The Thirty Meter Telescope's Dilemma in China

Lack of government funding casts shadow on Chinese participation in the next generation telescope project, but scientists vow to stick it out

By XIN Ling (Staff Reporter)

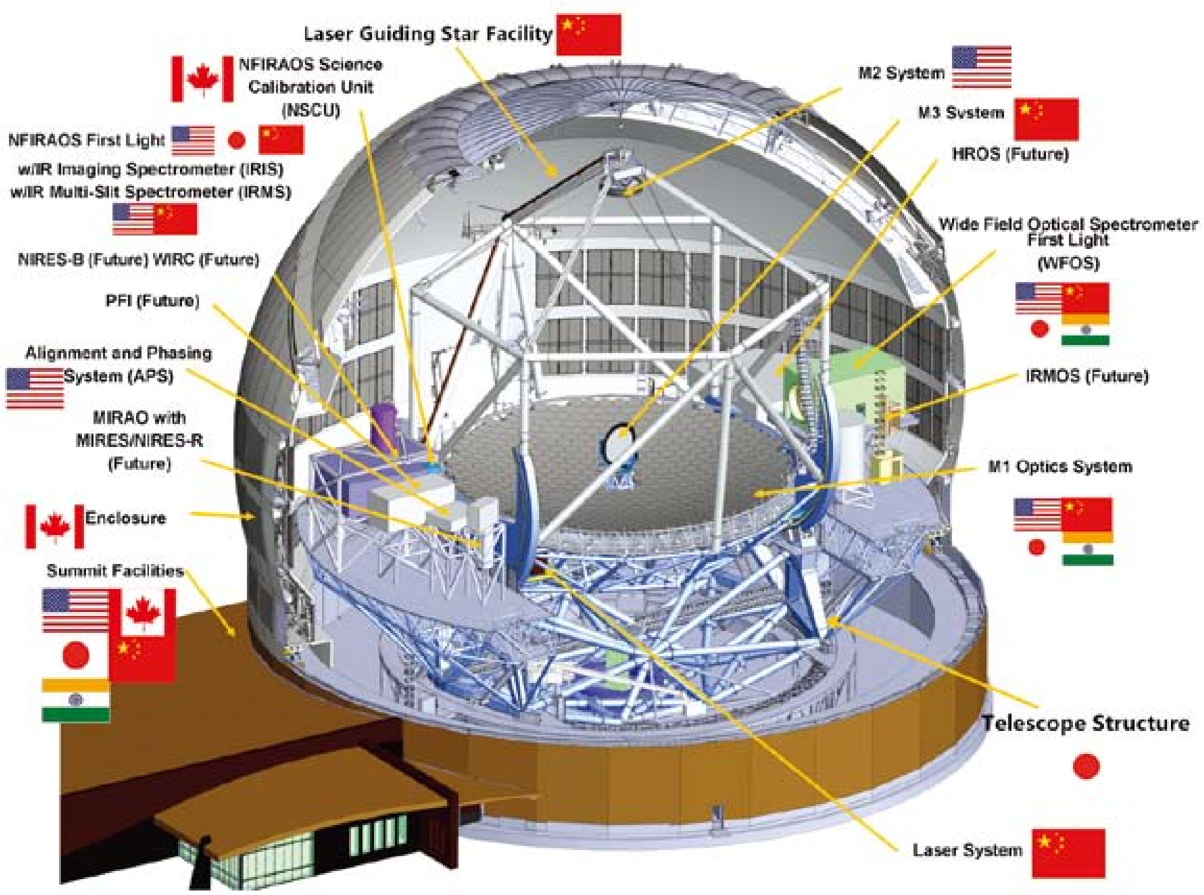
Credit: TMT International Observatory

Standing 4,205 meters above sea level in the heart of the Pacific Ocean, Mauna Kea – or the "white mountain" – is known not only as a sacred peak of the Hawaiian people but also as the Mecca for stargazers from around the world. Thanks to its high altitude, dry environment and stable airflow, this million-year-old dormant volcano is home to 13 telescopes built by 11 countries over the past five decades. The construction of the 14th started a year ago: once completed, it will become one of the most powerful and advanced instruments on Earth to see the very edge of our observable universe, near the beginning of time.

Just take a look at the design of the Thirty Meter Telescope (TMT), and you will be impressed by its futurist appearance and ambitious technologies. Compared to the current largest optical telescope, i.e. the 10 meter Keck Telescopes which is also located on Mauna Kea, TMT boasts a 30 meter aperture. Its primary mirror will consist of 492 pieces of 1.44m-diameter hexagonal segments, to see further and deeper than all ground-based predecessors by a factor of 10 to 100. Meanwhile, by using adaptive optics systems, it will gain spatial resolution more than 12 times sharper than what is achieved by the Hubble Space Telescope. With an increase of this magnitude in capability, TMT is expected to provide new observational opportunities in nearly every field of astronomy and astrophysics, and to help unravel the big picture of cosmic evolvement from the birth of the first lights to the formation of galaxies, stars, planets and massive black holes.

The TMT project is of special significance to China, because for the first time in history, Chinese astronomers are participating in building a next generation telescope which involves state-of-the-art technologies and likely research breakthroughs to push back the frontier of science in a definitive way. By working with the best scientists and engineers in the world, the Chinese sees TMT as a rare chance to achieve a major technological elevation, obtain first hand observational data, and accumulate managerial experiences on large astronomy projects.

As one of the seven participating parties, the Chinese TMT team is a consortium of scientists from a number of research institutions and universities from across the



Schematic of the TMT Observatory (Courtesy: XUE Suijian) country, headed by the National Astronomical Observatories of China (NAOC) under the Chinese Academy of Sciences. Its observer status was accepted in October 2009; four years later, on behalf of the team, NAOC director general YAN Jun inked a master agreement on the TMT project together with representatives from Canada, India, Japan and the United States.

"China is excited to be an active partner of such a world-leading facility, which represents a quantum leap for our community. With yet another major step taken, we look forward to many decades of solving the mysteries of the cosmos from Mauna Kea," YAN was quoted as saying at the signing ceremony in Hawaii.

TMT, however, is not the only 30m-class optical telescope being built at the moment. China's choice of TMT over the other two, namely the 25 meter Giant Magellan Telescope (GMT) and the 39 meter European Extremely Large Telescope (E-ELT), both under construction in Chile as TMT's rivals, is based on three considerations, according to XUE Suijian, who is NAOC deputy director and TMT project manager in China.

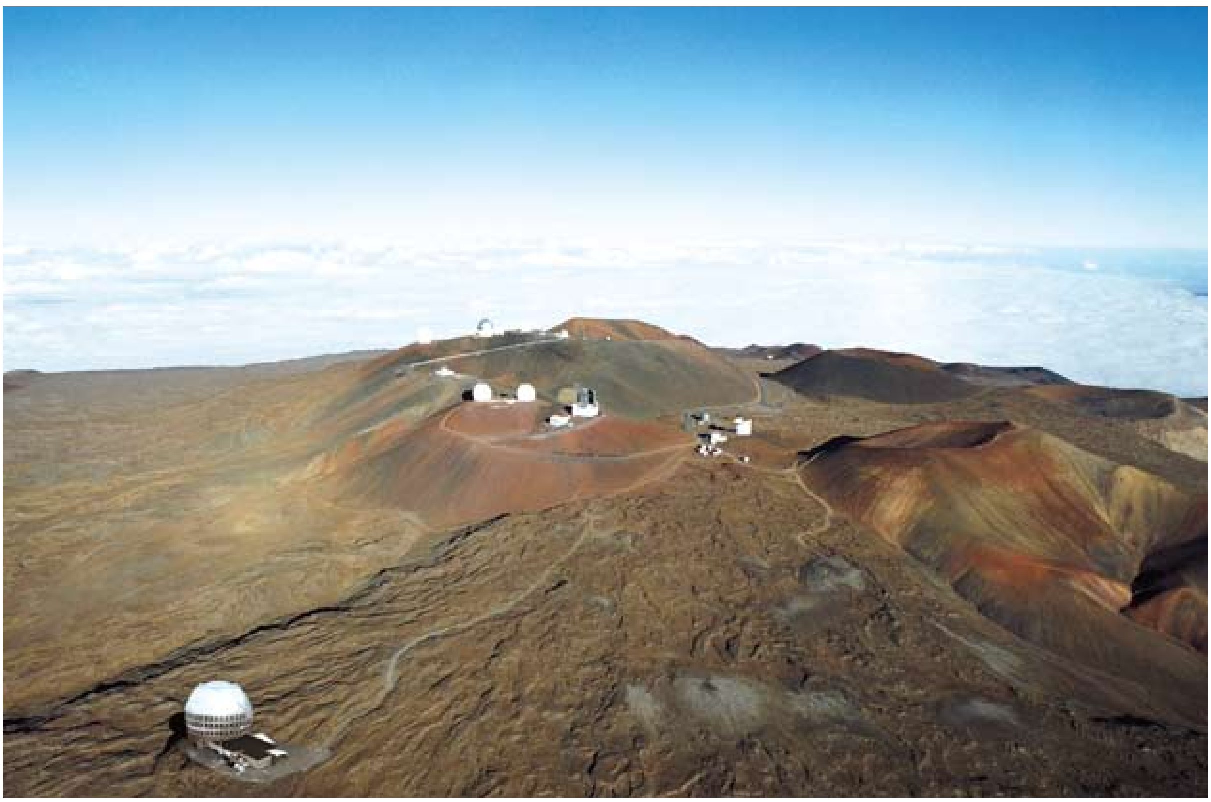
First, TMT is the only one of the three to be built in the northern hemisphere, where China's own super telescope LAMOST (The Large Sky Area Multi-Object Fiber Spectroscopic Telescope) and forthcoming FAST (The Five hundred meter Aperture Spherical Telescope) sit. Looking at the same northern sky, LAMOST, FAST and TMT will create enormous collaboration opportunities in the future.

Second, TMT is the least risky in terms of technology. As an enlarged version of the Keck Telescopes, TMT is born with mature, well-grounded segmentation and other key techniques. However, GMT, for instance, involves the casting of seven of the world's largest mirrors (each measuring 8.4 meters in diameter), as well as untraditional assembly techniques for these mirrors.

Last but not least, TMT is cost-effective for an emerging astronomical power like China to "catch up with the world in a relatively short period of time". By contributing 10% share to this 1.4 billion dollar project, China will be developing or co-developing major components of the telescope, and 70% of its total investment goes in the form of instruments, while the rest 30% in cash as the public management fund. "With less than one billion yuan, China will be reaping truly innovative science and technology advances", XUE believed.

China's soaring investment in science and technology and the construction of LAMOST and FAST have well prepared it to take up a challenge like TMT.

"China has made extraordinary investments in technical institutes in optics, precision mechanics, laser and adaptive



Mauna Kea (Courtesy: TMT International Observatory).

optics technologies. It has also invested in LAMOST which has advanced the technologies of large astronomy projects and systems, segmented mirrors, active mirrors and mirror sensing and controls. These investments have positioned China technically to leap forward to partnership in extremely large telescopes," observed Gary Sanders from the Californian Institute of Technology, a member of the TMT Delegation to China in December 2009.

Under the current work division scheme of TMT, China will be responsible for part of the optics system of the primary mirror (M1), with an effort led by the Nanjing Institute of Astronomical Optics and Technology. Meanwhile, researchers from the Changchun Institute of Optics, Fine Mechanics and Physics will be working independently on the telescope's tertiary mirror (M3) system, which is used to direct the light path to science instruments.

Some of the techniques are pioneered by Chinese scientists. For example, for the 4m-class polishing of the M3 system, "no other international TMT partner can do it," Sanders pointed out.

China is also in charge of the adaptive optics facilities of TMT. The CAS Technical Institute of Physics and Chemistry is now working on the telescope's laser system, while the CAS Institute of Optics and Electronics is taking care of the research and development of its guide star facility.

"Guide stars are artificial stars that are created by shining a laser into the sky near the actual observation target to help correct the atmospheric distortion of light", XUE explained.

And work on the laser system is moving smoothly into the prototype phase, said PENG Qingjun with the TMT group at the Technical Institute of Physics and Chemistry.

Besides these CAS institutes, universities like the University of Science and Technology Beijing, Peking University, Tsinghua, Xiamen University and Shanghai Jiao Tong University have been contributing steadily to the project, too.

Compared with technical challenges, the real concern for TMT people in China is their financial predicament, haunting the team from the very first day of joining the project.

"So far, we have not received any direct government funding yet," XUE told BCAS.

One reason should be the fierce competition between different astronomical proposals. Although the Chinese government has been generously pouring money into fundamental research in recent years, one fact XUE and his colleagues have to face is that astronomy is still a minor discipline in China, with a limited community scale. Therefore, the money earmarked for the field is finite and competition stays brutal.

The TMT Master Agreement was signed on July 25, 2013. YAN Jun (second from right), Director General of the National Astronomical Observatories of China, is signing the document on behalf of Chinese scientists.

And just recently, the Ministry of Science and Technology decided to give the green light to Chinese participation in another major international astronomical project: the Square Kilometer Array (SKA) in Australia and South Africa. For Phase I of SKA, China will spend around 65 million euro. That is to say, by the end of Phase II, the cost would add up to no less than China's share in TMT – one billion RMB.

Some say such a preference was politically motivated, but most people still believe that the choice was made out of the consensus of Chinese astronomers as a whole. The problem of TMT, therefore, comes not from outside but from inside the astronomical community itself, from peers including some senior scientists who have reserved their vote for TMT.

In fact, after the completion of LAMOST, there has long been a voice to build China's own next-generation telescope. The success of LAMOST has greatly boosted its designers' morale and confidence, and they believe that with the experiences gained from LAMOST, China already has the ability to build a 20 or even 30 meter class optical telescope.

When such a telescope may cost five billion yuan in total, China could choose to do it all on its own, or seek international partners like what TMT is doing, they say. "We are not against international cooperation. Instead, we welcome it. But the most important thing is China should take the lead," stressed CUI Xiangqun, chief engineer of LAMOST.

However, China's readiness to develop such a giant telescope remains controversial. On one hand, although LAMOST proves to be a success, it is only a 4 meter telescope – thus essentially unparallel to a 20 or 30 meter counterpart. On the other hand, even if the science part could work out, China's existing engineering level is not guaranteed to be able to deliver such a complicated design.

Anyway, for TMT, China is now the only participating nation who has not received official support from the government. In contrast, government support in Canada, India and Japan is robust. For instance, the Canadian Prime Minister claimed last April that they are going to provide 243.5 million dollars over the next decade to support Canada's participation in TMT.

As the construction of TMT is already suffering from local obstruction due to religious, political and environmental concerns, NAOC's financial dilemma cast a new shadow on the progress of the project, which is scheduled for completion in 2022.

And the Chinese TMT team might end up not getting government backup any sooner. When asked what to do if the worst happens, XUE shrugged his shoulders with some helplessness.

Now all the participating institutes are "bringing their own food", he joked, which means they are sparing their own people and research money to stay afloat with TMT. This situation is unsustainable, and one possible solution is to split the entire project into separate tasks and apply for separate funding, though it would be time and energy consuming with unpredictable results. Meanwhile, XUE plans to further mobilize the universities to contribute more to the project.

"China has large talented teams," said Sanders. "With collaborative development and some expert guidance, within two to five years, these teams can do almost anything that any other optical firm in the world can do."

Working and lobbying for the project over these years, XUE knows the meaning of TMT to China. "We don't want to lose the opportunity, and China can't afford to lose the opportunity," he said. "We will find a way to stay in the game and stick it out."

A series of protests and demonstrations have been going on at Mauna Kea, the most sacred mountain of the Hawaiian religion, over the choosing of the peak for the location of the Thirty Meter Telescope. Shown are protesters blocking the construction of TMT. (AlJazeera.com)