光学天文技术
领域动态

2020 年第 2 期（总第 3 期） 2020 年 12 月

国际大型望远镜项目（最新动态）

目录

本期概要：
本期动态专题扫描了 2020 年国际大型望远镜在建项目的进展及动态

Thirty Meter Telescope（TMT）

TMT Optical Cleaning System Reaches Design Milestone

September 8th，2020

TMT Optics and Systems Engineering teams recently conducted a technical evaluation of the primary mirror optical cleaning system, marking a major milestone in its design. The Optics Cleaning System (CLN) for TMT’s segmented primary mirror (M1) as well as the secondary (M2) and tertiary (M3) mirrors successfully passed Preliminary Design Review (PDR) on August 19 and 20, 2020 during a remote conference meeting.

TMT’s Cleaning system for the Primary Mirror (M1) optics is automated and uses CO2 to clean the 492 mirror segments mounted in the M1 cell. Four robotic cleaning arms will sweep nozzles spraying CO2 evenly across the primary mirror. This cleaning process will be performed with the telescope locked in horizon-pointing orientation

https://www.tmt.org

Latest Update from TMT

August 11th，2020

An important project for the global astronomy community, TMT is working collaboratively with the Giant Magellan Telescope (GMT) and the National Science Foundation’s (NSF’s) National Optical-Infrared Astronomy Research Laboratory (NOIRLab) to develop a U.S.-Extremely Large Telescope Program (US-ELTP). Its mission is to strengthen scientific leadership by the U.S. community-at-large through access to extremely large telescopes in the Northern and Southern Hemispheres, which will cover 100 percent of the night sky.

Earlier this year, TMT and GMT jointly presented their science and technical readiness to the U.S. National Academies Astro2020 panel. Chile is the site for GMT in the south and Maunakea is being considered as the primary site for TMT in the north. The panel will produce a series of recommendations for implementing a strategy and vision for the coming decade of U.S. Astronomy & Astrophysics frontier research and prioritize projects for future funding.

Also in collaboration with its US-ELTP partners, TMT has successfully submitted a Planning and Design Proposal to the NSF to help prepare for its entry into NSF’s major facilities review process

https://www.tmt.org

Extremely Large Telescope（ELT）

Contract signed for the ELT’s second prefocal station as design for the first close to approval

November 6th， 2020
A major component of ESO’s Extremely Large Telescope (ELT), its first prefocal station or PFS-A, is now close to completing its final design review. With this milestone nearly reached, ESO has signed a contract with Spanish company IDOM for a second prefocal station, PFS-B.

https://www.eso.org

New telescope promises boon for Turkish science

International megaprojects that cost well over $1 billion generate most of the excitement in observational astronomy today: the 39-meter Extremely Large Telescope under construction in Chile, for example, or the Thirty Meter Telescope, controversial because of its proposed location on Mauna Kea, a mountain sacred to some Native Hawaiians.
Science 06 Mar 2020:
Vol. 367, Issue 6482, pp. 1066
DOI: 10.1126/science.367.6482.1066

Giant Magellan Telescope（GMT）

Major NSF grant accelerates development for one of the world’s most powerful telescopes

The GMTO Corporation has received a $17.5 million grant from the National Science Foundation (NSF) to accelerate the prototyping and testing of some of the most powerful optical and infrared technologies ever engineered. These crucial advancements for the Giant Magellan Telescope (GMT) at the Las Campanas Observatory in Chile will allow astronomers to see farther into space with more detail than any other optical telescope before. The NSF grant positions the GMT to be one of the first in a new generation of large telescopes, approximately three times the size of any ground-based optical telescope built to date.

Magdalena Ridge Observatory Interferometer （MROI）

Focus on Delay Lines Chris Haniff, MROI System Architect

September 20th，2020

In June’s MROI Enquirer, MROI Project Scientist, Michelle Creech-Eakman, described the role of the MROI delay lines. This month we focus on a few of their special features. As Michelle explained, the delay lines’ task is to make sure the light from each of the MROI’s unit telescopes has travelled exactly the same distance before it’s combined with all the other telescopes’ beams and recorded. To make this happen the distance each light beam travels is adjusted continuously as the telescopes track their target, and as in all interferometers like the MROI, this is done using a so-called ‘’optical trombone’’ (Fig. 1). The core of such a trombone comprises three key elements. First, an optical part – the “cat’s eye’’ – that takes the light and reflects it back in the same direction it’s come from. Second, the part that changes the location of the cat’s eye. This means both a moveable “carriage’’ and a track for it to run on. And thirdly, a ranging system to tell the user where the cat’s eye is, so that we know how far each light beam has actually travelled. At the MROI, the 15kg cat’s eye and its 65kg carriage are known as a “trolley’’ and this moves inside a long vacuum pipe, the inside surface of which acts as the track (Fig. 2). The ranging device lives in the Beam Combining laboratory and is an off-theshelf laser metrology system, similar in function to the total stations used in surveying and construction, but able to measure distances ten thousand times more accurately. It shoots a beam of light towards the cat's eye (parallel to the starlight beam) and by basically timing how long it takes to come back, computes how far away it is. The decision to use the inside of the vacuum pipes as the delay line tracks was an ambitious one for the MROI, because the track, in principle, needs to be flat to about 250 microns over 200 metres at the MROI. Fortunately, by adjusting the tip and tilt of the cat's eye secondary mirror while the trolley moves, much looser tolerances on the flatness of the track are allowed. So, we were able to use low-cost extruded vacuum pipe sections and install them with much less effort than might have been expected. .Another interesting feature of the MROI trolleys, is that each cat's eye assembly is only loosely attached to its motorised carriage. Instead, the carbon fibre tube that holds the cat's eye optics is supported on "floppy'' flexures in an "inverted pendulum'' arrangement. This isolates the cat's eye from disturbances caused by bumps in the track but needs a system to make sure the cat's eye doesn't wobble back and forth as the carriage moves. To manage this we sense where the rear of the parabolic mirror cell is, and push and pull it so that it always remains in the same position relative to the carriage. Noncontact magnetic devices are used to both sense the position of the mirror cell and apply the necessary forces on it, so the cat's eye appears to be held "magically'' in place once the trolley is energised and the carriage moves back and forth inside the vacuum pipe. Although the delay line trolleys move only fractions of a centimetre a second when we are observing astronomical sources, when moving between targets the trolleys may have to be repositioned by many tens of meters. In these cases, we can drive them at up to 0.7m/s which is quite exciting to see and hear given their mass is 80kg! To stop the trolleys spiralling inside the vacuum pipes as they move – like shells in a cannon barrel – a sensor measures any rotation and a servo-system uses one of the four carriage wheels to steer them appropriately. And even when slewing at high speed, the exact position of each cat's eye is measured to about 5nm – that's 10,000 times less than the width of a human hair. When tracking stellar targets the light paths from each telescope are usually matched to about 20nm because of irregularities in the pipe surfaces, wheels, and motor drives in each trolley. So, the next time you try and thread a needle, you might want to ask yourself, could you move the thread as smoothly through the eye of the needle as we move our delay lines?

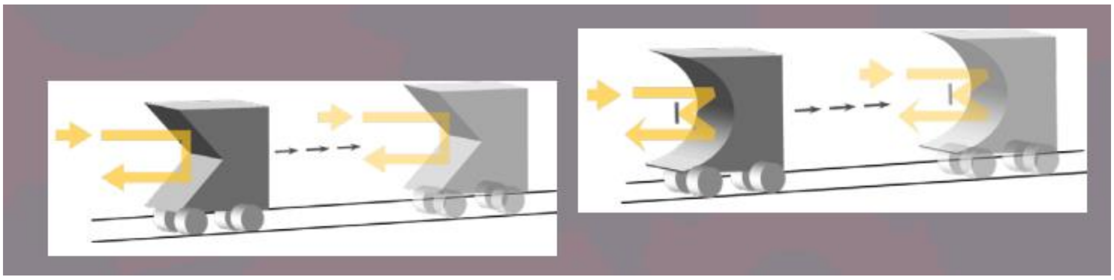

Fig. 1: Two cartoon examples of an optical trombone. In each case the light from the associated telescope enters from the left and is reflected back, in exactly the same direction but displaced in height. If the tracks are not flat, the height of the returned beam changes, and this can cause major problems. The MROI delay lines use the right-hand design where a

large parabolic mirror reflects the incoming light onto a small flat secondary mirror, which then sends it back to the parabola a second time to be sent off towards the science instruments.

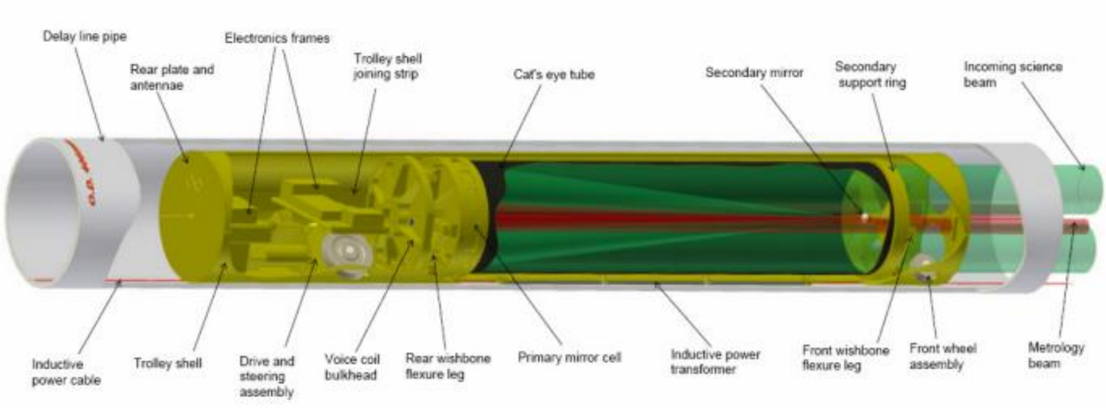

Fig. 2: A cartoon identifying the main elements of an MROI delay line trolley inside its vacuum pipe. Incoming starlight (green) and laser metrology (red) beams enter from the right and are returned in that direction by the cat's eye. The electronics, drive, and communication payloads are mounted to the left of the parabolic primary mirror (at center). The trolley is 2.3m long, has an outside diameter of 0.35m and a mass of 80kg.

http://www.mro.nmt.edu/