

Final reprocessing of FOC data

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Abstract

The report describes the final calibration of FOC data made by CADC, ST-ECF and STScI. The data products can be accessed at the three datacenters MAST, CADC and ST-ECF.

1. Introduction

At the annual HST archive coordination meeting in 2003, the CADC, in collaboration with STScI, decided to produce the final calibration files for the science observations¹ made with the HRS and the FOC generation 1 instruments. In 2005, after successfully recalibrating the science data, it was decided to add the non-science data.

The general motivation was threefold: First, it was obvious that no changes were occurring for these instruments for both calibration files and calibration software. Second, because of the lack of maintenance for the calibration software -- the original instrument team members are gone or busy supporting other instruments -- we were facing the danger of losing the capability to recalibrate the data in the near future. And third, the data was calibrated shortly after it was taken with sometimes not optimum reference files. On The Fly Reprocessing (OTFR) was never available for GHRS and so the files in the Archive were static and did not get reprocessed as better reference files came along later in the mission. We wanted to process the entire GHRS holding with a consistent set of reference files representing now the best calibration.

¹ The exclusion criteria for the science observations are listed in the appendix.

2. The first version

CADC reprocessed the science FOC data and we have chosen 18 datasets to compare to the archived data (retrieved from the MAST). Table 1 lists the names of these datasets.

We looked into the old and new FOC data by blinking the flatfielded images. About one third of the pre-COSTAR files (3 out of 10) showed changes in the images. Two images seemed to breathe (x1360103t, x19e0205t), one image showed a very subtle effect of rotation (x16i0j01t).

Table 1: List of comparison datasets

| Dataset name | Dataset name | Dataset name |
|--------------|--------------|--------------|
| X10e0401t | x16i1701t | x25j0402t |
| X14w0304t | x14h0302t | x3i0020lp |
| X18f5601t | x16i0j01t | x3i00306m |
| X1360103t | x14q0104t | x3i00307m |
| X15p0105t | x2xo0402t | x38i2103t |
| X19e0205t | x2ec010at | x3fn1103t |

Looking at the headers of the 10 images taken before COSTAR was put in (December 1993), it turned out that the 2 cases which breathe had the geometric correction GEOCORR set to OMIT in the new data version. The image, which showed a very small rotation, had actually GEOCORR set to COMPLETE, but the reference file for geometric correction had changed.

In addition, BACCORR and ITFCORR were performed in the new data, but not in the old data. The current version of the HST data handbook says that these corrections were never used/performed. Robert Jedrzejewski, the former FOC instrument scientist, confirmed this.

Robert Jedrzejewski pointed out two documents, Nota et al. (1994) Instrument Science Report FOC-082, and Jedrzejewski (1998) FOC Status and Overview (HST Calibration Workshop), where the guidelines for "best reference" files are described. The first one deals with pre-COSTAR data, the second one with the data taken after COSTAR was implemented in 1993. The geometric correction has to be performed for all scientific exposures!

BACCORR and ITFCORR actually use dummy files, that is setting these corrections to perform will not change the data at all. During ITF correction, the data is multiplied by 1 and during BAC correction, a 0 is subtracted (Robert Jedrzejewski private communication). The respective dummy files are checked and they contain indeed 1's and 0's respectively.

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The best reference file for geometric correction in all 18 datasets agrees with the recommendations presented in the two papers by Nota et al. (1994) and Jedrzejewski (1998).

Following this, CADC reprocessed a subsample of FOC data - the 10 pre-COSTAR datasets specified in the beginning - again with the above listed recommendations: GEOCORR perform, BACCORR perform, ITFCORR perform. The new and old data was once more checked and given the good agreement of the data subset, we proceeded to run all the datasets through the pipeline. Most probably, there are only very few datasets that actually change. The ones affected will mostly be those taken shortly before or after COSTAR implementation. The changes will be due to new "best geometric reference" files that were not present, when the data was initially ingested into the Archive. The differences manifest in a very small rotation of the image with respect to its old version.

2. The second version

During this second processing, it turned out that a significant fraction of the FOC datasets have `geohfile="N/A"` and hence `cal foc` does not process the data. Below follows a small statistic for this problem

```
shuswap 593% grep geohfile ../focck/X0* | grep "N/A" | wc
  530  3710  54590
shuswap 594% grep geohfile ../focck/X1* | grep "N/A" | wc
  147  1029  15141
shuswap 595% grep geohfile ../focck/X2* | grep "N/A" | wc
   40   280   4120
shuswap 596% grep geohfile ../focck/X3* | grep "N/A" | wc
   70   490   7210
```

A small number of these datasets were checked: `x0mz0101t`, `x0xg0105t`, `x0n00306t`, `x0xq0301t` and `x0si010dt`. They are all science exposures. In all cases, the best geometric correction file is `N/A`, although it should be actually the same one as in the old data (following the recommendations in Nota et al. (1994) and Jedrzejewski (1998)). This meant that the geometric reference file is NOT missing, because there is none available! All these datasets require geometric reference files that are actually present in the database.

A problem report to ESS(Mike Swam) gave 946 datasets that are affected by this problem.

```
1> select count(*) from foc_ref_data where fcr_best_geo = "N/A"  
2> go
```

```
-----  
      946
```

(1 row affected)

We figured out that for some filter combinations, no geometric reference file was ever taken. Since the filters have no impact on the geometric correction, we could simply expand the matrices in the BESTREF database to cover all filter wheel combinations. Mike did this and we were left with 228 remaining cases. All 228 datasets are all f48 data. 141 of them have set GEOCORR to OMIT or COMPLETE, so that we do not have to worry about the "N/A" entry for the geometric correction file. The remaining 87 have GEOCORR set to PERFORM. In these cases, the matrices cannot be expanded to cover different settings of SAMPOFF, SAMPPLN, LINEOFF, LINEPFM, SMMODE, because these settings will affect the geometric correction. The most likely explanation is, no geometric correction file was ever obtained for these specific settings.

3. The final version

The matrices in the BESTREF database have been updated by ESS and the FOC data was reprocessed. During the pipeline processing, the UNI_CORR keyword does not get updated when the correction is performed. To avoid confusion, we update this keyword – if necessary - a posteriori after checking the processing log.

3.1 Photometry changes

Photometry differences between the old and new version can be up to 20%. This is mainly due to different throughput tables used in the data calibration, pre-launch tables for the old processing versus in-flight for the new one.

3.2 Erroneous datasets

We checked the Archive and found that none of the 87 datasets mentioned in Section 2 had ever been fully processed before. Generating geometric reference files a posteriori for these datasets is extremely time consuming and the small amount of datasets affected does not justify this approach. Hence, it was decided to leave these 87 datasets – as done before – unprocessed.

4. Summary

The entire FOC database contains 6838 datasets; 5345 of these are science data. All of them are reprocessed with the best available reference files. 87 science datasets were not possible to calibrate and no attempt will be done to recover them. These datasets are listed in Table 2. This final calibration replaces the old version and is available at all three datacenters, MAST, CADC and ST-ECF.

Table 2: Problematic Datasets

| Dataset name | Dataset name | Dataset name |
|--------------|--------------|--------------|
| X2490102T | X38I0109T | X3E4010BT |
| X2490103T | X38I010AT | X3E4010DT |
| X2490104T | X38I1201T | X3FN0102T |
| X2490105T | X38I1202T | X3FN0105T |
| X2490106T | X38I1203T | X3FN0108T |
| X2490107T | X38I1206T | X3FN010BT |
| X2490108T | X38I1207T | X3FN1105T |
| X2490109T | X38I1208T | X3FN2102M |
| X249010AT | X38I2104T | X3FN2105M |
| X249010BT | X38I2105T | X3FN2108M |
| X2JM0103T | X38I2106T | X3FN3102T |
| X2JM0104T | X38I2107T | X3FN3105T |
| X2JM0106T | X38I2108T | X3FN3108T |
| X2JM0107T | X38I2109T | X3L80105T |
| X2JM0108T | X38I210AT | X3L80106T |
| X2JM010AT | X38I210BT | X3L80107T |
| X2JM010BT | X38I4102T | X3L8010AT |
| X2JM010CT | X38I4105T | X3L8010BT |
| X34I0101T | X38I4106T | X3L8010CT |
| X34I0102T | X38I4109T | X3L8010DT |
| X34I0103T | X38I410AT | X3L8010GT |
| X34I0104T | X3BD0102T | X3L8010HT |
| X34I0105T | X3BD0103T | X3L8010IT |
| X34I0106T | X3BD0202T | X3L80205T |
| X34I0108T | X3BD0203T | X3L80206T |
| X38I0103T | X3E40102T | X3L80207T |
| X38I0104T | X3E40105T | X3L80208T |
| X38I0105T | X3E40107T | X3L8020BT |
| X38I0108T | X3E40109T | X3L8020CT |

5. Acknowledgement

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Appendix

The list below contains the exclusion criteria used for the selection of science observations.

| | |
|--------------------------|---------------------|
| target_exclusion | NULL |
| target_exclusion | BIAS |
| target_exclusion | BORESIGHT |
| target_exclusion | DARD-PMT |
| target_exclusion | DARK |
| target_exclusion | EARTH*CALIB |
| target_exclusion | FFT* |
| target_exclusion | GLOW-TAR |
| target_exclusion | INTFLAT |
| target_exclusion | KSPOTS |
| target_exclusion | MOON* |
| target_exclusion | NICMOS-POINTED-FLAT |
| target_exclusion | NULL |
| target_exclusion | PMT-DARK-SKY |
| target_exclusion | TALED |
| target_exclusion | UVFLAT |
| target_exclusion | VISFLAT |
| target_exclusion | WAVE |
| target_exclusions | POST-SAA-DARK |
| groundmode_exclusion | IMAGE |
| groundmode_exclusion | TIME-RESOLVED |
| groundmode_exclusion | TARGET*ACQUISITION |
| grating_exclusion | M* |
| grating_exclusion | SAF |
| grating_exclusion | NDF |
| grating_exclusion | NULL |
| instrument_exclusion | NULL |
| instrument_exclusion | FGS |
| instrument_exclusion | HSP |
| operating_mode_exclusion | ACQ* |
| data_source_exclusion | LOGS |
| data_source_exclusion | REGR |
| data_source_exclusion | RING |
| data_source_exclusion | TAPE |