Hardware and software architecture on board solar orbiter/METIS: an update

Hardware and Software architecture on board Solar Orbiter - METIS: an update

M. Pancrazzi*[a,b], M. Focardi [a,b], G. Nicolini[c], V. Andretta[d], M. Uslenghi[e], E. Magli[f], M. Ricci[f], A. Bemporad[c], D. Spadaro[g], F. Landini [a,b], M. Romoli[b], E. Antonucci[c], S. Fineschi[c], G. Naletto[h,i], P. Nicolosi[h,i]

[a] INAF - Arcetri Astrophysical Observatory, Largo E. Fermi 5, 50125 Firenze - Italy;
[b]University of Florence - Dept. of Physics and Astronomy, Largo E. Fermi 2, 50125 Firenze - Italy;
[c] INAF- Turin Astronophysical Observatory, Via Osservatorio 20, 10025 Pino Torinese (TO) - Italy;
[d] INAF - Capodimonte Astronomical Observatory, Salita Moiariello 16, 80131 Napoli - Italy;
[e] INAF - Institute of Space Astrophysics and Cosmic Physics, Via Bassini 15, 20133 Milano – Italy;
[f] Politecnico of Torino, Dept. of Electronics, C. Duca degli Abruzzi 24, 10129 Torino - Italy;
[g]INAF - Catania Astronomical Observatory, Via S. Sofia 78, I-95123 Catania - Italy;
[h]University of Padova - Dept. of Information Engineering, Via Gradenigo 6/B, 35131 Padova - Italy;
[i]CNR - Institute of Photonics and Nanotechnologies, via Trasea 7, 35131 Padova - Italy;

ABSTRACT

METIS, is one of the ten instruments selected to be part of the Solar Orbiter payload; it is a coronagraph that will investigate the inner part of the heliosphere performing imaging in the visible band and in the hydrogen Lyman α line @ 121.6 nm. METIS has been recently undergone throughout a revision to simplify the instrument design. This paper will provide an overview of the updated hardware and software design of the coronagraph as presented at the Instrument Delta-Preliminary Design Review occurred in April 2014. The current configuration foresees two detectors, an Intensified APS for the UV channel and an APS for the visible light equipped with a Liquid Crystal Variable Retarder (LCVR) plate to perform broadband visible polarimetry. Each detector has a proximity electronics generating the control and readout signals for the sensor but the operations of the two devices are in charge of a centralized unit, the METIS Processing and Power Unit (MPPU). The MPPU operates the rest electrical subsystems supplying them with power and providing on board storage and processing capabilities. Its design foresees the redundancy of the most critical parts mitigating the effects of possible failures of the electronics subsystems. The central monitoring unit is also in charge of providing the communication with the S/C, handling the telemetry and telecommand exchange with the platform. The data acquired by the detectors shall undergo through a preliminary on-board processing to maximize the scientific return and to provide the necessary information to validate the results on ground. Operations as images summing, compression and cosmic rays monitoring and removal will be fundamental not only to mitigate the effects of the main sources of noise on the acquired data, but also to maximize the data volume to be transferred to the spacecraft in order to fully exploit the limited bandwidth telemetry downlink. Finally, being Solar Orbiter a deep-space mission, some METIS procedures have been designed to provide the instrument an efficient autonomous behavior in case of an immediate reaction is required as for the arising of transient events or the occurrence of safety hazards conditions.

Keywords: Solar corona, Solar Orbiter, METIS, coronagraph, instrument design.

1. INTRODUCTION

Solar Orbiter is the first Medium class mission selected by ESA within the Cosmic Vision program [1]. Solar Orbiter aims to improve the knowledge of those effects nowadays still not fully understood on the physical mechanisms underlying the behavior of our star, like the coronal heating process and the solar wind acceleration. The mission has a peculiar trajectory that will bring the S/C close to the Sun up to 0.28 AU, exploiting the opportunity to follow up our star

*panc@arcetri.astro.it; phone +39 055 2755 230

as close as never before. Ten experiments, six remote sensing and four in-situ instruments, constitutes the scientific payload of the mission. The crucial physics in the formation and activity of the heliosphere takes place close to the Sun therefore the opportunity to observe solar structures, combining remote and in-situ measurements, from this inner-heliospheric vantage point, provide us a unique tool to study solar wind, shocks, energetic particles, etc., as they are at the origin, before they evolve significantly. The simultaneous operation of such a suite of experiments will enable to understand the connections and the coupling between the Sun and the heliosphere that is of fundamental importance to understanding how our solar system really works.

METIS is a coronagraph and it is one of the instruments selected by the European Space Agency to be part of the payload of the SO mission. The instrument design has been conceived by an international team with the intent to perform multiband imaging of the solar corona. METIS, owing to its multi wavelength capability, can effectively address some of the major open issues in understanding the corona and the solar wind can be effectively addressed, exploiting the unique opportunities offered by the SO mission profile. METIS observations will be crucial for answering some fundamental solar physics questions concerning the origins of the fast and slow wind, the sources of solar energetic particles, and the eruption and early evolution of coronal mass ejections.

2. THE METIS INSTRUMENT

METIS is one of the six remote sensing instruments of the Solar Orbiter mission and is the result of a collaboration among members of an international scientific consortium. METIS is an inverted-occultation coronagraph that will simultaneously perform broad-band imaging of the solar corona in visible light (VL) from 580 nm to 640 nm and narrow-band (FWHM = 10 nm) imaging of ultraviolet (UV) wavelengths [2]. The visible channel includes a Polarimeter that will provide the means to detect and to observe the linearly polarized component of the K-corona.

The current METIS architecture consists of the following physical units (see **Figure 1**):

- Telescope, containing all the optical elements and the detectors producing the images of the solar corona in visible light and UV.
- METIS Processing and Power Unit (MPPU), the central electronics managing the instrument operations and providing the data interface with the spacecraft (S/C).
- Camera Power Converter (CPC) and High Voltage Unit (HVU), the electronics supplying, respectively, low and high voltage power to the detectors for the visible light (VLDA) and for the UV light (UVDA) assembly.
- The harness interconnecting all the METIS physical units.

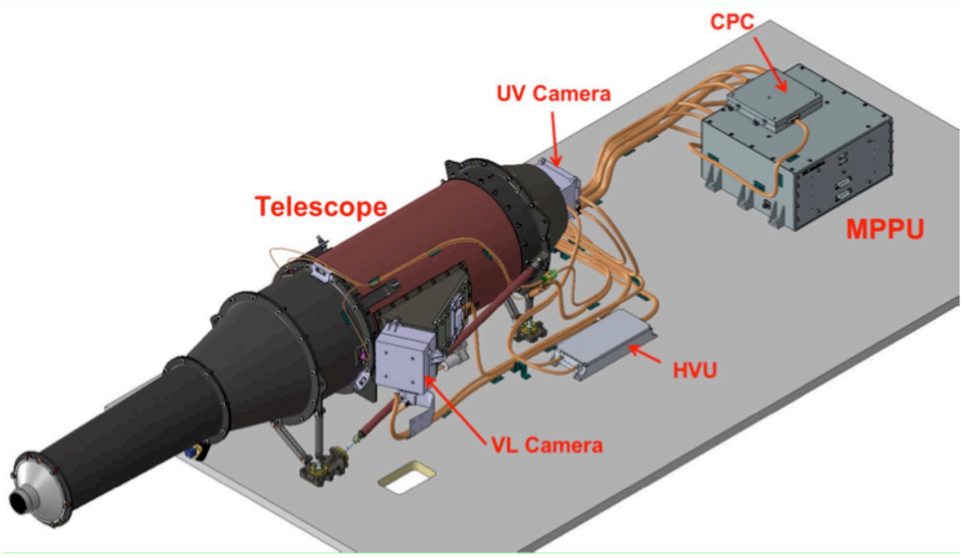

Figure 1: METIS instriument overview, courtesy of CGS-OHB

2.1 The Telescope

A coronagraph is a telescope that hides the Sun disk to enable the study of the surrounding solar corona. Coronagraphs use different schemes to reject the radiation coming from the bright disk of the Sun and they have to be properly designed to allow the observation of the dimmer (~10^{-7} in VL, ~10^{-5} in UV relative to the disk) coronal light. METIS uses an innovative configuration based on an Inverted External Occulter (IEO) that will be applied for the first time in a space-based instrument [3] This scheme moves the external occulter off from the external pupil where it is usually located and it leaves the solar disk and the corona light entering into the telescope from the external circular aperture. The solar disk light is then blocked and rejected back through IEO by a Sun disk rejecting mirror, M0. This configuration greatly reduces the thermal load inside the instrument diminishing the telescope front aperture and therefore simplifies the design.

Two annular-shaped mirrors, M1 and M2, constitute the Gregorian telescope that focuses the incoming coronal photons into two separated focal planes. An UV narrow bandpass interference filter in fact acts as VL-UV beam splitter by selecting the 121.6 nm UV band in transmission and reflecting the VL towards the polarimeter assembly that finally focuses the visible radiation on the detector array.

Great efforts have been devoted to optimization of the optical design to minimize the stray light level inside the instrument. The current design of both the IEO and the cylindrical boom that sustains it, had been selected after an optimization study [4], [5] and a test campaign carried out on a METIS boom prototype [6]. An Internal Occulter, IO, is placed along the optical axis in the conjugate plane of IEO relative to the primary mirror M1 in order to block light diffracted by the edge of IEO. The IO can be moved thanks to a double-actuators mechanism (the IOM, Internal Occulter Mechanism) to compensate for any external occulter misalignment occurred during the S/C launch.

The two METIS channel are equipped with two APS-based detectors: the UV detector assembly (UVDA) is an Intensified Active Pixel Sensor (IAPS), consisting of a microchannel plate (MCP) intensifier with phosphor screen output, optically coupled via fiber optic taper to a 1k x 1k, 15 µm pitch, APS sensor (Cypress Star1000). The detector shall be operated in analog mode or in Photon Counting mode depending on the intensifier gain set through the external High Voltage Unit (HVU). The IAPS detector and the control & readout system are provided by the Max-Planck-Institut für Sonnensystemforschung (MPS) of Gottingen, Germany, with a contribution of the Istituto di Astrofisica Spaziale e Fisica cosmica (IASF) in Milan for the development of the electronics and the software of the photon counting algorithm [7].

The Visible Light Detector Assembly (VLDA) is based on the same sensor adopted by the Solar Orbiter Polarimetric and Helioseismic Imager (PHI) instrument [8] and developed by CMOSIS [9] and MPS. The detector is a 2k x2k APS with a 10 µm pixel size @14 bits and it will be operated together with a polarimeter assembly, based on a Liquid Crystal Variable Retarder (LCVR) plate, in order to provide broadband (580 to 640 nm) linearly polarized images.

A Camera Power Converter (CPC) supplies both detectors. **Figure 2** provides a schematic view of the main electronics components of METIS.

With the aim to verify the correct operation of the detectors during the on ground AIT phases and the in-flight not observing windows, METIS is equipped with a three light emitting diodes (LEDs) calibration system. The current proposed method is to illuminate a quasi-Lambertian surface located on the front door, in front of the IEO, which will reflect the light in all directions inside the tube. This solution will provide a tool for detectors functional tests and the possibility to perform flat-field images (at least in the VL channel). The radiometric calibration will be instead performed in flight using the observation of reference stars [10] transiting within the METIS field of view.

The Telescope together with the HVU (which is separately mounted on the spacecraft panel) and the harness interconnecting the HVU constitutes the METIS Optical Unit (MOU).

2.2 METIS Processing and Power Unit (MPPU).

The MPPU is the main electronic unit of the METIS instrument: it is the electrical interface between the S/C and the instrument, providing all the needed processing, data storage, TM/TC handling and secondary power distribution functions. The MPPU manages the instrument operations as well and controls the mechanisms and the thermal hardware installed on the MOU.

The MPPU is a single box redounded unit and it is internally divided in various sections implementing the different tasks. Each section is allocated to a specific electronic board as follows:

- Two DC/DC redounded Power Supply Boards (PSB) for all the MPPU and METIS subsystems (IOM, calibration sources, thermal control system, polarimeter assembly)

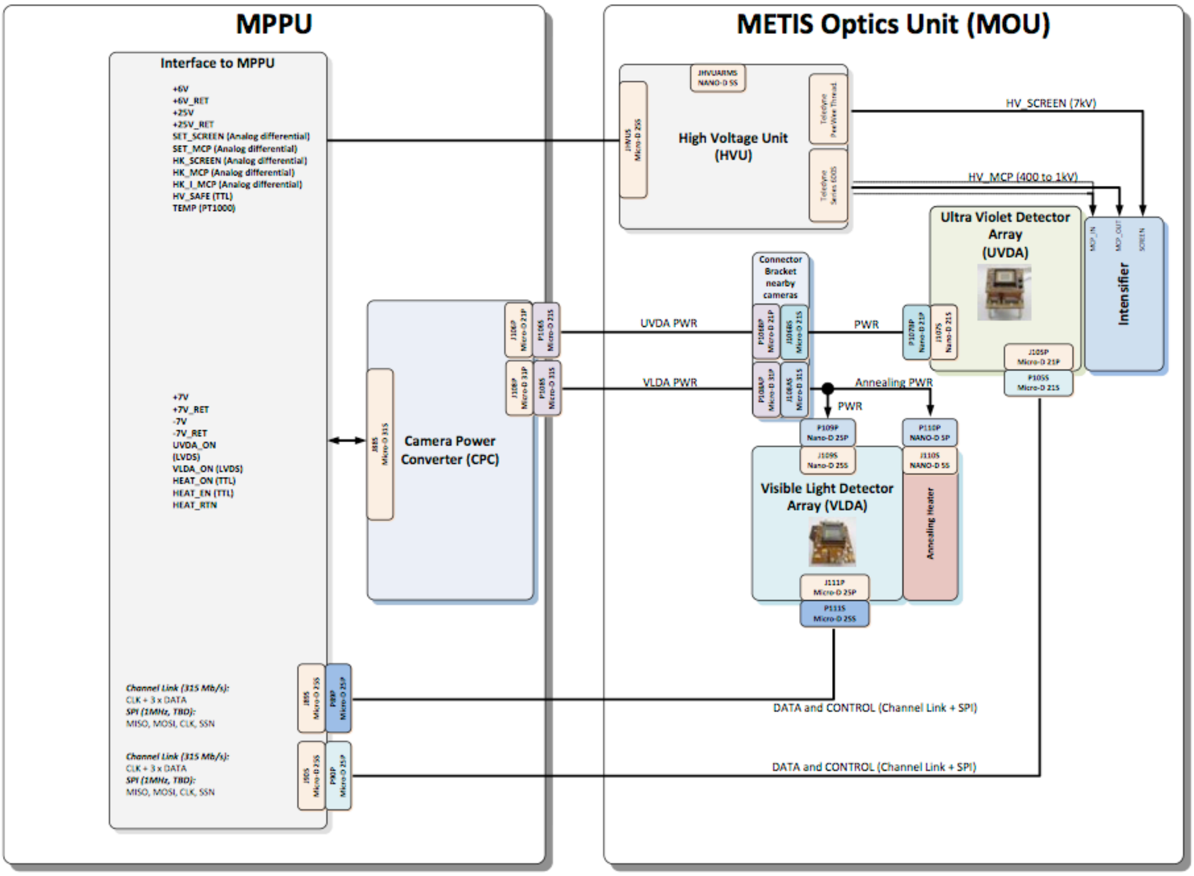

Figure 2: Block Diagram of the different subsystem of METIS, courtesy MPS.

- Two redounded micro-processor board (CPU), also hosting 2 SpaceWire (SpW) Interfaces towards the spacecraft and the Mass Memory for science data
- A single Housekeeping & Interface (HK&IF) board collecting data from the detector chains, analogue and digital HK within the instrument and providing thermal control for the detector chains and the LCVR
- A Motherboard backplane board allowing power and signal exchange between the various boards;

for a total of 5 boards plus a single motherboard. The MPPU architecture is provided in the following block diagram, along with the connections to the subsystems and to the spacecraft as well.

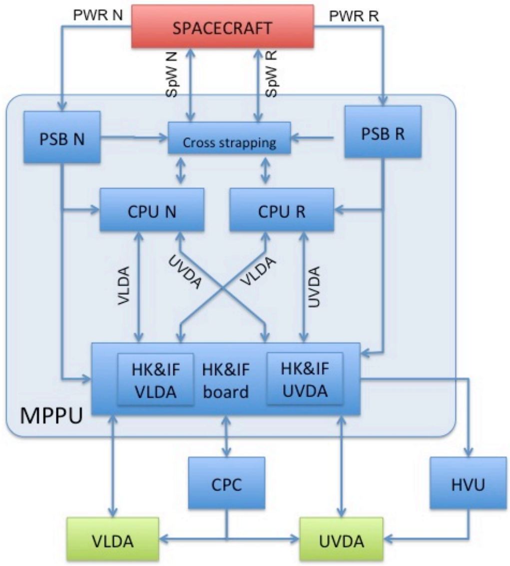

Figure 3: MPPU high-level block diagram, courtesy OHB-CGS.

Power Supply Boards

The PSB board is the power supply board for the METIS experiment that provides power to the external units and internal boards (CPU, HK&IF). Locally, on the supplied boards, post regulations will be realized in order to provide the voltage levels required to supply CPU Core and FPGAs (+1.5V and +1.8V).

There are two PSB boards in cold redundancies: PSB N (Nominal), PSB R (Redundant). The spacecraft supplies the two PSB boards using the nominal and redundant power bus and turns on/off one of the PSB using the ON/OFF pulse commands and receives the PSB status back via the Bi-Level signals. The PSB N supplies point to point the CPU N and the PSB R supplies the CPU R. There are two branches N and R constituted by PSB plus CPU that are in cold redundancies. When a PSB is switched on, the relative CPU is switched on as well.

The two PSB boards supply, in OR-hardware connection, the HK&IF in order to keep it on regardless of the PSB that is actually active.

The PSB is protected against an impulsive transition of the voltage input V_{in} over $2*V_{in}$ value and can tolerate, without damage, a permanent transition of V_{in} up to 33V (over Vin=30V the PSB stops working).

CPU boards

The CPU board (**Figure 4**) is based on the LEON2 AT697F processor that hosts on its PCI bus a FPGA assigned to manage the communications and to provide integer co-processing capability.

This FPGA, simply called CCU for Communication and Co-processing Unit, is connected through two separated control and data ports to two further FPGAs housed on the HK&IF board. As the two detector chains provide a large amount of data that requires on board processing (formatting as a minimum and possibly heavy compression), there is a need to properly manage data fluxes and temporary store them between the various stages of processing. To avoid the overcrowding of the processor, the CPU Board runs the instrument application software (ASW) whereas the ancillary 'Service Logic' FPGA is in charge of mass data flow between the detector chains, the mass memory and the S/C.

The envisaged solution is to provide a data buffer in the form of a SDRAM connected to the on-board FPGA itself. This memory area shall be sufficient for the whole processing of multiple UV and a VL frame at the same time (plus the area for the execution code and margins). This Memory Buffer will have the size of 64Mx40 (EDAC protected) and implemented with SDRAM.

The board also hosts the master clock oscillator (@66 MHz) and the needed LVDS I/F devices to implement the two SpW communication links towards the S/C.

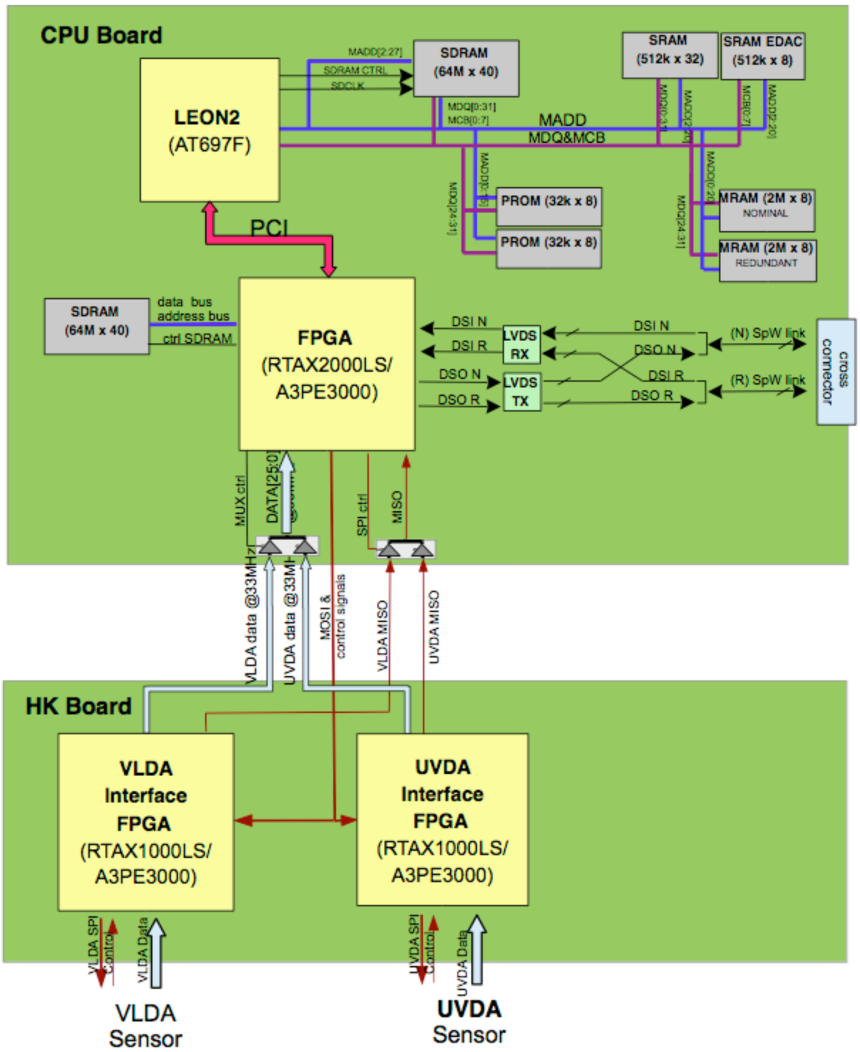

Figure 4: METIS processing board (CPU) architecture and internal links towards HK&IF board, courtesy SITAEL.

Housekeeping & Interface board

The HK&IF board collects the HK information coming from the different METIS subsystems and manages the communications with the two detectors assemblies through two Channel Links and SPI interfaces. The current design foresees the presence of 1 FPGAs per channel, each one implementing the control and data acquisition tasks for the supported sensor. The HK&IF board controls the annealing (for the VL channel) and the operational heaters of the detectors and manages, throughout the CPC commanding, the sensors power. It drives the LCVR plate of the polarimeter assembly with the related heaters/thermistors used to maintain the temperature of the retarder plate stable.

The HK&IF board is partially redounded providing a double control for what concerns the driving of the IOM motor, the calibration LED and the MOU operational heater + thermistor system. The block diagram of the board is shown in **Figure 5**.

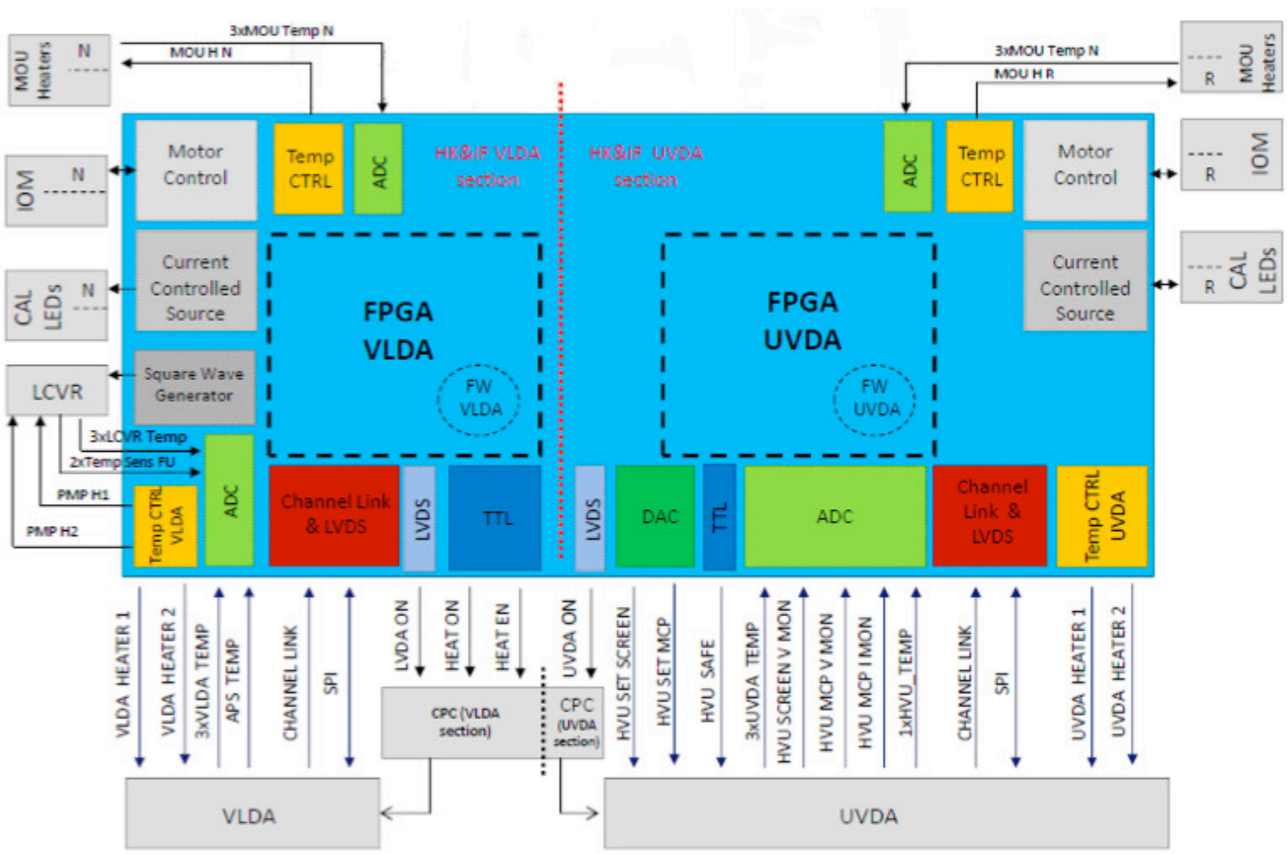

Figure 5: HK & IF Board architecture design, courtesy of SITAEL.

2.3 The HVU, CPC and harnessing

The Camera Power Converter (CPC) is mounted on-top the METIS MPPU and consists of a power converter system that receives power from the MPPU itself. The input power is converted and distributed to both sensor assemblies, the VLDA and the UVDA. The MPPU supplies the METIS CPC with switched +-7V unregulated (+- 0.5V) power. Three high efficiency point-of-load (POL) DC/DC converters and two linear regulators convert the input voltages to the camera electronics supply voltages of 1.5V, 2.5V, 3.3V and +-5.15 V for the UVDA and VLDA. The unit has main and redundant input lines decoupled by active diodes (MOSFET switches). Behind the active decoupling section, current sense amplifiers and a foldback current limiter monitor the current that flows into the system. Linear regulators provide a regulated +5.15V and -5.15V supplies that feed a start-up and power-good supervising section. The MPPU unit provides two static LVDS “ON”-signals, which are fed to the corresponding receivers on the CPC for the switching of the camera supply channels (UVDA and VLDA). The +7V supply is directly routed to the VLDA annealing heater, which is activated by two opto-isolated single ended static TTL signals provided from the MPPU.

The HVU converts the power received from the MPPU and supplies high voltage power to the MCP of the UV Camera. The MCP intensifier stage is sealed with an UV-grade magnesium fluoride (MgF_2) window and has an opaque KBr photocathode coating that is deposited on the MCP front side. The photocathode converts the incoming UV light into electrons that are then amplified by the MCP. The electrons are accelerated towards the output phosphor screen, where they are converted into visible light. The screen is coupled via a fiber optic taper to the APS sensor, to adapt the form factor of the intensifier output to the image sensor active area.
The High Voltage Unit (HVU) provides to the intensifier the supply voltages of +400 V to +1 kV to the MCP back side and up to +6 kV to the screen. The screen and the MCP high voltages setting are controlled by analog differential signals. The screen voltage is referenced to the MCP output voltage, to ensure that it is always at higher

positive potential than MCP.
The HVU PCB is mounted in an external dedicated housing (see **Figure 1**). The design is based on heritage from space instruments built at MPS that were successfully flown on, e.g., ROSETTA and other missions.

The harnesses connecting the different electronics subsystems are designed to provide the electrical links with the required electromagnetic cleanliness, while keeping mass as low as possible. The segregation of signals belonging to different EMC categories is implemented by means of wires shielding and unused pins allowing different signal classes to be separated. The current design leads the overall harness mass budget to 1.20 kg, with 20% contingency.

3. METIS SOFTWARE

The resources provided by the electronics hardware are fully exploited by the METIS on-board SW (OBSW) to realize the required functionalities of the instrument. In particular the SW tasks can be split in lower-level services needed to drive or access, for instance, the HW resources and in higher-level functions that instead implement the observing procedures and the on-board data processing and therefore enable to achieve the scientific observations. This division, although not so sharp, can be identified in tasks that have to be accomplished respectively by the Operative System (OS) + Basic Software (BSW) and by the Application Software (ASW). The former handles the HW-SW interface providing an application program interface to ASW and hiding the communication physical implementation and protocols complexity. The ASW realizes instead the high level operations of the METIS scientific payload.

3.1 OS & Basic Software

SW components for system start-up and for HW virtualization are classified as Basic SW. The OS provides the basic functionalities for a real time environment execution. BSW extends and completes the functionalities provided by the OS customizing them to the specific HW devices adopted and encompassing all the needed drivers.

BSW collects three SW packages covering different aspects, i.e.: Boot, BIOS and Service SW.
The Boot SW main purposes are to perform a basic initialization and test on the vital hardware resources and to verify, load and start the execution of the ASW. It starts running at processor power-on (cold reset) or on processor reset (warm reset). After a first task in which Boot SW execute a basic hardware initialization, a set of automatic power-on self test is performed. The results of such tests are stored in the memory and make available to ASW. When the initialization and checking phase terminates, Boot SW will load, verify and execute the ASW, transferring the execution control to its entry-point.

The BIOS Software is a package that provides a collection of SW drivers with the purpose to offer a SW interface to the Hardware components of the MPPU. The BIOS SW is intended to be compiled and linked together with the Application SW and the Operating System. Part of the BIOS SW will be linked with the Boot SW offering access to MPPU HW devices for what is needed by such SW.

The aim of the Service Software is to provide basic services to the Application and to the Boot-loader SW for METIS. It hides the complexity of operations linked for example to TM/TC handling, power management, and detectors communication.

3.2 Application Software

The ASW realizes the high-level functionalities of the instruments. The set of functions in charge of supervising the operations execution constitute a part of the ASW referred as the P*rocess controller*. The process controller, leveraging on the methods provided by the BSW, will interact with solar Orbiter Platform receiving telecommands and transferring telemetry using the Packet Utilization Service (PUS) standard. Moreover the *Process controller* will be in charge of the FDIR and Instrument Modes management.

The SW procedures related to the instrument commanding and control and the activities implementing the scientific data acquisition and processing, are collected into the ASW package named as *Instrument control functions (ICSW)*. This SW package concerns the actual control of METIS sub-equipment as well as the data processing end event monitoring required both for scientific and engineering purposes. It is logically split in

- Equipment commanding and control,
- Data processing,
- and Event management

sub-packages hereinafter described in more detail.

3.3 Equipment commanding and control

The *Equipment commanding and control SW* is part of the ICSW and it provides the means to activate, configure and operate all METIS devices such as the VLDA and UVDA detectors, the IO Mechanism and power and thermal management system. The functionalities provided by the package will enable to set each METIS sub-system in a proper condition to perform a planned observation bringing the instrument in a predefined known configuration.

3.4 Data processing

The data processing performed on board aims to correctly collect data from the 2 detectors and maximize the scientific return of each observation.

The two METIS channels show different equivalent focal lengths but provide the same field of view (FOV) on the detectors, i.e. a square FOV 5.8° x 5.8° wide. Actually the vignetting functions of both channels show an annular FOV ranging from 1.5° up to 2.9°, that spreads to ~ 3.6° at the sensor corners (see **Figure 6**). For both detectors, the central part of each frame will contain the occulter shadow and therefore it will not provide scientific information of the observed target but only an assessment of the camera noise (mainly read-out and dark noise). The image corners will carry out similar information as well. The central area represents more than the 20% of the total number of pixels of each frame and it will be normally dumped on board to save telemetry.

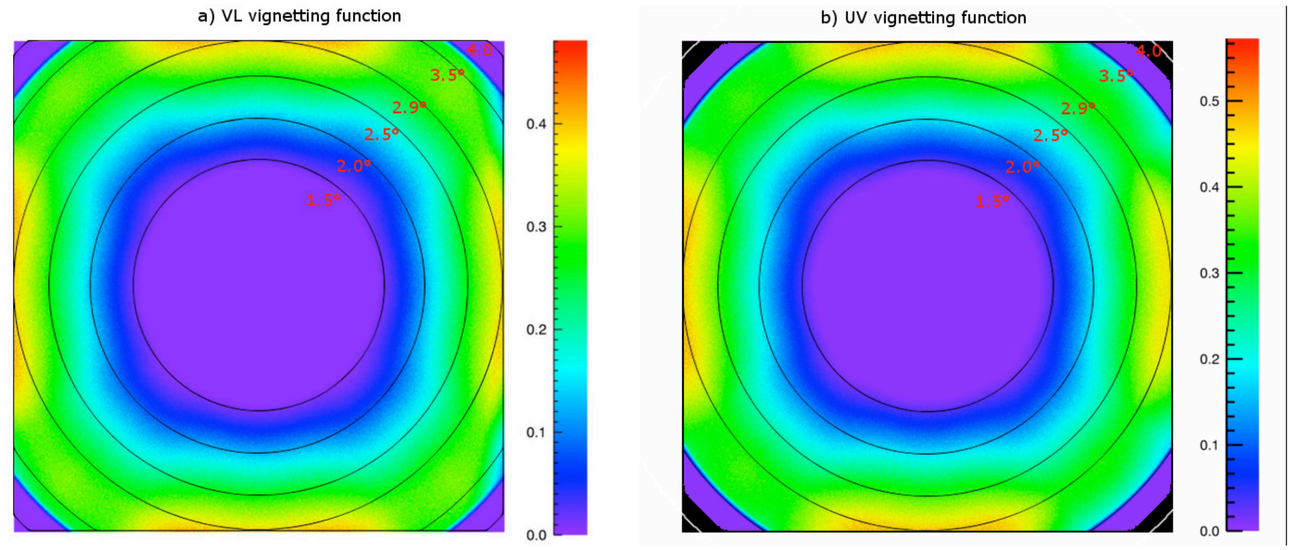

Figure 6: Vignetting function on the focal plane of the METIS VL (left) and UV (right) channels. The Colorbars report the efficiency of the optical system normalized to the input radiation. The concentric circles identify the radial FOV at different angles. The dark corners present in the UV vignetting (b) represent the APS areas not covered by the fiber optic taper that connect the sensor to the MCP intensifier.

In most of the cases, the VLDA and UVDA will be operated simultaneously creating two concurrent data streams that will be handled by the MPPU, processed and later on sent to the S/C for temporary storage. Whereas the UVDA has two main possible operational modes, analog and photon counting, the VLDA foresees only the analog mode. In analog (or integration) mode, both detectors collect the charge created by the incoming photons over the set integration time. In photon counting mode, the intensifier of the UVDA will be operated at high gain such that each single photon hitting the MCP photocathode will produce a signal that can be individually read onto the APS. The APS will be read out in rolling shutter mode at a rate of 12 frame/s that is sufficient to have no more than one photon hitting a single pixel per read frame. The UVDA photon counting mode is then compliant with the case of low UV photons fluxes.

When the detectors are operated in analog mode, the data they produce undergo throughout a similar on board processing. A first step concern a reordering routine that reconstructs the correct sequences of pixel of the acquired frame. A Masking procedure is then applied to remove the pixels of the occulter shadow as described above. For the UVDA a first procedure of frames co-addition is performed in order to produce a so-called *acquisition*, whereas each single frame of the VL detector constitutes an *acquisition* for the VL channel. A proper algorithm [11] is then applied to every *acquisition* to remove possible Cosmic Rays (CRs) and Solar Energetic Particles (SEPs) tracks that otherwise would cause a deterioration of the data. The corrected *acquisitions* will be then averaged for each channel providing the final higher-quality *exposure* with an improved signal to noise ratio. Some statistical computations, mainly the evaluation of the mean and of the standard deviation of some peculiar areas of the sensor, will be performed before passing the final exposure to the compression algorithm. The METIS compression algorithm is based on the CCSDS 123.0-B-1 standard and it has been adapted to be suitable for the purpose. The standard specifies a lossless predictive coding algorithm that, with some slight modification, can be extended to near-lossless compression, in which the absolute reconstruction error can be limited to a user-defined maximum bound. A more detailed description of how the algorithm works and the adaptation adopted for METIS can be found in [12]. The compressed data are finally packetized and delivered to the S/C. A scheme of the foreseen on-board data processing procedures is shown in **Figure 7** for both cameras.

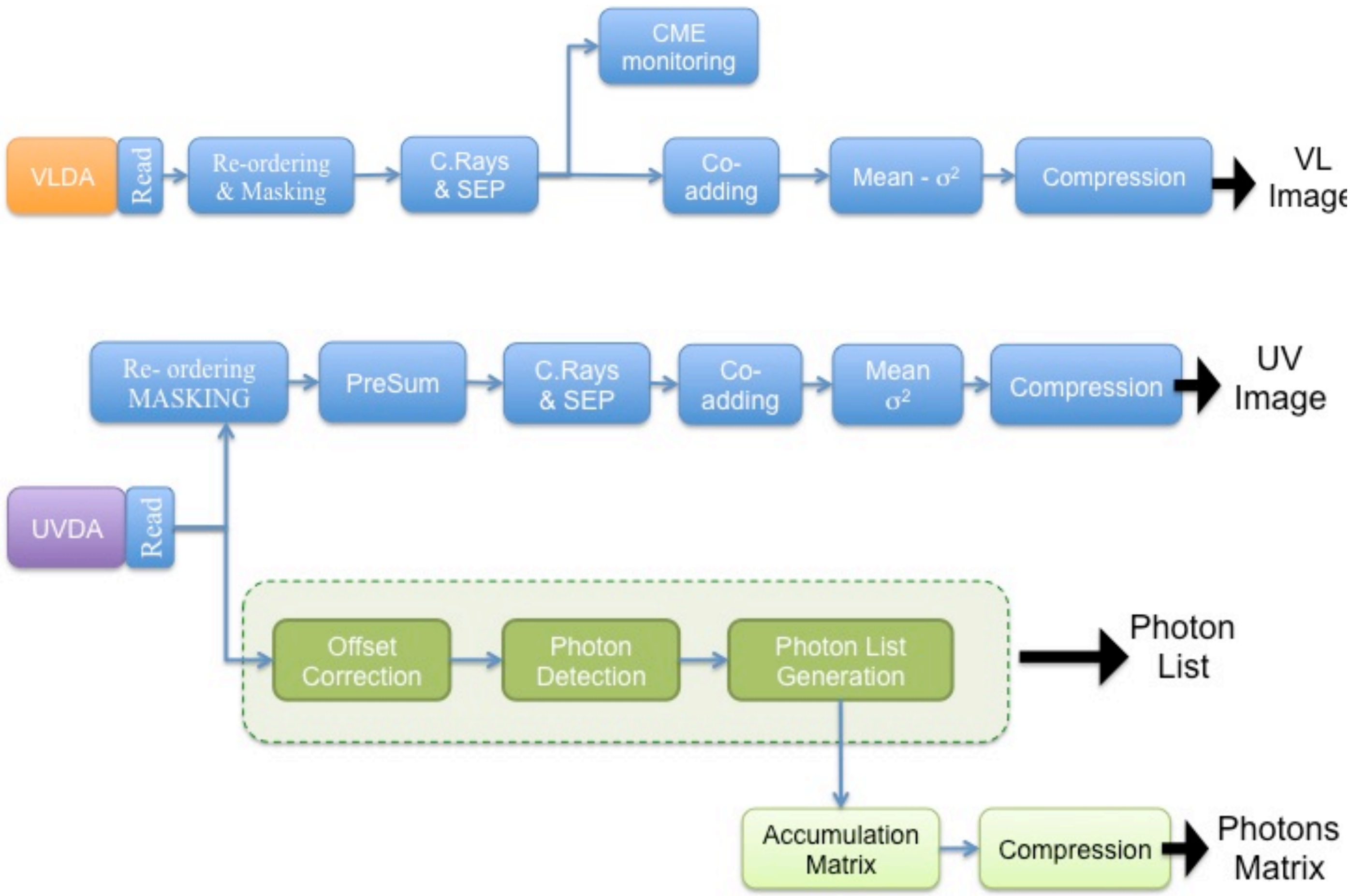

Figure 7: VLDA (top) and UVDA (bottom) data processing scheme.

Although the UV and VL channel can be operated independently, the usual METIS measurement should be performed in a sort of synchronized time period named '*cadence*' during which a full-consistent VL and UV measurement is performed. Usually a *cadence* interval produces 4 VL exposures and a single UV exposure. In the VL optical path in fact, the LCVR polarimetric group is present enabling the observation of linearly polarized coronal radiation. Tuning the LCVR driving voltage will set the polarization angle to a specific value and usually 4 different polarization angles will be used to perform a scientific VL measurement and extract the polarimetric information of the selected target.

Occasionally the MPPU, solicited by the proper command, shall also compute the related pixel-by-pixel temporal variance matrix on the acquired *frames* in order to periodically monitor the detectors noise performances.

In case the UVDA will be operated in photon counting mode, the intensifier will be powered with high gain and each primary photoelectron will be converted into a luminous spot on a phosphor screen preserving the (x,y) location of the event. Reading out the APS will make possible to detect the footprint of each event producing a list of (x,y) coordinates of detected photons as output. This list will be usually elaborated internally to the MPPU that will packetize the data and will send them to the S/C. In case of high rate of the incoming UV radiation flux will be observed, the on-board software will automatically switch to the *accumulation mode* where a stacked matrix containing the number of photons detected per pixel along with the integrated energy amplitude profile, will be produced instead of the normal list (see **Figure 7**).

Finally, with the UVDA in photon counting mode, the MPPU shall activate one or more internal real-time hits counters (see the *Event Management* section) in order to monitor the overall and local counts of UV photons hitting the MCP, as diagnostic mean to predict possible MCP gain variations.

3.5 Event Management

Event management functions provide the means to monitor the current status of METIS and to possibly override pre-planned operations or settings in response either to an event or to an unpredicted scientific opportunity (CME monitoring and detection).

The ASW shall manage Event conditions signaled via SW Flag, producing an output flag or receiving external flags (via the Inter Instrument Communication Service implemented on the S/C through PUS services 3 and 20) and reacting with programmable combined procedures. Currently the events that could modify the normal METIS observing plan are:

- Detection of a transient event as a Coronal Mass Ejection (CME)
- Measuring an incoming flux exceeding a parameterized threshold

Whereas the latter is a safety procedure foreseen to preserve the functionality of the detectors (especially the intensifier of the UVDA), the former has the aim to catch scientifically interesting phenomena which occurrence cannot be pre-planned in advance.

The detection of an arising transient event in the METIS field of view is performed through the analysis of sequences of VL images. Two consecutive images will be acquired and compared. Actually the relative normalized differences (running differences) between the acquired *frames* will be computed and the pixels belonging to a pre-determined sector (see **Figure 8**) will be averaged. The output mean numbers will be finally checked for values exceeding a given threshold. This check is done in order to detect significant changes from one image to the next one with the support of selection rules based on the LCVR polarization angle set when taking those images. Further details on the operational concept of the CME detection algorithm can be found in [13] together with the preliminary results obtained applying the algorithm to a set of data coming from the STEREO mission.

When the internal CME flag is raised, the ongoing observing program will be interrupted and the "CME observing program" will starts. At end of this program, the planned program for the current S/C time will be executed.

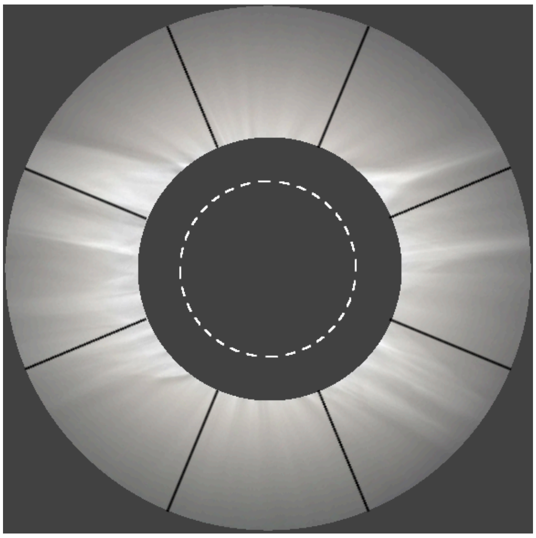

Figure 8: the 8 radial sectors splitting the METIS VL FOV used to monitor the occurrence of solar transient events. The dashed circle in the center of the image shown the Sun disk dimensions @ 0.28 AU.

4. CONCLUSIONS

The paper gives an overview on the current status of the METIS instrument design. METIS successfully passed the ESA Delta-Preliminary Design Review on April 2014. The main aspect arisen from the scientific requirements have been addressed by the current adopted design but some open issues still exist especially on the implementation of the on-board processing algorithms and event monitoring functions. Further analyses are ongoing on the scientific algorithms and their results will enable to identify the final HW and SW architecture of the instrument that has to be finalized within the Critical Design Review that is expected for the end of this year.

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