Metadata Definition for EUI

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Disclaimer: none of the present content has been discussed & approved by the EUI consortium. This is merely a draft of pending issues.

The Solar Orbiter-wide metadata are described in SOL-SGS-TN-0009_MetadataStandard_2.4.
The present document provides a description of the EUI-specific metadata on top of the Solar Orbiter ones.

Filename convention

Following the guidelines in Updated Proposal for Filename Convention (09/12/2014):

- The third field (descriptor) has the following structure:
  eui-<telescope><filter>-<producttype>, where <telescope> can be either “fsi”, “hrieuv”, or “hrilya”, <producttype> can be either “image”, “image-led”, “image-dark”, “image-occulter”, “image-short”, “histogram”, “statistics” or “list” (deadpix is an example of a list; note that EUI thumbnails will NOT be sent to the ground), and <filter> is described in the tables below:

Filter	Description
174	For either one of the two possible 174 filters
304	For either one of the two possible 304 filters
blk	For either one of the four possible blocking positions
###	For any other filter position in between the options above

Allowed values of <filter> for fsi.

Filter	Description
174	For either one of the two possible 174 filters
opn	For the open filter wheel position
blk	For the blocking position
zer	For the two zero position
###	For any other filter position in between the options above

Allowed values of <filter> for hrieuv.

Filter	Description
1216	The HRI Ly-α telescope does not have a filter wheel and only has one wavelength

Allowed values of <filter> for hrilya.

In the higher level data products (>=L3) one could have data products like “jhelio” or “annotated”.

- a raw (L0) EUI/HRI174 image from an imaging sequence operating at 10 Hz that makes use of the free field (see next bullet) could look like

solo_L0_eui-hrieuv174-image_20201108T121230899_V01_F11234.fits

- we may make use of the free format field F to uniquely identify source images: all filenames originating from the same image onboard can be traced back by doing "ls */solo*F11234.fits"

EUI specific FITS keywords

Unless specified, any keyword that is provided in Level n, will also be provided in all Levels m > n.

Level 0 and 1 FITS files should be untouched after the depacketizer, so they will be 12 bit DN values 0-4095 (TBC). Level 2 and higher FITS pixel values will be floats (this can include NaN values, but we will avoid those by always filling in missing pix values). If a user wants to know which pixels are bad, he can consult the bad pixel map.

Pixel values in level 2 and higher FITS files will be normalized over time (TBC).

Mechanisms

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
DOOREXT	'open'	external (heat shield) door position	'open', 'closed'	string	external (heat shield) door position	O	L1
DOORINT	'open'	internal (EUI) door position, from housekeeping	'open', 'closed', 'occulter' (only FSI), 'launch lock' (perhaps)	string	internal (EUI) door position, from housekeeping	O	L1

DOORPOS	0	raw value of the internal door position	FSI: 0=probably closed 22=occulter 34=probably open other=probably intermediate HRI EUV: 0=probably closed 34=probably open other=probably intermediate HRI Lya: 0=probably closed 26=probably open other=probably intermediate (real open/close status comes in the door sensor parameter)	unsigned 1 byte integer	raw value of the internal door position	O	L0

HRI EUV specific

The "FILTER" keyword is an optional Solar Orbiter keyword. Here we list its valid range for HRI EUV.

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
FILTER	'Aluminium_174_1'	Physical HRI EUV filter that was employed when the image was acquired	'Zero', 'Aluminium_174_1', 'Blocked', 'Zero_redundant', 'Aluminium_174_2', 'None/open', 'Unknown'	string	Physical HRI EUV filter that was employed when the image was acquired. Note the relationship to FILTPOS, which indicates the exact position of the filter wheel.	O	L1

FILTPOS	0	Filter position of HRI EUV filter wheel	0-199	Unsigned integer	Filter position of HRI EUV filter wheel. 0='zero_1'; 24='Aluminium_174_1'; 74='blocked'; 100='zero_2'; 124='Aluminium_174_2'; 174='none'; 200='undetermined' are the actual filter positions in FILTER keyword.	O	L1
FILCPOS	1	Commanded Filter position of HRI EUV filter wheel	0-255	Unsigned integer	Filter position of HRI EUV filter wheel. The HRI EUV filter wheel is currently not commanded by science tables, the expected value is 0.	O	L0

HRI Lyman alpha specific

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
LYAIMCP	1.09940E-05	[A] measured MCP current	TBD	real	[A] measured current high voltage Micro Channel Plate HRI Lyman alpha	O	L1

LYAVMCP	600	[V] measured MCP voltage	TBD	real	[V] measured high voltage Micro Channel Plate HRI Lyman alpha	O	L1
LYAVSCR	4000	[V] measured MCP+screen voltage	TBD	real	[V] measured high voltage MCP+screen HRI Lyman alpha	O	L1
LYACMCP	600	[V] commanded MCP voltage	TBD	real	[V] commanded high voltage Micro Channel Plate HRI Lyman alpha	O	L0
LYACSCR	4000	[V] commanded screen voltage	TBD	real	[V] commanded high voltage screen HRI Lyman alpha	O	L0

FSI specific

The "FILTER" keyword is an optional Solar Orbiter keyword. Here we list its valid range for FSI.

Technically speaking, the FSI filters are Al/Mg/Al and Al/Zr/Al sandwiches, but Zirconium and Magnesium are good denominations for operations.

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level

FILTER	‘Magnesium_304_n4’	Physical FSI filter that was employed when the image was acquired	‘Magnesium_304_n4’, ‘Zirconium_174_n25’, ‘Magnesium_304_n26’, ‘Zirconium_174_n13’, ‘blocked’, ‘undetermined’	string	Physical FSI filter that was employed when the image was acquired. Note the relationship to FILTPOS, which indicates the exact position of the filter wheel	O	L1
FILTPOS	0	Filter position of FSI filter wheel	0-199	Unsigned integer	Filter position of FSI filter wheel. 0 = Magnesium_304_n4 50 = Zirconium_174_n25 100 = Magnesium_304_n26 150 = Zirconium_174_n13 25,75,125,175 = blocked other value = undetermined are the actual filter positions in FILTER keyword.	O	L1

FILCPOS	1	Commanded Filter position of HRI EUV filter wheel	0-255	Unsigned integer	Commanded filter position of FSI	O	L0

Front End Electronics

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Typ	Level
DETGAINL	0.80	commanded multiplication factor for the low gain channel	0 to 16	real	The detector gain value (factor) that is commanded and sent to the FEE to determine the output level of the low gain channel. Onboard calibration maps will depend on this value	O	L1

DETGAINH	4.67	commanded multiplication factor for the high gain channel	0 to 16	real	The detector gain value (factor) that is commanded and sent to the FEE to determine the output level of the high gain channel. Onboard calibration maps will depend on this value	O	L1
GAINCOMB	'combined'	commanded low/high gain combination	'combined', 'both', 'other'	string	The data is thresholded in the FEE to choose either the high or low gain pixel value. Combined: The default (threshold) algorithm for combining low and high gain is applied. Normally corresponds to READOUTM = 4 and DOWNLOAM = 0. Both: two images are created: one containing the low gain image and one containing the high gain image. Normally corresponds to READOUTM = 2 and DOWNLOAM = 2. Other: another combination of readout mode (READOUTM) and download mode (DOWNLOAM) is employed.	O	L1

READOUTM	4	Commanded FEE readout mode	0-5	integer	Commanded FEE readout mode. 0=no data stored; 1=no data stored, continuous readout; 2=high and low gains stored; 3=high and low gains stored, continuous readout; 4=threshold gain stored; 5=threshold gain stored, continuous readout.	O	L1
DOWNLOAM	0	Commanded FEE download mode	0-2	integer	Commanded FEE download mode. 0=data already thresholded; 1=high or low gain (threshold); 2=all memory content.	O	L1
GAINTHRE	3900	commanded threshold value for high/low gain pixel value	0 to 2**12-1	integer	The data is thresholded in the FEE to choose either the high or low gain pixel value: pixel value <= GAINTHRE then we choose HG, else we choose LG. Remark: 0 => LG only , 2**12 => HG only.	O	L1
LEDVALUE	1057	commanded CEB-controlled LED current	0 to 2^12-1	integer	current shared between the LEDs in LEDSELEC	O	L1
LEDSELEC	7	commanded CEB-controlled LED selection	0 to 16	integer	determines which entrance filter and/or filter wheel LEDs are selected	O	L1

LEDCONTR	'000110'	commanded configuration calibration LED MAIN and LED Red in telescopes FSI, EUV, LYA	string of characters, each one representing a bit (0/1)	string	calibration LED MAIN and LED Red in telescopes FSI, EUV, LYA	O	L1
LEDSTATE		LEDCONTR for current telescope	'all off', 'main on', 'red on'	string	status calibration LED MAIN and LED Red in current telescope	O	L1

Detector

The "DETECTOR" keyword is a Solar Orbiter keyword. Here we list its valid values for EUI.

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
DETECTOR	'FSI'	Instrument subunit or sensor	'FSI', 'HRI_EUV', 'HRI_LYA'	string	To specify the subunit/sensor, e.g. 'FSI', 'HRI_EUV', 'HRI_LYA' for EUI, 'VL', 'UV' for Metis, ... to be defined by instrument teams and used consistently.	O	L1,2
TEMP1DET	240	[K] Last measured APS detector temperature before date-avg		real	[K] Last measured APS detector temperature before date-avg	O	L1

TEMP2DET	240	[K] Earliest measured APS detector temperature after date-avg		real	[K] Earliest measured APS detector temperature after date-avg	O	L1
TTEMP1	20201108T121230899	time corresponding to TEMP1DET measuremen		ISO8601 w/o Z	time corresponding to TEMP1DET measurement	O	L1
TTEMP2	20201108T121256827	time corresponding to TEMP2DET measuremen		ISO8601 w/o Z	time corresponding to TEMP2DET measurement	O	L1
TEMPINT	240	[K] internal APS detector temperature		real	[K] internal APS detector temperature (requires calibration)	O	L1

CEB pixel preprocessing

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
GAOFSTAT	'both'	status of the CEB gain and offset correction	'none', 'both'	string	status of the CEB gain and offset correction	O	L0

GAINHG	1024	global gain correction register in the high gain channel	0 to 4095	integer	Each global value is 12bits positive with a range of 0 to 4095 equating to a gain correction of 0.0000 to 15.996, with a step of 0.0039 per bit	O	L1
GAINLG	1024	global gain correction register in the low gain channel	0 to 4095	integer	Each global value is 12bits positive with a range of 0 to 4095 equating to a gain correction of 0.0000 to 15.996, with a step of 0.0039 per bit	O	L1
OFFSETHG	-50	[DN] global offset correction register in the high gain channel	-128 to 127	integer	[DN] offset value that is subtracted from incoming pixels that are 8bits with a range of -128 to +127	O	L1
OFFSETLG	-50	[DN] global offset correction register in the low gain channel	-128 to 127	integer	[DN] offset value that is subtracted from incoming pixels that are 8bits with a range of -128 to +127	O	L1
BADPXREM	‘on’	commanded bad pixel removal on or off	'on', 'off'	string	This keyword describes the state of the bad pixel removal: either on or off.	O	L1

BADPXDEF	50	commanded bad pixel default value	0-4095	unsigned integer	This keyword describes the bad pixel default value for bad pixel removal (employed for bad pixels on the border of a line).	O	L1
CRREM	'on'	cosmic ray removal on or off	'on', 'off'	string	This keyword describes the state of the cosmic ray removal: either on or off	O	L1

CRREMLIM	2.00000	[1 Gaussian sigma (in DN)] Limit for cosmic ray removal	0 to 16-1/256	real	A ‘range’ value is determined by taking from the list of 9 sorted values the 3rd and 7th values and calculating range= (value7- value3)/2. This value is then multiplied by a twelve bit value, programmed by software into a register, and the result is called the 'scaled range value'. The multiplication is fractional where the least significant eight bits give 1/256 increments. The above value provides the number of Gaussian sigmas above which outliers are removed.	O	L1

Compression

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
RECSTATE	‘on’	Recoding on or off?	‘on’, ‘off’	string	Recoding on or off?	O	L0

RECNRBIT	8	Bit depth of the output of the recoding process; number is always 8!	0 to 16; number is always 8!	integer	Bit depth of the output of the recoding process; number is always 8!	O	L0
RECLOW	12	value below which we clip all values to 0 in the recoding process	0 to 32767 (15 bit)	integer	value below which we clip all values to 0 in the recoding process. In the decoding process, all 0 values are mapped to RECLOW	O	L0
RECHIGH	31000	value above which we clip all values to 2^RECNRBIT - 1 in the recoding process	0 to 32767 (15 bit)	integer	value above which we clip all values to 2^RECNRBIT - 1 in the recoding process. In the decoding process, all 2^RECNRBIT - 1 values are mapped to RECHIGH	O	L0
COMBITPP	30	WICOM bits per pixel in the compressed image	1 to 250 (corresponding to 0.04-10 bits per pixel)	integer	WICOM bits per pixel in the compressed image. Note: compression rate = bits per pixel in the input image/ bits per pixel in the compressed image	O	L0

COMSTRIP	‘off’	type of the compression : off = whole image compression ; on = strip compression	‘on’, ‘off’	string	type of the compression: off = whole image compression (like JPEG2000); on = strip compression (older and less efficient)	O	L0
COMSPLMD	‘provided by user’	WICOM compression splitb3 mode	‘calculated internally’, ‘provided by user’	string	WICOM compression splitb3 mode: 0 = calculated internally, 1 = provided by user	O	L0
COMSPLVL		WICOM compression splitb3 value	4 bit	integer	WICOM compression splitb3 value	O	L0
COMWEIMD	‘on’	WICOM compression weighting mode	‘on’, ‘off’	string	WICOM compression weighting mode	O	L0
COMWEIVL	‘10,20,30, 40,50,60, 70,80,90, 100’	WICOM compression weighting sub-band coefficients 1 to 10	‘0,0,0,0,0,0,0, 0,0,0,0’ to ‘255,255,255, 255,255,255, 255,255,255, 255’	string of 10 comma-separated decimal numbers 0-255 (no spaces nor tabs after commas)	WICOM compression weighting sub-band coefficients 1 to 10	O	L0

COMSIZE		number of bytes onboard compressed image (including also rebinning, recoding, …)		integer	number of bytes onboard compressed image (including also rebinning, recoding, …)	O	L0

Data routing

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
PRIORITY	10	Priority Number of image/histogram when it was downloaded	0 to 255	integer	Priority Number of image/histogram when it was downloaded	O	L0
SCITABID		“Exposure identifier” in secondary science table		integer	“Exposure identifier” in secondary science table (e.g., LL02)	O	L0
SCITABNR	42	Sequential number of “Exposure identifier” in secondary science table		integer	Sequential number of “Exposure identifier” in secondary science table	O	L0

File identification

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level

IMGTYPE	“solar image”	Distinction between solar images and various calibration and engineering images	“solar image”, “solar image, short”, “dark image”, “LED image”, ”occulted image”, “gain image”, “offset image”	string	Distinction between solar images and various calibration and engineering images	O	L0
JOBID	19991231T235959.789Z_Abx	Unique pipeline job ID	ISO8601 datetime stamp + ‘_’ + 3 alphanumeric characters	string	Unique pipeline job ID	O	L0

Solar Ephemeris

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
RSUN_OBS	952.567	[arcsec] Apparent photospheric	Positive	Float	Apparent photospheric solar radius in arc seconds	O	L1

WCS

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
DCRVAL1	104.494	[arcsec] delta CRVAL1		Float	The delta applied to CRVAL1 value; e.g., by limb-fitting	O	L2
DCRVAL2	-8.19049	[arcsec] delta CRVAL2		Float	The delta applied to CRVAL2 value; e.g., by limb-fitting	O	L2

Derived image properties

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
EUXCEN	514.290	[pixel] axis 1 location of solar center in Level 1	can be outside FOV	Real	[pixel] axis 1 location of solar center in Level 1	O	L1
EUYCEN	514.290	[pixel] axis 2 location of solar center in Level 1	can be outside FOV	Real	[pixel] axis 2 location of solar center in Level 1	O	L1
DATAMEAN	938.27	[DN] average pixel value across the image		Real	[DN] average pixel value across the image	O	L0

General description

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
COMPLETE	'C'	'C': data product based on complete series of telemetry packets; 'I': data product based on incomplete series of telemetry packets	'C', 'I'	string	Indicates whether the data product comes from a complete series of telemetry packets	O	L0

Telemetry headers

Keyword	Example Value	Suggested FITS Comment	Valid Data Range	Value Type	Description	M-Type	Level
ALU	21178	CEB ALU reg		Unsigned 2 byte integer	CEB ALU reg	O	L0

ALU2	4	CEB ALU2 reg		Unsigned 2 byte integer	CEB ALU2 reg	O	L0
DETREG20	0	REG20_VDAC_CLIPP		Unsigned 1 byte integer	REG20_VDAC_CLIPP	O	L0
DETREG21	0	REG21_VDAC_OFFSETP		Unsigned 1 byte integer	REG21_VDAC_OFFSETP	O	L0
DETREG22	0	REG22_VDAC_CMREF		Unsigned 1 byte integer	REG22_VDAC_CMREF	O	L0
DETREG23	0	REG23_VDAC_OFFSETN		Unsigned 1 byte integer	REG23_VDAC_OFFSETN	O	L0
DETREG24	0	REG24_VDAC_CLIPN		Unsigned 1 byte integer	REG24_VDAC_CLIPN	O	L0
DETREG25	0	REG25_VDAC_CMREF_LV		Unsigned 1 byte integer	REG25_VDAC_CMREF_LV	O	L0
DETREG26	0	REG26_IDAC_CDSSTAGE2_3		Unsigned 1 byte integer	REG26_IDAC_CDSSTAGE2_3	O	L0
DETREG27	0	REG27_IDAC_CDSSTAGE1_COMPA		Unsigned 1 byte integer	REG27_IDAC_CDSSTAGE1_COMPA	O	L0
DETREG28	0	REG28_IDAC_INVBUFFER_REFBU		Unsigned 1 byte integer	REG28_IDAC_INVBUFFER_REFBU	O	L0
DETREG29	0	REG29_IDAC_COLBUFFER_COLBU		Unsigned 1 byte integer	REG29_IDAC_COLBUFFER_COLBU	O	L0
DETREG2A	0	REG2A_IDAC_COLPC_COLGAINST		Unsigned 1 byte integer	REG2A_IDAC_COLPC_COLGAINST	O	L0
DETREG2B	0	REG2B_IDAC_OUTPUTDRIVER_CO		Unsigned 1 byte integer	REG2B_IDAC_OUTPUTDRIVER_CO	O	L0
DETREG2C	0	REG2C_VDAC_BLACKSUN_EVEN		Unsigned 1 byte integer	REG2C_VDAC_BLACKSUN_EVEN	O	L0
DETREG2D	0	REG2D_IDAC_ABS_REBUFF_TEMP		Unsigned 1 byte integer	REG2D_IDAC_ABS_REBUFF_TEMP	O	L0
DETREG2E	0	REG2E_COLGAIN_EVEN_FF_MID		Unsigned 1 byte integer	REG2E_COLGAIN_EVEN_FF_MID	O	L0
DETREG2F	0	REG2F_COLGAIN_EVEN_FF_LOW		Unsigned 1 byte integer	REG2F_COLGAIN_EVEN_FF_LOW	O	L0

DETREG30	0	REG30_COLGAIN_EVEN_FB_MID		Unsigned 1 byte integer	REG30_COLGAIN_EVEN_FB_MID	O	L0
DETREG31	0	REG31_COLGAIN_EVEN_FB_LOW		Unsigned 1 byte integer	REG31_COLGAIN_EVEN_FB_LOW	O	L0
DETREG32	0	REG32_COLGAIN_EVEN_FB_HIGH		Unsigned 1 byte integer	REG32_COLGAIN_EVEN_FB_HIGH	O	L0
DETREG33	0	REG33_COLGAIN_ODD_FF_MID		Unsigned 1 byte integer	REG33_COLGAIN_ODD_FF_MID	O	L0
DETREG34	0	REG34_COLGAIN_ODD_FF_LOW		Unsigned 1 byte integer	REG34_COLGAIN_ODD_FF_LOW	O	L0
DETREG35	0	REG35_COLGAIN_ODD_FB_MID		Unsigned 1 byte integer	REG35_COLGAIN_ODD_FB_MID	O	L0
DETREG36	0	REG36_COLGAIN_ODD_FB_LOW		Unsigned 1 byte integer	REG36_COLGAIN_ODD_FB_LOW	O	L0
DETREG37	0	REG37_COLGAIN_VDAC_SIGCLAM		Unsigned 1 byte integer	REG37_COLGAIN_VDAC_SIGCLAM	O	L0
DETREG38	0	REG38_CDS_EN_SAMPLE_CLOCK		Unsigned 1 byte integer	REG38_CDS_EN_SAMPLE_CLOCK	O	L0
DETREG39	0	REG39_MBS_PIXCOL_ADDR_LOW		Unsigned 1 byte integer	REG39_MBS_PIXCOL_ADDR_LOW	O	L0
DETREG3A	0	REG3A_MBS_PIXCOL_ADDR_HIGH		Unsigned 1 byte integer	REG3A_MBS_PIXCOL_ADDR_HIGH	O	L0
DETREG3B	0	REG3B_MBS_MUXBUS_SR_EOSX_S		Unsigned 1 byte integer	REG3B_MBS_MUXBUS_SR_EOSX_S	O	L0
DETREG3C	0	REG3C_VDAC_SIGC_LAMP_BLACK		Unsigned 1 byte integer	REG3C_VDAC_SIGC_LAMP_BLACK	O	L0
DETREG3D	0	REG3D_XWIN_ADDRESS		Unsigned 1 byte integer	REG3D_XWIN_ADDRESS	O	L0
DETREG3E	0	REG3E_VDAC_BUSCLAMPHIGH		Unsigned 1 byte integer	REG3E_VDAC_BUSCLAMPHIGH	O	L0
DETREG3F	0	REG3F_VDAC_BUSCLAMPLOW		Unsigned 1 byte integer	REG3F_VDAC_BUSCLAMPLOW	O	L0