

PIAZZI 200

New frontiers in astrometry,
small bodies and technologies

Palermo, 30 Sep - 2 Oct 2026

New Technologies: Outcome or Engine of Scientific Research?

Roberto Ragazzoni (INAF & UniPd)



INAF
ISTITUTO NAZIONALE
DI ASTROFISICA



**Università
degli Studi
di Palermo**



Quantunque l'Astronomia non miri, che alla contemplazione, e studio dei Cieli; nondimeno i suoi progressi non van disgiunti dalla perfezione delle Scienze, dall'invenzione, introduzione, ed avanzamento delle arti tutte, alle quali certamente ha essa recato più vantaggio in men d'un Secolo, che fatto non avrebbe qualunque siasi umana industria.

Me

Although Astronomy aim to the observation of the sky, its advancements are not detached from the advancement of science, inventions, and benefits from all arts and crafts. the accomplishment achieved in less than a century are unattainable by any “only human” activity.

Google

Although astronomy aims solely at the contemplation and study of the heavens, its progress is nonetheless inseparable from the perfection of the sciences and the invention, introduction, and advancement of all the arts—to which it has certainly brought more benefit in less than a century than any human endeavor could have achieved.

Giuseppe Piazzi, 1790



Astronomy as an engine

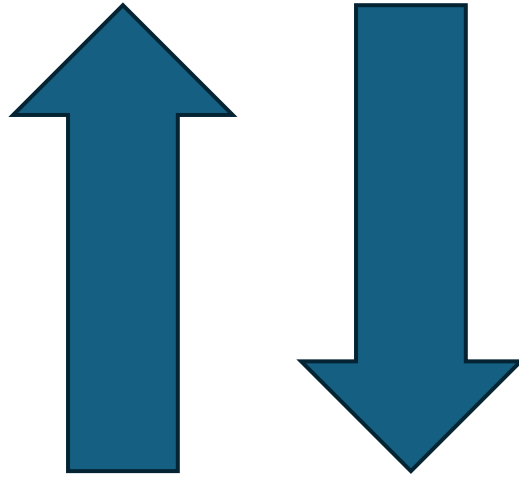
Technological efforts driven by astronomy related questions produced inventions and/or technological development, then used in other fields...

Astronomy as an outcome

Technological developments and inventions have been used almost straightly to achieve important telescopes or machines to study heavens...

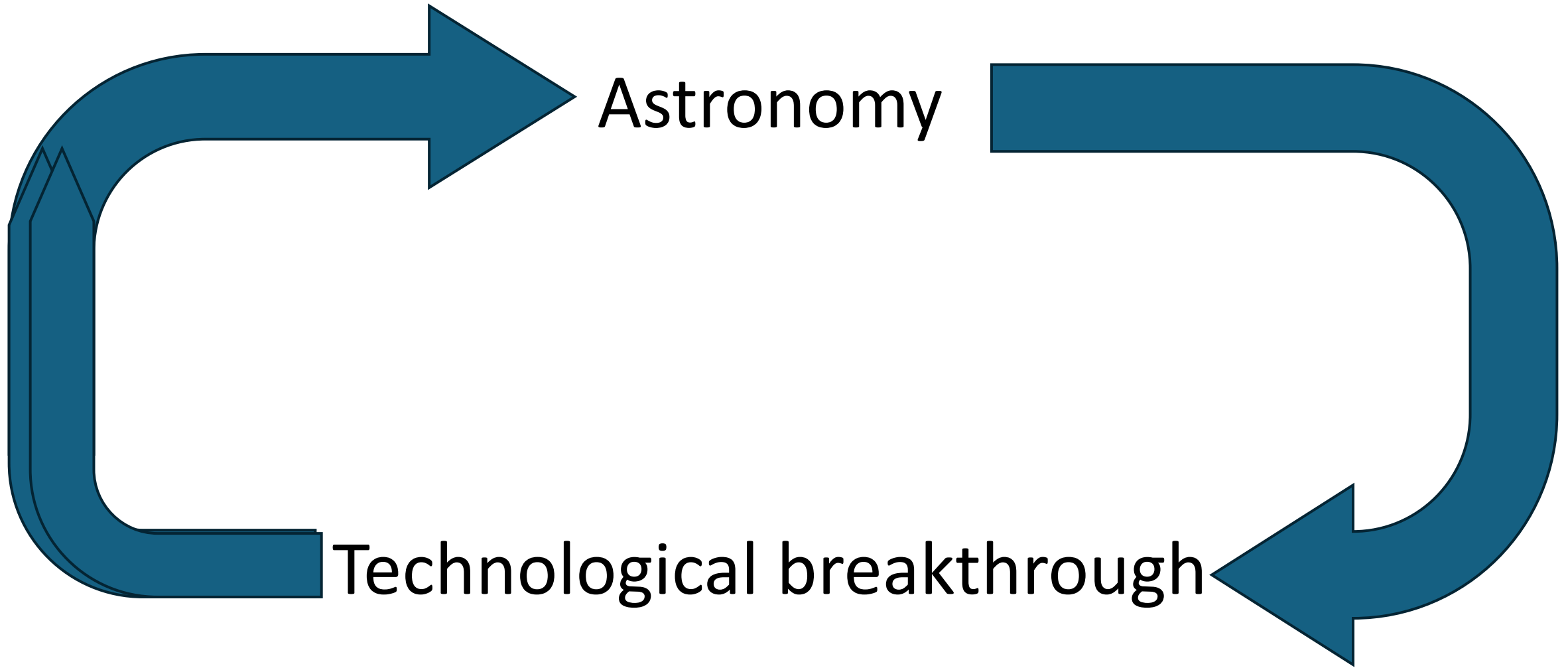
Two ways option....

Astronomy

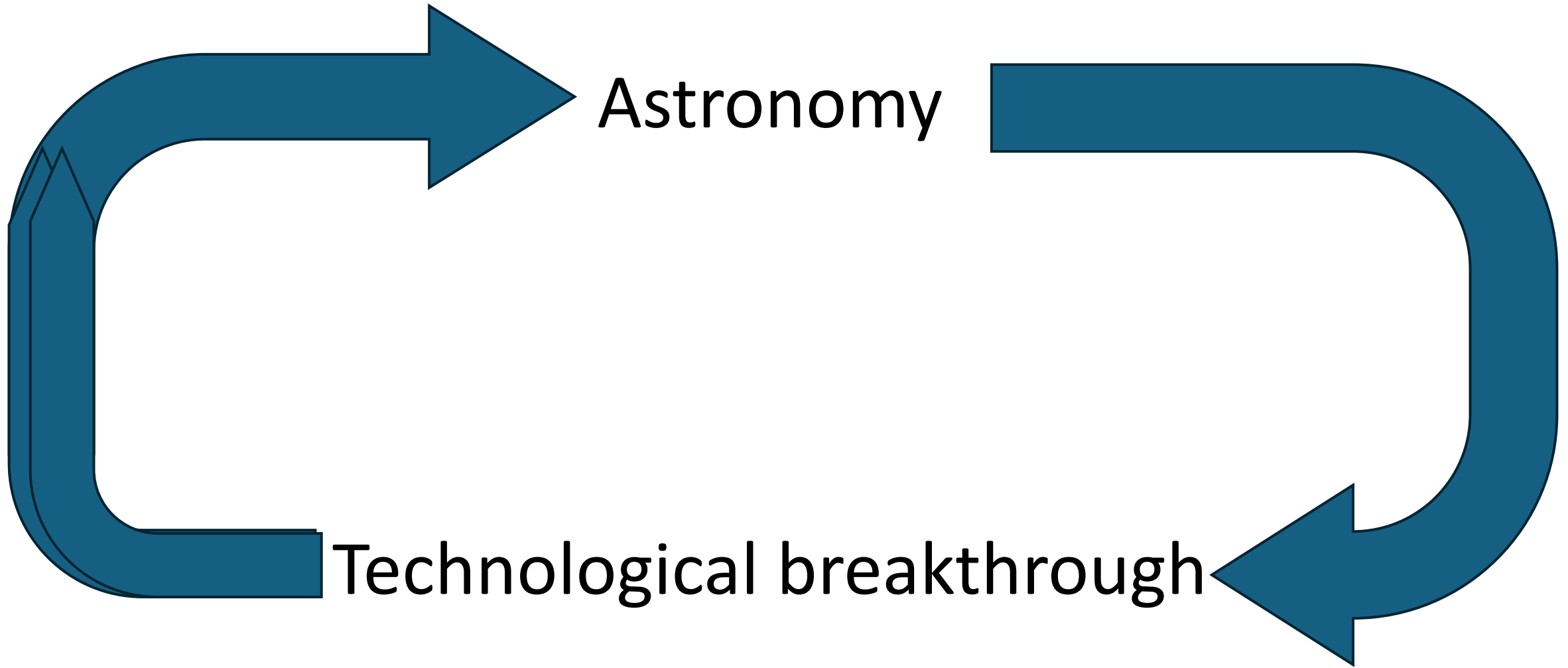


Technological breakthrough

....or an actual cycle...???



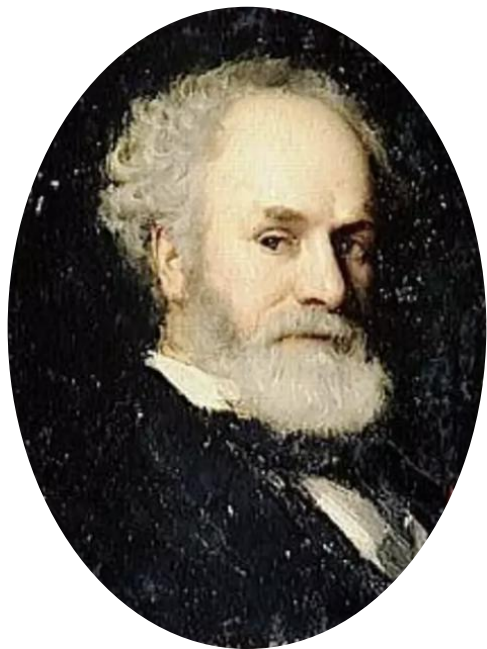
....or an actual cycle...???



Maybe only indirectly...

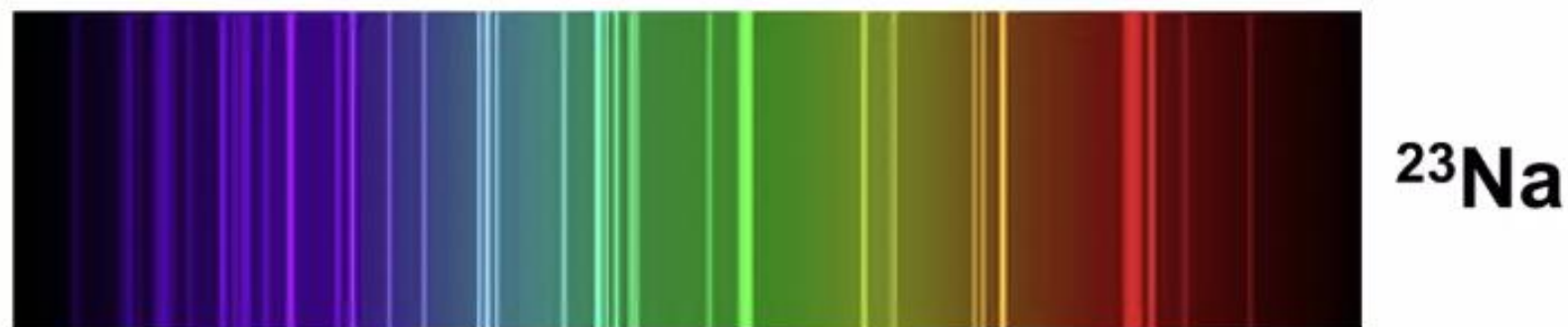
Astronomy as an engine

- Helium, what is this...???
- Clocks?? The longitude problem
- WiFi
- Adaptive Optics in...
 - Ophtalmology
 - Optical communication
 - Confocal sensing
- X-ray telescopes
- General relativity (in GNSS)
- Probably a few (??) others...



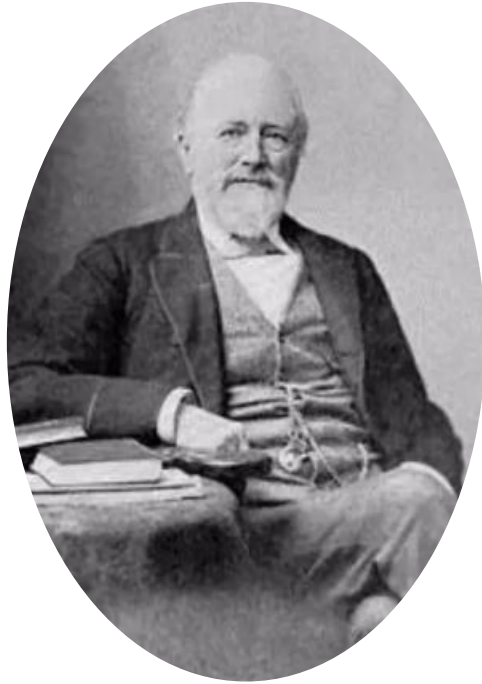
Julius Jannssen
(1824-1907)

August 18, 1868: a bright yellow spectral line at 587.49 nm was detected in the Sun's chromosphere during an eclipse and classified as Sodium...





Norman Lockyer
(1836–1920)



Edward Frankland
(1825–1899)

On October 20, 1868, English astronomer Norman Lockyer detected a yellow line in the solar spectrum, which he called the D3 Fraunhofer line because it appeared near the known sodium lines D1 and D2. He deduced this was caused by an element present in the Sun but unknown on Earth. Lockyer, together with chemist Edward Frankland, named this element after the Greek word **ἥλιος (helios)**



Longitude's problem...

Risorse Didattiche

Eventi

EDU INAF Il magazine di didattica e divulgazione dell'Istituto Nazionale di Astrofisica

Notizie

HOME DIDATTICA ▾ RUBRICHE ▾ APPROFONDIMENTI ▾ IN EVIDENZA ▾ EVENTI ▾ CHI SIAMO ▾

PERSONAGGI

John Harrison, il tempo e la longitudine

🕒 3 Aprile 2018 📖 5 Min Read

 Add Comment

La misura della longitudine è stata perfezionata grazie all'invenzione del cronografo, dovuta al valente orologiaio inglese John Harrison, che combattè per tutta la vita per vedere riconosciuti i meriti e il valore del proprio lavoro.

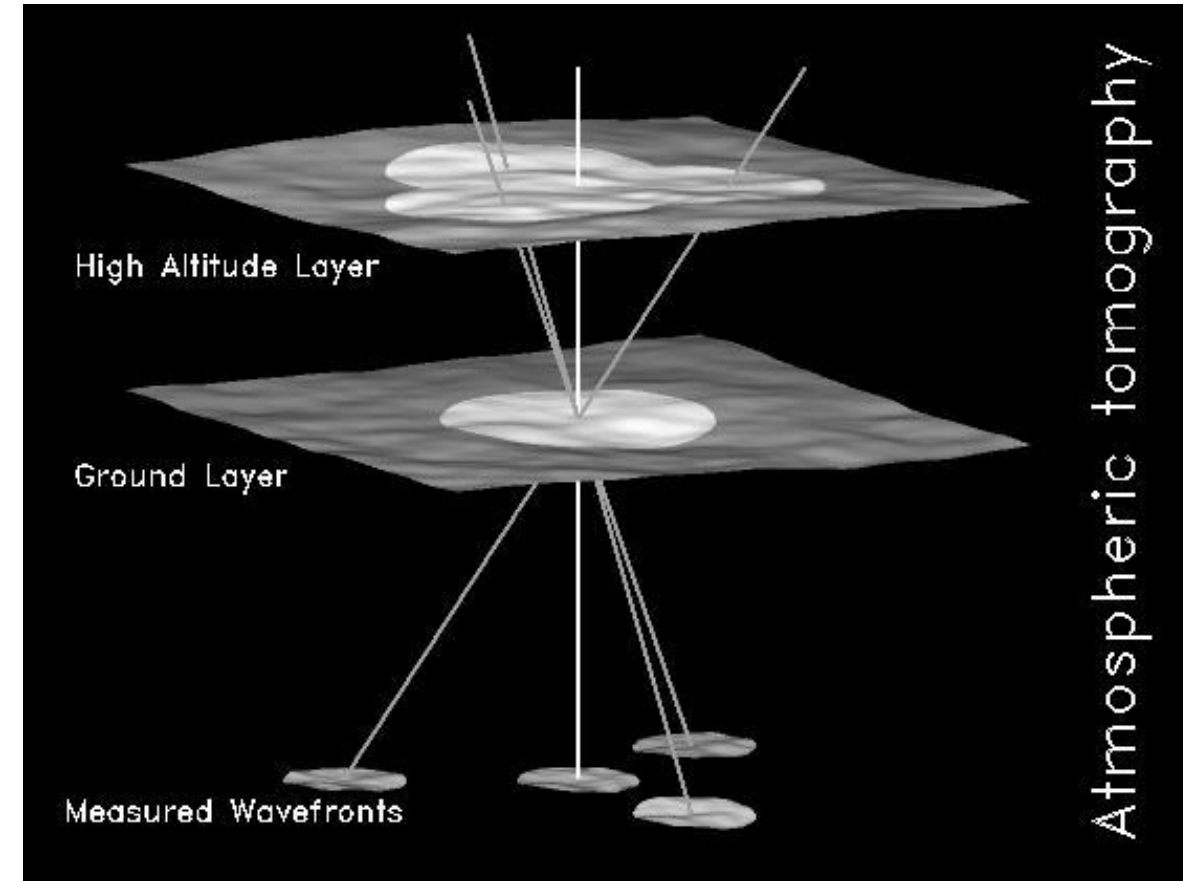
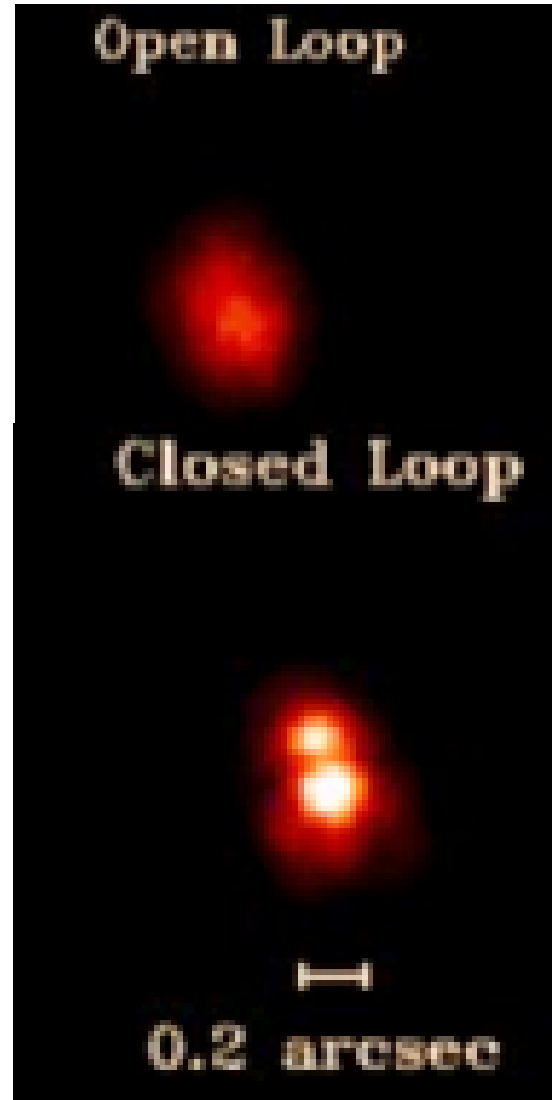
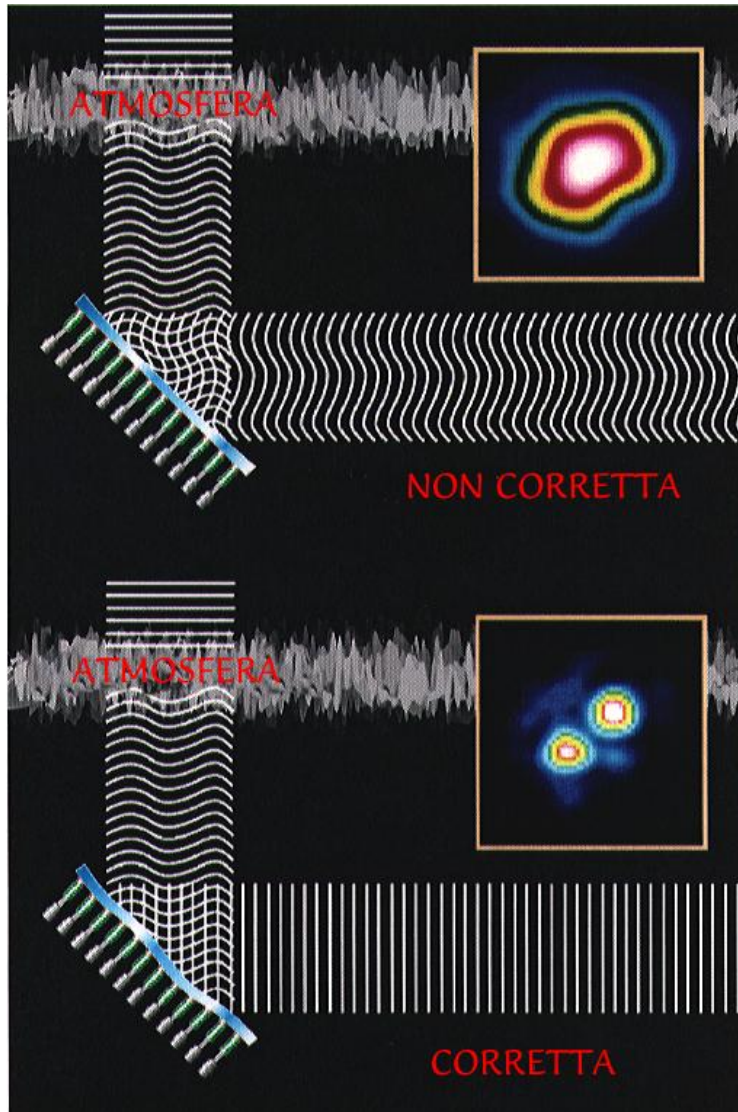
AGGIORNATO IL 28 NOVEMBRE 2024



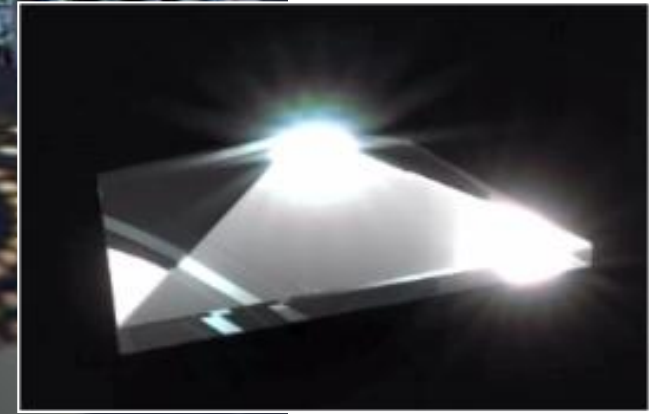
WiFi (tech) has been invented by –guess– (radio) astronomers



Adaptive Optics

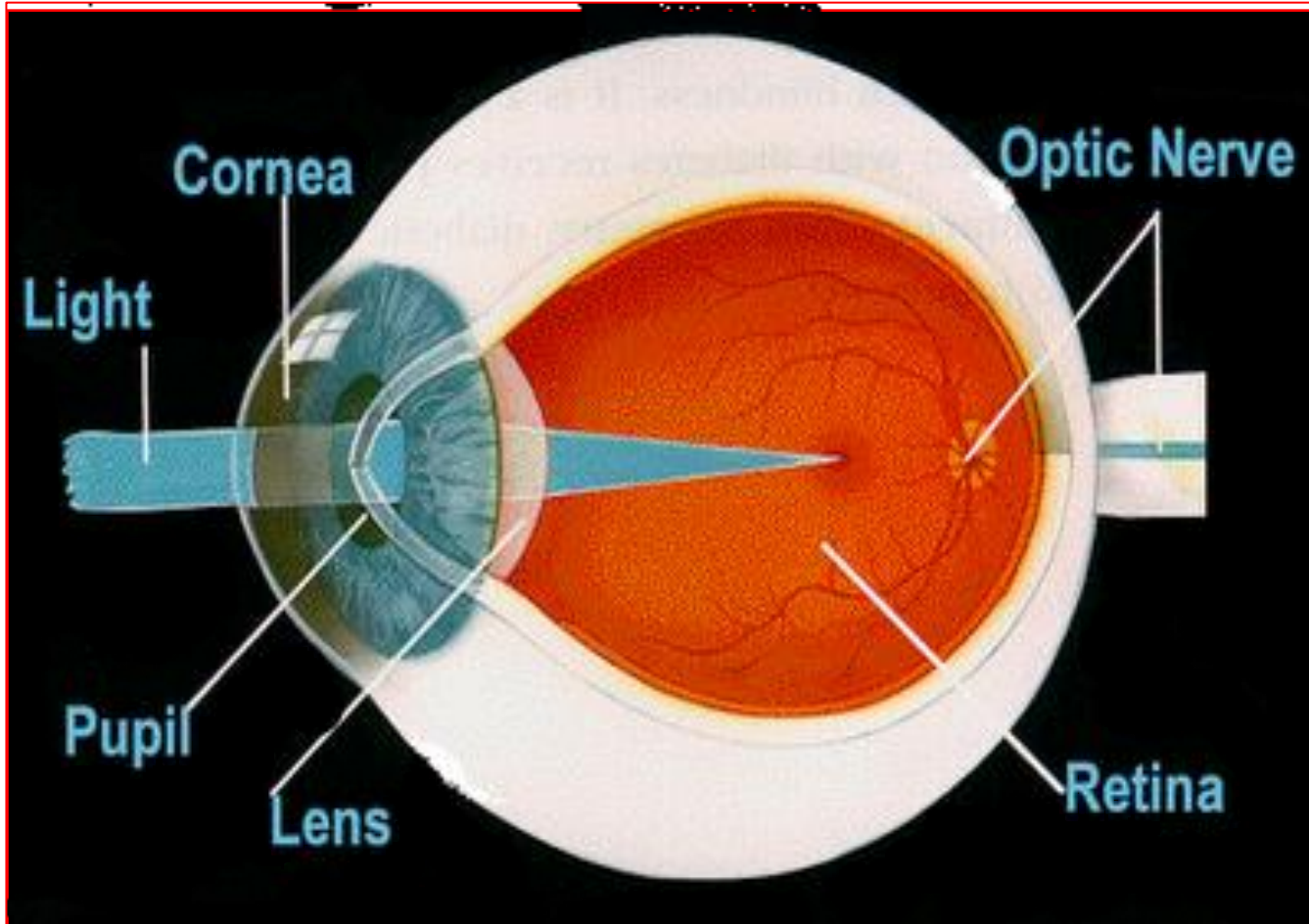


modello di atmosfera realizzato da
R. Ragazzoni e collaboratori

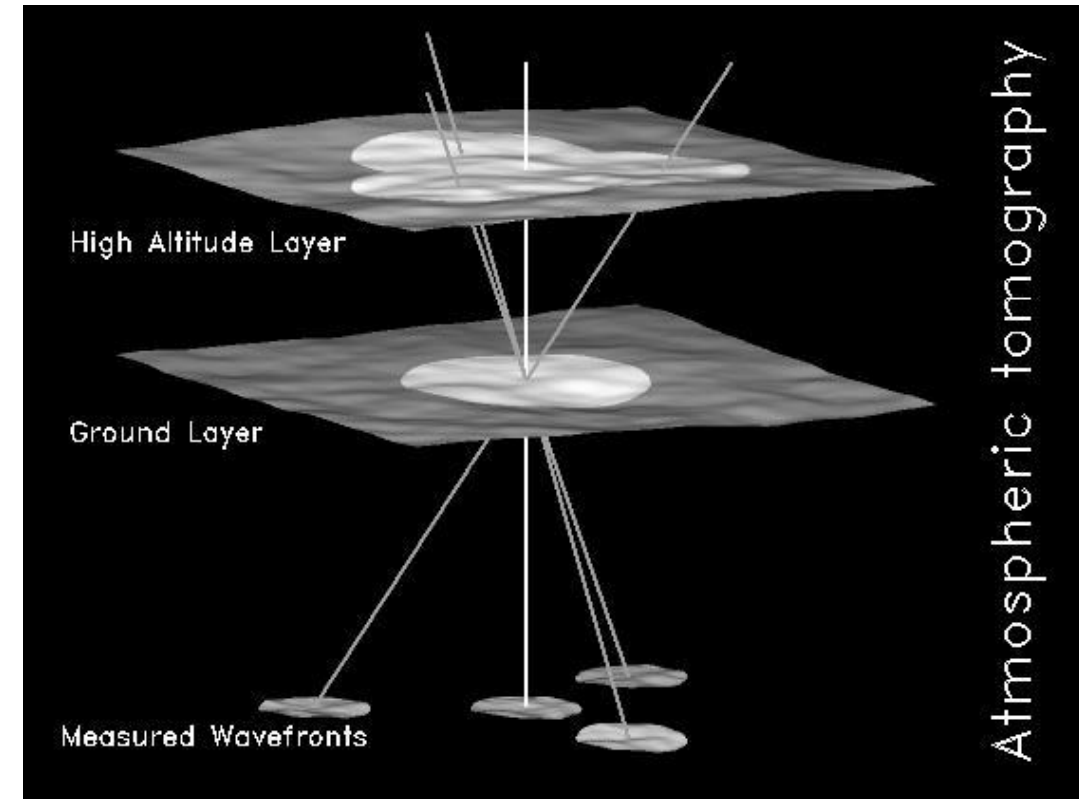




Switching to ophtalmology being just a matter of size...



8mm vs 8m



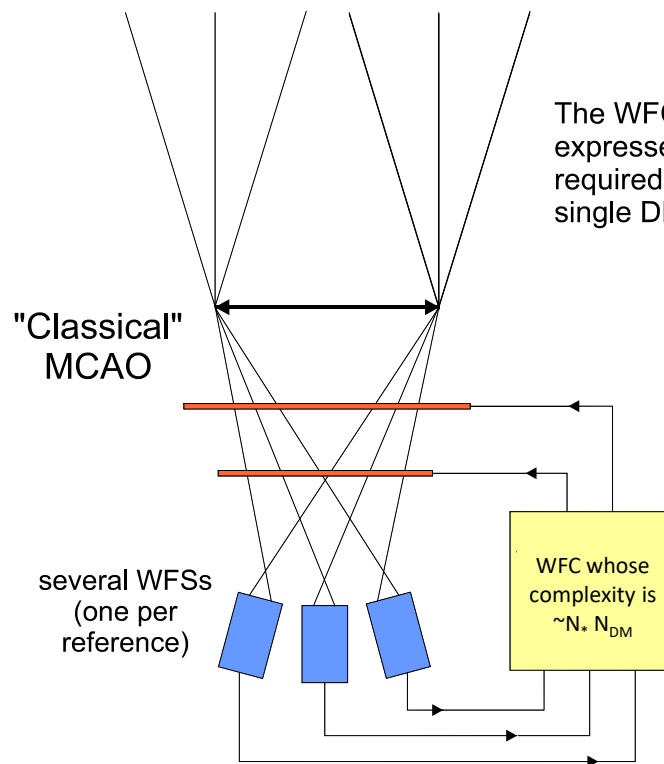
Star Oriented and Layer Oriented

Ragazzoni R., Farinato J., Marchetti E. "Adaptive optics for 100m class telescopes: new challenges require new solutions", Munich 2000

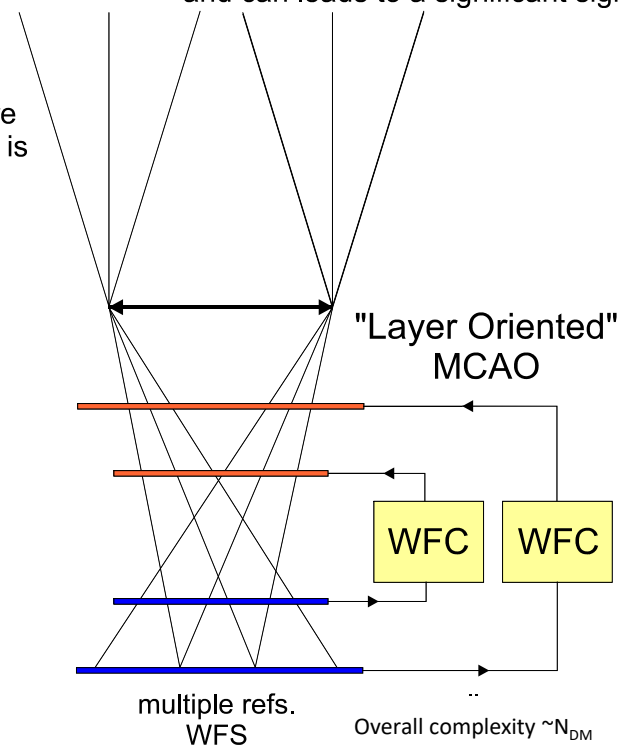
Each WFS is coupled to a single star hence a maximum magnitude is to be accomplished. Spatial and temporal sampling have to deal with overall turbulence. WFS optomechanics scale with number of references.

Comparison between concepts of "classical" vs. "layer oriented" MCAO

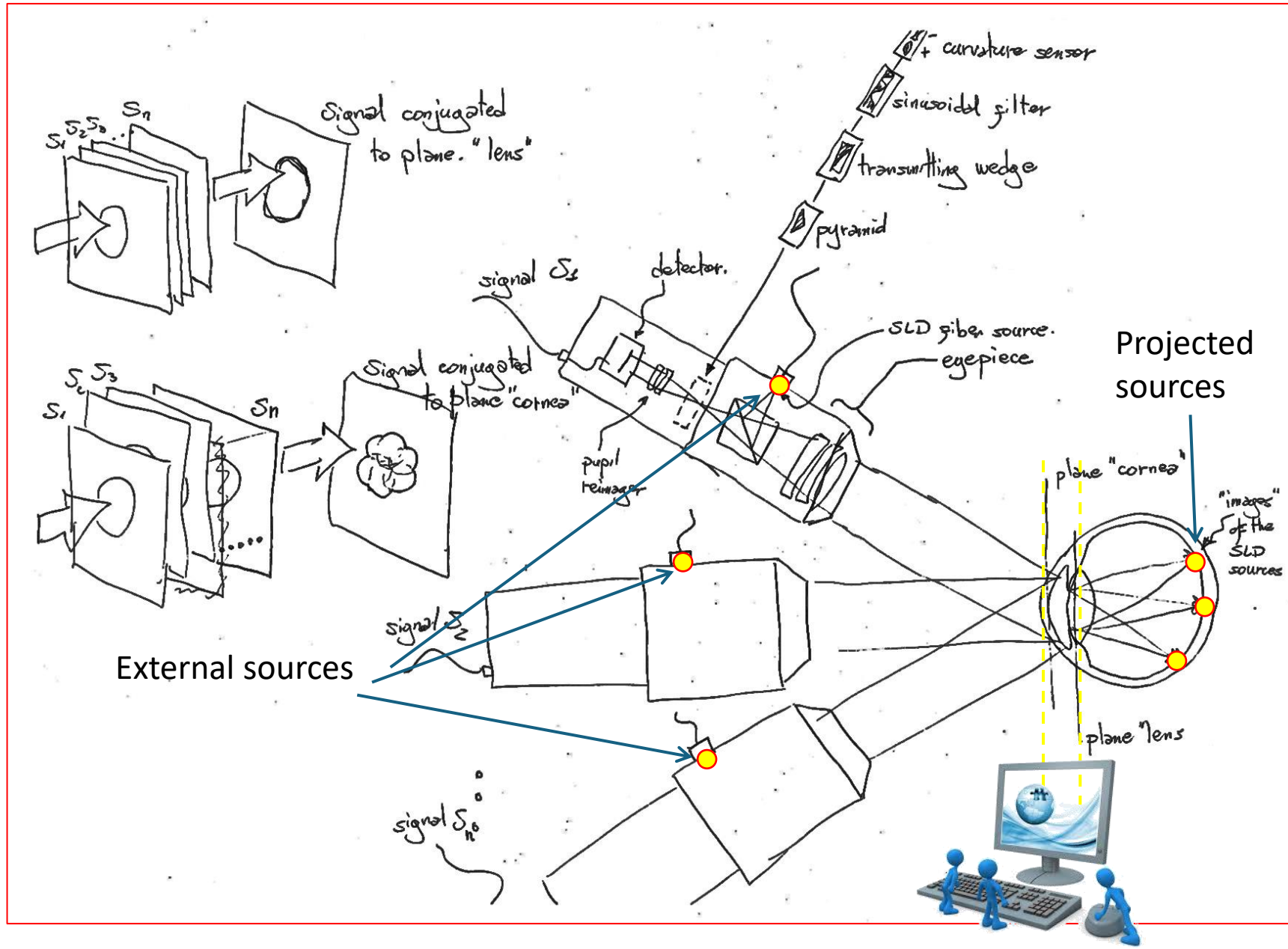
A single WFS collects light from several stars. Each WFS is conjugated with a single layer and can be optimized for the related spatial and temporal sampling. Light of several faint stars coadds and can leads to a significant signal.



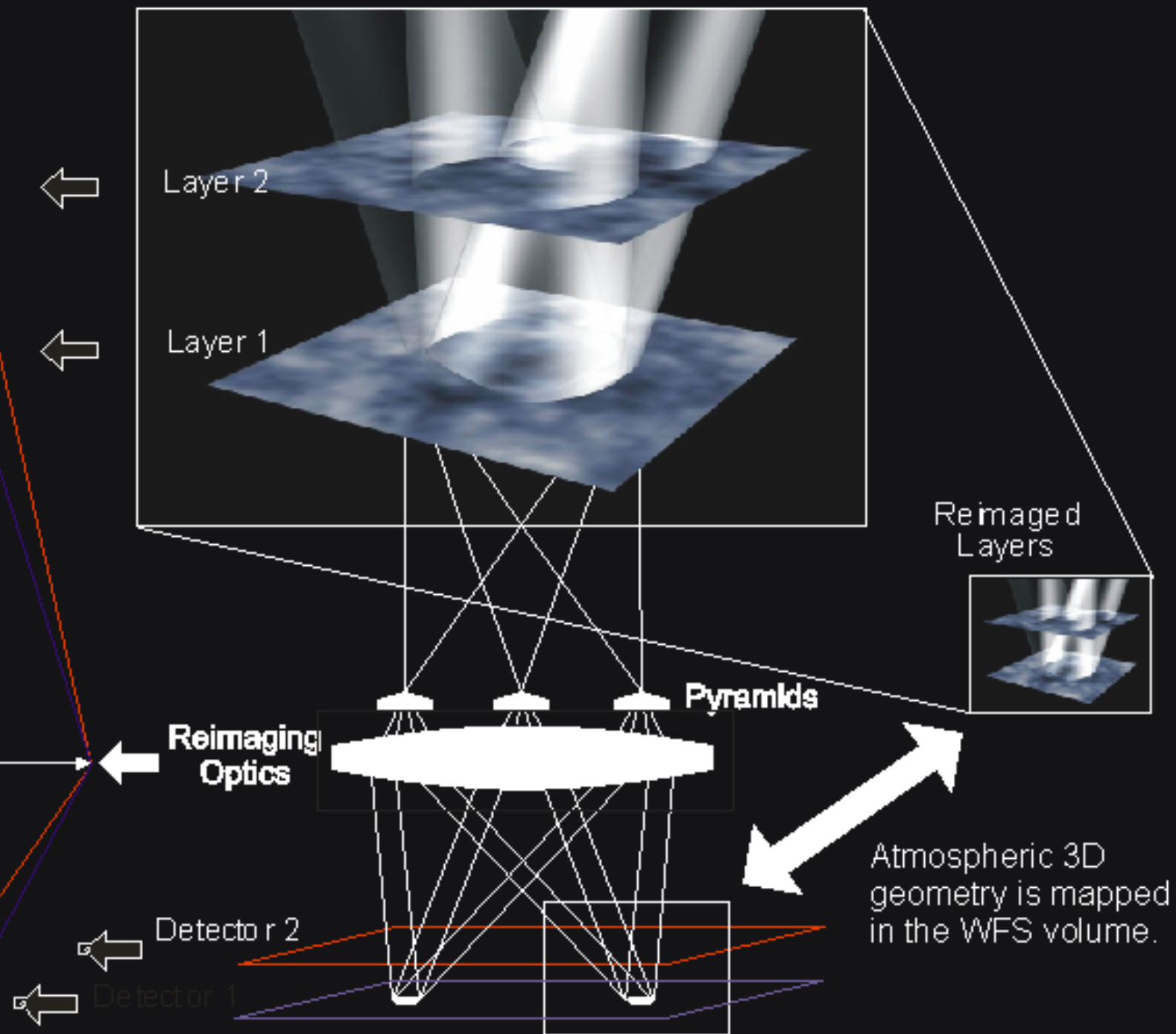
The WFC complexity is here expressed in terms of what is required for a single WFS, single DM AO loop.



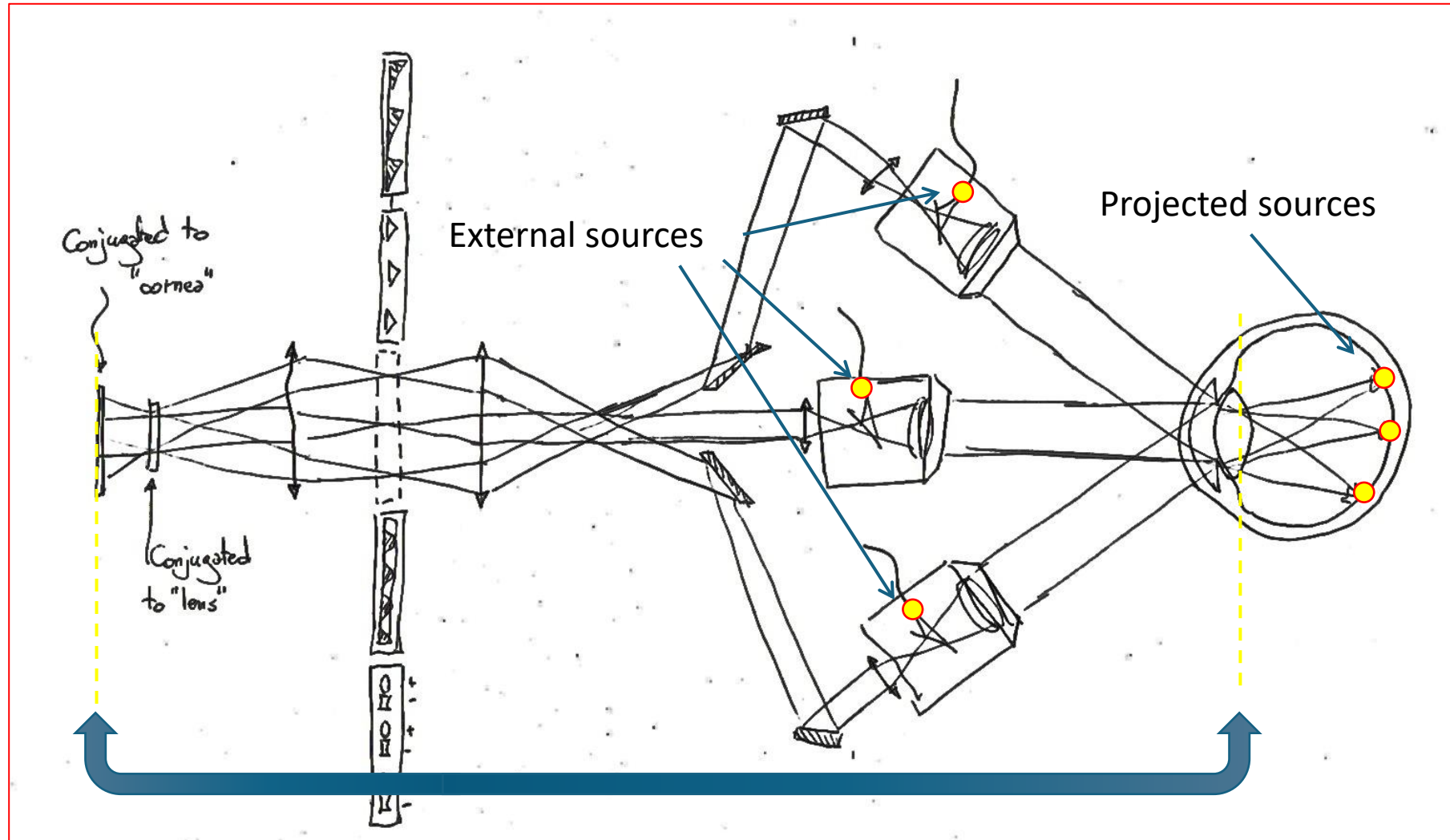
Layer Oriented 3D WFS with numerical reconstruction



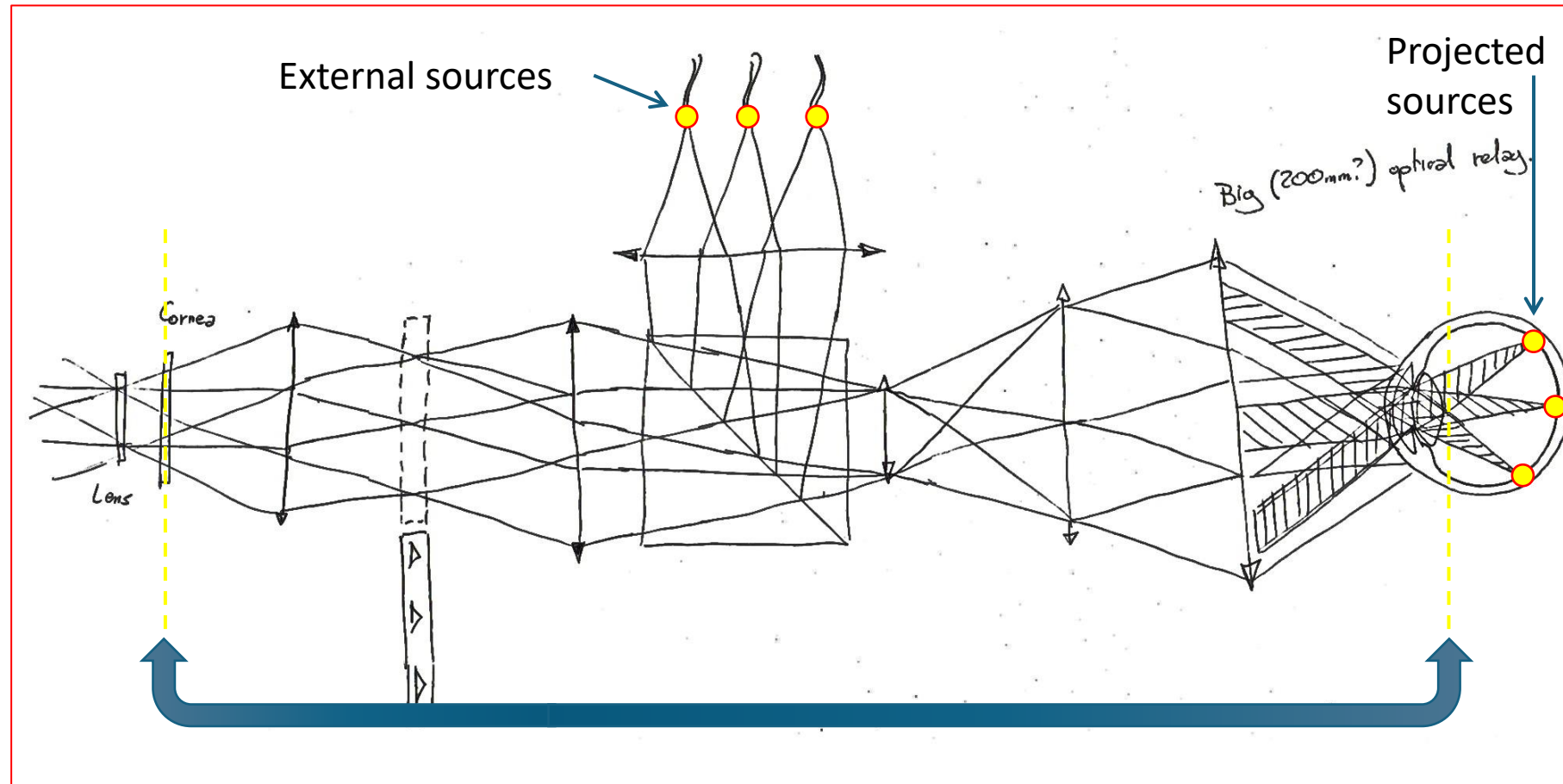
Pyramid WFS based system easily complies with such an approach. Complexity scales mostly with the number of sensed layers rather than with the number of references.

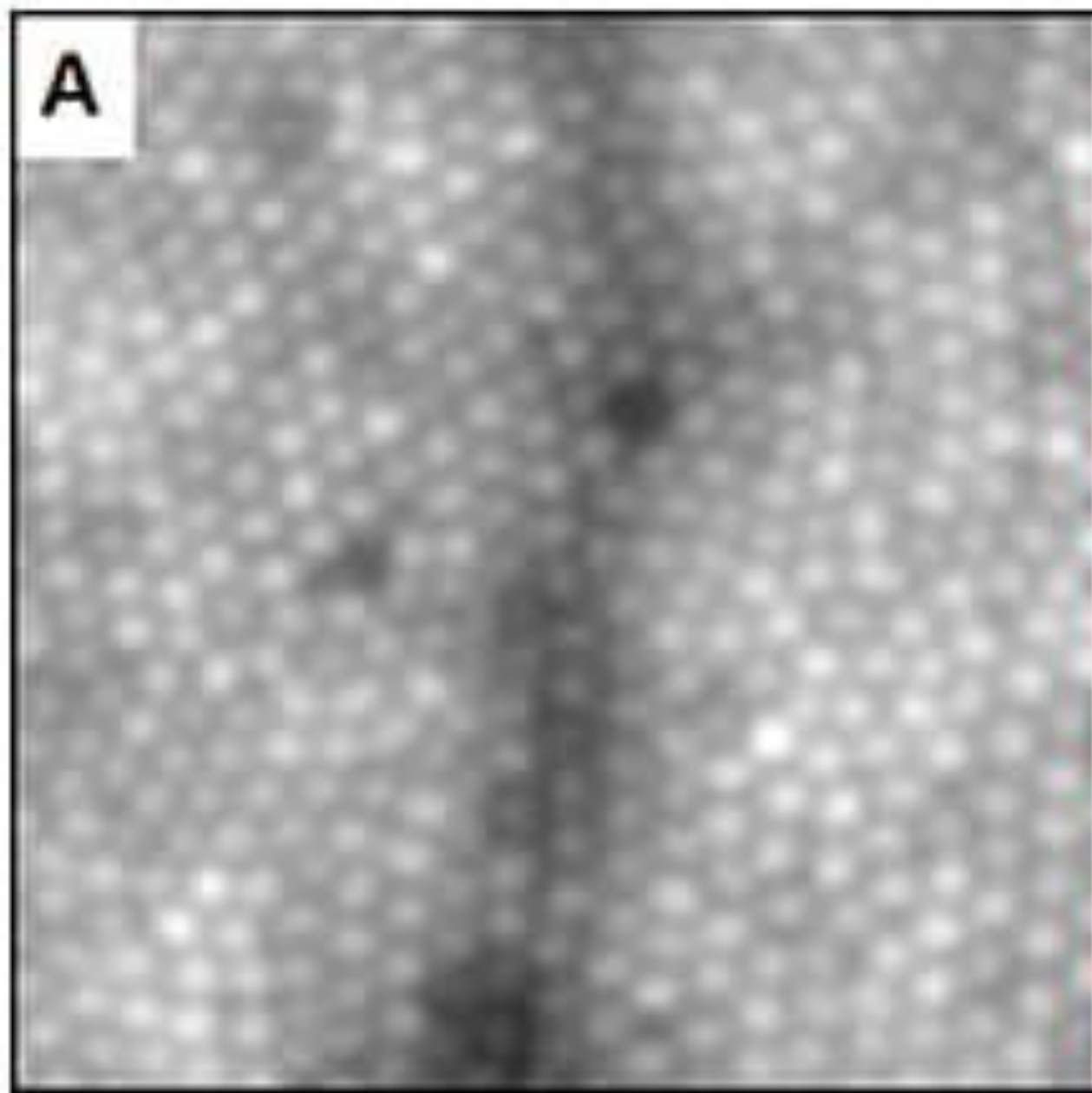
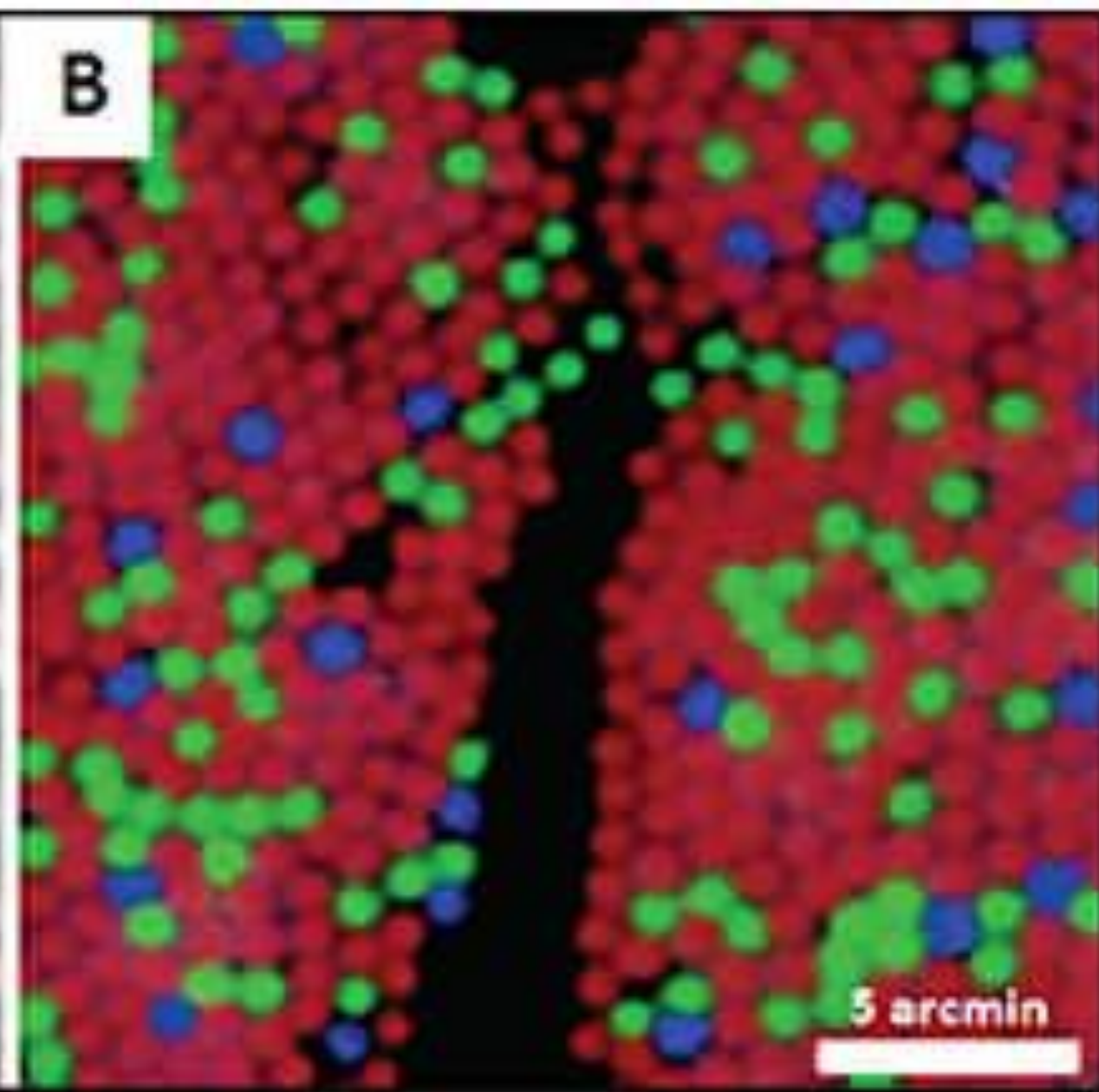


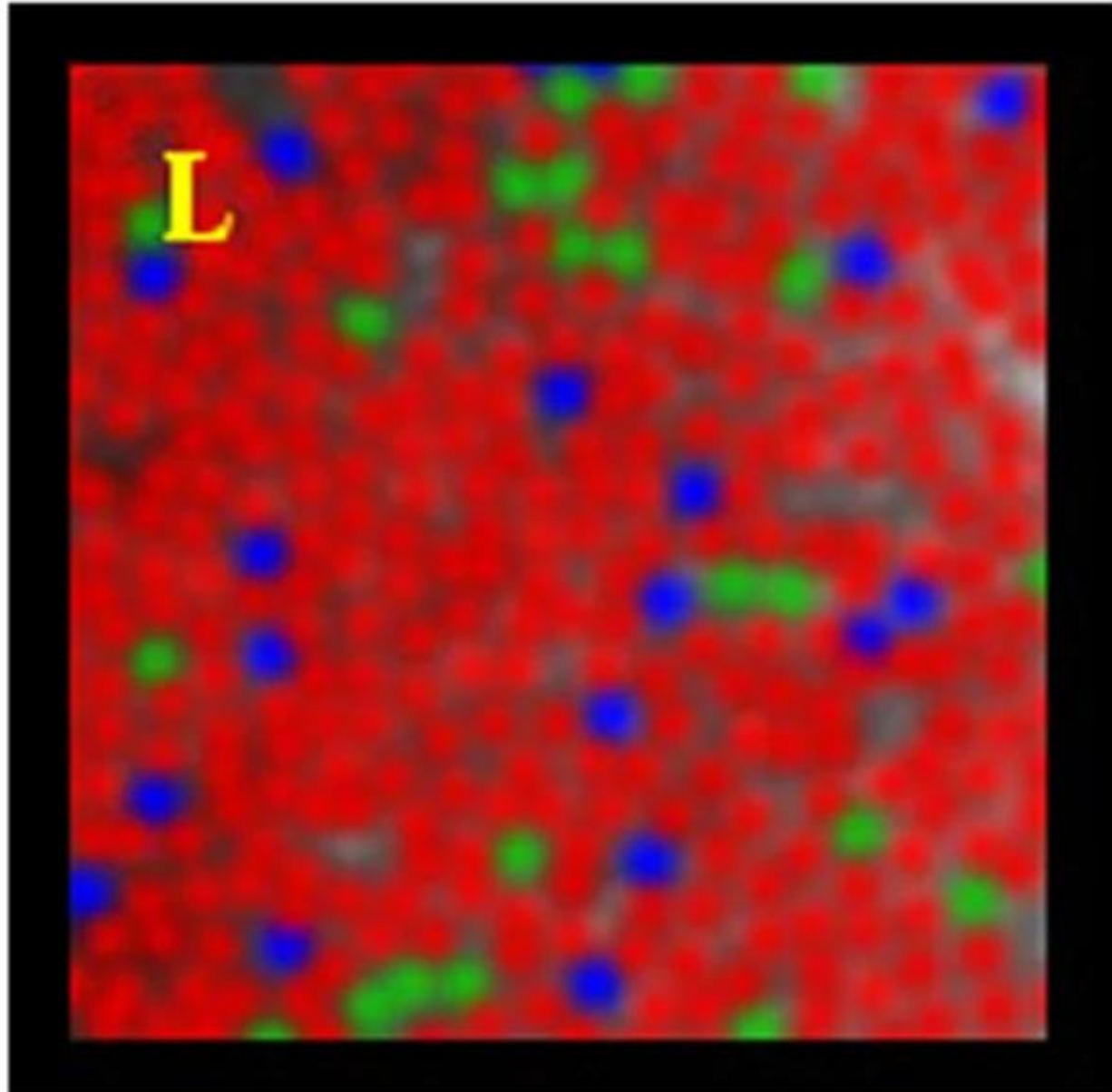
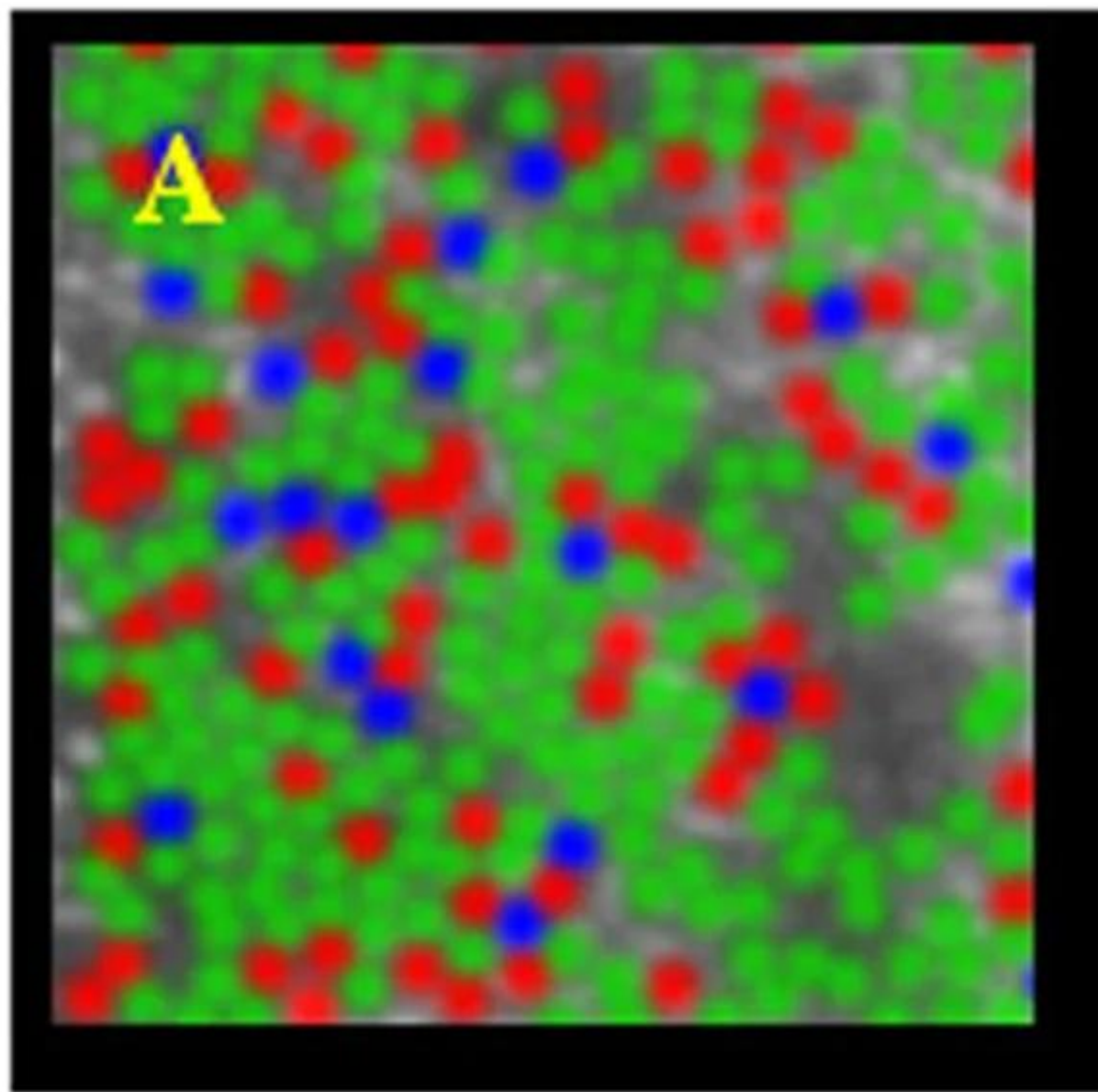
Layer Oriented 3D WFS with relayed small optics...

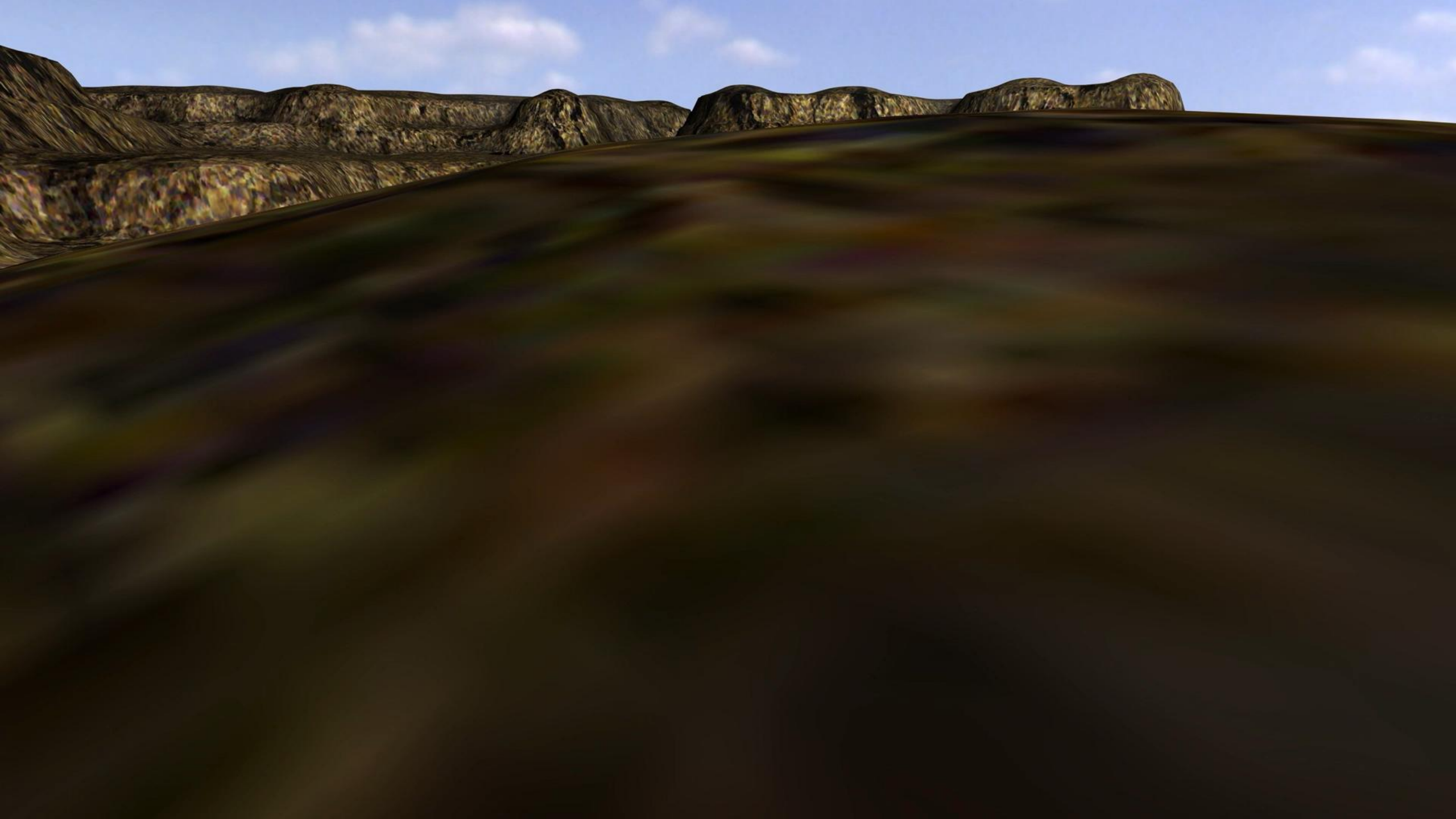


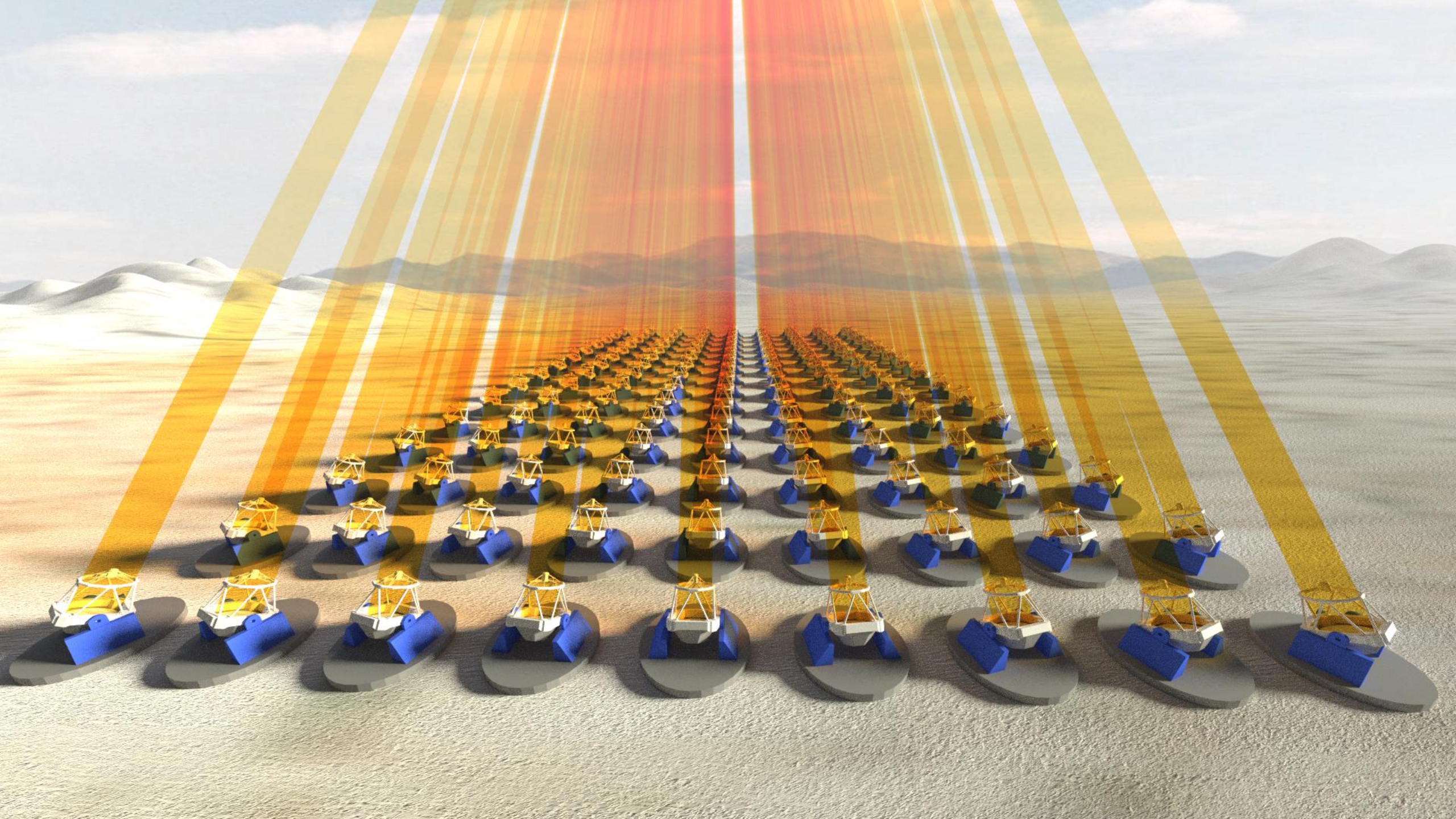
Layer Oriented 3D WFS with a *big* common optics...

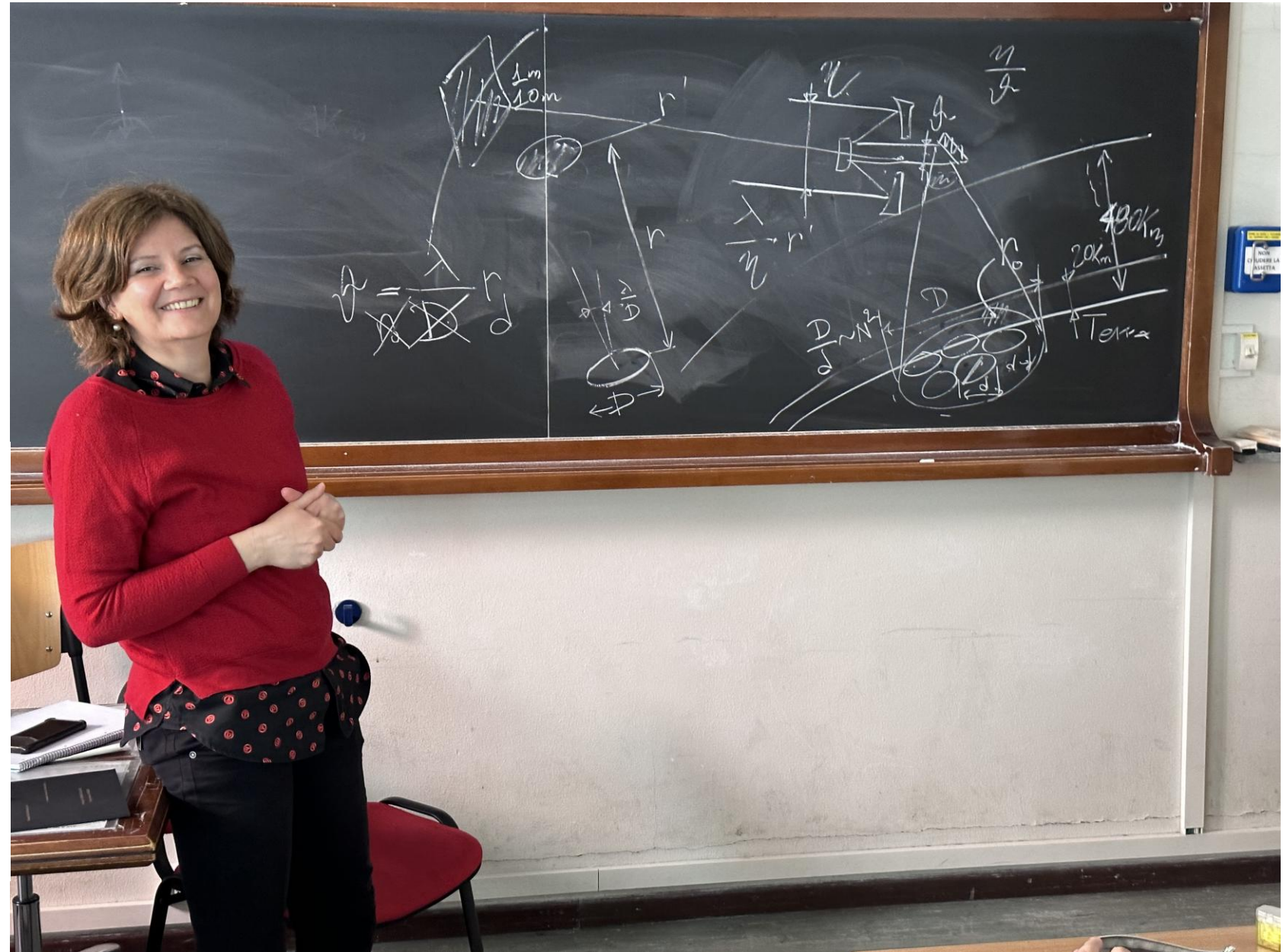


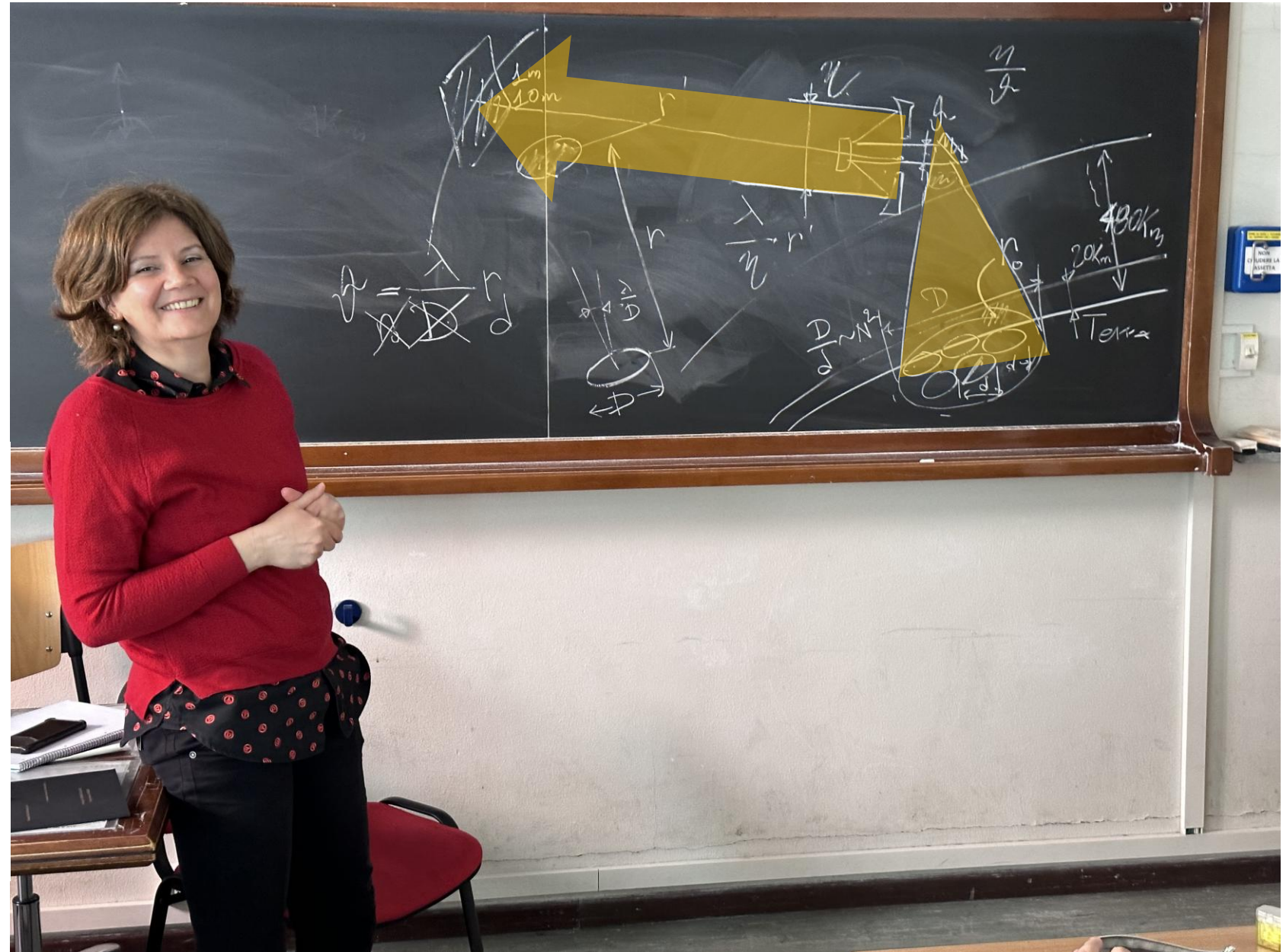
A**B**











Adaptive optical microscopy: the ongoing quest for a perfect image

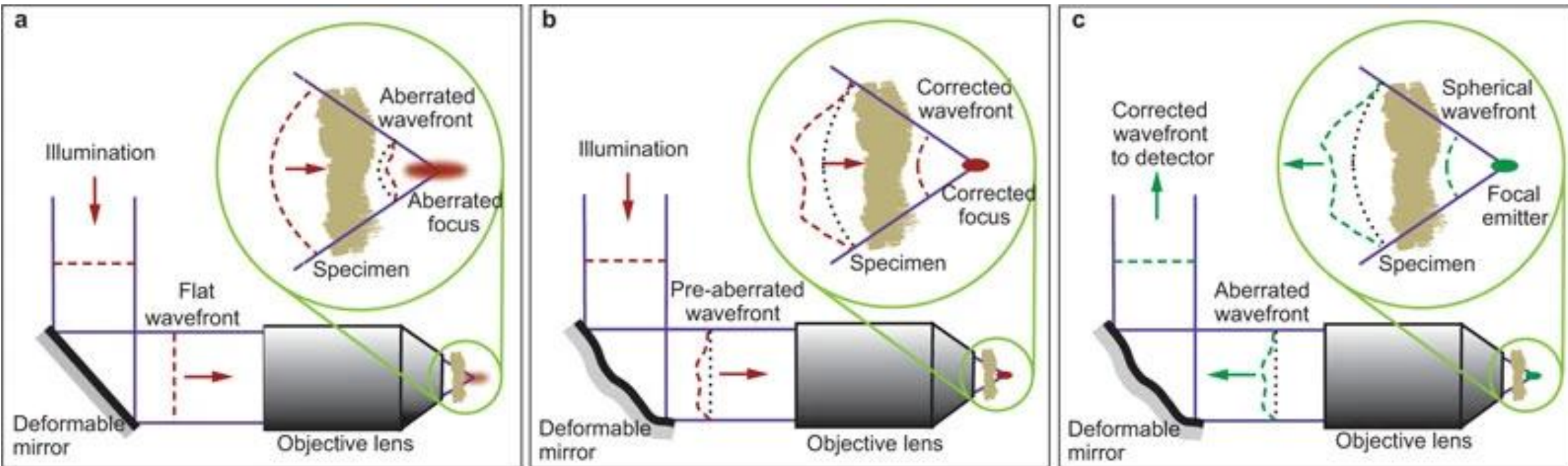
Light: Science & Applications (2014) 3, e165; doi:10.1038/lisa.2014.46
© 2014 CIOMP. All rights reserved 2047-7538/14

Martin J Booth^{1,2,3}

www.nature.com/lisa

Adaptive optics is becoming a valuable tool for high resolution microscopy, providing correction for aberrations introduced by the refractive index structure of specimens. This is proving particularly promising for applications that require images from deep within biological tissue specimens. We review recent developments in adaptive microscopy, including methods and applications. A range of advances in different microscope modalities is covered and prospects for the future are discussed.

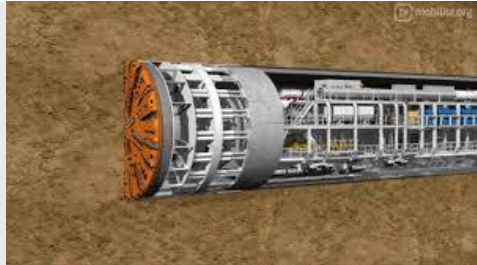
Light: Science & Applications (2014) 3, e165; doi:10.1038/lisa.2014.46; published online 25 April 2014



Taxonomy

	Wheel	Propeller
Water		
Ground		???
Air	???	

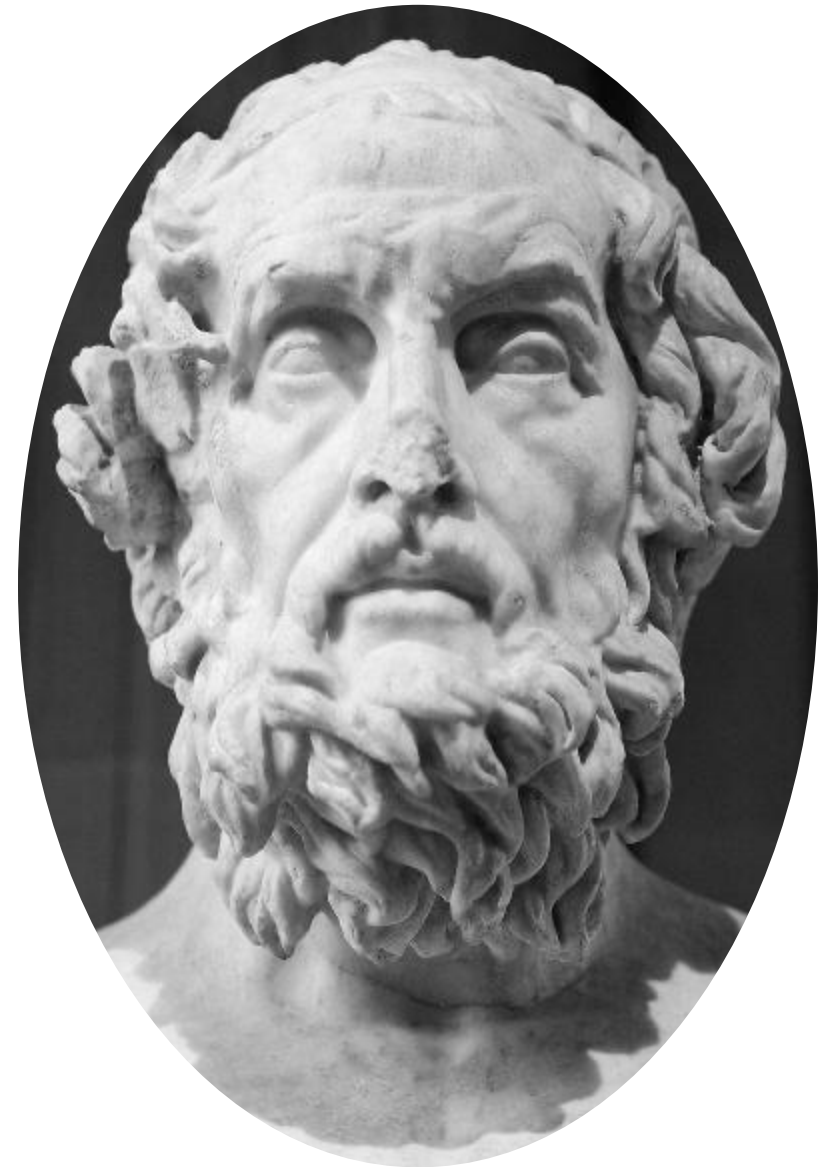
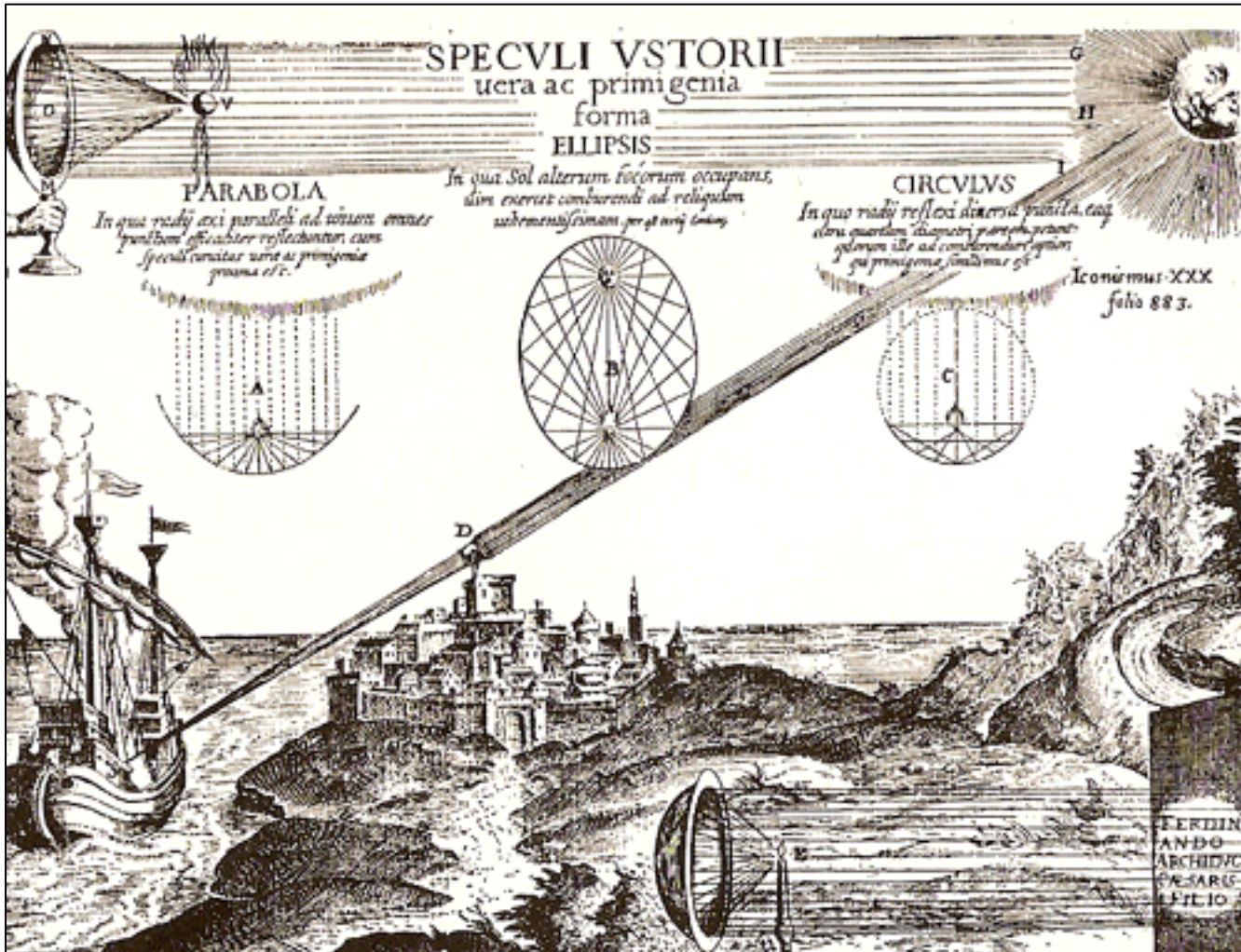
Taxonomy

	Wheel	Propeller
Water		
Ground		
Air		

Looking for taxonomic analogues...

- Quantitative differences
 - Sizes are rather different (Lagrange invariant limit...!!!)
 - Timescales are usually much faster in Astronomy
- Qualitative/substantial differences
 - Astronomical AO is (at the very end...) white light while both microscopy and communications AO can be almost monochromatic (or a combination of wavelengths)
 - You cannot “adjust” the source while in both microscopy and ophthalmology you can
 - In ophthalmology unless you want to be subjective there is always a “double pass”

Another “hot” idea...



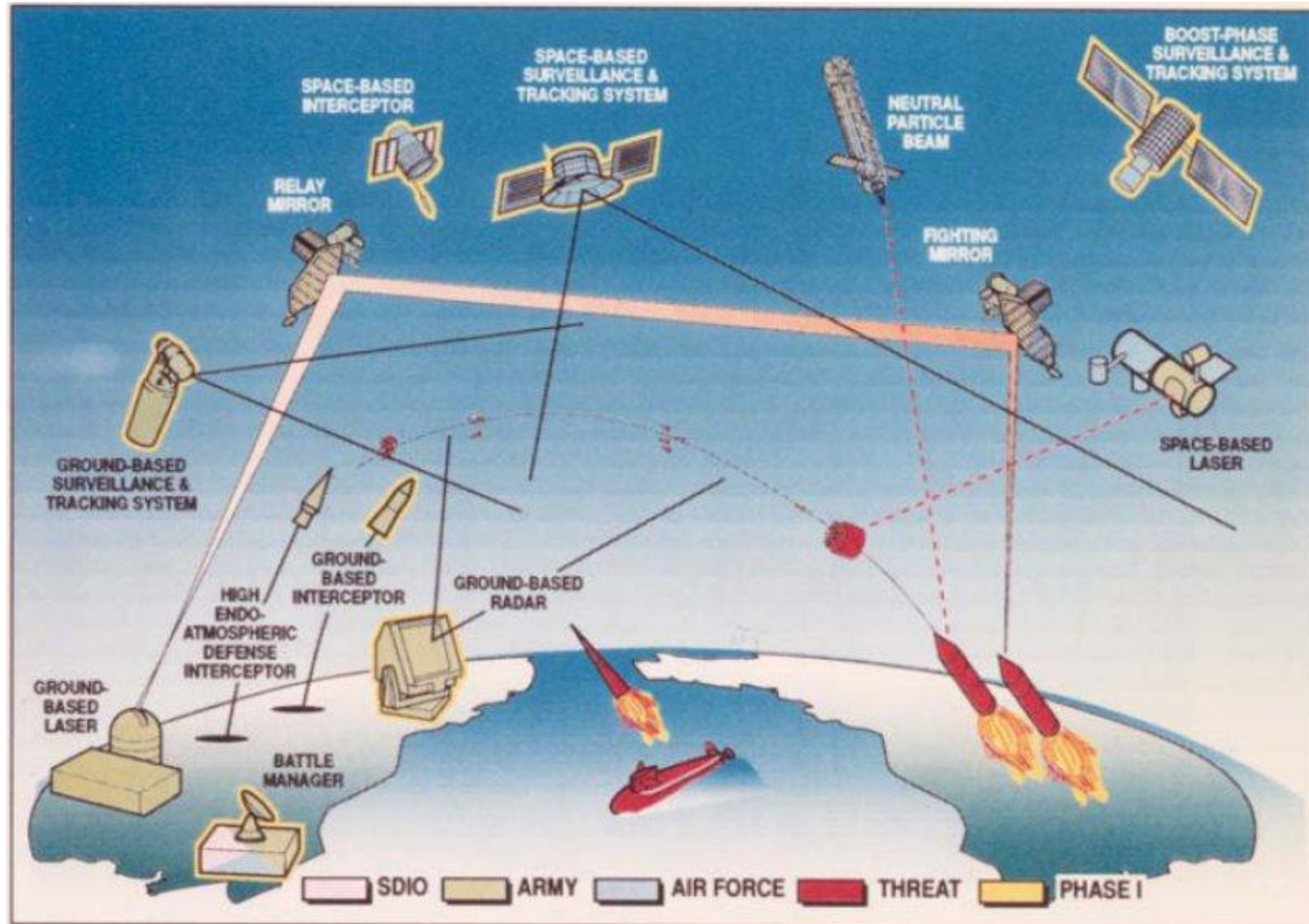
Archimede di Siracusa
(Siracusa 287aC – Siracusa 212aC)

About 2235 years ago in Syracuse (Sicily)



Strategic Defense Initiative (declassified in 1991)

Dual Use of Adaptive Optics Systems: Astronomical Observations at the Air Force Maui Optical Station (AMOS).



C. Morossi, M. Franchini

Osservatorio Astronomico di Trieste
Via G.B. Tiepolo, 11 I-34131 Trieste (Italy)

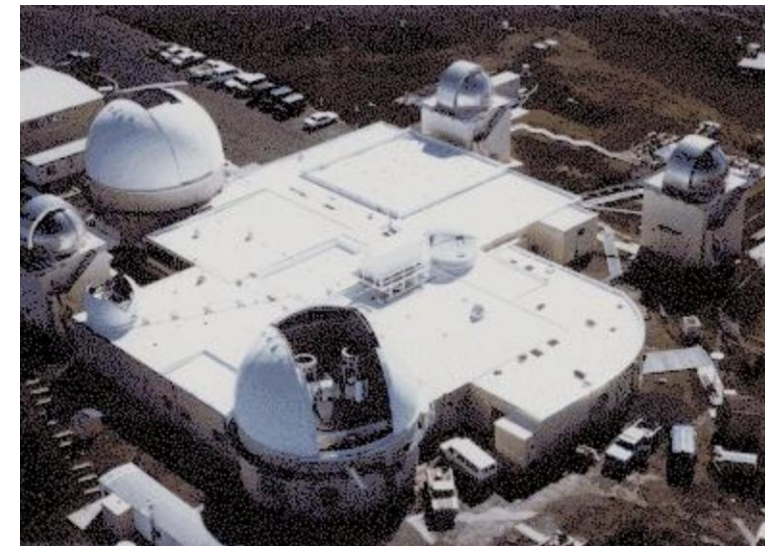
R. Ragazzoni

Osservatorio Astronomico di Padova
Vicolo dell'Osservatorio 5, I-35122 Padova (Italy)

J.S. Fender, S. Restaino
USAF Phillips Laboratory
New Mexico (USA)

J. Africano, D. Nishimoto
Rockwell Power Systems (USA)

T.L. Kreifels, P. Kervin
USAF Phillips Laboratory
Maui Optical Station (USA)



Aug. 4, 1964

R. GIACCONI ETAL

3,143,651

X-RAY REFLECTION COLLIMATOR ADAPTED TO FOCUS X-RADIATION

DIRECTLY ON A DETECTOR

Filed Feb. 23, 1961

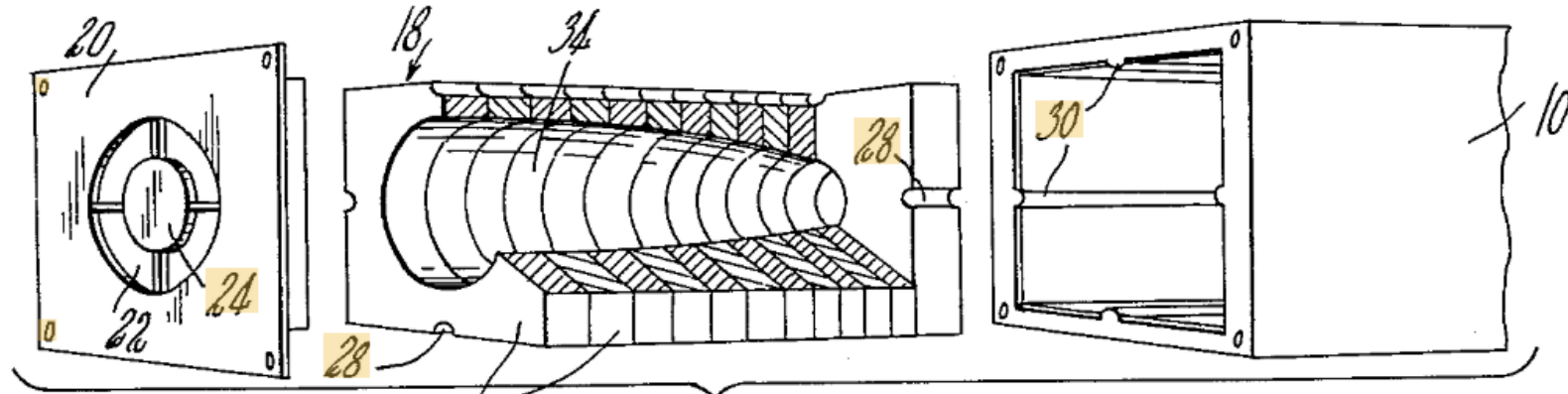


Fig. 1.

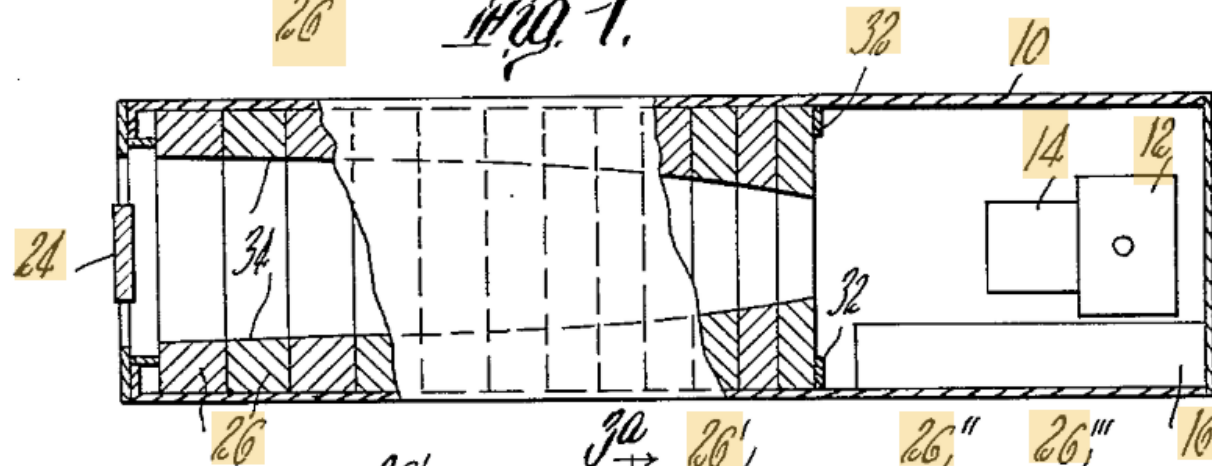


Fig. 2.

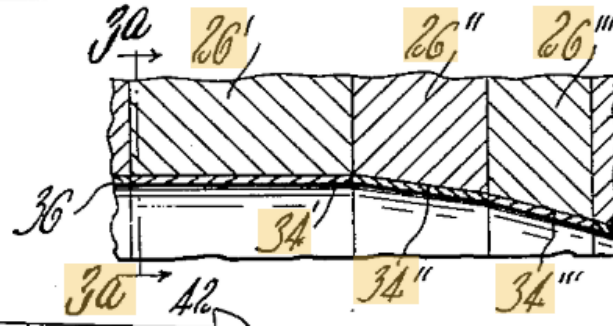
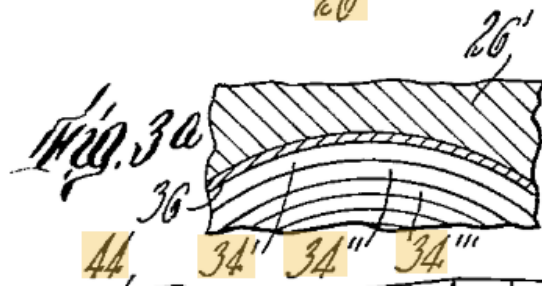
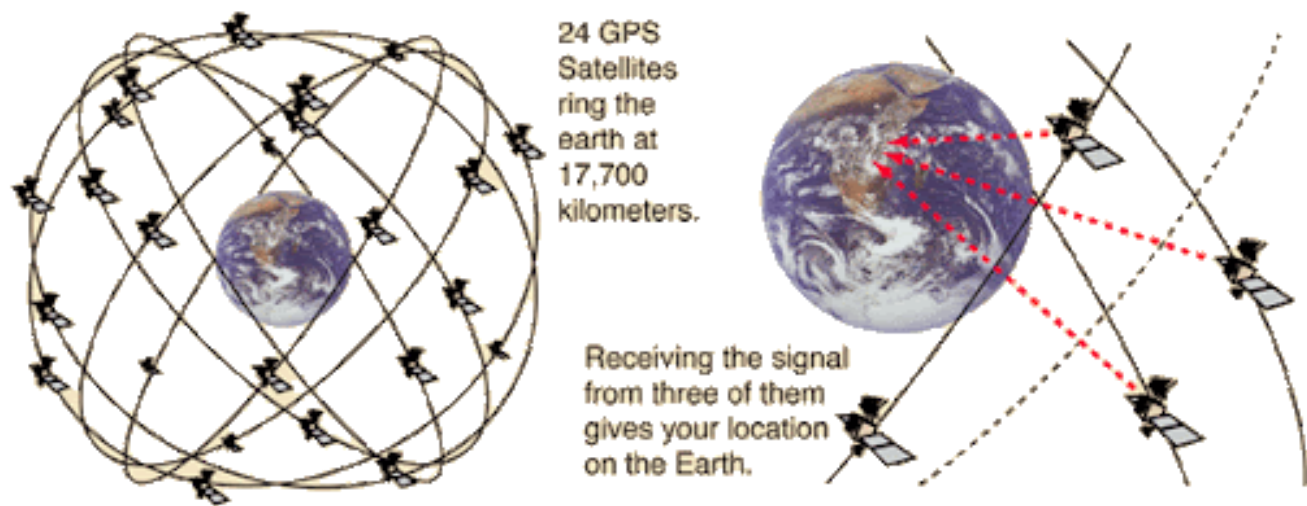
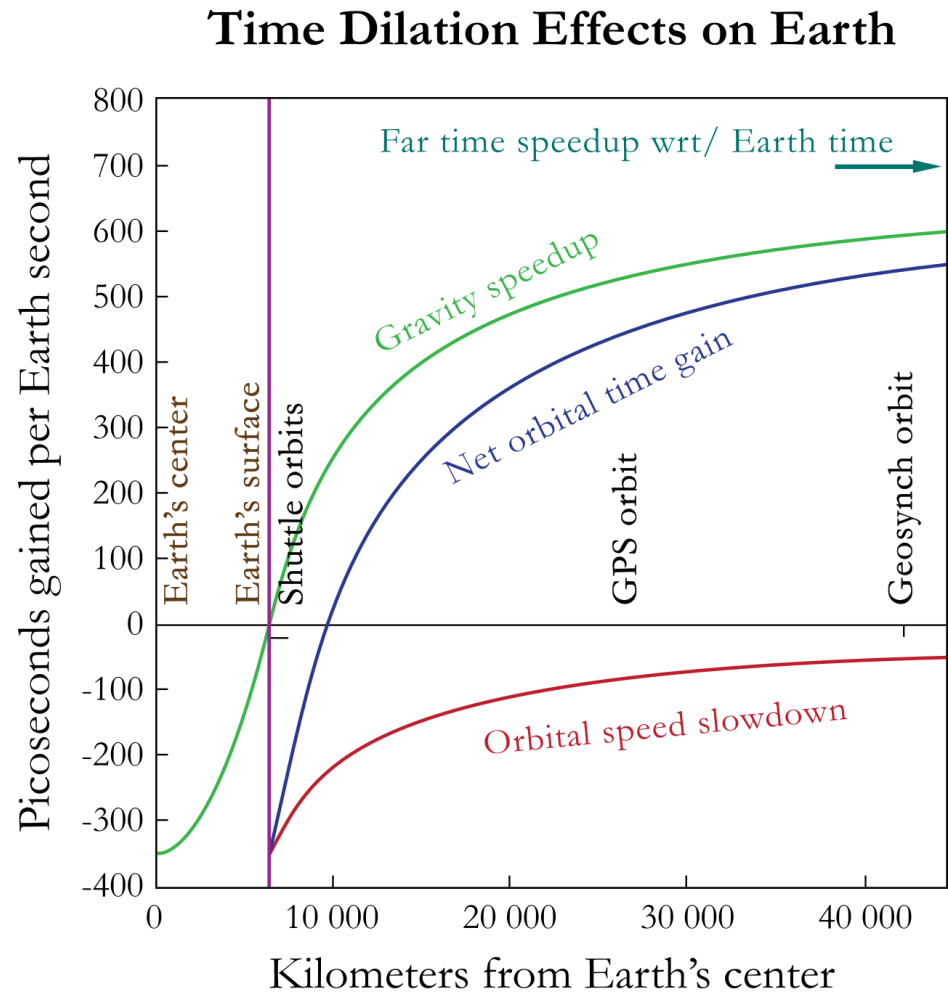


Fig. 3b

Global Navigation Satellite System

(GPS, Glonass, Galileo, BeiDou)



Albert Einstein
(1879 - 1955)

Astronomy as an outcome

- Mastering glass
- Photographic plates
- Radio Astronomy
- Photodetectors
- Multiplexing using fiber optics
- Space age
- Probably a lot others...



Nimrud's lens
Assiri, circa 730 a.c.
British museum.

Magnifying lens,
Burning glass,
decoration...?

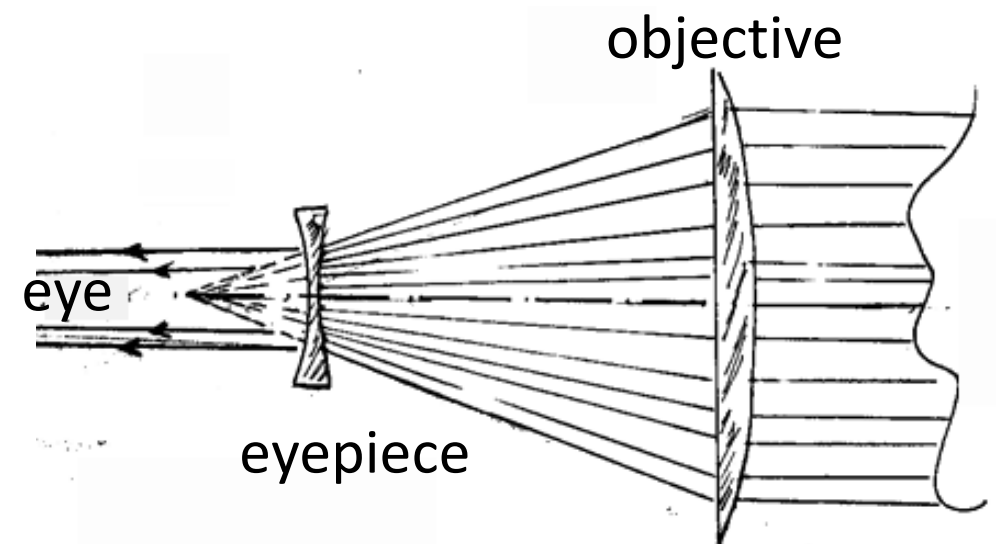
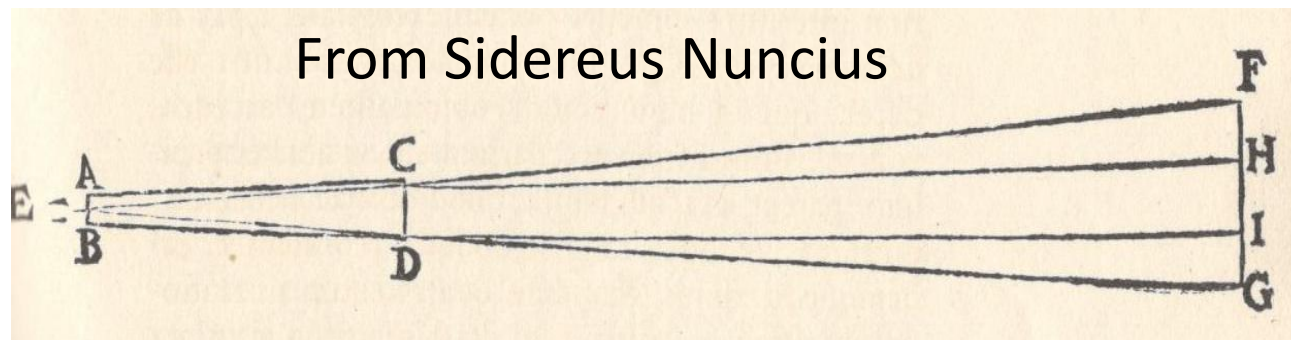
Plano convex
11cm focal length



Galileo Galilei's telescope



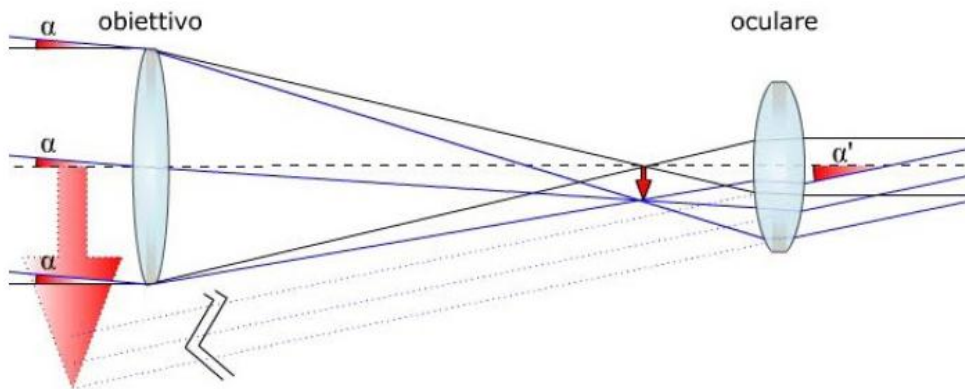
Galileo Galilei
1564-1642



Keplero

A lui dobbiamo le famose tre leggi che regolano il moto dei pianeti attorno al Sole, ma anche una prima teoria ottica, nel libro *Ad Vitellionem Paralipomena*.

Il suo *oculare* era molto migliore di quello di Galileo.



Invece di una lente prima del fuoco, Keplero la mise **dopo**, migliorando di gran lunga la visione con l'occhio.

Lo svantaggio è che l'oculare **capovolge le immagini**. La soluzione di Keplero fu poi perfezionata da Huygens, Ramsden e altri ancora nei secoli seguenti.

Paris 1900

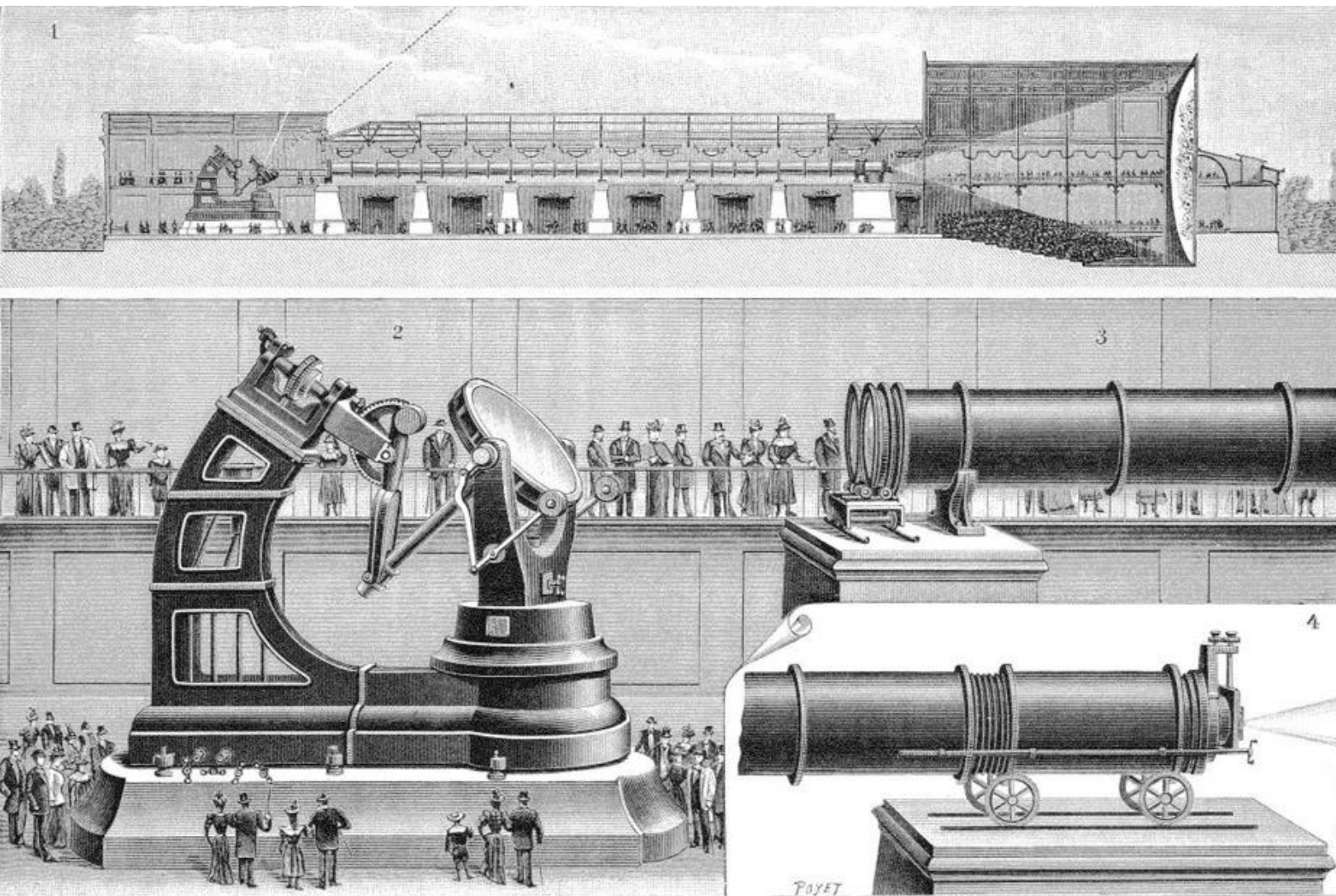
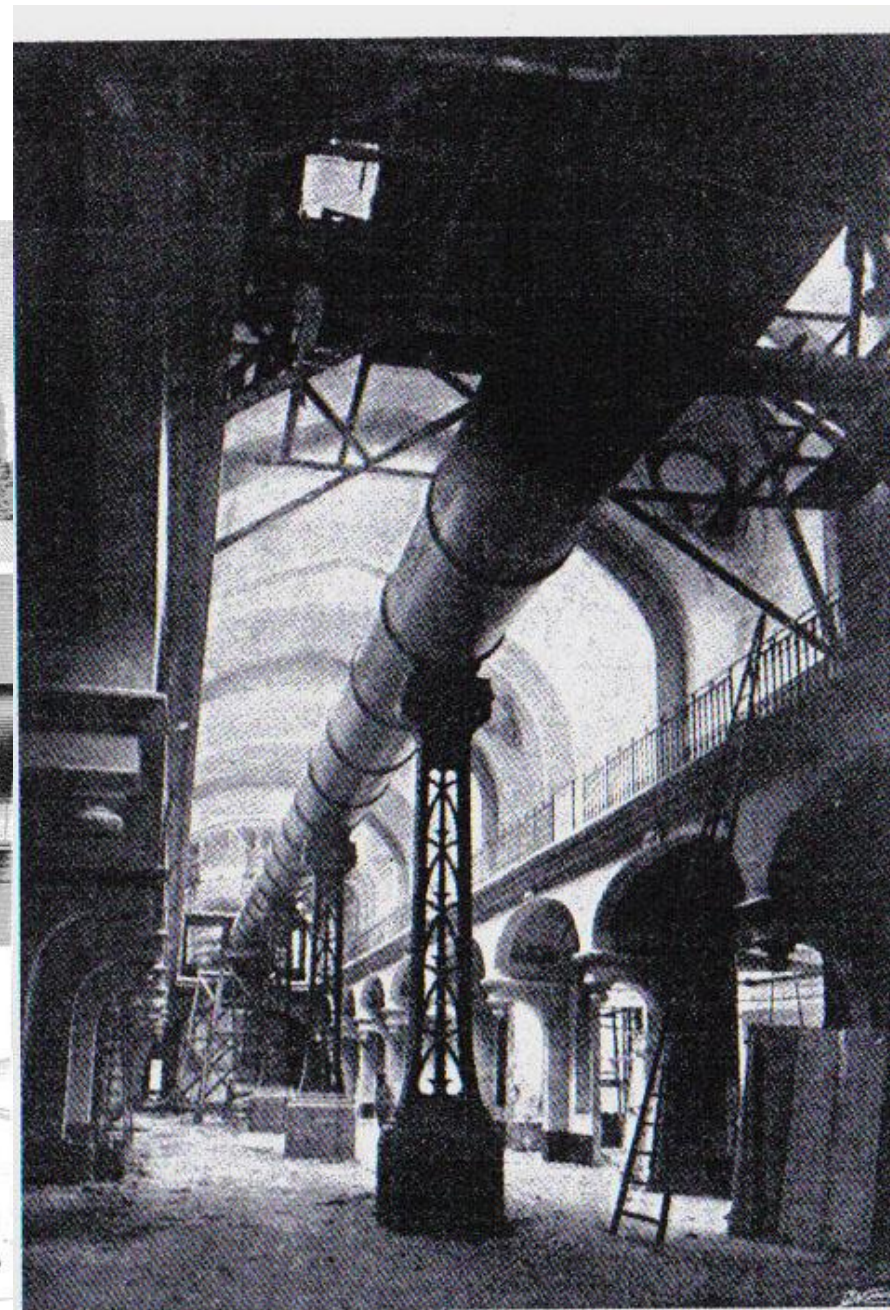
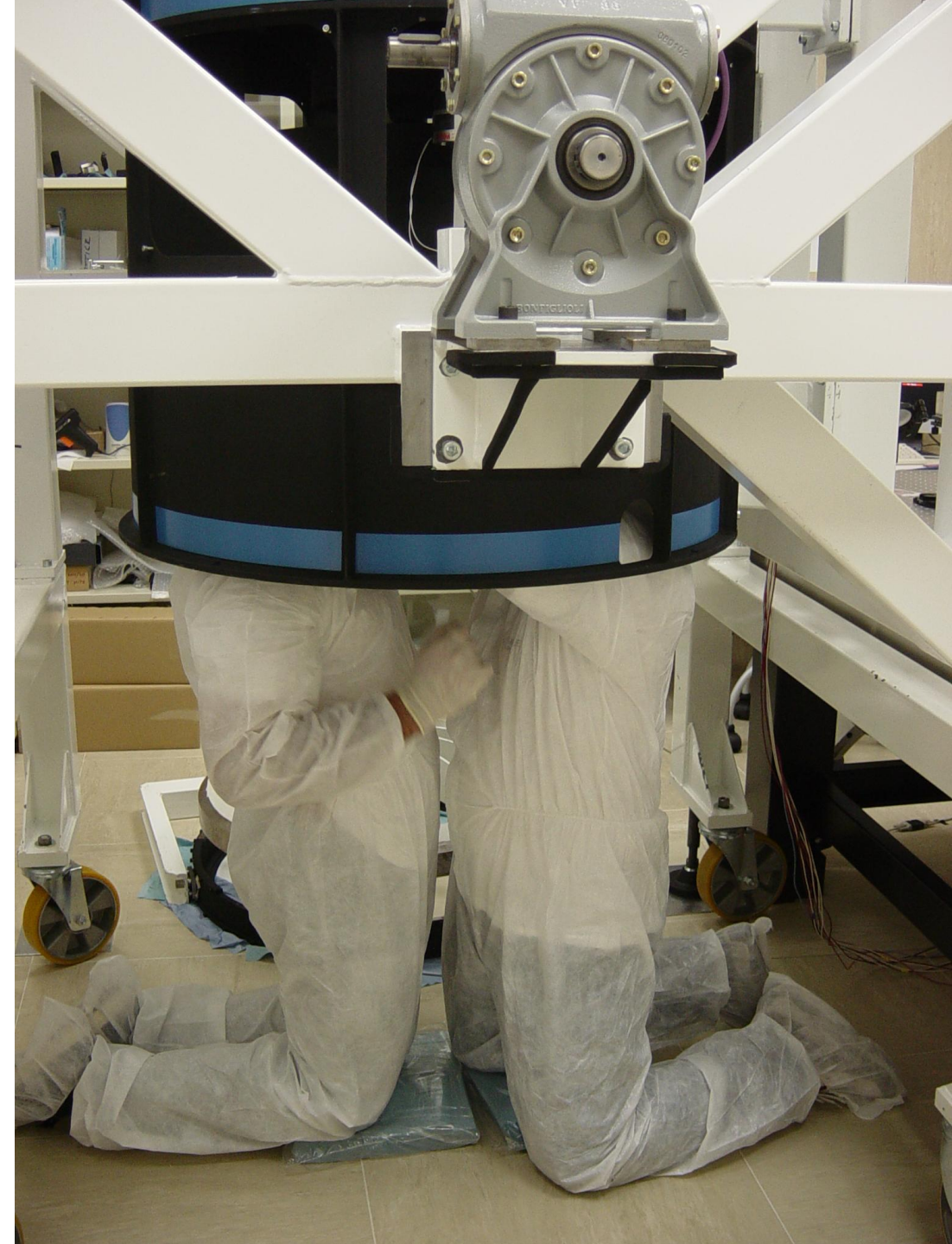


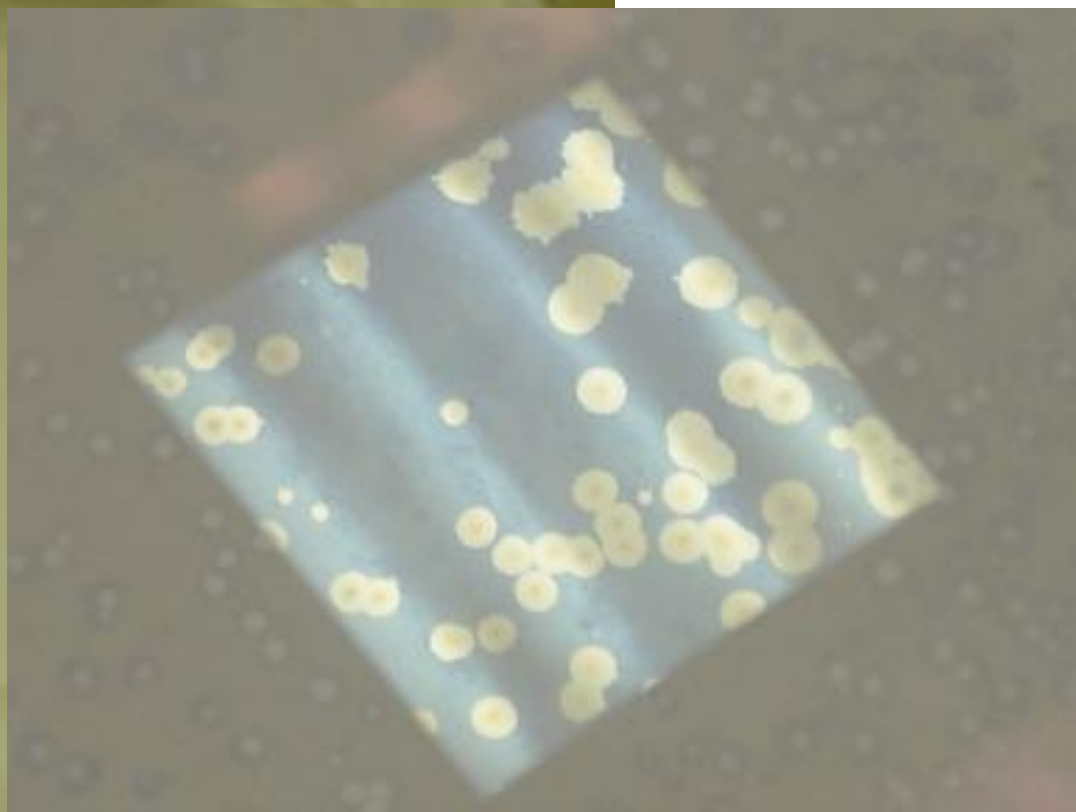
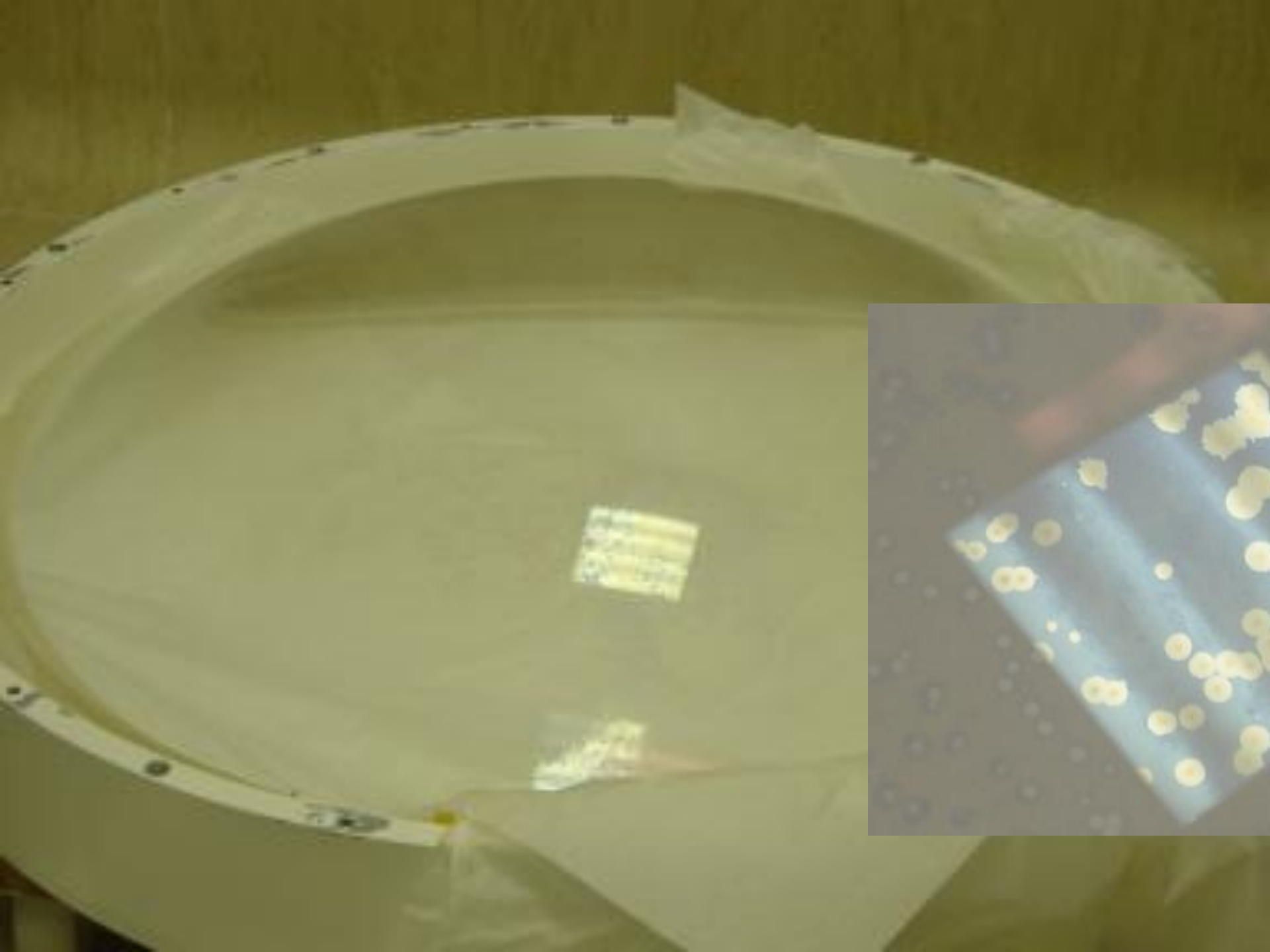
Fig. 3. — Détails de la grande lunette. — 1. Vue d'ensemble. — 2. Le sidérost. — 3. La lunette. — 4. L'oculaire.



Yerkes



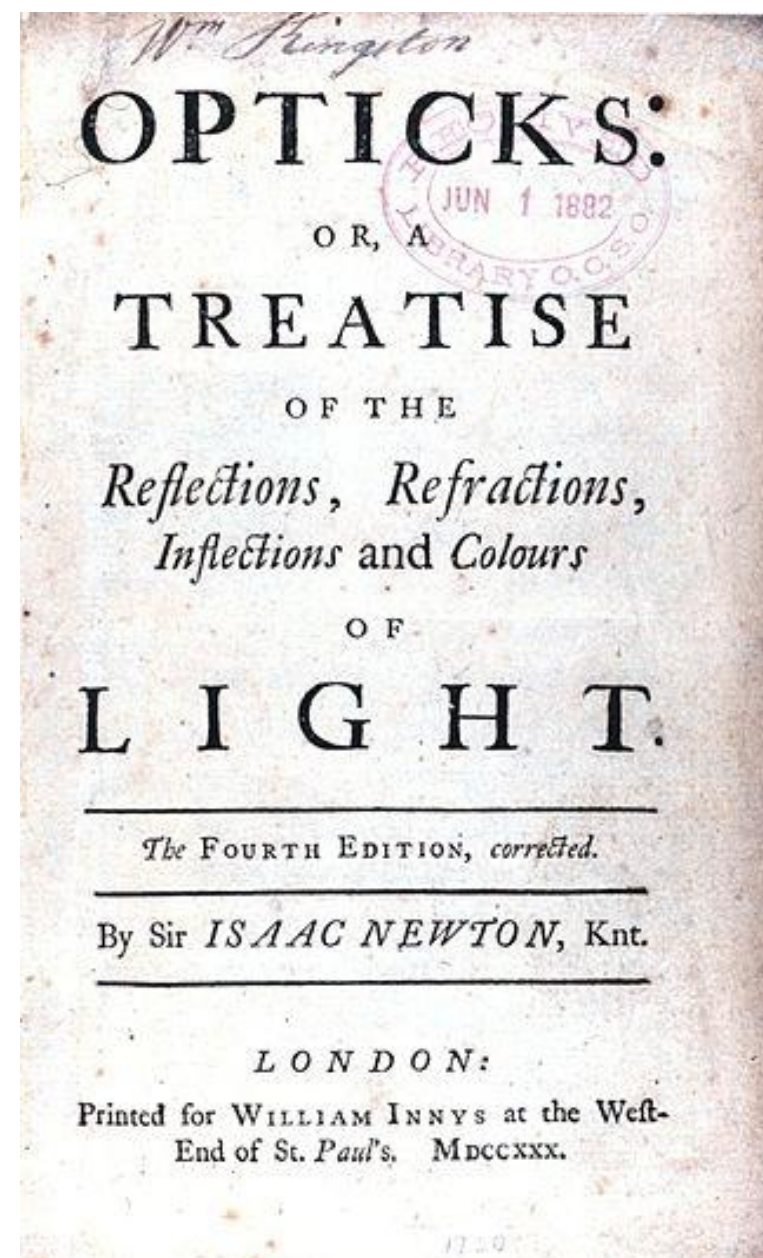
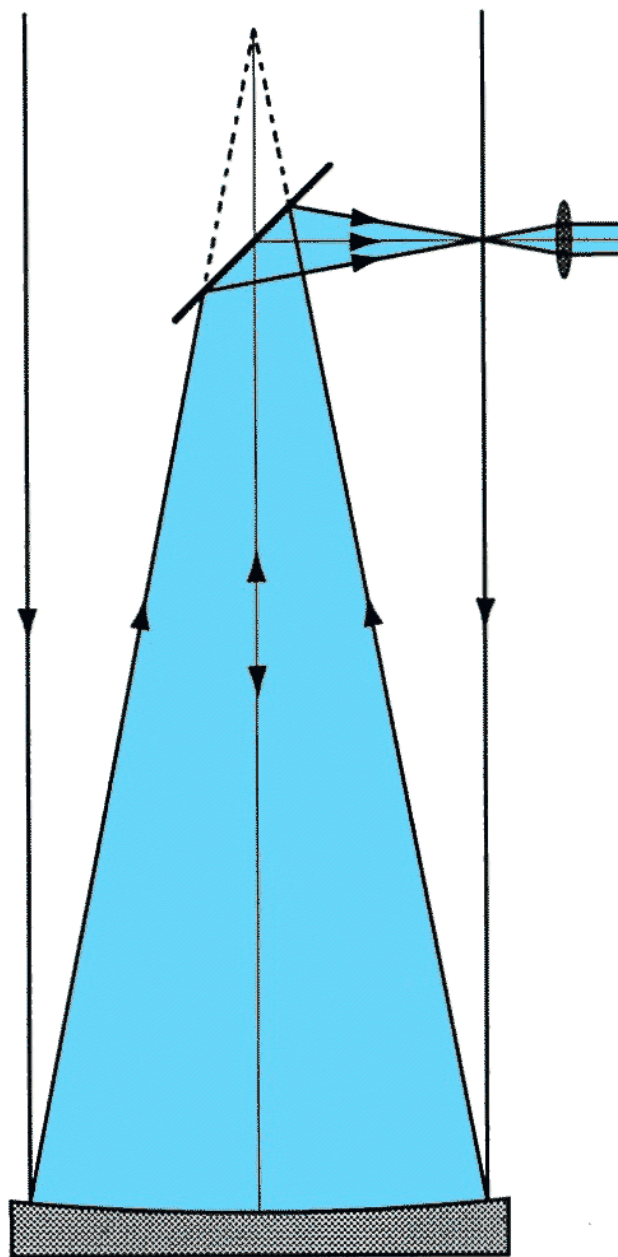


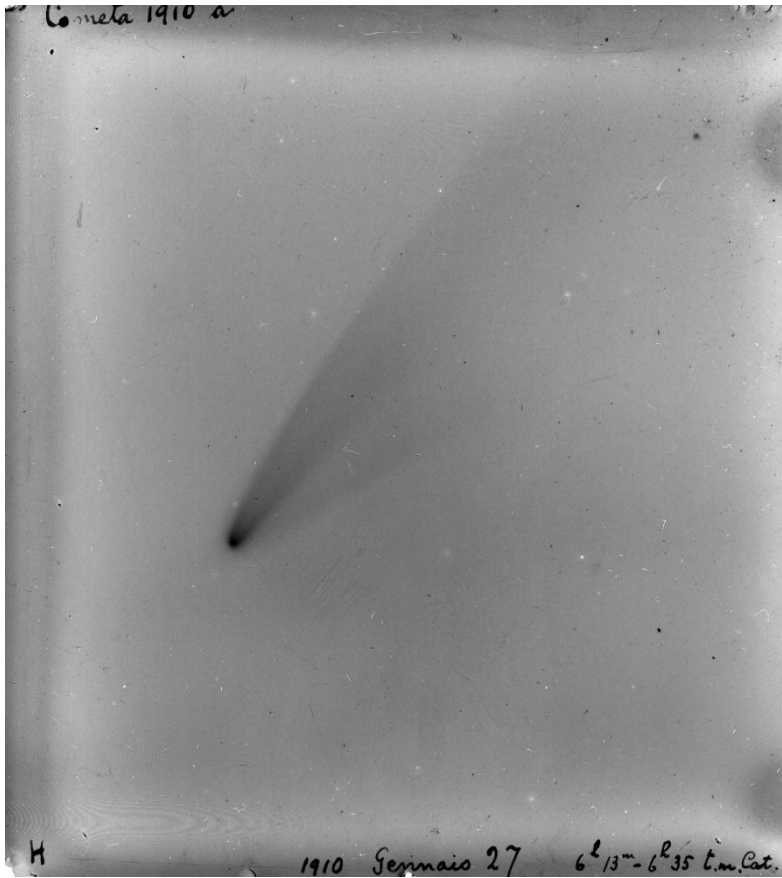




Happy New Year from the LBC optomechanics team





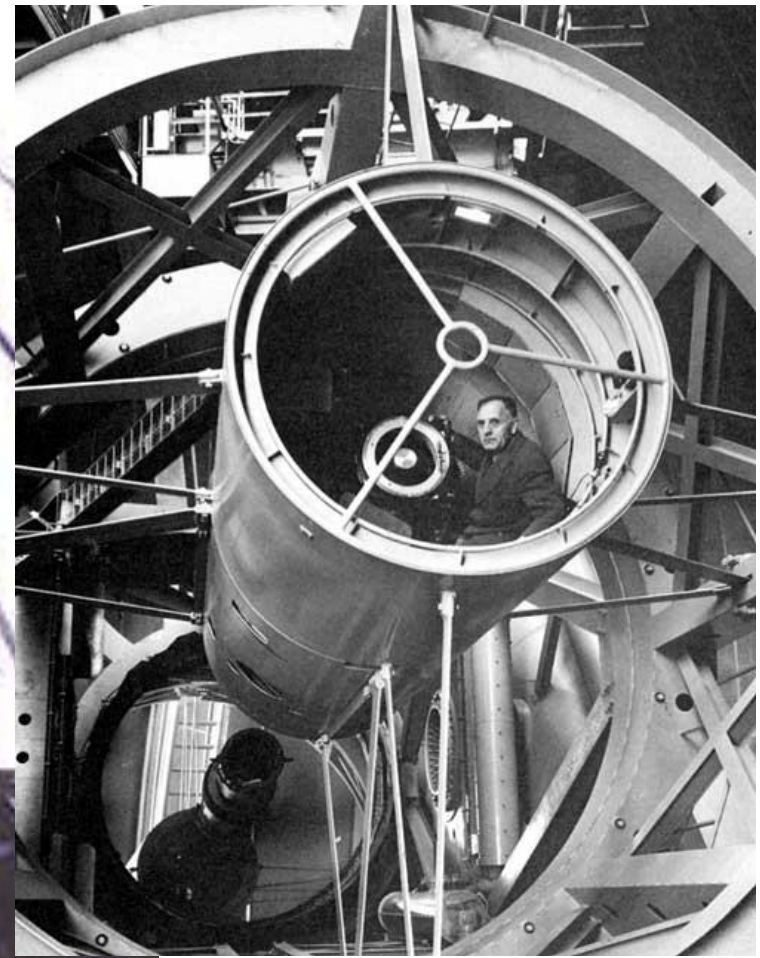
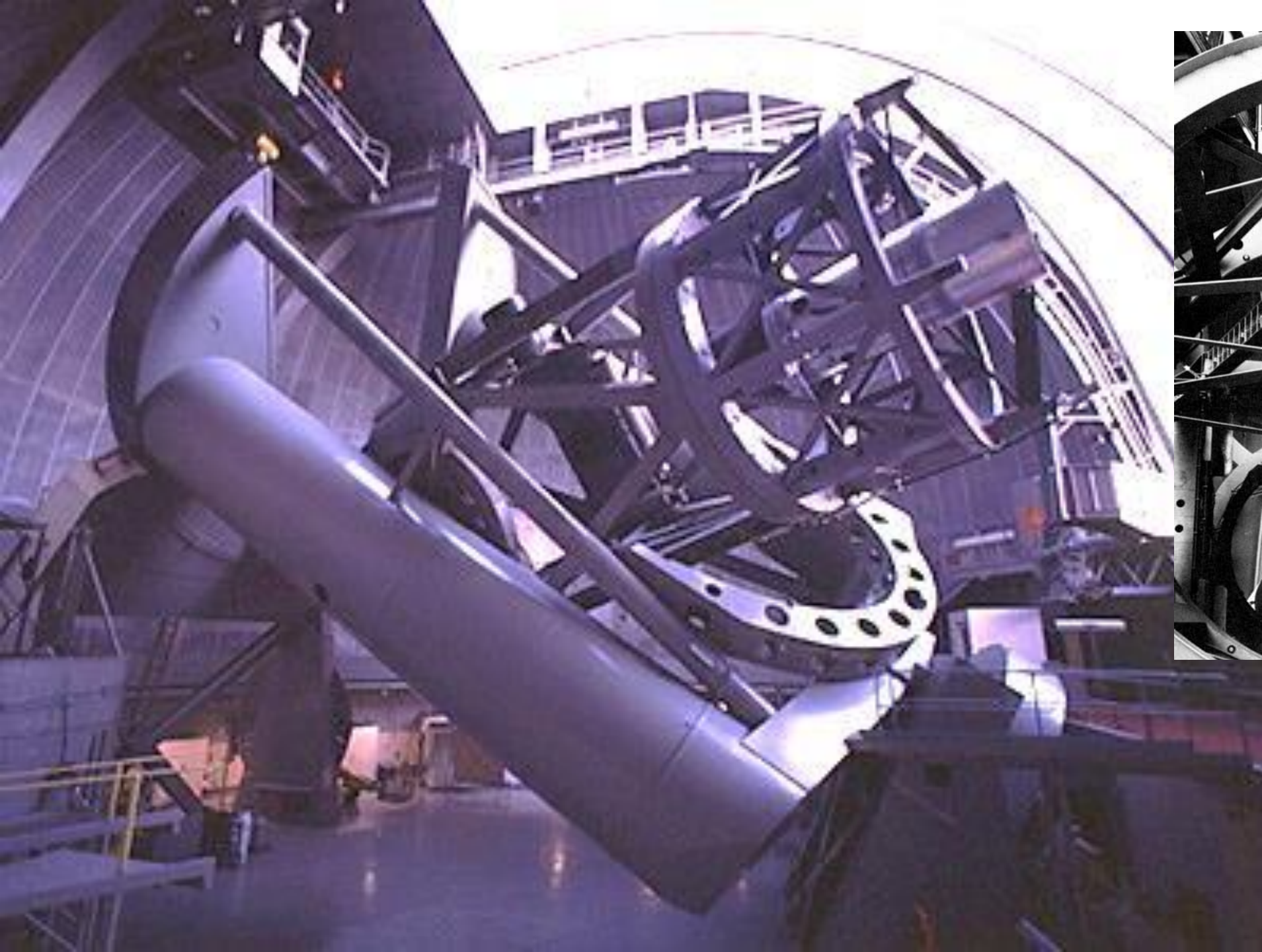


First picture of the Halley Comet
(Catania 1910)



5m Palomar
Honeycomb
Mirror

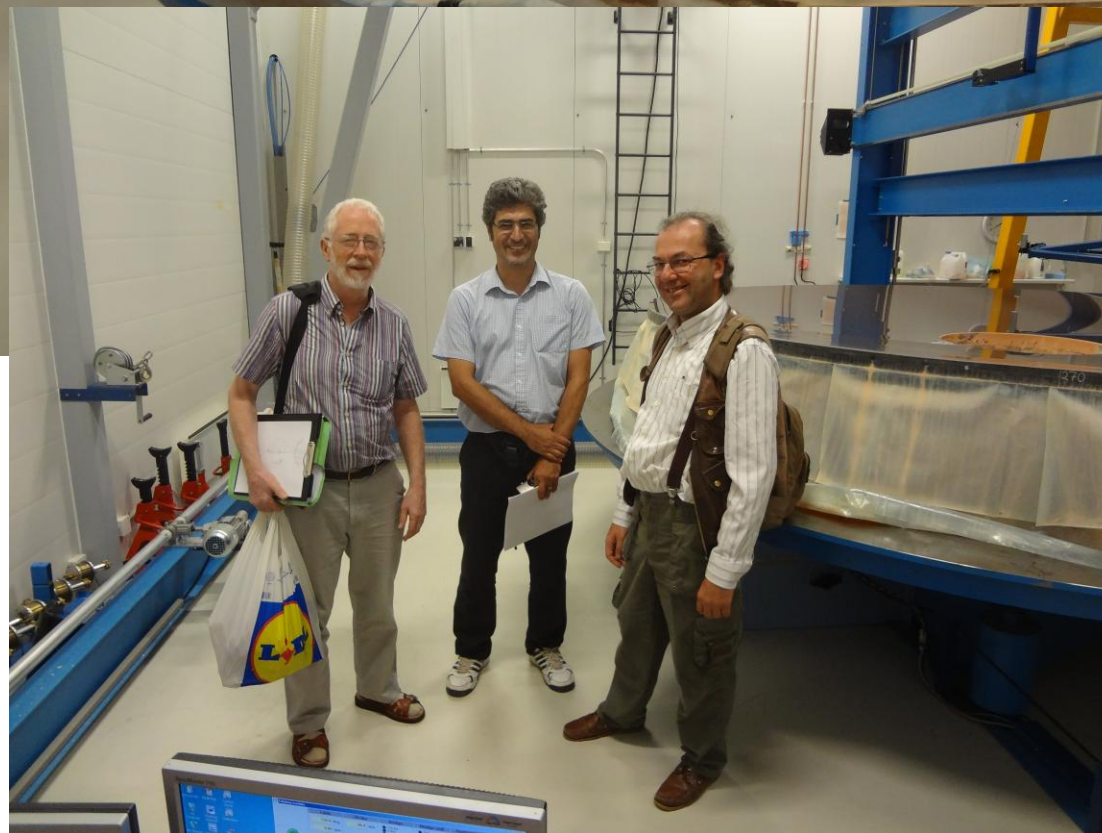
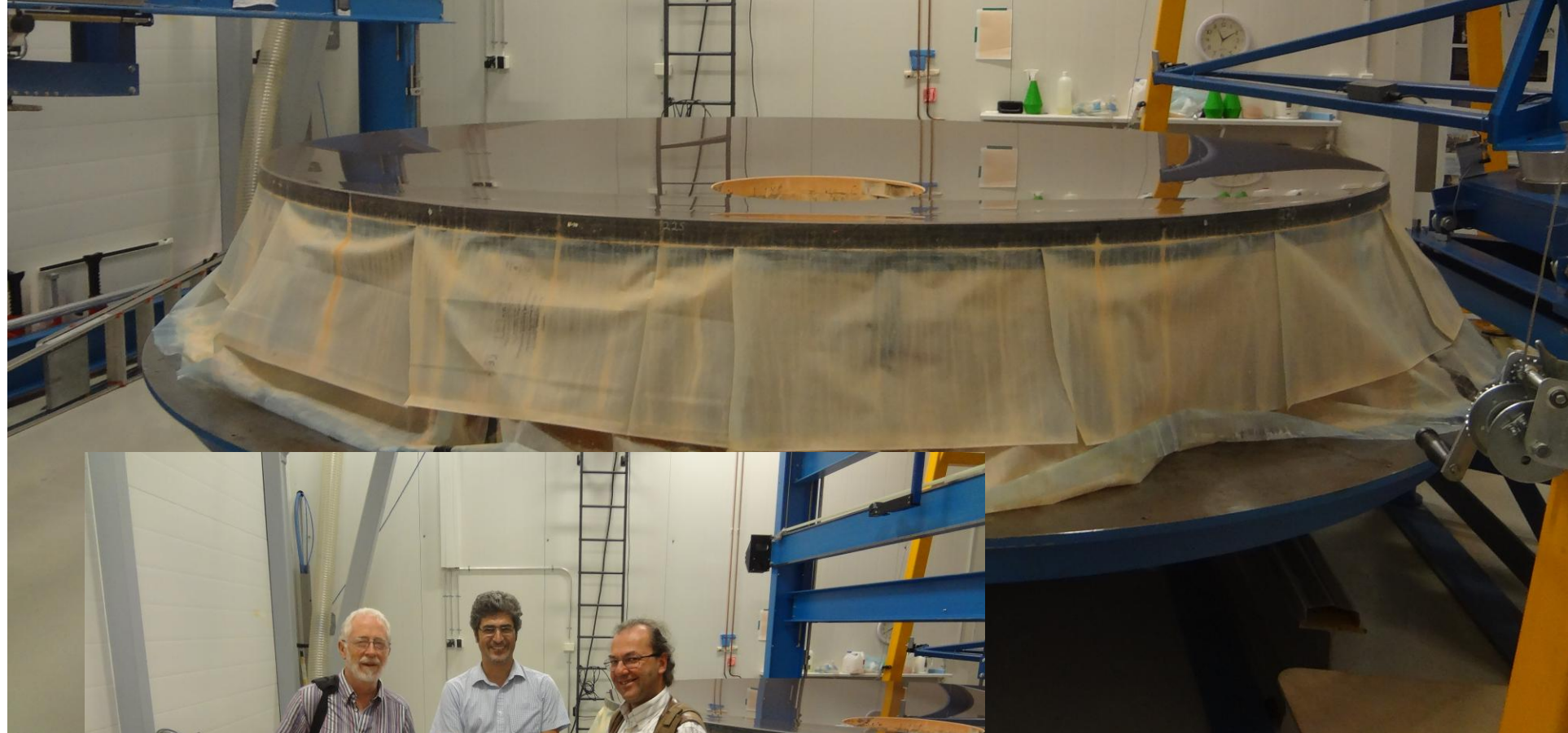






TNG





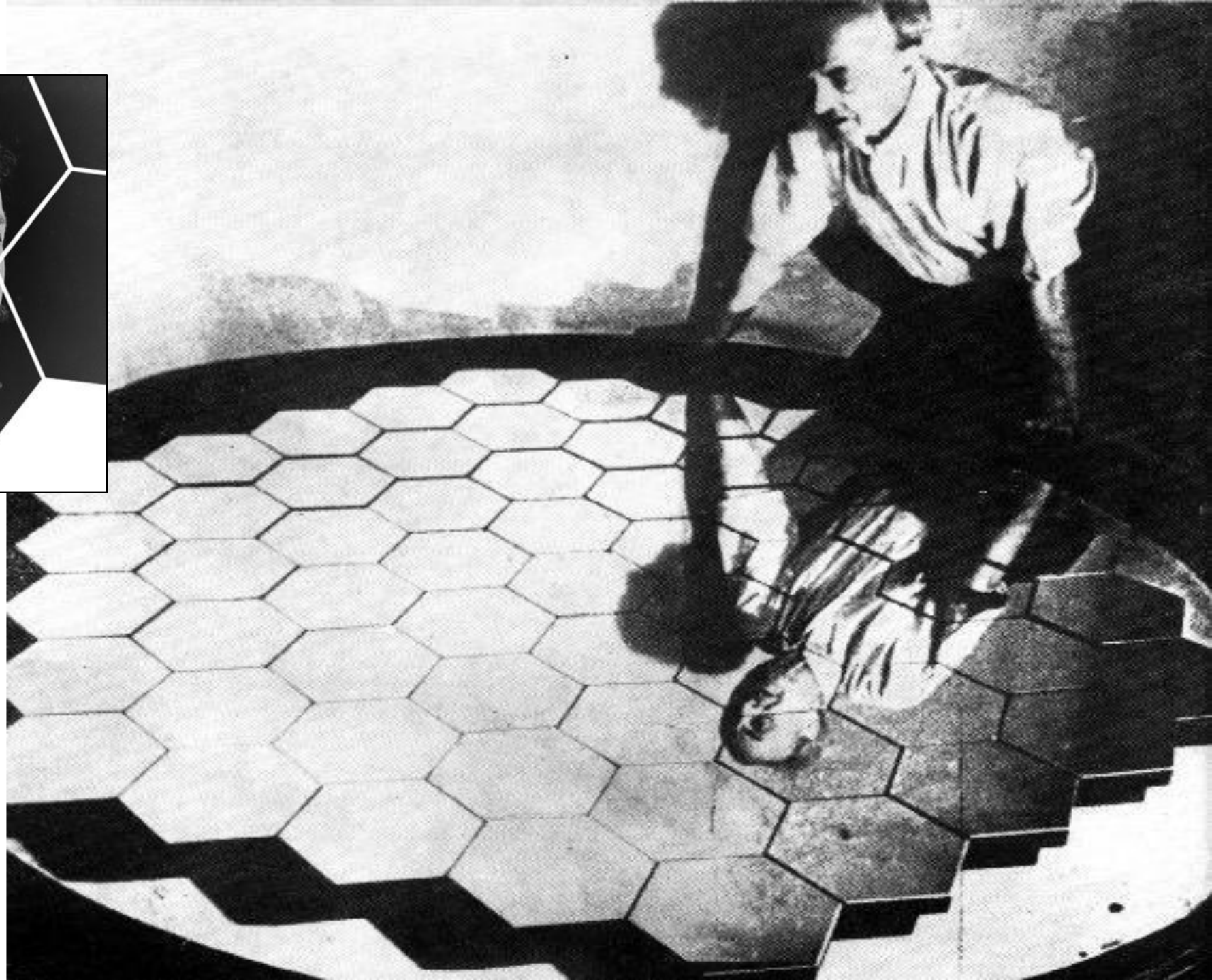
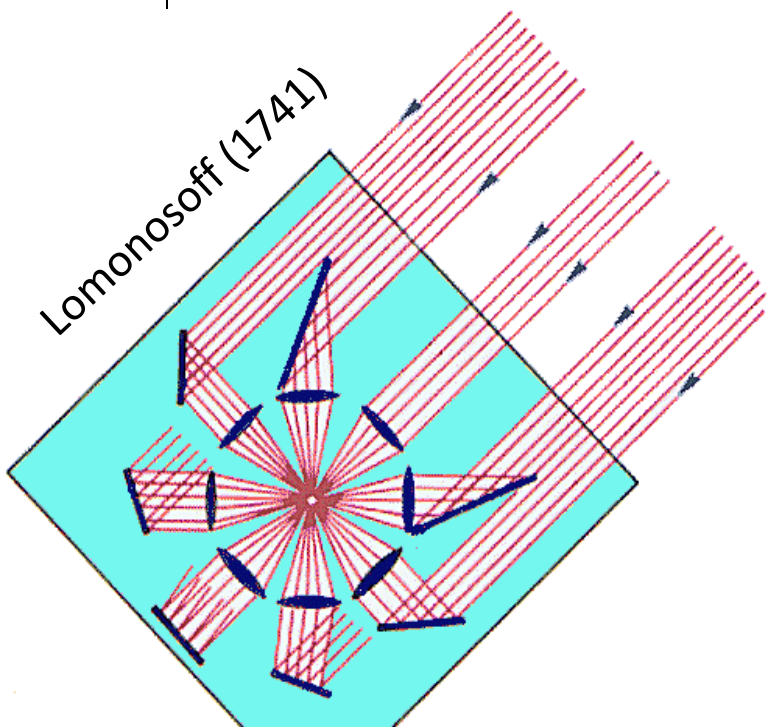

رصدخانه ملی ایران
پژوهشگاه دانشهای بنیادی
Iranian National Observatory

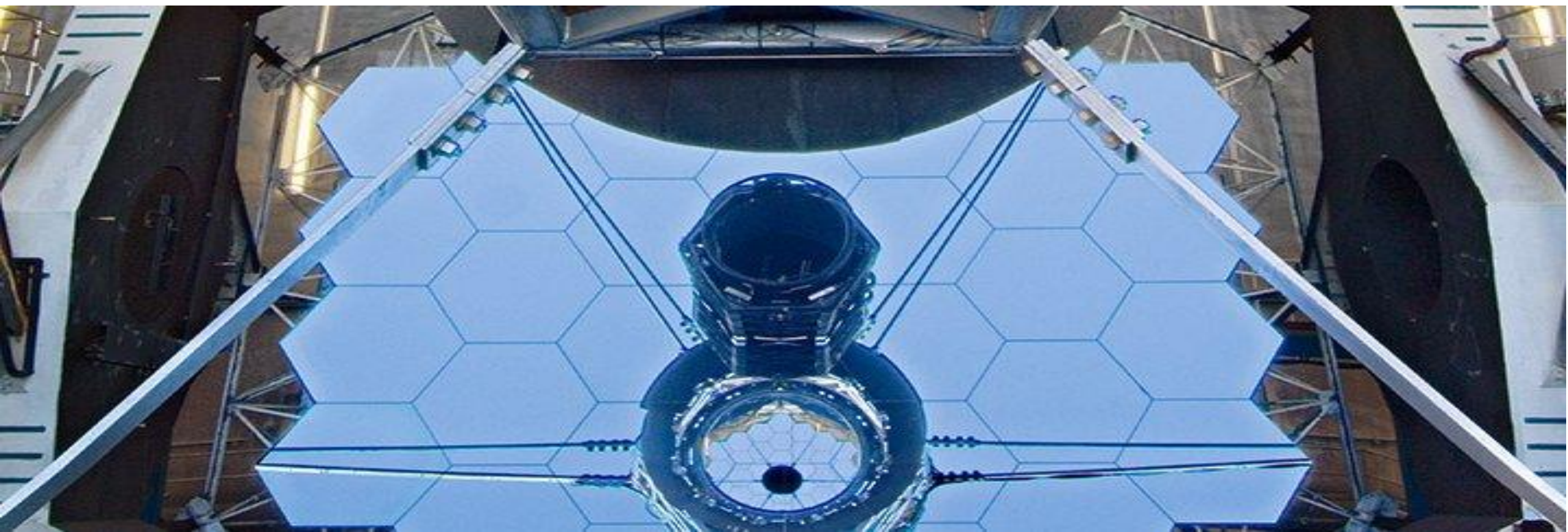
3.6m mirror
For Iranian
National
Observatory

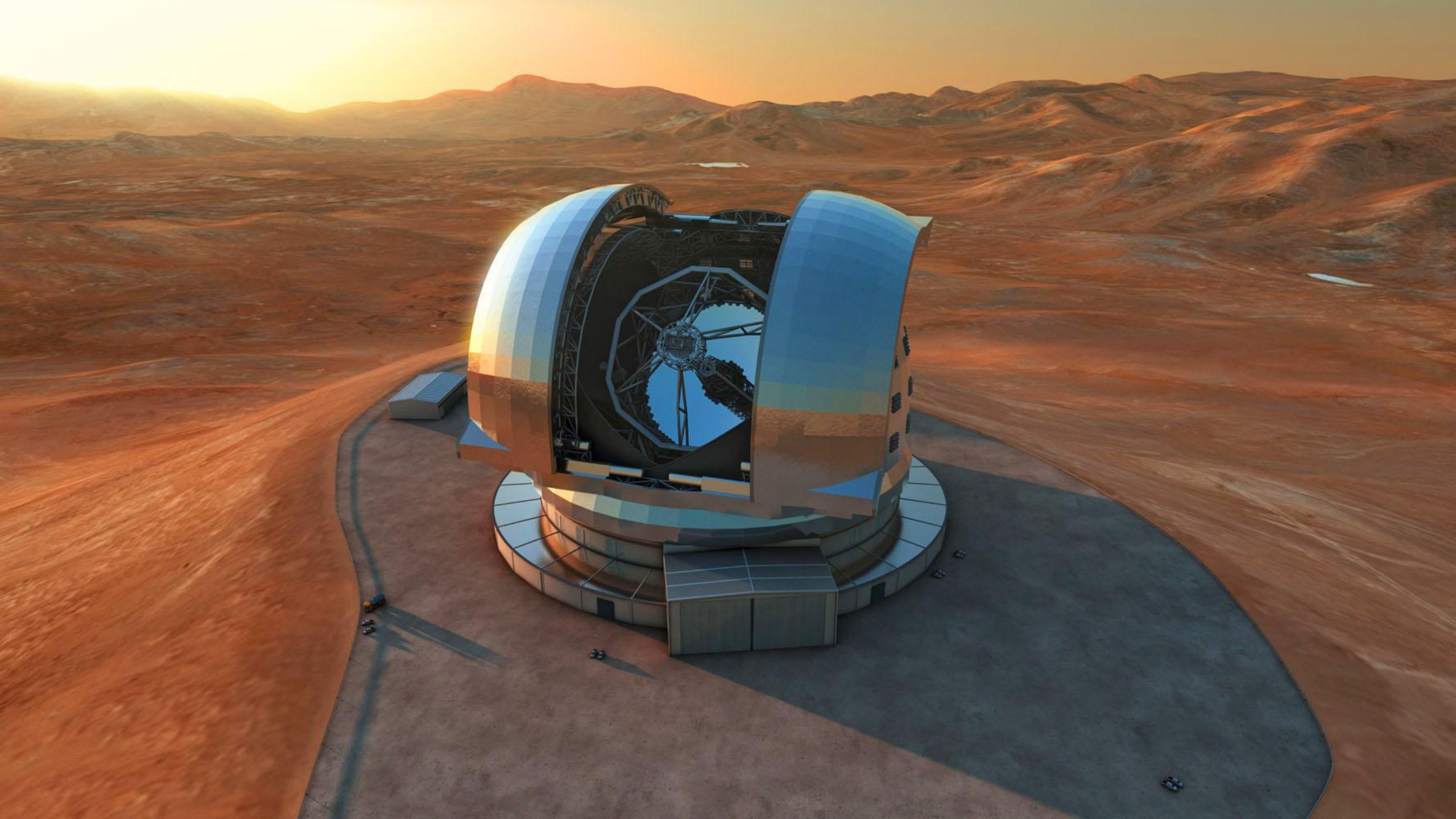


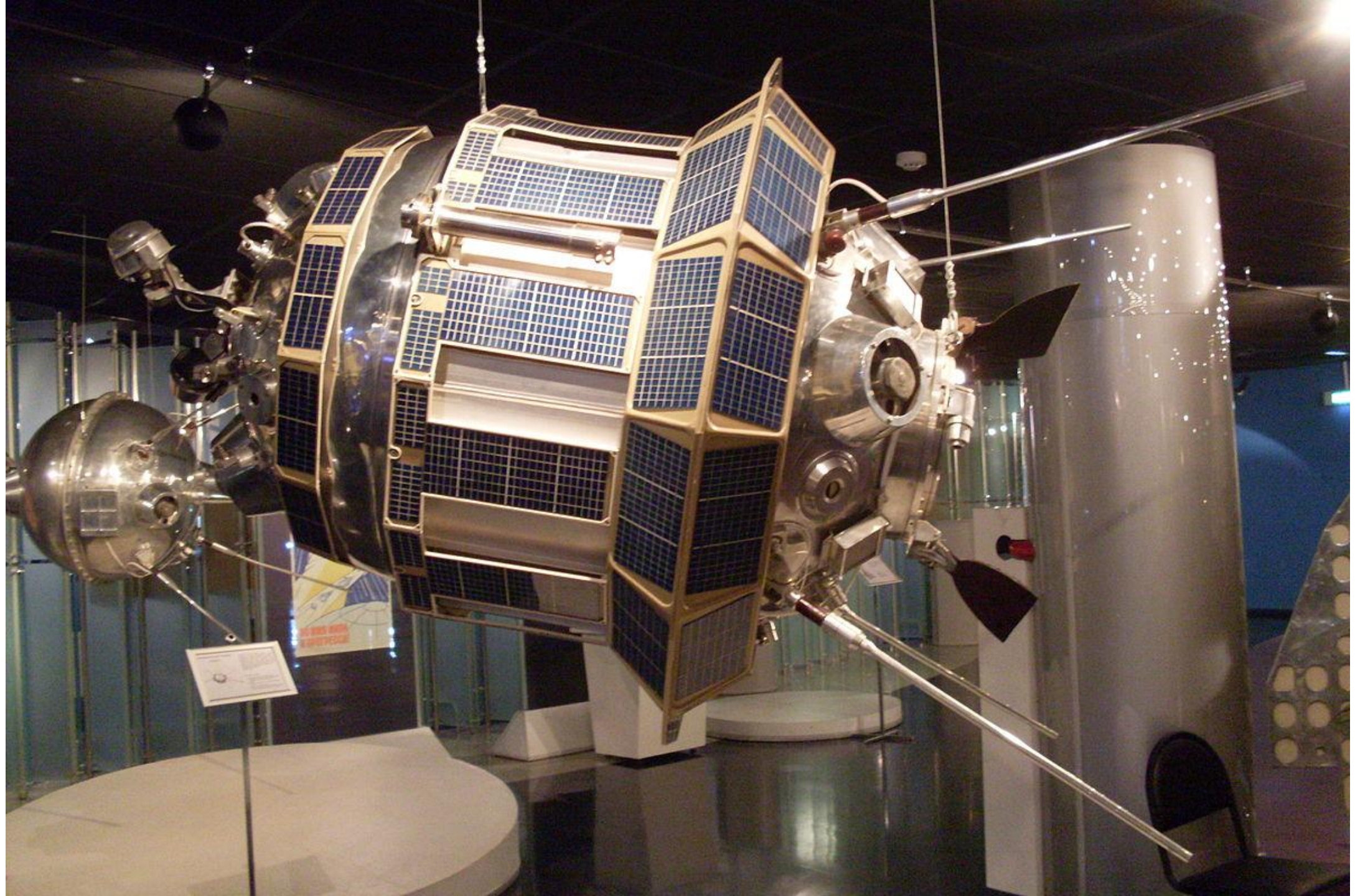


8.4m first LBT mirror











Ку

Кому

Адрес отправителя

fine art
america

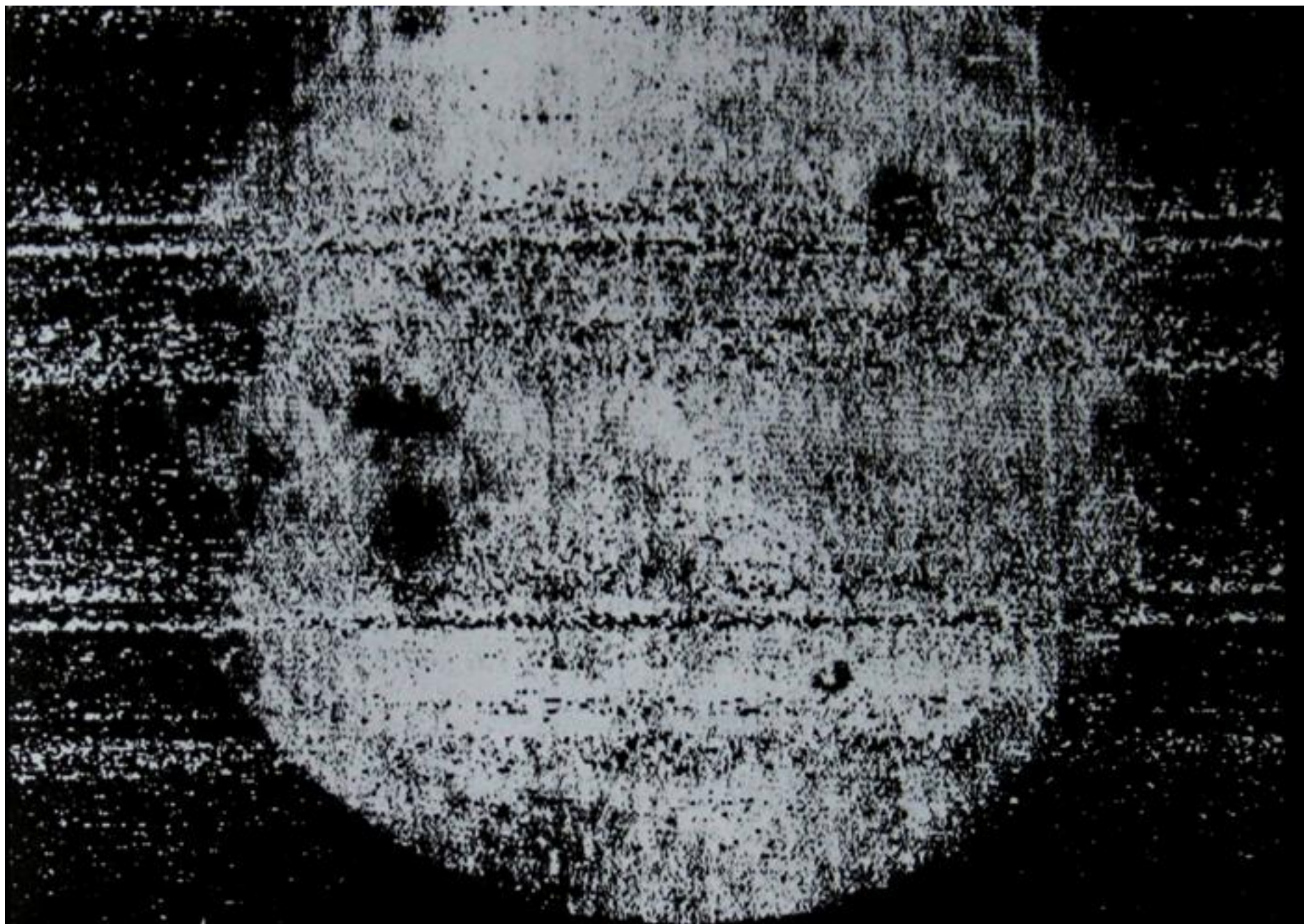
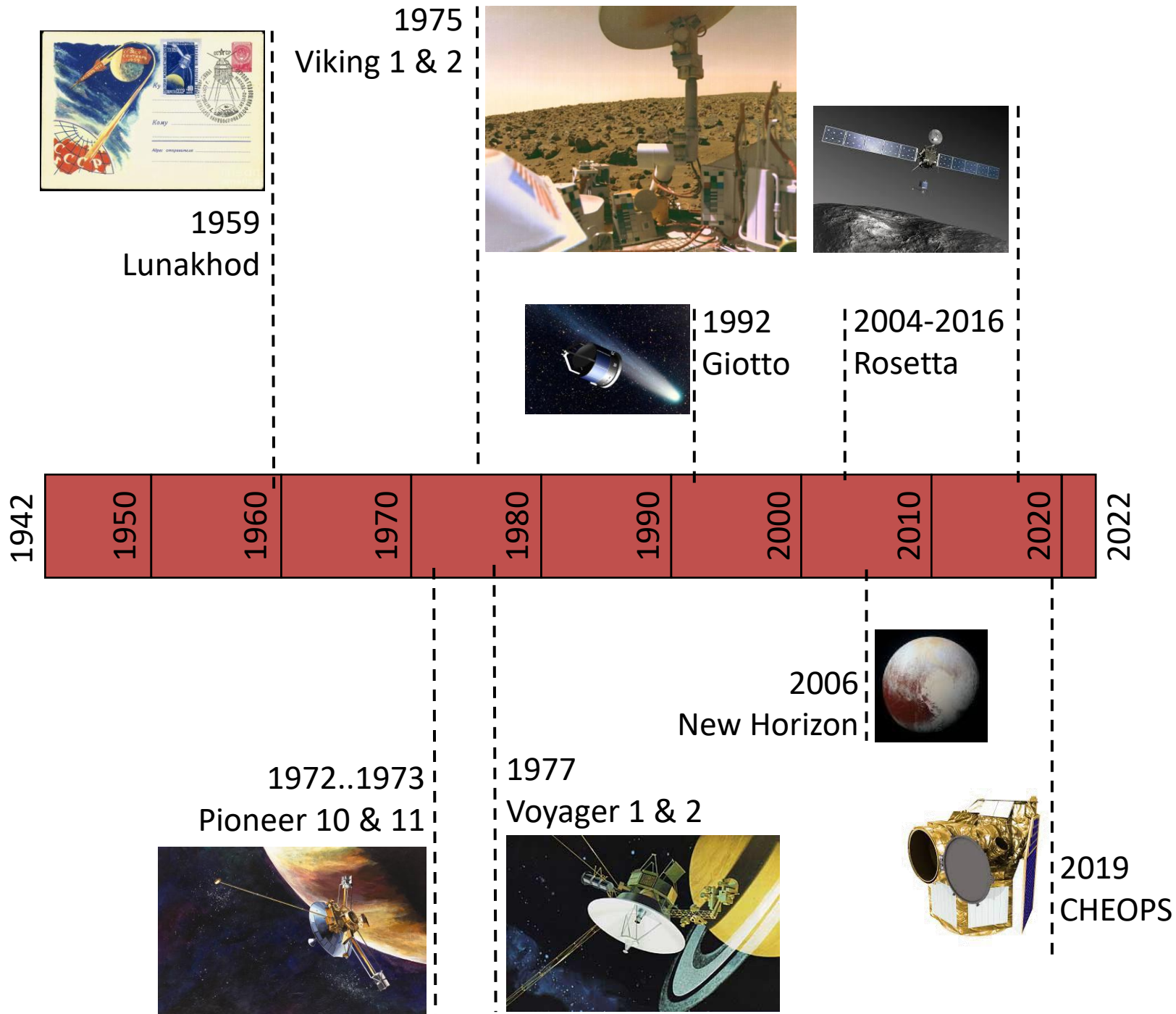
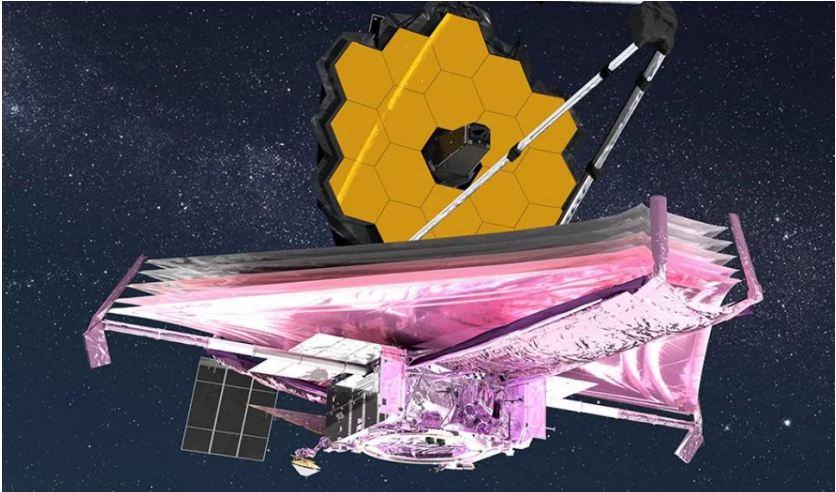


Fig. 10.1. One of the Luna 3 photographs of the Moon's far side taken by the Soviets in October 1959.
U.S.S.R. Photo

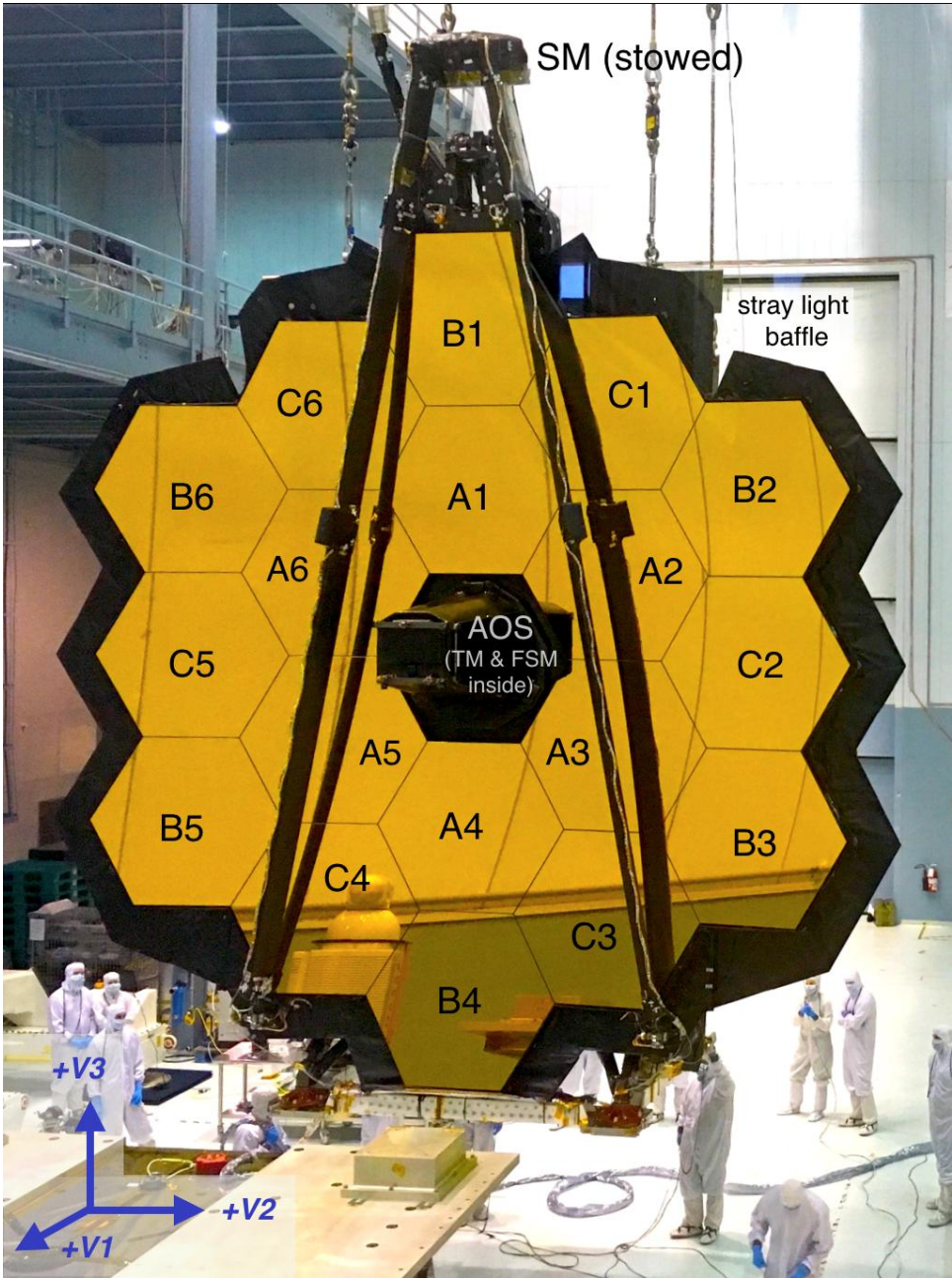
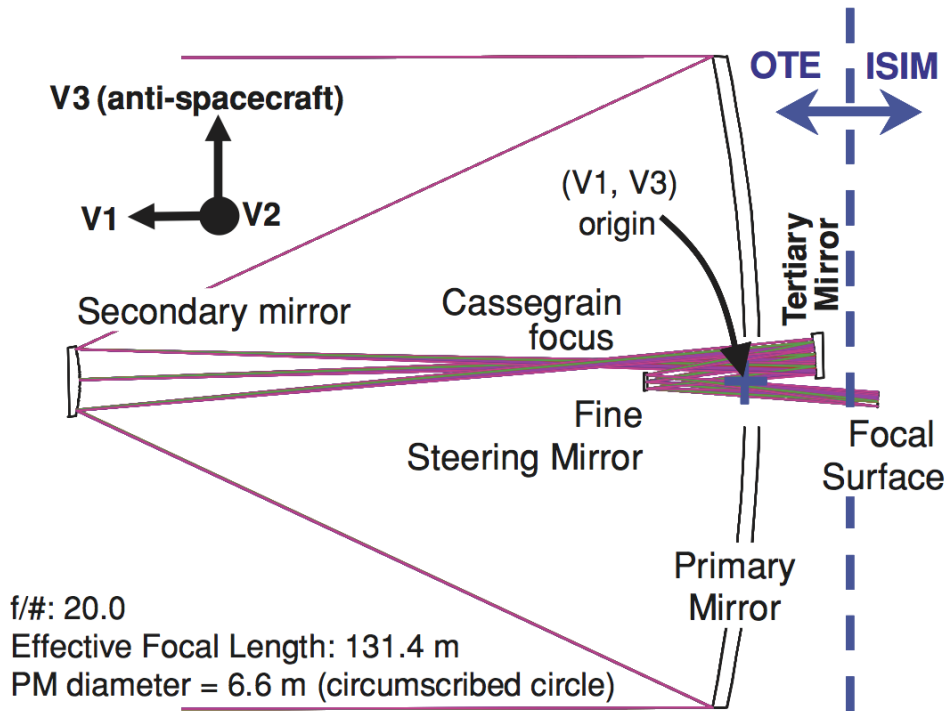


Space Age
Completely
Changed the
perspective...!!!

James Webb Space Telescope



18 beryllium
Mirrors gold
Coated...



BK7

BK7G5

BK7G10

BK7G18

Cerium
doped



Yes, Piazzi was right...!!!