OPENING THE DUTCH OPEN TELESCOPE

R.J. Rutten, A.G. de Wijn, P. Sütterlin, F.C.M. Bettonvil, R.H. Hammerschlag
Sterrekundig Instituut Utrecht
http://dot.astro.uu.nl

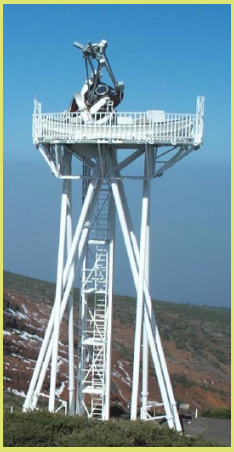
The Dutch Open Telescope (DOT) is an innovative solar telescope on La Palma, achieving high-cadence (20 s) solar imaging with 0.2 arcsec angular resolution over long durations (multiple hours) and wide fields of view (90×70 arcsec).

The beautiful movies on the DOT website dramatically convey the dynamical nature of the magnetically-dominated structure of the solar atmosphere. They demonstrate forcefully that long-duration high-cadence high-resolution observation is a must in solar physics. The DOT is the first solar telescope regularly producing such movies.

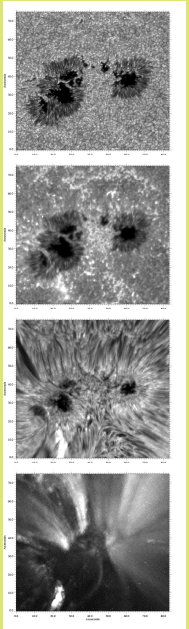
The DOT is presently being equipped with a five-camera multi-wavelength imaging system which turns it into a tomographic mapper, sampling the solar atmosphere from the deep photosphere to the high chromosphere. At the superb DOT resolution, this capability opens new and unique opportunities to study the magnetic coupling between the solar interior and the solar corona, in particular to exploit the H I Balmer-alpha line to chart chromospheric field topology and dynamics.

However, the DOT data production rate is presently limited to only a few observing campaigns per year. They suffice for our own Utrecht University research needs, but severely underexploit the enormous DOT science potential. The main bottleneck is the very time-consuming speckle processing – presently taking multiple months per observing day. Since speckle reconstruction parallellizes well, massive processor parallellization can speed it up to overnight turnaround.

Overnight processing will permit us to "open the DOT" as a high-throughput facility available for solar high-resolution observing to the whole international community. Our aim is to do so combining peer-review time allocation with a "hands-on-telescope" student education program that brings astronomy students to La Palma to assist in the actual observing.



- *Superb resolution – thanks to:*
  - special location: laminar oceanic trade wind, low inversion layer, absence of jet-stream shear;
  - open design: strong trade wind flushes telescope interior and primary mirror, support tower does not block wind, stable platform above ground-heated turbulent boundary layer;
  - advanced image processing: synchronous speckle burst registration at all cameras, large-volume speckle data collection, off-line speckle reconstruction at all wavelengths.



- *Tomographic mapping – combining:*
  - G band (4305 Å): molecular lines which brighten in magnetic elements through dissociation, showing photospheric fluxtubes at enhanced contrast;
  - Ca II H (3968 Å): brightens in magnetic areas, showing low-chromosphere topology similarly to ultraviolet images from space;
  - H-alpha (6563 Å): unique diagnostic of low-lying loops, showing magnetic canopies and their dynamics;
  - EUV Fe IX (171 Å) from space: bright thermal emission at 10^6 K and dark scattering absorption at 10^4 K, showing coronal loops and their dynamics.

Images T.E. Berger, SVST & TRACE

- *DOT science – content and niche:*
  - magnetic topology over large field: the DOT image-plane speckle reconstruction recovers all 1000 isoplanatic patches (pupil-plane adaptive optics would correct only the central one optimally);
  - magnetic dynamics over long duration: limited only by the speckle data storage capacity (2–6 hrs depending on cadence);
  - magnetic tomography spanning large height: through synchronous speckle registration at the multiple DOT wavelengths and precise co-alignment with utraviolet imaging from space (TRACE, SDO) through Ca II H.
  - niche: desirable as context imager to *virtually any observing program* studying solar magnetism, whether from the ground or from space.

- *DOT speckle processing – problem and solution:*
  - speckle problem: when the five DOT cameras run at full speed they fill the 360 GByte speckle storage in two hours (one "benchmark run" in the graph below). The subsequent speckle reconstruction using all DOT computers takes three months at present.
  - speckle solution: parallel computation on many processors with a large-bandwidth network. A parallel version of the speckle code has already been tested successfully.
  - estimate of the required cluster size: