



VIS Status

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On behalf of the VIS SW
Development Team

INAF IAPS



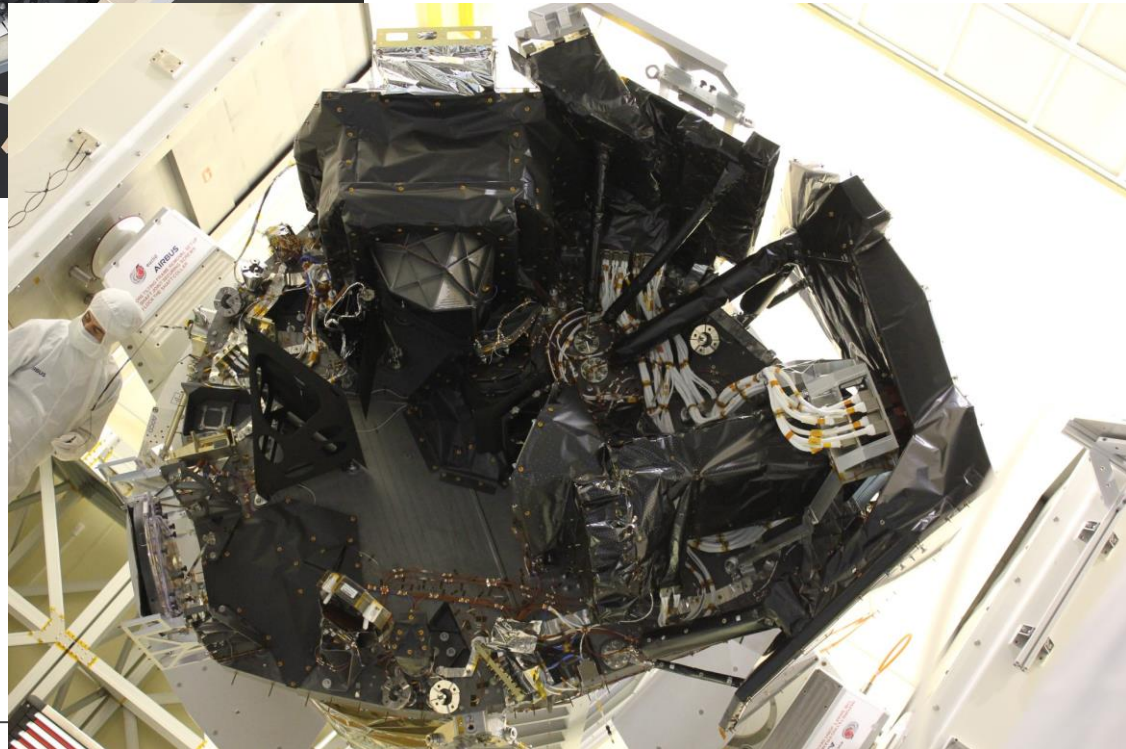
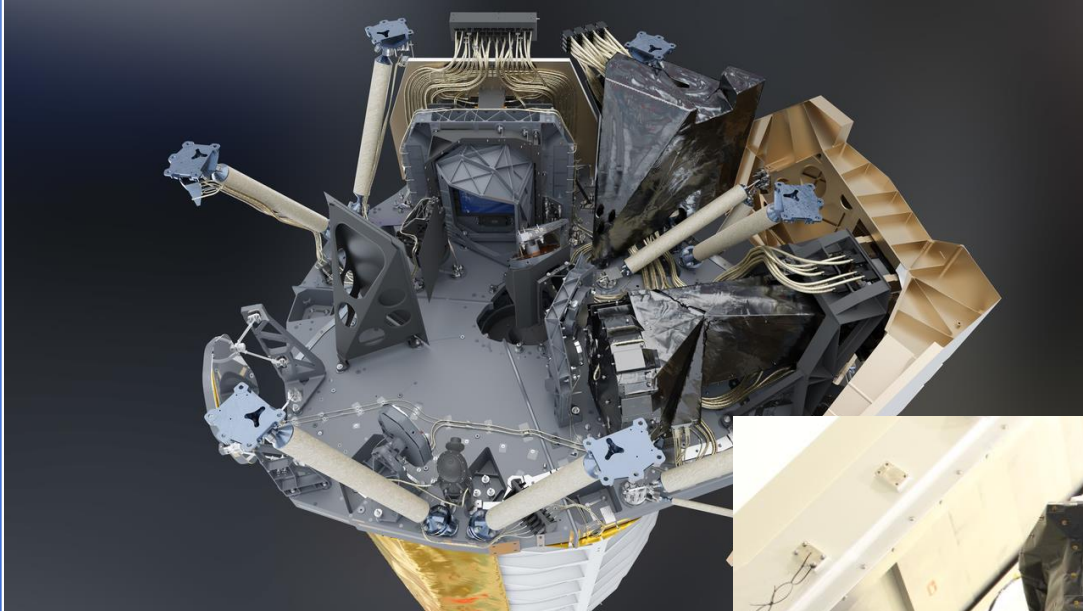
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23 - 25 Febbraio 2022

Presentation outline

- Euclid system and VIS
- Payload Module Tests
- VIS CDPU and On Board Software

Euclid Payload Module



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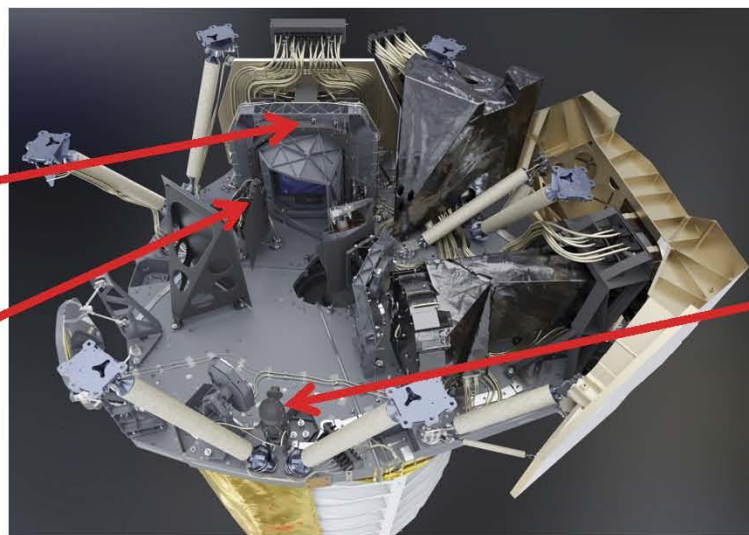
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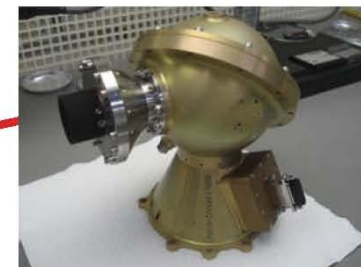
Reminder: VIS instrument



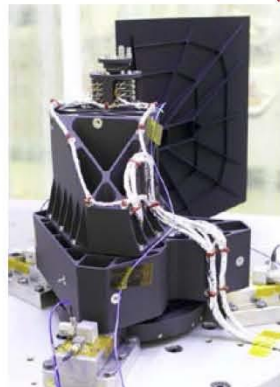
FPA
(Focal Plane Assembly)



Payload Module



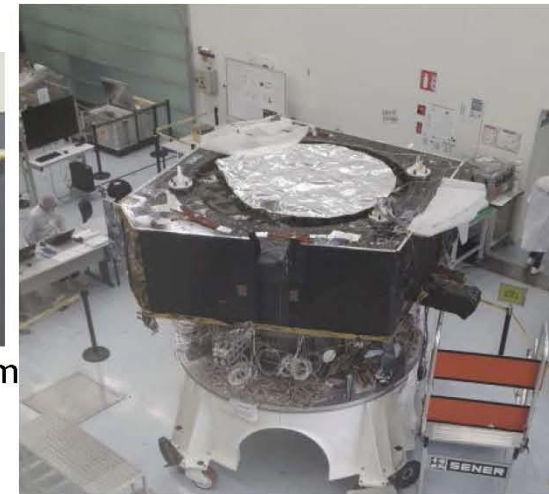
CU
(Calibration Unit)



RSU
(Readout Shutter Unit)



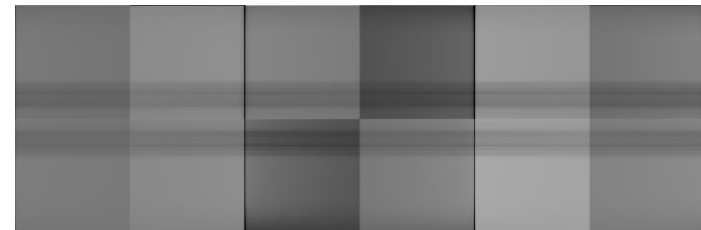
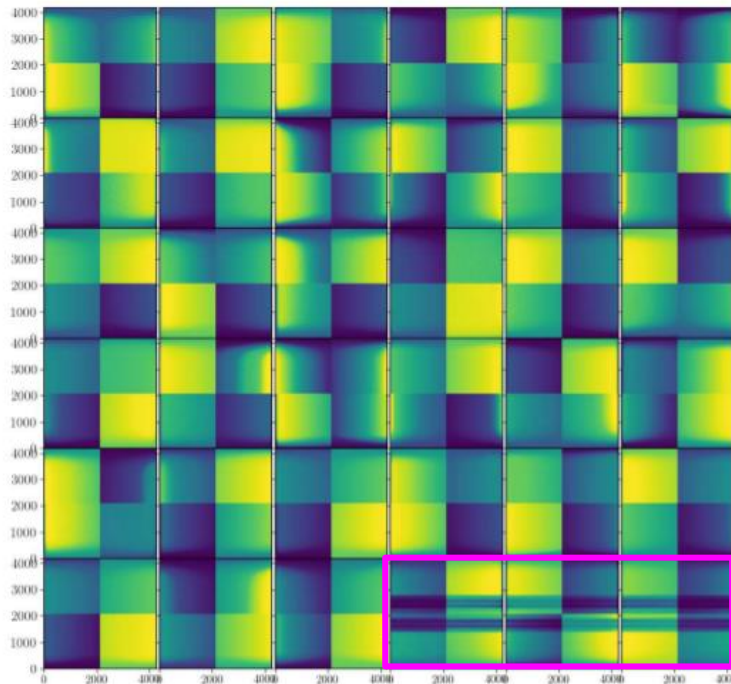
PMCU (Power & Mechanism Control Unit) &
CDPU (Control, Data Processing Unit)



Service Module (warm)

Readout Electronics Failure 23Oct20

- After several hours of EMC (Electromagnetic Compatibility) testing (VIS integrated on the telescope), dark bands were seen on the images from the 3 CCDs powered by electronics block 7 on the bottom right of the focal plane (ROE7)



- After a series of tests to track down the cause, it has been established with high confidence that this is a fault inside ROE7



Payload Module test campaign: VIS

PLM Campaign for VIS/NISP ran over 8 weeks from 12 May to 18 July 2021

VIS tests in the PLM campaign were carried out within four different categories:

1. VIS-specific tests for the purposes of quantifying its performance in flight configuration within the PLM;
2. VIS operation as the imager to quantify the performance of the Euclid optical system;
3. VIS operation to measure interference with other instruments/subsystems on the PLM;
4. VIS operation within the Reference Observation Sequence.

The data obtained during the testing included ~2600 channels of VIS housekeeping data at a cadence of 1 – 10 sec, and ~2800 VIS images (each 1.2 GByte).



PLM testing at CSL: summary



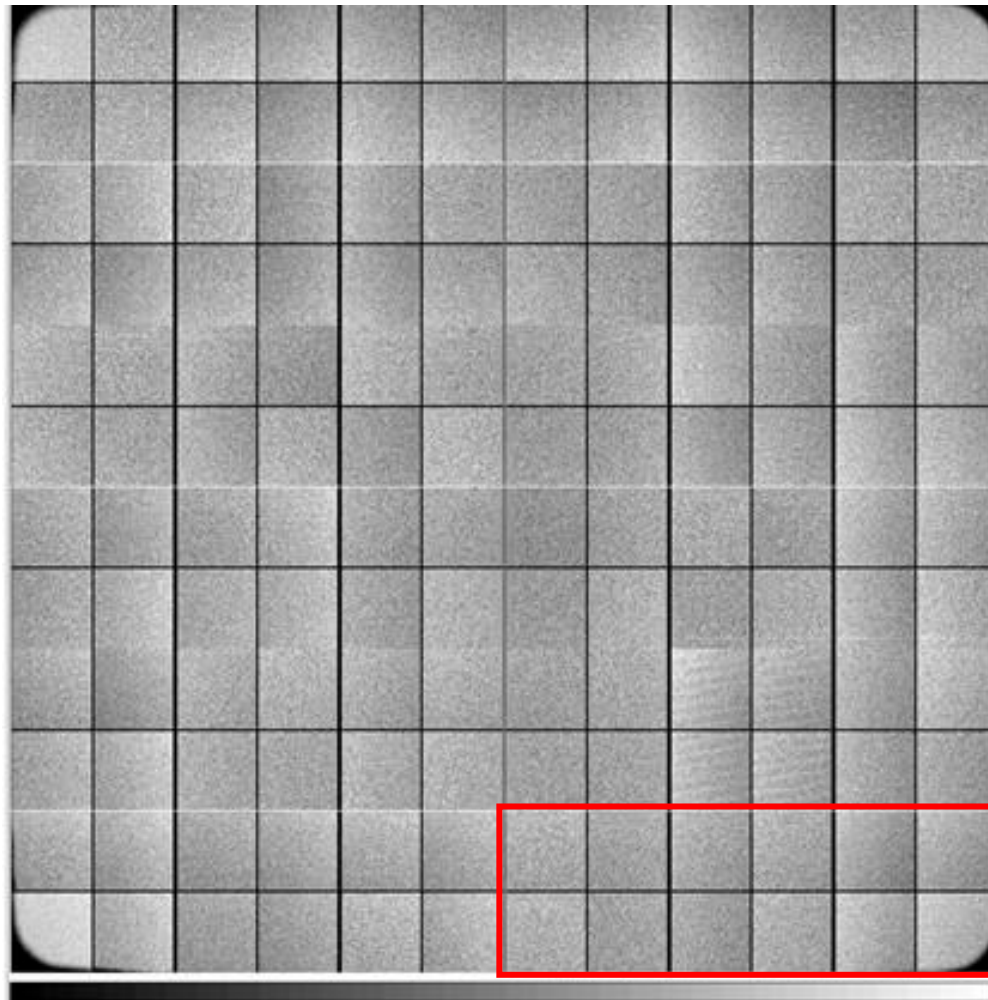
1. Image sizes including pre- and over-scans were as specified; detector ordering and orientation is correct;
2. ROE-7 operated nominally for in-orbit temperatures to provide a full focal plane;
3. Shutter operations were nominal;
4. All VIS performances (noise, bias levels etc.) were as for the Ground Calibration campaign.
5. Optical ghosts were as expected and within specification;
6. Scattered light from the VIS shutter and bright sources on the focal plane was at negligible levels;
7. Electrical and optical interference from NISP and the Fine Guidance Sensors was at negligible levels;
8. Images were processed by Instrument Operations Team and OU-VIS within the Euclid Science Ground Segment.

Two non-conformances:

- When at cold temperature, the CDPU failed to switch on the supply to the PMCU for driving the shutter: fixed
- There was unexpected bias behaviour in CCD4-1:G quadrant, cured by power cycling of the ROE: addressed in data processing



Flat Field



- Bias-subtracted and gain-corrected image at 720 nm
- Flux level is 50,000 e⁻
- Calibration Unit is well-aligned
- Drop-off in corners is much softer than appears in this high-contrast image

ROE 7 Operating nominally



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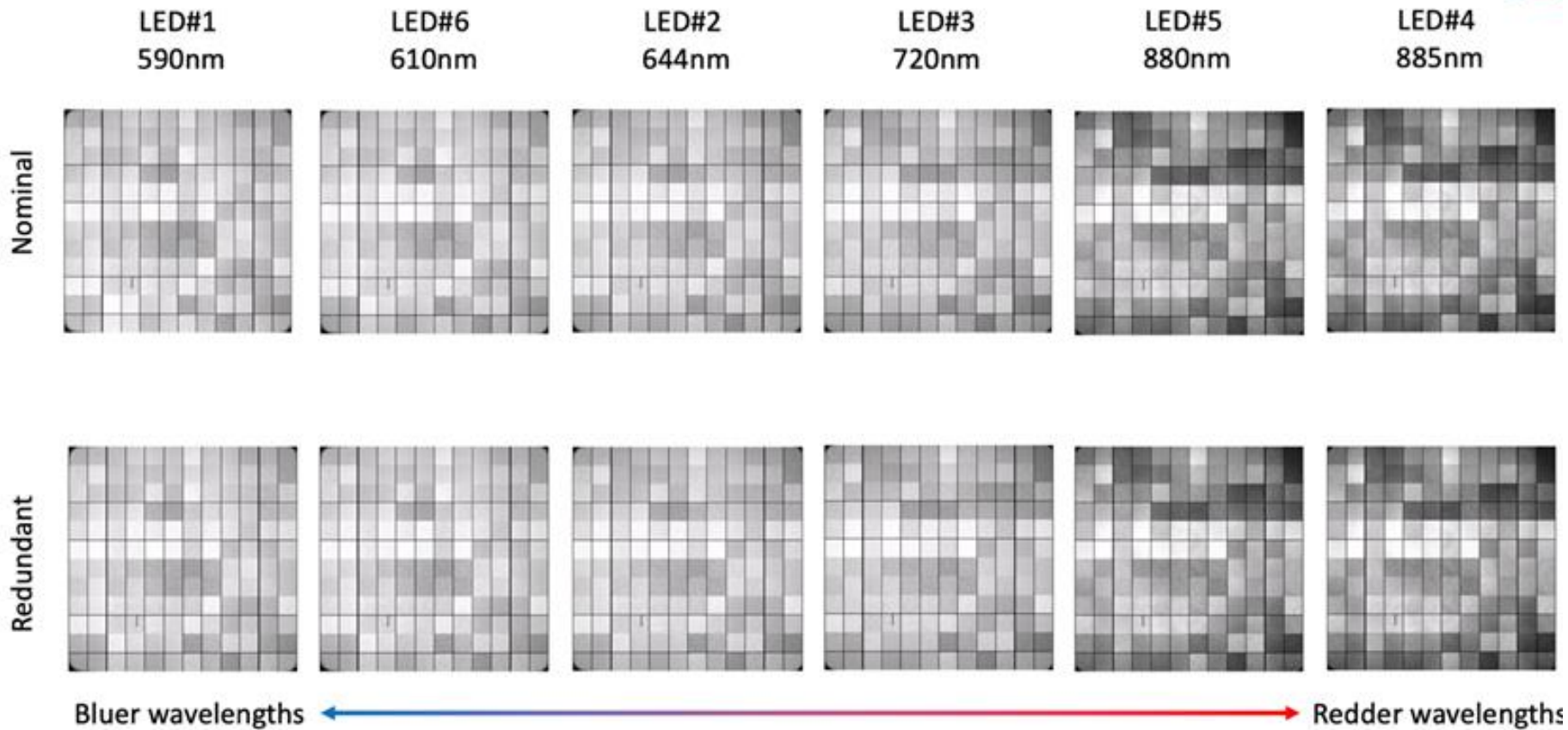
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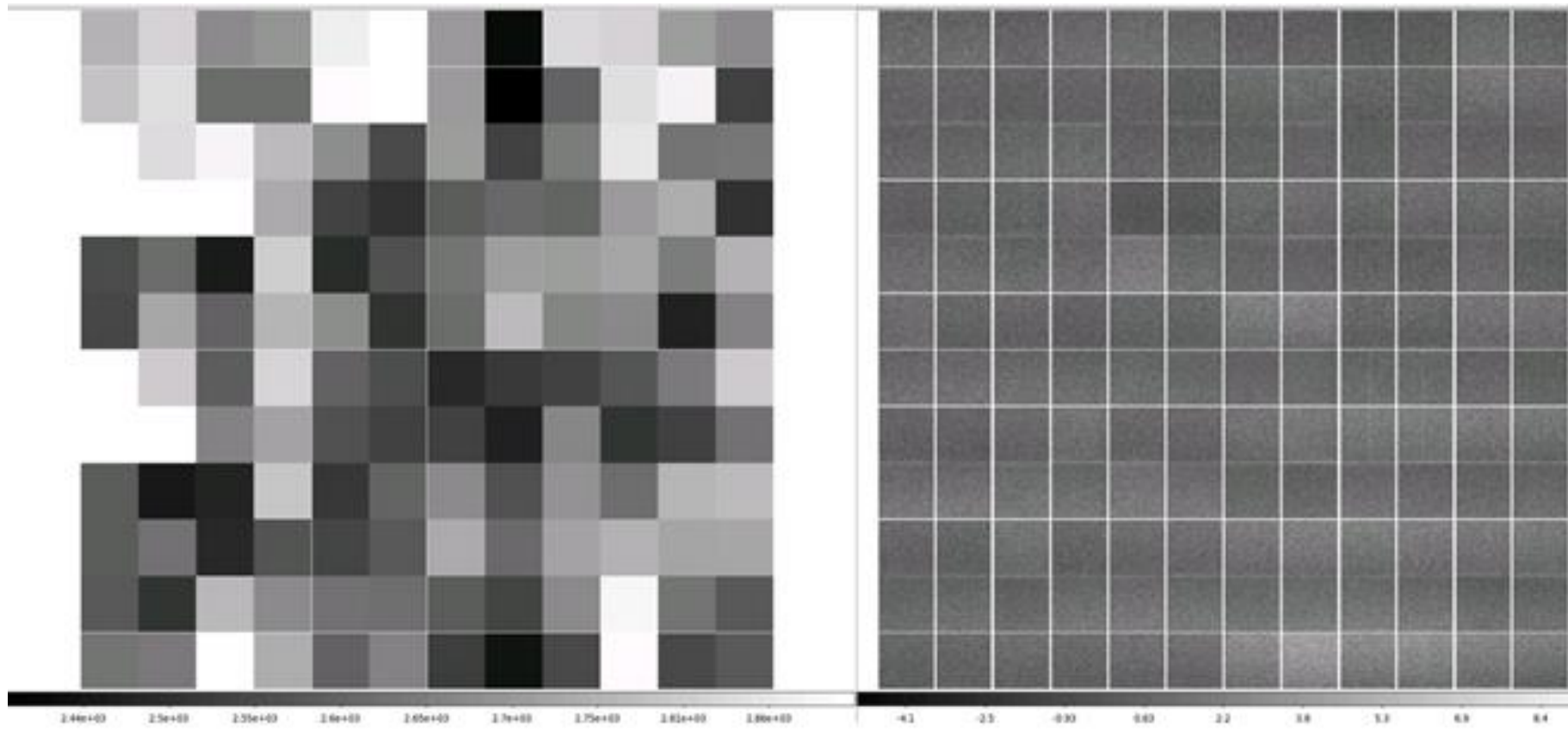
Flat Fields

Flat fields for all 6 Calibration Unit wavelengths for nominal & redundant sides

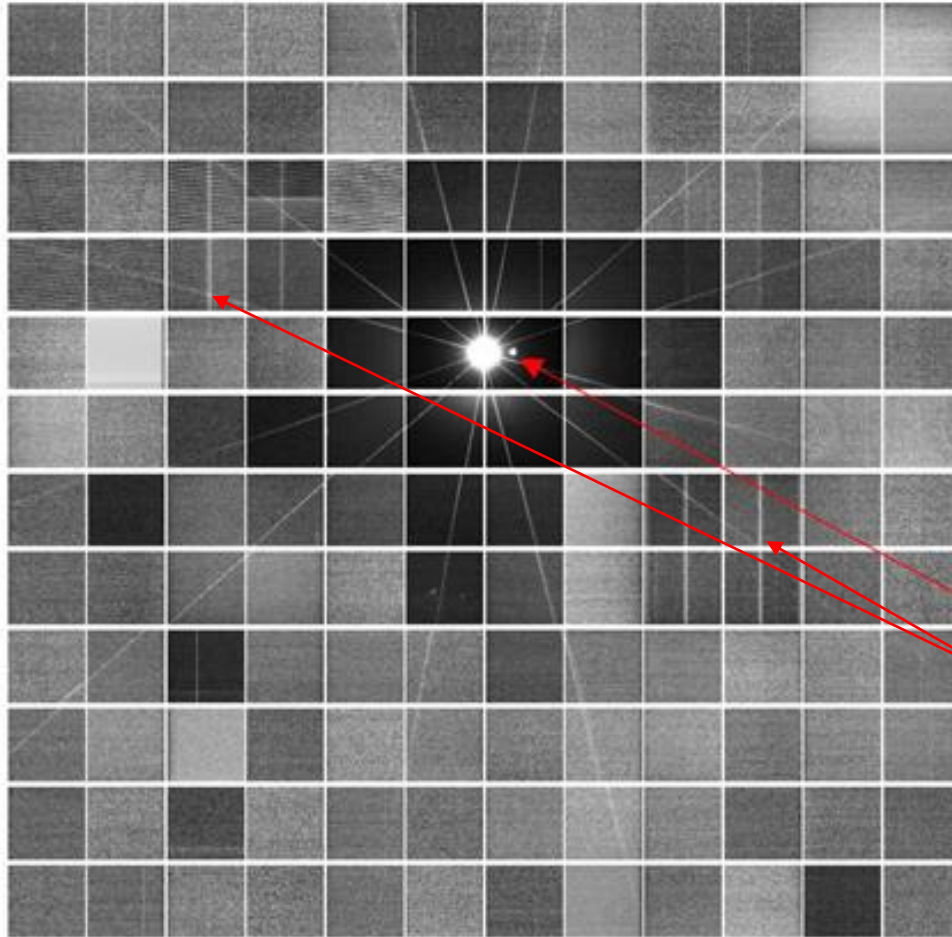


Bias Image

Bias before and after processing by OU-VIS



Science Images (source in array gap)



Very bright source placed between two CCDs

12 diffraction spikes (6 from Euclid and 6 from collimator show correct placement and orientation of the array

Ghost image is visible
Amplifier Glows in readout ($<1e^-$)

Each quadrant separately scaled



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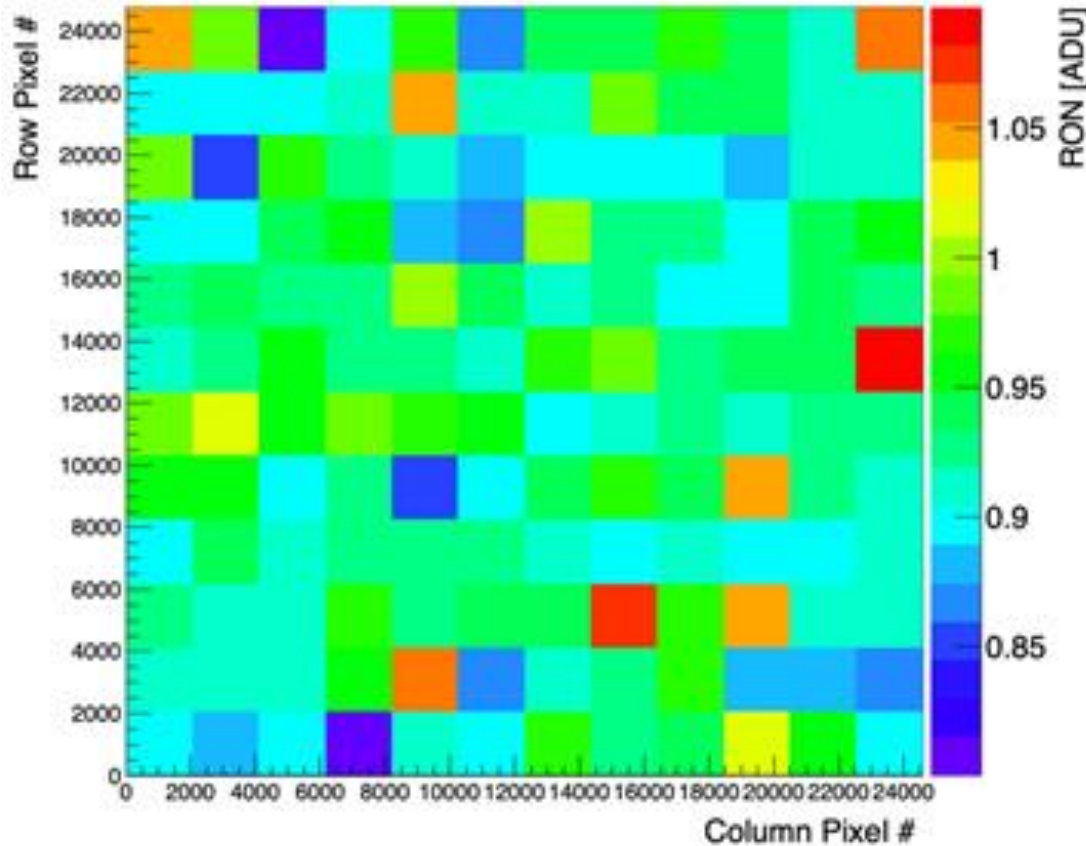
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Readout noise



Mean Readout Noise (Serial Overscan)



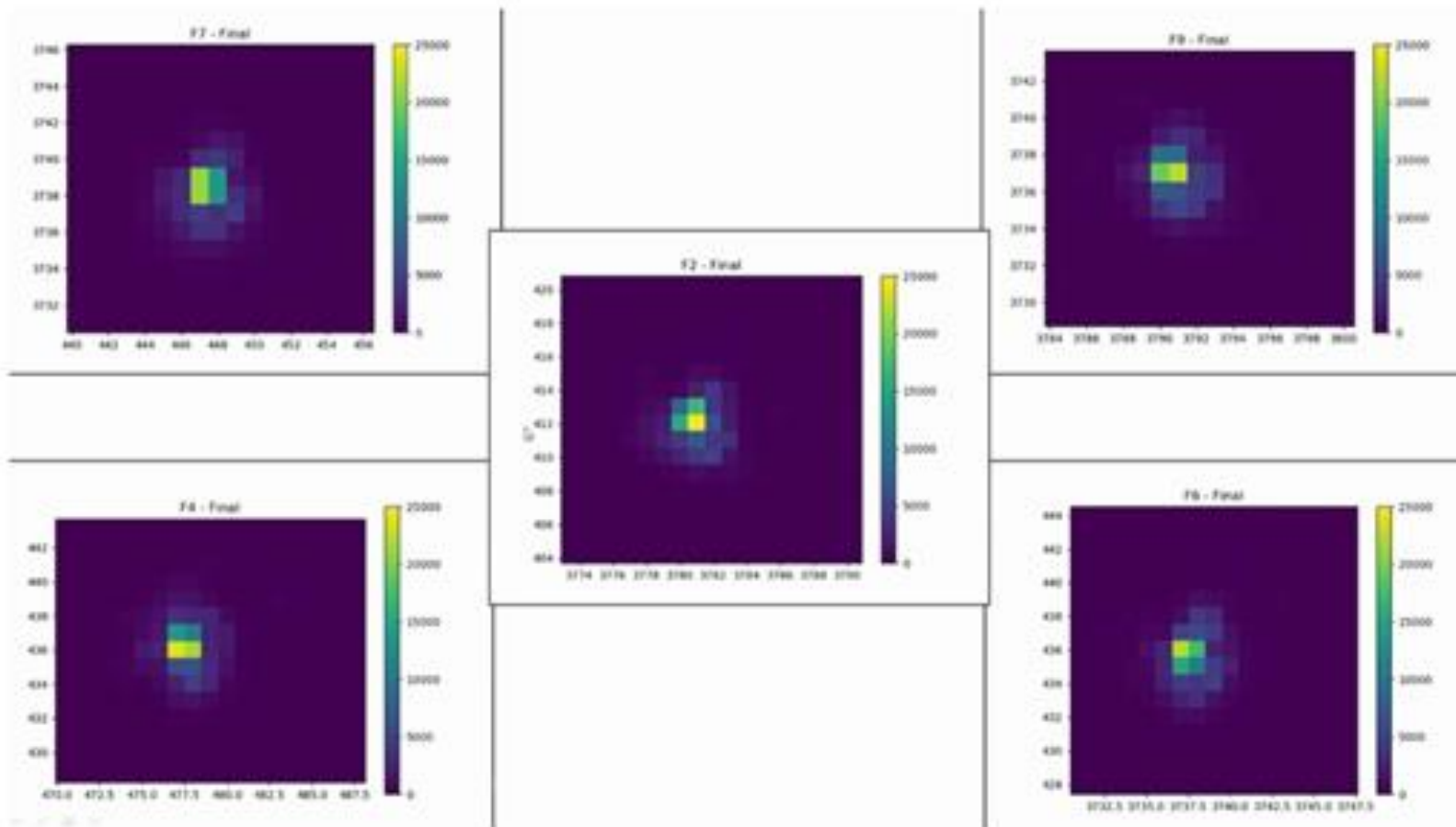
Readout noise
<3.8 e⁻
(spec ≤4.5 e⁻);

1 ADU = 3.5 e⁻



Science Images

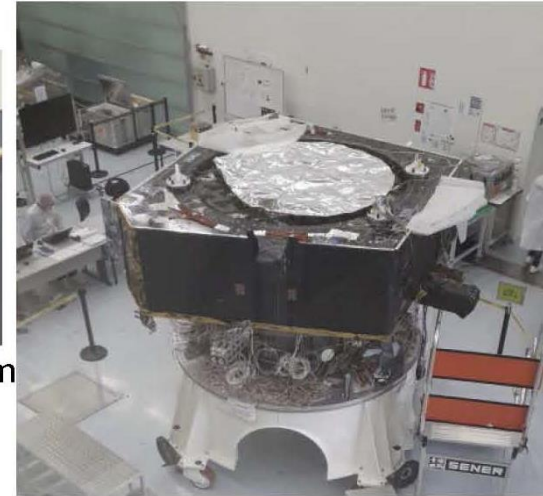
- Unsaturated images taken at different field points shown at full spatial resolution (image credit Airbus)
- Point Spread Functions are as expected



CDPU Failure



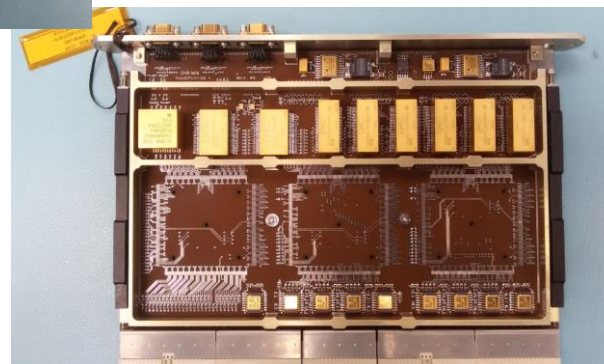
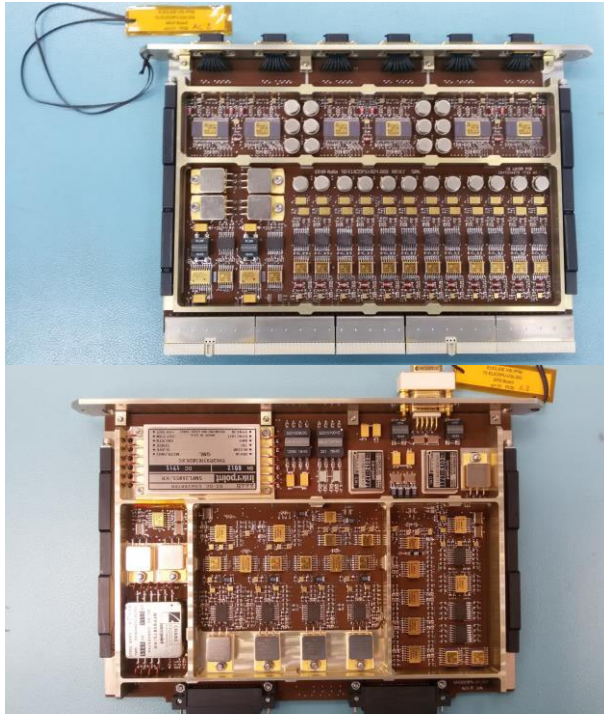
PMCU (Power & Mechanism Control Unit) &
CDPU (Control, Data Processing Unit)



Service Module (warm)

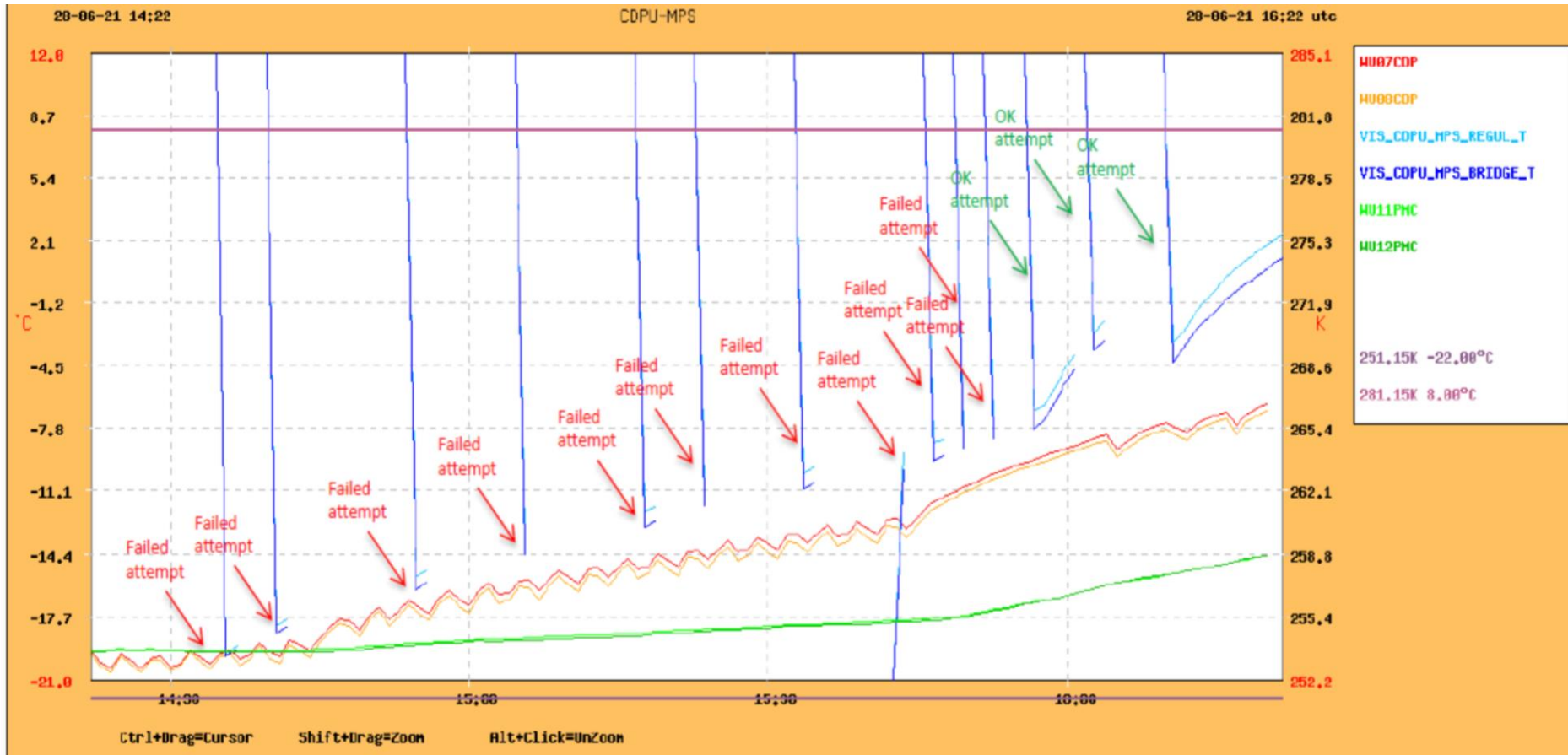
- CDPU provides the secondary Voltages needed to power on PMCU
- A specific electronic board inside the unit (MPS board) is dedicated to generate the necessary voltages transforming the Primary power provided by the Spacecraft
- This board is not powered at the unit switch-on, and a dedicated Telecommand is needed to power it up.
- The execution of this telecommand failed at temperature $< -10^{\circ}\text{C}$

CDPU Flight Model



CDPU Failure

- Occurs only on Nominal ICU (Redundat OK)
- Temperature and input Voltage dependent



CDPU Switch-on Failure (MPS Board)

OHB-I investigation - First step:

- Traced to a momentary un-allowed logic state on the overvoltage protection circuitry on the Motor Power Supply (MPS) Board
- Relatively easy fix identified and applied to the boards.
- Not sufficient to explain the Temperature/Primary voltage dependence



TRUTH TABLE

INPUTS				OUTPUTS	
SET	RESET	CP	D	Q	\bar{Q}
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H (Note 2)	H (Note 2)
H	H		H	H	L
H	H		L	L	H
H	H	L	X	Q0	$\bar{Q}0$

H = High Level (Steady State)

L = Low Level (Steady State)

X = Don't Care

= Transition from Low to High Level

NOTES:

1. Q0 = the level of Q before the indicated input conditions were established.
2. This configuration is nonstable, that is, it will not persist when set and reset inputs return to their inactive (high) level.

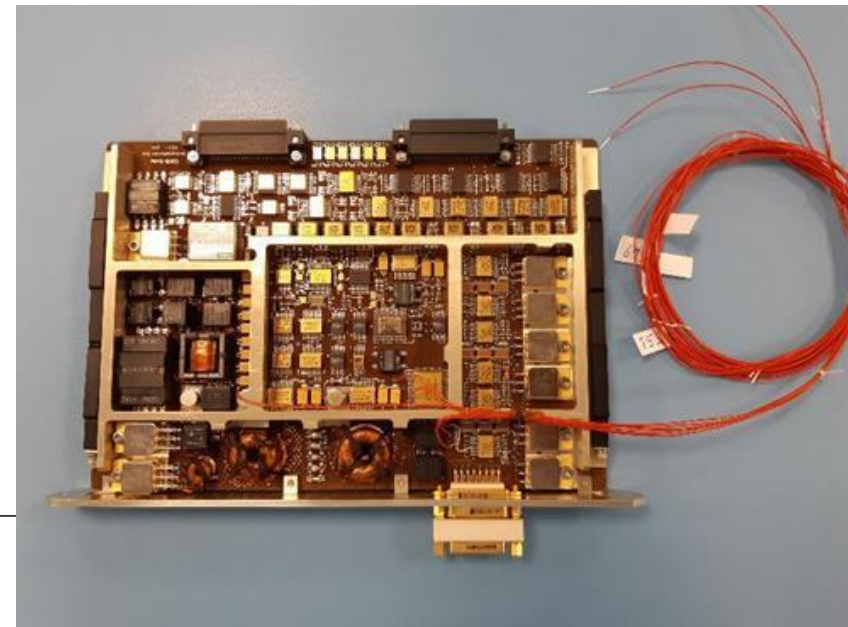
CDPU Switch-on Failure (MPS Board)



OHB-I investigation – Second Step

- All three FM boards characterized: nominal, redundant and Flight Spare.
- Explanation is associated with changes made to the Aux DC-DC Converter consequent to an Airbus Alert on an op-amp (type number ISL70444) which also happened to be used on the MPS Board (OHB NCR-EUC-ATI-C-028 on 2Aug18)
- The conclusion is that :
 - a. the secondary voltages are simply by their design sensitive to the primary voltages, and
 - b. owing to the tolerances of the components, the nominal board provides at the output a wider range than the other two boards.
 - c. This is not due to a degradation of the performances

Considering that the redundant and the spare boards have better performances (the values of +12V are sufficient to switch on the driver @cold temperature @26V) and that a design modification could introduce other undesirable effects, the decision to proceed with this 2 boards without any modification has been taken.





VIS Application Software

SW Development Team
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VIS ASW

- Number of files: 180
- Lines of code: 90100
- 127 Look up tables
- Total number of monitored HK parameters: 782
- Total Number of CDPU HW+SW requirements: 892
Total number of CDPU SW requirements: 250
Total number of CDPU SW Not Applicable (N/A) requirements: 12
Total number of CDPU requirements partially applicable to OBS (RFD or RFW issued): 5
Total number of CDPU requirements Applicable to OBS: 233
- All CDPU requirements applicable to OBS have a verification method:
141 reqs. covered by Review/inspection (60%)
92 reqs. covered by Tests (39%)



Version tree of VIS ASW



CDPU v 0.1.0

It works with PMCU, ROE and MMU OHB EGSE



CDPU v 0.4.1

OBS for VIS EM EMC test campaign.

CDPU v 0.4.x
ROE-EM

CDPU v 0.5.x
ROE-QM

CDPU v 1.0.0
VIS-EM

CDPU v 2.0
VIS-QM

CDPU v 3.0
VIS-FM

CDPU v 3.0.8

CDPU v 3.1.0

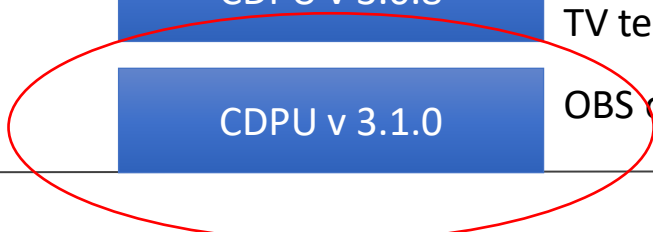
OBS on VIS EM @ TAS-I

OBS on VIS EM/QM @ TAS-I

OBS on VIS FM @ CEA- ADS

OBS on VIS FM @ ADS TV tests

OBS on VIS FM @ SVT



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Flight S/W



- A new issue of ASW has been delivered on February 15th 2022, implementing some new requirements:
- Modified shutter position control at initialization
- New requirements about onboard timeouts calculation
- New requirements about telecommand parameters to be used in the execution of science sequences
- Request to add the possibility to request additional diagnostic reports
- **Next steps**
- Support ESOC and IOT in the next SVT1 part 3 test campaign



VIS team



UoG& APCO–Switzerland,
IAPS & OHB–Italy,
CEA–France,
IAS–France,
MSSL–UK
ESA, Thales, Airbus
Funding Agencies: ASI, CNES, UKSA



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End presentation



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