Bedeutende astronomische Beobachtungsstätten

Europa

Pic du Midi

Calar Alto

Pico del Teide

La Palma

USA

Mauna Kea (Hawai)

Kitt Peak

MMT

(Mt. Hopkins)

Chile

La Silla

Cerro Tololo

Cerro Paranal

Russland

Kaukasus

(Mt. Postukov)

Australien

Siding Spring

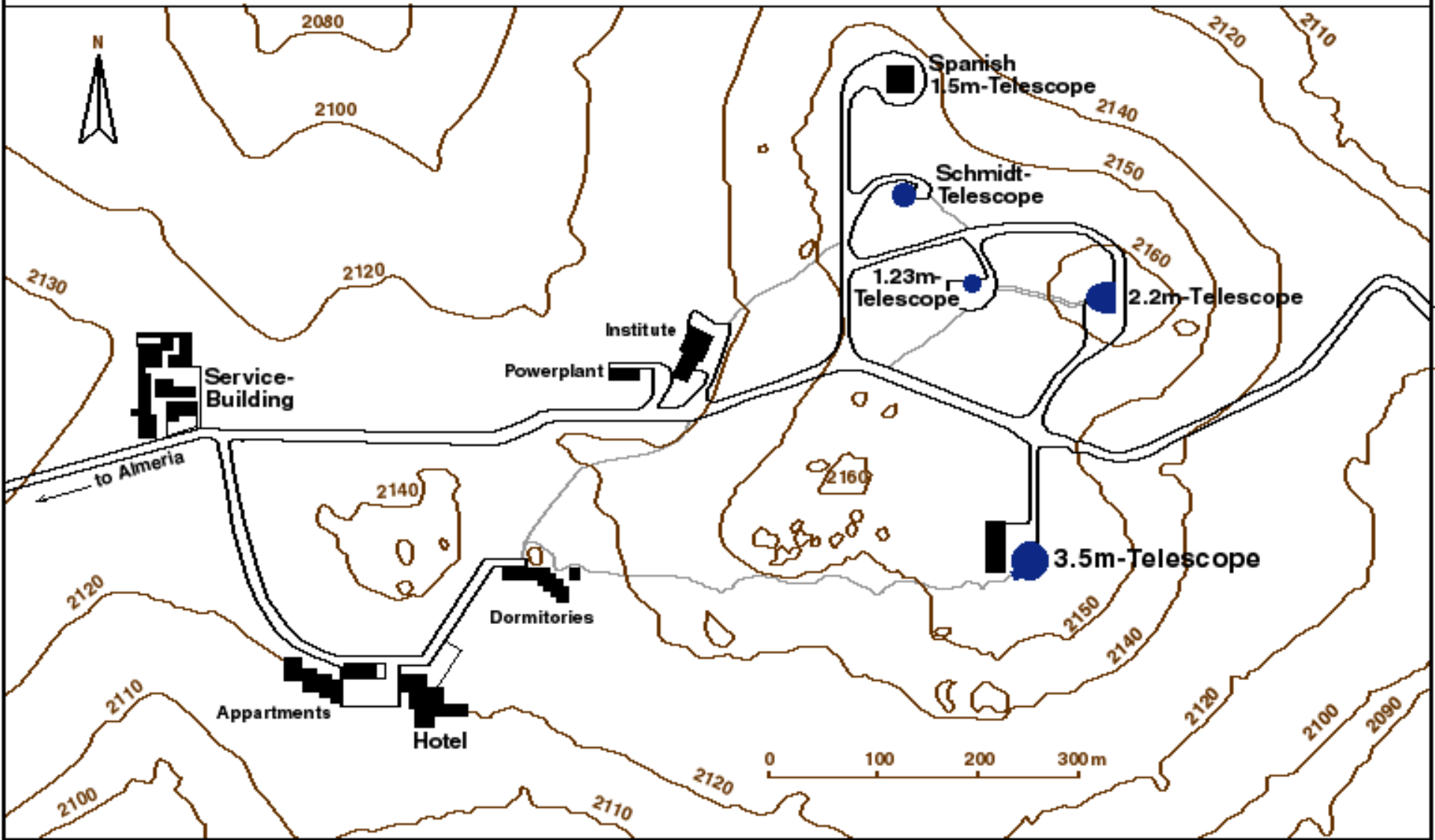
Pic du Midi

Ort: Pyrenäen; 2877 m
Geräte: 2-m, 1-m, 60-cm, Koronographen, Sonnenrefraktor

Calar Alto

Ort: bei Almeria (Spanien); 2160 m
Geräte: 3.5-m, 2.2-m, 1.5-m, 1.2-m, Schmidt-Spiegel

Calar Alto Observatory



Pico del Teide

Ort: Teneriffa; 2400 m
Geräte: diverse Sonnenteleskope

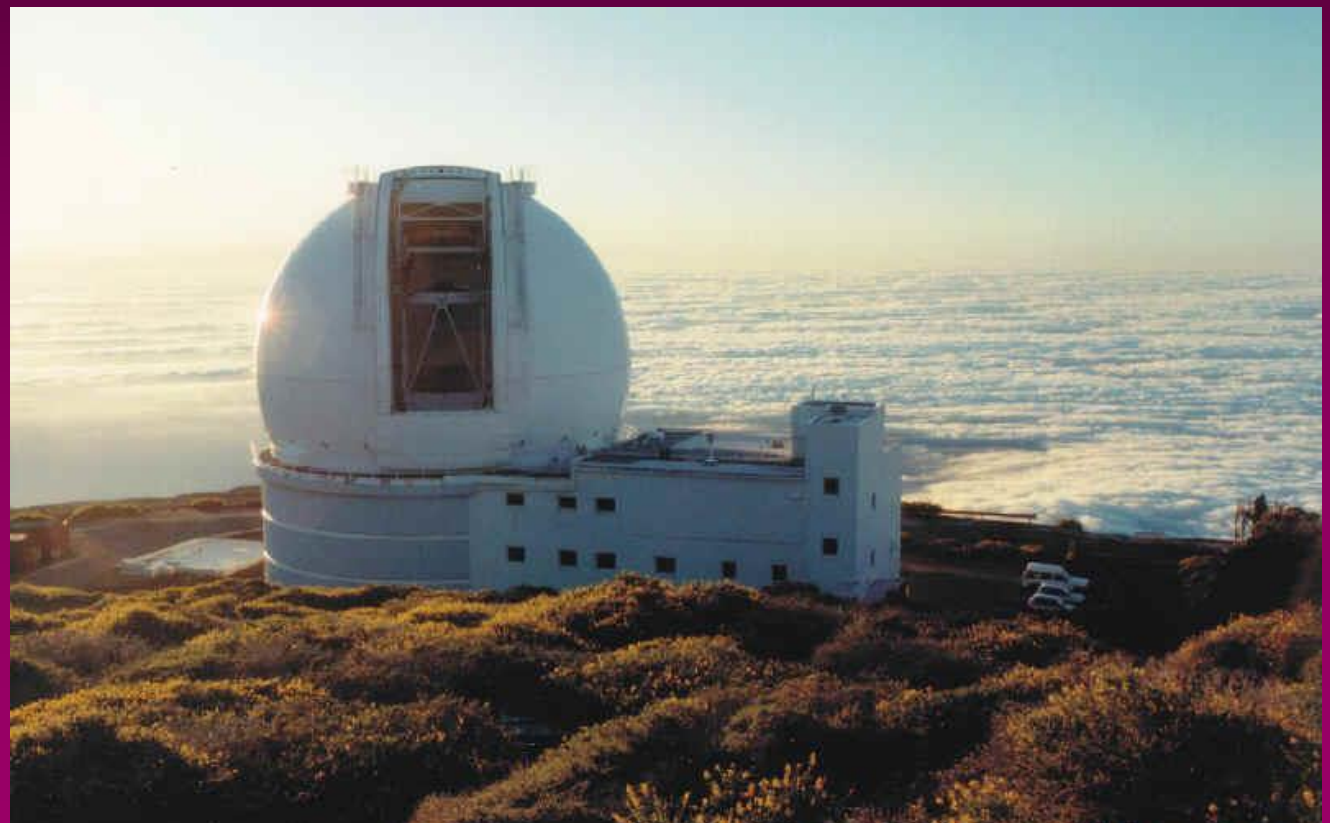
Themis Gebäude

La Palma

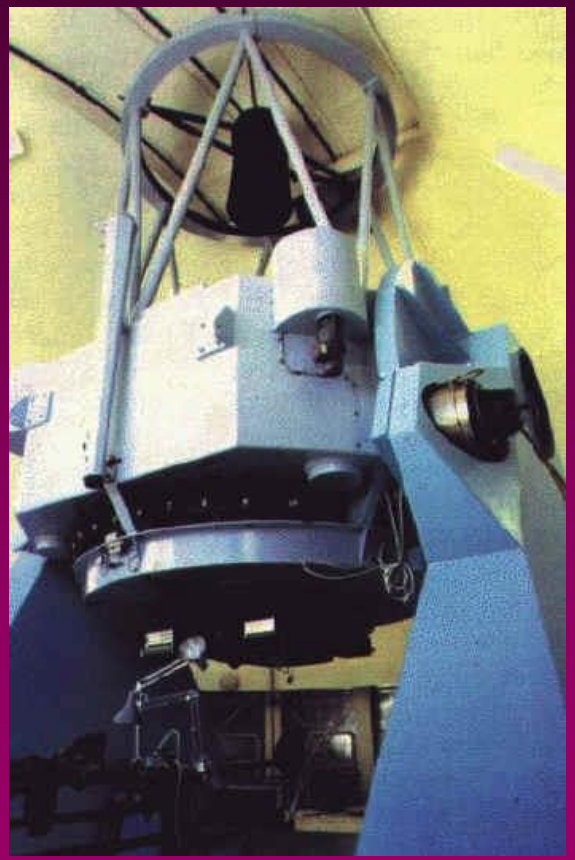
Höhe: 2400 m; Luftstabilität wie auf Hawai

Geräte: 4.2-m Herschel, 3.5-m Galileo, 2.5-m Newton,
2.5-m Nordic optical telescope; NEU: Gran Telescopio de Canarias

Herschel



Galileo



Nordic optical telescope

Das Gran Telescopio de Canarias (GTC)

Bedeutende astronomische Beobachtungsstätten

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Cerro Paranal

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(Mt. Postukov)

Australien

Siding Spring

Mauna Kea

Ort: Hawai; 2400 m

Kitt Peak

Ort: nahe Tucson, Arizona

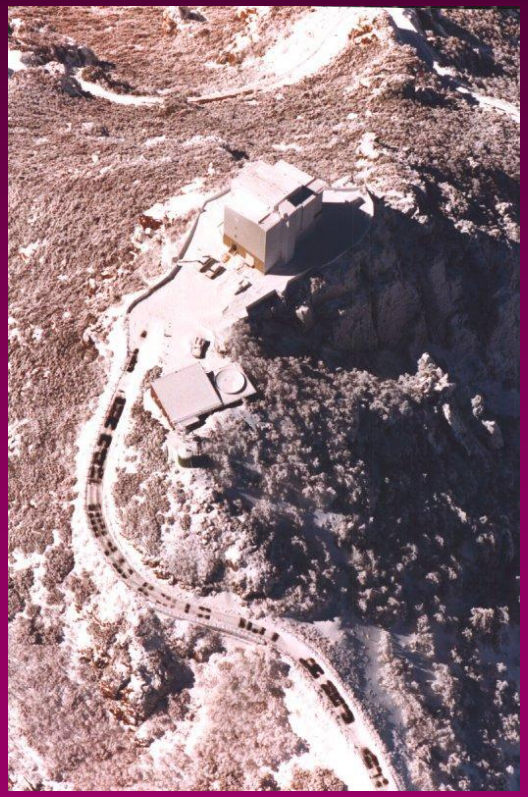
4-m Mayall

2.1-m

McMath-Pierce

MMT (Multi-Mirror Telescope)

Ort: Mt. Hopkins, Arizona



La Silla (Chile) ESA

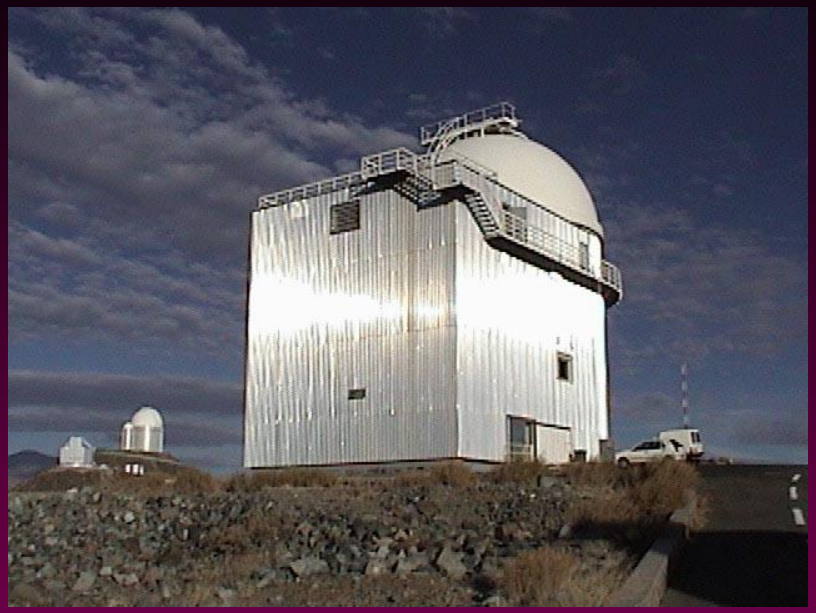
Ort: Chile; 2400-m

Cerro Paranal

La Silla

3.6 m

2.2 m

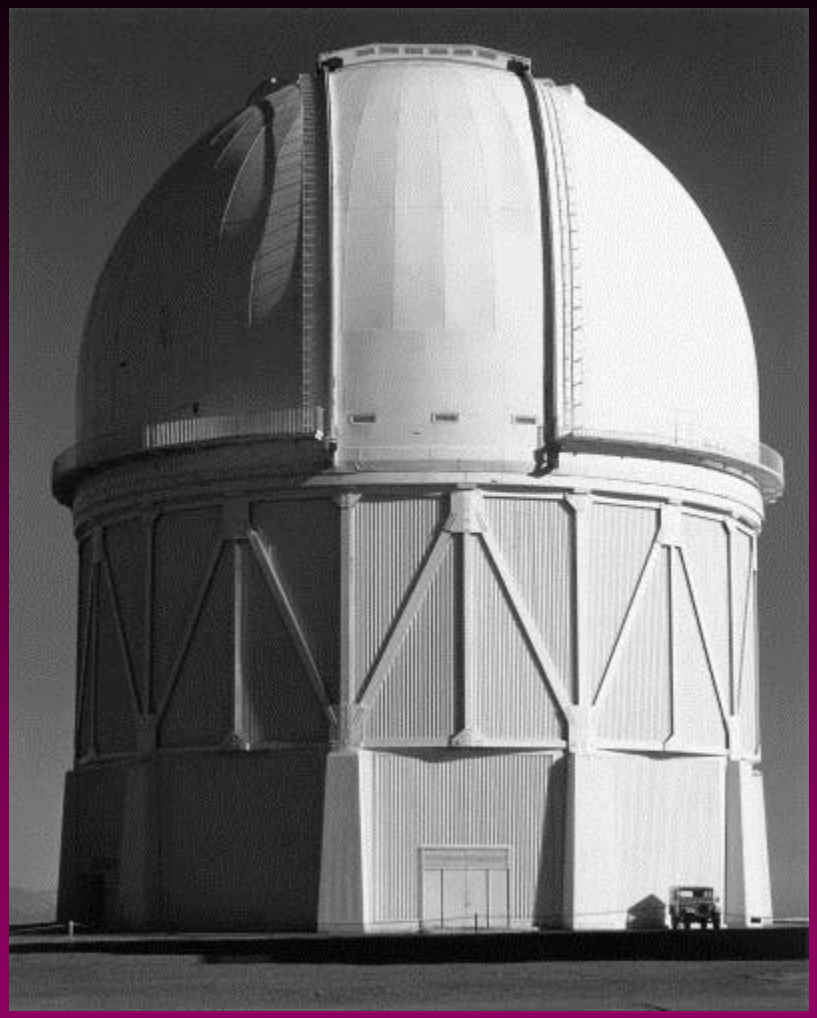


1.5 m

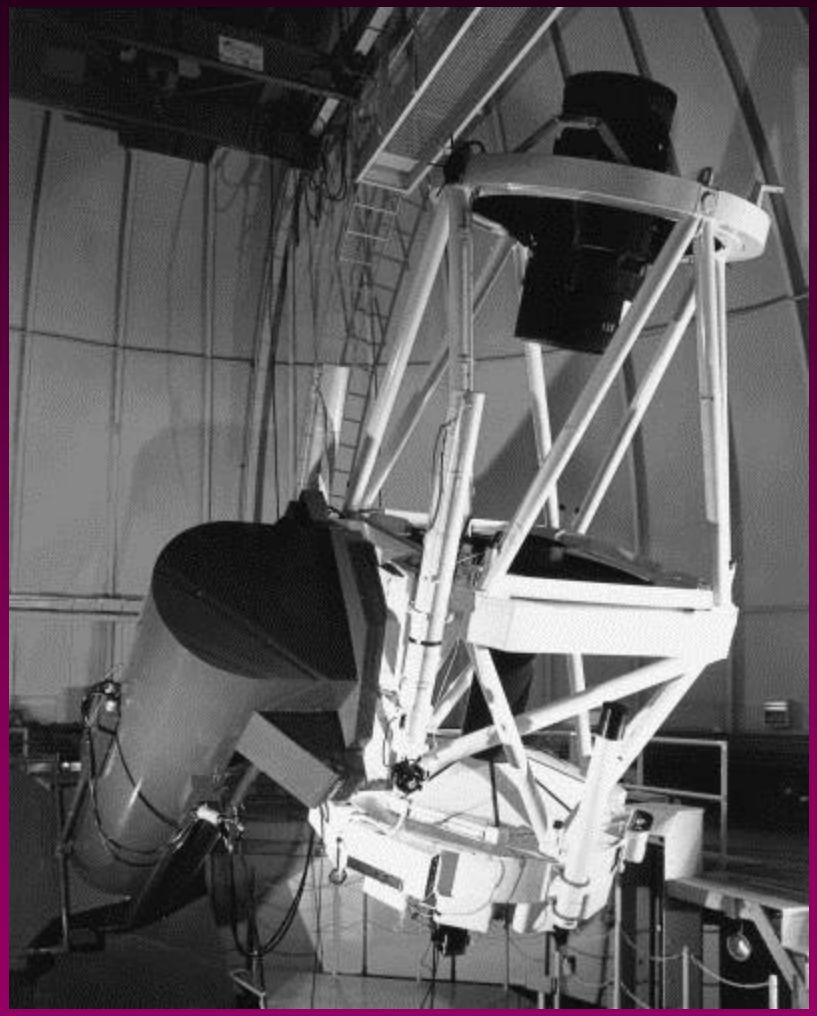
Swiss telescope

Cerro Tololo

Inter American observatory; 2200 m

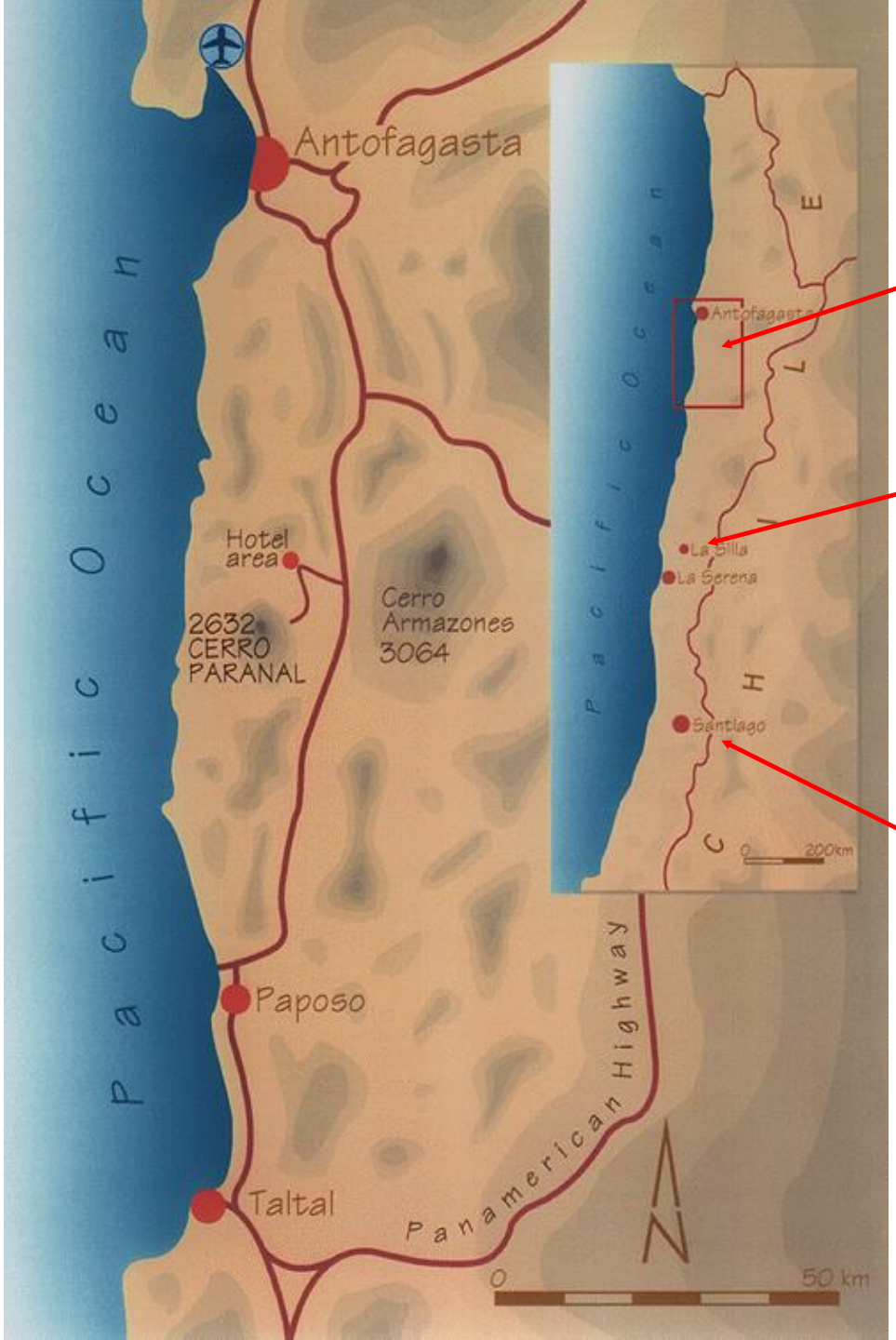


4-m



1.5-m

Cerro Tololo



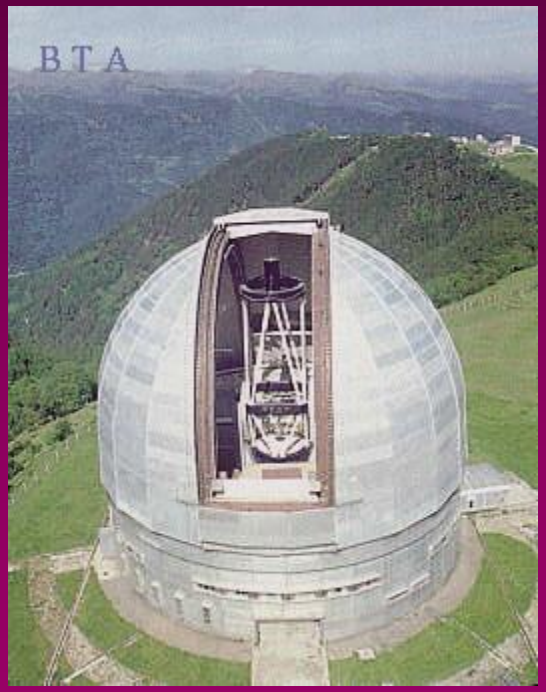
Cerro Paranal

La Silla

Santiago

Das russische 6-m Teleskop

Ort: Nordhang des Kaukasus (Stawropol)



Astronomische Grossgeräte

- Keck
- VLT
- SUBARU
- Gemini
- Hobby-Eberly
- LBT
- Gran Telescopio de Canarias

CURRENT PROJECTS FOR 8-M CLASS TELESCOPES

NO. OF TELESCOPES	LIGHT COLLECT-ING AREA	FOCI	SITE	SCHEDULE
• *VLT (ESO)*				
4 x 8.2m + 3 x 1.8m	$211m^2$ $8m^2$	18	Cerro Paranal	1998 - 2001
• *Keck*				
2 x 10m	$152m^2$	6	Mauna Kea	1994 - 1996
• *SUBARU*				
1 x 8m	$54m^2$	3	Mauna Kea	1998
• *Gemini*				
2 x 8m	$50m^2$ $50m^2$	2 (6)	Mauna Kea/ Cerro Pachon	1998 - 2000
• *Hobby-Eberly*				
1 x 11m	$95m^2$	2	McDonald	1996
• *LBT*				
2 x 8.4m	$111m^2$	5	Mount Graham	2001

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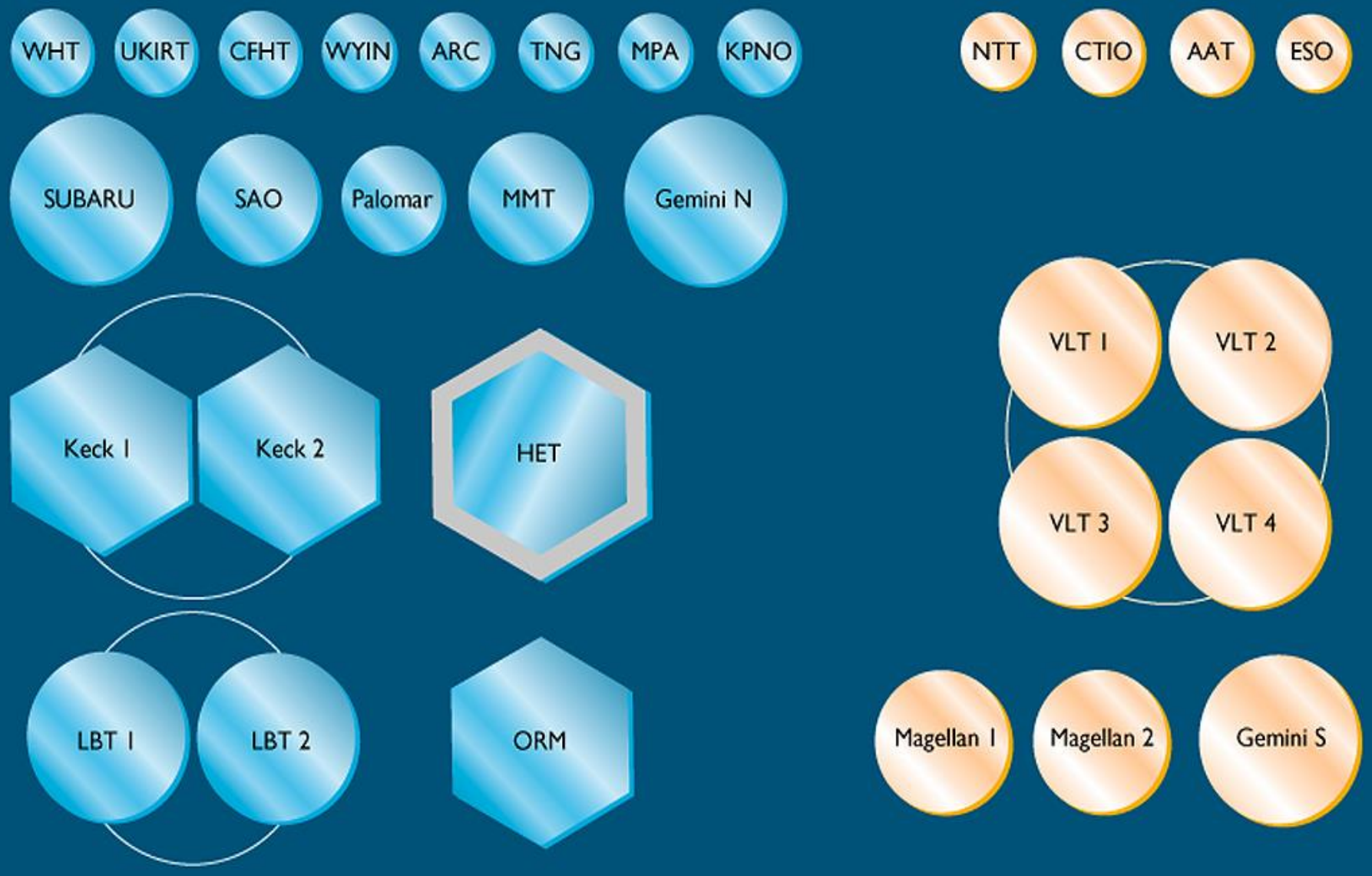
COLLECTING AREA OF THE LARGE TELESCOPES



Northern Hemisphere

Southern Hemisphere

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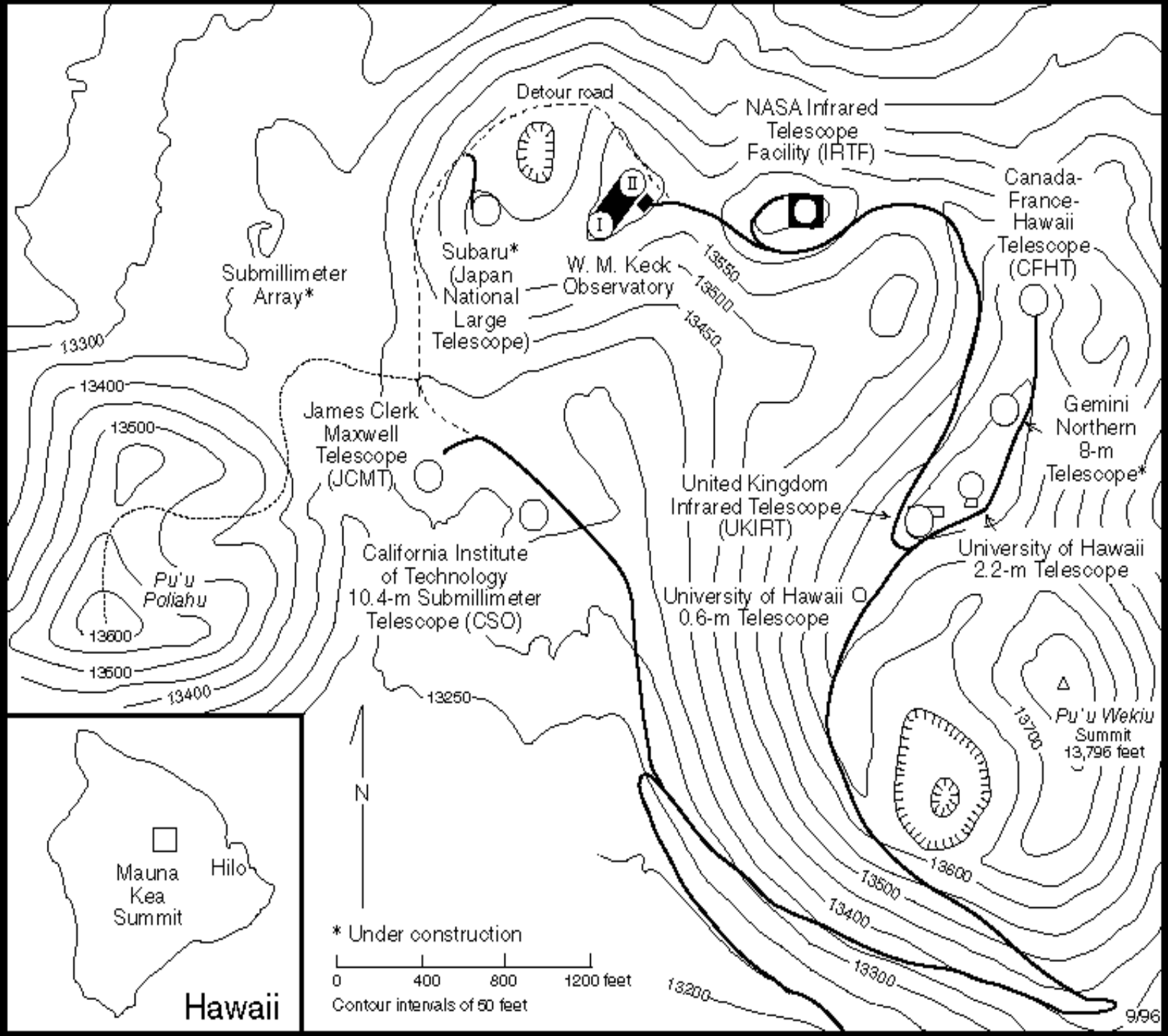
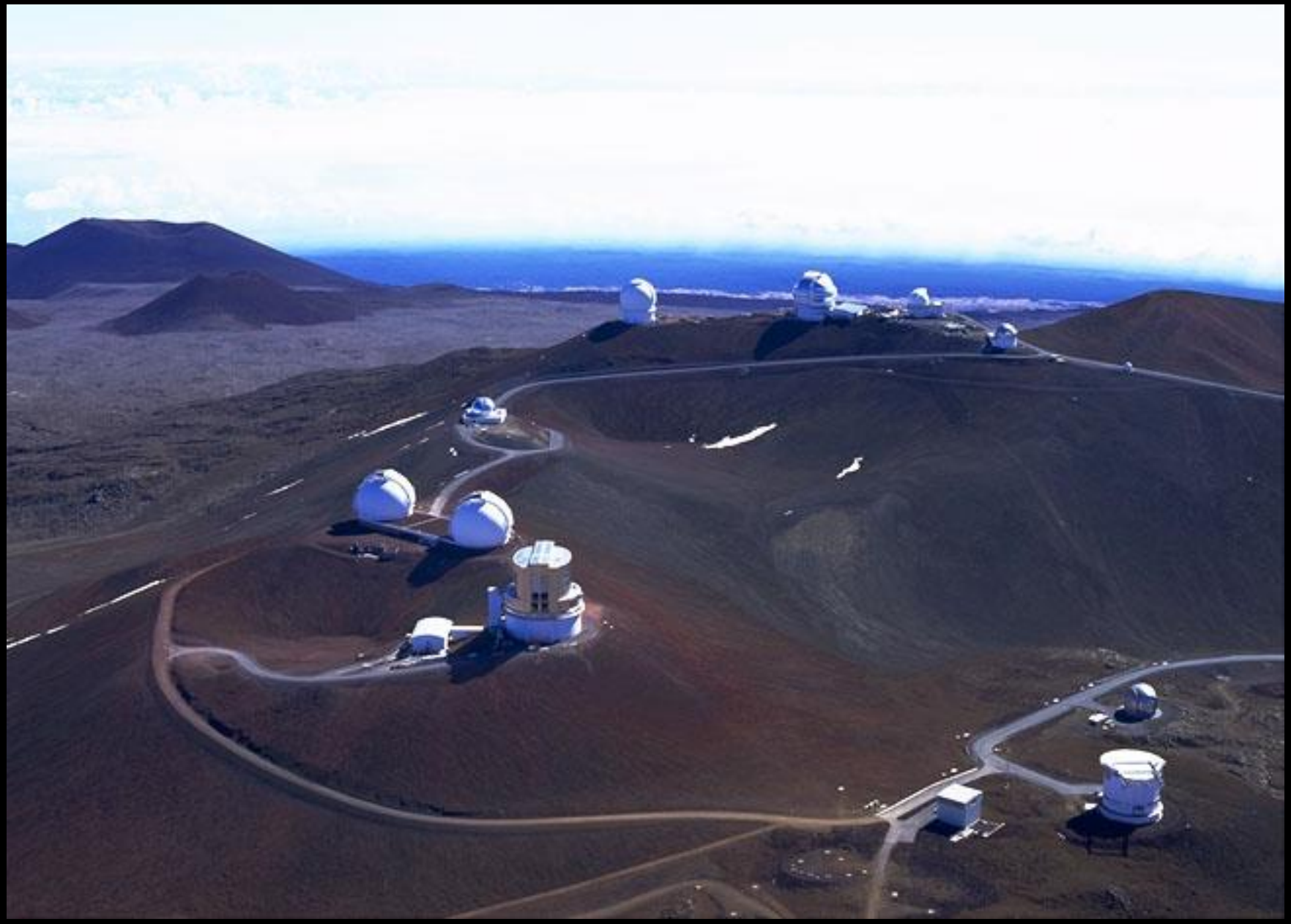
Keck Observatory & Telescopes

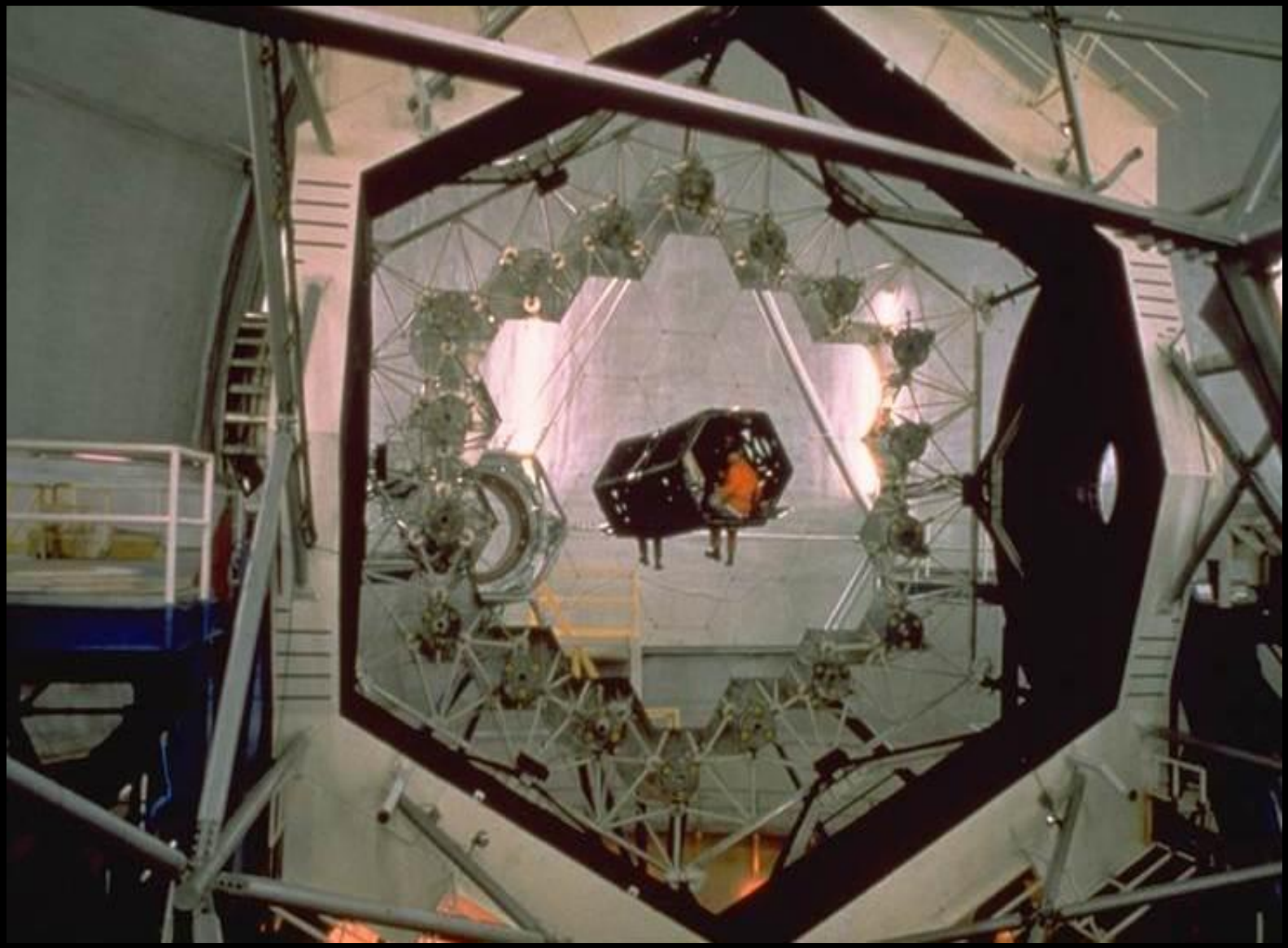
Mauna Kea, Hawaii

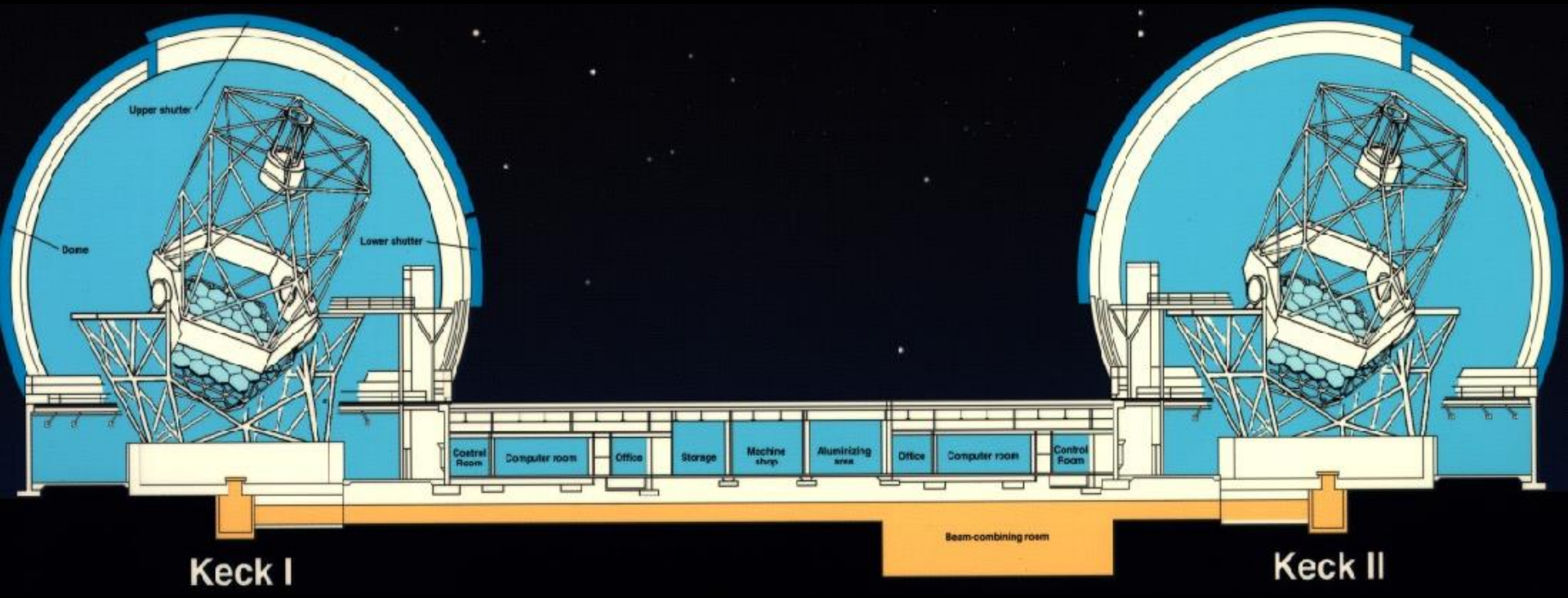

Detour road
NASA Infrared Telescope Facility (IRTF)
Canada-France-Hawaii Telescope (CFHT)
Subaru* (Japan National Large Telescope)
W. M. Keck Observatory
Submillimeter Array*
James Clerk Maxwell Telescope (JCMT)
California Institute of Technology 10.4-m Submillimeter Telescope (CSO)
United Kingdom Infrared Telescope (UKIRT)
University of Hawaii 0.6-m Telescope
University of Hawaii 2.2-m Telescope
Gemini Northern 8-m Telescope*
Pu'u Poliahu
Pu'u Wekiu
Summit
13,796 feet
13300
13400
13500
13600
13450
13550
13250
13200
13700
N
Mauna Kea Summit
Hilo
Hawaii
* Under construction
0
400
800
1200 feet
Contour intervals of 50 feet
9/96



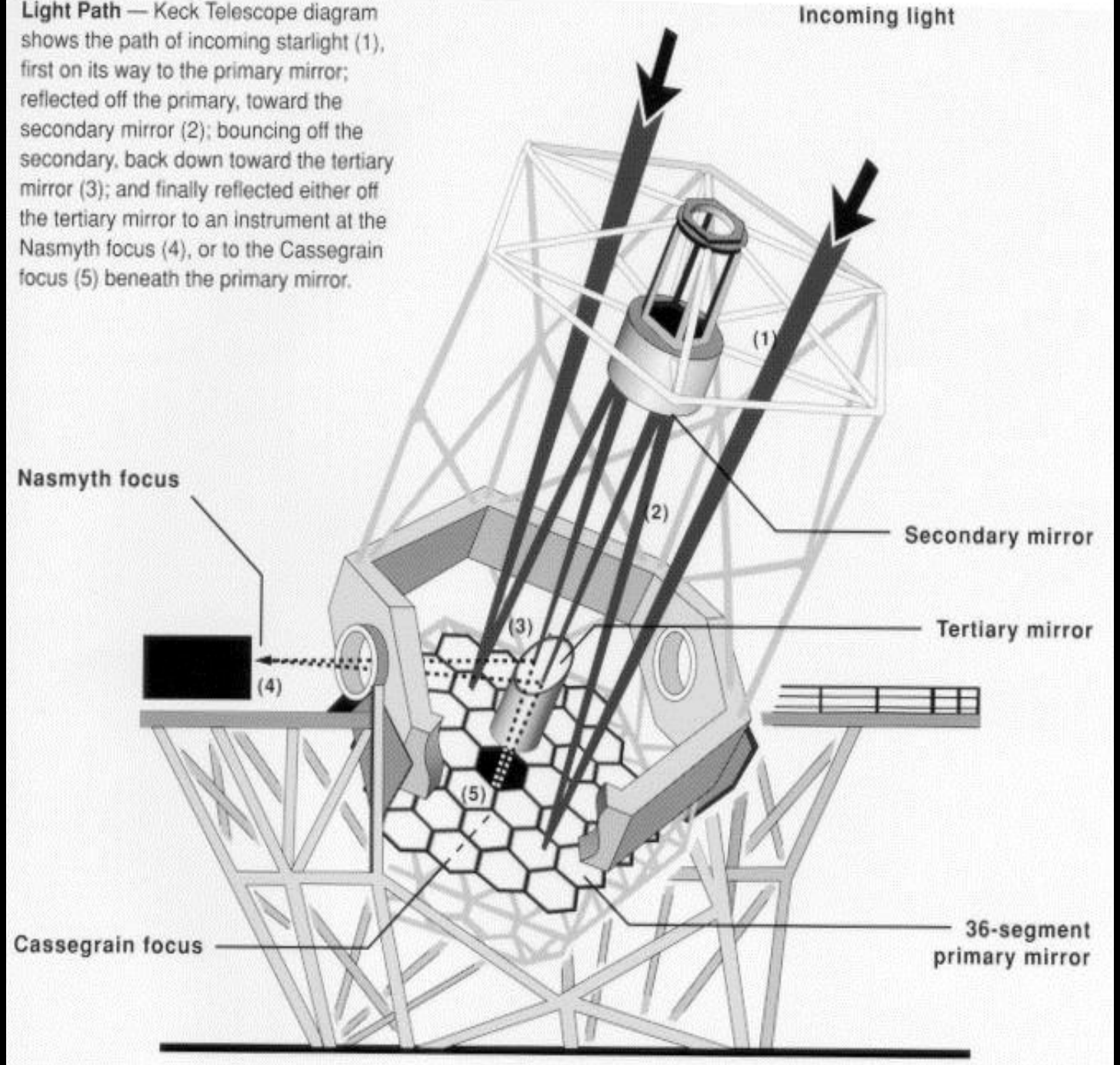
The Telescopes

- Mounting: azimuthal
- Primary mirror: 10 m, composed of 36 hexagonal segments, each 1.8 m in diameter
- active optics: segment adjustment, accuracy: 4 nm




Upper shutter
Dome
Lower shutter
Control Room
Computer room
Office
Storage
Machine shop
Aluminizing area
Office
Computer room
Control Room
Beam-combining room
Keck I
Keck II

Light Path — Keck Telescope diagram shows the path of incoming starlight (1), first on its way to the primary mirror; reflected off the primary, toward the secondary mirror (2); bouncing off the secondary, back down toward the tertiary mirror (3); and finally reflected either off the tertiary mirror to an instrument at the Nasmyth focus (4), or to the Cassegrain focus (5) beneath the primary mirror.



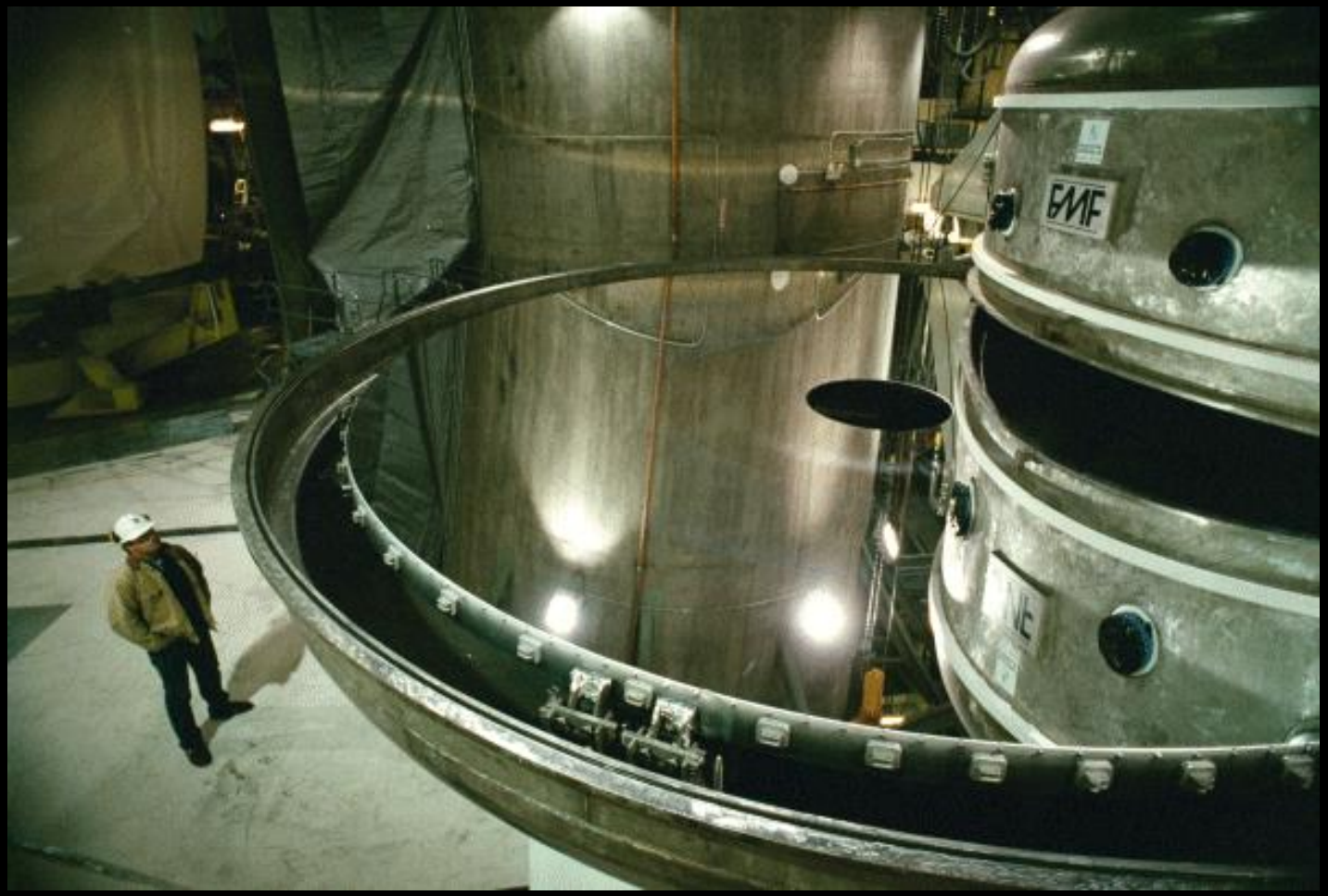
Credit: California Association for Research in Astronomy

The GEMINI Telescope

The Canada-France-Hawaii

Telecope

Gemini-North 1998



Gemini North mirror leaving coating chamber
December 1998

Gemini - South: Cerro Pachon

Gemini - South

Oct 18, 1999

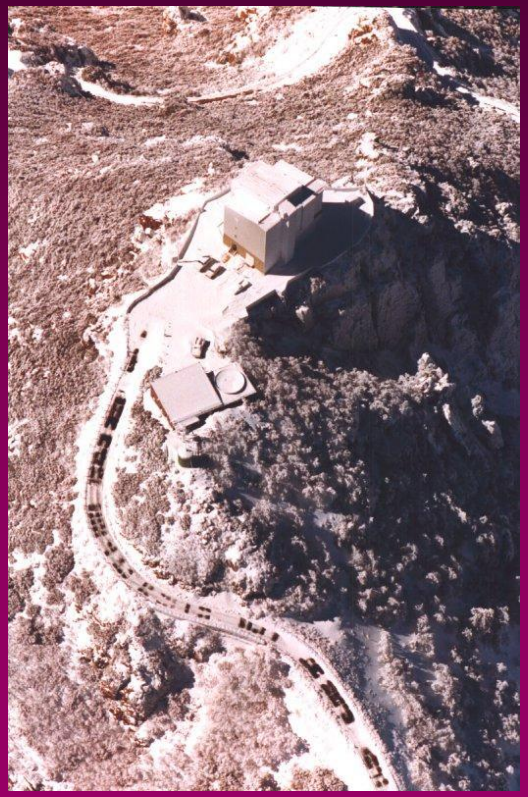
SUBARU

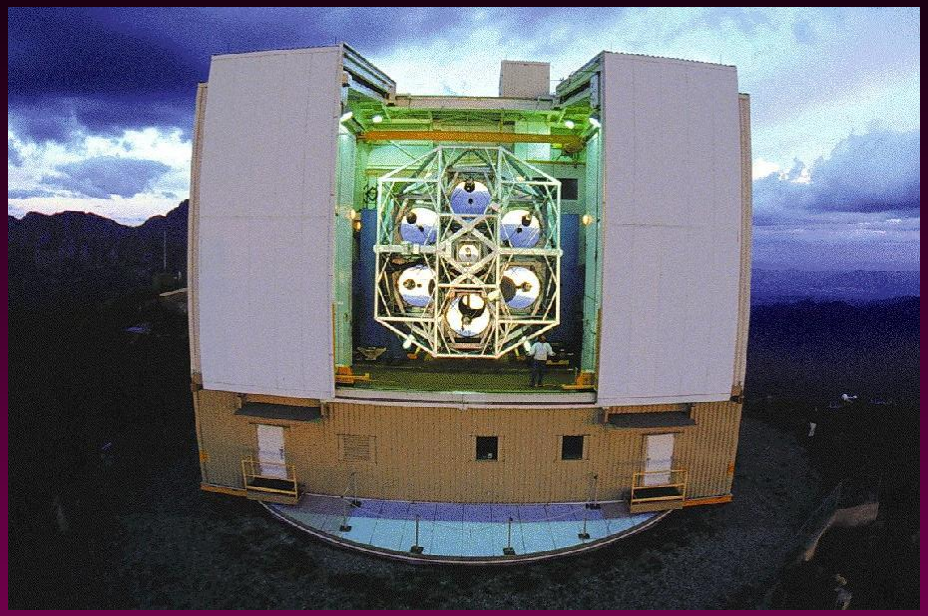
8 m Japanese National

Large Telescope

MMT (Multi-Mirror Telescope)

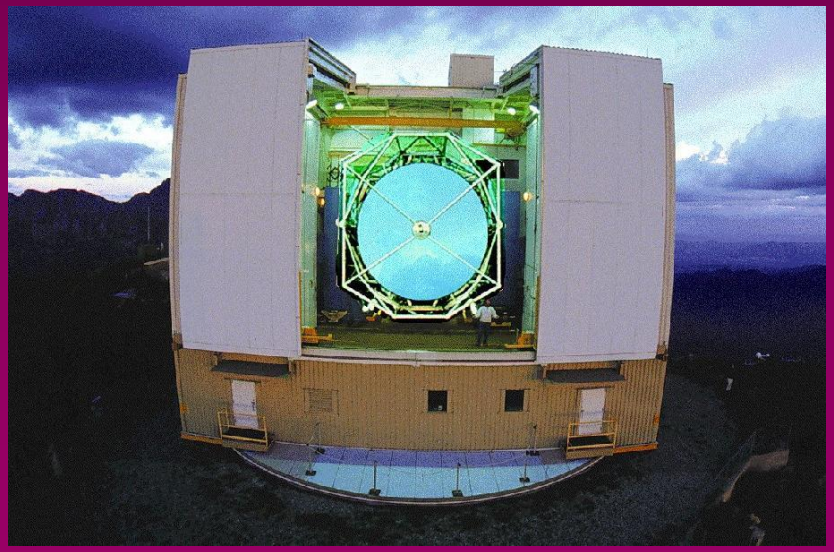
Ort: Mt. Hopkins, Arizona

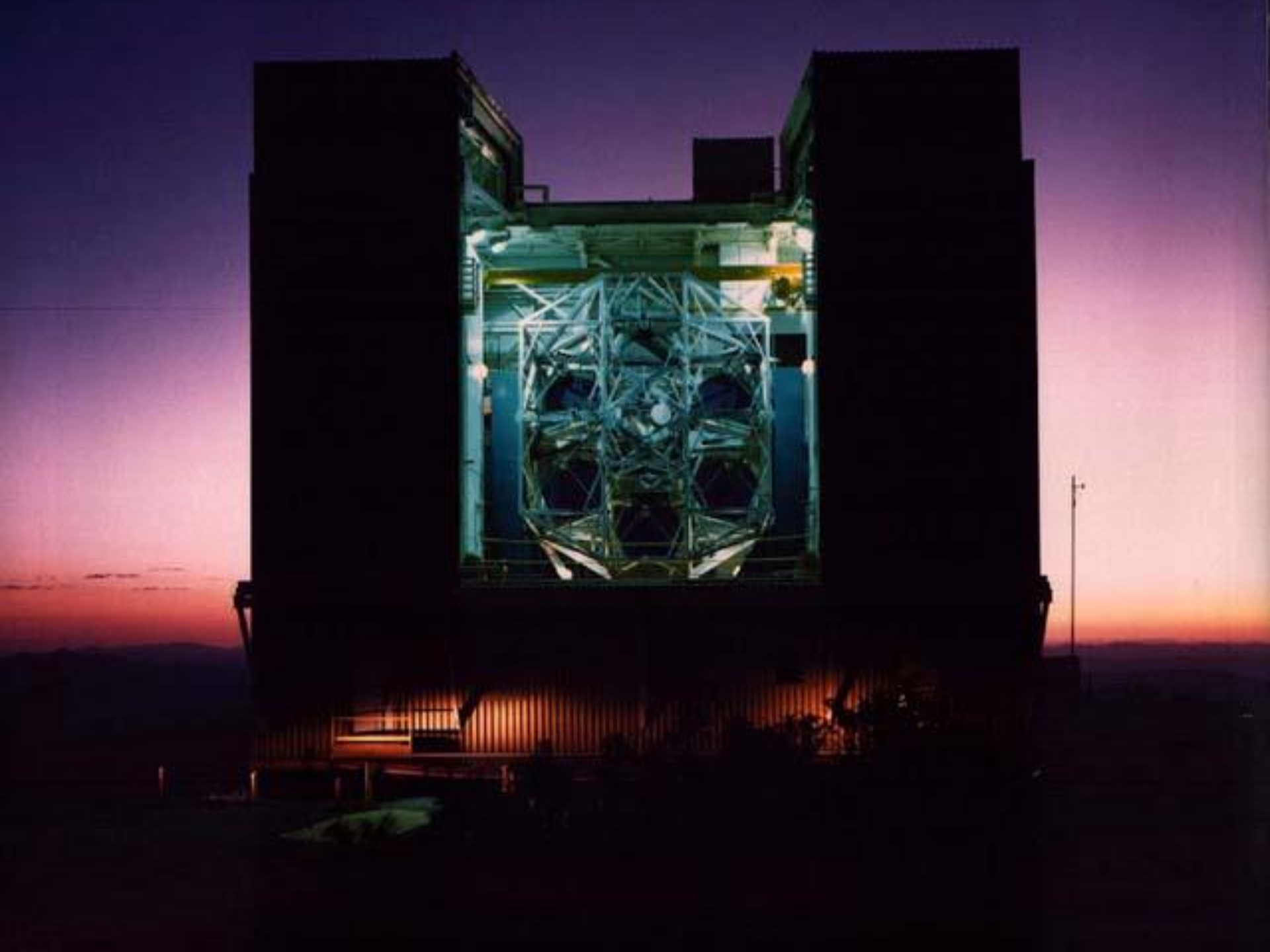


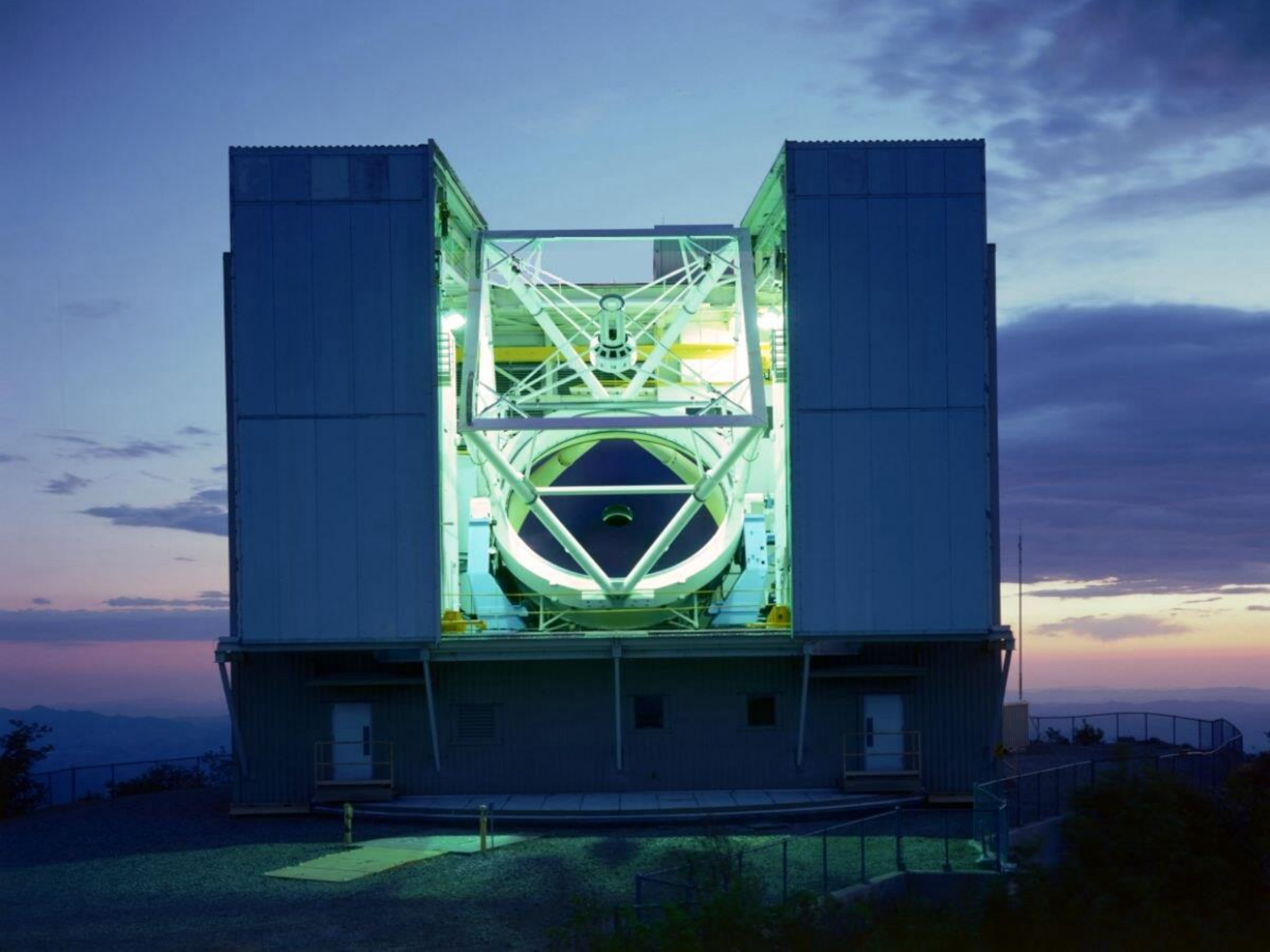


vorher

nachher





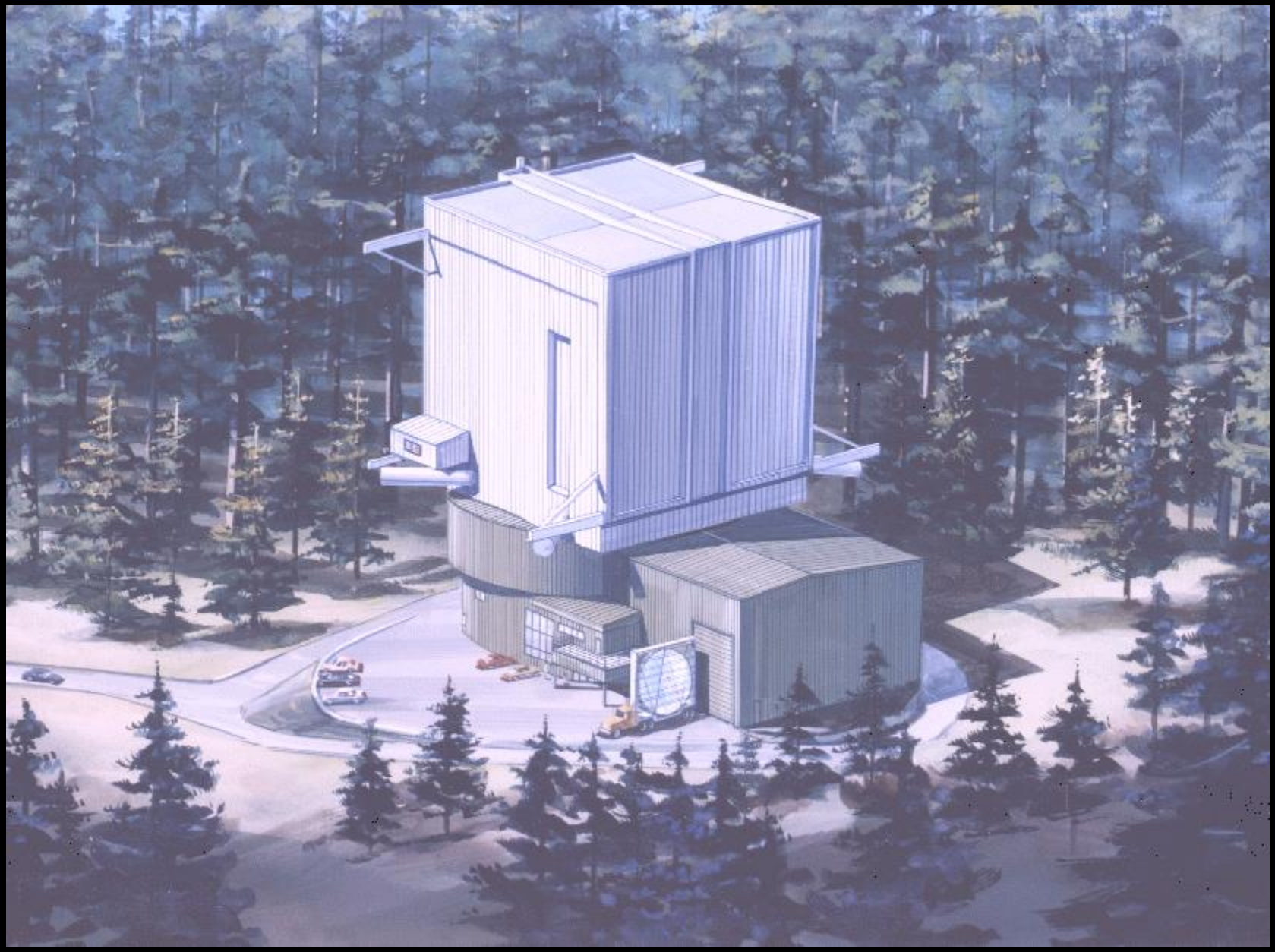


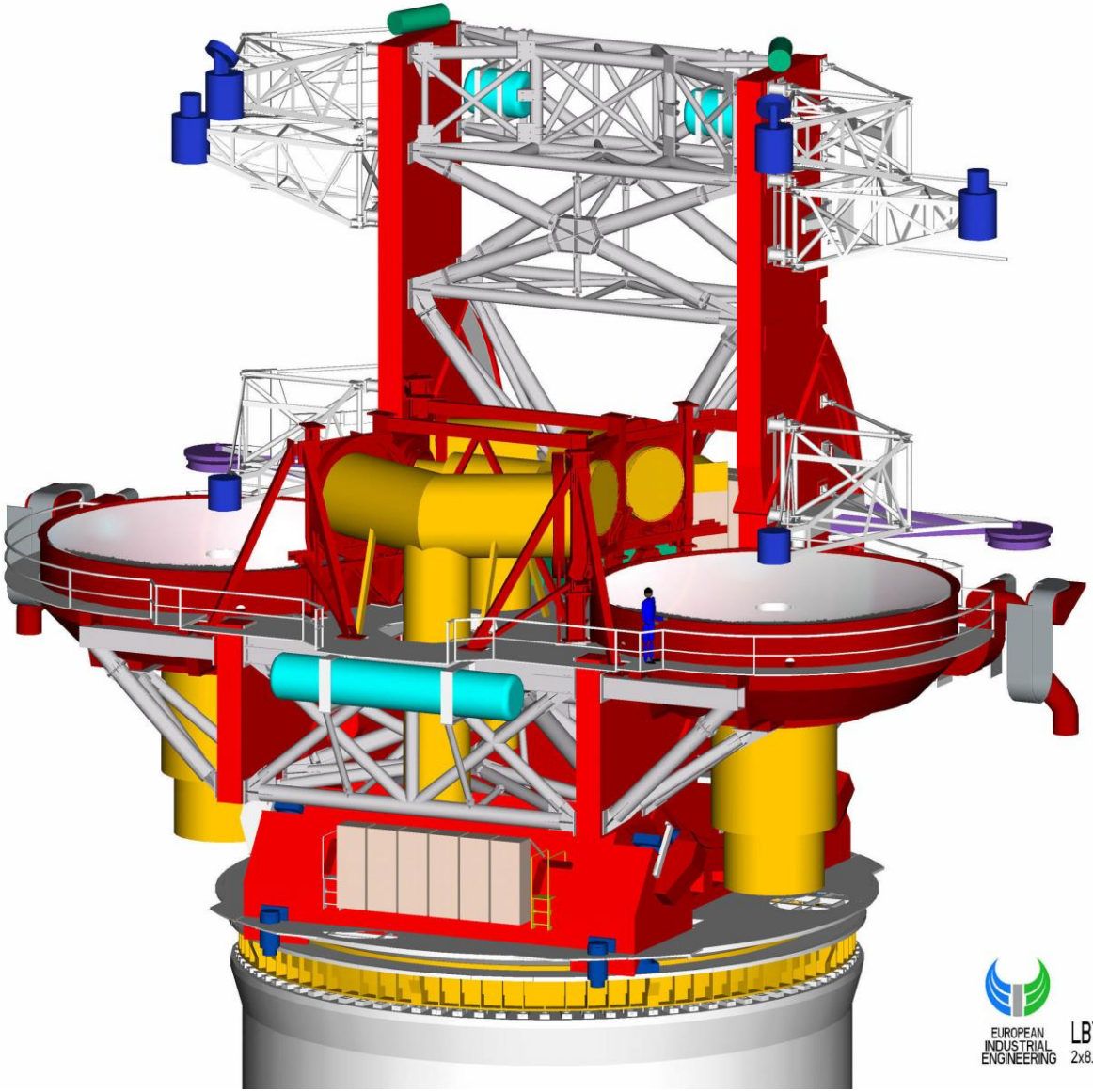
LBT (Large Binocular Telescope), Arizona

Organizations:

Arizona, Italy, Germany

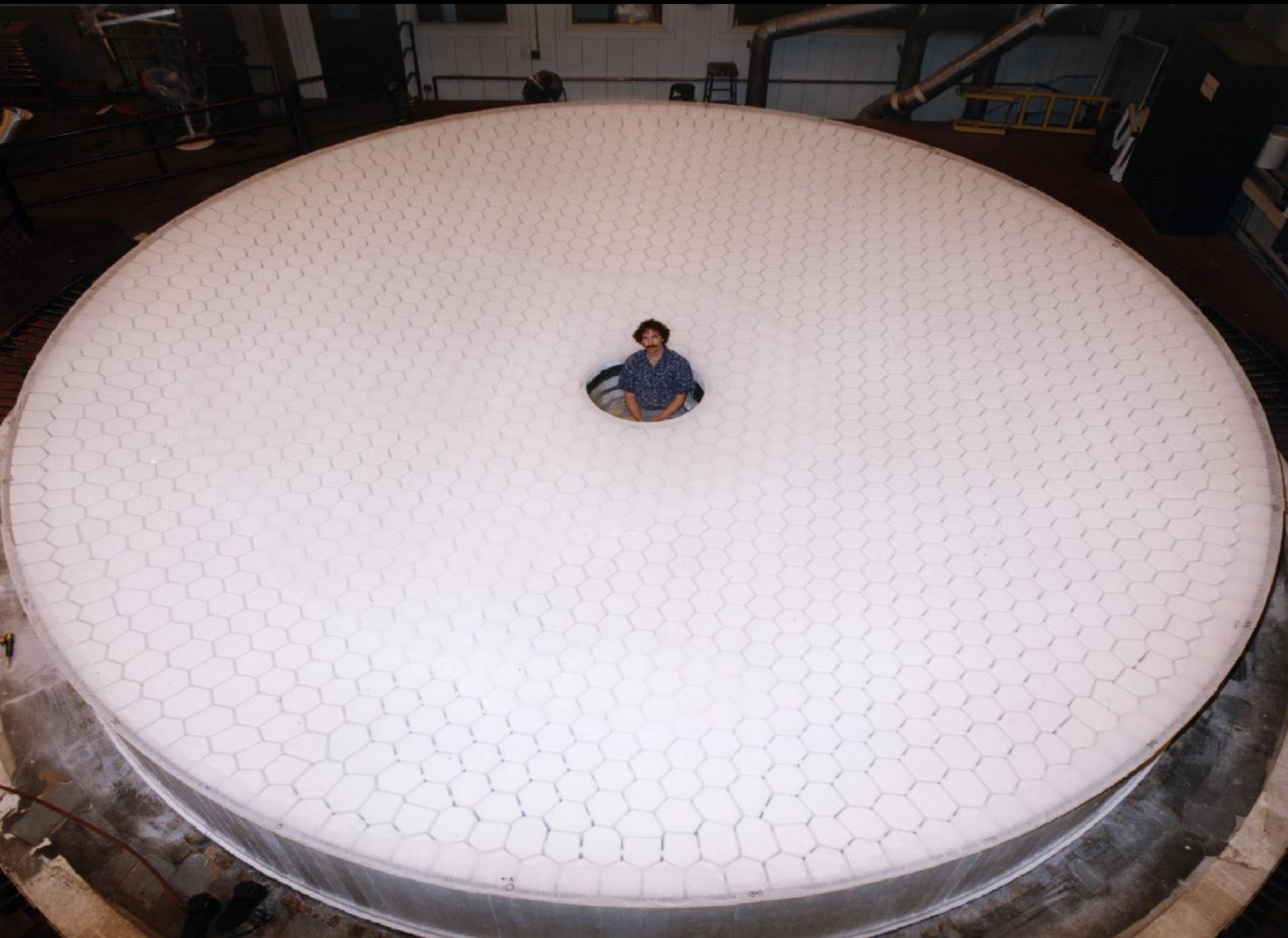
- MPI for Astro, Heidelberg
- Landessternwarte Heidelberg
- API Potsdam
- MPI for extraterr physics, Munich
- MPI for radioastro, Bonn





EUROPEAN INDUSTRIAL ENGINEERING

LBT Project
2x8.4m Telescope

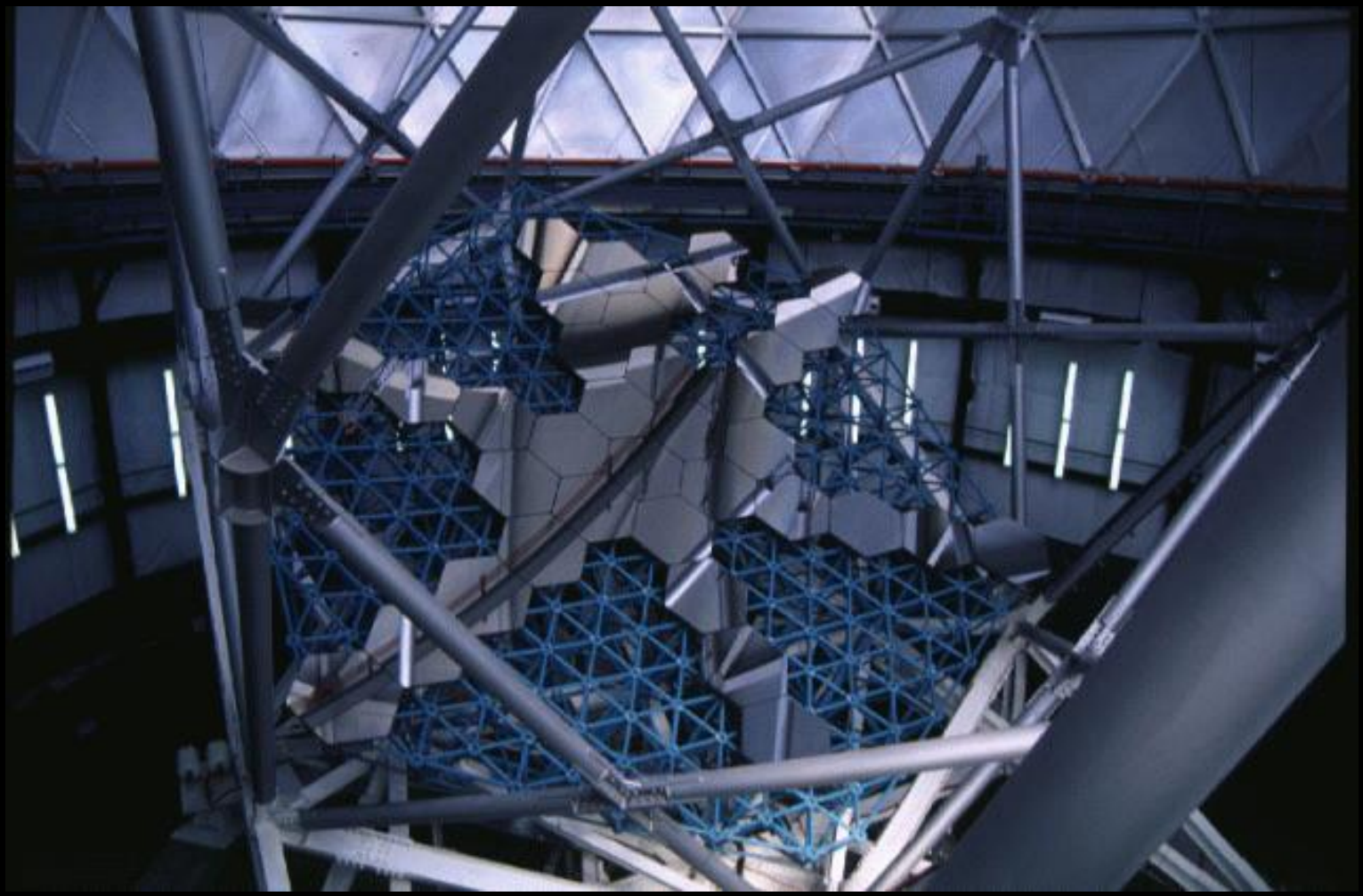


Juni 2001

Mai 2002: der erste 8,4 m Spiegel wird poliert

September 2002

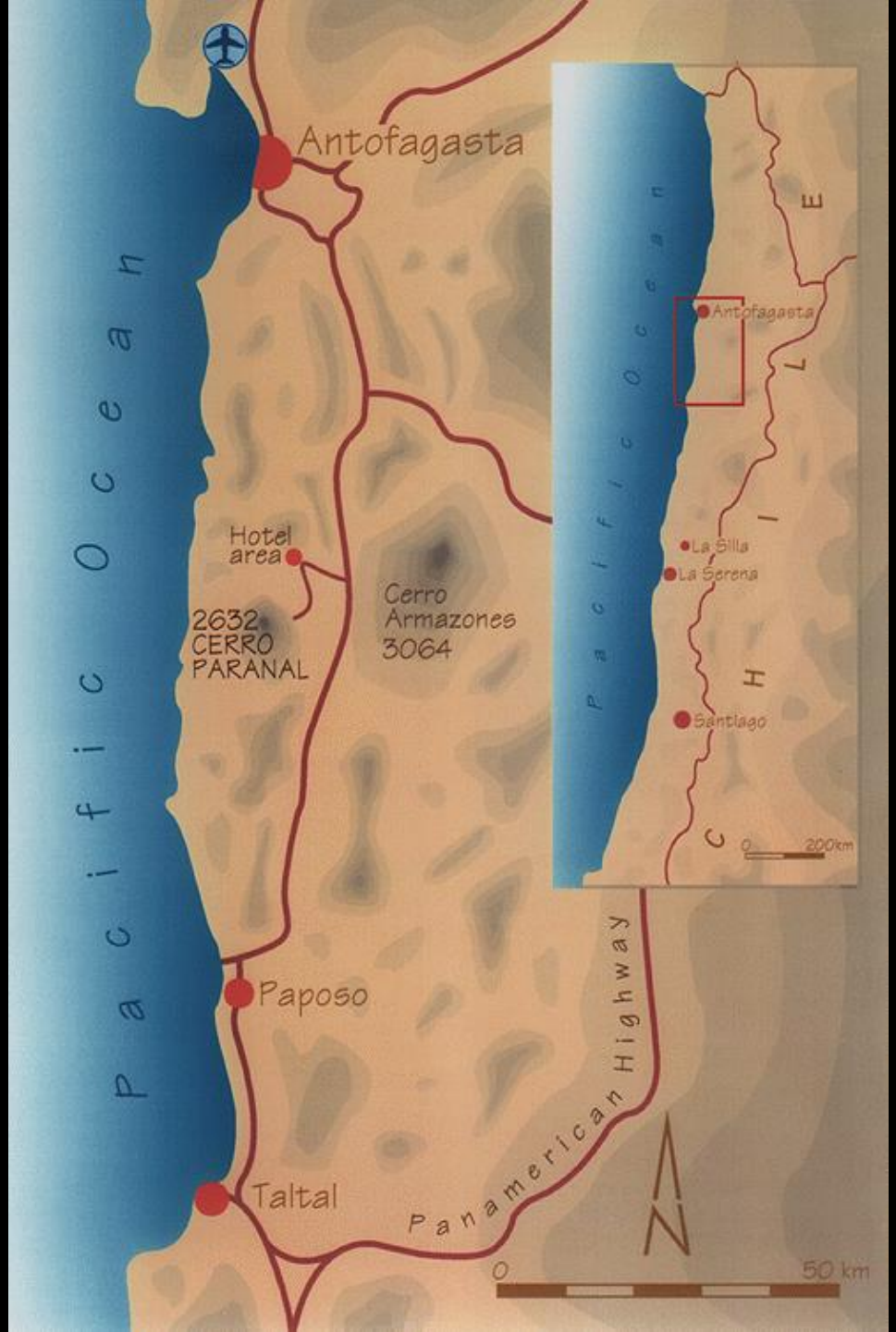
Hobby-Eberly Telescope



HET primary mirror

The ESO Very Large Telescope Array

Cerro Paranal Observatory


Pacific Ocean
Antofagasta
Hotel area
2632
CERRO
PARANAL
Cerro
Armazones
3064
Paposo
Taltal
Panamerican Highway
N
0
50 km
Pacific Ocean
Antofagasta
La Silla
La Serena
Santiago
CHILE
0
200km

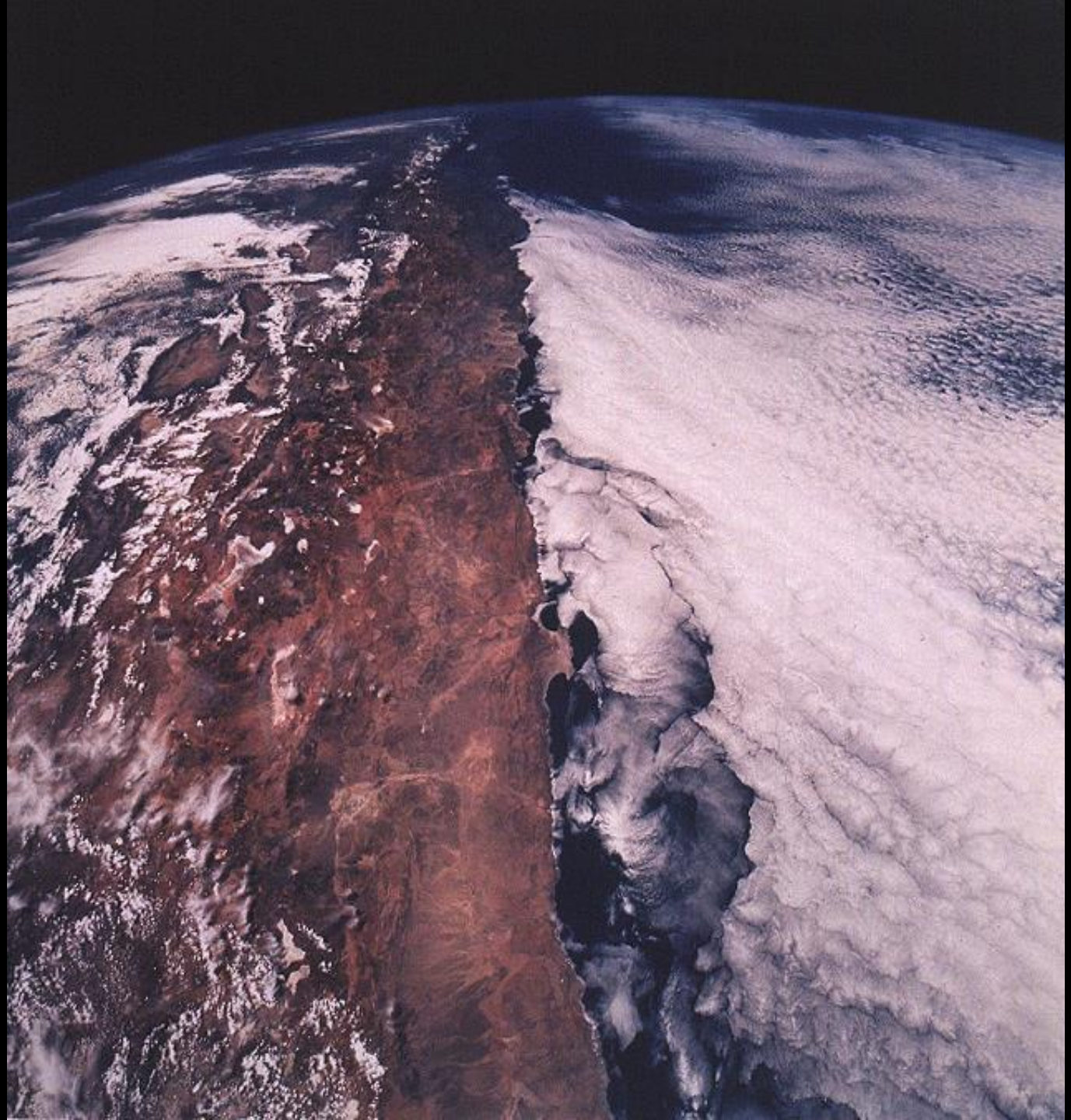
CERRO PARANAL - THE VLT SITE

Geographical Coordinates:
24 deg 37 min S, 70deg 24 min W

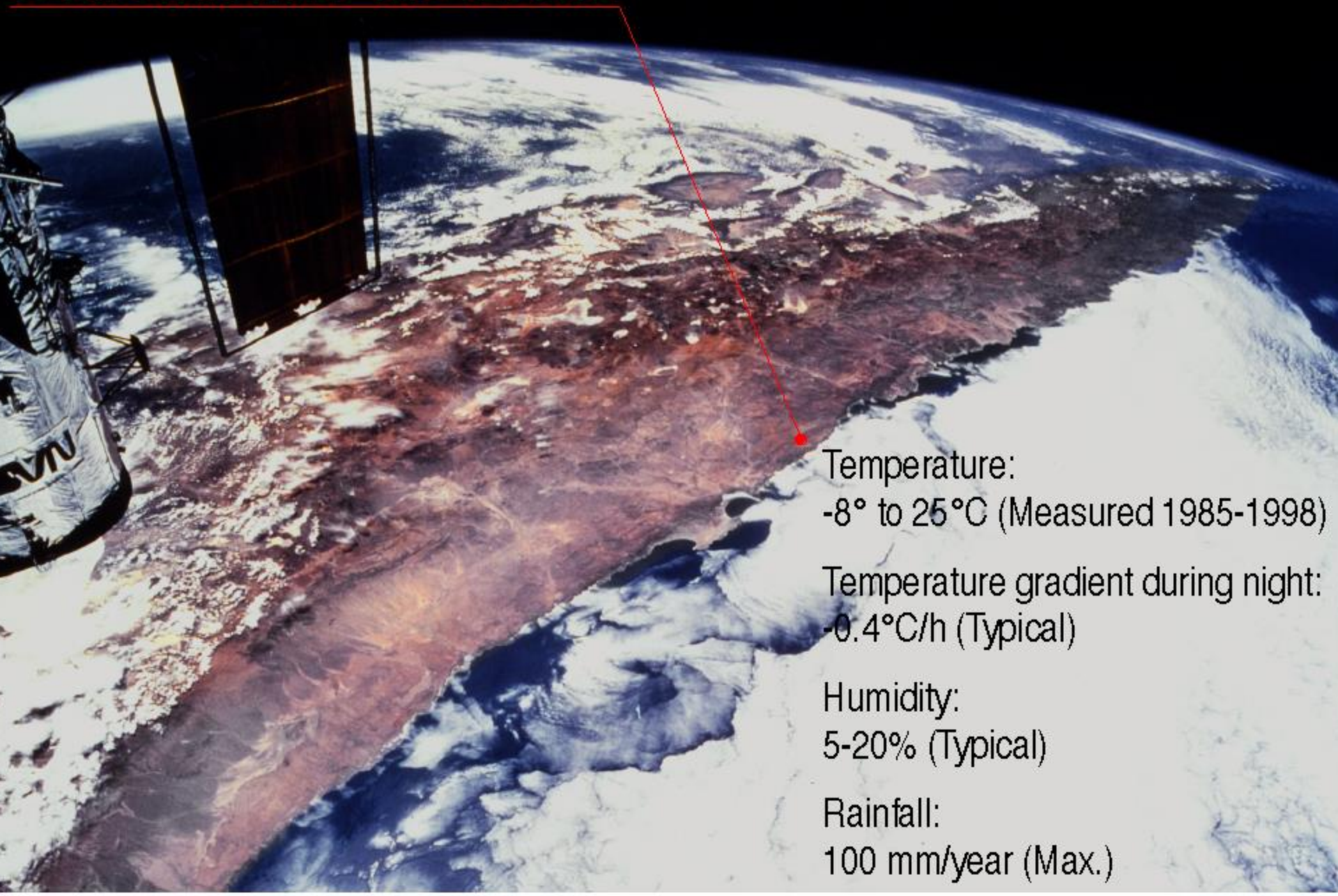
Altitude above sea level:
2635m

Distance from coast:
12 km

Road distances:
130 km to Antofagasta
1200 km to Santiago
600 km to La Silla



CERRO PARANAL - THE VLT SITE



Temperature:
-8° to 25°C (Measured 1985-1998)

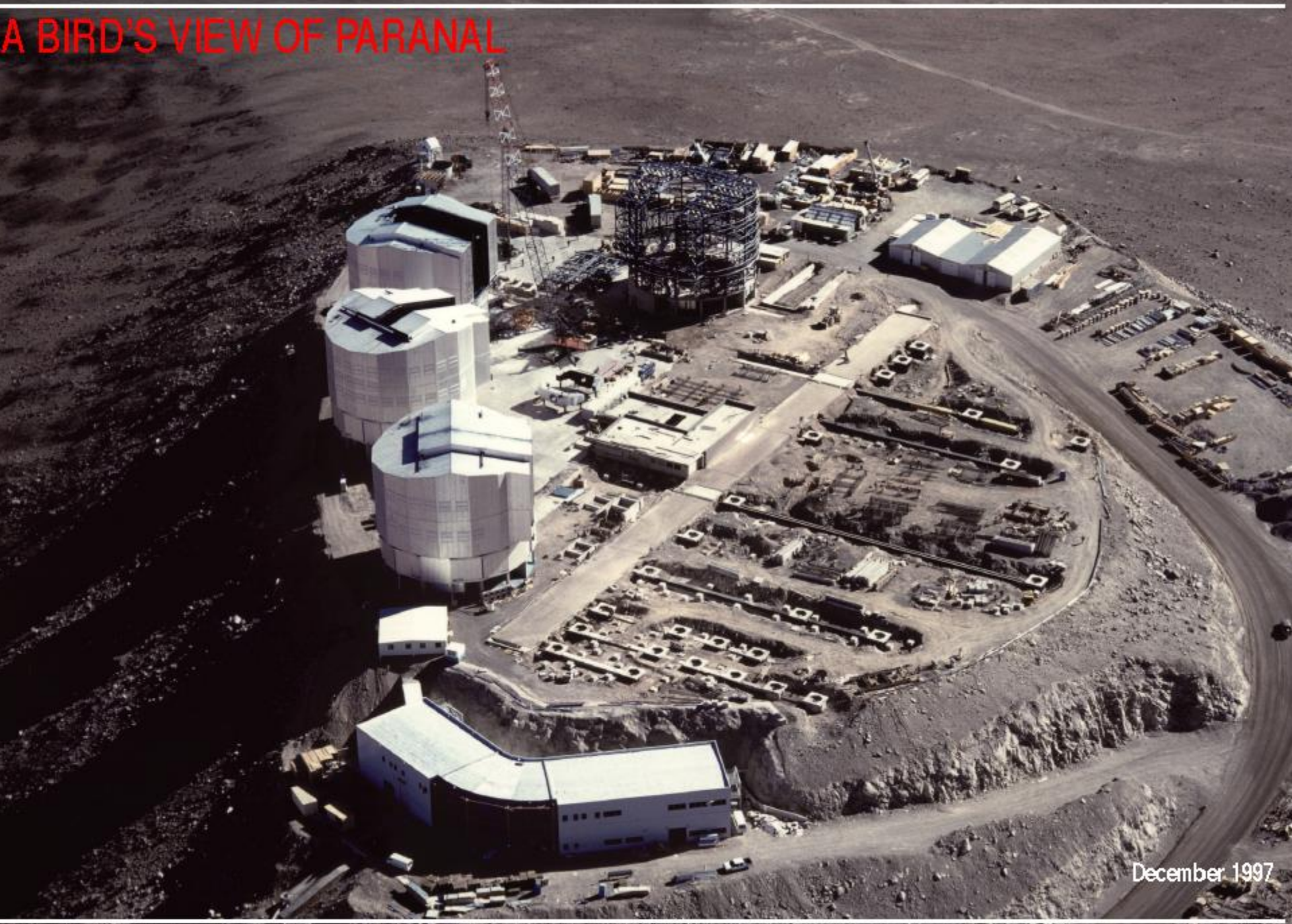
Temperature gradient during night:
-0.4°C/h (Typical)

Humidity:
5-20% (Typical)

Rainfall:
100 mm/year (Max.)

© ESO ERR

A BIRD'S VIEW OF PARANAL



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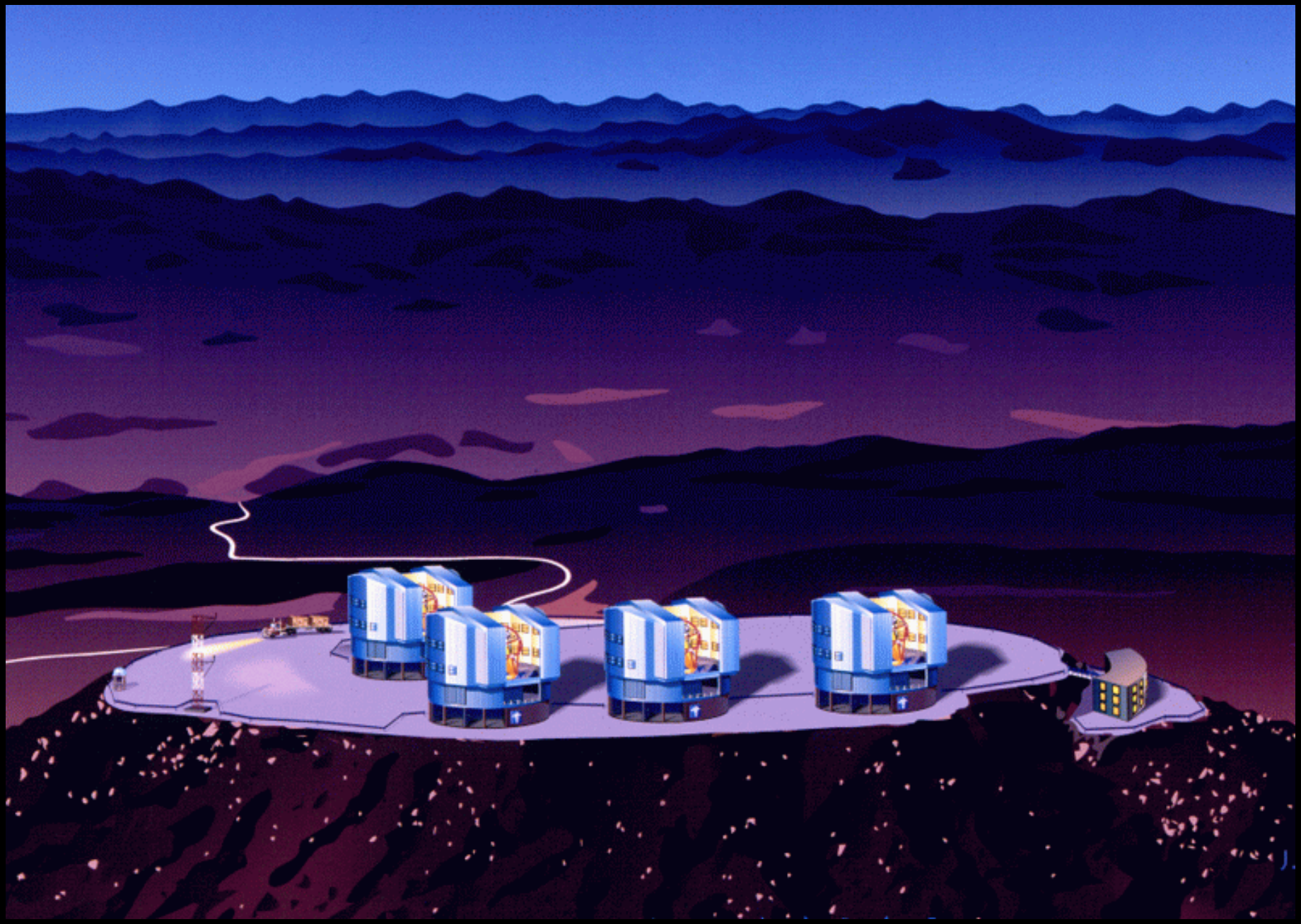
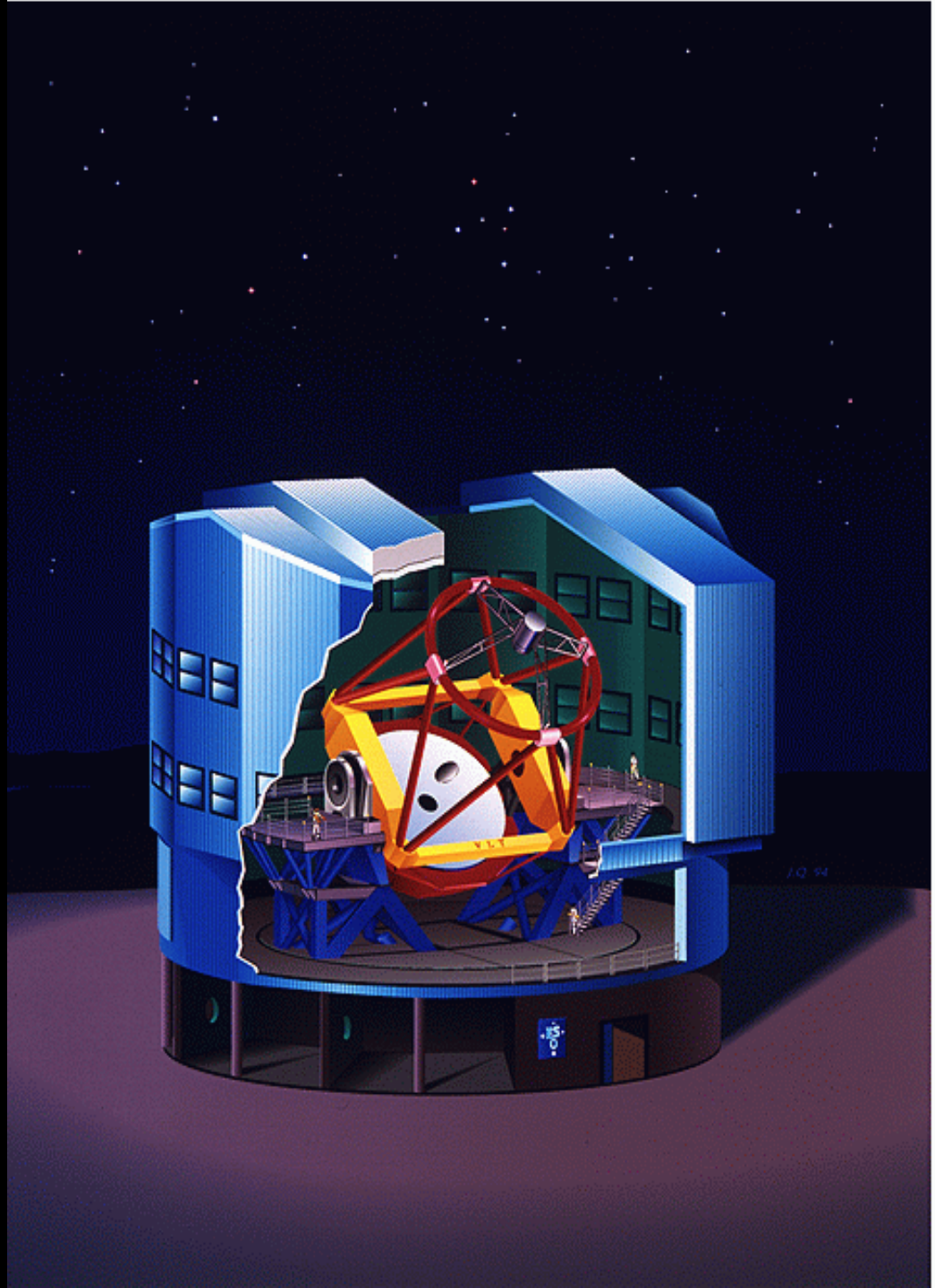
The ESO Very Large Telescope Array (VLT)

© ESO EPR





THE VLT UNIT TELESCOPE

Optics:

- 8.2 m, f/1.8 primary mirror, actively supported (150 axial/64 lateral supports)
- 1.2 m chopping secondary mirror with "tip/tilt" system

Mechanical structure:

- Very high mechanical precision
- Backlash and friction free torque motor drives
- High angular resolution encoders

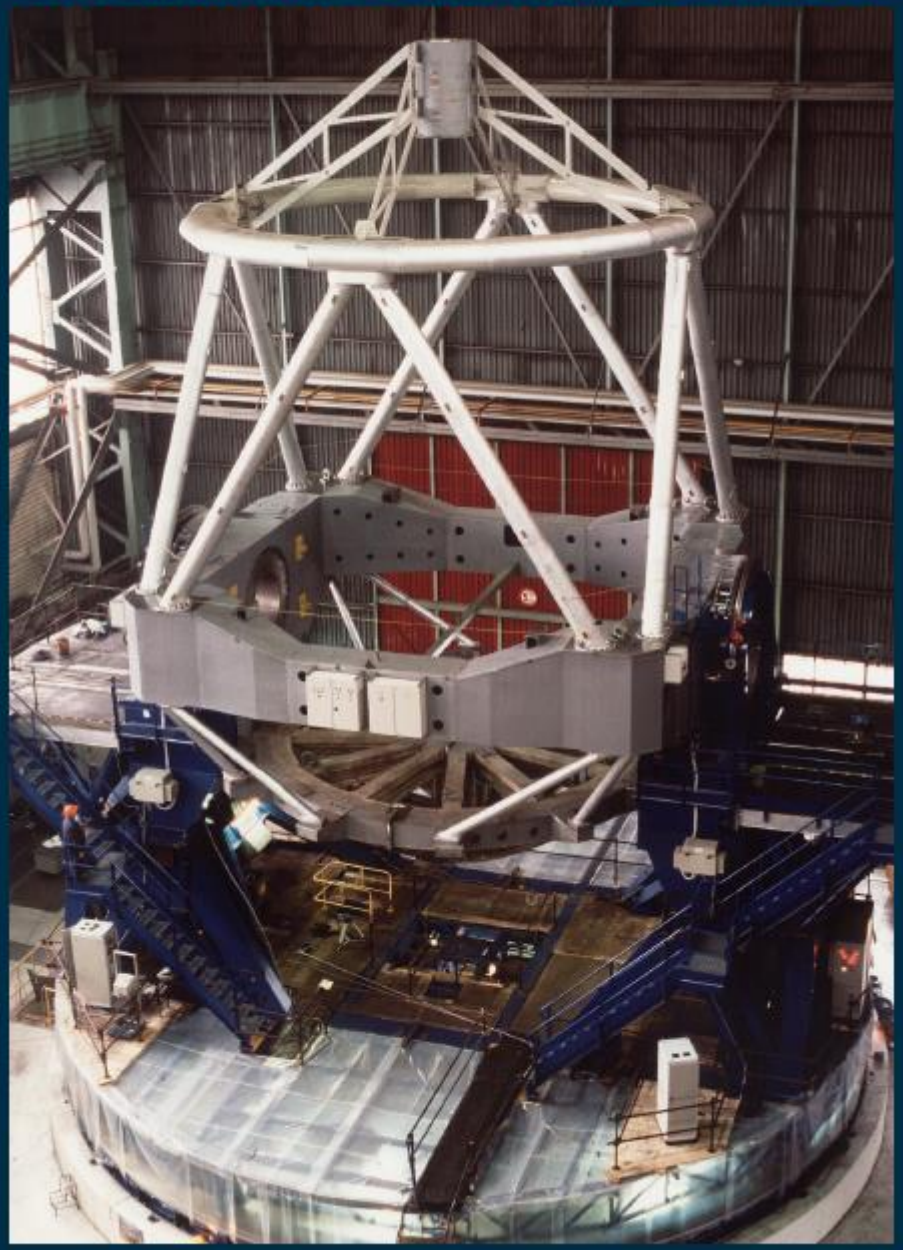
Enclosure:

- Designed to minimize thermal effects
- Earthquake resistent (7.8 on Richter Scale, 65 sec, 100 km dist.)

© ESO EPR

Unit Telescope
at Ansaldo, Milan
Nov. 1995

THE MAIN MECHANICAL STRUCTURE



Mount:
Alt-Az

Moving Mass:
430 t (total 542 t)

Lowest mechanical eigenfrequency:
8 Hz

Drive motors:
Direct (no gears)

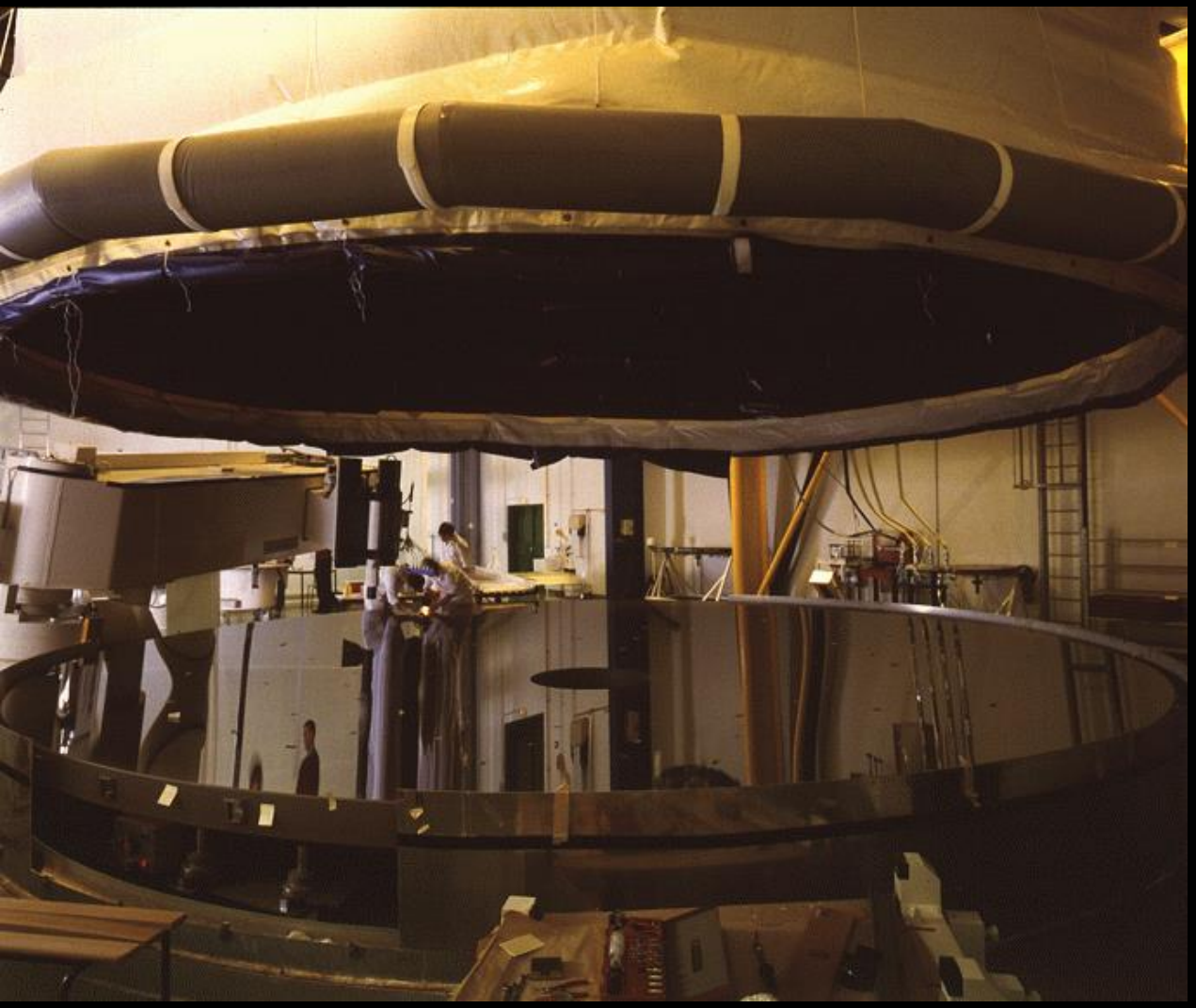
Encoders:
Strip Encoders

Bearings:
Hydrostatic

© ESO EPR

Making of
an 8.2-meter
VLT blank at Schott

Grinding at
REOSC
near PARIS



First 8.2-meter ready at REOSC

ACTIVE OPTICS AT THE VLT

No. of active, axial supports:
150

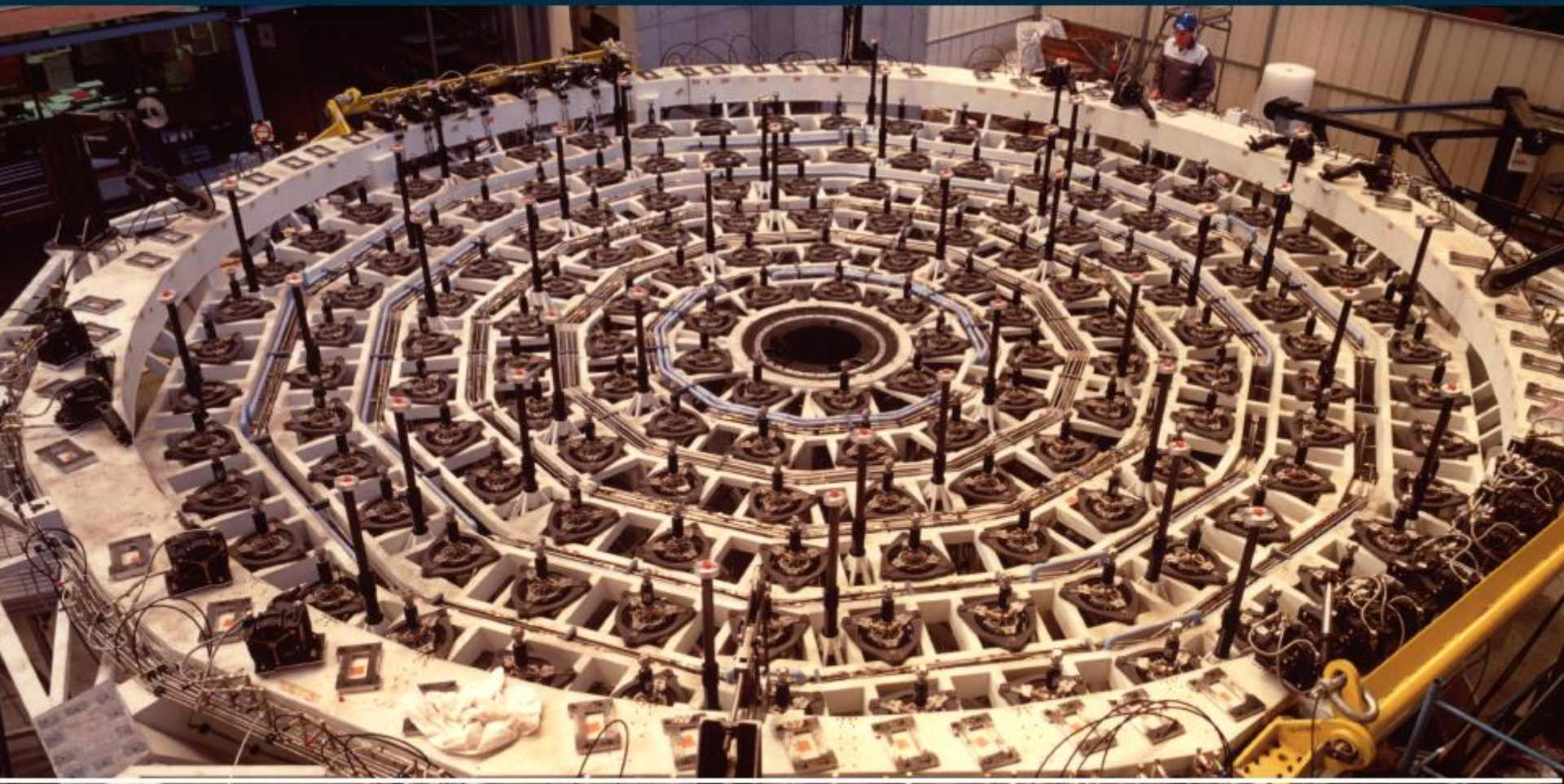
No. of lenslets in WFS:
30x30

Update interval:
30 sec (typ.)

Wavefront Sensor (WFS):
Shack-Hartmann

Correction scheme:
Modal

Coma and focus correction:
on M2



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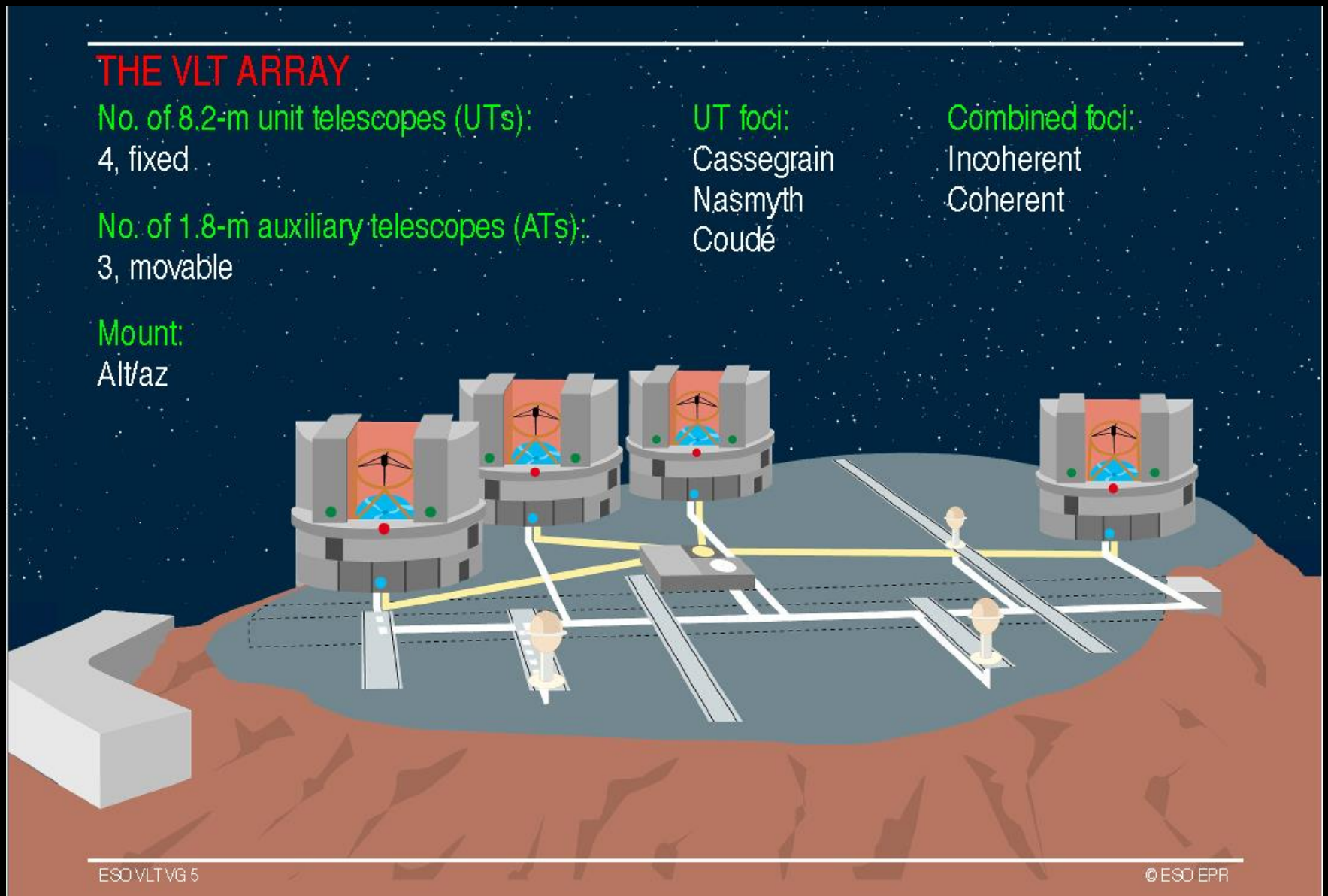
VLT-INTERFEROMETER



15. - 17. September 2002:

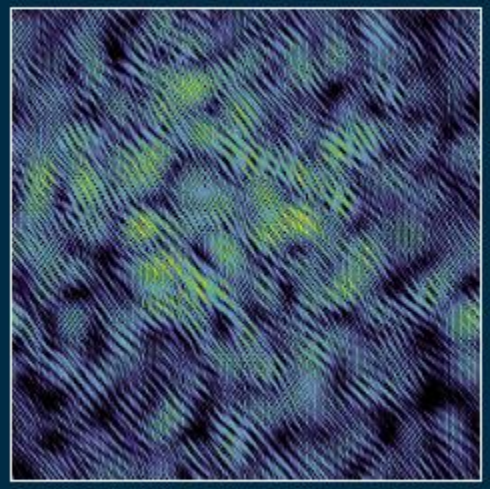
erste Tests des VLTI mit allen 4 Teleskopen erfolgreich

INTERFEROMETRY WITH THE VLT

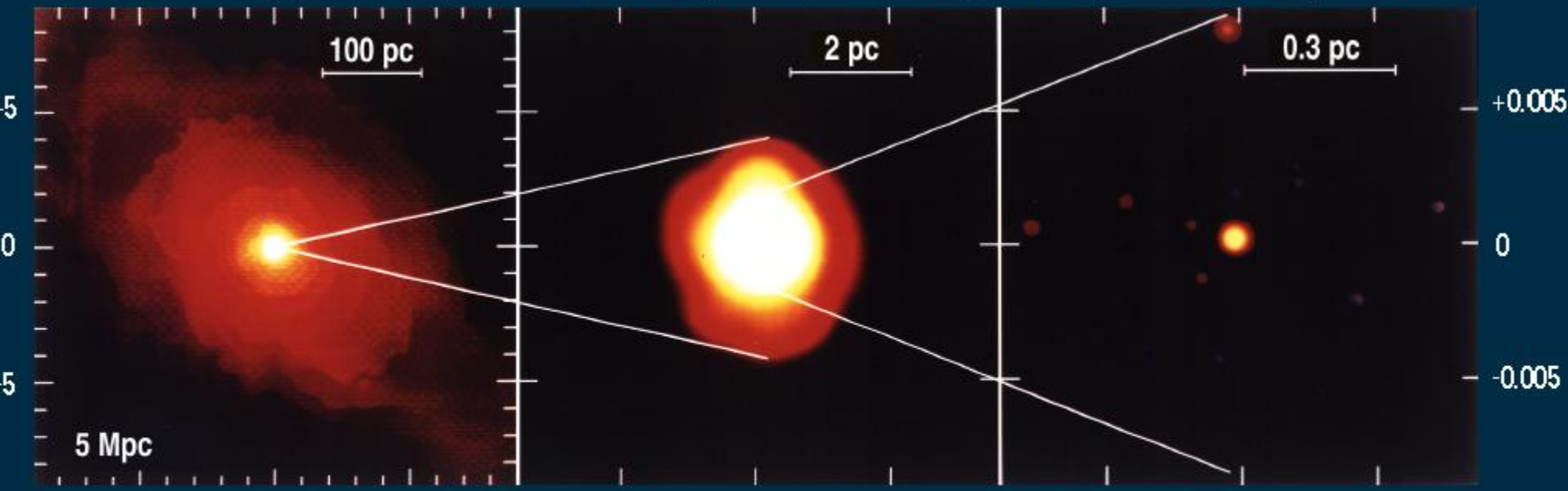
Coherent combination of light from two or more telescopes results in interference fringes.

Through computer analysis of the fringes, a high-resolution image of the source can be constructed.

The VLTI resolving power equals that of a 130 m telescope



Natural Seeing (0".5 Res) Adaptive Optics (0".06 Res) VLTI (0".0024 Res)



Courtesy Max Planck Society

K-band (2.4 µm)

© ESO EPR

VLT Instruments

- FORS (Focal Reducer/Low-Dispersion Spectrograph)
- ISAAC (Infrared Spectrometer and Array Camera)
- VISIR (Mid-Infrared Imager/Spectrometer)
- CONICA (High-Resolution Near-Infrared Camera)
- FUEGOS (Multi-Fibre Area Spectrograph)
- UVES (UV Echelle Spectrograph)

ISAAC

Infrared Spectrometer And Array Camera

Wavelength range:
1-5 μm

Designed for:
- 'wide' (2.5x2.5') field imaging
- long slit low and medium resolution spectroscopy

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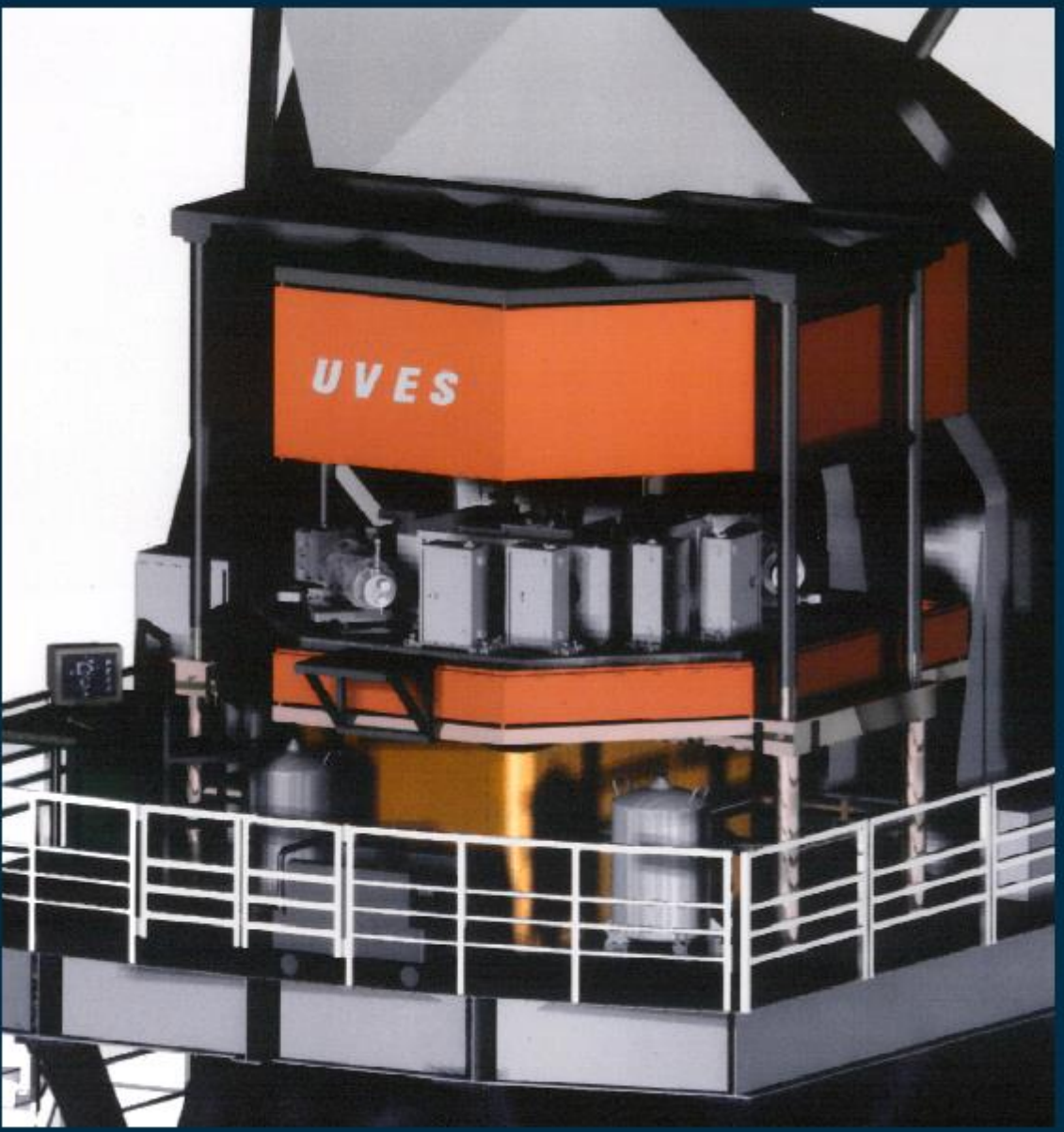
UVES



UV-Visual Echelle Spectrograph

UVES is a two-arm crossdispersed echelle spectrograph.

Wavelength range:
300-500 nm and 420-1100 nm

Designed for:
High spectral resolution spectroscopy

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Das Gran Telescopio de Canarias (GTC)

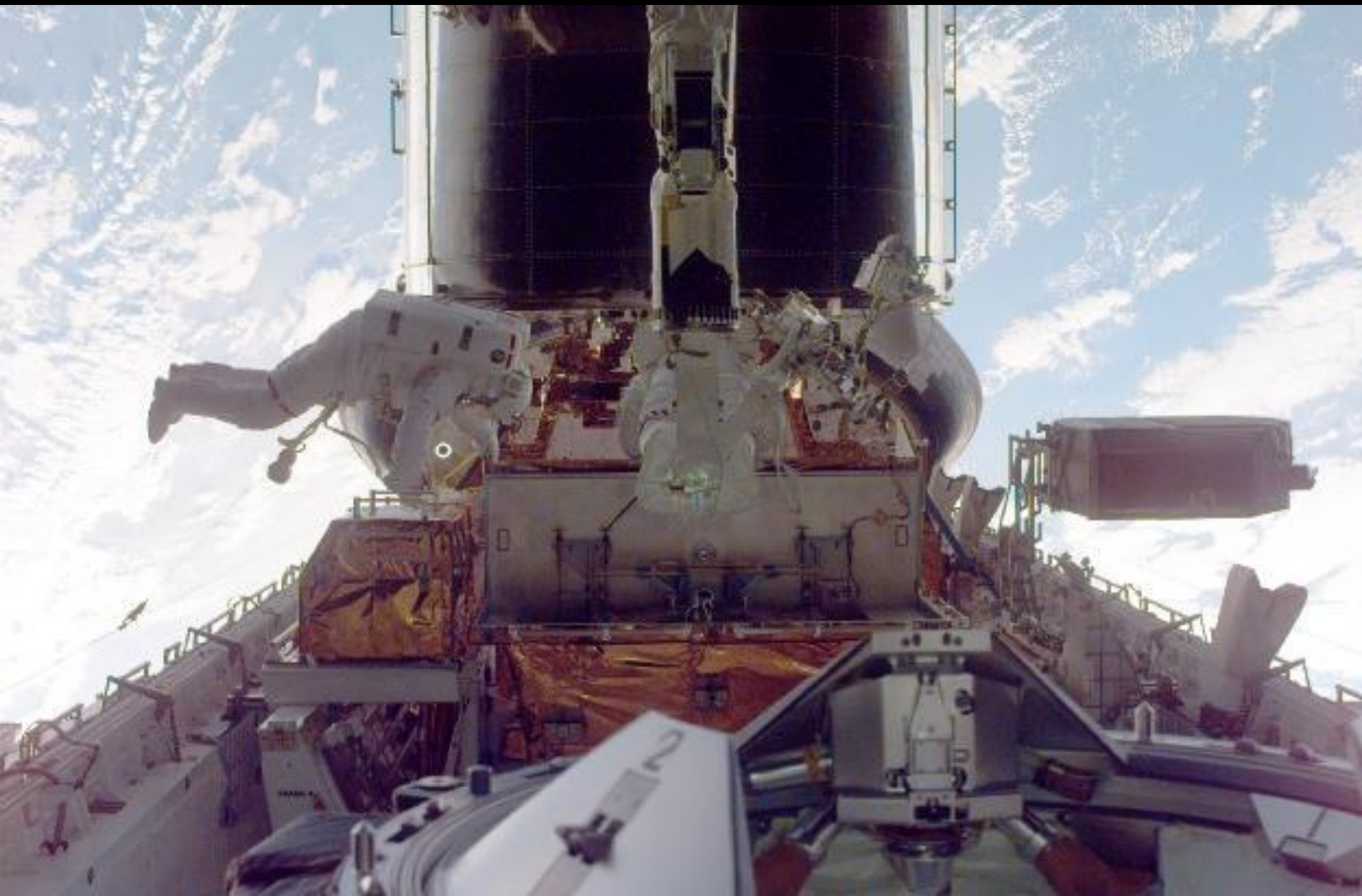
Auf dem Roque de las Muchachos (La Palma)

Gesamt-Durchmesser: 10,4 m

Bestehend aus 35 sechseckigen Teilspiegeln,
Durchmesser: 1,9 m; Dicke: 8,5 cm; Gewicht: 500 kg

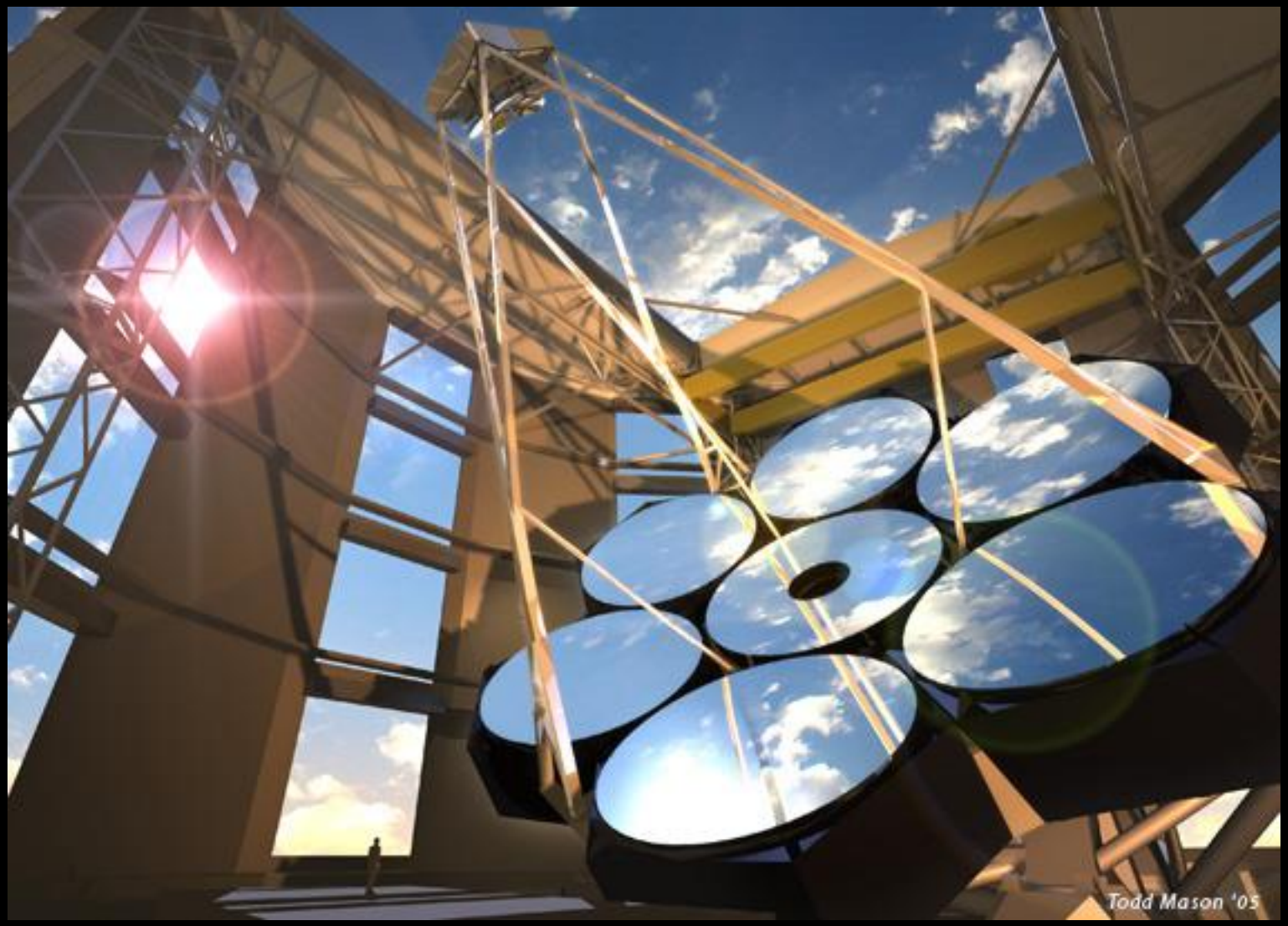
EXCEPTO PERSONAL
OBSERVATORIO
EXCEPT
OBSERVATORY STAFF

HST
Hubble Space Telescope

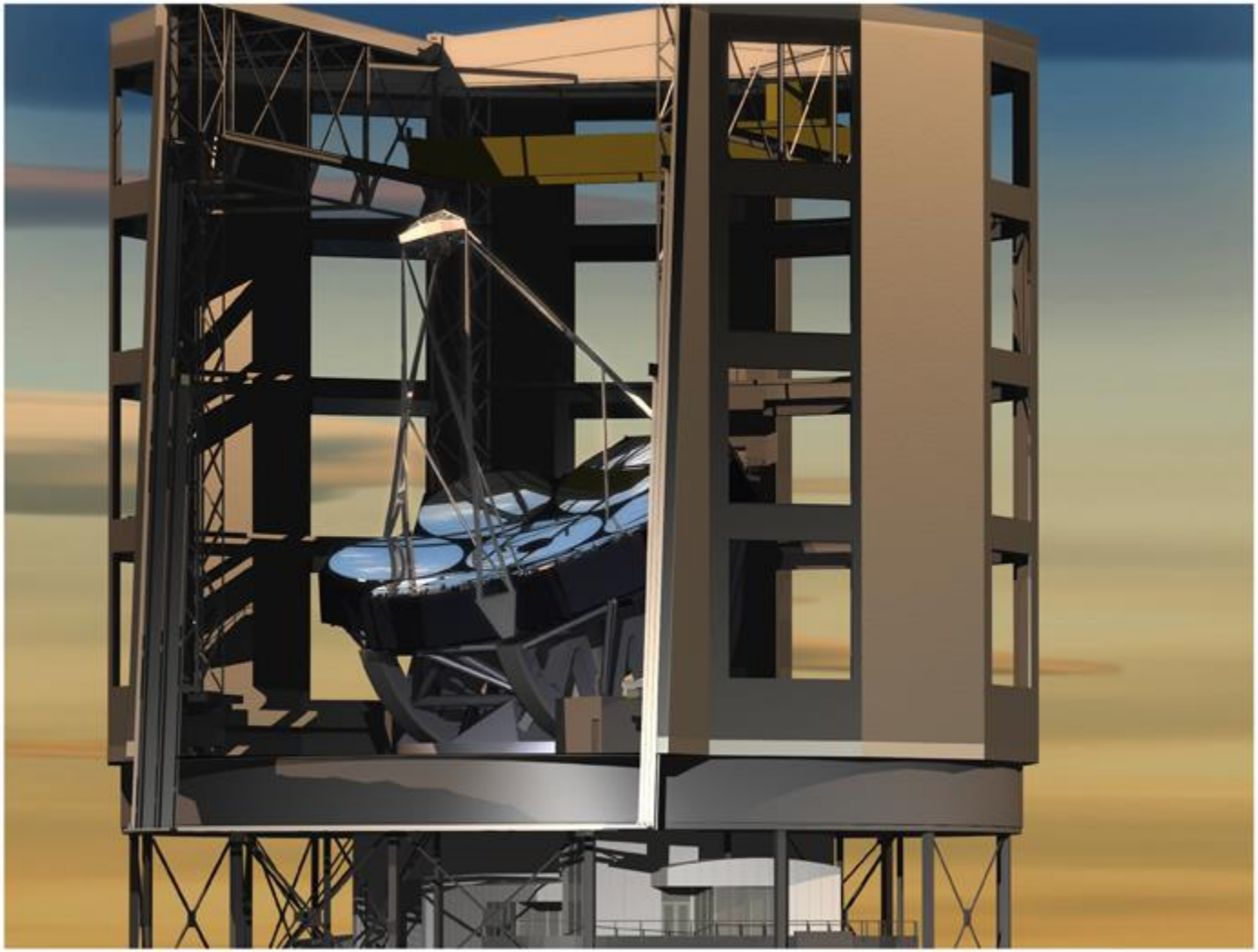


Geplante Riesenteleskope auf der Erde

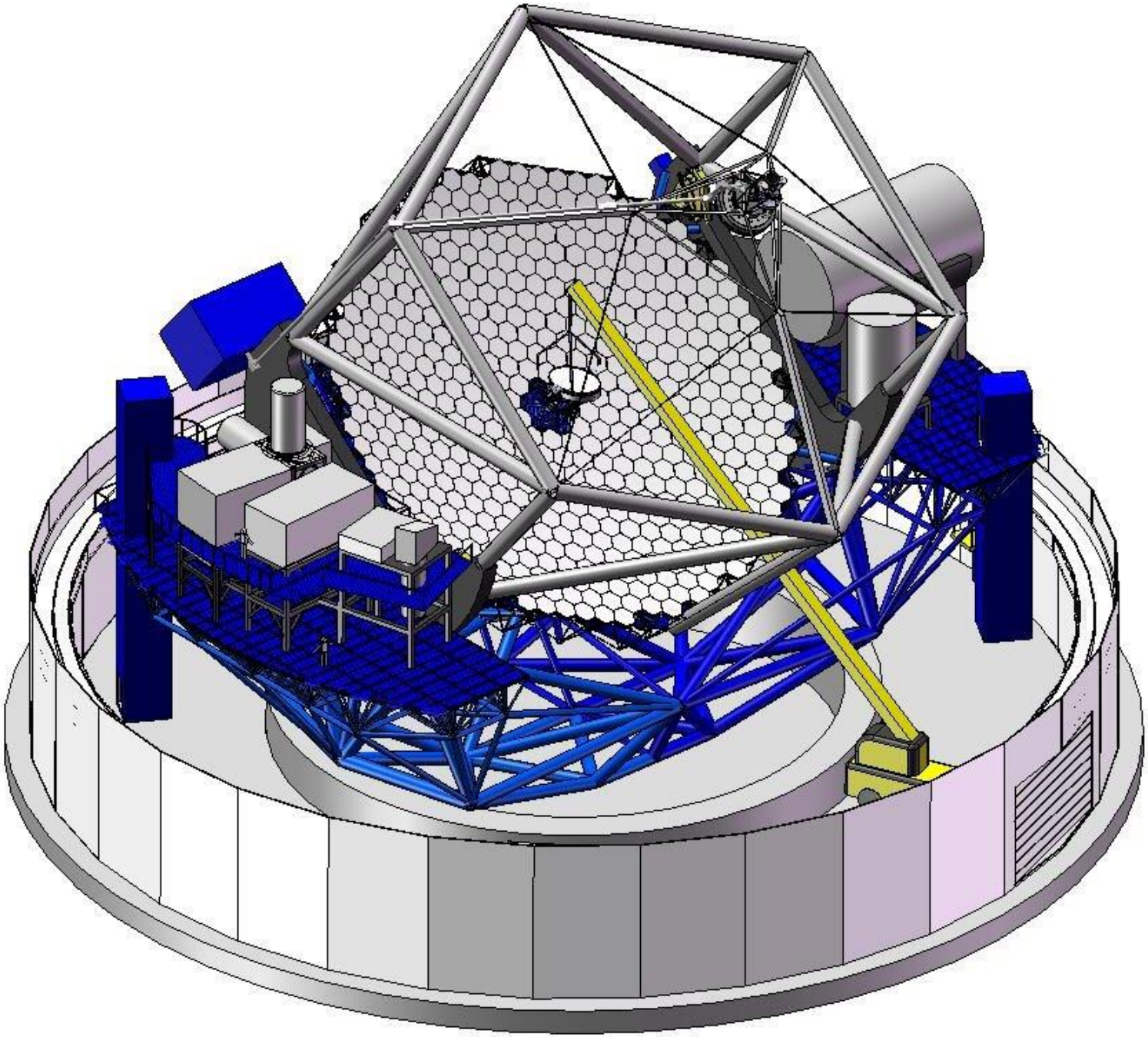
- Giant Magellan Telescope: 24,5 m (7 x 8,4 m) 625 M$
- 30 m Telescope: 30 m (492 x 1,4 m) 1 Milliarde $
- European extremely large telescope:
  42 m (906 x 1,45 m) 1,2 Milliarden $
- Overwhelmingly Large Telescope: 100 m (3048 Segm.)
  1 Milliarde EUR

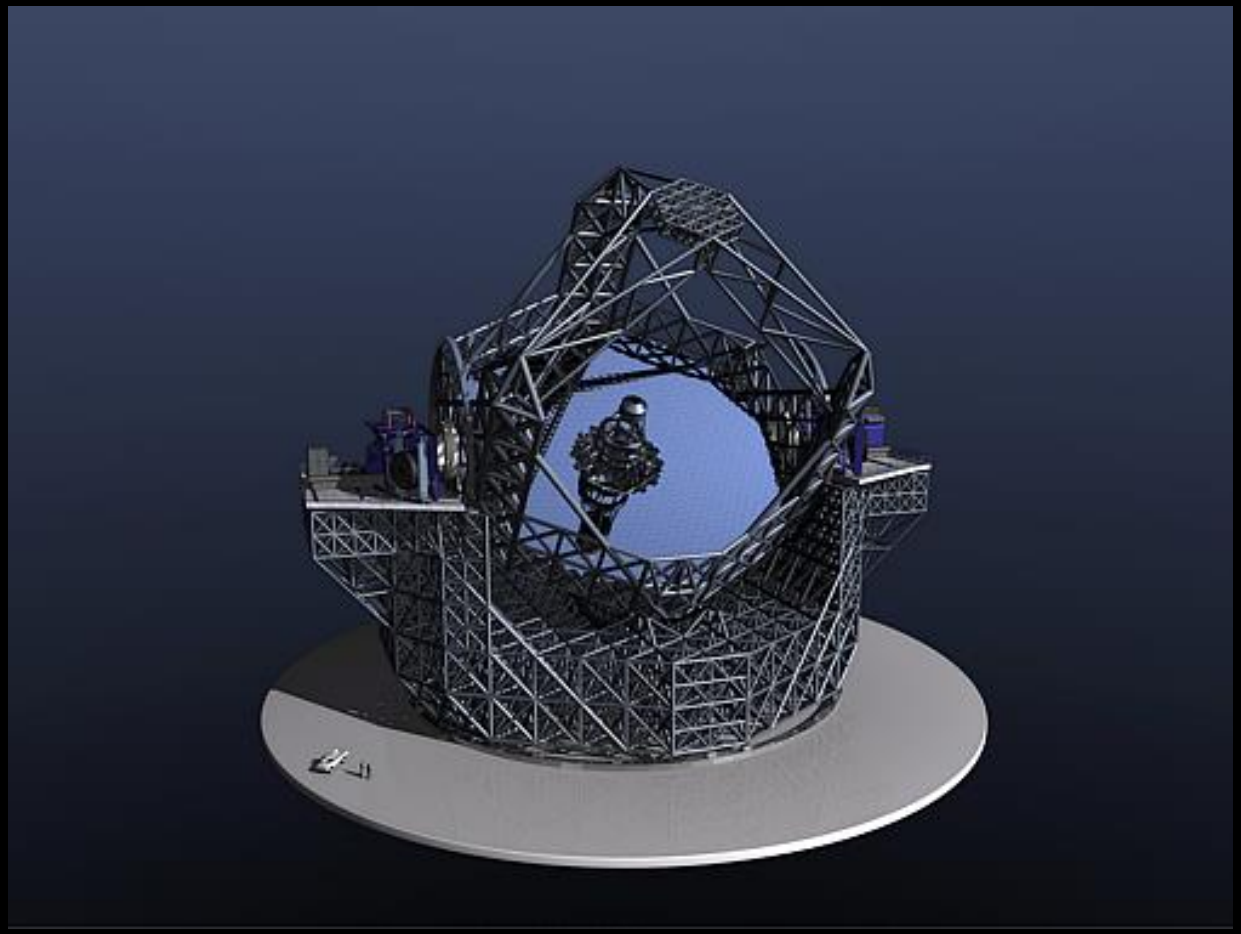


Giant Magellan Telescope

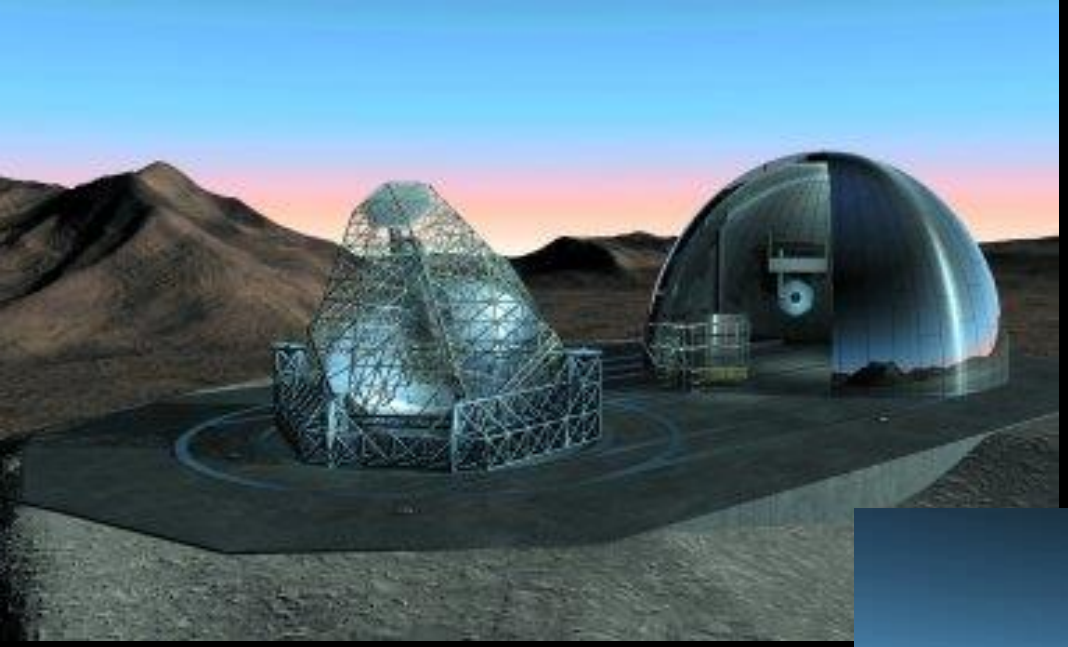


30m Telescope





EELT



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