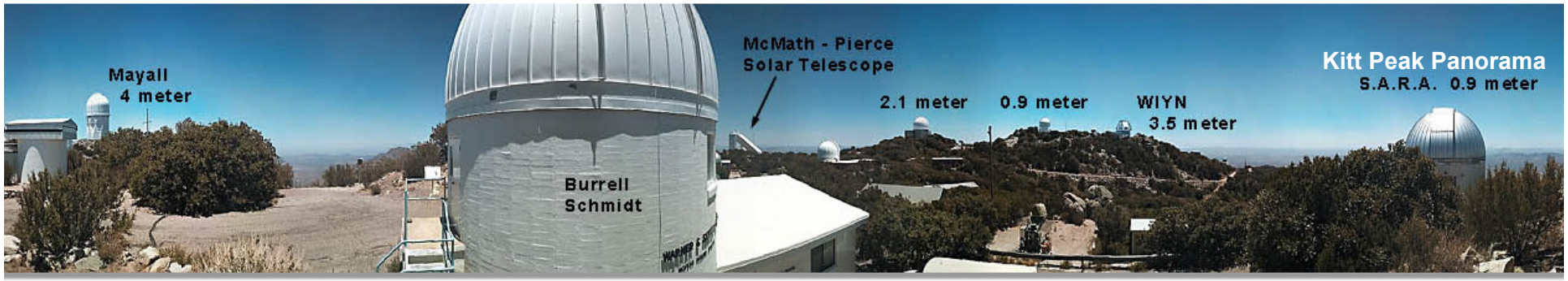
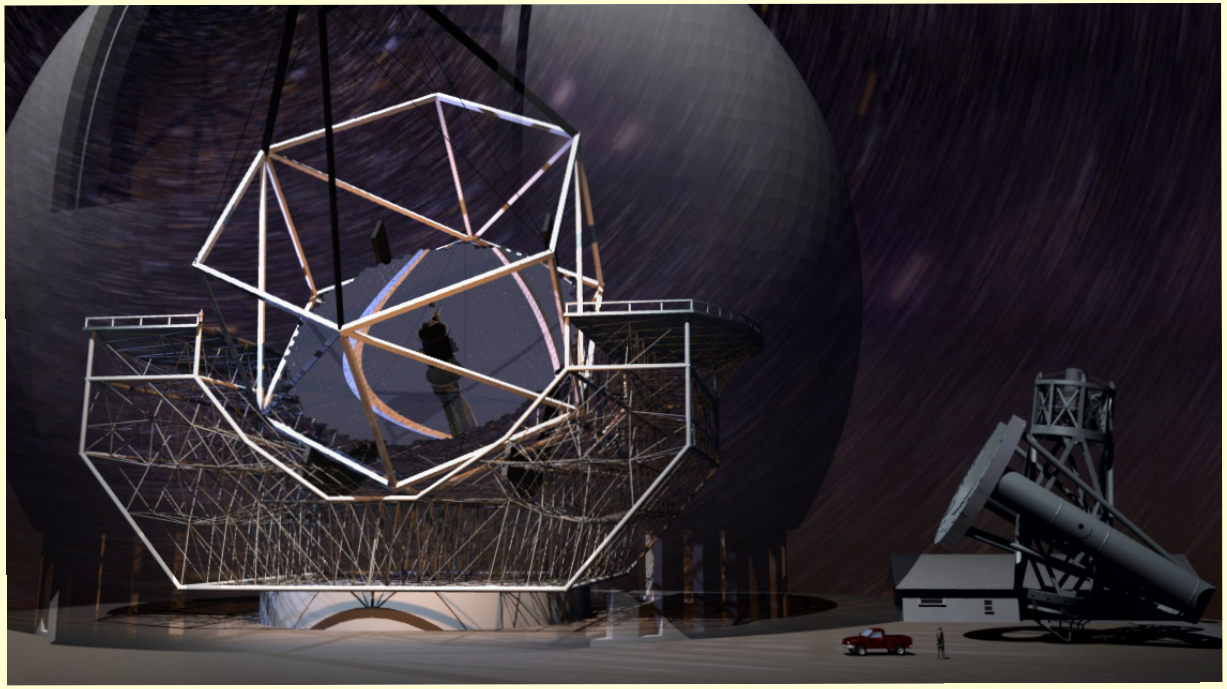
The Future of "Small" Telescopes

H.A. McAlister
March 11, 2011
Cosmic Trails #2 on Board the Nieuw Amsterdam



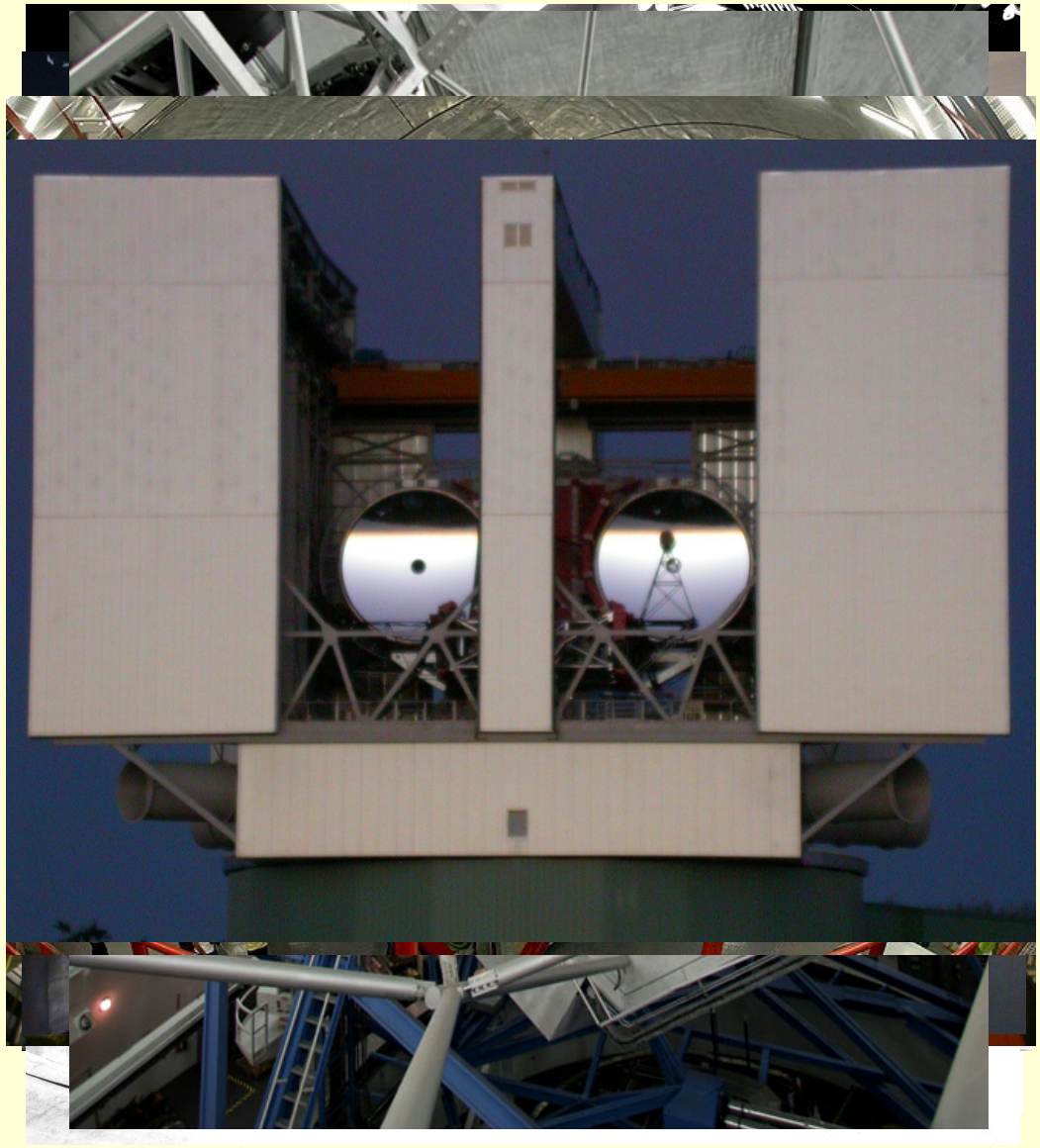
First, Let's Consider Large Telescopes

- **Light Gathering Power goes as the *area* of the light collecting mirror thus LGP is proportional to *aperture*^{2}**
  - **The 200-inch Hale telescope has a million times the LGP of the human eye.**



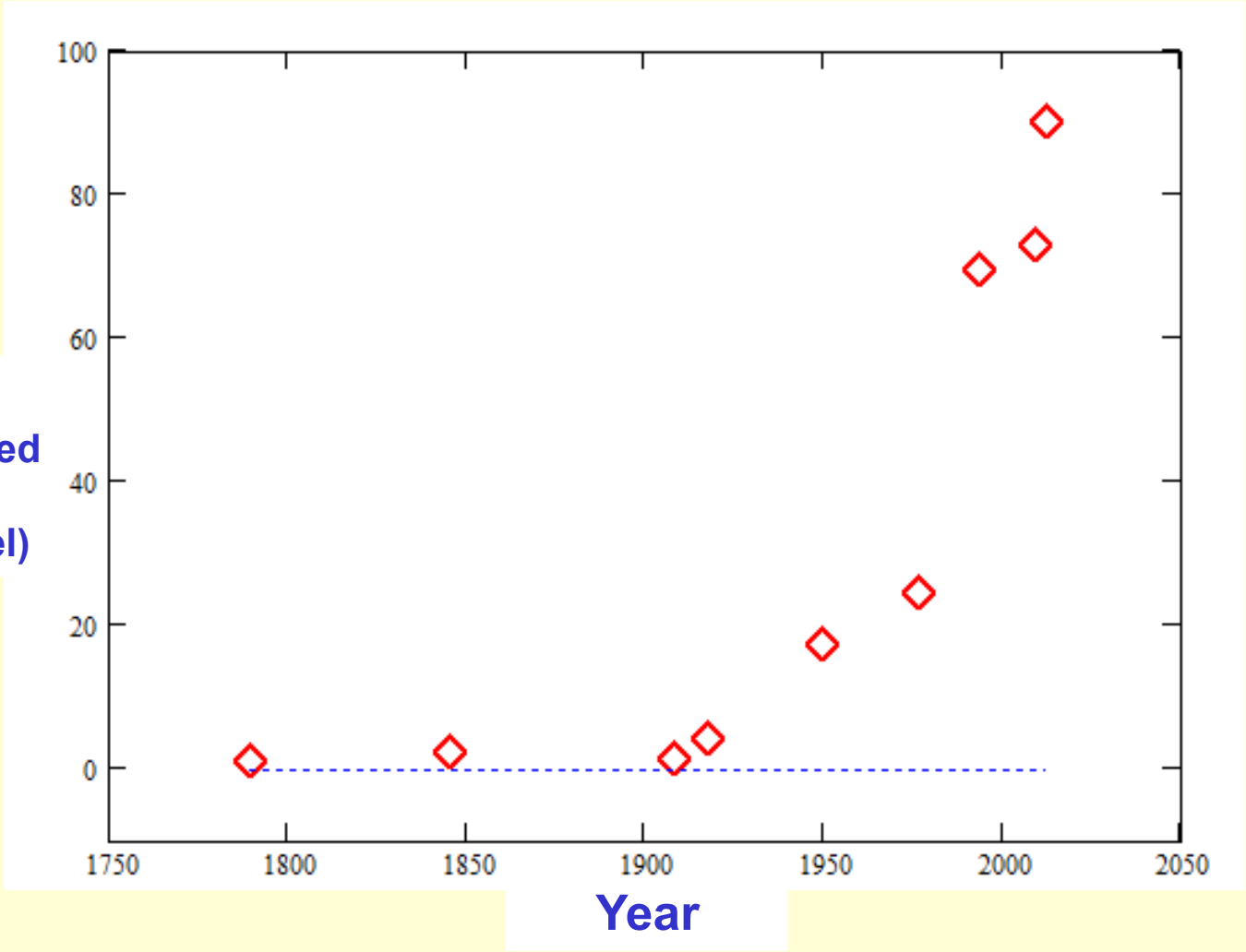
The proposed "Thirty Meter Telescope" will have 36 times the LGP of the Hale Telescope

World's Largest Telescopes Over the Years

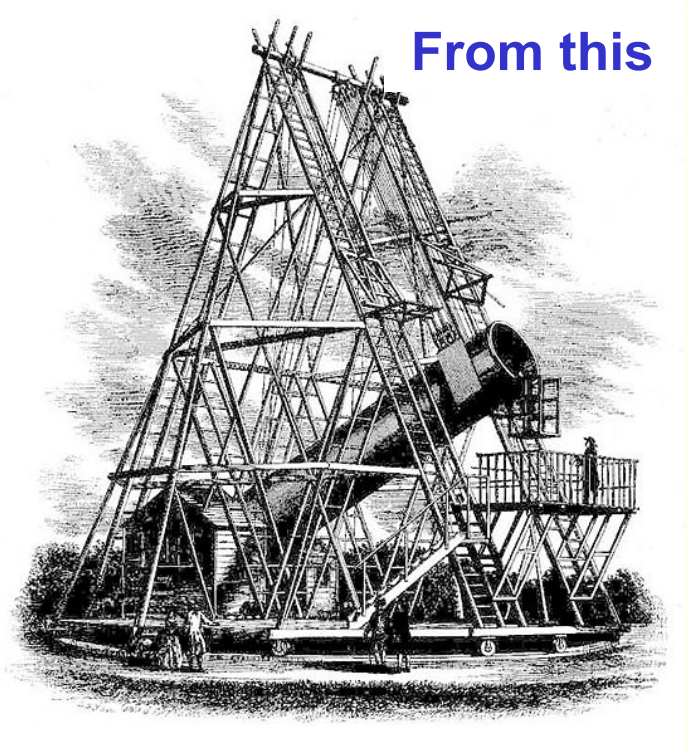


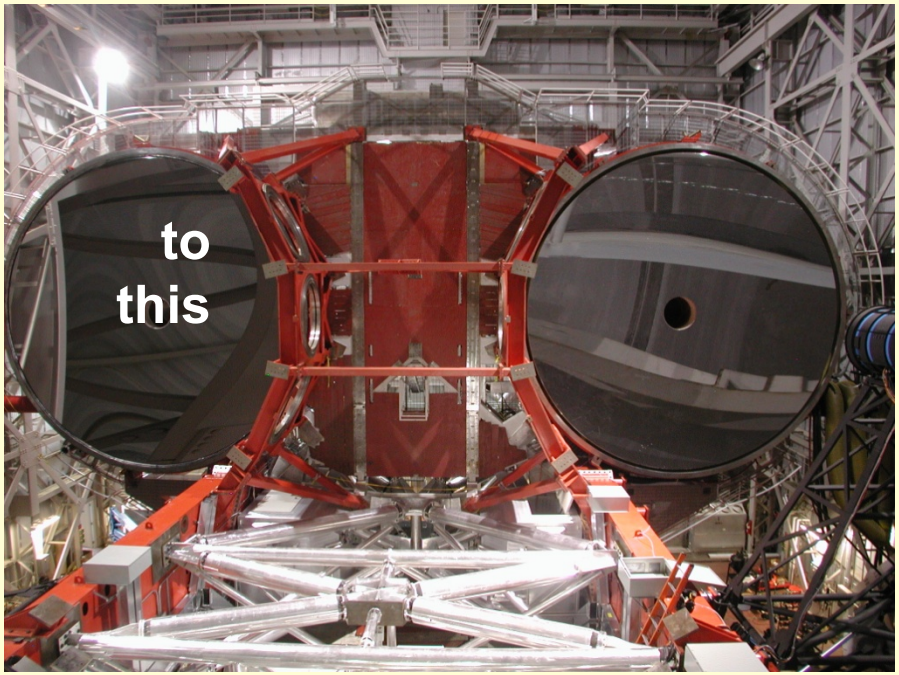
Large Binocular Telescope
456-inch:
initial operations underway; worlds largest until ?.

Light Gathering Power Over the Years



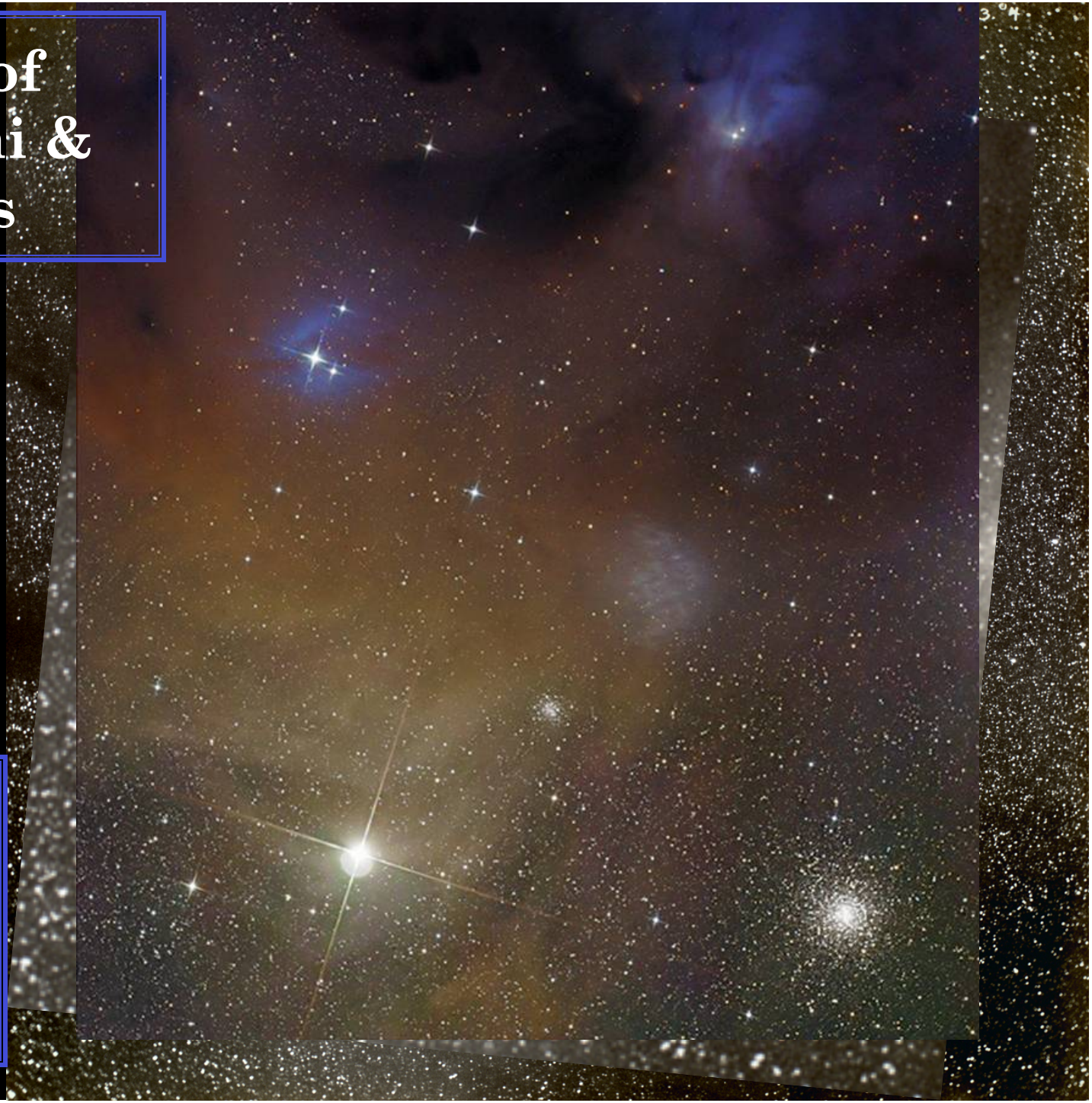
220 Years of Telescopic Progress





What's Coming Next?

Region of ρ Ophiuchi & Antares



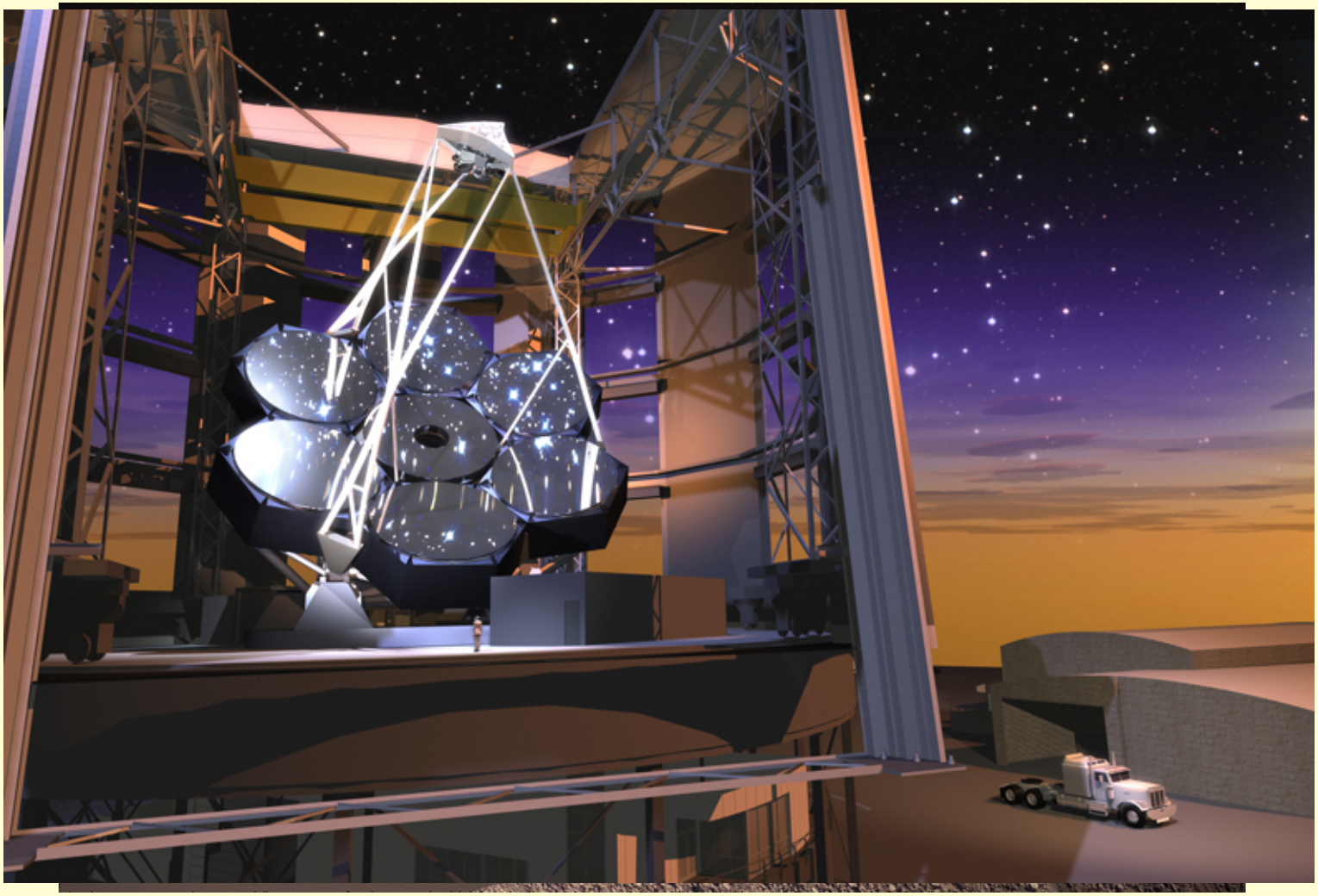
From David Jurasevich
starimager.com

From Barnard's *Atlas of the Milky Way*

2006 with 4.1-in Takahashi refractor from Mojave Desert

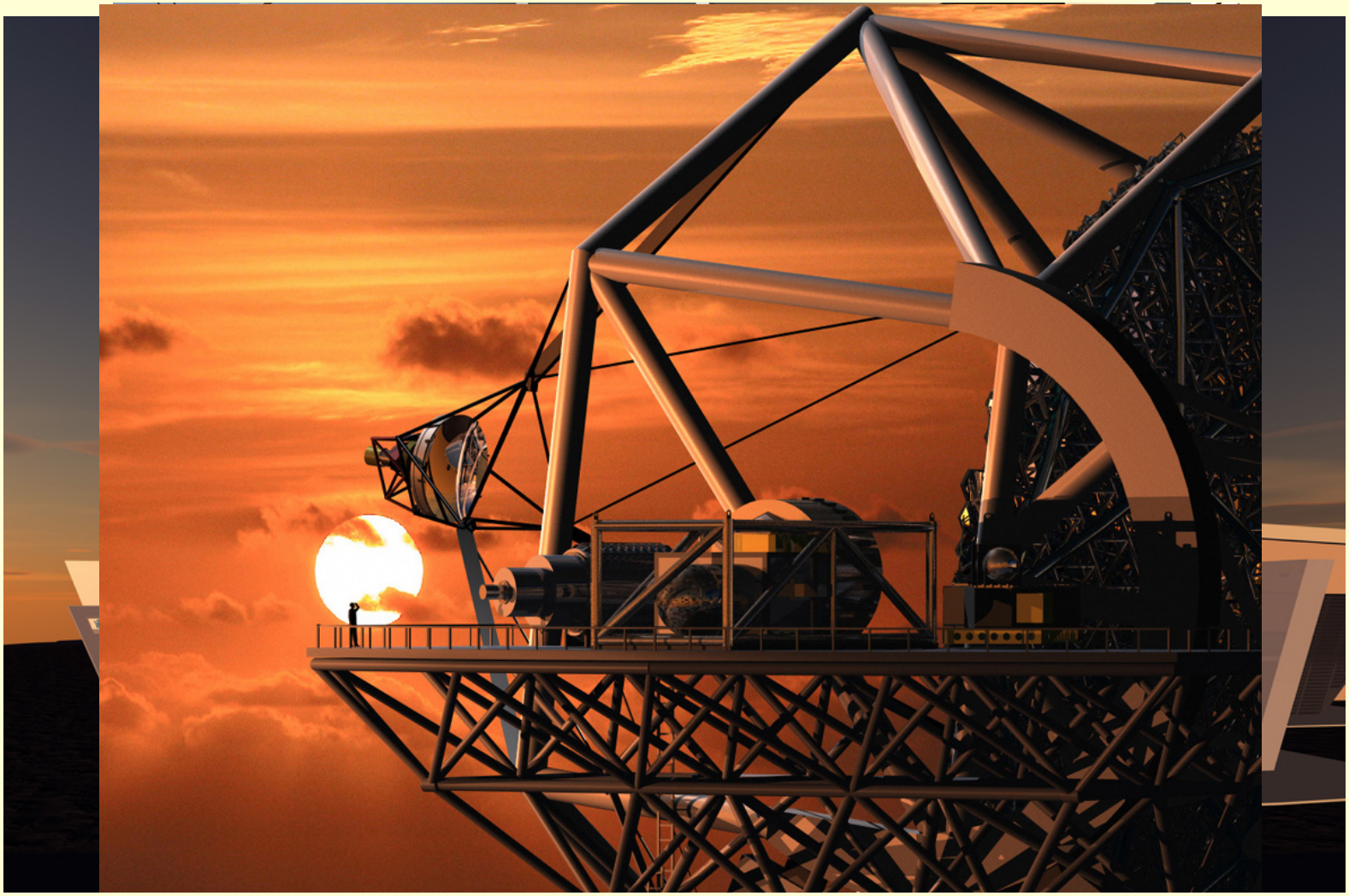
1905 with 10-in Bruce Telescope from Mount Wilson

One Behemoth After Another!



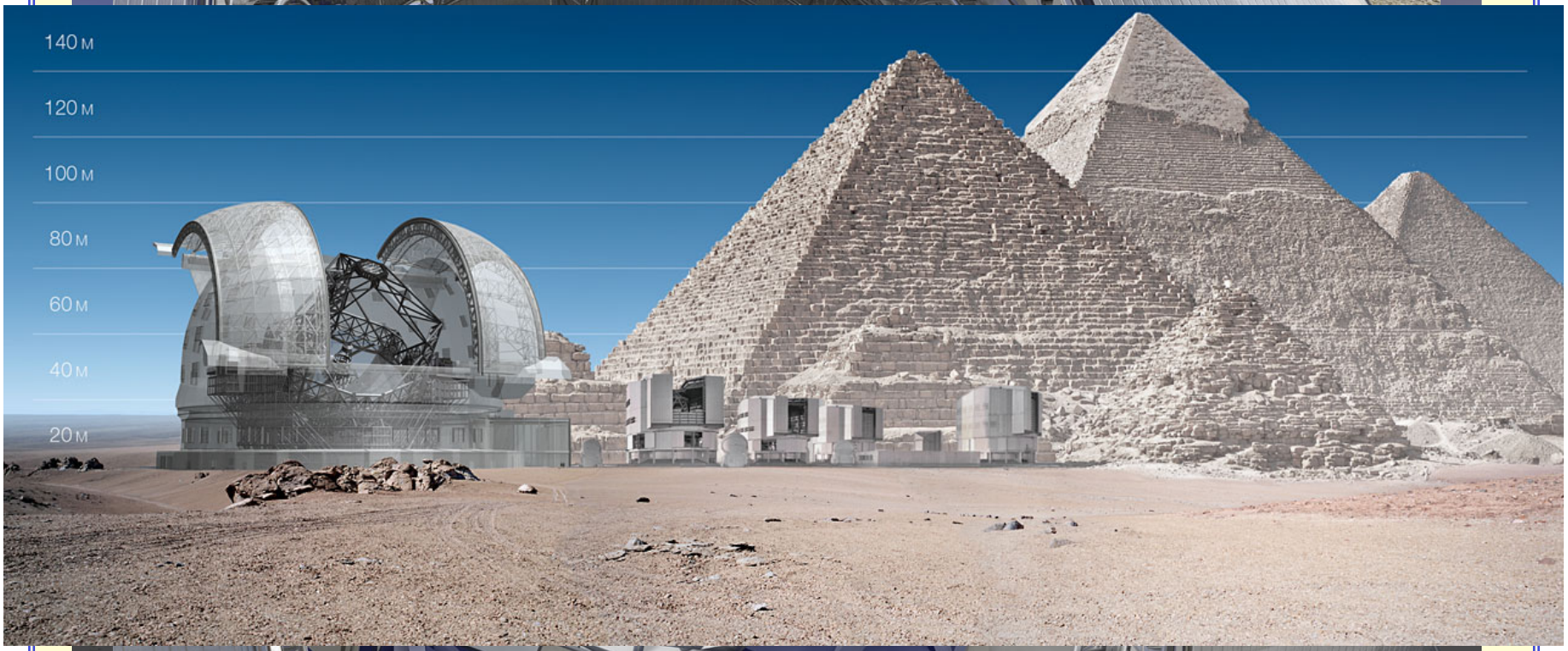
The Giant Magellan Telescope (854-inch) in 2018

One Behemoth After Another!



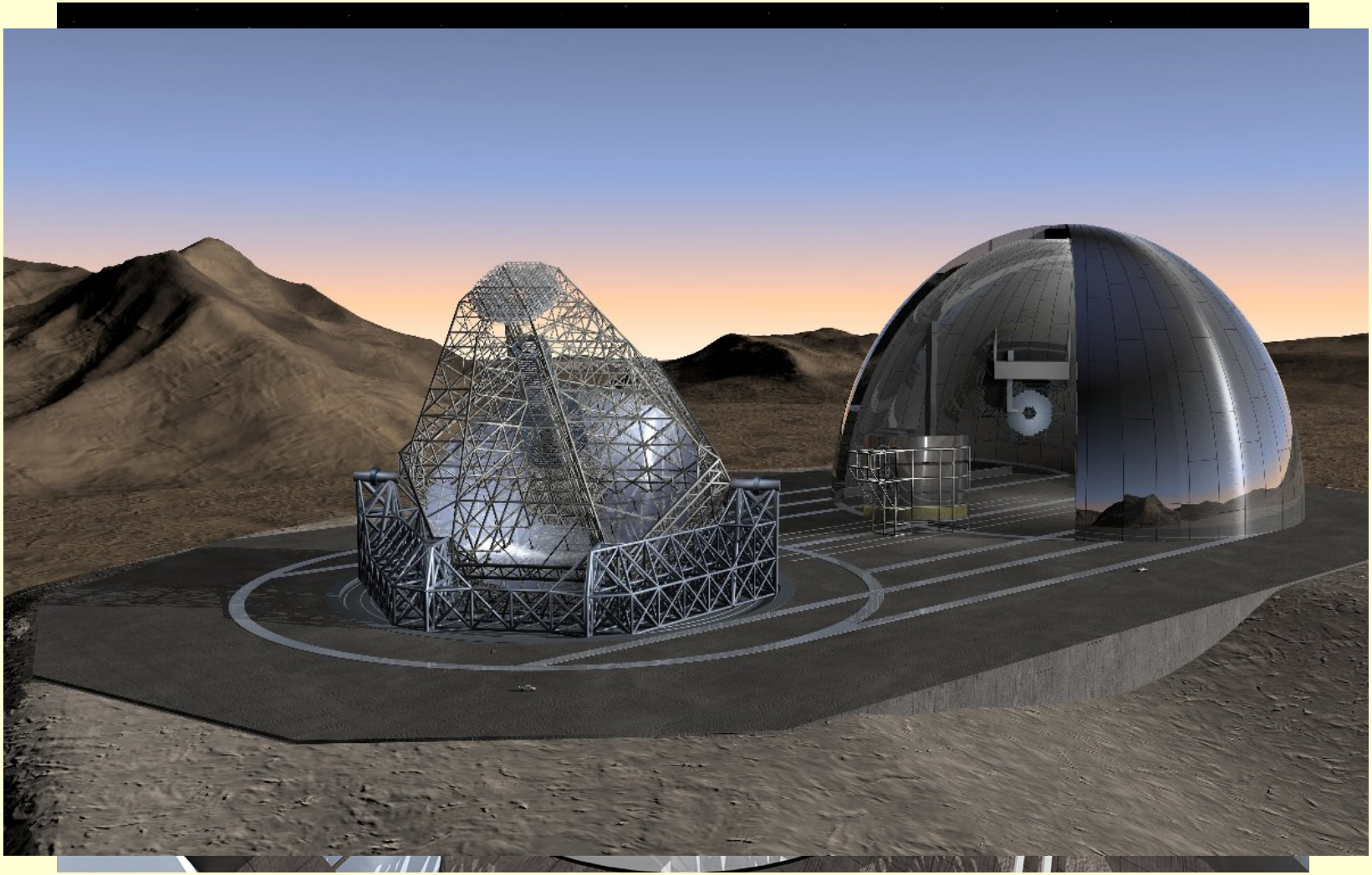
The Thirty Meter Telescope (1130-inch) – after 2020

One Behemoth After Another!



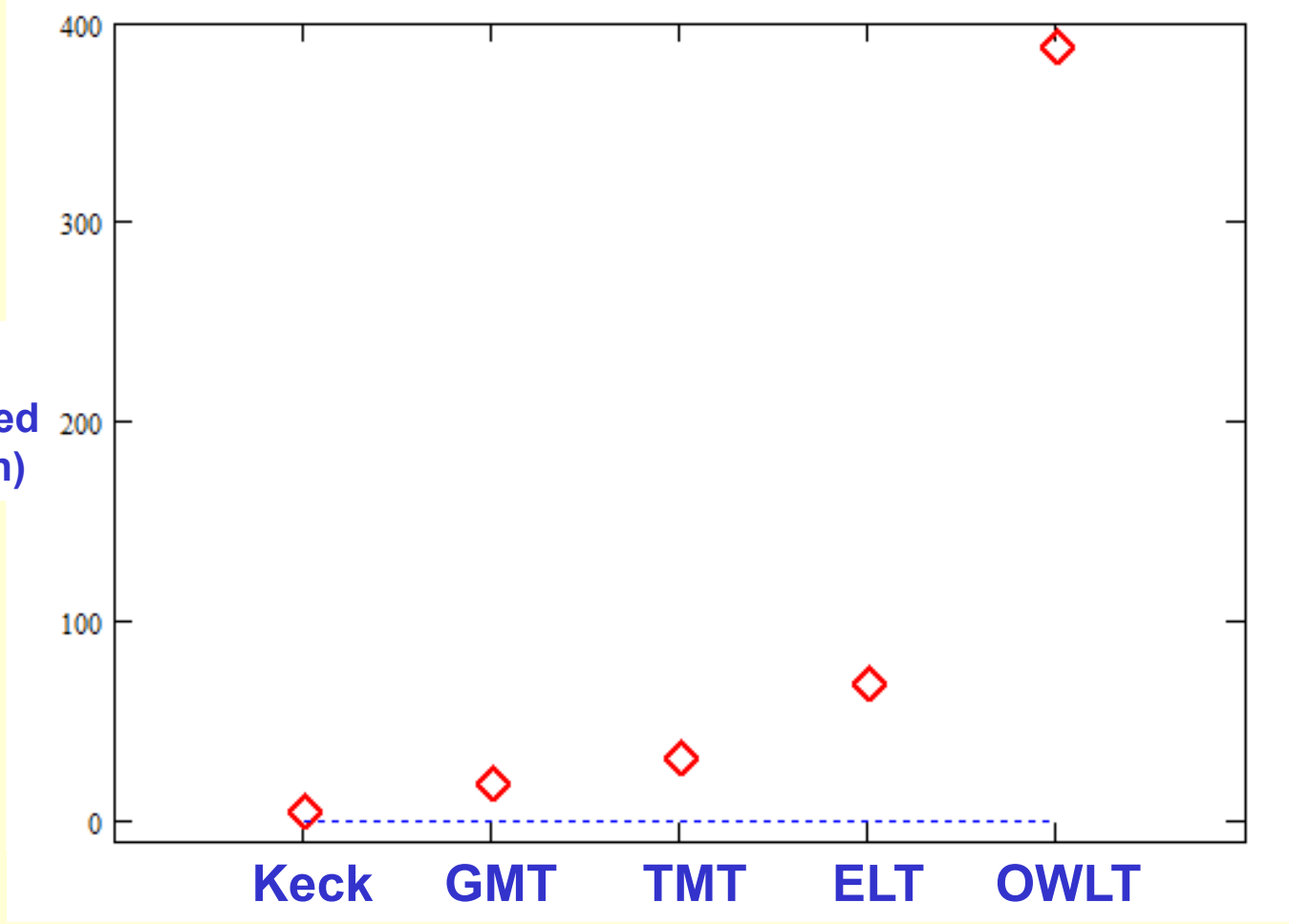
The ESO Extremely Large Telescope (1650-inch) – after 2020

One Behemoth After Another!

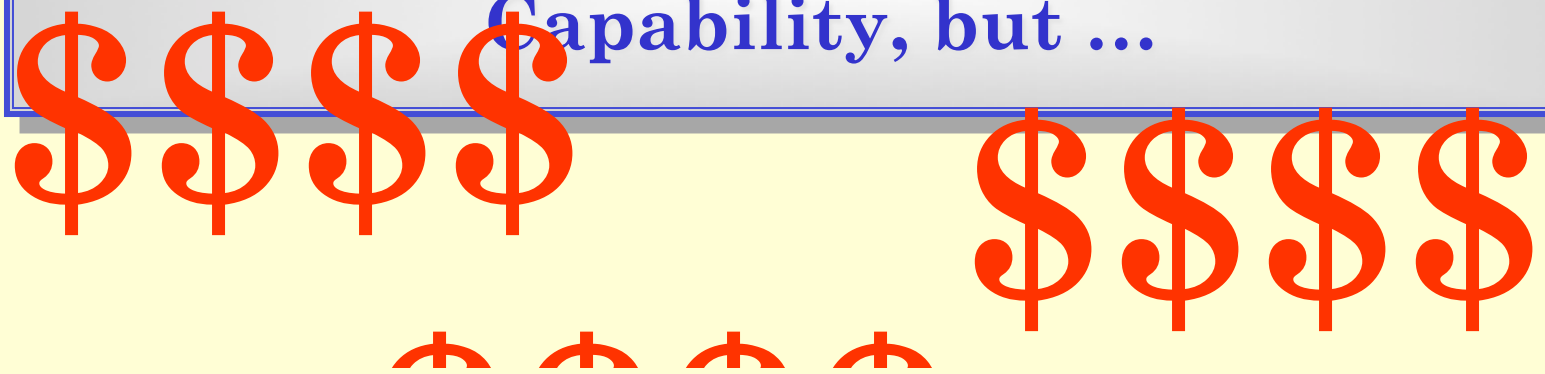


The Overwhelmingly Large Telescope (3940-inch) – ??

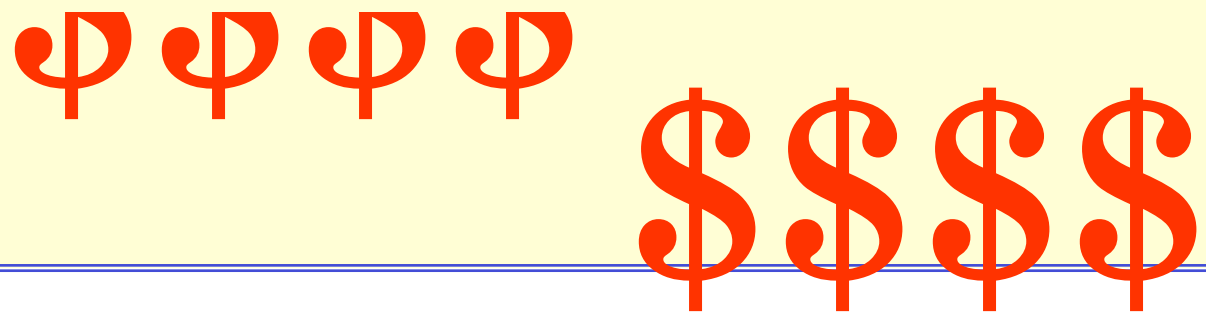
Light Gathering Power in the Future



This is an Astonishing Gain in Capability, but …



And who decides?



The "Decadal Reviews in Astronomy & Astrophysics" – That's Who Decides in the U.S

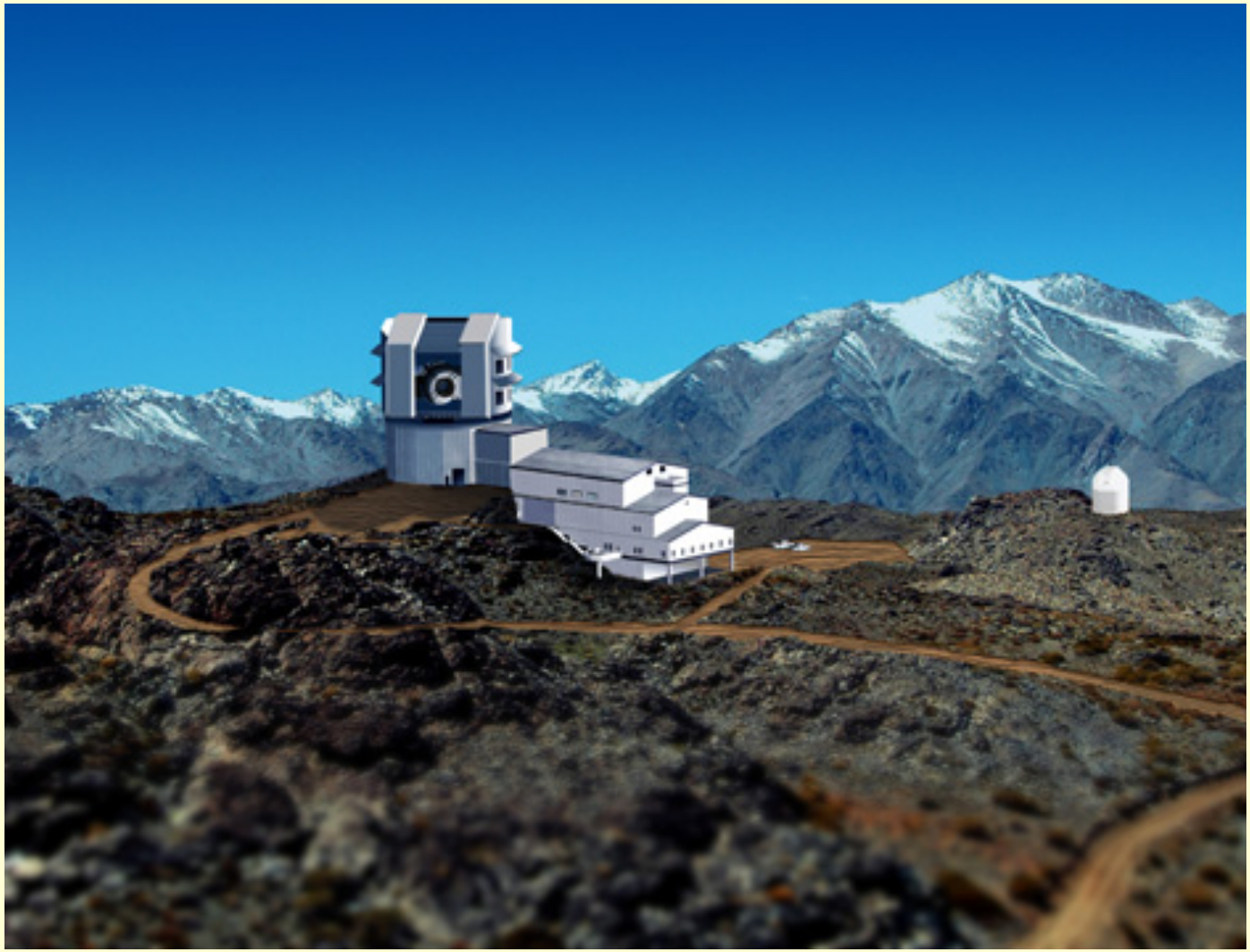
- These reviews are carried out by the NRC every ten years with reports published in
  - 1964 – The Whitford Report
  - 1972 – The Greenstein Report
  - 1982 – The Field Report
  - 1991 – The Bahcall Report
  - 2001 – The McKee/Taylor Report
  - 2010 – Astro2010 (The Blandford Report)
- Provide funding guidance to:
  - National Science Foundation (NSF)
  - National Aeronautics and Space Administration (NASA)
  - Department of Energy (DOE)
- If your major project isn't endorsed by the Decadal Review, it won't get funded

Astro2010 Prioritized Recommendations

- **In space:**
  1. **Wide-Field Infrared Survey Telescope (WFIRST)**
  2. **Augmentation to the Explorer Program**
  3. **Laser Interferometer Space Antenna (LISA)**
  4. **International X-Ray Observatory (IXO)**

- **On the ground:**
  1. **Large Synoptic Survey Telescope (LSST)**
  2. **Mid-Scale Innovations Program Augmentation**
  3. **Giant Segmented Mirror Telescope (GSMT e.g. GMT or TMT)**
  4. **Atmospheric Cerenkov Telescope Array (ACTA)**

The Large Synoptic Survey Telescope



The LSST will be located on Cerro Pachon in Chile

The LSST – A New Kind of Astronomy

- **This 8.4-m telescope:**
  - **Has the largest format camera ever built – 3200 megapixels**
  - **Will produce 30 terabytes of data nightly**
  - **Will image billions of objects in its entire sky every few nights, producing a motion picture of the Universe – *the greatest movie ever made***
  - **Google is a partner. Just imagine what that means!**
- **LSST Science:**
  - **Probing dark energy and dark matter**
  - **Taking an inventory of the solar system**
  - **Exploring the transient optical sky**
  - **Mapping the Milky Way**
- **It will produce high time resolution *megadatabases of*:**
  - **10 billion galaxies**
  - **10 billion stars**
  - **Unknown number of additional minor planets & comets in the inner and outer solar system**

The New Astronomy

Contemporary and near-term giant telescopes are incredibly exciting

Astronomy a decade hence may little resemble the astronomy of today

But, this talk is supposed to be about small telescopes!

Well, not that small.

Okay, but first what do we mean by "small"?

Believe it or not, a "small telescope" is anything with an aperture up to about 5 meters

What?! You mean the Palomar 200 inch is a small telescope?!

Yep. That's right.

Do Small Telescopes Really Still Contribute Much to Astronomy?

Maybe we' re wasting time and money on them?

But, they cost nothing compared to the Behemoths.

Maybe they're unproductive and nobody cares about their science?

Okay, let' s look into productivity and impact.

Go for it!

Research Papers vs. Aperture

Helmut Abt, *The Future...*, Vol. I, Chap. 7.

Journal	Telescope Aperture (m)						Sum	Aver
---	<1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	>5.0	---	---
A&A	18.2	36.9	30.4	14.7	5.5	10.0	115.7	2.48
AJ	15.2	17.2	13.2	10.8	8.9	8.8	74.1	2.78
ApJ	13.7	16.8	17.1	23.7	14.4	16.6	102.4	3.31
Icarus	0	4.2	1.2	2.5	0	0	7.9	--
MNRAS	4.2	6.9	4.5	7.7	3.3	0.3	26.9	2.51
Sum	51.3	82.0	66.4	59.4	32.2	35.7	327.0	2.81
%	15.7	25.1	20.3	18.2	9.8	10.9	100.0	--
Cum %	15.7	40.8	61.1	79.3	89.1	100.0	---	---

Citations vs. Aperture

Helmut Abt, *The Future*..., Vol. I, Chap. 7.

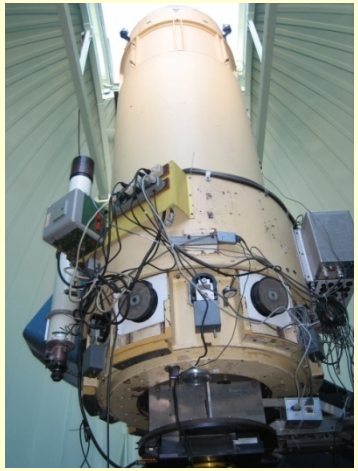
Journal	Telescope Aperture (m)						Sum	Aver
---	<1.0	1.0-2.0	2.0-3.0	3.0-4.0	4.0-5.0	>5.0	---	---
A&A	130.4	417.8	149.7	330.4	61.0	47.0	1136.2	2.43
AJ	181.1	340.5	161.9	92.7	117.8	143.0	1037.0	2.55
ApJ	128.5	465.0	292.9	402.5	320.6	329.9	1939.4	3.18
Icarus	04.0	4.0	0.7	0.0	0.7	0.7	10.1	--
MNRAS	35.5	154.5	134.4	144.0	145.5	0.0	613.9	2.84
Sum	479.9	1381.8	739.6	969.6	645.6	520.6	4737.1	2.81
%	10.1	29.2	15.6	20.5	13.6	11.0	100.0	--
Cum %	10.1	39.3	54.9	75.4	89.0	100.0	---	---

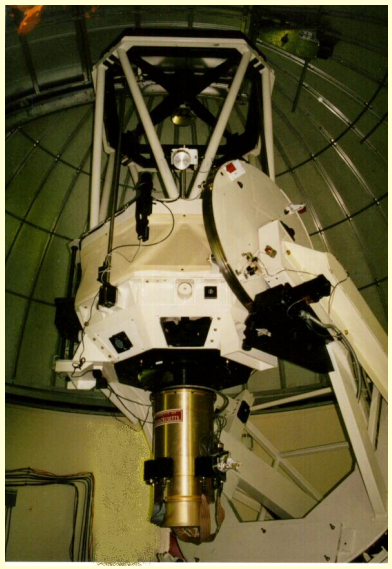
Cerro Tololo Inter-American Observatory

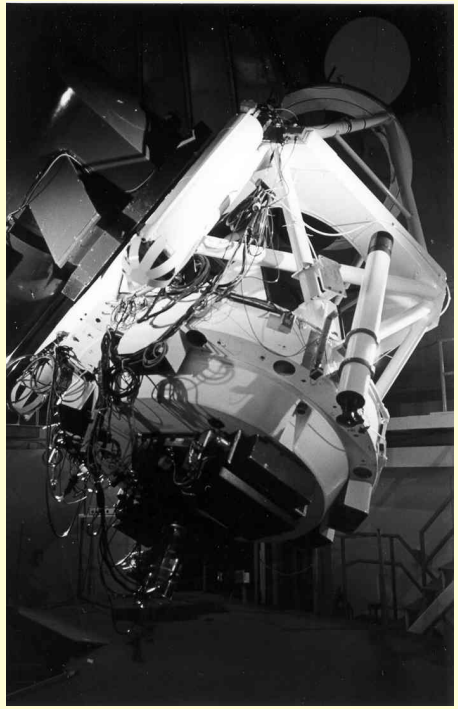
Gemini South 8.1-m on Cerro Pachon

SMARTS – Small & Moderate Aperture Research Telescope System

- SMARTS is a consortium of 13 institutions with HQ at Yale
- It operates four telescopes on Cerro Tololo
  - 0.9-m
  - 1.0-m
  - 1.3-m
  - 1.5-m







SMARTS – Finding New Nearby Stars

The RECONS group at Georgia State manages & uses the CTIO 0.9-m telescope to measure distances to newly discovered nearby Stars.

See their website at www.recons.org to learn how a 36-inch telescope is redefining the solar neighborhood.

GSU astronomer Todd Henry fills a dewar housing a CCD with liquid nitrogen