Max-Planck-Institut für Sonnensystemforschung

SO/PHI

Polarimetric and Helioseismic Imager for Solar Orbiter

SO/PHI Data Product Description Document

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1 Scope

This Data Product Definition Document (DPDD) describes the format and content of the SO/PHI 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 Science Operation Center (SOC).

The specifications described in this document apply to all SO/PHI 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 SO/PHI Team premises. It does not address the Low Latency data since it will be described in [IR1].

1.1 Definitions

The specified data volumes are consistent with IEEE-1541 (i.e. SI multipliers kbits/s, MBytes, etc. are always powers-of-10 units, power-of-two units are given in kibits/s, MiBytes etc.).

2 Instrument Description

SO/PHI provides maps of the magnetic field vector and of the line-of-sight (LOS) velocity in the solar photosphere. It thus probes the deepest layers of the Sun (including the solar interior using helioseismology) of all the instruments on Solar Orbiter. Since the magnetic field anchored at the solar surface produces most of the structures and energetic events in the upper solar atmosphere and significantly influences the heliosphere, SO/PHI plays a key role in reaching the science goals of Solar Orbiter. Extrapolations of the magnetic field observed by SO/PHI into the Sun's upper atmosphere and heliosphere provide the information needed for other optical and in-situ instruments to analyse and understand the data recorded by them in a proper physical context.

SO/PHI addresses and resolves basic questions in solar physics by studying the Sun at high resolution from close up and from high latitudes up to 33°. In particular, it is central for reaching SO's top-level science questions.

SO/PHI is composed of two telescopes. The off-axis Ritchey-Chrétien High Resolution Telescope (HRT) will image a fraction of the solar disk at a resolution reaching 200 km at perihelion (the same resolution as the Extreme Ultraviolet Imager's high resolution channels have). The refractor Full Disc Telescope (FDT) is able to image the full solar disk at all phases of the orbit. Each telescope has its own Polarisation Modulation Package (PMP) located early in the optical path in order to minimize polarization cross-talk effects. Polarimetry at a signal-to-noise level of 10^3 is baselined for SO/PHI. HRT or FDT sequentially send light to a Fabry-Perot Filtergraph (FG) system ($\sim$ 100 mÅ spectral resolution) and to an 2048 $\times$ 2048 pixels CMOS sensor integrated in the Focal Plane

Assembly (FPA). SO/PHI has an Image Stabilisation System that compensates spacecraft (S/C) jitter or other disturbances. This system is composed of a correlation tracker and a rapid tip-tilt mirror for the HRT.

The FeI 617.3 nm spectral line was chosen as the SO/PHI science wavelength after a careful comparison with a number of other widely used Zeeman-sensitive lines due to its ideal combination of properties allowing both vector magnetic field and helioseismic observations.

2.1 Measurement principle

The measurement principle of SO/PHI is to scan a solar photospheric absorption line with a tunable narrow-band FG and to obtain, thus, the spectral line profile of each point of the FOV (see Fig. 1a). In addition, at each spectral scan position the full polarimetric properties of the incoming solar light will be measured. This will be carried out by polarimetric modulation of the solar light by means of variable retarders and subsequent polarimetric analysis, i.e. by transformation of the polarization signals into intensity levels. Thus the primary observables of SO/PHI are intensity profiles of the solar absorption line at 4 dedicated polarization states (i.e. linear combinations of Stokes profiles, see Figs. 1b-d).

SO/PHI is designed to scan the FeI 617.3 nm spectral line for which the polarization properties are depending on the magnetic field structure in the line-forming regions of the solar atmosphere (Zeeman effect). In addition, the exact wavelength position of the spectral line is depending on the relative velocity of the observing target and the S/C (Doppler effect).

The SO/PHI data products will be extracted from the primary observables by onboard processing, i.e. by standard calibration (flat and dark field correction as well as polarimetric demodulation) and inverting the Radiative Transfer Equation (RTE) for the measured Stokes profiles. This inversion procedure is based on a synthesis of the Stokes profiles from a solar atmospheric model and by iterating the model parameters until the deviations (an error metric) of the model Stokes profiles and the observed ones are minimized. The atmospheric models will satisfy the Milne-Eddington approximation.

2.2 Science Objectives

All science goals of SO critically depends for their success on the velocity, intensity, and vector magnetic field maps provided by SO/PHI, see also [IR2].
The identification of the character and mechanisms of the solar dynamo, especially but not exclusively in the solar polar regions, is a major goal and design-driver behind SO/PHI. The fulfilment of SO objectives in this respect requires both local and global heliosismology studies that are based on HRT and FDT data products.
The determination of the origin of the solar wind, in its components and variability, relies on accurate and coherent magnetic field maps that can be used as input for global magnetic field coronal models. Such models provide the magnetic link to the origin of

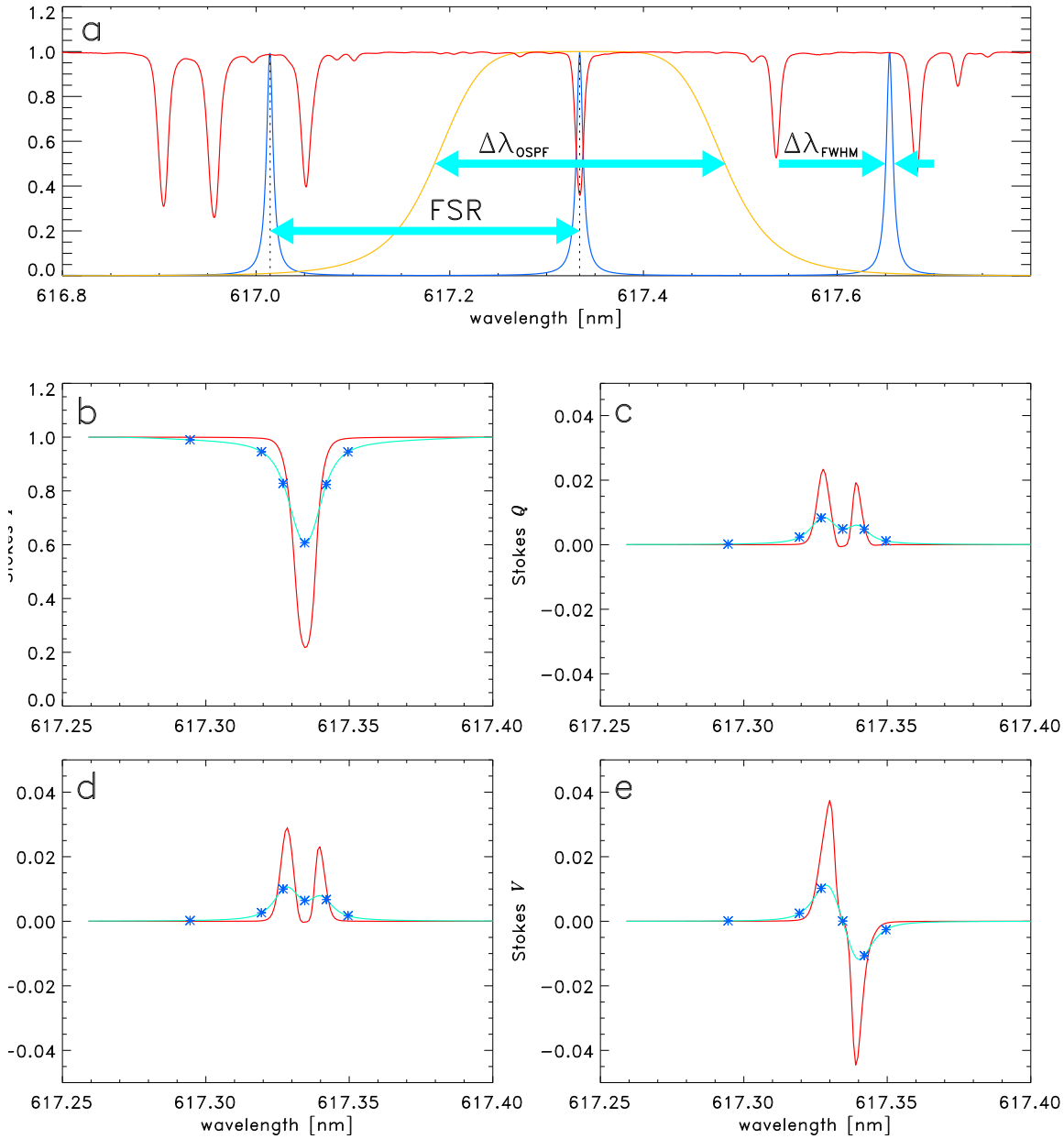

Figure 1: Measurement principle of SO/PHI. a: solar spectrum around around 617 nm (red), tunable filter profile (blue) and order-sorting prefilter (OSPF) bandpass (yellow); b-d: FeI 617.3 nm Stokes profiles obtained from one point of an MHD simulation (red) and ideally simulated PHI primary observables (light blue). The blue asterisks denote the expected SO/PHI measurements when tuning the FG to the dedicated wavelength positions.

physical signals that are detected by the in situ suite of instruments on board SO.
Similarly, on a smaller scale, the quasi co-rotation of SO allows SO/PHI to map the photospheric magnetic field of active regions at high-resolution and temporal cadence for longer periods of time than possible so far. In turn, such measurements, which are essential for the reliable modeling of active regions fields, are the key to the understanding of flares and coronal mass ejections generation, which are responsible for heliospheric variability.
A coherent model of the solar magnetic field is equally crucial to the understanding of the generation and propagation of solar energetic particles, which are typically produced during the magnetic reconnection events associated to flares and coronal mass ejection, and channeled in their propagation by the large scale magnetic field.
In addition, the possibility of stereoscopic observations allowed by SO in conjunction with other, typically Earth bound, observatories, opens novel possibilities, from purely observation-based disambiguation of vector magnetograms to the latitude- and direction-dependence of solar luminosity, to give just two examples.

2.3 Operational Modes

SO/PHI observations are concentrated in the Remote Sensing Windows (RSWs) of each orbit. During other phases of the orbit it will continue to provide, as necessary, synoptic and context observations of the magnetic field at a considerably lower cadence. It will also provide helioseismic data at the full cadence but at a vastly reduced spatial resolution. Specific operational modes have been defined to meet the science objectives during all mission phases within the allocated telemetry resources. To reduce the telemetry needed by SO/PHI, an initial reduction and analysis of the data will be carried out already onboard the spacecraft using a Milne-Eddington inversion of the recorded data prior to their transmission to the ground.

SO/PHI operations are grouped in system states and operating modes (see [IR5]). Besides the generic system states off, safe, idle, observational idle and annealing the instrument can be switched into its observation system state in which all science data and calibration data will be acquired or into a processing mode (process_sci, process_heater, process_cal, process_anneal) which carries out on-board processing tasks and generate higher-level versions of the acquired data.

SO/PHI science operating modes are providing either raw data (narrow-band filtergrams, $I(\lambda)$) or subsets of the physical parameter maps which are the magnetic field strength, $B = |\boldsymbol{B}|$, the line of sight (LOS) magnetic field strength, B_{LOS}, the magnetic field inclination to the LOS, γ, the magnetic field azimuth angle with respect to the LOS, ϕ, the continuum intensity at 617.3 nm, I_{c} and the LOS plasma velocity, v_{LOS}. Each science operating mode is also characterized by typical ranges of the cadence of the acquired data products and the typical image sizes which are obtained by either cropping to a fraction of the sensor area or by binning to a reduced resolution.

In addition, SO/PHI calibration operating modes produce calibration data which usually contain raw or calibrated narrow-band filtergrams.

2.4 Calibration

2.4.1 In-flight Calibration

SO/PHI performs an extensive on-board processing as described in [IR6] and which includes image accumulation, basic calibration tasks (e.g. flat and dark fielding) but also polarimetric demodulation and instrumental cross-talk compensation as well RTE inversion and bit truncation and CCSDS compression. The standard data products are thus physical parameter maps obtained by the on-board processing pipeline.

In addition, SO/PHI provides primary observable which consist of on-board accumulated narrow-band filtergrams which are only partially processed on-board and for which the calibration is completed on ground.

2.4.2 On-ground Calibration

Depending on the status of the downloaded dataset (raw images or inverted maps), part of the calibration is performed either in-flight or on-ground, respectively (see Section 3). The relative segments of the on-ground pipeline and the in-flight pipelines performing this preliminary calibration are formally identical. This is to ensure coherency across dataset that may undergo different processing due to operational or telemetry constraints and opportunities. While the on-ground pipeline is continuously used to test and improve the in-flight pipeline, the only essential difference between the two is that the in-flight pipeline is constrained by the integer arithmetics used by the on board DPU. The final part of the calibration is always done on ground, and essentially consists of rescaling the dataset to physical units and compilation of information for the FITS header, see Section 3.

3 Data Generation and Analysis Process

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

Science data received by the SOC from the SO/PHI team are made available to end users through the Solar Orbiter archive following the policies described in the Archiving Plan [IR3].

The procedure for delivery of the Science data from the SO/PHI Instrument Team to the SOC must be fully compliant with the IT-SOC Science Data Delivery ICD (tbw) [IR4].

3.1 Scientific Measurements

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

3.2 Data Flow Overview

Generation of SO/PHI data products is sketched in Fig. 2. All image data products will be acquired with SO/PHI's FPA, accumulated in the digital processing unit (DPU) and stored in SO/PHI's on-board Image data memory (NAND Flash). The flow of standard SO/PHI science data products is via "pre-processing" and "RTE Inversion" again to the NAND Flash. Alternatively, also partially processed science data or calibration data can be stored in the NAND Flash.

The SO/PHI science telemetry queue, i.e. the I/F to the SSMM will be fed from the NAND Flash. Both 16-bit RTE-inverted or 32-bit raw or partially processed data can be downlinked. Usually, all data go through "CCSDS Compression", however, as the compression module requires 16-bit input, all 32-bit data have to go through "Scaling and Bit-Truncation" before they can be compressed. Optionally, all generated TM packets can be linked via the "ZLIB compression" module to the SSMM.

Each image dataset is accompanied with a corresponding metadata file, which will be updated by each of the processing blocks and, finally, attached to the image data when delivered into the science telemetry queue. On ground all TM packets will be extracted, optionally decompressed and converted into FITS format by including the metadata into the main header and various FITS extensions.

3.3 Data Generation

3.3.1 L0 - Raw Data

SO/PHI level-0 raw data contain either single narrow-band filtergrams obtained by accumulating a number n raw camera read-outs, a series of such images (e.g. 4 polarimetric

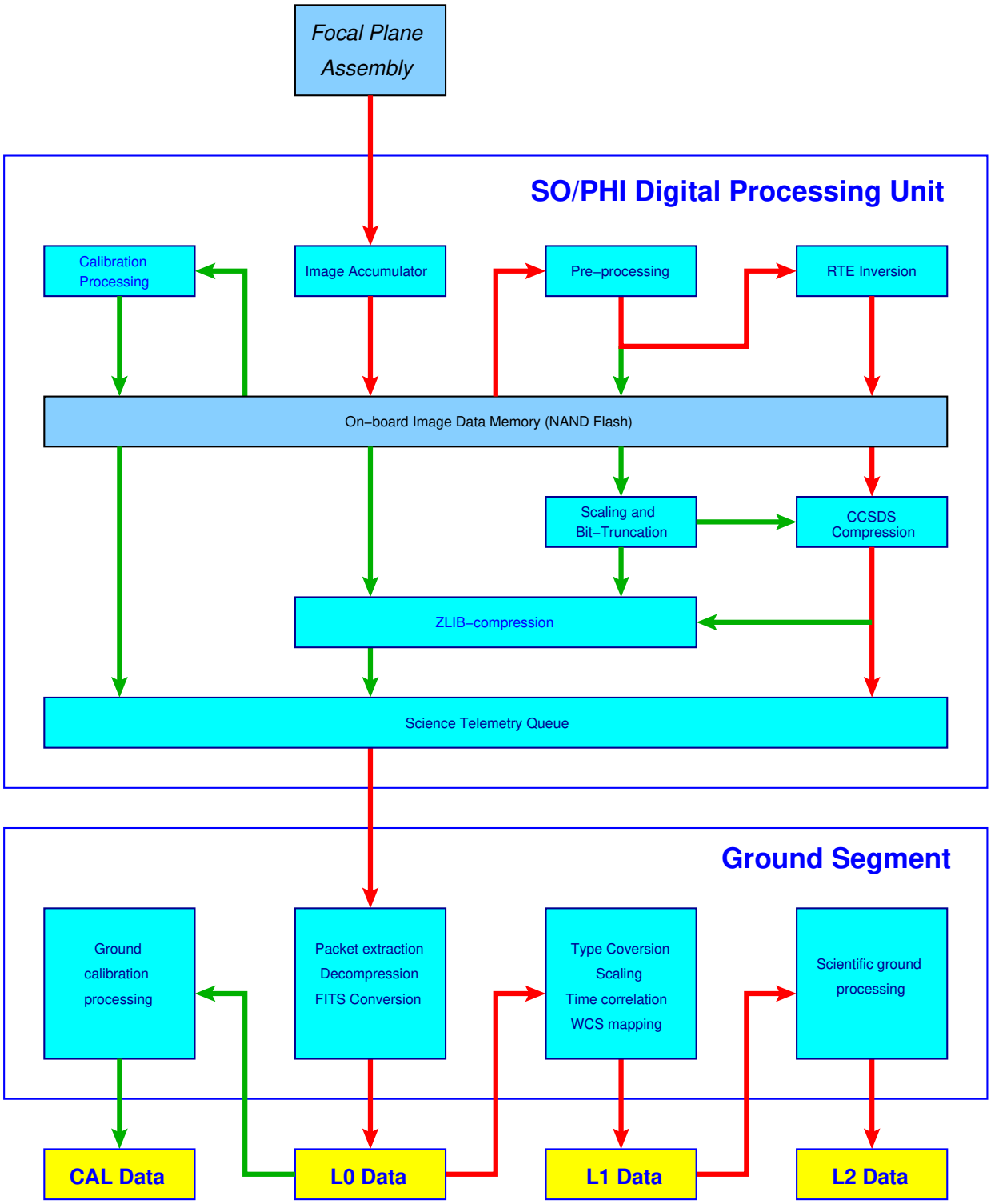

Figure 2: SO/PHI data flow diagram: Red lines denote the default data flow, green lines represent additional flow paths (e.g. the "PHI_raw_data_FDT" and "PHI_raw_data_HRT" operating modes as well as calibration data flows.

modulation states at 6 wavelength positions for default raw science data) or physical parameter maps obtained from the on-board calibration and RTE inversion. The absolute wavelength positions of raw or partially processed data are depending on the applied spectral calibration, i.e. on the orbital velocity of the S/C. Relative wavelength positions for science data are either $[-300, -140, -70, 0, 70, 140]$ mÅ or $[-140, -70, 0, 70, 140, 300]$ mÅ around the (assumed) line center of the FeI 617.3 nm spectral line. FITS extension 3 contains on-board estimated absolute wavelength settings for all camera read-outs contributing to the corresponding dataset.

No additional on-ground data processing is applied and the units are given either in Digital Numbers [DN] as obtained in the FPA and scaled in the SO/PHI DPU or in physical units as produced by the RTE inversion.

Appendix B shows the content of a typical L0 dataset as obtained with the SO/PHI-FDT during RSCW1 at the beginning of CP.

3.3.2 L1 - Engineering data (uncalibrated)

SO/PHI level-1 raw data contain either single narrow-band filtergrams obtained by accumulating a number n raw camera read-outs, a series of such images (e.g. 4 polarimetric modulation states at 6 wavelength positions for default raw science data) or physical parameter maps obtained from the on-board calibration and RTE inversion. The absolute wavelength positions of raw or partially processed data are depending on the applied spectral calibration, i.e. on the orbital velocity of the S/C. Relative wavelength positions for science data are either $[-300, -140, -70, 0, 70, 140]$ mÅ or $[-140, -70, 0, 70, 140, 300]$ mÅ around the (assumed) line center of the FeI 617.3 nm spectral line. FITS extension 3 contains on-board estimated absolute wavelength settings for all camera read-outs contributing to the corresponding dataset.

The data types in the FITS headers are in agreement with the numbers in the contained images and are either 16-bit or 32-bit integers or 32-bit floating point numbers. Units are given either in Digital Numbers [DN] as obtained in the FPA and scaled in the SO/PHI DPU or in physical units as produced by the RTE inversion.

Time correlation to UTC has been carried out and the primary FITS header contains a standard set of entries representing the WCS coordinates of the solar region imaged in the contained data.

3.3.3 L2 - Science Data (calibrated)

SO/PHI level-2 science data contain one of the following data products:

- a series of filtergrams (4 polarimetric modulation states at 6 wavelength positions resulting from the PHI_raw_data_FDT or PHI_raw_data_HRT operating modes) obtained by accumulating a number n camera read-outs;
- 24 polarimetrically demodulated Stokes images, i.e. polarized spectral line profiles at 6 wavelength positions;

- physical parameter maps obtained from either on-board or ground processing calibration and RTE inversion pipelines. On-board calibrated and processed and RTE inverted data also go through the ground processing pipeline (see Fig. 2) but only post-facto corrections will be applied. Depending on the science operating mode (see [IR5]) a subset of the following parameters is generated:
  - the continuum intensity around 617.3 nm, I_c
  - the magnetic field strength, $|\boldsymbol{B}|$
  - the magnetic field inclination with respect to the LOS, γ
  - the magnetic field azimuth around the LOS, ϕ
  - the LOS magnetic field strength, $B_{\rm LOS}$
  - the LOS flow velocity, $v_{\rm LOS}$.

The absolute wavelength positions of raw-mode data and Stokes images are depending on the applied spectral calibration, i.e. on the orbital velocity of the S/C. Relative wavelength positions for science data are either $[-300, -140, -70, 0, 70, 140]$ mÅ or $[-140, -70, 0, 70, 140, 300]$ mÅ around the (assumed) line center of the FeI 617.3 nm spectral line. FITS extension 3 contains a re-calibration of the on-board estimated absolute wavelength settings for all camera read-outs contributing to the corresponding dataset.

All data are flat and dark field calibrated. Stokes images are, in addition, demodulated and corrected for residual instrumental cross-talk. RTE inverted data are calibrated for absolute and relative wavelength shifts, i.e. $v_{\rm LOS}$ maps are corrected for orbital velocities and also for the etalon cavity map.

3.3.4 L3 - Higher level data

Higher level data are planned and in development. These includes vector magnetograms (from both HRT and FDT) with geometrical corrections and disambiguation of the transverse field component. In addition, LOS and vector synoptic maps obtained by combining SDO/HMI maps and FDT will be developed.
Such higher level data are currently under development at the time of writing, and not further described here.

tbc/tbw

3.3.5 CAL - Calibration data

SO/PHI CAL data contain calibration data which are ready to be applied to science raw data (L0 or L1 data products). They usually contain a single (e.g. dark fields) or a series of 2048×2048 pixels images (e.g. 4 polarization states at 6 wavelength positions as dark fields).

CAL data are produced by calibrating L0 flat or dark field data by means of the ground calibration processing pipeline (see Fig. 2).

3.3.6 ANC - Ancillary data

tbc/tbw

3.4 Validation

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

3.4.1 Instrument Team Validation

tbw

3.4.2 SOC Validation

The SOC will check the data types that the SO/PHI 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

SO/PHI data products are formatted in accordance with the [NR1] document. This section provides details on the formats used for each of the products included in the SO/PHI science data.

4.1 Primary Products Formats

The SO/PHI instrument uses the FITS format, compliant with the international FITS standard as described in [NR3], 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 ([NR1], section 2.1)

The definitions below shall include all metadata contained in the product, both Solar Orbiter mandatory metadata and Instrument Specific metadata if any. A description of the data content organisation (as described in the aforementioned section of [NR1] and in [NR2]) shall be given as well.

4.1.1 L0 - Raw data products

SO/PHI level-0 raw data are direct conversions of downlinked TM packets into FITS files without performing any type conversion, re-scaling or calibration. As SO/PHI carries out different levels of on-board data processing, the content of L0 data can be either single or accumulated camera read-outs, partially processed filtergrams or even demodulated Stokes images as well as physical parameter maps resulting from on-board calibration and RTE inversion. Also calibration data such as raw or on-board processed dark and flat field images will be converted into L0 data.

The L0 filenames are organized in the following way:

- The descriptor field contains one of the following options:
  - `phi-fdt-ilam`: single or a series of accumulated and/or on-board processed filtergrams (obtained with SO/PHI-FDT)
  - `phi-hrt-ilam`: single or a series of accumulated and/or on-board processed filtergrams (obtained with SO/PHI-HRT)
  - `phi-fdt-stokes`: single or a series of on-board polarimetrically demodulated filtergrams (obtained with SO/PHI-FDT)
  - `phi-hrt-stokes`: single or a series of on-board polarimetrically demodulated filtergrams (obtained with SO/PHI-HRT)
  - `phi-fdt-icnt`: calibrated 617.3 nm continuum intensity (obtained with SO/PHI-FDT)
  - `phi-hrt-icnt`: calibrated 617.3 nm continuum intensity (obtained with SO/PHI-HRT)
  - `phi-fdt-bmag`: magnetic field-strength map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-bmag`: magnetic field-strength map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-binc`: magnetic field inclination map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-binc`: magnetic field inclination map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-bazi`: magnetic field azimuth map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-bazi`: magnetic field azimuth map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-blos`: magnetic LOS magnetic field strength map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-blos`: magnetic LOS magnetic field strength map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-vlos`: magnetic LOS flow velocity map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-vlos`: magnetic LOS flow velocity map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-flat`: single or a series of raw or processed SO/PHI-FDT flat field images
  - `phi-hrt-flat`: single or a series of raw or processed SO/PHI-HRT flat field images
  - `phi-dark`: raw or processed SO/PHI dark field images

- The free field contains the Dataset Identifier (DID) as used during commanding and on-board operations. The DIDs typically follow the convention given in [IR7], i.e. they are based on 10 digits. In addition, sometimes only single images of a dataset are extracted. In the free field an index number will be then added to the DID.

L0 data are uncalibrated and have to undergo at least minimum calibration tasks prior to scientific usage. Calibration data used for on-board processing (e.g. dark and flat fields, OSPF curves, demodulation matrices, cross-talks calibration parameters, etc.) are detailed in FITS extensions 6 and 7; detailed on-board processing steps are given in FITS extensions 8, 9 and 10. Detailed image acquisition information is given in extension 11.

As no type conversion will be carried out, in the primary FITS header the L0 datasets are represented as either 32-bit or 16-bit (if on-board compressed) integers even if they have to be interpreted as floating point numbers. The required type conversion will be carried out when producing L1 data. Each full-size 2048×2048 pixels image has a size of 8 or 16 MiBytes and each data set can contain one or several images (typically 24 for unprocessed or partially processed science data). On-board cropped or binned images are correspondingly smaller. The FITS files also include the primary FITS header and 10 FITS extensions containing detailed instrument settings and observation and on-board processing parameters as binary or ASCII tables (see Appendix B).

4.1.2 L1 - Engineering data products

SO/PHI level-1 engineering data are conversions of downlinked TM packets into FITS files after performing a conversion to the data type used on-board. No re-scaling or calibration is applied. As SO/PHI carries out different levels of on-board data processing, the content of L1 data can be either single or accumulated camera read-outs, partially processed filtergrams or even demodulated Stokes images as well as physical parameter maps resulting from on-board RTE inversions. Also calibration data such as raw or on-board processed dark and flat field images will be converted into L1 data.

The L1 filenames are organized in the following way:

- The descriptor field contains one of the following options:
  - `phi-fdt-ilam`: single or a series of accumulated and/or on-board processed filtergrams (obtained with SO/PHI-FDT)
  - `phi-hrt-ilam`: single or a series of accumulated and/or on-board processed filtergrams (obtained with SO/PHI-HRT)
  - `phi-fdt-stokes`: single or a series of on-board polarimetrically demodulated filtergrams (obtained with SO/PHI-FDT)
  - `phi-hrt-stokes`: single or a series of on-board polarimetrically demodulated filtergrams (obtained with SO/PHI-HRT)
  - `phi-fdt-icnt`: calibrated 617.3 nm continuum intensity (obtained with SO/PHI-FDT)

  - `phi-hrt-icnt`: calibrated 617.3 nm continuum intensity (obtained with SO/PHI-HRT)
  - `phi-fdt-bmag`: magnetic field-strength map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-bmag`: magnetic field-strength map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-binc`: magnetic field inclination map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-binc`: magnetic field inclination map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-bazi`: magnetic field azimuth map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-bazi`: magnetic field azimuth map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-blos`: magnetic LOS magnetic field strength map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-blos`: magnetic LOS magnetic field strength map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-vlos`: magnetic LOS flow velocity map resulting from on-board RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-vlos`: magnetic LOS flow velocity map resulting from on-board RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-flat`: single or a series of raw or processed SO/PHI-FDT flat field images
  - `phi-hrt-flat`: single or a series of raw or processed SO/PHI-HRT flat field images
  - `phi-dark`: raw or processed SO/PHI dark field images

- The free field contains the Dataset Identifier (DID) as used during commanding and on-board operations. The DIDs typically follow the convention given in [IR7], i.e. they are based on 10 digits. In addition, sometimes only single images of a dataset are extracted. In the free field an index number will be then added to the DID.

L1 data are uncalibrated and have to undergo at least minimum calibration tasks prior to scientific usage. Calibration data used for on-board processing (e.g. dark and flat fields, OSPF curves, demodulation matrices, cross-talks calibration parameters, etc.) are detailed in FITS extensions 6 and 7; detailed on-board processing steps are given in FITS extensions 8, 9 and 10. Detailed image acquisition information is given in extension 11.

L1 datasets are represented as either 32-bit or 16-bit (if on-board compressed) integers or 32-bit floating point numbers (partially processed and uncompressed data). Each full-size 2048×2048 pixels image has a size of 8 or 16 MiBytes and each data set can contain

one or several images (typically 24 for unprocessed or partially processed science data). On-board cropped or binned images are correspondingly smaller. The FITS files also include the primary FITS header and 10 FITS extensions containing detailed instrument settings and observation and on-board processing parameters as binary or ASCII tables (see Appendix C).

4.1.3 L2 - Science data products

SO/PHI level-2 science data contain fully calibrated, science-ready images. Spectral scans (`phi-fdt-ilam` and `phi-hrt-ilam`) contain calibrated intensity maps for the 4 polarimetric states and the 6 wavelength positions. Units are given in [$\mathrm{W\,m^{-2}\,nm^{-1}\,sterad^{-1}}$] (tbc). Stokes images (`phi-fdt-stokes` and `phi-hrt-stokes`) contain spectral profiles (6 wavelength positions) of the calibrated Stokes parameters (I, Q, U, V). Units are also given in [$\mathrm{W\,m^{-2}\,nm^{-1}\,sterad^{-1}}$] (tbc). Finally, RTE inverted parameter maps (`phi-fdt-bmag`, `phi-fdt-binc`, `phi-fdt-bazi`, `phi-fdt-blos`, `phi-fdt-vlos` and `phi-hrt-bmag`, `phi-hrt-binc`, `phi-hrt-bazi`, `phi-hrt-blos`, `phi-hrt-vlos`) are given in physical units, i.e. [G], [°] and [$\mathrm{m\,s^{-1}}$]. The 617.3 nm continuum intensity (`phi-fdt-icnt` and `phi-hrt-icnt`) are parameter maps which are produced independently from RTE inversion are given in units of [$\mathrm{W\,m^{-2}\,nm^{-1}\,sterad^{-1}}$] (tbc). All L2 data are single precision floating point data.

The L1 filenames are organized in the following way:

- The descriptor field contains one of the following options:
  - `phi-fdt-ilam`: series of accumulated and processed filtergrams (obtained with SO/PHI-FDT)
  - `phi-hrt-ilam`: series of accumulated and processed filtergrams (obtained with SO/PHI-HRT)
  - `phi-fdt-stokes`: series of polarimetrically demodulated filtergrams (Stokes images obtained with SO/PHI-FDT)
  - `phi-hrt-stokes`: series of polarimetrically demodulated filtergrams (Stokes images obtained with SO/PHI-HRT)
  - `phi-fdt-icnt`: calibrated 617.3 nm continuum intensity (obtained with SO/PHI-FDT)
  - `phi-hrt-icnt`: calibrated 617.3 nm continuum intensity (obtained with SO/PHI-HRT)
  - `phi-fdt-bmag`: magnetic field-strength map resulting from RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-bmag`: magnetic field-strength map resulting from RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-binc`: magnetic field inclination map resulting from RTE inversion (obtained with SO/PHI-FDT)

  - `phi-hrt-binc`: magnetic field inclination map resulting from RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-bazi`: magnetic field azimuth map resulting from RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-bazi`: magnetic field azimuth map resulting from RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-blos`: magnetic LOS magnetic field strength map resulting from RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-blos`: magnetic LOS magnetic field strength map resulting from RTE inversion (obtained with SO/PHI-HRT)
  - `phi-fdt-vlos`: magnetic LOS flow velocity map resulting from RTE inversion (obtained with SO/PHI-FDT)
  - `phi-hrt-vlos`: magnetic LOS flow velocity map resulting from RTE inversion (obtained with SO/PHI-HRT)

- The free field contains the Dataset Identifier (DID) as used during commanding and on-board operations. The DIDs typically follow the convention given in [IR7], i.e. they are based on 10 digits.

L2 data are calibrated at best effort and ready for scientific use. Calibration data used for on-board and ground processing (e.g. dark and flat fields, OSPF curves, demodulation matrices, cross-talks calibration parameters, etc.) are detailed in FITS extensions 6 and 7; detailed on-board processing steps are given in FITS extensions 8, 9 and 10. Detailed image acquisition information is given in extension 11.

All L2 datasets are represented as 32-bit floating point numbers. Each full-size 2048 × 2048 pixels image has a size of 16 MiBytes and each data set can contain one or several images (typically 24 for raw-mode science data). Physical parameter maps obtained from RTE inversion are given as single images of 16 MiBytes size. On-board cropped or binned images are correspondingly smaller. The FITS files also include the primary FITS header and 10 FITS extensions containing detailed instrument settings and observation and on-board processing parameters as binary or ASCII tables (see Appendix D).

4.1.4 L3 - Higher level data products

tbc/tbw

4.1.5 CAL - Calibration data products

Some of the information included in the calibration data products are under optimization. Therefore, this section, which reflects the current status of the calibration data products, is to be considered as tbc.

CAL data contain processed SO/PHI calibration data ready to be applied to SO/PHI uncalibrated science data. All CAL data are given as 32-bit floating point numbers. Units of dark fields are given in [DN] for a single image at a certain exposure time, i.e. the corresponding dark field can be applied only to science data obtained at the same exposure time. Accumulated science data have to be divided by the number of accumulations before subtracting the dark field.

Flat fields are also given in [DN]. They either contain a single (wavelength and polarization independent) a series of 6 (polarization independent) or a series of 24 (wavelength and polarization dependent) flat field images. Applying the flat fields to science data has to take into account the variation of the absolute wavelengths with the orbit. FITS extension 3 contains a re-calibration of the on-board estimated absolute wavelength settings for all camera read-outs contributing to the corresponding dataset. CAL data do not only include the spatial but also the spectral flat field, i.e. the (field dependent) transmission profile of the OSPF.

The CAL filenames are organized in the following way:

- The descriptor field contains one of the following options:
  - `phi-fdt-flat`: single or a series of processed and calibrated SO/PHI-FDT flat field images
  - `phi-hrt-flat`: single or a series of processed and calibrated SO/PHI-HRT flat field images
  - `phi-dark`: processed and calibrated SO/PHI dark field image
- The free field contains the Dataset Identifier (DID) as used during commanding and on-board operations. The DIDs typically follow the convention given in [IR7], i.e. they are based on 10 digits.

4.1.6 ANC - Ancillary data products

tbc/tbw

A Data Products Matrix

Table 1: SO/PHI Data Products Matrix

Product name	**Description**	**Descriptor**	**Free_field**	Level
FDT narrow-band filtergram	raw FPA image(s)	`phi-fdt-ilam`	*DataSet ID*	L0
HRT narrow-band filtergram	raw FPA image(s)	`phi-hrt-ilam`	*DataSet ID*	L0
FDT narrow-band filtergram	(partially) calibrated FPA image(s)	`phi-fdt-ilam`	*DataSet ID*	L0, L1
HRT narrow-band filtergram	(partially) calibrated FPA image(s)	`phi-hrt-ilam`	*DataSet ID*	L0, L1
FDT narrow-band filtergram	calibrated and corrected FPA image(s)	`phi-fdt-ilam`	*DataSet ID*	L0, L1, L2
FDT narrow-band filtergram	calibrated and corrected FPA image(s)	`phi-hrt-ilam`	*DataSet ID*	L0, L1, L2
FDT Stokes maps	polarimetrically demodulated filtergrams	`phi-fdt-stokes`	*DataSet ID*	L0, L1, L2
HRT Stokes maps	polarimetrically demodulated filtergrams	`phi-fdt-stokes`	*DataSet ID*	L0, L1, L2
FDT continuum intensity map	calibrated 617.3 nm continuum intensity	`phi-fdt-icnt`	*DataSet ID*	L0, L1, L2
HRT continuum intensity map	calibrated 617.3 nm continuum intensity	`phi-hrt-icnt`	*DataSet ID*	L0, L1, L2
FDT $\lvert\boldsymbol{B}\rvert$ map	RTE inverted magnetic field strength	`phi-fdt-bmag`	*DataSet ID*	L0, L1, L2
HRT $\lvert\boldsymbol{B}\rvert$ map	RTE inverted magnetic field strength	`phi-hrt-bmag`	*DataSet ID*	L0, L1, L2
FDT γ map	RTE inverted magnetic field inclination	`phi-fdt-binc`	*DataSet ID*	L0, L1, L2
HRT γ map	RTE inverted magnetic field inclination	`phi-hrt-binc`	*DataSet ID*	L0, L1, L2
FDT ϕ map	RTE inverted magnetic field inclination	`phi-fdt-bazi`	*DataSet ID*	L0, L1, L2
HRT ϕ map	RTE inverted magnetic field inclination	`phi-hrt-bazi`	*DataSet ID*	L0, L1, L2
FDT B_{LOS} map	RTE inverted LOS magnetic field strength	`phi-fdt-blos`	*DataSet ID*	L0, L1, L2
HRT B_{LOS} map	RTE inverted LOS magnetic field strength	`phi-hrt-blos`	*DataSet ID*	L0, L1, L2
FDT v_{LOS} map	RTE inverted LOS flow velocity	`phi-fdt-vlos`	*DataSet ID*	L0, L1, L2
HRT v_{LOS} map	RTE inverted LOS flow velocity	`phi-hrt-vlos`	*DataSet ID*	L0, L1, L2
FDT flat fields	FDT flat fields	`phi-fdt-flat`	*DataSet ID*	L0, L1, CAL
HRT flat fields	HRT flat fields	`phi-hrt-flat`	*DataSet ID*	L0, L1, CAL
Dark fields	Dark fields	`phi-dark`	*DataSet ID*	L0, L1, CAL

B Sample L0 dataset file

This Section shows the content of an example SO/PHI L0 science dataset as taken on June 18, 2020 at the beginning of CP. The filename is:
`solo_L0_phi-fdt-ilam_20200618T040005_V202107081504C_0066180100.fits`
and one of the included images is shown in Fig. 3. The size of the file is 201.5 MBytes.

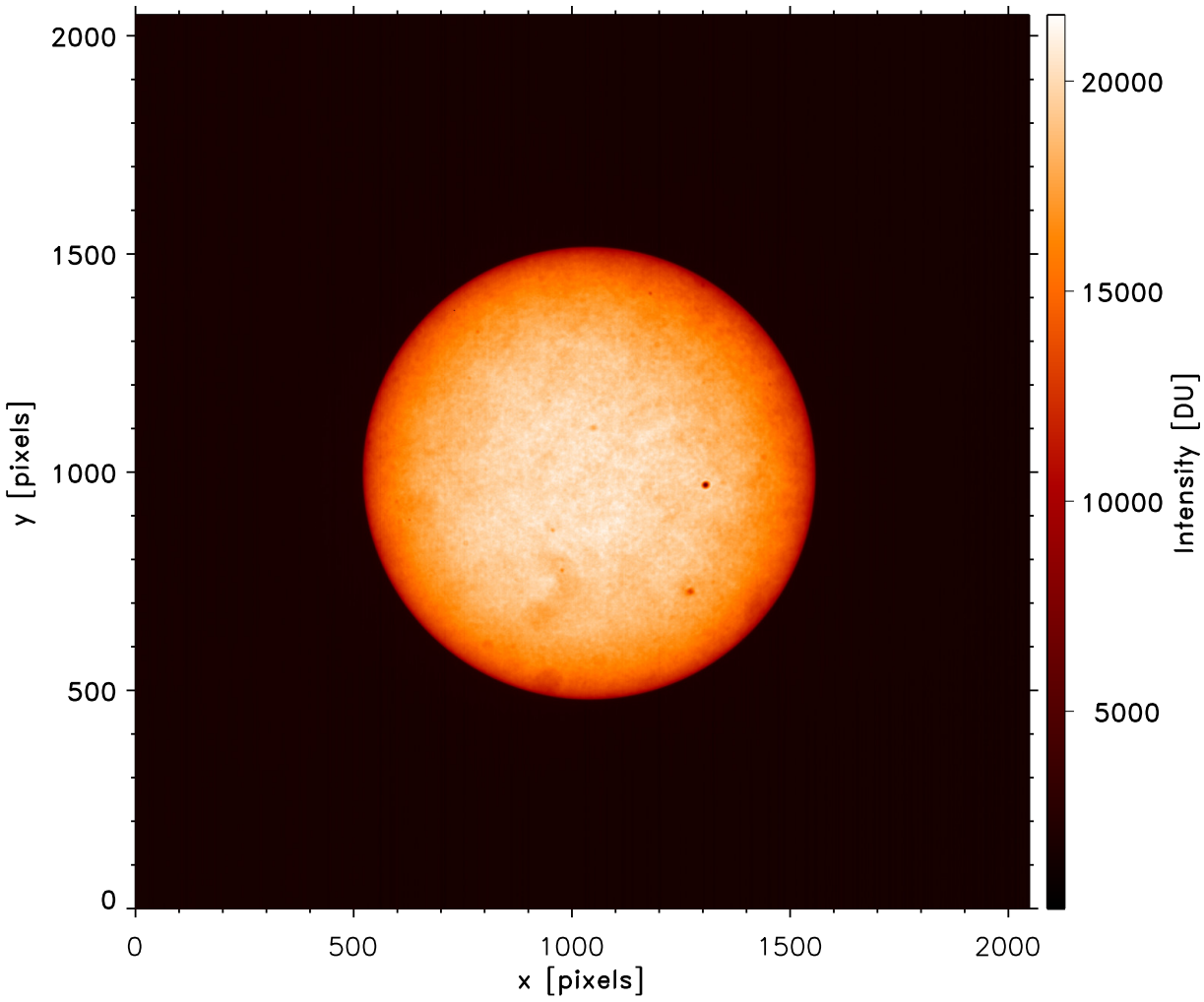

Figure 3: First image of an example SO/PHI L0 science dataset containing a spectral line scan at 6 wavelength positions and 4 polarization modulation states at each spectral position.

Below the defined FITS extensions are shown, with the exception of extension 1, named `PHI-RAW-META-DATA`, which is a copy of the (binary) raw metadata, and is not presented here.

B.1 L0 Example Main Header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   16 / number of bits per data pixel
NAXIS   =                    3 / number of data axes
NAXIS1  =                 2048 / length of data axis 1
NAXIS2  =                 2048 / length of data axis 2
NAXIS3  =                   24 / length of data axis 3
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
LONGSTRN= 'OGIP 1.0'           / The HEASARC Long String Convention may be used.
COMMENT   This FITS file may contain long string keyword values that are
COMMENT   continued over multiple keywords.  The HEASARC convention uses the &
COMMENT   character at the end of each substring which is then continued
COMMENT   on the next keyword which has the name CONTINUE.
FILENAME= 'solo_L0_phi-fdt-ilam_20200618T040005_V202107081504C_0066180100.fits'
DATE    = '2021-07-08T15:04:55' / file creation date (YYYY-MM-DDThh:mm:ss UT)

          / Instrument and observation configuration FITS keywords
OBSRVTRY= 'Solar Orbiter'      / Satellite Name
INSTRUME= 'PHI'                / Instrument name
TELESCOP= 'SOLO/PHI/FDT'       / Telescope
DETECTOR= 'FDT'                / Instrument subunit or sensor
OBS_MODE= ' '                  / Observation mode
OBS_ID  = ' '                  / Unique ID of Observation
OBJECT  = ' '                  / Type of object observed
OBS_TYPE= ' '                  / Encoded version of OBS_MODE
SOOPNAME= ' '                  / SOOP Campaign Name
SOOPTYPE= ' '                  / SOOP Campaign ID(s)
PURPOSE = ' '                  / Purpose of this observation
SUBJECT = ' '                  / Subject of this observation
SCIENTIS= ' '                  / Resposible scientist for this observation
WAVEMIN =             617.3116 / [Angstrom] min wavelength of observation
WAVEMAX =             617.3573 / [Angstrom] max wavelength of observation
TIMESYS = 'OBT'                / System used for time keywords
OBT_BEG =     1592452786.69924 / [OBT] Start time of observation
OBT_END =     1592452844.89668 / [OBT] End time of observation
LEVEL   = 'L0'                 / Data processing level
ORIGIN  = 'MPS'                / Name of institution
CREATOR = 'converter'          / FITS creation software
VERS_SW = '11268:11962'        / Version of SW that provided FITS file
VERSION = '202107081504'       / Version of FITS file

          / Description of data content keywords
BTYPE   = 'Intensity'          / Type of data
BSCALE  =                  1.0 / ratio of physical to array value at 0 offset
BUNIT   = 'DN'                 / Units of physical value, after application
DATAMIN =                300.  / Minimum valid physical value
DATAMAX =              23090.  / Maximum valid physical value

          / Image relative to detector electronics keywords
RPLTSCL =                  3.6 / [arcsec] Platescale of raw images
PXBEG1  =                    1 / First read-out pixel in dimension 1
PXEND1  =                 2048 / Last read-out pixel in dimension 1
PXBEG2  =                    1 / First read-out pixel in dimension 2
PXEND2  =                 2048 / Last read-out pixel in dimension 2
NBIN1   =                    1 / Data binning factor in dimension 1
NBIN2   =                    1 / Data binning factor in dimension 2
NBIN    =                    1 / Total binning factor
AVTTOFFX=                  0.0 / [arcec] average tip/tilt offset x
AVTTOFFY=                  0.0 / [arcec] average tip/tilt offset y

          / Onboard processing keywords
CAL_DARK=                    0 / Onboard calibrated for dark field
CAL_FLAT=                    0 / Onboard calibrated for gain table
CAL_PRE =                    0 / Prefilter correction (DID/file)
CAL_GHST= ''                   / Ghost correction (name + version of module
```

```
CAL_REAL= ''                  / Prealigment of images before demodulation (name
CAL_CRT0=                  0. / cross-talk from I to Q (slope)
CAL_CRT1  cross-talk from I to Q (offset)
CAL_CRT2=                  0. / cross-talk from I to U (slope)
CAL_CRT3  cross-talk from I to U (offset)
CAL_CRT4=                  0. / cross-talk from I to V (slope)
CAL_CRT5  cross-talk from I to V (offset)
CAL_CRT6=                  0. / cross-talk from V to Q (slope)
CAL_CRT7  cross-talk from V to Q (offset)
CAL_CRT8=                  0. / cross-talk from V to U (slope)
CAL_CRT9  cross-talk from V to U (offset)
CAL_NORM=               2590. / Normalization (normalization constant PROC_Ic)
CAL_FRIN  Fringe correction (name + version of module
CAL_PSF =                    0 / Onboard calibrated for instrumental PSF
CAL_IPOL=                    0 / Onboard calibrated for instrumental polarizatio
CAL_SCIP= 'None'             / Onboard scientific data analysis
RTE_ITER=          4294967295 / Number RTE inversion iterations
COMPRESS= '4Bits'            / Data compression quality
COMPRAT =                 0.25 / Data compression ratio
COMPVERS=                    0 / Version of Compression Core
PHIDATID= '66180100'         / PHI dataset Id

        / PHI_FITS_DPU_prehk
I_SYSST1= 'OBSERVATION'      / Instrument system state
CPULOAD1=                93.01 / [perc] CPU load
SPWDROP1=                    0 / Number of dropped SpaceWire packets
IICPCTN1=                35180 / Number of IIC packets
IICSEQN1=                10215 / Sequence number of the last IIC packet
OBSWVER1=                11120 / On-board software version
DPUHWVR1=             17434701 / DPU hardware version
DPUSSCR1=                24822 / DPU System Supervisor CR
DPUSSSR1=                    0 / DPU System Supervisor SR
TCREC_N1=                   52 / Number of received Telecommands
TCFAILN1=                    0 / Number of failed Telecommands
TCQUEUE1=                    0 / Fill level of Telecommanding queue
TMQUEUE1=                    0 / Fill level of Telemetry queue
SCQUEUE1=                    0 / Fill level of science Telemetry queue
RAMFS_N1=                   12 / Number of files in RAMFS
RAMFSSP1=            111268136 / [Byte] Available space in RAMFS
SRVSTFL1=                 4076 / Service status flags
GPIOLST1=            604141736 / Status of GPIO ports 0-31
GPIOHST1=              4298758 / Status of GPIO ports 32-63
SCDCMOD1= 'COMPRESS_NONE'    / Science data compression mode

        / PHI_FITS_PCM_prehk
APCMSTA1=                  241 / Active PCM status flag
APCM_VP1=               27.505 / [V] active PCM V_prim
APCM_IP1=                0.971 / [A] active PCM I_prim
APP28IH1=                0.022 / [A] active PCM I_Heaters_+28V
APP28IM1=                0.073 / [A] active PCM I_Mech_+28V
AP_P33I1=                2.665 / [A] active PCM I_+3V3
AP_P07I1=                0.636 / [A] active PCM I_+7V
AP_M07I1=                0.089 / [A] active PCM I_-7V
AP_P15I1=                0.062 / [A] active PCM I_+15V
AP_M15I1=                0.057 / [A] active PCM I_-15V
AP_P60I1=                0.007 / [A] active PCM I_+60V
ADPU33V1=                3.406 / [V] active PCM V_DPU_+3V3
AABP33V1=                3.406 / [V] active PCM V_AB_+3V3
AABP07V1=                 6.56 / [V] active PCM V_AB_+7V
AABP15V1=               14.417 / [V] active PCM V_AB_+15V
AABM15V1=               14.501 / [V] active PCM V_AB_-15V
ACPP07V1=                7.304 / [V] active PCM V_CPC_+7V
ACPM07V1=                7.475 / [V] active PCM V_CPC_-7V
AHVP07V1=                6.563 / [V] active PCM V_HVPS_+7V
AHVP15V1=               14.415 / [V] active PCM V_HVPS_+15V
AHVM15V1=                 14.5 / [V] active PCM V_HVPS_-15V
ATTP07V1=                 6.56 / [V] active PCM V_TTC_+7V
ATTP60V1=               59.983 / [V] active PCM V_TTC_+60V
```

```
POWSWST1=                  255 / Power Switch status

         / PHI_FITS_MECH_prehk
MEMOVST1=                    4 / Mechanism movement status flag
MEEOTST1=                    8 / Mechanism end-of-travel switch status flag
FRM_POS1=                 2911 / [um] Deduced FRM position
DHRM_PS1=                12363 / [um] Deduced HRM position
DCRM_PS1=                    0 / [um] Deduced CRM position
FSM_POS1=                    0 / [amin] Deduced FSM position
HVPSLPV1=                 -327 / [V] HVPS HV level side P
HVPSLNV1=                  311 / [V] HVPS HV level side N
TTCP55V1=               54.478 / [V] Voltage TTC_+55V
IABREFV1=                1.254 / [V] Internal AMHD voltage reference 1.25V
DEDFGWL1=              6173116 / [mAng] Deduced current FG wavelength
FDTPMPR1=                    1 / Deduced FDT PMP polarization state
LC1FDTV1=                2.099 / [V] commanded voltage on FDT PMP LC1
LC2FDTV1=                2.001 / [V] commanded voltage on FDT PMP LC2
HRTPMPR1=                  255 / Deduced HRT PMP polarization state
LC1HRTV1=                    0 / [V] commanded voltage on HRT PMP LC1
LC2HRTV1=                    0 / [V] commanded voltage on HRT PMP LC2

         / PHI_FITS_TEMP_prehk
FGOV1PT1=                60.99 / [degC] FG oven precision temperature 1
FGOV2PT1=                60.96 / [degC] FG oven precision temperature 2
FPMP1PT1=                39.96 / [degC] FDT PMP precision temperature 1
FPMP2PT1=                40.27 / [degC] FDT PMP precision temperature 2
HPMP1PT1=                44.17 / [degC] HRT PMP precision temperature 1
HPMP2PT1=                50.99 / [degC] HRT PMP precision temperature 2
FRM_MWT1=                14.94 / [degC] FRM motor temperature
HRM_MWT1=                16.86 / [degC] HRM motor temperature
CRM_MWT1=                15.94 / [degC] CRM motor temperature
FSM_MWT1=                16.63 / [degC] FSM motor temperature
AMHD_1T1=                13.65 / [degC] AMHD DCDC temperature
AMHD_2T1=                 9.63 / [degC] AMHD board temperature
FRMPANT1=                16.72 / [degC] FDT housing temperature
M2BAFFT1=                19.51 / [degC] M2 baffle temperature
OUREF1T1=                16.64 / [degC] O-Unit main baffle temperature
OUREF2T1=                16.51 / [degC] HRT PMP housing temperature
M1MNT_T1=                17.58 / [degC] M1 mounting temperature
M2MNT_T1=                23.44 / [degC] Tip-Tilt housing temperature
FGO_1CT1=                60.89 / [degC] FG oven coarse temperature 1
FGO_2CT1=                60.28 / [degC] FG oven coarse temperature 2
PCM_M1T1=                  9.3 / [degC] Main PCM board temperature 1
PCM_M2T1=                11.19 / [degC] Main PCM board temperature 2
PCM_R1T1=                 7.87 / [degC] Redundant PCM board temperature 1
PCM_R2T1=                 8.07 / [degC] Redundant PCM board temperature 2
DPU_B1T1=                20.65 / [degC] DPU board temperature 1
DPU_B2T1=                22.62 / [degC] DPU board temperature 2
TTCT_BT1=                10.69 / [degC] TTC board temperature
HVPS_BT1=                 9.34 / [degC] HVPS board temperature
ISSTT1T1=                16.84 / [degC] ISS tip/tilt temperature 1
ISSTT2T1=                16.51 / [degC] ISS tip/tilt temperature 2
EUREF_T1=                 8.69 / [degC] E-Unit reference temperature
HEATOVL1= 'Off     '           / Heater overlapping mode (0=off, 1=on)
FGHEATM1=                    1 / FG heater mode status
FGH_TSP1=                   61 / [degC] FG heater set point
FGH_POW1=                    0 / [W] FG heater power
HPHEATM1=                    0 / HRT PMP heater mode status
HPMPTSP1=                   40 / [degC] HRT PMP heater set point
HPMPPOW1=                    0 / [W] HRT PMP heater power
FPHEATM1=                    1 / FDT PMP heater mode status
FPMPTSP1=                   40 / [degC] FDT PMP heater set point
FPMPPOW1=                    0 / [W] FDT PMP heater power

         / PHI_FITS_FPA_prehk
FPAINPV1=                 0.49 / [A] FPA +7V input current
FPAINMV1=                -0.07 / [A] FPA -7V input current
FPACCIV1=                    0 / [V] FPA CCI voltage
```

```
FPASSIV1=                    0 / [V] FPA SSA voltage
FPACCDV1=                 3.24 / [V] FPA CCD voltage
FPACCAV1=                 2.42 / [V] FPA CCA voltage
FPACCBV1=                  1.5 / [V] FPA CCB voltage
FPGA_BT1=                15.27 / [degC] FPA FPGA board temperature
IS_PIXV1=                  2.5 / [V] image sensor voltage V_PIX
ISARSTV1=                 0.08 / [V] image sensor voltage V_PIX_RST_ACT
ISIRSTV1=                 3.17 / [V] image sensor voltage V_PIX_RST_INACT
ISASELV1=                 3.56 / [V] image sensor voltage V_PIX_SEL_ACT
ISATX1V1=                 2.99 / [V] image sensor voltage V_PIX_TX1_ACT1
ISATX2V1=                 0.09 / [V] image sensor voltage V_PIX_TX1_ACT2
ISITX1V1=                    0 / [V] image sensor voltage V_PIX_TX1_INACT
IS_ABSV1=                    0 / [V] image sensor ABS bias voltage
FPA_IST1=               -24.92 / [degC] FPA image sensor temperature
CAMR_ID1=                  513 / Camera ID
FPAFIRM1=                 1284 / FPA FPGA ID and firmware version
ANNEALH1= 'ANNEALING_OFF'      / Annealing heater status (0=off, 1=on)
CPC_T__1=                19.19 / [degC] CPC Temperature
CPC_ID_1=                 1742 / CPC ID
FPATMRS1=                  128 / TMR Status
FPATMRA1=                    0 / TMR error address
FPATMRC1=                    0 / Number of TMR cycles
FPASELS1=                  128 / SEL Status
FPASELT1=                    8 / [V] SEL threshold
ACCVERS1=                 3161 / Accumulator Version
ACCSTAT1=                    0 / Accumulator Status
ACCDEST1= 'NONE    '           / Accumulator destination
ACCDID_1=                    0 / Accumulator transfer dataset ID

         / PHI_FITS_ISS_prehk
ISSFIRM1=                 5389 / ISS controller firmware version
ISSVALN1=                   39 / Number of valid ISS controller commands
ISSINVN1=                    0 / Number of invalid ISS controller commands
ISSLAST1=                   13 / ID of last ISS command
ISSMODE1= 'ISS_IDLE'           / Current ISS mode (0=idle, 1=correlation)
CTCLAST1=                21834 / Last CTC command
CTCLRES1=                21834 / CTC last response
CTCLSTF1=                    0 / CTC last status frame
CTC_COR1=                    0 / CTC Column out of range
CTC_ROR1=                    0 / CTC Row out of range
CTCBREF1=                    0 / CTC black reference
CTCN5V_1=               -3.633 / [V] CTC negative 3V6
CTCP2V51=                2.389 / [V] CTC positive 2V5
CTCP3V31=                3.251 / [V] CTC positive 3V3
CTCP5V_1=                5.072 / [V] CTC positive 5V
CTCSENT1=                17.37 / [degC] CTC sensor temperature
CTCFPGT1=                19.38 / [degC] CTC FPGA temperature
CTCREF11=                0.987 / [V] CTC reference voltage 1V
CTCREF21=                  2.5 / [V] CTC reference voltage 2v
CTCSIMG1=                    0 / CTC send images
CTCRIMG1=                    0 / CTC received images
CTCBADD1=                    0 / CTC bad address
CTCEADD1=                    0 / CTC expected address
CWRGIMG1=                    0 / CTC wrong images
ISSBADP1=                    0 / ISS bad period
ISSOUTX1=                    0 / ISS out X
ISSOUTY1=                    0 / ISS out Y
ISSAVIR1=                    0 / ISS mean intensity reference
ISSRMSI1=                    0 / ISS rms intensity reference
ISSMXIR1=                    0 / ISS maximum intensity reference
ISSMNIR1=                    0 / ISS minimum intensity reference
ISS_AVJ1=                    0 / [asec] ISS mean offset
ISSRMSJ1=                    0 / [asec] ISS rms offset
ISSMAXJ1=                    0 / [asec] ISS maximum offset
ISSMINJ1=                    0 / [asec] ISS minimum offset
ISSA10P1=                    0 / ISS parabolic parameter A01
ISSA01P1=                    0 / ISS parabolic parameter A10
ISSA20P1=                    0 / ISS parabolic parameter A02
```

```
ISSA02P1=                    0 / ISS parabolic parameter A20
ISSA11P1=                    0 / ISS parabolic parameter A11
ISSREFI1=                    0 / Number of used ISS reference images
ISSOOBC1=                    0 / ISS out of bound count
ISSB2OF1=                    0 / ISS CT bank 2 offset
ISSPIMG1=                    0 / ISS pending images
ISLISOX1=                    0 / ISS LIS out X
ISLISOY1=                    0 / ISS LIS out Y
ISOTFOX1=                    0 / ISS SOTF out X
ISOTFOY1=                    0 / ISS SOTF out Y
ISROTOX1=                    0 / ISS ROT out X
ISROTOY1=                    0 / ISS ROT out Y
ISROTLE1=                    0 / ISS ROT log exponent
ISSSTFL1=                    0 / ISS status and error flags
ISSIMSZ1=                  128 / ISS image size (square)
ISSLDEL1=                    0 / ISS line delay
CTC_AGN1=                    0 / CTC analog gain
CTC_DGN1=                    0 / CTC digital gain
CTCSTOF1=                    0 / CTC static offset
ISSRSHT1=                    0 / ISS rolling shutter offset
ISSIMOX1=                  448 / ISS image offset X
ISSIMOY1=                  448 / ISS image offset Y
CTADPSF1=                   64 / CTC ADC phase shift
CTCRTRI1=                   15 / CTC retries
CTCDIMN1=                    0 / Number of dropped CTC images
ISSSTEP1=                    0 / ISS stats exponent
ISIMGST1=                    0 / ISS store images
ISIMGRS1=                    0 / ISS store raw images
ISTSTIM1=                    0 / ISS test images
ISSTISE1=                    7 / ISS test image size Exp
ISSTIEV1=                    0 / ISS test image even
ISSTIOD1=                    0 / ISS test image odd
ISSTDIS1=                    0 / ISS store displacement
ISTADIS1=                    0 / ISS stats displacement
ISSREFP1=                    0 / ISS reference period
TT_OFFX1=                 2047 / TT offset X
TT_OFFY1=                 2047 / TT offset Y
TTAMPXX1=                  256 / TT Amp XX
TTAMPXY1=                    0 / TT Amp XY
TTAMPYX1=                    0 / TT Amp YX
TTAMPYY1=                  256 / TT Amp YY
TT_MAX_1=                 3648 / TT max
TT_MIN_1=                  446 / TT min
TTSTPEX1=                    0 / TT steps exponent
TTSTPPD1=                    0 / TT steps period
PID_A1X1=                    0 / ISS PID X parameter A1
PID_A1Y1=                    0 / ISS PID Y parameter A1
PID_A2X1=                    0 / ISS PID X parameter A2
PID_A2Y1=                    0 / ISS PID Y parameter A2
PID_B0X1=                    1 / ISS PID X parameter B0
PID_B0Y1=                    1 / ISS PID Y parameter B0
PID_B1X1=                    0 / ISS PID X parameter B1
PID_B1Y1=                    0 / ISS PID Y parameter B1
PID_B2X1=                    0 / ISS PID X parameter B2
PID_B2Y1=                    0 / ISS PID Y parameter B2
LISSAAX1=                    0 / ISS Lissajous parameter AX
LISSAAY1=                    0 / ISS Lissajous parameter AY
LISSADX1=                    0 / ISS Lissajous parameter DX
LISSADY1=                    0 / ISS Lissajous parameter DY
LISSAWX1=                0.199 / ISS Lissajous parameter WX
LISSAWY1=                0.199 / ISS Lissajous parameter WY
LISSAFI1=                    0 / ISS Lissajous parameter FI
LISSATX1=                    0 / ISS Lissajous parameter TDX
LISSATY1=                    0 / ISS Lissajous parameter TDY
LISSATS1=                    0 / ISS Lissajous parameter TS
LISSPRS1=                    0 / ISS prescaler
LISSANS1=                    0 / ISS Lissajous parameter VS
ISSTHHX1=                    0 / ISS static threshold X
```

```
ISSTHHY1=                    0 / ISS static threshold Y
ISSHKPD1=                    0 / ISS HK period
ISSMEMP1=                    0 / ISS memory parameter
ISCLKPH1=                    0 / [PI] ISS clock phase

         / PHI_FITS_FPA_settings
FPIMGCMD=                    8 / FPA image command
FPA_SROW=                    0 / FPA start row setting
FPA_EROW=                 1022 / FPA end row setting
FPA_NIMG=                   20 / FPA number of images set
FPEXPSTC=           1592452786 / [s] FPA exposure start time coarse
FPEXPSTF=               699245 / [us] FPA exposure start time fine
INTTIME =                 0.01 / [s] Exposure time of single readout
TELAPSE =     58.1974400877953 / [s] Elapsed time between start and end of obser
NSUMEXP =                  480 / Number of detector readouts
XPOSURE =                  4.8 / [s] Total effective exposure time

         / PHI_FITS_ACCU_settings
ACCLENGT=              4194304 / ACCU number of pixel set
ACCNROWS=                    6 / ACCU number of rows set
ACCROWIT=                    1 / ACCU number of row iterations set
ACCNCOLS=                    4 / ACCU number of columns set
ACCCOLIT=                    1 / ACCU number of column iterations set
ACCACCUM=                   20 / ACCU number of accumulations set
ACCADDR =                    0 / ACCU readout address (start)
ACCSIZE =            402653184 / ACCU Data size in byte

         / PHI_FITS_DPU_posthk
I_SYSST2= 'OBSERVATION'        / Instrument system state
CPULOAD2=                93.98 / [perc] CPU load
SPWDROP2=                    0 / Number of dropped SpaceWire packets
IICPCTN2=                35270 / Number of IIC packets
IICSEQN2=                10935 / Sequence number of the last IIC packet
OBSWVER2=                11120 / On-board software version
DPUHWVR2=             17434701 / DPU hardware version
DPUSSCR2=                24792 / DPU System Supervisor CR
DPUSSSR2=                    0 / DPU System Supervisor SR
TCREC_N2=                   52 / Number of received Telecommands
TCFAILN2=                    0 / Number of failed Telecommands
TCQUEUE2=                    0 / Fill level of Telecommanding queue
TMQUEUE2=                    0 / Fill level of Telemetry queue
SCQUEUE2=                    0 / Fill level of science Telemetry queue
RAMFS_N2=                   12 / Number of files in RAMFS
RAMFSSP2=            111268136 / [Byte] Available space in RAMFS
SRVSTFL2=                 4076 / Service status flags
GPIOLST2=            604141736 / Status of GPIO ports 0-31
GPIOHST2=              4298758 / Status of GPIO ports 32-63
SCDCMOD2= 'COMPRESS_NONE'      / Science data compression mode

         / PHI_FITS_PCM_posthk
APCMSTA2=                  241 / Active PCM status flag
APCM_VP2=               27.486 / [V] active PCM V_prim
APCM_IP2=                0.989 / [A] active PCM I_prim
APP28IH2=                0.028 / [A] active PCM I_Heaters_+28V
APP28IM2=                0.074 / [A] active PCM I_Mech_+28V
AP_P33I2=                2.778 / [A] active PCM I_+3V3
AP_P07I2=                0.656 / [A] active PCM I_+7V
AP_M07I2=                 0.09 / [A] active PCM I_-7V
AP_P15I2=                0.063 / [A] active PCM I_+15V
AP_M15I2=                0.059 / [A] active PCM I_-15V
AP_P60I2=                0.007 / [A] active PCM I_+60V
ADPU33V2=                3.406 / [V] active PCM V_DPU_+3V3
AABP33V2=                3.406 / [V] active PCM V_AB_+3V3
AABP07V2=                 6.56 / [V] active PCM V_AB_+7V
AABP15V2=               14.415 / [V] active PCM V_AB_+15V
AABM15V2=               14.502 / [V] active PCM V_AB_-15V
ACPP07V2=                7.303 / [V] active PCM V_CPC_+7V
ACPM07V2=                7.483 / [V] active PCM V_CPC_-7V
```

```
AHVP07V2=                6.563 / [V] active PCM V_HVPS_+7V
AHVP15V2=               14.414 / [V] active PCM V_HVPS_+15V
AHVM15V2=               14.502 / [V] active PCM V_HVPS_-15V
ATTP07V2=                 6.56 / [V] active PCM V_TTC_+7V
ATTP60V2=               59.983 / [V] active PCM V_TTC_+60V
POWSWST2=                  255 / Power Switch status

         / PHI_FITS_MECH_posthk
MEMOVST2=                    4 / Mechanism movement status flag
MEEOTST2=                    8 / Mechanism end-of-travel switch status flag
FRM_POS2=                 2911 / [um] Deduced FRM position
DHRM_PS2=                12363 / [um] Deduced HRM position
DCRM_PS2=                    0 / [um] Deduced CRM position
FSM_POS2=                    0 / [amin] Deduced FSM position
HVPSLPV2=                 -327 / [V] HVPS HV level side P
HVPSLNV2=                  311 / [V] HVPS HV level side N
TTCP55V2=               54.478 / [V] Voltage TTC_+55V
IABREFV2=                1.254 / [V] Internal AMHD voltage reference 1.25V
DEDFGWL2=             6173116 / [mAng] Deduced current FG wavelength
FDTPMPR2=                    4 / Deduced FDT PMP polarization state
LC1FDTV2=                1.682 / [V] commanded voltage on FDT PMP LC1
LC2FDTV2=                1.653 / [V] commanded voltage on FDT PMP LC2
HRTPMPR2=                  255 / Deduced HRT PMP polarization state
LC1HRTV2=                    0 / [V] commanded voltage on HRT PMP LC1
LC2HRTV2=                    0 / [V] commanded voltage on HRT PMP LC2

         / PHI_FITS_TEMP_posthk
FGOV1PT2=                60.99 / [degC] FG oven precision temperature 1
FGOV2PT2=                60.96 / [degC] FG oven precision temperature 2
FPMP1PT2=                39.96 / [degC] FDT PMP precision temperature 1
FPMP2PT2=                40.27 / [degC] FDT PMP precision temperature 2
HPMP1PT2=                44.17 / [degC] HRT PMP precision temperature 1
HPMP2PT2=                50.99 / [degC] HRT PMP precision temperature 2
FRM_MWT2=                 14.9 / [degC] FRM motor temperature
HRM_MWT2=                16.82 / [degC] HRM motor temperature
CRM_MWT2=                15.98 / [degC] CRM motor temperature
FSM_MWT2=                16.59 / [degC] FSM motor temperature
AMHD_1T2=                13.69 / [degC] AMHD DCDC temperature
AMHD_2T2=                 9.71 / [degC] AMHD board temperature
FRMPANT2=                16.72 / [degC] FDT housing temperature
M2BAFFT2=                19.51 / [degC] M2 baffle temperature
OUREF1T2=                16.64 / [degC] O-Unit main baffle temperature
OUREF2T2=                16.51 / [degC] HRT PMP housing temperature
M1MNT_T2=                17.54 / [degC] M1 mounting temperature
M2MNT_T2=                 23.4 / [degC] Tip-Tilt housing temperature
FGO_1CT2=                60.85 / [degC] FG oven coarse temperature 1
FGO_2CT2=                60.32 / [degC] FG oven coarse temperature 2
PCM_M1T2=                 9.34 / [degC] Main PCM board temperature 1
PCM_M2T2=                11.35 / [degC] Main PCM board temperature 2
PCM_R1T2=                 7.87 / [degC] Redundant PCM board temperature 1
PCM_R2T2=                 8.15 / [degC] Redundant PCM board temperature 2
DPU_B1T2=                20.86 / [degC] DPU board temperature 1
DPU_B2T2=                22.66 / [degC] DPU board temperature 2
TTCT_BT2=                10.74 / [degC] TTC board temperature
HVPS_BT2=                 9.42 / [degC] HVPS board temperature
ISSTT1T2=                 16.8 / [degC] ISS tip/tilt temperature 1
ISSTT2T2=                16.47 / [degC] ISS tip/tilt temperature 2
EUREF_T2=                 8.73 / [degC] E-Unit reference temperature
HEATOVL2= 'Off     '           / Heater overlapping mode (0=off, 1=on)
FGHEATM2=                    1 / FG heater mode status
FGH_TSP2=                   61 / [degC] FG heater set point
FGH_POW2=                    0 / [W] FG heater power
HPHEATM2=                    0 / HRT PMP heater mode status
HPMPTSP2=                   40 / [degC] HRT PMP heater set point
HPMPPOW2=                    0 / [W] HRT PMP heater power
FPHEATM2=                    1 / FDT PMP heater mode status
FPMPTSP2=                   40 / [degC] FDT PMP heater set point
FPMPPOW2=                    0 / [W] FDT PMP heater power
```

```
         / PHI_FITS_FPA_posthk
FPAINPV2=                 0.51 / [A] FPA +7V input voltage
FPAINMV2=                -0.07 / [A] FPA -7V input voltage
FPACCIV2=                    0 / [V] FPA CCI voltage
FPASSIV2=                    0 / [V] FPA SSA voltage
FPACCDV2=                 3.23 / [V] FPA CCD voltage
FPACCAV2=                 2.42 / [V] FPA CCA voltage
FPACCBV2=                  1.5 / [V] FPA CCB voltage
FPGA_BT2=                15.76 / [degC] FPA FPGA board temperature
IS_PIXV2=                  2.5 / [V] image sensor voltage V_PIX
ISARSTV2=                 0.08 / [V] image sensor voltage V_PIX_RST_ACT
ISIRSTV2=                 3.17 / [V] image sensor voltage V_PIX_RST_INACT
ISASELV2=                 3.55 / [V] image sensor voltage V_PIX_SEL_ACT
ISATX1V2=                 2.99 / [V] image sensor voltage V_PIX_TX1_ACT1
ISATX2V2=                 0.09 / [V] image sensor voltage V_PIX_TX1_ACT2
ISITX1V2=                    0 / [V] image sensor voltage V_PIX_TX1_INACT
IS_ABSV2=                    0 / [V] image sensor ABS bias voltage
FPA_IST2=               -24.18 / [degC] FPA image sensor temperature
CAMR_ID2=                  513 / Camera ID
FPAFIRM2=                 1284 / FPA FPGA ID and firmware version
ANNEALH2= 'ANNEALING_OFF'      / Annealing heater status (0=off, 1=on)
CPC_T__2=                19.31 / [degC] CPC Temperature
CPC_ID_2=                 1741 / CPC ID
FPATMRS2=                  128 / TMR Status
FPATMRA2=                    0 / TMR error address
FPATMRC2=                    0 / Number of TMR cycles
FPASELS2=                  128 / SEL Status
FPASELT2=                    8 / [V] SEL threshold
ACCVERS2=                 3161 / Accumulator Version
ACCSTAT2=                   64 / Accumulator Status
ACCDEST2= 'NANDFS  '           / Accumulator destination
ACCDID_2=                    0 / Accumulator transfer dataset ID

         / PHI_FITS_ISS_posthk
ISSFIRM2=                 5389 / ISS controller firmware version
ISSVALN2=                   39 / Number of valid ISS controller commands
ISSINVN2=                    0 / Number of invalid ISS controller commands
ISSLAST2=                   13 / ID of last ISS command
ISSMODE2= 'ISS_IDLE'           / Current ISS mode (0=idle, 1=correlation)
CTCLAST2=                21834 / Last CTC command
CTCLRES2=                21834 / CTC last response
CTCLSTF2=                    0 / CTC last status frame
CTC_COR2=                    0 / CTC Column out of range
CTC_ROR2=                    0 / CTC Row out of range
CTCBREF2=                    0 / CTC black reference
CTCN5V_2=               -3.633 / [V] CTC negative 3V6
CTCP2V52=                2.389 / [V] CTC positive 2V5
CTCP3V32=                3.251 / [V] CTC positive 3V3
CTCP5V_2=                5.072 / [V] CTC positive 5V
CTCSENT2=                17.37 / [degC] CTC sensor temperature
CTCFPGT2=                19.38 / [degC] CTC FPGA temperature
CTCREF12=                0.987 / [V] CTC reference voltage 1V
CTCREF22=                  2.5 / [V] CTC reference voltage 2v
CTCSIMG2=                    0 / CTC send images
CTCRIMG2=                    0 / CTC received images
CTCBADD2=                    0 / CTC bad address
CTCEADD2=                    0 / CTC expected address
CWRGIMG2=                    0 / CTC wrong images
ISSBADP2=                    0 / ISS bad period
ISSOUTX2=                    0 / ISS out X
ISSOUTY2=                    0 / ISS out Y
ISSAVIR2=                    0 / ISS mean intensity reference
ISSRMSI2=                    0 / ISS rms intensity reference
ISSMXIR2=                    0 / ISS maximum intensity reference
ISSMNIR2=                    0 / ISS minimum intensity reference
ISS_AVJ2=                    0 / [asec] ISS mean offset
ISSRMSJ2=                    0 / [asec] ISS rms offset
```

```
ISSMAXJ2=                    0 / [asec] ISS maximum offset
ISSMINJ2=                    0 / [asec] ISS minimum offset
ISSA10P2=                    0 / ISS parabolic parameter A01
ISSA01P2=                    0 / ISS parabolic parameter A10
ISSA20P2=                    0 / ISS parabolic parameter A02
ISSA02P2=                    0 / ISS parabolic parameter A20
ISSA11P2=                    0 / ISS parabolic parameter A11
ISSREFI2=                    0 / Number of used ISS reference images
ISSOOBC2=                    0 / ISS out of bound count
ISSB2OF2=                    0 / ISS CT bank 2 offset
ISSPIMG2=                    0 / ISS pending images
ISLISOX2=                    0 / ISS LIS out X
ISLISOY2=                    0 / ISS LIS out Y
ISOTFOX2=                    0 / ISS SOTF out X
ISOTFOY2=                    0 / ISS SOTF out Y
ISROTOX2=                    0 / ISS ROT out X
ISROTOY2=                    0 / ISS ROT out Y
ISROTLE2=                    0 / ISS ROT log exponent
ISSSTFL2=                    0 / ISS status and error flags
ISSIMSZ2=                  128 / ISS image size (square)
ISSLDEL2=                    0 / ISS line delay
CTC_AGN2=                    0 / CTC analog gain
CTC_DGN2=                    0 / CTC digital gain
CTCSTOF2=                    0 / CTC static offset
ISSRSHT2=                    0 / ISS rolling shutter offset
ISSIMOX2=                  448 / ISS image offset X
ISSIMOY2=                  448 / ISS image offset Y
CTADPSF2=                   64 / CTC ADC phase shift
CTCRTRI2=                   15 / CTC retries
CTCDIMN2=                    0 / Number of dropped CTC images
ISSSTEP2=                    0 / ISS stats exponent
ISIMGST2=                    0 / ISS store images
ISIMGRS2=                    0 / ISS store raw images
ISTSTIM2=                    0 / ISS test images
ISSTISE2=                    7 / ISS test image size Exp
ISSTIEV2=                    0 / ISS test image even
ISSTIOD2=                    0 / ISS test image odd
ISSTDIS2=                    0 / ISS store displacement
ISTADIS2=                    0 / ISS stats displacement
ISSREFP2=                    0 / ISS reference period
TT_OFFX2=                 2047 / TT offset X
TT_OFFY2=                 2047 / TT offset Y
TTAMPXX2=                  256 / TT Amp XX
TTAMPXY2=                    0 / TT Amp XY
TTAMPYX2=                    0 / TT Amp YX
TTAMPYY2=                  256 / TT Amp YY
TT_MAX_2=                 3648 / TT max
TT_MIN_2=                  446 / TT min
TTSTPEX2=                    0 / TT steps exponent
TTSTPPD2=                    0 / TT steps period
PID_A1X2=                    0 / ISS PID X parameter A1
PID_A1Y2=                    0 / ISS PID Y parameter A1
PID_A2X2=                    0 / ISS PID X parameter A2
PID_A2Y2=                    0 / ISS PID Y parameter A2
PID_B0X2=                    1 / ISS PID X parameter B0
PID_B0Y2=                    1 / ISS PID Y parameter B0
PID_B1X2=                    0 / ISS PID X parameter B1
PID_B1Y2=                    0 / ISS PID Y parameter B1
PID_B2X2=                    0 / ISS PID X parameter B2
PID_B2Y2=                    0 / ISS PID Y parameter B2
LISSAAX2=                    0 / ISS Lissajous parameter AX
LISSAAY2=                    0 / ISS Lissajous parameter AY
LISSADX2=                    0 / ISS Lissajous parameter DX
LISSADY2=                    0 / ISS Lissajous parameter DY
LISSAWX2=                0.199 / ISS Lissajous parameter WX
LISSAWY2=                0.199 / ISS Lissajous parameter WY
LISSAFI2=                    0 / ISS Lissajous parameter FI
LISSATX2=                    0 / ISS Lissajous parameter TDX
```

```
LISSATY2=                    0 / ISS Lissajous parameter TDY
LISSATS2=                    0 / ISS Lissajous parameter TS
LISSPRS2=                    0 / ISS prescaler
LISSANS2=                    0 / ISS Lissajous parameter VS
ISSTHHX2=                    0 / ISS static threshold X
ISSTHHY2=                    0 / ISS static threshold Y
ISSHKPD2=                    0 / ISS HK period
ISSMEMP2=                    0 / ISS memory parameter
ISCLKPH2=                    0 / [PI] ISS clock phase

          / Processing keywords
PROCNODE= 'germerott-slm6'     / System which processed file
DWNLNKST= '2020-07-06 01:20:01' / Image packed onboard
INFO_URL= 'UNKNOWN'            / Link to additional string information
COMPLETE= 'C'                  / C complete, I incomplete, U undefined
PHIDBVER= '3266:11957'         / PHI Mib Db svn version
PARENT  = 'solo_L0_phi-raw_20200706012001_V20210708124101C_0066180100.phi' /  So
HISTORY Written with converter(FITS.cpp) Version: 11268:11962
HISTORY Build Host: germerott on Linux germerott-slm6 5.10.27-gentoo x86_64
HISTORY Build Time: Jul  5 2021 15:41:48
CHECKSUM= 'iZ3YlY2YiY2YiY2Y'   / HDU checksum updated 2021-07-08T15:05:45
DATASUM = '2002030320'         / data unit checksum updated 2021-07-08T15:05:45
END
```

B.2 L0 Example FITS Extension 2

Extension Name : `PHI_FITS_ACCU_settings`

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                   85 / width of table in characters
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   10 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FID '           / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A12     '           / Fortran-77 format of field
TUNIT2  = '        '           / physical unit of field
TTYPE3  = 'PHI_ACCU_frameLength' / label for field   3
TBCOL3  =                   34 / beginning column of field   3
TFORM3  = 'I10     '           / Fortran-77 format of field
TUNIT3  = '        '           / physical unit of field
TTYPE4  = 'PHI_ACCU_rows'      / label for field   4
TBCOL4  =                   45 / beginning column of field   4
TFORM4  = 'I3      '           / Fortran-77 format of field
TUNIT4  = '        '           / physical unit of field
TTYPE5  = 'PHI_ACCU_rowIterations' / label for field   5
TBCOL5  =                   49 / beginning column of field   5
TFORM5  = 'I3      '           / Fortran-77 format of field
TUNIT5  = '        '           / physical unit of field
TTYPE6  = 'PHI_ACCU_columns'   / label for field   6
TBCOL6  =                   53 / beginning column of field   6
TFORM6  = 'I3      '           / Fortran-77 format of field
TUNIT6  = '        '           / physical unit of field
TTYPE7  = 'PHI_ACCU_colIterations' / label for field   7
TBCOL7  =                   57 / beginning column of field   7
TFORM7  = 'I3      '           / Fortran-77 format of field
TUNIT7  = '        '           / physical unit of field
TTYPE8  = 'PHI_ACCU_accumulations' / label for field   8
```

```
TBCOL8  =                   61 / beginning column of field   8
TFORM8  = 'I3      '           / Fortran-77 format of field
TUNIT8  = '        '           / physical unit of field
TTYPE9  = 'PHI_ACCU_address'   / label for field   9
TBCOL9  =                   65 / beginning column of field   9
TFORM9  = 'I10     '           / Fortran-77 format of field
TUNIT9  = '        '           / physical unit of field
TTYPE10 = 'PHI_ACCU_size'      / label for field  10
TBCOL10 =                   76 / beginning column of field  10
TFORM10 = 'I10     '           / Fortran-77 format of field
TUNIT10 = '        '           / physical unit of field
EXTNAME = 'PHI_FITS_ACCU_settings' / name of this ASCII table extension
COMMENT PHI_FITS_ACCU_settings
CHECKSUM= 'D3S0F2Q0D2Q0D2Q0'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '3248541540'         / data unit checksum updated 2021-07-08T15:04:55
END
```

RecordTime Time	PHI_FID	PHI_ACCU_frameLength	PHI_ACCU_rows	PHI_ACCU_rowIterations	PHI_ACCU_columns
020-06-18 04:00:04	ITS_ACC_SET	4194304	6	1	4

PHI_ACCU_colIterations	PHI_ACCU_accumulations	PHI_ACCU_address	PHI_ACCU_size
1	20	0	402653184

Table of FITS Extension PHI_FITS_ACCU_settings, columns 6 to 9

B.3 L0 Example FITS Extension 3

Extension Name : PHI_FITS_FG_settings

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                   85 / width of table in characters
NAXIS2  =                   14 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    7 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FID '           / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A11     '           / Fortran-77 format of field
TUNIT2  = '        '           / physical unit of field
TTYPE3  = 'PHI_FG_voltage'     / label for field   3
TBCOL3  =                   33 / beginning column of field   3
TFORM3  = 'I6      '           / Fortran-77 format of field
TUNIT3  = 'V       '           / physical unit of field
TTYPE4  = 'PHI_FG_setWavelength' / label for field   4
TBCOL4  =                   40 / beginning column of field   4
TFORM4  = 'I10     '           / Fortran-77 format of field
TUNIT4  = 'mAng    '           / physical unit of field
TTYPE5  = 'PHI_FG_tuningConstant' / label for field   5
TBCOL5  =                   51 / beginning column of field   5
TFORM5  = 'I11     '           / Fortran-77 format of field
TUNIT5  = '        '           / physical unit of field
TTYPE6  = 'PHI_FG_refWavelength' / label for field   6
TBCOL6  =                   63 / beginning column of field   6
TFORM6  = 'I11     '           / Fortran-77 format of field
TUNIT6  = 'mAng    '           / physical unit of field
TTYPE7  = 'PHI_FG_voltageOffset' / label for field   7
TBCOL7  =                   75 / beginning column of field   7
TFORM7  = 'I11     '           / Fortran-77 format of field
TUNIT7  = 'V       '           / physical unit of field
EXTNAME = 'PHI_FITS_FG_settings' / name of this ASCII table extension
COMMENT PHI_FITS_FG_settings
CHECKSUM= 'dka6ghZ5dha5dhW5'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '2492750938'         / data unit checksum updated 2021-07-08T15:04:55
END
```

RecordTime Time	PHI_FID	PHI_FG_voltage V	PHI_FG_setWavelength mAng	PHI_FG_tuningConstant	PHI_FG_refWavelength mAng
020-06-18 04:00:04	ITS_FG_SET	-242	6173255	351300	6173341
020-06-18 04:00:13	ITS_FG_SET	-17	6173335	351300	6173341
020-06-18 04:00:18	ITS_FG_SET	-18	6173334	351300	6173341
020-06-18 04:00:20	ITS_FG_SET	-17	6173335	351300	6173341
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_FG_settings, columns 0 to 5

PHI_FG_voltageOffset V
0
0
0
0
⋮

Table of FITS Extension PHI_FITS_FG_settings, columns 6 to 6

B.4 L0 Example FITS Extension 4

Extension Name : PHI_FITS_FPA_settings

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                  130 / width of table in characters
NAXIS2  =                   24 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   11 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'EXP_START_TIME'     / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A24     '           / Fortran-77 format of field
TUNIT2  = 'Time    '           / physical unit of field
TTYPE3  = 'PHI_FID '           / label for field   3
TBCOL3  =                   46 / beginning column of field   3
TFORM3  = 'A12     '           / Fortran-77 format of field
TUNIT3  = '        '           / physical unit of field
TTYPE4  = 'PHI_FPA_imageCommand' / label for field   4
TBCOL4  =                   59 / beginning column of field   4
TFORM4  = 'I5      '           / Fortran-77 format of field
TUNIT4  = '        '           / physical unit of field
TTYPE5  = 'PHI_FPA_startRow'   / label for field   5
TBCOL5  =                   65 / beginning column of field   5
TFORM5  = 'I5      '           / Fortran-77 format of field
TUNIT5  = '        '           / physical unit of field
TTYPE6  = 'PHI_FPA_endRow'     / label for field   6
TBCOL6  =                   71 / beginning column of field   6
TFORM6  = 'I5      '           / Fortran-77 format of field
TUNIT6  = '        '           / physical unit of field
TTYPE7  = 'PHI_FPA_numberImages' / label for field   7
TBCOL7  =                   77 / beginning column of field   7
TFORM7  = 'I5      '           / Fortran-77 format of field
TUNIT7  = '        '           / physical unit of field
TTYPE8  = 'PHI_FPA_expStartCoarse' / label for field   8
TBCOL8  =                   83 / beginning column of field   8
TFORM8  = 'I10     '           / Fortran-77 format of field
TUNIT8  = 's       '           / physical unit of field
TTYPE9  = 'PHI_FPA_expStartFine' / label for field   9
TBCOL9  =                   94 / beginning column of field   9
TFORM9  = 'I10     '           / Fortran-77 format of field
TUNIT9  = 'us      '           / physical unit of field
```

```
TTYPE10 = 'PHI_FPA_expStartSync' / label for field  10
TBCOL10 =                  105 / beginning column of field  10
TFORM10 = 'I10     '           / Fortran-77 format of field
TUNIT10 = '        '           / physical unit of field
TTYPE11 = 'PHI_FPA_expTime'    / label for field  11
TBCOL11 =                  116 / beginning column of field  11
TFORM11 = 'F15.6   '           / Fortran-77 format of field
TUNIT11 = 's       '           / physical unit of field
EXTNAME = 'PHI_FITS_FPA_settings' / name of this ASCII table extension
COMMENT PHI_FITS_FPA_settings
CHECKSUM= 'aohDaoZCaofCaoZC'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '2747048386'         / data unit checksum updated 2021-07-08T15:04:55
END
```

RecordTime Time	EXP_START_TIME Time	PHI_FID	PHI_FPA_imageCommand	PHI_FPA_startRow	PHI_FPA_endRow
020-06-18 04:00:04	020-06-18T04:00:05.316	ITS_FPA_SET	8	0	1022
020-06-18 04:00:06	020-06-18T04:00:07.346	ITS_FPA_SET	8	0	1022
020-06-18 04:00:08	020-06-18T04:00:09.386	ITS_FPA_SET	8	0	1022
020-06-18 04:00:10	020-06-18T04:00:11.474	ITS_FPA_SET	8	0	1022
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_FPA_settings, columns 0 to 5

PHI_FPA_numberImages	PHI_FPA_expStartCoarse s	PHI_FPA_expStartFine us	PHI_FPA_expStartSync	PHI_FPA_expTime s
20	592452786	699245	1	0.010000
20	592452788	729288	1	0.010000
20	592452790	769118	1	0.010000
20	592452792	856683	1	0.010000
⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_FPA_settings, columns 6 to 10

B.5 L0 Example FITS Extension 5

Extension Name : PHI_FITS_PMP_settings

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                   64 / width of table in characters
NAXIS2  =                   24 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                    8 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FID '           / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A12     '           / Fortran-77 format of field
TUNIT2  = '        '           / physical unit of field
TTYPE3  = 'PHI_PMP_FDT_state'  / label for field   3
TBCOL3  =                   34 / beginning column of field   3
TFORM3  = 'I3      '           / Fortran-77 format of field
TUNIT3  = '        '           / physical unit of field
TTYPE4  = 'PHI_PMP_FDT_voltage1' / label for field   4
TBCOL4  =                   38 / beginning column of field   4
TFORM4  = 'I5      '           / Fortran-77 format of field
TUNIT4  = 'mV      '           / physical unit of field
TTYPE5  = 'PHI_PMP_FDT_voltage2' / label for field   5
TBCOL5  =                   44 / beginning column of field   5
TFORM5  = 'I5      '           / Fortran-77 format of field
TUNIT5  = 'mV      '           / physical unit of field
TTYPE6  = 'PHI_PMP_HRT_state'  / label for field   6
TBCOL6  =                   50 / beginning column of field   6
TFORM6  = 'I3      '           / Fortran-77 format of field
TUNIT6  = '        '           / physical unit of field
TTYPE7  = 'PHI_PMP_HRT_voltage1' / label for field   7
TBCOL7  =                   54 / beginning column of field   7
TFORM7  = 'I5      '           / Fortran-77 format of field
TUNIT7  = 'mV      '           / physical unit of field
TTYPE8  = 'PHI_PMP_HRT_voltage2' / label for field   8
TBCOL8  =                   60 / beginning column of field   8
TFORM8  = 'I5      '           / Fortran-77 format of field
TUNIT8  = 'mV      '           / physical unit of field
EXTNAME = 'PHI_FITS_PMP_settings' / name of this ASCII table extension
COMMENT PHI_FITS_PMP_settings
CHECKSUM= 'K5qgK4ndK4ndK4nd'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '2953151796'         / data unit checksum updated 2021-07-08T15:04:55
```

```
END
```

RecordTime Time	PHI_FID	PHI_PMP_FDT_state	PHI_PMP_FDT_voltage1 mV	PHI_PMP_FDT_voltage2 mV	PHI_PMP_HRT_state
020-06-18 04:00:04	ITS_PMP_SET	1	2099	2001	55
020-06-18 04:00:06	ITS_PMP_SET	2	2099	2828	55
020-06-18 04:00:08	ITS_PMP_SET	3	1682	5114	55
020-06-18 04:00:10	ITS_PMP_SET	4	1682	1653	55
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_PMP_settings, columns 0 to 5

PHI_PMP_HRT_voltage1 mV	PHI_PMP_HRT_voltage2 mV
0	0
0	0
0	0
0	0
⋮	⋮

Table of FITS Extension PHI_FITS_PMP_settings, columns 6 to 7

B.6 L0 Example FITS Extension 6

Extension Name : PHI_FITS_PROC_block

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                  117 / width of table in characters
NAXIS2  =                    4 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   14 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FID '           / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A13     '           / Fortran-77 format of field
TUNIT2  = '        '           / physical unit of field
TTYPE3  = 'PHI_PROC_blockResult' / label for field   3
TBCOL3  =                   35 / beginning column of field   3
TFORM3  = 'I4      '           / Fortran-77 format of field
TUNIT3  = '        '           / physical unit of field
TTYPE4  = 'PHI_PROC_udpId'     / label for field   4
TBCOL4  =                   40 / beginning column of field   4
TFORM4  = 'I5      '           / Fortran-77 format of field
TUNIT4  = '        '           / physical unit of field
TTYPE5  = 'PHI_PROC_operandDID' / label for field   5
TBCOL5  =                   46 / beginning column of field   5
TFORM5  = 'I10     '           / Fortran-77 format of field
TUNIT5  = '        '           / physical unit of field
TTYPE6  = 'PHI_PROC_param1'    / label for field   6
TBCOL6  =                   57 / beginning column of field   6
TFORM6  = 'I11     '           / Fortran-77 format of field
TUNIT6  = '        '           / physical unit of field
TTYPE7  = 'PHI_PROC_param2'    / label for field   7
TBCOL7  =                   69 / beginning column of field   7
TFORM7  = 'I11     '           / Fortran-77 format of field
TUNIT7  = '        '           / physical unit of field
TTYPE8  = 'PHI_PROC_imgStart'  / label for field   8
TBCOL8  =                   81 / beginning column of field   8
TFORM8  = 'I3      '           / Fortran-77 format of field
TUNIT8  = '        '           / physical unit of field
TTYPE9  = 'PHI_PROC_imgEnd'    / label for field   9
TBCOL9  =                   85 / beginning column of field   9
TFORM9  = 'I3      '           / Fortran-77 format of field
TUNIT9  = '        '           / physical unit of field
```

```
TTYPE10 = 'PHI_PROC_rowStart'  / label for field  10
TBCOL10 =                   89 / beginning column of field  10
TFORM10 = 'I5      '           / Fortran-77 format of field
TUNIT10 = '        '           / physical unit of field
TTYPE11 = 'PHI_PROC_rowEnd'    / label for field  11
TBCOL11 =                   95 / beginning column of field  11
TFORM11 = 'I5      '           / Fortran-77 format of field
TUNIT11 = '        '           / physical unit of field
TTYPE12 = 'PHI_PROC_colStart'  / label for field  12
TBCOL12 =                  101 / beginning column of field  12
TFORM12 = 'I5      '           / Fortran-77 format of field
TUNIT12 = '        '           / physical unit of field
TTYPE13 = 'PHI_PROC_colEnd'    / label for field  13
TBCOL13 =                  107 / beginning column of field  13
TFORM13 = 'I5      '           / Fortran-77 format of field
TUNIT13 = '        '           / physical unit of field
TTYPE14 = 'PHI_PROC_blockCount' / label for field  14
TBCOL14 =                  113 / beginning column of field  14
TFORM14 = 'I5      '           / Fortran-77 format of field
TUNIT14 = '        '           / physical unit of field
EXTNAME = 'PHI_FITS_PROC_block' / name of this ASCII table extension
COMMENT PHI_FITS_PROC_block
CHECKSUM= 'WhX9WeU7WeU7WeU7'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '1615017294'         / data unit checksum updated 2021-07-08T15:04:55
END
```

RecordTime Time	PHI_FID	PHI_PROC_blockResult	PHI_PROC_udpId	PHI_PROC_operandDID	PHI_PROC_param1
020-07-06 00:19:22	ITS_PROC_BLK	0	1351	26180100	102
020-07-06 00:19:31	ITS_PROC_BLK	0	1371	0	0
020-07-06 00:19:46	ITS_PROC_BLK	0	1352	66180100	1
020-07-06 00:19:46	ITS_PROC_BLK	0	1332	26180100	102
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_PROC_block, columns 0 to 5

PHI_PROC_param2	PHI_PROC_imgStart	PHI_PROC_imgEnd	PHI_PROC_rowStart	PHI_PROC_rowEnd	PHI_PROC_colStart
0	0	23	0	2047	0
0	0	23	0	2047	0
0	0	23	0	2047	0
0	0	23	0	2047	0
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_PROC_block, columns 6 to 11

PHI_PROC_colEnd	PHI_PROC_blockCount
2047	1159
2047	1160
2047	1161
2047	1162
⋮	⋮

Table of FITS Extension PHI_FITS_PROC_block, columns 12 to 13

B.7 L0 Example FITS Extension 7

Extension Name : PHI_FITS_PROC_environment

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                  174 / width of table in characters
NAXIS2  =                    1 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   16 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FID '           / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A13     '           / Fortran-77 format of field
TUNIT2  = '        '           / physical unit of field
TTYPE3  = 'PHI_PROC_dark'      / label for field   3
TBCOL3  =                   35 / beginning column of field   3
TFORM3  = 'I10     '           / Fortran-77 format of field
TUNIT3  = '        '           / physical unit of field
TTYPE4  = 'PHI_PROC_flat'      / label for field   4
TBCOL4  =                   46 / beginning column of field   4
TFORM4  = 'I10     '           / Fortran-77 format of field
TUNIT4  = '        '           / physical unit of field
TTYPE5  = 'PHI_PROC_demodulation' / label for field   5
TBCOL5  =                   57 / beginning column of field   5
TFORM5  = 'I10     '           / Fortran-77 format of field
TUNIT5  = '        '           / physical unit of field
TTYPE6  = 'PHI_PROC_fourierFilter' / label for field   6
TBCOL6  =                   68 / beginning column of field   6
TFORM6  = 'I10     '           / Fortran-77 format of field
TUNIT6  = '        '           / physical unit of field
TTYPE7  = 'PHI_PROC_prefilter' / label for field   7
TBCOL7  =                   79 / beginning column of field   7
TFORM7  = 'I10     '           / Fortran-77 format of field
```

```
TUNIT7  = '        '           / physical unit of field
TTYPE8  = 'PHI_PROC_Ic'        / label for field   8
TBCOL8  =                   90 / beginning column of field   8
TFORM8  = 'I11     '           / Fortran-77 format of field
TUNIT8  = '        '           / physical unit of field
TTYPE9  = 'PHI_PROC_I2Q'       / label for field   9
TBCOL9  =                  102 / beginning column of field   9
TFORM9  = 'I11     '           / Fortran-77 format of field
TUNIT9  = '        '           / physical unit of field
TTYPE10 = 'PHI_PROC_I2U'       / label for field  10
TBCOL10 =                  114 / beginning column of field  10
TFORM10 = 'I11     '           / Fortran-77 format of field
TUNIT10 = '        '           / physical unit of field
TTYPE11 = 'PHI_PROC_I2V'       / label for field  11
TBCOL11 =                  126 / beginning column of field  11
TFORM11 = 'I11     '           / Fortran-77 format of field
TUNIT11 = '        '           / physical unit of field
TTYPE12 = 'PHI_PROC_V2Q'       / label for field  12
TBCOL12 =                  138 / beginning column of field  12
TFORM12 = 'I11     '           / Fortran-77 format of field
TUNIT12 = '        '           / physical unit of field
TTYPE13 = 'PHI_PROC_V2U'       / label for field  13
TBCOL13 =                  150 / beginning column of field  13
TFORM13 = 'I11     '           / Fortran-77 format of field
TUNIT13 = '        '           / physical unit of field
TTYPE14 = 'PHI_PROC_rteOutputs' / label for field  14
TBCOL14 =                  162 / beginning column of field  14
TFORM14 = 'I5      '           / Fortran-77 format of field
TUNIT14 = '        '           / physical unit of field
TTYPE15 = 'PHI_PROC_rteConfig' / label for field  15
TBCOL15 =                  168 / beginning column of field  15
TFORM15 = 'I3      '           / Fortran-77 format of field
TUNIT15 = '        '           / physical unit of field
TTYPE16 = 'PHI_PROC_compression' / label for field  16
TBCOL16 =                  172 / beginning column of field  16
TFORM16 = 'I3      '           / Fortran-77 format of field
TUNIT16 = '        '           / physical unit of field
EXTNAME = 'PHI_FITS_PROC_environment' / name of this ASCII table extension
COMMENT PHI_FITS_PROC_environment
CHECKSUM= '95MFC4KD94KDC4KD'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '1179054152'         / data unit checksum updated 2021-07-08T15:04:55
END
```

RecordTime Time	PHI_FID	PHI_PROC_dark	PHI_PROC_flat	PHI_PROC_demodulation	PHI_PROC_fourierFilter
020-06-18 04:01:31	ITS_PROC_ENV	26181001	26181101	990510	0

Table of FITS Extension PHI_FITS_PROC_environment, columns 0 to 5

PHI_PROC_prefilter	PHI_PROC_Ic	PHI_PROC_I2Q	PHI_PROC_I2U	PHI_PROC_I2V	PHI_PROC_V2Q
990710	1357905920	0	0	0	0

Table of FITS Extension PHI_FITS_PROC_environment, columns 6 to 11

PHI_PROC_V2U	PHI_PROC_rteOutputs	PHI_PROC_rteConfig	PHI_PROC_compression
0	102	1	4

Table of FITS Extension PHI_FITS_PROC_environment, columns 12 to 15

B.8 L0 Example FITS Extension 8

Extension Name : PHI_FITS_PROC_operation

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                  194 / width of table in characters
NAXIS2  =                    5 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   16 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FID '           / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A12     '           / Fortran-77 format of field
TUNIT2  = '        '           / physical unit of field
TTYPE3  = 'PHI_PROC_mode'      / label for field   3
TBCOL3  =                   34 / beginning column of field   3
TFORM3  = 'I3      '           / Fortran-77 format of field
TUNIT3  = '        '           / physical unit of field
TTYPE4  = 'PHI_PROC_operation' / label for field   4
TBCOL4  =                   38 / beginning column of field   4
TFORM4  = 'A12     '           / Fortran-77 format of field
TUNIT4  = '        '           / physical unit of field
TTYPE5  = 'PHI_PROC_opStatus'  / label for field   5
TBCOL5  =                   51 / beginning column of field   5
TFORM5  = 'I4      '           / Fortran-77 format of field
TUNIT5  = '        '           / physical unit of field
TTYPE6  = 'PHI_PROC_opResult'  / label for field   6
TBCOL6  =                   56 / beginning column of field   6
TFORM6  = 'A47     '           / Fortran-77 format of field
TUNIT6  = '        '           / physical unit of field
TTYPE7  = 'PHI_PROC_sd1'       / label for field   7
TBCOL7  =                  104 / beginning column of field   7
TFORM7  = 'I10     '           / Fortran-77 format of field
TUNIT7  = '        '           / physical unit of field
TTYPE8  = 'PHI_PROC_sd2'       / label for field   8
TBCOL8  =                  115 / beginning column of field   8
TFORM8  = 'I10     '           / Fortran-77 format of field
TUNIT8  = '        '           / physical unit of field
TTYPE9  = 'PHI_PROC_sd3'       / label for field   9
TBCOL9  =                  126 / beginning column of field   9
TFORM9  = 'I10     '           / Fortran-77 format of field
TUNIT9  = '        '           / physical unit of field
TTYPE10 = 'PHI_PROC_rows'      / label for field  10
TBCOL10 =                  137 / beginning column of field  10
TFORM10 = 'I5      '           / Fortran-77 format of field
TUNIT10 = '        '           / physical unit of field
```

```
TTYPE11 = 'PHI_PROC_cols'      / label for field  11
TBCOL11 =                  143 / beginning column of field  11
TFORM11 = 'I5      '           / Fortran-77 format of field
TUNIT11 = '        '           / physical unit of field
TTYPE12 = 'PHI_PROC_dim1'      / label for field  12
TBCOL12 =                  149 / beginning column of field  12
TFORM12 = 'I5      '           / Fortran-77 format of field
TUNIT12 = '        '           / physical unit of field
TTYPE13 = 'PHI_PROC_dim2'      / label for field  13
TBCOL13 =                  155 / beginning column of field  13
TFORM13 = 'I5      '           / Fortran-77 format of field
TUNIT13 = '        '           / physical unit of field
TTYPE14 = 'PHI_PROC_scalar1'   / label for field  14
TBCOL14 =                  161 / beginning column of field  14
TFORM14 = 'I11     '           / Fortran-77 format of field
TUNIT14 = '        '           / physical unit of field
TTYPE15 = 'PHI_PROC_scalar2'   / label for field  15
TBCOL15 =                  173 / beginning column of field  15
TFORM15 = 'I11     '           / Fortran-77 format of field
TUNIT15 = '        '           / physical unit of field
TTYPE16 = 'PHI_PROC_opCount'   / label for field  16
TBCOL16 =                  185 / beginning column of field  16
TFORM16 = 'I10     '           / Fortran-77 format of field
TUNIT16 = '        '           / physical unit of field
EXTNAME = 'PHI_FITS_PROC_operation' / name of this ASCII table extension
COMMENT PHI_FITS_PROC_operation
CHECKSUM= 'kdTfndSfkdSfkdSf'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '3335214947'         / data unit checksum updated 2021-07-08T15:04:55
END
```

RecordTime Time	PHI_FID	PHI_PROC_mode	PHI_PROC_operation	PHI_PROC_opStatus	PHI_PROC_opResult
020-07-06 00:19:17	ITS_PROC_OP	2	ROC_LOAD	0	0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
020-07-06 00:19:22	ITS_PROC_OP	2	ROC_F_MUL_S	0	0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
020-07-06 00:19:25	ITS_PROC_OP	2	ROC_F_DIV_S	0	0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
020-07-06 00:19:31	ITS_PROC_OP	2	ROC_PACK	0	0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_PROC_operation, columns 0 to 5

PHI_PROC_sd1	PHI_PROC_sd2	PHI_PROC_sd3	PHI_PROC_rows	PHI_PROC_cols	PHI_PROC_dim1
26180100	0	201326592	0	0	0
201326592	0	201326592	9152	2048	0
201326592	0	201326592	2048	9152	0
201326592	0	0	2048	2048	24
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_PROC_operation, columns 6 to 11

PHI_PROC_dim2	PHI_PROC_scalar1	PHI_PROC_scalar2	PHI_PROC_opCount
0	0	402653184	95126
0	26214	0	95127
0	16777216	0	95128
0	0	0	95129
⋮	⋮	⋮	⋮

Table of FITS Extension PHI_FITS_PROC_operation, columns 12 to 15

B.9 L0 Example FITS Extension 9

Extension Name : PHI_FITS_imageSummary

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                  122 / width of table in characters
NAXIS2  =                    3 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   14 / number of fields in each row
TTYPE1  = 'RecordTime'         / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A19     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FID '           / label for field   2
TBCOL2  =                   21 / beginning column of field   2
TFORM2  = 'A12     '           / Fortran-77 format of field
TUNIT2  = '        '           / physical unit of field
TTYPE3  = 'PHI_IMG_type'       / label for field   3
TBCOL3  =                   34 / beginning column of field   3
TFORM3  = 'A11     '           / Fortran-77 format of field
TUNIT3  = '        '           / physical unit of field
TTYPE4  = 'PHI_IMG_format'     / label for field   4
TBCOL4  =                   46 / beginning column of field   4
TFORM4  = 'A13     '           / Fortran-77 format of field
TUNIT4  = '        '           / physical unit of field
TTYPE5  = 'PHI_IMG_binning'    / label for field   5
TBCOL5  =                   60 / beginning column of field   5
TFORM5  = 'I3      '           / Fortran-77 format of field
TUNIT5  = '        '           / physical unit of field
TTYPE6  = 'PHI_IMG_startIndex' / label for field   6
TBCOL6  =                   64 / beginning column of field   6
TFORM6  = 'I3      '           / Fortran-77 format of field
TUNIT6  = '        '           / physical unit of field
TTYPE7  = 'PHI_IMG_endIndex'   / label for field   7
TBCOL7  =                   68 / beginning column of field   7
TFORM7  = 'I3      '           / Fortran-77 format of field
```

```
TUNIT7  = '        '           / physical unit of field
TTYPE8  = 'PHI_IMG_extra'      / label for field   8
TBCOL8  =                   72 / beginning column of field   8
TFORM8  = 'I5      '           / Fortran-77 format of field
TUNIT8  = '        '           / physical unit of field
TTYPE9  = 'PHI_IMG_x1'         / label for field   9
TBCOL9  =                   78 / beginning column of field   9
TFORM9  = 'I5      '           / Fortran-77 format of field
TUNIT9  = '        '           / physical unit of field
TTYPE10 = 'PHI_IMG_y1'         / label for field  10
TBCOL10 =                   84 / beginning column of field  10
TFORM10 = 'I5      '           / Fortran-77 format of field
TUNIT10 = '        '           / physical unit of field
TTYPE11 = 'PHI_IMG_x2'         / label for field  11
TBCOL11 =                   90 / beginning column of field  11
TFORM11 = 'I5      '           / Fortran-77 format of field
TUNIT11 = '        '           / physical unit of field
TTYPE12 = 'PHI_IMG_y2'         / label for field  12
TBCOL12 =                   96 / beginning column of field  12
TFORM12 = 'I5      '           / Fortran-77 format of field
TUNIT12 = '        '           / physical unit of field
TTYPE13 = 'PHI_IMG_maxRange'   / label for field  13
TBCOL13 =                  102 / beginning column of field  13
TFORM13 = 'I10     '           / Fortran-77 format of field
TUNIT13 = '        '           / physical unit of field
TTYPE14 = 'PHI_IMG_reserved'   / label for field  14
TBCOL14 =                  113 / beginning column of field  14
TFORM14 = 'I10     '           / Fortran-77 format of field
TUNIT14 = '        '           / physical unit of field
EXTNAME = 'PHI_FITS_imageSummary' / name of this ASCII table extension
COMMENT PHI_FITS_imageSummary
CHECKSUM= 'Y3DGa19ET1AEY19E'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '3498115091'         / data unit checksum updated 2021-07-08T15:04:55
END
```

RecordTime Time	PHI_FID	PHI_IMG_type	PHI_IMG_format	PHI_IMG_binning	PHI_IMG_startIndex
020-06-18 04:01:31	ITS_SUMMARY	MG_FPA_RAW	MGFMT_24_8	1	0
020-07-06 00:19:22	ITS_SUMMARY	MG_FPA_RAW	MGFMT_24_8	1	0
020-07-06 00:19:46	ITS_SUMMARY	MG_FPA_RAW	MGFMT_16_0_S	1	0

Table of FITS Extension PHI_FITS_imageSummary, columns 0 to 5

PHI_IMG_endIndex	PHI_IMG_extra	PHI_IMG_x1	PHI_IMG_y1	PHI_IMG_x2	PHI_IMG_y2
23	0	0	0	2047	2047
23	0	0	0	2047	2047
23	0	0	0	2047	2047

Table of FITS Extension PHI_FITS_imageSummary, columns 6 to 11

PHI_IMG_maxRange	PHI_IMG_reserved
81920	0
8355840	0
127	0

Table of FITS Extension PHI_FITS_imageSummary, columns 12 to 13

B.10 L0 Example FITS Extension 10

Extension Name : PHI_PERIMAGE_information

```
XTENSION= 'TABLE   '           / ASCII table extension
BITPIX  =                    8 / 8-bit ASCII characters
NAXIS   =                    2 / 2-dimensional ASCII table
NAXIS1  =                  183 / width of table in characters
NAXIS2  =                   24 / number of rows in table
PCOUNT  =                    0 / no group parameters (required keyword)
GCOUNT  =                    1 / one data group (required keyword)
TFIELDS =                   20 / number of fields in each row
TTYPE1  = 'EXP_START_TIME'     / label for field   1
TBCOL1  =                    1 / beginning column of field   1
TFORM1  = 'A24     '           / Fortran-77 format of field
TUNIT1  = 'Time    '           / physical unit of field
TTYPE2  = 'PHI_FPA_imageCommand' / label for field   2
TBCOL2  =                   26 / beginning column of field   2
TFORM2  = 'I5      '           / Fortran-77 format of field
TTYPE3  = 'PHI_FPA_startRow'   / label for field   3
TBCOL3  =                   32 / beginning column of field   3
TFORM3  = 'I5      '           / Fortran-77 format of field
TTYPE4  = 'PHI_FPA_endRow'     / label for field   4
TBCOL4  =                   38 / beginning column of field   4
TFORM4  = 'I5      '           / Fortran-77 format of field
TTYPE5  = 'PHI_FPA_numberImages' / label for field   5
TBCOL5  =                   44 / beginning column of field   5
TFORM5  = 'I5      '           / Fortran-77 format of field
TTYPE6  = 'PHI_FPA_expStartCoarse' / label for field   6
TBCOL6  =                   50 / beginning column of field   6
TFORM6  = 'I10     '           / Fortran-77 format of field
TUNIT6  = 's       '           / physical unit of field
TTYPE7  = 'PHI_FPA_expStartFine' / label for field   7
TBCOL7  =                   61 / beginning column of field   7
TFORM7  = 'I10     '           / Fortran-77 format of field
TUNIT7  = 'us      '           / physical unit of field
TTYPE8  = 'PHI_FPA_expStartSync' / label for field   8
TBCOL8  =                   72 / beginning column of field   8
TFORM8  = 'I10     '           / Fortran-77 format of field
TTYPE9  = 'PHI_FPA_expTime'    / label for field   9
TBCOL9  =                   83 / beginning column of field   9
TFORM9  = 'F15.6   '           / Fortran-77 format of field
TUNIT9  = 's       '           / physical unit of field
TTYPE10 = 'PHI_PMP_FDT_state'  / label for field  10
TBCOL10 =                   99 / beginning column of field  10
TFORM10 = 'I3      '           / Fortran-77 format of field
TTYPE11 = 'PHI_PMP_FDT_voltage1' / label for field  11
```

```
TBCOL11 =                  103 / beginning column of field  11
TFORM11 = 'I5      '           / Fortran-77 format of field
TUNIT11 = 'mV      '           / physical unit of field
TTYPE12 = 'PHI_PMP_FDT_voltage2' / label for field  12
TBCOL12 =                  109 / beginning column of field  12
TFORM12 = 'I5      '           / Fortran-77 format of field
TUNIT12 = 'mV      '           / physical unit of field
TTYPE13 = 'PHI_PMP_HRT_state'  / label for field  13
TBCOL13 =                  115 / beginning column of field  13
TFORM13 = 'I3      '           / Fortran-77 format of field
TTYPE14 = 'PHI_PMP_HRT_voltage1' / label for field  14
TBCOL14 =                  119 / beginning column of field  14
TFORM14 = 'I5      '           / Fortran-77 format of field
TUNIT14 = 'mV      '           / physical unit of field
TTYPE15 = 'PHI_PMP_HRT_voltage2' / label for field  15
TBCOL15 =                  125 / beginning column of field  15
TFORM15 = 'I5      '           / Fortran-77 format of field
TUNIT15 = 'mV      '           / physical unit of field
TTYPE16 = 'PHI_FG_voltage'     / label for field  16
TBCOL16 =                  131 / beginning column of field  16
TFORM16 = 'I6      '           / Fortran-77 format of field
TUNIT16 = 'V       '           / physical unit of field
TTYPE17 = 'PHI_FG_setWavelength' / label for field  17
TBCOL17 =                  138 / beginning column of field  17
TFORM17 = 'I10     '           / Fortran-77 format of field
TUNIT17 = 'mAng    '           / physical unit of field
TTYPE18 = 'PHI_FG_tuningConstant' / label for field  18
TBCOL18 =                  149 / beginning column of field  18
TFORM18 = 'I11     '           / Fortran-77 format of field
TTYPE19 = 'PHI_FG_refWavelength' / label for field  19
TBCOL19 =                  161 / beginning column of field  19
TFORM19 = 'I11     '           / Fortran-77 format of field
TUNIT19 = 'mAng    '           / physical unit of field
TTYPE20 = 'PHI_FG_voltageOffset' / label for field  20
TBCOL20 =                  173 / beginning column of field  20
TFORM20 = 'I11     '           / Fortran-77 format of field
TUNIT20 = 'V       '           / physical unit of field
EXTNAME = 'PHI_PERIMAGE_information' / name of this ASCII table extension
COMMENT PHI collected information per image
CHECKSUM= '8ALB96J98AJA85J9'   / HDU checksum updated 2021-07-08T15:04:55
DATASUM = '481119001'          / data unit checksum updated 2021-07-08T15:04:55
END
```

EXP_START_TIME Time	PHI_FPA_imageCommand 0	PHI_FPA_startRow 0	PHI_FPA_endRow 0	PHI_FPA_numberImages 0	PHI_FPA_expStartCoarse s
020-06-18T04:00:05.316	8	0	1022	20	592452786
020-06-18T04:00:07.346	8	0	1022	20	592452788
020-06-18T04:00:09.386	8	0	1022	20	592452790
020-06-18T04:00:11.474	8	0	1022	20	592452792
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_PERIMAGE_information, columns 0 to 5

PHI_FPA_expStartFine us	PHI_FPA_expStartSync 0	PHI_FPA_expTime s	PHI_PMP_FDT_state 0	PHI_PMP_FDT_voltage1 mV	PHI_PMP_FDT_voltage2 mV
699245	1	0.010000	1	2099	2001
729288	1	0.010000	2	2099	2828
769118	1	0.010000	3	1682	5114
856683	1	0.010000	4	1682	1653
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_PERIMAGE_information, columns 6 to 11

PHI_PMP_HRT_state 0	PHI_PMP_HRT_voltage1 mV	PHI_PMP_HRT_voltage2 mV	PHI_FG_voltage V	PHI_FG_setWavelength mAng	PHI_FG_tuningConstant 0
55	0	0	-242	6173255	351300
55	0	0	-242	6173255	351300
55	0	0	-242	6173255	351300
55	0	0	-242	6173255	351300
⋮	⋮	⋮	⋮	⋮	⋮

Table of FITS Extension PHI_PERIMAGE_information, columns 12 to 17

PHI_FG_refWavelength mAng	PHI_FG_voltageOffset V
6173341	0
6173341	0
6173341	0
6173341	0
⋮	⋮

Table of FITS Extension PHI_PERIMAGE_information, columns 18 to 19

C Sample L1 dataset file header

This Section shows the content of an example SO/PHI L1 science dataset as taken on June 18, 2020 at the beginning of CP. The filename is:
`solo_L1_phi-fdt-ilam_20200618T040005_V202106111347C_0066180100.fits`
and one of the included images is shown in Fig. 4. The size of the file is 402.8 MBytes.

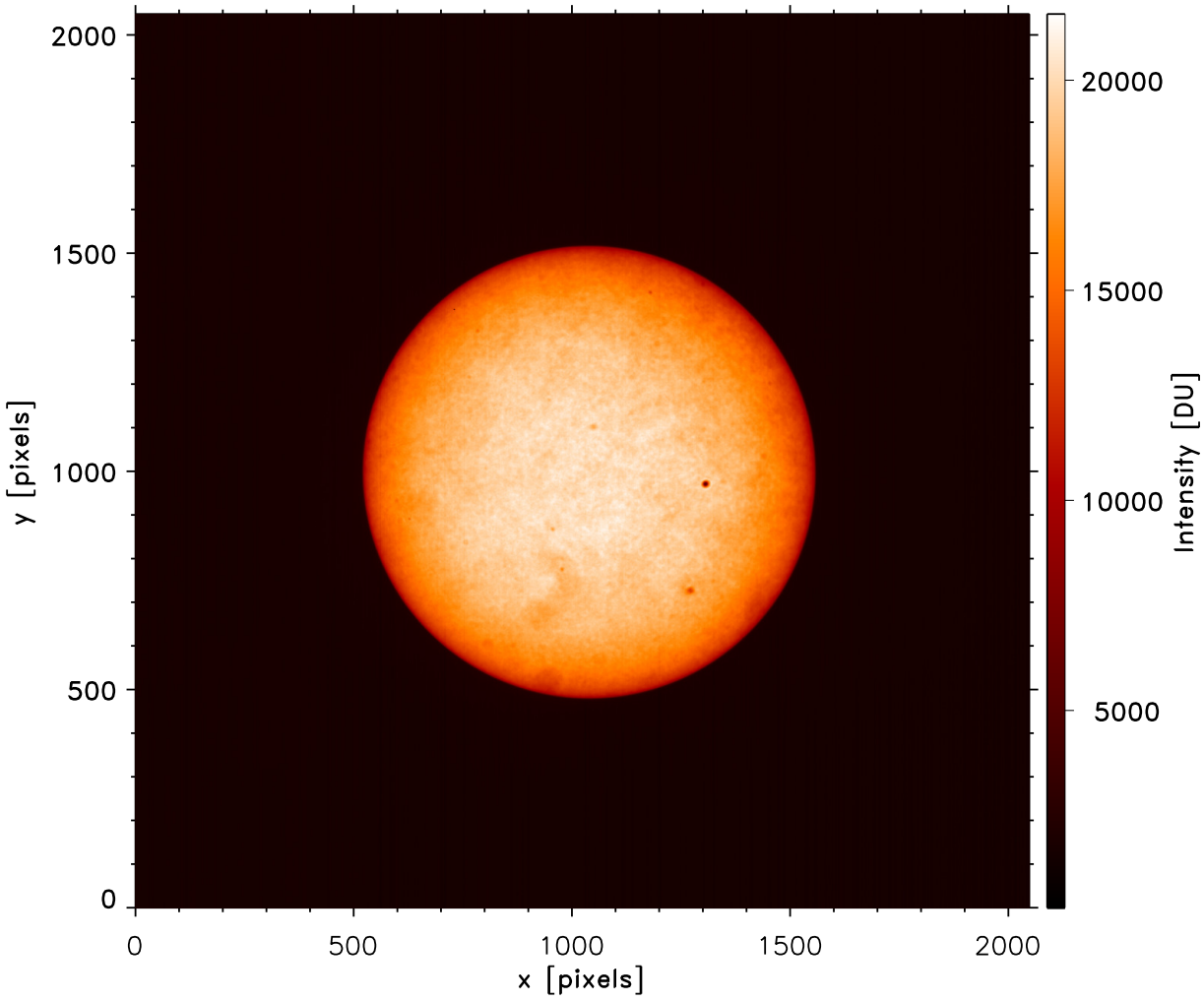

Figure 4: First image of an example SO/PHI L1 science dataset containing a spectral line scan at 6 wavelength positions and 4 polarization modulation states at each spectral position.

C.1 L1 Example Main Header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                  -32 / number of bits per data pixel
NAXIS   =                    3 / number of data axes
```

```
NAXIS1  =                 2048 / length of data axis 1
NAXIS2  =                 2048 / length of data axis 2
NAXIS3  =                   24 / length of data axis 3
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
LONGSTRN= 'OGIP 1.0'           / The HEASARC Long String Convention may be used.
COMMENT   This FITS file may contain long string keyword values that are
COMMENT   continued over multiple keywords.  The HEASARC convention uses the &
COMMENT   character at the end of each substring which is then continued
COMMENT   on the next keyword which has the name CONTINUE.
FILENAME= 'solo_L1_phi-fdt-ilam_20200618T040005_V202106111347C_0066180100.fits'
DATE    = '2021-06-11T13:47:27' / file creation date (YYYY-MM-DDThh:mm:ss UT)

          / Instrument and observation configuration FITS keywords
OBSRVTRY= 'Solar Orbiter'      / Satellite Name
INSTRUME= 'PHI'                / Instrument name
TELESCOP= 'SOLO/PHI/FDT'       / Telescope
DETECTOR= 'FDT'                / Instrument subunit or sensor
OBS_MODE= ' '                  / Observation mode
WAVEMIN =             617.3116 / [Angstrom] min wavelength of observation
WAVEMAX =             617.3573 / [Angstrom] max wavelength of observation
TIMESYS = 'UTC'                / System used for time keywords
DATE-OBS= '2020-06-18T04:00:05.316' / [UTC] Start time of observation
DATE-BEG= '2020-06-18T04:00:05.316' / [UTC] Start time of observation
DATE-AVG= '2020-06-18T04:00:34.415' / [UTC] Average time of observation
DATE-END= '2020-06-18T04:01:03.514' / [UTC] End time of observation
OBT_BEG =     1592452786.69924 / [OBT] Start time of observation
OBT_END =     1592452844.89668 / [OBT] End time of observation
LEVEL   = 'L1'                 / Data processing level
ORIGIN  = 'MPS'                / Name of institution
CREATOR = 'converter'          / FITS creation software
SPK_VERS= 'v107_20210604_001'  / Spice Kernel Version
VERS_SW = '11268:11839'        / Version of SW that provided FITS file
VERSION = '202106111347'       / Version of FITS file

          / Description of data content keywords
BTYPE   = 'Intensity'          / Type of data
BSCALE  =                  1.0 / ratio of physical to array value at 0 offset
BUNIT   = 'DN'                 / Units of physical value, after application
DATAMIN =                300. / Minimum valid physical value
DATAMAX =              23090. / Maximum valid physical value

          / Image relative to detector electronics keywords
RPLTSCL =                  3.6 / [arcsec] Platescale of raw images
PXBEG1  =                    1 / First read-out pixel in dimension 1
PXEND1  =                 2048 / Last read-out pixel in dimension 1
PXBEG2  =                    1 / First read-out pixel in dimension 2
PXEND2  =                 2048 / Last read-out pixel in dimension 2
NBIN1   =                    1 / Data binning factor in dimension 1
NBIN2   =                    1 / Data binning factor in dimension 2
NBIN    =                    1 / Total binning factor
AVTTOFFX=                  0.0 / [arcec] average tip/tilt offset x
AVTTOFFY=                  0.0 / [arcec] average tip/tilt offset y
IMGDIRX = 'NO      '           / Image mirrored along Y-Axis

          / Onboard processing keywords
CAL_DARK=                    0 / Onboard calibrated for dark field
CAL_FLAT=                    0 / Onboard calibrated for gain table
CAL_PSF =                    0 / Onboard calibrated for instrumental PSF
CAL_IPOL=                    0 / Onboard calibrated for instrumental polarizatio
CAL_SCIP= 'None'               / Onboard scientific data analysis
RTE_ITER=           4294967295 / Number RTE inversion iterations
COMPRESS= 'none'               / Data compression quality
COMPRAT =                   1. / Data compression ratio
COMPVERS=                    0 / Version of Compression Core
PHIDATID= '66180100'           / PHI dataset Id
```

```
         / WCS keywords
WCSNAME = 'Helioprojective-Cartesian' / hpc frame
CTYPE1  = 'HPLN-TAN'           / Spatial axis parallel Solar North
CTYPE2  = 'HPLT-TAN'           / Spatial axis parallel to Solar + West
CRPIX1  =             1042.839 / Description of ref pixel along axis 1
CRPIX2  =             998.7754 / Description of ref pixel along axis 2
CUNIT1  = 'arcsec'             / Units along axis 1
CUNIT2  = 'arcsec'             / Units along axis 2
PC1_1   =           -0.6074628 / Coordinate transformation to LIF
PC1_2   =           -0.7943481 / Coordinate transformation to LIF
PC2_1   =            0.7943481 / Coordinate transformation to LIF
PC2_2   =           -0.6074628 / Coordinate transformation to LIF
CROTA2  =     127.406271611114 / [deg] Rotation angle
CDELT1  =                  3.6 / Pixel scale along axis 1 in unit CUNIT1
CDELT2  =                  3.6 / Pixel scale along axis 2 in unit CUNIT2
CRVAL1  =            -1.795027 / Coordinates of ref pixel along axis 1
CRVAL2  =            0.8389881 / Coordinates of ref pixel along axis 2

         / Solar Ephemeris Data
RSUN_REF=           695508000. / [m] Assumed physical solar radius
RSUN_ARC=            1853.8463 / [arcsec] Apparent photospheric
SOLAR_B0=             6.670938 / [deg] s/c tilt of solar North pole
SOLAR_P0=             20.12907 / [deg] s/c celestial North to solar North angle
SOLAR_EP=            -1.356344 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =                 2231 / Carrington rotation number
HGLT_OBS=            6.6709381 / [deg] Stonyhurst latitude
HGLN_OBS=             67.93692 / [deg] Stonyhurst longitude
CRLT_OBS=            6.6709381 / [deg]Carrington latitude (B0 angle)
CRLN_OBS=            66.627137 / [deg]Carrington longitude (L0 angle)
DSUN_OBS=     77382338149.9702 / [m]  Distance from Sun
DSUN_AU =           0.51726898 / [m]  Distance from Sun
HEEX_OBS=     29084808019.9158 / [m] Heliocentric Earth Ecliptic X
HEEY_OBS=     71705812689.3929 / [m] Heliocentric Earth Ecliptic Y
HEEZ_OBS=    -613699075.020134 / [m] Heliocentric Earth Ecliptic Z
HCIX_OBS=    -14412057576.3182 / [m] Heliocentric Inertial X
HCIY_OBS=    -75495111498.1644 / [m] Heliocentric Inertial Y
HCIZ_OBS=      8989271041.2442 / [m] Heliocentric Inertial Z
HCIX_VOB=     46243.3854354213 / [m/s] Heliocentric Inertial X Velocity
HCIY_VOB=    -10600.4040574492 / [m/s] Heliocentric Inertial Y Velocity
HCIZ_VOB=    -124.677540511284 / [m/s] Heliocentric Inertial Z Velocity
HAEX_OBS=     70148139168.8326 / [m] Heliocentric Aries Ecliptic X
HAEY_OBS=    -32663280963.7283 / [m] Heliocentric Aries Ecliptic Y
HAEZ_OBS=    -612295182.878099 / [m] Heliocentric Aries Ecliptic Z
HEQX_OBS=     28870115325.8692 / [m] Heliocentric Earth Equatorial X
HEQY_OBS=      71230160078.259 / [m] Heliocentric Earth Equatorial Y
HEQZ_OBS=      8989271041.2442 / [m] Heliocentric Earth Equatorial Z
GSEX_OBS=     122920994095.708 / [m] Geocentric Solar Ecliptic X
GSEY_OBS=    -71705812689.3929 / [m] Geocentric Solar Ecliptic Y
GSEZ_OBS=    -613699075.020134 / [m] Geocentric Solar Ecliptic Z
SUN_TIME=     258.119696093123 / [s] Light travel time (Sun to S/C)

         / PHI_FITS_DPU_prehk
I_SYSST1= 'OBSERVATION'        / Instrument system state
CPULOAD1=                93.01 / [perc] CPU load
SPWDROP1=                    0 / Number of dropped SpaceWire packets
IICPCTN1=                35180 / Number of IIC packets
IICSEQN1=                10215 / Sequence number of the last IIC packet
OBSWVER1=                11120 / On-board software version
DPUHWVR1=             17434701 / DPU hardware version
DPUSSCR1=                24822 / DPU System Supervisor CR
DPUSSSR1=                    0 / DPU System Supervisor SR
TCREC_N1=                   52 / Number of received Telecommands
TCFAILN1=                    0 / Number of failed Telecommands
TCQUEUE1=                    0 / Fill level of Telecommanding queue
TMQUEUE1=                    0 / Fill level of Telemetry queue
SCQUEUE1=                    0 / Fill level of science Telemetry queue
RAMFS_N1=                   12 / Number of files in RAMFS
RAMFSSP1=            111268136 / [Byte] Available space in RAMFS
```

```
SRVSTFL1=                 4076 / Service status flags
GPIOLST1=            604141736 / Status of GPIO ports 0-31
GPIOHST1=              4298758 / Status of GPIO ports 32-63
SCDCMOD1= 'COMPRESS_NONE'      / Science data compression mode

         / PHI_FITS_PCM_prehk
APCMSTA1=                  241 / Active PCM status flag
APCM_VP1=               27.505 / [V] active PCM V_prim
APCM_IP1=                0.971 / [A] active PCM I_prim
APP28IH1=                0.022 / [A] active PCM I_Heaters_+28V
APP28IM1=                0.073 / [A] active PCM I_Mech_+28V
AP_P33I1=                2.665 / [A] active PCM I_+3V3
AP_P07I1=                0.636 / [A] active PCM I_+7V
AP_M07I1=                0.089 / [A] active PCM I_-7V
AP_P15I1=                0.062 / [A] active PCM I_+15V
AP_M15I1=                0.057 / [A] active PCM I_-15V
AP_P60I1=                0.007 / [A] active PCM I_+60V
ADPU33V1=                3.406 / [V] active PCM V_DPU_+3V3
AABP33V1=                3.406 / [V] active PCM V_AB_+3V3
AABP07V1=                 6.56 / [V] active PCM V_AB_+7V
AABP15V1=               14.417 / [V] active PCM V_AB_+15V
AABM15V1=               14.501 / [V] active PCM V_AB_-15V
ACPP07V1=                7.304 / [V] active PCM V_CPC_+7V
ACPM07V1=                7.475 / [V] active PCM V_CPC_-7V
AHVP07V1=                6.563 / [V] active PCM V_HVPS_+7V
AHVP15V1=               14.415 / [V] active PCM V_HVPS_+15V
AHVM15V1=                 14.5 / [V] active PCM V_HVPS_-15V
ATTP07V1=                 6.56 / [V] active PCM V_TTC_+7V
ATTP60V1=               59.983 / [V] active PCM V_TTC_+60V
POWSWST1=                  255 / Power Switch status

         / PHI_FITS_MECH_prehk
MEMOVST1=                    4 / Mechanism movement status flag
MEEOTST1=                    8 / Mechanism end-of-travel switch status flag
FRM_POS1=                 2911 / [um] Deduced FRM position
DHRM_PS1=                12363 / [um] Deduced HRM position
DCRM_PS1=                    0 / [um] Deduced CRM position
FSM_POS1=                    0 / [amin] Deduced FSM position
HVPSLPV1=                 -327 / [V] HVPS HV level side P
HVPSLNV1=                  311 / [V] HVPS HV level side N
TTCP55V1=               54.478 / [V] Voltage TTC_+55V
IABREFV1=                1.254 / [V] Internal AMHD voltage reference 1.25V
DEDFGWL1=              6173116 / [mAng] Deduced current FG wavelength
FDTPMPR1=                    1 / Deduced FDT PMP polarization state
LC1FDTV1=                2.099 / [V] commanded voltage on FDT PMP LC1
LC2FDTV1=                2.001 / [V] commanded voltage on FDT PMP LC2
HRTPMPR1=                  255 / Deduced HRT PMP polarization state
LC1HRTV1=                    0 / [V] commanded voltage on HRT PMP LC1
LC2HRTV1=                    0 / [V] commanded voltage on HRT PMP LC2

         / PHI_FITS_TEMP_prehk
FGOV1PT1=                60.99 / [degC] FG oven precision temperature 1
FGOV2PT1=                60.96 / [degC] FG oven precision temperature 2
FPMP1PT1=                39.96 / [degC] FDT PMP precision temperature 1
FPMP2PT1=                40.27 / [degC] FDT PMP precision temperature 2
HPMP1PT1=                44.17 / [degC] HRT PMP precision temperature 1
HPMP2PT1=                50.99 / [degC] HRT PMP precision temperature 2
FRM_MWT1=                14.94 / [degC] FRM motor temperature
HRM_MWT1=                16.86 / [degC] HRM motor temperature
CRM_MWT1=                15.94 / [degC] CRM motor temperature
FSM_MWT1=                16.63 / [degC] FSM motor temperature
AMHD_1T1=                13.65 / [degC] AMHD DCDC temperature
AMHD_2T1=                 9.63 / [degC] AMHD board temperature
FRMPANT1=                16.72 / [degC] FDT housing temperature
M2BAFFT1=                19.51 / [degC] M2 baffle temperature
OUREF1T1=                16.64 / [degC] O-Unit main baffle temperature
OUREF2T1=                16.51 / [degC] HRT PMP housing temperature
M1MNT_T1=                17.58 / [degC] M1 mounting temperature
```

```
M2MNT_T1=                23.44 / [degC] Tip-Tilt housing temperature
FGO_1CT1=                60.89 / [degC] FG oven coarse temperature 1
FGO_2CT1=                60.28 / [degC] FG oven coarse temperature 2
PCM_M1T1=                  9.3 / [degC] Main PCM board temperature 1
PCM_M2T1=                11.19 / [degC] Main PCM board temperature 2
PCM_R1T1=                 7.87 / [degC] Redundant PCM board temperature 1
PCM_R2T1=                 8.07 / [degC] Redundant PCM board temperature 2
DPU_B1T1=                20.65 / [degC] DPU board temperature 1
DPU_B2T1=                22.62 / [degC] DPU board temperature 2
TTCT_BT1=                10.69 / [degC] TTC board temperature
HVPS_BT1=                 9.34 / [degC] HVPS board temperature
ISSTT1T1=                16.84 / [degC] ISS tip/tilt temperature 1
ISSTT2T1=                16.51 / [degC] ISS tip/tilt temperature 2
EUREF_T1=                 8.69 / [degC] E-Unit reference temperature
HEATOVL1= 'Off     '            / Heater overlapping mode (0=off, 1=on)
FGHEATM1=                    1 / FG heater mode status
FGH_TSP1=                   61 / [degC] FG heater set point
FGH_POW1=                    0 / [W] FG heater power
HPHEATM1=                    0 / HRT PMP heater mode status
HPMPTSP1=                   40 / [degC] HRT PMP heater set point
HPMPPOW1=                    0 / [W] HRT PMP heater power
FPHEATM1=                    1 / FDT PMP heater mode status
FPMPTSP1=                   40 / [degC] FDT PMP heater set point
FPMPPOW1=                    0 / [W] FDT PMP heater power

          / PHI_FITS_FPA_prehk
FPAINPV1=                 0.49 / [A] FPA +7V input current
FPAINMV1=                -0.07 / [A] FPA -7V input current
FPACCIV1=                    0 / [V] FPA CCI voltage
FPASSIV1=                    0 / [V] FPA SSA voltage
FPACCDV1=                 3.24 / [V] FPA CCD voltage
FPACCAV1=                 2.42 / [V] FPA CCA voltage
FPACCBV1=                  1.5 / [V] FPA CCB voltage
FPGA_BT1=                15.27 / [degC] FPA FPGA board temperature
IS_PIXV1=                  2.5 / [V] image sensor voltage V_PIX
ISARSTV1=                 0.08 / [V] image sensor voltage V_PIX_RST_ACT
ISIRSTV1=                 3.17 / [V] image sensor voltage V_PIX_RST_INACT
ISASELV1=                 3.56 / [V] image sensor voltage V_PIX_SEL_ACT
ISATX1V1=                 2.99 / [V] image sensor voltage V_PIX_TX1_ACT1
ISATX2V1=                 0.09 / [V] image sensor voltage V_PIX_TX1_ACT2
ISITX1V1=                    0 / [V] image sensor voltage V_PIX_TX1_INACT
IS_ABSV1=                    0 / [V] image sensor ABS bias voltage
FPA_IST1=               -24.92 / [degC] FPA image sensor temperature
CAMR_ID1=                  513 / Camera ID
FPAFIRM1=                 1284 / FPA FPGA ID and firmware version
ANNEALH1= 'ANNEALING_OFF'      / Annealing heater status (0=off, 1=on)
CPC_T__1=                19.19 / [degC] CPC Temperature
CPC_ID_1=                 1742 / CPC ID
FPATMRS1=                  128 / TMR Status
FPATMRA1=                    0 / TMR error address
FPATMRC1=                    0 / Number of TMR cycles
FPASELS1=                  128 / SEL Status
FPASELT1=                    8 / [V] SEL threshold
ACCVERS1=                 3161 / Accumulator Version
ACCSTAT1=                    0 / Accumulator Status
ACCDEST1= 'NONE    '           / Accumulator destination
ACCTRNS1=                    0 / Accumulator transfered pixel

          / PHI_FITS_ISS_prehk
ISSFIRM1=                 5389 / ISS controller firmware version
ISSVALN1=                   39 / Number of valid ISS controller commands
ISSINVN1=                    0 / Number of invalid ISS controller commands
ISSLAST1=                   13 / ID of last ISS command
ISSMODE1= 'ISS_IDLE'           / Current ISS mode (0=idle, 1=correlation)
CTCLAST1=                21834 / Last CTC command
CTCLRES1=                21834 / CTC last response
CTCLSTF1=                    0 / CTC last status frame
CTC_COR1=                    0 / CTC Column out of range
```

```
CTC_ROR1=                    0 / CTC Row out of range
CTCBREF1=                    0 / CTC black reference
CTCN5V_1=               -3.633 / [V] CTC negative 3V6
CTCP2V51=                2.389 / [V] CTC positive 2V5
CTCP3V31=                3.251 / [V] CTC positive 3V3
CTCP5V_1=                5.072 / [V] CTC positive 5V
CTCSENT1=                17.37 / [degC] CTC sensor temperature
CTCFPGT1=                19.38 / [degC] CTC FPGA temperature
CTCREF11=                0.987 / [V] CTC reference voltage 1V
CTCREF21=                  2.5 / [V] CTC reference voltage 2v
CTCSIMG1=                    0 / CTC send images
CTCRIMG1=                    0 / CTC received images
CTCBADD1=                    0 / CTC bad address
CTCEADD1=                    0 / CTC expected address
CWRGIMG1=                    0 / CTC wrong images
ISSBADP1=                    0 / ISS bad period
ISSOUTX1=                    0 / ISS out X
ISSOUTY1=                    0 / ISS out Y
ISSAVIR1=                    0 / ISS mean intensity reference
ISSRMSI1=                    0 / ISS rms intensity reference
ISSMXIR1=                    0 / ISS maximum intensity reference
ISSMNIR1=                    0 / ISS minimum intensity reference
ISS_AVJ1=                    0 / [asec] ISS mean offset
ISSRMSJ1=                    0 / [asec] ISS rms offset
ISSMAXJ1=                    0 / [asec] ISS maximum offset
ISSMINJ1=                    0 / [asec] ISS minimum offset
ISSA10P1=                    0 / ISS parabolic parameter A01
ISSA01P1=                    0 / ISS parabolic parameter A10
ISSA20P1=                    0 / ISS parabolic parameter A02
ISSA02P1=                    0 / ISS parabolic parameter A20
ISSA11P1=                    0 / ISS parabolic parameter A11
ISSREFI1=                    0 / Number of used ISS reference images
ISSOOBC1=                    0 / ISS out of bound count
ISSB2OF1=                    0 / ISS CT bank 2 offset
ISSPIMG1=                    0 / ISS pending images
ISLISOX1=                    0 / ISS LIS out X
ISLISOY1=                    0 / ISS LIS out Y
ISOTFOX1=                    0 / ISS SOTF out X
ISOTFOY1=                    0 / ISS SOTF out Y
ISROTOX1=                    0 / ISS ROT out X
ISROTOY1=                    0 / ISS ROT out Y
ISROTLE1=                    0 / ISS ROT log exponent
ISSSTFL1=                    0 / ISS status and error flags
ISSIMSZ1=                  128 / ISS image size (square)
ISSLDEL1=                    0 / ISS line delay
CTC_AGN1=                    0 / CTC analog gain
CTC_DGN1=                    0 / CTC digital gain
CTCSTOF1=                    0 / CTC static offset
ISSRSHT1=                    0 / ISS rolling shutter offset
ISSIMOX1=                  448 / ISS image offset X
ISSIMOY1=                  448 / ISS image offset Y
CTADPSF1=                   64 / CTC ADC phase shift
CTCRTRI1=                   15 / CTC retries
CTCDIMN1=                    0 / Number of dropped CTC images
ISSSTEP1=                    0 / ISS stats exponent
ISIMGST1=                    0 / ISS store images
ISIMGRS1=                    0 / ISS store raw images
ISTSTIM1=                    0 / ISS test images
ISSTISE1=                    7 / ISS test image size Exp
ISSTIEV1=                    0 / ISS test image even
ISSTIOD1=                    0 / ISS test image odd
ISSTDIS1=                    0 / ISS store displacement
ISTADIS1=                    0 / ISS stats displacement
ISSREFP1=                    0 / ISS reference period
TT_OFFX1=                 2047 / TT offset X
TT_OFFY1=                 2047 / TT offset Y
TTAMPXX1=                  256 / TT Amp XX
TTAMPXY1=                    0 / TT Amp XY
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```
TTAMPYX1=                    0 / TT Amp YX
TTAMPYY1=                  256 / TT Amp YY
TT_MAX_1=                 3648 / TT max
TT_MIN_1=                  446 / TT min
TTSTPEX1=                    0 / TT steps exponent
TTSTPPD1=                    0 / TT steps period
PID_A1X1=                    0 / ISS PID X parameter A1
PID_A1Y1=                    0 / ISS PID Y parameter A1
PID_A2X1=                    0 / ISS PID X parameter A2
PID_A2Y1=                    0 / ISS PID Y parameter A2
PID_B0X1=                    1 / ISS PID X parameter B0
PID_B0Y1=                    1 / ISS PID Y parameter B0
PID_B1X1=                    0 / ISS PID X parameter B1
PID_B1Y1=                    0 / ISS PID Y parameter B1
PID_B2X1=                    0 / ISS PID X parameter B2
PID_B2Y1=                    0 / ISS PID Y parameter B2
LISSAAX1=                    0 / ISS Lissajous parameter AX
LISSAAY1=                    0 / ISS Lissajous parameter AY
LISSADX1=                    0 / ISS Lissajous parameter DX
LISSADY1=                    0 / ISS Lissajous parameter DY
LISSAWX1=                0.199 / ISS Lissajous parameter WX
LISSAWY1=                0.199 / ISS Lissajous parameter WY
LISSAFI1=                    0 / ISS Lissajous parameter FI
LISSATX1=                    0 / ISS Lissajous parameter TDX
LISSATY1=                    0 / ISS Lissajous parameter TDY
LISSATS1=                    0 / ISS Lissajous parameter TS
LISSPRS1=                    0 / ISS prescaler
LISSANS1=                    0 / ISS Lissajous parameter VS
ISSTHHX1=                    0 / ISS static threshold X
ISSTHHY1=                    0 / ISS static threshold Y
ISSHKPD1=                    0 / ISS HK period
ISSMEMP1=                    0 / ISS memory parameter
ISCLKPH1=                    0 / [PI] ISS clock phase

         / PHI_FITS_FPA_settings
FPIMGCMD=                    8 / FPA image command
FPA_SROW=                    0 / FPA start row setting
FPA_EROW=                 1022 / FPA end row setting
FPA_NIMG=                   20 / FPA number of images set
FPEXPSTC=           1592452786 / [s] FPA exposure start time coarse
FPEXPSTF=               699245 / [us] FPA exposure start time fine
INTTIME =                 0.01 / [s] Exposure time of single readout
TELAPSE =     58.1974400877953 / [s] Elapsed time between start and end of obser
NSUMEXP =                  480 / Number of detector readouts
XPOSURE =                  4.8 / [s] Total effective exposure time

         / PHI_FITS_ACCU_settings
ACCLENGT=              4194304 / ACCU number of pixel set
ACCNROWS=                    6 / ACCU number of rows set
ACCROWIT=                    1 / ACCU number of row iterations set
ACCNCOLS=                    4 / ACCU number of columns set
ACCCOLIT=                    1 / ACCU number of column iterations set
ACCACCUM=                   20 / ACCU number of accumulations set
ACCADDR =                    0 / ACCU readout address (start)
ACCSIZE =            402653184 / ACCU Data size in byte

         / PHI_FITS_DPU_posthk
I_SYSST2= 'OBSERVATION'        / Instrument system state
CPULOAD2=                93.98 / [perc] CPU load
SPWDROP2=                    0 / Number of dropped SpaceWire packets
IICPCTN2=                35270 / Number of IIC packets
IICSEQN2=                10935 / Sequence number of the last IIC packet
OBSWVER2=                11120 / On-board software version
DPUHWVR2=             17434701 / DPU hardware version
DPUSSCR2=                24792 / DPU System Supervisor CR
DPUSSSR2=                    0 / DPU System Supervisor SR
TCREC_N2=                   52 / Number of received Telecommands
TCFAILN2=                    0 / Number of failed Telecommands
```

```
TCQUEUE2=                    0 / Fill level of Telecommanding queue
TMQUEUE2=                    0 / Fill level of Telemetry queue
SCQUEUE2=                    0 / Fill level of science Telemetry queue
RAMFS_N2=                   12 / Number of files in RAMFS
RAMFSSP2=            111268136 / [Byte] Available space in RAMFS
SRVSTFL2=                 4076 / Service status flags
GPIOLST2=            604141736 / Status of GPIO ports 0-31
GPIOHST2=              4298758 / Status of GPIO ports 32-63
SCDCMOD2= 'COMPRESS_NONE'      / Science data compression mode

         / PHI_FITS_PCM_posthk
APCMSTA2=                  241 / Active PCM status flag
APCM_VP2=               27.486 / [V] active PCM V_prim
APCM_IP2=                0.989 / [A] active PCM I_prim
APP28IH2=                0.028 / [A] active PCM I_Heaters_+28V
APP28IM2=                0.074 / [A] active PCM I_Mech_+28V
AP_P33I2=                2.778 / [A] active PCM I_+3V3
AP_P07I2=                0.656 / [A] active PCM I_+7V
AP_M07I2=                 0.09 / [A] active PCM I_-7V
AP_P15I2=                0.063 / [A] active PCM I_+15V
AP_M15I2=                0.059 / [A] active PCM I_-15V
AP_P60I2=                0.007 / [A] active PCM I_+60V
ADPU33V2=                3.406 / [V] active PCM V_DPU_+3V3
AABP33V2=                3.406 / [V] active PCM V_AB_+3V3
AABP07V2=                 6.56 / [V] active PCM V_AB_+7V
AABP15V2=               14.415 / [V] active PCM V_AB_+15V
AABM15V2=               14.502 / [V] active PCM V_AB_-15V
ACPP07V2=                7.303 / [V] active PCM V_CPC_+7V
ACPM07V2=                7.483 / [V] active PCM V_CPC_-7V
AHVP07V2=                6.563 / [V] active PCM V_HVPS_+7V
AHVP15V2=               14.414 / [V] active PCM V_HVPS_+15V
AHVM15V2=               14.502 / [V] active PCM V_HVPS_-15V
ATTP07V2=                 6.56 / [V] active PCM V_TTC_+7V
ATTP60V2=               59.983 / [V] active PCM V_TTC_+60V
POWSWST2=                  255 / Power Switch status

         / PHI_FITS_MECH_posthk
MEMOVST2=                    4 / Mechanism movement status flag
MEEOTST2=                    8 / Mechanism end-of-travel switch status flag
FRM_POS2=                 2911 / [um] Deduced FRM position
DHRM_PS2=                12363 / [um] Deduced HRM position
DCRM_PS2=                    0 / [um] Deduced CRM position
FSM_POS2=                    0 / [amin] Deduced FSM position
HVPSLPV2=                 -327 / [V] HVPS HV level side P
HVPSLNV2=                  311 / [V] HVPS HV level side N
TTCP55V2=               54.478 / [V] Voltage TTC_+55V
IABREFV2=                1.254 / [V] Internal AMHD voltage reference 1.25V
DEDFGWL2=             6173116 / [mAng] Deduced current FG wavelength
FDTPMPR2=                    4 / Deduced FDT PMP polarization state
LC1FDTV2=                1.682 / [V] commanded voltage on FDT PMP LC1
LC2FDTV2=                1.653 / [V] commanded voltage on FDT PMP LC2
HRTPMPR2=                  255 / Deduced HRT PMP polarization state
LC1HRTV2=                    0 / [V] commanded voltage on HRT PMP LC1
LC2HRTV2=                    0 / [V] commanded voltage on HRT PMP LC2

         / PHI_FITS_TEMP_posthk
FGOV1PT2=                60.99 / [degC] FG oven precision temperature 1
FGOV2PT2=                60.96 / [degC] FG oven precision temperature 2
FPMP1PT2=                39.96 / [degC] FDT PMP precision temperature 1
FPMP2PT2=                40.27 / [degC] FDT PMP precision temperature 2
HPMP1PT2=                44.17 / [degC] HRT PMP precision temperature 1
HPMP2PT2=                50.99 / [degC] HRT PMP precision temperature 2
FRM_MWT2=                 14.9 / [degC] FRM motor temperature
HRM_MWT2=                16.82 / [degC] HRM motor temperature
CRM_MWT2=                15.98 / [degC] CRM motor temperature
FSM_MWT2=                16.59 / [degC] FSM motor temperature
AMHD_1T2=                13.69 / [degC] AMHD DCDC temperature
AMHD_2T2=                 9.71 / [degC] AMHD board temperature
```

```
FRMPANT2=                16.72 / [degC] FDT housing temperature
M2BAFFT2=                19.51 / [degC] M2 baffle temperature
OUREF1T2=                16.64 / [degC] O-Unit main baffle temperature
OUREF2T2=                16.51 / [degC] HRT PMP housing temperature
M1MNT_T2=                17.54 / [degC] M1 mounting temperature
M2MNT_T2=                 23.4 / [degC] Tip-Tilt housing temperature
FGO_1CT2=                60.85 / [degC] FG oven coarse temperature 1
FGO_2CT2=                60.32 / [degC] FG oven coarse temperature 2
PCM_M1T2=                 9.34 / [degC] Main PCM board temperature 1
PCM_M2T2=                11.35 / [degC] Main PCM board temperature 2
PCM_R1T2=                 7.87 / [degC] Redundant PCM board temperature 1
PCM_R2T2=                 8.15 / [degC] Redundant PCM board temperature 2
DPU_B1T2=                20.86 / [degC] DPU board temperature 1
DPU_B2T2=                22.66 / [degC] DPU board temperature 2
TTCT_BT2=                10.74 / [degC] TTC board temperature
HVPS_BT2=                 9.42 / [degC] HVPS board temperature
ISSTT1T2=                 16.8 / [degC] ISS tip/tilt temperature 1
ISSTT2T2=                16.47 / [degC] ISS tip/tilt temperature 2
EUREF_T2=                 8.73 / [degC] E-Unit reference temperature
HEATOVL2= 'Off     '           / Heater overlapping mode (0=off, 1=on)
FGHEATM2=                    1 / FG heater mode status
FGH_TSP2=                   61 / [degC] FG heater set point
FGH_POW2=                    0 / [W] FG heater power
HPHEATM2=                    0 / HRT PMP heater mode status
HPMPTSP2=                   40 / [degC] HRT PMP heater set point
HPMPPOW2=                    0 / [W] HRT PMP heater power
FPHEATM2=                    1 / FDT PMP heater mode status
FPMPTSP2=                   40 / [degC] FDT PMP heater set point
FPMPPOW2=                    0 / [W] FDT PMP heater power

         / PHI_FITS_FPA_posthk
FPAINPV2=                 0.51 / [A] FPA +7V input voltage
FPAINMV2=                -0.07 / [A] FPA -7V input voltage
FPACCIV2=                    0 / [V] FPA CCI voltage
FPASSIV2=                    0 / [V] FPA SSA voltage
FPACCDV2=                 3.23 / [V] FPA CCD voltage
FPACCAV2=                 2.42 / [V] FPA CCA voltage
FPACCBV2=                  1.5 / [V] FPA CCB voltage
FPGA_BT2=                15.76 / [degC] FPA FPGA board temperature
IS_PIXV2=                  2.5 / [V] image sensor voltage V_PIX
ISARSTV2=                 0.08 / [V] image sensor voltage V_PIX_RST_ACT
ISIRSTV2=                 3.17 / [V] image sensor voltage V_PIX_RST_INACT
ISASELV2=                 3.55 / [V] image sensor voltage V_PIX_SEL_ACT
ISATX1V2=                 2.99 / [V] image sensor voltage V_PIX_TX1_ACT1
ISATX2V2=                 0.09 / [V] image sensor voltage V_PIX_TX1_ACT2
ISITX1V2=                    0 / [V] image sensor voltage V_PIX_TX1_INACT
IS_ABSV2=                    0 / [V] image sensor ABS bias voltage
FPA_IST2=               -24.18 / [degC] FPA image sensor temperature
CAMR_ID2=                  513 / Camera ID
FPAFIRM2=                 1284 / FPA FPGA ID and firmware version
ANNEALH2= 'ANNEALING_OFF'      / Annealing heater status (0=off, 1=on)
CPC_T__2=                19.31 / [degC] CPC Temperature
CPC_ID_2=                 1741 / CPC ID
FPATMRS2=                  128 / TMR Status
FPATMRA2=                    0 / TMR error address
FPATMRC2=                    0 / Number of TMR cycles
FPASELS2=                  128 / SEL Status
FPASELT2=                    8 / [V] SEL threshold
ACCVERS2=                 3161 / Accumulator Version
ACCSTAT2=                   64 / Accumulator Status
ACCDEST2= 'NANDFS  '           / Accumulator destination
ACCTRNS2=                    0 / Accumulator transfered pixel

         / PHI_FITS_ISS_posthk
ISSFIRM2=                 5389 / ISS controller firmware version
ISSVALN2=                   39 / Number of valid ISS controller commands
ISSINVN2=                    0 / Number of invalid ISS controller commands
ISSLAST2=                   13 / ID of last ISS command
```

```
ISSMODE2= 'ISS_IDLE'           / Current ISS mode (0=idle, 1=correlation)
CTCLAST2=                21834 / Last CTC command
CTCLRES2=                21834 / CTC last response
CTCLSTF2=                    0 / CTC last status frame
CTC_COR2=                    0 / CTC Column out of range
CTC_ROR2=                    0 / CTC Row out of range
CTCBREF2=                    0 / CTC black reference
CTCSENT2=                17.37 / [degC] CTC sensor temperature
CTCFPGT2=                19.38 / [degC] CTC FPGA temperature
CTCREF12=                0.987 / [V] CTC reference voltage 1V
CTCREF22=                  2.5 / [V] CTC reference voltage 2v
CTCSIMG2=                    0 / CTC send images
CTCRIMG2=                    0 / CTC received images
CTCBADD2=                    0 / CTC bad address
CTCEADD2=                    0 / CTC expected address
CWRGIMG2=                    0 / CTC wrong images
ISSBADP2=                    0 / ISS bad period
ISSOUTX2=                    0 / ISS out X
ISSOUTY2=                    0 / ISS out Y
ISSAVIR2=                    0 / ISS mean intensity reference
ISSRMSI2=                    0 / ISS rms intensity reference
ISSMXIR2=                    0 / ISS maximum intensity reference
ISSMNIR2=                    0 / ISS minimum intensity reference
ISS_AVJ2=                    0 / [asec] ISS mean offset
ISSRMSJ2=                    0 / [asec] ISS rms offset
ISSMAXJ2=                    0 / [asec] ISS maximum offset
ISSMINJ2=                    0 / [asec] ISS minimum offset
ISSA10P2=                    0 / ISS parabolic parameter A01
ISSA01P2=                    0 / ISS parabolic parameter A10
ISSA20P2=                    0 / ISS parabolic parameter A02
ISSA02P2=                    0 / ISS parabolic parameter A20
ISSA11P2=                    0 / ISS parabolic parameter A11
ISSREFI2=                    0 / Number of used ISS reference images
ISSOOBC2=                    0 / ISS out of bound count
ISSB2OF2=                    0 / ISS CT bank 2 offset
ISSPIMG2=                    0 / ISS pending images
ISLISOX2=                    0 / ISS LIS out X
ISLISOY2=                    0 / ISS LIS out Y
ISOTFOX2=                    0 / ISS SOTF out X
ISOTFOY2=                    0 / ISS SOTF out Y
ISROTOX2=                    0 / ISS ROT out X
ISROTOY2=                    0 / ISS ROT out Y
ISROTLE2=                    0 / ISS ROT log exponent
ISSSTFL2=                    0 / ISS status and error flags
ISSIMSZ2=                  128 / ISS image size (square)
ISSLDEL2=                    0 / ISS line delay
CTC_AGN2=                    0 / CTC analog gain
CTC_DGN2=                    0 / CTC digital gain
CTCSTOF2=                    0 / CTC static offset
ISSRSHT2=                    0 / ISS rolling shutter offset
ISSIMOX2=                  448 / ISS image offset X
ISSIMOY2=                  448 / ISS image offset Y
CTADPSF2=                   64 / CTC ADC phase shift
CTCRTRI2=                   15 / CTC retries
CTCDIMN2=                    0 / Number of dropped CTC images
ISSSTEP2=                    0 / ISS stats exponent
ISIMGST2=                    0 / ISS store images
ISIMGRS2=                    0 / ISS store raw images
ISTSTIM2=                    0 / ISS test images
ISSTISE2=                    7 / ISS test image size Exp
ISSTIEV2=                    0 / ISS test image even
ISSTIOD2=                    0 / ISS test image odd
ISSTDIS2=                    0 / ISS store displacement
ISTADIS2=                    0 / ISS stats displacement
ISSREFP2=                    0 / ISS reference period
TT_OFFX2=                 2047 / TT offset X
TT_OFFY2=                 2047 / TT offset Y
TTAMPXX2=                  256 / TT Amp XX
```

```
TTAMPXY2=                    0 / TT Amp XY
TTAMPYX2=                    0 / TT Amp YX
TTAMPYY2=                  256 / TT Amp YY
TT_MAX_2=                 3648 / TT max
TT_MIN_2=                  446 / TT min
TTSTPEX2=                    0 / TT steps exponent
TTSTPPD2=                    0 / TT steps period
PID_A1X2=                    0 / ISS PID X parameter A1
PID_A1Y2=                    0 / ISS PID Y parameter A1
PID_A2X2=                    0 / ISS PID X parameter A2
PID_A2Y2=                    0 / ISS PID Y parameter A2
PID_B0X2=                    1 / ISS PID X parameter B0
PID_B0Y2=                    1 / ISS PID Y parameter B0
PID_B1X2=                    0 / ISS PID X parameter B1
PID_B1Y2=                    0 / ISS PID Y parameter B1
PID_B2X2=                    0 / ISS PID X parameter B2
PID_B2Y2=                    0 / ISS PID Y parameter B2
LISSAAX2=                    0 / ISS Lissajous parameter AX
LISSAAY2=                    0 / ISS Lissajous parameter AY
LISSADX2=                    0 / ISS Lissajous parameter DX
LISSADY2=                    0 / ISS Lissajous parameter DY
LISSAWX2=                0.199 / ISS Lissajous parameter WX
LISSAWY2=                0.199 / ISS Lissajous parameter WY
LISSAFI2=                    0 / ISS Lissajous parameter FI
LISSATX2=                    0 / ISS Lissajous parameter TDX
LISSATY2=                    0 / ISS Lissajous parameter TDY
LISSATS2=                    0 / ISS Lissajous parameter TS
LISSPRS2=                    0 / ISS prescaler
LISSANS2=                    0 / ISS Lissajous parameter VS
ISSTHHX2=                    0 / ISS static threshold X
ISSTHHY2=                    0 / ISS static threshold Y
ISSHKPD2=                    0 / ISS HK period
ISSMEMP2=                    0 / ISS memory parameter
ISCLKPH2=                    0 / [PI] ISS clock phase

          / Processing keywords
PROCNODE= 'germerott-slm6'     / System which processed file
DWNLNKST= '2020-07-06 01:20:01' / Image packed onboard
INFO_URL= 'UNKNOWN'            / Link to additional string information
COMPLETE= 'C'                  / C complete, I incomplete, U undefined
PHIDBVER= '3266:11837'         / PHI Mib Db svn version
PARENT  = 'solo_L0_phi-fdt-ilam_20200618T040005_V202106101808C_0066180100.fits'
SPICESYS= 'YES     '           / Availability of SPICE Kernel
DFMTSCAL=                   1. / Data format scale factor
DRNGSCAL=                  127 / Data range scale factor
HISTORY Written with converter(FITS.cpp) Version: 11268:11839
HISTORY Build Host: germerott on Linux germerott-slm6 5.10.27-gentoo x86_64
HISTORY Build Time: Jun 11 2021 14:38:06
CHECKSUM= '9fcEGZaD9daDEZaD'   / HDU checksum updated 2021-06-11T13:47:35
DATASUM = '3876715845'         / data unit checksum updated 2021-06-11T13:47:35
END
```

C.2 L1 Example FITS Extensions 1 to 10

Identical extensions 1 to 10 as for the L0 dataset are included in the L1 dataset, see section B.

D Sample L2 dataset file header

This Section shows the content of an example SO/PHI L2 science dataset as taken on June 18, 2020 at the beginning of CP. The filename is:
`solo_L2_phi-fdt-blos_20200618T040005_V202106111347C_0066180100.fits`
and one of the included images is shown in Fig. 5. The size of the file is 33.6 MBytes.

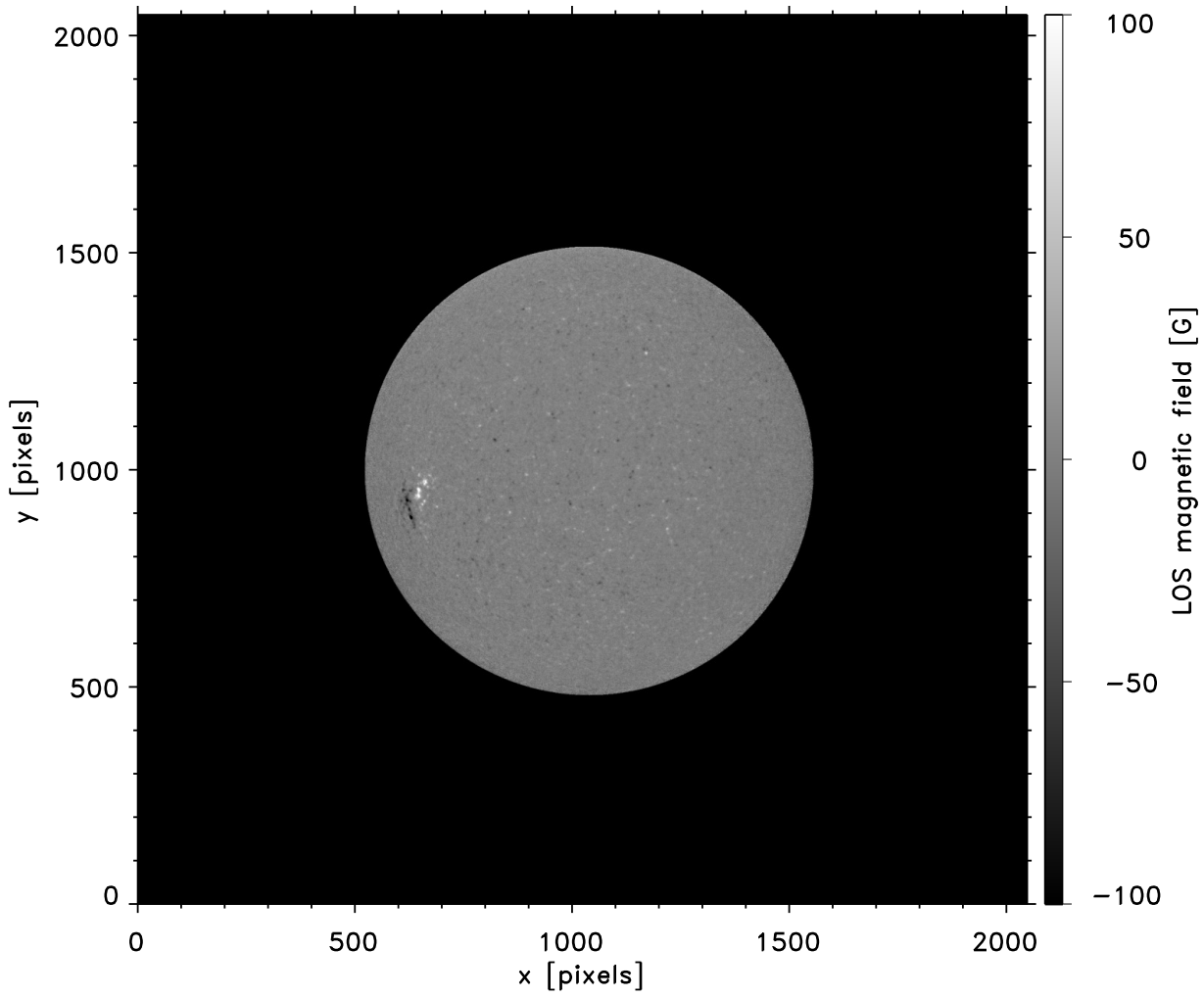

Figure 5: First image of an example SO/PHI L2 science dataset showing the LOS magnetic field, satuarted at ±100G.

D.1 L2 Example Main Header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                  -64 / 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
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format is defined in 'Astronomy
COMMENT   and Astrophysics', volume 376, page 359; bibcode: 2001A&A...376..359H
LONGSTRN= 'OGIP 1.0'           / The HEASARC Long String Convention may be used.
COMMENT   This FITS file may contain long string keyword values that are
COMMENT   continued over multiple keywords.  The HEASARC convention uses the &
COMMENT   character at the end of each substring which is then continued
COMMENT   on the next keyword which has the name CONTINUE.
FILENAME= 'solo_L1_phi-fdt-ilam_20200618T040005_V202106111347C_0066180100.fits'
DATE    = '2021-06-11T13:47:27' / file creation date (YYYY-MM-DDThh:mm:ss UT)

          / Instrument and observation configuration FITS keywords
OBSRVTRY= 'Solar Orbiter'      / Satellite Name
INSTRUME= 'PHI'                / Instrument name
TELESCOP= 'SOLO/PHI/FDT'       / Telescope
DETECTOR= 'FDT'                / Instrument subunit or sensor
OBS_MODE= ' '                  / Observation mode
OBS_ID  = 'SPHI_012A_CC1_113_Nj5k_111' / Unique ID of Observation
OBJECT  = '        '           / Type of object observed
OBS_TYPE= 'Nj5k    '           / Encoded version of OBS_MODE
SOOPNAME= '        '           / SOOP Campaign Name
SOOPTYPE= '        '           / SOOP Campaign ID(s)
PURPOSE = '        '           / Purpose of this observation
SUBJECT = '        '           / Subject of this observation
SCIENTIS= '        '           / Resposible scientist for this observation
WAVEMIN =            617.3116 / [Angstrom] min wavelength of observation
WAVEMAX =            617.3573 / [Angstrom] max wavelength of observation
TIMESYS = 'UTC'                / System used for time keywords
DATE-OBS= '2020-06-18T04:00:05.316' / [UTC] Start time of observation
DATE-BEG= '2020-06-18T04:00:05.316' / [UTC] Start time of observation
DATE-AVG= '2020-06-18T04:00:34.415' / [UTC] Average time of observation
DATE-END= '2020-06-18T04:01:03.514' / [UTC] End time of observation
OBT_BEG =     1592452786.69924 / [OBT] Start time of observation
OBT_END =     1592452844.89668 / [OBT] End time of observation
LEVEL   = 'L2      '           / Data processing level
ORIGIN  = 'MPS'                / Name of institution
CREATOR = 'converter'          / FITS creation software
SPK_VERS= 'v107_20210604_001'  / Spice Kernel Version
VERS_SW = '11268:11839'        / Version of SW that provided FITS file
VERSION = '202106111347'       / Version of FITS file

          / Description of data content keywords
BTYPE   = 'Intensity'          / Type of data
BSCALE  =                  1.0 / ratio of physical to array value at 0 offset
BUNIT   = 'DN'                 / Units of physical value, after application
DATAMIN =                300.  / Minimum valid physical value
DATAMAX =              23090.  / Maximum valid physical value

          / Image relative to detector electronics keywords
RPLTSCL =              3.57400 / [arcsec] Platescale of raw images
CPLTSCL =              3.58125 / Calculated plate scale
PXBEG1  =                    1 / First read-out pixel in dimension 1
PXEND1  =                 2048 / Last read-out pixel in dimension 1
PXBEG2  =                    1 / First read-out pixel in dimension 2
PXEND2  =                 2048 / Last read-out pixel in dimension 2
NBIN1   =                    1 / Data binning factor in dimension 1
NBIN2   =                    1 / Data binning factor in dimension 2
NBIN    =                    1 / Total binning factor
AVTTOFFX=                  0.0 / [arcec] average tip/tilt offset x
AVTTOFFY=                  0.0 / [arcec] average tip/tilt offset y
IMGDIRX = 'NO      '           / Image mirrored along Y-Axis

          / Onboard processing keywords
CAL_DARK= '66181001'           / Onboard calibrated for dark field
CAL_CRT0= 0.006368519956468037 / cross-talk from I to Q (slope value, wrt normal
CAL_CRT1= -0.00148600100066707 / cross-talk from I to Q (off-set value, wrt norm
CAL_CRT2= 0.003488493080455784 / cross-talk from I to U (slope value, wrt normal
```

```
CAL_CRT3= -0.00052736613539715 / cross-talk from I to U (off-set value, wrt norm
CAL_CRT4= -0.01614874250176498 / cross-talk from I to V (slope value, wrt normal
CAL_CRT5= 0.000838051938673925 / cross-talk from I to V (off-set value, wrt norm
CAL_NORM=    79.18601989746094 / Normalization (normalization constant PROC_Ic)
CAL_GHST= 'phi_correct_ghost V1.0 Jun 2021' / ghost correction version py module
CAL_FLAT= '66180100'           / Onboard calibrated for gain table
CAL_PSF =                    0 / Onboard calibrated for instrumental PSF
CAL_IPOL= 'FDT40   '           / Onboard calibrated for instrumental polarizatio
CAL_SCIP= 'None'               / Onboard scientific data analysis
RTE_ITER=           4294967295 / Number RTE inversion iterations
COMPRESS= '4Bits   '           / Data compression quality
COMPRAT =             0.250000 / Data compression ratio
COMPVERS=                    0 / Version of Compression Core
PHIDATID= '66180100'           / PHI dataset Id

          / WCS keywords
WCSNAME = 'Helioprojective-Cartesian' / hpc frame
CTYPE1  = 'HPLN-TAN'           / Spatial axis parallel Solar North
CTYPE2  = 'HPLT-TAN'           / Spatial axis parallel to Solar + West
CRPIX1  =              1040.20 / Description of ref pixel along axis 1
CRPIX2  =              999.223 / Description of ref pixel along axis 2
CUNIT1  = 'arcsec'             / Units along axis 1
CUNIT2  = 'arcsec'             / Units along axis 2
PC1_1   =           -0.6074628 / Coordinate transformation to LIF
PC1_2   =           -0.7943481 / Coordinate transformation to LIF
PC2_1   =            0.7943481 / Coordinate transformation to LIF
PC2_2   =           -0.6074628 / Coordinate transformation to LIF
CROTA2  =     127.406271611114 / [deg] Rotation angle
CDELT1  =              3.57400 / Pixel scale along axis 1 in unit CUNIT1
CDELT2  =              3.57400 / Pixel scale along axis 2 in unit CUNIT2
CRVAL1  =              0.00000 / [arcsec] Coordinates of ref pixel along axis 1
CRVAL2  =              0.00000 / [arcsec] Coordinates of ref pixel along axis 2

          / Solar Ephemeris Data
RSUN_REF=           695508000. / [m] Assumed physical solar radius
RSUN_ARC=              1853.92 / [arcsec] Apparent photospheric
SOLAR_B0=        6.67093100000 / [deg] s/c tilt of solar North pole
SOLAR_P0=        20.1293600000 / [deg] s/c celestial North to solar North angle
SOLAR_EP=       -1.35621700000 / [deg] s/c ecliptic North to solar North angle
CAR_ROT =                 2231 / Carrington rotation number
HGLT_OBS=        6.67093110000 / [deg] Stonyhurst latitude
HGLN_OBS=        67.9376300000 / [deg] Stonyhurst longitude
CRLT_OBS=        6.67093110000 / [deg]Carrington latitude (B0 angle)
CRLN_OBS=        66.6233880000 / [deg]Carrington longitude (L0 angle)
DSUN_OBS=        77382388052.0 / [m]  Distance from Sun
DSUN_AU =       0.517269310000 / [AU]  Distance from Sun
HEEX_OBS=        29083951236.2 / [m] Heliocentric Earth Ecliptic X
HEEY_OBS=        71706213694.6 / [m] Heliocentric Earth Ecliptic Y
HEEZ_OBS=       -613741564.319 / [m] Heliocentric Earth Ecliptic Z
HCIX_OBS=       -14410711938.3 / [m] Heliocentric Inertial X
HCIY_OBS=       -75495419950.2 / [m] Heliocentric Inertial Y
HCIZ_OBS=        8989267412.16 / [m] Heliocentric Inertial Z
HCIX_VOB=        46243.5056940 / [m/s] Heliocentric Inertial X Velocity
HCIY_VOB=       -10599.7749047 / [m/s] Heliocentric Inertial Y Velocity
HCIZ_VOB=       -124.752460661 / [m/s] Heliocentric Inertial Z Velocity
HAEX_OBS=        70148766188.6 / [m] Heliocentric Aries Ecliptic X
HAEY_OBS=       -32662051763.0 / [m] Heliocentric Aries Ecliptic Y
HAEZ_OBS=       -612337718.478 / [m] Heliocentric Aries Ecliptic Z
HEQX_OBS=        28869252621.5 / [m] Heliocentric Earth Equatorial X
HEQY_OBS=        71230564402.5 / [m] Heliocentric Earth Equatorial Y
HEQZ_OBS=        8989267412.16 / [m] Heliocentric Earth Equatorial Z
GSEX_OBS=        122921855011. / [m] Geocentric Solar Ecliptic X
GSEY_OBS=       -71706213694.6 / [m] Geocentric Solar Ecliptic Y
GSEZ_OBS=       -613741564.319 / [m] Geocentric Solar Ecliptic Z
OBS_VR  =        1715.00503335 / [m/s] Radial velocity of S/C relative to Sun
OBS_VW  =        47410.8106817 / [m/s] Westward velocity of S/C relative to Sun
OBS_VN  =       -326.187557136 / [m/s] Northward velocity of S/C relative to Sun
EAR_TDEL=        248.916929708 / [s] Time(Sun to Earth) - Time(Sun to S/C)
```

```
DATE_EAR= '2020-06-18T04:04:14.234' / [UTC] Start time of observation, corrected
DATE_SUN= '2020-06-18T03:55:47.196' / [UTC] Start time of observation, corrected
SPECSYS = 'TOPOCENT'           / Reference frame for spectral axes
SUN_TIME=       258.119862548 / [s] Light travel time (Sun to S/C)

        / PHI_FITS_DPU_prehk
I_SYSST1= 'OBSERVATION'        / Instrument system state
CPULOAD1=                93.01 / [perc] CPU load
SPWDROP1=                    0 / Number of dropped SpaceWire packets
IICPCTN1=                35180 / Number of IIC packets
IICSEQN1=                10215 / Sequence number of the last IIC packet
OBSWVER1=                11120 / On-board software version
DPUHWVR1=             17434701 / DPU hardware version
DPUSSCR1=                24822 / DPU System Supervisor CR
DPUSSSR1=                    0 / DPU System Supervisor SR
TCREC_N1=                   52 / Number of received Telecommands
TCFAILN1=                    0 / Number of failed Telecommands
TCQUEUE1=                    0 / Fill level of Telecommanding queue
TMQUEUE1=                    0 / Fill level of Telemetry queue
SCQUEUE1=                    0 / Fill level of science Telemetry queue
RAMFS_N1=                   12 / Number of files in RAMFS
RAMFSSP1=            111268136 / [Byte] Available space in RAMFS
SRVSTFL1=                 4076 / Service status flags
GPIOLST1=            604141736 / Status of GPIO ports 0-31
GPIOHST1=              4298758 / Status of GPIO ports 32-63
SCDCMOD1= 'COMPRESS_NONE'      / Science data compression mode

        / PHI_FITS_PCM_prehk
APCMSTA1=                  241 / Active PCM status flag
APCM_VP1=               27.505 / [V] active PCM V_prim
APCM_IP1=                0.971 / [A] active PCM I_prim
APP28IH1=                0.022 / [A] active PCM I_Heaters_+28V
APP28IM1=                0.073 / [A] active PCM I_Mech_+28V
AP_P33I1=                2.665 / [A] active PCM I_+3V3
AP_P07I1=                0.636 / [A] active PCM I_+7V
AP_M07I1=                0.089 / [A] active PCM I_-7V
AP_P15I1=                0.062 / [A] active PCM I_+15V
AP_M15I1=                0.057 / [A] active PCM I_-15V
AP_P60I1=                0.007 / [A] active PCM I_+60V
ADPU33V1=                3.406 / [V] active PCM V_DPU_+3V3
AABP33V1=                3.406 / [V] active PCM V_AB_+3V3
AABP07V1=                 6.56 / [V] active PCM V_AB_+7V
AABP15V1=               14.417 / [V] active PCM V_AB_+15V
AABM15V1=               14.501 / [V] active PCM V_AB_-15V
ACPP07V1=                7.304 / [V] active PCM V_CPC_+7V
ACPM07V1=                7.475 / [V] active PCM V_CPC_-7V
AHVP07V1=                6.563 / [V] active PCM V_HVPS_+7V
AHVP15V1=               14.415 / [V] active PCM V_HVPS_+15V
AHVM15V1=                 14.5 / [V] active PCM V_HVPS_-15V
ATTP07V1=                 6.56 / [V] active PCM V_TTC_+7V
ATTP60V1=               59.983 / [V] active PCM V_TTC_+60V
POWSWST1=                  255 / Power Switch status

        / PHI_FITS_MECH_prehk
MEMOVST1=                    4 / Mechanism movement status flag
MEEOTST1=                    8 / Mechanism end-of-travel switch status flag
FRM_POS1=                 2911 / [um] Deduced FRM position
DHRM_PS1=                12363 / [um] Deduced HRM position
DCRM_PS1=                    0 / [um] Deduced CRM position
FSM_POS1=                    0 / [amin] Deduced FSM position
HVPSLPV1=                 -327 / [V] HVPS HV level side P
HVPSLNV1=                  311 / [V] HVPS HV level side N
TTCP55V1=               54.478 / [V] Voltage TTC_+55V
IABREFV1=                1.254 / [V] Internal AMHD voltage reference 1.25V
DEDFGWL1=             6173116 / [mAng] Deduced current FG wavelength
FDTPMPR1=                    1 / Deduced FDT PMP polarization state
LC1FDTV1=                2.099 / [V] commanded voltage on FDT PMP LC1
LC2FDTV1=                2.001 / [V] commanded voltage on FDT PMP LC2
```

```
HRTPMPR1=                  255 / Deduced HRT PMP polarization state
LC1HRTV1=                    0 / [V] commanded voltage on HRT PMP LC1
LC2HRTV1=                    0 / [V] commanded voltage on HRT PMP LC2

         / PHI_FITS_TEMP_prehk
FGOV1PT1=                60.99 / [degC] FG oven precision temperature 1
FGOV2PT1=                60.96 / [degC] FG oven precision temperature 2
FPMP1PT1=                39.96 / [degC] FDT PMP precision temperature 1
FPMP2PT1=                40.27 / [degC] FDT PMP precision temperature 2
HPMP1PT1=                44.17 / [degC] HRT PMP precision temperature 1
HPMP2PT1=                50.99 / [degC] HRT PMP precision temperature 2
FRM_MWT1=                14.94 / [degC] FRM motor temperature
HRM_MWT1=                16.86 / [degC] HRM motor temperature
CRM_MWT1=                15.94 / [degC] CRM motor temperature
FSM_MWT1=                16.63 / [degC] FSM motor temperature
AMHD_1T1=                13.65 / [degC] AMHD DCDC temperature
AMHD_2T1=                 9.63 / [degC] AMHD board temperature
FRMPANT1=                16.72 / [degC] FDT housing temperature
M2BAFFT1=                19.51 / [degC] M2 baffle temperature
OUREF1T1=                16.64 / [degC] O-Unit main baffle temperature
OUREF2T1=                16.51 / [degC] HRT PMP housing temperature
M1MNT_T1=                17.58 / [degC] M1 mounting temperature
M2MNT_T1=                23.44 / [degC] Tip-Tilt housing temperature
FGO_1CT1=                60.89 / [degC] FG oven coarse temperature 1
FGO_2CT1=                60.28 / [degC] FG oven coarse temperature 2
PCM_M1T1=                  9.3 / [degC] Main PCM board temperature 1
PCM_M2T1=                11.19 / [degC] Main PCM board temperature 2
PCM_R1T1=                 7.87 / [degC] Redundant PCM board temperature 1
PCM_R2T1=                 8.07 / [degC] Redundant PCM board temperature 2
DPU_B1T1=                20.65 / [degC] DPU board temperature 1
DPU_B2T1=                22.62 / [degC] DPU board temperature 2
TTCT_BT1=                10.69 / [degC] TTC board temperature
HVPS_BT1=                 9.34 / [degC] HVPS board temperature
ISSTT1T1=                16.84 / [degC] ISS tip/tilt temperature 1
ISSTT2T1=                16.51 / [degC] ISS tip/tilt temperature 2
EUREF_T1=                 8.69 / [degC] E-Unit reference temperature
HEATOVL1= 'Off     '           / Heater overlapping mode (0=off, 1=on)
FGHEATM1=                    1 / FG heater mode status
FGH_TSP1=                   61 / [degC] FG heater set point
FGH_POW1=                    0 / [W] FG heater power
HPHEATM1=                    0 / HRT PMP heater mode status
HPMPTSP1=                   40 / [degC] HRT PMP heater set point
HPMPPOW1=                    0 / [W] HRT PMP heater power
FPHEATM1=                    1 / FDT PMP heater mode status
FPMPTSP1=                   40 / [degC] FDT PMP heater set point
FPMPPOW1=                    0 / [W] FDT PMP heater power

         / PHI_FITS_FPA_prehk
FPAINPV1=                 0.49 / [A] FPA +7V input current
FPAINMV1=                -0.07 / [A] FPA -7V input current
FPACCIV1=                    0 / [V] FPA CCI voltage
FPASSIV1=                    0 / [V] FPA SSA voltage
FPACCDV1=                 3.24 / [V] FPA CCD voltage
FPACCAV1=                 2.42 / [V] FPA CCA voltage
FPACCBV1=                  1.5 / [V] FPA CCB voltage
FPGA_BT1=                15.27 / [degC] FPA FPGA board temperature
IS_PIXV1=                  2.5 / [V] image sensor voltage V_PIX
ISARSTV1=                 0.08 / [V] image sensor voltage V_PIX_RST_ACT
ISIRSTV1=                 3.17 / [V] image sensor voltage V_PIX_RST_INACT
ISASELV1=                 3.56 / [V] image sensor voltage V_PIX_SEL_ACT
ISATX1V1=                 2.99 / [V] image sensor voltage V_PIX_TX1_ACT1
ISATX2V1=                 0.09 / [V] image sensor voltage V_PIX_TX1_ACT2
ISITX1V1=                    0 / [V] image sensor voltage V_PIX_TX1_INACT
IS_ABSV1=                    0 / [V] image sensor ABS bias voltage
FPA_IST1=               -24.92 / [degC] FPA image sensor temperature
CAMR_ID1=                  513 / Camera ID
FPAFIRM1=                 1284 / FPA FPGA ID and firmware version
ANNEALH1= 'ANNEALING_OFF'      / Annealing heater status (0=off, 1=on)
```

```
CPC_T__1=                19.19 / [degC] CPC Temperature
CPC_ID_1=                 1742 / CPC ID
FPATMRS1=                  128 / TMR Status
FPATMRA1=                    0 / TMR error address
FPATMRC1=                    0 / Number of TMR cycles
FPASELS1=                  128 / SEL Status
FPASELT1=                    8 / [V] SEL threshold
ACCVERS1=                 3161 / Accumulator Version
ACCSTAT1=                    0 / Accumulator Status
ACCDEST1= 'NONE    '           / Accumulator destination
ACCTRNS1=                    0 / Accumulator transfered pixel

          / PHI_FITS_ISS_prehk
ISSFIRM1=                 5389 / ISS controller firmware version
ISSVALN1=                   39 / Number of valid ISS controller commands
ISSINVN1=                    0 / Number of invalid ISS controller commands
ISSLAST1=                   13 / ID of last ISS command
ISSMODE1= 'ISS_IDLE'            / Current ISS mode (0=idle, 1=correlation)
CTCLAST1=                21834 / Last CTC command
CTCLRES1=                21834 / CTC last response
CTCLSTF1=                    0 / CTC last status frame
CTC_COR1=                    0 / CTC Column out of range
CTC_ROR1=                    0 / CTC Row out of range
CTCBREF1=                    0 / CTC black reference
CTCN5V_1=               -3.633 / [V] CTC negative 3V6
CTCP2V51=                2.389 / [V] CTC positive 2V5
CTCP3V31=                3.251 / [V] CTC positive 3V3
CTCP5V_1=                5.072 / [V] CTC positive 5V
CTCSENT1=                17.37 / [degC] CTC sensor temperature
CTCFPGT1=                19.38 / [degC] CTC FPGA temperature
CTCREF11=                0.987 / [V] CTC reference voltage 1V
CTCREF21=                  2.5 / [V] CTC reference voltage 2v
CTCSIMG1=                    0 / CTC send images
CTCRIMG1=                    0 / CTC received images
CTCBADD1=                    0 / CTC bad address
CTCEADD1=                    0 / CTC expected address
CWRGIMG1=                    0 / CTC wrong images
ISSBADP1=                    0 / ISS bad period
ISSOUTX1=                    0 / ISS out X
ISSOUTY1=                    0 / ISS out Y
ISSAVIR1=                    0 / ISS mean intensity reference
ISSRMSI1=                    0 / ISS rms intensity reference
ISSMXIR1=                    0 / ISS maximum intensity reference
ISSMNIR1=                    0 / ISS minimum intensity reference
ISS_AVJ1=                    0 / [asec] ISS mean offset
ISSRMSJ1=                    0 / [asec] ISS rms offset
ISSMAXJ1=                    0 / [asec] ISS maximum offset
ISSMINJ1=                    0 / [asec] ISS minimum offset
ISSA10P1=                    0 / ISS parabolic parameter A01
ISSA01P1=                    0 / ISS parabolic parameter A10
ISSA20P1=                    0 / ISS parabolic parameter A02
ISSA02P1=                    0 / ISS parabolic parameter A20
ISSA11P1=                    0 / ISS parabolic parameter A11
ISSREFI1=                    0 / Number of used ISS reference images
ISSOOBC1=                    0 / ISS out of bound count
ISSB2OF1=                    0 / ISS CT bank 2 offset
ISSPIMG1=                    0 / ISS pending images
ISLISOX1=                    0 / ISS LIS out X
ISLISOY1=                    0 / ISS LIS out Y
ISOTFOX1=                    0 / ISS SOTF out X
ISOTFOY1=                    0 / ISS SOTF out Y
ISROTOX1=                    0 / ISS ROT out X
ISROTOY1=                    0 / ISS ROT out Y
ISROTLE1=                    0 / ISS ROT log exponent
ISSSTFL1=                    0 / ISS status and error flags
ISSIMSZ1=                  128 / ISS image size (square)
ISSLDEL1=                    0 / ISS line delay
CTC_AGN1=                    0 / CTC analog gain
```

```
CTC_DGN1=                    0 / CTC digital gain
CTCSTOF1=                    0 / CTC static offset
ISSRSHT1=                    0 / ISS rolling shutter offset
ISSIMOX1=                  448 / ISS image offset X
ISSIMOY1=                  448 / ISS image offset Y
CTADPSF1=                   64 / CTC ADC phase shift
CTCRTRI1=                   15 / CTC retries
CTCDIMN1=                    0 / Number of dropped CTC images
ISSSTEP1=                    0 / ISS stats exponent
ISIMGST1=                    0 / ISS store images
ISIMGRS1=                    0 / ISS store raw images
ISTSTIM1=                    0 / ISS test images
ISSTISE1=                    7 / ISS test image size Exp
ISSTIEV1=                    0 / ISS test image even
ISSTIOD1=                    0 / ISS test image odd
ISSTDIS1=                    0 / ISS store displacement
ISTADIS1=                    0 / ISS stats displacement
ISSREFP1=                    0 / ISS reference period
TT_OFFX1=                 2047 / TT offset X
TT_OFFY1=                 2047 / TT offset Y
TTAMPXX1=                  256 / TT Amp XX
TTAMPXY1=                    0 / TT Amp XY
TTAMPYX1=                    0 / TT Amp YX
TTAMPYY1=                  256 / TT Amp YY
TT_MAX_1=                 3648 / TT max
TT_MIN_1=                  446 / TT min
TTSTPEX1=                    0 / TT steps exponent
TTSTPPD1=                    0 / TT steps period
PID_A1X1=                    0 / ISS PID X parameter A1
PID_A1Y1=                    0 / ISS PID Y parameter A1
PID_A2X1=                    0 / ISS PID X parameter A2
PID_A2Y1=                    0 / ISS PID Y parameter A2
PID_B0X1=                    1 / ISS PID X parameter B0
PID_B0Y1=                    1 / ISS PID Y parameter B0
PID_B1X1=                    0 / ISS PID X parameter B1
PID_B1Y1=                    0 / ISS PID Y parameter B1
PID_B2X1=                    0 / ISS PID X parameter B2
PID_B2Y1=                    0 / ISS PID Y parameter B2
LISSAAX1=                    0 / ISS Lissajous parameter AX
LISSAAY1=                    0 / ISS Lissajous parameter AY
LISSADX1=                    0 / ISS Lissajous parameter DX
LISSADY1=                    0 / ISS Lissajous parameter DY
LISSAWX1=                0.199 / ISS Lissajous parameter WX
LISSAWY1=                0.199 / ISS Lissajous parameter WY
LISSAFI1=                    0 / ISS Lissajous parameter FI
LISSATX1=                    0 / ISS Lissajous parameter TDX
LISSATY1=                    0 / ISS Lissajous parameter TDY
LISSATS1=                    0 / ISS Lissajous parameter TS
LISSPRS1=                    0 / ISS prescaler
LISSANS1=                    0 / ISS Lissajous parameter VS
ISSTHHX1=                    0 / ISS static threshold X
ISSTHHY1=                    0 / ISS static threshold Y
ISSHKPD1=                    0 / ISS HK period
ISSMEMP1=                    0 / ISS memory parameter
ISCLKPH1=                    0 / [PI] ISS clock phase

          / PHI_FITS_FPA_settings
FPIMGCMD=                    8 / FPA image command
FPA_SROW=                    0 / FPA start row setting
FPA_EROW=                 1022 / FPA end row setting
FPA_NIMG=                   20 / FPA number of images set
FPEXPSTC=           1592452786 / [s] FPA exposure start time coarse
FPEXPSTF=               699245 / [us] FPA exposure start time fine
INTTIME =                 0.01 / [s] Exposure time of single readout
TELAPSE =     58.1974400877953 / [s] Elapsed time between start and end of obser
NSUMEXP =                  480 / Number of detector readouts
XPOSURE =                  4.8 / [s] Total effective exposure time
```

```
         / PHI_FITS_ACCU_settings
ACCLENGT=              4194304 / ACCU number of pixel set
ACCNROWS=                    6 / ACCU number of rows set
ACCROWIT=                    1 / ACCU number of row iterations set
ACCNCOLS=                    4 / ACCU number of columns set
ACCCOLIT=                    1 / ACCU number of column iterations set
ACCACCUM=                   20 / ACCU number of accumulations set
ACCADDR =                    0 / ACCU readout address (start)
ACCSIZE =            402653184 / ACCU Data size in byte

         / PHI_FITS_DPU_posthk
I_SYSST2= 'OBSERVATION'         / Instrument system state
CPULOAD2=                93.98 / [perc] CPU load
SPWDROP2=                    0 / Number of dropped SpaceWire packets
IICPCTN2=                35270 / Number of IIC packets
IICSEQN2=                10935 / Sequence number of the last IIC packet
OBSWVER2=                11120 / On-board software version
DPUHWVR2=             17434701 / DPU hardware version
DPUSSCR2=                24792 / DPU System Supervisor CR
DPUSSSR2=                    0 / DPU System Supervisor SR
TCREC_N2=                   52 / Number of received Telecommands
TCFAILN2=                    0 / Number of failed Telecommands
TCQUEUE2=                    0 / Fill level of Telecommanding queue
TMQUEUE2=                    0 / Fill level of Telemetry queue
SCQUEUE2=                    0 / Fill level of science Telemetry queue
RAMFS_N2=                   12 / Number of files in RAMFS
RAMFSSP2=            111268136 / [Byte] Available space in RAMFS
SRVSTFL2=                 4076 / Service status flags
GPIOLST2=            604141736 / Status of GPIO ports 0-31
GPIOHST2=              4298758 / Status of GPIO ports 32-63
SCDCMOD2= 'COMPRESS_NONE'       / Science data compression mode

         / PHI_FITS_PCM_posthk
APCMSTA2=                  241 / Active PCM status flag
APCM_VP2=               27.486 / [V] active PCM V_prim
APCM_IP2=                0.989 / [A] active PCM I_prim
APP28IH2=                0.028 / [A] active PCM I_Heaters_+28V
APP28IM2=                0.074 / [A] active PCM I_Mech_+28V
AP_P33I2=                2.778 / [A] active PCM I_+3V3
AP_P07I2=                0.656 / [A] active PCM I_+7V
AP_M07I2=                 0.09 / [A] active PCM I_-7V
AP_P15I2=                0.063 / [A] active PCM I_+15V
AP_M15I2=                0.059 / [A] active PCM I_-15V
AP_P60I2=                0.007 / [A] active PCM I_+60V
ADPU33V2=                3.406 / [V] active PCM V_DPU_+3V3
AABP33V2=                3.406 / [V] active PCM V_AB_+3V3
AABP07V2=                 6.56 / [V] active PCM V_AB_+7V
AABP15V2=               14.415 / [V] active PCM V_AB_+15V
AABM15V2=               14.502 / [V] active PCM V_AB_-15V
ACPP07V2=                7.303 / [V] active PCM V_CPC_+7V
ACPM07V2=                7.483 / [V] active PCM V_CPC_-7V
AHVP07V2=                6.563 / [V] active PCM V_HVPS_+7V
AHVP15V2=               14.414 / [V] active PCM V_HVPS_+15V
AHVM15V2=               14.502 / [V] active PCM V_HVPS_-15V
ATTP07V2=                 6.56 / [V] active PCM V_TTC_+7V
ATTP60V2=               59.983 / [V] active PCM V_TTC_+60V
POWSWST2=                  255 / Power Switch status

         / PHI_FITS_MECH_posthk
MEMOVST2=                    4 / Mechanism movement status flag
MEEOTST2=                    8 / Mechanism end-of-travel switch status flag
FRM_POS2=                 2911 / [um] Deduced FRM position
DHRM_PS2=                12363 / [um] Deduced HRM position
DCRM_PS2=                    0 / [um] Deduced CRM position
FSM_POS2=                    0 / [amin] Deduced FSM position
HVPSLPV2=                 -327 / [V] HVPS HV level side P
HVPSLNV2=                  311 / [V] HVPS HV level side N
TTCP55V2=               54.478 / [V] Voltage TTC_+55V
```

```
IABREFV2=                1.254 / [V] Internal AMHD voltage reference 1.25V
DEDFGWL2=              6173116 / [mAng] Deduced current FG wavelength
FDTPMPR2=                    4 / Deduced FDT PMP polarization state
LC1FDTV2=                1.682 / [V] commanded voltage on FDT PMP LC1
LC2FDTV2=                1.653 / [V] commanded voltage on FDT PMP LC2
HRTPMPR2=                  255 / Deduced HRT PMP polarization state
LC1HRTV2=                    0 / [V] commanded voltage on HRT PMP LC1
LC2HRTV2=                    0 / [V] commanded voltage on HRT PMP LC2

         / PHI_FITS_TEMP_posthk
FGOV1PT2=                60.99 / [degC] FG oven precision temperature 1
FGOV2PT2=                60.96 / [degC] FG oven precision temperature 2
FPMP1PT2=                39.96 / [degC] FDT PMP precision temperature 1
FPMP2PT2=                40.27 / [degC] FDT PMP precision temperature 2
HPMP1PT2=                44.17 / [degC] HRT PMP precision temperature 1
HPMP2PT2=                50.99 / [degC] HRT PMP precision temperature 2
FRM_MWT2=                 14.9 / [degC] FRM motor temperature
HRM_MWT2=                16.82 / [degC] HRM motor temperature
CRM_MWT2=                15.98 / [degC] CRM motor temperature
FSM_MWT2=                16.59 / [degC] FSM motor temperature
AMHD_1T2=                13.69 / [degC] AMHD DCDC temperature
AMHD_2T2=                 9.71 / [degC] AMHD board temperature
FRMPANT2=                16.72 / [degC] FDT housing temperature
M2BAFFT2=                19.51 / [degC] M2 baffle temperature
OUREF1T2=                16.64 / [degC] O-Unit main baffle temperature
OUREF2T2=                16.51 / [degC] HRT PMP housing temperature
M1MNT_T2=                17.54 / [degC] M1 mounting temperature
M2MNT_T2=                 23.4 / [degC] Tip-Tilt housing temperature
FGO_1CT2=                60.85 / [degC] FG oven coarse temperature 1
FGO_2CT2=                60.32 / [degC] FG oven coarse temperature 2
PCM_M1T2=                 9.34 / [degC] Main PCM board temperature 1
PCM_M2T2=                11.35 / [degC] Main PCM board temperature 2
PCM_R1T2=                 7.87 / [degC] Redundant PCM board temperature 1
PCM_R2T2=                 8.15 / [degC] Redundant PCM board temperature 2
DPU_B1T2=                20.86 / [degC] DPU board temperature 1
DPU_B2T2=                22.66 / [degC] DPU board temperature 2
TTCT_BT2=                10.74 / [degC] TTC board temperature
HVPS_BT2=                 9.42 / [degC] HVPS board temperature
ISSTT1T2=                 16.8 / [degC] ISS tip/tilt temperature 1
ISSTT2T2=                16.47 / [degC] ISS tip/tilt temperature 2
EUREF_T2=                 8.73 / [degC] E-Unit reference temperature
HEATOVL2= 'Off     '           / Heater overlapping mode (0=off, 1=on)
FGHEATM2=                    1 / FG heater mode status
FGH_TSP2=                   61 / [degC] FG heater set point
FGH_POW2=                    0 / [W] FG heater power
HPHEATM2=                    0 / HRT PMP heater mode status
HPMPTSP2=                   40 / [degC] HRT PMP heater set point
HPMPPOW2=                    0 / [W] HRT PMP heater power
FPHEATM2=                    1 / FDT PMP heater mode status
FPMPTSP2=                   40 / [degC] FDT PMP heater set point
FPMPPOW2=                    0 / [W] FDT PMP heater power

         / PHI_FITS_FPA_posthk
FPAINPV2=                 0.51 / [A] FPA +7V input voltage
FPAINMV2=                -0.07 / [A] FPA -7V input voltage
FPACCIV2=                    0 / [V] FPA CCI voltage
FPASSIV2=                    0 / [V] FPA SSA voltage
FPACCDV2=                 3.23 / [V] FPA CCD voltage
FPACCAV2=                 2.42 / [V] FPA CCA voltage
FPACCBV2=                  1.5 / [V] FPA CCB voltage
FPGA_BT2=                15.76 / [degC] FPA FPGA board temperature
IS_PIXV2=                  2.5 / [V] image sensor voltage V_PIX
ISARSTV2=                 0.08 / [V] image sensor voltage V_PIX_RST_ACT
ISIRSTV2=                 3.17 / [V] image sensor voltage V_PIX_RST_INACT
ISASELV2=                 3.55 / [V] image sensor voltage V_PIX_SEL_ACT
ISATX1V2=                 2.99 / [V] image sensor voltage V_PIX_TX1_ACT1
ISATX2V2=                 0.09 / [V] image sensor voltage V_PIX_TX1_ACT2
ISITX1V2=                    0 / [V] image sensor voltage V_PIX_TX1_INACT
```

```
IS_ABSV2=                    0 / [V] image sensor ABS bias voltage
FPA_IST2=               -24.18 / [degC] FPA image sensor temperature
CAMR_ID2=                  513 / Camera ID
FPAFIRM2=                 1284 / FPA FPGA ID and firmware version
ANNEALH2= 'ANNEALING_OFF'      / Annealing heater status (0=off, 1=on)
CPC_T__2=                19.31 / [degC] CPC Temperature
CPC_ID_2=                 1741 / CPC ID
FPATMRS2=                  128 / TMR Status
FPATMRA2=                    0 / TMR error address
FPATMRC2=                    0 / Number of TMR cycles
FPASELS2=                  128 / SEL Status
FPASELT2=                    8 / [V] SEL threshold
ACCVERS2=                 3161 / Accumulator Version
ACCSTAT2=                   64 / Accumulator Status
ACCDEST2= 'NANDFS  '           / Accumulator destination
ACCTRNS2=                    0 / Accumulator transfered pixel

         / PHI_FITS_ISS_posthk
ISSFIRM2=                 5389 / ISS controller firmware version
ISSVALN2=                   39 / Number of valid ISS controller commands
ISSINVN2=                    0 / Number of invalid ISS controller commands
ISSLAST2=                   13 / ID of last ISS command
ISSMODE2= 'ISS_IDLE'           / Current ISS mode (0=idle, 1=correlation)
CTCLAST2=                21834 / Last CTC command
CTCLRES2=                21834 / CTC last response
CTCLSTF2=                    0 / CTC last status frame
CTC_COR2=                    0 / CTC Column out of range
CTC_ROR2=                    0 / CTC Row out of range
CTCBREF2=                    0 / CTC black reference
CTCSENT2=                17.37 / [degC] CTC sensor temperature
CTCFPGT2=                19.38 / [degC] CTC FPGA temperature
CTCREF12=                0.987 / [V] CTC reference voltage 1V
CTCREF22=                  2.5 / [V] CTC reference voltage 2v
CTCSIMG2=                    0 / CTC send images
CTCRIMG2=                    0 / CTC received images
CTCBADD2=                    0 / CTC bad address
CTCEADD2=                    0 / CTC expected address
CWRGIMG2=                    0 / CTC wrong images
ISSBADP2=                    0 / ISS bad period
ISSOUTX2=                    0 / ISS out X
ISSOUTY2=                    0 / ISS out Y
ISSAVIR2=                    0 / ISS mean intensity reference
ISSRMSI2=                    0 / ISS rms intensity reference
ISSMXIR2=                    0 / ISS maximum intensity reference
ISSMNIR2=                    0 / ISS minimum intensity reference
ISS_AVJ2=                    0 / [asec] ISS mean offset
ISSRMSJ2=                    0 / [asec] ISS rms offset
ISSMAXJ2=                    0 / [asec] ISS maximum offset
ISSMINJ2=                    0 / [asec] ISS minimum offset
ISSA10P2=                    0 / ISS parabolic parameter A01
ISSA01P2=                    0 / ISS parabolic parameter A10
ISSA20P2=                    0 / ISS parabolic parameter A02
ISSA02P2=                    0 / ISS parabolic parameter A20
ISSA11P2=                    0 / ISS parabolic parameter A11
ISSREFI2=                    0 / Number of used ISS reference images
ISSOOBC2=                    0 / ISS out of bound count
ISSB2OF2=                    0 / ISS CT bank 2 offset
ISSPIMG2=                    0 / ISS pending images
ISLISOX2=                    0 / ISS LIS out X
ISLISOY2=                    0 / ISS LIS out Y
ISOTFOX2=                    0 / ISS SOTF out X
ISOTFOY2=                    0 / ISS SOTF out Y
ISROTOX2=                    0 / ISS ROT out X
ISROTOY2=                    0 / ISS ROT out Y
ISROTLE2=                    0 / ISS ROT log exponent
ISSSTFL2=                    0 / ISS status and error flags
ISSIMSZ2=                  128 / ISS image size (square)
ISSLDEL2=                    0 / ISS line delay
```

```
CTC_AGN2=                    0 / CTC analog gain
CTC_DGN2=                    0 / CTC digital gain
CTCSTOF2=                    0 / CTC static offset
ISSRSHT2=                    0 / ISS rolling shutter offset
ISSIMOX2=                  448 / ISS image offset X
ISSIMOY2=                  448 / ISS image offset Y
CTADPSF2=                   64 / CTC ADC phase shift
CTCRTRI2=                   15 / CTC retries
CTCDIMN2=                    0 / Number of dropped CTC images
ISSSTEP2=                    0 / ISS stats exponent
ISIMGST2=                    0 / ISS store images
ISIMGRS2=                    0 / ISS store raw images
ISTSTIM2=                    0 / ISS test images
ISSTISE2=                    7 / ISS test image size Exp
ISSTIEV2=                    0 / ISS test image even
ISSTIOD2=                    0 / ISS test image odd
ISSTDIS2=                    0 / ISS store displacement
ISTADIS2=                    0 / ISS stats displacement
ISSREFP2=                    0 / ISS reference period
TT_OFFX2=                 2047 / TT offset X
TT_OFFY2=                 2047 / TT offset Y
TTAMPXX2=                  256 / TT Amp XX
TTAMPXY2=                    0 / TT Amp XY
TTAMPYX2=                    0 / TT Amp YX
TTAMPYY2=                  256 / TT Amp YY
TT_MAX_2=                 3648 / TT max
TT_MIN_2=                  446 / TT min
TTSTPEX2=                    0 / TT steps exponent
TTSTPPD2=                    0 / TT steps period
PID_A1X2=                    0 / ISS PID X parameter A1
PID_A1Y2=                    0 / ISS PID Y parameter A1
PID_A2X2=                    0 / ISS PID X parameter A2
PID_A2Y2=                    0 / ISS PID Y parameter A2
PID_B0X2=                    1 / ISS PID X parameter B0
PID_B0Y2=                    1 / ISS PID Y parameter B0
PID_B1X2=                    0 / ISS PID X parameter B1
PID_B1Y2=                    0 / ISS PID Y parameter B1
PID_B2X2=                    0 / ISS PID X parameter B2
PID_B2Y2=                    0 / ISS PID Y parameter B2
LISSAAX2=                    0 / ISS Lissajous parameter AX
LISSAAY2=                    0 / ISS Lissajous parameter AY
LISSADX2=                    0 / ISS Lissajous parameter DX
LISSADY2=                    0 / ISS Lissajous parameter DY
LISSAWX2=                0.199 / ISS Lissajous parameter WX
LISSAWY2=                0.199 / ISS Lissajous parameter WY
LISSAFI2=                    0 / ISS Lissajous parameter FI
LISSATX2=                    0 / ISS Lissajous parameter TDX
LISSATY2=                    0 / ISS Lissajous parameter TDY
LISSATS2=                    0 / ISS Lissajous parameter TS
LISSPRS2=                    0 / ISS prescaler
LISSANS2=                    0 / ISS Lissajous parameter VS
ISSTHHX2=                    0 / ISS static threshold X
ISSTHHY2=                    0 / ISS static threshold Y
ISSHKPD2=                    0 / ISS HK period
ISSMEMP2=                    0 / ISS memory parameter
ISCLKPH2=                    0 / [PI] ISS clock phase

          / Processing keywords
PROCNODE= 'germerott-slm6'     / System which processed file
DWNLNKST= '2020-07-06 01:20:01' / Image packed onboard
INFO_URL= 'UNKNOWN'            / Link to additional string information
COMPLETE= 'C'                  / C complete, I incomplete, U undefined
PHIDBVER= '3266:11837'         / PHI Mib Db svn version
PARENT  = 'solo_L0_phi-fdt-ilam_20200618T040005_V202106101808C_0066180100.fits'
SPICESYS= 'YES     '           / Availability of SPICE Kernel
DFMTSCAL=                   1. / Data format scale factor
DRNGSCAL=                  127 / Data range scale factor
HISTORY Written with converter(FITS.cpp) Version: 11268:11839
```

```
HISTORY Build Host: germerott on Linux germerott-slm6 5.10.27-gentoo x86_64
HISTORY Build Time: Jun 11 2021 14:38:06
CHECKSUM= 'GYX2JWV2GWV2GWV2'   / HDU checksum updated 2021-09-17T15:36:20
DATASUM = '3876715845'         / data unit checksum updated 2021-09-17T15:36:20
PWCSCORR= '1       '           / WCS entries corrected 1 = yes
HISTORY Applied p_cpheadentries version 1.0 17-Sep-2021 15:36:19.664
END
```

D.2 L2 Example FITS Extensions 1 to 10

Identical extensions 1 to 10 as for the L0 dataset are included in the L2 dataset, see section B.

Normative References

[NR1] *Metadata Definition for Solar Orbiter Science.*
SOL-SGS-TN-0009, issue 2, revision 4, 2019-09-02.

[NR2] *SO/PHI Metadata Standard.*
SOL-PHI-MPS-SW7400-SP-1, issue 1, revision 0, 2017-01-17.

[NR3] *Definition of the Flexible Image Transport System (FITS).*
http://fits.gsfc.nasa.gov/standard30/fits_standard30aa.pdf, issue 3, revision 0, 2008-07-10.

Informative References

[IR1] *SO/PHI Low Latency Dataset Description.*
SOL-PHI-MPS-SW7400-IF-2, issue 2, revision 1, 2020-03-30.

[IR2] *PHI Instrument Requirements Specification.*
SOL-PHI-MPS-DE2000-SP-1, issue 1, revision 2, 2013-10-31.

[IR3] *Solar Orbiter Archive Plan.*
SOL-SGS-PL-0009, issue 2, revision 5, 2017-11-07.

[IR4] *Data Producer to Archive ICD.*
SOL-SGS-ICD-002, issue -, revision -, tbw.

[IR5] *PHI Instrument User Manual.*
SOL-PHI-MPS-OP3000-MA-1, issue 3, revision 6, 2020-03-24.

[IR6] *PHI Data Processing Pipeline.*
SOL-PHI-MPS-SW3200-TN-1, issue 3, revision 0, 2017-06-13.

[IR7] *On-board DID Usage Convention.*
SOL-PHI-MPS-OP3100-SP-2, issue 1, revision 3, 2020-05-12.

List of Acronyms

CCSDS Consultative Committee for Space Data Systems

CMOS Complementary Metal–Oxide–Semiconductor

CP Cruise Phase

DID Dataset Identifier

DPU digital processing unit

ESA European Space Agency

EUI Extreme Ultraviolet Imager

FDT Full Disc Telescope

FG Filtergraph

FITS Flexible Image Transport System

FOV field of view

FPA Focal Plane Assembly

HRT High Resolution Telescope

ICD Interface Control Document

ID Identification

I/F interface

ISS Image Stabilisation System

LOS line of sight

MHD magneto-hydrodynamical

MPS Max–Planck–Institut für Sonnensystemforschung

OSPF order-sorting prefilter

PMP Polarisation Modulation Package

RSCW Remote Sensing Check-Out Window

RSW Remote Sensing Window

RTE Radiative Transfer Equation

S/C spacecraft

SO Solar Orbiter

SOAR Solar Orbiter Science Archive

SOC Science Operation Center

SO/PHI Polarimetric and Helioseismic Imager

SSMM Solid State Mass Memory

tbc to be confirmed

tbd to be determined

tbw to be written

TM telemetry

UTC Coordinated Universal Time

WCS World Coordinate System

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