DKIST

Daniel K. Inouye Solar Telescope

THE LARGEST SOLAR TELESCOPE IN THE WORLD

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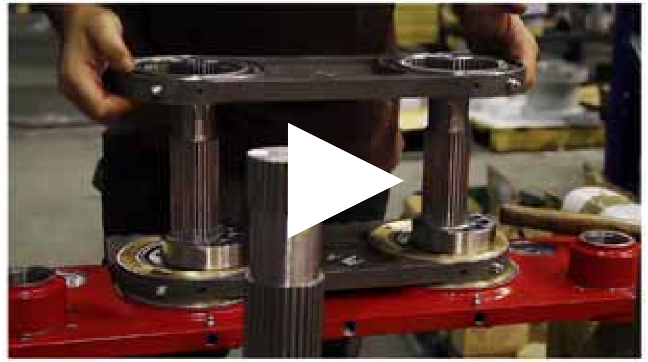
DANIEL K. INOUYE SOLAR TELESCOPE

FILMS

ATST, Advanced Technology Solar Telescope (Renamed as DKIST)

Crawler Mechanism



Crawler mechanism early unit on real scale test bench

Main structure fabrication (Base ring + arch girders)

Azimuth mechanism bogies

DESIGN AND FABRICATION

The Daniel K. Inouye Solar Telescope (DKIST), formerly the Advanced Technology Solar Telescope (ATST), is a 4-m class domed solar telescope located at the Haleakalā High Altitude Observatory in Maui, Hawaii, funded by the National Science Foundation (NSF) and coordinated by the Association of Universities for Research in Astronomy (AURA).

Being the largest solar telescope in the world, it will provide unprecedented abilities to view details of the Sun. Using adaptive optics technology, DKIST will be able to provide the sharpest views ever taken of the solar surface, which will allow scientists to learn even more about the Sun and solar-terrestrial interactions.

The Enclosure design contract with construction option was awarded to IDOM in June of 2010, completing successfully the design in January 2012.

The DKIST Enclosure, a large structural-mechanical system approximately 72 ft. [22m] tall and 87 ft. [26.6m] in diameter, is one of the observatory's key subsystems, providing complete protection for the telescope and optics.

In order to accomplish its functions, the DKIST Enclosure is comprised of a number of subsystems, including structure, mechanisms, cladding and ventilation gates, handling equipment, control systems, and electrical and pneumatic distribution.

The Enclosure's azimuth and altitude systems are driven by mechanisms especially designed to perform smooth operations at solar tracking speeds. In particular, the shutter motion is accomplished utilizing an innovative solution for driving large moveable structures, the "crawler" mechanism patented by Idom.

Following the completion of the detailed design, the fabrication of DKIST Enclosure was launched in May 2012 with the fabrication of a crawler mechanism early unit. As a solution implemented for the first time, the crawler was first subjected to both functional and endurance tests on a real scale test bench.

Simultaneously, the fabrication of long lead items like main structure – i.e. the base ring and the two arch girders-, azimuth mechanism, and control system was launched. When completed, dimensional controls on main structure partial assemblies were successfully accomplished.

In parallel with the shutter structures fabrication, the shutter tracks were assembled from machined sectors, preassembled and aligned on the arch girder to make sure they were accurately positioned so as to ensure a good pointing performance. Other systems like the enclosure cable wraps, the secondary structure and modular based façade were finished as part of the last stages of the enclosure fabrication process.

The DKIST Enclosure is unique in that it positions the optical system's first aperture stop and tracks the suns's motion with millimeter-level accuracy.

Two crawler units for driving the shutter motion

Shutter tracks assembly and alignment

Secondary Structure

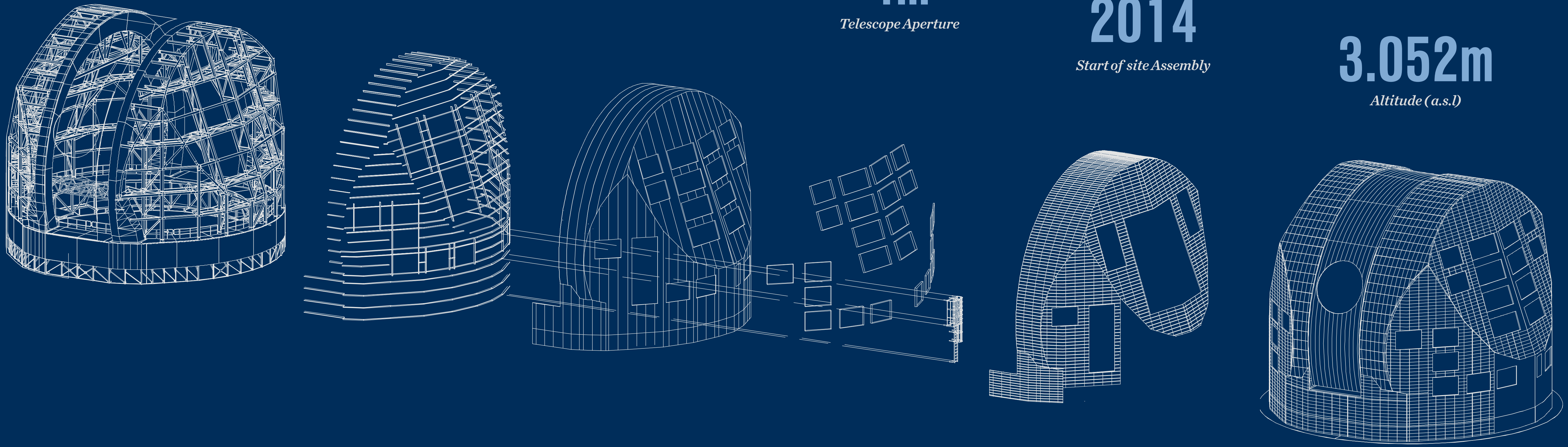
700t
Weight

26m
Approx. diameter

4m
Telescope Aperture

2014
Start of site Assembly

3.052m
Altitude (a.s.l)



DKIST ENCLOSURE IN NUMBERS

AURA
Client

Haleakalā High Altitude Observatory (Maui, Hawai'i)
Site

Base Ring modules assembled over the Azimuth Bogies

Arch Girders installation

Assembly of the Secondary structure

Shutters Modules installed in the tracks

Start-up of mechanisms during Factory Acceptance Tests

Modular based cladding system assembly

FACTORY ASSEMBLY & TESTING

Delivering the world's largest tracking solar telescope enclosure.

Haleakala High Altitude Observatory is a unique site for the astronomical observation, with superb seeing conditions and dominant clear skies.

However, the need for being respectful to a sacred space for native Hawaiians and careful with a fragile ecosystem with several endangered species, jointly with the lack of industrial capacity nearby, transport restrictions and high mountain weather limitations constitutes a complex Site to work.

Hence, the main purpose of performing the full Factory Assembly and Testing was to ensure the correct integration and performance of main structures, mechanisms, control system, secondary structure, smaller mechanisms and cladding system, in order to avoid the cost and the risk of the integration of those parts at the Site.

The Factory Assembly started with the installation and alignment of the Azimuth Mechanism Rail on April 2013 after factory site preparation. Soon afterwards, Base Ring modules with the Azimuth bogies assembled were installed in place on temporary supports and, once aligned, the Arch Girders were installed and correct assembly verified.

On July 2013, the assembly of the secondary structure started. With the vertical and horizontal trussed supporting the position of the arch girders, the shutter tracks tolerances were verified. In September, all the shutter modules were installed in the tracks, including the attached mechanisms, i.e. the Rear Door, Aperture Cover and Aperture Stop.

With the main structures and mechanisms assembled, the electrical assembly started in October 2013 and the control system began gradually testing subsystems functionality. The Enclosure was then lifted from the temporary supports and downloaded to rest on the azimuth bogie wheels.

Soon afterwards, the first azimuth rotation was completed and the Main Shutter separate halves were mechanically connected using the crawler mechanism on the motorized half. At this point, the control system commissioning started with the goal of having the mechanisms ready for the Factory Acceptance Tests, while the cladding system was being installed.

The Test Campaign was divided into two sets. The first set, conducted on December 2013, included the test on the Enclosure Structures, Mechanisms and Control Systems, while the second set, conducted on March 2014, included the test on the Cladding System and on the Maintenance.

The main mechanisms, altitude and azimuth, shown a very smooth operation at both maximum (2°/s) and minimum (0.004°/s) operation speeds. Regarding the entrance aperture stop pointing accuracy, the enclosure pointing performance is significantly better than the specified requirements.

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