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FITS Headers for Scans of Photographic Plates Version 1.0

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Interest Group
: Data Curation and Preservation

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Abstract

This note describes a FITS header structure suitable for the annotation of scans of photographic plates containing sky images intended for scientific use. This metadata structure is general enough to cover several observational techniques common in the plate area, such as multiply exposed plates or objective prism spectroscopy. While this metadata structure was being developed together with annotation software (PyPlate) and a specific digitisation project (APPLAUSE), we hope it is general enough to serve as a lingua franca for the annotation of scans of historical photographic observations.

Status of this document

This is an IVOA Note expressing suggestions from and opinions of the authors. It is intended to share best practices, possible approaches, or other perspectives on interoperability with the Virtual Observatory. It should not be referenced or otherwise interpreted as a standard specification.

A list of current IVOA Recommendations and other technical documents can be found at https://www.ivoa.net/documents/.

Contents

Conformance-related definitions

The words "MUST", "SHALL", "SHOULD", "MAY", "RECOMMENDED", and "OPTIONAL" (in upper or lower case) used in this document are to be interpreted as described in IETF standard RFC2119 (Bradner, 1997).

The *Virtual Observatory (VO)* is a general term for a collection of federated resources that can be used to conduct astronomical research, education, and outreach. The International Virtual Observatory Alliance (IVOA) is a global collaboration of separately funded projects to develop standards and infrastructure that enable VO applications.

1 Introduction

This document proposes FITS (Hanisch and Farris et al., 2001) header keywords, value types and an overall layout for storing metadata of digitized astronomical photographic plates, where we use "plates" here to include images on both glass or film.

The header format is intended to suit various cases: direct images with single exposures, multiple exposures of a single object/field, exposures of different objects/fields, objective-prism spectra, etc.

The goals of the present work is to

- facilitate writing software for automatically processing such data given the constraints of the historical material,
- aid data providers in selecting useful and relevant metadata to add to their scans,
- provide researchers with easily-inspectable information not only on the image itself, but also on its provenance.

The present work has greatly benefited from the Wide-Field Plate Database WFPDB (Tsvetkov and Stavrev et al., 1995), which informed many of the design choices made here. However, this effort is independent of the WFPDB as such. The direct predecessor of this Note is Kirov and Tsvetkov et al. (2012), which already introduced several of the concepts covered here.

While conformant FITS headers can be written with generic FITS software, higher-level interfaces have been written, in particular in the PyPlate software for calibrating and annotating scans of astronomical plates (Tuvikene, 2022), but also in the general Virtual Observatory server suite DaCHS (Demleitner and Neves et al., 2014).

This specification's core is Section 2, which describes the various groups contributing to a full description of a scanned plate's metadata. A complete sample header is shown in Section 3.

2 FITS header format

For better readability of the header, we organise keyword records into groups of related keywords and separate these groups with cards that have a blank keyword:

```
KEYWORD1= 'value   '           / sample keyword
KEYWORD2= 'value   '           / sample keyword
        -------------------------------------- Original data of the observation
KEYWORD3= 'value   '           / sample keyword
KEYWORD4= 'value   '           / sample keyword
        ---------------------------------------------------- Photographic plate
```

```
KEYWORD5= 'value   '           / sample keyword
KEYWORD6= 'value   '           / sample keyword
        --------------------------------------- Computed data of the observation
KEYWORD7= 'value   '           / sample keyword
KEYWORD8= 'value   '           / sample keyword
```

An italic n in header keywords denotes numbering, where n can range between 1 and 99. RAn will thus expand to keywords RA1, RA2, RA3, etc. Numbers in keywords are not padded with zeros.

All headers defined here are optional in the sense that a header without them still conforms to this specification. In particular, not even the group headers are mandatory. However, *if* a header card is present with a certain keyword defined here, that card must conform to the syntax and semantics defined here to be compliant.

In addition to the requirements and recommendations given here, all constraints resulting from the various standard documents on FITS apply.

This specification does not use any of the FITS conventions on long keywords. However, FITS CONTINUE cards[1] are explicitly allowed (and encouraged for some of the free text fields). This should no longer cause interoperability problems with FITS libraries in actual use in 2022.

Writers should in general not write cards with empty values. Readers, however, should be prepared to see all-blank strings being used as null values, as many files have been written assuming such a convention.

At this point, writers are encouraged to write uncompressed FITS files for interoperability, in which case the header described here will be the header of the primary HDU. We do, however, envisage the use of compressed FITS images. In this case, the header structure discussed here would be found in the header of the second HDU.

2.1 Group 1 – Basic FITS and Array Description Keywords

This group contains the minimal keywords necessary to interpret the HDU's data section as a pixel array.

Keyword	Type	Description
SIMPLE	logical	(FITS Standard) File conforms to FITS Standard.
BITPIX	integer	(FITS Standard) Number of bits per data pixel.
NAXIS	integer	(FITS Standard) Number of data axes.
NAXIS1	integer	(FITS Standard) Length of data axis 1 (number of pixels in a row).
NAXIS2	integer	(FITS Standard) Length of data axis 2 (number of rows).
BSCALE	float	(FITS Standard) Scaling factor to apply to values in the pixel array
BZERO	integer	(FITS Standard) Offset to add to values in the pixel array

For unsigned 16-bit integer data, set BSCALE=1.0 and BZERO=32768.

[1] https://fits.gsfc.nasa.gov/registry/continue_keyword.html

Example
(Array description keywords)

```
SIMPLE  =                    T / file conforms to FITS standard
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                18904 / length of data axis 1
NAXIS2  =                18904 / length of data axis 2
BSCALE  =                  1.0 / physical_value = BZERO + BSCALE * array_value
BZERO   =                32768 / physical_value = BZERO + BSCALE * array_value
```

2.2 Group 2 – Original Data of the Observation

This group captures the original information about the observation, as obtained from observation logbooks or similar sources.

Most of the values in this section are not intended to be (fully) machine-readable. This is partly because we could not hope to give a conclusive and useful vocabulary of, say, filters used over the 100 years astronomical plates were taken in. It is also because most of this information will only be necessary when following an individual plate's provenance; in that case, the information will be consumed by a human anyway.

Even so, data providers are urged to be at least internally consistent with observer names or the designations of filters, instruments, or time systems. Nonetheless, several pieces of metadata important for automatic processing in many interesting use cases are present here, too, for instance, SITELONG, SITELAT, and SITELEV. Their operational importance is also the reason why they are given in decimal degrees (rather than, say, a sexagesimal character string that you will probably find in the historical documents).

Keyword	Type	Description
DATEORIG	string	Original recorded date of the observation (evening date)
TMS-ORIG	string	Original recorded time of the start of the observation
TME-ORIG	string	Original recorded time of the end of the observation.
TIMEFLAG	string	Quality flag of the recorded observation time: 'error', 'missing', 'uncertain'. Do not give for good times.
RA-ORIG	string	Original recorded right ascension of the telescope pointing (plate center)
DEC-ORIG	string	Original recorded declination of the telescope pointing (plate center)
EQ-ORIG	string	Equinox of equatorial coordinates in RA-ORIG and DEC-ORIG
COORFLAG	string	Quality flag of the recorded coordinates (right ascension and declination): 'error', 'missing', 'uncertain'. Do not give for good positions.
OBJECT	string	(FITS Standard) Name of the target object or field of the observations. When the observation had multiple targets, put 'multiple' here and give individual target names in OBJECTn cards.

Keyword	Type	Description
OBJTYPE	string	Target object type (literal text); controlled vocabulary, see below
EXPTIME	float	Exposure time of the first exposure, expressed in seconds
NUMEXP	integer	Number of exposures
DATEORn	string	Original recorded date of the n-th exposure if exposures were made on multiple nights. Not used when all exposures are from one night, given by DATEORIG.
TMS-ORn	string	Original recorded time of the start of the n-th exposure.
TME-ORn	string	Original recorded time of the end of the n-th exposure.
RA-ORn	string	Original right ascension of the telescope pointing during the n-th exposure. Not used if only one pointing was used.
DEC-ORn	string	Original declination of the telescope pointing during the n-th exposure. Not used if only one pointing was used.
OBJECTn	string	Object (field) name on the n-th exposure. Not used if only one object (field) was observed.
OBJTYPn	string	Object type that corresponds to OBJECTn; see OBJTYPE
EXPTIMn	float	Exposure time of the n-th exposure
OBSERVAT	string	Observatory name
SITENAME	string	Observatory site name. Useful if the observatory has more than one observing site.
SITELONG	float	East longitude of the observing site, in decimal degrees
SITELAT	float	Latitude of the observing site, in decimal degrees
SITEELEV	float	Elevation of the observatory site [m]
TELESCOP	string	(FITS Standard) Telescope name
OTA-NAME	string	Free-text designation of the optical tube assembly (OTA)
OTA-DIAM	float	Diameter of the OTA (e.g., primary mirror; different from OTA-APER in instruments like Schmidt telescopes [m]
OTA-APER	float	Clear aperture of the OTA [m]
FOCLEN	float	Focal length of the telescope [m]
PLTSCALE	float	Plate scale of the telescope [arcsec/mm]
INSTRUME	string	(FITS Standard) Instrument name
DETNAM	string	Detector name; rather typcially, 'photographic plate'
METHOD	string	Observation method. See below for values allowed.
FILTER	string	Free text designation of a filter (if used)
PRISM	string	Free text designation on the objective prism (if used)
PRISMANG	string	Angle of the objective prism (format deg:min)
DISPERS	float	Dispersion in objective prism images [Angstrom/mm]
GRATING	string	Free text on the grating (if used)
FOCUS	float	Focus value (from logbook).
FOCUSn	float	Focus value of the n-th exposure; used instead of FOCUS when several exposures with different focus values were made.
TEMPERAT	float	Air temperature from logbook.
CALMNESS	string	Calmness (seeing conditions), scale 1–5
SHARPNES	string	Sharpness (seeing conditions), scale 1–5
TRANSPAR	string	Transparency, scale 1–5
SEEING	string	Quantitative statement on the seeing, typically as an angle (include the unit in that case)
SKYCOND	string	Notes on sky conditions from logbook
OBSERVER	string	(FITS Standard) Observer name
OBSNOTES	string	Observer notes from logbook
NOTES	string	Miscellaneous notes found in the observation logbook.

The notion of the "optical tube assembly" (OTA) is used here because in several cases multiple tubes shared a single mounting; calling each of these tubes a separate "telescope" is not in line with what the word was used for historically. We hence decided to use a new, dedicated term here. Other examples for where this notion helps include diaphragms used to stop down the aperture or instruments with multiple secondaries.

The values in `TMS-ORIG`, `TME-ORIG`, `TMS-ORn`, and `TMS-ORn` should have the format "TZ hh:mm:ss", where TZ denotes the time system. These values should not be transformed from what was taken from the logbook, except when correcting obvious (spelling) mistakes. Historically, all kinds of times were used on observatories, and hence we do not attempt to make time system identifiers properly machine-readable. Still, for local sidereal time, `ST` should be used, for universal time or Greenwhich Mean Time, `UT`. The use of other designations should be explained, e.g., in accompanying documentation and/or FITS comments. Multiple time notations are separated with commas (e.g. 'UT 18:13, ST 02:44'). Again, this data will generally be parsed by humans.

In case of multiple exposures (`NUMEXP` is greater than 1), exposure times of all subexposures are to be given with the `EXPTIMn` keywords. The `EXPTIME` and `EXPTIM1` cards then have the same value. This is different in the (relatively rare) cases of exposures with multiple focus values. For such plates, no `FOCUS` is given but only `FOCUS`n.

`EQ-ORIG` should give the equinox of the coordinates in `RA-ORIG`, `DEC-ORIG`. If given, it must be in years, with a B or J for Besselian or Julian years (as in J2000.0 or B1950.0). A plain floating point value is legal, too, and indicates an unnknown year convention. `RA-OR`n and `DEC-OR`n can be assumed to share `EQ-ORIG`.

When multiple `OBJECT`n and `TMS-OR`n cards are present, the relationship of exposures and target objects is not defined by this specification; it can mean one target object per exposure, multiple exposures of the same set of target objects, or any combination thereof.

`OBJTYPE` and `OBJTYP`n, where present and non-blank, has to contain one of the following values (taken from the WFPDB):

> comet, HII region, planetary nebula, reference star around a radio source, star, moon, field, asteroid, fundamental star , cluster of galaxies, nebula, galaxy, star cluster, planet, double star, sun, QSO, variable star, supernova, group of galaxies

Where present, `METHOD` has to contain one of the following values (again based on WFPDB practices):

> test plate, direct photograph, multiexposure, stellar tracks, sub-beam (Pickering) prism, with mask, objective prism, Hartmann test, out of focus, multiexposure, no guiding, objective grating, direct photograph, Metcalf's method, focusing, raster scan/trail

If a grating has been used, additional freetext should be given in GRATING; this could be text like “Coarse objective grating” (as used for bright-star astrometry or photometry) or “Spectroscopy objective grating” as appropriate.

DETNAME would typcially be the fixed string “photographic plate”, but other media are conceivable, in particular “film”. Please avoid being more specific here and rather do finer-grained descriptions EMULSION or OAT-NAME.

CALMNESS and SHARPNESS would probably both map to a modern seeing value; they were introduced to tell apart “Ruhe” and “Schärfe” that are common in German log books.

For CALMNESS, SHARPNES, and TRANSPAR, a numeric scale of 1-5 is used here, where 1 is best and 5 is worst. These keywords are probably too specific and may be removed in future versions of this document. Use free-text in SKYCOND instead or, where applicable, SEEING.

Example

(Observation data, multiple exposures)

```
EXPTIME =                600.0 / [s] exposure time (of exposure 1)
NUMEXP  =                    3 / number of exposures of the plate
EXPTIM1 =                600.0 / [s] exposure time of exposure 1
EXPTIM2 =                 60.0 / [s] exposure time of exposure 2
EXPTIM3 =                  2.0 / [s] exposure time of exposure 3
```

Example

(Observation data, single exposure)

```
EXPTIME =               1800.0 / [s] exposure time (of exposure 1)
NUMEXP  =                    1 / number of exposures of the plate
```

Example

(Observation data, full header)

```
        -------------------------------------- Original data of the observation
DATEORIG= '1910-08-02'         / recorded date of the observation
TMS-ORIG= 'ST 18:11:16'        / recorded time of the start of the observation
TME-ORIG= '        '           / recorded time of the end of the observation
TIMEFLAG= 'uncertain'          / quality of the recorded time
RA-ORIG = '19:11:42'           / recorded right ascension of telescope pointing
DEC-ORIG= '15:04:00'           / recorded declination of telescope pointing
COORFLAG= 'uncertain'          / quality of the recorded coordinates
OBJECT  = 'SA 87   '           / name of the observed object or field
OBJTYPE = 'field   '           / object type
EXPTIME =               1800.0 / [s] exposure time (of exposure 1)
NUMEXP  =                    1 / number of exposures of the plate
OBSERVAT= 'Astrophysikalische Observatorium Potsdam' / observatory name
SITENAME= 'Potsdam-Telegrafenberg' / observatory site name
SITELONG=            13.064167 / [deg] East longitude of the observatory
```

```
SITELAT =            52.380556 / [deg] latitude of the observatory
SITEELEV=                  107 / [m] elevation of the observatory
TELESCOP= 'Zeiss Triplet'      / telescope name
OTA-NAME= '15-cm camera'       / optical tube assembly (OTA)
OTA-DIAM=                 0.15 / [m] diameter of the OTA
OTA-APER=                 0.15 / [m] clear aperture of the OTA
FOCLEN  =                  1.5 / [m] focal length of the OTA
PLTSCALE=                  137 / [arcsec/mm] plate scale of the OTA
INSTRUME= '        '           / instrument
DETNAM  = 'photographic plate' / detector
METHOD  = 'direct photograph'  / method of observation
FILTER  = 'none    '           / filter type
PRISM   = '        '           / objective prism
PRISMANG= '        '           / prism angle "deg:min"
DISPERS =                      / [Angstrom/mm] dispersion
GRATING = '        '           / grating
FOCUS   =                 32.2 / focus value
TEMPERAT=                 21.8 / [deg C] air temperature (degrees Celsius)
CALMNESS= '2-3     '           / sky calmness (scale 1-5)
SHARPNES= '2       '           / sky sharpness (scale 1-5)
TRANSPAR= '1-2     '           / sky transparency (scale 1-5)
SKYCOND = 'moonlight'          / sky conditions
OBSERVER= 'W. Muench'          / observer name
OBSNOTES= 'bad guiding'        / observer notes
NOTES   = 'SA 87 = Kapteyn Selected Area 87' / miscellaneous notes
```

Example

(Observation data, multiple time systems)

```
        --------------------------------------- Original data of the observation
DATEORIG= '1964-01-02'         / recorded date of the observation
TMS-ORIG= 'UT 18:13, ST 02:44' / recorded time of the start of exposure 1
TME-ORIG= 'UT 19:13, ST 03:44' / recorded time of the end of exposure 1
TIMEFLAG= '        '           / quality of the recorded time
EXPTIME =               3600.0 / [s] exposure time (of exposure 1)
NUMEXP  =                    1 / number of exposures of the plate
```

Example

(Full header for multiple exposures)

```
        --------------------------------------- Original data of the observation
DATEORIG= '1934-04-01'         / recorded date of the observation
TMS-OR1 = 'ST 10:52'           / recorded time of the start of exposure 1
TMS-OR2 = 'ST 10:54'           / recorded time of the start of exposure 2
TMS-OR3 = 'ST 10:57'           / recorded time of the start of exposure 3
TME-OR1 = 'ST 10:53'           / recorded time of the end of exposure 1
TME-OR2 = 'ST 10:56'           / recorded time of the end of exposure 2
TME-OR3 = 'ST 11:01'           / recorded time of the end of exposure 3
TIMEFLAG= '        '           / quality of the recorded time
RA-ORIG = '        '           / recorded right ascension of telescope pointing
DEC-ORIG= '        '           / recorded declination of telescope pointing
```

```
COORFLAG= 'missing '           / quality of the recorded coordinates
OBJECT  = 'RY UMa  '           / name of the observed object or field
OBJTYPE = 'variable star'      / object type
EXPTIME =                 60.0 / [s] exposure time (of exposure 1)
NUMEXP  =                    3 / number of exposures of the plate
EXPTIM1 =                 60.0 / [s] exposure time of exposure 1
EXPTIM2 =                120.0 / [s] exposure time of exposure 2
EXPTIM3 =                240.0 / [s] exposure time of exposure 3
OBSERVAT= 'Astrophysikalische Observatorium Potsdam' / observatory name
SITENAME= 'Potsdam-Telegrafenberg' / observatory site name
SITELONG=            13.064167 / [deg] East longitude of the observatory
SITELAT =            52.380556 / [deg] latitude of the observatory
SITEELEV=                  107 / [m] elevation of the observatory
TELESCOP= 'Zeiss Triplet'      / telescope name
OTA-NAME= '15-cm camera'       / optical tube assembly (OTA)
OTA-DIAM=                 0.15 / [m] diameter of the OTA
OTA-APER=                 0.15 / [m] clear aperture of the OTA
FOCLEN  =                  1.5 / [m] focal length of the OTA
PLTSCALE=                  137 / [arcsec/mm] plate scale of the OTA
INSTRUME= '        '           / instrument
DETNAM  = 'photographic plate' / detector
METHOD  = 'direct photograph, multi-exposure' / method of observation
FILTER  = 'none    '           / filter type
PRISM   = '        '           / objective prism
PRISMANG= '        '           / prism angle "deg:min"
DISPERS =                      / [Angstrom/mm] dispersion
GRATING = '        '           / grating
FOCUS   =                 34.4 / focus value
TEMPERAT=                    8 / [deg C] air temperature (degrees Celsius)
CALMNESS= '        '           / sky calmness (scale 1-5)
SHARPNES= '        '           / sky sharpness (scale 1-5)
TRANSPAR= '        '           / sky transparency (scale 1-5)
SKYCOND = 'clouds  '           / sky conditions
OBSERVER= 'W. Muench'          / observer name
OBSNOTES= 'poor transparency'  / observer notes
NOTES   = '        '           / miscellaneous notes
```

2.3 Group 3 – Information about the Photographic Plate

This group contains information about the physical plate; this includes its size, the emulsion used, and similar pieces of metadata. This group is also where administrative information on the plate management is being kept.

Keyword	Type	Description
PLATENUM	string	Plate number in original observation catalogue
WFPDB-ID	string	Plate identification in the WFPDB
SERIES	string	Series or survey to which the plate belongs, e.g., Carte du Ciel, Kapteyn Selected Areas
PLATESZ1	float	Plate size along axis 1 [cm]
PLATESZ2	float	Plate size along axis 2 [cm]
EMULSION	string	Type of the photographic emulsion
DEVELOP	string	Plate development information (developer, time)
PQUALITY	string	Free text on the quality of the plate
PLATNOTE	string	Other notes about the plate (free text; e.g., on availability or historical relevance)
PRE-PROC	string	Free text on processing of the plate before scanning

Again, most of this information targets humans rather than machines. In particular, computers are not expected to be able to interpret PLATENUM, EMULSION, or PQUALITY. Individual archives should try to be internally consistent in the contents of these fields.

EMULSION may also contain information on whether a plate was backde, baked or otherwise treated to enhance sensitivity.

PLATESZ1 and PLATESZ2 represent the dimensions of the glass carrier (or other medium), not of the sensitive area or of the area scanned. One therefore cannot repliably compute the pixel density of the scan by dividing NAXIS1 by PLATESZ1 (although this will in general yield the right order of magnitude).

Several scanning projects remove markings on the plates before scanning. These should write "plate markings removed" in a PRE-PROC header.

Example
(Plate metadata)

```
        ---------------------------------------------------- Photographic plate
PLATENUM= '317     '           / plate number in original observation catalogue
WFPDB-ID= 'POT015_000317'      / plate identification in the WFPDB
SERIES  = 'Kapteyn Selected Areas' / plate series
PLATEFMT= '20x20   '           / plate format in cm
PLATESZ1=                 20.0 / [cm] plate size along axis 1
PLATESZ2=                 20.0 / [cm] plate size along axis 2
EMULSION= 'Schleussner'        / photographic emulsion type
DEVELOP = '        '           / plate development information
PQUALITY= 'broken  '           / quality of plate
PLATNOTE= 'contact copy of original plate that is not available' / plate notes
```

2.4 Group 4 – Computed Data For the Observation

This group by and large contains data derived from what is given in group 2, only using more modern units, formats, and frames. Machines ought to use the information given here to locate the plate in time and, where WCS is missing, space.

Keyword	Type	Description
DATE-OBS	string	(FITS Standard) UT date and time of the start of the observation (format YYYY-MM-DDThh:mm:ss, or YYYY-MM-DD if time is not specified). The date may differ from DATEORIG, because the original date usually refers to the evening of the observing night.
DT-OBSn	string	UT date and time of the start of the n-th exposure.
DATE-AVG	string	(FITS Standard) UT date and time of the mid-point of the first exposure (format YYYY-MM-DDThh:mm:ss)
DT-AVGn	string	UT date and time of the mid-point of the n-th exposure.
DATE-END	string	UT date and time of the end of the first exposure (format YYYY-MM-DDThh:mm:ss)
DT-ENDn	string	UT date and time of the end of the n-th exposure.
YEAR	float	Decimal year of the start of the first exposure
YEARn	float	Decimal year of the start of the n-th exposure
YEAR-AVG	float	Decimal year of the mid-point of the first exposure
YR-AVGn	float	Decimal year of the mid-point of the n-th exposure
JD	float	Julian date at the start of exposure 1
JDn	float	Julian date at the start of the n-th exposure
JD-AVG	float	Julian date at the mid-point of the first exposure
JD-AVGn	float	Julian date at the mid-point of the n-th exposure.
HJD-AVG	float	Heliocentric Julian date at the mid-point of the first exposure
HJD-AVn	float	Heliocentric Julian date at the mid-point of the n-th exposure.
RA	string	Right ascension of the telescope pointing (ICRS, sexagesimal format h:m:s)
DEC	string	Declination of the telescope pointing (ICRS, sexagesimal format d:m:s)
RAn	string	Right ascension of the telescope pointing, n-th exposure
DECn	string	Declination of the telescope pointing, n-th exposure.
RA_DEG	float	Right ascension of the telescope pointing in decimal degrees (ICRS)
DEC_DEG	float	Declination of the telescope pointing in decimal degrees (ICRS)
RA_DEGn	float	Right ascension of the telescope pointing in decimal degrees, n-th exposure.
DEC_DEn	float	Declination of the telescope pointing in decimal degrees, n-th exposure.

For historical reasons, `RA` and `DEC` are still given sexagesimally. Writers should make sure they also give their decimal equivalents (`RA_DEG`, `DEC_DEG`).

The `HJD-AVG` headers are to be understood as lighttime-corrected universal time for the solar system barycenter. For the other times, no lighttime correction should be applied (the time frame is TOPOCENTER in VO terms). Where we write “UT” here, we mean a reasonable approximation of our modern UT at the time, presumably GMT over most of the time photographic plates were taken. Times given in Ephemeris Time (or perhaps even Terrestial Time) should be converted (though the difference probably rarely matters for the sort of data this specification talks about).

Fractional seconds are allowed on both ISO-like time specifications (DATE-x, DT-x and on sexagesimal positions (RA, RAn, DEC, DECn).

Example

(Computed metadata, single exposure)

```
        --------------------------------------- Computed data of the observation
DATE-OBS= '1910-08-02T22:21:01' / UT date of the start of the observation
DATE-AVG= '1910-08-02T22:36:01' / UT date of the mid-point of exposure 1
DATE-END= '1910-08-02T22:51:01' / UT date of the end of exposure 1
YEAR    =       1910.583561644 / decimal year of the start of exposure 1
YEAR-AVG=       1910.583561644 / decimal year of the mid-point of exposure 1
JD      =       2418886.441678 / Julian date at the start of exposure 1
JD-AVG  =       2418886.441678 / Julian date at the mid-point of exposure 1
HJD-AVG =       2418886.441678 / heliocentric JD at the mid-point of exposure 1
RA      = '19:15:48'           / right ascension of pointing (J2000) "h:m:s"
DEC     = '+15:13:20'          / declination of pointing (J2000) "d:m:s"
RA_DEG  =           288.950000 / [deg] right ascension of pointing (J2000)
DEC_DEG =            15.222222 / [deg] declination of pointing (J2000)
```

Example

(Computed metadata, multiple exposures)

```
        --------------------------------------- Computed data of the observation
DATE-OBS= '1934-01-25T20:36:56' / UT date of the start of exposure 1
DT-OBS1 = '1934-01-25T20:36:56' / UT date of the start of exposure 1
DT-OBS2 = '1934-01-25T20:45:55' / UT date of the start of exposure 2
DT-OBS3 = '1934-01-25T20:55:53' / UT date of the start of exposure 3
DT-OBS4 = '1934-01-25T20:57:53' / UT date of the start of exposure 4
DATE-AVG= '1934-01-25T20:40:56' / UT date of the mid-point of exposure 1
DT-AVG1 = '1934-01-25T20:40:56' / UT date of the mid-point of exposure 1
DT-AVG2 = '1934-01-25T20:48:25' / UT date of the mid-point of exposure 2
DT-AVG3 = '1934-01-25T20:56:23' / UT date of the mid-point of exposure 3
DT-AVG4 = '1934-01-25T20:58:53' / UT date of the mid-point of exposure 4
DATE-END= '1934-01-25T20:44:55' / UT date of the end of exposure 1
DT-END1 = '1934-01-25T20:44:55' / UT date of the end of exposure 1
DT-END2 = '1934-01-25T20:50:54' / UT date of the end of exposure 2
DT-END3 = '1934-01-25T20:56:53' / UT date of the end of exposure 3
DT-END4 = '1934-01-25T20:59:52' / UT date of the end of exposure 4
YEAR    =        1934.06806018 / decimal year of the start of exposure 1
YEAR1   =        1934.06806018 / decimal year of the start of exposure 1
YEAR2   =        1934.06807726 / decimal year of the start of exposure 2
YEAR3   =        1934.06809621 / decimal year of the start of exposure 3
YEAR4   =        1934.06810001 / decimal year of the start of exposure 4
YEAR-AVG=        1934.06806779 / decimal year of the mid-point of exposure 1
```

```
YR-AVG1 =        1934.06806779 / decimal year of the mid-point of exposure 1
YR-AVG2 =        1934.06808202 / decimal year of the mid-point of exposure 2
YR-AVG3 =        1934.06809716 / decimal year of the mid-point of exposure 3
YR-AVG4 =        1934.06810192 / decimal year of the mid-point of exposure 4
JD      =        2427463.35898 / Julian date at the start of exposure 1
JD1     =        2427463.35898 / Julian date at the start of exposure 1
JD2     =        2427463.36522 / Julian date at the start of exposure 2
JD3     =        2427463.37214 / Julian date at the start of exposure 3
JD4     =        2427463.37353 / Julian date at the start of exposure 4
JD-AVG  =        2427463.36176 / Julian date at the mid-point of exposure 1
JD-AVG1 =        2427463.36176 / Julian date at the mid-point of exposure 1
JD-AVG2 =        2427463.36696 / Julian date at the mid-point of exposure 2
JD-AVG3 =        2427463.37249 / Julian date at the mid-point of exposure 3
JD-AVG4 =        2427463.37422 / Julian date at the mid-point of exposure 4
HJD-AVG =                      / heliocentric JD at the mid-point of exposure 1
```

Note that this example does not give a position; this is rather common when, for instance, the exposure was guided on a solar system object.

2.5 Group 5 – Scan Details

This group contains information about the scanning process. Except possibly for `WEDGE`, we do not expect that these headers will be automatically processed by machines.

Keyword	Type	Description
SCANRES1	integer	Scan resolution along axis 1 [dpi]
SCANRES2	integer	Scan resolution along axis 2 [dpi]
PIXSIZE1	float	Pixel size along axis 1 [μm]
PIXSIZE2	float	Pixel size along axis 2 [μm]
SCANSOFT	string	Name of the scanning software
SCANGAM	float	Scan gamma value
SCANFOC	string	Scan focus (e.g., 'glass')
WEDGE	string	Type of photometric step-wedge
DATESCAN	string	Scan date and time (UTC, format "YYYY-MM-DDThh:mm:ss")
SCANAUTH	string	Author of the scan
SCANNOTE	string	Free text notes about the scan (e.g., scan orientation)

By the FITS Standard, the `AUTHOR` and `REFERENCE` keywords are used when the data in the FITS file was compiled from a publication or multiple sources. For digitised photographic plates, these keywords are not appropriate for specifying the author of the scan or acknowledging a funding source. Hence, we add the `SCANAUTH` header with similar semantics as `AUTHOR`, just regarding the scanning process. Acknowledgments (as in `REFERENCE`) would currently go into a comment in group 8.

Example
(Scanning metadata)

```
        ---------------------------------------------- Scan Details
SCANNER = 'Epson Expression 10000XL' / scanner name
SCANRES1=                 2400 / [dpi] scan resolution along axis 1
SCANRES2=                 2400 / [dpi] scan resolution along axis 2
PIXSIZE1=              10.5833 / [um] pixel size along axis 1
PIXSIZE2=              10.5833 / [um] pixel size along axis 2
SCANSOFT= 'VueScan '           / scanning software
SCANGAM =                  1.0 / scan gamma value
SCANFOC = 'glass   '           / scan focus
WEDGE   = 'Danes-Picta TG21S'  / type of photometric step-wedge
DATESCAN= '2011-05-17T08:33:26' / scan date and time
SCANAUTH= 'K. Tsvetkova'       / author of scan
SCANNOTE= 'Plate rotated 90 degrees' / scan notes
```

2.6 Group 6 – Data Files

This group mainly contains references to digital artefacts resulting from the scanning process. The values of these can either be plain file names or, preferably, full URIs. Where plain file names are given, a FITS comment should give further information on where these files might be found.

Keyword	**Type**	**Description**
FILENAME	string	Filename of the plate scan (this file)
PID	string	A permanent identifier for the plate
FN-SCNn	string	Filename of the n-th scan of the same plate
FN-WEDGE	string	Filename of the wedge scan
FN-PRE	string	Filename of a low-resolution scan
FN-COVER	string	Filename of the plate cover (envelope) image
FN-LOGB	string	Filename of the logbook image
FN-NTBn	string	Filename of the n-th notebook image
ORIGIN	string	(FITS Standard) Institute responsible for creating the FITS file
DATE	string	(FITS Standard) Date and time of the last change of the file
SVC-URI	string	A URI of a service that will (probably) serve the file.

FN-PRE does not mean a thumbnail, but a compact, lossy representation – typically, a JPEG image. Within the APPLAUSE project, this low-resolution image was used to document annotations on the plates before they were erased in preparation of the full-resolution scan.

PID should be used if a plate has a permanent identifier of some sort, as for instance a Digital Object Identifier (DOI). Prefer the HTTP URI form (e.g., https://doi.org/10.1876/plate/dr.3s/006_0003) if possible.

While there are no guarantees that any of the artefacts mentioned here can actually be retrieved, operators can give a URI of a networked service that at least at one point has served the data in SVC-URI. This specification does not say anything about what URIs these are (obvious candidates include ftp, http, or Virtual Observatory ivo) or what sort of structure will be found at this URI; for instance, operators might choose to point to their ObsCore (Louys and Tody et al., 2017) service.

Example
(Associated files)

```
        ------------------------------------------------------------ Data files
FILENAME= 'POT015_000317.fits' / filename of the plate scan
FN-SCN1 = 'POT015_000317.fits' / filename of scan 1
FN-WEDGE= 'POT015_000317_w.fits' / filename of the wedge scan
FN-PRE  = 'POT015_000317_pre.jpg' / filename of the preview image
FN-COVER= '        '           / filename of the plate cover image
FN-LOG1 = 'ZT-LB01-000317-000334.jpg' / filename of logbook image 1
ORIGIN  = 'Leibniz-Institut fuer Astrophysik Potsdam (AIP)'
DATE    = '2022-03-01T07:55:13' / last change of this file
```

As stated above, giving a blank values – as in `FN-COVER` in this example – is the less preferred alternative to leaving out a card without a value.

Example
(Associated files, multiple notebook pages)

```
        ------------------------------------------------------------ Data files
FILENAME= 'LA00508_x.fits'     / filename of the plate scan
FN-SCN1 = 'LA00508_y.fits'     / filename of scan 1
FN-SCN2 = 'LA00508_x.fits'     / filename of scan 2
FN-WEDGE= '        '           / filename of the wedge scan
FN-PRE  = 'LA00508_pre.jpg'    / filename of the preview image
FN-COVER= 'LA00508_cover.jpg'  / filename of the plate cover image
FN-LOG1 = 'LA-PV01-LA00501_00510.jpg' / filename of logbook image 1
FN-LOG2 = 'LA-LB04-1916-10-18a.jpg' / filename of logbook image 2
FN-LOG3 = 'LA-LB04-1916-10-18b.jpg' / filename of logbook image 3
FN-LOG4 = 'LA-LB04-1916-10-18c.jpg' / filename of logbook image 4
FN-LOG5 = 'LA-LB04-1916-10-18d.jpg' / filename of logbook image 5
FN-LOG6 = 'LA-LB04-1916-10-18e.jpg' / filename of logbook image 6
FN-LOG7 = 'LA-LB04-1916-10-18f.jpg' / filename of logbook image 7
ORIGIN  = 'Hamburger Sternwarte (Universitaet Hamburg)'
DATE    = '2021-12-14T17:43:44' / last change of this file
SVC-URI = 'ivo://www.plate-archive.org/tap'
```

2.7 Group 7 – World Coordinate System (WCS)

Whenever possible, plate scans should come with a WCS solution as per Calabretta and Greisen (2002). In particular for wide-field plates, we recommend that polynomial (SIP) corrections be included. Approximate WCS solutions based on the observation log are permitted but discouraged.

Example
(WCS)

```
        -------------- World Coordinate System (WCS)
WCSAXES = 2 / number of axes in the WCS description
RADESYS = 'FK5'  / name of the reference frame
EQUINOX = 2000.0 / epoch of the mean equator and equinox in years
CTYPE1 = 'RA-TAN' / TAN (gnomonic) projection
CTYPE2 = 'DEC-TAN' / TAN (gnomonic) projection
CUNIT1 = 'deg' / physical units of CRVAL and CDELT for axis 1
CUNIT2 = 'deg' / physical units of CRVAL and CDELT for axis 2
CRPIX1 = 9452.5 / reference pixel for axis 1
CRPIX2 = 9452.5 / reference pixel for axis 2
CRVAL1 = 288.95 / right ascension at the reference point
CRVAL2 = 15.222222 / declination at the reference point
CD1_1 = -0.0004047524 / transformation matrix
CD1_2 = 0.0 / transformation matrix
CD2_1 = 0.0 / transformation matrix
CD2_2 = 0.0004047524 / transformation matrix
LONPOLE = 0.0 / native longitude of the celestial pole
```

The FITS WCS convention admits up to 27 reductions in a single header. This specification does not require any specific relationship between these reductions and the multiple exposures from group 1, as these may be arbitrarily complex. In case such a relationship can easily be given, use human-readable comments.

2.8 Group 8 – modification history and acknowledgements

The eighth group collects global free-text history and global comments; of course, comments on individual items can be present in other sections, too, and processing software should keep those comment cards in their original places (relative to the header card that follows them) when re-writing a header.

In particular, use comment cards for acknowledgements. None of this is intended to be consumable by machines, except possibly the LICENCE URI.

Keyword	Type	Description
LICENCE	string	A URI pointing to conditions of use. Prefer a URI widely known if possible, and if you use a licence (rather than, say CC0), specify the copyright holder in free text.

Example
(Header Metadata)

```
        ---------------------------------------------------------------- Licence
LICENCE = 'https://creativecommons.org/publicdomain/zero/1.0/'
        ------------------------------------------------------- Acknowledgements
COMMENT The digitized image is provided by Leibniz Institute for Astrophysics
COMMENT Potsdam (AIP). Funding for APPLAUSE has been provided by DFG (German
COMMENT Research Foundation), Leibniz Institute for Astrophysics Potsdam (AIP),
COMMENT Dr. Karl Remeis-Sternwarte, Bamberg (Friedrich-Alexander-Universitaet
COMMENT Erlangen-Nuernberg), Hamburger Sternwarte (Unversity Hamburg) and Tartu
```

```
COMMENT Observatory (University of Tartu). We thank Thueringer Landessternwarte
COMMENT Tautenburg (TLS), Astrophysikalisches Institut und
COMMENT Universitaetsternwarte Jena (University of Jena) and the Vatican
COMMENT Observatory for providing digitized Material for inclusion into the
COMMENT archive.
        ---------------------------------------------------------------- History
HISTORY Header updated with PyPlate v4.0.12 at 2022-03-01T07:53:29
HISTORY WCS added with PyPlate v4.0.12 at 2022-03-01T07:55:13
```

3 Complete sample header

The following example contains many cards without a value, which we are keeping here for completeness. Headers on released data should not include cards with empty values (see sect. 2 on such cards).

```
SIMPLE  =                    T / file conforms to FITS standard
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                18904 / length of data axis 1
NAXIS2  =                18904 / length of data axis 2
EXTEND  =                    T / file may contain extensions
BSCALE  =                  1.0 / physical_value = BZERO + BSCALE * array_value
BZERO   =                32768 / physical_value = BZERO + BSCALE * array_value
MINVAL  =                147.0 / minimum image value
MAXVAL  =              65532.0 / maximum image value
        --------------------------------------- Original data of the observation
DATEORIG= '1910-08-02'         / recorded date of the observation
TMS-ORIG= 'ST 19:52:08'        / recorded time of the start of exposure 1
TME-ORIG= '        '           / recorded time of the end of exposure 1
JDA-ORIG=                      / recorded Julian date, mid-point of exposure 1
TIMEFLAG= '        '           / quality flag of recorded time
RA-ORIG = '19:11:42'           / recorded right ascension of exposure 1
DEC-ORIG= '+15:04  '           / recorded declination of exposure 1
COORFLAG= '        '           / quality flag of recorded coordinates
OBJECT  = 'SA 87   '           / observed object or field (exposure 1)
OBJTYPE = 'field   '           / object type
EXPTIME =               1800.0 / [s] exposure time of exposure 1
NUMEXP  =                    1 / number of exposures of the plate
OBSERVAT= 'Astrophysikalische Observatorium Potsdam' / observatory name
SITENAME= 'Potsdam-Telegrafenberg' / observatory site
SITELONG=             13.06417 / [deg] East longitude of the observatory
SITELAT =             52.38056 / [deg] latitude of the observatory
SITEELEV=                  107 / [m] elevation of the observatory
TELESCOP= 'Zeiss Triplet'      / telescope name
OTA-NAME= '15-cm camera'       / optical tube assembly (OTA)
OTA-DIAM=                 0.15 / [m] diameter of the OTA
OTA-APER=                 0.15 / [m] clear aperture of the OTA
FOCLEN  =                  1.5 / [m] focal length of the OTA
PLTSCALE=                  137 / [arcsec/mm] plate scale of the OTA
INSTRUME= '        '           / instrument
DETNAM  = 'photographic plate' / detector
```

```
METHOD  = 'direct photograph'  / method of observation
FILTER  = 'none    '           / filter type
PRISM   = '        '           / objective prism
PRISMANG= '        '           / prism angle "deg:min"
DISPERS =                      / [Angstrom/mm] dispersion
GRATING = '        '           / grating
FOCUS   =                 32.2 / focus value
TEMPERAT=                 21.8 / [deg C] air temperature (degrees Celsius)
CALMNESS= '2-3     '           / sky calmness (scale 1-5)
SHARPNES= '2       '           / sky sharpness (scale 1-5)
TRANSPAR= '1-2     '           / sky transparency (scale 1-5)
SKYCOND = 'moonlight'          / sky conditions
OBSERVER= 'W. Muench'          / observer name
OBSNOTES= 'bad guiding'        / observer notes
NOTES   = 'SA 87 = Kapteyn Selected Area 87' / miscellaneous notes
BIBCODE = '        '           / bibcode of a related paper
        ---------------------------------------------------- Photographic plate
PLATENUM= '317     '           / plate number in archive
PNUMORIG= '        '           / original plate number in archive
WFPDB-ID= 'POT015_000317'      / plate identification in the WFPDB
SERIES  = 'Kapteyn series'     / plate series
PLATEFMT= '20x20   '           / plate format in cm
PLATESZ1=                   20 / [cm] plate size along axis 1
PLATESZ2=                   20 / [cm] plate size along axis 2
EMULSION= '        '           / photographic emulsion type
DEVELOP = '        '           / plate development details
PQUALITY= '        '           / quality of plate
PLATNOTE= '        '           / plate notes
        -------------------------------------- Computed data of the observation
DATE-OBS= '1910-08-02T22:17:23' / UT date of the start of exposure 1
DATE-AVG= '1910-08-02T22:32:23' / UT date of the mid-point of exposure 1
DATE-END=                      / UT date of the end of exposure 1
YEAR    =        1910.58570496 / decimal year of the start of exposure 1
YEAR-AVG=        1910.58573348 / decimal year of the mid-point of exposure 1
YEAR-END=                      / decimal year of the end of exposure 1
JD      =        2418886.42874 / Julian date at the start of exposure 1
JD-AVG  =        2418886.43916 / Julian date at the mid-point of exposure 1
JD-END  =                      / Julian date at the end of exposure 1
HJD-AVG =        2418886.44361 / heliocentric JD at the mid-point of exposure 1
RA      = '19:15:44.1'         / right ascension of pointing (J2000) "h:m:s"
DEC     = '15:13:29.9'         / declination of pointing (J2000) "d:m:s"
RA_DEG  =             288.9337 / [deg] right ascension of pointing (J2000)
DEC_DEG =               15.225 / [deg] declination of pointing (J2000)
        ------------------------------------------------------------------ Scan
SCANNER = 'Epson Expression 10000XL' / scanner name
SCANRES1=                 2400 / [dpi] scan resolution along axis 1
SCANRES2=                 2400 / [dpi] scan resolution along axis 2
PIXSIZE1=              10.5833 / [um] pixel size along axis 1
PIXSIZE2=              10.5833 / [um] pixel size along axis 2
SCANSOFT= 'VueScan '           / scanning software
SCANGAM =                  1.0 / scan gamma value
SCANFOC = 'glass   '           / scan focus
WEDGE   = 'Danes-Picta TG21S'  / type of photometric step-wedge
```

```
DATESCAN= '2011-05-17T08:33:26' / scan date and time
SCANAUTH= 'K. Tsvetkova'       / author of scan
SCANNOTE= 'Plate rotated 90 degrees' / scan notes
        ------------------------------------------------------------- Data files
FILENAME= 'POT015_000317.fits' / filename of the plate scan
FN-SCN1 = 'POT015_000317.fits' / filename of scan 1
FN-WEDGE= 'POT015_000317_w.fits' / filename of the wedge scan
FN-PRE  = 'POT015_000317_pre.jpg' / filename of the preview image
FN-COVER= '        '           / filename of the plate cover image
FN-LOG1 = 'ZT-LB01-000317-000334.jpg' / filename of logbook image 1
ORIGIN  = 'Leibniz-Institut fuer Astrophysik Potsdam (AIP)'
DATE    = '2022-03-01T07:55:13' / last change of this file
        -------------------------------------------------------------------- WCS
HISTORY   Astrometric solution by SCAMP version 2.10.0 (2021-06-07)
EQUINOX =        2000.00000000 / Mean equinox
RADESYS = 'ICRS    '           / Astrometric system
CTYPE1  = 'RA---TPV'           / WCS projection type for this axis
CTYPE2  = 'DEC--TPV'           / WCS projection type for this axis
CUNIT1  = 'deg     '           / Axis unit
CUNIT2  = 'deg     '           / Axis unit
CRVAL1  =   2.889496876869E+02 / World coordinate on this axis
CRVAL2  =   1.499181176825E+01 / World coordinate on this axis
CRPIX1  =   9.452500000000E+03 / Reference pixel on this axis
CRPIX2  =   9.452500000000E+03 / Reference pixel on this axis
CD1_1   =  -4.036655485153E-04 / Linear projection matrix
CD1_2   =  -3.621686854687E-06 / Linear projection matrix
CD2_1   =  -3.730596479942E-06 / Linear projection matrix
CD2_2   =   4.052335966967E-04 / Linear projection matrix
PV1_0   =   1.819365521161E-04 / Projection distortion parameter
PV1_1   =   1.001005528320E+00 / Projection distortion parameter
PV1_2   =   5.017392310243E-04 / Projection distortion parameter
PV1_4   =  -2.323791286135E-05 / Projection distortion parameter
PV1_5   =  -1.359281566747E-05 / Projection distortion parameter
PV1_6   =   1.638989950374E-05 / Projection distortion parameter
PV1_7   =  -1.356092599012E-04 / Projection distortion parameter
PV1_8   =  -5.900609933445E-06 / Projection distortion parameter
PV1_9   =  -9.583368487198E-05 / Projection distortion parameter
PV1_10  =   5.642839611951E-06 / Projection distortion parameter
PV2_0   =   6.375509204261E-04 / Projection distortion parameter
PV2_1   =   1.002544704064E+00 / Projection distortion parameter
PV2_2   =  -2.878680758084E-05 / Projection distortion parameter
PV2_4   =   6.122481161384E-04 / Projection distortion parameter
PV2_5   =  -5.500999776357E-06 / Projection distortion parameter
PV2_6   =   2.327669386965E-05 / Projection distortion parameter
PV2_7   =   1.570030554563E-04 / Projection distortion parameter
PV2_8   =   4.476899592895E-06 / Projection distortion parameter
PV2_9   =  -9.087182263726E-05 / Projection distortion parameter
PV2_10  =  -2.680250757454E-06 / Projection distortion parameter
FGROUPNO=                    1 / SCAMP field group label
ASTIRMS1=   0.000000000000E+00 / Astrom. dispersion RMS (intern., high S/N)
ASTIRMS2=   0.000000000000E+00 / Astrom. dispersion RMS (intern., high S/N)
ASTRRMS1=   1.139308494906E-04 / Astrom. dispersion RMS (ref., high S/N)
ASTRRMS2=   1.078386077369E-04 / Astrom. dispersion RMS (ref., high S/N)
```

```
ASTINST =                    1 / SCAMP astrometric instrument label
FLXSCALE=   0.000000000000E+00 / SCAMP relative flux scale
MAGZEROP=           0.00000000 / SCAMP zero-point
PHOTIRMS=           0.00000000 / mag dispersion RMS (internal, high S/N)
PHOTINST=                    1 / SCAMP photometric instrument label
PHOTLINK=                    F / True if linked to a photometric field
        ---------------------------------------------------------------- Licence
LICENCE = 'https://creativecommons.org/publicdomain/zero/1.0/'
        ------------------------------------------------------- Acknowledgements
COMMENT The digitized image is provided by Leibniz Institute for Astrophysics
COMMENT Potsdam (AIP). Funding for APPLAUSE has been provided by DFG (German
COMMENT Research Foundation), Leibniz Institute for Astrophysics Potsdam (AIP),
COMMENT Dr. Karl Remeis-Sternwarte, Bamberg (Friedrich-Alexander-Universitaet
COMMENT Erlangen-Nuernberg), Hamburger Sternwarte (Unversity Hamburg) and Tartu
COMMENT Observatory (University of Tartu). We thank Thueringer Landessternwarte
COMMENT Tautenburg (TLS), Astrophysikalisches Institut und
COMMENT Universitaetsternwarte Jena (University of Jena) and the Vatican
COMMENT Observatory for providing digitized Material for inclusion into the
COMMENT archive.
        ---------------------------------------------------------------- History
HISTORY Header updated with PyPlate v4.0.12 at 2022-03-01T07:53:29
HISTORY WCS added with PyPlate v4.0.12 at 2022-03-01T07:55:13
        -------------------------------------------------------------- Checksums
CHECKSUM= 'EUWaGSUXESUaESUU'   / HDU checksum updated 2022-03-01T08:55:18
DATASUM = '2591757796'         / data unit checksum updated 2022-03-01T08:55:18
        ------------------------------------------------------------------------
```

A Changes from Previous Versions

A.1 Changes from APPLAUSE's Header List

The following changes versus the header list at https://www.plate-archive.org/applause/wiki/fits-header-format-dr2/ were made during an informal review phase leading up to version 1.0 of the IVOA Note.

- New header EQ-ORIG for giving the equinox of the coordinates.
- DETNAM is now explicitly allowed to be something other than "photographic plate".
- New header SEEING, sort-of deprecating CALMNESS, SHARPNES, and TRANSPAR.
- New header PRE-PROC for indicating scrubbing of plates or the like.
- New header PID.
- New header SVC-URI to associate network services with the file names.
- New header LICENCE

- Renamed TELx headers to OTAx headers in order to clarify that it is not just the tube this is about.
- Removed diffs to "paper 1" (i.e., Kirov et al), which at this point are irrelevant.
- Updated example to what is actually in use in Applause DR4.

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