

Written Direct Testimony of Günther Hasinger

My name is Günther Hasinger. I am an astronomer and the Director of the Institute for Astronomy (“IfA”) at the University of Hawai‘i. I received a PhD in Astronomy in 1984 from Ludwig Maximilian University specializing in compact objects, the X-ray background and cosmology, and management expertise over a large spectrum of scientific institutions, including instrumentation and telescopes. A copy of my curriculum vitae was submitted as Exhibit A-32.

As the director of IfA, I am well acquainted with the Thirty Meter Telescope (“TMT”) Project as well as the role the TMT Project will play in the future of astronomy on Maunakea.

Hawai‘i is one of the best places on Earth to observe the heavens and hosts arguably the premier observatory in the Northern Hemisphere.

The TMT project is an optimum and sustainable use of natural characteristics that make Maunakea one of the best viewing locations in the world:

- a) generally little to no cloud cover;
- b) low humidity;
- c) a stable atmosphere;
- d) low mean temperature and temperature variability;
- e) low light pollution; and
- f) a location at a favorable latitude.

There has hardly been an astronomical breakthrough in the last 50 years where telescopes on Maunakea were not involved. Just consider Black Holes, Dark Matter, Dark Energy, and the quest for life on planets around other stars – Maunakea is at the forefront. The total number of scientific publications from Maunakea telescopes every year is larger than that from the Hubble Space Telescope or the European Southern Observatory. With the construction

and operation of the TMT Project, Hawai'i will maintain its leading position in generating new knowledge about the universe, as well as producing a new generation of leaders in science, technology and education.

The light collection power of TMT's large aperture will be about ten times bigger than that of the largest telescopes today. The size of its aperture, combined with the excellent atmospheric conditions above Maunakea will yield about ten times sharper images than the Hubble Space Telescope. With the larger aperture and the higher resolution, TMT will be 100 times more sensitive than the best current telescopes. That will allow it to observe any class of astronomical objects much further than current telescopes. Reaching further into the Universe enables a look back in time; the TMT is therefore also like a time machine. This will enable scientific breakthroughs in several of the most fundamental questions: What is the Universe made of? How did it form? How do stars and planets form? Where did we come from, where will we go to? Is there life elsewhere in the Universe?

One of the most exciting challenges is to find and study Earth-like planets in the habitable zone around stars, which are close enough that future generations might be able to fly there. We already have made great strides towards this goal. From work done here in Hawai'i, we know that approximately 20% of all stars have Earth-like planets in their habitable zone. The closest of these could be just several light years away. TMT will play a major role in this quest, and the gateway to "Earth-2" will hopefully be in Hawai'i.

In the current controversy about the construction of the TMT it is important to ask, what do the local and the Hawaiian communities get out of the telescopes on Maunakea? One of the intangible benefits is Hawai'i's reputation as a modern place of discovery. Several astronomical objects and structures have been given Hawaiian names, e.g., "Haumea" and "Makemake", the

first dwarf planets after Pluto, or the recently discovered supercluster “Laniakea”, which we call our cosmic home. Hawai‘i, as seen from afar, is not just defined by its wonderful nature, people and culture, but also by its modern science and discovery. In recognition of this, the International Astronomical Union held its triennial General Assembly in August 2015 in Honolulu, bringing several thousand astronomers to our State from around the world.

Astronomy also gives back more tangible values. After the devastating tsunami of 1960, the observatory on Maunakea and IfA were founded with the explicit dual goals of providing more educational opportunities to Hawai‘i students and to develop astronomy as an economic driver for the State of Hawai‘i, in particular for Hawai‘i Island. Over the past half century, IfA has been the driving force behind the development of world-class astronomy education and research in Hawai‘i, including in particular the development of the state-of-the-art international observatories on Maunakea and Haleakala. A study of the UH Economic Research Organization (“**UHERO**”) shows that in 2012 alone, astronomy had a total economic impact of \$168 million, a job creation impact of 1400, and generated State taxes of \$8.2 million. Exhibit A-33. Think about the additional tax dollars that provide important public funding for road improvements, the bus system, waste management, social services, public education, etc. Think about the direct spending of the astronomy enterprise in salaries and purchases that support local businesses, which again employ local people. This segment of the Big Island economy will grow considerably with the construction of TMT.

In addition to the economic benefits, astronomy in Hawaii provides substantial contributions to the public welfare. The Pan-STARRS and ATLAS observatories on Haleakala are providing the world's best early-warning system for dangerous asteroids, such as the one that struck Russia several years ago, and even larger ones that could have devastating impacts.

Telescopes on Maunakea, and in the future hopefully TMT, follow up on these discoveries and study the asteroids in detail to provide accurate information about their orbits, composition and ultimately the danger they pose. The Maunakea Weather Center (“MKWC”) was created to provide excellent custom forecasts for the observatories. Recently, MKWC has adapted its computer programs to predict the dispersion of vog from the Kilauea volcano. This is a valuable service to the Hawai‘i community at no cost to the State. Twenty years ago, a \$2 million up-front contribution from the Maunakea observatories expedited the installation of fiber-optics communications infrastructure on Hawai‘i Island, and today astronomy is leading the big data efforts in the State. The innovative technology that astronomy in Hawai‘i creates is a broad catalyst for future economic development in Hawai‘i that goes far beyond astronomy. For example, IfA innovation has spun off new Hawai‘i businesses working in remote sensing instrumentation and new technologies for solar power.

Astronomy provides close to 1,000 quality jobs in a clean high-tech activity that offers employment opportunities in STEM (science, technology, engineering, mathematics) fields to local young people. Beyond the simple numbers, there is the fact that astronomy diversifies the economy and gives local young people with scientific and technical talents a wealth of opportunities to realize their potential without having to leave family and friends to pursue a career elsewhere. These opportunities are not just for astronomers; most jobs are technical and administrative, and the workforce has more than 50% local employees.

Arguably the most important aspect in this workforce pipeline is education. The University of Hawai‘i and the Maunakea observatories support a pipeline of STEM education, which starts in the schools. Our astronomy outreach programs are particularly effective in sparking interest in Hawai‘i’s youth for all types of STEM-related fields - not just astronomy.

The fascination of astronomical research attracts a whole generation of children into the world of science to learn the tools of mathematics and science. Every year the *Journey through the Universe* program, a national program that focuses on science as a human endeavor, reaches over 7,000 elementary, middle, and high school students and is now well in its second decade. The *HI-Star* program trains local high school kids to participate in science fairs and go on to university careers in STEM fields. *HI-Star* alumni have received almost half a million dollars in prize fellowships and stipends. The *Akamai* program provides internships, many of them for Native Hawaiians, in observatories and high-tech companies for jobs not just in astronomy, but across many different industries. *Akamai* has a fantastic retention rate of close to 80% in STEM jobs. The academic education in the UH System, the undergraduate programs in Hilo and Mānoa, and the astronomy graduate program are some of the finest and most attractive in the country. We have recently graduated the first Native Hawaiian PhD astronomer. She is now making a career in astrophysics. Finally, all observatories and the University provide an excellent public outreach and general education program. For example, the Visitor Information Station at Hale Pōhaku provides free public stargazing seven nights per week and welcomes 300,000 visitors each year.

TMT's community efforts, together with matching funds from private donors, provide generous support to strengthen this education pipeline across a broad range of activities. The THINK (The Hawaii Island New Knowledge) fund distributes grants for teacher-generated classroom projects and funds projects at many Hawai'i Island public and public charter schools – benefitting thousands of students. It also has distributed funds for STEM learning grants to nonprofit organizations or schools. Each year there will be one million dollars available to support education, and more for the workforce development pipeline. In addition, TMT funds

postdoctoral positions for Hawai'i graduates.

Arguably one of the most important questions of our time and place here in Hawai'i is: *how to find a balance between the scientific exploration on Maunakea, and its cultural and spiritual significance to many people?* As the highest peak in Hawai'i, actually in all of Polynesia, Maunakea has enormous importance to Native Hawaiians and is among the most revered sites in the State. The resurgence of the native Hawaiian culture and the drive for political self-determination in the later 20th century coincided with the growth of astronomy development on Maunakea, leading to significant tensions and protests, culminating in the current conflict around the TMT. The future of Maunakea astronomy is therefore inextricably linked to finding a balance with Hawaiian culture.

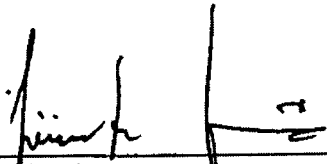
From my perspective, the Mauna Kea Comprehensive Management Plan (“CMP”) and the Office for Mauna Kea Management (“OMKM”) provide the appropriate framework for taking care of the mountain in all of its aspects. The mountain management has improved significantly over the last 15 years under OMKM. The most recent Hawai'i State audit report on the Management of Mauna Kea and the Mauna Kea Science Reserve in August 2014 states: “... *we found that UH and DLNR have addressed many of our recommendations, including developing and implementing management plans for Mauna Kea's natural cultural, and historic resources. The result is an improved and more comprehensive framework that coordinates the agencies' efforts to manage and protect Mauna Kea while balancing the competing interests of culture, conservation, scientific research, and recreation.” Exhibit A-34 (2014 Audit Report) (emphasis added). All proposed projects on the mountain - big and small - have to go through a public review process involving the Native Hawaiian advisory council *Kahu Ku Mauna* and the Maunakea Management Board. Cultural practitioners have always had priority in accessing the*

mountain, and we frequently see the result of cultural practices – ho‘okupu, and other offerings on the mountain. There are clear signs noting the special and cultural sensitivity of Maunakea and asking everyone to be respectful of the mountain. As concrete examples for the constructive cooperation of UH and Hawaiian cultural practitioners, please see the following examples: Next to the head of the trail to lake Waiau there is a somewhat hidden parking lot for cultural practitioners to safely park their cars on an otherwise steep portion of the road. Although Lake Waiau is not part of the UH managed lands leased to the University under General Lease S-4191, UH and the observatory organizations actively encourage their employees to respect this very sensitive area. They also fund and maintain the parking lot on the summit as part of their responsibility for the road.

Finally, TMT has committed to taking steps to preserve the very sensitive peak of Pu‘u Poliahu to its natural state. With its financial contribution to the management of the mountain, TMT has opened a new era, which will allow an even better mountain management in the future, and hopefully improve the balance between culture and science on Maunakea.

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DATED: Honolulu, Hawai'i, October 11, 2016.



Günther Hasinger
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