



Model-based instrument review for the Euclid mission for NISP- and VIS CDR

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European Space Agency

Agenda



Εὐκλείδης

- Euclid
- MBSE
- SysML
- ECSS Review Lifecycle
- MBSE Review?
- First Steps...
- Approach
- Examples
- Lessons Learned
- Recommendation



Euclid

What?

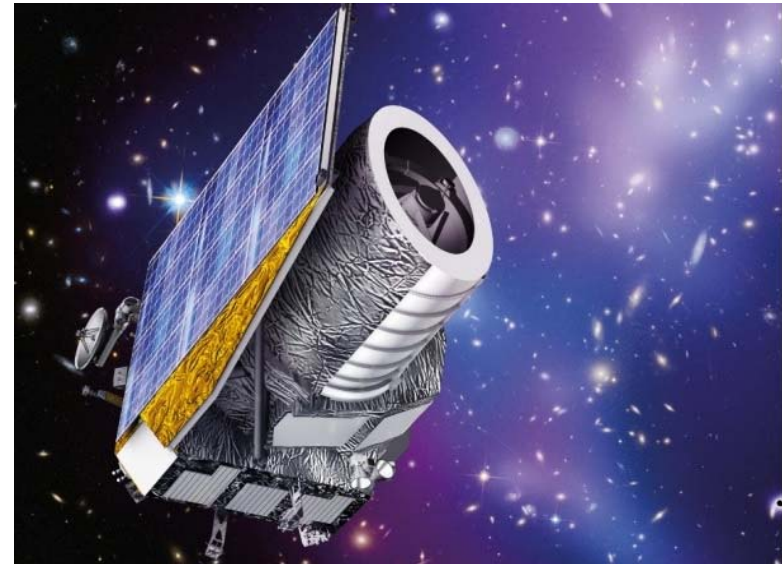
- Cosmology beyond the Planck mission:
 - Dark Matter distribution
 - Dark Energy nature

How?

- Baryonic Acoustic Oscillations (BAO)
- Weak Gravitational Lensing (WL)

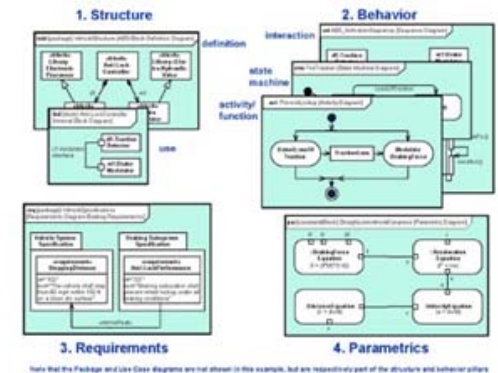
The Mission:

- Large Sky Survey: 15,000 deg²
- Visible imaging (VIS)/Near-Infrared (NISP)
- L2 Orbit, 5-6 year



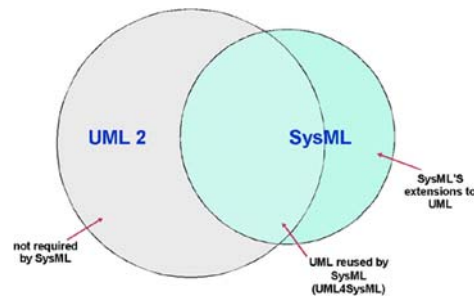
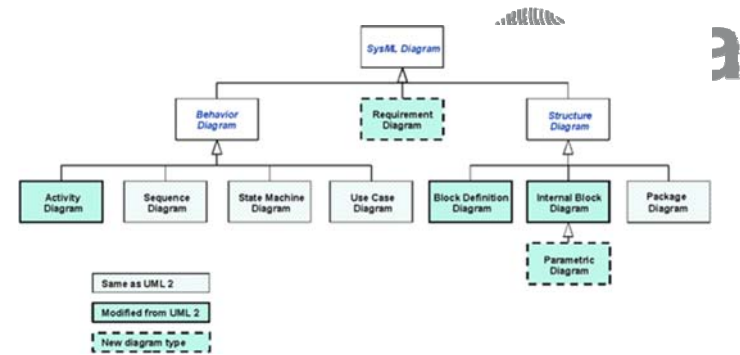
Model Based System Engineering (MBSE)

- **Shift in Paradigm**, Change in Approach
- Elevating **models** in the engineering process to a **central** and governing **role** in **all phases of the lifecycle** of a system
- Euclid is the first attempt to apply an MBSE approach at mission level for a major science project under development in ESA
- The System Modeling Language (**SysML**) was selected to build a representation of the system and capture the complete traceability of the mission break-down, from science objectives to verification and full life-cycle planning



SysML

SysML is a standardized graphical modelling language created to support system level visualization of requirements, architectures, interfaces, verification and behavioral aspects

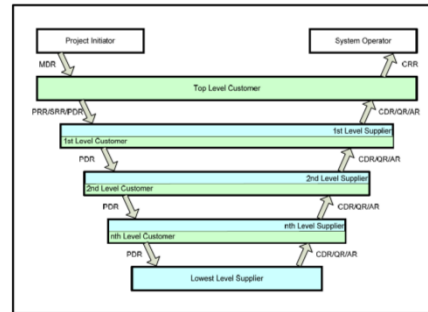


- SysML is based on the Unified Modeling Language (UML)
- Euclid specific SysML extension
- We model:
 - Requirements
 - Architecture (Decomposition, Interconnection, Characterization)
 - Behavior



ECSS REVIEW LIFECYCLE

- ECSS
- Review Life-Cycle
- Euclid follows the ECSS review lifecycle organized around the **V-model**
- The **Critical Design Review (CDR)** is held at the end of phase C. The outcome of this review is used to judge the readiness of the project to move into phase D
- “Datapack”



Activities	Phases						
	Phase 0	Phase A	Phase B	Phase C	Phase D	Phase E	Phase F
Mission/Function	MDR		FRR				
Requirements			SRR	PDR			
Definition				CDR			
Verification				CDR			
Production					AR	CDR	
Utilization						FRR	CDR
Disposal							CDR



ECSS-M-ST-10C Rev. 1
6 March 2009



Space project management

Project planning and implementation

ECSS Secretariat
ESA-ESTEC
Requirements & Standards Division
Noordwijk, The Netherlands

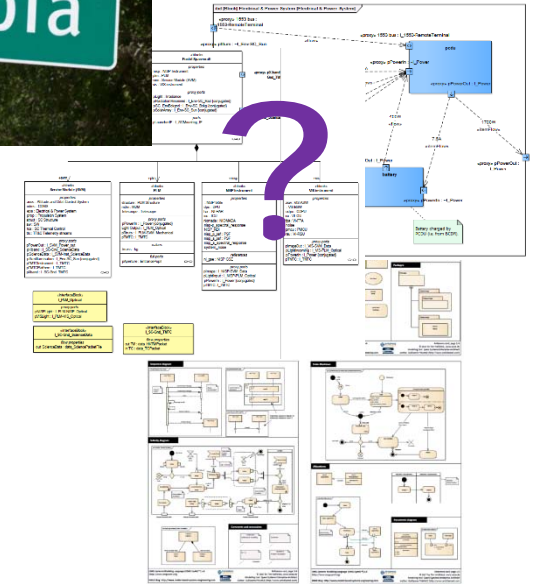


MBSE Review...

- Model Based Review - [Utopia?](#)
- [Review the model](#) instead of documents?
- [No datapack??](#)

- Documents still needed, but most of them can be [generated from the model](#).
- Maybe: a [collaborative environment](#) where we share information through the model and work jointly throughout the lifecycle
- Review is more [continuous](#) than discrete
- The milestones in the review lifecycle are still formal checkpoints but [no big-bang](#)

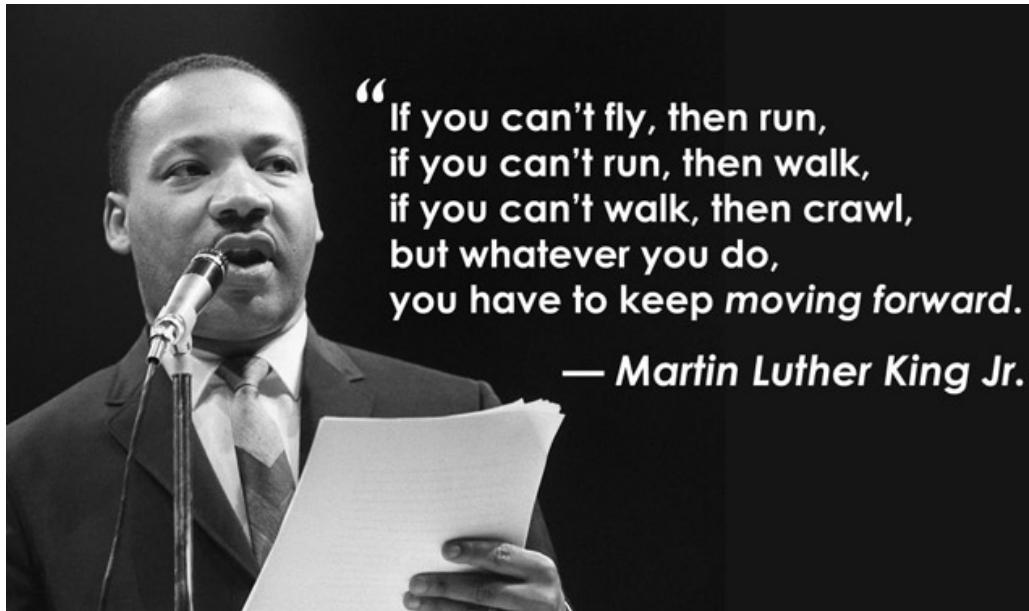
Present



You are here



MBSE reviews?

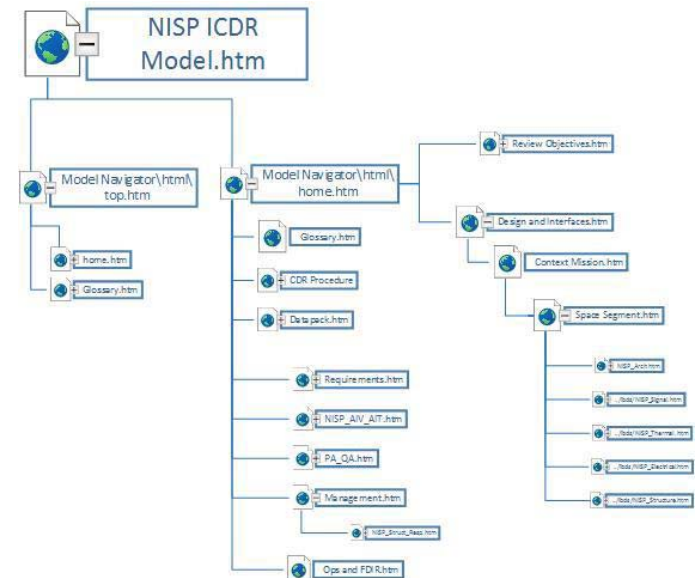


I have a dream...



Approach

- Existing diagrams basically taken “as is” from the model
- Diagrams specifically created to support the review
- The diagrams are decorated with text, images and hyperlinks
- Using Enterprise Architect to generate a website
- Providing enhanced navigation capabilities through the data pack,
- Supporting the user access to and interpretation of relevant information



Main page, entry point

- The Instrument CDR procedure
- Instrument Datapack
- Glossary/ List of Acronyms
- The Review Objectives
- Links to the main sections of the website



- [NISP CDR Procedure](#)
- [NISP CDR Datapack](#)
- [Glossary / List of Acronyms](#)

Euclid NISP Instrument Critical Design Review (ICDR)

The scope of this Review is the Euclid NISP Instrument detailed design, including interfaces with the Euclid platform as defined in the EID-A and NISP to S/C ICD.

The Review is considered successful if:

- the Review Board concludes that the [Review Objectives](#) are achieved,
- neither technical nor programmatic showstoppers are identified,
- all dispositions of the RIDs are completed, agreed by the relevant parties, and a detailed List of Actions has been established together with an adequate plan for the Action Items close-out.



Design and Interfaces I

- A collection of web pages reflecting the high-level architecture and decomposition, containing diagrams at various levels
- SysML Block Definition Diagrams (BDDs)
- A specific section for Interfaces (SysML Interface Block Diagrams (IBDs))

NISP Architectural Context: Space Segment Architecture

The Euclid The Euclid spacecraft consists of two main modules:

1. the Euclid Service Module (ESM) which includes the telescope assembly, supports the cold instruments units for VIS (Visible Imager) and NISP (Near Infrared Spectrometer and Photometer), the telescope outer baffle, overall structure and thermal control
2. the Euclid payload module (EPM) which comprises all the conventional spacecraft subsystems, the instruments warm electronics units, the sun shield and the solar arrays.

The Euclid payload consists of a 1.0 m aperture telescope which reflects and projects photons in two instruments: the VISual imager (VIS) and the Near-Infrared Spectrometer and Photometer (NISP). The instruments are spectrally separated in two different channels by a dichroic plate located at the exit pupil of the telescope while their Field of View (FOV) is the sky overlap.

VIS provides high quality images to carry out the weak lensing galaxy shear measurements. NISP performs imaging photometry to provide Near Infra Red (NIR) photometric measurements for photometric redshifts, and also carries out all the spectroscopy to obtain spectroscopic redshifts.

For a summary description of the mission and space segment architecture: [Euclid Mission Architecture Description Document](#)

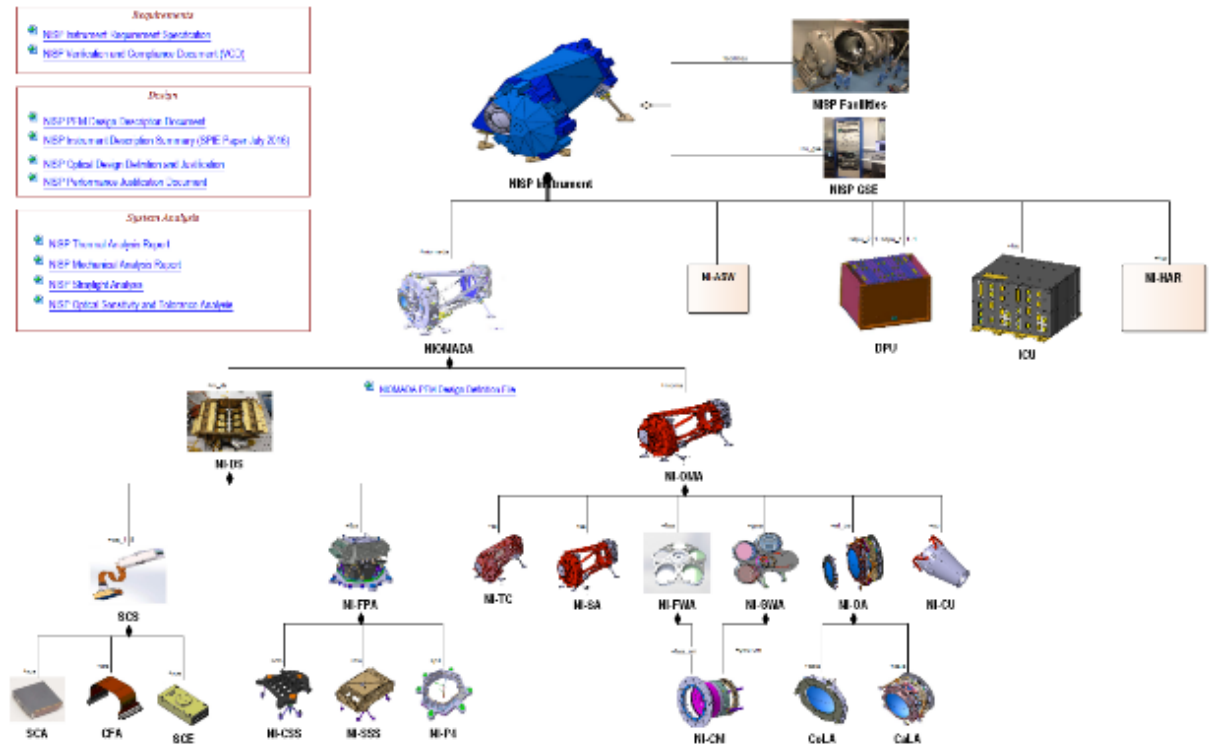
The NISP level interfaces with the ESM and SVM are controlled in the co-sized NISP to S/C ICD.

Interfaces
[FM NISP to Spacecraft ICD](#)

Design and Interfaces II

- Decomposition of the instrument (Product Tree)
- Leafs in the tree link to specific lower-level diagrams, linking to the documentation at that level

NISP architecture



Design and Interfaces III



- Thermal Perspective
- Conductive/radiative I/Fs

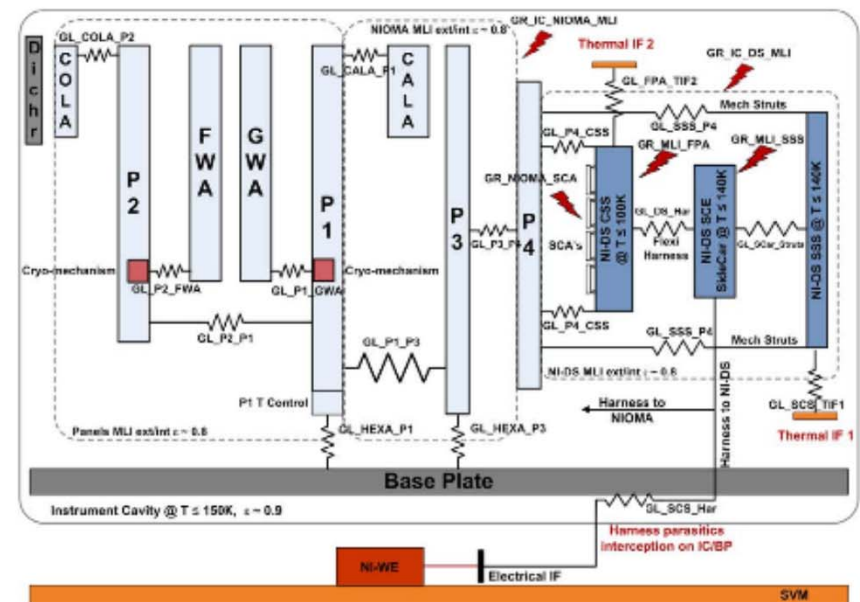
NISP Thermal Interfaces and Design

The PLM thermal design for the NISP instrument is based on a purely passive configuration: two radiators coupled to cold space, exploiting the favorable conditions of the L2 thermal environment, will provide the main temperature references for the NI OMA structure and the NI DS

Relevant Review Documents

- IM NISP Thermal IC
- NISP Thermal Analysis Report
- NISP Thermal Reduced Model
- Subsystem views : NISP iCDR: NI-TC Summary View

Click to see details of NISP Thermal Control Subsystem (NI-TC)



AIV/AIT

NISP AIV/AIT Documentation

NISP Level AIV/AIT documents

- [NISP AIT Plan](#)
- [NISP AIV Plan](#)
- [NISP functional \(SFT & FFT\) Test Specification](#)
- [NISP FM Thermal Vacuum Performance Test Specification](#)

Ground Support Equipment Information

- [NISP EGSE Requirements Specification](#)
- [NI-VGS Technical Requirements](#)
- [NISP Instrument WorkStation \(NI-IWS\) Software System Specification](#)

STM Test Campaign Documentation

- [NISP STM Vibration Test Specification](#)
- [NISP STM Vibration Test Report](#)
- [NIOMADA STM Thermal Balance Test Report](#)



NI-DS and NI-SCS AIV Documentation

- [NI-DS AIT Plan](#)
- [NI-DS DM Electrical Test Report](#)
- [NI-SCS Characterization Requirements](#)
- [NI-SCS Characterization Test Plan](#)
- [NI-SCS Characterization Setup Study Report](#)
- [NI-SCS Conducted Susceptibility of Euclid SCS](#)

NISP Warm Electronics and Software AIV Documentation

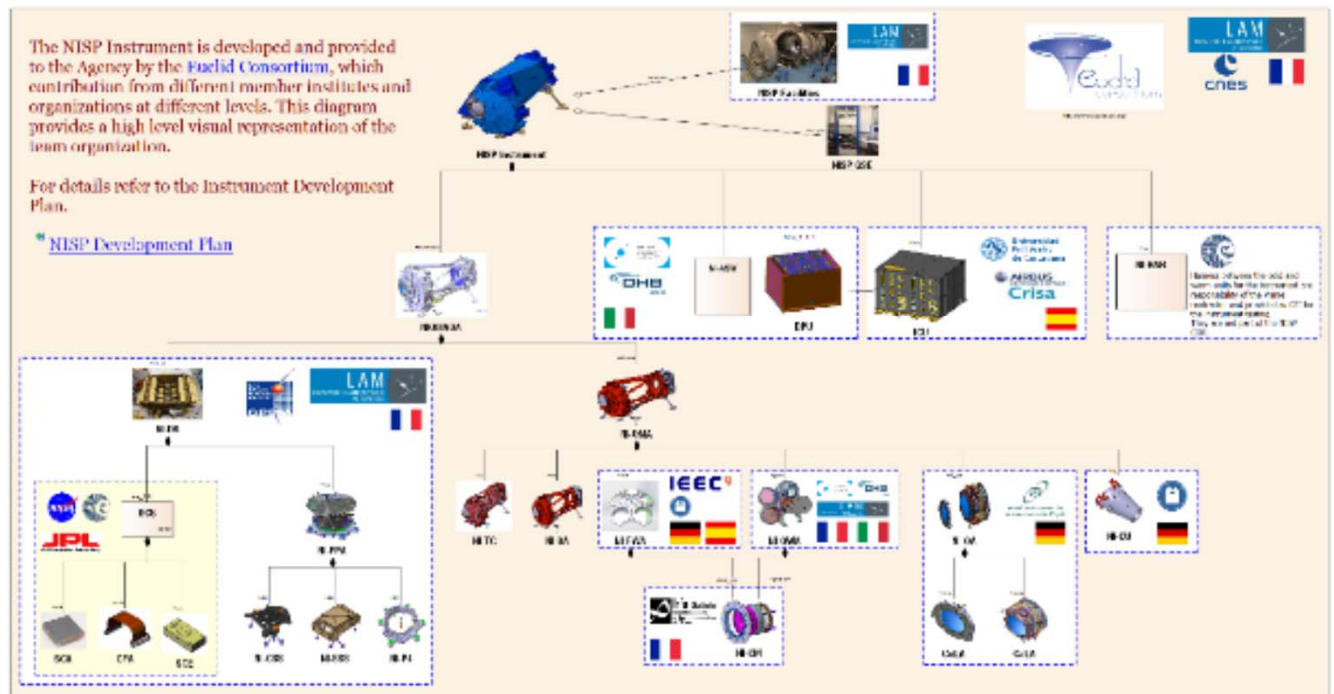
- [DPU DM & BSW Coupling Tests and Performance Report](#)
- [ICU HW / Boot SW and ASW Integration Report](#)
- [Preliminary Tests on ICU-DPU Communication](#)

Management



- Mgt. docs
- A link to a responsibilities diagram

NISP Instrument Structure and Responsibilities



Lessons Learned

- The “Model based review” was **well received**. It enables users to easily navigate the data pack, find the relevant document(s) and put them in the proper context
- If you are doing MBSE the **effort** involved organizing the review around the model is **modest**. You can leverage the **existing model** and create a few review specific diagrams utilizing existing model elements in order to support the review
- Existing reporting functionality of the modelling tool can be used
- **Keep it Simple**: you have to provide the **right level of detail** to the reviewers

RECOMMENDATION

Continue and expand the usage of models for supporting major milestone reviews.
In the course of time the transition to a fully model based review can be made



Questions?

