HARMONI – first light spectroscopy for the ELT: Spectrograph camera lens mounts

Andrea Hidalgo, James Kariuki, James Lynn, Wui Cheng, Adam Lowe, Fehim Taha Bagci, Fraser Clarke, Ian Lewis, Ian Tosh, John Capone, Matthias Tecza, Michael Booth, Myriam Rodriges, Nicholas Cann, Niranjan Thatte, Zeynep Ozer, Tom Foster

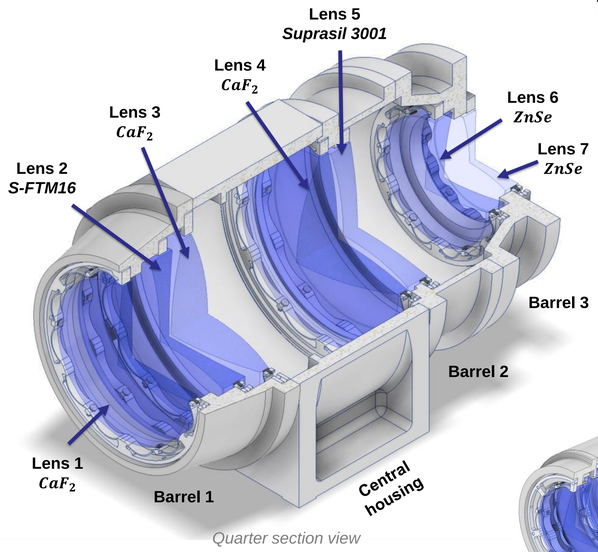
Overview

HARMONI is the first light visible and near-infrared integral field spectrograph for the Extremely Large Telescope.

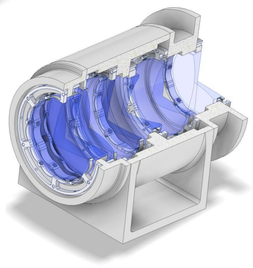
The spectrograph system will include four near-infrared cameras and two visible cameras, each with seven lenses.

The lenses will be supported in flexure mount rings based on a design inherited from FMOS and KMOS instruments.

The alignment requirements for this lens mount assembly that operate at 130 K are challenging and critical to the performance of the cameras.



Quarter section view



Near-infrared camera in f/11.71 *out f/2.71*

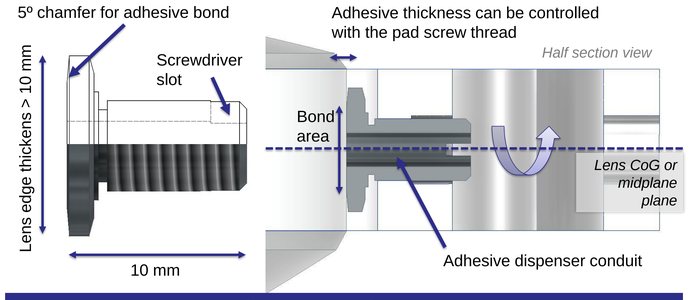
Operational temperature 130 K

Visible Camera in f/11.71 *out f/2.69*

Design and mounting concept

Design

- The centre of gravity of the lens mount assembly is as close as possible to the middle plane drawn by the pads.
- Pad material closely CTE matched to lens material (e.g. invar-fused silica, titanium-ZnSe).
- Spring flexure and pad bond area sized to minimise thermal stress using FEA.

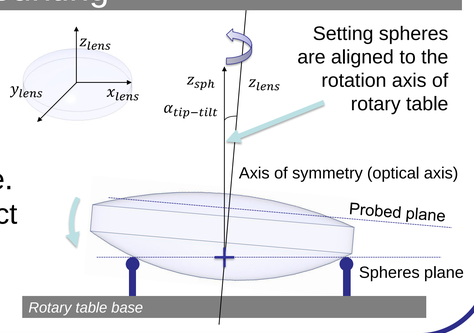


Alignment tolerances

DoF	DoF type	Description	Tolerance
x	Centred during mounting Limited by CTE interaction	Thermal coefficient mismatch decentring limitation in the lens mounts	Max. 20 µm
y			Max. 20 µm
z	Mechanically constrained	Lens spacing along the optical axis	±10 µm
Tip	Alignment DoF	Lenses subassembly tip and tilt misalignment	10 µm runout
Tilt			
Roll	Discrete compensator (60 deg)	Lenses clocking compensator	Compensator

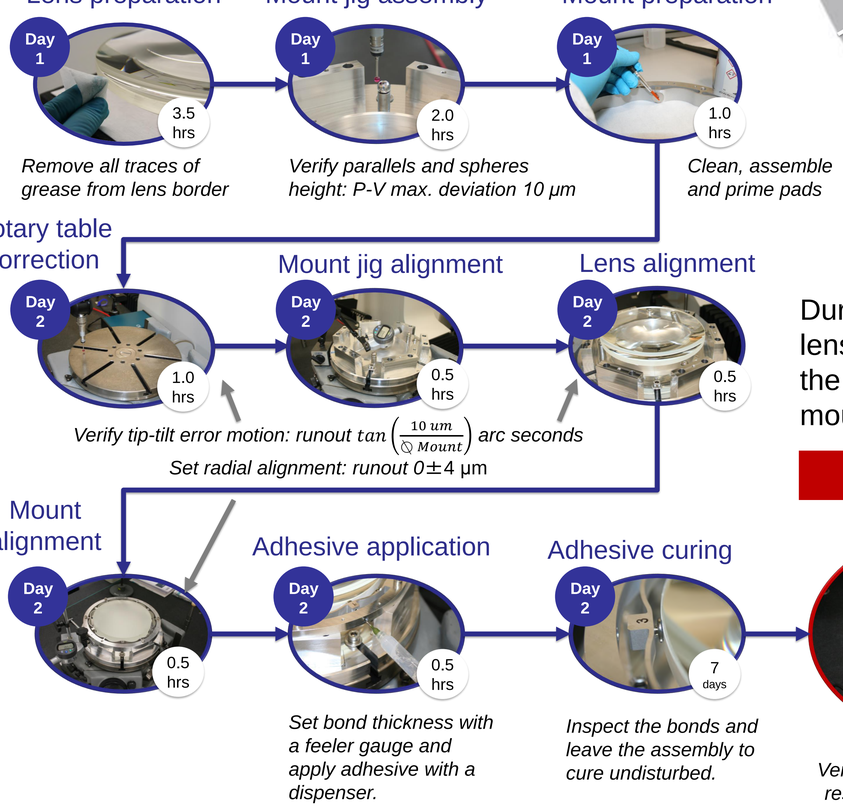
Mounting

- Optical axis found using low-force dial gauge to clock lens supported on setting spheres and centred on a rotary table.
- Lens aligned with respect to reference surface on mount.



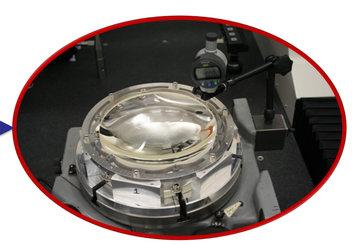
Assembly and verification

Assembly



During the lens assembly, the lenses optical axis is aligned to the mechanical reference of its mount ring.

Verification

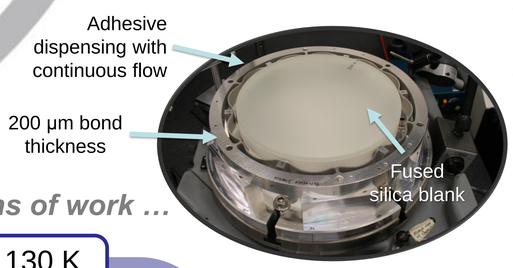


Verify lens optical axis alignment with respect to mount reference surface.

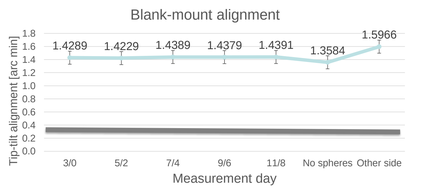
Prototypes

To validate design parameters, develop a mounting process and achieve desired alignment to meet the tolerance analysis estimations, we have worked on two prototype lens mount assemblies.

Flat blank and KMOS mount design



Variations in height (~25 µm) of the parallels and spheres play a role in the alignment of the assembly.

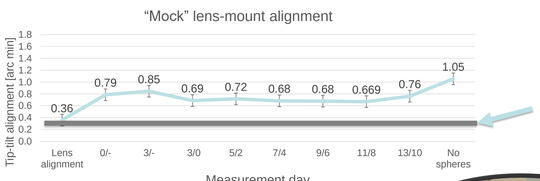


Next few months of work …

Cold testing – 130 K

- Measure **position (x and y)** of the lens with respect to the mount after cool down and **settled**. Validate tolerance analysis estimations.
- Measure lens **tip and tilt** orientation with respect to the mount after cool down and **settled**.
- Test bond **survivability** throughout HARMONI's accelerated lifetime.

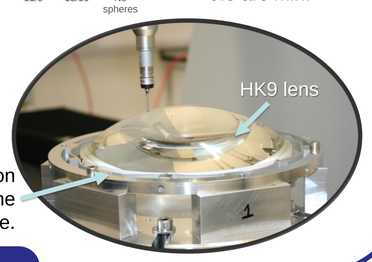
HARMONI "mock" lens and mount pre-design



A new prototype is to be mounted. Our goal is to meet our specification of 0.3 arc min.

Flatness and cylindricity specifications in the mount play a role in alignment.

Rotation axis has a tip-tilt error motion of 0.45 arc minutes with respect to the mount plane.



References

1. Spectrograph team, HRM-00322 IFS Spectrograph Design and Analysis Report, November 2020
2. Spectrograph team, HRM-00323 IFS Spectrograph MAIT Plan, November 2020
3. Spectrograph team, HRM-00602 IFS Spectrograph NIR and VIS camera, November 2020
4. Jamie R. Allen, Kieran O'Brien, James D. Lynn, Niranjan A. Thatte, Ian A. J. Tosh, Mike Tacon, "Characterizing the performance of cryogenic lens mounts for the HARMONI spectograph," Proc. SPIE 9912, Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation II, 99124Q (26 September 2016); https://doi.org/10.1117/12.2233613
5. See manuscript for complete list…

HARMONI spectrograph SPIE presentations

- **11447-343:** Zeynep Ozer, et al., HARMONI: First light spectroscopy for the ELT: Final design and assembly plan of the spectrographs
- **11447-347:** Hermine Schnetler, et al., HARMONI: First light spectroscopy for the ELT: The final design of the first diffraction limited 3-D spectrograph
- **11447-352:** John Capone, et al., HARMONI: First light spectroscopy for the ELT: Simulating the alignment of a three-mirror anastigmat

Contact or tweet the author:
andrea.hidalgo@physics.ox.ac.uk
@LaurethTEX