HUBBLE SPACE TELESCOPE

FAINT OBJECT SPECTROGRAPH

CALIBRATION DATA SPECIFICATIONS

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prepared by

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Contents

List of Figures

1 Purpose and Scope

1.1 Purpose

The purpose of this document, the Hubble Space Telescope (HST) Faint Object Spectrograph (FOS) Calibration Data Specifications, is to define the precise interface between the FOS Investigation Definition Team (IDT) and the Space Telescope Science Institute (STScI) Instrument Support Branch (ISB), with regard to IDT-deliverable FOS-specific calibration data required for the population of the Routine Science Data Processing (RSDP) part of the Science Operations Ground System (SOGS). This interface is to be established via magnetic tape, containing files mainly in Flexible Image Transport System (FITS) format. A separate second part to this document shall describe the specifications for calibration data required from the FOS IDT for inclusion into the Calibration Data Base System (CDBS) at STScI.

1.2 Scope

In support of its main purpose, this document provides the following detailed information:

1. List of reference documents, giving further definitions on data formats and content;
2. Summary of calibration data, to be delivered by the FOS IDT, and required for population of RSDP;
3. General description of the magnetic tape interface; and
4. Detailed format specifications for the Data Relationship File ('Reference Relations') and the Calibration Data Files ('Reference Data').

This document is binding on the FOS IDT for all deliveries made to the STScI ISB with regard to calibration data to be absorbed in the Calibration Data Base System (CDBS) for population of the RSDP.

2 Reference Documents

The documents given below provide additional information on the nature and format of the calibration data to be provided by the FOS IDT. They are binding only inasmuch as they are referenced in the text of the remaining chapters of this document. For convenience, the first three reference documents are provided as appendices to this document.

1. FITS Standard I: FITS: A Flexible Image Transport System, by D. C. Wells, E. W. Greisen, and R. H. Harten; Astronomy and Astrophysics Supplement Series 44, pp. 363-370, 1981.

2. FITS Standard II: An Extension of FITS for Groups of Small Arrays of Data, by E. W. Greisen and R. H. Harten; Astronomy and Astrophysics Supplement Series 44, pp. 371-374, 1981.

3. FITS Extensions: Generalized FITS Extensions, with Application to Tables, by R. H. Harten, P. Grosbøl, K. P. Tritton, E. W. Greisen, and D. C. Wells; Preprint, 1984.

4. ST-ICD-47: Post Observation Data Processing System to Calibration Data Base System Interface Control Document.

5. Calibration Data Base Data Design, Version 3.0, April 1987.

6. ANSI X3.4-1977: American National Standard, Code for Information Interchange, 1977.

7. ANSI X3.27-1978: American National Standard, Magnetic Tape Labels and File Structure for Information Interchange, 1978.

8. Faint Object Spectrograph Instrument Handbook, by Holland C. Ford; STScI, October 1985.

9. FOS Linearity Corrections, by D. Lindler and R. Bohlin; STScI Instrument Science Report CAL/FOS-025, January 1986.

3 General Interface Description

The interface formed between the FOS IDT and the STScI ISB for the FOS IDT deliverable calibration data required for RSDP population shall be established via magnetic tape, containing standard FITS or FITS-like files, as specified in the chapter on File Formats in this document.

3.1 Tape Format

Magnetic tapes used in the FOS IDT to STScI ISB interface shall be:

1. 9-track tapes;
2. recorded with a density of 1600 bits per inch (bpi) in phase-encoded (PE) mode, or with a density of 6250 bits per inch (bpi) in group coded record (GCR) mode;
3. unlabelled (in the sense of ANSI X3.27-1978);
4. file-structured according to ANSI X3.27-1978; and
5. coded in ASCII according to ANSI X3.4-1977 (applicable only to formatted or character data).

A humanly readable (paper) label shall be permanently attached to each tape reel, containing the following information:

1. identification ("FOS Calibration - RSDP")
2. sequence number (starting at 1, and incremented by 1 for each subsequent tape);
3. date of submission to the STScI ISB;
4. number of files contained on the tape; and
5. tape density (1600 or 6250 bpi).

3.2 Delivery Procedures

Each tape or set of tapes (if more than one tape is contained in a single delivery) submitted to the STScI ISB shall be accompanied by a letter signed by the FOS IDT Principal Investigator or his designee, specifying:

1. instrument (FOS);
2. number of tapes submitted;

3. date of submission to the STScI ISB;

4. sequence numbers of submitted tapes;

5. number of files contained on each tape; and

6. tape densities (1600 or 6250 bpi).

A listing of the FITS file headers for all submitted files, identified by tape sequence number and file sequence number (starting at 1 for each tape) shall be attached to this letter.

Upon receipt of this letter and the accompanying tape(s), the STScI ISB shall acknowledge this receipt in written form to the FOS IDT.

Magnetic tapes shall be provided by the FOS IDT, and remain at the STScI facility.

3.3 Tape Content

Each magnetic tape shall contain one or more Data Relationship files and zero or more Calibration Data Files. Each Calibration Data file is referenced by the Data Relationship File which most closely precedes it. In some cases, Data Relationship files are not followed by separate Calibration Data files. Descriptions of the contents and formats of these files are given in the following chapters.

4 Calibration Data Required for RSDP

The calibration data required from the FOS IDT in order to derive RSDP reference files is described below. In some cases the number of data files requested may appear excessive since the data will be the same for a number of instrument configurations. However, the mechanism of relating instrument modes and data files in the data relationship file allows for this situation and does not require submitting more than one copy of the data.

1. DARK CURRENT The dark current arrays together with the range over which the measurements took place as defined by FCHNL, NCHNLS, NXSTEPS, and OVERSCAN. The mean and median filter widths used are included as detector parameters and labeled as BCK_MD and BCK_MN for each detector.

2. WAVELENGTH COEFFICIENTS Sets of coefficients which are the results of polynomial fits of wavelength to diode number. These are to be provided for the following groups of wavelength analyzers.

   (a) Gratings. There are four coefficients, COEFF_0 to COEFF_3, for each valid combination of 2 Digicons, 15 apertures and 8 gratings. For 7 of the apertures polarizers are used, and data will be required for two polarizers each with two pass directions as well as for the unpolarized configuration. Each Digicon only uses 7 of the gratings. Polarization data is not collected for the 4 sets of paired apertures. Therefore, there may be up to 602 sets of coefficients. ($2 \times 7 \times 7 \times 4$ polarization sets plus $2 \times 15 \times 7$ sets without polarization data)

   (b) Prism. There are five coefficients, COEFF_0 TO COEFF_4, for each Digicon and aperture. For 7 of the 15 apertures there may be polarizer data so that up to 86 data sets may be required. For the prism mode alone, the fit is made to powers of 1/(x-x0) and so the value of x0 must be supplied. x0 is supplied as one of the detector parameters.

3. INVERSE SPECTRAL FLAT FIELDS There will be a vector of values for each Digicon, aperture, and disperser plus the prism and, where appropriate, for polarizer and pass direction combinations. The number of elements in each vector depends on the values of NCHNLS, NXSTEPS, and OVERSCAN.

4. SKY SUBTRACTION For each detector and for each set of paired apertures, the aperture areas are to be given in the Aperture Parameters data. Associated parameters that must be supplied are SKY_MD and SKY_MN, the widths of the median and mean filters used in smoothing the data.

The excluded ranges corresponding to strong emission or absorption features are provided in the data file labelled Emission Lines. The upper and lower wavelengths of these ranges shall be given in Angstroms. The sky spectrum may have to be shifted a certain number of pixels to bring it into spectral registration with the object spectrum. The value of this shift must also be given and is NSHIFT in the Sky Shift Parameter file

5. CORRECTIONS FOR PAIRED PULSES There are 7 constants which describe the paired pulse performance. There are 2 time constants TAU1 and TAU2. Measurements (Lindler and Bohlin, 1986) have determined that TAU1 may be set to zero if TAU2 is allowed to vary as follows. Below a certain count rate, THRESHOLD counts per second, no correction is performed. At rates between THRESHOLD and a higher rate, F, TAU2 is set to a constant Q0. At rates, greater than F, the time constant takes the form TAU2 = Q0 + Q1(RATE-F). The values of TAU1, Q0, Q1, F,and THRESHOLD will be taken from the report describing the measurements. In addition the values of EPSILON and ITERATIONS are required. These define the required accuracy and number of iterations to be used, where the Newton-Raphson method is needed to calculate the true count rate. (If TAU1 is indeed set to zero, an analytic solution is available and iteration is not necessary.)

6. ABSOLUTE INVERSE SENSITIVITY Spectrophotometric calibration vectors. For each detector , aperture and disperser, including the prism, a vector is required. For some apertures data is required with the polarizer in place for two pass directions and with the polarizer out.

   Multiplying the corrected count rate at any diode by the corresponding element of this vector gives the absolute flux in ergs per sec per square cm per Angstrom. The associated values of FCHNL, NCHNLS, NXSTEPS and OVERSCAN must be supplied.

7. POLARIMETRIC CALIBRATIONS Polarimetric data is to be supplied as files of retardation measurements for each polarizer element and, in each case, for two polarization directions.

8. DISABLED DIODE TABLE This lists the permanently disabled diodes. For each detector there will be a 512 long vector containing zeros to indicate bad diodes and ones to indicate good diodes.

9. DATA QUALITY MASKS Data quality masks are required to describe the validity of the data at each pixel.

In addition to the image data contained in the Calibration Data Files as listed above, full and extensive ancillary information is required on the nature and pedigree of such data, provided in the file headers. Finally, the following information is required:

10. DATA RELATIONSHIP FILES ('Reference Relations') to specify for each set of calibration data, i.e. for each Calibration Data File ('Reference Data'), the FOS instrument mode or modes to which the specific Calibration Data File is applicable.

5 File Formats

Files on the magnetic tapes submitted from the FOS IDT to the STScI ISB shall be in standard FITS format (Calibration Data Files) and in the anticipated FITS table format (Data Relationship File).

5.1 Data Relationship File

Data which is composed of images, or arrays, is treated differently from that which is represented by a small number of parameters. For each set of image data there will be an entry in a Data Relationship File which includes a pointer to the image data itself. This mechanism will be used for Data Quality Initialization, Background, Flat Field, Inverse Sensitivity, Retardation, and Disabled Diode files.

The Data Relationship File contains information on the 'Reference Relations' which connect instrument configurations to the applicable Calibration Data Files. The Relationship file has parameter values which describe an instrument configuration, or range of configurations, linked to the names of subsequent files which contain the calibration data. Note that a single Calibration Data File may be referenced more than once, since it may be applicable to more than one instrument configuration. A single Reference Relation file can only refer to one type of data file, since each type has a slightly different set of configuration parameters.

On any one tape, all Calibration Data files of the same type must be grouped together and must be immediately preceded by their Data Relationship file, which will contain at least one entry for each data file. One way to ensure adherence to this scheme is to use a separate tape for each type of calibration data and let the first file on each tape be the single Reference Relation file.

Data which is of the form of a number of separate parameters will be placed in a table form that is very similar to that of the Reference Relation file. In this case the configuration parameters and the data appear as one row of the table. Data types which fall into this category are: Aperture Parameters, Aperture Position Parameters, Emission Lines, Detector Parameters, Wollaston/waveplate Parameters, Sky Shift Parameters, Wavelength Parameters, and Aperture Positions. On any one tape, all data of the same type will appear in a single table and there will be separate tables (some consisting of a single row) for each type of data. Again, keeping each type of data on a separate tape is consistent with these conditions, but might be extremely wasteful of tape.

The general format of the Data Relationship File follows the proposed FITS Extension, as given in Appendix C of this document.

Note that in the figures of this chapter the comments starting in column 32 are given for information purposes only, and are not part of the required syntax. Lower case items in the data field (columns 11 through 30) have to be replaced by actual values; however, upper case items

```
Columns  1         2         3         4         5         6
12345678901234567890123456789012345678901234567890123456789012345678901234567890...

SIMPLE  =                    T / Standard FITS
BITPIX  =                    8 / Character information
NAXIS   =                    0 / No image data present
EXTEND  =                    T / Extension exists
DATE    = 'dd/mm/yy'           / Generation or modification date
END

12345678901234567890123456789012345678901234567890123456789012345678901234567890...
Columns  1         2         3         4         5         6
```

Figure 1: FITS Header for Data Relationship File.

and explicitly specified numerical data are part of the required format.

In addition to the keywords given in the figures, COMMENT and/or HISTORY records may be added to the various FITS Headers to provide further information.

5.1.1 FITS Header

The FITS Header of the Data Relationship File shall be formatted as specified in Figure 1.

The DATE keyword shall specify the date of preparation of the data, i.e the date the tape is written. Note that single digit values for day or month have to be preceded by a zero ('0'), e.g. '04/07/86' for the 4th of July, 1986.

5.1.2 FITS Extension Header

Following the FITS Header, the FITS Extension Header has to be specified, starting at the first byte of a new (2880 byte) block. Specifically, the FITS Extension Header for the Data Relationship File must contain, at a minimum, the keywords specified in Figure 2. for the Flat Field and Inverse Sensitivity Reference files. Other data files require fewer entries.

Keyword NAXIS1 specifies the total number of characters in each row of the table, but is omitted if NAXIS = 0.

Keyword NAXIS2 shall specify the total number of rows (lines, records) in the subsequent table part of the file, but is omitted if NAXIS is less than 2.

```
Columns  1         2         3         4         5         6
12345678901234567890123456789012345678901234567890123456789012345678901234567890...

XTENSION= 'TABLE   '           / Table extension
BITPIX  =                    8 / Character information
NAXIS   =                    2 / 2D matrix of characters
NAXIS1  =                   92 / Number of characters per row
NAXIS2  =       number_of_rows / Number of rows (records)
PCOUNT  =                    0
GCOUNT  =                    1 / One group
TFIELDS =                   13 / Thirteen fields per row
FILE_TYP= 'RELATION'           / Indicates reference relation
INSTRUME= 'FOS     '
IDENTIFI= 'FOS CALIBRATION - RSDP'
TAPE_SEQ=      tape_seq_number/ Number of delivered tape
TTYPE1  = 'DETECTOR'           / Amber or Blue Digicon
TBCOL1  =                    1 / Start in column 1
TFORM1  = 'A5      '           / 5 character field
TTYPE2  = 'FCHNL   '           / First channel to be processed
TBCOL2  =                    7 / Start in column 7
TFORM2  = 'I4      '
TTYPE3  = 'NCHNLS  '           / Number of channels
TBCOL3  =                   13 / Start in column 13
TFORM3  = 'I4      '
TTYPE4  = 'NXSTEPS '           / x-substeps 1,2,4,8,16
TBCOL4  =                   19
TFORM4  = 'I4      '
TTYPE5  = 'OVERSCAN'           / Overscan number
TBCOL5  =                   25
TFORM5  = 'I4      '

12345678901234567890123456789012345678901234567890123456789012345678901234567890...
Columns  1         2         3         4         5         6
```

Figure 2: FITS Extension Header for Data Relationship File.

```
Columns  1         2         3         4         5         6
12345678901234567890123456789012345678901234567890123456789012345678901234567890...

TTYPE6  = 'APER_ID '           / Aperture selection
TBCOL6  =                   31
TFORM6  = 'A3      '           / 3 character field
TTYPE7  = 'APER_POS'
TBCOL7  =                   35
TFORM7  = 'A6      '
TTYPE8  = 'POLAR_ID'           / Which polarizer used
TBCOL8  =                   41
TFORM8  = 'A1      '
TTYPE9  = 'PASS_DIR'           / Polarization pass direction
TBCOL9  =                   43
TFORM9  = 'I2      '
TTYPE10 = 'FGWA_ID '           / Name of grating or prism
TBCOL10 =                   47
TFORM10 = 'A3      '           / 3 character field
TTYPE11 = 'FILE_TYP'           / Type of data
TBCOL11 =                   51
TFORM11 = 'A3      '          / 3 character field
TTYPE12 = 'HEADER_F'          / Header file name
TBCOL12 =                   55
TFORM12 = 'A18     '          / 18 character field
TTYPE13 = 'DATA_FIL'          / Name of calib. data file
TBCOL13 =                   75
TFORM13 = 'A18     '           / 18 character field
END

12345678901234567890123456789012345678901234567890123456789012345678901234567890...
Columns  1         2         3         4         5         6
```

Figure 3: FITS Extension Header for Data Relationship File continued

Keyword TAPE_SEQ shall specify the tape sequence number, as given on the paper label attached to the tape, and as specified in the accompanying correspondence.

The set of TBCOL numbers given here need not be adhered to exactly. It is only necessary that successive values differ by at least the number of characters in the intervening field. NAXIS1 will be equal to one less than the sum of the last TBCOL plus the length of the last field. The subsequent data must, of course, be formatted to match the chosen TBCOL numbers.

All character information shall be given as upper case characters; character data shall be left-justified in their respective fields; any remaining character positions shall be filled with blanks.

Entries in the DETECTOR field shall be one of the following:

AMBER	- Amber Digicon, more commonly called the Red Digicon
BLUE	- Blue Digicon
ANY	- Indicates that the Calibration Data File does not depend on the value of this item.

FCHNL, NCHNLS, NXSTEPS, and OVERSCAN are all integers. FCHNL gives the first channel represented by the data and NCHNLS the number of channels. Both numbers are in the range 1 to 512. NXSTEPS, the number of x substeps is one of, 1,2,4,8, and 16. Overscan is the number of channels of overscan and is typically 5. All these numbers will be represented in I2 or I4 format to correspond to the IDM i2 and i4 requirements.

Entries in the APER_ID field shall be one of the following:

A-1, A-2, A-3, A-4, B-1, B-2, B-3, B-4, C-1, C-2, C-3, C-4	
ANY	- Indicates that the Calibration Data File does not depend on the value of this item.

The entry for the APER_POS field shall be one of the following:

SINGLE	- Single aperture
LOWER	- Lower aperture of pair
UPPER	- Upper aperture of pair
ANY	- Data independent of which one of paired aperture used

The entry for the POLAR_ID field shall be one of the following:

A	- Polarizer A
B	- Polarizer B
C	- No polarizer in place
N	- Data does not depend on presence of polarizer.

The entry for the PASS_DIR field shall be one of the following:

0 - Used if and only if POLAR_ID = C
1 - Pass direction 1
2 - Pass direction 2
-1 - Data does not depend on pass direction.

Entries in the FGWA_ID field represent the disperser and shall be one of the following:

CAM, H13, H19, H27, H40, H57, H78, L15, L65, PRI
ANY - Indicates that the Calibration Data File does not depend on the value of this item.

The FILE_TYP keyword shall specify the image type; the value shall be one of the following:

BAC - for dark frames,
FLT - for inverse spectral flat fields,
IVS - for inverse sensitivity files,
RET - for wavelength retardation files,
DDT - for disabled diode files,
QIN - for data quality masks.

The TTYPE entries are restricted to be 8 characters within FITS. Some of them are, therefore, truncated versions of the CDBS definitions such as 'FILE_TYPE', 'HEADER_FILE', and 'DATA_FILE'.

The entry for the HEADER_F field shall contain a filename for the header of the corresponding Calibration Data File. The identical name must appear in the HEADER_F keyword in the FITS header of the Calibration Data File, to be described subsequently. The filename shall be specified by up to fourteen alphanumeric characters, beginning with an alphabetic character (letter), optionally followed by a period and up to three more alphanumeric characters (this file extension may be used to distinguish the file type). The full file name is contained within an eighteen character field.

The entry for the DATA_FIL field shall contain the filename of the corresponding Calibration Data File. As with the header name, an identical string will be in the DATA_FIL keyword in the FITS header of the Calibration Data File. The filename shall be specified by up to fourteen alphanumeric characters, beginning with an alphabetic character (letter), optionally followed by a period and up to three more alphanumeric characters (this file extension may be used to distinguish the file type).

Separate HEADER_F and DATA_FIL names are to be provided for use in the generation of files for CDBS, although the header and data form a single FITS file.

5.1.3 FITS Table

The FITS Table follows the FITS Extension Header, starting at the first byte of a new (2880 byte) block. Its format is fully specified by the preceding FITS Header and FITS Extension Header.

5.2 Calibration Data Files

The Data Relationship File of the form described in section 5.1 is applicable only to image data and is always followed by one or more Calibration Data Files. The Calibration Data Files contain FOS images to be incorporated into the RSDP calibration process. The applicability of a Calibration Data File to a specific instrument configuration is established via the Data Relationship File. Note that a single Calibration Data File may be referenced more than once, since it may be applicable to more than one instrument configuration.

The general format of the Calibration Data File follows the FITS Standard, as given in Appendices A and B of this document.

Note that in the figures of this chapter the comments starting in column 32 are given for information purposes only, and are not part of the required syntax. Lower case items in the data field (columns 11 through 30) have to be replaced by actual values; however, upper case items and explicitly specified numerical data are part of the required format.

In addition to the keywords given in the figures, HISTORY records may be added to the various FITS Headers to provide further information.

5.2.1 FITS Header

The FITS Header of the Calibration Data File shall contain, at a minimum, the keywords specified in Figure 4.

The keyword NAXIS defines the dimensionality of the data (usually 1 for FOS) and keywords NAXIS1 (and NAXIS2 if NAXIS = 2) give the lengths of each dimension.

The FILE_TYP entry must be identical to the FILE_TYP in the header of the Data Relationship file which points to this data file via the HEADER_F and DATA_FIL keywords discussed below. This implies that a single Data Relationship file can only refer to a group of data files, all of which are the same type.

Note that the quotation marks and the blank filling to eight characters are required syntax.

The DATE keyword gives the date of generation, or the last revision (change), whichever is later in time, of the file. Note that single digit values for day or month have to be preceded by a zero ('0'), e.g. '04/07/86' for the 4th of July, 1986.

The value of HEADER_F shall match one or more HEADER_F entries in the Data Relationship file. The name, derived from the CDBS Data Design, has been truncated so that it may be an 8-letter FITS keyword.

```
Columns  1         2         3         4         5         6
12345678901234567890123456789012345678901234567890123456789012345678901234567890...

SIMPLE  =                    T / Standard FITS
BITPIX  =                   16 / 16-bit integer image data
NAXIS   =                    1 / One-dimensional image data
NAXIS1  =               naxis1 / Number of data points
FILE_TYP= 'filetype'           / Indicates type of image
INSTRUME= 'FOS     '           / Specifies instrument
DATE    = 'dd/mm/yy'           / Generation/modification date
HEADER_F= 'filename.ext'       / Header File Name
DATA_FIL= 'filename.ext'       / Data File name
HISTORY Concise but full description of instrument
HISTORY configuration, data sources, observation
HISTORY method, applied algorithms, etc.
HISTORY ...
HISTORY Must provide full pedigree of data!

END

12345678901234567890123456789012345678901234567890123456789012345678901234567890...
Columns  1         2         3         4         5         6
```

Figure 4: FITS Header for Calibration Data File.

The value of DATA_FIL shall match one or more DATA_FIL entries in the Data Relationship file.

As many HISTORY keywords as necessary, followed by one or more blanks and free-format text, shall be used to provide a full pedigree of the image, including such information as instrument configuration, data sources, applied processing, etc. Specifically, the following information shall be included: illumination source with its spectral temperature, spectral features, date and time of exposure, and temperature of detector.

5.2.2 FITS Image Data

The image data follow the FITS Header, starting at the first byte of a new (2880 byte) block. Their format is fully specified by the preceding FITS Header.

Note that the FITS standard requires that 16 or 32-bit pixel values be written on the tape in order of decreasing significance. The byte containing the most significant bits (and the sign bit, if present) will be first, and the byte containing the least significant bits will be last. Thus, users of DEC PDP or VAX equipment will be obliged to correct for the 'byte-swap' action of this computer architecture.

Where appropriate, the keywords BSCALE and BZERO should be used to scale the integer representation in the FITS image to the values of the real data.

The example given is directly applicable to the Flat Field and Inverse Sensitivity data files. The other image data files require different groups of configuration parameters, as summarised in the following table.

parameter	format	BAC	FLT	IVS	RET	DDT	QIN
DETECTOR	A5	•	•	•	•	•	•
FCHNL	I4	•	•	•	•		
NCHNLS	I4	•	•	•	•		
NXSTEPS	I2	•	•	•	•		
OVERSCAN	I4	•	•	•	•		
APER_ID	A3		•	•			
APER_POS	A6		•	•			
POLAR_ID	A1		•	•	•		
PASS_DIR	I2		•	•	•		
FGWA_ID	A3		•	•	•		

5.2.3 Data Quality Masks

In the Data Quality Mask pseudo-images, the (decimal) codes given in Figure 5 shall be used to indicate the various conditions. Note however, that not all codes may be applicable for the FOS.

A severity code shall be added to the condition code to form a complete Data Quality Mask word. The severity codes are given in Figure 6, together with levels of effect upon a corresponding data point. If more than one condition exists for a given pixel, only the most severe condition should be included.

As an example, the pixel value in the Data Quality Mask for a permanently hot pixel (220) with very large severity (3000) would be 3220.

CONDITION	DECIMAL CODE
General invalid data, not otherwise specified	260
Telemetry dropout	240
Permanent hot pixel	220
Permanent cold pixel	200
Cosmic ray hit	180
Overflow of counting electronics	160
Uncertain saturation correction	140
Uncertain quantum efficiency calibration	120
Uncertain geometric or wavelength correction	100
Specific low sensitivity detector feature (e.g. reseau mark, Kelsall spot)	80
General low sensitivity detector area (e.g. vignetted areas)	60
Low statistical weight due to some bad pixels averaged data	40
Residual image expected	20
Good data, no condition known	0

Figure5: Data QualityMask ConditionCodes.

SEVERITY	LEVEL	DECIMAL CODE
very large	> 20 %	3000
large	5 to 20 %	2000
small	1 to 5 %	1000
negligible	< 1 %	0

Figure6: Data QualityMask Severity Codes.

5.3 Non-Image Data

The non-image data will reside in extra columns of the Data Relationship files. Separate files, of the form described for the image data, are not needed. There will be no HEADER_F, DATA_FIL, or FILE_TYP entries, but there will be extra columns containing data, corresponding to the names given in the CDBS Data Design document. As an example, the FOS aperture parameters will be given in a table whose columns will have the names, DETECTOR, APER_NAM, APER_ID, APER_POS, APER_ARE. The corresponding formats for the values are, A5, A10, A3, A6, and Dm.n. The values of m and n must be chosen to provide the 17 significant digits of the D format. The smallest values consistent with this requirement are m = 24 and n = 17.

List of data sets for the other calibrations are given below for easy reference. ST-ICD-47 remains the definitive source for the names and formats of the data elements, and should be followed in the event of conflicts with this document.

		Aperture Parameters	Aperture Position	Emission Lines	Detector Parameters
DETECTOR	A5	•	•	•	•
APER_NAM	A10	•			
APER_ID	A3	•			
APER_POS	A6	•			
APER_ARE	Dm.n	•			
FGWA_ID	A3		•	•	
FCHNL	I4			•	
NXSTEPS	I2			•	
LINE_BEG	Dm.n			•	
LINE_END	Dm.n			•	
YUPPER	Dm.n		•		
YLOWER	Dm.n		•		
BCK_MD	I2				•
BCK_MN	I2				•
SKY_MD	I2				•
SKY_MN	I2				•

		Waveplate Parameters	Sky Shift Parameters	Wavelength Parameters
DETECTOR	A5	•	•	•
APER_ID	A3		•	•
APER_POS	A6		•	•
FGWA_ID	A3		•	•
NXSTEPS	I2		•	
POLAR_ID	A1	•		•
ALPHA1	Dm.n	•		
ALPHA2	Dm.n	•		
W1	Dm.n	•		
NSHIFT	I4		•	
PASS_DIR	I2			•
COEFF_0	Dm.n			•
COEFF_1	Dm.n			•
COEFF_2	Dm.n			•
COEFF_3	Dm.n			•
COEFF_4	Dm.n			•
XZERO	Dm.n			•

The Paired Pulse parameters have a common format for the HSP, FOS and HRS and include a distinguishing instrument entry.

Paired Pulse

parameter	format
INSTRUME	A3
DETECTOR	I2
TAU1	Dm.n
EPSILON	Dm.n
THRESHOL	Dm.n
Q0	Dm.n
Q1	Dm.n
F	Dm.n
ITERATIO	I2