WFCAM FITS Header Specification

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Data from WFCAM will be written initially in Starlink's internal HDS format. A copy of the header specification in that particular format is available for download at the following: http://www.ast.cam.ac.uk/~wfcam/docs/headers_1p1.doc. This note takes the header specified in that paper and demonstrates how the information will be divided up between the primary and extension header units. Broadly speaking the general information about the observation is all put into the primary header, whereas information specific to a particular detector is put in each detector's extension header.

Below are three example headers which demonstrate what raw WFCAM file headers should look like:

Primary Header Unit of a WFCAM frame:

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                    8 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
TELESCOP= 'UKIRT              ' / Telescope name
INSTRUME= 'WFCAM              ' / Instrument
DHSVER  = 'UKDHS 2002 Oct 31 ' / Data handling version
HDTFILE = 'wfcam.hdt          ' / Name of hdt file
OBSERVER= 'Daffy Duck         ' / Observers names
USERID  = 'DD       '          / Userid logged in as
OBSREF  = 'notPATT99'          / PATT or other reference
PROJECT = 'Example WFCAM data' / Time-allocation code
SURVEY  = 'Example WFCAM survey' / Survey Name
SURVEY_I= 'A pointing'         / Pointing ID within survey
MSBID   = 'b44d9b4e3b90e6f99b7c3a032301600b' / Id min.-schedulable block
OBJECT  = 'SGC_009D'           / Object name from telescope
RECIPE  = 'TEST_WFCAM_CIRSI '  / Data reduction recipe to be used
OBSTYPE = 'OBJECT  '           / Type (BIAS|DARK|ARC|FLAT|OBJECT|SKY)
OBSNUM  =                 6719 / Observation number
GRPNUM  =                 6715 / Group number applied to all members
GRPMEM  =                    T / Group membership
TILENUM =                 6700 / Tile number applied to all members
STANDARD=                    F / Is the target a standard star observation?
NJITTER =                    5 / Number of positions in tel pattern
JITTER_I=                    5 / Serial number in this tel jitter pattern
JITTER_X=                  15. / [arcsec] X (RA) offset in tel jitter pattern
JITTER_Y=                  15. / [arcsec] Y (Dec) offset in tel jitter pattern
NUSTEP  =                    1 / Number of positions in microstep pattern
USTEP_I =                    1 / Serial number in this microstep pattern
USTEP_X =                 0.00 / [arcsec] X (RA) offset in microstep pattern
USTEP_Y =                 0.00 / [arcsec] Y (Dec) offset in microstep pattern
NFOC    =                    0 / Number of positions in focus scan
NFOCSCAN=                    0 / Number of focus scans in focus test
FOC_I   =                    0 / Serial number in focus scan
FOC_OFF =                0.000 / [mm] Offset from base focus position
FOC_MM  =               2.4992 / [mm] Focus position
UTDATE  = '20010608'           / UT date as integer in yyyymmdd format
UTSTART =             5.397500 / [h] Start time of integration
UTEND   =             5.404167 / [h] End time of integration
DATE-OBS= '2001-06-08T05:23:51Z' / Date and time (UTC) of start of observation
DATE-END= '2001-06-08T05:24:15Z' / Date and time (UTC) of end of observation
MJD-OBS =          52932.60040 / DATE-OBS as Modified Julian Date
WCSAXES =                    2 / Number of axes in world co-ordinate system
```

```
RADESYS = 'FK5     '           / Mean IAU 1984 equatorial co-ordinates
EQUINOX =             2000.000 / [yr] Equinox of object position
RABASE  =             22.25301 / [h] Right ascension of base position
DECBASE =           0.06174444 / [deg] Declination of base position
TRAOFF  =                0.000 / [arcsec] Right ascension telescope offset
TDECOFF =                0.000 / [arcsec] Declination telescope offset
AMSTART =                1.312 / Airmass at start of observation
AMEND   =                1.310 / Airmass at end of observation
TELRA   =             22.25328 / [h] Current telescope right ascension
TELDEC  =               0.0659 / [deg] Current telescope declination
GSRA    =             22.25301 / [h] Right ascension of guide star
GSDEC   =           0.06174444 / [deg] Declination of guide star
EXP_TIME=                24.02 / [s] Integration time per exposure
NEXP    =                    1 / Number of exposures in integration
READINT =             0.300000 / [s] Interval between reads
NREADS  =                    0 / Number of reads per exposure
NINT    =                    1 / Number of integrations in observation
FILTER  = 'J       '           / Combined filter name
AIRTEMP =               -0.013 / [degC] Air temperature
BARPRESS=              650.000 / Ambient pressure
DEWPOINT=                2.000 / [degC] Dewpoint
DOMETEMP=                1.101 / [degC] Dome temperature
HUMIDITY=               45.816 / Relative Humidity
MIRRBSW =                7.123 / [degC] Temperature mirror B SW
MIRRNE  =                7.124 / [degC] Mirror temperature NE
MIRRNW  =                7.124 / [degC] Mirror temperature NW
MIRRSE  =                7.124 / [degC] Mirror temperature SE
MIRRSW  =                7.124 / [degC] Mirror temperature SW
MIRRBTNW=                7.128 / [degC] Mirror bottom temp. NW
MIRRTPNW=                7.128 / [degC] Mirror top temp. NW
SECONDAR=                7.133 / [degC] Temperature of secondary
TOPAIRNW=                7.134 / [degC] Top air NW
TRUSSENE=                3.286 / [degC] Truss leg ENE
TRUSSWSW=                2.048 / [degC] Truss leg WSW
WIND_DIR=              265.958 / [deg] Wind direction, azimuth
WIND_SPD=               48.915 / [km/h] Wind speed
CSOTAU  =                0.047 / Tau at 225 GHz from CSO
TAUDATE = '2001-11-30T04:07'   / Time and date opf Tau reading
TAUSRC  = 'CSO     '           /Source of opacity data
CNFINDEX=                    1 / Configuration index
END
```

Image extension in a standard WFCAM FITS container file

```
XTENSION= 'IMAGE   '           / IMAGE extension
BITPIX  =                  -32 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                 2048 / length of data axis 1
NAXIS2  =                 2048 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
INHERIT =                    T / Inherit primary header keywords
CTYPE1  = 'RA---ZPN'           / Algorithm type for axis 1
CTYPE2  = 'DEC--ZPN'           / Algorithm type for axis 2
CRPIX1  =               1000.0 / [pixel] Reference pixel along axis 1 (RA)
CRPIX2  =              -1000.0 / [pixel] Reference pixel along axis 2 (Dec)
CRVAL1  =            300.16419 / [deg] Right ascension at the reference pixel
CRVAL2  =           29.9749447 / [deg] Declination at the reference pixel
CRUNIT1 = 'deg     '           / Unit of right ascension co-ordinates
CRUNIT2 = 'deg     '           / Unit of declination co-ordinates
CD1_1   =         0.000000E+00 / Transformation matrix element
CD1_2   =         1.262008E-04 / Transformation matrix elemen
CD2_1   =         1.262008E-04 / Transformation matrix elemen
CD2_2   =         0.000000E+00 / Transformation matrix element
PV2_1   =         1.000000E+00 / Pol.coeff. for pixel -> celestial coord
PV2_2   =         0.000000E+00 / Pol.coeff. for pixel -> celestial coord
PV2_3   =         2.200000E+02 / Pol.coeff. for pixel -> celestial coord
CAMNUM  =                    1 / Number of WFCAM array
DETECTOR= 'RSC Hawaii 2'       / Detector array used
DETECTID= 'a.bc.123'           / Serial number of detector array
```

```
DROWS   =                 2048 / [pixel] Number of detector rows
DCOLUMNS=                 2048 / [pixel] Number of detector columns
RDOUT_X1=                    1 / Start column of array readout
RDOUT_X2=                 2048 / Start column of array readout
RDOUT_Y1=                    1 / Start row    of array readout
RDOUT_Y2=                 2048 / Start row    of array readout
PIXLSIZE=               0.4000 / [arcsec] Pixel size
HDTFILE2= 'wfcam_w.hdt        ' / Name of camera specific hdt file
PCSYSID = 'wfacq1  '            / PC system identifier
SDSUID  = '00222   '            / Serial number of SDSU controller
READMODE= 'CDS     '            / Name of camera readmode
CAPPLICN= 'do_mean_wfcam_cds'   / Name of camera readout application
CAMROLE = 'master  '            / Camera role (master|slave|unsync)
READOUT = 'CDS     '            / Camera readout (CDS|NDR|SAR|RRR)
GAIN    =                 3.171 / [electrons/ADU] Detector gain
DET_TEMP=                  25.0 / [K] Detector array temperature
END
```

Rice-tile compressed image extension in standard WFCAM FITS container file

```
XTENSION= 'BINTABLE'            / binary table extension
BITPIX  =                    8 / 8-bit bytes
NAXIS   =                    2 / 2-dimensional binary table
NAXIS1  =                   32 / width of table in bytes
NAXIS2  =                 1024 / number of rows in table
PCOUNT  =               847006 / size of special data area
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    4 / number of fields in each row
TTYPE1  = 'COMPRESSED_DATA'     / label for field   1
TFORM1  = '1PB(899)'            / data format of field: variable length array
TTYPE2  = 'UNCOMPRESSED_DATA'   / label for field   2
TFORM2  = '1PE(0)  '            / data format of field: variable length array
TTYPE3  = 'ZSCALE  '            / label for field   3
TFORM3  = '1D      '            / data format of field: 8-byte DOUBLE
TTYPE4  = 'ZZERO   '            / label for field   4
TFORM4  = '1D      '            / data format of field: 8-byte DOUBLE
EXTNAME = 'COMPRESSED_IMAGE'    / name of this binary table extension
ZIMAGE  =                    T / extension contains compressed image
ZBITPIX =                  -32 / data type of original image
ZNAXIS  =                    2 / dimension of original image
ZNAXIS1 =                 1024 / length of original image axis
ZNAXIS2 =                 1024 / length of original image axis
ZTILE1  =                 1024 / size of tiles to be compressed
ZTILE2  =                    1 / size of tiles to be compressed
ZCMPTYPE= 'RICE_1  '            / compression algorithm
ZNAME1  = 'BLOCKSIZE'           / compression block size
ZVAL1   =                   32 / pixels per block
ZNAME2  = 'NOISEBIT'            / floating point quantization level
ZVAL2   =                    4 / floating point quantization level
INHERIT =                    T / Inherit primary header keywords
CTYPE1  = 'RA---ZPN'            / Algorithm type for axis 1
CTYPE2  = 'DEC--ZPN'            / Algorithm type for axis 2
CRPIX1  =               1000.0 / [pixel] Reference pixel along axis 1 (RA)
CRPIX2  =              -1000.0 / [pixel] Reference pixel along axis 2 (Dec)
CRVAL1  =            300.16419 / [deg] Right ascension at the reference pixel
CRVAL2  =           29.9749447 / [deg] Declination at the reference pixel
CRUNIT1 = 'deg     '            / Unit of right ascension co-ordinates
CRUNIT2 = 'deg     '            / Unit of declination co-ordinates
CD1_1   =         0.000000E+00 / Transformation matrix element
CD1_2   =         1.262008E-04 / Transformation matrix elemen
CD2_1   =         1.262008E-04 / Transformation matrix elemen
CD2_2   =         0.000000E+00 / Transformation matrix element
PV2_1   =         1.000000E+00 / Pol.coeff. for pixel -> celestial coord
PV2_2   =         0.000000E+00 / Pol.coeff. for pixel -> celestial coord
PV2_3   =         2.200000E+02 / Pol.coeff. for pixel -> celestial coord
CAMNUM  =                    1 / Number of WFCAM array
DETECTOR= 'RSC Hawaii 2'        / Detector array used
DETECTID= 'a.bc.123'            / Serial number of detector array
DROWS   =                 2048 / [pixel] Number of detector rows
```

```
DCOLUMNS=                 2048 / [pixel] Number of detector columns
RDOUT_X1=                    1 / Start column of array readout
RDOUT_X2=                 2048 / Start column of array readout
RDOUT_Y1=                    1 / Start row    of array readout
RDOUT_Y2=                 2048 / Start row    of array readout
PIXLSIZE=               0.4000 / [arcsec] Pixel size
HDTFILE2= 'wfcam_w.hdt        ' / Name of camera specific hdt file
PCSYSID = 'wfacq1  '            / PC system identifier
SDSUID  = '00222   '            / Serial number of SDSU controller
READMODE= 'CDS     '            / Name of camera readmode
CAPPLICN= 'do_mean_wfcam_cds'   / Name of camera readout application
CAMROLE = 'master  '            / Camera role (master|slave|unsync)
READOUT = 'CDS     '            / Camera readout (CDS|NDR|SAR|RRR)
GAIN    =                 3.171 / [electrons/ADU] Detector gain
DET_TEMP=                  25.0 / [K] Detector array temperature
END
```

When the time comes to ship data to ESO a number of items will be added. These are the minimal requirements for the ESO archive system to accept the header. As all of these items are of a general nature, they will all be added to the primary headers unit.

```
HIERARCH ESO DPR CATG        = 'SCIENCE'    / Observation category
HIERARCH ESO DPR TYPE        = 'OBJECT'     / Observation type
HIERARCH ESO DPR TECH        = 'IMAGE'      / Observation technique
HIERARCH ESO OBS PROG ID     = '90.A-1234(A)' / ESO programme ID
HIERARCH ESO OBS ID          =      0 / Observation block ID
HIERARCH ESO TEL AIRM START  =  1.312 / Airmass at start
HIERARCH ESO TEL AIRM END    =  1.310 / Airmass at end
HIERARCH ESO TEL ALT         = 12.345 / Alt at start (deg)
HIERARCH ESO TEL AZ          = 45.678 / Az at start (deg) S=0,W=90
```

With the exception of the ESO programme ID and the Observation block ID, all of these can be derived from information already in the primary header. The programme and observation ID items will have to be assigned using some agreeed values between Cambridge and ESO.