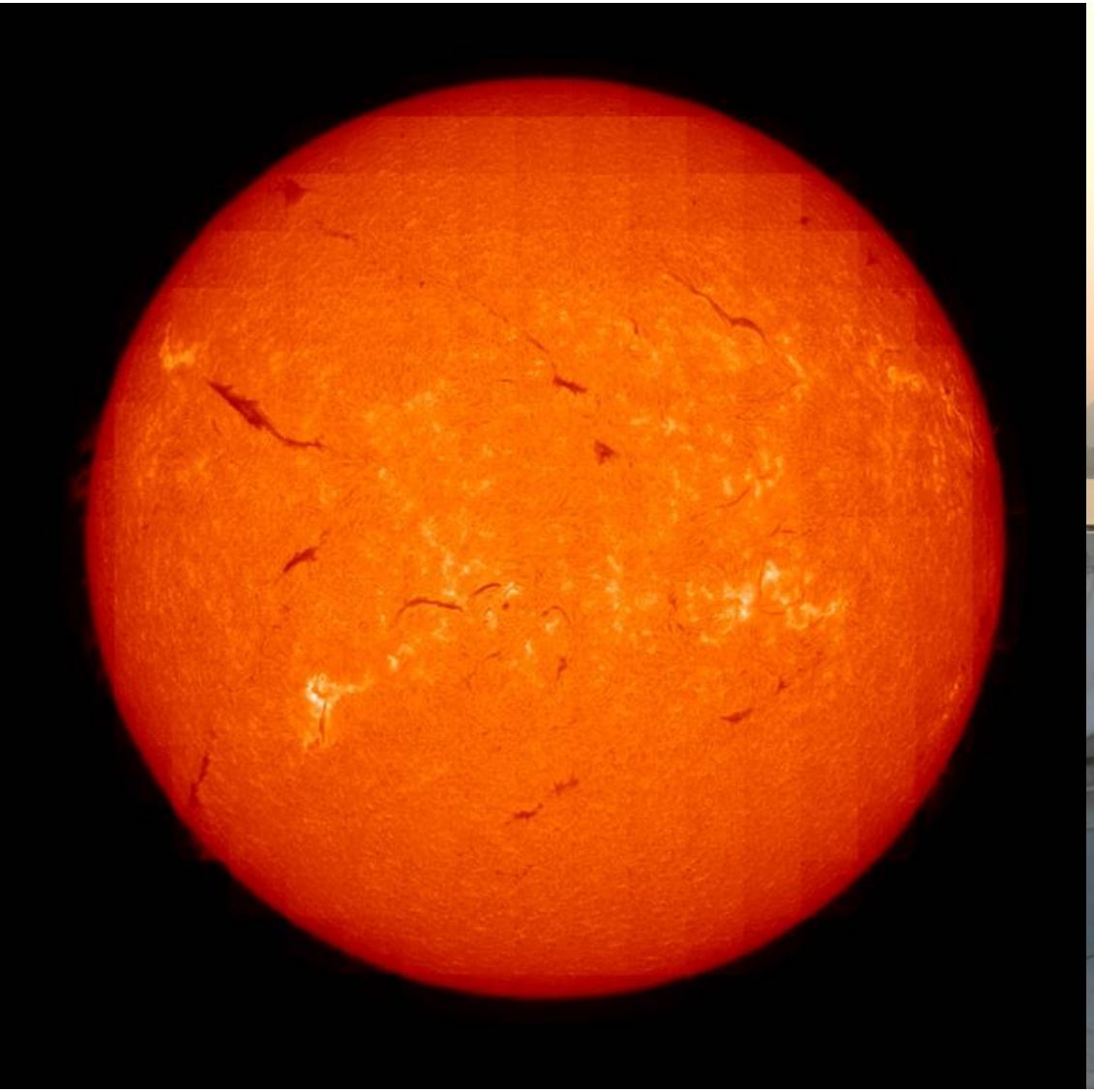
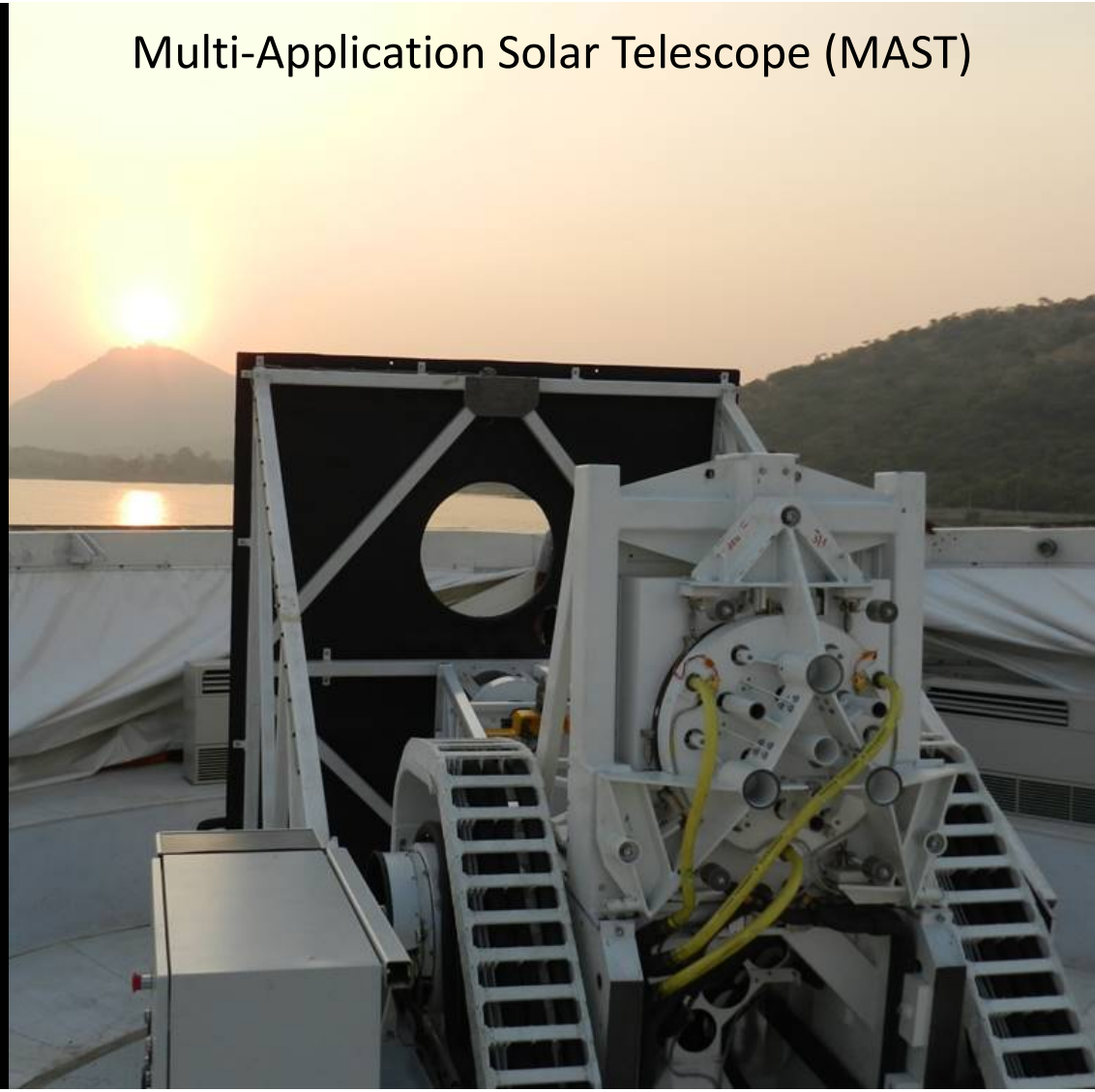


Multi-Application Solar Telescope (MAST)

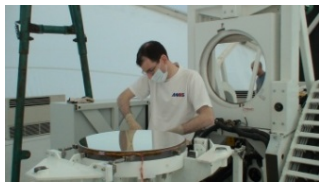


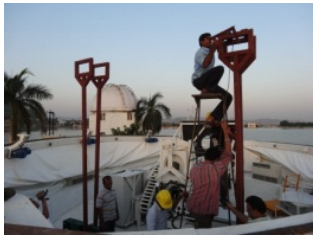
Multi-Application Solar Telescope (MAST) is an off-axis Gregorian afocal telescope with a clear aperture of 50 cm, installed on the island in the Lake Fatehsagar in Udaipur. The MAST was built by Advanced Mechanical and Optical Systems (AMOS) in Liege, Belgium. It has been installed on an alt-azimuth mount. It has salient features like a field de-rotator to compensate the image rotation and a guider to track the Sun continuously. It also has a wave front sensor for correcting optical misalignments caused due to temperature variations.

Transportation: MAST components were transported in 12 boxes across the lake on a pontoon to the island (around 700 m from the shore) with the help of a crane. It was a challenge to lift the heaviest box which weighed ~ 4.5 tonnes. A strut structure was erected on the island for lifting the boxes from the lake to the building top and were installed by a gantry crane.

Installation of MAST: The MAST telescope consists of 3 main components namely the tube, the fork and the ground interface structure (GIS). The main tube is basically a stiff central structure and is unconventional due to the off–axis optical design of the telescope. It is designed to hold the primary mirror M1 in the central part, the M2 unit comprising of a hexapod, its support and cooling systems and M3. The fork provides mechanical connection between the azimuth bearing and the two altitude supports. It also holds Coude train. The GIS is a steel welded stiff structure meant to provide connection between the azimuth assembly and the telescope pier to ensure a strong grip of the telescope with the ground rock. GIS includes the derotator system, field rotation mirror and the wavefront sensor unit.

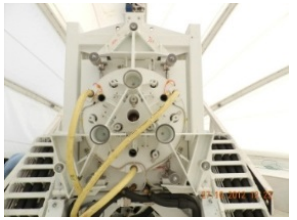
Integration of M1 mirror with the cell: The 50 cm mirror is held in an M1 cell. It is controlled by 3 screws that allow to align the M1 cell with respect to the tube structure. The mirror is supported by different kind of fixtures along different directions (axial, radial and tangential) to ensure that its surface accuracy remains intact from the mechanical and thermal loads while telescope is in operation. M1 mirror is an off-axis parabola with a surface accuracy of around λ/50.

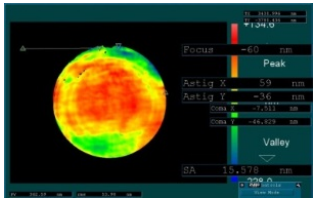




Front cover: MAST pointing towards the Sun as the Sun sets behind the 'Sajjangarh' hill.

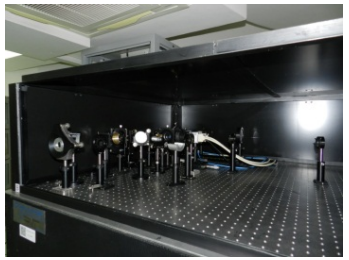
Thermal design: This is aimed at reducing the effects of solar flux falling on its opto-mechanical components in order to minimise the differential expansion. The tubes and the fork, are shaded from the sun's illumination by an upper sunshield system. The sunshield is a mechanical structure ending in a flat top plate, with two holes one for the M1 and other for the guider. The sunshield moves synchronously with the main telescope. The M1 mirror is also thermally controlled by flushing air at controlled temperature with a speed of 1.5 m/s. All the mechanical and optical parts are maintained within ± 1^0C of the ambient temperature.

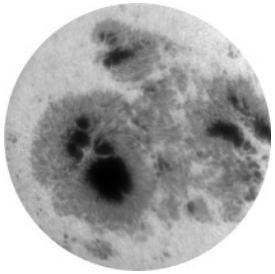


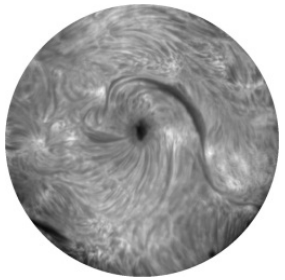


Optical Alignment and Tests on-site: A preliminary alignment of all the mirrors with respect to the telescope and optic axes was done using a theodolite. Telescope wavefront quality was tested by using a 45 cm reference flat and a Zygo interferometer in auto-collimation mode. Secondary hexapod parameters were adjusted to minimize the errors in the optical alignment of M1 & M2. The *rms* wave front was found to vary between λ/12 - λ/14.

Development of back-end instruments: The potential of the MAST has been realised with development of specialised back-end instruments, namely a Narrow–band Imager to record simultaneous images of the photosphere and chromosphere, a Polarimeter to measure the magnetic fields in sunspots and an Adaptive Optics system for image stabilisation and to achieve diffraction-limited performance. Several test images have been obtained using the MAST. Sample images of a 3 arc-min circular field-of-view of the Sun taken by a G-band 1nm filter (for photosphere) and 0.05 nm Halle Hα filter (for chromosphere) are shown.







Back cover: Hα full disk image constructed from a sequential mosaic of 293 images taken by MAST on 19th May 2015.

Udaipur Solar Observatory
Physical Research Laboratory
Badi Road, Udaipur – 313001,
Rajasthan , INDIA