Solar Orbiter EUI Data Product Description Document

Revision: 1.8

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1. Table of Contents

1 Introduction

1.1 Purpose and Scope

This Data Product Definition Document (DPDD) describes the format and content of the Extreme Ultraviolet Imager (EUI) Science data. It includes descriptions of the data products and associated metadata, including the data format, content, and generation pipeline. These products will be stored and distributed from the Solar Orbiter Science Archive (SOAR) of the SOC.

The specifications described in this DPDD apply to all EUI Science products submitted to ESA's Solar Orbiter SOC for further archival and exploitation. This document only includes descriptions of Science products delivered by the Science pipelines run at the EUI Team premises. It does not address the Low Latency data (see [RD.05]) since it will be described in [RD.03] and [RD.04].

1.2 Applicable Documents

[AD.01]   SOL-SGS-TN-0009 Metadata Definition for Solar Orbiter Science
[AD.02]   SOL-SGS-ICD-002 Data Producer to Archive ICD (DPAICD)

1.3 Reference Documents

[RD.03]   SOL-SGS-ICD-0005 Solar Orbiter Interface Control Document for Low Latency FITS Files
[RD.04]   SP-ROB-SOEUI-17001 EUI Low Latency Data Product Description Document
[RD.05]   SOL-SGS-TN-0003 Solar Orbiter Low Latency Data: Concept and Implementation
[DPDD]   Solar Orbiter EUI Data Product Description Document, template available from SOL-SGS-OTH-004-TPL_DPDD
[FITSDOC]   Definition of the Flexible Image Transport System, http://fits.gsfc.nasa.gov/standard30/fits_standard30aa.pdf
[JPEG2000]   TBC
[JHELIOVIEWER] TBC
[METADATA]   SOL-SGS-TN-0009, Metadata Definition for Solar Orbiter Science Data
[METADATAEUI] SP_ROB_SOEUI_19002_MetadataStandard_v1.8
[SEGU]   SOL-SGS-TN-0006, SOC Engineering Guidelines for External Users
[SOAR]   SOL-SGS-PL-0009, Solar Orbiter Archive Plan
[UM]   UM-MSSL-SOEUI-11001, EUI User Manual

1.4 Acronyms and Abbreviations

FITS   Flexible Image Transport System
HDU   Header/Data Unit
L0   Science Level 0 (raw data)
L1   Science Level 1 (engineering data)
L2   Science Level 2 (science data)
L3   Science Level 3 (higher level data)

CAL	Calibration data
SDVM	Science Data Virtual Machine
SOAR	Solar Orbiter Archive
TBC	To Be Completed
TBD	To Be Determined

2 EUI Instrument Description

The EUI instrument suite is composed of two High Resolution Imagers (HRI), one at Lyman-α and one at 17.4 nm, respectively named "HRILy-α" and "HRIEUV", and one dual band Full-Sun Imager (FSI) working alternatively at the 17.4 nm and 30.4 nm EUV passbands, named "FSI174/304". *TBC: High-level description of the instrument and instrument science objectives, with a reference to an external, publicly available instrument document (such as the instrument paper).*

2.1 Science Objectives

The Extreme Ultraviolet Imager (EUI) is a fundamental component of the Solar Orbiter mission. EUI will contribute to the following four outstanding Solar Orbiter science themes:

• What are the origins of the solar wind streams and the heliospheric magnetic field?
• What are the sources, acceleration mechanisms, and transport processes of solar energetic particles?
• How do coronal mass ejections evolve in the inner heliosphere?
• Explore, at all latitudes, the energetics, dynamics and fine-scale structure of the Sun's magnetized atmosphere.

2.2 Operational Modes producing Science data

The EUI instrument has five operating modes: Off, Basic, Safe, Configuration, Engineering and Science. For a full description of EUI modes see [UM] 4.3 Instrument Operating Modes. EUI produces Science data in Science mode only. In Science mode EUI produces Science image data and Housekeeping data.

2.3 Calibration

2.3.1 On-ground Calibration

TBC: Description of the on-ground calibration performed on the instrument, and results. Include references to calibration performance reports.

2.3.2 In-flight Calibration

TBC: Description of the in-flight calibration, with references to existing document where applicable.

3 Data Generation Process

The EUI science products are produced by the EUI Instrument Team. The data generation and analysis process is described in this section.

Science data received by the SOC from the EUI team are made available to end users through the Solar Orbiter archive following the policies described in the Archiving Plan [SOAR].

The procedure for delivery of the Science data from the EUI Instrument Team to the SOC must be fully compliant with the IT-SOC Science Data Delivery ICD (TBW) [AD.02].

3.1 Scientific Measurements

All EUI telescopes take images. The FSI telescope is 3072×3072 pixels in size, both HRI detectors have 2048×2048 pixels. All pixels have 16-bit depth. The images will be rebinned, recoded and/or compressed on board to reduce the telemetry bandwidth.

3.2 Data Flow Overview

After boot, the EUI SCVM automatically starts to monitor the creation of request directories in the */input/EUI/requests* directory. When the creation of a new request directory is detected, a program "Packet to Database" is started to insert all packets into the database. Each instance of this program reads packets from a single request. Multiple instances of this program can run simultaneously, as the database can handle multiple connections. This database simplifies the combination of packets originating from multiple passes to create a single set of packets that belong to a single image.

After the program "Packet to Database" has finished, a program "Database to L0" is started to extract a set of packets from the packet database, and write them to one or more FITS files in the */output/EUI/products* directory.

After the creation of a FITS file, additional programs are triggerred to produce higher level FITS files. These processes are described in the data generation sections below.
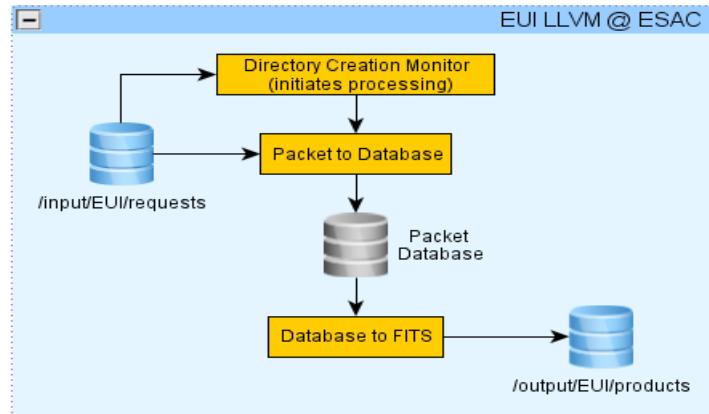
Illustration 1: Data flow overview

3.3 Data Generation

The following sections describe the process used to produce the data products described in section 4.

3.3.1 L0 - Raw Data

The program "Database to L0" extracts packets from the packet database, and writes them to one or more L0 FITS files. This program starts when all instances of the "Packet to Database" program have finished. For each image, the packets belonging to that image are selected from the database, ordered and concatenated. The concatenation is then uncompressed (if necessary) and written to a FITS file with the appropriate FITS header. This process is repeated for all images. If there are packets missing from an image, a normal FITS file will be written, with the COMPLETE keyword in the header set to 'I' (incomplete). In case of a compressed image, the FITS file will contain a full image, but with lower quality. In case of an uncompressed image, the FITS file will contain a truncated image (some pixels set to the value of the BLANK keyword in the header).

3.3.2 L1 - Engineering Data (uncalibrated)

The program "L0 to L1" produces L1 FITS files from L0 FITS files and a database containing housekeeping data and commanding history. TBC.

3.3.3 L2 - Science Data (calibrated)

The program "L1 to L2" produces L2 FITS files from L1 FITS files and calibration data. TBC.

3.3.4 L3 - Higher Level Data

The program "L2 to JP2000" produces L3 JPEG2000 data products from L2 FITS files. TBC.

3.3.5 CAL - Calibration Data

No calibration data products are created.

3.3.6 ANC - Ancillary Data

No ancillary data products are created.

3.4 Validation

The following sections describe the process by which the data products are validated.

3.4.1 Instrument Team Validation

The EUI instrument team will check the data products before sending it to SOC for archiving. The procedure consists of both automated and manual checks.

3.4.2 SOC Validation

The SOC will check the data types that the EUI team intends to archive. The SOC might also perform spot checks on contents of the files. The exact procedure in which this routine check will take place is still TBD

4 Data Product Descriptions

EUI data products are formatted in accordance with the [AD.01] document. This section provides details on the formats used for each of the products included in the EUI science data.

4.1 Primary Products Formats

The EUI instrument uses the FITS format for its science data products. This section describes the format and record structure of each of the Science data file types.

The following information should be given for each of the data products:

- Product name
- Description
- Descriptor
- Free field
- Level
- Dataset dependencies (if any)
- Associated calibration set (if any)
- expected cadence and dataset volume

The definitions of these attributes can be found in the Data Products and Filenames Confluence document ([AD.01], section 2.1).

The filenames for EUI L0, L1 and L2 files follow what is described in [AD.01], section 2.1.3, with the addition that for L0 files, the datetime field in the filename shall consist of the OBT coarse time (as described in [AD.01] section 2.1.3.1) but appended with a 4 character long hexadecimal representation of the OBT fine time of the image. The total length of the datetime field in L0 files is therefore 14 characters instead of 10.

The third field of the filename, the descriptor, has the following structure:

eui-<telescope><filter>-<producttype>, where <telescope> can be either "fsi", "hrieuv", or "hrilya", <filter> can be either "174", "304", "1216","blk","opn","zer", "###", and <producttype> can be either "image", "image-led", "image-dark", "image-occulter", "image-short".

Some example filenames for L0, L1, L2, and L3 can be found in the table below.

Level	Filenames
L0	solo_L0_eui-fsi174-image_064411444466f3_V05.fits solo_L0_eui-hrieuv174-image_0644163899ab72_V04.fits solo_L0_eui-hrilya1216-image_06441663747848_V01.fits
L1	solo_L1_eui-fsi174-image_20200530T004100211_V05.fits solo_L1_eui-hrieuv174-image_20200530T145400185_V04.fits solo_L1_eui-hrilya1216-image_20200530T150636376_V01.fits solo_L1_eui-fsi174-image-occulter_20230101T221455197_V01.fits solo_L1_eui-hrieuvopn-image_20230103T080319159_V01.fits
L2	solo_L2_eui-fsi174-image_20200530T004100211_V05.fits

	solo_L2_eui-hrieuv174-image_20200530T145400185_V04.fits solo_L2_eui-hrilya1216-image_20200530T150636376_V01.fits solo_L2_eui-fsi174-image-occulter_20230101T221455197_V01.fits solo_L2_eui-hrieuvopn-image_20230103T080319159_V01.fits
L3	solo_L3_eui-fsi174-image_20200530T004100211_V05.jp2 solo_L3_eui-hrieuv174-image_20200530T145400185_V04.jp2 solo_L3_eui-hrilya1216-image_20200530T150636376_V01.jp2 solo_L3_eui-fsi174-image-occulter_20230101T221455197_V01.jp2 solo_L3_eui-hrieuvopn-image_20230103T080319159_V01.jp2

Under exceptional conditions, the free field in the filenames will be used to identify source images that are broken. For example, when incorrect compression settings were used resulting in a broken and unsalvagable image, the freefield may contain the error code of the wicom decompression software appended to the name 'wicom'. En example L0 filename indicating a broken image is 'solo_L0_eui-hrieuvzer-image_0641603818a9be_V01_wicom2.fits', indicating that the WICOM decompression software returned an error code 2.

The EUI L0, L1, and L2 data are formatted in FITS files with one of the following general structures:

- one primary HDU containing one header and one image containing one or two channels.

- one primary HDU and one extension HDU with a binary table containing a compressed image with one or two channels. The images are compressed using tiled-image compression (RICE), and are compatible with software using the CFITSIO library (e.g., astropy.io.fits, SunPy, JHelioviewer, SSWIDL mreadfits_tilecomp, etc.) . The Solar Orbiter and EUI FITS keywords are accessible in the extension HDU.

The definitions below shall include all metadata contained in the product, both Solar Orbiter mandatory metadata [AD.01] and Instrument Specific metadata if any. A description of the data content organisation (as described in the aforementioned section of [AD.01]) shall be given as well.

4.1.1 L0 - Raw Data Products

All EUI L0 data products will contain the FITS keywords described below. These keywords are described in detail in [METADATA] and [METADATAEUI]. When a specific data product contains additional metadata, this is described in the subsections below.

Basic:
SIMPLE, BITPIX, NAXIS, NAXIS1, NAXIS2, EXTEND, LONGSTRN

General Description:
FILENAME, FILE_RAW, APID, DATE, TIMESYS, OBT_BEG, LEVEL, ORIGIN, CREATOR, VERS_SW, VERSION, COMPLETE

Instrument and Observation Configuration:

OBSRVTRY, TELESCOP, INSTRUME, DETECTOR, XPOSURE, WAVELNTH**

Description of Data Content:
BSCALE, BZERO, BTYPE, BUNIT, DATAMIN, DATAMAX, BLANK

Image Relative to Detector and Electronics:
PXBEG1, PXEND1, PXBEG2, PXEND2, NBIN1, NBIN2, NBIN

World Coordinate System Attitude
WCSNAME, CTYPE1, CTYPE2, CUNIT1, CUNIT2, CDELT1, CDELT2, CRVAL1,
CRVAL2, CRPIX1, CRPIX2, PC1_1, PC1_2, PC2_1, PC2_2

Parameters Describing Onboard Processing:
COMPRESS, COMP_RAT

Parameters Closing Metadata Description:
INFO_URL, COMMENT, CHECKSUM, DATASUM, HISTORY, END

EUI Telemetry Header:
ALU, ALU2, DETREG20 – DETREG3F (32 detector registers), DOORPOS

EUI Front End Electronics:
DETGAINL, DETGAINH, GAINGOMB, READOUTM, DOWNLOAM,
GAINTHRE,LEDSTATE

EUI Detector:
TEMPINT

EUI CEB pixel preprocessing:
GAOFSTAT, BADPXREM, CCREM

EUI Compression:
RECSTATE, RECNRBIT, RECLOW, RECHIGH, COMBITPP, COMSPLMD,
COMSPLVL, COMWEIMD, COMWEIVL, COMSIZE

EUI Data Routing:
PRIORITY, SCITABID, SCITABNR

EUI File identification:
JOBID

EUI Derived image properties:
DATAMEAN

* The WAVELNTH keyword will be absent when the filter wheel is in a blocking or in an undetermined position.

4.1.1.1 FSI Image

Product name
L0 FSI Image
Description
L0 image taken with the FSI telescope. Nominally 3072×3072 pixels, at 16-bit depth. The image may be subframed. The image may be taken with either the 174Å or 304Å filter. The image data is raw (unpacked and decompressed). Metadata reflect the information that was available in the TM packets only.
Descriptor
eui-fsiXXX-image, with XXX being one of:

174	Either one of the two possible 174Å filters
304	Either one of the two possible 304Å filters
blk	Either one of the four possible blocking positions
###	Any other filter position in between the options above

An appendix for the "image" field in the descriptor is added for specific data products, following the IMGTYPE keyword:

image-led	Calibration LED images
image-dark	Calibration Dark images
image-short	Short exposure images
image-occulter	Occulter images
image	All other (solar) images

Free field
The free field will be used to uniquely identify source images. The exact format of the free field is TBD.
Level
L0
Dataset dependencies (if any)
TBD
Associated calibration set (if any)
TBD
Expected cadence and dataset volume
TBC

FSI images will contain the following additional FITS keywords as described in [METADATAEUI]:
    FILTER, FILCPOS

4.1.1.2 HRI EUV Image

Product name
L0 HRI EUV Image
Description

L0 image taken with the HRI EUV telescope. Nominally 2048×2048 pixels, at 16-bit depth. The image may be subframed. The image may be up to 3072×3072 pixels in rare circumstances. The image data is raw (unpacked and decompressed). Metadata reflect the information that was available in the TM packets only.

Descriptor

eui-hrieuvXXX-image, with XXX being one of:

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

An appendix for the "image" field in the descriptor is added for specific data products, following the IMGTYPE keyword:

image-led	Calibration LED images
image-dark	Calibration Dark images
image-short	Short exposure images
image	All other (solar) images

Free field

The free field will be used to uniquely identify source images. The exact format of the free field is TBD.

Level

L0

Dataset dependencies (if any)

TBD

Associated calibration set (if any)

TBD

Expected cadence and dataset volume

TBC

HRI EUV images will contain the following additional FITS keywords as described in [METADATAEUI]:

    FILTER, FILCPOS

4.1.1.3 HRI Ly-α Image

Product name

L0 HRI Ly-α Image

Description

L0 image taken with the HRI Ly-α telescope. Nominally 2048×2048 pixels, at 16-bit depth. The image may be subframed. The image may be up to 3072×3072 pixels in rare circumstances. The image data is raw (unpacked and decompressed). Metadata reflect the information that was available in the TM packets only.

Descriptor

eui-hrilya1216-image

The HRI Ly-α telescope does not have a filterwheel and only has one wavelength.

An appendix for the "image" field in the descriptor is added for specific data products, following the IMGTYPE keyword:

image-led	Calibration LED images
image-dark	Calibration Dark images
image-short	Short exposure images
image	All other (solar) images

Free field

The free field will be used to uniquely identify source images. The exact format of the free field is TBD.

Level

L0

Dataset dependencies (if any)

TBD

Associated calibration set (if any)

TBD

Expected cadence and dataset volume

<mark>TBC</mark>

HRI Ly-α images will contain the following additional FITS keywords as described in [METADATAEUI]:

> LYACMCP, LYACSCR

4.1.2 L1 - Engineering data products

In addition to the keywords described in 4.1.1, all EUI L1 data products will contain the keywords described below (with the exception of keywords marked as optional). These keywords are described in detail in [METADATA] and [METADATAEUI]. When a specific data product contains additional metadata, this is described in the subsections below.

General Description keywords:

> PARENT, DATE-OBS, DATE-BEG, DATE-AVG

Instrument and Observation Configuration keywords:

> OBS_MODE, OBS_TYPE, WAVEMIN*, WAVEMAX*

Campaign Information:

> SOOPNAME, SOOPTYPE, OBS_ID, TARGET

Description of Data Content:

> UCD

Solar Ephemeris Data Keywords:

RSUN_ARC, RSUN_OBS, RSUN_REF, SOLAR_B0, SOLAR_P0, SOLAR_EP, CAR_ROT, HGLT_OBS, HGLN_OBS, CRLT_OBS, CRLN_OBS, DSUN_OBS, DSUN_AU, HEEX_OBS, HEEY_OBS, HEEZ_OBS, HCIX_OBS, HCIY_OBS, HCIZ_OBS, HCIX_VOB, HCIY_VOB, HCIZ_VOB, HAEX_OBS, HAEY_OBS, HAEZ_OBS, HEQX_OBS, HEQY_OBS, HEQZ_OBS, GSEX_OBS, GSEY_OBS, GSEZ_OBS, OBS_VR, EAR_TDEL, SUN_TIME, DATE_EAR, DATE_SUN

EUI Derived image properties:
    EUXCEN, EUYCEN

EUI Front End Electronics:
    LEDCONTR, LEDVALUE, LEDSELEC

EUI Detector:
    TEMP1DET, TEMP2DET, TTEMP1, TTEMP2

EUI CEB pixel preprocessing:
    BADPXDEF, CCREMLIM, GAINHG, GAINLG, OFFSETHG, OFFSETLG

EUI Compression:
    COMSTRIP

EUI Mechanisms:
    DOORINT, DOOREXT

EUI File identification:
    IMGTYPE

*** The WAVEMIN and WAVEMAX keywords will be absent when the filter wheel is in a blocking or an undetermined positions.**

4.1.2.1 FSI Image

Product name
L1 FSI Image
Description
L1 image taken with the FSI telescope. Nominally 3072×3072 pixels, at 16-bit depth. The image may be subframed. The image may be taken with either the 174Å or 304Å filter. Metadata reflect the information available in the lower level data product, but also contains extra engineering metadata from other sources (e.g., housekeeping). The data is uncalibrated.
Descriptor
See L0 data product
Free field
The free field will be used to uniquely identify source images. The exact format of the free field is TBD.
Level
L1
Dataset dependencies (if any)
TBD

Associated calibration set (if any)
TBD
Expected cadence and dataset volume
See 4.1.1.1

FSI images will contain the following additional FITS keywords as described in [METADATAEUI]:
    FILTPOS

4.1.2.2 HRI EUV Image

Product name
L1 HRI EUV Image
Description
L1 image taken with the HRI EUV telescope. Nominally 2048×2048 pixels, at 16-bit depth. The image may be subframed. The image may be up to 3072×3072 pixels in rare circumstances. Metadata reflect the information available in the lower level data product, but also contains extra engineering metadata from other sources (e.g., housekeeping). The data is uncalibrated.
Descriptor
See L0 data product
Free field
The free field will be used to uniquely identify source images. The exact format of the free field is TBD.
Level
L1
Dataset dependencies (if any)
TBD
Associated calibration set (if any)
TBD
Expected cadence and dataset volume
See 4.1.1.2

HRI EUV images will contain the following additional FITS keywords as described in [METADATAEUI]:
    FILTPOS

4.1.2.3 HRI Ly-α Image

Product name
L1 HRI Ly-α Image
Description
L1 image taken with the HRI Ly-α telescope. Nominally 2048×2048 pixels, at 16-bit depth. The image may be subframed. The image may be up to 3072×3072 pixels in rare circumstances. Metadata reflect the information available in the lower level data product, but also contains extra engineering metadata from other sources (e.g., housekeeping). The data is uncalibrated.
Descriptor
eui-hrilya-image
Free field

The free field will be used to uniquely identify source images. The exact format of the free field is TBD.

Level
L1
Dataset dependencies (if any)
TBD
Associated calibration set (if any)
TBD
Expected cadence and dataset volume
See 4.1.1.3

HRI Ly-α images will contain the following additional FITS keywords as described in [METADATAEUI]:

LYAVMCP, LYAVSCR

4.1.3 L2 - Science data products

In addition to the keywords described in 4.1.2, all EUI L2 data products will contain the the keywords described below. These keywords are described in detail in [METADATA] and [METADATAEUI]. When a specific data product contains additional metadata, this is described in the subsections below. For RICE compressed L2 images, the image data is typically scaled as 16-bit integer data using the BZERO and BSCALE keywords. When the data is stored as floating points, the BLANK keyword is removed and blank pixels are marked with the IEEE Not-a-Number (NaN) mechanism.

General Description keywords:
VERS_CAL

World Coordinate System Attitude:
DCRVAL1*, DCRVAL2*

* The DCRVALi keywords will be absent when the CRVALi keywords were not updated during L1 to L2 processing (e.g., limb-fitting on FSI images failed, or no other correction was applied to the space craft and instrument pointing information from L1 to L2)

4.1.3.1 FSI Image

Product name
L2 FSI Image
Description
L2 image taken with the FSI telescope. Nominally 3072×3072 pixels, at 16-bit depth. The image may be subframed. The image may be taken with either the 174Å or 304Å filter. Metadata reflect the information available in the lower level data product, but also contains extra engineering metadata from other sources (e.g., housekeeping). The image is calibrated science level data with full attitude information in WCS coordinate frame and time in UTC.
Descriptor
See L0 data product
Free field

The free field will be used to uniquely identify source images. The exact format of the free field is TBD.
Level
L2
Dataset dependencies (if any)
TBD
Associated calibration set (if any)
TBD
Expected cadence and dataset volume
See 4.1.1.1

4.1.3.2 HRI EUV Image

Product name
L2 HRI EUV Image
Description
L2 image taken with the HRI EUV telescope. Nominally 2048×2048 pixels, at 16-bit depth. The image may be subframed. The image may be up to 3072×3072 pixels in rare circumstances. Metadata reflect the information available in the lower level data product, but also contains extra engineering metadata from other sources (e.g., housekeeping). The image is calibrated science level data with full attitude information in WCS coordinate frame and time in UTC.
Descriptor
See L0 data product
Free field
The free field will be used to uniquely identify source images. The exact format of the free field is TBD.
Level
L2
Dataset dependencies (if any)
TBD
Associated calibration set (if any)
TBD
Expected cadence and dataset volume
See 4.1.1.2

4.1.3.3 HRI Ly-α Image

Product name
L2 HRI Ly-α Image
Description
L2 image taken with the HRI Ly-α telescope. Nominally 2048×2048 pixels, at 16-bit depth. The image may be subframed. The image may be up to 3072×3072 pixels in rare circumstances. Metadata reflect the information available in the lower level data product, but also contains extra engineering metadata from other sources (e.g., housekeeping). The image is calibrated science level data with full attitude information in WCS coordinate frame and time in UTC.
Descriptor
eui-hrilya-image
Free field
The free field will be used to uniquely identify source images. The exact format of the free field is TBD.
Level

L2
Dataset dependencies (if any)
TBD
Associated calibration set (if any)
TBD
Expected cadence and dataset volume
See 4.1.1.3

4.1.4 L3 - Higher level data products

Detailed description of the content and format of the derived data products.

EUI will generate L3 data products as JPEG 2000 files [JPEG2000] compatible with JHelioviewer [JHELIOVIEWER]. In addition to the metadata described in 4.1.3, all EUI L3 data products may contain additional keywords described below.

HV_INNER – This keyword is used to hide the occulter in JHelioviewer for FSI occulter images

4.1.5 CAL - Calibration data products

Detailed description of the content and format of the derived data products.

4.1.6 ANC - Ancillary data products

Detailed description of the content and format of the derived data products.

5 APPENDIX – Data products matrix

A table with a summary of the data products names and description.

Product name	Description	Descriptor	Free_field	Level
L0 FSI Image	L0 image taken with FSI telescope	eui-fsi174-image, eui-fsi304-image, eui-fsiblk-image, eui-fsi###-image,	Unique identifier to source image. E.g., F0125121	L0
L0 HRI EUV Image	L0 image taken with HRI EUV telescope	eui-hrieuv174-image, eui-hrieuvblk-image, eui-hrieuvzer-image, eui-hrieuv###-image	Unique identifier to source image. E.g., F0125123	L0
L0 HRI Ly-α Image	L0 image taken with HRI Ly-α telescope	eui-hrilya1216-image	Unique identifier to source image. E.g., F0125124	L0
L1 FSI Image	L1 image taken with FSI telescope	eui-fsi174-image, eui-fsi304-image, eui-fsiblk-image, eui-fsi###-image	Unique identifier to source image. E.g., F0125121	L1
L1 HRI EUV Image	L1 image taken with HRI EUV telescope	eui-hrieuv174-image, eui-hrieuvblk-image, eui-hrieuvzer-image, eui-hrieuv###-image	Unique identifier to source image. E.g., F0125123	L1
L1 HRI Ly-α Image	L1 image taken with HRI Ly-α telescope	eui-hrilya1216-image	Unique identifier to source image. E.g., F0125124	L1
L2 FSI Image	L2 image taken with FSI telescope	eui-fsi174-image, eui-fsi304-image, eui-fsiblk-image, eui-fsi###-image	Unique identifier to source image. E.g., F0125121	L2
L2 HRI EUV Image	L2 image taken with HRI EUV telescope	eui-hrieuv174-image, eui-hrieuvblk-image, eui-hrieuvzer-image, eui-hrieuv###-image	Unique identifier to source image. E.g., F0125123	L2
L2 HRI Ly-α Image	L2 image taken with HRI Ly-α telescope	eui-hrilya1216-image	Unique identifier to source image. E.g., F0125124	L2

Fore each of the above products, the following product variants and descriptors are defined.

Product name	Telescope	Description	Last field of descriptor	Level
LED image	FSI, HRI EUV, HRI LYA	Calibration image with an LED turned on	-image-led	L1
Dark image	FSI, HRI EUV, HRI LYA	Calibration image dark	-image-dark	L1
Short solar image	FSI, HRI EUV	Short exposure solar image, typically used for imaging flares with limited saturation (XPOSURE < 0.1 s for HRI EUV, < 0.5 s for FSI).	-image-short	L1, L2, L3
Occulter solar	FSI	Occulter image	-image-occulter	L1, L2, L3

image				
All other solar images	FSI, HRI EUV, HRI LYA	All other solar images that do not fall in any of the above categories	-image	L0, L1, L2, L3

6 SAMPLE FILE HEADERS

A sample of a valid file (header) per product is attached here. As the descriptor field of the filename does not affect the occurance of keywords, only one example file per telescope per level is provided.

6.1 L0

6.1.1 FSI Image

```
SIMPLE  =                    T / file conforms to basic FITS standards
BITPIX  =                   16 / number of bits per data pixel, rounded up
NAXIS   =                    2 / number of axes in data cube
NAXIS1  =                 2048 / length of data axis 1
NAXIS2  =                 2048 / length of data axis 2
EXTEND  =                    F / F = no extensions T = extension(s)
BSCALE  =                    1 / ratio of physical to array value at 0 offset
BZERO   =                32768 / physical value for the array value 0
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: --------------------------------------
FILENAME= 'solo_L0_eui-fsi174-image_06459500815c16_V01.fits' / FITS filename
DATE    = '2020-07-29T13:43:16.672' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2020.174.12.00.03.040.IvXC@2020.174.12.&'
CONTINUE  '00.04.108.1.xml&'
CONTINUE  '' / raw filename
APID    =                  940 / APID number of associated TM
TIMESYS = 'OBT     '           / system used for time keywords
OBT_BEG =      645950081.3597107 / start acquisition time in OBT
LEVEL   = 'L0      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = '/home/eui/pipeline/telemetry_parser.py --databaseExternal &'
CONTINUE  '--workingDirectory /tmp/telemetry_parser --configFile &'
CONTINUE  '/home/eui/config/config.ini --outputDirectory &'
CONTINUE  '/data/solo-eui/internal/L0/ --atROB&'
CONTINUE  '' / fits creation software
VERS_SW = '769     '           / version of SW that provided FITS file
VERSION = '01      '           / incremental version number
JOBID   = '20200729T083227.226Z_TPe' / unique pipeline job ID
COMPLETE= 'C       '           / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: --------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/FSI'       / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'FSI     '           / instrument subunit or sensor
XPOSURE =                 10.0 / [s] total effective exposure time
FILTER  = 'Zirconium_174_1'    / filter position
WAVELNTH=                  174 / [Angstrom] characteristic wavelength of observa
COMMENT --------- Description of Data Content: --------------------------------
BTYPE   = 'Intensity'          / type of data
BUNIT   = 'DN      '           / units of physical value, after BSCALE, BZERO
BLANK   =                32767 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: ------------------
PXBEG1  =                  513 / first read-out pixel in dimension 1
PXEND1  =                 2560 / last read-out pixel in dimension 1
PXBEG2  =                  513 / first read-out pixel in dimension 2
PXEND2  =                 2560 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: ---------------------------
WCSNAME = 'InstrumentLOS'      / name of coordinate system
CTYPE1  = 'YLOS-TAN'           / spatial axis parallel to S/C -Y
CTYPE2  = 'ZLOS-TAN'           / spatial axis parallel to S/C +Z
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
PC1_1   =                  1.0 / WCS coordinate transformation matrix
PC1_2   =                  0.0 / WCS coordinate transformation matrix
PC2_1   =                  0.0 / WCS coordinate transformation matrix
```

```
PC2_2   =                    1.0 / WCS coordinate transformation matrix
CDELT1  =              4.4353411 / [arcsec] pixel scale along axis 1
CDELT2  =              4.4449078 / [arcsec] pixel scale along axis 2
CRVAL1  =                    0.0 / [arcsec] value of reference pixel along axis 1
CRVAL2  =                    0.0 / [arcsec] value of reference pixel along axis 2
CRPIX1  =                 1024.5 / [pixel] reference pixel location along axis 1
CRPIX2  =                 1024.5 / [pixel] reference pixel location along axis 2
COMMENT --------- Front End Electronics: -------------------------------------
DETGAINL=                  0.875 / commanded low gain value
DETGAINH=                    3.0 / commanded high-gain value
GAINCOMB= 'high-only'            / commanded low/high gain combination
READOUTM=                      4 / commanded FEE readout mode
DOWNLOAM=                      0 / commanded FEE download mode
GAINTHRE=                  16383 / commanded threshold value for H/L gain
LEDSTATE= 'all off '             / LED control for current telescope
COMMENT --------- Temperature: ----------------------------------------------
TEMPINT =                   1004 / [DN] internal APS detector temperature (raw)
COMMENT --------- Telemetry Header: -----------------------------------------
ALU     =                  21120 / CEB ALU register
ALU2    =                      0 / CEB ALU2 register
DETREG20=                     85 / REG20_VDAC_CLIPP
DETREG21=                     87 / REG21_VDAC_OFFSETP
DETREG22=                     63 / REG22_VDAC_CMREF
DETREG23=                     39 / REG23_VDAC_OFFSETN
DETREG24=                     41 / REG24_VDAC_CLIPN
DETREG25=                     35 / REG25_VDAC_CMREF_LV
DETREG26=                    137 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                    136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                    136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                    136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                      8 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                    136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                      0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                    136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                    255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                    240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                      0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                     15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                      0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                    127 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                      0 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                      0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                    255 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                      0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                     63 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                      0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                      0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                      0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                      0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                     64 / REG3D_XWIN_ADDRESS
DETREG3E=                     65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                     65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                     34 / Door position (raw) = open
FILCPOS =                      1 / commanded filter wheel position
COMMENT --------- CEB Pixel Preprocessing: ----------------------------------
GAOFSTAT= 'none    '             / status of the CEB gain and offset correction
BADPXREM= 'off     '             / commanded bad pixel removal on or off
CRREM   = 'off     '             / cosmic ray removal on or off
COMMENT --------- Data Routing: ---------------------------------------------
PRIORITY=                     10 / priority # of image/histogram when downloaded
SCITABID=                    149 / exposure identifier in sec. science table
SCITABNR=                      0 / sequential number of SCITABID
COMMENT --------- Onboard Processing: ---------------------------------------
RECSTATE= 'off     '             / recoding on or off
RECNRBIT=                      8 / bit depth recoding output (sqrt)
RECLOW  =                      0 / rec. threshold low (clipped 0)
RECHIGH =                  32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                      0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'     / WICOM compression splitb3 mode
COMSPLVL=                      0 / WICOM compression splitb3 value
COMWEIMD= 'off     '             / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =                3415568 / number of bytes onboard compressed image
COMPRESS= 'Lossless'             / data compression quality (None/Lossless/Lossy)
```

```
COMP_RAT=    1.841994069507619 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: -----------------------------------
DATAMIN =                   0 / minimum valid physical value
DATAMAX =                3990 / maximum valid physical value
DATAMEAN=    513.8151731491089 / [DN] average pixel value across the image
COMMENT --------- Parameters Closing Metadata: -------------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= 'Wja2XiZ1Wia1WiY1'   / HDU checksum updated 2020-07-29T13:43:16
DATASUM = '1747469368'         / data unit checksum updated 2020-07-29T13:43:16
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
END
```

6.1.2 HRI EUV Image

```
SIMPLE  =                    T / file conforms to basic FITS standards
BITPIX  =                   16 / number of bits per data pixel, rounded up
NAXIS   =                    2 / number of axes in data cube
NAXIS1  =                 2048 / length of data axis 1
NAXIS2  =                 2048 / length of data axis 2
EXTEND  =                    F / F = no extensions T = extension(s)
BSCALE  =                    1 / ratio of physical to array value at 0 offset
BZERO   =                32768 / physical value for the array value 0
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: ------------------------------------
FILENAME= 'solo_L0_eui-hrieuvzer-image_064594666167ba_V01.fits' / FITS filename
DATE    = '2020-07-29T13:43:09.454' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2020.174.11.55.02.113.txlD@2020.174.11.&'
CONTINUE  '55.03.860.1.xml&'
CONTINUE  '' / raw filename
APID    =                  940 / APID number of associated TM
TIMESYS = 'OBT     '           / system used for time keywords
OBT_BEG =    645946661.4051819 / start acquisition time in OBT
LEVEL   = 'L0      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = '/home/eui/pipeline/telemetry_parser.py --databaseExternal &'
CONTINUE  '--workingDirectory /tmp/telemetry_parser --configFile &'
CONTINUE  '/home/eui/config/config.ini --outputDirectory &'
CONTINUE  '/data/solo-eui/internal/L0/ --atROB&'
CONTINUE  '' / fits creation software
VERS_SW = '769     '           / version of SW that provided FITS file
VERSION = '01      '           / incremental version number
JOBID   = '20200729T083227.226Z_TPe' / unique pipeline job ID
COMPLETE= 'C       '           / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: --------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/HRI_EUV'   / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'HRI_EUV '           / instrument subunit or sensor
XPOSURE =                  2.0 / [s] total effective exposure time
FILTER  = 'zero_1  '           / filter position
COMMENT --------- Description of Data Content: ---------------------------------
BTYPE   = 'Intensity'          / type of data
BUNIT   = 'DN      '           / units of physical value, after BSCALE, BZERO
BLANK   =                32767 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: ------------------
PXBEG1  =                  513 / first read-out pixel in dimension 1
PXEND1  =                 2560 / last read-out pixel in dimension 1
PXBEG2  =                  513 / first read-out pixel in dimension 2
PXEND2  =                 2560 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: ---------------------------
WCSNAME = 'InstrumentLOS'      / name of coordinate system
CTYPE1  = 'YLOS-TAN'           / spatial axis parallel to S/C -Y
CTYPE2  = 'ZLOS-TAN'           / spatial axis parallel to S/C +Z
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
PC1_1   =                  1.0 / WCS coordinate transformation matrix
PC1_2   =                  0.0 / WCS coordinate transformation matrix
PC2_1   =                  0.0 / WCS coordinate transformation matrix
PC2_2   =                  1.0 / WCS coordinate transformation matrix
CDELT1  =                0.492 / [arcsec] pixel scale along axis 1
CDELT2  =                0.492 / [arcsec] pixel scale along axis 2
CRVAL1  =                  0.0 / [arcsec] value of reference pixel along axis 1
CRVAL2  =                  0.0 / [arcsec] value of reference pixel along axis 2
CRPIX1  =               1024.5 / [pixel] reference pixel location along axis 1
CRPIX2  =               1024.5 / [pixel] reference pixel location along axis 2
COMMENT --------- Front End Electronics: ---------------------------------------
DETGAINL=                0.875 / commanded low gain value
DETGAINH=                  3.0 / commanded high-gain value
GAINCOMB= 'high-only'          / commanded low/high gain combination
READOUTM=                    4 / commanded FEE readout mode
DOWNLOAM=                    0 / commanded FEE download mode
GAINTHRE=                16383 / commanded threshold value for H/L gain
```

```
LEDSTATE= 'all off '          / LED control for current telescope
COMMENT --------- Temperature: -----------------------------------------
TEMPINT =               1078 / [DN] internal APS detector temperature (raw)
COMMENT --------- Telemetry Header: -------------------------------------
ALU     =              20800 / CEB ALU register
ALU2    =                  0 / CEB ALU2 register
DETREG20=                 85 / REG20_VDAC_CLIPP
DETREG21=                 86 / REG21_VDAC_OFFSETP
DETREG22=                 63 / REG22_VDAC_CMREF
DETREG23=                 39 / REG23_VDAC_OFFSETN
DETREG24=                 41 / REG24_VDAC_CLIPN
DETREG25=                 35 / REG25_VDAC_CMREF_LV
DETREG26=                137 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                  8 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                  0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                  0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                 15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                  0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                127 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                  0 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                  0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                255 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                  0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                 63 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                  0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                  0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                  0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                  0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                 64 / REG3D_XWIN_ADDRESS
DETREG3E=                 65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                 65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                 34 / Door position (raw) = open
FILCPOS =                  0 / commanded filter wheel position
COMMENT --------- CEB Pixel Preprocessing: -----------------------------
GAOFSTAT= 'none    '          / status of the CEB gain and offset correction
BADPXREM= 'off     '          / commanded bad pixel removal on or off
CRREM   = 'off     '          / cosmic ray removal on or off
COMMENT --------- Data Routing: ----------------------------------------
PRIORITY=                 10 / priority # of image/histogram when downloaded
SCITABID=                152 / exposure identifier in sec. science table
SCITABNR=                  0 / sequential number of SCITABID
COMMENT --------- Onboard Processing: -----------------------------------
RECSTATE= 'off     '          / recoding on or off
RECNRBIT=                  8 / bit depth recoding output (sqrt)
RECLOW  =                  0 / rec. threshold low (clipped 0)
RECHIGH =              32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                  0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'  / WICOM compression splitb3 mode
COMSPLVL=                  0 / WICOM compression splitb3 value
COMWEIMD= 'off     '          / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =            3964576 / number of bytes onboard compressed image
COMPRESS= 'Lossless'          / data compression quality (None/Lossless/Lossy)
COMP_RAT=   1.586917743536762 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: -----------------------------
DATAMIN =                  0 / minimum valid physical value
DATAMAX =               4027 / maximum valid physical value
DATAMEAN=   972.0249886512756 / [DN] average pixel value across the image
COMMENT --------- Parameters Closing Metadata: --------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= 'IphCJoeAIoeAIoeA'   / HDU checksum updated 2020-07-29T13:43:09
DATASUM = '3729436225'         / data unit checksum updated 2020-07-29T13:43:09
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
END
```

6.1.3 HRI Ly-α Image

```
SIMPLE  =                    T / file conforms to basic FITS standards
BITPIX  =                   16 / number of bits per data pixel, rounded up
NAXIS   =                    2 / number of axes in data cube
NAXIS1  =                 2048 / length of data axis 1
NAXIS2  =                 2048 / length of data axis 2
EXTEND  =                    F / F = no extensions T = extension(s)
BSCALE  =                    1 / ratio of physical to array value at 0 offset
BZERO   =                32768 / physical value for the array value 0
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: ----------------------------------------
FILENAME= 'solo_L0_eui-hrilya1216-image_06459466016c81_V01.fits' / FITS filename
DATE    = '2020-07-29T13:43:05.938' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2020.174.11.50.03.102.ZWas@2020.174.11.&'
CONTINUE  '50.04.668.1.xml;BatchRequest.PktTmRaw.SOL.0.2020.174.11.55.02.113.t&'
CONTINUE  'xlD@2020.174.11.55.03.860.1.xml&'
CONTINUE  '' / raw filename
APID    =                  940 / APID number of associated TM
TIMESYS = 'OBT     '           / system used for time keywords
OBT_BEG =      645946601.4238434 / start acquisition time in OBT
LEVEL   = 'L0      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = '/home/eui/pipeline/telemetry_parser.py --databaseExternal &'
CONTINUE  '--workingDirectory /tmp/telemetry_parser --configFile &'
CONTINUE  '/home/eui/config/config.ini --outputDirectory &'
CONTINUE  '/data/solo-eui/internal/L0/ --atROB&'
CONTINUE  '' / fits creation software
VERS_SW = '769     '           / version of SW that provided FITS file
VERSION = '01      '           / incremental version number
JOBID   = '20200729T083227.226Z_TPe' / unique pipeline job ID
COMPLETE= 'C       '           / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: --------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/HRI_LYA'   / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'HRI_LYA '           / instrument subunit or sensor
XPOSURE =                  1.0 / [s] total effective exposure time
WAVELNTH=                 1216 / [Angstrom] characteristic wavelength of observa
COMMENT --------- Description of Data Content: ---------------------------------
BTYPE   = 'Intensity'          / type of data
BUNIT   = 'DN      '           / units of physical value, after BSCALE, BZERO
BLANK   =                32767 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: ------------------
PXBEG1  =                  105 / first read-out pixel in dimension 1
PXEND1  =                 2152 / last read-out pixel in dimension 1
PXBEG2  =                  513 / first read-out pixel in dimension 2
PXEND2  =                 2560 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: ---------------------------
WCSNAME = 'InstrumentLOS'      / name of coordinate system
CTYPE1  = 'YLOS-TAN'           / spatial axis parallel to S/C -Y
CTYPE2  = 'ZLOS-TAN'           / spatial axis parallel to S/C +Z
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
PC1_1   =                  1.0 / WCS coordinate transformation matrix
PC1_2   =                  0.0 / WCS coordinate transformation matrix
PC2_1   =                  0.0 / WCS coordinate transformation matrix
PC2_2   =                  1.0 / WCS coordinate transformation matrix
CDELT1  =                0.502 / [arcsec] pixel scale along axis 1
CDELT2  =                0.502 / [arcsec] pixel scale along axis 2
CRVAL1  =                  0.0 / [arcsec] value of reference pixel along axis 1
CRVAL2  =                  0.0 / [arcsec] value of reference pixel along axis 2
CRPIX1  =               1024.5 / [pixel] reference pixel location along axis 1
CRPIX2  =               1024.5 / [pixel] reference pixel location along axis 2
COMMENT --------- HRI Lyman alpha: ---------------------------------------------
LYACMCP =              -53.302 / [V] commanded MCP voltage (0)
LYACSCR =      4415.469999999999 / [V] commanded screen voltage (2122)
COMMENT --------- Front End Electronics: ---------------------------------------
DETGAINL=      1.285714285714286 / commanded low gain value
DETGAINH=                  3.0 / commanded high-gain value
```

```
GAINCOMB= 'low-only'            / commanded low/high gain combination
READOUTM=                    4 / commanded FEE readout mode
DOWNLOAM=                    0 / commanded FEE download mode
GAINTHRE=                    0 / commanded threshold value for H/L gain
LEDSTATE= 'all off '           / LED control for current telescope
COMMENT --------- Temperature: ----------------------------------------------
TEMPINT =                 1130 / [DN] internal APS detector temperature (raw)
COMMENT --------- Telemetry Header: -----------------------------------------
ALU     =                20480 / CEB ALU register
ALU2    =                    0 / CEB ALU2 register
DETREG20=                   87 / REG20_VDAC_CLIPP
DETREG21=                   88 / REG21_VDAC_OFFSETP
DETREG22=                   63 / REG22_VDAC_CMREF
DETREG23=                   39 / REG23_VDAC_OFFSETN
DETREG24=                   39 / REG24_VDAC_CLIPN
DETREG25=                   35 / REG25_VDAC_CMREF_LV
DETREG26=                  142 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                  136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                  136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                  136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                    8 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                  136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                    0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                  136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                  255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                  240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                    0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                   15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                    0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                  255 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                  128 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                    0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                  127 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                    0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                   63 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                    0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                    0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                    0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                    0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                   64 / REG3D_XWIN_ADDRESS
DETREG3E=                   65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                   65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                   26 / Door position (raw) = open
COMMENT --------- CEB Pixel Preprocessing: ----------------------------------
GAOFSTAT= 'none    '           / status of the CEB gain and offset correction
BADPXREM= 'off     '           / commanded bad pixel removal on or off
CRREM   = 'off     '           / cosmic ray removal on or off
COMMENT --------- Data Routing: ---------------------------------------------
PRIORITY=                   10 / priority # of image/histogram when downloaded
SCITABID=                  151 / exposure identifier in sec. science table
SCITABNR=                    0 / sequential number of SCITABID
COMMENT --------- Onboard Processing: ---------------------------------------
RECSTATE= 'off     '           / recoding on or off
RECNRBIT=                    8 / bit depth recoding output (sqrt)
RECLOW  =                    0 / rec. threshold low (clipped 0)
RECHIGH =                32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                    0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'   / WICOM compression splitb3 mode
COMSPLVL=                    0 / WICOM compression splitb3 value
COMWEIMD= 'off     '           / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =              2022816 / number of bytes onboard compressed image
COMPRESS= 'Lossless'           / data compression quality (None/Lossless/Lossy)
COMP_RAT=    3.110246310094443 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: ---------------------------------
DATAMIN =                    0 / minimum valid physical value
DATAMAX =                 2347 / maximum valid physical value
DATAMEAN=     20.0002498626709 / [DN] average pixel value across the image
COMMENT --------- Parameters Closing Metadata: ------------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= 'EIpXEFnVEFnVEFnV'   / HDU checksum updated 2020-07-29T13:43:06
DATASUM = '2175829895'         / data unit checksum updated 2020-07-29T13:43:06
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
```

```
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
END
```

6.2 L1

6.2.1 FSI Image

```
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                 3072 / length of data axis 1
NAXIS2  =                 3072 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BSCALE  =                    1
BZERO   =                32768
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: -----------------------------------
FILENAME= 'solo_L1_eui-fsi304-image-occulter_20211104T211200214_V02.fits' / FITS
DATE    = '2023-01-11T19:58:14.248' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2021.309.02.52.03.195.izhz@2021.309.02.&'
PARENT  = 'solo_L0_eui-fsi174-image_0689375428e798_V00.fits' / source file curre
APID    =                  940 / APID number of associated TM
DATE-OBS= '2021-11-04T21:12:00.214' / [UTC] deprecated, same as DATE-BEG.
DATE-BEG= '2021-11-04T21:12:00.214' / [UTC] start time of observation
DATE-AVG= '2021-11-04T21:20:20.214' / [UTC] average time of observation
TIMESYS = 'UTC     '           / system used for time keywords
OBT_BEG =     689375428.9046631 / start acquisition time in OBT
LEVEL   = 'L1      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = '/home/eui/pipeline/level0_to_level1_release_v2.py --release_number &'
VERS_SW = '973     '           / version of SW that provided FITS file
VERSION = '02      '           / incremental version number
IMGTYPE = 'occulted image'     / type of image; solar, calib., engineering
JOBID   = '20230111T191047.685Z_01f' / unique pipeline job ID
COMPLETE= 'C       '           / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: --------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/FSI'       / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'FSI     '           / instrument subunit or sensor
DOORINT = 'occulter'           / internal door position
DOOREXT = 'open    '           / external HS Door 2 FSI @-284.06 s
XPOSURE =               1000.0 / [s] total effective exposure time
FILTER  = 'Magnesium_304_n26'  / physical filter during acquisition
FILTPOS =                  100 / (0-199) filter wheel position service5
WAVELNTH=                  304 / [Angstrom] characteristic wavelength observatio
WAVEUNIT= 'Angstrom'           / Wavelength unit
WAVEMIN =                  250 / [Angstrom] min wavelength resp. > 0.05 of max
WAVEMAX =                  350 / [Angstrom] max wavelength resp. > 0.05 of max
SOOPNAME= 'L_FULL_LRES_MCAD_Coronal-Synoptic' / name of the SOOP Campaign that t
SOOPTYPE= 'LF5     '           / campaign ID(s) that the data belong to
OBS_MODE= 'FSI_GENERIC_S_B'    / observation mode
OBS_TYPE= 'u7FA    '           / encoded version of OBS_MODE
OBS_ID  = 'SEUI_050A_000_000_u7FA_119' / unique ID of the individual observation
TARGET  = 'Sun, off-limb corona' / type of target from planning
COMMENT --------- Description of Data Content: --------------------------------
BTYPE   = 'Intensity'          / type of data
BUNIT   = 'DN      '           / units of physical value, after BSCALE, BZERO
UCD     = 'phot.count;em.UV.10-50nm' / Unified Content Descriptor
BLANK   =                32767 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: -----------------
PXBEG1  =                    1 / first read-out pixel in dimension 1
PXEND1  =                 3072 / last read-out pixel in dimension 1
PXBEG2  =                    1 / first read-out pixel in dimension 2
PXEND2  =                 3072 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: --------------------------
WCSNAME = 'Helioprojective-cartesian' / name of coordinate system
CTYPE1  = 'HPLN-TAN'           / helioprojective longitude (Solar X)
CTYPE2  = 'HPLT-TAN'           / helioprojective latitude (Solar Y)
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
PC1_1   =    0.9351860160225182 / WCS coordinate transformation matrix
```

```
PC1_2   =   0.3549207979721501 / WCS coordinate transformation matrix
PC2_1   =  -0.3533946619994144 / WCS coordinate transformation matrix
PC2_2   =   0.9351860160225182 / WCS coordinate transformation matrix
CDELT1  =            4.4353411 / [arcsec] pixel scale along axis 1
CDELT2  =            4.4449078 / [arcsec] pixel scale along axis 2
CROTA   =   -20.74178206764216 / [deg] rotation angle
CRVAL1  =    124.9713705945487 / [arcsec] value of reference pixel along axis 1
CRVAL2  =    78.48223866060275 / [arcsec] value of reference pixel along axis 2
CRPIX1  =               1536.5 / [pixel] reference pixel location along axis 1
CRPIX2  =               1536.5 / [pixel] reference pixel location along axis 2
LONPOLE =                180.0 / [deg] native longitude of the celestial pole
ATT_SKD = 'v107_20230110_001+flown' / attitude SKD version, +flown/+predicted
COMMENT --------- Front End Electronics: --------------------------------------
DETGAINL=                0.875 / commanded low gain value
DETGAINH=                  3.0 / commanded high-gain value
GAINCOMB= 'high-only'          / commanded low/high gain combination
READOUTM=                    4 / commanded FEE readout mode
DOWNLOAM=                    0 / commanded FEE download mode
GAINTHRE=                16383 / commanded threshold value for H/L gain
LEDSTATE= 'all off '           / LED control for current telescope
COMMENT --------- Temperature: ------------------------------------------------
TEMPINT =    211.3479264844486 / [K] internal APS detector temperature
TEMP1DET=    212.2904335532516 / [K] last measured APS det. T before date-avg
TEMP2DET=    212.6674363807728 / [K] earliest measured APS det. T after date-avg
TTEMP1  = '2021-11-04T21:19:37.515632' / [UTC] time TEMP1DET measurement
TTEMP2  = '2021-11-04T21:20:37.514910' / [UTC] time TEMP2DET measurement
COMMENT --------- Telemetry Header: --------------------------------------------
ALU     =                21121 / CEB ALU register
ALU2    =                    0 / CEB ALU2 register
DETREG20=                   85 / REG20_VDAC_CLIPP
DETREG21=                   87 / REG21_VDAC_OFFSETP
DETREG22=                   63 / REG22_VDAC_CMREF
DETREG23=                   39 / REG23_VDAC_OFFSETN
DETREG24=                   41 / REG24_VDAC_CLIPN
DETREG25=                   35 / REG25_VDAC_CMREF_LV
DETREG26=                  137 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                  136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                  136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                  136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                    8 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                  136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                    0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                  136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                  255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                  240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                    0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                   15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                    0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                  127 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                    0 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                    0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                  255 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                    0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                   61 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                    0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                    0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                    0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                    0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                    0 / REG3D_XWIN_ADDRESS
DETREG3E=                   65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                   65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                   23 / Door position (raw) = intermediate
FILCPOS =                    2 / filter wheel commanded position
COMMENT --------- CEB Pixel Preprocessing: ------------------------------------
GAOFSTAT= 'none    '           / status of the CEB gain and offset correction
BADPXREM= 'off     '           / commanded bad pixel removal on or off
BADPXDEF=                   50 / commanded bad pixel default @-58.69 s
CRREM   = 'off     '           / cosmic ray removal on or off
CRREMLIM=                 1024 / [1 G. sigma DN] cosmic ray limit @-58.69 s
GAINHG  =                   86 / global gain corr. high gain @PT-8.3 d
GAINLG  =                 2240 / global gain corr. low gain  @PT-8.3 d
OFFSETHG=                    9 / [DN] global offset corr. high gain @PT-8.3 d
OFFSETLG=                  210 / [DN] global offset corr. low gain @PT-8.3 d
COMMENT --------- Data Routing: -----------------------------------------------
```

```
PRIORITY=                    117 / priority # of image/histogram when downloaded
SCITABID=                   1732 / exposure identifier in sec. science table
SCITABNR=                      6 / sequential number of SCITABID
COMMENT --------- Onboard Processing: -------------------------------------------
RECSTATE= 'off      '           / recoding on or off
RECNRBIT=                      8 / bit depth recoding output (sqrt)
RECLOW  =                      0 / rec. threshold low (clipped 0)
RECHIGH =                  32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                      0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'    / WICOM compression splitb3 mode
COMSPLVL=                      0 / WICOM compression splitb3 value
COMWEIMD= 'off      '           / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =                7573200 / number of bytes onboard compressed image
COMSTRIP= 'off      '           / compression type: off=whole image; on=strip
COMPRESS= 'Lossless'            / data compression quality (None/Lossless/Lossy)
COMP_RAT=    1.869193471716051 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: -------------------------------------
EUXCEN  =    1516.403174982693 / [pixel] axis 1 location of solar center in L1
EUYCEN  =    1510.008914925833 / [pixel] axis 2 location of solar center in L1
DATAMIN =                      0 / minimum valid physical value
DATAMAX =                   4076 / maximum valid physical value
DATAMEAN=    146.0858675638835 / [DN] average pixel value across the image
COMMENT --------- Solar Ephemeris: ----------------------------------------------
RSUN_ARC=    1126.040666286041 / [arcsec] apparent photospheric solar radius
RSUN_OBS=    1126.040666286041 / [arcsec] apparent photospheric solar radius
RSUN_REF=              695700000 / [m] assumed physical solar radius
SOLAR_B0=    2.015392801128499 / [deg] s/c tilt of solar North pole
SOLAR_P0=    23.76236553474817 / [deg] s/c celestial North to solar North angle
SOLAR_EP=    6.013562864140908 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =    2250.515859984944 / carrington rotation number
HGLT_OBS=    2.015392801128499 / [deg] s/c Heliographic latitude (B0 angle)
HGLN_OBS=  -0.7846259809980215 / [deg] s/c Heliographic longitude
CRLT_OBS=    2.015392801128499 / [deg] s/c Carrington latitude (B0 angle)
CRLN_OBS=    174.2904054202723 / [deg] s/c Carrington longitude (L0 angle)
DSUN_OBS=    127436905950.3248 / [m] s/c distance from Sun
DSUN_AU =   0.8518631004172761 / [AU] s/c distance from Sun
HEEX_OBS=    127350008410.5414 / [m] s/c Heliocentric Earth Ecliptic X
HEEY_OBS=   -1272537644.917119 / [m] s/c Heliocentric Earth Ecliptic Y
HEEZ_OBS=   -4530011475.618224 / [m] s/c Heliocentric Earth Ecliptic Z
HCIX_OBS=    105634130543.0943 / [m] s/c Heliocentric Inertial X
HCIY_OBS=   -71144288827.70169 / [m] s/c Heliocentric Inertial Y
HCIZ_OBS=    4481699431.801558 / [m] s/c Heliocentric Inertial Z
HCIX_VOB=    26740.66469431491 / [m/s] s/c Heliocentric Inertial X Velocity
HCIY_VOB=    19427.71855267077 / [m/s] s/c Heliocentric Inertial Y Velocity
HCIZ_VOB=   -275.0440243945516 / [m/s] s/c Heliocentric Inertial Z Velocity
HAEX_OBS=    94930746003.66862 / [m] s/c Heliocentric Aries Ecliptic X
HAEY_OBS=    84898502670.31662 / [m] s/c Heliocentric Aries Ecliptic Y
HAEZ_OBS=   -4534611969.852157 / [m] s/c Heliocentric Aries Ecliptic Z
HEQX_OBS=    127346133594.8651 / [m] s/c Heliocentric Earth Equatorial X
HEQY_OBS=   -1744026041.576473 / [m] s/c Heliocentric Earth Equatorial Y
HEQZ_OBS=    4481699431.801558 / [m] s/c Heliocentric Earth Equatorial Z
GSEX_OBS=    20998197843.10543 / [m] s/c Geocentric Solar Ecliptic X
GSEY_OBS=    1272537644.917119 / [m] s/c Geocentric Solar Ecliptic Y
GSEZ_OBS=   -4530011475.618225 / [m] s/c Geocentric Solar Ecliptic Z
OBS_VR  =    33054.06626511928 / [m/s] Radial velocity of S/C relative to Sun
EAR_TDEL=    69.75258965094451 / [s] Time(Sun to Earth) - Time(Sun to S/C)
SUN_TIME=     425.083762281721 / [s] Time(Sun to S/C)
DATE_EAR= '2021-11-04T21:21:29.966' / [UTC] start time of observation Earth
DATE_SUN= '2021-11-04T21:13:15.130' / [UTC] start time of observation Sun
COMMENT --------- Parameters Closing Metadata: ----------------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= '1imh3Zkg1fkg1Zkg'   / HDU checksum updated 2023-01-11T19:58:14
DATASUM = '2090231674'         / data unit checksum updated 2023-01-11T19:58:14
ZCHECKSUM= 'UAjYX3hVU9hVU9hV'   / HDU checksum updated 2023-01-11T19:58:14
ZDATASUM= '2476219464'         / data unit checksum updated 2023-01-11T19:58:14
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
HISTORY created by /home/eui/pipeline/level0_to_level1_release_v2.py --release_n
HISTORY umber 6 --configFile /home/eui/config/config.ini
END
```

6.2.2 HRI EUV Image

```
BITPIX  =                   16 / 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
BSCALE  =                    1
BZERO   =                32768
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: ----------------------------------------
FILENAME= 'solo_L1_eui-hrieuvzer-image-short_20221018T142958231_V01.fits' / FITS
DATE    = '2023-01-12T04:07:50.885' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2022.297.18.37.03.395.shWx@2022.297.18.&'
PARENT  = 'solo_L0_eui-hrieuvzer-image_0719418455291c_V00.fits' / source file cu
APID    =                  940 / APID number of associated TM
DATE-OBS= '2022-10-18T14:29:58.231' / [UTC] deprecated, same as DATE-BEG.
DATE-BEG= '2022-10-18T14:29:58.231' / [UTC] start time of observation
DATE-AVG= '2022-10-18T14:29:58.246' / [UTC] average time of observation
TIMESYS = 'UTC     '           / system used for time keywords
OBT_BEG =    719418455.1605835 / start acquisition time in OBT
LEVEL   = 'L1      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = '/home/eui/pipeline/level0_to_level1_release_v2.py --release_number &'
VERS_SW = '973     '           / version of SW that provided FITS file
VERSION = '01      '           / incremental version number
IMGTYPE = 'solar image, short' / type of image; solar, calib., engineering
JOBID   = '20230112T032247.029Z_01f' / unique pipeline job ID
COMPLETE= 'C       '           / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: --------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/HRI_EUV'   / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'HRI_EUV '           / instrument subunit or sensor
DOORINT = 'open    '           / internal door position
DOOREXT = 'open    '           / external HS Door 3 HRI @-210.35 s
XPOSURE =                 0.03 / [s] total effective exposure time
FILTER  = 'zero_1  '           / physical filter during acquisition
FILTPOS =                    0 / (0-199) filter wheel position service5
SOOPNAME= 'R_SMALL_MRES_MCAD_AR-Long-Term' / name of the SOOP Campaign that the
SOOPTYPE= 'RS0     '           / campaign ID(s) that the data belong to
OBS_MODE= 'EUV_GENERIC'        / observation mode
OBS_TYPE= 'AtaE    '           / encoded version of OBS_MODE
OBS_ID  = 'SEUI_090A_RS0_114_AtaE_11B' / unique ID of the individual observation
TARGET  = 'Sun, subfield of on-disc corona' / type of target from planning
COMMENT --------- Description of Data Content: ---------------------------------
BTYPE   = 'Intensity'          / type of data
BUNIT   = 'DN      '           / units of physical value, after BSCALE, BZERO
UCD     = 'phot.count;em.UV.10-50nm' / Unified Content Descriptor
BLANK   =                32767 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: ------------------
PXBEG1  =                  641 / first read-out pixel in dimension 1
PXEND1  =                 2688 / last read-out pixel in dimension 1
PXBEG2  =                  577 / first read-out pixel in dimension 2
PXEND2  =                 2624 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: ---------------------------
WCSNAME = 'Helioprojective-cartesian' / name of coordinate system
CTYPE1  = 'HPLN-TAN'           / helioprojective longitude (Solar X)
CTYPE2  = 'HPLT-TAN'           / helioprojective latitude (Solar Y)
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
PC1_1   =    0.9919999074186953 / WCS coordinate transformation matrix
PC1_2   =   -0.1262385982229687 / WCS coordinate transformation matrix
PC2_1   =    0.1262385982229687 / WCS coordinate transformation matrix
PC2_2   =    0.9919999074186953 / WCS coordinate transformation matrix
CDELT1  =                0.492 / [arcsec] pixel scale along axis 1
CDELT2  =                0.492 / [arcsec] pixel scale along axis 2
CROTA   =     7.252288884959725 / [deg] rotation angle
CRVAL1  =    -1539.264371342719 / [arcsec] value of reference pixel along axis 1
```

```
CRVAL2  =    895.1292856502649 / [arcsec] value of reference pixel along axis 2
CRPIX1  =               896.5 / [pixel] reference pixel location along axis 1
CRPIX2  =               960.5 / [pixel] reference pixel location along axis 2
LONPOLE =               180.0 / [deg] native longitude of the celestial pole
ATT_SKD = 'v107_20230111_001+flown' / attitude SKD version, +flown/+predicted
COMMENT --------- Front End Electronics: ------------------------------------
DETGAINL=               0.875 / commanded low gain value
DETGAINH=                 3.0 / commanded high-gain value
GAINCOMB= 'combined'          / commanded low/high gain combination
READOUTM=                   4 / commanded FEE readout mode
DOWNLOAM=                   0 / commanded FEE download mode
GAINTHRE=               15900 / commanded threshold value for H/L gain
LEDSTATE= 'all off '          / LED control for current telescope
COMMENT --------- Temperature: -----------------------------------------------
TEMPINT =   222.6579365079365 / [K] internal APS detector temperature
TEMP1DET=   222.6579365079365 / [K] last measured APS det. T before date-avg
TEMP2DET=   222.8166666666666 / [K] earliest measured APS det. T after date-avg
TTEMP1  = '2022-10-18T14:29:00.802348' / [UTC] time TEMP1DET measurement
TTEMP2  = '2022-10-18T14:30:00.801510' / [UTC] time TEMP2DET measurement
COMMENT --------- Telemetry Header: -------------------------------------------
ALU     =               20835 / CEB ALU register
ALU2    =                   0 / CEB ALU2 register
DETREG20=                  85 / REG20_VDAC_CLIPP
DETREG21=                  86 / REG21_VDAC_OFFSETP
DETREG22=                  63 / REG22_VDAC_CMREF
DETREG23=                  39 / REG23_VDAC_OFFSETN
DETREG24=                  41 / REG24_VDAC_CLIPN
DETREG25=                  35 / REG25_VDAC_CMREF_LV
DETREG26=                 131 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                 136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                 136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                 136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                   4 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                 136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                   0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                 136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                 255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                 240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                   0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                  15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                   0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                 127 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                   0 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                   0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                 255 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                   0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                  63 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                   0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                   0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                   0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                   0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                  68 / REG3D_XWIN_ADDRESS
DETREG3E=                  65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                  65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                  34 / Door position (raw) = open
FILCPOS =                   0 / filter wheel commanded position
COMMENT --------- CEB Pixel Preprocessing: -----------------------------------
GAOFSTAT= 'both    '          / status of the CEB gain and offset correction
BADPXREM= 'off     '          / commanded bad pixel removal on or off
BADPXDEF=                  50 / commanded bad pixel default @-3.44 s
CRREM   = 'off     '          / cosmic ray removal on or off
CRREMLIM=                1024 / [1 G. sigma DN] cosmic ray limit @-3.44 s
GAINHG  =                  72 / global gain corr. high gain @PT-11.0 d
GAINLG  =                1806 / global gain corr. low gain  @PT-11.0 d
OFFSETHG=                   4 / [DN] global offset corr. high gain @PT-11.0 d
OFFSETLG=                  64 / [DN] global offset corr. low gain @PT-11.0 d
COMMENT --------- Data Routing: ----------------------------------------------
PRIORITY=                 180 / priority # of image/histogram when downloaded
SCITABID=               14543 / exposure identifier in sec. science table
SCITABNR=                 360 / sequential number of SCITABID
COMMENT --------- Onboard Processing: -----------------------------------------
RECSTATE= 'on      '          / recoding on or off
RECNRBIT=                   8 / bit depth recoding output (sqrt)
RECLOW  =                 250 / rec. threshold low (clipped 0)
```

```
RECHIGH =                25600 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                    0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'   / WICOM compression splitb3 mode
COMSPLVL=                    5 / WICOM compression splitb3 value
COMWEIMD= 'off     '           / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =                40992 / number of bytes onboard compressed image
COMSTRIP= 'off     '           / compression type: off=whole image; on=strip
COMPRESS= 'Lossless'           / data compression quality (None/Lossless/Lossy)
COMP_RAT=    191.8501170960187 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: -----------------------------------
EUXCEN  =    3770.382617105806 / [pixel] axis 1 location of solar center in L1
EUYCEN  =   -1239.261676881483 / [pixel] axis 2 location of solar center in L1
DATAMIN =                  250 / minimum valid physical value
DATAMAX =                  250 / maximum valid physical value
DATAMEAN=                250.0 / [DN] average pixel value across the image
COMMENT --------- Solar Ephemeris: ---------------------------------------------
RSUN_ARC=    2986.911373672879 / [arcsec] apparent photospheric solar radius
RSUN_OBS=    2986.911373672879 / [arcsec] apparent photospheric solar radius
RSUN_REF=            695700000 / [m] assumed physical solar radius
SOLAR_B0=    2.791470813782741 / [deg] s/c tilt of solar North pole
SOLAR_P0=    10.44786353794006 / [deg] s/c celestial North to solar North angle
SOLAR_EP=   -4.516042166914556 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =    2263.478924313159 / carrington rotation number
HGLT_OBS=    2.791470813782741 / [deg] s/c Heliographic latitude (B0 angle)
HGLN_OBS=   -77.87473975620243 / [deg] s/c Heliographic longitude
CRLT_OBS=    2.791470813782741 / [deg] s/c Carrington latitude (B0 angle)
CRLN_OBS=    187.5872472627962 / [deg] s/c Carrington longitude (L0 angle)
DSUN_OBS=    48044090734.38875 / [m] s/c distance from Sun
DSUN_AU =   0.3211549102241917 / [AU] s/c distance from Sun
HEEX_OBS=    10260326950.2788 / [m] s/c Heliocentric Earth Ecliptic X
HEEY_OBS=   -46873435910.77759 / [m] s/c Heliocentric Earth Ecliptic Y
HEEZ_OBS=   -2416888761.566544 / [m] s/c Heliocentric Earth Ecliptic Z
HCIX_OBS=   -29895159723.21988 / [m] s/c Heliocentric Inertial X
HCIY_OBS=   -37537173824.44016 / [m] s/c Heliocentric Inertial Y
HCIZ_OBS=    2339799327.103956 / [m] s/c Heliocentric Inertial Z
HCIX_VOB=    38557.4693544949 / [m/s] s/c Heliocentric Inertial X Velocity
HCIY_VOB=   -50360.09347085166 / [m/s] s/c Heliocentric Inertial Y Velocity
HCIZ_VOB=    8862.081176886701 / [m/s] s/c Heliocentric Inertial Z Velocity
HAEX_OBS=    29029193735.08664 / [m] s/c Heliocentric Aries Ecliptic X
HAEY_OBS=   -38205991046.43716 / [m] s/c Heliocentric Aries Ecliptic Y
HAEZ_OBS=   -2417191292.502366 / [m] s/c Heliocentric Aries Ecliptic Z
HEQX_OBS=    10079668342.59415 / [m] s/c Heliocentric Earth Equatorial X
HEQY_OBS=   -46916524591.09016 / [m] s/c Heliocentric Earth Equatorial Y
HEQZ_OBS=    2339799327.103956 / [m] s/c Heliocentric Earth Equatorial Z
GSEX_OBS=    138789941118.9205 / [m] s/c Geocentric Solar Ecliptic X
GSEY_OBS=    46873435910.7776 / [m] s/c Geocentric Solar Ecliptic Y
GSEZ_OBS=   -2416888761.566542 / [m] s/c Geocentric Solar Ecliptic Z
OBS_VR  =    64040.71143525701 / [m/s] Radial velocity of S/C relative to Sun
EAR_TDEL=    336.9203415211015 / [s] Time(Sun to Earth) - Time(Sun to S/C)
SUN_TIME=    160.2578365543431 / [s] Time(Sun to S/C)
DATE_EAR= '2022-10-18T14:35:35.166' / [UTC] start time of observation Earth
DATE_SUN= '2022-10-18T14:27:17.988' / [UTC] start time of observation Sun
COMMENT --------- Parameters Closing Metadata: --------------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= '9dXMBaXM9aXMAaXM'   / HDU checksum updated 2023-01-12T04:07:51
DATASUM = '3560999943'         / data unit checksum updated 2023-01-12T04:07:51
ZCHECKSUM= 'ZMongLnnZLnndLnn'  / HDU checksum updated 2023-01-12T04:07:51
ZDATASUM= '525344592'          / data unit checksum updated 2023-01-12T04:07:51
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
HISTORY created by /home/eui/pipeline/level0_to_level1_release_v2.py --release_n
HISTORY umber 6 --configFile /home/eui/config/config.ini
END
```

6.2.3 HRI Ly-α Image

```
BITPIX   =                   16 / 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
BSCALE   =                    1
BZERO    =                32768
LONGSTRN= 'OGIP 1.0'            / The OGIP long string convention may be used
COMMENT --------- General Description: -----------------------------------
FILENAME= 'solo_L1_eui-hrilya1216-image-dark_20230103T104919176_V01.fits' / FITS
DATE     = '2023-01-12T05:57:43.072' / [UTC] FITS file creation date
FILE_RAW = 'BatchRequest.PktTmRaw.SOL.0.2023.004.17.37.03.040.DMOY@2023.004.17.&'
PARENT   = 'solo_L0_eui-hrilya1216-image_07260580048746_V00.fits' / source file c
APID     =                  940 / APID number of associated TM
DATE-OBS= '2023-01-03T10:49:19.176' / [UTC] deprecated, same as DATE-BEG.
DATE-BEG= '2023-01-03T10:49:19.176' / [UTC] start time of observation
DATE-AVG= '2023-01-03T10:49:27.176' / [UTC] average time of observation
TIMESYS  = 'UTC     '           / system used for time keywords
OBT_BEG  =     726058004.5284119 / start acquisition time in OBT
LEVEL    = 'L1      '           / data processing level
ORIGIN   = 'Royal Observatory of Belgium' / file generation location
CREATOR  = '/home/eui/pipeline/level0_to_level1_release_v2.py --release_number &'
VERS_SW  = '973     '           / version of SW that provided FITS file
VERSION  = '01      '           / incremental version number
IMGTYPE  = 'dark image'         / type of image; solar, calib., engineering
JOBID    = '20230112T052446.851Z_01f' / unique pipeline job ID
COMPLETE= 'C       '            / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: --------------------
OBSRVTRY= 'Solar Orbiter'       / satellite name
TELESCOP= 'SOLO/EUI/HRI_LYA'    / telescope/Sensor name
INSTRUME= 'EUI     '            / instrument name
DETECTOR= 'HRI_LYA '            / instrument subunit or sensor
DOORINT  = 'closed  '           / internal door position
DOOREXT  = 'open    '           / external HS Door 3 HRI @-167.70 s
XPOSURE  =                 16.0 / [s] total effective exposure time
WAVELNTH=                 1216 / [Angstrom] characteristic wavelength observatio
WAVEUNIT= 'Angstrom'            / Wavelength unit
WAVEMIN  =                 1120 / [Angstrom] min wavelength resp. > 0.05 of max
WAVEMAX  =                 1340 / [Angstrom] max wavelength resp. > 0.05 of max
SOOPNAME= 'none    '            / name of the SOOP Campaign that the data belong
SOOPTYPE= 'none    '            / campaign ID(s) that the data belong to
OBS_MODE= 'LYA_CALIBRATION'     / observation mode
OBS_TYPE= '22fE    '            / encoded version of OBS_MODE
OBS_ID   = 'SEUI_100A_000_000_22fE_111' / unique ID of the individual observation
COMMENT --------- Description of Data Content: ---------------------------------
BTYPE    = 'Intensity'          / type of data
BUNIT    = 'DN      '           / units of physical value, after BSCALE, BZERO
UCD      = 'phot.count;em.UV.100-200nm' / Unified Content Descriptor
BLANK    =                32767 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: ------------------
PXBEG1   =                  105 / first read-out pixel in dimension 1
PXEND1   =                 2152 / last read-out pixel in dimension 1
PXBEG2   =                  513 / first read-out pixel in dimension 2
PXEND2   =                 2560 / last read-out pixel in dimension 2
NBIN1    =                    1 / on-board binning factor in dim 1
NBIN2    =                    1 / on-board binning factor in dim 1
NBIN     =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: ----------------------------
WCSNAME  = 'Helioprojective-cartesian' / name of coordinate system
CTYPE1   = 'HPLN-TAN'           / helioprojective longitude (Solar X)
CTYPE2   = 'HPLT-TAN'           / helioprojective latitude (Solar Y)
CUNIT1   = 'arcsec  '           / units along axis 1
CUNIT2   = 'arcsec  '           / units along axis 2
PC1_1    =   0.9920146497562566 / WCS coordinate transformation matrix
PC1_2    =   0.1261226968827242 / WCS coordinate transformation matrix
PC2_1    =  -0.1261226968827242 / WCS coordinate transformation matrix
PC2_2    =   0.9920146497562566 / WCS coordinate transformation matrix
CDELT1   =                0.514 / [arcsec] pixel scale along axis 1
CDELT2   =                0.514 / [arcsec] pixel scale along axis 2
CROTA    =   -7.245594722757787 / [deg] rotation angle
```

```
CRVAL1  =      -51.84235311163 / [arcsec] value of reference pixel along axis 1
CRVAL2  =    -675.349228512655 / [arcsec] value of reference pixel along axis 2
CRPIX1  =               1024.5 / [pixel] reference pixel location along axis 1
CRPIX2  =               1024.5 / [pixel] reference pixel location along axis 2
LONPOLE =                180.0 / [deg] native longitude of the celestial pole
ATT_SKD = 'v107_20230111_001+flown' / attitude SKD version, +flown/+predicted
COMMENT --------- HRI Lyman alpha: -----------------------------------------
LYAIMCP = -1.6822879999999E-06 / [A] measured MCP current @-8.71 s
LYAVMCP =    13.42554161000004 / [V] measured MCP voltage @-8.71 s
LYAVSCR =    152.5475300000001 / [V] measured MCP+screen voltage @-8.71 s
LYACMCP =              -53.302 / [V] commanded MCP voltage (0)
LYACSCR =               -115.0 / [V] commanded screen voltage (0)
COMMENT --------- Front End Electronics: -----------------------------------
DETGAINL=     1.285714285714286 / commanded low gain value
DETGAINH=                  3.0 / commanded high-gain value
GAINCOMB= 'low-only'           / commanded low/high gain combination
READOUTM=                    4 / commanded FEE readout mode
DOWNLOAM=                    0 / commanded FEE download mode
GAINTHRE=                    0 / commanded threshold value for H/L gain
LEDSTATE= 'all off '           / LED control for current telescope
COMMENT --------- Temperature: --------------------------------------------
TEMPINT =    232.9921052631579 / [K] internal APS detector temperature
TEMP1DET=    232.3078947368421 / [K] last measured APS det. T before date-avg
TEMP2DET=    232.9921052631579 / [K] earliest measured APS det. T after date-avg
TTEMP1  = '2023-01-03T10:49:00.470310' / [UTC] time TEMP1DET measurement
TTEMP2  = '2023-01-03T10:50:00.469407' / [UTC] time TEMP2DET measurement
COMMENT --------- Telemetry Header: ----------------------------------------
ALU     =                20481 / CEB ALU register
ALU2    =                    0 / CEB ALU2 register
DETREG20=                   87 / REG20_VDAC_CLIPP
DETREG21=                   88 / REG21_VDAC_OFFSETP
DETREG22=                   63 / REG22_VDAC_CMREF
DETREG23=                   39 / REG23_VDAC_OFFSETN
DETREG24=                   39 / REG24_VDAC_CLIPN
DETREG25=                   35 / REG25_VDAC_CMREF_LV
DETREG26=                  142 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                  136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                  136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                  136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                    8 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                  136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                    0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                  136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                  255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                  240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                    0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                   15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                    0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                  255 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                  128 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                    0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                  127 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                    0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                   63 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                    0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                    0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                    0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                    0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                   64 / REG3D_XWIN_ADDRESS
DETREG3E=                   65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                   65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                    0 / Door position (raw) = closed
COMMENT --------- CEB Pixel Preprocessing: ---------------------------------
GAOFSTAT= 'none    '           / status of the CEB gain and offset correction
BADPXREM= 'off     '           / commanded bad pixel removal on or off
BADPXDEF=                   50 / commanded bad pixel default @-6.70 s
CRREM   = 'off     '           / cosmic ray removal on or off
CRREMLIM=                 1024 / [1 G. sigma DN] cosmic ray limit @-6.70 s
GAINHG  =                  256 / global gain corr. high gain @PT-1.4 d
GAINLG  =                  256 / global gain corr. low gain  @PT-1.4 d
OFFSETHG=                    0 / [DN] global offset corr. high gain @PT-1.4 d
OFFSETLG=                    0 / [DN] global offset corr. low gain @PT-1.4 d
COMMENT --------- Data Routing: --------------------------------------------
PRIORITY=                   40 / priority # of image/histogram when downloaded
```

```
SCITABID=                15281 / exposure identifier in sec. science table
SCITABNR=                    6 / sequential number of SCITABID
COMMENT --------- Onboard Processing: ------------------------------------
RECSTATE= 'off     '              / recoding on or off
RECNRBIT=                    8 / bit depth recoding output (sqrt)
RECLOW  =                    0 / rec. threshold low (clipped 0)
RECHIGH =                32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                    0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'   / WICOM compression splitb3 mode
COMSPLVL=                    5 / WICOM compression splitb3 value
COMWEIMD= 'off     '              / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =              2045920 / number of bytes onboard compressed image
COMSTRIP= 'off     '              / compression type: off=whole image; on=strip
COMPRESS= 'Lossless'            / data compression quality (None/Lossless/Lossy)
COMP_RAT=    3.075123171971534 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: -----------------------------
EUXCEN  =     958.8414547215771 / [pixel] axis 1 location of solar center in L1
EUYCEN  =     2340.637793333317 / [pixel] axis 2 location of solar center in L1
DATAMIN =                    0 / minimum valid physical value
DATAMAX =                  321 / maximum valid physical value
DATAMEAN=    18.93468356132507 / [DN] average pixel value across the image
COMMENT --------- Solar Ephemeris: --------------------------------------
RSUN_ARC=    1010.195428884279 / [arcsec] apparent photospheric solar radius
RSUN_OBS=    1010.195428884279 / [arcsec] apparent photospheric solar radius
RSUN_REF=            695700000 / [m] assumed physical solar radius
SOLAR_B0=    3.592902422824907 / [deg] s/c tilt of solar North pole
SOLAR_P0=    11.72727885380186 / [deg] s/c celestial North to solar North angle
SOLAR_EP=    7.246707205469041 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =    2266.136779898227 / carrington rotation number
HGLT_OBS=    3.592902422824907 / [deg] s/c Heliographic latitude (B0 angle)
HGLN_OBS=   -21.85402609703183 / [deg] s/c Heliographic longitude
CRLT_OBS=    3.592902422824907 / [deg] s/c Carrington latitude (B0 angle)
CRLN_OBS=    310.7592366382449 / [deg] s/c Carrington longitude (L0 angle)
DSUN_OBS=    142050731241.8172 / [m] s/c distance from Sun
DSUN_AU =    0.949550488767867 / [AU] s/c distance from Sun
HEEX_OBS=    130865539341.0488 / [m] s/c Heliocentric Earth Ecliptic X
HEEY_OBS=    -54283376599.3504 / [m] s/c Heliocentric Earth Ecliptic Y
HEEZ_OBS=    10292515935.59542 / [m] s/c Heliocentric Earth Ecliptic Z
HCIX_OBS=    141302019445.9887 / [m] s/c Heliocentric Inertial X
HCIY_OBS=    11528492073.98158 / [m] s/c Heliocentric Inertial Y
HCIZ_OBS=    8901877179.592558 / [m] s/c Heliocentric Inertial Z
HCIX_VOB=    620.5885718037005 / [m/s] s/c Heliocentric Inertial X Velocity
HCIY_VOB=    20947.30914407341 / [m/s] s/c Heliocentric Inertial Y Velocity
HCIZ_VOB=   -2470.435755868838 / [m/s] s/c Heliocentric Inertial Z Velocity
HAEX_OBS=    24748148085.15561 / [m] s/c Heliocentric Aries Ecliptic X
HAEY_OBS=    139499604502.6793 / [m] s/c Heliocentric Aries Ecliptic Y
HAEZ_OBS=    10285900849.52453 / [m] s/c Heliocentric Aries Ecliptic Z
HEQX_OBS=    131583153252.0872 / [m] s/c Heliocentric Earth Equatorial X
HEQY_OBS=   -52773483959.77045 / [m] s/c Heliocentric Earth Equatorial Y
HEQZ_OBS=    8901877179.592558 / [m] s/c Heliocentric Earth Equatorial Z
GSEX_OBS=    16234084157.22679 / [m] s/c Geocentric Solar Ecliptic X
GSEY_OBS=     54283376599.3504 / [m] s/c Geocentric Solar Ecliptic Y
GSEZ_OBS=    10292515935.59541 / [m] s/c Geocentric Solar Ecliptic Z
OBS_VR  =    21101.77816572853 / [m/s] Radial velocity of S/C relative to Sun
EAR_TDEL=    16.84129177278504 / [s] Time(Sun to Earth) - Time(Sun to S/C)
SUN_TIME=    473.8302363891263 / [s] Time(Sun to S/C)
DATE_EAR= '2023-01-03T10:49:44.017' / [UTC] start time of observation Earth
DATE_SUN= '2023-01-03T10:41:33.345' / [UTC] start time of observation Sun
COMMENT --------- Parameters Closing Metadata: --------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= 'BNaHBNUHBNaHBNUH'   / HDU checksum updated 2023-01-12T05:57:43
DATASUM = '4168546390'         / data unit checksum updated 2023-01-12T05:57:43
ZHECKSUM= 'V771X740V740V740'   / HDU checksum updated 2023-01-12T05:57:43
ZDATASUM= '2940544881'         / data unit checksum updated 2023-01-12T05:57:43
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
HISTORY created by /home/eui/pipeline/level0_to_level1_release_v2.py --release_n
HISTORY umber 6 --configFile /home/eui/config/config.ini
END
```

6.3 L2

6.3.1 FSI Image

```
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    2 / number of data axes
NAXIS1  =                 3040 / length of data axis 1
NAXIS2  =                 3072 / length of data axis 2
PCOUNT  =                    0 / required keyword; must = 0
GCOUNT  =                    1 / required keyword; must = 1
BSCALE  =   0.1381207685371334
BZERO   =      4525.80322265625
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: ---------------------------------------
FILENAME= 'solo_L2_eui-fsi304-image_20230110T145420253_V01.fits' / FITS filename
DATE    = '2023-01-22T20:01:44.962' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2023.010.15.37.02.910.FwKj@2023.010.15.&'
PARENT  = 'solo_L1_eui-fsi304-image_20230110T145420253_V01.fits' / source file
APID    =                  940 / APID number of associated TM
DATE-OBS= '2023-01-10T14:54:20.253' / [UTC] deprecated, same as DATE-BEG.
DATE-BEG= '2023-01-10T14:54:20.253' / [UTC] start time of observation
DATE-AVG= '2023-01-10T14:54:25.253' / [UTC] average time of observation
TIMESYS = 'UTC     '           / system used for time keywords
OBT_BEG =     726677504.5290985 / start acquisition time in OBT
LEVEL   = 'L2      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = 'euiprep.py'         / See HISTORY
VERS_SW = '973     '           / (L1) version of SW that provided FITS file
VERS_CAL= 'a57d9e42'           / cal version (euiprep git short SHA-1)
VERSION = '01      '           / incremental version number
IMGTYPE = 'solar image'        / type of image; solar, calib., engineering
JOBID   = '20230112T052446.846Z_01f' / unique pipeline job ID
COMPLETE= 'C      '            / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: -------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/FSI'       / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'FSI     '           / instrument subunit or sensor
DOORINT = 'open    '           / internal door position
DOOREXT = 'open    '           / external HS Door 2 FSI @-164.70 s
XPOSURE =                 10.0 / [s] total effective exposure time
FILTER  = 'Magnesium_304_n26'  / physical filter during acquisition
FILTPOS =                  100 / (0-199) filter wheel position service5
WAVELNTH=                  304 / [Angstrom] characteristic wavelength observatio
WAVEUNIT= 'Angstrom'           / Wavelength unit
WAVEMIN =                  250 / [Angstrom] min wavelength resp. > 0.05 of max
WAVEMAX =                  350 / [Angstrom] max wavelength resp. > 0.05 of max
SOOPNAME= 'none    '           / name of the SOOP Campaign that the data belong
SOOPTYPE= 'none    '           / campaign ID(s) that the data belong to
OBS_MODE= 'FSI_SYNOPTIC_B'     / observation mode
OBS_TYPE= 'ZHq2    '           / encoded version of OBS_MODE
OBS_ID  = 'SEUI_100A_000_000_ZHq2_112' / unique ID of the individual observation
TARGET  = 'Sun, full disc'     / type of target from planning
COMMENT --------- Description of Data Content: -------------------------------
BTYPE   = 'Flux    '           / type of data
BUNIT   = 'DN/s    '           / units of physical value, after BSCALE, BZERO
UCD     = 'phot.count;em.UV.10-50nm' / Unified Content Descriptor
BLANK   =               -32768 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: -----------------
PXBEG1  =                    1 / first read-out pixel in dimension 1
PXEND1  =                 3040 / last read-out pixel in dimension 1
PXBEG2  =                    1 / first read-out pixel in dimension 2
PXEND2  =                 3072 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: ---------------------------
WCSNAME = 'Helioprojective-cartesian' / name of coordinate system
CTYPE1  = 'HPLN-TAN'           / helioprojective longitude (Solar X)
CTYPE2  = 'HPLT-TAN'           / helioprojective latitude (Solar Y)
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
```

```
PC1_1   =    0.9926723888200902 / WCS coordinate transformation matrix
PC1_2   =    0.1208367844417224 / WCS coordinate transformation matrix
PC2_1   =   -0.1208367844417224 / WCS coordinate transformation matrix
PC2_2   =    0.9926723888200902 / WCS coordinate transformation matrix
CDELT1  =           4.44012445 / [arcsec] pixel scale along axis 1
CDELT2  =           4.44012445 / [arcsec] pixel scale along axis 2
CROTA   =     -6.94039823408664 / [deg] rotation angle
CRVAL1  =     92.5252855133984 / [arcsec] value of reference pixel along axis 1
CRVAL2  =    104.7469484751836 / [arcsec] value of reference pixel along axis 2
DCRVAL1 =  -16.71359549842769 / [arcsec] delta applied to CRVAL1 (limb-fitting)
DCRVAL2 =   -8.013160574612584 / [arcsec] delta applied to CRVAL2 (limb-fitting)
CRPIX1  =              1536.5 / [pixel] reference pixel location along axis 1
CRPIX2  =              1536.5 / [pixel] reference pixel location along axis 2
LONPOLE =               180.0 / [deg] native longitude of the celestial pole
ATT_SKD = 'v107_20230111_001+flown' / attitude SKD version, +flown/+predicted
COMMENT --------- Front End Electronics: -------------------------------------
DETGAINL=               0.875 / commanded low gain value
DETGAINH=                 3.0 / commanded high-gain value
GAINCOMB= 'combined'          / commanded low/high gain combination
READOUTM=                   4 / commanded FEE readout mode
DOWNLOAM=                   0 / commanded FEE download mode
GAINTHRE=               15600 / commanded threshold value for H/L gain
LEDSTATE= 'all off '          / LED control for current telescope
COMMENT --------- Temperature: ------------------------------------------------
TEMPINT =    212.101932139491 / [K] internal APS detector temperature
TEMP1DET=   212.2904335532516 / [K] last measured APS det. T before date-avg
TEMP2DET=   212.2904335532516 / [K] earliest measured APS det. T after date-avg
TTEMP1  = '2023-01-10T14:53:58.796070' / [UTC] time TEMP1DET measurement
TTEMP2  = '2023-01-10T14:54:58.795106' / [UTC] time TEMP2DET measurement
COMMENT --------- Telemetry Header: --------------------------------------------
ALU     =               21155 / CEB ALU register
ALU2    =                   0 / CEB ALU2 register
DETREG20=                  85 / REG20_VDAC_CLIPP
DETREG21=                  87 / REG21_VDAC_OFFSETP
DETREG22=                  63 / REG22_VDAC_CMREF
DETREG23=                  39 / REG23_VDAC_OFFSETN
DETREG24=                  41 / REG24_VDAC_CLIPN
DETREG25=                  35 / REG25_VDAC_CMREF_LV
DETREG26=                 137 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                 136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                 136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                 136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                   8 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                 136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                   0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                 136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                 255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                 240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                   0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                  15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                   0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                 127 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                   0 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                   0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                 255 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                   0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                  61 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                   0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                   0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                   0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                   0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                   0 / REG3D_XWIN_ADDRESS
DETREG3E=                  65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                  65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                  34 / Door position (raw) = open
FILCPOS =                   3 / filter wheel commanded position
COMMENT --------- CEB Pixel Preprocessing: ------------------------------------
GAOFSTAT= 'both    '          / status of the CEB gain and offset correction
BADPXREM= 'off     '          / commanded bad pixel removal on or off
BADPXDEF=                  50 / commanded bad pixel default @-14.45 s
CRREM   = 'off     '          / cosmic ray removal on or off
CRREMLIM=                1024 / [1 G. sigma DN] cosmic ray limit @-14.45 s
GAINHG  =                  86 / global gain corr. high gain @PT-8.6 d
GAINLG  =                2240 / global gain corr. low gain  @PT-8.6 d
```

```
OFFSETHG=                    8 / [DN] global offset corr. high gain @PT-8.6 d
OFFSETLG=                  209 / [DN] global offset corr. low gain @PT-8.6 d
COMMENT --------- Data Routing: -------------------------------------------
PRIORITY=                   61 / priority # of image/histogram when downloaded
SCITABID=                15234 / exposure identifier in sec. science table
SCITABNR=                   23 / sequential number of SCITABID
COMMENT --------- Onboard Processing: -------------------------------------
RECSTATE= 'on      '          / recoding on or off
RECNRBIT=                    8 / bit depth recoding output (sqrt)
RECLOW  =                    0 / rec. threshold low (clipped 0)
RECHIGH =                32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                   14 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'  / WICOM compression splitb3 mode
COMSPLVL=                    5 / WICOM compression splitb3 value
COMWEIMD= 'off     '          / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =               660944 / number of bytes onboard compressed image
COMSTRIP= 'off     '          / compression type: off=whole image; on=strip
COMPRESS= 'Lossy-high quality' / data compression quality (None/Lossless/Lossy)
COMP_RAT=    26.77188990292672 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: -------------------------------
EUXCEN  =    1518.654262566069 / [pixel] axis 1 location of solar center in L1
EUYCEN  =    1507.785347336327 / [pixel] axis 2 location of solar center in L1
DATAMIN =                  0.0 / minimum valid physical value
DATAMAX =        9051.6064453125 / maximum valid physical value
DATAMEAN=    5.347850799560547 / [DN/s]average pixel value across image
COMMENT --------- Solar Ephemeris: ----------------------------------------
RSUN_ARC=    1005.420788629096 / [arcsec] apparent photospheric solar radius
RSUN_OBS=    1005.420788629096 / [arcsec] apparent photospheric solar radius
RSUN_REF=            695700000 / [m] assumed physical solar radius
SOLAR_B0=    2.930796633214148 / [deg] s/c tilt of solar North pole
SOLAR_P0=    9.328944642404867 / [deg] s/c celestial North to solar North angle
SOLAR_EP=    7.163258290538611 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =    2266.404906389059 / carrington rotation number
HGLT_OBS=    2.930796633214148 / [deg] s/c Heliographic latitude (B0 angle)
HGLN_OBS=   -23.95174508285151 / [deg] s/c Heliographic longitude
CRLT_OBS=    2.930796633214148 / [deg] s/c Carrington latitude (B0 angle)
CRLN_OBS=    214.2336999387917 / [deg] s/c Carrington longitude (L0 angle)
DSUN_OBS=    142725310221.4294 / [m] s/c distance from Sun
DSUN_AU =   0.9540597707279357 / [AU] s/c distance from Sun
HEEX_OBS=    129423227539.0074 / [m] s/c Heliocentric Earth Ecliptic X
HEEY_OBS=   -59275749356.60567 / [m] s/c Heliocentric Earth Ecliptic Y
HEEZ_OBS=    10321234877.78644 / [m] s/c Heliocentric Earth Ecliptic Z
HCIX_OBS=    140440629872.5748 / [m] s/c Heliocentric Inertial X
HCIY_OBS=    24365755089.36372 / [m] s/c Heliocentric Inertial Y
HCIZ_OBS=    7297509008.069255 / [m] s/c Heliocentric Inertial Z
HCIX_VOB=   -3387.937634345963 / [m/s] s/c Heliocentric Inertial X Velocity
HCIY_VOB=    20437.10961117593 / [m/s] s/c Heliocentric Inertial Y Velocity
HCIZ_VOB=   -2700.984984779622 / [m/s] s/c Heliocentric Inertial Z Velocity
HAEX_OBS=    11996431469.74681 / [m] s/c Heliocentric Aries Ecliptic X
HAEY_OBS=    141845707487.0871 / [m] s/c Heliocentric Aries Ecliptic Y
HAEZ_OBS=    10314798945.33259 / [m] s/c Heliocentric Aries Ecliptic Z
HEQX_OBS=    130264297715.1218 / [m] s/c Heliocentric Earth Equatorial X
HEQY_OBS=   -57865994166.40588 / [m] s/c Heliocentric Earth Equatorial Y
HEQZ_OBS=    7297509008.069255 / [m] s/c Heliocentric Earth Equatorial Z
GSEX_OBS=    17692284517.75524 / [m] s/c Geocentric Solar Ecliptic X
GSEY_OBS=    59275749356.60567 / [m] s/c Geocentric Solar Ecliptic Y
GSEZ_OBS=    10321234877.78645 / [m] s/c Geocentric Solar Ecliptic Z
OBS_VR  =    20891.36161770972 / [m/s] Radial velocity of S/C relative to Sun
EAR_TDEL=    14.64413702940203 / [s] Time(Sun to Earth) - Time(Sun to S/C)
SUN_TIME=    476.0803896588666 / [s] Time(Sun to S/C)
DATE_EAR= '2023-01-10T14:54:39.897' / [UTC] start time of observation Earth
DATE_SUN= '2023-01-10T14:46:29.172' / [UTC] start time of observation Sun
COMMENT --------- Parameters Closing Metadata: ----------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= 'TAmHT9k9TAkET7k9'   / HDU checksum updated 2023-01-22T20:01:45
DATASUM = '3572853542'         / data unit checksum updated 2023-01-22T20:01:45
ZHECKSUM= 'b8AJc83Hb8AHb83H'   / HDU checksum updated 2023-01-22T20:01:45
ZDATASUM= '2684585896'         / data unit checksum updated 2023-01-22T20:01:45
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
HISTORY created by /home/eui/pipeline/level0_to_level1_release_v2.py --release_n
HISTORY umber 6 --configFile /home/eui/config/config.ini
```

```
HISTORY euiprep.py (L1 to L2), UTC time: 2023-01-22T20:01:26
HISTORY S/W git version: a57d9e42ff194a49aa3352963442273ae1cff3ff
HISTORY Pointing updated with: CRVAL1=92.525286, CRVAL2=104.746948, EUXCEN=1518.
HISTORY 654263, EUYCEN=1507.785347, iter=11, attempt=1, tolerance=0.000030
HISTORY DN value scaled to HG value by a factor 2.976744.
HISTORY Image normalized by integration time.
HISTORY Image rectified using: order 1, optical.
HISTORY Last 32 columns removed.
END
```

6.3.2 L2 HRI EUV Image

```
BITPIX  =                   16 / 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
BSCALE  =  0.03112483445887971
BZERO   =     987.6085014343262
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: ----------------------------------------
FILENAME= 'solo_L2_eui-hrieuvopn-image_20230103T080319159_V01.fits' / FITS filen
DATE    = '2023-01-22T23:34:51.414' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2023.003.22.27.03.371.ekwy@2023.003.22.&'
PARENT  = 'solo_L1_eui-hrieuvopn-image_20230103T080319159_V01.fits' / source fil
APID    =                  940 / APID number of associated TM
DATE-OBS= '2023-01-03T08:03:19.159' / [UTC] deprecated, same as DATE-BEG.
DATE-BEG= '2023-01-03T08:03:19.159' / [UTC] start time of observation
DATE-AVG= '2023-01-03T08:03:20.659' / [UTC] average time of observation
TIMESYS = 'UTC     '           / system used for time keywords
OBT_BEG =     726048044.5293121 / start acquisition time in OBT
LEVEL   = 'L2      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = 'euiprep.py'         / See HISTORY
VERS_SW = '973     '           / (L1) version of SW that provided FITS file
VERS_CAL= 'a57d9e42'           / cal version (euiprep git short SHA-1)
VERSION = '01      '           / incremental version number
IMGTYPE = 'solar image'        / type of image; solar, calib., engineering
JOBID   = '20230112T052446.851Z_01f' / unique pipeline job ID
COMPLETE= 'C       '           / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: -------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/HRI_EUV'   / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'HRI_EUV '           / instrument subunit or sensor
DOORINT = 'open    '           / internal door position
DOOREXT = 'open    '           / external HS Door 3 HRI @-101.20 s
XPOSURE =                  3.0 / [s] total effective exposure time
FILTER  = 'open    '           / physical filter during acquisition
FILTPOS =                   26 / (0-199) filter wheel position service5
WAVELNTH=                  174 / [Angstrom] characteristic wavelength observatio
WAVEUNIT= 'Angstrom'           / Wavelength unit
WAVEMIN =                  171 / [Angstrom] min wavelength resp. > 0.05 of max
WAVEMAX =                  178 / [Angstrom] max wavelength resp. > 0.05 of max
SOOPNAME= 'none    '           / name of the SOOP Campaign that the data belong
SOOPTYPE= 'none    '           / campaign ID(s) that the data belong to
OBS_MODE= 'EUV_CALIBRATION'    / observation mode
OBS_TYPE= 'Vjfz    '           / encoded version of OBS_MODE
OBS_ID  = 'SEUI_100A_000_000_Vjfz_111' / unique ID of the individual observation
TARGET  = 'Sun, Mercury transit' / type of target from planning
COMMENT --------- Description of Data Content: --------------------------------
BTYPE   = 'Flux    '           / type of data
BUNIT   = 'DN/s    '           / units of physical value, after BSCALE, BZERO
UCD     = 'phot.count;em.UV.10-50nm' / Unified Content Descriptor
BLANK   =               -32768 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: -----------------
PXBEG1  =                  641 / first read-out pixel in dimension 1
PXEND1  =                 2688 / last read-out pixel in dimension 1
PXBEG2  =                  577 / first read-out pixel in dimension 2
PXEND2  =                 2624 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: --------------------------
WCSNAME = 'Helioprojective-cartesian' / name of coordinate system
CTYPE1  = 'HPLN-TAN'           / helioprojective longitude (Solar X)
CTYPE2  = 'HPLT-TAN'           / helioprojective latitude (Solar Y)
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
PC1_1   =   0.9916927930072228 / WCS coordinate transformation matrix
PC1_2   =   0.1286289403576563 / WCS coordinate transformation matrix
PC2_1   =  -0.1286289403576563 / WCS coordinate transformation matrix
```

```
PC2_2   =   0.9916927930072228 / WCS coordinate transformation matrix
CDELT1  =                0.492 / [arcsec] pixel scale along axis 1
CDELT2  =                0.492 / [arcsec] pixel scale along axis 2
CROTA   =   -7.390371209498066 / [deg] rotation angle
CRVAL1  =    296.6527027232021 / [arcsec] value of reference pixel along axis 1
CRVAL2  =   -707.3400076646399 / [arcsec] value of reference pixel along axis 2
DCRVAL1 =   -14.42859628693506 / [arcsec] delta CRVAL1 (FSI @-26424.0 82656.0 s)
DCRVAL2 =   -11.96875332287946 / [arcsec] delta CRVAL2 (FSI @-26424.0 82656.0 s)
CRPIX1  =                896.5 / [pixel] reference pixel location along axis 1
CRPIX2  =                960.5 / [pixel] reference pixel location along axis 2
LONPOLE =                180.0 / [deg] native longitude of the celestial pole
ATT_SKD = 'v107_20230111_001+flown' / attitude SKD version, +flown/+predicted
COMMENT --------- Front End Electronics: -------------------------------------
DETGAINL=                0.875 / commanded low gain value
DETGAINH=                  3.0 / commanded high-gain value
GAINCOMB= 'high-only'          / commanded low/high gain combination
READOUTM=                    4 / commanded FEE readout mode
DOWNLOAM=                    0 / commanded FEE download mode
GAINTHRE=                16383 / commanded threshold value for H/L gain
LEDSTATE= 'all off '           / LED control for current telescope
COMMENT --------- Temperature: ----------------------------------------------
TEMPINT =    222.4992063492063 / [K] internal APS detector temperature
TEMP1DET=    222.4992063492063 / [K] last measured APS det. T before date-avg
TEMP2DET=    222.7373015873016 / [K] earliest measured APS det. T after date-avg
TTEMP1  = '2023-01-03T08:03:00.614823' / [UTC] time TEMP1DET measurement
TTEMP2  = '2023-01-03T08:04:00.613814' / [UTC] time TEMP2DET measurement
COMMENT --------- Telemetry Header: ------------------------------------------
ALU     =                20801 / CEB ALU register
ALU2    =                    0 / CEB ALU2 register
DETREG20=                   85 / REG20_VDAC_CLIPP
DETREG21=                   86 / REG21_VDAC_OFFSETP
DETREG22=                   63 / REG22_VDAC_CMREF
DETREG23=                   39 / REG23_VDAC_OFFSETN
DETREG24=                   41 / REG24_VDAC_CLIPN
DETREG25=                   35 / REG25_VDAC_CMREF_LV
DETREG26=                  131 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                  136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                  136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                  136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                    4 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                  136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                    0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                  136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                  255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                  240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                    0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                   15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                    0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                  127 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                    0 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                    0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                  255 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                    0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                   63 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                    0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                    0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                    0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                    0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                   68 / REG3D_XWIN_ADDRESS
DETREG3E=                   65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                   65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                   34 / Door position (raw) = open
FILCPOS =                    0 / filter wheel commanded position
COMMENT --------- CEB Pixel Preprocessing: ----------------------------------
GAOFSTAT= 'none    '           / status of the CEB gain and offset correction
BADPXREM= 'off     '           / commanded bad pixel removal on or off
BADPXDEF=                   50 / commanded bad pixel default @-0.04 s
CRREM   = 'off     '           / cosmic ray removal on or off
CRREMLIM=                 1024 / [1 G. sigma DN] cosmic ray limit @-0.04 s
GAINHG  =                   72 / global gain corr. high gain @PT-1.3 d
GAINLG  =                 1806 / global gain corr. low gain  @PT-1.3 d
OFFSETHG=                    4 / [DN] global offset corr. high gain @PT-1.3 d
OFFSETLG=                   64 / [DN] global offset corr. low gain @PT-1.3 d
COMMENT --------- Data Routing: ---------------------------------------------
```

```
PRIORITY=                    40 / priority # of image/histogram when downloaded
SCITABID=                 15283 / exposure identifier in sec. science table
SCITABNR=                     9 / sequential number of SCITABID
COMMENT --------- Onboard Processing: -------------------------------------
RECSTATE= 'off     '            / recoding on or off
RECNRBIT=                     8 / bit depth recoding output (sqrt)
RECLOW  =                     0 / rec. threshold low (clipped 0)
RECHIGH =                 32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                     0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'    / WICOM compression splitb3 mode
COMSPLVL=                     5 / WICOM compression splitb3 value
COMWEIMD= 'off     '            / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =               4052432 / number of bytes onboard compressed image
COMSTRIP= 'off     '            / compression type: off=whole image; on=strip
COMPRESS= 'Lossless'            / data compression quality (None/Lossless/Lossy)
COMP_RAT=    1.552513651061881 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: --------------------------------
EUXCEN  =     87.67489864058371 / [pixel] axis 1 location of solar center in L1
EUYCEN  =     2280.78577954951 / [pixel] axis 2 location of solar center in L1
DATAMIN =   -32.25894927978516 / minimum valid physical value
DATAMAX =    2007.475952148438 / maximum valid physical value
DATAMEAN=    878.0980224609375 / [DN/s]average pixel value across image
COMMENT --------- Solar Ephemeris: -----------------------------------------
RSUN_ARC=    1010.349955299071 / [arcsec] apparent photospheric solar radius
RSUN_OBS=    1010.349955299071 / [arcsec] apparent photospheric solar radius
RSUN_REF=             695700000 / [m] assumed physical solar radius
SOLAR_B0=     3.603396663297644 / [deg] s/c tilt of solar North pole
SOLAR_P0=    11.76523607594064 / [deg] s/c celestial North to solar North angle
SOLAR_EP=     7.247568444712934 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =     2266.132467921834 / carrington rotation number
HGLT_OBS=     3.603396663297644 / [deg] s/c Heliographic latitude (B0 angle)
HGLN_OBS=   -21.82096328693896 / [deg] s/c Heliographic longitude
CRLT_OBS=     3.603396663297644 / [deg] s/c Carrington latitude (B0 angle)
CRLN_OBS=    312.3115481396472 / [deg] s/c Carrington longitude (L0 angle)
DSUN_OBS=    142029005685.652 / [m] s/c distance from Sun
DSUN_AU =    0.949405262394901 / [AU] s/c distance from Sun
HEEX_OBS=    130876709701.1984 / [m] s/c Heliocentric Earth Ecliptic X
HEEY_OBS=   -54199904874.96423 / [m] s/c Heliocentric Earth Ecliptic Y
HEEZ_OBS=    10290560013.33349 / [m] s/c Heliocentric Earth Ecliptic Z
HCIX_OBS=    141295509369.3994 / [m] s/c Heliocentric Inertial X
HCIY_OBS=    11319694025.05381 / [m] s/c Heliocentric Inertial Y
HCIZ_OBS=    8926478324.405983 / [m] s/c Heliocentric Inertial Z
HCIX_VOB=    685.8054979244919 / [m/s] s/c Heliocentric Inertial X Velocity
HCIY_VOB=    20952.58103970452 / [m/s] s/c Heliocentric Inertial Y Velocity
HCIZ_VOB=   -2466.321056332979 / [m/s] s/c Heliocentric Inertial Z Velocity
HAEX_OBS=    24950326222.68097 / [m] s/c Heliocentric Aries Ecliptic X
HAEY_OBS=    139441600941.1412 / [m] s/c Heliocentric Aries Ecliptic Y
HAEZ_OBS=    10283948872.31006 / [m] s/c Heliocentric Aries Ecliptic Z
HEQX_OBS=    131591939651.4214 / [m] s/c Heliocentric Earth Equatorial X
HEQY_OBS=   -52688877949.2934 / [m] s/c Heliocentric Earth Equatorial Y
HEQZ_OBS=    8926478324.405983 / [m] s/c Heliocentric Earth Equatorial Z
GSEX_OBS=    16223050693.08968 / [m] s/c Geocentric Solar Ecliptic X
GSEY_OBS=    54199904874.96423 / [m] s/c Geocentric Solar Ecliptic Y
GSEZ_OBS=    10290560013.33349 / [m] s/c Geocentric Solar Ecliptic Z
OBS_VR  =    21108.55111721772 / [m/s] Radial velocity of S/C relative to Sun
EAR_TDEL=    16.91421706357994 / [s] Time(Sun to Earth) - Time(Sun to S/C)
SUN_TIME=    473.7577677342769 / [s] Time(Sun to S/C)
DATE_EAR= '2023-01-03T08:03:37.574' / [UTC] start time of observation Earth
DATE_SUN= '2023-01-03T07:55:26.902' / [UTC] start time of observation Sun
COMMENT --------- Parameters Closing Metadata: -----------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= 'YcWAYZV6YbVAYZV3'   / HDU checksum updated 2023-01-22T23:34:52
DATASUM = '1571786657'         / data unit checksum updated 2023-01-22T23:34:52
ZCHECKSUM= 'baKpcUHmbaHmbUHm'  / HDU checksum updated 2023-01-22T23:34:52
ZDATASUM= '3180828257'         / data unit checksum updated 2023-01-22T23:34:52
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
HISTORY created by /home/eui/pipeline/level0_to_level1_release_v2.py --release_n
HISTORY umber 6 --configFile /home/eui/config/config.ini
HISTORY euiprep.py (L1 to L2), UTC time: 2023-01-22T23:34:49
HISTORY S/W git version: a57d9e42ff194a49aa3352963442273ae1cff3ff
HISTORY Dark frame correction using dark_hrieuv_HG_20210219T200104277.fts.
```

```
HISTORY Flat field correction using flat_hrieuv_HG_20210224T204005243.fts.
HISTORY Image normalized by integration time.
HISTORY generate_L2.py CRVAL values updated using nearby FSI limb-fitted images
END
```

6.3.3 L2 HRI Ly-α Image

```
BITPIX  =                   16 / 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
BSCALE  =     0.010186990357329
BZERO   =     333.5658630356193
LONGSTRN= 'OGIP 1.0'           / The OGIP long string convention may be used
COMMENT --------- General Description: -----------------------------------
FILENAME= 'solo_L2_eui-hrilya1216-image_20230103T080432159_V01.fits' / FITS file
DATE    = '2023-01-22T23:35:24.561' / [UTC] FITS file creation date
FILE_RAW= 'BatchRequest.PktTmRaw.SOL.0.2023.003.22.27.03.371.ekwy@2023.003.22.&'
PARENT  = 'solo_L1_eui-hrilya1216-image_20230103T080432159_V01.fits' / source fi
APID    =                  940 / APID number of associated TM
DATE-OBS= '2023-01-03T08:04:32.159' / [UTC] deprecated, same as DATE-BEG.
DATE-BEG= '2023-01-03T08:04:32.159' / [UTC] start time of observation
DATE-AVG= '2023-01-03T08:04:40.159' / [UTC] average time of observation
TIMESYS = 'UTC     '           / system used for time keywords
OBT_BEG =     726048117.5288239 / start acquisition time in OBT
LEVEL   = 'L2      '           / data processing level
ORIGIN  = 'Royal Observatory of Belgium' / file generation location
CREATOR = 'euiprep.py'         / See HISTORY
VERS_SW = '973     '           / (L1) version of SW that provided FITS file
VERS_CAL= 'a57d9e42'           / cal version (euiprep git short SHA-1)
VERSION = '01      '           / incremental version number
IMGTYPE = 'solar image'        / type of image; solar, calib., engineering
JOBID   = '20230112T052446.858Z_01f' / unique pipeline job ID
COMPLETE= 'C       '           / C or I for complete/incomplete
COMMENT --------- Instrument and Observation Configuration: --------------------
OBSRVTRY= 'Solar Orbiter'      / satellite name
TELESCOP= 'SOLO/EUI/HRI_LYA'   / telescope/Sensor name
INSTRUME= 'EUI     '           / instrument name
DETECTOR= 'HRI_LYA '           / instrument subunit or sensor
DOORINT = 'open    '           / internal door position
DOOREXT = 'open    '           / external HS Door 3 HRI @-180.70 s
XPOSURE =                 16.0 / [s] total effective exposure time
WAVELNTH=                 1216 / [Angstrom] characteristic wavelength observatio
WAVEUNIT= 'Angstrom'           / Wavelength unit
WAVEMIN =                 1120 / [Angstrom] min wavelength resp. > 0.05 of max
WAVEMAX =                 1340 / [Angstrom] max wavelength resp. > 0.05 of max
SOOPNAME= 'none    '           / name of the SOOP Campaign that the data belong
SOOPTYPE= 'none    '           / campaign ID(s) that the data belong to
OBS_MODE= 'LYA_CALIBRATION'    / observation mode
OBS_TYPE= '22fE    '           / encoded version of OBS_MODE
OBS_ID  = 'SEUI_100A_000_000_22fE_111' / unique ID of the individual observation
TARGET  = 'Sun, Mercury transit' / type of target from planning
COMMENT --------- Description of Data Content: ----------------------------------
BTYPE   = 'Flux    '           / type of data
BUNIT   = 'DN/s    '           / units of physical value, after BSCALE, BZERO
UCD     = 'phot.count;em.UV.100-200nm' / Unified Content Descriptor
BLANK   =               -32768 / value undefined pixels before BSCALE,BZERO
COMMENT --------- Image Relative to Detector and Electronics: ------------------
PXBEG1  =                  105 / first read-out pixel in dimension 1
PXEND1  =                 2152 / last read-out pixel in dimension 1
PXBEG2  =                  513 / first read-out pixel in dimension 2
PXEND2  =                 2560 / last read-out pixel in dimension 2
NBIN1   =                    1 / on-board binning factor in dim 1
NBIN2   =                    1 / on-board binning factor in dim 1
NBIN    =                    1 / total binning factor
COMMENT --------- World Coordinate System Attitude: --------------------------
WCSNAME = 'Helioprojective-cartesian' / name of coordinate system
CTYPE1  = 'HPLN-TAN'           / helioprojective longitude (Solar X)
CTYPE2  = 'HPLT-TAN'           / helioprojective latitude (Solar Y)
CUNIT1  = 'arcsec  '           / units along axis 1
CUNIT2  = 'arcsec  '           / units along axis 2
PC1_1   =   0.9920260905748646 / WCS coordinate transformation matrix
PC1_2   =   0.1260326767895954 / WCS coordinate transformation matrix
PC2_1   =  -0.1260326767895954 / WCS coordinate transformation matrix
PC2_2   =   0.9920260905748646 / WCS coordinate transformation matrix
CDELT1  =                0.514 / [arcsec] pixel scale along axis 1
```

```
CDELT2  =                 0.514 / [arcsec] pixel scale along axis 2
CROTA   =   -7.240395463186881 / [deg] rotation angle
CRVAL1  =    395.1313295719767 / [arcsec] value of reference pixel along axis 1
CRVAL2  =   -691.6760932361429 / [arcsec] value of reference pixel along axis 2
DCRVAL1 =    -14.4278942111187 / [arcsec] delta CRVAL1 (FSI @-26497.0 82583.0 s)
DCRVAL2 =   -11.96903396876604 / [arcsec] delta CRVAL2 (FSI @-26497.0 82583.0 s)
CRPIX1  =                1024.5 / [pixel] reference pixel location along axis 1
CRPIX2  =                1024.5 / [pixel] reference pixel location along axis 2
LONPOLE =                 180.0 / [deg] native longitude of the celestial pole
ATT_SKD = 'v107_20230111_001+flown' / attitude SKD version, +flown/+predicted
COMMENT --------- HRI Lyman alpha: ----------------------------------------------
LYAIMCP = 1.18391520000000E-05 / [A] measured MCP current @-1.55 s
LYAVMCP =    665.8637079900001 / [V] measured MCP voltage @-1.55 s
LYAVSCR =    5163.920915000001 / [V] measured MCP+screen voltage @-1.55 s
LYACMCP =    665.1573999999999 / [V] commanded MCP voltage (2137)
LYACSCR =              4500.87 / [V] commanded screen voltage (2162)
COMMENT --------- Front End Electronics: ----------------------------------------
DETGAINL=    1.285714285714286 / commanded low gain value
DETGAINH=                   3.0 / commanded high-gain value
GAINCOMB= 'low-only'           / commanded low/high gain combination
READOUTM=                     4 / commanded FEE readout mode
DOWNLOAM=                     0 / commanded FEE download mode
GAINTHRE=                     0 / commanded threshold value for H/L gain
LEDSTATE= 'all off '           / LED control for current telescope
COMMENT --------- Temperature: --------------------------------------------------
TEMPINT =    235.0447368421052 / [K] internal APS detector temperature
TEMP1DET=    235.0447368421052 / [K] last measured APS det. T before date-avg
TEMP2DET=    235.0447368421052 / [K] earliest measured APS det. T after date-avg
TTEMP1  = '2023-01-03T08:04:00.613539' / [UTC] time TEMP1DET measurement
TTEMP2  = '2023-01-03T08:05:00.612666' / [UTC] time TEMP2DET measurement
COMMENT --------- Telemetry Header: ---------------------------------------------
ALU     =                 20481 / CEB ALU register
ALU2    =                     0 / CEB ALU2 register
DETREG20=                    87 / REG20_VDAC_CLIPP
DETREG21=                    88 / REG21_VDAC_OFFSETP
DETREG22=                    63 / REG22_VDAC_CMREF
DETREG23=                    39 / REG23_VDAC_OFFSETN
DETREG24=                    39 / REG24_VDAC_CLIPN
DETREG25=                    35 / REG25_VDAC_CMREF_LV
DETREG26=                   142 / REG26_IDAC_CDSSTAGE2_3
DETREG27=                   136 / REG27_IDAC_CDSSTAGE1_COMPA
DETREG28=                   136 / REG28_IDAC_INVBUFFER_REFBU
DETREG29=                   136 / REG29_IDAC_COLBUFFER_COLBU
DETREG2A=                     8 / REG2A_IDAC_COLPC_COLGAINST
DETREG2B=                   136 / REG2B_IDAC_OUTPUTDRIVER_CO
DETREG2C=                     0 / REG2C_VDAC_BLACKSUN_EVEN
DETREG2D=                   136 / REG2D_IDAC_ABS_REBUFF_TEMP
DETREG2E=                   255 / REG2E_COLGAIN_EVEN_FF_MID
DETREG2F=                   240 / REG2F_COLGAIN_EVEN_FF_LOW
DETREG30=                     0 / REG30_COLGAIN_EVEN_FB_MID
DETREG31=                    15 / REG31_COLGAIN_EVEN_FB_LOW
DETREG32=                     0 / REG32_COLGAIN_EVEN_FB_HIGH
DETREG33=                   255 / REG33_COLGAIN_ODD_FF_MID
DETREG34=                   128 / REG34_COLGAIN_ODD_FF_LOW
DETREG35=                     0 / REG35_COLGAIN_ODD_FB_MID
DETREG36=                   127 / REG36_COLGAIN_ODD_FB_LOW
DETREG37=                     0 / REG37_COLGAIN_VDAC_SIGCLAM
DETREG38=                    63 / REG38_CDS_EN_SAMPLE_CLOCK_
DETREG39=                     0 / REG39_MBS_PIXCOL_ADDR_LOW
DETREG3A=                     0 / REG3A_MBS_PIXCOL_ADDR_HIGH
DETREG3B=                     0 / REG3B_MBS_MUXBUS_SR_EOSX_S
DETREG3C=                     0 / REG3C_VDAC_SIGC_LAMP_BLACK
DETREG3D=                    64 / REG3D_XWIN_ADDRESS
DETREG3E=                    65 / REG3E_VDAC_BUSCLAMPHIGH
DETREG3F=                    65 / REG3F_VDAC_BUSCLAMPLOW
DOORPOS =                    26 / Door position (raw) = open
COMMENT --------- CEB Pixel Preprocessing: --------------------------------------
GAOFSTAT= 'none    '           / status of the CEB gain and offset correction
BADPXREM= 'off     '           / commanded bad pixel removal on or off
BADPXDEF=                    50 / commanded bad pixel default @-19.54 s
CRREM   = 'off     '           / cosmic ray removal on or off
CRREMLIM=                  1024 / [1 G. sigma DN] cosmic ray limit @-19.54 s
GAINHG  =                   256 / global gain corr. high gain @PT-1.3 d
GAINLG  =                   256 / global gain corr. low gain  @PT-1.3 d
```

```
OFFSETHG=                      0 / [DN] global offset corr. high gain @PT-1.3 d
OFFSETLG=                      0 / [DN] global offset corr. low gain @PT-1.3 d
COMMENT --------- Data Routing: ------------------------------------------------
PRIORITY=                     40 / priority # of image/histogram when downloaded
SCITABID=                  15286 / exposure identifier in sec. science table
SCITABNR=                      0 / sequential number of SCITABID
COMMENT --------- Onboard Processing: ------------------------------------------
RECSTATE= 'off     '            / recoding on or off
RECNRBIT=                      8 / bit depth recoding output (sqrt)
RECLOW  =                      0 / rec. threshold low (clipped 0)
RECHIGH =                  32767 / rec. threshold high(clipped 2^RECNRBIT-1)
COMBITPP=                      0 / WICOM compression bpp ( COMBITPP*0.04=bpp)
COMSPLMD= 'provided by user'    / WICOM compression splitb3 mode
COMSPLVL=                      5 / WICOM compression splitb3 value
COMWEIMD= 'off     '            / WICOM compression weighting mode
COMWEIVL= '128,128,128,128,128,128,128,128,128,128' / WICOM sub-band coefficient
COMSIZE =                4261904 / number of bytes onboard compressed image
COMSTRIP= 'off     '            / compression type: off=whole image; on=strip
COMPRESS= 'Lossless'            / data compression quality (None/Lossless/Lossy)
COMP_RAT=    1.476207816975699 / compression ratio: uncompressed/compressed size
COMMENT --------- Derived Image Properties: ------------------------------------
EUXCEN  =    67.38183708040501 / [pixel] axis 1 location of solar center in L1
EUYCEN  =    2235.918854988135 / [pixel] axis 2 location of solar center in L1
DATAMIN =  -0.2312500029802322 / minimum valid physical value
DATAMAX =    667.3629760742188 / maximum valid physical value
DATAMEAN=    88.45269775390625 / [DN/s]average pixel value across image
COMMENT --------- Solar Ephemeris: ---------------------------------------------
RSUN_ARC=    1010.348712788553 / [arcsec] apparent photospheric solar radius
RSUN_OBS=    1010.348712788553 / [arcsec] apparent photospheric solar radius
RSUN_REF=            695700000 / [m] assumed physical solar radius
SOLAR_B0=    3.603312971915166 / [deg] s/c tilt of solar North pole
SOLAR_P0=    11.76493337893137 / [deg] s/c celestial North to solar North angle
SOLAR_EP=    7.247561635921421 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =    2266.132502316754 / carrington rotation number
HGLT_OBS=    3.603312971915166 / [deg] s/c Heliographic latitude (B0 angle)
HGLN_OBS=   -21.82122689861193 / [deg] s/c Heliographic longitude
CRLT_OBS=    3.603312971915166 / [deg] s/c Carrington latitude (B0 angle)
CRLN_OBS=    312.2991659684812 / [deg] s/c Carrington longitude (L0 angle)
DSUN_OBS=    142029180349.2309 / [m] s/c distance from Sun
DSUN_AU =   0.9494064299488113 / [AU] s/c distance from Sun
HEEX_OBS=    130876622155.1634 / [m] s/c Heliocentric Earth Ecliptic X
HEEY_OBS=   -54200570970.93247 / [m] s/c Heliocentric Earth Ecliptic Y
HEEZ_OBS=    10290575802.83318 / [m] s/c Heliocentric Earth Ecliptic Z
HCIX_OBS=    141295563870.0058 / [m] s/c Heliocentric Inertial X
HCIY_OBS=    11321359746.01156 / [m] s/c Heliocentric Inertial Y
HCIZ_OBS=    8926282251.467243 / [m] s/c Heliocentric Inertial Z
HCIX_VOB=    685.2851772274444 / [m/s] s/c Heliocentric Inertial X Velocity
HCIY_VOB=    20952.53935928786 / [m/s] s/c Heliocentric Inertial Y Velocity
HCIZ_VOB=   -2466.353930360303 / [m/s] s/c Heliocentric Inertial Z Velocity
HAEX_OBS=    24948713966.80554 / [m] s/c Heliocentric Aries Ecliptic X
HAEY_OBS=    139442066154.9803 / [m] s/c Heliocentric Aries Ecliptic Y
HAEZ_OBS=    10283964629.79869 / [m] s/c Heliocentric Aries Ecliptic Z
HEQX_OBS=    131591871166.6975 / [m] s/c Heliocentric Earth Equatorial X
HEQY_OBS=   -52689553031.78034 / [m] s/c Heliocentric Earth Equatorial Y
HEQZ_OBS=    8926282251.467243 / [m] s/c Heliocentric Earth Equatorial Z
GSEX_OBS=    16223137099.17769 / [m] s/c Geocentric Solar Ecliptic X
GSEY_OBS=    54200570970.93246 / [m] s/c Geocentric Solar Ecliptic Y
GSEZ_OBS=    10290575802.83317 / [m] s/c Geocentric Solar Ecliptic Z
OBS_VR  =    21108.49666629127 / [m/s] Radial velocity of S/C relative to Sun
EAR_TDEL=    16.91363064613927 / [s] Time(Sun to Earth) - Time(Sun to S/C)
SUN_TIME=    473.7583503492636 / [s] Time(Sun to S/C)
DATE_EAR= '2023-01-03T08:04:57.073' / [UTC] start time of observation Earth
DATE_SUN= '2023-01-03T07:56:46.401' / [UTC] start time of observation Sun
COMMENT --------- Parameters Closing Metadata: ---------------------------------
INFO_URL= 'http://sidc.be/EUI/data' / Link to additional information
CHECKSUM= '6OTX7NSW6NSW6NSW'   / HDU checksum updated 2023-01-22T23:35:25
DATASUM = '1266140759'         / data unit checksum updated 2023-01-22T23:35:25
ZHECKSUM= '5caJ7cVJ5cZJ5cZJ'   / HDU checksum updated 2023-01-22T23:35:25
ZDATASUM= '1447842900'         / data unit checksum updated 2023-01-22T23:35:25
HISTORY created by /home/eui/pipeline/telemetry_parser.py --databaseExternal --w
HISTORY orkingDirectory /tmp/telemetry_parser --configFile /home/eui/config/conf
HISTORY ig.ini --outputDirectory /data/solo-eui/internal/L0/ --atROB
HISTORY created by /home/eui/pipeline/level0_to_level1_release_v2.py --release_n
HISTORY umber 6 --configFile /home/eui/config/config.ini
```

```
HISTORY euiprep.py (L1 to L2), UTC time: 2023-01-22T23:35:23
HISTORY S/W git version: a57d9e42ff194a49aa3352963442273ae1cff3ff
HISTORY Dark frame correction using ref_dark_1s_88_39_142_8_LG.fts.
HISTORY Flat field correction using FF_EUI_LYA_LG_20200630.fts.
HISTORY Image normalized by integration time.
HISTORY generate_L2.py CRVAL values updated using nearby FSI limb-fitted images
END
```