



Concept Design of Retractable Dome for the Proposed 2m Class National Large Solar Telescope



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ABSTRACT

The National Large Solar Telescope (NLST) is a proposed 2 m class telescope dedicated for making high resolution solar observations. A suitable site has been identified at Merak village, near Pangong Tso Lake in Ladakh state, India.

It has been observed that installing a telescope near the lake produce good images during the day time observations. At the same time the open dome conditions help to reduce the “dome seeing effect”. The absence of dome around the telescope also ensures that no temperature gradient is created around the telescope and the cool breeze without any obstruction, helps to cool the telescope structure and mirror.

In this poster, we present a number of design concepts of retractable dome for NLST, their functionality, time taken to open and close the dome, power requirement, weights etc.

Keywords: Dome Concept Design, Retractable dome, National large Solar Telescope

INTRODUCTION- AN OVERVIEW OF NLST CONFIGURATION

The NLST configuration consist of building, instrument rotator table, telescope structure and retractable dome. The brief details are shown in the below Fig. 1:

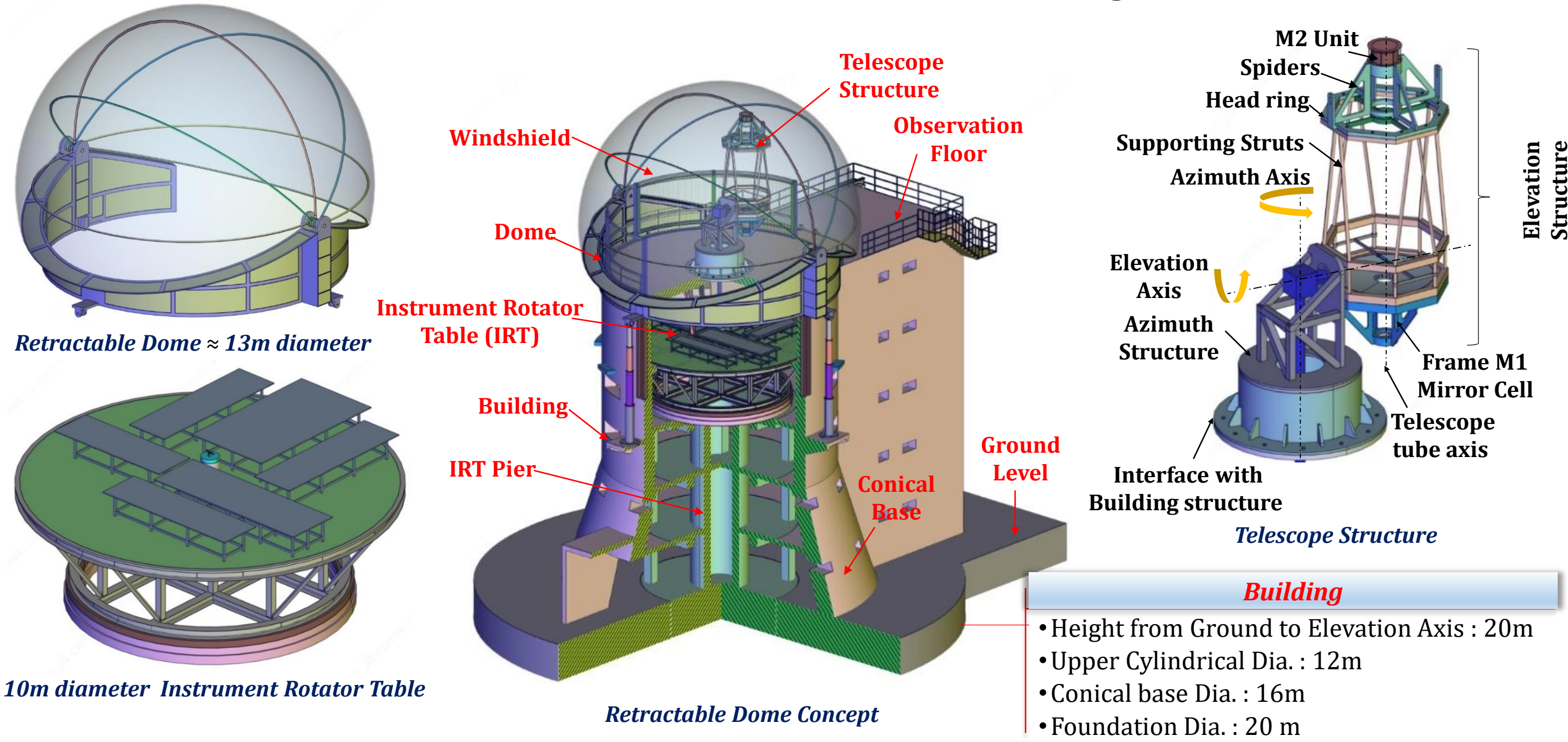


Fig. 1: An Overview of NLST Configuration

DESIGN REQUIREMENTS

The Retractable dome must fulfill the following design requirements:

1. The dome must retract below the observation floor to avoid air eddies formation.
2. The dome during the operation, should not interfere with the windshield, JIB crane, staircase & the building, telescope and IRT floor crane entry doors.
3. Retraction mechanism (Hydraulic jacks, rotating mechanism etc.) should be placed at suitable points of the building in order to transfer the loads.
4. Environment Parameters to be considered:

	Wind Velocity	Temperature Range	Relative Humidity
Performance	up to 15 m/s	- 25° C to + 25° C	5% to 90%
Functional	up to 20 m/s	- 30° C to + 30° C	5% to 95%
Survival	55 m/s	- 40° C to + 40° C	5% to 100%

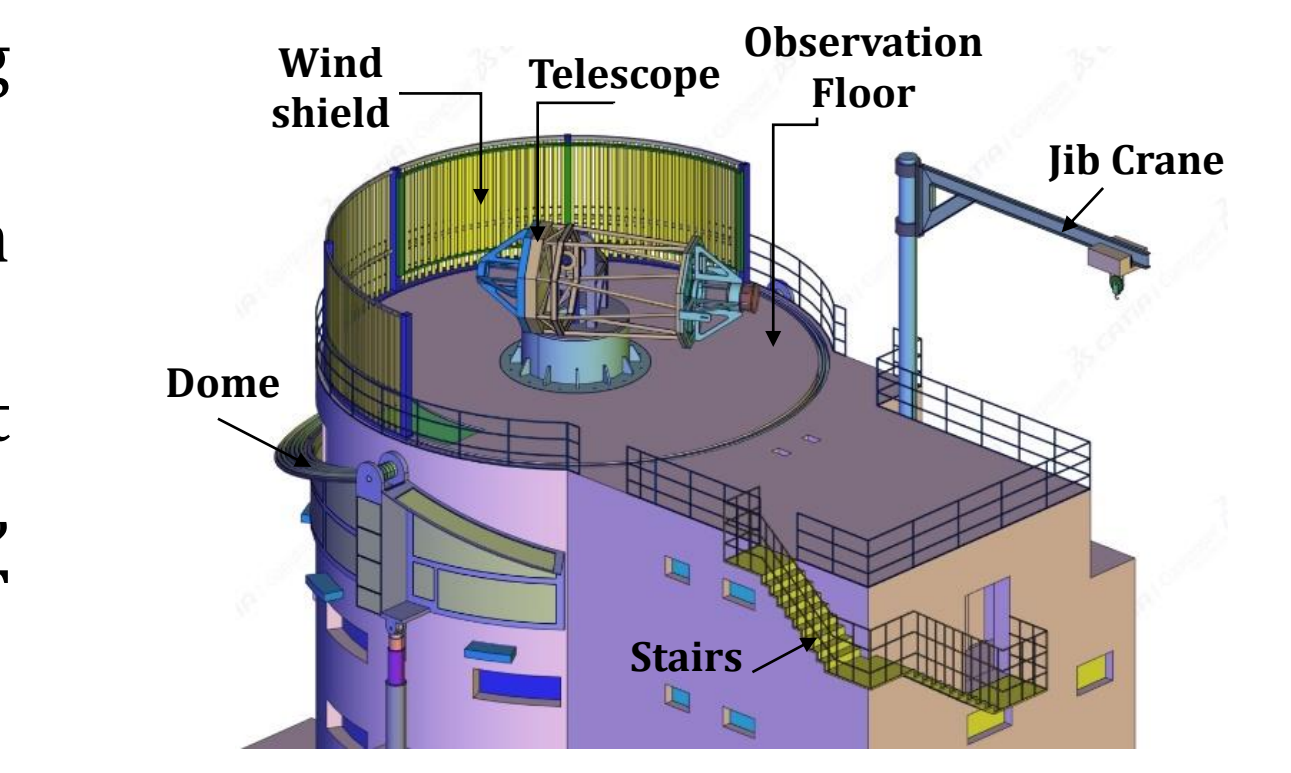


Fig. 2 : Design Requirements - NLST

Points to be considered:

- Stiff dome structure in closed condition.
- Optimized in size & weight.
- Space to access the subsystems.
- Minimum dome operation time.
- Low Power consumption for its operation.
- Mechanized operation with cutoff limits
- Minimum maintenance for the dome

DOME SIZE

The diameter of the retractable dome depends on various factors like; Telescope swing radius & Building size.

1. Telescope swing radius:

- After doing kinematic assessment, the telescope swing radius is obtained as 5.3 m and the height from the observation floor is 7.75 m.

2. Building Size

- NLST building houses 10m diameter Instrument Rotator Table (IRT).
- The size of the IRT defines the outer diameter of the cylindrical building as 12m.

Considering the telescope swing radius and building size, it is decided that the diameter of the dome should be in the range of **11m- 13.5m** and a height of minimum **8m** from the observation floor level.

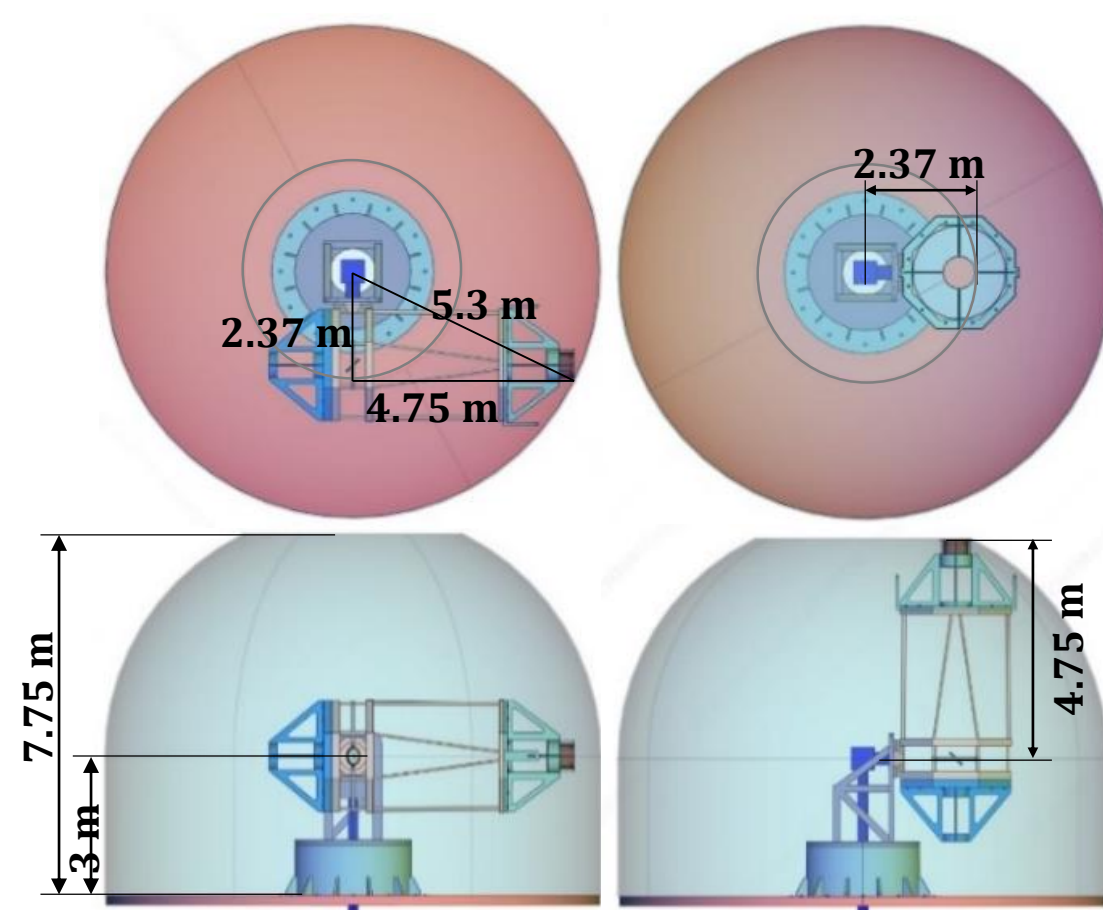


Fig. 3: Telescope Swing Radius

Motion Range	Operational	Functional
Azimuth	±270°	±270°
Elevation	+ 10° to +89.5°	-5 to +95°

RETRACTABLE DOME CONCEPTS

Different configurations were evolved for the retractable dome during the design phase and out of them, four configurations are presented in this poster.

1. Dome Concept 01:

- The dome has a number of “steel bows in octagonal shape” connected to pivots on both sides of the building.
- The bows are covered with fabric cloth and is supported over the steel structure platform that slides over the periphery of the building.

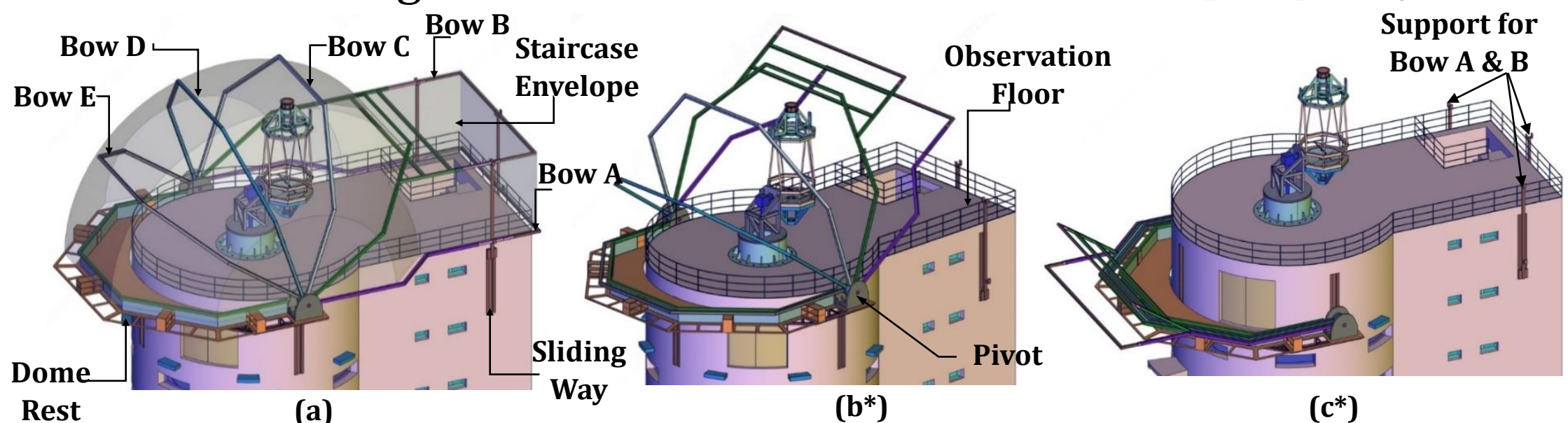


Fig. 4: Dome Concept 01 (* Fabric cloth removed for clear view)

Demerits:

- High power consumption
- Heavy structure required to provide stiffness to the dome.

Solution:

- Optimization in the larger projected area
- Provision of external staircase.

2. Dome Concept 02:

- The dome opens in two halves retracting one shell into another telescopically and slide down to the observation floor.

Demerits:

- High power consumption
- Requires water proof segment Joints and good fabrication skills.

Solution:

- Movement of Shell A,B & C in pieces and special sealing design.

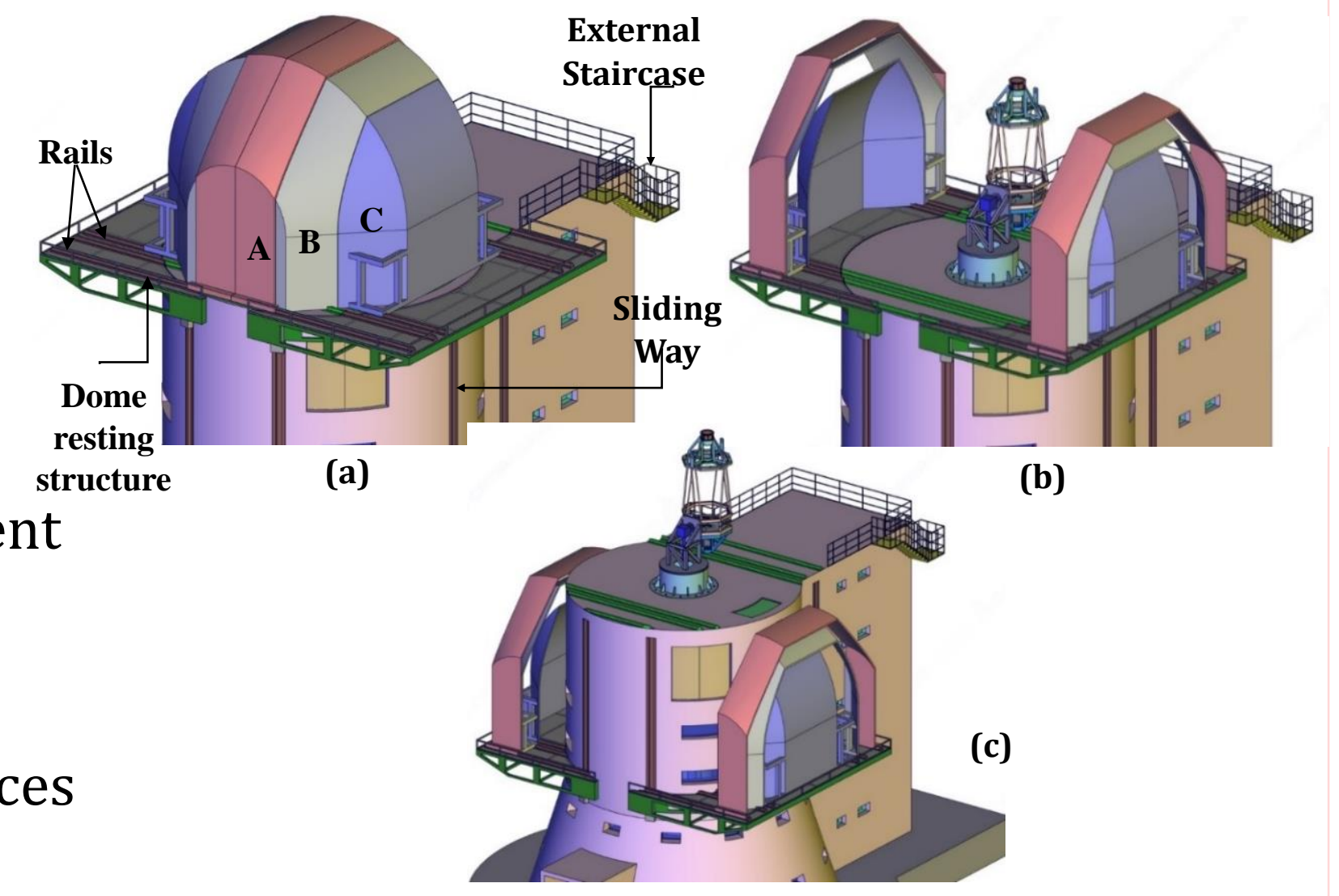


Fig. 5: Dome Concept 02

3. Dome Concept 03:

- The dome consists of steel bows with spanned fabric cloth in between.
- The two main bows are driven in opposite direction by electrically driven actuators.
- The dome is fully retractable below the observation floor.

Demerits:

- Requires three independent mechanism for its operation.

Solution:

- Reduce one motion of sequence i.e. sliding on observation floor.

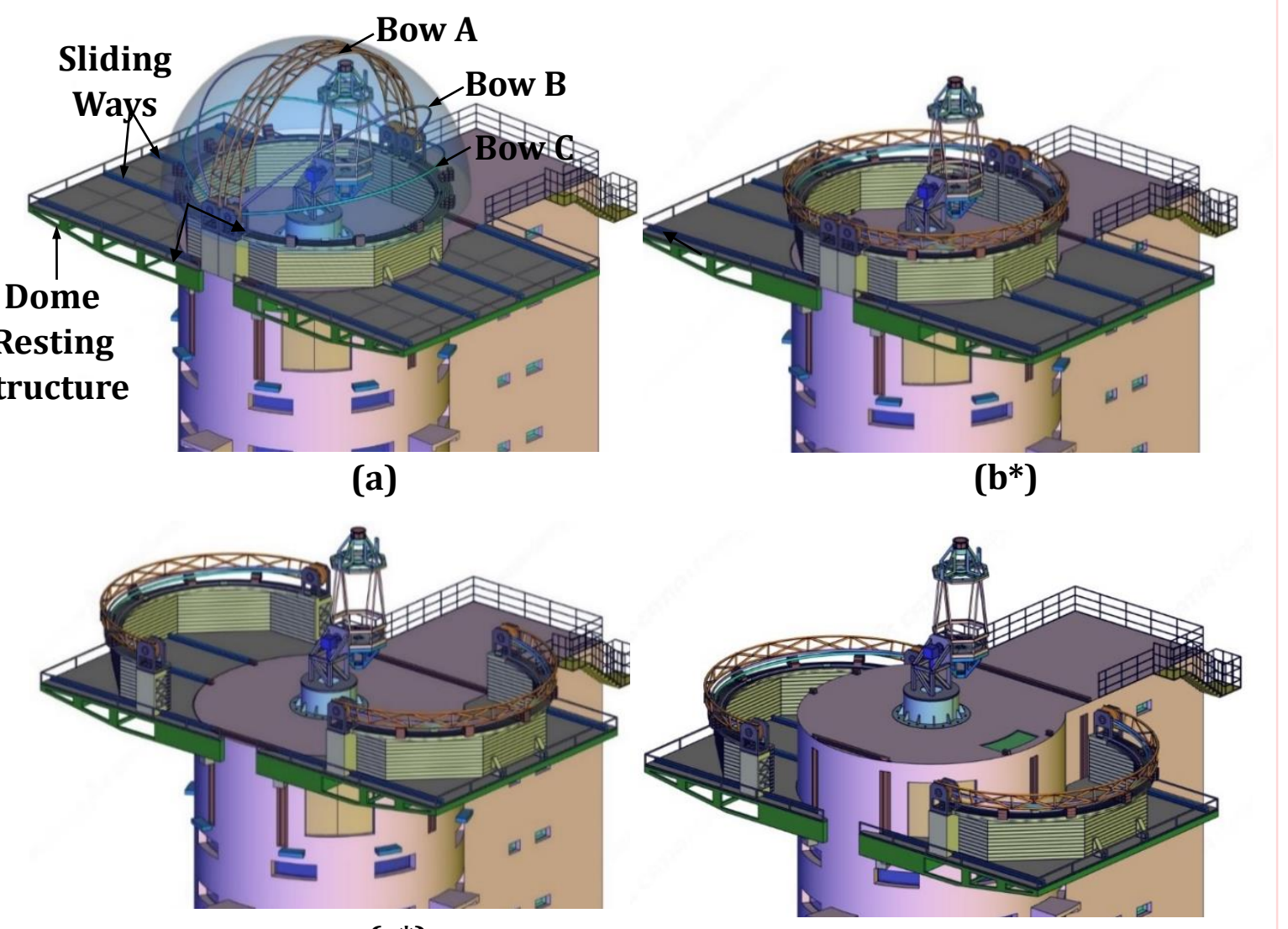


Fig. 6: Dome Concept-03 (*Fabric cloth removed for clear view)

4. Dome Concept 04:

- The dome has a number of “steel bows in circular shape covered with fabric cloth” which are connected to pivots on both side.
- The axis of bows rotation is at the same height of the elevation axis from the observation floor. The movement of bows is segment wise in one direction.

Merits:

- Low power consumption & weight,
- Less time requirement for operation
- Requires two independent mechanism.

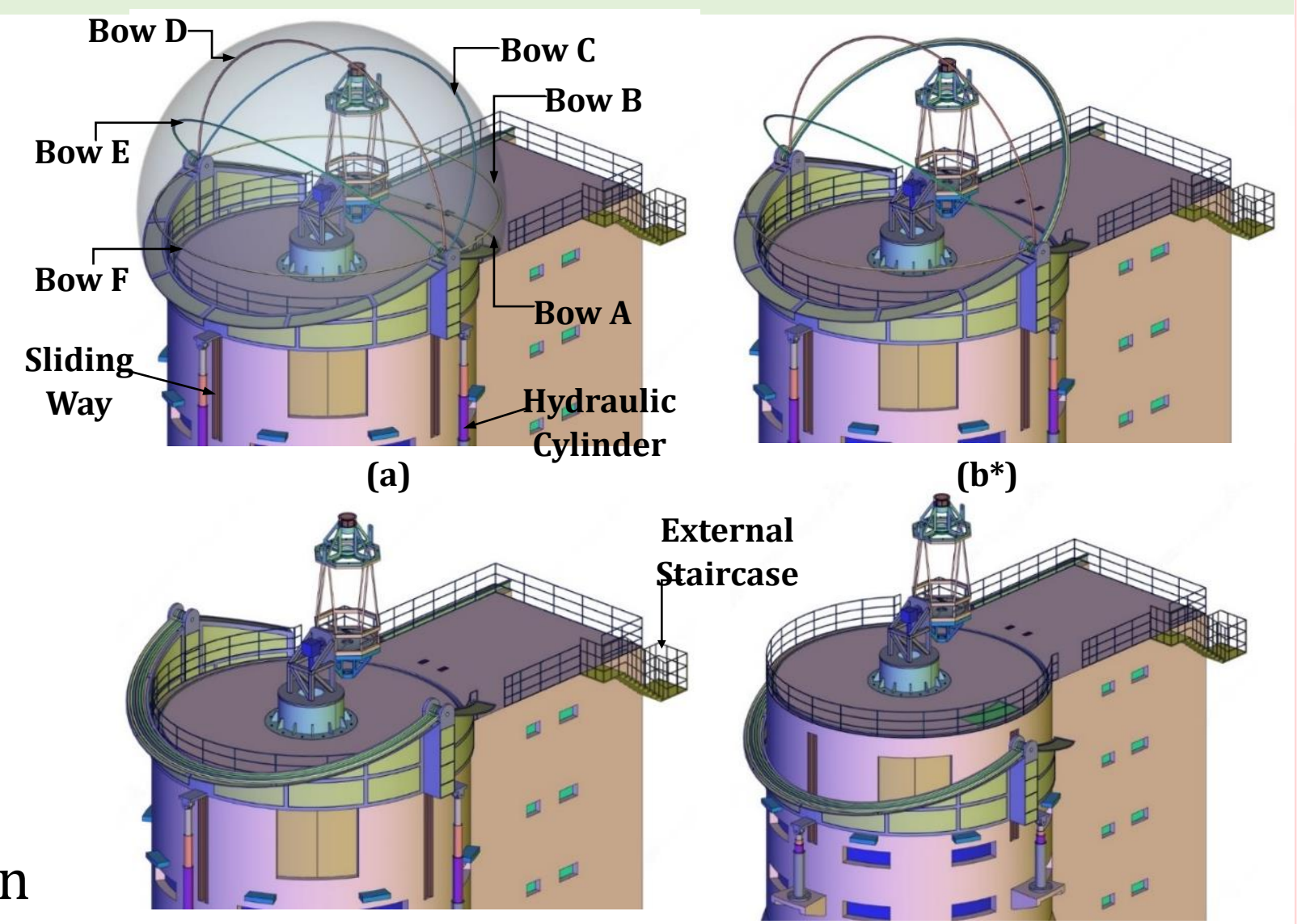


Fig. 7: Dome Concept-04 (*Fabric cloth removed for clear view)

DOME COMPARISON SUMMARY

Con. No.	Average Diameter (m)	Power Requirement (KW) and operation time (Sec)						Max. Power at a time	Opening / closing time (Sec.)	Mass (ton)
		Rotation		Sliding on observation floor		Sliding over Building periphery				
		Power	Time	Power	Time	Power	Time			
1	13.5	53.86	100	NA	NA	11.17	80	53.86	180	22.8
2	11	NA	NA	64.42	48	44.08	150	64.42	198	79
3	11.31	13.41	48	25.85	60	17.3	80	25.85	188	35.3
4	13	9.92	96	NA	NA	9.36	80	9.92	176	19.1

Based on the dome comparison summary, retractable dome concept 4 has been proposed for the NLST as this concept has minimum weight, less closing and opening time, lowest power consumption easy in operation and simpler mechanism.

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