

DUTCH OPEN TELESCOPE

Report for NOVA ISC meeting nr. 10

R.J. Rutten and the DOT team, Utrecht

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Summary

The three-year “DOT science validation phase” has formally expired. A high-level DOT Evaluation Committee (DEC) has advised to exploit the unique solar physics niche which the DOT offers the coming years by completing the multi-wavelength imaging capability, turning the DOT into a user-ready telescope, accelerate the speckle analysis processing, and pursue vigorous science exploitation. The pertinent documents are available at <http://dot.astro.uu.nl>.

A new three-year DOT science exploitation budget including grants from NWO and NOVA is presently being negotiated between A. Achterberg and the UU Faculteit Natuur- en Sterrenkunde. It budgets a prioritized development schedule. Details will be given during the meeting.

The second DOT imaging channel is expected to provide initial science data this autumn. Work on safeguarding the canopy control has started. Parallel speckle processing has been successfully initiated.

The first DOT science papers have been accepted by A&A.

The main DEC concern, the present smallness of Utrecht solar physics, has been recognized as general concern by the staff of the Sterrekundig Instituut Utrecht.

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1 Background and context

The Dutch Open Telescope is an innovative solar telescope at the Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias. It successfully aims at tomographic high-resolution imaging of the solar photosphere and chromosphere.

The DOT originated from C. Zwaan's involvement in European solar site testing in the 1970s and was designed and built by R.H. Hammerschlag of the Sterrekundig Instituut Utrecht with coworkers at Utrecht and at university workshops at Delft and Utrecht.

The DOT is now acclaimed as the sharpest solar imager worldwide, resulting from the combination of low solar-induced turbulence at La Palma (confined to a thin layer by the strong trade winds sweeping the Caldeira rim, with minimal disturbance from the open tower placing the telescope above it), the inhibition of internal turbulence by open-telescope wind flushing, the excellent DOT optics, and the consistent application of speckle reconstruction to correct image degradation by the remaining atmospheric seeing.

The DOT's extraordinary mechanical stability delivers high pointing precision even in strong trade-wind buffeting. The fold-away clamshell canopy survives the severe La Palma winter storms and ice loads.

A large-volume (350 Gb/day) speckle acquisition system has been installed at La Palma. Extension of the secondary optics from single-beam imaging to synchronous multi-wavelength registration is well underway. These additions together with the superior image quality make the DOT fill a solar physics frontline niche consisting of diffraction-limited multi-layer tomography of solar magnetic topology and dynamics over long durations. Such tomography is desirable for many research programs, especially in concert with spacebased ultraviolet imaging (SOHO and TRACE at present, Solar-B and SDO in future).

The open principle is now copied in large-telescope projects worldwide¹. The DOT niche will, however, remain important the coming decade even while larger high-resolution solar telescopes realize deployment of adaptive optics, since AO delivers full restoration to the diffraction limit only for the central isoplanatic patch. AO brings the important capability of feeding corrected wavefronts to spectrometer slits for Stokes spectropolarimetry – the major motivation to develop AO in combination with the large apertures needed for precise Stokes-vector measurement², which is the major science driver for (in most likely AO-effective order) NSST, GREGOR, THEMIS, and ATST.

Tomographic wide-field speckle imaging at the DOT and AO spectropolarimetry at other Canary Island telescopes, both with consistent long-duration 0.2'' resolution, will be highly complementary and the combination will have large impact on solar physics. We are confident that the DOT and the NSST (from whose building the DOT is operated, with adjacent control rooms and with intensive Swedish-Dutch collaboration) will form an outstanding and unique speckle imaging & AO polarimetry tandem the coming years.

¹GREGOR = German project to retrofit the GCT on Tenerife with an open 2.5 m reflector, time frame 2006. ATST = US project led by NSO to build an open 4 m reflector, site testing includes La Palma, time frame 2010. MAST = Indian proposal for open 6-telescope 2 m array, yet unfunded.

²Solar Stokes spectropolarimetry and other narrow-band applications are photon-starved. This may sound surprising to nighttime astronomers, but at high angular resolution the quantity to consider is intensity, not irradiant flux. The solar intensity is as low as from any other cool star.

2 Overall status

Past three-year program. The DOT project was funded the past years by SIU, UU, NWO-GBE, NOVA, and EC-TMR in a three-year “initial science validation” program which formally ended in September 2001 (in practice, the salaries of Bettonvil and Sütterlin continue into 2002, as does UU funding for exploitation and instrumentation). The program goals were:

- (i) – installation of multi-channel optics to feed solar images at different wavelengths simultaneously to synchronized CCD cameras in order to realize “tomographic” imaging of the deep photosphere (G band around 4305 Å), the low chromosphere (Ca II K at 3933 Å) and the high chromosphere ($H\alpha$ at 6563 Å, rapidly tunable);
- (ii) – initiation of high-resolution observing of solar-magnetism topology and dynamics;
- (iii) – exploration of image restoration techniques.

Item (iii) rapidly accelerated into the full design and realisation of a large-capacity five-camera synchronous speckle data-acquisition system. Item (ii) has produced initial DOT science papers (reprints at <http://dot.astro.uu.nl>) with more to come, in addition to the considerable fame of web-spread DOT movies. Item (i) proved the hardest, mostly for optical design and hardware problems which have been sorted out with much help from the ASTRON optical group at Dwingeloo.

A detailed report on this period has been prepared for the DOT Evaluation Committee (below) in spring. It is available, with other reports and the major DOT proposals, at <http://dot.astro.uu.nl/> under the heading “DOT documents”. The DOT website also links to the DOT movies and the (public) DOT database, next to giving background and outreach informaton.

New three-year program. A program for the coming years was drafted the past month and has resulted in a detailed three-year budget proposal which A. Achterberg has submitted to the UU Faculteit Natuur- en Sterrenkunde. The program tasks are, in agreement with the DEC recommendations:

- (i) – completion of the five-camera G-band, Ca II and $H\alpha$ multi-wavelength system;
- (ii) – safeguarding automation of canopy and telescope operation to enable observing by trained astronomers and students without requiring the DOT technical team;
- (iii) – scientific exploitation.

The corresponding budget proposal includes funding from SIU and substantial grants from NWO and NOVA, with a EC-TMR renewal proposal pending. It covers the technical development and exploitation of the DOT. Income and projected expenditure balance if the DOT project again receives a considerable allotment of IGF manpower. Details will be given during the meeting.

There are other tasks on the DOT agenda which are not part of the above budget negotiation:

- realization of parallel speckle processing in order to accelerate the image reconstruction. Also a high-priority DEC recommendation, but with the proviso that funding should be available outside Dutch astronomy. Efforts on such external fund raising have started, as have efforts on coding algorithms and cluster testing. These do emphatically not involve the DOT technical team until the stage of actual cluster installation on La Palma is reached.

- installation of the Irkutsk Ba II 4554 Å filter that was very successfully tested as Dopplergraph last year at the SVST (A&A paper). Specific funding for this effort has been obtained from INTAS, SOZOU and the Pieter Langerhuizen Lambertuszoom Fonds. In keeping with the DEC recommendation to give higher priority to the above program tasks, this task will rely heavily on manpower effort from Irkutsk and Kiev.
- similarly, and again in keeping with the DEC recommendation, testing the polarimetric capabilities of the Irkutsk Ba II 4554 Å filter will only be undertaken if IAC colleagues do most of the job.

Finally, there is also a longer-term list of desires which are not likely to be addressed the coming three years – but nevertheless remain desiderata:

- larger speckle processing capability (0.5 → 10 Tb/day), since the current storage capacity of 350 Gb limits the observing run duration to a few hours. The eventual desire is to realize parallel processing reaching overnight turnaround for 8-hour runs;
- zoom optics for H α , for which the trade-off between field of view and angular resolution is strongly set by the science application;
- larger field of view at full resolution (80 → 180 arcsec), requiring fast-readout 3K \times 3K CCD's;
- larger primary (45 → 125 cm), making the DOT the largest high-resolution solar telescope worldwide until GREGOR and ATST become operational.

3 Project management

The major management activity was the review by the DOT Evaluation Committee on March 29–30, 2001. The DEC consisted of Professor Oskar von der Lühe, director of the Kiepenheuer Institut für Sonnenphysik in Freiburg, Dr. Stephen E. Keil, director of the US National Solar Observatory at Sunspot and Tucson, and Dr. René G.M. Rutten, director of the Isaac Newton Group on La Palma. The DEC report is available under “documents” at <http://dot.astro.uu.nl/>, together with an extensive report to the DEC by the DOT team on the past three-year period and a detailed presentation by P. Sütterlin on the new DOT data-acquisition system.

As detailed in the DOT report for ISC9 (also on the website), most of the formal management concerns IGF planning and scheduling and ESMN activities. The core members of the DOT team (science: Rutten, Sütterlin; technical: Hammerschlag, Bettonvil) meet daily when in Utrecht.

There has been no formal meeting of the DOT TBC this period, except for the DEC review in which most TBC members participated.

4 Progress since last ISC report

- NWO program grant awarded;
- Pieter Langerhuizen Lambertuszoom Fonds grant awarded;
- 2nd and 3rd channel optics completed and tested at Dwingeloo;
- 2nd channel ready for installation;

- work on safeguarding dome control started;
- two DOT science papers accepted by A&A, a third nearly accepted;
- initial parallelization of the DOT speckle code completed and successfully demonstrated at the Utrecht University anniversary “Clustrum” manifestation;
- DOT presentations at various conferences (also in reviews by American colleagues);
- DOT movies played in “Five Years SOHO” public performances across the US and Europe.

5 Major meetings

DEC meeting, see above.

6 Milestones

- October 2001: green light for new three-year period;
- October 2001: installation of 2nd channel;
- October–November 2001: synchronous two-channel science observations;
- November 2001: start of Utrecht–Kiev collaboration on DOT observing (NATO grant, subsequently INTAS)
- spring 2002: installation of Ca II channel;
- autumn 2002: installation of H α channel
- autumn 2002: scientist-proof DOT operation (including RJR and students).

7 Relations with collaborators

Spain. The DOT remains permitted on La Palma under an unsigned MoU with the IAC, in the absence of a formal Netherlands–Spain agreement regarding the Dutch presence on La Palma. The DEC has advised

“from the perspective of the DOT project, the negotiations with Spain on The Netherlands joining the multi-national agreement for collaboration in astrophysics should continue”

and also that

“a part time on-site observer will greatly enhance the scientific effectiveness [of the DOT] and should therefore be supported. This could be achieved through collaboration with the IAC”

where the DEC implies that the problematic clause requiring a salary for the IAC (formerly a postdoc, nowadays an observer) might most usefully be met by appointing an IAC technician part-time at the DOT – on Dutch money. In the absence of such a solution, our counter argument remains that through the ESMN and INTAS (and hopefully ESMN-2) grants the DOT team already funnels substantial amounts to the IAC.

Europe. A proposal to the EC for an ESMN-2 TMR network grant has been coordinated by Rutten on behalf of 11 groups in 10 EC and future-EC countries. The verdict should be in by the end of October.

8 Critical areas

Personnel. The DEC advises:

“The DOT, being a small team delivering a demanding and diverse set of tasks, relies on a few key individuals. In particular for the science Süterling [*sic*] and Bettonvil are essential and options should be exploited to retain their effort. The realization of the scientific potential of the DOT requires the intellectual resources for the analysis and interpretation of the data in Utrecht. This means capacity in the solar group in the fields of radiative transfer and magneto-hydrodynamics. The scientific programme requires one or two additional positions to develop tomography, radiative transfer and advanced data processing techniques.”

The budget presently being negotiated with the UU Faculteit Natuur- en Sterrenkunde covers only technical efforts, not science personnel. Bettonvil is a likely candidate to fill the three-year engineer position provided by the NWO grant. Sütterlin is presently on the ESMN TMR grant; even if the EC accepts the ESMN-2 proposal he will not meet the stringent EC postdoc-from-elsewhere rules. Rutten is the only remaining solar physicist on the Utrecht staff. Thus, personnel on the science side remains a critical issue.

In addition, the DOT technical team misses optics expertise and electronics expertise. These needs are filled by helpful effort at Dwingeloo and IGF and by technical trainees — but only partially. A part-time observer on La Palma is also desirable.

On the other hand, the SIU staff has reached consensus that enlarging Utrecht solar physics by hiring a top-class solar physicist at the professorial level is now the top SIU staffing priority, and that additional filling of Rutten’s dakpan with another solar physicist may be appropriate too to revive Utrecht solar physics.

Management. The absence of management expertise in the DOT team remains an obvious weakness.

9 Budget

Details of the budget proposal that A. Achterberg has submitted to the UU Faculteit Natuur- en Sterrenkunde will be given during the meeting.

10 Items for specific consideration by the ISC

None, we think.