THE DUTCH OPEN TELESCOPE

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Abstract. The Dutch Open Telescope is now being installed at La Palma. It is intended for optical solar observations with high spatial resolution. Its open design aims to minimize disturbances of the local air flow and so reduce the locally-generated component of the atmospheric seeing. This paper briefly describes the design, construction, short-term plans, and longer-term prospects.

Key words: solar physics, telescope design, atmospheric turbulence

1. DOT history

The Dutch Open Telescope (DOT) originated from C. Zwaan's participation in the JOSO campaigns of the early seventies in which the Canary Islands were selected as the premier European site for optical solar observation. Originally envisaged as a site-verification telescope for LEST, it grew over the (many) years into a full-fledged solar telescope project under the name of "Utrecht Open Tower Telescope". It was recently rechristened into "Dutch Open Telescope" in a La Palma ceremony.

The original emphasis on site-test capability led Zwaan to propose — to R.H. Hammerschlag who designed and built the telescope — a transportable open telescope. The key proposition was that the strong winds (5–10 m/s) that bring good seeing at La Palma should also inhibit the turbulent thermals that normally arise within a non-vacuum telescope. This remains the stratagem of the DOT. It is the first fully open solar telescope, not only domeless but also without telescope tube.

[0]F.P. Pijpers, J. Christensen-Dalsgaard, C.S. Rosenthal (eds.), SCORe'96: *Solar Convection and Oscillations and their Relationship*, 289–293.

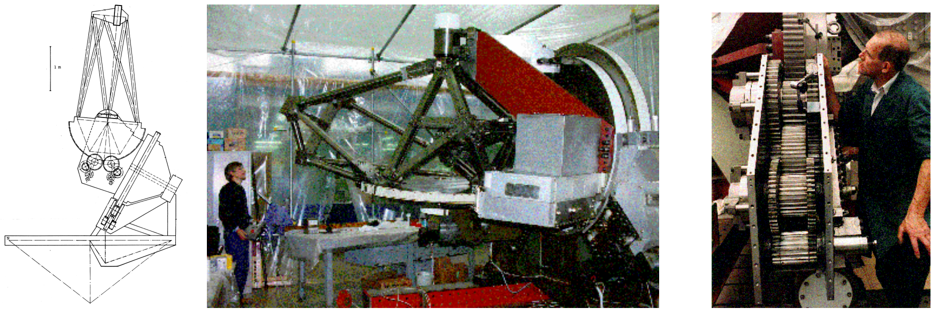

Figure 1. Left: DOT diagram. Middle: the DOT in Delft, with Hammerschlag. Right: technician P.W. Hoogendoorn with one drive train.

The requirement that the telescope should point stably, with accuracy better than its diffraction limit while exposed to strong and gusty winds, has led Hammerschlag to develop novel drives of unparalleled mechanical stiffness. Most of the DOT effort over the past two decades concerned these. Essentially a one-man project for many years that had to rely on tight university funding, the DOT progressed at about the pace of much larger solar telescope projects (THEMIS, LEST). It accelerated when the completion was funded by the Dutch foundation for technical sciences STW. STW also covers the current installation and verification phase.

2. DOT description

The DOT is a reflector. Initially, it will be equipped with a 45 cm parabolic mirror. However, the present structure admits a 80 cm mirror without change, and a yet larger mirror with minor modifications. The mirror sits out in the open. A water-cooled diaphragm in prime focus (at $f = 200$ cm, $f/D = 4.4$) selects a 2×2 arcmin field that is re-imaged onto a detector behind prime focus, or is deflected out of the incoming beam to the side where there is more space, or is folded back to a Cassegrain-like focus behind the primary.

The telescope has a parallactic mount. The hour angle and declination drives are considerably overdimensioned to avoid local heat dissipation. They also have large imbalance to withstand varying wind torques. They are driven by pairs of brushless servo motors, one preloading against the other to avoid backlash. A 1 : 75,000 transmission reduction is achieved in four steps with freely floating self-aligning gear wheels.

The support tower is 15 m high. Its four legs consist of steel triangles. Acting together they permit only translational motion of the telescope platform while inhibiting tilts. The platform is directionally stable within a

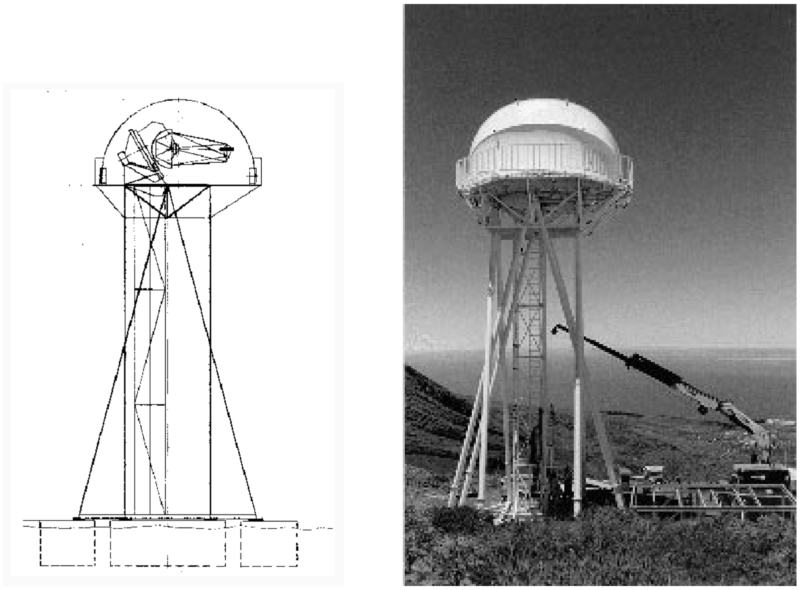

Figure 2. The DOT on La Palma. Left: sketch showing the telescope in its park position, pointing to the Northern horizon from the lower part of the hour angle wheel so that it fits below the closed canopy. While observing the Sun, the telescope points up to the left from the upper side of the hour angle wheel, with the prime mirror well above the support structure. Right: photograph taken in July 1996, shortly after the erection on La Palma. North is to the right. The DOT stands 60 m downslope from the SVST building from which it will be operated.

fraction of an arcsec even in very strong winds (up to 15 m/s).

The DOT is weather protected by a fold-away canopy made of heavy polyester fabric with PVC and teflon-like coatings. It may be opened and closed in winds up to 20 m/s and it should withstand 70 m/s winds when closed. Such storms do occur at the Roque de los Muchachos, and are most dangerous when large ice loads have previously been deposited by drifting low-temperature fog. The DOT is designed to withstand large ice loads. For example, the staircase plus elevator housing may fill up completely with 30 tons of ice without endangering the tower (weighing only 13 tons by itself) or the platform (5 tons) and telescope (17 tons).

3. DOT plans and prospects

The DOT is currently being installed at the Roque de los Muchachos next to the Swedish Solar Vacuum Telescope (SVST). The first item on the agenda is to verify the open-telescope principle as a means to achieve high spatial resolution. This includes experimentation with and fine-tuning of the heat budget within the telescope structure. Air suction will be applied around the prime-focus diaphragm, and schlieren tests will be performed to measure its effectiveness.

In addition, this verification phase should demonstrate the mechanical stability of the combined tower, telescope and drives. The innovative technology embedded in these with pointing stability as driver form STW's motivation to fund the completion, installation and stiffness test of the telescope.

For solar physics, the prime test will be to compare DOT image quality with SVST image quality. The Swedish telescope is widely acclaimed as a superb high-resolution facility. The DOT resembles the SVST in that the incoming solar rays encounter the imaging element itself as the very first optical component — 45 cm diameter in both cases — but the two are opposite in being a reflector and a refractor, respectively. The DOT will be operated from the SVST building. It will be exciting to compare the live images side by side!

After the verification phase, STW looses its interest so that funding for solar physics usage must come from elsewhere. This will be an uphill battle in which excellent results from the test phase are a prerequisite for success. An obvious goal is to replace the present 45 cm mirror by a larger one.

Initially, the DOT post-focus instrumentation will be limited to narrow-band imaging, with the molecular G–band around $\lambda = 430.5$ nm as start-off diagnostic and Ca II K and Hα (using a tunable filter on loan from V. Gaizauskas' Ottawa River Solar Observatory) as later add-ons. Our aim is to implement the sophisticated image selection and image restoration procedures that are pioneered at the SVST as quickly as possible. Scientifically, the aim is to furnish long-duration high-resolution image sequences to study solar magnetic field patterning and its evolution.

In summary, the DOT promises to be a high-resolution imager that may grow to considerably larger aperture than the SVST. The SVST is more suited to pioneering, by casting its image into a well-equipped laboratory in the cellar of its building. The DOT should become the facility where robust high-resolution imaging techniques are implemented for large-volume long-duration data gathering. Together, the two telescopes may form a tandem facility that to some extent makes up for the non-existence of the LEST close by.

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