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Synphot Data Files (creation, testing and delivery for STIS)

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ABSTRACT

The goal of this document is to clarify how Synphot uses instrument data files, in conjunction with the software, to make predictions about HST observations. This document discusses the most important aspects of Synphot data files. It also covers in detail the procedures for the creation, testing, and delivery of STIS Synphot data files.

Introduction

Synphot data files (also known as component files) are binary FITS tables with a special format for the header and data. These files are used by the Synthetic Photometry (Synphot) package that simulates photometric and spectrophotometric data observed with the Hubble Space Telescope (HST).

Also, given that the ETCs rely heavily on Synphot as their throughput calculator, these files are key to GOs when planning their HST observations. Here we provide a general overview of the Synphot data files for STIS and how these files are used in Synphot. We also describe how the ”Integrated Instrument Throughput” Synphot data files are created by using the information contained in the STIS PHT pipeline reference files. Finally the current procedures for testing and validation of these files are provided.

Note that most of the topics presented here apply to all Synphot data files in general; however, since this document also describes procedures that apply to STIS Synphot data files only, each section will be highlighted as ”general” or ”STIS only” in order to make a clear distinction for the reader.

Synphot Overview (general)

This document describes the framework of the Synphot software; for more details on the basic concepts, data structures, and software needed for dynamic throughput generation, see Horne, Burrows, and Koornneef (1986).

The Synphot software is an IRAF-based suite of programs that, using data files, dynamically generates the throughput for any of the HST observing modes. The information about the instruments is contained within Synphot data files, not the software, making it easy to maintain and to change or to add new modes by simply modifying the data files. All the information that Synphot needs to compute the throughput of an instrument mode, is contained within three types of data files:

1. an observatory configuration graph table, better known as "the master graph" table (hereafter referred as TMG). This is a FITS table that describes the allowed combination of the components or optical elements. Its format maps the light path as it travels through the spacecraft;

2. a master component lookup table, better know as "the master component" table (hereafter referred as TMC), with information on the physical location of the Synphot data files;

3. a set of Synphot data files for the optical components (e.g., OTA, mirror, filter, polarizer, disperser, slit, detector) used for HST, as well as for other supported photometric bandpasses.

In the Synphot software a particular observing mode is specified by a list of keywords, which might be names of filters, detectors, and gratings. These keywords are used to trace the light path of that mode via the TMG (extension `_tmg.fits`) table. The grand throughput function is then constructed by multiplying together the throughputs of the individual Synphot data files, at each wavelength, identified via the TMC table (extension `_tmc.fits`). Figure 1 shows an example of how the TMG and TMC tables are used to identify the Synphot data files for a particular HST mode. In this example, the Synphot parametrized string "`showfiles stis,fuvmama,e140h, 52x0.05,1234`" is broken into separate keywords (`stis`, `fuvmama`, `e140h`, `52x0.05`, and `1234`) which are then used to identify the component names in the TMG table. The TMG table has five columns: column 1 provides the component name (`COMPNAME`), column 2 contains the instrument keywords (`KEYWORD`), column 3 gives the input node value (`INNODE`), column 4 gives the output node value (`OUTNODE`), and column 5 gives comments (`COMMENT`). In this case, the input node and output node values are integer numbers used to associate the components that describe the optical elements, in the same order as these are encountered by the light from the observed source. For example, in STIS, the light entering the instrument goes from the first corrector mirror to the second corrector mirror and so on until it finally reaches the detector. Therefore, the `INNODE` value for the first corrector mirror is smaller than that of the second corrector mirror, while that of the CCD detector is bigger than the value for any of the grating or slit components. To find the components of a given instrument configuration (as in the example above), the value of the `OUTNODE` is matched with the row that has the same `INNODE` value, starting with the smallest `OUTNODE` value. If there are several rows with the same input node value, the row with a keyword that matches any of the keywords of the above instrument configuration, is selected. If there is no matching keyword, the row with the keyword "`default`" is selected. On the other hand, if there is only one row for the given input node value, this unique row is selected by default. The dashed lines in Figure 1 illustrate how the selection is done for the above example; with the arrows pointing to the direction of the selection. Once all the component values have been identified, the physical location of the corresponding Synphot data files are extracted from the TMC table. This is done by matching the component name column in both tables. The TMC table has four columns, which contain the time in which the individual Synphot data file was created (`TIME`), the component name (`COMPNAME`), the path to where the STSDAS file is stored (`FILENAME`), and comments pertaining to the file (`COMMENT`). Note that in this file the time and comment columns are not used, these are included for documentation only, and the only way to introduce time dependencies within Synphot is via parameterized keywords (see STIS TIR 2005-02).

An example: STIS Synphot Data Files

Each slit/filter, grating, camera, correction mirror, detector, etc. for a particular instrument has a unique data file that the Synphot software uses to dynamically generate the throughput of a particular observing mode. For STIS, these can be grouped into 4 categories (STIS TIR 98-04): i) optical elements, ii) grating setting wavelength ranges, iii) integrated instrument throughputs (not including OTA throughput), and iv) slit/ filter throughputs.

For the first category, there is one Synphot data file for each of the optical elements in STIS. Table 1 provides a list of all these files. Column 1 gives the Synphot data file root-name assigned to each of the STIS optical elements indicated in column 3, and the corresponding wavelength range is given in column 2. To better understand how the data files are used by Synphot and how they relate to the light path of the instrument, we provide in column 4 a tag value that can be used in conjunction with Figure 2 to identify the location of the associated optical element. For example, in this figure the Synphot data files for the detectors' fold mirrors correspond to the optical elements with tag M*, those for MAMA echelles are indicated with tags EG* and those for the camera mirrors have tags K*. In the past, all the Synphot data files describing STIS optical elements were essentially place holders for the instrument components (i.e., dummy files); however, after the implementation of Time Dependent Sensitivity (TDS) effects in Synphot (See STIS TIR 2005-02), some of the files associated with gratings and mirrors were modified. Column 5 indicates which files are still dummy (i.e., contain the value 1 for throughput) and which ones were used for TDS correction.

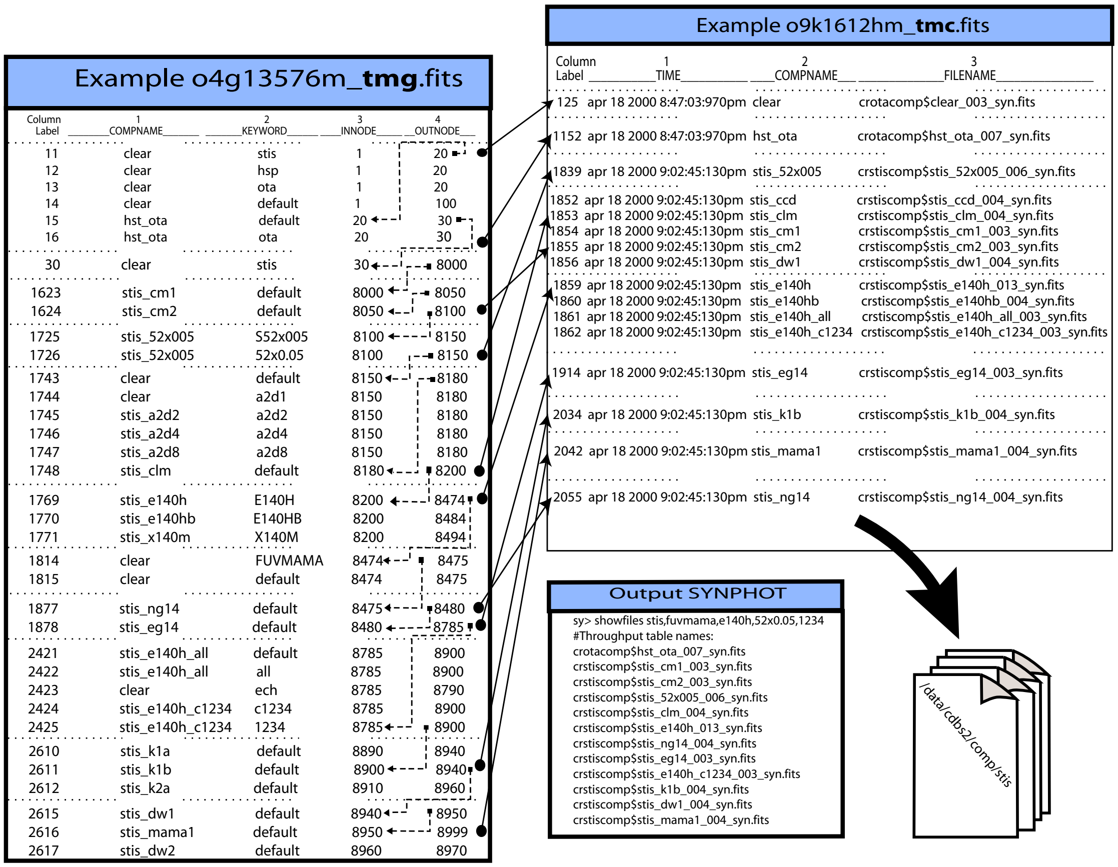

Figure 1: Schematic representation of the TMC and TMG tables and how these are used by Synphot to construct the grand throughput function. The dotted lines in the example boxes indicate where some lines in the original table were omitted. To show more clearly how the TMG table traces the light path of STIS, the dashed lines connect the OUTNODE with the corresponding innode row in the order they are selected. The solid lines connect the COMPNAMEs in the TMG file with those in the TMC table (top right box). The right bottom box shows the output of the `showfiles` Synphot tasks for the represented mode.

Table 1: Synphot data files for STIS Optical Elements

File Name	Wavelength range	Optical Element	type	tag
stis_cm1	500-14000	First Corrector Mirror	dummy	CM1
stis_cm2	500-14000	Second Corrector Mirror	dummy	CM2
stis_clm	1150-12000	Collimator Mirror	dummy	CLM
stis_os21	500-14000	Order Sorter G230L	dummy	OS21
stis_os22	500-14000	Order Sorter G230M	dummy	OS22
stis_os21b	500-14000	Order Sorter G230LB	dummy	OS21B
stis_os22b	500-14000	Order Sorter G230MB	dummy	OS22B
stis_os23	500-14000	Order Sorter E230M	dummy	OS23
stis_os24	500-14000	Order Sorter E230H	dummy	OS24
stis_os31	500-14000	Order Sorter G430L	dummy	OS31
stis_os32	500-14000	Order Sorter G430M	dummy	OS32
stis_os41	500-14000	Order Sorter G750L	dummy	OS41
stis_os42	500-14000	Order Sorter G750M	dummy	OS42
stis_ng11	500-14000	Parabolic Grating G140L	TDS	NG11
stis_ng21	500-14000	Parabolic Grating G230L	TDS	NG21
stis_ng12	500-14000	Plane Grating G140M	TDS	NG12
stis_ng22	500-14000	Plane Grating G230M	TDS	NG22
stis_ng21b	500-14000	Plane Grating G230LB	dummy	NG21B
stis_ng12b	500-14000	Plane Grating G140MB	TDS	NG12B
stis_ng22b	500-14000	Plane Grating G230MB	TDS	NG22B
stis_ng23	500-14000	Plane Grating E230M	TDS	NG23
stis_ng24	500-14000	Plane Grating E230H	TDS	NG24
stis_ng31	500-14000	Plane Grating G430L	TDS	NG31
stis_ng32	500-14000	Plane Grating G430M	TDS	NG32
stis_ng41	500-14000	Plane Grating G750L	TDS	NG41
stis_ng42	500-14000	Plane Grating G750M	TDS	NG42
stis_ng13	500-14000	Plane Grating E140M	TDS	NG13
stis_ng14	500-14000	Plane Grating E140H	TDS	NG14
stis_nm16	500-14000	Mode Select Parabolic Mirror MIRCUV	TDS	NM16
stis_nm26	500-14000	Mode Select Parabolic Mirror MIRNUV	TDS	NM26
stis_nm36	500-14000	Mode Select Fold Mirror MIRVIS	TDS	NM36
stis_eg13	500-14000	Echelle Grating E140M	dummy	EG13
stis_eg14	500-14000	Echelle Grating E140H	dummy	EG14
stis_eg23	500-14000	Echelle Grating E230M	dummy	EG23
stis_eg24	500-14000	Echelle Grating E230H	dummy	EG24

Table 1: Synphot data files for STIS Optical Elements

File Name	Wavelength range	Optical Element	type	tag
stis_m1	1150-12000	Fold Mirror FUV-MAMA	dummy	M1
stis_m2	1150-12000	Fold Mirror NUV-MAMA	dummy	M2
stis_m3	1150-12000	Fold Mirror CCD	dummy	M3
stis_k1a	1150-12000	Camera Mirror MAMA-FUV E modes	dummy	K1A
stis_k1b	1150-12000	Camera Mirror MAMA-FUV G modes	dummy	K1B
stis_k2a	1150-12000	Camera Mirror MAMA-NUV E modes	dummy	K2A
stis_k2b	1150-12000	Camera Mirror MAMA-NUV G modes	dummy	K2B
stis_k3	1150-12000	Camera Mirror CCD	dummy	K3
stis_dw1	1150-12000	Detector Window FUV-MAMA	dummy	DW1
stis_dw2	1150-12000	Detector Window NUV-MAMA	dummy	DW2
stis_dw3	1150-12000	Detector Window CCD	dummy	DW3
stis_mama1	1150-12000	CsI MAMA Detector	dummy	MAMA1
stis_mama2	1150-12000	Cs2Te MAMA Detector	dummy	MAMA2
stis_ccd	1150-12000	CCD Detector	dummy	CCD

The files for the grating setting wavelength ranges, on the other hand, set the wavelength range for the specific gratings and central wavelengths. In these files, the throughput value is 1 over the wavelength range of the grating, and that is how Synphot defines the coverage in λ of a given observing mode. Table 2 provides a list of these files. Column 1 is the file name, column 2 is the grating setting (or CENWAVE setting), and column 3 is the wavelength range in angstroms. Note that in addition to the particular CENWAVE setting there is one file that contains all the wavelength ranges for all available gratings; this file has extension "`all_*_syn.fits`".

The next category is the integrated throughput Synphot data files for each observing mode in STIS. These files contain the integrated instrument throughput from the instrument entrance aperture to the detector. The optical telescope assembly (OTA) throughput is contained in a separate file maintained by the Observatory Support Group (OSG) and called hst_ota_007_syn.fits (see Figure 1). Slit losses and filter throughputs are not included in these files. Table 3 lists the Synphot data files that contain the integrated instrument throughputs. Column 1 provides the Synphot data file name associated with the Synphot/Proposal Instructions keyword given in column 2. In column 3 we show the Investigation Definition Team (IDT) mode identification value. The wavelength range is provided in column 4. According to the configuration of the TMG table, these files are selected after the table associated to the collimator and before those for the optical elements located in the Mode Selection Mechanism (MSM) (see Figure 2).

The last category of Synphot data files are the filter and slit throughputs. In the

Table 2: Synphot data files for Grating Setting Wavelength Ranges

Filename	Grating Setting	Wavelength Range
stis_g140m_all	1655	1000-2310
stis_g140m_c1173	1173	1145-1200
stis_g140m_c1222	1222	1194-1249
stis_g140m_c1272	1272	1244-1299
stis_g140m_c1321	1321	1293-1348
stis_g140m_c1371	1371	1343-1398
stis_g140m_c1420	1420	1392-1447
stis_g140m_c1470	1470	1442-1497
stis_g140m_c1518	1518	1490-1545
stis_g140m_c1567	1567	1539-1594
stis_g140m_c1616	1616	1588-1643
stis_g140m_c1665	1665	1637-1692
stis_g140m_c1714	1714	1686-1741
stis_e140m_c1425	1425	1114-1735
stis_g140m_i1218	1218	1190-1245
stis_g140m_i1387	1387	1359-1414
stis_g140m_i1400	1400	1372-1427
stis_g140m_i1540	1540	1512-1567
stis_g140m_i1550	1550	1522-1577
stis_g140m_i1640	1640	1612-1667
stis_e140m_all	1765	1000-2530
stis_e140h_all	1685	1000-2370
stis_e140h_c1234	1234	1132-1335
stis_e140h_c1416	1416	1314-1517
stis_e140h_c1598	1598	1496-1699
stis_e140h_i1271	1271	1169-1372
stis_e140h_i1307	1307	1205-1408
stis_e140h_i1343	1343	1241-1444
stis_e140h_i1380	1380	1278-1481
stis_e140h_i1453	1453	1351-1554
stis_e140h_i1489	1489	1387-1590
stis_e140h_i1526	1526	1424-1627
stis_e140h_i1562	1562	1460-1663
stis_g230m_all	4150	1550-6750
stis_g230m_c1687	1687	1641-1732
stis_g230m_c1769	1769	1723-1814
stis_g230m_c1851	1851	1805-1896
stis_g230m_c1933	1933	1887-1978
stis_g230m_c2014	2014	1968-2059

Table 2: Synphot data files for Grating Setting Wavelength Ranges

Filename	Grating Setting	Wavelength Range
stis_g230m_c2095	2095	2049-2140
stis_g230m_c2176	2176	2130-2221
stis_g230m_c2257	2257	2211-2302
stis_g230m_c2338	2338	2292-2383
stis_g230m_c2419	2419	2373-2464
stis_g230m_c2499	2499	2453-2544
stis_g230m_c2579	2579	2533-2624
stis_g230m_c2659	2659	2613-2704
stis_g230m_c2739	2739	2693-2784
stis_g230m_c2818	2818	2772-2863
stis_g230m_c2898	2898	2852-2943
stis_g230m_c2977	2977	2931-3022
stis_g230m_c3055	3055	3009-3100
stis_g230m_c3134	3134	3088-3179
stis_g230m_c3135	3134	3088-3179
stis_g230m_i1884	1884	1838-1929
stis_g230m_i2600	2600	2554-2645
stis_g230m_i2800	2800	2754-2845
stis_g230m_i2828	2828	2782-2873
stis_e230m_all	4245	1550-6940
stis_e230m_c1978	1978	1573-2382
stis_e230m_c2707	2707	2302-3111
stis_e230m_i2124	2124	1719-2528
stis_e230m_i2269	2269	1864-2673
stis_e230m_i2415	2415	2010-2819
stis_e230m_i2561	2561	2156-2966
stis_e230h_all	4135	1550-6720
stis_e230h_c1763	1763	1624-1901
stis_e230h_c2013	2013	1874-2151
stis_e230h_c2263	2263	2124-2401
stis_e230h_c2513	2513	2374-2651
stis_e230h_c2762	2762	2623-2900
stis_e230h_c3012	3012	2873-3150
stis_e230h_i1813	1813	1674-1951
stis_e230h_i1863	1863	1724-2001
stis_e230h_i1913	1913	1774-2051
stis_e230h_i1963	1963	1824-2101
stis_e230h_i2063	2063	1924-2201
stis_e230h_i2113	2113	1974-2251
stis_e230h_i2163	2163	2024-2301

Table 2: Synphot data files for Grating Setting Wavelength Ranges

Filename	Grating Setting	Wavelength Range
stis_e230h_i2213	2213	2074-2351
stis_e230h_i2313	2313	2174-2451
stis_e230h_i2363	2363	2224-2501
stis_e230h_i2413	2413	2274-2551
stis_e230h_i2463	2463	2324-2601
stis_e230h_i2563	2563	2424-2701
stis_e230h_i2613	2613	2474-2751
stis_e230h_i2663	2663	2524-2801
stis_e230h_i2713	2713	2574-2851
stis_e230h_i2812	2812	2673-2950
stis_e230h_i2862	2862	2723-3000
stis_e230h_i2912	2912	2773-3050
stis_e230h_i2962	2962	2823-3100
stis_prism_c1200	3200	1199-5200
stis_prism_c2125	2125	1149-3100
stis_g430m_all	7340	2680-12000
stis_g430m_c3165	3165	3021-3308
stis_g430m_c3423	3423	3279-3566
stis_g430m_c3680	3680	3536-3823
stis_g430m_c3936	3936	3792-4079
stis_g430m_c4194	4194	4050-4337
stis_g430m_c4451	4451	4307-4594
stis_g430m_c4706	4706	4562-4849
stis_g430m_c4961	4961	4817-5104
stis_g430m_c5216	5216	5072-5359
stis_g430m_c5471	5471	5327-5614
stis_g430m_i3305	3305	3161-3448
stis_g430m_i3843	3843	3699-3986
stis_g430m_i4781	4781	4637-4924
stis_g430m_i5093	5093	4949-5236
stis_g750m_all	8590	5180-12000
stis_g750m_c5734	5734	5447-6020
stis_g750m_c6252	6252	5965-6538
stis_g750m_c6768	6768	6481-7054
stis_g750m_c7283	7283	6996-7569
stis_g750m_c7795	7795	7508-8081
stis_g750m_c8311	8311	8024-8597
stis_g750m_c8825	8825	8538-9111
stis_g750m_c9336	9336	9049-9622
stis_g750m_c9851	9851	9564-101371

Table 2: Synphot data files for Grating Setting Wavelength Ranges

Filename	Grating Setting	Wavelength Range
stis_g750m_c10363	10363	10076-10649
stis_g750m_c10871	10871	10584-11157
stis_g750m_i6094	6094	5807-6380
stis_g750m_i6581	6581	6294-6867
stis_g750m_i8561	8561	8274-8847
stis_g750m_i9286	9286	8999-9572
stis_g750m_i9806	9806	9519-10092

Table 3: Synphot data files for Integrated Instrument Throughput

Filename	Synphot/Proposal Instruction Keywords	IDT Mode#	Wavelength Range
stis_g140l	G140L,FUVMAMA	1.1	1000-11000
stis_g140m	G140M,FUVMAMA	1.2	1000-11000
stis_e140m	E140M,FUVMAMA	1.3	1000-11000
stis_e140h	E140H,FUVMAMA	1.4	1000-11000
stis_g140lb	G140LB,NUVMAMA	1.1b	1000-11000
stis_g140mb	G140MB,NUVMAMA	1.2b	1000-11000
stis_e140mb	E140MB,NUVMAMA	1.3b	1000-11000
stis_e140hb	E140HB,NUVMAMA	1.4b	1000-11000
stis_g230l	G230L,NUVMAMA	2.1	1000-11000
stis_g230m	G230M,NUVMAMA	2.2	1000-11000
stis_e230m	E230M,NUVMAMA	2.3	1000-11000
stis_e230h	E230H,NUVMAMA	2.4	1000-11000
stis_g230lb	G230LB,CCD	2.1b	1000-11000
stis_g230mb	G230MB,CCD	2.2b	1000-11000
stis_g430l	G430L,CCD	34.1	1000-11000
stis_g430m	G430M,CCD	3.2	1000-11000
stis_g750l	G750L,CCD	4.1	1000-11000
stis_g750m	G750M,CCD	4.2	1000-11000
stis_mirfuv	MIRROR,FUVMAMA	1.6	1000-11000
stis_mirnuv	MIRROR,NUVMAMA	2.6	1000-11000
stis_mirvis	MIRROR,CCD	3.6	1000-11000
stis_prism	PRISM,NUVMAMA	2.5	1000-11000
stis_x140	X140,FUVMAMA	1.7x3	1000-11000
stis_x140m	X140M,FUVMAMA	1.7x4	1000-11000
stis_x230	X230,NUVMAMA	2.7x3	1000-11000
stis_x230h	X230H,NUVMAMA	2.7x4	1000-11000

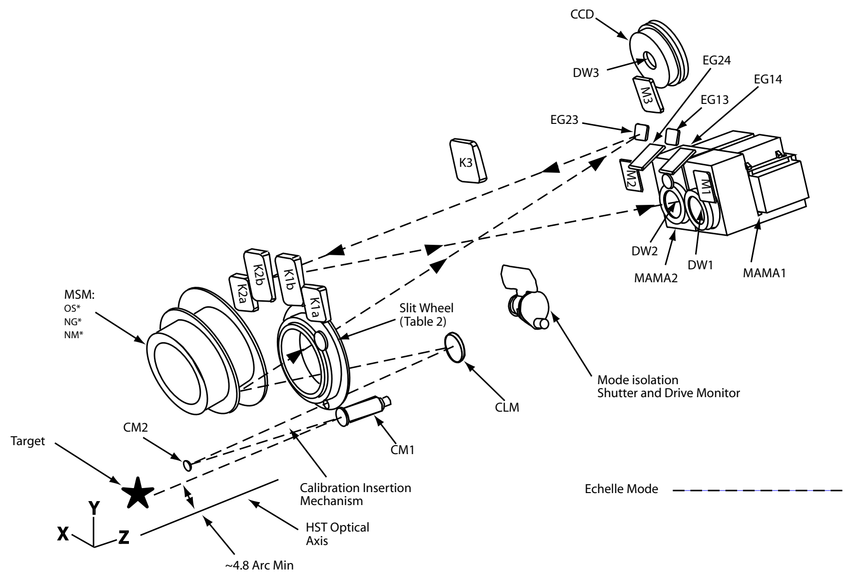

Figure 2: STIS Optical Configuration

case of filters, these are named with the same keyword used in the Phase II Proposal Instructions. In order to take into account the red leak found in many of the filters, these files range out to 13000 Å. Table 4 provides a list of the Synphot file names used for these files (column 1), the associated Synphot/Proposal Instructions keyword (column 2), and the wavelength range (column 3). Column 4 indicates which files take into account red leak (tag "Yes").

Like filters, Synphot data files for slit throughputs have names that are the same as the Phase II Proposal Instructions keywords. All supported slits and a subset of the available slits, have Synphot data files that show the wavelength dependence of the throughput. These files are identified through the slit wheel location, when following the light path of the detector, and have wavelength ranges from 1200-12000 Å. The remaining slits have a single value for slit throughput, i.e., the slit throughput at 5000 Å is used for all wavelengths. The Synphot slit throughput tables are listed in Table 5, where column 3 gives the wavelength range while column 4 indicates which of these files have a throughput that varies with wavelength.

Creating the Integrated Instrument Throughput Synphot Data Files (STIS only)

As of February 1998, the "Integrated Instrument Throughput" Synphot data files for STIS are created from the "Photometric Conversion Tables" (PHT) pipeline reference files. This ensures that the throughput files are exact matches in the pipeline, Synphot, and the ETCs. The PHT reference files used in the pipeline, with extension `*pht.fits`, get updated with throughput data produced by calibration efforts. Unfortunately, Synphot requires a different file format and therefore the PHT files need to

Table 4: Synphot data files for Filters Throughput

Filename	Synphot/Proposal Instruction Keywords	Wavelength Range	Redleak ?
stis_f25ciii	F25CIII	1260-13000	Yes
stis_f25cn182	F25CN182	1200-13000	Yes
stis_f25cn270	F25CN270	2560-13000	Yes
stis_f25lya	F25LYA	1160-13000	Yes
stis_f25mgii	F25MGII	2000-13000	Yes
stis_f25nd3	F25ND3	1000-11000	No
stis_f25nd5	F25ND5	1000-11000	No
stis_f25qtz	F25QTZ	1450-13000	No
stis_f25srf2	F25SRF2	1000-11000	No
stis_f28x50lp	F28x50LP	5200-11000	No
stis_f28x50oii	F28x50OII	1000-13000	No
stis_f28x50oiii	F28x50OIII	4998-11900	Yes

be transformed. Given the volume of data in these files, a script was written to extract the information from these `*pht.fits` files and write it to a FITS table in the format that Synphot requires.

The script written to create these Synphot data files is called `pht2sdas.py` and it can be found in the `XSTIS` package within PyRAF. It is a Python script and it is a modified version of the original CL script written by J. Wilson. The script assumes that the user has all of the `*pht.fits` files sitting in one directory and it loops through this list looking in each file for first order modes and mirror data. When it finds these modes, it extracts the wavelength, throughput, and error arrays and writes them to a file. The format for the Synphot throughput files (or more generally, any Synphot data file) is outlined in STIS TIR 98-04. The first column should be wavelength in Angstroms, the second column should be throughput (dimensionless), and the last column should contain an estimate of the error in the throughput. In general, the files should have a wavelength range from 1000-13000 Å; however, as explained previously, tables for grating efficiencies and the grating settings tables can have truncated bandpasses. If the `*pht.fits` file has more than one CENWAVE for each optical element, the script first joins their throughputs in an uniformly spaced wavelength range using the `Pyraf` script `SPLICE`. The output files of the procedure will be FITS binary tables containing the extracted arrays divided by the OTA throughput, since this is considered separately when Synphot runs. Because the OTA throughput is not included in the Synphot data files, these throughputs will not be the same as those used by the pipeline and CALSTIS software (i.e., provided by the PHT file), even though they yield the same results after calculation. The script also adds the appropriate header information. An example for the basic header for these files is:

Table 5: Synphot data files for Slits Throughput

Filename	Synphot/Proposal Instruction Keywords	Wavelength Range	Throughput varies with Wavelength?
	Supported Slits		
stis_01x009	0.1x0.09	1150-11000	Yes
stis_01x02	0.1x0.2	1150-11000	Yes
stis_02x006	0.2x0.06	1150-11000	Yes
stis_02x009	0.2x0.09	1150-11000	Yes
stis_02x02	0.2x0.2	1150-11000	Yes
stis_52x01	52x0.1	1150-11000	Yes
stis_52x02	52x0.2	1150-11000	Yes
stis_52x05	52x0.5	1150-11000	Yes
stis_52x2	52x2	1150-11000	Yes
stis_6x02	6x0.2	1150-11000	Yes
	Available Slits		
stis_0054x29	0.05x29	500-14000	No
stis_005x31nd24	0.05x31NDA	1200-10000	Yes
stis_005x31nd29	0.05x31NDB	1200-10000	Yes
stis_009x29	0.09x29	500-14000	No
stis_01x0025	0.1x0.03	1200-10000	Yes
stis_01x0063	0.1x0.06	1200-10000	Yes
stis_02	0.2x0.2	500-14000	No
stis_02a	0.2x0.2A	500-14000	No
stis_02b	0.2x0.2B	500-14000	No
stis_02c	0.2x0.2C	500-14000	No
stis_02d	0.2x0.2D	500-14000	No
stis_02e	0.2x0.2E	500-14000	No
stis_02x005nd06	0.2x0.05ND	1200-10000	Yes
stis_02x0063a	0.2x0.06A	500-14000	No
stis_02x0063b	0.2x0.06B	500-14000	No
stis_02x0063c	0.2x0.06C	500-14000	No
stis_02x0063d	0.2x0.06D	500-14000	No
stis_02x0063e	0.2x0.06E	500-14000	No
stis_02x05	0.2x0.5	1200-10000	Yes
stis_02x29	0.2x29	500-14000	No
stis_033x005nd12	0.3x0.05ND	1200-10000	Yes
stis_033x0063	0.3x0.06	500-14000	No
stis_033x009	0.3x0.09	500-14000	No
stis_033x02	0.3x0.2	500-14000	No
stis_05x05	0.5x0.5	500-14000	No

Table 5: Synphot data files for Slits Throughput

Filename	Synphot/Proposal Instruction Keywords	Wavelength Range	Throughput varies with Wavelength?
stis_10x0063	1.0x0.06	1200-10000	Yes
stis_10x02	1.0x0.2	1200-10000	Yes
stis_2	2x2	500-14000	No
stis_31x005nd19	31x0.05NDA	1200-10000	Yes
stis_31x005nd25	31x0.05NDB	1200-10000	Yes
stis_31x005nd29	31x0.05NDC	1200-10000	Yes
stis_357x005n	36x0.05N	500-14000	No
stis_357x005p	36x0.05P	500-14000	No
stis_357x06n	36x0.6N	500-14000	No
stis_357x06p	36x0.6N	500-14000	No
stis_50	50CCD	500-14000	No
stis_50wedge	50WEDGE	500-14000	No
stis_52x0049	52x0.05	1200-10000	Yes
stis_6x0063	6x0.06	500-14000	No
stis_6x05	6x0.5	500-14000	No
stis_6x6	6x6	500-14000	No

```
SIMPLE  =        T / file does conform to FITS standard
BITPIX  =       16 / number of bits per data pixel
NAXIS   =        0 / number of data axes
EXTEND  =        T / There may be standard extensions
ORIGIN  = 'STScI-STSDAS/TABLES' / Tables version 1999-03-22
NEXTEND =        1 / number of extensions in file
FILENAME= 'stis_g140l_new_syn.fits' / name of file
DESCRIP = 'stis_g140l'
DBTABLE = 'CRTHROUGHPUT'
COMPNAME= 'stis_g140l'
INSTRUME= 'stis '
USEAFTER= 'Sep 26 2005 00:00:00'
PEDIGREE= 'INFLIGHT 27/02/1997 25/06/2004'
COMMENT = "Data from reference file p822207oo_pht.fits"
HISTORY Created on Sep 26 2005 00:00:00
HISTORY File created by pht2sdas.py using p822207oo_pht.fits
HISTORY reference file as input
```

Some of these fields are standard FITS header keywords. Those required by the Synphot software are indicated in bold face font. In particular, the fields `DESCRIP` and `COMPNAME` should have the same value, which corresponds to the rootname of the Synphot component they describe. `DBTABLE` should be set to "`CRTHROUGHPUT`" always. The `USEAFTER` date should be set to the date when the files were created. As it can be seen in the `FILENAME` header keyword, the script assigns an output file name that agrees with the current Synphot data name format, except for the version number, which in this case, is replaced by the word "new": "`stis_oooeee_new_syn.fits`" where "`oooeee`" is the name of the optical element (e.g., g750l, g140m). Note also that the output filename is all lowercase letters, the keywords in the header of the file will be all caps, and the keyword entries will be all lowercase. This format is necessary for proper delivery of the files to CDBS. One way to verify that the files are in the correct format for delivery, is to run the CDBS utility called `certify` (see Final Delivery section). This script will look at the file and give an error message if there is a problem with the format used. Also note that currently this script does not work for the echelle modes.

In more detail, the steps are:

1. Get the new *pht.fits files and put them in a working directory.
2. Start PyRAF and load the `XSTIS` package.
3. Run the `pht2sdas` task for all of the `pht.fits` files by issuing the command:

   ```
   py> pht2sdas *pht.fits
   ```

   or by filling the parameter `listfile` of the parameter list. The script will create a certain number of FITS tables for each PHT file.

Updating Graph Tables (general)

Changes to the TMG table should be rare. The only foreseeable changes would be adding parameterized entries, changing keyword component names for consistency with the proposal instructions, adding header keywords, or adding grating settings. To change the TMG table, copy the latest version from the `mtab` directory (/data/cdbs1/mtab) to a local directory and use the IRAF task `tedit` to make the changes. It is vitally important that the component name in the `COMPNAME` column of the TMG table matches the value of the `COMPNAME` in the header of the corresponding optical component file (see the basic header example provided in the previous section). If they do not match, the new component file will not be found.

Testing Changes to Synphot Data Files (general)

Before the files can be delivered to CDBS, it is necessary to test the changes that were made to the Synphot data files. In order to do this, create a dummy master component table (TMC) that points to the location of the new Synphot data files. It is important to remember that ONLY the individual Synphot data files and the TMG table are delivered to CDBS, but NOT the TMC file. The TMC file is automatically re-created each time new files are delivered to CDBS, so any changes you make to the TMC table will be lost. This is why the `COMPNAME` column values need to match between the TMG table and the individual Synphot data file headers. The dummy TMC file can be created by making a copy of the last TMC table in the `mtab` directory (/data/cdbs1/mtab/ in the Solaris cluster). Note that this directory has more than one TMC file and that the most up to date one is listed last alphabetically. The dummy TMC table can be edited, to point to the new Synphot data files, using the IRAF task `tedit`. For example, put the new Synphot data files and the TMC and TMG tables in the directory `/data/garnet5/synphot/` and use the IRAF task `tedit` to change the values in the column `FILENAME` of the dummy TMC table to look something like this:

```
newsyn$g750l_new_syn.fits
```

Then define a variable in IRAF to point to this directory by typing:

```
sy> set newsyn = /data/garnet5/synphot/
```

Note that it is possible to specify the whole path and name of the directory too; although, be aware that there is a limit of 68 characters for this column. In this case, change the `FILENAME` column to something like this:

```
/data/garnet5/synphot/g750l_new_syn.fits
```

To use the private TMG and dummy TMC tables for testing, change the values in the `iraf.stsdas.hst_calib.synphot.refdata` parameter files to point to the new tables.

```
PACKAGE = synphot
TASK = refdata

(area   = 45238.93416) Telescope area in cm^2
(grtbl  = test_tmg.fits) Instrument graph table
(cmptbl = test_tmc.fits) Instrument component table
(mode   = a)
```

Note than in this example it is assumed that the `test_tmg.fits` and `test_tmc.fits` files are in the current working directory. If this is not the case, it is necessary to define an IRAF variable (as indicated above) with the path to the test files (as indicated above). For example, the `grtbl` and `cmptbl` parameters should be

```
grtbl = newsyn$test_tmg.fits
cmptbl = newsyn$test_tmc.fits
```

The IRAF task `unlearn` can be used to reset Synphot to use the default versions of the

TMG and TMC tables.

```
cl> unlearn refdata
cl> lpar refdata
(area   = 45238.93416)  Telescope area in cm2̂
(grtbl  = mtab$*.tmg) Instrument graph table
(cmptbl = mtab$*.tmc) Instrument component table
(mode   = a)
```

Testing the Files in Synphot (STIS only)

Now it is necessary to decide which instrument configurations were changed and verify that the changes are correct. For this, three curves — pipeline throughput table (PHT), old Synphot dat files, and new (test) Synphot data files — should be compared. Note that pipeline tables and Synphot data files have different wavelength ranges and therefore the plots will not match exactly when plotted together (this is also due to the differences between the tasks used to make these plots). The Synphot data files extend beyond the wavelength range of the pipeline tables; however, the value of the throughput is set to zero in these cases. To put all the curves in the same plot, first use the `sgraph` task to plot the row in the CALSTIS/pipeline PHT file for the grating you want to test. Second, using the default TMG and TMC tables and the `stsdas.hst_calib.synphot.plband` task, make a plot of the bandpass for this configuration. To overplot the `plband` plot on the `sgraph` grid use the append option in `plband` and specify which line pattern you would like to use to distinguish the `plband` plot from the `sgraph` plot. For example:

```
sy> plband stis,g230lb,ccd left=1000 right=8000 append=yes ltype=dotted
```

Third, change the parameters in the `iraf.stsdas.hst_calib.synphot.refdata` task to point to the dummy version of the TMC and new TMG (if applicable) tables (see instructions in previous section), and run the same `plband` command as above, but with a different `ltype` parameter, to overplot the bandpass configuration that is produced by the new Synphot data files.

If there is no change, use the `stsdas.hst_calib.synphot.showfiles` task to get a list of the Synphot data files used by Synphot. Make sure that the new Synphot data file names are in the list. If they are not, check the `refdata` parameter list and the test TMC table. First example, the output of the task before changing files:

```
sy> showfiles stis,f25mgii,nuvmama
#Throughput table names:
crotacomp$hst_ota_007_syn.fits
crstiscomp$stis_cm1_003_syn.fits
crstiscomp$stis_cm2_003_syn.fits
crstiscomp$stis_f25mgii_009_syn.fits
crstiscomp$stis_clm_004_syn.fits
```

```
crstiscomp$stis_mirnuv_009_syn.fits
crstiscomp$stis_nm26_010_syn.fits
crstiscomp$stis_dw2_004_syn.fits
crstiscomp$stis_mama2_004_syn.fits
```

Second example, with the proper changes:

```
sy> showfiles stis,f25mgii,nuvmama
#Throughput table names:
crotacomp$hst_ota_007_syn.fits
crstiscomp$stis_cm1_003_syn.fits
crstiscomp$stis_cm2_003_syn.fits
new_f25mgii.fits
crstiscomp$stis_clm_004_syn.fits
stis_mirnuv_new_syn.fits
crstiscomp$stis_nm26_010_syn.fits
crstiscomp$stis_dw2_004_syn.fits
crstiscomp$stis_mama2_004_syn.fits
```

plband can also be run on individual files, for example:

```
sy> plband newsyn$stis_f25mgii.fits
```

In summary, the steps for the test are:

1. Using `sgraph`, plot the row in the CALSTIS/pipeline PHT file for the grating you want to test. The plot should appear in a window on the screen.

2. Append the `plband` plots for the configuration that will be altered by the new Synphot data file. Note that we have not yet altered the TMC file, so these plots will show what the bandpass looks like using the older, current Synphot data files.

3. Copy the most current TMG and TMC tables from `/data/cdbs1/mtab` into a testing directory. Rename them as `test_tmg.fits` and `test_tmc.fits`.

4. Setup a logical path to this directory using the `set` command.

5. Edit the TMC table using `tedit` to point to your test files by changing the entry in the `FILENAME` column (see above). The new filename entry should be the logical path to your directory containing the dummy TMC and TMG tables, then a $, then the filename for the new table, e.g., `testfiles$stis_g230l_new_syn.fits`.

6. Use the `refdata` task to specify the TMC and TMG to be used by the Synphot task `plband`.

7. After this is done, produce the `plband` plots with your new Synphot data files, and the dummy TMC and TMG tables.

8. Use the `showfiles` command to verify that the new component files are being used by Synphot.
9. Once testing is finished, prepare the testing results to submit to the pipeline block lead. A summary of the new files to be delivered should be included with the comparison plots. Include the name of the tester (you), the date, a description of the new files (including how many and where they are), and the name of the files. The pipeline lead needs to look at the plots and approve the testing results before the new files can be delivered to CDBS.

Testing the Files using ETCs (general)

The INS/CDBS Group now requires that all Synphot data files are tested against the ETC software. The objective of this test is to make sure that the changes in these files produce the expected outputs in the ETC software. This test has to be done even if STIS is not currently using the ETCs, as we need to be prepared for a possible revival of the instrument. This test has to be done in `panthro.stsci.edu`, which is a Linux box, thus requiring to have an account in the Linux cluster. Follow the instructions in TIR CDBS 2005-01 to perform this test. If any problems or questions arise, contact the INS/CDBS Group (cdbs@stsci.edu) for help. Also, remember to update the necessary documentation in the ETCs help files to show which new throughputs have recently been delivered.

Final Delivery of Synphot Data Files and TMG Tables to CDBS (general)

The details on the testing procedures required by the INS/CDBS Group are outlined in TIR CDBS 2005-01 (http://www.stsci.edu/hst/observatory/cdbs/documents/TIR-CDBS-2005-01.pdf); here, the most relevant steps will be covered briefly. Other useful documentation regarding delivery of Synphot data files (and pipeline reference files) can be found in the INS/CDBS website (http://www.stsci.edu/hst/observatory/cdbs/deliveries/). To make sure that the Synphot data files are fit for delivery, run `farris_fitsverify` and the CDBS script `certify` on the data files and TMG table only. For example:

```
ta> farris_fitsverify *.fits
```

`certify` can be run within IRAF from the CDBSUTIL package or from the command line (in the Science cluster only). However, in the case of the command line, the whole path to the `certify` script has to be used:

```
ta> /data/cdbs1/tools/bin/certify *.fits
```

Note also that adding the "/data/cdbs1/tools/bin/" path to the `bin` path in the `/home/myaccount/.setenv` file, will make unnecessary to declare the whole path for the `certify` script. If no errors are found, proceed to fill the delivery form; which is provided in TIR CDBS 2005-01 or published in the INS/CDBS Group web site "Delivery Procedures" area (http://www.stsci.edu/hst/observatory/cdbs/deliveries/delivery_form .html). When the form is complete, e-mail it to the `cdbs@stsci.edu` e-mail address. Remember that STIS Synphot data files are delivered to the CDBS database only (not to OPUS or the archive), so the delivery form has to indicate this clearly. Currently this clarification is done in point #8 of the delivery template; however, if it were to change, make sure that it is clearly indicated where appropriate or at the top of the e-mail message to the INS/CDBS group. The INS/CDBS Group is responsible to install the files into CDBS and to copy them to the Science cluster storage area. Currently this area is located in the directory `/data/cdbs1/comp/stis`. The files will be renamed by the INS/CDBS Group following the guidelines outlined in TIR CDBS 2005-02, which requires to give these files the same name as those previously installed in the system but with a higher version number. The INS/CDBS Group will also create the required TMC file that points to the new Synphot data files. Once these files are in the system, the INS/CDBS Group will let the deliverer know that the files are in place by replying to the same address used to e-mail the delivery form. Receiving this message ends the delivery.

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