
NPC
new production concept
MO.R.AL
Alt-Azimuth one meter class mount for SLR
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SPACE MIND

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MORAL

- MORAL (MOunt Robotic ALt-azimuth) is an Alt-Az mount designed to satisfy the needs of many applications that require high accuracy, precision and fast pointing of in-orbit objects:

  - ✓ Optical Observation
  - ✓ Laser Ranging

- Project drives:

  - ✓ Lightweight structure – 10000 N maximum load
  - ✓ <2 arcsec of mechanical axis pointing error
  - ✓ up to 30 °/s slew rate
  - ✓ High torque (scalable)
  - ✓ 360 ° Free rotation in azimuth axis
  - ✓ Hollow shafts on both axis for laser path
  - ✓ Large clearance for large instruments

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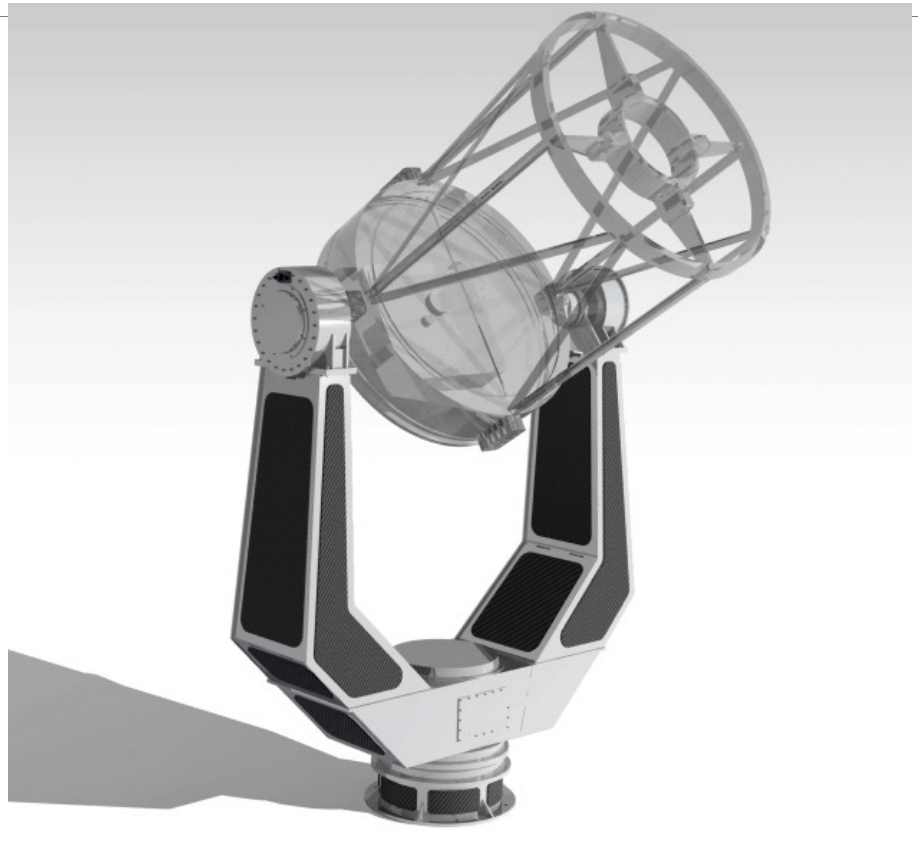

- The requirements have been defined in order to obtain a high quality solution for observation of really fast objects in LEO dimensioned for space debris monitoring and tracking.

- MORAL is a fully parametric and easy-adaptable product designed to withstand a large scale of loads (both mechanical and electrical) in which the level of the performance can be adjusted according to the needs.

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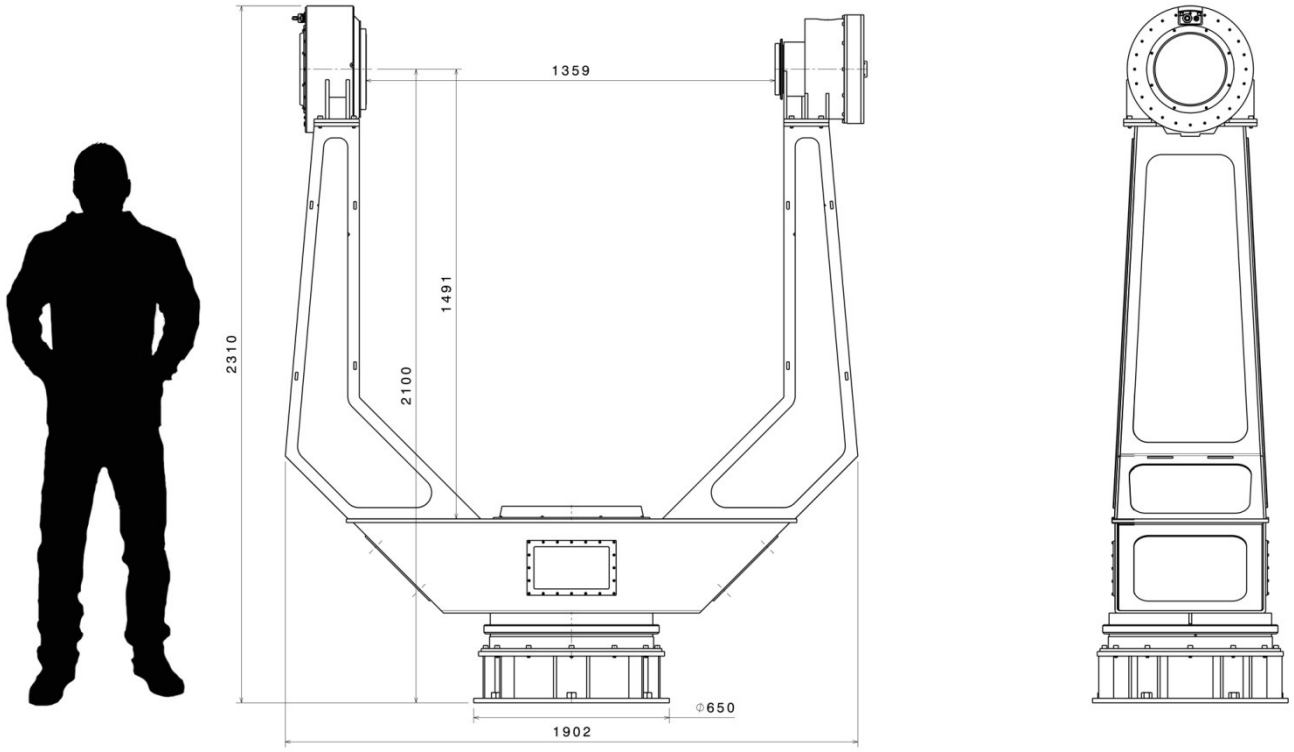
MORAL can mount instruments up to 1000 kg and over 1.3 m diameter.



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FAST POINTING HIGH ACCURACY

- MORAL exploits direct drive motors eliminating transmission hardware between the motor and telescope axes, with values of torque up to 600 Nm.
- High resolution absolute optical encoders measure mount angular motion with an extreme precision, with a resolution of 0,01 arcsec directly on telescope axes.
- High precision bearing units associated to an optimized mechanical design ensure excellent dimensional stability during operations.
- The electrical hardware is already designed to provide and withstand higher level of velocity if required acting only on the software controlling system.
- MORAL has been designed using aerospace methods and tools for structural optimization to ensure dynamic stiffness during operations.
- A reference load of 10000 N has been considered for static dimensioning, ensuring positive margins of safety and limited displacement.

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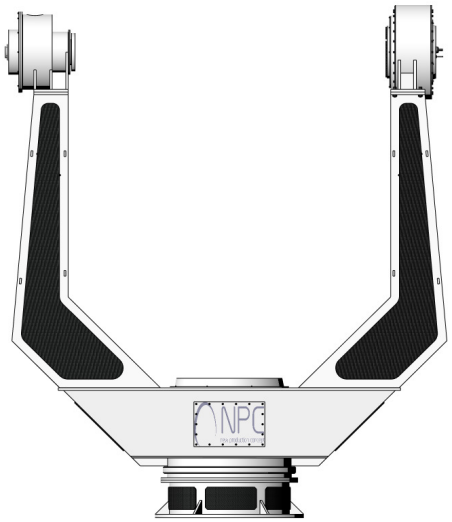
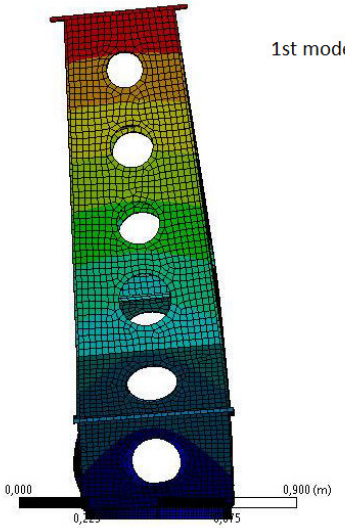
OPTIMIZED STRUCTURAL DESIGN

- When operating at high performances loads can induce vibration and micro deformation on the structure that can alterate measures
- MORAL has been designed using aerospace methods and tools for structural optimization in order to achieve a lightweight structure ans high performances in terms of stiffness.





Mode	Frequency [Hz]
1	23,3
2	23,5
3	106,9
4	139,2

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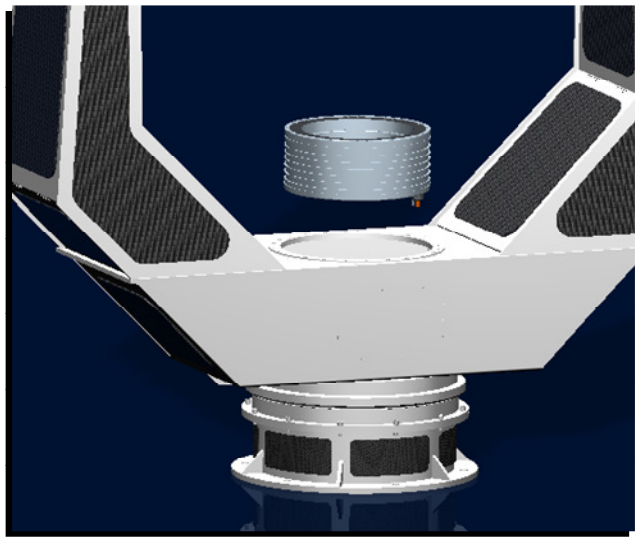
EASY HANDLING/ACCESS TO COMPONENTS

- The handling of the system has been studied in order to realize a product that can be easily inspected allowing a replacement of the main components avoiding the full disassembly of the system. This is important when MORAL is operating in harsh environment hardly accesible.



- Motors can be removed easily for inspection and maintenance.
- Encoders and controllers can be removed as well individually for maintenance
- The braking system ensures that maintenance operations can be carried out in safe conditions.

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CONTROL & OPERATIONS

- The controlling system is based on real time multi-axis control that allows really accurate and sincronous control of both axis.
- The control software has been built starting from ASCOM standards.
- Compatibility with commercial and compatibility with commercial astronomical equipment software control (e.g. ASCOM). and pointing model.
- Open communication protocol – TCP Server to send direct command to the mount
- GUI for standalone PC control
- Independent controlling Joystick

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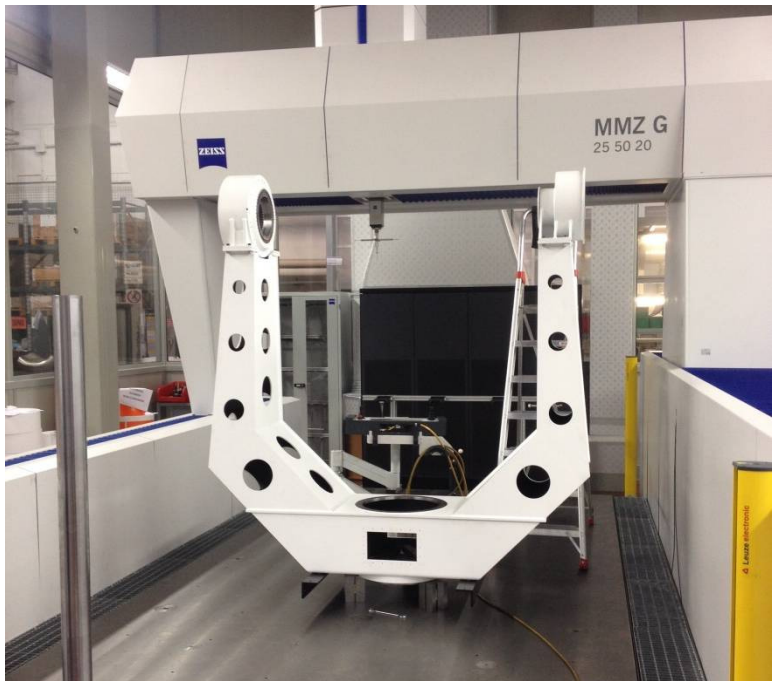
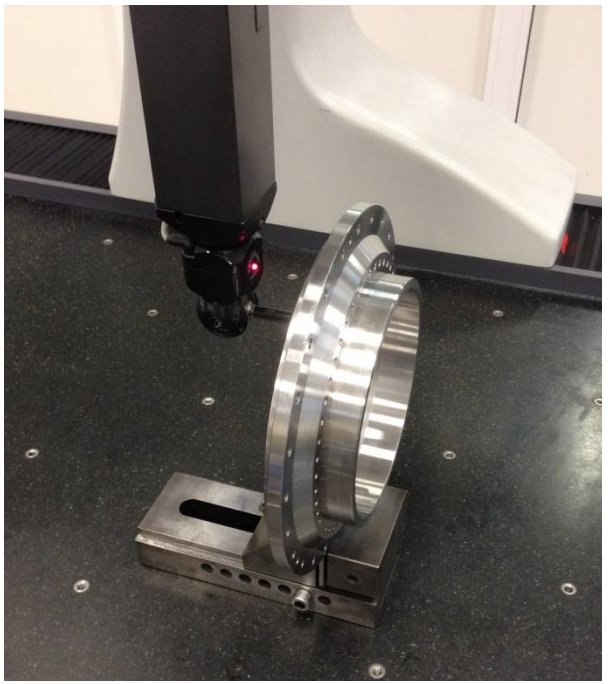
HIGH QUALITY STANDARDS

- Thanks to NPC experience and falicities it has been possible to ensure a high level of standards in terms of quality control before and during each step of integration.





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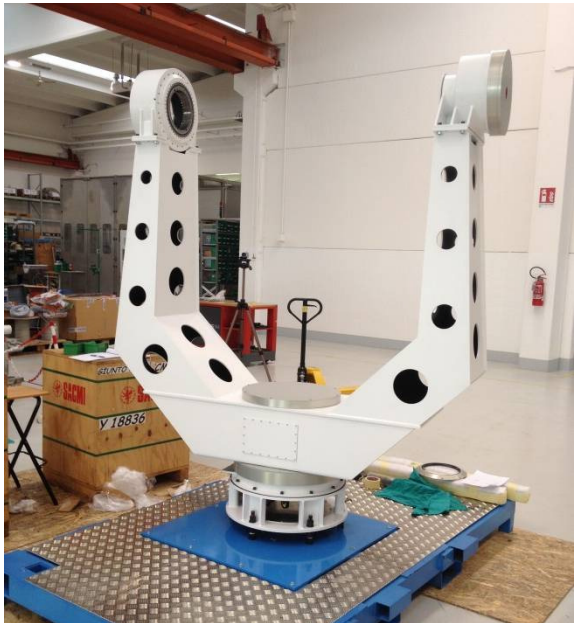
CURRENT STATUS

- The first prototype is being manufactured and realized within facilities of the company NPC which can provide great expertise in terms of mechatronic and assembly of high precision mechanical components. The test campaign has been scheduled for december 2015.



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SPECIFICATIONS

		Symbol	Unit	Value
Mechanical Data	Material	s355 Steel with antirust treatment		
	Weight	W	Kg	ca 750
	Height		mm	2310
	Fork Aperture		mm	1902
	Distance between Plates	DBP	mm	1359
	Nominal Load	NLd	N	5000
	Maximum Load	MLd	N	10000
	First Frequency mode (@NL)		Hz	23
	Protection	Protective seals		
	Treatment	Rust protective painting		
Operational Performances	Power Supply	Vsup	VAC	230
	Maximum Torque Az (peak)	TAZ	Nm	658
	Maximum Torque El (peak)	TEL	Nm	493
	Current Peak per motor	Ip	Amp	17.5
	Operative velocity	OSR	Deg/sec	settable
	Maximum operative velocity	MSR	Deg/sec	30
	Maximum acceleration	-	Deg/sec^2	settable
	Rotation angle on azimuth	Free rotation		
	Rotation angle on elevation	0 – 180°		
	Pointing accuracy	PA	Arcsec	<2
	Minimum Alt axis braking time	tbr	millisecond	<100
	Minimum time to MSR Azimuth	tAz	millisecond	732
	Minimum time to MSR Altitude	tAlt	millisecond	714
Operational Data	Controller	Real time 2ax synchronous control		
	Software and Interface	ASCOM Platform Driver GUI Controlling PAD TCP Server socket for open comm. protocol		
	Electrical line	Fixed power and signal lines 2A @ 24V Custom power and signal lines (standard is 4 x 250VDC/VAC – 10A, 2 USB 1.0/2.0)		
	Operative Temperature	Top	°C	-30°÷40°
	Storage Temperature	Tst	°C	-40°÷60°

- Maximum telescope weight: 500 kg
- Distance between support plates: 1410 mm
- Lightweight: overall weight 700 kg
- Mechanical Axes Error <2 Arcsec
- Maximum speed: 30 deg/sec (settable)
- Angle measurement resolution directly on the axes: 0,01 arcsec – accuracy 1 arcsec
- High torque direct drive motors
- ASCOM compliant communication protocol
- First quality industrial standard components
- Unlimited rotation in azimuth/elevation
- Optimized design using aerospace derived analysis methods
- Nasmyth – focus telescope compatible

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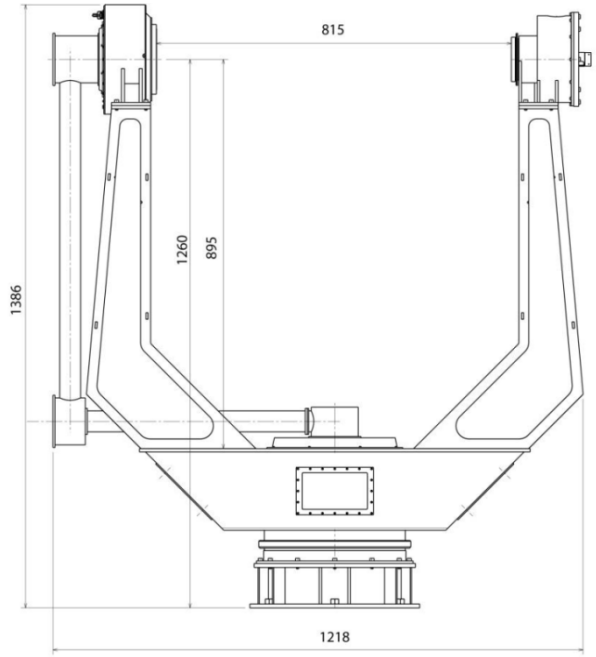
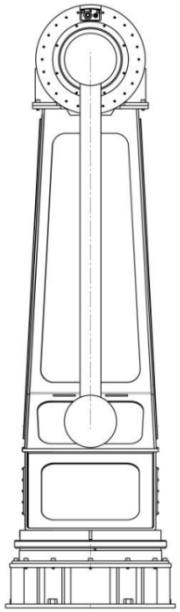
PARAMETRIC DESIGN

- MORAL has been designed exploiting parametric design philosophy that permits to rescale the system according to the needs (Custom data/power signals – Motors Performances - Dimensions)
- A first approach design of a rescaled system has been studied for a potential customer.





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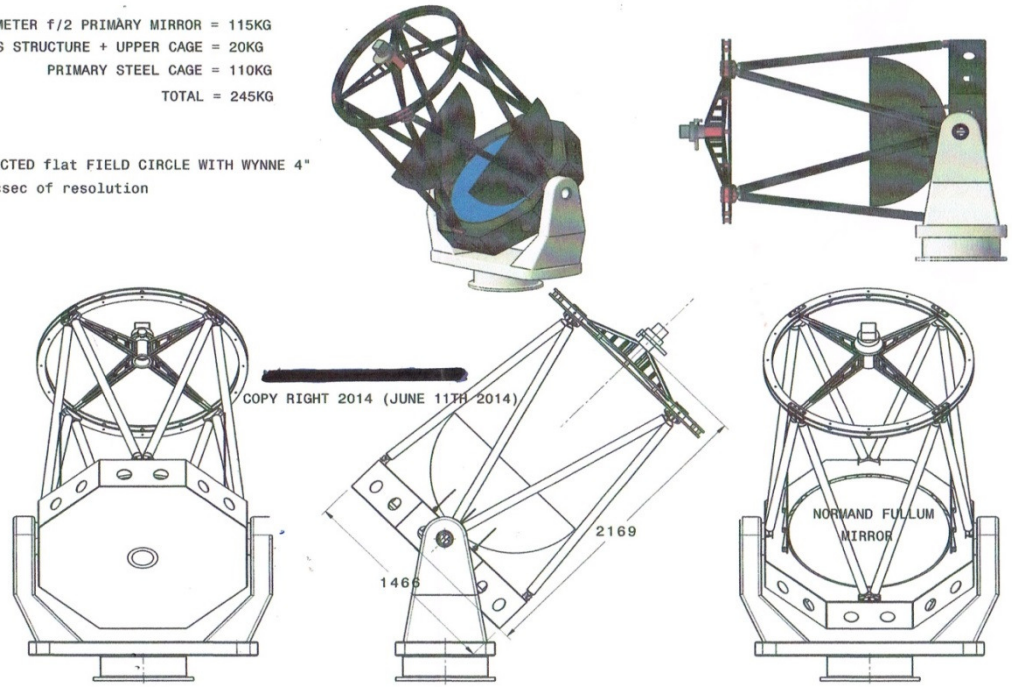
OPTICS PROVIDER

Normand Fullum 1 METER f/2 PRIMARY MIRROR = 115KG
CARBON TRUSS STRUCTURE + UPPER CAGE = 20KG
PRIMARY STEEL CAGE = 110KG
TOTAL = 245KG

60mm CORRECTED flat FIELD CIRCLE WITH WYNNE 4"
0.1158 arcsec of resolution



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PROJECT MILESTONES

- September 2014 - April 2015 – **Design**
- April 2015 – August 2015 - **Components supply/parts manufacturing**
- September 2015 -November 2015 **– Integration (on time)**
- December 2015 - **Begin of test campaign**

THANKS FOR THE ATTENTION

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VERSATILE OPERATIONAL APPROACH

- The philosophy adopted for the design of MORAL permits to modify the performance only changing few components. Drives and motors are designed to sustain higher voltage and in that way higher torques and velocity.
- All the components that can be switched according to requirements are integrated using flexible interfaces.
- The motion control components have been chosen in order to permit to reach the maximum value of power just changing the upstream power supply.
- The whole controlling chain can be modified in order to facilitate the use of specific software.
- Slip rings can be substituted with a different model offering more signal lines according to the required instruments.

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