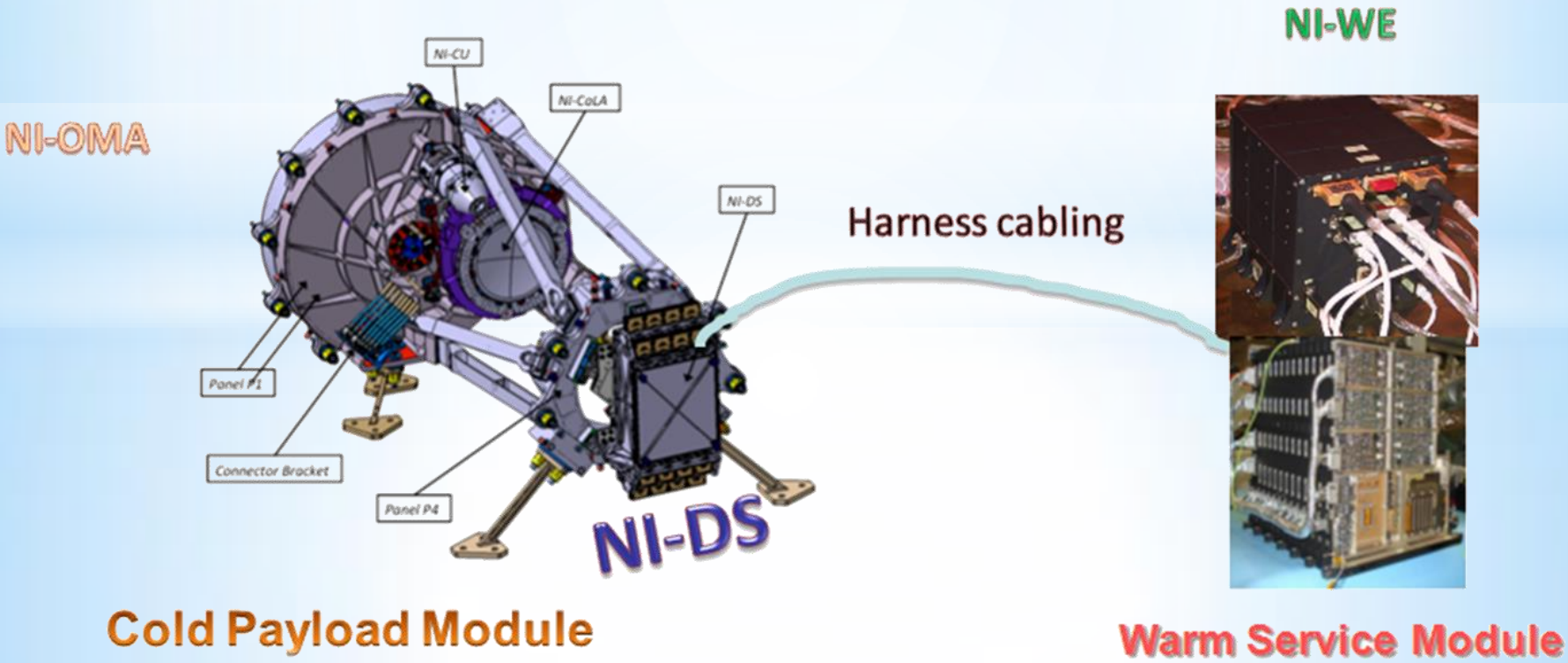
Assembly Integration and Verification (AIV) of the Near Infrared Spectro-Photometer's (NISP) Warm Electronics (WE) in the EUCLID mission



Fulvio Laudisio

22/09/2017

Layout

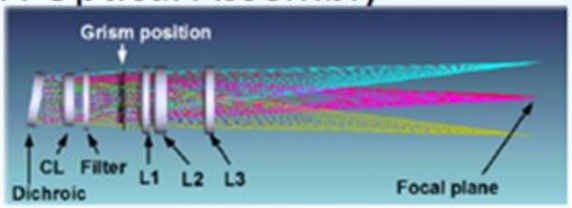
- Euclid Mission
- NISP – WE AIV
- My activity during second year
- Foreseen activities in third year

The Euclid Mission

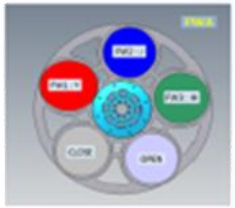
- **ESA mission**
- Selected in Oct. 2011 - Fully funded
- Partners: ESA, TAS, Airbus DS, Euclid Consortium (EC)
- Overall mass: ~2020 kg, Power : 1920 W (EOL)
- Data rate: 850 Gbit/day
- Telescope (T=125K, passive):
  - 1.2m aperture primary, 3 mirror Korsch anastigmat
- 2 Instruments (VIS, NISP) – T = 100-140 K (passive)
  - Wide field instrument, VIS: 36 e2v 4kx4k CCDs $0.55<\lambda<0.92$ µm, 576 M pixels, 0.11 arcsec/pix, 0.53 deg² FoV
  - Photom. (Y, J, H) +spectrom.: 16 H2GR HgCdTe detectors;
  - 64 Mpixels, 0.30 arcsec/pix, 0.53 deg² FoV (=VIS)
  - Grism slitless spectro (1B + 3R grisms) $0.92<\lambda<2.05$ µm, R>250
- Downlink Rate: X/X + K-band to Ground Station 55 Mbits/s. 850 Gbit/day to transfer 4hr/day.
- Ground Segment: ESA (50%,) EC (50%, EC leads science and external data): 1.5 billion galaxies for WL, 30 million redshifts, 12 billion sources (3sigma)
- L2 orbit
- Launch Vehicle – Soyuz-Fregat
- Launch date 2020, from Kourou space port
- 6.25 years mission + additional surveys (exopl, SN)
- Main surveys: 15,000 deg²+40 deg² 2 mag. deeper
- Science drivers: DE
- Science leads: Euclid Consortium

NISP (Opto Mechanincal Assembly) T ≈ 140K

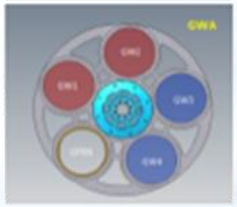
- NI-SA : Structure Assembly ; SiC Structure
- NI-OA : Optical Assembly



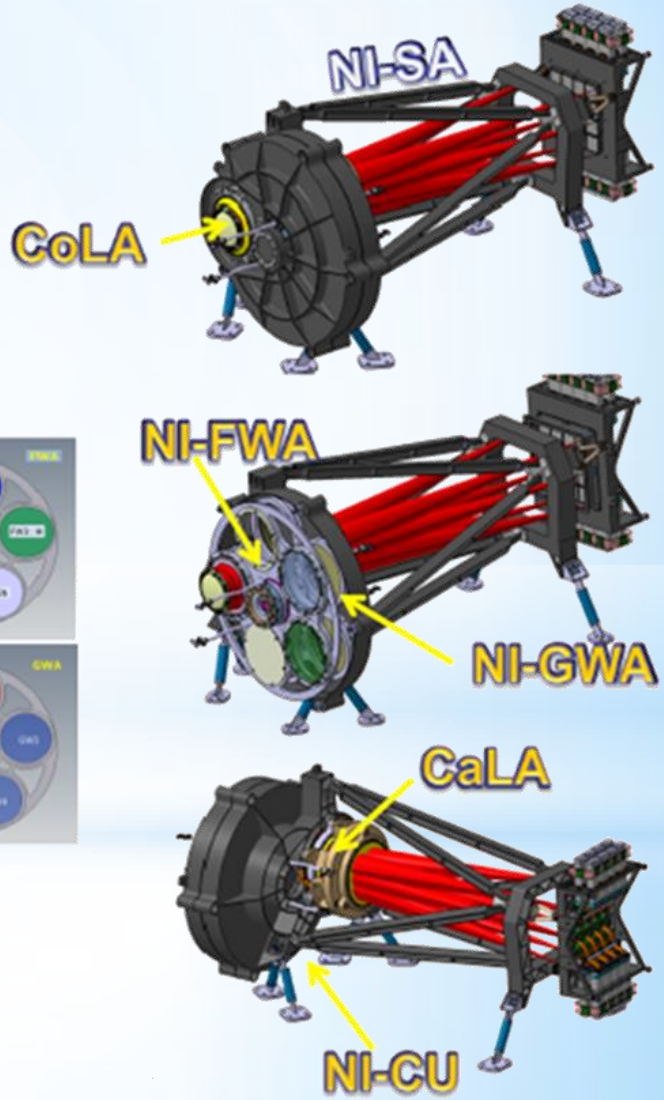
  - CoLA : Corrector Lens Assembly
  - CaLA : Camera lens Assembly
- NI-FWA : Filter Wheel Assembly
  - 3 Filters + CLOSE + OPEN



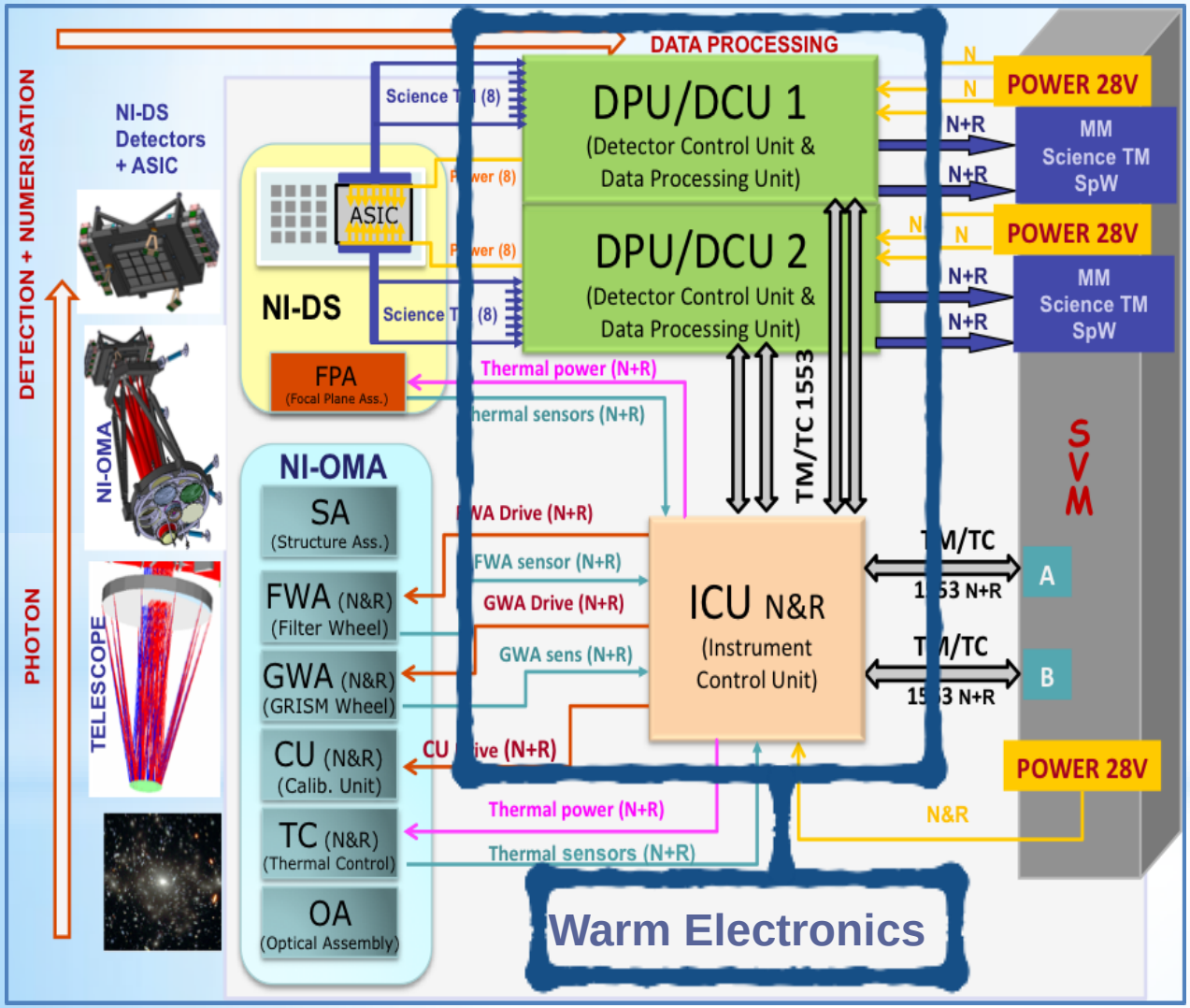
- NI-GWA : Grism Wheel Assembly
  - 4 Grisms + OPEN



- NI-CU : Calibration Unit
  - 3 wavelength
- NI-TC : Thermal Control
  - To control the optics at +/-0.3K all life (≈140K)



NISP Warm Electronics



DPU/DCU

- Data acquisition
- Data processing
- Data compression
- Data transfer to satellite memory

ICU

- Filter wheel & grism wheel control
- Telecommands dispatching
- Telemetry acquisition and transfer to SVM

NISP Warm Electronics AIV

Aim WE-AIV:

- Verify DPU & ICU ASW integration in the HW (unit level)
- Test end-to-end science data
- Test TC/TM flow (DPU+ICU)
- Documentation and test-plan preparation
- To be performed on EQM, AVM and FM models

Joint efforts

* INAF (Padua Observatory) – DPU/DCU ASW development
* INAF (Turin Observatory) – ICU ASW development
* Department of Physics UNIPD - WE - AIV
* CISAS - WE - AIV
* INFN (Padua and Bologna) - WE - AIV

my institution

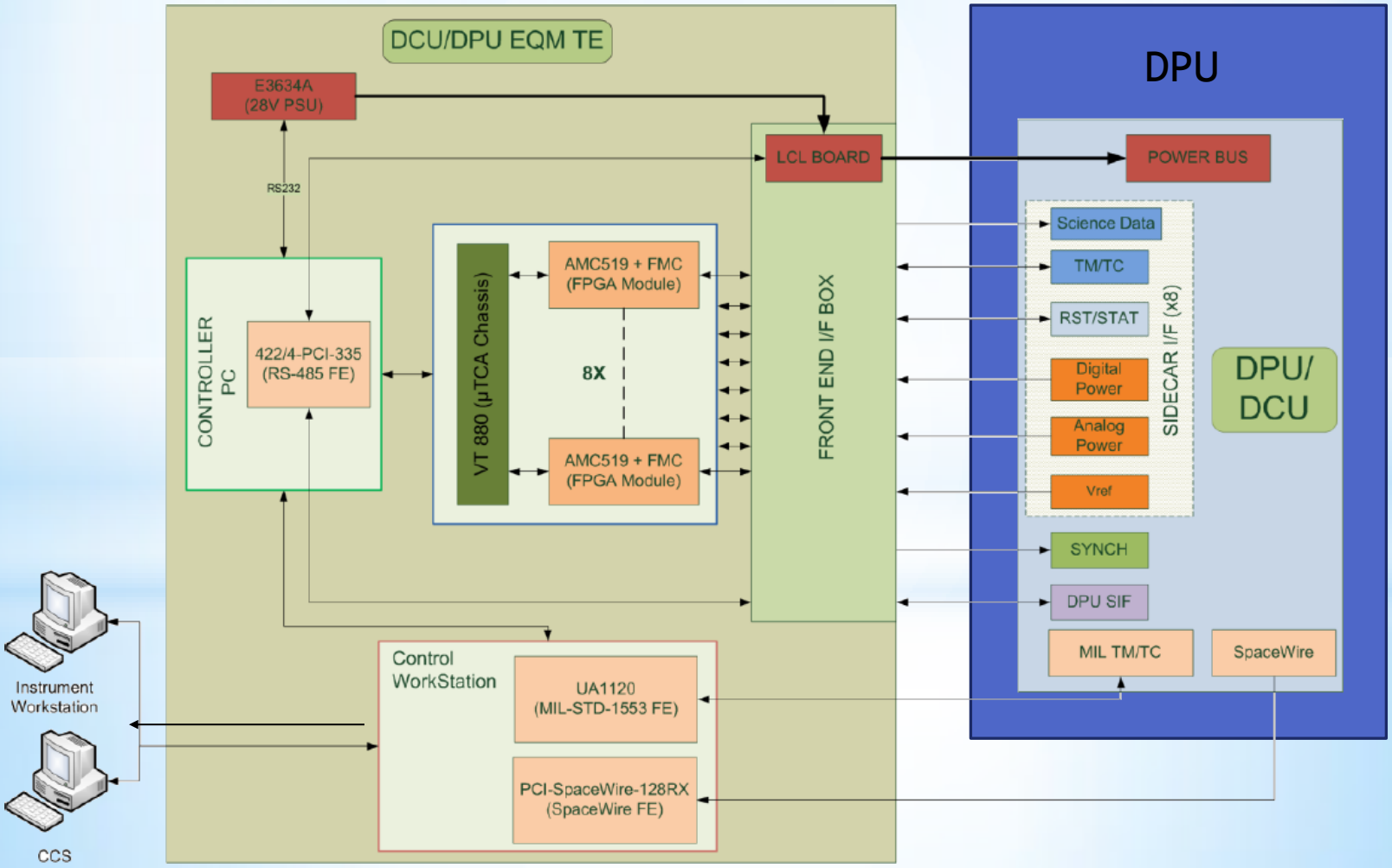
* LAM (Marseille Astrophysics Laboratory) – NISP instrument validation
* Euclid Consortium- Scientific validation

My activity during the second year

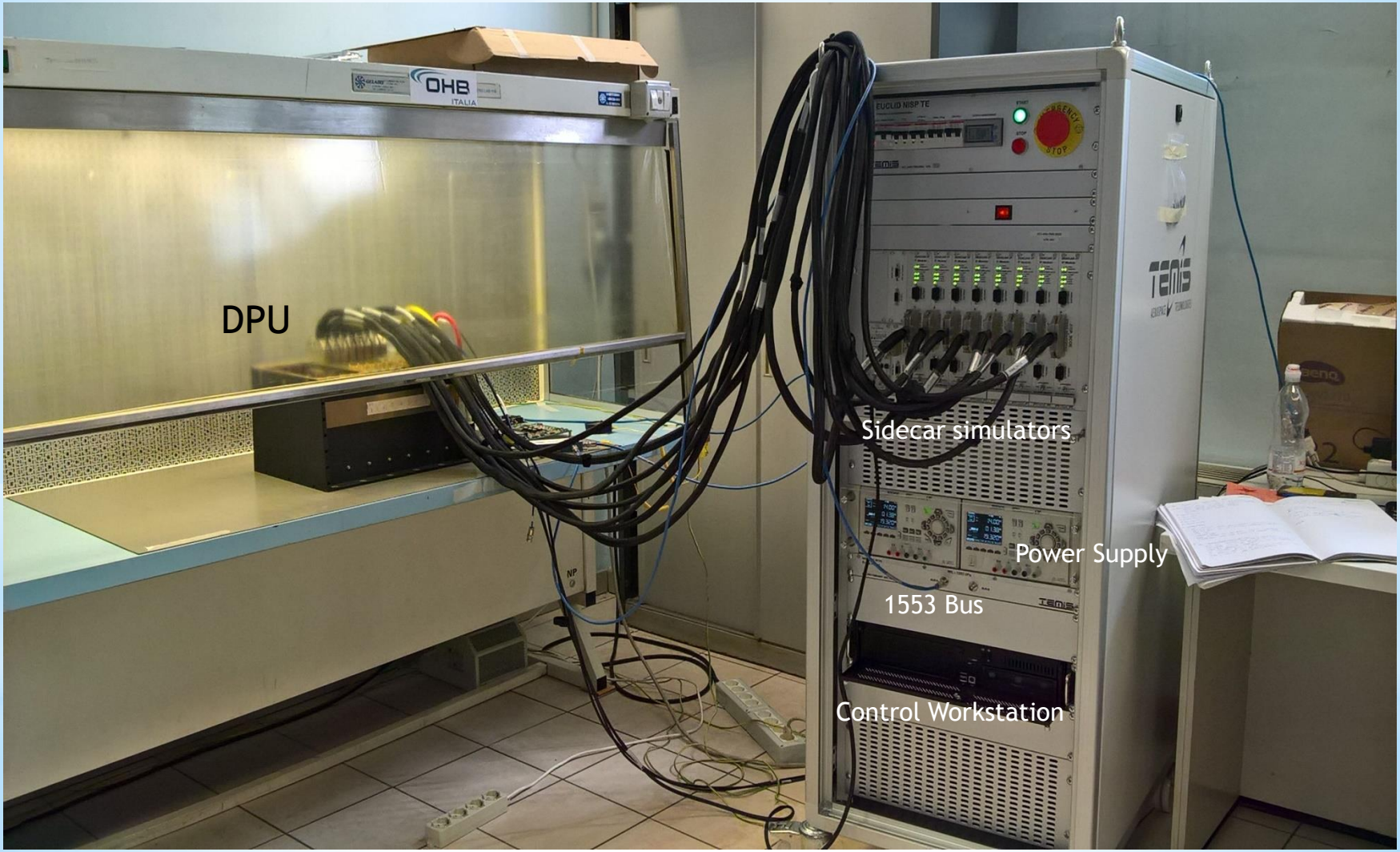
- ✓ Development of a 1553 software interface between the NISP Data Processing Board (DPU EM and EQM model) and the Test Equipments.
- ✓ Preparation of a Mission Data Base (MIB) for Telecommands and Telemetries of the NISP WE to be used in the TSC environment.
- ✓ Preparation of test procedures and test scripts for DPU EQM validation.
- ✓ Partecipation to the DPU ASW v0 integration and validation activity at OHB-I (June –September 2017)

DPU Test Equipment (TE)

- MILBUS-1553 to test DPU-ICU TC/TM flow
- SpaceWire I/F for scientific data transmission
- Sidecar simulators

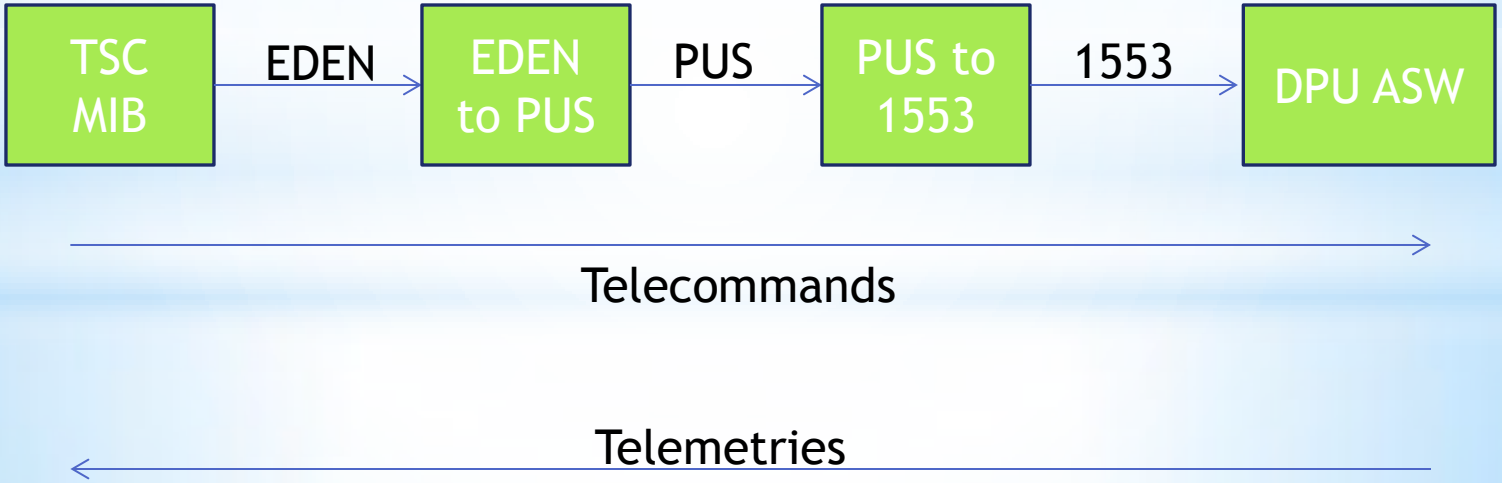


DPU EQM + TE @ OHB-I



Custom SW developed to interface DPU 1553 I/F to TSC environment and to send TC and collect TM

- Translation from PUS to 1553 packets
- 1553 bus schedule as NI-DPU ASW ICD EUCL-OPD-ICD-7-003 (v2.9)
- MIB implementing the DPU TC and TM as DPU Commanding Tables EUCL-OPD-TN-7-004 (v2.6)

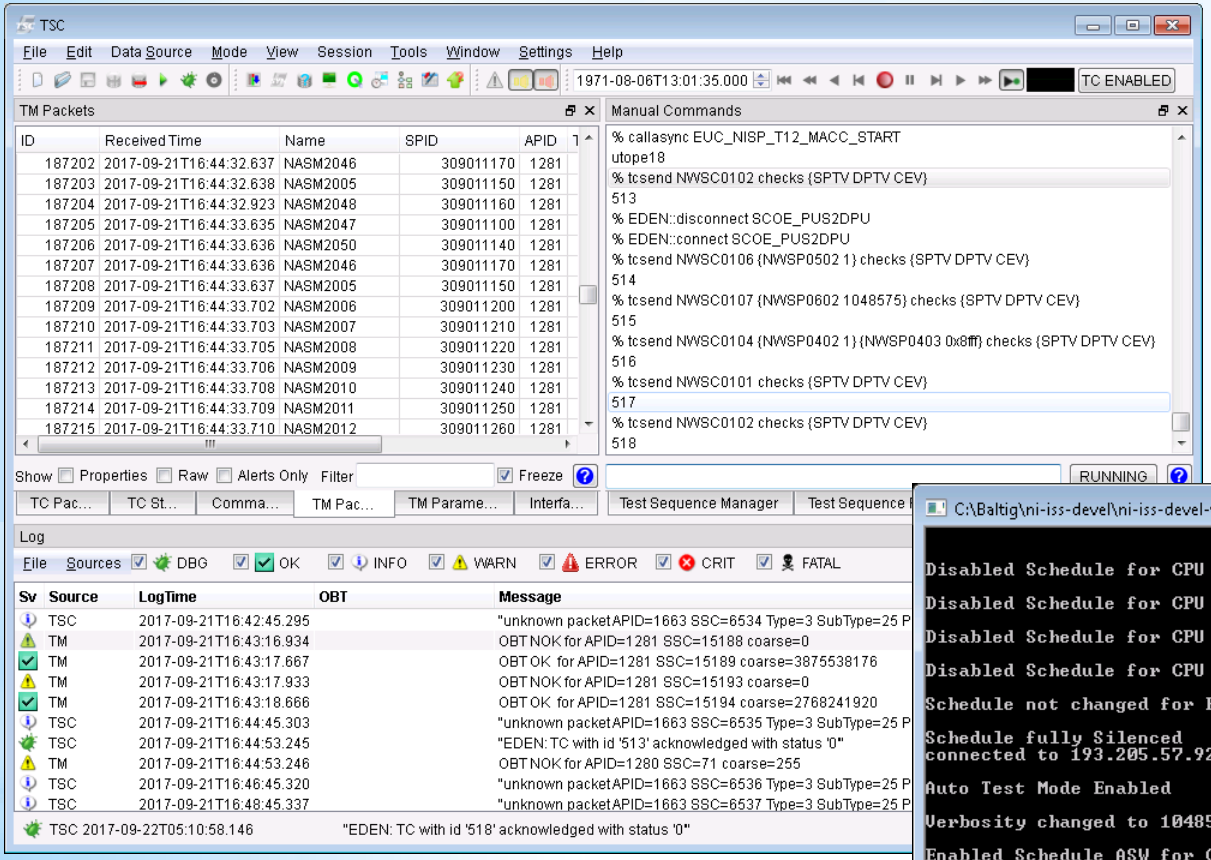


Test procedure example : exposure configuration and start

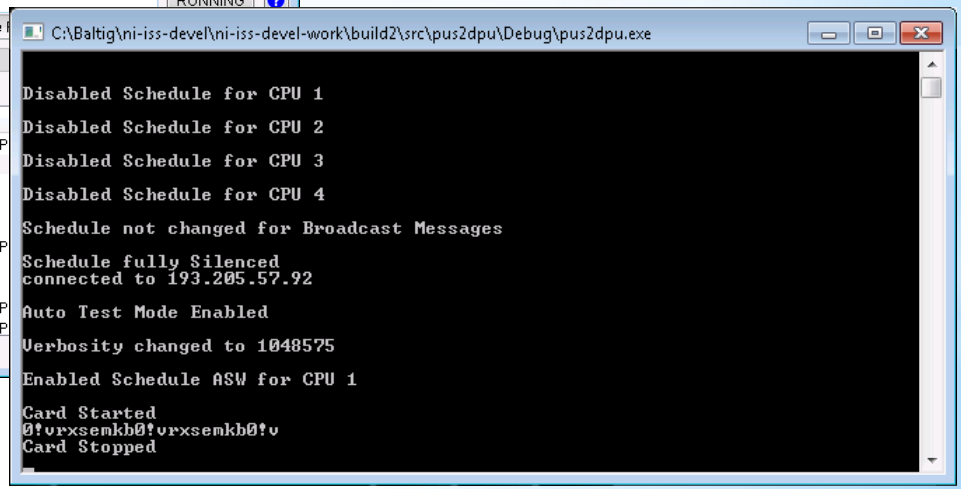
MACC_START	This script configures and start the science acquisition with standard or arbitrary MACC parameters on DCU boards and then start the science data transmission from EGSE or to command generation of simulated frames from DCU itself. Science data are elaborate by DPU (with the possibility to configure DBB scrubbing and DPU scrubbing and synchronization) applying or not compression and then sent to MMU. It is possible to start the MACC a single or all the DCU. The MACC is performed one time using the DBB memory bank chosen and at the end unit is ready to be commanded for a new operation. Macro steps: a. Configure DCU(s) to start MACC b. Start MACC on DCU(s) c. Wait 3sec d. Configure EGSE SCS(s) to start MACC e. Start MACC on EGSE SCS(s) f. Wait 3sec g. Verify power consumption checking EUT current consumption	Pre-requirements: - EGSE ON - SCS_CONF - Run of DPU_OFF-ASW - DPU_link_MMU - Run of DPU_ON (ALL) - DCU SCS ON (ALL) Script Parameters: - DCU MACC (0 – 7 or ALL) - Groups# (1 – 15) - Reads# (1 - 16) - Drops# (1 – 1000) - Data type (DCU_SIMU, SCS_DATA) - Raw row (YES,NO) - Raw row addresses (0-2047) - DBB scrub (YES, NO) - DBB Mem. Bank (A,B) - DPU scrub (YES,NO) - DPU sync (YES,NO) - Compression (YES,NO)

- Each step has to be converted in a sequence of telecommands
- Telecommands are routed to DPU
- Telemetries are acquired and checked
- Sidecar simulators are configured for data simulation
- Simulated data are processed by DPU ASW and sent via Spacewire interface to the host PC

TSC user interface



MILBUS 1553 Bus Controller



List of executed commands provided by TSC

496	2017-09-21T16:17:51.899	2017-09-21T16:17:51.900	NASC7908	S	S	S	I	S	S	
497	2017-09-21T16:17:52.992	2017-09-21T16:17:52.993	NASC5408	S	S	S	I	S	S	
498	2017-09-21T16:17:54.107	2017-09-21T16:17:54.108	NASC4900	S	S	S	I	S	S	
499	2017-09-21T16:18:00.500	2017-09-21T16:18:00.501	NASC4700	S	S	S	I	S	S	
500	2017-09-21T16:18:07.781	2017-09-21T16:18:07.782	NASC5308	S	S	S	I	S	S	
501	2017-09-21T16:18:09.900	2017-09-21T16:18:09.901	NASC1301	S	S	S	I	S	S	
502	2017-09-21T16:18:12.029	2017-09-21T16:18:12.030	NASC7108	S	S	S	I	S	S	

Start exposure

Exposure type and configuration

Processing parameters

DPU ASW periodic telemetries

187353	2017-09-21T16:44:49.631	NASM2005	309011150	1281	5	1	15	0	15956	2028-06-2
187354	2017-09-21T16:44:49.896	NASM2048	309011160	1281	5	1	16	0	15957	2006-09-0
187355	2017-09-21T16:44:50.630	NASM2047	309011100	1281	5	1	10	0	15958	2094-12-0
187356	2017-09-21T16:44:50.630	NASM2050	309011140	1281	5	1	14	0	15959	1993-12-0
187357	2017-09-21T16:44:50.630	NASM2046	309011170	1281	5	1	17	0	15960	1993-12-0
187358	2017-09-21T16:44:50.631	NASM2005	309011150	1281	5	1	15	0	15961	2028-06-2
187359	2017-09-21T16:44:50.906	NASM2048	309011160	1281	5	1	16	0	15962	2082-09-1
187360	2017-09-21T16:44:51.629	NASM2047	309011100	1281	5	1	10	0	15963	2094-12-0
187361	2017-09-21T16:44:51.630	NASM2050	309011140	1281	5	1	14	0	15964	2094-12-0
187362	2017-09-21T16:44:51.630	NASM2046	309011170	1281	5	1	17	0	15965	1993-12-0
187363	2017-09-21T16:44:51.631	NASM2005	309011150	1281	5	1	15	0	15966	1993-12-0

Foreseen activites for NISP-WE AIV in 2017-2018

- **AVM test (INFN) – October 2017 – December 2017**
  ICU HW-SW integration
  DPU HW-SW integration
  AVM integration and test

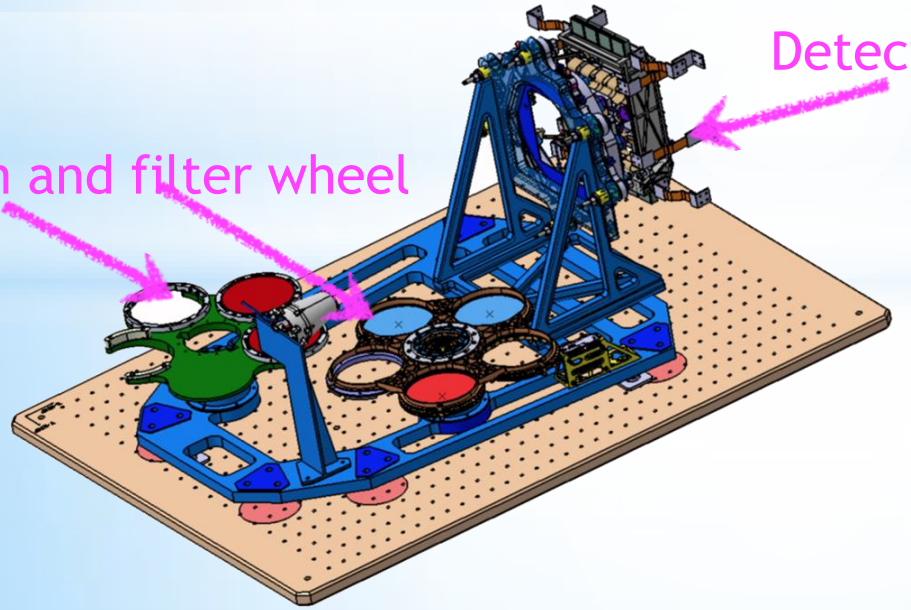
- **DPU EQM test with Focal Plane Simulator (@INFN Pd)**
  December 2017 –February 2018

- **NISP E(Q)M test @ LAM**
  Spring 2018

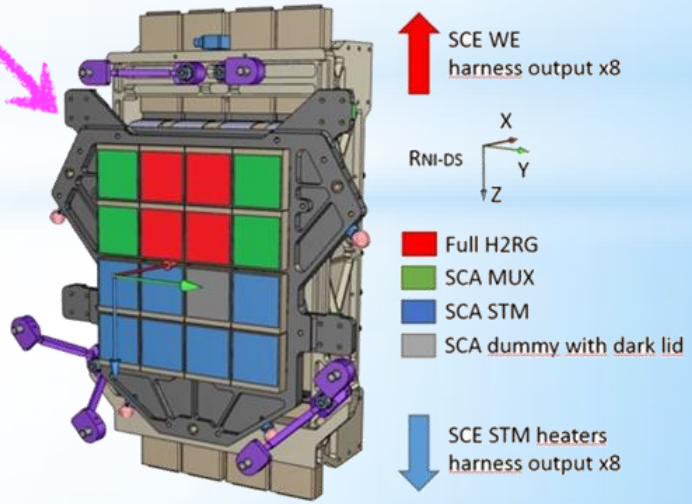
NISP-EM AIV test @ LAM

- allow at unit level, electrical, mechanical and thermal qualification
- allow the development of the ground checkout systems
- Validation of the, thermal, electrical, command & control test procedures for the FM
- test the NISP performances (limited to dark and flat field to 4 engineering detectors)

45 m^3 cryo-vacuum chamber
77K and 10^{-6} mbar
Large integration room (100tn seismic mass to provide high stability (< 10^{-7}g at 5 - 100 Hz))



Detector system



GANNT Diagram

Level			Activity Description WPS	I Year				II Year				III Year			
1	**0**	**0**	**Realization of DPU DM**	**140**	**140**	**140**	**80**	**85**	**50**						
1	1	0	Communication Protocols	140	140	140	140	40	30						
1	2	0	Performance Test	100	100	100	90	60	50						
2	**0**	**0**	**Flight Models Validation**									**40**	**60**	**100**	**110**
2	1	0	Porting				70	70	60	110	110	80	50	10	
2	2	0	Test Development					35	70	150	150	80	50	30	40
3	**0**	**0**	**Test Documentation**					**70**	**80**	**80**	**80**	**80**	**100**	**100**	**110**
4	**0**	**0**	**Educational Program**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**	**70**		
5	**0**	**0**	**Writing Thesis and reports**					**20**	**40**	**40**	**40**	**100**	**120**	**210**	**190**

Courses:

1. CCS 5 training @ TERMA – Leiden
2. IDEAS DB tools @ TASI – Torino
3. Detectors and Electronics for High Energy Physics @ INFN-LNL

Publications:

Proceedings of SPIE Space Telescopes and Instrumentation 2016

1. "Euclid Near Infrared Spectrometer and Photometer instrument concept and first test results obtained for different breadboards models at the end of phase C"
2. "On-board data processing for the near infrared spectrograph and photometer instrument (NISP) of the EUCLID mission" – Poster Presentation
3. "EGSE customization for the Euclid NISP Instrument AIV/AIT activities"
4. "Detailed design and first tests of the application software for the instrument control unit of Euclid-NISP"
5. "Instrument Workstation for the EGSE of the Near Infrared Spectro-Photometer instrument (NISP) of the EUCLID mission"
6. "High precision reconstruction of electromagnetic showers in the nuclear emulsions of the OPERA experiment – EPS-HEP 2017 – Poster Presentation"

Thank you for your attention