THE 4-m NEW ROBOTIC TELESCOPE (NRT): STATUS OF THE OPTOMECHANICAL SYSTEMS

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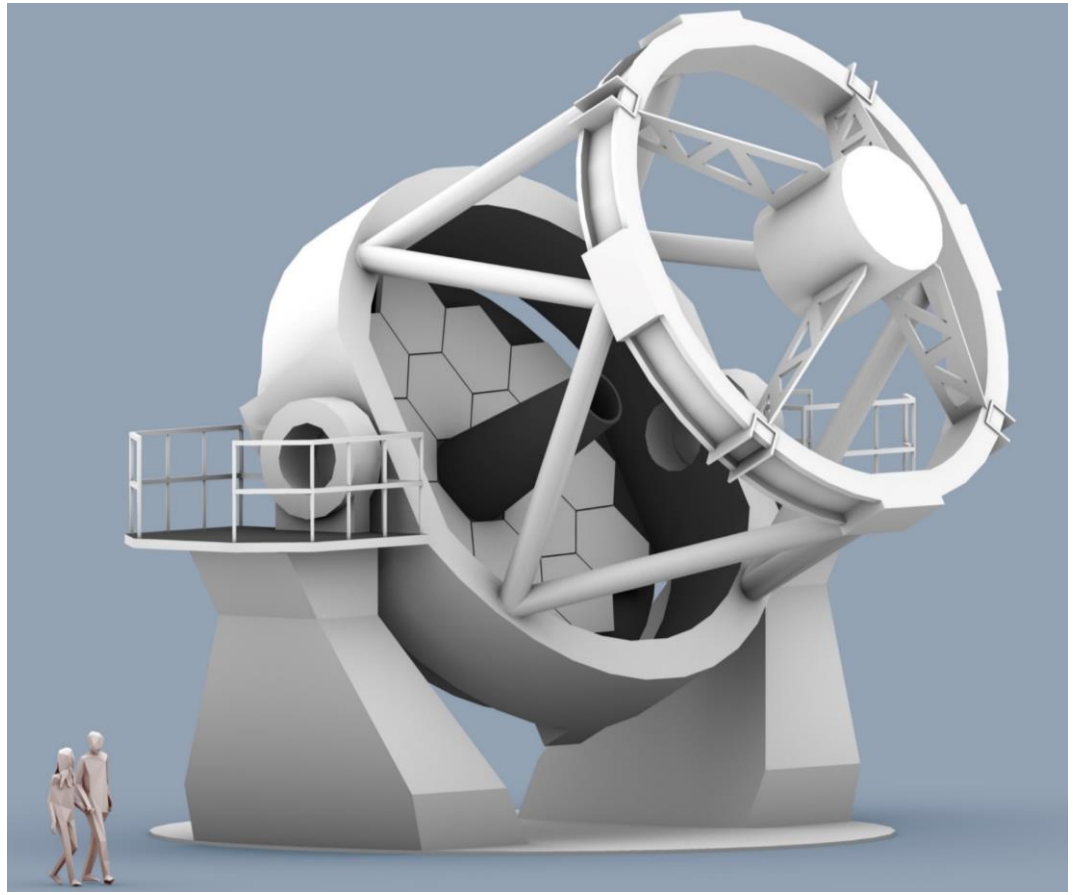
ABSTRACT

The New Robotic Telescope (NRT) is currently under conceptual phase design, will be sited on the Observatory of Roque de los Muchachos (ORM) in La Palma (Canary Islands), and will be the largest fully robotic telescope in the world when it enters into operation in a five years time. A collecting area four times larger than the current Liverpool Telescope and an extremely quick response will allow the detection and characterization of fast fade transients, playing a key role in many areas of time domain astrophysics (gravitational waves, gamma ray bursts, supernovae, etc). The robotic operation of NRT will be ideal also for regular follow up programmes.

This contribution is focused on the conceptual studies currently under development of the two main optical systems of the telescope: the M1 assembly and the M2 subsystem. The baseline design of both systems are briefly presented.



THE 4-m NEW ROBOTIC TELESCOPE

THE PROJECT

- Based on the success of the Liverpool Telescope (LT)
- Sited in the ORM in La Palma
- International collaboration:
  - Instituto de Astrofísica de Canarias (IAC)
  - Liverpool John Moore University (LJMU)
  - University of Oviedo (UoO)
  - National Astronomical Research Institute of Thailand (NARIT)
  - National Astronomical Observatories of China (NAOC)

KEY DESIGN DRIVERS

- Full robotic operation (without night-time supervision)
- Large aperture (Ø4m)
- Fast response (on target < 30s)
- Segmented primary mirror
- Wavelength range 350-2400 nm
- Versatile instrumentation, focused on spectroscopy (R=100, R~2000)
- Definition of standard concepts for future robotic telescopes
- Cost < 25 M€

STATUS

- Project office currently developing its conceptual design
- First light expected for 2025

OPTOMECHANICAL DESIGN AND ANALYSIS

OPTOMECHANICAL DESIGN

- Optomechanical design principles are essential in the design of modern large telescopes to achieve the required accurate positioning of the optical surfaces keeping under control possible deformations due to different inclinations and conditions (temperature, wind,…)
- To achieve the demanding science requirements precisions of the order λ/10, λ/20,… are necessary

ANALYSIS METHOD

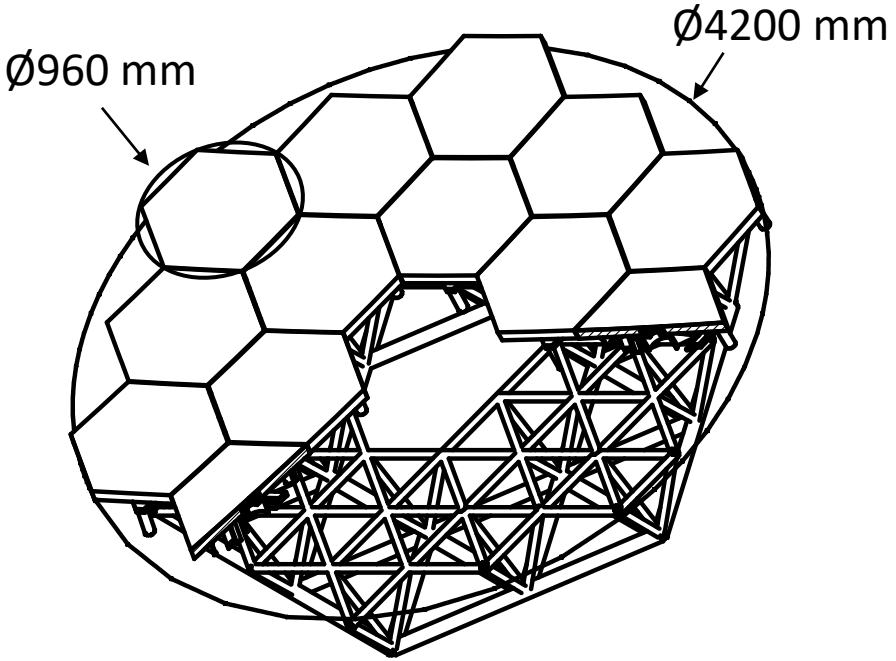
- The finite element method (FEM) is a numerical technique for converting a system of governing differential equations over a continuous domain to a set of discrete variables defined by a matrix equation
- The continuous domain is subdivided into a system of simple elements interconnected at a finite number of points
- The FEM is widely used in mechanical engineering analysis
- In the case of optomechanical analysis, additional postprocessing routines are usually required to convert the mechanical calculation results into meaningful metrics for optical performance assessment

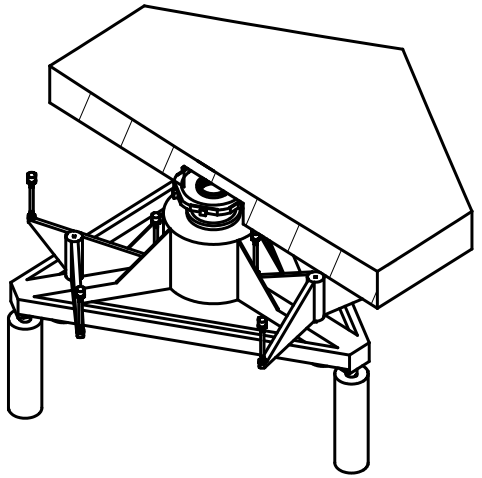
Ahmad, A. (Ed.). (1996). *Handbook of optomechanical engineering*. CRC Press.

M1 ASSEMBLY

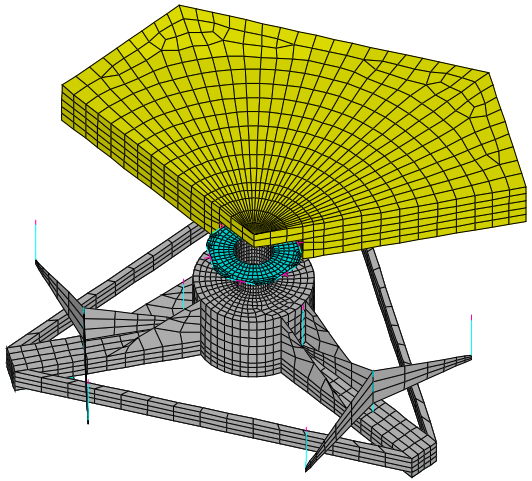
M1 SYSTEM

- Comprised of 18 independent hexagonal segments of Ø960 mm that form the Ø4.2 m telescope pupil
- Each segment position is actively controlled and corrected with 3 actuators to form the M1 mirror optical surface





CAD Model
(Design)



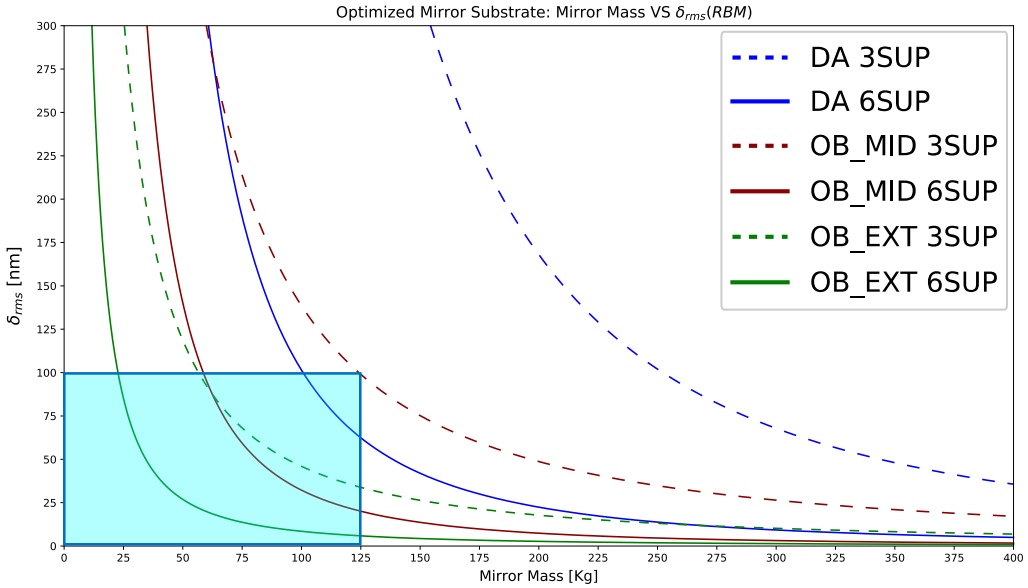
FE Model
(Analysis)

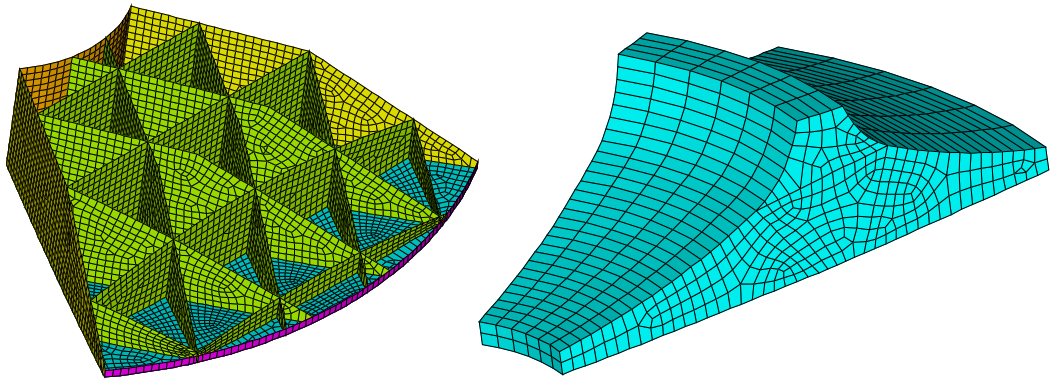
M1 SEGMENT SUPPORT SYSTEM CONCEPT

- Hexagonal Zerodur® plano-concave blanks, Ø960mm, 70mm thick
- Axial support: 9 point mechanical whiffle tree
- Lateral support: central diaphragm

M2 LIGHTWEIGHTING TRADE-OFF

- M2 system weight reduction is needed in order to reduce the overall telescope mass
- Different alternatives based on Double Arch (DA) and Open Back (OB) concepts, axially supported on 3 or 6 points were explored. The results are shown in the figure below (mirror performance vs mass)





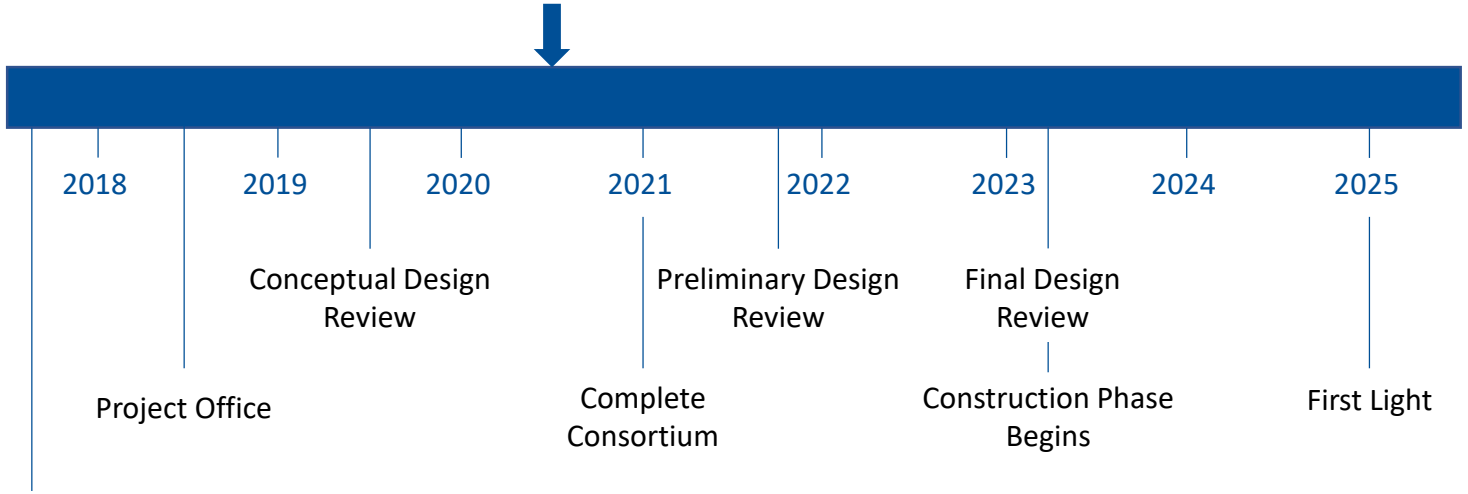
OPEN-BACK (OB) DOUBLE ARCH (DA)

M2 SUPPORT SYSTEM CONCEPT

- A Double Arch lightweighted Zerodur® blank of Ø1270mm, 100 mm height was identified as the best choice in terms of performance/complexity
- Axial support: 6 point mechanical whiffle tree
- Lateral support: central diaphragm
- Space available behind the central hole (possible active optics control elements)

IMPACT AND PROSPECTS FOR THE FUTURE

PROJECT TIMELINE



PRE 2018:

- Development of Science Case
- Feasibility Study
- Forming Consortium
- Funding

SUMMARY

The NRT aims to play a fundamental role in the new era of time-domain astrophysics. The project is in a mature phase in which solutions for the different subsystems are being explored. This contribution presents an overview of the project and the status of the M1 assembly and M2 substrate design.

More information in:
https://www.iac.es/es/proyectos/iactec-grandes-telescopios-new-robotic-telescope-nrt

This work will be part of the PhD: *Opto-Mechanical Systems Design for the 4-m New Robotic Telescope* by A.Oria, Supervisor: C.M. Gutiérrez (ULL, 2021)

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