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TITLE:	**Hardware Definition NI-Maintenance Setup**		
Date:	12/02/2024	**Issue:**	1.0
	Filomena Schiavone		

1. Change log

Issue	Date	Page	Description of Change
1.0	12/02/2021	all	First issue

2. Table of Contents

3. Reference documents

Applicable documents

AD	Title / Author	Document Reference	Issue	Date
1	Euclid SIDECAR ASIC Firmware ICD (ITAR protected)	MS-132-08	3.1	09/03/2017
2				
3				

Reference documents

RD	Title / Author	Document Reference	Issue	Date
0	NISP Acronyms List	EUCL-IAP-LI-1-001	2.0	05/04/2013
1	NI-DPU ASW Test Specifications	EUCL-OPD-PL-7-003	2.1	06/18/2020
2	NISP Flight User Manual	EUCL-IBO-MA-7-005	2.1	03/31/2021
3	Export Control Classification Declaration	EUCL-LAM-CE-7-021	3.0	12/08/2020

4. Maintenance Setup objectives

The NISP maintenance setup is located at INAF-OAS Bologna premises at room 606 at the 4th floor of the INAF building (Istituto Nazionale di Astrofisica - Osservatorio di Astrofisica e Scienza dello Spazio Bologna, Via Piero Gobetti, 93/3, 40129 Bologna BO).
This setup, described in this document, is aimed to the software maintenance of the NISP warm electronics - ICU and DPU instruments of the NISP system of the EUCLID mission, i.e. ICU and DPU Application Software (ASW).

To maintain both ASWs the complete set of software features corresponding to all the NISP operating modes should be executed using representative hardware of the final NISP flight setup. Therefore, a fully representative hardware setup was mounted at the INAF-OAS laboratory which is mainly composed by the ICU-EQM and DPU-EQM models and a focal plane composed of 8 SCEs mounted in the DM model of the NI-Focal plane array (this represents the half of the NI flight model, no SCAs are foreseen for this setup). All the connector harnesses completing the connections are fully compliant with the flight requirements. The setup is also equipped with EQM models of the wheel system array (with both Filter and Grism wheels) and a Calibration Unit. The system is governed by the NI-EGSE, which trough the CCS issues the commanding with the nominal NISP time specifications through the MILBUS1553 interface and simulates the data storage in the Mass Memory Unit of the SpC SVM via the Spacewire link; both interfaces are redundant. In addition, an Instrument Workstation (IWS) is linked to the CCS-SCOE allowing to access and quick look the NISP data products.

The DPU-ASW development ambient composed of a PC with the software tools necessary for the ASW development, cross compilation and debugging with the ability to be interfaced directly to the DPU-EQM unit through a dedicated USB-serial interface is present at the laboratory. As well as the dedicated infrastructure for the software engineering i.e. static tests and unit tests that can be executed in the in the same Real Time Operative System using the DPU-DM model also present in the laboratory.

All the hardware components are described in section 7 and the main differences and limitation with respect to the flight hardware are highlighted.

A stand-alone system to operate the ASICs is also present in the laboratory, is composed by two different readout systems that can be interfaced with interfaced with the detectors using nominal NISP connectors. The system is completed with a cryogenic array which allows the nominal operations of a SCA.

It is foreseen to have the maintenance setup available for the complete mission lifetime i.e. 6 years after launch. The maintenance setup can be accessed from external CCS stations using standard protocols.

3.1 PA-activities

TBD

5. Laboratory management and safety indications

5.1 General recommendations

All the activities in the NISP SW maintenance laboratory should be authorized by the laboratory operations and safety responsible. Lab. Operations and Safety Responsible (Italian regulation *preposto del laboratorio sotto regolazione locale dell'INAF-OAS*):

Eduardo Medinaceli, phone number +39 051 639 8698, room C-405 (2nd floor),
mobile number +39 3491507880, email: eduardo.medinaceli@inaf.it

In case of emergency or any kind of safety issue he must be contact immediately, if the responsible cannot be reach then the following people can be contact:
***Local INAF-OAS safety responsible (Italian regulation *RSPP*): Filomena Schiavone, phone number +390516398677
***Local INAF-OAS safety responsible (Italian regulation *RLS*): Vito Conforti, phone number +390516398737

Under any circumstances any hardware component part of the laboratory cannot be removed from the lab without previous authorization from the lab. responsible. ITAR regulated material (ASICs, SCAs, MUXs) can be removed from the lab. only previous written authorization and documented justification.

5.2 Safety signs description

If needed add description *****

6. Maintenance Setup infrastructure

In the INAF-OAS premises a laboratory was set up to contain all the NISP hardware dedicated to the SW maintenance described in the next section. And auxiliary PCs dedicated to the DPU-ASW development (PC-VxWorks) and regression tests (PC-Builder); a PC dedicated to the stand-alone ASICs readout systems (PC-Markury). Two CCS workstations (Console #1 and #2 CCS), plus the NISP SCOE rack and the NISP CCS rack.

Fig. 1, lab. Overview, on the right-hand side is shown the separated ambient that hosts the NISP components

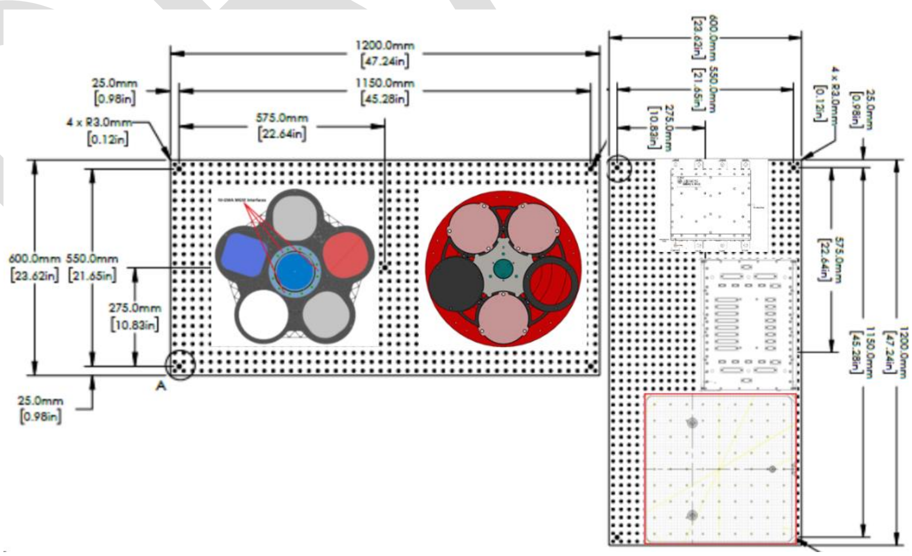


Fig. 2, scheme of the warm electronics, wheels assembly, and focal plane collocation at the maintenance laboratory.

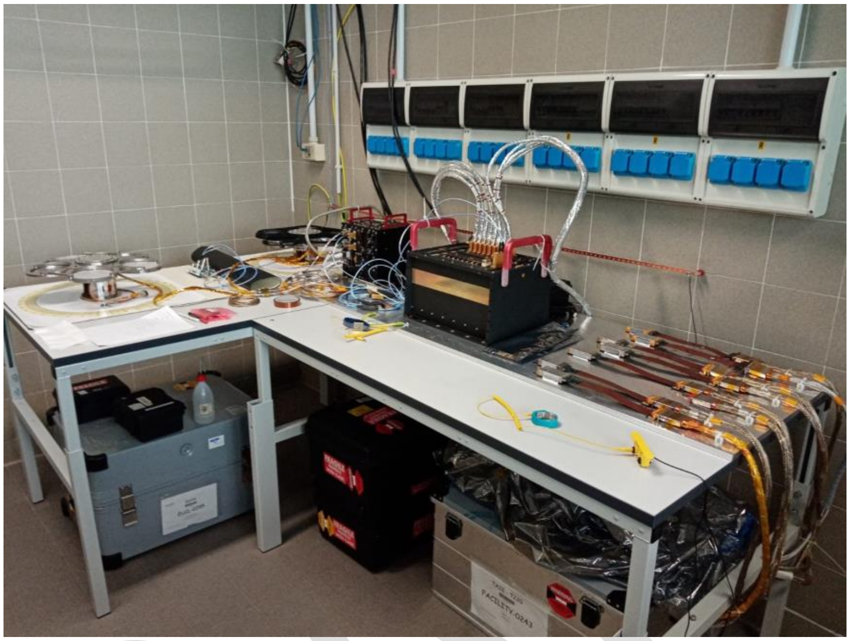
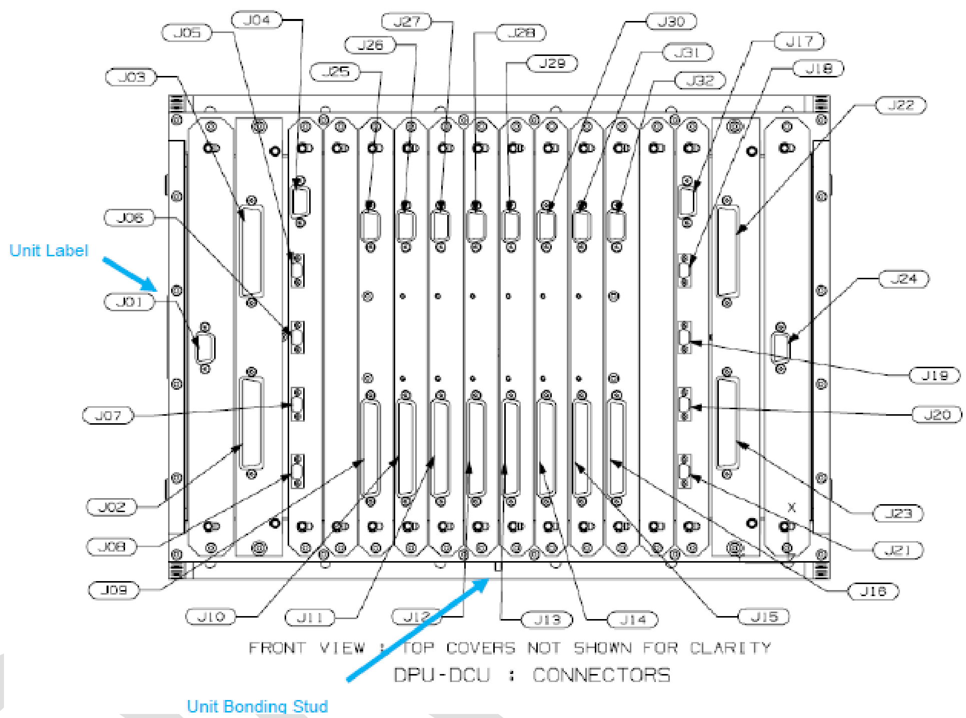


Fig. , Top: Warm electronics and 8 detector chains (DCU-Flex cable-SCE), Bottom: GWA and FWA.

7. Hardware definition

7.1 NI-DPU-EQM



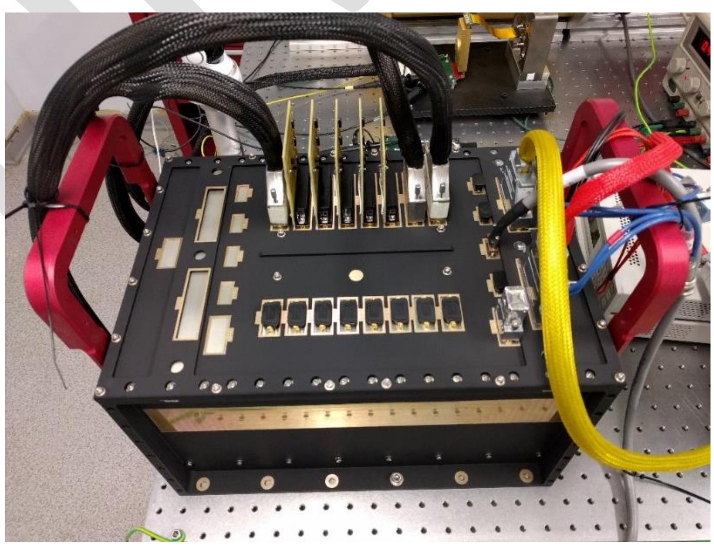


Fig 3, *Top*: DPU-EQM connector schematics; *bottom*: DPU-EQM unit equipped with 3 out of 8 detector chains (currently are mounted 8 detector chains)

The DPU-EQM model is fully representative of the NI-DPU-FM.
The DPU-EQM model has no redundant (R) section of the cPCI, composed by the power supply board (PSB), the data buffer board (DBB), and the data router board (DRB).

The DPU-EQM is composed with:

- is fully equipped with the 8 Digital Control Units (DCUs)
- CPU board Maxwell™ 3xSCS750®-PPC (N only) 400 MHz clock
  with error detection (1 ms), Radiation Tolerant class S – VxWorks 5.1 RTOS
- Memories:
  - SRAM 256 MB, EDAC protected
  - E2PROM 8 MB, ECC protected
  - DBB: 6 GB Dual Ported Data Buffer Board (N only)
- DRB: 127 MB Space Wire Router Board (N only)
- Power Supply Board (N only)
- Communication Interfaces:
  - 1553 MILBUS interface with ICU (N/R)
  - Space Wire interface with DCUs and MMU (N/R)

All the DPU-ASW features can be tested with the DPU-EQM model including FDIRs, besides the synchronization with a second DPU unit.

The CPU board of the DPU-EQM model is equipped with a serial debug port which allows the link with a PC through a USB-serial connector interfaced with the Tornado 2.2 debugger native of the software development ambient.

*** ADD Tornado I/F with DPU-EQM description plus photo ***

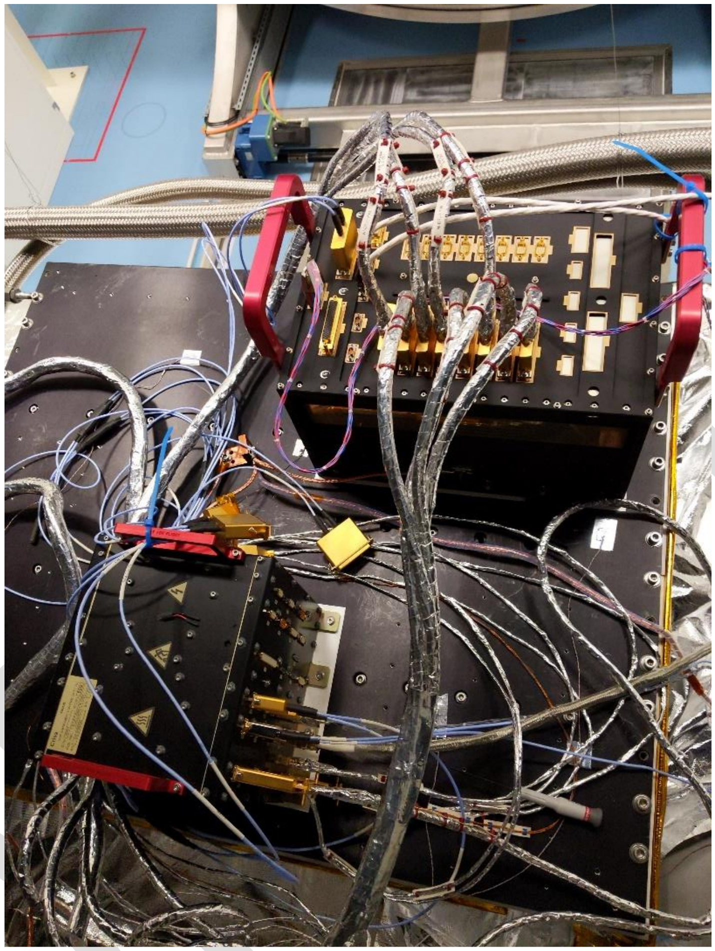
7.1.1 Hardware limitations with respect to the Flight model

- No redundant cPCI sector (PSB, DBB, DRB)
- With the single DPU-EQM model the synchronization of the two DPUs (and therefore more than 8 detectors) cannot be tested.

Software functionality

Besides the hardware limitations the software implementation of broadcast operations can be fully validated even with two detectors; only the total amount of data generation cannot be achieved with only 8 detectors (with respect to 16), but from the software point of view this do not imply a limitation because the operations are serialized for a single detector.
All the FDIRs can be enabled, and the SW functionalities associated can be tested.

7.2 NI-ICU-EQM



7.3 NI-Wheel system (FWA, GWA)

7.4 NI-CU

7.5 NI-Detector System (Focal plane array)

The detector system array is composed of a total of 8 SECs fully populating the DPU-EQM, this represents the half of the NI-Flight focal plane array. With 8 SCEs all the NISP features can be tested. The maintenance setup focal plane array is composed by 8 ASICs (SCEs) some of them linked to MUXs, and a fully representative set of connection harnesses.

The detector's array will be mounted in the NI-Focal Plane DM model, see details in section 6.5.3 (***** keep this reference updated)

7.5.1 NI-Harnesses

DPU-SCE HARNESS CABLES send from LAM (used in ERIOS)
CIS (~2.4m) – 15 cables
BKTI 0019P (BK_I P19) – BKTNISCE0108 006J (BKT_SCE_TOPJ06)
BKTI 0014P (BK_I P14) – BKTNISCE0108 001J (BKT_SCE_TOPJ01)
BKTI 0016P (BK_I P16) – BKTNISCE0108 003J (BKT_SCE_TOPJ03)
BKTI 0018P (BK_I P18) – BKTNISCE0108 005J (BKT_SCE_TOPJ05)
BKTI 0017P (BK_I P17) – BKTNISCE0108 004J (BKT_SCE_TOPJ04)
BKTI 0021P (BK_I P21) – BKTNISCE0108 008J (BKT_SCE_TOPJ08)
BKTI 0027P (BK_I P27) – BKTNISCE0916 0014J (BKT_SCE_BOTJ14)
BKTI 0023P (BK_I P23) – BKTNISCE0916 0010J (BKT_SCE_BOTJ10)
BKTI 0025P (BK_I P25) – BKTNISCE0916 0012J (BKT_SCE_BOTJ12)
BKTI 0029P (BK_I P29) – BKTNISCE0916 0016J (BKT_SCE_BOTJ16)
BKTI 0024P (BK_I P24) – BKTNISCE0916 0011J (BKT_SCE_BOTJ11)
BKTI 0022P (BK_I P22) – BKTNISCE0916 0009J (BKT_SCE_BOTJ09)
BKTI 0026P (BK_I P26) – BKTNISCE0916 0013J (BKT_SCE_BOTJ13)
from LAM

Back from TAS-I
BKTI 00*P (BK_I P*) – BKTNISCE0108 00*J (BKT_SCE_TOPJ07)
BKTI 00*P (BK_I P*) – BKTNISCE0916 00*J (BKT_SCE_BOTJ15)

HMU – 12 cables
INS-HMU 605 – NI-DPU1-P13
INS-HMU 606 – NI-DPU1-P14
INS-HMU 607 – NI-DPU1-P15
INS-HMU 608 – NI-DPU1-P16
INS-HMU 617 – NI-DPU2-P09
INS-HMU 618 – NI-DPU2-P10
INS-HMU 619 – NI-DPU2-P11
INS-HMU 620 – NI-DPU2-P12
INS-HMU 621 – NI-DPU2-P13
INS-HMU 622 – NI-DPU2-P14
INS-HMU 623 – NI-DPU2-P15
INS-HMU 624 – NI-DPU2-P16

TGS Bundles (from LAM) – 8 cables
All C & K Part Nr: CO20418-0052C:

NISP_SCE_TGS_B01
NISP_SCE_TGS_B02
NISP_SCE_TGS_B05
NISP_SCE_TGS_B06
NISP_SCE_TGS_B11
NISP_SCE_TGS_B13
NISP_SCE_TGS_B14
NISP_SCE_TGS_B15

7.5.2 NI-ASICs and MUXs

ASIC related equipment from CPPM
6 SCEs
All these SCE but the 500c are NRE or Flight parts which need adapters with level shifter.
500c is a prototype of flight SCE and do not need level shifter adapter.

At Bologna
1) **067** SCE PN 9510493-02; DC 1349
2) 033(038?)
3) 015-F019
4) 013-F043
5) SN 087=17491
6) SN 079=17492
7) SN 034

500c (SN=500, PN=10434511-1) – was at TAS-I (now back to JPL)

Back from TASI (3 SCE + 3 MUX?):
8) SCE F025 (from CPPM, old type see SCE F025 email) - MUX 17390 (MUX back to JPL???)
SCE 010C - MUX 17391 from ADS (MUX back to JPL) -> SCE BACK TO JPL 10/05/21(flight-like)
SCE-009C (from ADS) -> SCE BACK TO JPL 10/05/21(flight-like)

AVM setup at TASI/MOC: SCE PN 9510493-02; DC: 1325; SN: 039 mounted in NIOMADA SIM
FLEX S/N 003, MFR 636951722 - `ESA01EA00000 rev.003-002`(at TASI - AVM)

SCE PN 0910493-02; DC: 1325; SN: 033 (?)=this should be the #33 coming from TASI (one from INFN-Pd brought by Stefano)

INFN-Pd:
SCE+ MUX (with led, without pull-up) at INFN-Pd S/N TBD
SCE S/N TBD at INFN-Pd
(@INFN-Pd: 2xSCE (1 w issues), 1xMUX, 2+1(?) Flex)
2+1(?)– 1 w problems +3 flex (with pullup) + 2h2rg(francia) + 1xMUX +1MUX(rotto)=INFN 12182023

NSA Adapters
8 Adapters (NSA) – At Bologna
5 with level shifters plus 1 without level shifter (LS)
1) 002-001
2) 003-001
3) 002-003
4) 002-002
5) 001-001
6) 002-004
7) 3002/2002* without LS – send after Issue on SN2007
8) 3001/2007 without LS

EQUIPMENT FROM INAF-OAPd – for stand-alone setup (with pull-up)

- SCE 042 (SN=042, PN=9510493-02, DC=1325) Teledyne EM part without the pull-up circuit
- ZIN-MUX SN = 17228 (OAS) + SCE (S/N TBD): stand-alone setup
- CryoASIC S/N 100

7.5.3 HAWAII detectors

17178 Still in USA
17243 Still in USA
17187
17188
17186
17191
17192*

However, 17192 is suspected of being damaged (TBC) so I propose to replace it with the next best quality (grade 3) 17184 (IPNL).
Note that there are no grade 2 NRE H2RG,
This allocation should satisfy NISP maintenance needs until end of mission.

7.5.4 NI-Focal Plane DM

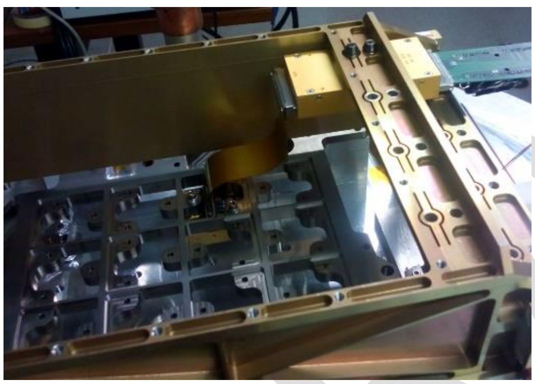
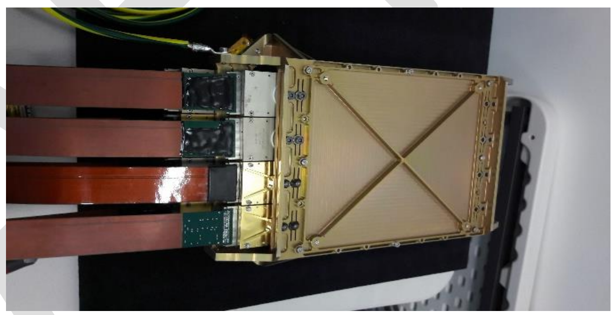



Fig. 4, left: SSS structure, DM Focal Plane (burnished truss) – right: fully loaded SSS – can hold up to 8 detectors.

The SSS burnished truss showed in detail in figure *** is the SCEs mechanical holder; and is fully representative of the NISP-SSS. Up to 16 SCEs can be screwed, using two bolds to the structure, ensuring the grounding connection; regular SCE connectors can be used to link them to the to the relatives DCUs. In the maintenance setup 8 SCE are used.

SSS currently at Bologna

Note:
Teledyne Series 17: engineering H2RGs
Teledyne Series 18: flight & flight spare H2RGs

8. NI-DPU DM system

The DPU Demonstration model (DM) is composed by:
- DM Maxwell board
- DM data router board
- DM data buffer board
- a single DM DCU board
- a DM power supply board
- MILBUS1553 and SpaceWire interfaces

and complemented with a MMU simulator (PC).
********** ADD 1553 pods – plus Copilot

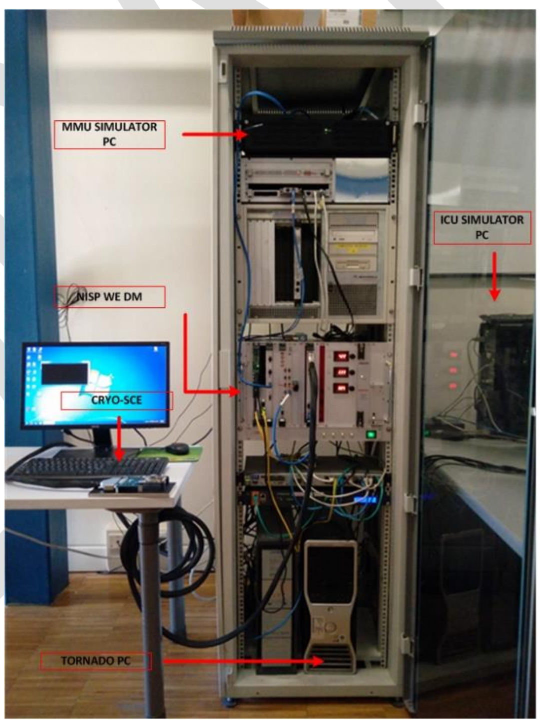


Fig. 5, DPU DM model – installed in the dedicated rack.

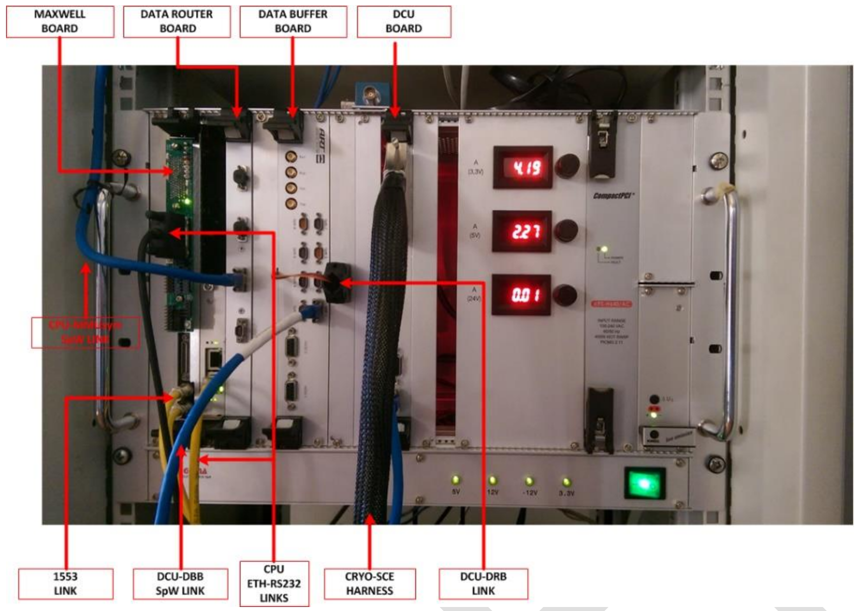


Fig. 6, Detail of the DPU DM components. The boards and the interfaces contained in the unit are shown in the picture.

8.1 Main usage of the NISP-DPU DM model

The DPU-DM will be used as a target RTOS for the execution of the Unit tests part of the continuous integration and regression tests of the DPU-ASW.
A Parasoft C/C++ test bench is interfaced to the Maxwell board of this equipment through an ethernet connection to the PC dedicated to the DPU-ASW maintenance (were the development Tornado 2.2 ambient is installed).

9. NI-DPU-ASW maintenance infrastructure

The maintenance activities for the NI-DPU-ASW are described in the EUCL-IBO-PL-7-024 NI-DPU ASW Maintenance Plan, and all the activities related to the software development, test, and validation will be performed using the NI maintenance setup described in the current document.
The infrastructure is equipped with a PC (pc-vxworks2) with the Tornado development environment which can be directly interfaced with the Maxwell board of the DPU-DM model through a ethernet link. The same PC hosts the C/C++ Parasoft ambient for the unit testing which also runs over the Maxwell board.
A second PC (pc-jenkins) with the Jenkins regression tests ambient (static test).
Both PCs access through Git to the DPU-ASW source code.

Fig. * dedicated infrastructure (PC, and Virtual Machine) with the DPU-ASW development ambient installed.

10. NI-ICU-ASW maintenance infrastructure

11. Test sequences input format for activities using the NI-Maintenance setup

Any activity programmed using the NI-maintenance setup e.g., test procedures debug, validation, refactoring, etc. must be written using the modular NI commanding sequences FOP defined in [RD-2]. All input formats of command sequences will be executed with the NISP-DB (NISP parameters and telemetry interpretation), and the CCS-SCOE will be used to execute the sequences; therefor, the timing implemented in the test procedures could be 100% representative of the NISP flight operations ones. (TBD is this true?????)

12. Stand-alone ASIC readout systems

Stand-alone "**R**(oom)**T**(emperature) Development kit" (or SAM Electronics) and the Markury Electronics connected by means of a cable to a SCS (SCE, Flex and Mux see next figure), this setup is representative of the NISP hardware (DCU-SCS Sensor Chip System).

The nominal EEF3.1 Euclid SIDECAR ASIC firmware [AD1] can be used and all the features of the ASIC microcode can be fully configured.

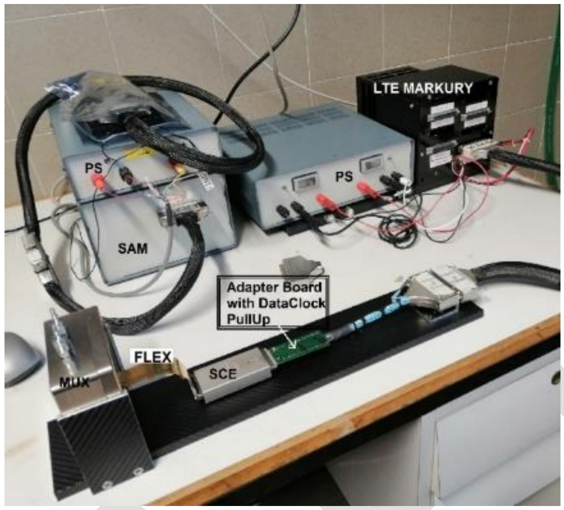


Fig. 7, Displayed on the background of the picture are shown the stand-alone ASIC's readout electronics systems available at the maintenance setup – SAM, LTE Markury with their respective power supplies (PS).

1. SAM Teledyne electronics + IDL Workbench Software Environment + SIDECAR Integrated Development Environment (IDE)
2. Markury LTE (Laboratory Test Electronics) + Serial Port Control V1.4

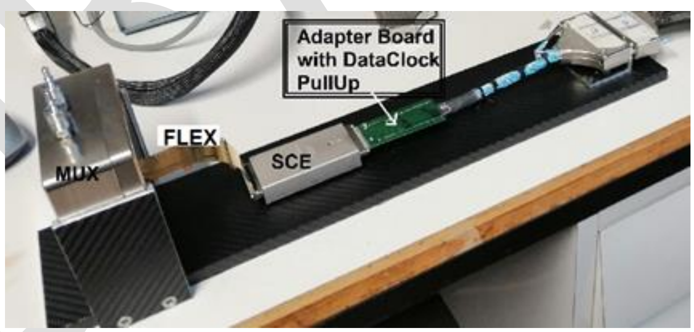


Fig. 8, SCS – SCE + Adapter Board with DataClock PullUp, Flex and MUX used with the stand-alone readout systems.

These hardware-software configurations are fully representative of whole functionalities implemented on the Euclid DPU-ASW.

The JADE board is also present at the laboratory. It can be interfaced to the SCE using a dedicated IDL software program, see Fig. 9.

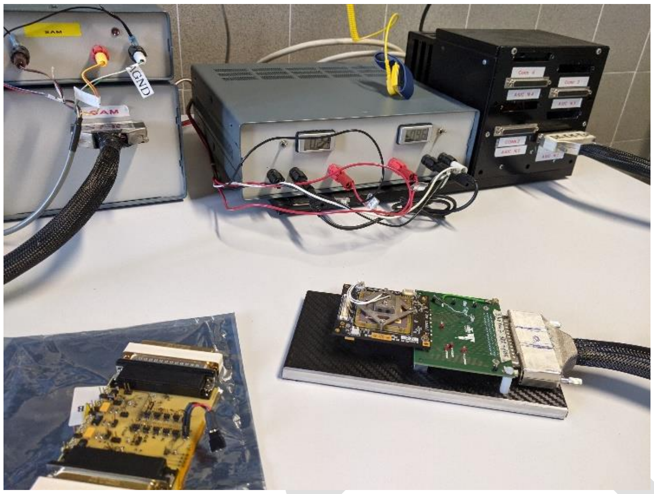
Figure 9, JADE stand-alone SCE readout system.

All the tree systems are interfaced with a PC (pc-markury) equipped with a dedicated video board (Matrox) and dedicated software.

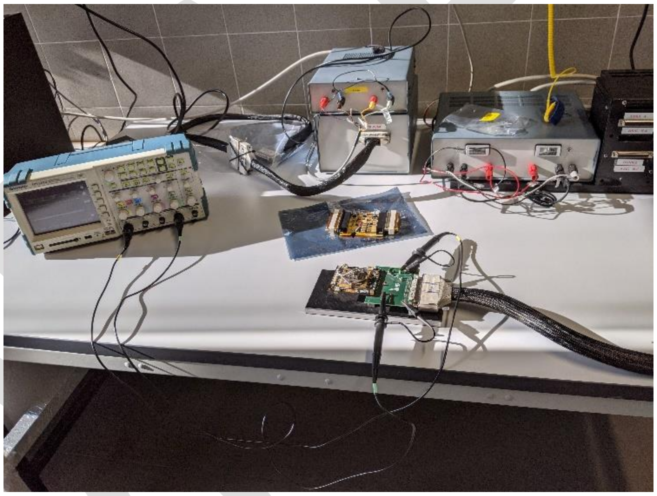
13. Electrical measurements on SCEs

13.1 SCE Break-out-boxes

Different types of Break Out Boxes (BoB) than can be plugged in the SCE (or cryo-ASIC) 62 pin connector are available; these allows the measurement of analog signals from the SCE in the LVDS bus using an oscilloscope.



BOB available for the measurement of electrical signals



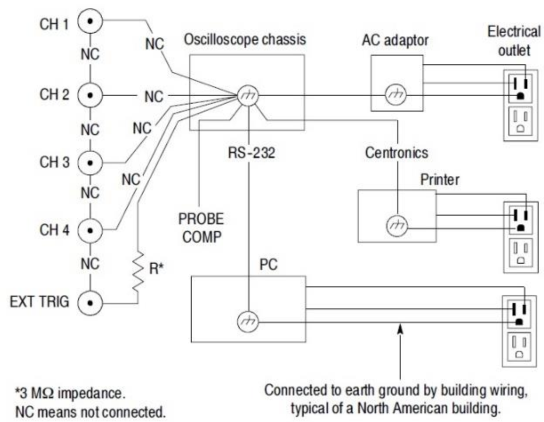
Setup for SCE's electrical signals measurements using a cryo-ASIC interfaced with a BoB, commanded by Markury-electronics, and read out by an oscilloscope.

13.2 Oscilloscope

A digital wide band oscilloscope with 4 channels with differential inputs like (independent ground) series MSO5000B – Tektronik is available in the laboratory.

Taking Floating Measurements

For taking floating measurements, the oscilloscope channel and Ext Trig inputs (3 MΩ) are isolated from the oscilloscope chassis and from each other. This allows independent floating measurements with channel 1, channel 2, and Ext Trig (and with channel 3 and channel 4 on four channel models).



The oscilloscope inputs float even when the oscilloscope is connected to a grounded power supply, a grounded printer, or a grounded computer.

Most other oscilloscopes share a common reference for the oscilloscope channel and Ext Trig inputs. This reference is typically connected to earth ground through the power cord. With common-referenced oscilloscopes, all input signals must have the same common reference when you take any multi-channel measurements.

Without differential preamplifiers or external signal isolators, common-referenced oscilloscopes are not suitable for taking floating measurements.

14. Cryogenic setup

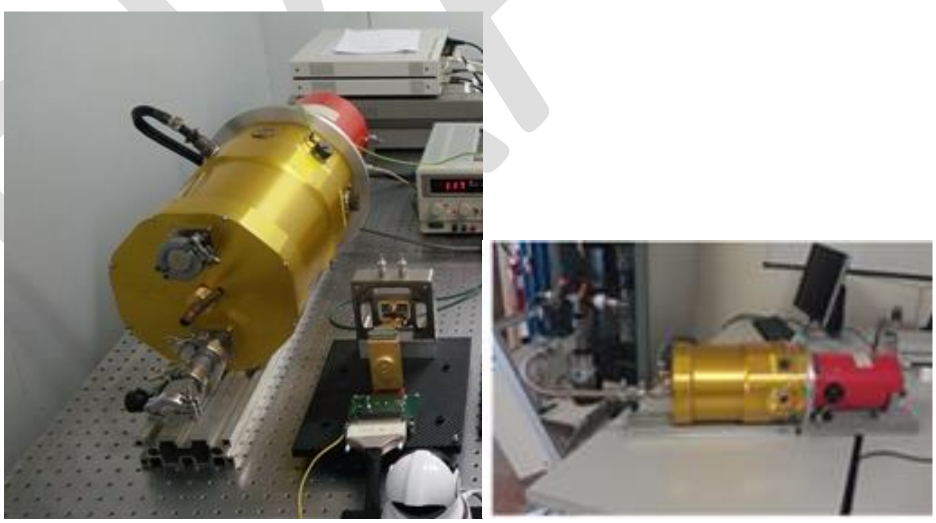


Fig. 9, cryogenic setup for SCA operations

- SCESYM3 : this is a complete LN_2 cooled cryostat system based on one NISP SCE coupled to a H2RG detector. The system (see Figure ***) can be connected to the EM/EQM units. The SCESYM3 can be internally illuminated via IR LEDs and allow the production of NISP representative frames, [RD-1]. The system can also be interfaced to the available Markury Scientific or TIS-SAM controllers.

- An EUCLID nominal HAWAII detector interfaced with a cryoASIC is used in the cryogenic setup (TBD serial numbers of the SCE/SCA units).

On-loan to INFN Pd. S. Dusini (since 13 April 2022), cryogenic setup three dedicated connection harnesses (analog/digital to Markury, and temperature regulation to LakeShore instrument)

15. On-line documentation

15.1 DPU and ICU ASW software repositories

DPU-ASW repository: https://baltig.infn.it/euclid/DPU-ASW (INFN credentials needed)
Public DPU-ASW webpage: https://euclid.baltig-pages.infn.it/DPU-ASW/index.html
Add Doxygen DPU-ASW???????
ICU-ASW repository: https://baltig.infn.it/euclid/ICU-ASW (INFN credentials needed)

15.2 NI documentation repositories

DPU-ASW QAR data-pack repository:
https://owncloud.iasfbo.inaf.it/owncloud/index.php/login?redirect_url=%252Fowncloud%252Findex.php%252Fapps%252Ffiles%252F%253Fdir%253D%252FDPU%252520ASW_QR-AR%252FDPU-ASW_implementedRIDS-QAR_FinalDatapack%2526fileid%253D248470 (INAF credentials needed)

15.3 EUCLID repositories

- NISP-QAR documentation (TBD)
- NISP-TV3 documentation (TBD)

16. SW licenses status

- WindRiver Tornado 2.2 (DPU-ASW development ambient and debugger).
- VxWorks (DPU RTOS) perpetual license linked to development PC provided to F. Bortoletto from INAF-OAPd.
- RTEMS (ICU RTOS) TBD.
- GRMON (ICU-ASW debugger) TBD.
- Eclipse (ICU-ASW) development ambient, free license GNU ********** TBD.
- EA Ultimate Edition (DPU-ASW modelling) currently version 15.1.1528 using the following licenses.

OAPd A. Balestra	OTT0-IK60-KTM8-PWAR
OAS E. Medinaceli	4G61-HL7F-PSCP-FB5V

- IDL (IWS interactive data visualization) currently using version 8.6.0 with license from INAF-OAS.

- GIT (software repository DPU and ICU), https://baltig.infn.it provided and maintained by INFN-CNAF.
- TeamViewer (remote connection to the infrastructure), currently using Corporate license from INAF-OAS.
- Jira (configuration control toolkit DPU-ASW), https://issues.infn.it/jira provided and maintained by INFN-CNAF.
- Jenkins (continuous integration and regression tests DPU-ASW) private but will be moved to https://ci.infn.it/jenkins/ maintained by INFN-CNAF.
- Polyspace R2020b (continuous integration and regression tests DPU-ASW), currently using INAF license.
- OwnCloud server (documentation repository), https://owncloud.iasfbo.inaf.it/ provided and maintained by INAF.
- Copilot? **************

Il CD d'istallazione della Matrox dell'OAPd (attualmente a OAS) e' in prestito all'INFN di Pd (S. Dusini).

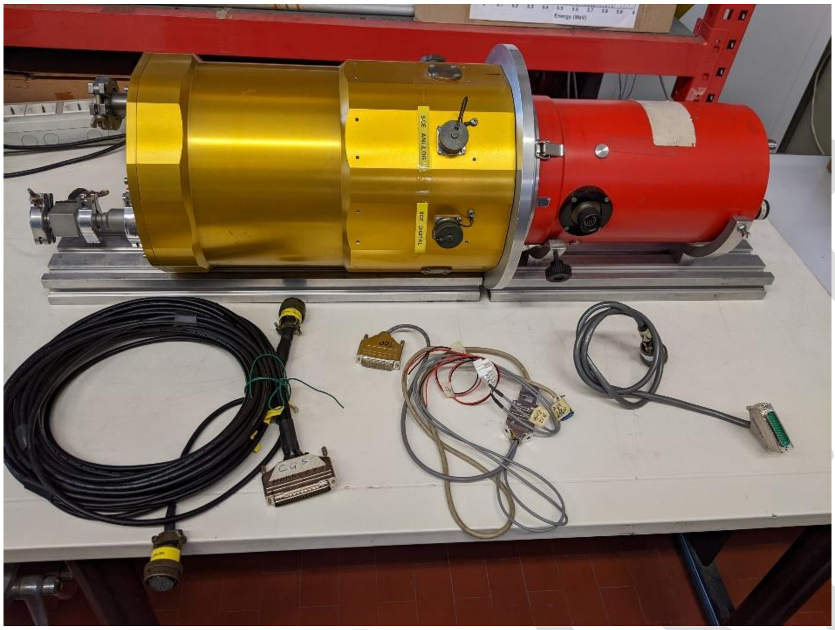
17. HW licenses

The following NISP material is subject to the ITAR regulation (export control classification declaration [RD-3]):

- CPU boards Maxwell™ 3xSCS750®-PPC present in DPU DM and EQM models
- SCEs mounted in the focal plane array – section 6 (subsection 5.5 *** keep this reference updated)
- H2RG detector currently at CPPM ******************

18. ON LOAN MATERIAL

Dewar plus connectors to S. Dusini @ INFN-Pd



19. INAF proposal for founding – mini grant

Request Title: Enhancement of the test facility dedicated to space-borne near infra-red detectors

Short Abstract:
A laboratory for activities related to any implementation of space-borne Teledyne ASICs readout system of the HAWAII2 near-infrared detectors is available at OAS. The laboratory is in part dedicated to the Euclid space mission warm electronics software maintenance of both ICU and DPU units. That setup includes the flight-like detectors interfaced with the frontend electronics. Also, stand-alone readout systems enabling the test of both the ASICs and the H2RG detectors are available.
The laboratory is the perfect test bench for space missions or ground-based observatories detecting radiation with these wavelengths, allowing the development of both hardware and software of new readout systems.
The objective of this project is to enhance the setup with a cryogenic infrastructure.

Request Description:

All the functionalities of the Teledyne's ASICs can be demonstrated in the laboratory operating at room temperature, as well as the full electrical characterization of the power supplies and output signals using different readout electronics. Nevertheless, using cryogenic infrastructure, the full operability of the H2RG detectors being operated at their nominal (flight) ambient conditions (ASICs T~135 K and H2RG T ~ 90K) can enable the full characterization of the science signals. In this configuration, new readout electronics interfaced with the detectors can be tested, as well as new scanning strategies.

Eventually, new features offered by new releases of the ASIC's firmware can be demonstrated and validated.

The dewar, see figure 1 has a fully operating interface with Teledyne's ASICs equipped with a H2RG detector, see figure 2. This equipment was built to test early Euclid's infrared detectors operations, currently is present at the OAS laboratory but needs to be refurbished because it was partially dismounted. The cryogenic interface using an active flux of liquid nitrogen has to be restored, as well as the temperature regulation system.
The dewar has an external interface (vacuum feedthrough connectors) compatible, from the pinouts point of view, with all readout systems (warm electronics) present at the OAS laboratory.

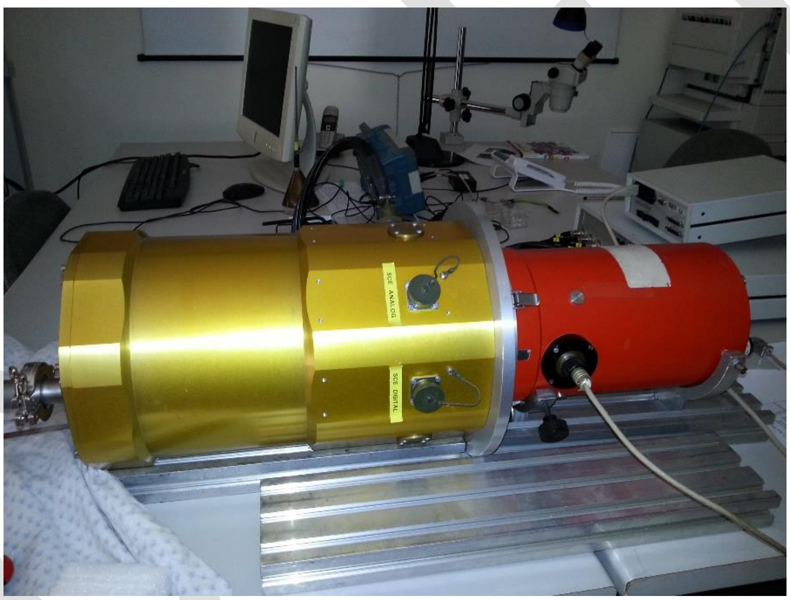
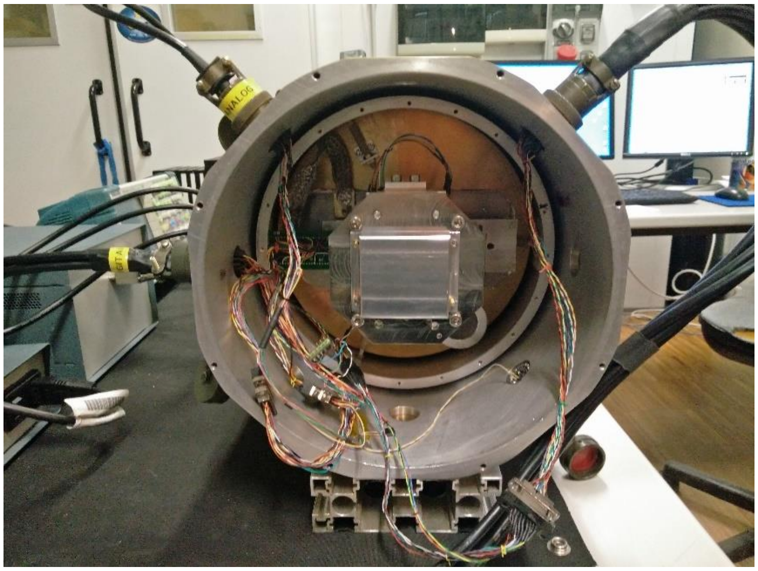


Fig. 1, H2RG detector cryogenic setup composed of a dewar to be actively cooled with liquid Nitrogen.



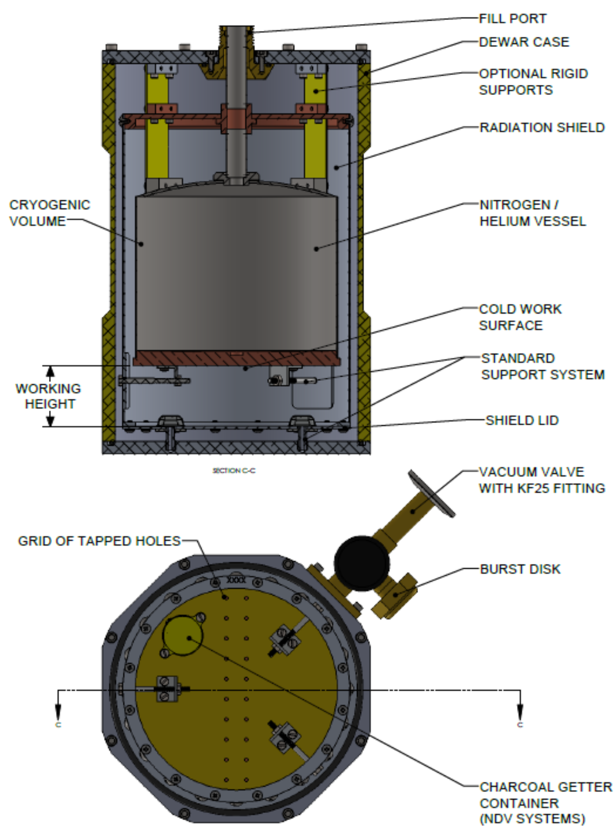


Fig. 2, cryo-dewar internal disposition of the front-end electronics (ASIC not shown), and the H2RG detector (placed behind an aluminum cover, shown at the center of the picture)

The dewar is internally ready to distribute the cold but the external system to pump liquid Nitrogen inside the LN2 tank is currently missing at the laboratory and must be also foreseen a vacuum pump system used to operate the dewar at low pressure. To complete the system an external temperature controller is needed to regulate the temperatures of the SCA and of the SCE, it is also used to decrease the H2RG's temperature gradually to avoid damaging the detector.

Participants

Name	E-mail	FTE 2022	FTE 2023
Eduardo Medinaceli	Eduardo.Medinaceli@inaf.it	0.2	0.2
Ruben Farinelli	Ruben.Farinelli@inaf.it	0.0	0.0
Enrico Franceschi	Enrico.Franceschi@inaf.it	0.0	0.0
Natalia Auricchio	Natalia.Auricchio@inaf.it	0.0	0.0
Adriano De Rosa	Adriano.Derosa@inaf.it	0.0	0.0
Fulvio Gianotti?	Fulvio.Gianotti@inaf.it	0.0	0.0
Andrea Balestra?	Andrea.Balestra@inaf.it	0.0	0.0
Paola Battaglia?	Paola.Battaglia@inaf.it	0.0	0.0
Sebastiano Ligore	Sebastiano.Ligore@inaf.it	0.0	0.0
Leonardo Corccione	Leonardo.Corcione@inaf.it	0.0	0.0
Donata Bonino	Donata.Bonino@inaf.it	0.0	0.0
Vito Capobianco?	Vito.Capobianco@inaf.it	0.0	0.0

PI: Ph.D. E. Medinaceli manager of the Data Processing Unit's (DPU) application software of the NISP detector is a specialist in all the operations of the infrared detectors (H2RG) and of the readout electronics (ASIC). Also, with experience in Germanium detectors.
Collaborator: Ph.D. R. Farinelli expert in the processing of the images obtained with the H2RG detectors, he was also a developer of the on-board software of the DPU of NISP.
Collaborator: E. Franceschi expert in the spacecraft's interface dedicated to the commandability of the NISP instrument.
Collaborator: Ph.D. N. Auricchio is the NISP PA of the Italian activities, has expertise in Euclid's infrared detectors, and in other solid-state detectors used for gamma radiation detection.
Collaborator: A. De Rosa, is the mechanical interfaces and thermal engineer.
Collaborator: F. Gianotti, computational support.
Collaborator: A. Balestra, DPU-ASW developer
Collaborator: P. Battaglia, NISP operation manager
Collaborator: S. Ligore, manager of the Instrument Control Unit's (ICU) application software.
Collaborator: L. Corcione, ICU-ASW developer and expert of the NISP electrical interfaces.
Collaborator: D. Bonino, ICU-ASW developer
Collaborator: V. Capobianco, ICU-ASW developer

External Collaborators: there are collaborators external to INAF, that participate in activities related to the setup present in the laboratory

Deliverables and Milestones

Cryogenic Setup Validation

With the present upgrade, at the bologna laboratory would be possible to make measurements with the space-borne infrared detectors representative of the ones obtained by Euclid during flight operations. With this a cross-check of the detector's performances can be done to validate the new experimental setup. This will be done using the full detector chain present at Bologna, starting with the cryogenic setup, readout by the NISP electronics, and applying the nominal onboard pre-processing to the acquired images. To do this the Electrical Qualification Models of the NISP warm electronics (Instrument Control Unit, and Data Processing Unit) will be used.

With the validated setup, new operational procedures or scanning strategies using the infrared detectors can be tested, and their impact on the science performances studied. This can enable the usage of new models of the readout electronics interfaced with the detectors.
This is of particular interest for future missions or ground observatories developing new readout electronics or new scanning and data pre-processing implementations. The test bench at Bologna will open the possibility to perform end-to-end tests, i.e., executing a given scanning strategy and evaluating the effects on the science data. (Without the cryogenic set up all the operations can be done regardless of the scientific data acquisition because at operating at room temperature only the thermal background can be measured).

- A report of the NISP detector performance cross-check is foreseen to validate the results of the cryogenic setup.

Cosmic Rays Study

A spin-off from the NISP activities is the study of the impact of Cosmic Rays on NISP science images; this working package is done by an extended group of people involved in the NISP system testing.

From the experimental point of view, the cryogenic setup of the NISP detectors could be used for testing the signal imprint of charged particles in the NISP signal. Several possible testing scenarios are under study, for example, the usage of radioactive sources, a study with muon cosmic rays, or using a proton beam impinging the sensitive detector. The feasibility of all the tests will be studied using Monte Carlo simulations, including the new geometry of the experimental setup. This implies rearranging the current setup to allow the interaction with an external charged particle source.

- The results of this analysis could be presented in a NISP technical note and depending on the relevance of the results they could be published in a peer-review journal.

Budget

Analytic budget description (numbers in Euro)

Item	Year 2022	Year 2023
Lakeshore 336 cryogenic temperature controller plus calibrated sensors (PT100-cryo)	10000 Euro	0 Euro
Liquid Nitrogen Container and dispenser (dewar TP 60)	5000 Euro	2000 Euro
Protection items for manipulating cryogenic material plus Liquid-N2 detectors for the laboratory	2000 Euro	1000 Euro

Description of how the budget will be used

The budget will be entirely dedicated to buying instrumentation that will support the cryogenic facility.
A cryogenic temperature controller is needed to monitor the temperature inside the dewar equipped with the infrared detector. For this scope, several calibrated temperature sensors are needed.
An external container of liquid nitrogen that allows feeding the cryogenic setup is needed. Also, the external supply of nitrogen is included in the budget.
To safely manipulate the cryogenic setup protection items should be acquired for the laboratory personnel, and the laboratory must be equipped with nitrogen detectors.

20. Scheda INAF:

8. Riassunto breve

Il laboratorio di manutenzione del software di bordo delle unità di controllo e data processing di NISP consente il test di tutte le funzionalità dello strumento e la qualità dei dati prodotti che sono gestiti da una Instrument Work Station.
Il sistema permette l'operatività e test indipendente della ICU, ed una interfaccia con la DPU per lo sviluppo software, supportato da una infrastruttura computazionale completa.
Il setup sarà disponibile per tutta la durata della missione Euclid (6 anni più stensione). Inoltre, il setup è equipaggiato con sistemi stand-alone di lettura degli ASIC per il trouble-shooting, sviluppo e test di nuove procedure operative dei rivelatori H2RG. Il sistema consente anche la caratterizzazione completa di tutti i segnali elettrici e digitali degli ASCI

9. Short Abstract (english)

At OAS is present a laboratory dedicated to software maintenance activities of the Instrument Control Unit (ICU) and Data Processing Unit (DPU) of the NISP instrument of the Euclid mission.
The setup is composed by the qualification units of the ICU and DPU interfaced with the flight-like readout electronics (ASIC) of the Teledyne's H2RG near-infrared detectors. An EGSE system for the commanding and control, and an infrastructure for data storage; and the qualification models of the filter and grism wheels assemblies plus the calibration unit. The setup is fully representative of all the NISP features and allows the development, test, and validation of potentially new versions of the on-board software of the units governing NISP. And offers a test bench for new flight procedures.

10. Obiettivi e Risultati

Il laboratorio è dedicato ad attività di mantenimento del software delle unità di controllo e processamento dati dello strumento NISP di Euclid.
Queste attività saranno svolte per la intera durata della missione Euclid, di sei anni più estensione.

12. Keywords ERC

13. Linee di riceca – campi di azione

infrared detectors;
cosmolgy;

14. Organizzazione del team

Collaborator: Ph.D. E. Medinaceli manager of the Data Processing Unit's (DPU) Application software of the NISP detector is a specialist in all the operations of the infrared detectors (H2RG) and of the readout electronics (ASIC). Also, with experience of Germanium detectors.
Collaborator: Ph.D. R. Farinelli is an expert in the processing of the images obtained with the H2RG detectors, he was also a developer of the on-board software of the DPU of NISP.
Collaborator: E. Franceschi is an expert in the spacecraft's interface dedicated to the commandability of the NISP instrument.
Collaborator: Ph.D. N. Auricchio has expertise in Euclid's infrared detectors, and in other solid-state detectors used for gamma radiation detection.
Collaborator: A. De Rosa, is a mechanical and thermal engineer.
Collaborator: F. Gianotti, computational support.
Collaborator: A. Balestra, DPU-ASW developer
Collaborator: P. Battaglia, NISP operation manager
Collaborator: S. Ligore, manager of the Instrument Control Unit’s (ICU) application software.
Collaborator: L. Corcione, ICU-ASW developer and expert of the NISP electrical interfaces.
Collaborator: D. Bonino, ICU-ASW developer
Collaborator: V. Capobianco, ICU-ASW developer
External Collaborators: there are collaborators external to INAF, that participate in activities related to the setup present in the laboratory

17. Ruolo di leadership INAF (se applicabile)

18. Organizzazione delle attività (se applicabile)

19. Evoluzione programmatica delle attività (se applicabile)

20. Infrastrutture coinvolte

ESA SOC

23. Produzione Scientifica e Tecnologica

Una descrizione estesa del laboratorio si può trovare nel seguente link

https://docs.google.com/document/d/1bczTq1ihyGf5h5g7uUSlYGl-2Q2F7Y2d/edit?usp=sharing&ouid=114684101322302837654&rtpof=true&sd=true

24. Competenze da Acquisire e Criticità

Membri del Team INAF

Stima dell'inviluppo complessivo di FTE INAF dall'inizio a fine attività 0.2
Stima delle FTE INAF a Tempo Indeterminato dall'inizio a fine attività 0.2
Stima dell'inviluppo complessivo di FTE (includendo tutti i partners, dall'inizio a fine attività) 0.5
Elenco di membri del team INAF

Eduardo.Medinaceli; PI; 0.2; 0.2; 0.2;
Ruben.Farinelli; collaboratore; 0.0; 0.0; 0.0;
Enrico.Franceschi; collaboratore; 0.0; 0.0; 0.0;
Natalia.Auricchio; collaboratore; 0.0; 0.0; 0.0;
Adriano.Derosa; collaboratore; 0.0; 0.0; 0.0;
Fulvio.Gianotti; collaboratore; 0.0; 0.0; 0.0;
Sebastiano.Ligore; collaboratore; 0.0; 0.0; 0.0;
Leonardo.Corcione; collaboratore; 0.0; 0.0; 0.0;
Donata.Bonino; collaboratore; 0.0; 0.0; 0.0;
Andrea.Balestra; collaboratore; 0.0; 0.0; 0.0;
Paola.Battaglia; collaboratore; 0.0; 0.0; 0.0;
Vito.Capobianco; collaboratore; 0.0; 0.0; 0.0;

(*Nome.Cognome; Ruolo nel Progetto; FTE_2022; FTE_2023; FTE_2024; Pot_2022; Pot_2023; Pot_2024; Extra*)