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# GHRS Calibration Changes since February 1997

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## 1. Introduction

The STScI GHRS Group has made some changes relating to GHRS calibration since the instrument was removed from HST in February 1997. These changes include an alternative method for calculating and removing background from observations, updates to most of the sensitivity files based on updates to the reference star data, and improvements and corrections to other Calibration Database (CDBS) files. This poster highlights 9 improvements that have been or could be made.

## 2. CALHRS Enhancement

In March 1997, CALHRS was enhanced to provide the option of calculating and subtracting a model background count rate for the two GHRS detectors. CALHRS v.1.3.11, (and later versions, if there will be any) expect 3 new keywords in the raw science header: SAAHFILE, CCRE, and BMD_CORR. The STSDAS task **hst_calib.ctools.chcalpar** can be used to add these keywords and their values to the raw science header. The model uses a mean relation determined for the FOS, scaled appropriately for Sides 1 and 2 of the GHRS. Geomagnetic longitude and latitude are used to predict the background count rate at the time of the observation, which must be outside of the South Atlantic Anomaly. Please see GHRS-ISR-084 for more details.

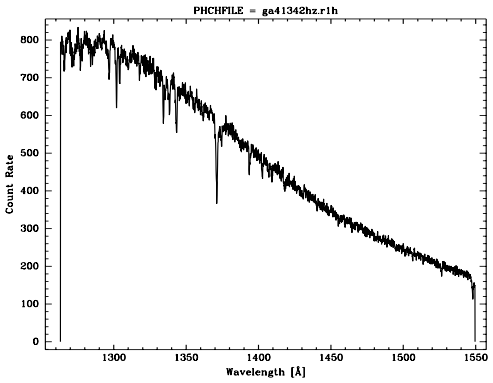


Figure 1. Data flat-fielded with ga41342hz.r1h containing INDEFs

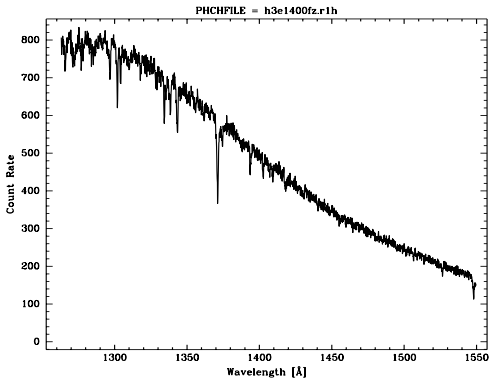


Figure 2. Same data flat-fielded with h3e1400fz.r1h with no INDEFs

## 3. CZZ File Update

A new, post-COSTAR Small Science Aperture Wavelength Offset (CZZ) file is being added to CDBS. The CZZ file is used only by the **zwavecal** task in **stsdas.hst_cal.hrs** to create a new wavelength dispersion based on a GHRS wavelength calibration observation. The table is now being updated for the new post-COSTAR Side 1 carrousel positions.

## 4. Minor changes to G140L flat-fields (PHCHFILEs) to fix accidental INDEFs

The INDEFs in the g*.r1h tables cause the first and last points of flat-fielded (photocathode nonuniformities removed) GHRS data to be 0, as illustrated in Figure 1. The problem is fixed by the h*.r1h tables, as shown in Figure 2. For more information about when to use G140L flat-fields, see GHRS-ISR-076.

Table 1. Image statistics for ga41342hz.r1h (Columns 2–5) and the corrected h3e1400fz.r1h (Columns 6–9)

| GROUP | MEAN | STDDEV | MIN | MAX | MEAN | STDDEV | MIN | MAX |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.6000E35 | 5.0584E36 | 0.918745 | INDEF | 1.00001 | 0.0131494 | 0.918745 | 1.04787 |
| 2 | 1.6000E35 | 5.0584E36 | 0.848478 | INDEF | 1.00004 | 0.0202133 | 0.848478 | 1.15366 |
| 3 | 1.6000E35 | 5.0584E36 | 0.946298 | INDEF | 1.00003 | 0.0133674 | 0.946298 | 1.03758 |
| 4 | 1.6000E35 | 5.0584E36 | 0.952967 | INDEF | 1.00004 | 0.0130505 | 0.952967 | 1.037 |
| 5 | 1.6000E35 | 5.0584E36 | 0.953588 | INDEF | 1.00001 | 0.0122881 | 0.953588 | 1.03679 |
| 6 | 1.6000E35 | 5.0584E36 | 0.956037 | INDEF | 1.00001 | 0.0131402 | 0.956037 | 1.03792 |
| 7 | 1.6000E35 | 5.0584E36 | 0.954318 | INDEF | 0.999982 | 0.0135689 | 0.954318 | 1.04381 |
| 8 | 1.6000E35 | 5.0584E36 | 0.951942 | INDEF | 0.999992 | 0.0142112 | 0.951942 | 1.0458 |
| 9 | 1.6000E35 | 5.0584E36 | 0.936251 | INDEF | 0.999999 | 0.0158543 | 0.936251 | 1.06082 |
| 10 | 1.6000E35 | 5.0584E36 | 0.916761 | INDEF | 1.00001 | 0.0188566 | 0.916761 | 1.07989 |

## 5. New CCR8 table containing updated LSA incidence angle offsets available 18 Feb 97

Figures 3 and 4 illustrate the differences in G160M wavelengths when old (e3t1250lz.cz8) and new (h2615285z.cz8) CCR8 tables are applied. Note that no update was made to the G140L incidence angle correction. For more information, please read GHRS-ISR-080.

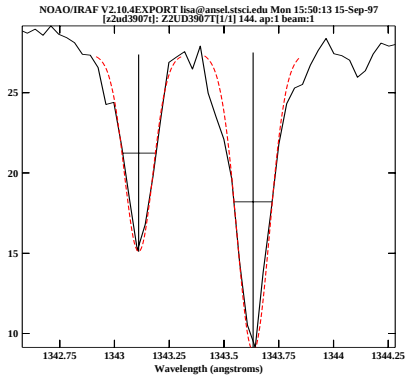


Figure 3. Positions of lines using old LSA incidence angle offsets

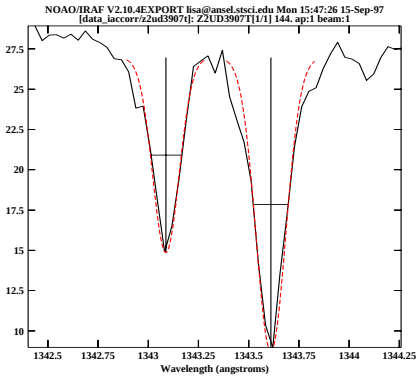


Figure 4. Positions of lines using new LSA incidence angle offsets

Table 2. Comparison of new and old LSA incidence angle offsets

| GRATING | A | B | Old CCR8 A value |
|---|---|---|---|
| G140L | 0. | 0. | 0. |
| G140M | -0.0065 | 0. | 0. |
| G160M | -0.0448 | 0. | -0.022±0.023 |
| G200M | -0.057 | 0. | -0.037±0.012 |
| G270M | -0.06 | 0. | -0.036±0.007 |
| ECH-A | $-0.0076 \times m$ | 0. | 0. |
| ECH-B | $-0.0078 \times m$ | 0. | 0. |

## 6. G140L post-COSTAR baseline and time-variable sensitivity files available 22 May 97

The top plot in both Figures 5 and 6 shows GHRS data flux-corrected with the appropriate time-variable sensitivity file divided by the reference star; the bottom plot in each set is the same ratio for data calibrated by the OPUS pipeline. Figure 5 shows data from Jan 95; and Figure 6 shows data from Jan 97. GHRS-ISR-085 gives more information.

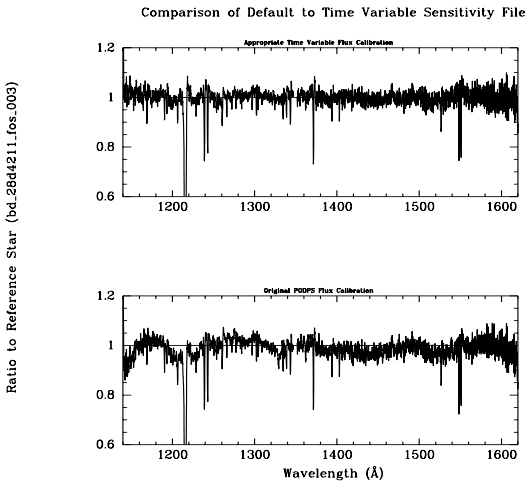


Figure 5. Jan 95 G140L data, before and after sensitivity file update

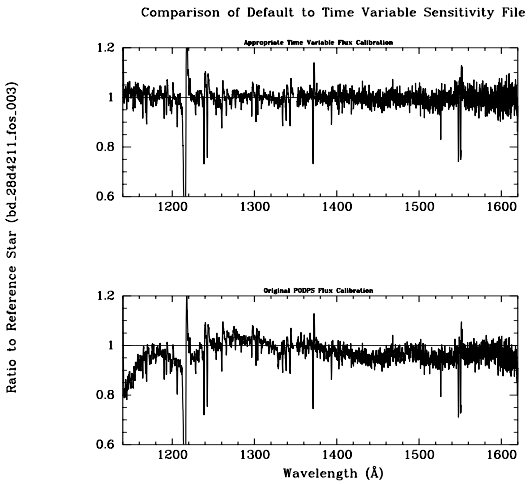


Figure 6. Jan 97 G140L data, before and after sensitivity file update

Table 3. New G140L post-COSTAR sensitivity files in CDBS

| ABSHFILE | NETHFILE | GRATING | DATE | USEAFTER | PEDIGREE |
|---|---|---|---|---|---|
| h5m10094z.r3h | h4s1130qz.r4h | G140L | 22 May 97 | 14/06/94 | INFLIGHT |
| h5m10095z.r3h | | | | 01/08/94 | |
| h5m10096z.r3h | | | | 21/10/94 | |
| h5m10097z.r3h | | | | 14/01/95 | |
| h5m10098z.r3h | | | | 17/04/95 | |
| h5m10099z.r3h | | | | 25/06/95 | |
| h5m1009az.r3h | | | | 17/09/95 | |
| h5m1009bz.r3h | | | | 04/01/96 | |
| h5m1009cz.r3h | | | | 02/05/96 | |
| h5m1009dz.r3h | | | | 30/08/96 | |
| h5m1009ez.r3h | | | | 22/11/96 | |
| h5m1009fz.r3h | | | | 24/01/97 | |

## 7. New G140M and Ech-A post-COSTAR sensitivities available 10 Sep 97

The improvement in G140M and Ech-A sensitivity is based on reference file mu_col_006.tab, updated 5 Oct 95, which is almost a year and a half after the original post-COSTAR sensitivity files (e5v0936qz.r3h and e5v0936nz.r3h) were placed in CDBS. Please read GHRS-ISR-088 for more details.

The top plot in Figure 7 shows reference IUE spectrum for *mu* Col is plotted with the merged G140M data using the most current reference files (e5v0936qz.r3h).

The middle plot in Figure 7 shows the ratio of G140M to the reference spectrum fit with a linear function for use in correcting the sensitivity.

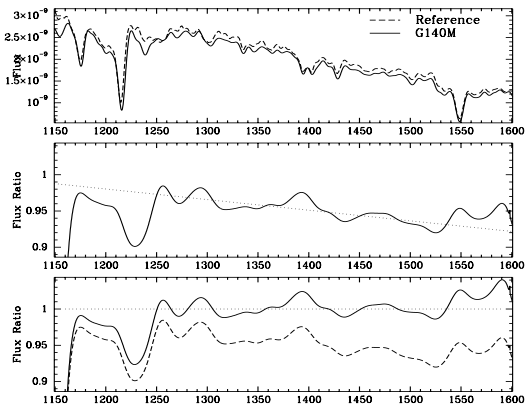


Figure 7. G140M data compared to $\mu$ Col before and after sensitivity file update

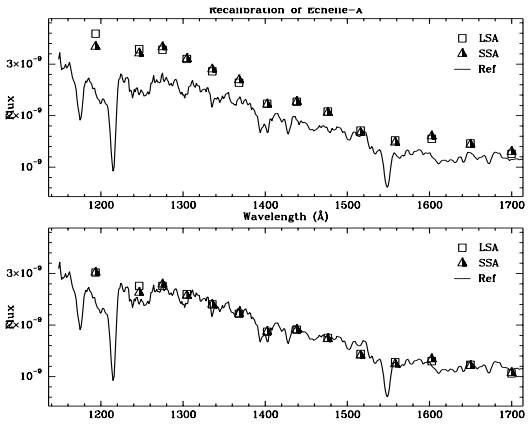


Figure 8. Ech-A data compared to $\mu$ Col before and after sensitivity file update

Applying the linear correction to the current sensitivity function improves the ratio dramatically, as shown in the bottom plot of Figure 7.

Figure 8 shows the reference flux for *mu* Col plotted with the calculated values from Ech-A. In the top plot, both LSA and SSA show an excess flux of $\tilde{1}9\%$ using the old sensitivity file (e5v0936nz.r3h). In the bottom plot, measured and reference flux values agree once a constant factor is applied.

Table 4. New G140M and Ech-A sensitivity files in CDBS

| ABSHFILE | NETHFILE | GRATING | DATE | USEAFTER | PEDIGREE |
|---|---|---|---|---|---|
| h9a11401z.r3h | e5v09367z.r4h | ECH-A | 10 Sep 97 | 04 Feb 94 | INFLIGHT |
| h9a11402z.r3h | e5v09369z.r4h | G140M | | | |

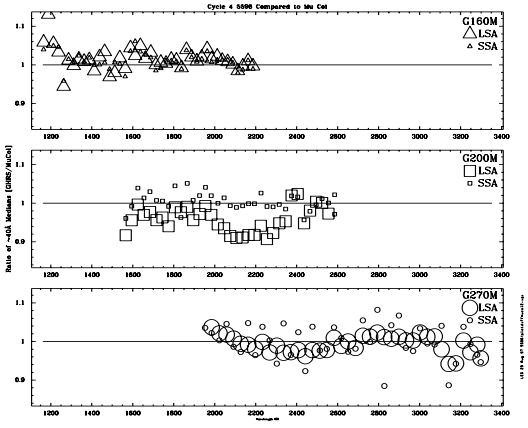


Figure 9. Side 2 first-order data compared to $\mu$ Col before using sensitivities from 31 May 94 (e5v*.r3h)

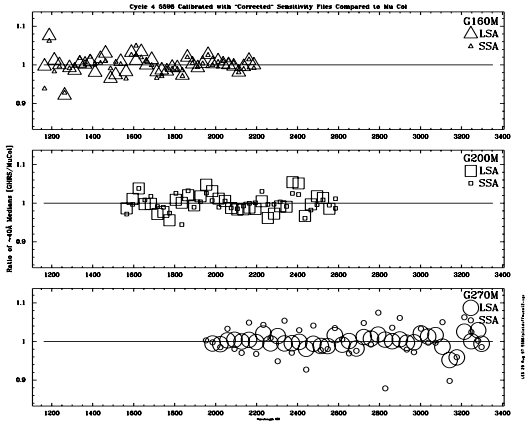


Figure 10. Same data after correcting sensitivity files for shape seen in Figure 9

## 8. Review of Side 2 medium resolution baseline sensitivities

Figure 9 shows the ratio of Cycle 4 Side 2 Sensitivity Calibration program 5596 to $\mu$ Col reference file (mu_col_006.tab, updated since post-COSTAR Side 2 sensitivity files were put into CDBS). These results were fit with 3rd order cubic splines and applied to the 31 May 94 sensitivity files in an attempt to correct them. Figure 10 shows the same ratio after using the "corrected" sensitivity files. Although the peak-to-peak variation is suppressed, the underlying structure is still evident. Perhaps a complete recalibrating may get rid of the underlying structure, but the current GHRS group may not have time to do the calibrations. These sensitivities also could be corrected for about a 2% decrease per year.

## 9. Review of Side 2 Ech-B baseline sensitivity

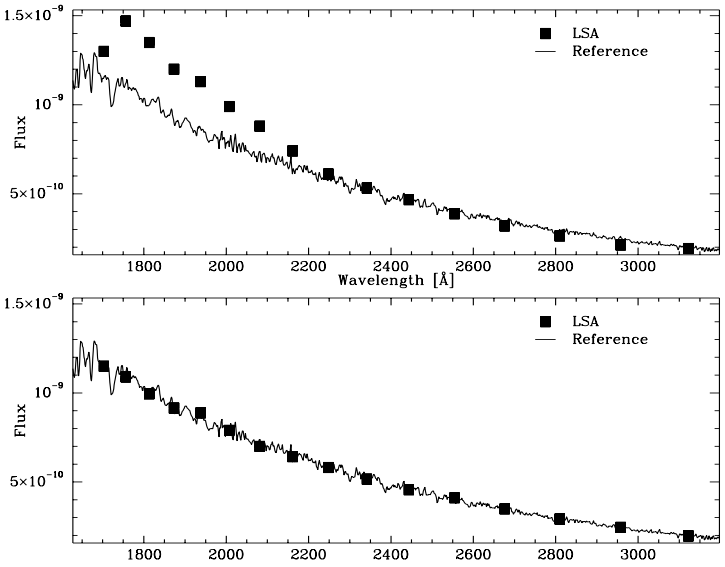


Figure 11. Ech-B data compared to $\mu$ Col before and after LSA sensitivity file update

The top of Figure 11 shows average values of the Cycle 4 Echelle-B Sensitivity Calibration program 5597 against the $\mu$ Col reference file (mu_col_006.tab, updated since post-COSTAR Side 2 sensitivity files were put into CDBS). The Ech-B LSA sensitivity was then completely recalculated and applied to the same data. The bottom of Figure 11 shows the same data after applying the "corrected" sensitivity files. The SSA sensitivity is proving a little more difficult, so a corrected Ech-B sensitivity file has not yet been put into CDBS.

**Acknowledgments.** We are grateful to J. Mack for doing the G140M, Ech-A, and Ech-B reductions and CDBS updates.

## References

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Schultz, A., 1996, Instrument Science Report GHRS-076 (Baltimore: STScI)

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Sherbert, L., 1997, Instrument Science Report GHRS-085 (Baltimore: STScI)

Mack, J., 1997, Instrument Science Report GHRS-088 (Baltimore: STScI)