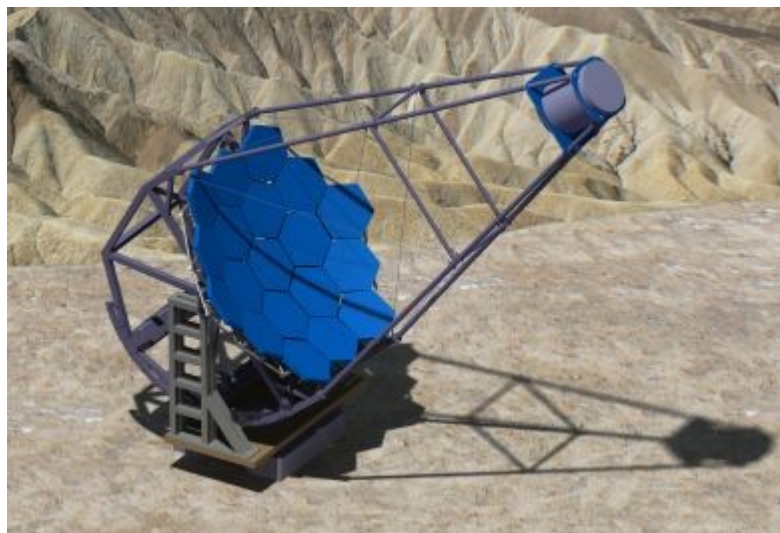




# Small Size Telescope – IFJ PAN Complete Proposal



***J.Kotula, J.Michalowski, M.Sienkiewicz, M.Stodulski,  
J.Swierblewski, P.Ziolkowski, P.Zychowski***



***presented by P.Ziolkowski***

Institute of Nuclear Physics Polish Academy of Sciences (IFJ PAN)  
Krakow, Poland

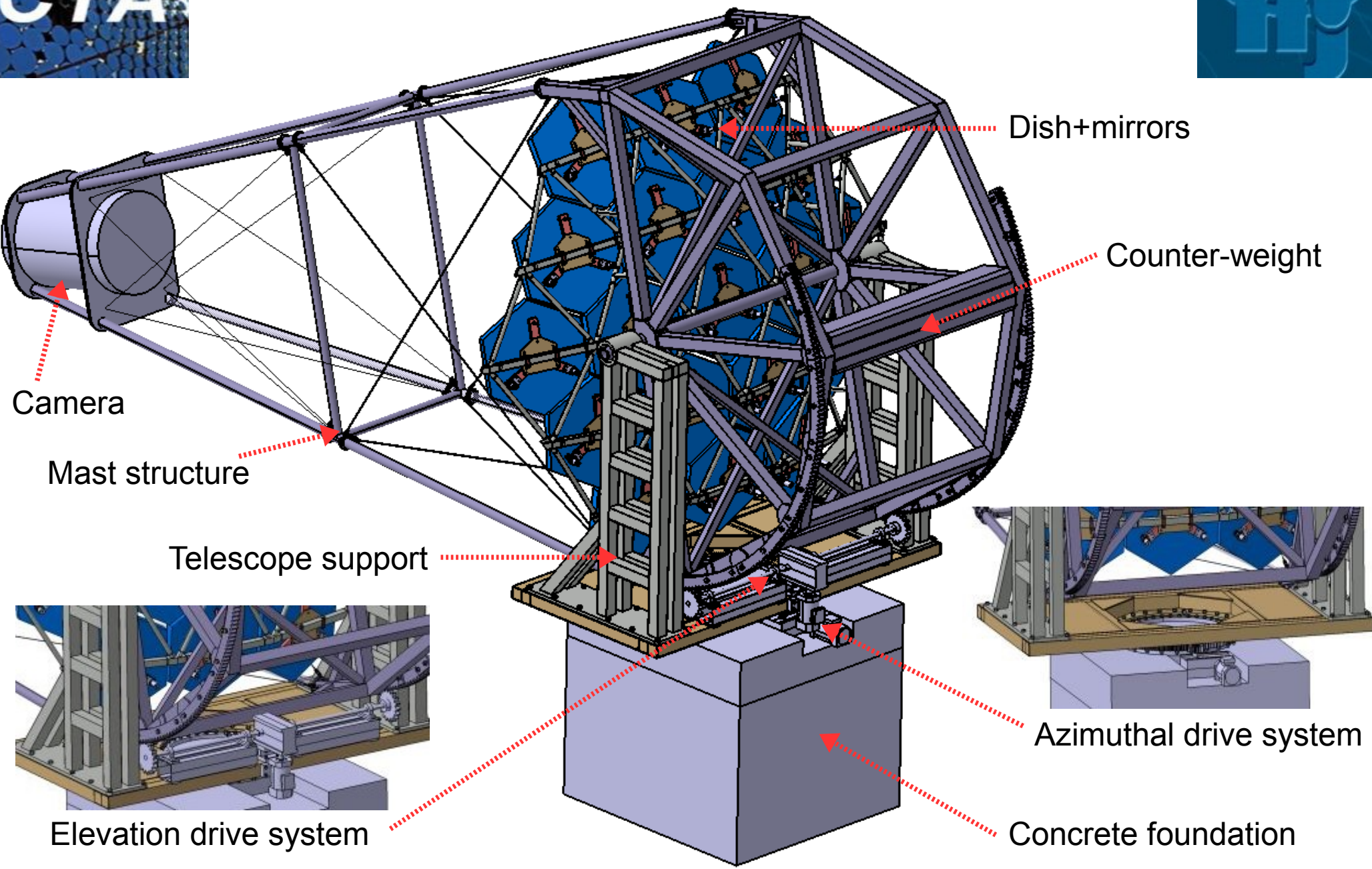


## Specs for the Small Size Telescope

- $f/D > 1.5$
- Camera weight 1.6 t
- Field of view  $8^\circ$
- Lowest Eigenfrequency  $> 3$  Hz
- Dish contribution to PSF  $< 1$  mrad
- Camera displacement 0.5 PMT pixel
- Any point in the sky within one minute
- Low price & ease of assembly on site



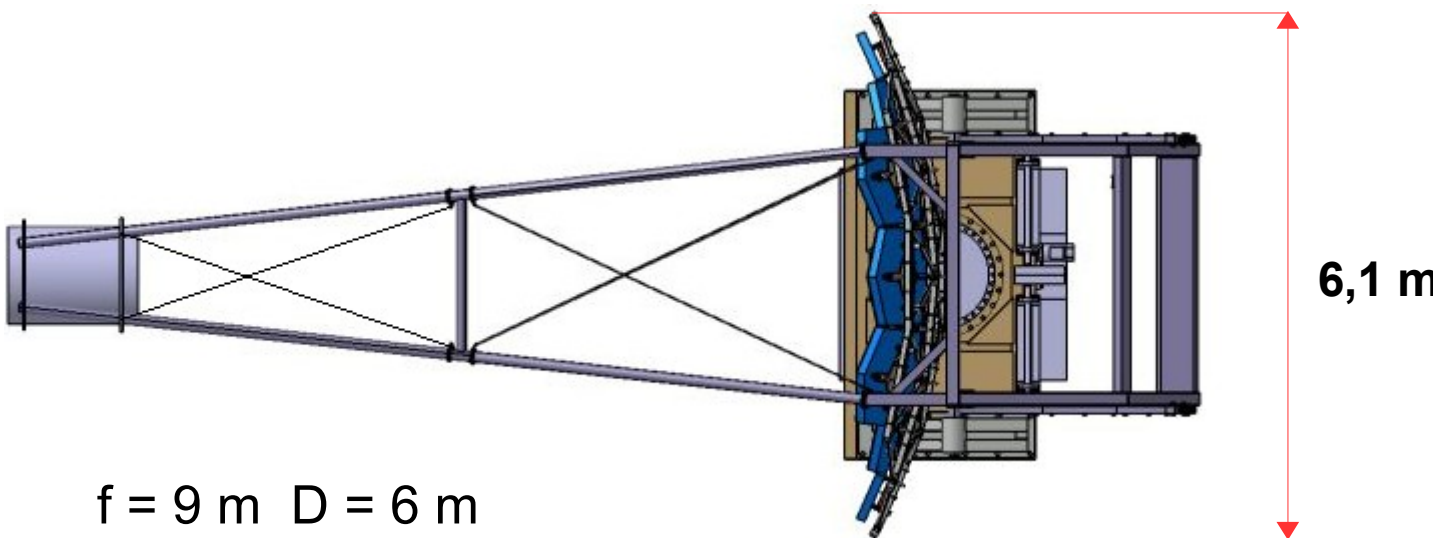
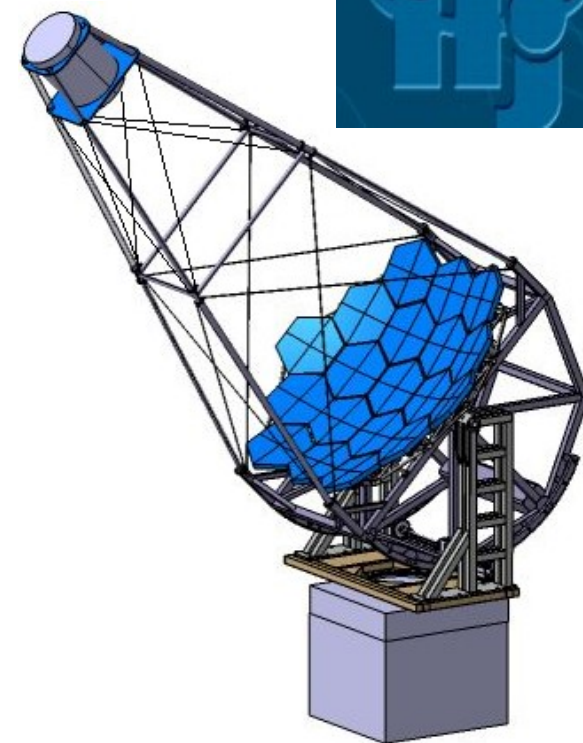
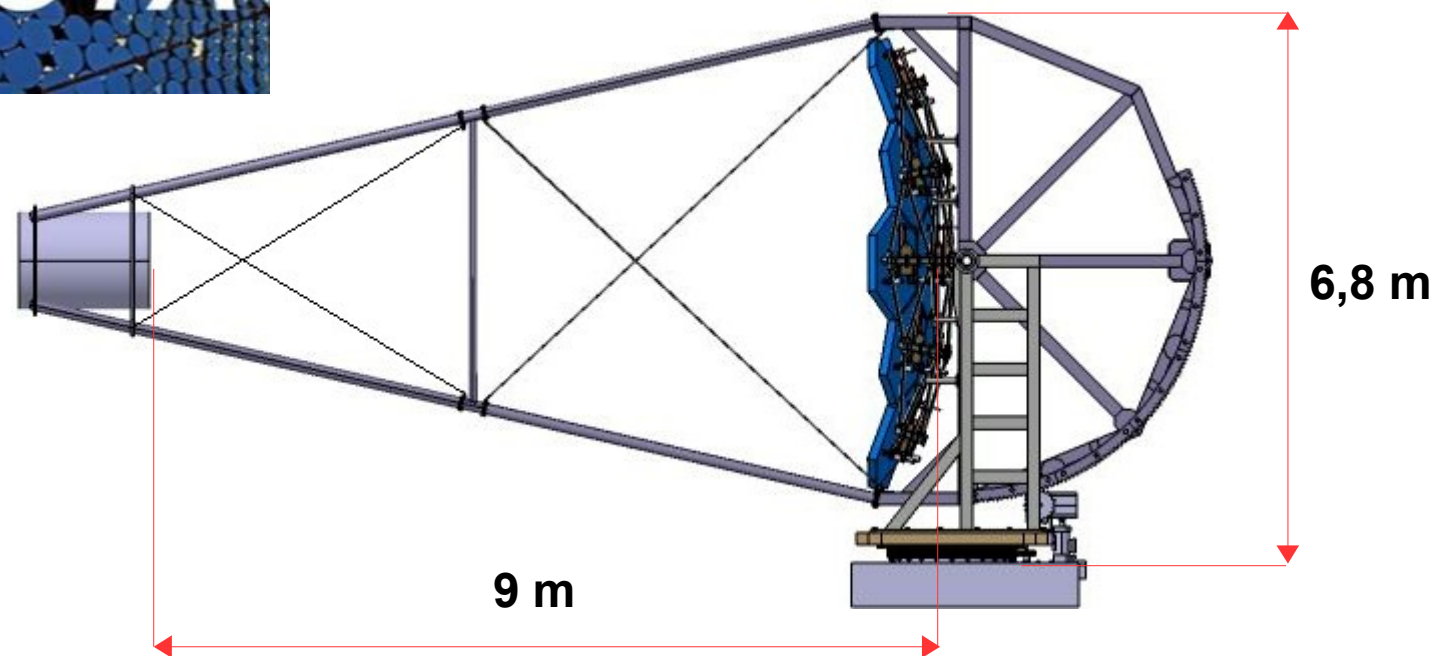
# Telescope Structure







# Telescope Structure – Chosen Parameters

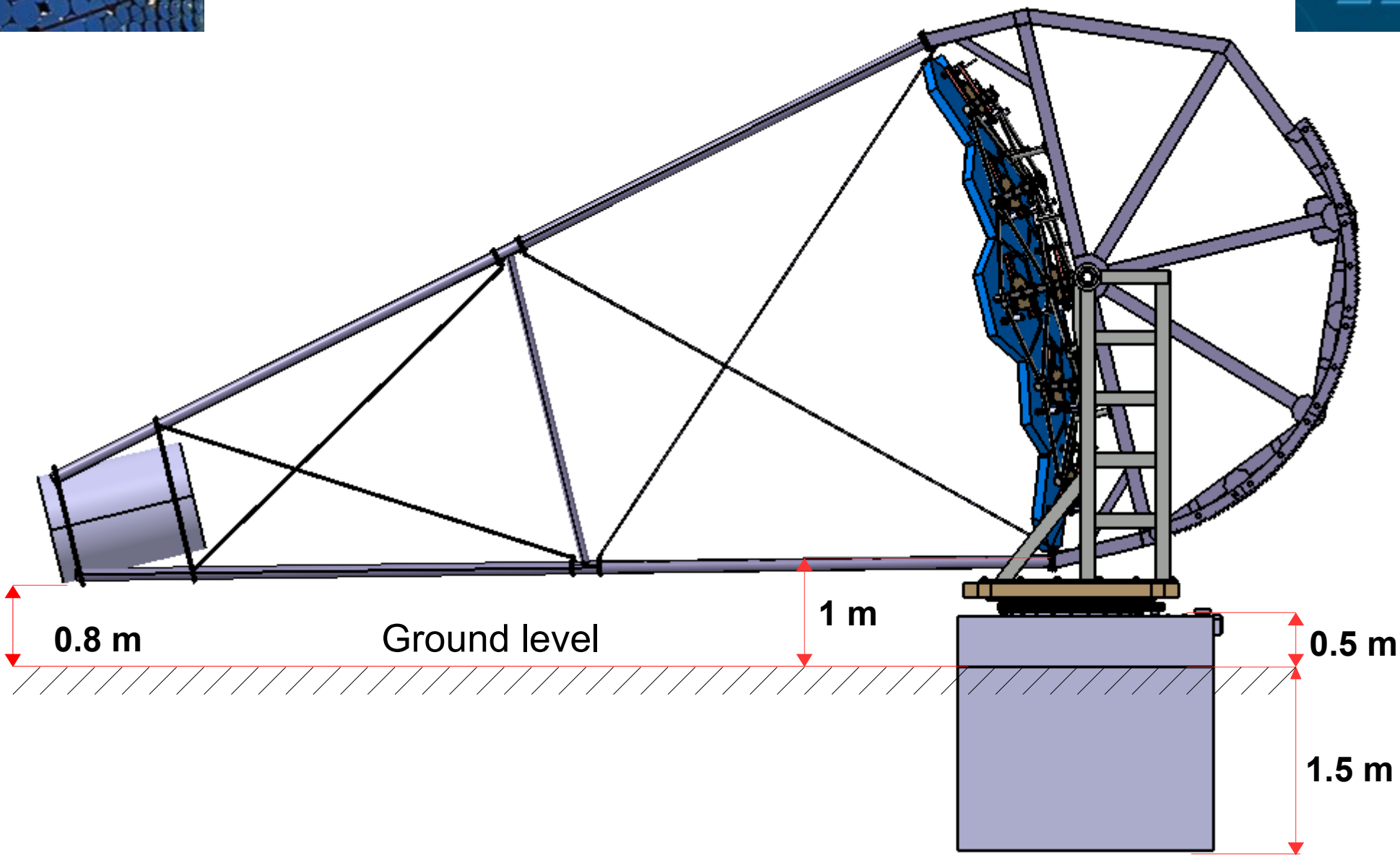


Weight = 18 tons:

- Mast structure – 4,5 t
- Telescope support – 3.5 t
- Counter-weight – 5 t
- Dish+mirrors – 1.2 t
- Drive systems – 2t
- Camera – 1,6 t



# Telescope at Parking Position

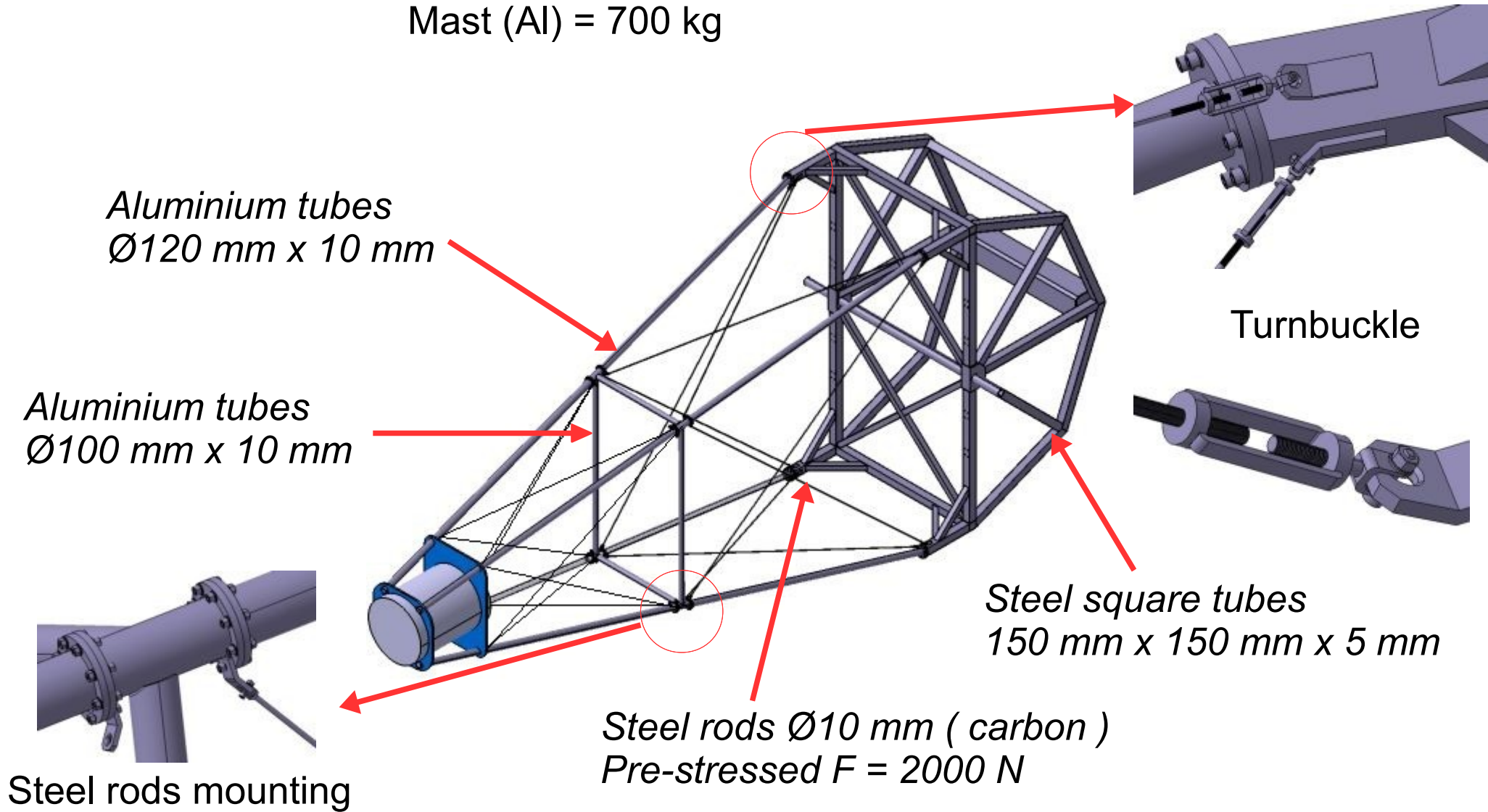




# Mast Structure - Design

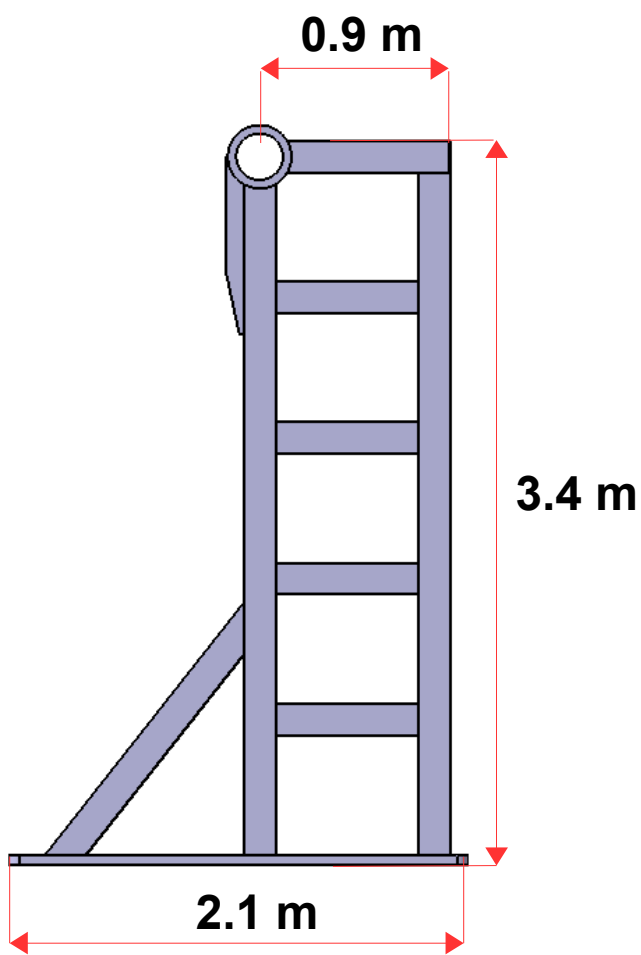


Dish Support = 3800 kg  
Mast (Al) = 700 kg

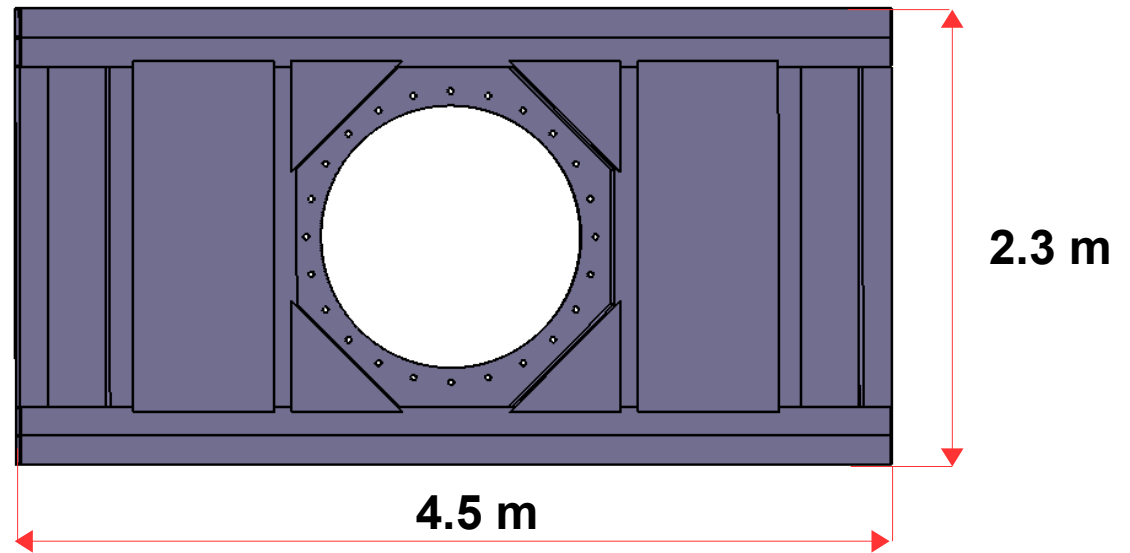
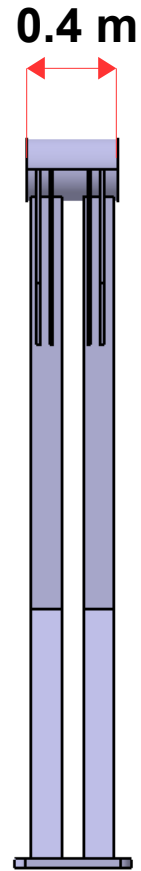




# Telescope Support - Design



**Column**

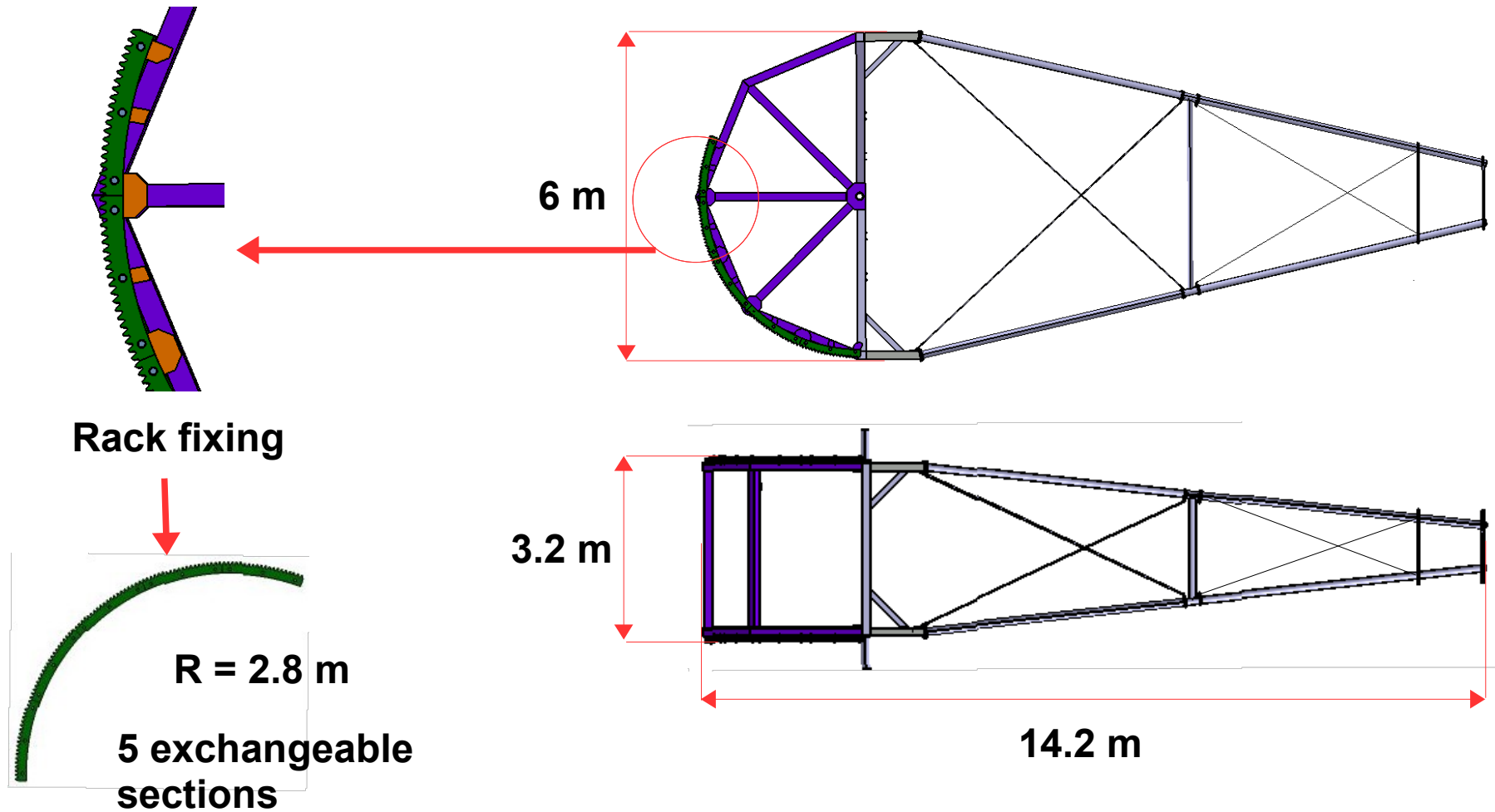


**Assembly plate**





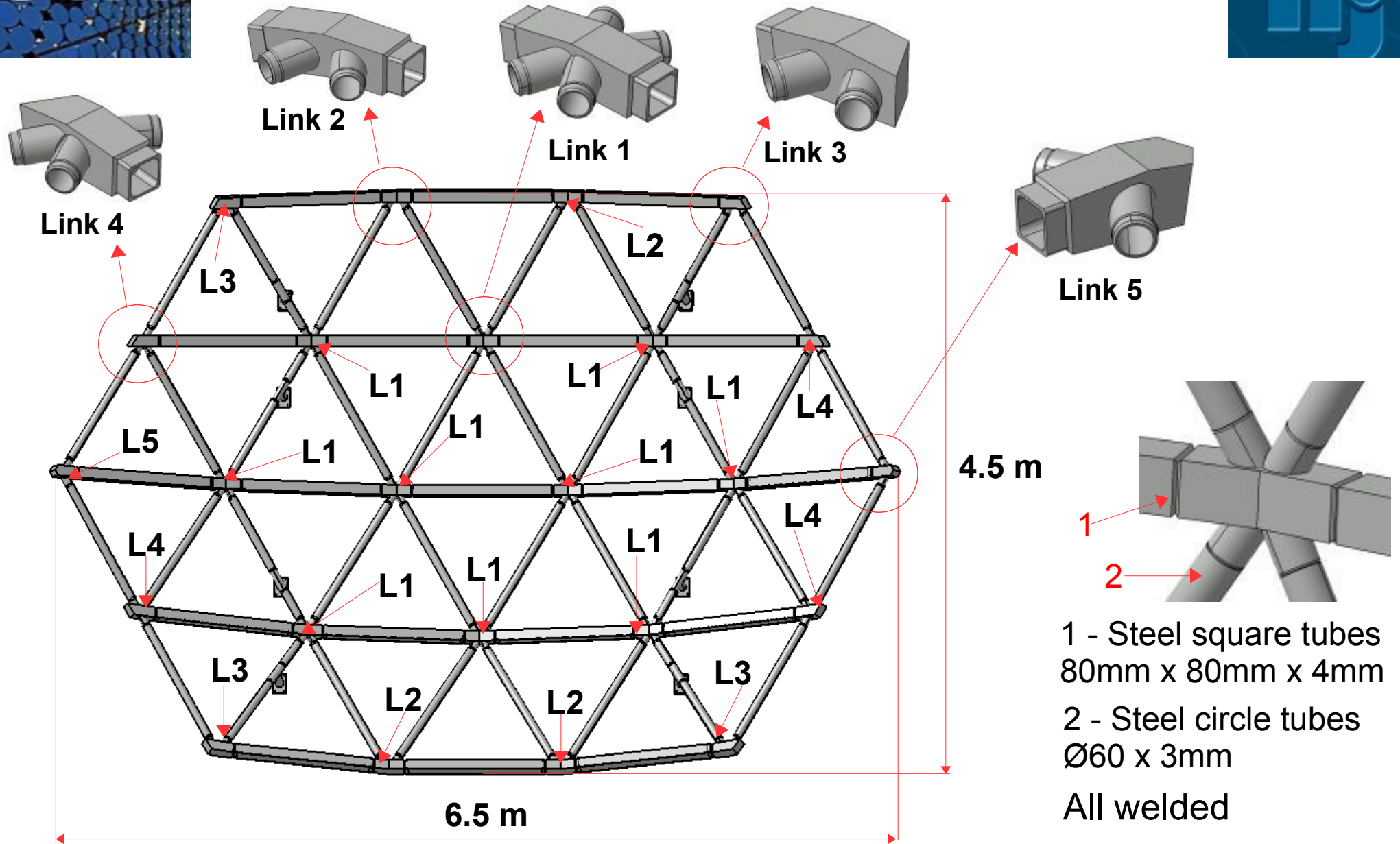
# Mast Structure – Chosen Dimensions



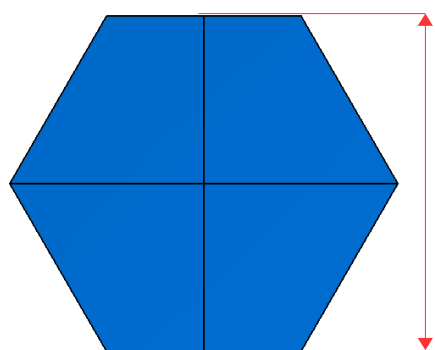




# Dish - Design

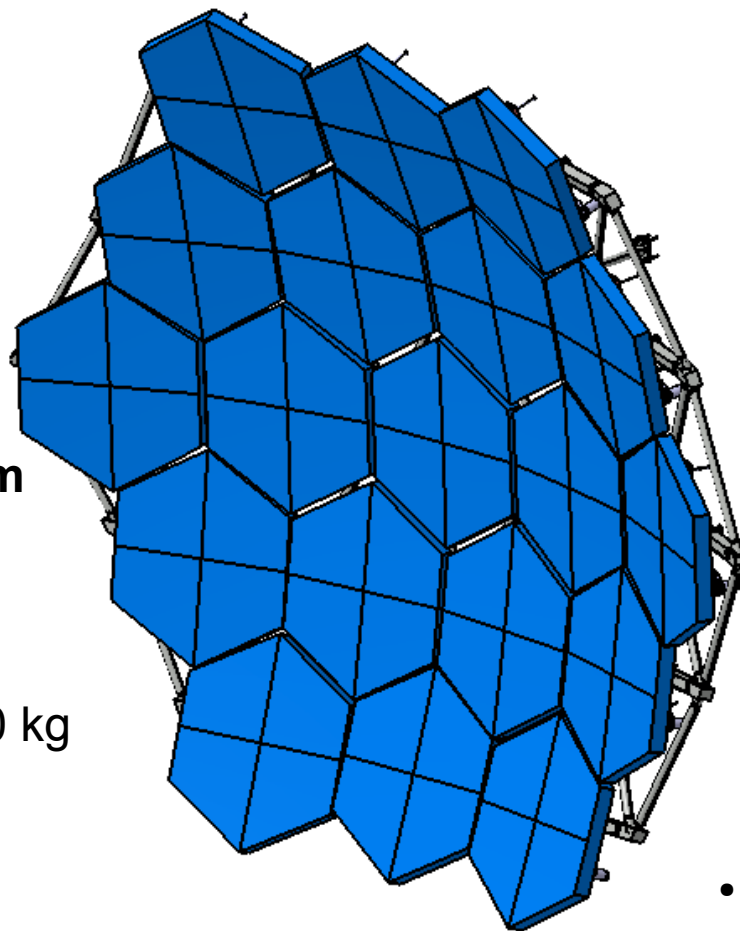


# Mirrors Layout



1.2 m

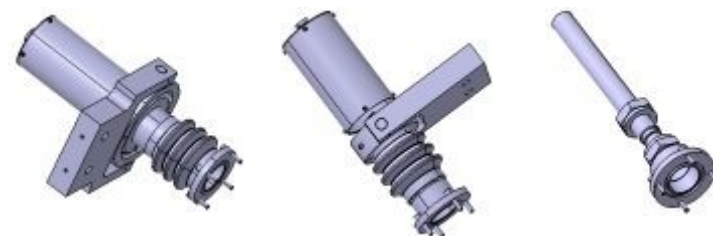
Singiel mirror weight – 20 kg



*19 spherical mirrors arranged on the steel dish*

Number of connection points:

- Dish to camera structure - 8
- Mirror to dish – 3 ( AMC )



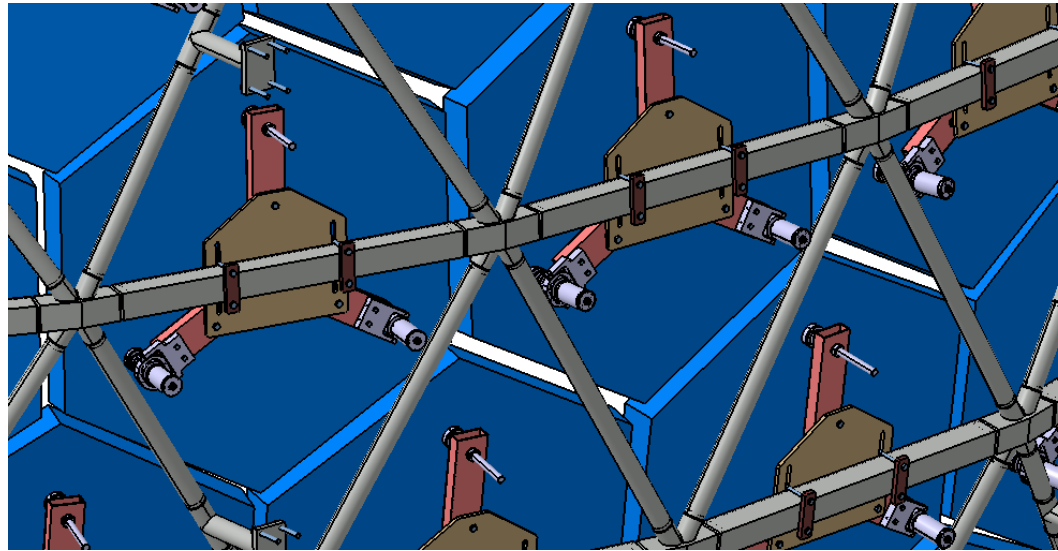
AMC from Zurich

Weights:

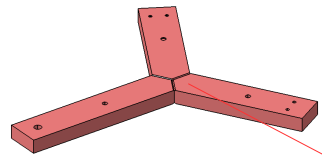
- Dish ( AMC not included ) - 800 kg
- Mirrors - 400 kg



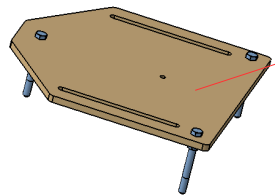
# Mirrors Mounts & Adjustment



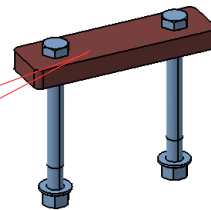
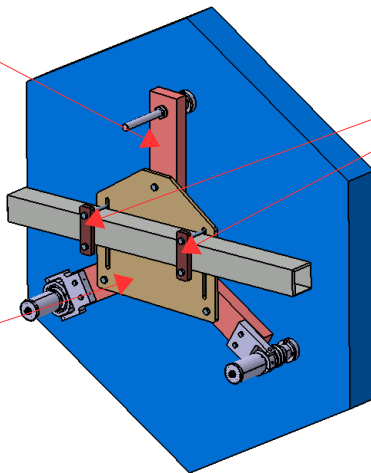
Back view of the mirror mounts



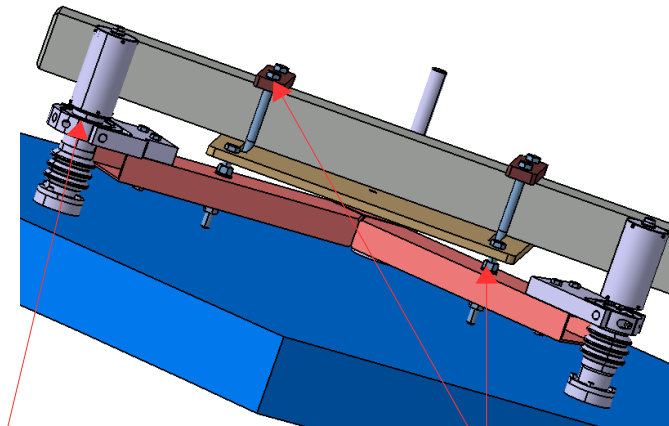
Mounting plate 2



Mounting plate 1



Mounting buckle



Fine adjustment

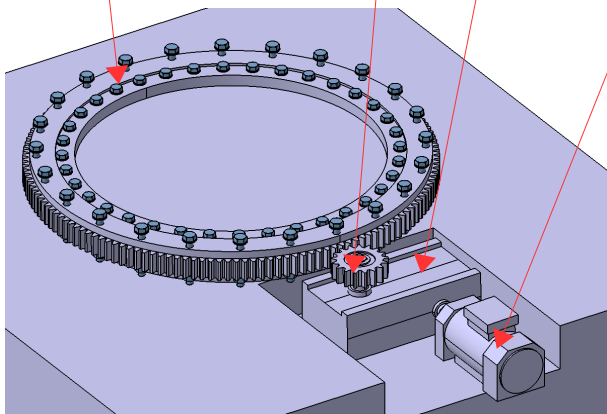
Rough adjustment

Roller Bearing  $\varnothing$  1.6 m

Primary gear

Gear box

DC Motor



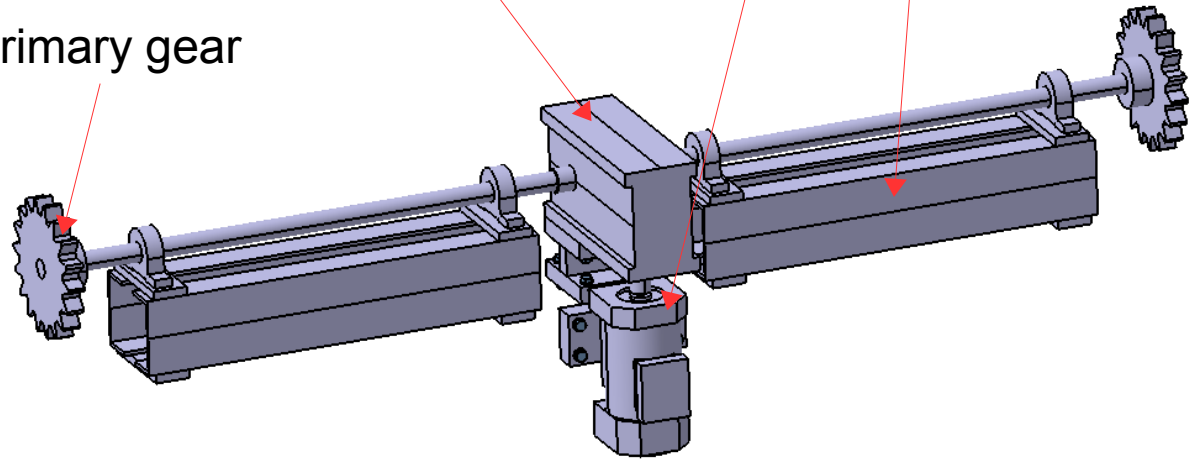
Azimuthal drive system

Mounting structure

DC Motor

Gear box

Primary gear



Elevation drive system



# Azimuthal Drive System (parameters)



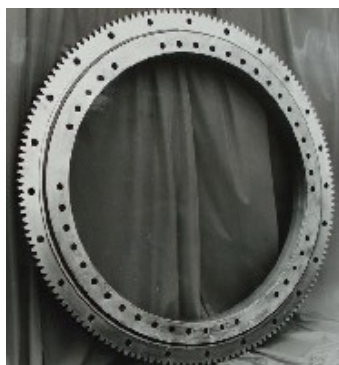
DC Motor

- DC Motor (EM Brno, Czech Republic) 9 kW
- Gear box (EXW TRAMEC Poland) 1:200
- Azimuthal roller bearing (ZAFAMA) OD = 1600 mm



Gear box

- Moment of inertia (telescope structure) 377800 kg\*m<sup>2</sup>
- Acceleration 1 deg/s<sup>2</sup>
- Friction Torque of Bearing 5600 Nm
- Total torque 24000 Nm



Azimuthal Roller Bearing  $\varnothing 1.6 m$

Delivery time 1 month (each component)

# Elevation Drive System (parameters)

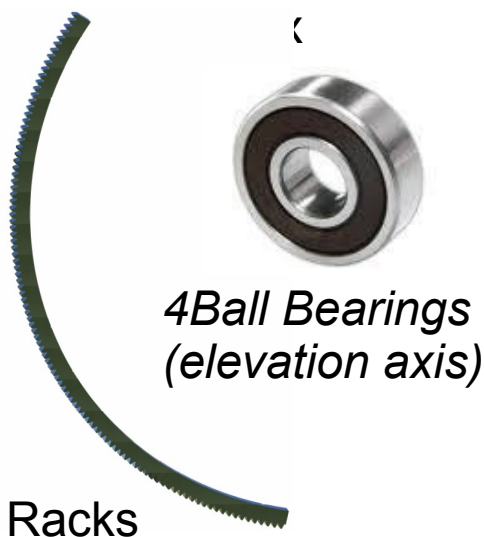


*DC Motor*



- DC Motor (EM Brno, Czech Republic)
- Gear box (EXW TRAMEC Poland)
- 4 Elevation ball bearings
- 2 Racksmax (PIVEXIN TECHNOLOGY)

9 kW  
 1:200  
 ID = 150 mm  
 R= 2800 mm



*4Ball Bearings  
 (elevation axis)*

*2 Racks*

- Moment of inertia (telescope structure)
- Acceleration
- Total torque

240000 kg\*m<sup>2</sup>  
 0.5 deg/s<sup>2</sup>  
 9000 Nm

Delivery time 1 month (each component)

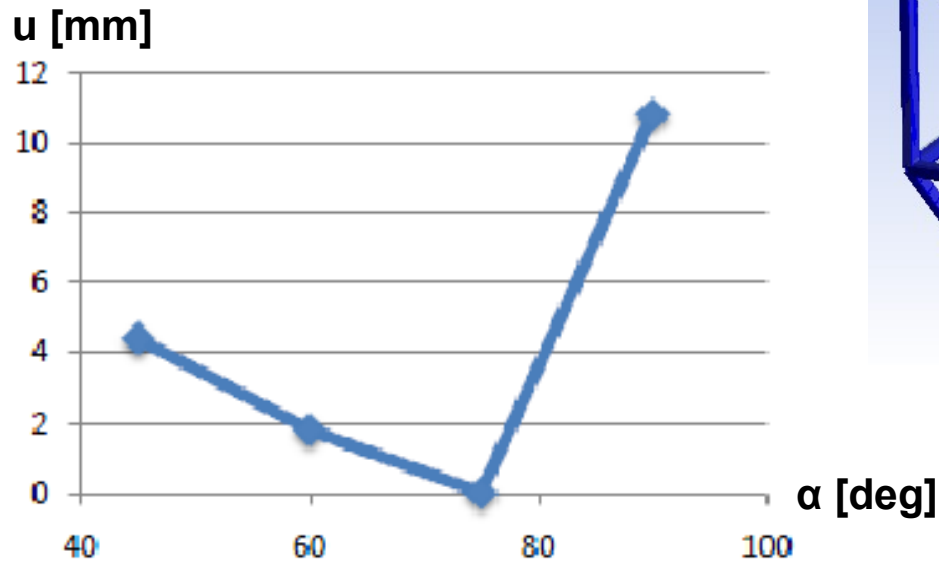


# Mast Deformation (static)

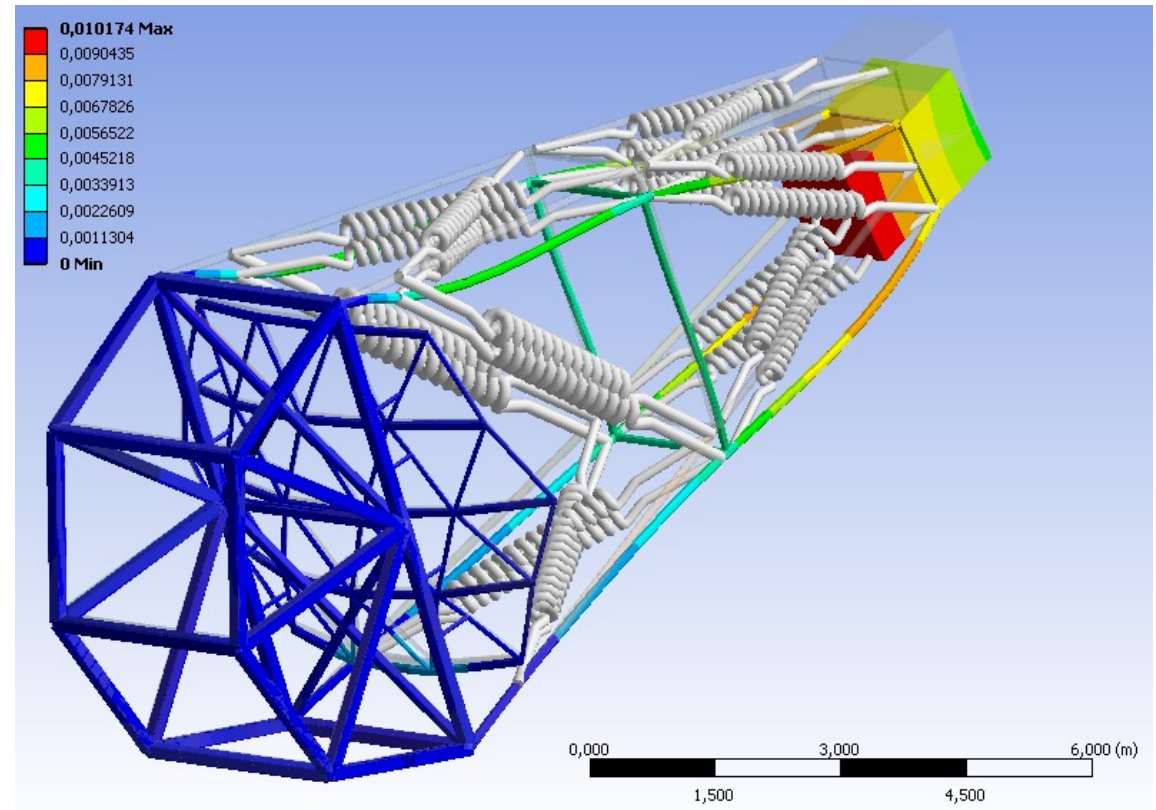


Telescope position [deg]	Mast Deflection [mm]
45	6.9 (4.4)
60	9.5 (1.8)
<b>75</b>	<b>11.3 (0)</b>
90	0.5 (10.8)

Reference point



Deflection in respect of reference point



Deformation at 75°



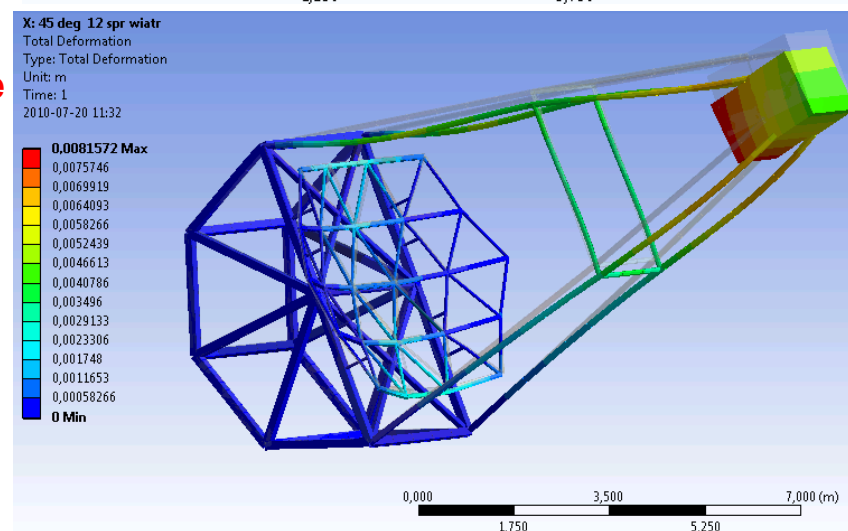
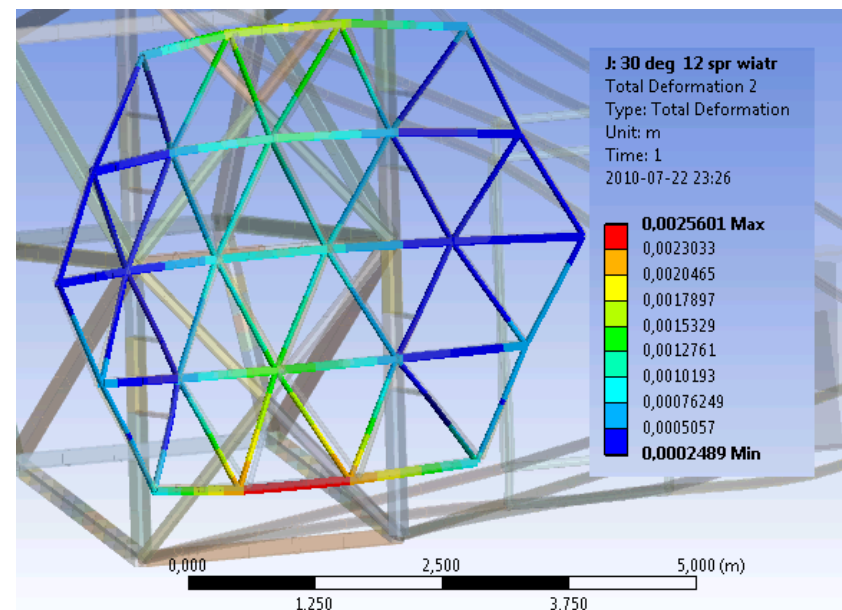
# Mast deformation (static+wind 50 km/h)



- Position of the camera with respect to a dish between 45 deg and 90 deg change < 7 mm (Reference point 75 deg)
- Dish deformation between 45 deg and 90 deg  $\leq 1$  mm (Reference point 75 deg)

Telescope position [deg]	Mast Deflection [mm]	Dish Deformation [mm]
45	8.2 (6.7)	2.6 (0.1)
60	5.3 (3.8)	2.5 (1)
<b>75</b>	<b>1.5 (0)</b>	<b>2.5 (0)</b>
90	0.2 (1.3)	1.5 (1)

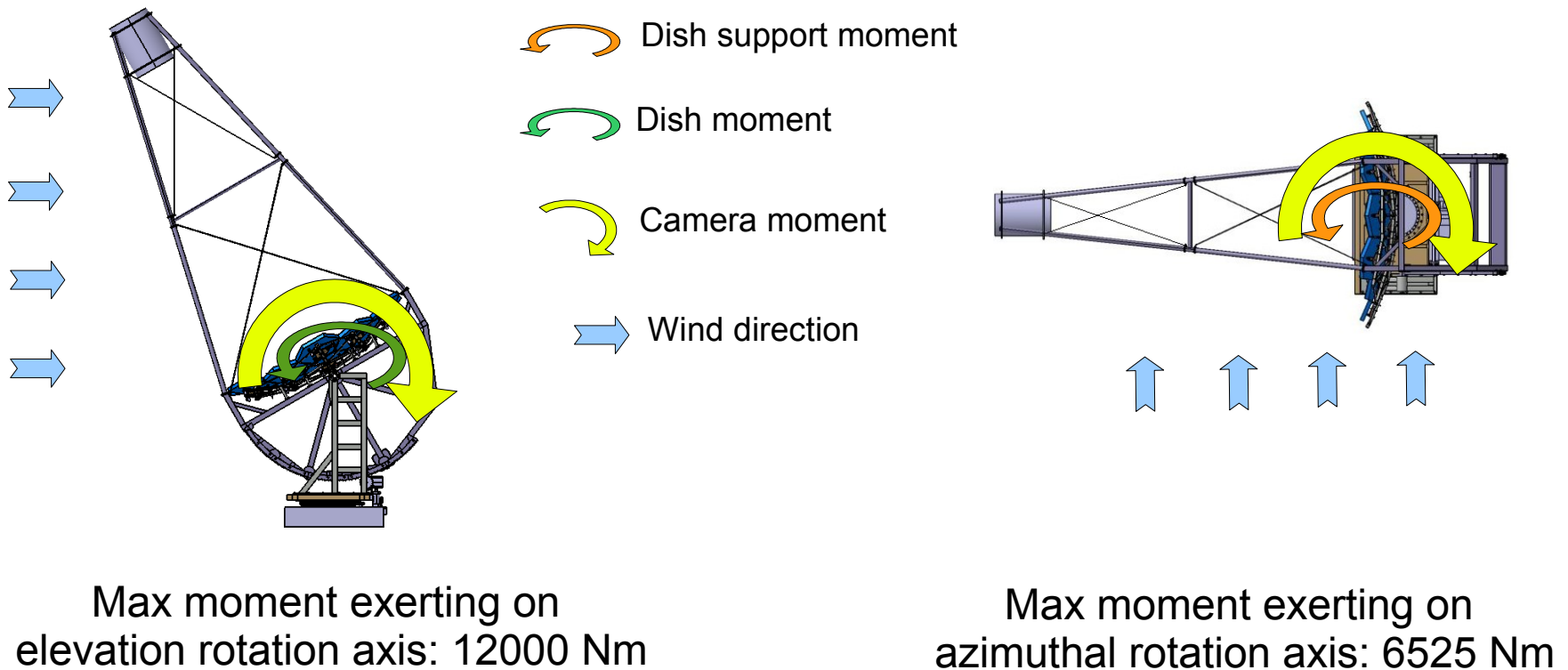
Reference point





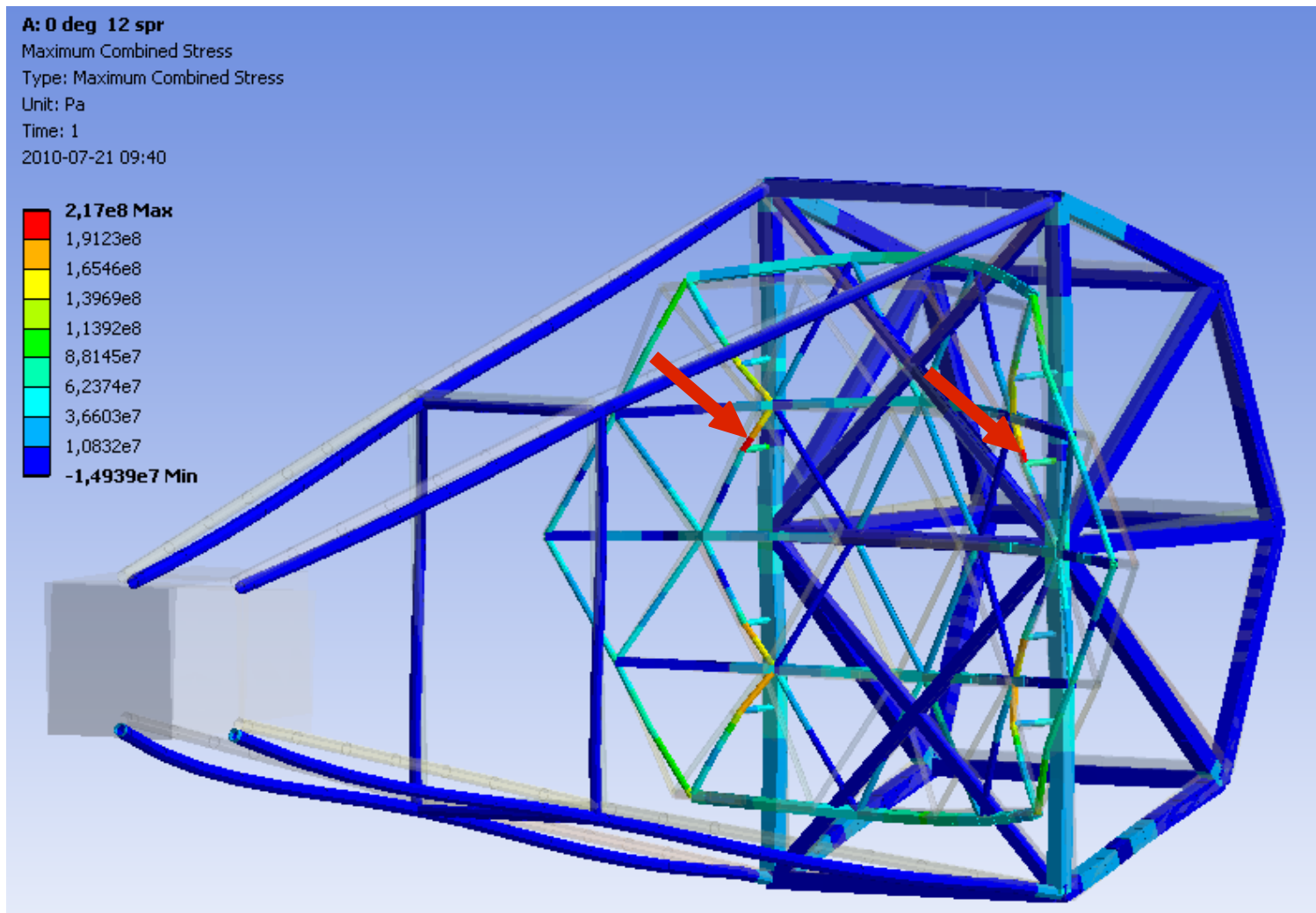


# Maximum moment (wind 100 km/h) – elevation and azimuthal axis



Results were taken into consideration while selecting drive systems

# Equivalent stress at 200 km/h – Parking Position



Maximum Stress 217 MPa ( i s OK )



# Prototype Cost Estimates



	Groups of costs	Deatails	Comments	Costs (€)	Industry confirmation
1	Structure	Camera structure + dish (no CW)	Welding and CNC Technology included	70 000	yes
2	Drive systems	2 Racks	32 500 (1 rack - 5 sections)	65 000	yes
		Elevation drive	Gear box+motor +break system	10 500	yes
		Azimuthal drive	Gear box+motor +break system	10 500	yes
		1 Azimuthal-Bearing	D=1600 mm	8 000	yes
3	Transport	Krakow-Namibia, 50t, 3 containers 2.3x2.6x12m		5 000	yes
4	Foundation	Hole digging+concrete		5 000	Estimate only
5	Assembly on site	Man-power	1000 work-hours	20 000	Estimate only
		Equipment/tools rental etc.	Crane, etc.	10 000	Estimate only
			<b>Total</b>	<b>199 000</b>	