
GIANT MAGELLAN TELESCOPE
THE UNIVERSE AWAITS

World's Most Powerful Telescope

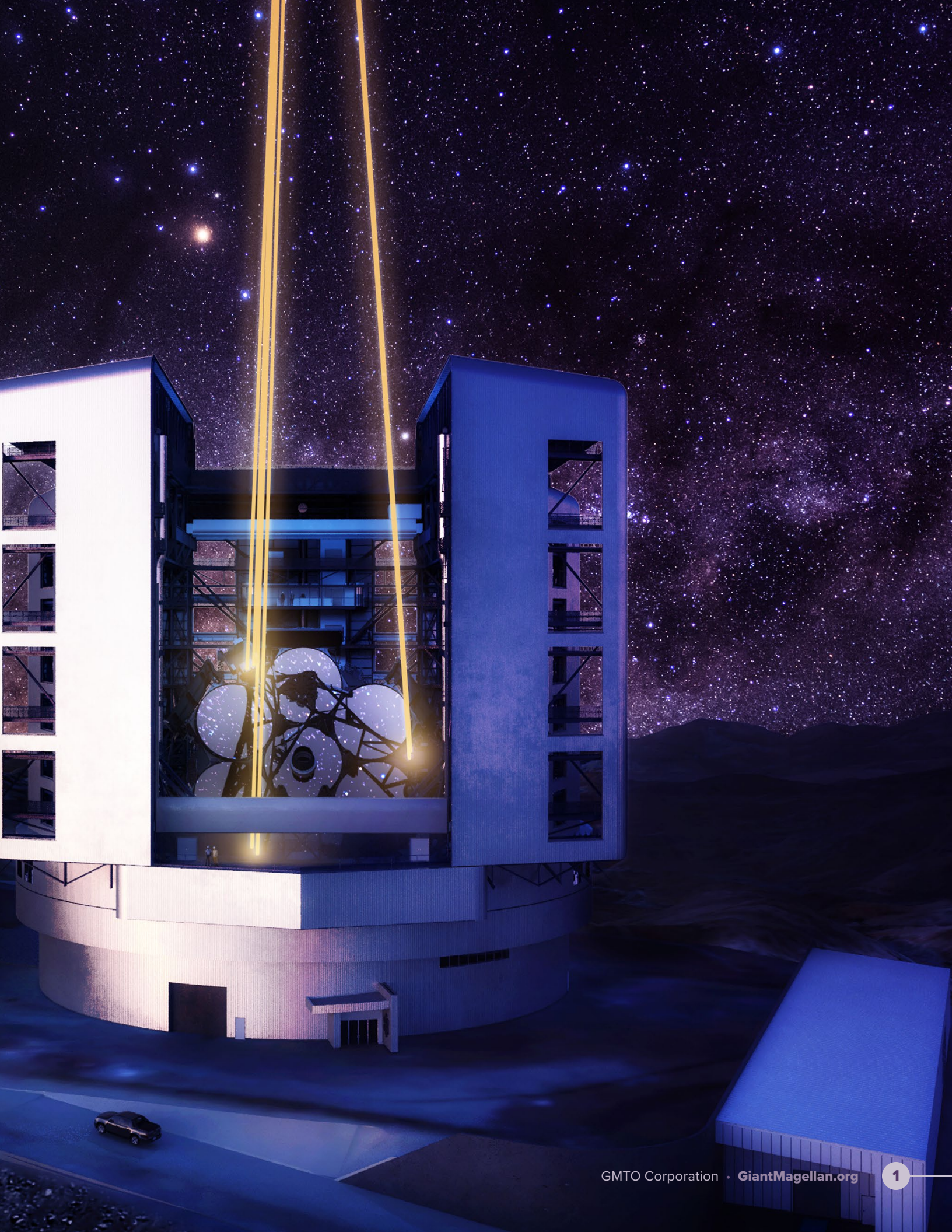
The Giant Magellan Telescope is the most powerful ground-based telescope ever engineered. It was designed to push the boundaries of human knowledge and discover the unknown. With unmatched image quality, seven of the world's largest mirrors will launch our view into the universe to uncover the cosmic mysteries of dark matter, investigate the origins of chemical elements, and search for signs of life on distant exoplanets for the first time.

The 30-meter class telescope is under construction at Las Campanas Observatory in Chile's Atacama Desert, one of the best locations on Earth to view the heavens. From this unrivaled vantage of the southern sky, the Giant Magellan Telescope will produce the sharpest and most detailed images ever taken of our universe—ten times greater than the famed Hubble Space Telescope and four times the James Webb Space Telescope.

Commissioning is anticipated in the late 2020s.
The Universe Awaits.

"We designed the Giant Magellan Telescope to discover the unknown, and it's the unimaginable discoveries that could change humanity forever."

— Dr. Robert Shelton, President



Monumental Endeavor

When complete, the Giant Magellan Telescope will be the largest public-private funded science project in history. This two-billion-dollar endeavor is made possible by visionary philanthropists and an international consortium of leading universities and research institutions representing five countries.

The initial concept for the Giant Magellan Telescope grew from a goal to advance the future of ground-based astronomy well beyond the capabilities of existing 10-meter class optical-infrared telescopes. The result was a 30-meter class, extremely large, segmented optical infrared telescope design using giant primary mirrors based on the heritage of the twin Magellan Telescopes and the Large Binocular Telescope. To achieve this bold vision, the consortium launched the GMTO Corporation, a 501(c)(3) nonprofit organization, to develop and operate the Giant Magellan Telescope.

The Giant Magellan Telescope is also a core partner of the United States Extremely Large Telescope Program (US-ELTP) along with the National Science Foundation's NOIRLab and the Thirty Meter Telescope. The visionary program aims to provide US-based astronomers with nationally funded, full sky observing access in both the Southern and Northern Hemisphere. The US-ELTP was recently ranked as the top frontier project for ground-based observatories in the US by the National Academies' 2020 Decadal Survey for Astronomy and Astrophysics.

"The many questions that the Giant Magellan Telescope seeks to answer impact all of humanity and speaks to the core of our existence. This knowledge belongs to the world and not just one country or institution. The telescope's immense scale and revolutionary technologies require global expertise and resources to accomplish, without them the project would not exist."

— Dr. Walter Massey, Board Chair

Advancing Science

While the design of the Giant Magellan Telescope has evolved over the course of the project to reflect new discoveries and scientific priorities, our vision to revolutionize humanity's view and understanding of the universe has remained the same. Here are just a few of the questions the telescope will explore:

Are We Alone in the Universe?

Unprecedented imaging sensitivity, resolution, and spectroscopic capabilities will allow us to explore the origins of the planetary systems in the galaxy around us, many of which we were unable to study before. We will be able to measure the physical properties of these planets, including the chemical composition of their atmospheres, to learn if they are habitable or host life as we currently understand it.

How Are Stars Born and How Do They Die?

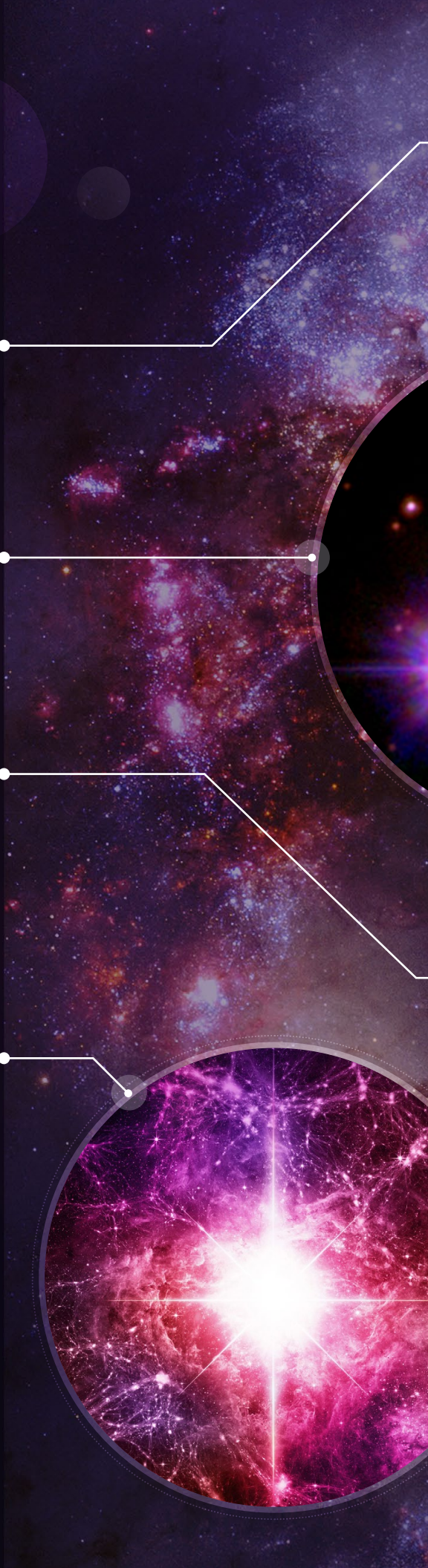
Infrared light will unveil forming stars in stellar nurseries across the Milky Way, allowing us to see the complex process of star formation with new clarity and providing new insights across all stages of the stellar birth. We will also probe the physics of the vast diversity of stellar explosions throughout the cosmos, searching for the chemical elements that are cast into space when a dying star explodes.

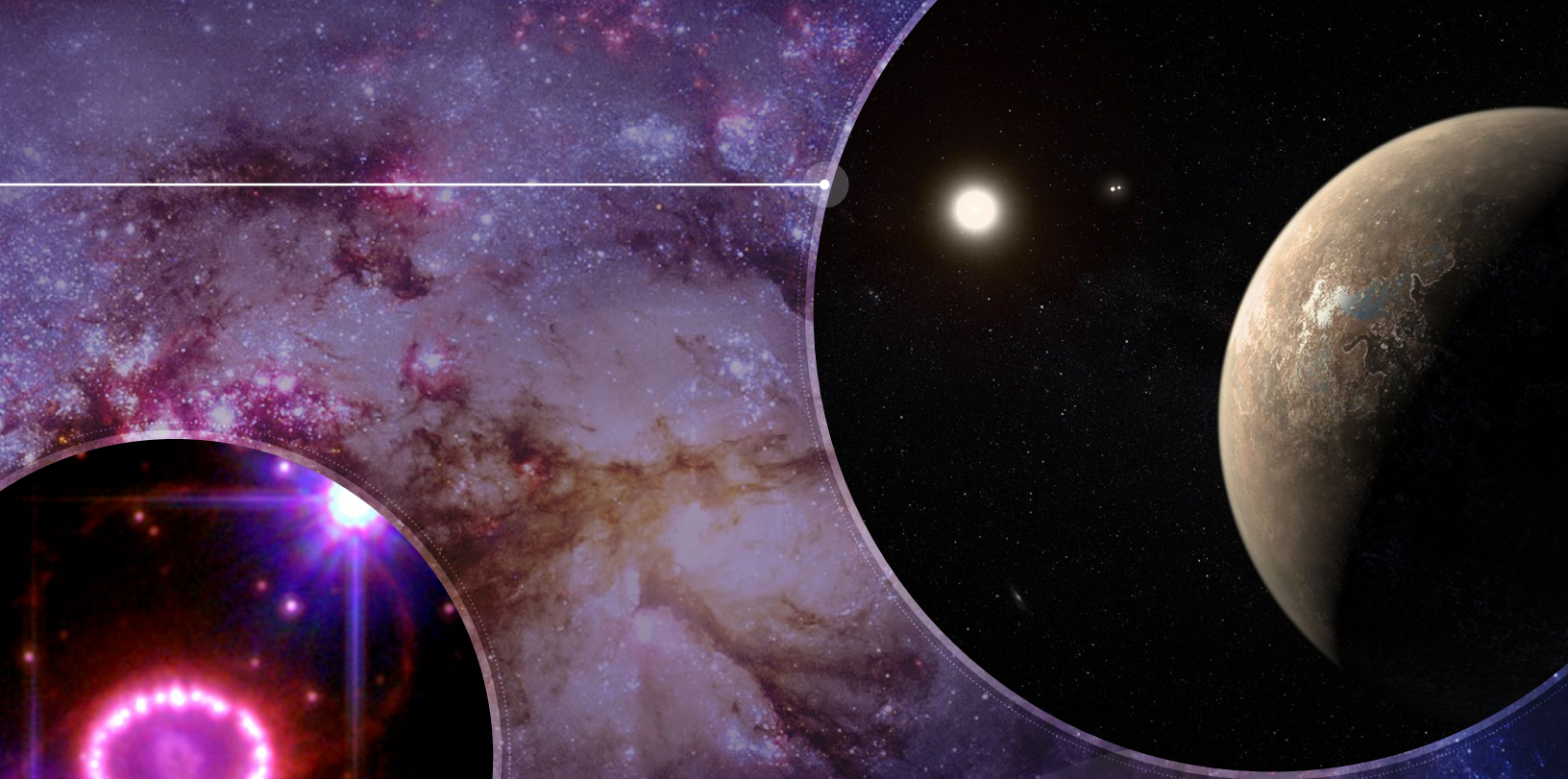
How Do Galaxies Grow and Evolve?

Tremendous light-gathering power will allow us to travel back in time to measure the smallest and faintest galaxies ever observed, revealing the complex internal workings of galaxies across the entirety of cosmic history. We will be able to map the vast volume of space that lies between galaxies, as well as the material surrounding galaxies. Our unmatched wide field of view and fiber-fed spectrographs will enable simultaneous observations of thousands of galaxies, yielding unprecedented statistics that are only available today in the local universe.

How Did the Universe Form and Grow?

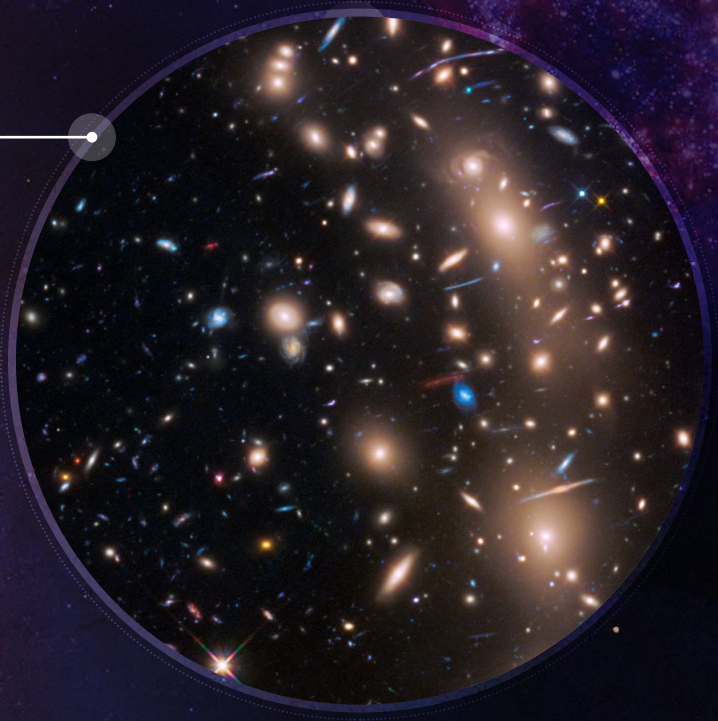
Innovative scientific instruments will offer new ways to profoundly challenge our understanding of the physical laws that govern the universe — potentially breaking theoretical frameworks in physics. By exploring the extreme environments in the cosmos, many for the first time, we will refine our knowledge of the properties of dark matter and dark energy to further our conception of the structure and contents of the universe and our place in it.





"The leap in sensitivity and resolution that we're going to make with the Giant Magellan Telescope will revolutionize our understanding of all areas of astronomy, from the formation and evolution of objects we can see, like planets, stars, black holes and galaxies, to cosmology and the things we can't directly see, like the nature of dark matter and dark energy."

– Dr. Rebecca Bernstein, Chief Scientist



BACKGROUND:
Antennae Galaxies NGC 4038-4039
NASA, ESA, and Hubble Heritage Team (STScI/AURA)

TOP TO BOTTOM:
Artists impression, planet orbiting Proxima b
ESO/M. Kornmesser

SN 1987A
NASA, ESA/P.Challis & R. Kirshner

Hubble Frontier Field Galaxy Cluster
NASA, ESA/L. Infante

Cosmic Web
Phil Mansfield (U Chicago) and Benedikt Diemer (ITC, Harvard)

Core Technologies

The Giant Magellan Telescope is the largest Gregorian optical-infrared telescope in history. With a total light collecting area of 368 square meters, the telescope will deliver images sharp enough to resolve the torch engraved on a dime from nearly 160 kilometers away. Here are the principal elements of its next-generation design:

Enclosure

A massive 22-story smart home shelters the Giant Magellan Telescope from harsh weather and extreme earthquakes that the Chilean Atacama Desert is famous for. The 4,800 metric ton enclosure can complete a full rotation in nearly 3 minutes. It's designed to disappear at night, equalize shifting airflows and temperatures, and reveal the telescope for unobstructed observations as the world's largest mirrors track celestial targets moving across the sky.

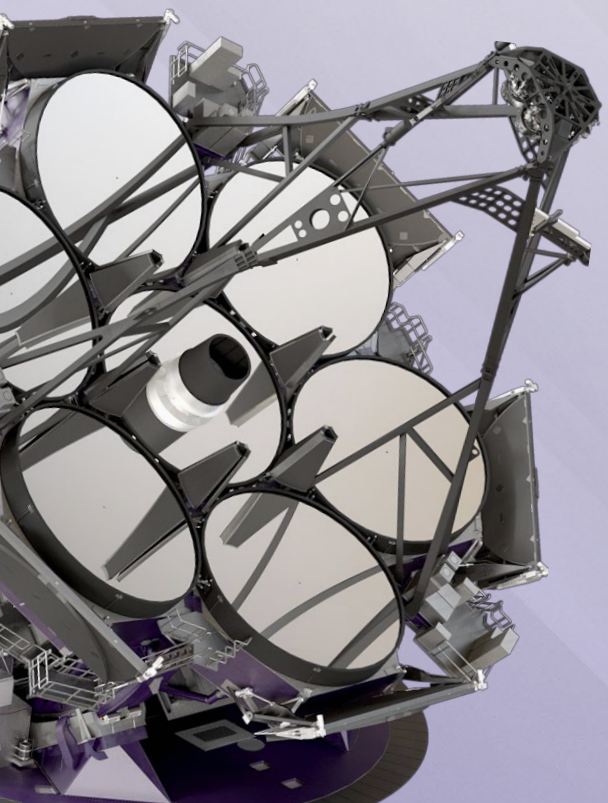
Telescope Mount

At 12 stories tall and 2,100 metric tons, the Giant Magellan Telescope's mount is an imposing yet agile structure. The altitude-azimuth mount provides the supporting framework for the world's largest mirrors, adaptive optics, scientific instruments, and control systems. The steel superstructure sits on a concrete pier that's 22 meters in diameter and is so stable that it can resist image quality interruptions from even the slightest vibration. While massive, this precision tool is designed to glide frictionlessly on a film of oil just 50 microns thick, in three degrees of freedom, so that the 18 metric ton primary mirrors have undisturbed access to study the night sky.

LEFT PAGE:
Top: Front view of Telescope Enclosure
Bottom: Primary Mirrors

CENTER:
Telescope Mount

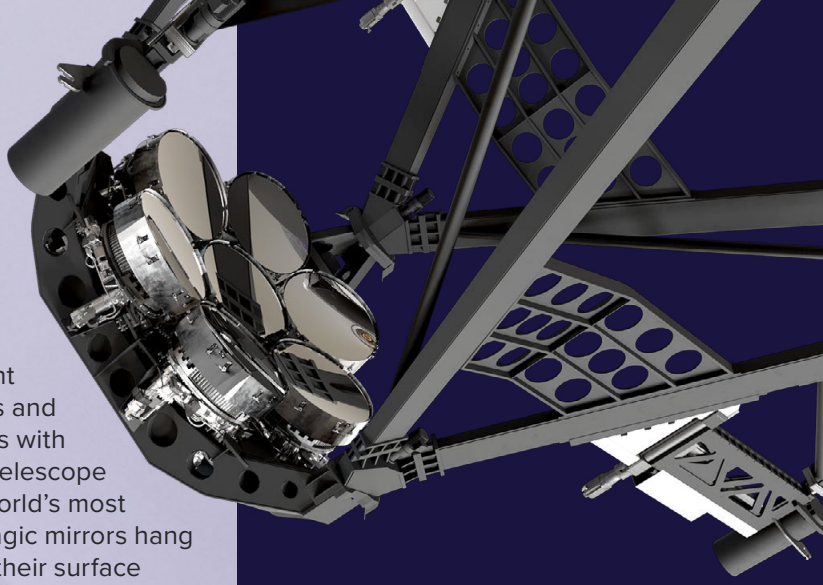
RIGHT PAGE:
Top: Adaptive Secondary Mirrors
Bottom: Large Earth Finder Instrument



Primary Mirrors

The Giant Magellan Telescope's seven primary mirrors are the world's largest and most challenging optics ever produced. The primary mirrors are the telescope's first contact surface that collects incoming light from the night sky. Each 8.4-meter diameter mirror has an astonishingly smooth surface, takes four years to complete, and weighs 18 metric tons. The segmented mirrors have a parabolic shape and are arranged in a unique flower pattern to form a 25.4 meters wide light-collecting surface, the largest of any built telescope to date. The efficient optical design is a world first and promises to see farther into the universe with more detail than any other telescope before.

The telescope's primary mirrors are fabricated at the University of Arizona's Richard F. Caris Mirror Laboratory. As of 2021, two mirrors are complete and four are under production.



Adaptive Optics System

Adaptive Optics corrects for the optical turbulence in the Earth's atmosphere by using deformable mirrors. The Giant Magellan Telescope has numerous adaptive optics modes and is the only extremely large telescope in the 30-meter class with ground layer adaptive optics over a full field of view. The telescope also has seven adaptive secondary mirrors that use the world's most advanced optical technologies ever developed. These magic mirrors hang above the giant primary mirrors' light path, deforming their surface 2,000 times per second as they collect distorted light reflections and clean them up before sending a concentrated beam of light to the telescope's scientific instruments.

The adaptive secondary mirrors are fabricated by AdOptica in partnership with our Founders.

Scientific Instruments

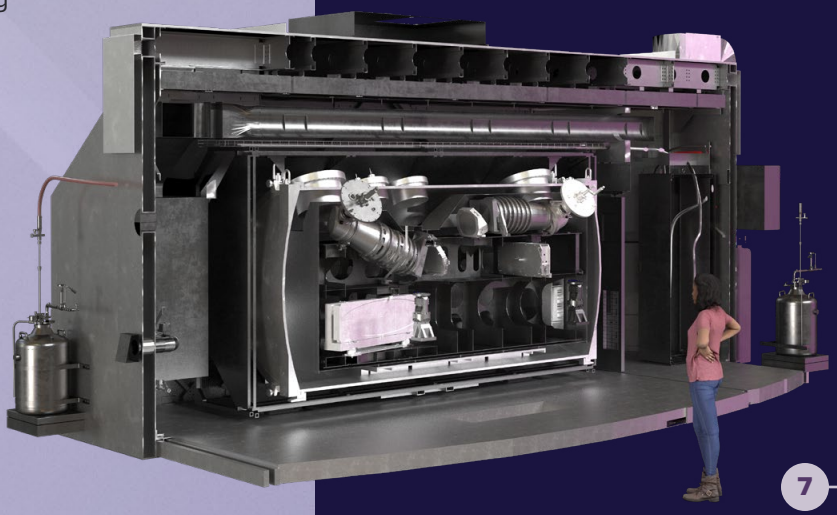
Scientific instruments are the superpowers of the Giant Magellan Telescope. The instruments allow scientists to unlock the secrets of the universe by dissecting light both spatially and spectrally to provide detailed chemical analyses of celestial objects, their history, and their origin. The Giant Magellan Telescope can accommodate up to ten instruments at once, more than any other telescope. Each one has a unique ability to explore the unknown: from analyzing a distant planet's atmosphere in search of life to looking back in time to when the universe first formed. The discoveries they make could rewrite history as we know it.

The telescope has two spectrographs that will operate in the visible region of the light spectrum and two that are sensitive to infrared light. In addition, an advanced fiber-optic system that uses tiny robotic positioners will expand the capabilities of the spectrographs by allowing them to access the full field of view provided by Giant Magellan Telescope's innovative optical design.

The first scientific instruments are being developed by scientists and engineers at our Founder institutions.

"The most important part of a telescope is its light-collecting mirror. The Giant Magellan Telescope's unique primary mirror design consists of seven of the world's largest mirrors. Once operational, the Giant Magellan Telescope will produce images ten times sharper than the Hubble Space Telescope. The discoveries these mirrors will make will transform our understanding of the universe."

—Dr. James Fanson, Project Manager



Unrivaled Advantages

The Giant Magellan Telescope is powerful by design. It will produce the highest possible resolution of the universe over the widest field of view. This extraordinary image clarity will enable scientists around the globe to obtain new clues to the fundamental nature of the universe. Here are a few innovations that will lead astronomy into the future of discovery:

Optical Supremacy

The Giant Magellan Telescope is the most optically efficient of all extremely large telescopes in the 30-meter class. Its optical design focuses on maximizing the light it collects by minimizing the light's reflected path between mirrors. There are only two mirror surfaces in the optical path when observing in wide field of view modes, and only three mirror surfaces for adaptive optics modes.

Image Clarity and Size

The Giant Magellan Telescope will have the widest field of view with the best image quality of any extremely large telescope. It is also the only 30-meter class with ground layer adaptive optics over a full field of view. This enables the telescope to see fainter objects with unrivaled resolution and sensitivity more than 19 million times the light gathering power of the human eye. The advantage is extremely powerful for spectroscopy and the precise measurements of distances, dynamics, chemistry, and masses of celestial objects in deep space.

Cost Efficiency

The Giant Magellan Telescope's optical design keeps a compact total image size in the focal plane, giving it a smaller plate scale than the other 30-meter class telescopes, which allows for smaller, better, and cheaper instruments that can be developed more rapidly in response to new scientific opportunities. The Gregorian design can also accommodate up to ten scientific instruments at once, more than any other extremely large telescope.

Synergies

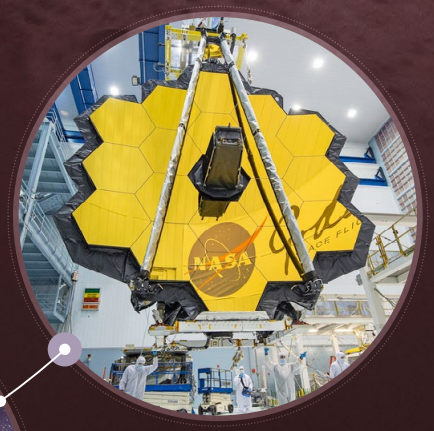
The Giant Magellan Telescope and the US Extremely Large Telescope will coordinate scientific efforts with the latest telescopes working at various wavelengths, making synergistic astronomical observations and high-impact discoveries. This includes complementing work with the Atacama Large Millimeter/submillimeter Array (ALMA), Vera C. Rubin Observatory, and the James Webb Space Telescope (JWST) in the same way that 8-meter class ground-based telescopes such as the Gemini and Keck telescopes currently work in concert with the Hubble Space Telescope.

BACKGROUND:
Giant Magellan Telescope
GMTO Corporation

TOP TO BOTTOM:
James Webb Space Telescope
NASA/Desiree Stover

ALMA
ESO,NAOJ, NRAO/C. Padilla

Vera C. Rubin Observatory
Rubin Obs./NSF/AURA



Location

The Giant Magellan Telescope is under construction in the Chilean Atacama Desert at the Carnegie Institution for Science's Las Campanas Observatory. The observatory's scientific value is supported by five decades of active telescope use. The desert is an astronomer's paradise because of its high altitude, clear skies, dark nights, and steady atmosphere. Low precipitable water vapor content improves the telescope's sensitivity at infrared wavelengths, providing amazing optical and infrared observing conditions for more than 300 nights of the year. On Las Campanas Peak, the median seeing is 0.63 arcseconds at 5000 Å, with the best quartile below 0.50 arcseconds — some of the best optical seeing on Earth.

Besides the scientific advantages of seeing through Earth's atmosphere, the Giant Magellan Telescope's location in the Southern Hemisphere provides astronomers with direct observation of many celestial objects of scientific interest. This includes the galactic center of the Milky Way, the nearest supermassive black hole (proximity to Sagittarius A*), the nearest star to our Sun (Proxima Centauri), the Magellanic Clouds, and many of the closest galaxies and exoplanets.

Telescope Progress

2004

Birth of a New Age of Space Exploration
Over a three-year period, scientists and engineers developed a concept for an extremely large telescope drawing upon experience in their field of expertise in optics, telescope structures, and instrumentation. The success of the conceptual design review activated the development of the Giant Magellan Telescope, a never before attempted astronomical marvel.

2005 — **July**

World's Largest Mirror is Cast
The first primary mirror of seven is cast in the world's only spinning furnace under the University of Arizona's football stadium.

2011 — **July**

Telescope Site Location
The Giant Magellan Telescope's home at the Las Campanas Observatory in the Atacama Desert is chosen: Las Campanas Peak, an astronomer's paradise.

2012 — **January**

Second Monolithic Primary Mirror is Cast

March

Construction Begins
Mountain top blasting at Las Campanas Peak launches the site preparation for construction.

2013 — **August**

Third Primary Mirror is Cast

2014 — **February**

Design Phase Completed
Successful external reviews mark the completion of the Giant Magellan Telescope's design phase.

2017 — **September**

First Primary Mirror Finalized
The first primary mirror is moved to temporary storage in Arizona.

November

Fifth Primary Mirror is Cast

2019 — **March**

The Summit Excavations are Completed

2020 — **September**

$17.5 million Grant From the National Science Foundation
Subaward accelerates the prototyping and testing of some of the most powerful optical and infrared technologies ever engineered.

2021 — **March**

The Penultimate Sixth Primary Mirror Is Cast

November

US-ELTP Ranked As Top Astro2020 Initiative
The 2020 United States Decadal Survey on Astronomy and Astrophysics, a foundational report that outlines strategic scientific priorities and investments over the next ten years, prioritized the US Extremely Large Telescope Program and the Giant Magellan Telescope as mission critical for advancing our understanding of the universe.

BACKGROUND:
Fifth Primary Mirror
GMTO Corporation

TOP TO BOTTOM:
Mountain top blasting at Las Campanas
GMTO Corporation

Former President of Chile, Michelle Bachelet
Alex Ibañez, Chile's Prensa Presidencia

Summit Excavation Complete
GMTO Corporation

Glass for Sixth Primary Mirror
GMTO Corporation

GMTO Corporation

501(c)(3) Tax Exempt Status

The GMTO Corporation is a standalone non-stock 501(c)(3) organization recognized by the United States Internal Revenue Service and the State of California as a charitable organization exempt from most taxes. The GMTO Corporation was created to execute the design, construction, and operation of the Giant Magellan Telescope on behalf of a Founding consortium of international academic and research institutions.

GMTO Corporation is currently governed by 13 Founder institutions representing five countries that act through Founder Representatives and a Board of Directors nominated and elected by the Founders, with additional Directors as determined by the Board and elected by the Founders. Founders include: Arizona State University, Astronomy Australia Limited, Australian National University, Carnegie Institution for Science, FAPESP–The São Paulo Research Foundation, Harvard University, Korea Astronomy and Space Science Institute, Smithsonian Institution, Texas A&M University, The University of Texas at Austin, University of Arizona, University of Chicago, Weizmann Institute of Science

The GMTO Corporation is subject to Delaware, California, U.S., and Chilean Law, the Third Amended and Restated Founders' Agreement dated October 1, 2015, and the Bylaws, adopted in 2008.

Status in Chile

The GMTO Corporation has an agreement with the University of Chile, which sets forth the GMTO Corporation's provisions to provide observing time to astronomers at Chilean universities. The GMTO Corporation has been recognized through a presidential decree as an "international organization" in Chile, giving it tax advantages and a high degree of legal immunity.

Workforce

The GMTO Corporation has offices in Pasadena, California and Santiago, Chile. The organization employs more than 100 people but will grow as construction of the Giant Magellan Telescope ramps up. We expect to host more than 200 contract employees in Chile at the peak of construction.

Visit GiantMagellan.org

Contact Information

Robert N. Shelton
President

rshelton@gmto.org
626-204-2213

Jennifer Eccles
Vice President for Development and External Relations

jeccles@gmto.org
626-204-0566

GMTO Corporation
465 N. Halstead Street, Suite 250
Pasadena, CA 91107

GiantMagellan.org

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