Evaluation 1999-2004

SRON Netherlands Institute for Space Research (SRON)

The Hague, August 2005
Netherlands Organisation for Scientific Research

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1 Introduction

1.1 Scope and context of this evaluation

This assessment concerns the research carried out since 1999 at the SRON Netherlands Institute for Space Research. The evaluation was commissioned and organized by the Netherlands Organisation for Scientific Research (NWO). SRON had submitted a self-evaluation document covering the period 1999–2009. This was approved by the Governing Board of NWO in April 2005.

This external assessment follows the Standard Evaluation Protocol 2003-2009 for Public Research Organizations (SEP).

The aims of the assessment system are:

- Improvement of the quality of research through an assessment carried out according to international standards of quality and relevance.
- Improvement of research management and leadership.
- Accountability to higher levels of research organizations and funding agencies, government and society.

The committee was asked to produce a reasoned judgement on the mission, strategy and performance of the institute. The SEP calls for an evaluation addressing both the research organization itself and the research programmes it conducts. Each research organization must submit details of the results achieved in each of its research programmes over the previous six years (including quantitative data about staff input, key publications and a list of publications), a short outline of the mission statement of each programme, and details of any changes expected to occur in its research profile. Site visits form an important part of every evaluation and include interviews with the management of the institute and its programme directors, as well as visits to laboratories and facilities.

1.2 The evaluation committee

The evaluation committee was appointed in December 2004 by the Governing Board of NWO, following consultation with SRON and with the NWO Council for Physical Sciences. Its members are:

Prof. Frans W. Saris	Dean, Faculty of Science, Leiden University (NL)
Prof. Len Culhane	Mullard Space Science Laboratory, University College London (UK)
Prof. Dan McCammon	Department of Physics, University of Wisconsin (USA)
Prof. Jean-Loup Puget	Institut d'Astrophysique Spatiale, Université Paris Sud (France)
Prof. Byron Tapley	Center for Space Research, University of Texas at Austin (USA)

A short curriculum vitae of each of the members is included in Annex 1. The committee was supported by NWO staff (Patricia Vogel, Dick van der Kroef, Foekje Grootoonk and Els el Idrissi).

All members of the committee declared that their assessment had been free of bias, personal preference or personal interest, and that it had been reached without undue influence by the institute, the programme or other stakeholders.

Any existing professional relationships between committee members and programmes under review were reported and discussed in the committee meeting. The committee concluded that there were no conflicts of interest.

1.3 Data supplied to the committee

The documentation included all the information required by the SEP, as well as answers to the additional questions addressed to SRON by NWO. It contained:

- The SRON self-evaluation report.
- The SRON Annual Report 2003, giving a general overview of SRON's scientific activities and some research highlights.
- A selection of full text papers for each programme.
- A bibliometric study by the CWTS at Leiden University.

1.4 Procedures followed by the committee

The committee proceeded in accordance with the Standard Evaluation Protocol 2003-2009. The assessment was based on the documentation provided by the institute, the selected key publications and the interviews conducted during a site visit on 12 and 13 May 2005. The programme of the site visit is included in Annex 2.

The self-evaluation report, the annual report, the selected papers and an explanatory letter were sent to the committee one month before the site visit.

The chair and secretary of the committee established a timetable for the site visit. The committee met on the afternoon preceding the site visit to discuss and plan the interviews with SRON's management, researchers, Governing Board and Scientific Advisory Committee. It agreed procedural matters and aspects of the assessment as described in the following paragraphs. Unfortunately Professor Tapley was not able to attend the meetings of the committee, but he fulfilled his role as a member of the committee by providing written input, holding distance discussions with other members of the committee and interviewing research staff via telephone conferencing during the site visit.

At a formal dinner in Utrecht, the committee had the opportunity to meet with prof.dr. P. Nijkamp, chair of the Governing Board of NWO.

The interviews with SRON's management, Governing Board, Scientific Advisory Committee, researchers and support staff took place during the site visit on 12 and 13 May 2005. Most of the interviews and discussions were conducted by the entire committee, although the committee split up on 13 May to interview researchers, postdocs and PhD students.

After the interviews, the committee discussed the scores and comments for the institute and the research programme and determined the final assessment.

At the end of the site visit, a meeting was held with the SRON director and the chair of the SRON Governing Board to report the main findings of the committee.

In July 2005, a draft version of this report was sent to the director of SRON for factual correction and comment. The corrected report was subsequently submitted to the Governing Board of NWO and accepted in August 2005.

1.5 Aspects and assessment scale

The committee used the ratings specified in the Standard Evaluation Protocol: excellent (5), very good (4), good (3), satisfactory (2) and unsatisfactory (1).

EXCELLENT

Work that is at the forefront internationally, and has had and most likely will have an important and substantial impact in the field. The institute is considered to be one of the international leaders.

VERY GOOD

Work that is internationally competitive, and has made and is expected to make a significant contribution to the field. The institute is considered to be an international player and to be one of the national leaders.

GOOD

Work that is competitive at the national level, and has made and most likely will make a valuable contribution to the field, both nationally and internationally. The institute is considered to be internationally visible and a national player.

SATISFACTORY

Work that is solid but not exciting, has added or will add to our understanding and is in principle worthy of support. But it is considered of less priority than the work in the above categories. The institute is nationally visible.

UNSATISFACTORY

Work that is neither solid nor exciting, possibly flawed in the scientific and or technical approach, a repetition of earlier work, etc. Work not worthy of pursuing.

The committee suggests that the assessment scale should be redefined so as to permit finer distinctions to be made near the top of the scale.

2 Institutional framework of SRON

2.1 Mission

SRON is the Dutch national institute for space research. It was founded in 1983 as the Stichting RuimteOnderzoek Nederland – Space Research Organization Netherlands. In 2004 the name of the institute was changed to SRON Netherlands Institute for Space Research. NWO is SRON's parent organization. Other stakeholders are the Dutch government, European and US space agencies (ESA and NASA), the national and international scientific community, and Dutch & foreign industrial enterprises. SRON has a Governing Board and a Science Advisory Council. The Governing Board consists of members of the scientific user community and experts from research and development organizations. It is accountable to NWO. The Science Advisory Council advises the Board on the long-term research programme of the institute.

The mission of SRON is to design and develop world-class innovative space instruments for astrophysical and Earth-oriented research and to analyze the data provided by these instruments for advanced research. The institute's ambition is to act as PI for the development of state-of-the-art satellite instruments for use in space research missions run by ESA, NASA and other space agencies.

In addition SRON has taken on the following tasks:
- to promote, coordinate and support Dutch activities in space research;
- to advise the Dutch government on participation in international space research programmes, in particular those of ESA;
- to support the national knowledge economy by making its knowledge and expertise available to Dutch society.

Day-to-day management is the responsibility of the director and deputy director. The director is also Professor of Space Technology at Delft University of Technology. Directors and divisional heads make up SRON's Management Team.

SRON has two laboratories: one located on the campus of Utrecht University and the other in a building belonging to the University of Groningen.

2.2 Research

The themes of SRON's research are astrophysics and Earth system science. These themes are accommodated in three programme divisions: High Energy Astrophysics (HEA), Low Energy Astrophysics (LEA) and Earth-Oriented Science (EOS). These are linked to a separate division for the development of innovative enabling sensor technology (SR&T), while an Engineering Division (ED) develops and sustains the institute's technical expertise and facilities. HEA, EOS, SR&T and ED are located in Utrecht, while LEA is in Groningen.

HEA

SRON has a long track record in high energy astrophysics. Since the early 1970s the institute has contributed to ten satellite missions and acted as PI institute for several missions. The HEA Division is focusing its future research on the evolution and physics of the hot universe, particularly by exploiting and advancing instruments for X-ray spectroscopy. In addition to the focus on X-ray spectroscopy, there is a natural interest in other areas: wide-field instruments that monitor the time-variable sky, and gamma-ray missions that address non-thermal processes and the properties of rotation-powered pulsars.

LEA

Low energy astrophysics has a strong tradition within SRON, with a history of PI roles in a number of missions. Recently, the main emphasis within LEA activities has been on the development and construction of the Heterodyne Instrument for the Far-Infrared (HIFI) for the Herschel project (PI role for SRON). The purpose of the low energy programme is to enable the study of both the cold and the obscured universe, addressing fundamental astrophysical questions on origins and evolution.

EOS

Since 1991, SRON has also been involved in Earth-oriented space research, in particular atmospheric physics. The institute was co-PI in the SCIAMACHY project, which designed a German-Dutch-Belgian instrument for ESA's ENVISAT satellite (launched in 2002).

In the mid-1990s SRON initiated the second EOS programme line: geodynamics and oceanography (in particular gravity field). This programme concerns the development of an end-to-end simulator for the GOCE (Gravity field and steady state Ocean Circulation Explorer) gradiometer instrument. This has resulted in the current scientific applications of satellite gravity data, as well as participation in preparatory activities for future gravity missions.

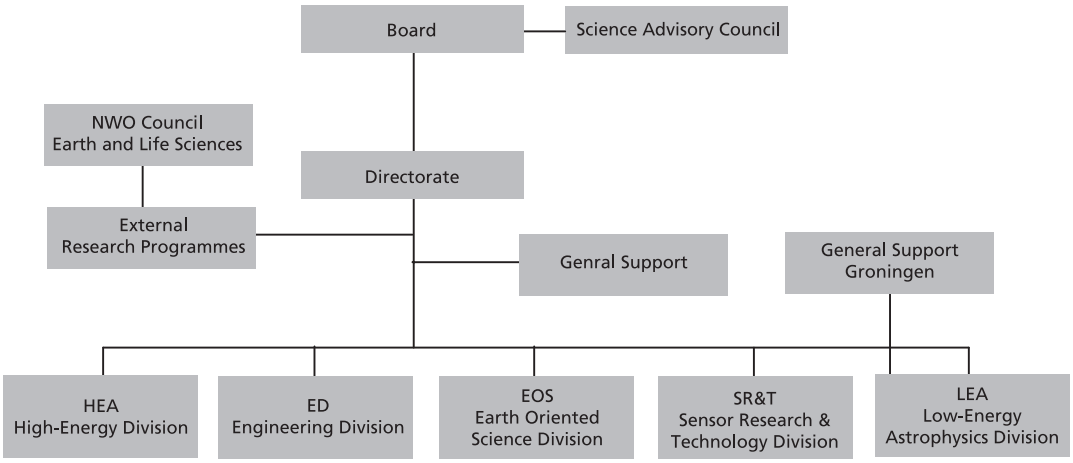
SR&T

This division of SRON is engaged in the non-stop development of advanced technology for use in future new-generation space missions. The purpose of the current programme is to develop state-of-the-art sensors and detector systems that will enable competitive future research programmes for low energy astrophysics (LEA), high energy astrophysics (HEA), and Earth-oriented science (EOS). The two major research lines involve the development of detectors for the X-ray part of the spectrum and the
IR/submm part of the spectrum.

Interferometry

Interferometry is a relatively new field within SRON. It is a cooperative venture by the LEA, HEA and EOS Divisions, with support from the Engineering Division. No formal research line has yet materialized. Interferometric techniques will be increasingly important in future space projects ranging from missions that use aperture synthesis to missions that require accurate measurements of distances between (inertial) masses on separate spacecraft. SRON will continue its investigations into the application of interferometry to astrophysical and Earth-oriented satellite missions, making full use of the knowledge that is available within universities, technological institutes and in industrial enterprises in the Netherlands.

2.3 Organizational structure



2.4 Financial matters

The budget for 2004 was M€ 15.5, of which M€ 12.7 is basic NWO funding, M€ 0.8 is structural support from the universities of Groningen and Utrecht and M€ 2.0 comes from third parties.

2.5 Staff

Total staff (in FTEs, January 2004):	
on permanent contract	139
on temporary contract	63
Total	202

Staff composition (in FTEs, January 2004):	
science	82
engineering	62
project management	9
general support	17
facility support	20
management	12
Total	202

3 Assessment of the institute

Assessment at the level of the institute	
Quality	5
Productivity	5
Relevance	4.5
Vitality	4.5
Overall assessment of the institute	5

3.1 Remarks on the overall assessment of the institute

a SRON compares well with the (few) other leading institutes in the world in this field, as is illustrated by the various PI roles it plays in the selected areas of research and the other information in this report. This is remarkable for a relatively small country like the Netherlands, as the other world-leaders are nearly all located in larger countries with significantly larger space programmes.

Due to the clear focus it maintains in its research programme, SRON is likely to be able to retain this leading position in the foreseeable future. To do this, however, SRON must be able to participate in the relevant missions, which are not necessarily all carried out by ESA. If opportunities occur for missions within SRON's fields of research, adequate funding must be made available.

The research themes selected by SRON address fundamental astrophysical and Earth system related questions. They figure prominently in the programmes of the space agencies, which are defined following extensive user consultations and peer review. They also reflect the interests of Dutch scientists (the top national research schools, NOVA and ISES) and therefore contribute significantly to the scientific environment in the Netherlands. This is clearly illustrated by the intense collaboration with relevant researchers at the universities, through, for example, the appointment of SRON staff to university posts.

b To remain at the forefront of space research, it is essential that the Netherlands should be able to act as PI in (selected) space projects. In the 'Netherlands Space Action Plan', the Dutch government (including the Ministry of Education, Culture and Science) has recently confirmed the importance of space science and has explicitly identified a PI role in at least one of the astrophysics research lines (X-ray spectroscopy, planet detection using interferometric techniques and low energy astrophysics) as a prime goal. In the case of the ESA optional programme, the Dutch government has identified a leading role in the study of the Earth's gravity field, atmospheric research, planetary research and microgravity research as a priority. The SRON research programme is entirely consistent with this.

SRON is also recognized by the Dutch government as the national home base for ESA-related activities conducted by Dutch scientists. To maximize the (scientific) return from Dutch participation in ESA missions, it is important to have a reasonable level of nationally funded activities. This also increases Dutch influence on the future development of ESA programmes. The presence of a large technological centre in the Netherlands (ESTeC at Noordwijk) is of great value to SRON.

SRON has produced remarkably successful instruments in a highly cost-effective manner. The institute is a world-leader in the fields of HEA and LEA instrumentation. To ensure that a programme of this kind continues to be strongly science-driven (and avoid technology push), it is important to have a number of leading scientists (users) at the same institute. A dedicated institute like SRON provides the right mix of these features and is therefore an asset to the Netherlands. The strength of this kind of institute needs to be combined with the more

political role of representing the Netherlands in the various space agencies. This is an important role for SRON, as space science is determined not only by the scientific merits of projects but also by other countries' political and strategic considerations.

c Space research calls for long-term investments in facilities, enabling technology and engineering capacity. An expert institute provides a highly efficient way of developing and fostering knowledge and expertise in the development of scientific instruments for use in space. University research groups have a different focus and often a shorter time horizon, while industry usually is not organized to permit the prolonged development effort required to maximize the output of scientific missions. In industry there is no possibility of the long-term technological investment needed for the development of new instruments.

SRON has produced remarkably successful instruments in a highly cost-effective manner. In view of the quality of the proposed future programme, this success is expected to continue, although it should be noted that the cycles involved in space missions are far longer than those in NWO's 6-year review cycle.

In the past, SRON has been unable to accommodate the development of all the scientific instruments in which the Dutch scientific community showed an interest. NWO is recommended to consider, together with SRON, options by which the institute can support other national initiatives without putting its own long-term strategic programme at risk (e.g. the development of JWST–MIRI, in which SRON could not take the lead due to heavy commitments to HIFI).

SRON's PI role should be given financial recognition. Both NWO and the Dutch government should provide appropriate funding for large projects in which SRON has become the PI. A continuously appropriate level of effort is exceedingly important in long-term technology development and in maintaining an expertise base. However, the space science business – and, more particularly, any one institution's part in it – is highly cyclical. Supplying special funding for the ramping-up of efforts required to produce a major flight instrument would enable these projects to be adequately supported without increasing the basic funding for the organization.

4 Programme assessments

4.1 High Energy Astrophysics (HEA) programme

Current theme leader: prof.dr. W. Hermsen

Programme assessment	
Quality	5
Productivity	5
Impact	5
Vitality	4
Overall	5

4.1.1 Remarks on the evaluation of the HEA Division

This division has an outstanding track record, including major contributions to ten High Energy Astrophysics (HEA) missions in X- and gamma-ray astronomy. Current achievements include PI roles in novel high resolution X-ray spectrometers on the Chandra and XMM-Newton missions. Data from these instruments are having a dramatic impact on the field, producing advances in our understanding of the high temperature gas in the cores of galaxy clusters, major results on the nature of super-massive black holes in active galaxies and the observational verification of the equation of state for a neutron star. Both instruments continue to be used extensively by the world astronomical community.

Work is continuing on data from Beppo-SAX. Observations from this spacecraft have led to a major breakthrough in our understanding of gamma-ray bursts. Following on from its very successful involvement in the COMPTEL instrument on the NASA Compton Gamma-Ray Observatory, the division is also playing a major and continuing role in exploiting results from the ESA INTEGRAL high energy gamma-ray astronomy mission, in which the head of the HEA Division is a Mission Scientist.

SRON HEA Division scientists have provided the drive and rationale for the development of the next generation of high resolution non-dispersive spectrometers using cryogenic transition edge sensors. In this area, SRON is the clear leader in the European field and ranks among the top few groups in the world. These developments in particular are likely to see the institute in a PI role in the next major X-ray astronomy mission. In addition the division is pursuing involvements in possible future Japanese and Italian missions.

4.2 Low Energy Astrophysics (LEA) programme

Current theme leader: dr. W. Wild

Programme assessment	
Quality	5
Productivity	4
Relevance	4
Vitality	5
Overall	5

4.2.1 Remarks on the evaluation of the LEA Division

The Low Energy Astrophysics Division (far infrared and submillimetre astronomy) holds the position of Principal Investigator (PI) for the heterodyne spectroscopy instrument on the ESA Herschel observatory (with important NASA contributions). This follows its PI position on the Short Wavelength Spectrometer (SWS) on the ESA Infrared Space Observatory and its very important contribution to the US-NL-UK IRAS mission more than twenty years ago. The SWS was a highly successful instrument, which made several breakthroughs in infrared spectroscopy (on ices on interstellar grains in proto-stellar sources and on the ubiquitous presence of water and organic aromatic molecules in galaxies that play an essential role in the overall energy balance).

The division is one of the four groups in Europe developing very high frequency heterodyne detectors and is the leader in Europe on space qualified devices, comparable only with the Caltech/JPL group in the USA.
The development of the HIFI instrument, although facing schedule and budget overrun difficulties, has progressed very well in term of performance of receivers and HIFI should achieve its very ambitious goals.

Finally, it should be said that the contributions to the ALMA world submillimetre interferometer and APEX antenna receivers use the technologies developed for space to place the Netherlands in a very good position in these two first-class ground observatories. The group is to be commended for this excellent scientific strategy.

4.3 Earth-Oriented Science (EOS) programme

Current theme leader: dr. A.M. Selig

Programme assessment	
Quality	3
Productivity	2
Relevance	4
Vitality	3
Overall	3

4.3.1 Remarks on the evaluation of the EOS Division

Despite some very exciting scientific results recently, the SCIAMACHY mission cannot yet be termed a success and SRON cannot afford it to be a failure. Unfortunately, there is nothing that can be done about the problem with ice-layers on two channels, which is a result of the unforeseen outgassing of the satellite structure. But the calibration problem needs to be solved and the SRON management should give a high priority to convince ESA and the other partners that the data distribution should be improved. As a result of these problems, the productivity of the EOS Division is low for a group of its size.

The following observations should be considered in implementing the programme strategy. In a resource-limited programme, choices have to be made concerning the programme structure. Basing long-range programme development on a single thrust is a high-risk, high-reward strategy. In assessing the robustness of implementation, the following concerns should be considered.

In the Geodynamics and Oceanography research line (in particular gravity field), the experience obtained from the GOCE mission is very relevant to LISA and LDIM and provides a competitive basis for SRON participation in these mission concepts. However, both missions require very demanding technology development, and are subject to potential cost growth which may prevent their implementation.

The LISA Pathfinder Mission will be important as a demonstration of the proposed LISA techniques. SRON participation in this mission is important in validating the SRON role in the actual missions.

There is some risk in the strong emphasis that is placed on LDIM. SRON EOS capabilities are very well suited to this mission and could lead to a significant role. The risk lies in the fact that LDIM may not be chosen as the GRACE/GOCE follow-on. The scientific community has not set the requirements for this mission and although there are technology development efforts under way both in the US and in Europe, it is not clear that the improved inter-satellite range precision to be obtained by LDIF is needed in the presence of aliasing errors from current high frequency atmospheric and ocean mass variability. The need for better temporal and spatial resolution dictates slight improvement in the range precision with multiple satellite clusters.

The expressed interest in satellite formation and the role that accelerometers could play in such a mission suggest an alternative direction that could prove fruitful.

The use of formation flying proposed in the DARWIN mission concept to increase the apparent aperture of orbiting telescopes is an innovative approach. The knowledge and control of the relative positioning of the satellites are central to the success of the mission and the techniques for data combination represent significant challenges that are appropriate to the SRON EOS group.

EOS's interest in extending the scope of its mission to include planetary exploration is prudent, given the current ESA and NASA interest in this area. The SRON interest in planetary atmospheres and planetary geodesy (gravity fields) provides a strong rationale for such an expansion.

Other areas worth considering might lie in the development of lower weight and power instruments for implementation on micro satellites. The formation flying aspects important to Darwin have potential applications to the Earth-oriented science community at large.

In any case, SRON should be careful to choose challenging missions for which its exceptional expertise is required and to refrain from acting in areas where industry could do the job just as well.

4.4 Sensor Research & Technology SR&T programme

Current theme leader: dr. H.F.C. Hoevers

Programme assessment	
Quality	5
Productivity	5
Relevance	5
Vitality	5
Overall	5

4.4.1 Remarks on the evaluation of the SR&T Division

This group is a major international player in key areas of both HEA and LEA instrumentation. Cryogenic microcalorimeters based on superconducting transition edge sensors (TES) have been identified by ESA, NASA and JAXA as the detectors of choice for their planned future X-ray missions, and the TES programme at SRON must certainly be ranked as the best in Europe and among the three best in the world. Similarly, 0.1 – 10 THz heterodyne receivers are essential for important applications in both space astronomy and Earth resources instrumentation. SRON's hot-electron bolometer (HEB) mixer programme, enriched by a very productive collaboration with Delft University, is again among the few best in the world. Newer projects in SQUID multiplexer readouts for TES arrays, Superconducting Integrated Receivers, and Kinetic Inductance Arrays address important space research needs and are closely related to the group's major strengths.

SRON's dual expertise creates additional opportunities for major instrumental contributions from crossover applications. Direct IR detection is an important alternative to the coherent receivers that are the institute's current strength, and the technology of choice for this is now TES bolometers. SRON's strong HEA work in TES arrays and its SQUID multiplexer readouts are directly applicable in this area, while IR applications are now being pursued through a collaboration with Cardiff University in Wales. Similarly, Kinetic Inductance Arrays can potentially be applied to X-ray astronomy to obtain arrays with very large numbers of pixels.

Since the schedule for XEUS seems to be quite long-term, SRON is wisely investigating the possibility of shorter-term collaborations with the Japanese or the US on smaller missions that could make good use of its cryogenic detector technology for High Energy Astrophysics. The European Cryogenic Imaging X-ray Spectrometer demonstration project is important for positioning Europe and SRON to supply a TES detector for a likely combined ESA/NASA X-ray mission, particularly if no significant short-term applications for a microcalorimeter instrument can be pursued. Possibilities for Earth-bound applications include detectors for laboratory X-ray analysis, condensed matter physics investigations, Dark Matter detection, and other fundamental physics. All of these could be successful if pursued as research rather than as commercial applications: commercialization is probably still premature, as the small market size seems to require a quite mature technology to attract commercial interest.

Finally, there is a considerable worldwide shortage of people with training in space astrophysics instrumentation generally and HEA in particular. The combined science and technology expertise at SRON coupled with the institute's ongoing state-of-the-art instrument work presents an unsurpassed opportunity for training students in this area. Some care would be required both in the selection of suitable thesis topics and in the recruitment of high quality candidates, but it would seem beneficial to everyone concerned to exploit this opportunity more extensively.

5 Answers to the questions addressed to the committee by NWO

Two sets of questions were put by NWO in addition to the Standard Evaluation Protocol. The first set was general (asked at all evaluations), while the second focused specifically on SRON.

General questions put by NWO

1 *What is and what could be the position of the institute in the near future, compared to leading institutes in the world that operate within the same field?*

SRON compares well with the (few) other leading institutes in the world in this field, as is illustrated by the various PI roles it plays in the selected areas of research and the other information in this report. This is remarkable for a relatively small country like the Netherlands, as the other world-leaders are nearly all located in larger countries with significantly larger space programmes.

Due to the clear focus it maintains in its research programme, SRON is likely to be able to maintain this leading position in the foreseeable future. To do this, however, SRON must be able to participate in the relevant missions, which are not necessarily all carried out by ESA. If opportunities occur for missions within SRON's fields of research, adequate funding must be made available.

The research themes selected by SRON address fundamental astrophysical and Earth system related questions. They figure prominently in the programmes of the world's space agencies, which are defined following extensive user consultations and peer review. They also reflect the interests of Dutch scientists (the top national research schools, NOVA and ISES) and therefore contribute significantly to the scientific environment in the Netherlands. This is clearly illustrated by the intense collaboration with relevant researchers at the universities, through, for example, the appointment of SRON staff to university posts.

2 *Should NWO continue to support the mission of the institute and for what reasons?*

To remain at the forefront of space research, it is essential that the Netherlands should be able to act as PI in (selected) space projects. In the 'Netherlands Space Action Plan', the Dutch government (including the Ministry of Education, Culture and Science) has recently confirmed the importance of space science and has explicitly identified a PI role in at least one of the astrophysics research lines (X-ray spectroscopy, planet detection using interferometric techniques and low energy astrophysics) as a prime goal. In the case of the ESA optional programme, the Dutch government has identified a leading role in the study of the earth's gravity field, atmospheric research, planetary research and microgravity research as a priority. The SRON research programme is entirely consistent with this.

SRON is also recognized by the Dutch government as the national home base for ESA-related activities conducted by Dutch scientists. To maximize the (scientific) return from Dutch participation in ESA missions, it is important to have a reasonable level of nationally funded activities. This also increases Dutch influence on the future development of ESA programmes. The presence of a large technological centre in the Netherlands (ESTeC at Noordwijk) is of great value to SRON.

SRON has produced remarkably successful instruments in a highly cost-effective manner. The institute is a world-leader in the fields of HEA and LEA instrumentation. To ensure that a programme of this kind continues to be strongly science-driven (and avoid technology push), it is important to have a number of leading scientists (users) at the same institute. A dedicated institute like SRON provides the right mix of these features and is therefore an asset to the

Netherlands. The strength of this kind of institute needs to be combined with the more political role of representing the Netherlands in the various agencies. This is an important role for SRON, as space science is determined not only by the scientific merits of projects but also by other countries' political and strategic considerations.

3 *Are there more effective ways for NWO to support the same type of research and/or facility?*

Space research calls for long-term investments in facilities, enabling technology and engineering capacity. An expert institute provides a highly efficient way of developing and fostering knowledge and expertise in the development of scientific instruments for use in space. University research groups have a different focus and often a shorter time horizon, while industry is not usually organized to permit the prolonged development effort often required to maximize the output of scientific missions.

SRON has produced remarkably successful instruments in a highly cost-effective manner. In view of its future programme, this success is expected to continue, although it should be noted that the cycles involved in space missions are far longer than those in NWO's 6-year review cycle.

In the past, SRON has been unable to accommodate the development of all the scientific instruments in which the Dutch scientific community showed an interest. For example SRON was unable to play a leading role in the development of JWST-MIRI due to heavy commitments to HIFI. While at some level this must always be the case, NWO is recommended to consider, together with SRON, options by which the institute could support other important national initiatives that are related to its core skills. However such activities would require some extra funding if risk to the long-terms SRON strategic programme is to be avoided.

It is clear that the present annual budget is marginal for the proper implementation of a programme that must include leading or PI-level roles for the institute on timescales that are externally driven by ESA and other world space agencies. This is illustrated by the comments in the previous paragraph. Targeted additional funding will therefore be required if the institute is selected to play a leading role in new large-scale or PI-type projects. It is clearly necessary that this additional funding can be granted on timescales matching those of the major space agency involved. It is a key feature of SRON strategic planning that the institute should succeed in being selected for a leadership role in major mission opportunities of a kind that may occur only once in a decade.

4 *What is your view of the analyses (made by the management of the institute) of the consequences if these institutional activities were to be discontinued?*

The committee agrees with the conclusion of the management that the entire current research programme, with the four research lines, should be maintained. If the activities of the institute were discontinued in their entirety, the result would be an unacceptable waste of resources and technological expertise and the negation of two decades of national investment. The track record and standing that SRON has established over many years would be very hard to replace and can easily be put at risk.

Partial discontinuation of SRON's activities should likewise be strongly opposed. The current budget permits the institute to maintain a programme in the selected research lines, participate at regular intervals in mission opportunities, conduct the fundamental detector research necessary to enable it to play a prominent role in future missions, and have the technical capability to realize missions at low cost. Reduction of the funding (e.g. discontinuation of one sub-programme line) would make a significant part of the current expertise sub-critical, posing a serious risk to the other parts of the institute's programme and therefore significantly jeopardizing the overall Dutch contribution to space research.

Questions specific to SRON

5 Is the development of the HIFI project (a very important PI project for SRON) proceeding on schedule?

The design of the instrument is excellent. The goal is very ambitious but the committee sees this as a positive aspect. The performances of subsystems are excellent and the instrument should achieve its goals. Nevertheless, integrating the large number of subsystems (many of them from international partners) will be a difficult task. Some difficulties are likely to occur in the process and these may have cost and scheduling implications. The available time is too short. NWO should be aware that some staff may be needed for longer than previously expected: it is not unrealistic to expect a delay of 3-6 months. In particular the delay in the Italian contribution (Data Processing Unit) could delay the whole mission. HIFI is one of the most ambitious projects in astronomy and it must not fail. This is SRON's priority, and rightly so. Failure would have serious consequences both for SRON and for the wider Dutch community. It is not an option!

6 SRON is located at two sites, one in Utrecht and the other in Groningen. How does the committee view SRON's current policy on this, taking account of what is needed for the advancement of space research in the Netherlands?

The current policy is to retain both locations (Utrecht as well as Groningen). SRON's management has advised the Board to maintain this policy. The use of sites close to the universities is highly advantageous to SRON research and technology development. It also benefits the two universities concerned. The committee saw little duplication of facilities. The committee agrees therefore with the current policy of retaining the two sites, although it feels that more attention should be paid to management aspects and the provision of better support for the scientific staff in Groningen, where the LEA Division is housed. Management support needs to be improved there. It is important that the chief scientist of a division should be able to focus on the main scientific tasks, relating to the scientific productivity, competitiveness and future of the division, and should be free of the more routine administrative tasks relating to the separate site.

7 How important are SRON's activities and its project portfolio to the Dutch research community?

In two fields of astronomy, SRON ranks among the top three institutes in the world. Where Earth-Oriented Science is concerned, SRON should specialize in special instruments rather than invest in general expertise. The committee welcomes the proactive attitude of SRON towards planetary work, but it is too early to evaluate this. Interferometry is one of the strengths of the Netherlands. The strong priority emerging in ESA's Cosmic Vision plan for the search and study of extrasolar planets creates a good opportunity to use the combined national know-how of SRON and interferometry in the context of the Darwin mission. The committee would urge SRON to explore this possibility.

8 Is there a need to change the decision structure with respect to space research and, if so, what would be the position of SRON in that context?

The Dutch government has presented a clear set of goals for its space programme in section 3 of the Netherlands Space Action Plan. This singles out SRON both to play a leadership role in communication, knowledge transfer and education, and to pursue ambitious goals in terms of attaining PI status on a number of major scientific missions. SRON has the right balance of knowledge and skills to do well as PI and PI status will strengthen the institute. However, SRON's sponsors must realize that this represents a substantial effort that will require additional resources. Regarding the target PI roles, the list in "Ambition 1" of section 3.1 of this action plan matches SRON's current strengths. The targets in "Ambition 2" are appropriate national goals, but they require the development of new areas for SRON, and their pursuit

should be managed in the light of available resources, subject to the overriding principle that scientific excellence should be the primary factor in deciding which projects to take on.

The committee strongly supports the idea that NWO should provide considerable extra funding when SRON becomes PI in a major project. NWO should recognize that SRON is in competition with other leading institutes in the European arena. Financial recognition of success and its consequences is appropriate not only on the part of NWO but also on that of the Dutch government.

6 Conclusions and recommendations

1 SRON's PI role should be given financial recognition. Both NWO and the Dutch government should provide appropriate funding for large projects in which SRON has become the PI. A continuously appropriate level of effort is exceedingly important in long-term technology development and in maintaining an expertise base. However, the space science business – and, more particularly, any one institution's part in it – is highly cyclical. Supplying special funding for the ramping-up of efforts required to produce a major flight instrument would enable these projects to be adequately supported without increasing the basic funding for the organization.

2 There are very few institutions that can give students hands-on experience of the development of space instrumentation. SRON offers a rare opportunity to give students a high-quality education in this important area. The committee advises SRON to take more advantage of this whenever possible. This will help supply trained young researchers for the field in general and will help to keep sufficient expertise in the institute. The combined science and technology expertise at SRON coupled with the institute's ongoing state-of-the-art instrument work presents an unsurpassed opportunity for training students in this area. Some care would be required both in the selection of suitable thesis topics and in the recruitment of high quality candidates, but it would seem beneficial to everyone concerned to exploit this opportunity more extensively.

3 SRON should be more active in competing for additional funding by submitting proposals to the NWO research council, the NWO Councils for Earth and Life Sciences, Technical Sciences and Physical Sciences, the EU and other funding agencies. This might be stimulated by rewarding every PhD or PD position earned on the 'open market' by an additional PhD or PD position from the SRON budget.

4 SRON's management has recently advised the institute's Governing Board to retain the two locations in Utrecht and Groningen. SRON benefits from being located close to the relevant university groups, which are fruitful in the area addressed by SRON research. Since the benefits to SRON and to the two universities would be lost if SRON were to be located at only one site, the committee agrees with this strategy.

5 Related to this dual-location strategy, there is a need for more investment in management support for the division located in Groningen. The principal investigator/divisional head should have sufficient support for management and administrative tasks to enable him to concentrate on the main scientific tasks.

6 SRON's financial administrators should address the costs of maintaining and updating older equipment and facilities, as already recommended by the previous evaluation committee in 1999. These costs should be included in SRON's balance sheet. In fact, the shortfall in SRON's budget is greater than that suggested by its current balance sheet.

7 After speaking with the SRON Governing Board and a delegation from the Science Advisory Council, the committee recommends that the terms of reference of the SAC should be reviewed with a view to improving the current (low) attendance rate at its meetings and ensuring that the expertise of the SAC is fully exploited by the management of SRON.

8 The management of projects developing large space instruments like HIFI requires rare skills which are difficult to retain at SRON. Project management could be subcontracted to industry so long as a strong in-house Systems Engineer at the institute maintains close contact with the scientists and keeps a careful eye on the trade-offs between performance on the one hand and feasibility, costs and scheduling on the other.

9 In any case, SRON should be careful to choose challenging missions for which its extraordinary expertise is required and to refrain from acting in areas where industry could do the job just as well.

10 The committee appreciated the bibliometric study of SRON carried out by the CWTS at Leiden University, which gave it an insight into the publications output of the institute and the international impact of publications by SRON researchers. Since the major scientific instruments produced by SRON represent one of the main reasons for the institute's existence, the committee advises NWO to provide information on and analyses of the use of instruments and satellites built by – or with the help of – SRON. This would provide a better insight into the international scientific impact of SRON facilities and instruments. A simple estimate could be made of the fraction of observations made by a given observatory using an SRON-supplied instrument, and – with rather more difficulty – it would be possible to estimate the number of scientific papers produced using data from that instrument.

11 The committee appreciated the very thorough self-evaluation documents provided and the high quality of the institute's effort in this respect. However, it is also aware of the considerable burden on SRON staff that this represented and therefore recommends that, wherever possible, the quantity and level of detail in the documentation required by the Standard Evaluation Protocol be reduced in future.

Annex 1: Curricula Vitae of committee members

SRON Evaluation Committee

Prof. Frans Saris, Dean, Faculty of Science, University of Leiden (NL)
Prof. Len Culhane, Mullard Space Science Laboratory, University College London (UK)
Prof. Dan McCammon, Department of Physics, University of Wisconsin (USA)
Prof. Jean-Loup Puget, Institut d'Astrophysique Spatiale, Université Paris Sud (France)
Prof. Byron Tapley, Center for Space Research, University of Texas at Austin (USA)

Curricula Vitae

Frans W. Saris

Frans Saris was born in 1942, trained as a physicist in Amsterdam and became Professor of Physics at Utrecht University in 1980. He has also lived and worked in Canada, the USA, China and Australia. After producing 250 scientific publications, supervising 45 PhD theses and winning prizes for the discovery of a new kind of X-ray and a new microscope with atomic resolution, he eventually decided to go into the management of science. Starting as director of the FOM Institute for Atomic and Molecular Physics (AMOLF) in Amsterdam, he went on to become CEO of the Energy Research Centre of the Netherlands (ECN) and is now Dean of Science at Leiden University. In addition, he has been (and is) a member of various scientific boards and advisory councils. He is also a science writer and editor of Dutch literary journal 'De Gids'.

Len Culhane

Len Culhane's PhD work involved the first direct demonstration, with the proportional counter spectrometer on the UK/US Ariel-I launched in 1962, that the sun's X-ray spectrum hardened during solar flares and was due to emission from high temperature (~ 10 000 000 K) gas. In 1969, he spent a year at the Lockheed Palo Alto Lab in California where he was Principal Investigator (PI) for an advanced multi-grid imaging detector on OSO-8. Returning to UCL, he was involved with the Ariel V X-ray Astronomy project and used the proportional counter spectrometer to discover emission lines of highly ionized iron in the spectra of galaxy clusters. This showed clearly that the extended X-ray sources in clusters were due to the presence of large volumes of hot (~ 100 000 000 K) gas. Returning to solar work, he became PI for a series of X-ray and EUV spectrometers on NASA's SMM and Spacelab-2 and on Japan's Yohkoh mission. He has served on a number of UK Research Council and European Space Agency committees and as a member of PPARC Council. He is an Honorary Doctor of Science at Wroclaw University in Poland (1994) and a Foreign Member of the Norwegian Academy of Science (1996).

Dan McCammon

Dan McCammon has been involved for many years in observations of the soft X-ray diffuse background, including the demonstration that most of the observed million-degree excess is not extragalactic but originates largely in a previously unsuspected hot component of the interstellar medium of our Galaxy. He is a Professor of Physics at the University of Wisconsin, and has participated in the Wisconsin Diffuse Sky Survey, Apollo S-150, OSO-8, ROSAT diffuse sky survey, and the Shuttle-based DXS X-ray background experiments. He has worked on the development of position-sensitive low background proportional counters and on thermal calorimetry for high resolution X-ray spectroscopy. These microcalorimeters have been used

by the Wisconsin group in sounding rocket studies of the diffuse background and will shortly be flown on the Japanese Astro-E2 X-ray observatory. Dan has served on the NRC Decadal Survey panel for High Energy Astrophysics, and on NASA's Structure and Evolution of the Universe Subcommittee.

Jean-Loup Puget

Jean-Loup Puget, born in 1947, is a former student of the École Normale Supérieure (Cachan) and obtained his PhD in cosmology (1973) under Evry Schatzman. He holds the position of "Directeur de Recherche" at the Centre national de la recherche scientifique and has been director of the Institut d'Astrophysique Spatiale (IAS) Orsay since 1998, having previously been deputy director of the institute (1990-1998).

Jean-Loup Puget has worked in observational cosmology, high energy astrophysics and interstellar medium physics. He has contributed to the development of space infrared and submillimetre astronomy in Europe (mission scientist on ISO, member of the FIRST study team (now Herschel) and Principal Investigator of the High Frequency Instrument for the Planck mission) and is a member of the French Académie des Sciences and Academia Europaea.

Byron Tapley

Byron Tapley obtained his PhD in Engineering Mechanics at the University of Texas at Austin (1960). His research interests focus on the application of nonlinear parameter estimation methods to determine crustal motion, Earth rotation, the Earth's geopotential, and ocean and atmosphere circulations, as well as the interactions between the aforementioned systems.

Dr. Tapley has served as chairman of the Geodesy Section of the American Geophysical Union (AGU). He is a member of the National Academy of Engineering and Fellow of AGU, AIAA, and AAAS.

He has been awarded many honours, including the Clare Cockrell Williams Centennial Chair in Engineering, the NASA Public Service Medal (1995), the NASA Exceptional Scientific Achievement Medal (1983), and the American Institute of Aeronautics & Astronautics' Mechanics & Control of Flight Award (1989).

Annex 2: Programme of the site visit

Wednesday 11 May 2005	
17.00 - 19.00	Closed session at hotel (synchronizing planning & approach)
20.00 - 22.00	Welcome dinner with Peter Nijkamp (chair of NWO)

Thursday 12 May 2005	
08.00	Transport from hotel in Utrecht - SRON (Utrecht)
08.30 - 09.30	Directorate (Wakker, Gathier); De Jager room
09.30 - 10.15	Board (Baede, Van der Zande, Wijers); De Jager room
10.15 - 11.15	Tour of clean room
11.15 - 12.00	Divisional heads HEA (Hermsen) and LEA (Wild); De Jager room
12.00 - 12.40	HEA and LEA scientists (Den Herder, Kaastra, De Graauw, Helmich); De Jager room
12.45 - 13.30	Lunch (closed committee session); Van de Hulst room
13.30 - 14.15	Tour of laboratories (see separate programme)
14.15 - 14.45	Divisional head EOS (Selig); De Jager room
14.45 - 15.15	EOS scientists (Koop, Aben, Hoogeveen); De Jager room
15.15 - 15.30	Break; De Jager room
15.30 - 16.00	Divisional head SR&T (Hoevers); De Jager room
16.00 - 16.30	SR&T scientists (De Korte, Gao); De Jager room
16.30 - 17.00	Divisional head ED (Van der Linden); De Jager room
17.00 - 18.00	Closed committee session; De Jager room
18.15 - 20.00	Dinner, restaurant in Utrecht
20.00 - 22.00	Transport to hotel in Groningen (closed committee session)

Friday 13 May 2005		
08.00	Transport from hotel in Groningen - SRON (Groningen)	
08.30 - 09.30	Tour of laboratories	
09.30 - 10.00	Facility managers in Utrecht (Van Rijn) and Groningen (Van Elmpt);room 257b	
10.00 - 10.45	Science Advisory Council (Van der Zande, Schilizzi); room 257b	
10.45 – 12.15	Interviews with researchers, Postdocs & PhD students	
	subcommittee 1; room 67	subcommittee 2; room 257b
	researchers EOS	researchers HEA/LEA
	PhDs & Postdocs EOS	PhDs & Postdocs HEA/LEA
	Researchers SR&T	PhDs & Postdocs SR&T
12.15 - 13.15	Lunch with directorate (Wakker, Gathier); Kapteyn room	
13.15 - 16.00	Closed committee session; room 257b	
16.00 - 16.30	Closure with directorate (Wakker, Gathier) and chairman of Board (Baede); room 257b	
16.30 - 16.45	Drinks and snacks; Kapteyn room	
16.45	Transport to Eelde Airport	
18.40	Arrival at Schiphol Airport	

Annex 3: List of researchers, PDs and PhDs interviewed

Friday 13 May 2005		
Division	Name of researcher	Research topic
HEA	W. Hermsen	Divisional Head HEA
HEA	E. Costantini	Active galactic nuclei
HEA	J. Heise	High energy phenomena of compact objects; γ-ray bursts
HEA	J. de Plaa	Clusters of galaxies with XMM/Newton
LEA	W. Wild	Divisional head LEA
LEA	T. de Graauw	Programme scientist LEA
LEA	P. Roelfsema	High-mass star formation, ultra-compact HII regions, HIFI ICC
LEA	G. de Lange	HIFI Mixer Bands 3 and 4, HIFI Signal Chain
LEA	K. Wildeman	HIFI FPU design and AIV
LEA	D. Poelman	Radiative transfer models of water
LEA	W. Frieswijk	Earliest stages of high-mass star formation
EOS	J. Landgraf	Radiative transfer modeling and ozone profile retrievals
EOS	M. Smit	Instruments LISA Pathfinder
EOS	S. Houweling	Atmospheric modeling; focus on CO2 and CH4 (SCIAMACHY and future troposphere mission)
SR&T	M. Bruijn	Lithography process development and design of transition edge sensors
SR&T	J. van der Kuur	Multiplexed SQUID read-out and TES-based X-ray detectors
SR&T	M. Hajenius	Hot electron bolometer mixers