DOT Evaluation Report

submitted to the Director of the Astronomical Institute, Utrecht University, in response to the invitation from July 14, 2000

Version: 28 May 2001

Preamble

On July 14, 2000, the director of the Astronomical Institute at the Faculty of Natural and Astronomical Sciences, Utrecht University, invited a committee of experts in Astronomy and Solar Physics to evaluate the performance and scientific standing of the Dutch Open Telescope (DOT) which is operated by the institute's solar group. The composition of the team is Prof. O. von der Lühe, director, Kiepenheuer Institut für Sonnenphysik (chair), Dr. R. Rutten, director, Isaac Newton Group, and Dr. S. L. Keil, director, National Solar Observatory.

Specifically, the evaluation committee was asked to respond to specific questions which are stated in the *Terms of Reference* accompanying the letter of invitation. The Terms of Reference are attached to this report in **Appendix A**.

The committee received a written report on the "Status and Prospects" of the Dutch Open Telescope which has been compiled by the DOT team the week before the convention in Utrecht. The report was accompanied by several documents related to the recent evolution of the DOT as well as recent scientific results in the form of several time sequences of high resolution observations. A list of the material received for review is presented in **Appendix B**.

The committee convened at the Institute for Astronomy, Utrecht University, March 29 and 30, 2001. The two days were spent with a general introduction to the structure of the Dutch astronomical community and the Institute, presentations by the DOT team about various aspects of their work, discussions with the DOT team, and deliberations of the committee. Major conclusions of the committe have been communicated to the director of the institute before the convention ended. The agenda of the convention is attached in **Appendix C.**

This report has been written during the following weeks and was delivered to the director of the Astronomical Institute on May 28, 2001.

Overview

The committe was impressed by the good progress which the DOT team has achieved during the last three years of the operation of the DOT on La Palma.

The long history of the construction of the telescope can be in part explained with the desire to use new design concepts. These concepts include in particular strict attention to thermal control, thereby making evacuation of the telescope unnecessary, and to making tower and telescope stiff and insensitive to wind buffeting. Another factor in the duration of the project is the university environment with very limited resources, little pressure to maintain a schedule and a tendency towards over-engineering. The progress has been steady and comparable in speed to other projects since a grant in the early Nineties resolved much of the resources issue.

Shortly after the telescope saw sunlight for the first time, it became apparent to the international solar community that it will be a success. It has demonstrated the viablility of the "open concept", replacing evacuated light paths by careful consideration of the thermal environment, and by using a fully retractable dome with a mechanically very stiff mount. These concepts are now entering the designs of larger solar telescopes, such as GREGOR in Germany and the ATST in the United States.

Since the last two and a half years, a Science Validation Phase which formally ends in the next half year has been carried out by the DOT team. The goal of this phase is to demonstrate the DOTs scientific value by enhancing the post focus system, exploring the performance of modern high resolution imaging algorithms with the DOT, and to initiate a science program.

Reviews and Comments regarding the Terms of Reference

1. *Review the scientific potential of the DOT for Solar Physics in its current configuration*

The telescope is capable to deliver time sequences with consistently high spatial resolution over large fields simultaneously in several wavelengths. This capability is unique.

The DOT team has formulated a viable science plan which foresees the three-dimensional mapping of the solar atmosphere ("tomography") into the corona, and the study of the dynamics of magnetic fields in active regions.

Tomography of the solar atmosphere is unique in itself and has the potential to provide a crucial coupling between the lower photosphere and the coronal magnetic loops. The long sequences of speckle reconstructed images will allow linking photospheric features with coronal features observed from space. If carried out in context of simultaneous space and ground based observations this provides an important viable scientific programme for the DOT.

Active region evolution requires the large field and the ability to produce long time sequences. In the broader scientific context, the ability to understand filamentation and organisation in cosmic magnetic fields makes the results solar research relevant in a much wider area of astrophysics. The DOT has the potential to make an important contribution here.

Much of the science plan can be carried out with the DOT in its current configuration, after completion of the technical goals of the science validation phase. We recommend that the DOT team should concentrate on scientifically exploiting what the DOT now offers, rather than spending large efforts in improving the capabilities even further.

2. *Comment on the international competitiveness of the DOT and its prospects in view of other existing and planned solar observatories, both ground based and space based*

The DOT is, and will remain, a unique instrument. Other solar telescopes, both on the Canary Islands and elsewhere have more diverse capability and must accommodate often-changing PI experiments. The experiments are generally directed toward high-resolution spectroscopy and spectropolarimetry and will not easily allow the long, uninterrupted campaigns which the DOT is able to offer.

The DOT, with its dedicated instrument and scheduling flexibility, is unique in its combination of simultaneous wavelengths coverage, high cadence and long sequences of high resolution data. Because of the DOT's capability to consistently deliver high quality wide field images, it can provide context data that ties together observations from space and other ground-based telescopes. This greatly enhances the scientific potential of data for testing theories of the development of magnetic structures. Opportunities for possible involvement of the DOT team in space missions abound and include at this time the ESA/NASA mission SOHO and NASAs TRACE. Future opportunities are Japan's SOLAR-B, the NASA missions HESSI and STEREO and, in the 2010 timeframe, ESAs Solar Orbiter.

The same quality of data could not be obtained by just using the post-focus instrument of the DOT with another telescope, as access to other telescopes will always be tightly constrained and they would not necessarily be able to deliver the consistent high spatial resolution.

From the perspective of the international solar community, the DOT deserves continuation of its operation as it adds substantial, unique capability to the existing complement of observing facilities.

3. *Comment on the requirements for the continued operation of the DOT after the three-year test phase, and make recommendations on possible international partners needed for such continued operation*

As a first priority the DOT team now must complete the multi-wavelength imaging capability during the remainder of the science validation phase. During the same phase, the telescope should be brought to a state of stability where it can be operated by trained persons, without requiring the continuous presence of the telescope builders. However, the evaluation committee does not consider it a necessity to develop DOT as a common user facility.

For two years following the science validation phase any further development of new telescope capabilities should be given lower priority. For example, incorporating the Barium filter or providing polarimetric capability should be paced such as not to interfere with obtaining scientific results with the multi-wavelength system.

Judging from the presentations and results already obtained, DOT will have the most productive system for speckle high resolution imaging for the foreseeable future. Therefore it is important that the DOT team concentrates its further development efforts on the acceleration of the speckle analysis process. This area can be considered highly suitable for international collaboration and external funding, in particular through national or European funding sources to develop high-speed image processing.

The DOT development has proven the viability of the open telescope concept. It has been spearheading the recent renewed interest in this concept of solar telescope design and has been incorporated in the GREGOR and ATST telescopes. The DOT could serve as a testbed facility in this regard, in collaboration with other observatories.

There is significant scope for scientific collaborations with other solar observatories. It is unlikely that partners can be found who contribute towards the running cost of the DOT, but there may be scope for manpower contributions through collaboration with organisations such as the IAC. The DOT team should pursue opportunities to collaborate in EU initiatives for improvements of the observatory in the Canary Islands.

4. *Comment on the requirements for the facility, financially, operationally and scientifically, so that the maximum scientific effectiveness of the DOT can be maintained*

The continued operation of the DOT promotes the project from an experimental technical development towards full scientific operation. Therefore, from the perspective of the DOT project, the negotiations with Spain on The Netherlands joining the multinational agreement for collaboration in astrophysics should continue. The continued operation of the DOT will depend on the hospitality from Stockholm Observatory.

From the proposed budget presented by the DOT team, the running cost of the telescope appears adequate to operate and maintain the telescope and make minor modifications and improvements. Continued operation also requires access to technical personnel who are familiar with the telescope at the level of half of the optical engineer requested and the mechanical technician. A part time on-site observer will greatly enhance the scientific effectiveness and should therefore be supported. This could be achieved through collaboration with the IAC.

The maximum scientific effectiveness of the DOT can be achieved only if the speckle reconstruction process is further developed. Therefore, an investment in the development of a reliable and powerful speckle image reconstruction pipeline is important for the direct scientific exploitation of the DOT. IGF would be capable to provide excellent support for this and these possibilities should be considered.

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 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 raditative transfer and magneto-hydrodynamics. The scientific programme requires one or two additional positions to develop tomography, radiative transfer and advanced data processing techniques.

Considering the above, the proposed 620 kf/year is considered a reasonable estimate for continued operation and scientific exploitation, excluding the hardware cost for the computer system for speckle processing. The DOT team should be asked to develop a time schedules with clear milestones for ongoing developments, including a clear prioritisation of tasks.

Summary of recommendations

1. The DOT is an internationally recognized solar facility with a unique scientific potential which could not be offered easily by another observatory. The DOT deserves continuation of its operation beyond the Science Verification Phase.
2. Following the Science Validation Phase and with the multi-wavelength imaging capability completed as planned, the DOT team should concentrate on scientific exploitation. The DOT should be brought to a state where it can be operated in a safe and reliable fashion by a trained person. Further development of the telescope or its instrumentation should take second priority after vigorous science exploitation. Furthermore, developments should not be allowed to slip in time.
3. An investment in the development of a reliable and powerful speckle image reconstruction procedures is essential for the direct scientific exploitation of the DOT. This area is highly suitable for international collaboration and external funding. It would also increase the intellectual resources for the analysis and interpretation of the data, and help secure the historic strength of the group in the fields of radiative transfer and MHD.

Acknowledgements

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May 28, 2001

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(Prof. Dr. Oskar von der Lühe) (Dr. Rene Rutten)

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(Dr. Stephen L. Keil)