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# Evaluation of the Royal Observatory of Belgium (ROB)

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## **Management summary**



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technopolis <sub>group</sub> June 2017

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## Management summary

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### *Introduction*

This report presents the final results of the evaluation of the research strategy and activities of the Royal Observatory of Belgium (ROB). ROB is one of the ten Federal Scientific Institutes (FSIs) in Belgium.

To support the Federal Scientific Institutes (FSIs) in the development and determination of their research strategies, the Belgian Science Policy Office (BELSPO) commissioned Technopolis Group to evaluate all ten FSIs. This evaluation includes the scientific research and services of the ROB, but does not cover the public oriented services provided by the Planetarium.

The evaluation is based on the results of a desk study, interviews with staff and external stakeholders of the ROB, a staff survey, casestudies, a benchmark amongst institutes with similar missions, a bibliometric analysis, a peer review by an independent panel of experts and a self-assessment report written by the ROB.

The complex institutional context in Belgium - a federal state with three territory-based regions and three language-based communities - has a profound influence on the governance of the FSIs. The competence for research policy at federal level is limited, because the primary competences are at regional level. Since the FSIs are part of the federal government, their financial and human resource autonomy is restricted. Management of its buildings fall under the responsibility of the Buildings Agency of the federal government, meaning that priorities for repairs or upgrades to the buildings are made in consideration of priorities amongst all federal buildings.

The overall mission of the FSIs has been to perform research and to deliver public services. FSIs are financed through a federal dotation and self-obtained project and service funding.

### *The ROB*

The Royal Observatory of Belgium was founded in 1826 and moved to its present location in Ukkel/Uccle in 1890. Over the years the number of research topics increased, and again decreased as the Royal Meteorological Institute and the Institute for Space Aeronomy were set up as separate FSIs in Ukkel/Uccle as well. As of 1976 the scientific research within the ROB has been organised across four departments: Positional astronomy and Geodynamics, Astrometry and Celestial Mechanics, Astrophysics, Radio Astronomy and Solar Physics. The 1990s were marked by the expansion of research in the areas of Space Weather and Planetology. This expansion went hand in hand with an increased participation in international consortia for solar and planetary observation missions.

The work of ROB focuses on the development and dissemination of knowledge in the field of astronomy, space geodesy and internal geophysics by performing scientific research and services.

## Finance

The annual income of the ROB is ranging between €10 and 12 mln. About half of this is 'basic' funding (Belspo staff envelope and Belspo general dotation). The other half is research and services income and other income (including Planetarium). Austerity measures have resulted in a reduction of basic funding by some 10%, which reduces room for free strategic research, and increases dependency on external funding.

The ROB has been rather successful at attracting additional funding from a wide range of Belgian and international funders. The income from BELSPO-projects forms the major part of this and has remained relatively stable over the years. A large share of the BELSPO-project funding (€1.5 mln/year) is allocated to the activities of the ROB in the Solar-Terrestrial Centre of Excellence. The income from foreign institutions (mainly ESA) has been rather significant as well, but far less stable. The income from the European Commission has grown strongly by 2015, to almost €0.9 mln. Other sources of government project funding play a marginal role in the total income for research and scientific services. Staff costs are the largest expenditure for the institute.

The institute has managed its balance between income and expenditure well. Over the period 2008-2015 a (small) positive result was obtained.

Investments in equipment were higher than the depreciation, signalling that equipment has been kept up to date. The peers however foresee a need of considerable larger investment in infrastructure in the near future (IT, laboratories, etc.) and there is also a need for more (support) staff.

The restrictions (because of austerity measures) on using the positive financial results for investments in forthcoming years hamper the development of the institute.

## HRM

Between 2009 and 2015, on average 181 people worked at ROB, of which a large part is employed on a fulltime basis. In 2015 ROB counted 177 staff members, consisting of 94 scientists and 83 non-scientific support staff. Of these 59% is employed contractually. Of the scientists, almost three quarters of staff is employed on a contract. No new statutory positions have been available in the past five years. Many of the contractual staff are (like statutory staff) outstanding scientists, with a long-term commitment to ROB's missions. However, they lack the security and advancement prospects appropriate for their roles. Researchers at similar levels with similar duties therefore have different salary schemes and different social security plans.

Of all the scientific departments, Solar Physics and Space Weather (OD4) is by far the largest, but it is highly dependent on contractual staff. This OD contains the lowest number of statutory scientists. On the other hand, the department Astronomy and Astrophysics (OD3) is the smallest but has most statutory scientists.

Over the years, the ROB has hosted 59 PhD students, 90 Master students and 27 guest scientists. The ability to attract PhD students to conduct research at the FSI varies greatly per

department and appears to be strongly dependent on individual links to students via parttime professorship positions.

In terms of human resource management, the staff has good access to external seminars, workshop and conferences, but relatively little access to further formal learning. Scientific staff members spend most of their time on the performance of scientific research and providing services to external partners and clients.

Due to the federal requirements to have a balance in Dutch and French speaking statutory staff, the institute struggles to offer international experts a statutory position. A contractual position does allow for non-native speakers to be hired, but is limited to the time available for the project.

Lengthy hiring procedures for contractual non-scientific staff prevent the FSI from being able to act quickly on new opportunities. Variation in the performance review system denotes the formality of the procedures without necessarily adding benefit to the institute.

## *Research*

### Research strategy

ROB's research strategy has been set out in its management plan for the period 2011-2017. ROB's strategy is based around participation in deepening expertise, participation in programmes, networks and observatories, cooperation and embedding within the national and international landscape, delivering services to the public and efficiently aligning its internal structure to its research objectives.

Broad objectives for the research strategy have been set at institute level and within this each OD has had subsequent autonomy to develop its own strategy.

The Observatory's role with respect to the other Federal Scientific Institutes with related missions is only vaguely formulated. Similarly, although ROB makes valuable contributions to growing the pool of Belgian scientists by hosting university student researchers, the relationship with Belgian universities is largely informal and ad hoc.

As to be expected from a SPACE FSI, ROB is rather internationally oriented in its research areas and approach. Staff is part of leading international networks and involved in highly valued international research projects. Each department within ROB strategically collaborates internationally in order to access the necessary research infrastructure.

### Research organisation

There are 4 operational directorates that perform research:

- The OD 'Reference Systems and Planetology' (OD1) conducts research and provides scientific services in the field of space geodesy and timescales and the geodynamics of the Earth and the other terrestrial planets. It also bears the responsibility for the integration of Belgium in international reference systems.

- OD2: Seismology and Gravimetry provides a public service since 1905, with the monitoring of seismic activity in Belgium and surrounding regions. It is responsible for the preservation, the development, the study, and the promotion of the scientific heritage related to earthquake activity in Belgium and in the world. Gravimetric measurements are used to monitor crustal deformations and hydrological effects.
- The OD ‘Astronomy and Astrophysics’ (OD3) conducts scientific research in stellar astrophysics and the study of other objects of the solar system (asteroids, satellites...). Structuring research themes include astrometry, stellar evolution and astero-seismology. Researchers from the OD are engaged in processing and obtaining the theoretical interpretation of astrophysical data with a variety of modern observational techniques. Amongst the objects studied are multiple stellar systems, variable stars, stars with large and intermediate masses, rapidly rotating stars, evolved stars as AGB (Asymptotic Giant Branch) and post-AGB stars, planetary nebulae and also asteroids and satellites of our solar system.
- The fourth OD of ROB is known internationally as the ‘Solar Influences Data analysis Center’ (SIDC). It has the mission to advance knowledge on the Sun and its influence on the solar system, through research and observations. The OD aims to provide this knowledge and expertise to the scientific community, to the society, the government and the industry through operational services and dissemination at both the national and the international level.

The large range of research activities combined with the wide range of research areas, poses a challenge to the relative small size of the staff. The emphasis of its priorities, conducted activities (balance between fundamental versus operational services, participation in networks etc.) and eventual scientific success thereby strongly varies between ODs.

Few employees are fully aware of the content of the institute’s mission and strategy, more have a clear view of their department’s mission and strategy. Also, the influence of employees on their department’s strategy was perceived as higher than that on the institute’s strategy.

As a consequence, to date, the Observatory functions as a loose federation of four directorates, each with a different scientific strategy and different emphasis on research and service activities. Although this has worked well until now, there is no guarantee that this works well in the future, especially not in times of increasing costs for research, decreasing budgets and larger uncertainties in budgets. More coordination is necessary here.

#### Performance in research and impact

ROB generates and manages a lot of data. These data are both historically relevant (time series dating back decades ago) as well as in general size and depth on specific topics. Through their websites they make data freely available to scientists, public authorities (such as mapping agencies in case of GNSS data) and in some cases the general public. The data varies from images of the solar corona and information on star systems to gravity data and ionospheric maps. There is no revenue from these data as ROB has an open data policy. It also does not register the number of users of the datasets as registration is not required.

Estimates made by ROB on the use of the different datasets in 2014 range from 100 to 10000, and for some even higher when based on the number of website visitors.

In addition to making data available, ROB also make software freely available. According to an inventory by ROB there are 16 software packages available. The number of users vary from 10 to 643 users (measured in downloads). The MSNoise software package for monitoring relative seismic velocity changes using ambient seismic noise, was downloaded 2082 times in 2014.

In the Scopus database, we find for ROB's peer-reviewed publications for the period 2005-2014 between 60-94 entries per year, with a total adding up to 774 documents (it should be noted that Scopus typically underestimates the number of publications by 15-20%). Despite the decrease in the total number of scientific staff, the number of publications did increase over time: over the period 2005-2013<sup>1</sup> a positive trend was observed with an average annual growth rate of 3.3%. In terms of total number of publications, 2012 was the strongest year of performance for the institute with 94 publications in Scopus.

ROB's scientists publish in international renowned high-quality journals including selected papers in Nature. The most common journals ROB researchers were publishing in during the period 2005 – 2014 (with at least 10 publications) are predominantly either Q1 or Q2, indicating the top two quartiles.

Bibliometric analysis shows that in the period 2005-2015, ROB published predominantly at toplevel in the field of 'astronomy and astrophysics' and 'space and planetary science'. The top publication is a 2009 publication on the 'chemical composition of the sun' with 430 external citations in the period 2009-2012. The share of non-cited articles has also been high in several years; this fluctuated between 12-33 percent.

In some domains, the science produced by ROB staff is at the international forefront, as e.g. space geodesy, solar system bodies, Northwest European earthquakes, solar physics and stellar evolution.

ROB submitted a total of 181 applications to BELSPO programmes between 2005 and 2015. The majority of applications (117 in total) were successful (the average success rate between 2005 and 2015 was 65%). This success rate was similar to FSI BISA (Belgian Institute for Space Aeronomy; which had an average success rate of 69%) and slightly higher than RMIB (Royal Meteorological Institute of Belgium) (with a success rate of 55% on average). ROB received just over €36 mln of funding from BELSPO programmes in the period 2005-2015.

Out of the 181 applications that ROB submitted to BELSPO programmes, 57 applications were developed in collaboration with in total 46 partner organisations. In total, 37 applications with partner organisations were successful, with a total of 32 partner organisations. Almost half of the collaborations were with other FSIs (48%). ROB collaborated with *all* of the other FSIs in BELSPO projects and most frequently with BISA (8 projects), the Royal Museum for Central Africa (4), Royal Meteorological Institute of Belgium (3) and the Royal Belgian Institute of Natural Sciences (3). A third of the collaborations were

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<sup>1</sup> This is the period considered in this analysis in order to calculate citations (with a citation window of three years).

with universities (32%; mainly the University of Leuven (KUL) and the Université Catholique de Louvain-la-Neuve (UCL)).

Based on data available from the European Commission's CORDA database (which was then validated by the institute itself), ROB participated in 22 EU-funded projects between 2007 and 2015, 18 of which fell under the FP7 programme and four under H2020 programme. The number of projects per year varied from one to six projects per year. In one project ROB was coordinator. ROB received a total contribution of € 5.5 mln from the EU for its participations in FP7 and H2020-projects.

Based on co-publications, the top cooperating institutions are mainly from Belgium, Germany, France, the UK and the US. Preferred partners are KU Leuven, Université de Liège, Max-Planck-Institut für Sonnensystemforschung, CNRS Centre National de la Recherche Scientifique, UCL, Université Paris 7- Denis Diderot, NASA Goddard Space Flight Center, Jet Propulsion Laboratory, California Institute of Technology, Université Pierre et Marie Curie and Lomonosov Moscow State University.

ROB strengthens the Belgian science and technology landscape through fundamental research in astronomy and astrophysics and earth and planetary science. An important role of ROB is to train the next generation of highly qualified scientists and engineers in the various areas of its activities. This happens in an internationally competitive environment which is of great importance for the qualification of young scientists and engineers.

ROB provides a number of high-level scientific services driven by fundamental research. The institute also plays a special role in the assessment of the non-negligible seismic hazard in Belgium and the surrounding regions and provides key information for hazard mitigation. ROB's results are furthermore of important social and economic relevance, for evaluating and quantifying solar-terrestrial interactions with direct impact on industrial and transport safety. Here ROB is playing a leading and very well-established role in European space weather service. ROB is the leading institute in Belgium for time definition and time transfer which is of great importance for society and economy. The institute has made an impressive contribution to the development of GNSS receivers, including the European Galileo system. The institute plays a major role in European space missions and has hosted operation centres for satellites. These are hightech activities with immediate economic implications for Belgium. Associated with the various scientific and technical activities ROB employees developed sophisticated imaging software for the analysis of high-level data products, a successful activity which should be strengthened in the future with potential to have impact in other fields.

Services and consultancy are delivered to government, universities, ESA, EU and various industries (mainly Belgian Space Industry and industries needing information on various risks).

Finally, most of ROB's science themes are attractive to the average citizen and may inspire youth's interest in science. This is especially true for themes related to space. To inform the general public, ROB organises a number of events for schools (for example student visits and observation courses), organises the Open Doors, provides virtual visits on their website, and keeps systematic links with the media (TV, radio) and the press.

### *Main conclusions*

The ROB is a well-performing research institute with a high level of scientific quality, science output and science recognition: bibliometric analysis, interviews and peer review in this evaluation confirm this. The scientists of the ROB publish in international renowned high-quality journals including selected papers in Nature. In some domains, the science produced by staff of the ROB is at the international forefront.

The ROB is a well-known contributor to the international communities in which the OD's are active.

The ROB provides a number of high-level scientific services driven by the fundamental research. Some of the services are unique at a European or even worldwide level, and are widely used by researchers and operators. Services and consultancy are delivered to government, universities, ESA, EU and various industries (mainly Belgian space industry and industries needing information on various risks).

### *Recommendations to the ROB*

- Formulate a scientific and service strategy for the future of the institute as a whole in order to maintain its strength and value in the future.
- To set priorities should be a major goal of the new strategy. Given decreasing budgets, it is crucial to prioritise among existing programmes rather than uniformly downscale them. Whatever the outcome of the ongoing budget process, a well-formulated scientific strategy would help the ROB explore new opportunities and directions, and remain at the forefront scientifically. This strategy should also be aligned with the Belgian policy towards international Space networks and missions.
- Explore the opportunities for improved internal collaboration and a more integral approach in order to benefit from synergies in scientific themes (for example, tectonic geodesy, or planetary interiors and exoplanets) and approaches (for example, image processing, data assimilation and forecasting).
- Collaboration with the Space FSIs in Ukkel/Uccle must include a common strategy, joint research projects (more interactive than at STCE) and technical support (facilities). The Space FSIs might even consider a merger in the future, not only to profit from synergies but also to create more critical mass (which will strengthen the national position, lobby power, etc.). The plans for a new Belgian Space Agency must be taken into consideration in such a long-term strategy.
- More formal collaboration with the universities will secure the influx of students and PhDs, and make the ROB an even stronger contributor education and science. It would make sense to develop a formal cooperation strategy with universities and formalise the structure under which the ROB hosts graduate students and staff of the ROB teach parttime.
- The ROB already collaborates well with the private sector, but could explore opportunities to do even better e.g. by Service Level Agreements and/or joint RTD-projects.

- Improve the visibility of the available services through better structured and user-friendly websites.
- Strengthen the research support function (“Project Office”)
- Strengthen the technical support by creating a common platform of engineers in the ROB to support the research activities and sharing expertise and experience. Consider combining technical functions with the other FSIs on the same campus.
- Develop a long-term strategy for infrastructure management with a complete and detailed overview of investment needs (linked with the priorities of the new strategy).
- Although there are restrictions because of civil service regulations, the ROB should improve the position of (especially contractual) staff. Improving the career and promotion prospects of the contractual staff, better communication to all staff, and a significant involvement of contractual staff in decisions would help to recognise the accomplishments of talented researchers and encourage them to stay at the ROB.

#### *Recommendations to the Belgian Federal Government*

- Naturally, adequate core funding for both the ROB and for science are crucial.
- Increasing administrative flexibility would be of great benefit for the ROB (and other FSIs). Main issues are increased financial flexibility (including ability to use financial assets across years) and staff management (more flexible procedures for hiring staff; decreased differences between contractual and statutory staff; formal appointments of senior management).
- Whilst professionalising management procedures, performance monitoring may be necessary and improve the functioning of the institute. Such procedures must be considered carefully, as they can also tip the scales and result in negative effects on the quality of the work by causing an increased administrative burden without the appropriate human resource capacity to manage the administration.
- Implement a long-term strategy for research infrastructure (a roadmap like in many other European countries) and participate in European research infrastructure projects in which the ROB can play a major role, such as the European Plate Observing System (EPOS).
- Guarantee sufficient alignment between the research activities of the ROB and Belgian participation (contribution) in international networks and missions.



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