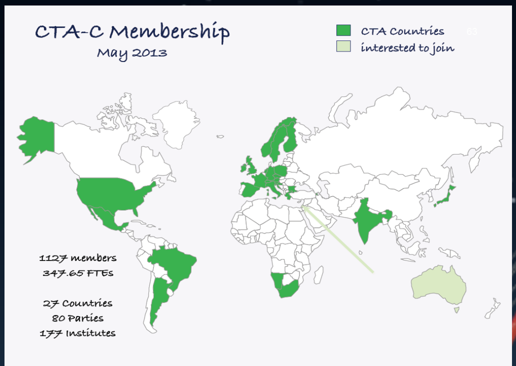
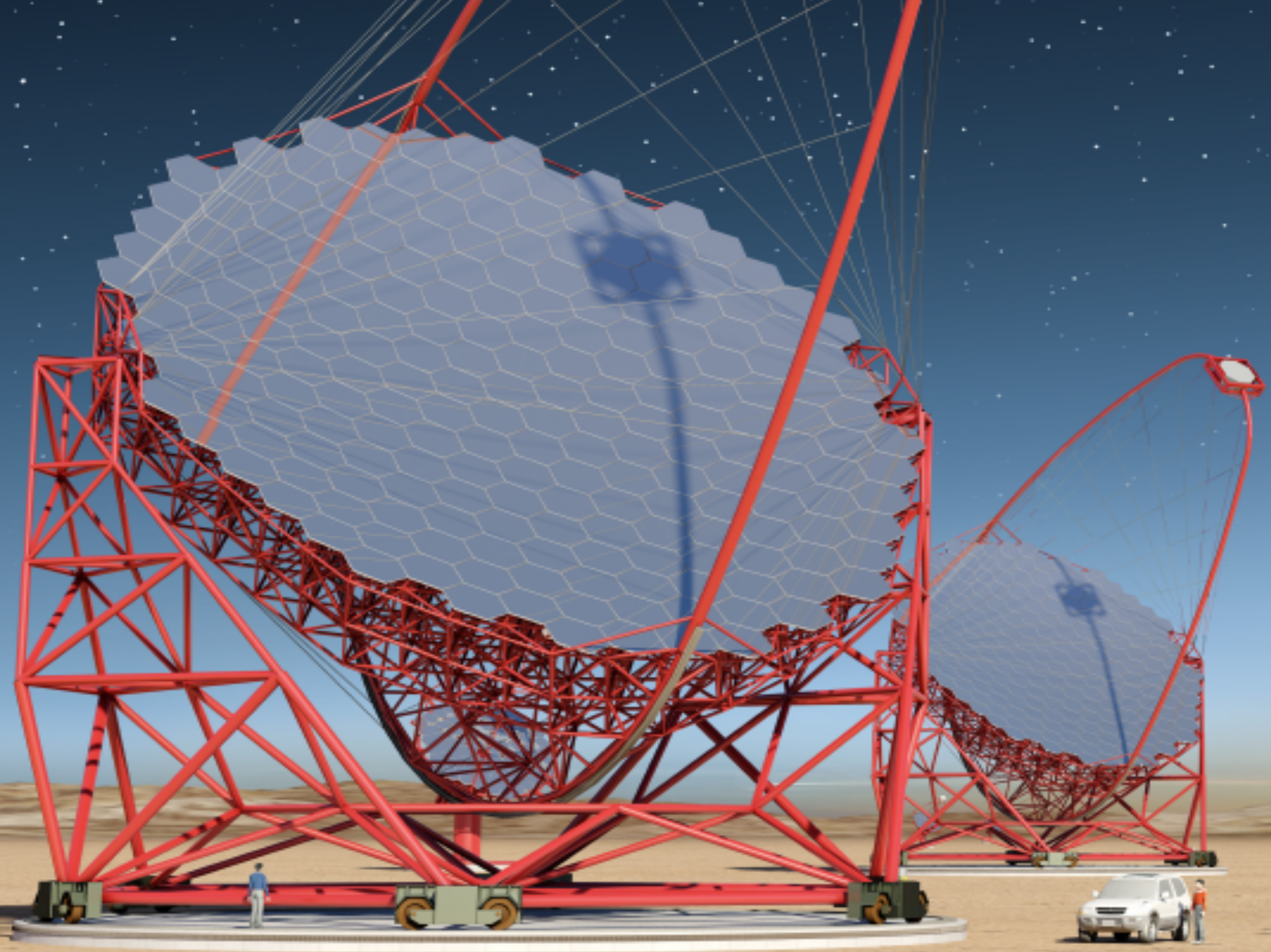


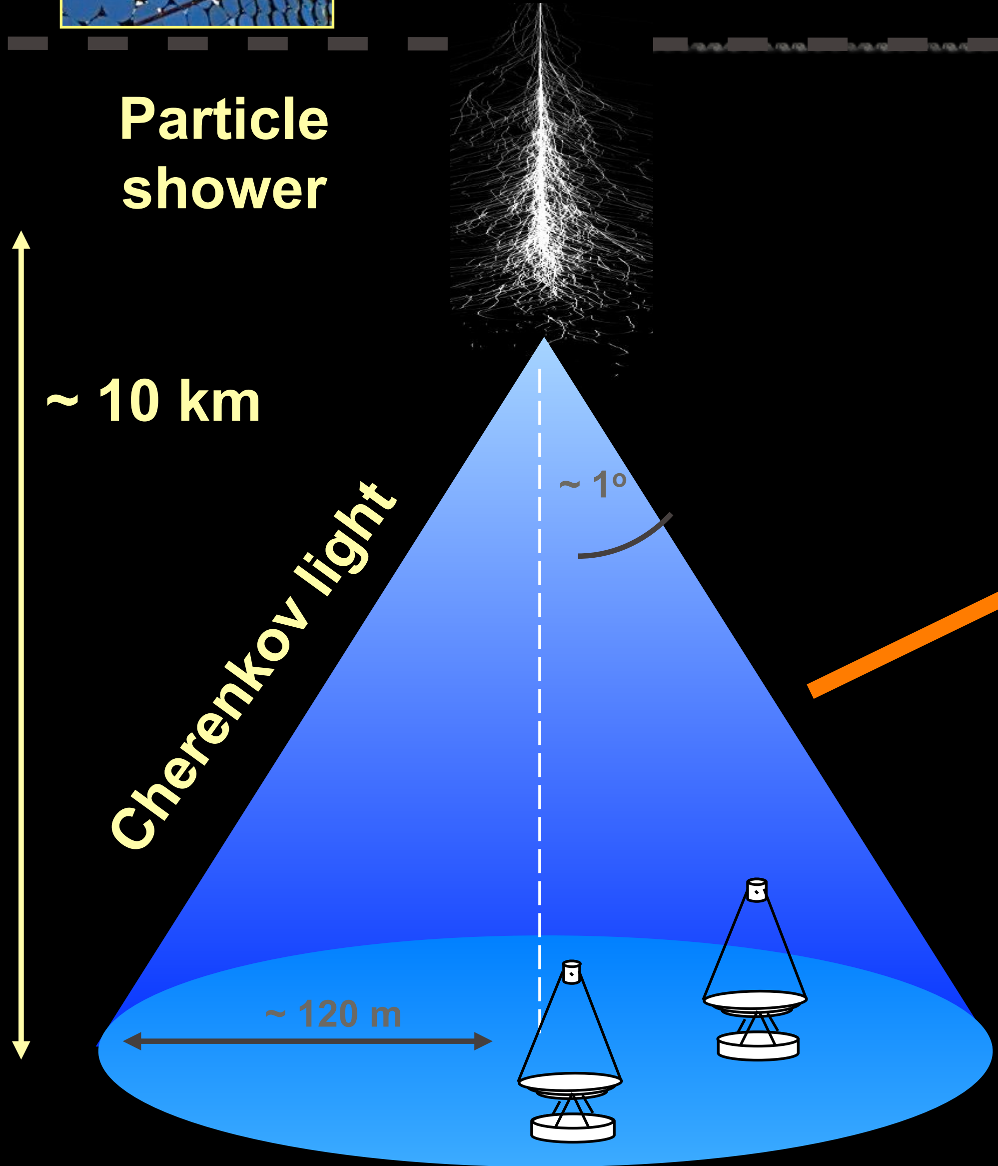


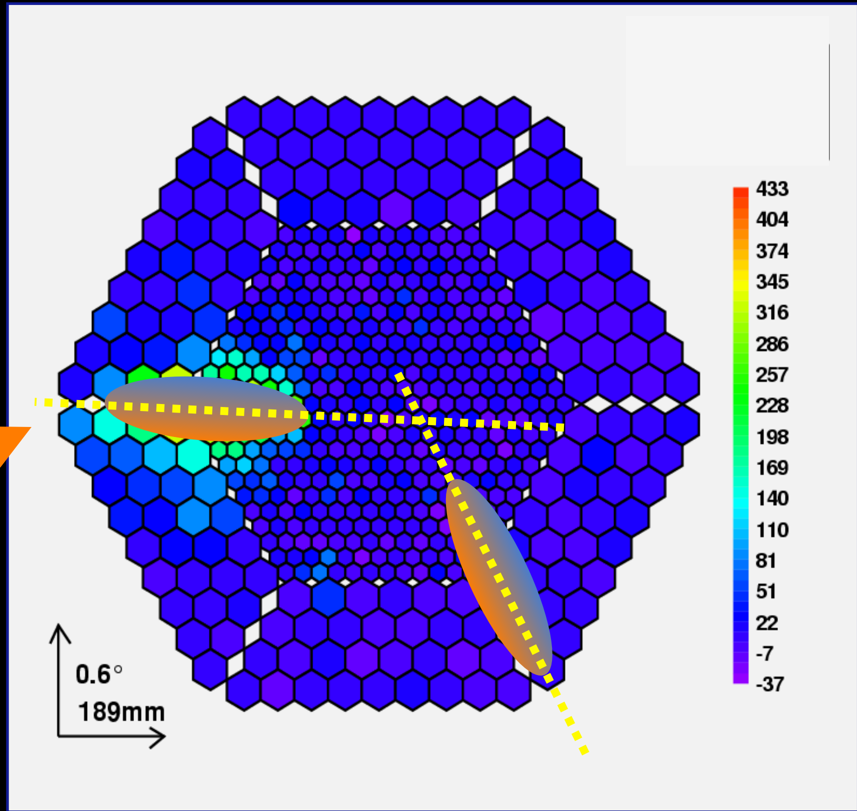
The CTA project

>1100 scientists
from 27 countries

Thomas Schweizer

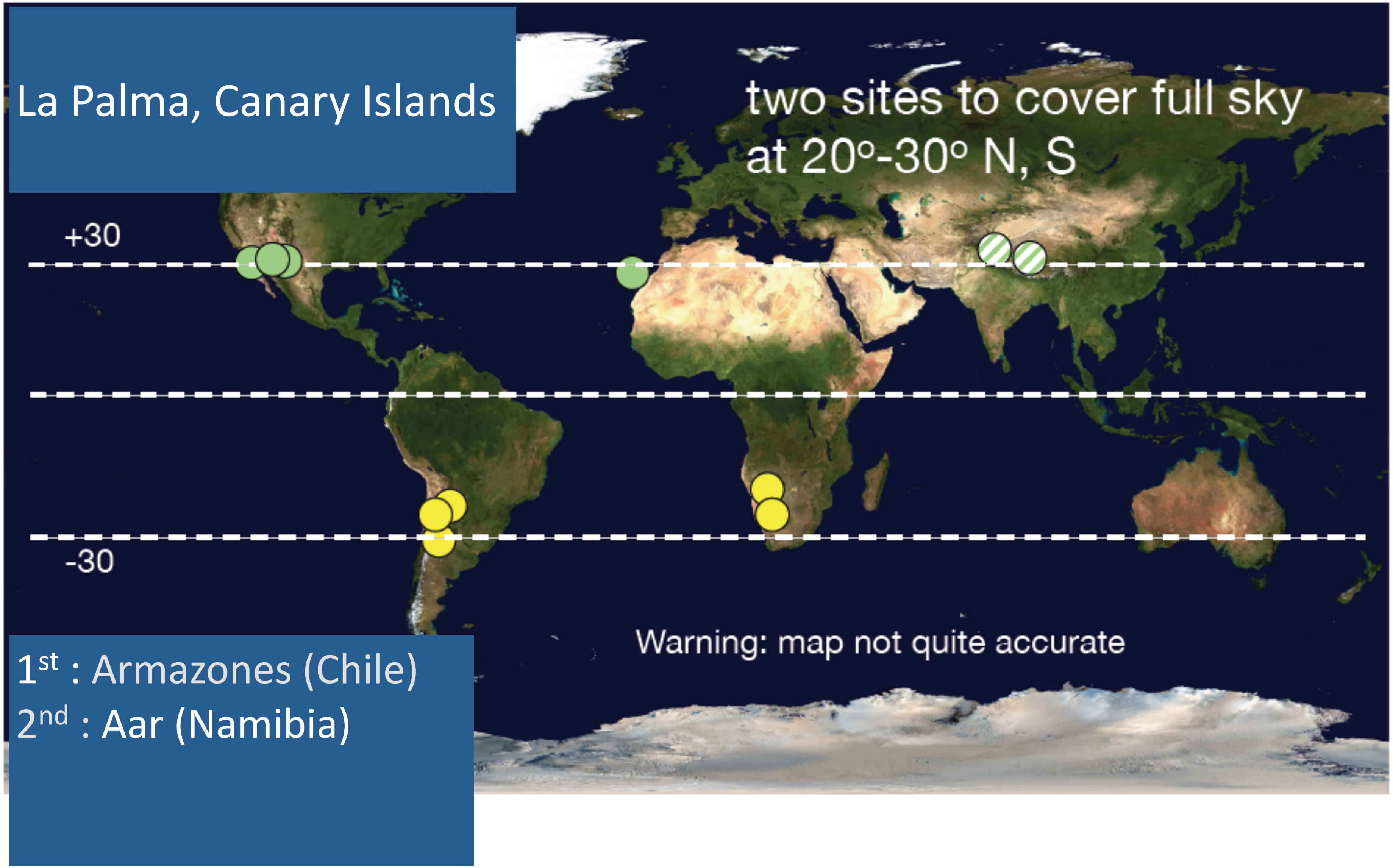
The Imaging Cherenkov Technique in stereo





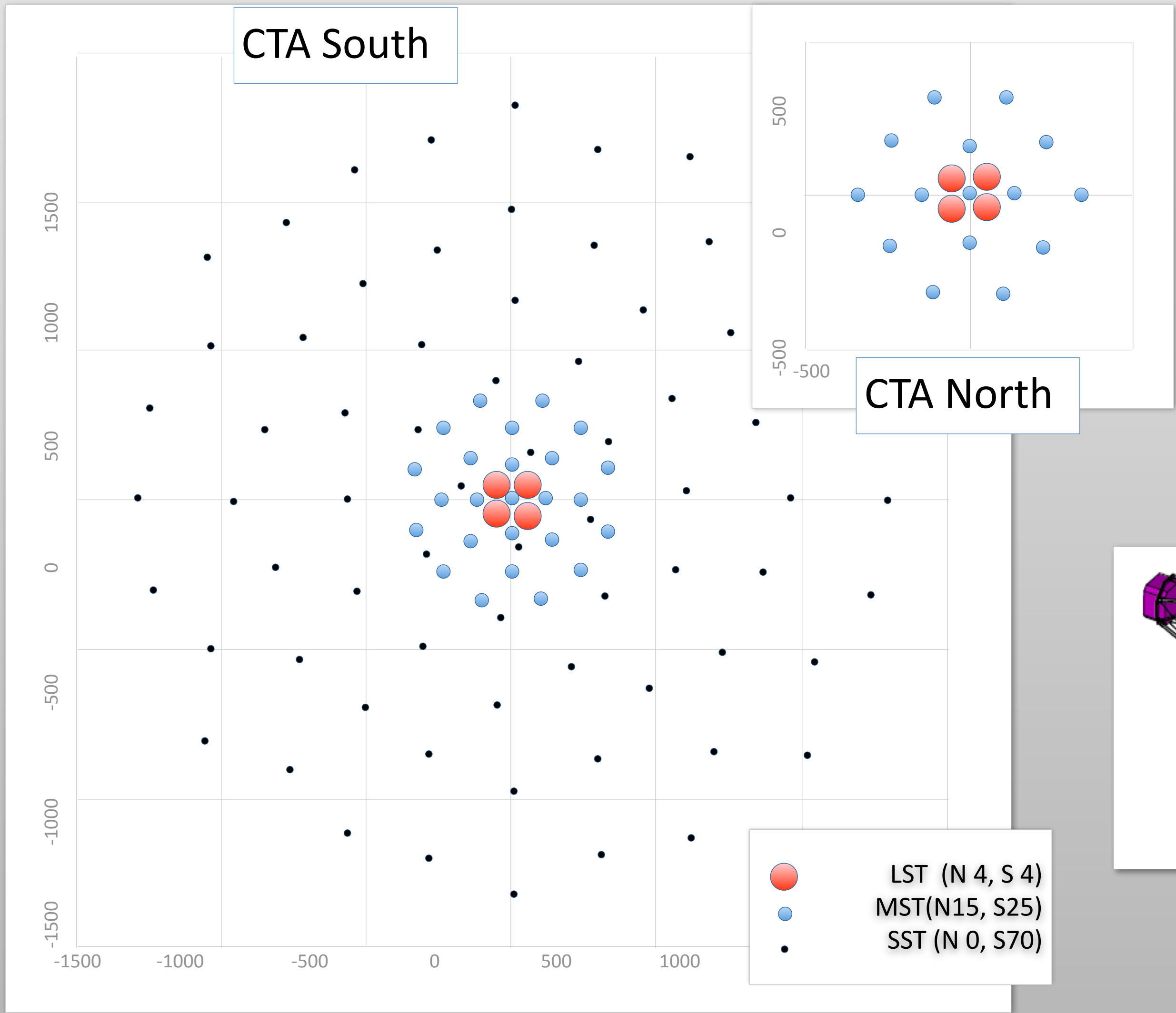
Better background reduction
Better angular resolution
Better energy resolution

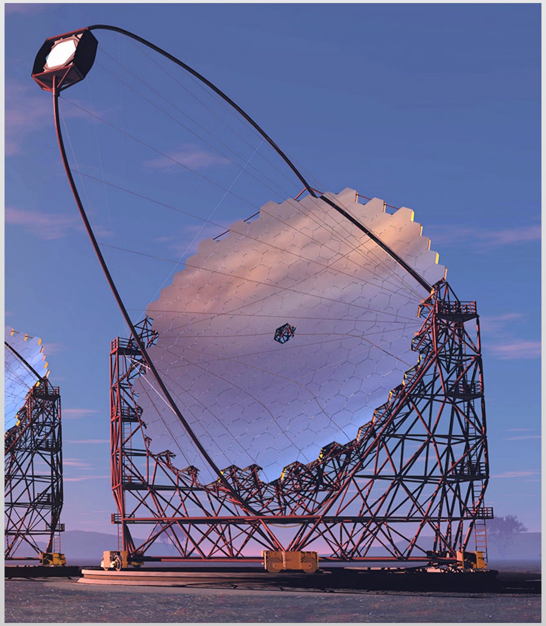
SITE CANDIDATES



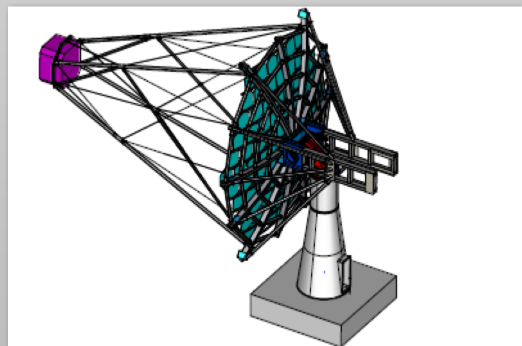
CTA Array Configuration
(Cherenkov Telescope Array)

CTA is all sky observatory consisting of two stations in South and North

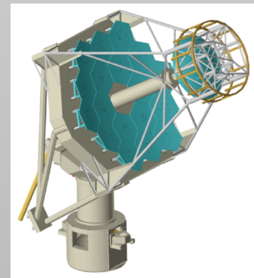




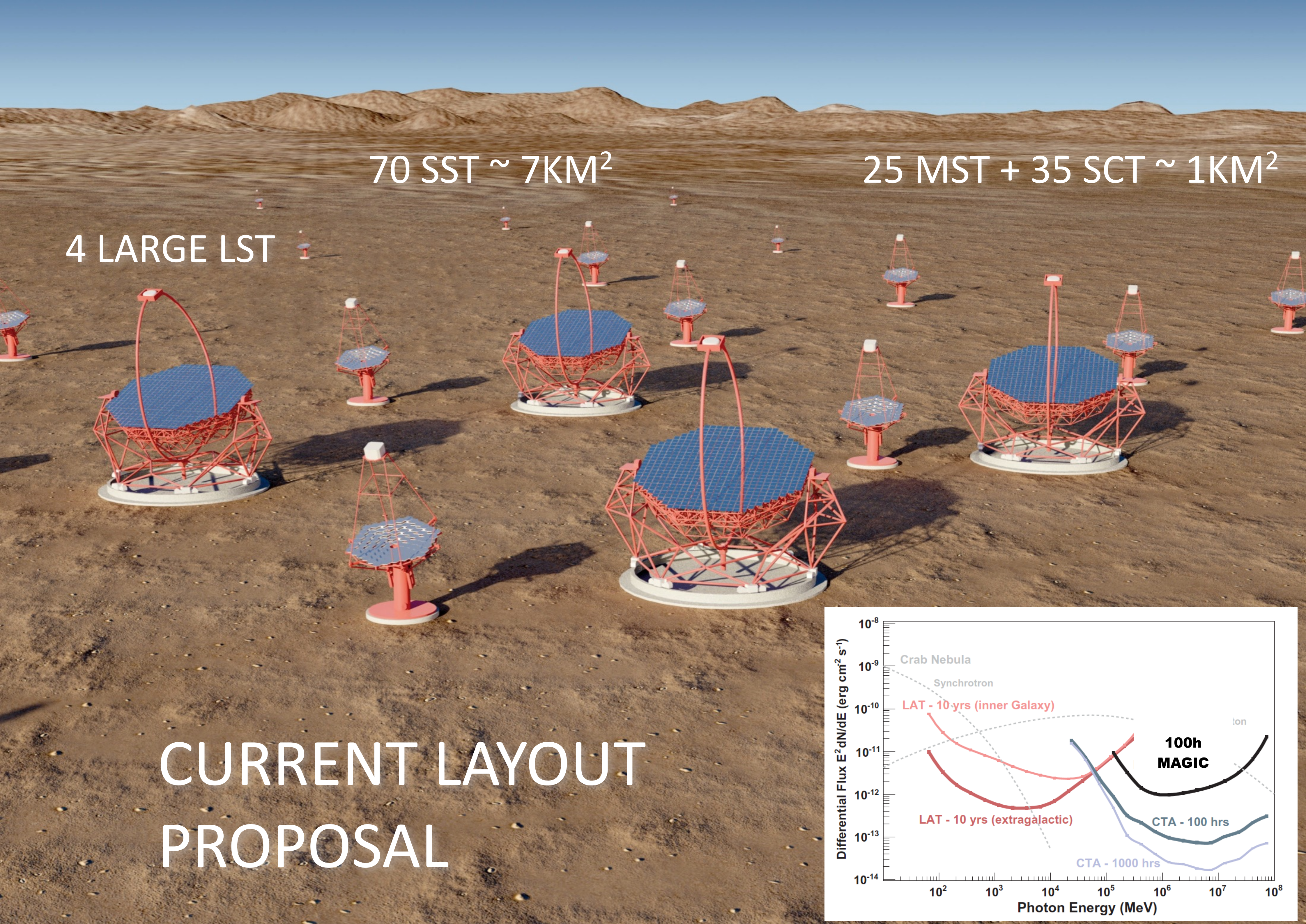
LST 23m



MST 12m

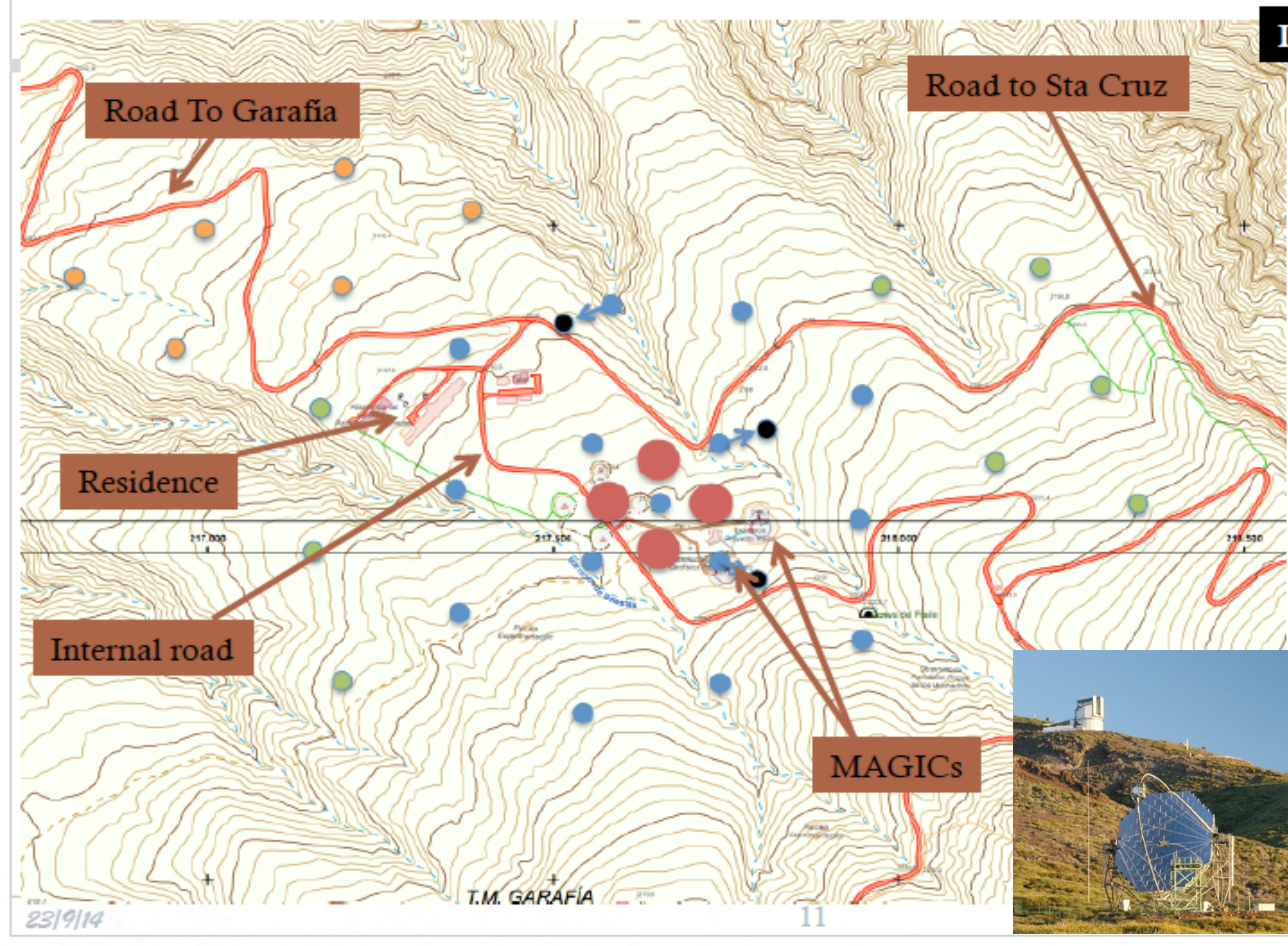


SST 4.3m



70 SST ~ 7KM²
25 MST + 35 SCT ~ 1KM²
4 LARGE LST
CURRENT LAYOUT
PROPOSAL
Crab Nebula
Synchrotron
LAT - 10 yrs (inner Galaxy)
LAT - 10 yrs (extragalactic)
100h
MAGIC
CTA - 100 hrs
CTA - 1000 hrs
Differential Flux E²dN/dE (erg cm⁻² s⁻¹)
Photon Energy (MeV)

Position of LSTs in La Palma

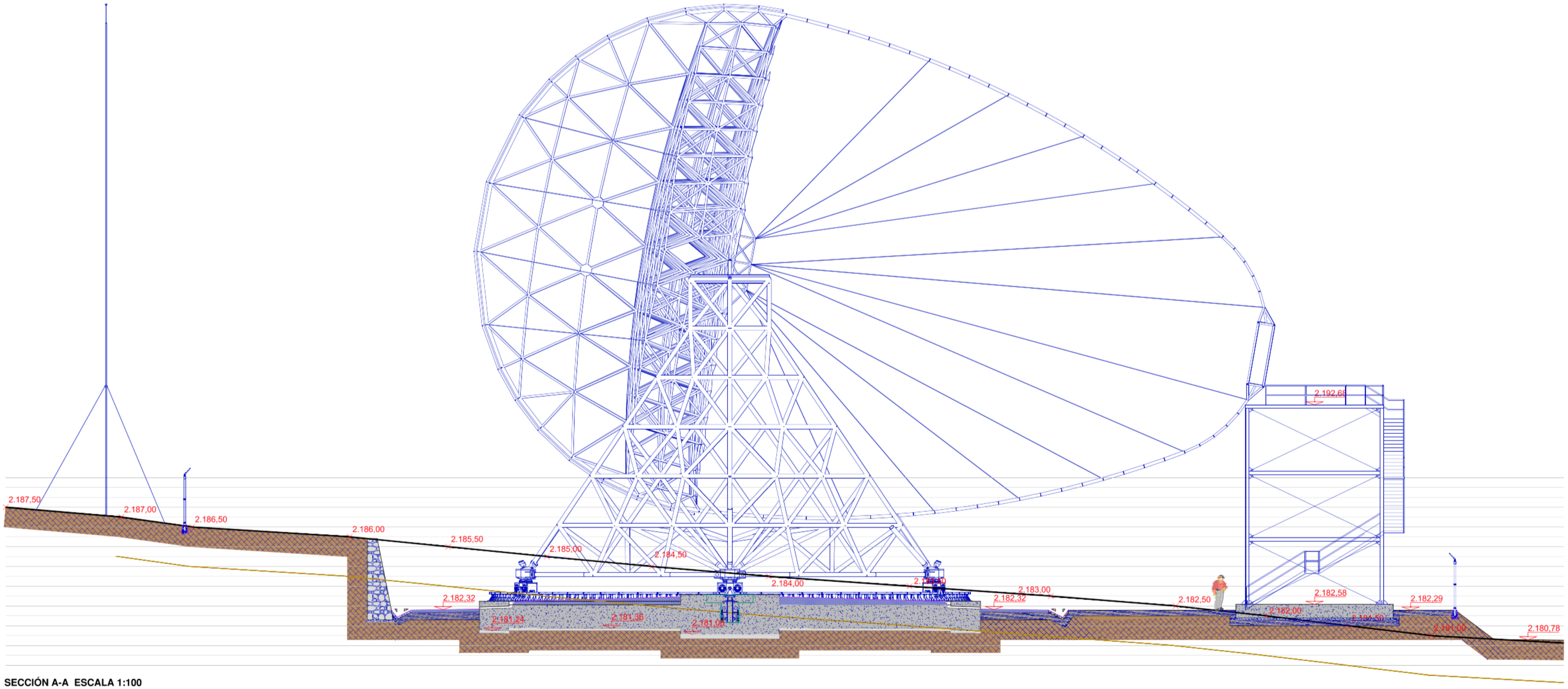


- •Red: LST
- •Blue: MST in baseline CTAN array
- •Green and orange: possible extensions of baseline array (total >1 km^2)

23m diameter
Large Size Telescope

- MPI Munich:
  - Telescope mechanics coordination
  - Dish structure
  - Understructure
  - Rail and parts of bogie
- IFAE, Barcelona, Spain:
  - Foundation
  - Bogie assembly
- LAPP, Annecy, France
  - Arch design
  - Camera Frame
  - Drive electronics
- Ciemat, Madrid, Spain:
  - Camera Body
- Spain, several institutes
  - Trigger electronics + Data transfer
- Japan:
  - Mirrors
  - Readout electronics

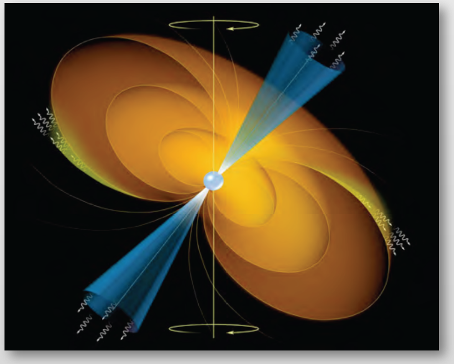
Side view of the 23m diameter with access tower and foundation

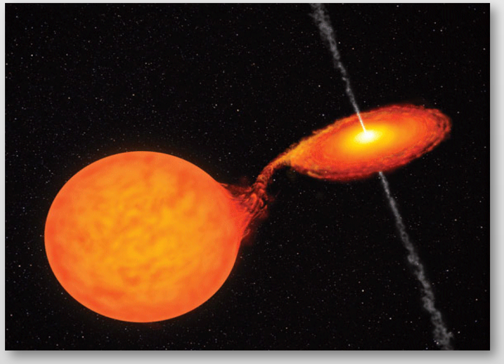


Rich Science cases with LSTs


High redshift AGNs (z<2)


GRBs (z<4)


Pulsars

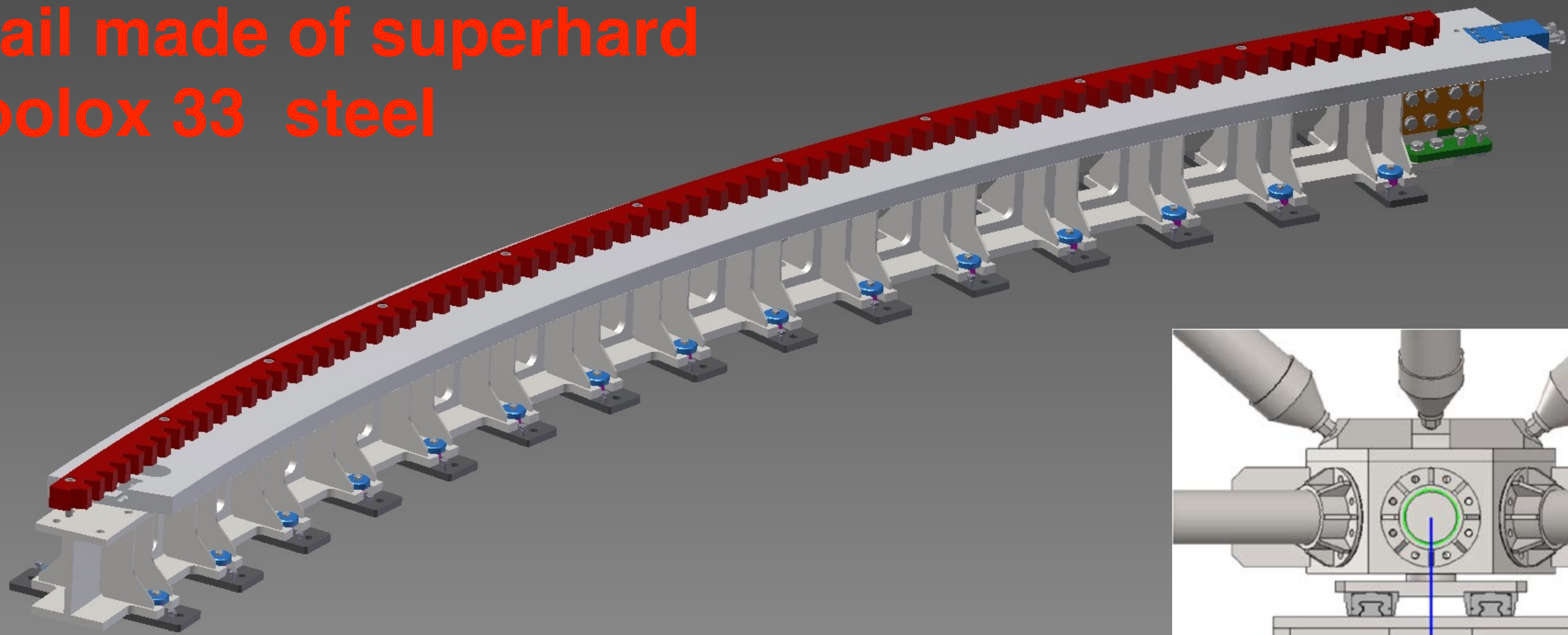

Binaries and transients

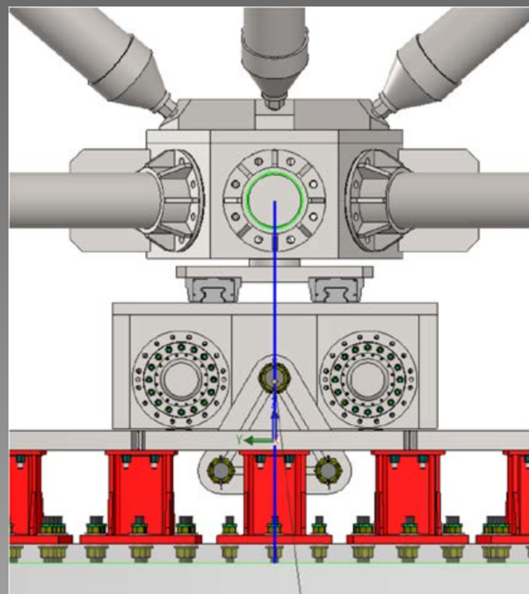
- LST has been optimized for the energy range between 20 - 200 GeV
- Low energy threshold
  - Trigger threshold: 15 GeV
  - Analysis threshold: 20 GeV

- key physics cases:
  - High-redshift AGNs and GRBs, Expand the Gamma Ray Horizon
  - Binaries, Pulsars and other type of transients at low energy

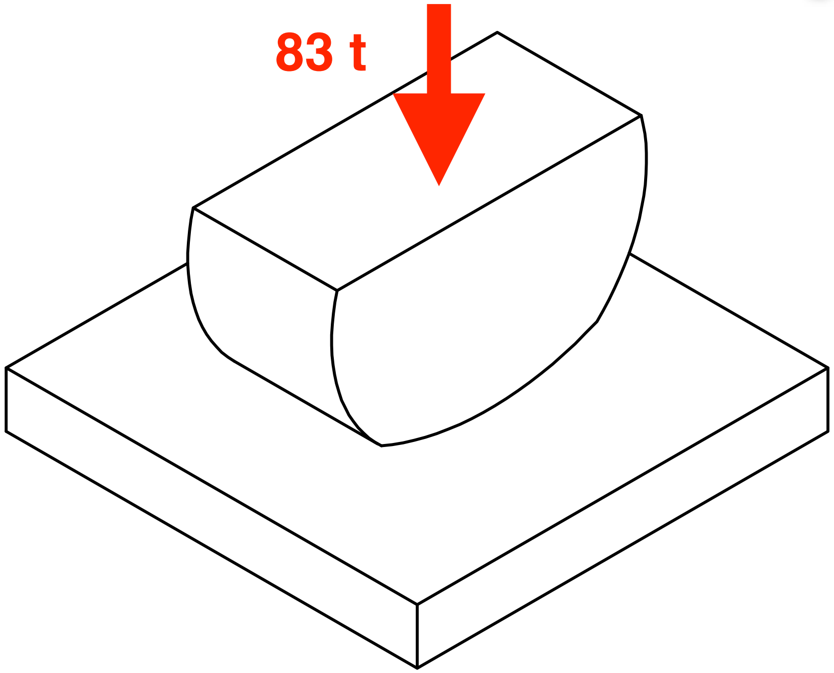
Rail system status

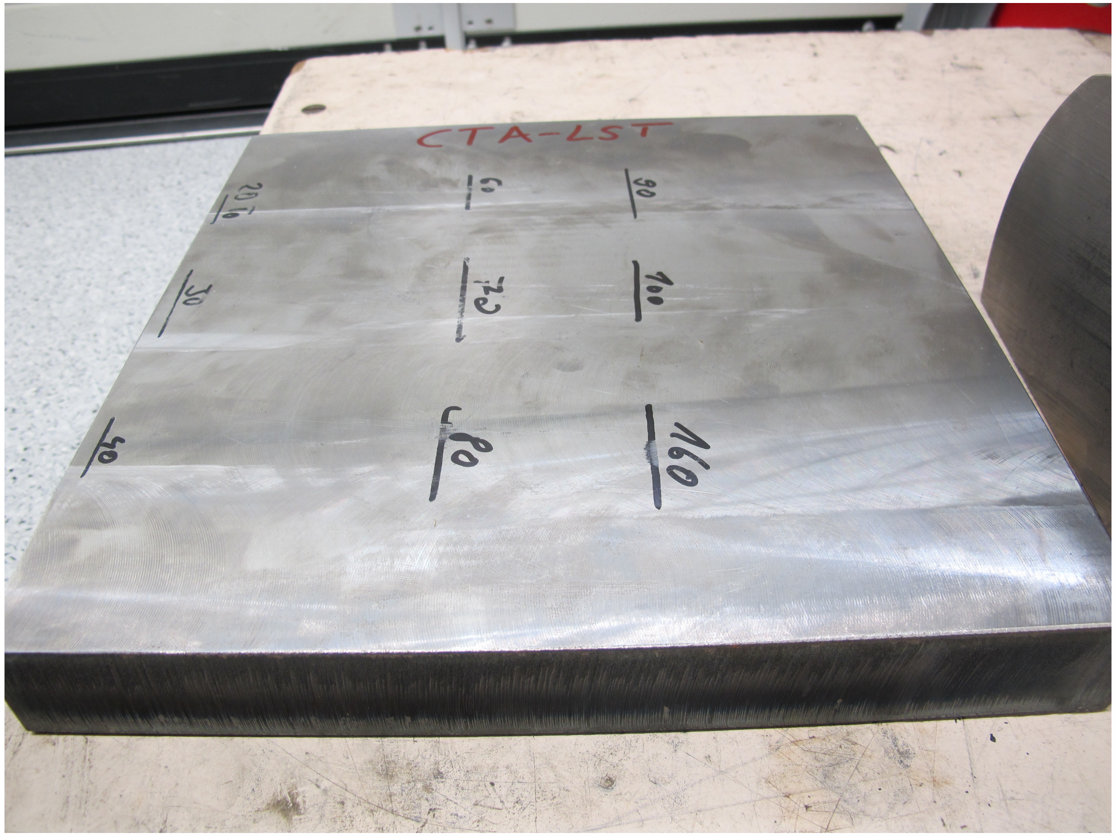
Rail made of superhard toolox 33 steel



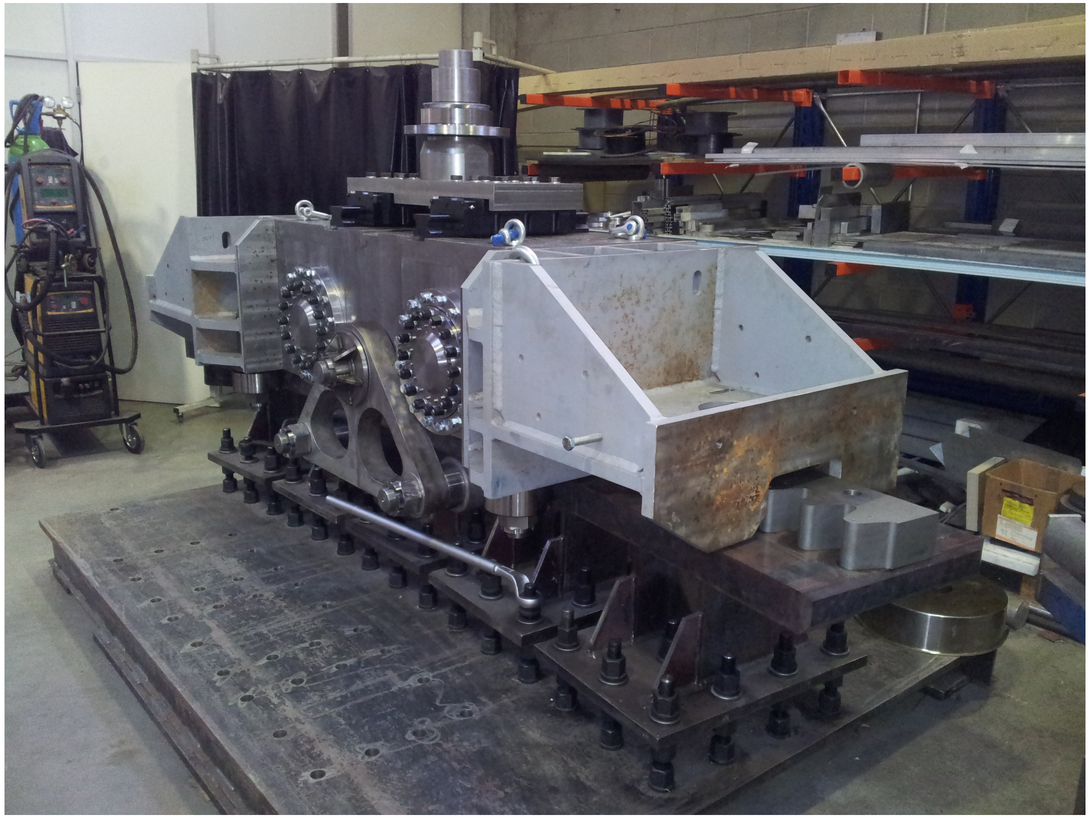


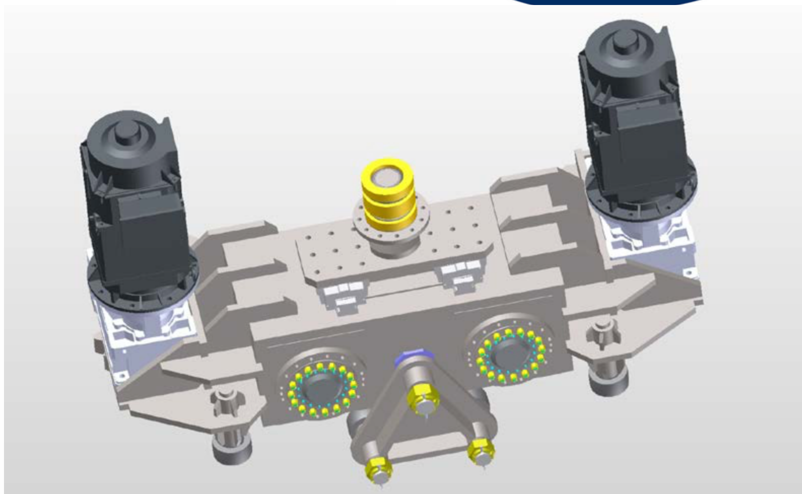
Test of strength of rail material with pressing wheel

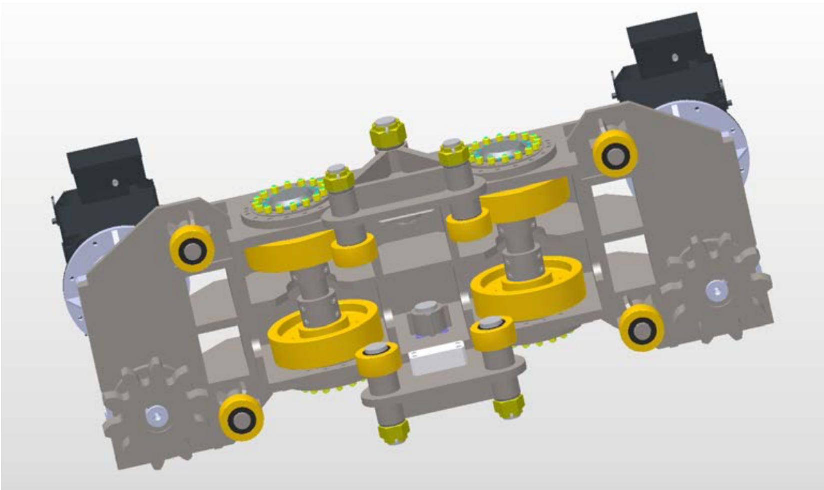


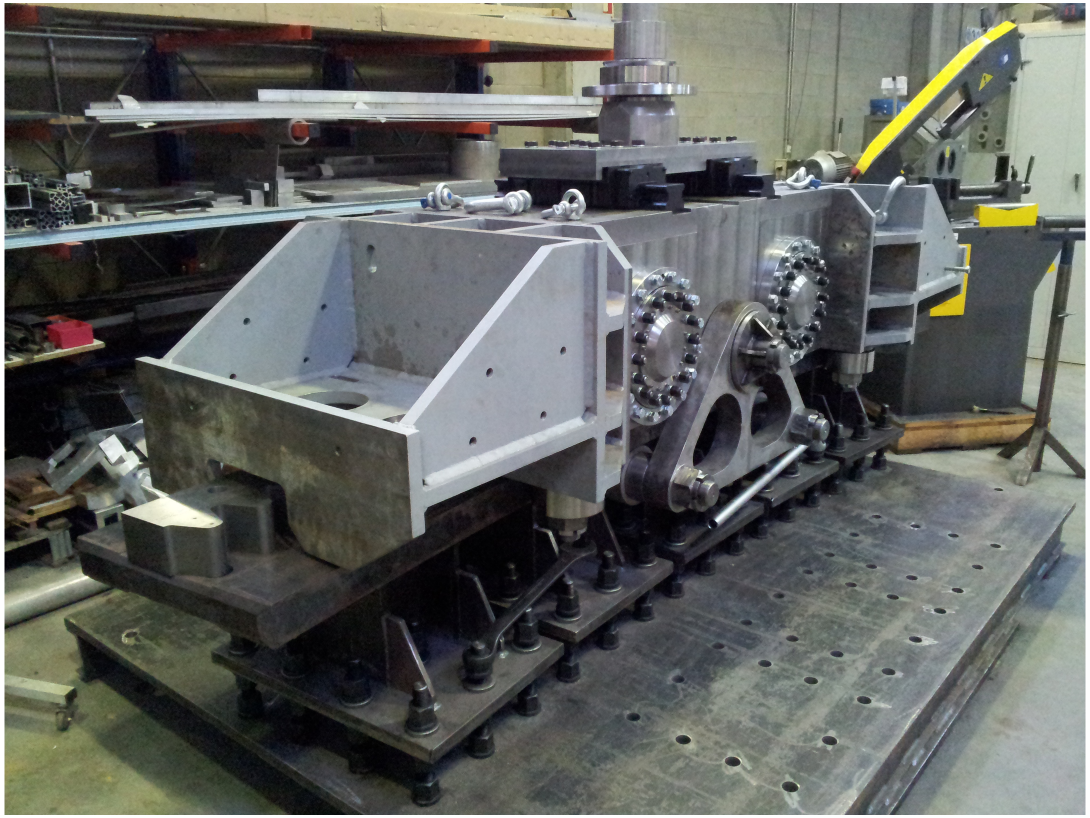


Prototype bogie

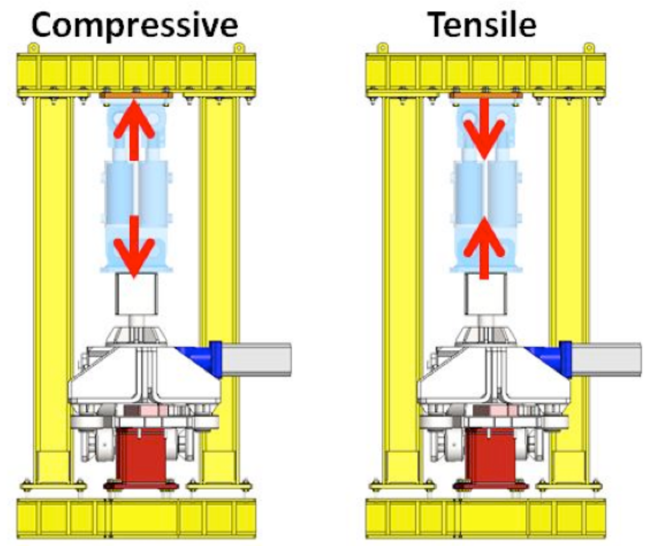




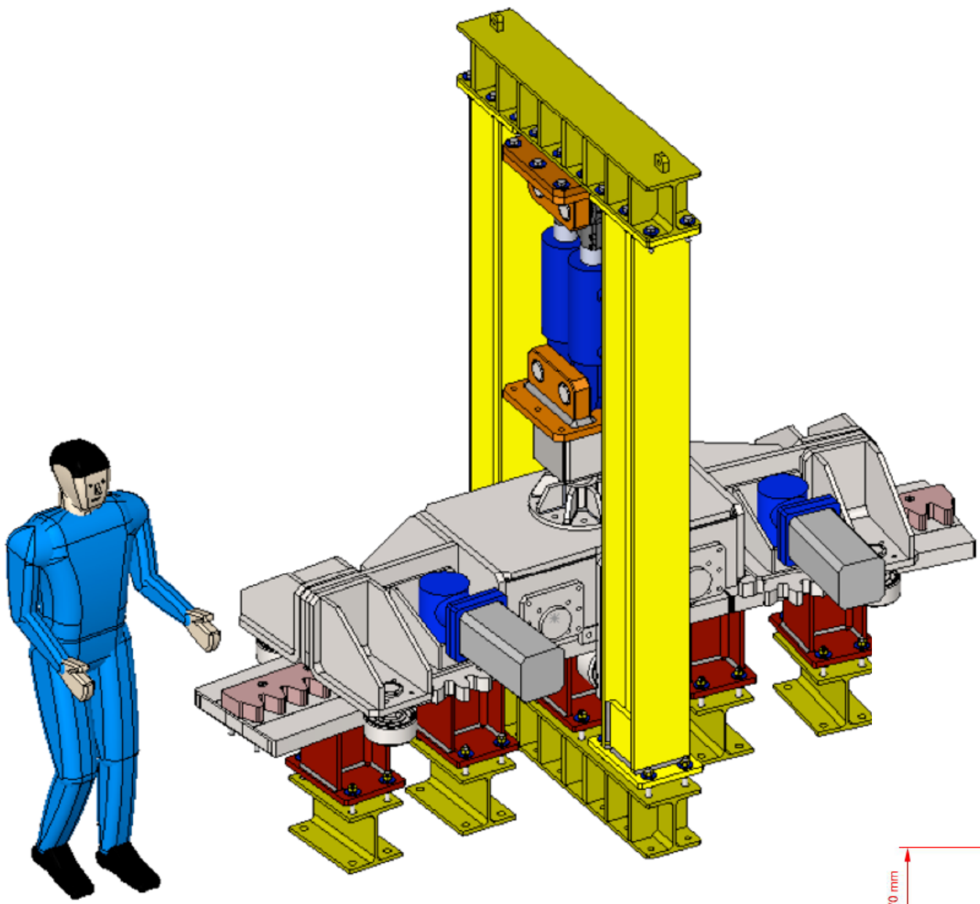


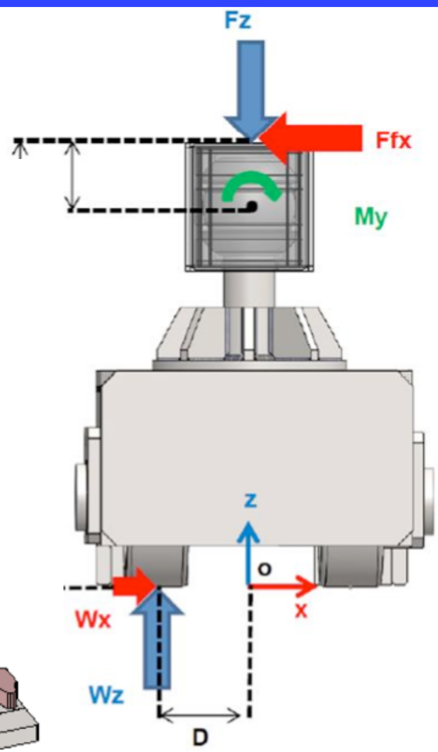


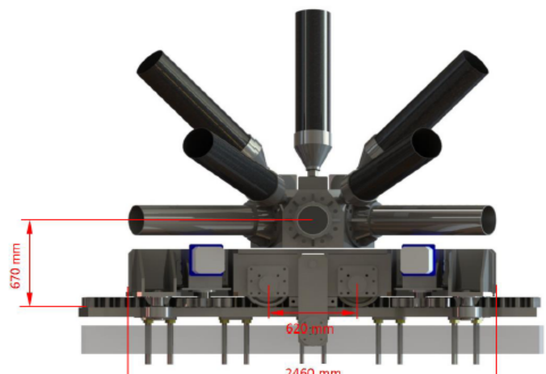
Tests to be performed on prototype bogie



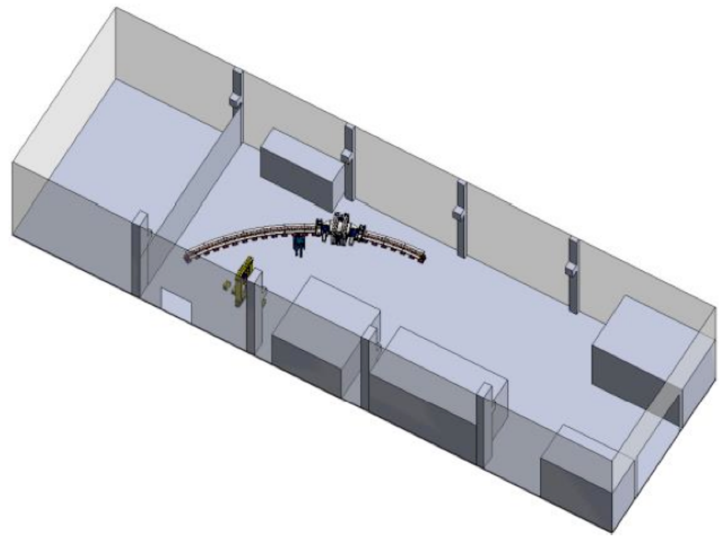
Compressive load: 90 tons
Tensile load: 50 tons



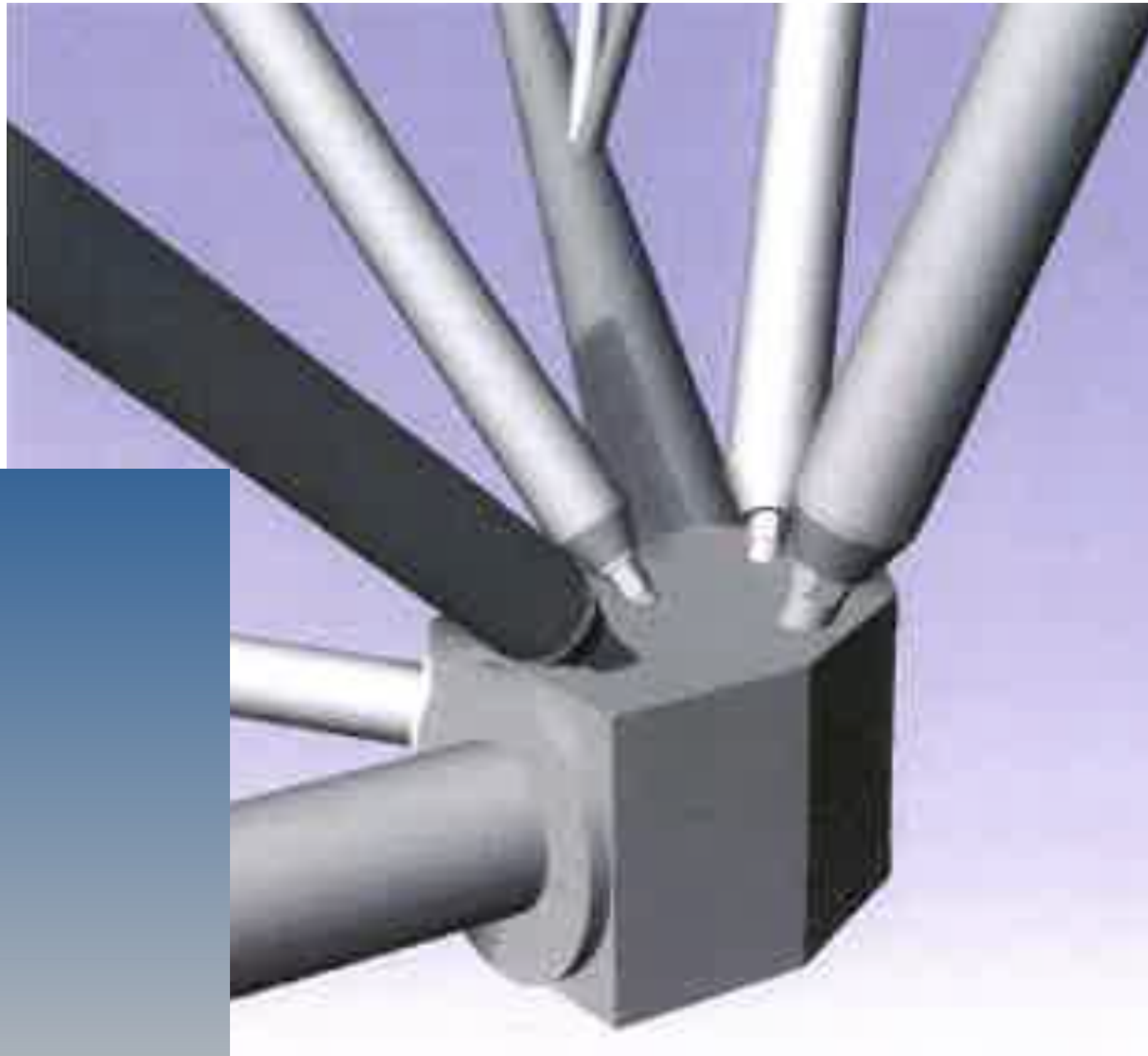


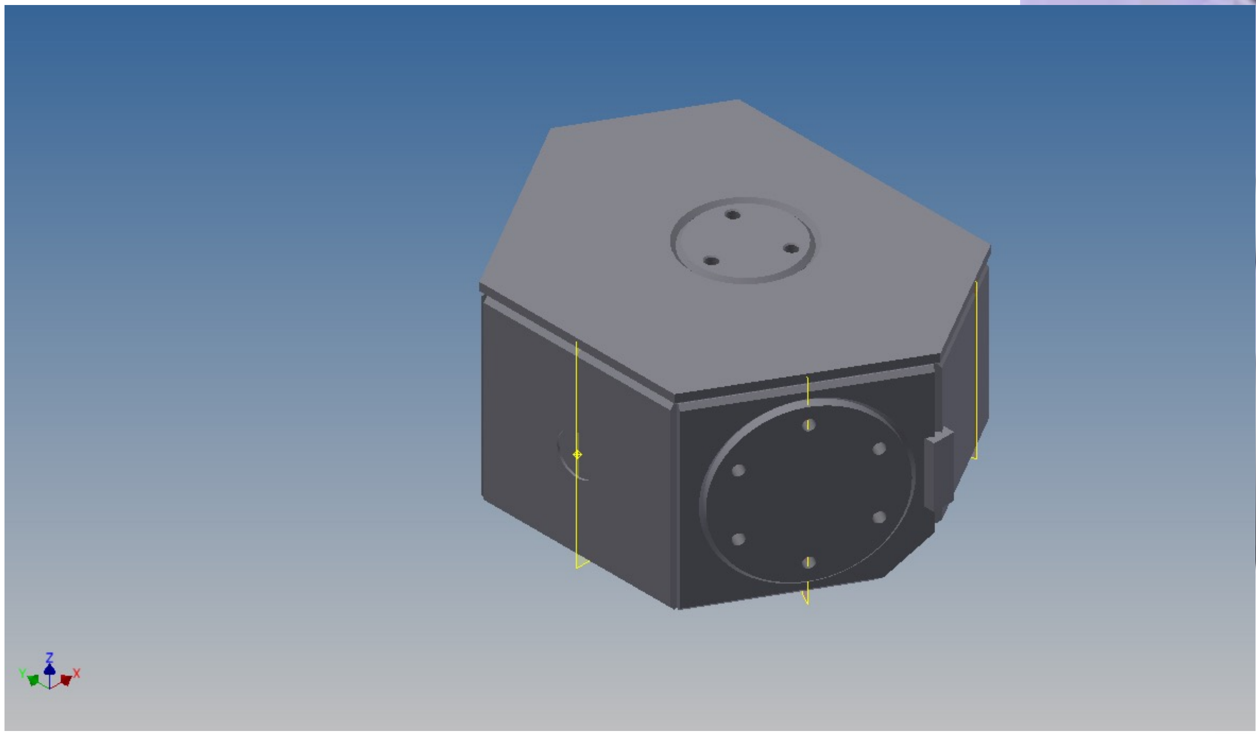


Test setup in IFAE workshop

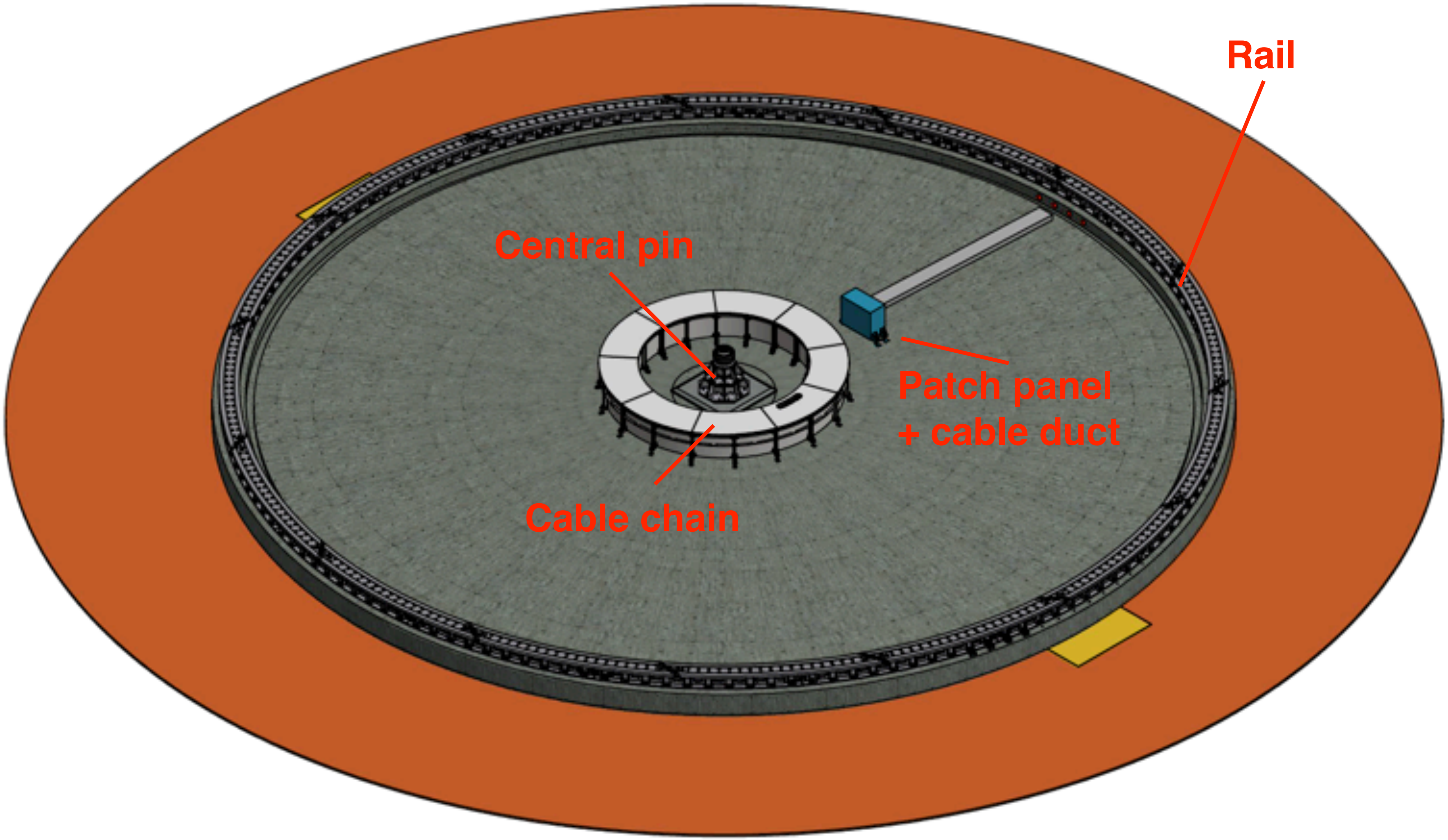


Bogie knot connection to telescope structure



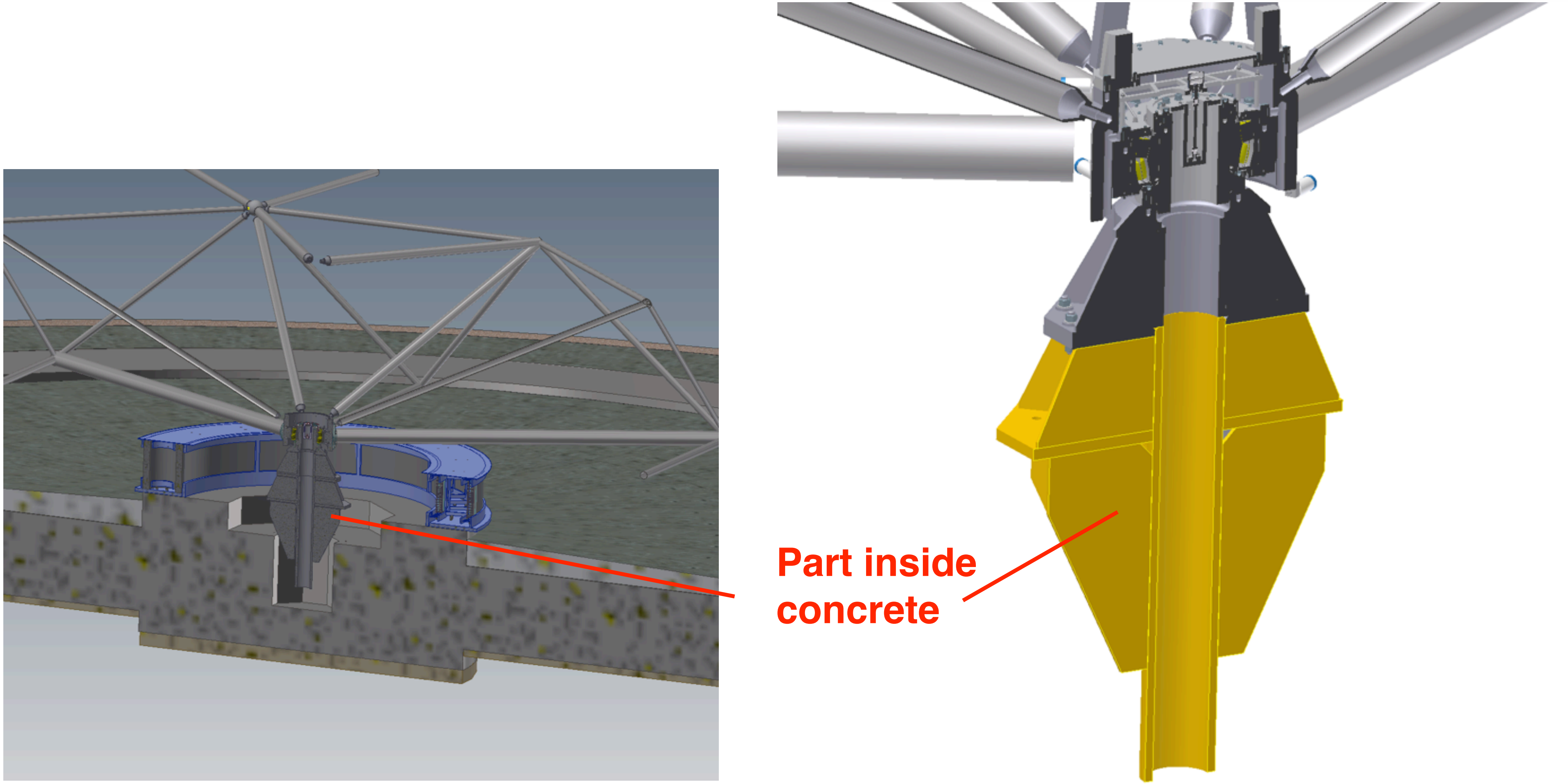


Foundation interface

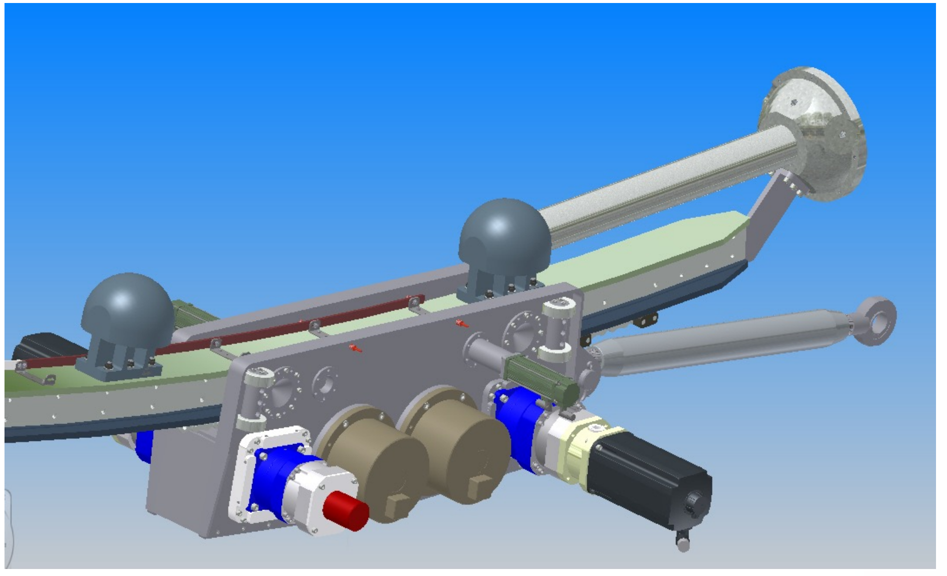


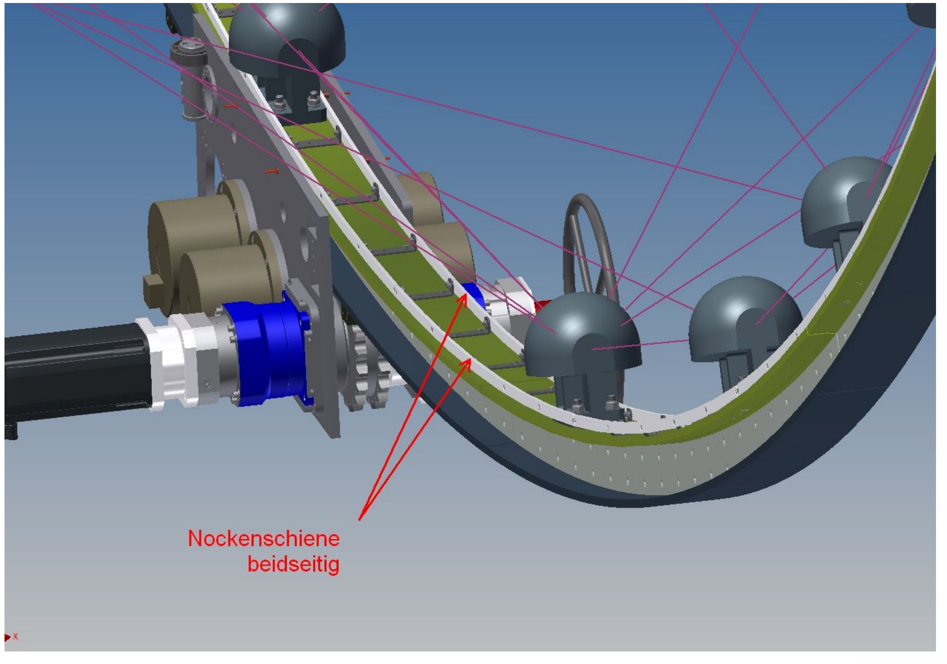
Design of central pin

cta
cherenkov telescope array



Elevation drive and backside arch



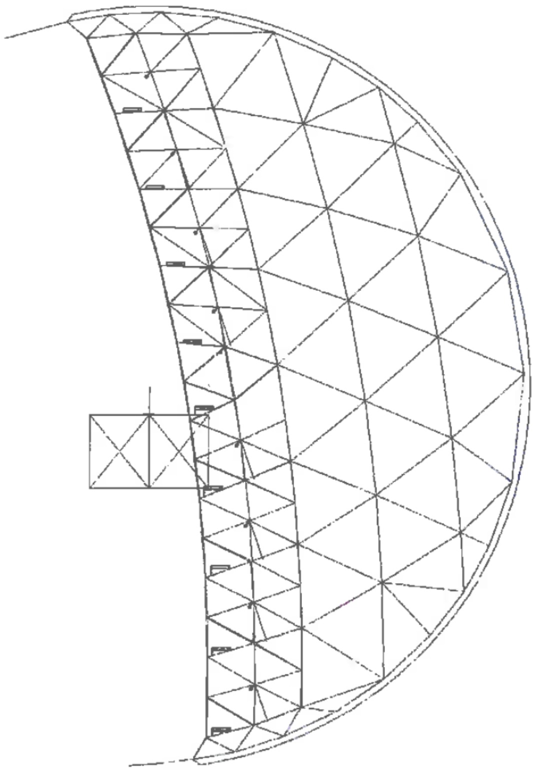


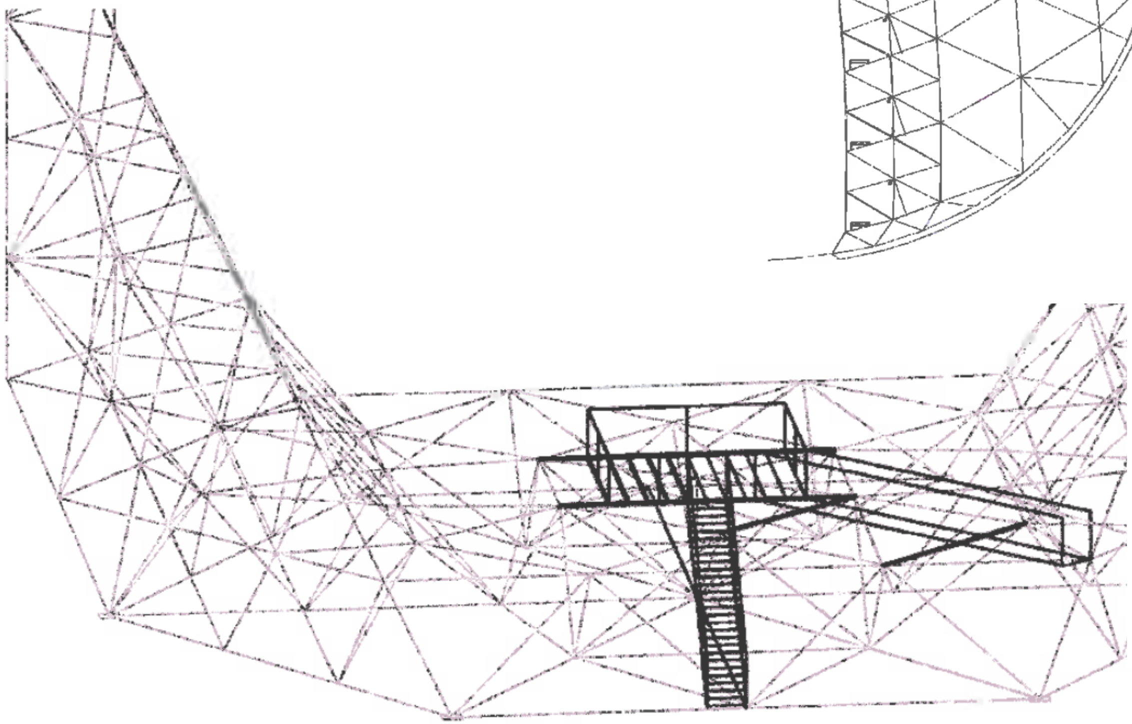
Catwalks/mount access

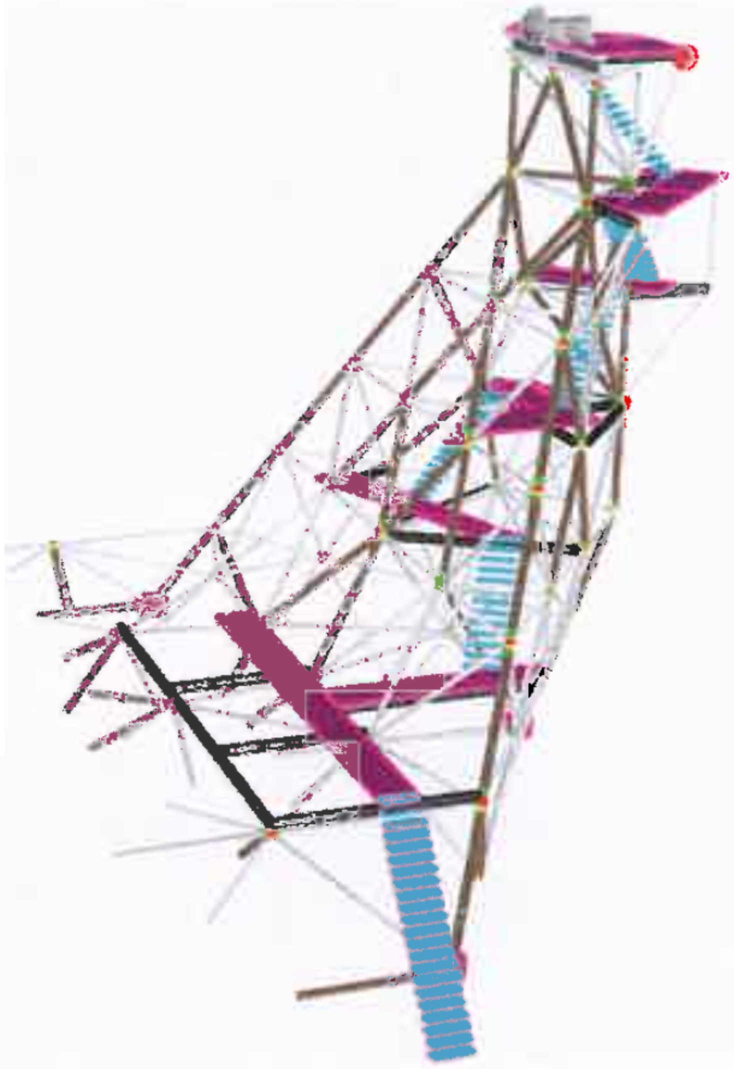
- The main access is on the right tower.

- There will be 9 catwalks inside the dish

- There will be a platform in the center





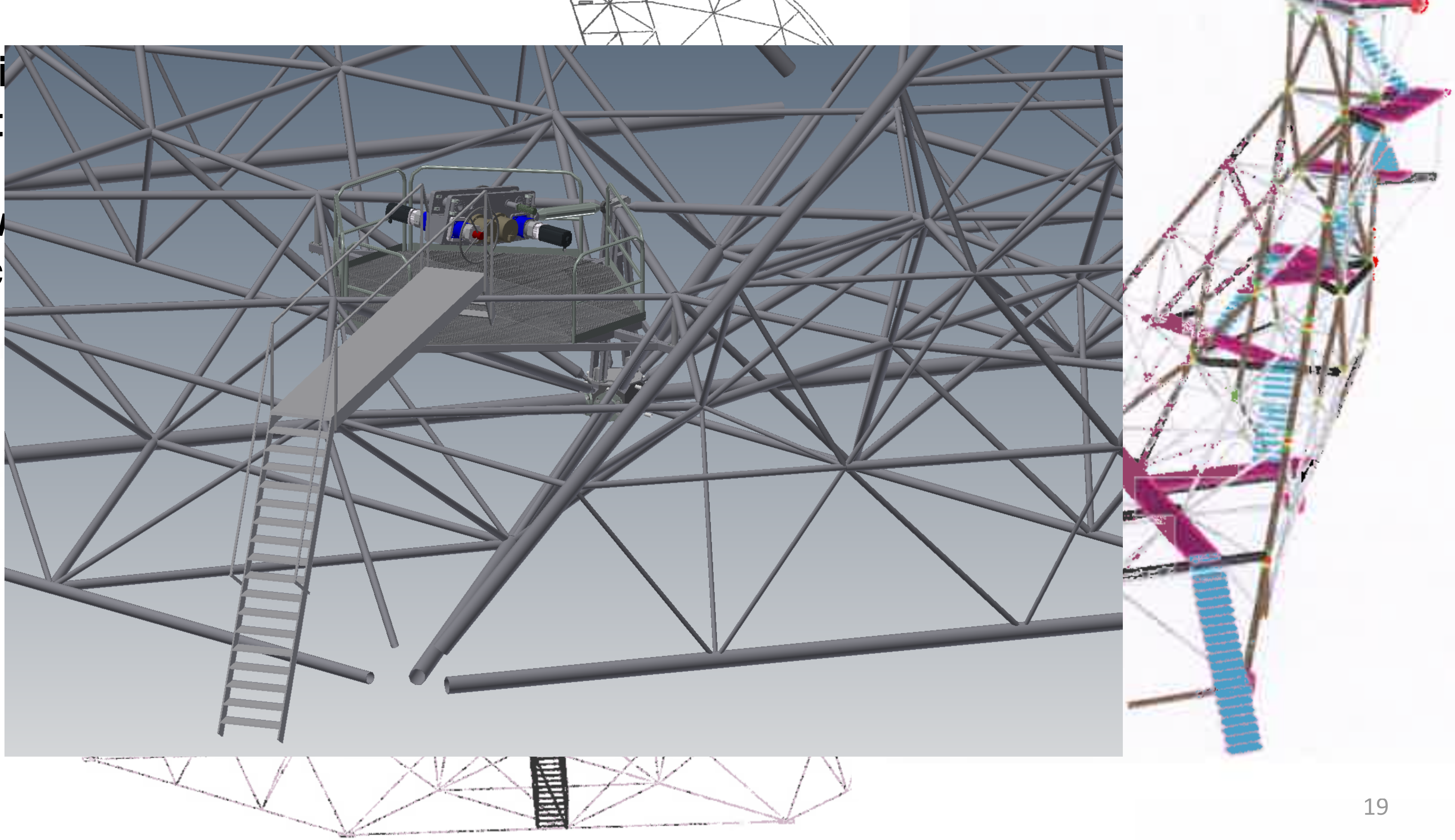


Catwalks/mount access

- The main access is on the right tower.

-There wi
inside t

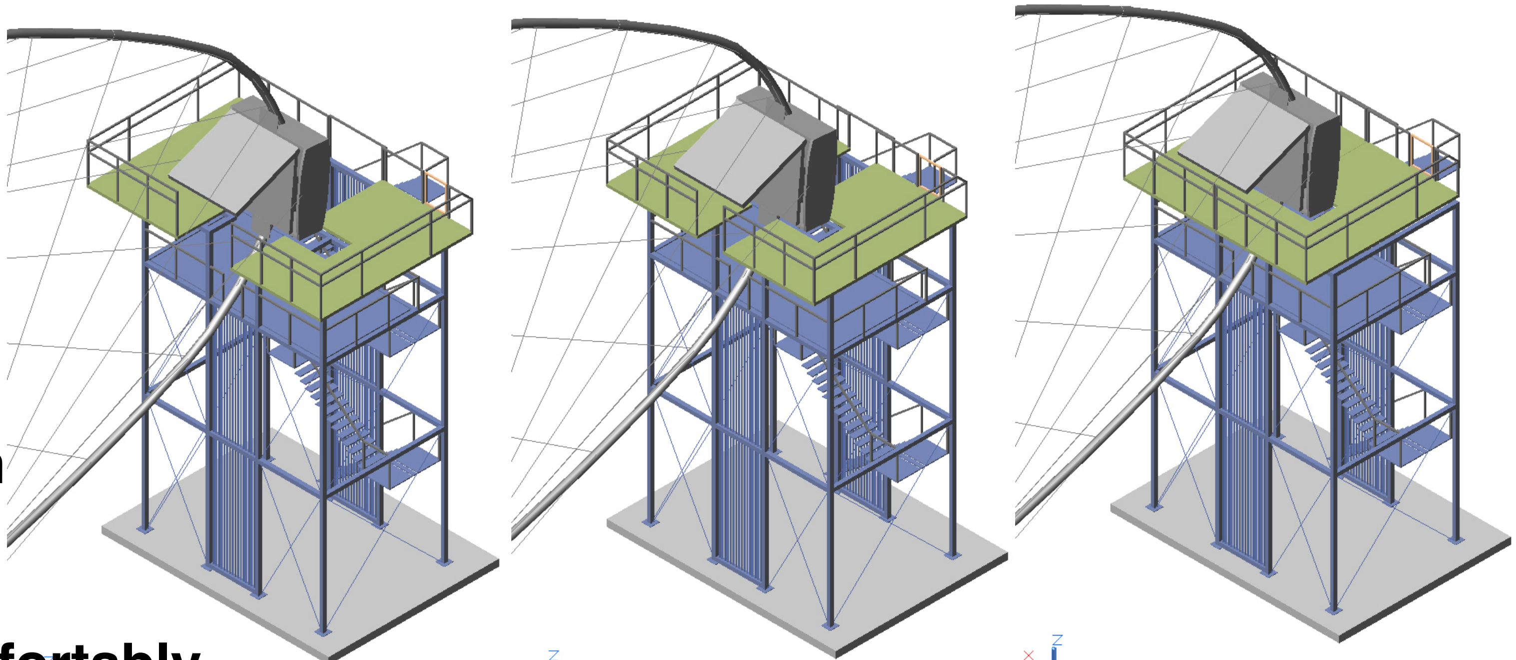
- There w
in the c



Access to the camera and design of access tower

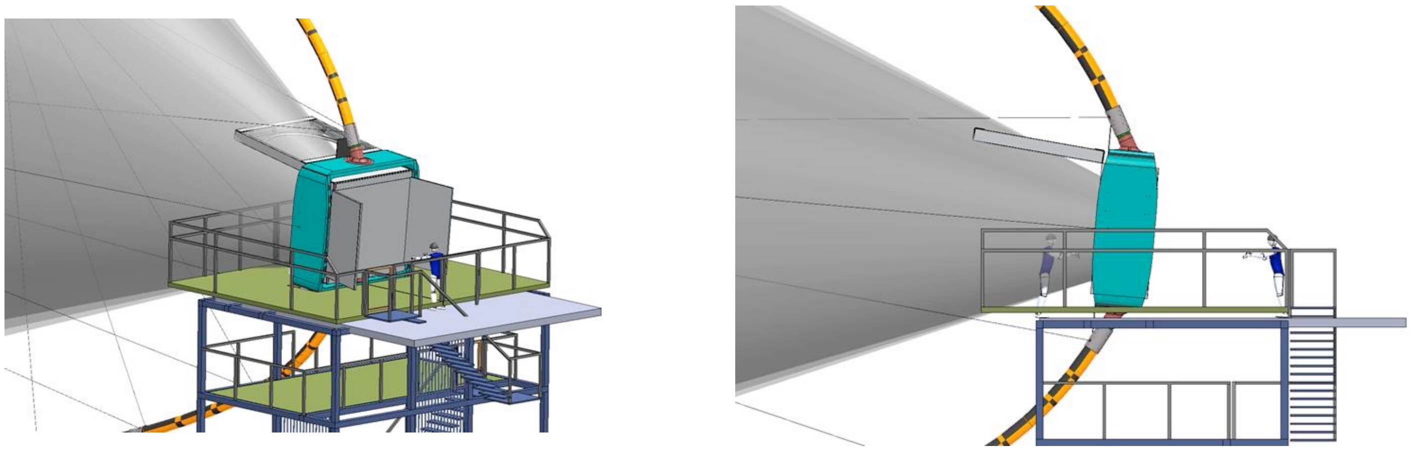
- During the parking procedure, the platform closes from left and right side.
- The entrance to the platform is secured by a key-locking-system

Camera locking sequence



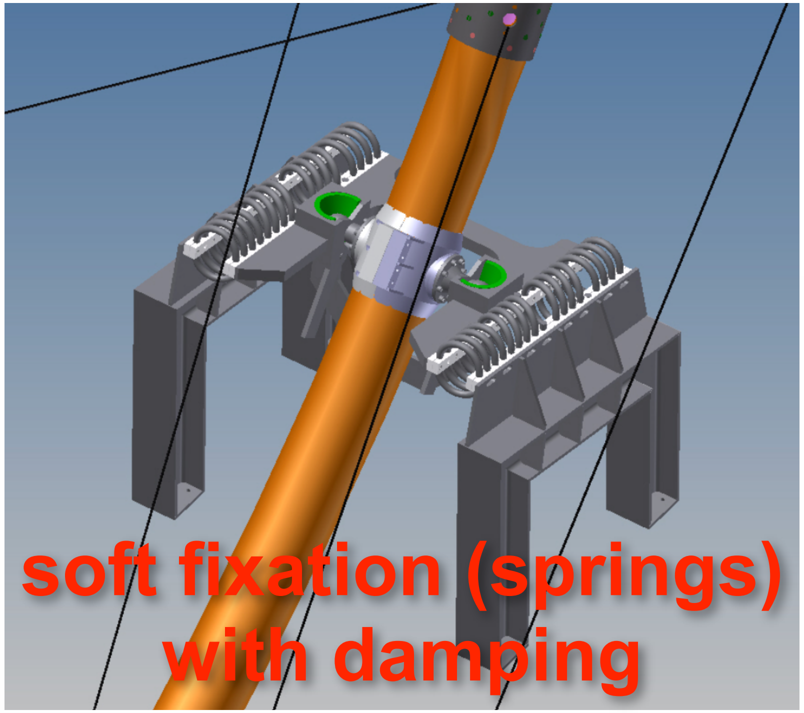
- The camera can be comfortably accessed from the front and backside

Camera access



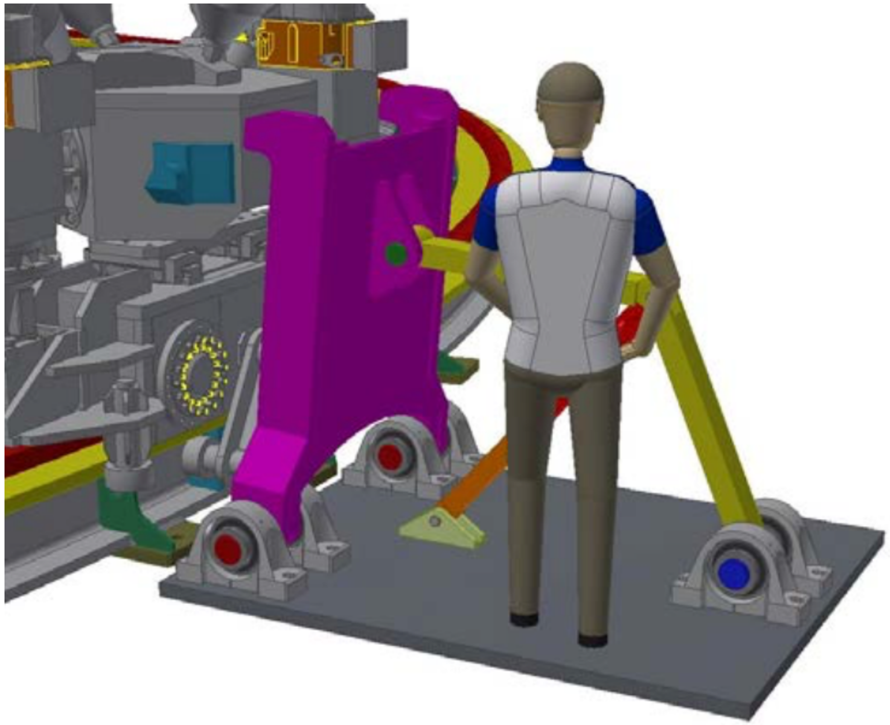
- All access will be designed for maximal human safety

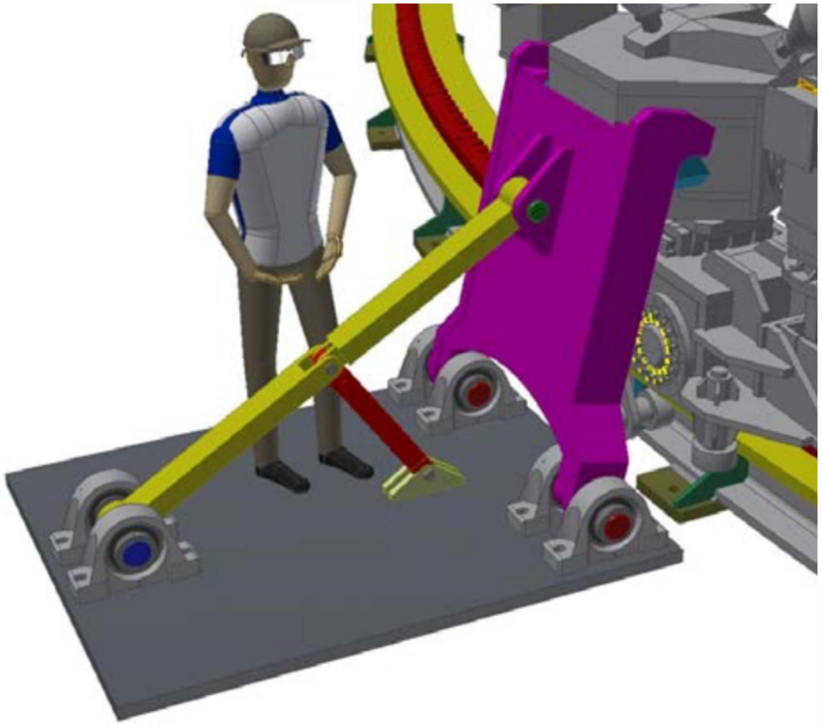
Locking systems



Arch locking at tower

Azimuth locking



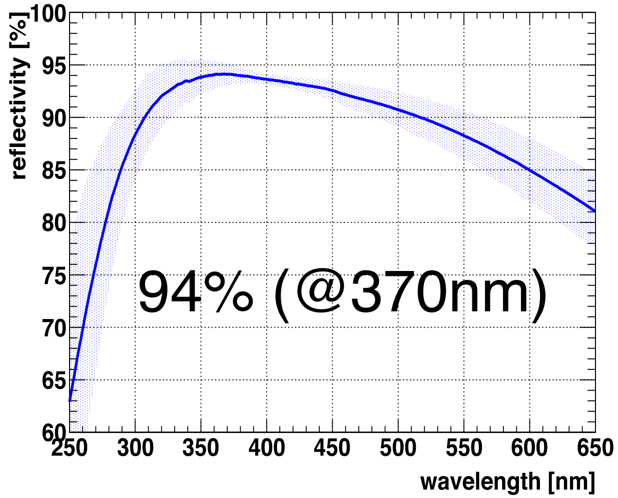


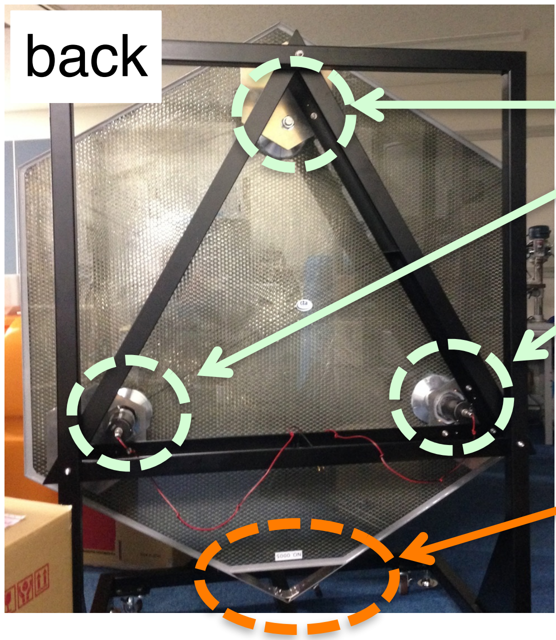
LST Mirrors of 1510 mm and Dynamic AMC System (actuators and CCD Camera)

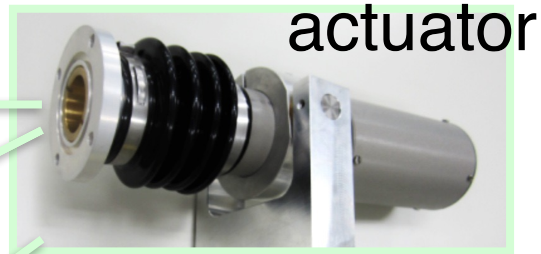
Specifications

- R: 56.0 – 58.4 m
- D80(@1f) : 16.6mm (1/3 pixel)
- Weight: 47 kg

Mirror coating: Sputtering ($Cr+Al+SiO_2+HfO_2+SiO_2$)





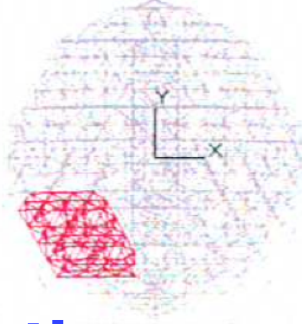


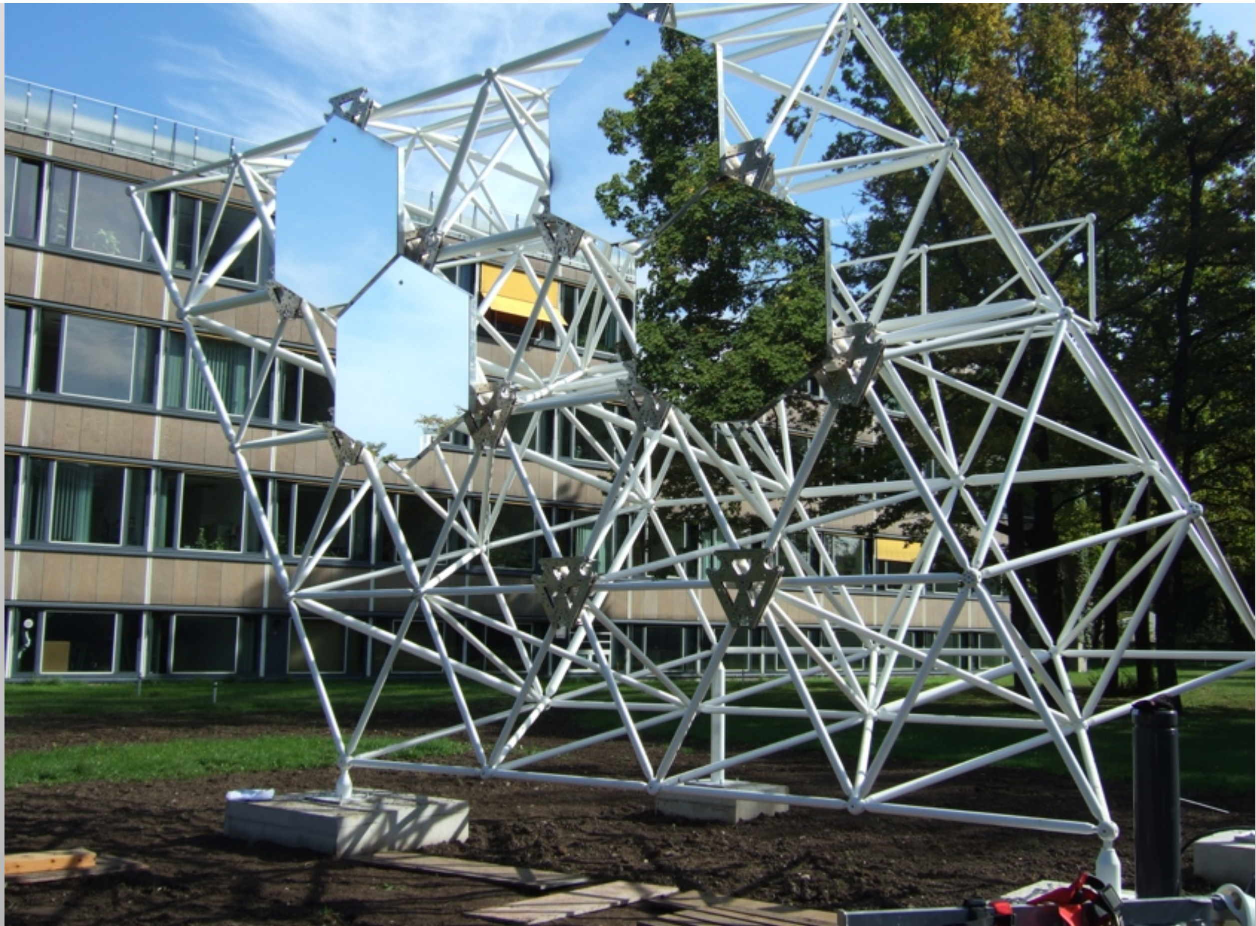
Dynamical AMC System

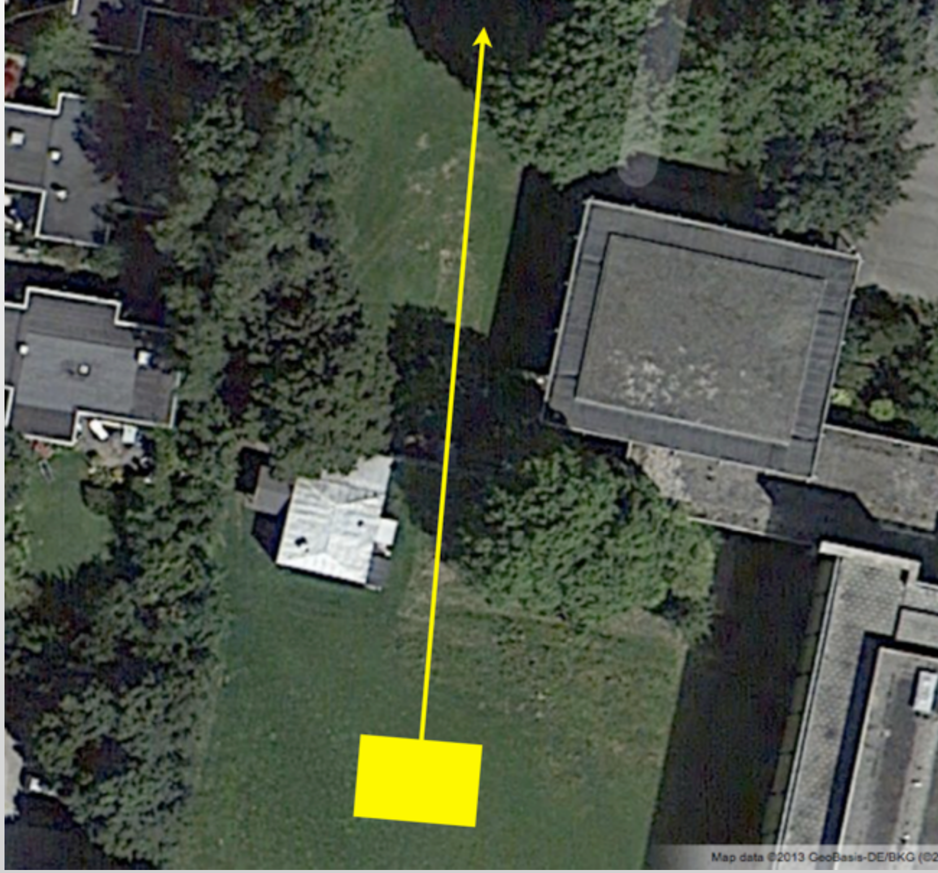
IP68 CMOS Camera monitors the mirror direction within ±15 arcsec

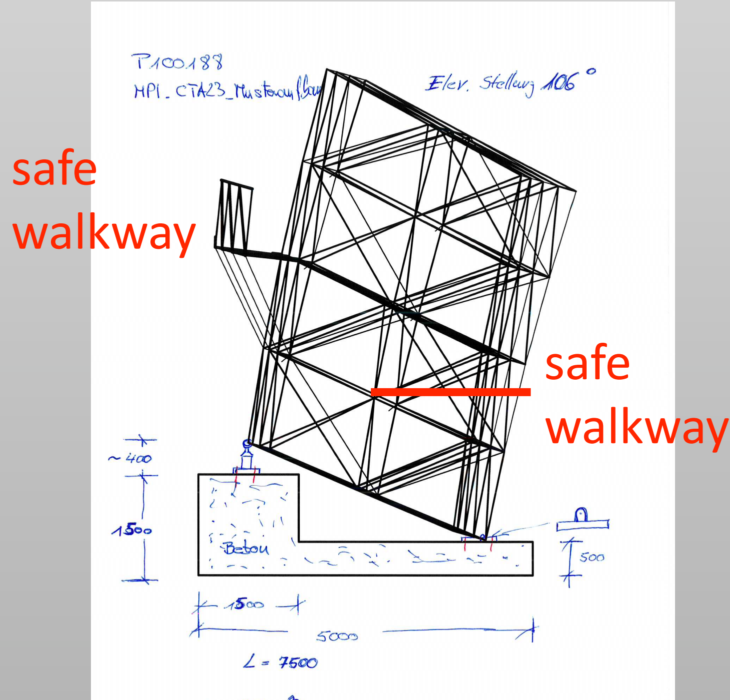
Actuators control the mirror facet direction with an accuracy of ±15 arcsec

Segment of dish structure in MPI back yard: Testbed for mirror mounting, AMC control and design of catwalks and safe access



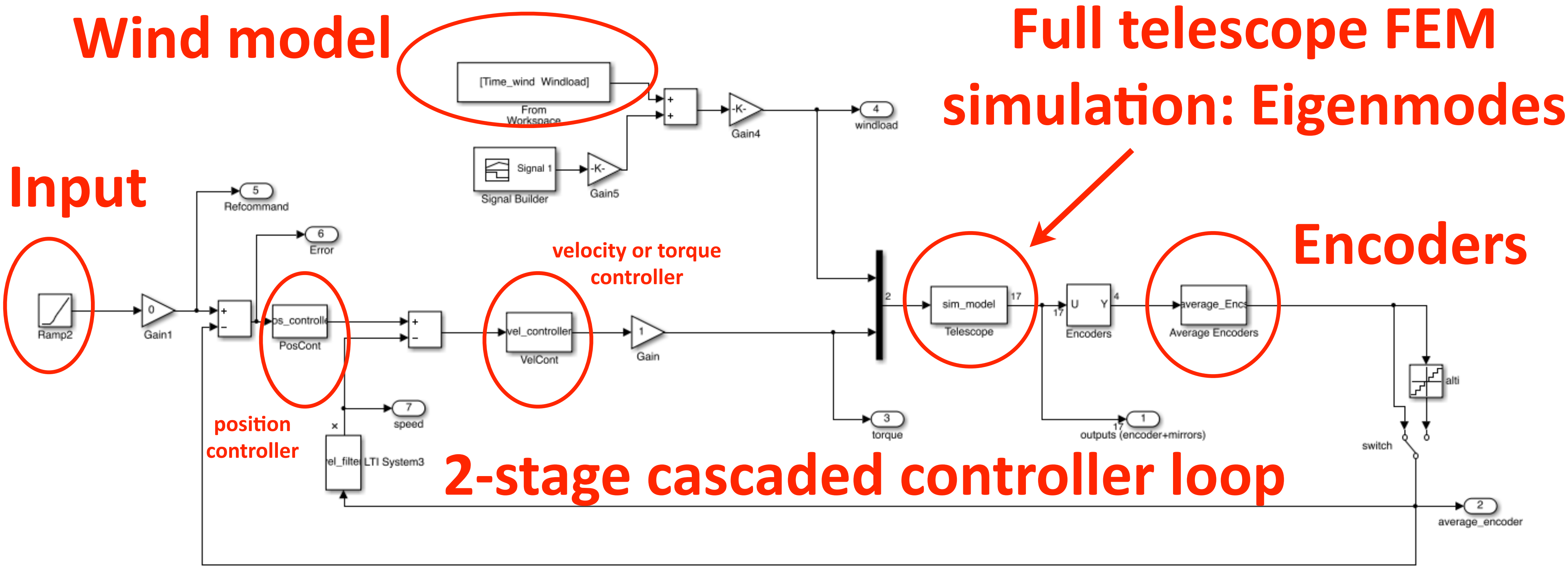






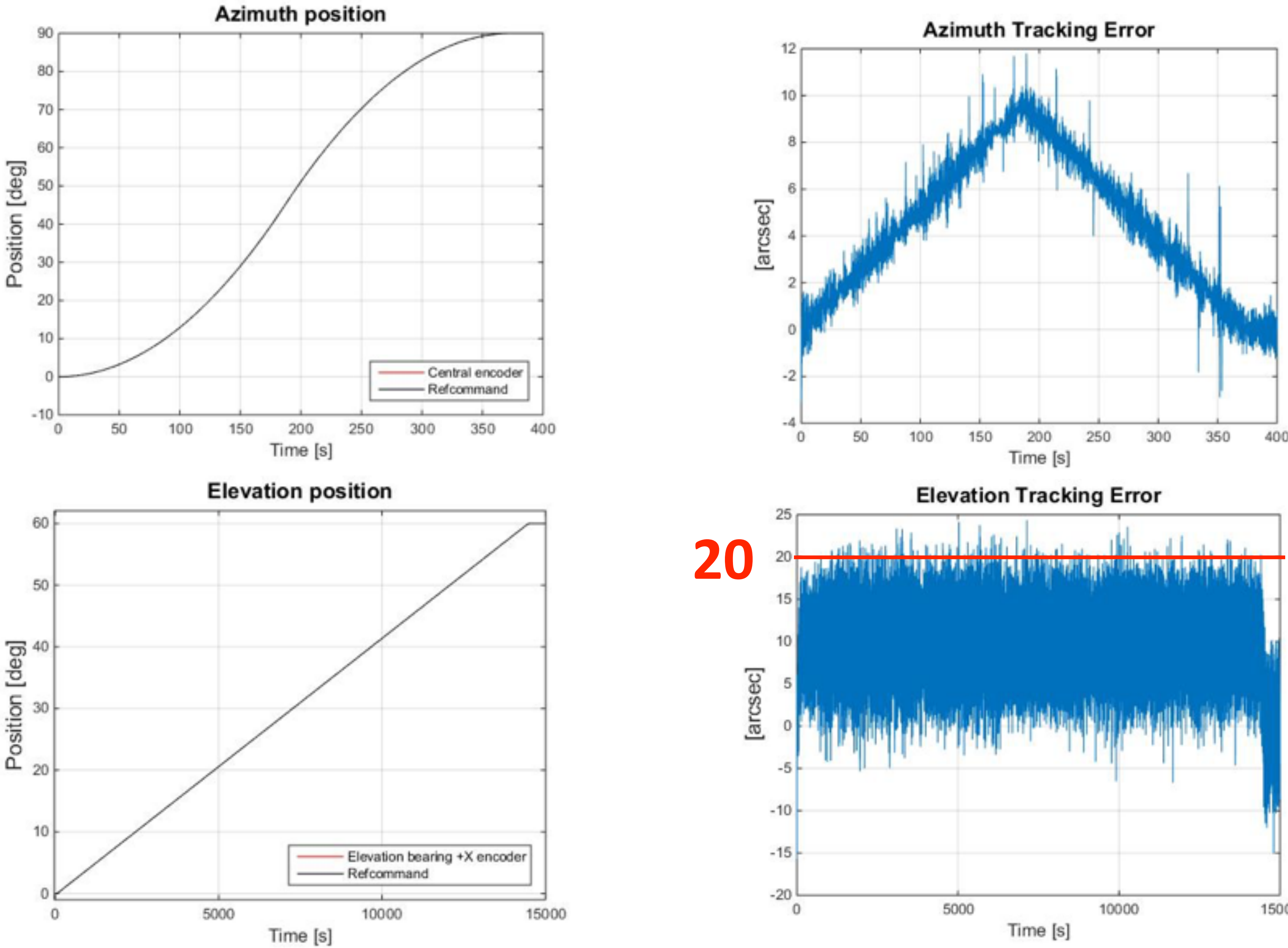
Control analysis, design and simulation for large LST telescope

- Simulation of the telescope structure in closed-loop
- Tracking, response to wind load, servo control imperfections and noise, deformation of optical elements such as M1 and Camera
- Using FEM dynamical models for design and simulation of the axes
- Using Matlab/Simulink for controller design and closed-loop simulation of axes
- Verify the dynamic responses and estimate motions of different elements of the telescope structure, e.g. M1, Camera, central axis etc.



The control diagram (using Simulink)

Full telescope simulation studies under wind excitation (wind gust up to 60 km/h)



Rough time line for mechanical construction

cta cherenkov telescope array

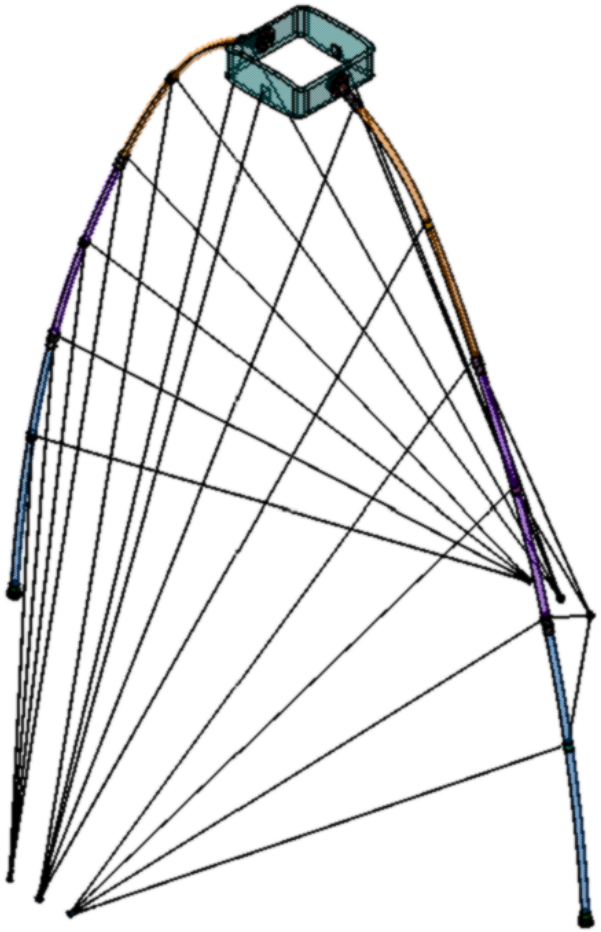
- The contract with MERO has been signed in August 2015
- The lower part of the central pin has been ordered in December 2015
- The rail has been ordered (last week)
- The bogie knots, elevation drive and backside arch will be soon in tendering process (January 2016)
- In March the pouring of the foundation will start
- In May the central pin, rail and bogies will be installed
- In July until September the lower structure and dish will be installed
- In October the camera arch and mirrors will be installed

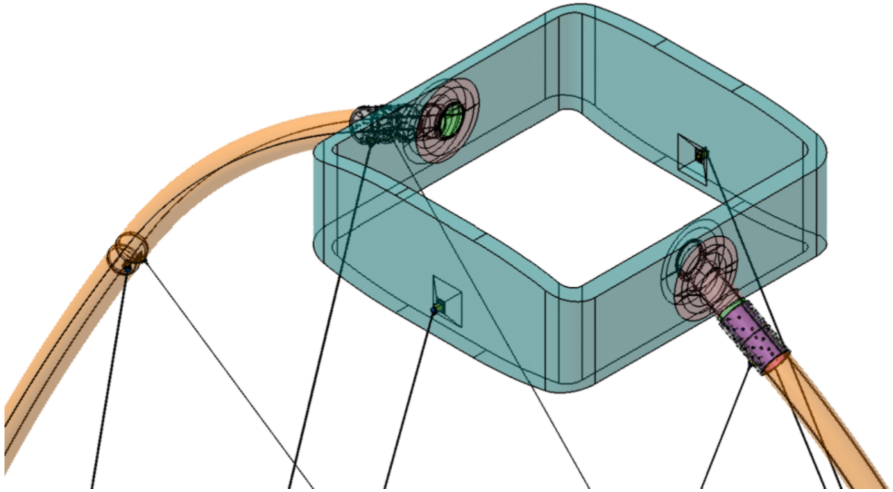
Picture of LST by Toni

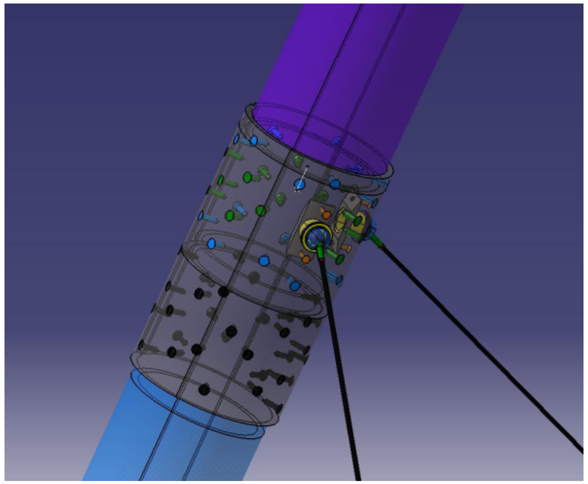
The end

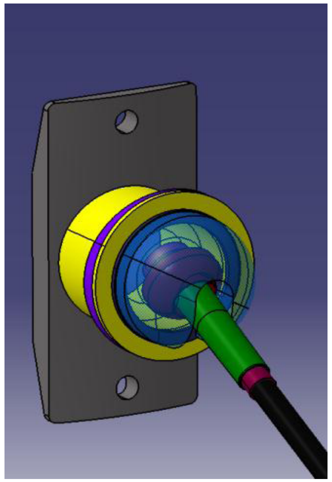

Eckart Lorenz

Camera support structure (CSS): LAPP

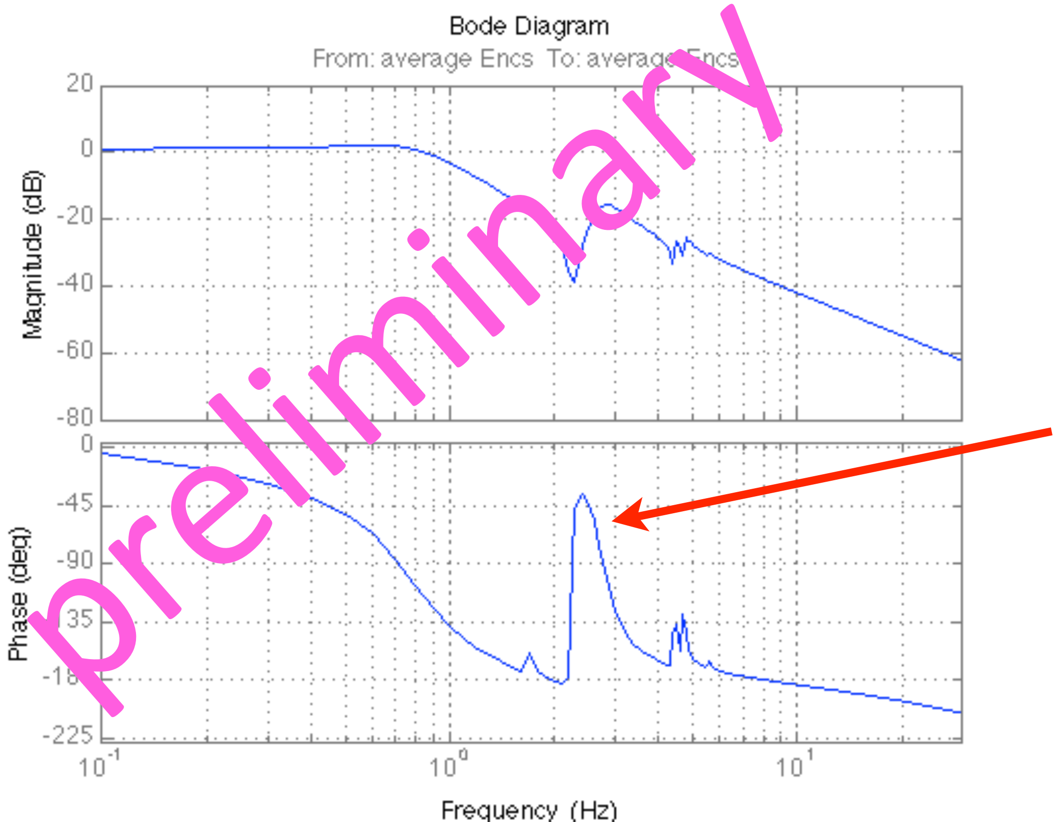








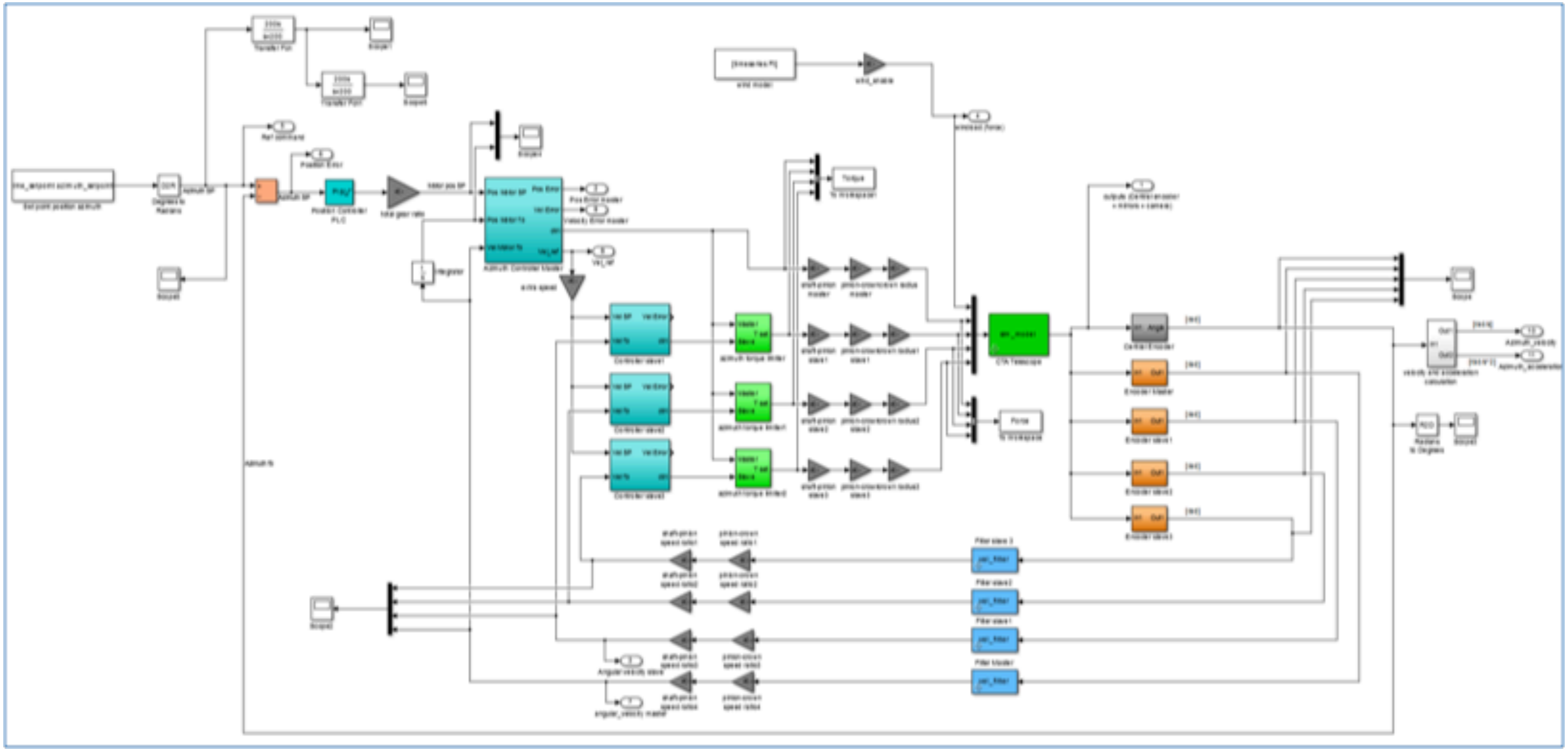
- **Example: Azimuth axis control**
- Master/slave control of bogies (4 motors) based on a cascaded velocity and position control loops
- Average encoder reading of 4 motors is used as velocity and position feedback signals and the control command is applied similarly on all motors
- FEM model: Open-loop frequency response for controller design
- Design PI controllers for velocity and position loops with standard robustness margins
- A closed-loop bandwidth of about 1Hz



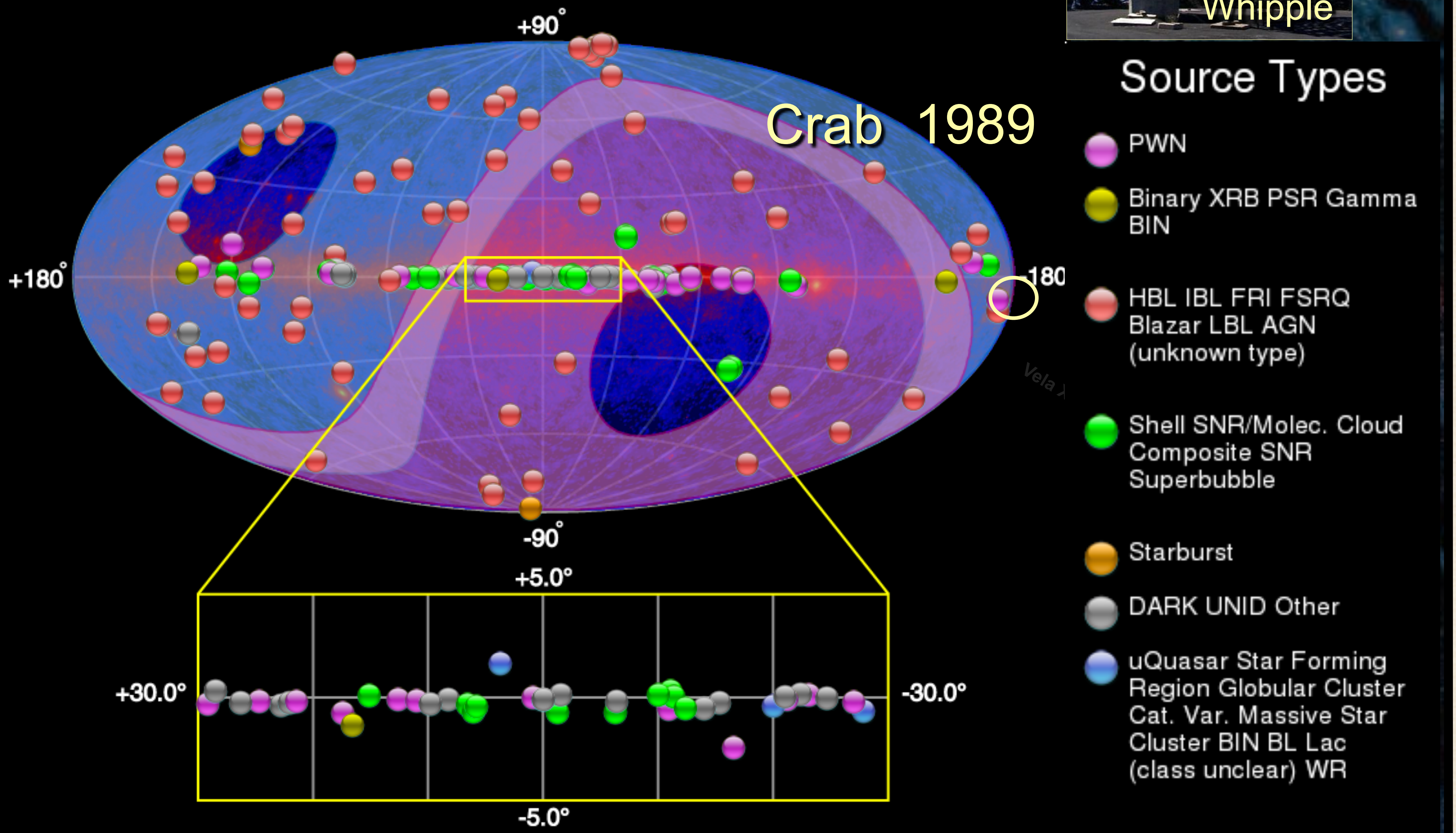
Oscillations may start at Eigenmode frequencies of the telescope, if not correctly designed

Control analysis, design and simulation for large LST telescope

- Tracking, response to wind load, servo control imperfections and noise, deformation of optical elements such as M1 and Camera
- Using FEM dynamical models for design and simulation of the axes
- Using Matlab/Simulink for controller design and closed-loop simulation of axes



HE Gamma ray astronomy *today:* around 162 sources



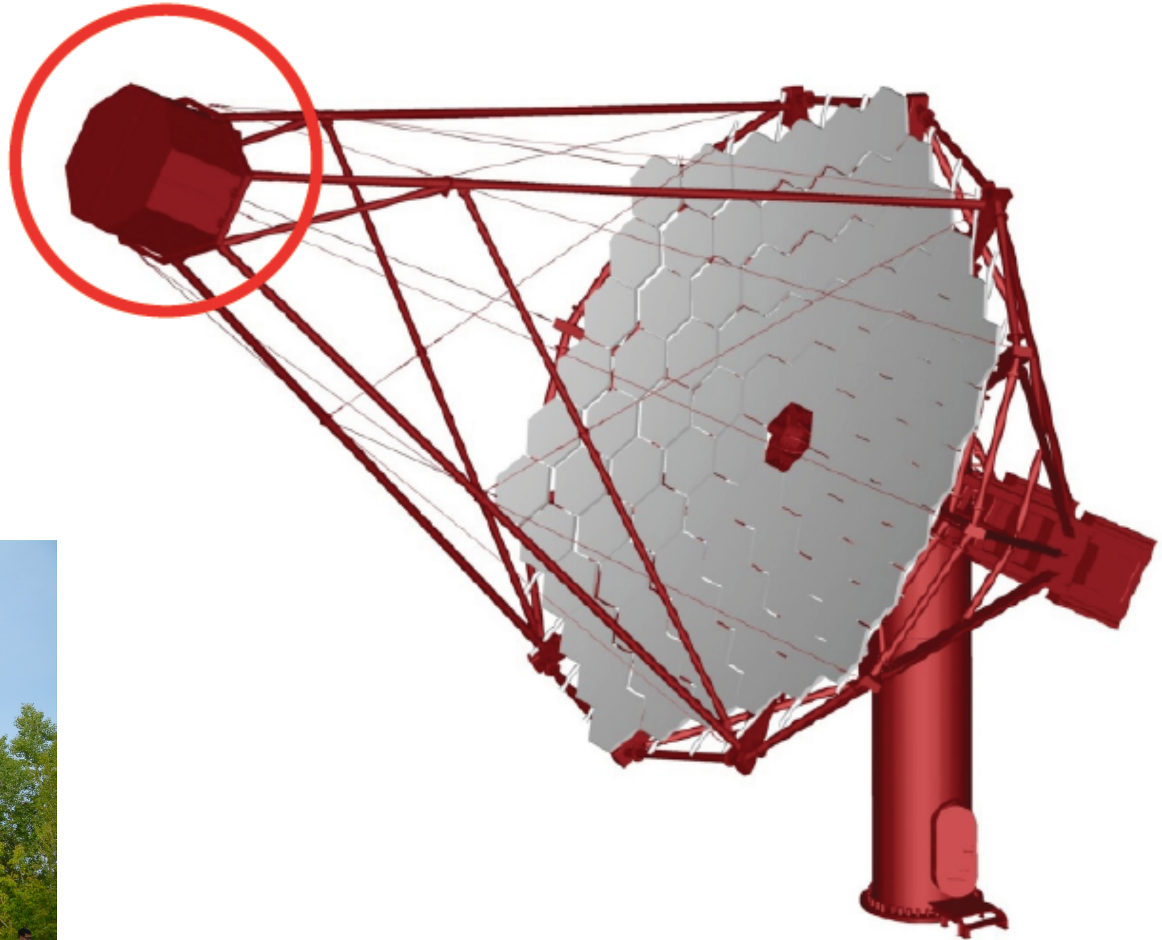
MEDIUM-SIZED 12 M TELESCOPE

OPTIMIZED FOR THE 100 GEV TO ~10 TEV RANGE

cherenkov telescope array

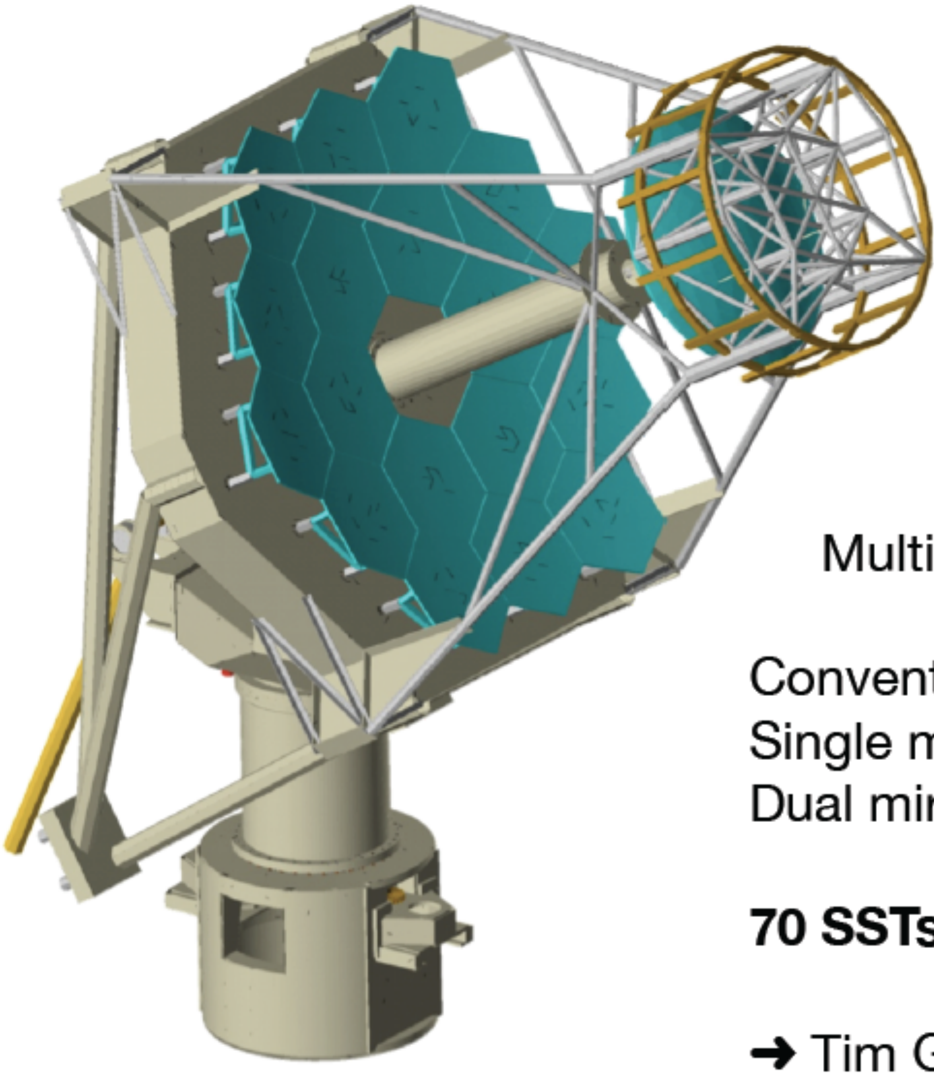
100 m^2 dish area
16 m focal length
1.2 m mirror facets

7-8^o field of view
~2000 x 0.18^o pixels



SMALL TELESCOPE

OPTIMIZED FOR THE RANGE ABOVE 10 TEV



ASTRI Design
4.3 m mirror
9.6° foV
0.25° pixels

Multiple options under study:

Conventional single mirror, PMT camera
Single mirror, silicon sensor camera
Dual mirror optics, silicon & MAPMT camera

70 SSTs on Southern site

➜ Tim Greenshaw

Look for PeVatron in our galaxy

The ideal solution