Programme: **ELT**

Project: **ELT MCAO Construction – MORFEO**

PM0 Technical Specifications

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2025-11-19	Functional requirement	Added **MAO-PM0-1.2.5.11 Liquid collector**

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1.Related Documents

1.1. Applicable Documents

MAO-PF0-1.6 Applicable documents

The following documents, of the exact version shown, form part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the content of this document, the content of this document shall be considered as superseding the others.

AD1. E-MAO-SE0-INA-SPE-006 MORFEO main structure and handling tools common requirements [1]Issue 01
AD2. E-MAO-PFK-ICD-DWG-001_01 CPM interface drawing
AD3. E-MAO-PFA-ICD-DWG-001_03 M6M interface drawing
AD4. E-MAO-PFB-ICD-DWG-001_03 M7M interface drawing
AD5. E-MAO-PFC-ICD-DWG-001_03 M8M interface drawing
AD6. E-MAO-PFE-ICD-DWG-001_03 M11M interface drawing
AD7. E-MAO-PFF-ICD-DWG-001_03 M12M interface drawing
AD8. E-MAO-PFD-ICD-DWG-001_03 DICHROIC interface drawing
AD9. E-MAO-PFG-ICD-DWG-001_03 LGSO-FM1 interface drawing
AD10. E-MAO-PFI-ICD-DWG-001_03 LGSO-FM3 interface drawing
AD11. E-MAO-PFJ-ICD-DWG-001_01 CUFM interface drawing
AD12. E-MAO-PFH-ICD-DWG-003_03 LGSO Volume and Optical Design
AD13. E-MAO-PDA-01.00.00.00-ADP-MOD-003_01 DM1 design volume.stp
AD14. E-MAO-PDB-ICD-DWG-001_01 M10M interface drawing
AD15. E-MAO-PUA-00-00-00-00-INA-DWG-001_02 - PUA Volume and Interfaces
AD16. E-MAO-PL0-00-00-00-00-ADP-ICD-001_10 LGS WFS Interface Drawing
AD17. E-MAO-000-00-00-00-00-INA-MOD-003_03 MORFEO System dynamic volume.stp

[1] This document is a flow down of the ESO document ESO-254547 common requirements for ELT instruments, that cannot be published in the cft, but only shared with the assigned contractor.

AD18. E-MAO-000-00-00-00-00-INA-MOD-010_01 MORFEO Functional Integrated Geometry Assembly

AD19. ESO-193497 SAF-GEN-MAN-3444 ESO Safety Conformity Assessment Procedure, issue 5

AD20. ESO-192984 ESO Mechanical Standards, issue 2

AD21. ESO-191462 ESO Engineering Analysis Standard, issue 2

AD22. E-MAO-000-INA-SOW-012_01 Morfeo Main Structure (MS) and AIV tools SOW

AD23. E-MAO-000-INA-PLA-003 MAORY Product and Quality Assurance Plan, issue 3

AD24. E-MAO-SM0-INA-SPE-001 MORFEO MAIT HTs-Seq Technical Specifications

AD25. ESO-351629 ICD between MAORY and MICADO (Calibration Unit)

AD26. ESO-323542 ICD between MAORY and MICADO (General)

AD27. E-MAO-SE0-INA-SPE-007 Nasmyth interface requirements for morfeo main structure subsystem and handling tools Issue 01[2]

AD28. CAD-135139 Nasmyth Platform Interfaces revision 4

AD29. MORFEO & MICADO Design Volume on MS-NPB (DWG); DE-CAD-202415 Version 2

AD30. MORFEO & MICADO Design Volume Location and Access on MS-NPB (DWG); DE-CAD-214778 Version 2

AD31. Instrument Control Hardware Requirements for MORFEO Subsystems - E-MAO-PHO-INA-SPE-001 Issue 03

AD32. https://www.eso.org/projects/elt/develop/ifw/ifw-fcf/sphinx/html/docs/devmgr.html#device-manager-state-machine

AD33. HARMONI Volume Envelope 00043508_05

AD34. ST0 Design Volume MM Mode ELT-DWG-MCD-56303-ST00000-ENV-E023957

AD35. Recirculator_v5 20260310.stp

AD36. E-MAO-PM0-05-00-00-01-DWG_01

[2] This document is a flow down of the ESO document ESO-253082 Common ICD between the E-ELT Nasmyth Instruments and the Rest of the E-ELT system, that cannot be published in the cft, but only shared with the assigned contractor.

AD37. ELT-DWG-MCD-56301-M32000-252-06-22_mca-morfeo-housing-5mm

AD38. E-MAO-PM0-02-02-01-01_DWG_01

AD39. E-MAO-PU0-00-00-00-00-MOD-03_01 MORFEO cu extraction dynamic volume.stp

AD40. E-MAO-SE0-00-00-00-00-MOD_02_01 MORFEO LGS extraction dynamic volume.stp

AD41. AST M&M assembly envelope ELT-DWG-MCD-56300-M62200-ENV-E00061029

AD42. RecirculatorM12_v5

AD43. E-MAO-PM0-01-03-00-00-INA-DWG-001_02 - Interface drawing PM0-PU0

1.2. Reference Documents

MAO-PF0-1.7 Reference documents

The following documents, of the exact version shown, has to be adopted as a reference of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the content of this document, the content of this document shall be considered as superseding the others.

RD1. General Definitions and Basic Conventions Related to Interfaces ESO-193459 Version 2

RD2. “Main Structure general overview: mechanical design update from PDR towards the final design phase”, V.De Caprio et all, Proc. of SPIE Vol. 13096, 130965L, doi: 10.1117/12.3019972.

RD3. “MAORY/MORFEO@ELT: Optomechanical preliminary design”, E.Redaelli et all, Proc. of SPIE Vol. 12185, 121854Q, 10.1117/12.2629864.

RD4. E-MAO-000-00-00-00-00-INA-MOD-001_02 MAORY System Model

RD5. ESO-225669 Packing Recommendations Issue 3

2.Introduction

2.1. Scope

MORFEO (formerly known as MAORY) is the Adaptive Optics Module for ELT.

This document contains the requirement specifications for Mechanical system which is made by Main Support Structure, CU selector, Enclosures and MAOMIC thermal duct).

This document contains two types of items: requirements and information. Requirements have to be verified by the Vendor while information items do not. Both types are binding.

2.2. Naming Convention

Requirements are identified with a requirement tag following the format [MAO-PM0-XXX], where XXX is a unique, non-speaking number.

In section 7 is reported for each requirement the minimum verification method to be applied for the requirement verification during the main project phases.

2.3. Abbreviations and Acronyms

AD	Applicable Document
AO	Adaptive Optics
ARR	Acceptance Readiness Review
BIH	Bologna Integration Hall
CNRS	Centre National de la Recherche Scientifique
CII	Core Integration Infrastructure
CPM	Corrective Plate of MORFEO
CUFM	Calibration Unit Folding mirror of MORFEO
DC	Dichroic
DER	Design Report
DM1	1st Deformable Mirror
DM2	2nd Deformable Mirror
ELT	European Extremely Large Telescope
ESO	European Southern Observatory
FDR	Final Design Review
FoV	Field of View
HW	Hardware
IAA	Instrument Assembly Area
ICD	Interface Control Document
ICH	Instrument Control Hardware

ICSS	Instrument Control System Software
I-PXX/PM0	Interface between PXX subsystem and PM0 subsystem
INAF	Istituto Nazionale di AstroFisica
INS	Instrumentation Software
INSU	Institut National des Sciences de l'Univers
IWS	Instrument Workstation
IORR	Instrument Operations Readiness Review
IPAG	Institut de Planétologie et d'Astrophysique de Grenoble
IRD	Interface Requirement Document
LCI	Local Communication Infrastructure
LCS	Local Coordinate System
LGS	Laser Guide Stars
LGSO	Laser Guide Stars Objective
LGSO-FM1	1st Laser Guide Stars Objective Folding mirror of MORFEO
LGSO-FM3	3rd Laser Guide Stars Objective Folding mirror of MORFEO
LOR	Low Order and Reference
LOS	Line of sight
MAIT	Manufacturing Assembly Integration and Test
M6M	6th Mirror of MORFEO
M7M	7th Mirror of MORFEO
M8M	8th Mirror of MORFEO
M11M	11th Mirror of MORFEO
M12M	12th Mirror of MORFEO
MORFEO	Multi conjugate adaptive Optics Relay For ELT Observatory
MCA	MICADO Calibration unit Assembly
MCAO	Multi Conjugate Adaptive Optics
MCMT	Maximum Corrective Maintenance Time
MICADO	Multi-AO Imaging Camera for Deep Observations
MDT	Mean Down Time
MOI	Moment of Inertia
MS	Main support Structure
MSA	Main Structure Assembly
MSS	Main Structure Subsystem
MTBF	Mean Time Between Failures
N/A	Not Applicable
NGS	Natural Guide Star
NP	Nasmyth Platform
PAC	Preliminary Acceptance Review in Chile
PAE	Preliminary Acceptance Europe
PDR	Preliminary Design Review
PFRO	Post Focual Relay Optics
PLC	Program Logic Controller
PFS	Primary Focal Station
PM0	MORFEO Main Structure subsystem
PH0	MORFEO Instrument control Electronics Subsystem
PI	Principal Investigator
PM	Project Manager
PM0	MORFEO Main Support Structure Subsystem
PSF	Point Spread Function
PT	Product Tree
PR0	MORFEO RTC subsystem

PSO	MORFEO Software subsystem
PT0	MORFEO Thermal control subsystem
RAMS	Reliability, Availability, Maintainability and Safety
RBM	Rigid Body Motion
RD	Reference Document
RMS	Root Mean Square
RON	Read Out Noise
RSS	Root Sum Square
RTC	Real-Time Computer
SAT	System Architect Team
SCAO	Single-conjugate Adaptive Optics
SCS	Standard Coordinates System
SE	System Engineer
SET	System Engineering Team
SOW	Statement of Work
SMR	Spherical Mounted retroreflector
SMU	Sensor Monitor Unit
SR	Strehl Ratio
SRR	System Requirements Review
SRS	Standard Reference System
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
TP	Temperature Probe
WFS	Wavefront Sensor
WP	Work Package
WS	Workstation

2.4. Definitions

MAO-PM0-1.2.3.4: Definition of Main Structure Subsystem *[Info]*

Main Structure subsystem (MSS) is the main mechanical system of MORFEO and includes:

- Main Structure Assembly.
    - Main Support Structure (MS): the main frame that provide support to all the payloads, this includes the global alignment system to the Nasmyth.
    - CU selector: an active system that allows switching of calibration devices
    - Enclosures, they provide thermal insulation and protection from dust and light:
        - Morfeo Thermal enclosure
        - Micado Thermal enclosure

- MAOMIC thermal duct and its supporting structure, it provides the connection between Micado and Morfeo volumes, its supporting structure hosts an electronic cabinet.
- Routing ducts and piping they deploy all cables and pipes necessary inside from the cabinets and the manifold to the various payloads on the Nasmyth
- Laser Tracker References: used for alignment and monitoring

- Main Structure Assembly Unpacking, shipping tools: all the tools needed to pack unpack and ship the various items identified hereby
- Main Structure Assembly, handling tools all the tools needed to integrate the various items and to transport them inside the BIH and IAA. It includes also proper tools to move the MS when integrated with all payloads and thermal cover (as defined in **MAO-PM0-1.2.3.6)** from IAA to the Telescope transit ring and to lift it onto the Nasmyth platform (as specified in **MAO-PM0-1.4.7 and MAO-PM0-1.4.8)**.
- Main Structure Assembly Test Equipment (if any), all equipments needed to test and characterize the MSA.
- Spares (if any).

MAO-PM0-1.2.3.5: Definition of Payloads *[Info]*

In this document we refer to payloads as all the components that the Main structure has to support, and in details:

for the Main support structures the payloads are:

- CPM (PFK)
- M6M (PFA)
- M7M (PFB)
- M8M (PFC)
- DM1 (PDA)
- DM2 (PDB)
- DC (PFD)
- M11M (PFE)
- LGSO-FM1 (PFG)
- LGSO (PFH)
- LGSO-FM3 (PFI)
- Calibration Unit (PU0)
- LGS (PL0)
- CU selector (Which hosts)
  - MCA
  - FMCU (PFJ)

- Thermal Cover

For the MICADO Thermal Cover the payload is

- M12M (PFF)
- Mechanical Structure

MAO-PM0-1.4.5: Definition of Handling *[Info]*

It covers the handling of the Main structure during packing, assembling, testing and maintenance.

MAO-PM0-1.4.6: Definition of Accessibility *[Info]*

It covers the access to the main structure, including inside the main structure, when necessary, for maintenance both at telescope and in the lab. It also covers all the auxiliary equipment providing access to the payloads that have interfaces with the Main Structure.

MAO-PM0-1.2.3.6: Acceptance of design

The manufacturer is free to propose his own **Main Structure Subsystem** design, that may be completely different from the consortium one RD4, a variation of it, or the consortium design itself. In any case, the manufacturer shall assure performances of the system and the design itself shall be discussed with, and accepted by, the consortium.

MAO-PM0-1.2.3.7: MORFEO integrated *[Info]*

In this document we refer to MORFEO Integrated as the configuration of the Main Structure fully populated with all its payload including the thermal cover that will be realized in the IAA.

2.5. Coordinate System

The MORFEO coordinate system is centred in the E-ELT Focus B1 focal plane and has the same orientation of E-ELT Standard Coordinate System (SCS, see Table 1). The gravity orientation is parallel to the Z axis with opposite verse.

Table 1 Location of MORFEO SCS

	X [mm]	Y [mm]	Z [mm]	α [deg]	β [deg]	γ [deg]
MORFEO SCS	27200	0	0	0	0	180

Table 1:

MAO-PM0-1.2.3.2: Local Coordinate System Main Structure

The Main structure LCS, expressed in the MORFEO SCS, shall be used for all deliverable drawings and 3D CAD models.

It superimposes to the MORFEO SCS

The three components of a vector expressed in the Main Structure LCS can be represented in the MORFEO SCS applying the following roto-translation matrix to the vector (translations in [mm]):

Table 2 LCS to SCS vector components

Rotation			Translation
0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000

3.Product Description

3.1. MORFEO overview

3.1.1. Morfeo concept

ELT (Extremely Large Telescope) is the world's largest telescope (39m diameter) under construction by ESO (https://elt.eso.org/) at Cerro Armazones in Chile. ELT is considered worldwide to be one of the highest priorities in ground based astronomy. MORFEO (http://wwwMORFEO.oabo.inaf.it/), as a first generation ELT instrument, will help compensate for the distortion of light caused by turbulence in the Earth's atmosphere. MORFEO is a Multi-Conjugate Adaptive Optics (MCAO) module that will allow spatially uniform adaptive optics compensation over a large field of view (about 1 arcmin^2) with high sky coverage. Wavefront sensing is performed by six Laser Guide Stars (LGS) and three Natural Guide Stars (NGS), for the measurement of high and low-order wavefront perturbations respectively.
The Post-Focal Relay Optics sub-system of MORFEO re-images the telescope focal plane to the exit ports (Figure 2 and Figure 3).

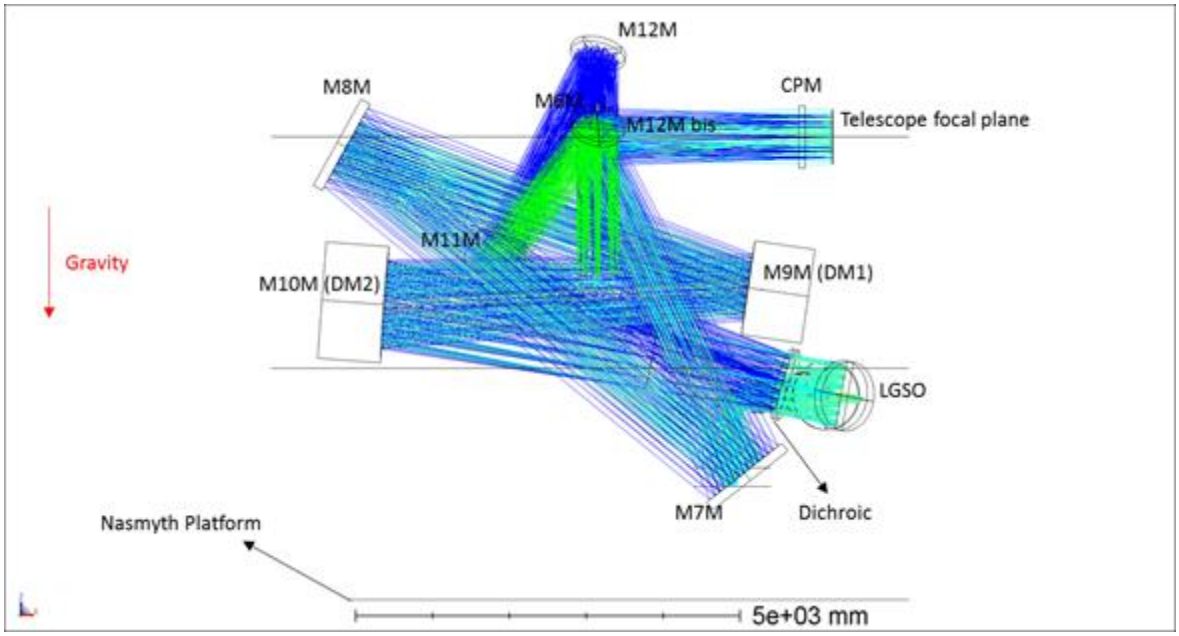

Figure 1 MORFEO optical design (side view)

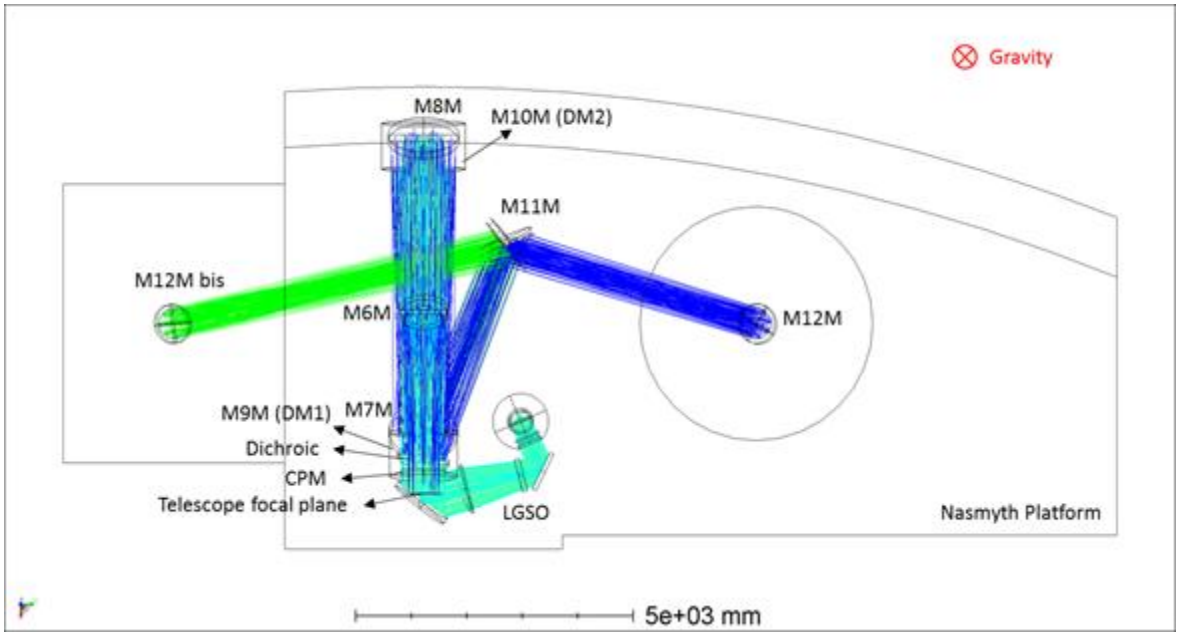

Figure 2 MORFEO optical design (top view)

The sub-system contains the following channels:

- Main Path Optics (also referred as Post Focal Relay Optics PFRO), which relay the telescope focal plane to the exit ports for the science instruments (MICADO and 2nd instrument);
- LGS Objective, which creates an image plane for the laser guide stars, used by the LGS WFS sub-system to measure in real-time the high-order wavefront aberrations for the MCAO mode of MORFEO.

Inside the optical path, two clear planes are created, optically conjugated to two different ranges from the telescope entrance pupil, allowing the insertion of two M6Ms (conjugated at 6-12Km and 17-20Km).

3.1.2. Payloads overview

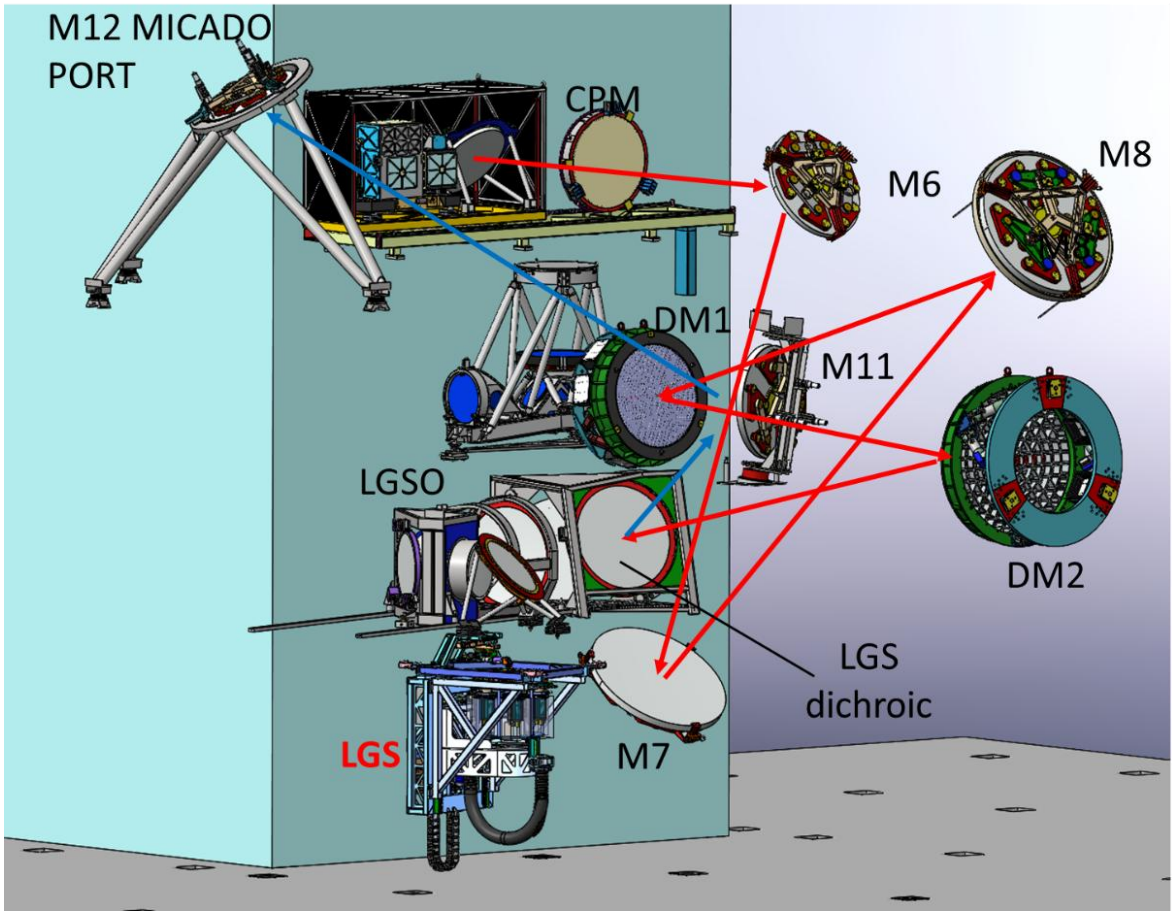

Figure 3 Overview of the elements inside the MORFEO optical path (in this picture DM2 is replaced by iys optical dummy M10M, and DM1 by M9M)

Figure 3 provides an overview of the elements inside the MORFEO optical path. The opto-mechanical architecture of MORFEO is divided into three main sub-systems: the MORFEO system module (including the Main Structure and Post-Focal Relay Optics), the LGS WFS module, and the NGS WFS module.

The primary payloads hosted directly by the MSS through the Optomechanical Support Structures (OSS) are key components of the Main Path Optics (MPO) and the Laser Guide Stars Objective (LGSO). The MPO path involves a total of 8 reflections. A detailed description of the payloads can be found in RD3. In the following is presented a general overview

3.1.2.1. Key Optomechanical Payloads:

The MSS accommodates several optical elements via Optomechanical Support Structures (OSS, typically painted orange in Figure 5). These hosted optical elements include:

- **M6M, M7M, M8M:** These are mirrors along the main path that starts after the beam passes through the **CPM** and reaches the first flat mirror, **M6M**. **M7M** and **M8M** are aspherical concave mirrors.
- **M9M/DM1 and M10M/DM2:** These are the two post-focal Deformable Mirrors (DMs). **M9M** (DM1) has a spherical convex surface, and **M10M** (DM2) is spherical and concave.
- **M11M:** A flat flip mirror that allows selection between the MICADO path and the second instrument port.
- **M12M:** A flat mirror installed over MICADO (or the second instrument).

Other crucial components and systems that interface with or are supported by the MS include:

- **Dichroic Filter:** A one-meter class diameter dichroic filter is placed after the MPO elements with power; it reflects science/NGS light (600 nm – 2400 nm) and transmits LGS light (589 nm).

3.1.2.2. Additional Optomechanical Payloads:

- **Laser Guide Stars Objective (LGSO):** This objective must draw the laser wavelength (589 nm) from the MPO and focus it at the entrance of the wavefront sensor. The LGSO comprises **4 silica spherical lenses** (LGSO-L1 to LGSO-L4) and **3 fold mirrors** (LGSO-FM1 to LGSO-FM3).
- **Calibration Unit Selector (CU Selector) hosted elements:** The CU selector (part of the MS), supports the MORFEO Folding Mirror Calibration Unit (**FM CU**) and the MICADO Calibration Assembly (**MCA**)[3].

3.1.2.3. Optomechanical Design Philosophy:

The optomechanical design is based on a **light-weighted mirror design** with athermal opto-mechanics, intended to satisfy requirements concerning stiffness, mass limits, and thermomechanical loads.

- **Support Structures (OSS):** The OSS assemblies are typically made of structural steel pipes and interface steel plates. They provide the mounting

[3] Note that at the time of the writing of this document it is under discussion the need of an additional slot on the CU selector. Tehcnical proposal that will include this option will have additional points as defined I the SOW

reference plane through three screwed reference steel plates, ensuring precise connection for the optomechanical sub-systems.

- **Mirror Mounts:** A crucial choice for the optomechanics was the use of a **whiffle tree solution** with several interface points (18–27 points were analyzed). This strategy was chosen to minimize the deformation of the optical surface. The whimple tree design balances forces without introducing moments into the optical elements.
- **Athermal Design:** To mitigate stresses caused by thermal loads, **Invar pads** are typically bonded to the glass mirrors to interface with the mechanics, helping to reduce stresses between the Zerodur glass and the titanium of the flexures. A central membrane, often made of Invar, defines the decentering degree of freedom.
- **Alignment:** Kinematic connections and a **wedge system** are used for repeatability and fine alignment of the mounts in tip/tilt and focus.
- **Motorized Functions:** Only two mirrors, **M11M and M12M**, have motorized functions, based on a three-point actuation system to provide tip/tilt.

3.1.3. Main Structure overview

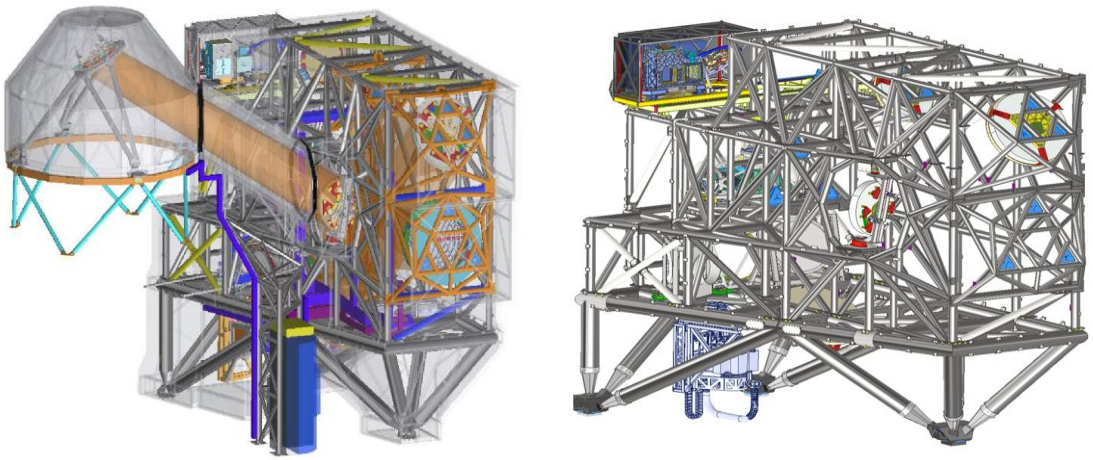

Figure 4 3D CAD model assembly of MORFEO Main Structure (complete and open view)

The drawing, 3D CAD model, or mechanical layout provided herein (such as those illustrating the MORFEO Main Support Structure or its sub-systems) is for reference and informational purposes only. This material reflects the conceptual or preliminary technical solution developed up to the Preliminary Design Review (PDR) phase.

This reference material is explicitly non-binding and non-prescriptive. The design depicted represents a specific configuration (e.g., the configuration presented for PDR in the first half of 2021). Proposers are entirely free to propose an alternative structural design, including a **complete departure from or substitution of this reference layout**, provided their solution rigorously adheres to all specified Technical Requirements.

The sole mandatory and prescriptive requirements for the design, realization, and performance of the structure are those explicitly stated within the accompanying Technical Specifications and System Requirements documentation according to chapter 4 to 8 of this document and the related ones of AD24. Compliance must be demonstrated exclusively against these defined technical requirements (e.g., stiffness, mass limits, and thermomechanical loads).

Considering what defined above, the following is a general overview of the MORFEO Main Structure (MMS) sub-system, intended to introduce the structural and thermal payloads to the Main Structure (MS) design and realization team. More details can be found in RD2 and in RD4.

The MMS consists of five main items:

3.1.3.1. MORFEO Main Support Structure (MORFEO_MSS)

The MORFEO_MSS is the **core mechanical structure** designed to host all the Optomechanical elements. Its primary purpose is to provide a highly stable opto-mechanical reference and support for all opto-mechanical elements and sub-assemblies mounted upon it.

- **Design and Structure:** The MSS is constructed from standard **structural steel** and is truss-beam shaped, utilizing tubes that are both welded and bolted. These tubes have varied section properties chosen to optimize the ratio between global stiffness and total mass. The structure's peculiar shape is dictated by the optical path, which develops mainly in a vertical plane, resulting in a structure that is "**almost empty**" in the central area to allow light passage and accommodate optomechanical components. The configuration presented at the Preliminary Design Review (PDR) had overall main dimensions of approximately 7.9 x 4.8 x 6.7 m (excluding the Thermal Enclosure).
- **Interfaces:** The MSS must be secured to the ESO Nasmyth Platform grid via **three main support points**. The lattice structure uses 10 legs that converge onto these three interface flanges.
- **Payload Accommodation:** It accommodates optomechanical elements via the **Optomechanical Support Structures (OSS)** (often colored orange in diagrams), which are specialized sub-assemblies made of structural steel pipes and interface steel plates. The estimated mass of the MORFEO MSS structure (updated after PDR, without contingency) is about **8400 kg**.

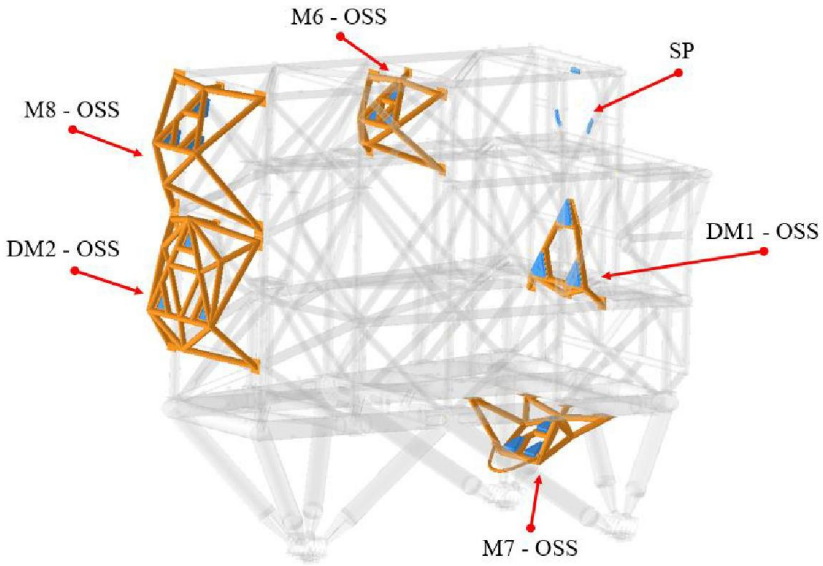

Figure 5 OSS - Optomechanical Support Structures (depicted in orange) mounted on MSS

3.1.3.2. Thermal Enclosure – MORFEO side

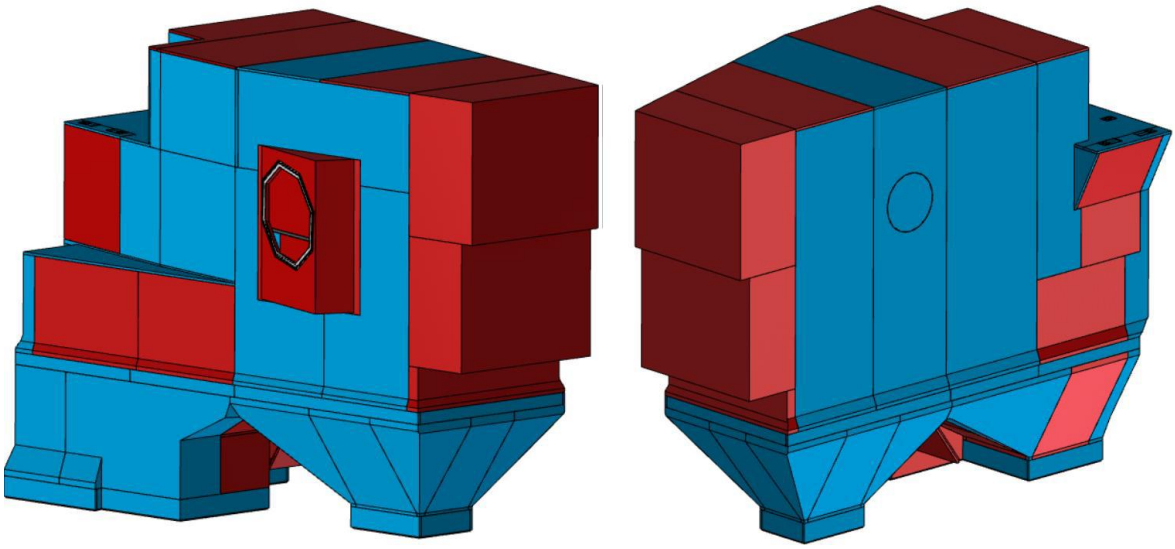

Figure 6 MORFEO: Thermal Enclosure overall view.

This component serves as the **cover structure** for the MORFEO_MSS.

- **Function:** It is a **passive thermal cover** designed to protect the optics from light and dust, while thermally insulating the internal side of MORFEO from the external environment.
- **Design:** The enclosure consists of several panels. Where direct mounting onto the MSS is not possible, intermediate aluminum structures are used as support frames.
- **Panel Composition:** The mechanical layout of the thermal panels uses multiple layers for passive insulation: an internal 1 mm aluminum sheet, a 70 mm thick layer of **PIR (polyisocyanurate)** thermal insulating material (selected for its low thermal conductivity and density), and a 1 mm external plastic sheet (polycarbonate).
- **Accessibility:** Panels are distinguished as removable (red in diagrams) for easy maintenance access, or fixed (blue in diagrams), requiring more effort to dismount.

3.1.3.3. MORFEO – MICADO Thermal Duct

This structure acts as a link between the MORFEO module and the MICADO instrument.

- **Function:** It covers and protects the optical path between the **M11** and **M12** optical elements.
- **Components:** It comprises two parts:
  1. The **mechanical support frame** (bottom part, or TOWER). This frame is made from steel (S275JR) tubes and is fixed directly onto the ESO Nasmyth platform through **three additional support points** (separate from the MSS main points).
  2. The **actual Thermal Duct structure**, which is mounted on the frame. This structure is built from aluminum (AL6082) standard tubes.
- **Connection:** The Thermal Duct is connected to both the MORFEO and MICADO Enclosures using **two bellows**. These bellows are essential to allow relative motion between the two instruments (MORFEO and MICADO), accommodating factors like earthquake events and/or thermal expansion.
- **Insulation:** The Thermal Duct is covered by an insulating layer composed of 100 mm thick PIR panels glued onto aluminum sheets, protected by an external polycarbonate sheet.

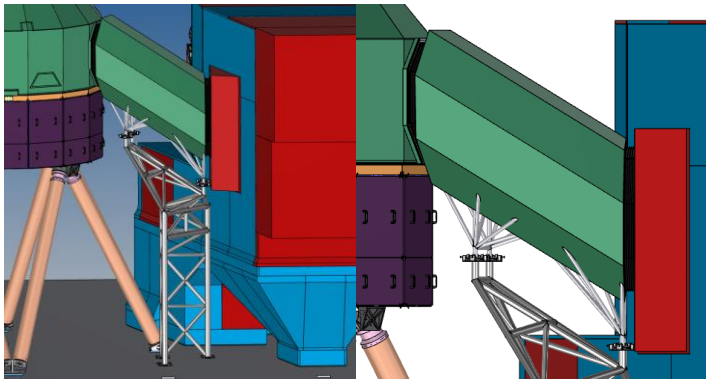

Figure 7 Overall view of MOR-MIC Thermal Duct

3.1.3.4. Thermal Enclosure – MICADO side

This structure functions as the cover around the **M12 mirror**, installed on the top side of MICADO.

- **Function:** It provides passive insulation and protects the upper part of the MICADO instrument and the M12 sub-system from light and dust. It is the interface towards Micado according to what defined in AD26and support the M12M structure.
- **Design:** It is located on top of the MICADO Top Bench. The structure is made of aluminum and is split into two halves, nearly symmetrical, for ease of transport. The shape, in plan view, is a polygon with 16 edges, designed to fit the shape of MICADO.
- **Interfaces:** It is mounted directly onto the MICADO Main Support Structure via four dedicated flanges. It must be light and easily removable for maintenance access; the connection bolts are on the external side. The M12 Optomechanical subassembly is supported by three of these interface plates.

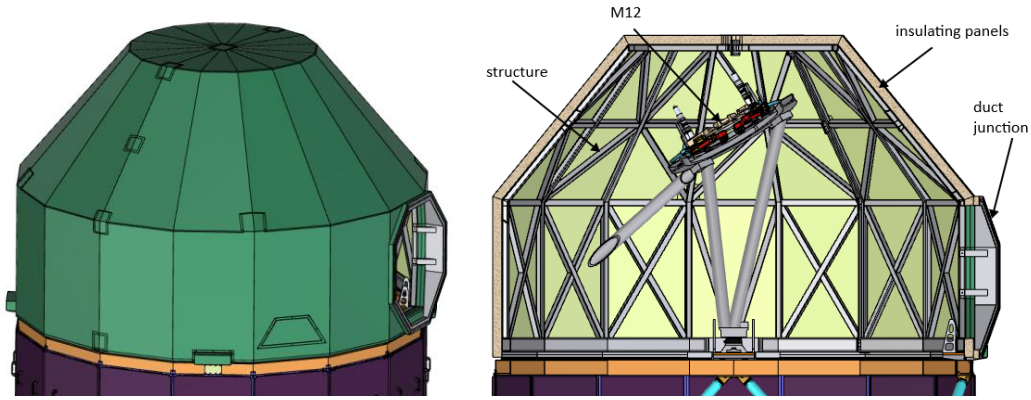

Figure 8 overall view of Micado thermal Duct

3.1.3.5. CU Selector for MORFEO Folding Mirror (FM CU) and MICADO Calibration Assembly (MCA)

The CU Selector is the mechanical sub-system that serves as a **linear guide carriage** allowing the calibration units to switch positions.

- **Function:** It enables the system to switch between different operational positions necessary for calibration. It supports two primary calibration instruments: the MORFEO Folding Mirror Calibration Unit (**FM CU**) and the MICADO Calibration Assembly (**MCA**) defined in AD25.
- **Mechanism:** It is composed mainly of a **fixed frame** (constrained to the MSS) and a **mobile frame**. The mobile frame performs a translation movement on guide rails and hosts the calibration instruments.

- **Positions[4]:** The mobile frame supports three possible "main" positions: a Rest position (where the Smith Plate is uncovered), the FM CU working position (aligned to the Smith Plate), and the MCA working position (central unit aligned).

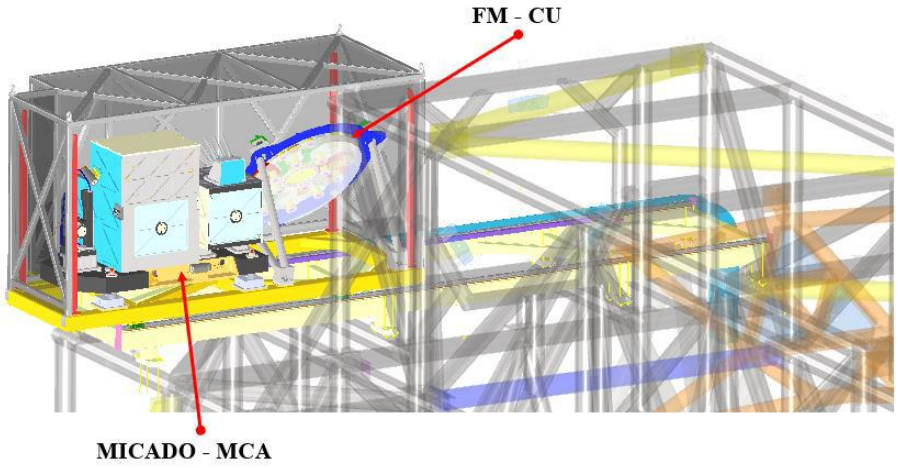

Figure 9View of the location of the CU Selector and its onboard modules (MCA and FM – CU)

3.1.3.6. Accessibility to the payloads

During the preliminary phase, two possible approaches were investigated to ensure safe and efficient accessibility to the payloads for integration, maintenance, and operational activities. The goal was to provide personnel with reliable access to all critical opto-mechanical subsystems while minimizing setup time and ensuring compliance with requirement **MAO-PM0-1.4.12**.

The first approach, considered, is shown in figure below. It involves a modular system of internal ladders, which can be mounted and dismounted inside the MSS as needed. This modular solution provides flexibility, allowing access only where and when required, and can be adapted to different payload configurations. However, the primary drawback is the installation time, which can be relatively long and is barely compliant with the timing constraints set by MAO-PM0-1.4.12. To mitigate this limitation, a permanently installed, foldable system comprising footbars, ladders, and walkways could be implemented. Such a solution would significantly reduce preparation time while still offering safe access to all necessary areas, combining modularity with readiness..

[4] Note that at the time of the writing of this document it is under discussion the need of an additional slot on the CU selector. Tehcnical proposal that will include this option will have additional points as defined I the SOW

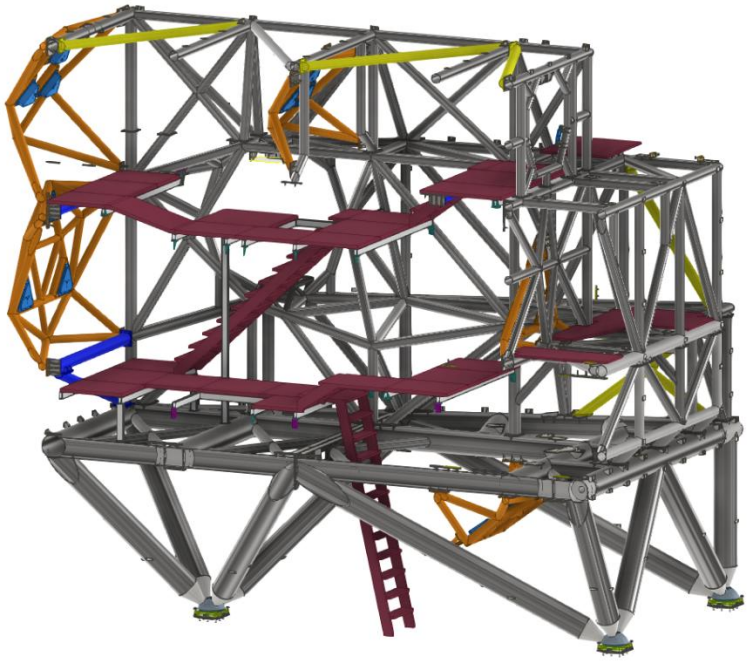

Figure 10 Internal view of the ladders approach accessibility

The second approach (preferred one), which has been adopted at the beginning of Phase D, consists of using a permanently installed elevator inside MORFEO, or alternatively, a rapidly deployable elevator that can be installed on demand. This elevator moves along dedicated rails and, when fully retracted, can be positioned in two to three different locations. This arrangement allows personnel (2 units) to reach multiple opto-mechanical subsystems efficiently, reducing the time and effort needed for access compared to the modular ladder approach. The elevator also offers a higher degree of safety and ergonomic convenience, particularly for accessing elevated or otherwise difficult-to-reach components.

When deployed the motion along the rails shall not be allowed (interlock or mechanical stops can be considered).

Figure 11 a conceptual view of the internal elevator, which can slide on rails when it is in the low position

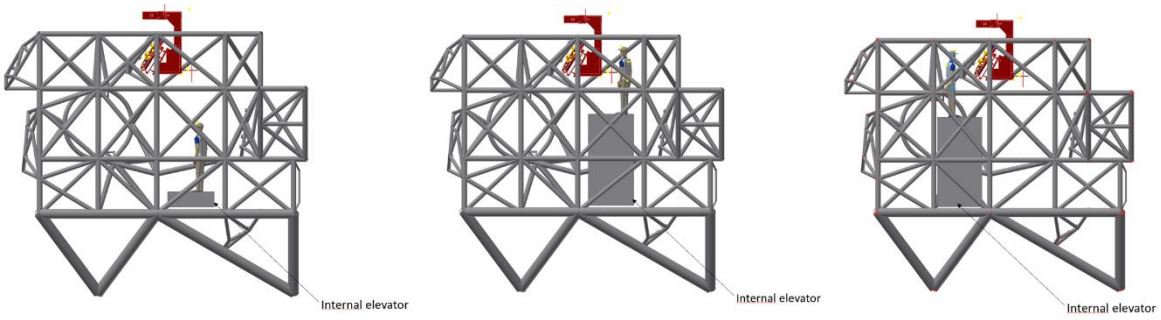

Figure 12 Scheme of the possible elevator approach

Both approaches aim to balance accessibility, safety, and compliance with system requirements, and the choice between them depends on the operational priorities, frequency of access, and the complexity of the payload integration and maintenance tasks.

3.2. Product Breakdown Structure

The items to be supplied by the contractors are defined in **MAO-PM0-1.2.3.4.**

MAO-PM0-1.2.2.2: Main Structure Product Breakdown shall comply with the one shown in Figure 4

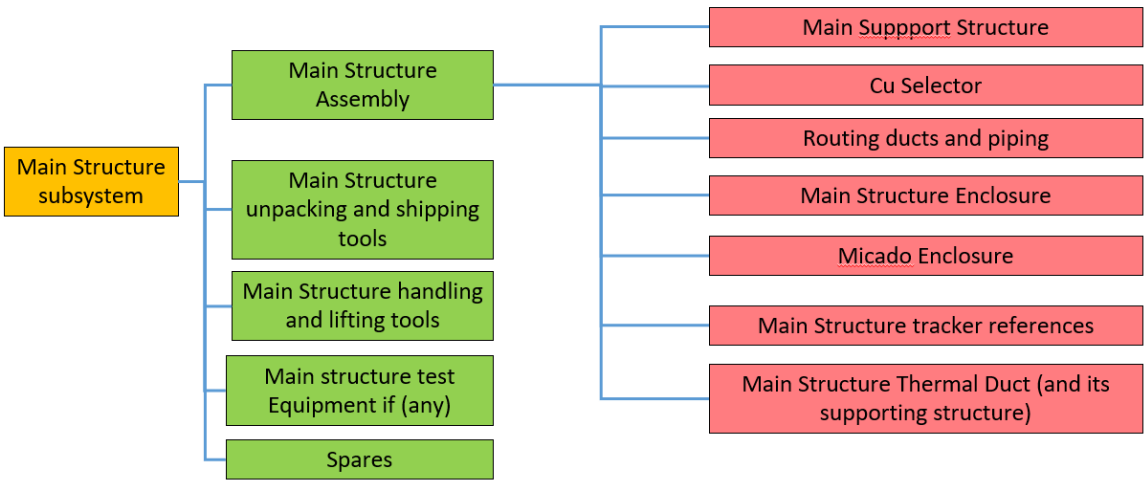

Figure 13 Product Breakdown Structure of Main Structure

3.3. Interface Definition

Whenever there is a relation between two subsystems, an Interface is identified.

The Main Structure will interface with all the payloads defined in MAO-PM0-1.2.3.5

MAO-PM0-1.3.4.5 Interface with DMs

Main Support structure shall comply with I-PM0/PD0 requirements as specified in as specified in 5.1 Interfaces with PAyloads

MAO-PM0-1.3.4.8 Interface with Optomechanics

Main Support structure shall comply with all interface requirements with optomechanics as specified in 5.1 Interfaces with PAyloads

MAO-PM0-1.3.4.9 Interface with CU

Main Support structure shall comply with I-PM0/PU0 requirements as specified in 5.1 Interfaces with PAyloads

MAO-PM0-1.3.4.11: Interface with Thermal System

Main Support structure shall comply with I-PM0/PT0 requirements 5.3 Thermal Interface: MORFEO Main Structure – MORFEO Instrument Thermal Control System

MAO-PM0-1.3.4.12: Interface with Instrument Control Electronics

Main Support structure shall comply with I-PH0/PM0 requirements as specified in 5.2 Electrical Interfaces: MORFEO Main Structures – MORFEO Instrument Control Hardware

MAO-PM0-1.3.4.13 Interface with LGS

Main Support structure shall comply with I-PM0/PL0 requirements as specified in 5.1 Interfaces with PAyloads

4.Physical, Functional and Performance Requirements

4.1. Performance Requirements

MAO-PM0-1.2.4.15 Payloads Reference Position

The Reference position of all the payloads defined in MAO-PM0-1.2.3.5 is defined in the model E-MAO-000-00-00-00-00-MOD-10_01 MORFEO Functional Integrated Geometry Assembly.stp AD18. The reference position is defined considering the reference temperature that is 9°C. The vendor shall take into account the difference related to the manufacturing and integration temperatures.

The interface of each optomechanics is on the rear of the kinematic wedges as can be seen on Figure 14

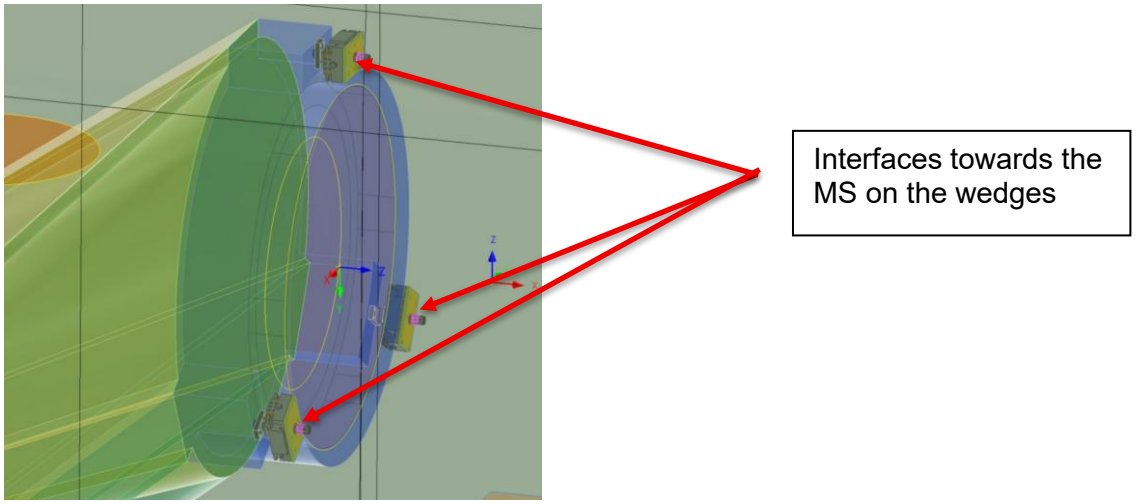

Figure 14 Typical volume definition for a payload (in this case CPM) the interface with the MS has to be inted as the rear surfaces of the kinematic wedges (red arrows)

In case of conflict between the interface drawings (AD2 to AD16) and the AD18 the content of AD18 shall be considered as superseding. This is valid with particular reference to **I-PM0/P$$-1.2.1.2:** and **I-PM0/P$$-1.2.1.4**[5]

MAO-PM0-1.2.4.16 Interfaces Tolerances

The tolerance of the as built mechanical interfaces wrt to the reference position of all the payloads, as defined in MAO-PM0-1.2.4.15, shall be within 0.1mm (ptv) with respect of the Main Structure LCS.

note 1: it is possible to share the same strategy adopted for the adaptation requested in MAO-PM0-1.2.4.25

note 2: the tolerance is defined referring to the nominal distance between the mechanical reference defined in MAO-PM0-1.2.2.3 and the positions defined in the various ICD drawings (AD2 to AD16)

MAO-PM0-1.2.4.17: Contribution to the thermal background of MICADO

The total emissivity of the main support structure shall be agreed during final design study. Namely the paint to be used both inside and outside the Main structure will be provided by the consortium and applied by the manufacturer.

MAO-PM0-1.3.2.3: Baffling

A baffling could be necessary pending on MORFEO straylight and thermal analysis: the baffling dimensions and characteristics will be defined by the Consortium during phase C (see SOW AD22). If needed, it shall be possible to add attachment interfaces for baffles. (Additional mass for the baffling interfaces will be agreed with the consortium).

MAO-PM0-1.2.3.3 Secondary path MORFEO

[5] For $$ it has to be considered all the payloads defined in **MAO-PM0-1.2.3.5**

Main support structure shall be designed to support also the secondary path, as described in sec 3.1 and specified in AD18

MAO-PM0-1.2.4.18 Alignability of the Main support structure

PM0 shall provide regulation system to align the whole Support structure with the following ranges:

Tx= ±5mm (resolution 0.1mm)

Ty= ±5mm (resolution 0.1mm)

Tz= ±2mm (resolution 0.1mm)

Rx= ±0.08° (resolution TBD)

Ry= ±0.05° (resolution TBD)

Rx= ±0.08° (resolution TBD)

Note: the regulation shall be possible with the main support structure fully equipped with its payloads

MAO-PM0-1.2.4.19 No vignetting

The Main Support structure shall not vignet the volume defined in AD18E-MAO-000-00-00-00-00-MOD-10_01 MORFEO Functional Integrated Geometry Assembly. A contingency of 5 cm (TBC) shall be considered around the defined volume.

MAO-PM0-1.2.4.21 Nasmyth induced distortion analysis

The main support structure shall perform a distortion analysis considering the following displacements to be applied at the Nasmyth interface points:

Foot 1 (-26750,0): Dx 0.1mm, Dy -0.1mm, Dz 0mm

Foot 2 (-26750,3000): Dx 0.1mm, Dy 0.1mm, Dz 0mm

Foot 3 (-31750,0): Dx -0.1mm, Dy -0.1mm, Dz 0mm

note: the resulting displacement shall comply with MAO-PM0-1.2.4.23

MAO-PM0-1.2.4.22 Wind induced distortion analysis

The main support structure shall perform a wind induced distortion analysis considering the following wind conditions

2m/s of wind (as specified in ESO-254547) in the following directions (separately):

+Y (acting on the right side of MORFEO)

+X (acting on the external side of MORFEO)

note: the resulting displacement shall comply with MAO-PM0-1.2.4.23

MAO-PM0-1.2.4.23 external perturbation Payload induced displacement

Under wind loads (defined in MAO-PM0-1.2.4.22) and Nasmyth distortion (defined in MAO-PM0-1.2.4.21), The MORFEO Main support structure shall not induce displacement to the payloads defined in MAO-PM0-1.2.3.5 higher than

Tx,Ty,Tz = 0.2mm

RY,RZ = 0.0013°

RX=0.016°

(Coordinates expressed in MORFEO reference system)

MAO-PM0-1.2.4.24 Lightightness

PM0 shall provide a system to maximize lightightness during Calibrations

MAO-PM0-1.2.4.25 Optics as built adaptation

PM0 shall provide a system to Correct the position of the optomechanics after the manufacturing of the optics, to consider the as built optical design (add the table).

The new position will be defined by the Consortium with an update of the reference file defined in MAO-PM0-1.2.4.15.

	Dx [mm]	Dx [mm]	Dx [mm]	tx [deg]	tx [deg]	tx [deg]
CPM	10.00	10.00	10.00	0.7	0.7	0.6
M6M	15.00	15.00	10.00	0.9	0.9	1.0
M7M	11.00	11.00	60.00	0.7	0.7	0.6
M8M	11.00	11.00	80.00	0.7	0.7	0.4
DM1	12.00	23.00	10.00	0.9	0.8	0.5
DM2	13.00	22.00	10.00	0.8	0.7	0.4
DC	10.00	11.00	10.00	0.9	0.7	0.7
M11M	10.00	10.00	10.00	0.8	0.8	0.4
M12M	10.00	10.00	10.00	0.8	0.8	0.4

Note: the preferred option is to have the possibility to replace the interface plates towards all the optomechanics with new ones remanufactured taking into account the new defined positions

MAO-PM0-1.2.4.26 No vingetting laser tracker

The Main Support structure shall not vignet the volume defined in E-MAO-000-00-00-00-00-MOD-10_01 MORFEO Functional Integrated Geometry Assembly.stp (AD18) that defines the laser trackers Line of Sights

MAO-PM0-1.2.4.27 internal perturbation distortion

The MORFEO main support structure shall not induce displacement to the payloads defined in MAO-PM0-1.2.3.5 higher than

Tx,Ty,Tz=0.2mm

RY,RZ 0.0013°

RX=0.016°

in any of the different position of the cu selector defined in MAO-PM0-1.2.5.1 and MAO-PM0-1.2.5.4 and in any configuration of the LGS defined in I-PM0/PL0-1.2.7 (coordinate expressed in MORFEO reference system)

4.2. Physical Characteristics

MAO-PM0-1.2.1: Common requirements applicability

Main Structure shall comply with all requirements in AD1 and a compliance and verification matrix shall be produced. Non applicable requirements must be marked as NA.

MAO-PM0-1.2.2.1 dwg OT definition

Unless otherwise explicitly indicated, all the dimensions in drawings AD28 AD29 and AD30 shall be assumed to be valid at 20°C (ISO 1).

Note: the reference temperature for the **MAO-PM0-1.2.4.15** and AD18 is 9°C

MAO-PM0-1.2.2.3 Mechanical Reference

It shall be defined a physical mechanical reference on the main support structure as near as possible to the Main structure LCS. it shall be possible to acquire this Mechanical Reference from the Laser Trackers defined in MAO-PM0-1.2.5.3.

MAO-PM0-1.2.2.4 Tracker References

The Main support Structure shall have at least 20 (TBC) Spherical Mounted Retro Reflectors (SMR) nest holders equipped with SMRs .
The position of the SMRs must be referenced to the Mechanical Reference defined in MAO-PM0-1.2.2.3.
The position will be defined with the customer during the final design
note: the fitting procedure shall be agreed with the vendor.

MAO-PM0-1.3.2.1 Main Structure Mass limitation

The total mass of the PM0 (Main Structure) shall not exceed 12300 kg (margin included) which includes:

- MSS

- CU selector

- enclosures (MORFEO and over MICADO)

- MAOMIC thermal duct

MAO-PM0-1.3.2.2 Main structure Nasmyth volume allocation

The volume of the Main structure cover included shall not exceed the design volume specified in AD29, AD30 and in AD33

4.3. Functional Requirements

MAO-PM0-1.2.5.1 FMCU selector deployment

PM0 shall provide a mechanism to position the FMCU in the required position to allow the CU to illuminate the main optical path (the same Mechanism shall not vignet the main beam when is retracted)

MAO-PM0-1.2.5.2 FMCU repositioning requirement

the FMCU has to be repositioned with a repeatability of (wrt global reference system:

- Rx,Ry and Rz ±0.003°(11asec)
- TY: ±1mm
- TZ, TX: ±0.1mm

note: The repeatability shall be kept also when the motor is disabled

MAO-PM0-1.2.5.3 Laser Tracker

PM0 shall provide support for at least 3 Laser Tracker (LEICA model AT930) The two positions are defined in AD18. Expressed in MORFEO Coordinate system are:

LT1:

x = -4560.21 y = -816.51 z = -3475.40

LT2:

x = -3043.85 y =-879.343 z = -1110.99

LT3:

x = -5246.00 y = 851,00 z = -1345.00

note: as a goal it shall be possible to add temporary LT stations

MAO-PM0-1.2.5.4 MCA repositioning requirement

the MCA has to be repositioned with a repeatability of (wrt global reference system:

- Tz, Tx=0.5mm
- Ty=0.1mm
- Rz,Rx=0.05°
- Ry=0.5°

note: The repeatability shall be kept also when the motor is disabled

MAO-PM0-1.2.5.5 Shutter capability

The PM0 shall as a goal provide a way to shutter the light from the PFS and Nasmyth. The same system should be designed to prove compliance to **MAO-PM0-1.2.4.24**

Note: an active foldable plate on the side of the cover of the carriage could be considered.

MAO-PM0-1.2.5.6 CU parking

The PM0 shall consider a parking position of the CU in order to access the DM1 for maintenance specified in I-PM0/PD0-1.2.1.11.

Note: for parking position it can be considered that the CU is dismounted from its interfaces and mounted on a slightly different position defined by the MS contractor

MAO-PM0-1.2.5.7 MCA deployment

the same mechanism required in MAO-PM0-1.2.5.1 shall position the MCA in front of the optical beam in the three positions defined in [I-MAO/MCA-108] from AD25ESO-351629 ICD between MAORY and MICADO (Calibration Unit)

MAO-PM0-1.2.5.8 Nasmyth Manifold

Main Structure shall provide mechanical support for the Nasmyth Manifold defined in I-PM0/PT0-1.2.15

MAO-PM0-1.2.5.9 Additional Slot

As a goal the CU selector shall include an additional spare slot of the dimensions of 600 x 600 x 600mm holding a weight of 200Kg

Note: in case the shuttering required in **MAO-PM0-1.2.5.5** is implemented with the active folding plate, the additional slot could be replaced by that plate if properly equipped with calibration sources to be agreed with the consortium.

MAO-PM0-1.2.5.10 Cleanliness inside Thermal cover

When in operation, (under the environment defined in AD1) and fully closed the Thermal enclosure shall be dust and sand tight. it shall provide a cleanliness level of ISO 6.5 (median), (goal ISO 6) according to EN ISO 14644-1: 1999.

MAO-PM0-1.2.5.11 Liquid collectors

The MSS shall implement a way to collect leakage from each relevant subsystems: DM1, DM2, LGS WFS unit and recirculating systems. The leakage shall converge to proper locations to be agreed with the consortium during final phase. The systems shall be designed to protect other payloads. The liquid collector design and location shall be agreed with the consortium.

MAO-PM0-1.2.5.14 MORFEO Calibration unit protection

When Calibration unit is not in use the top window shall be protected from dust, the protection shall be positioned with no human intervention.

note: a separate mechanism from the CU selector or the CU selector itself properly designed, can be considered

MAO-PM0-1.2.5.16 Lighting system

As a goal the MS shall be equipped with an internal lighting system, powered at 48V(TBC), to support maintenance activities.

4.4. Environmental Conditions

MAO-PM0-1.1.1: General applicable conditions

Unless otherwise specified all the requirements in this document and its applicable documents shall be met under the provisions specified in section 3.1 of AD1.

MAO-PM0-1.1.2: Specific conditions for Main Structure

In addition of section 3.1 of AD1, the following conditions shall be further considered:

- Air pressure to be considered in Europe integration is 1045mbar
- gravity orientation during integration could vary up to 90° (specifically defined by each element on AIV plan)
- Europe operative temperature 20-25°
- Europe operative humidity 50%-80%
- MORFEO operating reference temperature for the specifications verification, if not elsewhere specified, is 9°C.

4.5. Operational requirements

MAO-PM0-1.2.6.1 off/non-operational ready[6] switch time

The CU selector shall be capable to switch from off to non-operational ready and vice versa within less than 61 sec.

MAO-PM0-1.2.6.2 non-operational ready/operational switch time

The transition from non-operational ready to operational and vice versa shall require less than 10 sec.

MAO-PM0-1.2.6.3 night time operation preparation time

CU selector preparation for night time operation, if any, shall take less than 60s per day. And shall not require human intervention on the Nasmyth.

MAO-PM0-1.2.6.4 CU switch time

CU selector shall be capable to switch between any of its positions within less than 1 minute.

[6] Operational state definition can be found in AD32 Device Manager (fcfDevmgr) — ELT ICS Function Control Framework 7.1.4 documentation

5.Interfaces

The volumes of all the payloads defined in this sections have been grouped and positioned in the proper position in the AD18 E-MAO-000-00-00-00-00-MOD-10_01 MORFEO Functional Integrated Geometry Assembly (as defined in **MAO-PM0-1.2.4.15)** in order to simplify the design and the definition of the MSS.

MAO-PM0-1.3.1: Common Nasmyth ICD requirements applicability

Main Structure shall comply with all requirements in AD27 and a compliance and verification matrix shall be produced. Non applicable requirements must be marked as NA.

MAO-PM0-1.3.5.6 ICD between MAORY and MICADO (General) requirements applicability

Main Structure shall comply with all requirements in AD26 (ESO-323542) and a compliance and verification matrix shall be produced. Non applicable requirements must be marked as NA.

MAO-PM0-1.3.5.7 ICD between MAORY and MICADO (MCA) requirements applicability

Main Structure shall comply with all requirements in AD25 (ESO-351629) and a compliance and verification matrix shall be produced. Non applicable requirements must be marked as NA.

5.1. Interfaces with Payloads [7]

MAO-PM0-1.3.4.3 Optomechanics Integration

Main Support structure contractor shall define the procedure and related handling tools to integrate M6M, M7M, M8M, M11M, LGSO, LGSO-FM1, LGSO-FM3, CUFM onto the Main structure itself and M12M into the Micado thermal cover. (Temporary dismounting of thermal covers panels and MSS beams can be considered to enable this operation.). Detailed specifications can be found in AD24

MAO-PM0-1.3.4.1 DMs Integration

Main Support structure contractor shall define the procedure and related handling tools to integrate the two DMs onto the Main structure itself. (Temporary dismounting of thermal covers panels and MSS beams can be considered to enable this operation.). Detailed specifications can be found in AD24

[7] Note that the pictures in the following section are only for a better comprehension of the interface, they are not representative of the final design of the payloads

MAO-PM0-1.3.4.2 LGS integration

Main Support structure shall allow the integration of the LGS WFS as defined in the file AD40 E-MAO-SE0-00-00-00-00-MOD_02_01 MORFEO LGS extraction dynamic volume.stp. (Temporary dismounting of thermal covers panels and MSS beams can be considered to enable this operation).

MAO-PM0-1.3.4.14 CU integration

Main Support structure shall allow the integration of the CU as defined in the file AD39 E-MAO-PU0-00-00-00-00-MOD-03_01 MORFEO cu extraction dynamic volume.stp. (It is acceptable that the integration is allowed pending on dismounting of Component of the thermal cover and beams of the main Support structure)

5.1.1. MORFEO Main Structure – CPM

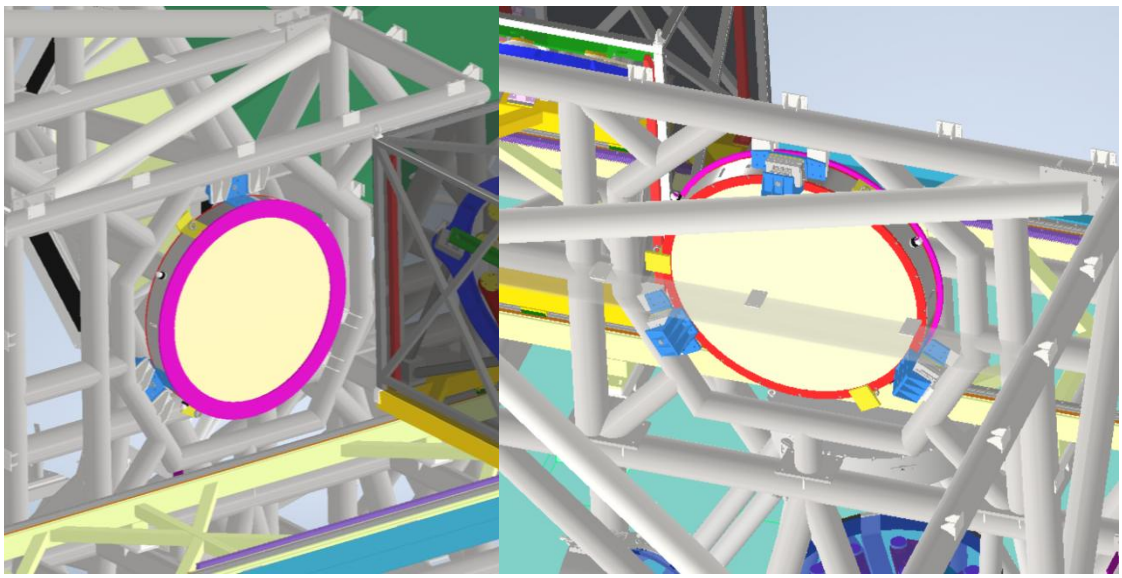

Figure 15Overview of the CPM inside the MSS

I-PM0/PFK-1.2.1.1: CPM Mass

The mass of CPM on the bench shall be lower than 130 Kg

I-PM0/PFK-1.2.1.2: CPM Volume allocation

The volume reserved for CPM unit is defined in E-MAO-PFK-ICD-DWG CPM interface drawing AD2

I-PM0/PFK-1.2.1.4: CPM mounting

The CPM unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-51-00-01-DWG_01 and E-MAO-PFK-ICD-DWG CPM interface drawing AD2

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PFK-1.2.1.6: MOI *[Info]*

The CPM moment of inertia shall be provided by the payload provider.

I-PM0/PFK-1.2.1.7: CoG

The CPM Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS
X [mm]	-398
Y [mm]	0
Z [mm]	0

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFK-1.2.1.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFK-1.2.1.9: CPM Unit Structural frequency

The lowest eigenfrequency of the CPM shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFK-1.2.1.11: CPM Access

The access to the CPM shall be:
• from side for thermal interface fixation detachment,
• from the back (inside the thermal cover) for cleaning, cover and handling tool installation and removal,
• from the front (outside the thermal cover) for cleaning, cover installation and removal,
• from the back tor alignment fine tuning and fixation.

the integration of the CPM will be, as a baseline,
• from the top of the Main structure in Bologna,
• from the top of the Main structure in the Armazones Integration assembly
• from the top of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFK-1.2.1.12: CPM Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFK-1.2.1.13: CPM Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC
Rz	± 10 arcsec TBC

I-PM0/PFK-1.2.1.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the vendor.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFK-1.2.1.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.2. MORFEO Main Structure – M6M

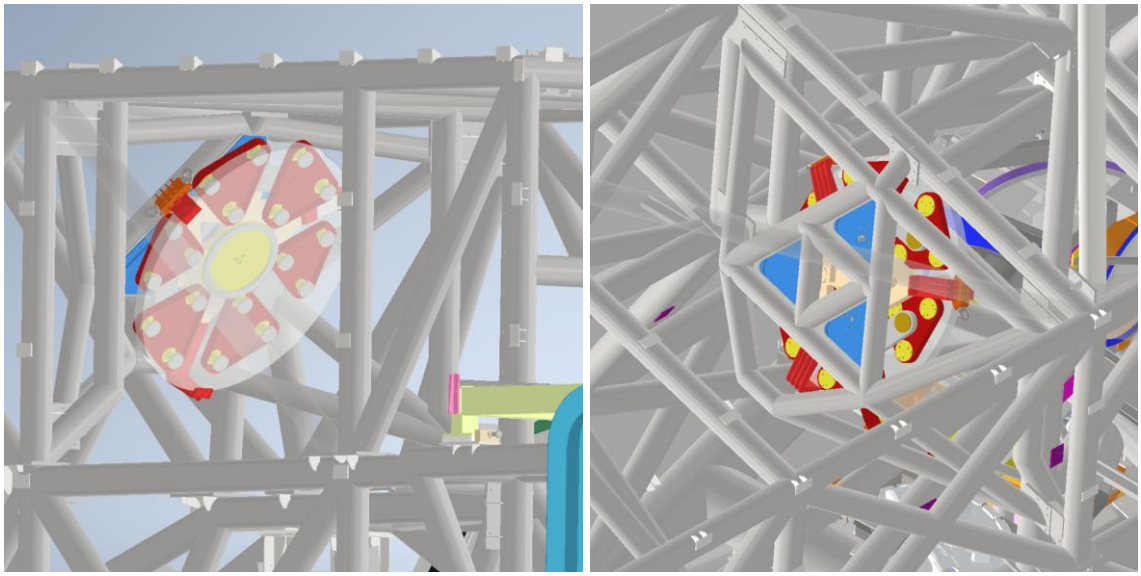

Figure 16 View of M6M inside the MSS

I-PM0/PFA-1.2.2.1: M6M Mass

The mass of M6M on the bench shall be lower than 178 Kg

I-PM0/PFA-1.2.2.2: M6M Volume allocation

The volume reserved for M6M unit is defined in E-MAO-PFA-ICD-DWG M6M interface drawing AD3

I-PM0/PFA-1.2.2.4: M6M mounting

The M6M unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-51-00-01-DWG_01 E-MAO-PFA-ICD-DWG M6M interface drawing AD3

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PFA-1.2.2.6: MOI *[Info]*

The M6M moment of inertia shall be provided by the payload provider .

I-PM0/PFA-1.2.2.7: CoG

The M6M Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS	M6M LCS
X [mm]	-3272	0
Y [mm]	0	4
Z [mm]	-35	-75

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFA-1.2.2.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFA-1.2.2.9: M6M Unit Structural frequency

The lowest eigenfrequency of the M6M shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFA-1.2.2.11: M6M Access

The access to the M6M shall be:

- from the front of the optical surface for cleaning, cover and handling tool installation and removal,
- from the back tor alignment fine tuning and fixation.

the integration of the M6M will be, as a baseline,

- from the top of the Main structure in Bologna,
- from the top of the Main structure in the Armazones Integration assembly
- from the top of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFA-1.2.2.12: M6M Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFA-1.2.2.13: M6M Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC
Rz	± 10 arcsec TBC

I-PM0/PFA-1.2.2.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFA-1.2.2.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.3. MORFEO Main Structure – M7M

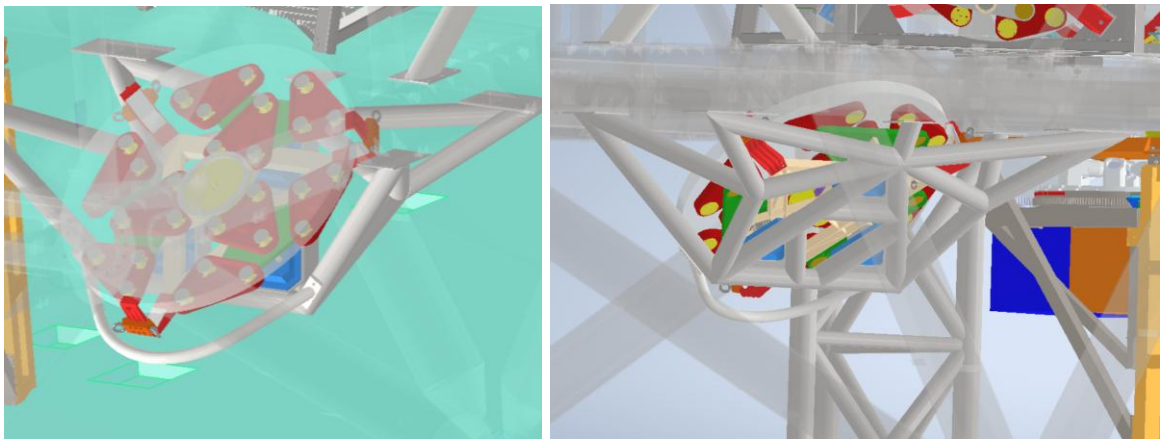

Figure 17 M7M overvew

I-PM0/PFB-1.2.3.1: M7M Mass

The mass of M7M on the bench shall be lower than 305 Kg

I-PM0/PFB-1.2.3.2: M7M Volume allocation

The volume reserved for M7M unit is defined in E-MAO-PFB-ICD-DWG M7M interface drawing AD4

I-PM0/PFB-1.2.3.4: M7M mounting

The M7M unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-51-00-01-DWG_01 in E-MAO-PFB-ICD-DWG M7M interface drawing AD4

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PFB-1.2.3.6: MOI ***[Info]***

The M7M moment of inertia shall be provided by the payload provider .

I-PM0/PFB-1.2.3.7: CoG

The M7M Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS	M7M LCS
X [mm]	-1095	0

Y [mm]	0	0
Z [mm]	-4409	-76

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFB-1.2.3.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFB-1.2.3.9: M7M Unit Structural frequency

The lowest eigenfrequency of the M7M shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFB-1.2.3.11: M7M Access

The access to the M7M shall be:
• from the front of the optical surface for cleaning, cover and handling tool installation and removal,
• from the back tor alignment fine tuning and fixation.

the integration of the M7M will be, as a baseline,
• from the top of the Main structure in Bologna,
• from the top of the Main structure in the Armazones Integration assembly
• from the top of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFB-1.2.3.12: M7M Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFB-1.2.3.13: M7M Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC
Rz	± 10 arcsec TBC

I-PM0/PFB-1.2.3.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFB-1.2.3.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.4. MORFEO Main Structure – M8M

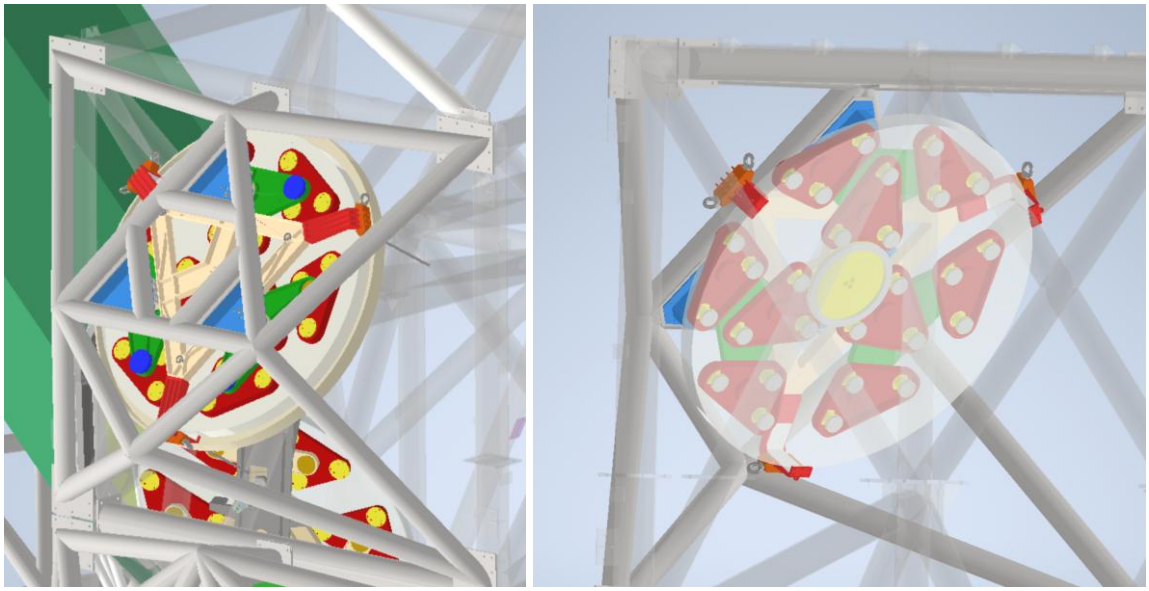

Figure 18 M8M overview

I-PM0/PFC-1.2.4.1: M8M Mass

The mass of M8M on the bench shall be lower than 334 Kg

I-PM0/PFC-1.2.4.2: M8M Volume allocation

The volume reserved for M8M unit is defined in E-MAO-PFC-ICD-DWG M8M interface drawing AD5

I-PM0/PFC-1.2.4.4: M8M mounting

The M8M unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-51-00-01-DWG_01 and E-MAO-PFC-ICD-DWG M8M interface drawing AD5

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PFC-1.2.4.6: MOI ***[Info]***

The M8M moment of inertia shall be provided by the payload provider .

I-PM0/PFC-1.2.4.7: CoG

The M8M Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS	M8M LCS
X [mm]	-6382	0
Y [mm]	0	0
Z [mm]	-100	-77

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFC-1.2.4.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFC-1.2.4.9: M8M Unit Structural frequency

The lowest eigenfrequency of the M8M shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFC-1.2.4.11: M8M Access

The access to the M8M shall be:
• from the front of the optical surface for cleaning, cover and handling tool installation and removal,
• from the back tor alignment fine tuning and fixation.

the integration of the M8M will be, as a baseline,
• from the top of the Main structure in Bologna,
• from the top of the Main structure in the Armazones Integration assembly
• from the top of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFC-1.2.4.12: M8M Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFC-1.2.4.13: M8M Alignment ***[Info]***

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy ± 0.05 mm TBC

Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC
Rz	± 10 arcsec TBC

I-PM0/PFC-1.2.4.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFC-1.2.4.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.5. MORFEO Main Structure – M11M

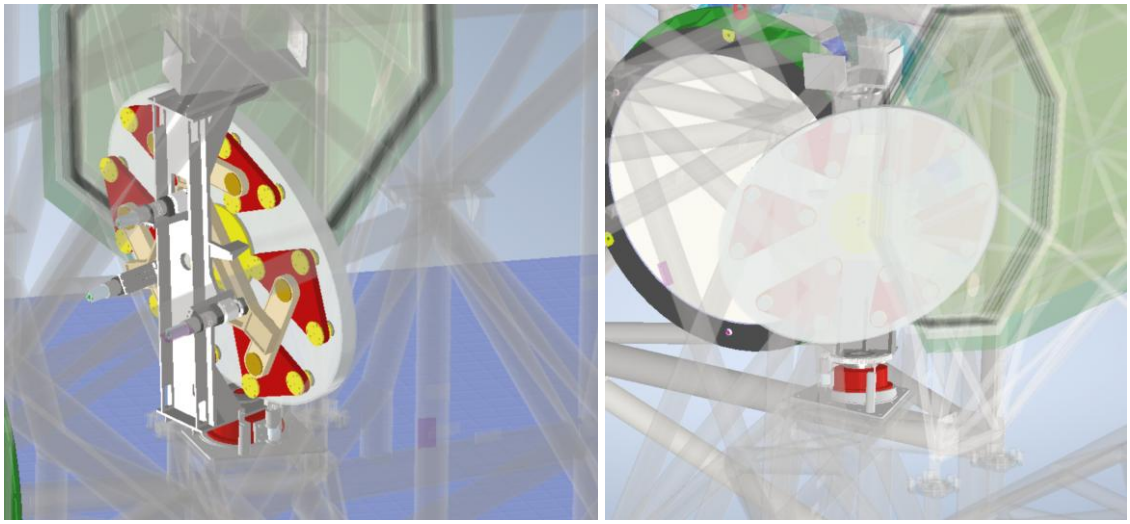

Figure 19 M11M overview

I-PM0/PFE-1.2.5.1: M11M Mass

The mass of M11M on the bench shall be lower than 320 Kg

I-PM0/PFE-1.2.5.2: M11M Volume allocation

The volume reserved for M11M unit is defined in E-MAO-PFE-ICD-DWG M11M interface drawing AD6

I-PM0/PFE-1.2.5.4: M11M mounting

The M11M unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-51-00-01-DWG_01 and E-MAO-PFE-ICD-DWG M11M interface drawing AD6

I-PM0/PFE-1.2.5.6: MOI ***[Info]***

The M11M moment of inertia shall be provided by the payload provider .

I-PM0/PFE-1.2.5.7: CoG

The M11M Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS	M11M LCS
X [mm]	- 4542	-11

Y [mm]	1442	19
Z [mm]	-1717	-100

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFE-1.2.5.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFE-1.2.5.9: M11M Unit Structural frequency

The lowest eigenfrequency of the M11M shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFE-1.2.5.11: M11M Access

The access to the M11M shall be:
• from the front of the optical surface for cleaning, cover and handling tool installation and removal,
• from the back for tip tilt actuators repairing, replacement,
• from the bottom for the toggling mechanism repairing, removal,
• from the back tor alignment fine tuning and fixation.

the integration of the M11M will be, as a baseline,
• from the external left side (Micado) of the Main structure in Bologna,
• from the external left side (Micado) of the Main structure in the Armazones Integration assembly
• from the external left side (Micado) of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

Note: it shall be possible to remove M11M from MORFEO by leaving the actuators installed

I-PM0/PFE-1.2.5.12: M11M Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFE-1.2.5.13: M11M Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC

I-PM0/PFE-1.2.5.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFE-1.2.5.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.6. MORFEO Main Structure – M12M

In this chapter we refer to M12M as the assembly of M12M Mirror + its mounting cell in cluding the actuators+ the structure to connect to the Interface to MICADO

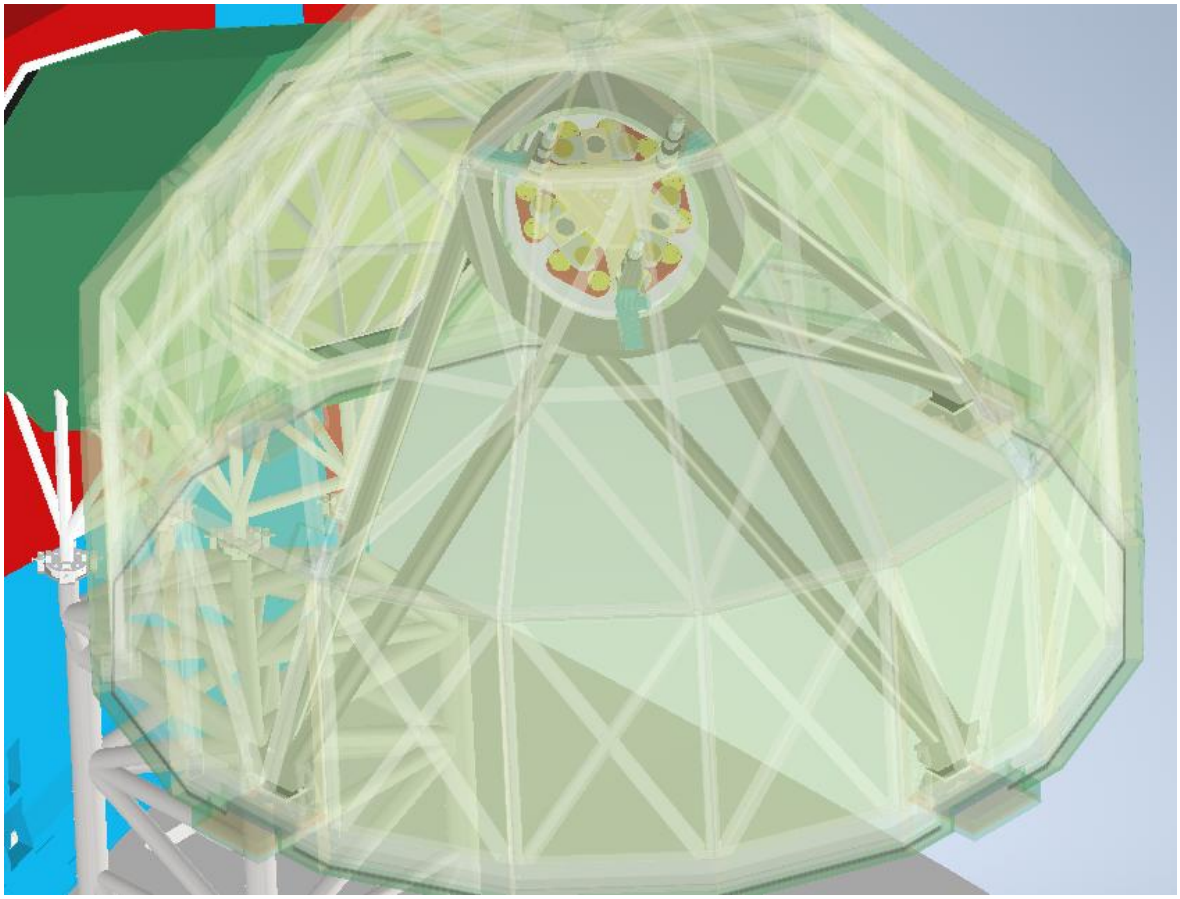

Figure 20 M12M Overview

I-PM0/PFF-1.2.10.1: M12M Mass

The mass of M12M on the bench shall be lower than 450 Kg

I-PM0/PFF-1.2.10.2: M12M Volume allocation

The volume reserved for M12M unit is defined in E-MAO-PFF-ICD-DWG M12M interface drawing AD7

I-PM0/PFF-1.2.10.4: M12M mounting

The M12M unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-51-00-01-DWG_01 and E-MAO-PFF-ICD-DWG E-MAO-PFF-ICD-DWG M12M interface drawing AD7

I-PM0/PFF-1.2.10.6: MOI *[Info]*

The M12M moment of inertia shall be provided by the payload provider .

I-PM0/PFF-1.2.10.7: CoG

The M12M Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS
X [mm]	- 3030
Y [mm]	6216
Z [mm]	588

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFF-1.2.10.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFF-1.2.10.9: M12M Unit Structural frequency

The lowest eigenfrequency of the M12M shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFF-1.2.10.11: M12M Access

The access to the M12M shall be:
• from the front of the optical surface for cleaning, cover and handling tool installation and removal,
• from the back for tip tilt actuators repairing, replacement,
• from the bottom for the toggling mechanism repairing, removal,
• from the back tor alignment fine tuning and fixation.

the integration of the M12M will be, as a baseline,
• from the external left side (Micado) of the Main structure in Bologna,
• from the external left side (Micado) of the Main structure in the Armazones Integration assembly
• from the external left side (Micado) of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

Note: it shall be possible to remove M11M from MORFEO by leaving the actuators installed

I-PM0/PFF-1.2.10.12: M12M Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFF-1.2.10.13: M12M Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy ± 0.05 mm TBC

Dz ± 0.01 mm TBC

Rx, Ry ± 2 arcsec TBC

I-PM0/PFF-1.2.10.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFF-1.2.10.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.7. MORFEO Main Structure – DICHROIC

I-PM0/PFD-1.2.11.1: DICHROIC Mass

The mass of DICHROIC on the bench shall be lower than 220 Kg

I-PM0/PFD-1.2.11.2: DICHROIC Volume allocation

The volume reserved for DICHROIC unit is defined in E-MAO-PFD-ICD-DWG DICHROIC interface drawing AD8

I-PM0/PFD-1.2.11.4: DICHROIC mounting

The DICHROIC unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-51-00-01-DWG_01 and in E-MAO-PFD-ICD-DWG DICHROIC interface drawing AD8

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PFD-1.2.11.6: MOI *[Info]*

The DICHROIC moment of inertia shall be provided by the payload provider .

I-PM0/PFD-1.2.11.7: CoG

The DICHROIC Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS
X [mm]	-608.44
Y [mm]	-7.261
Z [mm]	-3206.60

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFD-1.2.11.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFD-1.2.11.9: DICHROIC Unit Structural frequency

The lowest eigenfrequency of the DICHROIC shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFD-1.2.11.11: DICHROIC Access

The access to the Dichroic shall be:
• from the front and back of the splitting optical surface for cleaning, cover installation and removal, (TO BE VERIFIED WITH EDO)
• from the front of the splitting optical surface for handling tool installation and removal, (TO BE VERIFIED WITH EDO)
• from the front for alignment fine tuning and fixation. (TO BE VERIFIED WITH EDO)

the integration of the Dichroic will be, as a baseline,
• from the right (2nd instrument) side of the Main structure in Bologna,
• from the right (2nd instrument) side of the Main structure in the Armazones Integration assembly
• from the right (2nd instrument) side of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFD-1.2.11.12: DICHROIC Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFD-1.2.11.13: DICHROIC Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC

I-PM0/PFD-1.2.11.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFD-1.2.11.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.8. MORFEO Main Structure – LGSO-FM1

I-PM0/PFG-1.2.6.1: LGSO-FM1 Mass

The mass of LGSO-FM1 on the bench shall be lower than 230 Kg

I-PM0/PFG-1.2.6.2: LGSO-FM1 Volume allocation

The volume reserved for LGSO-FM1 unit is defined in E-MAO-PFG-ICD-DWG LGSO-FM1 interface drawing AD9

I-PM0/PFG-1.2.6.4: LGSO-FM1 mounting

The LGSO-FM1 unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-01-00-01-DWG_01 and E-MAO-PFG-ICD-DWG LGSO-FM1 interface drawing AD9

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PFG-1.2.6.6: MOI ***[Info]***

The LGSO-FM1 moment of inertia shall be provided by the payload provider .

I-PM0/PFG-1.2.6.7: CoG

The LGSO-FM1 Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS	LGSO-FM1 LCS
X [mm]	173	0
Y [mm]	-49	1
Z [mm]	-3357	72

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFG-1.2.6.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFG-1.2.6.9: LGSO-FM1 Unit Structural frequency

The lowest eigenfrequency of the LGSO-FM1 shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFG-1.2.6.11: LGSO-FM1 Access

The access to the LGSO-FM1 shall be:
• from the front of the optical surface for cleaning, cover installation and removal, (TO BE VERIFIED WITH EDO)
• from the back of the optical surface for handling tool installation and removal, (TO BE VERIFIED WITH EDO)
• from the back for alignment fine tuning and fixation. (TO BE VERIFIED WITH EDO)

the integration of the LGSO-FM1 will be, as a baseline,
• from the right (2nd instrument) side of the Main structure in Bologna,
• from the right (2nd instrument) side of the Main structure in the Armazones Integration assembly
• from the right (2nd instrument) side of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFG-1.2.6.12: LGSO-FM1 Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFG-1.2.6.13: LGSO-FM1 Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy ± 0.05 mm TBC

Dz ± 0.01 mm TBC

Rx, Ry ± 2 arcsec TBC

I-PM0/PFG-1.2.6.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFG-1.2.6.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.9. MORFEO Main Structure – LGSO-FM3

In this chapter we refer to LGSO-FM3 as the assembly of FM3 mirror + its mounting cell + the structure to connect to the Ms

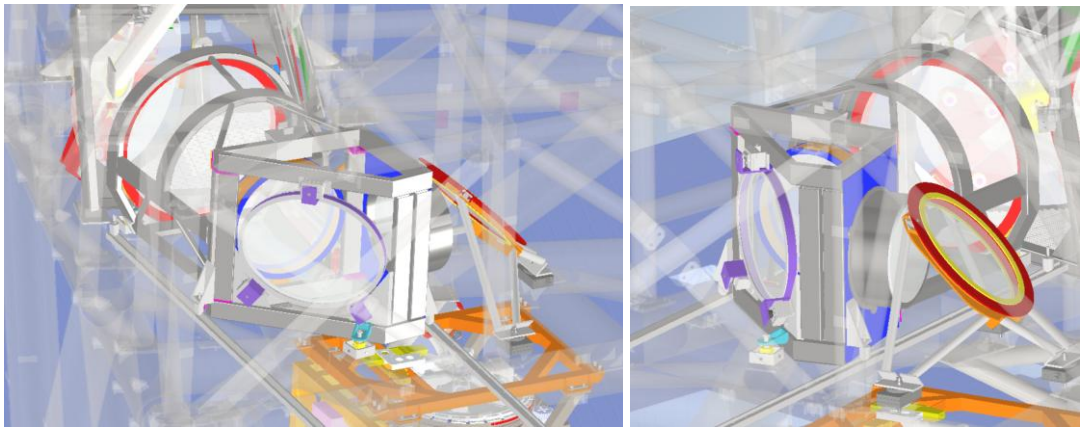

Figure 21 LGSO and FM3 detailed view

I-PM0/PFI-1.2.8.1: LGSO-FM3 Mass

The mass of LGSO-FM3 on the bench shall be lower than 100 Kg

I-PM0/PFI-1.2.8.2: LGSO-FM3 Volume allocation

The volume reserved for LGSO-FM3 unit is defined in E-MAO-PFI-ICD-DWG LGSO-FM3 interface drawing AD10

I-PM0/PFI-1.2.8.4: LGSO-FM3 mounting

The LGSO-FM3 unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-01-00-03-DWG_01 and E-MAO-PFI-ICD-DWG LGSO-FM3 interface drawing AD10

I-PM0/PFI-1.2.8.6: MOI *[Info]*

The LGSO-FM3 moment of inertia shall be provided by the payload provider .

I-PM0/PFI-1.2.8.7: CoG

The LGSO-FM3 Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS
X [mm]	-1321

Y [mm]	1732
Z [mm]	-3447

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFI-1.2.8.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFI-1.2.8.9: LGSO-FM3 Unit Structural frequency

The lowest eigenfrequency of the LGSO-FM3 shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFI-1.2.8.11: LGSO-FM3 Access

The access to the LGSO-FM3 shall be:
• from the front of the optical surface for cleaning, cover
• from the back of the optical surface for handling tool installation and removal, (TO BE VERIFIED WITH EDO)
• from the front for alignment fine tuning and fixation. (TO BE VERIFIED WITH EDO)

the integration of the LGSO-FM3 will be, as a baseline,
• from the left (Micado) side of the Main structure in Bologna,
• from the left (Micado) side of the Main structure in the Armazones Integration assembly
• from the left (Micado) side of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFI-1.2.8.12: LGSO-FM3 Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFI-1.2.8.13: LGSO-FM3 Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC

I-PM0/PFI-1.2.8.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFI-1.2.8.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.10. MORFEO Main Structure – LGS OBJECTIVE

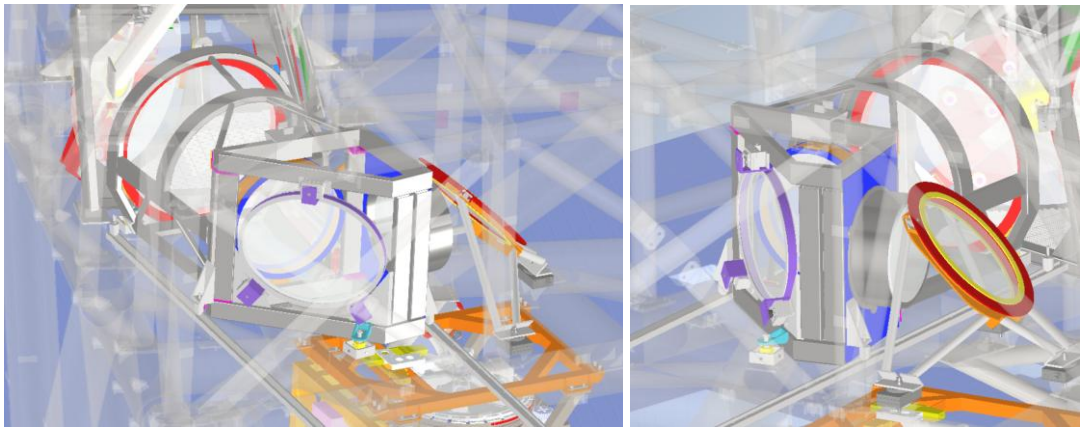

Figure 22 LGSO and FM3 detailed view

I-PM0/PFH-1.2.7.1: LGS OBJECTIVE Mass

The mass of LGS OBJECTIVE on the bench shall be lower than 450 Kg

I-PM0/PFH-1.2.7.2: LGS OBJECTIVE Volume allocation

The volume reserved for LGS OBJECTIVE unit is defined in E-MAO-PFH-ICD-DWG LGS OBJECTIVE interface drawing AD12

I-PM0/PFH-1.2.7.4: LGS OBJECTIVE mounting

The LGS OBJECTIVE unit mounting interface to PM0 shall be compliant to E-MAO-PM0-01-01-00-02-DWG_01 and E-MAO-PFH-ICD-DWG LGS OBJECTIVE interface drawing AD12

I-PM0/PFH-1.2.7.6: MOI ***[Info]***

The LGS OBJECTIVE moment of inertia shall be provided by the payload provider .

I-PM0/PFH-1.2.7.7: CoG

The LGS OBJECTIVE Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS	LGS OBJECTIVE LCS
X [mm]	-323	xx
Y [mm]	1482	xx

Z [mm]	-3363	xxx

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFH-1.2.7.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFH-1.2.7.9: LGS OBJECTIVE Unit Structural frequency

The lowest eigenfrequency of the LGS OBJECTIVE shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFH-1.2.7.11: LGS OBJECTIVE Access

The access to the LGS OBJECTIVE shall be:
• from the front of the optical surface for cleaning, cover
• from the back of the optical surface for handling tool installation and removal, (TO BE VERIFIED WITH EDO)
• from the front for alignment fine tuning and fixation. (TO BE VERIFIED WITH EDO)

the integration of the LGS OBJECTIVE will be, as a baseline,
• from the left (Micado) side of the Main structure in Bologna,
• from the left (Micado) side of the Main structure in the Armazones Integration assembly
• from the left (Micado) side of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFH-1.2.7.12: LGS OBJECTIVE Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFH-1.2.7.13: LGS OBJECTIVE Alignment *[Info]*

"The LGSobj to Main structure interface shall allow the following alignment ranges range (w.r.t. Local Coordinate system)

X-Y Tilts ± 1° TBC

X traslation ± 10 mm TBC

Y traslation ±10 mm TBC

Z traslation ± 10 mm TBC

Z rotation: ± 1 ° TBC

This adjustment is intended to be after measuring of all manufacturing errors (optics and mechanics) on the Main structure. With an accuracy of

X-Y Tilts ± 40 arcsec TBC

X-Y-Z traslation ± 0.15 mm TBC"**I-PM0/PFH-1.2.7.10.1: Vibration allowed**

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFH-1.2.7.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.11. MORFEO Main Structure – CUFM

In this chapter we refer to CUFM as the assembly of CU Folding Mirror + its mounting cell + the structure to connect to the Cu selector

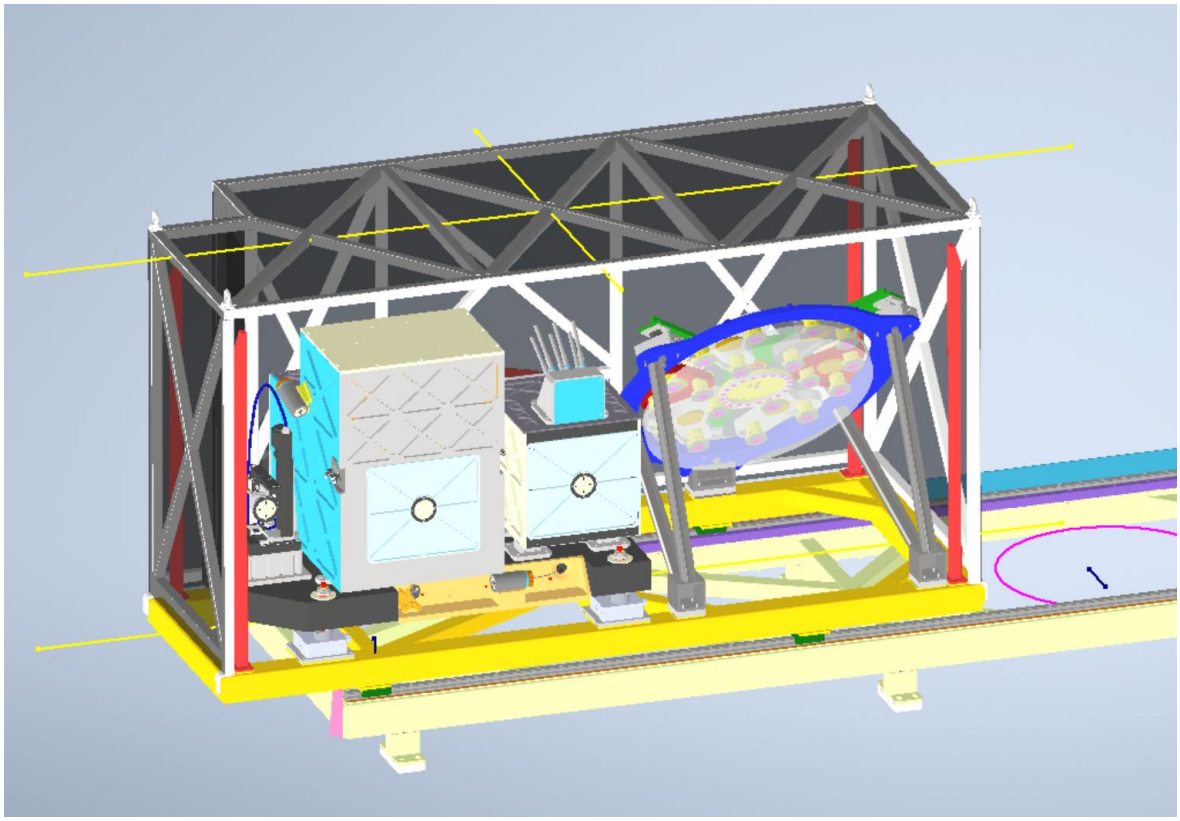

Figure 23 CUFM on the right

I-PM0/PFJ-1.2.9.1: CUFM Mass

The mass of CUFM on the bench shall be lower than 213 Kg

I-PM0/PFJ-1.2.9.2: CUFM Volume allocation

The volume reserved for CUFM unit is defined in E-MAO-PFJ-ICD-DWG CUFM interface drawing AD11

I-PM0/PFJ-1.2.9.4: CUFM mounting

The CUFM unit mounting interface to PM0 shall be compliant to E-MAO-PM0-02-02-01-02-DWG_01 and E-MAO-PFJ-ICD-DWG CUFM interface drawing AD11

I-PM0/PFJ-1.2.9.6: MOI *[Info]*

The CUFM moment of inertia shall be provided by the payload provider .

I-PM0/PFJ-1.2.9.7: CoG

The CUFM Center of Gravity wrt MORFEO LCS be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

Table 3 COG coordinates

	SCS
X [mm]	251
Y [mm]	0*
Z [mm]	10

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PFJ-1.2.9.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PFJ-1.2.9.9: CUFM Unit Structural frequency

The lowest eigenfrequency of the CUFM shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PFJ-1.2.9.11: CUFM Access

The access to the FMCU shall be:
• from the front of the optical surface for cleaning, cover and handling tool installation and removal,

• from the BACK of the optical surface for handling tool installation and removal, (TO BE VERIFIED WITH EDO)
• from the front for alignment fine tuning and fixation. (TO BE VERIFIED WITH EDO)

the integration of the FMCU will be, as a baseline,
• from the top of the calibration selector in Bologna,
• from the top of the calibration selector in the Armazones Integration assembly
• from the top of the calibration selector in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PFJ-1.2.9.12: CUFM Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PFJ-1.2.9.13: CUFM Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy ± 0.05 mm TBC

Dz ± 0.01 mm TBC

Rx, Ry ± 2 arcsec TBC

I-PM0/PFJ-1.2.9.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PFJ-1.2.9.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.12. MORFEO Main Structure – DM1

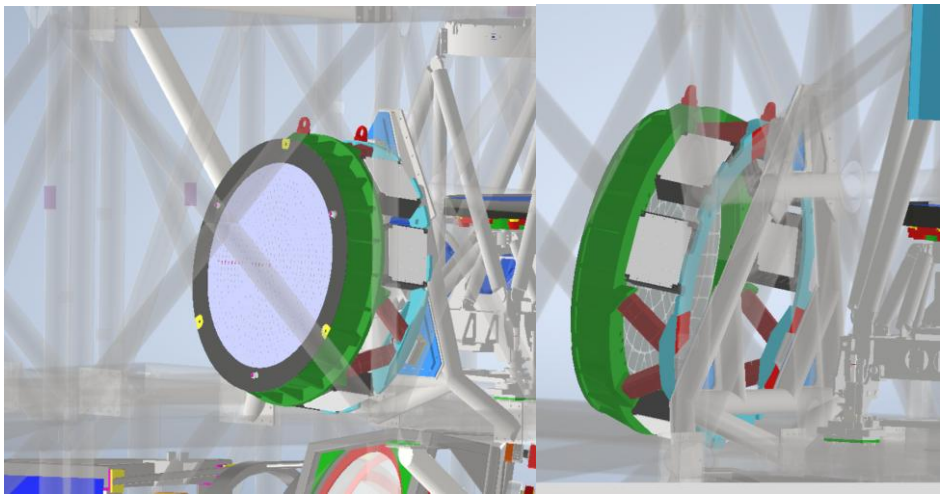

Figure 24 DM1 overall view

I-PM0/PDA-1.2.1.1: DM1 Mass

The mass of DM1 on the bench shall be lower than 650 Kg

I-PM0/PDA-1.2.1.2: DM1 Volume allocation

The volume reserved for DM1 unit is defined in E-MAO-PDA-ICD-DWG DM1 interface drawing AD13

I-PM0/PDA-1.2.1.4: DM1 mounting

The DM1 unit mounting interface to PM0 shall be compliant to E-MAO-PM0-02-02-01-02-DWG_01 and E-MAO-PDA-ICD-DWG DM1 interface drawing AD13

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PDA-1.2.1.6: MOI ***[Info]***

The DM1 moment of inertia shall be provided by the payload provider .

I-PM0/PDA-1.2.1.7: CoG

The DM1 Center of Gravity wrt MORFEO coordinate system shall be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

X: -902.2

Y: 0

Z: -1981.5

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PDA-1.2.1.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PDA-1.2.1.9: DM1 Unit Structural frequency

The lowest eigenfrequency of the DM1 shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PDA-1.2.1.11: DM1 Access

The access to the DM1 shall be:
• from side for electronics board replacement,
• from the front of the optical surface for cleaning, cover and handling tool installation and removal,
• from top for eyebolt fixing
• from the back tor alignment fine tuning and fixation. (this may require the repositioning of CU as specified in MAO-PM0-1.2.5.6)

the integration of the DM1 will be, as a baseline,
• from the top of the Main structure in Bologna,
• from the top of the Main structure in the Armazones Integration assembly
• from the top of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium

I-PM0/PDA-1.2.1.12: DM1 Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PDA-1.2.1.13: DM1 Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC

I-PM0/PDA-1.2.1.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PDA-1.2.1.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.13. MORFEO Main Structure – DM2

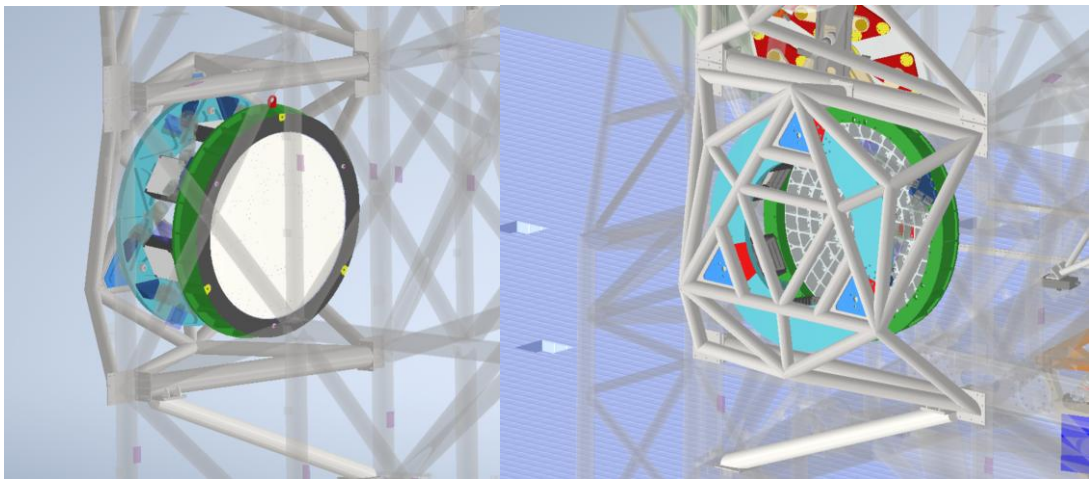

Figure 25 DM2 detailed view

I-PM0/PDB-1.2.2.1: DM2 Mass

The mass of DM2 on the bench shall be lower than 1100 Kg

I-PM0/PDB-1.2.2.2: DM2 Volume allocation

The volume reserved for DM2 unit is defined in E-MAO-PDB-ICD-DWG DM2 interface drawing AD14

I-PM0/PDB-1.2.2.4: DM2 mounting

The DM2 unit mounting interface to PM0 shall be compliant to E-MAO-PM0-02-02-01-02-DWG_01 and E-MAO-PDB-ICD-DWG DM2 interface drawing AD14

Note: the Interface with MS to be retrieved from AD18 is on the back of the wedges as shown (as example) on Figure 14

I-PM0/PDB-1.2.2.6: MOI *[Info]*

The DM2 moment of inertia shall be provided by the payload provider .

I-PM0/PDB-1.2.2.7: CoG

The DM2 Center of Gravity wrt MORFEO coordinate system shall be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

X: -6212.9

Y: 0

Z: -2145.5

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PDB-1.2.2.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PDB-1.2.2.9: DM2 Unit Structural frequency

The lowest eigenfrequency of the DM2 shall be higher than 30Hz. The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PDB-1.2.2.11: DM2 Access

The access to the DM2 shall be:
• from the back with respect of the optical surface for electronics board replacement,
• from the front of the optical surface for cleaning, cover and handling tool installation and removal,
• from top for eyebolt fixing
• from the back tor alignment fine tuning and fixation.

the integration of the DM2 will be, as a baseline,
• from the top of the Main structure in Bologna,
• from the back of the Main structure in the Armazones Integration assembly*
• from the top of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium
*in IAA the integration is as a basline done with the DM2 already installed on its interface frame to the Main structure

I-PM0/PDB-1.2.2.12: DM2 Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PDB-1.2.2.13: DM2 Alignment *[Info]*

The Kinematic interface, provided by the Consortium, will allow the remaining correction required with an accuracy of

Dx, Dy	± 0.05 mm TBC
Dz	± 0.01 mm TBC
Rx, Ry	± 2 arcsec TBC

I-PM0/PDB-1.2.2.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PDB-1.2.2.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110

Velocity [um/sN] RMS	3	1	3

5.1.14. MORFEO Main Structure – CALIBRATION UNIT

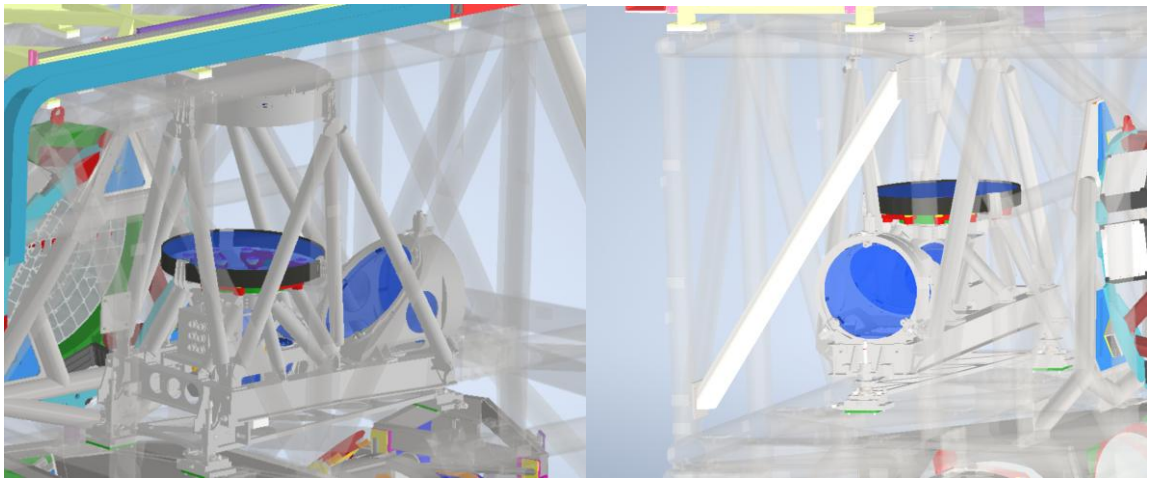

Figure 26 Calibration Unit detailed view

I-PM0/PU0-1.2.1.1: CALIBRATION UNIT Mass

The net mass of the Calibration Unit shall not exceed 385 kg. AIV tools excluded.

I-PM0/PU0-1.2.1.2: CALIBRATION UNIT Volume allocation

The volume of the Calibration unit which lays on the mss shall not exceed the design volume defined in AD15 E-MAO-PUA-00-00-00-00-**INA**-DWG-001_**02** design volume (this volume shall include the whole alignment range motion of the mirror)

I-PM0/PU0-1.2.1.4: CALIBRATION UNIT mounting

The Calibration Unit mounting interface to PM0 shall be compliant to AD15 and MAO-PM0-01_03_00_01_DWG_02 and AD43 E-MAO-PM0-01-03-00-00-INA-DWG-001_02 - Interface drawing PM0-PU0

I-PM0/PU0-1.2.1.6: MOI *[Info]*

The CALIBRATION UNIT moment of inertia shall be provided by the payload provider .

I-PM0/PU0-1.2.1.7: CoG

The CALIBRATION UNIT Center of Gravity wrt MORFEO coordinate system shall be provided by the payload provider .

For the time being the dimensioning of the MORFEO structure assumed the following values:

X: 255

Y: 154

Z: -1863

Any deviation shall be discussed and agreed with the Consortium.

I-PM0/PU0-1.2.1.8: Acting forces

If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PU0-1.2.1.9: CALIBRATION UNIT Unit Structural frequency

The lowest eigenfrequency of CU unit shall be higher than 21Hz (31Hz goal). The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PU0-1.2.1.11: CALIBRATION UNIT Access

The access to the CU shall be:
• from the left (micado) and right (2nd instrument) side for cleaning, cover and handling tool installation and removal,
• from the right (2nd instrument) for actuator maintenance,
• from the left (micado) and right (2nd instrument) for alignment fine tuning and fixation.
A permanent platform should be considered to easy maintenance procedures accessing from Second instrument side (-Y) including the one s related to DM1 defined in MAO-PM0-1.2.5.6

the integration of the CU will be, as a baseline,
• from the left (micado) side of the Main structure in Bologna,
• from the left (micado) side of the Main structure in the Armazones Integration assembly
• from the left (micado) side of the Main structure in Nasmyth platform

reference integration path can be found in AD17 and AD24, different integration path can be proposed but must be approved by the consortium
*in IAA the integration is as a basline done with the CALIBRATION UNIT already installed on its interface frame to the Main structure

I-PM0/PU0-1.2.1.12: CALIBRATION UNIT Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PU0-1.2.1.13: CALIBRATION UNIT Alignment *[Info]*

To be defined

I-PM0/PU0-1.2.1.10.1: Vibration allowed

The vibrations in following table shall be considered as limit for the allowed vibration induced from Main structure to its interface. Final values are pending on MORFEO vibration analysis that will be done in phase C and communicated to the payload provider.

The vibration levels are specified as RMS[N] Force per one-third octave frequency bands in the ranges indicated in the table below

Table 4 Allowed vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
(Force (x,y,z) [N] RMS per one-third octave frequency bands)	0.25	0.1	0.5

I-PM0/PU0-1.2.1.10.2: Vibration received

if not specified elsewhere the level of vibrations that the main structure receives from its interface are defined in the following table. Final values are pending on MORFEO vibration analysis that will be done in phase C and will be communicated to the vendor.

The vibration levels are specified as RMS[um/s] velocity per one-third octave frequency bands in the ranges indicated in the table below

Table 5 Received vibration specifications

	Frequency Range [Hz]		
Nasmyth Instruments	1-4.45	4.45-56	56-110
Velocity [um/sN] RMS	3	1	3

5.1.15. MORFEO Main Structure – LGS WFS UNIT

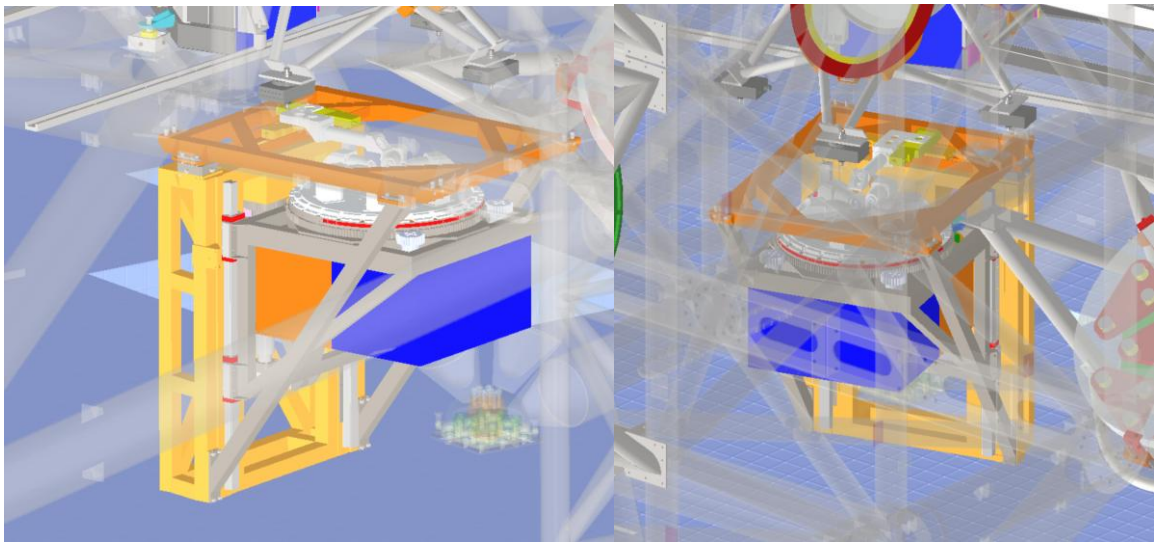

Figure 27 detailed view of the LGS WFS

I-PM0/PL0-1.2.1: LGS WFS UNIT Mass

The net mass of the LGS WFS unit shall not exceed 625 kg.

I-PM0/PL0-1.2.2: LGS WFS UNIT Volume allocation

The volume reserved for LGS WFS unit is defined in E-MAO-PL0-00-00-00-00-ADP-ICD-001_10 Interface Drawing AD16

I-PM0/PL0-1.2.4: LGS WFS UNIT mounting

The LGS mounting interface to PM0 shall be compliant to E-MAO-PL0-00-00-00-00-ADP-ICD-001_10 Interface Drawing AD16

I-PM0/PL0-1.2.6: MOI *[Info]*
The LGS WFS UNIT moment of inertia shall be provided by the payload provider .

I-PM0/PL0-1.2.7: CoG
The LGS WFS Center of Gravity is wrt global MORFEO SCS standard reference system

upper one:

X(mm): -1277.5

Y(mm): 1757.6

Z(mm): -4718.5

lower one:

X(mm): -1277.5

Y(mm): 1757.6

Z(mm): -4718.5

I-PM0/PL0-1.2.8: Acting forces
If not elsewhere specified, values coming from survival loads analysis shall be used as acting forces for dimensioning the mechanical interface.

I-PM0/PL0-1.2.0: LGS WFS UNIT Unit Structural frequency

The lowest eigenfrequency of CU unit shall be higher than 21Hz (31Hz goal). The corresponding analytical verification shall assume infinitely rigid interfaces.

I-PM0/PL0-1.2.11: LGS WFS UNIT Access

The access to LGS, in particular the ones defined in I-PM0/PL0-1.2.14 shall be (to be confirmed) from the bottom for any operation

I-PM0/PL0-1.2.14: LGS WFS UNIT Access needs

The MORFEO thermal shielding shall provide:
- opening doors to allow safe access (interock needed) of 1 person + equipment to the LGSWFS module for regular maintenance. (the Floor shall be walkable)

- removable inspection trapdoor (non interlocked) to allow maintenance inspection
- possibility to dismount and remove the whole LGS according to the path defined in E-MAO-SM0-INA-MOD-001_01.stp (this could imply the dismount of the panels supporting frame toghether with the panels)

I-PM0/PL0-1.2.12: LGS WFS UNIT Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PL0-1.2.13: LGS WFS UNIT Alignment *[Info]*

The LGS to Main structure interface shall allow the following alignment ranges range (w.r.t. Local Coordinate system) TBC

$\Delta XL < 5mm$, $\Delta YL < 5mm$, $\Delta ZL < 10mm$

$\Delta\alpha L <$ TBD°, $\Delta\beta L <$ TBD°, $\Delta\gamma L$ free

I-PM0/PL0-1.2.9.1: Vibration allowed

if not specified elsewhere R-INS-760 of ESO-254547 shall be considered as limit for the allowed vibration induced from LGSWFS to its interface

I-PM0/PL0-1.2.9.2: Vibration received

if not specified elsewhere I-INS/ELT-309 of ESO-253082defines the level of vibrations that the LGSWFS receives from its interface

5.2. Electrical interfaces: Main Structure Assembly – MORFEO Instrument Control Hardware

5.2.1. MORFEO Main Structure – Routing

MAO-PM0-1.2.5.12 Cable routing

MSS shall provide cable routing defined in this section in form of a metallic tray for cabling, permanently installed on the Nasmyth platform (view K sheet 4 of AD29) and Main Support structure.

If not explicitly forbidden it is possible to group common path of different segments in the same cable tray.

MAO-PM0-1.2.5.15 Cable access patch panel

MS shall foresee a patch panel to collect all the cables entering the Thermal covers.

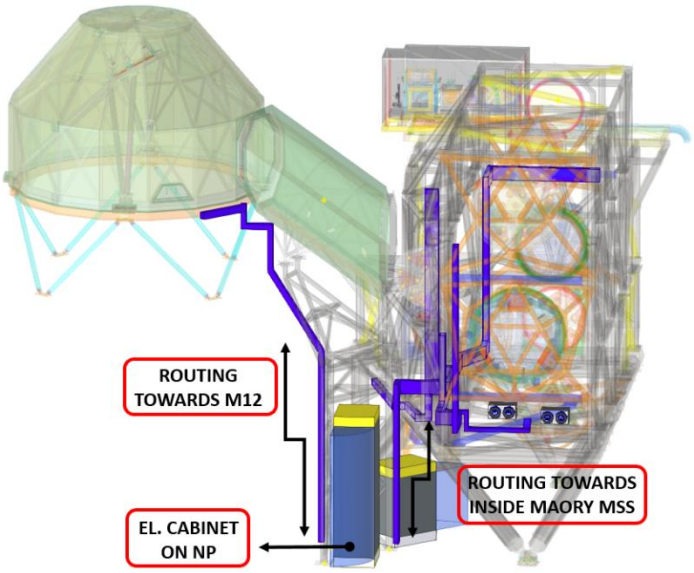

Figure 28 Overall scheme for cable routing

I-PH0/PM0-1.2.2 Cable routing CU selector

MS shall provide cable routing form Nasmyth Morfeo Cutout (AD29 sheet 4 View K) to the CU selector (end point definition under the responsibility of the vendor) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of 40x20 mm

Note: a local patch panel could be foreseen as cable interface.

I-PH0/PM0-1.2.3 Cable routing housekeeping

MS shall provide cable routing form Nasmyth Morfeo Cutout (AD29 sheet 4 View K) to the MORFEO housekeeping inside the Ms (end point inside the volume defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of (TBD) (the effective area will be agreed during final design.)

This include the thermal probes, leak sensors and humidity sensors defined in **I-PM0/PT0-1.2.9**, **I-PM0/PT0-1.2.16** and **I-PM0/PT0-1.2.17**

I-PH0/PM0-1.2.4 Cable routing Optomechanics

MS shall provide cable routing form the full cabinet on NP(defined in **I-PH0/PM0-1.4.8** Figure 29 possible location of the Nasmyth Cabinet) to the optomechanics in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of (TBD). (the effective area will be agreed during final design.). The length of the cables for the actuators shall be less than 8m.

Note: M12M is located inside the Micado thermal cover

Note2: a local patch panel could be foreseen as cable interface.

I-PH0/PM0-1.2.5 Cable Routing MORFEO calibration Unit

MS shall provide cable routing form MORFEO/MICADO Cutout (AD29 sheet 4 View F left) to the MORFEO Calibration Unit (end point at the entrance of the CU volume defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of (TBD) (the effective area will be agreed during final design.)

I-PH0/PM0-1.2.6 Cable Routing LGS WFS 1

MS shall provide cable routing form Nasmyth Morfeo Cutout (AD29sheet 4 View K) to the LGS WFS selector (end point at the entrance of the LGS volume defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of TBD (the effective area will be agreed during final design.)

I-PH0/PM0-1.2.9 Cable Routing LGS WFS 2

MS shall provide cable routing form the Electrical cabinet on NP (defined in **I-PH0/PM0-1.4.8** Figure 29) to the LGS WFS selector (end point at the entrance of the LGS volume defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of TBD (the effective area will be agreed during final design.). In any case the length of this routing shall be lower then 10m TBC.

I-PH0/PM0-1.2.10 Cable Routing LGS WFS 3

MS shall provide cable routing form the half cabinet on NP (defined in **I-PH0/PM0-1.4.9**) to the LGS WFS selector (end point at the entrance of the LGS volume defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of TBD (the effective area will be agreed during final design.). In any case the length of this routing shall be lower then 5m TBC.

I-PH0/PM0-1.2.7 Cable Routing DMs

MS shall provide cable routing form Nasmyth Morfeo Cutout (AD29 sheet 4 View K) to the DMs (end point at the entrance of the DM volumes defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of 2200 m^2.

I-PH0/PM0-1.2.8 Cable routing MCA

MS shall provide cable routing form Nasmyth MORFEO/MICADO Cutout (AD29 sheet 4 View F left) to the MCA in form of a tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, considering the cable list defined in section 9 of AD25

I-PH0/PM0-1.2.11 Cable Routing Laser Trackers

MS shall provide cable routing form Nasmyth Morfeo Cutout (AD29 sheet 4 View K) to the Laser Trackers defined in **MAO-PM0-1.2.5.3** (end point at the entrance of the LT volumes defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of TBD (the effective area will be agreed during final design.)

I-PH0/PM0-1.2.12 Cable routing Recirculation systems

MS shall provide cable routing form Nasmyth Morfeo Cutout (AD29 sheet 4 View K) to the MORFEO Recirculation systems defined in section 5.3.3 (end point at the entrance of the volume defined at the beginning of the final design phase) in form of a metallic tray for cabling, permanently installed on the Nasmyth platform and Main Support structure, with a minimum cross-section of (TBD) (the effective area will be agreed during final design.)

5.2.2. MORFEO Main Structure – Electrical interfaces

I-PH0/PM0-1.4.3 CU selector Electrical bonding

The electrical bonding between the MORFEO CU selector and the rest of Main Support Structure shall be defined according to I-PH0/PM0-1.4.1

I-PH0/PM0-1.4.4 CU selector Grounding and Isolation

A common grounding between the MORFEO CU selector and the rest of Main Support Structure shall be defined according to I-PH0/PM0-1.4.1

I-PH0/PM0-1.4.5 Shielding

The shielding strategy between the MORFEO CU selector and the rest of MORFEO will be defined for FDR

I-PH0/PM0-1.4.6 Electrical Power Allocation

The power allocation for the MS mechanisms is:

Average (over 24hours) normal power: 0.01 kW

Peak normal power: 1.8 kW

Average (over 24hours)

safety power: 0 kW

I-PH0/PM0-1.4.7 CU selector

CU position selector function shall be provided

I-PH0/PM0-1.4.1 Electrical guidelines

Unless otherwise specified Main Structure shall comply with Instrument Control Hardware Requirements for MORFEO Subsystems - E-MAO-PHO-INA-SPE-001 Version 3 and with - E-ELT Electrical and Electronic Design Requirements - ESO-262825 Version 1

I-PH0/PM0-1.4.8 Full Cabinet

In the design of the structure that that supports the MAOMIC thermal duct it must be taken into account that a cabinet (model type Varistar LHX3 34HEx600Bx800T) is hosted between the connection points and the Nasmyth feedthrough (view K sheet 4 of AD29). The exact position will be defined with the consortium in the final design phase.

I-PH0/PM0-1.4.9 Half Cabinet

In the overall design of the MSS it must be taken into account that a small cabinet (model type TBD) has to be positioned. The exact position will be defined with the consortium in the final design phase

I-PH0/PM0-1.4.10 Overall Electrical bonding

The electrical bonding between the Main Support Structure and the Nasmyth Platform shall be defined according to I-PH0/PM0-1.4.1

I-PH0/PM0-1.4.11 Overall Grounding and Isolation

A common grounding between the Main Support Structure and the Nasmyth Platform shall be defined according to I-PH0/PM0-1.4.1

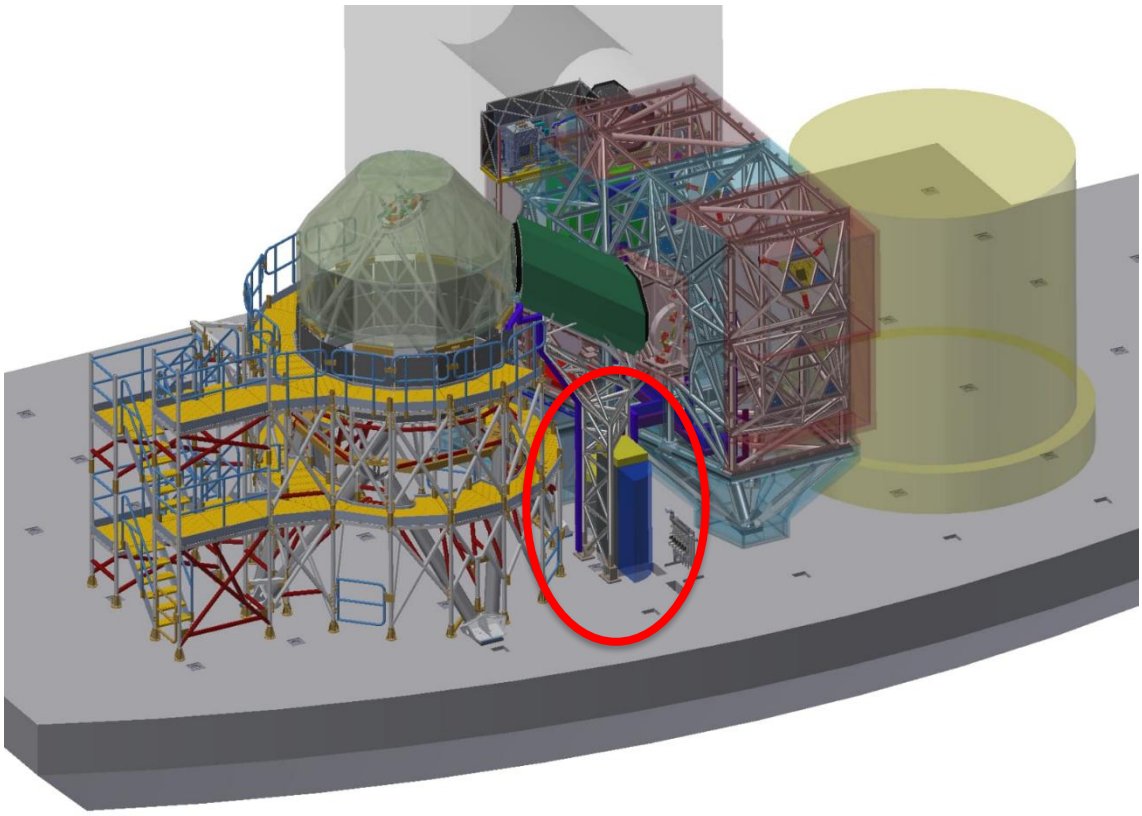

Figure 29 possible location of the Nasmyth Cabinet

I-PH0/PM0-1.4.12 CU motor compatibility

The motor shall be compatible with the controller selected by the Consortium (Beckhoff AX5203), in accordance with AD31.

Note: the Consortium may replace the controller, provided that the compatibility with the motor is maintained and justified.

5.3. Thermal Interface: Main Structure Assembly – MORFEO Instrument Thermal Control System

5.3.1. MORFEO Main Structure – Piping

MAO-PM0-1.2.5.13 Piping

MSS shall consider and define the piping from the manifold defined in section 5.3.4 to the payloads as defned in **I-PM0/PT0-1.2.11, I-PM0/PT0-1.2.12 and I-PM0/PT0-1.2.13**. The standard pipes to be considered are Stainless Steel tubing (OD defined by consortium at beginning of final design) for fixed segments and Swagelok PB + insulation (or equivalent) or Swagelok N (or equivalent) for flexible segments.

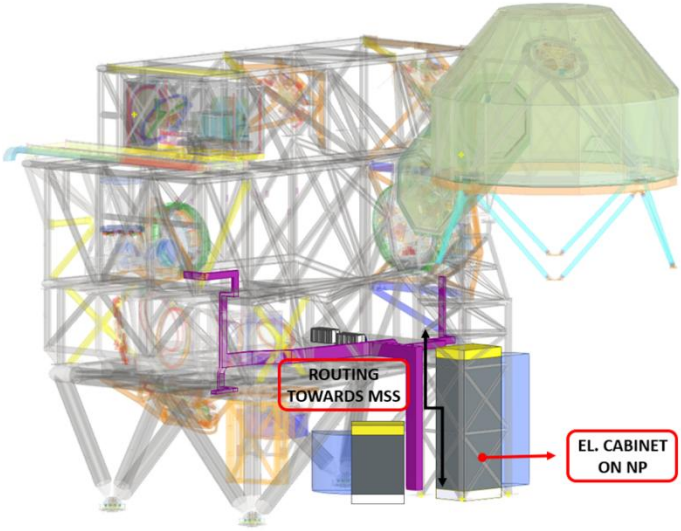

Figure 30 Global scheme of piping architecture

5.3.2. MORFEO Main Structure – Thermal system architecture

I-PM0/PT0-1.2.1 Thermal insulating architecture

The thermal cover shall be designed following the thermal insulating architecture defined in E-MAO-PT0-INA-DER-001

note: the architecture will provide constraints to

- pipe deployment (within the walls)
- feet insulation
- feedthroughs
- connection to the windows (even if this is more on PF0 and PU0)

I-PM0/PT0-1.2.2 Thermal insulating reduction

Upon agreement with Thermal System, if needed, it is possible to reduce the thickness of the insulating layer. The agreement will be defined case by case.

I-PM0/PT0-1.2.3 Thermal insulating material

The thermal cover shall be made out by the insulating shell:

the actual baseline insulating shell is made by a stack of different materials depending on the location.

Cover around MORFEO

- Polyisocyanurate 70 mm: Insulation

- Alluminum 1 mm: heat distribution

Cover between MORFEO and MICADO

- Polyisocyanurate 100 mm: Insulation

- Alluminum at least 1 mm: heat distribution

Cover above MICADO

- Polyisocyanurate 70 mm: Insulation

- Alluminum 2 mm: heat distribution

the external surfaces shall not produce any dust (as specified in AD1), they shall be compatible either with PVD solar coating applied over thin aluminium plate all around, or with low emissivity reflective paint (Solec) on the top parts of the instrument and normal paint on the other side

I-PM0/PT0-1.2.6 Skin temperature limit outside thermal enclosure

The active elements of the main structure (if any) shall not exceed the following skin temperature values:

Day-time: +/-1.5°C from ambient

Night-time: +/-1.5°C from ambient

I-PT0/PM0-1.2.9: Temperature Probes

At least 50 (TBC) temperature probes shall be located on Main Structure assemblies. The sensors will be provided by the consortium. The precise location will be agreed with the contractor before the Main Structure FDR.

I-PT0/PM0-1.2.10: Temperature sensors accuracy

The temperature sensors shall be PT100 1/3 DIN.

I-PM0/PT0-1.2.11 Pipe routing LGS WFS

MS shall provide piping from the Nasmyth manifold defined in section **Error! Reference source not found.** to the LGS WFS (the end point at the entrance of the LGS volume will be defined at the beginning of the final design phase). The final pipes (as per **MAO-PM0-1.2.5.13** will be defined by the consortium at the beginning of the final design phase

I-PM0/PT0-1.2.12 Pipe routing DM units

MS shall provide piping from the Nasmyth manifold defined in section 5.3.4 to the DMs (the end point at the entrance of the DM volumes will be defined at the beginning of the final design phase) The final pipes (as per **MAO-PM0-1.2.5.13** will be defined by the consortium at the beginning of the final design phase

I-PM0/PT0-1.2.13 Pipe routing Recirculation module

MS shall provide piping from the Nasmyth manifold defined in section 5.3.4 to the recirculation systems defined in section 5.3.3 (the end points will be defined at the beginning of the final design phase) The final pipes (as per **MAO-PM0-1.2.5.13** will be defined by the consortium at the beginning of the final design phase

Note: one of the recirculation systems is in the Micado Thermal cover

I-PT0/PM0-1.2.16: Leak sensors

The MS shall provide Interface and routing for all the Leak sensors needed to monitor the liquid collectors defined in **MAO-PM0-1.2.5.11** and 2 additional leak sensors located on Main Structure assemblies. The sensors will be provided by the consortium. The precise location will be agreed with the contractor before the Main Structure FDR

I-PT0/PM0-1.2.17: Humidity sensors

The MS shall provide Interface and routing for 2 humidity sensors on Main Structure assemblies and 2 inside the Micado thermal cover provided by the consortium. The precise location will be agreed with the contractor before the Main Structure FDR.

5.3.3. MORFEO Main Structure – Recirculation systems

Two separate recirculation systems shall be installed. The first one is inside the MORFEO thermal cover, the second one is inside the MICADO thermal cover.

I-PM0/PT0-1.2.14.1 Interface Material

The bench interface material will be steel (foreseen steel alloy is S355JR for the pipes and WELDOX700 for plates TBC).

I-PM0/PT0-1.2.14.2 Main support structure Recirculation module Mass

The mass of the Recirculation module in the Main support structure shall be shall be lower than 25 kg

I-PM0/PT0-1.2.14.3 Recirculation module access

It shall be possible to access all the recirculation modules for maintenance)

I-PM0/PT0-1.2.14.4 Main support structure Recirculation module volume allocation

The volume of the Main support structure Recirculation module shall not exceed the design volume defined in AD34 Recirculator_v520260310.stp

I-PM0/PT0-1.2.14.6 Main support structure Recirculation module mounting interface

The Main support structure Recirculation module mountings interface will be defined with the consortium at beginning of final design.

I-PM0/PT0-1.2.14.7 Recirculation module Vibration requirements

the Recirculation module shall not induce vibration when MORFEO is in operation mode the allowed level of vibration during daytime is TBD

I-PM0/PT0-1.2.14.8 Main support structure Recirculation module location

The Main support structure Recirculation module location will be finalized with the consortium defined at the beginning of the final design phase

I-PM0/PT0-1.2.14.9 Micado Thermal Cover Recirculation module Mass

The mass of the Recirculation module in the Micado Thermal Cover shall be shall be lower than 15kg

I-PM0/PT0-1.2.14.10 Micado Thermal Cover Recirculation module volume allocation

The volume of the Micado Thermal Cover Recirculation module shall not exceed the design volume defined in AD42 Recirculator_M12v5.stp

I-PM0/PT0-1.2.14.11 Micado Thermal Cover Recirculation module CoG in symmetrical

The Micado Recirculation module Center of Gravity will be finalized with the consortium defined at the beginning of the final design phase

I-PM0/PT0-1.2.14.12 Micado Thermal Cover Recirculation module mounting interface

The Main support structure Recirculation module mountings interface will be defined with the consortium at beginning of final design.

I-PM0/PT0-1.2.14.13 Micado Thermal Cover Recirculation module location

The Micado Recirculation module location will be finalized with the consortium defined at the beginning of the final design phase

5.3.4. MORFEO Main Structure – Nasmyth Manifold

I-PM0/PT0-1.2.15.1 Nasmyth Manifold Mass

The mass of the Nasmyth Manifold shall be shall be lower than 25 kg

I-PM0/PT0-1.2.15.2 Nasmyth Manifold access

It shall be possible to access the Nasmyth Manifold for maintenance)

I-PM0/PT0-1.2.15.3 Nasmyth Manifold volume allocation

The volume of the Nasmyth Manifold shall not exceed the design volume of 800 x 840 x 650 (W x H x T) mm

I-PM0/PT0-1.2.15.4 Nasmyth Manifold Location

The Nasmyth Manifold is located in the proximity of the Nasmyth feedthrough as shown in Figure 31. The exact position will be defined with the consortium in the final design phase.

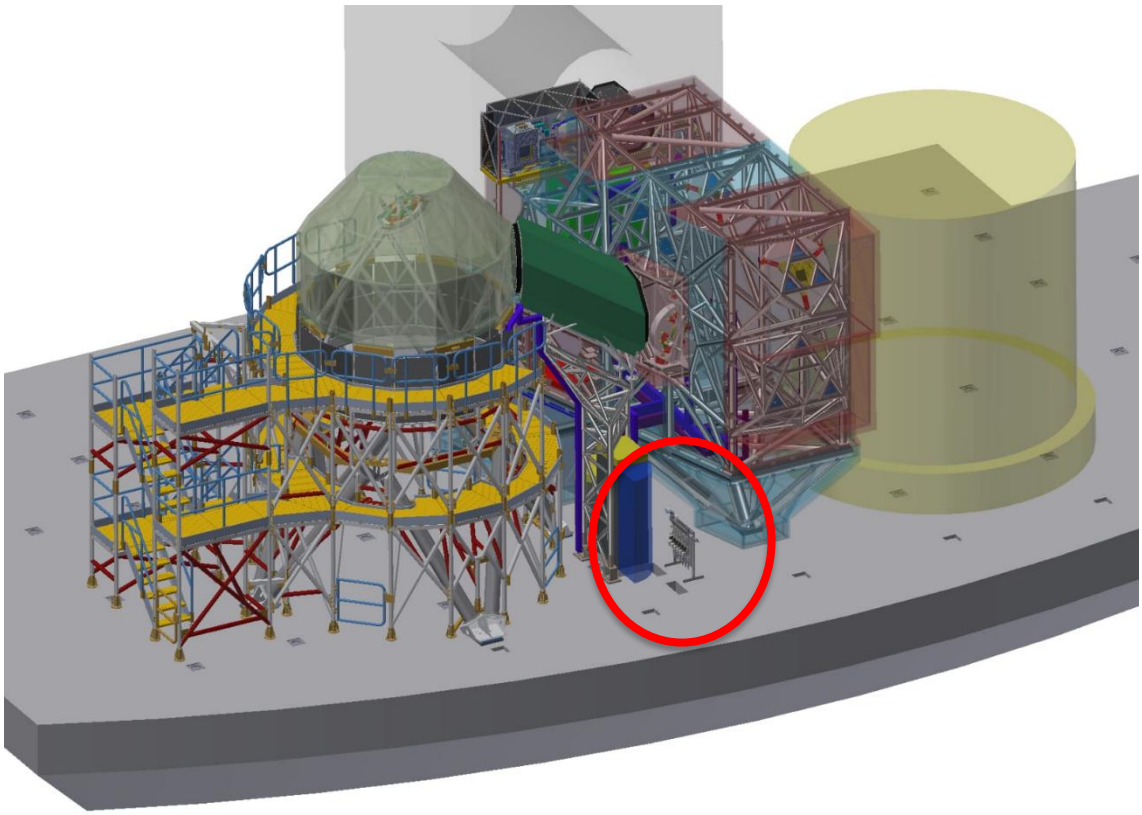

Figure 31 possible location of the Nasmyth Manyfold

5.4. External Interface: MORFEO MICADO

MAO-PM0-1.3.5.1 MICADO static Envelope

Main structure shall never violate the Micado static envelope is defined in **Error! Reference source not found.** and AD41

The MORFEO static envelope is defined in RD4

MAO-PM0-1.3.5.2 MICADO AIV envelope

the possibility to violate (or not) The micado AIV envelope (E000150103/001) is specified in AD26

The MORFEO AIV envelope is defined in AD17

MAO-PM0-1.3.5.3 MICADO Accessibility

Common accessibility is specified in AD26

5.4.1. MORFEO Main Structure: Micado Thermal cover[8] to MICADO

MAO-PM0-1.3.5.4.1 Micado thermal cover coordinate system

The Micado thermal cover local is located onto Micado

MAO-PM0-1.3.5.4.2 Micado thermal cover mounting

The Micado thermal cover mounting interface to Micado top Support structure is shown in DWG AD36 E-MAO-PM0-05-00-00-01-DWG_01

MAO-PM0-1.3.5.4.3 Micado thermal cover Volume allocation

The volume reserved for Micado thermal cover is defined in RD4 E-MA0-PM0-00-00-00-00-MOD.stp

MAO-PM0-1.3.5.4.4 Micado thermal cover Loads

Defined in AD26

MAO-PM0-1.3.5.4.5 Micado thermal cover Mass

The mass of the micado thermal cover shall be less than 680Kg

MAO-PM0-1.3.5.4.6 Micado thermal cover MOI

TBD

MAO-PM0-1.3.5.4.7 Micado thermal cover CoG

The Center of Gravity of Micado Thermal cover is:

x:-3053

y:5987

z:461

wrt MORFEO CSYS

[8] As defined in **MAO-PM0-1.2.3.4 this is part of MSS delivery**

5.4.2. MORFEO Main Structure – Micado MCA

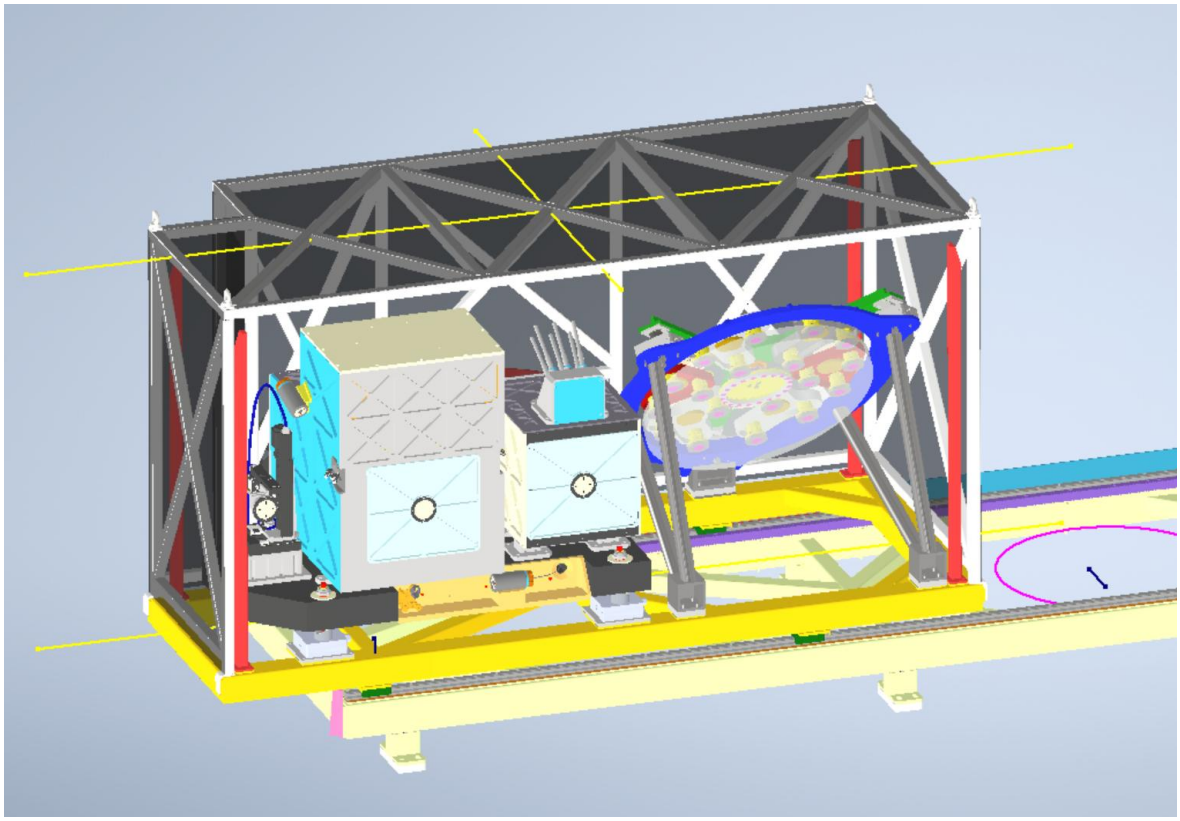

Figure 32 MCA on the left

MAO-PM0-1.3.5.5.1 Micado CU module coordinate system

The Micado CA local coordinate system is

x 0 y 0 z 0 al 0 be 0 ga 0

wrt to MORFEO reference system

MAO-PM0-1.3.5.5.2 MCA Mass

The mass is currently limited to 200Kg

MAO-PM0-1.3.5.5.3 MCA Volume allocation

The volume reserved for Micado CU is defined in AD37 mca-MORFEO-mode_asm.stp

MAO-PM0-1.3.5.5.4 MCA to CU selector mounting

The Micado CU mounting interface in the CU selector is shown in AD38 E-MAO-PM0-02-02-01-01_DWG_01

MAO-PM0-1.3.5.5.5 MCA MOI

TBD

MAO-PM0-1.3.5.5.6 MCA CoG

The Center of Gravity of MicadoCA is indicated in I-MAO /MCA-127 of AD25

MAO-PM0-1.3.5.5.8 MCA Acting forces

To be completed

MAO-PM0-1.3.5.5.9 MCA Structural frequency

MCA shall have an eigenfrequency higher than 50 Hz ± 5 Hz

MAO-PM0-1.3.5.5.10 MCA Vibration requirements

Vibration requirements are according to AD1and AD27

MAO-PM0-1.3.5.5.13 Cabling definition MCA

The Micado MCA in the elevator will be connected to its cabinets through the cable defined by Micado MCA in MCA MORFEO Harness list, defined in AD25. cabling requirement is defined in I-PH0/PM0-1.2.8

MAO-PM0-1.3.5.5.15 MCA protection

PM0 shall provide a protective cover for MCA in resting position

MAO-PM0-1.3.5.5.16 Access the MCA

The access to the MCA shall be for maintenance and integration:
• from the front (opposite side than the Pre Focal Station)
• from the left (MICADO) side of the Main structure

• from the right (2nd instrument) side of the Main structure

• from the front for alignment fine tuning and fixation. (TO BE VERIFIED WITH EDO)

the integration of the MCA will be, as a baseline,
• from the top

PM0 shall provide a (possibly) permanent ladder to allow the access to the MICADO MCA unit for maintenance.

note: in case the ladder is not permanent it shall be possible to mount or dismount it in less than half an hour.

5.5. External Interface: MORFEO to Telescope

The details of the interface to the telescope are specified in AD27. The actual design which is a reference for this call for tender further refines the interfaces agreed with ESO, and in particular:

The main support structure is connected to the Nasmyth through the following connection points defined in EELt standard reference system:

	X (mm)	Y(mm)	Z(mm)
#1	26750	0	-6000
#2	26750	-3000	-6000
#3	31750	0	-6000

Three additional support point are used by the structure that supports the thermal tube between Maory and Micado. They are compliant with AD27

	X (mm)	Y(mm)	Z(mm)
*2	31250	-3000	-5950
*3	32250	-3000	-5950
*1	31250	-2125	-5950

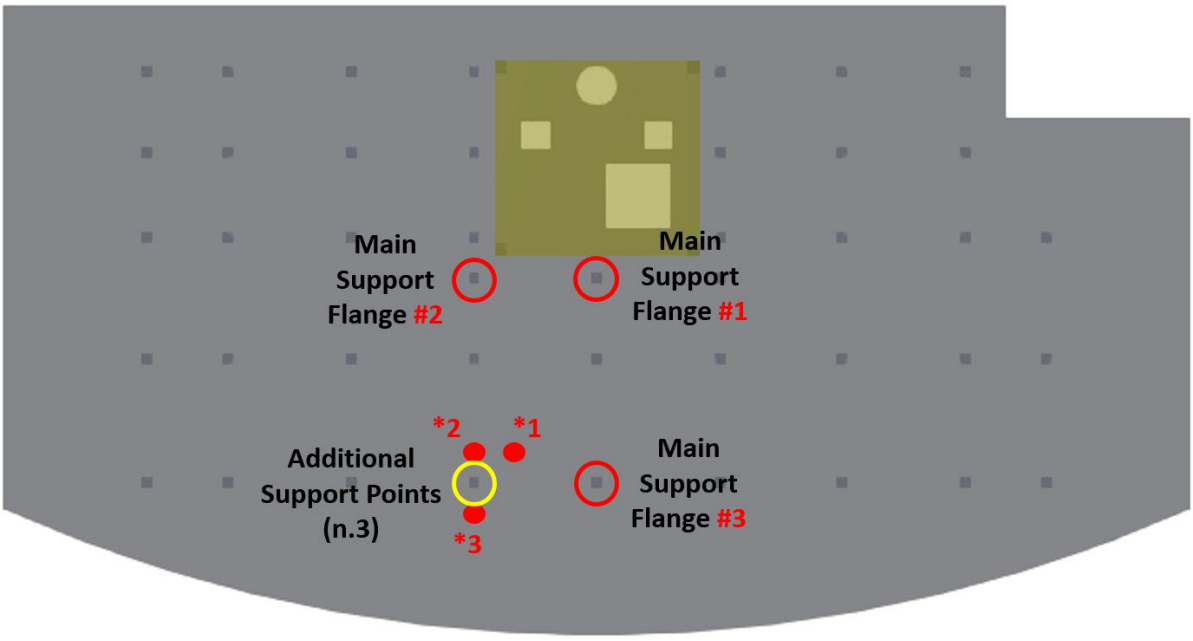

Figure 33 MAORY/ESO NP: top view of the required interfaces location

MAO-PM0- 1.3.2.4. Static Volume and contingency.

The applicable static volume is the external skin of RD4. If for any reason the proposed design differ from that volume it hast to be agreed with the consortium and in any case shall include at least 6cm (goal 10cm) of margin from the allowable volume defined in AD30 and AD29 and **Error! Reference source not found.** and AD41Micado volume.

6.Access and handling

MAO-PM0-1.4.1 Access to the instrument

Main support structure shall guarantee that the Access to the instrument across the Nasmyth platform will be exclusively via the walkway area shown in AD30

MAO-PM0-1.4.3: Main Structure Handling tools

The supplier shall provide proper and safe tools for all Main Structure activities. As a minimum this shall include the following activities:

- Main Structure Packing and unpacking
- Main Structure mounting and dismounting
- Main Structure handling as defined in **MAO-PM0-1.4.7** and **MAO-PM0-1.4.8**
- Main Structure maintenance and test (if any)

Additional interfaces for the tools will be defined and agreed during final design phase

The tools needed for payloads mounting on MORFEO main structure are part of this contract but specified in AD24**.**

MAO-PM0-1.4.7 Handling frame IAA to Transit ring

MSS shall provide a proper frame to allow the handling of the main structure.

This Frame shall be usable also to move the integrated MORFEO, as defined in **MAO-PM0-1.2.3.6,** from the ELT IAA to the ELT Transit ring, According the boundaries defined specified in AD1 and AD27.

MAO-PM0-1.4.8 Handling frame Transit ring to Nasmyth

MSS shall provide a proper tool to allow the lifting of the main structure.

This Tool shall be usable also to move the integrated MORFEO, as defined in **MAO-PM0-1.2.3.6,** from the ELT Transit ring to the ELT Nasmyth Platform, According the boundaries defined specified in AD1 and AD27.

Note: the tools specified in **MAO-PM0-1.4.7** and in **MAO-PM0-1.4.78** can be different

MAO-PM0-1.4.9: First integration time and personnel constraint

Mounting MORFEO-Main Structure subsystem at the telescope for the first time in the IAA shall require less than 10 days.

MAO-PM0-1.4.10: PM0 dismountability

The level of the disassembly of the MSS shall be as limited as possible but: compatible with standard shipment and enabling a reassembly on site as fast as possible

MAO-PM0-1.4.11 PM0 remounting repeatability

The Remounting repeatability of the interfaces defined in MAO-1.2.4.16, under any conditions defined in AD1and MAO-PM0-1.1.2, shall be within 50 microns.

note 2: the repeatability is defined with respect to the distance between the mechanical reference, defined in MAO-PM0-1.2.2.3, and the positions of the various payloads, defined in MAO-PM0-1.2.3.5, acquired before the last disassembly.

MAO-PM0-1.4.12 Access to all the subsystems

MSS shall provide a suitable system that allows two persons to access, within less than one hour, the front and rear (and, if required, the side) surfaces of all optical components for integration and maintenance activities. These activities include, but are not limited to, installation on the MSS, fine positional adjustments, cleaning, removal of protective covers, and dismounting. The detailed access requirements for each payload are specified in:

DM1: I-PM0/PD0-1.2.1.11

DM2: I-PM0/PD0-1.2.1.11

LGS WFS: I-PM0/PL0-1.2.11 and I-PM0/PL0-1.2.14

CPM; I-PM0/PF0-1.2.1.11

M6M: I-PM0/PF0-1.2.2.11

M7M: I-PM0/PF0-1.2.3.11

M8M: I-PM0/PF0-1.2.4.11

M11M: I-PM0/PF0-1.2.5.11

LGSO-FM1: I-PM0/PF0-1.2.6.11

LGSO: I-PM0/PF0-1.2.7.11

LGSO-FM3: I-PM0/PF0-1.2.8.11

FMCU: I-PM0/PF0-1.2.9.11

M12M: I-PM0/PF0-1.2.10.11

Dichroic: I-PM0/PF0-1.2.11.11

Calibration unit: I-PM0/PU0-1.2.1.11

Recirculation System: I-PM0/PT0-1.2.14.3

MCA: MAO-PM0-1.3.5.5.16

When the required operation is over, it shall be possible to remove the access system in less then 1 hour.

MAO-PM0-1.4.14 Accessibility panel removal

It shall be possible to dismount any of the thermal cover panels defined for the accessibility to the payloads by 2 persons in less than 30 min

Note: it has to be assumed that all access (boom lift / ladder / scaffolding) is available. Crane support can be available according to AD1and AD27

MAO-PM0-1.4.15 Panel removal

It shall be possible to dismount any of the thermal cover panels (except the ones specified in MAO-PM0-1.4.14) by 2 persons in less than 2h.

Note: it has to be assumed that all access (boom lift / ladder / scaffolding) is available. Crane support can be available according to AD1and AD27

MAO-PM0-1.4.16: Packing requirements

For the Packing, Recommendations from **Error! Reference source not found.** ESO-225669 Packing Recommendations Issue 3, shall be take into account

MAO-PM0-1.4.17: Packaging reusable

The packing and transport container used for delivery to the consortium shall be reusable for the shipping to the telescope site (note that the time estimated between the delivery to the consortium and the shipping in Chile is at least 4 years).

MAO-PM0-1.4.18: Procedures definition

For any activity defined in **MAO-PM0-1.4.3** the supplier shall provide detailed procedures and training to the consortium

MAO-PM0-1.4.19: Procedures limitations

It shall be possible to perform all the operations defined in the following requirements without violating the volume E-MAO-000-00-00-00-00-MOD-03_03 MORFEO System dynamic volume.stp AD17

- MAO-PM0-1.4.12
- MAO-PM0-1.4.14
- MAO-PM0-1.4.15
- I-PM0/PFK-1.2.1.11
- I-PM0/PFA-1.2.1.11
- I-PM0/PFB-1.2.1.11
- I-PM0/PFC-1.2.1.11
- I-PM0/PFD-1.2.1.11
- I-PM0/PFE-1.2.1.11
- I-PM0/PFF-1.2.1.11
- I-PM0/PFG-1.2.1.11
- I-PM0/PFH-1.2.1.11
- I-PM0/PFI-1.2.1.11
- I-PM0/PFJ-1.2.1.11
- I-PM0/PDA-1.2.1.11
- I-PM0/PDB-1.2.1.11
- I-PM0/PU0-1.2.1.11
- I-PM0/PL0-1.2.1.14
- MAO-PM0-1.3.5.5.16

MAO-PM0-1.4.20: Interlock

In case the access to a payload is granted through the dismounting of a panel and or a beam, one or more interlock signals (to be agreed in final design with the consortium) shall be triggered.
A further interlock has to be signal shall be triggered when the accessibility device defined in **MAO-PM0-1.4.12** is deployed. The implementation shall be according to AD32
Note: even if the access is granted in a different way an interlock shall be triggered.

MAO-PM0-1.4.21 Handles and hooking interfaces

All the items that are foreseen to be dismounted will be equipped with handling tools and/ or hooking interface for lifting tools. The details of each one will be agreed with the consortium during final design.

7.Product Assurance

MAO-PM0-1.5.1.9: Engineering standards

To facilitate the integration, operation and maintenance of the Main Structure in the ELT observatory the vendor shall follow the design guidelines reported in in AD19 (ESO-193497) AD20 (ESO-192984) AD21 (ESO-191462)

MAO-PM0-1.5.1.8 RAMS starting point

The Preliminary Acceptance Europe defined in the SOW AD22 sec 2.1, shall be the starting date for the verification of the as-built system RAMS requirements.

MAO-PM0-1.5.1.1: General RAMS requirements

Unless otherwise specified Main Structure shall comply with section 3.6 of AD1.

A compliance and verification matrix shall be produced (included in the verification of MAO-PM0-1.2.1). Non applicable requirements must be marked as NA

MAO-PM0-1.5.1.2: Main Structure includes safety and integrity measures

Main Structure shall include safety measures that the unit needs to undertake in order to ensure its own integrity and safety (hardware, software, and human safety) under all conditions and safety requirements specified herein. Human safety shall be guaranteed at all times.

MAO-PM0-1.5.1.3: no human intervention

Safety of the Main Structure itself shall not require human intervention if the Units are powered off by up to 24 hours.

MAO-PM0-1.5.1.4: Witness tests

Witness samples (described in AD1) can be agreed for all critical processes and materials

MAO-PM0-1.5.1.5: Analysis code and references

Any code used in Engineering calculations shall be indicated and references for formulas, assumptions, material data, etc. shall be provided.

MAO-PM0-1.5.1.6: Development test

Development tests shall be performed where needed to determine component characteristics or to validate analysis methods and assumptions.

MAO-PM0-1.5.1.7: Qualification of components before system tests

Qualification tests shall preferably be performed at component level as needed if system level tests will not be sufficient to simulate worst case conditions.

MAO-PM0-1.5.3.2: Staff limit

Each preventive/predictive maintenance action included the ones on the payloads defined in MAO-PM0-1.2.3.5 shall require at most 2 trained technicians.**MAO-PM0-1.5.3.3: Deploy and removal of accessibility devices**

The procedures to deploy and remove the devices to guarantee the accessibility required in **MAO-PM0-1.4.12** shall last less than 2 hours

MAO-PM0-1.2.6.5: Include measurement errors in mechanical verifications

The error budget shall include the measurement error with a confidence level of at least 2.5 sigma.

7.1. Reliability

MAO-PM0-1.5.2.1 MTBF definition

The Main support structure shall have (globally) a MTBF larger than 800000h

7.2. Maintenance

MAO-PM0-1.5.3.1 MCMT requirement

The CU selector shall have a maximum corrective maintenance time (MCMT) of 7h and a maximum mean time to repair/replace (Max MTTR) of 1h

MAO-PM0-1.5.3.2: Staff limit

Each preventive/predictive maintenance action included the ones on the payloads defined in MAO-PM0-1.2.3.5 shall require at most 2 trained technicians.

MAO-PM0-1.5.3.3: Deploy and removal of accessibility devices

The procedures to deploy and remove the devices to guarantee the accessibility required in **MAO-PM0-1.4.12** shall last less than 2 hours (in total)

MAO-PM0-1.5.3.4 MDT requirement

The MS shall have a MDT (mean down time) of 1h/y. It shall be calculated taking into consideration all active elements and electronics delivered in the frame of this contract

MAO-PM0-1.5.3.5 Cleaning compatibility

The maintenance of Payloads defined in MAO-PM0-1.2.3.5 may require the use of chemical aggressive cleaning component. The Main structure shall be compatible with them (to be specified within phase C) or as an alternative provide proper collecting ducts

MAO-PM0-1.5.3.6 Safe Position in case of Motor failure

In case of failure of the CU selector motor or power outage, it shall be possible to manually (or with dedicated tool) restore the parking position.

8. Requirement Verification

8.1. Technical specifications

Id	FDR Verification	ARR Verification	Comment
MAO-PM0-1.1.1	Design	Design	
MAO-PM0-1.1.2	Design	Design	
MAO-PM0-1.2.1	Design	Design	
MAO-PM0-1.2.2.1	Design	Design	
MAO-PM0-1.2.2.2	Design	Inspection	
MAO-PM0-1.2.2.3	Design	Test	
MAO-PM0-1.2.2.4	Design	Test	
MAO-PM0-1.2.3.2	Design	Design	
MAO-PM0-1.2.3.3	Design Analysis	Analysis Inspection	
MAO-PM0-1.2.4.15	Design	Test	
MAO-PM0-1.2.4.16	Design	Test	
MAO-PM0-1.2.4.17	Analysis	Test	
MAO-PM0-1.2.4.18	Design	Test	
MAO-PM0-1.2.4.19	Design	Test	
MAO-PM0-1.2.4.21	Analysis	Test	
MAO-PM0-1.2.4.22	Analysis	Test	
MAO-PM0-1.2.4.23	Analysis	Test	
MAO-PM0-1.2.4.24	Design	Test	
MAO-PM0-1.2.4.25	Design	Test	
MAO-PM0-1.2.4.26	Design	Test	
MAO-PM0-1.2.4.27	Analysis	Test	
MAO-PM0-1.2.5.1	Design	Inspection	
MAO-PM0-1.2.5.2	Analysis	Test	
MAO-PM0-1.2.5.3	Analysis	Test	
MAO-PM0-1.2.5.4	Analysis	Test	
MAO-PM0-1.2.5.5	Design	Test	
MAO-PM0-1.2.5.6	Design	Test	
MAO-PM0-1.2.5.7	Analysis	Test	
MAO-PM0-1.2.5.8	Design	Inspection	

MAO-PM0-1.2.5.9	Design	Inspection	
MAO-PM0-1.2.5.10	Design Analysis	Test	
MAO-PM0-1.2.5.11	Design	Inspection	
MAO-PM0-1.2.5.12	Design	Inspection	
MAO-PM0-1.2.5.13	Design	Inspection	
MAO-PM0-1.2.5.14	Design	Inspection	
MAO-PM0-1.2.5.15	Design	Inspection	
MAO-PM0-1.2.5.16	Design	Inspection	
MAO-PM0-1.2.6.1	Analysis	Test	
MAO-PM0-1.2.6.2	Analysis	Test	
MAO-PM0-1.2.6.3	Analysis	Test	
MAO-PM0-1.2.6.4	Analysis	Test	
MAO-PM0-1.2.6.5	Analysis	Test	
MAO-PM0-1.3.1	Design Analysis	Test Analysis	
MAO-PM0-1.3.2.1	Design	Test	
MAO-PM0-1.3.2.2	Design	Inspection Test	
MAO-PM0-1.3.2.3	Design	Test	
MAO-PM0-1.3.2.4	Design	Inspection	
MAO-PM0-1.3.4.1	Design	Inspection	
MAO-PM0-1.3.4.2	Design	Inspection	
MAO-PM0-1.3.4.3	Design	Inspection	
MAO-PM0-1.3.4.5	Design	Inspection	
MAO-PM0-1.3.4.8	Design	Inspection	
MAO-PM0-1.3.4.9	Design	Inspection	
MAO-PM0-1.3.4.11	Design	Inspection	
MAO-PM0-1.3.4.12	Design	Inspection	
MAO-PM0-1.3.4.13	Design	Inspection	
MAO-PM0-1.3.4.14	Design	Inspection	
MAO-PM0-1.3.5.1	Design	Inspection	
MAO-PM0-1.3.5.2	Design	Inspection	
MAO-PM0-1.3.5.3	Design	Inspection	
MAO-PM0-1.3.5.4.1	Design	Inspection	
MAO-PM0-1.3.5.4.2	Design	Inspection	
MAO-PM0-1.3.5.4.3	Design	Inspection	
MAO-PM0-1.3.5.4.4	Analysis	Analysis	
MAO-PM0-1.3.5.4.5	Design	Design	

MAO-PM0-1.3.5.4.6	Design	Design	
MAO-PM0-1.3.5.4.7	Design	Design	
MAO-PM0-1.3.5.4.9	Analysis	Analysis	
MAO-PM0-1.3.5.5.2	Design	Test	
MAO-PM0-1.3.5.5.3	Design	Inspection	
MAO-PM0-1.3.5.5.4	Design	Inspection	
MAO-PM0-1.3.5.5.5	Design	Design	
MAO-PM0-1.3.5.5.6	Design	Design	
MAO-PM0-1.3.5.5.8	Design	Design	
MAO-PM0-1.3.5.5.9	Analysis	Analysis	
MAO-PM0-1.3.5.5.10	Analysis	Analysis	
MAO-PM0-1.3.5.5.13	Design	Inspection	
MAO-PM0-1.3.5.5.15	Design	Inspection	
MAO-PM0-1.3.5.5.16	Design	Inspection	
MAO-PM0-1.3.5.6	Design Analysis	Test Analysis	
MAO-PM0-1.3.5.7	Design Analysis	Test Analysis	
MAO-PM0-1.4.1	Design	Inspection	
MAO-PM0-1.4.3	Design	Test	
MAO-PM0-1.4.7	Design	Inspection	
MAO-PM0-1.4.8	Design	Inspection	
MAO-PM0-1.4.9	Analysis	Test	
MAO-PM0-1.4.10	Design	Inspection	
MAO-PM0-1.4.11	Analysis	Test	
MAO-PM0-1.4.12	Design	Inspection	
MAO-PM0-1.4.14	Design	Inspection	
MAO-PM0-1.4.15	Design	Inspection	
MAO-PM0-1.4.16	Design	Inspection	
MAO-PM0-1.4.17	Design	Inspection	
MAO-PM0-1.4.18	Design	Inspection	
MAO-PM0-1.4.19	Design	Inspection	
MAO-PM0-1.4.20	Design	Inspection	
MAO-PM0-1.4.21	Design	Inspection	
MAO-PM0-1.5.1.1	Design	Inspection	
MAO-PM0-1.5.1.2	Design	Inspection	
MAO-PM0-1.5.1.3	Design	Test	
MAO-PM0-1.5.1.4	Design	Test	
MAO-PM0-1.5.1.5	Design	Test	

MAO-PM0-1.5.1.6	Design	Test	
MAO-PM0-1.5.1.7	Design	Test	
MAO-PM0-1.5.1.8	Design	Test	
MAO-PM0-1.5.1.9	Design	Test	
MAO-PM0-1.5.2.1	Analysis	Analysis	
MAO-PM0-1.5.3.1	Analysis	Analysis	
MAO-PM0-1.5.3.2	Analysis	Analysis	
MAO-PM0-1.5.3.3	Analysis	Analysis	
MAO-PM0-1.5.3.4	Analysis	Analysis	
MAO-PM0-1.5.3.5	Analysis	Analysis	
MAO-PM0-1.5.3.6	Test	Test	
MAO-PM0-1.6	Design	Design	
MAO-PM0-1.7	Design	Design	

8.2. Interfaces:

8.2.1. Interface With Optomechanics

Id	FDR Verification	ARR Verification	Comment
I-PM0/PFK-1.2.1.1	Design	Test	
I-PM0/PFK-1.2.1.2	Design	Inspection Test	
I-PM0/PFK-1.2.1.4	Design	Inspection Test	
I-PM0/PFK-1.2.1.7	Design	Design	
I-PM0/PFK-1.2.1.8	Analysis	Analysis	
I-PM0/PFK-1.2.1.9	Analysis	Analysis	
I-PM0/PFK-1.2.1.10.1	Analysis	Analysis	
I-PM0/PFK-1.2.1.10.2	Analysis	Analysis	
I-PM0/PFK-1.2.1.11	Design	Inspection	
I-PM0/PFK-1.2.1.12	Design	Inspection	
I-PM0/PFA-1.2.2.1	Design	Test	
I-PM0/PFA-1.2.2.2	Design	Inspection Test	
I-PM0/PFA-1.2.2.4	Design	Inspection Test	
I-PM0/PFA-1.2.2.7	Design	Design	

I-PM0/PFA-1.2.2.8	Analysis	Analysis	
I-PM0/PFA-1.2.2.9	Analysis	Analysis	
I-PM0/PFA-1.2.2.10.1	Analysis	Analysis	
I-PM0/PFA-1.2.2.10.2	Analysis	Analysis	
I-PM0/PFA-1.2.2.11	Design	Inspection	
I-PM0/PFA-1.2.2.12	Design	Inspection	
I-PM0/PFB-1.2.3.1	Design	Test	
I-PM0/PFB-1.2.3.2	Design	Inspection Test	
I-PM0/PFB-1.2.3.4	Design	Inspection Test	
I-PM0/PFB-1.2.3.7	Design	Design	
I-PM0/PFB-1.2.3.8	Analysis	Analysis	
I-PM0/PFB-1.2.3.9	Analysis	Analysis	
I-PM0/PFB-1.2.3.10.1	Analysis	Analysis	
I-PM0/PFB-1.2.3.10.2	Analysis	Analysis	
I-PM0/PFB-1.2.3.11	Design	Inspection	
I-PM0/PFB-1.2.3.12	Design	Inspection	
I-PM0/PFC-1.2.4.1	Design	Test	
I-PM0/PFC-1.2.4.2	Design	Inspection Test	
I-PM0/PFC-1.2.4.4	Design	Inspection Test	
I-PM0/PFC-1.2.4.7	Design	Design	
I-PM0/PFC-1.2.4.8	Analysis	Analysis	
I-PM0/PFC-1.2.4.9	Analysis	Analysis	
I-PM0/PFC-1.2.4.10.1	Analysis	Analysis	
I-PM0/PFC-1.2.4.10.2	Analysis	Analysis	
I-PM0/PFC-1.2.4.11	Design	Inspection	
I-PM0/PFC-1.2.4.12	Design	Inspection	
I-PM0/PFE-1.2.5.1	Design	Test	
I-PM0/PFE-1.2.5.2	Design	Inspection Test	
I-PM0/PFE-1.2.5.4	Design	Inspection Test	
I-PM0/PFE-1.2.5.7	Design	Design	
I-PM0/PFE-1.2.5.8	Analysis	Analysis	
I-PM0/PFE-1.2.5.9	Analysis	Analysis	
I-PM0/PFE-1.2.5.10.1	Analysis	Analysis	
I-PM0/PFE-1.2.5.10.2	Analysis	Analysis	

I-PM0/PFE-1.2.5.11	Design	Inspection	
I-PM0/PFE-1.2.5.12	Design	Inspection	
I-PM0/PFF-1.2.10.1	Design	Test	
I-PM0/PFF-1.2.10.2	Design	Inspection Test	
I-PM0/PFF-1.2.10.4	Design	Inspection Test	
I-PM0/PFF-1.2.10.7	Design	Design	
I-PM0/PFF-1.2.10.8	Analysis	Analysis	
I-PM0/PFF-1.2.10.9	Analysis	Analysis	
I-PM0/PFF-1.2.10.10.1	Analysis	Analysis	
I-PM0/PFF-1.2.10.10.2	Analysis	Analysis	
I-PM0/PFF-1.2.10.11	Design	Inspection	
I-PM0/PFF-1.2.10.12	Design	Inspection	
I-PM0/PFD-1.2.11.1	Design	Test	
I-PM0/PFD-1.2.11.2	Design	Inspection Test	
I-PM0/PFD-1.2.11.4	Design	Inspection Test	
I-PM0/PFD-1.2.11.7	Design	Design	
I-PM0/PFD-1.2.11.8	Analysis	Analysis	
I-PM0/PFD-1.2.11.9	Analysis	Analysis	
I-PM0/PFD-1.2.11.10.1	Analysis	Analysis	
I-PM0/PFD-1.2.11.10.2	Analysis	Analysis	
I-PM0/PFD-1.2.11.11	Design	Inspection	
I-PM0/PFD-1.2.11.12	Design	Inspection	
I-PM0/PFG-1.2.6.1	Design	Test	
I-PM0/PFG-1.2.6.2	Design	Inspection Test	
I-PM0/PFG-1.2.6.4	Design	Inspection Test	
I-PM0/PFG-1.2.6.7	Design	Design	
I-PM0/PFG-1.2.6.8	Analysis	Analysis	
I-PM0/PFG-1.2.6.9	Analysis	Analysis	
I-PM0/PFG-1.2.6.10.1	Analysis	Analysis	
I-PM0/PFG-1.2.6.10.2	Analysis	Analysis	
I-PM0/PFG-1.2.6.11	Design	Inspection	
I-PM0/PFG-1.2.6.12	Design	Inspection	

I-PM0/PFI-1.2.8.1	Design	Test	
I-PM0/PFI-1.2.8.2	Design	Inspection Test	
I-PM0/PFI-1.2.8.4	Design	Inspection Test	
I-PM0/PFI-1.2.8.7	Design	Design	
I-PM0/PFI-1.2.8.8	Analysis	Analysis	
I-PM0/PFI-1.2.8.9	Analysis	Analysis	
I-PM0/PFI-1.2.8.10.1	Analysis	Analysis	
I-PM0/PFI-1.2.8.10.2	Analysis	Analysis	
I-PM0/PFI-1.2.8.11	Design	Inspection	
I-PM0/PFI-1.2.8.12	Design	Inspection	
I-PM0/PFH-1.2.7.1	Design	Test	
I-PM0/PFH-1.2.7.2	Design	Inspection Test	
I-PM0/PFH-1.2.7.4	Design	Inspection Test	
I-PM0/PFH-1.2.7.7	Design	Design	
I-PM0/PFH-1.2.7.8	Analysis	Analysis	
I-PM0/PFH-1.2.7.9	Analysis	Analysis	
I-PM0/PFH-1.2.7.10.1	Analysis	Analysis	
I-PM0/PFH-1.2.7.10.2	Analysis	Analysis	
I-PM0/PFH-1.2.7.11	Design	Inspection	
I-PM0/PFH-1.2.7.12	Design	Inspection	
I-PM0/PFJ-1.2.9.1	Design	Test	
I-PM0/PFJ-1.2.9.2	Design	Inspection Test	
I-PM0/PFJ-1.2.9.4	Design	Inspection Test	
I-PM0/PFJ-1.2.9.7	Design	Design	
I-PM0/PFJ-1.2.9.8	Analysis	Analysis	
I-PM0/PFJ-1.2.9.9	Analysis	Analysis	
I-PM0/PFJ-1.2.9.10.1	Analysis	Analysis	
I-PM0/PFJ-1.2.9.10.2	Analysis	Analysis	
I-PM0/PFJ-1.2.9.11	Design	Inspection	
I-PM0/PFJ-1.2.9.12	Design	Inspection	

8.2.2. Interface with DMS

Id	FDR Verification	ARR Verification	Comment
I-PM0/PD0-1.2.1.1	Design	Test	
I-PM0/PD0-1.2.1.2	Design	Inspection Test	
I-PM0/PD0-1.2.1.4	Design	Inspection	
I-PM0/PD0-1.2.1.7	Design	Design	
I-PM0/PD0-1.2.1.8	Analysis	Analysis	
I-PM0/PD0-1.2.1.9	Analysis	Analysis	
I-PM0/PD0-1.2.1.10.1	Analysis	Analysis	
I-PM0/PD0-1.2.1.10.2	Analysis	Analysis	
I-PM0/PD0-1.2.1.11	Design	Inspection	
I-PM0/PD0-1.2.1.12	Design	Inspection	
I-PM0/PD0-1.2.2.1	Design	Test	
I-PM0/PD0-1.2.2.2	Design	Inspection Test	
I-PM0/PD0-1.2.2.4	Design	Inspection	
I-PM0/PD0-1.2.2.7	Design	Design	
I-PM0/PD0-1.2.2.8	Analysis	Analysis	
I-PM0/PD0-1.2.2.9	Analysis	Analysis	
I-PM0/PD0-1.2.2.10	Analysis	Analysis	
I-PM0/PD0-1.2.2.10.1	Analysis	Analysis	
I-PM0/PD0-1.2.2.10.2	Analysis	Analysis	
I-PM0/PD0-1.2.2.11	Design	Test	
I-PM0/PD0-1.2.2.12	Design	Inspection	

8.2.3. Interface with MORFEO Calibration Unit

Id	FDR Verification	ARR Verification	Comment
I-PM0/PU0-1.2.1.1	Design	Test	
I-PM0/PU0-1.2.1.2	Design	Inspection Test	
I-PM0/PU0-1.2.1.4	Design	Inspection Test	
I-PM0/PU0-1.2.1.7	Design	Design	
I-PM0/PU0-1.2.1.8	Analysis	Analysis	
I-PM0/PU0-1.2.1.9	Analysis	Analysis	
I-PM0/PU0-1.2.1.10.1	Analysis	Analysis	
I-PM0/PU0-1.2.1.10.2	Analysis	Analysis	

I-PM0/PU0-1.2.1.11	Design	Inspection	
I-PM0/PU0-1.2.1.12	Design	Inspection	
I-PM0/PU0-1.2.1.13	Analysis	Test	

8.2.4. Interface with LGS WFS

Id	FDR Verification	ARR Verification	Comment
I-PM0/PL0-1.2.1	Design	Test	
I-PM0/PL0-1.2.2	Design	Inspection Test	
I-PM0/PL0-1.2.4	Design	Inspection Test	
I-PM0/PL0-1.2.7	Design	Design	
I-PM0/PL0-1.2.8	Analysis	Analysis	
I-PM0/PL0-1.2.9.1	Analysis	Analysis	
I-PM0/PL0-1.2.9.2	Analysis	Analysis	
I-PM0/PL0-1.2.10	Analysis	Analysis	
I-PM0/PL0-1.2.11	Design	Inspection	
I-PM0/PL0-1.2.12	Design	Inspection	
I-PM0/PL0-1.2.13	Analysis	Test	
I-PM0/PL0-1.2.14	Design	Inspection	

8.2.5. Electrical Interfaces:

Id	FDR Verification	ARR Verification	Comment
I-PH0/PM0-1.2.2	Design	Inspection	
I-PH0/PM0-1.2.3	Design	Inspection	
I-PH0/PM0-1.2.4	Design	Inspection	
I-PH0/PM0-1.2.5	Design	Inspection	
I-PH0/PM0-1.2.6	Design	Inspection	
I-PH0/PM0-1.2.7	Design	Inspection	
I-PH0/PM0-1.2.8	Design	Inspection	
I-PH0/PM0-1.2.9	Design	Inspection	
I-PH0/PM0-1.2.10	Design	Inspection	
I-PH0/PM0-1.2.11	Design	Inspection	
I-PH0/PM0-1.2.12	Design	Inspection	
I-PH0/PM0-1.4.1	Design	Inspection	
I-PH0/PM0-1.4.3	Design	Test Inspection	
I-PH0/PM0-1.4.4	Design	Test	

I-PH0/PM0-1.4.5	Design	Test	
I-PH0/PM0-1.4.6	Analysis	Test	
I-PH0/PM0-1.4.7	Design	Inspection	
I-PH0/PM0-1.4.8	Design	Inspection	
I-PH0/PM0-1.4.9	Design	Inspection	
I-PH0/PM0-1.4.10	Design	Test	
I-PH0/PM0-1.4.11	Design	Test	
I-PH0/PM0-1.4.12	Design	Test	

8.2.6. Thermal interfaces

Id	FDR Verification	ARR Verification	Comment
I-PM0/PT0-1.2.1	Design	Inspection	
I-PM0/PT0-1.2.2	Design	Design Inspection	
I-PM0/PT0-1.2.3	Design	Design Inspection	
I-PM0/PT0-1.2.4	Analysis	Analysis	
I-PM0/PT0-1.2.6	Analysis	Test	
I-PM0/PT0-1.2.9	Design	Inspection	
I-PM0/PT0-1.2.10	Design	Test	
I-PM0/PT0-1.2.11	Design	Inspection	
I-PM0/PT0-1.2.12	Design	Inspection	
I-PM0/PT0-1.2.13	Design	Inspection	
I-PM0/PT0-1.2.14.1	Design	Inspection	
I-PM0/PT0-1.2.14.2	Design	Test	
I-PM0/PT0-1.2.14.3	Design	Inspection	
I-PM0/PT0-1.2.14.4	Design	Inspection Test	
I-PM0/PT0-1.2.14.5	Design	Design	
I-PM0/PT0-1.2.14.6	Design	Inspection Test	
I-PM0/PT0-1.2.14.7	Analysis	Analysis	
I-PM0/PT0-1.2.14.8	Design	Inspection	
I-PM0/PT0-1.2.14.9	Design	Test	
I-PM0/PT0-1.2.14.10	Design	Inspection Test	
I-PM0/PT0-1.2.14.11	Design	Design	
I-PM0/PT0-1.2.14.12	Design	Inspection Test	

I-PM0/PT0-1.2.14.13	Design	Inspection	
I-PM0/PT0-1.2.15.1	Design	Test	
I-PM0/PT0-1.2.15.2	Design	Inspection	
I-PM0/PT0-1.2.15.3	Design	Inspection Test	
I-PM0/PT0-1.2.15.4	Design	Inspection Test	
I-PM0/PT0-1.2.16	Design	Inspection	
I-PM0/PT0-1.2.17	Design	Inspection	