Herschel Data Products Contributor's Guide

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Summary

This document provides guidelines for the format and keywords of the User-Provided Data Products (UPDPs) to be submitted to the Herschel Science Centre. The document is organized as follows: Section 1 introduces the concept of the user-provided products. Section 2 gives instructions on how to submit the products. Section 3 provides instructions regarding mandatory documentation, format, and metadata. Section 4 provides further suggested guidelines to ensure that the UPDP remain usable to future generations of astronomers. Section 6 provides examples of headers and a list of mandatory, recommended, and optional keywords.

1. Introduction

1.1. The User-Provided Data Products

User-Provided Data Products (UPDPs) are expected to form an important long-term legacy of the Herschel Space Observatory. Although only the Key Program (KP) consortia are under obligation to provide such products, observers from all Herschel observing programmes are welcomed to contribute UPDPs to the Herschel Science Centre (HSC). All UPDPs will be disseminated to the entire community through the Herschel Science Archive (HSA).

Herschel data products are classified based on their processing level (from raw data to highly processed) and their contents. For an overview see the HSC Data Products pages and the Products Definition Document[1]. Generally, it is expected that the contributed products will be highly processed data products of the following type:

- Images and/or imaging maps
- Single point spectra, spectral cubes and/or spectral maps
- Catalogues (e.g., astronomical source catalogues, spectral line lists)
- Ancillary data (e.g., model SEDs, reference spectral line lists)

The UPDPs will be available from the Herschel Science Archive. Future HSA searches for Herschel targets will not only return the observation IDs of those objects and links to the standard data products, but also links to any UPDPs involving those observation IDs and the associated publications

Beyond this, it is expected that the metadata in the UPDPs will be queried by other archive services (e.g. IRSA), to provide enhanced capabilities such as

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[1] Available from http://herschel.esac.esa.int/hcss-doc-9.0/index.jsp#pdd:pdd

cross-mission comparison. It is likely that the UPDPs will be displayed and analyzed with third party software, not designed specifically to interpret Herschel data. For this purpose the UPDPs should be as generic in format and data model as possible.

Based on these goals, we have formulated a set of mandatory rules and a set of suggested guidelines. These are provided in Sections 3 and 4:

- In Section 3 we present the mandatory requirements for the data to be correctly linked to the observations in the HSA. These are very minimal and have been designed to make it simple for the users to submit the data to HSC.

- In Section 4 we discuss suggested guidelines designed to enhance future usability of the Herschel data, by ensuring that the UPDPs can be read by other archives and by third-party software. These are common-sense guidelines that most data products are likely to follow anyway (for example, images should have valid astrometry keywords). The suggested guidelines attempt to follow Virtual Observatory recommendations when possible.

The guidelines from Section 4 are ***not*** mandatory. Adopting them will ensure that the UPDPs remain usable for years to come but they are not required for incorporating the data into the HSA.

A list of possible keywords as well as examples of Catalogue, image, and spectral headers are provided in the Appendix.

Because it is unlikely that the teams contributing these data will survive for much longer in complete form, the full knowledge of the data characteristics needs to be captured now. Problems stemming from incomplete or confusing submissions probably cannot be solved in the future. The requirements outlined here ensure that all the relevant information is captured before the consortia dissolve.

The currently available User Provided Data Products sets are available from:

http://herschel.esac.esa.int/UserReducedData.shtml

Starting on the spring of 2013, all these data sets will be moved to the HSC and will be made available from the HAS, forming part of the Legacy Herschel Science Archive.

1.2. Who may contribute

All Herschel users are welcomed to submit UPDPs associated with their observing programmes to the HSC.

Key Programme consortia were awarded observation time based on the commitment that they would provide highly processed data products obtained from the programmes. These KP datasets are particularly important, as they represent about half of the total Herschel observing time and were designed to form large coherent sets of data, forming the backbone of the scientific legacy of Herschel.

Users awarded Herschel time through a Regular Programme Announcement of Opportunity (AO-1 or AO-2), are also encouraged to contribute, on a voluntary basis, with products and software tools to the Observatory, and to make use of the HSA to disseminate their results to the astronomical community.

2. How to submit

1. Put the products you want to deliver in an FTP site.
2. Include in the FTP site any custom scripts you have used to reduce your data and that you want to share with the community.
3. Include also any instructions or links to documentation (e.g. a published refereed paper) needed to understand the scripts and to reproduce your data.
4. Contact the Herschel Science Centre Helpdesk to notify of the availability of the data at: http://herschel.esac.esa.int/esupport/.

User Provided Data Products can be made available to the HSC by providing the address of the FTP site where the products are located. In the case of a permanent repository located at the consortium's home institute, the address will be included in the Herschel Science Centre public Web pages. Otherwise, provide the HSC with the temporary location of the data. These will be retrieved and made available to the community through the public web pages, with the data residing on a local ftp area at HSC. Please also provide any other web addresses from which data products are accessible (for instance, CDS/VizieR for catalogues).

3. Mandatory Elements

3.1. Documentation

Contributed products must be accompanied by the following information:

1. Proposal Identification (i.e. KPOT_XXXXX_1, as provided by HSpot at the time of submission)
2. The address of the FTP site where the products are located.
3. References to published papers.
4. A brief description of the algorithms, methods and processing steps involved in the creation of the product if not explicitly documented in a paper or inside the products (as metadata).

3.2. Format

Products can be submitted in any format but the HSC recommends FITS files, ASCII files and VO Tables.

The CLASS format and associated data model is widely used in radioastronomy but not so much among the wider community. However, on particular data sets (e.g. HIFI data), CLASS has some advantages over the HIPE data model. HSC has developed a tool that allows the user to transform CLASS files into flat FITS files, preserving the CLASS header. Submissions are accepted in CLASS format and both the FITS and CLASS versions will be linked to the HSA.

3.2. Metadata

The product metadata must contain the keyword **OBS_ID** or **OBSID001**, **OBSID002**, which refers to the observation identifier(s) used to produce the products. This information is absolutely essential to establish the links from the observations in the HSA to the UPDP. See the Appendix on how to add metadata to FITS files in HIPE.

4. Suggested Guidelines

None of the following guidelines is mandatory, but submissions that adhere to them will likely have a larger and longer-lasting impact among the astronomical community than the rest. Users are encouraged to adopt as many of them as possible. In what follows we use the terms “suggest” and “recommend” interchangeably.

In order to increase the legacy value, submitted products should correspond to highly reduced and processed datasets. They should also be as Herschel-independent as possible, and be readable with commonly used tools available to the wider community.

In what follows we distinguish between the data format (FITS, VOTable, JPEG) and the data model, which specifies how data are organized within the format. Some specific data models are defined for specific data formats, although metadata information is generally transferable among formats.

Any data model used by HIPE when saving final products as FITS files is acceptable for the UPDPs. Products saved in this way will have correct and complete metadata information (but please confirm this by looking at the keyword list in the Appendix. We describe additional data models below, for users that left the HIPE system at some point when processing the data.

All the recommendations below can be summarized as follows:

- **Documentation:** We suggest that, in addition to documents specifying how the data were reduced, summary documentation be provided within the product themselves, in the form of metadata using the HISTORY keyword.

- **Metadata:** The submitter should consider that database services will query the metadata. Therefore, the metadata keywords should be abundant and standard. When possible, the metadata keywords should be taken from the HIPE dictionaries.
- **Catalogs:** The suggested formats are the tabular, delimiter-separated (CSV), CDS/Vizier , or VOTable formats.
- **Images:** We suggest that images be provided in FITS format, with the metadata providing astrometric, as well as size, shape, units and uplink information. We recommend that the deliveries include postage stamp images to serve as quicklook browsing products. Multi-band images can be submitted as multi-extension files or as separate files. We suggest that images be accompanied by uncertainty maps, coverage maps, and bad pixels masks.
- **Spectra:** Spectral data can be submitted as FITS binary tables, tabular files, CSV files, or VOTables. As with images, we recommend that the delivery includes plots to serve as quicklook products and be accompanied by a catalogue providing the link between the target name and the file name.
- **Spectral Cubes:** These may be provided as single or multiextension FITS files, with the data cubes in one extension. No VO standard exists for spectral cubes but we recommend that they include the same metadata that are mandatory for both spectra and images. Any format written by HIPE is appropriate.

4.1. Documentation

We suggest that each data delivery be accompanied by a description of the data model, if it is not obvious, in a way that will allow users not involved with the project to work with the data. In addition to the mandatory elements described before, the documenters should pay special attention to describe systematic effects in the data: aperture corrections, colour corrections, slit-loss corrections, background level adjustments, etc.

Realistically, most future users will rely on the documentation contained within the data themselves, in the form of comments and keywords. Because of this, we suggest that users provide enough information within the product metadata to serve as a summarized description of the reduction process. The description can include the values of key pipeline knobs of the reduction process (e.g. the size of the half-pass filter for PACS images, gain values, special calibrations) or a free-form discussion using the HISTORY keyword.

4.2. Metadata

Databases perform searches by querying the metadata information. Therefore, when considering what metadata information to include, the submitter should think about which metadata should be queryable by astronomers not associated with the project.

We suggest that the metadata keywords be taken from the HIPE dictionaries, whenever possible. When writing FITS files, HIPE uses a set of dictionaries to translate metadata to FITS compliant keywords, as explained in the section “Translation of Herschel metadata to FITS keywords” from the Herschel Data Analysis Guide, available within the HIPE help system.[2] In order of priority, these dictionaries are the HCSS dictionary, the HEASARC dictionary, and the Standard FITS dictionary. All are listed in the HIPE help[3]. Metadata not defined in the dictionary are replaced in the FITS files by keywords of the form META_XXX. The keywords that define the FITS standard are added automatically.

Additional keywords, not defined in the dictionaries, may be necessary. The International Virtual Observatory Alliance (IVOA) further defines additional spectroscopic keywords for use in FITS formats.[4] If additional keywords are needed, we recommend that they be taken from the common reserved additional keywords from the FITS standard.[5] If new metadata/keywords are defined, they should be clearly documented. Note that FITS keywords have a maximum of 8 characters.

Deliveries in VOTable format should use the Utypes defined within the VO standard.[6]

4.3. Catalogues

We recommend that catalogues be provided in plain, flat ASCII coding and in one of the following formats:

- Tabular (.tbl) format[7] or delimiter-separated values (CSV)
- CDS/VizieR format: This is an ASCII format appropriate for submissions to the VizieR service[8]. It should be accompanied by a ReadMe file. See the Appendix for a detailed description.
- Virtual Observatory (VOTable) table format[9]: An XML format specifically designed to work with the VO infrastructure, although most VO tools work also with the .tbl format.

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[2] In HIPE 11.0 this is section 1.16.3. See http://herschel.esac.esa.int/hcss-doc-11.0#howtos:Dag.DataIO.Fits.

[3] Herschel Products Definition Document, Appendix A: http://herschel.esac.esa.int/hcss-doc-11.0#pdd:appendixa

[4] http://www.ivoa.net/Documents/SpectrumDM/index.html

[5] http://archive.stsci.edu/fits/fits_standard/node40.html

[6] http://www.ivoa.net/cgi-bin/twiki/bin/view/IVOA/Utypes

[7] http://irsa.ipac.caltech.edu/applications/DDGEN/Doc/ipac_tbl.html. Keywords should follow the FITS standard definitions.

[8] VizieR, Standard Documentation for Astronomical Catalogues: http://cds.u-strasbg.fr/doc/catstd.htx

[9] http://www.ivoa.net/Documents/VOTable/20040811/REC-VOTable-1.1-20040811.html

Each of these formats uses keywords and columns with a particular syntax. TopCat[10] can convert among different table formats with a minimum of trouble.

Regardless of the format, we suggest that catalogs contain the following keywords or their equivalent metadata information: **AUTHOR, DATE_OBS, INSTRUME, RADESYS, EQUINOX, OBSERVER, TELESCOP, TITLE, DATE, CREATOR, PROPOSAL** (or **PROPID01, PROPID02**, etc).[11] This is in addition to any mandatory keywords required for the format, the keyword required by HSC (**OBS_ID**[12]), and anything else the users consider necessary. Values and data types for the keywords are given in the references listed in the footnotes.

We recommend that catalogs include source names, coordinates (equatorial or galactic), coordinate uncertainties, brightness measurements (magnitudes, colours, and/or flux densities as appropriate), and uncertainties in those measurements. If the catalogue is the result of observations over multiple days or epochs, we suggest that **DATE_OBS** is included as a column and not a keyword. We also suggest that the catalogue documentation includes information regarding the data selection, detection limits and/or sample completeness.

As mentioned before, users need to pay special attention to select meaningful keywords/metadata and/or column headers, as in most databases these will become quearyable parameters.

4.4. Images

Images must comply with the definition of the FITS standard and represent the image footprint in the World Coordinate System.

On-line image validation tools are available from a variety of sources.[13] Those tools validate the syntax and completeness of FITS files and aid in validating the astrometric accuracy of images. Alternatively, users may download tools (such as fverify) that perform the same functionality and can be run on collections of files. WCS validation can be obtained from the 'mImgtbl' tool.[14]

Suggested keywords are indicated in Section 3. Additional keywords may indicate the coordinates at the center of the map, the image size, shape, and orientation, the map units, and other uplink information (the information contained in the AOR) such as the instrument mode, etc.

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10 http://www.star.bris.ac.uk/~mbt/topcat/

11 http://heasarc.gsfc.nasa.gov/docs/fcg/common_dict.html

12 Multiple obsids and proposals can be indicated as OBSID001, OBSID002, PROPID01, PROPID02, etc.

13 For example, http://irsa.ipac.caltech.edu/applications/ImageValidate/

14 http://montage.ipac.caltech.edu/docs/mImgtbl.html

Multi-colour images can be submitted as separate files or as single multi-extension FITS files. Regardless of the packaging, we suggest that each image be accompanied by an uncertainty image, a coverage image, and a bad pixel mask. Within HIPE, data in the SimpleImage class will be written as a 6-extension FITS file: image, uncertainty, coverage, plus three history extensions.

We suggest that image submissions be accompanied by image postage stamps in a "web-friendly" format (JPEG, PDF, PS). The purpose of these is to provide a quick rendering of the contents of the map, without having to download the full image.

Large images can be submitted as a single big file, or as smaller fragments. Some data portals provide cutout servers that allow for partial downloads of the data.[15]

4.5. Spectra

One-dimensional spectra may be submitted as a FITS binary tables, .tbl files, or VOTables. We suggest that the deliveries include plots with the spectra (either JPEG, Postscript, encapsulated Postscript, or PDF), to serve as quicklook products when querying the data. This is because, while some interfaces serving or querying the data may provide "on-the-fly" spectral plots for users to inspect the spectra before downloading them, there is no guarantee that this will be the case.

To link the spectra to the sources, we recommend that spectral deliveries be accompanied by a text file (with the catalogue format defined above) that provides the target name for the given file name, as well as any other derived quantities the users consider convenient. This is necessary for certain databe services such as VizieR. This text file can be part of the general catalogue, if the project is submitting one. As mentioned above, column and keyword names become queryable fields in most databases.

Within HIPE, single point level-2 spectra are written as variations of the Spectrum1d dataset, which in turn is an extension of the Table dataset. While here we do not specify the actual columns in the data table, at the very least the table should provide spectral information (wavelength, frequency, wavenumber, or energy), flux, and flux uncertainty (either as a 1σ uncertainties per spectral bin, or as upper and lower flux limits). Additional useful information includes coverage (as an effective exposure time), spectral order, quality flags, etc.

The IVOA defines a standard[16] for single point spectra and we recommend this for submission of UPDP, for those users working outside the HIPE

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[15] For example, the IRSA cutout server at http://irsa.ipac.caltech.edu/applications/Cutouts/

environment. The standard consists of a series of mandatory, recommended, and optional metadata for the spectra, as well as flux and spectral units. These are listed in Section 3.

Additional keywords may detail uplink information (the information contained in the AOR) such as the instrument mode, and the targeted line(s), if appropriate. Spectral energy distributions are special cases of spectra, and the same metadata constraints apply.

4.6. Spectral Cubes

No VO data model is available for spectral cubes. Various formats have been defined in the literature and differ by the number of required extensions, or by the way the data are allocated among those extensions.[17]

Within HIPE, spectroscopic level 2 data come in different classes depending on the instrument and the AOT (i.e. PacsRebinnedCube, SpectralSimpleCube, etc). The simpleFitsWriter task writes any product as a multi-extension file in which the extension 0 is always empty of data. The number of extensions with data depends on the number of components in the product outline and will be different for each instrument. For example a PACS line spectroscopy rebinned cube is written as a 12-extension FITS file in which the primary header has an empty data array, the first extension is a data cube, the second is a Right Ascension cube, etc.

For the purposes of the user-provided data, the only strong format suggestion is that the data be provided in a data cube within a FITS structure (i.e. no “Row-stacked spectra" - RSS - format; all spectral slices within one extension). Additional data cubes or arrays within the FITS structure specifying coverage, uncertainties, spectral and astrometric information are recommended. This means that any spectral format that HIPE produces is acceptable, but simpler formats are also acceptable.

The same metadata indicated for both spectra and images should be included for spectral cubes.

5. Redelivery of products

As the mission progresses, and our knowledge of the satellite and instrument behaviour improves, so will the data processing software and calibration. For the benefit of the mission's legacy, you may consider re-processing and re-delivering your observations with upgraded versions of the data reduction software and calibration.

[16] See Tables 1 and F.1 in http://www.ivoa.net/Documents/SpectrumDM/index.html
[17] http://www.starlink.rl.ac.uk/star/docs/sc16.htx/node17.html

6. Appendix

6.1. Acronyms

AO Announcement of Opportunity
AOR Astronomical Observation Request
DP Data Processing
HIPE Herschel Interactive Processing Environment
HOTAC Herschel Observing Time Allocation Committee
HSA Herschel Science Archive
HSC Herschel Science Centre
KP Key Programmes
SED Spectral Energy Distribution
SPG Systematic Product Generation
UPDP User-Provided Data Products

6.2. How to add keywords to FITS files in HIPE

- Read the FITS files in HIPE:
  HIPE> p = fitsReader(file = " ")

- Add keyword obsid into product p including a description:
  HIPE> p. meta['obsid']=LongParameter(12345678L,"Observation Identifier")

- Save the new product:
  simpleFitsWriter(product = p, file=" ")

6.3. List of keywords

The following is a list of mandatory (MAN), recommended (REC), and optional (OPT) keywords for the UPDP. Both recommended and optional keywords are suggestions. The difference between REC and OPT is the priority or relevance of the keyword for the application at hand. For example, the NAIFID keyword is not used for non-Solar System objects, and so it is only OPT.

Explanations for the meaning of the keywords are available from the HCSS dictionaries, the HEASARC dictionary, and the Standard FITS dictionary[18].

[18] HIPE Herschel Data Analysis Guide, Section 1.16.3: http://herschel.esac.esa.int/hcss-doc-11.0#howtos:Dag.DataIO.Fits; HIPE Help system, Appendix A. Common metadata keywords in Herschel products: http://herschel.esac.esa.int/hcss-doc-11.0#pdd:appendixa; Dictionary of Commonly used FITS Keywords: http://heasarc.gsfc.nasa.gov/docs/fcg/common_dict.html

Further descriptions are available from the definition of the FITS standard[19], the HIPE manual, and the VO Spectrum definition standard[20].

Note that some keywords are listed as:

```
HIERARCH     key.META_n='New_Keyword'
```

This is the convention used to include keywords that are not in any dictionary. In an actual header, each of these should be replaced by:

```
HIERARCH     key.META_n='New_Keyword'
META_n  =    Contents of New_keyword     \Comment explaining the keyword
```

where 'n' is any integer. Examples of this convention are available in almost any FITS file written with HIPE.

Additional keywords not in this list may be necessary for some datasets.

Note that FITS files written with HIPE will have most of the keywords indicated here. In this case, the user only needs to check that the MAN keywords are actually included.

Keywords	Priorities	Notes
FITS standard keywords		
BITPIX	MAN	Bits per data value
DS_X	OPT	HDU of Child Dataset
DSETS___	OPT	Number of datasets
END	MAN	FITS standard mandatory
EXTEND	OPT	File may contain extensions
GCOUNT	OPT	Number of groups
LONGSTRN	REC	OGIP 1.0 - The OGIP Long String Convention may be used.
NAXIS	MAN	FITS standard mandatory
NAXIS1	MAN	FITS standard mandatory
NAXIS2	MAN	FITS standard mandatory
PCOUNT	OPT	Number of extra parameters
SIMPLE	MAN	Image conforms to FITS standard
Dataset description		
AUTHOR	REC	Author of the Data
COMMENT	REC	Comment
CONTINUE	OPT	Continuation of comment

19 http://archive.stsci.edu/fits/fits_standard/node1.html

20 http://www.ivoa.net/Documents/SpectrumDM/index.html

CREATOR	REC	Generator of this product: Name and version of the software that created the product
DATE	REC	Creation UTC (YYYY-MM-DD) date of FITS header
DATE_END	REC	End date of this product (or EXPTIME)
DATE_OBS	REC	Start date of this product
EXTNAME	REC	Name of this HDU
HIERARCH	OPT	Keywords that denote non-standard FITS keyword format
HIPE_VER	OPT	Version of HIPE, if used
HISTORY	REC	A history of steps and procedures associated with the processing of the associated data.
INSTRUME	REC	Instrument name
NAIFID	OPT	SSO NAIF identifier
OBJECT	REC	Title of the dataset
OBS_ID	MAN	Observation identifier (or OBSID001, OBSID002, etc)
OBSERVER	REC	Observer name
ODNUMBE R	OPT	Operational day number
ORIGIN	OPT	Site that created the product
PROPOSAL	REC	Proposal name: e.g. KPOT_XXX (or PROPID01, PROPID02, etc)
TELESCOP	REC	Telescope name
TITLE	REC	Proposal title (also PROJECT)
Astrometric keywords		
CD1_1	REC	Element (1,1)
CD1_2	REC	Element (1,2)
CD2_1	REC	Element (2,1)
CD2_2	REC	Element (2,2)
CDELT1	OPT	Pixel scale axis 1
CDELT2	OPT	Pixel scale axis 2
CROTA2	OPT	Rotation angle
CRPIX1	REC	Reference pixel position
CRPIX2	REC	Reference pixel position
CRVAL1	OPT	First coordinate of reference corrected CD matrix
CRVAL2	OPT	Second coordinate of reference corrected CD matrix
CTYPE1	REC	Projection type axis 1
CTYPE2	REC	Projection type axis 2
CUNIT1	OPT	Units axis 1
CUNIT2	OPT	Units axis 2
PC1_1	OPT	PC1_1 element of PC matrix

PC1_2	OPT	PC1_2 element of PC matrix
PC2_1	OPT	PC2_1 element of PC matrix
PC2_2	OPT	PC2_2 element of PC matrix
Pointing keywords		
DEC	REC	Actual Declination of pointing
DEC_NOM	REC	Requested Declination of pointing
EPOCH	OPT	Epoch
EQUINOX	REC	Equinox of celestial coordinate system
PMDEC	REC	Target's proper motion
PMRA	REC	Target's proper motion
POSANGLE	REC	Position Angle of pointing
RA	REC	Actual Right Ascension of pointing
RA_NOM	REC	Requested Right Ascension of pointing
RADESYS	REC	Coordinate reference frame for the RA and DEC
General Keywords		
AOR	OPT	AOR Label as entered in HSpot
AOT	OPT	AOT Identifier
BUNIT	REC	Current units of data (also ZUNIT)
CUSMODE	OPT	CUS observation mode
INSTMODE	OPT	Instrument Mode
JANSCALE	OPT	Conversion from Jy/beam to MJy/sr
NODCYDEN	OPT	Switching/nodding cycle number
OBS_MODE	OPT	Observation mode name
POINTMOD	OPT	Pointing mode
PRODNOTE	OPT	Notes for product
TIMESYS	REC	All dates are in UTC time
Spectroscopy Keywords		
APERTURE	REC	Aperture angular size, deg
CRPIX3	OPT	Reference pixel position
CRVAL3	OPT	Third coordinate of reference corrected CD matrix
CTYPE3	OPT	Description of what the 3rd axis represent
CUNIT3	OPT	Units of axis 3
DS_IDPUB	REC	Publisher’s ID for the dataset ID
FLUXSDIM	REC	SI factor and dimensions
NAXIS3	OPT	The Number of layers in datacube
REGION	REC	Aperture region

SPEC SYE		REC	Spectral coord measurement error
SPEC_BW		REC	Width of spectrum
SPEC_ERR		REC	Spectral coord measurement error
SPEC_VAL		REC	Spectral coord value
SPECSDIM		REC	SI factor and dimensions
TDIMn		OPT	FITS column dimensions
TDMAXn		REC	Stop in spectral coordinate
TDMINn		REC	Start in spectral coordinate
TELAPSE		REC	Total elapsed time
TFORMn		OPT	FITS column type
TIMESDIM		REC	SI factor and dimensions
TMID		REC	Exposure midpoint (MJD, d)
TSTART		REC	Start time
TSTOP		REC	Stop time
TTYPEn		REC	Name: As many as columns in the data table
TUCDn		OPT	UCD: As many as columns in the data table
TUNITn		REC	Unit: As many as columns in the data table
VELDEF		REC	The velocity definition and frame
VFRAME		REC	Spacecraft velocity along the line of sight
VOCLASS		REC	Data model name and version
VOPUB		REC	Publisher
VOREF		REC	URL or Bibcode for documentation
VORIGHTS		REC	Restrictions: public, proprietary, mixed
WAVELNTH		REC	The reference wavelength at which the image is taken (Photometry)
PACS-Specific Keywords			
BAND		REC	Spectroscopy Band name (Spec)
HIERARCH	key.META_n='camName'	OPT	Name of the Camera
HIERARCH	key.META_n='blue'	OPT	Selected blue band (blue1=Blue, blue2=Green)
HIERARCH	key.META_n='calVersion'	REC	Version of Calibration Tree
HIERARCH	key.META_n='mapScanAngle'	OPT	HSpot: scan map position angle (deg)
HIERARCH	key.META_n='mapScanAngleRef'	OPT	HSpot: scan map reference (sky or inst)
HIERARCH	key.META_n='mapScanConstrFrom'	OPT	HSpot: scan map constraint angle from (deg)
HIERARCH	key.META_n='mapScanConstrTo'	OPT	HSpot: scan map constraint angle to (deg)
HIERARCH	key.META_n='mapScanCrossScan'	OPT	HSpot: scan map leg separation (arcsec)

HIERARCH	key.META_n='mapScanHomCoverage'	OPT	HSpot: scan map homogeneous coverage selected
HIERARCH	key.META_n='mapScanLegLength'	OPT	HSpot: scan map leg length (arcmin)
HIERARCH	key.META_n='mapScanNumLegs'	OPT	HSpot: number of scan map legs
HIERARCH	key.META_n='mapScanSpeed'	OPT	HSpot: scan map rate (high, medium or low)
HIERARCH	key.META_n='mapScanSquare'	OPT	HSpot: scan map square coverage selected
HIERARCH	key.META_n='repFactor'	OPT	HSpot: Repetition factor
HIERARCH	key.META_n='PACS_PHOT_GAIN'	OPT	gain settings for the bolometer
HIERARCH	key.META_n='chopAvoidFrom'	OPT	HSpot entry: chop avoidance zone
HIERARCH	key.META_n='chopAvoidTo'	OPT	HSpot entry: chop avoidance zone
HIERARCH	key.META_n='lineStep'	OPT	raster line step in arcsec
HIERARCH	key.META_n='m'	OPT	number of raster columns (a.k.a points) (taken from HSpot) (note: the default value is >0 even if the observation is not a raster)
HIERARCH	key.META_n='mapRasterAngleRef'	OPT	HSpot entry: requested map angle wrt the instrument or the sky, and the reference frame (wrt North or wrt the boresight)
HIERARCH	key.META_n='n'	OPT	number of raster lines (taken from HSpot) (note: the default value is >0 even if the observation is not a raster)
HIERARCH	key.META_n='pointStep'	OPT	raster step (point=column) in arcsec
HIERARCH	key.META_n='bluWave'	OPT	HSpot: blue limits for all ranges (um) (Spec)
HIERARCH	key.META_n='chopNod'	OPT	HSpot: chop-nod range scan observation (Spec)
HIERARCH	key.META_n='density'	OPT	HSpot: wavelength sampling density (Spec)
HIERARCH	key.META_n='gratScan'	OPT	HSpot: unchopped range scan observation (Spec)
HIERARCH	key.META_n='rangeId'	OPT	HSpot: range identifiers (Spec)
HIERARCH	key.META_n='redWave'	OPT	HSpot: red limits for all ranges (um) (Spec)
HIERARCH	key.META_n='repeatRange'	OPT	HSpot: repetition factors for all ranges (Spec)
HIERARCH	key.META_n='lineDescription'	OPT	summary of other Meta data line descriptions (Spec)
HIERARCH	key.META_n='lineId'	OPT	SLICE_INFO: line ID (Spec)
HIERARCH	key.META_n='minWave'	OPT	SLICE_INFO: minimum wavelength (Spec)
HIERARCH	key.META_n='maxWave'	OPT	SLICE_INFO: maximum wavelength (Spec)

HIERARCH	key.META_n='order'	OPT	grating order (Spec)
HIERARCH	key.META_n='userNODcycles'	OPT	HSpot: number of ABBA nod cycle (Spec)
HIERARCH	key.META_n='Number of Lines'	OPT	number of spectral lines (Spec)
HIERARCH	key.META_n='Chopper Throw'	OPT	HSpot: small, medium or large (Spec)
HIERARCH	key.META_n='Number of Nod cycles'	OPT	exactly what it says (Spec)
SOURCE		OPT	HSpot: source mapping type (point, small, largeRaster, largeScan)
SPIRE-Specific Keywords			
ACTRES		OPT	Actual Spectral Resolution (Spec)
BEAMSIZE		OPT	Beamsize in sr (Phot)
CMDRES		OPT	Commanded Spectral Resolution (Spec)
DETECTOR		OPT	Name of the bolometer array (Phot)
HIERARCH	key.META_n='version'	REC	SPIRE Calibration version
MAPSAMPL		OPT	Spatial sampling of map (Phot)
NUMREP		OPT	Number of times to repeat the basic unit
NUMSCANS		OPT	Number of Scans
HIFI-Specific Keywords			
HIERARCH	key.META_n='backend'	OPT	Spectrograph: WBS or HRS (HIFI)
HIERARCH	key.META_n='channels'	OPT	Number of channels
HIERARCH	key.META_n='wavedescription'	OPT	Description of WaveColumn
HIERARCH	key.META_n='Band'	REC	Active band
HIERARCH	key.META_n='pattAngle'	OPT	Map rotation angle
HIERARCH	key.META_n='crossStep'	OPT	Separation between scans of the map
HIERARCH	key.META_n='mapWidth'	OPT	Size of the map along the horizontal axis
HIERARCH	key.META_n='decoff'	OPT	Declination of the reference point
HIERARCH	key.META_n='raoff'	OPT	Right ascension of the reference point
HIERARCH	key.META_n='nyquistSampling'	OPT	Map is Nyquist sampled
HIERARCH	key.META_n='frame'	OPT	Frame of reference for Vlsr
HIERARCH	key.META_n='redshiftType'	OPT	Type of redshift: optical, radio, redshift
HIERARCH	key.META_n='redshiftFrame'	OPT	Reference frame of redshift
HIERARCH	key.META_n='subbands'	REC	Number of subbands
HIERARCH	key.META_n='hassubbands'	REC	Whether it has subbands
HIERARCH	key.META_n='wavename'	OPT	Actual name of the WaveColumn
HIERARCH	key.META_n='channelSpacing'	OPT	
HIERARCH	key.META_n='resolution'	OPT	[MHz]
HIERARCH	key.META_n='frequencyGroup'	OPT	
HIERARCH	key.META_n='loFrequency'	REC	[GHz] The LO frequency

			of the source phase
HIERARCH	key.META_n='loThrow'	REC	[GHz] The LO frequency throw
HIERARCH	key.META_n='freqFrame'	OPT	Frame of reference the frequency scale refers to
HIERARCH	key.META_n='forwardEff'	OPT	Forward efficiency used when applying DoAntennaTemp.
HIERARCH	key.META_n='sideband'	REC	status: upper or lower side band
HIERARCH	key.META_n='subbandlength_1'	OPT	Length of subband 1
HIERARCH	key.META_n='subbandlength_2'	OPT	Length of subband 2
HIERARCH	key.META_n='subbandstart_1'	OPT	Starting channel for subband 1
HIERARCH	key.META_n='subbandstart_2'	OPT	Starting channel for subband 2
HIERARCH	key.META_n='resolution_resampled'	OPT	Approximate resolution after resampling
HIERARCH	key.META_n='frequencyWidth'	OPT	[GHz] The spacing of the frequency grids after resampling
HIERARCH	key.META_n='calVersion'	REC	HIFI Calibration version
MAPHGT		OPT	Size of the map along the vertical axis
RASTCOL		OPT	Raster Column
RASTLINE		OPT	Raster line
SCANLINE		OPT	Scan Line
WAVEUNIT		OPT	Units of the WaveColumn

6.4. The CDS/VizieR format

The CDS/VizieR system recommends submission of catalogs in plain ascii files, with the details about their structures described in a `ReadMe` file. Other data formats such as FITS files are accepted, but they will be converted into plain ascii files.

According to ISO 9660 standard, file names are restricted to 8 + 3 characters: 8 characters in the set [a-z0-9_-], followed by a dot and an extension made of 3 characters with the following conventions: `.dat` for data files, `.fit` for FITS files, `.tex` for TeX/LaTeX files, and `.txt` for text files (ascii files containing only printable text).

The `ReadMe` file describes all data files stored in a catalogued data set (description of columns), and provides the necessary explanations and references.

A full description of the conventions used in this ReadMe file can be found in the Standards for Astronomical Catalogues.

Brief explanations of the different sections of the Readme file:

- The volume and page numbers of the related publication.

- The ADC_Keywords, a list of data-related keywords out of a VizieR controlled set.

- The list of keywords as in the printed publication.

- The Description section describes the context of the data, like the instrumentation used or the observing conditions, it differs from the Abstract which tends to describe the scientific results derived from the data.

- The File Summary describes the files making up the set; for each file are specified its filename, the length of the longest line (lrecl), the number of records (number of lines), and a caption (short title of the file). Lengthy notes can be added if necessary.

- The Byte-by-byte Description of file section describes the structure of each of the data files (files with the `.dat` extension). It contains the following columns:

1. The starting and ending byte of each column.
2. The format of the field as a fortran-like format:
   A*n* text string of n characters.
   I*n* integer number of n digits.
   F*n.d* real number, n digits and up to d digits in the fractional part.
   E*n.d* real number, exponential notation.
   D*n.d* double precision number,exponential notation.
3. The units used in the field; usage of SI units strongly encouraged.
4. The label of the field made of a single word (no embedded blank); a few basic conventions are used for usual.
5. The explanations can start with the following special characters related to some important data characteristics:
   * (the asterisk) indicating a lengthy note
   [...] (square brackets) indicating data ranges
   ? (question mark) indicating a possibility of blank or NULL

- The References section contains the necessary references; the usage of the bibcode is strongly encouraged. For large sets of references, it is suggested to gather them into a dedicated reference file named `refs.dat`.

Detailed information can be found at: http://cds.u-strasbg.fr/doc/catstd.htx
`ReadMe` template: http://cdsarc.u-strasbg.fr/ftp/cats/J/A+A/ReadMe.txt
Data verification: http://cdsarc.u-strasbg.fr/viz-bin/Submit

6.5. Example of an IPAC Table catalogue submission

This is an example of a catalogue in the tabular format.

```
\ *******************************************
\ Mandatory HSC keywords ********************
```

```
\ The OBS_IDs used in the preparation of the delivery:
\OBSID001 = '0001000101'
\OBSID002 = '0001000103'
\ End of mandatory HSC keywords **************
\ ********************************************
\ Recommended Keywords *********
\ The date of this delivery:
\DATE = '2012-04-25'
\ The software version(s) used in the reduction:
\CREATOR1 = 'SPG v8.1.2
\CREATOR2 = 'Private pipeline'
\PROPOSAL = 'KPOT_wherschel_1'
\AUTHOR = 'Anonymous Herschel grad student'
\OBSERVE = 'William Herschel'
\TITLE  = 'Everything and then more'
\TELESCOP = 'Herschel Space Observatory'
\ If more than one date or epoch, list in the body of the table
\DATE_OBS = '1820-02-29'
\EQUINOX = 'J2000'
\RADESYS = 'FK5'
\INSTRUM1 = 'PACS'
\INSTRUM2 = 'SPIRE'
\ End of required keywords ******************
\ ********************************************
\ Other Comments ********************************
\ Other Comments ********************************
\ Other Comments ********************************
\ Other Comments ********************************
\
| name |  ra   | dec   | ra_err | dec_err | f70  | f70_err |
| char |  real | real  | real   |   real  | real |   real  |
|      |  deg  |  deg  |  deg   |   deg   |  Jy  |    Jy   |
| null | -100  |  -100 |  -100  |   -100  | -100 |   -100  |

  M31   10.6847 41.268   0.0005    0.005     3.21     0.1
```

6.6. Example of a FITS image header

This is an example of a “primary header plus data” image. It is also possible to submit images with an empty primary, and data starting in the first extension.

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                 2400 / length of data axis 1
NAXIS2  =                 2401 / length of data axis 2
OBS_ID001  = '0009327872'        / OBSIDS used in this mosaic
OBS_ID002  = '0009328896'        / OBSIDS used in this mosaic
CREATOR1 = 'Private Pipeline'   / SW that created this FITS file
CREATOR2 = 'SPG v6.3.1 '        / Generator of this product
CREATOR3 = 'SPG v8.2.1'         / Generator of this product
DATE    = '2012-04-24T18:29:34.851000' / Creation date of this
product
PROPOSAL = 'KPOT_wherschel_1'           /Proposal
TITLE   = 'Everything and then more' / Program Title
OBSERVER= 'William Herschel'       /Principal Investigator
AUTHOR  = 'W Herschel'      / Preparer of this file
DATE_OBS = '2009-11-01T09:15:52.000000'  / Date of observations
INSTRUME= 'PACS    '           / Instrument ID
TELESCOP= 'Herschel Space Observatory' / Name of telescope
```

```
EQUINOX =               2000.0 / [] Equinox of celestial coordinate
RADESYS = 'ICRS    '           / Coord ref frame RA and DEC
COMMENT = 'This is one possible format for WCS information'
CUNIT1  =  'deg'          / WCS: Units axis 1,default="deg"
CUNIT2  =  'deg'          / WCS: Units axis 2,default="deg"
CDELT1  =   -8.888888888889E-4 / [] WCS: Pixel scale axis 1,
unit=Angle
CDELT2  = 8.888888888888889E-4 / [] WCS: Pixel scale axis 2,
unit=Angle
CTYPE1  = 'RA---TAN'           / WCS: Proj type axis
1,default="LINEAR"
CTYPE2  = 'DEC--TAN'           / WCS: Proj type axis
2,default="LINEAR"
CROTA2  =                  0.0 / [] The Rotation angle
CRPIX1  =                114.5 / [] WCS: Ref pixel position axis 1
CRPIX2  =                 66.0 / [] WCS: Ref pixel position axis 2
CRVAL1  =     86.8225609715261 / [] WCS: First coord of ref pixel
CRVAL2  =  -51.066523865056155 / [] WCS: Second coord of ref pixel
CD1_1   =      -1.66666665E-04
CD1_2   =       0.00000000E+00
CD2_1   =       0.00000000E+00
CD2_2   =       1.66666665E-04
COMMENT = 'These are additional useful keywords'
OBJECT  = 'The Universe'           / Target name
CUSMODE = 'PacsPhoto'          / CUS observation mode
INSTMODE= 'PacsPhoto'          / Instrument Mode
POINTMOD= 'Line_scan'          / Pointing mode
OBS_MODE= 'Scan map'           / Observation mode name
AOT     = 'Photometer'         / AOT Identifier
WAVELNTH= 100.0               / Band Identifier
RA      =          237.93341064 / [Deg] Right ascension at mosaic
center
DEC     =          -54.03887177 / [Deg] Declination at mosaic center
DELTA-X =            1.10666668 / [Deg] size of image in axis 1
DELTA-Y =            0.80666667 / [Deg] size of image in axis 2
PMRA    = 0.004999999888241291 / [arcsec a-1] Prop motion, RA
asec/year
PMDEC   =   0.0820000022649765 / [arcsec a-1] Prop motion, DEC
asec/year
RA_NOM  =    86.82120833333333 / [deg] Requested RA of pointing
DEC_NOM =   -51.06652777777777 / [deg] Requested Dec of pointing
POSANGLE=   130.91566199627925 / [deg] Position Angle of pointing
EXPTIME =                  1.2 / [sec] Eff. integration time per
pixel
BUNIT   = 'MJy/sr  '           / Units of image data
NIMAGES =                  2    / Number of PACS Frames in Mosaic
VELDEF  = 'RADI-LSR'           / The velocity definition and frame
VFRAME  =  -13.231820801380517 / [km s-1]
END
```

6.7. Example of a FITS spectral header

This is an example of a VO-compliant FITS header for a single point spectrum. In this particular case, the data table is assumed to be:

```
WAVE   WAVE_LO WAVE_HI   FLUX        ERR_LO      ERR_HI      QUALITY
3200.0 3195.0 3205.0    1.48E-12    2.0E-14     2.0E-14     0
3210.0 3205.0 3215.0    1.52E-12    3.0E-14     3.0E-14     0
3220.0 3215.0 3225.0    0.38E-12    0.38E-12    0.0   0
3230.0 3225.0 3235.0    1.62E-12    3.0E-14     3.0E-14     0
...
```

```
5000.0 4995.0 5005.0    1.33E-11    3.0E-13     3.0E-13     1
```

The header is as follows:

```
XTENSION= 'BINTABLE' / binary table extension
BITPIX = 8 / 8-bit bytes
NAXIS = 2 / 2-dimensional binary table
NAXIS1 = 57344 / width of table in bytes
NAXIS2 = 1 / number of rows in table
OBS_ID001  = '0009327872'         / OBSIDS used in this mosaic
OBS_ID002  = '0009328896'         / OBSIDS used in this mosaic
CREATOR1 = 'Private Pipeline'   / SW that created this FITS file
CREATOR2 = 'SPG v6.3.1 '        / Generator of this product
CREATOR3 = 'SPG v8.2.1'         / Generator of this product
PROPOSAL = 'KPOT_wherschel_1'           /Proposal
OBSERVER= 'William Herschel'       /Principal Investigator
DATE_OBS = '2009-11-01T09:15:52.000000'  / Date of observations
PCOUNT = 0 / size of special data area
GCOUNT = 1 / one data group (required keyword)
TFIELDS = 7 / number of fields in each row
EXTNAME = 'SPECTRUM ' / name of this binary table extension
VOCLASS = 'Spectrum V1.0' / VO Data Model
DATALEN = 180 / Segment size
VOSEGT = 'Spectrum' / Segment type
VOCSID = 'MY-ICRS-TOPO' / Coord sys ID
RADESYS= 'FK5 ' / Not default - usually ICRS
EQUINOX = 2.0000000000000E+03 / default
TIMESYS = 'TT ' / Time system
MJDREF = 0.0 / [d] MJD zero point for times
SPECSYS = 'TOPOCENT' / Wavelengths are as observed
VOPUB = 'CfA Archive' / VO Publisher authority
VOREF = '2006ApJ...999...99X' / Bibcode for citation
VOPUBID = 'ivo://cfa.harvard.edu' / VO Publisher ID URI
VOVER = '1.0' / VO Curation version
CONTACT = 'Jonathan McDowell, CfA'/
EMAIL = 'jcm@cfa.harvard.edu' /
VORIGHTS= 'public' /
VODATE = '2004-08-30' /
DS_IDPUB= 'ivo://cfa.harvard.edu/spec#10304' / Publisher DID for
dataset
COMMENT DS_IDPUB usually the same as DS_IDENT?
OBJECT = 'ARP 220 ' / Source name
OBJDESC = 'Merging galaxy Arp 220' / Source desc
SRCCLASS= 'Galaxy' /
SPECTYPE= 'ULIRG' /
REDSHIFT= 0.01812 / Emission redshift
RA_TARG = 233.73791700 / [deg] Observer's specified target RA
DEC_TARG = 23.50333300 / [deg] Observer's specified target Dec
TARGVAR = 0.2 / 20 percent variability amplitude
TITLE = 'Observations of Merging Galaxies' /
AUTHOR = 'MMT Archive' / VO Creator
COLLECT1= 'Misc Pointed Observations' / Collection
DS_IDENT= 'ivo://cfa.harvard.edu/spec#10304' / Publisher DID for
dataset
CR_IDENT= 'ivo://cfa.harvard.edu/tdc#MMT4302-102' / Creator internal
ID for dataset
DATE = '2004-08-30T14:18:17' / Date and time of file creation
VERSION = 2 / Reprocessed 2004 Aug
TELESCOP= 'MMT ' / Telescope [Not part of Spectrum DM]
INSTRUME= 'MMT/BCS ' / Instrument
FILTER = 'G220 ' / Grating [Not part of Spectrum DM]
CRETYPE = 'Archival' / Not an on-the-fly dataset
```

```
VOLOGO = 'http://cfa.harvard.edu/vo/cfalogo.jpg' / VO Creator logo
CONTRIB1= 'Jonathan McDowell' / Contributor
CONTRIB2= 'Wilhelm Herschel' / Contributor
CONTRIB3= 'Harlow Shapley' / Contributor
DSSOURCE= 'Pointed' / Survey or pointed, etc
DER_SNR = 5.0 / Estimate of signal-to-noise
DER_Z = 0.01845 / Redshift measured in this spectrum
DER_ZERR = 0.00010 / Error in DER_Z
TIMESDIM= 'T' / Time SIDim
SPECSDIM= '10-10 L' / Spectral SIDim
FLUXSDIM= '10+7 ML-1T-3' / Flux SDim
SYS_ERR = 0.05 / Fractional systematic error in flux
FLUX_CAL= 'Calibrated' /
SPEC_ERR= 0.01 / Stat error in spec coord, in SPEC units
SPEC_SYE= 0.001 / Frac sys error in spec coord
SPEC_CAL= 'Calibrated'
SPEC_RES= 5.0 / [angstrom] Spectral resolution
SPECBAND= 'Optical' / SED.Bandpass
SPEC_RP = 800.0 / Spectral resolving power
SPEC_VAL= 4100.0 / [angstrom] Characteristic spec coord
SPEC_BW = 1800.0 / [angstrom] Width of spectrum
SPEC_FIL= 1.0 / No gaps between channels
TIME_CAL = 'Calibrated' /
DATE-OBS= '2004-06-03T21:18:17' / Date and time of observation
EXPOSURE = 1500.015 / [s] Effective exposure time
TSTART = 52984.301203 / [d] MJD
TSTOP = 52984.318564 / [d] MJD
TMID = 52984.309883 / [d] MJD mid expsoure
SKY_CAL = 'Calibrated' /
SKY_RES = 1.0 / [arcsec] Spatial.Resolution
RA = 233.73791 / [deg] Pointing position
DEC = 23.50333 / [deg] Pointing position
APERTURE= 2.0 / [arcsec] Aperture diameter/Slit width
TIME = 52984.309883 / [d] MJD of midpoint
COMMENT ---------------------------
COMMENT WCS Paper 3 Keywords
1S4_1 = 'WAVE' / Column name with spectral coord
1CTYP4 = 'WAVE-TAB' / Spectral coord is WAVE
1S5_1 = 'WAVE' / Column name with spectral coord
1CTYP5 = 'WAVE-TAB' / Spectral coord is WAVE
1S6_1 = 'WAVE' / Column name with spectral coord
1CTYP6 = 'WAVE-TAB' / Spectral coord is WAVE
1S7_1 = 'WAVE' / Column name with spectral coord
1CTYP7 = 'WAVE-TAB' / Spectral coord is WAVE
COMMENT ---------------------------
TTYPE1 = 'WAVE' / Wavelength
TFORM1 = '180E'
TUNIT1 = 'angstrom'
TUCD1 = 'em.wl' /
TDMIN1 = 3195.0 /
TDMAX1 = 5005.0 /
TUTYP1 = 'Spectrum.Data.SpectralAxis.Value'
TTYPE2 = 'WAVE_LO' /
TFORM2 = '180E'
TUNIT2 = 'angstrom'
TUTYP2 = 'Spectrum.Data.SpectralAxis.Accuracy.StatErrLow'
TTYPE3 = 'WAVE_HI' /
TFORM3 = '180E'
TUNIT3 = 'angstrom'
TUTYP3 = 'Spectrum.Data.SpectralAxis.Accuracy.StatErrHigh'
TTYPE4 = 'FLUX' /
TFORM4 = '180E'
TUNIT4 = 'erg cm**(-2) s**(-1) angstrom**(-1)'
```

```
TUTYP4 = 'Spectrum.Data.FluxAxis.Value'
TUCD4 = 'phot.fluDens;em.wl' / Type of Y axis: F-lambda
TTYPE5 = 'ERR_LO' /
TFORM5 = '180E'
TUNIT5 = 'erg cm**(-2) s**(-1) angstrom**(-1)'
TUTYP5 = 'Spectrum.Data.FluxAxis.Accuracy.StatErrLow'
TTYPE6 = 'ERR_HI' /
TFORM6 = '180E'
TUNIT6 = 'erg cm**(-2) s**(-1) angstrom**(-1)'
TUTYP6 = 'Spectrum.Data.FluxAxis.Accuracy.StarErrHigh'
TTYPE7 = 'QUALITY' /
TFORM7 = '180I'
TUTYP7 = 'Spectrum.Data.FluxAxis.Quality'
```