

7.4 ACS/WFC: Optimizing the Image Sampling for a Single Visit

Introduction

This example describes the combination of four ACS/WFC images, obtained using the `ACS-WFC-DITHER-LINE` pattern, which includes subsampling in the x and y directions, and a large offset over the 50 pixel-wide WFC chip gap. Several `astrodrizzle` runs using different parameter values are used to determine the best settings for optimizing image sampling.

Summary of Steps

1. Description of the data.
2. Run `astrodrizzle` with *final_scale* of *0.03* arcseconds using three *final_pixfrac* setting: *0.1*, *0.6*, and *1.0*.
3. Evaluate the results to determine which parameters provide improved image resolution while preserving signal-to-noise to an acceptable level.

7.4.1 Description of the Data

Data for this example are images of the galaxy NGC 4449 (Program 10585), obtained by the ACS/WFC using the F555W filter. These four images were obtained using primary and secondary two-point `ACS-WFC-DITHER-LINE` patterns. The primary dither pattern had a large offset to cover the 50 pixel-wide WFC chip, while the secondary dither pattern was a two-point subpixel dither at each point in the primary pattern. Offsets in the detector x and y direction are shown in [Table 7.6](#) as `POS TARG` values in arcseconds.

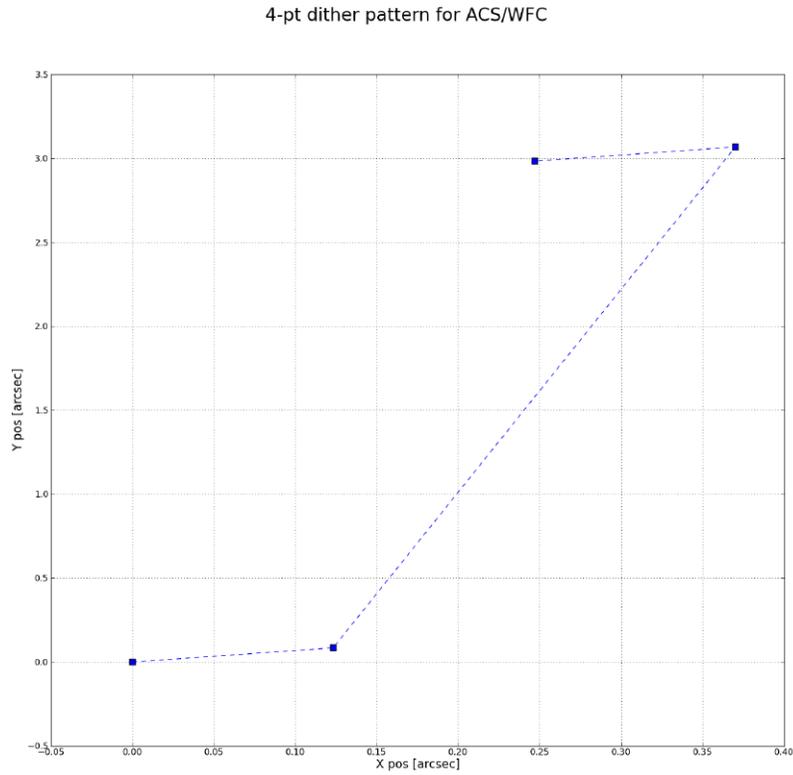
Table 7.6: Summary of Images in this Example

Image Name	Association ID	Proposal ID	Visit & Line Number	POS TARG ¹ (x,y in arcsec.)	PA_V3 Orientation (degrees)	Observation Date	Exposure Time (sec.)
j9cd01kq_q_flc.fits	J9CD01020	10585	01.002	0.0000,0.0000	141.2433	2005-11-10	608.00
j9cd01l5q_q_flc.fits	J9CD01020	10585	01.002	0.1232,0.0839	141.2433	2005-11-10	615.00
j9cd01mfq_q_flc.fits	J9CD01020	10585	01.002	0.2469,2.9838	141.2433	2005-11-10	616.00
j9cd01ldq_q_flc.fits	J9CD01020	10585	01.002	0.3700,3.0677	141.2433	2005-11-10	621.00

1. `POS TARG` are commanded offsets. The actual measured offsets would be slightly different.

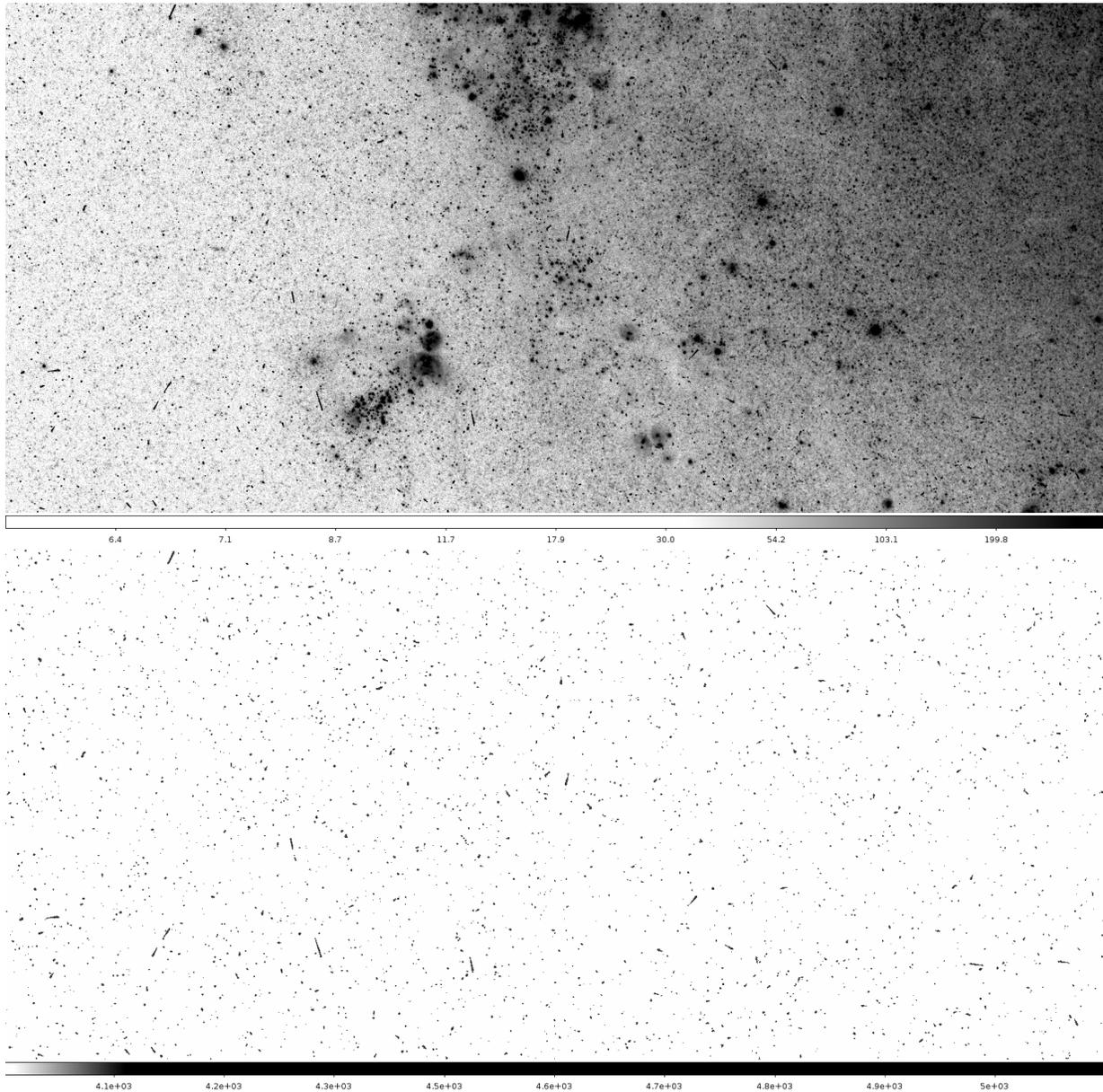
These images are flat field-calibrated by `calacs`, and the `flc.fits` extension indicates they were corrected for CTE.

Figure 7.25: Dither Pattern Used for these Observations



Pattern includes subpixel sampling and large offset in y for covering the CCD gap.

Figure 7.26: Science (Top) and Data Quality Arrays (Bottom) of the First Image in the Association



The bottom image has been scaled to only show cosmic ray bits.

As described in [Section 2.2](#), subpixel dithering has the potential to improve the resolution of the final combined image. Input pixels may be “shrunk” before being transformed to the subsampled output image. This is done to create a smaller input “footprint” in the output frame. The shrunk pixels, also called “drops,” rain down on the subsampled output frame where each shrunk input pixel is averaged into an output pixel with a weight proportional to the area of overlap between the “drop” and the output subsampled grid.

If the drop size is too small, not all output pixels will have data added to them from each input image. Care should be taken in selecting a drop size that is small enough to avoid degrading the image, but large enough to provide reasonably uniform coverage in the final output image. The drop size is controlled by the **astrodrizzle** parameter called *final_pixfrac*, which is the ratio of the linear size of the drop to the input pixel (before geometric distortion corrections). The level of subsampling for the output image is specified by the *final_scale* parameter.

Values for *final_pixfrac* and *final_scale* depend on the number of input images and the size of the shifts. In this example, the dither pattern provides some subsampling so the resolution can be improved. Ideally, the best scale is half that of the native scale, but to avoid degrading the PSF, users should not excessively decrease the value of the *final_scale* parameter.

For this example, a *final_scale* value of **0.03** arcseconds/pixel is adopted, which is 60% the linear size of the native plate scale (0.05 arcseconds/pixel.). A series of experiments will be run to determine the best *final_pixfrac* value for the selected output image scale.

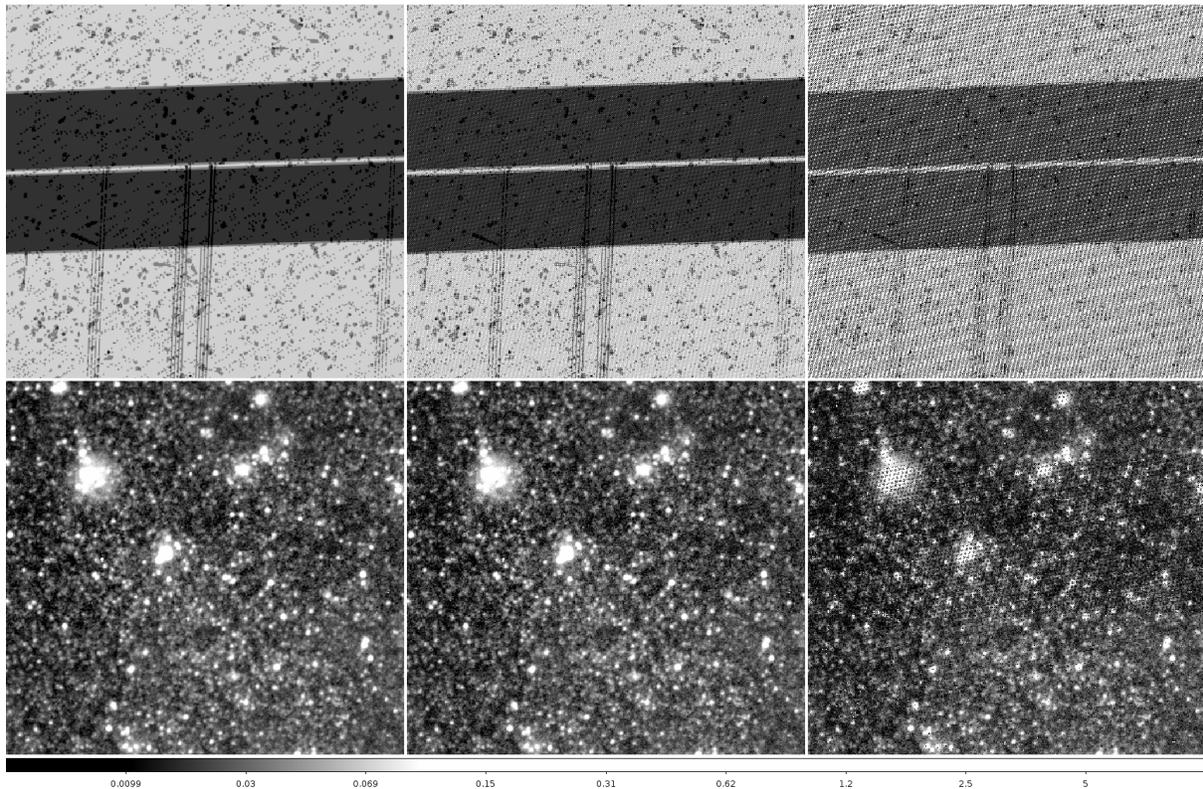
As suggested in the [HST Dither Handbook](#), statistics performed on the drizzled weight image should yield a RMS/median value less than 0.2. This threshold controls the trade-off between improving image resolution versus increasing background noise due to pixel resampling.

A series of **astrodrizzle** commands, executed in PyRAF, can be written to create a test grid of different *final_pixfrac* values. Default values have been used for the parameters, except for *final_pixfrac* and *final_scale*. In the example below, three *final_pixfrac* values are used to illustrate its effect on the image quality: **1.0**, **0.6**, and **0.1**.

```
--> import drizzlepac
--> from drizzlepac import astrodrizzle
--> unlearn astrodrizzle
--> astrodrizzle.AstroDrizzle('*flc.fits',output='test1',final_scale=0.03,final_pixfrac=1.0)
--> astrodrizzle.AstroDrizzle('*flc.fits',output='test2',final_scale=0.03,final_pixfrac=0.6)
--> astrodrizzle.AstroDrizzle('*flc.fits',output='test3',final_scale=0.03,final_pixfrac=0.1)
```

Each **astrodrizzle** run produces three images; the science file (suffix *drc_sci.fits*), the weight map (*drc_wht.fits*), and the context image (*drc_ctx.fits*).

[Figure 7.27](#) shows the central region of the science and weight images produced by *final_pixfrac* values of **1.0**, **0.6**, and **0.1**. The science image with the smallest *final_pixfrac*, **0.1**, shows a noisy background with hot pixels improperly removed. There are “holes” in the images where no input pixels fall into the output grid because they have been shrunk too small. Inspection of the weight map corresponding to the smallest *final_pixfrac* value shows many places with weights of zero, indicating that a *final_pixfrac* value of 0.1 is clearly too small, and was only included in this example for illustrative purposes.

Figure 7.27: Results for Three Tests with *final_pixfrac* Values of 1.0, 0.6, and 0.1

Left column corresponds to *final_pixfrac* = 1.0, the middle column corresponds to a *final_pixfrac* = 0.6, and the right column was created using *final_pixfrac* = 0.1. The top row shows the weight maps, and the bottom row shows the science frames.

Weight statistics, (RMS/median) for each trial are obtained for a 500x500 pixel box in the center and lower right corner of each weight image. Statistics for the weight image created with *final_pixfrac* of 0.6 meet the general requirement of RMS/median < 0.2. A visual inspection of the weight image shows how the RMS varies over the field of view, due to changes in geometric distortion over the chip where input pixels cover different areas on the sky. (For more information, refer to the discussion on [Pixel Area Maps at the ACS website](#).)

Determining the best solution for drizzle-combining images will also depend on the position of the target on the detector. For a compact source in the lower right corner of the image, one could set *final_pixfrac* to 0.5. For this example, however, objects are distributed over the entire field so a *final_pixfrac* of 0.6 is found to provide the best result, where the RMS/median does not exceed 0.2 on any portion of the detector.

Figure 7.28: Weight Map Statistics in a 500x500 Pixel Box at the Center and Lower Right Corner of the Image

