

Dish Structure Status

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MASUM - May 2022



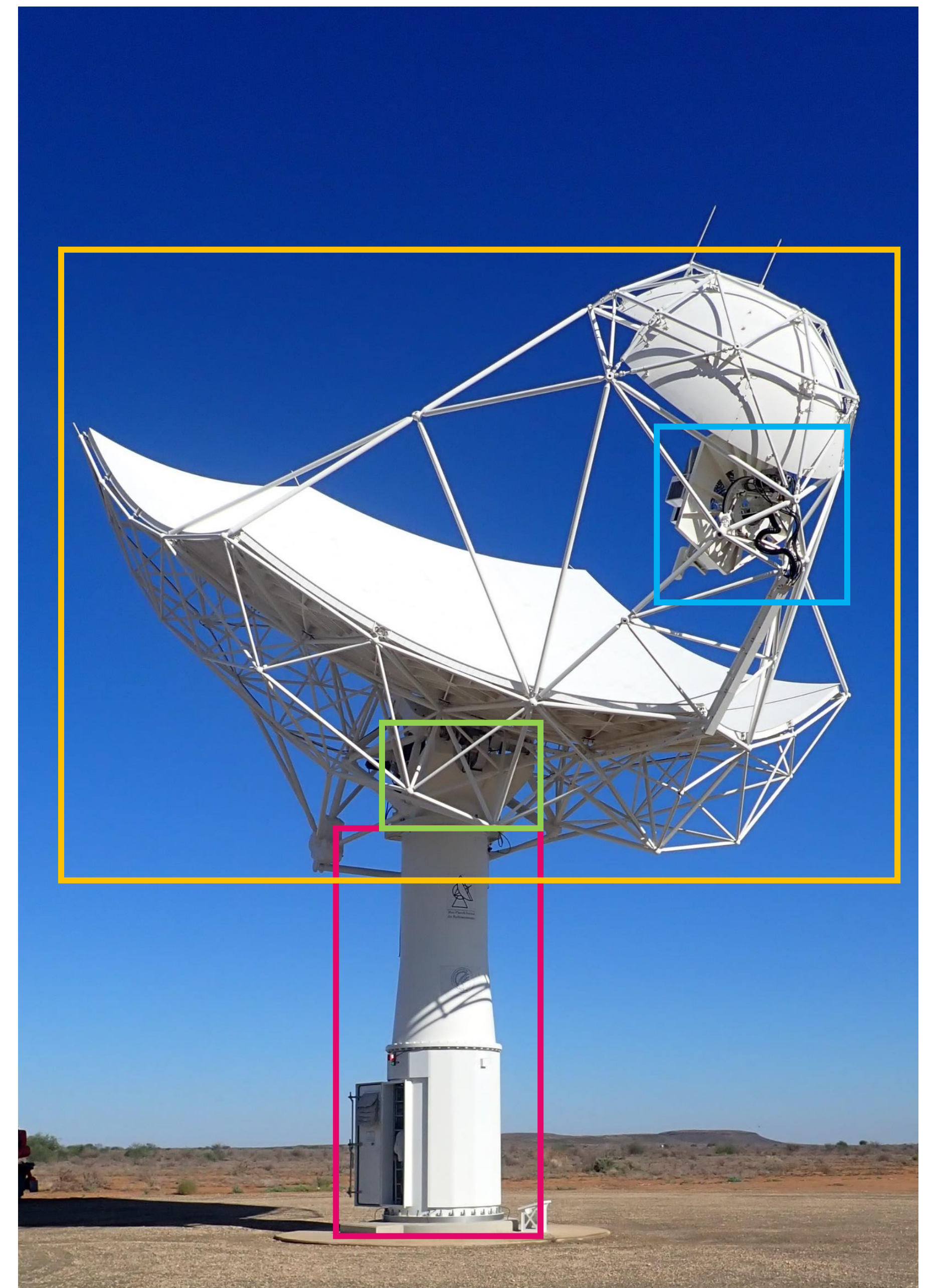
Agenda

- What is DS?
- Where are we?
- Where are we going?
- Summary



What is Dish Structure?

- Pedestal
- Turn Head
- Elevating Assembly
- Feed Indexer
- Control System



SKA-MPI Demonstrator under the beautiful Karoo sky.



Pedestal

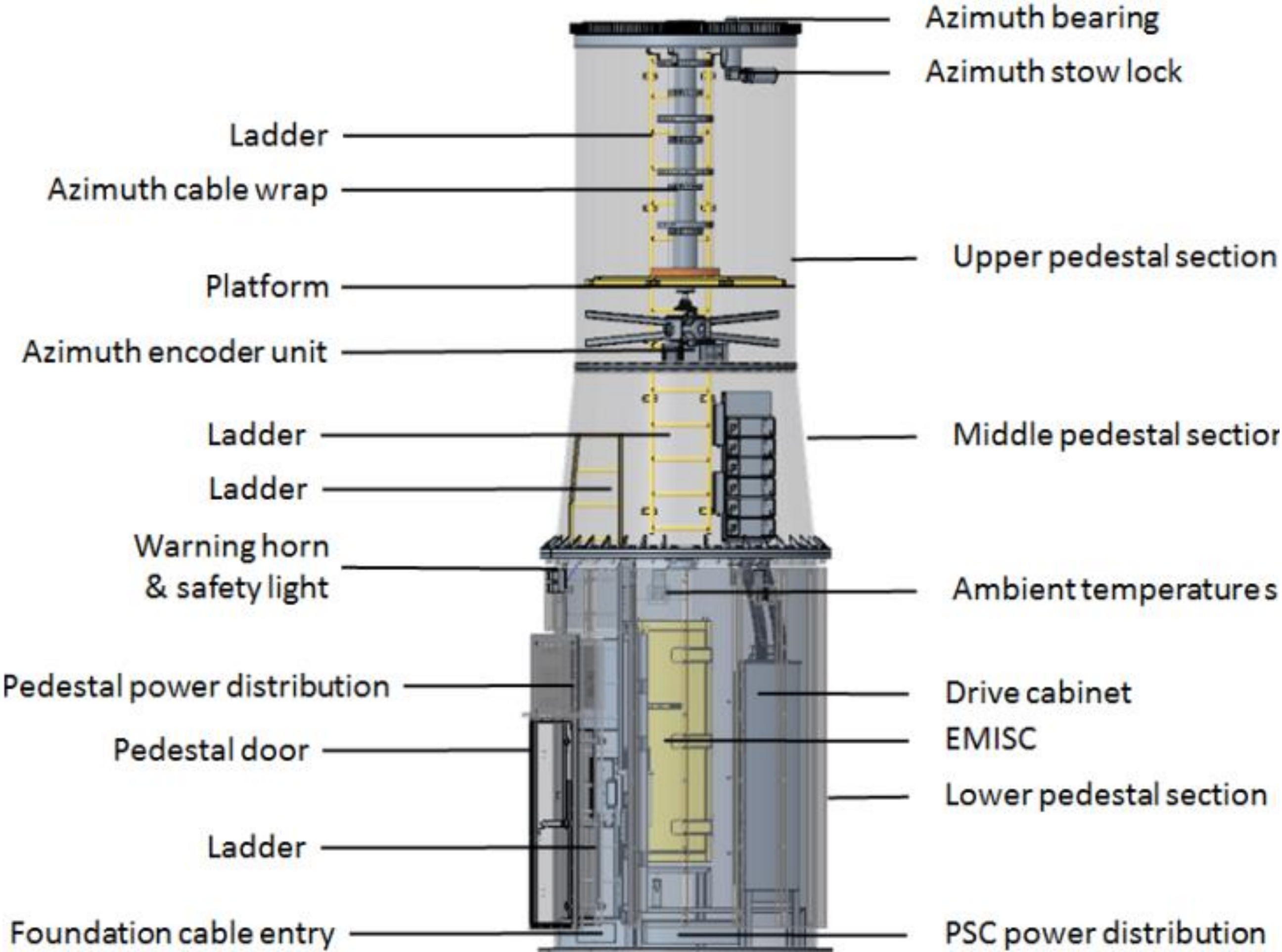
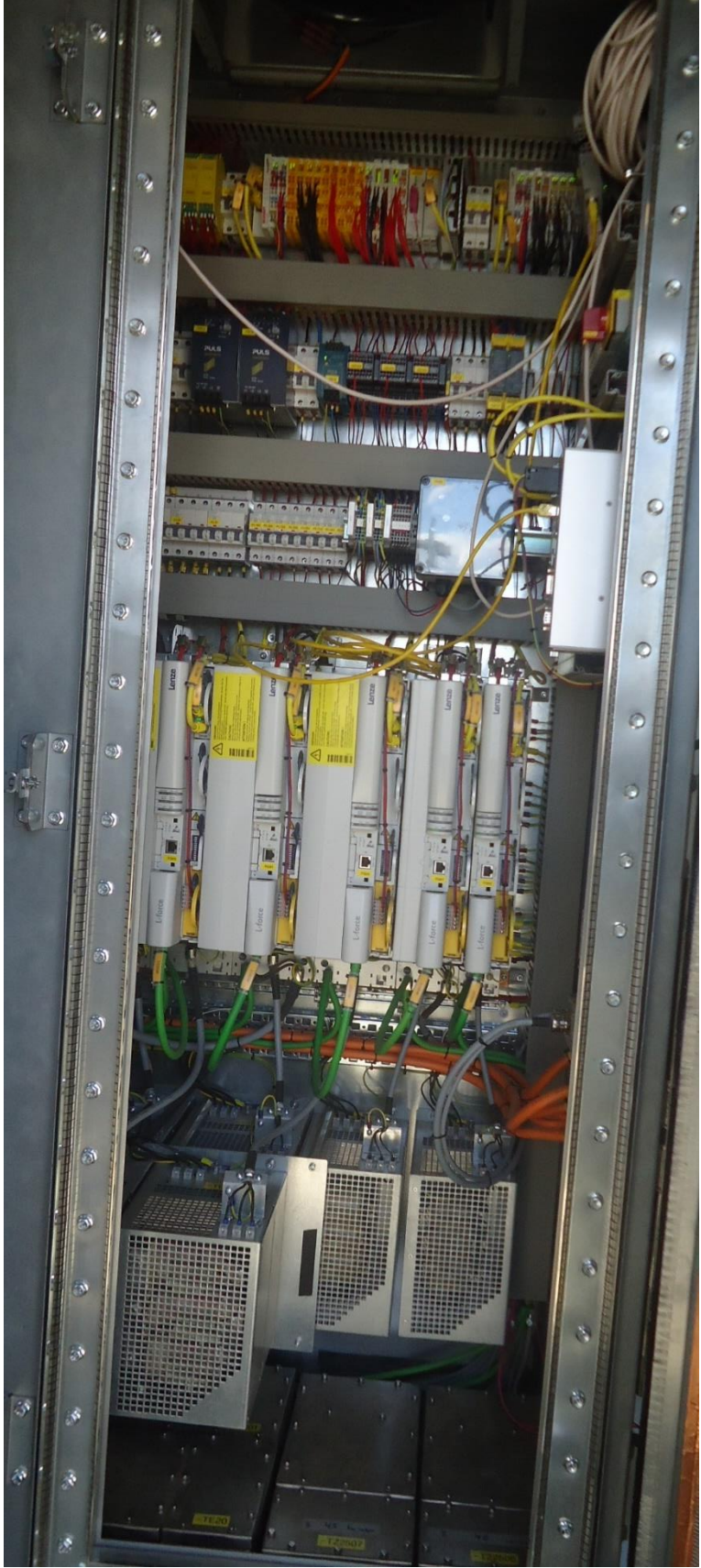


Figure 11: Pedestal Overview



Looking up at Azimuth Cable Handler in the upper part of the pedestal.

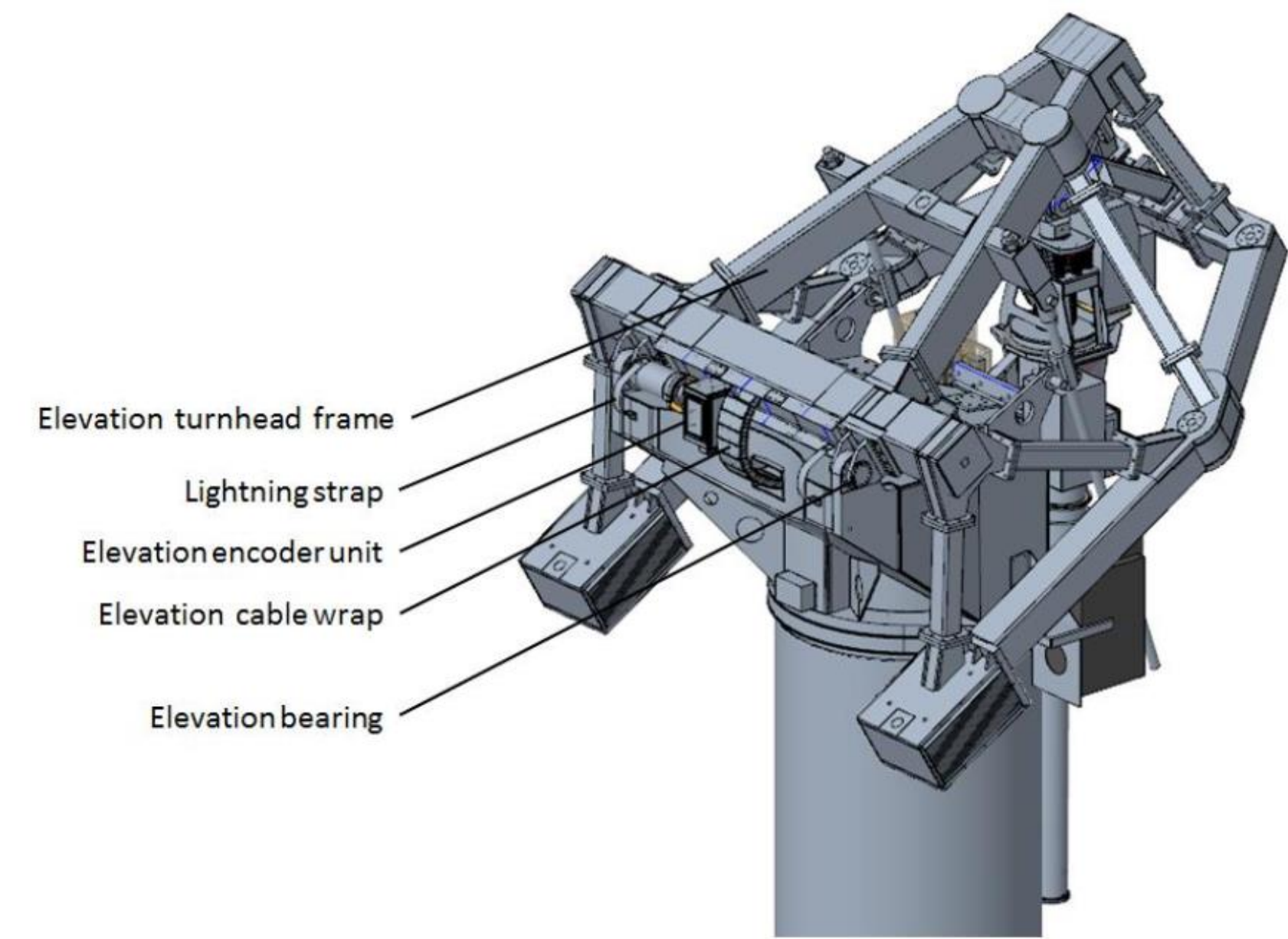


LH: Test Equipment in the EMISC during Thermal & Ventilation QTP.
RH: SKA-MPI Drive Cabinet.

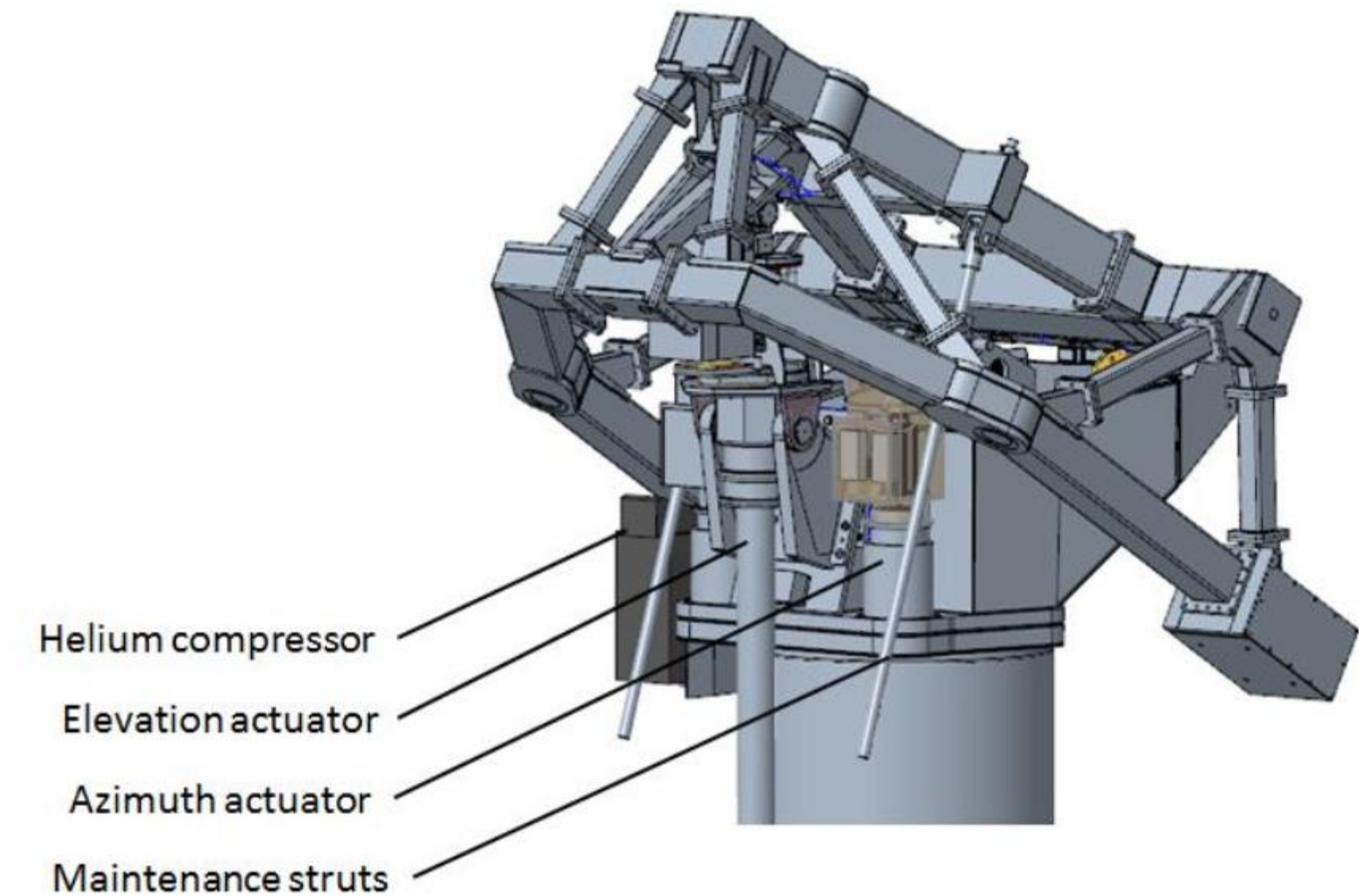


Turnhead

- Turnhead rests on Azimuth Bearing and supports the:
 - Azimuth Actuators
 - Elevation Axis and Actuator
 - Elevating Assembly
- Turnhead stiffness optimised using topology optimisation



Turnhead seen from the front.



Turnhead seen from the rear.



Elevating Assembly

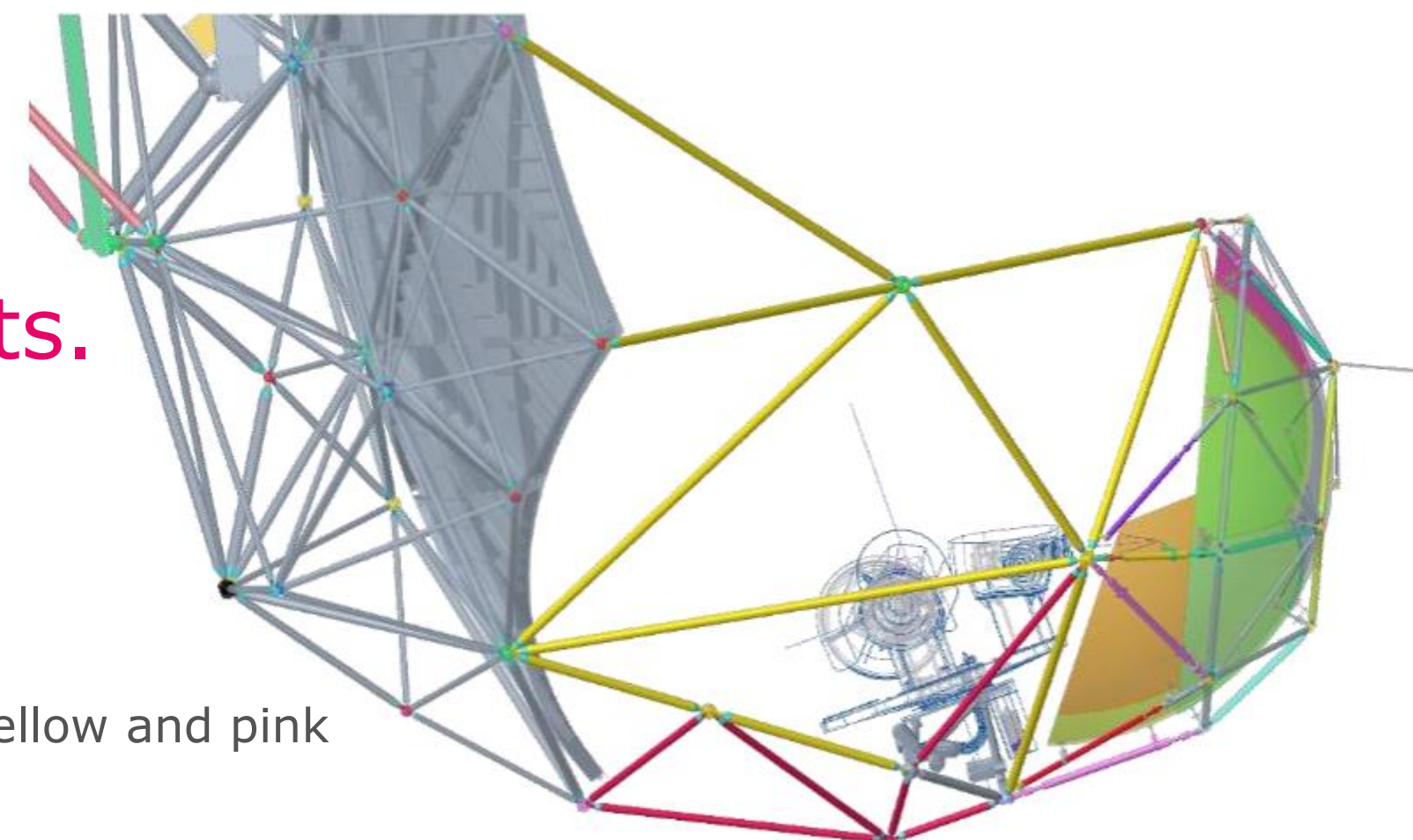
- Back up Structure (BUS)
 - Steel Ball and Strut Spaceframe
- Main Reflector (MR)
 - Aluminium Panels and Ribs
- Sub Reflector (SR)
 - Low CTE Carbon Fibre sandwich panels
- SR Support Structure (SS)
 - Combination Steel Ball and Carbon Fibre Strut Spaceframe
- Feed Indexer Interface
 - Hexapod using commercial struts.



Indexer Interface.



Main Reflector Backup Structure



SR Support Structure in yellow and pink

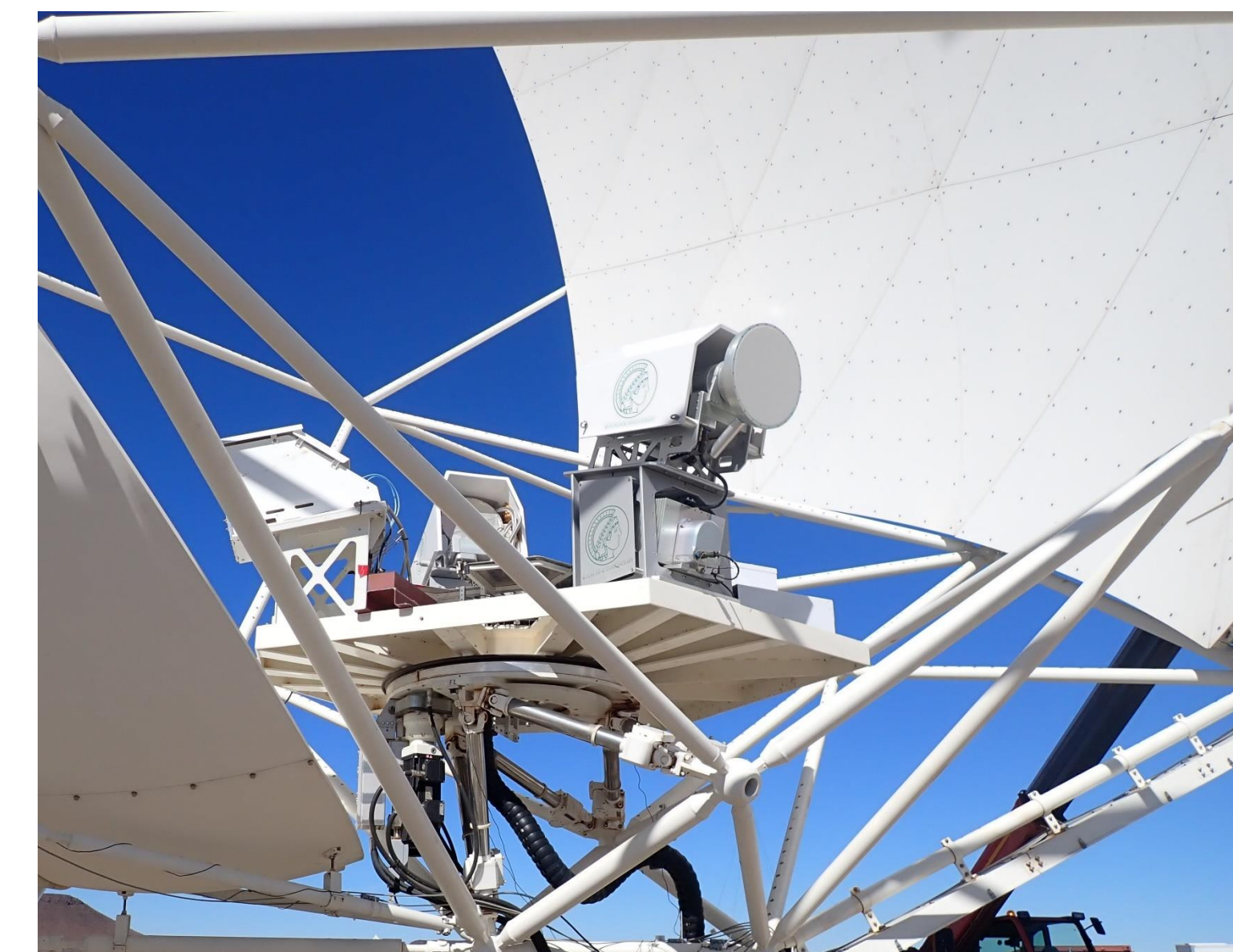


Feed Indexer

- Design has been further optimised for SKA-001
 - Structurally simplified.
 - Improved bearing selection.
 - Improve walkways.
 - Improved maintenance access.
 - Improved weather seals.



Feed Indexer for SKA-P



Feed Indexer on SKA-MPI

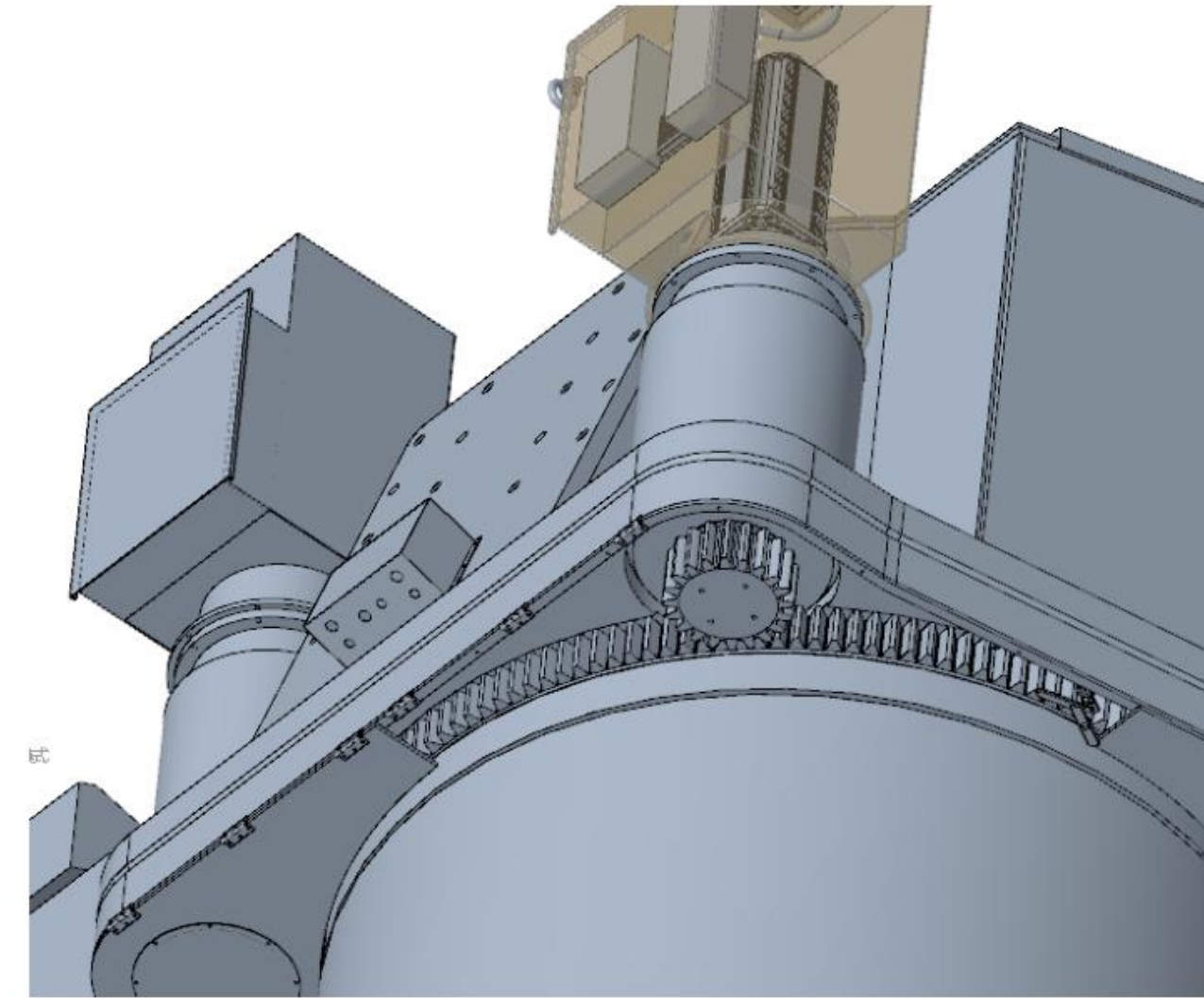


Improved Feed Indexer for SKA-001

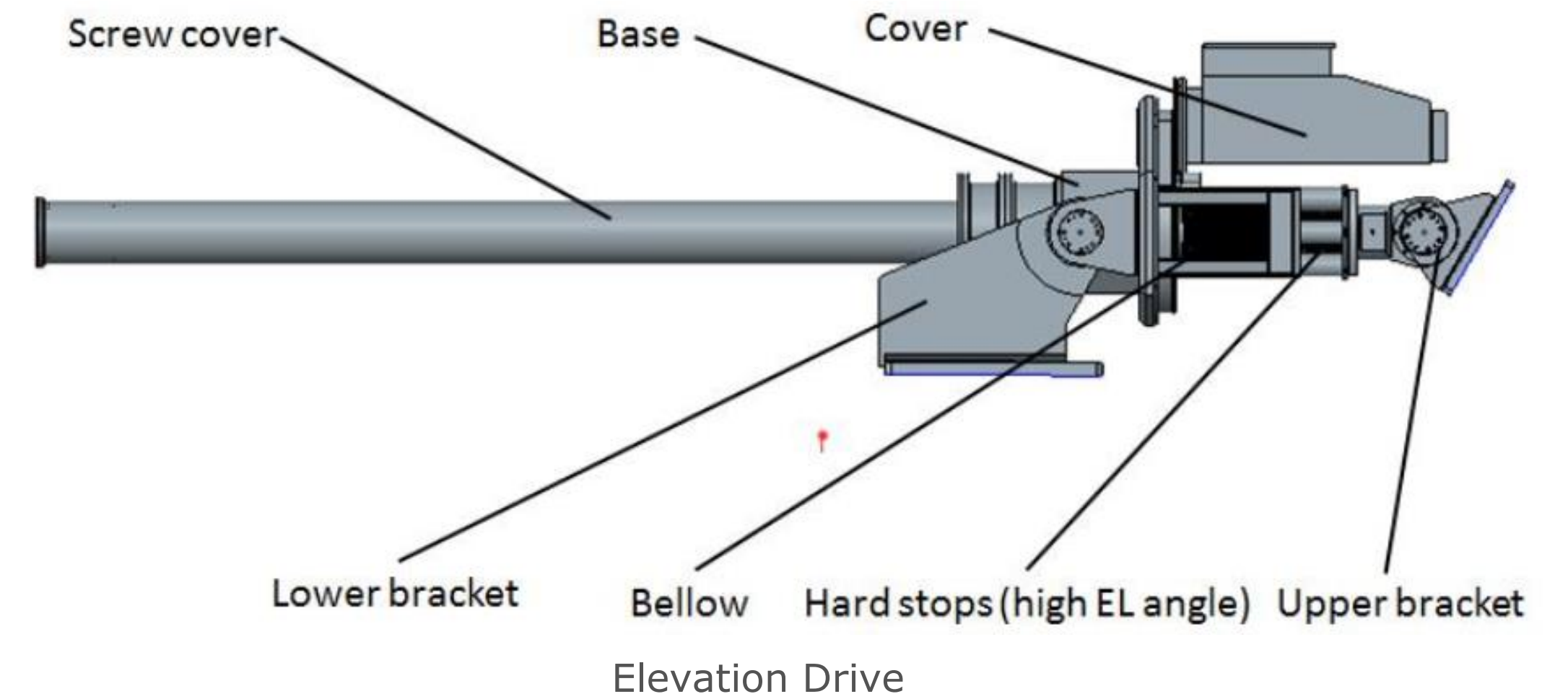


Control System

- Rexroth based system
- Azimuth Drive
 - Dual motors for Backlash compensation
- Elevation Actuator
 - High preload ball screw
 - Single motor and gearbox to drive nut
 - Stiff connections to structure.



Azimuth Drive

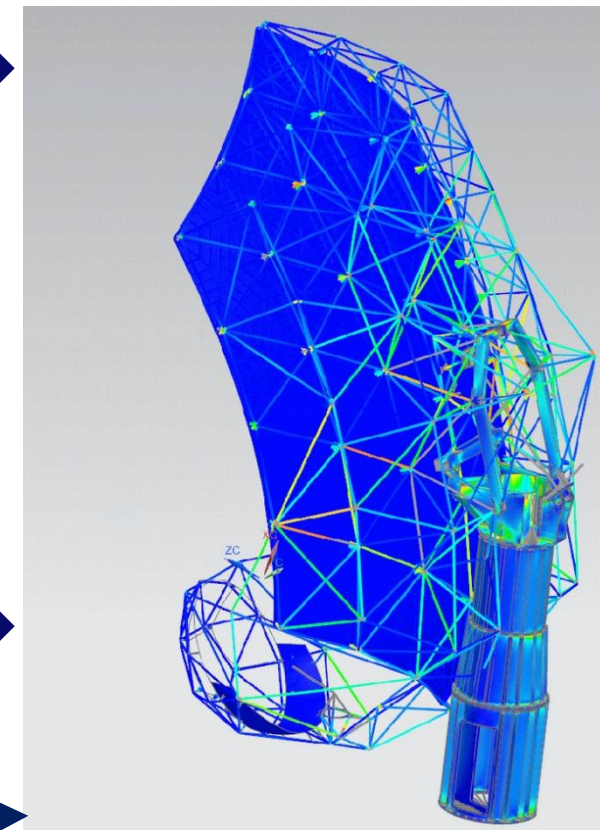


Elevation Drive

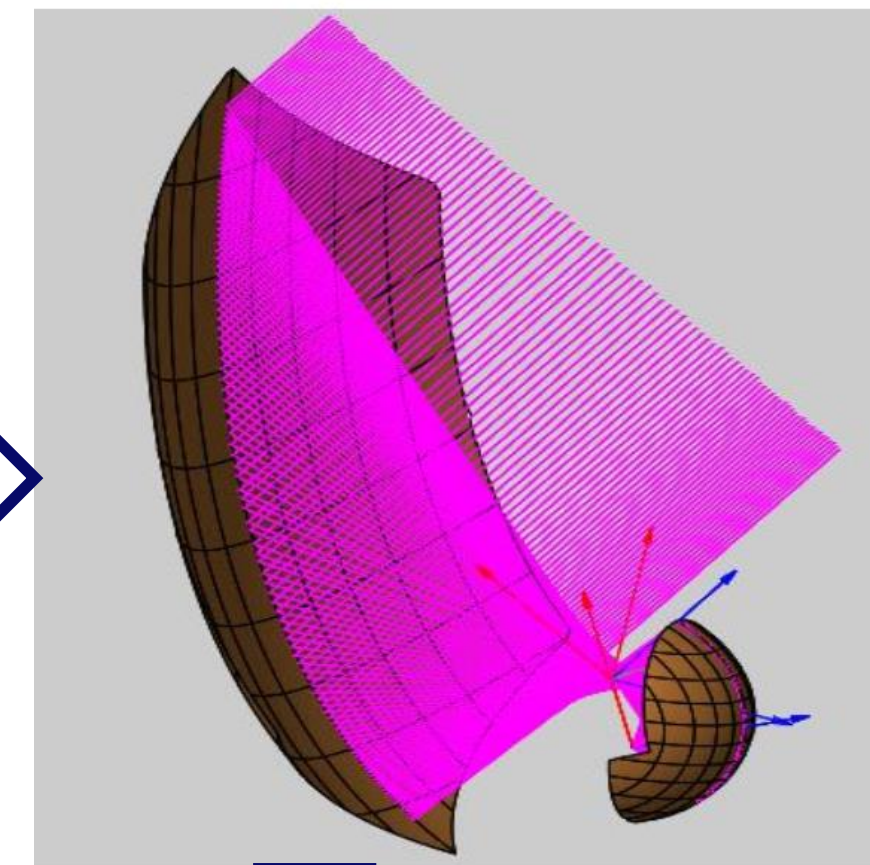


Analysis and Design

Finite Element Analysis

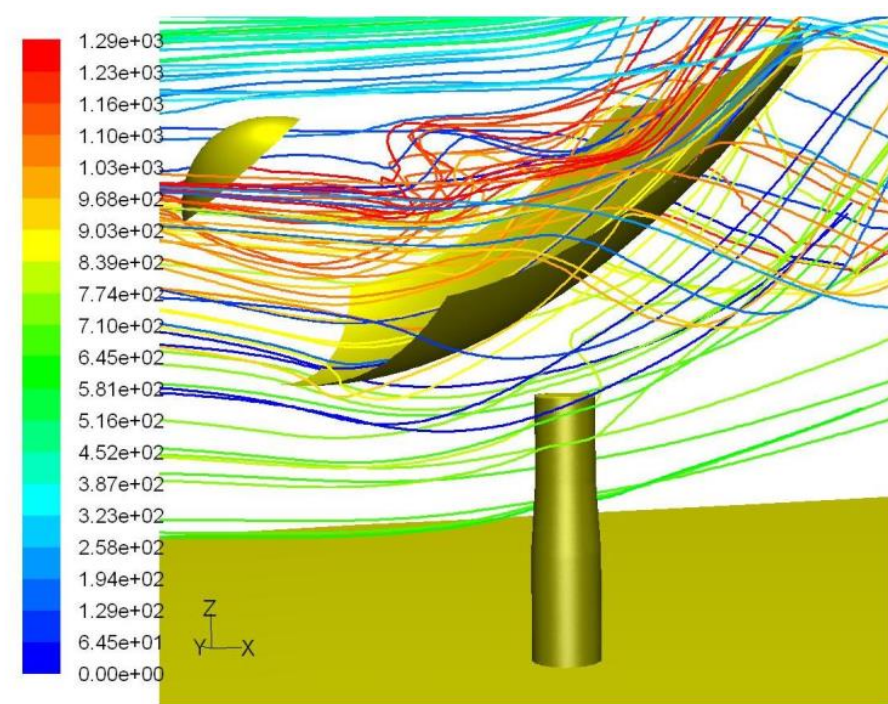


Physical Optics Simulation - GRASP



Thermal Loads from Measurement

Computational Fluid Dynamics



Wind Forces

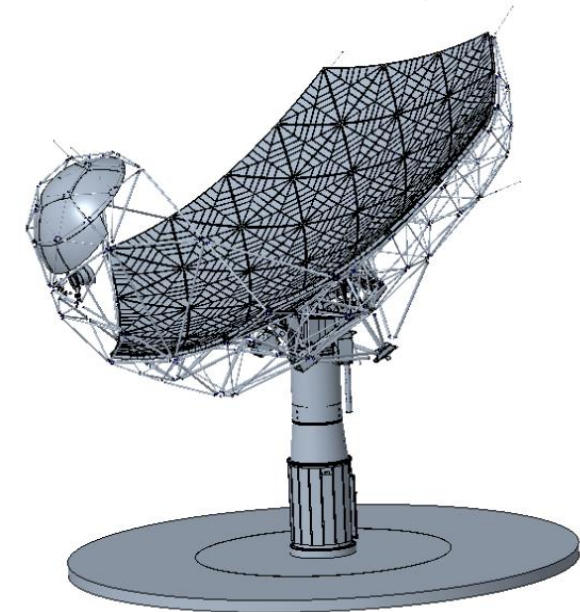
Deformed Structure

Dynamic Properties

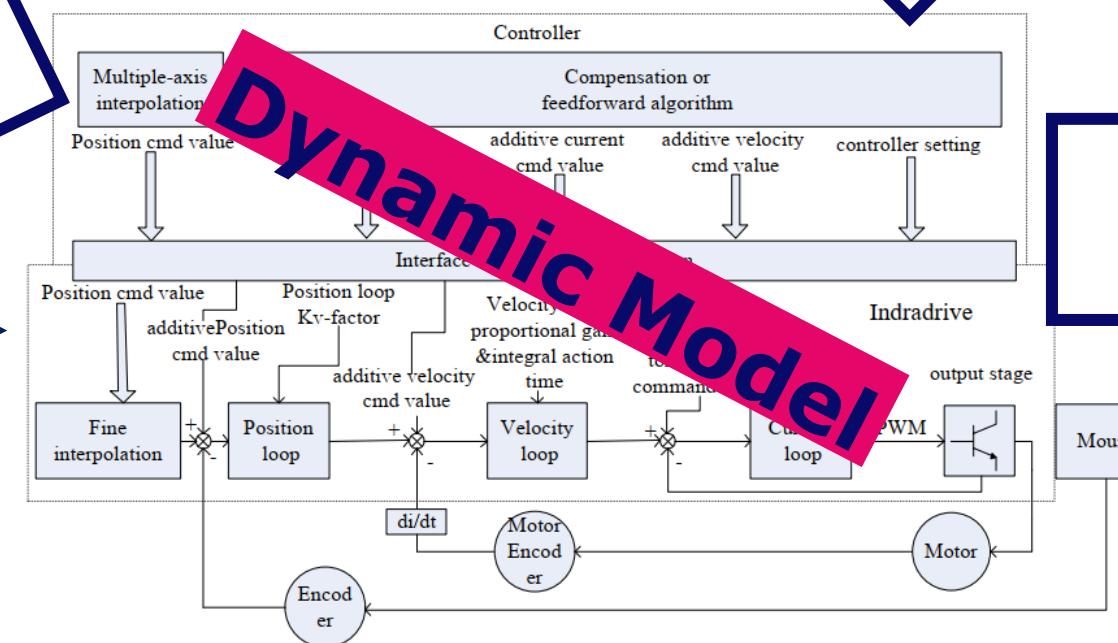
Static Pointing

Static Pointing

DS Design



Wind Forces



Dynamic Pointing

Pointing Error Budget

Verification Demonstrators

- Three prototypes have been built to date.
 - **SKA-P#1** - located at CETC in Shijiazhuang built primarily to test integration of the structure and alignment of the Reflector panels.
 - **SKA-MPI** Same structure as SKA-P#1 with OHB control system, located onsite in the Karoo and used to validate the Pointing, RF performance.
 - **SKA-P#2** is an upgrade of SKA-P#1 with a new CETC control system and will be used for performance testing of control system.



SKA-MPI at SKA Mid Site



SKA-P1 in Shijiazhuang



- **MeerKAT+**



- **SKA-001 Design for deployment in AA0.5**



Programme & Status

- **List of the Qualification Test Procedures (QTP) performed on the different prototypes:**

Qualification Test Procedure	SKA-P#1	MPI	SKA-P#2	SKA-001
DS Control System QTP – Functional	N/A			QTP @ AA0.5
DS Reflector System Alignment and Performance QTP				QTP @ AA0.5
DS EMI/RFI QTP	N/A			QTP @ AA0.5
DS Optical Pointing and Servo System Performance QTP	N/A			QTP @ AA0.5
DS RF Performance QTP	N/A		N/A	QTP @ AA0.5
DS Power Distribution QTP	N/A		N/A	QTP @ AA0.5
DS Lightning Protection QTP	N/A		N/A	QTP @ AA0.5
DS Miscellaneous Requirements QTP	N/A		N/A	QTP @ AA0.5
DS Ventilation and Thermal Load QTP	N/A		N/A	QTP @ AA0.5

- **Recently completed IDR – awaiting final panel report.**
- **CDR is planned for A.S.A.P.**
- **Evaluating risk for early procurement of Long Lead Items.**



Work Ahead

- Following the QTP's and IDR, we are focussing on:
 - **Pointing**
 - Increase Structural Stiffness
 - Improved Wind load (CFD) modelling
 - Improved Thermal modelling
 - Improved Dynamic modelling
 - **Control System Performance**
 - Closing out the Observations and Actions from IDR.



Structural Improvements

- Much work has been done to increase the stiffness of Structure to meet 2.5 Hz requirement.
- Major changes to Pedestal, Turnhead and Elevating Assy.
- Further optimisation underway for performance under wind loads.

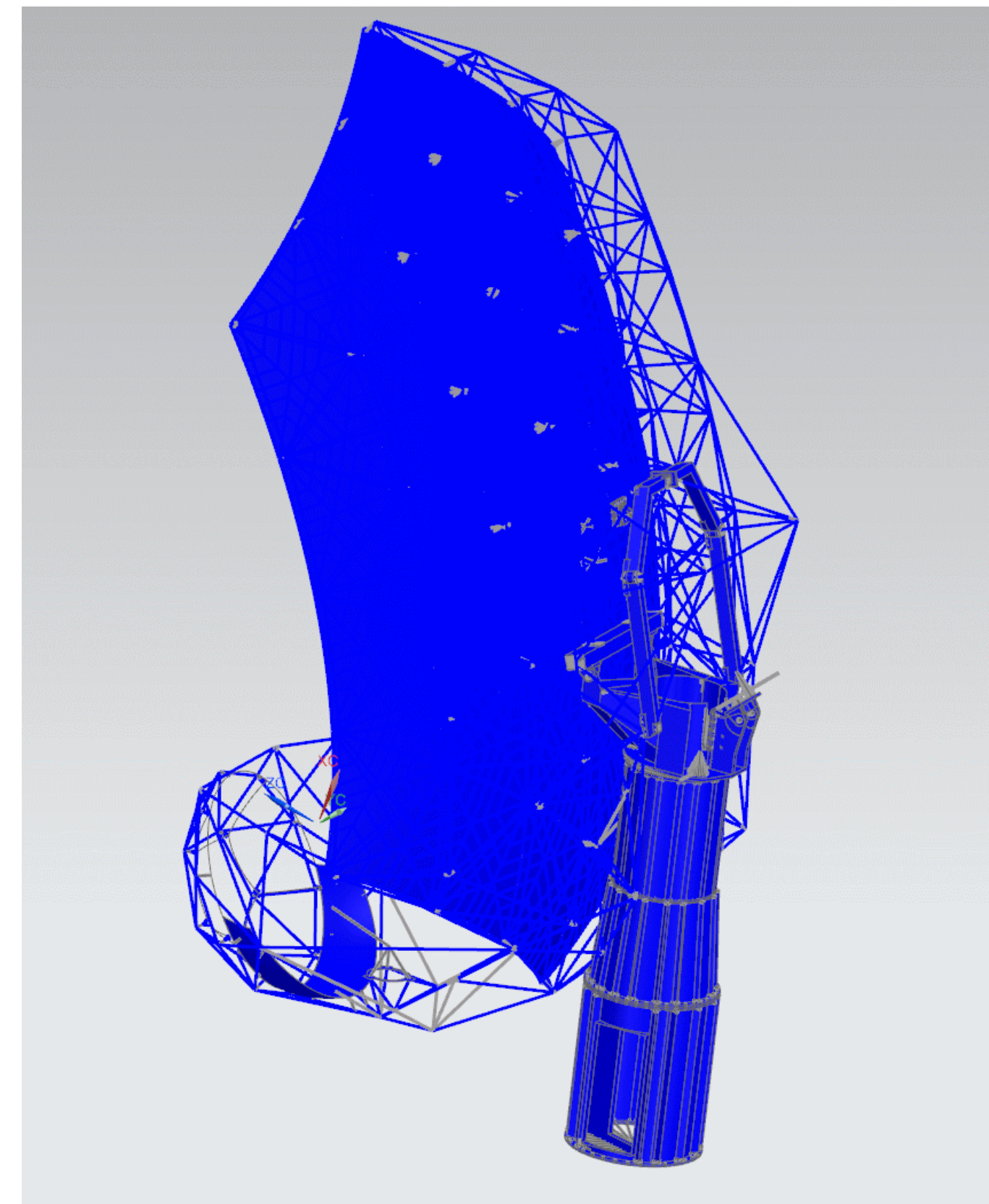
Modal Frequencies of the Prototype DS [Hz]

Elevation angle (°)	15	45	60
Longitudinal Bending Mode (Elevation)	1.95	2.09	2.11
Torsional Mode (Azimuth)	1.99	2.01	2.02

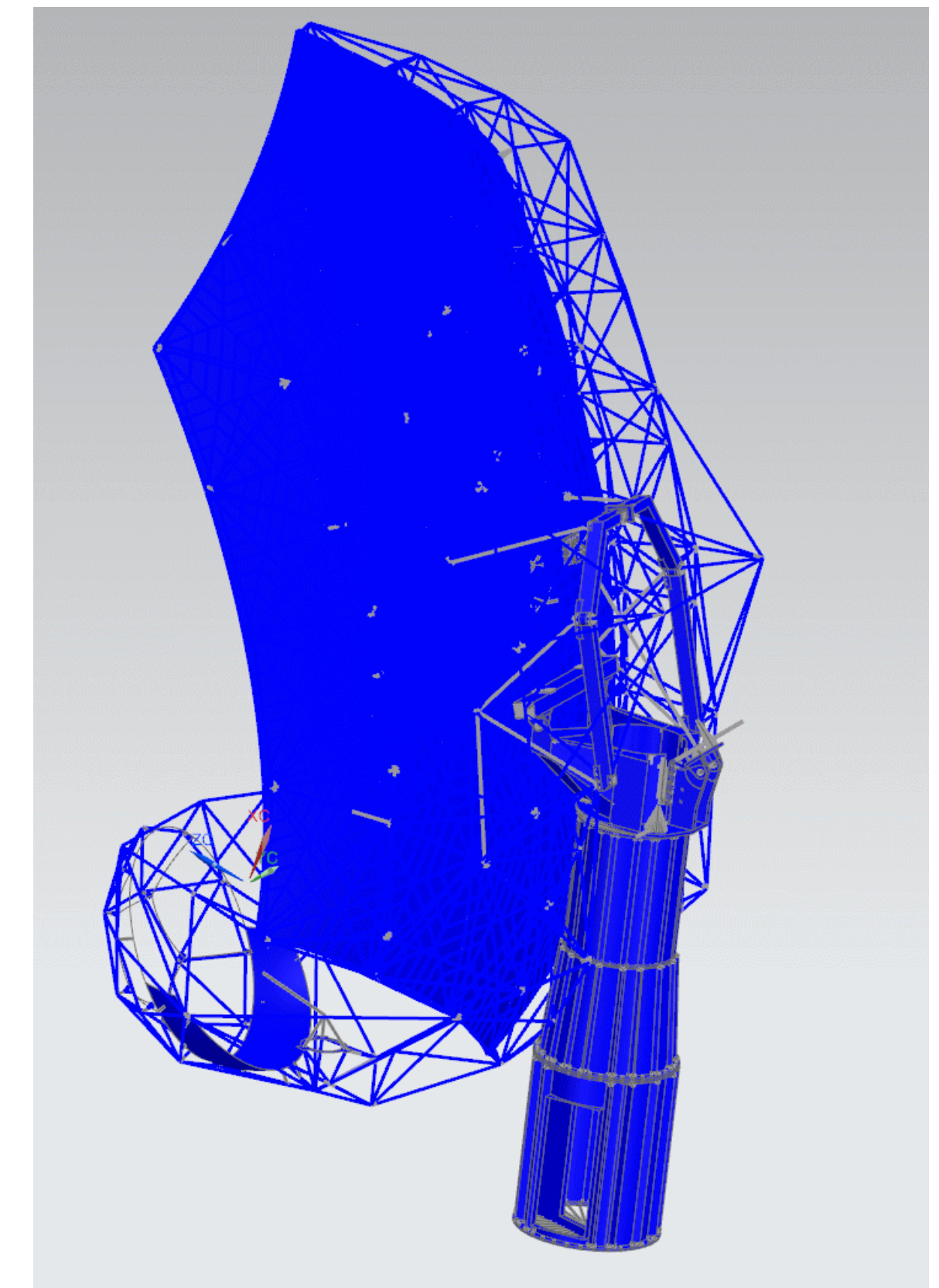
Modal Frequencies of the Improved DS [Hz]

Elevation(°)	15	30	45	60	75	90
Torsional Mode (Azimuth)	2.77	2.67	2.60	2.54	2.51	2.50
Longitudinal Bending Mode (Elevation)	2.78	2.86	2.88	2.88	2.86	2.84
Transverse Bending Mode	3.42	3.46	3.48	3.48	3.47	3.47

Torsional Mode



Longitudinal Mode



Control System

- Complete the performance verification on SKA-P#2.
- Complete the actuator Detail Design and ILS.
- Complete the EMI/RFI compliance test programme and completing any rework necessary.
- Complete the Dynamic model for SKA-001.



Summary

- We have advanced design solution.
- Just completed the IDR.
- Pointing and Control Systems is our focus.
- We are working to reaching CDR asap.



Thank you, questions?

*We recognise and acknowledge the
Indigenous peoples and cultures that have
traditionally lived on the lands on which
our facilities are located.*

SKAO

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