

Strategy for the Nordic Optical Telescope 2010-2015

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Background

European astronomy is currently working to establish a coherent long-term plan to ensure its future healthy development. The plan includes proposals for more rational ways of operating the European 2-4m telescopes, both in scientific and financial terms: Coordinating their instrumentation, allocating observing time jointly across the network, and integrating operations whenever feasible will produce a scientifically more powerful and cost-effective overall facility than the present set of essentially standalone national telescopes.

A comprehensive review of scientific, technical, and operational needs and opportunities for such rationalisation was performed recently by the *European Telescope Strategy Review Committee* (ETSRC; May 2010). This report was commissioned by the ASTRONET consortium of European funding agencies in continuation of the ASTRONET *Science Vision* (2007) and *Infrastructure Roadmap* (2008), and we now need to proceed to the implementation stage.

Regarding the *Nordic Optical Telescope* (NOT) and the other 2-4m telescopes at *the Roque de los Muchachos Observatory* (ORM) on La Palma, the ETSRC recommendation is clear: They should be merged to form a single, integrated facility. Following a comprehensive strategy review of the Nordic user community in 2006, this is already the top-level goal for the NOT. No tangible progress has been made so far, but the strong ETSRC recommendations, backed by the owner agencies, should accelerate the process soon. Therefore, as directed by the Council, we have conducted a new survey of our user community to obtain an overview of its current needs for such a facility (the questionnaire used for the survey can be found at <http://www.not.iac.es/q2010>).

Based on the 77 replies we have received, an updated draft strategy has been defined as outlined below. Comments on this draft will be collected until August 31, 2010, after which a revised plan will be prepared and finalised during September.

Scientific strategy

The 2006 strategy discussion, while recognising the major differences in scientific profile between the Nordic countries, concluded that "*the NOT should focus on the highest-impact Nordic science*". A more detailed analysis of the replies led to the conclusion that emphasis should be on transient and variable sources. The subsequent development of our services has precisely that aim.

In general, the current survey corroborates the scientific strategy defined in 2006. Supernovae from new surveys appear to become more prominent among transient sources, and exoplanet hosts have joined the more traditional variable, active and spotted variable stars. Three-quarters of the replies list the NOT as the highest-priority facility, and 90% of all users assign first priority for its use to scientific research. About 1/3 of the replies list cosmology and the distant Universe as their first scientific priority, while stellar astrophysics and exoplanets account for about half of the replies (with somewhat more emphasis on the latter by outside users). For those indicating a second scientific priority, the same subjects were listed by similar fractions of replies.

The future NOT will be a more European facility, and indeed 20-25% of our current users and the same fraction of questionnaire replies are already non-Nordic. Most users ask for a larger share of service observations in the future; the number of Target-of-Opportunity and Monitoring programmes stay approximately constant, but some projects need very large amounts of time. (Near-)simultaneous multi-wavelength capability is in strong demand, as is (spectro-)polarimetry. Many detailed comments were provided and are helpful in distilling a useful plan of action from the survey. The implications of the scientific priorities emerging from the survey for the future organisation, instrumentation, time allocation and operation of the NOT are discussed below.

Organisation at ORM

Given that the strategy for the NOT to join an integrated European 2-4m facility at ORM was approved by the Associates and endorsed by the users in 2006, the issue is how to implement it. The necessary steps are both formal and practical, and NOTSA should address them as follows:

- Apply pressure through ASTRONET and OPTICON as appropriate to persuade the funding agencies to act on the ETSRC recommendation for an integrated facility at ORM as soon as possible.
- Initiate discussions with all relevant partner facilities at ORM to define an overall optimum set of instruments, respecting the Nordic priorities as above and including such hardware and software upgrades as appropriate to facilitate future common operations.
- Initiate discussions with all interested partner facilities at ORM to define an optimum mode of operations to optimise overall efficiency in the future. Discussions should include a funding and "juste retour" model that will make it acceptable to all participating funding agencies.
- Continue to work with the host country (Spain) to obtain more suitable boundary conditions for the new facility than provided by the international Agreement from 1979.
- Work with OPTICON to include support for the transition to an integrated facility in the next OPTICON proposal for an extension of the EC contract. To prepare the user community for a future integrated facility we will start providing 'foreign' access to the NOT only through the OPTICON common time allocation process, in competition with all proposals for all telescopes in the OPTICON trans-national access programme.

Instrumentation

The priorities expressed in the survey confirm the need to:

- Implement a single, permanent instrument configuration at the NOT to increase flexibility of response and reduce operational effort. A standby successor to ALFOSC working in tandem with NOTCam is essential; a polarimetric option is important, but a large field ($>4' \times 4'$) is not essential if provided elsewhere.
- Implement the existing fast photometry option as a permanent feature in the new-generation array controllers, making it available in all optical and NIR imagers at the NOT.
- Provide a spectro-polarimetric option for FIES and extend the spectral range towards the red with higher QE and lower fringing. Improving the radial-velocity stability to a competitive level for exoplanet work is desirable, but may require an entirely new instrument; in view of the move towards lower-mass planets and possibly fainter hosts, the corresponding investment may not be justified at the 2.5-m NOT, given the availability of HARPS II at a 4m-class telescope at ORM. Stellar spectroscopy at $R > 100,000$ can be provided by HARPS and/or SARG@TNG.

Time allocation

Time allocation in the future facility will be through a common proposal and review process. The NOT should continue to play an active and constructive role in the OPTICON pilot project for this mechanism, as outlined above. The joint time allocation process should allow for a fast-track option for short projects as currently available at the NOT and extremely popular with users (requested in 83% of the replies). It must also be possible to reserve large fractions of time to special projects, such as large surveys or coordinated ground-space campaigns that are funded for specific purposes by dedicated consortia. Nationally funded shares will likely have to be respected with a reasonable degree of flexibility, but all time should be allocated through a single process.

Mode of operation

Overall, ~50% of users prefer to have their projects executed flexibly in service mode, against only ~30% favouring classical visitor mode, with no significant variation between the Nordic countries (but the opposite distribution for non-Nordic users). Target-of-Opportunity and monitoring projects are listed in ~25% of the replies. Several users preferring visitor mode list the educational value of the hands-on experience as the motivation (see below). Our current development of an end-to-end observing system is preparing the NOT for 100% operations in queue scheduled service mode. However, full implementation would require significant strengthening of the staff. Indeed, in 2009 when we had a full-time postdoc on the staff, funded by NordForsk, observations were made in service mode during 36% of all time - nearly 100 nights.

Other ORM telescopes

Survey participants clearly base their future science at ORM primarily on the NOT, followed by the WHT and TNG in that order; preferences between the WHT and TNG seem to depend on the still-uncertain future instrument suite at each. The INT could offer valuable opportunities as well, e.g. in wide-field imaging, high-speed photometry or high-precision polarimetry, with the Liverpool telescope providing supplementary robotic services.

Education

The 2006 strategy recommended a more systematic approach to the educational use of the NOT, and three-quarters of the answers to the present survey list education as an important second priority. Since then, a coherent suite of tested models for on-site and off-site courses at student levels from high school to PhD has been implemented and completely documented. The most recent extension of this offer is the series of optical-IR-mm radio training course organised jointly by NOTSA and Onsala Space Observatory, Sweden, with support from NordForsk, to prepare students for the multi-wavelength future of European astronomy. The success of this type of course should be pursued not only at the Nordic, but also the European level, in cooperation with other interested partners such as ESA, IRAM, or Spanish institutes. The future organisation of the infrastructure at ORM should include improved common facilities for on-site courses (classroom with adequate network and projection equipment), and the funding model should include observing time for educational activities.

The NOT Research Student programme is highly successful and popular; since 2002 it has provided hands-on experience for some 30 Nordic students, nearly all of whom have gone on to successful careers in astronomy and related sciences. The future integrated facility should accommodate an enlarged Europe-wide programme, which will provide an even broader and richer scientific and social experience and international networks for the students.

In tandem with these improvements, a more systematic effort is needed to make these opportunities known to all European universities with astronomy departments and seek to implement them as a standardised feature in their curricula. Additional funding should be sought (e.g. from the EC) to make these offers available to all deserving European students.

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