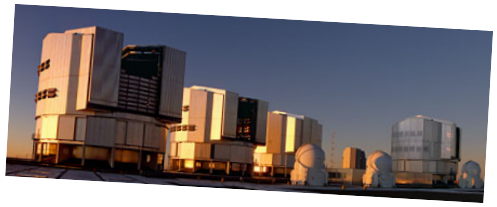
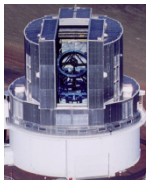
Grandes Telescópios Óticos

De 8-10m a 23-39m





Atualização: 8/4/14

Giant telescopes

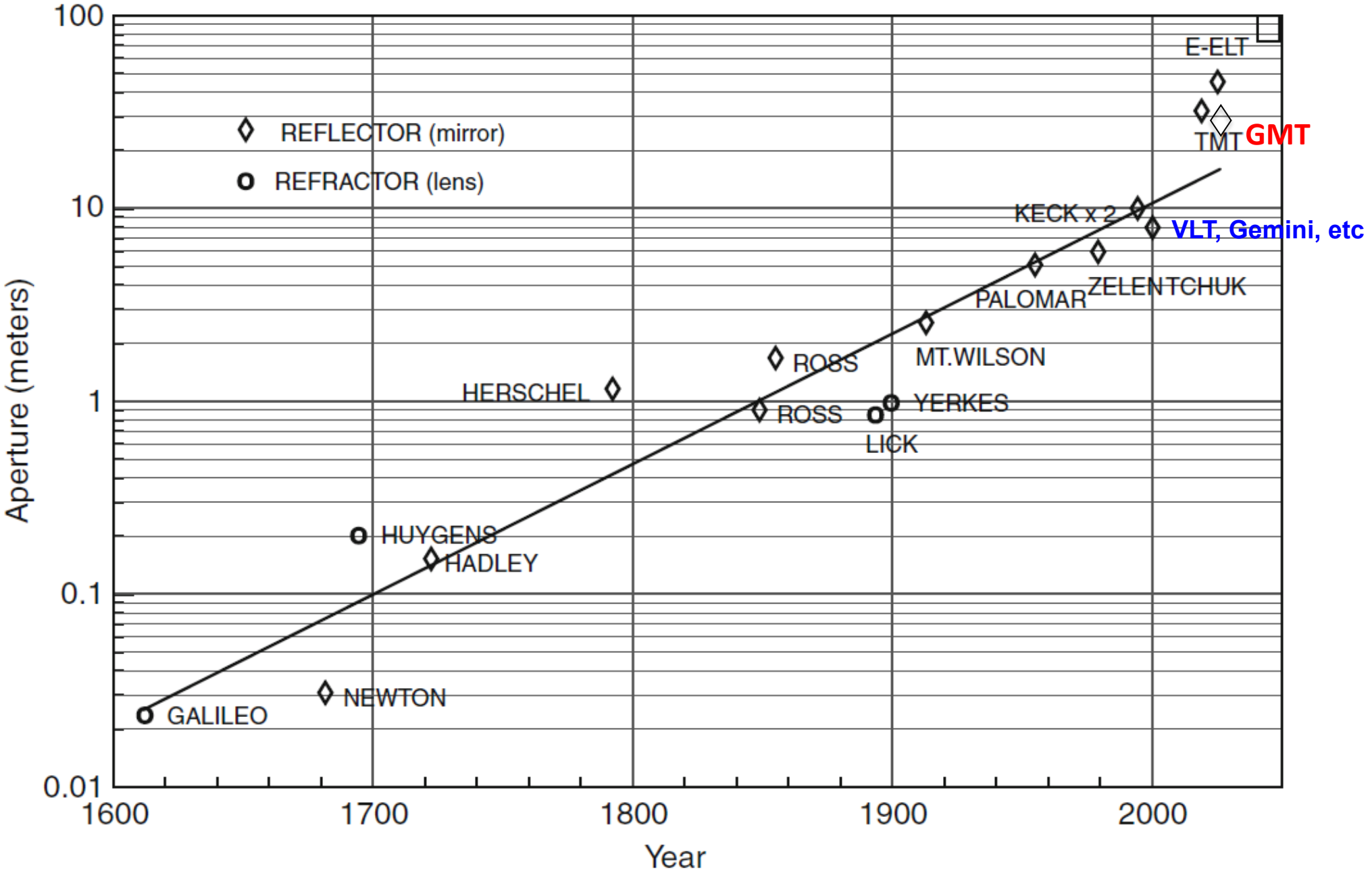
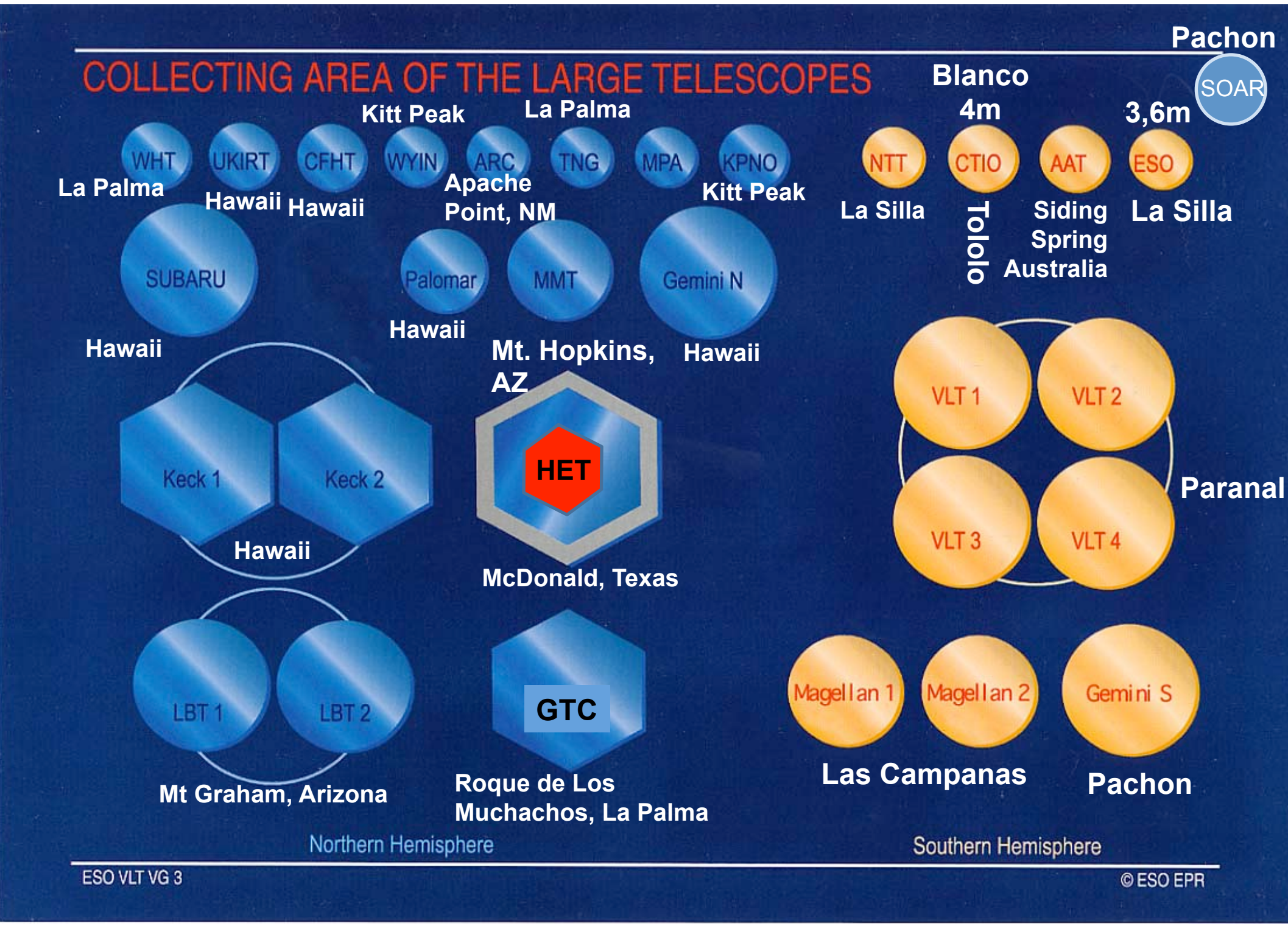


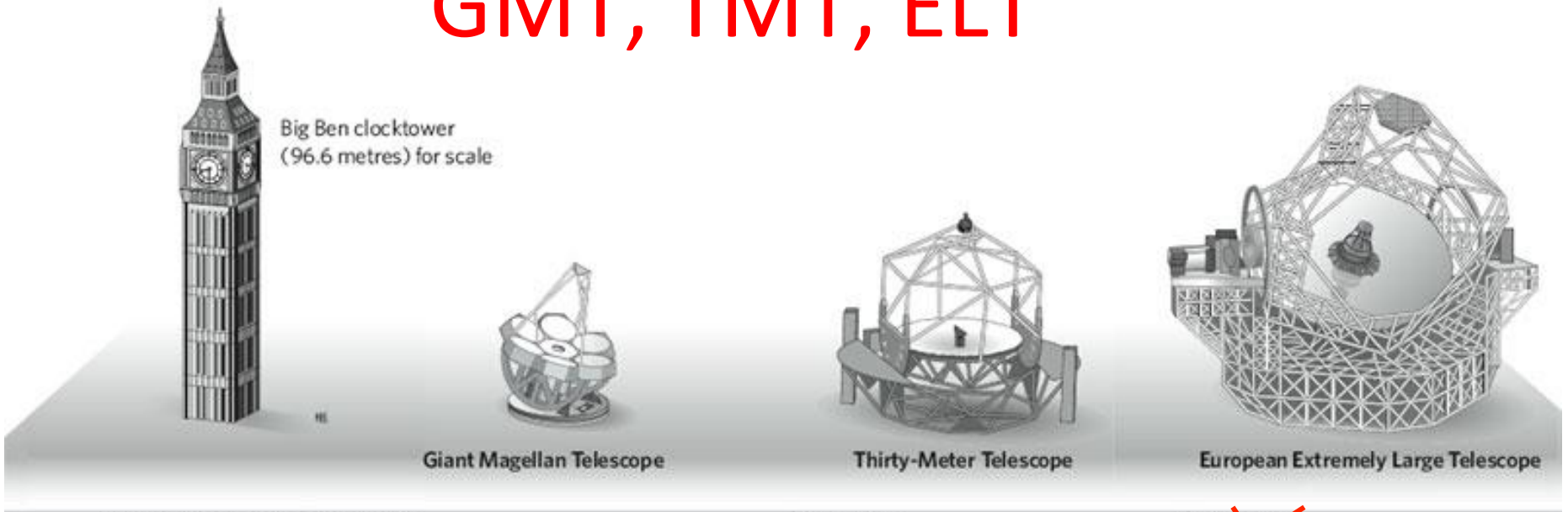
Fig. 1.8, Lena, 3rd Ed.



Updated by J.M. on May 2nd, 2012

Giant telescopes

GMT, TMT, ELT



Telescope diameter	25.2 metres	30 metres	42 metres **39 m**
Component mirror segments	7 (8.4-metre segments)	492 (1.44-metre segments)	984 (1.45-metre segments)
Cost	US$600 million	US$754 million	€900 million (US$1.37 billion)
Planned location	Chile	Candidates: Hawaii; Mexico; three sites in Chile	Candidates: Canary Islands; Morocco; Argentina; two sites in Chile
Planned construction period	2010–2017 (First mirror already cast)	2009–2016	2010–2017
Technical advantages	Adaptive optics integrated within secondary mirror Shortest focal length means it has the smallest and cheapest structure	Mirror segments are comparatively cheap and more easily replaced Similar scaled-up version of the existing Keck telescopes	Five-mirror design results in a flat focal plane and better images Similar mirror-segment size to the TMT, so greater vendor choice
Financial advantages	Potential support from $34-billion Harvard endowment or Texas billionaire George Mitchell	$200-million gift from Intel founder Gordon Moore	Steady European funding stream
Disadvantages	Only one place can make the mirrors Gaps in mirror limit the effective aperture to 21.5 metres	Adaptive optics performed after the light leaves the telescope, so the 'natural seeing' mode cannot benefit from adaptive corrections to wind effects	Biggest and most expensive design No similar design experience Reflections through five mirrors reduce light levels

Nature 452, 142-145 (2008)

Telescópios gigantes

- A construção de telescópios com grandes espelhos esbarra em dificuldades

- Soluções

⇨espelho muito finos

⇨mosaico de espelhos

⟶ Keck: 10m = 36 x 1,8m

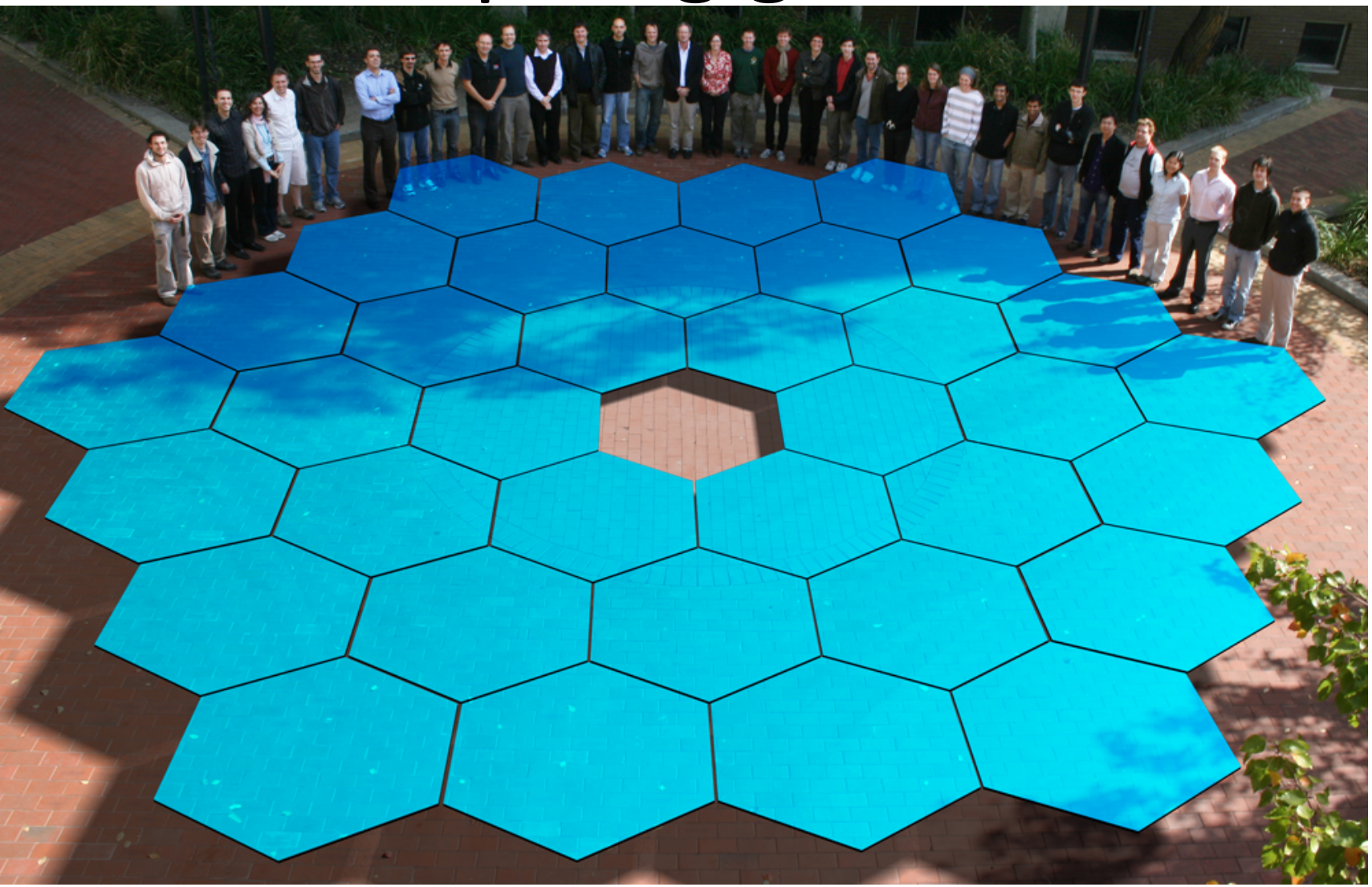
⟶ suporte de c/espelho é independente

(ótica ativa)

Os telescópios Keck de 10m foram inicialmente construídos e desenvolvidos pelo CALTECH e Universidade de California.

What about USP?

Telescópios gigantes : Keck 10m



Swinburne's Centre for Astrophysics & Supercomputing (Australia) staff and students mark out the size of one Keck mirror. They have an agreement to use up to 20 nights of Keck time.

http://astronomy.swin.edu.au/keck/

Telescópios gigantes : 2 x Keck 10m

- Swinburne University tem 20 noites Keck ao ano
- Australian National University (ANU) tem 15 noites Keck ao ano

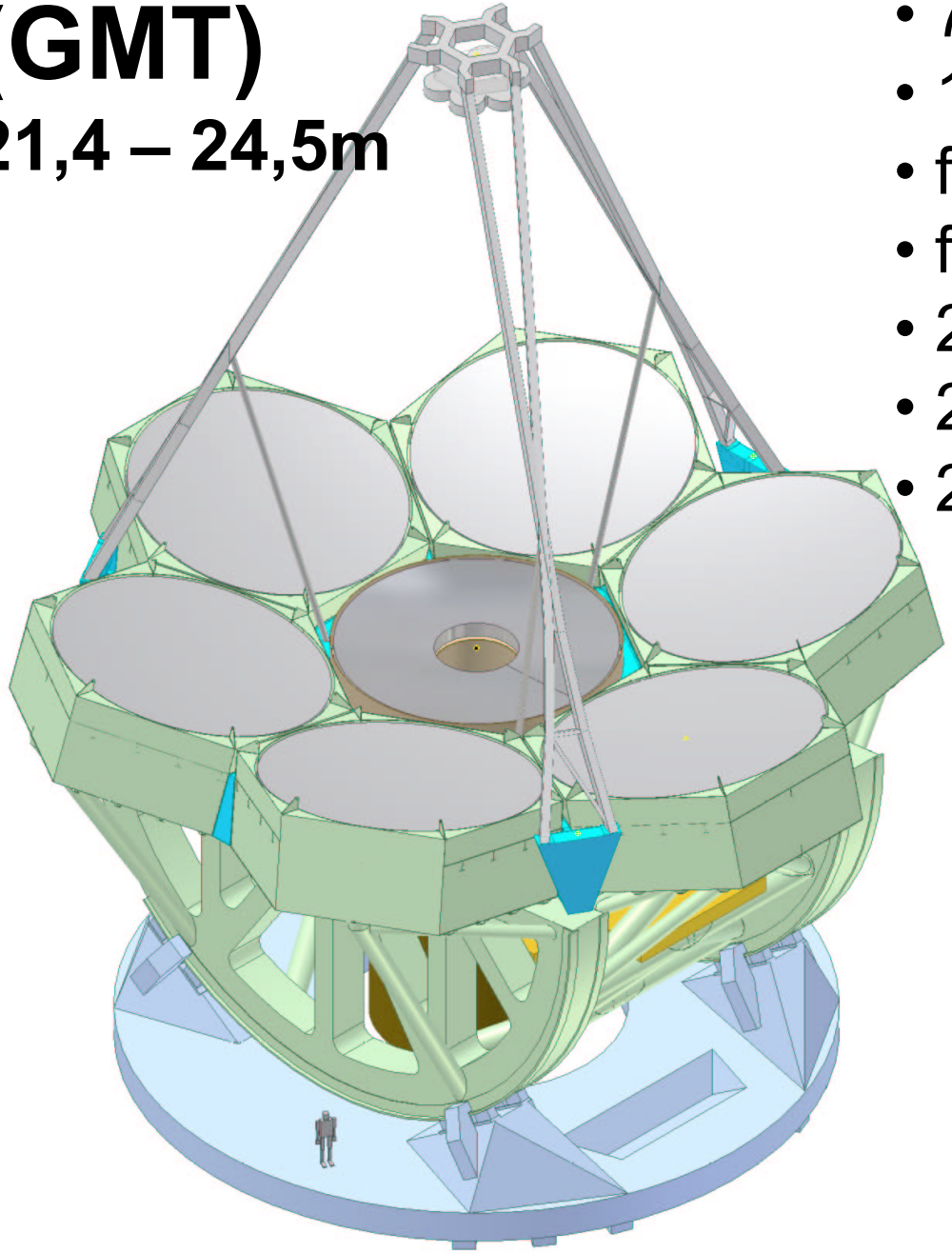
(gestão do novo diretor da Research School of Astronomy & Astrophysics da ANU).

Orcamento da ANU = AU$886milhões? = 1,8 bilhões

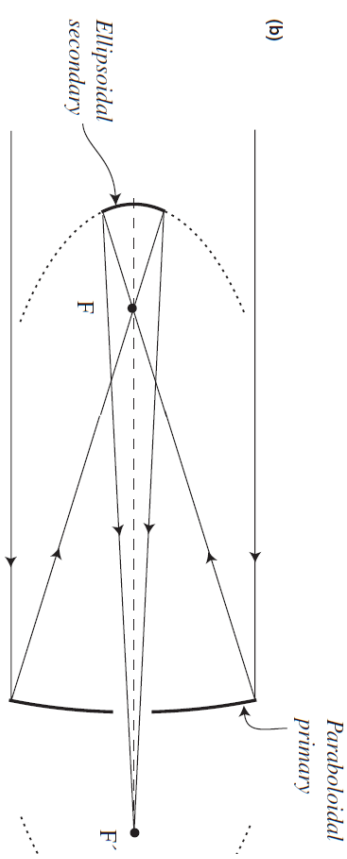
- USP = 0 noites (orcamento R$5 bilhões)

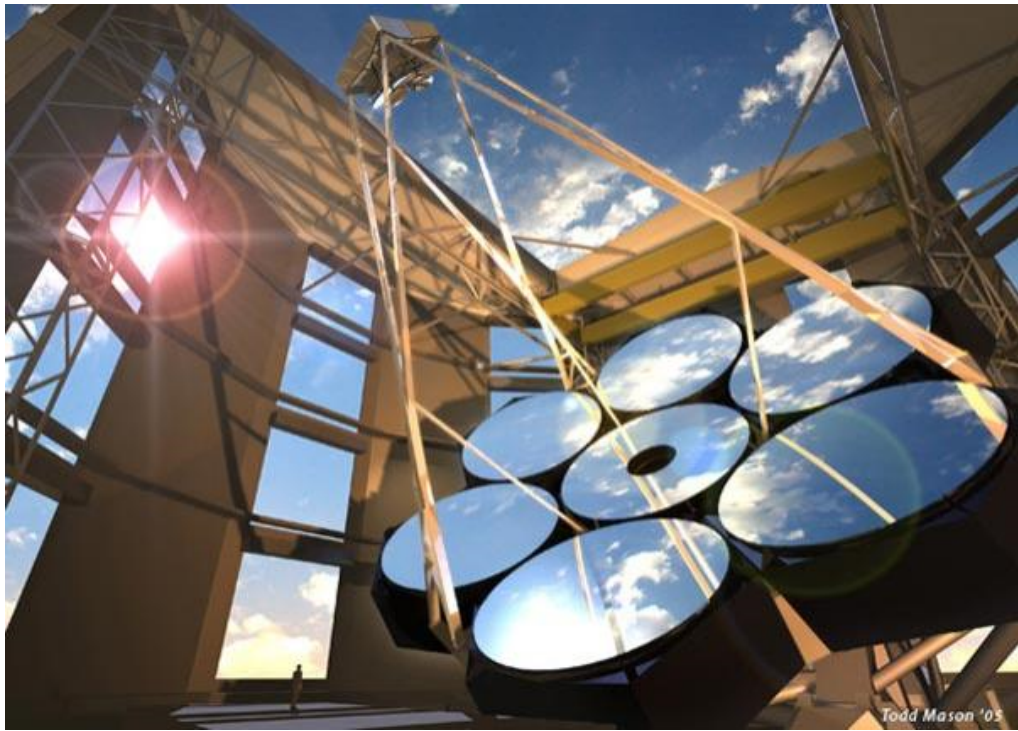
The Giant Magellan Telescope (GMT)

21,4 – 24,5m

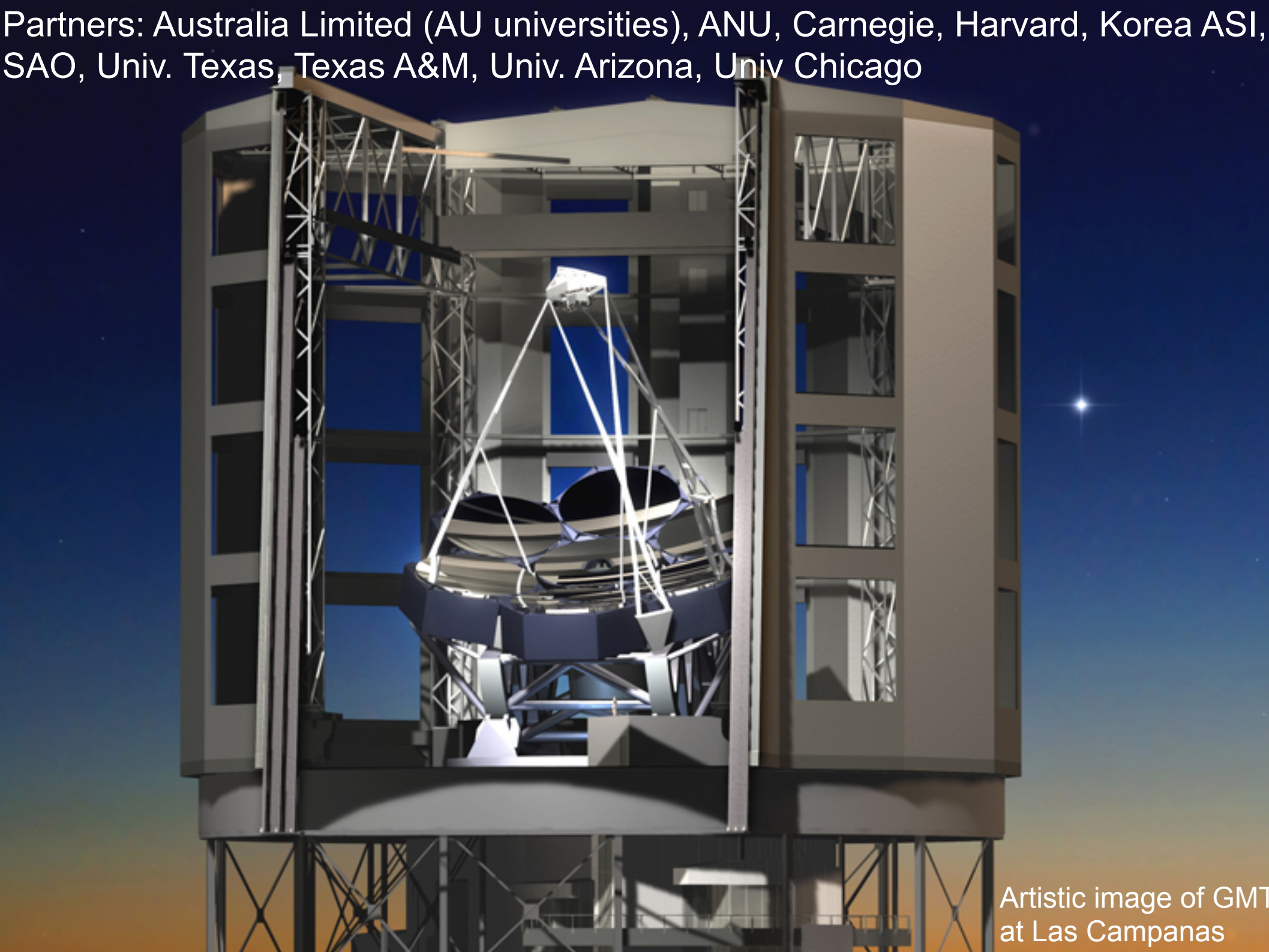


- 7 X 8.4m Segments
- 18m focal length
- f/0.7 primary
- f/8 Gregorian focus
- 21.4m equiv. area
- 24.5m equiv. ang. res.
- 20-25’ FOV

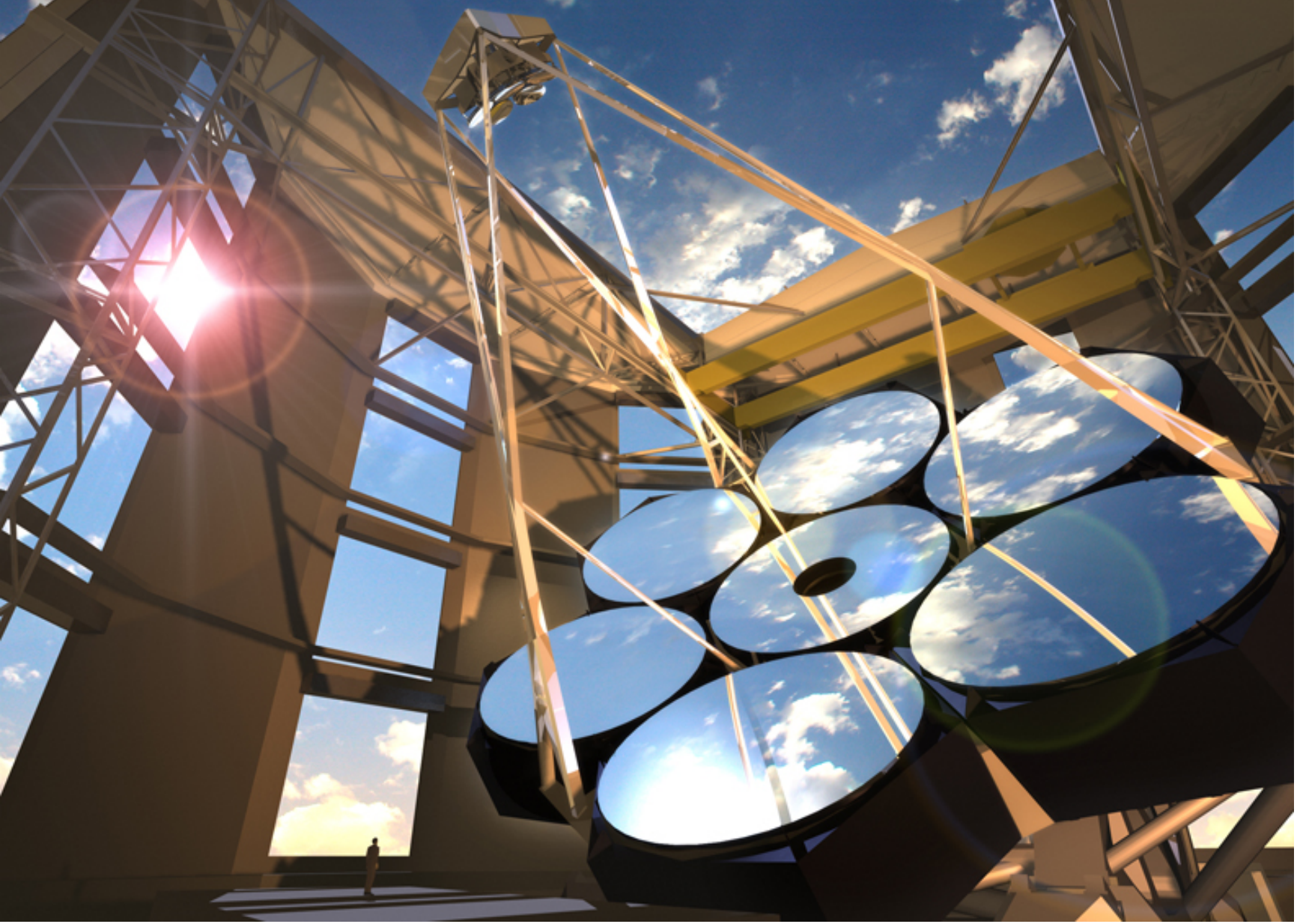




Partners: Australia Limited (AU universities), ANU, Carnegie, Harvard, Korea ASI, SAO, Univ. Texas, Texas A&M, Univ. Arizona, Univ Chicago



Artistic image of GMT at Las Campanas



- Cost in 2008, US$600 milliion, cost as of May 2012, US$700 million
- Completion target in 2008 : 2017; completion target now : 2020
- Location - Las Campanas Observatory, Chile (2,516 meters)
- Height of telescope housing - 200 feet (61 meters)

GIANT MAGELLAN TELESCOPE

NEWSLETTER WINTER, 2012

The second of GMT's seven 8.4 meter (27-foot) diameter primary mirrors was cast on 2012 January 14th at the University of Arizona's Steward Observatory Mirror Laboratory.

GMT Press Release (March 23, 2012)

BIG BANG ON EARTH - BLASTING A MOUNTAINTOP TO MINE THE SKY

Astronomers have begun to blast 3 million cubic feet of rock from a mountaintop in the Chilean Andes to make room for what will be the world's largest telescope when completed near the end of the decade. The telescope will be located at the Carnegie Institution's Las Campanas Observatory - one of the world's premier astronomical sites, known for its pristine conditions and clear, dark skies. Over the next few months, more than 70 controlled blasts will breakup the rock while leaving a solid bedrock foundation for the telescope and its precision scientific instruments.

George P. Mitchell Commits $25 Million to Giant Magellan Telescope

George P. Mitchell

George P. Mitchell, founder of Mitchell Energy & Development Corp. and The Cynthia and George Mitchell Foundation, recently committed an unprecedented $25-million gift to the Giant Magellan Telescope (GMT) project. Mr. Mitchell announced his gift at a fundraising dinner he hosted for Texas A&M University and The University of Texas at Austin on May 10, 2011.

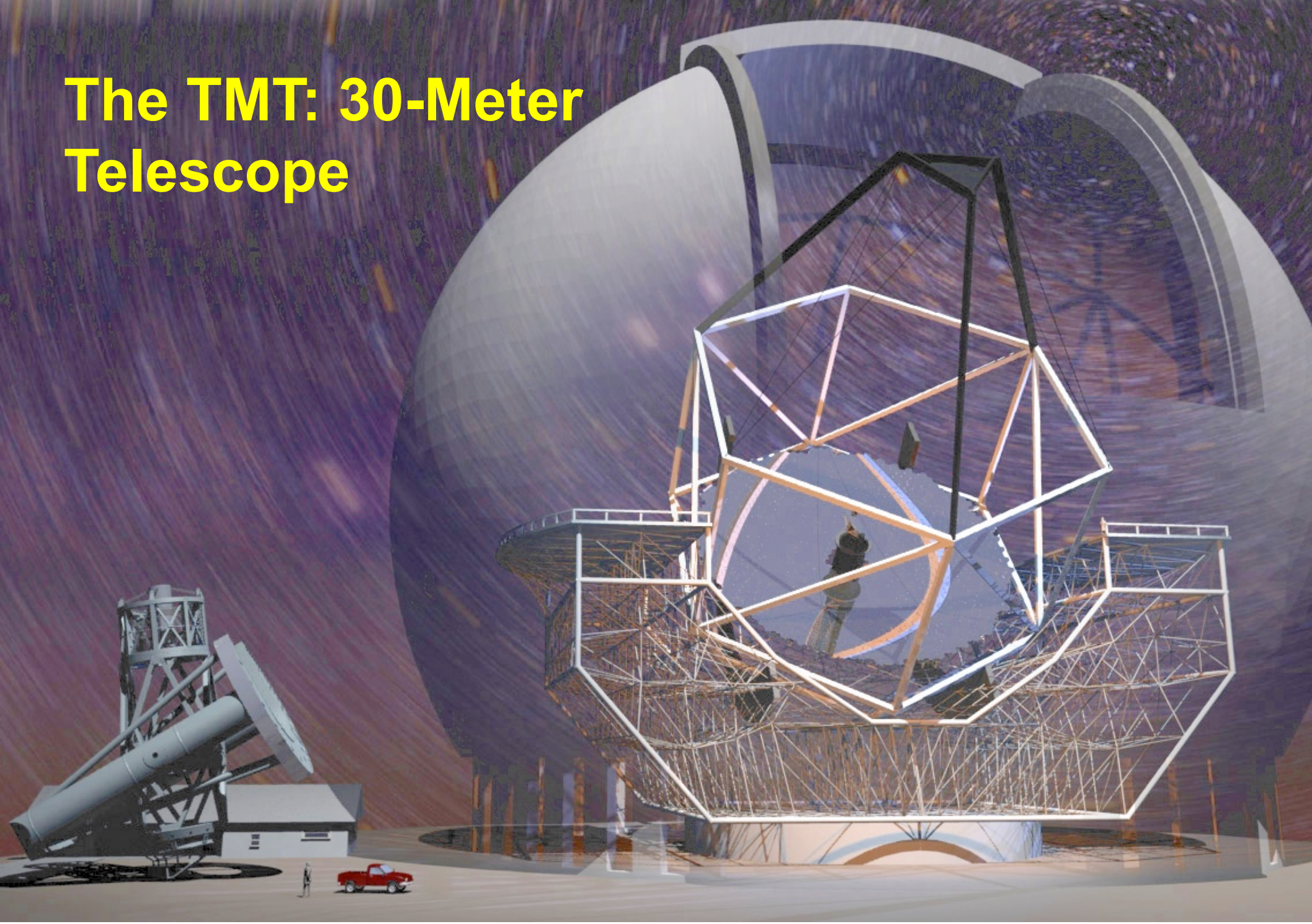
Half of the gift ($12.5 million) was made to Texas A&M University (Mitchell's alma mater) and half to the Carnegie Institution for Science. Texas A&M and Carnegie are two of the GMT's 10 partners. The gift will help support the GMT during the next five years.

GMT Press Release (April 2, 2012)

GIANT TELESCOPE PROJECT PARTNERS PASS ON FEDERAL FUNDS

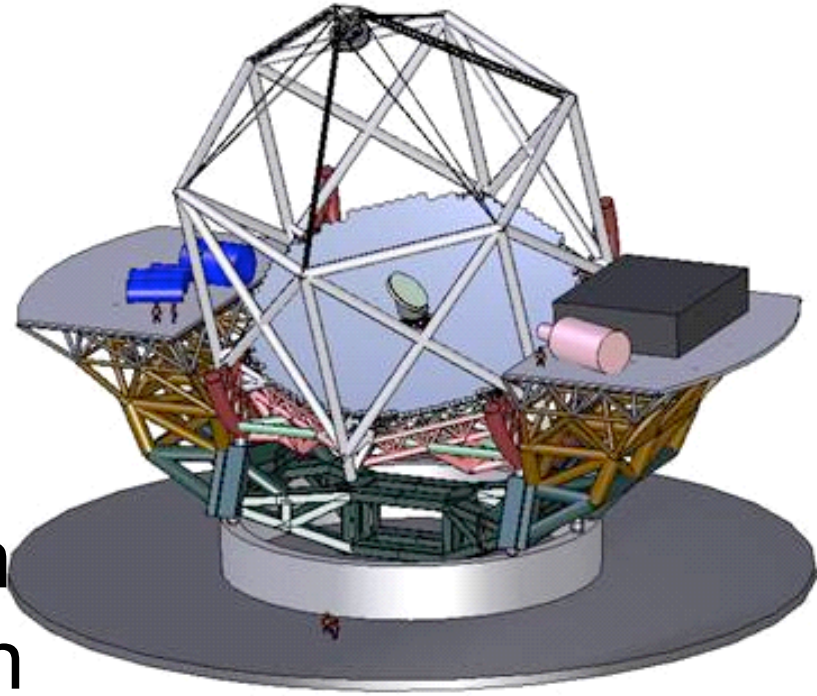
Pasadena, CA --The board of directors of the Giant Magellan Telescope Organization (GMTO) has informed the National Science Foundation (NSF) that they will not participate in an upcoming funding opportunity. The partners in the project feel that they are making such rapid progress that they have chosen to press ahead at full speed, looking to link up with the NSF at a later date. With nearly half of the $700M needed to build the observatory committed, the partners are confident that they will complete the telescope.

The TMT: 30-Meter Telescope



The TMT Conceptual Design

- 30-meter filled aperture mirror
- 492 segments of 1.4m diameter
- Alt-azimuth mount
- Ritchey-Chrétien design
- f/1 primary, f/15 final focus
- Very AO-intensive
- Field of View = 20 arcmin
- Instruments located at Nasmyth foci, multiple instruments on each Nasmyth platform addressable by agile tertiary mirror



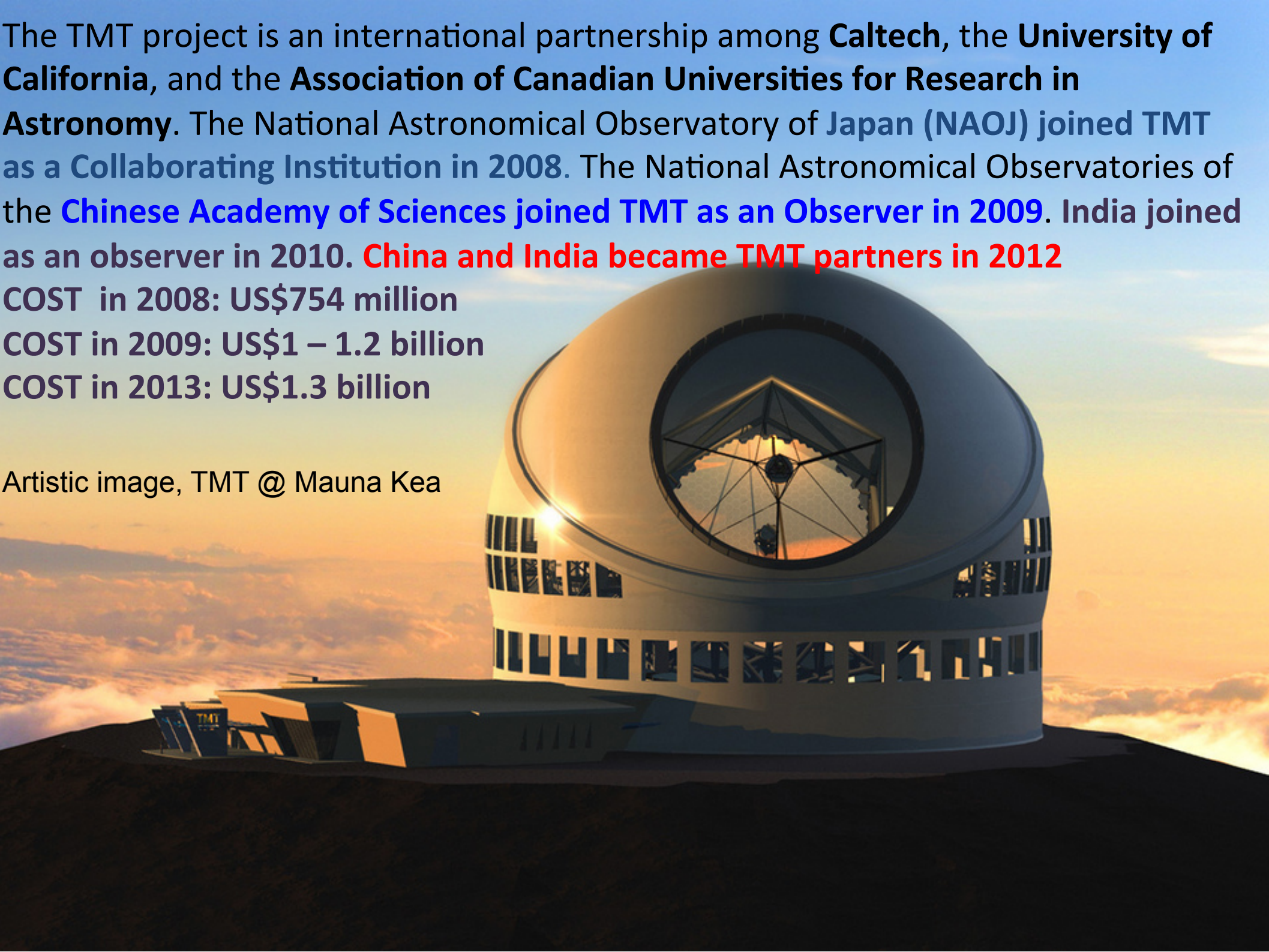
First light (2008 estimate) ~ 2016.
2012 estimate : 2018
2013 estimate: completion in 2021?

The TMT project is an international partnership among **Caltech**, the **University of California**, and the **Association of Canadian Universities for Research in Astronomy**. The National Astronomical Observatory of **Japan (NAOJ) joined TMT as a Collaborating Institution in 2008**. The National Astronomical Observatories of the **Chinese Academy of Sciences joined TMT as an Observer in 2009**. **India joined as an observer in 2010. China and India became TMT partners in 2012**

COST in 2008: US$754 million

COST in 2009: US$1 – 1.2 billion

COST in 2013: US$1.3 billion



Artistic image, TMT @ Mauna Kea

India gets money for the TMT

India to join project to build largest telescope

Kounteya Sinha, TNN Apr 17, 2012, 06.32AM IST

Tags: astronomy | advanced telescope

NEW DELHI: In a giant leap for astronomy, India will help build the world's largest and most advanced telescope. About 20 institutions like the Indian Institute of Astrophysics, Aryabhatta Research Institute of Observational Sciences, Inter-University Centre for Astronomy and Astrophysics and the Tata Institute of Fundamental Research will join construction of the Thirty Metre Telescope (TMT) - a telescope that will have nine times the collecting area of the current largest optical/infrared telescopes and will provide unparalleled high-sensitivity spatial resolution more than 12 times sharper than what is achieved by the Hubble Space Telescope.

The Department of Atomic Energy has proposed a budget of Rs 700 crore for the project over the next five years.

700 crore proposed budget
1 crore = 10 million **Indian rupees**
700 crore = 132 million US$

European Extremely Large Telescope (E-ELT)

Aperture: ~~42 m~~ **39,3 m (798 hexagonal 1.4 m mirror segments)**

Field of view: 10 arcminute diameter

Mounting: Nasmyth mount

Location: **Cerro Armazones,** Chile @ 3060 m

Housing: Dome

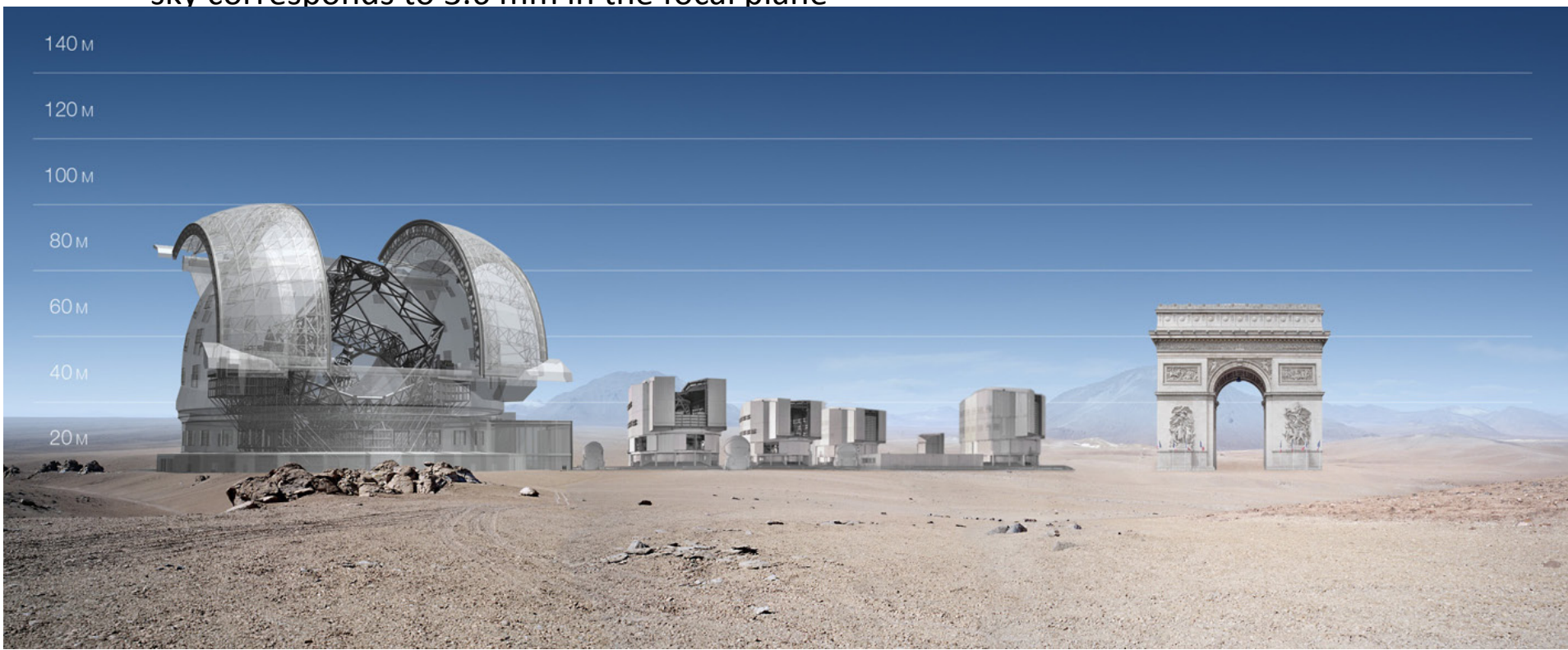
Start of operations: ~~2018 (planned)~~ **Early next decade**

Wavelength range: blue atmospheric cut-off (300 nm) to mid-infrared (24 microns)

Instrumentation: 9 stations for fixed instruments

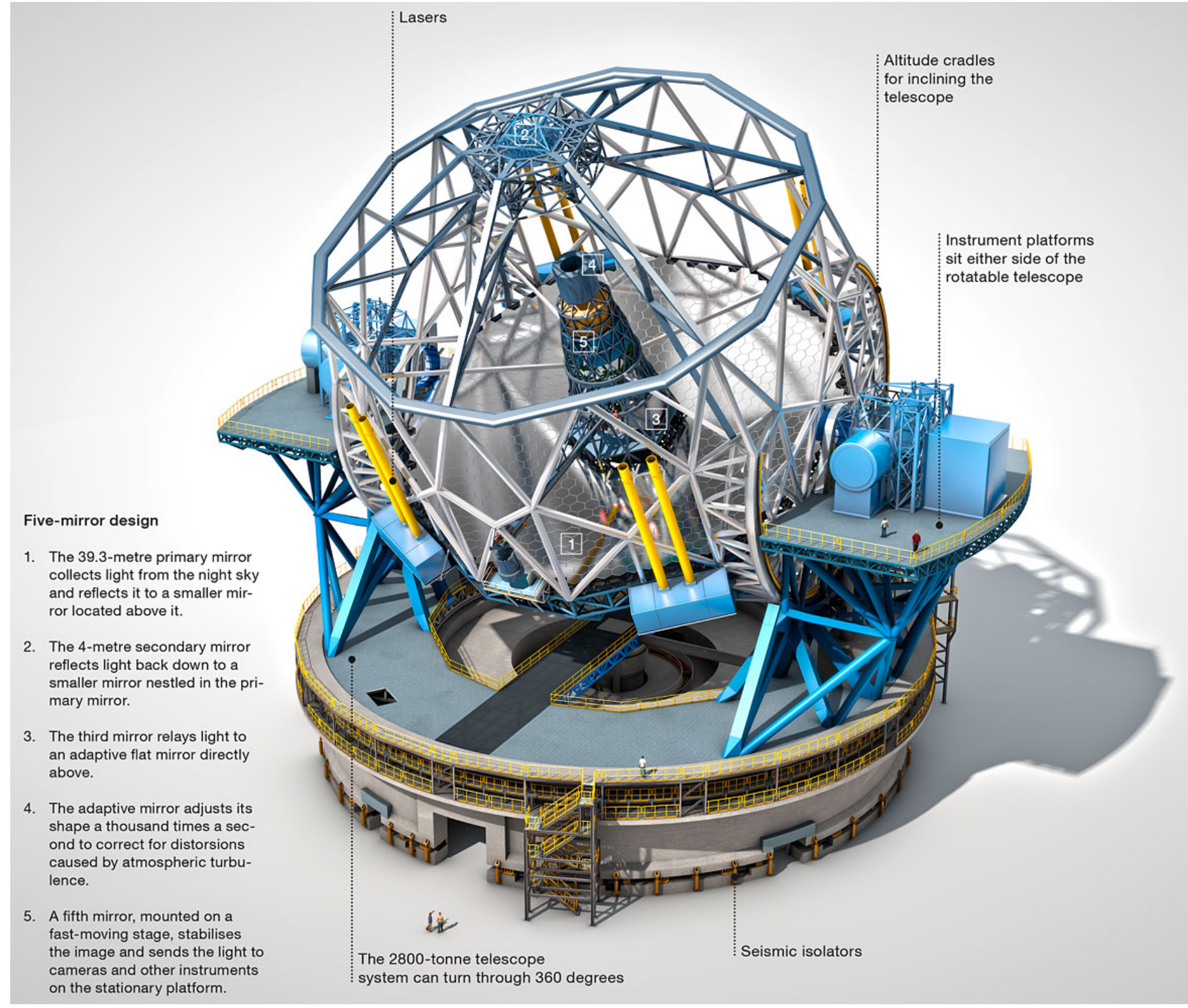
Pixel scale: at Nasmyth focus (F/17.7), 1 arcsecond on sky corresponds to 3.6 mm in the focal plane

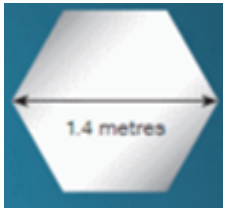
Cost about 1 billion euros



Cerro Armazones, home for the ELT

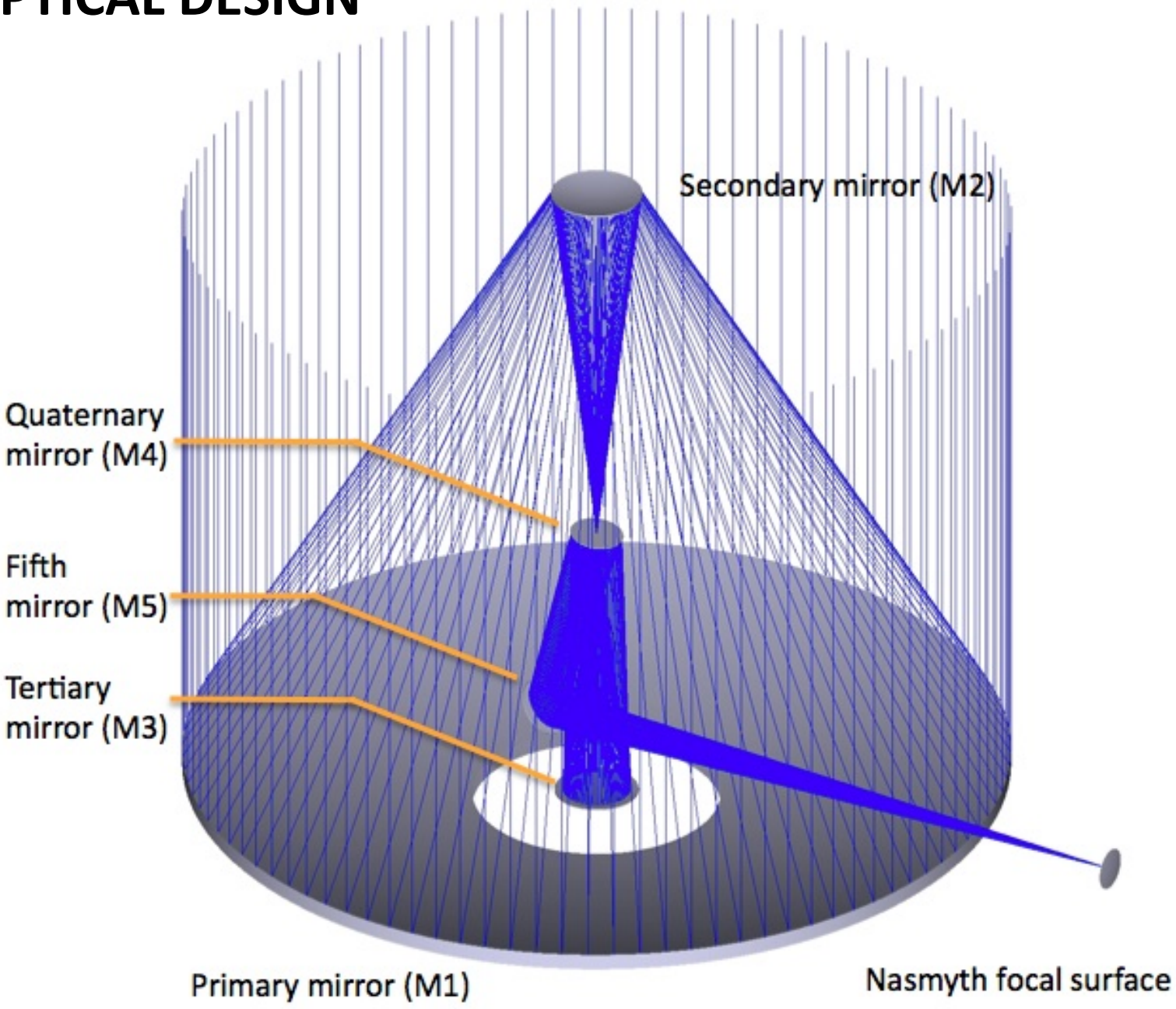
This aerial view shows the Chilean Atacama Desert around the ESO Paranal Observatory, home to the Very Large Telescope (seen at the bottom right). Close to the VLT, one can see the VISTA survey telescope, and to the right, the Paranal Residence and basecamp. The high peak in the distance is the 6739-metre high volcano Llullaillaco. Also in the image, to the middle left, one can see an isolated peak with a curvy road leading to its summit. This is Cerro Armazones, the selected home for the future E-ELT



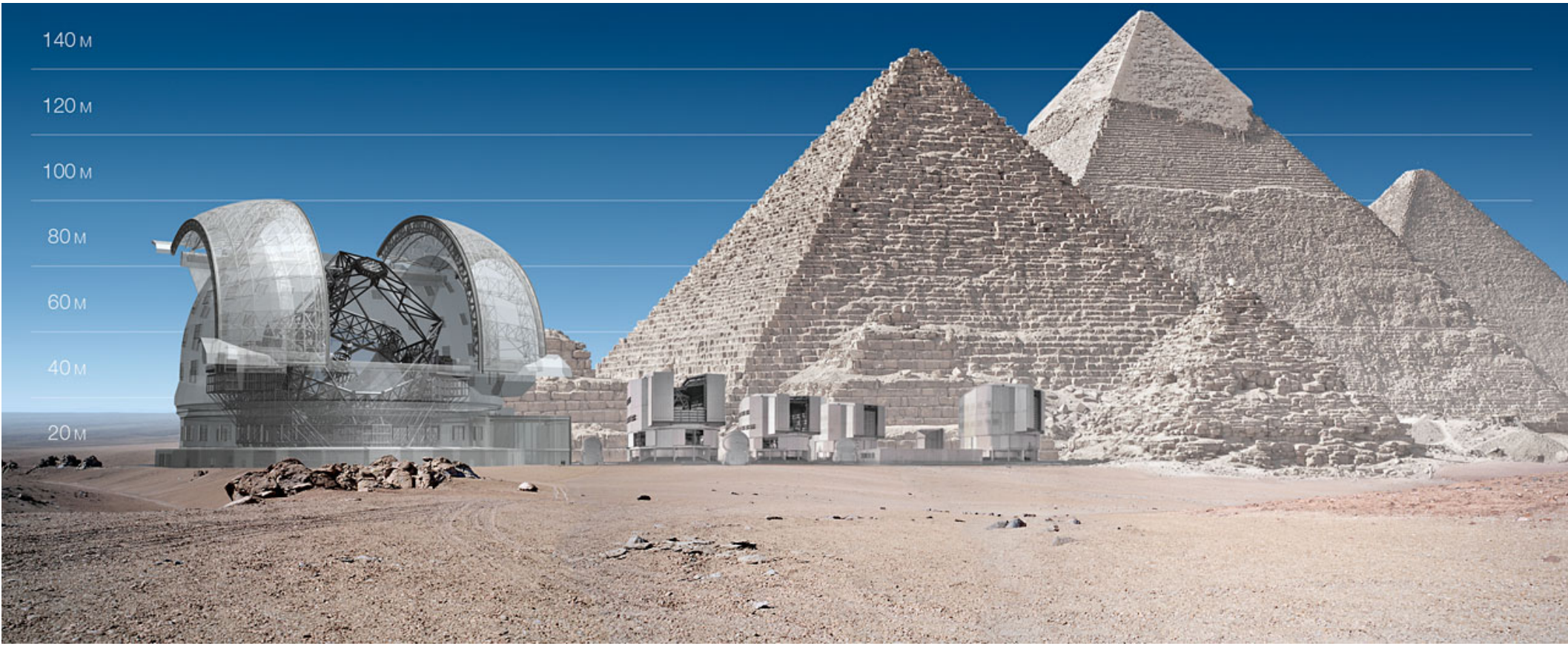


Cada segmento tem 1,4m (total ~ 800)

E-ELT OPTICAL DESIGN



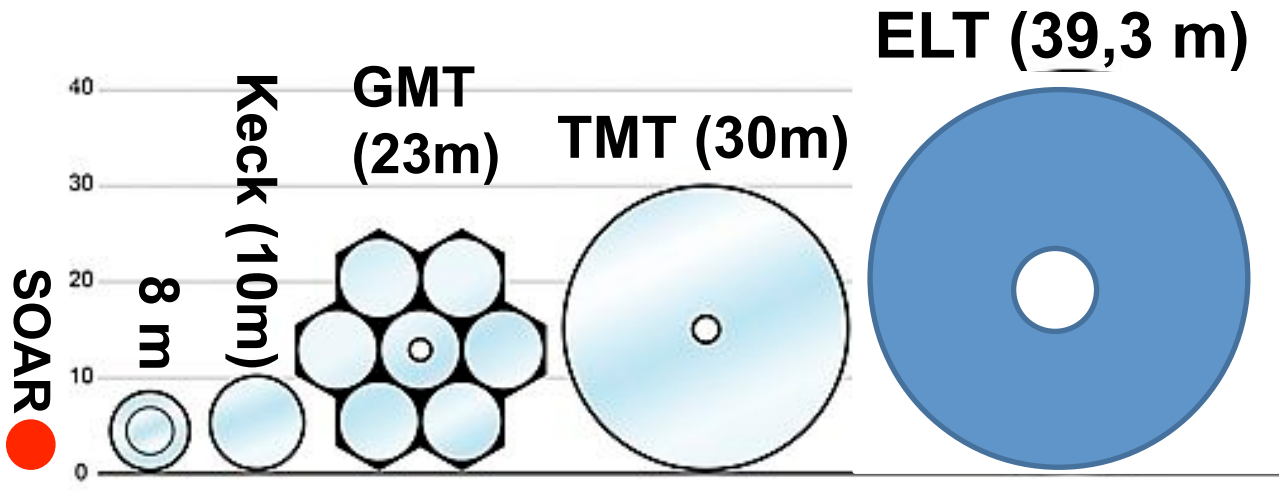
E-ELT and VLT vs Giza Pyramids



GMT = 5 Keck

TMT = 9 Keck

ELT = 15 Keck



Current status of the giant telescopes

http://www.skyandtelescope.com/skytel/beyondthepage/The-Megatelescopes-are-Coming-238455861.html

GMT. With more than half the funding in place, the Steward Observatory Mirror Lab has already cast three of the seven mirror segments that make up the GMT's primary mirror, and the team has finished polishing one of them. Meanwhile, the organization has already broken ground in Las Campanas, Chile, and in mid-2014 will begin work on the GMT facility.

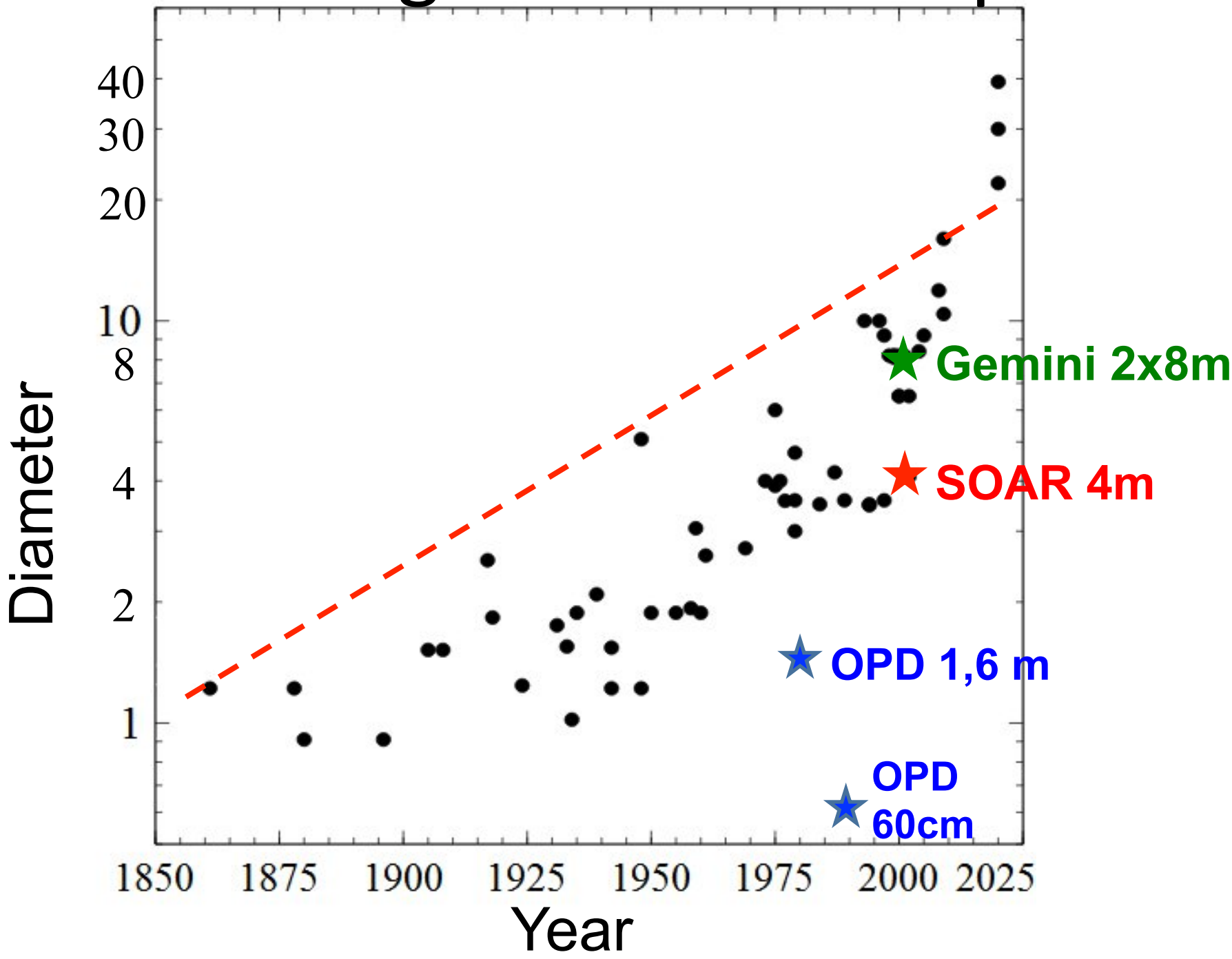
São Paulo parceiro do GMT? FAPESP US$40 milhões, decisão em Abril 2014?

The **TMT** has completed its design and development program and has secured about 80% of its funding. Construction will begin in April 2014, now that the facility has received approval after some contention regarding environmental and religious concerns.

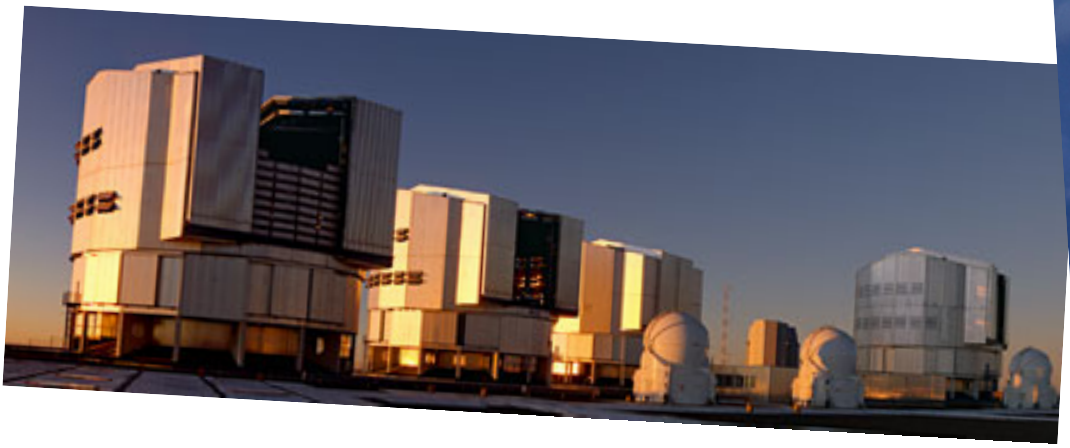
The E-ELT completed its design in 2010, passing the final design review in September of that year, but then revised the design the following year to reduce cost. In the process, the primary mirror was reduced in size from an initial planned 42 meters to the current 39.3 meters. So far, work has started on the challenging optical design of the adaptive mirror "M4," and construction of the road leading to the summit will begin in March 2014. The organization also expects to secure all funding by the end of 2014.

Brasil parceiro do ESO (ELT+ALMA+VLT+La Silla)? 270 milhões € em 10 anos

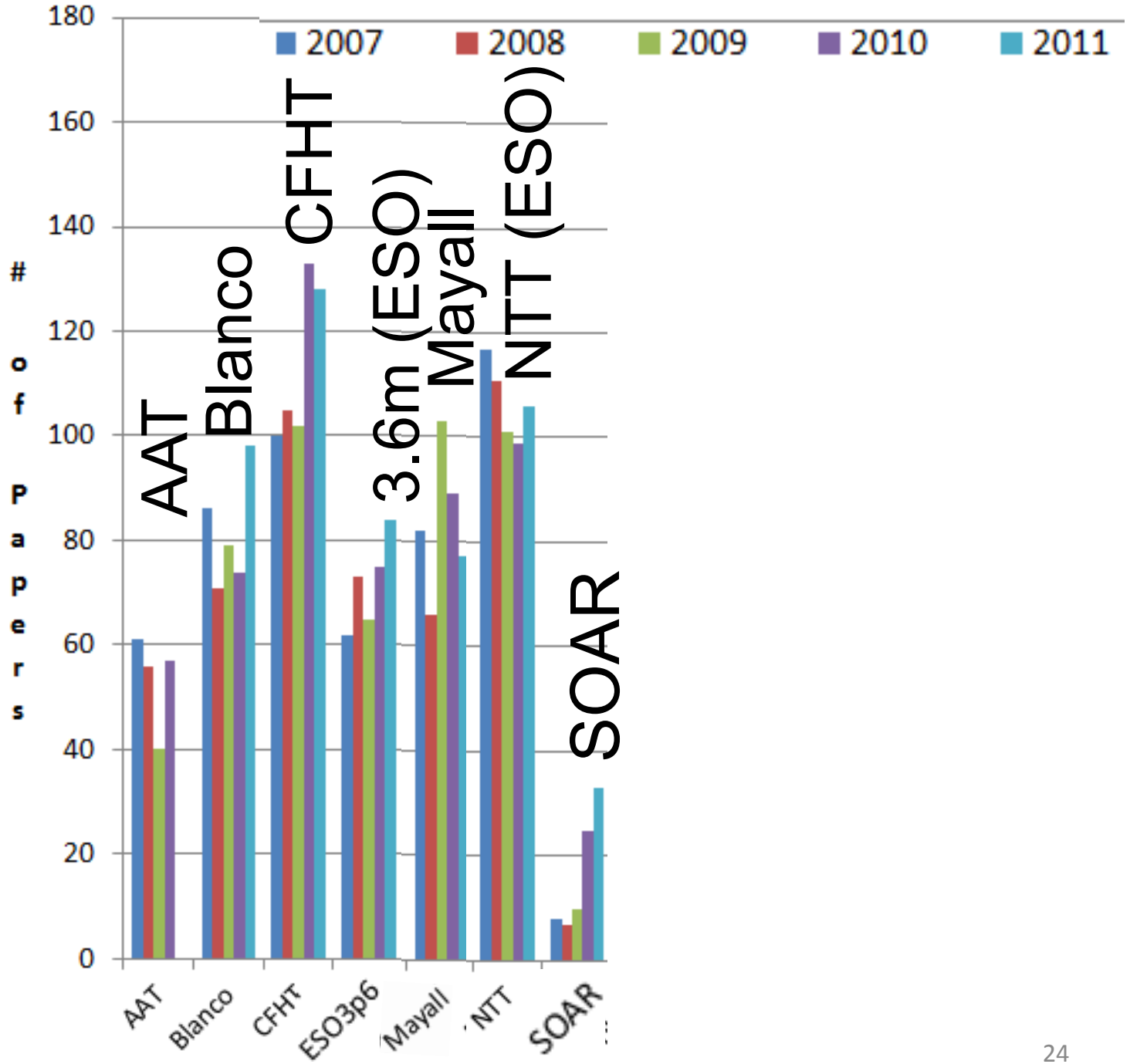
Brasil e os grandes telescópios



Como o SOAR e o Gemini se comparam com outros grandes telescópios?

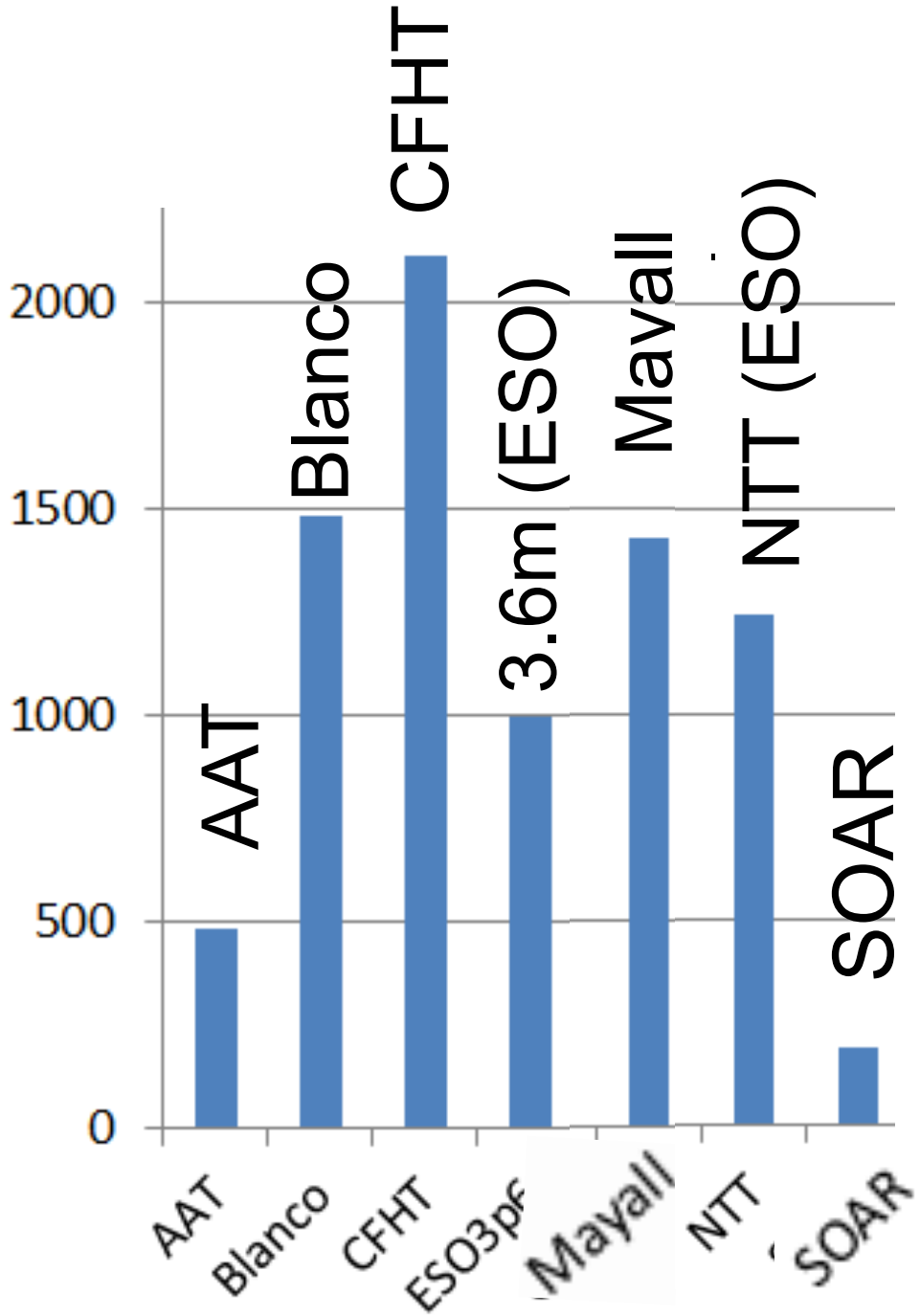


Produtividade 4m



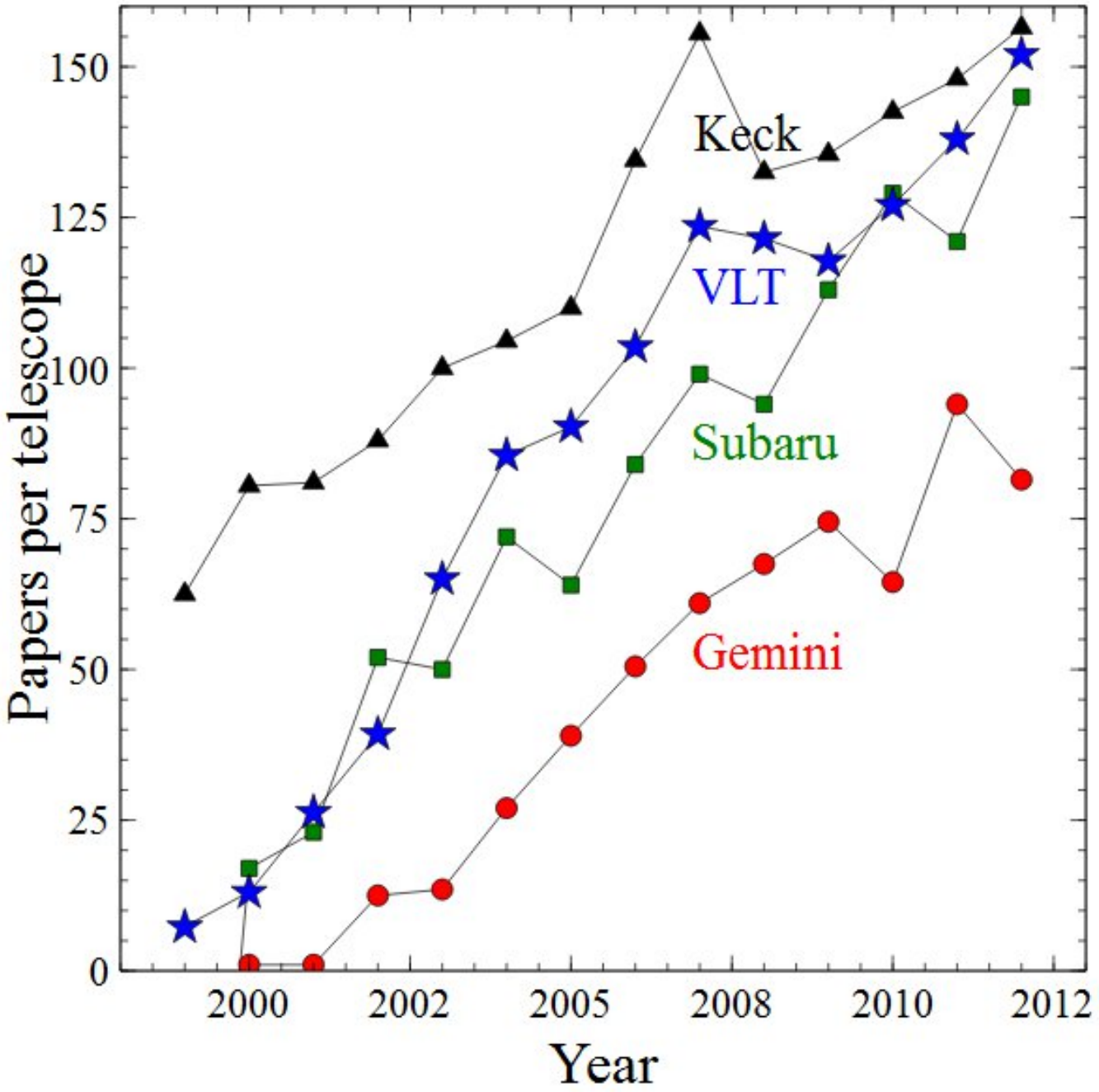
Crabtree 2013
Private communication

Impacto 4m



Crabtree 2013
Private communication

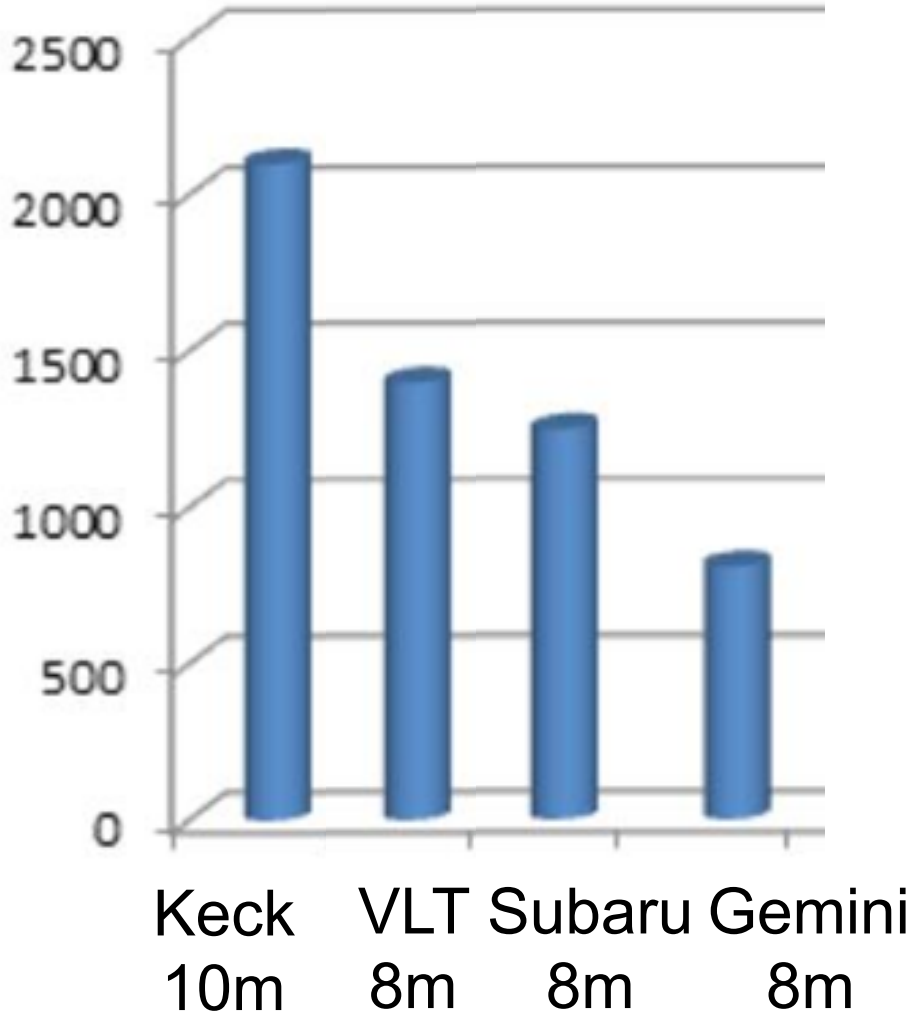
Artigos arbitrados por telescópio 8-10m



Using official number of papers given by each observatory

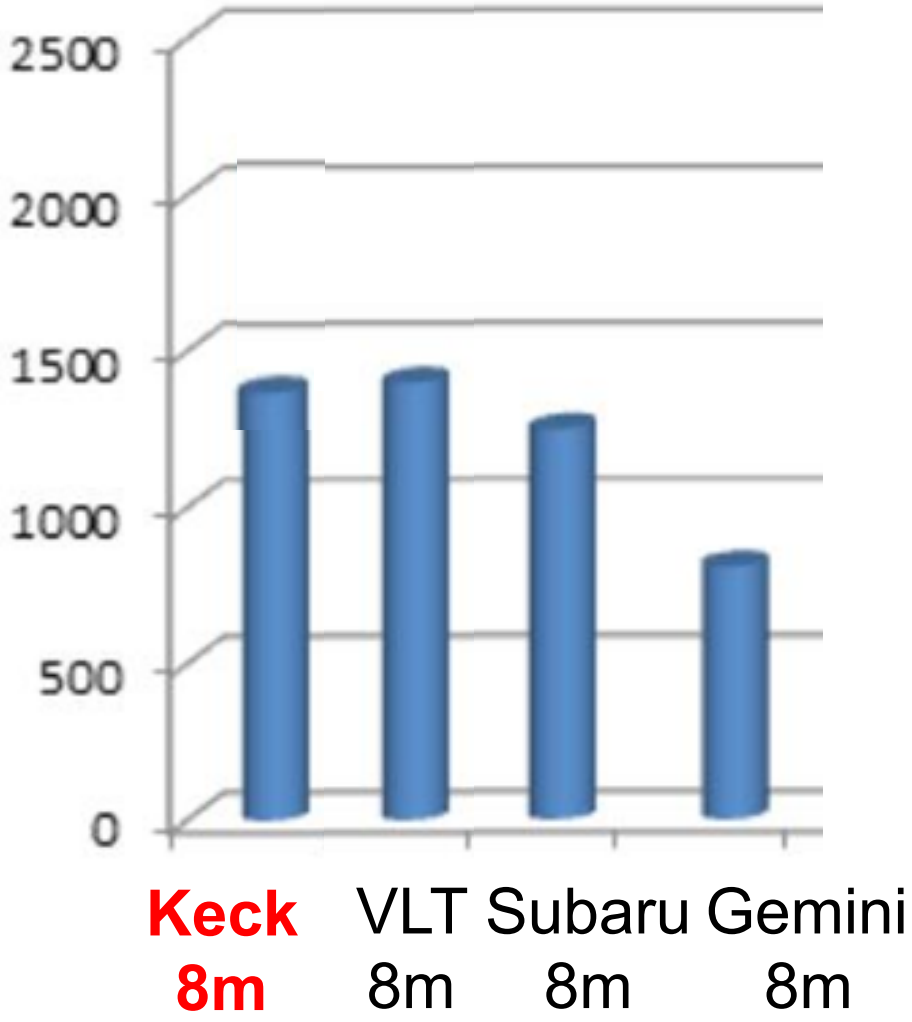
Total impact (citations) per telescope

adapted from Crabtree (2011)



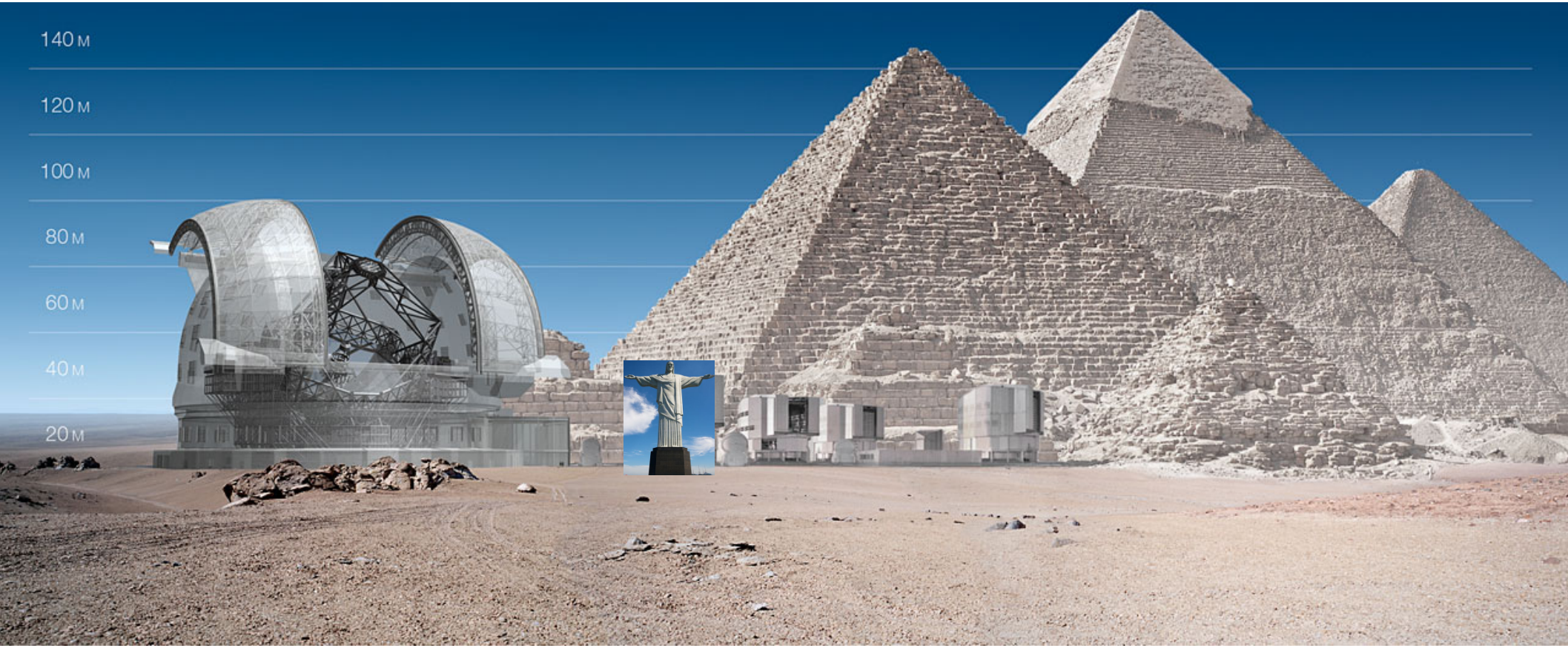
Total impact (citations) per telescope

normalizado a D = 8 metros



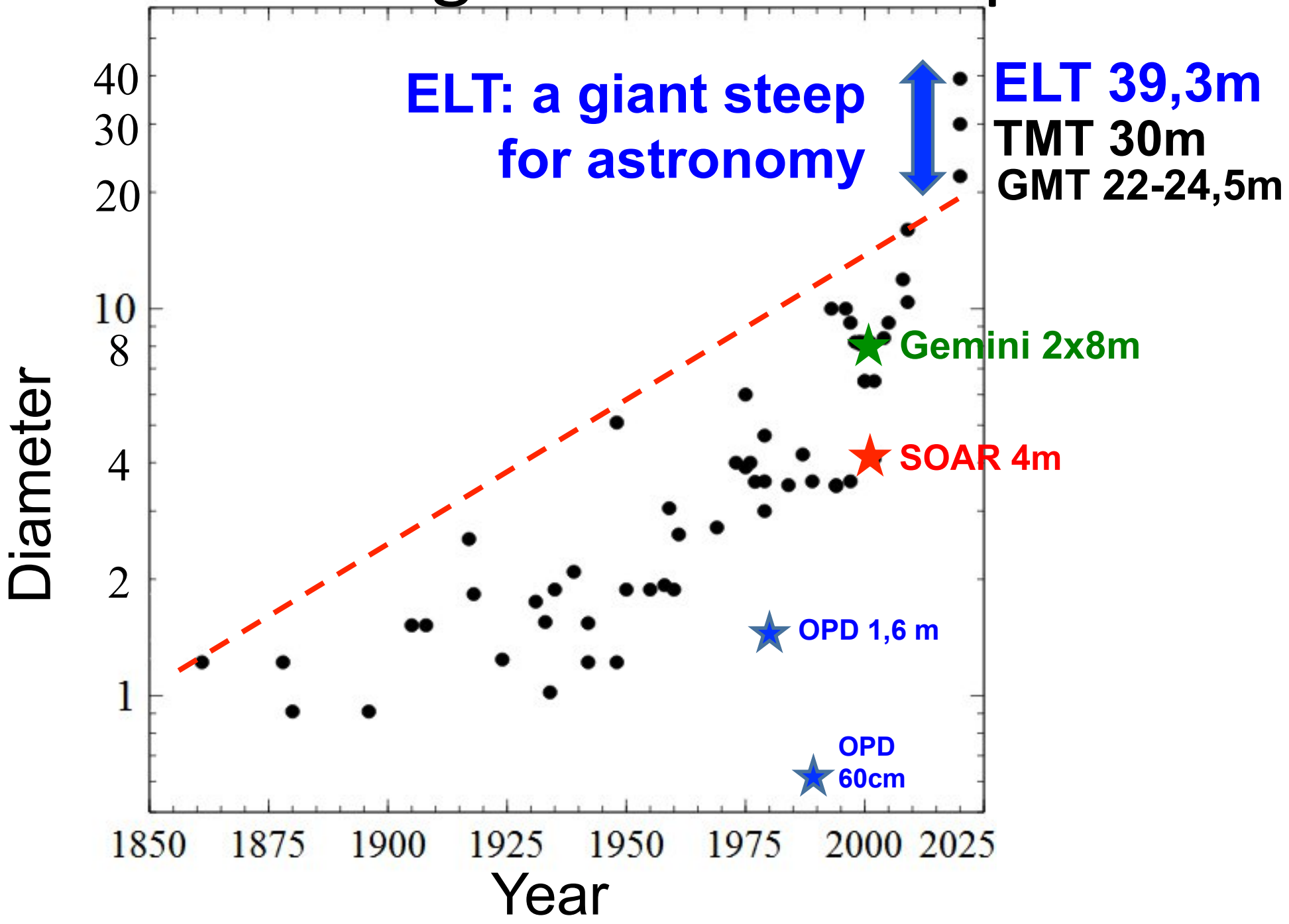
adapted from Crabtree (2011)

Learning from the past and looking to the future



Impacto dos grandes telescópios mais produtivos (Keck, VLT, Subaru) é proporcional à área

Brasil e os grandes telescópios



O extremely large telescope (ELT) poderá ter um impacto 3 veces maior ao GMT e quase 2 veces maior ao TMT

ELT
39,3m
= 3,2 GMT
= 1,7 TMT
Europa + Brasil?

TMT
30m
U.S.A.+India
+China+Japão

GMT
22m
(24.5m)
Universidades de
U.S.A.+Korea+ANU

Brasil e o ESO

Se concretizada a entrada ao ESO, teremos acesso a:

- 4 telescópios de 8m (VLT)

Instrumentação avanzada disponível nos 4 VLT

- Telescópios em La Silla, incluindo instrumentação de ponta como por exemplo o espectrógrafo mais sofisticado para procura de planetas (HARPS)
- Outros telescópios, como o VISTA, VST, alem do interferometro VLTI e arranjo ALMA (mm e submm)

ESO Instruments Summary Table

Instrument	Spectral Coverage	Observing Mode	Spectral Resolution	Multiplex	Note	Telescope
FORS2	optical 330 - 1100 nm	imaging (incl. configurable occulting bars), long slit and multi-object spectroscopy, spectropolarimetry, imaging polarimetry	260 - 2600	yes	Spectroscopy with ~7' long slit, ~20" multi-slit, and laser-cut slit masks; high time resolution modes (imaging and spectroscopy) in visitor mode only; RRM	VLT UT1
CRIRES	IR 1-5 µm	echelle, slit spectroscopy	100,000	no	AO	VLT UT1

ESO Instruments Summary Table

Instrument	Spectral Coverage	Observing Mode	Spectral Resolution	Multiplex	Note	Telescope
UVES	optical 300 - 1100 nm	echelle, image slicer, slit spectroscopy	up to 80,000 (blue arm) / 110,000 (red arm)	no	long slit capability in single order; iodine cell; RRM	VLT UT2
FLAMES	optical 370 - 950 nm	multi-fibre echelle,integral field spectroscopy	6000 - 47000	yes	135 Medusa fibres; 15 deployable IFUs, one large IFU; GIRAFFE: single echelle order; 8 fibres to UVES	VLT UT2
X-SHOOTER	UV-optical-NIR 300 - 2500 nm	echelle, slit and integral field spectroscopy	~5000-17000	no	full spectral coverage with one pointing; slit + IFU; RRM	VLT UT2

ESO Instruments Summary Table

Instrument	Spectral Coverage	Observing Mode	Spectral Resolution	Multiplex	Note	Telescope
VIMOS	optical 360 - 1000 nm	imaging, multi-object spectroscopy, integral field spectroscopy	200-2500	yes	IFU size on sky from 13"x13" to 54"x54"; multi-object spectroscopy (MOS) with 4 laser-cut slit masks; Imaging and MOS field of view 4 times 7'x8'.	VLT UT3
ISAAC	IR 1-5 µm	imaging, spectroscopy, polarimetry, fast photometry	~250-10000	no	2.5'x2.5' field of view (1-5µm), 73"x73" (3-5µm) subwindow readout capability; RRM Expected to be decommissioned in 2012.	VLT UT3
VISIR	mid-IR 5-13 µm, 17-24 µm	imaging, spectroscopy	150-30,000	no	field of view selectable: 19"x19" to 32" x 32" . After the upgrade the new FOV of VISIR will be selectable between 46" x 46" and 78"x 78".	VLT UT3

ESO Instruments Summary Table

Instrument	Spectral Coverage	Observing Mode	Spectral Resolut.	Multiplex	Note	Telescope
NACO	IR 1-4 µm	imaging, imaging polarimetry, spectroscopy, coronography (incl. 4 Quadrant Phase Mask, and Apodoizing Phase Plate), simultaneous differential imaging, sparse aperture masking (incl. w/ polarimetry), Angular Differential Imaging (Pupil Tracking)	<1500	no	AO with visible and IR wave front sensor; laser guide star; no AO and Cube Mode available Expected to be decommissioned in 2012.	VLT UT4
SINFONI	near-IR 1.1 - 2.45 µm	integral field spectroscopy	1500-4000	no	AO with natural and laser guide star; RRM	VLT UT4
HAWK-I	near-IR 1-2.2 µm	imaging, fast photometry	-	-	field: 7.5'x7.5', subwindow readout capability; RRM	VLT UT4

ESO Instruments Summary Table

Instrument	Spectral Coverage	Observing Mode	Spectral Resolut.	Multiplex	Note	Telescope
MIDI	mid-IR 8-13 µm	spectro - interferom etry	R=30 (prism) or R=230 (grism); spatial resolution up to 15 mas at 10µm	no	2 beam combiner - measures visibility	VLTI - ATs VLTI - UTs
AMBER	near-IR 1.5 - 2.5 µm	spectro - interferom etry	R~30, 1500 or 12000	no	3 beam combiner - measures also closure phase; spatial resolution up to 3 mas at 2 µm	VLTI - ATs VLTI - UTs
MIDI	mid-IR 8-13 µm	spectro - interferom etry	R=30 (prism) or R=230 (grism); spatial resolution up to 15 mas at 10µm	no	2 beam combiner - measures visibility	VLTI - ATs VLTI - UTs

ESO Instruments Summary Table

Instrument	Spectral Coverage	Observing Mode	Spectral Resolution	Multiplex	Note	Telescope
HARPS	optical 378-691 nm	echelle, polarimetry	120,000	no	2 fibres, high accuracy	3.6m
EFOSC-2	optical 350 - 1100nm	imaging, spectroscopy, polarimetry, coronography	~1000	no	imaging and spectroscopic polarimetry	NTT
SOFI	near-IR 1-2.5 µm	imaging, spectroscopy	600-2200	no	-	NTT
FEROS	optical 350 - 920nm	echelle spectroscopy	~48,000	no	-	MPG/ESO 2.2m
WFI	optical 350 - 1000 nm	imaging	-	-	30x30 arcmin sq. field	MPG/ESO 2.2m

ESO Instruments Summary Table

Instrument	Spectral Coverage	Observing Mode	Spectral Resolution	Multiplex	Note	Telescope
SHFI	211-370 GHz, 385-500 GHz and 1.25-1.39 THz	heterodyne receiver	-		-	APEX
LABOCA	870 µm	bolometer array	-		295 channels	APEX
SABOCA	350 µm	bolometer array	-		37 channels	APEX
FLASH	280-370 GHz	heterodyne receiver			single pixel sideband separating receiver	APEX

APEX is a 12-metre diameter telescope, operating at millimetre and submillimetre wavelengths, at an elevation of 5100 metres, high on the Chajnantor plateau

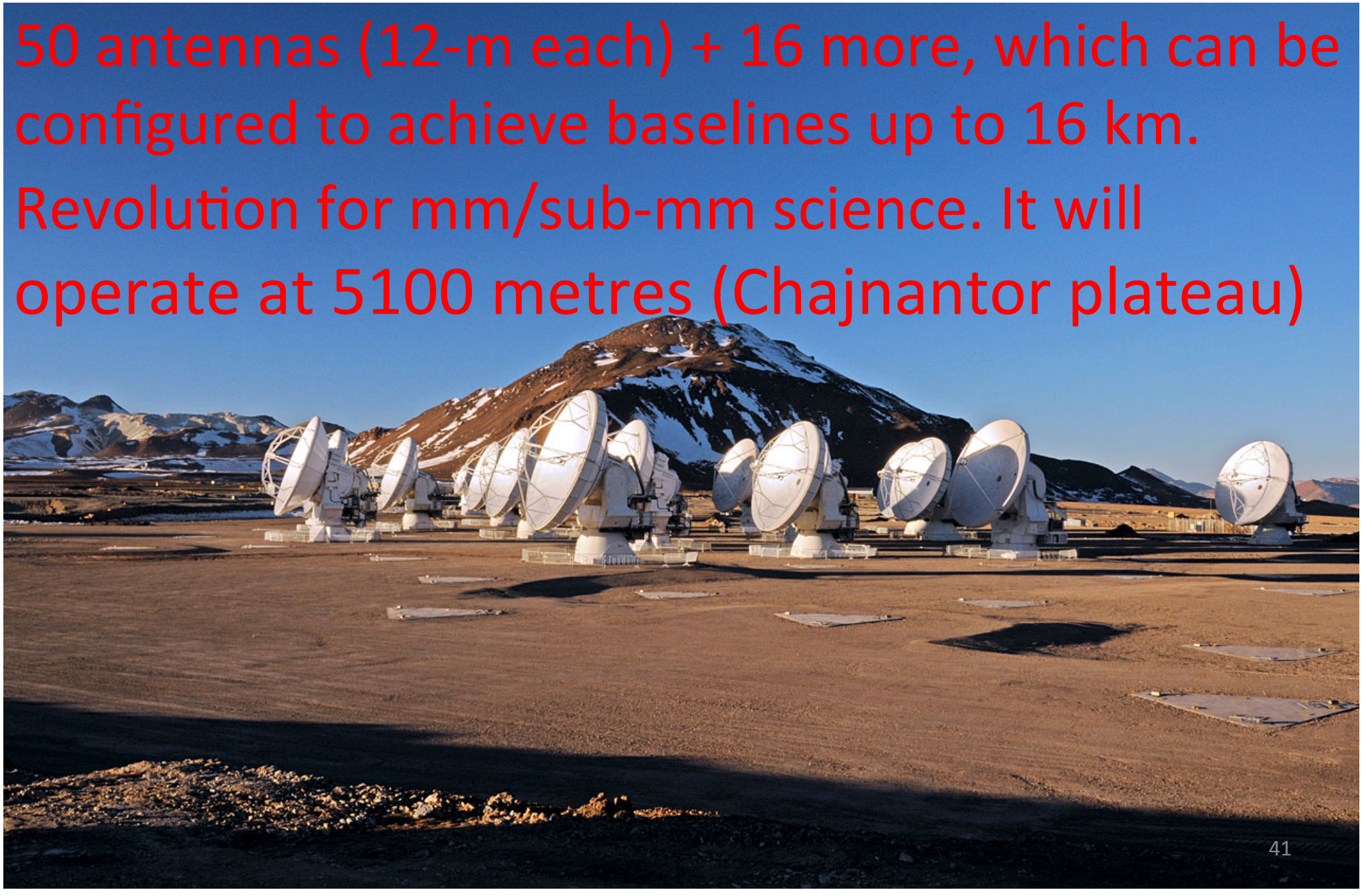
ESO Instruments Summary Table

Survey telescopes

Instrument	Spectral Coverage	Observing Mode	Spectral Resolution	Multiplex	Note	Telescope
VIRCAM	near-IR 0.8-2.2 µm	imaging	-	-	1.5 degree x 1 degree field of view with 0.34" average pixel size	VISTA
OmegaCAM	optical 0.35-0.91 µm	imaging	-	-	1 degree x 1 degree unvignetted field of view with 0.21" pixel size	VST

ESO Instruments Summary Table

ALMA will be comprised of a giant array of 50 antennas (12-m each) + 16 more, which can be configured to achieve baselines up to 16 km. Revolution for mm/sub-mm science. It will operate at 5100 metres (Chajnantor plateau)



SKY & TELESCOPE

Alma Observatory Inaugurated

The future is now — the world's most powerful radio telescope array was inaugurated yesterday.

The Atacama Large Millimeter/submillimeter Array (ALMA) has already been astounding the astronomical world since it first came online in 2011, returning the sharpest views ever of the cold universe. But now it's official: the former construction site is now a full-fledged observatory.

The ALMA observatory perches on the Cha towers at an altitude of 16,600 feet in the C This image shows half of the 66 dishes tha world's most powerful radio observatory.

ALMA (ESO / NAOJ / NRAO), C. Padilla

Yesterday afternoon's ceremony in the Chilean Andes inaugurated ALMA with 50 operational antennas. By the end of 2013, 66 dishes will dot the plateau, placed by two 130-ton transporters fondly named Otto and Lore.

The Chilean president Sebastián Piñera, ALMA staff, and a global assortment of scientists attended the ceremony yesterday, which took place at the observatory's Operations Support Facility at a still-breathable altitude of 9,500 feet (2,900 meters). The observatory's dishes are arrayed atop the Chajnantor Plateau at 16,600 feet (5,050 meters).

Posted by Monica Young, March 13, 2013

CiênciaHoje®

Quinta-feira, 14 de Março de 2013

Jornal de Ciência, Tecnologia e Empreendedorismo

Diretor: Jorge Massada

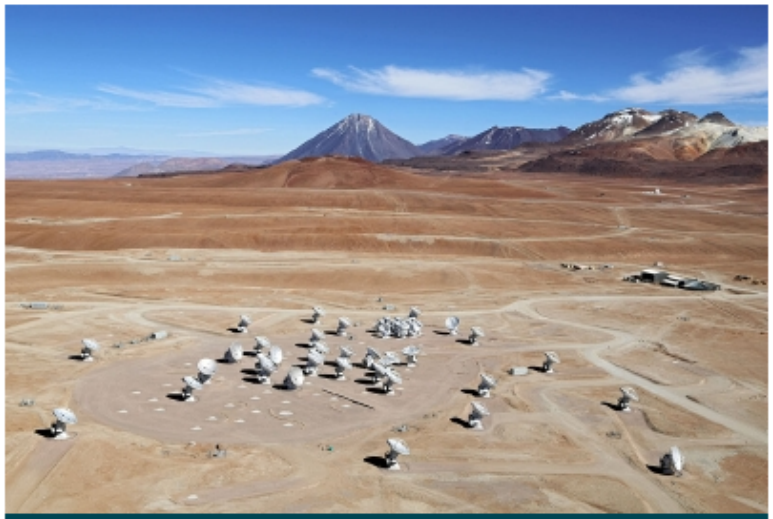
Subdiretores: Raquel Soares e Tiago Fleming Outeiro

Home | Ciências | Revista | Dossiers | Colunistas | Encartes | Utilidades

Inauguração do ALMA anuncia nova era de descobertas

Telescópio revolucionário dá uma nova visão do Cosmos

2013-03-13



Vista aérea sobre a rede ALMA (Imagem: Clem & Adri Bacri-Normier/ESO)

Hoje, num local remoto dos Andes chilenos, o Atacama Large Millimeter/submillimeter Array (ALMA) foi inaugurado durante uma cerimónia oficial. O evento marca o final da construção da maior parte dos principais sistemas do telescópio gigante e a transição formal de projecto em fase de construção a observatório completamente operacional. O ALMA é uma parceria entre a Europa, a América do Norte e o Leste Asiático, em cooperação com a República do Chile.

***"O espectacular céu nocturno do Chile é um dos nossos imensos recursos naturais. Penso que a ciência tem contribuído de forma vital para o desenvolvimento do Chile nos últimos anos. Estou muito orgulhoso das nossas colaborações internacionais em astronomia, das quais o ALMA é o mais recente e maior resultado"**, referiu o Presidente do Chile, Sebastián Piñera, aquando da inauguração.*

ESTADÃO.COM.BR

Receita para o Brasil ganhar seu primeiro Nobel: “paciência e planejamento estratégico”

Entrevista com o astrônomo Brian Schmidt, de 45 anos, pesquisador da Universidade Nacional da Austrália e co-ganhador do Prêmio Nobel de Física de 2011, por descobrir que o universo está se expandindo de forma acelerada (em vez de estar em desaceleração, como se imaginava até então). Publicada na edição de hoje do Estadão, com algumas informações adicionais

No caso específico da astronomia, o senhor acha que o Brasil precisa virar sócio do ESO para ser competitivo?
Absolutamente. Para ter impacto na astronomia, assim como em outras áreas da ciência, é preciso ter bons pesquisadores. E esses pesquisadores precisam ter acesso à melhor infraestrutura de pesquisa possível.

Na Austrália, onde já se faz astronomia desde a década de 1940, nossa prioridade número um é entrar para o ESO, justamente por isso. Porque para ser competitivo na astronomia você precisa ter acesso a uma grande variedade de instrumentos, para uma grande variedade de aplicações.

http://blogs.estadao.com.br/herton-escobar/receita-para-o-brasil-ganhar-seu-primeiro-nobel-paciencia-e-planejamento-estrategico/

Caltech Nobel Prizes

- 31 recipients, 32 Nobel prizes
- Very small institution <<< USP
- 294 professorial faculty (900 total?)
- 978 undergrad, 1253 grad
- *ASTRONOMY: 26 faculty + 5 emeritus*
- Operates the Palomar observatory (5m telescope, the largest in the world for several decades)
- Keck observatory, largest telescopes (2 x 10m)
- Access to few months/year at 2 x 10m telescopes
- Orçamento equivalente a 4 bilhões de reais

USP : ZERO Nobel prizes
Brazil: ZERO Nobel prizes

- Huge institution
- 5 732 faculty
- 56 998 undergrad, 25 591 graduate
- Largest astronomy department in Brazil
- *ASTRONOMY: 33 faculty + 2 retired with contract*
- Operates the Valinhos observatory (~ 30 cm)
- Access to a few nights/year with Gemini (8m) – in competition with all Brazilian community
- *Orçamento de 5 bilhões de reais*