STScI | SPACE TELESCOPE SCIENCE INSTITUTE

Instrument Science Report WFC3 2017-11

WFC3/UVIS: Updates to SYNPHOT Reference Files and IMPHTTAB

Susana E. Deustua and Varun Bajaj
May 02 2017

ABSTRACT

Updates since February 2016 to SYNPHOT configuration reference files and the photometry lookup up table, IMPHTTAB, for WFC3/UVIS are described. We also document the history and description of changes implemented for previous versions of the same reference files.

1. Updates to SYNPHOT files

In February 2016, WFC3 implemented chip dependent photometric calibration, wherein each CCD in the WFC3/UVIS channel is calibrated independently: each has its own flat field and inverse sensitivity value, as well as filter based encircled energy fractions (Deustua et al. 2016). Similarly the throughput tables in the CDBS configuration files used by the synthetic photometry tools, PySYNPHOT and SYNPHOT, were modified. Filter-based encircled energy tables (often referred to as the aperture correction tables) for each detector were provided (Deustua 2016).

The component lookup table, _tmc.fits, was updated to point to the new UVIS1 and UVIS2 throughput and encircled energy. The instrument graph table, _tmg.fits, was modified so that each WFC3/UVIS CCD has its own path. The TMC and TMG files are available from the CRDS at http://www.stsci.edu/hst/observatory/crds/throughput.html. Below we list the delivery date and names of the TMC and TMG files in chronological order and a brief description of what changed for WFC3. These configuration files are used by PySynphot to calculate system throughputs, expected count rates and so forth

for all HST instruments. The TMG files provide the order in which the various optical components are 'seen' by an incoming photon. The TMC files list the names of the optical component tables that PySynphot should use. As with all reference files, these follow the unique name convention described in the document, ICD-47_RevF.pdf, available from http://www.stsci.edu/hst/observatory/crds/file_structure.html. Essentially, the convention is ymdhmsi_typ.fits for year, month, day, hour, minute, second, instrument, and typ is the kind of reference file. e.g. drk for dark, tmc for telescope component file.

TMC Files:

Delivery Date	Filename	Description
21 may 2016,	04k2013bm_tmc.fits	WFC3/UVIS chip dependent component files added, no changes to WFC3/IR
21 may 2016	04k2012am_tmc.fits	No changes to any WFC3 files
23 Jul 2016	0661429jm_tmc.fits	Updated wfc3uvis1_f953n file which had incorrect COMPNAME
28 Jul 2016	07r1502nm_tmc.fits	New WFC3 UVIS1 and UVIS2 apertures. Updated grism and F763M file names. No changes for WFC3/IR.
Jun 2017	16XXXXXXX_tmc.fits	Updates aperture corrections for UVIS Quad Filters

Table 1. History of the *tmc.fits files for WFC3

TMG Files

Delivery Date	Filename	Description
April 27 2016	04k2013hm_tmg.fits	WFC3/UVIS Chip dependent paths added. No changes for WFC3/IR
May 23 2016	04k2014bm_tmg.fits	WFC3/UVIS Chip dependent paths edited
Jun 6 2016	0661437lm_tmg.fits	removed duplicated entry for WFC3 G280
Jul 28 2016	07r1502mm_tmg.fits	updated to add MJD support for WFC3 G280
Nov 16 2016	0bf2050hm_tmg.fits	(same as 07r1502mm_tmg.fits)
Jan 30 2017	11q0123nj_tmg.fits	Corrected WFC3 G280 background underprediction issue and fixed FQ937N path.
April 2017	14l1632sm_tmg.fits	Corrects the quad filter path so that regardless of CCD selected, the results from PySYNPHOT, e.g predicted count rates, mean flux and so forth are the same as in 2012.

Table 2. History of the *tmg.fits relevant to WFC3

Quad Filters

A quad filter, so named because each filter only covers one quadrant of the UVIS CCD array, is paired with either chip 1 or chip 2 but not both, so therefore half of the quad filters are only used with UVIS1, and half with UVIS2. Thus each quad has exactly one inverse sensitivity value (photflam), and because the flat fields for the twenty quad filters have not been updated since 2012, their photflam values remain unchanged. Synthetic photometry (synphot) for these filters therefore still use the original, 'single-chip' tables. When the chip dependent calibration was implemented, in 2016, the quad filter paths were inadvertently changed in the tmg.fits file. With the April 2017 version, the quad filter paths were restored to the original, 2012 solution.

NOTE: WFC3/IR paths in the tmg.fits files have not been modified since WFC3's installation in HST. Component files for the WFC3/IR were last updated in 2012.

Effect on ETC calculations

The ETC (exposure time calculator) uses the synphot tmg.fits and tmc.fits files to call the throughput tables in order to compute exposure times and signal-to-noise. Thus when either the tmg.fits and/or the tmc.fits files are modified there will be changes to the ETC output. Usually these are small effects, and reflect changes in instrument behavior (e.g. sensitivity), improvements in calibration (e.g. better polynomial fits), and/or observation strategies (e.g. Postflash)

- 11q0123nj_tmg.fits affects ETC calculations for the G280 grism, such that now the correct background is applied.
- The 14l1632sm _tmg.fits will affect the ETC calculation for the WFC3/UVIS quad filters. The ETC uses the tmg.fits files and so after the chip dependent implementation the ETC computations incorrectly applied the new throughputs to the quad filters. The UV quad filters were most affected, by up to 20%. With the April 2017 14l1632sm_tmg.fits files, the appropriate 2012 quad filter tables are now applied, regardless of which CCD users select.

2. Updates to the photometry lookup table, IMPHTTAB

In June 2017, new, improved, inverse sensitivity values replace the 2016 values in the UVIS photometry lookup table, IMPHTTAB, that is used by calwf3 to populate the photometry header keywords. In response to user input and to conform to standard practice, these **new values are for the infinite aperture**[1], which makes its application straight-forward for use with extended sources.

These new values are approximately 10% smaller than the values in the previous version of the lookup table due to the change from the r=10 pixel aperture to the infinite aperture. Table 3 provides a history of the IMPHTTAB files since 2012 when the change was made to no longer directly call the synphot tables for pipeline processing.

[1] HST's working definition of the infinite aperture, within which all the light from a point source is contained, has radius of r=6 arcseconds, The uncertainty is +/- 0.5%.

Delivery Date/ Activation Date	Filename	Description
Jun 19 2012	w6j2355pi_imp.fits	UVIS first 'new' format, one-chip look up table, test only
Jun 19 2012	w6j2355oi_imp.fits	IR first 'new' format, test only
Nov 19 2012/ Dec. 28 2012	wbj1825ri_imp.fits	IR first active IMPHTTAB, with 2012 solutions for 3 WDs and P330E
Nov 19 2012/ Dec. 28 2012	wbj1825si_imp.fits	First active UVIS IMPHTTAB, 3 extension FITS file, Used with HSTCAL.calwf3 v3.1. 'Single Chip' solution. Based on 2012 solutions for 3 WDs and P330E.
May 17 2013/ Jul 03, 2013	x5h1320fi_imp.fits	UVIS, inflight, one-chip, , corrected by <1% to remove flat field normalization
Apr 3 2014	y431853ri_imp.fits, y4s1821gi_imp.fits, y4t19557i_imp.fits	UVIS chip dependent structure, used ONLY for testing, containing 'dummy' values. Included for completeness
Feb 2 2016:/ Feb 23 2016	zcv2057li_imp.fits	First Chip Dependent IMPHTTAB, 5 extension fits file, Master DRZ per filter for 3 WDs, works with calwf3 v3.3+
Nov 18 2016/ Nov 21 2016	0bi2206ti_imp.fits	Chip-dependent photometry lookup table, for an aperture with r=10 pixels, Same as zcv2057li_imp.fits but with modified PHTFLAM1 values of four UV filters (F200LP, F218W, F225W and F275W) so that PHTFLAM2/PHTFLAM1 is the same as the count ratio, C_1/C_2 between the two CCDs.
June 2017	16XXXXX_imp.fits	Chip-dependent photometry lookup table, sensitivity values given for the infinite aperture, and with modified PHTFLAM1 values of four UV filters (F200LP, F218W, F225W and F275W) so that PHTFLAM2/PHTFLAM1 is the same as the count ratio, C_1/C_2 between the two CCDs. Infinite aperture, Better polynomial fits to data and updated models, matches April 2016 synphot tables

Table 3. History of the wfc3 photometry lookup table, imphttab.

Effect on aperture correction

Users analyzing point sources will still need to apply an aperture correction for their aperture radii to the infinite aperture using the encircled energy fraction tables available on the WFC3 website (or in Deustua et al 2016, Bowers et al 2016).

3. Acknowledgements

We thank Kailash Sahu for his useful comments and suggestions which improved this report's readability and information transfer.

4. References

Bajaj, V., 2016, WFC3 ISR 2016-02: The Updated Calibration Pipeline for WFC3/UVIS: A Cookbook to Calwf3 3.3

Bowers et al., 2016, WFC3-ISR-2016-XX: WFC3: UVIS 2.0 Filter Dependent Encircled Energy Fractions (in preparation)

Deustua, S., et al., 2016, WFC3 ISR 2016-03 WFC3 : UVIS 2.0 Chip-dependent Inverse Sensitivity Values

Deustua, S., 2016, WFC3 ISR-2016-07: Updated WFC3/UVIS Chip Dependent SYNPHOT/PYSYNPHOT Files

Ryan et al., 2016, WFC3 ISR 2016-01: The Updated Calibration Pipeline for WFC3/UVIS: A Reference Guide to Calwf3 3.3