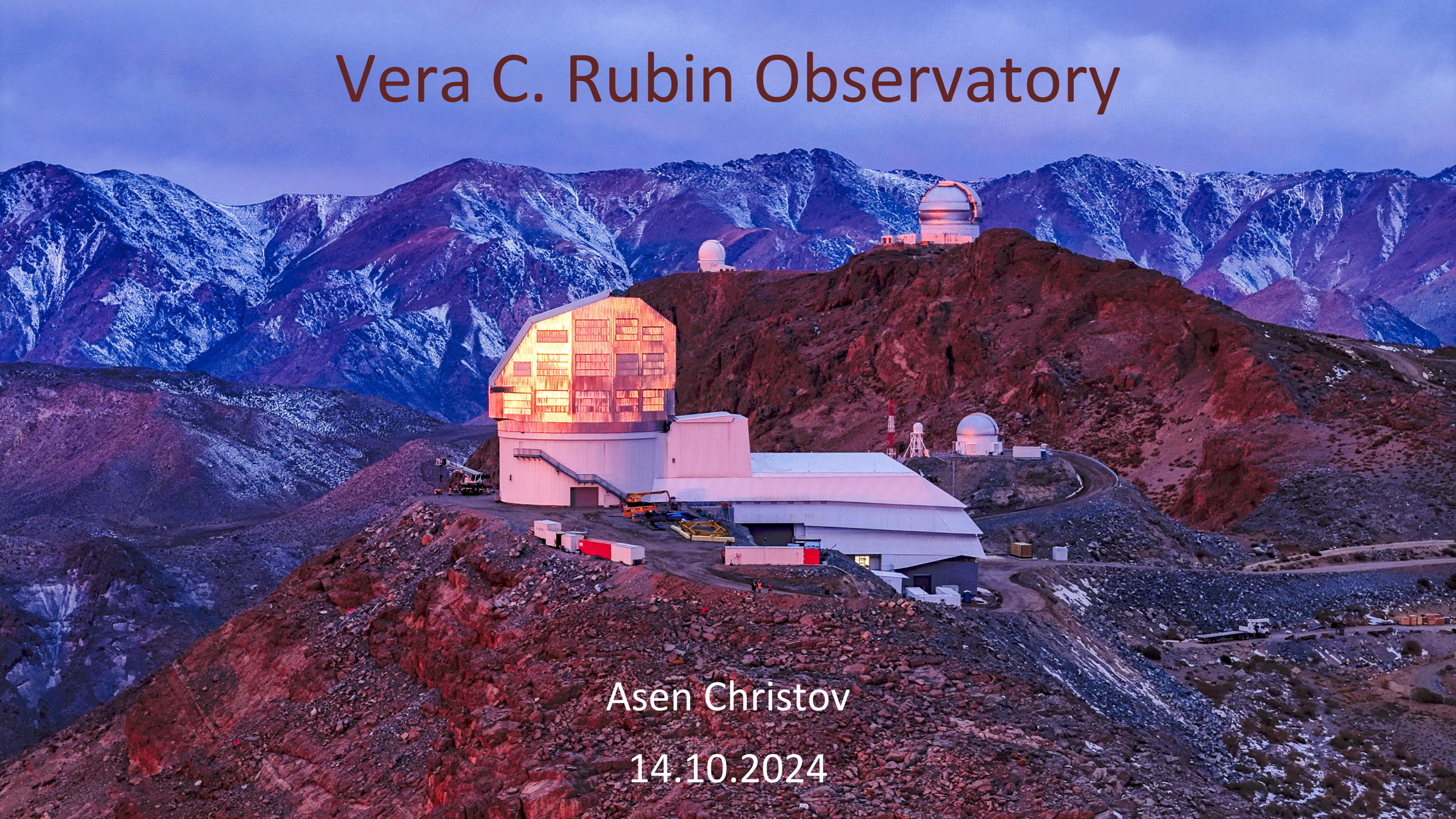
Vera C. Rubin Observatory



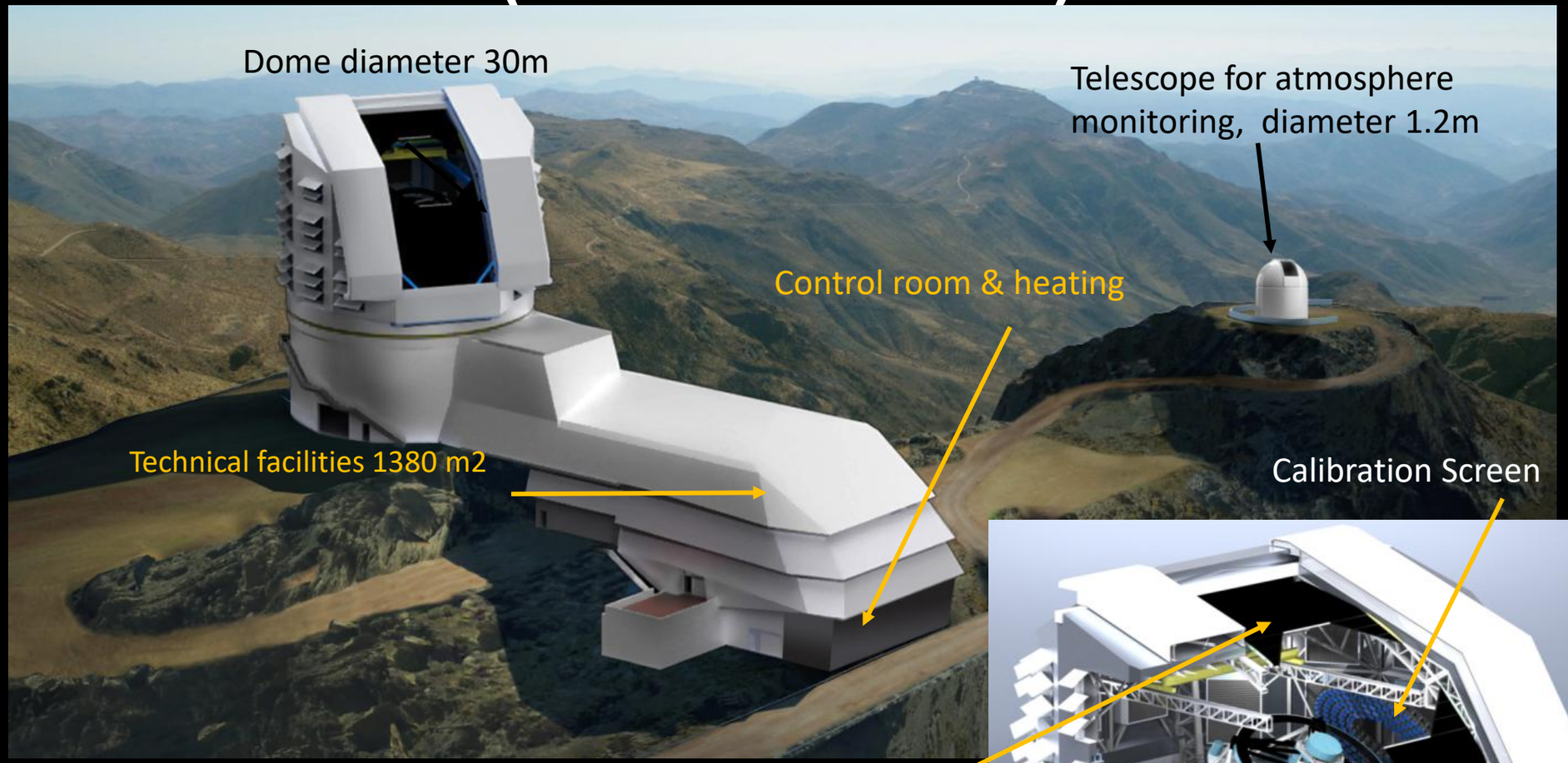
Asen Christov

14.10.2024

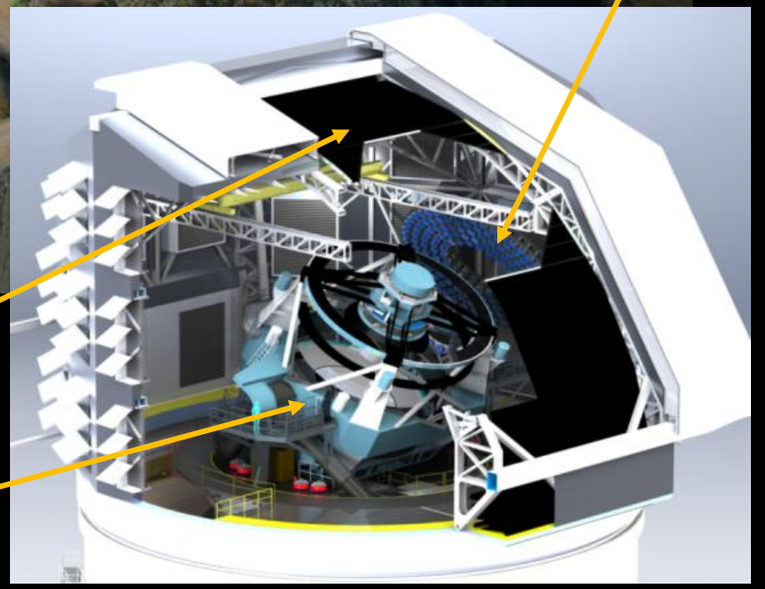
Location


Cerro Pachón selected in 2006
La Serena
La Serena airport
Port Coquimbo
LSST Base Facility
50 km paved highway
Vicuña
Cerro Tololo Inter-American Observatory (CTIO)
40km dirt road
Gemini & SOAR
LSST SITE
Pan-American Highway
N
0
10
20
km

Cerro Pachón (2682 m. nm)



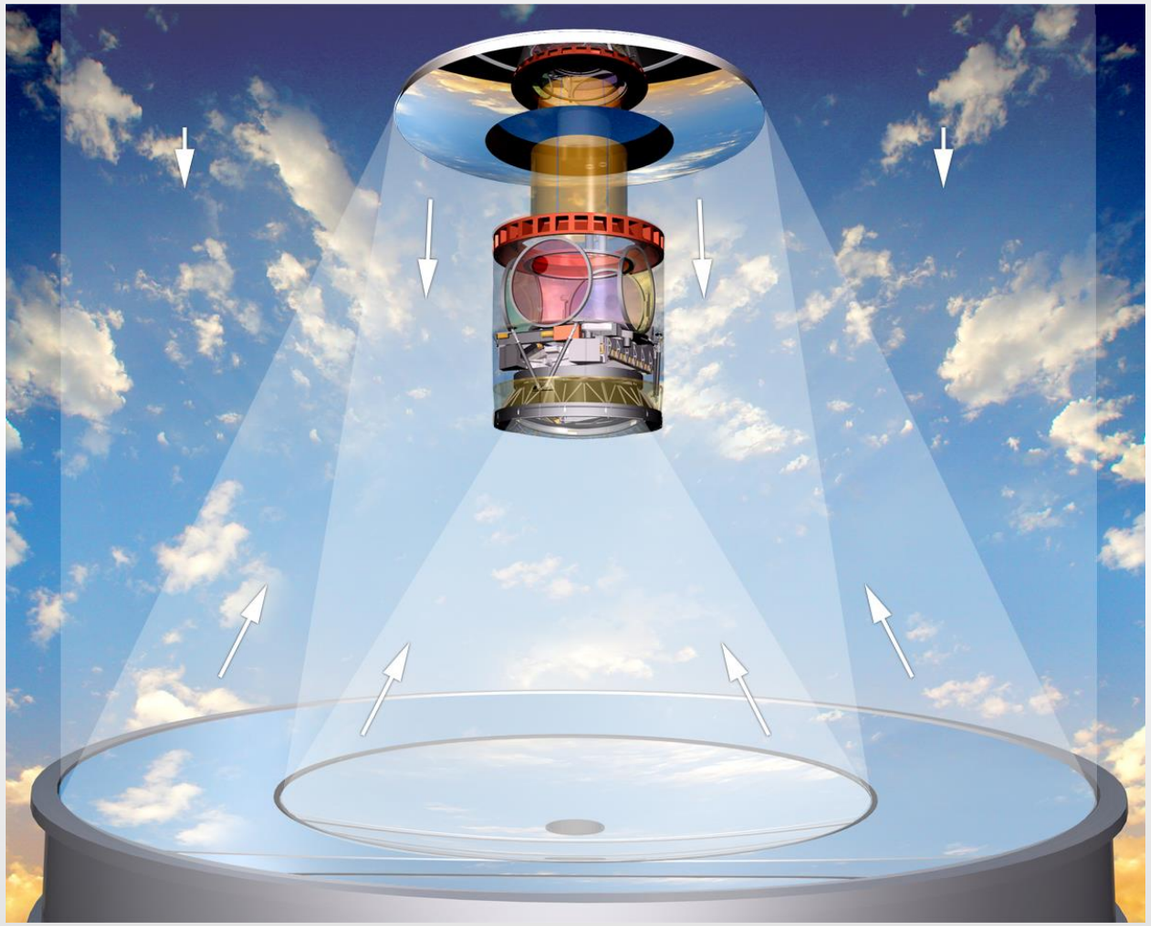
350T telescope



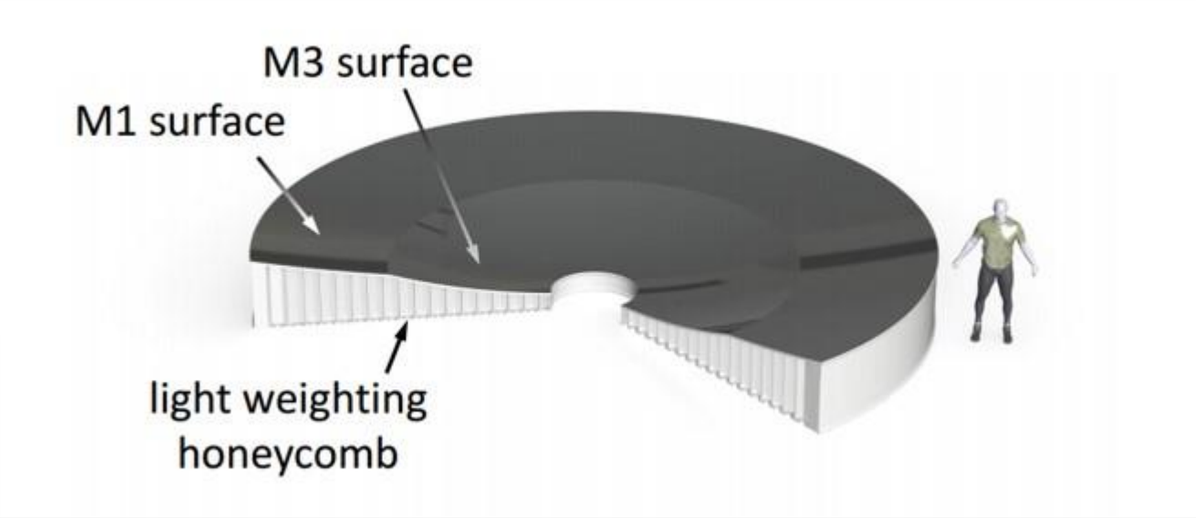
Cerro Pachón (2682 m. nm)

Cerro Pachón (2682 m. nm)

Optics

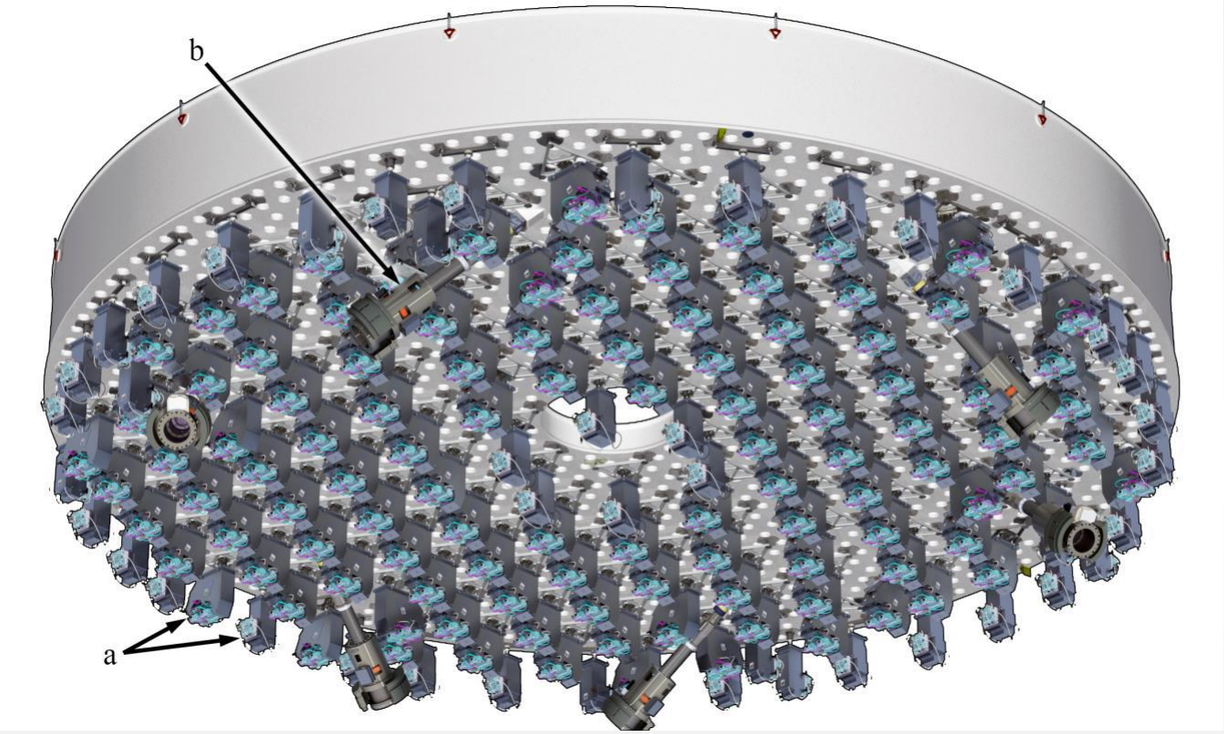


- Primary and tertiary mirror (M1M3)



M1M3

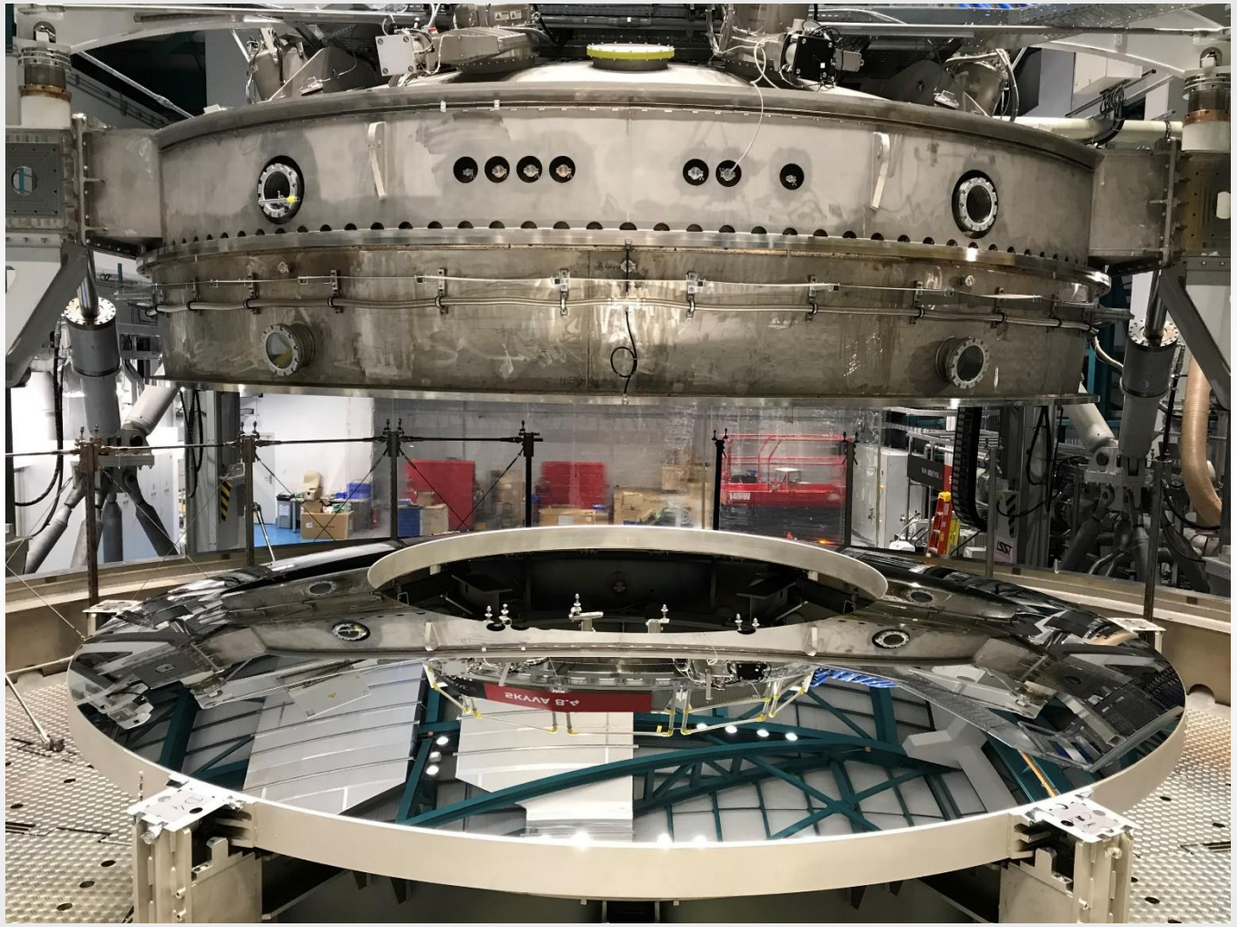
polishing



Actuators for deformation corrections

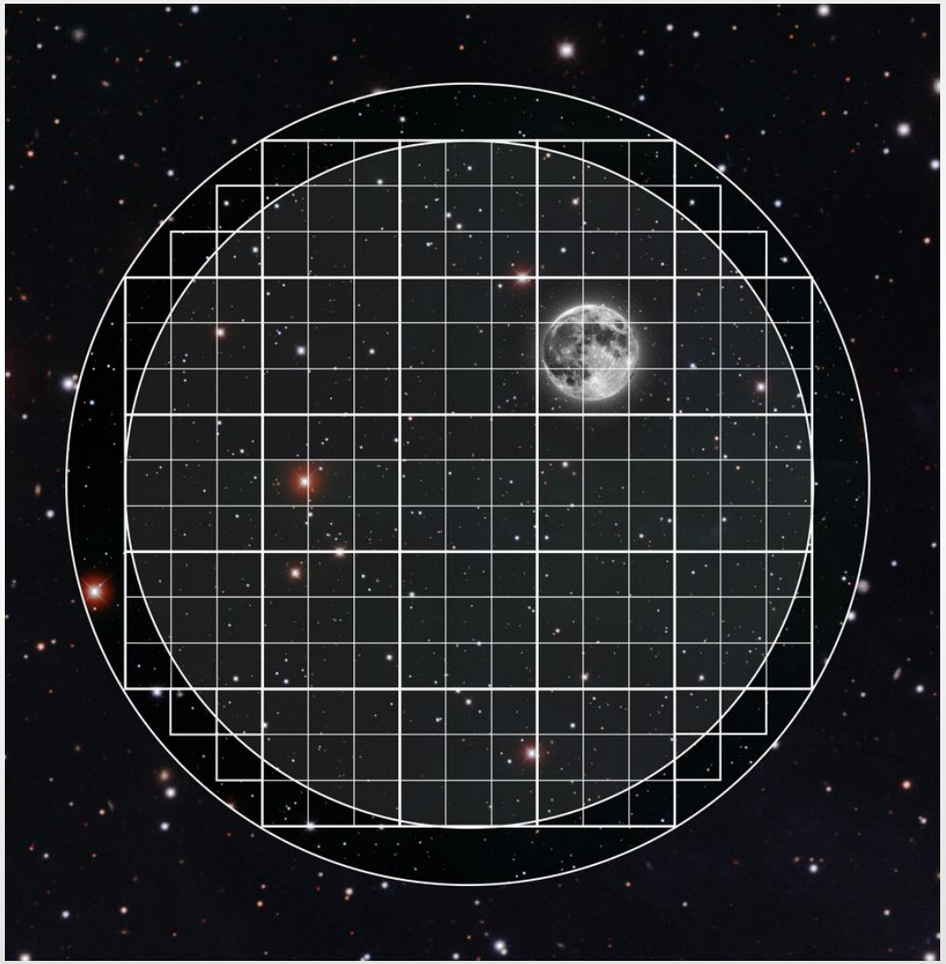
M1M3

M2



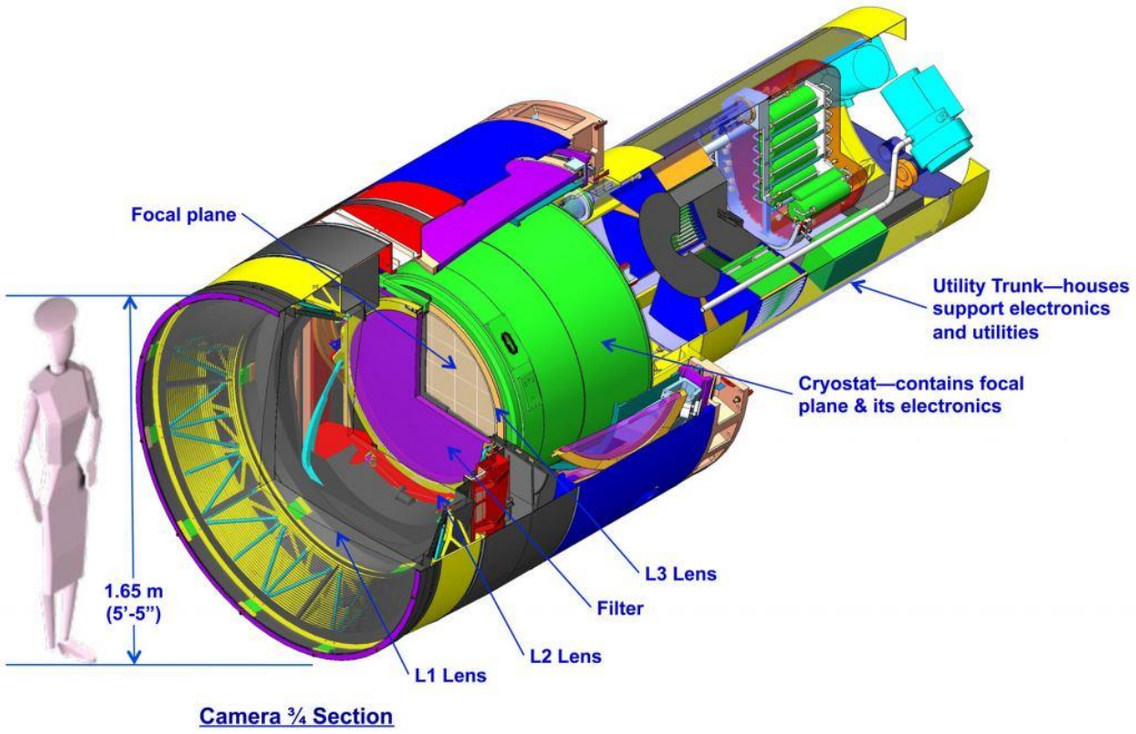
Biggest concave mirror in the world

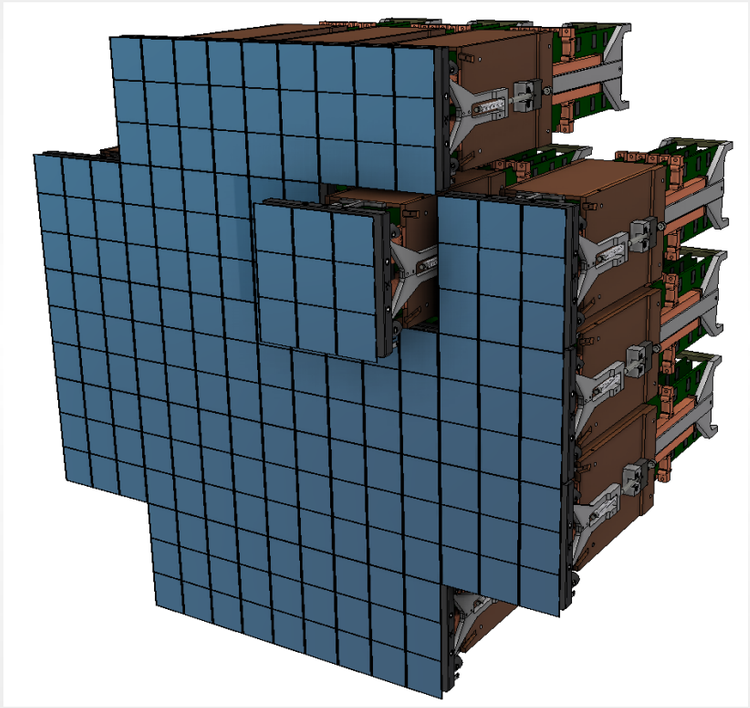
Field of view



- Field of view 3.5 degrees (9.6 square degrees)

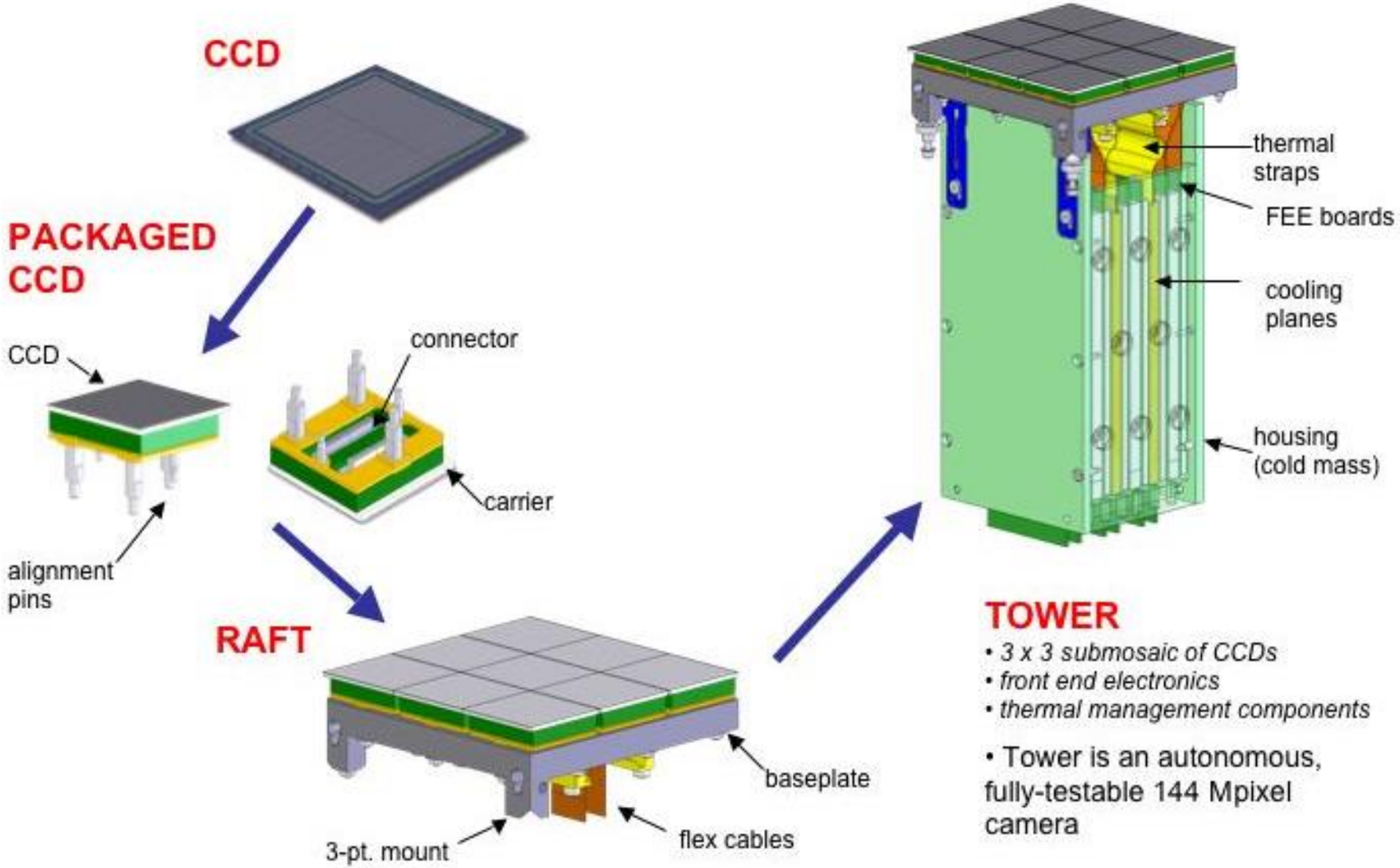
Camera



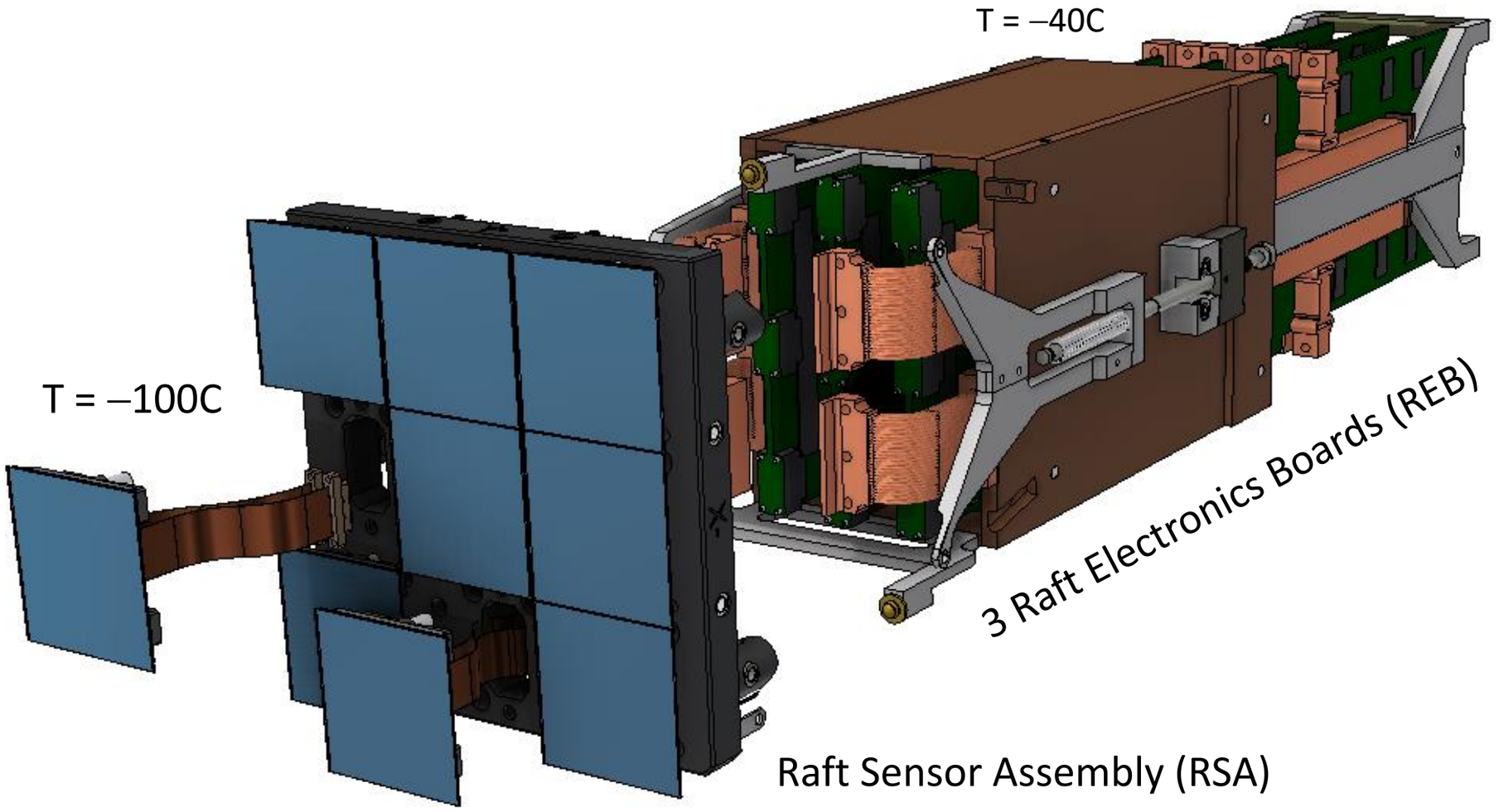


- Diameter of the detection plane: 64 cm
- 189 4K × 4K CCDs → 3 Gigapixels
- 21 rafts, 9 chips each
- Operation temperature -100 ℃

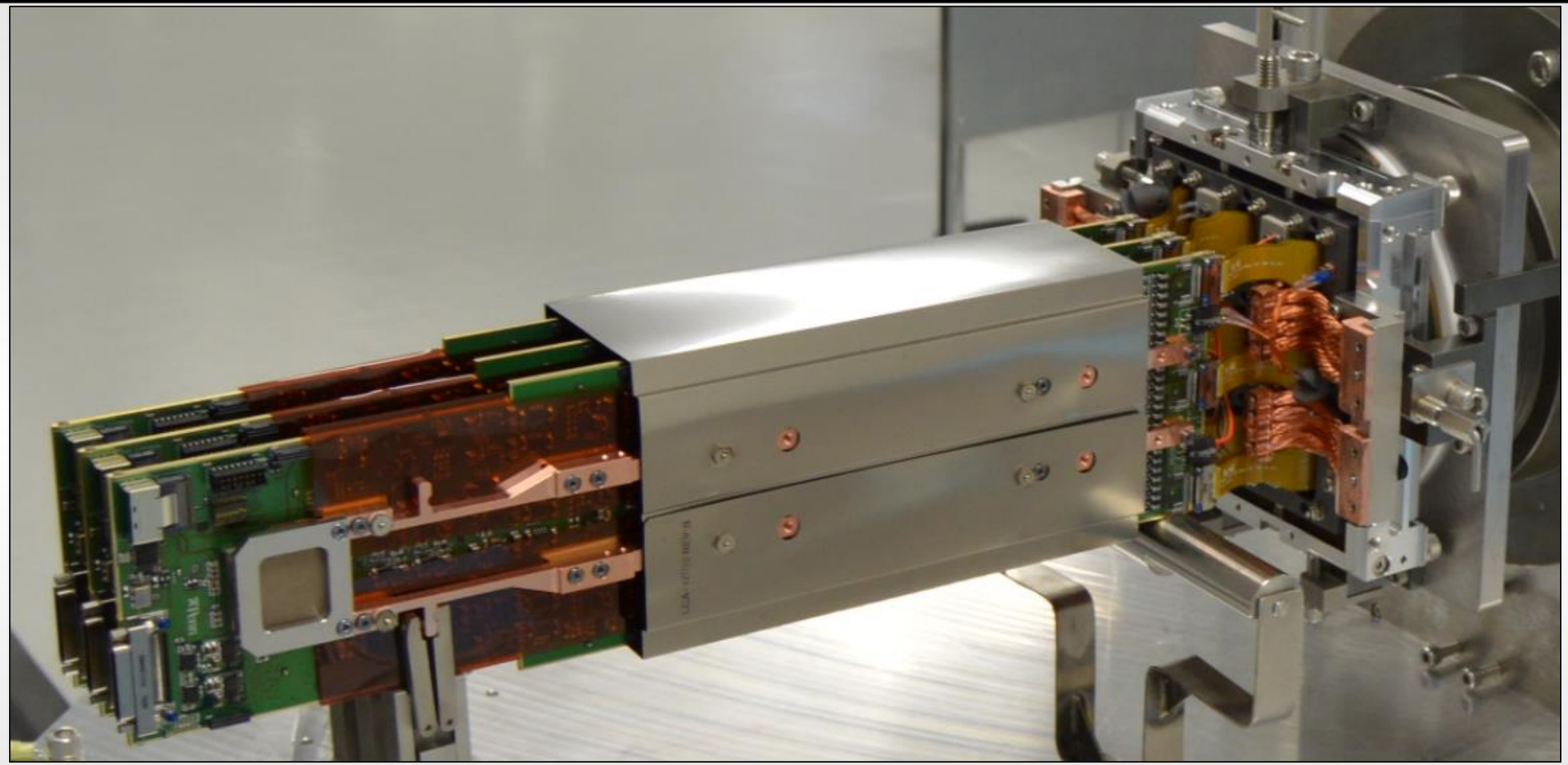
Camera


CCD
PACKAGED CCD
CCD
connector
carrier
alignment pins
RAFT
baseplate
3-pt. mount
flex cables
thermal straps
FEE boards
cooling planes
housing (cold mass)
TOWER
• 3 x 3 submosaic of CCDs
• front end electronics
• thermal management components
• Tower is an autonomous, fully-testable 144 Mpixel camera

Raft Tower Module (RTM)



Science Raft in BNL



Testing in BNL, participation of FZU

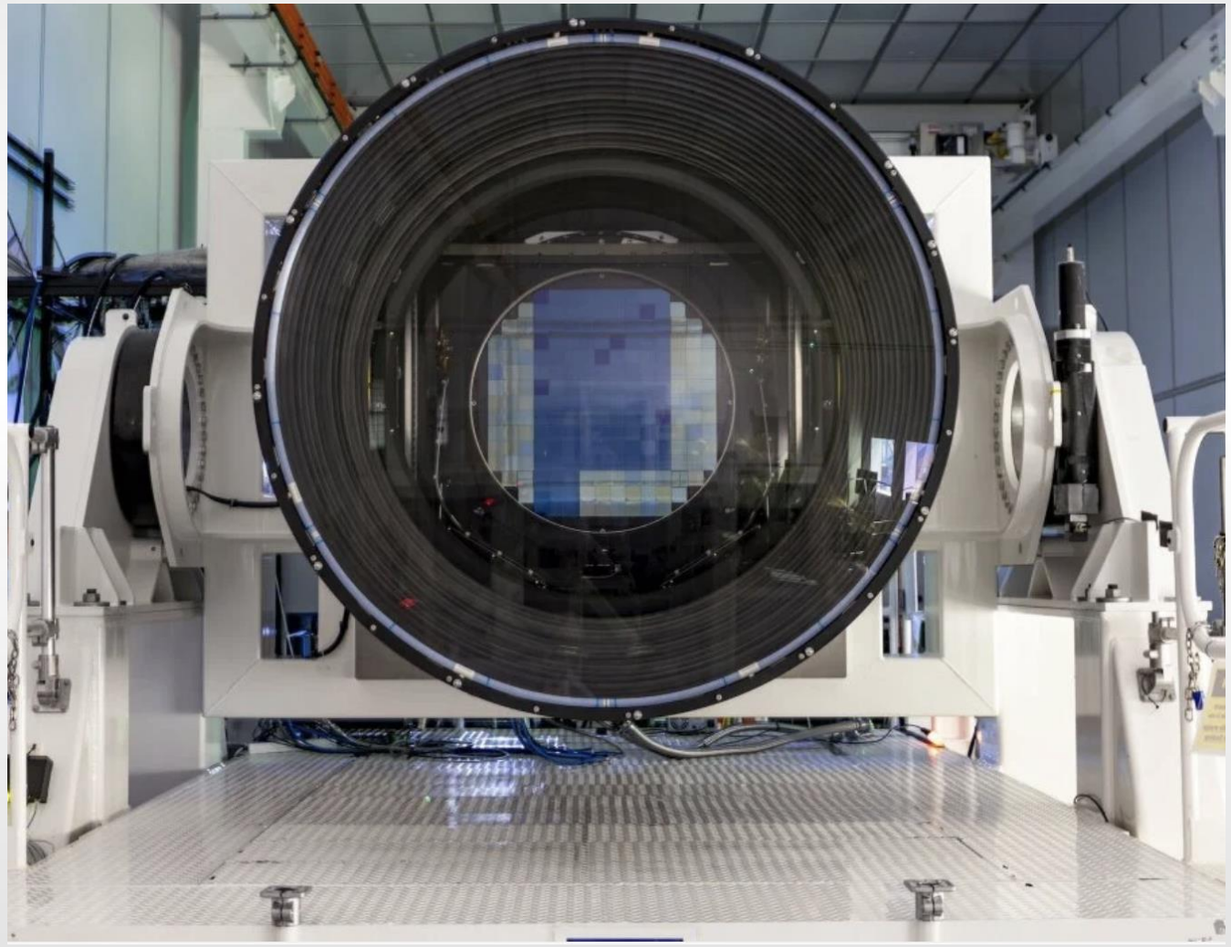
Petr Kubanek, Michal Vrastil
(M.Prouza group, Institute of Physics, CAS)
in BNL cleanroom

Early participation of M. Prouza and P. Kubánek earned us data rights

Sergey Karpov, Asen Chistov
CCD characterization

Final assembly in SLAC

LSST Camera, SLAC 2023

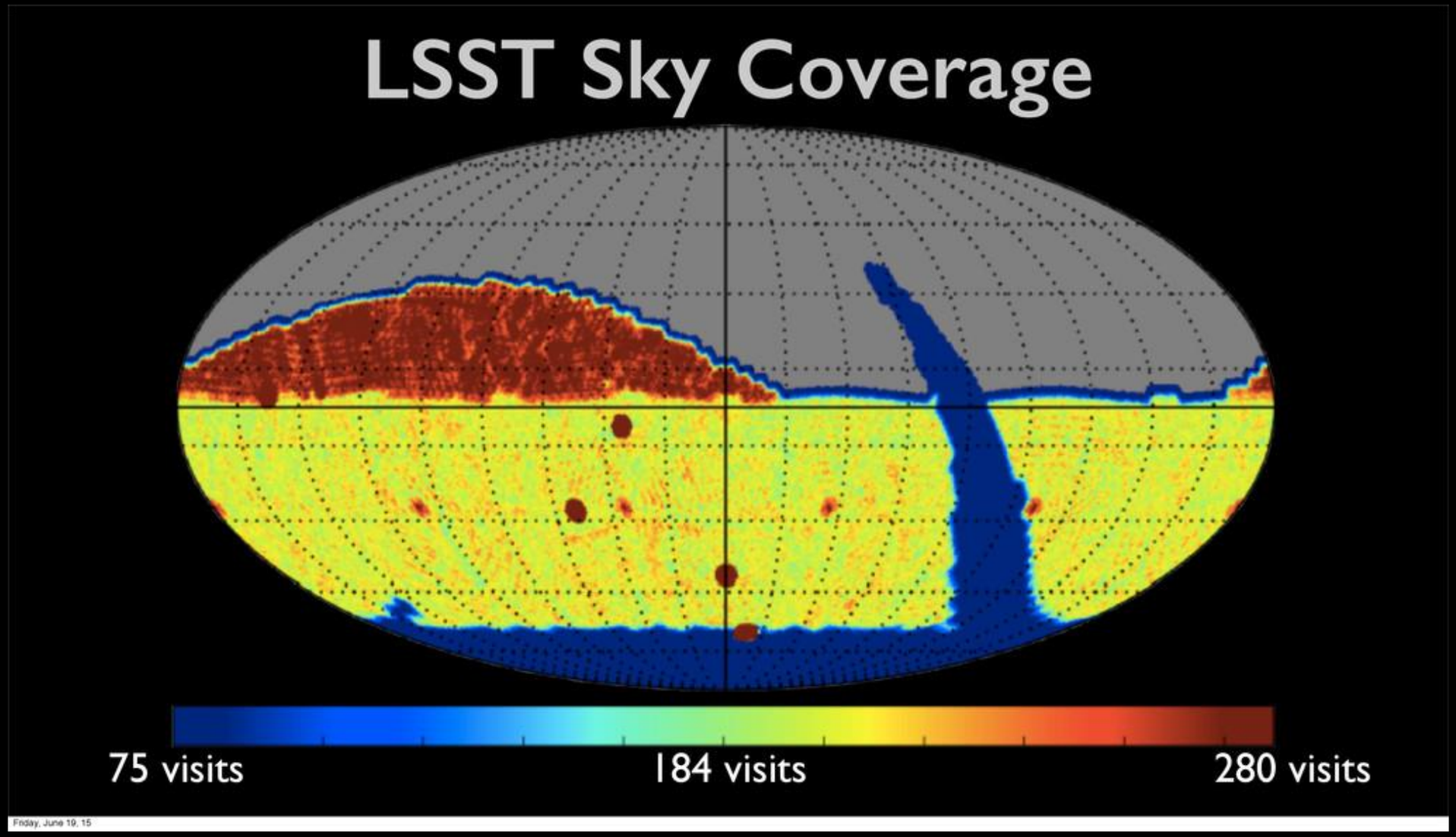


Current status

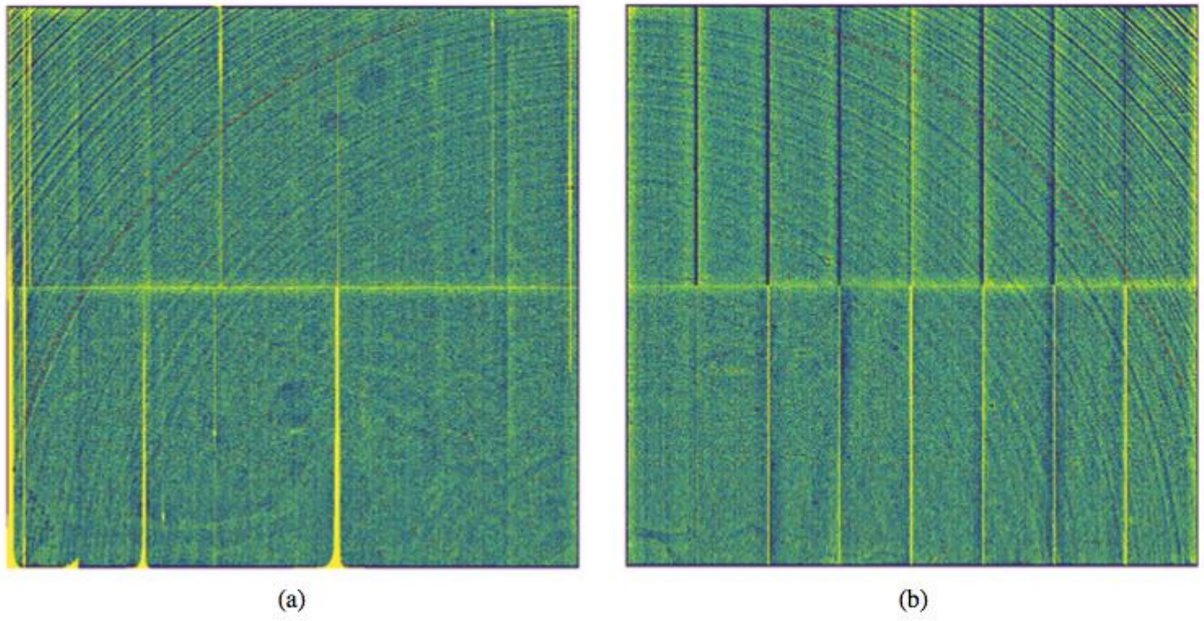
- (Reported by P. Kubánek on the 30.9.)
- The telescope is parked in zenith position, M2 installed
- The main mirror M1M3 installed
- Mid October the telescope should be complete
- Next step to tilt it down from zenith, actuator setup
- "ComCAM" installation at the end of the month
- The main camera is at the site, installation at the end of the year

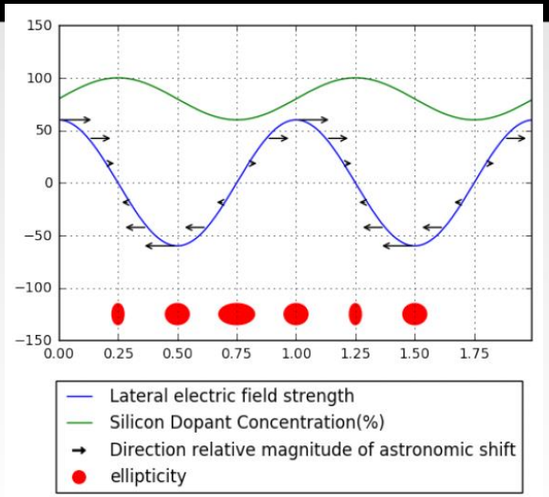
- First light – beginning of 2025

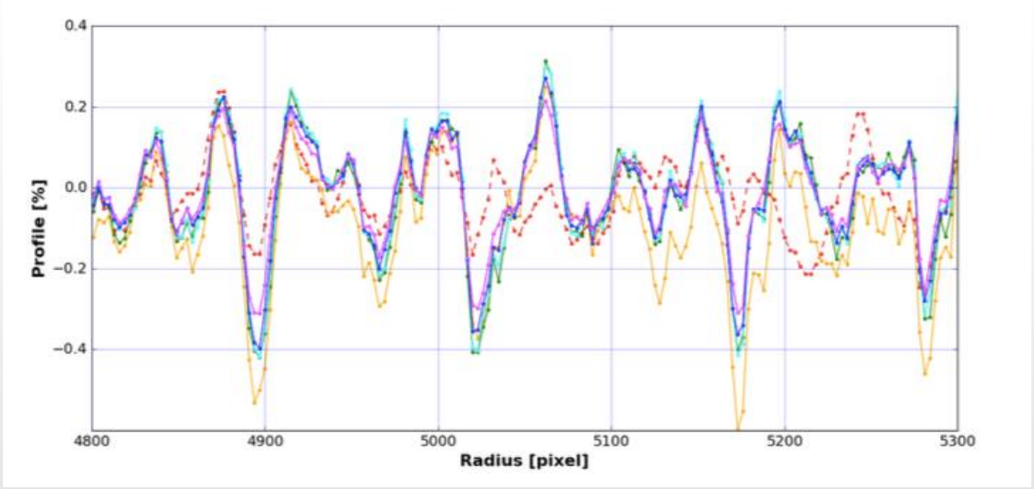
Visits map


LSST Sky Coverage
75 visits
184 visits
280 visits
Friday, June 19, 15

Tree Ring analysis







H.Y. Park *et al* 2017 *JINST* **12** C05015

Tree Rings on LSST production sensors : its dependence on radius, wavelength, and back bias voltage

HyeYun Park[a,b], **Sergey Karpov**[c], **Andrei Nomerotski**[b], **Dmitri Tsybychev**[a]
[a]SUNY Stony Brook, Physics and Astronomy department, 100 Nicolls road, Stroy Brook, NY11794, USA
[b]Brookhaven National Laboratory, LSST-DESC, Physics department, 98 Rochester St, Upton, NY11973, USA
[c]CEICO, Institute of Physics of the Czech Academy of Sciences, Na Slovance 1999/2, 182 00 Praha 8, Czech Republic

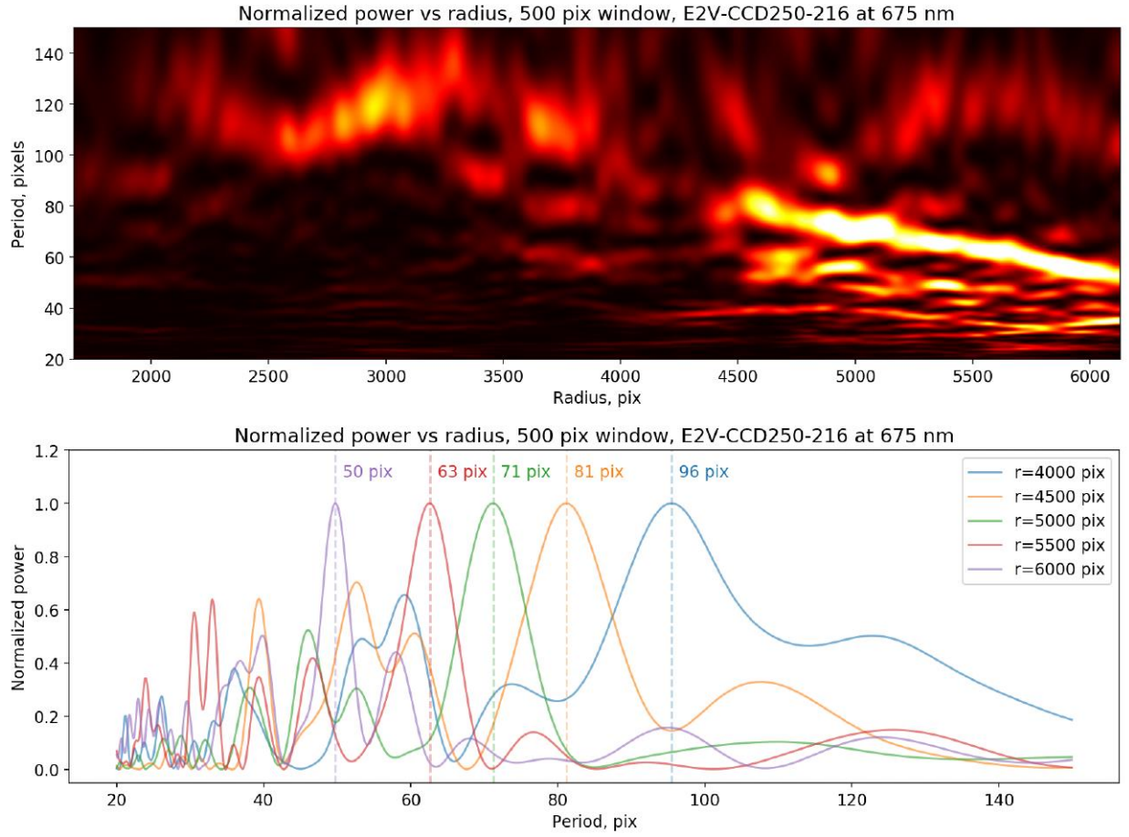
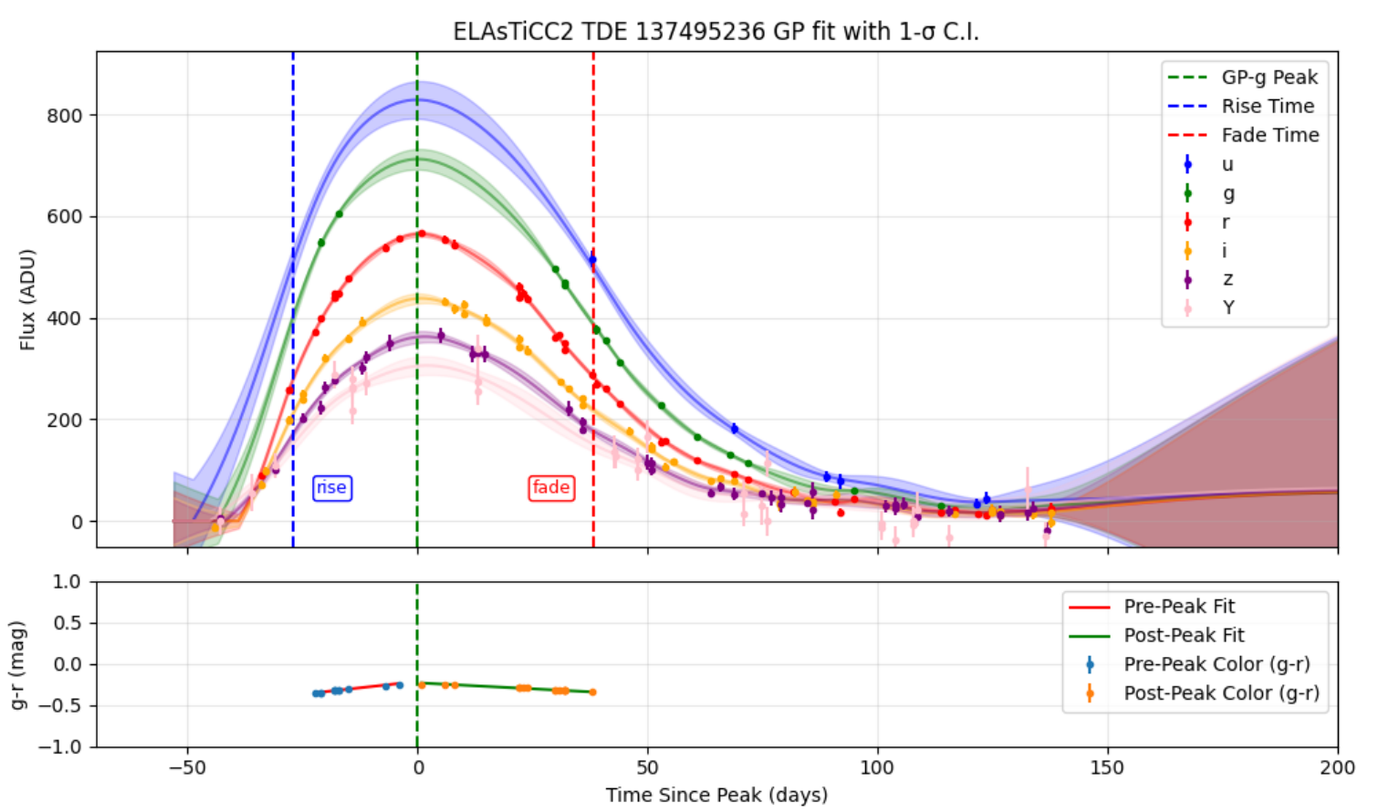


Fig 6 Upper panel – radius-resolved periodogram of a tree rings on E2V sensor. The drift of primary period (period decrease with radius increase) is clearly seen. Lower panel – Lomb-Scargle periodograms of the tree rings for the same sensor on several radii, with marked positions of the primary peak, which drifts to lower periods towards the edge of silicon wafer.

Sergey Karpov, FZU

TDE identification



PhD student **Kunal Bhardwaj**
"Gaussian Processes" fit

- Current FZU activities
  - TDE identification algorithms
  - Light curves extraction and fits
  - Implementation in the brokers

Czech Contribution to LISA Mechanisms for the Optical Bench

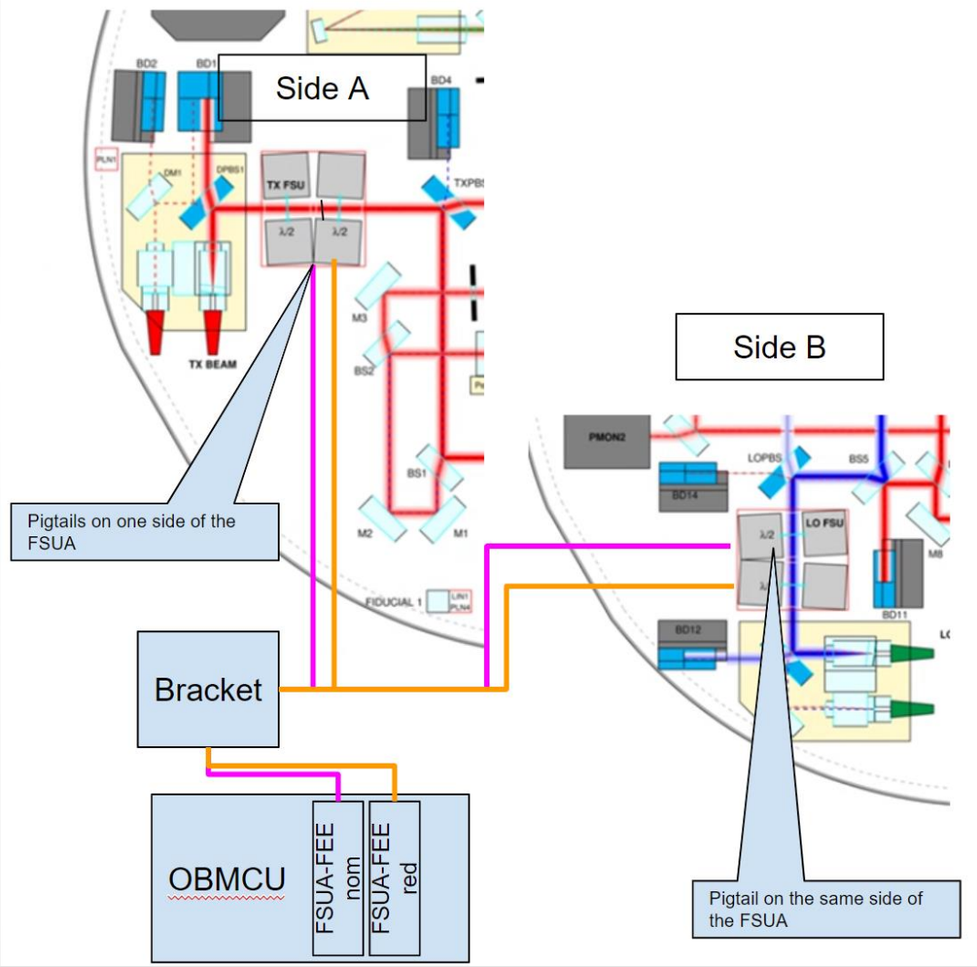
Astronomical Institute of the Czech Academy of Sciences

FZU Institute of Physics of the Czech Academy of Sciences

INSTITUTE OF THERMOMECHANICS
CZECH ACADEMY OF SCIENCES

ÚSTAV FYZIKY ATMOSFÉRY
AV ČR

FSUA system

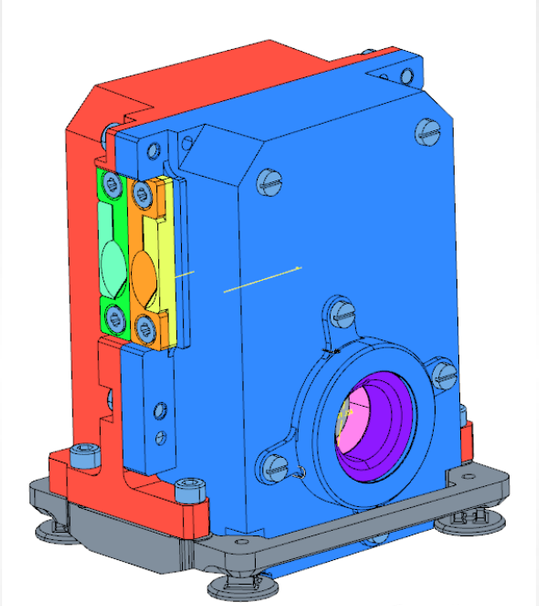


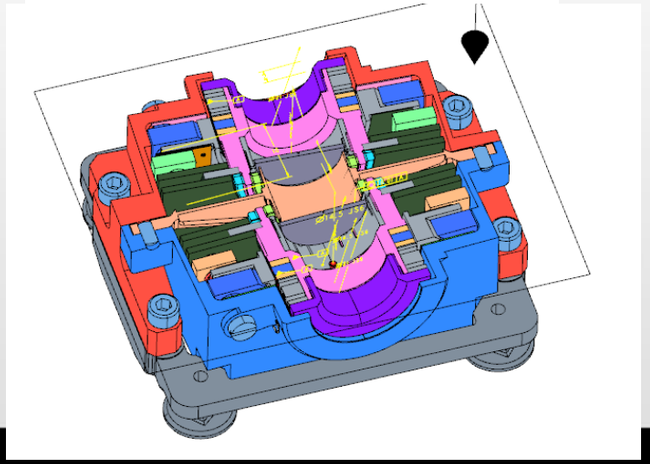
- FSUA = Fibre Switch Unit Actuator
- OBMCU = Optical Bench Mechanism Control Unit
- Goal: reliably rotate polarization of incoming beam
- LISA = 3 satellites
  - 2 optical benches
    - 2 **FSUA**
  - 2 OBMCU
    - 2 control board (**FSUA-FEE**), nominal and redundant, each controlling nominal (redundant) part of two FSUA mechanisms
    - All control boards inside **OBMCU mechanics / housing**

FSUA mechanism requirements

- Non-magnetic
- Fully redundant (sensing, actuators, optical elements, cabling) – critical mechanism
- Accommodate 2x lambda/2 waveplates
- Rotate each of waveplate by 45 deg, but shall be able to rotate to arbitrary orientation
- Each waveplate its own absolute encoder
- High thermal stability

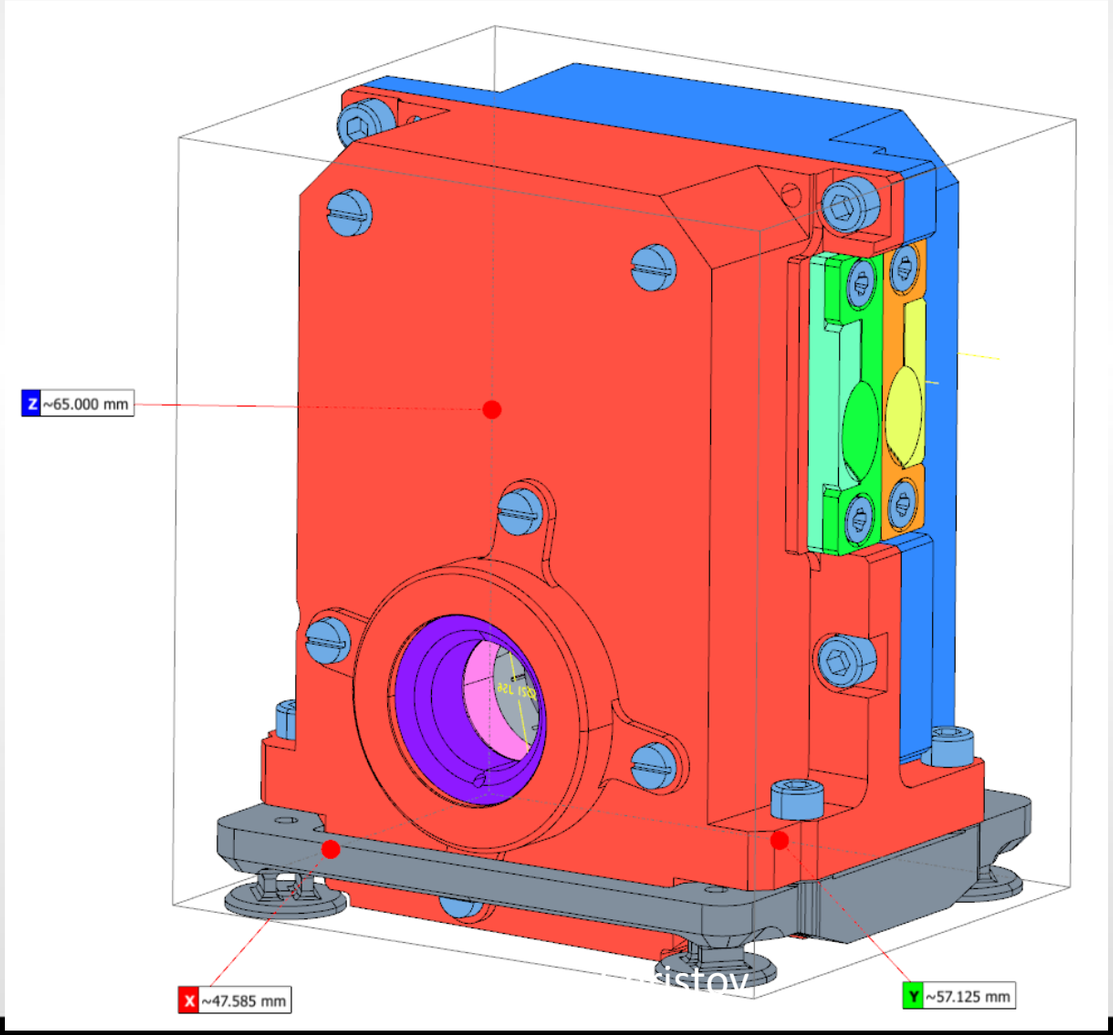
FSUA mechanism – current status





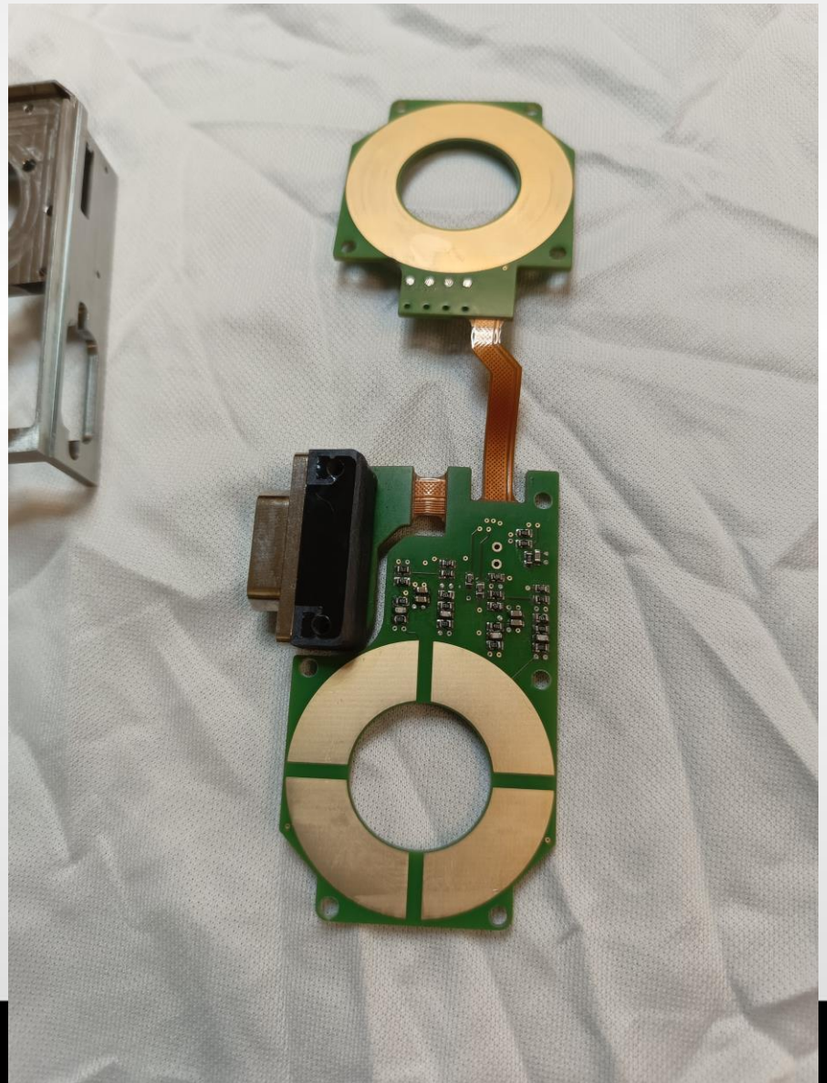
- 2 rotation axes in each mechanism (because of redundancy), including pigtail, encoder, actuator etc.
- Materials
  - Ti gr 5 main parts
  - Inconel screws (typically M2 – M2.5) + brass helicoils (optional)
  - PEEK CA30 slip stick inserts + cable clamps
  - Fused silica encoder (capacitive)
  - Teflon + kapton insulation parts
  - Piezo stacks (8pieces of 6x2x2 mm)

FSUA mechanism - dimensions



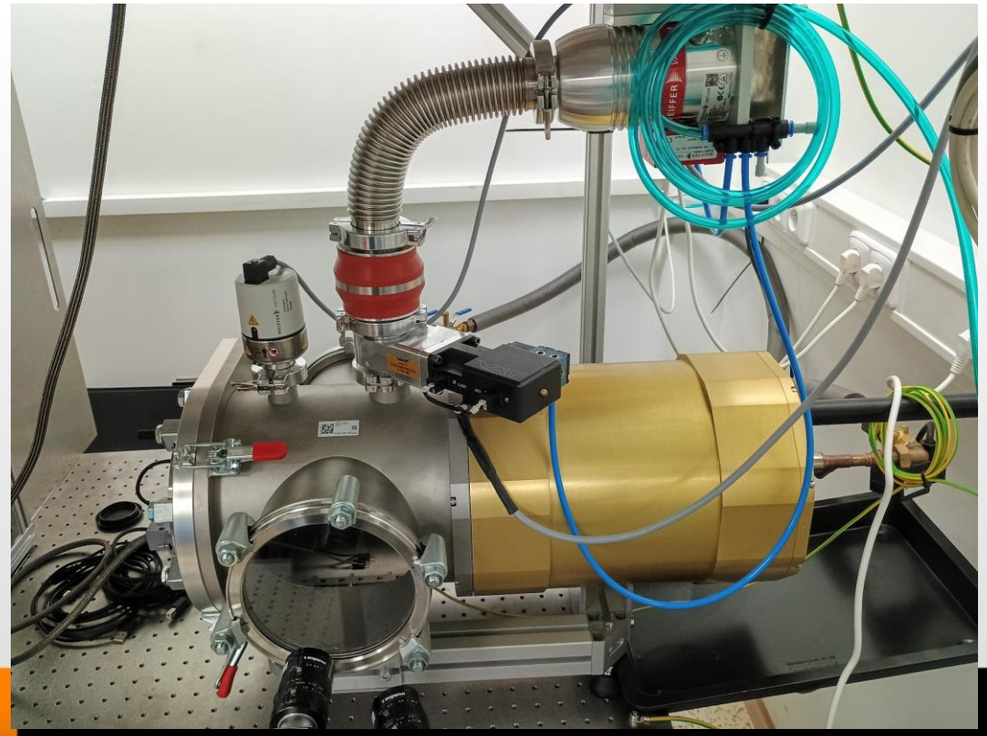
FSUA mechanism – DM

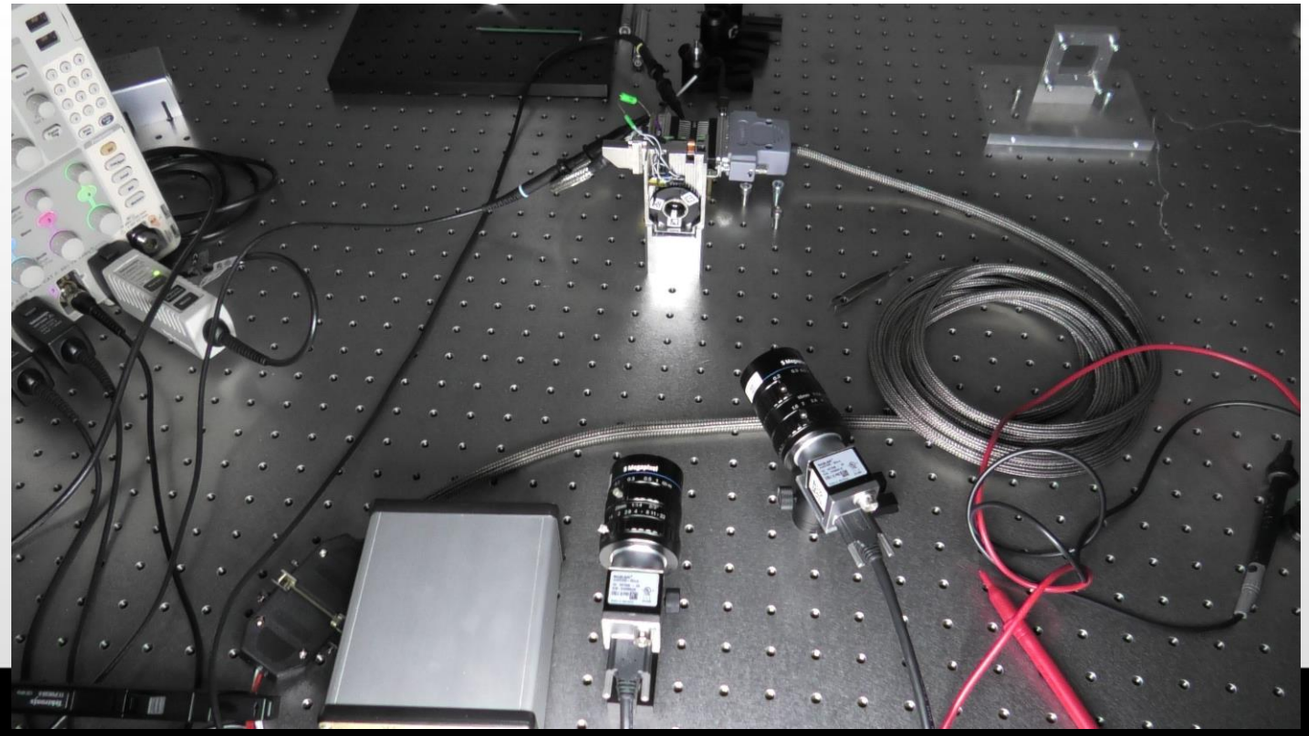
Asen Christov



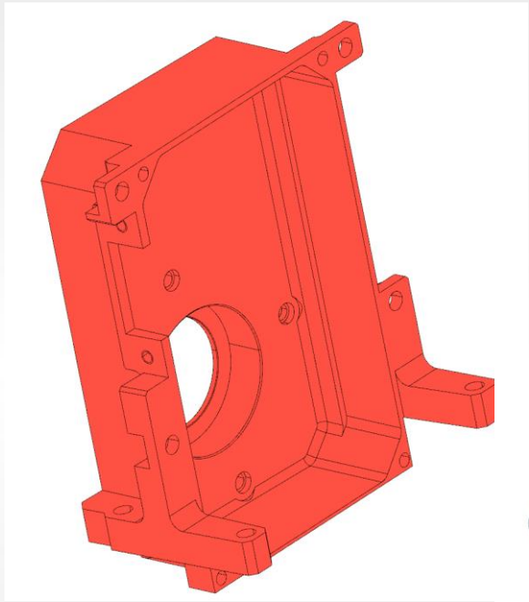
FSUA DM mechanism - tests

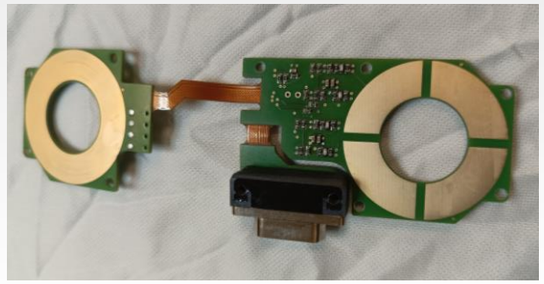
- Air / vacuum lifetime tests
- Speed and stability tests
- Particulate contamination
- Magnetic moment measurements

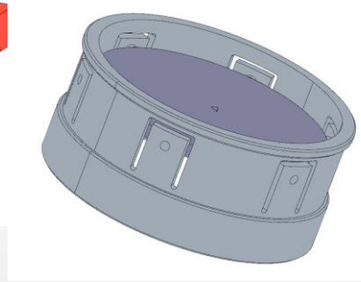


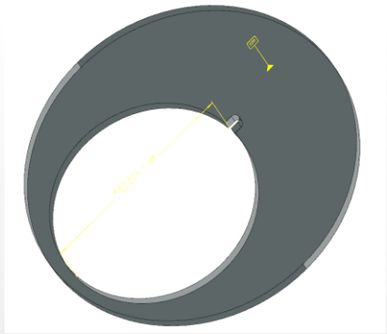


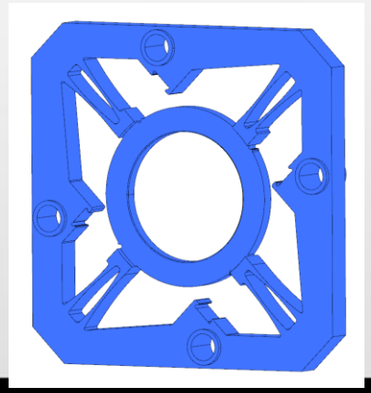
FSUA mechanism – procurement

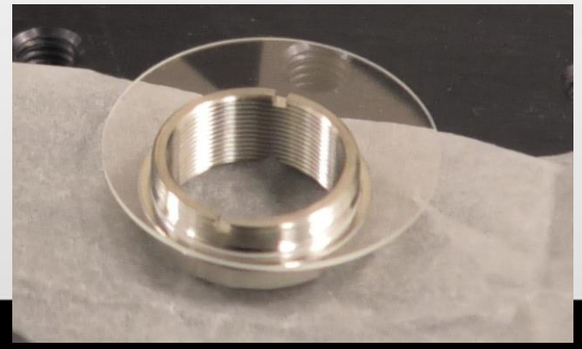






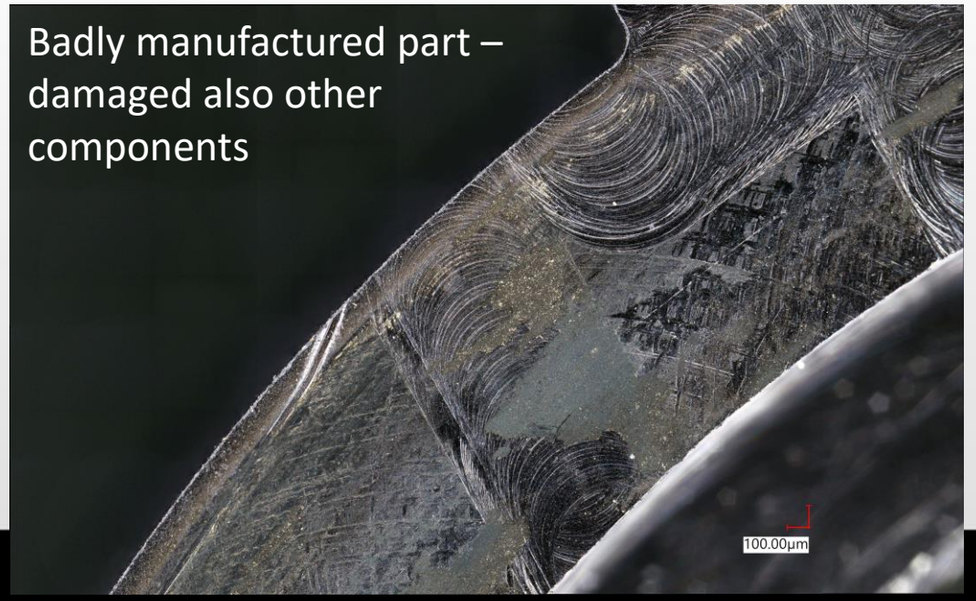






- Mechanical parts manufacturing
  - Precision Ti gr 5, PEEK CA30, Teflon machining brass helicoils (optional) (avoid using EDM)
- Mechanical components
  - Inconel screws
- Optical parts manufacturing
  - Fused silica excentric encoder rotors
- Electronic parts
  - Components – CPPA (ESA)
  - Hybrid Rigid/Flex PCBs
  - Pigtail cables
  - PCB population
- Services
  - Mechanical tests (sine, shock, random), ISO5
  - Optical element gluing (centroscope), ISO5
  - Digital twin metrology, ISO5
  - Degaussing, ISO5
  - Outgassing
  - Thermal stability test

FSUA mechanism – procurement



- Final test of the DM
- Desing of the EM almost finished

- Next: Production of EM and testing

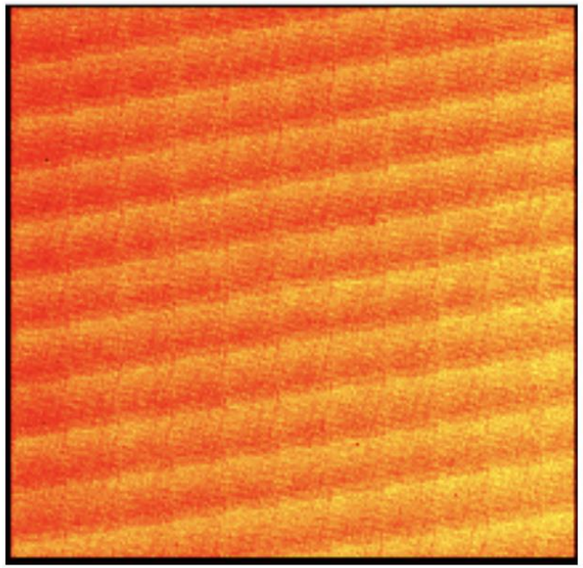
LSST v číslech

- FOV 3.5 stupně
- Primární zrcadlo 8.4 m
- Ohnisková vzdálenost 6.423 m
- Clonové číslo 1.234
- Kamera 3.060 kg
- M1M3 16.284 kg
- Limitní magnitudy (ve filtrech)
- u: 23.9, 26.1
- g: 25.0, 27.4
- r: 24.7, 27.5
- i: 24.0, 26.8
- z: 23.3, 26.1
- y: 22.1, 24.9

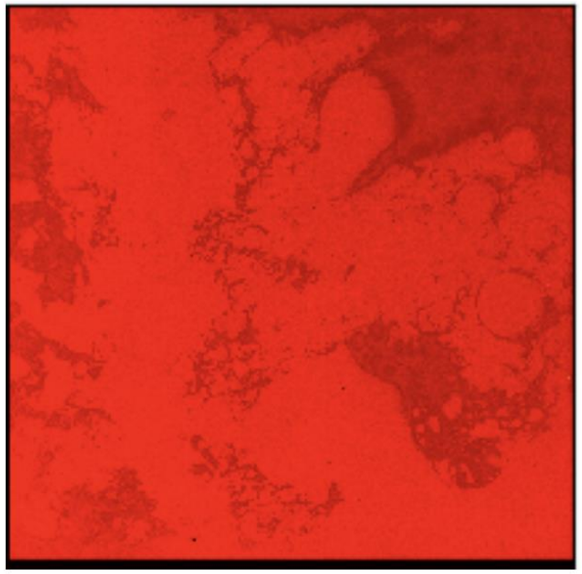
- 3.2 Gpixelů
- 189 4kx4k science CCD
- minimální expozice 1 vteřina
- pixel 10 um
- Medián PSF 0.67”
- 53% fotometrických nocí
- Přesnost fotometrem 10 mmag
- Astrometrie 50 mas
- 20 TB/noc
- 15 PB za deset let (DR11)
- 20 miliard galaxií
- 17 miliard hvězd
- 6 miliónů planetek etc.
- 10 miliónů alertů za noc

Backup

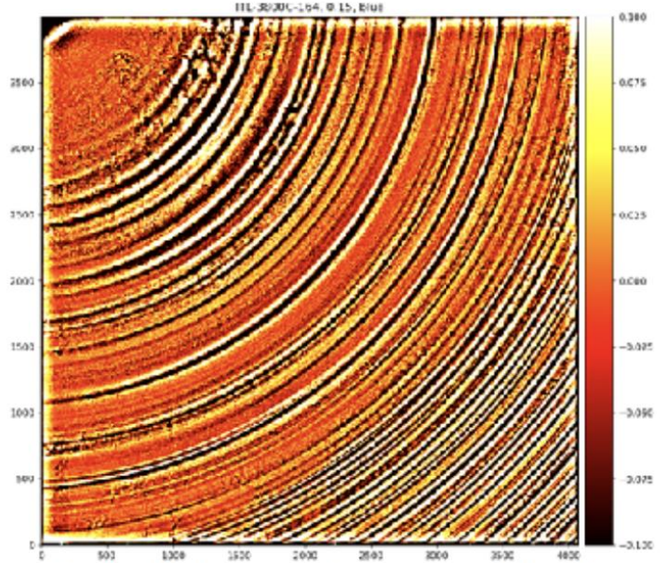
Features in flat images



Laser annealing pattern in blue for e2v

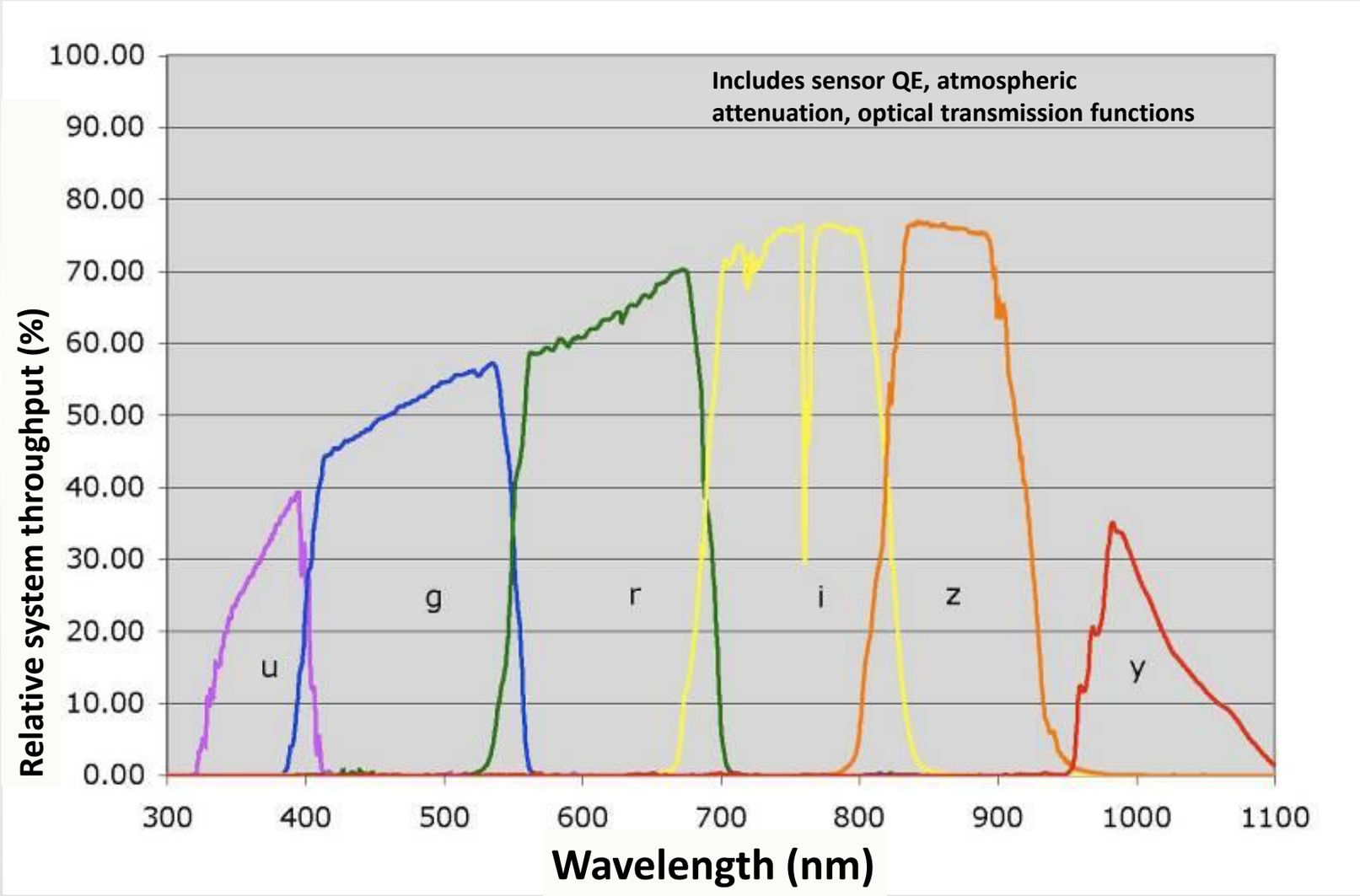


“Coffee stain” — chemical finish pattern in blue? for ITL



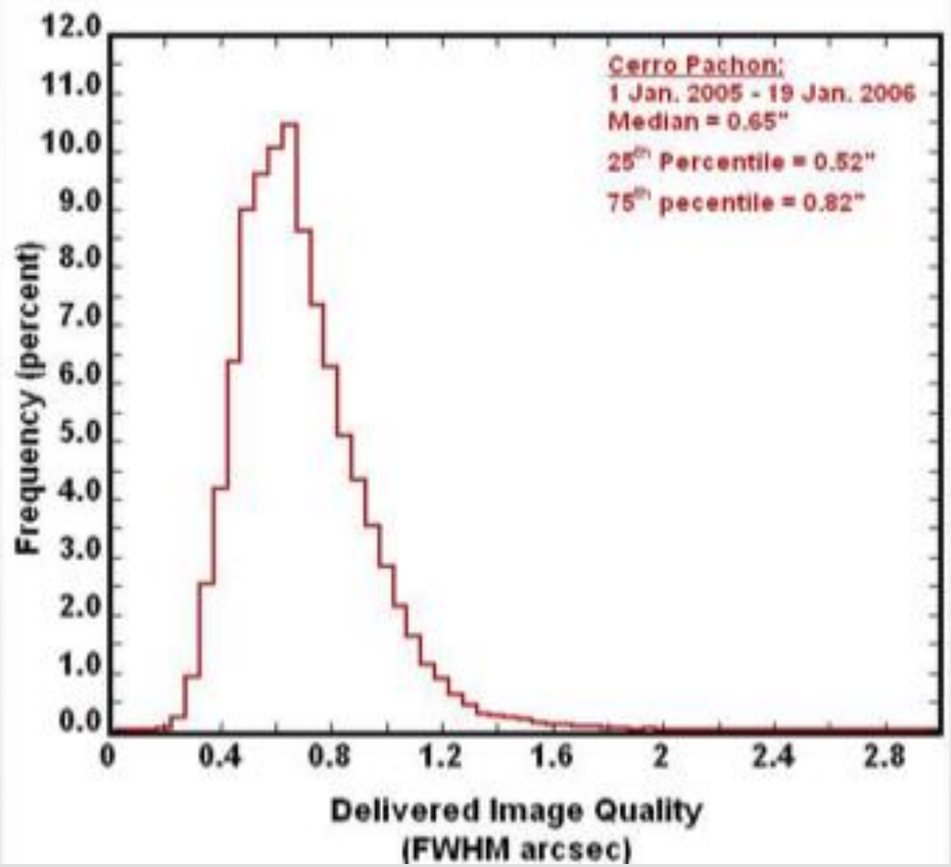
Tree-rings for both types of sensors (significantly enhanced; HV off; see Zhuoqi Zhang’s poster)

LSST six color system: redshifts



Seeing

- Blurring due to turbulence of atmosphere



CCD sensor

- Požadavek: vyčítací čas 2s → 16 zesilovačů per 16 Mpix CCD
- Úroveň sumu 8 e-
- frekvence vyčítání pixelů 550 Kpix/s

- celý čip: 4k x 4k = 16 Mpixels
- velikost pixelu: 10x10 micronů

- tloušťka Si drift zóny 100 micronů →
  Lepší odezva v infračervené oblasti
- antireflexní coating