



Technical Instrument Report WFPC2 2008-02

Updated Procedures for Creating a WFPC2 Yearly Superdark

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ABSTRACT

We describe the procedure used to make the “final” WFPC2 superdark in early 2008. The superdark file is generated from one hundred and twenty weekly dark frames taken during the previous year(s), and is used to produce weekly dark calibration files which are in turn used to calibrate all WFPC2 observations. The new procedure is similar to that used in the past, but contains important modifications to deal with the WF4 CCD anomaly, changes in how CTE is treated, and additional steps to flag variable warm pixels in the Data Quality File.

Introduction

Five WFPC2 weekly dark images are taken during each week of operation. These five images and the previous year’s superdark, are used to create weekly dark calibration files. These files are delivered to the archive for use in calibrating all the WFPC2 observations for that week. The basis for each weekly dark file is the previous years superdark, created from 120 of the individual dark frames from that year. The superdark provides the values for pixels with stable dark current, while the weekly darks provide the values for pixels that vary significantly and differ from the superdark pixel values by five sigma or more.

The procedure for creating the 2004 superdark is discussed in Richardson and Biretta 2005 (TIR WFPC2 2005-004). The procedure used for the 2007 superdark is similar, but with various changes needed to address evolution in the instrument’s performance. One

important change is the anomaly in the WF4 CCD, whereby WF4 images now require gain corrections and streak removal to produce optimal data. Another area with important changes is the treatment of CTE tails – we no longer use *dark_ar.pro* for this purpose, but instead use a revised set of input parameters to *mkdark*, which accomplishes many of the same goals. Finally, since the numbers of warm pixels continues to grow, and since the failure of ACS increases the importance of accurate dark calibration for WFPC2, we have made greater efforts to identify and flag pixels where the dark current cannot be well-characterized due to time-variability.

Procedure

(1) Select and Retrieve Data

We have added a new selection criteria based on the WF4 bias level, so as to avoid dark frames with large gain errors (and hence large gain corrections) in the WF4 CCD. Only images near the “normal” bias level of 311 are used (i.e. bias > 295). Secondly, we draw the images from a period of 22 months, whereas earlier superdarks generally utilized data from only a one-year timespan. We do this to ensure an adequate number of dark frames, as many are corrupted by the WF4 CCD anomaly, and are rejected by the selection on WF4 bias value. The criteria below produced 141 darks for potential use in the superdark.

Retrieve all darks (.c0h files) between February 21, 2006 and December 3, 2007 that satisfy the following selection criteria in Starview.

Start Time = 02/21/2006..12/03/2007

Gain = 7

Serials = OFF

Exposure time = 1800

Imagetype = Dark

WF4 biaseven > 295.

In Starview custom query generator right click on wp2_biaseven4 (DATABASE STRUCTURE > catalog > wfpc2_primary_data > wp2_biaseven_4) and add it to the general search form which can then be used for choosing WF4 biaseven > 295.

Use the show override (Expert Only) option in Starview to select just the extensions c0f and c1f.

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Only images near the “normal” bias level of 311 are used (i.e. bias > 295). Secondly, we draw the images from a period of 22 months, whereas earlier superdarks generally utilized data from only a one-year timespan. We do this to ensure an adequate number of dark frames, as many are corrupted by the WF4 CCD anomaly, and are rejected by the selection on WF4 bias value.

In IRAF

```
set imtype=hhh
strfits *c0f.fits "" ""
mkdir fits
mv *.fits fits
```

(2) Delete Anomalous Images

Delete the images with anomalies after visually inspecting all the c0h images. From the remaining images any 120 dark images can be chosen. Anomalies include image features such as residual images of prior over-exposure targets, and excessive numbers of cosmic rays.

(3) Apply Corrections for WF4 CCD Anomaly.

The script *fix4sd.cl* is run on the c0h images (see Appendix B). This performs two types of correction – a correction for low gain in the WF4 CCD (including a correction for non-linearity of the A-to-D converter), and a removal of horizontal (X-direction) streaks throughout the WF4 images. (See Biretta and Gonzaga 2005.)

This WF4 correction script is specifically tailored for the superdarks, and is somewhat different from that used on the biases and science data. The primary difference is that the goal is usually to remove all streaks from the images, but here the darks contain real horizontal structure which must be retained in the calibration files. At both low and high CCD Y-coordinates there is horizontal structure associated with the roll-off of the scintillation effect dark current. The method to retain this structure was to subtract a dark reference file from the image (r4c14402u.r3h[4]) which would contain an approximation of the roll-off pattern. Following this, the horizontal streak pattern is modeled in the standard way. As a final step, the streak pattern is spatially filtered to remove low frequencies from incomplete subtraction of the roll-off pattern. And finally the model streak pattern is subtracted from the c0h image. This method will tend to leave some small amplitude of low spatial frequency streaks in the darks, but these will tend to average-out when the 120 darks are combined. While high spatial frequency streaks, which contribute the greatest amount of pixel-to-pixel noise, are removed from the

image. We feel this approach will preserve true or “real” structures in the darks to the greatest extent possible.

(4) Copy Image Files

Copy the corrected 120 darks (c0h files) to the working directory

```
ls *c0h > filesused_c0h.txt
!awk '{print "gcopy /directory/where/c0h/files/are/stored/"$1"
.}"' filesused_c0h.txt >> gcopy.cl
```

In IRAF (in working directory)

```
cl < gcopy.cl
```

(5) Copy DQF Files

Create a subdirectory called all_clf of the superdark working directory and copy all clf files to that directory.

```
mkdir all_clf
cp /directory/where/the/clf/files/are/stored/*clf.fits all_clf

nawk '{sub(/.c0h/, "_clf.fits"); if ($0 !~/xxx/) print}'
filesused_c0h.txt >> filesused_clf.txt
awk '{print "cp all_clf/"$1" .}"' filesused_clf.txt >> cp.cl
```

In IRAF

```
set imtype=hhh
strfits *clf.fits "" ""
!rm -r all_clf
```

The superdark working directory now has 120 c0h files and their corresponding c1h files.

(6) Combine Images with MKDARK

This step incorporates several important changes from the 2004 superdark. For the 2004 superdark, input c0h files were used where an IDL script called *dark_ar.pro* had been run on the files to subtract and remove CTE tails on cosmic rays and bright hot pixels (this step was actually performed during calculation of the weekly darks, and the files were re-used when making the superdark). But tests of applying *dark_ar.pro* to current data showed that it no longer worked very well – there were many pixels with large over-corrections. Apparently the CTE signature has changed significantly from when the script developed many years ago. We decided not to use *dark_ar.pro*, but instead chose to accomplish many of the same goals by using more selective criteria in the *mkdark* task.

By using a lower value of the *readnoise* (in *noisepar*), and more iterations as specified by the *sigmas* parameter, we could cause *mkdark* to reject CTE tails of the cosmic rays. The *readnoise* parameter was reduced from 1.73 to 0.7, and the *sigmas* were changed from (4,4,3,2) to (10,10,8,6,5,4,3). Note that since the *readnoise* and *sigmas* are effectively multiplied by *mkdark*, these changes result in a stricter test for admitting pixels into the final average image, and hence will tend to reject the CTE tails on cosmic rays.

The application of *dark_ar.pro* in making the 2004 superdark also had the effect to remove CTE tails on bright hotpixels. However, we decided to leave these CTE tails in the superdark for 2007, since they are likely to appear in science data, and could be usefully corrected by the superdark. The CTE, of course, depends on the uniform background counts in the images, so is unlikely to be perfectly corrected by conventional dark exposures.

Hence our procedure for 2007 is as follows: combine the darks (c0h) files into three files consisting of 40 darks each using *mkdark*. Using any text editor make three lists, list1, list2 and list3 where list1 has images from 1 to 40, list2 has images from 41 to 80 and list3 has images from 81 to 120 from filesused_c0h.txt.

In IRAF

```
noisepar.readnoise = 0.7
gain                = 7
scale noise         = 0
```

epar mkdark

Image Reduction and Analysis Facility

```
PACKAGE = wfpc
TASK = mkdark
```

```
infile = @list1 Input images
outfile = dark_pt1.r3h Output image name
outfile2= dark_pt1.b3h Output (number of good points) image
name (optio
sigmas = 10,10,8,6,5,4,3 Rejections levels in each iteration
radius = 1.5 CR expansion radius in pixels
pfactor = 0.5 CR expansion discriminator reduction
factor
hotthres= 4096. Hot pixel threshold in DN
minval = 0. Minimum allowed DN value
initial = min Initial value estimate scheme (min, med,
```

```

or file
(noisepa=                ) Noise model parameters (pset)
(fillval=                INDEF) Fill value for pixels having CR in all
input ima
(verbose=                yes) Print out verbose messages?
(mode   =                al)

```

Do the same for list2 and list3.

(7) Create Superdark Image

Combine the three files to create a single superdark and normalize the result to one second. Update the header accordingly.

```

imcalc "dark_pt1.r3h,dark_pt2.r3h,dark_pt3.r3h" "dark_all.r3h"
"((im1+im2+im3)/3.0)/1843.60"
hedit (images="dark_all.r3h",fields="exptime", value=1.0,
add=yes,addonly=no,delete=no,verify=no, show=yes,update=yes)
hedit (images="dark_all.r3h",fields="darktime", value=1.0,
add=yes,addonly=no,delete=no,verify=no, show=yes,update=yes)

```

In WFPC2 the exposure starts at 16.4 seconds after the minute mark on HST clock, and image read-out always starts on the minute mark. So there is an extra time of 43.6 seconds in addition to the exposure time during which CCD collects dark current. Hence the real exposure time is $1800 + 43.6 = 1843.6$ seconds and not 1800 seconds as given by the image header.

(8) Split DQF Files into Subsets

Divide the DQF files into six lists of twenty images each, using python script *list_split.py*

```

ls *clh > filesused_clh.txt

python list_split.py
Input filelist: filesused_clh.txt
Number to select: 20
Random(rnd) or sequently (seq)?: rnd

```

(9) Combine DQF Files

Add the individual dark c1h files to create two new masks, one with flagged pixels for those pixels with flags in ANY of the individual masks, and one with flags for only those pixels that had flags in ALL of the individual masks.

#The expressions used in adding the masks are in the files *par20_or.txt* and *par20_and.txt*.

par20_or.txt reads:

```
im1 || im2 || im3 || im4 || im5 || im6 || im7 || im8 || im9 || im10 || im11 || im12 ||
im13|| im14 || im15 || im16 || im17 || im18 || im19 || im20
```

Using *par20_or.txt* as the *addmasks* evaluation expression produces a mask that has flags set for pixels that are flagged in ANY of the 20 masks being added

```
addmasks "@list_20_1" tmp1.b3h "@par20_or.txt"
addmasks "@list_20_2" tmp2.b3h "@par20_or.txt"
addmasks "@list_20_3" tmp3.b3h "@par20_or.txt"
addmasks "@list_20_4" tmp4.b3h "@par20_or.txt"
addmasks "@list_20_5" tmp5.b3h "@par20_or.txt"
addmasks "@list_20_6" tmp6.b3h "@par20_or.txt"
```

Now combine all six OR masks into a single mask for all one hundred twenty DQF files.

```
ls tmp*b3h > masklist.txt
addmasks "@masklist.txt" dark_bit_OR.b3h "im1 || im2 || im3 ||
im4 || im5 || im6"
imdel tmp*b3h
```

par20_and.txt reads:

```
im1 && im2 && im3 && im4 && im5 && im6 && im7 && im8 && im9 && im10 &&
im11 && im12 && im13 && im14 && im15 && im16 && im17 && im18 && im19
&&im20
```

Using *par20_and.txt* as the *addmasks* evaluation expression produces a mask that has flags set for only those pixels that are flagged in ALL of the 20 masks that are being added

```
addmasks "@list_20_1" tmp1.b3h "@par20_and.txt"
addmasks "@list_20_2" tmp2.b3h "@par20_and.txt"
addmasks "@list_20_3" tmp3.b3h "@par20_and.txt"
addmasks "@list_20_4" tmp4.b3h "@par20_and.txt"
addmasks "@list_20_5" tmp5.b3h "@par20_and.txt"
addmasks "@list_20_6" tmp6.b3h "@par20_and.txt"
```

Now combine all six AND masks into a single mask for all one hundred twenty DQF files.

```
addmasks "@masklist.txt" dark_bit_AND.b3h "im1 && im2 && im3 &&
im4 && im5 && im6"
imdel tmp*b3h
```

(10) Create Final DQF File

The final DQF is another area where the procedure has been significantly modified for 2007. Due to the large numbers of warm pixels late in the WFPC2 mission, and a desire to have the best possible dark correction in an era where WFPC2 is replacing ACS, we have added new criteria to flag pixels in the DQF where the dark current appears to be poorly known, or where it appears to vary significantly between the 120 input darks. The various criteria used to identify these pixels were chosen so that no more than ~2% of the pixels would be flagged in the final superdark file.

Create a final DQF mask based on certain criteria:

Combine the three c1h files from the *mkdark* steps in Section 6 to get the sum of images used as input for each pixel (each pixel value will be the number of individual images that were used in determining the value of that pixel in the final superdark).

```
imcalc "dark_pt1.b3h,dark_pt2.b3h,dark_pt3.b3h" "dark_sum.b3h"
"im1+im2+im3"
```

Flag pixels that have more than half of the infiles used in *dark_sum.b3h* AND had a dark rate > 0.02 with DQF value = 512 (defined as “unrepaired warm pixel”).

```
imcalc "dark_sum.b3h,dark_all.r3h" "dark_msk.b3h" "if im1.ge.60
&& im2.gt.0.02 then 512. else 0."
```

Warm pixels (>0.00155 DN) that are also variable (<98.5 images used by *mkdark*) are flagged as uncorrectable (512).

```
imcalc "dark_sum.b3h,dark_all.r3h,dark_msk.b3h" "dark_msk.b3h"
"if im1.lt.98.5 && im2.gt.0.00155 then 512. else im3"
```

Measure the variation between the three sets of 40 images, and flag the pixel as uncorrectable (512) if the variation exceeds approximately 3 times that expected from noise.

```
imcalc "dark_pt1.r3h,dark_pt2.r3h,dark_pt3.r3h"
"dark_change_sigma.r3h"
"(abs(im3-im2)+abs(im2-im1)+abs(im3-im1)) /
(sqrt((im1+im2+im3)*93.+1000.)/99.)"
```

```
imcalc "dark_change_sigma.r3h,dark_msk.b3h" "dark_msk.b3h" "if
im1.gt.10. then 512. else im2"
```

If less than half of the one hundred twenty individual darks were used and the *dark_bit_OR.b3h* file does not equal zero, then use the *dark_msk.b3h* value. If less than sixty images were used and the *dark_bit_OR.b3h* value is zero, then set the DQF pixel to 2 (defined as "calibration file defect").

```
imcalc "dark_sum.b3h,dark_bit_OR.b3h,dark_msk.b3h"
"dark_tot1.b3h" "if im1.lt.60 && im2.eq.0.0 then 2.0 else im3"
imcalc "dark_sum.b3h,dark_bit_OR.b3h,dark_tot1.b3h"
"dark_tot2.b3h" "if im1.lt.60 && im2.ne.0.0 then im2 else im3"
```

If none of the individual files were used, then use the *dark_bit_AND.b3h* value. If there was a non-zero value to start, use the *dark_tot2.b3h* value from the last step.

```
imcalc "dark_bit_AND.b3h,dark_tot2.b3h" "dark_tot3.b3h" "if
im1.ne.0.0 then im1 else im2"
```

If the DQF pixel value is eight or ten, replace it with 512 (general bad pixel value).
imcalc "dark_tot3.b3h" "dark_tot3b.b3h" "if im1 .eq. 8 .or. im1 .eq. 10 then 512. else im1"

```
gcopy dark_tot3b.b3h super2007.b3h
gcopy dark_all.r3h super2007.r3h
```

(11) Create Header for the New Superdark

(a) Use the scripts *hedit_r3h_2004.cl* and *hedit_b3h_2004.cl* from previous year to create scripts *hedit_r3h_2007.cl* and *hedit_b3h_2007.cl* for the new superdark.

Change all years in the *hedit* programs from the old to the new year.

```
!nawk '{gsub(/2004/, "2007"); if ($0 !~/xxx/) print}'
hedit_r3h_2004.cl >> hedit_r3h_2007.cl
```

```
!nawk '{gsub(/2004/, "2007"); if ($0 !~/xxx/) print}'
hedit_b3h_2004.cl >> hedit_b3h_2007.cl
```

Run the *hedit* programs and additional formatting steps to finish the header updates.

```
cl < hedit_r3h_2007.cl
groupmod super2007.r3h super2007a.r3h group.txt delete
imdel super2007.r3h
imrename super2007a.r3h super2007.r3h
cl < hedit_b3h_2004.cl
groupmod super2007.b3h super2007a.b3h group.txt delete
```

```
imdel super2007.b3h
imrename super2007a.b3h super2007.b3h
```

The file group.txt used above has the following contents.

```
MEDIAN
MEDSHADO
HISTWIDE
SKEWNESS
MEANC10
MEANC25
MEANC50
MEANC100
MEANC200
MEANC300
BACKGRND
```

Add PEDIGREE, USEAFTER, DESCRIP and COMMENT header keywords.

```
hedit super2007.?3h PEDIGREE 'INFLIGHT 21/02/06 - 03/12/2007'
add+ verify-
hedit super2007.?3h USEAFTER 'February 21, 2006 00:00:00' add+
verify-
hedit super2007.?3h DESCRIP = 'Feb 2006-Dec 2007 yearly
Superdark' add+ verify-
hedit super2007.?3h COMMENT 'WFPC2 Yearly Superdark created by
D. Thatte' add+ verify-
```

(b) Make a history file hist_2007 as follows

This is a SUPERDARK created from an average of 120 input darks. The input darks were from the date range of Feb 21, 2006, through Dec 3, 2007, and consisted of the following files.

```
u9in2n01m u9in2r01m u9in2s01m u9in3e01m u9in3w01m
u9in3z01m u9in4801m u9in4d01m u9in4e01m u9in4g01m
u9in4h01m u9in5m01m u9jac301m u9jac302m u9jac303m
u9jac304m u9l55301m u9l55501m u9l55601m u9l56401m
u9ly2101m u9uj6701m u9uj6801m u9uj6901m u9uj6a01m
u9uj6b01m u9uj6e01m u9uj6f01m u9uj6h01m u9uj6j01m
u9uj6l01m u9uj6m01m u9uj6n01m u9uj6p01m u9uj6q01m
u9uj6r01m u9uj6s01m u9uj6t01m u9uj6w01m u9uj6x01m
u9uj6y01m u9uj6z01m u9uj7201m u9uj7301m u9uj7401m
u9uj7501m u9ul1v01m u9ul1z01m u9ul2101m u9ul2201m
u9ul2301m u9ul2401m u9ul2501m u9ul2a01m u9ul2b01m
u9ul2e01m u9ul2g01m u9ul2h01m u9ul2j01m u9ul2k01m
u9ul2l01m u9ul2n01m u9ul2p01m u9ul2s01m u9ul3d01m
u9ul3e01m u9ul3f01m u9ul3h01m u9ul3m01m u9ul4v01n
u9ul4w01m u9ul4x01m u9ul4y01m u9ul4z01m u9ul5101m
u9ul5201m u9ul5301m u9ul5401m u9ul5501m u9ul5701m
u9ul5801m u9ul5901m u9ul5a01m u9ul5b01m u9ul5d01m
u9ul5e01m u9ul5f01m u9ul5g01m u9ul5h01m u9ul5j01m
u9ul5k01m u9ul5l01m u9ul5m01m u9ul5n01m u9ul5q01m
u9ul5r01m u9ul5s01m u9ul5t01m u9ul5v01m u9ul5w01m
u9ul5x01m u9ul5y01m u9ul5z01m u9ul6101m u9ul6301m
u9ul6401m u9ul6501m u9unb306m u9unb308m u9unb309m
u9unba01m u9une303m u9une304m u9unea03m u9unea04m
```

u9unf301m u9unf302m u9unf303m u9unf304m u9unf305m

All the datasets were calibrated using CALWP Version 2.2, utilizing the most up-to-date reference files, including the new superbias (r6c1454eu). The WF4 images were also processed through special software to remove horizontal (x-direction) streaks from the images (see ISR WFPC2 2005-02). Only images with WF4 BIASEVEN > 295 were used, so as to avoid large gain corrections.

Cosmic rays and their CTE trails were removed and the images were combined in sets of 40, using mkdark. The resulting 3 images were combined to create the final superdark file, which was normalized to an exposure time of 1.0 second. Mkdark parameters used for combining the images were:

```
sigmas =      10,10,8,6,5,4,3
radius =                      1.5
pfactor =                    0.5
hotthres=                   4096.
minval =                      0.
initial =                     min
```

The associated DQF file was computed in the following manner:

If more than 60 of the 120 input files are valid and the dark current is ≤ 0.02 DN/s, then the pixel value is 0 (valid data).

If more than 60 input files are valid and the dark current is > 0.02 DN/s, then the pixel value is 512 (uncorrectable warm pixel).

Warm pixels (>0.00155 DN) that are also variable (<98.5 images used by mkdark) are flagged as uncorrectable (512).

Measure the variation between the three sets of 40 images, and flag the pixel as uncorrectable (512) if the variation exceeds approximately 3 times that expected from noise.

If ≤ 60 input files are valid, set the pixel value to the "bitwise-OR" of all input masks (any flag set in any of the input files is set on the mask).

If none of the input files are valid, set the pixel value to the "bitwise-AND" of all input masks (bad pixel)

Open the r3h and b3h files with a text editor and delete all the HISTORY lines. Append the new HISTORY to the superdark headers.

sfthistory super2007.?3h @hist_2007

(12) Compare Old and New Superdarks

Subtract the old superdarks from the new superdarks for comparison

```
mkdir compare
cd compare
```

copy the old and the new superdark to the compare directory.

```
imcalc super2007.r3h,super2004.r3h, super2007-2004.r3h "im1-im2"
imcalc super2007.b3h,super2004.b3h, super2007-2004.b3h "im1-im2"
```

- a) Display the new superdark and the difference images.
- b) Compute general image statistics, and look for significant changes from previous years.

```
gstat super200?.r3h >> stats.txt
gstat super200?.b3h >> dqf_stats.txt
```

- c) Compute statistics for bad pixels.

```
gstat super2007-*.b3h low=0.1 fiel='npix' >> new_badpix.txt
# This gives the number of pixels which are flagged in the new superdark which were not
flagged in the previous superdark
gstat super2007-*.b3h up=-0.1 fiel='npix' >> old_badpix.txt
# This gives the number of pixels which were flagged in the previous superdark which
are not flagged in the new superdark
```

(13) Deliver Superdark to CDBS

Please follow CDBS TIR 2005-01A and -02A (Diaz-Miller and Cracraft 2007, and any later revisions) for delivery quality checks and also check with CDBS if there are any changes from the procedure described below.

```
!source /grp/hst/cdbS/tools/util/defines.csh

!/grp/hst/cdbS/tools/bin/certify super2007.?3h
!/grp/hst/cdbS/tools/bin/mkload super2007.?3h

#Update load files
!perl -pi -e 's/LEVEL = /LEVEL = SEVERE/g' *lod
!perl -pi -e 's/OPUS_FLAG = /OPUS_FLAG = Y/g' *lod

hSel (images="super2007.r3h",fields="descrip",expr="yes",> "tmp")

!cat super2007.r3h | grep HISTORY >> tmp

!perl -pi -e 's/HISTORY //g' tmp

!perl -ne 'print if(/FILE_NAME/ ? ($c=7) : (--$c>0))' super2007.lod >
junk

!sed "/COMMENT =/r tmp" junk > junk1

!perl -ne 'print if(/ENDHEADER/ ? ($c=13) : (--$c>0))' super2007.lod >
junk2
```

```

!cat junk1 junk2 > super2007.lod

delete("junk*",ver-)
delete("tmp*",ver-)

!/grp/hst/cdbs/tools/bin/certify *.lod
!/grp/hst/cdbs/tools/bin/check_load *.lod

type files_in
super2007.r3h
super2007.b3h

type files_out
super2007_r3f.fits
super2007_b3f.fits

stwfits("@files_in","@files_out")

!farris_fitsverify *.fits

#Create unique filenames.
!/grp/hst/cdbs/tools/bin/uniqname super2007*

```

(13) Make a Linux Version of the Superdark

Create a directory 'linux' in the superdark working directory. Convert the GEIS superdark with the new name to waiver fits format using stwfits. Copy the waiver fits files and the .lod file to the linux directory. Ssh to a linux machine, start IRAF/PyRAF and go to the linux directory. Convert the fits files to GEIS format using strfits.

(14) Notify CDBS

Send an e-mail to cdbs@stsci.edu with the completed CDBS template. Copy the e-mail to biretta@stsci.edu and to the person who makes weekly darks.

Below is the template for CDBS delivery of the superdark.

Subject: WFPC2 Superdark Delivery (February 2006 - December 2007 yearly Superdark)

- 1- Name of deliverer: Deepashri Thatte
- 2- Date of delivery: January 24, 2008
- 3- Instrument: WFPC2
- 4- Type of file (bias,pht,etc.): dark

- 5- History section in header [0] complete?: yes
- 6- USEAFTER, PEDIGREE, DESCRIP, and COMMENT have been checked?: yes
- 7- CDBS Verification complete? (farris_fitsverify, certify,etc.): Yes
- 8- Should these files be ingested in the OPUS, DADS and CDBS databases? Yes
- 9- Files run through CALXXX or SYNPHOT?: Yes (calwp2)
- 10- Does it replace an old reference file?: no
- 10a- If yes, which one?
- 11- What is the level of change of the file?: SEVERE
- 12- Description of how the files were "tested" for correctness:
Ran certify, calwp2, and compared the images with previous superdark.
- 13- Disk location and name of files:

Solaris

```
/grp/hst/wfpc2/thatte/2007_superdark/
-rw-r--r-- 1 thatte wfpc2 5121056 Jan 23 11:24 s1n1124cu.b3d
-rw-r--r-- 1 thatte wfpc2 32102 Jan 24 10:53 s1n1124cu.b3h
-rw-r--r-- 1 thatte wfpc2 5793 Jan 23 11:24 s1n1124cu.lod
-rw-r--r-- 1 thatte wfpc2 10240880 Jan 23 11:24 s1n1124cu.r3d
-rw-r--r-- 1 thatte wfpc2 32062 Jan 24 10:44 s1n1124cu.r3h
```

Linux

```
/grp/hst/wfpc2/thatte/2007_superdark/linux/
-rw-r--r-- 1 thatte wfpc2 5120880 Jan 24 11:05 s1n1124cu.b3d
-rw-r--r-- 1 thatte wfpc2 32076 Jan 24 11:05 s1n1124cu.b3h
-rw-r--r-- 1 thatte wfpc2 5793 Jan 24 11:06 s1n1124cu.lod
-rw-r--r-- 1 thatte wfpc2 10240880 Jan 24 11:05 s1n1124cu.r3d
-rw-r--r-- 1 thatte wfpc2 31995 Jan 24 11:05 s1n1124cu.r3h
```

References

Biretta, J. and Gonzaga, S., "Early Assessment of the WF4 Anomaly,"
WFPC2 ISR 2005-02.

Diaz-Miller, R. and Cracraft, M. "Assessment and Delivery of Reference Files,"
CDBS TIR 2005-01A (revised 2007).

Diaz-Miller, R. and Cracraft, M. "Delivery of Reference Files to the Data
Management Systems," CDBS TIR 2005-02A (revised 2007).

Richardson, M. and Biretta, J. "Creating a WFPC2 Yearly Superdark,"
WFPC2 TIR 2005-04.

Appendix A – Scripts to Edit Final Header

These scripts are located in /grp/hst/wfpc2/DOCUMENTS/wfpc2_scripts/superdark07/

(1) *hedit_r3h_2007.cl*

```

hedit super2007.r3h CRVAL1           0
hedit super2007.r3h CRVAL2           0
hedit super2007.r3h CRPIX1           0
hedit super2007.r3h CRPIX2           0
hedit super2007.r3h CD1_1            0
hedit super2007.r3h CD1_2            0
hedit super2007.r3h CD2_1            0
hedit super2007.r3h CD2_2            0
hedit super2007.r3h DATAMIN          0
hedit super2007.r3h DATAMAX          0
hedit super2007.r3h FPKTTIME         0.
hedit super2007.r3h LPKTTIME         0.
hedit super2007.r3h CTYPE1           ' '
hedit super2007.r3h CTYPE2           ' '
hedit super2007.r3h[1] DETECTOR        1
hedit super2007.r3h[2] DETECTOR        2
hedit super2007.r3h[3] DETECTOR        3
hedit super2007.r3h[4] DETECTOR        4
hedit super2007.r3h DEZERO            0
hedit super2007.r3h BIASSEVEN         0
hedit super2007.r3h BIASODD           0
hedit super2007.r3h GOODMIN           0
hedit super2007.r3h GOODMAX           0
hedit super2007.r3h DATAMEAN         0
hedit super2007.r3h GPIXELS           0
hedit super2007.r3h CALIBDEF          0
hedit super2007.r3h ATODSAT           0

hedit super2007.r3h FILETYPE          'DRK           ' #/ type of data found in
data file
hedit super2007.r3h TELESCOP          'HST           ' #/ telescope used to
acquire data
hedit super2007.r3h INSTRUME          'WFPC2         ' #/ identifier for
instrument used to acquire data
hedit super2007.r3h EQUINOX           2001.0 #/ equinox of celestial
coord. system

hedit super2007.r3h ROOTNAME          ' '           #/ rootname of the
observation set

hedit super2007.r3h MODE              'FULL         ' #/ instr. mode: FULL (full
res.), AREA (area int.)
hedit super2007.r3h SERIALS           'OFF          ' #/ serial clocks: ON, OFF

hedit super2007.r3h IMAGETYP          'CDBS         ' #/ type of exposure
identifier
hedit super2007.r3h CDBSFILE          'DARK         ' #/
GENERIC#/BIAS#/DARK#/PREF#/FLAT#/MASK#/ATOD#/
hedit super2007.r3h PKTFMT           34 #/ packet format code

hedit super2007.r3h FILTNAM1          ' '           ' #/ first filter name
hedit super2007.r3h FILTNAM2          ' '           ' #/ second filter name
hedit super2007.r3h FILTER1           0 #/ first filter number (0-
48)
hedit super2007.r3h FILTER2           0 #/ second filter number (0-
48)
hedit super2007.r3h FILTROT           0.000000 #/ partial filter rotation
angle (degrees)
hedit super2007.r3h LRFWAVE           0.000000 #/ linear ramp filter
wavelength

```

```

hedit super2007.r3h UCH1CJTM          0. #/ TEC cold junction #1
temperature (Celsius)
hedit super2007.r3h UCH2CJTM          0. #/ TEC cold junction #2
temperature (Celsius)
hedit super2007.r3h UCH3CJTM          0. #/ TEC cold junction #3
temperature (Celsius)
hedit super2007.r3h UCH4CJTM          0. #/ TEC cold junction #4
temperature (Celsius)
hedit super2007.r3h UBAY3TMP          0. #/ bay 3 A1 temperature
(deg C)
hedit super2007.r3h KSPOTS            'OFF      ' #/ Status of Kelsall spot
lamps: ON, OFF
hedit super2007.r3h SHUTTER          '         ' #/ Shutter in place at
beginning of the exposure
hedit super2007.r3h ATODGAIN          7.0 #/ Analog to Digital Gain
(Electrons#/DN)

hedit super2007.r3h MASKCORR          '         ' #/ Do mask correction:
PERFORM, OMIT, COMPLETE
hedit super2007.r3h ATODCORR          '         ' #/ Do A-to-D correction:
PERFORM, OMIT, COMPLETE
hedit super2007.r3h BLEVCORR          '         ' #/ Do bias level correction
hedit super2007.r3h BIASCORR          '         ' #/ Do bias correction:
PERFORM, OMIT, COMPLETE
hedit super2007.r3h DARKCORR          '         ' #/ Do dark correction:
PERFORM, OMIT, COMPLETE
hedit super2007.r3h FLATCORR          '         ' #/ Do flat field correction
hedit super2007.r3h SHADCORR          '         ' #/ Do shaded shutter
correction
hedit super2007.r3h DOSATMAP          '         ' #/ Output saturated pixel
map
hedit super2007.r3h DOPHOTOM          '         ' #/ Fill photometry keywords
hedit super2007.r3h DOHISTOS          '         ' #/ Make histograms:
PERFORM, OMIT, COMPLETE
hedit super2007.r3h OUTDTYPE          '         ' #/ Output image datatype:
REAL, LONG, SHORT

hedit super2007.r3h MASKFILE          '         ' #/ name of the input DQF of
known bad pixels
hedit super2007.r3h ATODFILE          '         ' #/ name of the A-to-D
conversion file
hedit super2007.r3h BLEVFILE          '         ' #/ Engineering file with
extended register data
hedit super2007.r3h BLEVDFIL          '         ' #/ Engineering file DQF
hedit super2007.r3h BIASFILE          '         ' #/ name of the bias frame
reference file
hedit super2007.r3h BIASDFIL          '         ' #/ name of the bias frame
reference DQF
hedit super2007.r3h DARKFILE          '         ' #/ name of the dark
reference file
hedit super2007.r3h DARKDFIL          '         ' #/ name of the dark
reference DQF
hedit super2007.r3h FLATFILE          '         ' #/ name of the flat field
reference file
hedit super2007.r3h FLATDFIL          '         ' #/ name of the flat field
reference DQF
hedit super2007.r3h SHADFILE          '         ' #/ name of the reference
file for shutter shading
hedit super2007.r3h PHOTTAB          '         ' #/ name of the photometry
calibration table
hedit super2007.r3h GRAPHTAB          '         ' #/ the HST graph table
hedit super2007.r3h COMPTAB          '         ' #/ the HST components table

hedit super2007.r3h SATURATE          4095 #/ Data value at which
saturation occurs
hedit super2007.r3h USCALE            1.0 #/ Scale factor for output
image
hedit super2007.r3h UZERO             0.0 #/ Zero point for output
image

hedit super2007.r3h READTIME          0 #/ Length of time for CCD
readout in clock ticks

```

```

hedit super2007.r3h PA_V3          0 #/ position angle of v3 of
HST
hedit super2007.r3h RA_SUN        0 #/ right ascension of the
sun
hedit super2007.r3h DEC_SUN       0 #/ declination of the sun
hedit super2007.r3h EQN $\bar{X}$ _SUN 2001.0 #/ equinox of the sun
hedit super2007.r3h MTFFLAG      F #/ moving target flag; T if
it is a moving target
hedit super2007.r3h EQRADTRG     0.000000 #/ equatorial radius of
target (km)
hedit super2007.r3h FLATNTRG     0.000000 #/ flattening of target
hedit super2007.r3h NPDECTRG     0.000000 #/ north pole declination
of target
hedit super2007.r3h NPRATRG      0.000000 #/ north pole right
ascension of target
hedit super2007.r3h ROTRTRG      0.000000 #/ rotation rate of target
hedit super2007.r3h LONGPMER     0.000000 #/ longitude of prime
meridian
hedit super2007.r3h EPLONGPM     0.000000 #/ epoch of longitude of
prime meridian (sec)
hedit super2007.r3h SURFLATD     0.000000 #/ surface feature latitude
hedit super2007.r3h SURFLONG     0.000000 #/ surface feature
longitude
hedit super2007.r3h SURFALTD     0.000000 #/ surface feature altitude
(km)

hedit super2007.r3h PODPSFF      0 #/ 0 (no podps fill); 1
(podps fill present)
hedit super2007.r3h STDCFFF      0 #/ ST DDF fill present
(T#/F)
hedit super2007.r3h STDCFFP      ' #/ ST DDF fill pattern
(hex)
hedit super2007.r3h RSDPFILL     -100 #/ bad data fill value for
calibrated images

hedit super2007.r3h UEXPODUR     0 #/ commanded duration of
exposure (sec)
hedit super2007.r3h NSHUTA17     0 #/ Number of AP17 shutter B
closes
hedit super2007.r3h DARKTIME     1.0 #/ Dark time (seconds)
hedit super2007.r3h UEXPOTIM     0 #/ Major frame pulse time
preceding exposure start
hedit super2007.r3h PSTRTIME     ' #/ predicted obs. start
time (yyyy.ddd:hh:mm:ss)
hedit super2007.r3h PSTPTIME     ' #/ predicted obs. stop time
(yyyy.ddd:hh:mm:ss)

hedit super2007.r3h SUNANGLE     0 #/ angle between sun and V1
axis
hedit super2007.r3h MOONANGL     ' #/ angle between moon and
V1 axis
hedit super2007.r3h SUN_ALT      0. #/ altitude of the sun
above Earth's limb
hedit super2007.r3h FGSLOCK      ' #/ commanded FGS lock
(FINE, COARSE, GYROS, UNKNOWN)
hedit super2007.r3h TIME-OBS     ' #/ UT time of start of
observation (hh:mm:ss)
hedit super2007.r3h EXPSTART     0. #/ exposure start time
(Modified Julian Date)
hedit super2007.r3h EXPEND       0. #/ exposure end time
(Modified Julian Date)
hedit super2007.r3h EXPTIME      0. #/ exposure duration
(seconds)--calculated
hedit super2007.r3h EXPFLAG      ' #/ Exposure interruption
indicator

hedit super2007.r3h TARGNAME     'DARK ' #/ proposer's target name
hedit super2007.r3h RA_TARG      0.000000 #/ right ascension of the
target
hedit super2007.r3h DEC_TARG     0.000000 #/ declination of the
target

```

```

hedit super2007.r3h ECL_LONG      0.000000 #/ ecliptic longitude of
the target
hedit super2007.r3h ECL_LAT      0.000000 #/ ecliptic latitude of the
target
hedit super2007.r3h GAL_LONG      0. #/ galactic longitude of
the target
hedit super2007.r3h GAL_LAT      0. #/ galactic latitude of the
target
hedit super2007.r3h PROPOSID      '      '
hedit super2007.r3h PEP_EXPO      '      ' #/ PEP exposure identifier
including sequence
hedit super2007.r3h LINENUM      0. #/ PEP proposal line number
hedit super2007.r3h SEQLINE      '      ' #/ PEP line number of
defined sequence
hedit super2007.r3h SEQNAME      '      ' #/ PEP define#/use sequence
name

hedit super2007.r3h exptime      1.0
hedit super2007.r3h darktime     1.0

```

(2) hedit_b3h_2007.cl

```

hedit super2007.b3h CRVAL1      0
hedit super2007.b3h CRVAL2      0
hedit super2007.b3h CRPIX1      0
hedit super2007.b3h CRPIX2      0
hedit super2007.b3h CD1_1      0
hedit super2007.b3h CD1_2      0
hedit super2007.b3h CD2_1      0
hedit super2007.b3h CD2_2      0
hedit super2007.b3h DATAMIN      0
hedit super2007.b3h DATAMAX      0
hedit super2007.b3h FPKTTIME     0.
hedit super2007.b3h LPKTTIME     0.
hedit super2007.b3h CTYPE1      '      '
hedit super2007.b3h CTYPE2      '      '
hedit super2007.b3h [1] DETECTOR  1
hedit super2007.b3h [2] DETECTOR  2
hedit super2007.b3h [3] DETECTOR  3
hedit super2007.b3h [4] DETECTOR  4
hedit super2007.b3h DEZERO      0
hedit super2007.b3h BIASEVEN     0
hedit super2007.b3h BIASODD      0
hedit super2007.b3h GOODMIN      0
hedit super2007.b3h GOODMAX      0
hedit super2007.b3h DATAMEAN     0
hedit super2007.b3h GPIXELS      0
hedit super2007.b3h CALIBDEF     0
hedit super2007.b3h ATODSAT      0

hedit super2007.b3h FILETYPE     'DRK      ' #/ type of data found in
data file
hedit super2007.b3h TELESCOP     'HST      ' #/ telescope used to
acquire data
hedit super2007.b3h INSTRUME     'WFPC2    ' #/ identifier for
instrument used to acquire data
hedit super2007.b3h EQUINOX      2000.0 #/ equinox of celestial
coord. system

hedit super2007.b3h ROOTNAME     '      ' #/ rootname of the
observation set

hedit super2007.b3h MODE         'FULL     ' #/ instr. mode: FULL (full
res.), AREA (area int.)
hedit super2007.b3h SERIALS     'OFF      ' #/ serial clocks: ON, OFF

```

```

hedit super2007.b3h IMAGETYP 'CDBS ' #/ type of exposure
identifier
hedit super2007.b3h CDBSFILE 'DARK ' #/
GENERIC#/BIAS#/DARK#/PREF#/FLAT#/MASK#/ATOD#/
hedit super2007.b3h PKTFMT 34 #/ packet format code

hedit super2007.b3h FILTNAM1 ' ' #/ first filter name
hedit super2007.b3h FILTNAM2 ' ' #/ second filter name
hedit super2007.b3h FILTER1 0 #/ first filter number (0-
48)
hedit super2007.b3h FILTER2 0 #/ second filter number (0-
48)
hedit super2007.b3h FILTROT 0.000000 #/ partial filter rotation
angle (degrees)
hedit super2007.b3h LRFWAVE 0.000000 #/ linear ramp filter
wavelength

hedit super2007.b3h UCH1CJTM 0. #/ TEC cold junction #1
temperature (Celsius)
hedit super2007.b3h UCH2CJTM 0. #/ TEC cold junction #2
temperature (Celsius)
hedit super2007.b3h UCH3CJTM 0. #/ TEC cold junction #3
temperature (Celsius)
hedit super2007.b3h UCH4CJTM 0. #/ TEC cold junction #4
temperature (Celsius)
hedit super2007.b3h UDAY3TMP 0. #/ bay 3 A1 temperature
(deg C)
hedit super2007.b3h KSPOTS 'OFF ' #/ Status of Kelsall spot
lamps: ON, OFF
hedit super2007.b3h SHUTTER ' ' #/ Shutter in place at
beginning of the exposure
hedit super2007.b3h ATODGAIN 7.0 #/ Analog to Digital Gain
(Electrons#/DN)

hedit super2007.b3h MASKCORR ' ' #/ Do mask correction:
PERFORM, OMIT, COMPLETE
hedit super2007.b3h ATODCORR ' ' #/ Do A-to-D correction:
PERFORM, OMIT, COMPLETE
hedit super2007.b3h BLEVCORR ' ' #/ Do bias level correction
hedit super2007.b3h BIASCORR ' ' #/ Do bias correction:
PERFORM, OMIT, COMPLETE
hedit super2007.b3h DARKCORR ' ' #/ Do dark correction:
PERFORM, OMIT, COMPLETE
hedit super2007.b3h FLATCORR ' ' #/ Do flat field correction
hedit super2007.b3h SHADCORR ' ' #/ Do shaded shutter
correction
hedit super2007.b3h DOSATMAP ' ' #/ Output saturated pixel
map
hedit super2007.b3h DOPHOTOM ' ' #/ Fill photometry keywords
hedit super2007.b3h DOHISTOS ' ' #/ Make histograms:
PERFORM, OMIT, COMPLETE
hedit super2007.b3h OUTDTYPE ' ' #/ Output image datatype:
REAL, LONG, SHORT

hedit super2007.b3h MASKFILE ' ' #/ name of the input DQF of
known bad pixels
hedit super2007.b3h ATODFILE ' ' #/ name of the A-to-D
conversion file
hedit super2007.b3h BLEVFILE ' ' #/ Engineering file with
extended register data
hedit super2007.b3h BLEVDFIL ' ' #/ Engineering file DQF
hedit super2007.b3h BIASFILE ' ' #/ name of the bias frame
reference file
hedit super2007.b3h BIASDFIL ' ' #/ name of the bias frame
reference DQF
hedit super2007.b3h DARKFILE ' ' #/ name of the dark
reference file
hedit super2007.b3h DARKDFIL ' ' #/ name of the dark
reference DQF
hedit super2007.b3h FLATFILE ' ' #/ name of the flat field
reference file

```

```

hedit super2007.b3h FLATDFIL ' ' #/ name of the flat field
reference DQF
hedit super2007.b3h SHADFILE ' ' #/ name of the reference
file for shutter shading
hedit super2007.b3h PHOTTAB ' ' #/ name of the photometry
calibration table
hedit super2007.b3h GRAPHTAB ' ' #/ the HST graph table
hedit super2007.b3h COMPTAB ' ' #/ the HST components table

hedit super2007.b3h SATURATE 4095 #/ Data value at which
saturation occurs
hedit super2007.b3h USCALE 1.0 #/ Scale factor for output
image
hedit super2007.b3h UZERO 0.0 #/ Zero point for output
image

hedit super2007.b3h READTIME 0 #/ Length of time for CCD
readout in clock ticks

hedit super2007.b3h PA_V3 0 #/ position angle of v3 of
HST
hedit super2007.b3h RA_SUN 0 #/ right ascension of the
sun
hedit super2007.b3h DEC SUN 0 #/ declination of the sun
hedit super2007.b3h EQNX SUN 2000.0 #/ equinox of the sun
hedit super2007.b3h MTFFLAG F #/ moving target flag; T if
it is a moving target
hedit super2007.b3h EQRADTRG 0.000000 #/ equatorial radius of
target (km)
hedit super2007.b3h FLATNTRG 0.000000 #/ flattening of target
hedit super2007.b3h NPDECTRG 0.000000 #/ north pole declination
of target
hedit super2007.b3h NPRATRNG 0.000000 #/ north pole right
ascension of target
hedit super2007.b3h ROTRTRNG 0.000000 #/ rotation rate of target
hedit super2007.b3h LONGPMER 0.000000 #/ longitude of prime
meridian
hedit super2007.b3h EPLONGPM 0.000000 #/ epoch of longitude of
prime meridian (sec)
hedit super2007.b3h SURFLATD 0.000000 #/ surface feature latitude
hedit super2007.b3h SURFLONG 0.000000 #/ surface feature
longitude
hedit super2007.b3h SURFALTD 0.000000 #/ surface feature altitude
(km)

hedit super2007.b3h PODPSFF 0 #/ 0 (no podps fill); 1
(podps fill present)
hedit super2007.b3h STDCFFF 0 #/ ST DDF fill present
(T#/F)
hedit super2007.b3h STDCFFP ' ' #/ ST DDF fill pattern
(hex)
hedit super2007.b3h RSDPFILL -100 #/ bad data fill value for
calibrated images

hedit super2007.b3h UEXPODUR 0 #/ commanded duration of
exposure (sec)
hedit super2007.b3h NSHUTA17 0 #/ Number of AP17 shutter B
closes
hedit super2007.b3h DARKTIME 1.0 #/ Dark time (seconds)
hedit super2007.b3h UEXPOTIM 0 #/ Major frame pulse time
preceding exposure start
hedit super2007.b3h PSTRTIME ' ' #/ predicted obs. start
time (yyyy.ddd:hh:mm:ss)
hedit super2007.b3h PSTPTIME ' ' #/ predicted obs. stop time
(yyyy.ddd:hh:mm:ss)

hedit super2007.b3h SUNANGLE 0 #/ angle between sun and V1
axis
hedit super2007.b3h MOONANGL ' ' #/ angle between moon and
V1 axis
hedit super2007.b3h SUN_ALT 0. #/ altitude of the sun
above Earth's limb

```

```

hedit super2007.b3h  FGSLOCK      '          ' #/ commanded FGS lock
(FINE, COARSE, GYROS, UNKNOWN)
hedit super2007.b3h  TIME-OBS     '          ' #/ UT time of start of
observation (hh:mm:ss)
hedit super2007.b3h  EXPSTART     0. #/ exposure start time
(Modified Julian Date)
hedit super2007.b3h  EXPEND       0. #/ exposure end time
(Modified Julian Date)
hedit super2007.b3h  EXPTIME      0. #/ exposure duration
(seconds)--calculated
hedit super2007.b3h  EXPFLAG      '          ' #/ Exposure interruption
indicator

hedit super2007.b3h  TARGNAME     'DARK      ' #/ proposer's target name
hedit super2007.b3h  RA_TARG      0.000000 #/ right ascension of the
target
hedit super2007.b3h  DEC_TARG     0.000000 #/ declination of the
target
hedit super2007.b3h  ECL_LONG     0.000000 #/ ecliptic longitude of
the target
hedit super2007.b3h  ECL_LAT      0.000000 #/ ecliptic latitude of the
target
hedit super2007.b3h  GAL_LONG     0. #/ galactic longitude of
the target
hedit super2007.b3h  GAL_LAT      0. #/ galactic latitude of the
target
hedit super2007.b3h  PROPOSID     '          ' #/ PEP proposal identifier
hedit super2007.b3h  PEP_EXPO     '          ' #/ PEP exposure identifier
incl sequence
hedit super2007.b3h  LINENUM      0. #/ PEP proposal line number
hedit super2007.b3h  SEQLINE     '          ' #/ PEP line number of
defined sequence
hedit super2007.b3h  SEQNAME      '          ' #/ PEP define#/use sequence
name
hedit super2007.b3h  exptime      1.0
hedit super2007.b3h  darktime     1.0

hedit super2007.b3h  FILETYPE     'DQF      ' #/ type of data found in
data file

chpixtype super2007.b3h[1]  super2007a.b3h[1/4]  short
chpixtype super2007.b3h[2]  super2007a.b3h[2]   short
chpixtype super2007.b3h[3]  super2007a.b3h[3]   short
chpixtype super2007.b3h[4]  super2007a.b3h[4]   short

```

Appendix B – Procedure FIX4SD.CL to Repair WF4 Data

This script is located in /grp/hst/wfpc2/DOCUMENTS/wfpc2_scripts/superdark07/

```

procedure fix4sd(input)
#
#
# This version was tailored to make the 2007 gain 7 super-dark.
# IT CANNOT BE USED ON ANY OTHER TYPE OF DATA. IT WILL ONLY
# WORK PROPERLY ON 1800 SECOND DARKS.
#
# Changes (17jul2007):
# - Gain correction applied for bias >290 DN.
# - Improved handling of columns x=1, 2, 799, 800.
# - Subtract old dark before computing streak image
#   to remove scintillation pattern.
# - Use mask expansion for better removal of cosmic rays
# - Use masking of vertical coherent features to remove CTE tails
# - Remove low spatial frequencies from the streak image.
# - More diagnostics printed to streak_list file.
#
# Changes (28-30Nov2007):
# - Only expand mask and test for vertical streaks on the first iteration.
# - Add zeroth iteration.
# - Add switch to allow removal (or not) of large spatial scale streaks.
#
# Changes (14-15Dec2007):
# - Change Gaussian smoothing to get large scale features from 100
#   pixel to 40 pixel sigma. Also change from boundary "nearest"
#   to "reflection."
#
# This script processes images from an input list,
# makes linearity and gain corrections to WF4,
# removes the streaks from WF4, and outputs images
# with the same names into a subdirectory "fixed".
#
# A table listing the image names, their WF4 bias levels,
# and WF4 streak intensities is also output to file "streak_list".
#
# A subdirectory "scratch" is created in the "fixed"
# directory and used for temporary files. These temporary
# files are not deleted after the final image is processed.
#
# The streak intensity is measured with the streaker.cl
# algorithm.
#
# The only script input is the name of the file containing
# list of the images to be processed.
#
# This version for making super-darks needs to have the dark
# reference file r4c14402u.r3h in the same directory as the data.
#
# to run:
#
# generate fake param file
# cp (some param file) test.par
# mv test.par (to directory where running)
# edit test.par to look plausible
#
# stsdas
# too
# imgt
# task fix4sd = "fix4sd.cl"
# fix4sd junk < list
#
# Where "image_list" is a list of input images to
# be processed, one per line. This can be generated by
# ls *.c0h > image_list

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#
# This version works only on 4-group GIES format WFPC2 images.
#
# A copy of the generated streak image is left in the
# scratch directory as "streak.hhh".
#
# John Biretta -- 19jul2007
#

string input {prompt = "Name of input file?"}

begin
string expression, output2, name, junk, junk2
string resultsfile, out, scr, files, filename, filename4
real fval, upper, lower, streak_rms, biaseven
real arg1, lowercorr, gain, be
real l1, l2, l3, l4
real l_corr, inv_gain

# set and creat directories
out="fixed/"
scr="fixed/scratch/"
!mkdir fixed
!mkdir fixed/scratch

# set name of output text file
!rm fixed/streak list
resultsfile=out//7"streak_list"

# print results to file
files="          image          biaseven  streak RMS  lin_corr  inv_gain"
printf ("%47s\n",files)
printf ("%47s\n",files,
        >> resultsfile)

#
# loop through input file containing image names to process
while(scan(filename) != EOF){

# copy the input image to the scratch directory
imcop(filename//"[1]",scr//filename//[1/4])
imcop(filename//"[2]",scr//filename//[2])
imcop(filename//"[3]",scr//filename//[3])
imcop(filename//"[4]",scr//filename//[4])

# delete old scratch files
imdel(scr//"qq*.hhh")
imdel(scr//"streak.hhh")
#
# start processing wf4:
filename4=filename//[4]

# get BIASEVEN value
hedit (filename4,"BIASEVEN",".") | scan (junk,junk2,biaseven)
# if image is not bias-corrected, can use median in place of BIASEVEN
#hedit (filename4,"MEDIAN",".") | scan (junk,junk2,biaseven)
print (biaseven)

# linearity correction:
# compute linearity correction
# compute correction on bias level first
# linearity correction coeff
l1=4.
l2=30.
l3=20.
l4=290.

# only correct linearity if biaseven < 290
l_corr=0.
if(biaseven < 14) {
imcop(filename4,scr//"qqa.hhh")
# the lower correction depends only on the bias level, so compute separately

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arg1=(14-biaseven)/14
print (arg1)
lowercorr=l1*arg1+l2*arg1+l3*arg1*arg1
print (lowercorr)
# now compute the upper correction as function of (bias + pixel value)
# the net correction is (lower correction - upper correction)
expression="(//14// - min((im1+//biaseven//), //14//) )//14
print (expression)
imcalc(scr// "qqa.hhh", scr// "qqarg2.hhh", expression)
expression=lowercorr// - ( //l1// *im1+ //l2// *im1*im1+ //l3// *im1*im1*im1 )
print (expression)
imcalc(scr// "qqarg2.hhh", scr// "qqlincorr.hhh", expression)
# apply linearity correction
imarith(scr// "qqa.hhh", "+", scr// "qqlincorr.hhh", scr// "qqlincorred.hhh")
# save and print the median correction
imstat(scr// "qqlincorr.hhh[100:750,100:750]", fields="mean", lower=-10, upper=10,
        nclip=3, lsigma=3., usigma=3.,
        binwidht=0.1, format-, mode="ql" ) | scan (fval)
l_corr=fval

# biaseven > 290 skips linearity correction
} else {
imcop(filename4, scr// "qqlincorred.hhh")
}

# gain correction:
# gain correction is function of bias level only
be=biaseven
gain=0.848
gain=gain-0.000196*be
gain=gain+0.00000596*be*be
gain=gain-0.0000000320*be*be*be
gain=gain+0.000000000645*be*be*be*be
print (gain)
inv_gain=1./gain
# apply gain correction
imarith(scr// "qqlincorred.hhh", "/", gain, scr// "qqcorrect.hhh")

# 17jul2007: Apply gain correction for all bias values.
# Even at bias >290 there is a 3% gain correction to make.
#} else {
#imcop(filename4, scr// "qqcorrect.hhh")
#}

# streak correction:
# remove streaks from image
#
# subtract recent dark frame to remove most "real" structures,
# before modeling the streak pattern so that real features
# are not removed during streak removal
imarith("r4c14402u.r3h[4]", "*", 1836., scr// "qqdrk1800.hhh")
imarith(scr// "qqcorrect.hhh", "-", scr// "qqdrk1800.hhh", scr// "qq0.hhh")
# exclude edges
name=scr// "qq0.hhh[3:798,1:800]"
print (name)
imcop(name, scr// "qq0.hhh")
# compute image mean
imstat(scr// "qq0.hhh[100:750,100:750]", fields="mean", lower=-10, upper=10,
        nclip=3, lsigma=3., usigma=3.,
        binwidht=0.1, format-, mode="ql" ) | scan (fval)
print (fval)

# iterate #0
# Pre-pass image masking only bad CR, and generate approximate
# streak model image.
# Set high and low regions to mean.
# Use mask expansion to remove wings of cosmic rays.
# For readnoise 5e- and gain 7 the threshold "7" is about 10 sigma.
expression="if abs(im1-//fval//) .gt. 7. then 1. else 0."
print (expression)
imcalc(scr// "qq0.hhh", scr// "qqmaska0.hhh", expression)
gauss(scr// "qqmaska0.hhh", scr// "qqmaskg0.hhh", 1., ratio=1., theta=0.,

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        nsigma=3., bilinea+, boundar="reflect")
# compute the mask, 1=bad data
expression="if im1 .gt. 0.05 then 1. else 0."
print (expression)
imcalc(scr// "qgmaskg0.hhh", scr// "qgmaskgt0.hhh", expression)
# apply expanded mask
expression="if im2 .gt. 0.5 then "//fval/" else im1"
print (expression)
files=scr// "qq0.hhh", "//scr// "qgmaskgt0.hhh"
imcalc(files, scr// "qgmasked0.hhh", expression)
# check for coherent vertical features, i.e. cosmic ray tails
# and add them to the mask, 1=bad data
#gauss(scr// "qgmasked1.hhh", scr// "qggv1.hhh", 10., ratio=0.01, theta=90.,
#      nsigma=3., bilinea+, boundar="reflect")
#expression="if im2 .gt. 0.8 then 1. else im1"
#print (expression)
#files=scr// "qgmaskgt1.hhh", "//scr// "qggv1.hhh"
#imcalc(files, scr// "qgmask1.hhh", expression)
# apply updated mask to the data, replace bad data with the image mean
#expression="if im2 .gt. 0.5 then "//fval/" else im1"
#print (expression)
#files=scr// "qq0.hhh", "//scr// "qgmask1.hhh"
#imcalc(files, scr// "qqout1.hhh", expression)
# convolve with broad gaussian in X
gauss(scr// "qgmasked0.hhh", scr// "qggauss0.hhh", 200., ratio=0.001, theta=0.,
      nsigma=3., bilinea+, boundar="reflect")

# iterate #1
# Set high and low regions to crude streak image qgmasked0.
# Use mask expansion to remove wings of cosmic rays.
# For readnoise 5e- and gain 7 the threshold "5" is about 7 sigma.
expression="if abs(im1-im2) .gt. 5. then 1. else 0."
print (expression)
files=scr// "qq0.hhh", "//scr// "qggauss0.hhh"
imcalc(files, scr// "qgmaska1.hhh", expression)
gauss(scr// "qgmaska1.hhh", scr// "qgmaskg1.hhh", 1., ratio=1., theta=0.,
      nsigma=3., bilinea+, boundar="reflect")
# compute the mask, 1=bad data
expression="if im1 .gt. 0.05 then 1. else 0."
print (expression)
imcalc(scr// "qgmaskg1.hhh", scr// "qgmaskgt1.hhh", expression)
# apply expanded mask
expression="if im2 .gt. 0.5 then im3 else im1"
print (expression)
files=scr// "qq0.hhh", "//scr// "qgmaskgt1.hhh", "//scr// "qggauss0.hhh"
imcalc(files, scr// "qgmasked1.hhh", expression)
# check for coherent vertical features, i.e. cosmic ray tails
# and add them to the mask, 1=bad data
imarith(scr// "qgmasked1.hhh", "-", scr// "qggauss0.hhh", scr// "qgdiffl.hhh")
gauss(scr// "qgdiffl.hhh", scr// "qggv1.hhh", 10., ratio=0.01, theta=90.,
      nsigma=3., bilinea+, boundar="reflect")
expression="if im2 .gt. 0.8 then 1. else im1"
print (expression)
files=scr// "qgmaskgt1.hhh", "//scr// "qggv1.hhh"
imcalc(files, scr// "qgmask1.hhh", expression)
# apply updated mask to the data, replace bad data with the image mean
expression="if im2 .gt. 0.5 then im3 else im1"
print (expression)
files=scr// "qq0.hhh", "//scr// "qgmask1.hhh", "//scr// "qggauss0.hhh"
imcalc(files, scr// "qqout1.hhh", expression)
# convolve with broad gaussian in X
gauss(scr// "qqout1.hhh", scr// "qggauss1.hhh", 200., ratio=0.001, theta=0.,
      nsigma=3., bilinea+, boundar="reflect")

# iterate #2
# Re-use previous mask, and add more bad pixels to it.
# Do not expand the added bad pixels.
# Set high and low regions to streak image from first iteration.
# For readnoise 5e- and gain 7 the threshold "4" is about 5.5 sigma.
expression="if abs(im1-im2) .gt. 4. then 1. else im3"
print (expression)
files=scr// "qq0.hhh", "//scr// "qggauss1.hhh", "//scr// "qgmask1.hhh"

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imcalc(files,scr// "qqmask2.hhh",expression)
#gauss(scr// "qqmask2.hhh",scr// "qqmaskg2.hhh",1.,ratio=1.,theta=0.,
#       nsigma=3.,bilinea+,boundar="reflect")
# compute the mask
#expression="if im1 .gt. 0.05 then 1. else 0."
#print (expression)
#imcalc(scr// "qqmaskg2.hhh",scr// "qqmaskgt2.hhh",expression)
# apply updated mask
expression="if im2 .gt. 0.5 then im3 else im1"
print (expression)
files=scr// "qq0.hhh",scr// "qqmask2.hhh",scr// "qqgauss1.hhh"
imcalc(files,scr// "qqout2.hhh",expression)
# check for coherent vertical features, and replace
#gauss(scr// "qqmasked2.hhh",scr// "qqgv2.hhh",10.,ratio=0.01,theta=90.,
#       nsigma=3.,bilinea+,boundar="reflect")
#expression="if im2 .gt. 1. then im3 else im1"
#print (expression)
#files=scr// "qqmasked2.hhh",scr// "qqgv2.hhh",scr// "qqgauss1.hhh"
#imcalc(files,scr// "qqout2.hhh",expression)
# convolve with broad gaussian in X
gauss(scr// "qqout2.hhh",scr// "qqgauss2.hhh",200.,ratio=0.001,theta=0.,
      nsigma=3.,bilinea+,boundar="reflect")

# iterate #3
# Re-use previous mask, and add more bad pixels to it.
# Do not expand the added bad pixels.
# Set high and low regions to streak image from first iteration.
# For readnoise 5e- and gain 7 the threshold "3" is about 4 sigma.
expression="if abs(im1-im2) .gt. 3. then 1. else im3"
print (expression)
files=scr// "qq0.hhh",scr// "qqgauss2.hhh",scr// "qqmask2.hhh"
imcalc(files,scr// "qqmask3.hhh",expression)
#gauss(scr// "qqmask3.hhh",scr// "qqmaskg3.hhh",1.,ratio=1.,theta=0.,
#       nsigma=3.,bilinea+,boundar="reflect")
# compute the mask
#expression="if im1 .gt. 0.05 then 1. else 0."
#print (expression)
#imcalc(scr// "qqmaskg3.hhh",scr// "qqmaskgt3.hhh",expression)
# apply updated mask
expression="if im2 .gt. 0.5 then im3 else im1"
print (expression)
files=scr// "qq0.hhh",scr// "qqmask3.hhh",scr// "qqgauss2.hhh"
imcalc(files,scr// "qqout3.hhh",expression)
# check for coherent vertical features, and replace
#gauss(scr// "qqmasked3.hhh",scr// "qqgv3.hhh",10.,ratio=0.01,theta=90.,
#       nsigma=3.,bilinea+,boundar="reflect")
#expression="if im2 .gt. 1. then im3 else im1"
#print (expression)
#files=scr// "qqmasked3.hhh",scr// "qqgv3.hhh",scr// "qqgauss2.hhh"
#imcalc(files,scr// "qqout3.hhh",expression)
# convolve with broad gaussian in X
gauss(scr// "qqout3.hhh",scr// "qqgauss3.hhh",200.,ratio=0.001,theta=0.,
      nsigma=3.,bilinea+,boundar="reflect")

# zero the mean of the streak image
#imstat(scr// "qqgauss3.hhh[100:750,100:750]",fields="mean",lower=-10,upper=10,
#       nclip=3,lsigma=3.,usigma=3.,
#       binwid=0.1,format-,mode="ql") | scan (fval)
#print (fval)
#imarith(scr// "qqgauss3.hhh","-",fval,scr// "qqgauss3x.hhh")

## remove low spatial frequencies from the streak image
## -- do this to preserve field-flattener scintillation roll-off
gauss(scr// "qqgauss3.hhh",scr// "qqgauss4.hhh",40.,ratio=1.,theta=0.,
      nsigma=3.,bilinea+,boundar="reflect")
imarith(scr// "qqgauss3.hhh","-",scr// "qqgauss4.hhh",scr// "qqgauss3x.hhh")
#
# choose your output image -- with or without large scale
# streaks removed
# not removed
#imcop(scr// "qqgauss3.hhh",scr// "qqout4.hhh")

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# removed
imcop(scr// "qqgauss3x.hhh",scr// "qqout4.hhh")

# make the streak image
imcop(filename4,scr// "streak.hhh")
imarith(scr// "streak.hhh", "*", 0.,scr// "streak.hhh")
# re-align the image
imcop(scr// "qqout4.hhh[1:796,1:800]",scr// "streak.hhh[3:798,1:800] ")
# special treatment of last columns X=799 and X=800...
# apply correction from previous columns
imcop(scr// "qqout4.hhh[796:796,1:800]",scr// "streak.hhh[799:799,1:800] ")
imcop(scr// "qqout4.hhh[796:796,1:800]",scr// "streak.hhh[800:800,1:800] ")
# special treatment of first columns X=1 and X=2
# apply correction from previous columns
imcop(scr// "qqout4.hhh[1:1,1:800]",scr// "streak.hhh[1:1,1:800] ")
imcop(scr// "qqout4.hhh[1:1,1:800]",scr// "streak.hhh[2:2,1:800] ")

# generate results:
# final output image
imarith(scr// "qqcorrect.hhh", "-",scr// "streak.hhh",scr// "qqfinal.hhh")
imcop(scr// filename// "[1]",out// filename// "[1/4] ")
imcop(scr// filename// "[2]",out// filename// "[2] ")
imcop(scr// filename// "[3]",out// filename// "[3] ")
imcop(scr// "qqfinal.hhh",out// filename// "[4] ")

# stats on streak image
imstat(scr// "streak.hhh[50:750,50:750]",fields="stddev",lower=undef,upper=undef,
        nclip=0,lsigma=3.,usigma=3.,
        binwidth=0.1,format "-",mode="ql") | scan (fval)
print (fval)
streak_rms=fval

# print results to file
printf ("%20s %10.3f %10.3f %10.3f
%10.3f\n",filename4,biaseven,streak_rms,l_corr,inv_gain)
printf ("%20s %10.3f %10.3f %10.3f
%10.3f\n",filename4,biaseven,streak_rms,l_corr,inv_gain,
        >> resultsfile)
}
end

```