	Document #	Date Effective	Status
Large Synoptic Survey Telescope	**LCA-10140-C**		V5
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Document Title

Specification for FITS Images from Electro-Optical Tests

1. Change History Log

Revision	Effective Date	Description of Changes
A	October 3, 2013	Revised order of subdirectories to place 'final' at the top; introduce 'research' and 'sandbox' directories Changed sensorData to CCD in the specification of directory paths for compatibility with Job Harness/LIMS conventions Extended the specification of the directory paths to include LIMS job ID (for Job Harness-controlled tasks) and the test version Revised sensor ID to be of form NNN-MM instead of NNN-MMM, because MMM will never be >99 in any given year (encoded in NNN) Defined complete set of values of <test type> for the directory paths and for the TESTTYPE header keyword
B	April 11, 2014	Converted the definitions of the TEST_COND and CCD_COND extensions to be (empty) image extensions rather than (empty) binary table extensions. Both now also have CHECKSUM and DATASUM keywords
C	June 26, 2015	Explicitly names all allowed values of TESTTYPE and IMGTYPE keywords (and their corresponding versions in the file names), and their allowed combinations; includes new PERSISTENCE test type, generalizes the <sensor id> component of the file names

2. Contents

3. Scope

This document describes the naming, organization, and formats of the FITS files from LSST sensor acceptance tests. The definitions of other data products related to sensor testing (as inputs or as analysis products) will be described elsewhere.

4. Introduction

Prototype CCD image sensors for the LSST camera are being evaluated at a number of sites, and production sensors will of course need to be closely studied as well. The specifications in this document are to ensure portability of the image data products across sites, to provide a well-defined common interface for the analysis scripts, and to facilitate curation of the sensor test data.

Sensor image files will be used for any of a variety of analyses, depending on the set-up of the test stands, including Flat Field Exposures, Pocket-Pumping Exposures, Dark Integrations, Fe-55 X-ray Exposures, Wavelength Scan, Superflat Images, Spot Imaging Exposures, Readout System Noise Images, and Readout System Crosstalk Images.

The format specifications of the corresponding image files are very similar but some tests have test-specific keywords.

5. File Naming and Directory Structure

Considerations of human readability, data curation, and automated processing motivate specification of conventions for naming and organization of the image files.

5.1. File Names

5.1.1. Electro-optical sensor test data

The file names for a given sensor, test type, and processing step shall be of the form

`<sensor id>_<test type>_<image type>_<seq. info>_<time stamp>.fits`

`<sensor id>` has the form `E2V-CCD250-NNN` for E2V sensors and `ITL-3800C-NNNN` for ITL sensors, where the digits `N` are the vendor-assigned serial numbers. Note that the separator is a hyphen rather than an underscore character, to facilitate automated parsing of the file names.

`<test type>` is one of `dark`, `fe55`, `flat`, `lambda`, `persistence`, `spot`, `sflat_nnn` [where `nnn` is the wavelength in nm], or `trap`

`<image type>` is one of `bias`, `dark`, `fe55`, `flat`, `spot`, `ppump`

For reference, below are the combinations of <test type> and <image type> produced by the electro-optical test measurements.

<test type>	**<image type>**

dark	bias, dark
fe55	bias, fe55
flat	flat
lambda	bias, flat
persistence	bias, dark, flat
spot	bias, spot
sflat_nnn	flat
trap	bias, flat, ppump

<seq. info> is normally a 3-digit sequence number such as 000, 001, 002. Photon Transfer Curve data (pairs of flats) shall have exposure times and flat1/flat2 designators, e.g., 0010.0s_flat1

<time stamp> is a string of the form YYYYMMDDHHMMSS recording the year, month, day, hour, minute, and second (UTC) of the start of the data acquisition for the image. **For VST images <time stamp> is replaced with the image tag string.**

With this naming convention the longest file names (for pairs of flats) will be 50 characters.

5.2. Directory Structure

5.2.1. Research data to be mirrored to SLAC

For mirroring (data transfer) between institutions and for registration in the Data Catalog at SLAC, image data specific to individual sensors shall be organized in subdirectories according to

research/<institution>/CCD/<sensor id>/<test type>/<version of test>/<date stamp or LIMS/eTraveler job ID>

Image data for tests that are **not sensor specific** (e.g., readout system noise) are to be stored in subdirectories according to

research/<institution>/system/<test type>/<version of test>/<date stamp or LIMS job ID>

where **<institution>** is one of bnl, harvard, lpnhe, ~~penn~~, ucd and **<date stamp>** is of the form **YYMMDD-HHMMSS**, with no deeper levels of directory nesting. The **version of test** string is expected to represent the version of the test script. For tasks controlled by the Job Harness it is the job version string. The **LIMS/eTraveler job ID** is assigned by LIMS/eTraveler and will be used for sensor acceptance testing at BNL and LPNHE.

It is to be understood that data in these directories are to be mirrored and curated.

VST-related files are assumed here to be in an entirely different directory tree not specified here.

5.2.2. Final (production) sensor acceptance test data to be mirrored to SLAC

For mirroring (data transfer) between institutions and for registration in the Data Catalog at SLAC, image data specific to the acceptance testing of individual sensors shall be organized in subdirectories according to

production/<institution>/CCD/<sensor id>/<test type>/<version of test>/<LIMS/eTraveler job ID>

Image data for tests that are **not sensor specific** (e.g., readout system noise) are to be stored in subdirectories according to

production/<institution>/system/<test type>/<version of test>/<LIMS/eTraveler job ID>

where **<institution>** is `bnl` or `lpnhe`.

with no deeper levels of directory nesting. It is to be understood that data in these directories are to be mirrored and curated.

5.2.3. Data to be stored locally

The individual test sites will of course store all data taken locally, and decide what files to write or copy to the directory hierarchy above for mirroring to SLAC and sharing with other sites. It is **recommended** local data be stored in a hierarchy as for the **research/** data but with the top-level directory named sandbox/. Data in the **sandbox/** subdirectories will not be mirrored.

5.2.4. Example directory trees

Here is a hypothetical example of the directory tree for BNL Fe55 data for sensor 112-01 (although of course, sensor 112-01 is not a production sensor):

production/bnl/CCD/E2V-CCD250-009/fe55/v1/

research/bnl/CCD/E2V-CCD250-009/fe55/v1/20160103-172044

research/bnl/CCD/E2V-CCD250-009/fe55/v1/20160103-145522

Here is a hypothetical example of the directory tree for a readout system noise measurement from BNL:

final/bnl/system/noise/

research/bnl/system/teststand/noise/20160322-062314

6. Internal File Organization

The image files are multiple-extension FITS files with basic (not site-specific) information in the primary header, then 16 image extensions (one per segment), followed by test condition, CCD operating condition, and site-specific extension(s). For the latter, examples are given here but are not formally part of the specification. **N.B.:** The analysis scripts should not depend on information in the site-specific extensions.

6.1. Primary Header

Here is an example primary header.

Table 1. Primary FITS Header Keywords and Values

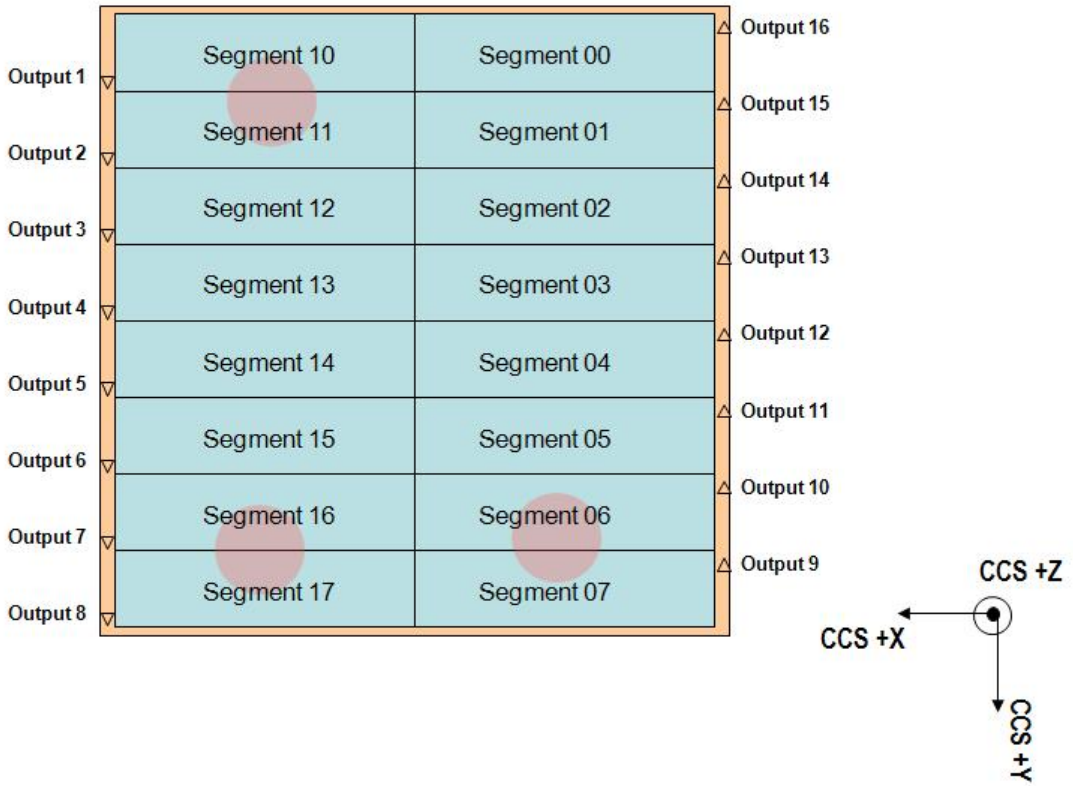
Keyword	Example Value	Data Type	Units	Comment
SIMPLE	T	Boolean		

BITPIX	8			
NAXIS	0	Integer		
EXTEND	T	Boolean		
ORIGIN	BNL	String		Which site acquired the data; allowed values: BNL, HARVARD, UCD, LPHNE.
DATE	'2012-12-05T14:27:25.644'	String		Creation Date and Time of File
DATE-OBS	'2012-12-05T14:27:15.976'	String		Date of the observation (image acquisition), UTC
MJD-OBS	56266.60226	Float		Modified Julian Date (5 decimal places) of image acquisition
IMAGETAG	‘[lots of digits]’	String		Image tag (CCS/VST)
TSTAND	BNL1	String		Which Test stand at the site was used; allowed values BNL1, BNL2, HARVARD, UCD
INSTRUME	SAO4	String		CCD Controller type: SAO4, SAO16, STA,or LSST (this list is not exclusive)
CONTROLL	SAO4	String		Duplicates INSTRUME
CONTNUM	3	Integer		CCD Controller Serial Number
CCD_MANU	E2V **-or-** ITL	String		CCD Manufacturer: either E2V or ITL
CCD_TYPE	CCD250 **-or-** 3800C	String		CCD Model Number
CCD_SERN	009 **-or-** 0009	String		Manufacturer’s CCD Serial Number; the 4-digit form is for ITL
LSST_NUM	E2V-CCD250-009 **-or-** ITL-3800C-0009	String		LSST Assigned CCD Number: Combination of CCD Manufacturer, Model Number, and Manufacturer’s Serial Number
TESTTYPE	FLAT	String		Allowed values: DARK, FE55, FLAT, LAMBDA, PERSISTENCE, SPOT, SFLAT_nnn [where nnn is the wavelength in nm], TRAP. These correspond to the allowed values of <test type> in the file names and directory paths
IMGTYPE	‘FLAT’	String		BIAS, DARK, FE55, FLAT, PPUMP, SPOT
SEQNUM	123	Integer		Sequence number extracted from the original filename
TEMP_SET	-95.00	Float	deg C	Temperature set point
CCDTEMP	-95.12	Float	deg C	Measured temperature
MONDIODE	143.12	Float	nA	Current in the monitoring diode
MONOWL	550.00	Float	nm	Monochromator wavelength
FILTER	‘550LP’	String		Name of the filter
EXPTIME	10.00	Float	Seconds	Exposure Time in Seconds
SHUT_DEL	100.00	Float	msec	Delay between shutter close command and readout
CTLRCFG	‘abcde.xml’	String		Name of the CCD controller configuration file. For this to be useful, the file names must be different for each configuration modification. May instead be a database index value

FILENAME	[Original name of the file]	String		Original name of the file
DETSIZE	'[1:4096,1:4044]'			NOAO MOSAIC keywords
BINX	1	Integer	pixels	Binning along X axis
BINY	1	Integer	pixels	Binning along Y axis
HEADVER	1	Integer		Version number of header
CCDGAIN	5.52	Float	e-/DN	Estimate of overall system gain
CCDNOISE	6	Float	e- rms	Rough guess at system noise
CHECKSUM				Checksum for entire HDU
DATASUM				Checksum for data portion of HDU
END				

6.2. Image Extensions

See "LSST CCD Electro-Optical Acceptance Testing" (LCA-10103) for specification of the numbering of the amplifier segments and their mapping to the extensions. The figure below is copied from that document. **The arrangement of output nodes illustrated is specific to e2V sensors; this relates to the values of the NOAO Mosaic keywords in the example headers below. The segments are ordered by Output number and named according to their (octal) Segment numbers.**



Here is an example header for an image extension. It includes the specific NOAO Mosaic keyword values that define the relation between the segment (including prescan/overscan regions) and the overall image for the sensor. These keyword values are specific to each segment, and example headers with the exact values for each of the segments **for e2V sensors** and an assumed pre-scan region are included in

the last section of this document. The only other keywords not required by a FITS convention are CHANNEL (segment number), AVERAGE, and STDEV.

Table 2. FITS Header for an Image Extension (e2V Mosaic Keywords) [Not completely updated]

```
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment10'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    1 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'    /
DETSEC  = '[512:1,1:2002]'     /
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -3574.00 /
LTV2    =              0.00000 /
DTV1    =             -3574.00 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =             -3584.00 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
```

6.3. Test Condition Extension

These describe the CCD controller settings, the lamp settings, temperature controller settings, anything that reasonably can be common between sites **but that does not need to be in the primary header (although duplications of primary header contents are allowed if convenient).**

Table 3. FITS Header for the Test Condition Extension

Keyword	Example Value	Data Type	Units	Comment
XTENSION	'IMAGE '			IMAGE is followed by three blank spaces. N.B. The extension does not contain any image data.
BITPIX	8			
NAXIS	2			
NAXIS1	0			Width of table in bytes
NAXIS2	0			Number of rows in table

PCOUNT	0			Size of special data area
GCOUNT	1			One data group
EXTNAME	TEST_COND	String		Name of the extension
TEMP_SET	-95.00	Float	~~deg~~ C	Temperature set point
CCDTEMP	-95.12	Float	~~deg~~ C	Measured temperature
ROOMTEMP	25.3	Float	C	Room Temperature
DWRTEMP	25.4	Float	C	External Dewar Temperature
DWRPRESS	4.50E-05	Float	Torr	Dewar internal pressure level
SRCTYPE	QTH	String		Type of light source used
SRCMODL	66892	String		Manufacturer's Model number
SRCPWR	200	Float	Watts	Light source power
ND_FILT	ND3	String	Opt. Density	ND Filter after lamp (if any)
FILTER	550LP	String	Filter Desc.	Optical Filter used
MONOTYPE	Newport	String		
MONOMODL	66883	String		Monochromator model number
MONOPOS	1	Integer		Monochromator grating turret position
MONOGRAT	1200	Integer	lines per inch	Monochromator grating in use
MONOWL	550.00	Float	nanometers	Monochromator WL setting
PD_MODEL	'H9876'	String		Monitor Photodiode model number
PD_SER	'OD1234'	String		Monitor Photodiode serial number
CHECKSUM				
DATASUM				

6.4. CCD Operating Conditions

These describe the voltages and currents that define the operating conditions of the CCD.

Table 4. FITS Header for CCD Operating Conditions

Keyword	Example Value	Data Type	Units	Comment
XTENSION	'IMAGE '			IMAGE is followed by 3 blank spaces. N.B. the extension does not contain any data
BITPIX	8			
NAXIS	2			
NAXIS1	0			
NAXIS2	0			
PCOUNT	0			Size of special data area
GCOUNT	1			One data group
EXTNAME	CCD_COND	String		Name of the extension
V_OD1	30.00	Float	Volts	
V_OD2	30.00	Float	Volts	
V_OD3	30.00	Float	Volts	
V_OD4	30.00	Float	Volts	
V_OD5	30.00	Float	Volts	
V_OD6	30.00	Float	Volts	
V_OD7	30.00	Float	Volts	

V_OD8	30.00	Float	Volts
V_OD9	30.00	Float	Volts
V_OD10	30.00	Float	Volts
V_OD11	30.00	Float	Volts
V_OD12	30.00	Float	Volts
V_OD13	30.00	Float	Volts
V_OD14	30.00	Float	Volts
V_OD15	30.00	Float	Volts
V_OD16	30.00	Float	Volts
V_RD1	18.00	Float	Volts
V_RD2	18.00	Float	Volts
V_RD3	18.00	Float	Volts
V_RD4	18.00	Float	Volts
V_RD5	18.00	Float	Volts
V_RD6	18.00	Float	Volts
V_RD7	18.00	Float	Volts
V_RD8	18.00	Float	Volts
V_RD9	18.00	Float	Volts
V_RD10	18.00	Float	Volts
V_RD11	18.00	Float	Volts
V_RD12	18.00	Float	Volts
V_RD13	18.00	Float	Volts
V_RD14	18.00	Float	Volts
V_RD15	18.00	Float	Volts
V_RD16	18.00	Float	Volts
V_OG1	3.00	Float	Volts
V_OG2	3.00	Float	Volts
V_OG3	3.00	Float	Volts
V_OG4	3.00	Float	Volts
V_OG5	3.00	Float	Volts
V_OG6	3.00	Float	Volts
V_OG7	3.00	Float	Volts
V_OG8	3.00	Float	Volts
V_OG9	3.00	Float	Volts
V_OG10	3.00	Float	Volts
V_OG11	3.00	Float	Volts
V_OG12	3.00	Float	Volts
V_OG13	3.00	Float	Volts
V_OG14	3.00	Float	Volts
V_OG15	3.00	Float	Volts
V_OG16	3.00	Float	Volts
V_S1L	0.00	Float	Volts
V_S1H	9.50	Float	Volts
V_S2L	0.00	Float	Volts
V_S2H	9.50	Float	Volts
V_S3L	0.00	Float	Volts
V_S3H	9.50	Float	Volts
V_RGL	0.00	Float	Volts
V_RGH	12.00	Float	Volts
V_P1L	0.00	Float	Volts
V_P1H	8.00	Float	Volts

V_P2L	0.00	Float	Volts	
V_P2H	8.00	Float	Volts	
V_P3L	0.00	Float	Volts	
V_P3H	8.00	Float	Volts	
V_P4L	0.00	Float	Volts	
V_P4H	8.00	Float	Volts	
V_GD	30.00	Float	Volts	
V_BSS	-70.00	Float	Volts	
I_OD1	2500.00	Float	uA	If not measured, then guess?
I_OD2	2500.00	Float	uA	ditto
I_OD3	2500.00	Float	uA	ditto
I_OD4	2500.00	Float	uA	ditto
I_OD5	2500.00	Float	uA	ditto
I_OD6	2500.00	Float	uA	ditto
I_OD7	2500.00	Float	uA	ditto
I_OD8	2500.00	Float	uA	ditto
I_OD9	2500.00	Float	uA	ditto
I_OD10	2500.00	Float	uA	ditto
I_OD11	2500.00	Float	uA	ditto
I_OD12	2500.00	Float	uA	ditto
I_OD13	2500.00	Float	uA	ditto
I_OD14	2500.00	Float	uA	ditto
I_OD15	2500.00	Float	uA	ditto
I_OD16	2500.00	Float	uA	ditto
I_RD1	10.00	Float	uA	ditto
I_RD2	10.00	Float	uA	ditto
I_RD3	10.00	Float	uA	ditto
I_RD4	10.00	Float	uA	ditto
I_RD5	10.00	Float	uA	ditto
I_RD6	10.00	Float	uA	ditto
I_RD7	10.00	Float	uA	ditto
I_RD8	10.00	Float	uA	ditto
I_RD9	10.00	Float	uA	ditto
I_RD10	10.00	Float	uA	ditto
I_RD11	10.00	Float	uA	ditto
I_RD12	10.00	Float	uA	ditto
I_RD13	10.00	Float	uA	ditto
I_RD14	10.00	Float	uA	ditto
I_RD15	10.00	Float	uA	ditto
I_RD16	10.00	Float	uA	ditto
I_OG1	0.00	Float	uA	ditto
I_OG2	0.00	Float	uA	ditto
I_OG3	0.00	Float	uA	ditto
I_OG4	0.00	Float	uA	ditto
I_OG5	0.00	Float	uA	ditto
I_OG6	0.00	Float	uA	ditto
I_OG7	0.00	Float	uA	ditto
I_OG8	0.00	Float	uA	ditto
I_OG9	0.00	Float	uA	ditto
I_OG10	0.00	Float	uA	ditto

I_OG11	0.00	Float	uA	ditto
I_OG12	0.00	Float	uA	ditto
I_OG13	0.00	Float	uA	ditto
I_OG14	0.00	Float	uA	ditto
I_OG15	0.00	Float	uA	ditto
I_OG16	0.00	Float	uA	ditto
I_GD	5.40E-02	Float	uA	ditto
I_BSS	1.02E-02	Float	uA	Measured Value
CHECKSUM				
DATASUM				

6.5. Site-Specific Extensions

These could be anything, and subject to change. Files could have more than one such extension. This document does not define the contents of these extensions. The only requirement imposed here is that they do not contain information needed by the electro-optical test scripts

6.6. Coordinate Transformation Parameters for the Image Extensions

Many of the keywords in the image extensions define the relation between the amplifier (segment) and sensor pixel coordinate systems, using the NOAO conventions for mosaicked CCD images. These transformations define the overscan regions and how the segment images map into the overall image for the sensor, including possible coordinate inversions, so the specific values are different for each image segment but they can be defined in advance. Here are example headers for each image segment, with the correct transformation parameters for each.

Table 5. Example Headers for Each Image Extension (e2V Mosaic Keywords)

```
Image extension # 1
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment10'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    1 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[512:1,1:2002]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -3574.00 /
LTV2    =              0.00000 /
DTV1    =             -3574.00 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =              0.00000 /
```

```
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension # 2
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment11'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    2 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[1024:513,1:2002]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -3062.00 /
LTV2    =              0.00000 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =             -3072.00 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension # 3
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment12'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    3 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[1536:1025,1:2002]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -2550.00 /
LTV2    =              0.00000 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
```

```
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =             -2560.00 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension # 4
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment13'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    4 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[2048:1537,1:2002]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -2038.00 /
LTV2    =              0.00000 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =             -2048.00 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension # 5
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment14'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    5 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[2560:2049,1:2002]'
```

```
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -1526.00 /
LTV2    =              0.00000 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =             -1536.00 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension # 6
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment15'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    6 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[3072:2561,1:2002]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -1014.00 /
LTV2    =              0.00000 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =             -1024.00 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension # 7
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment16'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
```

```
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    7 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[3584:3073,1:2002]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =             -502.000 /
LTV2    =              0.00000 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =             -512.000 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension # 8
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment17'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    8 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[4096:3585,1:2002]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              10.0000 /
LTV2    =              0.00000 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =              1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =              1.00000 /
ATV1    =              0.00000 /
ATV2    =              0.00000 /
ATM1_1  =              1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =              1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------
```

```
Image extension # 9
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment07'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                    9 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[3585:4096,4004:2003]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              523.000 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              513.000 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension #10
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment06'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                   10 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[3073:3584,4004:2003]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              1035.00 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              1025.00 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
```

```
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension #11
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment05'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                   11 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[2561:3072,4004:2003]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              1547.00 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              1537.00 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension #12
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment04'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                   12 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[2049:2560,4004:2003]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              2059.00 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
```

```
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              2049.00 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension #13
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment03'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                   13 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[1537:2048,4004:2003]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              2571.00 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              2561.00 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension #14
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment02'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                   14 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[1025:1536,4004:2003]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
```

```
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              3083.00 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              3073.00 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension #15
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment01'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
BSCALE  =                    1 /
CHANNEL =                   15 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[513:1024,4004:2003]'
BIASSEC = '[523:544,1:2002]'   / serial overscan region
GAIN    =                    4 / backfilled from Fe55 analysis
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              3595.00 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              3585.00 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
------------------------------

Image extension #16
XTENSION= 'IMAGE   '           / IMAGE extension
EXTNAME = 'Segment00'          /
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                  542 / length of data axis 1
NAXIS2  =                 2022 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BZERO   =                32768 /
```

```
BSCALE  =                    1 /
CHANNEL =                   16 / channel number
AVERAGE =              12345.7 /
STDEV   =              6789.01 /
DATASEC = '[11:522,1:2002]'
DETSEC  = '[1:512,4004:2003]'
CCDSUM  = '1 1     '           / CCD binning
LTV1    =              4107.00 /
LTV2    =              4005.00 /
DTV1    =              0.00000 /
DTV2    =              0.00000 /
DTM1_1  =              1.00000 /
DTM1_2  =              0.00000 /
DTM2_1  =              0.00000 /
DTM2_2  =              1.00000 /
LTM1_1  =             -1.00000 /
LTM1_2  =              0.00000 /
LTM2_1  =              0.00000 /
LTM2_2  =             -1.00000 /
ATV1    =              4097.00 /
ATV2    =              4005.00 /
ATM1_1  =             -1.00000 /
ATM1_2  =              0.00000 /
ATM2_1  =              0.00000 /
ATM2_2  =             -1.00000 /
CHECKSUM= 'VVdCWTZ9VTbCVTZ9'   /
DATASUM = '2189405276'         /
END
```