SUMMARY

Large-scale research facilities are important for scientific progress and to support disciplines. They also make a sizeable contribution to innovation and to solving a number of major societal issues related to health, the environment, climate change, security and civilisation. Many of the questions posed in the Dutch National Research Agenda will be impossible to answer without advanced research facilities. Because such facilities require an enormous investment and take a long time to develop, it is important to consider early which facilities will be required by Dutch researchers in the future. Virtually every facility starts with an ambitious idea about the best way to tackle a certain research question. Now is the time to lay the foundations for the facilities of the future. That is why the Academy started working on an Agenda for Large-scale Research Facilities. By taking this step, the Academy hopes to inspire Dutch researchers, especially the younger generation, to develop plans for constructing and operating large-scale research facilities. The present publication is the tangible end product of its work.

What is the Agenda?

The Academy Agenda for Large-scale Research Facilities identifies thirteen large-scale research facilities that the Academy thinks will be desirable in the somewhat distant future – around or after 2025 – for innovative research at the forefront of knowledge and that will also help position high-profile Dutch research groups in international science.

As the time horizon suggests, the aim is to study ideas for facilities that are still in the early stages of development or exploration, and not facilities that could be put on the national or European roadmap in the near future. Inclusion in the national or European roadmap is a prerequisite for a facility that wishes to receive funding. To qualify for funding, the initiators must submit highly detailed proposals that are then

tested on numerous different criteria. This means that only 'mature' plans can receive roadmap funding. Experience shows that it can take many years before a proposal for a facility is sufficiently 'mature'. The Academy Agenda therefore complements the national and European roadmap by functioning as a **nursery for facilities on future roadmaps**.

Facilities listed in the Academy Agenda

The thirteen selected facilities are listed below, in random order:

1. M3: From Molecule to Society and Back, an interdisciplinary data infrastructure for population research
2. DESIDERIA: a flexible semantic infrastructure for digital exploratory text analysis
3. ADVANT: an advanced programme for video analyses
4. Health RI: a large-scale infrastructure for personalised medicine & health research
5. Bioscopy: a large-scale distributed infrastructure for studying the building blocks of life in living cells
6. MORP: a multifunctional research platform for oceanic research
7. Ruisdael Observatory: a facility for atmospheric research above the Netherlands
8. FEL-NL: a soft X-ray free-electron laser research infrastructure
9. 60 Tesla DC: a magnet system with a continuous field strength of 60 Tesla
10. Einstein Telescope: a gravitational wave observatory on Earth
11. LISA: a gravitational wave observatory in space
12. Radio 2025: a radio astronomy facility to study signals from the deep Universe with LOFAR 2.0
13. EPICS: an instrument on the European Large Telescope for studying planets beyond our solar system

This publication describes in layman's terms what these facilities entail and which research questions they can address. The more detailed proposals are presented on the Academy's website.

The committee found three of the proposals exceptionally interesting but of a different nature than the thirteen ultimately selected. They are included as 'honourable mentions'.

- Smart*Light: a tabletop synchrotron
- Netherlands Center for Neurotechnology
- Neurophotonics Institute

By and with researchers

The path leading to the end product was at least as important as the tangible end product, the thirteen facilities. In drafting its Agenda, the Academy worked in a bottom up process by involving numerous researchers. In the spring of 2015, the committee called on the entire Dutch research community to send in their ideas for 'dream' facilities. The response was significant and resulted in forty-eight brief descriptions of potential facilities across all areas of science. Of these, twenty-seven were ultimately selected as finalists. Because there were synergies between various proposals, the committee urged their teams to develop a joint proposal. The committee also organised meetings to facilitate this process. As a result, multidisciplinary, clustered proposals emerged in and even between various domains. To help the applicants take their proposals a step further, the Academy provided them with a budget, for example to examine the feasibility – technical or otherwise – of their ideas. This resulted in eighteen detailed proposals. The committee, aided by experts at the Academy and The Young Academy, judged thirteen of these to be compatible with the concept of the Academy Agenda. The committee wishes to emphasise that the Agenda is not meant to be static, and that new ideas will emerge in the years ahead.

The committee also made five recommendations of a more general nature.

RECOMMENDATION 1

A large-scale research facility differs from a research programme or research institute on a number of essential points. The committee advises those developing proposals to consider the nature of their proposal carefully and then to articulate that nature in explicit terms. It may be helpful to refer to the list of characteristics of each type of instrument that the Academy has included in this report.

RECOMMENDATION 2

Many large-scale research facilities store and process large quantities of data. That requires specialist, cutting-edge knowledge of informatics. In the first phase of this procedure, some of the consortia had little or no expertise in this area. The committee recommends that proposers include informatics experts in the development team in the subsequent phases.

RECOMMENDATION 3

It takes many years of R&D to turn ideas for large-sale research facilities into complete and mature proposals. The budget necessary to do so amounts to approximately 5% of the actual cost of construction. There are almost no sources of funding available for this R&D at either the national or the European level. This lack of funding impedes the development of such facilities. The committee advises the government to create a funding instrument to support this early stage of development, based on a peer review model.

RECOMMENDATION 4

Large-scale research facilities are extremely expensive. Most facilities require a long-term investment that only an international alliance can make possible in many cases. NWO's current budget for large-scale research facilities is too small to achieve even a small part of such dreams. In view of the growing importance of large-scale facilities in the national and global research landscape, the committee advises the government to raise the budget for such facilities considerably.

RECOMMENDATION 5

Given the scale of investment required, it will be necessary to choose which facilities are needed most and, possibly, in which order. In the years ahead, researchers must prioritise the necessary facilities in each field. This prioritisation should be a permanent component of the sector plans and strategic agendas drawn up in the various fields and by the various institutions.