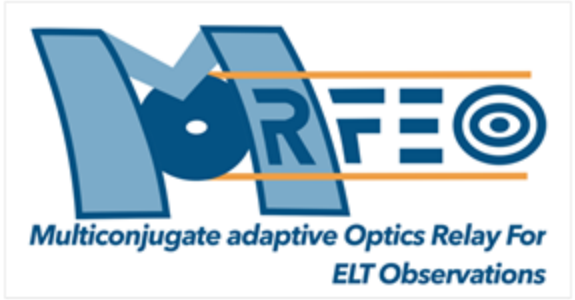


ELT-Instrumentation Procurement Webinar

Paolo Ciliegi on behalf of MORFEO Consortium

MORFEO CONSORTIUM

INAF (Leader Institute): Principal Investigator, Proj. Management, PA/QA, System Engineering, System AO, AIT/AIV and all the other subsystems
→ 85 % of the FTE from INAF

CNRS France : LGS WFS module

University of Galway Ireland : Test Unit

NRC Victoria - Canada : Hard Real-Time Computer

NAOJ/Kyoto University/Osaka University Japan : Two Optical elements (Corrective Plate and CU Folding Mirror)

AO with MORFEO at ELT

SCAO

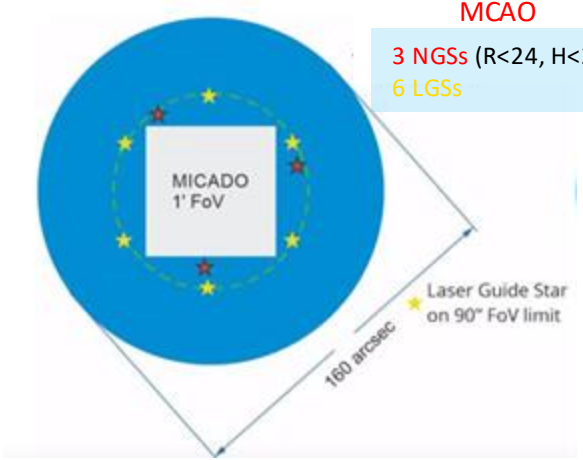
1 NGS (R<16)

MCAO

3 NGSs (R<24, H<21)
6 LGSs

✓ MORFEO will provide spatially uniform multi-conjugate adaptive optics (MCAO) correction to MICADO over a large field of view (~1 arcmin^2)

✓ MORFEO will also support SCAO over a smaller ~10" field of view

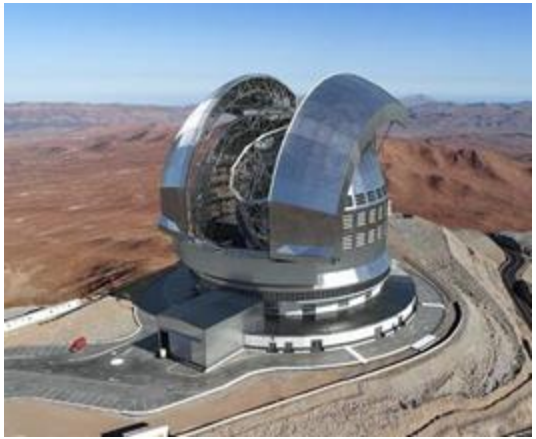


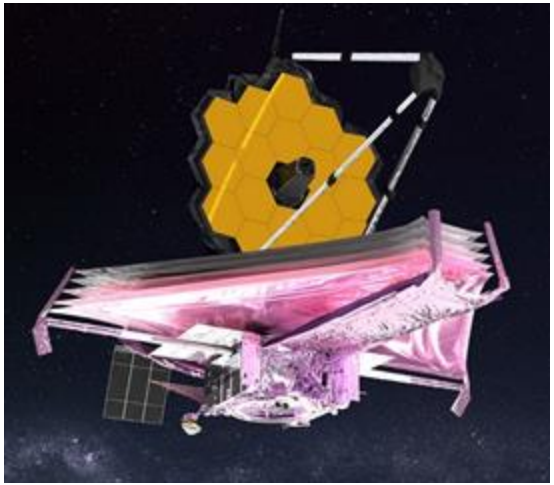
✓ Uniform Strehl Ratio and FWHM over a large field of view

✓ Large sky coverage

Possibility to address a large variety of science cases based on <u>astrophysical relevance</u> rather than on feasibility criteria

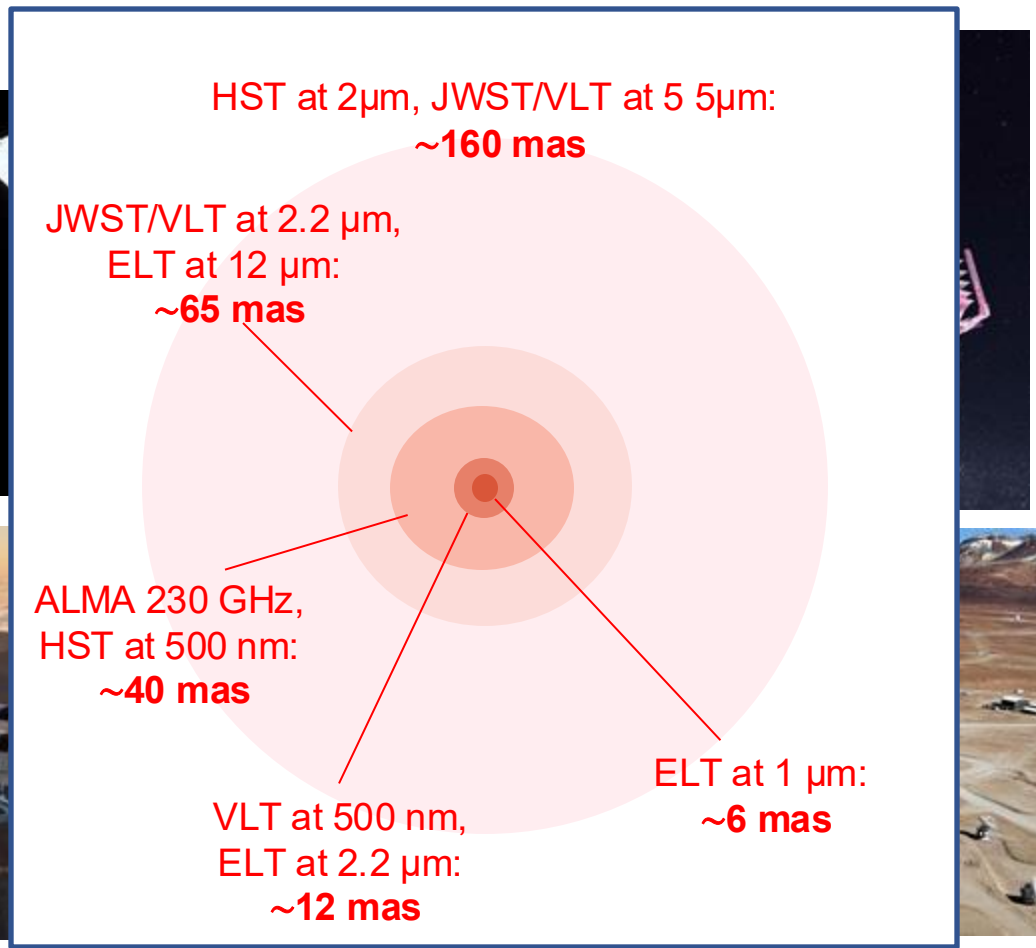
MORFEO+MICADO: resolution in context





MORFEO+MICADO: resolution in context

10 mas at:		
Galactic Center	8 kpc	0.4 mpc
Cen A	4 Mpc	0.2 pc
Virgo Cluster	18 Mpc	1 pc
Cosmic Noon	z~ 2	80 pc

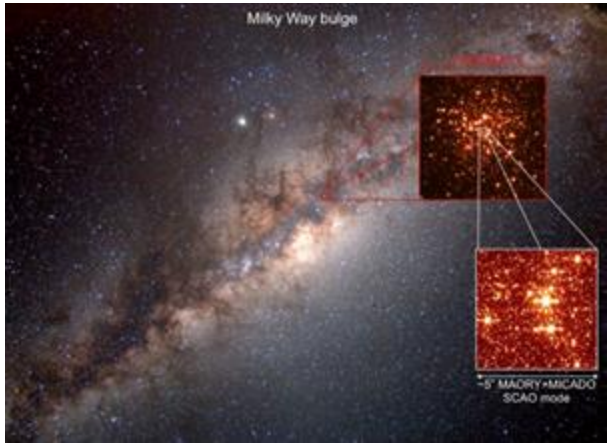


MORFEO MICADO SCIENCE THEMES

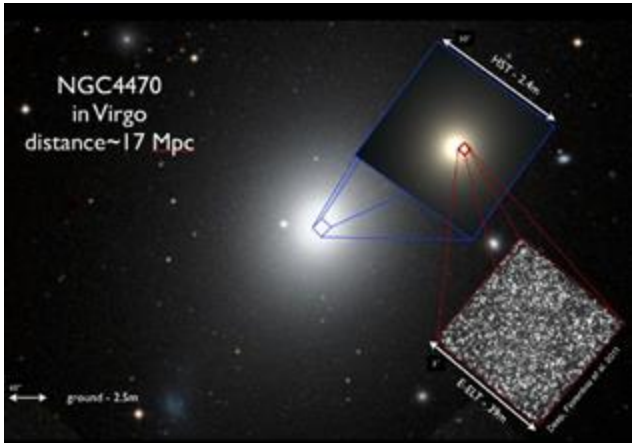
- **Potential to address a large number of science topics**

  - Dynamics of dense stellar systems,
  - Black holes in galaxies and the centre of the Milky Way,
  - Formation and evolution of galaxies in the early universe,
  - Star formation history of galaxies through resolved stellar populations,
  - Planets and planet formation,
  - The solar system.

Nearby Stellar System

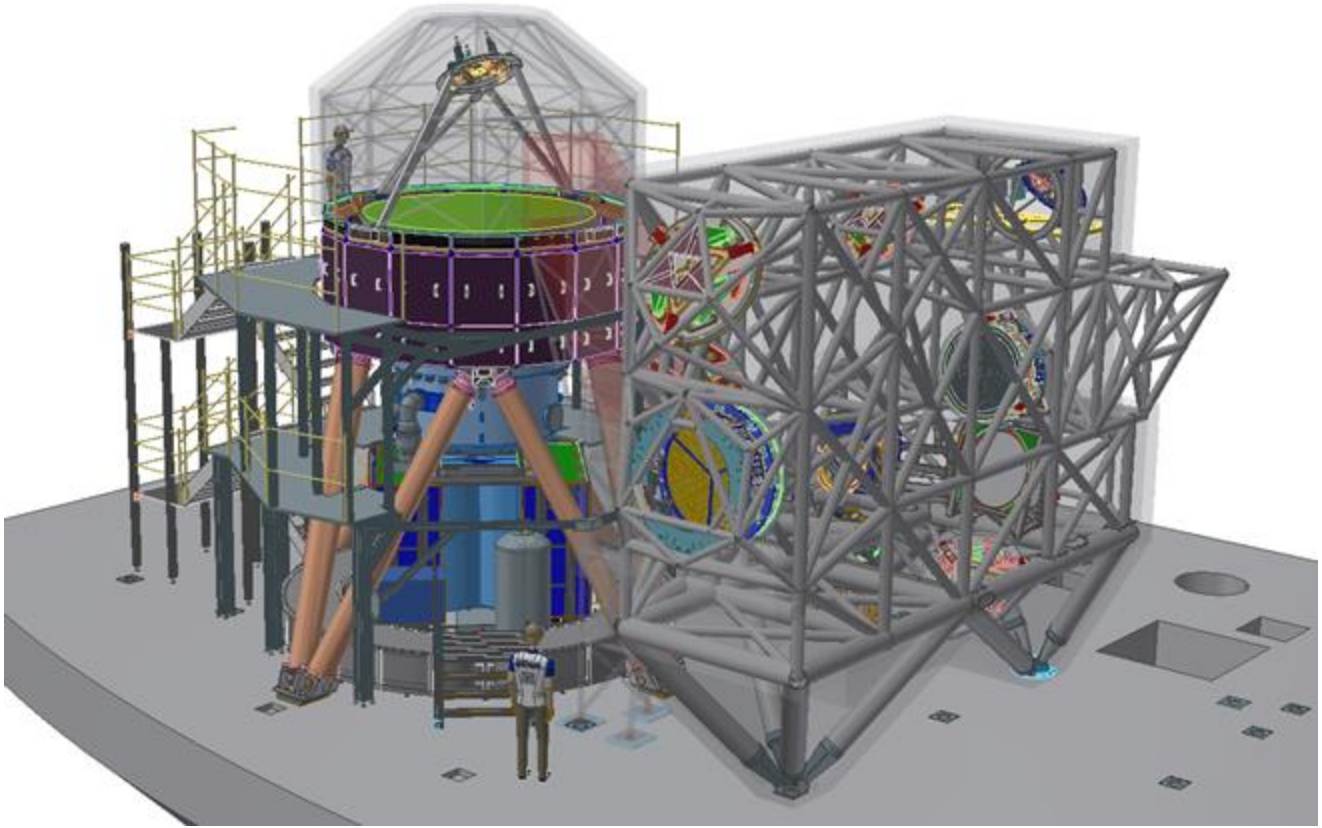


Local Universe



High Redshift Universe

MORFEO Overview

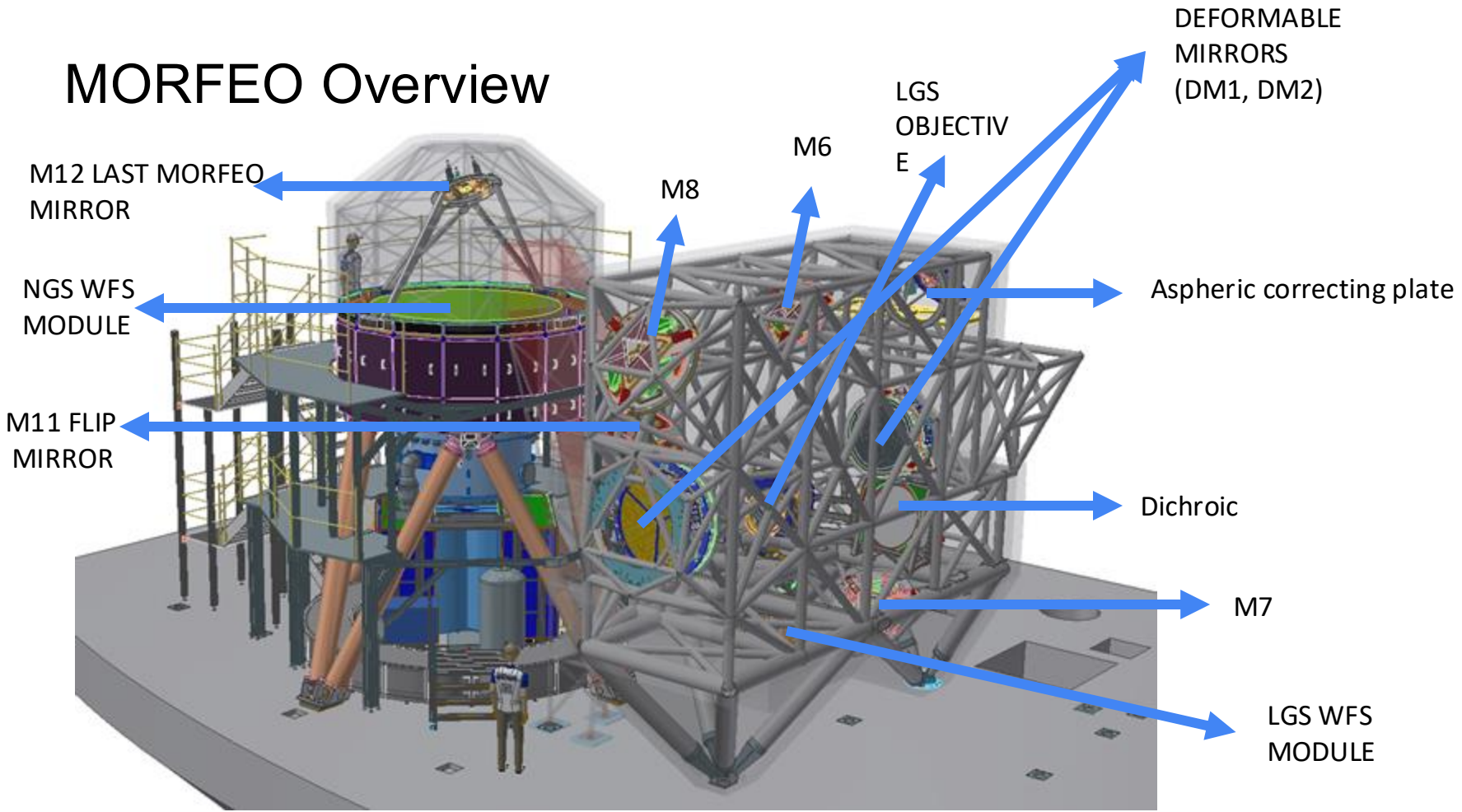


MORFEO will use 9 Guide STARS : 6 LGS and 3 NGS, last generation WFS and 3 DM (including M4) to correct the atmospheric turbolence

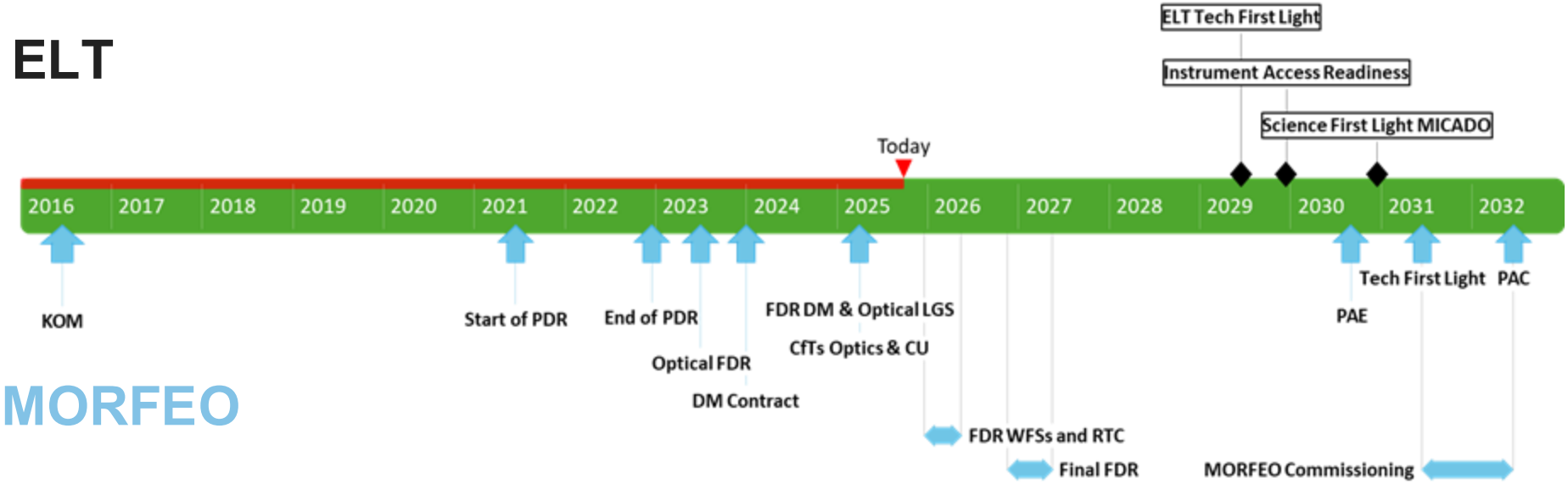
We will use 7 big mirrors (2 of which are DM) to bring the photons from the PFS to MICADO

A dichroic in the Mani Optical Path will split the light between the LGS WFS module and the NGS WFS module + Scientific Detectors.

MORFEO Overview



MORFEO Timeline

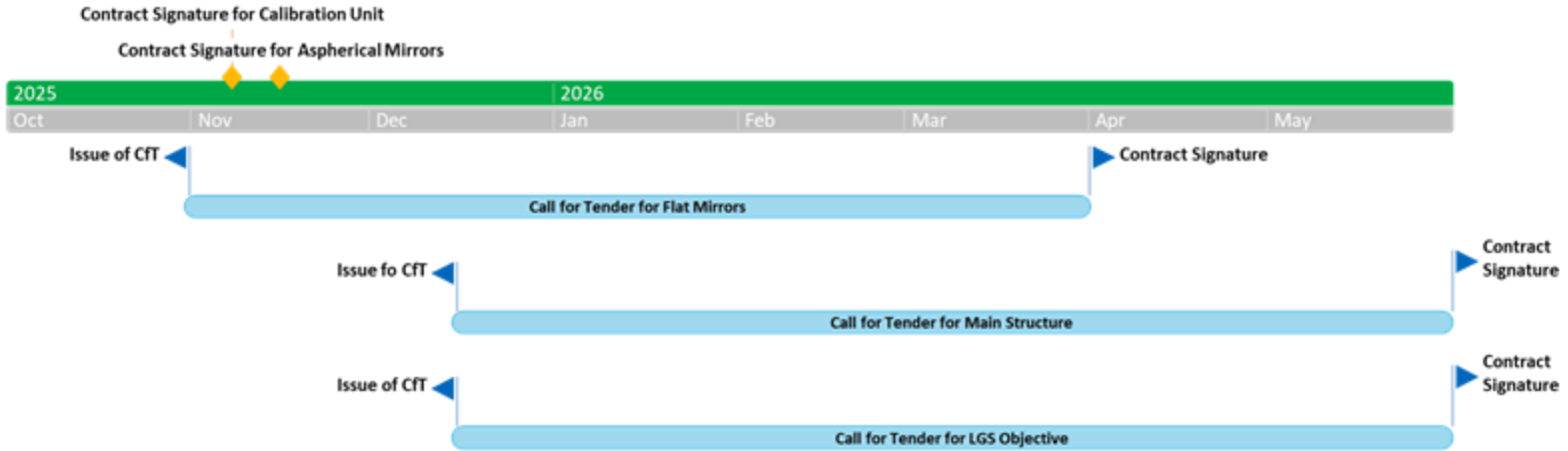


Main Contracts and Procurements

- Deformable Mirrors : Contract signed 29/12/2023 ~ 14.9 M €
- Aspherical Mirrors - Published on 28/3/2025 < 6.0 M €
- CU – Published on 16/5/2025 <2.8 M €

Flat Mirrors/LGS Objective and Main Structure - Call for Tenders under preparation

By mid 2026 80-90 % of total cost will be under contract !!!!!



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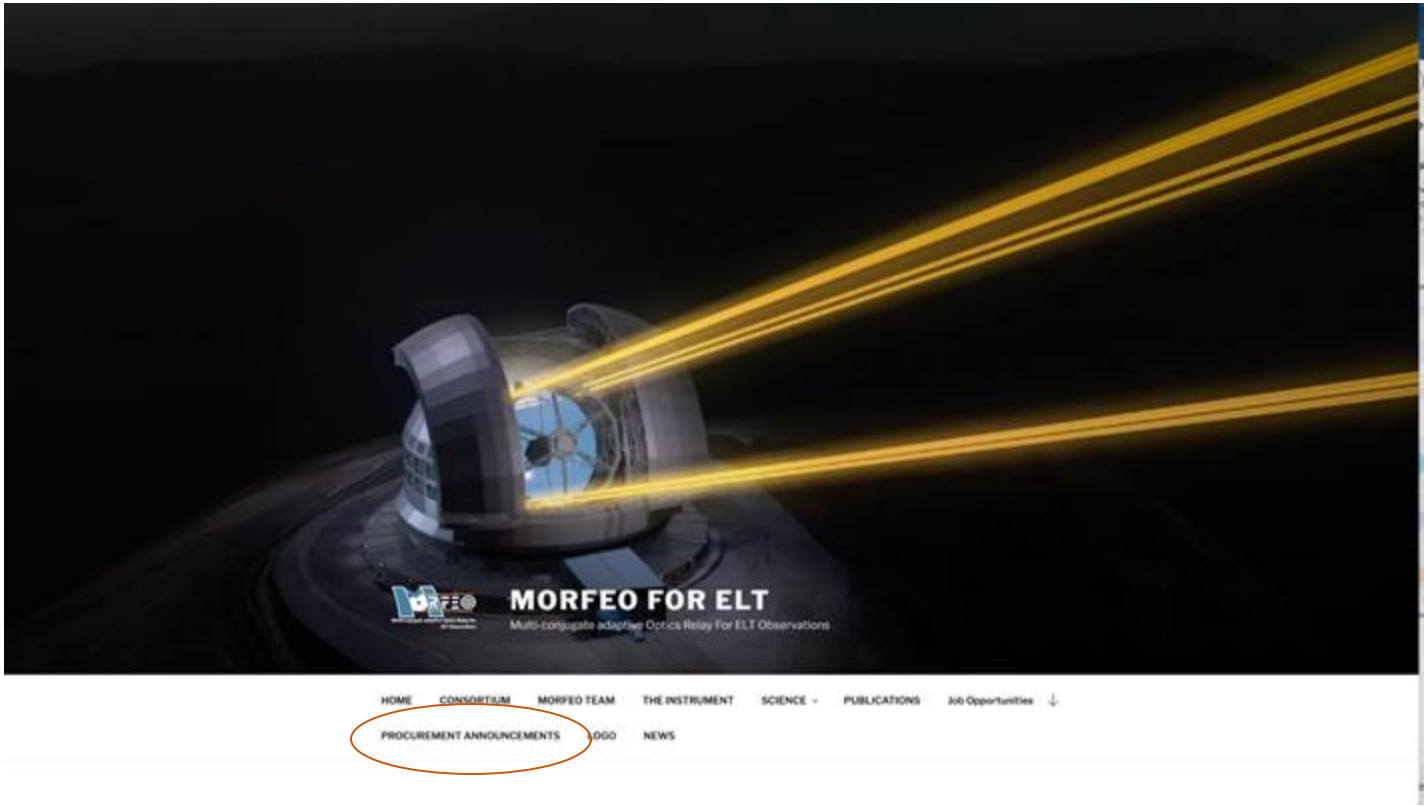

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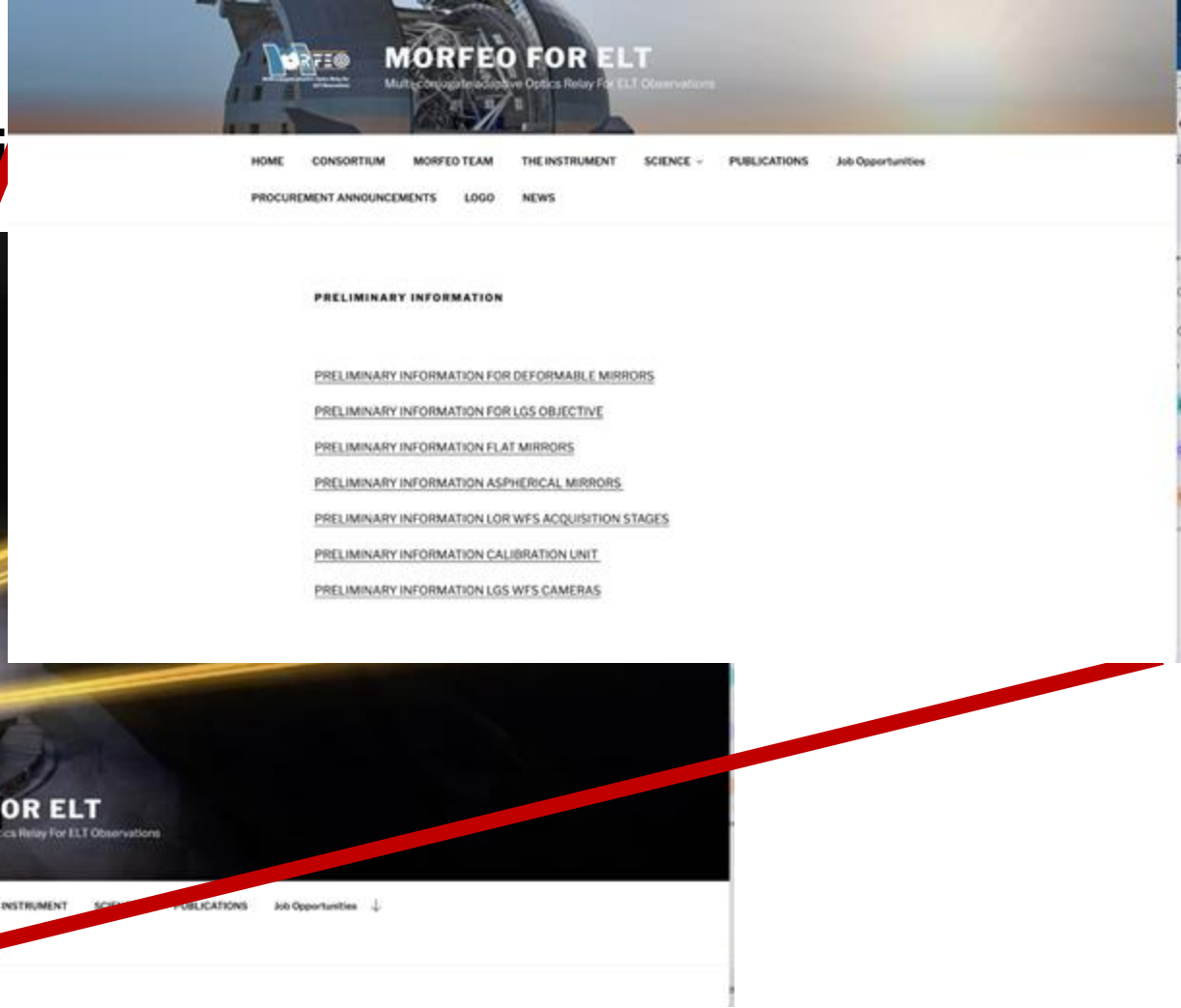
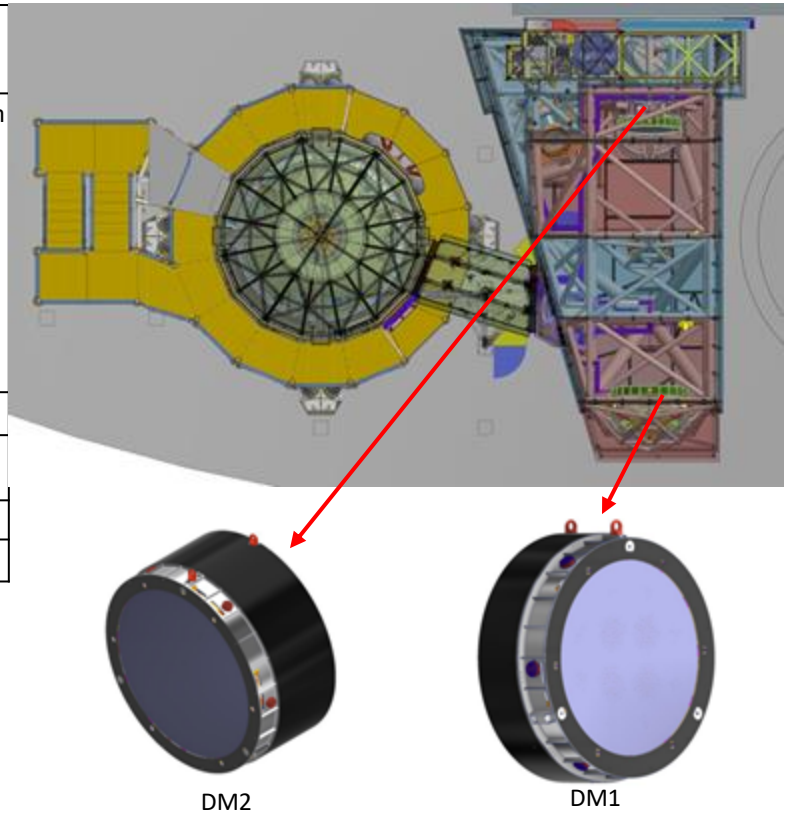


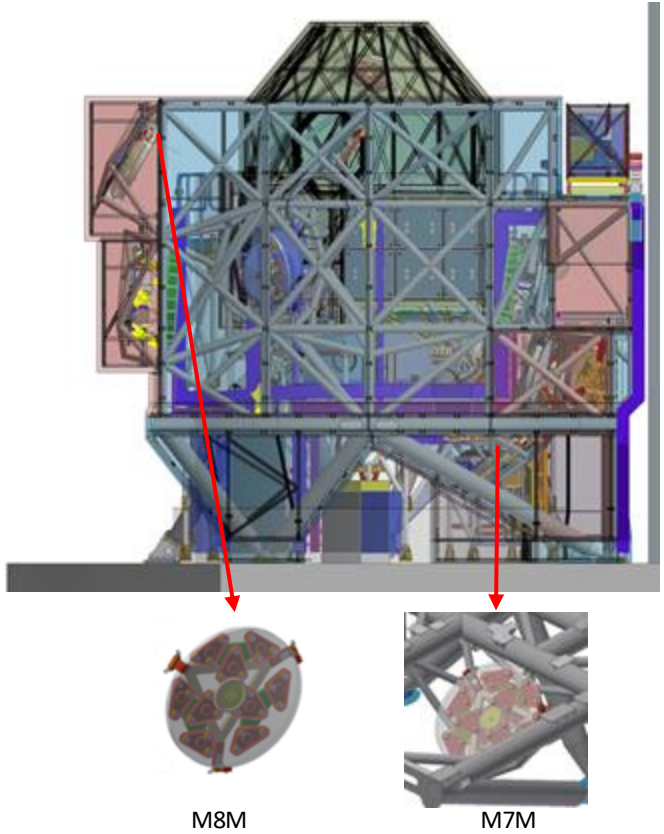
Procurement #1: Deformable Mirrors DM1 and DM2 (AWARDED)

Location in System	• Core of MORFEO MCAO module; post-focal wavefront correction
Main Specifications	• Clear apertures: DM1 ~900 mm (convex), DM2 ~1200 mm (concave), Curvature radius: ~15 m • Coating: High reflectivity 550–2500 nm (Aluminum baseline) • Mass: DM1 ~650 kg, DM2 ~1100 kg Depth: DM1 ~0.5 m, DM2 ~1 m • ≥700 actuators per DM, Response time: ≤2 ms • Residual WFE: <40 nm RMS • Misfigure tolerance: ≤1 arcsec slope
Number of Items	• 2 deformable mirrors
Planning	• Call issued in June 2023 concluded. **AWARDED to AdOptica**
Procurement Procedure	• Competitive tender
Who to Contact	• RUP Paolo Ciliegi - INAF OAS (paolo.ciliegi@inaf.it)



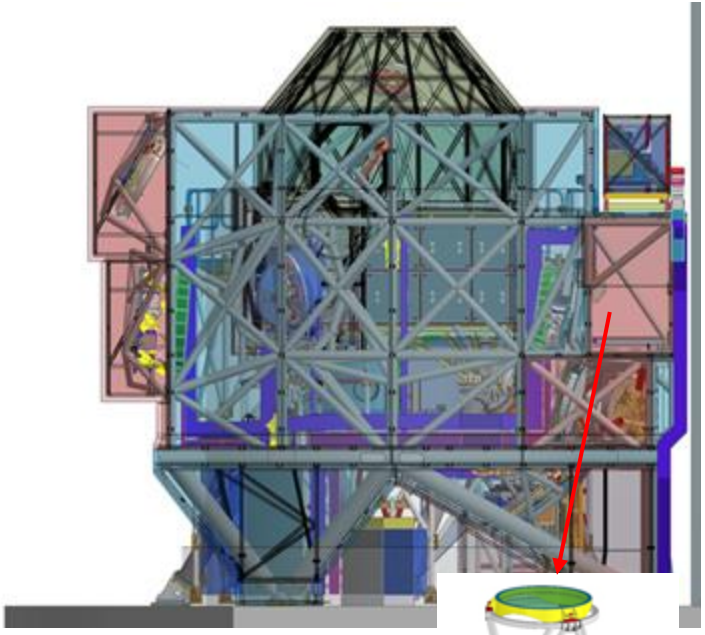
Procurement #2: MORFEO Aspherical Mirrors (M7M & M8M) (CfT CLOSED)

Location in System	• MORFEO MCAO module; part of post-focal relay optics
Main Specifications	• Clear apertures: M7M ~1190 mm, M8M ~1230 mm • Curvature radii: M7M ~35 m, M8M ~38.5 m • Substrate: Zerodur or equivalent • Coating: Silver-protected, 550–2500 nm • Mass: M7M ~300 kg, M8M ~320 kg • Depth: 0.2–0.25 m • Eigenfrequency: >21 Hz (goal >31 Hz) • SMR alignment tolerance: Tx/Ty ±0.5 mm, Tz ±1 mm, Rx/Ry ±0.5 arcmin, Rz ±5 arcmin
Number of Items	• 2 mirrors (M7M and M8M) + 2 mechanical dummies
Planning	• Call for Tender issued on March 2025 concluded. • **VERIFICATION PHASE - CONTRACT SIGNATURE EXPECTED IN 1-2 months** • Final Design Phase: 6 months from Contract signature • Delivery: 24 months from FDR closure
Procurement Procedure	• Competitive tender, single contract for design, manufacturing, integration, and verification
Who to Contact	• RUP Matteo Munari - INAF Catania (matteo.munari@inaf.it)
Other Relevant Aspects	• Design + Manufacturing • Delivered to INAF Integration Hall (Bologna) • Includes handling tools, dust covers, and SMR referencing • Compliance with ESO and ELT standards • Verification by test or validated analysis in operational conditions



Procurement #3: Calibration Unit Optomechanics (CfT CLOSED)

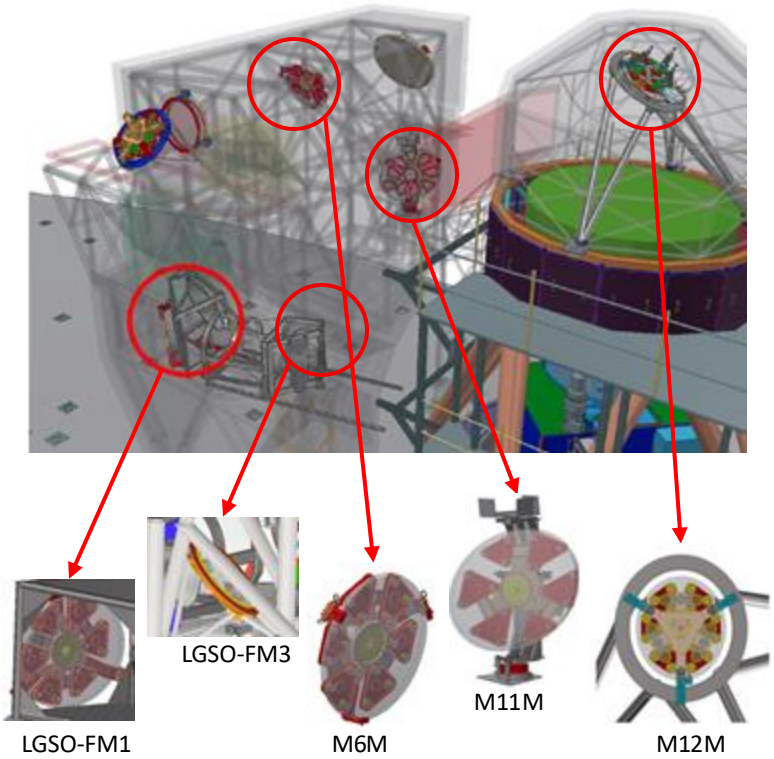
Location in System	• MORFEO Calibration Unit; supports calibration optics and mechanisms
Main Specifications	• 13 optical elements incl. dichroics, beam splitters, aspheres, and mirrors • Materials: Fused Silica, Zerodur, S-BSL7, S-NSL36, S-LAL18, S-TIH14 • Coatings: AR <3%, HR >97%, dichroic split @600 nm • Wavelength ranges: 500–1800 nm • Max WFE: <100 nm @589 nm, <60 nm @800/1650 nm (on-axis) • Homogeneity: ≤10 ppm (CBS ≤2 ppm) • Total mass: ≤350 kg; volume: 800×1700×1500 mm³ • Eigenfrequency: >21 Hz (goal >31 Hz) • Earthquake survival: 3.3g in all directions
Number of Items	• 1 complete fully aligned optomechanical unit + 1 mechanical dummy
Planning	• Call for Tender issued on May 2025 concluded. • **VERIFICATION PHASE - CONTRACT SIGNATURE EXPECTED IN 1-2 months** • Final Design Phase: 10 months from Contract signature • Delivery: 21 months from MAIT Kick-Off
Procurement Procedure	• Competitive tender, single contract for design, manufacturing, integration, and verification
Who to Contact	• RUP: Gianluca Di Rico – INAF OA d'Abruzzo (gianluca.dirico@inaf.it)
Other Relevant Aspects	• Delivered to INAF OA d'Abruzzo (Teramo). • Includes tools for alignment, handling, and SMR referencing • Must support interchangeable DM and PM components • Test setup optomech included, validated analysis in operating conditions • 5 year warranty; ESO standards apply;



Calibration Unit

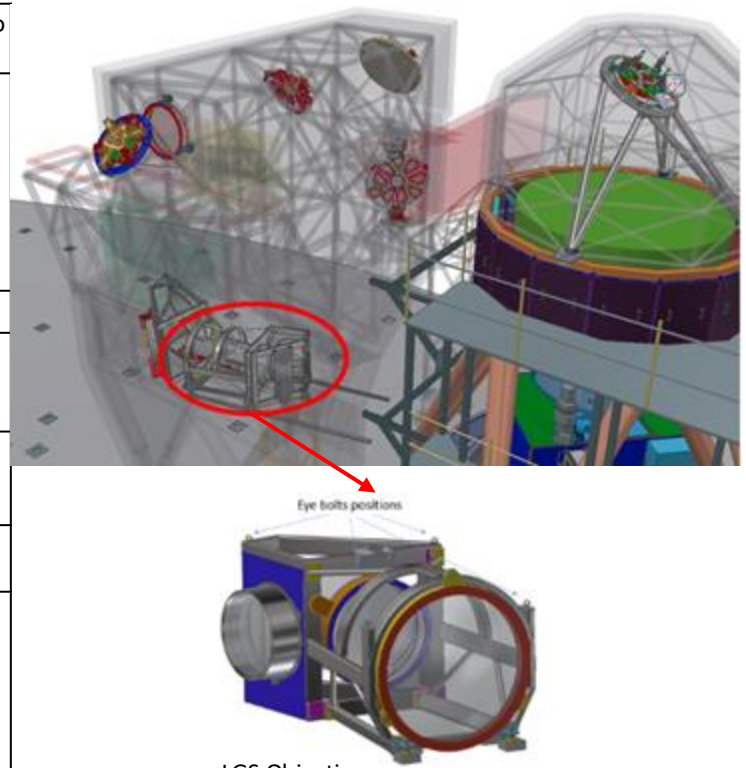
Procurement #5: MORFEO Flat Mirrors (M6M, M11M, M12M, LGSO-FM1, LGSO-FM3)

Location in System	• MORFEO MCAO module and LGS Objective subsystem
Main Specifications	• 5 mirrors: elliptical apertures ranging from 405×550 mm to 1200×890 mm • Substrate: Zerodur or equivalent • Coatings: Protected Silver (M6M, M11M, M12M), Laser Line @589 nm (LGSO-FM1, FM3) • Surface accuracy: Zernike RMS (Z4–Z36) ≤100 nm (defocus), ≤8 nm (astigmatism), ≤5 nm (coma), ≤3 nm (trefoil) • Micro-roughness: <2 nm • Mirrors must survive 3.6g seismic loads • **SEE MORFEO WEB PAGE FOR PRELIMINARY INFORMATION**
Number of Items	• 5 flat mirrors + 5 mechanical dummies
Planning	• Issue of Call for Tender Q4 2025 for design and manufacturing • Final Design Phase: 6 months from Contract signature • Delivery: 24 months from MAIT Kick-Off
Procurement Procedure	• Competitive tender; single contract for design, manufacturing, integration, and verification
Who to Contact	• INAF Principal Investigator Paolo Ciliegi (paolo.ciliegi@inaf.it)
Other Relevant Aspects	• Delivered to INAF Integration Hall (Bologna) • Includes SMR referencing, handling tools, and ESO-compliant packing • Inclination angles vary per mirror (30° to 97°) • Dummy units replicate mass, volume, COG, and interfaces for early integration testing



Procurement #6: LGS Objective

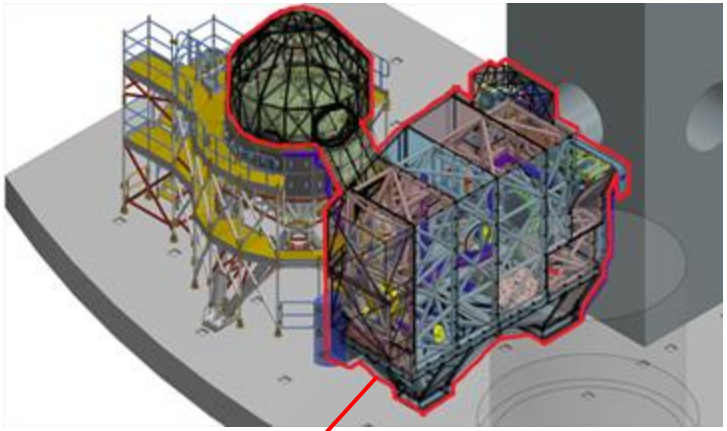
Location in System	• Mounted within MORFEO MCAO module; delivers telecentric F/5 beam to LGS WFS
Main Specifications	• 5 optical elements: Silica lenses + Zerodur mirror • Coatings: AR @ 589 nm (lenses), HR @ 589 nm (mirror) • Mass: ≤ 400 kg • Repeatability: ±50 µm (X, Y, Z) • Earthquake survival: 3.6g in all directions • Delivered beam: F/5 telecentric **SEE MORFEO WEB PAGE FOR PRELIMINARY INFORMATION**
Number of Items	• 1 complete integrated and aligned objective + 1 mechanical dummy
Planning	• **Issue of Call for Tender Q4 2025** • Final Design Phase: 8 months from T0 • Delivery: 18 months from FDR closure
Procurement Procedure	• Competitive tender, single contract for design, manufacturing, integration, and verification
Who to Contact	• INAF Principal Investigator Paolo Ciliegi (paolo.ciliegi@inaf.it)
Other Relevant Aspects	• Design + Manufacturing • Delivered to INAF Integration Hall (Bologna) • Includes handling tools, dust covers, and SMR alignment features • Must comply with ESO standards for ELT instrumentation • Dummy unit required for early handling validation



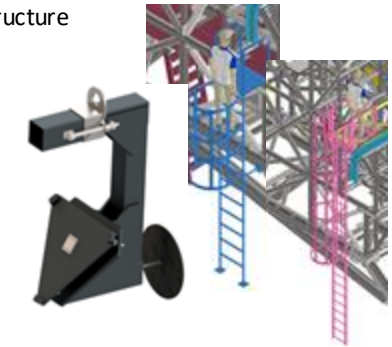
LGS Objective

Procurement #4: Morfeo Main Structure (MS) and AIV Tools

Location in System	• Central support for MORFEO payloads (excluding MICADO); AIV tools used at BIH (Bologna) and Armazones (Chile)
Main Specifications	• Total mass ≤ 12,300 kg • Alignment capability: ±5 mm (Tx, Ty), ±2 mm (Tz), ±0.08° (Rx), ±0.05° (Ry) • Seismic resistance: 3.0g horizontal, 2.5g vertical • Minimum eigenfrequency > 9.5 Hz
Number of Items	• 1 Main Structure + multiple AIV tools (handling, support, thermal, packing)
Planning	• **Call for Tender planned in Q4 2025**
Procurement Procedure	• Competitive tender, single contract for design, manufacturing, integration, and verification in Europe and shipping+integration to Chile
Who to Contact	• INAF Principal Investigator Paolo Ciliegi (paolo.ciliegi@inaf.it)
Other Relevant Aspects	• Integration support required at BIH (Bologna) and Armazones (Chile) • AIV tools must enable safe handling, alignment, and servicing across both sites • Equipment must be CE-certified and earthquake-safe • Packing must be reusable for European and Chilean transport



Main Structure



Handling Tool and Support Equipment