Report of the Visiting Committee for the Isaac Newton Group of Telescopes

September 2005

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1. Terms of Reference

The Isaac Newton Group Board wish to set up a Visiting Group to review the Isaac Newton Group of Telescopes (ING) on La Palma in order to provide an international and independent perspective on its likely scientific programme and strategic direction beyond 2009, when current agreements end. The Visiting Group will make recommendations to the ING Board, and through it to the Director ING and the funding agencies PPARC, the NWO and IAC.

The aims of the Visiting Group are to:

1. Identify the likely role or roles for the ING in the era beyond the current international agreements (which are due to end in 2009), to include scientific direction, instrumentation, international competitiveness and an assessment of options to ensure the facility meets the strategic needs of the UK, NL and Spanish astronomical communities;

2. With respect to the above consider:

    2.1 the scientific use and competitiveness of the ING facilities within the UK, NL and Spanish astronomical communities;

    2.2 the options for organisation of the ING facilities in the context of the European astronomical community;

    2.3 options for development of the facilities and their mode of operation;

3. Having undertaken 1 and 2, produce a written report to the ING Board, to include recommendations for the future, to guide the ING partners in their strategic planning.

2. STATUS of the ING

Since the previous visiting committee in 2001, the ING has undergone significant operational changes without losing scientific eminence or its importance to its constituents. The 1-meter Kapteyn telescope has been closed to proposal-driven science (although it is used to monitor atmospheric turbulence) and the Newton telescope (INT) has been reduced to use of a single, albeit good, instrument, the wide-field camera (WFC). The Herschel telescope (WHT) has therefore increased its importance to the research program for the ING. The significant reduction in budgetary support by the UK was picked up in part by increased support from Spain, but overall the budget has declined by about 29% (37% when inflation is included). The ING has sustained itself and its scientific productivity by supplementing the budget by a large separate grant to support the development of ground-layer adaptive optics from the NWO and EU support for purchase of observing time. Proposal pressure remains high, especially for the Herschel telescope (WHT), over 3 for the UK and Dutch communities, and over 2 for the Spanish community. The demand involves a healthy mix of "workhorse" instruments such as ISIS and more specific visitor instruments such as SAURON and the Planetary Nebula Spectrograph (PNS). The committee notes that the proposal requests are about equally balanced between ISIS, visitor instruments, and the remaining instruments, over the recent semesters. Weather downtime is small (≈ 25%), and technical downtime is well below the 5% target. Uncorrected image quality is among the best of any developed site.

The Observatorio de Roques de los Muchachos (ORM), remains a superb site, thanks to long-established laws regarding light pollution controls throughout the islands, and has become the home of several new facilities, most notably the Gran Telescopio Canarias (GTC), the 10.4-meter telescope being constructed by the Instituto de Astrofísica de Canarias (IAC) and the two 17-meter Cerenkov detectors, MAGIC-1 and MAGIC-2. The committee also noted the new facilities developed to detect and monitor transient events, in particular "SuperWASP" and the Liverpool Telescope. The infrastructure and promise of the site are in excellent shape, with much higher bandwidth internet connections planned for the near term. The committee believes that these new facilities, and others on the ground (LOFAR; ALMA) and in space (GAIA) will put major demands on well-equipped 4-meter telescopes for a long time.

The cash partners, the UK, the Netherlands, and Spain, are equitably and well served by the ING. In each case, almost half of the submitted observing proposals include named students and one third have a single responsible student. Observing proposal pressure is high, and comparable among the partners. Finally, a limited study of the top 25% most-cited papers published in 2000-2004 shows a distribution of first authors roughly in agreement with the (evolving) partner observing time shares (UK: 29; Netherlands: 8; Spain: 9). A more complete study is in preparation, following the previous study by Benn & Sanchez (PASP, 113, 385, 2001), and it will be restricted to a smaller and more appropriate set of major journals. The committee was informed that 4-meter class (and smaller) telescopes "contribute more than half of top science from **all** ground based facilities (covering all wavelength ranges)". The committee suspects that this is due to

several factors, including supporting as many (or more) users of the largest telescopes and hence opportunities for truly creative science; longer observing runs, resulting in an equal or greater number of recorded photons compared to shorter runs on larger telescopes; and more versatile, dedicated instrumentation. The 2d-F instrument on the AAT, and the continued operation of the Sloan Digital Sky Survey, are the most prominent (and extreme) examples. So long as proposal pressure remains high, new instruments can be deployed, and new observing modes can be enabled, the committee believes that the ING telescopes, especially the WHT, have a strong future.

3. Instrumentation Strategy

The committee was treated to a summary of specific science highlights, which reflected the personal tastes of the committee members. Three premier studies relied on "facility" instruments, including the large-scale study for substructure in the halo of M31 using the INT/WFC, the detection of cosmic shear using the WHT/PFC, and evidence for dark matter in a low surface brightness galaxy using WHT/AF2. The committee was struck by the major importance of "visitor instruments", especially the PNS (apparent lack of a dark matter halo in a mid-sized elliptical galaxy) and SAURON (dynamics in the central regions of elliptical galaxies; a galaxy's global "superwind").

The WHT provides a stable platform for visitor instruments. Its opto-mechanical quality is demonstrated by the possibility of implementing adaptive optics at optical wavelengths, something not attempted anywhere else. Also, the successful visitor instruments speak for the excellent quality of the support staff and the operational setup of the WHT. The recent high-impact research is coming from the visitor instruments SAURON and PNS, both instrument with a strong and clear science programme. Observing time on these instruments is exclusively granted to the instrument teams. Runs for these instruments are thus necessarily limited due to the size of the research teams. This places an additional burden on the observatory, as visitor instruments have to be mounted and (re-)commissioned for relatively short runs of one to two weeks at the time.

These visitor instruments are critical to the success of the ING because the reduced budget no longer includes funding for facility instruments, and because the ING partners are clearly capable of defining new "experiments" requiring somewhat specialized instrumentation, which is shared by all users. The ING maintains a skilled engineering/technical staff, the second largest concentration of such people for both the UK and the Netherlands. The ING has invested its limited personnel and financial resources wisely, with three primary emphases.

The first of three emphases within the ING include wide-field observational capabilities, which have always been a hallmark of both the INT and the WHT. The upgrades to AUTOFIB and WYFFOS will improve the scientific capabilities.
The second major emphasis at the ING was not envisioned when the INT and WHT were built, but have been part of the ING program for almost a decade: major improvements in image quality using two different paths for adaptive optics. Ground-layer adaptive optics does not promise diffraction-limited performance, but does offer a substantial

improvement and at optical wavelengths, and over a relatively large field of view (several arcminutes), making its overall "AΩ" performance quite competitive. This will have practical benefits for imaging as well as integral field unit (IFU) spectroscopy using OASIS (a French-led facility, previously deployed at CFHT). The ING has done considerable work in this area, thanks to the support of the NWO, and the site is well suited to the application. With the addition of the laser facility GLAS the sky coverage will be dramatically improved. It appears the major technical and operational issues have been solved, and deployment is scheduled for 2006. The WHT will likely see an increase in proposals and scientific output in consequence of the new instrumentation. Farther down the road, but perhaps of more fundamental importance, is the higher-order adaptive optics program. This capability is critical for the justification and performance of an extremely large telescope (ELT), and since ORM is a possible site, the investment in its development and further study of the site characteristics appear prudent. The development process at the WHT is well-conceived, with a permanent use of one of the Nasmyth foci in a controlled environment (GRACE). The prior visiting committee report emphasized the key science that would be enabled by successful implementation of an IFU with NAOMI. Progress has been made, but at a slower rate than hoped (but not slower than could be reasonably expected). NAOMI/INGRID imaging in the near-infrared is performing well and the integration of OASIS is proceeding.

The final major emphasis at the ING lies with detectors, and here the ING engineering group is a recognized leader. The "photon counting CCD" capability is critical to wavefront sensing for improved AO performance. (Indeed, much of the engineering work at the ING, in terms of detectors as well as site characterization, are done with a view toward an ELT program.) Other efforts to increase performance of red sensitivity and autoguiders are having success, and will benefit the WHT, INT, and, in all probability, other observatories.

Currently, no future facility instrument is planned. The laser guide star, financed through NWO, is the last major project developed and built by the ING engineering group. ISIS continues to be sufficient with minor upgrades considered. LIRIS is relatively new and was provided as a contribution of the IAC in joining the ING. Adaptive optics with NAOMI/OASIS is not yet requested heavily. It remains to be seen, whether this will change once the laser guide star facility GLAS is implemented.

A disappointment from the previous review is that the ING remains housed in a former hotel in downtown Santa Cruz. The space is compartmentalized, which reduces staff interactions, and the small working spaces inhibit some instrumentation efforts. A common sea-level facility for the ING, GTC/IAC, and possibly the Galileo and Nordic Optical telescopes, remains a worthy goal.

4. ING Science in 2012

The scientific role of the ING beyond 2009 needs careful evaluation. The ING's strategy of providing, in the WHT, a world-class instrument development platform for University groups, yielding unique developments such as SAURON and PNS, will assume even greater importance in the next decade. Many of the existing and, indeed, any future members of the collaboration, will undoubtedly have aspirations in the development/construction of the next generation of extremely large telescopes. With 8m-class telescopes increasingly run in service mode, and many 4m-class telescopes run in long campaign mode, opportunities for experimental scientists to gain valuable experience in building and commissioning small-scale instrumentation will be critically reduced. As a result, astronomy may face a 'skills crisis' in the development of the next generation of instrument scientists, particular those with the systems engineering experience gained through directing interfacing instrumentation with a telescope. In this era, the WHT may therefore provide a unique capability by its ability to accept University scale instrumentation (particularly those that take less than PhD term to build and exploit). Continued support for the WHT in the next decade would maintain and develop the essential skills base in experimental astronomy in those countries participating in the ING.

Moreover, new instrumentation is likely to focus on exploiting the strategic advantage provided by the AO developments of the past decade and the excellent atmospheric conditions of the La Palma site. Specialist instrumentation can also respond quickly to scientific issues or developments in technology as they arise, providing an opportunity to maintain high-impact science on the WHT.

Specific examples of the science enabled by AO-related instrumentation include resolved kinematics of stars in early-type galaxies, yielding invaluable information on the formation history of these systems. Following the conjecture of Freeman and Bland Hawthorn (2003), we anticipate that spectroscopic observations at high spatial- and spectral- resolution of nearby galaxies may also provide the opportunity for chemical-tagging of stars to trace back the merger history of nearby galaxies including our own Milky Way galaxy. Such observations will prove vital in the GAIA era, with the WHT providing important complementary (deeper) information of stellar radial velocities and compositions in our own Milky Way Galaxy. In this respect, the WHT assumes significant strategic importance as the only optical 4m-class telescope in the Northern Hemisphere to which UK and the Netherlands have access. Northern Hemisphere access is also relevant for objects such as M31 (also likely to be a target for many large-scale kinematic studies in the GAIA era) and specific deep fields, including HDFN and CDFN.

The excellent properties of the La Palma site also offer future opportunities in the narrow band imaging domain, e.g. narrow-band or tunable-filter imaging survey of z~6 Lyman alpha systems, complementing JWST observations of high redshift galaxies in the optical rest frame or rest-frame UV spectroscopy of such galaxies by means of an upgraded AUTOFIB2 with next generation OH-suppression fibres. Such programs illustrate the combined strategic advantages of the ING in the next decade:

- Unique platform for innovative or University-scale instrumentation
- High quality of site
- Opportunity for campaign-style programs
- Northern hemisphere location
- Support of space astronomy

Many of these programs would require significant numbers (many tens to hundreds) of nights at the telescope and would therefore benefit from a campaign-mode approach. This also provides the opportunity to innovate different (or supplementary) support models for the ING, with the University consortia conducting these campaigns potentially providing operational resources to partially support the programs.

The division between large consortia-driven programs and individual targeted programs may be left to the ING Board and TAC to decide on the basis of scientific merit. TACs, guided by PATT have a good history of balancing the needs of large and smaller programmes on UK facilities and of monitoring the performance of consortia running multi-semester programmes[1]. The committee also recommends that the ING Board may wish to develop an indicative 'year in the life of the ING'; a potentially powerful tool in illuminating the nature, diversity and impact of the science programs which will be possible with the ING facility. A 'year in the life of the ING' may also help clarify future operational models and their resource requirements.

The panel recommends to the ING Board that further staff resources are invested in the areas of user support and data analysis/archiving. This may be achieved by direct investment in additional facility staff, or possibly through in-kind provision of staff effort from the consortia established to facilitate major survey programs as suggested above. The latter approach has the advantage that any additional resources are specifically targeted to delivering the science of key programs. In the past, science consortia have successfully developed and distributed sophisticated data-handling tools and data management systems, based on their own exploitation of their survey data. This has provided improved facilities for the entire community, as well as supported the timely release of well-analysed datasets[2].

In summary, the Visiting Committee sees the ING, and in particular the WHT, contributing significantly to the partners' science in 2012 in the study of galactic structure and galaxy formation, through the development of innovative instrumentation, and by complementing space astronomy, especially GAIA.

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[1] Such programs include the 2dF galaxy and QSO redshift surveys on the Anglo-Australian Telescope, the SCUBA survey programme on the JCMT and the wide-field imaging surveys on the INT.

[2] The 2dF galaxy and QSO redshift survey consortia provided at least 5DSY in the development of their publicly-available archives and interrogation/analysis tools following data release.

5. Evolution of the observatory model

From the perspective of science, governance and financial support, the most practical approach to continued productivity of the ING is to evolve the present successful model forwards. The essential ingredients of that model are a strong ING Board, representing multiple partners, each of whom is committed financially, intellectually, and creatively to the immediate future of the facility as a tool for astronomical discovery. Broadly speaking, the ING's present budget is appropriate for its present role, and the free parameters in the model are the partner shares and the number of partners. A more detailed assessment of the operational model is given in the next section. The Visiting Committee's interviews with the IAC, NWO and PPARC suggest that IAC wishes to increase its share, NWO wishes to remain fixed, and PPARC wishes to decrease its share substantially. From a geographic, political and scientific perspective, a natural new partner in the ING would be CNRS of France. The leading nations using international non-ING-member time are France and the USA, according to publications listed in the 2002-2003 biennial report.

In the longer term, which means between two years hence, up to the time when international agreements must be renewed for the ORM, the Visiting Committee sees a real opportunity to create the CNO envisaged by the Directors of the NOT, TNG, and ING. Given the scientific need to support European Space Astronomy from the ground, and to support radio astronomy in the northern hemisphere, and given the success of the Opticon trans-national access programme, the Visiting Committee finds the vision for the CNO to be compelling, "to create a facility with the most powerful combination of these capabilities, available in a transparent manner to a broad European astronomical community and operating as a coordinated, cost-effective facility."

As a practical matter, the immediate future of the ING needs to be secured first. Once this is done, the Visiting Committee recommends that the ING endorse this vision and invite the agencies to join a CNO Council, composed of one scientist and one agency representative from each of the prospective CNO partners, to explore the future of a CNO. For all involved there are potential benefits of telescope aperture matched to scientific opportunity and the stimulus of scientific collaboration and competition across the European community, and, indeed, globally. For scientists and research funding agencies this is a win-win situation. The IAC is a key partner in a CNO, as it can play a leadership role by contributing the enormous power of the GTC.

6. Operational mode

6.1 General operations

The WHT is successfully running stable operations with several competitive instruments. Typical run lengths of a few nights (longer at the INT) are still the norm and depend somewhat on the national allocation committees.

Visitor instruments are using about 20% of the available time at the moment. One could consider expanding access to visitor instruments by offering them through the WHT call for observing proposals. ING support for observations with these instruments would have to be arranged accordingly. A first test case will be locating UltraCam at the INT. With the long-term vision presented in this report, community access to visitor instruments might be a useful option to consider, especially in the current funding profile in the UK, where instruments can be funded through PPARC directly. It nevertheless would be useful to have the ING staff involved in the instrument development early on.

The most successful recent visitor instruments (SAURON and PNS) are collaborations between the UK and Dutch astronomical communities (with some other partners as well). This model could certainly be expanded further. The instrument capabilities of the IAC, as demonstrated by LIRIS, are considerable.

6.2 Service observing

For observations with the optical AO system NAOMI, the ING is considering service observing in the future to make use of the best atmospheric conditions. Observations with NAOMI indeed profit most from good seeing.

Queue observing has intrinsic overheads, which need to be considered carefully, before such an experiment is started. The queue always needs to be overpopulated to make sure that all possible atmospheric conditions are covered. This leads naturally to unfinished projects, projects being carried-over into future periods and – sometimes – dissatisfied users. The promise of service observing is 'guaranteed' data quality, optimal use of the prevailing observing conditions and best service to the highest ranked proposals. Other overheads are time lost to repeated observations, e.g. when conditions change, the burden put on the observatory for calibrations, information gathering, aka Phase II, and data distribution. These should not be neglected and the resource estimates need to be drawn up in a realistic way. The ING is strongly encouraged to discuss the details of queue observing with colleagues at Gemini and ESO, who have experience with this *modus operandi*.

There appears to be a breakpoint when queue observing becomes useful. If too little time is set aside for the queue then the advantages can not be fully explored. Where this breakpoint lies depends on the observatory site and its most frequent conditions.

The ING is considering setting aside about two (continuous) months during the summer period for queue observing. These are typically the ones with the best atmospheric conditions. Also, only NAOMI/OASIS in combination with ISIS, LIRIS and possibly the auxiliary port camera should be used for queue observing.

Conceptual planning for queue observing is fairly well advanced, but it was unclear how much is still needed for the implementation. Software development, e.g. in databases to maintain the observing programme and observation definitions, as well as data is required. Support software for the observing process (e.g. scheduling, keeping track of the conditions, required calibrations, etc.) is also needed. It did not become clear, how far the implementation of queue observing has progressed.

An alternative mode of operation could be long runs for programmes with matching conditions, where observers of two projects are available. This might result in some loss as not all atmospheric conditions can be optimally used, but decreases the burden on the observatory dramatically. Having more projects finished should be beneficial for the overall load on the observatory.

6.3 Time Allocation Committee

Currently time at the ING is allocated by four different TACs. Each partner maintains its own TAC and the International Time Committee for ORM distributes 5%. The schedule is managed by the observatory Director. The arguments for independent TACs are that in each country the proposals are evaluated in context with other observatories, to which the astronomers have access, and that TAC members have a better knowledge of local priorities and research fields.
In the long run such an arrangement is detrimental for the overall competitiveness of the ING. Proposals do not compete at an international level as national communities are not exposed to the overall competition and can fall behind. In the Europe of the 21st century such a model appears not appropriate any longer. Even now larger proposals have to be submitted to separate TACs, which creates an unnecessary double jeopardy. This is the general method of the larger projects making use of the visitor instruments. Given the exploration of joint operations with other telescopes at the ORM, as laid out in the proposal for a Common Northern Observatory, the ING needs to receive its full support from a single TAC. Time will still be distributed according to the contributions, but the selection of the proposals is done in a more competitive environment. Eventually, the international TAC could be replaced by the single TAC for all telescopes at ORM.
The unique capability of the ING needs to be better explored by its community. The TAC must play an active part, possibly instructed by guidelines of the ING Board. Allocations for the most competitive and unique instrument, NAOMI/OASIS and the visiting instruments, need to be increased. TACs never like to be told what they should do, but it might be useful for the ING Board to pre-allocate time fractions to some under-explored unique modes.

6.4 Long-term competitiveness

With an evolution to a closer collaboration between the telescopes at ORM a single observatory, including the GTC, can be envisaged. The ING should work to prepare itself as an attractive partner in such a collaboration. It could become the lead institution within the consortium. The conditions to be fulfilled are:

- maintain a competitive staff (astronomical and technical)
- maintain the lead in adaptive optics development at the ORM
- maintain an interesting instrument complement, possibly acquired as visitor instruments

- maintain the high operational performance currently present.

The ING right now is in an excellent position in regard of the above criteria and certainly leading all observatories at the ORM. It has a very motivated and skilled staff. The operations are very smooth and probably the most efficient at ORM.
The WHT must remain a leading 4m telescope competing favourably with 8m facilities in some areas (e.g. adaptive optics). Only in such a situation can it become an attractive partner in the ORM observatory.
The WHT plays an important role in the UK instrumentation programme. It provides the platform where unique and innovative instruments can be deployed. These instruments can still be built by university consortia putting them apart from the instrumentation efforts required at larger telescopes. Yet, the ING engineering group is fairly isolated and does not collaborate closely with other instrument groups in the UK and the Netherlands. Losing any of the above advantages makes the ING less attractive as a partner.

6.5 ING and ELT

The ORM is a possible site for a future European ELT. The ING has started to invest resources (a few nights per year) to experiment with ELT technology (phasing, laser guide star, etc.). It is being used as a test bed for technology developments. Site characterisation has also been supported by the ING (e.g. SLODAR). The ING partners need to be prepared to capitalize on this investment.

7. Summary

Small and medium aperture optical telescopes, and in particular those of the ING, continue to contribute a highly significant fraction of top science from ground based facilities. In the next decade the Visiting Committee sees the ING, and in particular the WHT, contributing significantly to the partners' science in the study of galactic structure and galaxy formation, through the development of innovative instrumentation, and by complementing space astronomy, especially GAIA. The WHT may provide a unique capability through its ability to accept University scale instrumentation. From the perspective of science, governance and financial support, the most practical approach to continued productivity of the ING is to evolve the present successful model forwards. Broadly speaking, the ING's present budget is appropriate for its present role, and the free parameters in the model are the partner shares and the number of partners. In the short term, if one of the partners intends to reduce its current share, a new partner in the ING should be sought promptly.

In the longer term, the Visiting Committee sees a real opportunity to create the CNO envisaged by the Directors of the NOT, TNG, and ING. Given the scientific need to support European Space Astronomy from the ground, and to support radio astronomy in the northern hemisphere, the Visiting Committee finds the vision for the CNO to be compelling, "to create a facility with the most powerful combination of these capabilities, available in a transparent manner to a broad European astronomical community and operating as a coordinated, cost-effective facility."

The ING is considering service observing in the future to make use of the best atmospheric conditions. Queue observing has intrinsic overheads, which need to be considered carefully, before such an experiment is started. The ING would benefit from the stimulus of the more competitive environment provided by a single TAC.
Time would still be distributed according to the contributions, but the selection of the proposals should be done by a single committee. Eventually, the international TAC might be replaced by the single TAC for all telescopes at ORM.

To realize its future promise, the ING should maintain a competitive staff, retain leadership in adaptive optics development at the ORM, support an interesting instrument complement, possibly acquired as visitor instruments, and continue the present proficiency in operations.

Acknowledgement
The ING Visiting Committee would like to thank PPARC for facilitating its visit to the Isaac Newton Group of telescopes and, in particular, Deborah Telfer of PPARC for her support.

Brian Boyle
Bruce Carney
Bruno Leibundgut
Jeremy Mould (Chair)

8. Diary of the ING Review Panel Visit, July 2005

ING, La Palma
Monday July 18th

Presentations:
General Overview Presentation: Director
Historic Framework: Director
Organization and Performance: Director
Science Highlights: Romano Corradi

Travel to Roque de los Muchachos Observatory (ORM)
Tour of William Herschel Telescope (WHT) and Isaac Newton Telescope (INT)
Tour of Gran Telescopio Canarias (GTC)

Dinner with Management Team (Director, Danny Lennon, Gordon Talbot, Kevin Dee, Les Edwins)

ING, La Palma
Tuesday July 19th
Presentations:
Engineering Capabilities: Gordon Talbot
In-house Research: Danny Lennon

Optics Lab visit

Presentations:
Development strategy: Director
GLAS Introduction: Director
GLAS Status: Gordon Talbot
Queue scheduled observing: Ian Skillen
Post 2009 Prospects: Director

Review Panel closed session

Dinner with Director ING

IAC, La Laguna, Tenerife
Wednesday July 20th

Introduction to the IAC

Round table discussion with IAC representatives:
Dr. Juan Antonio Belmonte (actual president of the CAT)
Dr. Evencio Mediavilla Gradolph (previous president of the CAT and PI of INTEGRAL)
Dra. Casiana Muñoz Tuñón (in charge of site characterization at the ORM)

Dr. José Miguel Rodríguez Espinosa (project scientist of GTC)
Dr. Antonio Mampaso (previous representative of the IAC at the ING Board)
Dr. Alfonso López Aguerri (log-term postdoc "Ramón y Cajal")
Prof. Artemio Herrero Davó (Head of the Research Division)

Tour of the IAC optics labs and engineering facilities

Discussion with Prof. Francisco Sáncez Martínez

Lunch with IAC representatives including Prof. Sáncez Martínez and Dr Ramón García López

NWO, The Hague, NL
Thursday July 21st

Welcome by GBE delegation and lunch
Discussion with GBE delegation:
Prof. Rene Kamermans – vice chair Physical Sciences Council (GBE), Particle Physics
Prof. Henk van der Vorst – Member GBE, Mathematics
Prof. Rens Waters – Chair Astronomy Advisory Committee (ACA)
Prof. Thijs van der Hulst – Chair ING Board, Member ACA
Dr. Annejet Meijler - Director NWO Physical Sciences
Dr. Nico Kos - Deputy Director NWO Physical Sciences
Dr. Ronald Stark - Secretary ACA, Member ING Board

Discussion with astronomers on NL astronomy interest in ING—Present and Future:
Prof. Piet van der Kruit - chair Netherlands Committee Astronomy
Prof. Tim de Zeeuw - director NOVA, PI Sauron
Prof. Thijs van der Hulst - chair ING, NL-PI OASIS

Discussion with ING instrument scientists and astronomers:
Mariska Kriek Msc, Leiden
Dr. Paul Groot, Nijmegen
Dr. Richard McDermid, Leiden
Dr. Nigel Douglas, Groningen
Prof. Reynier Peletier, Groningen

Informal dinner with Physical Sciences Delegation (Annejet Meijler, Nico Kos, Ronald Stark, Thijs van der Hulst)

PPARC, London
Friday July 22nd
Discussion with PPARC and ING Board representatives:
Prof Richard Wade
Prof Janet Drew
Mr Graham Brooks

Mr Colin Vincent
Dr Gavin Dalton

Visiting instrument talks:
PN.S and the ING: Mike Merrifield
ULTRACAM: Vik Dhillon
PlanetPol: Phil Lucas

Follow-up discussion session with ING Board representatives

Final Review Panel closed session

9. Glossary of Acronyms

AAT	Anglo Australian Telescope
AF2	Fiber Optic positioner
ALMA	Atacama Large Millimeter Array
AO	Adaptive Optics
AUTOFIB	Fiber Optic positioner
AΩ	Aperture times field of view
CAT	Comite Asignacion de Tiempo
CCD	Charge Coupled Device
CDFN	Chandra Deep Field North
CFHT	Canada France Hawaii Telescope
CNO	Common Northern Observatory
ELT	Extremely Large Telescope
GAIA	Astrometric space mission
GLAS	Rayleigh laser beacon system
GRACE	Ground-based Adaptive Optics Controlled Environment
GTC GranTeCan	Gran Telescopio Canarias
HDFS	Hubble Deep Field South
IAC	Instituto de Astrophyiscas Canarias
IFU	integral field unit
ING	Isaac Newton Group of Telescopes
INGRID	ING infrared camera
INT	Isaac Newton Telescope
INT/WFC	INT Wide Field Camera
INTEGRAL	integral field fibre feed for WYFFOS
ISIS	double spectrograph
JCMT	James Clark Maxwell Telescope
JWST	James Webb Space Telescope
LOFAR	Low Frequency Array
LIRIS	IR spectrograph and imager
MAGIC-1/MAGIC-2	two 17-meter Cerenkov detectors
NAOMI	Natural guide star AO system for Multi Instrumentation
NOT	Nordic Optical Telescope
NOVA	Netherlands Research School for Astronomy
NWO	NL Organisatie Wettenschappelijk Onderzoek
OASIS	Integral field spectrograph
ORM	Observatorio de Roques de los Muchachos
PNS	Planetary Nebula Spectrograph
PPARC	Particle Physics and Astronomy Research Council
QSO	Quasi Stellar Object
SAURON	Spectrographic Areal Unit for Research on Nebulae
SCUBA	Submm Common User Bolometer Array
SLODAR	Slope Detection and Ranging
“SuperWASP”	Planet search survey telescope
TAC	Time Allocation Committee

TNG	Telescopio Nazionale Galileo
UV	Ultraviolet
WFC	Wide-field camera
WHT	William Herschel telescope
WHT/PFC	WHT Prime Focus Camera
WHT/AF2	WHT fibre positioner
WYFFOS	Wide Field Fibre Optic Spectrograph
2dF	Two degree field spectrograph of the AAT