline metadata:

Table	Description
`headers`	Select FITS header keywords for all input images
`run_log`	Runtime log messages
`run_pars`	Value of each runtime option
`run_status`	Runtime status information for each module
`raw`	A *VIEW* of the header table listing only the raw FITS image headers

4.2 undopuft

The `undopuft` module attempts to remove the electronic ghosts that can appear when observing a bright source. For details see Electronic Ghosts: Mr. Staypuft, Ringing, and Streaking.

4.3 calped

The `calped` module performs basic instrumental calibration (dark current subtraction, flat fielding, conversion to count rates, and cosmic ray identification and rejection) and attempts to remove the NICMOS pedestal effect. These task are performed by the STSCI IRAF package tasks calnica and pedsky.

The NICMOS pedestal effect is the result of variable biases in each of the four NICMOS detector quadrants these varying bias levels can leave a significant pedestal signature in the processed data. For details see the NICMOS anomaly page Residual Bias (Pedestal)

NICRED runs all of the calibration steps provided by calnica in the default sequence with the exception of one additional step. Before the calnica cosmic ray identification and removal step *CRIDCALC* is run NICRED runs an additional step to improve the cosmic ray rejection. For NICMOS MultiAccum mode observations, *CRIDCALC* assumes that accumulating background counts over the entire observation is a linear function. This assumption may not be the true for all observations. Depending on circumstances of the observation the background count rate may vary over the duration of the observation. In order to determine if the background count rate is sufficiently non-linear, NICRED computes the median of the first and last three readouts of the MultiAccum observation. If the NIRCED finds the count rate has varied it applies the additional step of running pedsky on each of the individual readouts in the MultiAccum observation. This additional step assures the background count rate is linear before running the *CRIDCALC* step.

4.4 saaclean

The `saaclean` module removes cosmic ray persistence due to observations following an HST transit of the South Atlantic Anomaly (SAA). See Removing Post-SAA Persistence in NICMOS Data. NICRED uses the PyRAF task `saaclean` to perform this processing.

4.5 medsub

The `medsub` module attempts to remove any residual instrument signature left over after basic calibration by subtracting a “super-median” reference image. These super-median images are created by median stacking a large number of images that have been processed by the NICRED modules `undopuft`, `calped` and `saaclean`. Many super-median reference images (based on various camera, sample-sequence, observation window or HST proposal ID, and filter combinations) have been pre-generated and are provided in nicred_reffiles.tgz.

`medsub` uses the following criteria for determining which super-median image to use:

1. Same camera.
2. Same sample sequence.
3. Same filter.
4. Same HST proposal ID (PROP_ID fits header keyword). Or..
5. The super-median reference image with and observation date nearest the observation date of the input image.

4.6 `flatten`

The `flatten` module attempts to remove any discontinuities between the four quadrants of a NICMOS camera 2 or 3 image. Discontinuities between quadrants can occur when an exposure contains a large bright object in one of the quadrants.

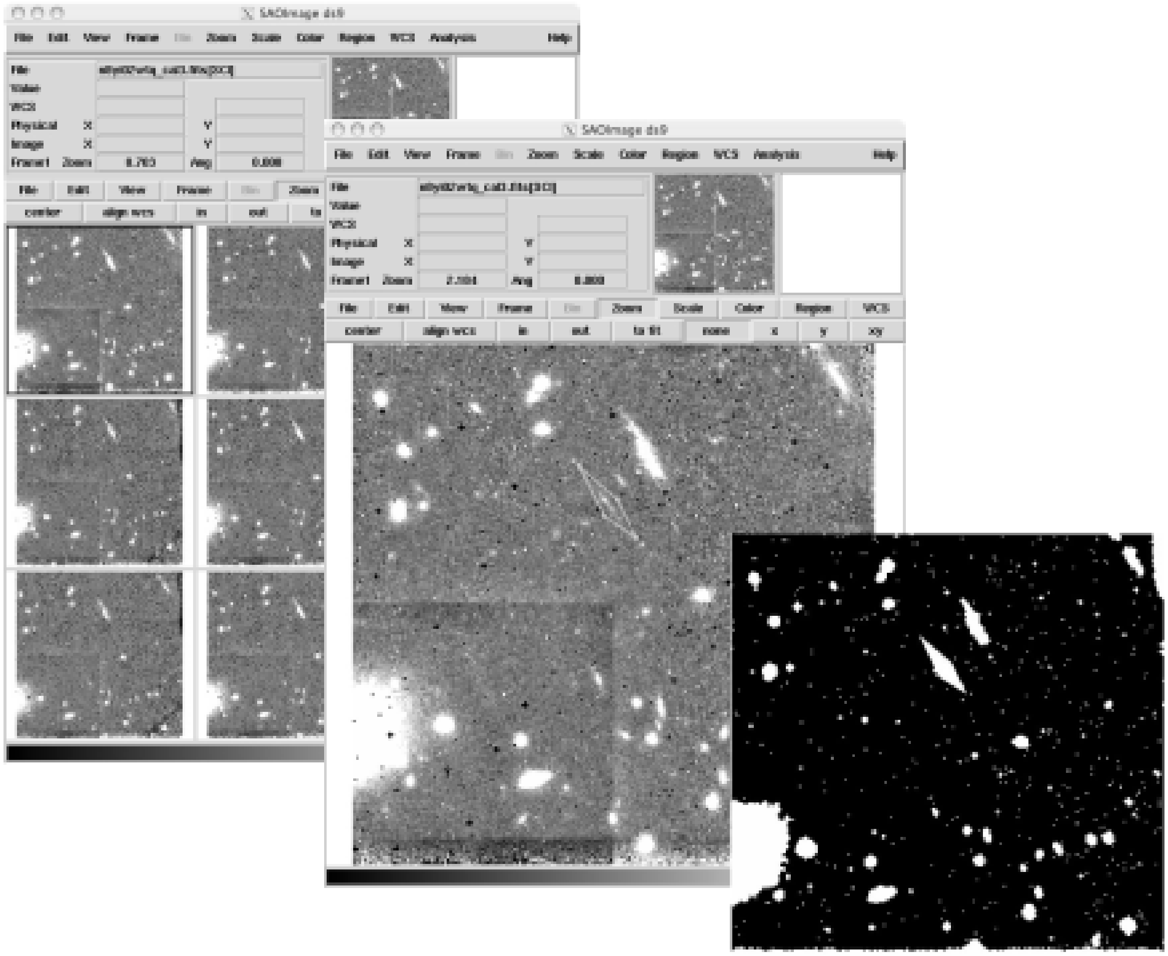
4.7 `nonlincor`

The `nonlincor` module corrects NICMOS images for their count-rate dependent non-linearity. It used the header keywords CAMERA and FILTER to determine the non-linearity parameter. It corrects the first image, and in the case of a multi-extension image, the second image as well, with the appropriate power law. For details see Correcting the NICMOS count-rate dependent non-linearity

4.8 `applymask`

NICRED has the ability to mask any residual artifacts that may occur in one's data (e.g., as may occur when satellites pass through the HST focal plane). Masks are easily generated using SAO's DS9 image display tool using the following procedure:

1. Display all `_cal4.fits` images in DS9.
2. Marked artifacts on each image with the DS9 polygon region tool.
3. A script is run that saves a DS9 region file for each image which has a marked artifact.
4. A second script is run that applies the marked regions in these region files to the associated image's data-quality array.



4.9 align

The `align` module uses the external package `superalign` to determine the internal shifts and rotations for an arbitrary number of (overlapping) contiguous images from a set of (distortion free) catalogs. It requires good initial guesses for the shifts and rotations (within 2.5 arcsec and 0.5 degrees of the true solution, respectively), and thus is ideal for use with NICMOS HST data where these quantities are approximately known. It offers several useful advantages relative to other alignment programs:

1. It does not require that all images be contiguous with a single reference image. This allows one to construct arbitrarily large mosaics out of individual images.
2. Input catalogs can include substantial (>80%) contamination from cosmic rays.

For more details on `superalign` see the Appendix section *superalign*.

4.10 weightmap

The `weightmap` module generates an inverse variance weigh map image of each input image as input to MultiDrizzle.

Where *D* is the dark image; *A* is the amplifier glow image; *G* is the gain; *B* is the average background as computed by `calnica`; *sigma* is the readnoise; *f* is the inverse flatfield image; and *t* is the exposure time.

4.11 `mdrizzle`

The `mdrizzle` module performs cosmic ray rejection and combination of dithered observations using the STSCi software package MultiDrizzle. For a complete discussion of MultiDrizzle and the Drizzle alorgithm for combining dithered imaging data see the MultiDrizzle Handbook Wiki.

CHAPTER

FIVE

INDICES AND TABLES

- *genindex*
- *modindex*
- *search*

INDEX