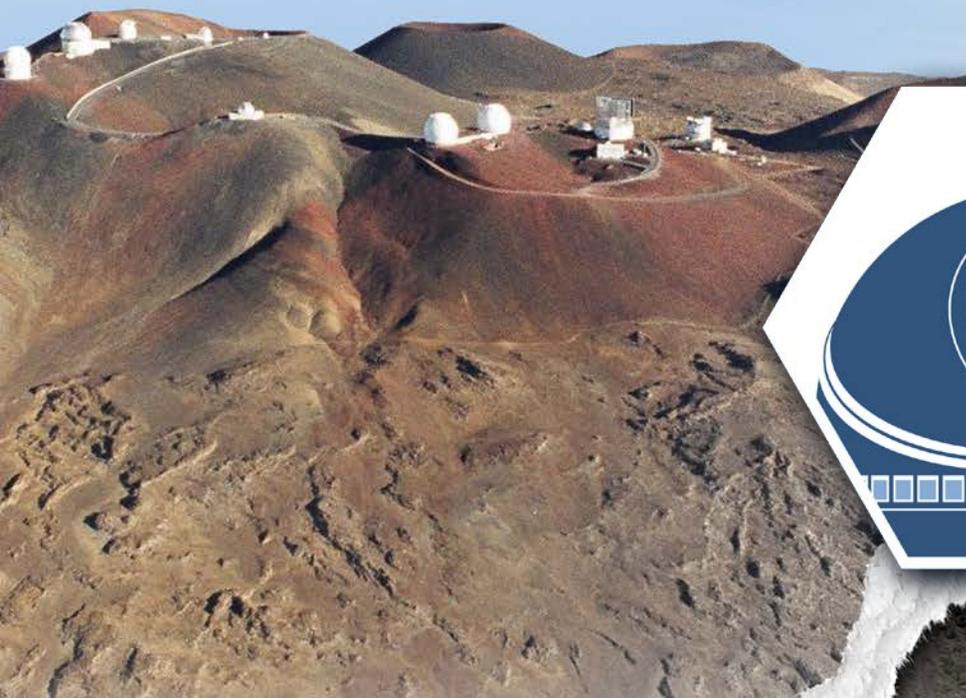


# Thirty Meter Telescope Site Locations



# TMT

## Maunakea Observatory



## Observatorio del Roque de Los Muchachos



30 m 望遠鏡  
三十米望远镜  
तीस मीटर दूरबीन  
Thirty Meter Telescope  
Télescope de Trente Mètres

Caltech



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## Where will TMT go?

In 2009, the Thirty Meter Telescope International Observatory (TIO) selected Maunakea, in Hawaii, as the preferred site to build and operate TMT. However, in December 2015, the Hawaii Supreme Court ruled that the state's permitting process was flawed, and the State Board of Land and Natural Resources was ordered to re-do the permit process.

TMT is currently working to re-obtain the permit necessary to start onsite construction in Hawaii. But, **while Maunakea continues to be TIO's preferred site**, TMT has also extensively investigated several alternative sites to ensure that construction can begin in a timely fashion. The alternate sites considered were distributed over the two hemispheres: Two sites in Chile, and two others in Mexico and Spain (respectively San Pedro Martir and Roque de los Muchachos Observatories). All sites presented a different set of advantages and challenges. The investigation looked into the various risks associated with each site and many other parameters in addition to site quality, such as the costs for construction and operations, the timeline to first-light, and the legal processes and timescale to obtain the necessary permits.

On October 31st, 2016, the TIO Board of Directors selected the 'Observatorio del Roque de Los Muchachos' (ORM), in La Palma, on the Canary Islands (Spain) as the alternate site for TMT. This decision was based on:

- The scientific importance for TMT to remain located in the Northern Hemisphere and position itself as a unique facility amongst other ELT projects.
- The quality of the ORM site, which will support TMT core science programs.
- The range of advantages related to the ORM site, including lower costs of construction and operations, faster timeline to initiate construction and reach 'first-light', and lower project risks based on the existence of support infrastructure.

## TMT science & first-light instrumentation

The Thirty Meter telescope will combine adaptive-optics corrected wavefronts with powerful imaging and spectroscopy capabilities to significantly transform how ground-based exploration of our universe is carried out.

With its thirty meter aperture, and diffraction limited imaging capabilities, TMT will provide dramatic improvement in sensitivity and spatial resolution across the visible, near- and thermal-infrared regimes. First-light instrumentation will include:

- An LGS assisted adaptive optics facility (NFIRAOS) delivering diffraction-limited images in the J,H and K bands to three instrument ports.
- An AO-fed near-infrared (0.8-2.5 $\mu$ m) imager and IFU spectrograph (IRIS).
- A UV/visible [0.31-1.0 $\mu$ m] wide-field imaging multi-object spectrograph (WFOS).

Its innovative design, the excellent astronomical quality of its future location, and the scientific capability that will be enabled by its suite of instruments, all contribute to position TIO as a major ground-based facility of the next decade.

| Site characteristics<br>(median values, unless stated) | MKO<br>(USA) | ORM<br>(Spain) |
|--|--------------|----------------|
| Altitude of site (m)                                   | 4050         | 2250           |
| Fraction of yearly usable time (%)                     | 72           | 72             |
| Seeing at 60m above ground (arcsecond)                 | 0.50         | 0.55           |
| Isoplanatic angle (arcsecond)                          | 2.55         | 2.33           |
| Atmospheric coherence time (ms)                        | 7.3          | 6.0            |
| Precipitable Water Vapor (% of time < 2mm)             | 54           | $\geq 20$      |
| Mean nighttime temperature ( $^{\circ}$ C)             | 2.3          | 7.6            |
| Extinction (V mag/airmass)                             | 0.111        | 0.137          |
| Ground dust concentration ( $\mu$ g/m <sup>3</sup> )   | 0.815        | 1.006          |

## Facts about ORM

### Mid-IR and the UV:

Although most of TMT science cases can be carried out as nearly as efficiently from ORM in comparison to Maunakea, a lower and warmer site for TMT would cause a lower sensitivity and efficiency, especially at the very shortest and longest wavelengths regimes. For instance, mid-IR observations in Q-band (> 18 microns), which are extremely challenging from the ground, will be significantly impacted from ORM.

### Adaptive Optics observations:

The turbulence profile over ORM is very similar to Maunakea's and our study shows that ORM is the second best site, after Maunakea, to support the AO-assisted observations that will be carried out with NFIRAOS, our AO facility.

### Dust:

There are various stories in the community regarding the impact of dust on observations at ORM. Our analysis shows that the occurrences of increased atmospheric extinction (regardless of the causes) are comparable for all Northern sites we studied. Overall, the presence of atmospheric dust was not a discriminating factor between alternate sites.

### Protection of night-sky above La Palma :

The entire island of La Palma, where the "Roque de Los Muchachos" Observatory (ORM) is located, is a UNESCO biosphere reserve, which is protected against light contamination. An impressive series of measures are already in effect to keep the sky above ORM among the darkest skies worldwide for all future generations.