ESO SCIENCE DATA PRODUCTS STANDARD

Doc. No. GEN-SPE-ESO-33000-5335, Issue 5

Addendum

Date: 16/02/2016

Gran Telescopio CANARIAS Data Products

The purpose of this section is to characterise fully reduced images and spectra taken with the Gran Telescopio CANARIAS (GTC) using the instruments OSIRIS and CanariCam. In particular, it is addressed to the data providers, especially to the ESO PIs whose Large Programmes were carried out at GTC, who, accordingly to the ESO policies stating that Phase 3 is mandatory for Large Programmes, have to prepare and submit reduced products to the ESO Archive.

List of approved ESO/GTC Large Programmes

- Programme 182.B-2005 Alonso-Herrero et al.
- Programme 182.C-2018 Sing et al.
- Programme 184.A-2018 Perez-Gonzalez et al.
- Programme 184.C-2004 Snellen et al.
- Programme 184.A-2005 Miley et al.
- Programme 186.A-2012 Sánchez-Portal et al.
- Programme 186.D-2013 Clementini et al.
- Programme 188.A-2022 Aragon-Salamanca et al.
- Programme 189.D-2007 Kotak et al.

Data Types

Images and 1d spectra are the primary data products. Other type of ancillary data products may be optionally associated. The keyword PRODCATG defines the data product category:

PRODCATG	**Description**
SCIENCE.IMAGE	Single image stored in the primary HDU
SCIENCE.SPECTRUM	Single target one-dimensional spectrum and is associated data. In the 1D spectrum binary table format (one primary header and a single extension containing the data).

The modes listed in Table 2 are covered in this document. To be noted that the following modes of CanariCam are not supported: polarimetry, spectropolarimetry and cronography.

In general, the rules defining data format and metadata for the different categories of data products illustrated in the SDPS (especially for generic images, sect. 3.1, 1-d spectra, sect. 4 and catalogues sect. 5) apply to GTC reduced data as well.

Table 1: FITS keyword definitions.

Type	Keyword	Description
(S)	ORIGIN	Observatory or facility where the data were originally obtained (not where data processing was done). In this case: `ORIGIN  = 'GRANTECAN'  / Facility`
(S)	TELESCOP	Telescope designation: `TELESCOP= 'GTC '  / Telescope name`

(S)	INSTRUME	`INSTRUME= 'OSIRIS '  / Instrument name`
		or
		`INSTRUME= 'CANARICAM'  / Instrument name`

(L)	NOESODAT	To indicate that the product includes non-ESO data `NOESODAT=  T  / Includes non-ESO data`
(S)	PROG_ID PROGID*i*	The identification code assigned to each observing run by the ESO Observing Programme Committee (OPC) in the format *PPP.C-NNNN(R)*. If more than one the value shall be PTOG_ID='MULTI' and the individual programme IDs shall be stored in keywords PROGID*i*, where *i* is an integer index between 1 and 99, with no leading zeros. In addition to this keywords the use of GTCPRGID and GTCOBID to be adopted from the original data, is recommended.
(L)	MULTI_OB	TRUE if resulting from a combination of multiple observation blocks. This flag indicates that the data product includes observations obtained in more than one observation block.
(I)	NCOMBINE	Number of raw science data files that were combined to generate this data product. Calibration data files do not contribute to this count.
(S)	OBSTECH	Technique used during the observation. Refer to Table 2 to have indications about the values that this keyword can assume.
(R)	WAVELMIN WAVELMAX	Electromagnetic wave band coverage in terms of the wavelength interval in units of nanometers (nm). These keywords are mandatory for OSIRIS imaging products taken in narrow band (tunable filters) mode and for the spectral products.
Specific for imaging		
(S)	FILTER	Filter name. It applies only to imaging products. It must be dropped from the headers of spectroscopic products, or it can be renamed to OFILTER.
(R)	PHOTZP	Photometric zeropoint that relates the pixel data to total magnitudes (MAG) according to

		MAG=-2.5*log(data)+PHOTZP Together with this it is also recommended to indicate the (1 sigma) uncertainty of the photometric zeropoint in the keyword PHOTZPER.
Specific for spectra		
(S)	DISPELEM	The name of the main dispersive element. For OSIRIS it shall be set to the GRISM identifier (ex. 'R1000R') while for CanariCam to the GRATING (ex. 'LowRes-10').

Not applicable keywords

The keywords OBIDi and PROVi, specific to data taken with ESO telescopes for which the raw frames are also archived in the ESO Science Archive Facility, do not apply to GTC data.

Table 2: Examples of values for the keyword OBSTECH.

Instrument	**Mode**		**OBSTECH**
OSIRIS	Imaging	Broad band (SDSS filters) Narrow band (Tunable filters) Medium band (SHARDS filters)	'IMAGE' 'IMAGE,FABRY-PEROT' 'IMAGE'
	Spectroscopy	Long slit	'SPECTRUM'
CanariCam	Imaging		'IMAGE,CHOPNOD' 'IMAGE,NODDING' 'IMAGE,CHOPPING' 'IMAGE,STARE'
	Spectroscopy		'SPECTRUM,CHOPNOD' 'SPECTRUM,NODDING' 'SPECTRUM,CHOPPING' 'SPECTRUM,STARE'

Table 3: Sample FITS header of a OSIRIS Broad Band Image.

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                  -32 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  954 / Axis length
NAXIS2  =                 1960 / Axis length
EXTEND  =                    T / FITS dataset may contain extensions
BUNIT   = 'ADU'                / Physical unit of array values
```

```
ORIGIN  = 'GRANTECAN'          / Facility
DATE    = '2015-01-22T15:27:20'/ file creation date (YYYY-MM-DDThh:mm:ss UT)
TELESCOP= 'GTC'                / Telescope
INSTRUME= 'OSIRIS   '          / Instrument name
NOESODAT=                    T / Includes non-ESO data
FILTER  = 'i_SDSS'             / Filter name
OBJECT  = 'GRB130528A-ri'      / Target designation
RA      =           140.851866 / [deg] Image centre RA (J2000)
DEC     =            -30.39136 / [deg] Image centre DEC (J2000)
EQUINOX =                2000. / Standard FK5
RADECSYS= 'FK5     '           / Coordinate system
EXPTIME =                 100. / Total integration time per pixel (s)
TEPXTIME=                 100. / Total integration time of all exposures (s)
MJD-OBS =         56444.099242 / Start of observations
MJD-END =         56444.100399 / End of observations
PROG_ID = '182.C-2018(A)'      / ESO programme identification code
MULTI_OB=                    F / TRUE if resulting from multiple observations
OBSTECH = 'IMAGE   '           / Technique of observation
PRODCATG= 'SCIENCE.IMAGE'      / Data product category
FLUXCAL = 'ABSOLUTE'           / Type of flux calibration
CTYPE1  = 'RA---TAN'           / R.A. in tangent plane projection
CTYPE2  = 'DEC--TAN'           / DEC. in tangent plane projection
CD1_1   = -7.0655555555555E-05 / Transformation matrix element
CD1_2   =                   0. / Transformation matrix element
CD2_1   =                   0. / Transformation matrix element
CD2_2   = 7.06555555555555E-05 / Transformation matrix element
CRPIX1  = -630.5               / Ref pix of axis 1
CRPIX2  = 946.                 / Ref pix of axis 2
CRVAL1  = 140.851592113002     / RA at Ref pix in decimal degrees
CRVAL2  = 87.3008277672256     / DEC at Ref pix in decimal degrees
PHOTZP  = 28.891               / Photometric zeropoint MAG=-2.5*log(data)+PHOTZP
PHOTSYS = 'AB'                 / Photometric system VEGA or AB
PSW_FWHM= 0.571                / Spatial resolution (arcsec)
ABMAGLIM= 24.356               / 5-sigma limiting AB mag for point sources
ABMAGSAT= 15.720               / Saturation limit for point sources (AB mag)
PROCSOFT= 'Gemini IRAF package v1.13.1' / Data reduction software/version n.
REFERENC= '2014A&A…569A..93J'  / Bibliographic reference
CHECKSUM= 'DEWbDDTZDDTaDDTY'   / HDU checksum
DATASUM = '         0'         / Data unit checksum
END
```

Table 4: Sample FITS header of a OSIRIS long slit spectrum.

```
SIMPLE  =                    T / conforms to FITS standard
BITPIX  =                    8 / Number of bits per data pixel
NAXIS   =                    0 / Number of data axes
EXTEND  =                    T / Extensions may be present
ORIGIN  = 'GRANTECAN'            / Facility
DATE    = '2014-01-21T12:59:24'  / Date FITS file was generated
TELESCOP= 'GTC '                 / Telescope
INSTRUME= 'OSIRIS '              / Instrument Name
NOESODAT=                    T / Includes non-ESO data
DISPELEM= 'R1000B '              / GRISM identifier
SPECSYS = 'TOPOCENT'             / Reference frame for spectral coordinates
OBJECT  = 'M2549 30mx4'          / Name of the object observed
EXT_OBJ =                    T / TRUE if extended
RA      = 9.1921336778457        / [deg] Spectroscopic target position (J2000.0)
DEC     = 42.1139717981329       / [deg] Spectroscopic target position (J2000.0)
EQUINOX = 2000.                  / Standard FK5 (years)
RADECSYS= 'FK5 '                 / Equatorial coordinate system
EXPTIME = 1800.                  / Exposure Time in seconds
TEXPTIME= 1800.                  / Total integration time of all exposures (s)
MJD-OBS =            56575.86861 / Start of observations (days)
MJD-END =            56576.10039 / End of observations (days)
PROG_ID = '180.C-0045(A)'        / ESO programme identification code
MULTI_OB=                    F / TRUE if resulting from multiple observations
OBSTECH = 'SPECTRUM'             / Technique of observation
PRODCATG= 'SCIENCE.SPECTRUM'     / Data product category
FLUXCAL = 'ABSOLUTE'             / Type of flux calibration
CONTNORM=                   F / TRUE if normalised to the continuum
WAVELMIN= 362.899008           / [nm] Minimum wavelength
WAVELMAX= 787.560337           / [nm] Maximum wavelength
SPEC_BIN= 0.19                 / [nm] Wavelength bin size
TOT_FLUX=                   F / TRUE if all source flux is captured
FLUXERR = -2.                  / Uncertainty in flux scale (%)
PROCSOFT= 'Gemini IRAF package v1.13.1' / Data reduction software/version n.
REFERENC= '2015A&A…580L..15P'   / Bibliographic reference
SNR     = 2.955     / Average signal to noise ratio per pixel
SPEC_RES= 1018.                / Reference spectral resolving power
NCOMBINE= 4                    / No. of combined raw science frames
CHECKSUM= '3048vtyb3DCVdeF982w'
DATASUM = 0
END

===> xtension 1
XTENSION= 'BINTABLE'             / binary table extension
```

```
BITPIX  = 8                     / array data type
NAXIS   = 3                     / number of array dimensions
NAXIS1  = 16392                 / number of bytes per row
NAXIS2  = 1                     / number of rows
PCOUNT  = 0                     / number of group parameters
GCOUNT  = 1                     / number of groups
VOCLASS ='SPECTRUM V2.0'        / VO Data Model
VOPUB   = 'ESO/SAF'             / VO Publishing Authority
TITLE   = 'M2549_30mx4_Osiris_LSS_2007-12' / Dataset title
OBJECT  = 'M2549 30mx4'         / Name of the object observed
RA      = 9.1921336778457       / [deg] Spectroscopic target position (J2000.0)
DEC     = 42.1139717981329      / [deg] Spectroscopic target position (J2000.0)
APERTURE= 0.000222              / [deg] Aperture diameter
TELAPSE = 1842.111              / [s] Total elapsed time
TMID    = 56575.9845            / [d] MJD mid exposure
SPEC_VAL= 545.5                 / [nm] Mean wavelength
SPEC_BW = 387.0                 / [nm] Bandpass width = Wmax - Wmin
TFIELDS = 3                     / number of table fields
NELEM   = 2049                  / Length of the data array
TTYPE1  = 'WAVE '               / Label for field 1
TUTYP1  = 'spec:Data.SpectralAxis.Value' / IVOA data model element for field
TFORM1  = '2049E '              / Data format of field 1
TUNIT1  = 'Angstrom'            / Physical unit of field 1
TUCD1   = 'em.wl'               / UCD for field 1
TTYPE2  = 'FLUX '               / Label for field 2
TUTYP2  = 'spec:Data.FluxAxis.Value' / IVOA data model element for field 2
TFORM2  = '2049E '               / Data format of field 2
TUNIT2  = 'erg/cm2/s/Angstrom'    / Physical unit of field 2
TUCD2   = 'phot.flux.density;em.wl;src.net;meta.main' / UCD for field 2
TTYPE3  = 'ERR '                 / Label for field 3
TUTYP3  = 'spec:Data.FluxAxis.Accuracy.StatError' / IVOA data model element
TFORM3  = '2049E'                / Data format of field 3
TUNIT3  = 'erg/cm2/s/Angstrom'    / Physical unit of field 3
TUCD3   = 'stat.error;phot.flux.density;meta.main' / UCD for field 3
TDMIN1  = 3628.9900878906         / [Angstrom] Min Value for Wavelength
TDMAX1  = 7875.603369140699       / [Angstrom] Max Value for Wavelength
TDMIN2  = -3.4141710211100E-18    / [erg/cm2/s/Angstrom] Min Value for Flux
TDMAX2  = 1.16298513042610E-15    / [erg/cm2/s/Angstrom] Max Value for Flux
EXTNAME = 'SPECTRUM'              / Extension name
CHECKSUM= '3287rbGYSUdh738TTg8r'
DATASUM = '34876582954873'
END
```