

Partnership between giants

President of the GMT telescope explains why he joined with competitor TMT to secure funding from the National Science Foundation

Marcos Pivetta | PUBLISHED IN AUGUST 2018

After almost two decades of intense competition, two international megaconsortiums comprising universities and research institutions decided to join forces in pursuit of a common goal: to persuade the National Science Foundation (NSF), the leading research funding agency in the USA, to invest in their astronomy projects. With no money to complete their super telescopes, which are scheduled to begin operating in the next decade, the Giant Magellan Telescope (GMT) and the Thirty Meter Telescope (TMT)—whose headquarters are situated just eight kilometers apart in the California city of Pasadena—are aligning their scientific goals to jointly seek funding from the United States government. At an estimated cost of US\$1 billion, the GMT is building a 24.5-meter telescope in Chile. The TMT, at US\$1.4 billion, is further behind schedule. The northern hemisphere location where the telescope will be built has yet to be determined. The initial plan called for a location in Hawaii, but those behind the project are now also considering the Canary Islands.

In 2017, American physicist Robert Shelton was appointed president of the

GMT consortium, which is coordinated by Carnegie Observatories, and he has played a key role in forging a partnership between the two projects. Having previously worked with the University of California and the California Institute of Technology (Caltech), the two institutions managing the TMT, Shelton has dedicated himself to strengthening the scientific and administrative ties between the two projects. He regularly visits GMT partners to discuss the progress of the project and more recently, the new relationship with TMT. Shelton was in São Paulo in early August to visit FAPESP, one of the GMT partner institutions, and to meet the São Paulo astrophysicist community, which will be given 4% of the telescope's observation time. He later met with researchers in Porto Alegre and Rio de Janeiro. "I want to understand the perspective of Brazilian researchers," said the physicist, interviewed days before landing in Brazil for the first time.

How did the GMT and TMT collaboration begin?

The two projects have been working in parallel for many years, and both are based in Pasadena, California. TMT is

located at Caltech and GMT at Carnegie. These two organizations have a history of collaborating and competing, both of which can be positive. My background initially was more connected to the University of California [he studied for his PhD at the UC San Diego campus], which is partnered with TMT. I specialize in condensed matter, but I first got involved with astronomy when I served on the governing board of the Keck Observatory in Hawaii, which is linked to Caltech and the University of California. So, I am familiar with the key players from TMT. Later, I was on the boards of other telescopes, including that of Hubble. Since I came to GMT, my interest has been in making sure the two projects are supportive of each other. For the US astronomy community, having access to super telescopes in both the northern and southern hemispheres is a very powerful incentive. The leaders of both boards have been talking about the two projects for over a year. Now, there is a new ingredient: the possibility of federal US funding for the two telescopes.

This possibility already existed in the past...

Yes, but in the past, the two projects were



We have raised US\$520 million so far, approximately half of the initial budget target for the GMT



not as compatible. At the time, the projects each approached the federal government in their own way. There is nothing wrong with that, but it can put the government in the difficult position of having to choose between one proposal or the other. Now, we agree that we must work together for the benefit of astronomy at large.

Was the lack of money available to complete both projects a determining factor in establishing this collaboration?

Yes, although money has always been a factor. I cannot speak for TMT, but both projects have always been looking for a way to complete their telescopes. What has changed is that now they see themselves as more complementary than competitive.

Was it a mistake to start two different super telescope projects at the same time?

I do not know how to answer that question. At the time, there was every reason to think that there would be sufficient funds from the USA and partner countries to sustain both projects, which use very different observation technologies.

The two telescopes are at different stages of development. Will each project ask for the same amount of money from the NSF?

We have not written the joint proposal yet. There is sequence of events that has to happen before we can do so. The first task is to identify key science projects that require both telescopes. We need to formulate a strong scientific proposal to be presented to the National Academy of Sciences decadal survey [a report that identifies priority research areas to be supported by funding agencies over the next decade]. We set up a steering group with people from GMT, TMT, and the National Optical Astronomy Observatory [NOAO] that represents the NSF. We hold meetings every three weeks, either at our office or the TMT office.

How much time do you have to submit the proposal for the decadal survey?

We are aiming to provide our documentation in the first half of 2019. Then, the proposal will go through about a year's worth of work, and we hope that the recommendations based on the decadal survey will be released in January 2021. If we are able to secure federal govern-

ment funding, the money will probably be available in 2023. It is a long process. But, of course, things can change along the way. In parallel with demonstrating the scientific need for these telescopes, we have to submit a financial proposal, which means we have to decide: how much money should we ask for? Honestly, we do not have a set figure right now. But, the request will be in the hundreds of millions of dollars. In principle, each project should ask for the same amount of money but will probably use the money in different ways. Our needs and the TMT's needs may differ. Throughout this process of discussing and formulating a joint scientific proposal, we have made sure to include representation of our international partners, such as FAPESP. We need this international perspective to make the GMT a success.

If the NSF does not finance the telescopes, is there a plan B?

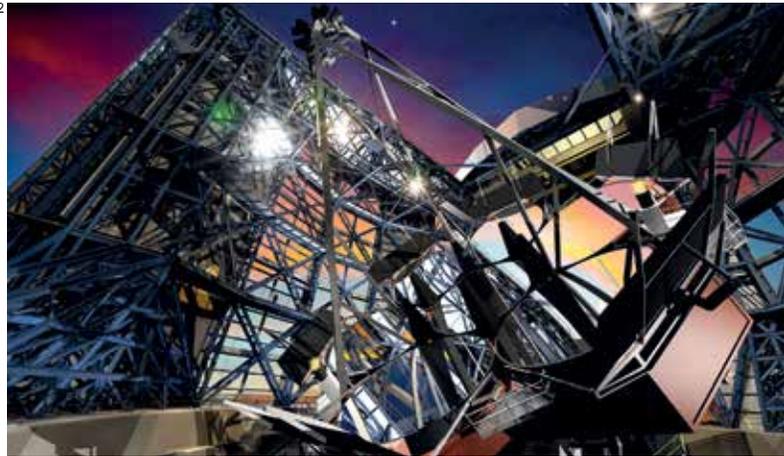
Raise more money, probably from private sources. Either way, we will have to get to the first light stage almost on our own before the NSF money comes through. We want to partner with NSF not just because they have the money—of course that is important—but also because it would allow other astronomers who are not currently part of our consortium to use the telescope. That will give intelligent people with excellent ideas the chance to use the GMT in ways that might not have been thought of otherwise.

Will the collaboration with TMT change the relationship between GMT and its international partners in any way?

We are being very careful to ensure that the role of our international partners is respected—not just because of the money our partners have invested but also for the scientific contributions they bring to the project. If the NSF gives us significant funding, our partners will want control over some of the time on the telescope. So, for example, if they give 25% of the total cost, they will ask for 25% of the time, which will not be a problem for us, because we have not assigned all of the observation time yet. What could have an impact on every partner, though, is if the total cost increases. The US\$40 million that FAPESP has invested in the project, which today equates to 4% of the observation time, could turn into 3% if the cost



1 The location of the TMT project, budgeted at US\$1.4 billion, has not yet been confirmed



2 Artist's representation of the seven GMT telescope mirrors under construction in Chile

of the telescope rises to US\$1.2 billion. However, there is another issue to be considered. Those who entered the project early are more protected than those who entered later. Most international partners invested money into the project at a time when the risk was higher. We cannot adopt the simple cost proportion rule for those who supported the project from the start. That will not change. A change to that principle would have to be approved by all the founding partners, and I cannot imagine anyone would want to do that, which is why the founding partners of the GMT play such an important role. The astronomers from São Paulo will be granted observation time due to the partnership with FAPESP. Those in the US who are not associated with the founding institutions will have to ask the NSF for time, and they may or may not get it.

How much money has GMT raised so far?

Approximately US\$520 million, which is roughly half of the initial budget target. One thing I have learned from being on the boards of various telescopes is that astronomers can always spend more. I say that as a compliment. Astronomers will always be able to think of new instruments, new data analysis software. So, we know we need to raise more money.

What is the telescope development schedule?

We are experiencing a period of strong technical progress. The first of the seven GMT mirrors has been completed. The second is almost complete and has taken much less time than the first mirror. We

are learning all the time. We have all the glass we need, 40 tons of it, to cast the sixth and seventh mirrors, which reduces risk. We are currently finalizing the design of the mount [the structure that supports and moves the telescope], which will cost approximately US\$100 million. At the GMT site in Chile, we already have electricity, water, roads, and the internet. If we continue at this pace, we hope the telescope will begin operating—with the first four mirrors—in 2024. Even with just four mirrors, GMT will be the largest telescope in the world. The remaining mirrors will then be added as they are completed. Right now, our schedule is for all seven mirrors to be operating by 2027.

What are the first scientific targets of the GMT?

One of the first will be the study of exoplanets. Many of these Earth-like planets have been discovered in recent years, a number of which are located in the habitable zone of their systems. Currently, we know that these planets exist, but we are not able to collect enough light to actually analyze their atmospheres. We have no way of knowing if these planets contain oxygen, water vapor, or methane, all the chemical elements that we think of as signatures of life. Even with four mirrors operating in 2024, we believe the GMT will be able to do this, though obviously not as efficiently as when we have seven mirrors. The TMT and the E-ELT [European project planning the construction of a 390-meter telescope in Chile within the next decade] will also study these exoplanets.

What other topics will be a priority?

There are many questions about the growth of galaxies and black holes that are very important to what is known as multimessenger astronomy. Our location in Chile is highly valuable. We are right next to the largest synoptic telescope in the world [LSST], which will begin operating in 2023 or 2024. The LSST will survey the entire sky every night, and when the LSST detects significant changes, we will be right by their side to look at those changes in detail with the GMT. When all of our instruments are installed, we will be able to look back in time to the beginning of the universe. The GMT will function for 50 years or more. Over time, new instruments and software will be added and the telescope will improve more and more.

How do you expect the São Paulo astronomy community to contribute to the project?

We expect brilliant ideas on how to use the GMT to produce the best science possible. We are grateful to FAPESP for the financial support—we know that such support is not simple for any institution. We hope astronomers from São Paulo will collaborate with colleagues from other GMT partners. We value different perspectives in our decision-making processes. When I started working on this project, I promised to visit all the partners. I think it is important to meet the Brazilian astronomers, understand their viewpoints and priorities, and share the latest information about the telescope. I like to do this personally, face to face. ■